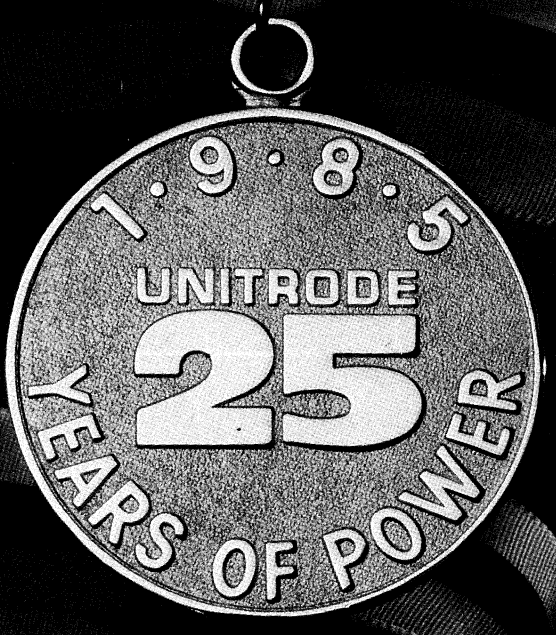
Semiconductor Databook 1985-86



UNITRODE

PART NUMBER INDEX	1
LINEAR INTEGRATED CIRCUITS	2
POWER MOSFETS, POWER TRANSISTORS & DARLINGTONS	3
POWER HYBRIDS	4
RECTIFIERS & RECTIFIER ASSEMBLIES	5
POWER ZENERS & TRANSIENT VOLTAGE SUPPRESSORS	6
THYRISTORS (SCRs, PUTs)	7
SWITCHING & GENERAL PURPOSE DIODES	8
PIN DIODES	9
SENSISTORS®	10
MONOLITHIC CERAMIC CAPACITORS	11
HI-REL SCREENING	12
SALES OFFICES	13

©Copyright 1985 Unitrode Corporation, Lexington, MA. All rights reserved.

Unitrode Corporation makes no representation that the use or interconnection of the circuits described herein will not infringe on existing or future patent rights, nor do the descriptions contained herein imply the granting of licenses to make, use or sell equipment constructed in accordance therewith.

©1985, by Unitrode Corporation. All rights reserved. This book, or any part or parts thereof, must not be reproduced in any form without permission of the copyright owner.

NOTE: The information presented in this section is believed to be accurate and reliable. However, no responsibility is assumed by Unitrode Corporation for its use.

Doorbell®, Sensistor®, and Magnum® are registered trademarks of Unitrode Corporation

BISYN™ is a trademark of Unitrode Corporation

MULTIWATT® is a registered trademark of SGS Corporation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

INTRODUCTION

Unitrode is known today, throughout the world, as a leader in the design, manufacture and marketing of electronic components, assemblies and subsystems. From its inception, over twenty-five years ago, Unitrode has earned and maintained a reputation for setting the highest standards of reliability and performance. The Company's reputation was first established with the unique "fused-in-glass" packaging concept for axial leaded rectifiers and zeners for the military market. This package is still unsurpassed in its reliability and performance.

Unitrode's products are designed to meet the critical needs of many markets including:

- Data Processing
- Military/Aerospace
- Communications
- Industrial Controls
- Instrumentation

Today, Unitrode offers a broad line of high quality, high performance, high reliability electronic components for an ever-increasing range of applications, particularly applications in power management and control. Included in our product offering are:

- Linear Integrated Circuits
- Power Hybrid Circuits
- Power MOSFETs
- Power Transistors and Darlingtons
- Power Rectifiers
- Rectifier Assemblies
- Transient Voltage Suppressors and Power Zeners
- Thyristors
- PIN Diodes
- Switching and General Purpose Signal Diodes
- Monolithic Ceramic Capacitors (Axial & Radial Leaded and Chip Capacitors)

Unitrode is also a leading manufacturer of data acquisition and conversion products through our Micro Networks Division in Worcester, MA and a leading manufacturer of multiple output switching power supplies, DC-DC converters and miniaturized power supply modules through our Power General and Powercube subsidiaries, located in Canton and Billerica, MA respectively. In addition, our US Microtek Components subsidiary is a manufacturer of monolithic ceramic capacitors and miniature (EMI) filters for military, aerospace and industrial applications.

This Databook contains a broad line of discrete semiconductors, linear integrated circuits and capacitors for a wide range of applications, particularly those in power management and control.

We take pride in our products. We have the products you require to add more value to your company's products.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

TABLE OF CONTENTS

Section Page

1 PART NUMBER INDEX 1-3

2 LINEAR INTEGRATED CIRCUITS
- Pulse Width Modulators - Product Selection Guide 2-3
- Power Supply Support Functions - Product Selection Guide 2-4
- Voltage Regulators - Product Selection Guide 2-5
- Motor Control Circuits - Product Selection Guide 2-6
- General Ordering Information/Screening Procedures 2-7
- Process Flow Chart 2-8
- Data Sheets 2-9

3 POWER MOSFETS, POWER TRANSISTORS & DARLINGTONS
- N-Channel Power MOSFETs - Product Selection Guide 3-3
- NPN Bipolar Power Switching Transistors - Product Selection Guide 3-6
- Power Darlingtons - Product Selection Guide 3-10
- Data Sheets 3-11

4 POWER HYBRIDS & MODULES
- Product Selection Guide 4-3
- Data Sheets 4-4

5 RECTIFIERS & RECTIFIER ASSEMBLIES
- Schottky Rectifiers - Product Selection Guide 5-3
- Ultra-Fast Recovery Rectifiers - Product Selection Guide 5-4
- Super-Fast Recovery Rectifiers - Product Selection Guide 5-6
- Fast Recovery Rectifiers - Product Selection Guide 5-7
- Standard Recovery Rectifiers - Product Selection Guide 5-8
- High Voltage Rectifiers & Rectifier Modules - Product Selection Guide 5-9
- Rectifier Bridges - Product Selection Guide 5-15
- Data Sheets 5-18

6 POWER ZENERS & TRANSIENT VOLTAGE SUPPRESSORS
- Transient Voltage Suppressors - Product Selection Guide 6-3
- Bi-Directional Zeners - Product Selection Guide 6-5
- Power Zeners - Product Selection Guide 6-6
- Data Sheets 6-8

7 THYRISTORS (SCRs & PUTs)
- Product Selection Guide 7-3
- Data Sheets 7-5

8 SWITCHING & GENERAL PURPOSE DIODES
- Product Selection Guide 8-3
- Data Sheets 8-4

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Section Page

9 PIN DIODES
Product Selection Guide 9-3
Data Sheets 9-6

10 SENSISTORS®
Product Selection Guide 10-3
Data Sheets 10-4

11 MONOLITHIC CERAMIC CAPACITORS (Axial & Radial Leaded and Chip Capacitors)
Data Sheets 11-3

12 HI-REL SCREENING 12-1

13 SALES OFFICES 13-1

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PART NUMBER INDEX 1

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PAGE	PART NUMBER	DESCRIPTION
		GENERAL PURPOSE DIODE
8-4	1N251, J	75mA; 40V; DO-7
8-5	1N456	90mA; 25V
*	1N456A	75mA; 60V
8-5	1N457, J	55mA; 125V; DO-7
*	1N457A	40mA; 175V
8-5	1N458, J	55mA; 150V; DO-7
*	1N458A	100mA; 150V
8-5	1N459, J	40mA; 200V; DO-7
*	1N459A	100mA; 200V
*	1N483	100mA; 70V
*	1N483A	100mA; 70V
8-6	1N483B, J, JTX	200mA; 80V; DO-7
*	1N483C	100mA; 70V
*	1N485	100mA; 180V
8-6	1N485B, J, JTX	200mA; 200V; DO-7
		SWITCHING DIODE
8-8	1N643, J	40mA; 200V; DO-7
		RECTIFIER
8-10	1N645J, JTX	400mA; 270V
8-10	1N645-1J, JTX, JTXV	400mA; 270V
8-10	1N647, J, JTX	400mA; 480V
8-10	1N647-1, J, JTX, JTXV	400mA; 480V
		SWITCHING DIODE
8-8	1N662, J	40mA; 100V; DO-7
8-8	1N663, J	60mA; 100V; DO-7
8-12	1N914, J, JTX	75mA; 100V
*	1N914-1, A, B	75mA; 100V
*	1N916, B	75mA; 100V
8-14	1N3064J, JTX	75mA; 75V; DO-7
8-15	1N3070, J, JTX, JTXV	150mA; 200V; DO-35
		GENERAL PURPOSE DIODE
8-16	1N3595, J, JTX, JTXV	150mA; 150V; DO-7
		SWITCHING DIODE
8-17	1N3600, J, JTX, JTXV	200mA; 75V; DO-7
		RECTIFIER
5-49	1N3611, J, JTX	1.0A; 200V
5-49	1N3612, J, JTX	1.0A; 400V
5-49	1N3613, J, JTX	1.0A; 600V
5-49	1N3614, J, JTX	1.0A; 800A
5-92	1N3643 (HVE10)	1.0kV
5-92	1N3644 (HVE15)	1.5kV
5-92	1N3645 (HVE20)	2.0kV
5-92	1N3646 (HVE25)	2.5kV
5-92	1N3647 (HVE30)	3.0kV
*	1N3656	0.75A; 200V
*	1N3657	0.75A; 400V
*	1N3658	0.75A; 600V
*	1N3957	1.0A; 1000V
*	1N3981	2.0A; 200V
*	1N3982	2.0A; 400V
*	1N3983	1.0A; 600V
		ZENER
6-29	1N4096-1N4098	3.0W; 5%
		SWITCHING DIODE
8-12	1N4148, J, JTX, JTXV	200mA; 100V; DO-35
8-12	1N4148-1J, JTX, JTXV	150mA; 100V; DO-35
8-19	1N4149	200mA; 75V; DO-35
8-17	1N4150, J, JTX, JTXV	200mA; 75V; DO-35
8-17	1N4150-1J, JTX, JTXV	200mA; 75V; DO-35
8-19	1N4151	200mA; 75V; DO-35
8-20	1N4152	200mA; 40V; DO-35
8-21	1N4153, J, JTX, JTXV	150mA; 75V; DO-35

PAGE	PART NUMBER	DESCRIPTION
		SWITCHING DIODE
*	1N4153-1J, JTX, JTXV	150mA; 75V; DO-35
8-19	1N4154	200mA; 35V; DO-35
		RECTIFIER
5-51	1N4245, J, JTX, JTXV	1.0A; 200V
5-51	1N4246, J, JTX, JTXV	1.0A; 400V
5-51	1N4247, J, JTX, JTXV	1.0A; 600V
5-51	1N4248, J, JTX, JTXV	1.0A; 800V
5-51	1N4249, J, JTX, JTXV	1.0A; 1000V
		SWITCHING DIODE
8-20	1N4305	200mA; 75V; DO-35
8-20	1N4444	200mA; 70V; DO-35
8-19	1N4446	200mA; 75V; DO-35
8-19	1N4447	200mA; 75V; DO-35
8-19	1N4448	200mA; 75V; DO-35
8-19	1N4449	200mA; 75V; DO-35
8-23	1N4450	200mA; 40V; DO-35
8-23	1N4451	200mA; 40V; DO-35
8-24	1N4452	400mA; 40V; DO-35
8-23	1N4453	200mA; 30V; DO-35
8-14	1N4454, J, JTX, JTXV	200mA; 75V; DO-35
8-14	1N4454-1, J, JTX, JTXV	200mA; 75V; DO-35
		ZENER
6-8	1N4461-1N4496, J, JTX, JTXV	1.5W; 5%
		SWITCHING DIODE
8-25	1N4500, J, JTX	300mA; 80V; DO-35
8-12	1N4531, J, JTX, JTXV	125mA; 100V; DO-34
8-14	1N4532, J, JTX, JTXV	125mA; 75V; DO-34
8-21	1N4534, J, JTX, JTXV	150mA; 75V; DO-34
8-24	1N4607	400mA; 85V; DO-35
8-24	1N4608	500mA; 85V; DO-35
		ZENER
6-29	1N4883-1N4884	3.0W; 5%
		SWITCHING DIODE
8-15	1N4938, J, JTX	150mA; 200V; DO-7
		RECTIFIER
5-53	1N4942, J, JTX, JTXV	1.0A; 200V
5-53	1N4944, J, JTX, JTXV	1.0A; 400V
5-53	1N4946, J, JTX, JTXV	1.0A; 600V
		ZENER
6-10	1N4954-1N4995, J, JTX, JTXV	5.0W; 5%
6-10	1N4996	5.0W; 5%
6-29	1N5063-1N5117	3.0W; 5%
6-33	1N5118-1N5134	5.0W; 5%
		RECTIFIER
*	1N5180	4.0A; 100V
5-92	1N5181 (HVE40)	4.0kV
5-92	1N5182 (HVE50)	5.0kV
5-92	1N5183 (HVE75)	7.5kV
5-92	1N5184 (HVE100)	10.0kV
*	1N5185	3.0A; 60V
5-55	1N5186, J, JTX	3.0A; 100V
5-55	1N5187, J, JTX	3.0A; 200V
5-55	1N5188, J, JTX	3.0A; 400V
5-55	1N5190, J, JTX	3.0A; 600V
*	1N5207	4.0A; 400V
*	1N5320	1.0A; 120V
*	1N5330	0.5A; 1500V
5-57	1N5415, J, JTX, JTXV	3.0A; 50V
5-57	1N5416, J, JTX, JTXV	3.0A; 100V
5-57	1N5417, J, JTX, JTXV	3.0A; 200V

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

PART NUMBER INDEX

PAGE	PART NUMBER	DESCRIPTION
		RECTIFIER
5-57	1N5418, J, JTX, JTXV	3.0A; 400V
5-57	1N5419, J, JTX, JTXV	3.0A; 500V
5-57	1N5420, J, JTX, JTXV	3.0A; 600V
*	1N5433	2.0A; 700V
*	1N5434	2.0A; 700V
*	1N5435	12.0A; 700V
5-59	1N5550, J, JTX, JTXV	5.0A; 200V
5-59	1N5551, J, JTX, JTXV	5.0A; 400V
5-59	1N5552, J, JTX, JTXV	5.0A; 600V
5-59	1N5553, J, JTX, JTXV	5.0A; 800V
		RECTIFIER MODULE
5-61	1N5597, J	10kV
5-61	1N5600, J	5.0kV
5-61	1N5603, J	5.0kV
		TRANSIENT VOLTAGE SUPPRESSOR
6-12	1N5610, J, JTX	33V
6-12	1N5611, J, JTX	43.7V
6-12	1N5612, J, JTX	54V
6-12	1N5613, J, JTX	191V
		RECTIFIER
5-64	1N5614, J, JTX, JTXV	1.0A; 200V
5-66	1N5615, J, JTX, JTXV	1.0A; 200V
5-64	1N5616, J, JTX, JTXV	1.0A; 400V
5-66	1N5617, J, JTX, JTXV	1.0A; 400V
5-64	1N5618, J, JTX, JTXV	1.0A; 600V
5-66	1N5619, J, JTX, JTXV	1.0A; 600V
5-64	1N5620, J, JTX, JTXV	1.0A; 800V
		PIN DIODE
9-10	1N5767	General Purpose, PIN
		RECTIFIER
5-68	1N5802	2.5A; 50V
5-72	1N5802, J, JTX, JTXV	2.5A; 50V
5-68	1N5803	2.5A; 75V
5-68	1N5804	2.5A; 100V
5-72	1N5804, J, JTX, JTXV	2.5A; 100V
5-68	1N5805	2.5A; 125V
5-68	1N5806	2.5A; 150V
5-72	1N5806, J, JTX, JTXV	2.5A; 150V
5-68	1N5807	6.0A; 50V
5-72	1N5807, J, JTX, JTXV	6.0A; 50V
5-68	1N5808	6.0A; 75V
5-68	1N5809	6.0A; 100V
5-72	1N5809, J, JTX, JTXV	6.0A; 100V
5-68	1N5810	6.0A; 125V
5-68	1N5811	6.0A; 150V
5-72	1N5811, J, JTX, JTXV	6.0A; 150V
5-68	1N5812	20.0A; 50V; DO-4
5-75	1N5812, J, JTX, JTXV	20.0A; 50V; DO-4
5-68	1N5813	20.0A; 75V; DO-4
5-68	1N5814	20.0A; 100V; DO-4
5-75	1N5814, J, JTX, JTXV	20.0A; 100V; DO-4
5-68	1N5815	20.0A; 125V; DO-4
5-68	1N5816	20.0A; 150V; DO-4
5-75	1N5816, J, JTX, JTXV	20.0A; 150V; DO-4
		SCHOTTKY RECTIFIER
5-77	1N5817	1.0A; 20V; Sim. to DO-41
5-77	1N5818	1.0A; 30V; Sim. to DO-41
5-77	1N5819	1.0A; 40V; Sim. to DO-41
5-79	1N5820	3.0A; 20V; Sim. to DO-201AD
5-79	1N5821	3.0A; 30V; Sim. to DO-201AD
5-79	1N5822	3.0A; 40V; Sim. to DO-201AD
		PIN DIODE
9-10	1N5957	Low Distortion, AGC Diode

PAGE	PART NUMBER	DESCRIPTION
		ZENER
6-10	1N5968	5.0W; 5%
6-10	1N5969	5.0W; 5%
		SCHOTTKY RECTIFIER
5-81	1N6097	50A; 30V; DO-5
5-81	1N6098	50A; 40V; DO-5
		RECTIFIER
5-83	1N6304, J, JTX, JTXV	70A; 50V; DO-5
5-83	1N6305, J, JTX, JTXV	70A; 100V; DO-5
5-83	1N6306, J, JTX, JTXV	70A;150V; DO-5
		SCHOTTKY RECTIFIER
5-86	1N6391, J, JTX, JTXV	25A; 45V; DO-4
5-88	1N6392, J, JTX, JTXV	60A; 45V; DO-5
		TRANSIENT VOLTAGE SUPPRESSOR
6-14	1N6461, J, JTX, JTXV	5.0V
6-14	1N6462, J, JTX, JTXV	6.0V
6-14	1N6463, J, JTX, JTXV	12.0V
6-14	1N6464, J, JTX, JTXV	15.0V
6-14	1N6465, J, JTX, JTXV	24.0V
6-14	1N6466, J, JTX, JTXV	30.5V
6-14	1N6467, J, JTX, JTXV	40.3V
6-14	1N6468, J, JTX, JTXV	51.6V
		SCR
*	2N876	.35A@100°C 15V; TO-18
*	2N877	.35A@100°C 30V; TO-18
*	2N878	.35A@100°C 60V; TO-18
*	2N879	.35A@100°C 100V; TO-18
*	2N880	.35A@100°C 150V; TO-18
*	2N881	.35A@100°C 200V; TO-18
*	2N882	.35A@100°C 300V; TO-18
*	2N883	.35A@100°C 400V; TO-18
*	2N884	.35A@100°C 15V; TO-18
*	2N885	.35A@100°C 30V; TO-18
*	2N886	.35A@100°C 60V; TO-18
*	2N887	.35A@100°C 100V; TO-18
*	2N888	.35A@100°C 150V; TO-18
*	2N889	.35A@100°C 200V; TO-18
*	2N890	.35A@100°C 300V; TO-18
*	2N891	.35A@100°C 400V; TO-18
*	2N948	.26A@125°C 30V; TO-18
*	2N949	.26A@125°C 60V; TO-18
*	2N950	.26A@125°C 100V; TO-18
*	2N951	.26A@125°C 200V; TO-18
*	2N1595	1.0A@80°C 50V; TO-39
*	2N1596	1.0A@80°C 100V; TO-39
*	2N1597	1.0A@80°C 200V; TO-39
*	2N1598	1.0A@80°C 300V; TO-39
*	2N1599	1.0A@80°C 400V; TO-39
		POWER TRANSISTOR
*	2N1647	NPN; 3.0A; 60V; TO-59
*	2N1648	NPN; 3.0A; 80V; TO-59
*	2N1649	NPN; 3.0A; 60V; TO-59
*	2N1650	NPN; 3.0A; 80V; TO-59
*	2N1714	NPN; 0.75A; 60V; TO-5
*	2N1715	NPN; 0.75A; 100V; TO-5
*	2N1716	NPN; 0.75A; 60V; TO-5
*	2N1717	NPN; 0.75A; 100V; TO-5
*	2N1718	NPN; 0.75A; 60V; TO-5; Stud Mount
*	2N1719	NPN; 0.75A; 100V; TO-5; Stud Mount
*	2N1720	NPN; 0.75A; 60V; TO-5; Stud Mount
*	2N1721	NPN; 0.75A; 100V; TO-5; Stud Mount

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PAGE	PART NUMBER	DESCRIPTION
		SCR
*	2N1869	1.25A@100°C 15V; TO-9
7-5	2N1870A, J	1.25A@100°C 30V; TO-9
7-5	2N1871A, J	1.25A@100°C 60V; TO-9
7-5	2N1872A, J	1.25A@100°C 100V; TO-9
7-5	2N1873A	1.25A@100°C 150V; TO-9
7-5	2N1874A, J	1.25A@100°C 200V; TO-9
		POWER TRANSISTOR
*	2N1886	NPN; 3.0A; TO-59
		SCR
*	2N2009	1.3A@80°C 25V; TO-39
*	2N2010	1.3A@80°C 50V; TO-39
*	2N2011	1.3A@80°C 100V; TO-39
*	2N2012	1.3A@80°C 200V; TO-39
*	2N2013	1.3A@80°C 300V; TO-39
*	2N2014	1.3A@80°C 400V; TO-39
		POWER TRANSISTOR
*	2N2150	NPN; 2.0A; 80V; TO-59
3-11	2N2151 J, JTX	NPN; 2.0A; 80V; TO-59
		SCR
7-9	2N2322	1.6A@85°C 25V; TO-39
7-9	2N2323	1.6A@85°C 50V; TO-39
7-9	2N2323, SJ, SJTX, SJTXV	1.6A@85°C 50V; TO-39
7-9	2N2323A, SJ, SJTX, SJTXV	1.6A@85°C 50V; TO-39
7-9	2N2324, SJ, SJTX, SJTXV	1.6A@85°C 100V; TO-39
7-9	2N2324A, SJ, SJTX, SJTXV	1.6A@85°C 100V; TO-39
7-9	2N2325	1.6A@85°C 150V; TO-39
7-9	2N2325A	1.6A@85°C 150V; TO-39
7-9	2N2326, SJ, SJTX, SJTXV	1.6A@85°C 200V; TO-39
7-9	2N2326A, SJ, SJTX, SJTXV	1.6A@85°C 200V; TO-39
7-9	2N2327	1.6A@85°C 250V; TO-39
7-9	2N2327A	1.6A@85°C 250V; TO-39
7-9	2N2328, SJ, SJTX, SJTXV	1.6A@85°C 300V; TO-39
7-9	2N2328A, SJ, SJTX, SJTXV	1.6A@85°C 300V; TO-39
7-9	2N2329, SJ, SJTX, SJTXV	1.6A@85°C 400V; TO-39
*	2N2344	1.6A@55°C 25V; TO-39
*	2N2345	1.6A@55°C 50V; TO-39
*	2N2346	1.6A@55°C 100V; TO-39
*	2N2347	1.6A@55°C 150V; TO-39
*	2N2348	1.6A@55°C 200V; TO-39
		POWER TRANSISTOR
*	2N2657	NPN; 5.0A; 60V; TO-5
*	2N2658	NPN; 5.0A; 80V; TO-5
		SCR
*	2N2679	.35A@55°C 30V; TO-18
*	2N2680	.35A@55°C 60V; TO-18
*	2N2681	.35A@55°C 100V; TO-18
*	2N2682	.35A@55°C 200V; TO-18
*	2N2683	.28A@55°C 30V; TO-18
*	2N2684	.28A@55°C 60V; TO-18
*	2N2685	.28A@55°C 100V; TO-18
*	2N2686	.28A@55°C 200V; TO-18
*	2N2687	.28A@55°C 30V; TO-18
*	2N2688	.28A@55°C 60V; TO-18
*	2N2689	.28A@55°C 100V; TO-18
*	2N2690	.28A@55°C 200V; TO-18

PAGE	PART NUMBER	DESCRIPTION
		POWER TRANSISTOR
*	2N2828	NPN; 3A; 60V; TO-59
*	2N2829	NPN; 3A; 60V; TO-59
*	2N2858	NPN; 3A; 80V; TO-5
*	2N2859	NPN; 3A; 100V; TO-5
*	2N2877, 2N2878	NPN; 5A; 80V; TO-59
*	2N2879	NPN; 5A; 100V; TO-59
3-15	2N2880, J, JTX, JTXV	NPN; 5A; 80V; TO-59
*	2N2890, 2N2891	NPN; 5A; 80V; TO-5
*	2N2892, 2N2893	NPN; 5A; 80V; TO-59
*	2N2983	NPN; 3A; 80V; TO-5
*	2N2984	NPN; 3A; 120V; TO-5
*	2N2985	NPN; 3A; 80V; TO-5
*	2N2986	NPN; 3A; 120V; TO-5
*	2N2987	NPN; 1A; 80V; TO-5
*	2N2988	NPN; 1A; 100V; TO-5
*	2N2989	NPN; 1A; 80V; TO-5
*	2N2990	NPN; 1A; 100V; TO-5
*	2N2991	NPN; 1A; 80V; TO-5 Stud
*	2N2992	NPN; 1A; 100V; TO-5 Stud
*	2N2993	NPN; 1A; 80V; TO-5 Stud
*	2N2994, 2N2995	NPN; 1A; 100V; TO-5 Stud
		SCR
*	2N3001	.25A@55°C 30V; TO-18
*	2N3002	.25A@55°C 60V; TO-18
*	2N3003	.25A@55°C 100V; TO-18
*	2N3004	.25A@55°C 200V; TO-18
*	2N3005	.25A@55°C 30V; TO-18
*	2N3006	.25A@55°C 60V; TO-18
*	2N3007	.25A@55°C 100V; TO-18
*	2N3008	.25A@55°C 200V; TO-18
7-12	2N3027, J, JTX	500mA@100°C 30V; TO-18
7-12	2N3028, J, JTX	500mA@100°C 60V; TO-18
7-12	2N3029, J, JTX	500mA@100°C 100V; TO-18
7-12	2N3030, J, JTX	.5A@100°C 30V; TO-18
7-12	2N3031, J, JTX	.5A@100°C 60V; TO-18
7-12	2N3032, J, JTX	.5A@100°C 100V; TO-18
*	2N3273	2.2A@85°C 100V; TO-39
*	2N3274	2.2A@85°C 200V; TO-39
*	2N3275	2.2A@85°C 300V; TO-39
*	2N3276	2.2A@85°C 400V; TO-39
		POWER TRANSISTOR
3-19	2N3418, J, JTX, JTXV	NPN; 3.0A; 60V; TO-5
3-19	2N3419, J, JTX, JTXV	NPN; 3.0A; 80V; TO-5
3-19	2N3420, J, JTX, JTXV	NPN; 3.0A; 60V; TO-5
3-19	2N3421, J, JTX, JTXV	NPN; 3.0A; 80V; TO-5
*	2N3445	NPN; 7.5A; 60V; TO-3
*	2N3446	NPN; 7.5A; 80V; TO-3
*	2N3447	NPN; 7.5A; 60V; TO-3
*	2N3448	NPN; 7.5A; 80V; TO-3
*	2N3469	NPN; 5.0A; 25V; TO-5
		SCR
*	2N3555	1.6A; 30V; TO-39
*	2N3556	1.6A; 60V; TO-39
*	2N3557	1.6A; 100V; TO-39
*	2N3558	1.6A; 200V; TO-39
*	2N3559	1.6A; 30V; TO-39
*	2N3560	1.6A; 60V; TO-39
*	2N3561	1.6A; 100V; TO-39
*	2N3562	1.6A; 200V; TO-39
		POWER TRANSISTOR
*	2N3744	NPN; 5.0A; 40V; TO-111
*	2N3745	NPN; 5.0A; 60V; TO-111
*	2N3746	NPN; 5.0A; 80V; TO-111
*	2N3747	NPN; 5.0A; 40V; TO-111
*	2N3748	NPN; 5.0A; 60V; TO-111

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PART NUMBER INDEX

PAGE	PART NUMBER	DESCRIPTION
		POWER TRANSISTOR
3-15	2N3749, J, JTX, JTXV	NPN; 5.0A; 80V; TO-111
*	2N3750	NPN; 5.0A; 40V; TO-111
*	2N3751	NPN; 5.0A; 60V; TO-111
*	2N3752	NPN; 5.0A; 80V; TO-111
*	2N3850	NPN; 5.0A; 80V; TO-59
*	2N3851	NPN; 5.0A; 80V; TO-59
*	2N3852	NPN; 5.0A; 40V; TO-59
*	2N3853	NPN; 5.0A; 40V; TO-59
3-23	2N3996, J, JTX, JTXV	NPN; 5.0A; 80V; TO-111
3-23	2N3997, J, JTX, JTXV	NPN; 5.0A; 80V; TO-111
3-23	2N3998, J, JTX, JTXV	NPN; 5.0A; 80V; TO-59
3-23	2N3999, J, JTX, JTXV	NPN; 5.0A; 80V; TO-59
*	2N4000	NPN; 1.0A; 80V; TO-5
*	2N4001	NPN; 1.0A; 100V; TO-5
*	2N4070	NPN; 10.0A; 100V; TO-3
*	2N4075	NPN; 3.0A; 80V; TO-111
*	2N4076	NPN; 3.0A; 80V; TO-111
		SCR
*	2N4108	180mA@25°C 50V; TO-18
*	2N4109	180mA@25°C 100V; TO-18
*	2N4110	180mA@25°C 200V; TO-18
*	2N4144	250mA@75°C 15V; TO-18
*	2N4145	250mA@75°C 30V; TO-18
*	2N4146	250mA@75°C 60V; TO-18
*	2N4147	250mA@75°C 100V; TO-18
*	2N4148	250mA@75°C 150V; TO-18
*	2N4149	250mA@75°C 200V; TO-18
		POWER TRANSISTOR
3-27	2N4150, J, JTX, JTXV	NPN; 10.0A; 70V; TO-5
		SCR
*	2N4212	1.0A@85°C 25V; TO-39
*	2N4213	1.0A@85°C 50V; TO-39
*	2N4214	1.0A@85°C 100V; TO-39
*	2N4215	1.0A@85°C 150V; TO-39
*	2N4216	1.0A@85°C 200V; TO-39
*	2N4217	1.0A@85°C 250V; TO-39
*	2N4218	1.0A@85°C 300V; TO-39
*	2N4219	1.0A@85°C 400V; TO-39
		POWER TRANSISTOR
*	2N4237-2N4239	NPN; 1.0A
*	2N4300	NPN; 2.0A
3-31	2N5038, J, JTX, JTXV	NPN; 20.0A; 150V; TO-3
3-31	2N5039, J, JTX, JTXV	NPN; 20.0A; 120V; TO-3
*	2N5074-2N5075	NPN; 3A; 200V; TO-59
*	2N5076-2N5077	NPN; 3A; 250V; TO-59
*	2N5334	NPN; 3A; 60V; TO-39
*	2N5335	NPN; 3A; 80V; TO-39
*	2N5336-2N5337	NPN; 5A; 80V; TO-39
*	2N5338-2N5339	NPN; 5A; 100V; TO-39
*	2N5346-2N5347	NPN; 7A; 80V; TO-59
*	2N5348-2N5349	NPN; 7A; 100V; TO-59
*	2N5477-2N5478	NPN; 7A; 80V; TO-59
*	2N5479-2N5480	NPN; 7A; 100V; TO-59
3-35	2N5660, J, JTX, JTXV	NPN; 3A; 200V; TO-66
3-35	2N5661, J, JTX, JTXV	NPN; 3A; 300V; TO-66
3-35	2N5662, J, JTX, JTXV	NPN; 3A; 200V; TO-5
3-35	2N5663, J, JTX, JTXV	NPN; 3A; 300V; TO-5
3-40	2N5664, J, JTX, JTXV	NPN; 5A; 200V; TO-66
3-40	2N5665, J, JTX, JTXV	NPN; 5A; 300V; TO-66
3-40	2N5666, J, JTX, JTXV	NPN; 5A; 200V; TO-5
3-40	2N5667, J, JTX, JTXV	NPN; 5A; 300V; TO-5
		SCR
7-18	2N5724	1.6A@85°C 60V; TO-39
7-18	2N5725	1.6A@85°C 100V; TO-39
7-18	2N5726	1.6A@85°C 200V; TO-39
7-18	2N5727	1.6A@85°C 300V; TO-39
7-18	2N5728	1.6A@85°C 400V; TO-39
		POWER TRANSISTOR
*	2N6077	NPN; 7A; 300V; TO-66
*	2N6078	NPN; 7A; 275V; TO-66
		PUT
7-22	2N6119	400mW@25°C 40V; TO-18
7-22	2N6120	400mW@25°C 40V; TO-18
7-26	2N6137	300mW@25°C 40V; TO-18
		POWER TRANSISTOR
*	2N6233	NPN; 5A; 225V; TO-66
*	2N6234	NPN; 5A; 275V; TO-66
*	2N6235	NPN; 5A; 325V; TO-66
3-45	2N6306, J, JTX, JTXV	NPN; 8.0A; 500V; TO-3
3-45	2N6307	NPN; 8.0A; 600V; TO-3
3-45	2N6308, J, JTX, JTXV	NPN; 8.0A; 700V; TO-3
		SCR
*	2N6332	2.0A@80°C 30V; TO-39
*	2N6333	2.0A@80°C 50V; TO-39
*	2N6334	2.0A@80°C 100V; TO-39
*	2N6335	2.0A@80°C 200V; TO-39
*	2N6336	2.0A@80°C 300V; TO-39
*	2N6337	2.0A@80°C 400V; TO-39
		POWER DARLINGTON
3-49	2N6350, J, JTX, JTXV	NPN; 10.0A; 80V; TO-33
3-49	2N6351, J, JTX, JTXV	NPN; 10.0A; 150V; TO-33
3-49	2N6352, J, JTX, JTXV	NPN; 10.0A; 80V; TO-66
3-49	2N6353, J, JTX, JTXV	NPN; 10.0A; 150V; TO-66
		POWER TRANSISTOR
3-53	2N6354	NPN; 10.0A; 150V; TO-3
3-53	2N6496	NPN; 15.0A; 150V; TO-3
3-57	2N6542	NPN; 5A; 650V; TO-3
3-57	2N6543	NPN; 5A; 850V; TO-3
3-62	2N6544	NPN; 8.0A; 650V; TO-3
3-62	2N6545	NPN; 8.0A; 850V; TO-3
3-67	2N6546, J, JTX, JTXV	NPN; 15A; 650V; TO-3
3-67	2N6547, J, JTX, JTXV	NPN; 15A; 850V; TO-3
*	2N6579	NPN; 10A; 350V; TO-3
*	2N6580	NPN; 10A; 400V; TO-3
*	2N6581	NPN; 10A; 450V; TO-3
*	2N6582	NPN; 10A; 350V; TO-3
*	2N6583	NPN; 10A; 400V; TO-3
*	2N6584	NPN; 10A; 450V; TO-3
3-71	2N6671	NPN; 8A; 450V; TO-3
3-71	2N6672	NPN; 8A; 550V; TO-3
3-71	2N6673	NPN; 8A; 650V; TO-3
3-75	2N6674	NPN; 10A; 450V; TO-3
3-75	2N6675	NPN; 10A; 650V; TO-3
3-79	2N6676	NPN; 15A; 450V; TO-3
3-79	2N6677	NPN; 15A; 550V; TO-3
3-79	2N6678	NPN; 15A; 650V; TO-3
		POWER MOSFET TRANSISTOR
3-83	2N6755	12A; 60V; 0.25Ω; TO-3
3-83	2N6756, J, JTX, JTXV	14A; 100V; 0.18Ω; TO-3
3-87	2N6757	8A; 150V; 0.6Ω; TO-3
3-87	2N6758, J, JTX, JTXV	9A; 200V; 0.4Ω; TO-3
3-91	2N6759	4.5A; 350V; 1.5Ω; TO-3
3-91	2N6760, J, JTX, JTXV	5.5A; 400V; 1.0Ω; TO-3
3-95	2N6761	4A; 450V; 2.0Ω; TO-3
3-95	2N6762, J, JTX, JTXV	4.5A; 500V; 1.5Ω; TO-3
3-99	2N6763	31A; 60V; 0.08Ω; TO-3 (Modified)
3-99	2N6764, J, JTX, JTXV	38A; 100V; 0.055Ω; TO-3 (Modified)

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PAGE	PART NUMBER	DESCRIPTION
		POWER MOSFET TRANSISTOR
3-103	2N6765	25A; 150V; 0.120Ω; TO-3 (Modified)
3-103	2N6766, J, JTX, JTXV	30A; 200V; 0.085Ω; TO-3 (Modified)
3-107	2N6767	12A; 350V; 0.4Ω; TO-3
3-107	2N6768, J, JTX, JTXV	14A; 400V; 0.3Ω; TO-3
3-111	2N6769	11A; 450V; 0.5Ω; TO-3
3-111	2N6770, J, JTX, JTXV	12A; 500V; 0.4Ω; TO-3
3-115	2N6781	3.5A; 60V; 0.6Ω; TO-39
3-115	2N6782	3.5A; 100V; 0.6Ω; TO-39
3-121	2N6783	2.25A; 150V; 1.5Ω; TO-39
3-121	2N6784	2.25A; 200V; 1.5Ω; TO-39
3-127	2N6785	1.25A; 350V; 3.6Ω; TO-39
3-127	2N6786	1.25A; 400V; 3.6Ω; TO-39
3-133	2N6787	6.0A; 60V; 0.3Ω; TO-39
3-133	2N6788	6.0A; 100V; 0.3Ω; TO-39
3-139	2N6789	3.5A; 150V; 0.8Ω; TO-39
3-139	2N6790	3.5A; 200V; 0.8Ω; TO-39
3-145	2N6791	2.0A; 350V; 1.8Ω; TO-39
3-145	2N6792	2.0A; 400V; 1.8Ω; TO-39
3-151	2N6793	1.5A; 450V; 3.0Ω; TO-39
3-151	2N6794	1.5A; 500V; 3.0Ω; TO-39
3-157	2N6795	8.0A; 60V; .18Ω; TO-39
3-157	2N6796	8.0A; 100V; .18Ω; TO-39
3-163	2N6797	5.5A; 150V; 0.4Ω; TO-39
3-163	2N6798	5.5A; 200V; 0.4Ω; TO-39
3-169	2N6799	3.0A; 350V; 1.0Ω; TO-39
3-169	2N6800	3.0A; 400V; 1.0Ω; TO-39
3-175	2N6801	2.5A; 450V; 1.5Ω; TO-39
3-175	2N6802	2.5A; 500V; 1.5Ω; TO-39
		FULL WAVE BRIDGE
5-18	469-1, J, JTX	1 ph; 10A; 200V
5-18	469-2, J, JTX	1 ph; 10A; 400V
5-18	469-3, J, JTX	1 ph; 10A; 600V
5-20	483-1, JTX	3 ph; 25.0A; 200V
5-20	483-2, JTX	3 ph; 25.0A; 400V
5-20	483-3, JTX	3 ph; 25.0A; 600V
5-22	673-1	1 ph; 1.5A; 100V
5-22	673-2	1 ph; 1.5A; 200V
5-22	673-3	1 ph; 1.5A; 300V
5-22	673-4	1 ph; 1.5A; 400V
5-22	673-5	1 ph; 1.5A; 500V
5-22	673-6	1 ph; 1.5A; 600V
5-24	673-7	1 ph; 0.6A; 1200V
5-24	673-7.5	1 ph; 0.5A; 1800V
5-24	673-8	1 ph; 0.4A; 2400V
5-24	673-8.5	1 ph; 0.3A; 3000V
5-24	673-9	1 ph; 0.2A; 3600V
5-24	673-10	1 ph; .18A; 4200V
5-24	673-11	1 ph; .16A; 4800V
5-24	673-12	1 ph; .16A; 5000V
5-22	676-1	1 ph; 1.0A; 100V
5-22	676-2	1 ph; 1.0A; 200V
5-22	676-3	1 ph; 1.0A; 300V
5-22	676-4	1 ph; 1.0A; 400V
5-22	676-5	1 ph; 1.0A; 500V
5-22	676-6	1 ph; 1.0A; 600V
5-24	676-12	1 ph; 0.4A; 1200V
5-24	676-18	1 ph; .35A; 1800V
5-24	676-24	1 ph; .325A; 2400V
5-24	676-30	1 ph; .25A; 3000V
5-24	676-36	1 ph; .175A; 3600V
5-24	676-42	1 ph; .15A; 4200V
5-24	676-48	1 ph; .135A; 4800V
5-24	676-50	1 ph; .125A; 5000V
5-27	678-1	3 ph; 25A; 100V
5-27	678-2	3 ph; 25A; 200V
5-27	678-3	3 ph; 25A; 300V
5-27	678-4	3 ph; 25A; 400V
5-27	678-5	3 ph; 25A; 500V
5-27	678-6	3 ph; 25A; 600V
5-30	679-1	1 ph; 25A; 100V
5-30	679-2	1 ph; 25A; 200V
5-30	679-3	1 ph; 25A; 300V
5-30	679-4	1 ph; 25A; 400V
5-30	679-5	1 ph; 25A; 500V
5-30	679-6	1 ph; 25A; 600V
5-30	680-1	1 ph; 10A; 100V
5-30	680-2	1 ph; 10A; 200V
5-30	680-3	1 ph; 10A; 300V
5-30	680-4	1 ph; 10A; 400V
5-30	680-5	1 ph; 10A; 500V
5-30	680-6	1 ph; 10A; 600V
		DOUBLER OR CENTER-TAP
5-33	681-1	15A; 100V
5-33	681-2	15A; 200V
5-33	681-3	15A; 300V
5-33	681-4	15A; 400V
5-33	681-5	15A; 500V
5-33	681-6	15A; 600V
		FULL WAVE BRIDGE
5-27	682-1	3 ph; 20A; 100V
5-27	682-2	3 ph; 20A; 200V
5-27	682-3	3 ph; 20A; 300V
5-27	682-4	3 ph; 20A; 400V
5-27	682-5	3 ph; 20A; 500V
5-27	682-6	3 ph; 20A; 600V
5-30	683-1	1 ph; 20A; 100V
5-30	683-2	1 ph; 20A; 200V
5-30	683-3	1 ph; 20A; 300V
5-30	683-4	1 ph; 20A; 400V
5-30	683-5	1 ph; 20A; 500V
5-30	683-6	1 ph; 20A; 600V
5-30	684-1	1 ph; 10A; 100V
5-30	684-2	1 ph; 10A; 200V
5-30	684-3	1 ph; 10A; 300V
5-30	684-4	1 ph; 10A; 400V
5-30	684-5	1 ph; 10A; 500V
5-30	684-6	1 ph; 10A; 600V
		RECTIFIER MODULE
5-35	688-10	10kV
5-35	688-12	12kV
5-35	688-15	15kV
5-35	688-18	18kV
5-35	688-20	20kV
5-35	688-25	25kV
		DOUBLER OR CENTER-TAP
5-33	689-1	15A; 100V
5-33	689-2	15A; 200V
5-33	689-3	15A; 300V
5-33	689-4	15A; 400V
5-33	689-5	15A; 500V
5-33	689-6	15A; 600V
		FULL WAVE BRIDGE
5-27	695-1	3 ph; 15A; 100V
5-27	695-2	3 ph; 15A; 200V

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PART NUMBER INDEX

PAGE	PART NUMBER	DESCRIPTION
		FULL WAVE BRIDGE
5-27	695-3	3 ph; 15A; 300V
5-27	695-4	3 ph; 15A; 400V
5-27	695-5	3 ph; 15A; 500V
5-27	695-6	3 ph; 15A; 600V
5-27	696-1	3 ph; 15A; 100V
5-27	696-2	3 ph; 15A; 200V
5-27	696-3	3 ph; 15A; 300V
5-27	696-4	3 ph; 15A; 400V
5-27	696-5	3 ph; 15A; 500V
5-27	696-6	3 ph; 15A; 600V
5-37	697-1	1 ph; 2.5A; 100V
5-37	697-2	1 ph; 2.5A; 200V
5-37	697-3	1 ph; 2.5A; 300V
5-37	697-4	1 ph; 2.5A; 400V
5-37	697-5	1 ph; 2.5A; 500V
5-37	697-6	1 ph; 2.5A; 600V
5-37	698-1	1 ph; 2.25A; 100V
5-37	698-2	1 ph; 2.25A; 200V
5-37	698-3	1 ph; 2.25A; 300V
5-37	698-4	1 ph; 2.25A; 400V
5-37	698-5	1 ph; 2.25A; 500V
5-37	698-6	1 ph; 2.25A; 600V
5-39	700-1	3 ph; 2.5A; 100V
5-39	700-2	3 ph; 2.5A; 200V
5-39	700-3	3 ph; 2.5A; 300V
5-39	700-4	3 ph; 2.5A; 400V
5-39	700-5	3 ph; 2.5A; 500V
5-39	700-6	3 ph; 2.5A; 600V
5-39	701-1	3 ph; 2.25A; 100V
5-39	701-2	3 ph; 2.25A; 200V
5-39	701-3	3 ph; 2.25A; 300V
5-39	701-4	3 ph; 2.25A; 400V
5-39	701-5	3 ph; 2.25A; 500V
5-39	701-6	3 ph; 2.25A; 600V
5-41	800-1	3 ph; 40A; 50V
5-41	800-2	3 ph; 40A; 100V
5-41	800-3	3 ph; 40A; 125V
5-41	800-4	3 ph; 40A; 150V
5-41	801-1	3 ph; 20A; 50V
5-41	801-2	3 ph; 20A; 100V
5-41	801-3	3 ph; 20A; 125V
5-41	801-4	3 ph; 20A; 150V
5-44	802-1	1 ph; 35A; 50V
5-44	802-2	1 ph; 35A; 100V
5-44	802-3	1 ph; 35A; 125V
5-44	802-4	1 ph; 35A; 150V
5-44	803-1	1 ph; 20A; 50V
5-44	803-2	1 ph; 20A; 100V
5-44	803-3	1 ph; 20A; 125V
5-44	803-4	1 ph; 20A; 150V
		DOUBLER OR CENTER-TAP
5-47	804-1	20A; 50V
5-47	804-2	20A; 100V
5-47	804-3	20A; 125V
5-47	804-4	20A; 150V
		SCR
7-30	AA100	0.5A@100°C 60V; TO-18
7-30	AA101	0.5A@100°C 100V; TO-18
7-30	AA102	0.5A@100°C 200V; TO-18
7-30	AA103	0.5A@100°C 300V; TO-18
7-30	AA104	0.5A@100°C 400V; TO-18
7-30	AA107	0.5A@100°C 60V; TO-18
7-30	AA108	0.5A@100°C 100V; TO-18
7-30	AA109	0.5A@100°C 200V; TO-18
7-30	AA110	0.5A@100°C 300V; TO-18
7-30	AA111	0.5A@100°C 400V; TO-18
7-30	AA114	0.5A@100°C 60V; TO-18
7-30	AA115	0.5A@100°C 100V; TO-18
7-30	AA116	0.5A@100°C 200V; TO-18
7-30	AA117	0.5A@100°C 300V; TO-18
7-30	AA118	0.5A@100°C 400V; TO-18
7-33	AD100	1.6A@85°C 60V; TO-39
7-33	AD101	1.6A@85°C 100V; TO-39
7-33	AD102	1.6A@85°C 200V; TO-39
7-33	AD103	1.6A@85°C 300V; TO-39
7-33	AD104	1.6A@85°C 400V; TO-39
7-33	AD107	1.6A@85°C 60V; TO-39
7-33	AD108	1.6A@85°C 100V; TO-39
7-33	AD109	1.6A@85°C 200V; TO-39
7-33	AD110	1.6A@85°C 300V; TO-39
7-33	AD111	1.6A@85°C 400V; TO-39
7-33	AD114	1.6A@85°C 60V TO-39
7-33	AD115	1.6A@85°C 100V; TO-39
7-33	AD116	1.6A@85°C 200V; TO-39
7-33	AD117	1.6A@85°C 300V; TO-39
7-33	AD118	1.6A@85°C 400V; TO-39
		DIODE
*	BA127D	200mA; 100V; DO-35
*	BA129	225mA; 200V; DO-35
*	BA130	75mA; 35V; DO-35
		SCR
*	BA150	0.5A@100°C 30V; TO-18
*	BA151	0.5A@100°C 60V; TO-18
*	BA152	0.5A@100°C 100V; TO-18
		DIODE
*	BA155	100mA; 150V; DO-35
*	BA166	50mA; 20V; DO-35
*	BA167W	50mA; 25V; DO-35
*	BA180	50mA; 10V; DO-35
*	BA181	50mA; 20V; DO-35
*	BA209	225mA; 100V; DO-35
*	BA219	100mA; 100V; DO-35
*	BA220	200mA; 10V; DO-35
*	BA221	200mA; 30V; DO-35
*	BA317	100mA; 30V; DO-35
*	BAV10	300mA; 60V; DO-35
*	BAV18	250mA; 60V; DO-35
*	BAV19	250mA; 120V; DO-35
*	BAV20	250mA; 180V; DO-35
*	BAV21	250mA; 250V; DO-35
8-27	BAW24	600mA; 50V; DO-35
8-27	BAW25	600mA; 50V; DO-35
8-27	BAW26	600mA; 75V; DO-35
8-27	BAW27	600mA; 75V; DO-35
*	BAW62	100mA; 75V; DO-35
8-27	BAW75	300mA; 35V; DO-35
8-27	BAW76	300mA; 75V; DO-35
8-28	BAX12	400mA; 90V; DO-35
*	BAX13	75mA; 50V; DO-35
*	BAX16	200mA; 150V; DO-35
*	BAX17	200mA; 200V; DO-35
*	BAX81	350mA; 90V; DO-35
*	BAX84	75mA; 50V; DO-35
*	BAX92	75mA; 50V; DO-35
*	BAY18	250mA; 60V; DO-35
*	BAY19	250mA; 120V; DO-35
*	BAY20	250mA; 180V; DO-35
*	BAY21	250mA; 350V; DO-35
*	BAY31	15V; DO-35
*	BAY36	100mA; 30V; DO-35
8-28	BAY41	225mA; 40V; DO-35

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PAGE	PART NUMBER	DESCRIPTION
		DIODE
8-28	BAY42	225mA; 60V; DO-35
8-28	BAY43	225mA; 80V; DO-35
*	BAY44	250mA; 50V; DO-35
*	BAY45	250mA; 150V; DO-35
*	BAY46	250mA; 300V; DO-35
8-28	BAY60	115mA; 25V; DO-35
*	BAY71	75mA; 70V; DO-35
*	BAY72	225mA; 125V; DO-35
*	BAY73	225mA; 125V; DO-35
*	BAY80	250mA; 150V; DO-35
		POWER TRANSISTOR
*	BUS11	NPN; 5A; 400V; TO-3
*	BUS11A	NPN; 5A; 450V; TO-3
*	BUS12	NPN; 8A; 400V; TO-3
*	BUS12A	NPN; 8A; 450V; TO-3
*	BUS13	NPN; 15A; 400V; TO-3
*	BUS13A	NPN; 15A; 450V; TO-3
*	BUW24	NPN; 10A; 350V; TO-3
*	BUW25	NPN; 10A; 400V; TO-3
*	BUW26	NPN; 10A; 450V; TO-3
*	BUW34	NPN; 10A; 400V; TO-3
*	BUW35	NPN; 10A; 400V; TO-3
*	BUW36	NPN; 10A; 450V; TO-3
*	BUW42	NPN; 15A; 400V; TO-3
*	BUW44	NPN; 15A; 400V; TO-3
*	BUW45	NPN; 15A; 400V; TO-3
*	BUW46	NPN; 15A; 450V; TO-3
*	BUX13	NPN; 15A; 325V; TO-3
*	BUX14	NPN; 10A; 400V; TO-3
*	BUX44	NPN; 8A; 400V; TO-3
*	BUX46	NPN; 3.5A; 400V; TO-3
*	BUX47	NPN; 9A; 400V; TO-3
*	BUX47A	NPN; 9A; 450V; TO-3
3-67	BUX48	NPN; 15A; 400V; TO-3
3-62	BUX80	NPN; 10A; 400V; TO-3
3-57	BUX82	NPN; 6A; 400V; TO-3
		DIODE
*	BY401	500mA; 50V; DO-7
*	BY402	500mA; 100V; DO-7
*	BY403	500mA; 200V; DO-7
*	BY404	500mA; 400V; DO-7
		SCHOTTKY RECTIFIER
*	BYS60-45	60A; 45V; DO-5
*	BYS75-20	75A; 20V; DO-5
*	BYS75-30	75A; 30V; DO-5
*	BYS75-45	75A; 45V; DO-5
*	BYV19-35	12A; 35V; TO-220AC
*	BYV19-40	12A; 40V; TO-220AC
*	BYV19-45	12A; 45V; TO-220AC
*	BYV23-35μ	75A; 35V; DO-5
*	BYV23-45μ	75A; 45V; DO-5
		RECTIFIER
5-156	BYV27-50 (UES1101)	2.5A; 50V
5-156	BYV27-100 (UES1102)	2.5A; 100V
5-156	BYV27-150 (UES1103)	2.5A; 150V
5-161	BYV28-50	3.5A; 50V
5-161	BYV28-100	3.5A; 100V
5-161	BYV28-150	3.5A; 150V
*	BYV28-200	3.5A; 200V
		SCHOTTKY RECTIFIER
*	BYV33-35	16A; 35V; TO-220AB
*	BYV33-40	16A; 40V; TO-220AB
*	BYV33-45	16A; 45V; TO-220AB

PAGE	PART NUMBER	DESCRIPTION
		RECTIFIER
*	BYV79-50	16A; 50V; TO-220AC
*	BYV79-100	16A; 100V; TO-220AC
*	BYV79-150	16A; 150V; TO-220AC
*	BYV79-200	16A; 200V; TO-220AC
*	BYW27-50	2.0A; 50V
*	BYW27-100	2.0A; 100V
*	BYW27-150	2.0A; 150V
*	BYW27-200	2.0A; 200V
5-166	BYW29-50	7.0A; 50V; TO-220AC
5-166	BYW29-100	7.0A; 100V; TO-220AC
5-166	BYW29-150	7.0A; 150V; TO-220AC
5-166	BYW29-200	7.0A; 200V; TO-220AC
5-143	BYW31-50	25A; 50V; DO-4
5-143	BYW31-100	25A; 100V; DO-4
5-143	BYW31-150	25A; 150V; DO-4
*	BYW51-50	16A; 50V; TO-220AB
*	BYW51-100	16A; 100V; TO-220AB
*	BYW51-150	16A; 150V; TO-220AB
*	BYW51-200	16A; 200V; TO-220AB
5-143	BYW77-50	30A; 50V; DO-4
5-143	BYW77-100	30A; 100V; DO-4
5-143	BYW77-150	30A; 150V; DO-4
*	BYW77-200	30A; 200V; DO-4
5-149	BYW78-50	50A; 50V; DO-5
5-149	BYW78-100	50A; 100V; DO-5
5-149	BYW78-150	50A; 150V; DO-5
*	BYW78-200	50A; 200V; DO-5
5-166	BYW80-50	7.0A; 50V; TO-220AC
5-166	BYW80-100	7.0A; 100V; TO-220AC
5-166	BYW80-150	7.0A; 150V; TO-220AC
5-166	BYW80-200	7.0A; 200V; TO-220AC
*	BYW81-50	25A; 50V; DO-4
*	BYW81-100	25A; 100V; DO-4
*	BYW81-150	25A; 150V; DO-4
*	BYW81-200	25A; 200V; DO-4
*	BYW93-50μ	70A; 50V; DO-5
*	BYW93-100μ	70A; 100V; DO-5
*	BYW93-150μ	70A; 150V; DO-5
*	BYW93-200μ	70A; 200V; DO-5
*	BYW99-50	30A; 50V; TO-3
*	BYW99-100	30A; 100V; TO-3
*	BYW99-150	30A; 150V; TO-3
		ZENER
*	BZV16C6V8	7%; 3W
*	BZV16C7V8	7%; 3W
*	BZV16C8V2	7%; 3W
*	BZV16C9V1	7%; 3W
*	BZV16C10	7%; 3W
*	BZV16C11	7%; 3W
*	BZV16C12	7%; 3W
*	BZV16C13	7%; 3W
*	BZV16C15	7%; 3W
*	BZV16C16	7%; 3W
*	BZV16C18	7%; 3W
*	BZV16C20	7%; 3W
*	BZV16C22	7%; 3W
*	BZV16C24	7%; 3W
*	BZV16C27	7%; 3W
*	BZV16C30	7%; 3W
*	BZV16C33	7%; 3W
*	BZV16C36	7%; 3W
*	BZV16C39	7%; 3W
*	BZV16C43	7%; 3W
*	BZV16C47	7%; 3W
*	BZV16C51	7%; 3W

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PART NUMBER INDEX

PAGE	PART NUMBER	DESCRIPTION
		ZENER
*	BZV16C56	7%; 3W
*	BZV16C62	7%; 3W
*	BZV16C68	7%; 3W
*	BZV16C75	7%; 3W
*	BZV16C82	7%; 3W
		SCR
*	CB200	0.5A@100°C 30V; TO-18
*	CB201	0.5A@100°C 60V; TO-18
*	CB202	0.5A@100°C 100V; TO-18
*	CB203	0.5A@100°C 200V; TO-18
*	CD200	1.6A@85°C 30V; TO-39
*	CD201	1.6A@85°C 60V; TO-39
*	CD202	1.6A@85°C 100V; TO-39
*	CD203	1.6A@85°C 200V; TO-39
7-36	GA100	400mA@100°C 30V; TO-18
7-36	GA101	400mA@100°C 60V; TO-18
7-36	GA102	400mA@100°C 80V; TO-18
7-40	GA200-GA200A	60V; TO-18
7-40	GA201-GA201A	100V; TO-18
7-43	GA300-GA300A	60V; TO-18
7-43	GA301-GA301A	100V; TO-18
7-40	GB200-GB200A	60V; TO-59
7-40	GB201-GB201A	100V; TO-59
7-43	GB300-GB300A	60V; TO-59
7-43	GB301-GB301A	100V; TO-59
		HIGH VOLTAGE RECTIFIER
5-90	HA10	1.0kV
5-90	HA15	1.5kV
5-90	HA20	2.0kV
5-90	HA25	2.5kV
5-90	HA30	3.0kV
5-90	HA40	4.0kV
5-90	HA50	5.0kV
5-90	HA75	7.5kV
5-90	HA100	10kV
5-92	HS10	1.0kV
5-92	HS15	1.5kV
5-92	HS20	2.0kV
5-92	HS25	2.5kV
5-92	HS30	3.0kV
5-92	HS40	4.0kV
5-92	HS50	5.0kV
5-92	HS75	7.5kV
5-92	HS100	10kV
5-92	HVE10 (1N3643)	1.0kV
5-92	HVE15 (1N3644)	1.5kV
5-92	HVE20 (1N3645)	2.0kV
5-92	HVE25 (1N3646)	2.5kV
5-92	HVE30 (1N3647)	3.0kV
5-92	HVE40 (1N5181)	4.0kV
5-92	HVE50 (1N5182)	5.0kV
5-92	HVE75 (1N5183)	7.5kV
5-92	HVE100 (1N5184)	10kV
5-94	HVF2500	2.5kV
5-94	HVF5000	5.0kV
5-94	HVF7500	7.5kV
5-94	HVF10000	10kV
5-94	HVF12500	12.5kV
5-94	HVF15000	15kV
5-94	HVF20000	20kV
5-94	HVF25000	25kV
5-96	HVFS2500	2.5kV
5-96	HVFS5000	5.0kV
5-96	HVFS7500	7.5kV
5-96	HVFS10000	10kV
5-96	HVFS12500	**HIGH VOLTAGE RECTIFIER** 12.5kV
5-96	HVFS15000	15kV
5-96	HVFS17500	17.5kV
5-96	HVFS20000	20kV
5-98	HVH5000	5.0kV
5-98	HVH7500	7.5kV
5-98	HVH10000	10kV
5-98	HVH12500	12.5kV
5-98	HVH15000	15kV
5-98	HVH20000	20kV
5-98	HVH25000	25kV
5-100	HVHF5000	5.0kV
5-100	HVHF7500	7.5kV
5-100	HVHF10000	10kV
5-100	HVHF12500	12.5kV
5-100	HVHF15000	15kV
5-100	HVHF20000	20kV
5-100	HVHF25000	25kV
5-102	HVHJ15K	15kV
5-102	HVHJ20K	20kV
5-102	HVHJ22.5K	22.5kV
5-102	HVHJ25K	25kV
5-102	HVHJ30K	30kV
5-102	HVHJ35K	35kV
5-102	HVHJ37.5K	37.5kV
5-102	HVHJ40K	40kV
5-102	HVHJ45K	45kV
5-104	HVHS2500	2.5kV
5-104	HVHS5000	5.0kV
5-104	HVHS7500	7.5kV
5-104	HVHS10000	10kV
5-104	HVHS12500	12.5kV
5-104	HVHS15000	15kV
5-104	HVHS17500	17.5kV
5-104	HVHS20000	20kV
5-106	HVJX15K	15kV
5-106	HVJX20K	20kV
5-106	HVJX22.5K	22.5kV
5-106	HVJX25K	25kV
5-106	HVJX30K	30kV
5-106	HVJX35K	35kV
5-106	HVJX37.5K	37.5kV
5-106	HVJX40K	40kV
5-106	HVJX45K	45kV
5-90	HVX10	1.0kV
5-90	HVX15	1.5kV
5-90	HVX20	2.0kV
5-90	HVX25	2.5kV
5-90	HVX30	3.0kV
5-90	HVX40	4.0kV
5-90	HVX50	5.0kV
5-90	HVX75	7.5kV
5-90	HVX100	10kV
		SCR
7-46	ID100	0.5A@100°C 30V; TO-18
7-46	ID101	0.5A@100°C 60V; TO-18
7-46	ID102	0.5A@100°C 100V; TO-18
7-46	ID103	0.5A@100°C 150V; TO-18
7-46	ID104	0.5A@100°C 200V; TO-18
7-46	ID105	0.5A@100°C 300V; TO-18
7-46	ID106	0.5A@100°C 400V; TO-18
7-49	ID200	1.6A@70°C 50V; TO-39
7-49	ID201	1.6A@70°C 100V; TO-39
7-49	ID202	1.6A@70°C 150V; TO-39
7-49	ID203	1.6A@70°C 200V; TO-39

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PAGE	PART NUMBER	DESCRIPTION
		SCR
7-49	ID300	1.6A@70°C 300V; TO-39
7-49	ID301	1.6A@70°C 400V; TO-39
		HIGH VOLTAGE RECTIFIER
5-108	KX15	1.5kV
5-108	KX20	2.0kV
5-108	KX25	2.5kV
5-108	KX30	3.0kV
5-108	KX40	4.0kV
5-108	KX50	5.0kV
5-108	KX60	6.0kV
5-108	KX80	8.0kV
5-108	KX100	10kV
5-108	KXS15	1.5kV
5-108	KXS20	2.0kV
5-108	KXS25	2.5kV
5-108	KXS30	3.0kV
5-108	KXS40	4.0kV
5-108	KXS50	5.0kV
5-108	KXS60	6.0kV
5-108	KXS80	8.0kV
5-108	KXS100	10kV
		LINEAR INTEGRATED CIRCUITS
2-9	L292	2A; 35V, H-Bridge; Power SIP
2-16	L293	1A; 35V; 4 Channel Push-Pull Driver; "Batwing" Plastic Dip
2-16	L293D	1A; 35V; 4 Channel Driver With Diodes; "Batwing Plastic Package"
2-20	L295	2.5A; 45V; Dual PWM Solenoid Driver; Power SIP
2-24	L296	4A; 40V; High Current Switching Regulator; Power SIP
2-26	L298	Dual Full Bridge Driver; Power SIP
		POWER TRANSISTOR
3-181	MJE13004	NPN; 4A; 300V; TO-220AB
3-181	MJE13005	NPN; 4A; 400V; TO-220AB
3-185	MJE13006	NPN; 8A; 300V; TO-220AB
3-185	MJE13007	NPN; 8A; 400V; TO-220AB
3-189	MJE13008	NPN; 12A; 300V; TO-220AB
3-189	MJE13009	NPN; 12A; 400V; TO-220AB
		SCHOTTKY RECTIFIER
*	PHS51	60A; 45V; DO-5
		RECTIFIER
*	PHS1001	1.0A; 50V
*	PHS1002	1.0A; 100V
*	PHS1003	1.0A; 150V
*	PHS2401	16A; 50V; TO-220AB
*	PHS2402	16A; 100V; TO-220AB
*	PHS2403	16A; 150V; TO-220AB
*	PHS2404	16A; 200V; TO-220AB
		POWER HYBRID
4-4	PIC600	5.0A; 60V (Pos.); TO-66
4-4	PIC601	5.0A; 80V (Pos.); TO-66
4-4	PIC602	5.0A; 100V (Pos.); TO-66
4-4	PIC610	5.0A; 60V (Neg.); TO-66
4-4	PIC611	5.0A; 80V (Neg.); TO-66
4-4	PIC612	5.0A; 100V (Neg.); TO-66
4-8	PIC625	15.0A; 60V (Pos.); TO-66
4-8	PIC626	15.0A; 80V (Pos.); TO-66
4-8	PIC627	15.0A; 100V (Pos.); TO-66
4-8	PIC635	15.0A; 60V (Neg.); TO-66
4-8	PIC636	15.0A; 80V (Neg.); TO-66
4-8	PIC637	15.0A; 100V (Neg.); TO-66
4-12	PIC645	15.0A; 60V (Pos.); TO-3
4-12	PIC646	15.0A; 80V (Pos.); TO-3
4-12	PIC647	15.0A; 100V (Pos.); TO-3
4-12	PIC655	15.0A; 60V (Neg.); TO-3
4-12	PIC656	15.0A; 80V (Neg.); TO-3
4-12	PIC657	15.0A; 100V (Neg.); TO-3
4-16	PIC660	10.0A; 60V (Pos.); TO-66
4-16	PIC661	10.0A; 80V (Pos.); TO-66
4-16	PIC662	10.0A; 100V (Pos.); TO-66
4-16	PIC670	10.0A; 60V (Neg.); TO-66
4-16	PIC671	10.0A; 80V (Neg.); TO-66
4-16	PIC672	10.0A; 100V (Neg.); TO-66
		SENSISTOR
10-4	RTH22ES	Hermetic 1/8 W, Post. Temp.
10-4	RTH42ES	Coefficient Thermistor
		TRANSIENT VOLTAGE SUPPRESSOR
6-16	SA5.0-SA170 series	500W Plastic ASA; 5-170V
6-16	SA5.0A-SA170A series	500W Plastic ASA; 5-170V
6-20	SAB5.0-SAB28.0 series	500W Plastic ASA; 5-28V
		SCHOTTKY RECTIFIER
5-110	SD51	60A; 45V; DO-5
5-112	SD241	60A; 45V; TO-3
5-112	SD241HR	60A; 45V; TO-3
		RECTIFIER
5-114	SES5001	2.0A; 50V
5-114	SES5002	2.0A; 100V
5-114	SES5003	2.0A; 150V
5-116	SES5301	5.0A; 50V
5-116	SES5302	5.0A; 100V
5-116	SES5303	5.0A; 150V
5-118	SES5401	8.0A; 50V; TO-220AC
5-118	SES5402	8.0A; 100V; TO-220AC
5-118	SES5403	8.0A; 150V; TO-220AC
5-118	SES5404	8.0A; 200V; TO-220AC
		RECTIFIER, CENTER-TAP
5-120	SES5401C	16A; 50V; TO-220AB
5-120	SES5402C	16A; 100V; TO-220AB
5-120	SES5403C	16A; 150V; TO-220AB
5-120	SES5404C	16A; 200V; TO-220AB
		RECTIFIER
5-122	SES5501	16.0A; 50V; TO-220AC
5-122	SES5502	16.0A; 100V; TO-220AC
5-122	SES5503	16.0A; 150V; TO-220AC
5-122	SES5504	16.0A; 200V; TO-220AC
		RECTIFIER, CENTER-TAP
5-124	SES5601C	25A; 50V; TO-3
5-124	SES5602C	25A; 100V; TO-3
5-124	SES5603C	25A; 150V; TO-3
		RECTIFIER
5-126	SES5701	20A; 50V; DO-4
5-126	SES5702	20A; 100V; DO-4
5-126	SES5703	20A; 150V; DO-4
5-128	SES5801	60A; 50V; DO-5

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PART NUMBER INDEX

PAGE	PART NUMBER	DESCRIPTION
		RECTIFIER
5-128	SES5802	60A; 100V; DO-5
5-128	SES5803	60A; 150V; DO-5
		FULL WAVE BRIDGE
5-130	SPA25, J	1 ph; 25A; 100V
5-130	SPB25, J	1 ph; 25A; 200V
5-130	SPC25, J	1 ph; 25A; 400V
5-130	SPD25, J	1 ph; 25A; 600V
		HIGH VOLTAGE RECTIFIER
5-132	SX10	1.0kV
5-132	SX15	1.5kV
5-132	SX20	2.0kV
5-132	SX25	2.5kV
5-132	SX30	3.0kV
5-132	SX40	4.0kV
5-132	SX50	5.0kV
5-132	SX60	6.0kV
5-132	SX80	8.0kV
5-132	SX100	10kV
5-132	SXS10	1.0kV
5-132	SXS15	1.5kV
5-132	SXS20	2.0kV
5-132	SXS25	2.5kV
5-132	SXS30	3.0kV
5-132	SXS40	4.0kV
5-132	SXS50	5.0kV
5-132	SXS60	6.0kV
5-132	SXS80	8.0kV
5-132	SXS100	10kV
		DIODE
*	TD018	100mA; 50V; DO-35
*	TD041	100mA; 150V; DO-35
*	TD068	100mA; 50V; DO-35
*	TD117	30mA; 30V; DO-35
*	TD129	100mA; 50V; DO-35
*	TD153	250mA; 50V; DO-35
*	TD176	150mA; 200V; DO-35
*	TD190	250mA; 300V; DO-35
*	TD190C	400mA; 450V; DO-7
*	TD300	15mA; 15V; DO-35
*	TD377	50mA; 10V; DO-35
*	TD413G	180mA; 10V; DO-35
*	TD414	50mA; 250V; DO-35
*	TD473	110mA; 20V; DO-35
*	TD474	110mA; 20V; DO-35
*	TD475	50mA; 20V; DO-35
*	TD482	300mA; 80V; DO-35
*	TD785	60mA; 35V; DO-35
*	TD789	60mA; 35V; DO-35
*	TD789A	60mA; 45V; DO-35
*	TD789B	60mA; 60V; DO-35
*	TD791	85mA; 15V; DO-35
*	TD809	200mA; 25V; DO-35
*	TD891	60mA; 85V; DO-35
*	TD893	150mA; 100V; DO-35
*	TD905	150mA; 100V; DO-35
*	TD922	100mA; 50V; DO-35
*	TD993	400mA; 380V; DO-7
*	TD996	250mA; 380V; DO-35
		SENSISTOR®
10-4	TG 1/8	Hermetic 1/8W, Pos. Temp. Coefficient Thermistor
10-4	TM 1/8	Plastic 1/8W, Pos. Temp. Coefficient Thermistor

PAGE	PART NUMBER	DESCRIPTION
		TRANSIENT VOLTAGE SUPPRESSOR
6-22	TVS305-TVS360	150W
6-22	TVS410-TVS430	150W
6-22	TVS505-TVS528	500W
		PUT
7-51	U13T1	400mW@25°C 40V; TO-18
7-51	U13T2	400mW@25°C 40V; TO-18
		POWER DARLINGTON
3-193	U2T101	NPN; 10.0A; 80V; TO-33
3-193	U2T105	NPN; 10.0A; 150V; TO-33
3-193	U2T201	NPN; 10.0A; 80V; TO-66
3-193	U2T205	NPN; 10.0A; 150V; TO-66
3-195	U2T301	NPN; 5.0A; 60V; TO-33
3-195	U2T305	NPN; 5.0A; 150V; TO-33
3-195	U2T401	NPN; 5.0A; 60V; TO-66
3-195	U2T405	NPN; 5.0A; 150V; TO-66
3-197	U2TA506	NPN; 3.0A; 60V; TO-92
3-197	U2TA508	NPN; 3.0A; 80V; TO-92
3-197	U2TA510	NPN; 3.0A; 100V; TO-92
		SYNCHRONOUS RECTIFIER
5-134	UBS430	NPN; 40A; 50V; TO-3
		LOW VOLTAGE TRANSISTOR
3-199	UBT430	NPN; 40A; 50V; TO-3
		FULL WAVE BRIDGE
*	UC3BA1	3 ph; 25A; 100V
*	UC3BA1F	3 ph; 20A; 100V
*	UC3BA2	3 ph; 25A; 200V
*	UC3BA2F	3 ph; 20A; 200V
*	UC3BA4	3 ph; 25A; 400V
*	UC3BA4F	3 ph; 20A; 400V
*	UC3BA6	3 ph; 25A; 600V
*	UC3BA6F	3 ph; 20A; 600V
		LINEAR INTEGRATED CIRCUITS
2-30	UC117K	1.5A; TO-3; Pos. Adj. Reg.
*	UC120-05K	1.0A; −5V; TO-3; Precision Fixed Reg.
*	UC120-12K	1.0A; −12V; TO-3; Precision Fixed Reg.
*	UC120-15K	1.0A; −15V; TO-3; Precision Fixed Reg.
2-34	UC137K	1.5A; TO-3; Neg. Adj. Reg.
*	UC140-05K	1.0A; +5V; TO-3; Precision Fixed Reg.
*	UC140-12K	1.0A; +12V; TO-3; Precision Fixed Reg.
*	UC140-15K	1.0A; +15V; TO-3; Precision Fixed Reg.
2-37	UC150K	3.0A; TO-3; Pos. Adj. Reg.
2-30	UC217K	1.5A; TO-3; Pos. Adj. Reg.
2-34	UC237K	1.5A; TO-3; Neg. Adj. Reg.
2-37	UC250K	3.0A; TO-3; Pos. Adj. Reg.
2-30	UC317K	1.5A; TO-3; Pos. Adj. Reg.
2-30	UC317T	1.5A; TO-220; Pos. Adj. Reg.
*	UC320-05K	1A; −5V; TO-3; Precision Fixed Reg.
*	UC320-05T	1A; −5V; TO-220; Precision Fixed Reg.
*	UC320-12K	1A; −12V; TO-3; Precision Fixed Reg.
*	UC320-12T	1A; −12V; TO-220; Precision Fixed Reg.

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PAGE	PART NUMBER	DESCRIPTION
		LINEAR INTEGRATED CIRCUITS
*	UC320-15K	1A; −15V; TO-3; Precision Fixed Reg.
*	UC320-15T	1A; −15V; TO-220; Precision Fixed Reg.
2-34	UC337K	1.5A; TO-3; Neg. Adj. Reg.
2-34	UC337T	1.5A; TO-220; Neg. Adj. Reg.
*	UC340-05K	1A; +5V; TO-3; Precision Fixed Reg.
*	UC340-05T	1A; +5V; TO-220; Precision Fixed Reg.
*	UC340-12K	1A; +12V; TO-3; Precision Fixed Reg.
*	UC340-12T	1A; +12V; TO-220; Precision Fixed Reg.
*	UC340-15K	1A; +15V; TO-3; Precision Fixed Reg.
*	UC340-15T	1A; +15V; TO-220; Precision Fixed Reg.
2-37	UC350K	3A; TO-3; Pos. Adj. Reg.
2-41	UC493ACJ	40V; 200mA; Precision PWM; Ceramic Dip
2-41	UC493ACN	40V; 200mA; Precision PWM; Plastic Dip
2-41	UC493AJ	40V; 200mA; Precision PWM; Ceramic Dip
2-41	UC493AN	40V; 200mA; Precision PWM; Plastic Dip
2-41	UC494ACJ	40V; 200mA; Precision PWM; Ceramic Dip
2-41	UC494ACN	40V; 200mA; Precision PWM; Plastic Dip
2-41	UC494AJ	40V; 200mA; Precision PWM; Ceramic Dip
2-41	UC494AN	40V; 200mA; Precision PWM; Plastic Dip
2-41	UC495ACJ	40V; 200mA; Precision PWM; Ceramic Dip
2-41	UC495ACN	40V; 200mA; Precision PWM; Plastic Dip
2-41	UC495AJ	40V; 200mA; Precision PWM; Ceramic Dip
2-41	UC495AN	40V; 200mA; Precision PWM; Plastic Dip
2-41	UC495BCJ	Precision PWM w/Buffered Output; Ceramic Dip
2-41	UC495BCN	Precision PWM w/Buffered Output; Plastic Dip
2-41	UC495BJ	Precision PWM w/Buffered Output; Ceramic Dip
2-41	UC495BN	Precision PWM w/Buffered Output; Plastic Dip
2-50	UC1524AJ	60V; 200mA; Precision PWM; Ceramic Dip
2-45	UC1524J	40V; 100mA; PWM; Ceramic Dip
2-54	UC1525AJ	40V; 500mA; Precision PWM; Ceramic Dip
2-67	UC1526AJ	Ceramic Dip Advanced High Performance PWM
2-67	UC1526AJ/883B	Ceramic Dip Advanced High Performance PWM
2-61	UC1526J	High Performance PWM; Ceramic Dip
2-54	UC1527AJ	40V; 500mA; Precision PWM; Ceramic Dip
2-73	UC1543J	**LINEAR INTEGRATED CIRCUITS** Power Supply Supervisory Circuit; Ceramic Dip
2-73	UC1544J	Power Supply Supervisory Circuit; Ceramic Dip
2-77	UC1610J	Dual Schottky Diode Bridge 8-Pin; Ceramic Dip
2-79	UC1637J	500mA; 40V; PWM DC Servo Motor Control Chip; Ceramic Dip
2-87	UC1704J	Bridge Transducer Switch; −25°C to +125°C; Ceramic Dip
2-91	UC1706J	Dual Output Driver; Ceramic Dip
2-95	UC1707J	Dual Uncommitted Power Drivers; Ceramic Dip
2-95	UC1707J/883	Dual Uncommitted Power Drivers; Ceramic Dip
2-101	UC1717J	1A; 40V; Stepper Motor Drive Circuit; Ceramic Dip
2-109	UC1825J	Ultra High Frequency PWM; Ceramic Dip
2-109	UC1825J/883B	Ultra High Frequency PWM; Ceramic Dip
2-117	UC1834J	High Efficiency Linear Regulator; Ceramic Dip
2-121	UC1840J	40V; 200mA; PWM Controller; Ceramic Dip
2-129	UC1842J	Off-line Current Mode PWM; Ceramic Dip
2-135	UC1843J	Economy PWM; Ceramic Dip
2-135	UC1843J/883B	Economy PWM; Ceramic Dip
2-136	UC1846J	Current Mode PWM; Ceramic Dip
2-136	UC1847J	Current Mode PWM; Ceramic Dip
2-144	UC1850J	Switching Power Supply Control Sys.; Ceramic Pkg.
2-144	UC1850J/883B	Switching Power Supply Control Sys.; Ceramic Pkg
2-148	UC1901J	Isolated Feedback Generator; Ceramic Dip
2-152	UC1903J	Triple Voltage and Line Monitor; Ceramic Dip
2-50	UC2524AJ	60V; 200mA; Precision PWM; Ceramic Dip
2-50	UC2524AN	60V; 200mA; Precision PWM; Plastic Dip
2-45	UC2524J	40V; 100mA; PWM; Ceramic Dip
2-45	UC2524N	40V; 100mA; PWM; Plastic Dip
2-54	UC2525AJ	40V; 500mA; Precision PWM; Ceramic Dip
2-54	UC2525AN	40V; 500mA; Precision PWM; Plastic Dip
2-67	UC2526AJ	Ceramic Dip Advanced High Performance PWM

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PART NUMBER INDEX

PAGE	PART NUMBER	DESCRIPTION
		LINEAR INTEGRATED CIRCUITS
2-67	UC2526AN	Plastic Dip Advanced High Performance PWM
2-61	UC2526J	High Performance PWM; Ceramic Dip
2-61	UC2526N	High Performance PWM; Plastic Dip
2-54	UC2527AJ	40V; 500mA; Precision PWM; Ceramic Dip
2-54	UC2527AN	40V; 500mA; Precision PWM; Plastic Dip
2-73	UC2543J	Power Supply Supervisory Circuit; Ceramic Dip
2-73	UC2543N	Power Supply Supervisory Circuit; Plastic Dip
2-73	UC2544J	Power Supply Supervisory Circuit; Ceramic Dip
2-73	UC2544N	Power Supply Supervisory Circuit; Plastic Dip
2-79	UC2637J	500mA; 40V; PWM DC Servo Motor Control Chip; Ceramic Dip
2-79	UC2637N	500mA; 40V; PWM DC Servo Motor Control Chip Plastic Dip
*	UC2707J	Dual Uncommited Power Drivers; Ceramic Dip
*	UC2707N	Dual Uncommitted Power Drivers; Plastic Dip
2-109	UC2825J	Ultra High Frequency PWM; Ceramic Dip
2-109	UC2825N	Ultra High Frequency PWM; Plastic Dip
2-117	UC2834J	High Efficiency Linear Regulator; Ceramic Dip
2-117	UC2834N	High Efficiency Linear Regulator; Plastic Dip
2-121	UC2840J	40V; 200mA; PWM Controller; Ceramic Dip
2-121	UC2840N	40V; 200mA; PWM Controller; Plastic Pkg
2-129	UC2842J	Off-line Current Mode PWM; Ceramic Dip
2-129	UC2842N	Off-line Current Mode PWM; Plastic Dip
2-135	UC2843J	Economy PWM; Ceramic Dip
2-135	UC2843N	Economy PWM; Plastic Dip
2-136	UC2846J	Current Mode PWM; Ceramic Dip
2-136	UC2846N	Current Mode PWM; Plastic Dip
2-136	UC2847J	Current Mode PWM; Ceramic Dip
2-136	UC2847N	Current Mode PWM; Plastic Dip
2-148	UC2901J	Isolated Feedback Generator; Ceramic Dip
2-148	UC2901N	Isolated Feedback Generator; Plastic Dip
2-152	UC2903J	Triple Voltage and Line Monitor; Ceramic Dip
2-152	UC2903N	Triple Voltage and Line Monitor; Plastic Dip
2-159	UC2906J	Lead Acid Battery Charger; Ceramic
2-159	UC2906N	Lead Acid Battery Charger; Plastic
*	UC3517J	Unipolar Bilevel Stepper Motor Drive; Ceramic
*	UC3517N	Unipolar Bilevel Stepper Motor Drive; Plastic
2-50	UC3524AJ	50V; 200mA; Precision PWM; Ceramic Dip
2-50	UC3524AN	50V; 200mA; Precision PWM; Plastic Dip
2-45	UC3524J	40V; 100mA; PWM; Ceramic Dip
2-45	UC3524N	40V; 100mA; PWM; Plastic Dip
2-54	UC3525AJ	40V; 500mA; Precision PWM; Ceramic Dip
2-54	UC3525AN	40V; 500mA; Precision PWM; Plastic Dip
2-67	UC3526AJ	Ceramic Dip Advanced High Performance PWM
2-67	UC3526AN	Plastic Dip Advanced High Performance PWM
2-61	UC3526J	High Performance PWM; Ceramic Dip
2-61	UC3526N	High Performance PWM; Plastic Dip
2-54	UC3527AJ	40V; 500mA; Precision PWM; Ceramic Dip
2-54	UC3527AN	40V; 500mA; Precision PWM; Plastic Dip
2-73	UC3543J	Power Supply Supervisory Circuit; Ceramic Dip
2-73	UC3543N	Power Supply Supervisory Circuit; Plastic Dip
2-73	UC3544J	Power Supply Supervisory Circuit; Ceramic Dip
2-73	UC3544N	Power Supply Supervisory Circuit; Plastic Dip
2-77	UC3610N	Dual Schottky Diode Bridge 8-Pin; Plastic Dip
2-166	UC3620	3-Phase DC Motor Controller; Power SIP
2-79	UC3637J	500mA; 40V; PWM DC Servo Motor Control Chip; Ceramic Dip
2-79	UC3637N	500mA; 40V; PWM DC Servo Motor Control Chip; Plastic Dip
2-87	UC3704J	Bridge Transducer Switch; 0°C to +70°C; Ceramic Dip
2-87	UC3704N	Bridge Transducer Switch; 0°C to +70°C; Plastic Dip
2-91	UC3706J	Dual Output Driver; Ceramic Dip
2-91	UC3706N	Dual Output Driver; Plastic Dip
2-95	UC3707J	Dual Uncommitted Power Drivers; Ceramic Dip
2-95	UC3707N	Dual Uncommitted Power Drivers; Plastic Dip

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PAGE	PART NUMBER	DESCRIPTION
		LINEAR INTEGRATED CIRCUITS
2-101	UC3717J	1A; 40V; Stepper Motor Drive Circuit; Ceramic Dip
2-101	UC3717N	1A;40V; Stepper Motor Drive Circuit; Plastic Dip
2-171	UC3717NB	1A; 25V Stepper Motor Drive Circuit
2-171	UC3717NC	1A; 35V Stepper Motor Drive Circuit
*	UC3770J	2A High Current Stepper Motor Drive; Ceramic
*	UC3770N	2A High Current Stepper Motor Drive; Plastic
2-109	UC3825J	Ultra High Frequency PWM; Ceramic Dip
2-109	UC3825N	Ultra High Frequency PWM; Plastic Dip
2-117	UC3834J	High Efficiency Linear Regulator; Ceramic Dip
2-117	UC3834N	High Efficiency Linear Regulator; Plastic Dip
2-121	UC3840J	40V; 200mA; PWM Controller; Ceramic Dip
2-121	UC3840N	40V; 200mA; PWM Controller; Plastic Dip
2-129	UC3842J	Off-line Current Mode PWM; Ceramic Dip
2-129	UC3842N	Off-line Current Mode PWM; Plastic Dip
2-135	UC3843J	Economy PWM; Ceramic Dip
2-135	UC3843N	Economy PWM; Plastic Dip
2-136	UC3846J	Current Mode PWM; Ceramic Dip
2-136	UC3846N	Current Mode PWM; Plastic Dip
2-136	UC3847J	Current Mode PWM; Ceramic Dip
2-136	UC3847N	Current Mode PWM; Plastic Dip
2-144	UC3850J	Switching Power Supply Control Sys.; Ceramic Pkg
2-144	UC3850N	Switching Power Supply Control Sys.; Plastic Pkg
2-148	UC3901J	Isolated Feedback Generator; Ceramic Dip
2-148	UC3901N	Isolated Feedback Generator; Plastic Dip
2-152	UC3903J	Triple Voltage and Line Monitor; Ceramic Dip
2-152	UC3903N	Triple Voltage and Line Monitor; Plastic Dip
2-159	UC3906J	Lead Acid Battery Charger; Ceramic
2-159	UC3906N	Lead Acid Battery Charger; Plastic
2-173	UC7805ACK	1A; +5V; TO-3; Precision Fixed Reg.
2-173	UC7805ACT	1A; +5V; TO-220; Precision Fixed Reg.
2-173	UC7805AK	1A; +5V; TO-3; Precision Fixed Reg.
2-173	UC7805CK	1A; +5V; TO-3; Fixed Reg.
2-173	UC7805CT	1A; +5V; TO-220; Fixed Reg.
2-173	UC7805K	1A; +5V; TO-3; Fixed Reg.
2-173	UC7812ACK	1A; +12V; TO-3; Precision Fixed Reg.
2-173	UC7812ACT	1A; +12V; TO-220; Precision Fixed Reg.
2-173	UC7812AK	1A; +12V; TO-3; Precision Fixed Reg.
2-173	UC7812CK	1A; +12V; TO-3; Fixed Reg.
2-173	UC7812CT	1A; +12V; TO-220 Fixed Reg.
2-173	UC7812K	1A; +12V; TO-3; Fixed Reg.
2-173	UC7815ACK	1A; +15V; TO-3; Precision Fixed Reg.
2-173	UC7815ACT	1A; +15V; TO-220; Precision Fixed Reg.
2-173	UC7815AK	1A; +15V; TO-3; Precision Fixed Reg.
2-173	UC7815CK	1A; +15V; TO-3; Fixed Reg.
2-173	UC7815CT	1A; +15V; TO-220; Fixed Reg.
2-173	UC7815K	1A; +15V; TO-3; Fixed Reg.
2-178	UC7905ACK	1A; -5V; TO-3; Precision Fixed Reg.
2-178	UC7905ACT	1A; -5V; TO-220; Precision Fixed Reg.
2-178	UC7905AK	1A; -5V; TO-3; Precision Fixed Reg.
2-178	UC7905CK	1A; -5V; TO-3; Fixed Reg.
2-178	UC7905CT	1A; -5V; TO-220; Fixed Reg.
2-178	UC7905K	1A; -5V; TO-3; Fixed Reg.
2-178	UC7912ACK	1A; -12V; TO-3; Precision Fixed Reg.
2-178	UC7912ACT	1A; -12V; TO-220; Precision Fixed Reg.
2-178	UC7912AK	1A; -12V; TO-3; Precision Fixed Reg.
2-178	UC7912CK	1A; -12V; TO-3; Fixed Reg.
2-178	UC7912CT	1A; -12V; TO-220 Fixed Reg.
2-178	UC7912K	1A; -12V; TO-3; Fixed Reg.
2-178	UC7915ACK	1A; -15V; TO-3; Precision Fixed Reg.
2-178	UC7915ACT	1A; -15V; TO-220; Precision Fixed Reg.
2-178	UC7915AK	1A; -15V; TO-3; Precision Fixed Reg.
2-178	UC7915CK	1A; -15V; TO-3; Fixed Reg.
2-178	UC7915CT	1A; -15V; TO-220; Fixed Reg.
2-178	UC7915K	1A; -15V; TO-3; Fixed Reg.
		FULL WAVE BRIDGE
*	UCBA1	1 ph; 25A; 100V
*	UCBA1F	1 ph; 20A; 100V
*	UCBA2	1 ph; 25A; 200V
*	UCBA2F	1 ph; 20A; 200V
*	UCBA4	1 ph; 25A; 400V
*	UCBA4F	1 ph; 20A; 400V
*	UCBA6	1 ph; 25A; 600V
*	UCBA6F	1 ph; 20A; 600V
*	UCBHM1	1 ph; 10A; 100V
*	UCBHM1F	1 ph; 10A; 100V
*	UCBHM2	1 ph; 10A; 200V

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PART NUMBER INDEX

PAGE	PART NUMBER	DESCRIPTION
		FULL WAVE BRIDGE
*	UCBHM2F	1 ph; 10A; 200V
*	UCBHM4	1 ph; 10A; 400V
*	UCBHM4F	1 ph; 10A; 400V
*	UCBHM6	1 ph; 10A; 600V
*	UCBHM6F	1 ph; 10A; 600V
		DOUBLER OR CENTER-TAP
*	UCDA1	15A; 100V
*	UCDA1F	15A; 100V
*	UCDA2	15A; 200V
*	UCDA2F	15A; 200V
*	UCDA4	15A; 400V
*	UCDA4F	15A; 400V
*	UCDA6	15A; 600V
*	UCDA6F	15A; 600V
*	UCNA1	15A; 100V
*	UCNA1F	15A; 100V
*	UCNA2	15A; 200V
*	UCNA2F	15A; 200V
*	UCNA4	15A; 400V
*	UCNA4F	15A; 400V
*	UCNA6	15A; 600V
*	UCNA6F	15A; 600V
*	UCPA1	15A; 100V
*	UCPA1F	15A; 100V
*	UCPA2	15A; 200V
*	UCPA2F	15A; 200V
*	UCPA4	15A; 400V
*	UCPA4F	15A; 400V
*	UCPA6	15A; 600V
*	UCPA6F	15A; 600V
		RECTIFIER MODULE
5-140	UDA5	5.0kV
5-140	UDA7.5	7.5kV
5-140	UDA10	10kV
5-140	UDA15	15kV
5-140	UDB2.5	2.5kV
5-140	UDB5	5.0kV
5-140	UDB7.5	7.5kV
5-140	UDC5	5.0kV
5-140	UDC7.5	7.5kV
5-140	UDC10	10kV
5-140	UDC15	15kV
5-140	UDD2.5	2.5kV
5-140	UDD5	5.0kV
5-140	UDD7.5	7.5kV
5-140	UDE2.5	2.5kV
5-140	UDE5	5.0kV
5-140	UDF2.5	2.5kV
5-140	UDF5	5.0kV
		ZENER
6-26	UDZ707-UDZ790	Bidirectional; 3W; 5%
6-26	UDZ807-UDZ890	Bidirectional; 3W; 10%
6-26	UDZ5707-UDZ5790	Bidirectional; 5W; 5%
6-26	UDZ5807-UDZ5890	Bidirectional; 5W; 10%
6-26	UDZ8707-UDZ8791	Bidirectional; 1W; 5%
6-26	UDZ8807-UDZ8891	Bidirectional; 1W; 10%
		RECTIFIER
5-68	UES101 (1N5802)	2.5A; 50V
5-68	UES102 (1N5803)	2.5A; 75V
5-68	UES103 (1N5804)	2.5A; 100V
5-68	UES104 (1N5805)	2.5A; 125V
5-68	UES201 (1N5807)	6.0A; 50V
5-68	UES202 (1N5808)	6.0A; 75V
5-68	UES203 (1N5809)	6.0A; 100V
5-68	UES204 (1N5810)	6.0A; 125V
*	UES301	20.0A; 50V
*	UES302	20.0A; 75V
*	UES303	20.0A; 100V
*	UES304	20.0A; 125V
5-143	UES701	25.0A; 50V; DO-4
5-143	UES702	25.0A; 100V; DO-4
5-143	UES703	25.0A; 150V; DO-4
5-146	UES704	20.0A; 200V; DO-4
5-146	UES704HR	20.0A; 200V; DO-4
5-146	UES705	20.0A; 300V; DO-4
5-146	UES705HR	20.0A; 300V; DO-4
5-146	UES706	20.0A; 400V; DO-4
5-146	UES706HR	20.0A; 400V; DO-4
5-149	UES801	70.0A; 50V; DO-5
5-149	UES802	70.0A; 100V; DO-5
5-149	UES803	70.0A; 150V; DO-5
5-151	UES804	50.0A; 200V; DO-5
5-151	UES804HR	50.0A; 200V; DO-5
5-151	UES805	50.0A; 300V; DO-5
5-151	UES805HR	50.0A; 300V; DO-5
5-151	UES806	50.0A; 400V; DO-5
5-151	UES806HR	50.0A; 400V; DO-5
5-154	UES1001	1A; 50V
5-154	UES1002	1A; 100V
5-154	UES1003	1A; 150V
5-156	UES1101	2.5A; 50V
5-156	UES1102	2.5A; 100V
5-156	UES1103	2.5A; 150V
5-158	UES1104	2.0A; 200V
5-158	UES1104HR	2.0A; 200V
5-158	UES1105	2.0A; 300V
5-158	UES1105HR	2.0A; 300V
5-158	UES1106	2.0A; 400V
5-158	UES1106HR	2.0A; 400V
5-161	UES1301	6.0A; 50V
5-161	UES1302	6.0A; 100V
5-161	UES1303	6.0A; 150V
5-163	UES1304	5.0A; 200V
5-163	UES1304HR	5.0A; 200V
5-163	UES1305	5.0A; 300V
5-163	UES1305HR	5.0A; 300V
5-163	UES1306	5.0A; 400V
5-163	UES1306HR	5.0A; 400V
5-166	UES1401	8.0A; 50V; TO-220AC
5-166	UES1402	8.0A; 100V; TO-220AC
5-166	UES1403	8.0A; 150V; TO-220AC
5-166	UES1404	8.0A; 200V; TO-220AC
5-169	UES1420	8A; 600V; TO-220AC
5-169	UES1421	8A; 700V; TO-220AC
5-169	UES1422	8A; 800V; TO-220AC
5-169	UES1423	8A; 900V; TO-220AC
5-171	UES1501	16A; 50V; TO-220AC
5-171	UES1502	16A; 100V; TO-220AC
5-171	UES1503	16A; 150V; TO-220AC
5-171	UES1504	16A; 200V; TO-220AC
		RECTIFIER, CENTER-TAP
5-174	UES2401	16A; 50V; TO-220AB
5-174	UES2402	16A; 100V; TO-220AB
5-174	UES2403	16A; 150V; TO-220AB
5-174	UES2404	16A; 200V; TO-220AB
5-177	UES2601	30A; 50V; TO-3
5-177	UES2601HR	30A; 50V; TO-3
5-177	UES2602	30A; 100V; TO-3
5-177	UES2602HR	30A; 100V; TO-3

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PAGE	PART NUMBER	DESCRIPTION
		RECTIFIER, CENTER-TAP
5-177	UES2603	30A; 150V; TO-3
5-177	UES2603HR	30A; 150V; TO-3
5-180	UES2604	30A; 200V; TO-3
5-180	UES2604HR	30A; 200V; TO-3
5-180	UES2605	30A; 300V; TO-3
5-180	UES2605HR	30A; 300V; TO-3
5-180	UES2606	30A; 400V; TO-3
5-180	UES2606HR	30A; 400V; TO-3
		RECTIFIER MODULE
5-183	UFB2.5	2.5kV
5-183	UFB5	5.0kV
5-183	UFB7.5	7.5kV
		POWER MOSFET TRANSISTOR
3-203	UFN120	8A; 100V; 0.30Ω; TO-3
3-203	UFN121	8A; 60V; 0.30Ω; TO-3
3-203	UFN122	7A; 100V; 0.40Ω; TO-3
3-203	UFN123	7A; 60V; 0.40Ω; TO-3
3-209	UFN130	14A; 100V; 0.18Ω; TO-3
3-209	UFN131	14A; 60V; 0.18Ω; TO-3
3-209	UFN132	12A; 100V; 0.25Ω; TO-3
3-209	UFN133	12A; 60V; 0.25Ω; TO-3
3-215	UFN140	27A; 100V; 0.85Ω; TO-3 (Modified)
3-215	UFN141	27A; 60V; 0.85Ω; TO-3 (Modified)
3-215	UFN142	24A; 100V; 0.11Ω; TO-3 (Modified)
3-215	UFN143	24A; 60V; 0.11Ω; TO-3 (Modified)
3-221	UFN150	40A; 100V; 0.055Ω; TO-3 (Modified)
3-221	UFN151	40A; 60V; 0.055Ω; TO-3 (Modified)
3-221	UFN152	33A; 100V; 0.08Ω; TO-3 (Modified)
3-221	UFN153	33A; 60V; 0.08Ω; TO-3 (Modified)
3-227	UFN220	5A; 200V; 0.8Ω; TO-3
3-227	UFN221	5A; 150V; 0.8Ω; TO-3
3-227	UFN222	4A; 200V; 1.2Ω; TO-3
3-227	UFN223	4A; 150V; 1.2Ω; TO-3
3-233	UFN230	9A; 200V; 0.4Ω; TO-3
3-233	UFN231	9A; 150V; 0.4Ω; TO-3
3-233	UFN232	8A; 200V; 0.6Ω; TO-3
3-233	UFN233	8A; 150V; 0.6Ω; TO-3
3-239	UFN240	18A; 200V; 0.18Ω; TO-3 (Modified)
3-239	UFN241	18A; 150V; 0.18Ω; TO-3 (Modified)
3-239	UFN242	16A; 200V; 0.22Ω; TO-3 (Modified)
3-239	UFN243	16A; 150V; 0.22Ω; TO-3 (Modified)
3-245	UFN250	30A; 200V; 0.085Ω; TO-3 (Modified)
3-245	UFN251	30A; 150V; 0.085Ω; TO-3 (Modified)
3-245	UFN252	25A; 200V; 0.120Ω; TO-3 (Modified)
3-245	UFN253	25A; 150V; 0.120Ω; TO-3 (Modified)
3-251	UFN320	3A; 400V; 1.8Ω; TO-3
3-251	UFN321	3A; 350V; 1.8Ω; TO-3
3-251	UFN322	2.5A; 400V; 2.5Ω; TO-3
3-251	UFN323	2.5A; 350V; 2.5Ω; TO-3
3-257	UFN330	5.5A; 400V; 1.0Ω; TO-3
3-257	UFN331	5.5A; 350V; 1.0Ω; TO-3
3-257	UFN332	4.5A; 400V; 1.5Ω; TO-3
3-257	UFN333	4.5A; 350V; 1.5Ω; TO-3
3-263	UFN340	10A; 400V; 0.55Ω; TO-3
3-263	UFN341	10A; 350V; 0.55Ω; TO-3
3-263	UFN342	8A; 400V; 0.80Ω; TO-3
3-263	UFN343	8A; 350V; 0.80Ω; TO-3
3-269	UFN350	15A; 400V; 0.3Ω; TO-3
3-269	UFN351	15A; 350V; 0.3Ω; TO-3
3-269	UFN352	13A; 400V; 0.4Ω; TO-3
3-269	UFN353	13A; 350V; 0.4Ω; TO-3
3-275	UFN420	2.5A; 500V; 3.0Ω; TO-3
3-275	UFN421	2.5A; 450V; 3.0Ω; TO-3
3-275	UFN422	2A; 500V; 4.0Ω; TO-3
3-275	UFN423	2A; 450V; 4.0Ω; TO-3
3-281	UFN430	4.5A; 500V; 1.5Ω; TO-3
3-281	UFN431	4.5A; 450V; 1.5Ω; TO-3
3-281	UFN432	4A; 500V; 2.0Ω; TO-3
3-281	UFN433	4A; 450V; 2.0Ω; TO-3
3-287	UFN440	8A; 500V; 0.85Ω; TO-3
3-287	UFN441	8A; 450V; 0.85Ω; TO-3
3-287	UFN442	7A; 500V; 1.10Ω; TO-3
3-287	UFN443	7A; 450V; 1.10Ω; TO-3
3-293	UFN450	13A; 500V; 0.4Ω; TO-3
3-293	UFN451	13A; 450V; 0.4Ω; TO-3
3-293	UFN452	12A; 500V; 0.5Ω; TO-3
3-293	UFN453	12A; 450V; 0.5Ω; TO-3
3-299	UFN510	4A; 100V; 0.6Ω; TO-220AB
3-299	UFN511	4A; 60V; 0.6Ω; TO-220AB
3-299	UFN512	3.5A; 100V; 0.8Ω; TO-220AB
3-299	UFN513	3.5A; 60V; 0.8Ω; TO-220AB
3-305	UFN520	8A; 100V; 0.30Ω; TO-220AB
3-305	UFN521	8A; 60V; 0.30Ω; TO-220AB
3-305	UFN522	7A; 100V; 0.40Ω; TO-220AB
3-305	UFN523	7A; 60V; 0.40Ω; TO-220AB
3-311	UFN530	14A; 100V; 0.18Ω; TO-220AB
3-311	UFN531	14A; 60V; 0.18Ω; TO-220AB
3-311	UFN532	12A; 100V; 0.25Ω; TO-220AB
3-311	UFN533	12A; 60V; 0.25Ω; TO-220AB
3-317	UFN540	27A; 100V; 0.085Ω; TO-220AB
3-317	UFN541	27A; 60V; 0.085Ω; TO-220AB
3-317	UFN542	24A; 100V; 0.11Ω; TO-220AB
3-317	UFN543	24A; 60V; 0.11Ω; TO-220AB
3-323	UFN610	2.5A; 200V; 1.5Ω; TO-220AB
3-323	UFN611	2.5A; 150V; 1.5Ω; TO-220AB
3-323	UFN612	2A; 200V; 2.4Ω; TO-220AB
3-323	UFN613	2A; 150V; 2.4Ω; TO-220AB
3-329	UFN620	5A; 200V; 0.8Ω; TO-220AB
3-329	UFN621	5A; 150V; 0.8Ω; TO-220AB
3-329	UFN622	4A; 200V; 1.2Ω; TO-220AB
3-329	UFN623	4A; 150V; 1.2Ω; TO-220AB
3-335	UFN630	9A; 200V; 0.4Ω; TO-220AB
3-335	UFN631	9A; 150V; 0.4Ω; TO-220AB
3-335	UFN632	8A; 200V; 0.6Ω; TO-220AB
3-335	UFN633	8A; 150V; 0.6Ω; TO-220AB
3-341	UFN640	18A; 200V; 0.18Ω; TO-220AB
3-341	UFN641	18A; 150V; 0.18Ω; TO-220AB
3-341	UFN642	16A; 200V; 0.22Ω; TO-220AB
3-341	UFN643	16A; 150V; 0.22Ω; TO-220AB
3-347	UFN710	1.5A; 400V; 3.6Ω; TO-220AB
3-347	UFN711	1.5A; 350V; 3.6Ω; TO-220AB
3-347	UFN712	1.3A; 400V; 5.0Ω; TO-220AB
3-347	UFN713	1.3A; 350V; 5.0Ω; TO-220AB

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PART NUMBER INDEX

PAGE	PART NUMBER	DESCRIPTION
		POWER MOSFET TRANSISTOR
3-353	UFN720	3A; 400V; 1.8Ω; TO-220AB
3-353	UFN721	3A; 350V; 1.8Ω; TO-220AB
3-353	UFN722	2.5A; 400V; 2.5Ω; TO-220AB
3-353	UFN723	2.5A; 350V; 2.5Ω; TO-220AB
3-359	UFN730	5.5A; 400V; 1.0Ω; TO-220AB
3-359	UFN731	5.5A; 350V; 1.0Ω; TO-220AB
3-359	UFN732	4.5A; 400V; 1.5Ω; TO-220AB
3-359	UFN733	4.5A; 350V; 1.5Ω; TO-220AB
3-365	UFN740	10A; 400V; 0.55Ω; TO-220AB
3-365	UFN741	10A; 350V; 0.55Ω; TO-220AB
3-365	UFN742	8A; 400V; 0.80Ω; TO-220AB
3-365	UFN743	8A; 350V; 0.80Ω; TO-220AB
3-371	UFN820	2.5A; 500V; 3.0Ω; TO-220AB
3-371	UFN821	2.5A; 450V; 3.0Ω; TO-220AB
3-371	UFN822	2.0A; 500V; 4.0Ω; TO-220AB
3-371	UFN823	2.0A; 450V; 4.0Ω; TO-220AB
3-377	UFN830	4.5A; 500V; 1.5Ω; TO-220AB
3-377	UFN831	4.5A; 450V; 1.5Ω; TO-220AB
3-377	UFN832	4.0A; 500V; 2.0Ω; TO-220AB
3-377	UFN833	4.0A; 450V; 2.0Ω; TO-220AB
3-383	UFN840	8.0A; 500V; 0.85Ω; TO-220AB
3-383	UFN841	8.0A; 450V; 0.85Ω; TO-220AB
3-383	UFN842	7.0A; 500V; 1.10Ω; TO-220AB
3-383	UFN843	7.0A; 450V; 1.10Ω; TO-220AB
3-389	UFND1Z0	0.5A; 100V; 2.4Ω; DIL-4
3-389	UFND1Z3	0.4A; 60V; 3.2Ω; DIL-4
3-395	UFND110	1.0A; 100V; 0.6Ω; DIL-4
3-395	UFND113	0.8A; 60V; 0.8Ω; DIL-4
3-401	UFND120	1.3A; 100V; 0.3Ω; DIL-4
3-401	UFND123	1.1A; 60V; 0.4Ω; DIL-4
3-407	UFND210	0.6A; 200V; 1.5Ω; DIL-4
3-407	UFND213	0.45A; 150V; 2.4Ω; DIL-4
3-413	UFND220	0.8A; 200V; 0.8Ω; DIL-4
3-413	UFND223	0.7A; 150V; 1.2Ω; DIL-4
3-419	UFNF110	3.5A; 100V; 0.6Ω; TO-39
3-419	UFNF111	3.5A; 60V; 0.6Ω; TO-39
3-419	UFNF112	3.5A; 100V; 0.8Ω; TO-39
3-419	UFNF113	3.5A; 60V; 0.8Ω; TO-39
3-425	UFNF120	6A; 100V; 0.30Ω; TO-39
3-425	UFNF121	6A; 60V; 0.30Ω; TO-39
3-425	UFNF122	5A; 100V; 0.40Ω; TO-39
3-425	UFNF123	5A; 60V; 0.40Ω; TO-39
3-431	UFNF130	8A; 100V; 0.18Ω; TO-39
3-431	UFNF131	8A; 60V; 0.18Ω; TO-39
3-431	UFNF132	7A; 100V; 0.25Ω; TO-39
3-431	UFNF133	7A; 60V; 0.25Ω; TO-3*
3-437	UFNF210	2.2A; 200V; 1.5Ω; TO-39
3-437	UFNF211	2.2A; 150V; 1.5Ω; TO-39
3-437	UFNF212	1.8A; 200V; 2.4Ω; TO-39
3-437	UFNF213	1.8A; 150V; 2.4Ω; TO-39
3-443	UFNF220	3.5A; 200V; 0.8Ω; TO-39
3-443	UFNF221	3.5A; 150V; 0.8Ω; TO-39
3-443	UFNF222	3.0A; 200V; 1.2Ω; TO-39
3-443	UFNF223	3.0A; 150V; 1.2Ω; TO-39
3-449	UFNF230	5.5A; 200V; 0.4Ω; TO-39
3-449	UFNF231	5.5A; 150V; 0.4Ω; TO-39
3-449	UFNF232	4.5A; 200V; 0.6Ω; TO-39
3-449	UFNF233	4.5A; 150V; 0.6Ω; TO-39
3-455	UFNF310	1.35A; 400V; 3.6Ω; TO-39
3-455	UFNF311	1.35A; 350V; 3.6Ω; TO-39
3-455	UFNF312	1.15A; 400V; 5.0Ω; TO-39
3-455	UFNF213	1.15A; 350V; 5.0Ω; TO-39
3-461	UFNF320	2.5A; 400V; 1.8Ω; TO-39
3-461	UFNF321	2.5A; 350V; 1.8Ω; TO-39
3-461	UFNF322	2.0A; 400V; 2.5Ω; TO-39
3-461	UFNF323	2.0A; 350V; 2.5Ω; TO-39
3-467	UFNF330	3.5A; 400V; 3.5Ω; TO-39
3-467	UFNF331	3.5A; 350V; 3.5Ω; TO-39
3-467	UFNF332	3.0A; 400V; 3.0Ω; TO-39
3-467	UFNF333	3.0A; 350V; 3.0Ω; TO-39
3-473	UFNF420	1.6A; 500V; 3.0Ω; TO-39
3-473	UFNF421	1.6A; 450V; 3.0Ω; TO-39
3-473	UFNF422	1.4A; 500V; 4.0Ω; TO-39
3-473	UFNF423	1.4A; 450V; 4.0Ω; TO-39
3-479	UFNF430	2.75A; 500V; 1.5Ω; TO-39
3-479	UFNF431	2.75A; 450V; 1.5Ω; TO-39
3-479	UFNF432	2.25A; 500V; 2.0Ω; TO-39
3-479	UFNF433	2.25A; 450V; 2.0Ω; TO-39
3-485	UFNZ20	15A; 50V; 0.10Ω; TO-220
3-485	UFNZ22	14A; 50V; 0.12Ω; TO-220
3-491	UFNZ30	30A; 50V; 0.05Ω; TO-220
3-491	UFNZ32	25A; 50V; 0.07Ω; TO-220
3-497	UFNZ40	51A; 50V; 0.28Ω; TO-220
3-497	UFNZ42	46A; 50V; 0.35Ω; TO-220
		RECTIFIER MODULE
5-183	UFS5	5.0kV
5-183	UFS7.5	7.5kV
5-183	UFS10	10kV
5-186	UGB5	5.0kV
5-186	UGB7.5	7.5kV
5-186	UGB10	10kV
5-186	UGD5	5.0kV
5-186	UGD7.5	7.5kV
5-186	UGD10	10kV
5-186	UGE2.5	2.5kV
5-186	UGE5	5.0kV
5-186	UGE7.5	7.5kV
5-186	UGF2.5	2.5kV
5-186	UGF5	5.0kV
5-186	UGF7.5	7.5kV
		PIN DIODE
9-13	UM4000 series	0.5Ω;3.0pF;25W;100-1200V
9-16	UM4300 series	1.5Ω;2.2pF;18W;100-1000V
9-13	UM4900 series	0.5Ω;3.0pF; 37W;100-600V
9-20	UM6000 series	1.7Ω;0.5pF; 6W;100-1000V
9-20	UM6200 series	0.4Ω; 1.1pF; 6W;100-400V
9-20	UM6600 series	2.5Ω;0.4pF; 4W;100-1000V
9-24	UM7000 series	1.0Ω;0.9pF;10W;100-1600V
9-24	UM7100 series	0.6Ω; 1.2pF;10W; 100-800V
9-24	UM7200 series	0.25Ω;2.2pF;10W;100-400V
9-16	UM7300 series	3.5Ω; 0.7pF; 7.5W; 100-1000V
9-28	UM9301 series	CATV Attenuator Diodes
9-31	UM9401 series	2-Way Radio Switch Diodes
9-31	UM9402 series	2-Way Radio Switch Diodes
9-31	UM9415	2-Way Radio Switch Diodes
9-35	UM9441	Radiation Detector
9-37	UM9601-UM9608	Microstrip PIN
9-47	UM9701	Low R_S Antenna Switch
		POWER TRANSISTOR
3-503	UMT1006	NPN; 5A; 400V; TO-3
3-503	UMT1007	NPN; 5A; 500V; TO-3
3-507	UMT1008	NPN; 8A; 300V; TO-3
3-507	UMT1009	NPN; 8A; 400V; TO-3
3-511	UMT1011	NPN; 15A; 400V; TO-3
3-511	UMT1012	NPN; 15A; 500V; TO-3
3-515	UMT1203	NPN; 3.0A; 300V; TO-220
3-515	UMT1204	NPN; 3.0A; 400V; TO-220
3-519	UMT2000	NPN; 15A; 850V; TO-3
3-523	UPTA510	NPN; 0.5A; 100V; TO-92
3-523	UPTA520	NPN; 0.5A; 200V; TO-92

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PAGE	PART NUMBER	DESCRIPTION
		POWER TRANSISTOR
3-523	UPTA530	NPN; 0.5A; 300V; TO-92
3-525	UPTB520	NPN; 0.1A; 200V; TO-92
3-525	UPTB530	NPN; 0.1A; 300V; TO-92
3-525	UPTB540	NPN; 0.1A; 400V; TO-92
3-525	UPTB550	NPN; 0.1A; 500V; TO-92
		RECTIFIER
5-189	UR105	2.0A; 50V
5-189	UR110	1.0A; 100V
5-189	UR115	1.0A; 150V
5-189	UR120	1.0A; 200V
5-189	UR125	1.0A; 250V
5-189	UR205	2.0A; 50V
5-189	UR210	2.0A; 100V
5-189	UR215	2.0A; 150V
5-189	UR220	2.0A; 200V
5-189	UR225	2.0A; 250V
*	UR710	1.0A; 100V
*	UR720	1.0A; 200V
		RECTIFIER MODULE
5-191	US12	1.2kV
5-191	US15	1.5kV
5-191	US18	1.8kV
5-191	US20	2.0kV
5-191	US25	2.5kV
5-191	US30	3.0kV
5-191	US35	3.5kV
5-191	US40	4.0kV
5-191	US45A	4.5kV
5-191	US50A	5.0kV
5-191	US60A	6.0kV
5-191	US70A	7.0kV
5-191	US80A	8.0kV
5-191	US100A	10kV
5-191	US120A	12kV
5-191	US150A	15kV
5-191	US180A	18kV
5-191	US200A	20kV
5-183	USB2.5	2.5kV
5-183	USB5	5.0kV
5-183	USB7.5	7.5kV
5-183	USB10	10kV
		SCHOTTKY RECTIFIER
5-195	USD245	4A; 45V; TO-39
5-195	USD245HR	4A; 45V; TO-39
5-198	USD320C	30A; 20V; TO-3
5-198	USD320CHR	30A; 20V; TO-3
5-198	USD335C	30A; 35V; TO-3
5-198	USD335CHR	30A; 35V; TO-3
5-198	USD345C	30A; 45V; TO-3
5-198	USD345CHR	30A; 45V; TO-3
5-200	USD520	75A; 20V; DO-5
5-200	USD535	75A; 35V; DO-5
5-200	USD545	75A; 45V; DO-5
5-200	USD550	75A; 50V; DO-5
5-202	USD620	6A; 20V; TO-220AC
5-204	USD620C	12A; 20V; TO-220AB
5-202	USD635	6A; 35V; TO-220AC
5-204	USD635C	12A; 35V; TO-220AB
5-202	USD640	6A; 40V; TO-220AC
5-204	USD640C	12A; 40V; TO-220AB
5-202	USD645	6A; 45V; TO-220AC
5-204	USD645C	12A; 45V; TO-220AB
5-206	USD720	8A; 20V; TO-220AC
5-208	USD720C	16A; 20V; TO-220AB
5-206	USD735	8A; 35V; TO-220AC

PAGE	PART NUMBER	DESCRIPTION
		SCHOTTKY RECTIFIER
5-208	USD735C	16A; 35V; TO-220AB
5-206	USD740	8A; 40V; TO-220AC
5-208	USD740C	16A; 40V; TO-220AB
5-206	USD745	8A; 45V; TO-220AC
5-208	USD745C	16A; 45V; TO-220AB
5-210	USD820	12A; 20V; TO-220AC
5-210	USD835	12A; 35V; TO-220AC
5-210	USD840	12A; 40V; TO-220AC
5-210	USD845	12A; 45V; TO-220AC
5-212	USD920	16A; 20V; TO-220AC
5-212	USD935	16A; 35V; TO-220AC
5-212	USD940	16A; 40V; TO-220AC
5-212	USD945	16A; 45V; TO-220AC
5-214	USD1120	1.0A; 20V; ASA
5-214	USD1130	1.0A; 30V; ASA
5-214	USD1140	1.0A; 40V; ASA
*	USD6035	60A; 35V; DO-5
*	USD6045	60A; 45V; DO-5
		SCHOTTKY MODULE
5-216	USM140C	100A; 40V; M1
5-216	USM145C	100A; 45V; M1
5-216	USM150C	100A; 50V; M1
		RECTIFIER MODULE
5-191	USR12	1.2kV
5-191	USR15	1.5kV
5-191	USR18	1.8kV
5-191	USR20	2.0kV
5-191	USR25	2.5kV
5-191	USR30	3.0kV
5-191	USR35	3.5kV
5-191	USR40A	4.0kV
5-191	USR45A	4.5kV
5-191	USR50A	5.0kV
5-191	USR60A	6.0kV
5-191	USR70A	7.0kV
5-191	USR80A	8.0kV
5-191	USR100A	10kV
5-191	USR120A	12kV
5-191	USR150A	15kV
5-191	USR180A	18kV
5-183	USS5	5.0kV
5-183	USS7.5	7.5kV
5-183	USS10	10kV
5-183	USS15	15kV
		RECTIFIER
*	UT111 (1N536)	0.75A; 50V
*	UT112 (1N537)	0.75A; 100V
*	UT113 (1N3656)	0.75A; 200V
*	UT114 (1N539)	0.75A; 300V
*	UT115 (1N3657)	0.75A; 400V
*	UT117 (1N547)	0.75A; 500V
*	UT118 (1N3658)	0.75A; 600V
*	UT119	0.75A; 800V
*	UT120	0.75A; 1000V
*	UT211 (1N645)	0.75A; 225V
*	UT212 (1N646)	0.75A; 300V
*	UT213 (1N647)	0.75A; 400V
*	UT214 (1N648)	0.75A; 500V
*	UT215 (1N649)	0.75A; 600V
*	UT221 (1N676)	0.5A; 100V
*	UT222 (1N677)	0.75A; 100V
*	UT223 (1N678)	0.5A; 200V
*	UT224 (1N679)	0.75A; 200V
*	UT225 (1N681)	0.5A; 300V
*	UT226 (1N682)	0.75A; 300V

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PART NUMBER INDEX

PAGE	PART NUMBER	DESCRIPTION
		RECTIFIER
*	UT227 (1N683)	0.5A; 400V
*	UT228 (1N684)	0.75A; 400V
*	UT229 (1N685)	0.5A; 500V
*	UT231 (1N686)	0.75A; 500V
*	UT232 (1N687)	0.5A; 600V
*	UT233 (1N689)	0.75A; 600V
5-218	UT234	1.0A; 200V
5-218	UT235	1.0A; 400V
5-218	UT236	1.0A; 100V
5-218	UT237	1.0A; 500V
5-218	UT238	1.0A; 600V
5-218	UT242	1.25A; 200V
5-218	UT244	1.25A; 400V
5-218	UT245	1.25A; 500V
5-218	UT247	1.25A; 600V
5-218	UT249	1.25A; 100V
5-218	UT251	1.5A; 100V
5-218	UT252	1.5A; 200V
5-218	UT254	1.5A; 400V
5-218	UT255	1.5A; 500V
5-218	UT257	1.5A; 600V
5-218	UT258	1.5A; 800V
5-218	UT261	2.0A; 100V
5-218	UT262	2.0A; 200V
5-218	UT264	2.0A; 400V
5-218	UT265	2.0A; 500V
5-218	UT267	2.0A; 600V
5-218	UT268	2.0A; 800V
5-218	UT347	1.0A; 1000V
5-218	UT361	1.0A; 800V
5-218	UT362	1.2A; 800V
5-218	UT363	1.2A; 1000V
5-218	UT364	1.5A; 1000V
5-221	UT2005	2.0A; 50V
5-221	UT2010	2.0A; 100V
5-221	UT2020	2.0A; 200V
5-221	UT2040	2.0A; 400V
5-221	UT2060	2.0A; 600V
*	UT2080	2.0A; 800V
*	UT3005	3.0A; 50V
5-221	UT3010	3.0A; 100V
5-221	UT3020	3.0A; 200V
5-221	UT3040	3.0A; 400V
5-221	UT3060	3.0A; 600V
*	UT3080	3.0A; 800V
5-221	UT4005	4.0A; 50V
5-221	UT4010	4.0A; 100V
5-221	UT4020	4.0A; 200V
5-221	UT4040	4.0A; 400V
5-221	UT4060	4.0A; 600V
*	UT4080	4.0A; 800V
*	UT4100	4.0A; 1000V
5-224	UT5105	7.5A; 50V
5-224	UT5105HR	7.5A; 50V
5-224	UT5110	7.5A; 100V
5-224	UT5110HR	7.5A; 100V
5-224	UT5120	7.5A; 200V
5-224	UT5120HR	7.5A; 200V
5-224	UT5130	7.5A; 300V
5-224	UT5130HR	7.5A; 300V
5-224	UT5140	7.5A; 400V
5-224	UT5140HR	7.5A; 400V
5-224	UT5150	7.5A; 500V
5-224	UT5150HR	7.5A; 500V
5-224	UT5160	7.5A; 600V
5-224	UT5160HR	7.5A; 600V
5-224	UT6105	9.0A; 50V
5-224	UT6105HR	9.0A; 50V
5-224	UT6110	9.0A; 100V
5-224	UT6110HR	9.0A; 100V
5-224	UT6120	9.0A; 200V
5-224	UT6120HR	9.0A; 200V
5-224	UT6130	9.0A; 300V
5-224	UT6130HR	9.0A; 300V
5-224	UT6140	9.0A; 400V
5-224	UT6140HR	9.0A; 400V
5-224	UT6160	9.0A; 600V
5-224	UT6160HR	9.0A; 600V
5-224	UT8105	12.0A; 50V
5-224	UT8105HR	12.0A; 50V
5-224	UT8110	12.0A; 100V
5-224	UT8110HR	12.0A; 100V
5-224	UT8120	12.0A; 200V
5-224	UT8120HR	12.0A; 200V
5-224	UT8130	12.0A; 300V
5-224	UT8130HR	12.0A; 300V
5-224	UT8140	12.0A; 400V
5-224	UT8140HR	12.0A; 400V
5-224	UT8160	12.0A; 600V
5-224	UT8160HR	12.0A; 600V
5-227	UTR01	1.0A; 50V
5-227	UTR02	2.0A; 50V
5-227	UTR10	0.5A; 100V
5-227	UTR11	1.0A; 100V
5-227	UTR12	2.0A; 100V
5-227	UTR20	0.5A; 200V
5-227	UTR21	1.0A; 200V
5-227	UTR22	2.0A; 200V
5-227	UTR30	0.5A; 300V
5-227	UTR31	1.0A; 300V
5-227	UTR32	2.0A; 300V
5-227	UTR40	0.5A; 400V
5-227	UTR41	1.0A; 400V
5-227	UTR42	2.0A; 400V
5-227	UTR50	0.5A; 500V
5-227	UTR51	1.0A; 500V
5-227	UTR52	2.0A; 500V
5-227	UTR60	0.5A; 600V
5-227	UTR61	1.0A; 600V
5-227	UTR62	2.0A; 600V
*	UTR70	0.5A; 700V
*	UTR71	1.0A; 700V
5-230	UTR2305	2.0A; 50V
5-230	UTR2310	2.0A; 100V
5-230	UTR2320	2.0A; 200V
5-230	UTR2340	2.0A; 400V
5-230	UTR2350	2.0A; 500V
5-230	UTR2360	2.0A; 600V
5-230	UTR3305	3.0A; 50V
5-230	UTR3310	3.0A; 100V
5-230	UTR3320	3.0A; 200V
5-230	UTR3340	3.0A; 400V
5-230	UTR3350	3.0A; 500V
5-230	UTR3360	3.0A; 600V
5-230	UTR4305	4.0A; 50V
5-230	UTR4310	4.0A; 100V
5-230	UTR4320	4.0A; 200V
5-230	UTR4340	4.0A; 400V
5-230	UTR4350	4.0A; 500V
5-230	UTR4360	4.0A; 600V
5-233	UTR4405	6.0A; 50V
5-233	UTR4405HR	6.0A; 50V

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PAGE	PART NUMBER	DESCRIPTION
		RECTIFIER
5-233	UTR4410	6.0A; 100V
5-233	UTR4410HR	6.0A; 100V
5-233	UTR4420	6.0A; 200V
5-233	UTR4420HR	6.0A; 200V
5-233	UTR4430	6.0A; 300V
5-233	UTR4430HR	6.0A; 300V
5-233	UTR4440	6.0A; 400V
5-233	UTR4440HR	6.0A; 400V
5-233	UTR5405	7.5A; 50V
5-233	UTR5405HR	7.5A; 50V
5-233	UTR5410	7.5; 100V
5-233	UTR5410HR	7.5A; 100V
5-233	UTR5420	7.5A; 200V
5-233	UTR5420HR	7.5A; 200V
5-233	UTR5430	7.5A; 300V
5-233	UTR5430HR	7.5A; 300V
5-233	UTR5440	7.5A; 400V
5-233	UTR5440HR	7.5A; 400V
5-233	UTR6405	9.0A; 50V
5-233	UTR6405HR	9.0A; 50V
5-233	UTR6410	9.0A; 100V
5-233	UTR6410HR	9.0A; 100V
5-233	UTR6420	9.0A; 200V
5-233	UTR6420HR	9.0A; 200V
5-233	UTR6430	9.0A; 300V
5-233	UTR6430HR	9.0A; 300V
5-233	UTR6440	9.0A; 400V
5-233	UTR6440HR	9.0A; 400V
5-236	UTX105	1.0A; 50V
5-236	UTX110	1.0A; 100V
5-236	UTX115	1.0A; 150V
5-236	UTX120	1.0A; 200V
5-236	UTX125	1.0A; 250V
5-236	UTX205	2.0A; 50V
5-236	UTX210	2.0A; 100V
5-236	UTX215	2.0A; 150V
5-236	UTX220	2.0A; 200V
5-236	UTX225	2.0A; 250V
5-239	UTX3105	3.0A; 50V
5-239	UTX3110	3.0A; 100V
5-239	UTX3115	3.0A; 150V
5-239	UTX3120	3.0A; 200V
*	UTX3125	3.0A; 250V
5-239	UTX4105	4.0A; 50V
5-239	UTX4110	4.0A; 100V
5-239	UTX4115	4.0A; 150V
5-239	UTX4120	4.0A; 200V
*	UTX4125	4.0A; 250V
		ZENER
6-29	UZ110-UZ119	3W; 5%
6-29	UZ110HR-UZ119HR	3W; 5%
6-29	UZ120-UZ140	3W; 5%
6-29	UZ140HR-UZ706HR	3W; 5%
6-29	UZ210-UZ219	3W; 10%
6-29	UZ220-UZ240	3W; 10%
6-29	UZ706-UZ760	3W; 5%
6-29	UZ770-UZ790	3W; 5%
6-29	UZ806-UZ860	3W; 10%
6-29	UZ870-UZ890	3W; 10%
6-31	UZ4110-UZ4120	5W; 5%
6-31	UZ4210-UZ4220	5W; 10%
6-31	UZ4706-UZ4791	5W; 5%
6-31	UZ4806-UZ4891	5W; 10%
6-33	UZ5110-UZ5119	5W; 5%
6-33	UZ5120	5W; 5%
6-33	UZ5210-UZ5240	5W; 10%
6-33	UZ5706-UZ5760	5W; 5%
6-33	UZ5770-UZ5790	5W; 5%
6-33	UZ5806-UZ5860	5W; 10%
6-33	UZ5870-UZ5890	5W; 10%
6-35	UZ7110	10W; 5%
6-35	UZ7110L	6W; 5%
6-35	UZ7210	10W; 10%
6-35	UZ7210L	6W; 10%
6-35	UZ7706-UZ7750	10W; 5%
6-35	UZ7706L-UZ7750L	6W; 5%
6-35	UZ7756-UZ7790	10W; 5%
6-35	UZ7756L-UZ7790L	6W; 5%
6-35	UZ7806-UZ7850	10W; 10%
6-35	UZ7806L-UZ7850L	6W; 10%
6-35	UZ7856-UZ7890	10W; 10%
6-35	UZ7856L-UZ7890L	6W; 10%
6-38	UZ8110-UZ8120	1W; 5%
6-38	UZ8210-UZ8220	1W; 10%
6-38	UZ8706-UZ8790	1W; 5%
6-38	UZ8806-UZ8890	1W; 10%
6-38	UZS306-UZS440	3W; 5%
6-38	UZS506-UZS640	3W; 10%

*Contact Unitrode
Legend: J—JAN JTX—JANTX JTXV—JANTXV

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.

LINEAR INTEGRATED CIRCUITS 2

Pulse Width Modulators - Product Selection Guide 2-3
Power Supply Support Functions - Product Selection Guide 2-4
Voltage Regulators - Product Selection Guide 2-5
Motor Control Circuits - Product Selection Guide 2-6
General Ordering Information/Screening Procedures 2-7
Process Flow Chart 2-8
Data Sheets 2-9

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

LINEAR INTEGRATED CIRCUITS

Pulse Width Modulators

TYPE	PERFORMANCE CHARACTERISTICS: Voltage Reference ± 4%	Voltage Reference ± 1%	Soft Start	PWM Latch	Under-Voltage Lockout	Pulse-by-Pulse Current Limiting	Shutdown Terminal	Output Current	Feed Forward	Maximum Frequency Oscillator	Dual Uncommitted Outputs	Single-Ended Output	Totem Pole Outputs	Separate Oscillator Sync Terminal	Adjustable Deadtime Control	Latch Off or Continuous Retry Mode	Double Pulse Suppression	Low Current Start Up	Package
Regulating PWMs UC1524/2524/3524	X					X		100mA		300kHz	X								16 Pin DIP
Advanced Regulating PWMs UC1524A/2524A/3524A		X		X	X	X	X	200mA		500kHz	X						X		16 Pin DIP
Advanced Regulating PWMs UC1525A/2525A/3525A		X	X	X	X		X	100mA 0.4A Pulse		500kHz			X	X	X				16 Pin DIP
Advanced Regulating PWMs UC1527A/2527A/3527A		X	X	X	X		X	100mA 0.4A Pulse		500kHz			X	X	X				16 Pin DIP
Advanced Regulating PWMs UC1526A/2526A/3526A		X	X	X	X	X	X	100mA		400kHz			X	X	X		X		18 Pin DIP
Regulating PWMs UC493/UC494/		X						200mA		300kHz	X				X		X		16 Pin DIP
UC495																			18 Pin DIP
Advanced Regulating PWMs UC493A/UC493AC UC494A/UC494AC		X			X			200mA		300kHz	X				X		X		16 Pin DIP
UC495A/UC495AC UC495B/UC495BC																			18 Pin DIP
Current Mode PWM Controllers UC1846/2846/3846		X	X	X	X	X	X	200mA	X	500kHz			X	X	X	X	X		16 Pin DIP
Current Mode PWM Controllers UC1847/2847/3847		X	X	X	X	X	X	200mA	X	500kHz			X	X	X	X	X		16 Pin DIP
Programmable Primary Side PWMs UC1840/2840/3840		X	X	X	X	X	X	200mA	X	500kHz		X			X	X	N/A	X	18 Pin DIP
Programmable Primary Side PWMs UC1842/2842/3842 UC1843/2843/3843		X		X	X	X		100mA 1A Pulse	X	500kHz		X			X		N/A	X	8 Pin DIP
High Frequency PWM Controllers UC1825/2825/3825		X	X	X	X	X		500mA 1.5A Pulse		500kHz & up		X	X	X	X		X	X	16 Pin DIP

Note: All series available screened to /883B Rev. C

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Power Supply Support Functions

TYPE	DESCRIPTION	KEY FEATURES	PACKAGE
UC1543/2543/3543 UC1544/2544/3544	Power Supply Supervisory Circuit, Monitors and Controls Power Supply Output	• Over/Under-Voltage, and Current Sensing Circuits • Programmable Time Delays • SCR "Crowbar" Drive of 300mA • Optional Over-Voltage Latch • Internal 1% Accurate Reference • Remote Activation Capability • Uncommitted Comparator • Inputs for Low Voltage Sensing (UC1544 series only)	16 Pin DIL (1543 Series) 18 Pin DIL (1544 series)
UC1706/2706/3706 UC1707/2707/3707	Dual High Current MOSFET Compatible Output Driver Dual Uncommitted High Current MOSFET Compatible Output Driver	• Dual, 1.5A, Totem Pole Outputs • Parallel or Push-Pull Operations • Single-Ended to Push-Pull Conversion (1706 series) • Internal Overlap Protection • Analog, Latched Shutdown • High-Speed, Power MOSFET Compatible • Thermal Shutdown Protection • 5 to 40V Operation • Low Quiescent Current	16 Pin DIL "Batwing"
UC1834/2834/3834	High Efficiency Linear Regulator, Low Input-Output Differential	• Minimum V_{IN}—V_{OUT} less than 0.5V at 5A Load with External Pass Device • Equally Usable for either Positive or Negative Regulator Design • Adjustable Low Threshold Current Sense Amplifier • Under- and Over-Voltage Fault Alert with Programmable Delay • Over-Voltage Fault Latch with 100mA Crowbar Drive Output	16 Pin DIL
UC1901/2901/3901	Isolated Feedback Generator Stable and Reliable Alternative to an Optical Coupler	• An Amplitude-Modulation System for Transformer Coupling an Isolated Feedback Error Signal • Internal 1% Reference and Error Amplifier • Loop Status Monitor • Low-Cost Alternative to Optical Couplers • Internal Carrier Oscillator Usable to 5MHz • Modulator Synchronizable to an External Clock	14 Pin DIL
UC1903/2903/3903	Quad Supply and Line Monitor Precision System	• Monitor Four Power Supply Output Voltage Levels • Both Over- and Under-Voltage Indicators • Internal Inverter for Negative Level Sense • Adjustable Fault Window • Additional Input for Early Line Fault Sense • On Chip, High-Current General Purpose OP-AMP	18 Pin DIL

Product Applications

PRODUCT/SERIES	TYPICAL APPLICATIONS
UC1704/3704 Bridge Transducer Switch	Any Analog to Digital monitoring system; coupled with any of a wide range of sensors almost any type of physical phenomena may be monitored. Samples: • Air-Flow Sensor Circuits • Liquid or Gas Flow Circuits • Passing Object circuits
UC1906/2906 Lead-Acid Battery Charger	"IC Circuitry that results in optimized charge cycles for specific battery applications" • Uninterruptable Power Supplies • Portable Electrical Equipment • Emergency Power and Light Systems • Volatile Data Handling Computers — Power back-up

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Voltage Regulators

Three Terminal Voltage Regulators, Adjustable

TYPE	OUTPUT CURRENT (A)	POLARITY	REGULATED OUTPUT VOLTAGE (V)	PACKAGE
UC117K/LM117K UC217K/LM217K *UC317K/LM317K	1.5A	Pos.	Adjustable from 1.2V to 37V	TO-3 TO-3 TO-3
UC137K/LM137K UC237K/LM237K *UC337K/LM337K	1.5A	Neg.	Adjustable from −1.2V to −37V	TO-3 TO-3 TO-3
UC150K/LM150K UC250K/LM250K *UC350K/LM350K	3.0A	Pos.	Adjustable from 1.2V to 33V	TO-3 TO-3 TO-3

Three Terminal Voltage Regulators, Fixed, Positive

TYPE	OUTPUT CURRENT (A)	POLARITY	REGULATED OUTPUT VOLTAGE (V)			PACKAGE
UC7800AK/LM140AK SERIES *UC7800ACK/LM340AK SERIES	1.5A	Pos.	5V ± 1%	12V ± 1%	15V ± 1%	TO-3 TO-3
UC7800K/LM140K SERIES *UC7800CK/LM340K SERIES	1.5A	Pos.	5V ± 4%	12V ± 4%	15V ± 4%	TO-3 TO-3

Three Terminal Voltage Regulators, Fixed, Negative

TYPE	OUTPUT CURRENT (A)	POLARITY	REGULATED OUTPUT VOLTAGE (V)			PACKAGE
UC7900AK/LM120K SERIES *UC7900ACK SERIES	1.5A	Neg.	−5V ± 1%	−12V ± 1%	−15V ± 1%	TO-3 TO-3
UC7900K SERIES *UC7900CK/LM320K SERIES	1.5A	Neg.	−5V ± 4%	−12V ± 4%	−15V ± 4%	TO-3 TO-3

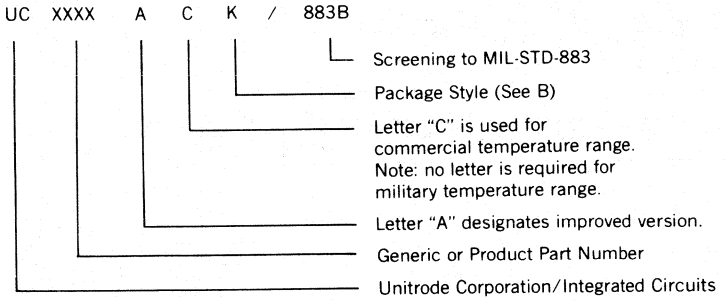
*** Also available in TO-220 package.**

Motor Control Integrated Circuits

TYPE	DESCRIPTION	TYPICAL APPLICATION	V_C	V_{SS}	I_{OUT}	P_D	PACKAGE
L292	H-Bridge Transconductance Amplifier with PWM Current Control.	DC Motors, Torque Control, Stepping Motors, Microstepping, Solenoid Controlled Valves.	18V to 36V		2.0A Cont.	25W Max.	15 Pin Power Tab
L293	Four Totem-Pole Drivers.	DC Motors Stepping Motors Solenoids Other Inductive or Resistive Loads.	36V Max.	4.5V to 36V	1.0A Cont.	2.0W Max.	16 Pin Dip "Batwing"
L293D	L293 with Eight Bridge Diodes; Reduced I_{OUT}.		36V Max.	4.5V to 36V	0.6A Cont.	2.0W Max.	
L295	Dual Solenoid Driver with Current Control.	Hammer Driver in Matrix Printers Solenoid Driver Motor Driver	12V to 46V	4.5V to 10V	2.0A Cont.	25W Max.	15 Pin Power Tab
L298	Dual Full-Bridge with Individual Logic Inputs for Each Bridge.	Power Stage for Motor and Solenoid Drivers. Low Standby Power Drain makes it Ideal for Battery Operated Equipment.	Vss to 46V	4.5V to 7.0V	2.0A Cont.	25W Max.	15 Pin Power Tab
UC3610*	Dual Diode Bridge with Eight Schottky Diodes (V_f = 1V @ 2A)	Use as Circulating Diodes with Motor or Solenoid Drivers.	40V Max.		3.0A Max.	1.0W Max.	8 Pin Dip
UC3620	Brushless DC Motor with Switching Current Control.	Drive Brushless DC Motors with 60 Mechanical Degree Hall Devices. Other Decoding Options available.	40V Max.		2.0A Cont.	25W Max.	15 Pin Power Tab
UC3637*	PWM Driver for DC Servomotors; Current Limit, Under-Voltage Lock-Out.	Drive Bipolar or MOSFET Power H-Bridge in DC Velocity and Position Servo-Loops.	40V Max.		500mA Peak	2.0W Max.	18 Pin Dip
UC3706*† UC3707*††	Dual Driver for Power MOSFETs; 50nsec into 1000pF, 1.5A Peak. TTL Compatible Inputs.	Interface between Low-Level Functions and High Power Control Devices, Particularly Power MOSFETs.	40V Max.	40V Max.	1.5A Peak	2.0W Max.	16 Pin Dip "Batwing"
UC3717*	Stepping Motor Phase Driver; TTL Compatible Inputs. Pulse-by-Pulse Current Control, and Full Output H-Bridge with Diodes	Stepping Motor Driver in Full-Step, Half-Step, or Microstep Mode. Separate Digital Control Sets Current at 100%, 60%, 19%. Bipolar Operation.	10V to 40V	4.75V to 5.25V	1.0A Peak	2.0W Max.	16 Pin Dip "Batwing"
UC3517	Stepping Motor Driver Unipolar, Bilevel. Minimal RFI. Activates Both Motor Phases.	Driver for Stepping Motor in Applications Requiring Least Possible RFI. Internal Logic for Full-Step/Half-Step. High Voltage Pulse Width Set by Single RC.	10V to 40V	4.75V to 5.25V	350mA Cont.	1.6W Max.	16 Pin Dip
UC3770	Stepping Motor Phase Driver Pin Compatible with UC3717, but with Higher Output Current and No Circulating Diodes.	See UC3717 Application	10V to 40V	4.75V to 5.25V	1.5A Peak	2.0W Max.	16 Pin Dip "Batwing"

* Also available in MIL temp ranges
† Single ended to push-pull conversion
†† Dual uncommitted outputs

A. PART NUMBER DESIGNATORS



B. PACKAGE SUFFIXES

Letter Designator	Package Type
K	— TO-3 (steel)
T	— TO-220
N	— 16 or 18 Pin Molded DIP
J	— 16 or 18 Pin Ceramic DIP
D	— 14 Pin SO
L	— 20 Pin Ceramic LCC
Q	— 20 Pin Plastic LCC

C. HI-REL SCREENING

Unitrode offers devices screened to MIL-STD-883, customer requirements, and will perform tests as specified by MIL-M-38510.

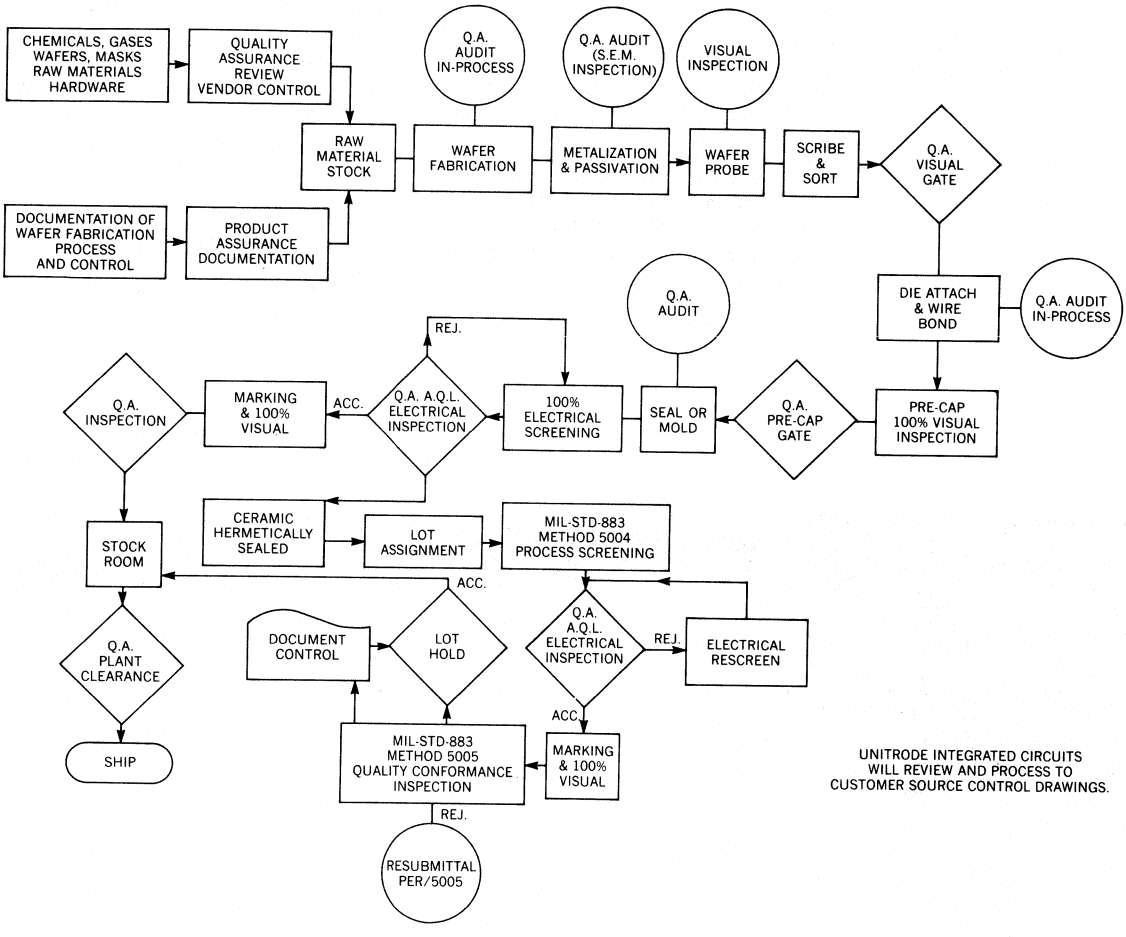
When ordering MIL-STD-883 Screening, specify:

- Prime electrical and military temperature range, generic part number and package type
- Class of 883 screening (class B) Example: UC1524J/883B

MIL-STD-883 SCREENING PROCEDURES

	MIL-STD-883, CLASS B		MIL-STD-883, CLASS C	
SCREEN	METHOD	REQM'T	METHOD	REQM'T
Internal Visual Pre or Post Cap	2010, Condition B	100%	2010, Condition B	100%
Stabilization Bake	1008, Condition C 24 Hours @ 150°C	100%	1008, Condition C 24 Hours @ 150°C	100%
Temperature Cycling	1010, Condition C 10 Cycles, −65°C to +150°C	100%	1010, Condition C 10 Cycles, −65°C to +150°C	100%
Constant Acceleration	2001, Condition E 30,000 g, Y_1 Plane	100%	2001, Condition E 30,000 g, Y_1 Plane	100%
Pre-Burn-in Electrical Test	Per Applicable Procurement Document	100%		
Burn-in Test	1015, Condition A or F 168 hours @ 125°C	100%		
Final Electrical Test	Per Applicable Procurement Document		Per Applicable Procurement Document	
a) DC @ 25°C		100%		100%
b) DC @ Max. and Min. Rated Temperature		100%		
c) Dynamic @ 25°C		100%		
d) Functional @ 25°		100%		100%
Hermeticity a) Fine	1014, Condition A Helium 5 x 10^{-8} atm/cc/sec	100%	1014, Condition A Helium 10^{-7} atm/cc/sec	100% LTPD
b) Gross	1014, Condition C2 Fluorocarbon	100%	1014, Condition C2 Fluorocarbon	100% LTPD
Radiographic				
Qualification and Quality Conformance Testing	Method 5005	Per Applicable Document	DC Electrical @ 25°C	5% LTPD
External Visual	Method 2009	100%	Method 2009	100%

UNITRODE INTEGRATED CIRCUITS PROCESS FLOW



UNITRODE INTEGRATED CIRCUITS WILL REVIEW AND PROCESS TO CUSTOMER SOURCE CONTROL DRAWINGS.

UNITRODE ASSEMBLY PACKAGE CODE	ASSEMBLY LOCATION CLASS B PRODUCT
K	Korea
S	Philippines — S.M.I.
P	Philippines — S.D.P.I.
T	Philippines — Telefunken
I	U.S.A. — Indy

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

LINEAR INTEGRATED CIRCUITS
Switchmode Driver for DC Motors

FEATURES
- Driving capability: 2A, 36V, 30KHz
- Two logic chip enable inputs
- External loop gain adjustment
- Single power supply (18 to 36V)
- Input signal symmetric to ground
- Thermal protection

DESCRIPTION
The L292 is a monlithic LSI circuit in a 15-lead Multiwatt® package. It is intended to drive DC motors controlling positioning devices such as used in typewriters, printers, plotters and other computer peripherals.

The device contains a level shifter, triangle waveform oscillator, error amplifier, PWM comparator, current sensing amplifier, H-bridge output stage with a 2A, 36V driving capability and two output enable inputs. Protection circuitry includes under-voltage output inhibit and thermal protection.

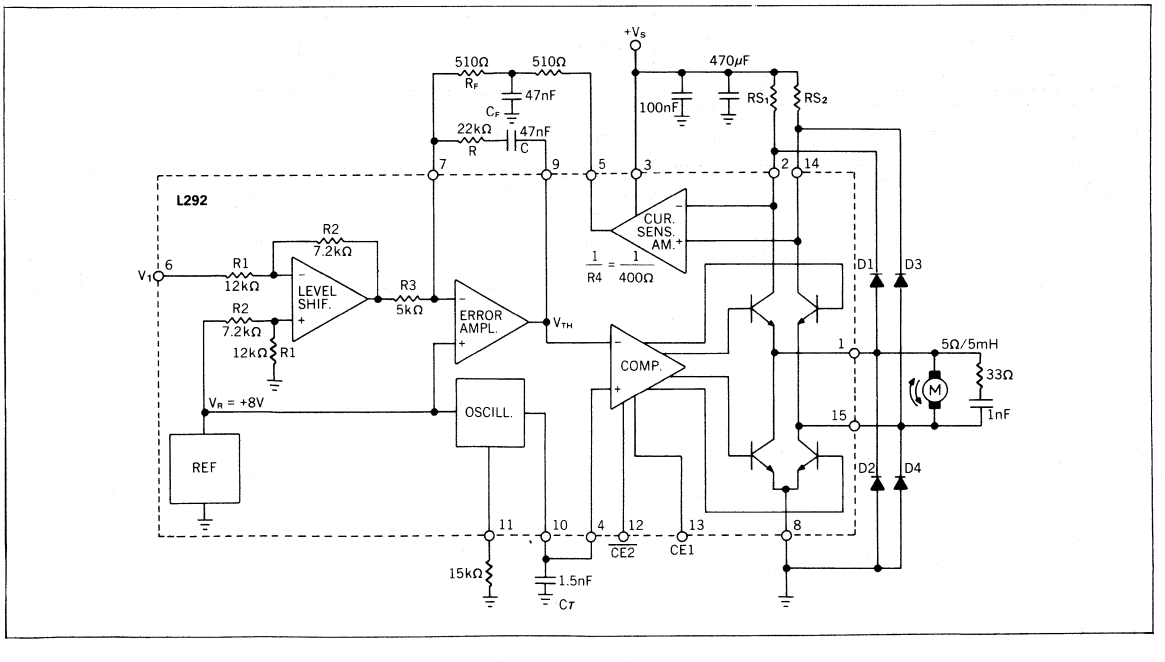
ABSOLUTE MAXIMUM RATINGS

Power Supply, V_s 36V
Input Voltage, V_1 ..... −15 to +V_sV
Inhibit Voltage, $V_{inhibit}$ ..... 0 to V_sV
Output Current, I_o 2.5A
Total Power Dissipation (T_{case} = 75°C) 25W
Storage and Junction Temperature, T_{stg} .....−40 to +150°C
Thermal Resistance Junction-Case, θ_{JC} ..... 3°C/W

THERMAL DATA

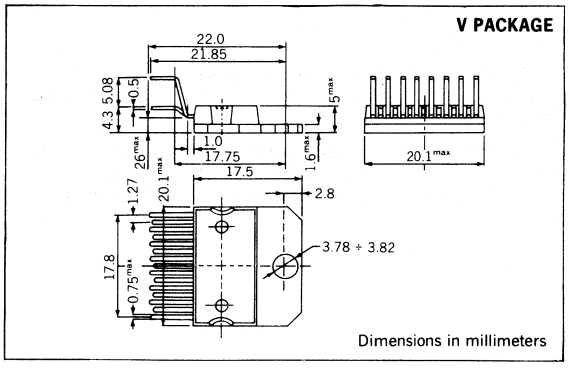
Thermal Resistance Junction-Case, θ_{JC} ..... 3°C/W max

BLOCK DIAGRAM

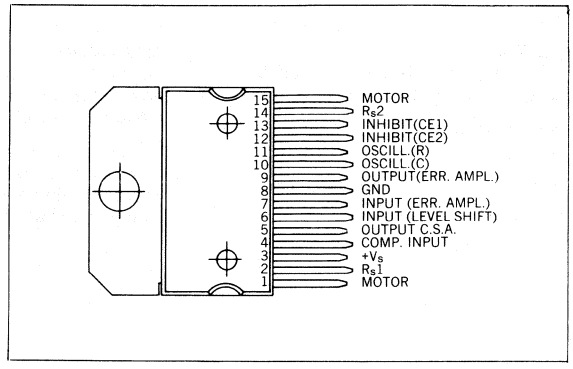


UNITRODE

MECHANICAL DATA



CONNECTION DIAGRAM



ELECTRICAL CHARACTERISTICS (T_A = 25°C; f_{osc} = 20KHz unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNITS
Supply Voltage	V_s			18		36	V
Quiescent Drain Current	I_d	V_s = 20V (offset null)			30	50	mA
Input Offset Voltage (Pin 6)	V_{os}	V_s = 36V, I_o = 0				±350	mV
Inhibit Input Voltage (Pin 12, 13)	$V_{inh.}$ L					2	V
	$V_{inh.}$ H			3.2			V
Inhibit Input Current	$I_{inh.}$ L	$V_{inh.}$ (L) = 0.4V				-100	μA
	$I_{inh.}$ H	$V_{inh.}$ (H) = 3.2V				10	μA
Input Current (Pin 6)	I_i		V_I = -8.8V			-1.8	mA
			V_I = +8.8V			0.5	mA
Input Voltage (Pin 6)	V_i	$R_{S1} = R_{S2} = 0.2\Omega$	I_o = 2A		9.1		V
			I_o = -2A		-9.1		V
Output Current	I_o	V_I ± 9.8V, $R_{S1} = R_{S2} = 0.2\Omega$		±2			A
Total Drop Out Voltage	V_D	(including sensing resistors)	I_o = 2A			5	V
			I_o = 1A			3.5	V
Sensing Resistor Voltage Drop	V_{RS}	T_j = 150°C, I_o = 2A				0.44	V
Transconductance	$\frac{I_o}{V_i}$	$R_{S1} = R_{S2} = 0.2\Omega$		220	240	260	mA/V
		$R_{S1} = R_{S2} = 0.4\Omega$			120		mA/V
Frequency Range (Pin 10)	f_{osc}			1		30	KHz

TRUTH TABLE

$V_{inhibit}$		Output Stage Condition
Pin 12	Pin 13	
L	L	Disabled
L	H	Normal Operation
H	L	Disabled
H	H	Disabled

FUNCTIONAL DESCRIPTION

The error signal input has been designed to accept a bidirectional error signal symmetrical to ground. The level shifter converts the ± error signal into a single positive signal with the aid of an internally generated 8V reference. This same reference voltage supplies the triangle wave oscillator whose frequency is fixed by the external RC network (R_T, C_T - pins 11 and 10) where:

$$f_{osc} = \frac{1}{2RC} \quad (\text{with } R \geq 8.2K\Omega)$$

The oscillator determines the switching frequency of the output stage and should be in the range 1 to 30KHz.

Motor current is regulated by an internal loop in the L292 which is performed by the resistors R_{S1}, R_{S2} and the differential current sense amplifier, the output of which is filtered by an external RC network and fed back to the error amplifier.

The choice of the external components in this RC network (pins 5, 7, 9) is determined by the motor type and the bandwidth requirements. The values shown in the diagram are for a 5Ω, 5mH motor. (See L292 Transfer Function Calculation in Application Information).

The error signal obtained by the addition of the input and the current feedback signals (pin 7) is used to pulse width modulate the oscillator signal by means of the comparator. The pulse width modulated signal controls the duty cycle of the H-bridge to give an output current corresponding to the L292 input signal.

The interval between one side of the bridge switching off and the other switching on, τ, is programmed by C_τ in conjunction with an internal resistor R_τ.

This can be found from:

$\tau = R_\tau \cdot C_{PIN\ 10}$ (C_τ in the diagram)

Since R_τ is approximately 1.5 KΩ and the recommended τ to avoid simultaneous conduction is 2.5μS, $C_{PIN\ 10}$ should be around 1.5nF.

The current sense resistors R_{S1} and R_{S1} should be high precision types (maximum tolerance ±2%) and the recommended value is given by:

$R_{max} \cdot I_{o\ max} \leq 0.44V$

It is possible to synchronize two L292s, if desired, using the network shown in Figure 1.

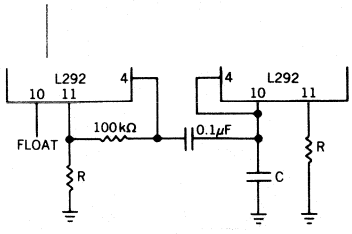


Figure 1.

Finally, two enable inputs are provided on the L292 (pins 12 and 13-active low and high respectively). Thus the output stage may be inhibited by taking pin 12 high or by taking pin 13 low. The output will also be inhibited if the supply voltage falls below 18V.

The enable inputs were implemented in this way because they are intended to be driven directly by a microprocessor. Currently available microprocessors may generate spikes as high as 1.5V during power-up. These inputs may be used for a variety of applications such as motor inhibit during reset of the logical system and power-on reset (see Figure 2).

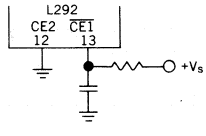


Figure 2.

APPLICATION INFORMATION

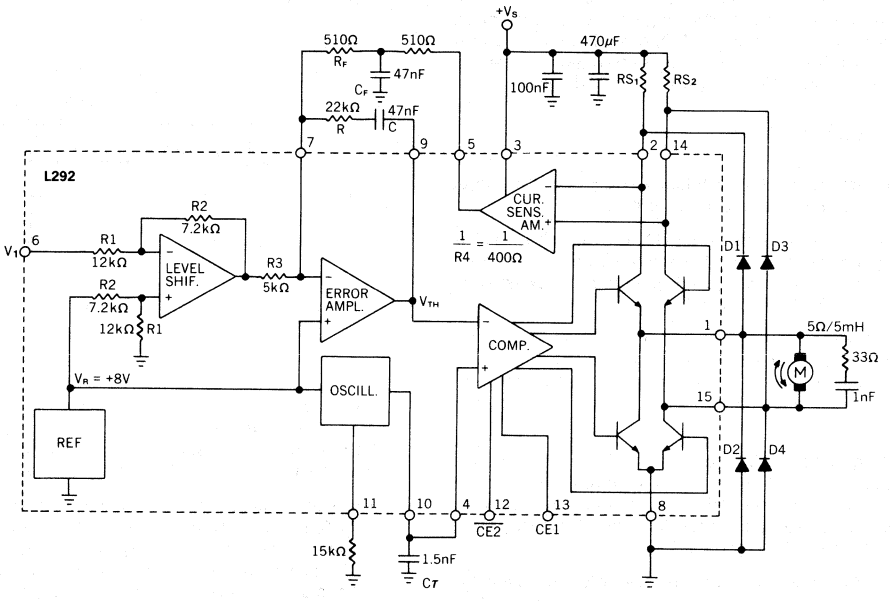
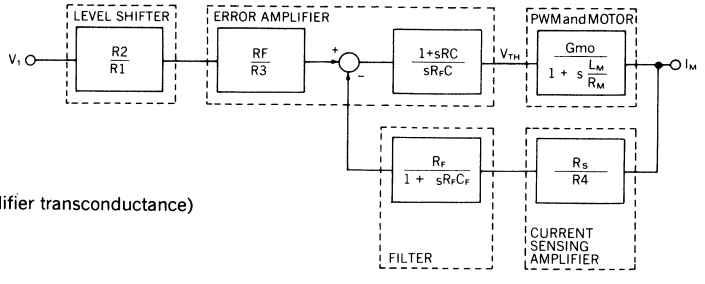


Figure 3.

The schematic diagram used for the Laplace analysis of the system is shown in Figure 4.



$R_{S1} = R_{S2} = R_s$ (sensing resistors)

$\frac{1}{R_4} = 2.5 \cdot 10^{-3} \Omega$ (current sensing amplifier transconductance)

L_M = Motor inductance

R_M = Motor resistance

I_M = Motor current

$G_{mo} = \frac{I_M}{V_{TH}}\Big|_{s=0}$ (DC transfer function from the input of the comparator (V_{TH}) to the motor current (I_M)).

Figure 4.

APPLICATION INFORMATION (continued)

Neglecting the $V_{CE\ sat}$ of the bridge transistor and the V_{BE} of the diodes:

$$G_{mo} = \frac{1}{R_M}\frac{2V_S}{V_R} \quad \text{where: } V_S = \text{supply voltage} \qquad (1)$$

V_R = 8V (reference voltage)

DC Transfer Function

In order to be sure that the current loop is stable the following condition is imposed:

$$1 + sRC = 1\ s\frac{L_M}{R_M} \qquad \text{(pole cancellation)} \qquad (2)$$

$$\text{from which } RC = \frac{L_M}{R_M} \qquad \text{(Note that in practice R must be greater than 5.6KΩ)}$$

The transfer function is then, (3)

$$\frac{I_M}{V_i}(s) = \frac{R_2R_4}{R_1R_3}\,G_{mo}\,\frac{1 + sR_FC_F}{G_{mo}R_s + s\,R_4C + s^2\,R_FC_FR_4C}$$

In DC condition, this is reduced to

$$\frac{I_M}{V_i}(o) = \frac{R_2R_4}{R_1R_3}\cdot\frac{1}{R_s} = \frac{0.048}{R_s}\left[\frac{A}{V}\right]$$

Open-Loop Gain and Stability Criterion

For $RC = L_M/R_M$, the open loop gain is: (5)

$$A\beta = \frac{1}{sR_FC}\cdot G_{mo}\,\frac{R_s}{R_4}\,\frac{R_F}{1 + sR_FC_F} = \frac{G_{mo}\,R_s}{R_4C}\,\frac{1}{s\,(1 + sR_FC_F)}$$

In order to achieve good stability, the phase margin must be greater than 45°C when $|A\beta| = 1$.

That means that, at $f_F = \frac{1}{2\pi R_FC_F}$, $|A\beta|$ must be < 1

(see Figure 5), that is:

$$|A\beta|\ f = \frac{1}{2\pi R_FC_F} = \frac{G_{mo}R_s}{R_4C}\,\frac{R_FC_F}{\sqrt{2}} < 1 \qquad (6)$$

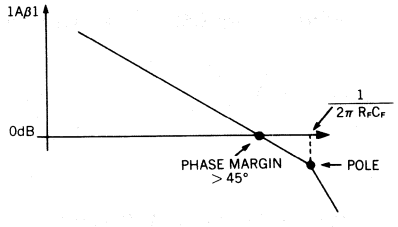


Figure 5. Open-Loop Frequency Response

Closed-Loop System Step Response

a) Small-signals analysis

The transfer function (3) can be written as follows:

$$\frac{I_M}{V_i}(s) = \frac{0.048}{R_s}\,\frac{1 + \frac{s}{2\,\xi\,\omega_o}}{1 + \frac{2\xi s}{\omega_o} + \frac{s^2}{\omega_o^2}} \qquad (7)$$

where: $\omega_o = \sqrt{\frac{G_{mo}R_s}{R_4C\ R_FC_F}}$ is the cutoff frequency

where: $\xi = \sqrt{\frac{R_4C}{4\ R_FC_F\ G_{mo}\ R_s}}$ is the damping factor

By choosing the ξ value, it is possible to determine the system response to an input step signal. Examples:

1) $\xi = 1$ from which

$$I_M(t) = \frac{0.048}{R_s}\left[1 - e^{-\frac{t}{2R_FC_F}}\left(1 + \frac{t}{4\ R_FC_F}\right)\right]\cdot V_i$$

(where V_i is the amplitude of the input step).

2) $\xi = \frac{1}{\sqrt{2}}$ from which

$$I_M(t) = \frac{0.048}{R_s}\left(1 - \cos\frac{t}{2R_FC_F}\,e^{-\frac{t}{2\,R_FC_F}}\right)V_i$$

From Figure 7 it is possible to verify that the L292 works in "closed-loop" conditions during the entire motor current rise-time: the voltage at pin 7 (inverting input of the error amplifier is locked to the reference voltage V_R, present at the non-inverting input of the same amplifier.

The previous linear analysis is correct for this example.

Decreasing the ξ value, the rise-time of the current decreases. But for a good stability, from relationship (6), the minimum value of ξ is:

$$\xi_{min} = \frac{1}{2\sqrt[4]{2}} \qquad \text{(phase margin = 45°)}$$

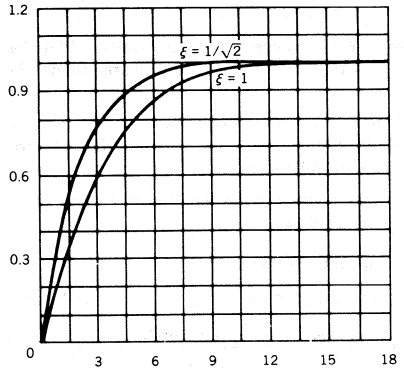
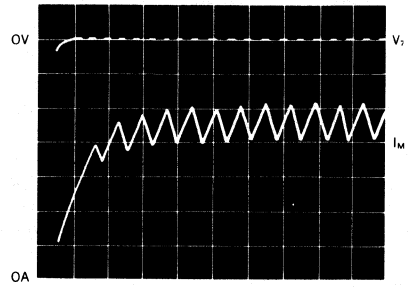


Figure 6. Small Signal Step Response (Normalized Amplitude vs t/R_FC_F)

APPLICATION INFORMATION (continued)

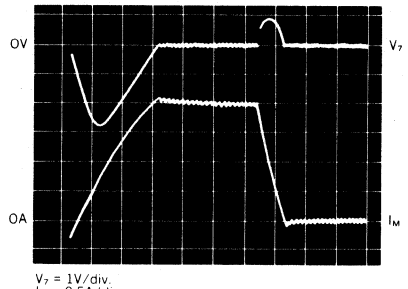


V_7 = 200mV/div.
I_M = 100mA/div.
t = 100μs/div.
with V_s = 1.5 Vp.

Figure 7. Motor Current and Pin 7 Voltage Waveforms (Application of Figure 3). Small Signal Response

b) Large signal response

The large step signal response is limited by slew-rate and inductive load. In this case, during the rise-time of the motor current, the L292 works in open-loop condition, as can be seen from Figure 8.



V_7 = 1V/div.
I_M = 0.5A/div.
t = 500μs/div.

Figure 8. Motor Current and Pin 7 Voltage Waveforms (Application of Figure 3). Large Signal Response

The voltage at pin 7 (inverting input of the error amplifier) departs from the reference voltage V_R present at the non-inverting input and the feedback loop is open.

The feedback loop is on when the motor current reaches its steady-state value (2A).

Closed Loop System Bandwidth

A good choice for ξ is the value $1/\sqrt{2}$. In this case:

$$\frac{I_M}{V_i}(s) = \frac{0.048}{R_s} \cdot \frac{1 + s\,R_F C_F}{1 + 2s\,R_F C_F + 2s^2 R_F^2 C_F^2} \qquad (8)$$

The module of the transfer function is: (9)

$$\left|\frac{I_M}{V_i}\right| = \frac{0.048}{R_s} \cdot \frac{2\sqrt{1 + \omega^2 R_F^2 C_F^2}}{\sqrt{[(1 + 2\omega R_F C_F)^2 + 1] \cdot [(1 - 2\omega R_F C_F)^2 + 1]}}$$

The cutoff frequency is derived from expression (9) by putting

$$\left|\frac{I_M}{V_i}\right| = 0.707 \cdot \frac{0.048}{R_s} \text{ (-3dB);}$$

from which:

$$\omega_T = \frac{0.9}{R_F C_F} \qquad f_T = \frac{0.9}{2\pi R_F C_F} \qquad (10)$$

Note that R_F must be less than 1.5KΩ in order to have the maximum current swing at the output of current sensing amplifier.

Working Frequency and Motor Current Ripple

For a value of rotation speed ω the e.m.f. E is equal to $K_E\omega$, where K_E is the motor speed constant.

Neglecting the motor resistance R_M, the V_{CEsat} of the bridge transistors and the V_{BE} of the diodes, we have:

$$\Delta t_1 = \frac{\Delta I_M}{V_s - E} L_M \quad \text{(transistors conduction period)} \qquad (11)$$

$$\Delta t_2 = \frac{\Delta I_M}{V_s + E} L_M \quad \text{(diodes conduction period)}$$

Where ΔI_M is the current ripple in the motor (see Figure 9).

The working frequency is:

$$f = \frac{1}{2\,R_T C_T} = \Delta t_1 = \Delta t_2 \qquad (12)$$

where R_T is the resistance at pin 11 and C_T the capacitor at pin 10. R_T must be ≥8.2KΩ due to the output current capability at pin 11.

If we consider E = 0 (ω = 0; motor stopped) we have:

$$\Delta t_1 = \Delta t_2 = \frac{\Delta I_M}{V_s} L_M \qquad (13)$$

from this formula we can write

$$\Delta I_M = \frac{V_s}{L_M} \frac{T}{2} \qquad (\frac{T}{2} = \Delta t_1 = \Delta t_2 = \text{half period}) \qquad (13 \text{ bis})$$

The motor current ripple ΔI_M must be limited in order to reduce dissipation in the motor and the peak output current of the L292.

ΔI_{Mmax} should be less than 10% of I_{Mmax} (see Figure 9).

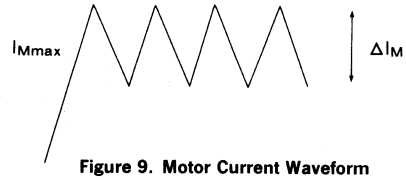


Figure 9. Motor Current Waveform

From the equation (13 bis) and considering $\Delta I_M = 0.1\ I_{M\,max}$ we have:

$$0.1\ I_{Mmax} = \frac{V_s}{2f\ L_{Mmin}} \qquad (14)$$

from which:

$$L_{Mmin} = \frac{5\ V_s}{f\ I_{Mmax}} \qquad (15)$$

The switching characteristics of the L292 demand that the working frequency f is less than 30KHz.

If for f = 30KHz, L_M is less than $L_{M\,min}$, an external inductor should be put in series with the motor.

From relationship (15) we have:

$$L_{series} = \frac{5\,V_s}{f\,I_{M\,max}} - L_M \qquad (16)$$

Deadtime

A problem associated with the system used in the L292 is the danger of simultaneous conduction in both legs of the output bridge which, if it were allowed to occur would damage them. To overcome this the comparator that drives the final stage in effect consists of two separate comparators (Figure 10): both receive the same Vt signal but on opposite inputs. The other two inputs are driven by V_{TH} shifted by plus or minus $R_T I'$. This voltage shift when compared with Vt results in a delay in switching from one comparator to the other. In this way there will always be a delay between switching off one leg of the bridge and switching on the other. The delay τ is a function of the integrated resistor R_T (1.5K) and an external capacitor C_T connected to pin 10 which also fixes oscillator frequency.

It is: $\tau = R_T C_T$

In a typical application, a capacitor of 1.5nF is used to give a switching delay of 2.25μs, a more than adequate time when you consider that the switch-off delay of the integrated transistors is only 0.5μs.

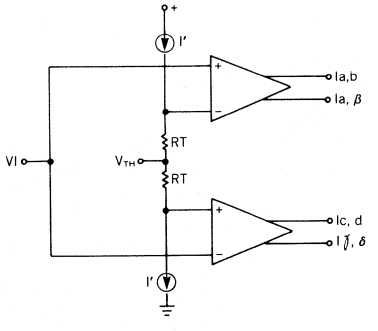


Figure 10. L292 Deadtime Control

Efficiency and Power Dissipation

The expression for the bridge efficiency, independently of the losses due to the switching times and neglecting the dissipation due to the motor current ripple, is:

$$\eta = 1 - \frac{\Delta t_1}{\Delta t_1 + \Delta t_2} \cdot \frac{V_{sat}}{V_s} - \frac{\Delta t_2}{\Delta t_1 + \Delta t_2} \cdot \frac{V_{over}}{V_s} \qquad (17)$$

where $V_{over} \cong 2V\ (2V_{BE} + R_s I_M)$
$V_{sat} \cong 4V\ (2V_{CE\,sat} + 3V_{BE})$
Δt_1 = transistors conduction period.
Δt_2 = diodes conduction period.

If $\Delta t_1 \gg \Delta t_2$ and $V_s = 20V$, we obtain:

$$\eta = 1 - \frac{4}{20} = 80\% \qquad (18)$$

In practice, the efficiency will be slightly lower due to the signal circuit dissipation (1W @ 20V) and the finite switching times (about 1W). If we transfer to the motor a power of 40W the bridge power dissipation from (18) is 10W and the total dissipation is 12W. This is an actual efficiency of 77%. Considering a maximum dissipation equal to 20W for the L292 (Multiwatt package), it is possible to handle continuous powers greater than 60W.

EXAMPLE

a) Data
- Motor characteristics: $L_M = 5mH$, $R_M = 5\Omega$, $L_M/R_M = 1msec$
- Voltage and current characteristics: $V_s = 20V$ $I_M = 2A$ $V_i = 8.3V$
- Closed loop bandwidth: 3kHz.

b) Calculation
- From relationship (4):

$$R_s = \frac{0.048}{I_M} V_i = 0.2\Omega$$

and from (1):

$$G_{mo} = \frac{2V_s}{R_M V_R} 1\Omega^{-1}$$

- RC = 1msec [from expression (2)].
- Assuming $\xi = 1/\sqrt{2}$; from (7) follows:

$$\xi^2 = \frac{1}{2} = \frac{400\,C}{4\,R_F C_F \cdot 0.2}$$

The cutoff frequency is:

$$f_T = \frac{143 \cdot 10^{-3}}{R_F C_F} = 3kHz$$

c) Summarizing
- $RC = 1 \cdot 10^{-3}$ sec
- $\frac{1000\,C}{R_F C_F} = 1$
- $R_F C_F \cong 47\mu s$

} C = 47nF, R = 22KΩ, For $R_F = 510\Omega$ → $C_F = 92nF$

LINEAR INTEGRATED CIRCUITS
Push-Pull Four Channel Driver

L293
L293D

FEATURES
- Output current 1A per channel (600mA for L293D)
- Peak output current 2A per channel (1.2A for L293D)
- Inhibit facility
- High noise immunity
- Separate logic supply
- Over-temperature protection

DESCRIPTION
The L293 and L293D are quad push-pull drivers capable of delivering output currents to 1A or 600mA per channel respectively. Each channel is controlled by a TTL-compatible logic input and each pair of drivers (a full bridge) is equipped with an inhibit input which turns off all four transistors. A separate supply input is provided for the logic so that it may be run off a lower voltage to reduce dissipation.

Additionally the L293D includes the output clamping diodes within the IC for complete interfacing with inductive loads.

Both devices are packaged in 16-pin plastic DIPs; both use the four center pins to conduct heat to the printed circuit boards.

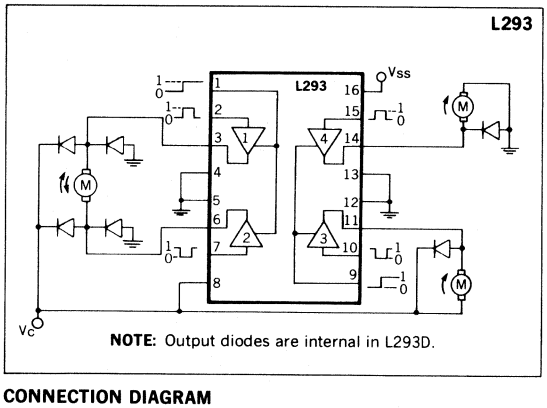
ABSOLUTE MAXIMUM RATINGS

Collector Supply Voltage, V_c 36V
Logic Supply Voltage, V_{ss} 36V
Input Voltage, V_i 7V
Inhibit Voltage, V_{inh} 7V
Peak Output Current (Non-Repetitive), I_{out} (L293) 2A
I_{out} (L293D) 1.2A
Total Power Dissipation at $T_{ground-pins}$ = 80°C, P_{tot} 5W
Storage and Junction Temperature, T_{stg}, T_j .....-40 to +150°C

THERMAL DATA

Thermal Resistance Junction-Case, θ_{JC} ..... 14°C/W max
Thermal Resistance Junction-Ambient, θ_{JA} ..... 80°C/W max

BLOCK DIAGRAM



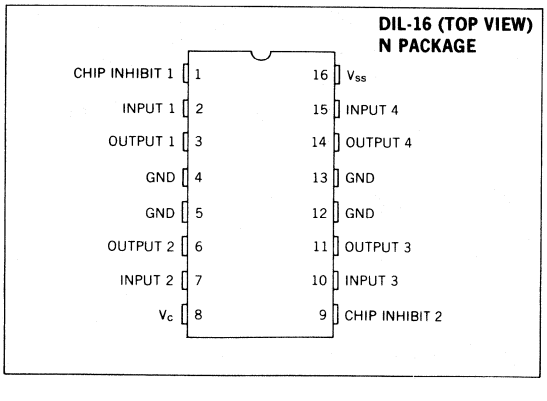
NOTE: Output diodes are internal in L293D.

TRUTH TABLE

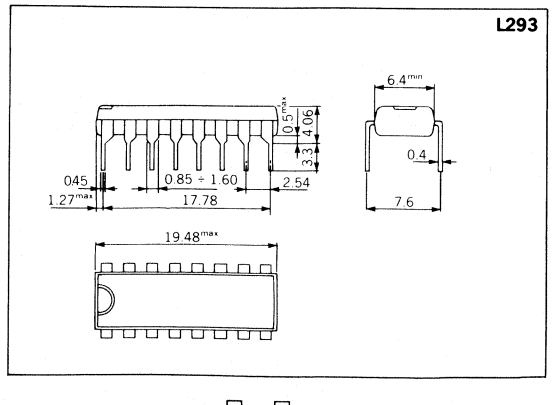
V_i (each channel)	V_{inh}.*	V_o
H	H	H
L	H	L
H	L	X**
L	L	X**

*Relative to the considered channel.
**High output impedance.

CONNECTION DIAGRAM



MECHANICAL DATA

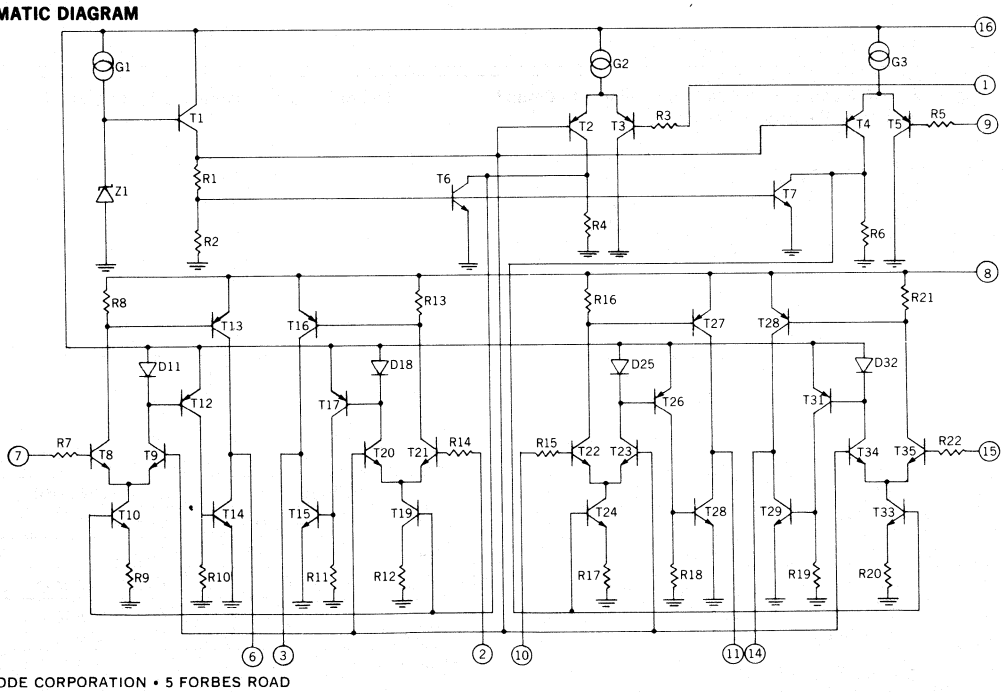


UNITRODE

ELECTRICAL CHARACTERISTICS (For each channel, V_c = 24V, V_{ss} = 5V, T_{amb} = 25°C, unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector Supply Voltage	V_c				36	V
Logic Supply Voltage	V_{ss}		4.5		36	V
Collector Supply Current	I_c	V_i = L, I_o = 0, $V_{inh.}$ = H		2	6	mA
		V_i = H, I_o = 0, $V_{inh.}$ = H		16	24	
		$V_{inh.}$ = L			4	
Total Quiescent Logic Supply Current	I_{ss}	V_i = L, I_o = 0, $V_{inh.}$ = H		44	60	mA
		V_i = H, I_o = 0, $V_{inh.}$ = H		16	22	
		$V_{inh.}$ = L		16	24	
Input Low Voltage	V_{iL}		-0.3		1.5	V
Input High Voltage	V_{iH}	$V_{ss} \leq 7V$	2.3		V_{ss}	V
		$V_{ss} > 7V$	2.3		7	
Low Voltage Input Current	I_{iL}	V_i = L			-10	μA
High Voltage Input Current	I_{iH}	V_i = H		30	100	μA
Inhibit Low Voltage	$V_{inh.L}$		-0.3		1.5	V
Inhibit High Voltage	$V_{inh.H}$	$V_{ss} \leq 7V$	2.3		V_{ss}	V
		$V_{ss} > 7V$	2.3		7	
Low Voltage Inhibit Current	$I_{inh.L}$			-30	-100	μA
High Voltage Inhibit Current	$I_{inh.H}$				10	μA
Source Output Saturation Voltage	V_{CEsatH}	I_o = -1A (-0.6A for L293D)		1.4	1.8	V
Sink Output Saturation Voltage	V_{CEsatL}	I_o = 1A (0.6A for L293D)		1.2	1.8	V
Clamp Diode Forward Voltage (L293D only)	V_F	I_F = 0.6A		1.3		V
Rise Time	t_r	0.1 to 0.9 V_o (See Figure 1)		250		ns
Fall Time	t_f	0.9 to 0.1 V_o (See Figure 1)		250		ns
Turn-On Delay	t_{ON}	0.5 V_i to 0.5 V_o (See Figure 1)		450		ns
Turn-Off Delay	t_{OFF}	0.5 V_i to 0.5 V_o (See Figure 1)		200		ns

SCHEMATIC DIAGRAM



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Figure 1. Switching Times

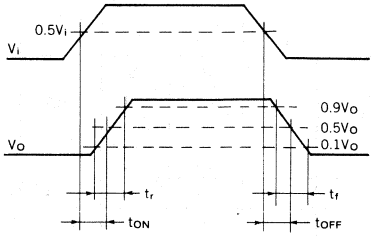


Figure 2. Quiescent Logic Supply Current vs Logic Supply Voltage

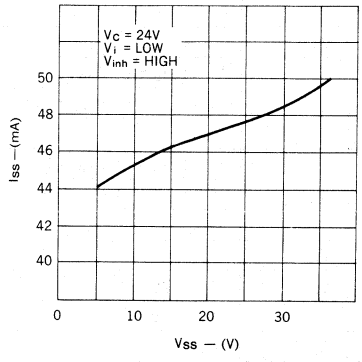


Figure 3. Output Voltage vs Input Voltage

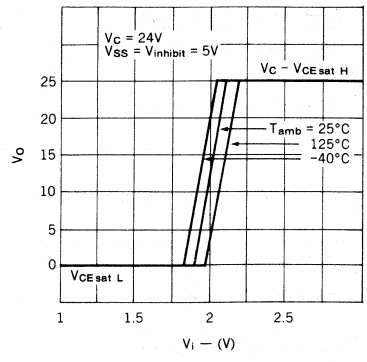


Figure 4. L293 Saturation vs Output Current

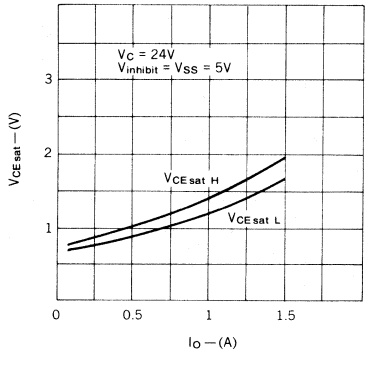


Figure 5. L293 Source Saturation vs Ambient Temperature

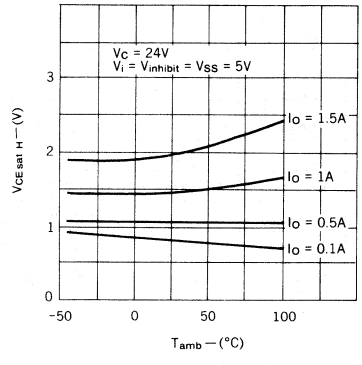
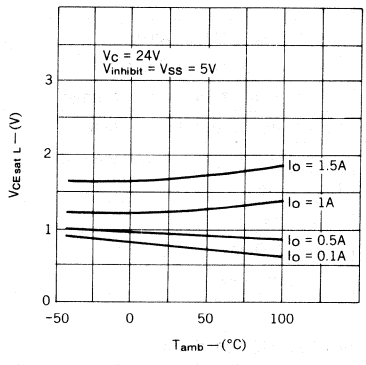


Figure 6. L293 Sink Saturation Voltage vs Ambient Temperature



NOTE: For L293D curves, multiply output current by 0.6

Figure 7. DC Motor Controls (with Connection to Ground and to the Supply Voltage)

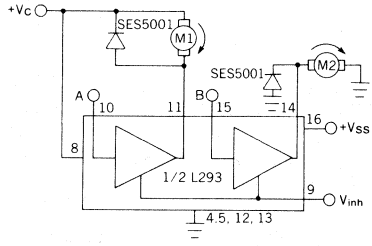
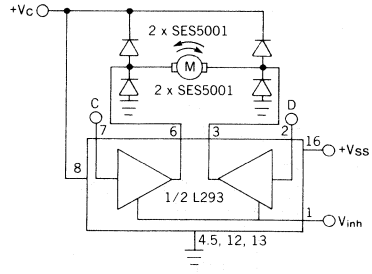


Figure 8. Bidirectional DC Motor Control



$V_{inh.}$	A	M1	B	M2
H	H	Fast Motor Stop	H	Run
H	L	Run	L	Fast Motor Stop
L	X	Free Running Motor Stop	X	Free Running Motor Stop

L = Low H = High X = Don't care

INPUTS		FUNCTION
$V_{inh.}$ = H	C = H; D = L	Turn Right
	C = L; D = H	Turn Left
	C = D	Fast Motor Stop
$V_{inh.}$ = L	C = X; D = X	Free Running Motor Stop

L = Low H = High X = Don't care

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

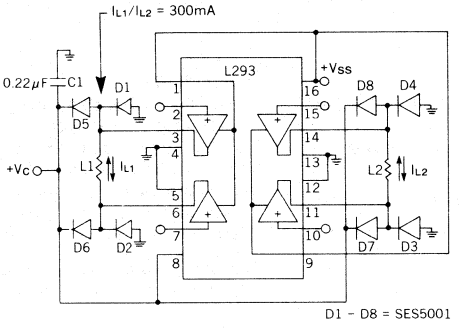


Figure 9. Bipolar Stepping Motor Control

MOUNTING INSTRUCTIONS

The $R_{thj-amp}$ of the L293 can be reduced by soldering the GND pins to a suitable copper area of the printed circuit board or to an external heatsink.

The diagram of Figure 13 shows the maximum package power P_{tot} and the θ_{JA} as a function of the side " ℓ " of two equal square copper areas having a thickness of 35μ (see Figure 12). In addition, it is possible to use an external heatsink (see Figure 14).

During soldering the pins' temperature must not exceed 260°C and the soldering time must not be longer than 12 seconds.

The external heatsink or printed circuit copper area must be connected to electrical ground.

Figure 10. Example of P.C. Board Copper Area which is used as Heatsink

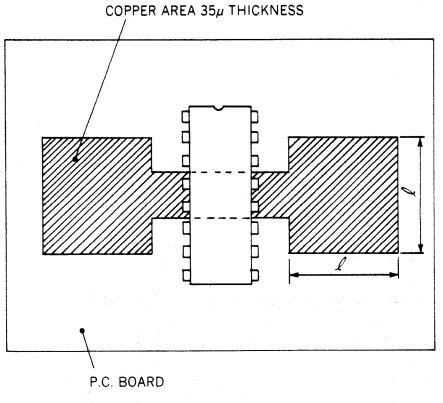


Figure 11. External Heatsink Mounting Example (θ_{JA} = 25°C/W)

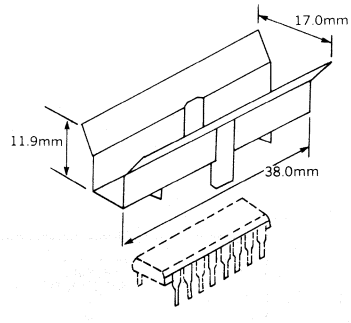


Figure 12. Maximum Package Power and Junction to Ambient Thermal Resistance vs Size " ℓ "

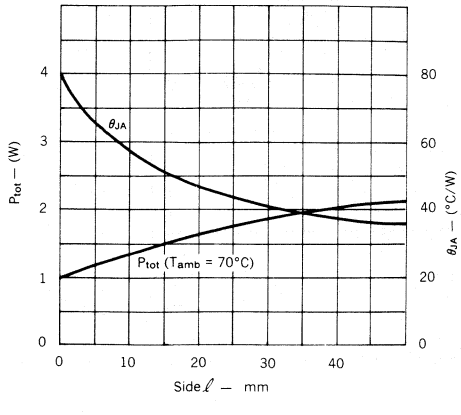
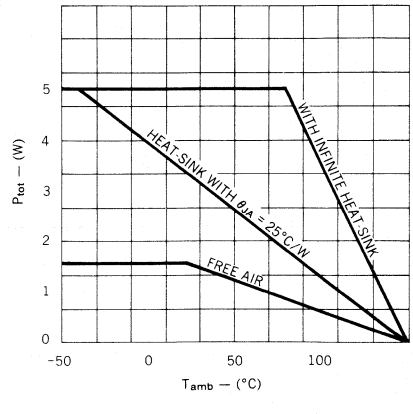


Figure 13. Maximum Allowable Power Dissipation vs Ambient Temperature



LINEAR INTEGRATED CIRCUITS
Dual Switchmode Solenoid Driver

FEATURES
- High current capability (up to 2.5A per channel)
- High voltage operation (up to 46V for power stage)
- High efficiency switchmode operation
- Regulated output current (adjustable)
- Few external components
- Separate logic supply
- Thermal protection

DESCRIPTION
The L295 is a monolithic integrated circuit in a 15 lead MULTIWATT® package; it incorporates all the functions for direct interfacing between digital circuitry and inductive loads. The L295 is designed to accept standard microprocessor logic levels and drive 2 independent solenoids. The output current is completely controlled by means of a switching technique allowing very efficient operation. Furthermore, it includes an enable input and separate power supply inputs for bilevel operation such as interfacing with peripherals running at higher voltage levels.

The L295 is particularly suitable for applications such as hammer driving in matrix printers, step motor driving and electromagnet controllers.

ABSOLUTE MAXIMUM RATINGS

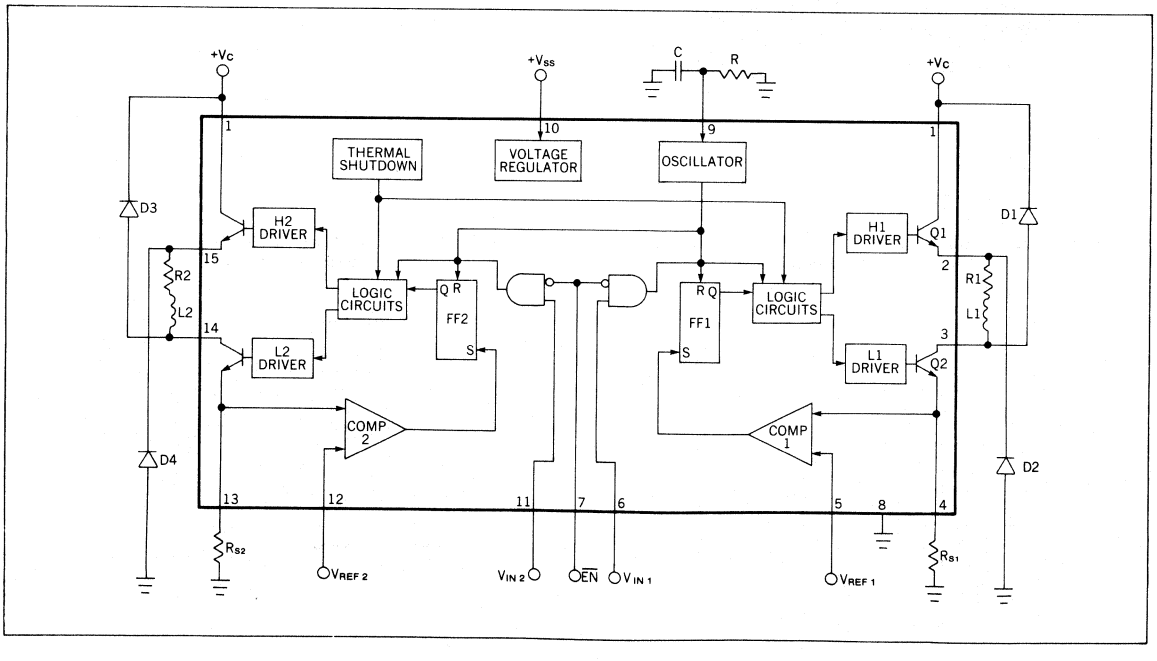
Collector Supply Voltage, V_C 50V
Logic Supply Voltage, V_{SS} 12V
Enable and Input Voltage, V_{EN}, V_i 7V
Reference Voltage, V_{REF} 7V
Peak Output Current (each channel)
- Non-Repetitive, (t = 100μsec), I_o 3A
- Repetitive (80% on −20% off; t_{ON} = 10ms) 2.5A
- DC Operation 2A

Total Power Dissipation (at T_{case} = 75°C) 25W
Storage and Junction Temperature ..... −40 to +150°C

THERMAL DATA

Thermal Resistance Junction-Case, θ_{JC} ..... 3°C/W max
Thermal Resistance Junction-Ambient, θ_{JA} ..... 35°C/W max

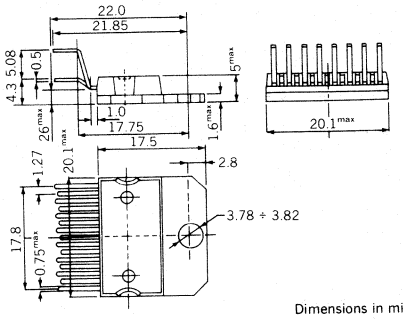
BLOCK DIAGRAM



UNITRODE

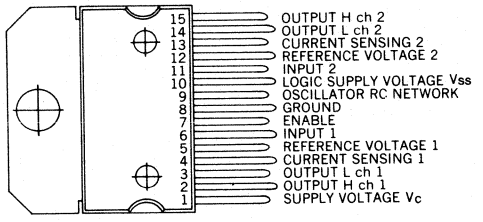
MECHANICAL DATA

V Package



Dimensions in millimeters

CONNECTION DIAGRAM (TOP VIEW)

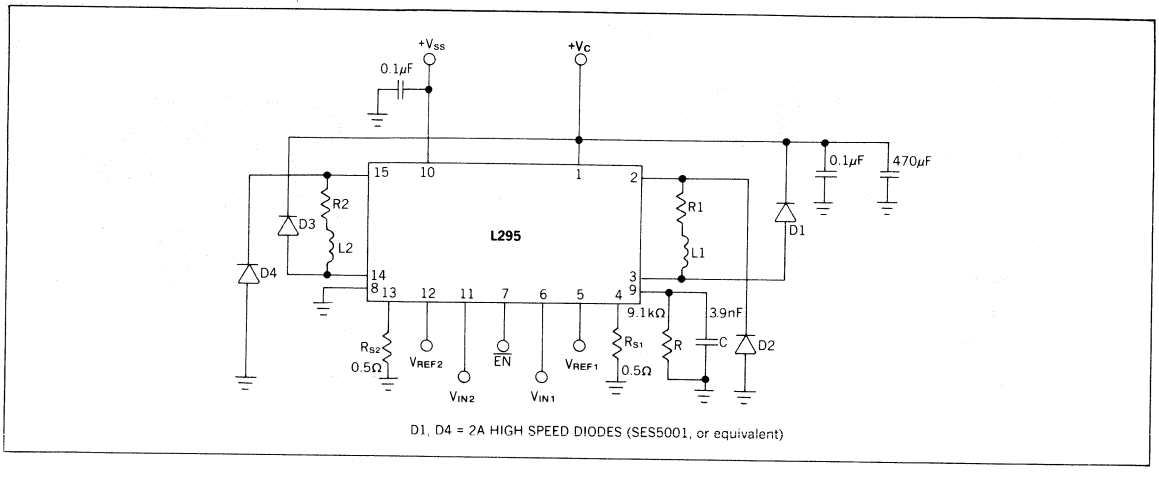


ELECTRICAL CHARACTERISTICS (Refer to the application circuit, V_{SS} = 5V, V_C = 36V, T_j = 25°C; unless otherwise specified, L = Low; H = High)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Supply Voltage	V_C		12		46	V
Logic Supply Voltage	V_{SS}		4.75		10	V
Quiescent Drain Current (from V_C)	I_C	V_C = 46V; V_{i1} = V_{i2} = V_{EN} = L			4	mA
Quiescent Drain Current (from V_{SS})	I_{SS}	V_{SS} = 10V			46	mA
Low Input Voltage	$V_{i1}L$, $V_{i2}L$		-0.3		0.8	V
High Input Voltage	$V_{i1}H$, $V_{i2}H$		2.2		7	V
Low Enable Input Voltage	$V_{EN}L$		-0.3		0.8	V
High Enable Input Voltage	$V_{EN}H$		2.2		7	V
Input Current	I_{i1}, I_{i2}	V_{i1} = V_{i2} = L			-100	μA
		V_{i1} = V_{i2} = H			10	
Enable Input Current	I_{EN}	V_{EN} = L			-100	μA
		V_{EN} = H			10	
Input Reference Voltage	V_{REF1}, V_{REF2}		0.2		2	V
Input Reference Current	I_{REF1}, I_{REF2}				-5	μA
Oscillation Frequency	f_{osc}	C = 3.9nF, R = 9.1KΩ		25		KHz
Transconductance (each channel)	$\frac{I_p}{V_{REF}}$	V_{REF} = 1V, R_s = 0.5Ω	1.9	2	2.1	A/V
Total Output Voltage Saturation (each channel)*	V_{sat}	I_o = 2A		2.8	3.6	V
External Sensing Resistors Voltage Drop	$V_{sens\ 1}$, $V_{sens\ 2}$				2	V

*V_{sat} = $V_{CEsatQ1}$ + $V_{CEsatQ2}$.

APPLICATION CIRCUIT



D1, D4 = 2A HIGH SPEED DIODES (SES5001, or equivalent)

FUNCTIONAL DESCRIPTION

The L295 incorporates two independent driver channels with separate inputs and outputs, each capable of driving an inductive load (see block diagram).

The device is controlled by three microprocessor compatible digital inputs and two analog inputs. These inputs are;

$\overline{EN}$ chip enable (digital input, active low), enables both channels when in the low state.

V_{IN1}, V_{IN2} channel inputs (digital inputs, active high), enable each channel independently. A channel is activated when both $\overline{EN}$ and the appropriate channel input are active.

V_{REF1}, V_{REF2} reference voltages (analog inputs), used to program the peak load currents. Peak load current is proportional to V_{REF}.

Since the two channels are identical, only channel one will be described. The following description applies equally to channel two, replacing FF2 for FF1, V_{REF2} for V_{REF1} etc. When the channel is activated by a low level on the $\overline{EN}$ input and a high level on the channel input V_{IN1}, the output transistors Q1 and Q2 switch on and current flows in the load according to the exponential law:

$$I = \frac{V}{R1}\left(1 - e^{\frac{-R1t}{L1}}\right)$$

where: R1 and L1 are the resistance and inductance of the load and V is the voltage available on the load

The current increases until the voltage on the external sensing resistor, R_{S1}, reaches the reference voltage, V_{REF1}. This peak current, I_{p1}, is given by:

$$I_{p1} = \frac{V_{REF1}}{R_{S1}}$$

At this point the comparator output, Comp 1, sets the RS flip-flop, FF1, that turns off the output transistor, Q1. The load current flowing through D2, Q2, R_{S1}, decreases according to the law:

$$I = \left(\frac{V_A}{R1} + I_{P1}\right) e^{\frac{-R1\,t}{L1}} - \frac{V_A}{R1}$$

where: $V_A = V_{CEsat\ Q2} + V_{sense\ 1} + V_{D2}$

If the oscillator pin (9) is connected to ground the load current falls to zero as shown in Figure 1.

At time t_2, channel 1 is disabled by taking the inputs V_{IN1} low and/or $\overline{EN}$ high, and the output transistor Q2 is turned off. The load current flows through D2 and D1 according to the law:

$$I = \left(\frac{V_B}{R1} + I_{T2}\right) e^{\frac{-R1t}{L1}} - \frac{V_B}{R1}$$

where: $V_B = V_C + V_{D1} + V_{D2}$
I_{T2} = current value at the time t_2.

Figure 2 shows the current waveform obtained with an RC network connected between pin 9 and ground. From t_o to t_1 the current increases as in Figure 1. A difference exists at the time t_2 because the current starts to increase again. At this time a pulse is produced by the oscillator circuit that resets the flip flop, FF1, and switches on the output transistor, Q1. The current increases until the drop on the sensing resistor R_{s1} is equal to V_{REF1} (t_3) and the cycle repeats.

The switching frequency depends on the values of R and C, as shown in Figure 4 and must be chosen in the range 10 to 30KHz.

It is possible with external hardware to change the reference voltage V_{REF} in order to obtain a high peak current I_p and a lower holding current I_h (see Figure 3).

The L295 is provided with a thermal protection that switches off all the output transistors when the junction temperature exceeds 150°C. The presence of a hysteresis circuit makes the IC work again after a fall of the junction temperature of about 20°C.

The analog input pins (V_{REF1}, V_{REF2}) can be left open or connected to V_{ss}; in this case the circuit works with an internal reference voltage of about 2.5V and the peak current in the load is fixed only by the value of R_s:

$$I_p = \frac{2.5}{R_s}$$

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SIGNAL WAVEFORMS

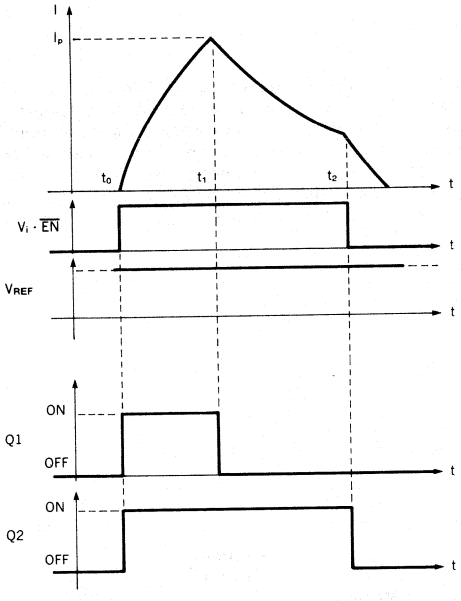


Figure 1. Load current waveform with pin 9 connected to GND

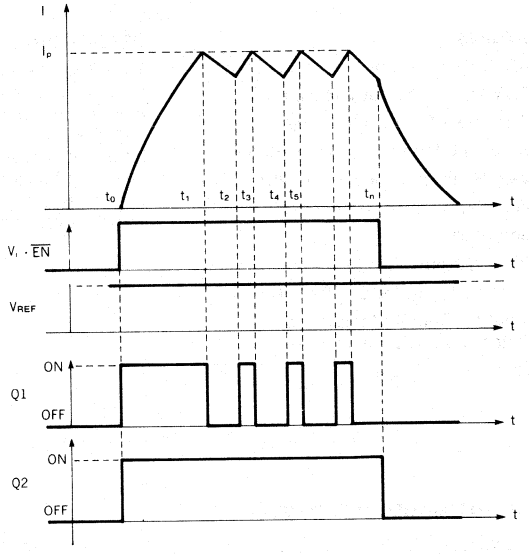


Figure 2. Load current waveform with external R-C network connected between pin 9 and ground

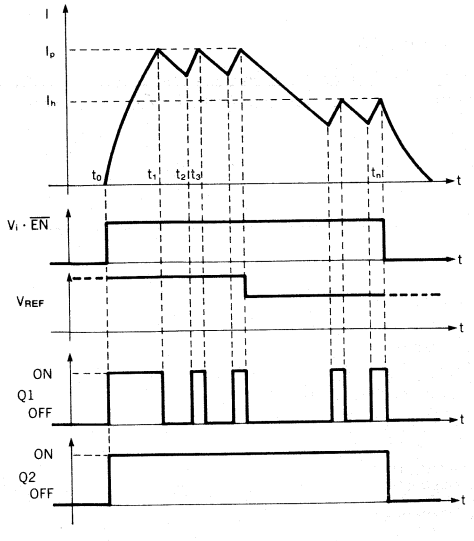


Figure 3. With V_{REF} changed by hardware

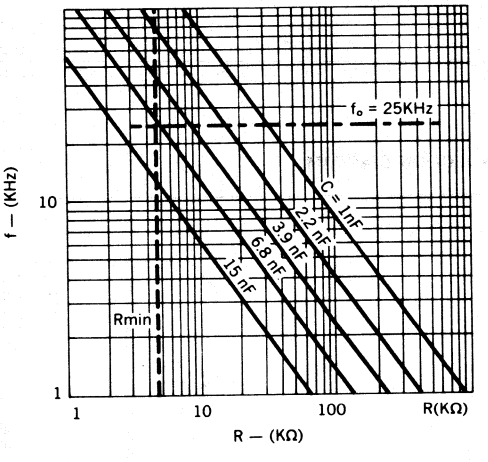


Figure 4. Switching frequency vs values of R and C

LINEAR INTEGRATED CIRCUITS

L 296

High Current Switching Regulator

PRELIMINARY

FEATURES

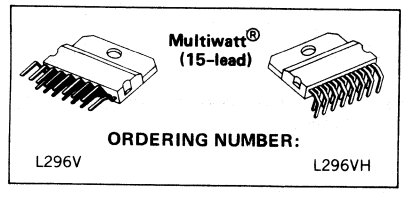
- 4A Output Current
- 5.1V to 40V Output Voltage Range
- 0 to 100% Duty Cycle Range
- Switching Frequency Up to 200KHz
- Very High Efficiency (Up to 90%)
- Very Few External Components
- Soft Start
- Reset Output
- Control Circuit for Crowbar SCR
- Input for Remote Inhibit and Synchronous Operation
- Thermal Shutdown

DESCRIPTION

The L296 is a stepdown power switching regulator delivering 4A at voltages from 1.5V to 40V. The device features programmable current limiting, remote inhibit, soft start, thermal protection, reset output for microprocessors, and a PWM comparator input for synchronization in multichip configurations. The L296 is offered in a 15-lead Multiwatt® plastic power package and requires very few external components. Efficient operation at switching frequencies up to 200KHz allows reduction, in size and cost, of external filter components. A voltage sense input and SCR drive output are provided for optional crowbar over-voltage protection with an external SCR.

ABSOLUTE MAXIMUM RATINGS

Input Voltage (Pin 3)	50V
Input to Output Voltage Difference	50V
Output DC Voltage	-1V
Output Peak Voltage at t = 0.1μsec, f = 200kHz	-7V
Voltage at Pins 1 and 12	10V
Voltage at Pins 6 and 15	15V
Voltage at Pins 4, 5, 7 and 9	5.5V
Voltage at Pins 10 and 6	7V
Voltage at Pin 14 ($I_{14} \leq 1mA$)	V_I
Pin 9 Sink Current	1mA
Pin 11 Source Current	20mA
Pin 14 Sink Current ($V_{14} < 5V$)	50mA
Power Dissipation at $T_{CASE} \leq 90°C$	20W



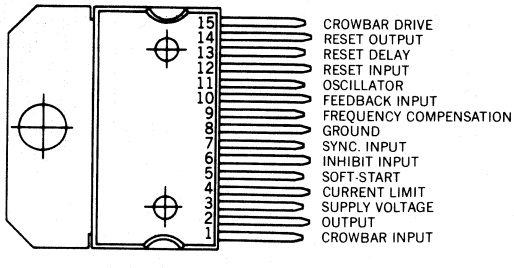
ORDERING NUMBER:

L296V L296VH

THERMAL DATA

Thermal Resistance Junction-Case, θ_{JC}	3°C/W max
Thermal Resistance Junction-Ambient, θ_{JA}	35°C/W max

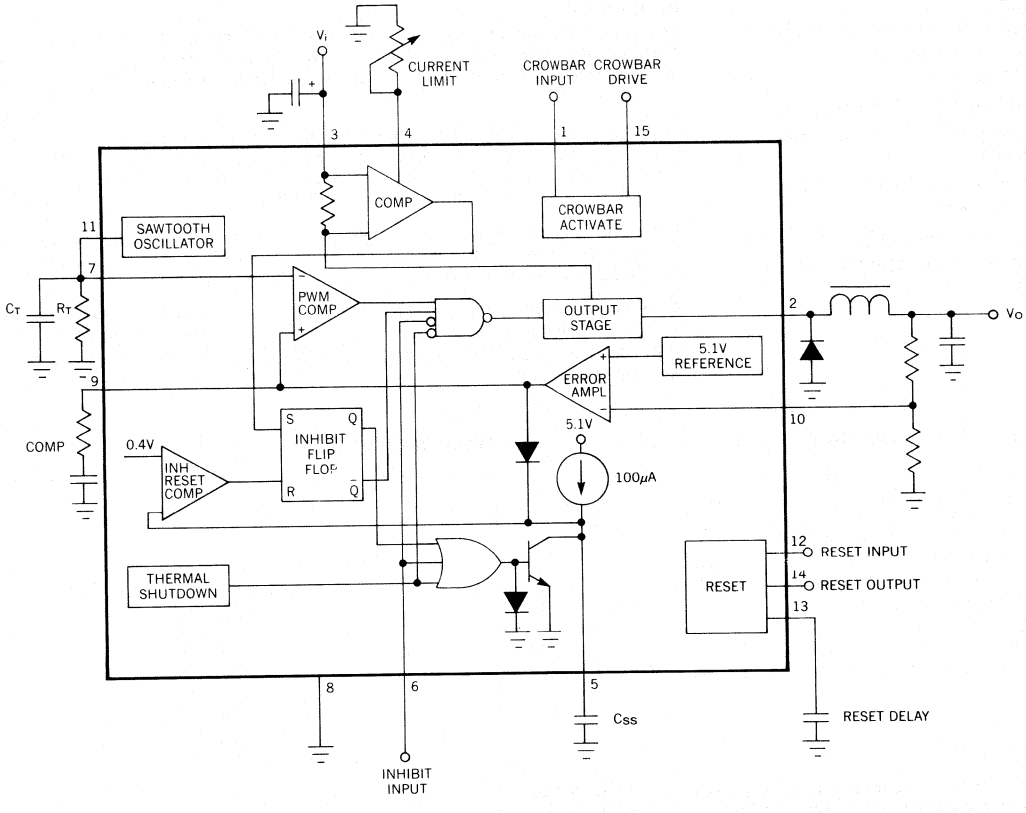
CONNECTION DIAGRAM



TAB CONNECTED TO PIN 8

UNITRODE

BLOCK DIAGRAM



For further detailed electrical information, please consult factory.

LINEAR INTEGRATED CIRCUITS
Dual Full-Bridge Driver Power

FEATURES
- Operating Supply Voltage up to 46V
- Total Saturation Voltage 3.4V max at 1A
- Overtemperature Protected
- Operates in Switched and Linear Regulation Modes
- 25W Power-Tab Package for Low Installed Cost
- Individual Logic Inputs for Each Driver
- Channel-Enable Logic Inputs for Driver Pairs

DESCRIPTION
The L298 is a power integrated circuit usable for driving resistive and inductive loads. This device contains four push-pull drivers with separate logic inputs. Two enable inputs are provided for power down and chopping. Each driver is capable of driving loads up to 2A continuously.

Logic inputs to the L298 have high input thresholds (1.85V) and hysteresis to provide trouble-free operation in noisy environments normally associated with motors and inductors. The L298 input currents and thresholds allow the device to be driven by TTL and CMOS systems without buffering or level shifting.

The emitters of the low-side power drivers are separately available for current sensing. Feedback from the emitters can be used to control load current in a switching mode, or can be used to detect load faults.

Separate logic and load supply lines are provided to reduce total IC power consumption. Power consumption is reduced further when the enable inputs are low. This makes the L298 ideal for systems that require low standby current, such as portable or battery-operated equipment.

ABSOLUTE MAXIMUM RATINGS

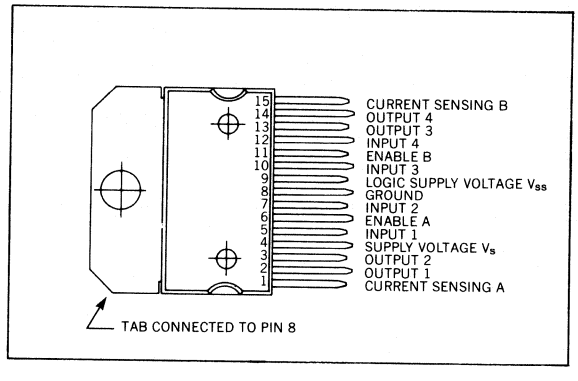
Power Supply, V_s 50V
Logic Supply Voltage, V_{ss} 7V
Input and Inhibit Voltage, V_i, $V_{inhibit}$ ..... -0.3V to +7V
Peak Output Current (each channel), I_o
- Non-Repetitive (t = 100μs) 3A
- Repetitive (80% on - 20% off; t_{ON} = 10ms) 2.5A
- DC Operation 2A

Sensing Voltage, V_{sens} ..... -1V to +2.3V
Total Power Dissipation (T_{case} = 75°C), P_{tot} 25W
Storage and Junction Temperature, T_{stg}, T_j ..... -40°C to +150°C

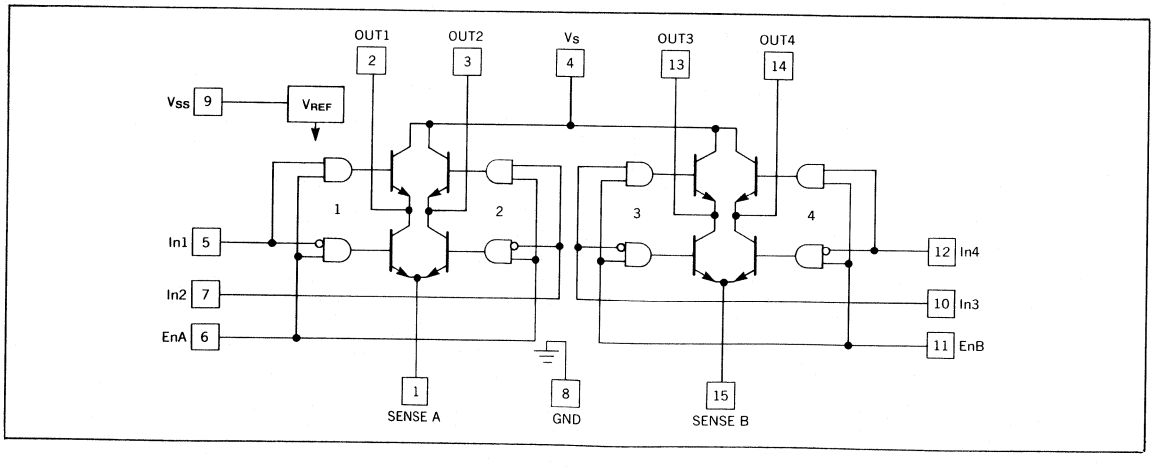
THERMAL DATA

Thermal Resistance Junction-Case, $R_{th\ j\text{-}case}$ ..... 3°C/W max.
Thermal Resistance Junction-Ambient, $R_{th\ j\text{-}amb}$ .... 35°C/W max.

CONNECTION DIAGRAM



BLOCK DIAGRAM



UNITRODE

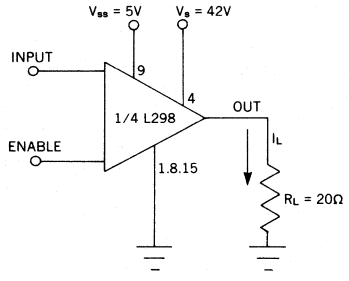
ELECTRICAL CHARACTERISTICS (for each channel, V_s = 42V, V_{ss} = 5V, T_j = 25°C)

PARAMETERS	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Supply Voltage (Pin 4), V_s	Operative Condition	V_{IH}+2.5		46	V
Logic Supply Voltage (Pin 9), V_{ss}		4.5		7	V
Quiescent Supply Current (Pin 4), I_s	$V_{inh.}$ = H V_i = L		3	7	mA
	I_L = 0 V_i = H		15	20	
	$V_{inh.}$ = L			1	
Quiescent Current from V_{ss} (Pin 9), I_{ss}	$V_{inh.}$ = H V_i = L		5	10	mA
	I_L = 0 V_i = H		1.5	3	
	$V_{inh.}$ = L		1	1.5	
Input Low Voltage (Pins 5, 7, 10, 12), $V_{i\ L}$		-0.3		1.5	V
Input High Voltage (Pins 5, 7, 10, 12), $V_{i\ H}$		2.3		V_{ss}	
Low Voltage Input Current (Pins 5, 7, 10, 12), $I_{i\ L}$	V_i = L			-10	μA
High Voltage Input Current (Pins 5, 7, 10, 12), $I_{i\ H}$	V_i = H		30	100	
Inhibit Low Voltage (Pins 6, 11), $V_{inh.\ L}$		-0.3		1.5	V
Inhibit High Voltage (Pins 6, 11), $V_{inh.\ H}$		2.3		7	
Low Voltage Inhibit Current (Pins 6, 11), $I_{inh.\ L}$	$V_{inh.}$ = L			-10	μA
High Voltage Inhibit Current (Pins 6, 11), $I_{inh.\ H}$	$V_{inh.}$ = H ≤ V_{ss} -0.6V		30	100	
Source Saturation Voltage, $V_{CE\ sat(H)}$	I_L = 1A		1.2	1.8	V
	I_L = 2A		1.8	2.8	
Sink Saturation Voltage, $V_{CE\ sat(L)}$	I_L = 1A		1.2	1.8	V
	I_L = 2A		1.7	2.6	
Total Drop, $V_{CE\ sat}$	I_L = 1A			3.4	V
	I_L = 2A			5.2	
Sensing Voltage (Pins 1, 15), V_{sens}		-1 (1)		2	V
Source Current Turn-Off Delay, $T_1(V_i)$	0.5 V_i to 0.9 I_L (2)		1.7		μs
Source Current Fall Time, $T_2(V_i)$	0.9 I_L to 0.1 I_L (2)		0.2		μs
Source Current Turn-On Delay, $T_3(V_i)$	0.5 V_i to 0.1 I_L (2)		2.5		μs
Source Current Rise Time, $T_4(V_i)$	0.1 I_L to 0.9 I_L (2)		0.35		μs
Sink Current Turn-Off Delay, $T_5(V_i)$	0.5 V_i to 0.9 I_L (3)		0.7		μs
Sink Current Fall Time, $T_6(V_i)$	0.9 I_L to 0.1 I_L (3)		0.2		μs
Sink Current Turn-On Delay, $T_7(V_i)$	0.5 V_i to 0.1 I_L (3)		1.5		μs
Sink Current Rise Time, $T_8(V_i)$	0.1 I_L to 0.9 I_L (3)		0.2		μs
Commutation Frequency, f_c	I_L = 2A		25	40	KHz

1) Sensing voltage can be -1V for t ≤ 50μS; in steady state V_{sens} min ≥ -0.5V.
2) See figure 1a.
3) See figure 2a.

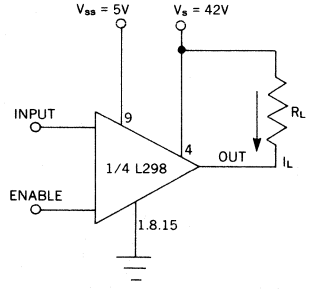
SWITCHING CHARACTERISTICS

Figure 1. Switching times test circuits.



NOTE: For INPUT chopper, set EN = H.

Figure 2. Switching Times Test Circuits.



NOTE: For INPUT chopper, set EN = H.

Figure 1a. Source Current Delay Times vs. Input or Enable Chopper.

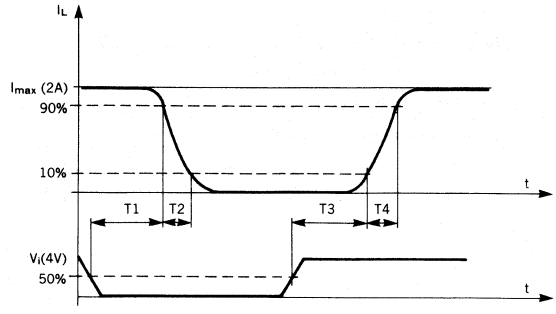
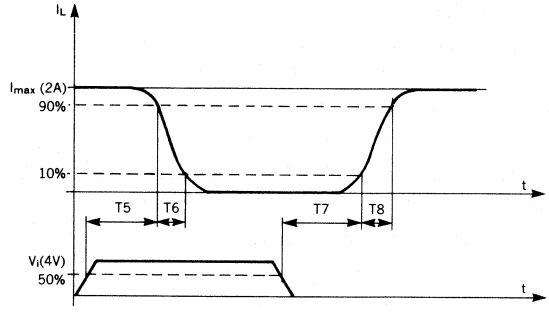
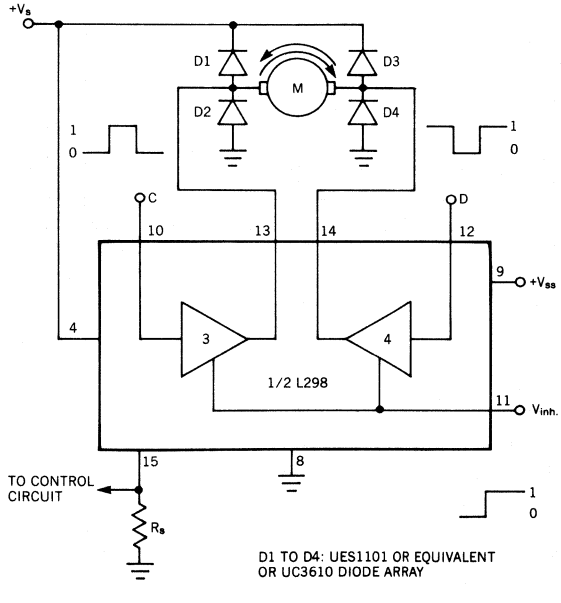


Figure 2a. Sink Current Delay Times vs. Input or Enable Chopper.



APPLICATIONS

Figure 3. Bi-Directional DC Motor Control.



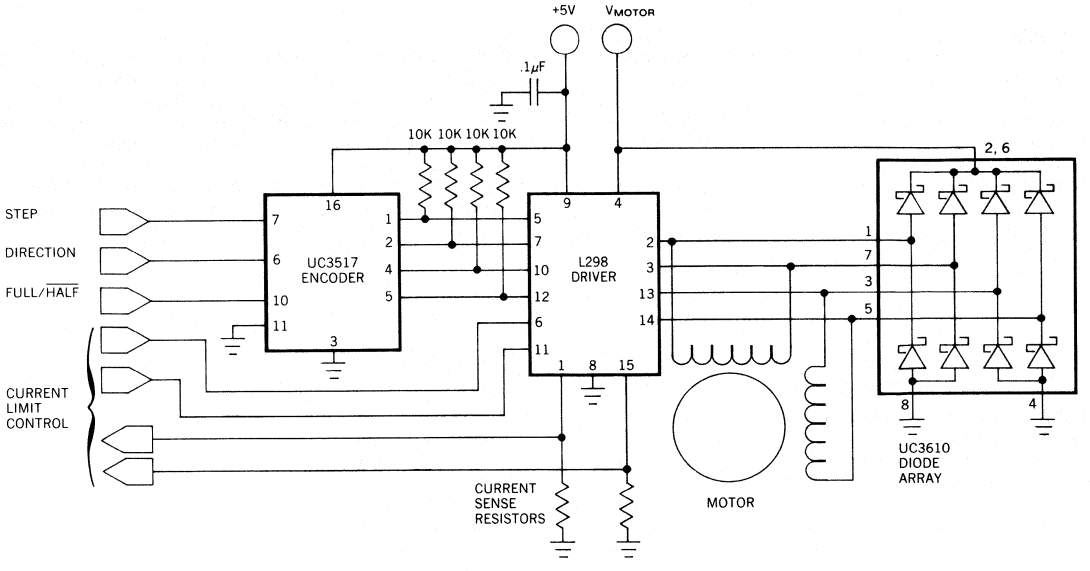
	INPUTS	FUNCTION
$V_{inh.}$ = H	C = H; D = L	Turn right
	C = L; D = H	Turn left
	C = D	Fast motor stop
$V_{inh.}$ = L	C = X; D = C	Free running motor stop

L = Low
H = High
X = Don't Care

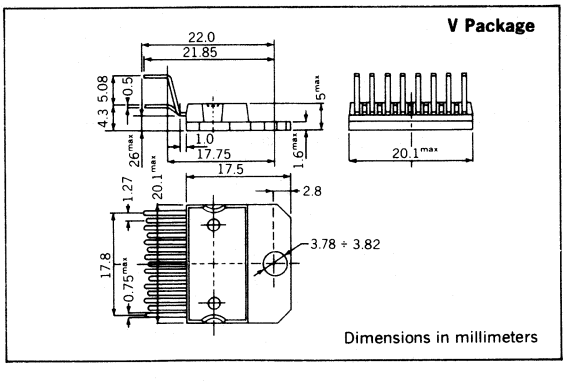
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Figure 4. Bipolar Step Motor Driver.



MECHANICAL DATA



LINEAR INTEGRATED CIRCUITS

1.5A, Three Terminal Adjustable Positive Voltage Regulators

UC117
UC217
UC317

FEATURES

- Output voltage adjustable from 1.2 to 37V
- Guaranteed 1.5A output current
- Line regulation typically 0.01%/V
- Load regulation typically 0.1%
- Temperature-independent current limit
- Standard 3-lead transistor packages (TO-3, TO-220)

DESCRIPTION

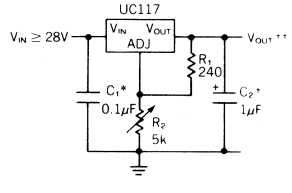
This monolithic integrated circuit is an adjustable 3-terminal positive voltage regulator designed to supply more than 1.5A of load current with an output voltage adjustable over a 1.2 to 37V range. Although ease of setting the output voltage to any desired value with only two external resistors is a major feature of this circuit, exceptional line and load regulation are also offered. In addition, full overload protection consisting of current limiting, thermal shutdown and safe-area control are included in this device which is packaged in TO-3 and TO-220 packages. The UC117 is rated for operation from −55°C to +150°C, the UC217 from −25°C to +150°C and the UC317 from 0°C to +125°C.

ABSOLUTE MAXIMUM RATINGS

Power Dissipation ..... Internally limited
Input—Output Voltage Differential 40V
Operating Junction Temperature Range
  UC117 ..... −55°C to +150°C
  UC217 ..... −25°C to +150°C
  UC317 ..... 0°C to +125°C
Storage Temperature ..... −65°C to +150°C
Lead Temperature (Soldering, 10 seconds) ..... 300°C

TYPICAL APPLICATIONS

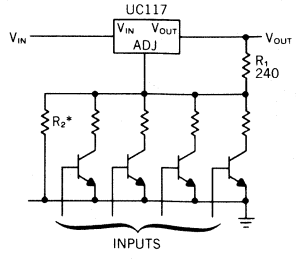
1.2V—25V Adjustable Regulator



*Needed if device is far from filter capacitors
†Optional—improves transient response

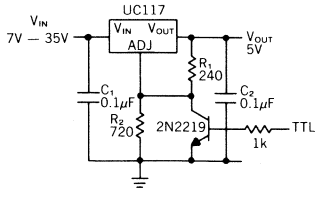
†† $V_{OUT} = 1.25V \left(1 + \frac{R_2}{R_1}\right)$

Digitally Selected Outputs



*Value determines maximum V_{OUT}

5V Logic Regulator with Electronic Shutdown*



*Min output ≈ 1.2V

UNITRODE

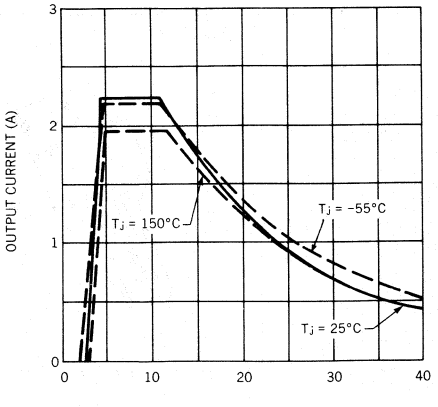
ELECTRICAL CHARACTERISTICS (Note 1)

PARAMETER	TEST CONDITIONS	UC117/UC217			UC317			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Line Regulation	T_A = 25°C, 3V ≤ (V_{IN} − V_{OUT}) ≤ 40V, (Note 2)		0.01	0.02		0.01	0.04	%/V
Load Regulation	T_A = 25°C, 10mA ≤ I_{OUT} ≤ I_{MAX} V_{OUT} ≤15V, (Note 2) V_{OUT} ≥ 5V, (Note 2)		 5 0.1	 15 0.3		 5 0.1	 25 0.5	 mV %
Thermal Regulation	T_A = 25°C, 20ms Pulse		0.03	0.07		0.04	0.07	%/W
Adjustment Pin Current			50	100		50	100	μA
Adjustment Pin Current Change	10mA ≤ I_L ≤ I_{MAX} 2.5V ≤ (V_{IN} − V_{OUT}) ≤ 40V		0.2	5		0.2	5	μA
Reference Voltage	3 ≤ (V_{IN} − V_{OUT}) ≤ 40V 10mA ≤ I_{OUT} ≤ I_{MAX}, P ≤ P_{MAX}	1.20	1.25	1.30	1.20	1.25	1.30	V
Line Regulation	3 ≤ (V_{IN} − V_{OUT}) ≤ 40V, (Note 2)		0.02	0.05		0.02	0.07	%/V
Load Regulation	10mA ≤ I_{OUT} ≤ I_{MAX}, (Note 2) V_{OUT} ≤ 5V V_{OUT} ≥ 5V		 20 0.3	 50 1		 20 0.3	 70 1.5	 mV %
Temperature Stability	T_{MIN} ≤ T_j ≤ T_{MAX}		1			1		%
Minimum Load Current	V_{IN} − V_{OUT} = 40V		3.5	5		3.5	10	mA
Current Limit	(V_{IN} − V_{OUT}) ≤15V K Package T Package (V_{IN} − V_{OUT}) = 40V K Package T Package	 1.5 1.5 	 2.2 2.2 0.4 0.4	 	 1.5 1.5 	 2.2 2.2 0.4 0.4	 	 A A A A
RMS Output Noise	T_A = 25°C, 10Hz ≤ f ≤ 10kHz		0.003			0.003		%
Ripple Rejection Ratio	V_{OUT} = 10V, f = 120Hz C_{ADJ} = 10μF	 66	 65 80	 	 66	 65 80	 	 dB dB
Long Term Stability	T_A = 125°C, 1000 Hrs.		0.3	1		0.3	1	%
Thermal Resistance, Junction to Case	K Package T Package		2.3	3		2.3 4	3	°C/W °C/W

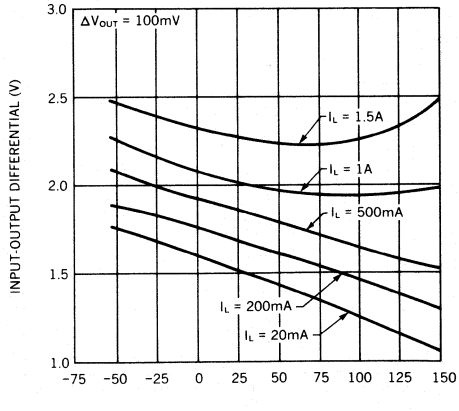
Notes: 1. Unless otherwise noted, the above specifications apply over the following conditions:
UC117: −55°C ≤ T_j ≤ 150°C
UC217: −25°C ≤ T_j ≤ 150°C
UC317: 0°C ≤ T_j ≤ 125°C
(V_{IN} − V_{OUT}) = 5V, I_o = 0.5A, I_{MAX} =1.5A
2. All regulation specifications are measured at constant junction temperatures using low duty-cycle pulse testing.

TYPICAL PERFORMANCE CHARACTERISTICS

Current Limit



Dropout Voltage

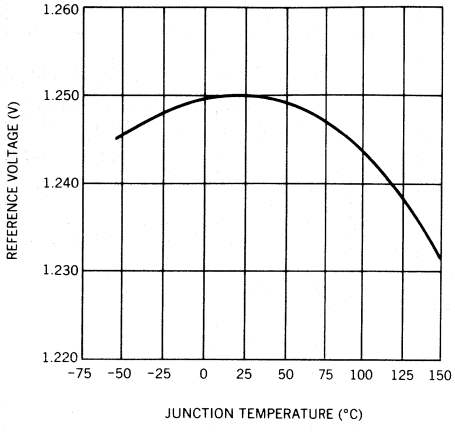


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

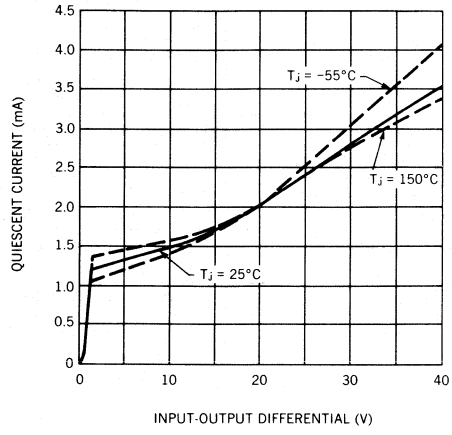
PRINTED IN U.S.A.

TYPICAL PERFORMANCE CHARACTERISTICS

Temperature Stability

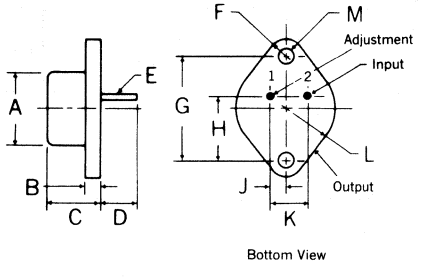


Minimum Operating Current



MECHANICAL SPECIFICATIONS AND CONNECTION DIAGRAMS

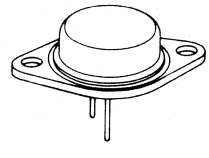
UC117 UC217 UC317



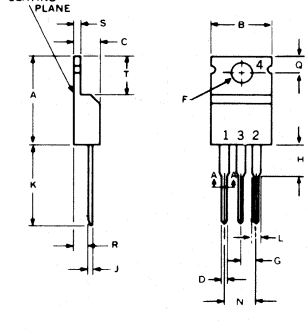
Bottom View

	INCHES	MILLIMETERS
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA K(TO-3)



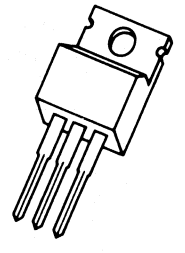
UC317



1-Adjustment
2-Input
3-Output
4-Output

	INCHES		MILIMETERS	
	MIN	MAX	MIN	MAX
A	0.560	0.625	14.23	15.87
B	0.380	0.420	9.66	10.66
C	0.140	0.190	3.56	4.82
D	0.020	0.045	0.51	1.14
F	0.139	0.147	3.531	3.733
G	0.090	0.110	2.29	2.79
H	—	0.250	—	6.35
J	0.015	0.025	0.38	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.070	1.14	1.77
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.115	2.04	2.92
S	0.045	0.055	1.14	1.39
T	0.230	0.270	5.85	6.85

T(TO-220)



Note: When ordering, add suffix "K" (for TO-3 package) or "T" (for TO-220 package) to the Part Number.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

APPLICATION HINTS

In operation, the UC117 develops a nominal 1.25V reference voltage, V_{REF}, between the output and adjustment terminal. The reference voltage is impressed across program resistor R_1 and, since the voltage is constant, a constant current I_1 then flows through the output set resistor R_2, giving an output voltage of

$$V_{OUT} = V_{REF}\left(1 + \frac{R_2}{R_1}\right) + I_{ADJ}R_2$$

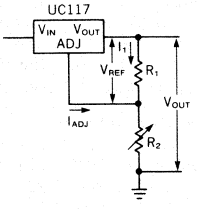


Figure 1

Since the 100μA current from the adjustment terminal represents an error term, the UC117 was designed to minimize I_{ADJ} and make it very constant with line and load changes. To do this, all quiescent operating current is returned to the output establishing a minimum load current requirement. If there is insufficient load on the output, the output will rise.

External Capacitors

An input bypass capacitor is recommended. A 0.1μF disc or 1μF solid tantalum on the input is suitable input bypassing for almost all applications. The device is more sensitive to the absence of input bypassing when adjustment or output capacitors are used but the above values will eliminate the possibility of problems.

The adjustment terminal can be bypassed to ground on the UC117 to improve ripple rejection. This bypass capacitor prevents ripple from being amplified as the output voltage is increased. With a 10μF bypass capacitor 80 dB ripple rejection is obtainable at any output level.

In general, the best type of capacitors to use are solid tantalum. Solid tantalum capacitors have low impedance even at high frequencies. Depending upon capacitor construction, it takes about 25μF in aluminum electrolytic to equal 1μF solid tantalum at high frequencies.

Although the UC117 is stable with no output capacitors, like any feedback circuit, certain values of external capacitance can cause excessive ringing. This occurs with values between 500pF and 5000pF. A 1μF solid tantalum (or 25μF aluminum electrolytic) on the output swamps this effect and insures stability.

Load Regulation

The UC117 is capable of providing extremely good load regulation but a few precautions are needed to obtain maximum performance. The current set resistor connected between the adjustment terminal and the output terminal (usually 240Ω) should be tied directly to the output of the regulator rather than near the load. This eliminates line drops from appearing effectively in series with the reference and degrading regulation.

With the TO-3 package, it is easy to minimize the resistance from the case to the set resistor by using 2 separate leads to the case. The ground of R_2 can be returned near the ground of the load to provide remote ground sensing and improve load regulation.

Protection Diodes

When external capacitors are used with *any* IC regulator it is sometimes necessary to add protection diodes to prevent the capacitors from discharging through low current points into the regulator. Most 10μF capacitors have low enough internal series resistance to deliver 20A spikes when shorted. Although the surge is short there is enough energy to damage parts of the IC.

When an output capacitor is connected to a regulator and the input is shorted, the output capacitor will discharge into the output of the regulator. The discharge current depends on the value of the capacitor, the output voltage of the regulator, and the rate of decrease of V_{IN}. In the UC117, this discharge path is through a large junction that is able to sustain 15A surge with no problem. This is not true of other types of positive regulators. For output capacitors of 25μF or less, there is no need to use diodes.

The bypass capacitor on the adjustment terminal can discharge through a low current junction. Discharge occurs when *either* the input or output is shorted. Internal to the UC117 is a 50Ω resistor which limits the peak discharge current. No protection is needed for output voltages of 25V or less and 10μF capacitance. *Figure 2* shows a UC117 with protection diodes included for use with outputs greater than 25V and high values of output capacitance.

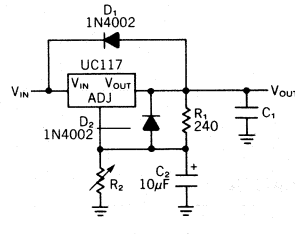


Figure 2. Regulator with Protection Diodes

LINEAR INTEGRATED CIRCUITS

1.5A, Three Terminal Adjustable Negative Voltage Regulators

UC137
UC237
UC337

FEATURES

- Output voltage adjustable from −1.2 to −37V
- Guaranteed 1.5A output current
- Line regulation typically 0.01%/V
- Load regulation typically 0.3%
- Excellent thermal regulation, 0.002%/W
- 77 dB ripple rejection
- Excellent rejection of thermal transients
- 50 ppm/°C temperature coefficient
- Temperature-independent current limit
- Internal thermal overload protection
- Standard 3-lead transistor packages (TO-3, TO-220)

DESCRIPTION

The UC137/UC237/UC337 are adjustable 3-terminal negative voltage regulators capable of supplying in excess of −1.5A over an output voltage range of −1.2V to −37V. These regulators are exceptionally easy to apply, requiring only 2 external resistors to set the output voltage and 1 output capacitor for frequency compensation. The circuit design has been optimized for excellent regulation and low thermal transients. Further, the UC137 series features internal current limiting, thermal shutdown and safe-area compensation, making them virtually blowout-proof against overloads.

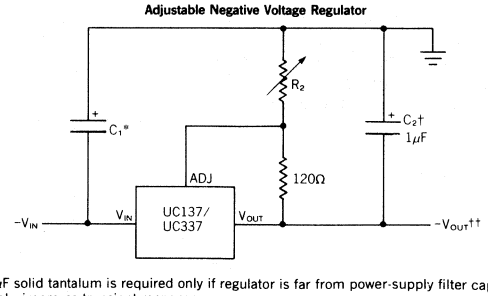
The UC137/UC237/UC337 serve a wide variety of applications including local on-card regulation, programmable-output voltage regulation or precision current regulation. The UC137/UC237/UC337 are ideal complements to the UC117/UC217/UC317 adjustable positive regulators. These devices are available in TO-3 and TO-220 packages. The UC137 is rated for operation from −55°C to +150°C, the UC237 from −25°C to +150°C and the UC337 from 0°C to +125°C.

ABSOLUTE MAXIMUM RATINGS

Power Dissipation	Internally limited
Input—Output Voltage Differential	40V
Operating Junction Temperature Range	
UC137	−55°C to +150°C
UC237	−25°C to +150°C
UC337	0°C to +125°C
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

TYPICAL APPLICATION

Adjustable Negative Voltage Regulator



*C_1 = 1μF solid tantalum is required only if regulator is far from power-supply filter capacitor.
†Optional—improves transient response
†† $-V_{OUT} = -1.25V\left(1 + \frac{R_2}{120\Omega}\right)$

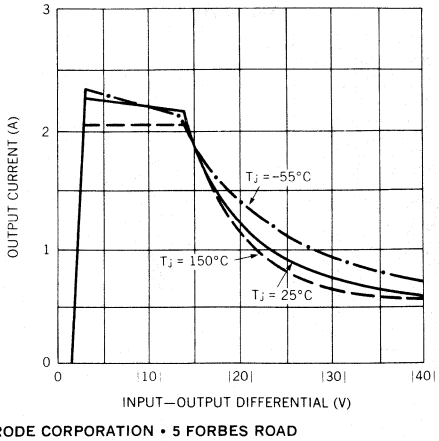
UNITRODE

ELECTRICAL CHARACTERISTICS (Note 1)

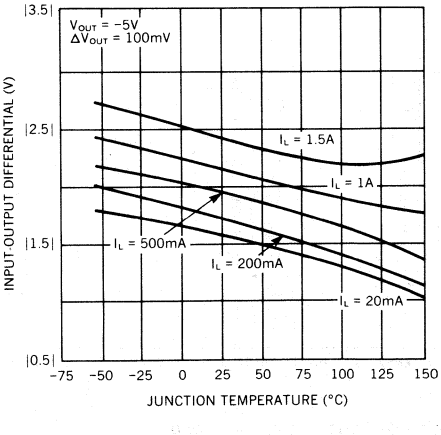
PARAMETER	TEST CONDITIONS	UC137/UC237			UC337			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Line Regulation	T_A = 25°C, 3V ≤ $\|V_{IN} - V_{OUT}\|$ ≤ 40V (Note 2)		0.01	0.02		0.01	0.04	%/V
Load Regulation	T_A = 25°C, 10mA ≤ I_{OUT} ≤ I_{MAX} $\|V_{OUT}\|$ ≤5V, (Note 2) $\|V_{OUT}\|$ ≥ 5V, (Note 2)		 15 0.3	 25 0.5		 15 0.3	 50 1.0	 mV %
Thermal Regulation	T_A = 25°C, 10ms Pulse		0.002	0.02		0.003	0.04	%/W
Adjustment Pin Current			65	100		65	100	μA
Adjustment Pin Current Change	10mA ≤ I_L ≤ I_{MAX} 2.5V ≤ $\|V_{IN} - V_{OUT}\|$ ≤ 40V, T_A = 25°C		2	5		2	5	μA
Reference Voltage	T_A = 25°C 3≤ $\|V_{IN} - V_{OUT}\|$ ≤ 40V 10mA ≤ I_{OUT} ≤ I_{MAX}, P ≤ P_{MAX}	 -1.225 -1.200	 -1.250 -1.250	 -1.275 -1.300	 -1.213 -1.200	 -1.250 -1.250	 -1.287 -1.300	 V V
Line Regulation	3V ≤ $\|V_{IN} - V_{OUT}\|$ ≤ 40V, (Note 2)		0.02	0.05		0.02	0.07	%/V
Load Regulation	10mA ≤ I_{OUT} ≤ I_{MAX}, (Note 2) $\|V_{OUT}\|$ ≤ 5V $\|V_{OUT}\|$ ≥ 5V		 20 0.3	 50 1		 20 0.3	 70 1.5	 mV %
Temperature Stability	T_{MIN} ≤ T_j ≤ T_{MAX}		0.6			0.6		%
Minimum Load Current	$\|V_{IN} - V_{OUT}\|$ ≤ 40V $\|V_{IN} - V_{OUT}\|$ ≤ 10V		2.5 1.2	5 3		2.5 1.5	10 6	mA mA
Current Limit	$\|V_{IN} - V_{OUT}\|$ ≤ 15V K Package T Package $\|V_{IN} - V_{OUT}\|$ = 40V K Package T Package	 1.5 1.5	 2.2 2.2 0.4 0.4		 1.5 1.5	 2.2 2.2 0.4 0.4		 A A A A
RMS Output Noise	T_A = 25°C, 10Hz ≤ f ≤ 10kHz		0.003			0.003		%
Ripple Rejection Ratio	V_{OUT} = -10V, f = 120Hz C_{ADJ} = 10μF	 66	60 77		 66	60 77		dB dB
Long Term Stability	T_A = 125°C, 1000 Hours		0.3	1		0.3	1	%
Thermal Resistance, Junction to Case	K Package T Package		2.3	3		2.3 4	3	°C/W °C/W

Notes: 1. Unless otherwise noted, the above specifications apply over the following conditions:
UC137: −55°C ≤ T_j ≤ 150°C
UC237: −25°C ≤ T_j ≤ 150°C
UC337: 0°C ≤ T_j ≤ 125°C
$|V_{IN} - V_{OUT}|$ =5V, I_O =0.5A, I_{MAX} =1.5A
2. All regulation specifications are measured at constant junction temperatures using low duty-cycle pulse testing.

Current Limit



Dropout Voltage

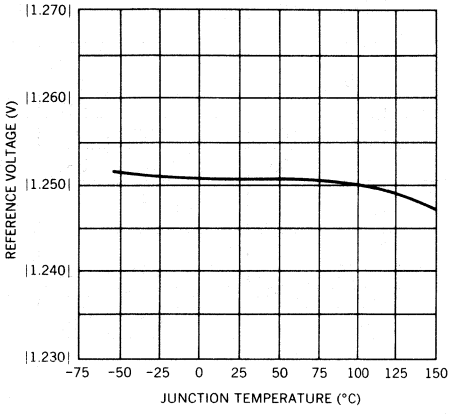


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

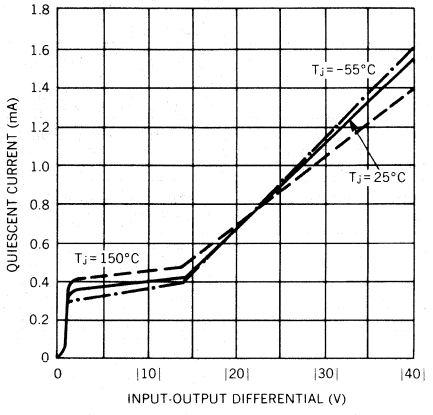
PRINTED IN U.S.A.

TYPICAL PERFORMANCE CHARACTERISTICS

Temperature Stability

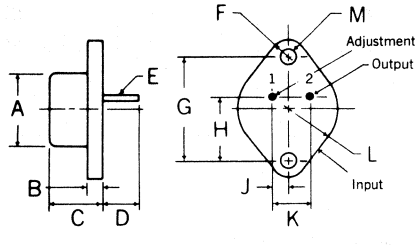


Minimum Operating Current



MECHANICAL SPECIFICATIONS AND CONNECTION DIAGRAMS

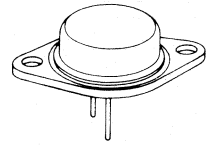
UC137 UC237 UC337



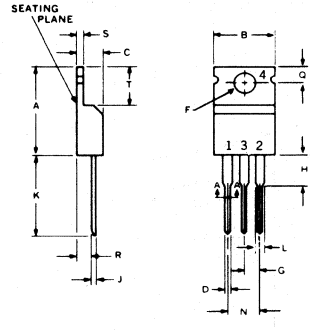
Bottom View

	INCHES	MILLIMETERS
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA K(TO-3)



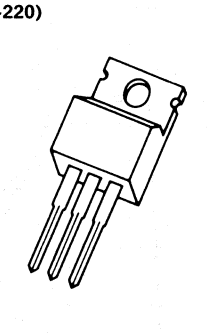
UC337



1-Adjustment
2-Output
3-Input
4-Input

	INCHES		MILIMETERS	
	MIN	MAX	MIN	MAX
A	0.560	0.625	14.23	15.87
B	0.380	0.420	9.66	10.66
C	0.140	0.190	3.56	4.82
D	0.020	0.045	0.51	1.14
F	0.139	0.147	3.531	3.733
G	0.090	0.110	2.29	2.79
H	—	0.250	—	6.35
J	0.015	0.025	0.38	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.070	1.14	1.77
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.115	2.04	2.92
S	0.045	0.055	1.14	1.39
T	0.230	0.270	5.85	6.85

T(TO-220)



Note: When ordering, add suffix "K" (for TO-3 package) or "T" (for TO-220 package) to the Part Number.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

LINEAR INTEGRATED CIRCUITS

3A, Three Terminal Adjustable Positive Voltage Regulators

UC150
UC250
UC350

2

FEATURES

- Output voltage adjustable from 1.2V to 33V
- Guaranteed 3A output current
- Line regulation typically 0.005%/V
- Load regulation typically 0.1%
- Guaranteed thermal regulation
- Current limit constant with temperature
- Standard 3-lead transistor package

DESCRIPTION

The UC150/UC250/UC350 are adjustable 3-terminal positive voltage regulators capable of supplying in excess of 3A over a 1.2V to 33V output range. They require only 2 external resistors to set the output voltage. Further, both line and load regulation are comparable to discrete designs.

In addition to higher performance than fixed regulators, the UC150 series offers full overload protection. Included on the chip are current limit, thermal overload protection and safe area protection. All overload protection circuitry remains fully functional even if the adjustment terminal is accidentally disconnected.

Since the regulator is "floating" and sees only the input-to-output differential voltage, supplies of several hundred volts can be regulated as long as the maximum input to output differential is not exceeded.

Supplies requiring electronic shutdown can be achieved by clamping the adjustment terminal to ground which programs the output to 1.2V where most loads draw little current.

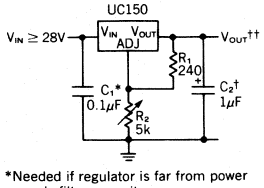
The UC150/UC250/UC350 are packaged in standard TO-3 transistor packages. The UC150 is rated for operation from −55°C to +150°C, the UC250 from −25°C to +150°C and the UC350 from 0°C to +125°C.

ABSOLUTE MAXIMUM RATINGS

Power Dissipation	Internally limited
Input—Output Voltage Differential	35V
Operating Junction Temperature Range	
UC150	−55°C to +150°C
UC250	−25°C to +150°C
UC350	0°C to +125°C
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

TYPICAL APPLICATIONS

1.2V—25V Adjustable Regulator

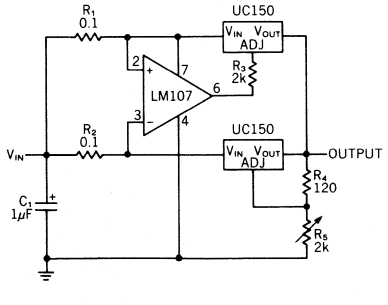


*Needed if regulator is far from power supply filter capacitor
†Optional—improves transient response

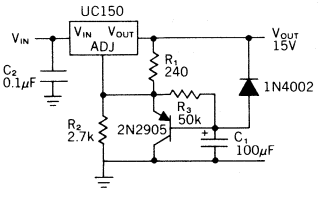
†† $V_{OUT} = 1.25V \left(1 + \frac{R_2}{R_1}\right)$

Note: Usually R_1 = 240Ω for UC150 and UC250 and R_1 = 120Ω for UC350

6A Regulator



Slow Turn-On 15V Regulator



UNITRODE

ELECTRICAL CHARACTERISTICS (Note 1)

PARAMETER	TEST CONDITIONS	UC150/UC250			UC350			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Line Regulation	T_A = 25°C, 3V ≤ (V_{IN} − V_{OUT}) ≤ 35V, (Note 2)		0.005	0.01		0.005	0.03	%/V
Load Regulation	T_A = 25°C, 10mA ≤ I_{OUT} ≤ 3A V_{OUT} ≤5V, (Note 2) V_{OUT} ≥ 5V, (Note 2)		 5 0.1	 15 0.3		 5 0.1	 25 0.1	 mV %
Thermal Regulation	Pulse = 20ms		0.002	0.01		0.002	0.03	%/W
Adjustment Pin Current			50	100		50	100	μA
Adjustment Pin Current Change	10mA ≤ I_L ≤ 3A 3V ≤ (V_{IN} − V_{OUT}) ≤ 35V		0.2	5		0.2	5	μA
Reference Voltage	3 ≤ (V_{IN} − V_{OUT}) ≤ 35V, 10mA ≤ I_{OUT} ≤ 3A, P ≤ 30W	1.20	1.25	1.30	1.20	1.25	1.30	V
Line Regulation	3 ≤ (V_{IN} − V_{OUT}) ≤ 35V, (Note 2)		0.02	0.05		0.02	0.07	%/V
Load Regulation	V_{OUT} ≤ 5V 10mA ≤ I_{OUT} ≤ 3A, (Note 2) V_{OUT} ≥ 5V		20 0.3	50 1		20 0.3	70 1.5	mV %
Temperature Stability	T_{MIN} ≤ T_j ≤ T_{MAX}		1			1		%
Minimum Load Current	(V_{IN} − V_{OUT}) = 35V		3.5	5		3.5	10	mA
Current Limit	(V_{IN} − V_{OUT}) ≤10V (V_{IN} − V_{OUT}) = 30V	3.0	4.5 1		3.0	4.5 1		A A
RMS Output Noise	T_A = 25°C, 10Hz ≤ f ≤ 10kHz		0.003			0.003		%
Ripple Rejection Ratio	V_{OUT} = 10V, f = 120Hz C_{ADJ} = 10μF	 66	65 86		 66	65 86		dB dB
Long Term Stability	T_A = 125°C, 1000 Hrs.		0.3	1		0.3	1	%
Thermal Resistance, Junction to Case				1.5			1.5	°C/W

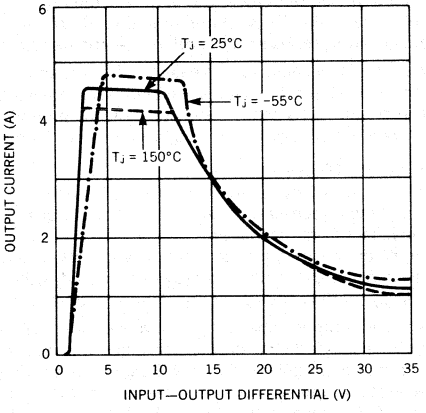
Notes: 1. Unless otherwise noted, the above specifications apply over the following conditions:
UC150: −55°C ≤ T_j ≤ 150°C
UC250: −25°C ≤ T_j ≤ 150°C
UC350: 0°C ≤ T_j ≤ 125°C
(V_{IN} − V_{OUT}) = 5V, I_{OUT} = 1.5A
2. All regulation specifications are measured at constant junction temperatures using low duty-cycle pulse testing.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

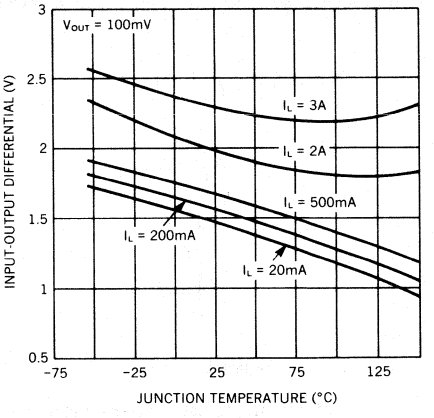
PRINTED IN U.S.A.

TYPICAL PERFORMANCE CHARACTERISTICS

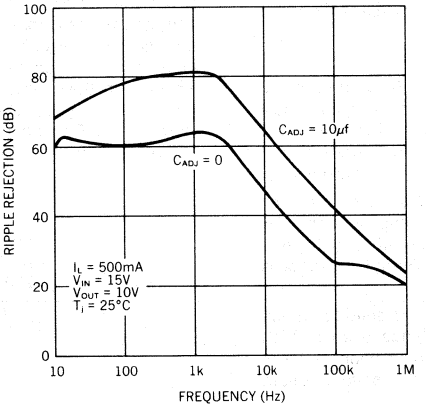
Current Limit



Dropout Voltage

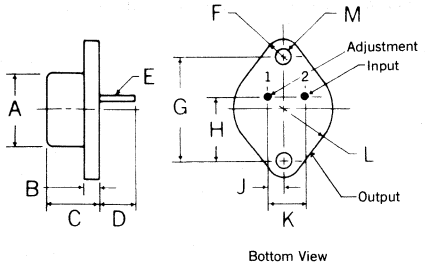


Ripple Rejection



MECHANICAL SPECIFICATIONS AND CONNECTION DIAGRAM

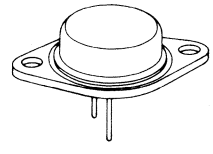
UC150 UC250 UC350



Bottom View

	INCHES	MILLIMETERS
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA K(TO-3)



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

APPLICATION HINTS

In operation, the UC150 develops a nominal 1.25V reference voltage, V_{REF}, between the output and adjustment terminal. The reference voltage is impressed across program resistor R_1 and, since the voltage is constant, a constant current I_1 then flows through the output set resistor R_2, giving an output voltage of

$$V_{OUT} = V_{REF}\left(1 + \frac{R_2}{R_1}\right) + I_{ADJ}R_2$$

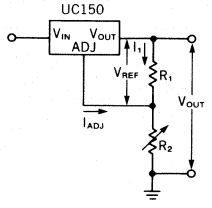


Figure 1

Since the 50μA current from the adjustment terminal represents an error term, the UC150 was designed to minimize I_{ADJ} and make it very constant with line and load changes. To do this, all quiescent operating current is returned to the output establishing a minimum load current requirement. If there is insufficient load on the output, the output will rise.

External Capacitors

An input bypass capacitor is recommended. A 0.1μF disc or 1μF solid tantalum on the input is suitable input bypassing for almost all applications. The device is more sensitive to the absence of input bypassing when adjustment or output capacitors are used but the above values will eliminate the possibility of problems.

The adjustment terminal can be bypassed to ground on the UC150 to improve ripple rejection. This bypass capacitor prevents ripple from being amplified as the output voltage is increased. With a 10μF bypass capacitor 86 dB ripple rejection is obtainable at any output level.

In general, the best type of capacitors to use are solid tantalum. Solid tantalum capacitors have low impedance even at high frequencies. Depending upon capacitor construction, it takes about 25μF in aluminum electrolytic to equal 1μF solid tantalum at high frequencies.

Although the UC150 is stable with no output capacitors, like any feedback circuit, certain values of external capacitance can cause excessive ringing. This occurs with values between 500pF and 5000pF. A 1μF solid tantalum (or 25μF aluminum electrolytic) on the output swamps this effect and insures stability.

Load Regulation

The UC150 is capable of providing extremely good load regulation but a few precautions are needed to obtain maximum performance. The current set resistor connected between the adjustment terminal and the output terminal (usually 240Ω) should be tied directly to the output of the regulator rather than near the load. This eliminates line drops from appearing effectively in series with the reference and degrading regulation.

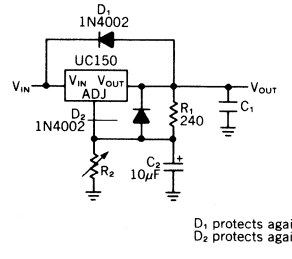
With the TO-3 package, it is easy to minimize the resistance from the case to the set resistor by using 2 separate leads to the case. The ground of R_2 can be returned near the ground of the load to provide remote ground sensing and improve load regulation.

Protection Diodes

When external capacitors are used with *any* IC regulator it is sometimes necessary to add protection diodes to prevent the capacitors from discharging through low current points into the regulator. Most 10μF capacitors have low enough internal series resistance to deliver 20A spikes when shorted. Although the surge is short there is enough energy to damage parts of the IC.

When an output capacitor is connected to a regulator and the input is shorted, the output capacitor will discharge into the output of the regulator. The discharged current depends on the value of the capacitor, the output voltage of the regulator, and the rate of decrease of V_{IN}. In the UC150, this discharge path is through a large junction that is able to sustain 25A surge with no problem. This is not true of other types of positive regulators. For output capacitors of 25μF or less, there is no need to use diodes.

The bypass capacitor on the adjustment terminal can discharge through a low current junction. Discharge occurs when *either* the input or output is shorted. Internal to the UC150 is a 50Ω resistor which limits the peak discharge current. No protection is needed for output voltages of 25V or less and 10μF capacitance. *Figure 2* shows a UC150 with protection diodes included for use with outputs greater than 25V and high values of output capacitance.



$$V_{OUT} = 1.25V\left(1 + \frac{R_2}{R_1}\right) + R_2I_{ADJ}$$

Figure 2. Regulator with Protection Diodes

LINEAR INTEGRATED CIRCUITS

Advanced Regulating Pulse Width Modulators

UC493A UC493AC
UC494A UC494AC
UC495A UC495AC
UC495B UC495BC

2

FEATURES

- Dual uncommitted 40V, 200mA output transistors
- 1% accurate 5V reference
- Dual error amplifiers
- Wide range, variable deadtime
- Single-ended or push-pull operation
- Under-voltage lockout with hysteresis
- Double pulse protection
- Master or slave oscillator operation
- UC493A/UC495B: Built in 80mV threshold for current limiting
- UC495A/UC495B: Internal 39V zener diode
- UC495A/UC495B: Buffered steering control

DESCRIPTION

This entire series of PWM modulators each provide a complete pulse width modulation system in a single monolithic integrated circuit. These devices include a 5V reference accurate to ±1%, two independent amplifiers usable for both voltage and current sensing, an externally synchronizable oscillator with its linear ramp generator, and two uncommitted transistor output switches. These two outputs may be operated either in parallel for single-ended operation or alternating for push-pull applications with an externally controlled dead-band. These units are internally protected against double-pulsing of a single output or from extraneous output signals when the input supply voltage is below minimum.

The UC495A and UC495B also contain an on-chip 39V zener diode for high-voltage applications where V_{CC} would be greater than 40V, and a buffered output steering control that overrides the internal control of the pulse steering flip-flop.

UC493A and UC494A are packaged in a 16-pin DIP, while the UC495A and UC495B are packaged in an 18-pin DIP. The UC493A, UC494A, UC495A and UC495B are specified for operation over the full military temperature range of −55°C to +125°C, while the UC493AC, UC494AC, UC495AC and UC495BC are designed for industrial applications from 0°C to +70°C.

ABSOLUTE MAXIMUM RATINGS (Note 1)

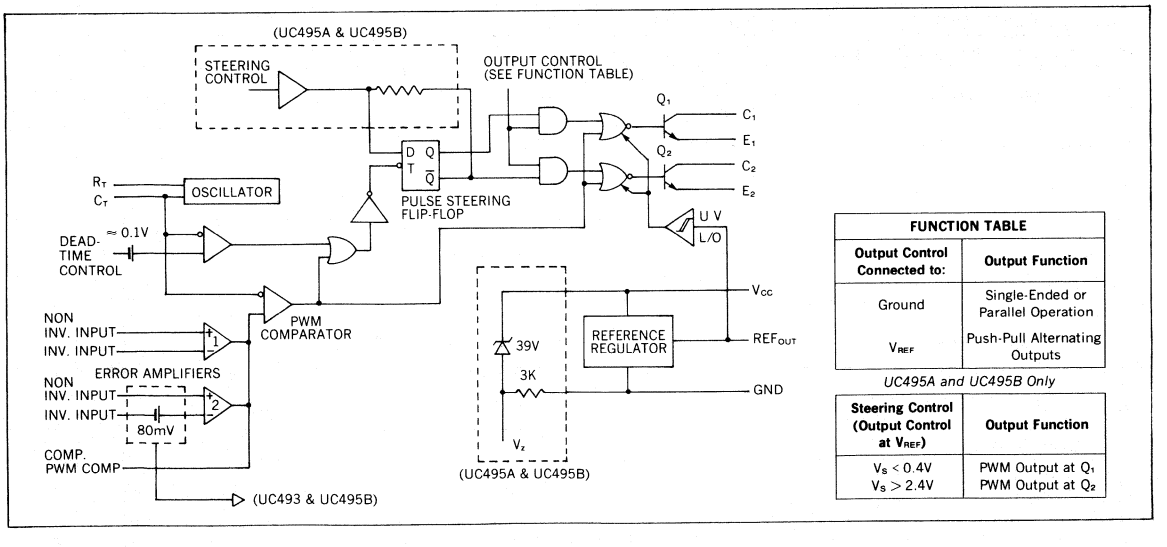
Supply Voltage, V_{CC} (Note 2) 45V
Amplifier Input Voltages ..... V_{CC} + 0.3V
Collector Output Voltage 41V
Collector Output Current 250mA
Continuous Total Dissipation 1000mW
@ (or below) 25°C free air temperature range (Note 3)
Storage Temperature Range ..... −65° to +150°C
Lead Temperature 1/16" (1.6mm) from case for 60 seconds,
J Package ..... 300°C
Lead Temperature 1/16" (1.6mm) from case for 10 seconds,
N Package ..... 260°C

Notes: 1. Over operating free air temperature range unless otherwise noted.
2. All voltage values are with respect to network ground terminal.
3. For J package, derate at 8.2mW/°C for ambient temperature above +28°C. For N package, derate at 9.2mW/°C for ambient temperature above +41°C.

RECOMMENDED OPERATING CONDITIONS

Supply Voltage V_{CC} ..... 7V to 40V
Error Amplifier Input Voltages ..... −0.3V to V_{CC}−2V
Collector Output Voltage 40V
Collector Output Current (each transistor) 200mA
Current into Feedback Terminal 0.3mA
Timing Capacitor, C_T ..... 0.47nF to 10,000nF
Timing Resistor, R_T ..... 1.8KΩ to 500KΩ
Oscillator Frequency ..... 1kHz to 300kHz
Operating Free Air Temperature
UC493A, UC494A, UC495A, UC495B ..... −55°C to +125°C
UC493AC, UC494AC, UC495AC, UC495BC ..... 0°C to +70°C

BLOCK DIAGRAM



FUNCTION TABLE	
Output Control Connected to:	**Output Function**
Ground	Single-Ended or Parallel Operation
V_{REF}	Push-Pull Alternating Outputs

UC495A and UC495B Only

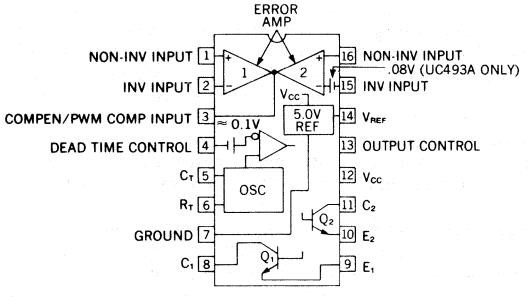
Steering Control (Output Control at V_{REF})	**Output Function**
$V_S < 0.4V$	PWM Output at Q_1
$V_S > 2.4V$	PWM Output at Q_2

UNITRODE

CONNECTION DIAGRAMS

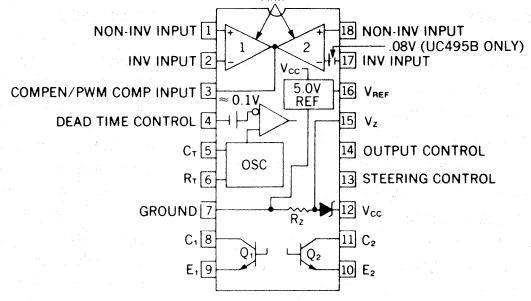
DIL-16 (Top View)
J or N Package

UC493A/UC493AC
UC494A/UC494AC



DIL-18 (Top View)
J or N Package

UC495A/UC495AC
UC495B/UC495BC



ELECTRICAL CHARACTERISTICS (Unless otherwise stated, over recommended operating free-air temperature range, V_{CC} = 15V, f = 10kHz.)

PARAMETER		TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Reference Section						
Output Voltage (V_{REF})		I_O = 1mA, T_A = 25°C	4.95	5	5.05	V
Input Regulation		V_{CC} = 7V to 40V		2	25	mV
Output Regulation		I_O = 1mA to 10mA		1	15	mV
Output Voltage over Temperature		Δ T_A = Min. to Max.	4.90		5.10	V
Short Circuit Output Current (Note 1)		V_{REF} = 0, T_A = 25°C	10	35	50	mA
Oscillator Section						
Frequency (Note 2)		C_T = 0.01μF, R_T = 12kΩ		10		kHz
Standard Deviation of Frequency (Note 3)		All values of V_{CC}, C_T, R_T, T_A constant		10		%
Frequency Change with Voltage		V_{CC} = 7V to 40V, T_A = 25°C		0.1		%
Frequency Change with Temperature		C_T = 0.01μF, R_T = 12kΩ Δ T_A = Min. to Max.			2	%
Deadtime Control Section (Output Control connected to V_{REF})						
Input Bias Current (Pin 4)		$V_{(PIN\ 4)}$ = 0V to 5.25V		−2	−10	μA
Maximum Duty-Cycle (Each Output)		$V_{(PIN\ 4)}$ = 0V	45			%
Input Threshold Voltage (Pin 4)		Zero Duty-Cycle		3	3.3	V
		Maximum Duty-Cycle	0			
Amplifier Section (Current Limit specifications apply to UC493A and UC495B only)						
Input Offset Voltage	Error	$V_{O\ (PIN\ 3)}$ = 2.5V		2	10	mV
	Current Limit		70	80	90	
Input Offset Current		$V_{O\ (PIN\ 3)}$ = 2.5V		25	250	nA
Input Bias Current	Error	$V_{O\ (PIN\ 3)}$ = 2.5V		−0.2	−1	μA
	Current Limit			−1	−2	
Common-Mode Input Voltage Range		V_{CC} = 7V to 40V	0.3 to V_{CC} −2			V
Open Loop Voltage Gain	Error	Δ V_O = 3V, V_O = 0.5V to 3.5V	70	95		dB
	Current Limit		66	90		
Unity Gain Bandwidth				800		kHz
Common-Mode Rejection Ratio	Error	V_{CC} = 40V, T_A = 25°C	65	80		dB
	Current Limit		50	70		
Output Sink Current (Pin 3)		V_{ID} = −15mV to −5V, $V_{(PIN\ 3)}$ = 0.7V	0.3	0.7		mA
Output Source Current (Pin 3)		V_{ID} = 15mV to 5V, $V_{(PIN\ 3)}$ = 3.5V	−2			mA

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, over recommended operating free-air temperature range, V_{CC} = 15V, f = 10kHz.)

PARAMETER		TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Output Section						
Collector Off-State Current		V_{CE} = 40V, V_{CC} = 40V		2	100	μA
Emmitter Off-State Current		V_{CC} = V_C = 40V, V_E = 0			-100	μA
Collector-Emitter Saturation Voltage	Common-Emitter	V_E = 0, I_C = 200mA		1.1	1.3	V
	Emitter-Follower	V_C = 15V, I_E = -200mA		1.5	2.5	
Output Control Input Current		V_I = V_{REF}			3.5	mA
PWM Comparator Section						
Input Threshold Voltage (Pin 3)		Zero Duty-Cycle		4	4.5	V
Input Sink Current (Pin 3)		$V_{(PIN\ 3)}$ = 0.7V	0.3	0.7		mA
Steering Control (UC495A and UC495B only, see Function Table)						
Input Current		$V_{(PIN\ 13)}$ = 0.4V, Q_1 active			-200	μA
		$V_{(PIN\ 13)}$ = 2.4V, Q_2 active			300	
Deadband				500		mV
Zener Diode Circuit (UC495A and UC495B only)						
Breakdown Voltage		V_{CC} = 45V, I_Z = 2mA	36	39	45	V
Sink Current		$V_{(PIN\ 15)}$ = 1V	0.2	0.3	0.6	mA
Total Device						
Standby Supply Current		Pin 6 at V_{REF}. All other V_{CC} = 15V		6	10	mA
		inputs and outputs open. V_{CC} = 40V		9	15	
Under-Voltage Lockout			3.5		6.5	V
Hysteresis				300		mV
Switching Characteristics (T_A = 25°C)						
Output Voltage Rise Time		Common-Emitter Configuration		100	200	ns
Output Voltage Fall Time		R_L = 68Ω, C_L = 15pF		25	100	ns
Output Voltage Rise Time		Emitter-Follower Configuration		100	200	ns
Output Voltage Fall Time		R_L = 68Ω, C_L = 15pF		40	100	ns

Notes: 1. Duration of the short circuit should not exceed one second.

2. Frequency for other values of C_T and R_T is approximately $f = \frac{1.1}{R_T C_T}$

3. Standard deviation is a measure of the statistical distribution about the mean as derived from the formula $\sigma = \sqrt{\frac{\sum_{n=1}^{n} (x_n - x)^2}{n-1}}$

Figure 1. Slaving Two or More Control Circuits

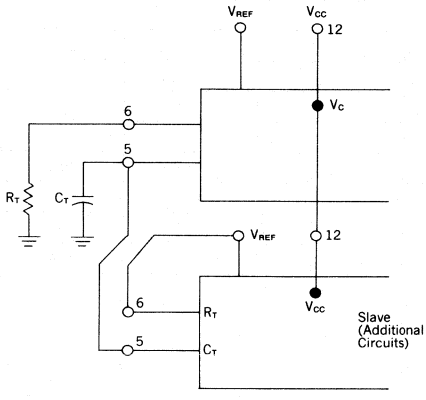


Figure 2. Output Circuit of Error Amplifiers

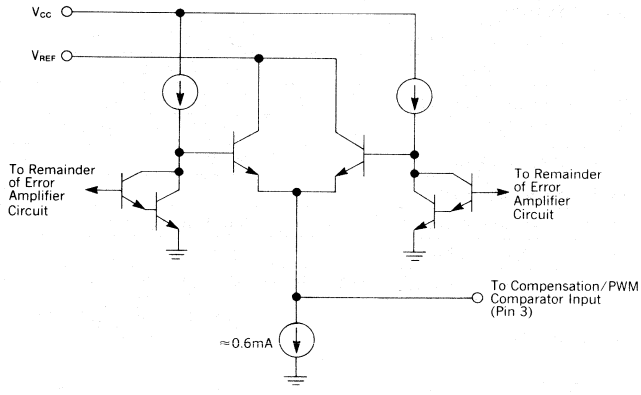
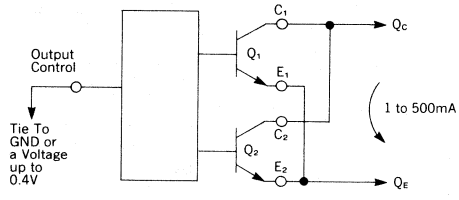
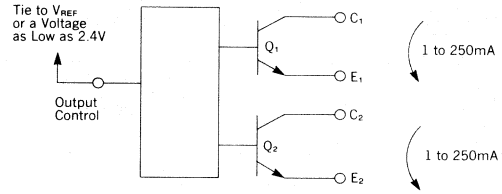


Figure 3. Output Connections for Single-Ended and Push-Pull Configurations



Single-Ended Configuration



Push-Pull Configuration

Figure 4. Internal Buffer with Deadband for Steering Control on UC495A and UC495B

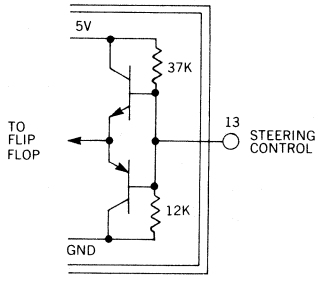


Figure 5. Operation with $V_{IN} > 40V$ Using Internal Zener (UC495A and UC495B Only)

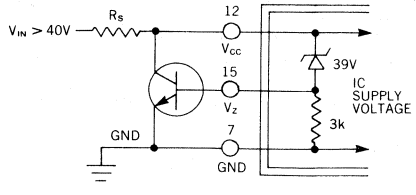
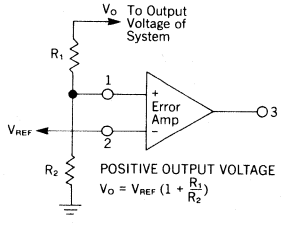
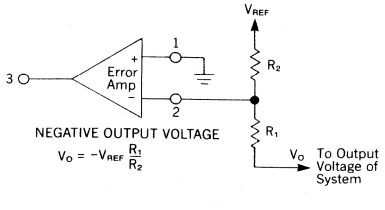


Figure 6. Error Amplifier Sensing Techniques





LINEAR INTEGRATED CIRCUITS
Regulating Pulse Width Modulators

UC1524
UC2524
UC3524

2

FEATURES
- Complete PWM Power control circuitry
- Uncommitted outputs for single-ended or push-pull applications
- Low standby current ... 8mA typical
- Interchangeable with SG1524, SG2524 and SG3524, respectively

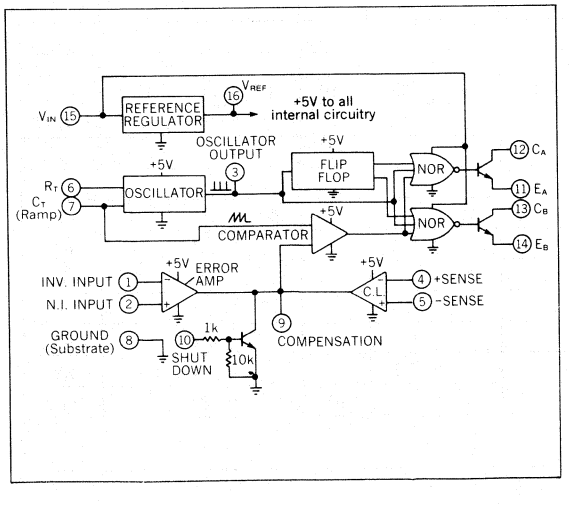
DESCRIPTION
The UC1524, UC2524 and UC3524 incorporate on a single monolithic chip all the functions required for the construction of regulating power supplies inverters or switching regulators. They can also be used as the control element for high-power-output applications. The UC1524 family was designed for switching regulators of either polarity, transformer-coupled dc-to-dc converters, transformerless voltage doublers and polarity converter applications employing fixed-frequency, pulse-width modulation techniques. The dual alternating outputs allow either single-ended or push-pull applications. Each device includes an on-chip reference, error amplifier, programmable oscillator, pulse-steering flip-flop, two uncommitted output transistors, a high-gain comparator, and current-limiting and shut-down circuitry. The UC1524 is characterized for operation over the full military temperature range of −55°C to +125°C. The UC2524 and UC3524 are designed for operation from −25°C to +85°C and 0°C to +70°C, respectively.

ABSOLUTE MAXIMUM RATINGS (Note 1)
Supply Voltage, V_{CC} (Notes 2 and 3) 40V
Collector Output Current 100mA
Reference Output Current 50mA
Current Through C_T Terminal ..... −5mA
Power Dissipation at T_A = +25°C (Note 4) 1000mW
Thermal Resistance, Junction to Ambient ..... 100°C/W
Power Dissipation at T_C = +25°C (Note 5) 2000mW
Thermal Resistance, Junction to Case ..... 60°C/W
Operating Junction Temperature Range ..... −55°C to +150°C
Storage Temperature Range ..... −65°C to +150°C

Notes: 1. Over operating free-air temperature range unless otherwise noted.
2. All voltage values are with respect to the ground terminal, pin 8
3. The reference regulator may be bypassed for operation from a fixed 5V supply by connecting the V_{CC} and reference output pins both to the supply voltage. In this configuration the maximum supply voltage is 6V.
4. Derate at 10mW/°C for ambient temperatures above +50°C
5. Derate at 16mW/°C for case temperatures above +25°C

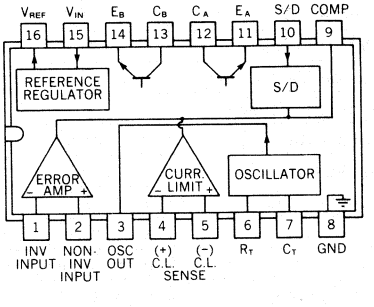
RECOMMENDED OPERATING CONDITIONS
Supply Voltage, V_{CC} ..... 8V to 40V
Reference Output Current ..... 0 to 20mA
Current through C_T Terminal ..... −0.03mA to −2mA
Timing Resistor, R_T ..... 1.8KΩ to 100KΩ
Timing Capacitor, C_T ..... 0.001μF to 0.1μF
Operating Ambient Temperature Range
UC1524 ..... −55°C to +125°C
UC2524 ..... −25°C to +85°C
UC3524 ..... 0°C to +70°C

BLOCK DIAGRAM



CONNECTION DIAGRAM

DIL-16
J or N Package



UNITRODE

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for the UC1524, −25°C to +85°C for the UC2524, and 0°C to +70°C for the UC3524, V_{IN} = 20V, and f = 20kHz)

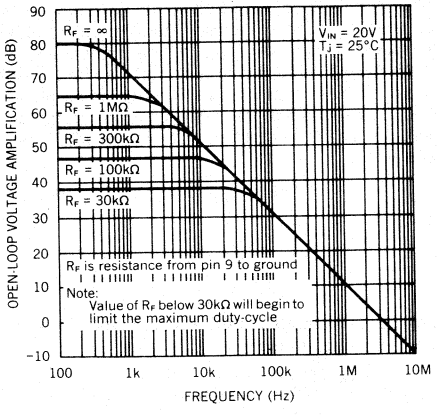
PARAMETER	TEST CONDITIONS	UC1524/UC2524			UC3524			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Reference Section								
Output Voltage		4.8	5.0	5.2	4.6	5.0	5.4	V
Line Regulation	V_{IN} = 8 to 40V		10	20		10	30	mV
Load Regulation	I_L = 0 to 20mA		20	50		20	50	mV
Ripple Rejection	f = 120Hz, T_j = 25°C		66			66		dB
Short Circuit Current Limit	V_{REF} = 0, T_j =25°C		100			100		mA
Temperature Stability	Over Operating Temperature Range		0.3	1		0.3	1	%
Long Term Stability	T_j = 125°C, t = 1000 Hrs.		20			20		mV
Oscillator Section								
Maximum Frequency	C_T = .001mfd, R_T = 2kΩ		300			300		kHz
Initial Accuracy	R_T and C_T Constant		5			5		%
Voltage Stability	V_{IN} = 8 to 40V, T_j = 25°C			1			1	%
Temperature Stability	Over Operating Temperature Range			2			2	%
Output Amplitude	Pin 3, T_j =25°C		3.5			3.5		V
Output Pulse Width	C_T = .01mfd, T_j = 25°C		0.5			0.5		μs
Error Amplifier Section								
Input Offset Voltage	V_{CM} = 2.5V		0.5	5		2	10	mV
Input Bias Current	V_{CM} = 2.5V		2	10		2	10	μA
Open Loop Voltage Gain		72	80		60	80		dB
Common Mode Voltage	T_j = 25°C	1.8		3.4	1.8		3.4	V
Common Mode Rejection Ratio	T_j = 25°C		70			70		dB
Small Signal Bandwidth	A_V = 0dB, T_j = 25°C		3			3		MHz
Output Voltage	T_j = 25°C	0.5		3.8	0.5		3.8	V
Comparator Section								
Duty-Cycle	% Each Output On	0		45	0		45	%
Input Threshold	Zero Duty-Cycle		1			1		V
Input Threshold	Maximum Duty-Cycle		3.5			3.5		V
Input Bias Current			1			1		μA
Current Limiting Section								
Sense Voltage	Pin 9 = 2V with Error Amplifier Set for Maximum Out, T_j = 25°C	190	200	210	180	200	220	mV
Sense Voltage T.C.			0.2			0.2		mV/°C
Common Mode Voltage		−1		+1	−1		+1	V
Output Section (Each Output)								
Collector-Emitter Voltage		40			40			V
Collector Leakage Current	V_{CE} = 40V		0.1	50		0.1	50	μA
Saturation Voltage	I_C = 50mA		1	2		1	2	V
Emitter Output Voltage	V_{IN} = 20V	17	18		17	18		V
Rise Time	R_C = 2K ohm, T_j = 25°C		0.2			0.2		μs
Fall Time	R_C = 2K ohm, T_j = 25°C		0.1			0.1		μs
Total Standby Current (Excluding oscillator charging current, error and current limit dividers, and with outputs open)	V_{IN} = 40V		8	10		8	10	mA

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

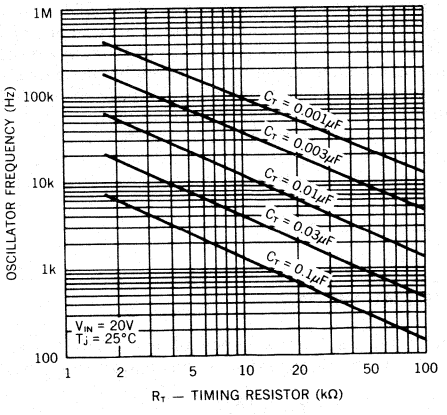
PRINTED IN U.S.A.

TYPICAL CHARACTERISTICS

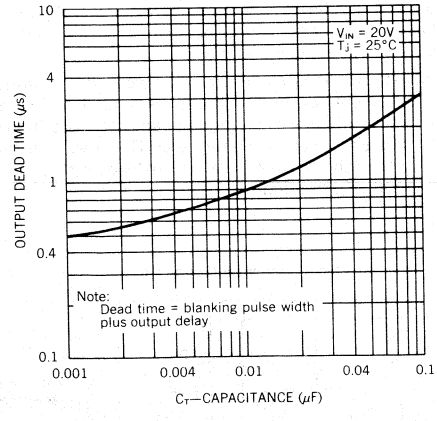
Open-Loop Voltage Amplification of Error Amplifier vs Frequency



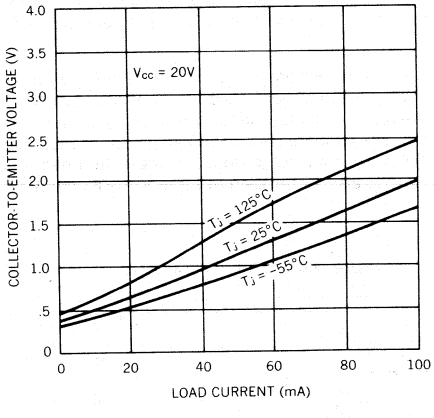
Oscillator Frequency vs Timing Components



Output Dead Time vs Timing Capacitance Value



Output Saturation Voltage vs Load Current



PRINCIPLES OF OPERATION

The UC1524 is a fixed-frequency pulse-width-modulation voltage regulator control circuit. The regulator operates at a frequency that is programmed by one timing resistor (R_T) and one timing capacitor (C_T). R_T establishes a constant charging current for C_T. This results in a linear voltage ramp at C_T, which is fed to the comparator providing linear control of the output pulse width by the error amplifier. The UC1524 contains an on-board 5V regulator that serves as a reference as well as powering the UC1524's internal control circuitry and is also useful in supplying external support functions. This reference voltage is lowered externally by a resistor divider to provide a reference within the common-mode range of the error amplifier or an external reference may be used. The power supply output is sensed by a second resistor divider network to generate a feedback signal to the error amplifier. The amplifier output voltage is then compared to the linear voltage ramp at C_T. The resulting modulated pulse out of the high-gain comparator is then steered to the appropriate output pass transistor (Q_1 or Q_2) by the pulse-steering flip-flop, which is synchronously toggled by the oscillator output. The oscillator output pulse also serves as a blanking pulse to assure both outputs are never on simultaneously during the transition times. The width of the blanking pulse is controlled by the value of C_T. The outputs may be applied in a push-pull configuration in which their frequency is half that of the base oscillator, or paralleled for single-ended applications in which the frequency is equal to that of the oscillator. The output of the error amplifier shares a common input to the comparator with the current limiting and shutdown circuitry and can be overridden by signals from either of these inputs. This common point is also available externally and may be employed to control the gain of, or to compensate, the error amplifier, or to provide additional control to the regulator.

TYPICAL APPLICATIONS DATA

Oscillator

The oscillator controls the frequency of the UC1524 and is programmed by R_T and C_T according to the approximate formula:

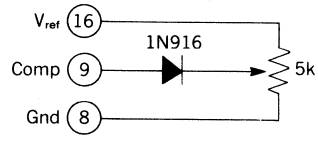
$$f \simeq \frac{1.18}{R_T C_T}$$

where R_T is in kilohms
C_T is in microfarads
f is in kilohertz

Practical values of C_T fall between 0.001 and 0.1 microfarad. Practical values of R_T fall between 1.8 and 100 kilohms. This results in a frequency range typically from 120 hertz to 500 kilohertz.

Blanking

The output pulse of the oscillator is used as a blanking pulse at the output. This pulse width is controlled by the value of C_T. If small values of C_T are required for frequency control, the oscillator output pulse width may still be increased by applying a shunt capacitance of up to 100pF from pin 3 to ground. If still greater dead-time is required, it should be accomplished by limiting the maximum duty cycle by clamping the output of the error amplifier. This can easily be done with the circuit below:

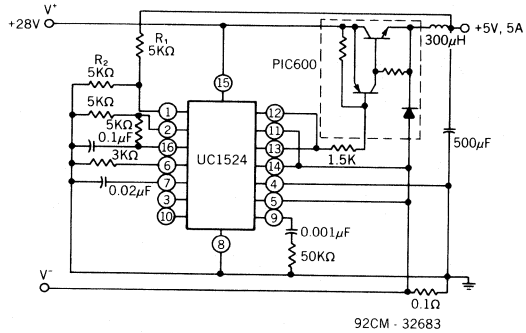


Synchronous Operation

When an external clock is desired, a clock pulse of approximately 3V can be applied directly to the oscillator output terminal. The impedance to ground at this point is approximately 2 kilohms. In this configuration R_T C_T must be selected for a clock period slightly greater than that of the external clock.

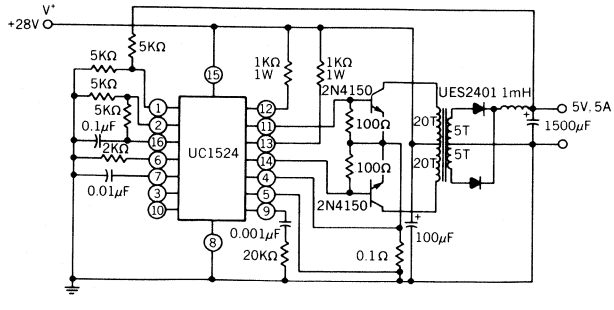
If two or more UC1524 regulators are to be operated synchronously, all oscillator output terminals should be tied together, all C_T terminals connected to a single timing capacitor, and the timing resistor connected to a single R_T terminal. The other R_T terminals can be left open or shorted to V_{REF}. Minimum lead lengths should be used between the C_T terminals.

Single-Ended LC Switching Regulator Circuit



92CM - 32683

Push-Pull Transformer-Coupled Circuit

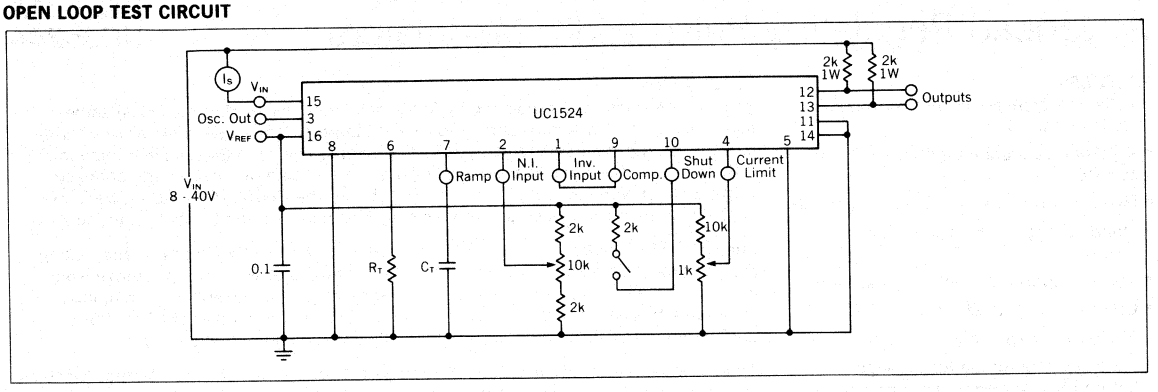


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

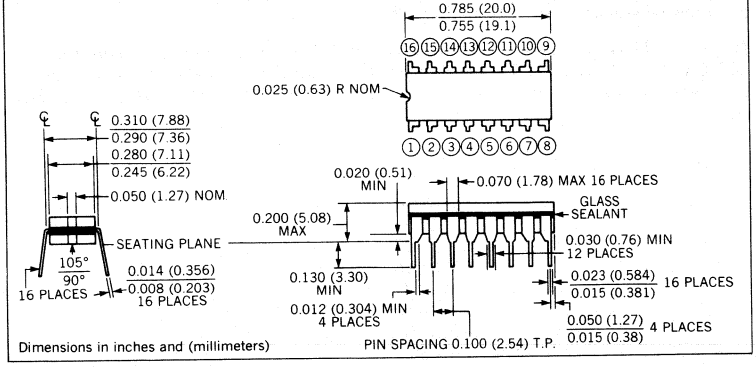
2

OPEN LOOP TEST CIRCUIT



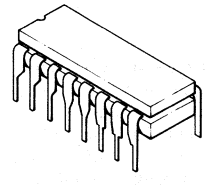
MECHANICAL SPECIFICATIONS

UC1524 UC2524 UC3524

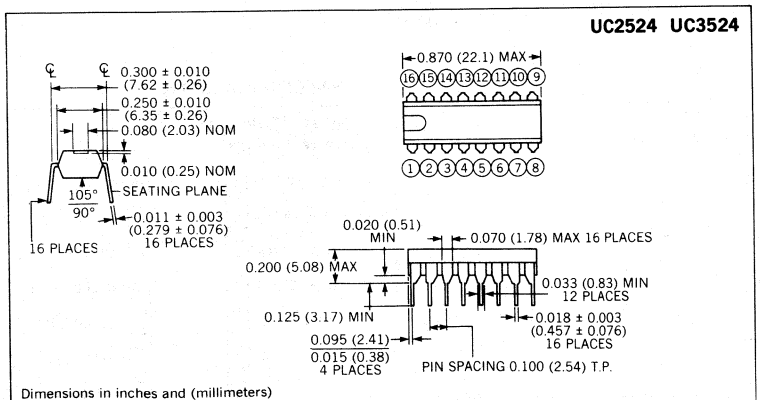


Dimensions in inches and (millimeters)

16-PIN J CERAMIC

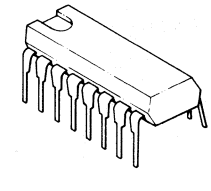


UC2524 UC3524



Dimensions in inches and (millimeters)

16-PIN N PLASTIC



Note: When ordering, add suffix "J" (for 16 pin ceramic package) or "N" (for 16 pin plastic package) to the part number.

LINEAR INTEGRATED CIRCUITS

Advanced Regulating Pulse Width Modulators

UC1524A
UC2524A
UC3524A

FEATURES

- Fully interchangeable with standard UC1524 family
- Precision reference internally trimmed to ±1%
- High-Performance current limit function
- Under-voltage lockout with hysteretic turn-on
- Start-up supply current less than 4mA
- Output current to 200mA
- 60V output capability
- Wide common-mode input range for both error and current limit amplifiers
- PWM latch insures single pulse per period
- Double pulse suppression logic
- 200ns shutdown through PWM latch
- Guaranteed frequency accuracy
- Thermal shutdown protection

DESCRIPTION

The UC1524A family of regulating PWM ICs has been designed to retain the same highly versatile architecture of the industry standard UC1524 (SG1524) while offering substantial improvements to many of its limitations. The UC1524A is pin compatible with "non-A" models and in most existing applications can be directly interchanged with no effect on power supply performance. Using the UC1524A, however, frees the designer from many concerns which typically had required additional circuitry to solve.

The UC1524A includes a precise 5V reference trimmed to ±1% accuracy, eliminating the need for potentiometer adjustments; an error amplifier with an input range which includes 5V, eliminating the need for a reference divider; a current sense amplifier useful in either the ground or power supply output lines; and a pair of 60V, 200mA uncommitted transistor switches which greatly enhance output versatility.

An additional feature of the UC1524A is an under-voltage lockout circuit which disables all the internal circuitry, except the reference, until the input voltage has risen to 8V. This holds standby current low until turn-on, greatly simplifying the design of low power, off-line supplies. The turn-on circuit has approximately 600mV of hysteresis for jitter-free activation.

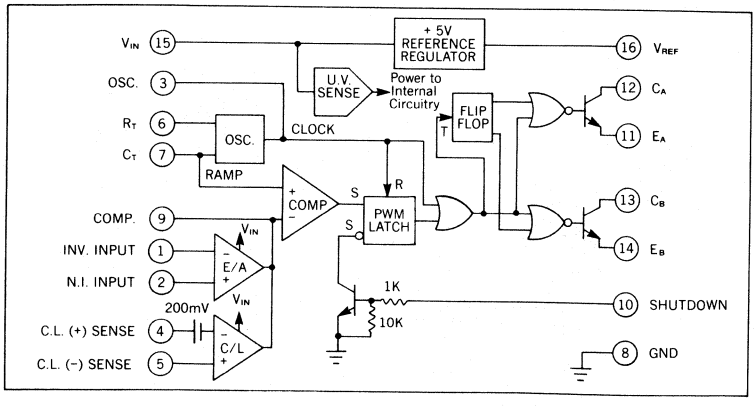
Other product enhancements included in the UC1524A's design include a PWM latch which insures freedom from multiple pulsing within a period, even in noisy environments, logic to eliminate double pulsing on a single output, a 200ns external shutdown capability, and automatic thermal protection from excessive chip temperature. The oscillator circuit of the UC1524A is usable beyond 500kHz and is now easier to synchronize with an external clock pulse.

The UC1524A is packaged in a hermetic 16-pin DIP and is rated for operation from −55°C to +125°C. The UC2524A and UC3524A are available in either ceramic or plastic packages and are rated for operation from −25°C to +85°C and 0°C to 70°C, respectively.

ABSOLUTE MAXIMUM RATINGS

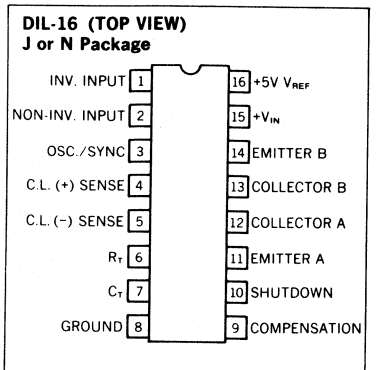
Supply Voltage (V_{IN})	40V
Collector Supply Voltage (V_C)	60V
Output Current (Each Output)	200mA
Reference Output Current	50mA
Oscillator Charging Current	5mA
Power Dissipation at T_A = +25°C	1000mW
Derate above +50°C	10mW/°C
Power Dissipation at T_C = +25°C	2000mW
Derate for Case Temperature above +25°C	16mW/°C
Operating Temperature Range	−55°C to +125°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	+300°C

BLOCK DIAGRAM



CONNECTION DIAGRAM

DIL-16 (TOP VIEW)
J or N Package



UNITRODE

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for the UC1524A, −25°C to +85°C for the UC2524A, and 0°C to +70°C for the UC3524A; V_{IN} = V_C = 20V.)

PARAMETER	TEST CONDITIONS	UC1524A UC2524A			UC3524A			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Turn-on Characteristics								
Input Voltage	Operating Range after Turn-on	8		40	8		40	V
Turn-on Threshold		5.5	7.5	8.5	5.5	7.5	8.5	V
Turn-on Current	V_{IN} = 6V		2.5	4		2.5	4	mA
Operating Current	V_{IN} = 8 to 40V		5	10		5	10	mA
Turn-on Hysteresis*			0.6			0.6		V
Reference Section								
Output Voltage	T_j = 25°C	4.95	5.00	5.05	4.90	5.00	5.10	V
Line Regulation	V_{IN} = 10 to 40V		10	20		10	30	mV
Load Regulation	I_L = 0 to 20mA		20	50		20	50	mV
Temperature Stability*	Over Operating Range*		20	50		20	50	mV
Short Circuit Current	V_{REF} = 0, T_j = 25°C		80	100		80	100	mA
Output Noise Voltage*	10hz ≤ f ≤ 10kHz, T_j = 25°C		40			40		μVrms
Long Term Stability*	T_j = 125°C, 1000 Hrs.		20	50		20	50	mV
Oscillator Section (Unless otherwise specified, R_T = 2700Ω, C_T = 0.01 mfd)								
Initial Accuracy	T_j = 25°C	41	43	45	39	43	47	kHz
Temperature Stability	Over Operating Temperature Range		1	2		1	2	%
Minimum Frequency*	R_T = 150kΩ, C_T = 0.1 mfd			140			120	Hz
Maximum Frequency	R_T = 2.0kΩ, C_T = 470 pF	500			500			kHz
Output Amplitude*	T_j = 25°C		3.5			3.5		V
Output Pulse Width*	T_j = 25°C		0.5			0.5		μs
Ramp Peak		3.3	3.5	3.7	3.3	3.5	3.7	V
Ramp Valley	T_j = 25°C	0.7	0.8	0.9	0.7	0.8	0.9	V
Ramp Valley T.C.			−1.0			−1.0		mV/°C
Error Amplifier Section (Unless otherwise specified, V_{CM} = 2.5V)								
Input Offset Voltage			0.5	5		2	10	mV
Input Bias Current			1	5		1	10	μA
Input Offset Current			.05	1		0.5	1	μA
Common Mode Rejection Ratio	V_{CM} = 1.5 to 5.5V	60	75		60	75		dB
Power Supply Rejection Ratio	V_{IN} = 10 to 40V	50	60		50	60		dB
Output Swing	Minimum Total Range	0.5		5.0	0.5		5.0	V
Open Loop Voltage Gain	ΔV_O = 1 to 4V, $R_L \geq$ 10 Meg Ω	72	80		60	80		dB
Gain-Bandwidth*	T_j = 25°C, A_V = 0dB	1	3		1	3		MHz
DC Transconductance*†	T_j = 25°C, 30kΩ ≤ R_L ≤ 1MΩ	1.7	2.3		1.7	2.3		mS

* These parameters are guaranteed by design but not 100% tested in production.

† DC transconductance (g_M) relates to DC open-loop voltage gain according to the following equation: $A_V = g_M R_L$ where R_L is the resistance from pin 9 to ground.
The minimum g_M specification is used to calculate minimum A_V when the error amplifier output is loaded.

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for the UC1524A, −25°C to +85°C for the UC2524A, and 0°C to +70°C for the UC3524A; V_{IN} = V_C = 20V.)

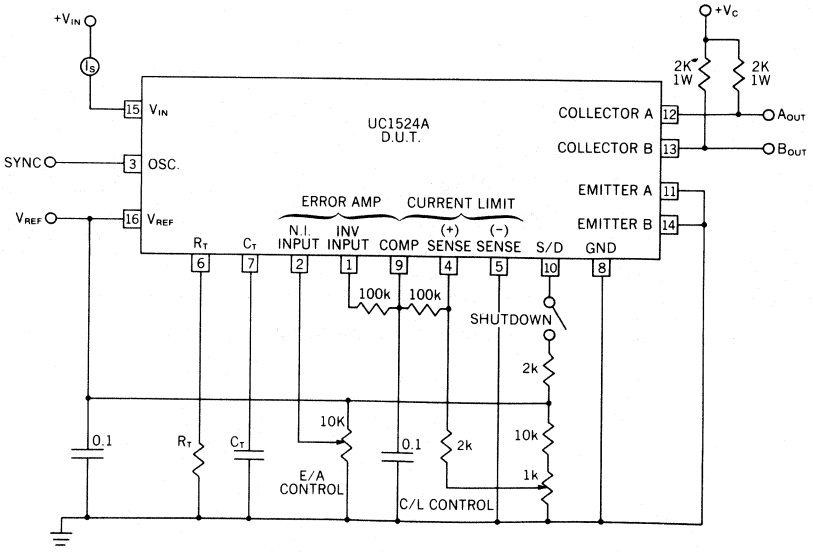
PARAMETER	TEST CONDITIONS	UC1524A UC2524A			UC3524A			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Current Limit Amplifier (Unless otherwise specified, Pin 5 = 0V)								
Input Offset Voltage	T_j = 25°C, E/A Set for Maximum Output	190	200	210	180	200	220	mV
Input Offset Voltage	Over Operating Temperature Range	180		220	170		230	mV
Input Bias Current			−1	−10		−1	−10	μA
Common Mode Rejection Ratio	$V_{(Pin\ 5)}$ = −0.3V to +5.5V	50	60		50	60		dB
Power Supply Rejection Ration	V_{IN} = 10 to 40V	50	60		50	60		dB
Output Swing	Minimum Total Range	0.5		5.0	0.5		5.0	V
Open-Loop Voltage Gain	ΔV_O = 1 to 4V, $R_L \geq$ 10 Meg Ω	70	80		70	80		dB
Delay Time*	Pin 4 to Pin 9, ΔV_{IN} = 300mV		300			300		ns
Output Section (Each Output)								
Collector Emitter Voltage	I_C = 100μA	60	80		50	80		V
Collector Leakage Current	V_{CE} = 50V		.1	20		.1	20	μA
Saturation Voltage	I_C = 20mA I_C = 200mA		.2 1	.4 2.2		.2 1	.4 2.2	V V
Emitter Output Voltage	I_E = 50mA	17	18		17	18		V
Rise Time*	T_j = 25°C, R = 2K Ω		200			200		ns
Fall Time*	T_j = 25°C, R = 2K Ω		100			100		ns
Comparator Delay*	T_j = 25°C, Pin 9 to output		300			300		ns
Shutdown Delay*	T_j = 25°C, Pin 10 to Output		200			200		ns
Shutdown Threshold	T_j = 25°C, R_C = 2K Ω	0.6	.7	1.0	0.6	.7	1.0	V
Thermal Shutdown*			165			165		°C

* These parameters are guaranteed by design but not 100% tested in production.

OPEN-LOOP TEST CIRCUIT

Note: The UC1524A should be able to be tested in any 1524 test circuit with two possible exceptions:
1. The higher gain-bandwidth of the current limit amplifier in the UC1524A may cause oscillations in an uncompensated 1524 test circuit.
2. The effect of the shutdown, pin 10, cannot be seen at the compensation terminal, pin 9, but must be observed at the outputs.

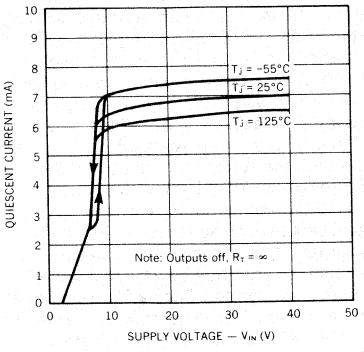
The circuit below will allow all UC1524A functions to be evaluated.



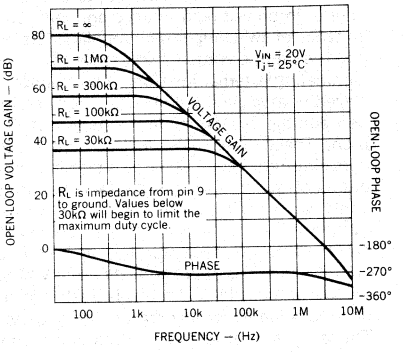
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

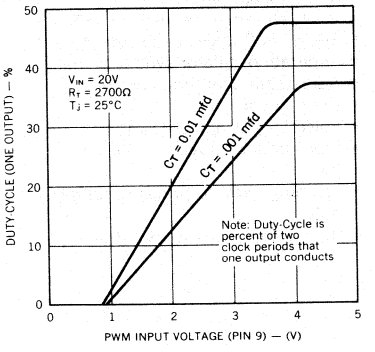
Supply Current vs Voltage



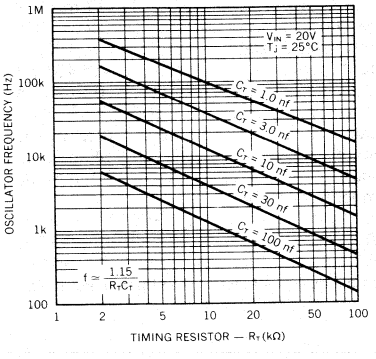
Error Amplifier Voltage Gain and Phase vs Frequency



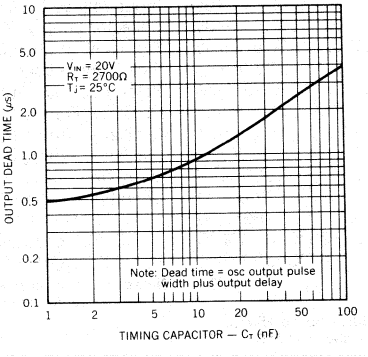
Pulse Width Modulator Transfer Function



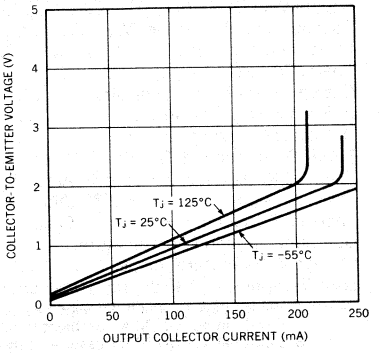
Oscillator Frequency vs Timing Components



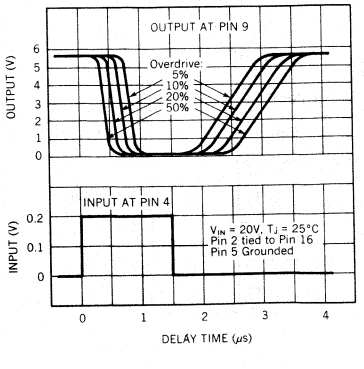
Output Dead Time vs Timing Capacitor Value



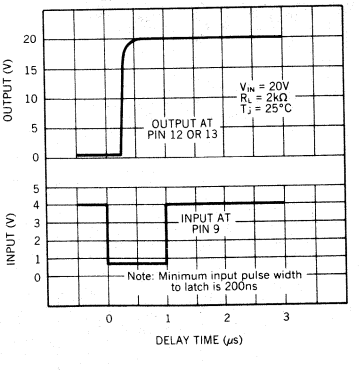
Output Saturation Voltage



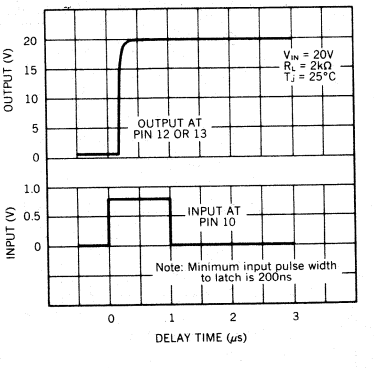
Current Limit Amplifier Delay



Shutdown Delay From PWM Comparator — Pin 9



Turn-Off Delay From Shutdown — Pin 10



LINEAR INTEGRATED CIRCUITS
Regulating Pulse Width Modulators

UC1525A UC1527A
UC2525A UC2527A
UC3525A UC3527A

FEATURES
- 8 to 35V operation
- 5.1V reference trimmed to ±1%
- 100Hz to 500kHz oscillator range
- Separate oscillator sync terminal
- Adjustable deadtime control
- Internal soft-start
- Pulse-by-pulse shutdown
- Input undervoltage lockout with hysteresis
- Latching PWM to prevent multiple pulses
- Dual source/sink output drivers

DESCRIPTION
The UC1525A/1527A series of pulse width modulator integrated circuits are designed to offer improved performance and lowered external parts count when used in designing all types of switching power supplies. The on-chip +5.1V reference is trimmed to ±1% and the input common-mode range of the error amplifier includes the reference voltage, eliminating external resistors. A sync input to the oscillator allows multiple units to be slaved or a single unit to be synchronized to an external system clock. A single resistor between the C_T and the discharge terminals provide a wide range of dead time adjustment. These devices also feature built-in soft-start circuitry with only an external timing capacitor required. A shutdown terminal controls both the soft-start circuitry and the output stages, providing instantaneous turn off through the PWM latch with pulsed shutdown, as well as soft-start recycle with longer shutdown commands. These functions are also controlled by an undervoltage lockout which keeps the outputs off and the soft-start capacitor discharged for sub-normal input voltages. This lockout circuitry includes approximately 500mV of hysteresis for jitter-free operation. Another feature of these PWM circuits is a latch following the comparator. Once a PWM pulse has been terminated for any reason, the outputs will remain off for the duration of the period. The latch is reset with each clock pulse. The output stages are totem-pole designs capable of sourcing or sinking in excess of 200mA. The UC1525A output stage features NOR logic, giving a LOW output for an OFF state. The UC1527A utilizes OR logic which results in a HIGH output level when OFF.

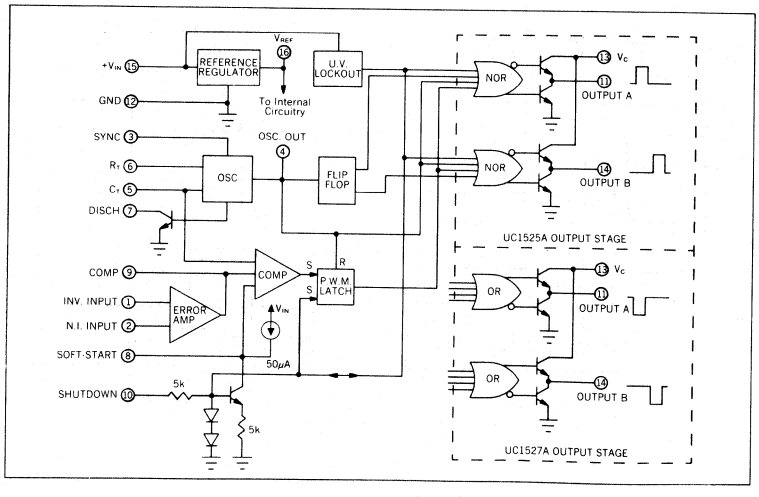
ABSOLUTE MAXIMUM RATINGS (Note 1)
Supply Voltage, ($+V_{IN}$) ..... +40V
Collector Supply Voltage (V_C) ..... +40V
Logic Inputs ..... -0.3V to +5.5V
Analog Inputs ..... -0.3V to $+V_{IN}$
Output Current, Source or Sink 500mA
Reference Output Current 50mA
Oscillator Charging Current 5mA
Power Dissipation at T_A= +25°C (Note 2) 1000mW
Thermal Resistance, Junction to Ambient ..... 100°C/W
Power Dissipation at T_C = +25°C (Note 3) 2000mW
Thermal Resistance, Junction to Case ..... 60°C/W
Operating Junction Temperature ..... -55°C to +150°C
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (Soldering, 10 seconds) ..... +300°C

Notes: 1. Values beyond which damage may occur.
2. Derate at 10mW/°C for ambient temperatures above +50°C.
3. Derate at 16mW/°C for case temperatures above +25°C.

RECOMMENDED OPERATING CONDITIONS (Note 4)
Input Voltage ($+V_{IN}$) ..... +8V to +35V
Collector Supply Voltage (V_C) ..... +4.5V to +35V
Sink/Source Load Current (steady state) ..... 0 to 100mA
Sink/Source Load Current (peak) ..... 0 to 400mA
Reference Load Current ..... 0 to 20mA
Oscillator Frequency Range ..... 100Hz to 400kHz
Oscillator Timing Resistor ..... 2kΩ to 150kΩ
Oscillator Timing Capacitor ..... .001μF to 0.1μF
Dead Time Resistor Range ..... 0 to 500Ω
Operating Ambient Temperature Range
UC1525A, UC1527A ..... -55°C to +125°C
UC2525A, UC2527A ..... -25°C to +85°C
UC3525A, UC3527A ..... 0°C to +70°C

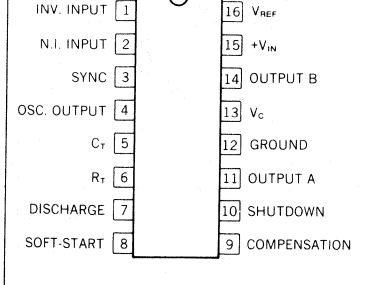
Notes: 4. Range over which the device is functional and parameter limits are guaranteed.

BLOCK DIAGRAM



CONNECTION DIAGRAM

DIL-16 (Top View)
J or N Package



UNITRODE

ELECTRICAL CHARACTERISTICS (+V_{IN} = 20V, and over operating temperature, unless otherwise specified)

PARAMETER	TEST CONDITIONS	UC1525A/UC2525A UC1527A/UC2527A			UC3525A UC3527A			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Reference Section								
Output Voltage	T_j = 25°C	5.05	5.10	5.15	5.00	5.10	5.20	V
Line Regulation	V_{IN} = 8 to 35V		10	20		10	20	mV
Load Regulation	I_L = 0 to 20mA		20	50		20	50	mV
Temperature Stability (Note 5)	Over Operating Range		20	50		20	50	mV
Total Output Variation (Note 5)	Line, Load, and Temperature	5.00		5.20	4.95		5.25	V
Short Circuit Current	V_{REF} = 0, T_j =25°C		80	100		80	100	mA
Output Noise Voltage (Note 5)	10Hz ≤ 10kHz, T_j = 25°C		40	200		40	200	μVrms
Long Term Stability (Note 5)	T_j = 125°C		20	50		20	50	mV
Oscillator Section (Note 6)								
Initial Accuracy (Notes 5 & 6)	T_j = 25°C		±2	±6		±2	±6	%
Voltage Stability (Notes 5 & 6)	V_{IN} = 8 to 35V		±0.3	±1		±1	±2	%
Temperature Stability (Note 5)	Over Operating Range		±3	±6		±3	±6	%
Minimum Frequency	R_T = 200kΩ, C_T = 0.1μF			120			120	Hz
Maximum Frequency	R_T = 2kΩ, C_T = 470pF	400			400			kHz
Current Mirror	I_{RT} = 2mA	1.7	2.0	2.2	1.7	2.0	2.2	mA
Clock Amplitude (Notes 5 & 6)		3.0	3.5		3.0	3.5		V
Clock Width (Notes 5 & 6)	T_j = 25°C	0.3	0.5	1.0	0.3	0.5	1.0	μs
Sync Threshold		1.2	2.0	2.8	1.2	2.0	2.8	V
Sync Input Current	Sync Voltage = 3.5V		1.0	2.5		1.0	2.5	mA
Error Amplifier Section (V_{CM} = 5.1V)								
Input Offset Voltage			0.5	5		2	10	mV
Input Bias Current			1	10		1	10	μA
Input Offset Current				1			1	μA
DC Open Loop Gain	R_L ≥ 10 Meg Ω	60	75		60	75		dB
Gain-Bandwidth Product (Note 5)	A_V = 0dB, T_j = 25°C	1	2		1	2		MHz
DC Transconductance (Notes 5 & 7)	T_j = 25°C, 30kΩ ≤ R_L ≤ 1MΩ	1.1	1.5		1.1	1.5		mS
Output Low Level			0.2	0.5		0.2	0.5	V
Output High Level		3.8	5.6		3.8	5.6		V
Common Mode Rejection	V_{CM} = 1.5 to 5.2V	60	75		60	75		dB
Supply Voltage Rejection	V_{IN} = 8 to 35V	50	60		50	60		dB

Notes: 5. These parameters, although guaranteed over the recommended operating conditions, are not 100% tested in production.

6. Tested at f_{OSC} = 40KHz (R_T = 3.6kΩ, C_T = .01μF, R_D = 0Ω). Approximate oscillator frequency is defined by: $f = \frac{1}{C_T(0.7R_T + 3R_D)}$

7. DC transconductance (g_M) relates to DC open-loop voltage gain (A_V) according to the following equation: $A_V = g_M R_L$ where R_L is the resistance from pin 9 to ground.
The minimum g_M specification is used to calculate minimum A_V when the error amplifier output is loaded.

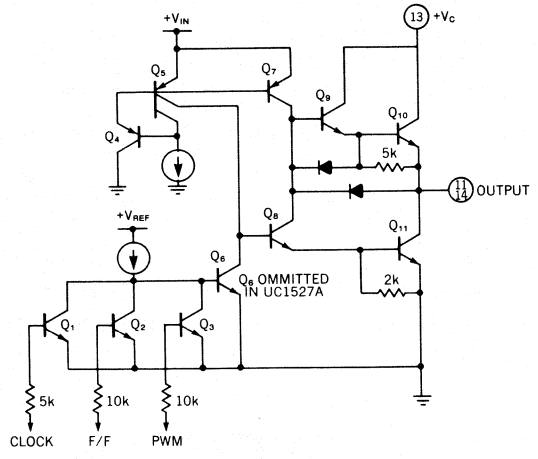
ELECTRICAL CHARACTERISTICS (+V_{IN} = 20V, and over operating temperature, unless otherwise specified)

PARAMETER	TEST CONDITIONS	UC1525A/UC2525A UC1527A/UC2527A			UC3525A UC3527A			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
PWM Comparator								
Minimum Duty-Cycle				0			0	%
Maximum Duty-Cycle		45	49		45	49		%
Input Threshold (Note 6)	Zero Duty-Cycle	0.7	0.9		0.7	0.9		V
Input Threshold (Note 6)	Maximum Duty-Cycle		3.3	3.6		3.3	3.6	V
Input Bias Current (Note 5)			.05	1.0		.05	1.0	μA
Shutdown Section								
Soft Start Current	V_{SD} = 0V, V_{SS} = 0V	25	50	80	25	50	80	μA
Soft Start Low Level	V_{SD} = 2.5V		0.4	0.7		0.4	0.7	V
Shutdown Threshold	To outputs, V_{SS} = 5.1V, T_j = 25°C	0.6	0.8	1.0	0.6	0.8	1.0	V
Shutdown Input Current	V_{SD} = 2.5V		0.4	1.0		0.4	1.0	mA
Shutdown Delay (Note 5)	V_{SD} = 2.5V, T_j = 25°C		0.2	0.5		0.2	0.5	μS
Output Drivers (Each Output) (V_C = 20V)								
Output Low Level	I_{SINK} = 20mA		0.2	0.4		0.2	0.4	V
	I_{SINK} = 100mA		1.0	2.0		1.0	2.0	V
Output High Level	I_{SOURCE} = 20mA	18	19		18	19		V
	I_{SOURCE} = 100mA	17	18		17	18		V
Under-Voltage Lockout	V_{COMP} and V_{SS} = High	6	7	8	6	7	8	V
V_C OFF Current (Note 7)	V_C = 35V			200			200	μA
Rise Time (Note 5)	C_L = 1nF, T_j = 25°C		100	600		100	600	ns
Fall Time (Note 5)	C_L = 1nf, T_j =25°C		50	300		50	300	ns
Total Standby Current								
Supply Current	V_{IN} = 35V		14	20		14	20	mA

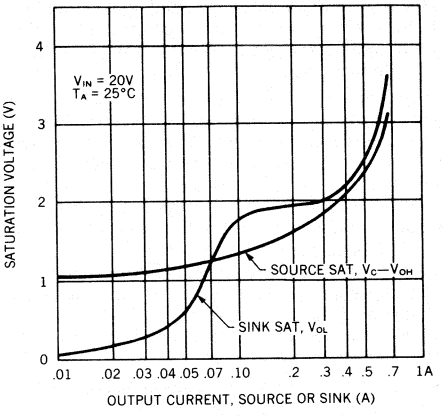
Notes: 5. These parameters, although guaranteed over the recommended operating conditions, are not 100% tested in production.
6. Tested at f_{OSC} = 40KHz (R_T =3.6kΩ, C_T = 0.1μF, R_D = 0Ω).
7. Collector off-state quiescent current measured at pin 13 with outputs low for UC1525A and high for UC1527A.

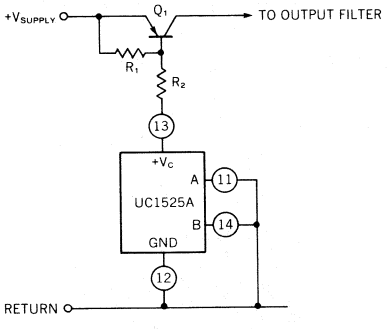
PRINCIPLES OF OPERATION AND TYPICAL CHARACTERISTICS

UC1525A Output Circuit
(½ Circuit Shown)

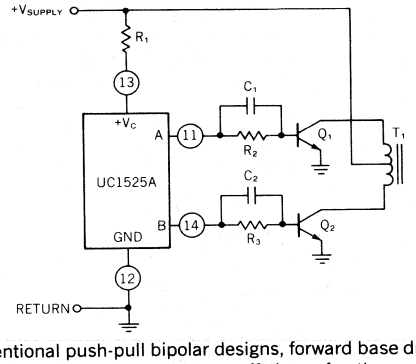


UC1525A Output Saturation Characteristics

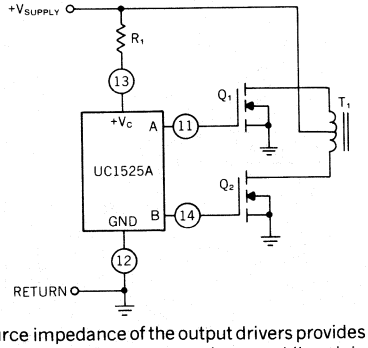




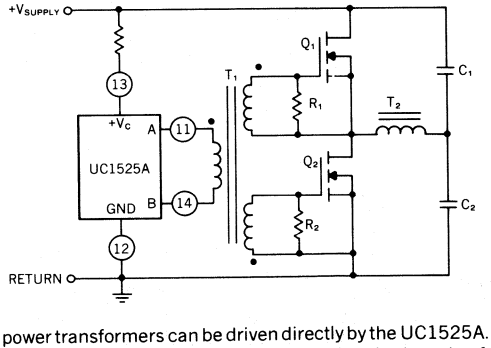
For single-ended supplies, the driver outputs are grounded. The V_C terminal is switched to ground by the totem-pole source transistors on alternate oscillator cycles.



In conventional push-pull bipolar designs, forward base drive is controlled by R_1-R_3. Rapid turn-off times for the power devices are achieved with speed-up capacitors C_1 and C_2.



The low source impedance of the output drivers provides rapid charging of power FET input capacitance while minimizing external components.



Low power transformers can be driven directly by the UC1525A. Automatic reset occurs during dead time, when both ends of the primary winding are switched to ground.

PRINCIPLES OF OPERATION AND TYPICAL CHARACTERISTICS

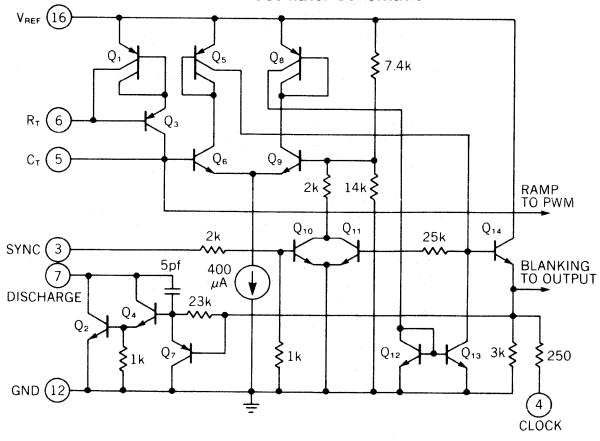
SHUTDOWN OPTIONS (See Block Diagram)

Since both the compensation and soft-start terminals (Pins 9 and 8) have current source pull-ups, either can readily accept a pull-down signal which only has to sink a maximum of 100μA to turn off the outputs. This is subject to the added requirement of discharging whatever external capacitance may be attached to these pins.

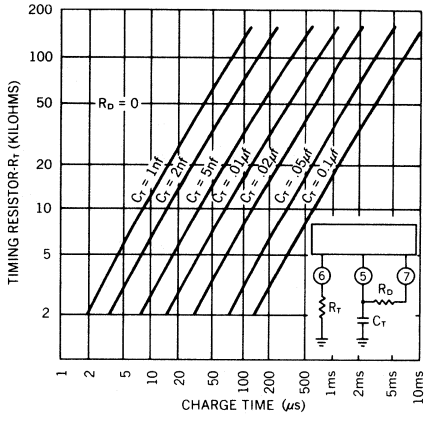
An alternate approach is the use of the shutdown circuitry of Pin 10 which has been improved to enhance the available shutdown options. Activating this circuit by applying a positive signal on Pin 10 performs two functions: the PWM latch is immediately set providing the fastest turn-off signal to the outputs; and a 150μA current sink begins to discharge the external soft-start capacitor. If the shutdown command is short, the PWM signal is terminated without significant discharge of the soft-start capacitor, thus, allowing, for example, a convenient implementation of pulse-by-pulse current limiting. Holding Pin 10 high for a longer duration, however, will ultimately discharge this external capacitor, recycling slow turn-on upon release.

Pin 10 should not be left floating as noise pickup could conceivably interrupt normal operation.

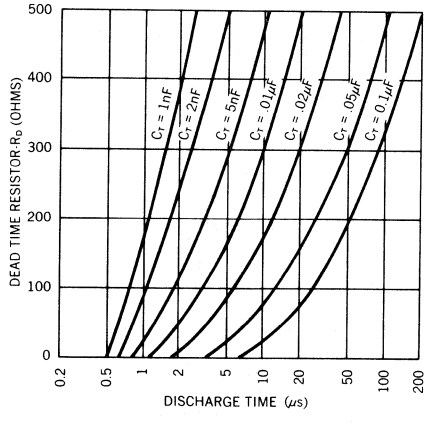
UC1525A Oscillator Schematic



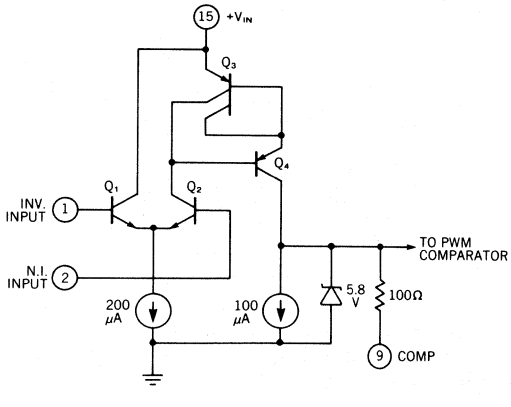
Oscillator Charge Time vs. R_T and C_T



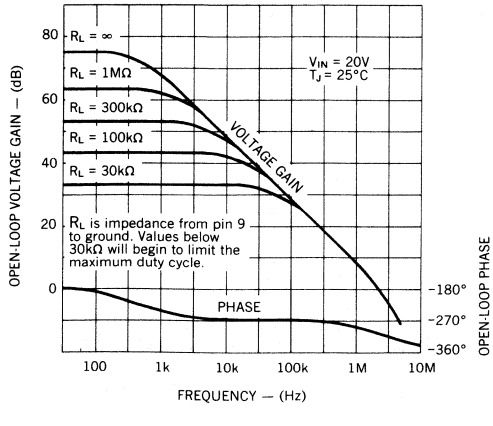
Oscillator Discharge Time vs. R_D and C_T



UC1525A Error Amplifier



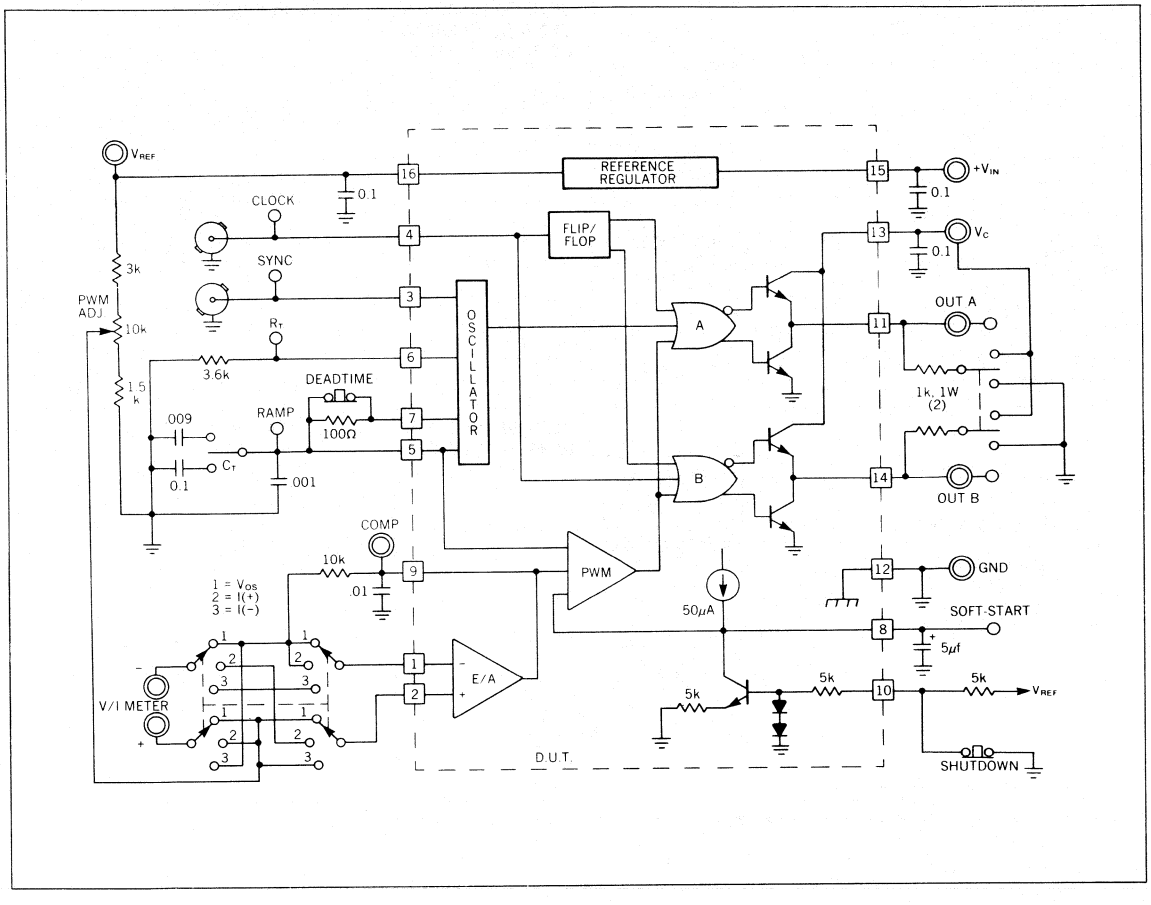
Error Amplifier Voltage Gain and Phase vs Frequency



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

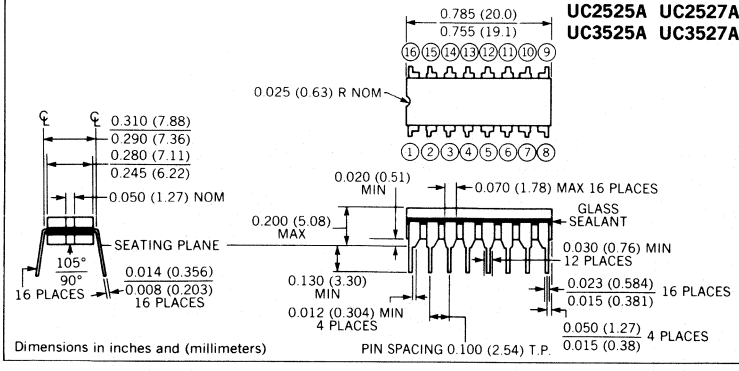
PRINTED IN U.S.A.

LAB TEST FIXTURE



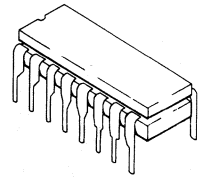
MECHANICAL SPECIFICATIONS

UC1525A UC1527A
UC2525A UC2527A
UC3525A UC3527A

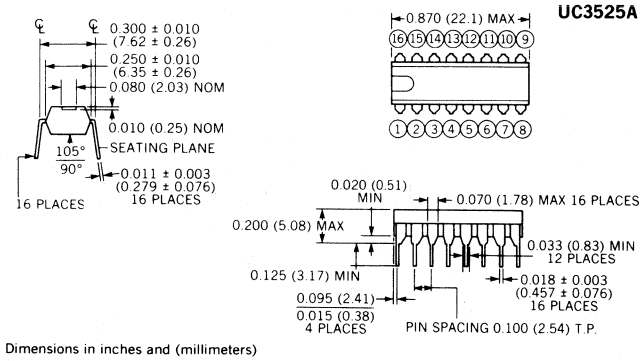


Dimensions in inches and (millimeters)

DIL-16 J CERAMIC

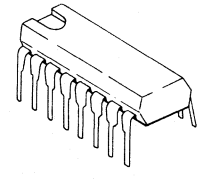


UC2525A UC2527A
UC3525A UC3527A



Dimensions in inches and (millimeters)

DIL-16 N PLASTIC



Note: When ordering, add suffix "J" (for 16 pin ceramic package) or "N" (for 16 pin plastic package) to the part number.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

LINEAR INTEGRATED CIRCUITS

Regulating Pulse Width Monitor

UC1526
UC2526
UC3526

2

FEATURES

- 8 to 35V operation
- 5V reference trimmed to ±1%
- 1Hz to 400kHz oscillator range
- Dual 100mA source/sink outputs
- Digital current limiting
- Double pulse suppression
- Programmable deadtime
- Under-voltage lockout
- Single pulse metering
- Programmable soft-start
- Wide current limit common mode range
- TTL/CMOS compatible logic ports
- Symmetry correction capability
- Guaranteed 6 unit synchronization

DESCRIPTION

The UC1526 is a high performance monolithic pulse width modulator circuit designed for fixed-frequency switching regulators and other power control applications. Included in an 18-pin dual-in-line package are a temperature compensated voltage reference, sawtooth oscillator, error amplifier, pulse width modulator, pulse metering and steering logic, and two low impedance power drivers. Also included are protective features such as soft-start and under-voltage lockout, digital current limiting, double pulse inhibit, a data latch for single pulse metering, adjustable deadtime, and provision for symmetry correction inputs. For ease of interface, all digital control ports are TTL and B-series CMOS compatible. Active LOW logic design allows wired-OR connections for maximum flexibility. This versatile device can be used to implement single-ended or push-pull switching regulators of either polarity, both transformerless and transformer coupled. The UC1526 is characterized for operation over the full military temperature range of −55°C to +125°C. The UC2526 is characterized for operation from −25°C to +85°C, and the UC3526 is characterized for operation from 0°C to +70°C.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Voltage ($+V_{IN}$)	+40V
Collector Supply Voltage ($+V_C$)	+40V
Logic Inputs	−0.3V to +5.5V
Analog Inputs	−0.3V to $+V_{IN}$
Source/Sink Load Current (each output)	200mA
Reference Load Current	50mA
Logic Sink Current	15mA
Power Dissipation at T_A = +25°C (Note 2)	1000mW
Thermal Resistance, Junction to Ambient	100°C/W
Power Dissipation at T_C = +25°C (Note 3)	3000mW
Thermal Resistance, Junction to Case	42°C/W
Operating Junction Temperature	+150°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (soldering, 10 seconds)	+300°C

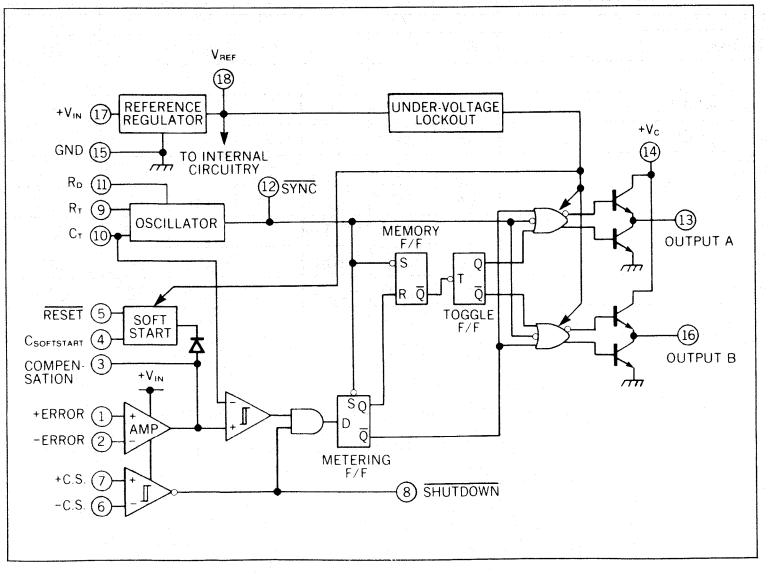
Notes: 1. Values beyond which damage may occur.
2. Derate at 10mW/°C for ambient temperatures above +50°C.
3. Derate at 24mW/°C for case temperatures above +25°C.

RECOMMENDED OPERATING CONDITIONS (Note 4)

Input Voltage	+8V to +35V
Collector Supply Voltage	+4.5V to +35V
Sink/Source Load Current (each output)	0 to 100mA
Reference Load Current	0 to 20mA
Oscillator Frequency Range	1Hz to 400kHz
Oscillator Timing Resistor	2kΩ to 150kΩ
Oscillator Timing Capacitor	1nF to 20μF
Available Deadtime Range at 40kHz	3% to 50%
Operating Ambient Temperature Range	
UC1526	−55°C to +125°C
UC2526	−25°C to +85°C
UC3526	0°C to +70°C

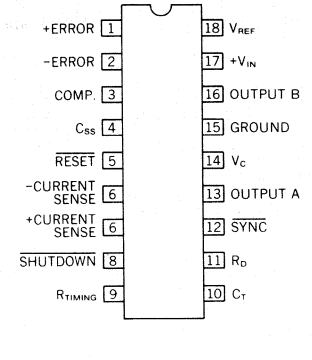
Note: 4. Range over which the device is functional and parameter limits are guaranteed.

BLOCK DIAGRAM



CONNECTION DIAGRAM

J PACKAGE
TO-116 STYLE (TOP VIEW)



UNITRODE

ELECTRICAL CHARACTERISTICS (+V_{IN} = 15V, and over operating ambient temperature, unless otherwise specified)

PARAMETER	TEST CONDITIONS	UC1526/UC2526			UC3526			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Reference Section (Note 5)								
Output Voltage	T_J = +25°C	4.95	5.00	5.05	4.90	5.00	5.10	V
Line Regulation	+V_{IN} = 8 to 35V		10	20		10	30	mV
Load Regulation	I_L = 0 to 20mA		10	30		10	50	mV
Temperature Stability	Over Operating T_J		15	50		15	50	mV
Total Output Voltage Range	Over Recommended Operating Conditions	4.90	5.00	5.10	4.85	5.00	5.15	V
Short Circuit Current	V_{REF} = 0V	25	50	100	25	50	100	mA
Under-Voltage Lockout								
$\overline{\text{RESET}}$ Output Voltage	V_{REF} = 3.8V		0.2	0.4		0.2	0.4	V
$\overline{\text{RESET}}$ Output Voltage	V_{REF} = 4.8V	2.4	4.8		2.4	4.8		V
Oscillator Section (Note 6)								
Initial Accuracy	T_J = +25°C		±3	±8		±3	±8	%
Voltage Stability	+V_{IN} = 8 to 35V		0.5	1		0.5	1	%
Temperature Stability	Over Operating T_J		7	10		3	5	%
Minimum Frequency	R_T = 150kΩ, C_T = 20μF			1			1	Hz
Maximum Frequency	R_T = 2kΩ, C_T = 1.0nF	400			400			kHz
Sawtooth Peak Voltage	+V_{IN} = 35V		3.0	3.5		3.0	3.5	V
Sawtooth Valley Voltage	+V_{IN} = 8V	0.5	1.0		0.5	1.0		V
Error Amplifier Section (Note 7)								
Input Offset Voltage	$R_S \leq$ 2kΩ		2	5		2	10	mV
Input Bias Current			-350	-1000		-350	-2000	nA
Input Offset Current			35	100		35	200	nA
DC Open Loop Gain	$R_L \geq$ 10 Meg Ω	64	72		60	72		dB
HIGH Output Voltage	Vpin1-Vpin2≥150mV, I_{source} = 100μA	3.6	4.2		3.6	4.2		V
LOW Output Voltage	Vpin2-Vpin1≥150mV, I_{sink} = 100μA		0.2	0.4		0.2	0.4	V
Common Mode Rejection	$R_S \leq$ 2kΩ	70	94		70	94		dB
Supply Voltage Rejection	+V_{IN} = 12 to 18V	66	80		66	80		dB
PWM Comparator (Note 6)								
Minimum Duty Cycle	$V_{compensation}$ = +0.4V			0			0	%
Maximum Duty Cycle	$V_{compensation}$ = +3.6V	45	49		45	49		%
Digital Ports ($\overline{\text{SYNC}}$, $\overline{\text{SHUTDOWN}}$, and $\overline{\text{RESET}}$)								
HIGH Output Voltage	I_{source} = 40μA	2.4	4.0		2.4	4.0		V
LOW Output Voltage	I_{sink} = 3.6mA		0.2	0.4		0.2	0.4	V
HIGH Input Current	V_{IH} = +2.4V		-125	-200		-125	-200	μA
LOW Input Current	V_{IL} = +0.4V		-225	-360		-225	-360	μA

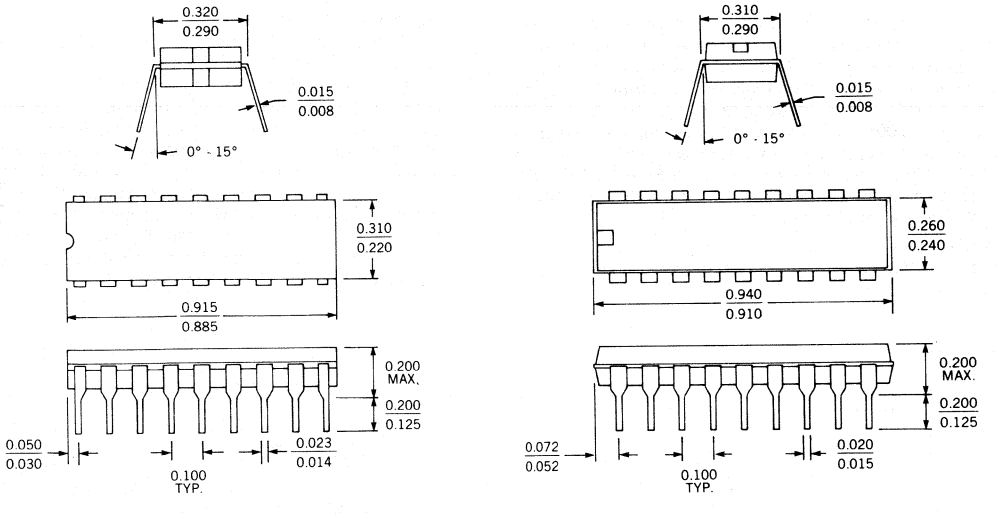
Notes: 5. I_L = 0mA.
6. F_{OSC} = 40kHz (R_T = 4.12kΩ ± 1%, C_T = .01μF ± 1%, R_D = 0Ω
7. V_{CM} = 0 to +5.2V

ELECTRICAL CHARACTERISTICS (+V_{IN} = 15V, and over operating ambient temperature, unless otherwise specified)

PARAMETER	TEST CONDITIONS	UC1526/UC2526			UC3526			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Current Limit Comparator (Note 8)								
Sense Voltage	$R_S \leq 50\Omega$	90	100	110	80	100	120	mV
Input Bias Current			-3	-10		-3	-10	μA
Soft-Start Section								
Error Clamp Voltage	$\overline{RESET}$ = +0.4V		0.1	0.4		0.1	0.4	V
C_S Charging Current	$\overline{RESET}$ = +2.4V	50	100	150	50	100	150	μA
Output Drivers (Each Output) (Note 9)								
HIGH Output Voltage	I_{source} = 20mA	12.5	13.5		12.5	13.5		V
	I_{source} = 100mA	12	13		12	13		V
LOW Output Voltage	I_{sink} = 20mA		0.2	0.3		0.2	0.3	V
	I_{sink} = 100mA		1.2	2.0		1.2	2.0	V
Collector Leakage	V_C = 40V		50	150		50	150	μA
Rise Time	C_L = 1000pF		0.3	0.6		0.3	0.6	μs
Fall Time	C_L = 1000pF		0.1	0.2		0.1	0.2	μs
Power Consumption (Note 10)								
Standby Current	$\overline{SHUTDOWN}$ = +0.4V		18	30		18	30	mA

Notes: 8. V_{CM} = 0 to +12V
9. V_C = +15V
10. +V_{IN} = +35V, R_T = 4.12kΩ

PACKAGE DIMENSIONS



J Package
18-Pin Cerdip
Alloy 42 Leadframe

N Package
18-Pin Plastic Dip
Copper Alloy Leadframe

APPLICATIONS INFORMATION

Voltage Reference

The reference regulator of the UC1526 is based on a temperature compensated zener diode. The circuitry is fully active at supply voltages above +8V, and provides up to 20mA of load current to external circuitry at +5.0V. In systems where additional current is required, an external PNP transistor can be used to boost the available current. A rugged low frequency audio-type transistor should be used, and lead lengths between the PWM and transistor should be as short as possible to minimize the risk of oscillations. Even so, some types of transistors may require collector-base capacitance for stability. Up to 1 amp of load current can be obtained with excellent regulation if the device selected maintains high current gain.

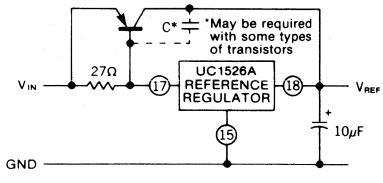


Figure 1. Extending Reference Output Current

Under-Voltage Lockout

The under-voltage lockout circuit protects the UC1526 and the power devices it controls from inadequate supply voltage. If $+V_{IN}$ is too low, the circuit disables the output drivers and holds the $\overline{RESET}$ pin LOW. This prevents spurious output pulses while the control circuitry is stabilizing, and holds the soft-start timing capacitor in a discharged state.

The circuit consists of a +1.2V bandgap reference and comparator circuit which is active when the reference voltage has risen to $3V_{BE}$ or +1.8V at 25°C. When the reference voltage rises to approximately +4.4V, the circuit enables the output drivers and releases the $\overline{RESET}$ pin, allowing a normal soft-start. The comparator has 200mV of hysteresis to minimize oscillation at the trip point. When $+V_{IN}$ to the PWM is removed and the reference drops to +4.2V, the under-voltage circuit pulls $\overline{RESET}$ LOW again. The soft-start capacitor is immediately discharged, and the PWM is ready for another soft-start cycle.

The UC1526 can operate from a +5V supply by connecting the V_{REF} pin to the $+V_{IN}$ pin and maintaining the supply between +4.8 and +5.2V.

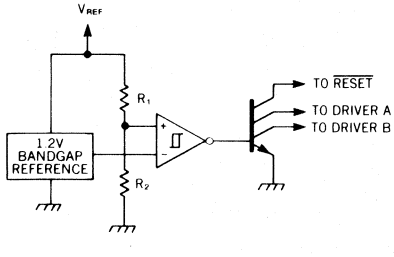


Figure 2. Under-Voltage Lockout Schematic

Soft-Start Circuit

The soft-start circuit protects the power transistors and rectifier diodes from high current surges during power supply turn-on. When supply voltage is first applied to the UC1526, the under-voltage lockout circuit holds $\overline{RESET}$ LOW with Q_3. Q_1 is turned on, which holds the soft-start capacitor voltage at zero. The second collector of Q_1 clamps the output of the error amplifier to ground, guaranteeing zero duty cycle at the driver outputs. When the supply voltage reaches normal operating range, $\overline{RESET}$ will go HIGH. Q_1 turns off, allowing the internal 100μA current source to charge C_S. Q_2 clamps the error amplifier output to $1V_{BE}$ above the voltage on C_S. As the soft-start voltage ramps up to +5V, the duty cycle of the PWM linearly increases to whatever value the voltage regulation loop requires for an error null.

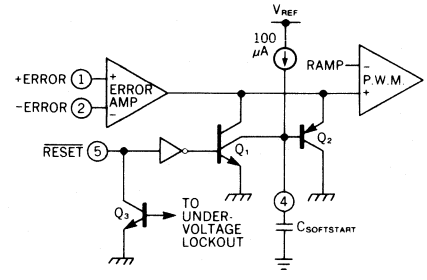


Figure 3. Soft-Start Circuit Schematic

Digital Control Ports

The three digital control ports of the UC1526 are bi-directional. Each pin can drive TTL and 5V CMOS logic directly, up to a fan-out of 10 low-power Schottky gates. Each pin can also be directly driven by open-collector TTL, open-drain CMOS, and open-collector voltage comparators; fan-in is equivalent to 1 low-power Schottky gate. Each port is normally HIGH; the pin is pulled LOW to activate the particular function. Driving $\overline{SYNC}$ LOW initiates a discharge cycle in the oscillator. Pulling $\overline{SHUTDOWN}$ LOW immediately inhibits all PWM output pulses. Holding $\overline{RESET}$ LOW discharges the soft-start capacitor. The logic threshold is +1.1V at +25°C. Noise immunity can be gained at the expense of fan-out with an external 2K pull-up resistor to +5V.

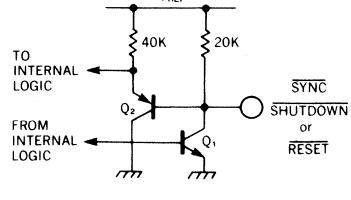


Figure 4. Digital Control Port Schematic

Oscillator

The oscillator is programmed for frequency and dead time with three components: R_T, C_T and R_D. Two waveforms are generated: a sawtooth waveform at pin 10 for pulse width modulation, and a logic clock at pin 12. The following procedure is recommended for choosing timing values:

1. With $R_D = 0\Omega$ (pin 11 shorted to ground) select values for R_T and C_T from Figure 7 to give the desired oscillator period. Remember that the frequency at each driver output is half the oscillator frequency, and the frequency at the $+V_C$ terminal is the same as the oscillator frequency.
2. If more dead time is required, select a large value of R_D. At 40kHz dead time increases by 400nS/Ω.
3. Increasing the dead time will cause the oscillator frequency to decrease slightly. Go back and decrease the value of R_T slightly to bring the frequency back to the nominal design value.

The UC1526 can be synchronized to an external logic clock by programming the oscillator to free-run at a frequency 10% slower than the sync frequency. A periodic LOW logic pulse approximately 0.5μs wide at the $\overline{SYNC}$ pin will then lock the oscillator to the external frequency.

Multiple devices can be synchronized together by programming one master unit for the desired frequency, and then sharing its sawtooth and clock waveforms with the slave units. All C_T terminals are connected to the C_T pin of the master, and all $\overline{SYNC}$ terminals are likewise connected to the $\overline{SYNC}$ pin of the master. Slave R_T terminals are left open or connected to V_{REF}. Slave R_D terminals may be either left open or grounded.

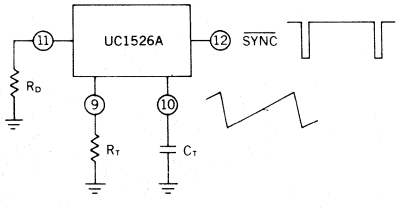


Figure 5. Oscillator Connections and Waveforms

Error Amplifier

The error amplifier is a transconductance design, with an output impedance of 2MΩ. Since all voltage gain takes place at the output pin, the open-loop gain/frequency characteristics can be controlled with shunt reactance to ground. When compensated for unity-gain stability with 100pF, the amplifier has an open-loop pole at 400Hz.

The input connections to the error amplifier are determined by the polarity of the switching supply output voltage. For positive supplies, the common-mode voltage is +5.0V and the feedback connections in Figure 6A are used. With negative supplies, the common-mode voltage is ground and the feedback divider is connected between the negative output and the +5.0V reference voltage, as shown in Figure 6B.

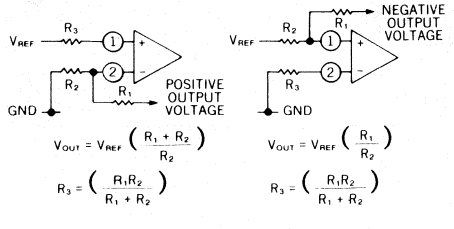


Figure 6. Error Amplifier Connections

Output Drivers

The totem-pole output drivers of the UC1526 are designed to source and sink 100mA continuously and 200mA peak. Loads can be driven either from the output pins 13 and 16, or from the $+V_C$, as required.

Since the bottom transistor of the totem-pole is allowed to saturate, there is a momentary conduction path from the $+V_C$ terminal to ground during switching. To limit the resulting current spikes a small resistor in series with pin 14 is always recommended. The resistor value is determined by the driver• supply voltage, and should be chosen for 200mA peak currents.

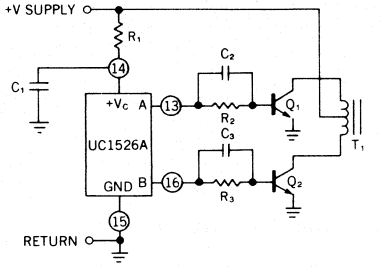


Figure 7. Push-Pull Configuration

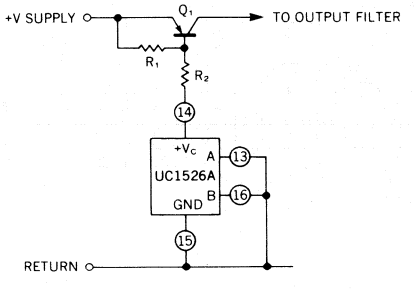


Figure 8. Single-Ended Configuration

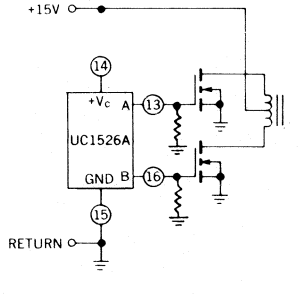
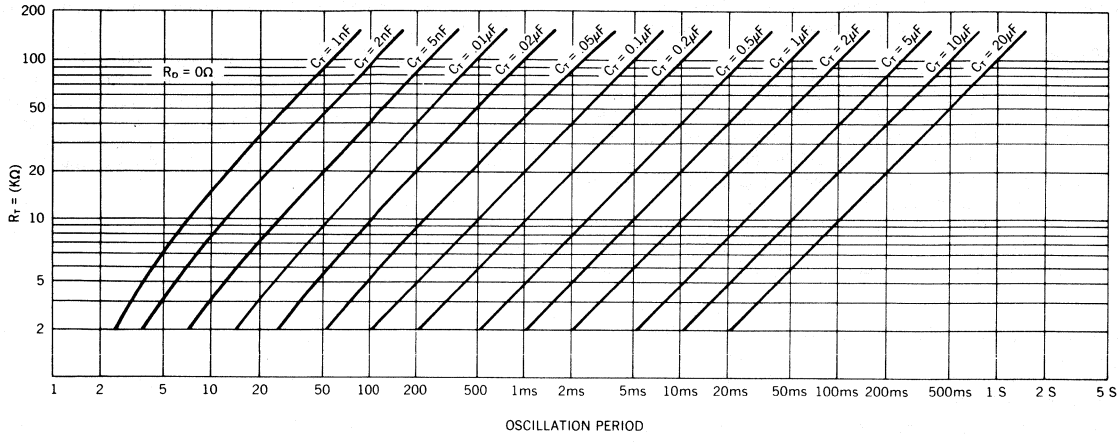


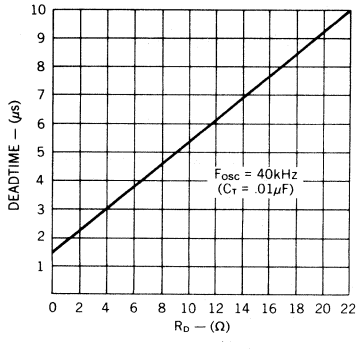
Figure 9. Driving N-Channel Power Mosfets

TYPICAL CHARACTERISTICS

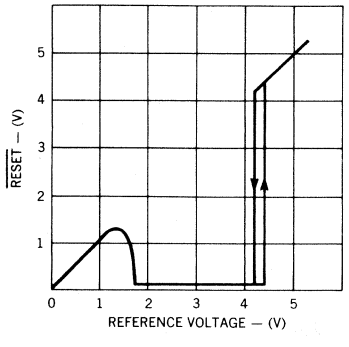
Oscillator Period vs R_T and C_T



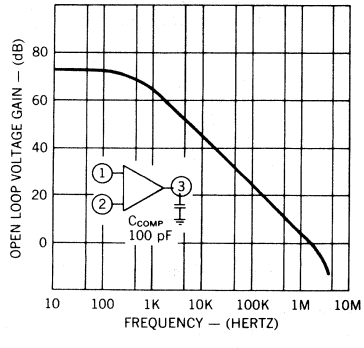
Output Driver Deadtime vs R_D Value



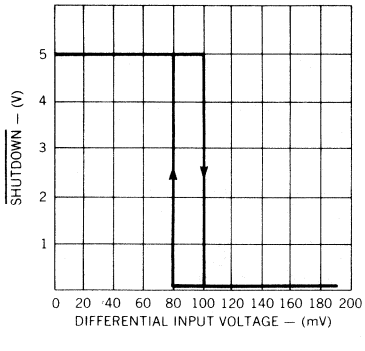
Under-Voltage Lockout Characteristic



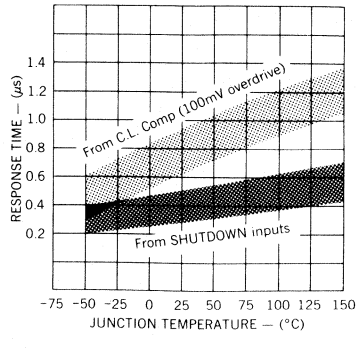
Error Amplifier Open Loop Gain vs Frequency



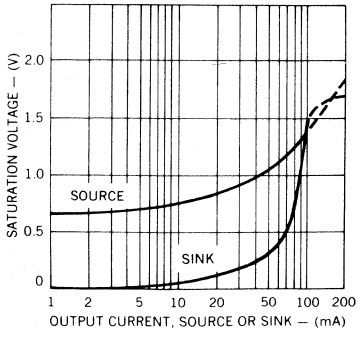
Current Limit Transfer Function



Shutdown Delay



Output Driver Saturation Voltage



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

LINEAR INTEGRATED CIRCUITS

Regulating Pulse Width Modulator

UC1526A
UC2526A
UC3526A

2

FEATURES

- Reduced Supply Current
- Oscillator Frequency to 600KHz
- Precision Band-Gap Reference
- 7 to 35V Operation
- Dual 100mA Source/Sink Outputs
- Minimum Output Cross-Conduction
- Double-Pulse Suppression Logic
- Under-Voltage Lockout
- Programmable Soft-Start
- Thermal Shutdown
- TTL/CMOS Compatible Logic Ports

DESCRIPTION

The UC1526A Series are improved-performance pulse-width modulator circuits intended for direct replacement of equivalent non-"A" versions in all applications. Higher frequency operation has been enhanced by several significant improvements including: a more accurate oscillator with less minimum dead time, reduced circuit delays (particularly in current limiting), and an improved output stage with negligible cross-conduction current. Additional improvements include the incorporation of a precision, band-gap reference generator, reduced overall supply current, and the addition of thermal shutdown protection.

Along with these improvements, the UC1526A Series retains the protective features of under-voltage lockout, soft-start, digital current limiting, double pulse suppression logic, and adjustable deadtime. For ease of interfacing, all digital control ports are TTL compatible with active low logic.

These versatile devices may be used to implement single-ended or push-pull switching regulators of all topologies.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Voltage ($+V_{IN}$)	+40V
Collector Supply Voltage ($+V_C$)	+40V
Logic Inputs	-0.3V to +5.5V
Analog Inputs	-0.3V to $+V_{IN}$
Source/Sink Load Current (each output)	200mA
Reference Load Current	50mA
Logic Sink Current	15mA
Power Dissipation at T_A = +25°C (Note 2)	1000mW
Thermal Resistance, Junction to Ambient	100°C/W
Power Dissipation at T_C = +25°C (Note 3)	3000mW
Thermal Resistance, Junction to Case	42°C/W
Operating Junction Temperature	+150°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (soldering, 10 seconds)	+300°C

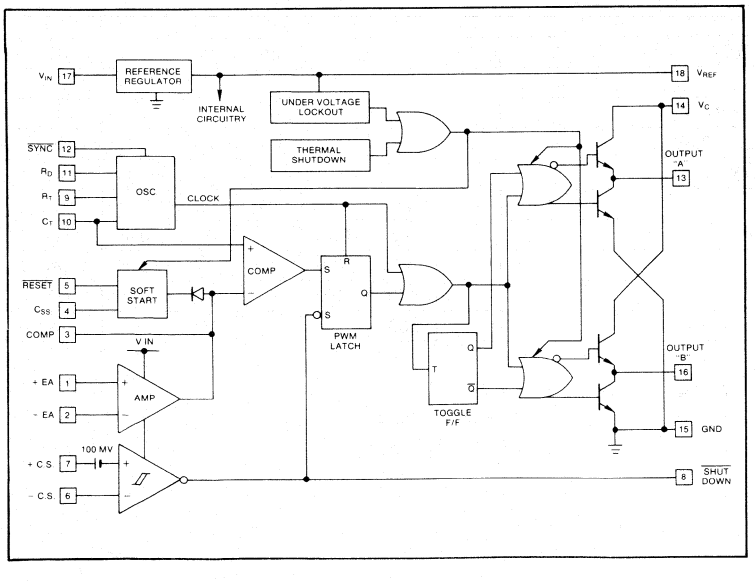
Notes: 1. Values beyond which damage may occur.
2. Derate at 10mW/°C for ambient temperatures above +50°C.
3. Derate at 24mW/°C for case temperatures above +25°C.

RECOMMENDED OPERATING CONDITIONS (Note 4)

Input Voltage	+7V to +35V
Collector Supply Voltage	+4.5V to +35V
Sink/Source Load Current (each output)	0 to 100mA
Reference Load Current	0 to 20mA
Oscillator Frequency Range	1Hz to 600kHz
Oscillator Timing Resistor	2kΩ to 150kΩ
Oscillator Timing Capacitor	400pF to 20μF
Available Deadtime Range at 40kHz	1% to 50%
Operating Ambient Temperature Range	
UC1526A	-55°C to +125°C
UC2526A	-25°C to +85°C
UC3526A	0°C to +70°C

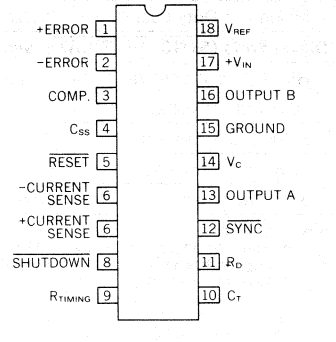
Note: 4. Range over which the device is functional and parameter limits are guaranteed.

BLOCK DIAGRAM



CONNECTION DIAGRAM

DIL-18 (TOP VIEW)
J or N PACKAGE



UNITRODE

ELECTRICAL CHARACTERISTICS ($+V_{IN}$ = 15V, and over operating ambient temperature, unless otherwise specified)

PARAMETER	TEST CONDITIONS	UC1526A/UC2526A			UC3526A			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Reference Section (Note 5)								
Output Voltage	T_J = +25°C	4.95	5.00	5.05	4.90	5.00	5.10	V
Line Regulation	$+V_{IN}$ = 7 to 35V		2	10		2	15	mV
Load Regulation	I_L = 0 to 20mA		5	20		5	20	mV
Temperature Stability	Over Operating T_J (Note 6)		15	50		15	50	mV
Total Output Voltage Range	Over Recommended Operating Conditions	4.90	5.00	5.10	4.85	5.00	5.15	V
Short Circuit Current	V_{REF} = 0V	25	50	100	25	50	100	mA
Under-Voltage Lockout								
$\overline{\text{RESET}}$ Output Voltage	V_{REF} = 3.8V		0.2	0.4		0.2	0.4	V
$\overline{\text{RESET}}$ Output Voltage	V_{REF} = 4.7V	2.4	4.7		2.4	4.8		V
Oscillator Section (Note 7)								
Initial Accuracy	T_J = +25°C		±3	±8		±3	±8	%
Voltage Stability	$+V_{IN}$ = 7 to 35V		0.5	1		0.5	1	%
Temperature Stability	Over Operating T_J (Note 6)		2	6		1	3	%
Minimum Frequency	R_T = 150kΩ, C_T = 20μF (Note 6)			1			1	Hz
Maximum Frequency	R_T = 2kΩ, C_T = 470pF	550			650			kHz
Sawtooth Peak Voltage	$+V_{IN}$ = 35V		3.0	3.5		3.0	3.5	V
Sawtooth Valley Voltage	$+V_{IN}$ = 7V	0.5	1.0		0.5	1.0		V
$\overline{\text{SYNC}}$ Pulse Width	T_J = 25°C, R_L = 2.7kΩ to V_{REF}		1.1			1.1		μs
Error Amplifier Section (Note 8)								
Input Offset Voltage	$R_S \leq$ 2kΩ		2	5		2	10	mV
Input Bias Current			-350	-1000		-350	-2000	nA
Input Offset Current			35	100		35	200	nA
DC Open Loop Gain	$R_L \geq$ 10 Meg Ω	64	72		60	72		dB
HIGH Output Voltage	Vpin1−Vpin2≥150mV, I_{source} = 100μA	3.6	4.2		3.6	4.2		V
LOW Output Voltage	Vpin2−Vpin1≥150mV, I_{sink} = 100μA		0.2	0.4		0.2	0.4	V
Common Mode Rejection	$R_S \leq$ 2kΩ	70	94		70	94		dB
Supply Voltage Rejection	$+V_{IN}$ = 12 to 18V	66	80		66	80		dB
PWM Comparator (Note 7)								
Minimum Duty Cycle	$V_{compensation}$ = +0.4V			0			0	%
Maximum Duty Cycle	$V_{compensation}$ = +3.6V	45	49		45	49		%
Digital Ports ($\overline{\text{SYNC}}$, $\overline{\text{SHUTDOWN}}$, and $\overline{\text{RESET}}$)								
HIGH Output Voltage	I_{source} = 40μA	2.4	4.0		2.4	4.0		V
LOW Output Voltage	I_{sink} = 3.6mA		0.2	0.4		0.2	0.4	V
HIGH Input Current	V_{IH} = +2.4V		-125	-200		-125	-200	μA
LOW Input Current	V_{IL} = +0.4V		-225	-360		-225	-360	μA
Shutdown Delay	From Pin 8, T_J = 25°C		160			160		ns

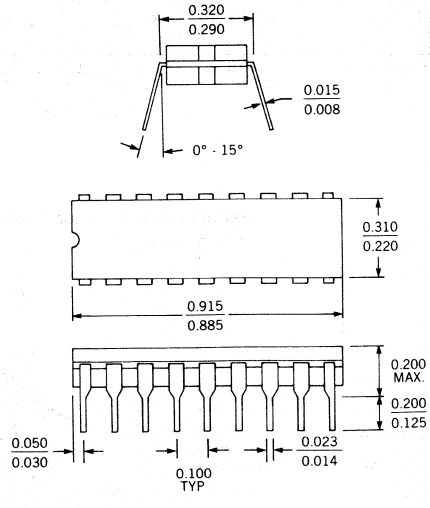
Notes: 5. I_L = 0mA.
6. Guaranteed by design, not 100% tested in production.
7. F_{OSC} = 40kHz (R_T = 4.12kΩ ± 1%, C_T = 0.01μF ± 1%, R_D = 0Ω)
8. V_{CM} = 0 to +5.2V

ELECTRICAL CHARACTERISTICS ($+V_{IN}$ = 15V, and over operating ambient temperature, unless otherwise specified)

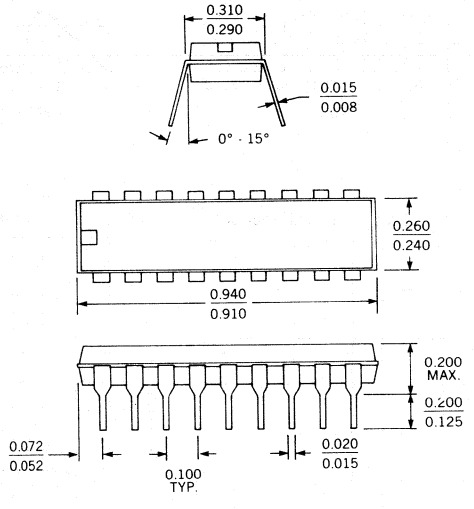
PARAMETER	TEST CONDITIONS	UC1526A/UC2526A			UC3526A			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Current Limit Comparator (Note 9)								
Sense Voltage	$R_S \leq 50\Omega$	90	100	110	80	100	120	mV
Input Bias Current			-3	-10		-3	-10	μA
Shutdown Delay	From Pin 7, 100mV Overdrive, T_J = 25°C		260			260		nS
Soft-Start Section								
Error Clamp Voltage	$\overline{RESET}$ = +0.4V		0.1	0.4		0.1	0.4	V
C_S Charging Current	$\overline{RESET}$ = +2.4V	50	100	150	50	100	150	μA
Output Drivers (Each Output) (Note 10)								
HIGH Output Voltage	I_{source} = 20mA	12.5	13.5		12.5	13.5		V
	I_{source} = 100mA	12	13		12	13		V
LOW Output Voltage	I_{sink} = 20mA		0.2	0.3		0.2	0.3	V
	I_{sink} = 100mA		1.2	2.0		1.2	2.0	V
Collector Leakage	V_C = 40V		50	150		50	150	μA
Rise Time	C_L = 1000pF (Note 6)		0.3	0.6		0.3	0.6	μs
Fall Time	C_L = 1000pF (Note 6)		0.1	0.2		0.1	0.2	μs
Cross-Conduction Charge	Per cycle, T_J = 25°C		8			8		nC
Power Consumption (Note 11)								
Standby Current	$\overline{SHUTDOWN}$ = +0.4V		14	20		14	20	mA

Notes: 9. V_{CM} = 0 to +12V
10. V_C = +15V
11. $+V_{IN}$ = +35V, R_T = 4.12kΩ

PACKAGE DIMENSIONS



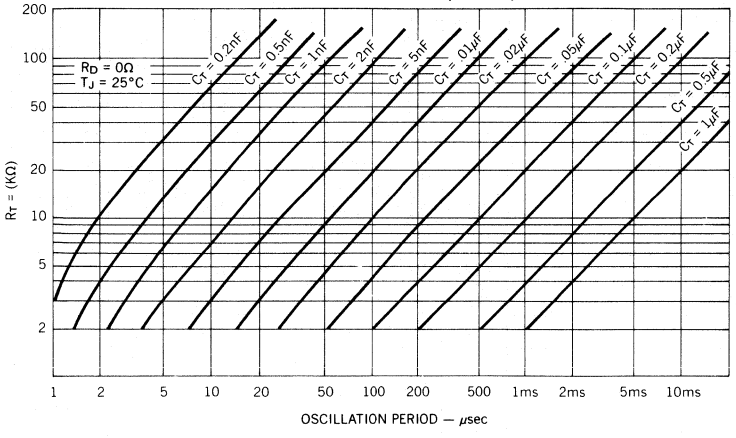
J Package
18-Pin Cerdip
Alloy 42 Leadframe



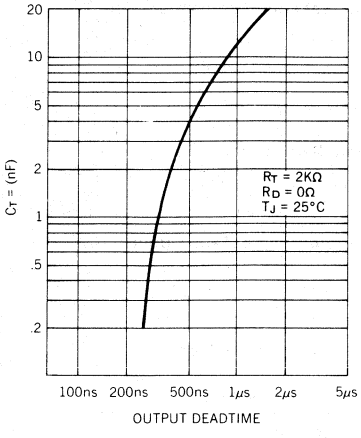
N Package
18-Pin Plastic Dip
Copper Alloy Leadframe

TYPICAL CHARACTERISTICS

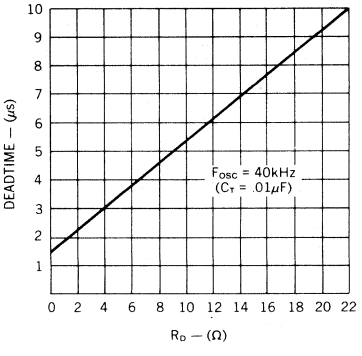
Oscillator Period vs R_T and C_T



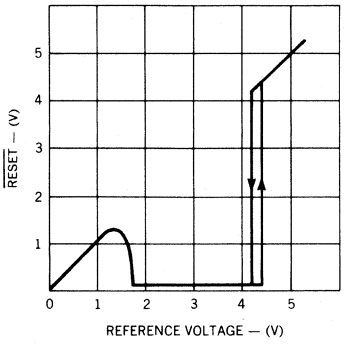
Output Blanking



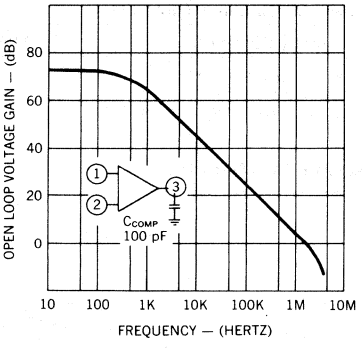
Output Driver Deadtime vs R_D Value



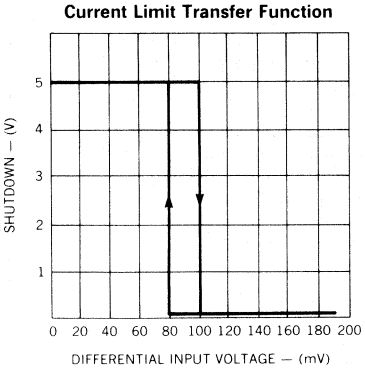
Under-Voltage Lockout Characteristic



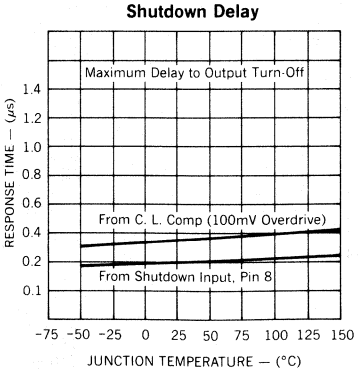
Error Amplifier Open Loop Gain vs Frequency



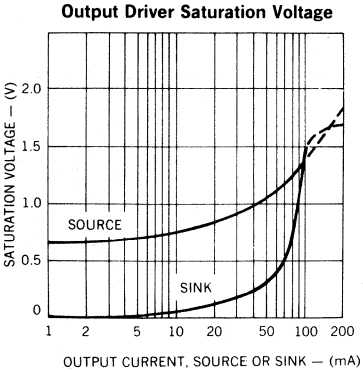
Current Limit Transfer Function



Shutdown Delay



Output Driver Saturation Voltage



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

APPLICATIONS INFORMATION

Voltage Reference

The reference regulator of the UC1526A is based on a precision band-gap reference, internally trimmed to ±1% accuracy. The circuitry is fully active at supply voltages above +7V, and provides up to 20mA of load current to external circuitry at +5.0V. In systems where additional current is required, an external PNP transistor can be used to boost the available current. A rugged low frequency audio-type transistor should be used, and lead lengths between the PWM and transistor should be as short as possible to minimize the risk of oscillations. Even so, some types of transistors may require collector-base capacitance for stability. Up to 1 amp of load current can be obtained with excellent regulation if the device selected maintains high current gain.

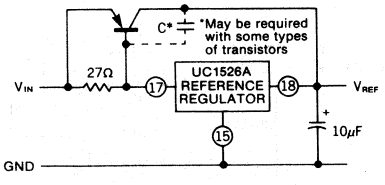


Figure 1. Extending Reference Output Current

Under-Voltage Lockout

The under-voltage lockout circuit protects the UC1526A and the power devices it controls from inadequate supply voltage. If $+V_{IN}$ is too low, the circuit disables the output drivers and holds the $\overline{RESET}$ pin LOW. This prevents spurious output pulses while the control circuitry is stabilizing, and holds the soft-start timing capacitor in a discharged state.

The circuit consists of a +1.2V bandgap reference and comparator circuit which is active when the reference voltage has risen to $3V_{BE}$ or +1.8V at 25°C. When the reference voltage rises to approximately +4.4V, the circuit enables the output drivers and releases the $\overline{RESET}$ pin, allowing a normal soft-start. The comparator has 350mV of hysteresis to minimize oscillation at the trip point. When $+V_{IN}$ to the PWM is removed and the reference drops to +4.2V, the under-voltage circuit pulls $\overline{RESET}$ LOW again. The soft-start capacitor is immediately discharged, and the PWM is ready for another soft-start cycle.

The UC1526A can operate from a +5V supply by connecting the V_{REF} pin to the $+V_{IN}$ pin and maintaining the supply between +4.8 and +5.2V.

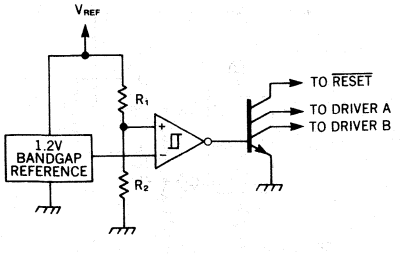


Figure 2. Under-Voltage Lockout Schematic

Soft-Start Circuit

The soft-start circuit protects the power transistors and rectifier diodes from high current surges during power supply turn-on. When supply voltage is first applied to the UC1526A, the under-voltage lockout circuit holds $\overline{RESET}$ LOW with Q_3. Q_1 is turned on, which holds the soft-start capacitor voltage at zero. The second collector of Q_1 clamps the output of the error amplifier to ground, guaranteeing zero duty cycle at the driver outputs. When the supply voltage reaches normal operating range, $\overline{RESET}$ will go HIGH. Q_1 turns off, allowing the internal 100μA current source to charge C_S. Q_2 clamps the error amplifier output to $1V_{BE}$ above the voltage on C_S. As the soft-start voltage ramps up to +5V, the duty cycle of the PWM linearly increases to whatever value the voltage regulation loop requires for an error null.

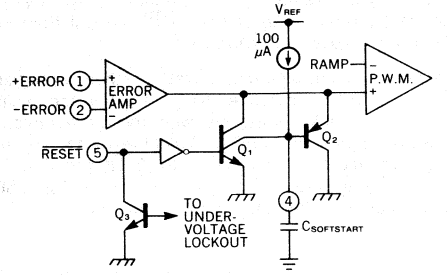


Figure 3. Soft-Start Circuit Schematic

Digital Control Ports

The three digital control ports of the UC1526A are bi-directional. Each pin can drive TTL and 5V CMOS logic directly, up to a fan-out of 10 low-power Schottky gates. Each pin can also be directly driven by open-collector TTL, open-drain CMOS, and open-collector voltage comparators; fan-in is equivalent to 1 low-power Schottky gate. Each port is normally HIGH; the pin is pulled LOW to activate the particular function. Driving $\overline{SYNC}$ LOW initiates a discharge cycle in the oscillator. Pulling $\overline{SHUTDOWN}$ LOW immediately inhibits all PWM output pulses. Holding $\overline{RESET}$ LOW discharges the soft-start capacitor. The logic threshold is +1.1V at +25°C. Noise immunity can be gained at the expense of fan-out with an external 2K pull-up resistor to +5V.

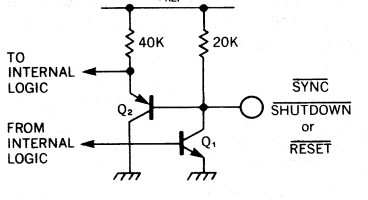


Figure 4. Digital Control Port Schematic

Oscillator

The oscillator is programmed for frequency and dead time with three components: R_T, C_T and R_D. Two waveforms are generated: a sawtooth waveform at pin 10 for pulse width modulation, and a logic clock at pin 12. The following procedure is recommended for choosing timing values:

1. With $R_D = 0\Omega$ (pin 11 shorted to ground) select values for R_T and C_T from the graph on page 4 to give the desired oscillator period. Remember that the frequency at each driver output is half the oscillator frequency, and the frequency at the $+V_C$ terminal is the same as the oscillator frequency.
2. If more dead time is required, select a larger value of R_D. At 40kHz dead time increases by 400ns/Ω.
3. Increasing the dead time will cause the oscillator frequency to decrease slightly. Go back and decrease the value of R_T slightly to bring the frequency back to the nominal design value.

The UC1526A can be synchronized to an external logic clock by programming the oscillator to free-run at a frequency 10% slower than the sync frequency. A periodic LOW logic pulse approximately 0.5μs wide at the $\overline{SYNC}$ pin will then lock the oscillator to the external frequency.

Multiple devices can be synchronized together by programming one master unit for the desired frequency, and then sharing its sawtooth and clock waveforms with the slave units. All C_T terminals are connected to the C_T pin of the master, and all $\overline{SYNC}$ terminals are likewise connected to the $\overline{SYNC}$ pin of the master. Slave R_T terminals are left open or connected to V_{REF}. Slave R_D terminals may be either left open or grounded.

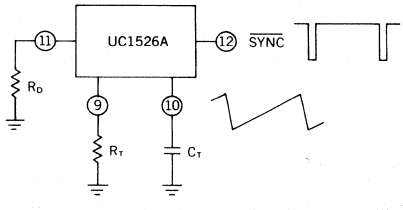


Figure 5. Oscillator Connections and Waveforms

Error Amplifier

The error amplifier is a transconductance design, with an output impedance of 2MΩ. Since all voltage gain takes place at the output pin, the open-loop gain/frequency characteristics can be controlled with shunt reactance to ground. When compensated for unity-gain stability with 100pF, the amplifier has an open-loop pole at 400Hz.

The input connections to the error amplifier are determined by the polarity of the switching supply output voltage. For positive supplies, the common-mode voltage is +5.0V and the feedback connections in Figure 6A are used. With negative supplies, the common-mode voltage is ground and the feedback divider is connected between the negative output and the +5.0V reference voltage, as shown in Figure 6B.

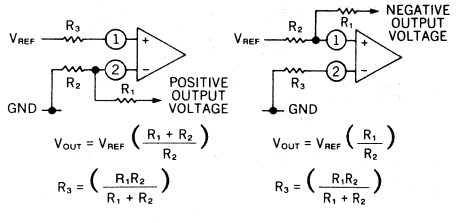


Figure 6. Error Amplifier Connections

Output Drivers

The totem-pole output drivers of the UC1526A are designed to source and sink 100mA continuously and 200mA peak. Loads can be driven either from the output pins 13 and 16, or from the $+V_C$, as required.

Since the bottom transistor of the totem-pole is allowed to saturate, there is a momentary conduction path from the $+V_C$ terminal to ground during switching; however, improved design has limited this cross-conduction period to less than 50ns. Capacitor decoupling at V_C is recommended and careful grounding of Pin 15 is needed to insure that high peak sink currents from a capacitive load do not cause ground transients.

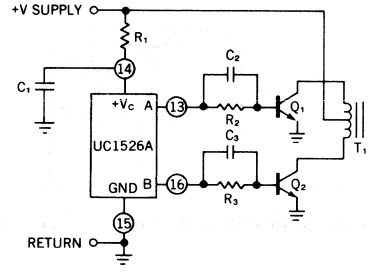


Figure 7. Push-Pull Configuration

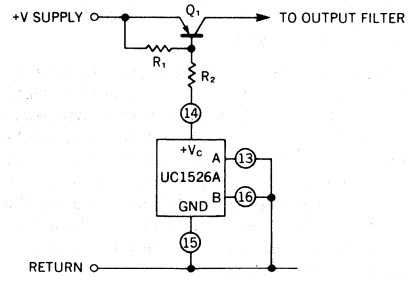


Figure 8. Single-Ended Configuration

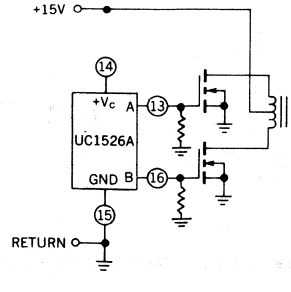


Figure 9. Driving N-Channel Power Mosfets

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

LINEAR INTEGRATED CIRCUITS

Power Supply Supervisory Circuit

UC1543 UC1544
UC2543 UC2544
UC3543 UC3544

2

FEATURES

- Includes over-voltage, under-voltage, and current sensing circuits
- Internal 1% accurate reference
- Programmable time delays
- SCR "crowbar" drive of 300mA
- Remote activation capability
- Optional over-voltage latch
- Uncommitted comparator inputs for low voltage sensing (UC1544 series only)

DESCRIPTION

These monolithic integrated circuits contain all the functions necessary to monitor and control the output of a sophisticated power supply system. Over-voltage (O.V.) sensing with provision to trigger an external SCR "crowbar" shutdown; an under-voltage (U.V.) circuit which can be used to monitor either the output or to sample the input line voltage; and a third op amp/comparator usable for current sensing (C.L.) are all included in this IC, together with an independent, accurate reference generator.

Both over- and under-voltage sensing circuits can be externally programmed for minimum time duration of fault before triggering. All functions contain open collector outputs which can be used independently or wire-or'ed together, and although the SCR trigger is directly connected only to the over-voltage sensing circuit, it may be optionally activated by any of the other outputs, or from an external signal. The O.V. circuit also includes an optional latch and external reset capability.

The UC1544/2544/3544 devices have the added versatility of completely uncommitted inputs to the voltage sensing comparators so that levels less than 2.5V may be monitored by dividing down the internal reference voltage.

The current sense circuit may be used with external compensation as a linear amplifier or as a high-gain comparator. Although nominally set for zero input offset, a fixed threshold may be added with an external resistor. Instead of current limiting, this circuit may also be used as an additional voltage monitor.

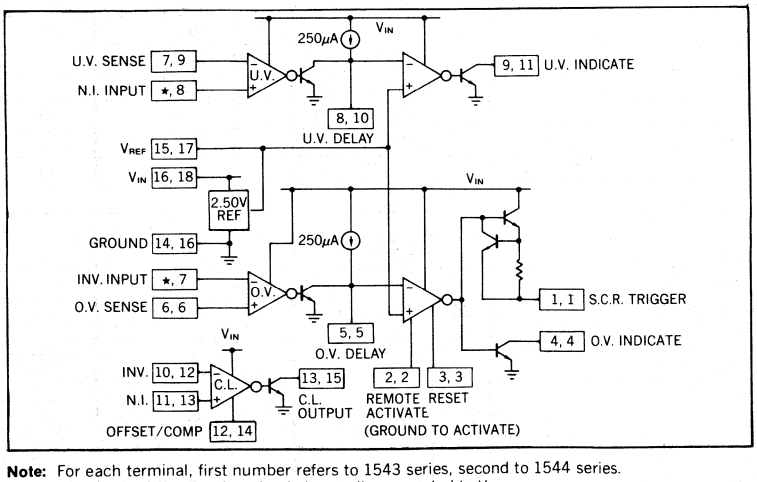
The reference generator circuit is internally trimmed to eliminate the need for external potentiometers and the entire circuit may be powered directly from either the output being monitored or from a separate bias voltage.

ABSOLUTE MAXIMUM RATINGS

Input Supply Voltage, V_{IN} 40V
Sense Inputs, Voltage Range ..... 0 to V_{IN}
SCR Trigger Current ..... -600mA*
Indicator Output Voltage 40V
Indicator Output Sink Current 50mA
Power Dissipation (Package Limitation) 1000mW
  Derate Above 25°C ..... 8.0mW/°C
Operating Temperature Range
  UC1543, UC1544 ..... -55°C to +125°C
  UC2543, UC2544 ..... -25°C to +85°C
  UC3543, UC3544 ..... 0°C to +70°C
Storage Temperature Range ..... -65°C to +150°C

*At higher input voltages, a dissipation limiting resistor, R_G, is required.
Note: Currents are positive-into, negative-out of the specified terminal.

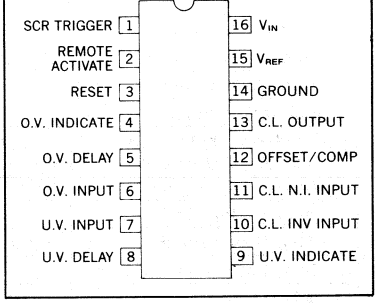
BLOCK DIAGRAM



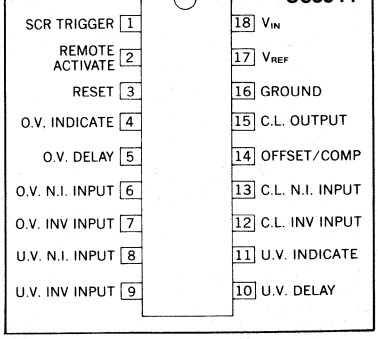
Note: For each terminal, first number refers to 1543 series, second to 1544 series.
★ On 1543 series, this function is internally connected to V_{REF}.

CONNECTION DIAGRAMS

DIL-16 (TOP VIEW) **UC1543**
J or N PACKAGE **UC2543**
UC3543



DIL-18 (TOP VIEW) **UC1544**
J or N PACKAGE **UC2544**
UC3544

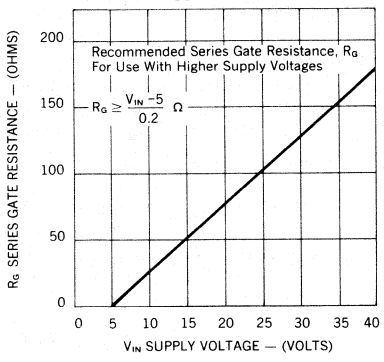


UNITRODE

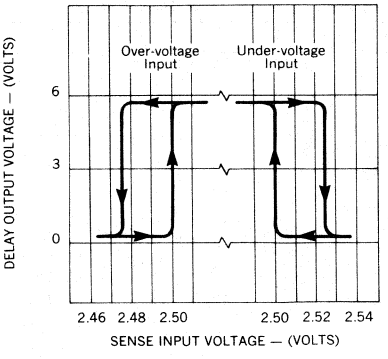
ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for the UC1543 & UC1544; −25°C to +85°C for the UC2543 & UC2544; and 0°C to +70°C for the UC3543 & UC3544; and for V_{IN} = 5 to 35V. Electrical tests are performed with V_{IN} = 10V and 2kΩ pull-up resistors on all indicator outputs. All electrical ratings and specifications for the UC1544, UC2544 & UC3544 devices are tested with the inverting over-voltage input and the non-inverting under-voltage input externally connected to the 2.5V reference.)

PARAMETER	TEST CONDITIONS	UC1543/UC2543 UC1544/UC2544			UC3543 UC3544			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Input Voltage Range	T_J = 25°C to T_{MAX}	4.5		40	4.5		40	V
Input Voltage Range	T_{MIN} to T_{MAX}	4.7		40	4.7		40	V
Supply Current	V_{IN} = 40V, Outputs Open		7	10		7	10	mA
Reference Section								
Output Voltage	T_J = 25°C	2.48	2.50	2.52	2.45	2.50	2.55	V
Output Voltage	Over Temperature Range	2.45		2.55	2.40		2.60	V
Line Regulation	V_{IN} = 5 to 30V		1	5		1	5	mV
Load Regulation	I_{REF} = 0 to 10mA		1	10		1	10	mV
Short Circuit Current	V_{REF} = 0	−12	−20	−40	−12	−20	−40	mA
Temperature Stability			50			50		ppm/°C
SCR Trigger Section								
Peak Output Current	V_{IN} = 5V, R_G = 0, V_O = 0	−100	−300	−600	−100	−300	−600	mA
Peak Output Voltage	V_{IN} = 15V, I_O = −100mA	12	13		12	13		V
Output Off Voltage	V_{IN} = 40V		0	0.1		0	0.1	V
Remote Activate Current	R/A Pin = Gnd		−0.4	−0.8		−0.4	−0.8	mA
Remote Activate Voltage	R/A Pin Open		2	6		2	6	V
Reset Current	Reset = Gnd, R/A = Gnd		−0.4	−0.8		−0.4	−0.8	mA
Reset Voltage	Reset Open, R/A = Gnd		2	6		2	6	V
Output Current Rise Time	R_L = 50Ω, T_J = 25°C, C_D = 0		400			400		mA/μs
Prop. Delay from R/A			300			300		ns
Prop. Delay from O/V input			500			500		ns
Comparator Sections								
Input Threshold (Input voltage rising on O.V. and falling on U.V.)	T_J = 25°C	2.45	2.50	2.55	2.40	2.50	2.60	V
	Over Temperature Range	2.40		2.60	2.35		2.65	V
Input Hysteresis			25			25		mV
Input Bias Current	Sense Input = 0V		−0.3	−1.0		−0.3	−1.0	μA
Delay Saturation			0.2	0.5		0.2	0.5	V
Delay High Level			6	7		6	7	V
Delay Charging Current	V_D = 0	−200	−250	−300	−200	−250	−300	μA
Indicate Saturation	I_L = 10mA		0.2	0.5		0.2	0.5	V
Indicate Leakage	V_{IND} = 40V		.01	1.0		.01	1.0	μA
Propagation Delay	Input Overdrive = 200mV, T_J = 25°C, C_D = 0		400			400		ns
	Input Overdrive = 200mV, T_J = 25°C, C_D = 1μF		10			10		ms
Current Limit Section								
Input Voltage Range		0		(V_{IN}−3V)	0		(V_{IN}−3V)	V
Input Bias Current	Offset Pin Open, V_{CM} = 0		−0.3	−1.0		−0.3	−1.0	μA
Input Offset Voltage	Offset Pin Open, V_{CM} = 0		0	10		0	10	mV
Input Offset Voltage	10kΩ from Offset Pin to Gnd	80	100	120	80	100	120	mV
CMRR	0 ≤ V_{CM} ≤ 12V, V_{IN} = 15V	60	70		60	70		dB
AVOL	Offset Pin Open, V_{CM} = 0V	72	80		72	80		dB
Output Saturation	I_L = 10mA		0.2	0.5		0.2	0.5	V
Output Leakage	V_{IND} = 40V		.01	1.0		.01	1.0	μA
Small Signal Bandwidth	A_V = 0dB, T_J = 25°C		5			5		MHz
Propagation Delay	$V_{overdrive}$ = 100mV, T_J = 25°C		200			200		ns

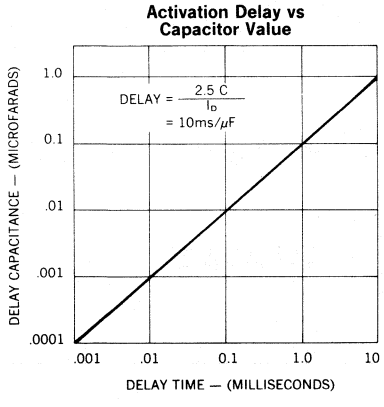
SCR Trigger Power Limiting



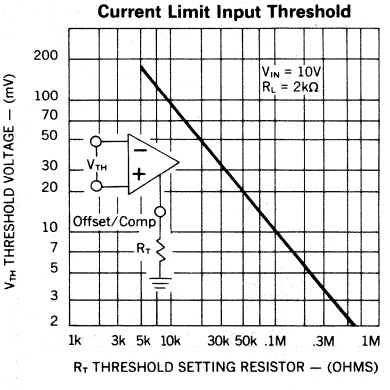
Comparator Input Hysteresis



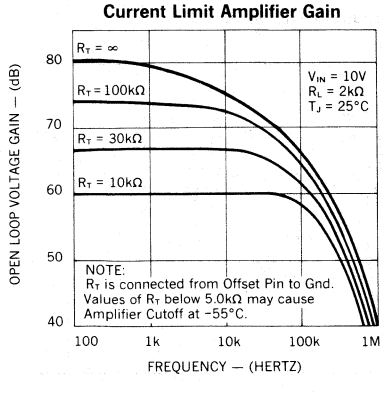
Activation Delay vs Capacitor Value



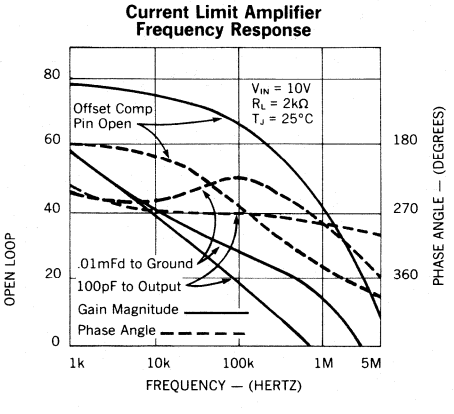
Current Limit Input Threshold



Current Limit Amplifier Gain

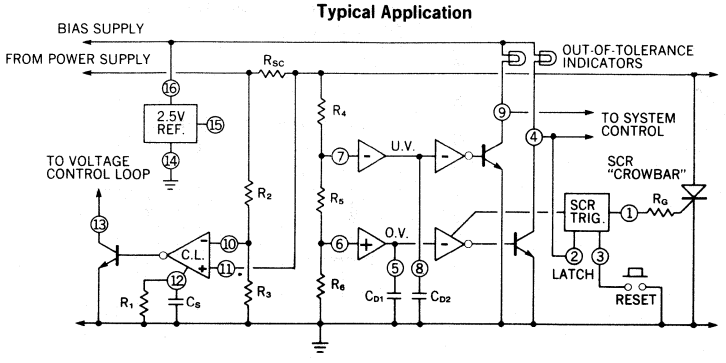


Current Limit Amplifier Frequency Response



APPLICATIONS (Pin Numbers given for UC1543 series devices)

Typical Application



The values for the external components are determined as follows:

Current limit input threshold, $V_{th} \approx \frac{1000}{R_1}$

C_s is determined by the current loop dynamics

Peak current to load, $Ip \cong \frac{V_{th}}{R_{SC}} + \frac{V_O}{R_{SC}} \left(\frac{R_2}{R_2 + R_3} \right)$

Short circuit current, $Isc = \frac{V_{th}}{R_{SC}}$

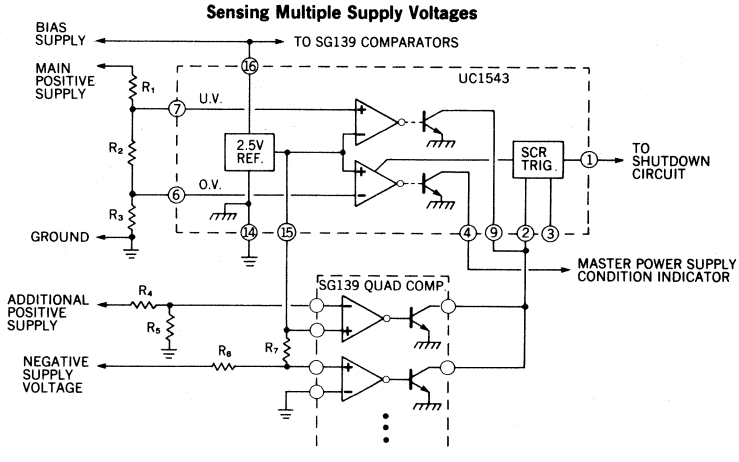
Low output voltage limit, $V_O(Low) = \frac{2.5\ (R_4 + R_5 + R_6)}{R_5 + R_6}$

High output voltage limit $V_O(High) = \frac{2.5\ (R_4 + R_5 + R_6)}{R_6}$

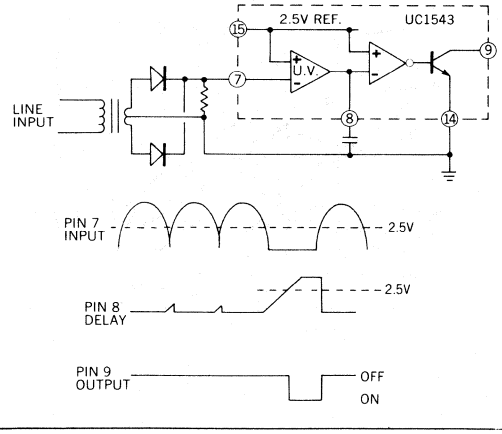
Voltage sensing delay, t_d = 10,000 Cd

SCR trigger power limiting resistor, $R_G > \frac{V_{IN} - 5}{0.2}$

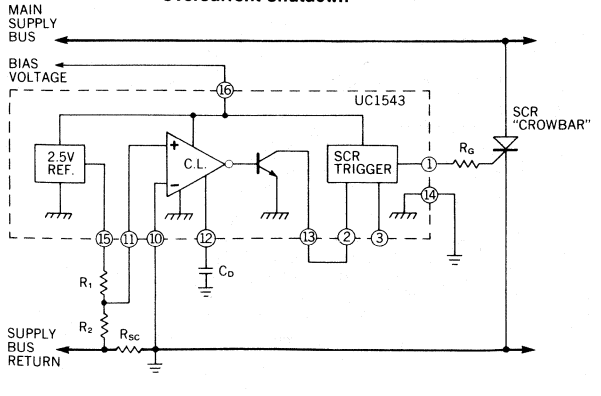
Sensing Multiple Supply Voltages



Input Line Monitor



Overcurrent Shutdown



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

UNITRODE INTEGRATED CIRCUITS

DUAL Schottky Diode Bridge

FEATURES

- Monolithic Eight-Diode Array
- Exceptional Efficiency
- Low Forward Voltage
- Fast Recovery Time
- High Peak Current
- Small Size

DESCRIPTION

This eight-diode array is designed for high-current, low duty-cycle applications typical of flyback voltage clamping for inductive loads. The dual bridge connection makes this device particularly applicable to bipolar driven stepper motors.

The use of Schottky diode technology features high efficiency through lowered forward voltage drop and decreased reverse recovery time.

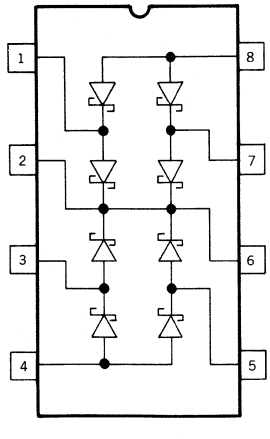
This single monolithic chip is fabricated in both hermetic cerdip and copper-leaded plastic minidip packages. The UC1610 in ceramic is designed for −55°C to +125°C environments but with reduced peak current capability; while the UC3610 in plastic has higher current rating over a 0°C to 70°C ambient temperature range.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage (per diode) 50V
Peak Forward Current
  UC1610 ..... 1A
  UC3610 ..... 3A
Power Dissipation at T_A = 70°C 1W
  Derate 12.5mW/°C above 70°C
Storage Temperature Range ..... −65°C to +150°C
Lead Temperature (Soldering, 10 Seconds) ..... 300°C

CONNECTION DIAGRAM

DIL-8 (TOP VIEW)
N or J PACKAGE



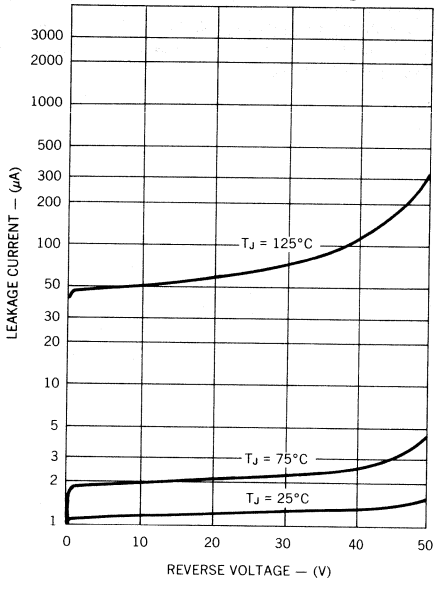
UNITRODE

ELECTRICAL CHARACTERISTICS (All specifications apply to each individual diode. T_J = 25°C except as noted.)

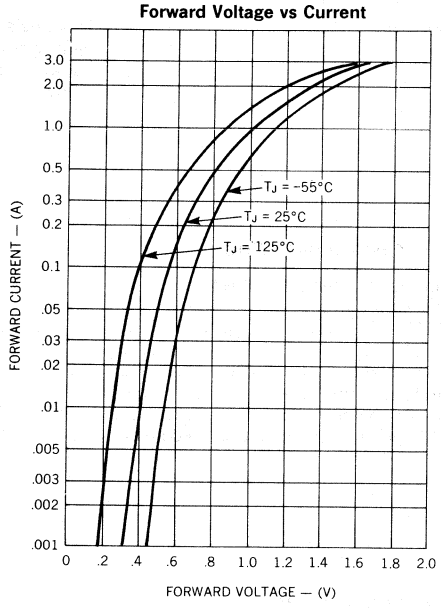
PARAMETER	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Forward Voltage Drop	I_F = 100mA I_F = 1A	0.4 0.8	0.5 1.0	0.7 1.3	V
Leakage Current	V_R = 40V V_R = 40V, T_J = 100°C		.01 0.1	0.1 1.0	mA
Reverse Recovery	.5A Forward to .5A Reverse		15		nSec
Forward Recovery	1A Forward to 1.1V Recovery		30		nSec
Junction Capacitance	V_R = 5V		70		pF

Note: At forward currents of greater than 1.0A, a parasitic current of approximately 10mA may be collected by adjacent diodes.

Reverse Current vs Voltage



Forward Voltage vs Current



LINEAR INTEGRATED CIRCUITS

Switched Mode Controller for DC Motor Drive

UC1637
UC2637
UC3637

2

FEATURES

- Single or dual supply operation
- ± 2.5V to ± 20V input supply range
- ± 5% initial oscillator accuracy; ± 10% over temperature
- Pulse-by-pulse current limiting
- Under-voltage lockout
- Shutdown input with temperature compensated 2.5V threshold
- Uncommitted PWM comparators for design flexibility
- Dual 100mA, source/sink output drivers

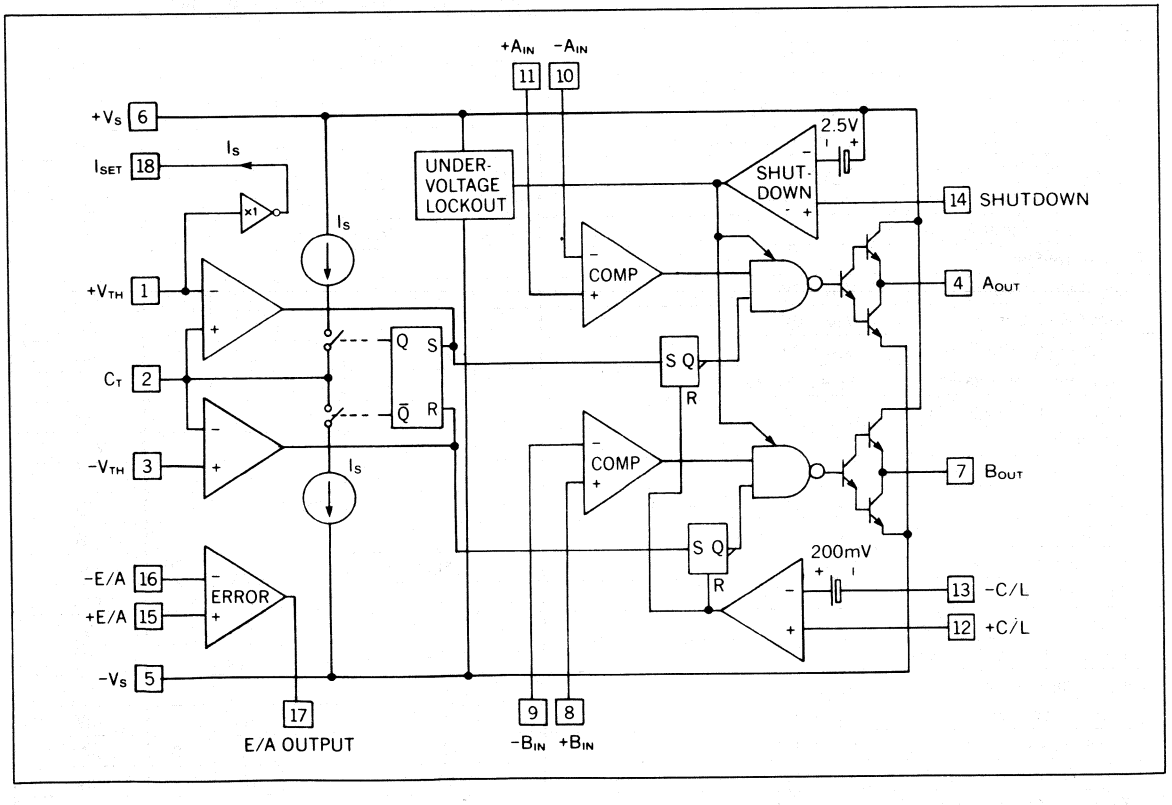
DESCRIPTION

The UC1637 is a pulse width modulator circuit intended to be used for a variety of PWM motor drive and amplifier applications requiring either uni-directional or bi-directional drive circuits. When used to replace conventional drivers, this circuit can increase efficiency and reduce component costs for many applications. All necessary circuitry is included to generate an analog error signal and modulate two bi-directional pulse train outputs in proportion to the error signal magnitude and polarity.

This monolithic device contains a sawtooth oscillator, error amplifier, and two PWM comparators with ± 100mA output stages as standard features. Protection circuitry includes under-voltage lockout, pulse-by-pulse current limiting, and a shutdown port with a 2.5V temperature compensated threshold.

The UC1637 is characterized for operation over the full military temperature range of −55°C to +125°C, while the UC2637 and UC3637 are characterized for −25°C to +85°C and 0°C to +70°C, respectively.

BLOCK DIAGRAM



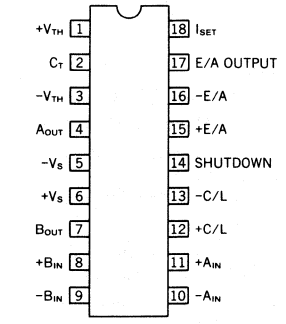
ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage ($\pm V_S$) ..... ±20V
Output Current, Source/Sink (Pins 4, 7) 500mA
Analog Inputs (Pins 1, 2, 3, 8, 9, 10, 11, 12, 13, 14, 15, 16) ..... $\pm V_S$
Error Amplifier Output Current (Pin 17) ..... ±20mA
Oscillator Charging Current (Pin 18) ..... -2mA
Power Dissipation at T_A = 25°C 1000mW
Derate at 10mW/°C For T_A Above 50°C
Power Dissipation at T_C = 25°C 2000W
Derate at 16mW/°C for T_C above 25°C
Thermal Resistance, Junction to Ambient ..... 100°C/W
Thermal Resistance, Junction to Case ..... 60°C/W
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (Soldering, 10 Seconds) ..... +300°C

Note: 1. Currents are positive into, negative out of the specified terminal.

CONNECTION DIAGRAM

DIL-18 (TOP VIEW)
J or N PACKAGE



ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = -55°C to +125°C for UC1637; -25°C to +85°C for the UC2637; and 0°C to +70°C for the UC3637; $+V_S$ = +15V, $-V_S$ = -15V, $+V_{TH}$ = 5V, $-V_{TH}$ = -5V, R_T = 16.7kΩ, C_T = 1500pF)

PARAMETER	TEST CONDITIONS	UC1637/UC2637			UC3637			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Oscillator								
Initial Accuracy	T_j = 25°C	9.4	10	10.6	9	10	11	kHz
Voltage Stability	V_S = ± 5V to ± 20V, $V_{PIN\ 1}$ = 3V, $V_{PIN\ 3}$ = -3V		5	7		5	7	%
Temperature Stability	Over Operating Range		0.5	2		0.5	2	%
$+V_{TH}$ Input Bias Current	$V_{PIN\ 2}$ = 6V	-10	0.1	10	-10	0.1	10	µA
$-V_{TH}$ Input Bias Current	$V_{PIN\ 2}$ = 0V	-10	-0.5		-10	-0.5		µA
$+V_{TH}$, $-V_{TH}$ Input Range		$+V_S$-2		$-V_S$+2	$+V_S$-2		$-V_S$+2	V
Error Amplifier								
Input Offset Voltage	V_{CM} = 0V		1.5	5		1.5	10	mV
Input Bias Current	V_{CM} = 0V		0.5	5		0.5	5	µA
Input Offset Current	V_{CM} = 0V		0.1	1		0.1	1	µA
Common Mode Range	V_S = ± 2.5 to 20V	$-V_S$+2		$+V_S$	$-V_S$+2		$+V_S$	V
Open Loop Voltage Gain	R_L = 10K	75	100		80	100		dB
Slew Rate			15			15		V/µs
Unity Gain Bandwidth								
CMRR	Over Common Mode Range	75	100		75	100		dB
PSRR	V_S = ± 2.5V to ± 20V	75	110		75	110		dB
Output Sink Current	$V_{PIN\ 17}$ = 0V		-50	-20		-50	-20	mA
Output Source Current	$V_{PIN\ 17}$ = 0V	5	11		5	11		mA
High Level Output Voltage		13	13.6		13	13.6		V
Low Level Output Voltage			-14.8	-13		-14.8	-13	V
PWM Comparators								
Input Offset Voltage	V_{CM} = 0V		20			20		mV
Input Bias Current	V_{CM} = 0V		2	10		2	10	µA
Input Hysteresis	V_{CM} = 0V		10			10		mV
Common Mode Range	V_S = ± 5 to ± 40V	$-V_S$+1		$+V_S$-2	$-V_S$+1		$+V_S$-2	V

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for UC1637; −25°C to +85°C for the UC2637; and 0°C to +70°C for the UC3637; $+V_S$ = +15V, $-V_S$ = −15V, $+V_{TH}$ = 5V, $-V_{TH}$ = −5V, R_T = 16.7kΩ, C_T = 1500pF)

PARAMETER	TEST CONDITIONS	UC1637/UC2637			UC3637			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Current Limit								
Input Offset Voltage	V_{CM} = 0V, T_j = 25°C	190	200	210	180	200	220	mV
Input Offset Voltage T.C.			−0.2			−0.2		mV/°C
Input Bias Current		−10	−1.5		−10	−1.5		μA
Common Mode Range	V_S = ± 2.5V to ± 20V	$-V_S$		$+V_S$−3	$-V_S$		$+V_S$ −3	V
Shutdown								
Shutdown Threshold	(Note 3)	−2.3	−2.5	−2.7	−2.3	−2.5	−2.7	V
Hysteresis			40			40		mV
Input Bias Current	$V_{PIN\ 14}$ = $+V_S$ to $-V_S$	−10	−0.5		−10	−0.5		μA
Under-Voltage Lockout								
Start Threshold	(Note 4)		4.15	5.0		4.15	5.0	V
Hysteresis			0.25			0.25		mV
Total Standby Current								
Supply Current			8.5	15		8.5	15	mA
Output Section								
Output Low Level	I_{SINK} = 20mA		−14.9	−13		−14.9	−13	V
	I_{SINK} = 100mA		−14.5	−13		−14.5	−13	
Output High Level	I_{SOURCE} = 20mA	13	13.5		13	13.5		V
	I_{SOURCE} = 100mA	12	13.5		12	13.5		
Rise Time	(Note 2) C_L = 1nf, T_j = 25°C		100	600		100	600	ns
Fall Time	(Note 2) C_L = 1nf, T_j = 25°C		100	300		100	300	ns

Notes: 2. These parameters, although guaranteed over the recommended operating conditions, are not 100% tested in production.
3. Parameter measured with respect to $+V_S$ (Pin 6).
4. Parameter measured at $+V_S$ (Pin 6) with respect to $-V_S$ (Pin 5).

FUNCTIONAL DESCRIPTION

Following is a description of each of the functional blocks shown in the Block Diagram.

Oscillator

The oscillator consists of two comparators, a charging and discharging current source, a current source set terminal, I_{set}, and a flip-flop. The upper and lower threshold of the oscillator waveform is set externally by applying a voltage at pins $+V_{TH}$ and $-V_{TH}$ respectively. The $+V_{TH}$ terminal voltage is buffered internally and also applied to the I_{set} terminal to develop the capacitor charging current through R_T. If R_T is referenced to $-V_S$ as shown in Figure 1, both the threshold voltage and charging current will vary proportionally to the supply differential, and the oscillator frequency will remain constant. The triangle waveform oscillators frequency and voltage amplitude is determined by the external components using the formulas given in Figure 1.

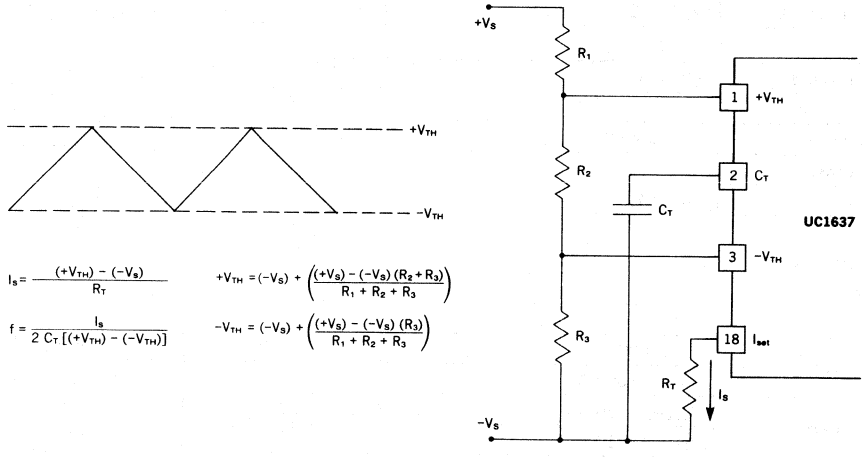


Figure 1. Oscillator Set Up

PWM Comparators

Two comparators are provided to perform pulse width modulation for each of the output drivers. Inputs are uncommitted to allow maximum flexability. The pulse width of the outputs A and B is a function of the sign and amplitude of the error signal. A negative signal at Pin 10 and 8 will lengthen the high-state of output A and shorten the high-state of output B. Likewise, a positive error signal reverses the procedure. Typically, the oscillator waveform is compared against the summation of the error signal and the threshold set on Pin 10 and 8.

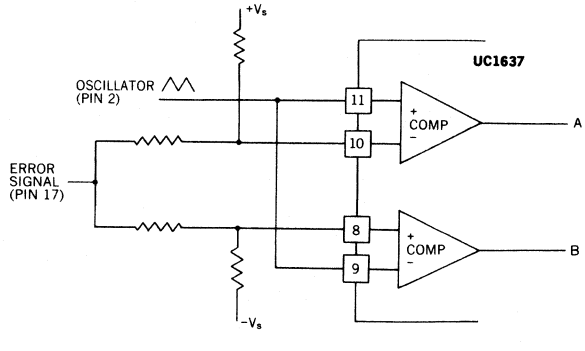


Figure 2. Comparator Biasing

MODULATION SCHEMES

Case A Zero Deadtime (Equal voltage on Pin 10 and Pin 8)

In this configuration, maximum holding torque or stiffness and position accuracy is achieved. However, the power input into the motor is increased. Figure 3A shows this configuration.

Case B Small Deadtime (Voltage on Pin 10 > Pin 8)

A small differential voltage between Pin 10 and 8 provides the necessary time delay to reduce the chances of momentary short circuit in the output stage during transitions, especially where power-amplifiers are used. Refer to Figure 3B.

Case C Increased Deadtime and Deadband Mode (Voltage on Pin 10 > Pin 8)

With the reduction of stiffness and position accuracy, the power input into the motor around the null point of the servo loop can be reduced or eliminated by widening the window of the comparator circuit to a degree of acceptance. Where position accuracy and mechanical stiffness is unimportant, deadband operation can be used. This is shown in Figure 3C.

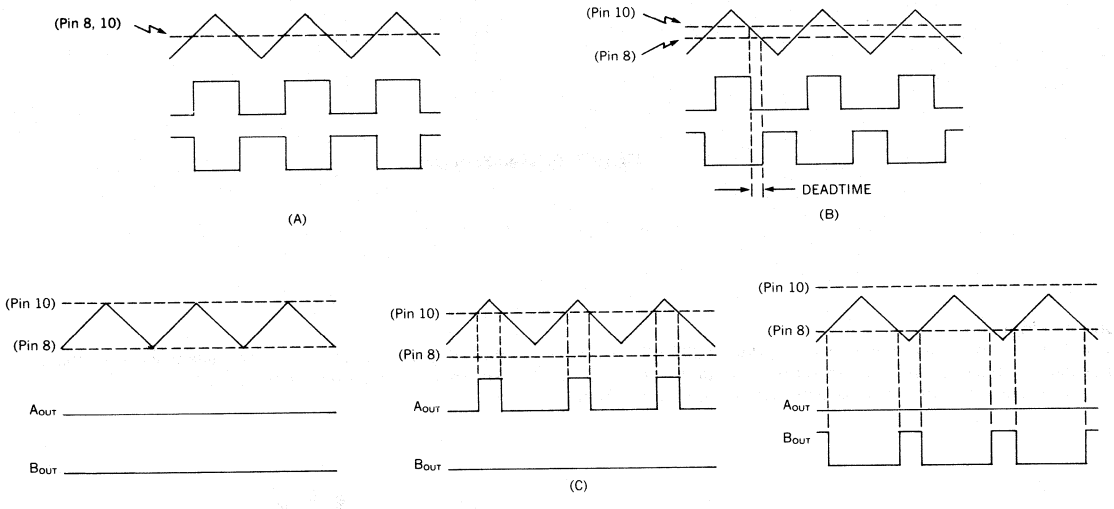


Figure 3. Modulation Schemes Showing (A) Zero Deadtime (B) Deadtime and (C) Deadband Configurations.

Output Drivers

Each output driver is capable of both sourcing and sinking 100mA steady state and up to 500mA on a pulsed basis for rapid switching of either POWERFET or bipolar transistors. Output levels are typically $-V_S + 0.2V$ @ 50mA low level and $+V_S - 2.0V$ @ 50mA high level.

Error Amplifier

The error amplifier consists of a high slew rate (15V/μs) op-amp with a typical 1MHz bandwidth and low output impedance. Depending on the $\pm V_S$ supply voltage, the common mode input range and the voltage output swing is within 2V of the V_S supply.

Under-Voltage Lockout

An under-voltage lockout circuit holds the outputs in the off state until a minimum of 4V is reached. At this point, all internal circuitry is functional and the output drivers are switched on. If external circuitry requires a higher starting voltage, an over-riding voltage can be programmed through the shutdown terminal as shown in Figure 4.

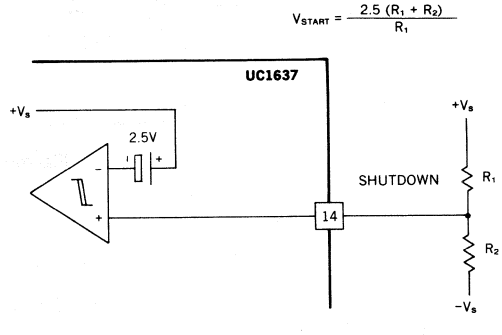


Figure 4. External Under-Voltage Lockout

Shutdown Comparator

The shutdown terminal may be used for implementing various shutdown and protection schemes. By pulling the terminal more than 2.5V below V_{IN}, the output drivers will be enabled. This can be realized using an open collector gate or NPN transistor biased to either ground or the negative supply. Since the threshold is temperature stabilized, the comparator can be used as an accurate low voltage lockout (Figure 4) and/or delayed start as in Figure 5.

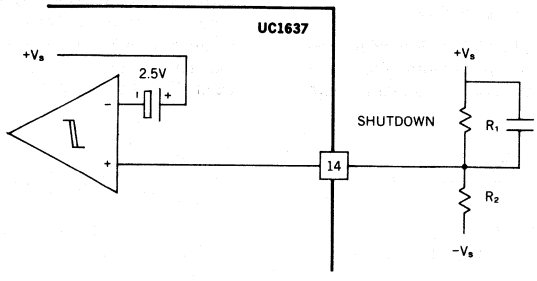


Figure 5. Delayed Start-Up

Current Limit

A latched current limit amplifier with an internal 200mV offset is provided to allow pulse-by-pulse current limiting. Differential inputs will accept common mode signals from $-V_S$ to within 3V of the $+V_S$ supply while providing excellent noise rejection. Figure 6 shows a typical current sense circuit.

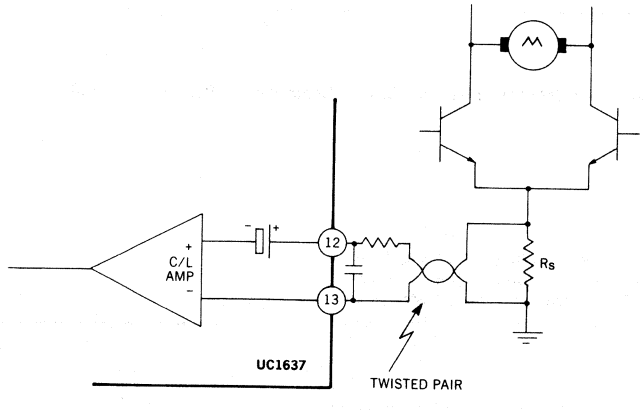


Figure 6. Current Limit Sensing

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

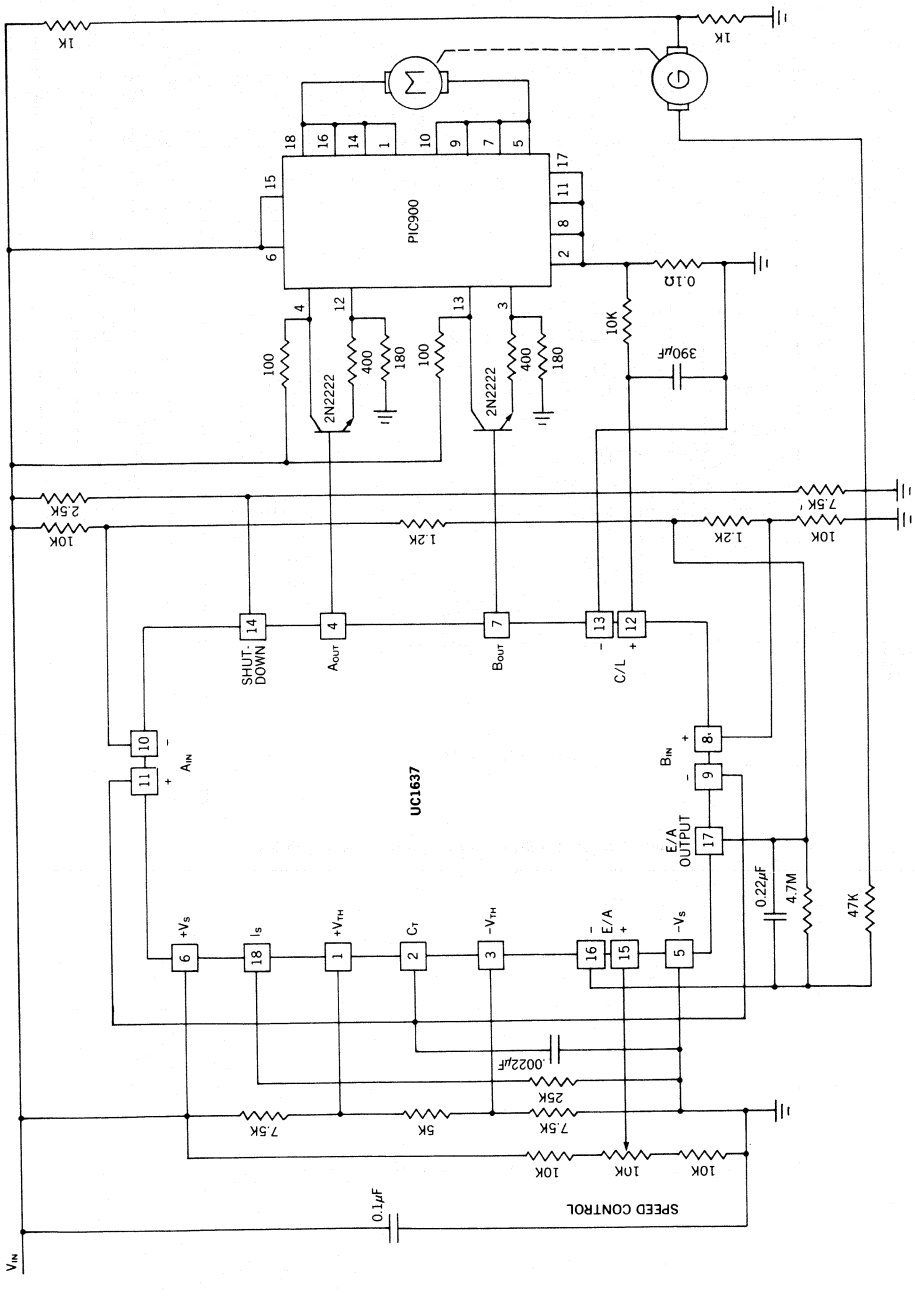


Figure 7. Bi-Directional Motor Drive with Speed Control and Power-Amplifier

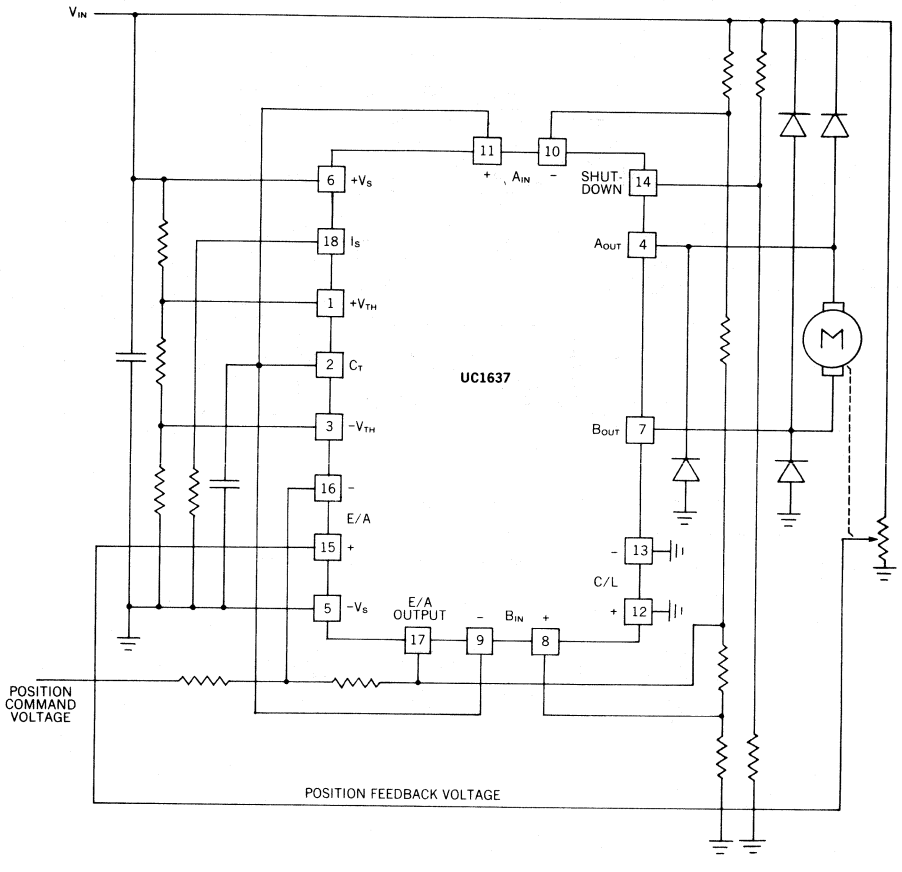


Figure 8. Single Supply Position Servo Motor Drive

LINEAR INTEGRATED CIRCUITS
Bridge Transducer Switch

UC1704
UC3704

2

UC1704 COMPATIBLE SENSORS

SENSOR TYPE	ACTIVATION SOURCE: Temperature	Pressure	Force	Position	Displacement	Velocity	Shock
Thermistor	X					X	
Sensistor	X					X	
Thermocouple	X						
Semiconductor	X	X	X				
Photo Voltaic				X	X	X	
Photo Resistive				X	X	X	
Strain Gage		X	X	X	X	X	X
Piezoelectric		X	X		X	X	X
Magneto Resistive				X	X		
Inductive				X	X	X	X
Hall Effect				X	X		
Capacitive							X

FEATURES

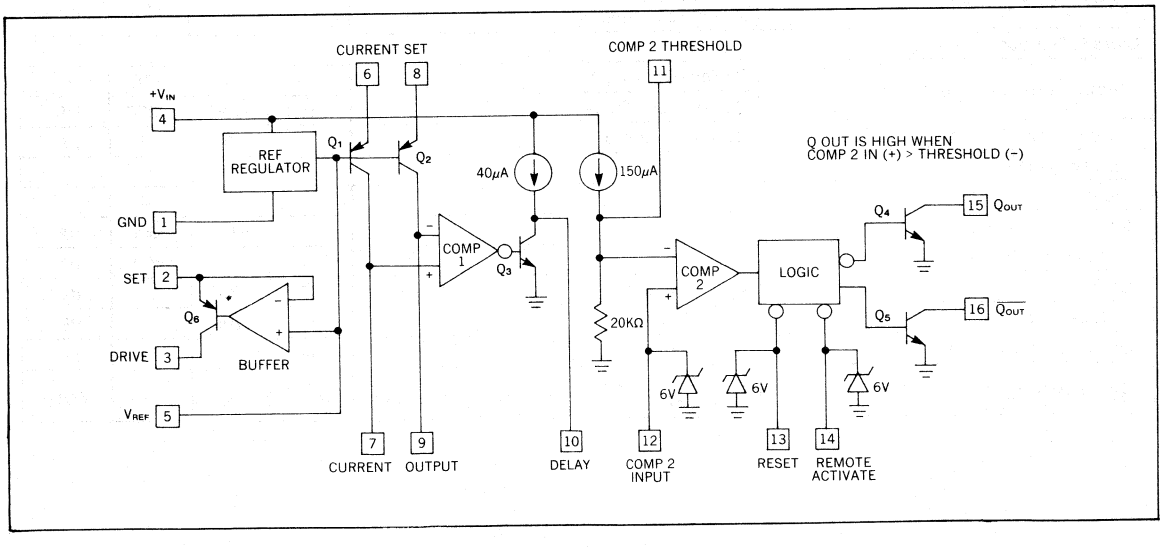
- Dual matched current sources
- High-gain differential sensing circuit
- Wide common-mode input capability
- Complimentary digital open-collector outputs
- Externally programmable time delay
- Optional output latch with reset
- Built-in diagnostic activation
- Wide supply voltage range
- High current heater power source driver

DESCRIPTION

This integrated circuit contains a complete signal conditioning system to interface low-level variable impedance transducers to a digital system. A pair of matched, temperature-compensated current sources are provided for balanced transducer excitation followed by a precision, high-gain comparator. The output of this comparator can be delayed by a user-selectable duration, after which a second comparator will switch complimentary outputs compatible with all forms of logic. This output section can be separately activated for diagnostic operation and has an optional latch with external reset capability. An added feature is a high current power source useful as a heater driver in differential temperature sensing applications.

The UC1704 is characterized for operation over the full military temperature range of −55°C to +125°C while the UC3704 is designed for 0°C to +70°C environments.

BLOCK DIAGRAM



UNITRODE

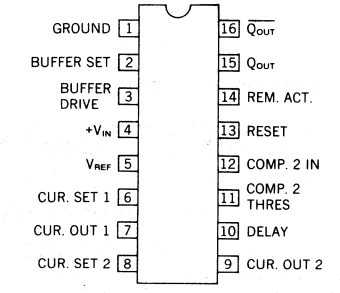
ABSOLUTE MAXIMUM RATINGS

Supply Voltage ($+V_{IN}$) 40V
Output Current (each output) 50mA
Buffer Power Source Current 200mA
Comparator 1 Inputs ..... −0.5V to V_{REF}
Comparator 2 Inputs ..... 0 to 5.5V
Remote Activation and Reset Inputs ..... 0 to 5.5V
Power Dissipation at T_A = 25°C 1000mW
Derate at 10mW/°C for $T_A > 50°C$
Operating Junction Temperature ..... −55°C to +150°C
Storage Temperature Range ..... −65°C to +150°C
Lead Temperature (Soldering, 10 Seconds) ..... +300°C

NOTE: Unless otherwise specified, all voltages are with respect to ground (Pin 1). Currents are positive into, negative out of the specified terminal.

CONNECTION DIAGRAM

DIL-16 (TOP VIEW)
J or N PACKAGE



ELECTRICAL CHARACTERISTICS

(Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for the UC1704 and 0°C to +70°C for the UC3704; V_{IN} = 15V)

PARAMETER	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Power Inputs					
Supply Voltage Range	$T_A > 0°C$	4.2		36	V
Supply Current	V_{IN} = 36V		5	10	mA
Reference Section (with respect to V_{IN})					
V_{REF} Value $\lvert V_{IN} - V_{REF} \rvert$	T_J = 25°C	2.1	2.2	2.3	V
V_{REF} Temperature Coefficient	Note 1	−1	−2	−3	mV/°C
Line Regulation	ΔV_{IN} = 4.2 to 25V		2	10	mV
Load Regulation	ΔI_O = 0 to 4mA		2	10	mV
Short Circuit Current	V_{IN} = 36V V_{REF} = V_{IN} or Ground			±25	mA
Current Sources (Q_1 and Q_2)					
Output Current (Note 2)	Current Set = 10μA	−9	−9.5	−10	μA
	Current Set = 200μA	−180	−195	−200	μA
Output Offset Current	$R_{E6} = R_{E8}$ = 20KΩ		0	±1	μA
Comparator One					
Input Offset Voltage			±1	±4	mV
Input Bias Current			−100	−300	nA
Input Offset Current				±60	nA
CMRR	V_{CM} = 0 to 12V	60	70		dB
Voltage Gain	$R_L > 150K\Omega$	70	85		dB
Delay Current Source		34	40	52	μA
Output Rise Time	Overdrive = 10mV, C_D = 15pF, T_J = 25°C		2		V/μs

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for the UC1704 and 0°C to +70°C for the UC3704; V_{IN} = 15V)

PARAMETER	TEST CONDITIONS		MIN.	TYP.	MAX.	UNITS
Comparator Two (Q_{OUT} and $\overline{Q_{OUT}}$)						
Threshold Voltage			2.2	3.0	3.8	V
Threshold Resistance	To Ground		14	20	24	KΩ
Input Bias Current	V_{IN} (Pin 12) = 5V			1	3	μA
Remote Activate Current	Pin 14 = 0V			0.2	0.5	mA
Reset Current	Pin 13 = 0V			0.2	0.5	mA
Remote Activate Threshold	T_A = 25°C		0.8	1.2		V
Reset Threshold	T_A = 25°C		0.8	1.2		V
Output Saturation	I_{OUT} = 16mA			0.2	0.5	V
	I_{OUT} = 50mA			0.7	2.0	V
Output Leakage	V_{OUT} = 40V			0.2	10	μA
Output Response	Comp. Overdrive = 1V, R_L = 5K to V_{IN}	Turn-on		0.4		μs
		Turn-off		1.0		
Buffer						
Set Voltage (V_{IN} − V_S)	T_J = 25°C, I_S = 100mA		1.9	2.1	2.3	V
Drive Current	T_J = 25°C, R_S = 200Ω, V_D = 0V		90	100	120	mA

Note: 1. Parameter guaranteed by design, not tested in production.

2. Collector output current = $\frac{V_{IN} - V_{REF} - V_{BE}}{R_E} \approx \frac{1.5V}{R_E}$

APPLICATIONS INFORMATION

Sensor Section

The input portion of the UC1704 provides both excitation and sensing for a low-level, variable impedance transducer. This circuitry consists of a pair of highly matched PNP transistors biased for operation as constant current sources followed by a high gain precision comparator.

The reference voltage at the bases of the PNP transistors has a TC to offset the base-emitter voltage variation of these transistors resulting in a constant voltage across the external emitter resistors and correspondingly constant collector currents. With the emitter resistors external, the user has the option of tailoring the collector currents for balancing, offsetting, or to provide a unique temperature characteristic.

With the PNP transistors' optimum current ranging from 10 to 200μA, and the common-mode input voltage of the comparator usable from ground to (V_{IN} − 3V), a wide range of transducer impedance levels is possible.

The sensor comparator has a current source pull-up at the output so that an external capacitor from this point to ground can be used to provide a programmable delay before reaching the second comparator's threshold. The low-impedance on-state of Comp 1's output provides quick reset of this capacitor. This programmable delay function is useful for providing transient protection by requiring that Comp 1 remain activated for a finite period of time before Comp 2 triggers. Another application is in counting repetitive pulses where a missing pulse will allow Comp 1's output to rise to Comp 2's threshold. This time delay function is:

$$\text{Delay} = \frac{\text{Comp 2 Threshold}}{\text{Delay Current}} \times C_D \approx 175 \text{ ms}/\mu\text{F}$$

If hysteresis is desired for Comparator 1, it may be accommodated by applying positive feedback from the delay terminal to the non-inverting input on Pin 7. This will aid in providing oscillation-free transitions for very slowly changing inputs.

Output Section

The output portion of the UC1704 is basically a second comparator with complimentary, open-collector outputs. This comparator has a built-in, ground-referenced threshold implemented with a high-impedance current source and resistor so that it may be easily overridden with an external voltage source if desired. Comp 2's input transistors are NPN types which require at least 1V of common-mode voltage for accurate operation and should not see a differential input voltage greater than 6V.

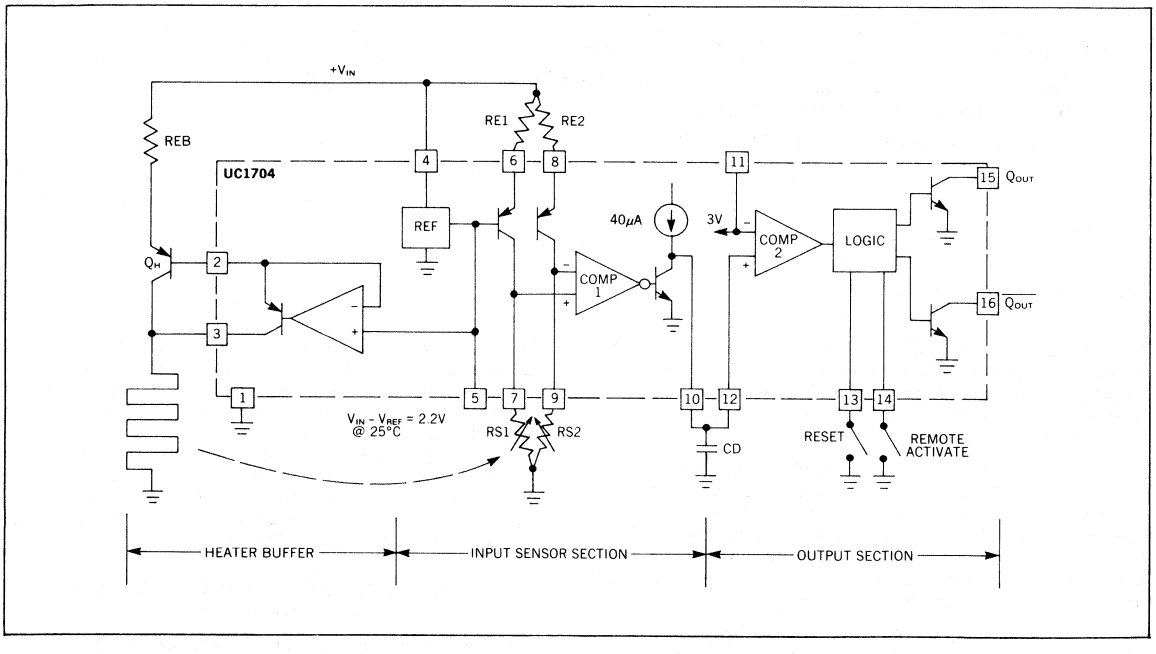
For diagnostic or latching purposes, the output logic is equipped with a Remote Activate and Reset function. These pins have internal pull-ups and are only active when pulled low below a threshold of approximately 1V. A low signal at the Remote Activate Pin causes the outputs to change state in exactly the same manner as if Comp 2's input is raised above the threshold on Pin 11. If Pin 16 is connected to Pin 14, positive feedback results and the outputs will latch once triggered by Comp 2's input. Pulling the Reset terminal low overrides the Remote Activate Pin releasing the latch.

Reference Buffer

This circuit is designed to provide up to 100mA to drive a high-current external PNP transistor useful for powering a heater for differential temperature measurements. Care must be taken that power dissipation in Q_6 does not cause excessive thermal gradients which will degrade the accuracy of the sensing circuitry.

Using a heating element attached to a temperature sensitive resistor, RS1, in one leg of the input bridge implements a flow sensor for either gasses or liquids. As long as there is flow, heat from the element is carried away and the sensor voltage remains below threshold. Using an identical sensor, RS2, without a heater to establish this threshold compensates for the ambient temperature of the flow.

Typical Application For Monitoring Liquid or Gas Flow



LINEAR INTEGRATED CIRCUITS

Dual Output Driver

UC1706
UC3706

2

FEATURES

- Dual, 1.5A Totem Pole Outputs
- 40nsec Rise and Fall into 1000pF
- Parallel or Push-Pull Operation
- Single-Ended to Push-Pull Conversion
- High-Speed, Power MOSFET Compatible
- Low Cross-Conduction Current Spike
- Analog, Latched Shutdown
- Internal Deadband Inhibit Circuit
- Low Quiescent Current
- 5 to 40V Operation
- Thermal Shutdown Protection
- 16-Pin Dual-In-Line Package

DESCRIPTION

The UC1706 family of output drivers are made with a high-speed Schottky process to interface between low-level control functions and high-power switching devices - particularly power MOSFET's. These devices implement three generalized functions as outlined below:

First: They accept a single-ended, low-current digital input of either polarity and process it to activate a pair of high-current, totem pole outputs which can source or sink up to 1.5A each.

Second: They provide an optional single-ended to push-pull conversion through the use of an internal flip-flop driven by double-pulse-suppression logic. With the flip-flop disabled, the outputs work in parallel for 3.0A capability.

Third: Protection functions are also included for pulse-by-pulse current limiting, automatic deadband control, and thermal shutdown.

These devices are available in a two-watt plastic "bat-wing" DIP for operation over a 0° to +70°C temperature range and, with reduced power, in a hermetically sealed cerdip for −55°C to +125°C operation.

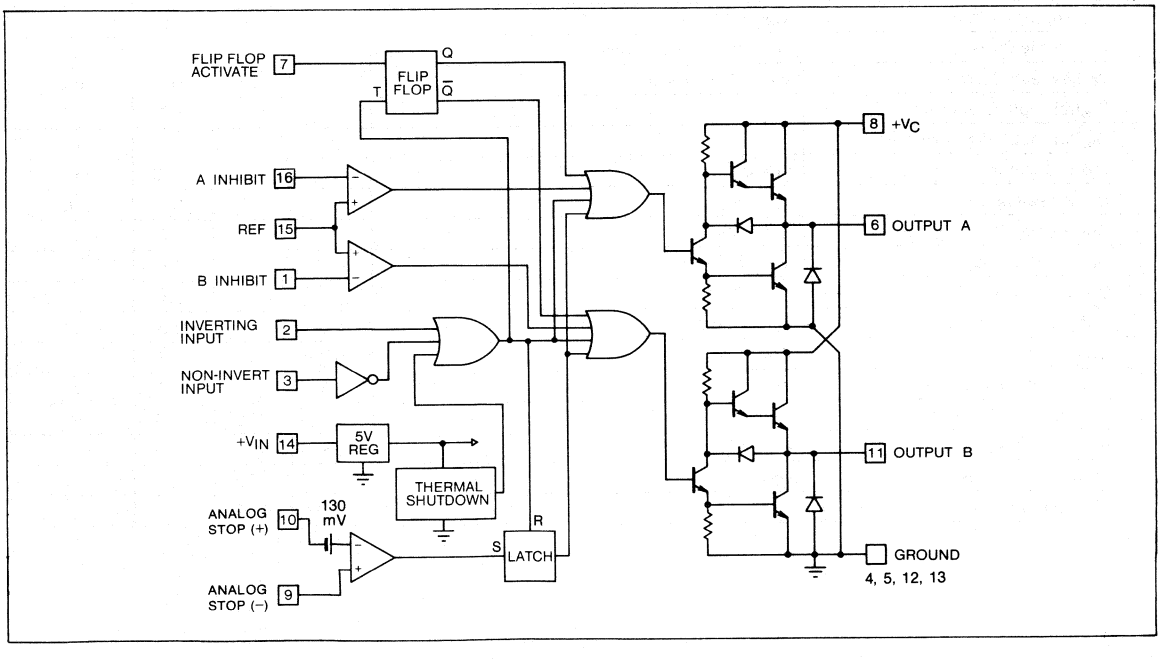
TRUTH TABLE

INV.	N.I.	OUT
H	H	L
L	H	H
H	L	L
L	L	L

OUT = $\overline{\text{INV}}$ and N.I.

$\overline{\text{OUT}}$ = INV or $\overline{\text{N.I.}}$

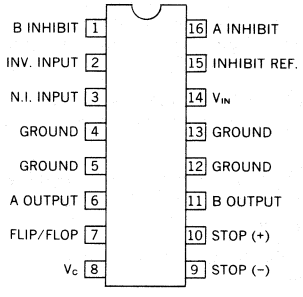
BLOCK DIAGRAM



UNITRODE

CONNECTION DIAGRAM

DIL-16 (TOP VIEW)
J or N PACKAGE



Note: All four ground pins must be connected to a common ground.

ABSOLUTE MAXIMUM RATINGS

	N-Pkg	J-Pkg
Supply Voltage, V_{IN}	40V	40V
Collector Supply Voltage, V_C	40V	40V
Output Current (Each Output, Source or Sink)		
Steady-State	±500mA	±500mA
Peak Transient	±1.5A	±1.0A
Capacitive Discharge Energy	20μJ	15μJ
Digital Inputs	5.5V	5.5V
Inhibit Inputs	5.5V	5.5V
Stop Inputs	V_{IN}	V_{IN}
Power Dissipation at T_A = 25°C	2W	1W
Derate above 50°C	20mW/°C	10mW/°C
Power Dissipation at T (Leads/Case) = 25°C	5W	2W
Derate for Ground Lead Temperature above 25°C	40mW/°C	—
Derate for Case Temperature above 25°C	—	16mW/°C
Operating Temperature Range	−55°C to +125°C	
Storage Temperature Range	−65°C to +150°C	
Load Temperature (Soldering, 10 Seconds)	300°C	

Note: All voltages are with respect to the four ground pins which must be connected together. All currents are positive into, negative out of the specified terminal.

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55° to +125°C for the UC1706 and 0°C to +70°C for the UC3706; V_{IN} = V_C = 20V.)

PARAMETER	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
V_{IN} Supply Current	V_{IN} = 40V		8	10	mA
V_C Supply Current	V_C = 40V, Outputs Low		4	5	mA
V_C Leakage Current	V_{IN} = 0, V_C = 40V		.05	0.1	mA
Digital Input Low Level				0.8	V
Digital Input High Level		2.2			V
Input Current	V_I = 0		−0.6	−1.0	mA
Input Leakage	V_I = 5V		.05	0.1	mA
Output High Sat., V_C−V_O	I_o = −50mA			2.0	V
Output High Sat., V_C−V_O	I_o = −500mA			2.5	V
Output Low Sat., V_O	I_o = 50mA			0.4	V
Output Low Sat., V_O	I_o = 500mA			2.5	V
Inhibit Threshold	V_{REF} = 0.5V	0.4		0.6	V
Inhibit Threshold	V_{REF} = 3.5V	3.3		3.7	V
Inhibit Input Current	V_{REF} = 0		−10	−20	μA
Analog Threshold	V_{CM} = 0 to 15V	100	130	150	mV
Input Bias Current	V_{CM} = 0		−10	−20	μA
Thermal Shutdown			155		°C

TYPICAL SWITCHING CHARACTERISTICS (V_{IN} = V_C = 20V, T_A = 25°C. Delays measured 50% in to 50% out.)

PARAMETER	TEST CONDITIONS	OUTPUT C_L=			UNITS
From Inv. Input to Output:		open	1.0	2.2	nF
Rise Time Delay		110	130	140	ns
10% to 90% Rise		20	40	60	ns
Fall Time Delay		80	90	110	ns
90% to 10% Fall		25	30	50	ns
From N.I. Input to Output:					
Rise Time Delay		120	130	140	ns
10% to 90% Rise		20	40	60	ns
Fall Time Delay		100	120	130	ns
90% to 10% Fall		25	30	50	ns
V_C Cross-Conduction Current Spike Duration	Output Rise	25			ns
	Output Fall	0			ns
Inhibit Delay	Inhibit Ref. = 1V Inhibit = 0.5 to 1.5V	250			ns
Analog Shutdown Delay	Stop (+) Ref. = 0 Stop (−) Input = 0 to 0.5V	180			ns

CIRCUIT DESCRIPTION

Outputs

The totem-pole outputs have been designed to minimize cross-conduction current spikes while maximizing fast, high-current rise and fall times. Current limiting can be done externally either at the outputs or at the common V_C pin. The output diodes included have slow recovery and should be shunted with high-speed external diodes when driving high-frequency inductive loads.

Flip/Flop

Grounding pin 7 activates the internal flip-flop to alternate the two outputs. With pin 7 open, the two outputs operate simultaneously and can be paralleled for higher current operation. Since the flip-flop is triggered by the digital input, an off-time of at least 200nsec must be provided to allow the flip/flop to change states. Note that the circuit logic is configured such that the "OFF" state is defined as the outputs low.

Digital Inputs

With both an inverting and non-inverting input available, either active-high or active-low signals may be accepted. These are true TTL compatible inputs — the threshold is approximately 1.2V with no hysteresis; and external pull-up resistors are not required.

Inhibit Circuit

Although it may have other uses, this circuit is included to eliminate the need for deadband control when driving relatively slow bipolar power transistors. A diode from each inhibit input to the opposite power switch collector will keep one output from turning-on until the other has turned-off. The threshold is determined by the voltage on pin 15 which can be set from 0.5 to 3.5V. When this circuit is not used, ground pin 15 and leave 1 and 16 open.

Analog Shutdown

This circuit is included to get a latched shutdown as close to the outputs as possible, from a time standpoint. With an internal 130mV threshold, this comparator has a common-mode range from ground to (V_{IN} − 3V). When not used, both inputs should be grounded. The time required for this circuit to latch is inversely proportional to the amount of overdrive but reaches a minimum of 180nsec. As with the flip-flop, an input off-time of at least 200nsec is required to reset the latch between pulses.

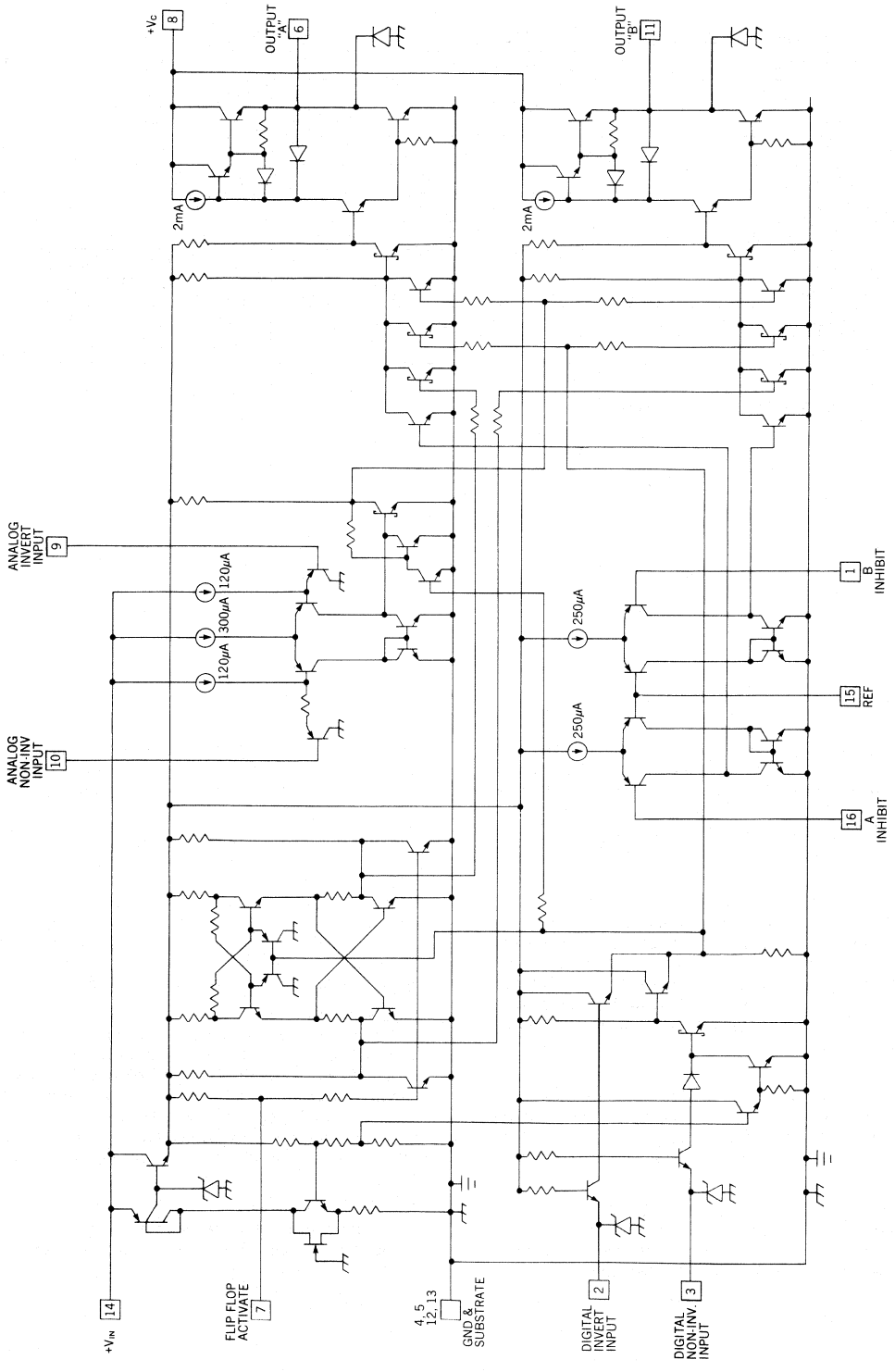
Supply Voltage

With an internal 5V regulator, this circuit is optimized for use with a 7 to 40V supply; however, with some slight response time degradation, it can also be driven from 5V.When V_{IN} is low, the entire circuit is disabled and no current is drawn from V_C. When combined with a UC1840 PWM, the Driver Bias switch can be used to supply V_{IN} to the UC1706. V_{IN} switching should be fast as if V_C is high, undefined operation of the outputs may occur with V_{IN} less than 5V.

Thermal Considerations

Should the chip temperature reach approximately 155°C, a parallel, non-inverting input is activated driving both outputs to the low state.

SIMPLIFIED SCHEMATIC DIAGRAM



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

LINEAR INTEGRATED CIRCUITS

Dual Channel Power Driver

UC1707
UC3707

2

FEATURES

- Two Independent Drivers
- 1.5A Totem Pole Outputs
- Inverting and Non-Inverting Inputs
- 40ns Rise and Fall into 1000pF
- High-Speed, Power MOSFET Compatible
- Low Cross-Conduction Current Spike
- Analog Shutdown with Optional Latch
- Low Quiescent Current
- 5V to 40V Operation
- Thermal Shutdown Protection
- 16-Pin Dual-In-Line Package

DESCRIPTION

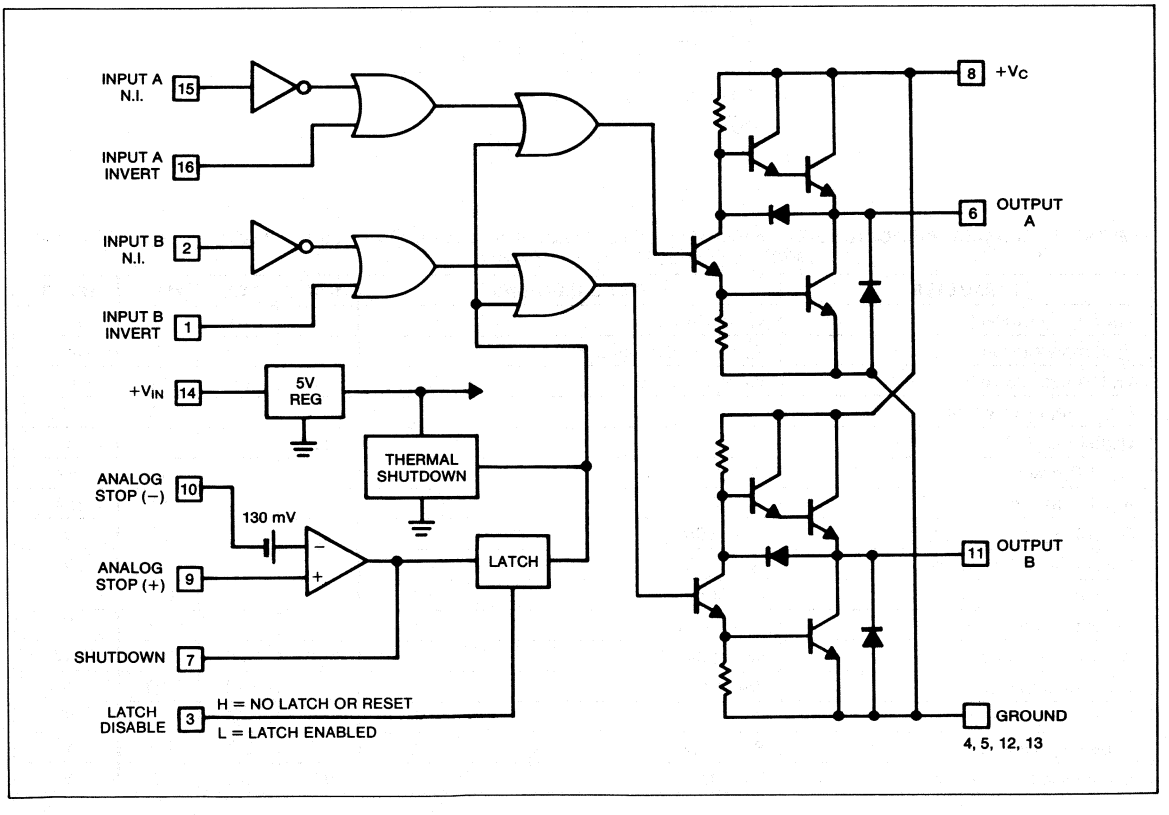
The UC1707 family of power drivers is made with a high-speed Schottky process to interface between low-level control functions and high-power switching devices — particularly power MOSFETs. These devices contain two independent channels, each of which can be activated by either a high or low input logic level signal. Each output can source or sink up to 1.5A as long as power dissipation limits are not exceeded.

Although each output can be activated independently with its own inputs, it can be forced low in common through the action either of a digital high signal at the Shutdown terminal or a differential low-level analog signal. The Shutdown command from either source can either be latching or not, depending on the status of the Latch Disable pin.

Supply voltage for both V_{IN} and V_C can independently range from 4.5V to 40V. V_{IN} can also be used to gate the outputs as when V_{IN} is less than 4V, both outputs are held in the high impedance state and no current is drawn from V_C.

These devices are available in a two-watt plastic "bat-wing" DIP for operation over a 0°C to +70°C temperature range and, with reduced power, in a hermetically sealed cerdip for −55°C to +125°C operation.

BLOCK DIAGRAM



UNITRODE

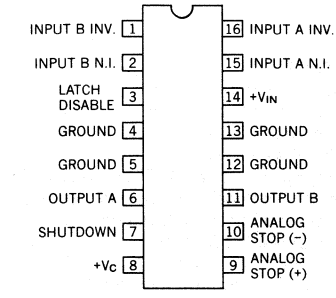
ABSOLUTE MAXIMUM RATINGS

	N-Pkg	J-Pkg
Supply Voltage, V_{IN}	40V	40V
Collector Supply Voltage, V_C	40V	40V
Output Current (Each Output, Source or Sink)		
Steady-State	±500mA	±500mA
Peak Transient	±1.5A	±1.0A
Capacitive Discharge Energy	20μJ	15μJ
Digital Inputs (see note)	5.5V	5.5V
Analog Stop Inputs	V_{IN}	V_{IN}
Power Dissipation at T_A = 25°C	2W	1W
Derate above 50°C	20mW/°C	10mW/°C
Power Dissipation at T (Leads/Case) = 25°C	5W	2W
Derate for Ground Lead Temperature above 25°C	40mW/°C	—
Derate for Case Temperature above 25°C	—	16mW/°C
Operating Temperature Range	-55°C to +125°C	
Storage Temperature Range	-65°C to +150°C	
Load Temperature (Soldering, 10 seconds)	300°C	

NOTE: All voltages are with respect to the four ground pins which must be conected together.
All currents are positive into, negative out of the specified terminal.
Digital Drive can exceed 5.5V if input current is limited to 10mA.

CONNECTION DIAGRAM

DIL-16 (TOP VIEW)
J OR N PACKAGE



NOTE: All four ground pins must be connected to a common ground.

TRUTH TABLE (Each Channel)

INV.	N.I.	OUT
H	H	L
L	H	H
H	L	L
L	L	L

OUT = $\overline{INV.}$ and N.I.

$\overline{OUT}$ = INV. or $\overline{N.I.}$

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for the UC1707 and 0°C to +70°C for the UC3707; V_{IN} = V_C = 20V.)

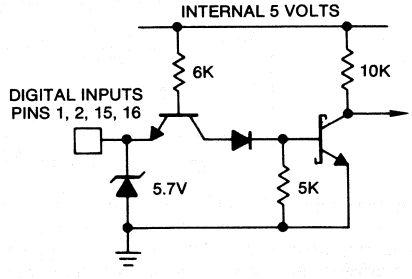
PARAMETER	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
V_{IN} Supply Current	V_{IN} = 40V		10	12	mA
V_C Supply Current	V_C = 40V, Outputs Low		4	5	mA
V_C Leakage Current	V_{IN} = 0, V_C = 40V		.05	0.1	mA
Digital Input Low Level				0.8	V
Digital Input High Level		2.2			V
Input Current	V_I = 0		-0.6	-1.0	mA
Input Leakage	V_I = 5V		.05	0.1	mA
Output High Sat., V_C-V_O	I_o = -50mA			2.0	V
Output High Sat., V_C-V_O	I_o = -500mA			2.5	V
Output Low Sat., V_O	I_o = 50mA			0.4	V
Output Low Sat., V_O	I_o = 500mA			2.5	V
Analog Threshold	V_{CM} = 0V to 15V	100	130	150	mV
Input Bias Current	V_{CM} = 0		-10	-20	μA
Thermal Shutdown			155		°C
Shutdown Threshold	Pin 7 Input	0.4	1.0	2.2	V
Latch Disable Threshold	Pin 3 Input	0.8	1.2	2.2	V

TYPICAL SWITCHING CHARACTERISTICS (V_{IN} = V_C = 20V, T_A = 25°C. Delays measured to 10% output change.)

PARAMETER	TEST CONDITIONS	OUTPUT C_L =			UNITS
From Inv. Input to Output:		open	1.0	2.2	nF
Rise Time Delay		60	60	60	ns
10% to 90% Rise		20	40	60	ns
Fall Time Delay		60	60	60	ns
90% to 10% Fall		25	40	50	ns
From N.I. Input to Output:					
Rise Time Delay		90	90	90	ns
10% to 90% Rise		20	40	60	ns
Fall Time Delay		60	60	60	ns
90% to 10% Fall		25	40	50	ns
V_C Cross-Conduction Current Spike Duration	Output Rise	25			ns
	Output Fall	0			ns
Analog Shutdown Delay	Stop (+) Ref. = 0 Stop (−) Input = 0V to 0.5V	160			ns
Digital Shutdown Delay	2V Input on Pin 7	50			ns

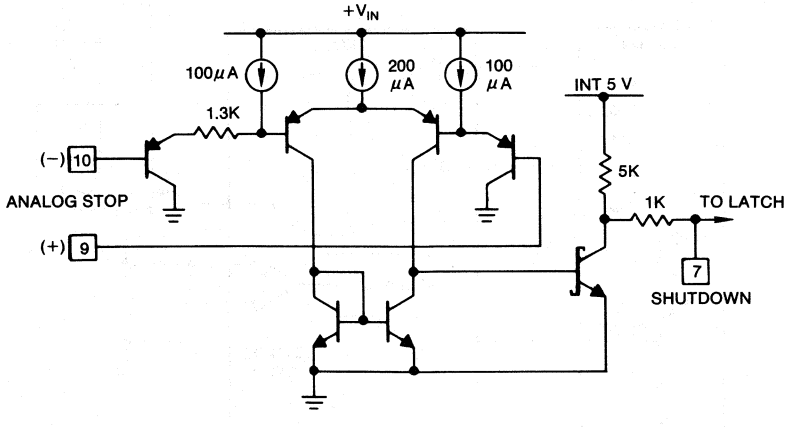
SIMPLIFIED INTERNAL CIRCUITRY

Typical Digital Input Gate



The input zener may be used to clamp input signal voltages higher than 5V as long as the zener current is limited to 10mA max. External pull-up resistors are not required.

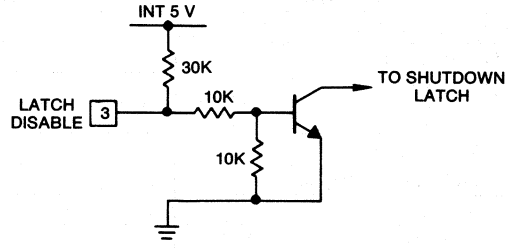
Analog Shutdown Comparator Circuit



The input common-mode voltage range is from ground to (V_{IN}−3V). When not used both inputs should be grounded. Activate time is a function of overdrive with a minimum value of 160ns. Pin 7 serves both as a comparator output and as a common digital shutdown input. A high signal here will accomplish the fastest turn off of both outputs. Note that "OFF" is defined as the outputs low.

SIMPLIFIED INTERNAL CIRCUITRY (continued)

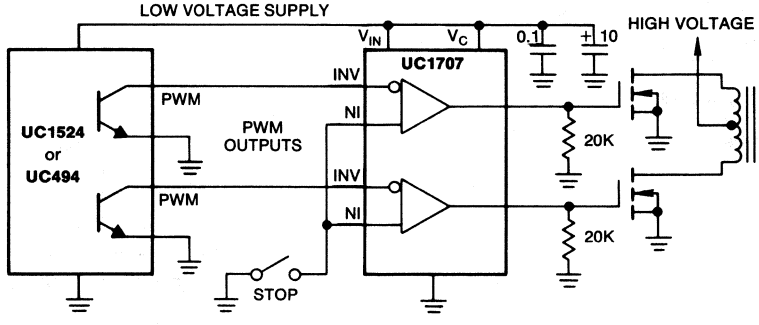
Latch Disable



The Shutdown latch is disabled when pin 3 is open. An impedance of 4KΩ or less from pin 3 to ground will allow a shutdown signal to set the latch which can then be reset by either recycling the V_{IN} supply or by momentarily (>200ns) raising pin 3 high.

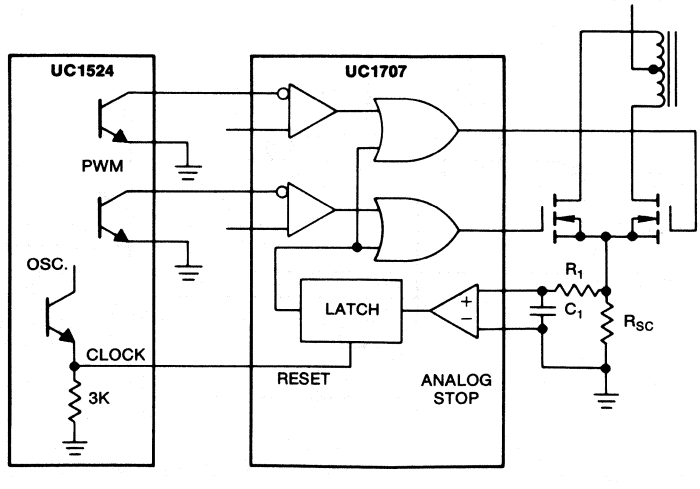
APPLICATIONS

Conventional Dual-Output Drive



Driving the inverting inputs from open-collector, dual-output PWM Controllers. If unneeded for programming functions, the non-inverting inputs can be left open. Note that the high peak current drive for MOS gates requires good supply decoupling at V_C. V_{IN} and V_C need not be at the same levels. The 20K resistors hold the FETs off during startup when the UC1707 output impedance is high.

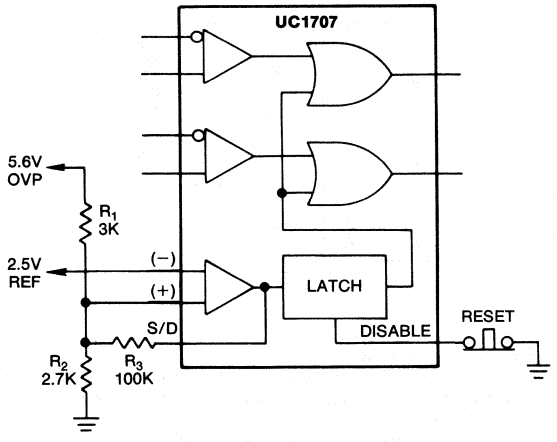
Current Limiting



The Analog shutdown can give pulse-by-pulse current limiting with a reset pulse from the clock output of the UC1524. R_1C_1 is used to filter leading edge spikes.

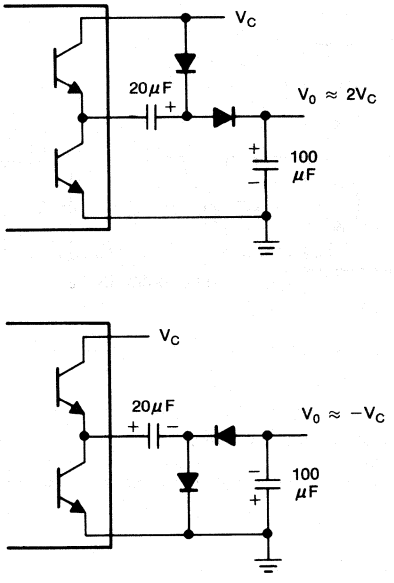
APPLICATIONS (continued)

Over-Voltage Protection



With an external reference, the shutdown comparator can be used for over-voltage protection. R_1 and R_2 set the shutdown level while R_3 adds positive feedback for hysteresis.

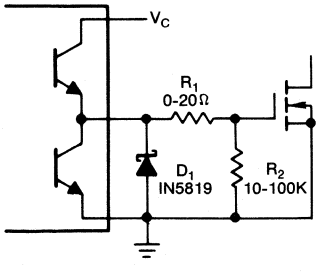
Voltage Multipliers



When driven with a TTL square wave drive, the low output impedance of the UC1707 allows ready implementation of charge pump voltage converters.

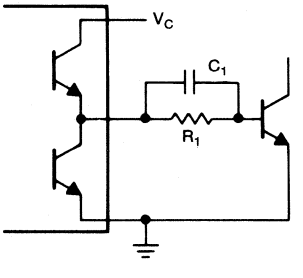
OUTPUT STAGE COUPLING

Power MOSFET



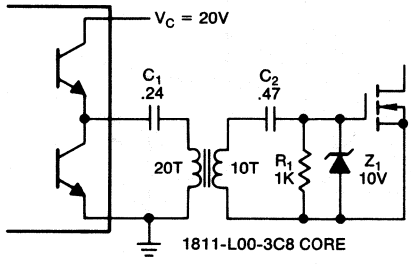
Simple direct drive to gate requires close coupling:
- R_1 adds damping at the expense of gate rise time.
- R_2 insures against turn on with leakage currents.
- D_1 is necessary if ringing would drive output pin negative.

Bipolar Power Transistor

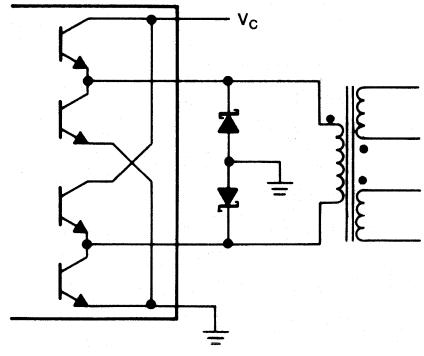


Fast turn-off bipolar switch drive:
- Charge on C_1 will drive base negative at turn-off.
- For large V_C, clamping to prevent E-B breakdown may be necessary.
- V_{OL} at low current will keep bipolar switch off.

TRANSFORMER COUPLING



Single-ended transformer drive:
C_1 blocks DC.
Z_1 clamps gate voltage, both positive and negative.



Balanced Transformer Drive:
With no net DC in primary, capacitors are unnecessary.
Clamp diodes necessary if leakage inductance drives outputs negative.
May require secondary snubbing circuitry.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

LINEAR INTEGRATED CIRCUITS

Stepper Motor Drive Circuit

UC1717
UC3717

2

FEATURES

- Half-step and full-step capability
- Bipolar constant current motor drive
- Built-in fast recovery Schottky commutating diodes
- Wide range of current control 5-1000mA
- Wide voltage range 10-45V
- Designed for unregulated motor supply voltage
- Current levels can be selected in steps or varied continuously
- Thermal overload protection

DESCRIPTION

The UC3717 has been designed to control and drive the current in one winding of a bipolar stepper motor. The circuit consists of an LS-TTL-compatible logic input, a current sensor, a monostable and an output stage with built-in protection diodes. Two UC3717s and a few external components form a complete control and drive unit for LS-TTL or micro-processor controlled stepper motor systems.

The UC1717 is characterized for operation over the full military temperature range of −55°C to +125°C, while the UC3717 is characterized for 0°C to +70°C.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Voltage
- Logic Supply, V_{CC} 7V
- Output Supply, V_m 45V

Input Voltage
- Logic Inputs (Pins 7, 8, 9) 6V
- Analog Input (Pin 10) ..... V_{CC}
- Reference Input (Pin 11) 15V

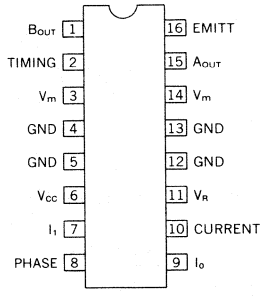
Input Current
- Logic Inputs (Pins 7, 8, 9) ..... −10mA
- Analog Inputs (Pins 10, 11) ..... −10mA

Output Current (Pins 1,15) ..... ±1A
Junction Temperature, T_j ..... +150°C
Thermal Resistance, Junction to Ambient (NE Package) ..... 45°C/W
Thermal Resistance, Junction to Case (NE Package) ..... 11°C/W
Thermal Resistance, Junction to Ambient (J Package) ..... 100°C/W
Thermal Resistance, Junction to Case (J Package) ..... 60°C/W
Storage Temperature Range, T_S ..... −55°C to +150°C

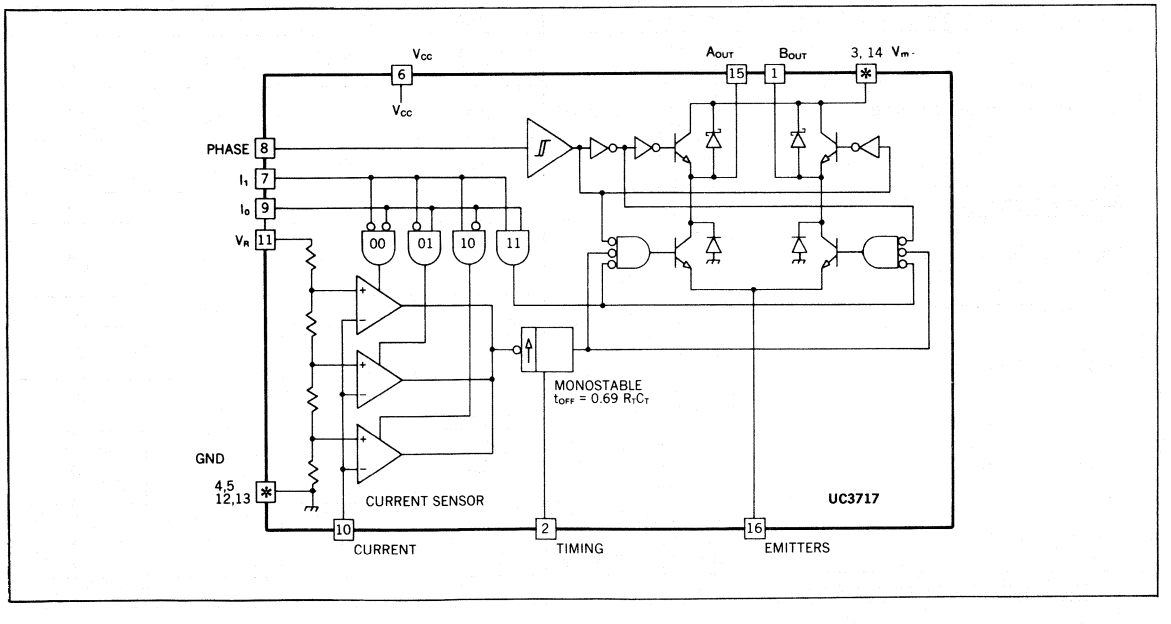
Note: 1. All voltages are with respect to ground, Pins 4, 5, 12, 13. Currents are positive into, negative out of the specified terminal.

CONNECTION DIAGRAM

DIL-16 (TOP VIEW)
J or NE PACKAGE



BLOCK DIAGRAM



UNITRODE

RECOMMENDED OPERATING CONDITIONS

PARAMETER	MIN.	TYP.	MAX.	UNITS
Supply Voltage, V_{CC}	4.75	5	5.25	V
Supply Voltage, V_m	10		40	V
Output Current, I_m	20		800	mA
Rise Time Logic Inputs, t_r			2	μs
Fall Time Logic Inputs, t_f			2	μs
Ambient Temperature, t_a				
UC1717	−55		125	°C
UC3717	0		70	°C

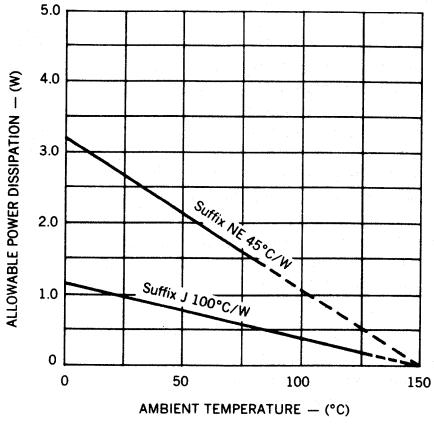


Figure 1.

ELECTRICAL CHARACTERISTICS (Over recommended operating conditions unless otherwise stated)

PARAMETER	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Supply Current, I_{CC}				25	mA
High-Level Input Voltage, Pins 7, 8, 9		2.0			V
Low-Level Input Voltage, Pins 7, 8, 9				0.8	V
High-Level Input Current, Pins 7, 8, 9	V_I = 2.4V			20	μA
Low-Level Input Current, Pins 7, 8, 9	V_I = 0.4V	−0.4			mA
Comparator Threshold Voltage	I_0 = 0, I_1 = 0, V_R = 5.0V	390	420	440	mV
	I_0 = 1, I_1 = 0, V_R = 5.0V	230	250	270	mV
	I_0 = 0, I_1 = 1, V_R = 5.0V	65	80	90	mV
Comparator Input Current		−20		20	μA
Output Leakage Current	I_0 = 1, I_1 = 1, T_A = + 25°C			100	μA
Total Saturation Voltage Drop	I_m = 500mA			4.0	V
Total Power Dissipation	I_m = 500mA, f_s = 30kHz		1.4	2.1	W
	I_m = 800mA, f_s = 30kHz		2.9	3.1	W
Cut Off Time, t_{OFF}	See Figure 5 and 6, V_m = 10V, $t_{ON} \geqq 5\mu$s	25	30	35	μs
Turn Off Delay, t_d	See Figure 5 and 6, T_A = +25°C; $dV_C/dt \geqq 50mV/\mu s$		1.6	2.0	μs
Thermal Shutdown Junction Temperature		+160		+180	°C

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

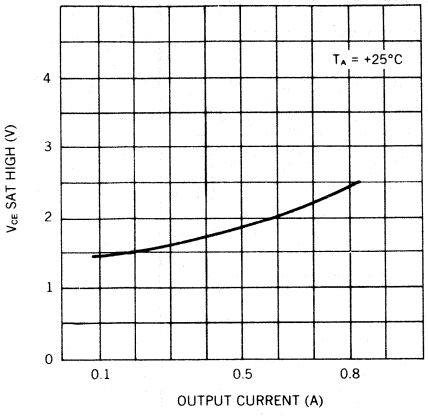


Figure 2. Typical Source Saturation Voltage vs Output Current

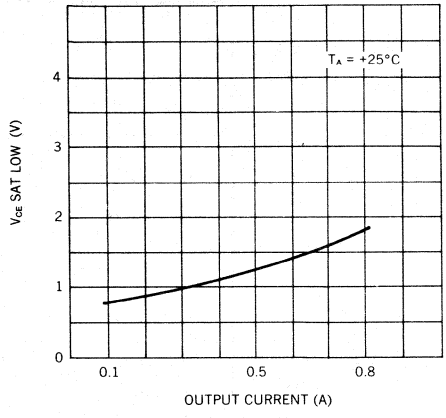


Figure 3. Typical Sink Saturation Voltage vs Output Current

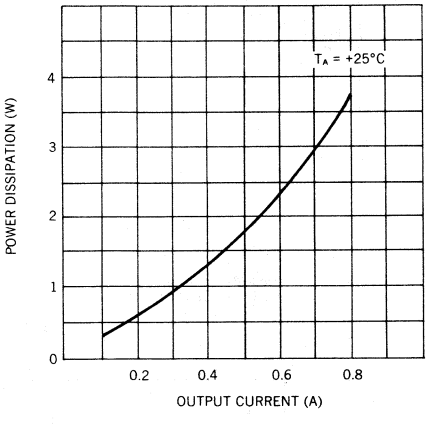


Figure 4. Typical Power Losses vs Output Current

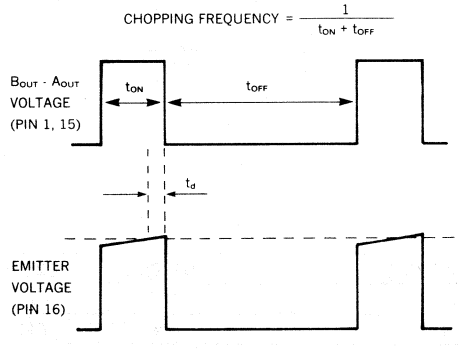


Figure 5. Connections and Component Values as in Figure 6

FUNCTIONAL DESCRIPTION

The UC3717 drive circuit shown in the block diagram includes the following functions.

(1) Phase Logic and H-Bridge Output Stage
(2) Voltage Divider with three Comparators for current control
(3) Two Logic inputs for Digital current level select
(4) Monostable for off time generation

Input Logic
If any of the logic inputs are left open, the circuit will treat it as a high level input.

Phase Input
The phase input terminal, pin 18, controls the direction of the current through the motor winding. The Schmidt-Trigger input coupled with a fixed time delay assures noise immunity and eliminates cross conduction in the output stage during phase changes. A low level on the phase input will turn Q2 on and enable Q3 while a high level will turn Q1 on and enable Q4. (See Figure 7).

Output Stage
The output stage consists of four Darlington transistors and associated diodes connected in an H-Bridge configuration. The diodes are needed to provide a current path when the transistors are being switched. For fast recovery, Schottky diodes are used across the source transistors. The Schottky diodes allow the current to circulate through the winding while the sink transistors are being switched off. The diodes across the sink transistors in conjunction with the Schottkys provide the path for the decaying current during phase reversal. (See Figure 7).

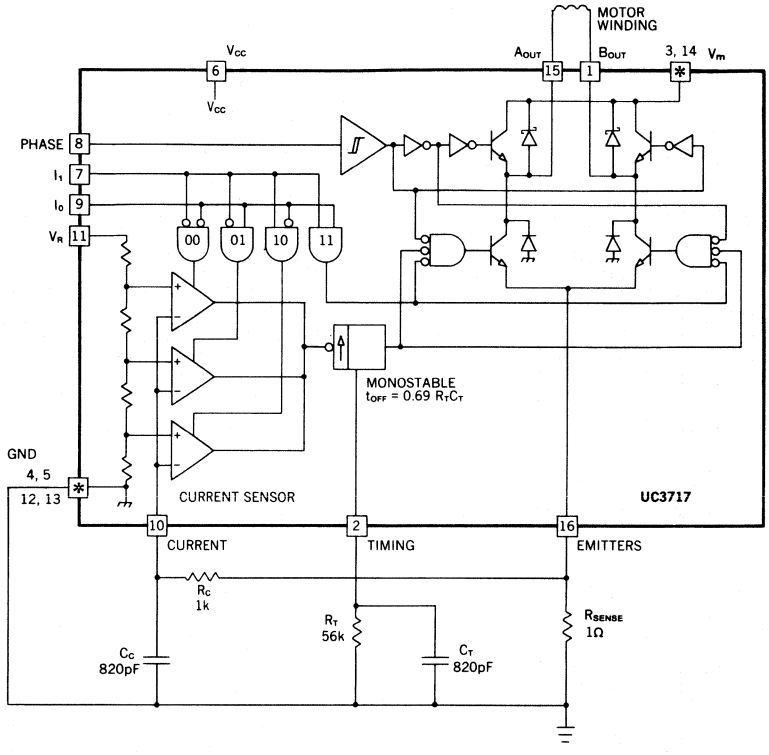


Figure 6.

PHASE INPUT	Q1, Q4	Q2, Q3
LOW	OFF	ON
HIGH	ON	OFF

TABLE 1

I_0	I_1	CURRENT LEVEL
0	0	100%
1	0	60%
0	1	19%
1	1	CURRENT INHIBIT

Current Control

The voltage divider, comparators and monostable provide a means for current sensing and control. The two bit input (I_0, I_1) logic selects the desired comparator. The monostable controls the off time and therefore the magnitude of the current decrease. The time duration is determined by R_T and C_T connected to the timing terminal (pin 2). The reference terminal (pin 11) provides a means of continuously varying the current for situations requiring half-stepping and micro-stepping. The relationship between the logic input signals at pin 7 and 9 in reference to the current level is shown in Table 1. The values of the different current levels are determined by the reference voltage together with the value of the external sense resistor R_s (pin 16).

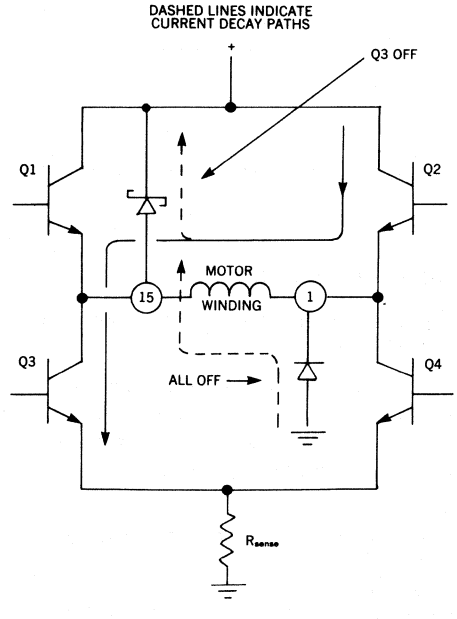


Figure 7. Simplified Schematic of Output Stage

Single-Pulse Generator

The pulse generator is a monostable triggered on the positive going edge of the comparator. Its output is high during the pulse time and this pulse switches off the power feed to the motor winding causing the current to decay. The time is determined by the external timing components R_T and C_T as:

$$t_{OFF} = 0.69\ R_T C_T$$

If a new trigger signal should occur during t_{OFF}, it is ignored.

Overload Protection

The circuit is equipped with a thermal shutdown function, which will limit the junction temperature by reducing the output current. It should be noted however, that a short circuit of the output is not permitted.

Operation

When the voltage is applied across the motor winding the current rises linearly and appears across the external sense resistor as an analog voltage. This voltage is fed through a low-pass filter R_C, C_C to the the voltage comparator (pin 10). At the moment the voltage rises beyond the comparator threshold voltage the monostable is triggered and its output turns off the sink transistors. The current then circulates through the source transistor and the appropriate Schottky diode. After the one shot has timed out, the sink transistor is turned on again and the procedure repeated until a current reverse command is given. By reversing the logic level of the phase input (pin 8), both active transistors are being turned off and the opposite pair turned on. When this happens the current must first decay to zero before it can reverse. The current path then provided is through the two diodes and the power-supply. Refer to Figure 7. It should be noticed at this time that the slope of the current decay is steeper, and this is due to the higher voltage build up across the winding. For better speed performance of the stepping motor at half step mode, the phase logic level should be changed the same time the current inhibit is applied. A typical current wave form is shown in Figure 8.

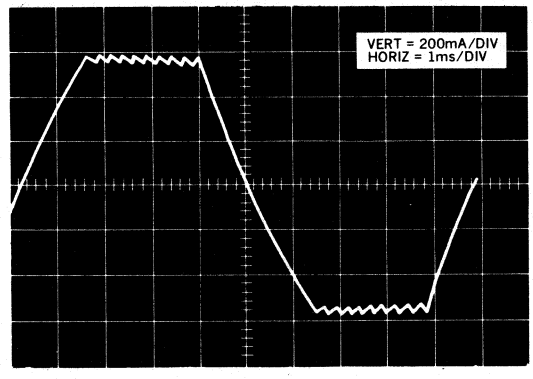


Figure 8.

APPLICATIONS

A typical chopper drive for a two phase bipolar permanent magnet or hybrid stepping motor is shown in Figure 9. The input can be controlled by a microprocessor, TTL, LS or CMOS logic.

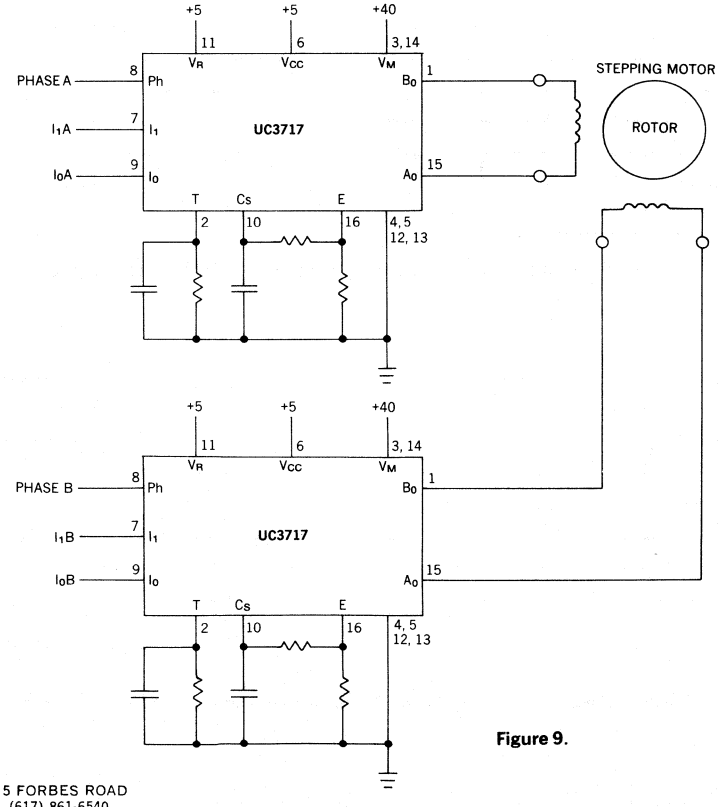


Figure 9.

The timing diagram in Figure 10 shows the required signal input for a two phase, full step, stepping sequence. Figure 11 shows a one phase, full step, stepping sequence, commonly referred to as wave drive. Figure 12 shows the required input signal for a one phase-two phase stepping sequence called half-stepping.

The circuit of Figure 13 provides the signal shown in Figure 10, and in conjunction with the circuit shown in Figure 9, will implement a pulse-to-step two phase, full step, bidirectional motor drive.

The schematic of Figure 14 shows a pulse to half step circuit generating the signal shown in Figure 12. Care has been taken to change the phase signal the same time the current inhibit is applied. This will allow the current to decay faster and therefore enhance the motor performance at higher step rates.

The UC3717 can also be used to drive an external high power output stage such as the Unitrode PIC900 hybrid circuit in an 18-Pin dual-in-line package. The 5A output of the PIC900 can be controlled with as little as 5mA base drive. Using the UC3717 to drive the PIC900 provides a uniquely packaged state-of-the-art high power stepper motor control and drive. See Figure 15.

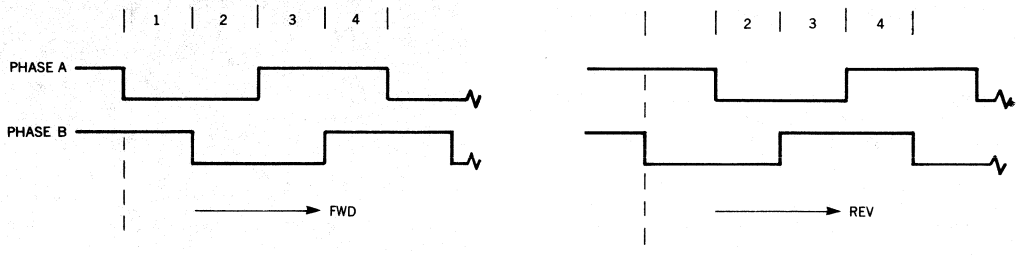


Figure 10. Phase Input Signal for Two Phase Full Step Drive (4 Step Sequence)

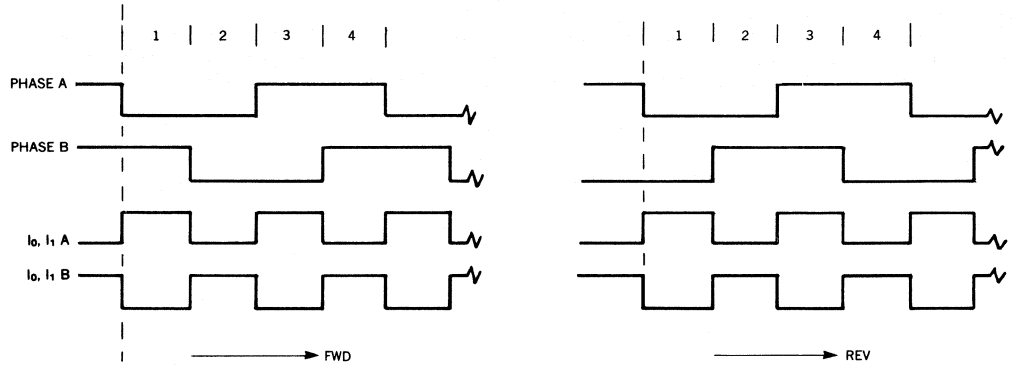


Figure 11. Phase and Current-Inhibit Signal for Wave Drive (4 Step Sequence)

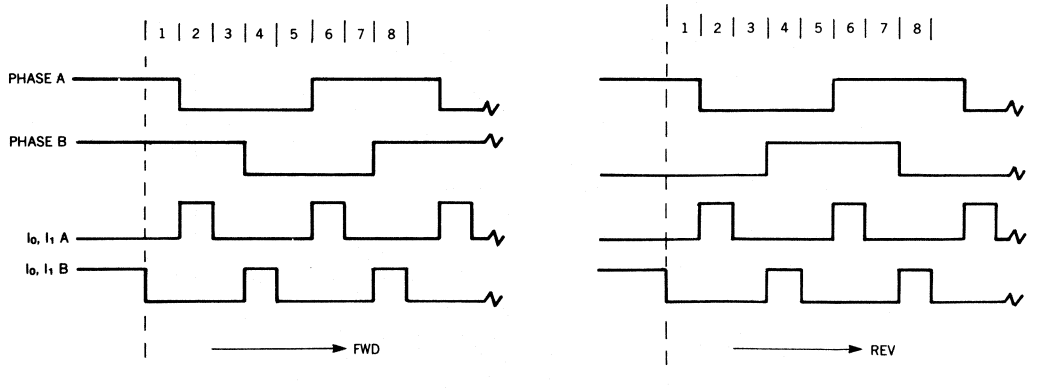


Figure 12. Phase and Current-Inhibit Signal for Half-Stepping (8 Step Sequence)

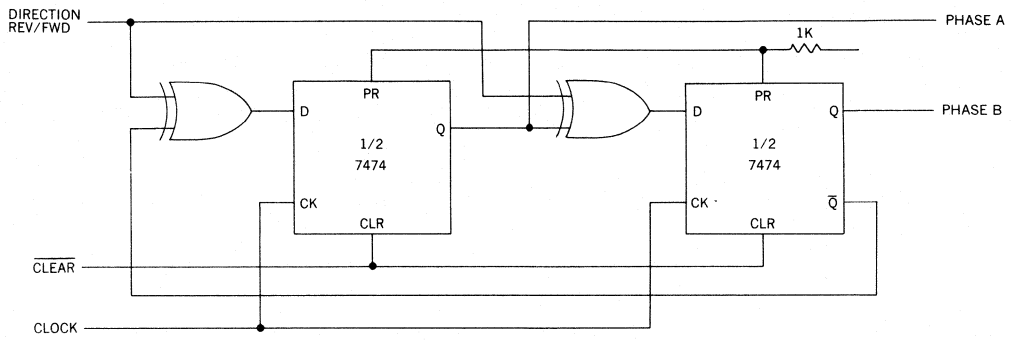


Figure 13. Full Step, Bidirectional Two Phase Drive Logic

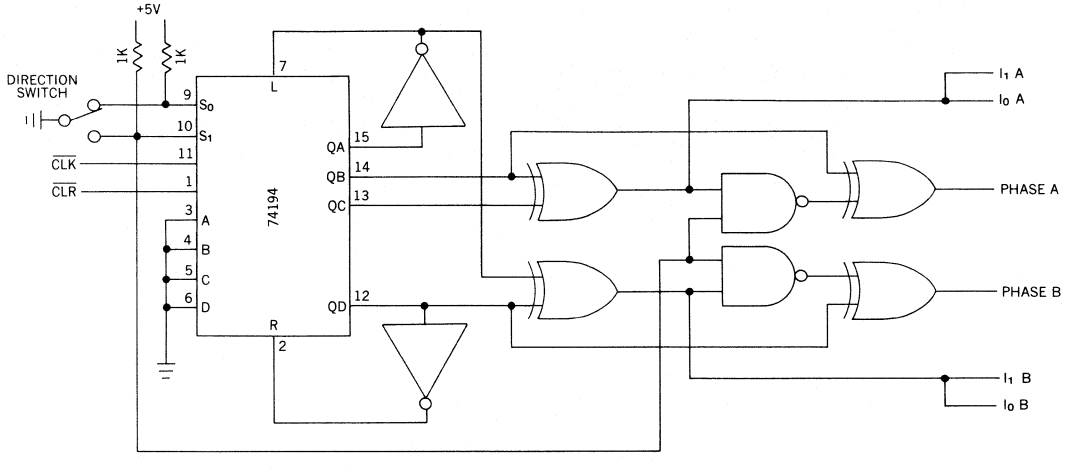


Figure 14. Half Step, Bidirectional Drive Logic

CONSIDERATION

Half-Stepping

In the half step sequence the power input to the motor alternates between one or two phases being energized. In a two phase motor the electrical phase shift between the windings is 90 degrees. The torque developed is the vector sum of the two windings energized. Therefore when only one winding is energized the torque of the motor is reduced by approximately 30%. This causes a torque ripple and if it is necessary to compensate for this, the V_R input can be used to boost the current of the single energized winding.

Ramping

Every drive system has inertia and must be considered in the drive scheme. The rotor and load inertia plays a big role at higher speeds. Unlike the DC motor the stepping motor is a synchronous motor and does not change its speed due to load variations. Examining typical stepping motors torque vs. speed curves indicates a sharp torque drop off for the start-stop without error curve, even with a constant current drive. The reason for this is that the torque requirements increase by the square of the speed change, and the power need increases by the cube of the speed change. As it can be seen, for good motor performance controlled acceleration and deceleration should be considered.

Iron Core Losses

Some motors, especially the Tin-Can type, exhibit high iron losses mostly due to eddy currents which rise in an exponental matter as the frequency or step rate is increased. The power losses can not be calculated by I^2R where I is the chopping current level and R the DC resistance of the coil. Actual measurements indicate the effective resistance may be many times larger. Therefore, for 100% duty cycle the current must be limited to a value which will not overheat the motor. This may not be necessary for lower duty cycle operation.

Interference

Electrical noise generated by the chopping action can cause interference problems, particularly in the vicinity of magnetic storage media. With this in mind, printed circuit layouts, wire runs and decoupling must be considered. 0.01 to 0.1μF ceramic capacitors for high frequency bypass located near the drive package across V+ and ground might be very helpful. The connection and ground leads of the current sensing components should be kept as short as possible.

Ordering Information

UNITRODE TYPE NUMBER
UC3717NE — 16 Pin Dual-in-line (DIL) "Bat Wing" Package
UC3717J — 16 Pin Dual-in-line Ceramic Package
UC1717J — 16 Pin Dual-in-line Ceramic Package

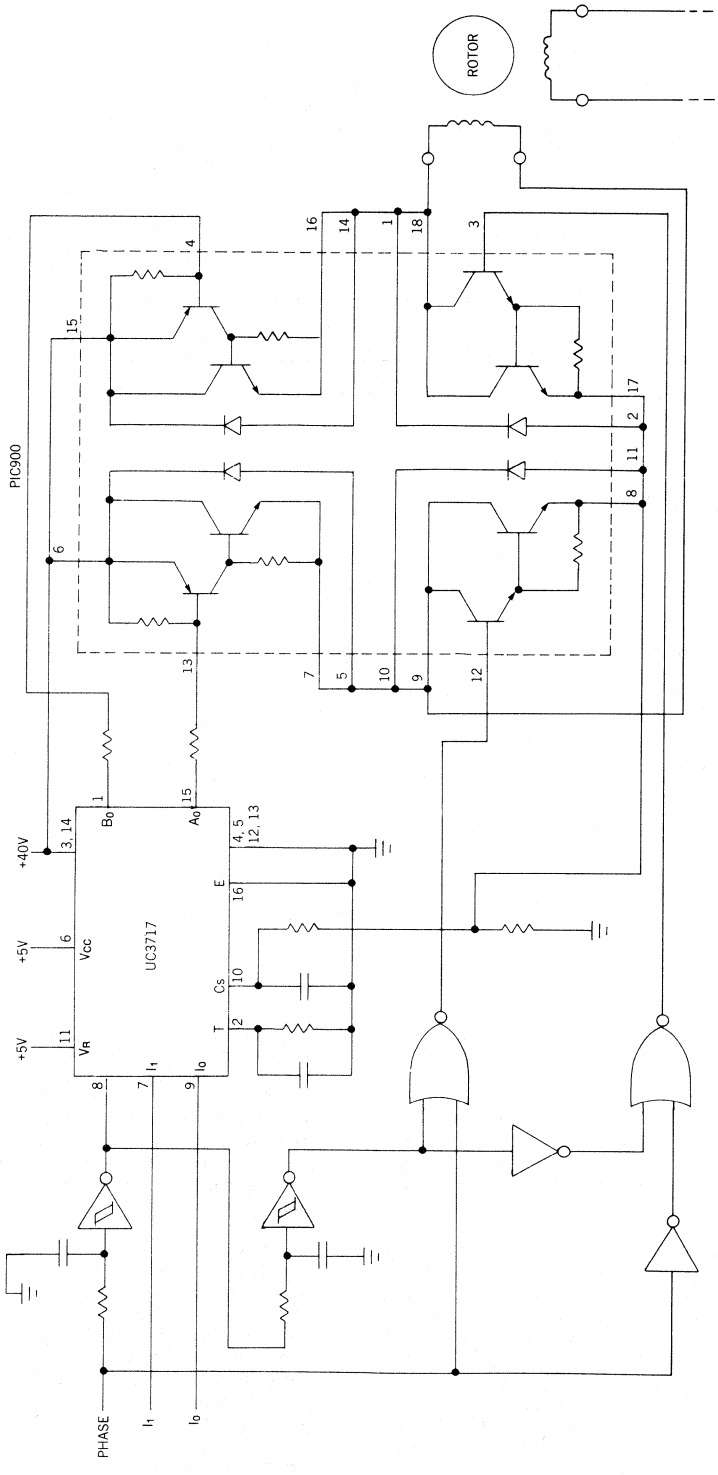


Figure 15. UC3717 with PIC900 Power Amplifier

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

LINEAR INTEGRATED CIRCUITS
High Speed PWM Controller

UC1825
UC2825
UC3825

2

PRELIMINARY

FEATURES

- Compatible with Voltage or Current-Mode Topologies
- Practical Operation @ Switching Frequencies to 1.0MHz
- 50ns Propagation Delay to Output
- High Current Dual Totem Pole Outputs (1.5A peak)
- Wide Bandwidth Error Amplifier
- Fully Latched Logic with Double Pulse Suppression
- Pulse-by-Pulse Current Limiting
- Soft Start/Max. Duty Cycle Control
- Under-Voltage Lockout with Hysteresis
- Low Start Up Current (1.1mA)
- Trimmed Bandgap Reference (5.1V +/- 1%)

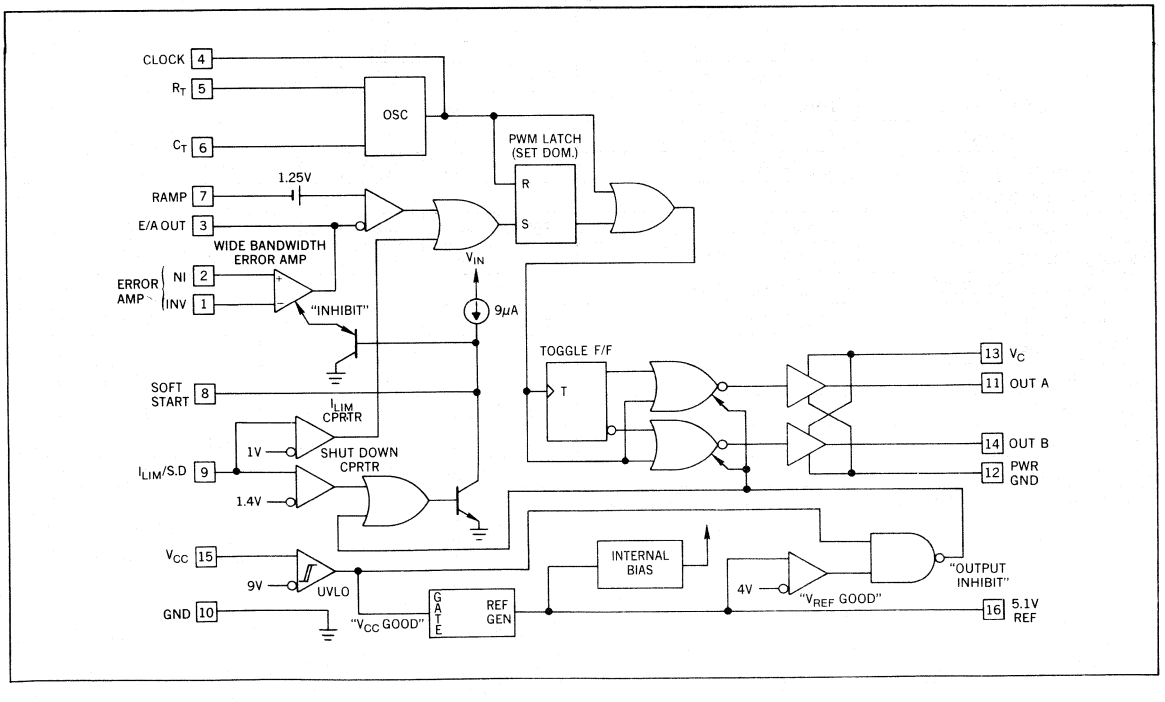
DESCRIPTION

The UC1825 family of PWM control ICs is optimized for high frequency switched mode power supply applications. Particular care was given to minimizing propagation delays through the comparators and logic circuitry while maximizing bandwidth and slew rate of the error amplifier. This controller is designed for use in either current-mode or voltage mode systems with the capability for input voltage feed-forward.

Protection circuitry includes a current limit comparator with a 1V threshold, a TTL compatible shutdown port, and a soft start pin which will double as a maximum duty cycle clamp. The logic is fully latched to provide jitter free operation and prohibit multiple pulses at an output. An under-voltage lockout section with 800mV of hysteresis assures low start up current. During under-voltage lockout, the outputs are high impedance.

These devices feature totem pole outputs designed to source and sink high peak currents from capacitive loads, such as the gate of a power MOSFET. The on state is defined as a high level.

BLOCK DIAGRAM



UNITRODE

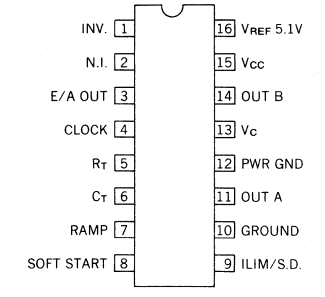
ABSOLUTE MAXIMUM RATINGS

Supply Voltage (Pins 15, 13) 30V
Output Current, Source or Sink (Pins 11, 14)
DC 0.5A
Pulse (0.5μs) 2.0A
Analog Inputs
(Pins 1, 2, 7) ..... -0.3V to 7V
(Pin 9, 8) ..... -0.3V to 6V
Clock Output Current (Pin 4) ..... -5mA
Error Amplifier Output Current (Pin 3) 5mA
Soft Start Sink Current (Pin 8) 20mA
Oscillator Charging Current (Pin 5) ..... -5ma
Power Dissipation at T_A = 60°C 1W
Derate 11mW/°C for $T_A > 60°C$
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (Soldering, 10 seconds) ..... 300°C

NOTE: All voltages are with respect to ground, Pin 10.
Currents are positive into the specified terminal.

CONNECTION DIAGRAM

DIL-16 (TOP VIEW)
J or N PACKAGE



ELECTRICAL CHARACTERISTICS (Unless otherwise noted, these specifications apply for R_T = 3.65K, C_T = 1nF, V_{cc} = 15V, $0 < T_A < 70°C$ for the UC3825, $-25°C < T_A < 85°C$ for the UC2825, and $-55°C < T_A < 125°C$ for the UC1825.)

PARAMETERS	TEST CONDITIONS	UC1825 UC2825			UC3825			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Reference Section								
Output Voltage	T_j = 25°C, I_O = 1mA	5.05	5.10	5.15	5.00	5.10	5.20	V
Line Regulation	$10 < V_{CC} < 30V$		2	20		2	20	mV
Load Regulation	$1 < I_O < 10mA$		5	20		5	20	mV
Temperature Stability*	$T_{MIN} < T_A < T_{MAX}$		0.2	0.4		0.2	0.4	mV/°C
Total Output Variation*	Line, Load, Temp.	5.00		5.20	4.95		5.25	V
Output Noise Voltage	10Hz < f < 10KHz		50			50		μV
Long Term Stability*	T_j = 125°C, 1000 hrs.		5	25		5	25	mV
Short Circuit Current	V_{REF} = 0V	-15	-50	-100	-15	-50	-100	mA
Oscillator Section								
Initial Accuracy	T_j = 25°C	360	400	440	360	400	440	KHz
Voltage Stability	$10 < V_{CC} < 30V$		0.2	2		0.2	2	%
Temperature Stability*	$T_{MIN} < T_A < T_{MAX}$		5			5		%
Total Variation*	Line, Temp.	340		460	340		460	KHz
Clock Out High		3.9	4.5		3.9	4.5		V
Clock Out Low			2.3	2.9		2.3	2.9	V
Ramp Peak*		2.6	2.8	3.0	2.6	2.8	3.0	V
Ramp Valley*		0.7	1.0	1.1	0.7	1.0	1.1	V
Ramp Valley to Peak*		1.6	1.8	2.0	1.6	1.8	2.0	V

* This parameter not 100% tested in production but guaranteed by design.

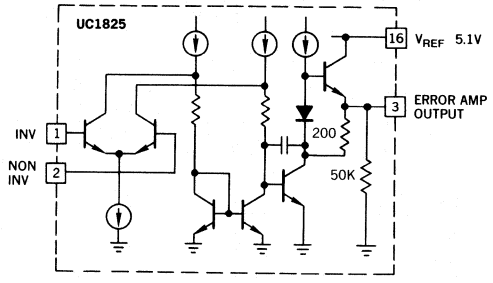
ELECTRICAL CHARACTERISTICS (Unless otherwise noted, these specifications apply for R_T = 3.65K, C_T = 1nF, V_{cc} = 15V, $0 < T_A < 70°C$ for the UC3825, $-25°C < T_A < 85°C$ for the UC2825, and $-55°C < T_A < 125°C$ for the UC1825.)

PARAMETERS	TEST CONDITIONS	UC1825 UC2825			UC3825			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Error Amplifier Section								
Input Offset Voltage				10			15	mV
Input Bias Current			0.6	3		0.6	3	μA
Input Offset Current			0.1	1		0.1	1	μA
Open Loop Gain	$1 < V_O < 4V$	60	95		60	95		dB
CMRR	$1.5 < V_{CM} < 5.5V$	75	95		75	95		dB
PSRR	$10 < V_{CC} < 30V$	85	110		85	110		dB
Output Sink Current	$V_{PIN\ 3}$ = 1V	1	2.5		1	2.5		mA
Output Source Current	$V_{PIN\ 3}$ = 4V	-0.5	-1.3		-0.5	-1.3		mA
Output High Voltage	$I_{PIN\ 3}$ = -0.5mA	4.0	4.7	5.0	4.0	4.7	5.0	V
Output Low Voltage	$I_{PIN\ 3}$ = 1mA	0	0.5	1.0	0	0.5	1.0	V
Unity Gain Bandwidth*		3	5.5		3	5.5		MHz
Slew Rate*		6	12		6	12		V/μs
PWM Comparator Section								
Pin 7 Bias Current	$V_{PIN\ 7}$ = 0V		-1	-5		-1	-5	μA
Duty Cycle Range		0		85	0		85	%
Pin 3 Zero D.C. Threshold	$V_{PIN\ 7}$ = 0V	1.1	1.25		1.1	1.25		V
Delay to Output*			50	80		50	80	ns
Soft-Start/Duty Cycle Clamp Section								
Charge Current	$V_{PIN\ 8}$ = 0.5V	3	9	20	3	9	20	μA
Discharge Current	$V_{PIN\ 8}$ = 1V	1			1			mA
Duty Cycle Clamp Accuracy	$V_{PIN\ 8}$ = 3.15V, Pin 6 to Pin 7	40	50	60	40	50	60	%
Current Limit/Shutdown Section								
Pin 9 Bias Current	$0 < V_{PIN\ 9} < 4V$			±10			±10	μA
Current Limit Threshold		0.9	1.0	1.1	0.9	1.0	1.1	V
Shutdown Threshold		1.25	1.40	1.55	1.25	1.40	1.55	V
Delay to Output*			50	80		50	80	ns
Output Section								
Output Low Level	I_{OUT} = 20mA		0.25	0.40		0.25	0.40	V
	I_{OUT} = 200mA		1.2	2.2		1.2	2.2	
Output High Level	I_{OUT} = -20mA	13.0	13.5		13.0	13.5		V
	I_{OUT} = -200mA	12.0	13.0		12.0	13.0		
Collector Leakage	V_C = 30V		100	200		100	200	μA
Rise/Fall Time*	CL = 1nF		30	60		30	60	ns
Under-Voltage Lockout Section								
Start Threshold		8.8	9.2	9.6	8.8	9.2	9.9	V
UVLO Hysteresis			0.8			0.8		V
Supply Current								
Start Up Current	V_{CC} = 8V		1.1	2.0		1.1	2.0	mA
I_{CC}	$V_{PIN\ 1}$, $V_{PIN\ 7}$, $V_{PIN\ 9}$ = 0V $V_{PIN\ 2}$ = 1V		22	30		22	30	mA

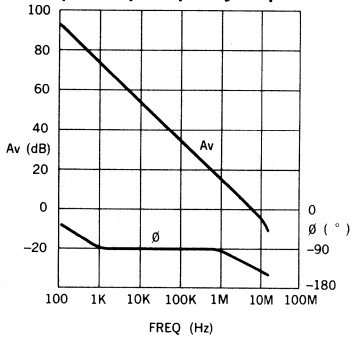
* This parameter not 100% tested in production but guaranteed by design.

ERROR AMPLIFIER CIRCUIT

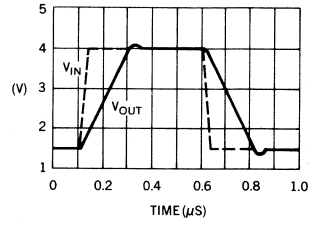
Simplified Schematic



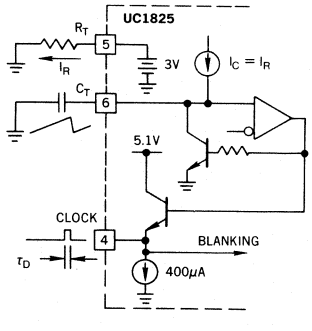
Open Loop Frequency Response



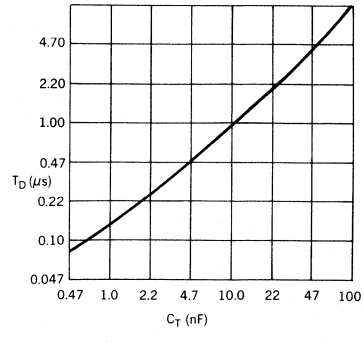
Unity Gain Slew Rate



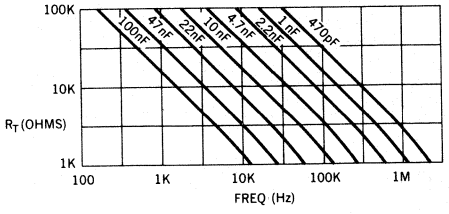
OSCILLATOR CIRCUIT



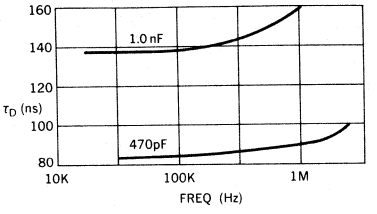
Deadtime vs C_T ($3 \leq R_T \leq 100K$)



Timing Resistance vs Frequency

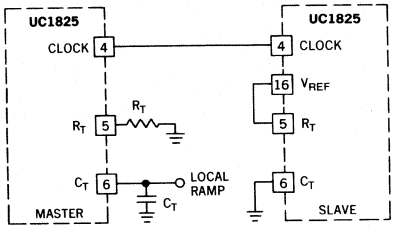


Deadtime vs Frequency

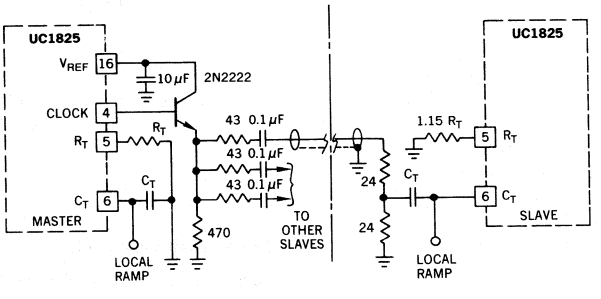


SYNCHRONIZED OPERATION

Two Units in Close Proximity:

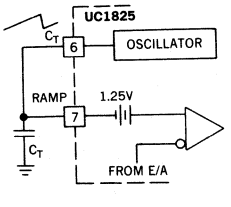


Generalized Synchronization:

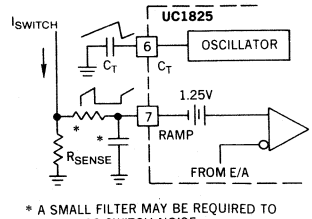


PWM APPLICATIONS

Conventional (Voltage Mode)

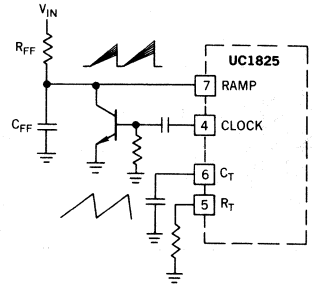


Current-Mode



* A SMALL FILTER MAY BE REQUIRED TO SUPPRESS SWITCH NOISE

FEED FORWARD TECHNIQUE FOR OFF-LINE VOLTAGE MODE APPLICATION



PROTECT FUNCTIONS

Soft-Start Calculations

Soft Start dv/dt = 9μA/C_{SS}. (R_1 = R_2 = open)
Soft Start τ = (C_{SS} × R_1 × R_2)/(R_1 + R_2)

Duty Cycle Clamp Calculations:

These calculations apply to voltage mode operation ($V_{PIN\ 7}$ = $V_{PIN\ 6}$).

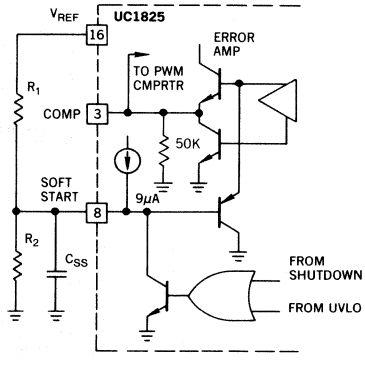
For $V_{PIN\ 3}$ < 2.25V, D = 0%
For 2.25 < $V_{PIN\ 3}$ < 4.05V,
D = (100%/1.8V) × ($V_{PIN\ 3}$ − 2.25V)
For $V_{PIN\ 3}$ > 4.05, D = 100%
$V_{PIN\ 3}$ (MAX) = $V_{PIN\ 8}$

Therefore:

D(MAX) = (100%/1.8V) × ($V_{PIN\ 8}$ − 2.25V)

Example:

Desired D(MAX) = 75%
V(Pin 8) = ((75%/100%) × 1.8V) + 2.25V
= 3.6V
Arbitrarily let R_2 = 10K
Then R_1 = (V_{REF} − $V_{PIN\ 8}$)/(($V_{PIN\ 8}$/R_2) − I_{SS})
= (5.1V − 3.6V)/((3.6V/10K) − 9μA)
= 4.27K
If R_1 is chosen to be 4.3K, then
$V_{PIN\ 8}$ = (((9μA × 4.3K) + 5.1V) × 10K)/14.3K
= 3.593V
D(MAX) = (100%/1.8V) × (3.593V − 2.25)
= 74.6%

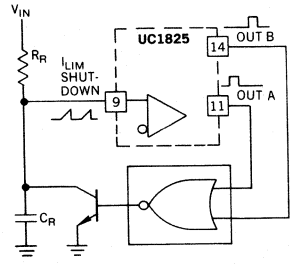


Current Limit Clamp Schemes

Maximum current clamping in a current-mode topology can be achieved via several schemes with the UC1825. One method is to apply a voltage to Pin 8 in the same manner prescribed for voltage mode duty cycle clamping (above). This clamps the error amp output thereby establishing a maximum current threshold at the PWM comparator. Another method is to feed an appropriately scaled analog of the current sense signal into Pin 9, the current limit/shutdown pin (see block diagram). The threshold at this pin is 1V.

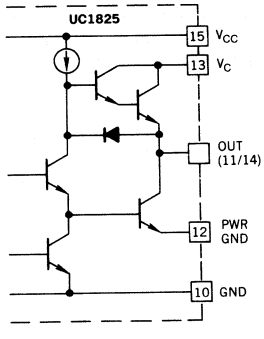
Constant Volt-Second Clamp Circuit

The circuit shown here will achieve a constant volt-second product clamp over varying input voltages. The ramp generator components, R_T and C_R are chosen so that the ramp at Pin 9 crosses the 1V threshold at the same time the desired maximum volt-second product is reached. The delay through the functional nor block must be such that the ramp capacitor can be completely discharged during the minimum deadtime.

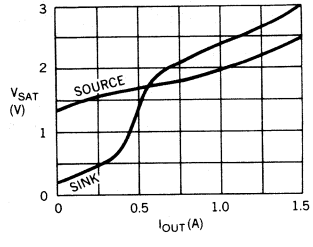


OUTPUT SECTION

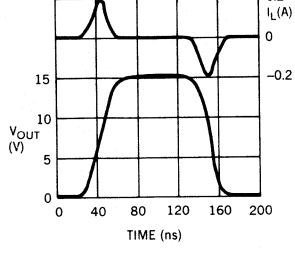
Simplified Schematic



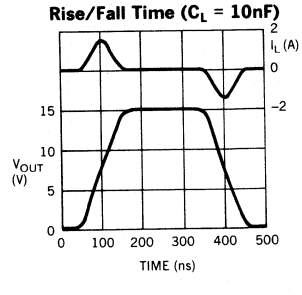
Saturation Curves



Rise/Fall Time (C_L = 1nF)



Rise/Fall Time (C_L = 10nF)

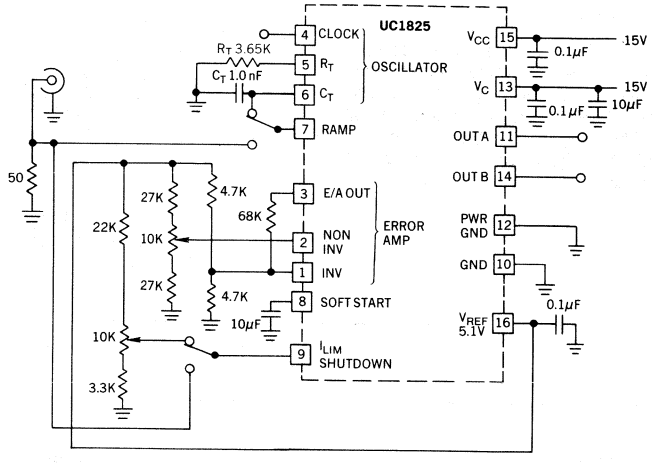


HIGH-SPEED DESIGN CONSIDERATIONS

High-speed circuits demand careful attention to layout and component placement. Excessive lead lengths will result in parasitic lead inductance guaranteeing ringing on the high-speed pins of the chip. On the output pins (11 and 14), ringing can have two adverse effects; excessive power consumption, and, in the case of ringing below ground, confusion of the internal logic.

To avoid these problems and optimize the performance of the UC1825, all lead lengths should be minimized, including bypass capacitor leads on the V_{CC}, V_C, and V_{REF} pins. Printed circuit board layout should include a ground plane. If gate rise and fall times are not extremely critical, series damping resistance is helpful. If excessive ringing below ground is still present, a high-speed clamp diode is recommended on each output pin.

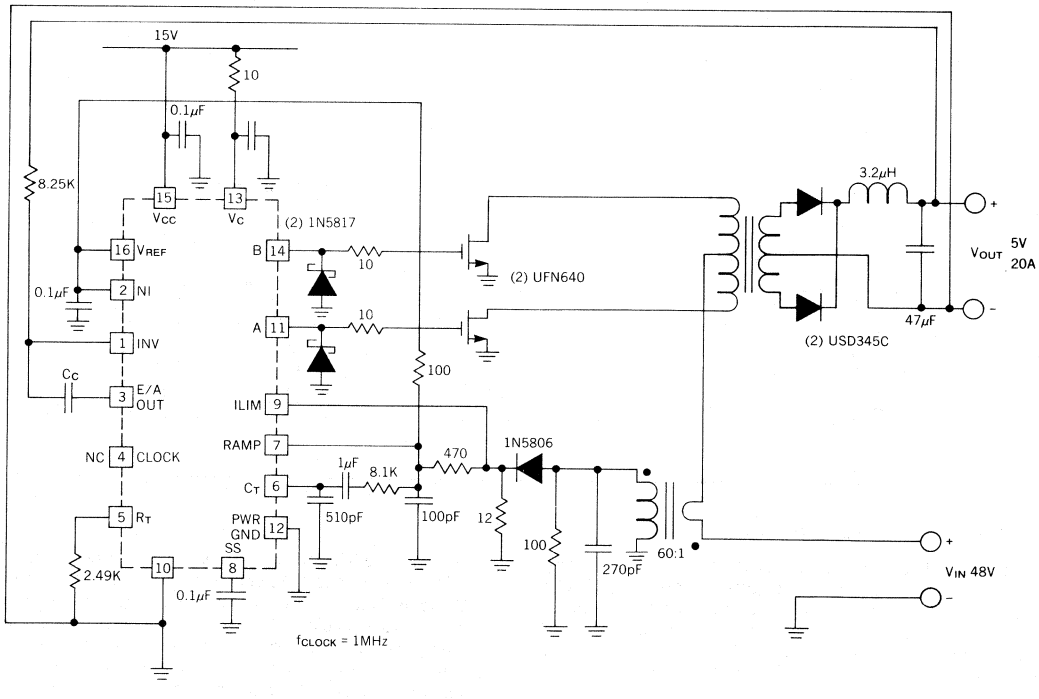
OPEN LOOP LABORATORY TEST FIXTURE



This test fixture is useful for exercising many of the UC1825's functions and measuring their specifications.

As with any wideband circuit, careful grounding and bypass procedures should be followed. The use of a ground plane is highly recommended.

DESIGN EXAMPLE: 100W, 48V TO 5V DC TO DC CONVERTER



LINEAR INTEGRATED CIRCUITS
High Efficiency Linear Regulator

UC1834
UC2834
UC3834

2

FEATURES
- Minimum V_{IN} - V_{OUT} less than 0.5V at 5A load with external pass device
- Equally usable for either positive or negative regulator design
- Adjustable low threshold current sense amplifier
- Under and over-voltage fault alert with programmable delay
- Over-voltage fault latch with 100mA crowbar drive output

DESCRIPTION
The UC1834 family of integrated circuits is optimized for the design of low input-output differential linear regulators. A high gain amplifier and 200mA sink or source drive outputs facilitate high output current designs which use an external pass device. With both positive and negative precision references, either polarity of regulator can be implemented. A current sense amplifier with a low, adjustable, threshold can be used to sense and limit currents in either the positive or negative supply lines.

In addition, this series of parts has a fault monitoring circuit which senses both under and over-voltage fault conditions. After a user defined delay for transient rejection, this circuitry provides a fault alert output for either fault condition. In the over-voltage case, a 100mA crowbar output is activated. An over-voltage latch will maintain the crowbar output and can be used to shutdown the driver outputs. System control to the device can be accommodated at a single input which will act as both a supply reset and remote shutdown terminal. These die are protected against excessive power dissipation by an internal thermal shutdown function.

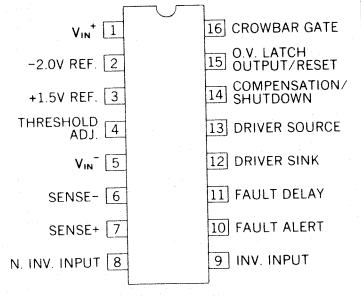
ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Supply Voltage, V_{IN}^+	40V
Driver Current	400mA
Driver Source to Sink Voltage	40V
Crowbar Current	-200mA
+1.5V Reference Output Current	-10mA
Fault Alert Voltage	40V
Fault Alert Current	15mA
Error Amplifier Inputs	-0.5V to 35V
Current Sense Inputs	-0.5V to 40V
O.V. Latch Output Voltage	-0.5V to 40V
O.V. Latch Output Current	15mA
Power Dissipation at T_A = 25°C	1000mW
Derate at 10mW/°C above T_A = 50°C	
Power Dissipation at T_C = 25°C	2000mW
Derate at 16mW/°C above T_C = 25°C	
Thermal Resistance, Junction to Ambient	100°C/W
Thermal Resistance, Junction to Case	60°C/W
Operating Junction Temperature	-55°C to +150°C
Storage Temperature	-65°C to +150°C
Lead Temperature (soldering, 10 seconds)	300°C

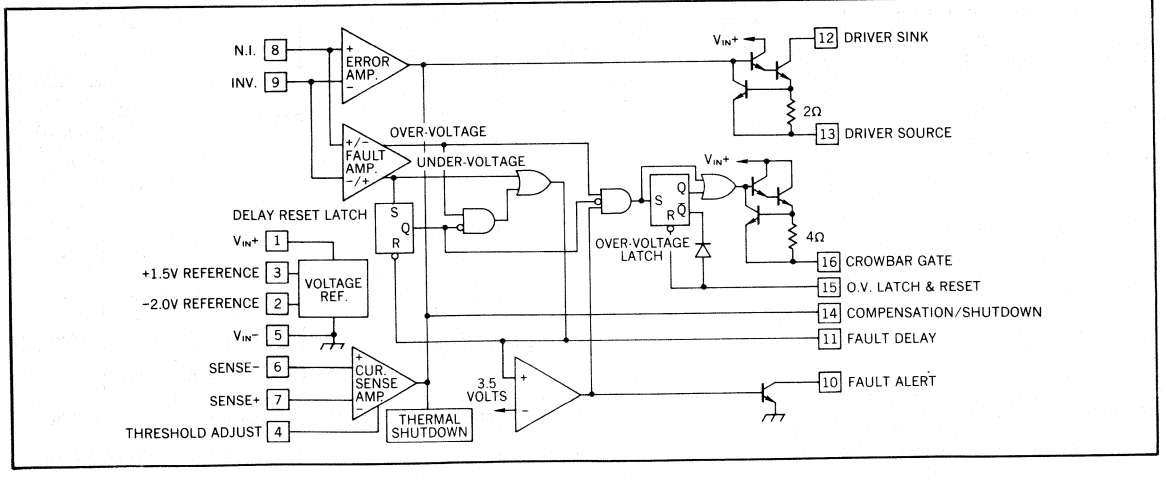
Note: 1. Voltages are reference to V_{IN}^-, Pin 5.
Currents are positive into, negative out of the specified terminals.

CONNECTION DIAGRAM

DIL-16 (TOP VIEW)
J or N PACKAGE



BLOCK DIAGRAM



UNITRODE

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for the UC1834; −25°C to +85°C for the UC2834; and 0°C to +70°C for the UC3834; V_{IN}^+ = 15V, V_{IN}^- = 0V.)

PARAMETER	TEST CONDITIONS	UC1834/UC2834			UC3834			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Standby Supply Current			5.5	7		5.5	10	mA
+1.5 Volt Reference								
Output Voltage	T_j = 25°C	1.485	1.5	1.515	1.47	1.5	1.53	V
	$T_{j(MIN)} \le T_j \le T_{j(MAX)}$	1.47		1.53	1.455		1.545	
Line Regulation	V_{IN}^+ = 5 to 35V		1	10		1	15	mV
Load Regulation	I_{OUT} = 0 to 2mA		1	10		1	15	mV
−2.0 Volt Reference (Note 2)								
Output Voltage (Referenced to V_{IN}^+)	T_j = 25°C	2.04	−2	1.96	2.06	−2	1.94	V
	$T_{j(MIN)} \le T_j \le T_{j(MAX)}$	2.06		1.94	2.08		1.92	
Line Regulation	V_{IN}^+ = 5 to 35V		1.5	15		1.5	20	mV
Output Impedance			2.3			2.3		kΩ
Error Amplifier Section								
Input Offset Voltage	V_{CM} = 1.5V		1	6		1	10	mV
Input Bias Current	V_{CM} = 1.5V		−1	−4		−1	−8	μA
Input Offset Current	V_{CM} = 1.5V		0.1	1		0.1	2	μA
Small Signal Open Loop Gain	Output @ Pin 14, Pin 12 = V_{IN}^+ Pin 13, 20Ω to V_{IN}^-	50	65		50	65		dB
CMRR	V_{CM} = 0.5 to 33V, V_{IN}^+ = 35V	60	80		60	80		dB
PSRR	V_{IN}^+ = 5 to 35V, V_{CM} = 1.5V	70	100		70	100		dB
Driver Section								
Maximum Output Current		200	350		200	350		mA
Saturation Voltage	I_{OUT} = 100mA		0.5	1.2		0.5	1.5	V
Output Leakage Current	Pin 12 = 35V, Pin 13 = V_{IN}^-, Pin 14 = V_{IN}^-		0.1	50		0.1	50	μA
Shutdown Input Voltage at Pin 14	$I_{OUT} \le 100\mu A$, Pin 13 = V_{IN}^-, Pin 12 = V_{IN}^+	0.4	1		0.4	1		V
Shutdown Input Current at Pin 14	Pin 14 = V_{IN}^-, Pin 12 = V_{IN}^+, $I_{OUT} \le 100\mu A$, Pin 13 = V_{IN}^-		−100	−150		−100	−150	μA
Thermal Shutdown (Note 3)			165			165		°C
Fault Amplifier Section								
Under- and Over- Voltage Fault Threshold	V_{CM} = 1.5V, @ E/A Inputs	120	150	180	110	150	190	mV
Common Mode Sensitivity	V_{IN}+ = 35V, V_{CM} = 1.5 to 33V		−0.4	−0.8		−0.4	−1.0	%/V
Supply Sensitivity	V_{CM} =1.5V, V_{IN}^+ = 5 to 35V		−0.5	−1.0		−0.5	−1.2	%/V
Fault Delay		30	45	60	30	45	60	ms/μF
Fault Alert Output Current		2	5		2	5		mA
Fault Alert Saturation Voltage	I_{OUT} =1mA		0.2	0.5		0.2	0.5	V
O.V. Latch Output Current		2	4		2	4		mA
O.V. Latch Saturation Voltage	I_{OUT} = 1mA		1.0	1.3		1.0	1.3	V
O.V. Latch Output Reset Voltage		0.3	0.4	0.6	0.3	0.4	0.6	V
Crowbar Gate Current		−100	−175		−100	−175		mA
Crowbar Gate Leakage Current	V_{IN}^+ = 35V, Pin 16 = V_{IN}^-		−0.5	−50		−0.5	−50	μA

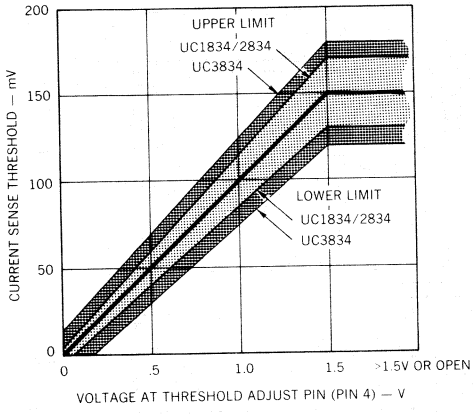
Note: 2. When using both the 1.5V and −2.0V references the current out of Pin 3 should be balanced by an equivalent current into Pin 2. The −2.0V output will change −2.3mV per μA of inbalance.

3. Thermal shutdown turns off the driver. If Pin 15 (O.V. Latch Output) is tied to Pin 14 (Compensation/Shutdown), the O.V. Latch will be reset.

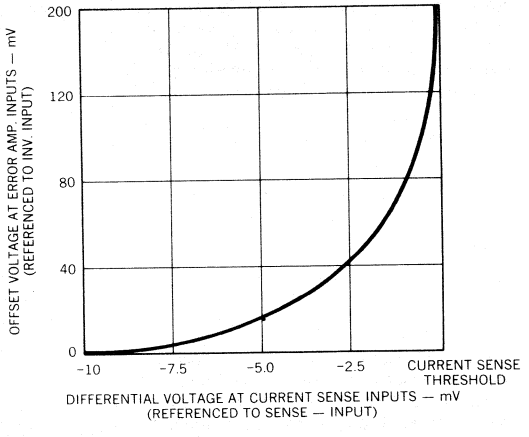
ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for the UC1834; −25°C to +85°C for the UC2834; and 0°C to +70°C for the UC3834; V_{IN}^+ = 15V, V_{IN}^- = 0V.)

PARAMETER	TEST CONDITIONS	UC1834/UC2834			UC3834			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Current Sense Amplifier Section								
Threshold Voltage	Pin 4 Open, $V_{CM} = V_{IN}^+$ or V_{IN}^-	130	150	170	120	150	180	mV
	Pin 4 = 0.5V, $V_{CM} = V_{IN}^+$ or V_{IN}^-	40	50	60	30	50	70	
Threshold Supply Sensitivity	Pin 4 Open, $V_{CM} = V_{IN}^-$, V_{IN}^+ = 5 to 35V		-0.1	-0.3		-0.1	-0.5	%/V
Adj. Input Current	Pin 4 = 0.5V		-2	-10		-2	-10	μA
Sense Input Bias Current	$V_{CM} = V_{IN}^+$		100	200		100	200	μA
	$V_{CM} = V_{IN}^-$		-100	-200		-100	-200	

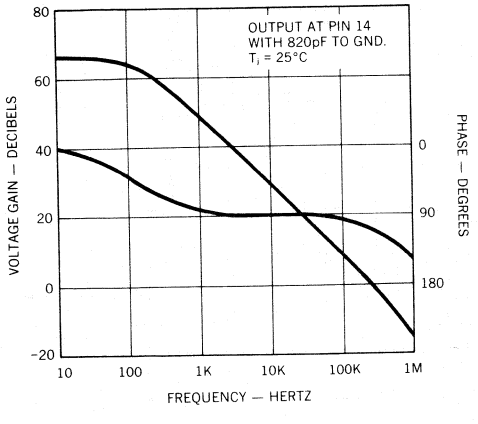
Current Sense Threshold Adjustment



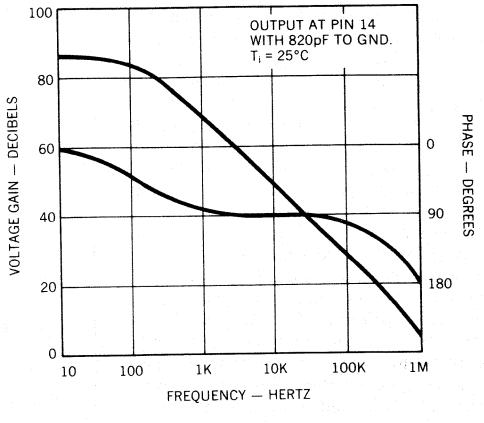
Current Limiting Knee Characteristic



Error Amplifier Gain and Phase Frequency Response



Current Sense Amplifier Gain and Phase Frequency Response

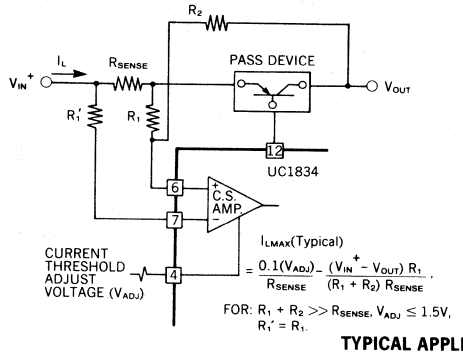


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

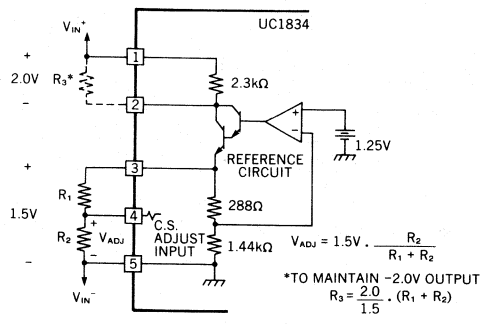
PRINTED IN U.S.A.

APPLICATION INFORMATION

Foldback Current Limiting



Setting The Threshold Adjust Voltage (V_{ADJ})



TYPICAL APPLICATIONS

Both the current sense and error amplifiers on the UC1834 are transconductance type amplifiers. As a result, their voltage gain is a direct function of the load impedence at their shared output pin, Pin 14. Their small signal voltage gain as a function of load and frequency is nominally given by;

$$A_{V\ E/A} = \frac{Z_L(f)}{700\Omega} \text{ and } A_{V\ C.S./A} = \frac{Z_L(f)}{70\Omega}$$

for: $f \leq 500kHz$ and $|Z_L(f)| \leq 1M\Omega$,

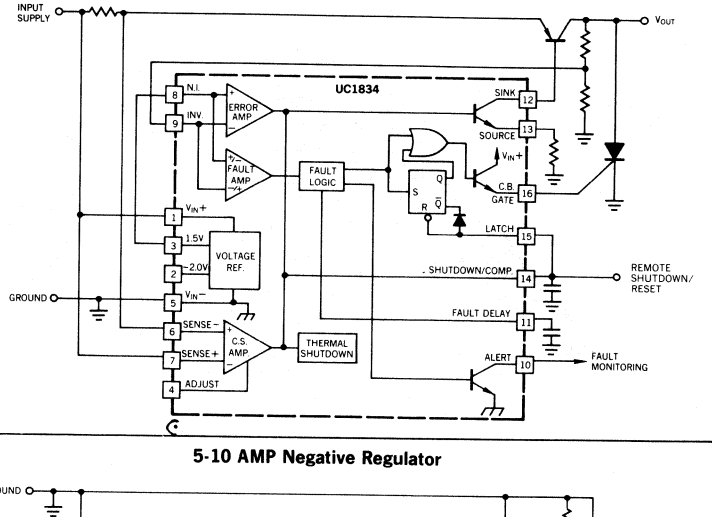
where:

A_V = small signal voltage gain to Pin 14,
$Z_L(f)$ = load impedence at Pin 14.

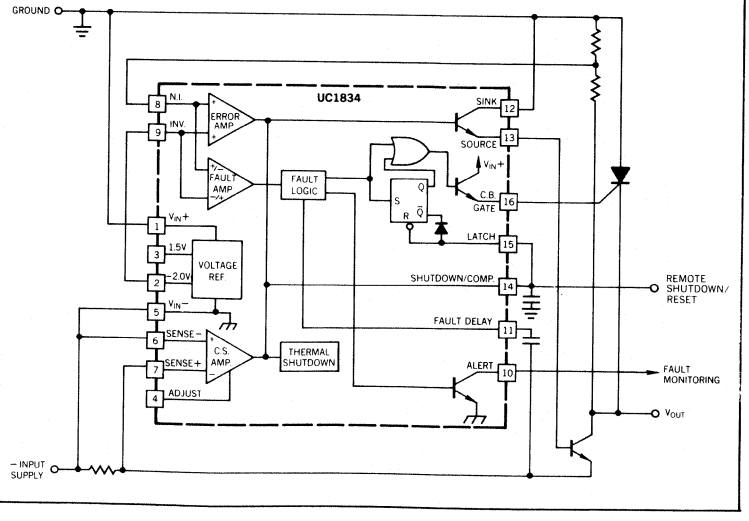
The UC1834 fault delay circuitry prevents the fault outputs from responding to transient fault conditions. The delay reset latch insures that the full, user defined, delay passes before an over-voltage fault response occurs. This prevents unnecessary crowbar, or latched-off conditions, from occurring following sharp under-voltage to over-voltage transients.

The crowbar output on the UC1834 is activated following a sustained over-volatge condition. The crowbar output remains high as long as the fault condition persists, or, as long as the over-voltage latch is set. The latch is set with an over-voltage fault if the voltage at Pin 15 is above the latch reset threshold, typically 0.4V. When the latch is set, its $\overline{Q}$ output will pull Pin 15 low through a series diode. As long as a nominal pull-up load exists, the series diode prevents $\overline{Q}$ from pulling Pin 15 below the reset threshold. However, Pin 15 is pulled low enough to disable the driver outputs if Pins 15 and 14 are tied together. With Pin 15 and 14 common, the regulator will latch off in response to an over-voltage fault. If the fault condition is cleared and Pins 14 and 15 are momentarily pulled below the latch reset threshold, the driver outputs are re-enabled.

5-10 AMP Positive Regulator



5-10 AMP Negative Regulator



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

LINEAR INTEGRATED CIRCUITS
Programmable, Off-Line, PWM Controller

FEATURES

- All control, driving, monitoring, and protection functions included
- Low-current, off-line start circuit
- Feed-forward line regulation over 4 to 1 input range
- PWM latch for single pulse per period
- Pulse-by-pulse current limiting plus shutdown for over-current fault
- No start-up or shutdown transients
- Slow turn-on and maximum duty-cycle clamp
- Shutdown upon over- or under-voltage sensing
- Latch off or continuous retry after fault
- Remote, pulse-commandable start/stop
- PWM output switch usable to 1A peak current
- 1% reference accuracy
- 500kHz operation
- 18-pin DIL package

DESCRIPTION

Although containing most of the features required by all types of switching power supply controllers, the UC1840 family has been optimized for highly-efficient boot-strapped primary-side operation in forward or flyback power converters. Two important features for this mode are a starting circuit which requires little current from the primary input voltage and feed-forward control for constant volt-second operation over a wide input voltage range.

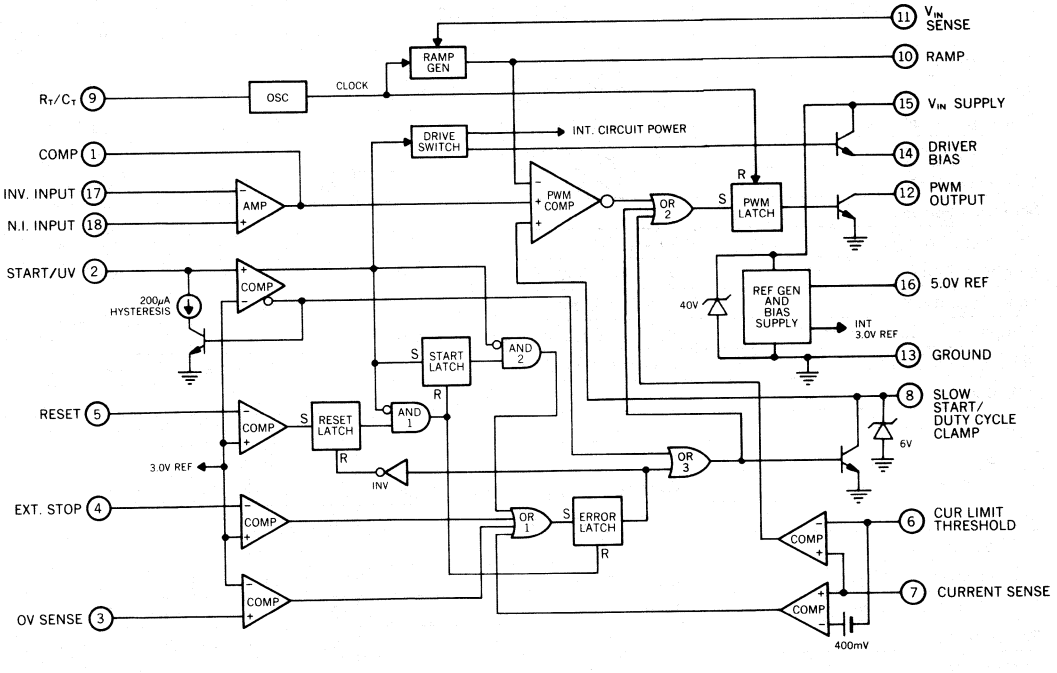
In addition to startup and normal regulating PWM functions, these devices offer built-in protection from over-voltage, under-voltage, and over-current fault conditions. This monitoring circuitry contains the added features that any fault will initiate a complete shutdown with provisions for either latch off or automatic restart. In the latch-off mode, the controller may be started and stopped with external pulsed or steady-state commands.

Other performance features of these devices include a 1% accurate reference, provision for slow-turn-on and duty-cycle limiting, and high-speed pulse-by-pulse current limiting in addition to current fault shutdown.

The UC1840's PWM output stage includes a latch to insure only a single pulse per period and is designed to optimize the turn off of an external switching device by conducting during the "OFF" time with a capability for both high peak current and low saturation voltage. These devices are available in an 18-pin dual-in-line plastic or ceramic package.

The UC1840 is characterized for operation over the full military temperature range of −55°C to +125°C. The UC2840 and UC3840 are designed for operation from −25°C to +85°C and 0°C to +70°C, respectively.

BLOCK DIAGRAM



Note: Positive true logic, latch outputs high with set, reset has priority.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage, $+V_{IN}$ (Pin 15)
- Voltage Driven ..... +32V
- Current Driven, 100mA maximum ..... Self-limiting

PWM Output Voltage (Pin 12) 40V
PWM Output Current, Steady-State (Pin 12) 400mA
PWM Output Peak Energy Discharge 20μJoules
Driver Bias Current (Pin 14) ..... -200mA
Reference Output Current (Pin 16) ..... -50mA
Slow-Start Sink Current (Pin 8) 20mA
V_{IN} Sense Current (Pin 11) 10mA
Current Limit Inputs (Pins 6 & 7) ..... -0.5 to +5.5V
Comparator Inputs (Pins 2, 3, 4, 5, 17, 18) ..... -0.3 to +32V
Power Dissipation at T_A = 25°C 1000mW
- Derate at 10 mW/°C for T_A above 50°C

Power Dissipation at T_C = 25°C 2000mW
- Derate at 16 mW/°C for T_C above 25°C

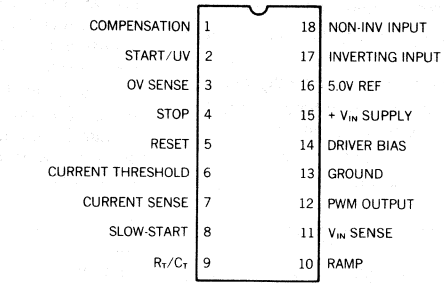
Thermal Resistance, Junction to Ambient ..... 100°C/W
Thermal Resistance, Junction to Case ..... 60°C/W
Operating Junction Temperature ..... -55°C to +150°C
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (Soldering, 10 sec) ..... +300°C

Notes: 1. All voltages are with respect to ground, Pin 13.
Currents are positive-into, negative-out of the specified terminal.

CONNECTION DIAGRAM

DIL-18 (TOP VIEW)
J or N PACKAGE

UC1840
UC2840
UC3840



ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = -55°C to +125°C for the UC1840, -25°C to +85°C for the UC2840, and 0°C to 70°C for the UC3840; V_{IN} = 20V, R_T = 20k, C_T = .001mfd, C_R = .001mfd, Current Limit Threshold = 200mV)

PARAMETER	TEST CONDITIONS	UC1840 UC2840			UC3840			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Power Inputs								
Start-Up Current	V_{IN} = 30V, Pin 2 = 2.5V, T_J = 25°C		4	5.5		4	5.5	mA
Start-Up Current T.C.*	V_{IN} = 30V, Pin 2 = 2.5V		-0.1	-0.2		-0.1	-0.2	%/°C
Operating Current	V_{IN} = 30V, Pin 2 = 3.5V	5	10	15	5	10	15	mA
Supply OV Clamp	I_{IN} = 20mA	33	40	45	33	40	48	V
Reference Section								
Reference Voltage	T_J = 25°C	4.95	5.0	5.05	4.9	5.0	5.1	V
Line Regulation	V_{IN} = 8 to 30V		10	15		10	20	mV
Load Regulation	I_L = 0 to 20mA		10	20		10	30	mV
Temperature Coefficient*	Over operating temperature range			±0.4			±0.4	mV/°C
Short Circuit Current	V_{REF} = 0, T_J = 25°C		-80	-100		-80	-100	mA
Oscillator								
Nominal Frequency	T_J = 25°C	47	50	53	45	50	55	kHz
Voltage Stability	V_{IN} = 8 to 30V		0.5	1		0.5	1	%
Temperature Coefficient*	Over operating temperature range			±.08			±.08	%/°C
Maximum Frequency	R_T = 2kΩ, C_T = 330pF	500			500			kHz
Ramp Generator								
Ramp Current, Minimum	I_{SENSE} = -10μA		-11	-14		-11	-14	μA
Ramp Current, Maximum	I_{SENSE} = 1.0mA	-0.9	-.95		-0.9	-.95		mA
Ramp Valley		0.3	0.5	0.7	0.3	0.5	0.7	V
Ramp Peak	Clamping Level	3.9	4.2	4.5	3.9	4.2	4.5	V

*Guaranteed by design. Not 100% tested in production.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for the UC1840, −25°C to +85°C for the UC2840, and 0°C to 70°C for the UC3840; V_{IN} = 20V, R_T = 20k, C_T = .001mfd, C_R = .001mfd, Current Limit Threshold = 200mV)

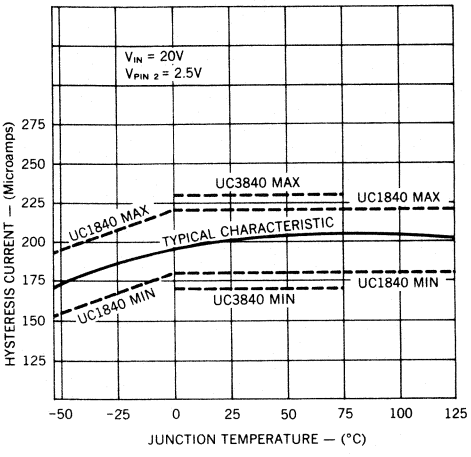
PARAMETER	TEST CONDITIONS	UC1840 UC2840			UC3840			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Error Amplifier								
Input Offset Voltage	V_{CM} = 5.0V		0.5	5		2	10	mV
Input Bias Current			0.5	2		1	5	μA
Input Offset Current				0.5			0.5	μA
Open Loop Gain	ΔV_O = 1 to 3V	60	66		60	66		dB
Output Swing (Max. Output ≤ Ramp Peak − 100mV)	Minimum Total Range	0.3		3.5	0.3		3.5	V
CMRR	V_{CM} = 1.5 to 5.5V	70	80		70	80		dB
PSRR	V_{IN} = 8 to 30V	40	50		40	50		dB
Short Circuit Current	V_{COMP} = 0V		−4	−10		−4	−10	mA
Gain Bandwidth*	T_J = 25°C, A_{VOL} = 0dB	1	2		1	2		MHz
Slew Rate*	T_J = 25°C, A_{VCL} = 0dB		0.8			0.8		V/μs
PWM Section								
Continuous Duty Cycle Range* (other than zero)	Minimum Total Continuous Range Ramp Peak < 4.2V	5		95	5		95	%
Output Saturation	I_{OUT} = 20mA		0.2	0.4		0.2	0.4	V
Output Saturation	I_{OUT} = 200mA		1.7	2.2		1.7	2.2	V
Output Leakage	V_{OUT} = 40V		0.1	10		0.1	10	μA
Comparator Delay*	Pin 8 to Pin 12 T_J = 25°C, R_L = 1kΩ		300	500		300	500	ns
Sequencing Functions								
Comparator Thresholds	Pins 2, 3, 4, 5	2.8	3.0	3.2	2.8	3.0	3.2	V
Input Bias Current	Pins 3, 4, 5 = 0V		−1.0	−3.0		−1.0	−3.0	μA
Start/UV Hysteresis Current	Pin 2 = 2.5V, T_J = 25°C	180	200	220	170	200	230	μA
Input Leakage	Input V = 20V		0.1	10		0.1	10	μA
Driver Bias Saturation Voltage, V_{IN} − V_{OH}	I_B = −50mA		2	3		2	3	V
Driver Bias Leakage	V_B = 0V		−0.1	−10		−0.1	−10	μA
Slow-Start Saturation	I_S = 2mA		0.2	0.5		0.2	0.5	V
Slow-Start Leakage	V_S = 4.5V		0.1	2.0		0.1	2.0	μA
Current Control								
Current Limit Offset			0	5		0	10	mV
Current Shutdown Offset		370	400	430	360	400	440	mV
Input Bias Current	Pin 7 = 0V		−2	−5		−2	−5	μA
Common Mode Range*		−0.4		3.0	−0.4		3.0	V
Current Limit Delay*	T_J = 25°C, Pin 7 to 12, R_L = 1k		200	400		200	400	ns

*Guaranteed by design. Not 100% tested in production.

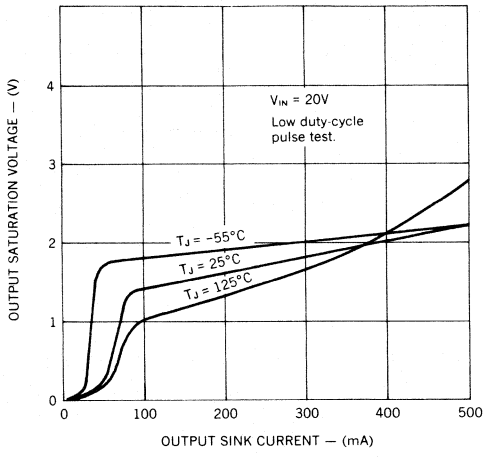
FUNCTIONAL DESCRIPTION

PWM CONTROL	
1. Oscillator:	Generates a fixed-frequency internal clock from an external R_T and C_T. Frequency $= \frac{K_c}{R_T C_T}$ where K_c is a first-order correction factor $\approx 0.3 \log (C_T \times 10^{12})$.
2. Ramp Generator:	Develops a linear ramp with a slope defined externally by $\frac{dv}{dt} = \frac{\text{sense voltage}}{R_R C_R}$ C_R is normally selected $\leq C_T$ and its value will have some effect upon valley voltage. C_R terminal can be used as an input port for current mode control.
3. Error Amplifier:	Conventional operational amplifier for closed-loop gain and phase compensation. Low output impedance; unity-gain stable.
4. Reference Generator:	Precision 5.0V for internal and external usage to 50mA. Tracking 3.0V reference for internal usage only with nominal accuracy of ± 2%. 40V clamp zener for chip OV protection, 100mA maximum current.
5. PWM Comparator:	Generates output pulse which starts at termination of clock pulse and ends when the ramp input crosses the lowest of two positive inputs.
6. PWM Latch:	Terminates the PWM output pulse when set by inputs from either the PWM comparator, the pulse-by-pulse current limit comparator, or the error latch. Resets with each internal clock pulse.
7. PWM Output Switch:	Transistor capable of sinking current to ground which is off during the PWM on-time and turns on to terminate the power pulse. Current capacity is 400mA saturated with peak capacitance discharge in excess of one amp.
SEQUENCING FUNCTIONS	
1. Start/UV Sense:	This comparator performs three functions— With an increasing voltage, it generates a turn-on signal at a start threshold. With a decreasing voltage, it generates a UV fault signal at a lower level separated by a 200μA hysteresis current. At the UV threshold, it also resets the Error Latch if the Reset Latch has been set.
2. Drive Switch:	Disables most of the chip to hold internal current consumption low, and Driver Bias OFF, until input voltage reaches start threshold.
3. Driver Bias:	Supplies drive current to external power switch to provide turn-on bias.
4. Slow Start:	Clamps low to hold PWM OFF. Upon release, rises with rate controlled by $R_S C_S$ for slow increase of output pulse width. Also used to clamp maximum duty cycle with divider R_S R_{DC}.
5. Start Latch:	Keeps low input voltage at initial turn-on from being defined as a UV fault. Sets at start level to monitor for UV fault.
6. Reset Latch:	When reset, this latch insures no reset signal to either Start or Error latches so that first fault will lock the PWM off. When set, this latch resets the Start and Error latches at the UV low threshold, allowing a restart.
PROTECTION FUNCTIONS	
1. Error Latch:	When set by momentary input, this latch insures immediate PWM shutdown and hold off until reset. Inputs to Error Latch are: a. UV low (after turn-on) b. OV high c. Stop low d. Current Sense 400mV over threshold. Error Latch resets at UV threshold if Reset Latch is set.
2. Current Limiting:	Differential input comparator terminates individual output pulses each time sense voltage rises above threshold. When sense voltage rises to 400mV above threshold, a shutdown signal is sent to Error Latch.

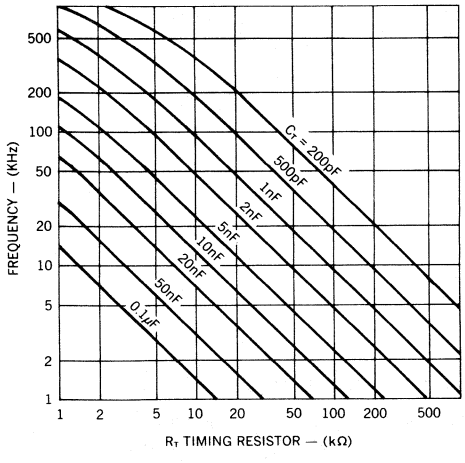
Start/UV Hysteresis Current



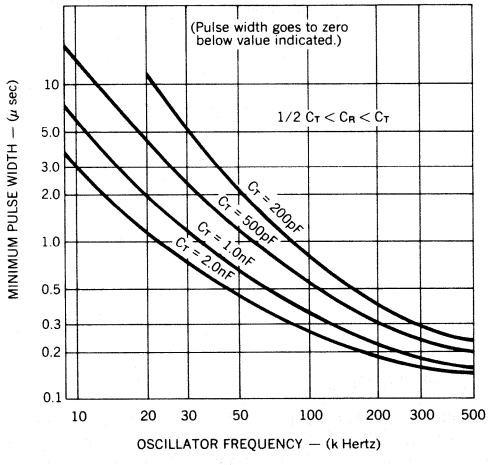
PWM Output Saturation Voltage



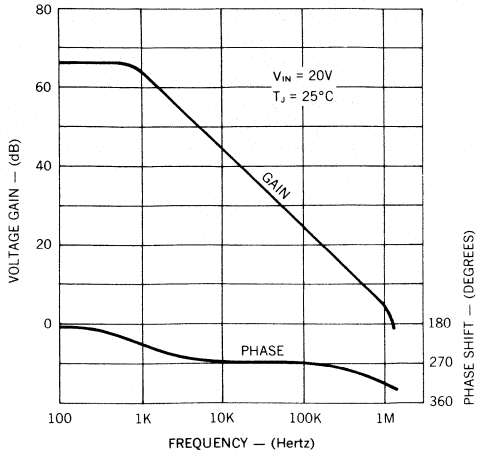
Oscillator Frequency



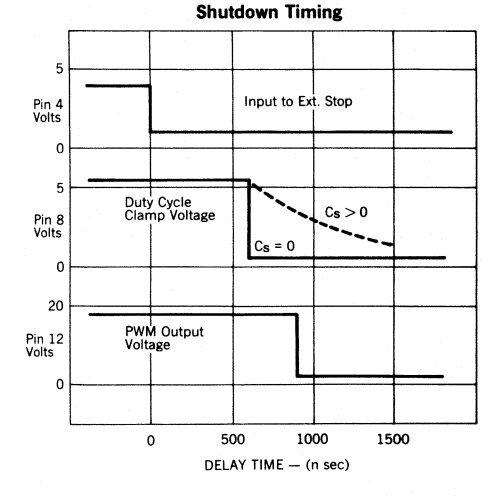
PWM Output Minimum Pulse Width



Error Amplifier Open-Loop Gain and Phase



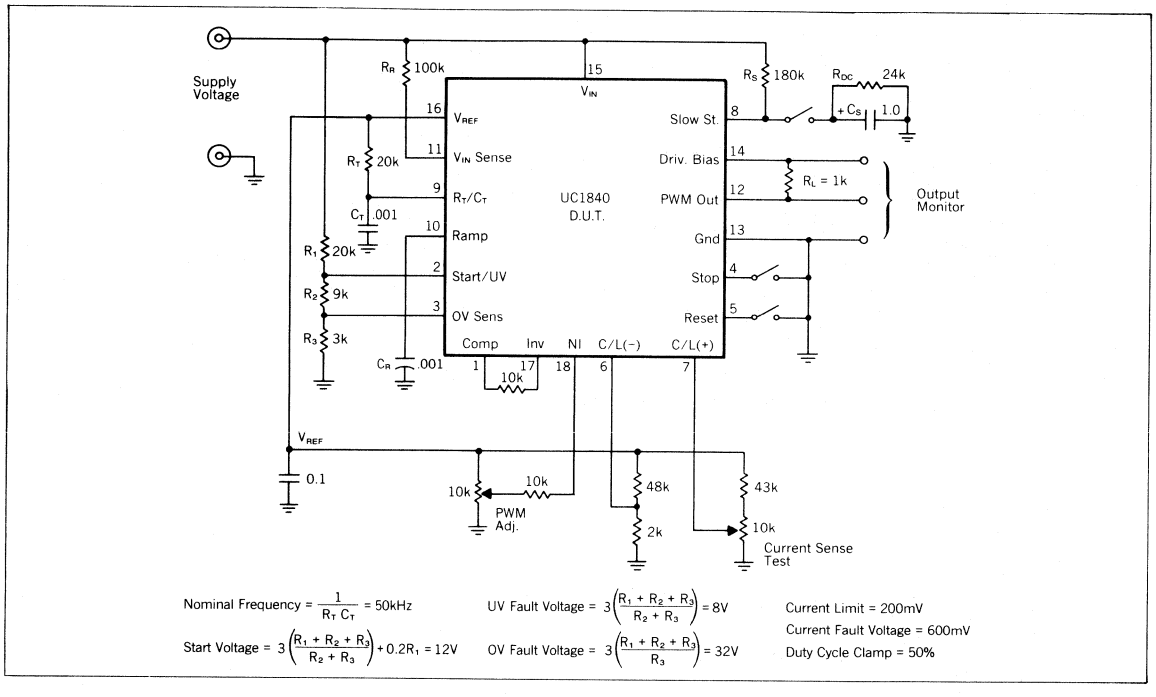
Shutdown Timing



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

OPEN-LOOP TEST CIRCUIT



FLYBACK APPLICATION (A)

In this application (see Figure A, next page), complete control is maintained on the primary side. Control power is provided by R_{IN} and C_{IN} during start-up, and by a primary-referenced low voltage winding, N2, for efficient operation after start. The error amplifier loop is closed to regulate the DC voltage from N2 with other outputs following through their magnetic coupling — a task made even easier with the UC1840's feed-forward line regulation.

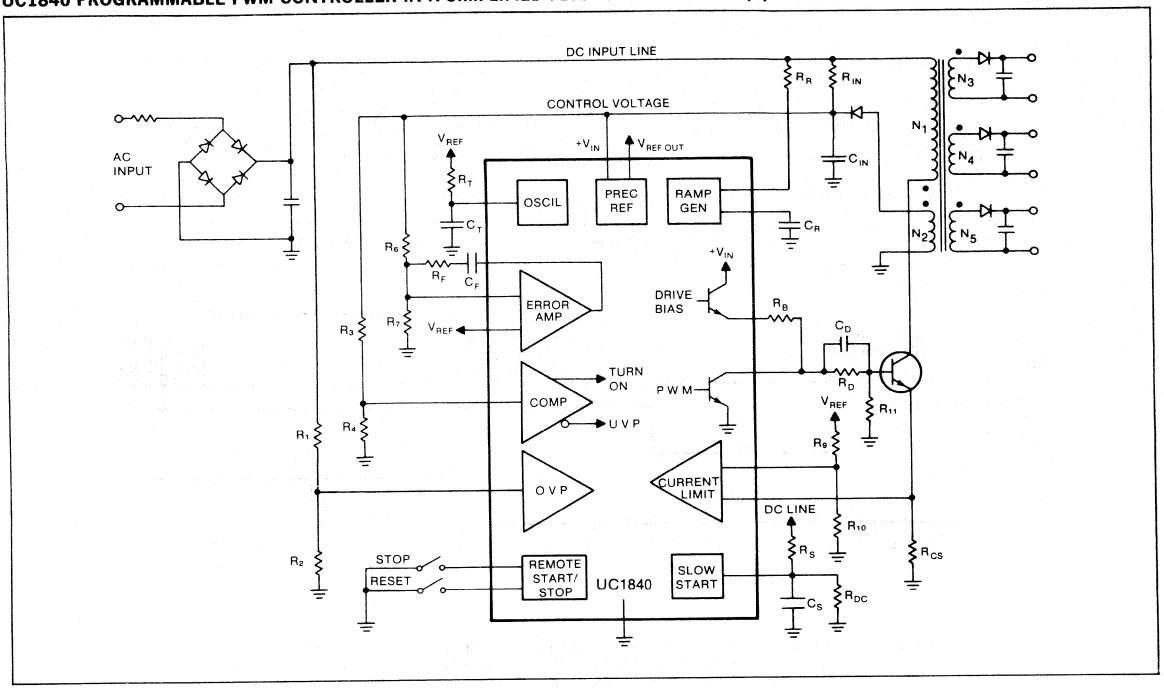
An extension to this application for more precise regulation would be the use of the UC1901 Isolated Feedback Generator for direct closed-loop control to an output. The UC1840 will readily accept digital start/stop commands transmitted from the secondary side by means of optical couplers.

Not shown are protective snubbers or additional interface circuitry which may be required by the choice of the high-voltage switch, Qs, or the application.

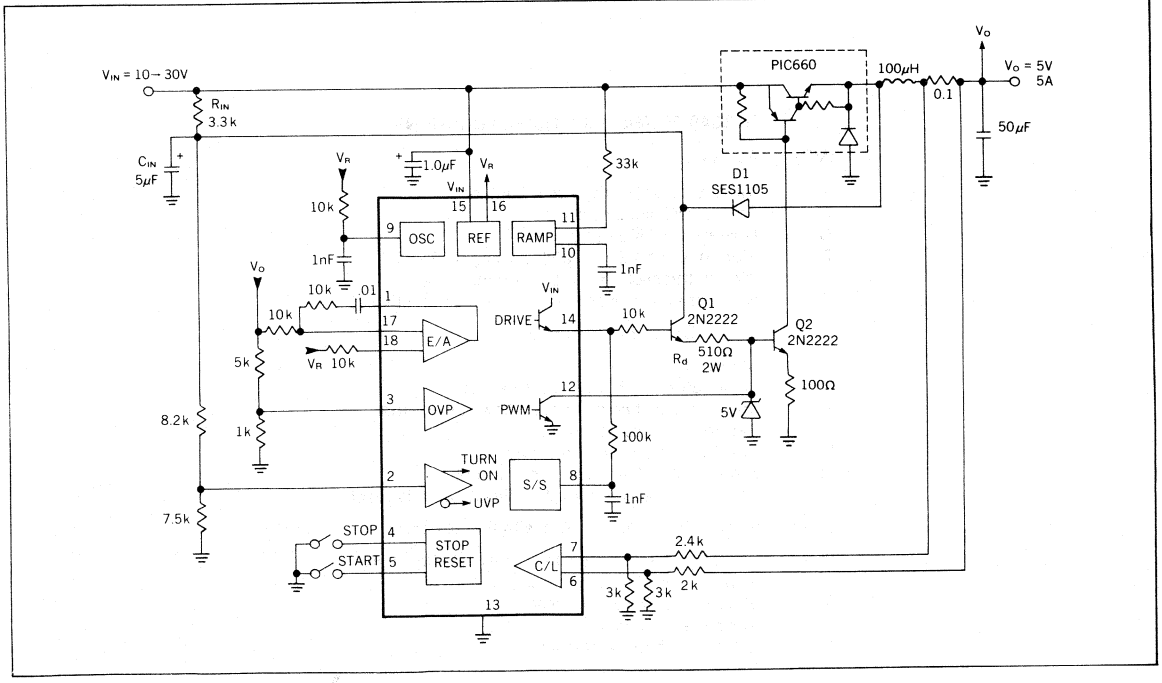
REGULATOR APPLICATION (B)

Although primarily intended for transformer-coupled power systems, the UC1840's advantages of feed-forward for high ripple-rejection, a fully contained fault monitoring system and remote start/stop capability make it worth considering for other types of regulators. Since the fault logic within the UC1840 requires recycling the voltage sensed by the Start/UV Comparator to reset the error latch, a need for automatic restart must be addressed in a manner similar to that shown in Figure B (next page). In this simple, non-isolated, buck regulator; diode D1 provides a low-impedence bootstrapped drive power source after start-up is achieved through R_{IN} and C_{IN}. When a fault shutdown terminates switching action, the loading of Q1 and R_d will lower the voltage on pin 2 to effect an automatic re-start attempt which will continuously recycle until the fault is removed.

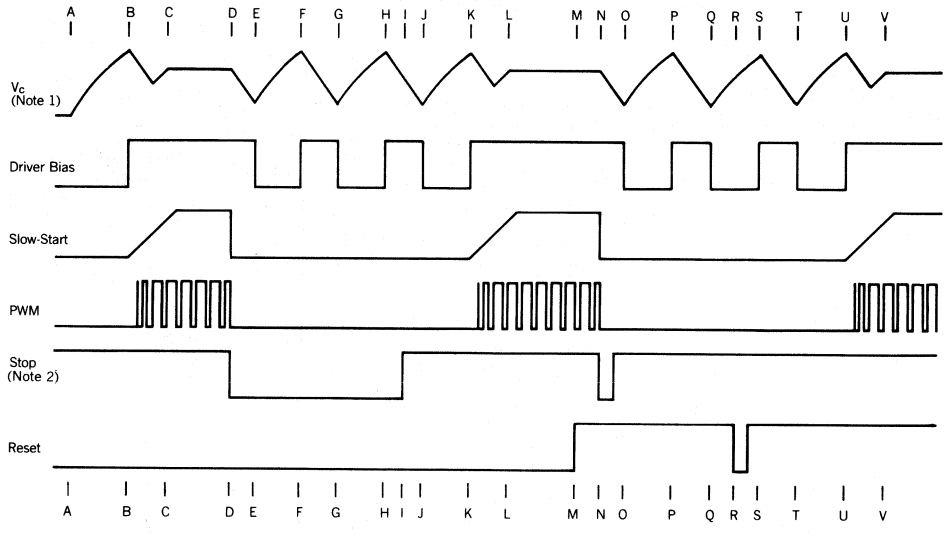
UC1840 PROGRAMMABLE PWM CONTROLLER IN A SIMPLIFIED FLYBACK REGULATOR (A)



UC1840 CONTROLS A HIGH-CURRENT NON-ISOLATED BUCK REGULATOR (B)



UC1840 POWER SEQUENCING FUNCTIONS



Notes: 1. VC represents an analog of the output voltage generated by a primary-referenced secondary winding on the power transformer. It is the voltage monitored by the start/UV comparator and, in most cases, is the supply voltage, V_{IN}, for the UC1840.

2. Although input to External Stop, Pin 4, is shown, results are the same for any fault input which sets the Error Latch.

UC1840 POWER SEQUENCING FUNCTIONS

TIME	EVENT
A	Initial turn-on, V_C rises with light load
B	Start threshold. Driver Bias loads V_C
C	Operating PWM regulates V_C
D	Stop input sets Error Latch turning off PWM
E	UV low threshold, Error Latch remains set
F	Start turns on Driver Bias but Error Latch still set
G, H	V_C and Driver Bias continue to cycle
I	Stop command removed
J	Error Latch reset at UV low threshold
K	Start threshold now removes slow-start clamp
L	Return to normal run state
M	Reset Latch set signal removed
N	Error Latch set with momentary fault
O	Error Latch does not reset as Reset Latch is reset
P, Q	V_C and Driver Bias recycle with no turn-on.
R	Reset Latch set is set with momentary Reset signal
S	V_C must complete cycle to turn-on
T	Start and Error Latches reset
U	Normal start initiated
V	Return to normal run state

LINEAR INTEGRATED CIRCUITS

Off-Line Current Mode PWM Controller

UC1842
UC2842
UC3842

FEATURES

- Optimized for off-line control
- Low start up current (<1mA)
- Automatic feed forward compensation
- Pulse-by-pulse current limiting
- Enhanced load response characteristics
- Under-voltage lockout with 6V hysteresis
- Double pulse suppression
- High current totem pole output
- Internally trimmed bandgap reference
- 500kHz operation

DESCRIPTION

The UC1842 family of control ICs provides the necessary features to implement off-line, fixed frequency current mode control schemes with a minimal external parts count. The superior performance of this technique can be measured in improved line regulation, enhanced load response characteristics, and a simpler, easier to design control loop. Topological advantages include inherent pulse-by-pulse current limiting.

Protection circuitry includes built in under-voltage lockout and current limiting. Other features include fully latched operation, a 1% trimmed bandgap reference, and start-up current less than 1mA.

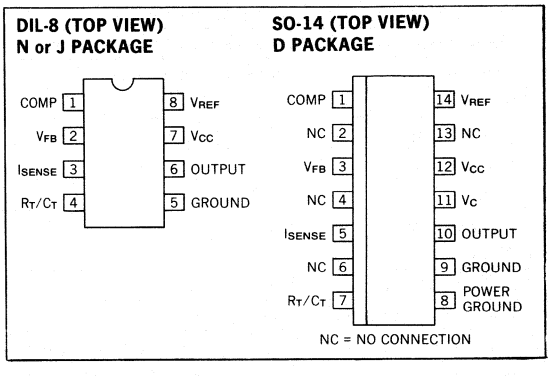
These devices feature a totem pole output designed to source and sink high peak current from a capacitive load, such as the gate of a power MOSFET. Consistent with N Channel power devices, the output is low in the OFF state.

ABSOLUTE MAXIMUM RATINGS (Note 1)

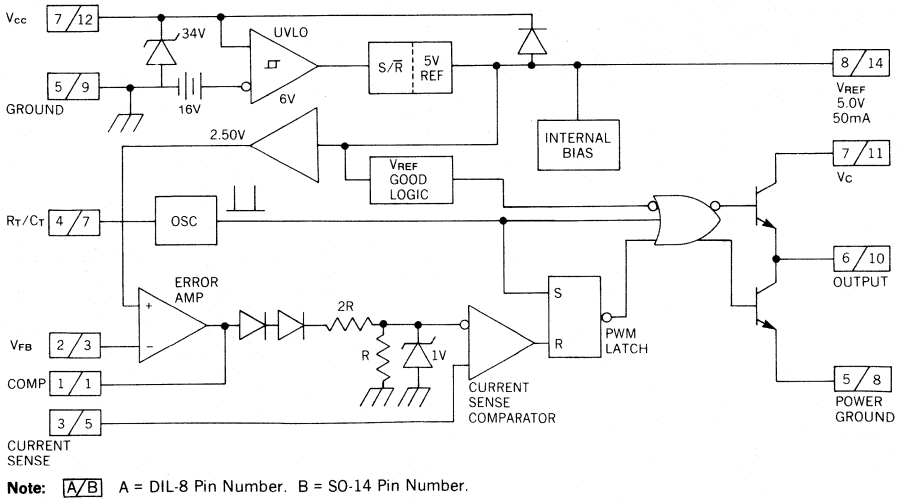
Supply Voltage (I_{CC} < 30mA) ..... Self Limiting
Supply Voltage (Low Impedence Source) 30V
Output Current ..... ±1A
Output Energy (Capacitive Load) 5µJ
Analog Inputs (Pin 2, Pin 3) ..... -0.3V to V_{CC}
Error Amp Output Sink Current 10mA
Power Dissipation at $T_A \leq 25°C$ (DIL-8) 1W
Derate 8mW/°C for $T_A > 25°C$
Power Dissipation at $T_A \leq 25°C$ (SO-14) 725mW
Derate 5.8mW/°C for $T_A > 25°C$
Storage Temperature Range ..... -65°C to 150°C
Lead Temperature (Soldering, 10 Seconds) ..... 300°C

Note: 1. All voltages are with respect to Pin 5.
All currents are positive into the specified terminal.

CONNECTION DIAGRAM



BLOCK DIAGRAM



Note: A/B A = DIL-8 Pin Number. B = SO-14 Pin Number.

UNITRODE

ELECTRICAL SPECIFICATIONS (Unless otherwise stated, these specifications apply for $-55 \leq T_A \leq 125°C$ for UC1842; $-25 \leq T_A \leq 85°C$ for UC2842; $0 \leq T_A \leq 70°C$ for UC3842; V_{CC} = 15V (Note 5); R_T = 10K; C_T = 3.3nF.)

PARAMETER	TEST CONDITIONS	UC1842 UC2842			UC3842			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Reference Section								
Output Voltage	T_j = 25°C, I_O = 1mA	4.95	5.00	5.05	4.90	5.00	5.10	V
Line Regulation	$12 \leq V_{IN} \leq 25V$		6	20		6	20	mV
Load Regulation	$1 \leq I_O \leq 20mA$		6	25		6	25	mV
Temp. Stability	(Note 2)		0.2	0.4		0.2	0.4	mV/°C
Total Output Variation	Line, Load, Temp. (Note 2)	4.90		5.10	4.82		5.18	V
Output Noise Voltage	$10Hz \leq f \leq 10kHz$, T_j = 25°C (Note 2)		50			50		μV
Long Term Stability	T_A = 125°C, 1000 Hrs. (Note 2)		5	25		5	25	mV
Output Short Circuit		−30	−100	−180	−30	−100	−180	mA
Oscillator Section								
Initial Accuracy	T_j = 25°C	47	52	57	47	52	57	kHz
Voltage Stability	$12 \leq V_{CC} \leq 25V$		0.2	1		0.2	1	%
Temp. Stability	$T_{MIN} \leq T_A \leq T_{MAX}$ (Note 2)		5			5		%
Amplitude	$V_{PIN\ 4}$ peak to peak		1.7			1.7		V
Error Amp Section								
Input Voltage	$V_{PIN\ 1}$ = 2.5V	2.45	2.50	2.55	2.42	2.50	2.58	V
Input Bias Current			−0.3	−1		−0.3	−2	μA
A_{VOL}	$2 \leq V_O \leq 4V$	65	90		65	90		dB
Unity Gain Bandwidth	(Note 2)	0.7	1		0.7	1		MHz
PSRR	$12 \leq V_{CC} \leq 25V$	60	70		60	70		dB
Output Sink Current	$V_{PIN\ 2}$ = 2.7V, $V_{PIN\ 1}$ = 1.1V	2	6		2	6		mA
Output Source Current	$V_{PIN\ 2}$ = 2.3V, $V_{PIN\ 1}$ = 5V	−0.5	−0.8		−0.5	−0.8		mA
V_{OUT} High	$V_{PIN\ 2}$ = 2.3V, R_L = 15K to ground	5	6		5	6		V
V_{OUT} Low	$V_{PIN\ 2}$ = 2.7V, R_L = 15K to Pin 8		0.7	1.1		0.7	1.1	V
Current Sense Section								
Gain	(Notes 3 & 4)	2.85	3	3.15	2.85	3	3.15	V/V
Maximum Input Signal	$V_{PIN\ 1}$ = 5V (Note 3)	0.9	1	1.1	0.9	1	1.1	V
PSRR	$12 \leq V_{CC} \leq 25V$ (Note 3)		70			70		dB
Input Bias Current			−2	−10		−2	−10	μA
Delay to Output			150	300		150	300	ns
Output Section								
Output Low Level	I_{SINK} = 20mA		0.1	0.4		0.1	0.4	V
	I_{SINK} = 200mA		1.5	2.2		1.5	2.2	V
Output High Level	I_{SOURCE} = 20mA	13	13.5		13	13.5		V
	I_{SOURCE} = 200mA	12	13.5		12	13.5		V
Rise Time	T_j = 25°C, C_L = 1nF (Note 2)		50	150		50	150	ns
Fall Time	T_j = 25°C, C_L = 1nF (Note 2)		50	150		50	150	ns

Notes: 2. These parameters, although guaranteed, are not 100% tested in production.
3. Parameter measured at trip point of latch with $V_{PIN\ 2}$ = 0.
4. Gain defined as:

$$A = \frac{\Delta V_{PIN\ 1}}{\Delta V_{PIN\ 3}}; \quad 0 \leq V_{PIN\ 3} \leq 0.8V.$$

5. Adjust V_{CC} above the start threshold before setting at 15V.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

ELECTRICAL SPECIFICATIONS (Unless otherwise stated, these specifications apply for $-55 \leq T_A \leq 125°C$ for UC1842; $-25 \leq T_A \leq 85°C$ for UC2842; $0 \leq T_A \leq 70°C$ for UC3842; V_{CC} = 15V (Note 5); R_T = 10K; C_T = 3.3nF.)

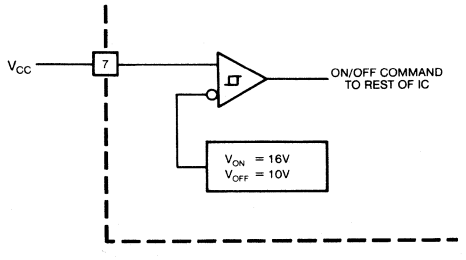
PARAMETER	TEST CONDITIONS	UC1842 UC2842			UC3842			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Under-Voltage Lockout Section								
Start Threshold		15	16	17	14.5	16	17.5	V
Min. Operating Voltage	After Turn On	9	10	11	8.5	10	11.5	V
Total Standby Current								
Start-Up Current			0.5	1		0.5	1	mA
Operating Supply Current	$V_{PIN\ 2} = V_{PIN\ 3} = 0V$		11	17		11	17	mA
V_{CC} Zener Voltage	I_{CC} = 25mA		34			34		V

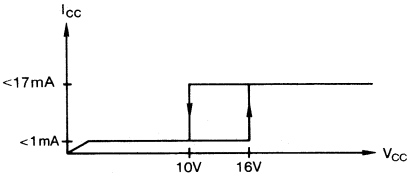
Notes: 2. These parameters, although guaranteed, are not 100% tested in production.
3. Parameter measured at trip point of latch with $V_{PIN\ 2} = 0$.
4. Gain defined as:

$$A = \frac{\Delta V_{PIN\ 1}}{\Delta V_{PIN\ 3}}; \quad 0 \leq V_{PIN\ 3} \leq 0.8V.$$

5. Adjust V_{CC} above the start threshold before setting at 15V.

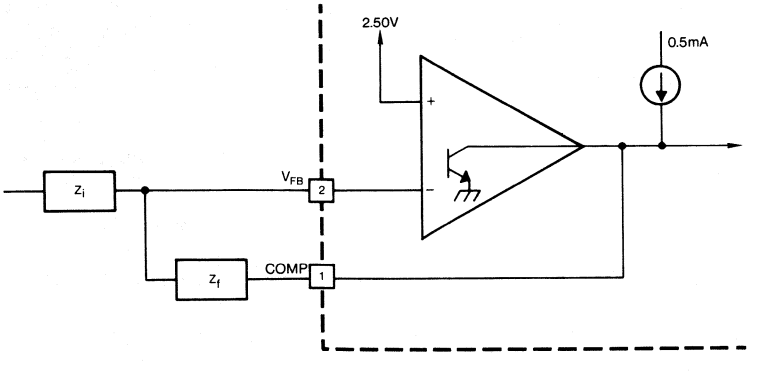
UNDER-VOLTAGE LOCKOUT





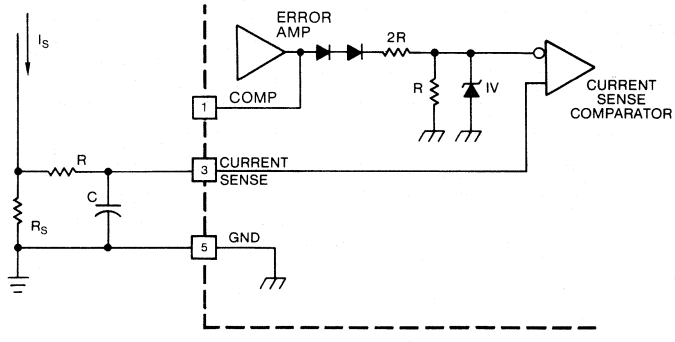
During Under-Voltage Lockout, the output driver is biased to sink minor amounts of current. Pin 6 should be shunted to ground with a bleeder resistor to prevent activating the power switch with extraneous leakage currents.

ERROR AMP CONFIGURATION



ERROR AMP CAN SOURCE OR SINK UP TO 0.5mA

CURRENT SENSE CIRCUIT

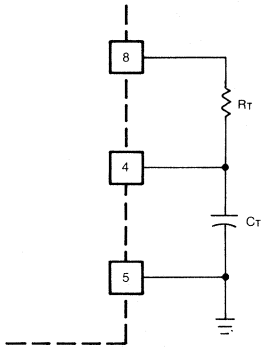


PEAK CURRENT (I_S) IS DETERMINED BY THE FORMULA:

$$I_S max \approx \frac{1.0V}{R_S}$$

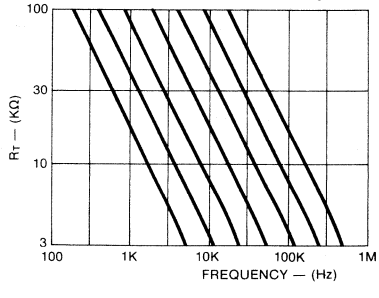
A SMALL RC FILTER MAY BE REQUIRED TO SUPPRESS SWITCH TRANSIENTS.

OSCILLATOR WAVEFORMS AND MAXIMUM DUTY CYCLE

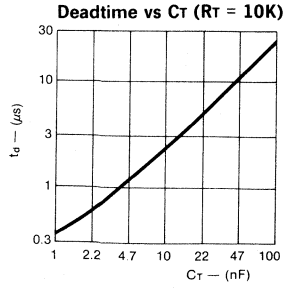


For $R_T > 5k$ $f \approx \frac{1.72}{R_T C_T}$

Timing Resistance vs Frequency



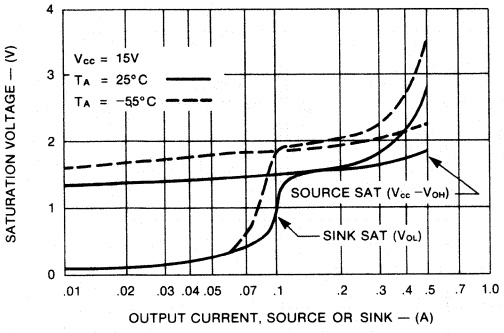
Deadtime vs C_T (R_T = 10K)



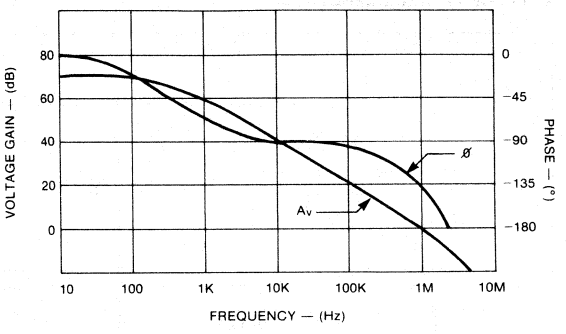
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

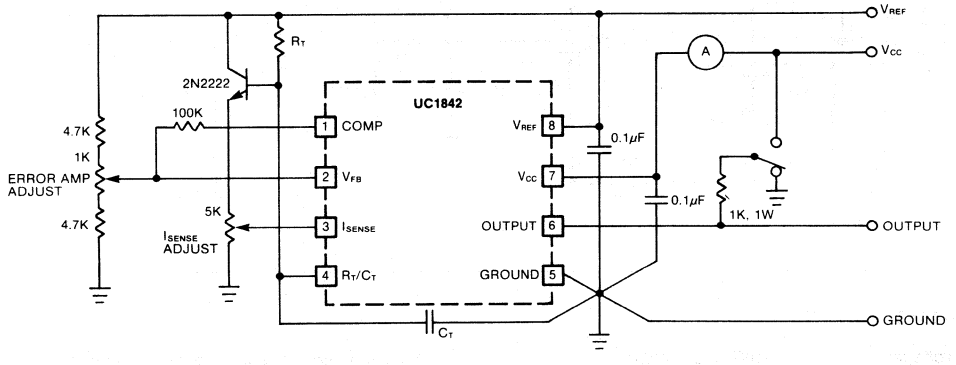
Output Saturation Characteristics



Error Amplifier Open-Loop Frequency Response



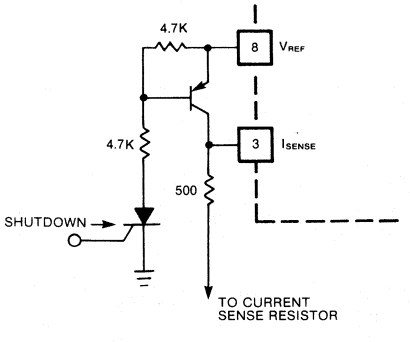
OPEN-LOOP LABORATORY TEST FIXTURE

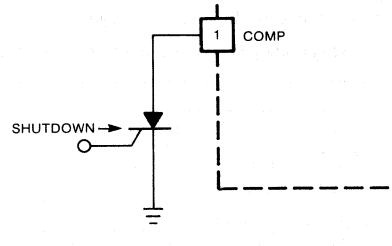


High peak currents associated with capacitive loads necessitate careful grounding techniques. Timing and bypass capacitors should be connected close to pin 5 in a single point ground.

The transistor and 5K potentiometer are used to sample the oscillator waveform and apply an adjustable ramp to pin 3.

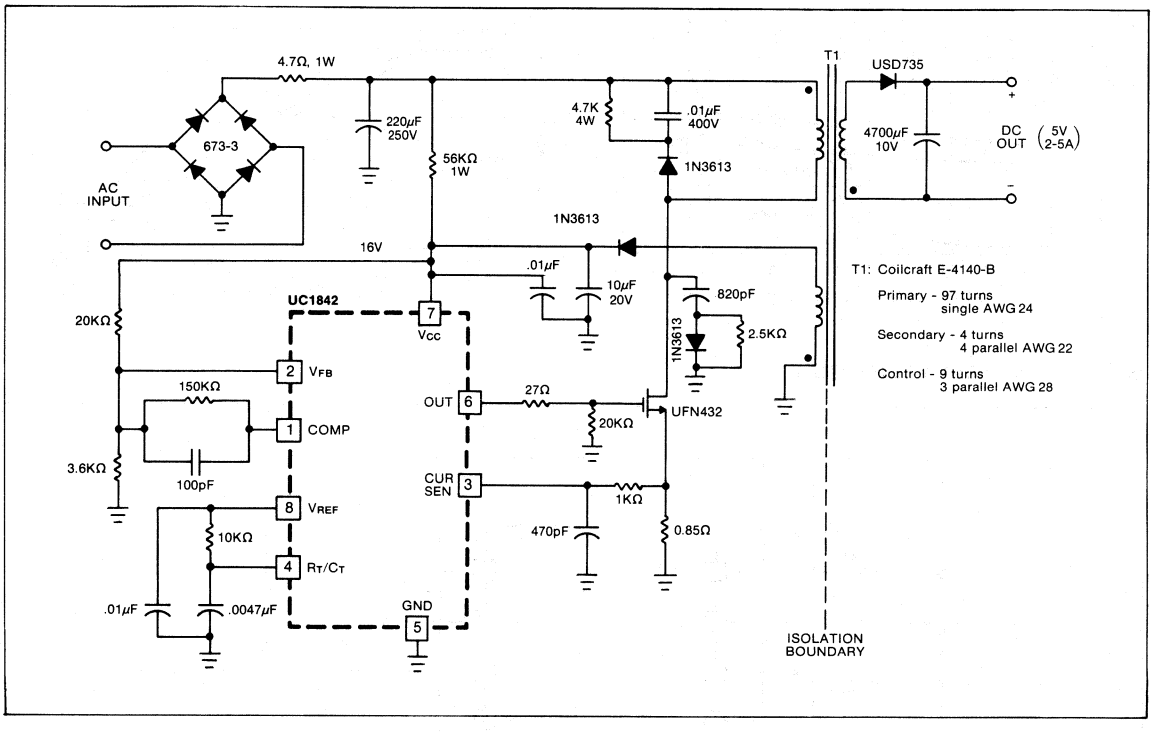
SHUTDOWN TECHNIQUES





Shutdown of the UC1842 can be accomplished by two methods; either raise pin 3 above 1V or pull pin 1 below a voltage two diode drops above ground. Either method causes the output of the PWM comparator to be high (refer to block diagram). The PWM latch is reset dominant so that the output will remain low until the next clock cycle after the shutdown condition at pins 1 and/or 3 is removed. In the examples shown, an externally latched shutdown may be accomplished by adding an SCR which will be reset by cycling V_{CC} below the lower UVLO threshold (10V). At this point all internal bias is removed allowing the SCR to reset.

OFF-LINE FLYBACK REGULATOR

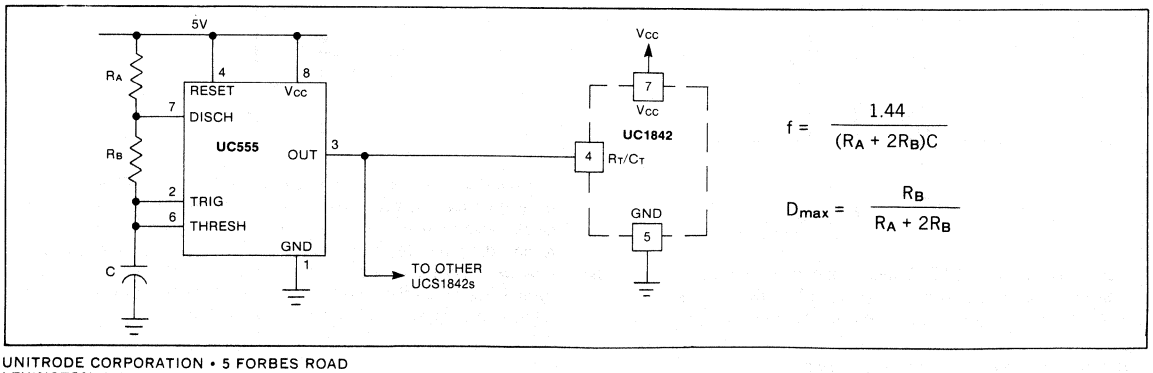


SPECIFICATIONS

Input line voltage:	90VAC to 130VAC
Input frequency:	50 or 60Hz
Switching frequency:	40kHz ±10%
Output power:	25W maximum
Output voltage:	5V ± 5%
Output current:	2 to 5A
Line regulation:	0.01%/V
Load regulation:	8%/A*
Efficiency @ 25 Watts,	
V_{IN} = 90VAC:	70%
V_{IN} = 130VAC:	65%
Output short-circuit current:	2.5A average

* This circuit uses a low-cost feedback scheme in which the DC voltage developed from the primary-side control winding is sensed by the UC1842 error amplifier. Load regulation is therefore dependent on the coupling between secondary and control windings, and on transformer leakage inductance. For applications requiring better load regulation, a UC1901 Isolated Feedback Generator can be used to directly sense the output voltage.

SYNCHRONIZATION AND MAXIMUM DUTY CYCLE CLAMP



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

LINEAR INTEGRATED CIRCUITS
Current-Mode PWM Controller

UC1843
UC2843
UC3843

2

FEATURES

- Pin for Pin Compatible with UC1842
- Under-Voltage Lockout (8.4V) with Hysteresis (0.5V)

DESCRIPTION

The UC1843 family of ICs provides the necessary features to implement fixed frequency current-mode pulse width modulation control schemes with a minimum external parts count. Functionally, the UC1843 is identical to the UC1842 with the exception of lower Under-Voltage Lockout thresholds and hysteresis.

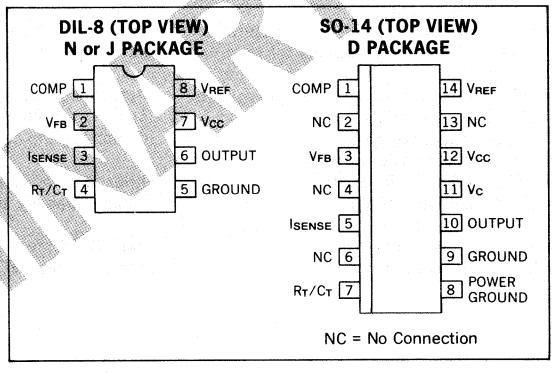
PRELIMINARY

ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage (I_{CC} < 30mA) ..... Self Limiting
Supply Voltage (Low Impedence Source) 30V
Output Current ..... ±1A
Output Energy (Capacitive Load) 5μJ
Analog Inputs (Pin 2, Pin 3) ..... -0.3V to V_{CC}
Error Amp Output Sink Current 10mA
Power Dissipation at $T_A \leq 25°C$ (DIL-8) 1W
Derate 8mW/°C for $T_A > 25°C$
Power Dissipation at $T_A \leq 25°C$ (SO-14) 725mW
Derate 5.8mW/°C for $T_A > 25°C$
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (Soldering, 10 Seconds) ..... 300°C

Note: 1. All voltages are with respect to Pin 5.
All currents are positive into the specified terminal.

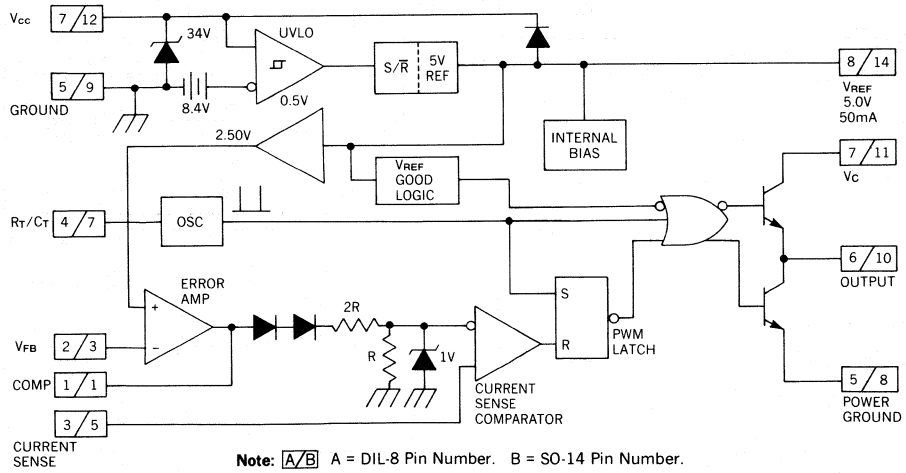
CONNECTION DIAGRAM



ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for $-55°C < T_A < 125°C$ for the UC1843; $-25°C < T_A < 85°C$ for the UC2843; $0 < T_A < 70°C$ for the UC3843; V_{CC} = 15V; R_T = 10K; C_T = 3.3nF. All specifications of the UC1842 family not explicitly changed here apply to the UC1843 family.

PARAMETER	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Start-Up Current	V_{CC} = 7V		0.5	1.0	mA
UVLO Start Threshold		7.8	8.4	9.0	V
Minimum Operating Voltage		7.0	7.9	8.2	V

BLOCK DIAGRAM



UNITRODE

LINEAR INTEGRATED CIRCUITS

Current Mode PWM Controller

UC1846 UC1847
UC2846 UC2847
UC3846 UC3847

FEATURES

- Automatic feed forward compensation
- Programmable pulse by pulse current limiting
- Automatic symmetry correction in push-pull configuration
- Enhanced load response characteristics
- Parallel operation capability for modular power systems
- Differential current sense amplifier with wide common mode range
- Double pulse suppression
- 200mA totem-pole outputs
- ±1% bandgap reference
- Under-voltage lockout
- Soft start capability
- Shutdown terminal
- 500kHz operation

DESCRIPTION

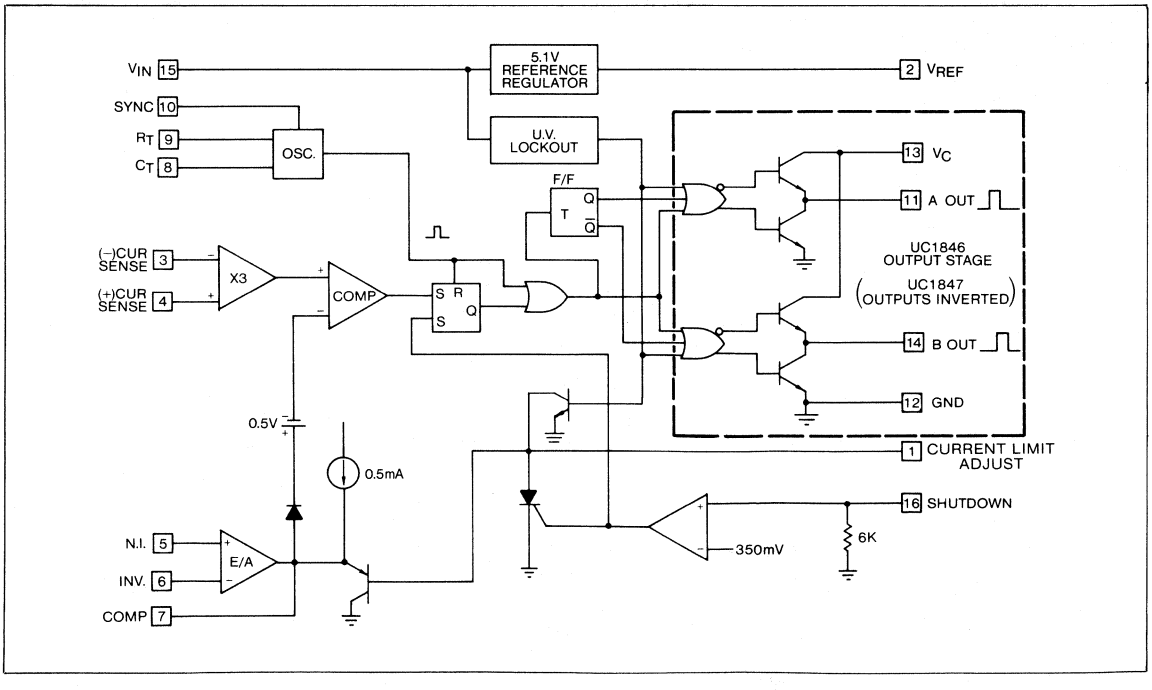
The UC1846/1847 family of control ICs provides all of the necessary features to implement fixed frequency, current mode control schemes while maintaining a minimum external parts count. The superior performance of this technique can be measured in improved line regulation, enhanced load response characteristics, and a simpler, easier-to-design control loop. Topological advantages include inherent pulse-by-pulse current limiting capability, automatic symmetry correction for push-pull converters, and the ability to parallel "power modules" while maintaining equal current sharing.

Protection circuitry includes built-in under-voltage lockout and programmable current limit in addition to soft start capability. A shutdown function is also available which can initiate either a complete shutdown with automatic restart or latch the supply off.

Other features include fully latched operation, double pulse suppression, deadtime adjust capability, and a ±1% trimmed bandgap reference.

The UC1846 features low outputs in the OFF state, while the UC1847 features high outputs in the OFF state.

BLOCK DIAGRAM



UNITRODE

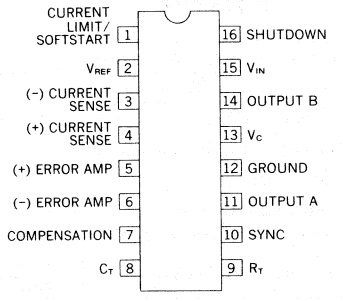
ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage (Pin 15) ..... +40V
Collector Supply Voltage (Pin 13) ..... +40V
Output Current, Source or Sink (Pins 11, 14) 500mA
Analog Inputs (Pins 3, 4, 5, 6, 16) ..... −0.3V to $+V_{IN}$
Reference Output Current (Pin 2) ..... −30mA
Sync Output Current (Pin 10) ..... −5mA
Error Amplifier Output Current (Pin 7) ..... −5mA
Soft Start Sink Current (Pin 1) 50mA
Oscillator Charging Current (Pin 9) 5mA
Power Dissipation at T_A = 25°C 1000mW
Derate at 10mW/°C for T_A above 50°C
Power Dissipation at T_C = 25°C 2000mW
Derate at 16mW/°C for T_C above 25°C
Thermal Resistance, Junction to Ambient ..... 100°C/W
Thermal Resistance, Junction to Case ..... 60°C/W
Storage Temperature Range ..... −65°C to +150°C
Lead Temperature (soldering, 10 seconds) ..... +300°C

Note: 1. All voltages are with respect to Ground, Pin 13.
Currents are positive into, negative out of the specified terminal.

CONNECTION DIAGRAM

DIL-16 (TOP VIEW)
J or N PACKAGE



ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for UC1846/UC1847; −25°C to +85°C for the UC2846/UC2847; and 0°C to +70°C for the UC3846/UC3847; V_{IN} =15V, R_T = 10k, C_T = 4.7nF)

PARAMETER	TEST CONDITIONS	UC1846/UC1847 UC2846/UC2847			UC3846/UC3847			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Reference Section								
Output Voltage	T_j = 25°C, I_O = 1mA	5.05	5.10	5.15	5.00	5.10	5.20	V
Line Regulation	V_{IN} = 8 to 40V		5	20		5	20	mV
Load Regulation	I_L = 1mA to 10mA		3	15		3	15	mV
Temperature Stability	Over Operating Range, (Note 2)		0.4			0.4		mV/°C
Total Output Variation	Line, Load, and Temperature (Note 2)	5.00		5.20	4.95		5.25	V
Output Noise Voltage	10Hz ≤ f ≤ 10kHz, T_j = 25°C (Note 2)		100			100		μV
Long Term Stability	T_j =125°C, 1000Hrs., (Note 2)		5			5		mV
Short Circuit Output Current	V_{REF} = 0V	−10	−45		−10	−45		mA
Oscillator Section								
Initial Accuracy	T_j = 25°C	39	43	47	39	43	47	kHz
Voltage Stability	V_{IN} = 8 to 40V		−1	2		−1	2	%
Temperature Stability	Over Operating Range (Note 2)		−1			−1		%
Sync Output High Level		3.9	4.35		3.9	4.35		V
Sync Output Low Level			3	2.5		3	2.5	V
Sync Input High Level	Pin 8 = 0V	3.9			3.9			V
Sync Input Low Level	Pin 8 = 0V			2.5			2.5	V
Sync Input Current	Sync Voltage = 5.25V, Pin 8 = 0V		1.3	1.5		1.3	1.5	mA
Error Amp Section								
Input Offset Voltage			0.5	5		0.5	10	mV
Input Bias Current			−0.6	−1		−0.6	−2	μA
Input Offset Current			40	250		40	250	nA
Common Mode Range	V_{IN} = 8 to 40V	0		V_{IN}−2V	0		V_{IN}−2V	V
Open Loop Voltage Gain	ΔV_O = 1.2 to 3V, V_{CM} = 2V	80	105		80	105		dB
Unity Gain Bandwidth	T_j = 25°C (Note 2)	0.7	1.0		0.7	1.0		MHz
CMRR	V_{CM} = 0 to 38V, V_{IN} = 40V	75	100		75	100		dB
PSRR	V_{IN} = 8 to 40V	80	105		80	105		dB
Output Sink Current (7)	V_{ID} = −15mV to −5V, $V_{Pin\ 7}$ = 1.2V	2	6		2	6		mA
Output Source Current (7)	V_{ID} = 15mV to 5V, $V_{Pin\ 7}$ = 2.5V	−0.4	−0.5		−0.4	−0.5		mA

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for UC1846/UC1847; −25°C to +85°C for the UC2846/UC2847; and 0°C to +70°C for the UC3846/UC3847; V_{IN} =15V, R_T = 10k, C_T = 4.7nF)

PARAMETER	TEST CONDITIONS	UC1846/UC1847 UC2846/UC2847			UC3846/UC3847			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Error Amp Section (continued)								
High Level Output Voltage	R_L = (Pin 7) 15kΩ	4.3	4.6		4.3	4.6		V
Low Level Output Voltage	R_L = (Pin 7) 15kΩ		0.7	1		0.7	1	V
Current Sense Amplifier Section								
Amplifier Gain	$V_{Pin\ 3}$ = 0V, Pin 1 Open (Notes 3 & 4)	2.5	2.75	3.0	2.5	2.75	3.0	V
Maximum Differential Input Signal ($V_{Pin\ 4}$-$V_{Pin\ 3}$)	Pin 1 Open (Note 3) R_L (Pin 7) = 15kΩ	1.1	1.2		1.1	1.2		V
Input Offset Voltage	$V_{Pin\ 1}$ = 0.5V Pin 7 Open (Note 3)		5	25		5	25	mV
CMRR	V_{CM} = 1 to 12V	60	83		60	83		dB
PSRR	V_{IN} = 8 to 40V	60	84		60	84		dB
Input Bias Current	$V_{Pin\ 1}$ = 0.5V, Pin 7 Open (Note 3)		−2.5	−10		−2.5	−10	μA
Input Offset Current	$V_{Pin\ 1}$ = 0.5V, Pin 7 Open (Note 3)		0.08	1		0.08	1	μA
Input Common Mode Range		0		V_{IN}−3	0		V_{IN}−3	V
Delay to Outputs	T_j = 25°C, (Note 2)		200	500		200	500	ns
Current Limit Adjust Section								
Current Limit Offset	$V_{Pin\ 3}$ = 0V, $V_{Pin\ 4}$ = 0V, Pin 7 Open (Note 3)	0.45	0.5	0.55	0.45	0.5	0.55	V
Input Bias Current	$V_{Pin\ 5}$ = V_{REF}, $V_{Pin\ 6}$ = 0V		−10	−30		−10	−30	μA
Shutdown Terminal Section								
Threshold Voltage		250	350	400	250	350	400	mV
Input Voltage Range		0		V_{IN}	0		V_{IN}	V
Minimum Latching Current ($I_{Pin\ 1}$)	(Note 6)	3.0	1.5		3.0	1.5		mA
Maximum Non-Latching Current ($I_{Pin\ 1}$)	(Note 7)		1.5	0.8		1.5	0.8	mA
Delay to Outputs	T_j = 25°C (Note 2)		300	600		300	600	ns
Output Section								
Collector-Emitter Voltage		40			40			V
Collector Leakage Current	V_C = 40V (Note 5)			200			200	μA
Output Low Level	I_{SINK} = 20mA		0.1	0.4		0.1	0.4	V
	I_{SINK} = 100mA		0.4	2.1		0.4	2.1	
Output High Level	I_{SOURCE} = 20mA	13	13.5		13	13.5		V
	I_{SOURCE} = 100mA	12	13.5		12	13.5		
Rise Time	C_L = 1nF, T_j = 25°C (Note 2)		50	300		50	300	ns
Fall Time	C_L = 1nF, T_j = 25°C (Note 2)		50	300		50	300	ns
Under-Voltage Lockout Section								
Start-Up Threshold			7.7	8.0		7.7	8.0	V
Threshold Hysteresis			0.75			0.75		
Total Standby Current								
Supply Current			17	21		17	21	mA

Notes:

2. These parameters, although guaranteed over the recommended operating conditions, are not 100% tested in production.
3. Parameter measured at trip point of latch with $V_{Pin\ 5}$ = V_{REF}, $V_{Pin\ 6}$ = 0V.
4. Amplifier gain defined as:

$$G = \frac{\Delta V_{Pin\ 7}}{\Delta V_{Pin\ 4}} \quad ; \Delta V_{Pin\ 4} = 0 \text{ to } 1.0V$$

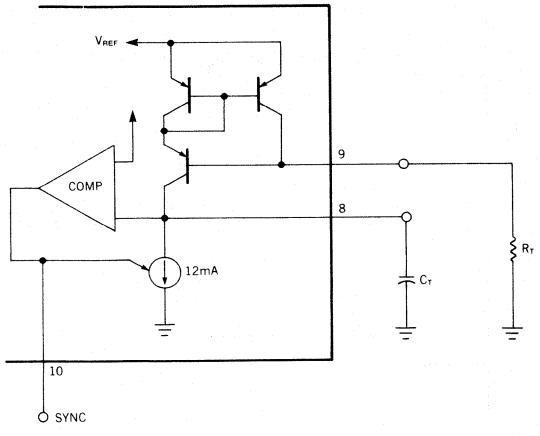
5. Applies to UC1846/UC2846/UC3846 only due to polarity of outputs.
6. Current into Pin 1 guaranteed to latch circuit in shutdown state.
7. Current into Pin 1 guaranteed not to latch circuit in shutdown state.

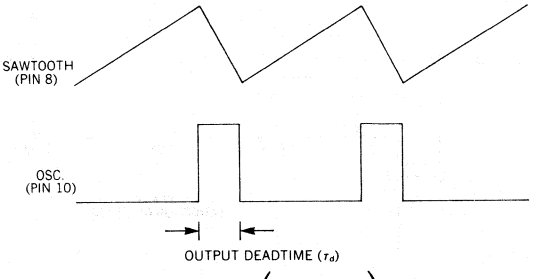
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

APPLICATIONS DATA

Oscillator Circuit



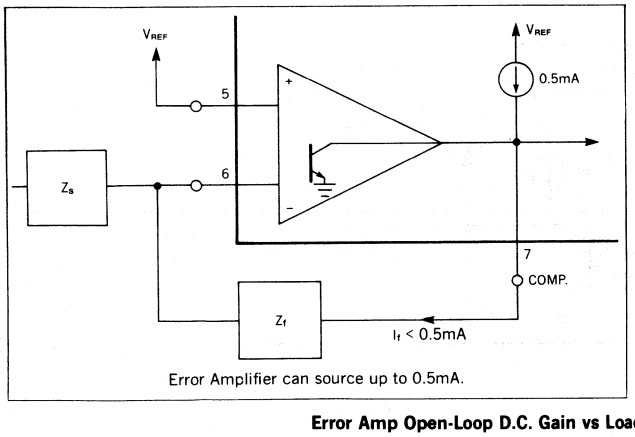


Output deadtime is determined by size of the external capacitor, C_T, according to the formula: $\tau_d = 145C_T\left(\frac{12}{12 - \frac{3.6}{R_T\,(k\Omega)}}\right)$

For large values of R_T: $\tau_d \approx 145C_T$

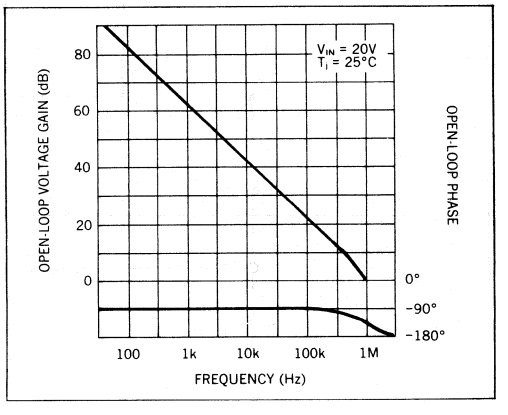
Oscillator frequency is approximated by the formula: $f_T \approx \frac{2.2}{R_TC_T}$

Error Amp Output Configuration

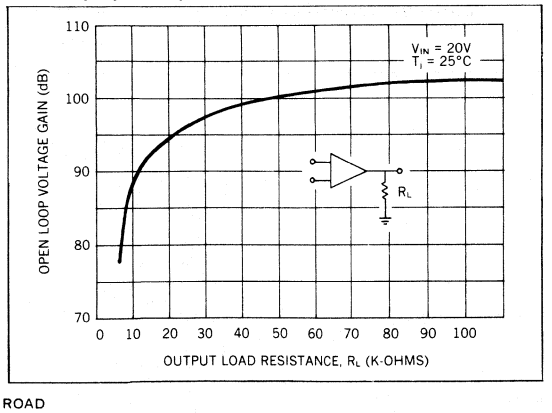


Error Amplifier can source up to 0.5mA.

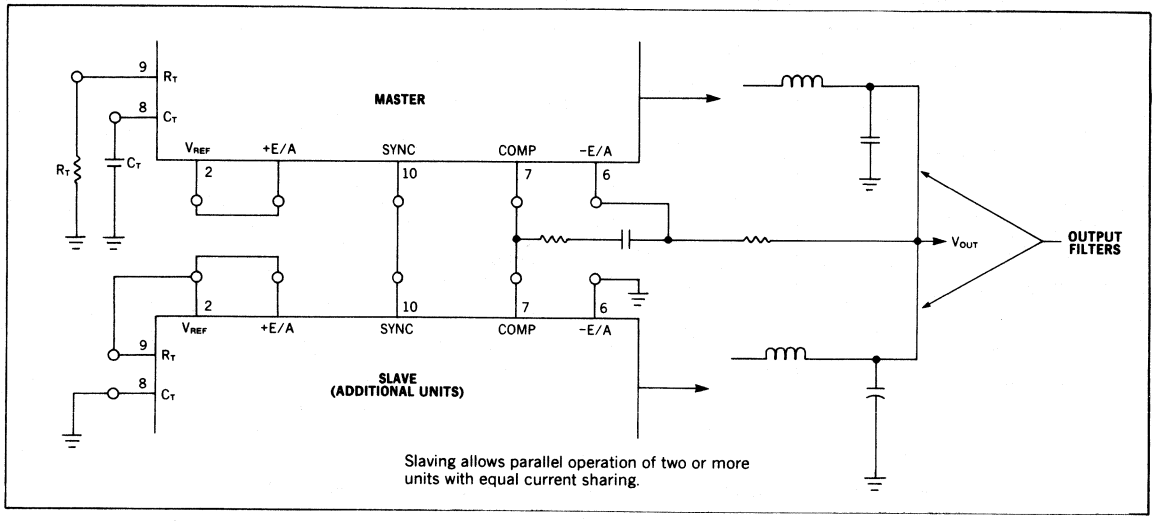
Error Amp Gain and Phase vs Frequency



Error Amp Open-Loop D.C. Gain vs Load Resistance

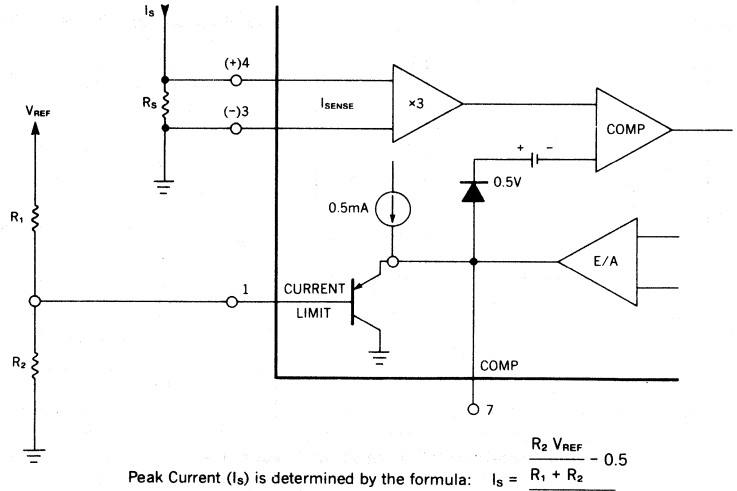


Parallel Operation



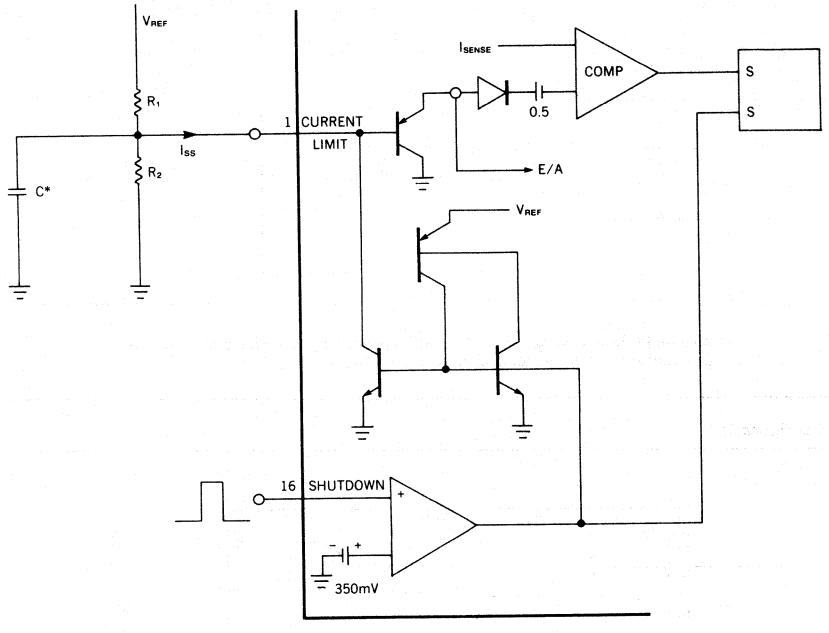
Slaving allows parallel operation of two or more units with equal current sharing.

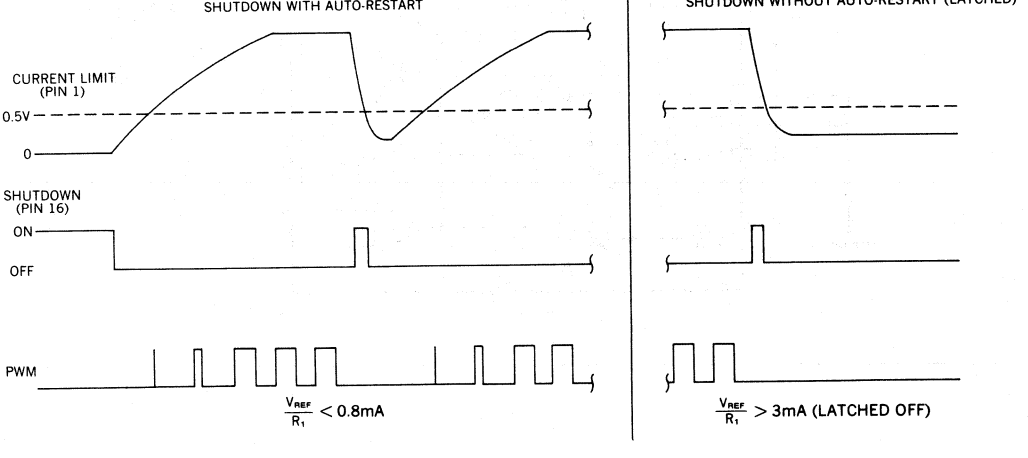
Pulse by Pulse Current Limiting



Peak Current (I_S) is determined by the formula: $I_S = \dfrac{\dfrac{R_2 V_{REF}}{R_1 + R_2} - 0.5}{3R_S}$

Soft Start and Shutdown/Restart Functions

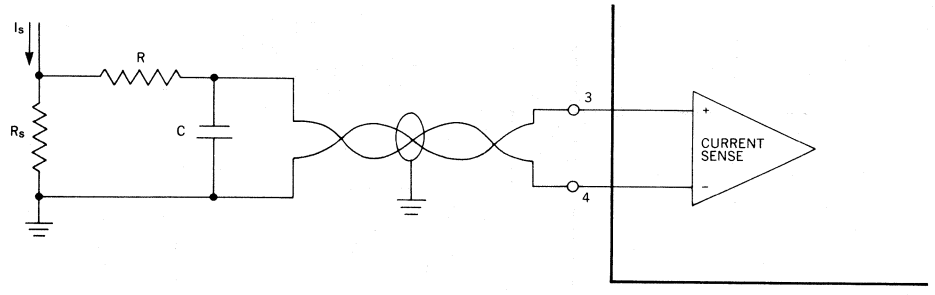




If $\frac{V_{REF}}{R_1} < 0.8mA$, the shutdown latch will commutate when I_{ss} = 0.8mA and a restart cycle will be initiated.

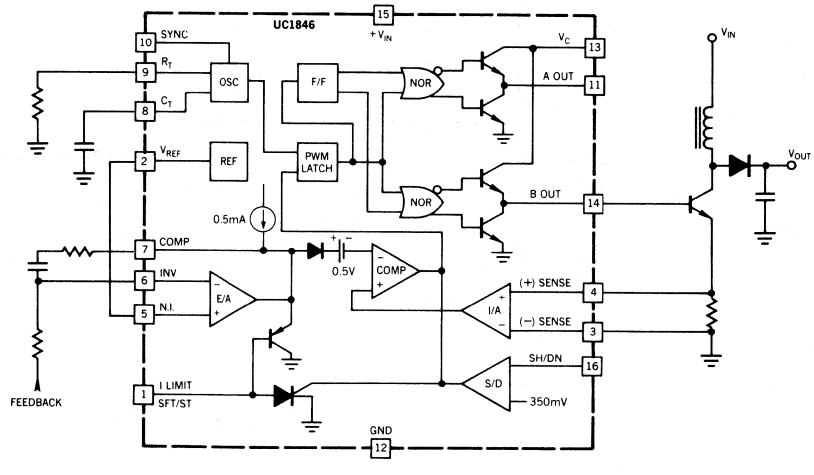
If $\frac{V_{REF}}{R_1} > 3mA$, the device will latch off until power is recycled.

Current Sense Amp Connections

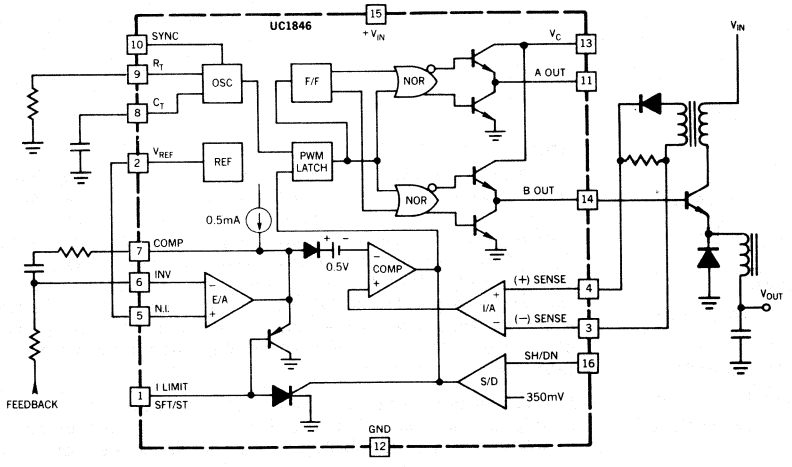


A small RC filter may be required in some applications to reduce switch transients.
Differential input allows remote, noise free sensing.

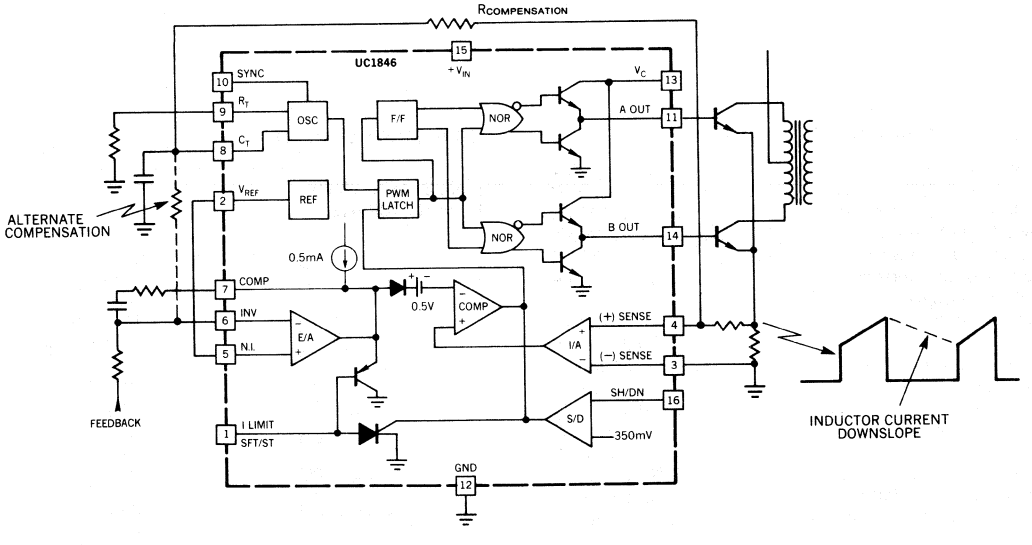
Single Ended Boost Configuration



Buck Converter with Current Sense Winding



Push/Pull Converter with Slope Compensation



Current loop instability above 50% duty cycle can be corrected using slope compensation derived from the sawtooth oscillator. Compensation magnitude should be greater than ½ of the downslope of the inductor current waveform as shown. Alternatively, the compensation signal can be summed into the negative input of the error amplifier.

LINEAR INTEGRATED CIRCUITS
Switching Power Supply Control System

UC1850
UC3850

FEATURES
- Single Chip PWM Control System
- Programmable Under-Voltage Sense
- Remote Enable with Soft-Start
- Adjustable Deadtime
- Over-Voltage Shutdown Latch
- Dual Uncommitted Output Transistors
- Double-Pulse Suppression Logic
- High-Gain, High-Output Error Amplifier
- Controlled-Gain Current Limit Amplifier
- Oscillator Disable for Current-Mode Control
- "Power Good" Logic Indication
- Internal 5V Reference Generator
- 24-Pin DIP Configuration

DESCRIPTION
The UC1850 or UC3850 devices provide a complete control system for high-performance switching power supplies. In addition to a fixed-frequency, dual-output, pulse width modulator, these chips also contain full programming and protection circuitry. While the output of the error amplifier provides the normal regulating input to the PWM comparator, this signal may be overridden with two other comparator inputs. One is a dead-band control which serves to limit the maximum duty cycle, and the other is a protection bus activated by any of several functions. These include a current limit amplifier, an over-voltage shutdown latch, an under-voltage sense comparator and the remote enable input. These last two functions activate a soft-start with an external capacitor.

Additional features included in these devices are logic signal outputs for input "power good" and an indicator when the OVP latch is set. The internal oscillator can be disabled allowing compatability with external frequency sources, voltage feed-forward, or current-mode control.

The PWM output transistors have uncommitted collectors and emitters and have 40V, 100mA capability. The logic arrangement prevents multiple pulses per period and repetitive pulses on one output.

Packaged in a 24-pin DIP, the UC1850 is rated for operation from −55°C to +125°C while the UC3850 in either plastic or ceramic is intended for 0°C to +70°C applications.

ABSOLUTE MAXIMUM RATINGS

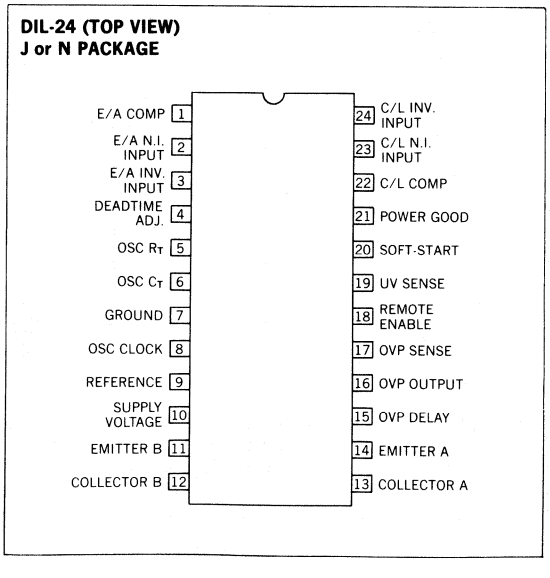
Supply Voltage (V_{IN}) 40V
Collector Voltage (V_C) 40V
Output Current (each output) 100mA
Reference Output Current 20mA
Logic Output Current Sink 10mA
Oscillator Charging Current 5mA
Input Voltage Ranges:
a. Remote Enable ..... −0.3V to V_{REF}
b. Error Amplifier ..... −0.3V to +7V
c. Current Limit Amplifier ..... −0.3V to +7V
d. Under-Voltage Sense ..... −0.3V to +V_{IN}
e. Over-Voltage Sense ..... −0.3V to +7V
Power Dissipation at T_A = 25°C 800mW
Derate Above 50°C ..... 8mW/°C
Operating Temperature Range ..... −55°C to +125°C
Storage Temperature Range ..... −65°C to +150°C
Lead Temperature (soldering, 10 seconds) ..... +300°C

RECOMMENDED OPERATING CONDITIONS

Supply Voltage, V_{IN} ..... 11V to 36V
Oscillator Frequency ..... 10KHz to 200KHz
Timing Resistor, R_T ..... 3KΩ to 20KΩ
Timing Capacitor, C_T ..... .001μF to 1.0μF
Error Amp Input Range ..... 1.5V to 5.5V
Current Amp Input Range ..... 0V to 5.5V

CONNECTION DIAGRAM

DIL-24 (TOP VIEW)
J or N PACKAGE



UNITRODE

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for the UC1850 and 0°C to +70° for the UC3850; V_{IN} = 24V, F_{OSC} = 40KHz.)

PARAMETERS	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Reference Section					
Output Voltage	T_J = 25°C	4.8	5.0	5.2	V
Line Regulation	V_{IN} = 11V to 36V	—	0.10	0.33	mV/V
Load Regulation	I_L = 1mA to 10mA	—	10	30	mV
Temperature Stability*	Over Operating Range	—	20	50	mV
Short Circuit Current	V_{REF} = 0, T_J = 25°C	—	55	100	mA
Oscillator Section					
Nominal Frequency	R_T = 11.5K, C_T = 2.2nF	35	40	45	KHz
Temperature Stability*	Over Operating Range	—	2.5	5	%
Output Pulse Amplitude*		2.0	3.3	4.5	V
Output Pulse Width*		—	0.4	0.8	μS
Maximum Frequency	R_T = 3K, C_T =1.0nF	200	—	—	KHz
Oscillator Output Impedance		—	300	—	Ω
Error Amplifier (V_{CM} = 2.5V)					
Input Offset Voltage		—	5	10	mV
Input Bias Current		—	.05	2	μA
Input Offset Current		—	—	0.1	μA
Open Loop Voltage Gain	R_L > 50KΩ	70	100	—	dB
Gain Bandwidth*	T_J = 25°C, A_V = 0dB	—	0.7	—	MHz
Common-Mode Rejection Ratio	V_{CM} = 0.3V to 5.5V	50	70	—	dB
Output Sink Current	V_O = 0.5V	0.2	0.4	1.0	mA
Output Source Current	V_O = 0V	5.0	7.0	10	mA
Output Swing	Minimum Total Range	0.5	—	4.5	V
Current Limit Amplifier (V_{CM} = 1V)					
Input Offset Voltage		—	—	30	mV
Input Bias Current		—	1	3	μA
Input Offset Current		—	—	0.2	μA
Open Loop Voltage Gain		35	40	—	dB
Output Load Resistance		32	44	56	KΩ
Response Time*		—	0.2	0.4	μS
Deadtime Control					
Nominal Deadtime	Pin 4 = Open	12	16	20	%
Minimum Deadtime	Pin 4 = V_{REF}	—	—	5	%
Control Gain	Pin 4 = 0.5V to 4.5V	—	25	—	%/V
Current to Disable Oscillator*	Pin 4 > 6V	—	—	1	mA

* These parameters although guaranteed over the recommended operating conditions, are not 100% tested in production.

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for the UC1850 and 0°C to +70° for the UC3850; V_{IN} = 24V, F_{OSC} = 40KHz.)

PARAMETERS	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Under-Voltage Sense					
Lower Trip Point Threshold		4.53	4.78	5.02	V
UVS Hysteresis		—	0.25	—	V
UVS Input Current		—	-2	-10	μA
Soft-Start Charge Current	Pin 20 = 0V	56	70	84	μA
Soft-Start Discharge	Pin 20 = 4.7V	200	250	300	μA
Power Good On Threshold		4.8	5.0	5.2	V
Power Good Hysteresis		—	0.7	—	V
Remote Enable Threshold		0.8	1.6	2.0	V
Power Good Off Current	Pin 21 = 5V	—	—	10	μA
Power Good On Voltage	I_{21} = 5mA	—	0.3	0.4	V
Over-Voltage Sense					
OVS Threshold		1.9	2.0	2.1	V
OVS Input Current		—	—	10	μA
Delay Charge Current	Pin 15 = 0V	44	55	66	μA
OVP Off Current	Pin 16 = 5V	—	—	10	μA
OVP On Voltage	I_{16} = 5mA	—	.3	.4	V
Output Switches					
Collector-Emitter Voltage		—	—	20	V
Collector Leakage Current	V_{CE} = 20V	—	—	100	μA
C-E Saturation Voltage	I_C = 50mA	—	1.2	2	V
Emitter Output Voltage	V_C = 11V, I_E = 50mA	8	—	—	V
Short Circuit Current	V_{cc} = 36V	—	200	—	mA
Supply Current					
Standby	V_{cc} = 40V	—	8	12	mA
Operating	V_{cc} = 30V	—	9	14	mA

FUNCTIONAL DESCRIPTION

1. **Reference Regulator:** The regulator supplies several internal reference levels as well as a 5.0V source for external use up to 20mA.

2. **Oscillator:** An external resistor establishes a constant charging current into an external capacitor. In addition to a fixed frequency clock output, the voltage across C_T forms a sawtooth waveform for the PWM comparator. This oscillator may be synchronized to an external source with a positive input into the clock terminal. Alternatively, it may be completely disabled by raising pin 4 above V_{REF} with a source able to provide 1-10mA. In this application, pin 6 is a high impedance input into the PWM comparator and an external blanking pulse must be applied to pin 8 for latch reset and deadtime control.

3. **PWM Comparator:** The output of this comparator will go from low to high — setting the PWM Latch high — when the ramp input on pin 6 rises above the voltage level at its inverting input. This inverting input will follow the lowest of three levels — Deadtime, Error amplifier output, or the Fault line. The comparator will accept inputs down to 0V and once set, the PWM latch requires a clock signal before the next pulse can begin.

4. **Deadtime Adjust:** An internal divider establishes a nominal output duty cycle clamp at 84% but by setting pin 4 to a voltage between 0 and 5V, the duty cycle limit can be set from 0 to 95%. This pin can also be used to disable the oscillator (see above).

5. **Error Amplifier:** This amplifier provides the normal means of controlling pulse width with its gain and frequency response a function of external feedback. The amplifier is stable with closed-loop gains of 10 or above and its output cannot rise above the soft-start voltage on pin 20.

6. **Current Limit:** This amplifier takes control away from the Error amplifier when load current is excessive. The gain characteristics are non-linear to provide a rapid response to an over-current condition, but lower gain for stable current regulation after the initial transient period. Compensation of the current loop can be effected at the Fault line, pin 22.

7. **Fault Line:** Pin 22 is normally pulled to V_{REF} through an internal 44K resistor, but will be held low for any of the following conditions:
   a. Current limit amplifier active
   b. Under-voltage sense low
   c. Over-voltage sense high
   d. Remote enable low

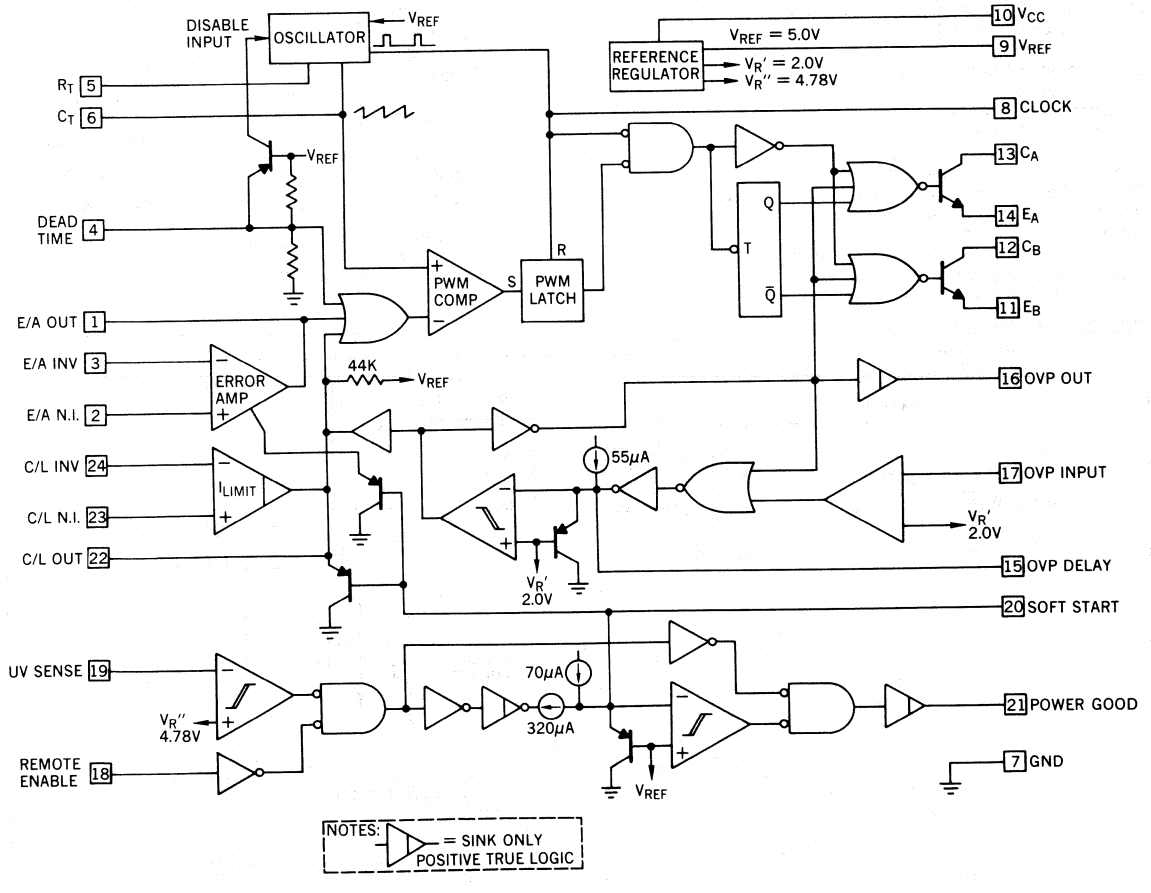
   When the fault cause is removed, the Fault line will go high at a rate determined by the soft-start voltage on pin 20.

8. **Under-Voltage/Remote Sense:** The regulator will be active only when both the Under-Voltage Sense and Remote Enable inputs are high. When this occurs, a "soft-start" is effected with the internal 70μA current source and an external capacitor on pin 20. Should either input fall below its threshold, the Power Good output on pin 21 will immediately go to an active low, followed by regulator shutdown after a delay controlled by the soft-start capacitor and the net pull-down current of 250μA.

9. **Over-Voltage Sense:** When this comparator senses a voltage in excess of its threshold, with a duration longer than an interval established by the 55μA current source and an external capacitor on pin 15, the circuit will latch, terminate the PWM output signal, pull the fault line low, and indicate with a high level on pin 16, the OV shutdown state. Once latched, the circuit may be restarted by recycling the input Vcc voltage, momentarily lowering the Remote Enable input, or discharging the OVP delay capacitor on pin 15.

10. **Output Switches:** The switches will operate alternately with logic to insure that once a given pulse is terminated, the same output cannot reactivate during the remainder of that period or in any succeeding period until after a pulse has been delivered by the other output. The output transistors may be operated in either common emitter or common collector configuration.

UC1850/3850 BLOCK DIAGRAM



LINEAR INTEGRATED CIRCUITS
Isolated Feedback Generator

UC1901
UC2901
UC3901

FEATURES

- An amplitude-modulation system for transformer coupling an isolated feedback error signal
- Low-cost alternative to optical couplers
- Internal 1% reference and error amplifier
- Internal carrier oscillator usable to 5MHz
- Modulator synchronizable to an external clock
- Loop status monitor

DESCRIPTION

The UC1901 family is designed to solve many of the problems associated with closing a feedback control loop across a voltage isolation boundary. As a stable and reliable alternative to an optical coupler, these devices feature an amplitude modulation system which allows a loop error signal to be coupled with a small RF transformer or capacitor.

The programmable, high-frequency oscillator within the UC1901 series permits the use of smaller, less expensive transformers which can readily be built to meet the isolation requirements of today's line-operated power systems. As an alternative to RF operation, the external clock input to these devices allows synchronization to a system clock or to the switching frequency of a SMPS.

An additional feature is a status monitoring circuit which provides an active-low output when the sensed error voltage is within ±10% of the reference.

Since these devices can also be used as a DC driver for optical couplers, the benefits of 4.5 to 40V supply operation, a 1% accurate reference, and a high gain general purpose amplifier offer advantages even though an AC system may not be desired.

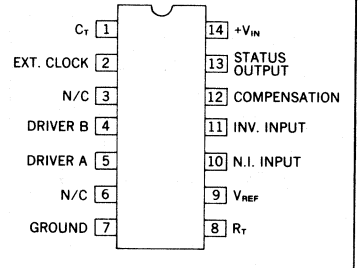
ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Supply Voltage, V_{IN}	40V
Reference Output Current	-10mA
Driver Output Currents	-35mA
Status Indicator Voltage	40V
Status Indicator Current	20mA
Ext. Clock Input	40V
Error Amplifier Inputs	-0.5V to +35V
Power Dissipation at T_A = 25°C	
Derate at 10mW/°C above T_A = 50°C	1000mW
Power Dissipation at T_C = 25°C	
Derate at 16mW/°C above T_A = 25°C	2000mW
Thermal Resistance, Junction to Ambient	100°C/W
Thermal Resistance, Junction to Case	60°C/W
Operating Junction Temperature	-55°C to +150°C
Storage Temperature	-65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

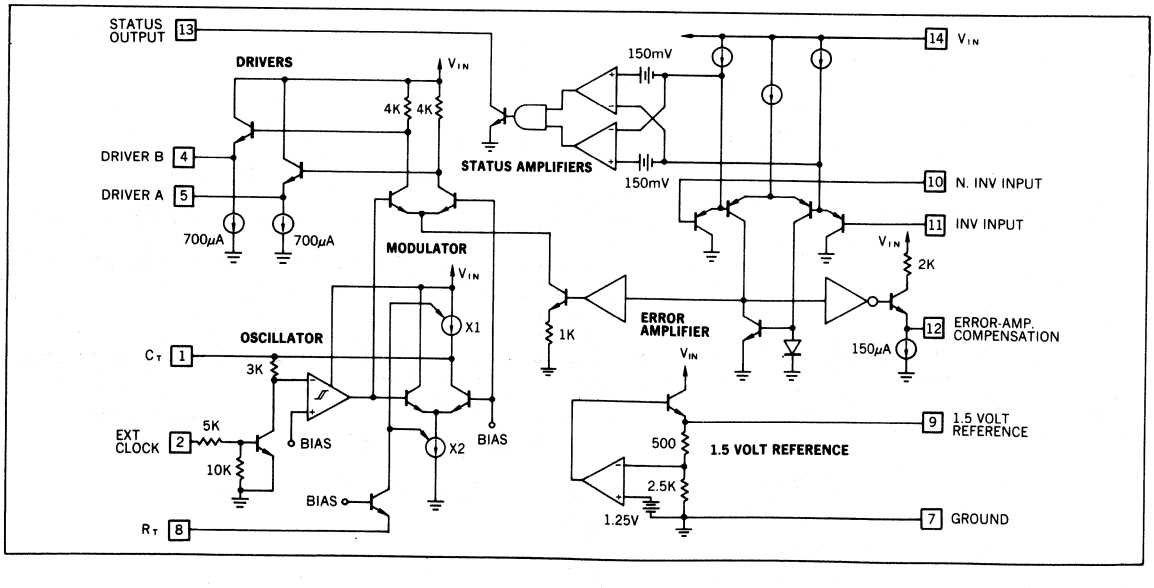
Note 1: Voltages are referenced to ground, Pin 7.
Currents are positive into, negative out of the specified terminal.

CONNECTION DIAGRAM

DIL-14 (TOP VIEW)
J or N PACKAGE



UC1901 SIMPLIFIED SCHEMATIC

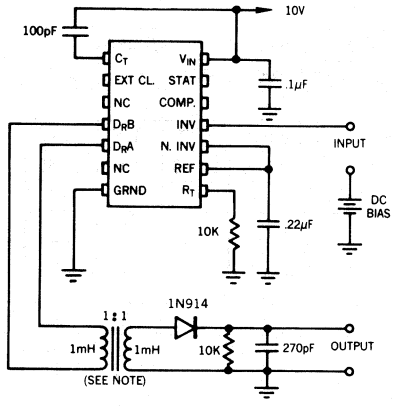


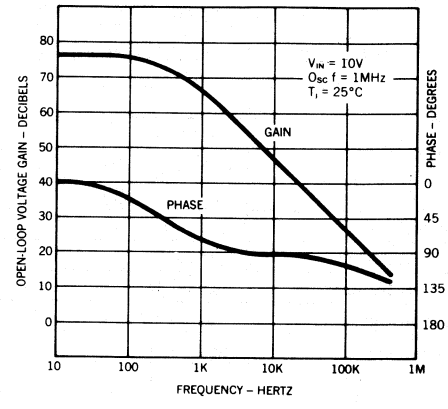
UNITRODE

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for the UC1901; −25°C to +85°C for the UC2901; and 0°C to +70°C for the UC3901; V_{IN} = 10V, R_T = 10kΩ, C_T = 820pF)

PARAMETER	TEST CONDITIONS	UC1901/UC2901			UC3901			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Reference Section								
Output Voltage	T_j = 25°C	1.485	1.5	1.515	1.47	1.5	1.53	V
	$T_{MIN} \leq T_j \leq T_{MAX}$	1.470	1.5	1.530	1.455	1.5	1.545	
Line Regulation	V_{IN} = 4.5 to 35V		2	10		2	15	mV
Load Regulation	I_{OUT} = 0 to 5mA		4	10		4	15	mV
Short Circuit Current	T_j = 25°C		−35	−45		−35	−45	mA
Error Amplifier Section (To Compensation Terminal)								
Input Offset Voltage	V_{CM} = 1.5V		1	4		1	8	mV
Input Bias Current	V_{CM} = 1.5V		−1	−3		−1	−6	μA
Input Offset Current	V_{CM} = 1.5V		0.1	1		0.1	2	μA
Small Signal Open Loop Gain		40	60		40	60		dB
CMRR	V_{CM} = 0.5 to 7.5V	60	80		60	80		dB
PSRR	V_{IN} = 5 to 25V	80	100		80	100		dB
Output Swing, Δ Vo		0.4	0.7		0.4	0.7		V
Maximum Sink Current		90	150		90	150		μA
Maximum Source Current		−2	−3		−2	−3		mA
Gain Band Width Product			1			1		MHz
Slew Rate			0.3			0.3		V/μs
Modulator/Drivers Section (From Compensation Terminal)								
Voltage Gain		11	12	13	10	12	14	dB
Output Swing		±1.6	±2.8		±1.6	±2.8		V
Driver Sink Current		500	700		500	700		μA
Driver Source Current		−15	−35		−15	−35		mA
Gain Band Width Product			25			25		MHz
Oscillator Section								
Initial Accuracy	T_j = 25°C	140	150	160	130	150	170	kHz
	$T_{MIN} \leq T_j \leq T_{MAX}$	130		170	120		180	kHz
Line Sensitivity	V_{IN} = 5 to 35V		.15	.35		.15	.60	%/V
Maximum Frequency	R_T = 10K, C_T = 10pF		5			5		MHz
Ext. Clock Low Threshold	Pin 1 (C_T) = V_{IN}	0.5			0.5			V
Ext. Clock High Threshold	Pin 1 (C_T) = V_{IN}			1.6			1.6	V
Status Indicator Section								
Input Voltage Window	@ E/A Inputs, V_{CM} = 1.5V	±135	±150	±165	±130	±150	±170	mV
Saturation Voltage	E/A Δ Input = 0V, I_{SINK} = 1.6mA			0.45			0.45	V
Max. Output Current	Pin 13 = 3V, E/A Δ Input = 0.0V	8	15		8	15		mA
Leakage Current	Pin 13 = 40V, E/A Δ Input = 0.2V		.05	1		.05	5	μA
Supply Current	V_{IN} = 35V		5	8		5	10	mA

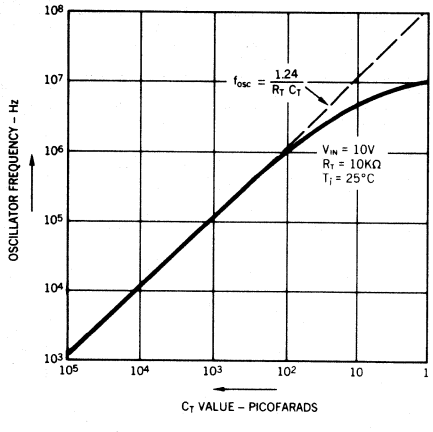
Transformer Coupled Open Loop Transfer Function



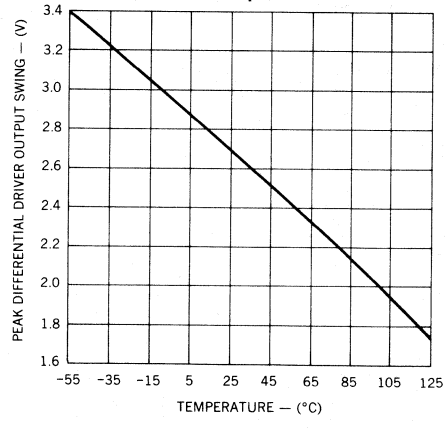


Transformer Data: N1 = N2 = 20T AWG 26
Core = Ferroxcube 3E2A Ferrite, 0.5" O.D. toroid
Carrier Frequency = 1MHz

Oscillator Frequency



Typical Driver Output Swing vs Temperature



APPLICATION INFORMATION

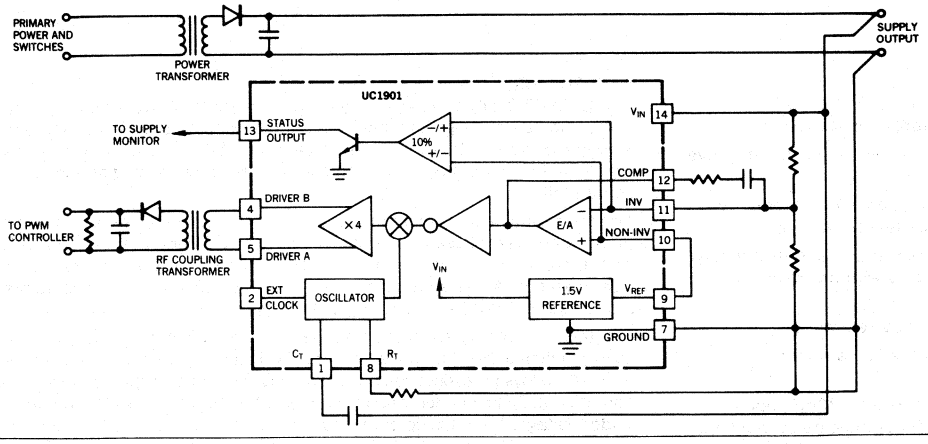
The error amplifier compensation terminal, Pin 12, is intended as a source of feedback to the amplifier's inverting input at Pin 11. For most applications, a series DC blocking capacitor should be part of the feedback network. The amplifier is internally compensated for unity feedback.

The waveform at the driver outputs is a squarewave with an amplitude that is proportional to the error amplifier input signal. There is a fixed 12dB of gain from the error amplifier compensation pin to the modulator driver outputs. The frequency of the output waveform is controlled by either the internal oscillator or an external clock signal. With the internal oscillator the squarewave will have a fixed 50% duty cycle. If the internal oscillator is disabled by connecting Pin 1, C_T, to V_{IN} then the frequency and duty cycle of the output will be determined by the input clock waveform at Pin 2. If the oscillator remains disabled and there is no clock input at Pin 2, there will be a linear 12dB of signal gain to one or the other of the driver outputs depending on the DC state of Pin 2.

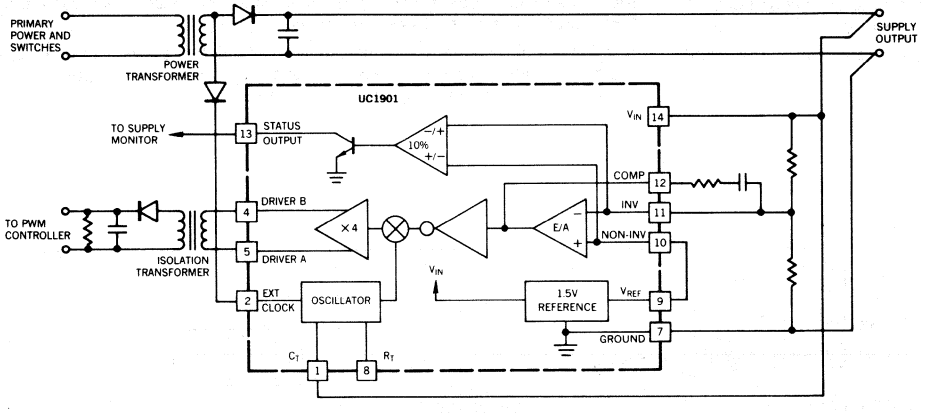
The driver outputs are emitter followers which will source a minimum of 15mA of current. The sink current, internally limited at 700μA, can be increased by adding resistors to ground at the driver outputs.

TYPICAL APPLICATIONS

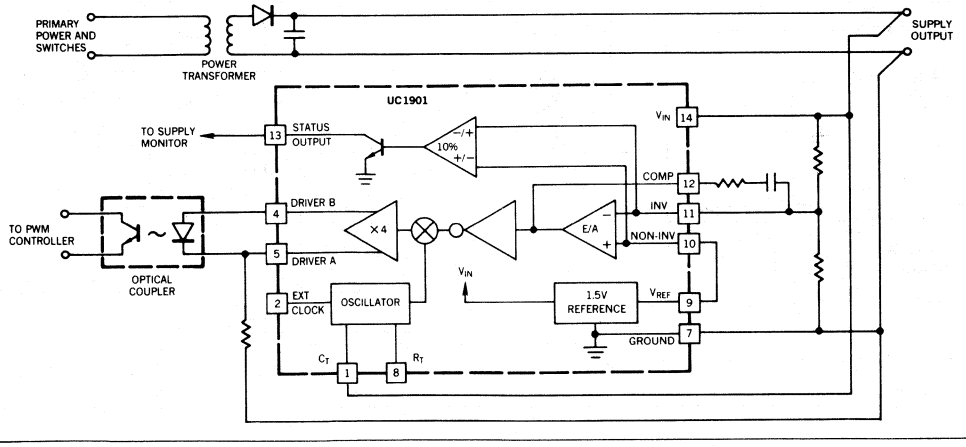
R.F. Transformer Coupled Feedback



Feedback Coupled at Switching Frequency



Optically Coupled DC Feedback



LINEAR INTEGRATED CIRCUITS
Quad Supply and Line Monitor

UC1903
UC2903
UC3903

FEATURES

- Inputs for monitoring up to four separate supply voltage levels
- Internal inverter for sensing a negative supply voltage
- Line/switcher sense input for early power source failure warning
- Programmable under- and over-voltage fault thresholds with proportional hysteresis
- A precision 2.5V reference
- General purpose op-amp for auxillary use
- Three high current, >30mA, open-collector outputs indicate over-voltage, under-voltage and power OK conditions
- Input supply under-voltage sensing and start-latch eliminate erroneous fault alerts during start-up
- 8-40V supply operation with 7mA stand-by current

DESCRIPTION

The UC1903 family of quad supply and line monitor integrated circuits will respond to under- and over-voltage conditions on up to four continuously monitored voltage levels. An internal op-amp inverter allows at least one of these levels to be negative. A separate line/switcher sense input is available to provide early warning of line or other power source failures.

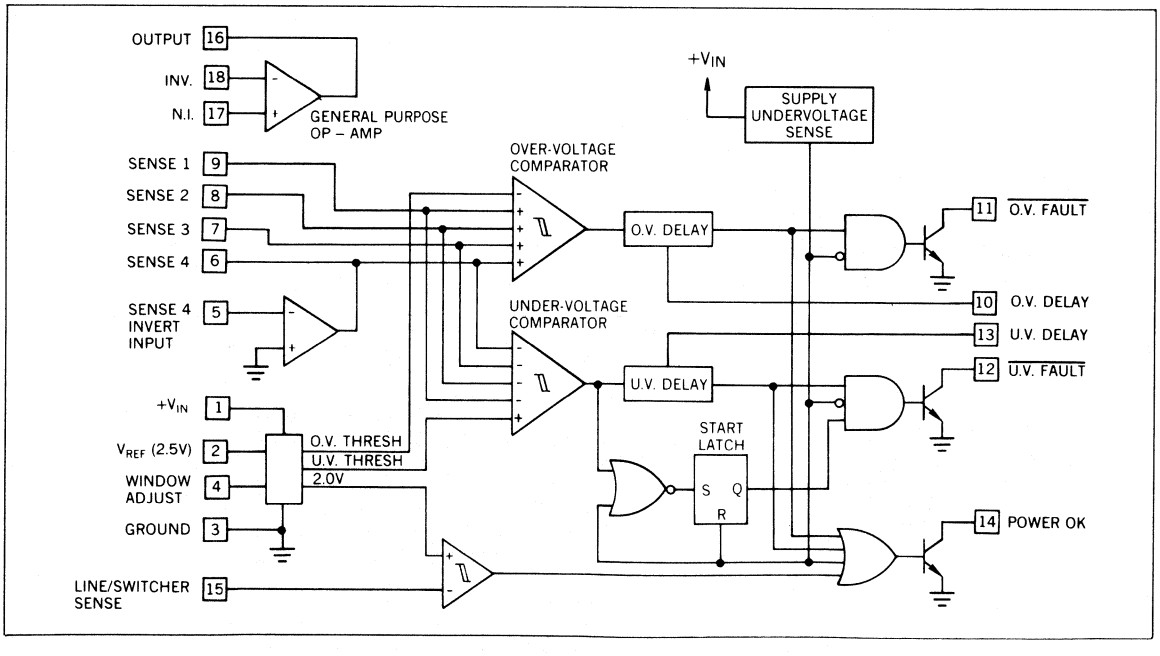
The fault window adjustment circuit on these devices provides easy programming of under- and over-voltage thresholds. The thresholds, centered around a precision 2.5V reference, have an input hysteresis that scales with the window width for precise, glitch-free operation. A reference output pin allows the sense input fault windows to be scaled independently using simple resistive dividers.

The three open collector outputs on these devices will sink in excess of 30mA of load current when active. The under- and over-voltage outputs respond after separate, user defined, delays to respective fault conditions. The third output is active during any fault condition including under- and over-voltage, line/switcher faults, and input supply under-voltage. The off state of this output indicates a "power OK" situation.

An additional, uncommitted, general purpose op-amp is also included. This op-amp, capable of sourcing 20mA of output current, can be used for a number of auxiliary functions including the sensing and amplification of a feedback error signal when the 2.5V output is used as a system reference.

In addition, these ICs are equipped with a start-latch to prevent erroneous under-voltage indications during start-up. These parts operate over an 8-40V input supply range and require a typical stand-by current of only 6mA.

BLOCK DIAGRAM



UNITRODE

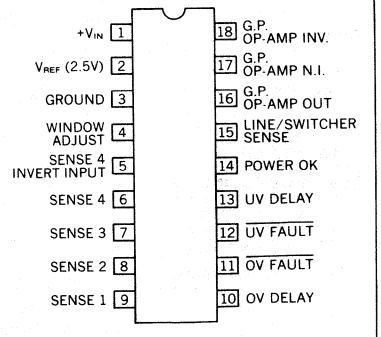
ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage ($+V_{IN}$) ..... +40V
Open Collector Output Voltages ..... +40V
Open Collector Output Currents 50mA
Sense 1-4 Input Voltages ..... -0.3V to +20V
Line/Switcher Sense Input Voltage ..... -0.3V to +40V
Op-Amp and Inverter Input Voltages ..... -0.3V to +40V
Op-Amp and Inverter Output Currents ..... -40mA
Window Adjust Voltage ..... 0.0V to +10V
Delay Pin Voltages ..... 0.0V to +5V
Reference Output Current ..... -40mA
Power Dissipation at T_A = 25°C 1000mW
  Derate at 10mW/°C above T_A = 25°C
Power Dissipation at T_C = 25°C 2000mW
  Derate at 16mW/°C above T_C = 25°C
Thermal Resistance, Junction to Ambient ..... 100°C/W
Thermal Resistance, Junction to Case ..... 60°C/W
Operating Junction Temperature ..... -55°C to +150°C
Storage Temperature ..... -65°C to +150°C
Lead Temperature (Soldering, 10 Seconds) ..... 300°C

Note: 1. Voltages are referenced to ground (Pin 3). Currents are positive into, negative out of, the specified terminals.

CONNECTION DIAGRAM

DIL-18 (Top View)
J or N Package



ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = -55°C to +125°C for the UC1903; -25°C to +85°C for the UC2903; and 0°C to +70°C for the UC3903; $+V_{IN}$ = 15V; Sense Inputs (Pins 6-9 and Pin 15) = 2.5V; $V_{PIN\ 4}$ = 1.0V.)

PARAMETER	TEST CONDITIONS	UC1903/UC2903			UC3903			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Supply								
Input Supply Current	No Faults	—	7	9	—	7	11	mA
	UV, OV and Line Fault	—	10	15	—	10	18	mA
Supply Under Voltage Threshold (V_{SUV})	Fault Outputs Enabled	6.0	7.0	7.5	5.5	7.0	8.0	V
Minimum Supply to Enable Power OK Output		—	3.0	4.0	—	3.0	4.0	V
Reference								
Output Voltage (V_{REF})	T_j = 25°C	2.485	2.5	2.515	2.470	2.5	2.530	V
	Over Temperature	2.465	—	2.535	2.465	—	2.535	V
Load Regulation	I_L = 0 to 10mA	—	1	10	—	1	15	mV
Line Regulation	$+V_{IN}$ = V_{SUV} + 0.1V to 40V	—	1	4	—	1	8	mV
Short Circuit Current	T_j = 25°C	—	40	—	—	40	—	mA
Fault Thresholds								
OV Threshold Adj.	Offset from V_{REF} as a function of V_{PIN4} Input = Low to High, .5V ≤ $V_{PIN\ 4}$ ≤ 2.5V	.230	.25	.270	.230	.25	.270	V/V
UV Threshold Adj.	Offset from V_{REF} as a function of V_{PIN4} Input = High to Low, .5V ≤ $V_{PIN\ 4}$ ≤ 2.5V	-.270	-.25	-.230	-.270	-.25	-.230	V/V
OV & UV Threshold Hyst.	.5V ≤ $V_{PIN\ 4}$ ≤ 2.5V	10	20	30	10	20	30	mV/V
OV & UV Threshold Supply Sensitivity	$+V_{IN}$ = V_{SUV} +0.1V to 40V	—	.002	.01	—	.002	.02	%/V
Adjust Pin (Pin 4) Input Bias Current	.5V ≤ $V_{PIN\ 4}$ ≤ 2.5V	—	±1	±10	—	±1	±12	μA/V
Line Sense Threshold	Input = High to Low	1.94	2.0	2.06	1.9	2.0	2.1	V
Line Sense Threshold Hyst.		125	175	225	100	175	250	mV

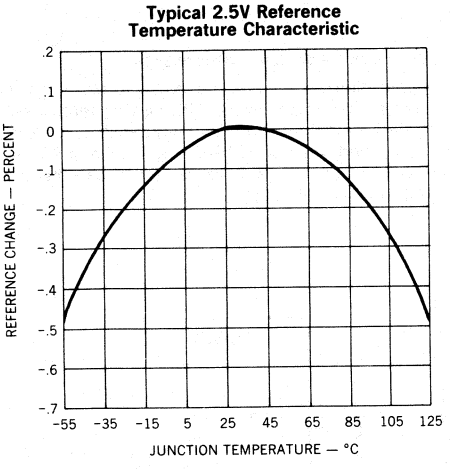
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

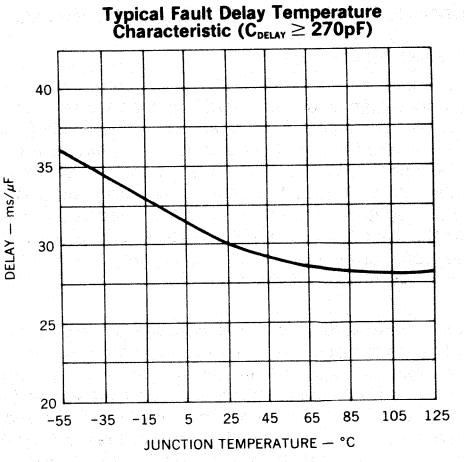
PRINTED IN U.S.A.

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for the UC1903; −25°C to +85°C for the UC2903; and 0°C to +70°C for the UC3903; $+V_{IN}$ = 15V; Sense Inputs (Pins 6-9 and Pin 15) = 2.5V; $V_{PIN\ 4}$ = 1.0V.)

PARAMETER	TEST CONDITIONS	UC1903/UC2903			UC3903			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Sense Inputs								
Sense 1-4 Input Bias Current	Input = 2.8V (Note 2)	—	1	3	—	1	6	μA
	Input = 2.2V (Note 2)	—	-1	-3	—	-1	-6	μA
Line Sense Input Bias Current	Input = 2.3V (Note 2)	—	1	3	—	1	6	μA
OV and UV Fault Delay								
Charging Current		—	60	—	—	60	—	μA
Threshold Voltage	Delay Pin = Low to High	—	1.8	—	—	1.8	—	V
Threshold Hysteresis	T_j = 25°C	—	250	—	—	250	—	mV
Delay	Ratio of Threshold Voltage to Charging Current	20	30	50	20	30	50	ms/μF
Fault Outputs ($\overline{OV}$, $\overline{UV}$, & Power OK)								
Maximum Current	V_{OUT} = 2V	30	70	—	30	70	—	mA
Saturation Voltage	I_{OUT} = 12mA	—	.25	.40	—	.25	.40	V
Leakage Current	V_{OUT} = 40V	—	3	25	—	3	25	μA
Sense 4 Inverter								
Input Offset Voltage		—	2	8	—	2	10	mV
Input Bias Current		—	.1	2	—	.1	4	μA
Open Loop Gain		65	80	—	65	80	—	dB
PSRR	$+V_{IN}$ = 8 to 40V	65	100	—	65	100	—	dB
Unity Gain Frequency		—	1	—	—	1	—	MHz
Slew Rate		—	.4	—	—	.4	—	V/μs
Short Circuit Current	T_j = 25°C	—	40	—	—	40	—	mA
G.P. Op-Amp								
Input Offset Voltage		—	1	5	—	1	8	mV
Input Bias Current		—	.1	2	—	.1	4	μA
Input Offset Current		—	.01	.5	—	.01	1.0	μA
Open Loop Gain		65	120	—	65	120	—	dB
CMRR	V_{CM} = 0 to $+V_{IN}$ −2.0V	65	100	—	65	100	—	dB
PSRR	$+V_{IN}$ = 8 to 40V	65	100	—	65	100	—	dB
Unity Gain Frequency		—	1	—	—	1	—	MHz
Slew Rate		—	.4	—	—	.4	—	V/μs
Short Circuit Current	T_j = 25°C	—	40	—	—	40	—	mA

Note: 2. These currents represent maximum input bias currents required as the sense inputs cross appropriate thresholds.





OPERATION AND APPLICATION INFORMATION

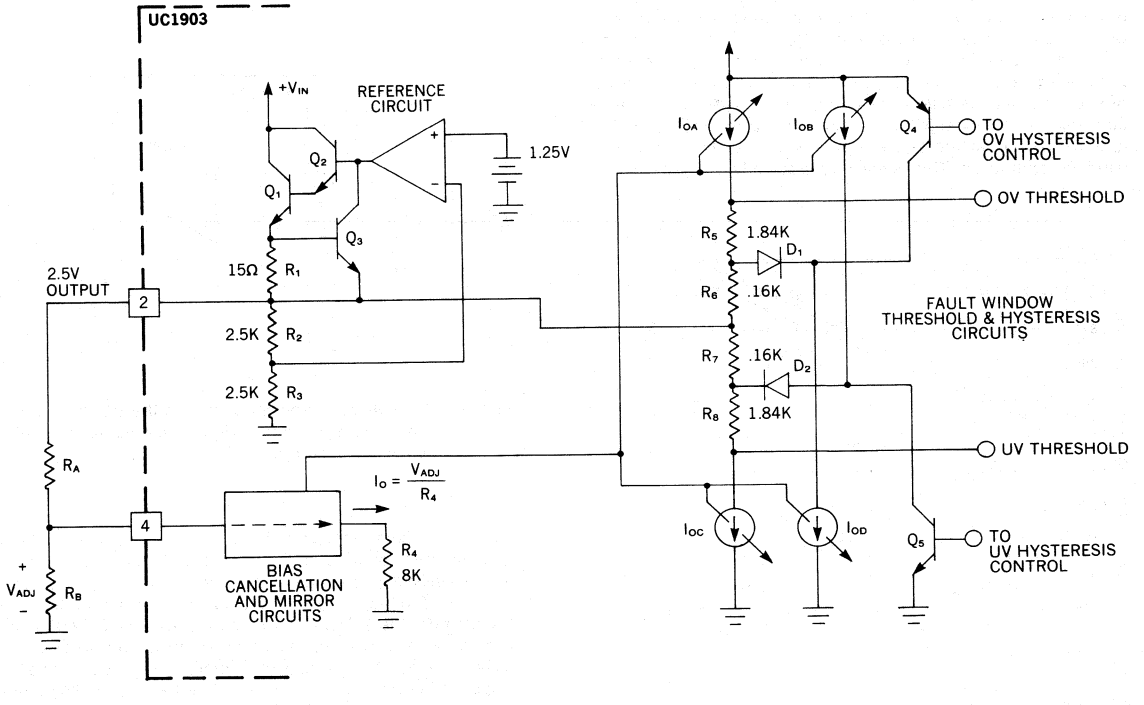


Figure 1. The UC1903 fault window circuitry generates OV and UV thresholds centered around the 2.5V reference. Window magnitude and threshold hysteresis are proportional to the window adjust input voltage at Pin 4.

OPERATION AND APPLICATION INFORMATION (continued)

Setting a Fault Window

The fault thresholds on the UC1903 are generated by creating positive and negative offsets, equal in magnitude, that are referenced to the chip's 2.5V reference. The resulting fault window is centered around 2.5V and has a magnitude equal to that of the applied offsets. Simplified schematics of the fault window and reference circuits are shown in Figure 1 (see previous page). The magnitude of the offsets is determined by the voltage applied at the window adjust pin, Pin 4. A bias cancellation circuit keeps the input current required at Pin 4 low, allowing the use of a simple resistive divider off the reference to set the adjust pin voltage.

The adjust voltage at Pin 4 is internally applied across R_4, an 8K resistor. The resulting current is mirrored four times to generate current sources I_{OA}, I_{OB}, I_{OC}, and I_{OD}, all equal in magnitude. When all four of the sense inputs are inside the fault window, a no-fault condition, Q_4 and Q_5 are turned on. In combination with D_1 and D_2 this prevents I_{OB} and I_{OD} from affecting the fault thresholds. In this case, the OV and UV thresholds are equal to $V_{REF} + I_{OA}(R_5 + R_6)$ and $V_{REF} - I_{OC}(R_7 + R_8)$ respectively. The fault window can be expressed as:

(1) $$2.5V \pm \frac{V_{ADJ}}{4}$$

In terms of a sensed nominal voltage level, V_S, the window as a percent variation is:

(2) $$V_S \pm (10 \cdot V_{ADJ})\%$$

When a sense input moves outside the fault window given in equation (1), the appropriate hysteresis control signal turns off Q_4 or Q_5. For the under-voltage case, Q_5 is disabled and current source I_{OB} flows through D_2. The net current through R_7 becomes zero as I_{OB} cancels I_{OC}, giving an 8% reduction in the UV threshold offset. The over-voltage case is the same, with Q_4 turning off, allowing I_{OD} to cancel the current flow, I_{OA}, through R_6. The result is a hysteresis at the sense inputs which is always 8% of the window magnitude. This is shown graphically in Figure 2.

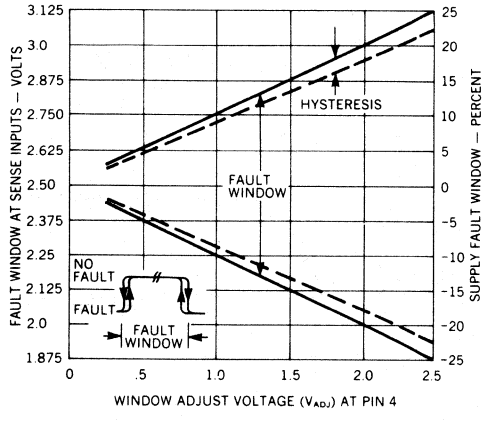


Figure 2. The fault window and threshold hysteresis scale as a function of the voltage applied at Pin 4, the window adjust pin.

Fault Windows Can be Scaled Independently

In many applications, it may be desirable to monitor various supply voltages, or voltage levels, with varying fault windows. Using the reference output and external resistive dividers this is easily accomplished with the UC1903. Figures 3 and 4 illustrate how the fault window at any sense input can be scaled independently of the remaining inputs.

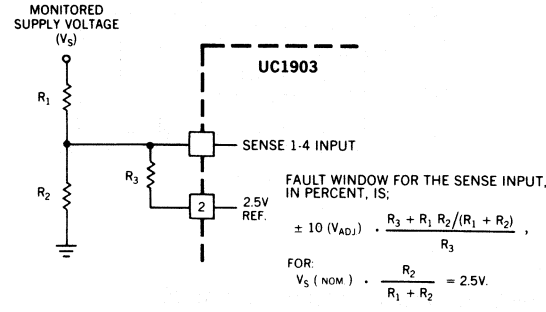


Figure 3. Using the reference output and a resistive divider, a sense input with an independently wider fault window can be generated.

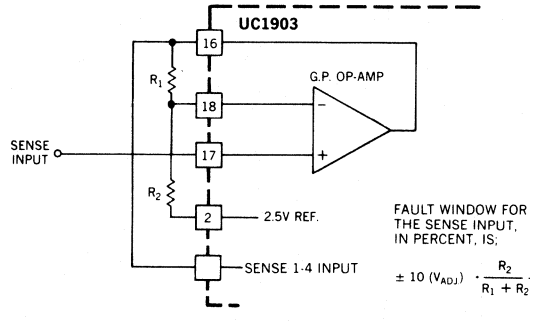


Figure 4. The general purpose op-amp on the UC1903 can be used to create a sense input with an independently tighter fault window.

Figure 4 demonstrates one of many auxillary functions that the uncommitted op-amp on the UC1903 can be used for. Alternatively, this op-amp can be used to buffer high impedence points, perform logic functions, or for sensing and amplification. For example, the G.P. op-amp, combined with the 2.5V reference, can be used to produce and buffer an optically coupled feedback signal in isolated supplies with primary side control. The output stage of this op-amp is detailed in Figure 5. The NPN emitter follower provides high source current capability, ≥20mA, while the substrate device, Q_3, provides good transient sinking capability.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

OPERATION AND APPLICATION INFORMATION (continued)

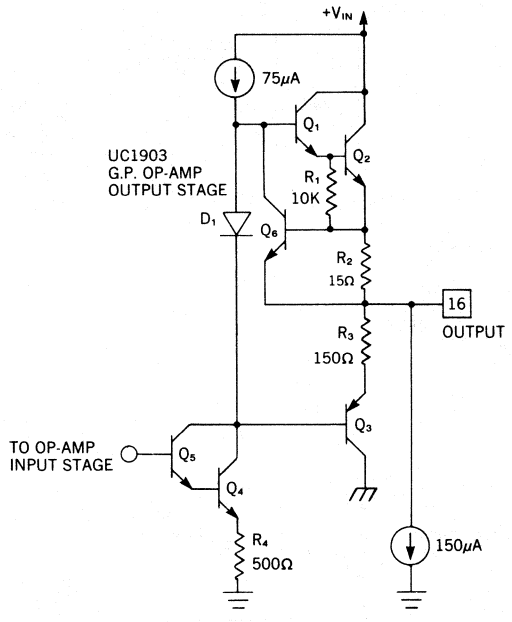


Figure 5. The G.P. op-amp on the UC1903 has a high source current (≥20mA) capability and enhanced transient sinking capability through substrate device Q_3.

Sensing a Negative Voltage Level

The UC1903 has a dedicated inverter coupled to the sense 4 input. With this inverter, a negative voltage level can be sensed as shown in Figure 6. The output of this inverter is an unbiased emitter follower. By tying the inverting input, Pin 5, high the output emitter follower will be reverse biased, leaving the sense 4 input in a high impedence state. In this manner, the sense 4 input can be used, as the remaining sense inputs would be, for sensing positive voltage levels.

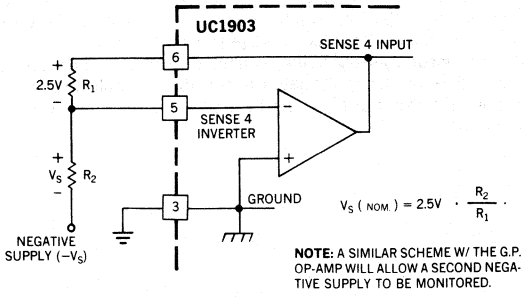


Figure 6. Inverting the sense 4 input for monitoring a negative supply is accommodated with the dedicated inverter.

Using The Line/Switcher Sense Output

The line switcher sense input to the UC1903 can be used for early detection of line, switcher, or other power source, failures. Internally referenced to 2.0V, the line sense comparator will cause the POWER OK output to indicate a fault (active low) condition when the LINE/SWITCHER SENSE input goes from above to below 2.0V. The line sense comparator has approximately 175mV of hysteresis requiring the line/switcher input to reach 2.175V before the POWER OK output device can be turned-off, allowing a no-fault indication. In Figure 7 an example showing the use of the LINE/SWITCHER SENSE input for early switcher-fault detection is detailed. A sample signal is taken from

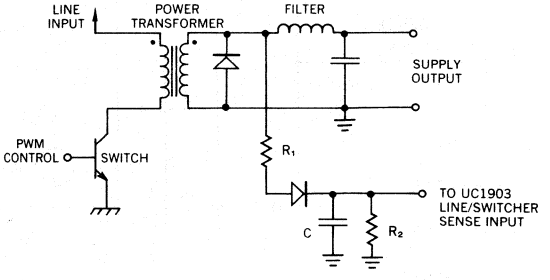


Figure 7. The line/switcher sense input can be used for an early line or switcher fault indication.

the output of the power transformer, rectified and filtered, and used at the line/switcher input. By adjusting the R_2C time constant with respect to the switching frequency of the supply and the hold up time of the output capacitor, switcher faults can be detected before supply outputs are significantly affected.

OV and UV Comparators Maintain Accurate Thresholds

The structure of the $\overline{OV}$ and $\overline{UV}$ comparators, shown in Figure 8 results in accurate fault thresholds even in the case where multiple sense inputs cross a fault threshold simultaneously. Unused sense inputs can be tied either to the 2.5V reference, or to another, utilized, sense input. The four under- and over-voltage sense inputs on the UC1903 are clamped as detailed on the Sense 1 input in Figure 8. The series 2K resistor, R_1, and zener diode, Z_1, prevent extreme under- and over-voltage conditions from inverting the outputs of the fault comparators. A parasitic diode, D_1, is present at the inputs as well. Under normal operation it is advisable to insure that voltage levels at all of the sense inputs stay above −0.3V. The same type of input protection exists at the line sense input, Pin 15, except a 5K series resistor is used.

The fault delay circuitry on the UC1903 is also shown in Figure 8. In the case of an over-voltage condition at one of the sense inputs Q_{20} is turned off, allowing the internal 60μA current source to charge the user-selected delay capacitor. When the capacitor voltage reaches 1.8V, the $\overline{OV}$ and POWER OK outputs become active low. When the fault condition goes away Q_{20} is turned back on, rapidly discharging the delay capacitor. Operation of the under-voltage delay is, with appropriate substitutions, the same.

OPERATION AND APPLICATION INFORMATION (continued)

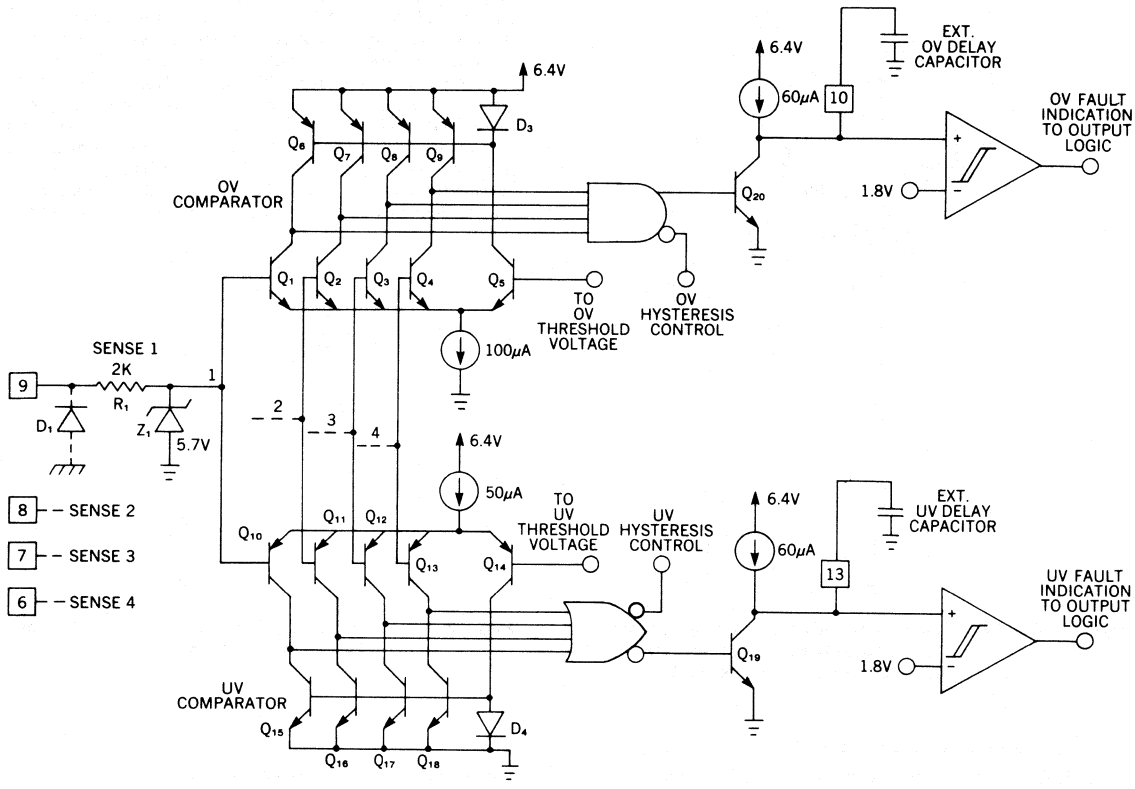


Figure 8. The OV and UV comparators on the UC1903 trigger respective fault delay circuits when one or more of the sense inputs move outside the fault window. Input clamps insure proper operation under extreme fault conditions.

Start Latch and Supply Under-Voltage Sense Allow Predictable Power-Up

The supply under-voltage sense and start-latch circuitry on the UC1903 prevents fault indications during start-up or low input supply ($+V_{IN}$) conditions. When the input supply voltage is below the supply under-voltage threshold the $\overline{OV}$ and $\overline{UV}$ fault outputs are disabled and the POWER OK output is active low. The POWER OK output will remain active until the input supply drops below approximately 3.0V. With $+V_{IN}$ below this level, all of the open collector outputs will be off.

When the input supply is low, the under-voltage sense circuitry resets the start-latch. With the start-latch set, the $\overline{UV}$ fault output will remain disabled as the input supply rises to its normal operating level (8-40V). The latch stays set until all of the sense inputs are above the under-voltage threshold. This allows slow starting, or supply sequencing, without an artificial under-voltage fault indication. Once the latch is set, the $\overline{UV}$ fault output will respond if any of the sense inputs drop below the under-voltage threshold.

LINEAR INTEGRATED CIRCUITS
Sealed Lead-Acid Battery Charger

FEATURES

- Optimum control for maximum battery capacity and life
- Internal state logic provides three charge states
- Precision reference tracks battery requirements over temperature
- Controls both voltage and current at charger output
- System interface functions
- Typical standby supply current of only 1.6mA

DESCRIPTION

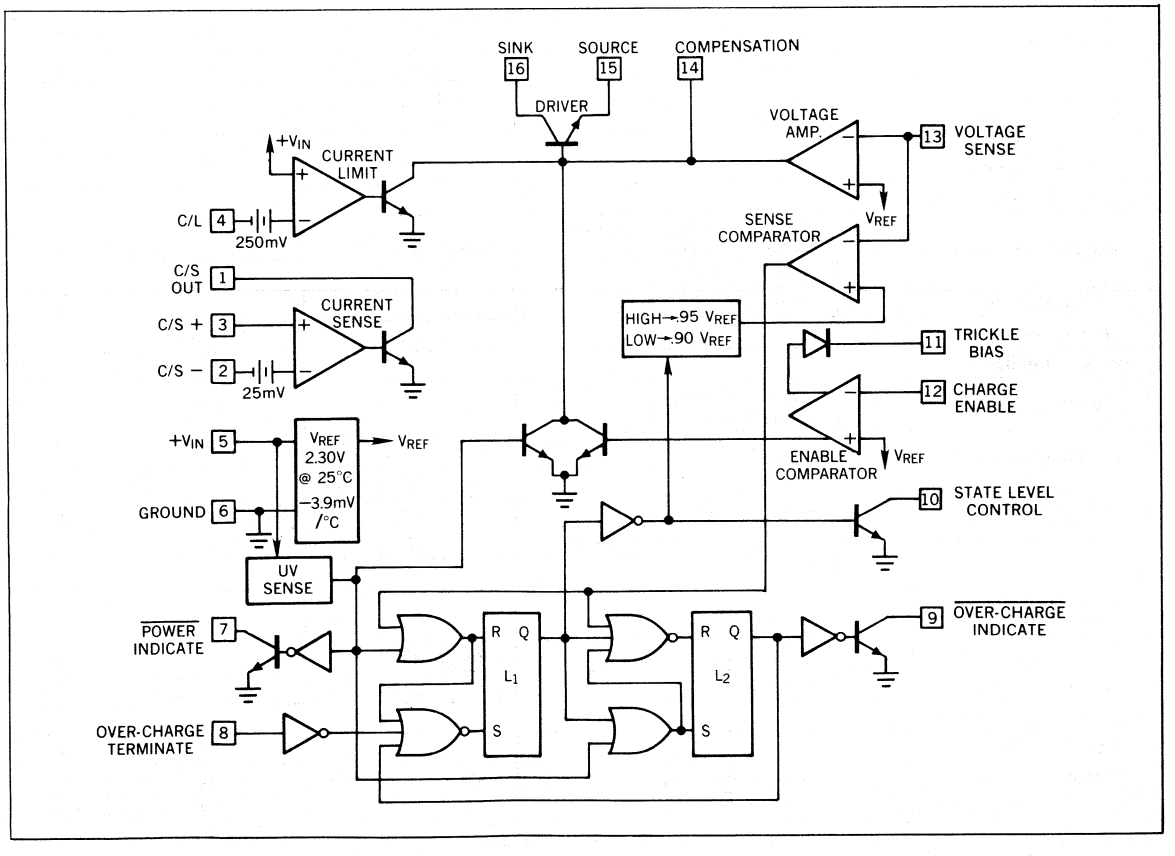
The UC2906 series of battery charger controllers contains all of the necessary circuitry to optimally control the charge and hold cycle for sealed lead-acid batteries. These integrated circuits monitor and control both the output voltage and current of the charger through three separate charge states; a high current bulk-charge state, a controlled over-charge, and a precision float-charge, or standby, state.

Optimum charging conditions are maintained over an extended temperature range with an internal reference that tracks the nominal temperature characteristics of the lead-acid cell. A typical standby supply current requirement of only 1.6mA allows these ICs to predictably monitor ambient temperatures.

Separate voltage loop and current limit amplifiers regulate the output voltage and current levels in the charger by controlling the onboard driver. The driver will supply up to 25mA of base drive to an external pass device. Voltage and current sense comparators are used to sense the battery condition and respond with logic inputs to the charge state logic. A charge enable comparator with a trickle bias output can be used to implement a low current turn-on mode of the charger, preventing high current charging during abnormal conditions such as a shorted battery cell.

Other features include a supply under-voltage sense circuit with a logic output to indicate when input power is present. In addition the over-charge state of the charger can be externally monitored and terminated using the over-charge indicate output and over-charge terminate input.

UC2906 BLOCK DIAGRAM



UNITRODE

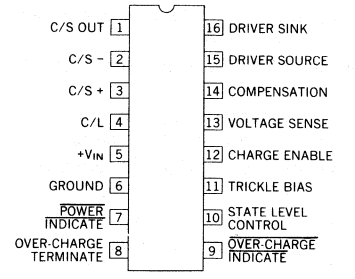
ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage ($+V_{IN}$) 40V
Open Collector Output Voltages 40V
Amplifier and Comparator Input Voltages ..... -0.3V to +40V
Over-Charge Terminate Input Voltage ..... -0.3V to +40V
Current Sense Amplifier Output Current 40mA
Other Open Collector Output Currents 5mA
Trickle Bias Output Current ..... -40mA
Driver Current 40mA
Power Dissipation at T_A = 25°C
  Derate at 10mW/°C Above T_A = 25°C 1000mW
Power Dissipation at T_C = 25°C
  Derate at 16mW/°C Above T_C = 25°C 2000mW
Thermal Resistance, Junction-to-Ambient ..... 100°C/W
Thermal Resistance, Junction-to-Case ..... 60°C/W
Operating Junction Temperature ..... -55°C to +150°C
Storage Temperature ..... -65° to +150°C
Lead Temperature (Soldering, 10 Seconds) ..... 300°C

Note: 1. Voltages are referenced to ground (Pin 6).
Currents are positive into, negative out of, the specified terminals.

CONNECTION DIAGRAM

DIL-16 (TOP VIEW)
J or N PACKAGE



ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = -40°C to +70°C for the UC2906 and 0°C to +70°C for the UC3906, $+V_{IN}$ = 10V.)

PARAMETER	TEST CONDITIONS	2906			3906			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Input Supply								
Supply Current	$+V_{IN}$ = 10V		1.6	2.5		1.6	2.5	mA
	$+V_{IN}$ = 40V		1.8	2.7		1.8	2.7	mA
Supply Under-Voltage Threshold	$+V_{IN}$ = Low to High	4.2	4.5	4.8	4.2	4.5	4.8	V
Supply Under-Voltage Hysteresis			.20	.30		.20	.30	V
Internal Reference (V_{REF})								
Voltage Level (Note 2)	Measured as Regulating Level At Pin 13 w/ Driver Current = 1mA, T_j = 25°C	2.275	2.3	2.325	2.270	2.3	2.330	V
Line Regulation	$+V_{IN}$ = 5 to 40V		3	8		3	8	mV
Temperature Coefficient			-3.9			-3.9		mV/°C
Voltage Amplifier								
Input Bias Current	Total Input Bias at Regulating Level	-.5	-.2		-.5	-.2		μA
Maximum Output Current	Source	-45	-30	-15	-45	-30	-15	μA
	Sink	30	60	90	30	60	90	μA
Open Loop Gain	Driver Current = 1mA	50	65		50	65		dB
Output Voltage Swing	Volts Above GND or Below $+V_{IN}$		.2			.2		V
Driver								
Minimum Supply to Source Differential	Pin 16 = $+V_{IN}$, I_O = 10mA		2.0	2.2		2.0	2.2	V
Maximum Output Current	Pin 16 to Pin 15 = 2V	25	40		25	40		mA
Saturation Voltage	Driver Current = 10mA		.2	.45		.2	.45	V
Current Limit Amplifier								
Input Bias Current			.2	1.0		.2	1.0	μA
Threshold Voltage	Offset Below $+V_{IN}$	225	250	275	225	250	275	mV
Threshold Supply Sensitivity	$+V_{IN}$ = 5 to 40V		.03	.25		.03	.25	%/V

Note: 2. The reference voltage will change as a function of power dissipation on the die according to the temperature coefficient of the reference and the thermal resistance, junction-to-ambient.

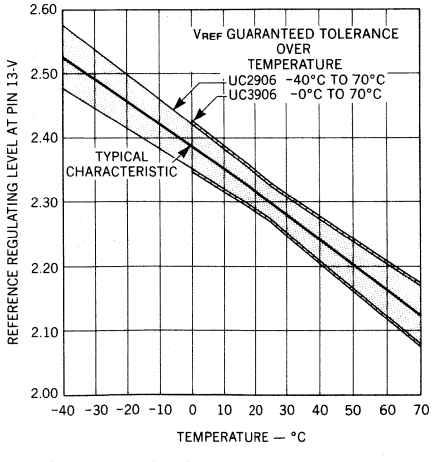
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = −40°C to +70°C for the UC2906 and 0°C to +70°C for the UC3906, $+V_{IN}$ = 10V.)

PARAMETER	TEST CONDITIONS		2906			3906			UNITS
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Voltage Sense Comparator									
Threshold Voltage	As a Function of V_{REF}	L_1 = RESET	.945	.95	.955	.945	.95	.955	V/V
		L_1 = SET	.895	.90	.905	.895	.90	.905	V/V
Input Bias Current	Total Input Bias at Thresholds		−.5	−.2		−.5	−.2		μA
Current Sense Comparator									
Input Bias Current				.1	.5		.1	.5	μA
Input Offset Current				.01	.2		.01	.2	μA
Input Offset Voltage	Referenced to Pin 2, I_{OUT} = 1mA		20	25	30	20	25	30	mV
Offset Supply Sensitivity	$+V_{IN}$ = 5 to 40V			.05	.35		.05	.35	%/V
Offset Common Mode Sensitivity	CMV = 2V to $+V_{IN}$			.05	.35		.05	.35	%/V
Maximum Output Current	V_{OUT} = 2V		25	40		25	40		mA
Output Saturation Voltage	I_{OUT} = 10mA			.2	.45		.2	.45	V
Enable Comparator									
Threshold Voltage	As a Function of V_{REF}		.99	1.0	1.01	.99	1.0	1.01	V/V
Input Bias Current			−.5	−.2		−.5	−.2		μA
Trickle Bias Maximum Output Current	V_{OUT} = $+V_{IN}$ − 3V		25	40		25	40		mA
Trickle Bias Maximum Output Voltage	Volts Below $+V_{IN}$, I_{OUT} = 10mA			2.0	2.6		2.0	2.6	V
Trickle Bias Reverse Hold-Off Voltage	$+V_{IN}$ = 0V, I_{OUT} = −10μA		6.3	7.0		6.3	7.0		V
Over-Charge Terminate Input									
Threshold Voltage			.7	1.0	1.3	.7	1.0	1.3	V
Internal Pull-Up Current	At Threshold			10			10		μA
Open Collector Outputs (Pins 7, 9 and 10)									
Maximum Output Current	V_{OUT} = 2V		2.5	5		2.5	5		mA
Saturation Voltage	I_{OUT} = 1.6mA			.25	.45		.25	.45	V
	I_{OUT} = 50μA			.03	.05		.03	.05	V
Leakage Current	V_{OUT} = 40V			1	3		1	3	μA

Internal Reference Temperature Characteristic and Tolerance



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

OPERATION AND APPLICATION INFORMATION

Dual Level Float Charger Operation

The UC2906 is shown configured as a dual level float charger in Figure 1. All high currents are handled by the external PNP pass transistor with the driver supplying base drive to this device. This scheme uses the TRICKLE BIAS output and the charge enable comparator to give the charger a low current turn-on mode. The output current of the charger is limited to a low level until the battery reaches a specified voltage, preventing high current charging if a battery cell is shorted. Figure 2 shows the state diagram of the charger. Upon turn-on the UV sense circuitry puts the charger in state 1, the high rate bulk-charge state. In this state, once the enable threshold has been exceeded, the charger will supply a peak current that is determined by the 250mV offset in the C/L amplifier and the sensing resistor R_S.

To guarantee full re-charge of the battery, the charger's voltage loop has an elevated regulating level, V_{OC}, during state 1 and state 2. When the battery voltage reaches 95% of V_{OC}, the charger enters the over-charge state, state 2. The charger stays in this state until the OVER-CHARGE TERMINATE pin goes high. In Figure 1, the charger uses the current sense amplifier to generate this signal by sensing when the charge current has tapered to a specified level, I_{OCT}. Alternatively the over-charge could have been controlled by an external source, such as a timer, by using the $\overline{\text{OVER-CHARGE INDICATE}}$ signal at Pin 9. If a load is applied to the battery and begins to discharge it, the charger will contribute its full output to the load. If the battery drops 10% below the float level, the charger will reset itself to state 1. When the load is removed a full charge cycle will follow. A graphical representation of a charge, and discharge, cycle of the dual level float charger is shown in Figure 3.

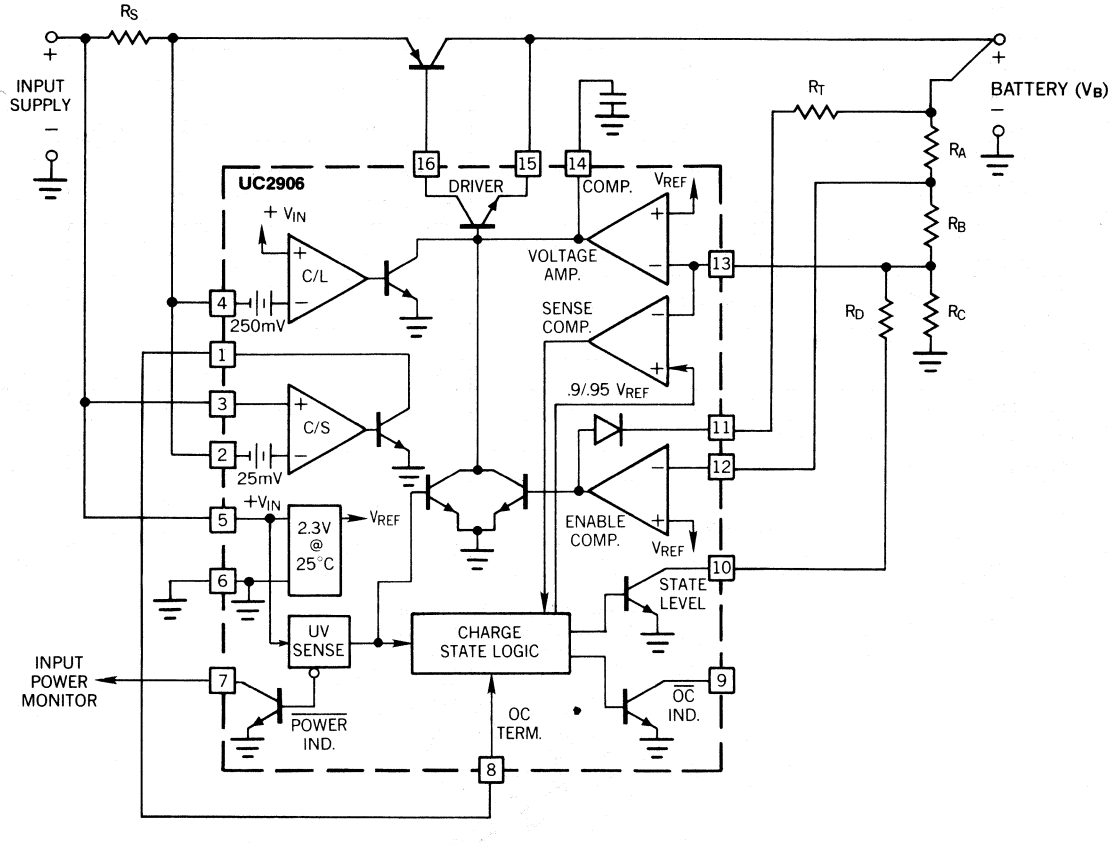
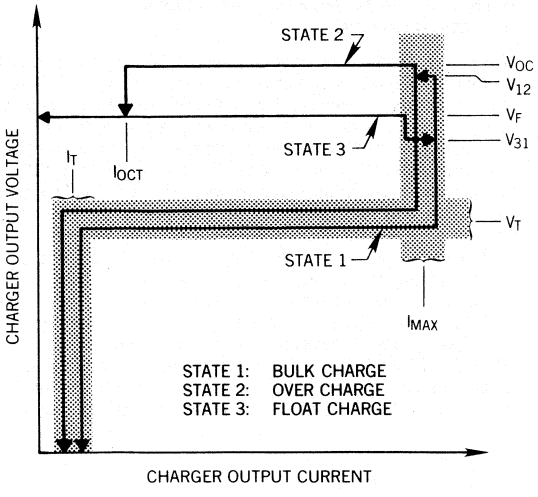


Figure 1. The UC2906 in a Dual Level Float Charger



1.) $V_T = V_{REF}\ (1 + \frac{R_A}{R_B + R_X})$ Where: $R_X = \frac{R_D\ R_C}{R_D + R_C}$

2.) $V_{OC} = V_{REF}\ (1 + \frac{R_A + R_B}{R_C} + \frac{R_A + R_B}{R_D})$

3.) $V_F = V_{REF}\ (1 + \frac{R_A + R_B}{R_C})$

4.) $V_{12} = .95\ V_{OC}$

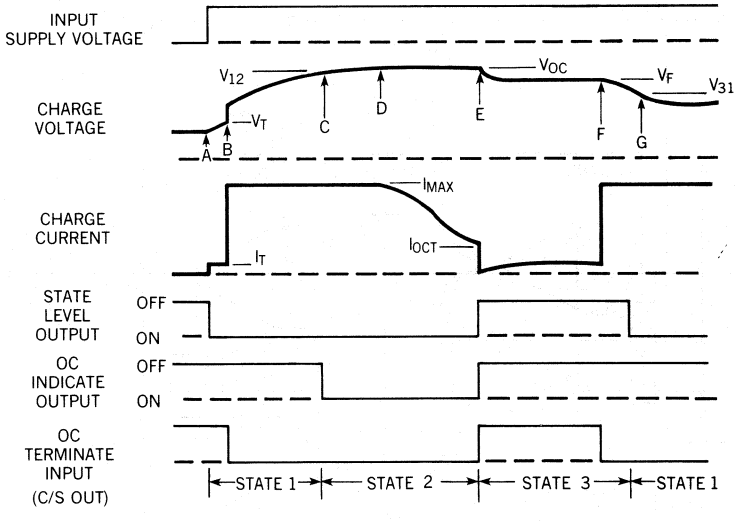
5.) $V_{31} = .9\ V_F$

6.) $I_{MAX} = \frac{.25V}{R_S}$

7.) $I_{OCT} = \frac{.025V}{R_S}$

8.) $I_T = \frac{V_{IN} - V_B - 2.5V}{R_T}$

Figure 2. State Diagram and Design Equations For the Dual Level Float Charger



Explanation: Dual Level Float Charger

A. Input power turns on, battery charges at trickle current rate.

B. Battery voltage reaches V_T enabling the driver and turning off the trickle bias output, battery charges at I_{MAX} rate.

C. Transition voltage V_{12} is reached and the charger indicates that it is now in the over-charge state, state 2.

D. Battery voltage approaches the over-charge level V_{OC} and the charge current begins to taper.

E. Charge current tapers to I_{OCT}. The current sense amplifier output, in this case tied to the OC TERMINATE input, goes high. The charger changes to the float state and holds the battery voltage at V_F.

F. Here a load ($>I_{MAX}$) begins to discharge the battery.

G. The load discharges the battery such that the battery voltage falls below V_{31}. The charger is now in state 1, again.

Figure 3. Typical Charge Cycle: UC2906 Dual Level Float Charger

Compensated Reference Matches Battery Requirements

When the charger is in the float state, the battery will be maintained at a precise float voltage, V_F. The accuracy of this float state will maximize the standby life of the battery while the bulk-charge and over-charge states guarantee rapid and full re-charge. All of the voltage thresholds on the UC2906 are derived from the internal reference. This reference has a temperature coefficient that tracks the temperature characteristic of the optimum charge and hold levels for sealed lead-acid cells. This further guarantees that proper charging occurs, even at temperature extremes.

Dual Step Current Charger Operation

Figures 4, 5 and 6 illustrate the UC2906's use in a different charging scheme. The dual step current charger is useful when a large string of series cells must be charged. The holding-charge state maintains a slightly elevated voltage across the batteries with the holding current, I_H. This will tend to guarantee equal charge distribution between the cells. The bulk-charge state is similar to that of the float charger with the exception that when V_{12} is reached, no over-charge state occurs since Pin 8 is tied high at all times. The current sense amplifier is used to regulate the holding current. In some applications a series resistor, or external buffering transistor, may be required at the current sense output to prevent excessive power dissipation on the UC2906.

A PNP Pass Device Reduces Minimum Input to Output Differential

The configuration of the driver on the UC2906 allows a good bit of flexibility when interfacing to an external pass transistor. The two chargers shown in Figures 1 and 4 both use PNP pass devices, although an NPN device driven from the source output of the UC2906 driver can also be used. In situations where the charger must operate with low input to output differentials the PNP pass device should be configured as shown in Figure 4. The PNP can be operated in a saturated mode with only the series diode and sense resistor adding to the minimum differential. The series diode, D1, in many applications, can be eliminated. This diode prevents any discharging of the battery, except through the sensing divider, when the charger is attached to the battery with no input supply voltage. If discharging under this condition must be kept to an absolute minimum, the sense divider can be referenced to the $\overline{\text{POWER INDICATE}}$ pin; Pin 7, instead of ground. In this manner the open collector off state of Pin 7 will prevent the divider resistors from discharging the battery when the input supply is removed.

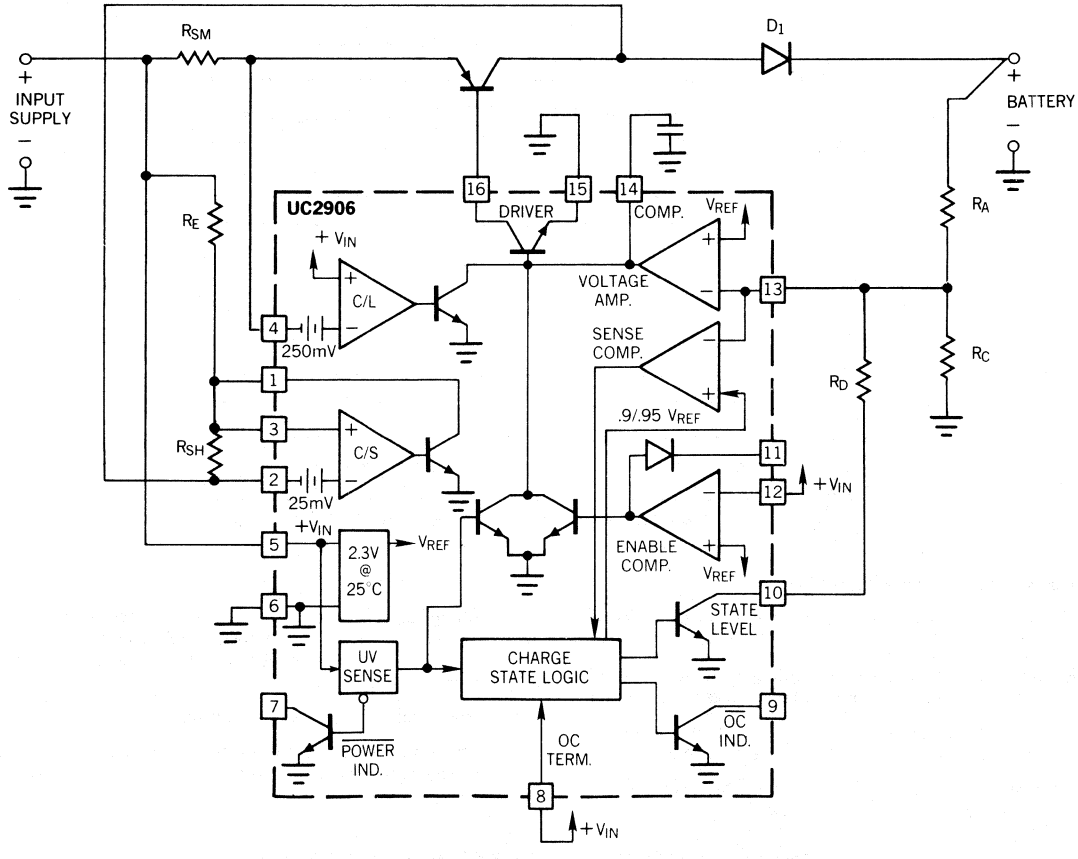
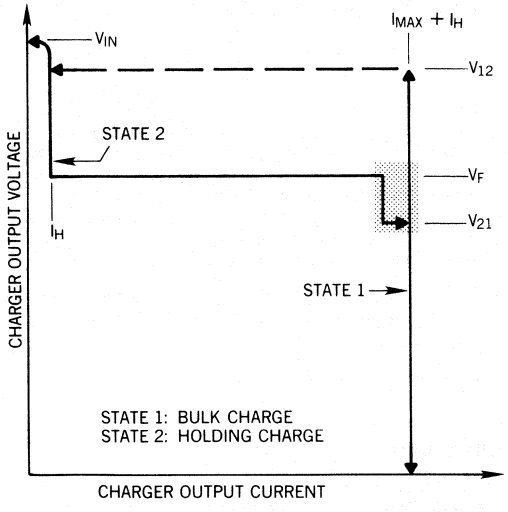


Figure 4. The UC2906 in a Dual Step Current Charger



1.) $V_{12} = .95\ V_{REF}\ (1 + \frac{R_A}{R_C} + \frac{R_A}{R_D})$

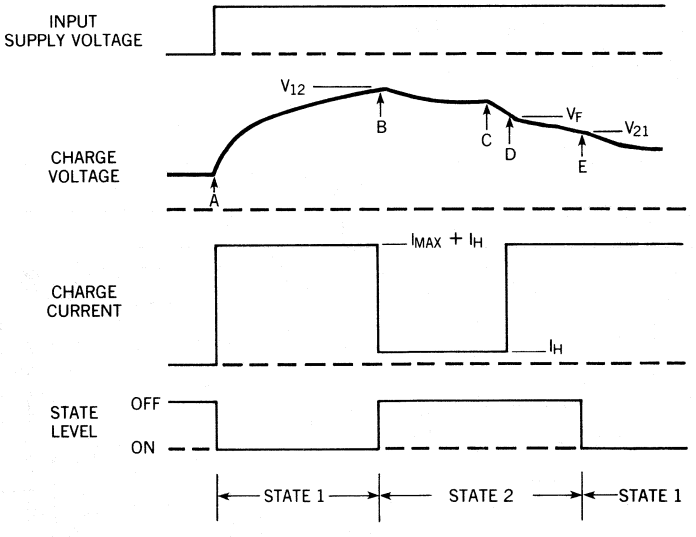
2.) $V_F = V_{REF}\ (1 + \frac{R_A}{R_C})$

3.) $V_{21} = .9\ V_F$

4.) $I_{MAX} = \frac{.25V}{R_{SM}}$

5.) $I_H = \frac{.025V}{R_{SH}}$

Figure 5. State Diagram and Design Equations for the Dual Step Current Charger



Explanation: Dual Step Current Charger

A. Input power turns on, battery charges at a rate of $I_H + I_{MAX}$.

B. Battery voltage reaches V_{12} and the voltage loop switches to the lower level V_F. The battery is now fed with the holding current I_H.

C. An external load starts to discharge the battery.

D. When V_F is reached the charger will supply the full current $I_{MAX} + I_H$.

E. The discharge continues and the battery voltage reaches V_{21} causing the charger to switch back to state 1.

Figure 6. Typical Charge Cycle: UC2906 Dual Step Current Charger

LINEAR INTEGRATED CIRCUITS

UC3620

Switchmode Driver For 3-ϕ Brushless DC Motors

FEATURES

- 2A Continuous, 3A Peak Output Current
- 8V to 40V Operation
- Internal High Gain Amplifier for Servo Applications
- TTL Compatible Hall Inputs
- Mask Programmable Decode Logic
- Pulse-by-Pulse Current Limiting
- Internal Thermal Shutdown Protection
- Under-Voltage Lockout
- 15 Lead, 25W Multiwatt® Package

DESCRIPTION

The UC3620 is a brushless DC motor driver capable of decoding and driving all 3 windings of a 3-phase brushless DC motor. In addition, an on-board current comparator, oscillator, and high gain Op-Amp provide all necessary circuitry for implementing a high performance, chopped mode servo amplifier. Full protection, including thermal shutdown, pulse-by-pulse current limiting, and under-voltage lockout aid in the simple implementation of reliable designs. Both conducted and radiated EMI have been greatly reduced by limiting the output dv/dt to 150V/μs for any load condition.

The UC3620 offers standard 60 mechanical degree, four-pole, hall decoding per Table 1. Other decoding options are available via mask programming at the factory.

PRELIMINARY

ABSOLUTE MAXIMUM RATINGS (Note 1)

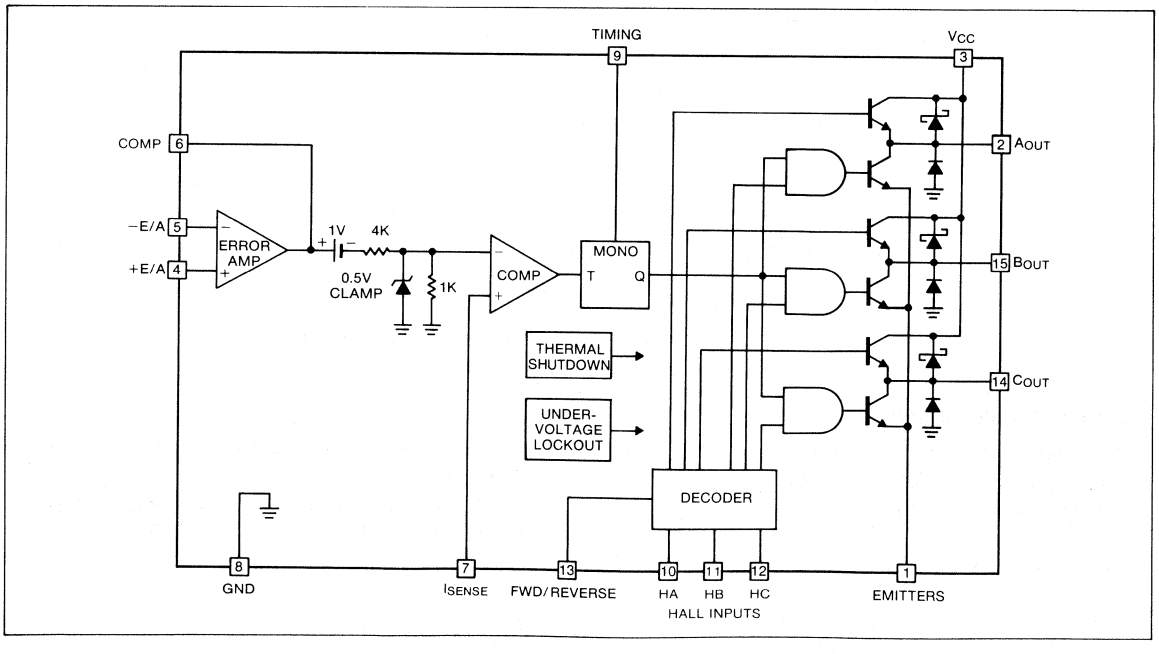
Supply Voltage, V_{CC} 40V
Output Current, Source or Sink
  Non-Repetitive (t = 100μsec), I_O 3A
  Repetitive (80% on - 20% off; t_{ON} = 10ms) 2.5A
  DC Operation 2A
Analog Inputs ..... -0.3 to +V_{CC}
Logic Inputs ..... -0.3 to +V_{CC}
Total Power Dissipation (at T_{CASE} = 75°C) 25W
Storage and Junction Temperature ..... -40°C to +150°C

Note: 1. All voltages are with respect to ground, pin 8. Currents are positive into, negative out of the specified terminal.

THERMAL DATA

Thermal Resistance Junction-Case, θ_{jc} ..... 3°C/W Max
Thermal Resistance Junction-Ambient, θ_{ja} ..... 35°C/W Max

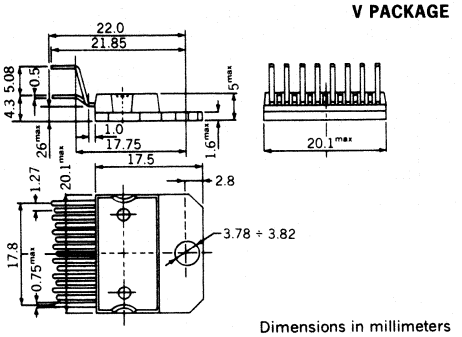
BLOCK DIAGRAM



UNITRODE

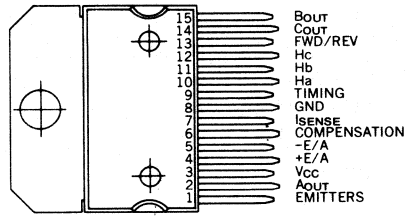
MECHANICAL DATA

V PACKAGE



Dimensions in millimeters

CONNECTION DIAGRAM (TOP VIEW)



ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = 0°C to 70°C; $V_{cc(PIN\ 3)}$ = 20V, R_T = 10k, C_T = 2.2nF)

PARAMETER	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Error Amplifier Section					
Input Offset Voltage			1.5	10	mV
Input Bias Current			−.25	−2.0	μA
Input Offset Current			15	250	nA
Common Mode Range	V_{cc} = 8V to 40V	0		V_{IN}-2	V
Open Loop Gain	$\Delta V_{PIN\ 6}$ = 1V to 4V	80	100		dB
Unity Gain Bandwidth	T_j = 25°C, Note 2		0.8		MHz
Output Sink Current	$V_{PIN\ 6}$ = 1V		2		mA
Output Source Current	$V_{PIN\ 6}$ = 4V		8		mA
Current Sense Section					
Input Bias Current			−2.0	−5	μA
Internal Clamp		.425	0.5	.575	V
Divider Gain		.180	0.2	.220	V/V
Internal Offset Voltage		.8	1.0	1.2	V
Timing Section					
Output Off Time		18	20	22	μs
Upper Mono Threshold			5.0		V
Lower Mono Threshold			2.0		V
Decoder Section					
High-Level Input Voltage		2.0			V
Low-Level Input Voltage				0.8	V
High-Level Input Current				10	μA
Low-Level Input Current		−10			μA
Output Section					
Output Leakage Current	V_{cc} = 40V			500	μA
V_F, Schottky Diode	I_o = 2A		1.5	2.0	V
V_F, Substrate Diode	I_o = 2A		2.2	3.0	V
Total Output Voltage Drop	I_o = 2A, Note 3		3.0	3.6	V
Output Rise Time	I_o = 2A		150		ns
Output Fall Time	I_o = 2A		150		ns

Notes: 2. These parameters, although guaranteed over the recommended operating conditions, are not 100% tested in production.
3. The total voltage drop is defined as the sum of both top and bottom side driver.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A = 0°C to 70°C; $V_{cc(PIN\ 3)}$ = 20V, R_T = 10k, C_T = 2.2nF)

PARAMETER	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Under-Voltage Lockout					
Start-Up Threshold				8.0	V
Threshold Hysteresis			0.5		V
Thermal Shutdown					
Junction Temperature		150		180	°C
Total Standby Current					
Supply Current				55	mA

TABLE 1

STEP	FWD/ REV	Ha	Hb	Hc		AOUT	BOUT	COUT
1	1	1	0	1		H	L	0
2	1	1	0	0		H	0	L
3	1	1	1	0		0	H	L
4	1	0	1	0		L	H	0
5	1	0	1	1		L	0	H
6	1	0	0	1		0	L	H
1	0	1	0	1		L	H	0
2	0	1	0	0		L	0	H
3	0	1	1	0		0	L	H
4	0	0	1	0		H	L	0
5	0	0	1	1		H	0	L
6	0	0	0	1		0	H	L

H = HIGH OUTPUT
L = LOW OUTPUT
O = OPEN OUTPUT

CIRCUIT DESCRIPTION

The UC3620 is designed for implementation of a complete 3-Φ brushless DC servo drive using a minimum number of external components. Below is a functional description of each major circuit feature.

DECODER

As shown in Table 1, the decoder employs a 60 mechanical degree hall decode scheme (others available via mask programming) to decode and drive each of three high current totem pole output stages. A forward/reverse signal, pin 13, is used to provide direction. At any point in time, one driver is sourcing, one driver is sinking, and the remaining driver is off or tri-stated. Pulse width modulation is accomplished by turning the sink driver off during the monostable reset time, producing a fixed off-time chop mode. Controlled output rise and fall times help reduce electrical switching noise while maintaining relatively small switching losses.

CURRENT SENSING

Referring to Figure 1, emitter current is sensed across R_S and fed back through a low pass filter to the current sense pin 7. This filter is required to eliminate false triggering of the monostable due to leading edge current spikes. Actual filter values, although somewhat dependent on external loads, will generally be in the 1KΩ and 1000pF range.

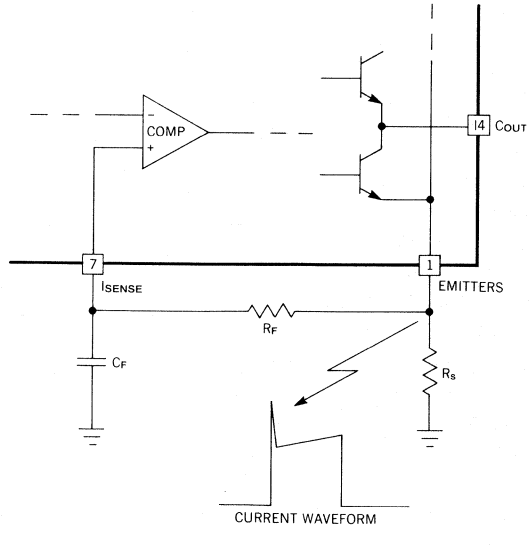


Figure 1. Current Sense Filter

TIMING

An R-C time constant on pin 9 is used by the monostable to generate a fixed off time at the outputs according to the formula:

$T_{OFF} = .916\ R_T C_T$

As the peak current in the emitters approaches the value at the minus (−) input of the on-board comparator, the monostable is triggered, causing the outputs to be turned off. On time is determined by the amount of time required for motor current to increase to the value required to re-trip the monostable. A timing sequence of these events is shown in Figure 2.

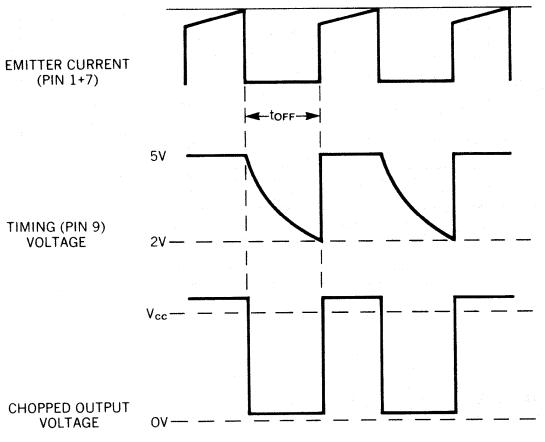


Figure 2. Chopped Mode Timing Diagram

CURRENT LIMIT

Since peak current is being controlled at all times by the internal comparator, a simple voltage clamp at its negative (−) input will limit peak current to a maximum value. A fixed 0.5V internal clamp has been included on the UC3620, and any current spike in the output which generates a sensed voltage greater than 0.5V will immediately shut down the outputs. Actual peak current values may be programmed by selecting the appropriate value of R_S according to the formula:

$$R_S = 0.5/I_{CURRENT\ LIMIT}$$

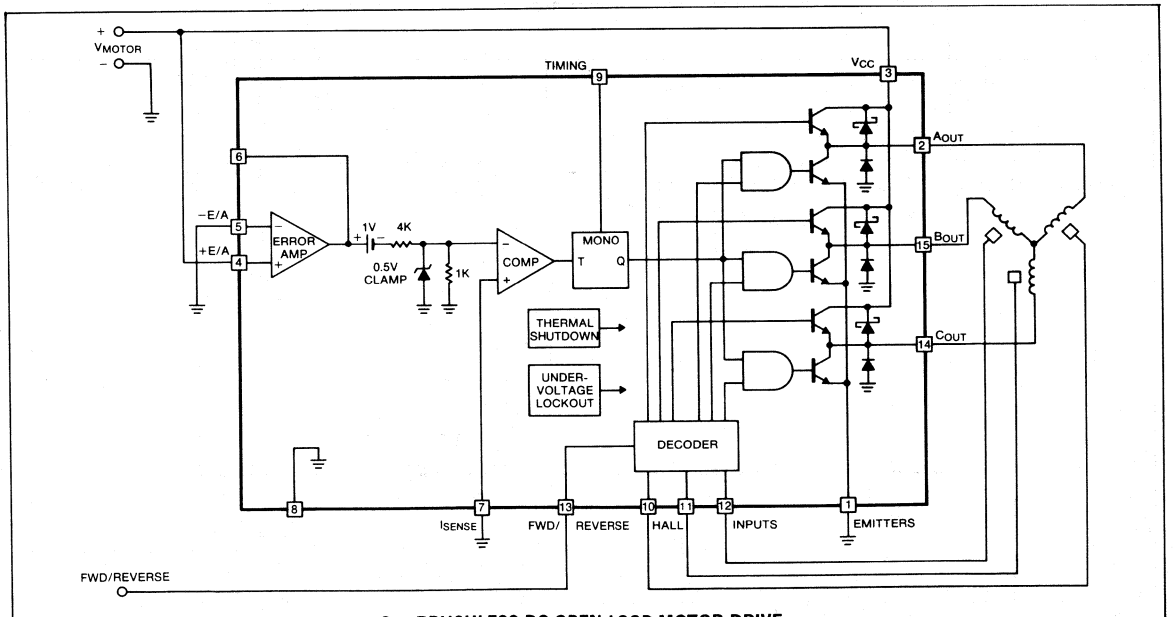
ERROR AMPLIFIER

A high performance, on-board error amplifier is included to facilitate implementing closed loop motor control. Error voltage generation and loop compensation are easily accomplished by appropriately configuring the gain and feedback of this amplifier. To provide a larger dynamic signal range at the output of the error amplifier, a divide by 5 resistor network is used to reduce the error signal level before applying to the internal comparator. In addition, a one volt offset has been introduced at the output of the error amplifier to guarantee control down to zero current in the output stages. Since this offset is divided by the open loop gain of the feedback loop, it has virtually no effect on closed loop performance.

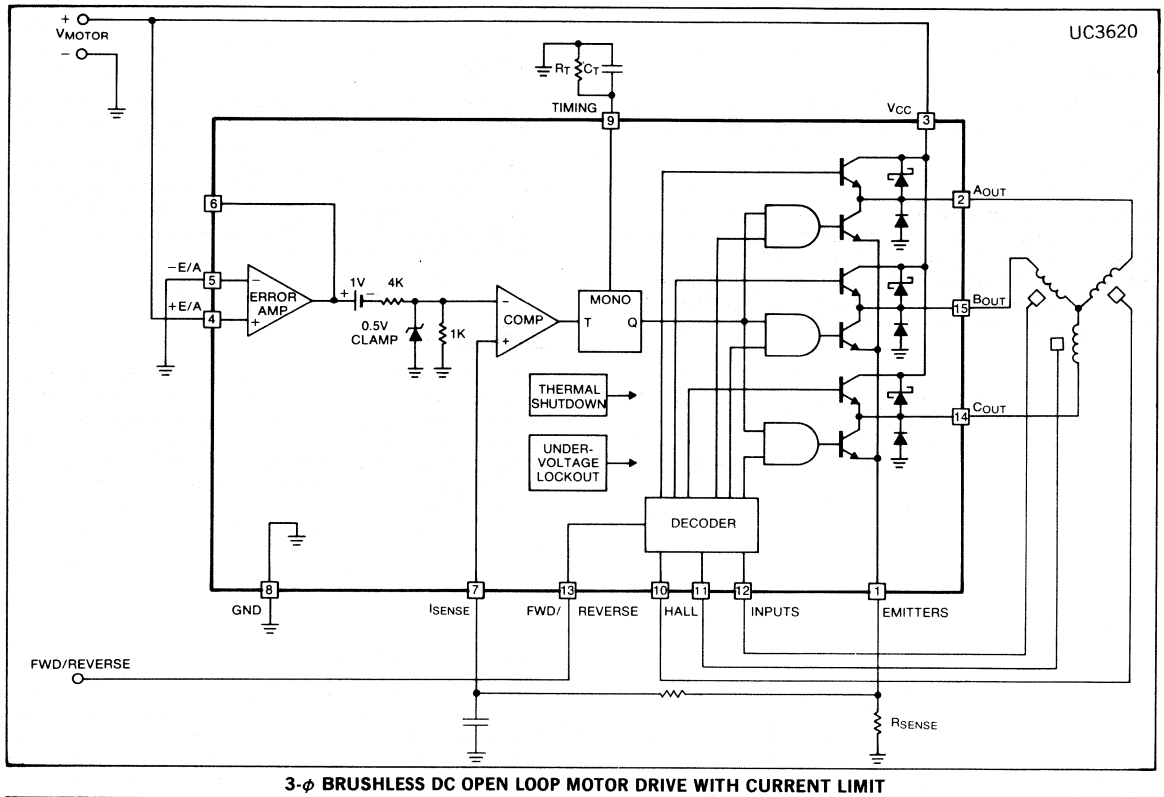
PROTECTION FUNCTIONS

Protective functions including under-voltage lockout, peak current limiting, and thermal shutdown, provide an extremely rugged device capable of surviving under many types of fault conditions. Under-voltage lockout guarantees the outputs will be off or tri-stated until V_{CC} is sufficient for proper operation of the chip. Current limiting limits the peak current for a stalled or shorted motor, whereas thermal shutdown will tri-state the outputs if a temperature above 150°C is reached.

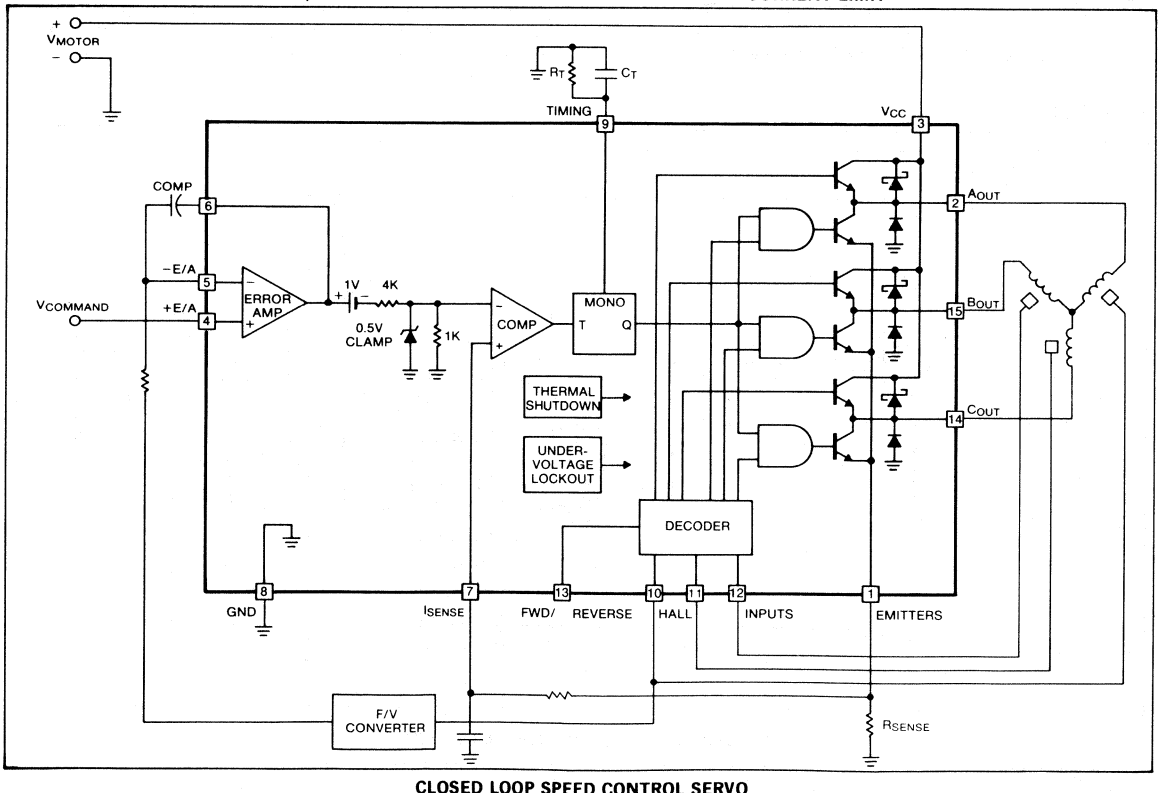
TYPICAL APPLICATIONS



3-ϕ BRUSHLESS DC OPEN LOOP MOTOR DRIVE



3-ϕ BRUSHLESS DC OPEN LOOP MOTOR DRIVE WITH CURRENT LIMIT



CLOSED LOOP SPEED CONTROL SERVO

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

LINEAR INTEGRATED CIRCUITS

Stepper Motor Drive Circuit

UC3717NB
UC3717NC

2

FEATURES

- Half-step and full-step capability
- Bipolar constant current motor drive
- Built-in fast recovery Schottky commutating diodes
- Wide range of current control 5-1000mA
- Designed for unregulated motor supply voltage
- Current levels can be selected in steps or varied continuously
- Thermal overload protection

DESCRIPTION

The UC3717 has been designed to control and drive the current in one winding of a bipolar stepper motor. The circuit consists of an LS-TTL-compatible logic input, a current sensor, a monostable and an output stage with built-in protection diodes. Two UC3717s and a few external components form a complete control and drive unit for LS-TTL or micro-processor controlled stepper motor systems.

The UC3717 is characterized for 0°C to +70°C.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Voltage
- Logic Supply, V_{cc} 7V
- Output Supply, V_m UC3717NB, UC3717NC 25V, 35V

Input Voltage
- Logic Inputs (Pins 7, 8, 9) 6V
- Analog Input (Pin 10) ..... V_{cc}
- Reference Input (Pin 11) 15V

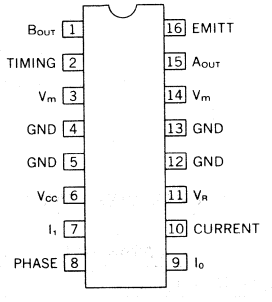
Input Current
- Logic Inputs (Pins 7, 8, 9) ..... -10mA
- Analog Inputs (Pins 10, 11) ..... -10mA

Output Current (Pins 1,15) ..... ±1A
Junction Temperature, T_j ..... +150°C
Thermal Resistance, Junction to Ambient (Plastic Package) ..... 45°C/W
Thermal Resistance, Junction to Case (Plastic Package) ..... 11°C/W
Thermal Resistance, Junction to Ambient (Ceramic Package) ..... 100°C/W
Thermal Resistance, Junction to Case (Ceramic Package) ..... 60°C/W
Storage Temperature Range, T_s ..... -55°C to +150°C

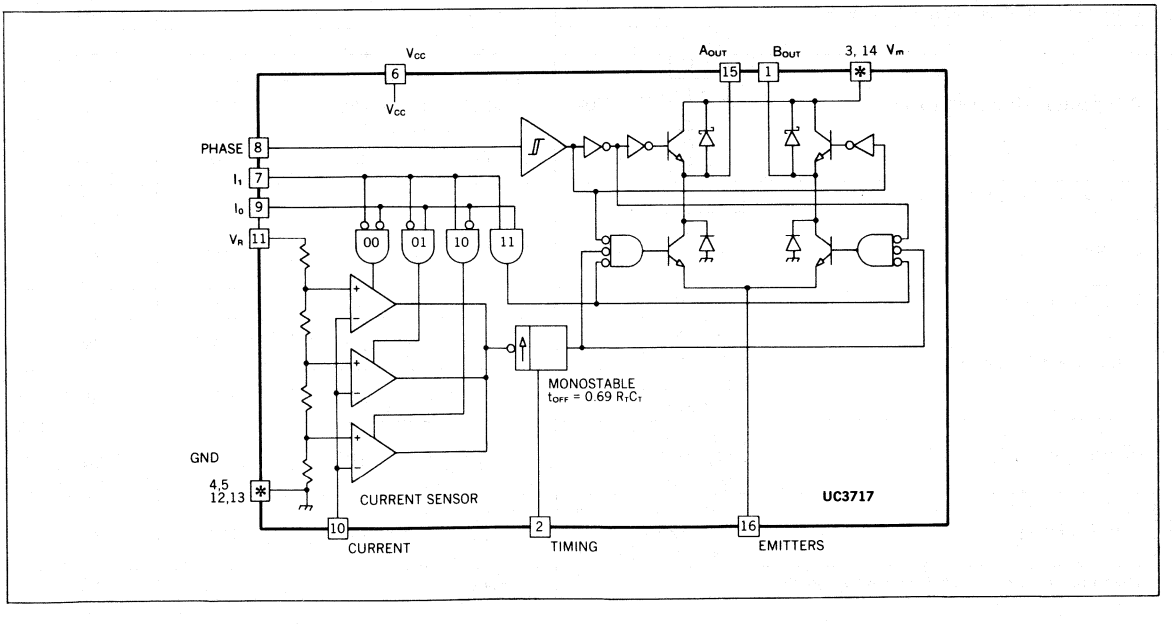
Note: 1. All voltages are with respect to ground, Pins 4, 5, 12, 13. Currents are positive into, negative out of the specified terminal.

CONNECTION DIAGRAM

DIL-16 (TOP VIEW)
NB or NC PACKAGE



BLOCK DIAGRAM



UNITRODE

RECOMMENDED OPERATING CONDITIONS

PARAMETER		MIN.	TYP.	MAX.	UNITS
Supply Voltage, V_{CC}		4.75	5	5.25	V
Supply Voltage, V_{mm}	UC3717NB	10		25	V
	UC3717NC	10		35	
Output Current, I_m		20		800	mA
Rise Time Logic Inputs, t_r				2	μs
Fall Time Logic Inputs, t_f				2	μs
Ambient Temperature, t_a	UC3717	0		70	°C

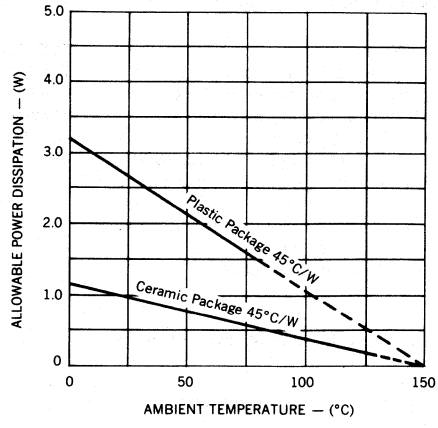


Figure 1.

ELECTRICAL CHARACTERISTICS (Over recommended operating conditions unless otherwise stated)

PARAMETER	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Supply Current, I_{CC}				25	mA
High-Level Input Voltage, Pins 7, 8, 9		2.0			V
Low-Level Input Voltage, Pins 7, 8, 9				0.8	V
High-Level Input Current, Pins 7, 8, 9	V_I = 2.4V			20	μA
Low-Level Input Current, Pins 7, 8, 9	V_I = 0.4V	-0.4			mA
Comparator Threshold Voltage	I_0 = 0, I_1 = 0, V_R = 5.0V	390	420	440	mV
	I_0 = 1, I_1 = 0, V_R = 5.0V	230	250	270	mV
	I_0 = 0, I_1 = 1, V_R = 5.0V	65	80	90	mV
Comparator Input Current		-20		20	μA
Output Leakage Current	I_0 = 1, I_1 = 1, T_A = + 25°C			200	μA
Total Saturation Voltage Drop	I_m = 500mA			4.0	V
Total Power Dissipation	I_m = 500mA, f_s = 30kHz		1.4	2.1	W
	I_m = 800mA, f_s = 30kHz		2.9	3.1	W
Cut Off Time, t_{OFF}	See Figure 5 and 6, V_m = 10V, $t_{ON} \geqq 5\mu s$	25	30	35	μs
Turn Off Delay, t_d	See Figure 5 and 6, T_A = +25°C; $dV_C/dt \geqq 50mV/\mu s$		1.6	2.0	μs
Thermal Shutdown Junction Temperature		+160		+180	°C

LINEAR INTEGRATED CIRCUITS
Three Terminal Fixed Voltage Positive Regulators

UC7800A
UC7800AC
UC7800
UC7800C

2

FEATURES

- ±1% Output Voltage on 7800A, AC Series
- Complete Specifications at 1A Load
- No External Components
- Internal Thermal Overload Protection
- Internal Short Circuit Current Limiting
- Output Transistor Safe Area Compensation
- Available in TO-3 and TO-220 Packages
- Output Voltages of 5V, 12V and 15V (For Other Voltages, Please Contact the Factory)

DESCRIPTION

These three terminal monolithic positive voltage regulators employ internal current limiting, thermal shutdown and safe area compensation, making them essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A of output current. They are intended as fixed voltage regulators in a wide range of applications including local (on card) regulation for elimination of distribution problems associated with single point regulation. In addition to use as fixed voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents. The 7800 and 7800C series have output tolerances of ±4%. The 7800A and 7800AC series offer ±1% tolerances on initial output voltage and, in addition, are specified to provide better regulator performance.

ABSOLUTE MAXIMUM RATINGS

Input Voltage 35V
Power Dissipation ..... Internally limited
Operating Junction Temperature Range
- UC7800A SERIES ..... -55°C to +150°C
- UC7800AC SERIES ..... 0°C to +125°C
- UC7800 SERIES ..... -55°C to +150°C
- UC7800C SERIES ..... 0°C to +125°C

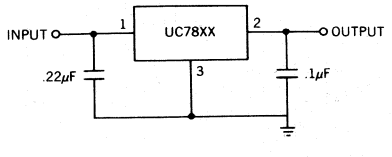
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (Soldering, 10 seconds)
- K (TO-3) package ..... 300°C
- T (TO-220) package ..... 230°C

Power/Thermal Characteristics

	K (TO-3) Package	T (TO-220) Package
Rated Power @ 25°C		
T_C	20W	15W
T_A	4.3W	2W
Thermal Resistance		
θ_{JC}	3°C/W	3°C/W
θ_{JA}	35°C/W	60°C/W

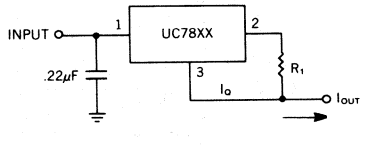
TYPICAL APPLICATIONS

Fixed Output Regulator



Notes: 1. To specify an output voltage, substitute voltage value for "XX".
2. Although no output capacitor is needed for stability, it does improve transient responses.
3. Input capacitor required if regulator is located an appreciable distance from power supply filter.

Current Regulator



$I_{OUT} = \frac{V_{OUT}}{R_1} + I_Q$

UNITRODE

ELECTRICAL CHARACTERISTICS

PARAMETER	TEST CONDITIONS	UC7805A			UC7805AC			UC7805			UC7805C			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Output Voltage	T_j = 25°C, V_{IN} = 10V, I_O = 1A	4.95		5.05	4.95		5.05	4.8		5.2	4.8		5.2	V
	T_j = 25°C, 7.5V ≤ V_{IN} ≤ 20V 5mA ≤ I_{OUT} ≤ 1A, P_D ≤ 15W	4.9		5.1	4.87		5.13	4.8		5.2	4.77		5.23	V
	Over Temperature, $T_{MIN} \leq T_j \leq T_{MAX}$	4.85		5.15	4.85		5.15	4.75		5.25	4.75		5.25	V
Line Regulation	T_j = 25°C, 7.5V ≤ V_{IN} ≤ 20V, I_O = 500mA			5			6			25			35	mV
	Over Temperature, $T_{MIN} \leq T_j \leq T_{MAX}$		3	10		3	10		10	50		10	50	mV
Load Regulation	T_j = 25°C, V_{IN} = 10V, 5mA ≤ I_O ≤ 1.5A		10	12		10	17		20	26		20	40	mV
	V_{IN} = 10V, 5mA ≤ I_O ≤ 1A Over Temperature, $T_{MIN} \leq T_j \leq T_{MAX}$			25			25			50			50	mV
Quiescent Current	T_j = 25°C, V_{IN} = 10V, I_O = 1A		4.5	6		4.5	6		4.5	6		4.5	6	mA
	Over Temperature, $T_{MIN} \leq T_j \leq T_{MAX}$			6.5			6.5			6.5			6.5	mA
Quiescent Current Change	T_j = 25°C, V_{IN} = 10V, 5mA ≤ I_O ≤ 1A			.4			.4			.4			.4	mA
	Over Temperature, $T_{MIN} \leq T_j \leq T_{MAX}$			.5			.5			.5			.5	mA
	T_j = 25°C, 7.5V ≤ V_{IN} ≤ 20V, I_O = 500mA			.6			.6			.8			.8	mA
	Over Temperature, $T_{MIN} \leq T_j \leq T_{MAX}$			.8			.8			1.0			1.0	mA
Ripple Rejection	T_j = 25°C, 8V ≤ V_{IN} ≤ 18V, I_O = 500mA	69			69			63			63			dB
Output Noise Voltage	T_j = 25°C, V_{IN} = 10V, I_O = 1A		40			40			40			40		μV
Dropout Voltage	T_j = 25°C, I_O = 1A		2			2			2			2		V
Short Circuit Current	T_j = 25°C, V_{IN} = 10V		2.1			2.1			2.1			2.1		A
Peak Output Current	T_j = 25°C		2.4			2.4			2.4			2.4		A
Avg. Temp. Variation of V_{OUT}	0°C ≤ $T_j \leq T_{MAX}$, V_{IN} = 10V, I_O = 5mA		-.4			-.4			-.4			-.4		mV/°C
Long Term Stability	1000 Hrs. @ T_j = 125°C, V_{IN} = 10V, I_O = 5mA		20			20			20			20		mV
Thermal Shutdown	V_{IN} = 10V, I_O = 5mA		175			175			175			175		°C
	T_{MAX}		150			125			150			125		°C
	T_{MIN}		-55			0			-55			0		°C

Note: All characteristics except noise voltage and ripple rejection are measured using pulse techniques ($t_w \leq$ 10ms, duty-cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

ELECTRICAL CHARACTERISTICS

PARAMETER	TEST CONDITIONS	UC7812A			UC7812AC			UC7812			UC7812C			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Output Voltage	T_j = 25°C, V_{IN} = 19V, I_O = 1A	11.88		12.12	11.88		12.12	11.52		12.48	11.52		12.48	V
	T_j = 25°C, 14.5V ≤ V_{IN} ≤ 27V 5mA ≤ I_{OUT} ≤ 1A, P_D ≤ 15W	11.76		12.24	11.70		12.30	11.52		12.48	11.46		12.54	V
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}	11.64		12.36	11.64		12.36	11.40		12.60	11.40		12.60	V
Line Regulation	T_j = 25°C, 14.5V ≤ V_{IN} ≤ 27V, I_O = 500mA			12			15			60			84	mV
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}		4	18		4	18		20	120		20	120	mV
Load Regulation	T_j = 25°C, V_{IN} = 19V, 5mA ≤ I_O ≤ 1.5A		12	32		12	50		50	64		50	100	mV
	V_{IN} = 19V, 5mA ≤ I_O ≤ 1A Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}			60			60			120			120	mV
Quiescent Current	T_j = 25°C, V_{IN} = 19V, I_O = 1A		4.5	6		4.5	6		4.5	7		4.5	7	mA
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}			6.5			6.5			6.5			6.5	mA
Quiescent Current Change	T_j = 25°C, V_{IN} = 19V, 5mA ≤ I_O ≤ 1A			.4			.4			.4			.4	mA
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}			.5			.5			.5			.5	mA
	T_j = 25°C, 14.5V ≤ V_{IN} ≤ 27V, I_O = 500mA			.6			.6			.8			.8	mA
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}			.8			.8			1.0			1.0	mA
Ripple Rejection	T_j = 25°C, 15V ≤ V_{IN} ≤ 25V, I_O = 500mA	62			62			56			56			dB
Output Noise Voltage	T_j = 25°C, V_{IN} = 19V, I_O = 5mA		75			75			75			75		μV
Dropout Voltage	T_j = 25°C, I_O = 1A		2			2			2			2		V
Short Circuit Current	T_j = 25°C, V_{IN} = 19V		1.5			1.5			1.5			1.5		A
Peak Output Current	T_j = 25°C		2.4			2.4			2.4			2.4		A
Avg. Temp. Variation of V_{OUT}	0°C ≤ T_j ≤ T_{MAX}, V_{IN} = 19V, I_O = 5mA		-.8			-.8			-.8			-.8		mV/°C
Long Term Stability	1000 Hrs. @ T_j = 125°C, V_{IN} = 19V, I_O = 5mA		50			50			50			50		mV
Thermal Shutdown	V_{IN} = 19V, I_O = 5mA		175			175			175			175		°C
T_{MAX}			150			125			150			125		°C
T_{MIN}			-55			0			-55			0		°C

Note: All characteristics except noise voltage and ripple rejection are measured using pulse techniques (t_w ≤ 10ms, duty-cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A

ELECTRICAL CHARACTERISTICS

PARAMETER	TEST CONDITIONS	UC7815A			UC7815AC			UC7815			UC7815C			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Output Voltage	T_j = 25°C, V_{IN} = 23V, I_O = 1A	14.85		15.15	14.85		15.15	14.4		15.6	14.4		15.6	V
	T_j = 25°C, 17.5V ≤ V_{IN} ≤ 30V 5mA ≤ I_{OUT} ≤ 1A, P_D ≤ 15W	14.7		15.3	14.60		15.40	14.4		15.6	14.3		15.7	V
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}	14.55		15.45	14.55		15.45	14.25		15.75	14.25		15.75	V
Line Regulation	T_j = 25°C, 17.5V ≤ V_{IN} ≤ 30V, I_O = 500mA			15			19			75			100	mV
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}		4	22		4	22		22	150		22	150	mV
Load Regulation	T_j = 25°C, V_{IN} = 23V, 5mA ≤ I_O ≤ 1.5A		12	35		12	50		50	80		50	120	mV
	V_{IN} = 23V, 5mA ≤ I_O ≤ 1A Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}			75			75			150			150	mV
Quiescent Current	T_j = 25°C, V_{IN} = 23V, I_O = 1A		4.5	6		4.5	6		4.5	7		4.5	7	mA
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}			6.5			6.5			6.5			6.5	mA
Quiescent Current Change	T_j = 25°C, V_{IN} = 23V, 5mA ≤ I_O ≤ 1A			.4			.4			.4			.4	mA
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}			.5			.5			.5			.5	mA
	T_j = 25°C, 17.5V ≤ V_{IN} ≤ 30V, I_O = 500mA			.6			.6			.8			.8	mA
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}			.8			.8			1.0			1.0	mA
Ripple Rejection	T_j = 25°C, 18.5V ≤ V_{IN} ≤ 28.5V, I_O = 500mA	60			60			54			54			dB
Output Noise Voltage	T_j = 25°C, V_{IN} = 23V, I_O = 5mA		90			90			90			90		μV
Dropout Voltage	T_j = 25°C, I_O = 1A		2			2			2			2		V
Short Circuit Current	T_j = 25°C, V_{IN} = 23V		1.2			1.2			1.2			1.2		A
Peak Output Current	T_j = 25°C		2.4			2.4			2.4			2.4		A
Avg. Temp. Variation of V_{OUT}	0°C ≤ T_j ≤ T_{MAX}, V_{IN} = 23V, I_O = 5mA		-1.0			-1.0			-1.0			-1.0		mV/°C
Long Term Stability	1000 Hrs. @ T_j = 125°C, V_{IN} = 23V, I_O = 5mA		60			60			60			60		mV
Thermal Shutdown	V_{IN} = 23V, I_O = 5mA		175			175			175			175		°C
T_{MAX}			150			125			150			125		°C
T_{MIN}			-55			0			-55			0		°C

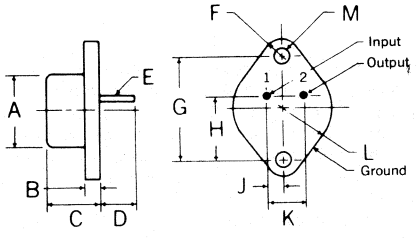
Note: All characteristics except noise voltage and ripple rejection are measured using pulse techniques (t_w ≤ 10ms, duty-cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

MECHANICAL SPECIFICATIONS AND CONNECTION DIAGRAMS

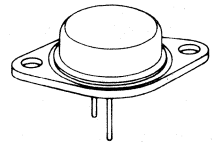
UC7800AC UC7800A SERIES
UC7800C UC7800 SERIES



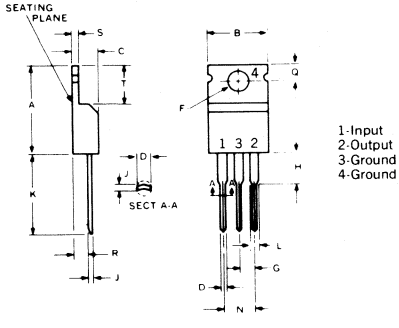
Bottom View

	INCHES	MILLIMETERS
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA K(TO-3)



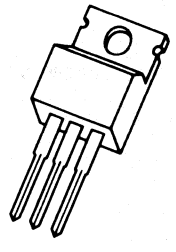
UC7800C UC7800AC SERIES



1-Input
2-Output
3-Ground
4-Ground

	INCHES		MILIMETERS	
	MIN	MAX	MIN	MAX
A	0.560	0.625	14.23	15.87
B	0.380	0.420	9.66	10.66
C	0.140	0.190	3.56	4.82
D	0.020	0.045	0.51	1.14
F	0.139	0.147	3.531	3.733
G	0.090	0.110	2.29	2.79
H	—	0.250	—	6.35
J	0.015	0.025	0.38	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.070	1.14	1.77
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.115	2.04	2.92
S	0.045	0.055	1.14	1.39
T	0.230	0.270	5.85	6.85

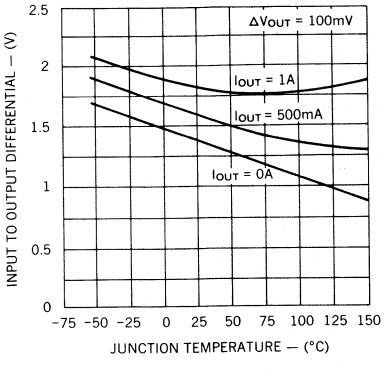
T(TO-220)



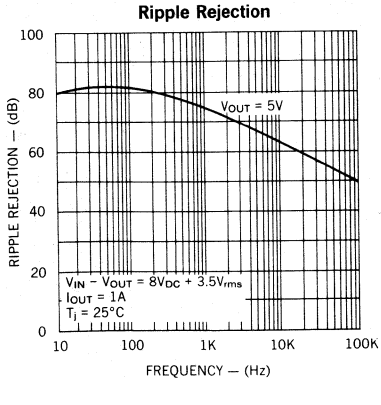
ORDERING INFORMATION

OUTPUT VOLTAGE	PACKAGE SUFFIX			
	K(TO-3)		T(TO-220)	
5V	UC7805AK UC7805ACK	UC7805K UC7805CK	— UC7805ACT	— UC7805CT
12V	UC7812AK UC7812ACK	UC7812K UC7812CK	— UC7812ACT	— UC7812CT
15V	UC7815AK UC7815ACK	UC7815K UC7815CK	— UC7815ACT	— UC7815CT

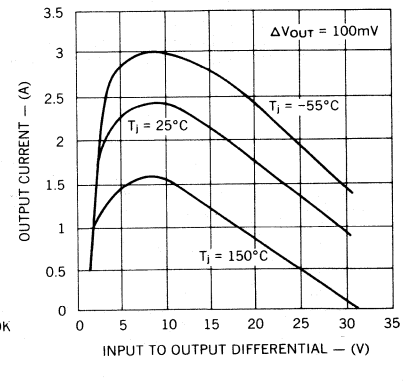
Dropout Voltage



Ripple Rejection



Peak Output Current



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

LINEAR INTEGRATED CIRCUITS

Three Terminal Fixed Voltage Negative Regulators

UC7900A
UC7900AC
UC7900
UC7900C

FEATURES

- ±1% Output Voltage on 7900A, AC Series
- Output Current to 1.5A
- One External Component
- Internal Thermal Overload Protection
- Internal Short Circuit Current Limiting
- Output Transistor Safe Area Compensation
- Available in TO-3 and TO-220 Packages
- Output Voltages of −5V, −12V and −15V (For Other Voltages, Please Contact the Factory)

DESCRIPTION

These three terminal monolithic negative voltage regulators employ internal current limiting, thermal shutdown and safe area compensation, making them essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A of output current. They are intended as fixed voltage regulators in a wide range of applications including local (on card) regulation for elimination of distribution problems associated with single point regulation. In addition to use as fixed voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents. The 7900 and 7900C series have output tolerances of ±4%. The 7900A and 7900AC series offer ±1% tolerances on initial output voltage and, in addition, are specified to provide better regulator performance.

ABSOLUTE MAXIMUM RATINGS

Input Voltage ..... −35V
Input-Output Voltage Differential 30V
Power Dissipation ..... Internally limited
Operating Junction Temperature Range
  UC7900A SERIES ..... −55°C to +150°C
  UC7900AC SERIES ..... 0°C to +125°C
  UC7900 SERIES ..... −55°C to +150°C
  UC7900C SERIES ..... 0°C to +125°C
Storage Temperature Range ..... −65°C to +150°C
Lead Temperature (Soldering, 10 seconds)
  K (TO-3) package ..... 300°C
  T (TO-220) package ..... 230°C

Power/Thermal Characteristics

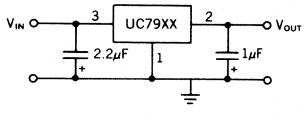
	K (TO-3) Package	T (TO-220) Package
Rated Power @ 25°C		
T_C	20W	15W
T_A	4.3W	2W
Thermal Resistance		
θ_{JC}	3°C/W	3°C/W
θ_{JA}	35°C/W	60°C/W

TYPICAL APPLICATIONS

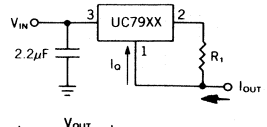
Input bypass capacitors are recommended for stable operation of the UC7900 series of regulators over the input voltage and output current ranges. Output bypass capacitors will improve the transient response of the regulator.

The bypass capacitors, (2.2μF on the input, 1μF on the output) should be ceramic or solid tantalum which have good high frequency characteristics. If aluminum electrolytics are used, their values should be 10μF or larger. The bypass capacitors should be mounted with the shortest leads, and if possible, directly across the regulator terminals.

Fixed Output Regulator



Basic Current Regulator



$$I_{OUT} = \frac{V_{OUT}}{R_1} + I_Q$$

UNITRODE

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELLEX 95-1064

ELECTRICAL CHARACTERISTICS

PARAMETER	TEST CONDITIONS	UC7905A			UC7905AC			UC7905			UC7905C			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.*	TYP.	MAX.	
Output Voltage	T_j = 25°C, V_{IN} = -10V, I_O = 5mA	-5.05		-4.95	-5.05		-4.95	-5.20		-4.80	-5.20		-4.80	V
	T_j = 25°C, -25V ≤ V_{IN} ≤ -8V 5mA ≤ I_{OUT} ≤ 1.0A, P ≤ P_D	-5.10		-4.90	-5.13		-4.87	-5.20		-4.80	-5.23		-4.77	V
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}	-5.15		-4.85	-5.15		-4.85	-5.25		-4.75	-5.25		-4.75	V
Line Regulation	T_j = 25°C, -25V ≤ V_{IN} ≤ -7V, I_O = 5mA		10	15		10	25		25	50		25	50	mV
Load Regulation	T_j = 25°C, V_{IN} = -10V, 5mA ≤ I_O ≤ 1.5A		20	50		20	100			50			100	mV
Quiescent Current	T_j = 25°C, V_{IN} = -10V, I_O = 500mA		1	2		1	2		1	2.5		1	2.5	mA
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}			2.5			2.5			3			3	mA
Quiescent Current Change	T_j = 25°C, V_{IN} = -10V, 5mA ≤ I_O ≤ 1.5A			.4			.4			1.0			1.0	mA
	T_j = 25°C, -25V ≤ V_{IN} ≤ -8V, I_O = 500mA			.4			.4			.5			.5	mA
Ripple Rejection	T_j = 25°C, -18V ≤ V_{IN} ≤ -8V, I_O = 500mA	54			54			54			54			dB
Output Noise Voltage	f = 10Hz to 100KHz, C_L = 1μf T_j = 25°C, V_{IN} = -10V, I_O = 500mA		100			100			100			100		μV
Dropout Voltage	T_j = 25°C, I_O = 1A		2.0			2.0			2.0			2.0		V
Short Circuit Current	T_j = 25°C, V_{IN} = -10V		1.8			1.8			1.8			1.8		A
Peak Output Current	T_j = 25°C		2.0			2.0			2.0			2.0		A
Avg. Temp. Variation of V_{OUT}	0°C ≤ T_j ≤ T_{MAX}, V_{IN} = -10V, I_O = 5mA		-.4			-.4			-.4			-.4		mV/°C
Long Term Stability	1000 Hrs. @ T_j = 125°C, V_{IN} = -10V, I_O = 5mA		20			20			20			20		mV
Thermal Shutdown	V_{IN} = -10V, I_O = 5mA		175			175			175			175		°C
	T_{MAX}		150			125			150			125		°C
	T_{MIN}		-55			0			-55			0		°C

Note: All characteristics except noise voltage and ripple rejection are measured using pulse techniques (t_w ≤ 10ms, duty-cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately. P_D = 20W for TO-3 (K) and 15W for TO-220 (T); Min $|V_O - V_{IN}|$ @ -55°C = 2.5V.

PRINTED IN U.S.A.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

ELECTRICAL CHARACTERISTICS

UC7900A UC7900AC UC7900 UC7900C SERIES 12V, NEGATIVE

PARAMETER	TEST CONDITIONS	UC7912A			UC7912AC			UC7912			UC7912C			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Output Voltage	T_j = 25°C, V_{IN} = −17V, I_O = 5mA	−12.12		−11.88	−12.12		−11.88	−12.48		−11.52	−12.48		−11.52	V
	T_j = 25°C, −32V ≤ V_{IN} ≤ −14V 5mA ≤ I_{OUT} ≤ 1.0A, P ≤ P_D	−12.24		−11.76	−12.30		−11.70	−12.48		−11.52	−12.54		−11.46	V
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}	−12.36		−11.64	−12.36		−11.64	−12.60		−11.40	−12.60		−11.40	V
Line Regulation	T_j = 25°C, −32V ≤ V_{IN} ≤ −14V, I_O = 5mA		10	20		10	30		30	80		30	80	mV
Load Regulation	T_j = 25°C, V_{IN} = −17V, 5mA ≤ I_O ≤ 1.5A		40	80		40	80			120			240	mV
Quiescent Current	T_j = 25°C, V_{IN} = −17V, I_O = 500mA		3			3			3			3		mA
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}			4			4			4			4	mA
Quiescent Current Change	T_j = 25°C, V_{IN} = −17V, 5mA ≤ I_O ≤ 1.5A			.4			.4			.8			.8	mA
	T_j = 25°C, −32V ≤ V_{IN} ≤ −14V, I_O = 500mA			.4			.4			.5			.5	mA
Ripple Rejection	T_j = 25°C, −25V ≤ V_{IN} ≤ −15V, I_O = 500mA	56			56			56			56			dB
Output Noise Voltage	f = 10Hz to 100KHz, C_L = 1μf T_j = 25°C, V_{IN} = −17V, I_O = 500mA		200			200			200			200		μV
Dropout Voltage	T_j = 25°C, I_O = 1A		1.1			1.1			1.1			1.1		V
Short Circuit Current	T_j = 25°C, V_{IN} = −17V		1.3			1.3			1.3			1.3		A
Peak Output Current	T_j = 25°C		2.0			2.0			2.0			2.0		A
Avg. Temp. Variation of V_{OUT}	0°C ≤ T_j ≤ T_{MAX}, V_{IN} = −17V, I_O = 5mA		-.9			-.9			-.9			-.9		mV/°C
Long Term Stability	1000 Hrs. @ T_j = 125°C, V_{IN} = −17V, I_O = 5mA		48			48			48			48		mV
Thermal Shutdown	V_{IN} = −17V, I_O = 5mA		175			175			175			175		°C
	T_{MAX}		150			125			150			125		°C
	T_{MIN}		−55			0			−55			0		°C

Note: All characteristics except noise voltage and ripple rejection are measured using pulse techniques (t_w ≤ 10ms, duty-cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately. P_D = 20W for TO-3 (K) and 15W for TO-220 (T).

PRINTED IN U.S.A.

ELECTRICAL CHARACTERISTICS

PARAMETER	TEST CONDITIONS	UC7915A			UC7915AC			UC7915			UC7915C			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Output Voltage	T_j = 25°C, V_{IN} = -20V, I_O = 5mA	-15.15		-14.85	-15.15		-14.85	-15.60		-14.40	-15.60		-14.40	V
	T_j = 25°C, -35V ≤ V_{IN} ≤ -17V 5mA ≤ I_{OUT} ≤ 1.0A, P ≤ P_D	-15.30		-14.70	-15.38		-14.63	-15.60		-14.40	-15.68		-14.32	V
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}	-15.45		-14.55	-15.45		-14.55	-15.75		-14.25	-15.75		-14.25	V
Line Regulation	T_j = 25°C, -35V ≤ V_{IN} ≤ -17V, I_O = 5mA		10	20		10	30		35	100		35	100	mV
Load Regulation	T_j = 25°C, V_{IN} = -20V, 5mA ≤ I_O ≤ 1.5A		50	80		50	80			150			300	mV
Quiescent Current	T_j = 25°C, V_{IN} = -20V, I_O = 500mA		3			3			3			3		mA
	Over Temperature, T_{MIN} ≤ T_j ≤ T_{MAX}			4			4			4			4	mA
Quiescent Current Change	T_j = 25°C, V_{IN} = -20V, 5mA ≤ I_O ≤ 1.5A			.4			.4			.8			.8	mA
	T_j = 25°C, -35V ≤ V_{IN} ≤ -17V, I_O = 500mA			.4			.4			.5			.5	mA
Ripple Rejection	T_j = 25°C, -28V ≤ V_{IN} ≤ -18V, I_O = 500mA	56			56			56			56			dB
Output Noise Voltage	f = 10Hz to 100KHz, C_L = 1μf T_j = 25°C, V_{IN} = -17V, I_O = 500mA		250			250			250			250		μV
Dropout Voltage	T_j = 25°C, I_O = 1A		1.1			1.1			1.1			1.1		V
Short Circuit Current	T_j = 25°C, V_{IN} = -20V		1.1			1.1			1.1			1.1		A
Peak Output Current	T_j = 25°C		2.0			2.0			2.0			2.0		A
Avg. Temp. Variation of V_{OUT}	0°C ≤ T_j ≤ T_{MAX}, V_{IN} = -20V, I_O = 5mA		-1.0			-1.0			-1.0			-1.0		mV/°C
Long Term Stability	1000 Hrs. @ T_j = 125°C, V_{IN} = -20V, I_O = 5mA		60			60			60			60		mV
Thermal Shutdown	V_{IN} = -20V, I_O = 5mA		175			175			175			175		°C
T_{MAX}			150			125			150			125		°C
T_{MIN}			-55			0			-55			0		°C

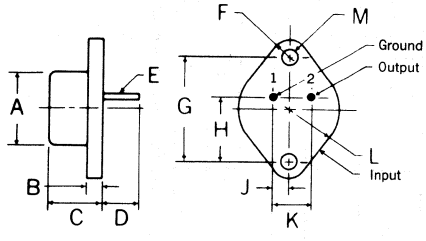
Note: All characteristics except noise voltage and ripple rejection are measured using pulse techniques (t_w ≤ 10ms, duty-cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately. P_D = 20W for TO-3 (K) and 15W for TO-220 (T).

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

MECHANICAL SPECIFICATIONS AND CONNECTION DIAGRAMS

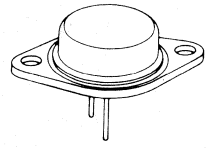
UC7900A UC7900AC SERIES
UC7900 UC7900C SERIES



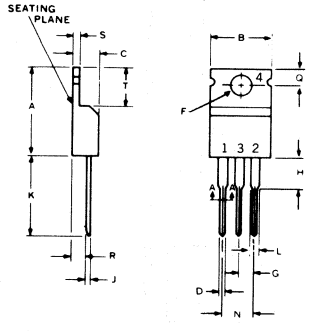
Bottom View

	INCHES	MILLIMETERS
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA K(TO-3)



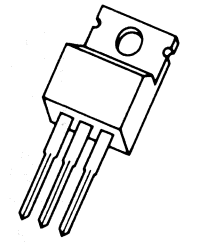
UC7900AC UC7900C SERIES



1-Ground
2-Output
3-Input
4-Input

	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.560	0.625	14.23	15.87
B	0.380	0.420	9.66	10.66
C	0.140	0.190	3.56	4.82
D	0.020	0.045	0.51	1.14
F	0.139	0.147	3.531	3.733
G	0.090	0.110	2.29	2.79
H	—	0.250	—	6.35
J	0.015	0.025	0.38	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.070	1.14	1.77
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.115	2.04	2.92
S	0.045	0.055	1.14	1.39
T	0.230	0.270	5.85	6.85

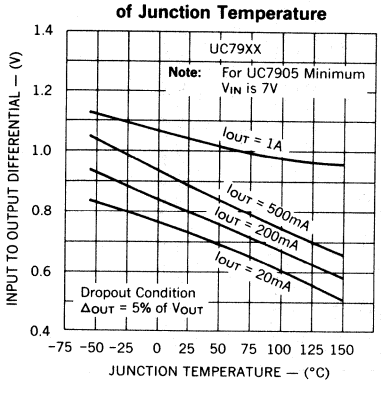
T(TO-220)



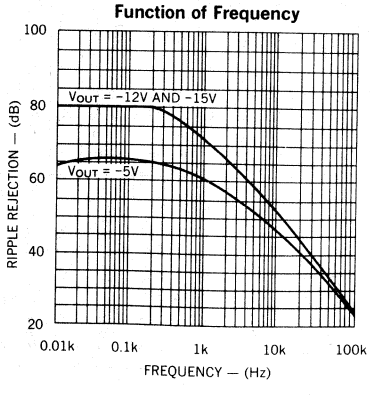
ORDERING INFORMATION

OUTPUT VOLTAGE	PACKAGE SUFFIX			
	K(TO-3)		T(TO-220)	
-5V	UC7905AK UC7905ACK	UC7905K UC7905CK	— UC7905ACT	— UC7905CT
-12V	UC7912AK UC7912ACK	UC7912K UC7912CK	— UC7912ACT	— UC7912CT
-15V	UC7915AK UC7915ACK	UC7915K UC7915CK	— UC7915ACT	— UC7915CT

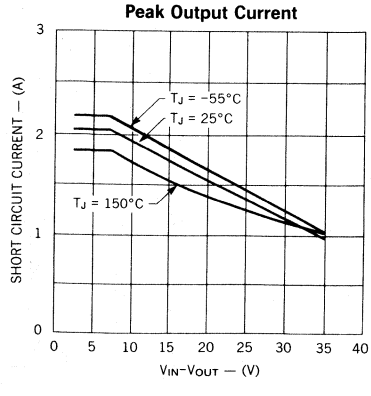
Dropout Voltage as a Function of Junction Temperature



Ripple Rejection as a Function of Frequency



Peak Output Current



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFETS, POWER TRANSISTORS & DARLINGTONS 3

N-Channel Power MOSFETs - Product Selection Guide 3-3
NPN Bipolar Power Switching Transistors - Product Selection Guide 3-6
Power Darlingtons - Product Selection Guide 3-10
Data Sheets 3-11

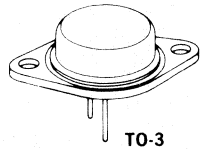
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

N-CHANNEL POWER MOSFETS



TO-3

V_{DS} Drain Source Voltage (Volts)	$R_{DS(on)}$ On-State Resistance (Ohms)	Part Numbers	I_D Continuous Drain Current (Amps) 100°C Case	I_D Continuous Drain Current (Amps) 25°C Case	I_{DM} Pulsed Drain Current (Amps)	$P_{D\ MAX}$ Power Dissipation (Watts)
500	0.4	2N6770*	7.75	12.0	48	150
500	0.4	UFN450	8.0	13.0	52	150
500	0.5	UFN452	7.0	12.0	48	150
500	0.85	UFN440	5.0	8.0	32	125
500	1.1	UFN442	4.0	7.0	28	125
500	1.5	2N6762*	3.0	4.5	18	75
500	1.5	UFN430	3.0	4.5	18	75
500	2.0	UFN432	3.5	4.0	16	75
500	3.0	UFN420	1.5	2.5	10	40
500	4.0	UFN422	1.0	2.0	8	40
450	0.4	UFN451	8.0	13.0	52	150
450	0.5	2N6769	7.0	11.0	44	150
450	0.5	UFN453	7.0	12.0	48	150
450	0.85	UFN441	5.0	8.0	32	125
450	1.1	UFN443	4.0	7.0	28	125
450	1.5	UFN431	3.0	4.5	18	75
450	2.0	2N6761	2.5	4.0	16	75
450	2.0	UFN433	2.5	4.0	16	75
450	3.0	UFN421	1.5	2.5	10	40
450	4.0	UFN423	1.0	2.0	8	40
400	0.3	2N6768*	9.0	14.0	56	150
400	0.3	UFN350	9.0	15.0	60	150
400	0.4	UFN352	8.0	13.0	52	150
400	0.55	UFN340	6.0	10.0	40	125
400	0.8	UFN342	5.0	8.0	32	125
400	1.0	2N6760*	3.5	5.5	22	75
400	1.0	UFN330	3.5	5.5	22	75
400	1.5	UFN332	3.0	4.5	18	75
400	1.8	UFN320	2.0	3.0	12	40
400	2.5	UFN322	1.5	2.5	10	40
350	0.3	UFN351	9.0	15.0	60	150
350	0.4	2N6767	7.75	12.0	48	150
350	0.4	UFN353	8.0	13.0	52	150
350	0.55	UFN341	6.0	10.0	40	125
350	0.8	UFN343	5.0	8.0	32	125
350	1.0	UFN331	3.5	5.5	22	75
350	1.5	2N6759	3.0	4.5	18	75
350	1.5	UFN333	3.5	4.5	18	75
350	1.8	UFN321	2.0	3.0	12	40
350	2.5	UFN323	1.5	2.5	10	40

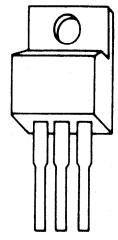
V_{DS} Drain Source Voltage (Volts)	$R_{DS(on)}$ On-State Resistance (Ohms)	Part Numbers	I_D Continuous Drain Current (Amps) 100°C Case	I_D Continuous Drain Current (Amps) 25°C Case	I_{DM} Pulsed Drain Current (Amps)	$P_{D\ MAX}$ Power Dissipation (Watts)
200	0.085	2N6766*	19.0	30.0	120	150
200	0.085	UFN250	19.0	30.0	120	150
200	0.12	UFN252	16.0	25.0	100	150
200	0.18	UFN240	11.0	18.0	72	125
200	0.22	UFN242	10.0	16.0	64	125
200	0.4	2N6758*	6.0	9.0	36	75
200	0.4	UFN230	6.0	9.0	36	75
200	0.6	UFN232	5.0	8.0	32	75
200	0.8	UFN220	3.0	5.0	20	40
200	1.2	UFN222	2.5	4.0	16	40
150	0.085	UFN251	19.0	30.0	120	150
150	0.12	2N6765	16.0	25.0	100	150
150	0.12	UFN253	16.0	25.0	100	150
150	0.18	UFN241	11.0	18.0	72	125
150	0.22	UFN243	10.0	16.0	64	125
150	0.4	UFN231	6.0	9.0	36	75
150	0.6	2N6757	5.0	8.0	32	75
150	0.6	UFN233	5.0	8.0	32	75
150	0.8	UFN221	3.0	5.0	20	40
150	1.2	UFN223	2.5	4.0	16	40
100	0.055	2N6764*	24.0	38.0	152	150
100	0.055	UFN150	25.0	40.0	160	150
100	0.08	UFN152	20.0	33.0	132	150
100	0.085	UFN140	17.0	27.0	108	125
100	0.11	UFN142	15.0	24.0	96	125
100	0.18	2N6756*	9.0	14.0	56	75
100	0.18	UFN130	9.0	14.0	56	75
100	0.25	UFN132	8.0	12.0	48	75
100	0.3	UFN120	5.0	8.0	32	40
100	0.4	UFN122	4.0	7.0	28	40
60	0.055	UFN151	25.0	40.0	160	150
60	0.08	2N6763	20.0	31.0	124	150
60	0.08	UFN153	20.0	33.0	132	150
60	0.085	UFN141	17.0	27.0	108	125
60	0.11	UFN143	15.0	24.0	96	125
60	0.18	UFN131	9.0	14.0	56	75
60	0.25	2N6755	8.0	12.0	48	75
60	0.25	UFN133	8.0	12.0	48	75
60	0.3	UFN121	5.0	8.0	32	40
60	0.4	UFN123	4.0	7.0	28	40

* Available as JAN, JANTX, and JANTXV types.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

N-CHANNEL POWER MOSFETS



TO-220AB

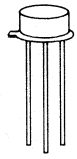
V_{DS} Drain Source Voltage (Volts)	$R_{DS(on)}$ On-State Resistance (Ohms)	Part Numbers	I_D Continuous Drain Current (Amps) 100°C Case	I_D Continuous Drain Current (Amps) 25°C Case	I_{DM} Pulsed Drain Current (Amps)	$P_{D\ MAX}$ Power Dissipation (Watts)
500	0.85	UFN840	5.0	8.0	32	125
500	1.1	UFN842	4.0	7.0	28	125
500	1.5	UFN830	3.0	4.5	18	75
500	2.0	UFN832	2.5	4.0	16	75
500	3.0	UFN820	1.5	2.5	10	40
500	4.0	UFN822	1.0	2.0	8	40
450	0.85	UFN841	5.0	8.0	32	125
450	1.1	UFN843	4.0	7.0	28	125
450	1.5	UFN831	3.0	4.5	18	75
450	2.0	UFN833	2.5	4.0	16	75
450	3.0	UFN821	1.5	2.5	10	40
450	4.0	UFN823	1.0	2.0	8	40
400	0.55	UFN740	6.0	10.0	40	125
400	0.80	UFN742	5.0	8.0	32	125
400	1.0	UFN730	3.5	5.5	22	75
400	1.5	UFN732	3.0	4.5	18	75
400	1.8	UFN720	2.0	3.0	12	40
400	2.5	UFN722	1.5	2.5	10	40
400	3.6	UFN710	1.0	1.5	6	20
400	5.0	UFN712	0.8	1.3	5	20
350	0.55	UFN741	6.0	10.0	40	125
350	0.8	UFN743	5.0	8.0	32	125
350	1.0	UFN731	3.5	5.5	22	75
350	1.5	UFN733	3.0	4.5	18	75
350	1.8	UFN721	2.0	3.0	12	40
350	2.5	UFN723	1.5	2.5	10	40
350	3.6	UFN711	1.0	1.5	6	20
350	5.0	UFN713	0.8	1.3	5	20
200	0.18	UFN640	11.0	18.0	72	125
200	0.22	UFN642	10.0	16.0	64	125

V_{DS} Drain Source Voltage (Volts)	$R_{DS(on)}$ On-State Resistance (Ohms)	Part Numbers	I_D Continuous Drain Current (Amps) 100°C Case	I_D Continuous Drain Current (Amps) 25°C Case	I_{DM} Pulsed Drain Current (Amps)	$P_{D\ MAX}$ Power Dissipation (Watts)
200	0.4	UFN630	6.0	9.0	36	75
200	0.6	UFN632	5.0	8.0	32	75
200	0.8	UFN620	3.0	5.0	20	40
200	1.2	UFN622	2.5	4.0	16	40
200	1.5	UFN610	1.5	2.5	10	20
200	2.4	UFN612	1.25	2.0	8	20
150	0.18	UFN641	11.0	18.0	72	125
150	0.22	UFN643	10.0	16.0	64	125
150	0.4	UFN631	6.0	9.0	36	75
150	0.6	UFN633	5.0	8.0	32	75
150	0.8	UFN621	3.0	5.0	20	40
150	1.2	UFN623	2.5	4.0	16	40
150	1.5	UFN611	1.5	2.5	10	20
150	2.4	UFN613	1.25	2.0	8	20
100	0.085	UFN540	17.0	27.0	108	125
100	0.11	UFN542	15.0	24.0	96	125
100	0.18	UFN530	9.0	14.0	56	75
100	0.25	UFN532	8.0	12.0	48	75
100	0.3	UFN520	5.0	8.0	32	40
100	0.4	UFN522	4.0	7.0	28	40
100	0.6	UFN510	2.5	4.0	16	20
100	0.8	UFN512	2.0	3.5	14	20
60	0.085	UFN541	17.0	27.0	108	125
60	0.11	UFN543	15.0	24.0	96	125
60	0.18	UFN531	9.0	14.0	56	75
60	0.25	UFN533	8.0	12.0	48	75
60	0.3	UFN521	5.0	8.0	32	40
60	0.4	UFN523	4.0	7.0	28	40
60	0.6	UFN511	2.5	4.0	16	20
60	0.8	UFN513	2.0	3.5	14	20
50	.028	UFNZ40	32.0	51.0	160	125
50	.035	UFNZ42	29.0	46.0	145	125
50	.050	UFNZ30	19.0	30.0	80	75
50	.070	UFNZ32	16.0	25.0	60	75
50	.100	UFNZ20	10.0	15.0	60	40
50	.120	UFNZ22	9.0	14.0	56	40

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

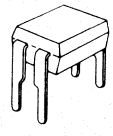
PRINTED IN U.S.A.

N-CHANNEL POWER MOSFETS



TO-39

V_{DS} Drain Source Voltage (Volts)	$R_{DS(on)}$ On-State Resistance (Ohms)	Part Numbers	I_D Continuous Drain Current (Amps) 100°C Case	I_D Continuous Drain Current (Amps) 25°C Case	I_{DM} Pulsed Drain Current (Amps)	$P_{D\ MAX}$ Power Dissipation (Watts)
500	1.5	UFNF430	1.75	2.75	11	25
500	1.5	2N6802*	1.5	2.5	11	25
500	2.0	UFNF432	1.5	2.25	9	25
500	3.0	UFNF420	1.0	1.6	65	20
500	3.0	2N6794*	0.95	1.5	6.5	20
500	4.0	UFNF422	0.9	1.4	5.5	20
450	1.5	UFNF431	1.75	2.75	11	25
450	1.5	2N6801	1.5	2.5	11	25
450	2.0	UFNF433	1.5	2.25	9	25
450	3.0	UFNF421	1.0	1.6	6.5	20
450	3.0	2N6793	0.95	1.5	6.5	20
450	4.0	UFNF423	0.9	1.4	5.5	20
400	1.0	UFNF330	2.0	3.5	14	25
400	1.0	2N6800*	1.6	3.0	14	25
400	1.5	UFNF332	1.6	3.0	12	25
400	1.8	UFNF320	1.45	2.5	10	20
400	1.8	2N6792*	1.25	2.0	10	20
400	2.5	UFNF322	1.2	2.0	8	20
400	3.6	UFNF310	0.85	1.35	5.5	15
400	3.6	2N6786*	0.80	1.25	5.5	15
400	5.0	UFNF312	0.70	1.15	4.5	15
350	1.0	UFNF331	2.0	3.5	14	25
350	1.0	2N6799	1.6	3.0	14	25
350	1.5	UFNF333	1.6	3.0	12	25
350	1.8	UFNF321	1.45	2.5	10	20
350	1.8	2N6791	1.25	2.0	10	20
350	2.5	UFNF323	1.2	2.0	8	20
350	3.6	UFNF311	0.85	1.35	5.5	15
350	3.6	2N6785	0.80	1.25	5.5	15
350	5.0	UFNF313	0.70	1.15	4.5	15
200	0.4	2N6798*	3.5	5.5	22	25
200	0.4	UFNF230	3.5	5.5	22	25
200	0.6	UFNF232	2.8	4.5	18	25
200	0.8	2N6790*	2.1	3.5	14	20
200	0.8	UFNF220	2.1	3.5	14	20
200	1.2	UFNF222	1.75	3.0	12	20
200	1.5	2N6784*	1.45	2.25	9	15
200	1.5	UFNF210	1.4	2.2	9	15
200	2.4	UFNF212	1.1	1.8	7.5	15
150	0.4	2N6797	3.5	5.5	22	25
150	0.4	UFNF231	3.5	5.5	22	25
150	0.6	UFNF233	2.8	4.5	18	25
150	0.8	2N6789	2.1	3.5	14	20
150	0.8	UFNF221	2.1	3.5	14	20
150	1.2	UFNF223	1.75	3.0	12	20
150	1.5	2N6783	1.45	2.25	9	15
150	1.5	UFNF211	1.4	2.2	9	15
150	2.4	UFNF213	1.1	1.8	7.5	15
100	0.18	2N6796*	5.0	8.0	32	25
100	0.18	UFNF130	5.0	8.0	32	25
100	0.25	UFNF132	4.5	7.0	28	25
100	0.3	2N6788*	3.5	6.0	24	20
100	0.3	UFNF120	3.5	6.0	24	20
100	0.4	UFNF122	3.0	5.0	20	20
100	0.6	2N6782*	2.25	3.5	14	15
100	0.6	UFNF110	2.25	3.5	14	15
100	0.8	UFNF112	2.0	3.0	12	15
60	0.18	2N6795	5.0	8.0	32	25
60	0.18	UFNF131	5.0	8.0	32	25
60	0.25	UFNF133	4.5	7.0	28	25
60	0.3	2N6787	3.5	6.0	24	20
60	0.3	UFNF121	3.5	6.0	24	20
60	0.4	UFNF123	3.0	5.0	20	20
60	0.6	2N6781	2.25	3.5	14	15
60	0.6	UFNF111	2.25	3.5	14	15
60	0.8	UFNF113	2.0	3.0	12	15



DIL-4

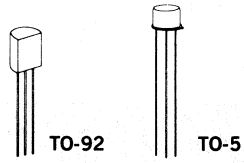
V_{DS} Drain Source Voltage (Volts)	$R_{DS(on)}$ On-State Resistance (Ohms)	Part Numbers	I_D Continuous Drain Current (Amps) 25°C Case	I_{DM} Pulsed Drain Current (Amps)	$P_{D\ MAX}$ Power Dissipation (Watts)
200	1.5	UFND210	0.6	2.5	1.0
200	0.8	UFND220	0.8	6.4	1.0
150	2.4	UFND213	0.45	1.8	1.0
150	1.2	UFND223	0.7	5.6	1.0
100	0.3	UFND120	1.3	5.2	1.0
100	0.6	UFND110	1.0	4.0	1.0
100	2.4	UFND1Z0	0.5	2.0	1.0
60	0.4	UFND123	1.1	4.4	1.0
60	0.8	UFND113	0.8	3.0	1.0
60	3.2	UFND1Z3	0.4	1.5	1.0

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

NPN BIPOLAR POWER SWITCHING TRANSISTORS

.5-30A, 60-500V



LOW VOLTAGE

Maximum Collector Current		1 AMP (PEAK)	2 AMP	3 AMP	
Package Style		TO-92	TO-5	TO-5	
COLLECTOR-EMITTER SUSTAINING VOLTAGE $V_{CEO\ (SUS)}$	60V		UPT212	2N3418*	2N3420*
	80V		UPT213	2N3419*	2N3421*
	100V	UPTA510	UPT214 UPT215		
h_{FE} Minimum		20 @ 1A	30 @ .5A	20 @ 1A	40 @ 1A
V_{CE} (sat) Max.		1V @ .5A	1V @ 2A	5V @ 2A	5V @ 2A
t_f Maximum		0.2μs (typical)	0.1μs (typical)	1.2μs ($t_{OFF} = t_s + t_f$)	

HIGH VOLTAGE

Maximum Collector Current		.5 AMP (PEAK)	1 AMP (PEAK)	2 AMP*	
Package Style		TO-92	TO-92	TO-5	
COLLECTOR-EMITTER SUSTAINING VOLTAGE $V_{CEO\ (SUS)}$	150V			UPT311	
	200V	UPTB520	UPTA520	UPT312	2N5662*
	250V			UPT313	
	275V				
	300V	UPTB530	UPTA530	UPT314 UPT315	2N5663*
	350V				
	400V	UPTB540			
	500V	UPTB550			
h_{FE} Minimum		20 @ 25mA	25 @ .1A	30 @ .5A	40 @ .5A (2N5662) 25 @ .5A (2N5663)
V_{CE} (sat) Max.		1.2v @ 50mA	1V @ .5A	1V @ 2A	.4V @ 1A
t_f Maximum		1.0μs (typical)	0.2μs (typical)	0.3μs (typical)	0.4μs (2N5662) 0.6μs (2N5663)

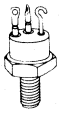
*Available as JAN, JANTX, JANTXV.

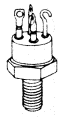
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

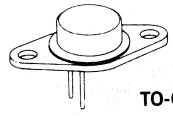
PRINTED IN U.S.A.

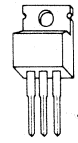
NPN BIPOLAR POWER SWITCHING TRANSISTORS

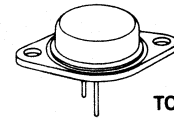
.5-30A, 60-500V


TO-59


TO-111


TO-66


TO-220AB


TO-3

LOW VOLTAGE

Maximum Collector Current		5AMP					40AMP
Package Style		**TO-5**	**TO-59**		**TO-111**		**TO-3**
COLLECTOR-EMITTER SUSTAINING VOLTAGE $V_{CEO(SUS)}$	40V						UBT430
	60V	UPT612					
	80V	UPT613	2N2151** 2N2880* 2N3998*	2N3999*	2N3749* 2N3996*	2N3997*	
	100V	UPT614 UPT615					
h_{FE} Minimum		30 @ 1A	40 @ 1A	80 @ 1A	40 @ 1A	80 @ 1A	50 @ 20A
V_{CE}(sat) Max.		1V @ 5A	.25V @ 1A (1V @ 1A for 2N2151)				1V @ 10A
t_f Maximum		0.1μs (typical)	0.3μs (2N2880)	1.0μs	0.3μs (2N3749)	1.0μs	0.12μs
			0.8μs (2N3998)		0.8μs (2N3996)		

HIGH VOLTAGE

Maximum Collector Current		2 AMP		3 AMP		4 AMP	8 AMP
Package Style		**TO-66**		**TO-66**	**TO-220AB**	**TO-220AB**	**TO-3**
COLLECTOR-EMITTER SUSTAINING VOLTAGE $V_{CEO(SUS)}$	150V	UPT321		UPT521			
	200V	UPT322	2N5660*	UPT522			
	250V	UPT323		UPT523			
	275V						
	300V	UPT324 UPT325	2N5661*	UPT524 UPT525	UMT1203	MJE13004	2N6671
	350V						2N6672
	400V				UMT1204	MJE13005	2N6673
	500V						
h_{FE} Minimum		30 @ .5A	40 @ .5A (2N5660)	25 @ 1A	7 @ 2A	8 @ 2A	10 @ 5A
			25 @ .5A (2N5661)				
V_{CE} (sat) Max.		1V @ 2A	4V @ 1A	1V @ 3A	3V @ 3A	0.6V @ 2A	1.0 @ 5A
t_f Maximum		0.3μs (typical)	0.4μs (2N5660)	0.4μs (typical)	0.7μs	0.9μs	0.4μs
			0.6μs (2N5661)				

*Available as JAN, JANTX, JANTXV.

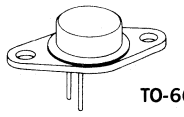
**Available as JAN, JANTX.

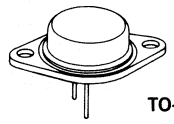
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

NPN BIPOLAR POWER SWITCHING TRANSISTORS

.5-30A, 60-500V


TO-66


TO-3


TO-5

LOW VOLTAGE

Maximum Collector Current		10 AMP	
Package Style		**TO-5**	**TO-3**
COLLECTOR-EMITTER SUSTAINING VOLTAGE $V_{CEO\ (SUS)}$	70V	2N4150**	
	75V		
	80V		
	90V		
	100V		
	120V		2N6354
h_{FE} Minimum		50 @ 5A	10 @ 10A
V_{CE} (sat) Max.		0.6V @ 5A	1.0V @ 10A
t_f Maximum		0.5μs	0.2μs

HIGH VOLTAGE

Maximum Collector Current		5 AMP							8AMP		
Package Style		**TO-5**		**TO-66**			**TO-3**		**TO-220AB**	**TO-3**	
COLLECTOR-EMITTER SUSTAINING VOLTAGE $V_{CEO\ (SUS)}$	150V					UPT721					
	200V	2N5666*		2N5664*		UPT722					
	250V					UPT723				2N6306	
	275V										
	300V		2N5667*		2N5665*	UPT724 UPT725	2N6542		MJE13006	2N6307	
	350V							UMT1006			2N6308
	400V						2N6543 BUX82	UMT1007	MJE13007		
	450V										
h_{FE} Minimum		40 @ 1A	25 @ 1A	40 @ 1A	25 @ 1A	25 @ 1A	7 @ 3A	7 @ 3A	6 @ 5A	15 @ 3A	12 @ 3A
V_{CE} (sat) Max.				0.4V @ 3A		1V @ 3A	1.0V @ 3A	1.0V @ 3A	1.5V @ 5A	0.8V @ 3A	1.5V @ 3A
t_f Maximum		0.8μs	1.0μs	0.8μs	1.0μs	0.5μs (typical)	0.8μs	0.4μs	0.7μs	0.4μs	

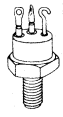
*Available as JAN, JANTX, JANTXV.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

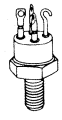
PRINTED IN U.S.A.

NPN BIPOLAR POWER SWITCHING TRANSISTORS

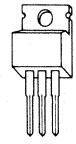
.5-30A, 60-500V



TO-59



TO-111



TO-220AB

LOW VOLTAGE

Maximum Collector Current		10 AMP		15 AMP	20 AMP	
Package Style		**TO-59**	**TO-111**	**TO-3**	**TO-3**	
COLLECTOR-EMITTER SUSTAINING VOLTAGE $V_{CEO(SUS)}$	70V					
	75V					2N5039*
	80V	2N5658	2N5659			
	90V				2N5038*	
	100V			2N6496		
	120V					
h_{FE} Minimum		50 @ 5A		12 @ 8A	20 @ 12A	20 @ 10A
V_{CE} (sat) Max.		0.5V @ 5A		1.0V @ 8A	1.2V @ 12A	1.0V @ 10A
t_f Maximum		0.5μs		0.5μs	0.5μs	0.5μs

*Available as JAN, JANTX, JANTXV.

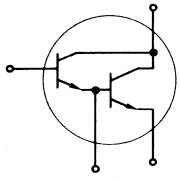
HIGH VOLTAGE

8 AMP	10 AMP				12 AMP	15 AMP			
TO-3	**TO-3**				**TO-220AB**	**TO-3**			
UMT1008 2N6544		2N6674			MJE13008		2N6546		2N6676
						UMT1011			2N6677
UMT1009 2N6545	BUX80	2N6675			MJE13009	UMT1012	2N6547 BUX48		2N6678
								UMT2000	
7 @ 5A	30 @ 1.5A	8 @ 10A	8 @ 10A	6 @ 10A	6 @ 8A	6 @ 10A	6 @ 10A	7 @ 15A	8 @ 15A
1.5V @ 5A	1.5V @ 5A	1.0V @ 10A	1.5V @ 10A	1.5V @ 10A	1.5V @ 8A	1.0V @ 10A	1.5V @ 10A	3.0V @ 10A	1.0 @ 15A
0.9μs (2N6544, 5) 0.4μs (UMT1008,9)	3.5μs	0.5μs	1.0μs	1.0μs	0.7μs	0.4μs	0.7μs	0.15μs	0.5μs

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A

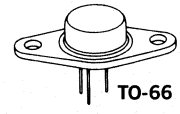
POWER DARLINGTONS



External bias types — for fast switching or other special purpose applications



TO-33



TO-66 (3-Pin)

NPN Power Darlingtons

Maximum Collector Current		2A				5A			
Package Style		**TO-33**		**TO-66 (3-Pin)**		**TO-33**		**TO-66 (3-Pin)**	
COLLECTOR-EMITTER SUSTAINING VOLTAGE $V_{CEO\ (SUS)}$	60V	U2T301		U2T401					
	80V					2N6350* U2T101		2N6352* U2T201	
	150V		U2T305		U2T405		2N6351* U2T105		2N6353* U2T205
h_{FE} Minimum		1000 @ 2A		1000 @ 2A		2000 @ 5A	1000 @ 5A	2000 @ 5A	1000 @ 5A
V_{CE}(sat) Maximum		1.5V @ 2A	2.5V @ 2A	1.5V @ 2A	2.5V @ 2A	1.5V @ 5A	2.5V @ 5A	1.5V @ 5A	2.5V @ 5A
t_f Typical		0.3μs				0.5μs			

*Available as JAN, JANTX, and JANTVX types

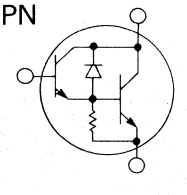
Plastic NPN Power Darlingtons



TO-92

Maximum Collector Current		5A (PEAK)
Package Style		**TO-92**
COLLECTOR-EMITTER SUSTAINING VOLTAGE $V_{CEO\ (SUS)}$		NPN
	60V	U2TA506
	80V	U2TA508
	100V	U2TA510
h_{FE} Minimum		500 @ 3A
V_{CE} (sat) Maximum		1.5V @ 3A
t_f Typical		0.8μs

NPN



Plastic Package types with integral bias resistance and shunt diode for maximum economy in standard applications

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER TRANSISTORS

2 Amp, 80V, Planar NPN

JAN & JANTX 2N2151

3

FEATURES

- Meets MIL-S-19500/277
- Collector-Base Voltage: up to 150V
- D.C. Collector Current: 2A
- Beta Guaranteed at 3 Current Levels
- Characterized for Safe Operating Area

DESCRIPTION

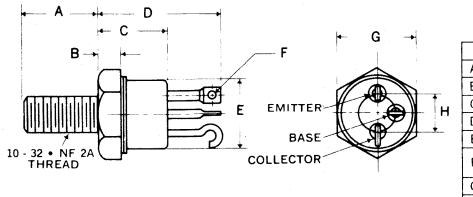
Unitrode power transistors provide a unique combination of low saturation voltage, high gain and fast switching. They are ideally suited for power supply pulse amplifier and similar high efficiency power switching applications.

ABSOLUTE MAXIMUM RATINGS

Collector-Base Voltage, V_{CBO}	150V
Collector-Emitter Voltage, V_{CEO}	100V
Emitter-Base Voltage, V_{EBO}	8V
D.C. Collector Current, I_C	2A
Base Current, I_B	2A
Power Dissipation	
100°C Case	30W
Operating Temperature Range	—55°C to 175°C
Storage Temperature Range	—65°C to 200°C

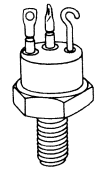
MECHANICAL SPECIFICATIONS

JAN & JANTX2N2151



	INCHES	MILLIMETERS
A	.400-.455	10.16-11.56
B	.090-.150	2.28-3.81
C	.320-.468	8.13-11.88
D	.570-.763	14.48-19.38
E	.318-.380	8.07-9.65
F	.055 ± .010 .015	1.40 ± .254 .381
G	.424-.437	10.77-11.10
H	.185-.215	4.70-5.46

TO-59



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	Min.	Max.	Units	/277C Sub-group	Method	MIL-STD-750 Test Conditions
25°C							
Collector-Base Breakdown Voltage	BV_{CBO}	150	—	Vdc	A-2	3001	$I_C = 100$uAdc, Cond. D
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CEO}	100	—	Vdc	A-2	3011	$I_C = 50$mAdc, Cond. D
Collector-Emitter Cutoff Current	I_{CES}	—	5	uAdc	A-2	3041	$V_{CE} = 120$Vdc, $V_{BE} = 0$, Cond. C
Collector-Emitter Cutoff Current	I_{CEX}	—	5	uAdc	A-2	3041	$V_{CE} = 120$Vdc, $V_{EB} = 1$Vdc, Cond. A
Collector-Emitter Cutoff Current	I_{CEO}	—	10	uAdc	A-2	3041	$V_{CE} = 80$Vdc, Cond. D
Collector-Base Cutoff Current	I_{CBO}	—	5	uAdc	A-2	3036	$V_{CB} = 120$Vdc, Cond. D
Emitter-Base Cutoff Current	I_{EBO}	—	2	uAdc	A-2	3061	$V_{EB} = 8$Vdc, Cond. D
D.C. Current Gain (Note 1)	h_{FE}	40	120	—	A-3	3076	$I_C = 1$Adc, $V_{CE} = 5$Vdc
D.C. Current Gain (Note 1)	h_{FE}	40	120	—	A-3	3076	$I_C = 0.5$Adc, $V_{CE} = 5$Vdc
D.C. Current Gain (Note 1)	h_{FE}	40	—	—	A-3	3076	$I_C = 0.1$Adc, $V_{CE} = 5$Vdc
Collector Saturation Voltage (Note 1)	V_{CE} (sat)	0.1	1.0	Vdc	A-3	3071	$I_C = 1$Adc, $I_B = 0.1$Adc
Base Saturation Voltage (Note 1)	V_{BE} (sat)	—	1.2	Vdc	A-3	3066	$I_C = 1$Adc, $I_B = 0.1$Adc, Cond. A
Base-Emitter Voltage (Note 1)	V_{BE}	—	1.2	Vdc	A-3	3066	$I_C = 1$Adc, $V_{CE} = 5$Vdc, Cond. B
A.C. Current Gain	h_{fe}	40	160	—	A-5	3206	$I_C = 0.1$Adc, $V_{CE} = 30$Vdc, f = 1kHz
Gain-Bandwidth Product	f_T	10	70	MHz	A-5	3306	$I_C = 0.1$Adc, $V_{CE} = 30$Vdc, f = 10MHz
Output Capacitance	C_{ob}	—	160	pf	A-5	3236	$V_{CB} = 20$Vdc, $I_E = 0$, f = 1MHz
Thermal Resistance	Θ_{J-C}	—	2.5	$^oC/W$	C-1	3151	
100°C							
Forward-Biased Second Breakdown	$I_{S/B}$	2	—	Adc	B-9	—	$V_{CE} = 15$Vdc, t = 60 sec, see curve
Forward-Biased Second Breakdown	$I_{S/B}$	200	—	mAdc	B-9	—	$V_{CE} = 57$Vdc, t = 60 sec, see curve
Forward-Biased Second Breakdown	$I_{S/B}$	25	—	mAdc	B-9	—	$V_{CE} = 100$Vdc, t = 60 sec, see curve
Unclamped Inductive Sweep	$E_{S/B}$	20	—	mj	B-5	—	$I_C = 2$Adc, L = 10mh
Clamped Inductive Sweep	$E_{S/B}$	80	—	mj	B-6	—	$I_C = 2$Adc, L = 40mh, $V_{clamp} = 150$V
150°C							
Collector-Emitter Cutoff Current	I_{CES}	—	100	uAdc	A-4	3041	$V_{CE} = 120$Vdc, $V_{BE} = 0$, Cond. C
Collector-Emitter Cutoff Current	I_{CEX}	—	100	uAdc	A-4	3041	$V_{CE} = 120$Vdc, $V_{EB} = 1$Vdc
Emitter-Base Cutoff Current	I_{EBO}	—	20	uAdc	A-4	3061	$V_{EB} = 8$Vdc, Cond. D
−55°C							
D.C. Current Gain (Note 1)	h_{FE}	20	—	—	A-4	3076	$I_C = 0.5$Adc, $V_{CE} = 5$Vdc

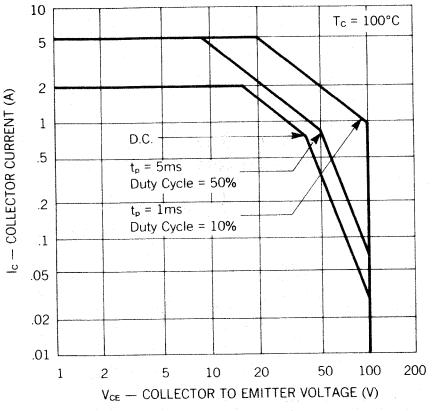
Note: 1. Pulse width = 300μs; duty cycle ≤ 2%.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

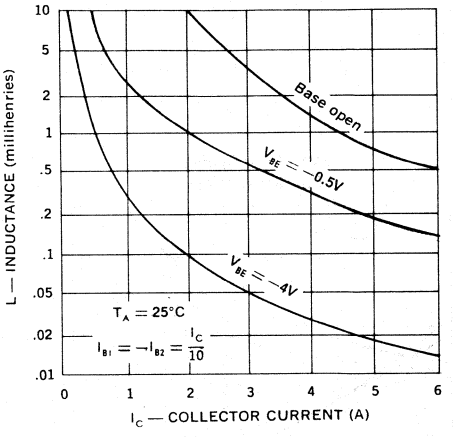
PRINTED IN U.S.A.

3

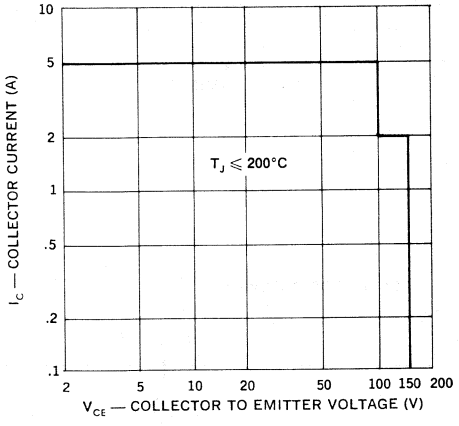
Forward Bias Safe Operating Area



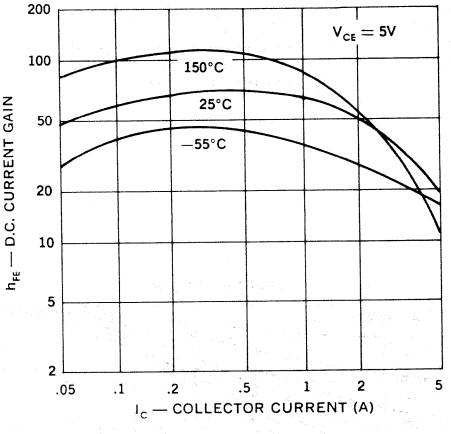
Unclamped Reverse Bias Second Breakdown



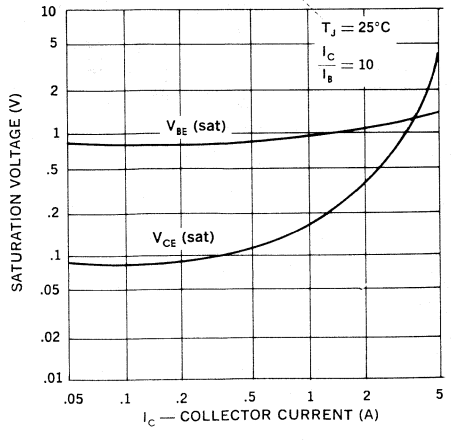
Reverse Bias Safe Operating Area Clamped Inductive Switching



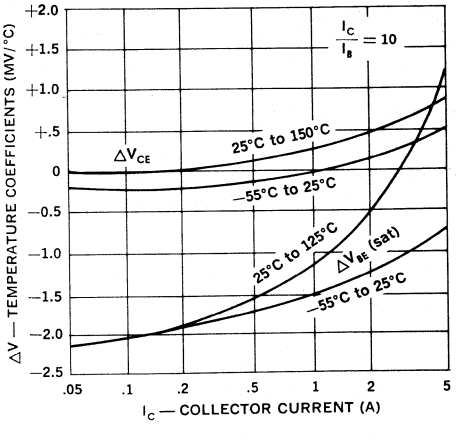
D.C. Current Gain



Saturation Voltages



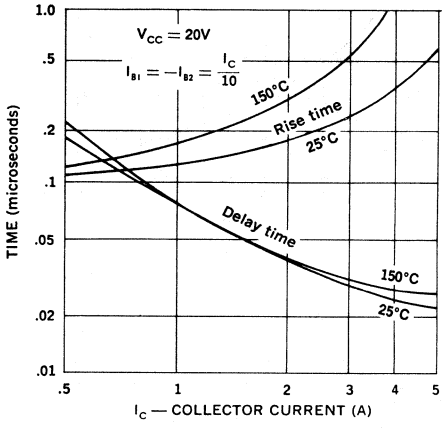
Saturation Voltage Temperature Coefficients



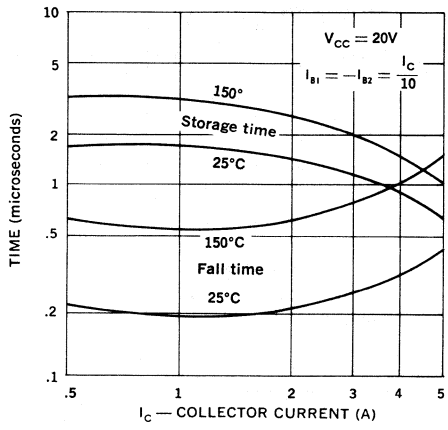
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

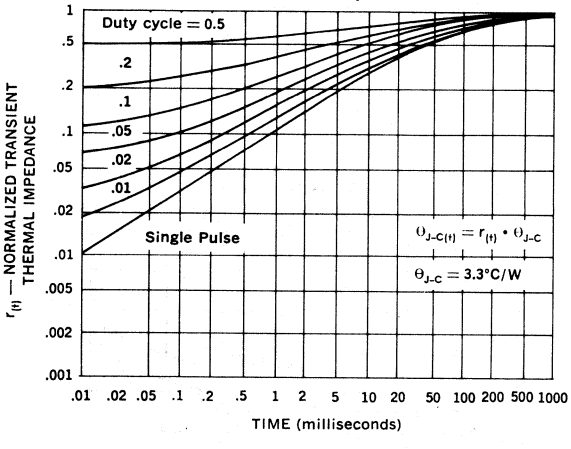
Switching Speed Characteristics



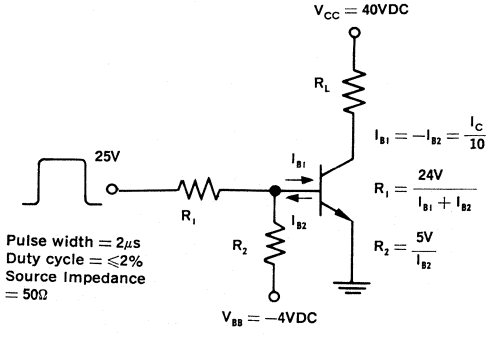
Switching Speed Characteristics



Thermal Response



Switching Speed Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER TRANSISTORS
5 Amp, 80V, Planar, NPN

JAN, JANTX, & JANTXV 2N2880
JAN, JANTX, & JANTXV 2N3749

3

FEATURES
- Meets MIL-S-19500/315
- Collector-Base Voltage: 110V
- Fast Switching: t_r, t_f = 300nSec max
- Low Saturation Voltage: 0.25V max @ 1A

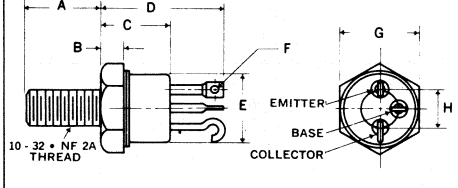
DESCRIPTION
Unitrode power transistors provide a unique combination of low saturation voltage, high gain and fast switching. They are ideally suited for power supply, pulse amplifier and similar high efficiency power switching applications.

ABSOLUTE MAXIMUM RATINGS

Collector-Base Voltage, V_{CBO}	110V
Collector-Emitter Voltage, V_{CEO}	80V
Emitter-Base Voltage, V_{EBO}	8V
D.C. Collector Current, I_C	5A
Power Dissipation	
25°C Ambient	2W
100°C Case	30W
Operating and Storage Temperature Range	−65°C to +200°C

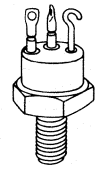
MECHANICAL SPECIFICATIONS

JAN, JANTX, & JANTXV 2N2880

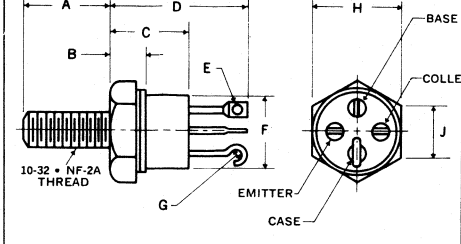


	INCHES	MILLIMETERS
A	.400-.455	10.16-11.56
B	.090-.150	2.28-3.81
C	.320-.468	8.13-11.88
D	.570-.763	14.48-19.38
E	.318-.380	8.07-9.65
F	.055 ± .010/.015	1.40 ± .254/.381
G	.424-.437	10.77-11.10
H	.185-.215	4.70-5.46

TO-59

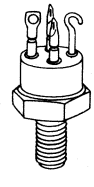


JAN, JANTX, & JANTXV 2N3749



	INCHES	MILLIMETERS
A	.400 - .455	10.16 - 11.55
B	.090 - .250	2.28 - 6.35
C	.320 - .468	8.13 - 11.88
D	.570 - .763	14.48 - 19.38
E	.065 - .090	1.65 - 2.28
F	.313 - .318	7.95 - 8.07
G	.070 - .090	1.77 - 2.28
H	.423 - .438	10.74 - 11.12
J	.135 - .215	3.43 - 5.46

TO-111



UNITRODE

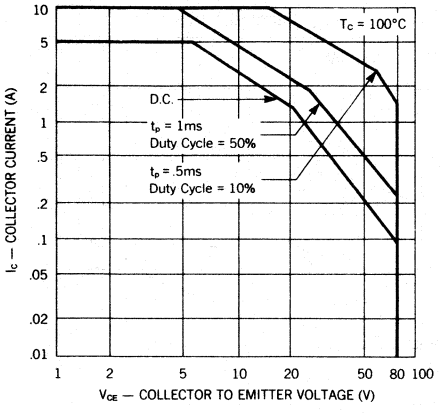
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

TEST	SYMBOL	MIN.	MAX.	UNITS	/315 Sub group	MIL - STD - 750 METHOD	MIL - STD - 750 TEST CONDITIONS
Visual and Mechanical	—	—	—		A-1	2071	See Mechanical Data
Collector-Base Voltage	BV_{CBO}	110	—	Vdc	A-2	3001	$I_C = 10\mu$Adc, Cond. D
Collector-Emitter Voltage (1.)	BV_{CEO}	80	—	Vdc	A-2	3011	$I_C = 0.1$Adc, Cond. D
Emitter-Base Voltage	BV_{EBO}	8	—	Vdc	A-2	3026	$I_E = 10\mu$Adc, Cond. D
Collector-Emitter Cutoff Current	I_{CEO}	—	100	μAdc	A-2	3041	$V_{CE} = 60$Vdc, Cond. D
Collector-Emitter Cutoff Current	I_{CEX}	—	10	μAdc	A-2	3041	$V_{CE} = 110$Vdc, $V_{EB} = 0.5$Vdc, Cond. A
Collector-Base Cutoff Current	I_{CBO}	—	0.4	μAdc	A-2	3036	$V_{CB} = 80$Vdc, Cond. D
Emitter-Base Cutoff Current	I_{EBO}	—	0.4	μAdc	A-2	3061	$V_{EB} = 6$Vdc, Cond. D
D.C. Current Gain (1.)	h_{FE}	40	—	—	A-3	3076	$I_C = 50$mAdc, $V_{CE} = 5$Vdc
D.C. Current Gain (1.)	h_{FE}	40	120	—	A-3	3076	$I_C = 1$Adc, $V_{CE} = 5$Vdc
D.C. Current Gain (1.)	h_{FE}	15	—	—	A-3	3076	$I_C = 5$Adc, $V_{CE} = 5$Vdc
Collector Saturation Voltage (1.)	$V_{CE\ (sat)}$	—	0.25	Vdc	A-3	3071	$I_C = 1$Adc, $I_B = 0.1$Adc
Collector Saturation Voltage (1.)	$V_{CE\ (sat)}$	—	1.5	Vdc	A-3	3071	$I_C = 5$Adc, $I_B = 0.5$Adc
Base Saturation Voltage (1.)	$V_{BE\ (sat)}$	—	1.2	Vdc	A-3	3066	$I_C = 1$Adc, $I_B = 0.1$Adc
Base On-Voltage (1.)	$V_{BE\ (on)}$	—	1.2	Vdc	A-3	3066	$I_C = 1$Adc, $V_{CE} = 2$Vdc
A.C. Current Gain	h_{FE}	40	120	—	A-4	3206	$I_C = 50$mAdc, $V_{CE} = 5$Vdc, f = 1KHz
Gain-Bandwidth Product	f_T	20	120	MHz	A-4	3306	$I_C = 1$Adc, $V_{CE} = 10$Vdc, f = 10MHz
Output Capacitance	C_{ob}	—	150	pf	A-4	3236	$V_{CB} = 10$Vdc, $I_E = 0$, f = 1MHz
Switching Parameters							
Delay Time	t_d	—	60	ns	A-4	—	See Switching Speed Circuit
Rise Time	t_r	—	300	ns	A-4	—	
Storage Time	t_s	—	1.7	μs	A-4	—	
Fall Time	t_f	—	300	ns	A-4	—	
Thermal Resistance	Θ_{JC}	—	3.33	°C/W	C-1	3151	
100°C							
Forward-Biased Second Breakdown	$I_{S/B}$	5	—	Adc	B-5	3051	$V_{CE} = 6$Vdc, t= 60Sec, $T_C = 100$°C
Forward-Biased Second Breakdown	$I_{S/B}$	80	—	mAdc	B-5	3051	$V_{CE} = 80$Vdc, t = 60Sec, $T_C = 100$°C
Clamped Reverse-Biased Second Breakdown	$E_{S/B}$	12.5	—	mj	B-7	—	$I_C = 5$A, L = 1mH, $V_{Clamp} = 110$V, $T_C = 100$°C
Unclamped Revers -Biased Second Breakdown	$E_{S/B}$	12.5	—	mj	B-6	3053	$I_C = 5$A, L = 1mH Base Open
Unclamped Reverse-Biased Second Breakdown	$E_{S/B}$	12.8	—	mj	B-6	3053	$I_C = 1.6$A, L = 10mH Base Open
150°C Collector-Emitter Cutoff Current	I_{CEX}	—	50	μA	A-5	3041	$V_{CE} = 80$Vdc, $V_{EB} = 0.5$Vdc Cond. A, $T_A = 150$°C
−65°C D.C. Current Gain (1.)	h_{FE}	15	—	—	A-5	3076	$I_C = 1$Adc, $V_{CE} = 5$Vdc $T_A = -65$°C

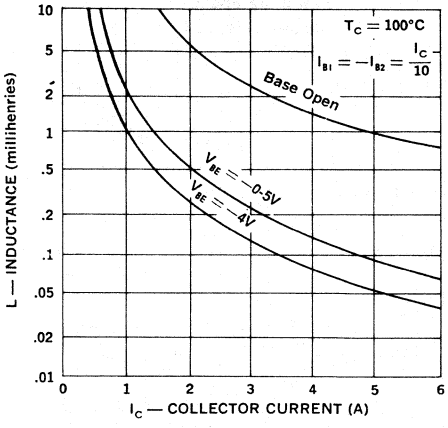
Note 1. Pulse Width = 300μSec, duty cycle ≤ 2%

3

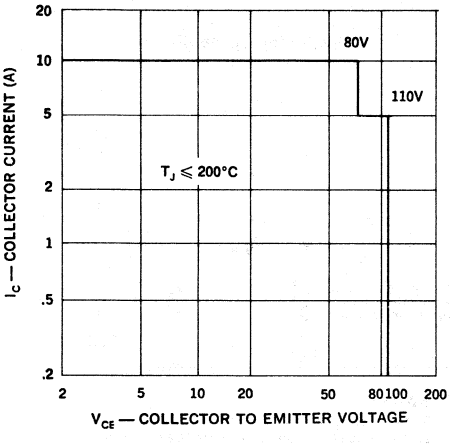
Forward Bias Safe Operating Area



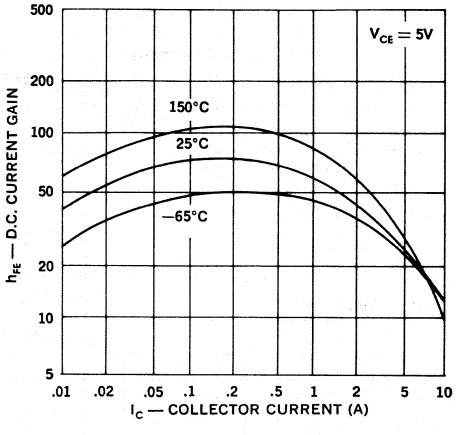
Unclamped Reverse Bias Second Breakdown



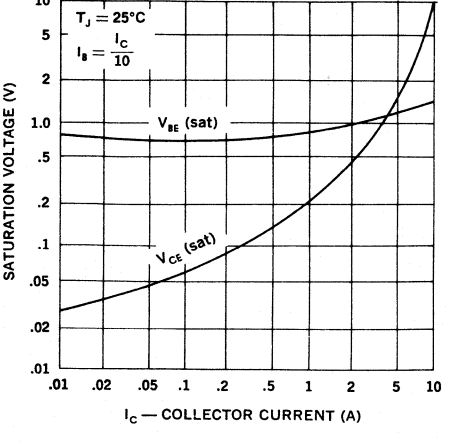
Reverse Bias Safe Operating Area Clamped Inductive Switching



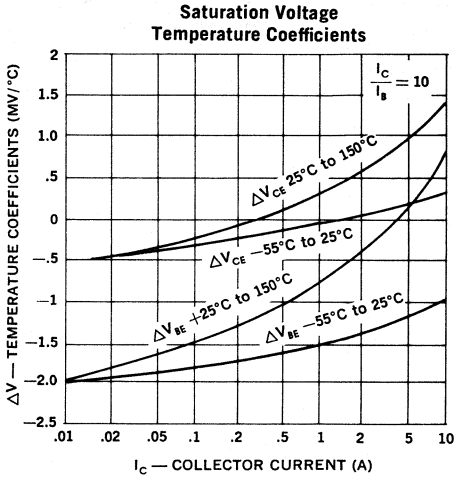
D.C. Current Gain 2N2880-2N3749



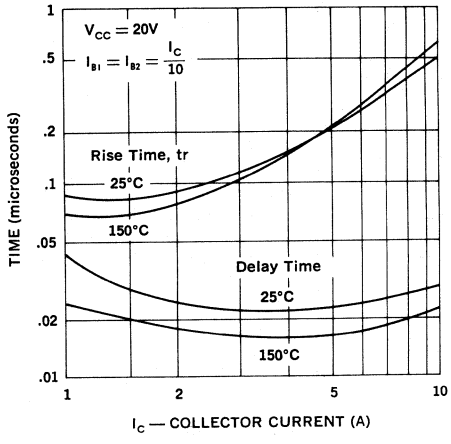
Saturation Voltages



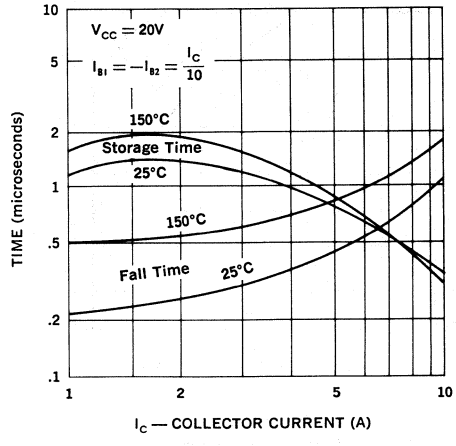
Saturation Voltage Temperature Coefficients



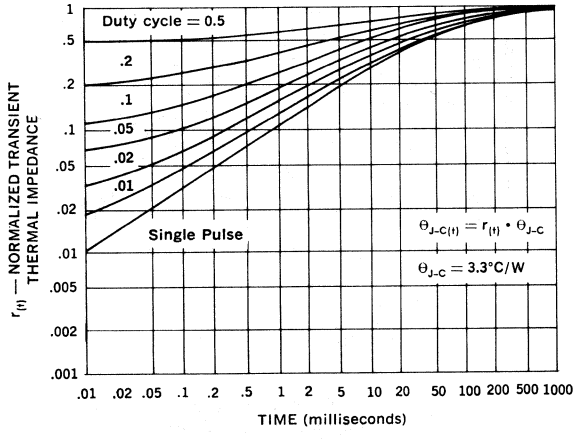
Switching Speed Characteristics



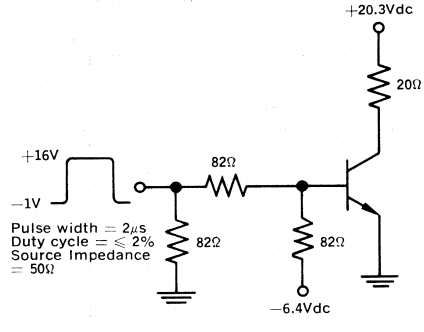
Switching Speed Characteristics



Thermal Response



Switching Speed Circuit



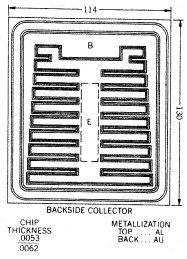
NOTES:
1. $I_C \approx 1A$, $I_{B1} \approx -I_{B2} \approx 100mA$
2. The values of collector current and base current are nominal. The actual values will vary slightly with transistor parameters.

POWER TRANSISTORS
3 Amp, 80V, Planar NPN

JAN, JANTX, & JANTXV 2N3418
JAN, JANTX, & JANTXV 2N3419
JAN, JANTX, & JANTXV 2N3420
JAN, JANTX, & JANTXV 2N3421

3

FEATURES
- Meets MIL-S-19500/393
- Collector-Base Voltage: up to 125V
- Peak Collector Current: 5A
- High Power Dissipation in TO-5: 15W @ $T_C = 100°C$
- Fast Switching



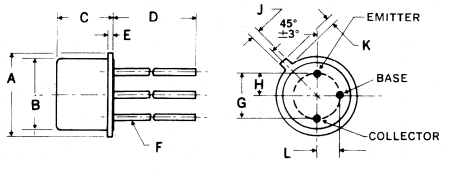
DESCRIPTION
Unitrode power transistors provide a unique combination of low saturation voltage, high gain, and fast switching. They are ideally suited for power supply, pulse amplifier and similar high frequency power switching applications.

ABSOLUTE MAXIMUM RATINGS

	JAN, JANTX, & JANTXV 2N3418 2N3420	JAN, JANTX, & JANTXV 2N3419 2N3421
Collector-Base Voltage, V_{CBO}	85V	125V
Collector-Emitter Voltage, V_{CEO}	60V	80V
Emitter-Base Voltage, V_{EBO}	8V	8V
D.C. Collector Current, I_C	3A	3A
Peak Collector Current, I_C	5A	5A
Power Dissipation		
25°C Ambient	1.0W	1.0W
100°C Case	15W	15W
Operating and Storage Temperature Range	−65°C to +200°C	

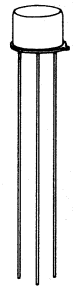
MECHANICAL SPECIFICATIONS

JAN, JANTX, & JANTXV 2N3418-2N3421



	INCHES	MILLIMETERS
A	.335-.370	8.51-9.40
B	.305-.335	7.75-8.51
C	.240-.260	6.09-6.60
D	1.5 MIN.	38.10 MIN.
E	.010-.030	.254-.762
F	.017 ± .002 .001	.432 ± .051 .025
G	.200	5.08
H	.100	2.54
J	.031±.003	.787±.076
K	.029-.045	.736-1.14
L	.100	2.54

TO-5



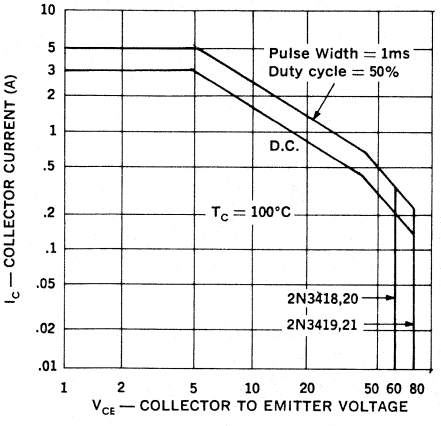
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

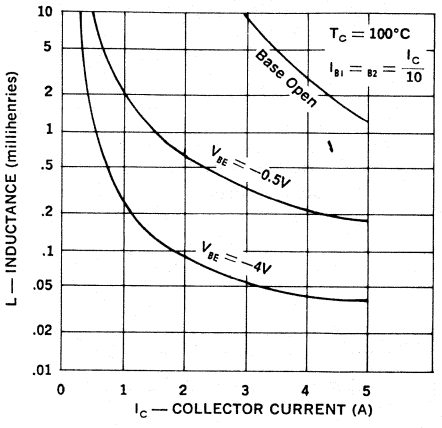
TEST	SYMBOL	MIN.	MAX.	UNITS	/393 Sub-group	MIL - STD - 750 METHOD	MIL - STD - 750 TEST CONDITIONS
Visual and Mechanical	—	—	—	—	A-1	2071	See Mechanical Data
Collector-Emitter Breakdown Voltage (1.)	BV_{CEO}				A-2	3011	I_C = 50mAdc, Cond. D
2N3418, 2N3420		60	—	Vdc			
2N3419, 2N3421		80	—	Vdc			
Collector-Emitter Cutoff Current	I_{CEX}				A-2	3041	V_{EB} = 0.5Vdc, Cond. A
2N3418, 2N3420		—	0.5	μAdc			V_{CE} = 80Vdc
2N3419, 2N3421		—	0.5	μAdc			V_{CE} = 120Vdc
Collector-Emitter Cutoff Current	I_{CEO}				A-2	3041	Cond. D
2N3418, 2N3420		—	5.0	μAdc			V_{CE} = 45Vdc
2N3419, 2N3421		—	5.0	μAdc			V_{CE} = 60Vdc
Emitter-Base Cutoff Current	I_{EBO}	—	0.5	μAdc	A-2	3061	V_{EB} = 6Vdc, Cond. D
Emitter-Base Cutoff Current	I_{EBO}	—	10	μAdc	A-2	3061	V_{EB} = 8Vdc, Cond. D
D.C. Current Gain (1.)	h_{FE}				A-3	3076	I_C = 100mAdc, V_{CE} = 2Vdc
2N3418, 2N3419		20	—	—			
2N3420, 2N3421		40	—	—			
D.C. Current Gain (1.)	h_{FE}				A-3	3076	I_C = 1Adc, V_{CE} = 2Vdc
2N3418, 2N3419		20	60	—			
2N3420, 2N3421		40	120	—			
D.C. Current Gain (1.)	h_{FE}				A-3	3076	I_C = 2Adc, V_{CE} = 2Vdc
2N3418, 2N3419		15	—	—			
2N3420, 2N3421		30	—	—			
D.C. Current Gain (1.)	h_{FE}				A-3	3076	I_C = 5Adc, V_{CE} = 5Vdc
2N3418, 2N3419		10	—	—			
2N3420, 2N3421		15	—	—			
Collector-Emitter Saturation Voltage (1.)	$V_{CE(sat)}$	—	0.25	Vdc	A-3	3071	I_C = 1Adc, I_B = 0.1Adc
Collector-Emitter Saturation Voltage (1.)	$V_{CE(sat)}$	—	0.5	Vdc	A-3	3071	I_C = 2Adc, I_B = 0.2Adc
Base-Emitter Saturation Voltage (1.)	$V_{BE(sat)}$	0.6	1.2	Vdc	A-3	3066	I_C = 1Adc, I_B = 0.1Adc
Base-Emitter Saturation Voltage (1.)	$V_{BE(sat)}$	0.7	1.4	Vdc	A-3	3066	I_C = 2Adc, I_B = 0.2Adc
Gain Bandwidth Product	f_T	40	160	MHz	A-4	3306	I_C = 0.1Adc, V_{CE} = 10Vdc, f = 20MHz
Output Capacitance	C_{ob}	—	150	pf	A-4	3236	V_{CB} = 10Vdc, I_E = 0, f = 1MHz
Switching Parameters							
Turn-on Time	t_{on}	—	0.3	μS	A-4	—	I_C = 1Adc, $I_{B1} = -I_{B2}$ = 0.1Adc
Turn-off Time	t_{off}	—	1.2	μS	A-4	—	See Switching Speed Circuit
100°C							
Forward Biased Second Breakdown	$I_{s/b}$	3	—	Adc	B-6	3005	V_{CE} = 5Vdc, t = 60sec, T_C = 100°C
Forward Biased Second Breakdown	$I_{s/b}$	1	—	Adc	B-6	3005	V_{CE} = 15Vdc, t = 60sec, T_C = 100°C
Forward Biased Second Breakdown	$I_{s/b}$	0.4	—	Adc	B-6	3005	V_{CE} = 37Vdc, t = 60sec, T_C = 100°C
Forward Biased Second Breakdown	$I_{s/b}$				B-6	3005	t = 60sec, T_C = 100°C
2N3418, 2N3420		185	—	mAdc			V_{CE} = 60Vdc
2N3419, 2N3421		120	—	mAdc			V_{CE} = 80Vdc
Unclamped Reverse Biased Second Breakdown	$E_{s/b}$	45	—	mj	B-7	—	I_C = 3Adc, L = 10mH, Base Open
Clamped Reverse Biased Second Breakdown	$E_{s/b}$	180	—	mj	B-8	—	I_C = 3Adc, L = 40mH, V clamp = Rated V_{CBO}
150°C							
Collector-Emitter Cutoff Current	I_{CEX}				A-5	3041	V_{EB} = 0.5Vdc, Cond. A, T_A = 150°C
2N3418, 2N3420		—	50	μAdc			V_{CE} = 80Vdc,
2N3419, 2N3421		—	50	μAdc			V_{CE} = 120Vdc,
−55°C							
D.C. Current Gain (1.)	h_{FE}	10	—	—	A-5	3076	I_C = 1Adc, V_{CE} = 2Vdc, T_A = −55°C

Note: 1. Pulse width = 300μSec, duty cycle ⩽ 2%.

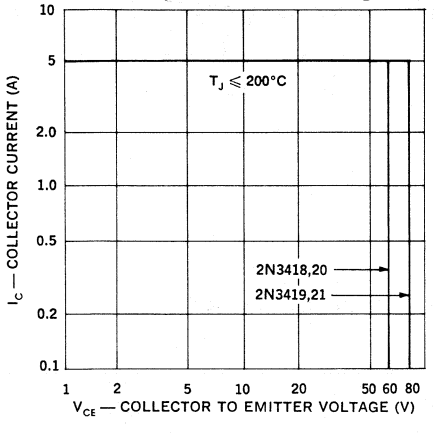
Forward Bias
Safe Operating Area



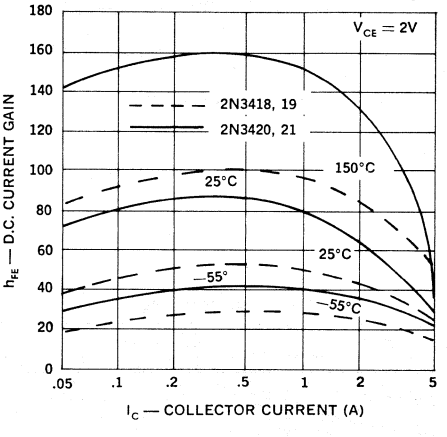
Unclamped Reverse Bias
Second Breakdown



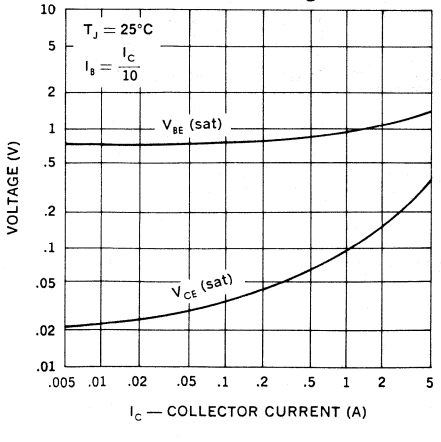
Reverse Bias
Safe Operating Area
Clamped Inductive Switching



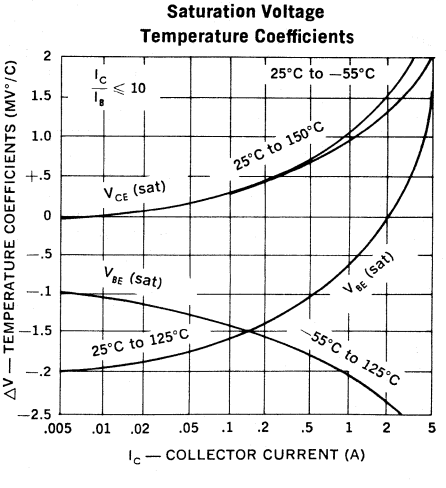
D.C. Current Gain Vs. Collector Current



Saturation Voltage



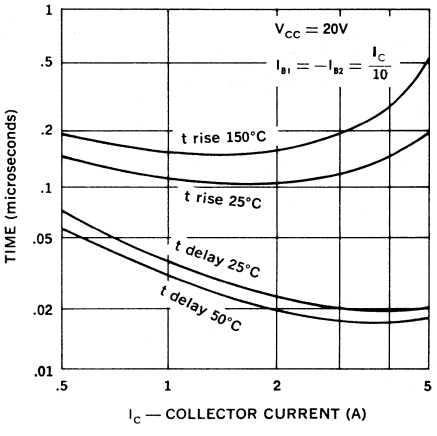
Saturation Voltage
Temperature Coefficients



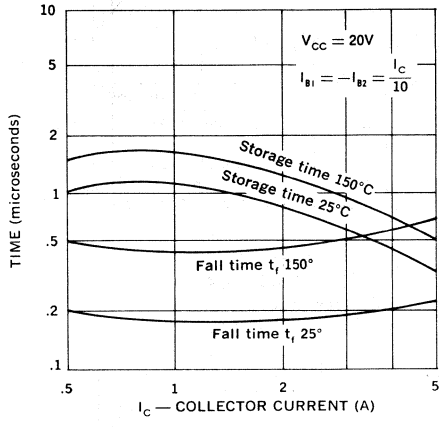
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

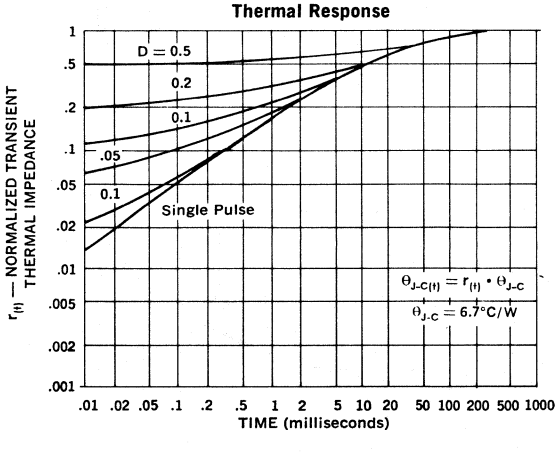
Switching Speed Characteristics



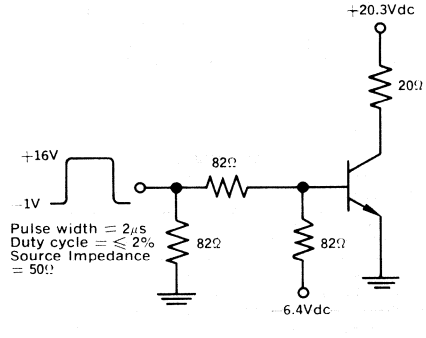
Switching Speed Characteristics



Thermal Response



Switching Speed Circuit



POWER TRANSISTORS

5 Amp, 80V, Planar NPN

JAN, JANTX, & JANTXV 2N3996
JAN, JANTX, & JANTXV 2N3997
JAN, JANTX, & JANTXV 2N3998
JAN, JANTX, & JANTXV 2N3999

3

FEATURES

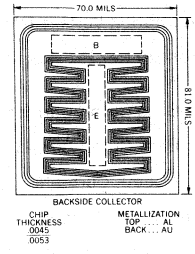
- Meets MIL-S-19500/374*
- Collector-Base Voltage: Up to 100V
- D.C. Collector Current: 5A
- Fast Switching
- Beta Guaranteed at 3 Current Levels

DESCRIPTION

Unitrode power transistors provide a unique combination of low saturation voltage, high gain and fast switching. They are ideally suited for power supply pulse amplifier and similar high efficiency power switching applications.

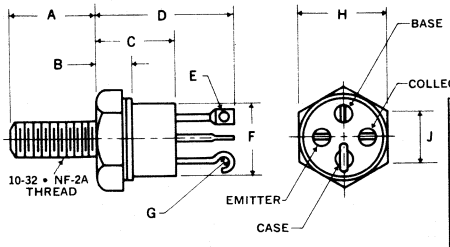
ABSOLUTE MAXIMUM RATINGS

Collector-Base Voltage, V_{CBO}	100V
Collector-Emitter Voltage, V_{CER}	80V
Emitter-Base Voltage, V_{EBO}	8V
D.C. Collector Current, I_C	5A
Peak Collector Current, I_C	10A
Power Dissipation	
25°C Ambient	2W
100°C Case	30W
Operating and Storage Temperature Range	−65°C to 200°C



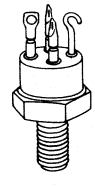
MECHANICAL SPECIFICATIONS

JAN, JANTX, & JANTXV 2N3996, 2N3997

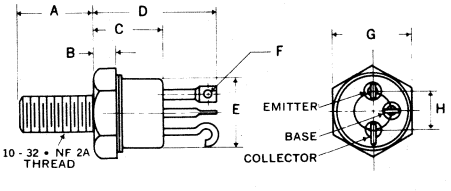


	INCHES	MILLIMETERS
A	.400 - .455	10.16 - 11.55
B	.090 - .250	2.28 - 6.35
C	.320 - .468	8.13 - 11.88
D	.570 - .763	14.48 - 19.38
E	.065 - .090	1.65 - 2.28
F	.313 - .318	7.95 - 8.07
G	.070 - .090	1.77 - 2.28
H	.423 - .438	10.74 - 11.12
J	.135 - .215	3.43 - 5.46

TO-111

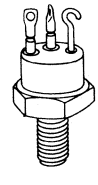


JAN, JANTX, & JANTXV 2N3998, 2N3999



	INCHES	MILLIMETERS
A	.400-.455	10.16-11.56
B	.090-.150	2.28-3.81
C	.320-.468	8.13-11.88
D	.570-.763	14.48-19.38
E	.318-.380	8.07-9.65
F	.055 ± $^{.010}_{.015}$	1.40 ± $^{.254}_{.381}$
G	.424-.437	10.77-11.10
H	.185-.215	4.70-5.46

TO-59



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)†

Test	Symbol	2N3996* 2N3998* Min.	2N3996* 2N3998* Max.	2N3997* 2N3999* Min.	2N3997* 2N3999* Max.	Units	Test Conditions
D.C. Current Gain	h_{FE}	30	—	60	—	—	I_C=50 mA, V_{CE}=2V
D.C. Current Gain (Note 1)	h_{FE}	40	120	80	240	—	I_C=1A, V_{CE}=2V
D.C. Current Gain (Note 1)	h_{FE}	15	—	20	—	—	I_C=5A, V_{CE}=5V
D.C. Current Gain, —55°C (Note 1)	h_{FE}	10	—	20	—	—	I_C=1A, V_{CE}=2V
Collector Saturation Voltage (Note 1)	V_{CE} (sat)	—	0.25	—	0.25	V	I_C=1A, I_B=100 mA
Collector Saturation Voltage (Note 1)	V_{CE} (sat)	—	2	—	2	V	I_C=5A, I_B=500 mA
Base Saturation Voltage (Note 1)	V_{BE} (sat)	0.6	1.2	0.6	1.2	V	I_C=1A, I_B=100 mA
Base Saturation Voltage (Note 1)	V_{BE} (sat)	—	1.6	—	1.6	V	I_C=5A, I_B=500 mA
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CEO}	80	—	80	—	V	I_C=50 mA, I_B=0
Emitter-Base Cutoff Current	I_{EBO}	—	0.2	—	0.2	μA	V_{BE}=5V, I_C=0
Emitter-Base Cutoff Current	I_{EBO}	—	10	—	10	μA	V_{BE}=8V, I_C=0
Collector Cutoff Current	I_{CES}	—	5	—	5	μA	V_{CE}=90V, R_{BE}=0
Collector Cutoff Current	I_{CEO}	—	10	—	10	μA	V_{CE}=60V, I_B=0
Collector Cutoff Current, 150°C	I_{CES}	—	50	—	50	μA	V_{CE}=90, R_{BE}=0
Collector Capacitance	C_{ob}	—	150	—	150	pf	V_{CB}=10V, I_E=0, f=1 MHz
A.C. Current Gain (High Frequency)	h_{fe}	4	—	4	—	—	I_C=1A, V_{CE}=5V, f=10 MHz
Switching Speeds Turn-on Time	t_{on}	—	0.3	—	0.3	μS	I_C=1A
Switching Speeds Turn-off Time	t_{off}	—	1.5	—	2	μS	I_{b1}=100mA, I_{b2}= —100 mA

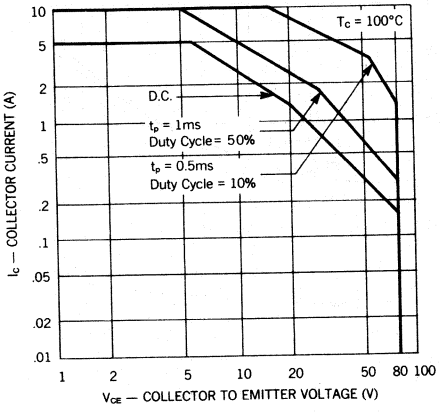
Notes:
1. Pulse width = 300μS; duty cycle ≤2%.
† All values in this table are JEDEC registered.

*Also applicable to JAN and JANTX versions

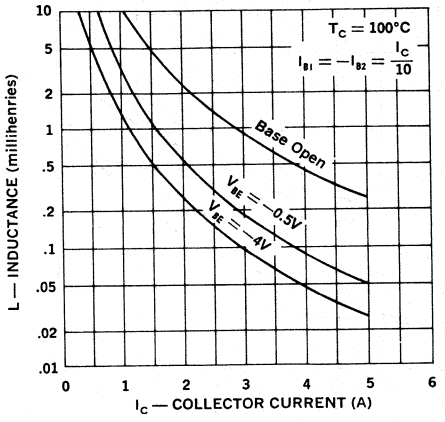
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

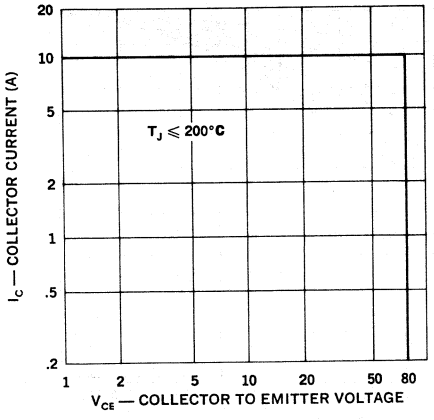
Forward Bias
Safe Operating Area



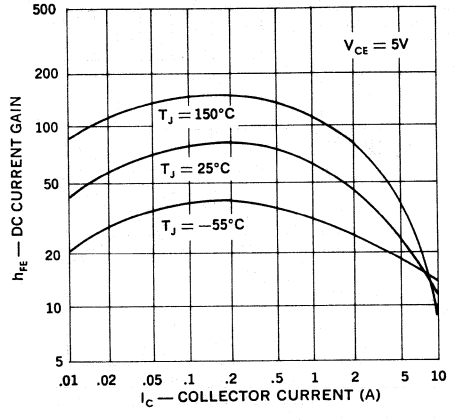
Unclamped Reverse Bias
Second Breakdown



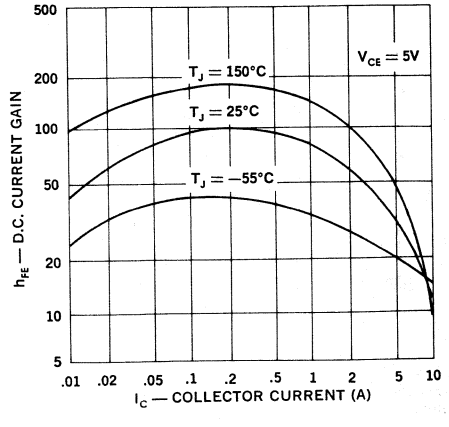
Reverse Bias
Safe Operating Area
Clamped Inductive Switching



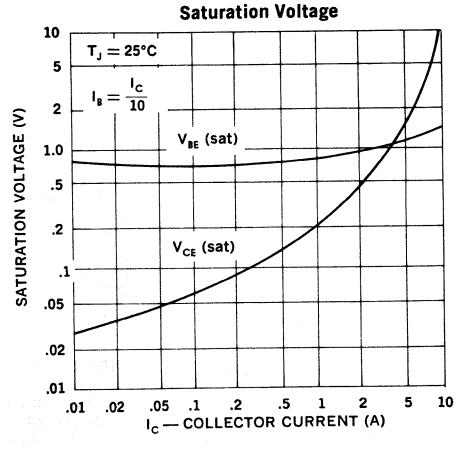
D.C. Current Gain
2N3996-2N3998



D.C. Current Gain
2N3997-2N3999



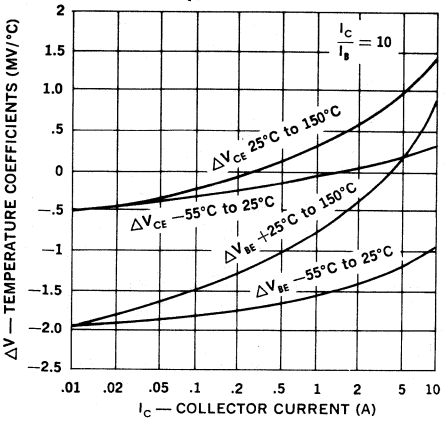
Saturation Voltage



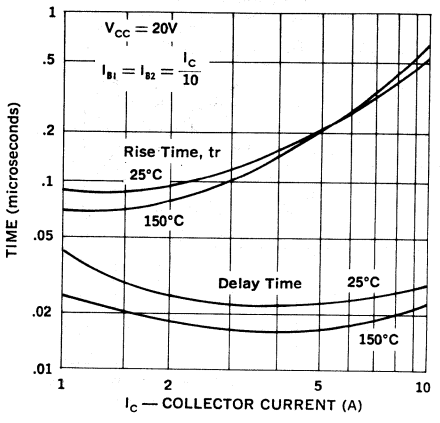
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

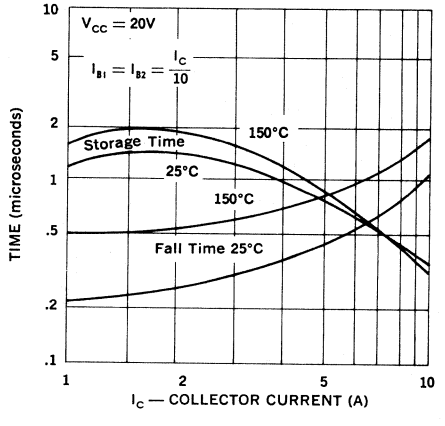
Saturation Voltage Temperature Coefficients



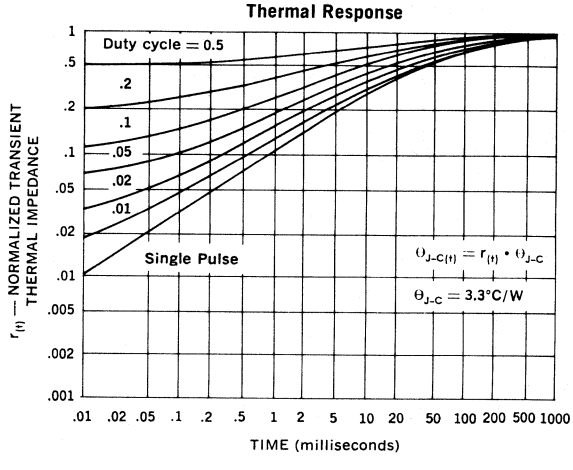
Switching Speed Characteristics



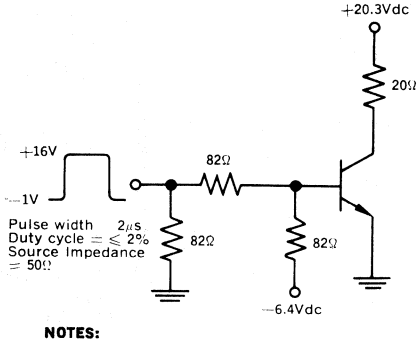
Switching Speed Characteristics



Thermal Response



Switching Speed Circuit



NOTES:

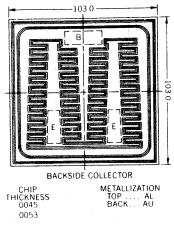
1. $I_C \approx 1A$, $I_{B1} \approx -I_{B2} \approx 100mA$
2. The values of collector current and base current are nominal. The actual values will vary slightly with transistor parameters.

POWER TRANSISTORS
10 Amp, 70V, Planar NPN

JAN, JANTX & JANTXV 2N4150

3

FEATURES
- Meets MIL-S-19500/394
- Collector-Base Voltage: up to 100V
- Peak Collector Current: 10A
- Fast Switching
- Low Saturation Voltage



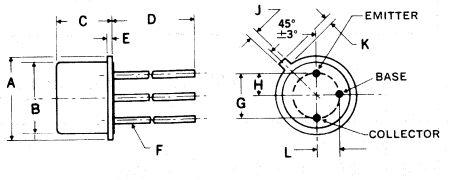
DESCRIPTION
Unitrode power transistors provide a unique combination of low saturation voltage, high gain and fast switching. They are ideally suited for power supply pulse amplifier and similar high efficiency power switching applications.

ABSOLUTE MAXIMUM RATINGS

Collector-Base Voltage, V_{CBO}	100V
Collector-Emitter Voltage, V_{CEO}	70V
Emitter-Base Voltage, V_{EBO}	7V
Peak Collector Current, I_C	10A
Power Dissipation	
25°C Ambient	1.5W
100°C Case	5W
Operating and Storage Temperature Range	−65°C to 200°C

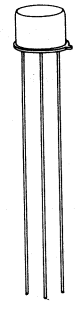
MECHANICAL SPECIFICATIONS

JAN, JANTX & JANTXV 2N4150



	INCHES	MILLIMETERS
A	.335-.370	8.51-9.40
B	.305-.335	7.75-8.51
C	.240-.260	6.09-6.60
D	1.5 MIN.	38.10 MIN.
E	.010-.030	.254-.762
F	.017 ± .002 .001	.432 ± .051 .025
G	.200	5.08
H	.100	2.54
J	.031±.003	.787±.076
K	.029-.045	.736-1.14
L	.100	2.54

TO-5



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	Min.	Max.	Units	/394 Sub group	Method	MIL-STD-750 Test conditions
Visual and Mechanical					A-1	2071	See Mechanical Data
25°C							
Collector-Base Breakdown Voltage	BV_{CBO}	100	—	Vdc	A-2	3001	I_C = 10uAdc; Cond. D
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CEO}	70	—	Vdc	A-2	3011	I_C = 0.1Adc; Cond. D
Emitter-Base Breakdown Voltage	BV_{EBO}	7	—	Vdc	A-2	3026	I_E = 10uAdc; Cond. D
Collector-Emitter Cutoff Current	I_{CEO}	—	10	μAdc	A-2	3041	V_{CE} = 60Vdc; Cond. D
Collector-Emitter Cutoff Current	I_{CEX}	—	10	μAdc	A-2	3041	V_{CE} = 100Vdc, V_{EB} = 0.5Vdc; Cond. A
Collector-Base Cutoff Current	I_{CBO}	—	0.1	μAdc	A-2	3036	V_{CB} = 80Vdc; Cond. D
Emitter-Base Cutoff Current	I_{EBO}	—	0.1	μAdc	A-2	3061	V_{EB} = 5Vdc; Cond. D
D.C. Current Gain (Note 1)	h_{FE}	40	120	—	A-3	3076	I_C = 5Adc, V_{CE} = 5Vdc
D.C. Current Gain (Note 1)	h_{FE}	10	—	—	A-3	3076	I_C = 10Adc, V_{CE} = 5Vdc
D.C. Current Gain (Note 1)	h_{FE}	50	—	—	A-3	3076	I_C = 1Adc, V_{CE} = 5Vdc
Collector Saturation Voltage (Note 1)	V_{CE} (sat)	—	0.6	Vdc	A-4	3071	I_C = 5Adc, I_B = 0.5Adc
Collector Saturation Voltage (Note 1)	V_{CE} (sat)	—	2.5	Vdc	A-4	3071	I_C = 10Adc, I_B = 1Adc
Base Saturation Voltage (Note 1)	V_{BE} (sat)	—	1.5	Vdc	A-4	3066	I_C = 5Adc, I_B = 0.5Adc; Cond. A
Base Saturation Voltage (Note 1)	V_{BE} (sat)	—	2.5	Vdc	A-4	3066	I_C = 10Adc, I_B = 1Adc; Cond. A
A.C. Current Gain	h_{fe}	40	160	—	A-4	3206	I_C = 50mAdc, V_{CE} = 5Vdc, f = 1KHz
Gain-Bandwidth Product	f_T	15	75	MHz	A-4	3306	I_C = 0.2Adc, V_{CE} = 10Vdc, f = 10 MHz
Output Capacitance	C_{ob}	—	350	pf	A-4	3236	V_{CB} = 10Vdc, I_E = 0, f = 1MHz
Thermal Resistance	θ_{J-C}	—	20	°C/W	C-1	3151	
Switching Speeds — Delay Time	t_d	—	50	ns	A-4	—	V_{CC} = 20V, I_C = 5A, $I_{B1} = I_{B2}$, I_{B1} = 0.5A
Switching Speeds — Rise Time	t_r	—	500	ns	A-4	—	
Switching Speeds — Storage Time	t_s	—	1.5	μs	A-4	—	
Switching Speeds — Fall Time	t_f	—	500	ns	A-4	—	
100°C							
Forward-Biased Second Breakdown	$I_{S/B}$	5	—	Adc	B-6	3005	V_{CE} = 1Vdc, t = 60Sec,
Forward-Biased Second Breakdown	$I_{S/B}$	70	—	mAdc	B-6	3005	V_{CE} = 1Vdc, t = 60Sec,
Unclamped Reverse Biased Second Breakdown	$E_{S/B}$	12.5	—	mj	B-7	—	I_C = 5Adc, L = 1mh
Clamped Reverse Biased Second Breakdown	$E_{S/B}$	200	—	mj	B-8	—	I_C = 5Adc, L = 40mh, V_{clamp} = 70V
150°C							
Collector-Emitter Cutoff Current	I_{CEX}	—	100	μAdc	A-5	3041	V_{CE} = 80Vdc, V_{EB} = 0.5Vdc, Cond. A
−55°C							
D.C. Current Gain (Note 1)	h_{FE}	20	—	—	A-5	3076	I_C = 5Adc, V_{CE} = 5Vdc

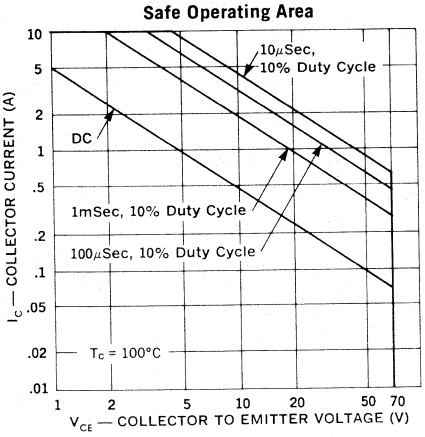
Note:
1. Pulse width = 300μS; duty cycle ≤2%.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

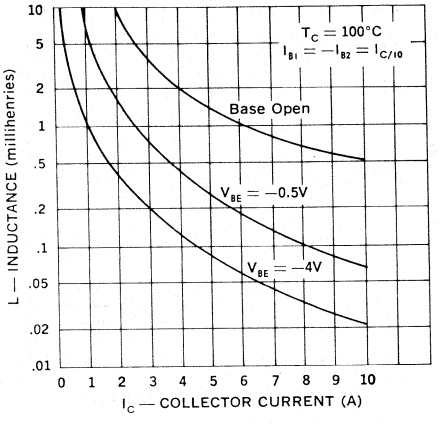
PRINTED IN U.S.A.

3

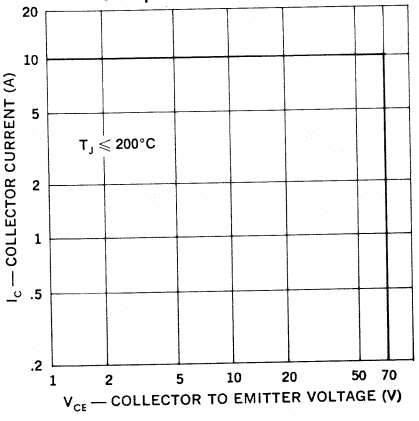
Forward Bias Safe Operating Area



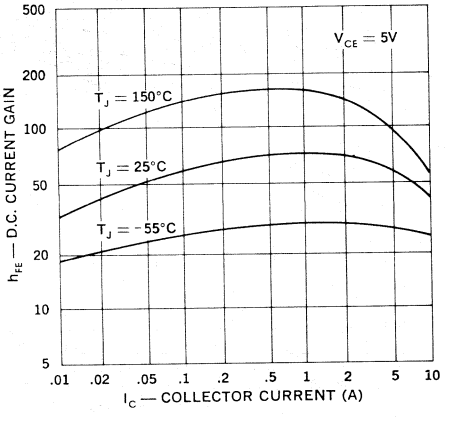
Unclamped Reverse Bias Second Breakdown



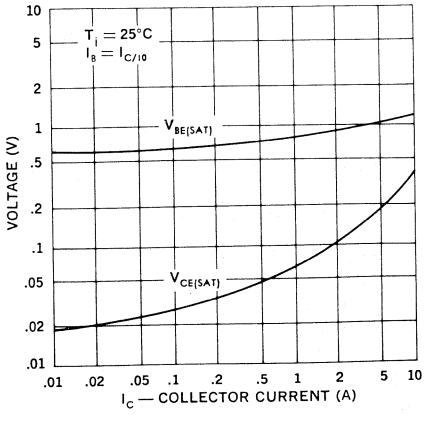
Reverse Bias Safe Operating Area Clamped Inductive Switching



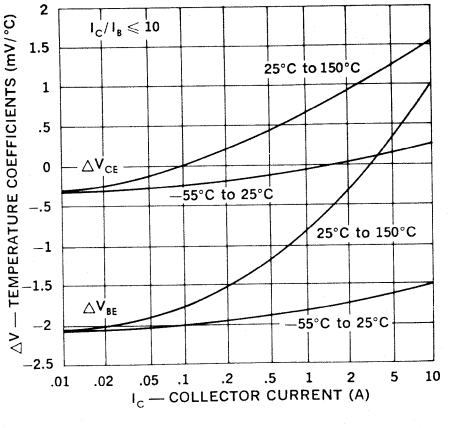
D.C. Current Gain



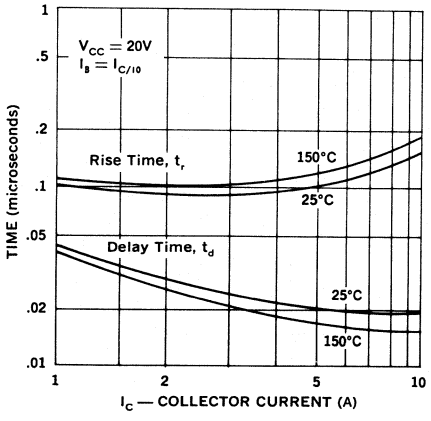
Saturation Voltages



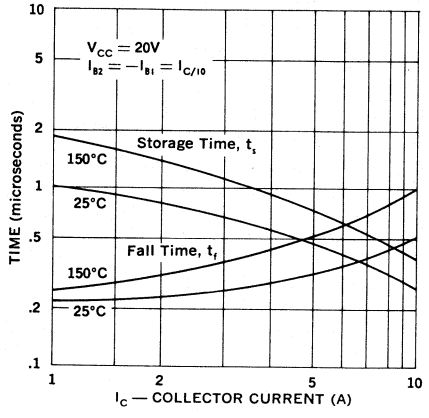
Saturation Voltage Temperature Coefficients



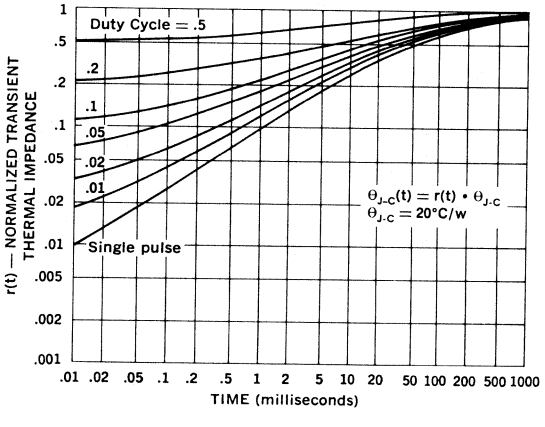
Switching Speed Characteristics



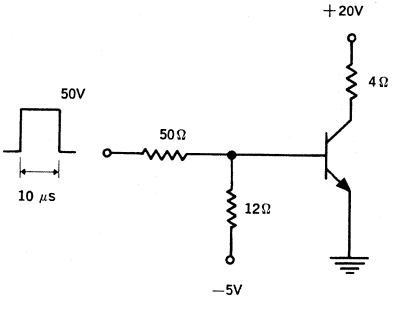
Switching Speed Characteristics



Thermal Response



Switching Speed Circuit



$I_C = 5A$, $I_{B1} = -I_{B2} = .5A$

POWER TRANSISTORS

20 Amp, 150V, Double Diffused NPN Mesa

JAN, JANTX, JANTXV 2N5038
JAN, JANTX, JANTXV 2N5039

3

FEATURES
- Collector-Base Voltage: up to 150V
- Peak Collector Current: 30A
- t_{on} Time $\leqslant$500 nS
- t_{off} Time $\leqslant 2\ \mu S$
- Qualified to MIL-S-19500/439

DESCRIPTION
These MIL approved double diffused glass passivated mesa power transistors combine fast-switching, low saturation voltage and rugged $E_{s/b}$ capability. They are designed for use in switching regulators, converters, inverters and switching-control amplifiers.

ABSOLUTE MAXIMUM RATINGS

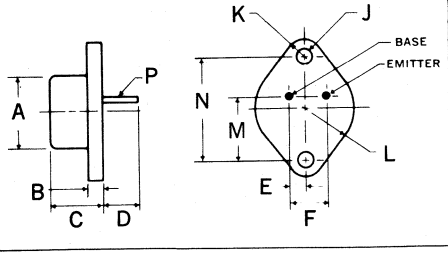
	JAN, JANTX & JANTXV 2N5038	JAN, JANTX & JANTXV 2N5039
Collector-Base Voltage, V_{CBO}	150V	125V
Collector-Emitter Sustaining Voltage, $V_{CER\ (SUS)}$ (1)	110V	95V
$V_{CEO\ (SUS)}$	90V	75V
Emitter-Base Voltage, V_{EBO}	7V	7V
Collector Current, I_C continuous	20A	20A
Collector Current, I_{CM} peak	30A	30A
Base Current, I_B continuous	5A	5A
Power Dissipation, 25°C Case	140W	140W
Operating and Storage Temperature Range	−65 to 200°C	

(1) With $R_{BE} \leqslant 50\Omega$

MECHANICAL SPECIFICATIONS

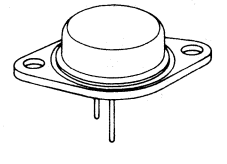
NOTE:
Leads may be soldered to within $^1/_{16}$" of base provided temperature-time exposure is less than 260°C for 10 seconds.

JAN, JANTX, JANTXV 2N5038, 2N5039



	ins.	mm
A	.875 MAX.	2.22 MAX.
B	.135 MAX.	0.34 MAX.
C	.250—.450	0.64—1.14
D	.312 MIN.	0.79 MIN.
E	.205—.225	0.52—0.57
F	.420—.440	1.07—1.12
J	.151—.161 DIA.	0.38—0.41
K	.188 MAX. RAD.	0.48 MAX. RAD.
L	.525 MAX. RAD.	1.33 MAX. RAD.
M	.655—.675	1.66—1.71
N	1.177—1.197	2.99—3.04
P	.038—.043 DIA.	0.10—0.11 DIA.

TO-204AA (TO-3)



Electrical Specifications (at 25°C unless noted)

Test	Symbol	2N5038		2N5039		Units	Test Conditions
		MIN.	MAX.	MIN.	MAX.		
D.C. Current Gain (Note 1)	h_{FE}	50	—	30	—	—	$I_C = 0.5, V_{CE} = 5V$
		50	200	30	150		$I_C = 2A, V_{CE} = 5V$
D.C. Current Gain (Note 1)	h_{FE}	—	—	20	—	—	$I_C = 10A, V_{CE} = 5V$
		20	—	—	—		$I_C = 12A, V_{CE} = 5V$
D.C. Current Gain —65°C	h_{FE}	—	—	10	—	—	$I_C = 10A, V_{CE} = 5V$
		10	—	—	—		$I_C = 12A, V_{CE} = 5V$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	—	—	1.0	V	$I_C = 10A, I_B = 1.0A$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	1.0	—	—	V	$I_C = 12A, I_B = 1.2A$
		—	2.5	—	2.5		$I_C = 20A, I_B = 5A$
Base-Emitter Voltage (Note 1)	V_{BE}	—	—	—	1.8	V	$I_C = 10A, V_{CE} = 5V$
		—	1.8	—	—	V	$I_C = 12A, V_{CE} = 5V$
Collector-Emitter Sustaining Voltage (Notes 2, 3)	$V_{CEO(sus)}$	90	—	75	—	V	$I_C = 0.2A, L = 15mH$
Collector-Emitter Sustaining Voltage (Notes 2, 3)	$V_{CEX(sus)}$	150	—	125	—	V	$I_C = 0.2A, L = 2mH$ $V_{BE} = -1.5V$ $I_B = 0$ $R_{BE} = 100\ \Omega$
Collector-Emitter Sustaining Voltage (Notes 2, 3)	$V_{CER(sus)}$	110	—	95	—	V	$R_{BE} = 50\ \Omega, I_C = 0.2A, L = 15\ mH$
Emitter-Base Voltage	V_{EBO}	7.0	—	7.0	—	V	$I_E = 25mA$
Collector Cutoff Current	I_{CBO}	—	—	—	25	mA	$V_{CB} = 125V$
		—	25	—	—		$V_{CB} = 150V$
Collector Cutoff Current	I_{CEO}	—	—	—	10	mA	$V_{CE} = 55V$
		—	10	—	—		$V_{CE} = 70V$
Collector Cutoff Current	I_{CEX}	—	—	—	5.0	mA	$V_{CE} = 85V, V_{BE} = -1.5V$
		—	5.0	—	—		$V_{CE} = 100V, V_{BE} = -1.5V$
Collector Cutoff Current, 150°C	I_{CEX}	—	—	—	10	mA	$V_{CE} = 85V, V_{BE} = -1.5V$
		—	10	—	—		$V_{CE} = 100V, V_{BE} = -1.5V$
Emitter Cutoff Current	I_{EBO}	—	5.0	—	5.0	mA	$V_{BE} = -5V$
Magnitude of Small Signal Forward — Current Transfer Ratio	$\lvert h_{fe} \rvert$	12	48	12	48	—	$V_{CE} = 10V, I_C = 2A, f = 5\ MHz$
Collector Capacitance	C_{ob}	—	500	—	500	pF	$V_{CB} = 10V, f = 1\ MHz$
Thermal Resistance: Junction-to-Case	$R\Theta_{JC}$	—	1.25	—	1.25	°C/W	$V_{CE} = 10V, I_C = 10A$

Notes:
1. Pulse width = 250μS; duty cycle $\leq$1%.
2. Sustaining Voltage. Measured at a high current point where collector-emitter voltage is lowest. Current pulse length $\cong$ 50μS; duty cycle $\leq$ 1%. Voltage clamped at maximum collector-emitter voltage.
3. Unclamped inductive load.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

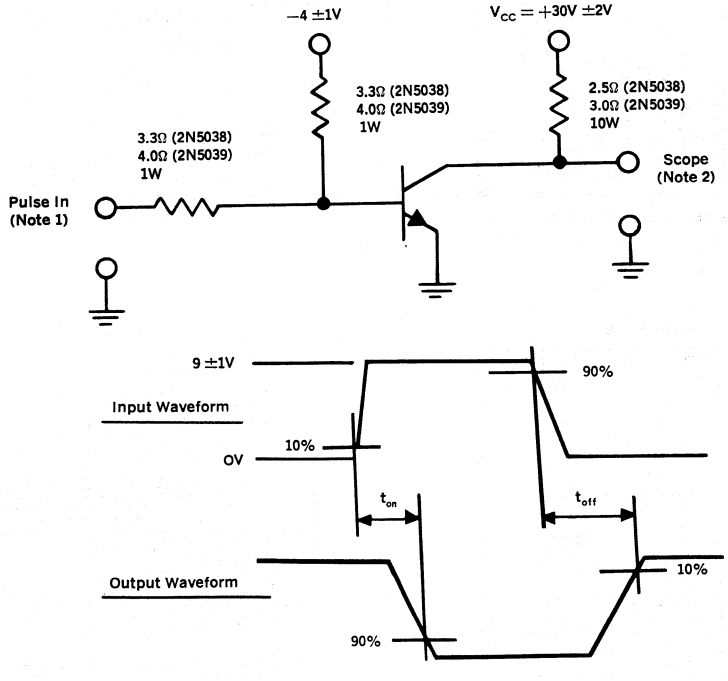
PRINTED IN U.S.A.

3

Electrical Specifications (at 25°C unless noted)

Test	Symbol	2N5038 MIN.	2N5038 MAX.	2N5039 MIN.	2N5039 MAX.	Units	Test Conditions
Second Breakdown Energy	$E_{s/b}$ clamped	14	—	14	—	mJ	$I_C = 20Adc$, $L = 70\mu H$, 0.1Ω $V_{CC} = 75V, 90V$ $R_L = 3.75\Omega, 4.5\Omega$
	$E_{s/b}$ unclamped	5.06	—	5.06	—		$I_C = 4.5Adc$, $L = 500\mu H$, 0.1Ω $V_{CC} = 10Vdc$
Forward Bias Second Breakdown Collector Current	$I_{s/b}$	5.0	—	5.0	—	A	$V_{CE} = 28V$, $t = 1s$, non-rep.
		0.9	—	0.9	—		$V_{CE} = 45V$, $t = 1s$, non-rep.
Switching Speeds Turn-on Time	t_{on}	—	0.5	—	—	μS	$I_C = 12Adc$ $I_{B1} = I_{B2} = 1.2Adc$ $V_{CC} = 30Vdc \pm 2V$
Turn-on Time	t_{on}	—	—	—	0.5	μS	$I_C = 10Adc$ $I_{B1} = I_{B2} = 1Adc$ $V_{CC} = 30Vdc \pm 2V$
Turn-off Time	t_{off}	—	—	—	2.0	μS	$I_C = 10Adc$ $I_{B1} = I_{B2} = 1.0Adc$ $V_{CC} = 30Vdc \pm 2V$
Turn-off Time	t_{off}	—	2.0	—	—	μS	$I_C = 12Adc$ $I_{B1} = I_{B2} = 1.2Adc$ $V_{CC} = 30Vdc \pm 2V$

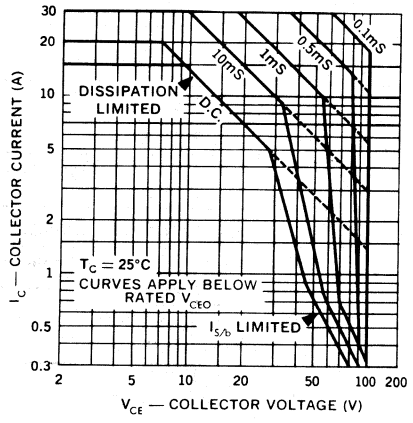
Switching Time Test Circuit



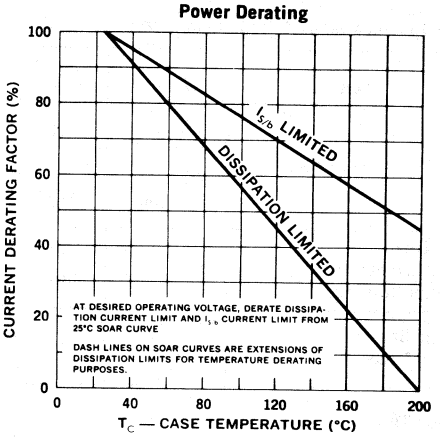
Notes

1. The rise time (t_r) and fall time (t_f) of the applied pulse shall be each ⩽20 nanoseconds; duty cycle ⩽2%; generator source impedance shall be 50 ohms; Pulse width = 20 μS
2. Output sampling oscilloscope: Z_{in} ⩾100K ohms; C_{in} ⩽50pf; rise time ⩽20 nanoseconds.

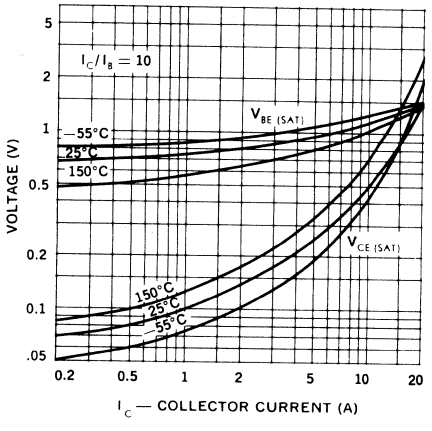
Forward Bias Safe Operating Area for 2N5038 and 2N5039



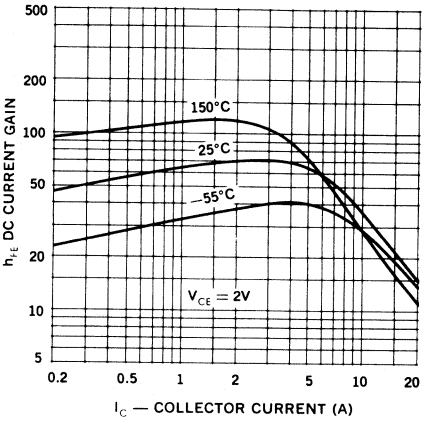
Power Derating



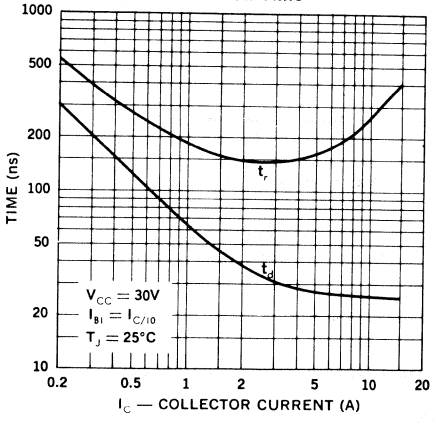
Saturation Voltages



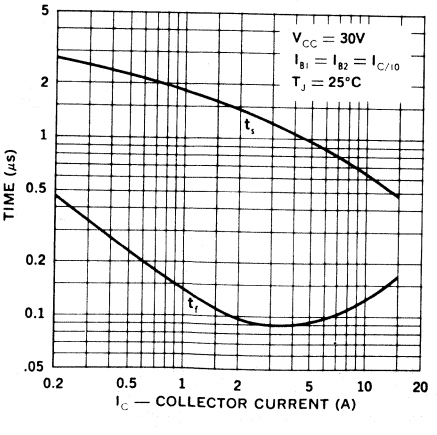
DC Current Gain



Turn-On Time



Turn-Off Time



UNITRODE CORPORATION • 5 FORBES ROAD •
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

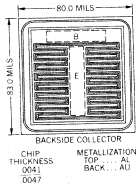
PRINTED IN U.S.A.

POWER TRANSISTORS
2 Amp, 300V, Planar NPN

JAN, JANTX, & JANTXV 2N5660
JAN, JANTX, & JANTXV 2N5661
JAN, JANTX, & JANTXV 2N5662
JAN, JANTX, & JANTXV 2N5663

3

FEATURES
- Meets MIL-S-19500/454
- Collector-Base Voltage: up to 400V
- D.C. Collector Current: 5A
- Peak Collector Current: 10A
- Fast Switching



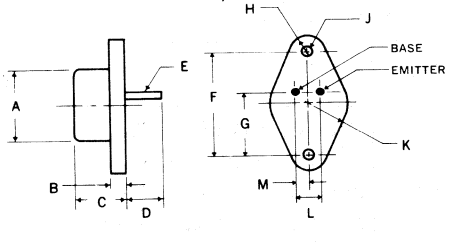
DESCRIPTION
Unitrode high voltage transistors provide a unique combination of low saturation voltage, fast switching, and excellent gain. They are ideally suited for off-line power supply designs and other applications where the increased voltage rating adds to system reliability.

ABSOLUTE MAXIMUM RATINGS

	JAN, JANTX, & JANTXV 2N5660	JAN, JANTX, & JANTXV 2N5661	JAN, JANTX, & JANTXV 2N5662	JAN, JANTX, & JANTXV 2N5663
Collector-Base Voltage, V_{CBO}	250V	400V	250V	400V
Collector-Emitter Voltage, V_{CEO}	200V	300V	200V	300V
Emitter-Base Voltage, V_{EBO}	6V	6V	6V	6V
D.C. Collector Current, I_C	2A	2A	2A	2A
Peak Collector Current, I_C	5A	5A	5A	5A
Power Dissipation				
25°C Ambient	2.0W	2.0W	1.2W	1.2W
100°C Case	20W	20W	15W	15W
Operating and Storage Temperature Range	—65°C to 200°C			

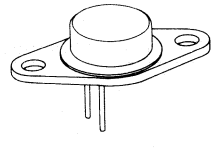
MECHANICAL SPECIFICATIONS

JAN, JANTX, & JANTXV 2N5660 JAN, JANTX, & JANTXV 2N5661

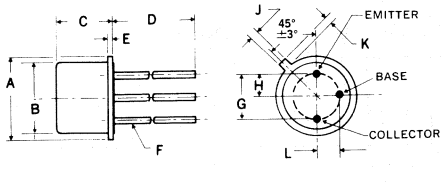


	INCHES	MILLIMETERS
A	.620 MAX.	15.75 MAX.
B	.050 - .075	1.27 - 1.90
C	.250 - .340	6.35 - 8.63
D	.360 MIN.	9.14 MIN.
E	.028 - .034 DIA.	.711 - .863
F	.958 - .962	24.33 - 24.43
G	.570 - .590	14.47 - 14.98
H	.145 MAX. RAD.	3.68 MAX. RAD.
J	.142 - .152 DIA.	3.60 - 3.86 DIA.
K	.350 MAX. RAD.	8.89 MAX. RAD.
L	.190 - .210	4.82 - 5.33
M	.093 - .107	2.36 - 2.72

TO-66

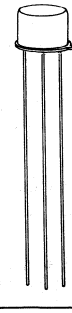


JAN, JANTX, & JANTXV 2N5662 JAN, JANTX, & JANTXV 2N5663



	INCHES	MILLIMETERS
A	.335-.370	8.51-9.40
B	.305-.335	7.75-8.51
C	.240-.260	6.09-6.60
D	1.5 MIN.	38.10 MIN.
E	.010-.030	.254-.762
F	.017 ± .002 .001	.432 ± .051 .025
G	.200	5.08
H	.100	2.54
J	.031±.003	.787±.076
K	.029-.045	.736-1.14
L	.100	2.54

TO-5



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)
2N5660, 2N5662

Test	Symbol	Min.	Max.	Units	/454 Sub group	MIL-STD-750 Method	MIL-STD-750 Test conditions
Visual and mechanical					A-1	2071	See Mechanical Data
25°C							
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CER}*	250	—	Vdc	A-2	3011	I_C = 10mAdc; R_{BE} = 100Ω; Cond. B
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CEO}*	200	—	Vdc	A-2	3011	I_C = 10mAdc; Cond. D
Emitter-Base Breakdown Voltage	BV_{EBO}*	6	—	Vdc	A-2	3026	I_E = 10μAdc; Cond. D
Collector-Emitter Cutoff Current	I_{CES}*	—	0.2	μAdc	A-2	3041	V_{CE} = 200Vdc; Cond. C
Collector-Base Cutoff Current	I_{CBO}	—	0.1	μAdc	A-2	3036	V_{CB} = 200Vdc; Cond. D
Collector-Base Cutoff Current	I_{CBO}	—	1.0	mAdc	A-2	3036	V_{CB} = 250Vdc; Cond. D
D.C. Current Gain (Note 1)	h_{FE}*	40	—	—	A-3	3076	I_C = 50mAdc, V_{CE} = 2Vdc
D.C. Current Gain (Note 1)	h_{FE}*	40	120	—	A-3	3076	I_C = 0.5Adc, V_{CE} = 5Vdc
D.C. Current Gain (Note 1)	h_{FE}*	15	—	—	A-3	3076	I_C = 1Adc, V_{CE} = 5Vdc
D.C. Current Gain (Note 1)	h_{FE}	5	—	—	A-3	3076	I_C = 2Adc, V_{CE} = 5Vdc
Collector Saturation Voltage (Note 1)	V_{CE}(sat)*	—	0.4	Vdc	A-3	3071	I_C = 1Adc, I_B = 0.1Adc
Collector Saturation Voltage (Note 1)	V_{CE}(sat)	—	0.8	Vdc	A-3	3071	I_C = 2Adc, I_B = 0.4Adc
Base Saturation Voltage (Note 1)	V_{BE}(sat)*	—	1.2	Vdc	A-3	3066	I_C = 1Adc, I_B = 0.1Adc; Cond. A
Base Saturation Voltage (Note 1)	V_{BE}(sat)	—	1.5	Vdc	A-3	3066	I_C = 2Adc, I_B = 0.4Adc; Cond. A
Gain-Bandwidth Product	f_T*	20	70	MHz	A-4	3306	I_C = 0.1Adc, V_{CE} = 5Vdc, f = 10MHz
Output Capacitance	C_{ob}	—	45	pf	A-4	3236	V_{CB} = 10Vdc, I_E = 0, f = 1MHz
Thermal Resistance	Θ_{J-C}				C-1	3151	
2N5660		—	5.0	°C/W			
2N5662		—	6.7	°C/W			
Switching Speeds — Turn-on time	t_{on}*	—	0.25	μs	A-4	—	I_C = 0.5Adc
Switching Speeds — Turn-off time	t_{off}*	—	0.85	μs	A-4	—	
100°C							
Forward Biased Second Breakdown							
2N5660	$I_{s/B}$	2	—	Adc	B-6	3051	V_{CE} = 10Vdc, t = 1Sec
	$I_{s/B}$	0.5	—	Adc	B-6	3051	V_{CE} = 40Vdc, t = 1Sec
	$I_{s/B}$	36	—	mAdc	B-6	3051	V_{CE} = 200Vdc, t = 1Sec
2N5662	$I_{s/B}$	2	—	Adc	B-7	3051	V_{CE} = 7.5 Vdc, t = 1Sec
	$I_{s/B}$	0.6	—	Adc	B-7	3051	V_{CE} = 25Vdc, t = 1Sec
	$I_{s/B}$	27	—	mAdc	B-7	3051	V_{CE} = 200Vdc, t = 1Sec
Unclamped Reverse Biased Second Breakdown	$E_{s/B}$	0.2	—	mj	B-8	3053	I_C = 2Adc, L = 0.1 mh
Clamped Reverse Biased Second Breakdown	$E_{s/B}$	80	—	mj	B-9	3053	I_C = 2Adc, L = 40mh, V_{clamp} = 200V
150°C							
Collctor-Emitter Cutoff Current	I_{CES}*	—	100	μAdc	A-5	3041	V_{CE} = 200Vdc, Cond. C
−65°C							
D.C. Current Gain (Note 1)	h_{FE}	15	—	—	A-6	3076	I_C = 0.5Adc, V_{CE} = 5Vdc

Notes:
1. Pulse width = 300μS; duty cycle ≤2%.
* Those parameters marked with a * are JEDEC registered and devices meeting these specifications are available as commercial 2N devices.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

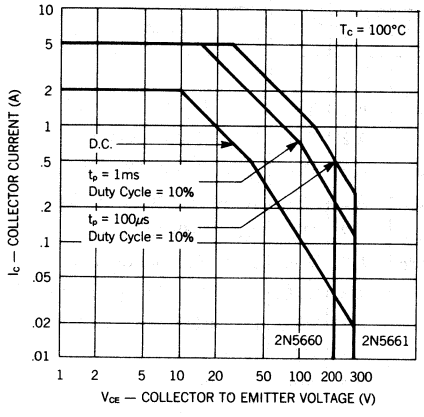
PRINTED IN U.S.A.

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)
2N5661, 2N5663

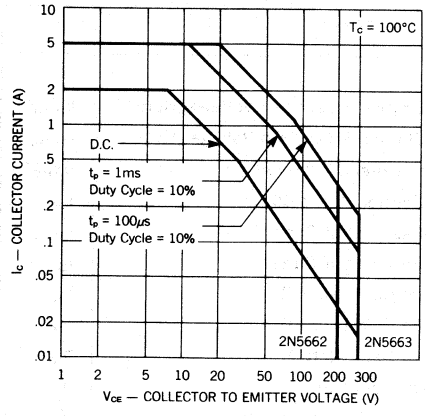
Test	Symbol	Min.	Max.	Units	/454 Sub group	MIL-STD-750 Method	MIL-STD-750 Test conditions
Visual and mechanical					A-1	2071	See Mechanical Data
25°C							
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CER}*	400	—	Vdc	A-2	3011	I_C = 10mAdc; R_{BE} = 100Ω; Cond. B
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CEO}*	300	—	Vdc	A-2	3011	I_C = 10mAdc; Cond. D
Emitter-Base Breakdown Voltage	BV_{EBO}*	6	—	Vdc	A-2	3026	I_E = 10μAdc; Cond. D
Collector-Emitter Cutoff Current	I_{CES}	—	0.2	μAdc	A-2	3041	V_{CE} = 300 Vdc; Cond. C
Collector-Base Cutoff Current	I_{CBO}	—	0.1	μAdc	A-2	3036	V_{CB} = 300Vdc; Cond. D
Collector-Base Cutoff Current	I_{CBO}	—	1.0	mAdc	A-2	3036	V_{CB} = 400Vdc; Cond. D
D.C. Current Gain (Note 1)	h_{FE}*	25	—	—	A-3	3076	I_C = 50mAdc, V_{CE} = 2Vdc
D.C. Current Gain (Note 1)	h_{FE}*	25	75	—	A-3	3076	I_C = 0.5Adc, V_{CE} = 5Vdc
D.C. Current Gain (Note 1)	h_{FE}*	15	—	—	A-3	3076	I_C = 1Adc, V_{CE} = 5Vdc
D.C. Current Gain (Note 1)	h_{FE}	5	—	—	A-3	3076	I_C = 2Adc, V_{CE} = 5Vdc
Collector Saturation Voltage (Note 1)	V_{CE}(sat)*	—	0.4	Vdc	A-3	3071	I_C = 1Adc, I_B = 0.1Adc
Collector Saturation Voltage (Note 1)	V_{CE}(sat)	—	0.8	Vdc	A-3	3071	I_C = 2Adc, I_B = 0.4Adc
Base Saturation Voltage (Note 1)	V_{BE}(sat)*	—	1.2	Vdc	A-3	3066	I_C = 1Adc, I_B = 0.1Adc; Cond. A
Base Saturation Voltage (Note 1)	V_{BE}(sat)	—	1.5	Vdc	A-3	3066	I_C = 2Adc, I_B = 0.4Adc; Cond. A
Gain-Bandwith Product	f_T*	20	70	MHz	A-4	3306	I_C = 0.2Adc, V_{CE} = 10Vdc, f = 10MHz
Output Capacitance	C_{ob}	—	45	pf	A-4	3236	V_{CB} = 10Vdc, I_E = 0, f = 1MHz
Thermal Resistance	Θ_{J-C}				C-1	3151	
2N5661		—	5.0	°C/W			
2N5663		—	6.7	°C/W			
Switching Speeds — Turn-on time	t_{on}*	—	0.25	μs	A-4	—	I_C = 0.5Adc
Switching Speeds — Turn-off time	t_{off}*	—	1.2	μs	A-4	—	
100°C							
Forward Biased Second Breakdown							
2N5661	$I_{S/B}$	2	—	Adc	B-6	3051	V_{CE} = 10Vdc, t = 1Sec
	$I_{S/B}$	0.5	—	Adc	B-6	3051	V_{CE} = 40Vdc, t = 1Sec
	$I_{S/B}$	19	—	mAdc	B-6	3051	V_{CE} = 300Vdc, t = 1Sec
2N5663	$I_{S/B}$	2	—	Adc	B-7	3051	V_{CE} = 7.5 Vdc, t = 1Sec
	$I_{S/B}$	0.6	—	Adc	B-7	3051	V_{CE} = 25Vdc, t = 1Sec
	$I_{S/B}$	14	—	mAdc	B-7	3051	V_{CE} = 300Vdc, t = 1Sec
Unclamped Reverse Biased Second Breakdown	$E_{S/B}$	0.2	—	mj	B-8	3053	I_C = 2Adc, L = 0.1 mh
Clamped Reverse Biased Second Breakdown	$E_{S/B}$	80	—	mj	B-9	3053	I_C = 2Adc, L = 40mh, V_{clamp} = 300V
150°C							
Collector-Emitter Cutoff Current	I_{CES}	—	100	μAdc	A-5	3041	V_{CE} = 300Vdc, Cond. C
−65°C							
D.C. Current Gain (Note 1)	h_{FE}	10	—	—	A-6	3076	I_C = 0.5Adc, V_{CE} = 5Vdc

Notes:
1. Pulse width = 300μS; duty cycle ≤2%.
* Those parameters marked with a * are JEDEC registered and devices meeting these specifications are available as commercial 2N devices.

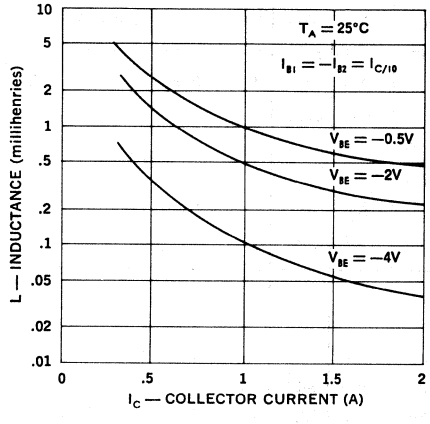
Forward Bias Safe Operating Area 2N5660, 2N5661



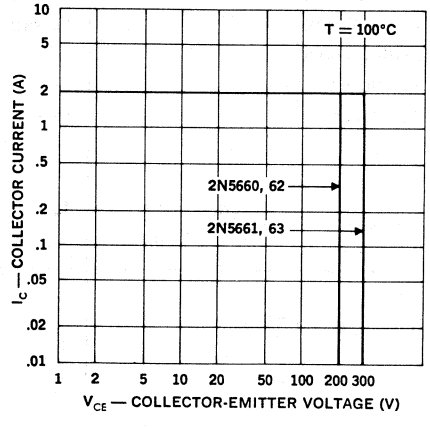
Forward Bias Safe Operating Area 2N5662, 2N5663



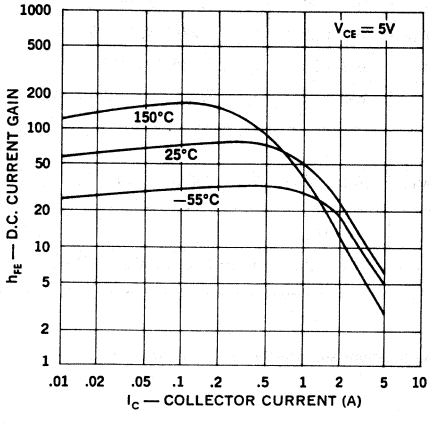
Unclamped Reverse Bias Second Breakdown



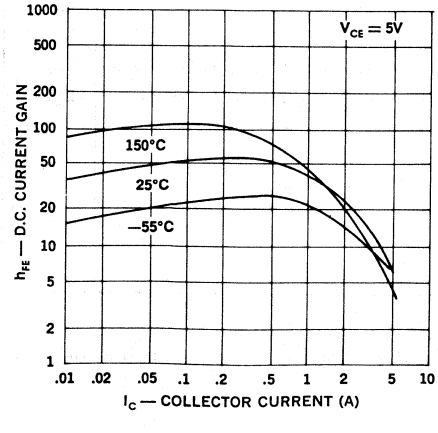
Reverse Bias Safe Operating Area Clamped Inductive Switching



D.C. Current Gain 2N5660, 2N5662



D.C. Current Gain 2N5661, 2N5663

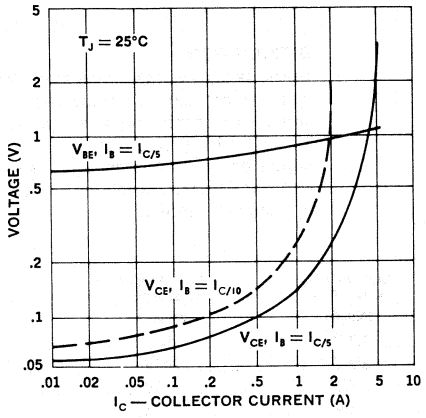


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

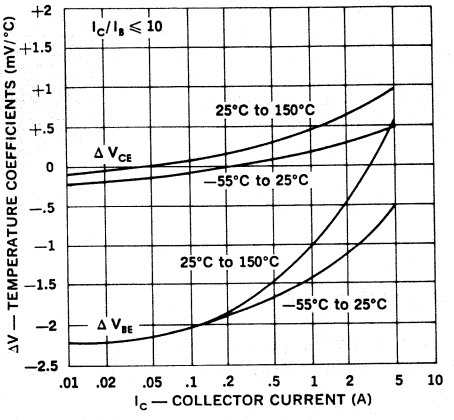
PRINTED IN U.S.A.

3

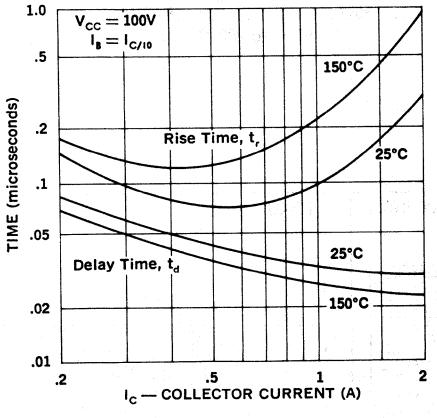
Saturation Voltages



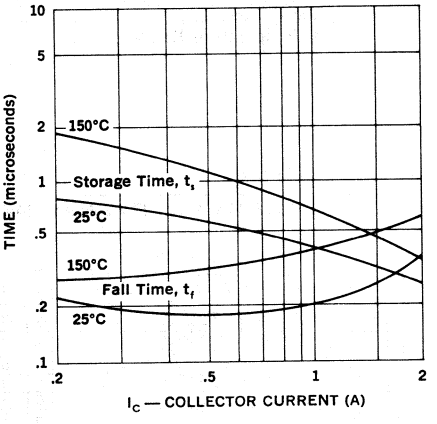
Saturation Voltage Temperature Coefficients



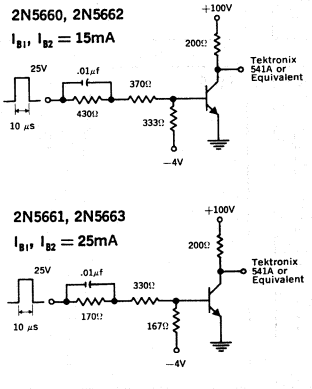
Switching Speed Characteristics



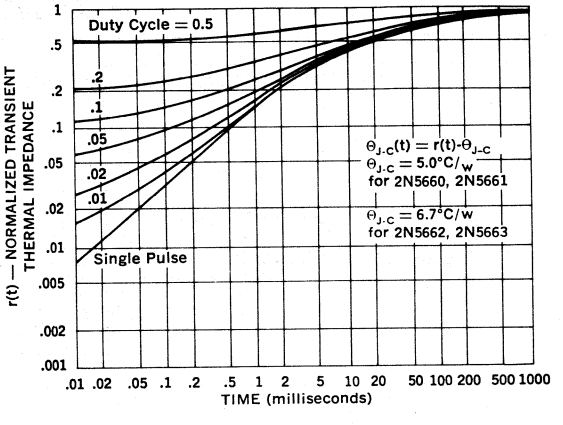
Switching Speed Characteristics



Switching Speed Circuits



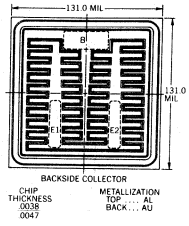
Thermal Response



POWER TRANSISTORS
5 Amp, 300V, Planar NPN

JAN, JANTX, & JANTXV 2N5664
JAN, JANTX, & JANTXV 2N5665
JAN, JANTX, & JANTXV 2N5666
JAN, JANTX, & JANTXV 2N5667

FEATURES
- Meets MIL-S-19500/455
- Collector-Base Voltage: up to 400V
- D.C. Collector Current: 5A
- Peak Collector Current: 10A
- Fast Switching



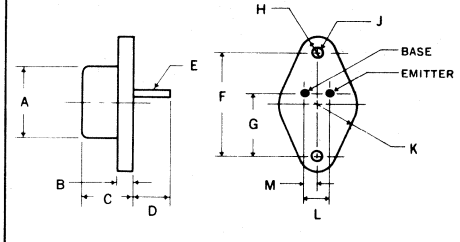
DESCRIPTION
Unitrode high voltage transistors provide a unique combination of low saturation voltage, fast switching, and excellent gain. They are ideally suited for off-line power supply designs and other applications where the increased voltage rating adds to system reliability.

ABSOLUTE MAXIMUM RATINGS

	JAN, JANTX, & JANTXV 2N5664	JAN, JANTX, & JANTXV 2N5665	JAN, JANTX, & JANTXV 2N5666	JAN, JANTX, & JANTXV 2N5667
Collector-Base Voltage, V_{CBO}	250V	400V	250V	400V
Collector-Emitter Voltage, V_{CEO}	200V	300V	200V	300V
Emitter-Base Voltage, V_{EBO}	6V	6V	6V	6V
D.C. Collector Current, I_C	5A	5A	5A	5A
Peak Collector Current, I_C	10A	10A	10A	10A
Power Dissipation				
25°C Ambient	2.5W	2.5W	1.2W	1.2W
100°C Case	30W	30W	15W	15W
Operating and Storage Temperature Range	—65°C to 200°C			

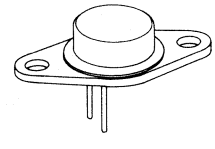
MECHANICAL SPECIFICATIONS

JAN, JANTX, & JANTXV 2N5664 JAN, JANTX, & JANTXV 2N5665

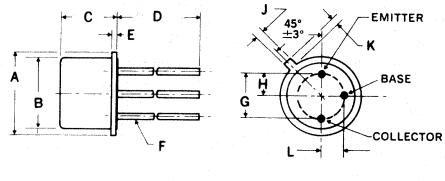


	INCHES	MILLIMETERS
A	.620 MAX.	15.75 MAX.
B	.050 - .075	1.27 - 1.90
C	.250 - .340	6.35 - 8.63
D	.360 MIN.	9.14 MIN.
E	.028 - .034 DIA.	.711 - .863
F	.958 - .962	24.33 - 24.43
G	.570 - .590	14.47 - 14.98
H	.145 MAX. RAD.	3.68 MAX. RAD.
J	.142 - .152 DIA.	3.60 - 3.86 DIA.
K	.350 MAX. RAD.	8.89 MAX. RAD.
L	.190 - .210	4.82 - 5.33
M	.093 - .107	2.36 - 2.72

TO-66

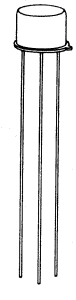


JAN, JANTX, & JANTXV 2N5666 JAN, JANTX, & JANTXV 2N5667



	INCHES	MILLIMETERS
A	.335-.370	8.51-9.40
B	.305-.335	7.75-8.51
C	.240-.260	6.09-6.60
D	1.5 MIN.	38.10 MIN.
E	.010-.030	.254-.762
F	.017 ± .002 .001	.432 ± .051 .025
G	.200	5.08
H	.100	2.54
J	.031±.003	.787±.076
K	.029-.045	.736-1.14
L	.100	2.54

TO-5



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25 C unless noted)
2N5664, 2N5666

Test	Symbol	Min.	Max.	Units	455 Sub group	MIL-STD-750 Method	MIL-STD-750 Test conditions
Visual and mechanical					A-1	2071	See Mechanical Data
25°C							
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CER}*	250	—	Vdc	A-2	3011	I_C = 10mAdc; R_{BE} = 100 Ω, Cond. B
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CEO}*	200	—	Vdc	A-2	3011	I_C = 10mAdc; Cond. D
Emitter-Base Breakdown Voltage	BV_{EBO}*	6.0	—	Vdc	A-2	3026	I_E = 10μAdc; Cond. D
Collector-Emitter Cutoff Current	I_{CES}	—	0.2	μAdc	A-2	3041	V_{CE} = 200 Vdc; Cond. C
Collector-Base Cutoff Current	I_{CBO}	—	0.1	μAdc	A-2	3036	V_{CB} = 200Vdc; Cond. D
Collector-Base Cutoff Current	I_{CBO}	—	1.0	mAdc	A-2	3036	V_{CB} = 250Vdc; Cond. D
D.C. Current Gain (Note 1)	h_{FE}*	40	—	—	A-3	3076	I_C = 0.5Adc, V_{CE} = 2Vdc
D.C. Current Gain (Note 1)	h_{FE}*	40	120	—	A-3	3076	I_C = 1Adc, V_{CE} = 5Vdc
D.C. Current Gain (Note 1)	h_{FE}*	15	—	—	A-3	3076	I_C = 3Adc, V_{CE} = 5Vdc
D.C. Current Gain (Note 1)	h_{FE}	5	—	—	A-3	3076	I_C = 5Adc, V_{CE} = 5Vdc
Collector Saturation Voltage (Note 1)	V_{CE} (sat)*	—	0.4	Vdc	A-3	3071	I_C = 3Adc, I_B = 0.3Adc
Collector Saturation Voltage (Note 1)	V_{CE} (sat)	—	1.0	Vdc	A-3	3071	I_C = 5Adc, I_B = 1Adc
Base Saturation Voltage (Note 1)	V_{BE} (sat)*	—	1.2	Vdc	A-3	3066	I_C = 3Adc, I_B = 0.3Adc; Cond. A
Base Saturation Voltage (Note 1)	V_{BE} (sat)	—	1.5	Vdc	A-3	3066	I_C = 5Adc, I_B = 1Adc; Cond. A
Gain-Bandwith Product	f_t*	20	70	MHz	A-4	3306	I_C = 0.5Adc, V_{CE} = 5Vdc, f = 10MHz
Output Capacitance	C_{ob}	—	120	pf	A-4	3236	V_{CB} = 10Vdc, I_E = 0, f = 1MHz
Thermal Resistance	θ_{J-C}				C-1	3151	
2N5664		—	3.3	°C/W			
2N5666		—	6.7	°C/W			
Switching Speeds — Turn-on Time	t_{on}*	—	0.25	μs	A-4	—	I_C = 1Adc
Switching Speeds — Turn-off Time	t_{off}*	—	1.5	μs	A-4	—	
100°C							
Forward Biased Second Breakdown 2N5664	$I_{S/B}$	5	—	Adc	B-6	3051	V_{CE} = 6Vdc, t = 1sec
	$I_{S/B}$	0.75	—	Adc	B-6	3051	V_{CE} = 40Vdc, t = 1sec
	$I_{S/B}$	43	—	mAdc	B-6	3051	V_{CE} = 200Vdc, t = 1sec
2N5666	$I_{S/B}$	5	—	Adc	B-7	3051	V_{CE} = 3Vdc, t = 1sec
	$I_{S/B}$	0.4	—	Adc	B-7	3051	V_{CE} = 37.5Vdc, t = 1sec
	$I_{S/B}$	27	—	mAdc	B-7	3051	V_{CE} = 200Vdc, t = 1sec
Unclamped Reverse Biased Second Breakdown	$E_{S/B}$	0.81	—	mj	B-8	3053	I_C = 5Adc, L = .065mh
Clamped Reverse Biased Second Breakdown	$E_{S/B}$	500	—	mj	B-9	3053	I_C = 5Adc, L = 40mh, V_{clamp} = 200V
150°C							
Collector-Emitter Cutoff Current	I_{CES}	—	100	μAdc	A-5	3041	V_{CE} = 200 Vdc, Cond. C
−65°C							
D.C. Current Gain (Note 1)	h_{FE}	15	—	—	A-6	3076	I_C = 1Adc, V_{CE} = 5Vdc

Notes:
1. Pulse width = 300μS; duty cycle ≤2%.
* Those parameters marked with a * are JEDEC registered and devices meeting these specifications are available as commercial 2N devices.

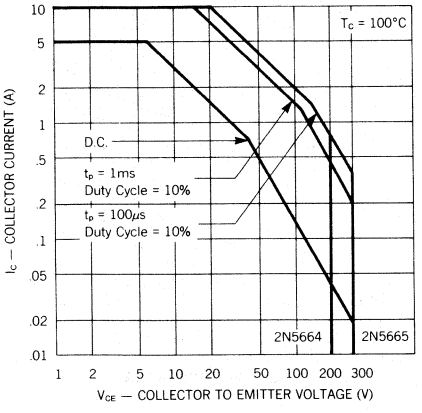
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)
2N5665, 2N5667

Test	Symbol	Min.	Max.	Units	/455 Sub group	MIL-STD-750 Method	MIL-STD-750 Test conditions
Visual and mechanical					A-1	2071	See Mechanical Data
25°C							
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CER}*	400	—	Vdc	A-2	3011	I_C = 10mAdc; R_{BE} = 100 Ω, Cond. B
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CEO}*	300	—	Vdc	A-2	3011	I_C = 10mAdc; Cond. D
Emitter-Base Breakdown Voltage	BV_{EBO}*	6	—	Vdc	A-2	3026	I_E = 10μAdc; Cond. D
Collector-Emitter Cutoff Current	I_{CES}	—	0.2	μAdc	A-2	3041	V_{CE} = 300 Vdc; Cond. C
Collector-Base Cutoff Current	I_{CBC}	—	0.1	μAdc	A-2	3036	V_{CB} = 300Vdc; Cond. D
Collector-Base Cutoff Current	I_{CBO}	—	1.0	mAdc	A-2	3036	V_{CB} = 400Vdc; Cond. D
D.C. Current Gain (Note 1)	h_{FE}*	25	—	—	A-3	3076	I_C = 0.5Adc, V_{CE} = 2Vdc
D.C. Current Gain (Note 1)	h_{FE}*	25	75	—	A-3	3076	I_C = 1Adc, V_{CE} = 5Vdc
D.C. Current Gain (Note 1)	h_{FE}*	15	—	—	A-3	3076	I_C = 3Adc, V_{CE} = 10Vdc
D.C. Current Gain (Note 1)	h_{FE}	5	—	—	A-3	3076	I_C = 5Adc, V_{CE} = 5Vdc
Collector Saturation Voltage (Note 1)	V_{CE} (sat)*	—	0.4	Vdc	A-3	3071	I_C = 3Adc, I_B = 0.6Adc
Collector Saturation Voltage (Note 1)	V_{CE} (sat)	—	1.0	Vdc	A-3	3071	I_C = 5Adc, I_B = 1Adc
Base Saturation Voltage (Note 1)	V_{BE} (sat)*	—	1.2	Vdc	A-3	3066	I_C = 3Adc, I_B = 0.6Adc; Cond. A
Base Saturation Voltage (Note 1)	V_{BE} (sat)	—	1.5	Vdc	A-3	3066	I_C = 5Adc, I_B = 1Adc; Cond. A
Gain-Bandwith Product	f_T*	20	70	MHz	A-4	3306	I_C = 0.5Adc, V_{CE} = 5Vdc, f = 10MHz
Output Capacitance	C_{ob}	—	90	pf	A-4	3236	V_{CB} = 10Vdc, I_E = 0, f = 1MHz
Thermal Resistance	θ_{J-C}				C-1	3151	
2N5665		—	3.3	°C/W			
2N5667		—	6.7	°C/W			
Switching Speeds — Turn-on time	t_{on}*	—	0.25	μs	A-4	—	I_C = 1Adc
Switching Speeds — Turn-off time	t_{off}*	—	2.0	μs	A-4	—	
100°C							
Forward Biased Second Breakdown 2N5665	$I_{S/B}$	5	—	Adc	B-6	3051	V_{CE} = 6Vdc, t = 1sec
	$I_{S/B}$	0.75	—	Adc	B-6	3051	V_{CE} = 40Vdc, t = 1 sec
	$I_{S/B}$	21	—	mAdc	B-6	3051	V_{CE} = 300Vdc, t = 1sec
2N5667	$I_{S/B}$	5	—	Adc	B-7	3051	V_{CE} = 3Vdc, t = 1sec
	$I_{S/B}$	0.4	—	Adc	B-7	3051	V_{CE} = 37.5Vdc, t = 1sec
	$I_{S/B}$	14	—	mAdc	B-7	3051	V_{CE} = 300Vdc, t = 1sec
Unclamped Reverse Biased Second Breakdown	$E_{S/B}$	0.81	—	mj	B-8	3053	I_C = 5Adc, L = .065mh
Clamped Reverse Biased Second Breakdown	$E_{S/B}$	500	—	mj	B-9	3053	I_C = 5Adc, L = 40mh, V_{clamp} = 300V
150°C							
Collector-Emitter Cutoff Current	I_{CES}	—	100	μAdc	A-5	3041	V_{CE} = 300 Vdc, Cond. C
−65°C							
D.C. Current Gain (Note 1)	h_{FE}	10	—	—	A-6	3076	I_C = 1Adc, V_{CE} = 5Vdc

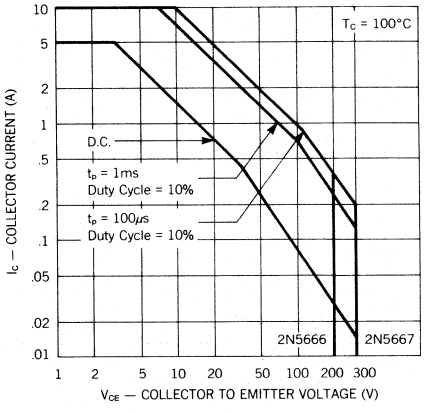
Notes:
1. Pulse width = 300μS; duty cycle ≤2%.
* Those parameters marked with a * are JEDEC registered and devices meeting these specifications are available as commercial 2N devices.

3

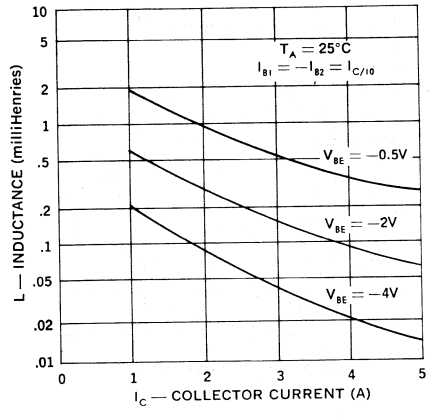
Forward Bias
Safe Operating Area
2N5664, 2N5665



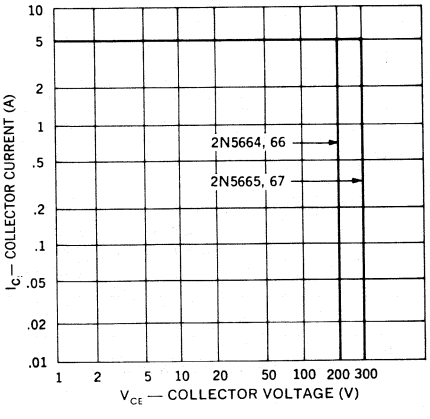
Forward Bias
Safe Operating Area
2N5666, 2N5667



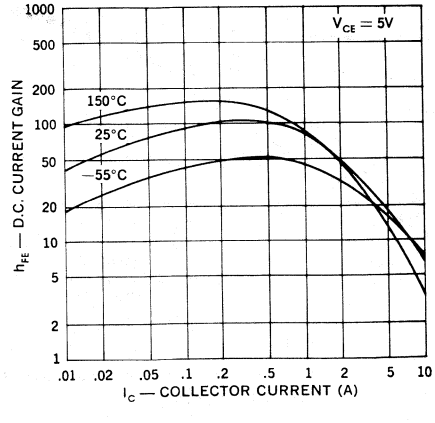
Unclamped Reverse Bias
Second Breakdown



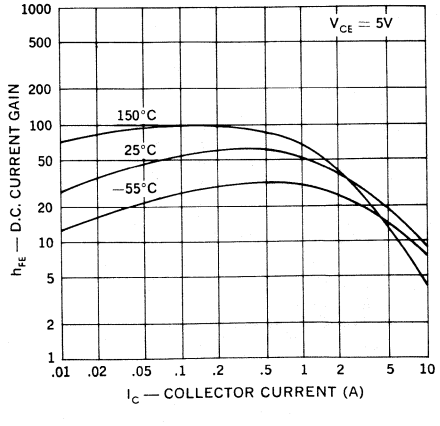
Reverse Bias
Safe Operating Area
Clamped Inductive Switching



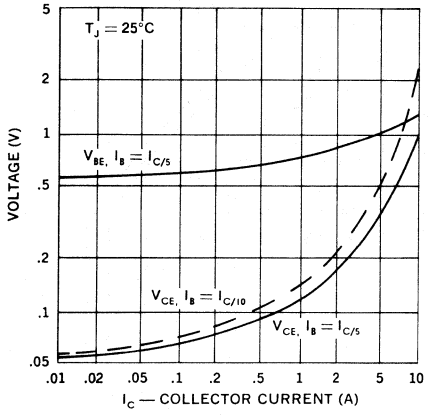
D.C. Current Gain
2N5664, 2N5666



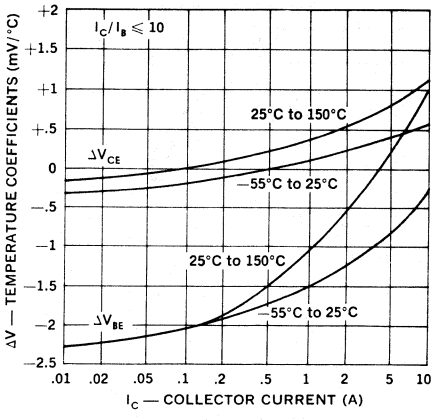
D.C. Current Gain
2N5665, 2N5667



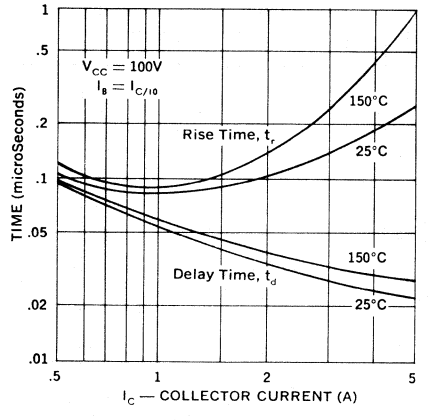
Saturation Voltages



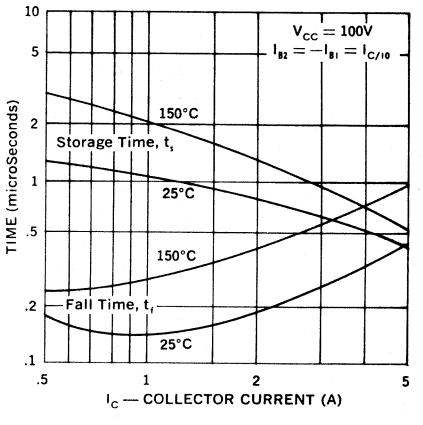
Saturation Voltage Temperature Coefficients



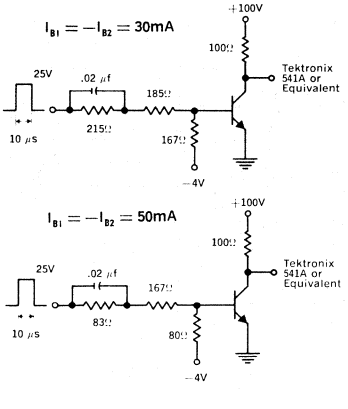
Switching Speed Characteristics



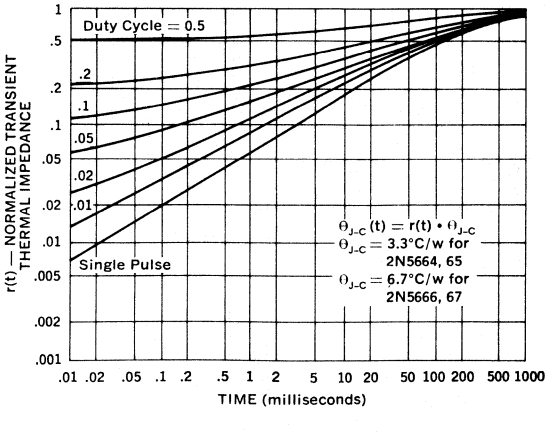
Switching Speed Characteristics



Switching Speed Circuits



Thermal Response



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER TRANSISTORS

8 Amp, 700V,
Triple Diffused NPN Mesa

JAN, JANTX, & JANTXV 2N6306
2N6307
JAN, JANTX, & JANTXV 2N6308

3

FEATURES
- Collector-Base Voltage: up to 700V
- Peak Collector Current: 16A
- Rise Time: ≤ 600ns } @ I_C = 3A
- Fall Time: ≤ 400ns }
- JAN, JANTX, & JANTXV available in
- 2N6306 and 2N6308

DESCRIPTION
These high voltage triple diffused glass passivated power transistors combine fast switching, low saturation voltage and rugged $E_{S/b}$ capability. They are designed for use in off-line power supplies, high voltage inverters, switching regulators, ignition systems and deflection circuits.

ABSOLUTE MAXIMUM RATINGS *

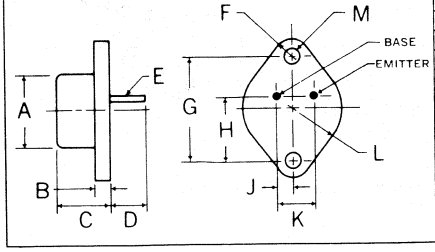
	JAN, JANTX, & JANTXV 2N6306	2N6307	JAN, JANTX, & JANTXV 2N6308
Collector-Base Voltage, V_{CBO}	500V	600V	700V
Collector-Emitter Voltage, V_{CEO}	250V	300V	350V
Emitter-Base Voltage, V_{EBO}	8V	8V	8V
Collector Current, I_C continuous	8A	8A	8A
Collector Current, I_{CM} peak	16A	16A	16A
Base Current, I_B, continuous	4A	4A	4A
Power Dissipation, P_T 25°C Case	125W	125W	125W
Operating and Storage Temperature Range		−65 to +200°C	

* JEDEC registered values.

MECHANICAL SPECIFICATIONS

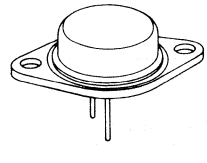
NOTE:
Leads may be soldered to within 1/16" of base provided temperature-time exposure is less than 260°C for 10 seconds.

JAN, JANTX, & JANTXV 2N6306
2N6307
JAN, JANTX, & JANTXV 2N6308



	ins.	mm.
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA (TO-3)



UNITRODE

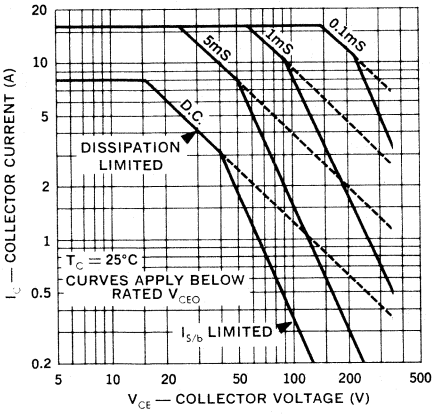
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)*

Test	Symbol	J, JTX, JTXV 2N6306		2N6307		J, JTX, JTXV 2N6308		Units	Test Conditions
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
D.C. Current Gain (Note 1)	h_{FE}	15	75	15	75	12	60		$I_C = 3A, V_{CE} = 5V$
D.C. Current Gain (Note 1)	h_{FE}	4	—	4	—	3	—		$I_C = 8A, V_{CE} = 5V$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	0.8	—	1.0	—	1.5	V	$I_C = 3A, I_B = 0.6A$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	5.0	—	5.0	—	—	V	$I_C = 8A, I_B = 2A$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	—	—	—	—	5.0	V	$I_C = 8A, I_B = 2.67A$
Base Saturation Voltage (Note 1)	$V_{BE(sat)}$	—	2.3	—	2.3	—	—	V	$I_C = 8A, I_B = 2A$
Base Saturation Voltage (Note 1)	$V_{BE(sat)}$	—	—	—	—	—	2.5	V	$I_C = 8A, I_B = 2.67A$
Base-Emitter Voltage (Note 1)	$V_{BE(on)}$	—	1.3	—	1.3	—	1.5	V	$I_C = 3A, V_{CE} = 5V$
Collector-Emitter Sustaining Voltage (Note 2)	$V_{CEO(SUS)}$	250	—	300	—	350	—	V	$I_C = 100mA, I_B = O$
Emitter-Base Cutoff Current	I_{EBO}	—	1.0	—	1.0	—	1.0	mA	$V_{EB} = 8V$
Collector Cutoff Current	I_{CEO}	—	0.5	—	—	—	—	mA	$V_{CE} = 250V$
		—	—	—	0.5	—	—		$V_{CE} = 300V$
		—	—	—	—	—	0.5		$V_{CE} = 350V$
Collector Cutoff Current	I_{CEV}	—	0.5	—	—	—	—	mA	$V_{CE} = 500V$ } $V_{BE} = -1.5V$
		—	—	—	0.5	—	—		$V_{CE} = 600V$ } $V_{BE} = -1.5V$
		—	—	—	—	—	0.5		$V_{CE} = 700V$ } $V_{BE} = -1.5V$
Collector Cutoff Current, 150°C	I_{CEV}	—	2.5	—	—	—	—	mA	$V_{CE} = 500V$ } $V_{BE} = -1.5V$
		—	—	—	2.5	—	—		$V_{CE} = 600V$ } $V_{BE} = -1.5V$
		—	—	—	—	—	2.5		$V_{CE} = 700V$ } $V_{BE} = -1.5V$
Second Breakdown Energy	$E_S/_b$	180	—	180	—	180	—	mJ	$I_C = 3.0A, L = 40$ mH $R_{BE} = 3K\Omega, V_{BB2} = 1.5V$
Collector Capacitance	C_{ob}	—	250	—	250	—	250	pF	$V_{CB} = 10V, I_E = 0, f = 1$ MHz
Gain-Bandwidth Product	f_T	5	—	5	—	5	—	MHz	$I_C = .3A, V_{CE} = 10V, f = 1$ MHz
Switching Speeds:									
Rise Time	t_{on}	—	0.6	—	0.6	—	0.6	μs	$V_{CC} = 125V, I_C = 3A$ $I_{B1} = 0.6A$
Storage Time	t_s	—	1.6	—	1.6	—	1.6	μs	$V_{CC} = 125V, I_C = 3A$ $I_{B1} = 0.6A, I_{B2} = 1.5A$ Pulse Width $= 25\ \mu$s
Storage Time	t_s	—	0.8	—	0.8	—	0.8	μs	$V_{CC} = 125V, I_C = 3A$ $I_{B1} = 0.6A, I_{B2} = 1.5A$ Pulse Width $= 5.0\ \mu$s
Fall Time	t_f	—	0.4	—	0.4	—	0.4	μs	$V_{CC} = 125V, I_C = 3A$ $I_{B1} = 0.6A, I_{B2} = 1.5A$
Thermal Resistance	$R_{\theta JC}$	—	1.2	—	1.4	—	1.2	°C/W	

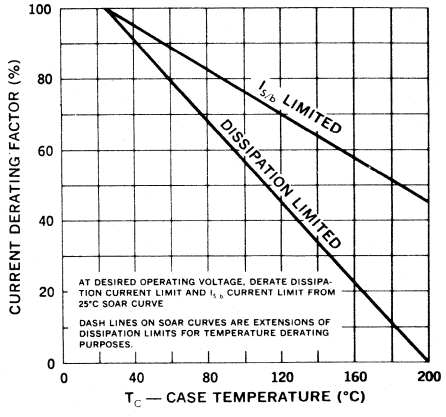
Notes:
1. Pulse width = 250μS; duty cycle ≤1%.
2. Sustaining Voltage. Measured at a high current point where collector-emitter voltage is lowest. Current pulse length ≅ 50μS; duty cycle ≤ 1%. Voltage clamped at maximum collector-emitter voltage.

* JEDEC registered values.

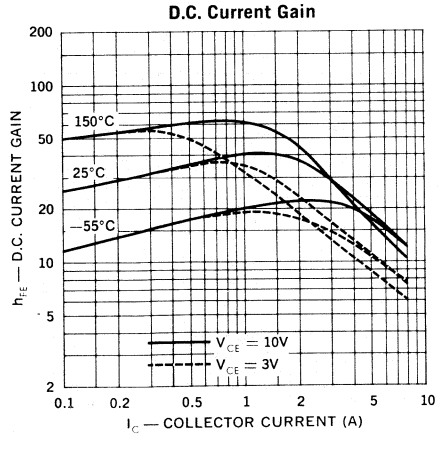
Forward Bias Safe Operating Area



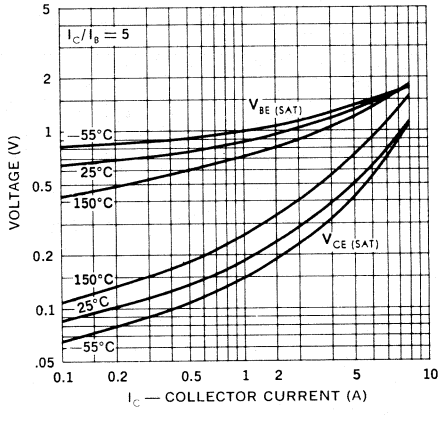
Power Derating



D.C. Current Gain



Saturation Voltages

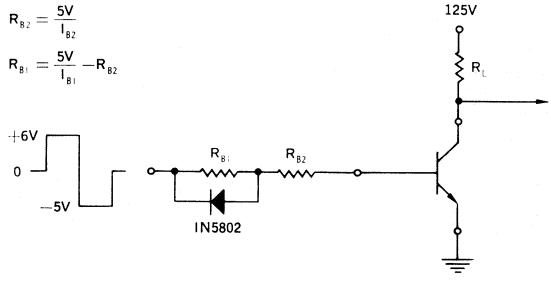


Switching Time Test Circuit

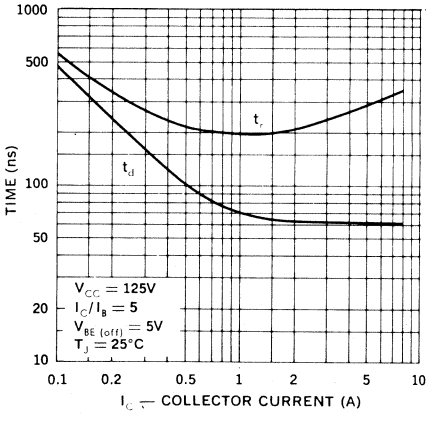
$R_L = \frac{125V}{I_C}$

$R_{B2} = \frac{5V}{I_{B2}}$

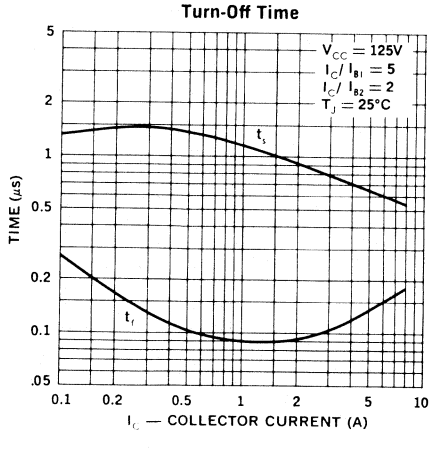
$R_{B1} = \frac{5V}{I_{B1}} - R_{B2}$



Turn-On Time



Turn-Off Time



POWER DARLINGTONS

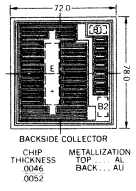
5 Amp, 150V, NPN

JAN, JANTX & JANTXV 2N6350
JAN, JANTX & JANTXV 2N6351
JAN, JANTX & JANTXV 2N6352
JAN, JANTX & JANTXV 2N6353

3

FEATURES

- High Current Gain: up to 2000 min. @ $I_C = 5A$
- Low Saturation Voltage: as low as 1.5V max. @ $I_C = 2A$
- Peak Current: to 10A
- JAN/JANTX/JANTXV versions meet MIL-S-19500/472



DESCRIPTION

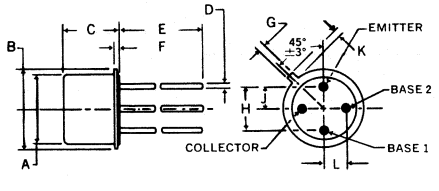
Unitrode NPN Darlingtons consist of a two transistor circuit on a single monolithic planar chip. The 2N6350 series is characterized for fast switching applications.

ABSOLUTE MAXIMUM RATINGS

	TO-33		3 PIN TO-66	
	JAN, JANTX & JANTXV 2N6350	JAN, JANTX & JANTXV 2N6351	JAN, JANTX & JANTXV 2N6352	JAN, JANTX & JANTXV 2N6353
Collector—Emitter Voltage	80V	150V	80V	150V
Emitter—Base Voltages				
V_{EB2}	6V	6V	6V	6V
V_{EB1}	12V	12V	12V	12V
D.C. Collector Current	5A	5A	5A	5A
Peak Collector Current	10A	10A	10A	10A
Base 1 Current	0.5A	0.5A	0.5A	0.5A
Power Dissipation				
25°C Ambient	1W	1W	2W	2W
100°C Case	5W	5W	25W	25W
Thermal Resistance				
Junction-to-Case	20°C/W		40°C/W	
Operating and StorageTemperature Range	-65°C to +200°C		-65°C to +200°C	

MECHANICAL SPECIFICATIONS

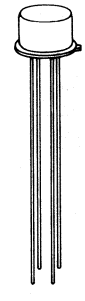
JAN, JANTX & JANTXV 2N6350 **JAN, JANTX & JANTXV 2N6351**



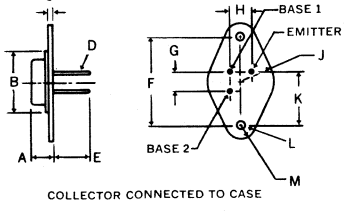
COLLECTOR CONNECTED TO CASE

	ins.	mm
A	.305-.335	7.75-8.51
B	.335-.370	8.51-9.40
C	.240-.260	6.10-6.60
D	.017 ± .002 .001	.432 ± .051 .025
E	1.5 MIN.	38.10 MIN.
F	.018 MAX.	0.46 MAX.
G	.031 ± .003	0.79 ± .08
H	.200	1.02
J	.100	2.54
K	.029-.045	0.74-1.14
L	.100	2.54

TO-33



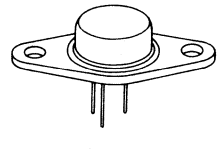
JAN, JANTX & JANTXV 2N6352 **JAN, JANTX & JANTXV 2N6353**



COLLECTOR CONNECTED TO CASE

	ins	mm
A	.250-.340	6.35-8.64
B	.620 MAX.	15.75 MAX.
C	.050-.075	1.27-1.91
D	.028-.034	0.71-0.86
E	.360 MIN.	9.14 MIN.
F	.958-.962	24.33-24.43
G	.190-.210	4.83-5.33
H	.190-.210	4.83-5.33
J	.350 MAX. RAD.	8.89 MAX. RAD.
K	.570-.590	14.48-14.99
L	.142-.152	3.61-3.86
M	.145 MAX. RAD.	3.68 MAX. RAD.

3 PIN TO-66

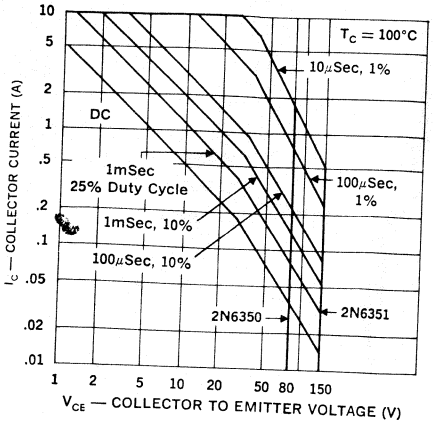


UNITRODE

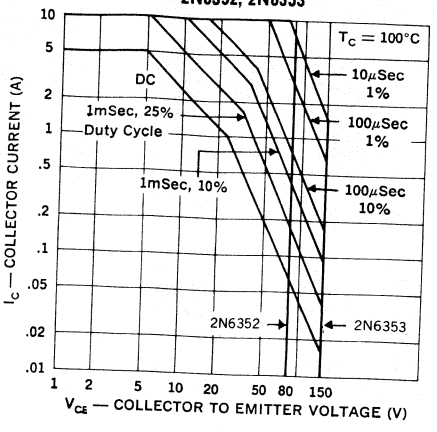
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	Min.	Max.	Units	MIL-STD-750 Method	MIL-STD-750 Test Conditions
Visual and Mechanical					2071	See Mechanical Data
25°C Collector–Emitter Breakdown Voltage 2N6350, 2N6352 2N6351, 2N6353	BV_{CER}	 80 150		 Vdc Vdc	3011	I_C = 25mA, R_{BE1} = 2.2K, R_{BE2} = 100 Ohms
Emitter Base Breakdown Voltage, Base 1 Emitter Base Breakdown Voltage, Base 2 Collector — Emitter Cutoff Current D.C. Current Gain 2N6350, 2N6352 2N6351, 2N6353	BV_{EBO1} BV_{EBO2} I_{CEX} h_{FE}	12 6 2000 1000	 1.0 	Vdc Vdc μAdc 	3026 3026 3041 3076	I_E = 12mA Base 2 Open I_E = 12mA Base 1 Open V_{CE} = BV_{CER} Rating V_{CE} = 5Vdc; I_C = 1.0A (pulse) R_{BE2} = 1K
D.C. Current Gain 2N6350, 2N6352 2N6351, 2N6353	h_{FE}	 2000 1000	 10000 10000		3076	V_{CE} = 5Vdc; I_C = 5.0Adc (pulse) R_{BE2} = 100 Ohms
D.C. Current Gain 2N6350, 2N6352 2N6351, 2N6353	h_{FE}	 400 200			3076	V_{CE} = 5Vdc; I_C = 10Adc (pulse) R_{BE2} = 100 Ohms
Collector Saturation Voltage 2N6350, 2N6352 2N6351, 2N6353	V_{CE} (sat)		 1.5 2.5	 Vdc Vdc	3071	I_C = 5.0Adc, R_{BE2} = 100 Ohms I_{B1} = 5mAdc (pulse) I_{B1} = 10mAdc (pulse)
Base Saturation Voltage	V_{BE1} (on)		2.5	Vdc	3066	I_C = 5.0Adc (pulse), V_{CE} = 5Vdc R_{BE2} = 100 Ohms
A.C. Current Gain	$\lvert h_{FE} \rvert$	5	25		3066	V_{CE} = 10Vdc, I_C = 1.0Adc, f = 10MHz R_{BE2} = 100 Ohms
Output Capacitance	C_{OBO1}		120	pf	3236	V_{CB1} = 10Vdc, 100KHz ⩽ f ⩽ 1MHz Base 2 open
Turn-on Time	t_{on}		0.5	μs	3251	V_{CC} = 30Vdc; I_C = 5.0Adc See Switching Speed Circuit
Turn-off Time	t_{off}		1.2	μs	3251	V_{CC} = 30Vdc; I_C = 5.0Adc See Switching Speed Circuit
150°C Collector–Emitter Cutoff Current	I_{CEX}		1.0	mAdc	3041	V_{EB1} = 2Vdc, R_{BE2} = 100 Ohms V_{CE} = BV_{CER} Rating
−65°C D.C. Current Gain 2N6350, 2N6352 2N6351, 2N6353	h_{FE}	 400 200			3076	V_{CE} = 5Vdc, I_C = 5.0Adc (pulse) R_{BE2} = 100 Ohms

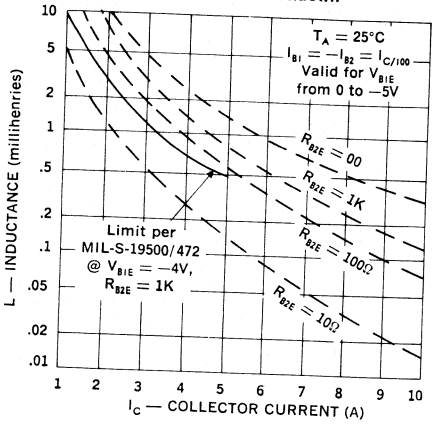
Forward Bias Safe Operating Area 2N6350, 2N6351



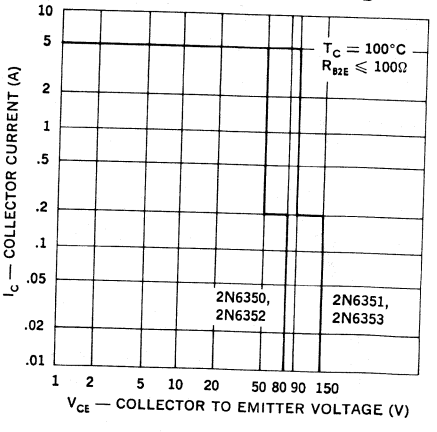
Forward Bias Safe Operating Area 2N6352, 2N6353



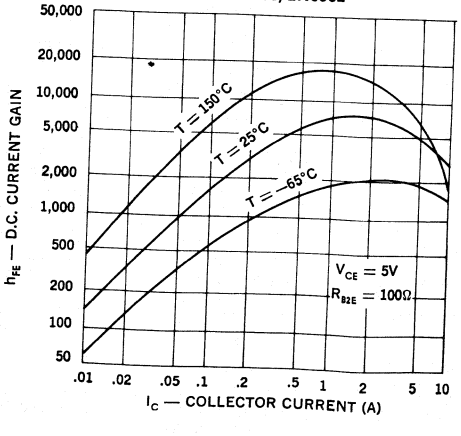
Unclamped Reverse Bias Second Breakdown



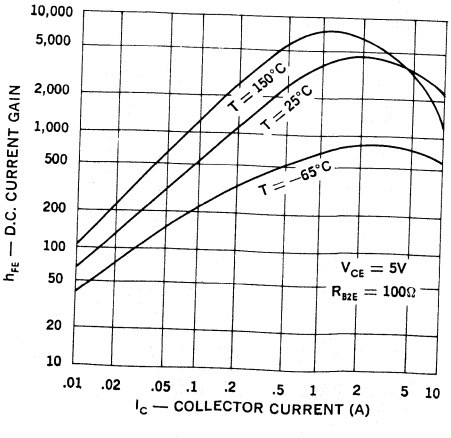
Reverse Bias Safe Operating Area Clamped Inductive Switching



D.C. Current Gain 2N6350, 2N6352



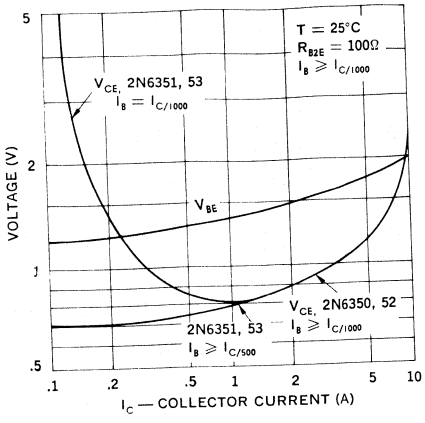
D.C. Current Gain 2N6351, 2N6353



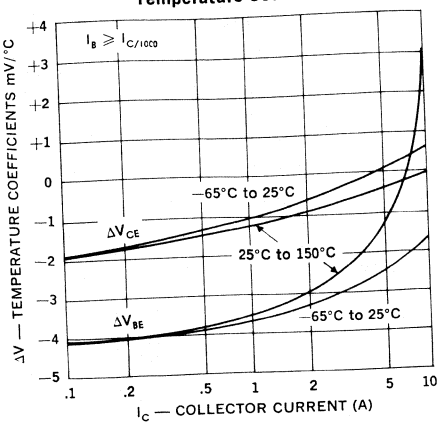
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

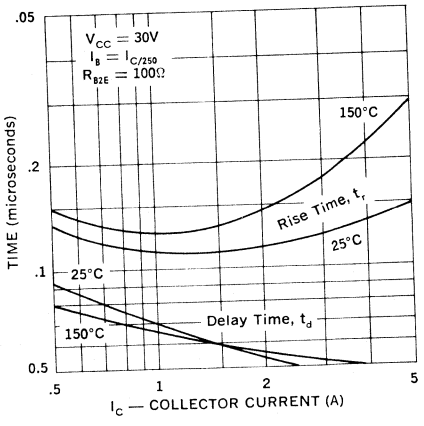
Saturation Voltages



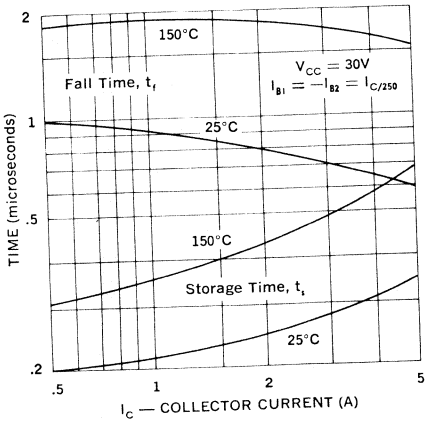
Saturation Voltage Temperature Coefficients



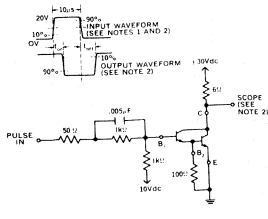
Switching Speed Characteristics



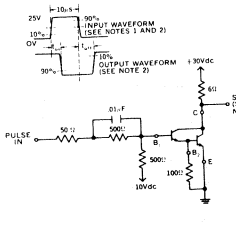
Switching Speed Characteristics



2N6350 & 52 Switching Speed Circuit

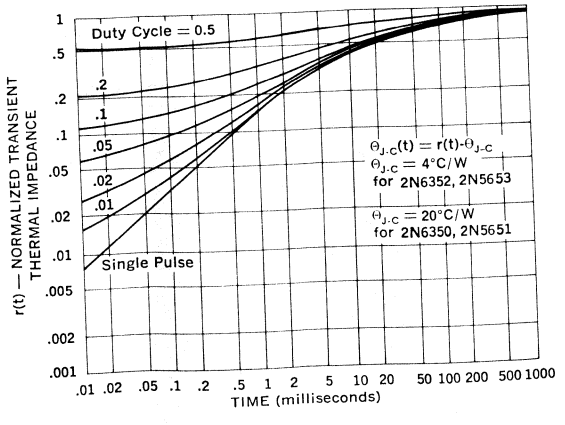


2N6351 & 3 Switching Speed Circuit



NOTES:
1. The input waveform is supplied by a pulse generator with the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, $Z_{out} = 50\Omega$, PW = 10 μs, Duty cycle ≤ 2%.
2. Output waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $Z_{in} \geq 10$ MΩ, $C_{in} \leq 11.5$ pF.
3. Resistors shall be noninductive types.
4. The DC power supplies may require additional by-passing in order to minimize ringing.

Thermal Response



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER TRANSISTORS
20 Amp, 150 V, Double Diffused NPN Mesa

2N6354
2N6496

3

FEATURES
- Collector-Base Voltage: up to 150V
- Peak Collector Current: 30A
- Rise Time: ⩽ 500ns
- Fall Time: ⩽ 500ns } @ I_C up to 12A

DESCRIPTION
These double diffused glass passivated mesa power transistors combine fast-switching, low saturation voltage and rugged $E_{S/b}$ capability. They are designed for use in switching regulators, converters, inverters and switching-control amplifiers.

ABSOLUTE MAXIMUM RATINGS*

	2N6354	2N6496
Collector-Base Voltage, V_{CBO}	150V	150V
Collector-Emitter Sustaining Voltage, $V_{CER\ (SUS)}$ (1)	—	130V
$V_{CEO\ (SUS)}$	120V	110V
Emitter-Base Voltage, V_{EBO}	6.5V	7V
Collector Current, I_C continuous	10A	15A
Collector Current, I_{CM} peak	12A	—
Base Current, I_B continuous	5A	5A
Power Dissipation, 25°C Case	140W	140W
Operating and Storage Temperature Range	—65 to 200°C	

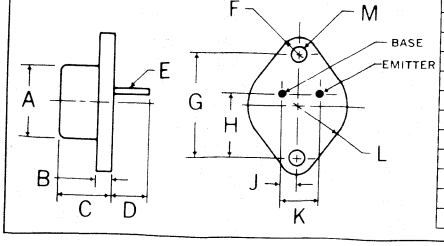
(1) With $R_{BE} \leqslant 50\Omega$

* JEDEC registered values.

MECHANICAL SPECIFICATIONS

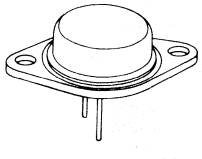
NOTE:
Leads may be soldered to within 1/16" of base provided temperature-time exposure is less than 260°C for 10 seconds.

2N6354, 2N6496



	ins.	mm.
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA (TO-3)



UNITRODE

Electrical Specifications (at 25°C unless noted)

	Test	Symbol	2N6354 MIN.	2N6354 MAX.	2N6496 MIN.	2N6496 MAX.	Units	Test Conditions
*	D.C. Current Gain (Note 1)	h_{FE}	—	—	—	—		$I_C = 2A, V_{CE} = 5V$
			20	150	—	—		$I_C = 5A, V_{CE} = 2V$
*	D.C. Current Gain (Note 1)	h_{FE}	—	—	12	100		$I_C = 8A, V_{CE} = 2V$
			10	100	—	—		$I_C = 10A, V_{CE} = 2V$
*	D.C. Current Gain (Note 1)	h_{FE}	—	—	—	—		$I_C = 10A, V_{CE} = 5V$
			—	—	—	—		$I_C = 12A, V_{CE} = 5V$
*	Collector Saturation Voltage (Note 1)	$V_{CE\ (sat)}$	—	0.5	—	—	V	$I_C = 5A, I_B = .5A$
			—	—	—	1.0	V	$I_C = 8A, I_B = .8A$
	Collector Saturation Voltage (Note 1)	$V_{CE\ (sat)}$	—	1.0	—	—	V	$I_C = 10A, I_B = 1.0A$
	Collector Saturation Voltage (Note 1)	$V_{CE\ (sat)}$	—	—	—	—	V	$I_C = 12A, I_B = 1.2A$
			—	—	—	—	V	$I_C = 20A, I_B = 5A$
	Base Saturation Voltage (Note 1)	$V_{BE\ (sat)}$	—	1.3*	—	—	V	$I_C = 5A, I_B = 0.5A$
			—	—	—	2.0	V	$I_C = 8A, I_B = 0.8A$
*	Base Saturation Voltage (Note 1)	$V_{BE\ (sat)}$	—	2.0	—	—	V	$I_C = 10A, I_B = 1A$
			—	—	—	—	V	$I_C = 20A, I_B = 5A$
	Collector-Emitter Sustaining Voltage (Note 2)	$V_{CEO\ (sus)}$	120	—	100	—	V	$I_C = 0.2A$
	Collector-Emitter Sustaining Voltage (Note 2)	$V_{CEX\ (sus)}$	—	—	—	—	V	$I_C = 0.2A$ $V_{BE} = -1.5V$ $I_B = 0$ $R_{BE} = 100\ \Omega$
	Collector-Emitter Sustaining Voltage (Note 2)	$V_{CER\ (sus)}$	—	—	130	—	V	$R_{BE} = 50\ \Omega, I_C = 0.2A$
			130	—	—	—	V	$R_{BE} = 100\ \Omega, I_C = 0.2A$
*	Emitter-Base Voltage	V_{EBO}	6.5	—	—	—	V	$I_E = 5mA$
			—	—	7.0	—	V	$I_E = 50mA$
*	Collector Cutoff Current	I_{CBO}	—	5	—	—	mA	$V_{CB} = 150V$
	Collector Cutoff Current	I_{CEO}	—	—	—	—	mA	$V_{CE} = 55V$
			—	—	—	—	mA	$V_{CE} = 70V$
			—	20	—	—	mA	$V_{CE} = 100V$
*	Collector Cutoff Current	I_{CEV}	—	—	—	—	mA	$V_{CE} = 110V, V_{BE} = -1.5V$
			—	—	—	20	mA	$V_{CE} = 130V, V_{BE} = 0$
			—	—	—	—	mA	$V_{CE} = 140V, V_{BE} = -1.5V$
			—	10	—	—	mA	$V_{CE} = 140V, V_{BE} = 0$
*	Collector Cutoff Current, 125°C	I_{CEV}	—	20	—	—	mA	$V_{CE} = 140V$
*	Collector Cutoff Current, 150°C	I_{CEV}	—	—	—	—	mA	$V_{CE} = 85V, V_{BE} = -1.5V$
			—	—	—	—	mA	$V_{CE} = 100V, V_{BE} = -1.5V$
			—	—	—	25	mA	$V_{CE} = 130V, V_{BE} = 0V$
*	Emitter Cutoff Current	I_{EBO}	—	—	—	—	mA	$V_{BE} = -5V$
			—	5.0	—	—	mA	$V_{BE} = -6.5V$
			—	—	—	50	mA	$V_{BE} = -7V$
	Magnitude of Small Signal Forward — Current Transfer Ratio	$\lvert h_{fe} \rvert$	—	—	12	—		$V_{CE} = 10V, I_C = 2A, f = 5\ MHz$
			8.0	—	—	—		$V_{CE} = 10V, I_C = 1A, f = 10\ MHz$
	Collector Capacitance	C_{ob}	—	300	—	300	pF	$V_{CB} = 10V, f = 1\ MHz$
	Thermal Resistance: Junction-to-Case	$R_{\theta JC}$	—	—	—	1.25	°C/W	$V_{CE} = 10V, I_C = 10A$
			—	1.25	—	—	°C/W	$V_{CE} = 20V, I_C = 1A$

Notes:
1. Pulse width = 250μS; duty cycle ≤1%.
2. Sustaining Voltage. Measured at a high current point where collector-emitter voltage is lowest. Current pulse length ≅ 50μS; duty cycle ≤ 1%.
   Voltage clamped at maximum collector-emitter voltage.

* JEDEC registered values.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

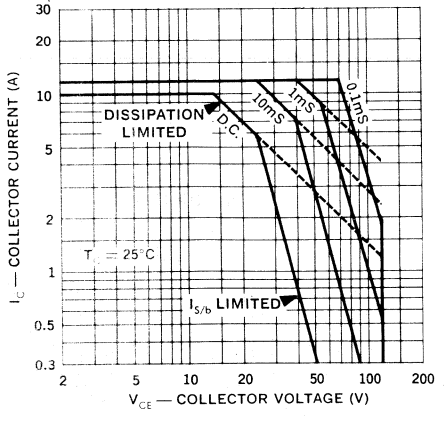
PRINTED IN U.S.A.

Electrical Specifications (at 25°C unless noted)

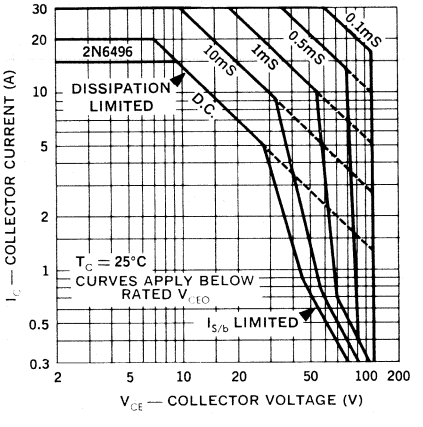
Test	Symbol	2N6354 MIN.	2N6354 MAX.	2N6496 MIN.	2N6496 MAX.	Units	Test Conditions
Second Breakdown Energy	$E_{s/b}$	0.3	—	—	—	mJ	$I_C = 5A$, $V_{BE} = -1.0V$, $R_{BE} = 51\ \Omega$, $L = 25\mu H$
		—	—	5.7	—		$I_C = 8A$, $V_{BE} = -4.0V$, $R_{BE} = 20\ \Omega$, $L = 180\mu H$
		—	—	—	—		$I_C = 13A$, $V_{BE} = -4.0V$, $R_{BE} = 20\ \Omega$, $L = 180\mu H$
Forward Bias Second Breakdown Collector Current	$I_{s/b}$	5.5	—	—	—	A	$V_{CE} = 25V$, t = 1s, non-rep.
		—	—	5.0	—		$V_{CE} = 28V$, t = 1s, non-rep.
		—	—	0.9	—		$V_{CE} = 45V$, t = 1s, non-rep.
* Switching Speeds							
Rise Time	t_r	—	0.3	—	—	μs	$I_C = 5A$
Storage Time	t_s	—	1.0	—	—		$I_{B1} = I_{B2} = .5A$
Fall Time	t_f	—	0.2	—	—		$V_{CC} = 30V$
Rise Time	t_r	—	—	—	0.5	μs	$I_C = 8A$
Storage Time	t_s	—	—	—	1.5		$I_{B1} = I_{B2} = .8A$
Fall Time	t_f	—	—	—	0.5		$V_{CC} = 30V$
Rise Time	t_r	—	—	—	—	μs	$I_C = 10A$
Storage Time	t_s	—	—	—	—		$I_{B1} = I_{B2} = 1.0A$
Fall Time	t_f	—	—	—	—		$V_{CC} = 30V$
Rise Time	t_r	—	—	—	—	μs	$I_C = 12A$
Storage Time	t_s	—	—	—	—		$I_{B1} = I_{B2} = 1.2A$
Fall Time	t_f	—	—	—	—		$V_{CC} = 30V$

* JEDEC registered values.

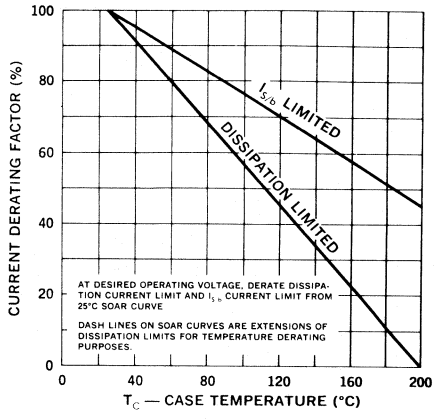
Forward Bias Safe Operating Area for 2N6354



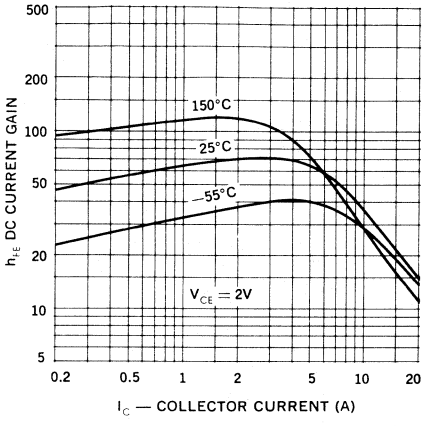
Forward Bias Safe Operating Area for 2N6496



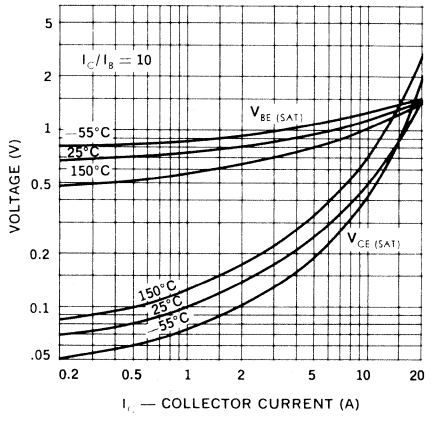
Power Derating



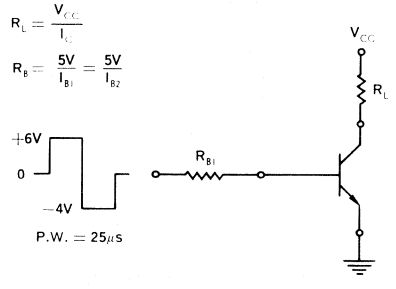
DC Current Gain



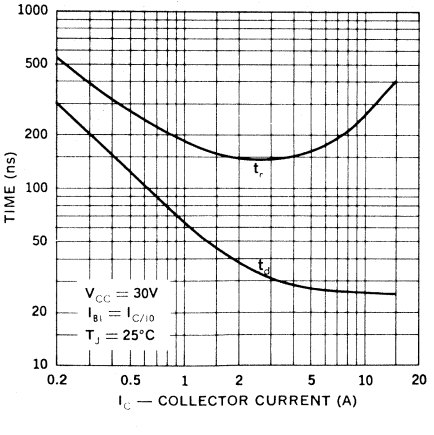
Saturation Voltages



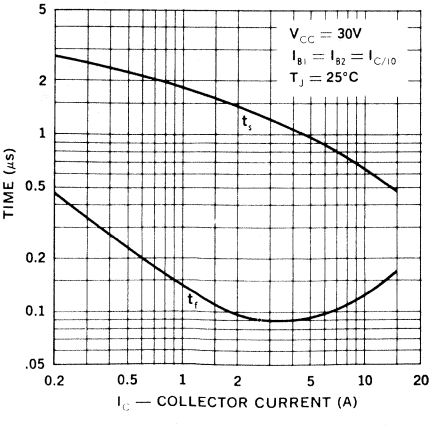
Switching Time Test Circuit



Turn-On Time



Turn-Off Time



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER TRANSISTORS

5A, 850V, Fast Switching, Silicon NPN Mesa

2N6542
2N6543
BUX82

3

FEATURES

- Collector-Base Voltage: up to 850V
- Peak Collector Current: 10A
- Rise Time: $\leq 0.7\mu S$ } @ $I_C = 3A$
- Fall Time: $\leq 0.8\mu S$ }
- Key Parameters characterized at 100°C

DESCRIPTION

These high voltage glass passivated power transistors combine fast switching, low saturation voltage and rugged E_S/I_b capability. They are designed for use in off-line power supplies, high voltage inverters, switching regulators, ignition systems and deflection circuits.

ABSOLUTE MAXIMUM RATINGS *

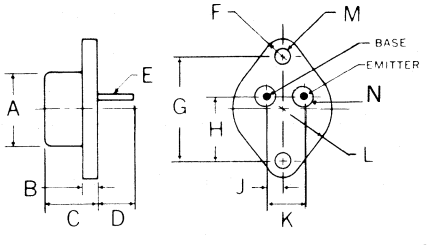
	BUX82	2N6542	2N6543
Collector-Base Voltage, V_{CBO}	800V	650V	850V
Collector-Emitter Voltage, $V_{CEO\ (SUS)}$	400V	300V	400V
Emitter-Base Voltage, V_{EBO}	9V	9V	9V
Collector Current, I_C, continuous	6A	5A	5A
Collector Current, I_C peak	10A	10A	10A
Base Current, I_B, continuous	5A	5A	5A
Power Dissipation, 25°C Case	60W**	100W	100W
Derating Factor	60W/°C	.571W/°C	.571W/°C
Operating and Storage Temperature Range	−65°C to +150°C	−65 to 200°C	

* JEDEC registered values.
** 50°C case.

MECHANICAL SPECIFICATIONS

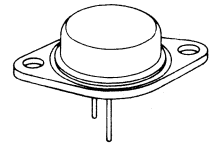
NOTE:
Leads may be soldered to within 1/16" of base provided temperature-time exposure is less than 260°C for 10 seconds.

2N6542 2N6543 BUX82



	ins.	mm.
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.
N	.190-.210	4.83-5.33

TO-204AA (TO-3)



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)*

Test	Symbol	2N6542 MIN.	2N6542 MAX.	2N6543 MIN.	2N6543 MAX.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{FE}	12	60	12	60		$I_C = 1.5A$, $V_{CE} = 2V$
D.C. Current Gain (Note 1)	h_{FE}	7	35	7	35		$I_C = 3.0A$, $V_{CE} = 2V$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	1.0	—	1.0	V	$I_C = 3.0A$, $I_B = 0.6A$
Collector Saturation Voltage, $T_C = 100°C$ (Note 1)	$V_{CE(sat)}$	—	2.0	—	2.0	V	$I_C = 3.0A$, $I_B = 0.6A$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	5.0	—	5.0	V	$I_C = 5.0A$, $I_B = 1.0A$
Base Saturation Voltage (Note 1)	$V_{BE(sat)}$	—	1.4	—	1.4	V	$I_C = 3.0A$, $I_B = 0.6A$
Base Saturation Voltage, $T_C = 100°C$ (Note 1)	$V_{BE(sat)}$	—	1.4	—	1.4	V	$I_C = 3.0A$, $I_B = 0.6A$
Collector-Emitter Sustaining Voltage (Note 2)	$V_{CEO(sus)}$	300	—	400	—	V	$I_C = 0.1A$, $I_B = 0$
Collector-Emitter Sustaining Voltage $T_C = 100°C$ (Note 2)	$V_{CEX(sus)}$	350	—	450	—	V	$L = 180\mu H$, $I_C = 2.6A$ $V_{BE} = -5V$ V_{CE} clamped to rated $V_{CEX(sus)}$
Collector-Emitter Sustaining Voltage $T_C = 100°C$ (Note 2)	$V_{CEX(sus)}$	200	—	300	—	V	$L = 180\mu H$, $I_C = 5A$ $V_{BE(off)} = -5V$ V_{CE} clamp to V_{CEO} −100V
Emitter-Base Cutoff Current	I_{EBO}	—	1	—	1	mA	$V_{EB} = 9V$
Collector Cutoff Current	I_{CEV}	— —	0.5 —	— —	— 0.5	mA	$V_{CE} = 650V$, $V_{BE} = -1.5V$ $V_{CE} = 850V$, $V_{BE} = -1.5V$
Collector Cutoff Current, $T_C = 100°C$	I_{CEV}	— —	2.5 —	— —	— 2.5	mA	$V_{CE} = 650V$, $V_{BE} = -1.5V$ $V_{CE} = 850V$, $V_{BE} = -1.5V$
Collector Cutoff Current, $T_C = 100°C$	I_{CER}	— —	3.0 —	— —	— 3.0	mA	$V_{CE} = 650V$, $R = 50\Omega$ $V_{CE} = 850V$, $R = 50\Omega$
Output Capacitance, Common Base	C_{obo}	50	150	50	150	pF	$V_{CB} = 10V$, $f = 1$ MHz
Gain-Bandwidth Product	F_T	6	24	6	24	MHz	$V_{CE} = 10V$, $I_C = 0.2A$, $f = 1$ MHz
Forward Bias Second Breakdown	$I_{s/b}$	200	—	200	—	mA	P.W. = 1 sec. single shot $V_{CE} = 100V$
Energy Second Breakdown (unclamped)	$E_{s/b}$	180	—	180	—	μJ	$I_C = 3.0A$ $L = 40\mu H$, $V_{BE(off)} = 4.0$ Vdc
Resistive Switching Speeds Delay Time Rise Time Storage Time Fall Time	 t_d t_r t_s t_f	 — — — —	 0.05 0.7 4.0 0.8	 — — — —	 0.05 0.7 4.0 0.8	μS	$I_C = 3.0A$, $t_p = 100\mu$sec $V_{CC} = 250V$ $I_{B1} = I_{B2} = 0.6A$ $V_{BE(off)} = 5V$
Inductive Switching Speeds $T_C = 100°C$ Storage Time Fall Time	 t_s t_f	 — —	 4.0 0.8	 — —	 4.0 0.8	μS	$I_C = 3.0A$ $I_B = 0.6A$, $V_{BE(off)} = 5.0$ Vdc $V_{BE(off)} = 5V$ V_{CE} clamp = rated $V_{CEX(sus)}$
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	—	1.75	—	1.75	°C/W	

Notes:
1. Pulse width = 250μS; duty cycle ≤1%.
2. Sustaining Voltage. Measured at a high current point where collector-emitter voltage is lowest. Current pulse length ≅ 50μS; duty cycle ≤ 1%. Voltage clamped at maximum collector-emitter voltage.

* JEDEC registered values.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

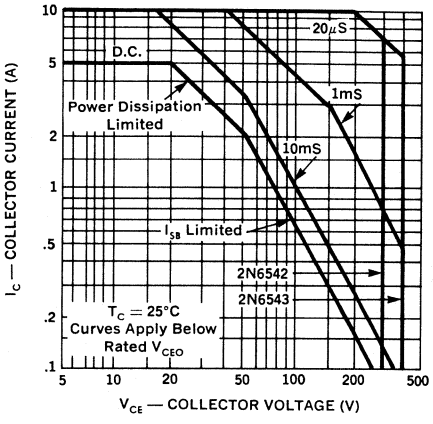
PRINTED IN U.S.A.

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

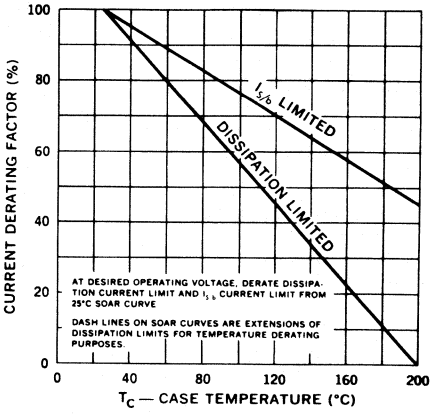
Test	Symbol	BUX82 MIN.	BUX82 MAX.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{fe}	30Typ			$I_C = 0.6A$, $V_{CE} = 5V$
Collector Saturation Voltage (Note 1)	$V_{CE\ (sat)}$	—	1.5	V	$I_C = 2.5A$, $I_B = 0.5A$
Collector Saturation Voltage (Note 1)	$V_{CE\ (sat)}$	—	3.0	V	$I_C = 4.0A$, $I_B = 1.25A$
Base Saturation Voltage (Note 1)	$V_{BE\ (sat)}$	—	1.4	V	$I_C = 2.5A$, $I_B = 0.5A$
Collector-Emitter Sustaining Voltage (Note 2)	$V_{CEO\ (sus)}$	400	—	V	$I_C = 0.1A$, $I_B = 0$, L = 25mH
Collector Emitter Sustaining Voltage $T_C = 100°C$ (Note 2)	$V_{CEX\ (sus)}$	450	—	V	L = 180μH, $I_C = 2.6A$ $V_{BE} = -5V$ V_{CE} clamped to rated $V_{CEX\ (sus)}$
Collector Emitter Sustaining Voltage $T_C = 100°C$ (Note 2)	$V_{CEX\ (sus)}$	300	—	V	L = 180μH, $I_C = 5A$ $V_{BE\ (off)} = -5V$ V_{CE} clamped to $V_{CEO} -100V$
Emitter-Base Cutoff Current	I_{EBO}	—	10	mA	$V_{EB} = 10V$
Collector Cutoff Current	I_{CEV}	—	1.0	mA	$V_{CE} = 800V$, $V_{BE} = 0V$
Collector Cutoff Current, $T_C = 125°C$	I_{CEV}	—	2.0	mA	$V_{CE} = 800V$, $V_{BE} = 0V$
Output Capacitance, Common Base	C_{obo}	50	150	pF	$V_{CB} = 10V$, f = 1MHz
Gain-Bandwidth Product	F_T	6	24	MHz	$V_{CE} = 10V$, $I_C = 0.2A$, f = 1MHz
Forward Bias Second Breakdown	$I_s/_b$	200	—	mA	P.W. = 1 sec. single shot $V_{CE} = 100V$
Energy Second Breakdown (unclamped)	$E_s/_b$	180	—	μJ	$I_C = 3.0A$ L = 40μH, $V_{BE(off)} = 4.0$ Vdc
Resistive Switching Speeds On Time Off Time	 t_{on} t_{off}	 — —	 0.5 3.5	 μS	$I_C = 2.5A$ $V_{CC} = 250V$ $I_{B1} = 0.5A$ $I_{B2} = 1.0A$
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	—	1.65	°C/W	

NOTES:
1. Pulse width = 250μS; duty cycle ≤1%.
2. Sustaining Voltage. Measured at a high current where collector-emitter voltage is lowest. Current pulse length ≅ 50μS; duty cycle ≤1%. Voltage clamped at maximum collector- emitter voltage.

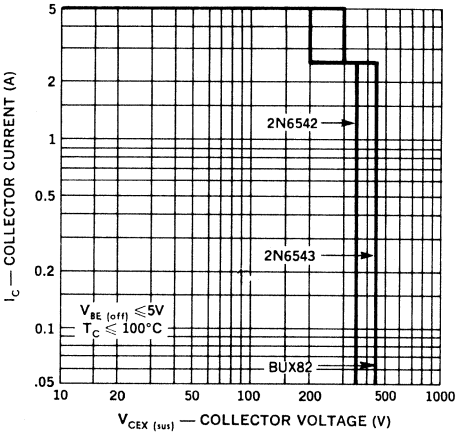
Forward Bias Safe Operating Area



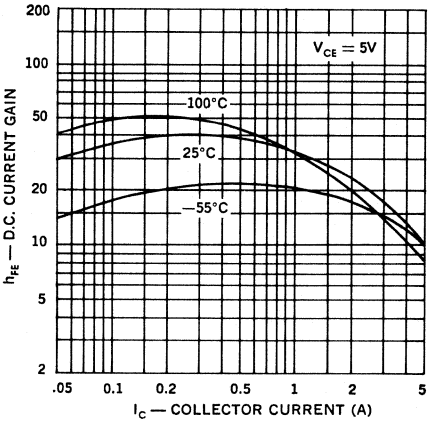
Power Derating



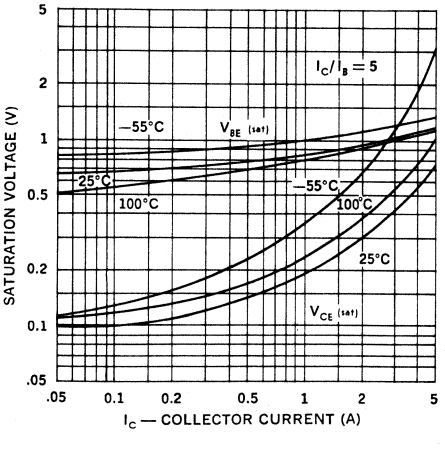
Reverse Biased Safe Operating Area



D.C. Current Gain



Saturation Voltages



Typical Inductive Load Switching Performance

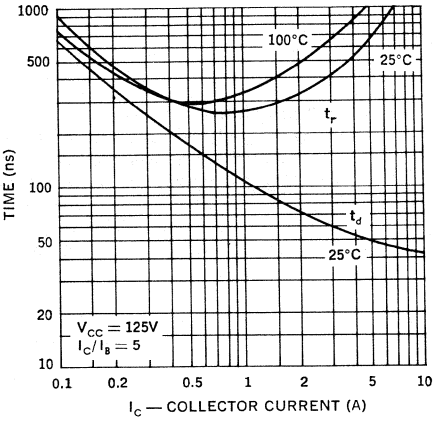
I_C Amps	T_J °C	t_s μS	t_{fv} nS	t_{fi} nS
3.0	25	.45	70	10
	100	.575	100	20
5.0	25	.475	25	4
	100	.60	45	10
8.0	25	.525	20	10
	100	.625	45	15

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

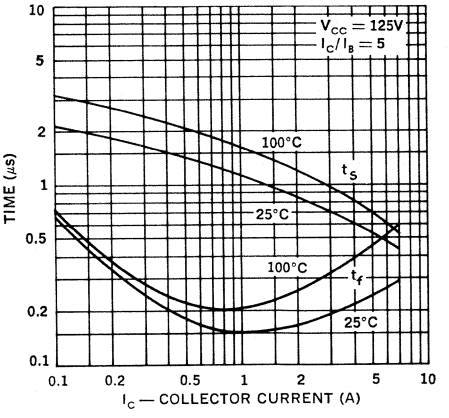
PRINTED IN U.S.A.

3

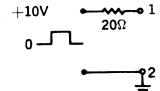
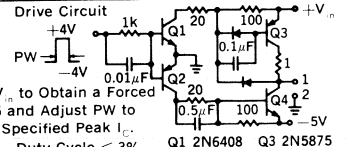
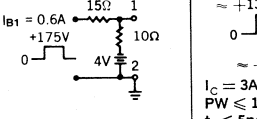
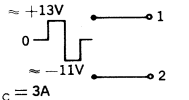
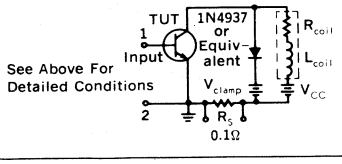
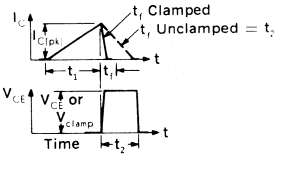
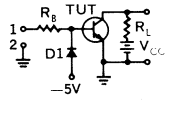
Resistive Turn-On Time



Resistive Turn-Off Time



TEST CONDITIONS FOR DYNAMIC PERFORMANCE

	$V_{CEO(SUS)}$	$V_{CEX\ (SUS)}$ AND INDUCTIVE SWITCHING	$E_{S/b}$	RESISTIVE SWITCHING
INPUT CONDITIONS	 PW Varied to Attain I_C = 100mA	 Set +V_n to Obtain a Forced h_{FE} = 5 and Adjust PW to Attain Specified Peak I_C. Duty Cycle ⩽ 3% f = 1kHz Q1 2N6408 Q3 2N5875 Q2 2N6406 Q4 2N5877 Diodes 1N4933	 PW Varied to Attain I_C	 I_C = 3A PW ⩽ 100μs t_r ⩽ 5ns t_f ⩽ 50ns Duty Cycle ⩽ 2%
CIRCUIT VALUES	L_{coil} = 80mH V_{CC} = 10V R_{coil} = 0.7Ω V_{clamp} (Unclamped)	L_{coil} = 180μH R_{coil} = 0.05Ω V_{CC} = 20V f_o = 500kHz V_{clamp} = Rated V_{CEX} Value	L_{coil} = 40μH V_{CC} = 10V R_{coil} = 0.2Ω V_{clamp} (Unclamped)	V_{CC} = 250V R_L = 83Ω D1 = 1N5820 or Equiv. R_B = 20Ω
TEST CIRCUITS	INDUCTIVE TEST CIRCUIT  See Above For Detailed Conditions	OUTPUT WAVEFORMS 	t_1 Adjusted to Obtain I_C $t_1 \approx \frac{L_{coil}\ (I_{Cpk})}{V_{CC}}$ $t_2 \approx \frac{L_{coil}\ (I_{Cpk})}{V_{clamp}}$ Test Equipment Tektronix Scope 475 or Equivalent	RESISTIVE TEST CIRCUIT 

POWER TRANSISTORS

8 Amp, 850V, Triple Diffused, NPN, Mesa

2N6544
2N6545
BUX80

FEATURES

- Collector-Base Voltage: up to 850V
- Peak Collector Current: 16A
- Rise Time: $\leqslant 1.0\mu s$ } @ $I_C = 5A$
- Fall Time: $\leqslant 1.0\mu s$ }
- Key Parameters characterized at 100°C

DESCRIPTION

These high voltage triple diffused glass passivated power transistors combine fast switching, low saturation voltage and rugged $E_{S/b}$ capability. They are designed for use in off-line power supplies, high voltage inverters, switching regulators, ignition systems and deflection circuits.

ABSOLUTE MAXIMUM RATINGS *

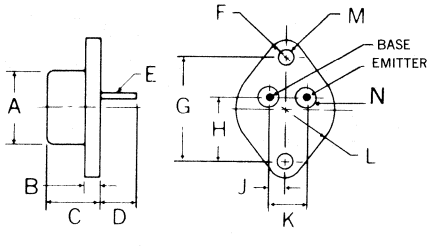
	BUX80	2N6544	2N6545
Collector-Base Voltage, V_{CBO}	800V	650V	850V
Collector-Emitter Voltage, $V_{CEO\ (SUS)}$	400V	300V	400V
Emitter-Base Voltage, V_{EBO}	8V	9V	9V
Collector Current, I_C, continuous	10A	8A	8A
Base Current, I_B, continuous	4A	8A	8A
Emitter Current, I_E, continuous	14A	16A	16A
Power Dissipation, 25°C Case	100**	125W	125W
Derating Factor		.714W/°C	.714W/°C
Operating and Storage Temperature Range	-65°C to +150 °C	—65 to 200°C	

* JEDEC registered values.
** 40°C case.

MECHANICAL SPECIFICATIONS

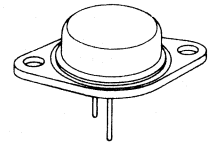
NOTE:
Leads may be soldered to within $^1/_{16}$" of base provided temperature-time exposure is less than 260°C for 10 seconds.

2N6544 2N6545 BUX80



	ins.	mm.
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.
N	.190-.210	4.83-5.33

TO-204AA (TO-3)



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)*

Test	Symbol	2N6544 MIN.	2N6544 MAX.	2N6545 MIN.	2N6545 MAX.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{FE}	12	60	12	60		$I_C = 2.5A, V_{CE} = 3V$
D.C. Current Gain (Note 1)	h_{FE}	7	35	7	35		$I_C = 5.0A, V_{CE} = 3V$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	1.5	—	1.5	V	$I_C = 5.0A, I_B = 1.0A$
Collector Saturation Voltage, $T_C = 100°C$ (Note 1)	$V_{CE(sat)}$	—	2.5	—	2.5	V	$I_C = 5.0A, I_B = 1.0A$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	5.0	—	5.0	V	$I_C = 8.0A, I_B = 2.0A$
Base Saturation Voltage (Note 1)	$V_{BE(sat)}$	—	1.6	—	1.6	V	$I_C = 5.0A, I_B = 1.0A$
Base Saturation Voltage, $T_C = 100°C$ (Note 1)	$V_{BE(sat)}$	—	1.6	—	1.6	V	$I_C = 5.0A, I_B = 1.0A$
Collector-Emitter Sustaining Voltage (Note 2)	$V_{CEO(sus)}$	300	—	400	—	V	$I_C = 0.1A$
Collector-Emitter Sustaining Voltage $T_C = 100°C$ (Note 2)	$V_{CEX(sus)}$	350	—	450	—	V	$L = 180\mu H, I_C = 4.5A$ $V_{BE} = -5V$ V_{CE} clamped to rated $V_{CEX(sus)}$
Emitter-Base Cutoff Current	I_{EBO}	—	1	—	1	mA	$V_{EB} = 9V$
Collector Cutoff Current	I_{CEV}	— —	0.5 —	— —	— 0.5	mA	$V_{CE} = 650V, V_{BE} = -1.5V$ $V_{CE} = 850V, V_{BE} = -1.5V$
Collector Cutoff Current, $T_C = 100°C$	I_{CEV}	— —	2.5 —	— —	— 2.5	mA	$V_{CE} = 650V, V_{BE} = -1.5V$ $V_{CE} = 850V, V_{BE} = -1.5V$
Collector Cutoff Current, $T_C = 100°C$	I_{CER}	— —	3.0 —	— —	— 3.0	mA	$V_{CE} = 650V, R = 50\Omega$ $V_{CE} = 850V, R = 50\Omega$
Output Capacitance, Common Base	C_{obo}	100	200	100	200	pF	$V_{CB} = 10V, f = 1$ MHz
Gain-Bandwidth Product	F_T	6	24	6	24	MHz	$V_{CE} = 10V, I_C = 0.3A, f = 1$ MHz
Energy Second Breakdown (unclamped)	$E_{S/b}$	500	—	500	—	μJ	$I_C = 5.0A$ $I_B = 1.0A$ $L = 40\mu H$
Resistive Switching Speeds Delay Time Rise Time Storage Time Fall Time	 t_d t_r t_s t_f	 — — — —	 0.05 1.0 4.0 1.0	 — — — —	 0.05 1.0 4.0 1.0	μs	$I_C = 5.0A$ $V_{CC} = 250V$ $I_{B1} = I_{B2} = 1.0A$ $V_{BE(off)} = 5V$
Inductive Switching Speeds $T_C = 100°C$ Storage Time Fall Time	 t_s t_f	 — —	 4.0 0.9	 — —	 4.0 0.9	μs	$I_C = 5.0A$ $I_B = 1.0A$ $V_{BE(off)} = 5V$ V_{CE} clamp = rated $V_{CEX(sus)}$
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	—	1.4	—	1.4	°C/W	

Notes:
1. Pulse width = 250μS; duty cycle $\leq$1%.
2. Sustaining Voltage. Measured at a high current point where collector-emitter voltage is lowest. Current pulse length $\cong$ 50μS; duty cycle $\leq$ 1%. Voltage clamped at maximum collector-emitter voltage.

* JEDEC registered values.

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

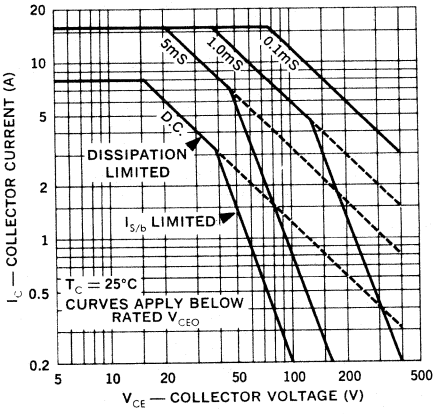
Test	BUX80 Symbol	MIN.	MAX.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{fe}	30 Typ			$I_C = 1.2A$, $V_{CE} = 5V$
Collector Saturation Voltage (Note 1)	$V_{CE\ (sat)}$	—	1.5	V	$I_C = 5A$, $I_B = 1A$
Collector Saturation Voltage (Note 1)	$V_{CE\ (sat)}$	—	3.0	V	$I_C = 8A$, $I_B = 2.5A$
Base Saturation Voltage (Note 1)	$V_{BE\ (sat)}$	—	1.4	V	$I_C = 5A$, $I_B = 1A$
Base Saturation Voltage (Note 1)	$V_{BE\ (sat)}$	—	1.8	V	$I_C = 8A$, $I_B = 2.5A$
Collector-Emitter Sustaining Voltage (Note 2)	$V_{CEO\ (sus)}$	400	—	V	$I_C = 100mA$, $I_B = 0$, L = 25mH
Emitter-Base Cutoff Current	I_{EBO}	—	10	mA	$V_{EB} = 10V$, $I_C = 0$
Collector Cutoff Current	I_{CEO}	—	0.5	mA	$V_{CE} = 400V$
Collector Cutoff Current	I_{CEV}	—	1.0	mA	$V_{CE} = 800V$, $V_{BE} = 0V$
Second Breakdown Energy	$E_{S/b}$	—	180	mJ	$I_C = 3.0A$, L = 40mH $R_{BE} = 3K\Omega$, $V_{BB2} = 1.5V$
Collector Capacitance	C_{ob}	—	250	pF	$V_{CB} = 10V$, $I_E = 0$,f = 1MHz
Gain-Bandwidth Product	f_T	5	—	MHz	$I_C = .3A$, $V_{CE} = 10V$, f = 1MHz
Switching Speeds: On Time	t_{on}	—	0.5	μS	$V_{CC} = 250V$, $I_C = 5A$ $I_{B1} = 1A$, $I_{B2} = 2A$
Off Time	t_{off}	—	3.5	μS	
Thermal Resistance	$R_{\theta JC}$	—	1.0	°C/W	

NOTES:
1. Pulse width = 250μS; duty cycle ≤1%.
2. Sustaining Voltage. Measured at a high current where collector-emitter voltage is lowest. Current pulse length ≅ 50μS; duty cycle ≤1%. Voltage clamped at maximum collector- emitter voltage.

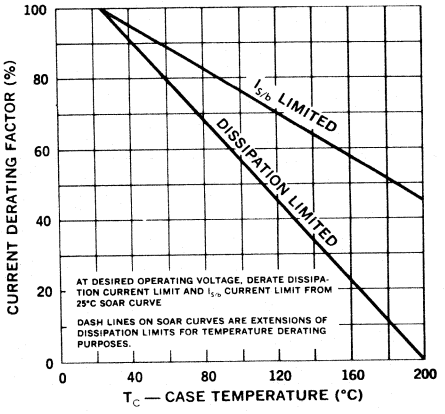
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

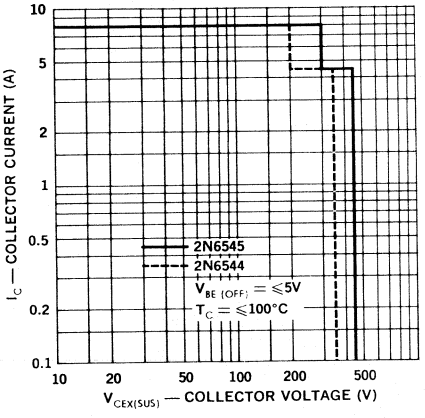
Forward Bias Safe Operating Area



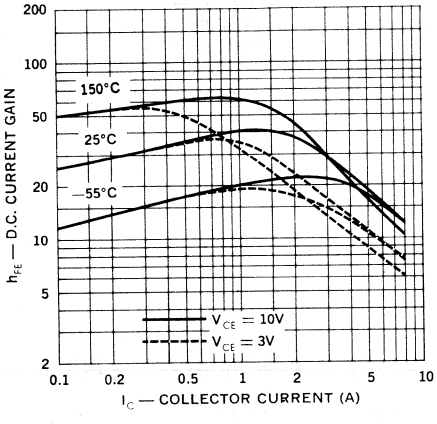
Power Derating



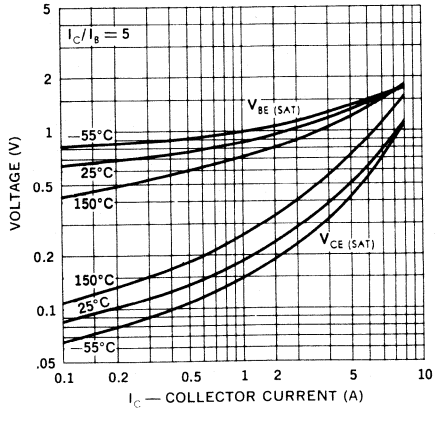
Reverse Biased Safe Operating Area



D.C. Current Gain



Saturation Voltages



Inductive Load Switching Performance

I_C Amps	T_J °C	t_s μs	t_{fv} μs	t_{fi} μs
3.0	25	.90	.07	.07
	100	1.40	.12	.15
5.0	25	.98	.10	.11
	100	1.52	.15	.20
8.0	25	1.10	.14	.11
	100	1.70	.20	.18

t_{fv} = voltage fall time; 10-90%
t_{fi} = current fall time; 10-90%

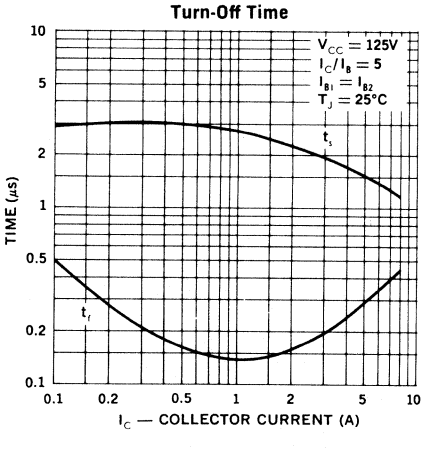
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

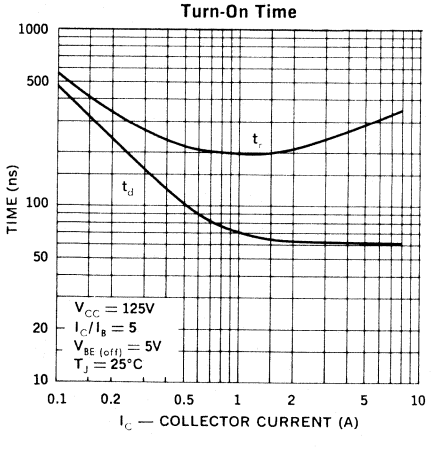
TEST CONDITIONS FOR DYNAMIC PERFORMANCE

	$V_{CEO(SUS)}$	$V_{CEX\ (SUS)}$ AND INDUCTIVE SWITCHING	$E_{S/b}$	RESISTIVE SWITCHING
INPUT CONDITIONS	+10V, 0, 20Ω, 1, 2 PW Varied to Attain I_C = 100mA	Drive Circuit +4V, −4V, PW, 1k, 0.01μF, 20, 100, +V_{in}, Q1, Q2, Q3, Q4, 0.1μF, 0.5μF, 1, 2, −5V Set +V_{in} to Obtain a Forced h_{FE} = 5 and Adjust PW to Attain Specified Peak I_C. Duty Cycle ≤ 3% f = 1kHz Q1 2N6408 Q3 2N5875 Q2 2N6406 Q4 2N5877 Diodes 1N4933	I_{B1} = 1.0A, 15Ω, 1, +23.5, 0, 10Ω, 4V, 2 PW Varied to Attain I_C	≈ +13V, 0, ≈ −11V, 1, 2 I_C = 3A PW ≤ 100μs t_r ≤ 5ns t_f ≤ 50ns Duty Cycle ≤ 2%
CIRCUIT VALUES	L_{coil} = 80mH V_{CC} = 10V R_{coil} = 0.7Ω V_{clamp} (Unclamped)	L_{coil} = 180μH R_{coil} = 0.05Ω V_{CC} = 20V f_o = 500kHz V_{clamp} = Rated V_{CEX} Value	L_{coil} = 40μH V_{CC} = 10V R_{coil} = 0.2Ω V_{clamp} (Unclamped)	V_{CC} = 250V R_L = 83Ω D1 = 1N5820 or Equiv. R_B = 20Ω
TEST CIRCUITS	INDUCTIVE TEST CIRCUIT See Above For Detailed Conditions TUT, 1N4937 or Equivalent, 1, 2, Input, R_{coil}, L_{coil}, V_{clamp}, V_{CC}, R_S 0.1Ω	OUTPUT WAVEFORMS I_C, $I_{C(pk)}$, t_f Clamped, t_f Unclamped = t_2, t_1, t_f, t V_{CE}, V_{CE} or V_{clamp}, Time, t_2, t	t_1 Adjusted to Obtain I_C $t_1 \approx \frac{L_{coil}\ (I_{C(pk)})}{V_{CC}}$ $t_2 \approx \frac{L_{coil}\ (I_{C(pk)})}{V_{clamp}}$ Test Equipment Tektronix Scope 475 or Equivalent	RESISTIVE TEST CIRCUIT R_B, TUT, 1, 2, D1, R_L, V_{CC}, −5V

Turn-Off Time



Turn-On Time



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER TRANSISTORS

15A, 850V, Fast Switching, Silicon NPN Mesa

JAN, JANTX, & JANTXV 2N6546
JAN, JANTX, & JANTXV 2N6547
BUX48

3

FEATURES
- Collector-Emitter Voltage: up to 850V
- Peak Collector Current: 30A
- Rise Time: ≤ 0.7μS } @ I_C = 10A
- Fall Time: ≤ 0.7μS }
- Qualified to MIL-S-19500/525

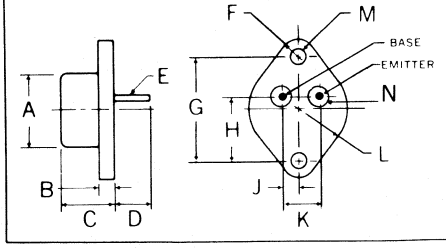
DESCRIPTION
These high voltage glass passivated power transistors combine fast switching, low saturation voltage and rugged $E_S/_b$ capability. They are designed for use in off-line power supplies, high voltage inverters, switching regulators, ignition systems and deflection circuits.

ABSOLUTE MAXIMUM RATINGS

	BUX48	2N6546	2N6547
Collector-Emitter Sustaining Voltage, V_{CEX}	850V	650V	850V
Collector-Emitter Voltage, $V_{CEO\ (SUS)}$	400V	300V	400V
Emitter-Base Voltage, V_{EBO}	7V	8V	8V
Collector Current, I_C, continuous	15A	15A	15A
Collector Current, I_C peak	30A	30A	30A
Base Current, I_B, continuous	4A	10A	10A
Emitter Current, I_E, continuous		25A	25A
Power Dissipation, 25°C Case	175W	175W	175W
Derating Factor	1W/°C	1W/°C	1W/°C
Operating and Storage Temperature Range		-65 to +200°C	

MECHANICAL SPECIFICATIONS

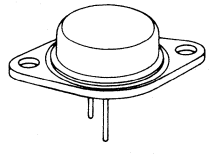
NOTE:
Leads may be soldered to within $^1/_{16}$" of base provided temperature-time exposure is less than 260°C for 10 seconds.



JAN, JANTX, & JANTXV 2N6546
JAN, JANTX, & JANTXV 2N6547
BUX48

	ins.	mm.
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.
N	.190-.210	4.83-5.33

TO-204AA (TO-3)



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)*

Test	Symbol	2N6546 MIN.	2N6546 MAX.	2N6547 MIN.	2N6547 MAX.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{FE}	12	60	12	60		I_C = 5.0A, V_{CE} = 2.0V
D.C. Current Gain (Note 1)	h_{FE}	6	—	6	—		I_C = 10A, V_{CE} = 2.0V
D.C. Current Gain (Note 1)	h_{FE}	15	—	15	—		I_C = 1A, V_{CC} = 2V
Collector Saturation Voltage (Note 1)	$V_{CE\ (sat)}$	—	1.5	—	1.5	V	I_C = 10A, I_B = 2.0A
Collector Saturation Voltage (Note 1)	$V_{CE\ (sat)}$	—	5.0	—	5.0	V	I_C = 15A, I_B = 3.0A
Base Saturation Voltage (Note 1)	$V_{BE\ (sat)}$	—	1.6	—	1.6	V	I_C = 10A, I_B = 2.0A
Collector-Emitter Sustaining Voltage (Note 2)	$V_{CEO\ (sus)}$	300	—	400	—	V	I_C = 0.1A, I_B = 0
Emitter-Base Cutoff Current	I_{EBO}	—	1	—	1	mA	V_{EB} = 8V
Collector Cutoff Current	I_{CEX}	— —	1 —	— —	— 1	mA	V_{CE} = 650V, V_{BE} = −1.5V V_{CE} = 850V, V_{BE} = −1.5V
Collector Cutoff Current, T_C = 150°C	I_{CEX}	— —	30 —	— —	— 30	mA	V_{CE} = 650V, V_{BE} = −1.5V V_{CE} = 850V, V_{BE} = −1.5V
Output Capacitance Common Base	C_{obo}	—	500	—	500	pF	V_{CB} =10V, f = 1MHz
Resistive Switching Speeds Turn-on Time Turn-off Time	 t_{ON} t_{OFF}	 — —	 1.0 4.7	 — —	 1.0 4.7	 μS	 I_C = 10A V_{CC} = 250V I_{B1} = I_{B2} = 2.0A
Thermal Resistance, Junction-to-Case	$R\theta_{JC}$	—	1.0	—	1.0	°C/W	

Notes:
1. Pulse width = 250μS; duty cycle ≤1%.
2. Sustaining Voltage. Measured at a high current point where collector-emitter voltage is lowest. Current pulse length ≅ 50μS; duty cycle ≤ 1%. Voltage clamped at maximum collector-emitter voltage.

* JEDEC registered values.

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

PARAMETER	SYMBOL	BUX48 MIN.	BUX48 TYP.	BUX48 MAX.	UNITS	TEST CONDITIONS
Off Characteristics						
Collector Emitter Sustaining Voltage	$V_{CEO(sus)}$	400	—	—	V	I_C = 0.2A, I_B = 0 L = 25mH
Emitter Base Voltage	V_{EBO}	7	—	30	V	I_C = 0A, I_B = 0.05A
Collector Cutoff Current	I_{CEX}	—	—	0.2	mA	V_{CE} = V_{CEX} V_{BE} = −2.5V
Collector Cutoff Current T_C = 125°C	I_{CEX}	—	—	2	mA	V_{CE} = V_{CEX} V_{BE} = −2.5V
Emitter Cutoff Current	I_{EBO}	—	—	1	mA	V_{EB} = 5V, I_C = 0
On Characteristics (Note 1)						
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	—	—	1.5	V	I_C = 10A, I_B = 2A
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	—	—	5	V	I_C = 15A, I_B = 3A
Base Emitter Saturation Voltage	$V_{BE(sat)}$	—	—	1.6	V	I_C = 10A, I_B = 2A
Dynamic Characteristics						
Gain-Bandwidth Product	f_T	—	5	—	MHz	V_{CE} = 10V, I_C = 1A f = 1MHz
Output Capacitance	C_{obo}	—	250	—	pF	V_{CE} = 10V, f = 1MHz
Switching Characteristics						
Resistive Switching Speeds Turn on Time Storage Time	 t_{on} t_s	 — —	 — —	 1 3	 μs μs	 I_C = 10A V_{CC} = 150V I_{B1} = $-I_{B2}$ = 2A
Inductive Switching Speeds T_C = 25°C Storage Time Fall Time	 t_s t_f	 — —	 3 0.08	 — —	 μs μs	 I_C = 10A, I_{B2} = 2A L_B = 3μH V_{CC} = 300V, $-V_{BE}$ = 5V
T_C = 100°C Storage Time Fall Time	 t_s t_f	 — —	 — —	 5 0.4	 μs μs	 I_C = 10A, I_{B2} = 2A L_B = 3μH V_{CC} = 300V, $-V_{BE}$ = 5V

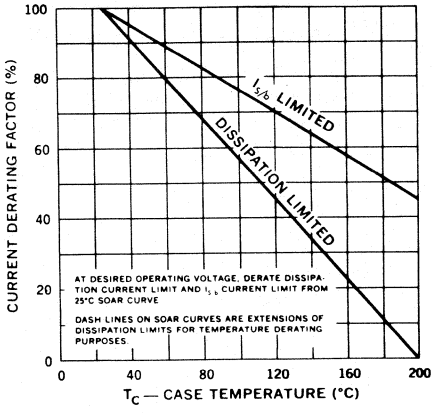
Note: 1. t_p = 300μs; duty cycle ≤ 2%.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

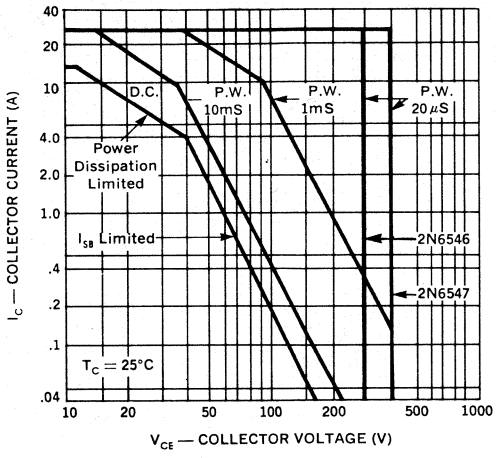
PRINTED IN U.S.A.

3

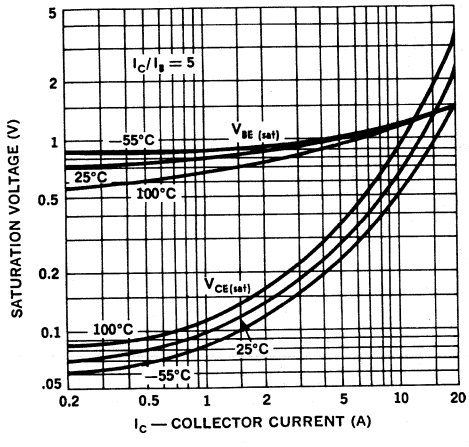
Power Derating



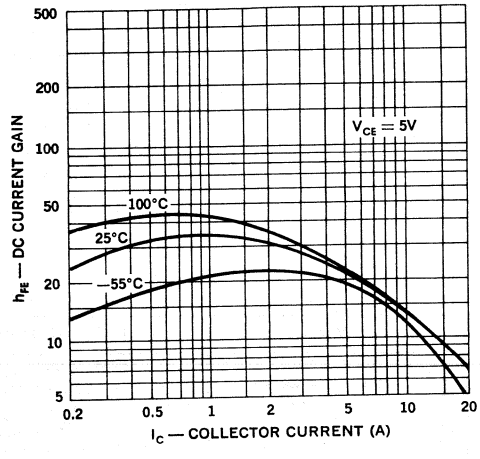
Forward Bias Safe Operating Area



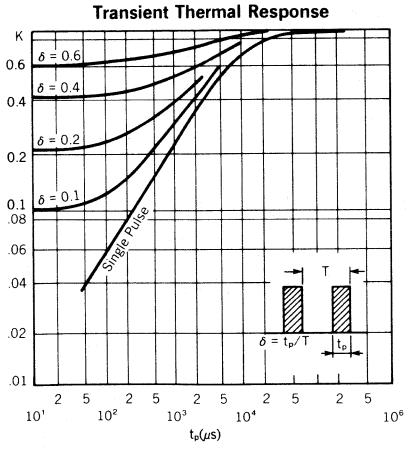
Saturation Voltages



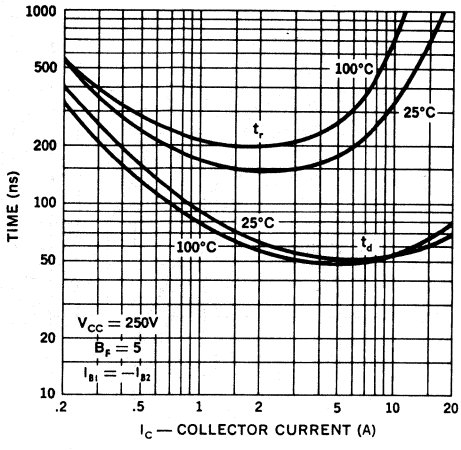
DC Current Gain



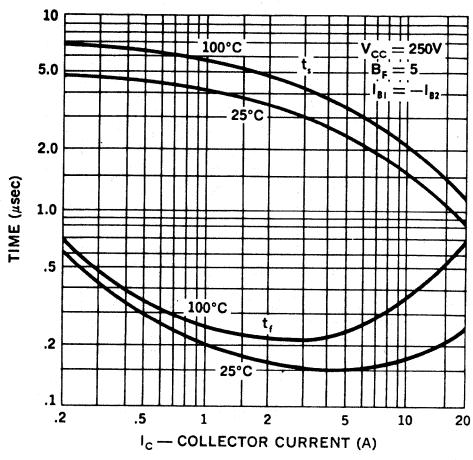
Transient Thermal Response



Resistive Turn-On Time



Resistive Turn-Off Time



Typical Inductive Load Switching Performance

I_C Amps	T_J °C	t_s μS	t_{fv} nS	t_{fi} nS
3	25	.8	.14	.025
	100	1.10	.18	.030
5	25	.90	.14	.025
	100	1.20	.16	.030
10	25	1.20	.05	.050
	100	1.50	.12	.10

TEST CONDITIONS FOR DYNAMIC PERFORMANCE

	$V_{CEO(SUS)}$	$V_{CEX\ (SUS)}$ AND INDUCTIVE SWITCHING	$E_{S/b}$	RESISTIVE SWITCHING
INPUT CONDITIONS	+10V, 20Ω, 0, 1, 2 PW Varied to Attain I_C = 100mA	Drive Circuit: +4V, −4V, PW, 1k, 0.01μF, 20, 100, 0.1μF, 0.5μF, Q1, Q2, Q3, Q4, $+V_{in}$, −5V Set $+V_{in}$ to Obtain a Forced h_{FE} = 5 and Adjust PW to Attain Specified Peak I_C. Duty Cycle ⩽ 3% f = 1kHz Q1 2N6408 Q3 2N5875 Q2 2N6406 Q4 2N5877 Diodes 1N4933	I_{BA} = 2.0A, 15Ω, 38.5V, 10Ω, 4V, 0 PW Varied to Attain I_C	≈ +13V, ≈ −11V, 0, 1, 2 I_C = 10A PW ⩽ 100μs t_r ⩽ 5ns t_f ⩽ 50ns Duty Cycle ⩽ 2%
CIRCUIT VALUES	L_{coil} = 80mH V_{CC} = 10V R_{coil} = 0.7Ω V_{clamp} (Unclamped)	L_{coil} = 180μH R_{coil} = 0.05Ω V_{CC} = 20V f_o = 500kHz V_{clamp} = Rated V_{CEX} Value	L_{coil} = 40μH V_{CC} = 10V R_{coil} = 0.2Ω V_{clamp} (Unclamped)	V_{CC} = 250V R_L = 25Ω D1 = 1N5820 or Equiv. R_B = 6Ω
TEST CIRCUITS	INDUCTIVE TEST CIRCUIT See Above For Detailed Conditions TUT, 1N4937 or Equivalent, Input, R_{coil}, L_{coil}, V_{clamp}, V_{CC}, R_S 0.1Ω	OUTPUT WAVEFORMS I_C, $I_{C(pk)}$, t_f Clamped, t_f Unclamped = t_2, t_1, t_f, t V_{CE}, V_{CE} or V_{clamp}, Time, t_2, t	t_1 Adjusted to Obtain I_C $t_1 \approx \frac{L_{coil}\ (I_{Cpk})}{V_{CC}}$ $t_2 \approx \frac{L_{coil}\ (I_{Cpk})}{V_{clamp}}$ Test Equipment Tektronix Scope 475 or Equivalent	RESISTIVE TEST CIRCUIT R_B, TUT, R_L, V_{CC}, 1, 2, D1, −5V

POWER TRANSISTORS
8A, 400V, NPN Mesa

2N6671
2N6672
2N6673

3

FEATURES
- Collector Emitter Voltage: up to 650V
- Peak Collector Current: 10A
- Storage Time ≤ 2.5μs
- Fall Time ≤ 0.4μs

} at I_C = 5A

DESCRIPTION
These high voltage, multiple layer epitaxial, glass passivated power transistors combine fast switching, low saturation voltage and rugged second-breakdown capability. They are designed for use in off-line power supplies, high voltage inverters and switching regulators.

ABSOLUTE MAXIMUM RATINGS*

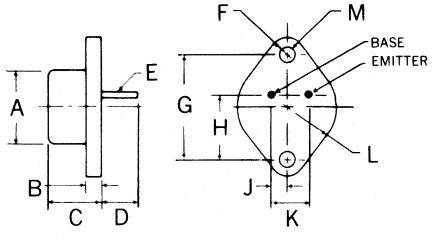
	2N6671	2N6672	2N6673
Collector Emitter Voltage, V_{CEV}	450V	550V	650V
Collector Emitter Voltage, V_{CEX}	350V	400V	450V
Collector Emitter Voltage, $V_{CEO(SUS)}$	300V	350V	400V
Emitter Base Voltage, V_{EBO}		8V	
Collector Current, I_C continuous		8A	
Collector Current, $I_{CM(peak)}$		12A	
Base Current, I_B continuous		4A	
Power Dissipation, up to 25°C		150W	
above 25°C, derate linearly		0.86W/°C	
Operating and Storage Temperature Range		-65°C to +200°C	

*JEDEC registered values.

MECHANICAL SPECIFICATIONS

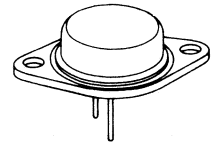
NOTE:
Leads may be soldered to within 1/16" of base provided temperature-time exposure is less than 260°C for 10 seconds.

2N6671 2N6672 2N6673



	INCHES	MILLIMETERS
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.043 DIA.	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-.17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA (TO-3)



ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

TEST	SYMBOL	2N6671		2N6672		2N6673		UNITS	TEST CONDITIONS
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
Collector Cutoff Current	I_{CEV}	—	0.1	—	—	—	—	mA	V_{CE} = 450V, V_{BE} = −1.5V
		—	—	—	0.1	—	—	mA	V_{CE} = 550V, V_{BE} = −1.5V
		—	—	—	—	—	0.1	mA	V_{CE} = 650V, V_{BE} = −1.5V
Collector Cutoff Current T_C =125°C	I_{CEV}	—	1	—	—	—	—	mA	V_{CE} = 450V, V_{BE} = −1.5V
		—	—	—	1	—	—	mA	V_{CE} = 550V, V_{BE} = −1.5V
		—	—	—	—	—	1	mA	V_{CE} = 650V, V_{BE} = −1.5V
Emitter Base Cutoff Current	I_{EBO}	—	2	—	2	—	2	mA	V_{BE} = −8V, I_C = 0
Collector Emitter Sustaining Voltage (Notes 1 & 2)	$V_{CEO(sus)}$	300	—	350	—	400	—	V	I_C = 0.2A, I_B =0
DC Current Gain (Note 1)	h_{FE}	10	40	10	40	10	40		I_C = 5A, V_{CE} = 3V
Base Saturation Voltage (Note 1)	$V_{BE(sat)}$	—	1.6	—	1.6	—	1.6	V	I_C = 5A, I_B = 1A
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	1	—	1	—	1	V	I_C = 5A, I_B = 1A
Collector Saturation Voltage T_C = 125°C (Note 1)	$V_{CE(sat)}$	—	2	—	2	—	2	V	I_C = 5A, I_B = 1A
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	2	—	2	—	2	V	I_C = 8A, I_B = 4A
Collector Emitter Voltage (Note 2)	V_{CEX}	350	—	400	—	450	—	V	L = 170μH, R_{BB} = 5Ω V_{BE} = −5V I_C = 5A, I_B = 1A
		200	—	250	—	300	—	V	L = 170μH, R_{BB} = 5Ω V_{BE} = −5V I_C = 8A, I_B = 3A
AC Current Gain	$\|h_{fe}\|$	3	12	3	12	3	12		I_C = 0.2A V_{CE} = 10V f =5MHz
Gain-Bandwidth Product	f_T	15	60	15	60	15	60	MHz	V_{CE} = 10V, I_C = 0.2A
Output Capacitance Common Base	C_{obo}	50	300	50	300	50	300	pF	V_{CB} = 10V, f = 0.1MHz
Switching Speeds									
Delay Time	t_d	—	0.1	—	0.1	—	0.1	μs	I_C = 5A, I_B = 1A V_{CC} = 125V t_p = 20μs
Rise Time	t_r	—	0.5	—	0.5	—	0.5		
Storage Time	t_s	—	2.5	—	2.5	—	2.5	μs	I_C = 5A, $-I_B$ = 1A V_{CC} = 125V t_p = 20μs
Fall Time	t_f	—	0.4	—	0.4	—	0.4		
Crossover Time	t_c	—	0.4	—	0.4	—	0.4	μs	I_C = 5A, I_{B2} = 1A V_{CC} = 125V L_C = 170μH, R_C = 25Ω Collector clamped to V_{CEX}
Switching Speeds T_C = 125°C									
Rise Time	t_r	—	0.8	—	0.8	—	0.8	μs	I_C = 5A, I_B = 1A V_{CC} = 125V t_p = 20μs
Storage Time	t_s	—	4	—	4	—	4	μs	I_C = 5A, $-I_B$ = 1A V_{CC} = 125V t_p = 20μs
Fall Time	t_f	—	0.8	—	0.8	—	0.8		
Crossover Time	t_c	—	0.8	—	0.8	—	0.8	μs	I_C = 5A, I_{B2} = 1A V_{CC} = 125V L = 170μH, R_C = 25Ω Collector clamped to V_{CEX}
Thermal Resistance, Junction to Case	$R_{\theta JC}$	—	1.17	—	1.17	—	1.17	°C/W	

*JEDEC registered values.

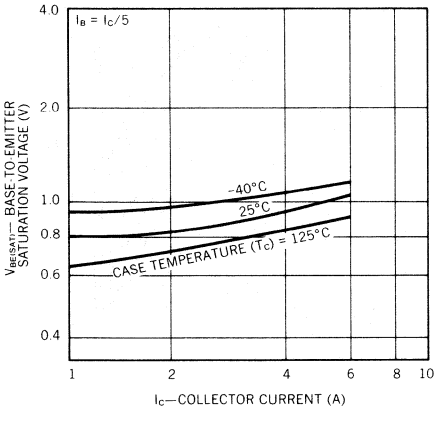
Notes: 1. Pulse duration = 300μs; duty factor ≤ 2%

2. CAUTION: The sustaining voltage $V_{CEO(sus)}$ and V_{CEX} must not be measured on a curve tracer.

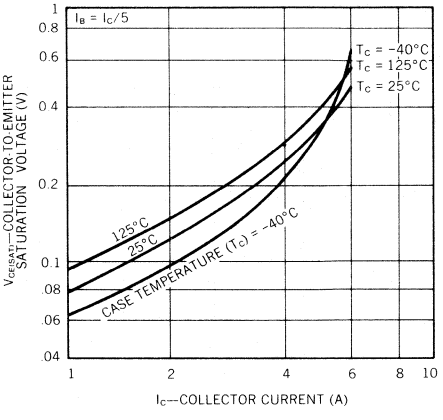
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

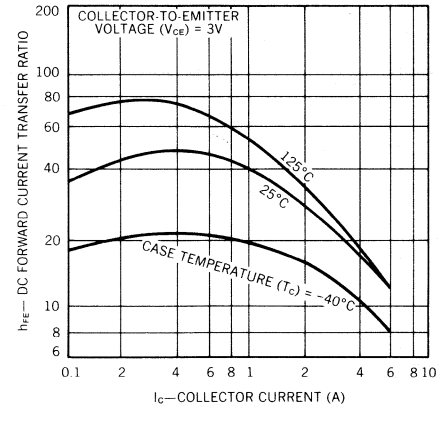
Typical Base-to-Emitter Saturation Voltage as a Function of Collector Current



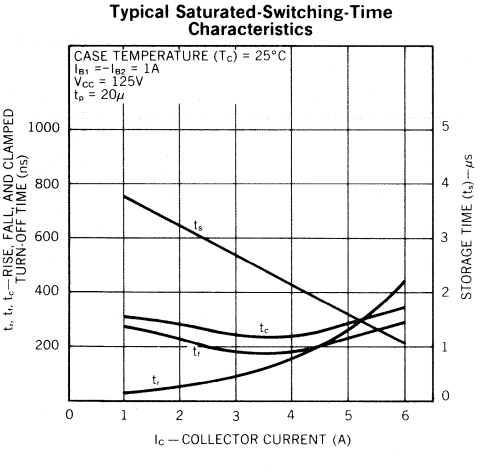
Typical Collector-to-Emitter Saturation Voltage as a Function of Collector Current



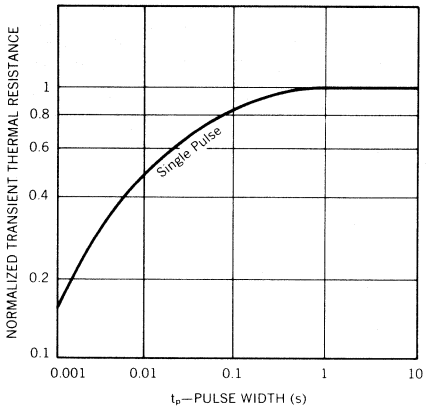
Typical dc beta Characteristics



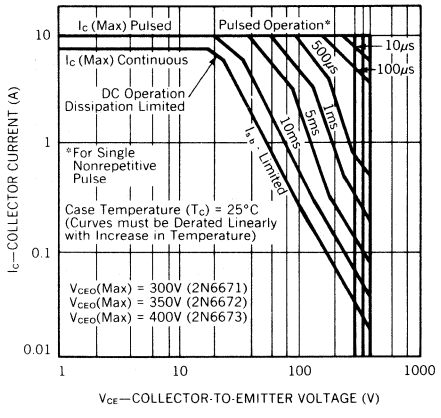
Typical Saturated-Switching-Time Characteristics



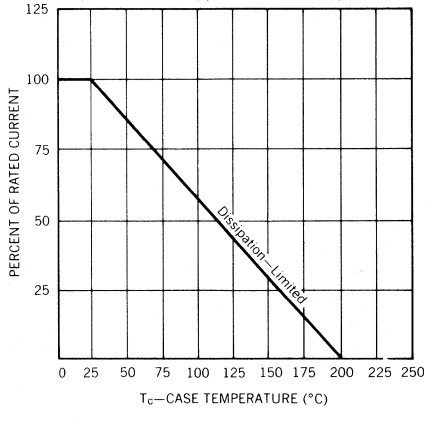
Typical Thermal-Response Characteristics (Normalized)



Maximum Operating Areas (T_C = 25°C)



Dissipation and $I_{S/B}$ Derating Curves



POWER TRANSISTORS
10A, 400V NPN Mesa

2N6674
2N6675

3

FEATURES
- Collector Emitter Voltage: up to 650V
- Peak Collector Current: 20A
- Storage Time ≤ 2.5μs
- Fall Time ≤ 0.5μs

} at I_C = 10A

DESCRIPTION
These high voltage, multiple layer epitaxial, glass passivated power transistors combine fast switching, low saturation voltage and rugged second-breakdown capability. They are designed for use in off-line power supplies, high voltage inverters and switching regulators.

ABSOLUTE MAXIMUM RATINGS*

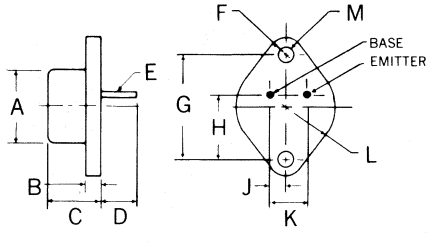
	2N6674	2N6675
Collector Emitter Voltage, V_{CEV}	450V	650V
Collector Emitter Voltage, V_{CEX}	350V	450V
Collector Emitter Voltage, $V_{CEO(sus)}$	300V	400V
Emitter Base Voltage, V_{EBO}	7V	
Collector Current, I_C continuous	15A	
Collector Current, $I_{CM(peak)}$	20A	
Base Current, I_B continuous	5A	
Power Dissipation, up to 25°C	175W	
above 25°C, derate linearly	1W/°C	
Operating and Storage Temperature Range	−65°C to +200°C	

*JEDEC registered values.

MECHANICAL SPECIFICATIONS

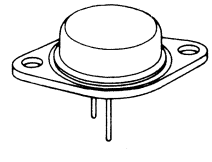
NOTE:
Leads may be soldered to within 1/16" of base provided temperature-time exposure is less than 260°C for 10 seconds.

2N6674 2N6675



	INCHES	MILLIMETERS
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.043 DIA.	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-.17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA (TO-3)



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

TEST	SYMBOL	2N6674		2N6675		UNITS	TEST CONDITIONS
		MIN.	MAX.	MIN.	MAX.		
Collector Cutoff Current	I_{CEV}	—	0.1			mA	V_{CE} = 450V, V_{BE} = −1.5V
				—	0.1	mA	V_{CE} = 650V, V_{BE} =−1.5V
Collector Cutoff Current T_C = 100°C	I_{CEV}	—	1	—	—	mA	V_{CE} = 450V, V_{BE} = −1.5V
		—	—	—	1	mA	V_{CE} = 650V, V_{BE} = −1.5V
Emitter Base Cutoff Current	I_{EBO}	—	2	—	2	mA	V_{BE} = −7V, I_C = 0
Collector Emitter Sustaining Voltage (Notes 1 & 2)	$V_{CEO(sus)}$	300	—	400	—	V	I_C = 0.2A, I_B =0
DC Current Gain (Note 1)	h_{FE}	8	20	8	20		I_C = 10A, V_{CE} = 2V
Base Saturation Voltage (Note 1)	$V_{BE(sat)}$	—	1.5	—	1.5	V	I_C = 10A, V_{CE} = 2A
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	1	—	1	V	I_C = 10A, I_B = 2A
Collector Saturation Voltage T_C = 100°C (Note 1)	$V_{CE(sat)}$	—	2	—	2	V	I_C = 10A, I_B = 2A
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	5	—	5	V	I_C = 15A, I_B = 5A
Collector Emitter Voltage (Note 2)	V_{CEX}	350	—	450	—	V	L = 50μH, R_{BB} = 2Ω V_{BE} = −4V, V_{CE} is clamped I_C = 10A, I_B = 2A
AC Current Gain	$\|h_{fe}\|$	3	10	3	10		I_C = 1A V_{CE} = 10V f =5MHz
Gain-Bandwidth Product	f_T	15	50	15	50	MHz	V_{CE} = 10V, I_C = 1A
Output Capacitance Common Base	C_{obo}	150	500	150	500	pF	V_{CB} = 10A, f = 0.1MHz
Switching Speeds Delay Time	t_d	—	0.1	—	0.1	μs	I_C = 10A, I_B = 2A V_{CC} = 125V, V_{BE} = −6V t_p = 20μs
Rise Time	t_r	—	0.6	—	0.6		
Storage Time	t_s	—	2.5	—	2.5	μs	I_C = 10A, $-I_B$ = 2A V_{CC} = 125V, V_{BE} = −6V t_p = 20μs
Fall Time	t_f	—	0.5	—	0.5		
Crossover Time	t_c	—	0.5	—	0.5	μs	I_C = 10A, I_{B2} = 2A V_{CC} = 135V, V_{BE} = −6V L_C = 50μH, $R_C \leq$ 13.5Ω Collector clamped to V_{CEX}
Switching Speeds T_C = 100°C Rise Time	t_r	—	1	—	1	μs	I_C = 10A, I_B = 2A V_{CC} = 125V, V_{BE} = −6V t_p = 20μs
Storage Time	t_s	—	4	—	4	μs	I_C = 10A, $-I_B$ = 2A V_{CC} = 125V, V_{BE} = −6V t_p = 20μs
Fall Time	t_f	—	1	—	1		
Crossover Time	t_c	—	0.8	—	0.8	μs	I_C = 10A, I_{B2} = 2A V_{CC} = 135V, V_{BE} = −6V L = 50μH, $R_C \leq$ 13.5Ω Collector clamped to V_{CEX}
Thermal Resistance, Junction to Case	$R_{\theta JC}$	—	1	—	1	°C/W	

*JEDEC registered values.

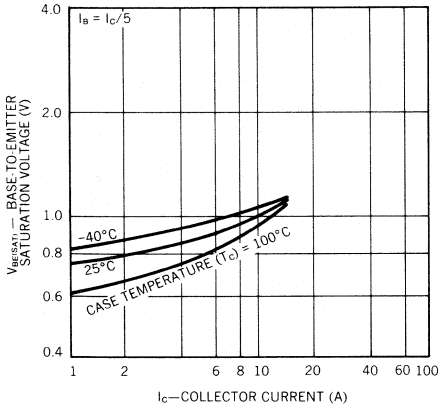
Notes: 1. Pulse duration = 300μs; duty factor ≤ 2%

2. CAUTION: The sustaining voltage $V_{CEO(sus)}$ and V_{CEX} must not be measured on a curve tracer.

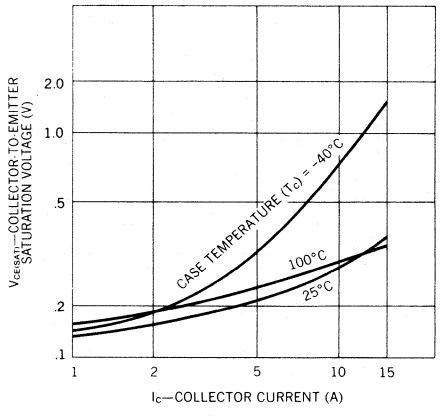
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

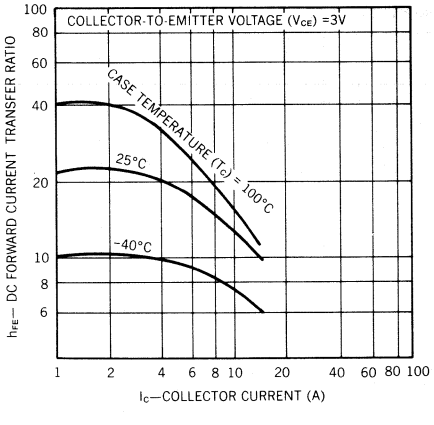
Typical Base-to-Emitter Saturation Voltage as a Function of Collector Current



Typical Collector-to-Emitter Saturation Voltage Characteristics



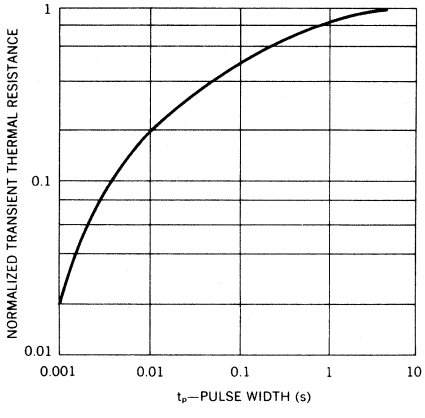
Typical dc beta Characteristics



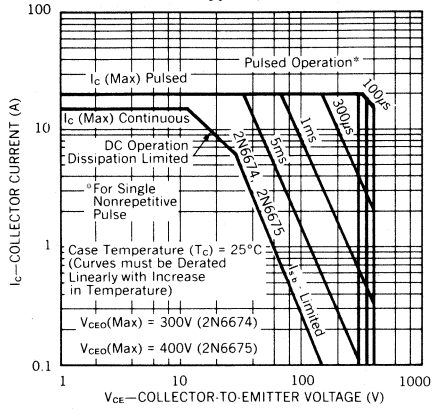
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

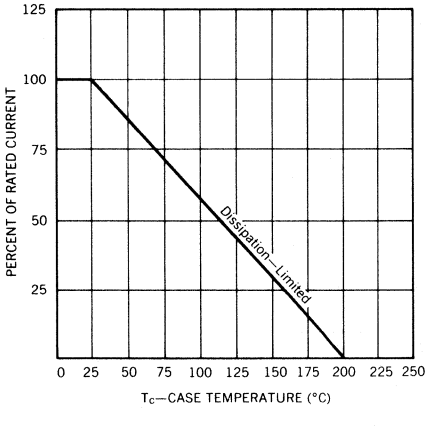
Typical Thermal-Response Characteristics (Normalized)



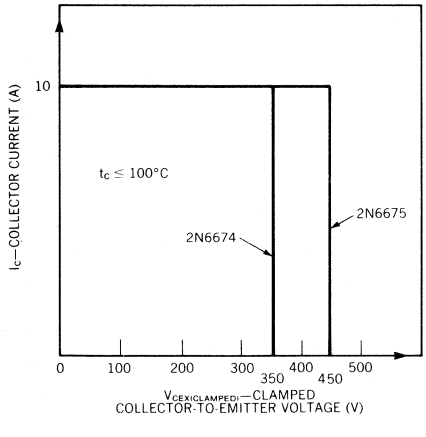
Maximum Operating Areas For All Types (T_C = 25°C)



Dissipation and $I_{s/b}$ Derating Curves



Maximum Operating Conditions for Switching Between Saturation and Cutoff



POWER TRANSISTORS
15A, 400V NPN Mesa

2N6676
2N6677
2N6678

3

FEATURES
- Collector Emitter Voltage: up to 650V
- Peak Collector Current: 20A
- Storage Time ≤ 2.5μs
- Fall Time ≤ 0.5μs

} at I_C = 15A

DESCRIPTION
These high voltage, multiple layer epitaxial, glass passivated power transistors combine fast switching, low saturation voltage and rugged second-breakdown capability. They are designed for use in off-line power supplies, high voltage inverters and switching regulators.

ABSOLUTE MAXIMUM RATINGS*

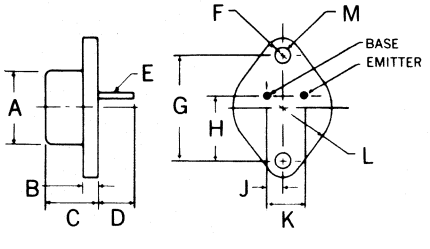
	2N6676	2N6677	2N6678
Collector Emitter Voltage, V_{CEV}	450V	550V	650V
Collector Emitter Voltage, V_{CEX}	350V	400V	450V
Collector Emitter Voltage, $V_{CEO(sus)}$	300V	350V	400V
Emitter Base Voltage, V_{EBO}	8V		
Collector Current, I_C continuous	15A		
Collector Current, $I_{CM(peak)}$	20A		
Base Current, I_B continuous	5A		
Power Dissipation, up to 25°C	175W		
above 25°C, derate linearly	1W/°C		
Operating and Storage Temperature Range	-65°C to +200°C		

*JEDEC registered values.

MECHANICAL SPECIFICATIONS

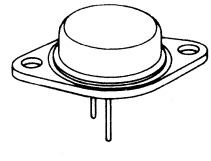
NOTE:
Leads may be soldered to within 1/16" of base provided temperature-time exposure is less than 260°C for 10 seconds.

2N6676 2N6677 2N6678



	INCHES	MILLIMETERS
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.043 DIA.	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-.17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA (TO-3)



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)*

TEST	SYMBOL	2N6676		2N6677		2N6678		UNITS	TEST CONDITIONS
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
Collector Cutoff Current	I_{CEV}	—	0.1	—	—	—	—	mA	V_{CE} = 450V, V_{BE} = −1.5V
		—	—	—	0.1	—	—	mA	V_{CE} = 550V, V_{BE} = −1.5V
		—	—	—	—	—	0.1	mA	V_{CE} = 650V, V_{BE} = −1.5V
Collector Cutoff Current T_C =100°C	I_{CEV}	—	1	—	—	—	—	mA	V_{CE} = 450V, V_{BE} = −1.5V
		—	—	—	1	—	—	mA	V_{CE} = 550V, V_{BE} = −1.5V
		—	—	—	—	—	1	mA	V_{CE} = 650V, V_{BE} = −1.5V
Emitter Base Cutoff Current	I_{EBO}	—	2	—	2	—	2	mA	V_{BE} = −8V, I_C = 0
Collector Emitter Sustaining Voltage (Notes 1 & 2)	$V_{CEO(sus)}$	300	—	350	—	400	—	V	I_C = 0.2A, I_B =0
DC Current Gain (Note 1)	h_{FE}	8	—	8	—	8	—		I_C = 15A, V_{CE} = 3V
Base Saturation Voltage (Note 1)	$V_{BE(sat)}$	—	1.5	—	1.5	—	1.5	V	I_C = 15A, I_B = 3A
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	1	—	1	—	1	V	I_C = 15A, I_B = 3A
Collector Saturation Voltage T_C = 100°C	$V_{CE(sat)}$	—	2	—	2	—	2	V	I_C = 15A, I_B = 3A
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	1.5	—	1.5	—	1.5	V	I_C = 15A, I_B = 3A
Collector Emitter Voltage (Note 2)	V_{CEX}	350	—	400	—	450	—	V	L = 50μH, R_{BB} = 2Ω V_{BE} = −6V, V_{CE} is clamped I_C = 15A, I_B = 3A
AC Current Gain	$\|h_{fe}\|$	3	10	3	10	3	10		I_C = 1A V_{CE} = 10V f =5MHz
Gain-Bandwidth Product	f_T	15	50	15	50	15	50	MHz	V_{CE} = 10V, I_C = 1A
Output Capacitance Common Base	C_{obo}	150	500	150	500	150	500	pF	V_{CB} = 10V, f = 0.1MHz
Switching Speeds									
Delay Time	t_d	—	0.1	—	0.1	—	0.1	μs	I_C = 15A, I_B = 3A V_{CC} = 200V, $-V_{BE}$ = −6V t_p = 20μs
Rise Time	t_r	—	0.6	—	0.6	—	0.6		
Storage Time	t_s	—	2.5	—	2.5	—	2.5	μs	I_C = 15A, $-I_{B2}$ = 3A V_{CC} = 200V, $-V_{BE}$ = −6V t_p = 20μs
Fall Time	t_f	—	0.5	—	0.5	—	0.5		
Crossover Time	t_c	—	0.5	—	0.5	—	0.5	μs	I_C = 15A, I_B = 3A V_{CC} = 200V, V_{BE} = −6V L = 50μH, $R_C \leq$ 13.50Ω Collector clamped to V_{CEX}
Switching Speeds T_C = 100°C Rise Time	t_r	—	1	—	1	—	1	μs	I_C = 15A, I_B = 3A V_{CC} = 200V, V_{BE} = −6V L = 50μH, $R_C \leq$ 13.5Ω Collector Clamped to V_{CEX}
Storage Time	t_s	—	4	—	4	—	4	μs	I_C = 15A, $-I_{B2}$ = 3A V_{CC} = 200V, V_{BE} =−6V L = 50μH, $R_C \leq$ 13.5Ω Collector clamped to V_{CEX}
Fall Time	t_f	—	1	—	1	—	1		
Crossover Time	t_c	—	0.8	—	0.8	—	0.8	μs	I_C = 15A, I_B = 3A V_{CC} = 200V, V_{BE} = −6V L = 50μH, $R_C \leq$ 13.5Ω Collector clamped to V_{CEX}
Thermal Resistance, Junction to Case	$R_{\theta JC}$	—	1	—	1	—	1	°C/W	

*JEDEC registered values

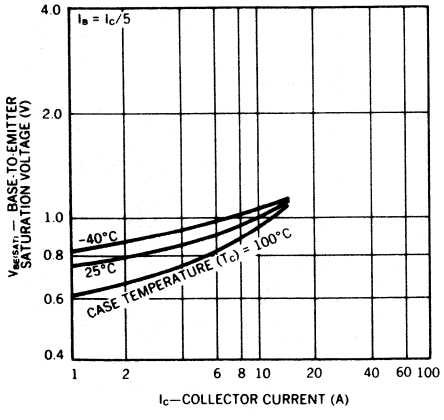
Notes: 1. Pulse duration = 300μs; duty factor ≤ 2%

2. CAUTION: The sustaining voltage $V_{CEO(sus)}$ and V_{CEX} must not be measured on a curve tracer.

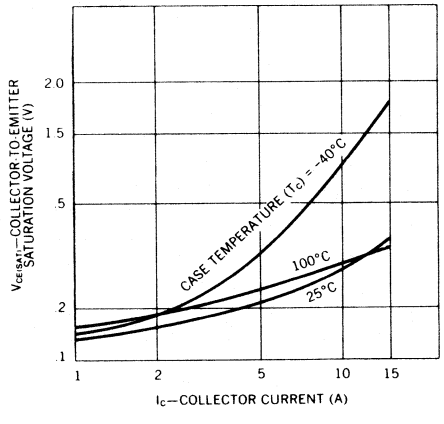
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

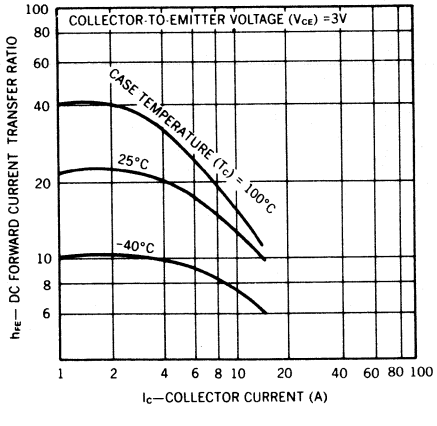
Typical Base-to-Emitter Saturation Voltage as a Function of Collector Current



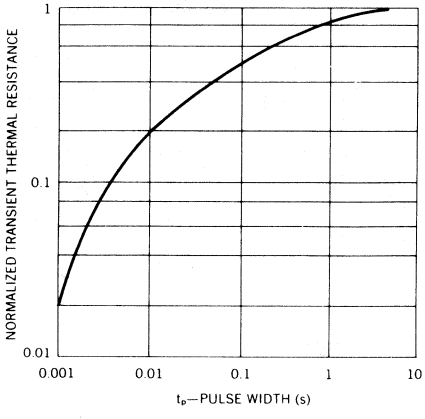
Typical Collector-to-Emitter Saturation Voltage Characteristics



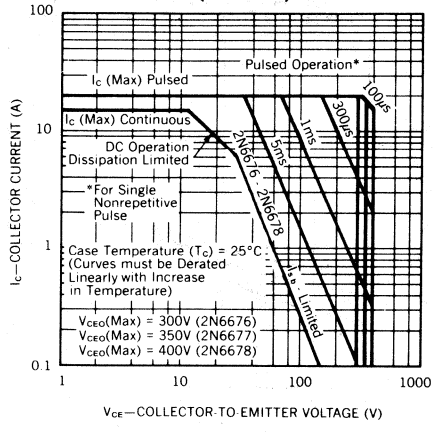
Typical dc beta Characteristics



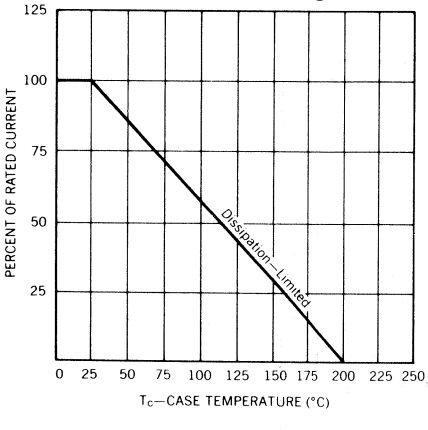
Typical Thermal-Response Characteristics (Normalized)



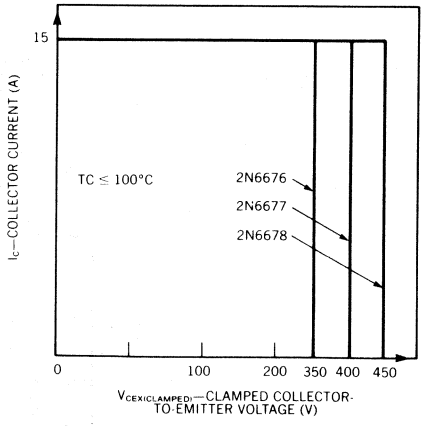
Maximum Operating Areas (T_C = 25°C)



Dissipation and $I_{s/b}$ Derating Curves



Maximum Operating Conditions For Switching Between Saturation and Cutoff



POWER MOSFET TRANSISTORS

2N6755
J, JTX, JTXV 2N6756

100 Volt, 0.18 Ohm N-Channel

3

FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability
- Qualified to MIL-S-19500/542A

DESCRIPTION

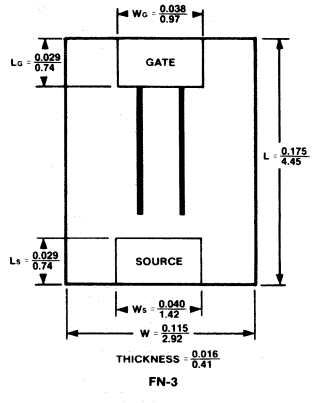
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

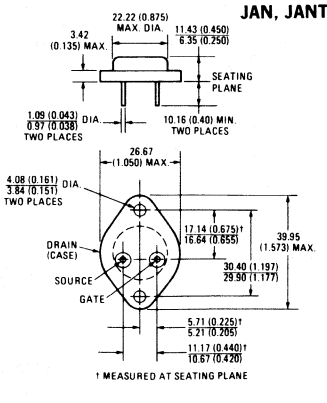
Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6755	60V	0.25Ω	12A
2N6756	100V	0.18Ω	14A



FN-3

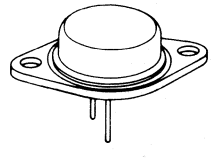
MECHANICAL SPECIFICATIONS

2N6755
JAN, JANTX, & JANTXV 2N6756



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

ABSOLUTE MAXIMUM RATINGS

Parameter		2N6755	2N6756	Units
V_{DS}	Drain – Source Voltage	60*	100*	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ)	60*	100*	V
I_D @ T_C = 25°C	Continuous Drain Current	12*	14*	A
I_D @ T_C = 100°C	Continuous Drain Current	8.0*	9.0*	A
I_{DM}	Pulsed Drain Current	25	30	A
V_{GS}	Gate – Source Voltage	±20*		V
P_D @ T_C = 25°C	Max. Power Dissipation	75* (See Fig. 11)		W
P_D @ T_C = 100°C	Max. Power Dissipation	30* (See Fig. 11)		W
	Linear Derating Factor	0.6* (See Fig. 11)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 1 and 2) L = 100 μH 25 | 30		A
T_J T_{stg}	Operating and Storage Temperature Range	-55* to 150*		°C
	Lead Temperature	300* (0.063 in. (1.6mm) from case for 10s)		°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	2N6755	60	–	–	V	V_{GS} = 0
		2N6756	100	–	–	V	I_D = 1.0 mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	–	4.0*	V	V_{DS} = V_{GS}, I_D = 1 mA
I_{GSSF}	Gate – Body Leakage Forward	ALL	–	–	100*	nA	V_{GS} = 20V
I_{GSSR}	Gate – Body Leakage Reverse	ALL	–	–	100*	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	0.1	1.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0
			–	0.2	4.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0, T_C = 125°C
$V_{DS(on)}$	Static Drain-Source On-State Voltage ①	2N6755	–	–	3.0*	V	V_{GS} = 10V, I_D = 12A
		2N6756	–	–	2.52*	V	V_{GS} = 10V, I_D = 14A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6755	–	0.20	0.25*	Ω	V_{GS} = 10V, I_D = 8A
		2N6756	–	0.14	0.18*	Ω	V_{GS} = 10V, I_D = 9A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6755	–	–	0.45*	Ω	V_{GS} = 10V, I_D = 8A, T_C = 125°C
		2N6756	–	–	0.33*	Ω	V_{GS} = 10V, I_D = 9A, T_C = 125°C
g_{fs}	Forward Transconductance ①	ALL	4.0*	5.5	12.0*	S (℧)	V_{DS} = 15V, I_D = 9A
C_{iss}	Input Capacitance	ALL	350*	600	800*	pF	V_{GS} = 0, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	150*	300	500*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	50*	100	150*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	30*	ns	V_{DD} ≅ 36V, I_D = 9A, Z_o = 15Ω (See Figs. 13 and 14) (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	75*	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	40*	ns	
t_f	Fall Time	ALL	–	–	45*	ns	

THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.67*	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

BODY-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	2N6755	–	–	12*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		2N6756	–	–	14*		
I_{SM}	Pulsed Source Current (Body Diode)	2N6755	–	–	25	A	
		2N6756	–	–	30		
V_{SD}	Diode Forward Voltage ①	2N6755	0.85*	–	1.7*	V	T_C = 25°C, I_S = 12A, V_{GS} = 0
		2N6756	0.90*	–	1.8*	V	T_C = 25°C, I_S = 14A, V_{GS} = 0
t_{rr}	Reverse Recovery Time	ALL	–	300	–	ns	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	4.0	–	μC	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs

*JEDEC registered values. ① Pulse Test: Pulse Width ≤ 300 μsec, Duty Cycle ≤ 2%

Fig. 1 – Clamped Inductive Test Circuit

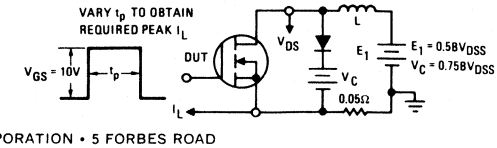
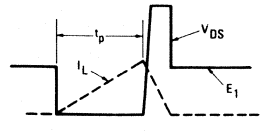


Fig. 2 – Clamped Inductive Waveforms



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 3 — Typical Output Characteristics

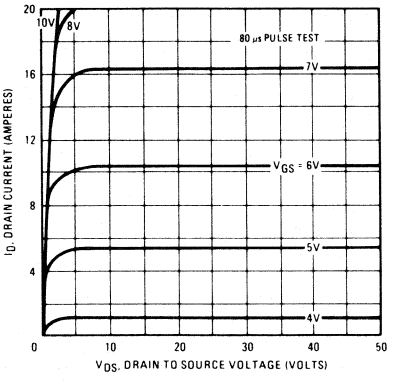


Fig. 4 — Typical Transfer Characteristics

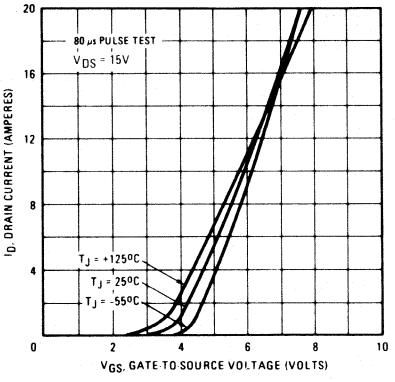


Fig. 5— Typical Saturation Characteristics (2N6755)

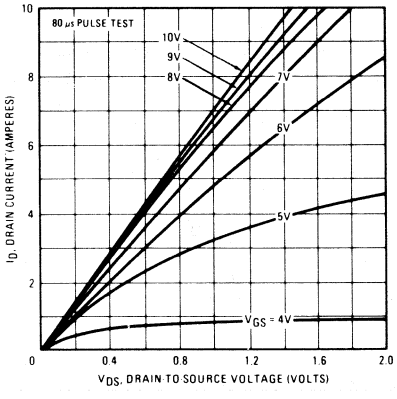


Fig. 6— Typical Saturation Characteristics (2N6756)

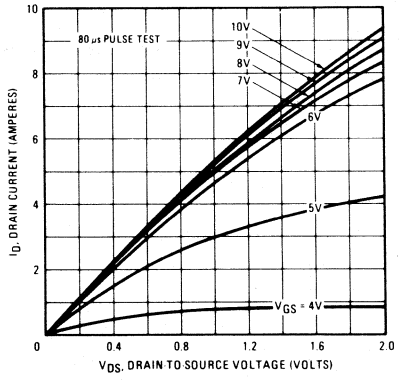


Fig. 7 — Typical Transconductance Vs. Drain Current

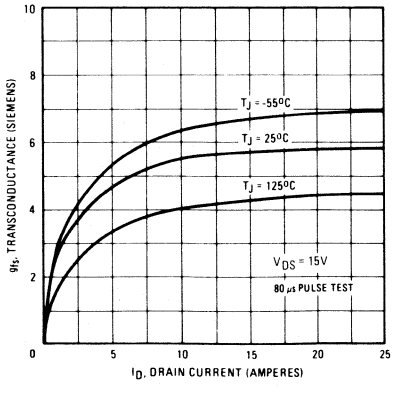


Fig. 8 — Maximum Safe Operating Area

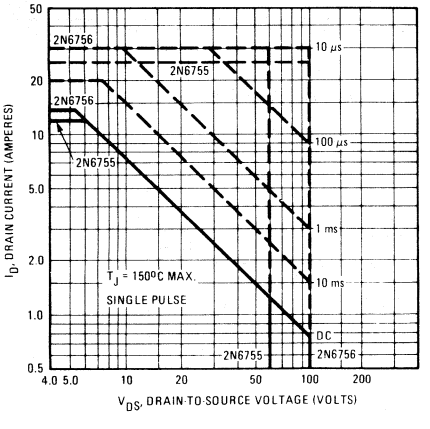


Fig. 9 — Normalized Typical On-Resistance Vs. Temperature

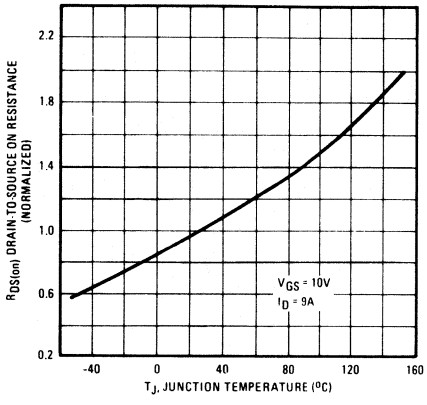


Fig. 10 — Typical Capacitance Vs. Drain-to-Source Voltage

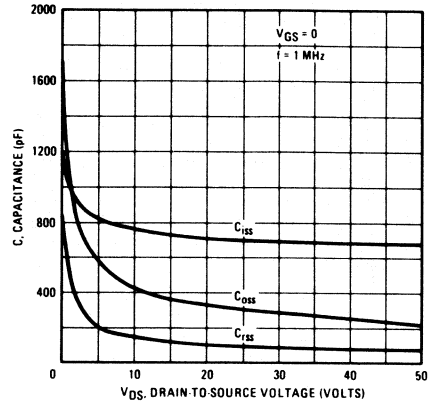


Fig. 11 — Power Vs. Temperature Derating Curve

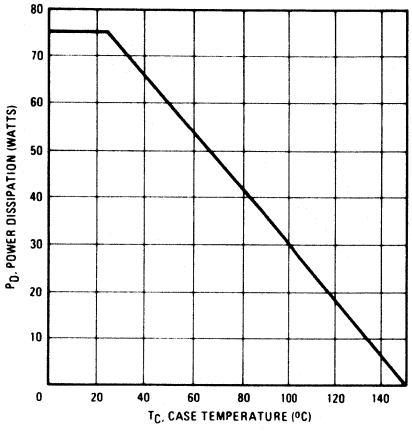


Fig. 12 — Typical Body-Drain Diode Forward Voltage

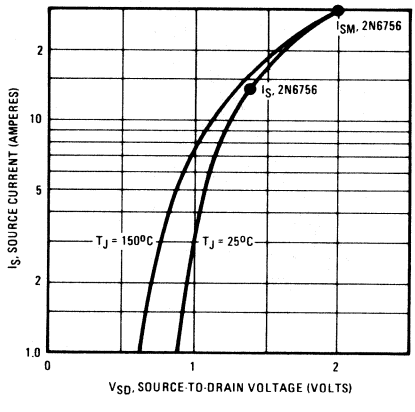


Fig. 13 — Switching Time Test Circuit

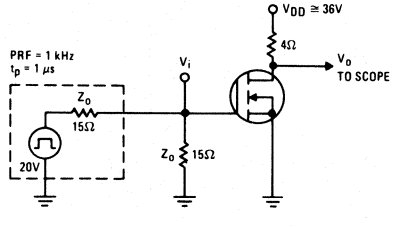
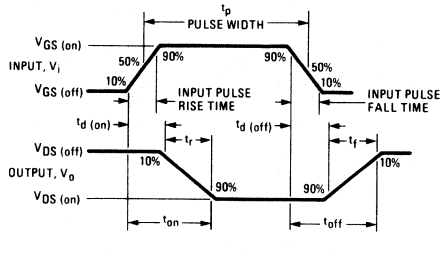


Fig. 14 — Switching Time Waveforms



POWER MOSFET TRANSISTORS

2N6757
J, JTX, JTXV 2N6758

200 Volt, 0.4 Ohm N-Channel

3

FEATURES

- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability
- Qualified to MIL-S-19500/542A

DESCRIPTION

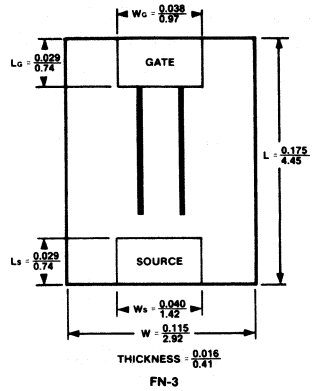
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

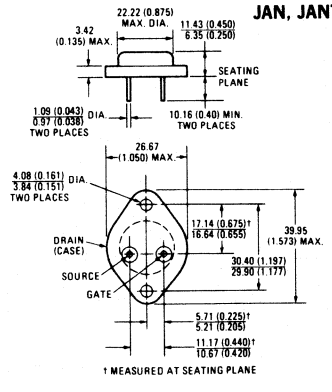
PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6757	150V	0.6Ω	8A
2N6758	200V	0.4Ω	9A



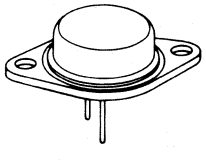
MECHANICAL SPECIFICATIONS

2N6757
JAN, JANTX, & JANTXV 2N6758



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



ABSOLUTE MAXIMUM RATINGS

Parameter		2N6757	2N6758	Units
V_{DS}	Drain – Source Voltage	150*	200*	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ)	150*	200*	V
I_D @ T_C = 25°C	Continuous Drain Current	8.0*	9.0*	A
I_D @ T_C = 100°C	Continuous Drain Current	5.0*	6.0*	A
I_{DM}	Pulsed Drain Current	12	15	A
V_{GS}	Gate – Source Voltage	±20*		V
P_D @ T_C = 25°C	Max. Power Dissipation	75* (See Fig. 11)		W
P_D @ T_C = 100°C	Max. Power Dissipation	30* (See Fig. 11)		W
	Linear Derating Factor	0.6* (See Fig. 11)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 1 and 2) L = 100 μH 12 | 15		A
T_J T_{stg}	Operating and Storage Temperature Range	-55* to 150*		°C
	Lead Temperature	300* (0.063 in. (1.6mm) from case for 10s)		°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	2N6757	150	–	–	V	V_{GS} = 0
		2N6758	200	–	–	V	I_D = 1.0 mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	–	4.0*	V	V_{DS} = V_{GS}, I_D = 1 mA
I_{GSSF}	Gate – Body Leakage Forward	ALL	–	–	100*	nA	V_{GS} = 20V
I_{GSSR}	Gate – Body Leakage Reverse	ALL	–	–	100*	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	0.1	1.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0
			–	0.2	4.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0, T_C = 125°C
$V_{DS(on)}$	Static Drain-Source On-State Voltage ①	2N6757	–	–	4.8*	V	V_{GS} = 10V, I_D = 8A
		2N6758	–	–	3.6*	V	V_{GS} = 10V, I_D = 9A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6757	–	0.4	0.6*	Ω	V_{GS} = 10V, I_D = 5A
		2N6758	–	0.25	0.4*	Ω	V_{GS} = 10V, I_D = 6A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6757	–	–	1.13*	Ω	V_{GS} = 10V, I_D = 5A, T_C = 125°C
		2N6758	–	–	0.75*	Ω	V_{GS} = 10V, I_D = 6A, T_C = 125°C
g_{fs}	Forward Transconductance ①	ALL	3.0*	5.0	9.0*	S (℧)	V_{DS} = 15V, I_D = 6A
C_{iss}	Input Capacitance	ALL	350*	600	800*	pF	V_{GS} = 0, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	100*	250	450*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	40*	80	150*	pF	
$t_{d\ (on)}$	Turn-On Delay Time	ALL	–	–	30*	ns	$V_{DD} \cong$ 90V, I_D = 6A, Z_o = 15Ω (See Figs. 13 and 14) (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	50*	ns	
$t_{d\ (off)}$	Turn-Off Delay Time	ALL	–	–	50*	ns	
t_f	Fall Time	ALL	–	–	40*	ns	

THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.67*	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

BODY-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	2N6757	–	–	8.0*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		2N6758	–	–	9.0*		
I_{SM}	Pulsed Source Current (Body Diode)	2N6757	–	–	12	A	
		2N6758	–	–	15		
V_{SD}	Diode Forward Voltage ①	2N6757	0.75*	–	1.50*	V	T_C = 25°C, I_S = 8A, V_{GS} = 0
		2N6758	0.80*	–	1.60*	V	T_C = 25°C, I_S = 9A, V_{GS} = 0
t_{rr}	Reverse Recovery Time	ALL	–	650	–	ns	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	10	–	μC	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs

*JEDEC registered values. ① Pulse Test: Pulse Width ≤ 300 μsec, Duty Cycle ≤ 2%

Fig. 1 – Clamped Inductive Test Circuit

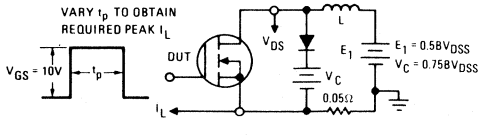
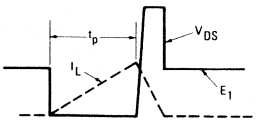


Fig. 2 – Clamped Inductive Waveforms



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 3 – Typical Output Characteristics

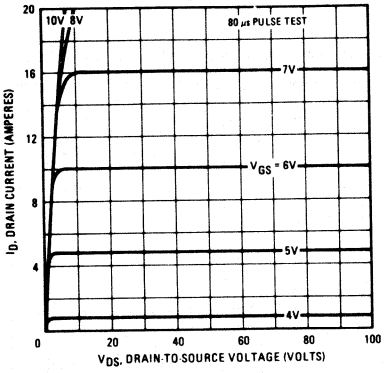


Fig. 4 – Typical Transfer Characteristics

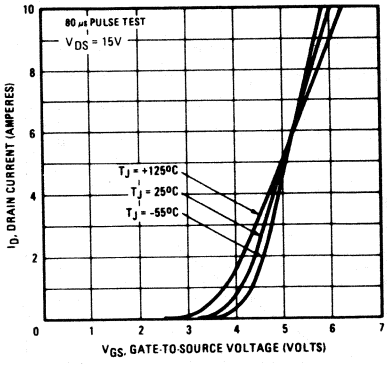


Fig. 5– Typical Saturation Characteristics (2N6757)

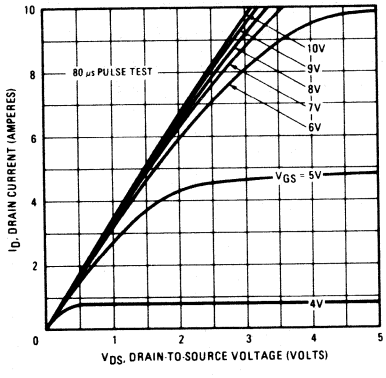


Fig. 6– Typical Saturation Characteristics (2N6758)

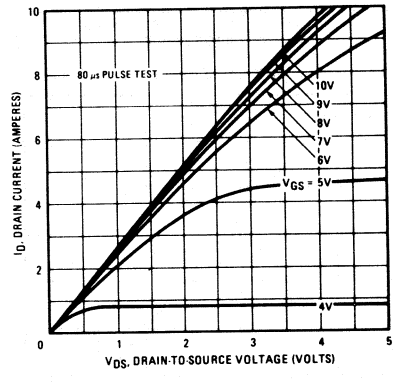


Fig. 7 – Typical Transconductance Vs. Drain Current

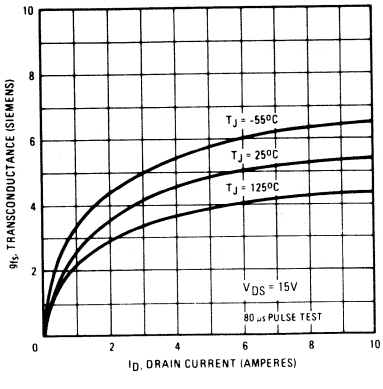


Fig. 8 – Maximum Safe Operating Area

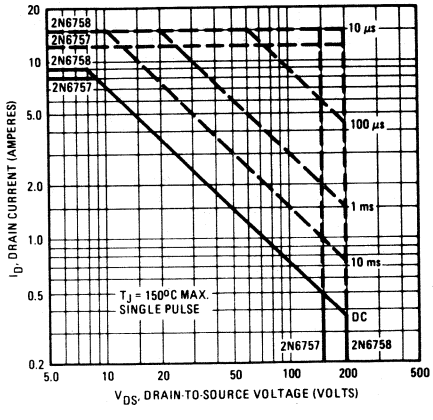


Fig. 9 — Normalized Typical On-Resistance Vs. Temperature

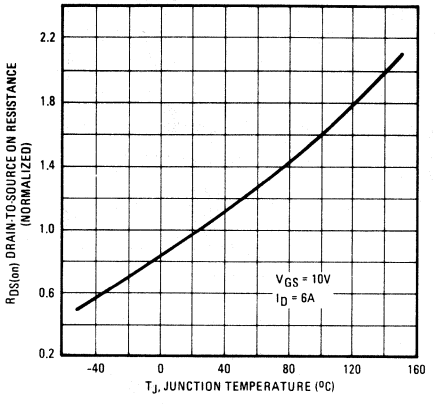


Fig. 10 — Typical Capacitance Vs. Drain-to-Source Voltage

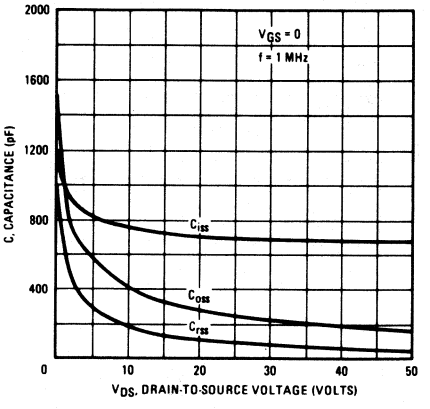


Fig. 11 — Power Vs. Temperature Derating Curve

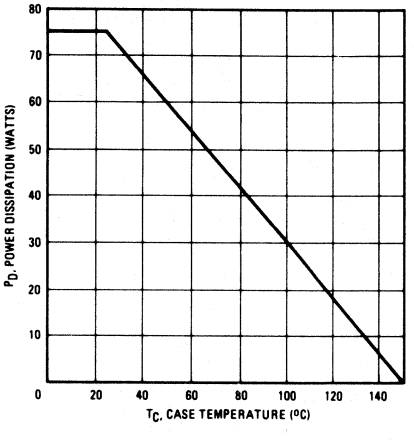


Fig. 12 — Typical Body-Drain Diode Forward Voltage

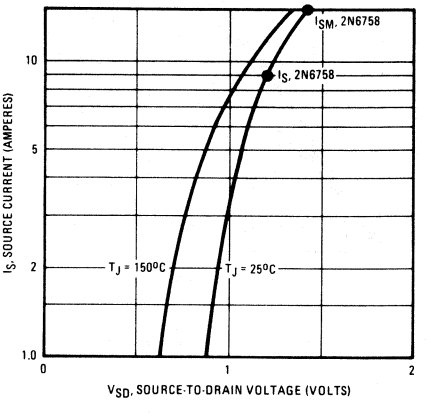


Fig. 13 — Switching Time Test Circuit

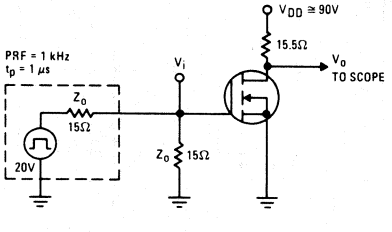
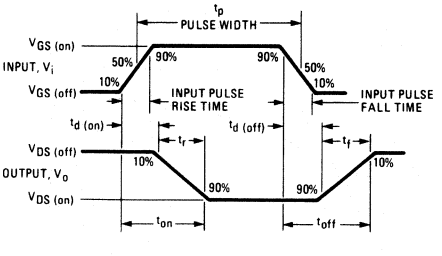


Fig. 14 — Switching Time Waveforms



POWER MOSFET TRANSISTORS

2N6759
J, JTX, JTXV 2N6760

400 Volt, 1.0 Ohm
N-Channel

3

FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability
- Qualified to MIL-S-19500/542A

DESCRIPTION

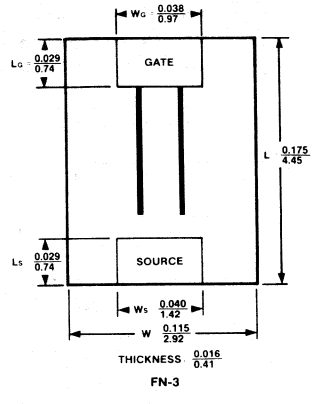
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

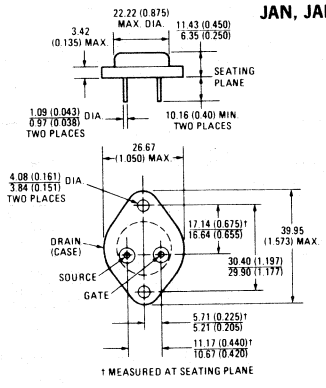
Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6759	350V	1.5Ω	4.5A
2N6760	400V	1.0Ω	5.5A



FN-3

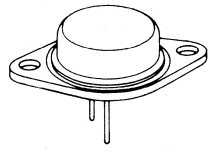
MECHANICAL SPECIFICATIONS

2N6759
JAN, JANTX, & JANTXV 2N6760



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

ABSOLUTE MAXIMUM RATINGS

Parameter		2N6759	2N6760	Units
V_{DS}	Drain – Source Voltage	350*	400*	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ)	350*	400*	V
I_D @ T_C = 25°C	Continuous Drain Current	4.5*	5.5*	A
I_D @ T_C = 100°C	Continuous Drain Current	3.0*	3.5*	A
I_{DM}	Pulsed Drain Current	7.0	8.0	A
V_{GS}	Gate – Source Voltage	±20*		V
P_D @ T_C = 25°C	Max. Power Dissipation	75* (See Fig. 11)		W
P_D @ T_C = 100°C	Max. Power Dissipation	30* (See Fig. 11)		W
	Linear Derating Factor	0.6* (See Fig. 11)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 1 and 2) L = 100 μH 7.0 | 8.0		A
T_J T_{stg}	Operating and Storage Temperature Range	-55* to 150*		°C
	Lead Temperature	300* (0.063 in. (1.6mm) from case for 10s)		°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	2N6759	350	–	–	V	V_{GS} = 0
		2N6760	400	–	–	V	I_D = 1.0 mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	–	4.0*	V	V_{DS} = V_{GS}, I_D = 1 mA
I_{GSSF}	Gate – Body Leakage Forward	ALL	–	–	100*	nA	V_{GS} = 20V
I_{GSSR}	Gate – Body Leakage Reverse	ALL	–	–	100*	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	0.1	1.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0
			–	0.2	4.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0, T_C = 125°C
$V_{DS(on)}$	Static Drain-Source On-State Voltage ①	2N6759	–	–	7.0*	V	V_{GS} = 10V, I_D = 4.5A
		2N6760	–	–	6.7*	V	V_{GS} = 10V, I_D = 5.5A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6759	–	1.0	1.5*	Ω	V_{GS} = 10V, I_D = 3A
		2N6760	–	0.8	1.0*	Ω	V_{GS} = 10V, I_D = 3.5A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6759	–	–	3.3*	Ω	V_{GS} = 10V, I_D = 3A, T_C = 125°C
		2N6760	–	–	2.2*	Ω	V_{GS} = 10V, I_D = 3.5A, T_C = 125°C
g_{fs}	Forward Transconductance ①	ALL	3.0*	4.5	9.0*	S (℧)	V_{DS} = 15V, I_D = 3.5A
C_{iss}	Input Capacitance	ALL	350*	600	800*	pF	V_{GS} = 0, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	50*	150	300*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	20*	40	80*	pF	
$t_{d\ (on)}$	Turn-On Delay Time	ALL	–	–	30*	ns	$V_{DD} \cong$ 175V, I_D = 3.5A, Z_o = 15Ω
t_r	Rise Time	ALL	–	–	35*	ns	(See Figs. 13 and 14)
$t_{d\ (off)}$	Turn-Off Delay Time	ALL	–	–	55*	ns	(MOSFET switching times are essentially
t_f	Fall Time	ALL	–	–	35*	ns	independent of operating temperature.)

THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.67*	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

BODY-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	2N6759	–	–	4.5*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		2N6760	–	–	5.5*		
I_{SM}	Pulsed Source Current (Body Diode)	2N6759	–	–	7.0	A	
		2N6760	–	–	8.0		
V_{SD}	Diode Forward Voltage ①	2N6759	0.70*	–	1.4*	V	T_C = 25°C, I_S = 4.5A, V_{GS} = 0
		2N6760	0.75*	–	1.5*	V	T_C = 25°C, I_S = 5.5A, V_{GS} = 0
t_{rr}	Reverse Recovery Time	ALL	–	550	–	ns	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	8.0	–	μC	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs

*JEDEC registered values. ① Pulse Test: Pulse Width ≤ 300 μsec, Duty Cycle ≤ 2%

Fig. 1 – Clamped Inductive Test Circuit

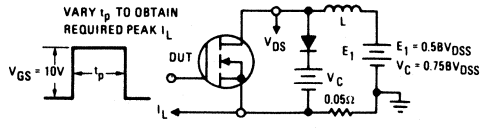
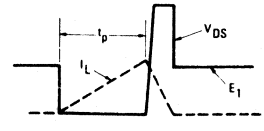


Fig. 2 – Clamped Inductive Waveforms



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 3 — Typical Output Characteristics

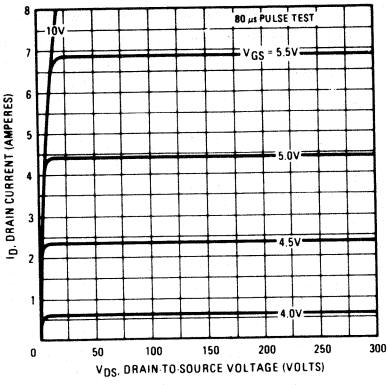


Fig. 4 — Typical Transfer Characteristics

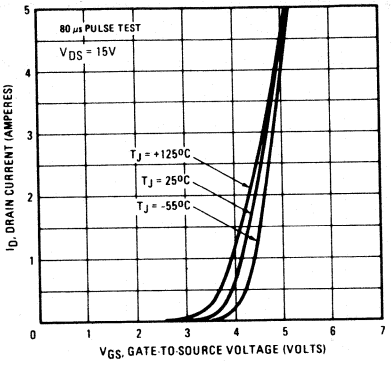


Fig. 5— Typical Saturation Characteristics (2N6759)

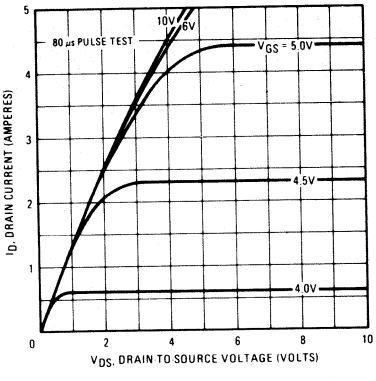


Fig. 6— Typical Saturation Characteristics (2N6760)

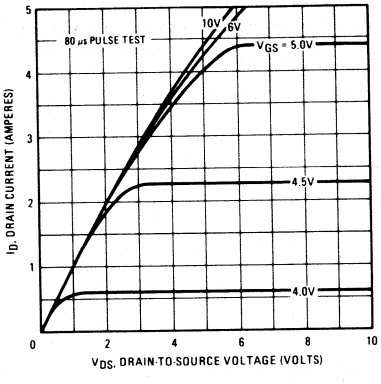


Fig. 7 — Typical Transconductance Vs. Drain Current

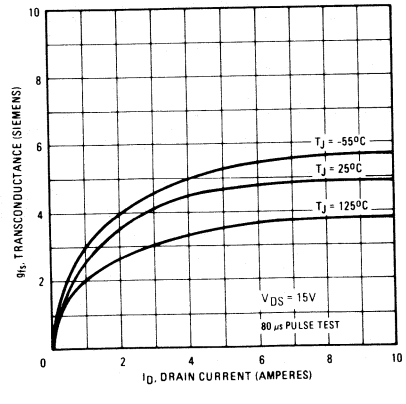


Fig. 8 — Maximum Safe Operating Area

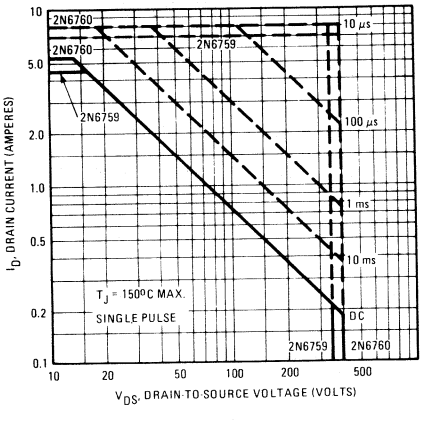


Fig. 9 – Normalized Typical On-Resistance Vs. Temperature

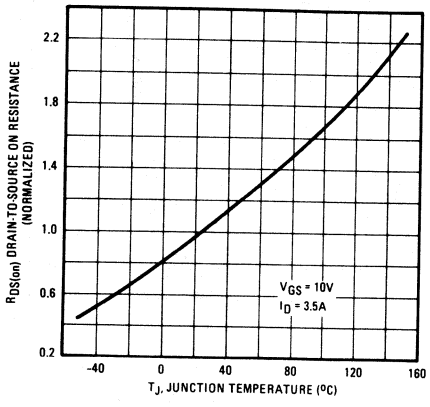


Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

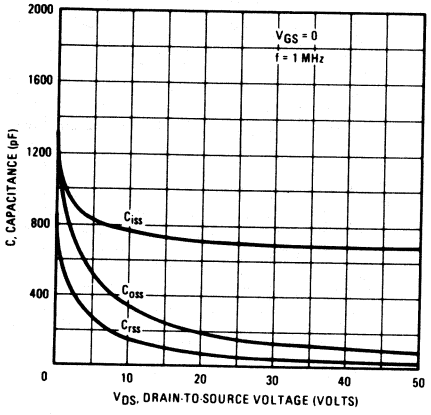


Fig. 11 – Power Vs. Temperature Derating Curve

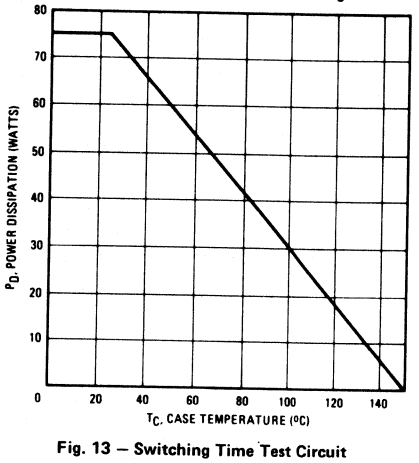


Fig. 12 – Typical Body-Drain Diode Forward Voltage

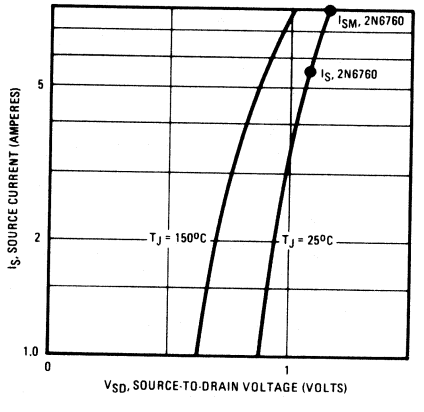


Fig. 13 – Switching Time Test Circuit

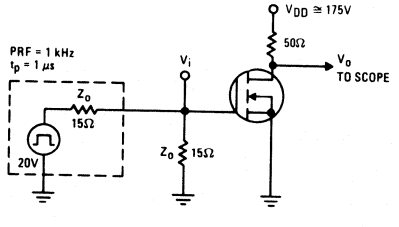
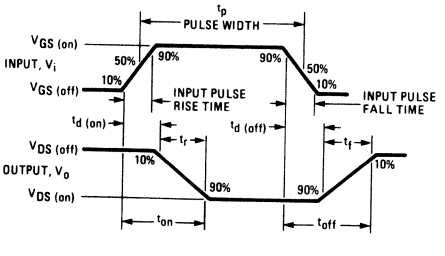


Fig. 14 – Switching Time Waveforms



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

2N6761
J, JTX, JTXV 2N6762

500 Volt, 1.5 Ohm N-Channel

3

FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability
- Qualified to MIL-S-19500/542A

DESCRIPTION

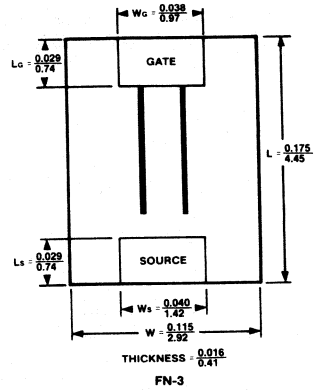
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

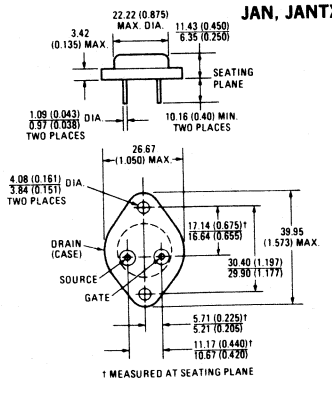
PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6761	450V	2.0Ω	4.0A
2N6762	500V	1.5Ω	4.5A



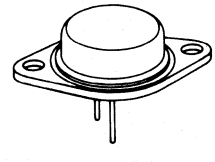
MECHANICAL SPECIFICATIONS

2N6761
JAN, JANTX, & JANTXV 2N6762



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

ABSOLUTE MAXIMUM RATINGS

Parameter		2N6761	2N6762	Units
V_{DS}	Drain – Source Voltage	450*	500*	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ)	450*	500*	V
I_D @ T_C = 25°C	Continuous Drain Current	4.0*	4.5*	A
I_D @ T_C = 100°C	Continuous Drain Current	2.5*	3.0*	A
I_{DM}	Pulsed Drain Current	6.0	7.0	A
V_{GS}	Gate – Source Voltage	±20*		V
P_D @ T_C = 25°C	Max. Power Dissipation	75* (See Fig. 11)		W
P_D @ T_C = 100°C	Max. Power Dissipation	30* (See Fig. 11)		W
	Linear Derating Factor	0.6* (See Fig. 11)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 1 and 2) L = 100 μH	6.0 | 7.0	A
T_J / T_{stg}	Operating and Storage Temperature Range	-55* to 150*		°C
	Lead Temperature	300* (0.063 in. (1.6mm) from case for 10s)		°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	2N6761	450	–	–	V	V_{GS} = 0
		2N6762	500	–	–	V	I_D = 4.0 mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	–	4.0*	V	V_{DS} = V_{GS}, I_D = 1 mA
I_{GSSF}	Gate – Body Leakage Forward	ALL	–	–	100*	nA	V_{GS} = 20V
I_{GSSR}	Gate – Body Leakage Reverse	ALL	–	–	100*	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	0.1	1.0*	mA	V_{DS} = 0.8 x Max. Rating, V_{GS} = 0
			–	0.2	4.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0, T_C = 25°C to 125°C
$V_{DS(on)}$	Static Drain-Source On-State Voltage ①	2N6761	–	–	8.0*	V	V_{GS} = 10V, I_D = 4A
		2N6762	–	–	7.7*	V	V_{GS} = 10V, I_D = 4.5A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6761	–	1.5	2.0*	Ω	V_{GS} = 10V, I_D = 2.5A
		2N6762	–	1.3	1.5*	Ω	V_{GS} = 10V, I_D = 3.0A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6761	–	–	4.4*	Ω	V_{GS} = 10V, I_D = 2.5A, T_C = 125°C
		2N6762	–	–	3.3*	Ω	V_{GS} = 10V, I_D = 3.0A, T_C = 125°C
g_{fs}	Forward Transconductance ①	ALL	2.5*	3.5	7.5*	S (℧)	V_{DS} = 16V, I_D = 3A
C_{iss}	Input Capacitance	ALL	350*	600	800*	pF	V_{GS} = 0, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	25*	100	200*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	15*	30	60*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	30*	ns	$V_{DD} \cong$ 225V, I_D = 3A, Z_o = 15Ω (See Figs. 13 and 14) (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	30*	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	55*	ns	
t_f	Fall Time	ALL	–	–	30*	ns	

THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.67*	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

BODY-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	2N6761	–	–	4.0*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		2N6762	–	–	4.5*		
I_{SM}	Pulsed Source Current (Body Diode)	2N6761	–	–	6.0	A	
		2N6762	–	–	7.0		
V_{SD}	Diode Forward Voltage ①	2N6761	0.65*	–	1.3*	V	T_C = 25°C, I_S = 4A, V_{GS} = 0
		2N6762	0.7*	–	1.4*	V	T_C = 25°C, I_S =4.5A, V_{GS} = 0
t_{rr}	Reverse Recovery Time	ALL	–	500	–	ns	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	7.0	–	μC	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs

*JEDEC registered values. ① Pulse Test: Pulse Width ≤ 300 μsec, Duty Cycle ≤ 2%

Fig. 1 – Clamped Inductive Test Circuit

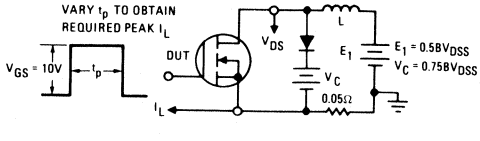
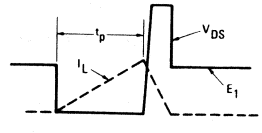


Fig. 2 – Clamped Inductive Waveforms



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 3 – Typical Output Characteristics

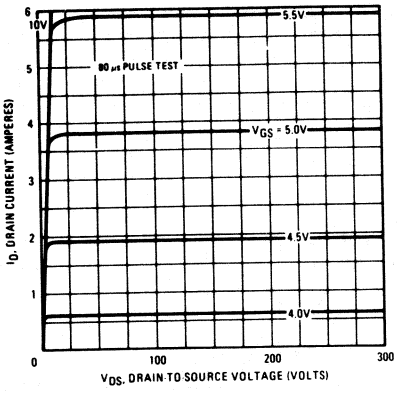


Fig. 4 – Typical Transfer Characteristics

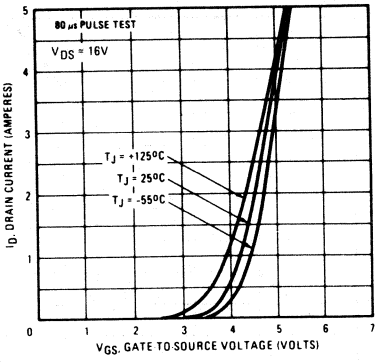


Fig. 5– Typical Saturation Characteristics (2N6761)

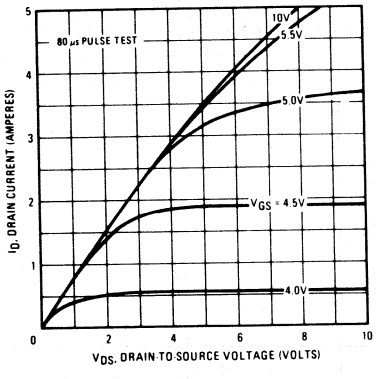


Fig. 6– Typical Saturation Characteristics (2N6762)

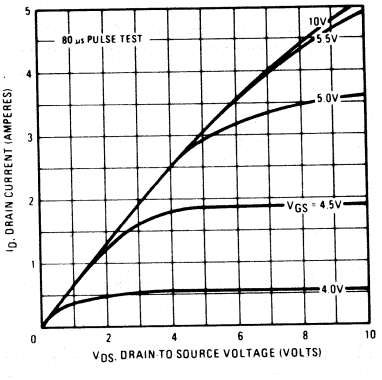


Fig. 7 – Typical Transconductance Vs. Drain Current

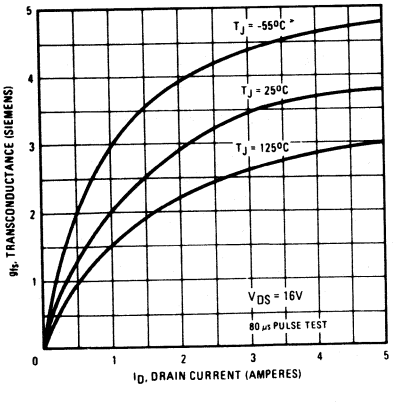


Fig. 8 – Maximum Safe Operating Area

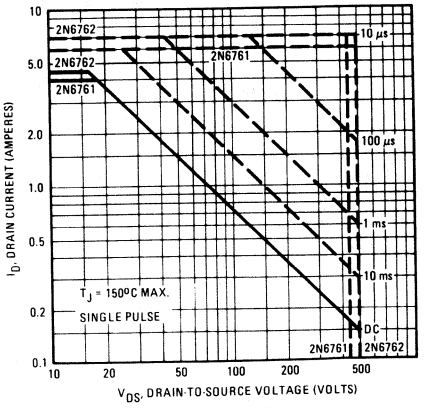


Fig. 9 – Normalized Typical On-Resistance Vs. Temperature

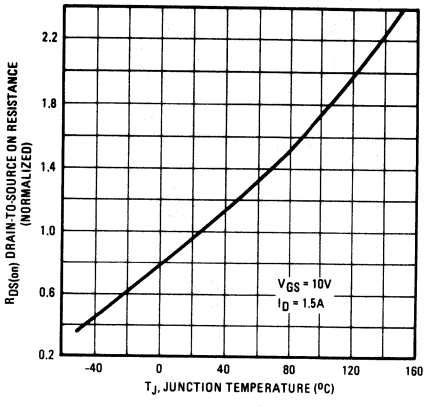


Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

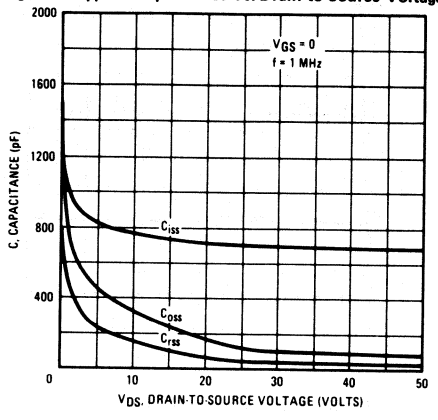


Fig. 11 – Power Vs. Temperature Derating Curve

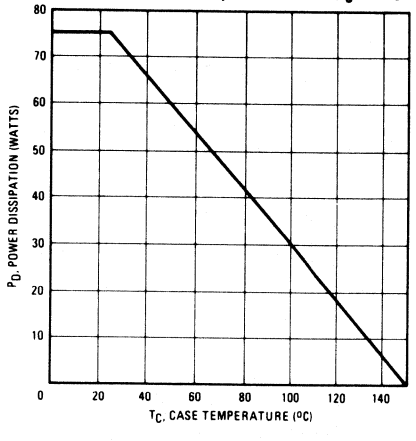


Fig. 12 – Typical Body-Drain Diode Forward Voltage

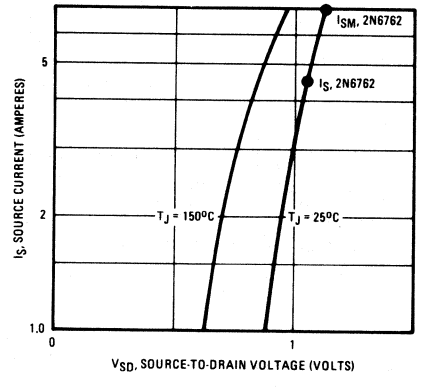


Fig. 13 – Switching Time Test Circuit

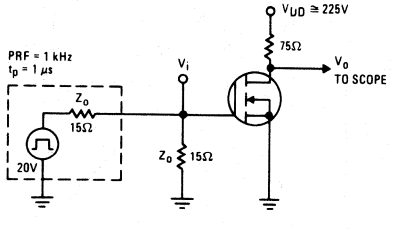
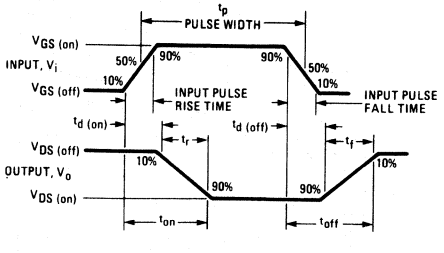


Fig. 14 – Switching Time Waveforms



POWER MOSFET TRANSISTORS

2N6763
J, JTX, JTXV 2N6764

100 Volt, 0.055 Ohm N-Channel

3

FEATURES

- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability
- Qualified to MIL-S-19500/543A

DESCRIPTION

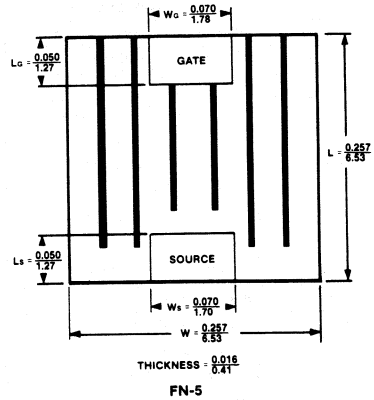
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

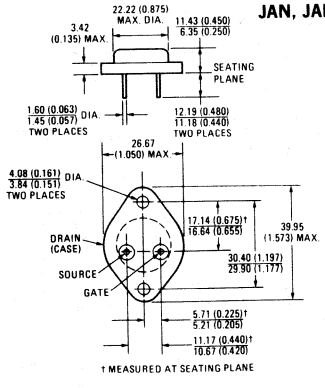
Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6763	60V	0.08Ω	31A
2N6764	100V	0.055Ω	38A



FN-5

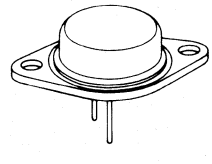
MECHANICAL SPECIFICATIONS

2N6763
JAN, JANTX, & JANTXV 2N6764



Dimensions in Millimeters and (Inches)

TO-204AE (TO-3 modified)



ABSOLUTE MAXIMUM RATINGS

Parameter		2N6763	2N6764	Units
V_{DS}	Drain – Source Voltage	60*	100*	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ)	60*	100*	V
I_D @ T_C = 25°C	Continuous Drain Current	31*	38*	A
I_D @ T_C = 100°C	Continuous Drain Current	20*	24*	A
I_{DM}	Pulsed Drain Current	60	70	A
V_{GS}	Gate – Source Voltage	±20*		V
P_D @ T_C = 25°C	Max. Power Dissipation	150* (See Fig. 11)		W
P_D @ T_C = 100°C	Max. Power Dissipation	60* (See Fig. 11)		W
	Linear Derating Factor	1.2* (See Fig. 11)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 1 and 2) L = 100 μH		A
		60	70	
T_J T_{stg}	Operating and Storage Temperature Range	-55* to 150*		°C
	Lead Temperature	300* (0.063 in. (1.6mm) from case for 10s)		°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	2N6763	60	–	–	V	V_{GS} = 0
		2N6764	100	–	–	V	I_D = 1.0 mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	–	4.0*	V	V_{DS} = V_{GS}, I_D = 1 mA
I_{GSSF}	Gate – Body Leakage Forward	ALL	–	–	100*	nA	V_{GS} = 20V
I_{GSSR}	Gate – Body Leakage Reverse	ALL	–	–	100*	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	0.1	1.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0
			–	0.2	4.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0, T_C = 125°C
$V_{DS(on)}$	Static Drain-Source On-State Voltage ①	2N6763	–	–	2.48*	V	V_{GS} = 10V I_D = 31A
		2N6764	–	–	2.09*	V	V_{GS} = 10V, I_D = 38A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6763	–	0.06	0.08*	Ω	V_{GS} = 10V, I_D = 20A
		2N6764	–	0.045	0.055*	Ω	V_{GS} = 10V, I_D = 24A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6763	–	–	0.136*	Ω	V_{GS} = 10V, I_D = 20A, T_C = 125°C
		2N6764	–	–	0.094*	Ω	V_{GS} = 10V, I_D = 24A, T_C = 125°C
g_{fs}	Forward Transconductance ①	ALL	9.0*	12.5	27*	S (℧)	V_{DS} = 15V, I_D = 24A
C_{iss}	Input Capacitance	ALL	1000*	2000	3000*	pF	V_{GS} = 0, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	500*	1000	1500*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	150*	350	500*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	35*	ns	$V_{DD} \cong$ 24V, I_D = 24A, Z_o = 4.7Ω (See Figs. 13 and 14) (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	100*	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	125*	ns	
t_f	Fall Time	ALL	–	–	100*	ns	

THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	0.83*	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

BODY-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	2N6763	–	–	31*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		2N6764	–	–	38*		
I_{SM}	Pulsed Source Current (Body Diode)	2N6763	–	–	60	A	
		2N6764	–	–	70		
V_{SD}	Diode Forward Voltage ①	2N6763	0.90*	–	1.8*	V	T_C = 25°C, I_S = 31A, V_{GS} = 0
		2N6764	0.95*	–	1.9*	V	T_C = 25°C, I_S = 38A, V_{GS} = 0
t_{rr}	Reverse Recovery Time	ALL	–	500	–	ns	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	10	–	μC	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs

*JEDEC registered values. ① Pulse Test: Pulse Width ≤ 300 μsec, Duty Cycle ≤ 2%

Fig. 1 – Clamped Inductive Test Circuit

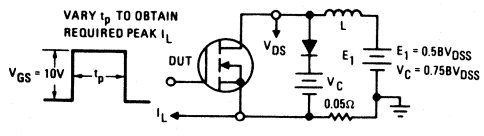
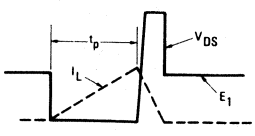


Fig. 2 – Clamped Inductive Waveforms



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 3 — Typical Output Characteristics

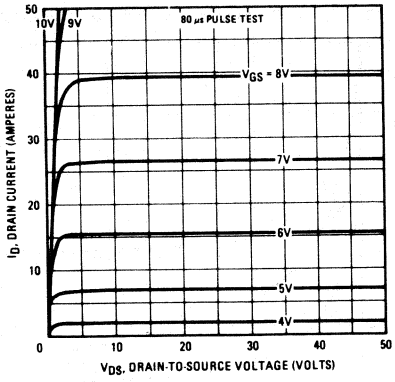


Fig. 4 — Typical Transfer Characteristics

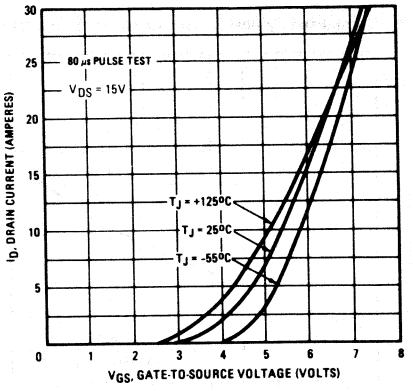


Fig. 5— Typical Saturation Characteristics (2N6763)

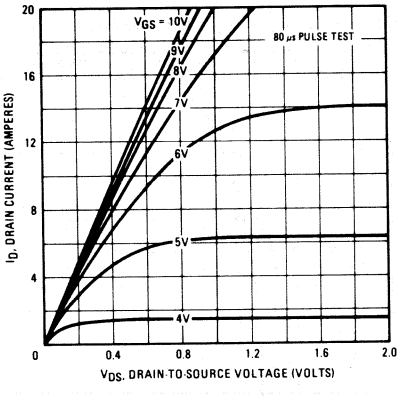


Fig. 6— Typical Saturation Characteristics (2N6764)

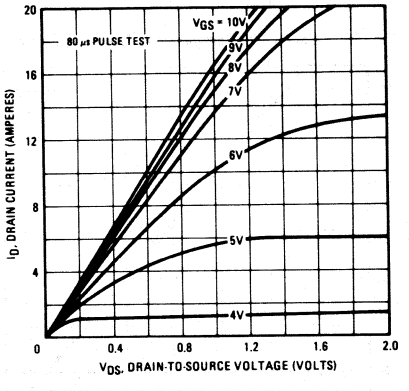


Fig. 7 — Typical Transconductance Vs. Drain Current

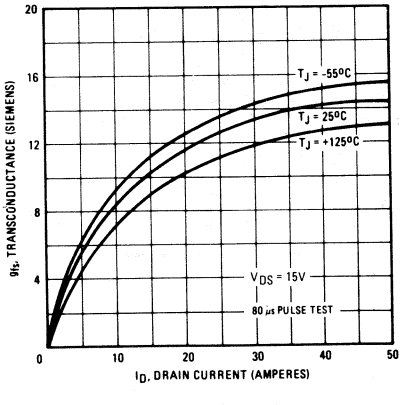


Fig. 8 — Maximum Safe Operating Area

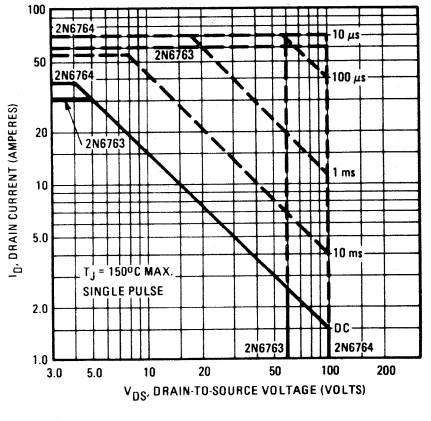


Fig. 9 — Normalized Typical On-Resistance Vs. Temperature

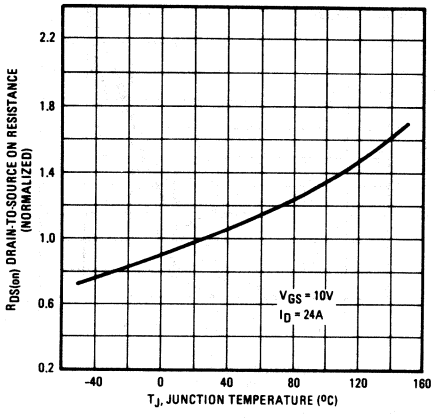


Fig. 10 — Typical Capacitance Vs. Drain-to-Source Voltage

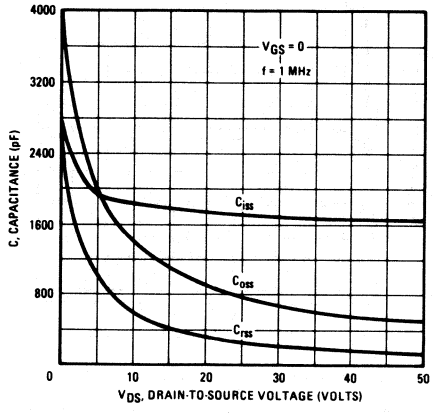


Fig. 11 — Power Vs. Temperature Derating Curve

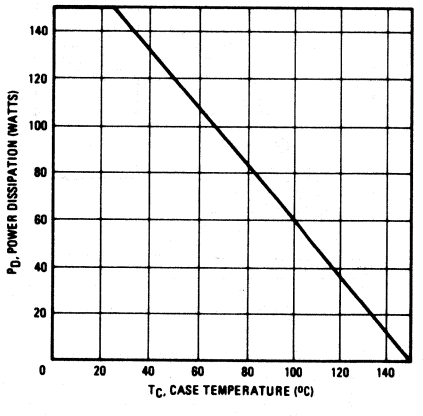


Fig. 12 — Typical Body-Drain Diode Forward Voltage

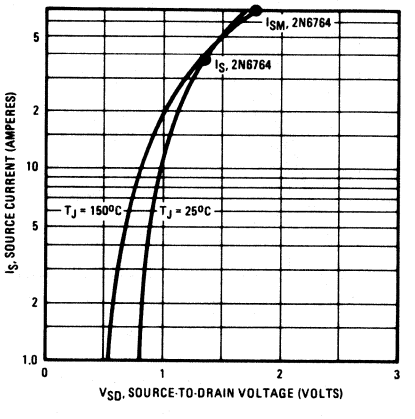


Fig. 13 — Switching Time Test Circuit

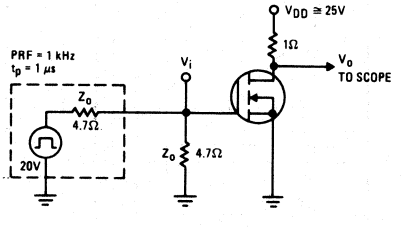
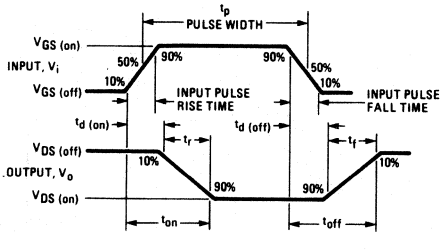


Fig. 14 — Switching Time Waveforms



POWER MOSFET TRANSISTORS

200 Volt, 0.085 Ohm N-Channel

2N6765
J, JTX, JTXV 2N6766

3

FEATURES

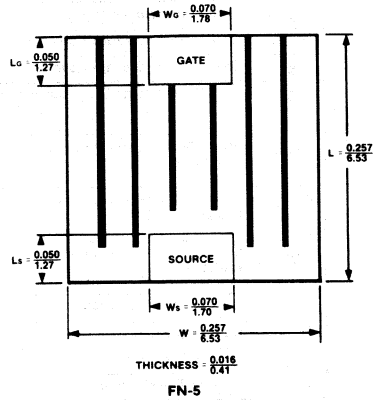
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability
- Qualified to MIL-S-19500/543A

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

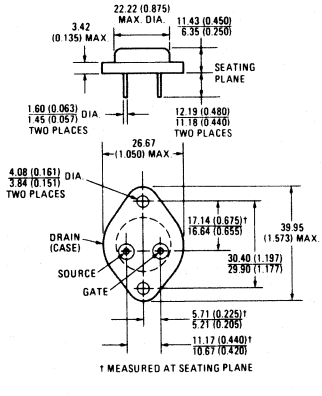


PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6765	150V	0.120Ω	25A
2N6766	200V	0.085Ω	30A

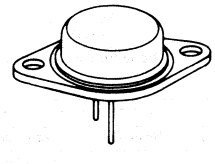
MECHANICAL SPECIFICATIONS

2N6765
JAN, JANTX, & JANTXV 2N6766



Dimensions in Millimeters and (Inches)

TO-204AE (TO-3 modified)



UNITRODE

ABSOLUTE MAXIMUM RATINGS

Parameter		2N6765	2N6766	Units
V_{DS}	Drain – Source Voltage	150*	200*	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ)	150*	200*	V
I_D @ T_C = 25°C	Continuous Drain Current	25*	30*	A
I_D @ T_C = 100°C	Continuous Drain Current	16*	19*	A
I_{DM}	Pulsed Drain Current	50	60	A
V_{GS}	Gate – Source Voltage	±20*		V
P_D @ T_C = 25°C	Max. Power Dissipation	150* (See Fig. 11)		W
P_D @ T_C = 100°C	Max. Power Dissipation	60* (See Fig. 11)		W
	Linear Derating Factor	1.2* (See Fig. 11)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 1 and 2) L = 100 μH 50 | 60		A
T_J T_{stg}	Operating and Storage Temperature Range	-55* to 150*		°C
	Lead Temperature	300* (0.063 in. (1.6mm) from case for 10s)		°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	2N6765	150	–	–	V	V_{GS} = 0
		2N6766	200	–	–	V	I_D = 1.0 mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	–	4.0*	V	V_{DS} = V_{GS}, I_D = 1 mA
I_{GSSF}	Gate – Body Leakage Forward	ALL	–	–	100*	nA	V_{GS} = 20V
I_{GSSR}	Gate – Body Leakage Reverse	ALL	–	–	100*	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	0.1	1.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0
			–	0.2	4.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0, T_C = 125°C
$V_{DS(on)}$	Static Drain-Source On-State Voltage ①	2N6765	–	–	3.0*	V	V_{GS} = 10V, I_D = 25A
		2N6766	–	–	2.7*	V	V_{GS} = 10V, I_D = 30A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6765	–	0.09	0.12*	Ω	V_{GS} = 10V, I_D = 16A
		2N6766	–	0.07	0.085*	Ω	V_{GS} = 10V, I_D = 19A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6765	–	–	0.216*	Ω	V_{GS} = 10V, I_D = 16A, T_C = 125°C
		2N6766	–	–	0.153*	Ω	V_{GS} = 10V, I_D = 19A, T_C = 125°C
g_{fs}	Forward Transconductance ①	ALL	9.0*	15.5	27*	S (℧)	V_{DS} = 15V, I_D = 19A
C_{iss}	Input Capacitance	ALL	1000*	2000	3000*	pF	V_{GS} = 0, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	450*	800	1200*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	150*	300	500*	pF	
$t_{d\ (on)}$	Turn-On Delay Time	ALL	–	–	35*	ns	V_{DD} ≅ 95V, I_D = 19A, Z_o = 4.7Ω (See Figs. 13 and 14) (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	100*	ns	
$t_{d\ (off)}$	Turn-Off Delay Time	ALL	–	–	125*	ns	
t_f	Fall Time	ALL	–	–	100*	ns	

THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	0.83*	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

BODY-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	2N6765	–	–	25*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		2N6766	–	–	30*		
I_{SM}	Pulsed Source Current (Body Diode)	2N6765	–	–	50	A	
		2N6766	–	–	60		
V_{SD}	Diode Forward Voltage ①	2N6765	0.85*	–	1.7*	V	T_C = 25°C, I_S = 25A, V_{GS} = 0
		2N6766	0.9*	–	1.8*	V	T_C = 25°C, I_S = 30A, V_{GS} = 0
t_{rr}	Reverse Recovery Time	ALL	–	500	–	ns	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	10	–	μC	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs

*JEDEC registered values. ① Pulse Test: Pulse Width ≤ 300 μsec, Duty Cycle ≤ 2%

Fig. 1 – Clamped Inductive Test Circuit

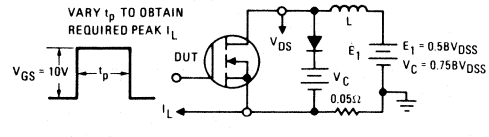
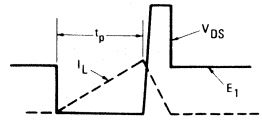


Fig. 2 – Clamped Inductive Waveforms



3

Fig. 3 – Typical Output Characteristics

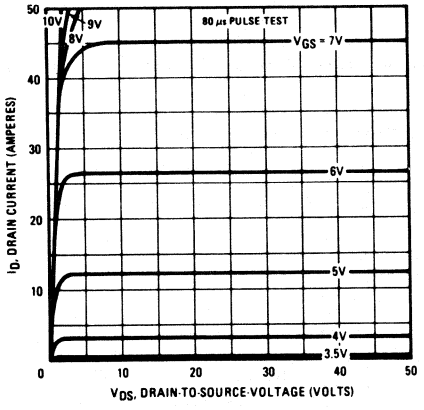


Fig. 4 – Typical Transfer Characteristics

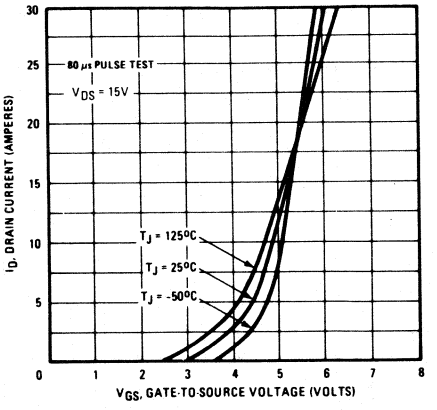


Fig. 5– Typical Saturation Characteristics (2N6765)

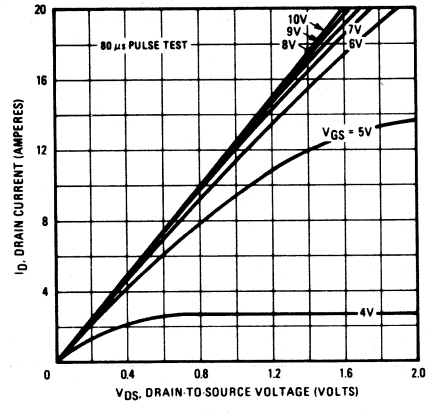


Fig. 6– Typical Saturation Characteristics (2N6766)

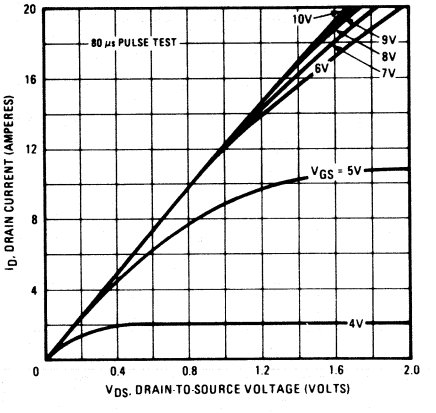


Fig. 7 – Typical Transconductance Vs. Drain Current

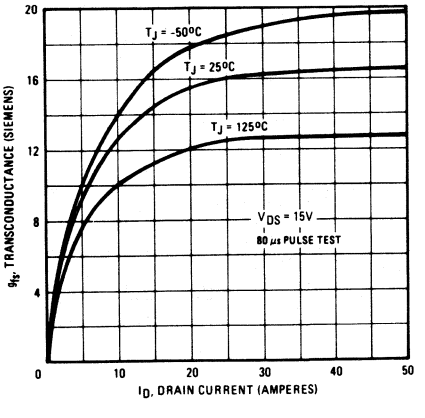


Fig. 8 – Maximum Safe Operating Area

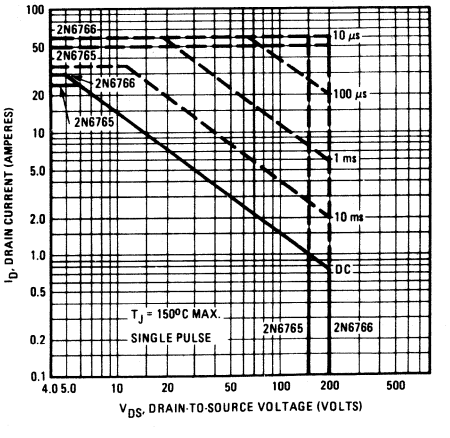


Fig. 9 — Normalized Typical On-Resistance Vs. Temperature

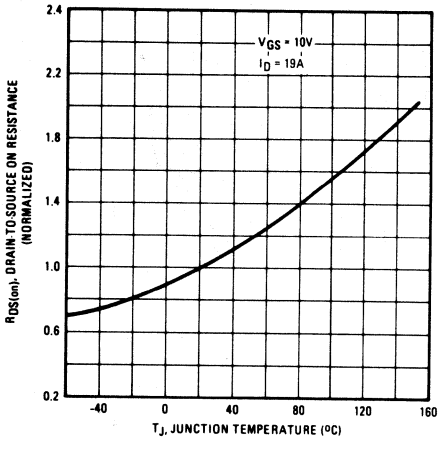


Fig. 10 — Typical Capacitance Vs. Drain-to-Source Voltage

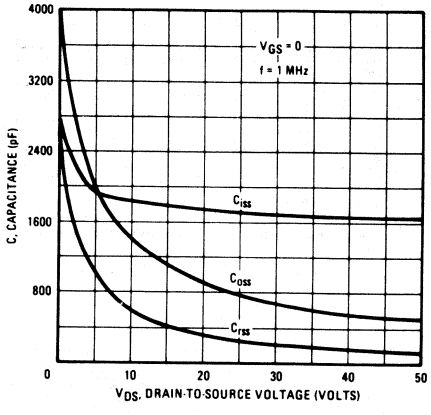


Fig. 11 — Power Vs. Temperature Derating Curve

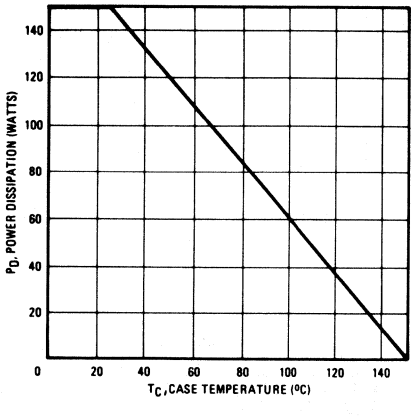


Fig. 12 — Typical Body-Drain Diode Forward Voltage

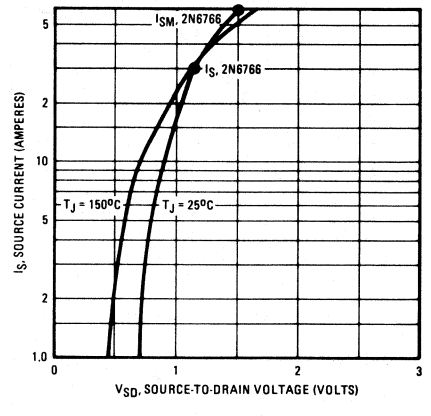


Fig. 13 — Switching Time Test Circuit

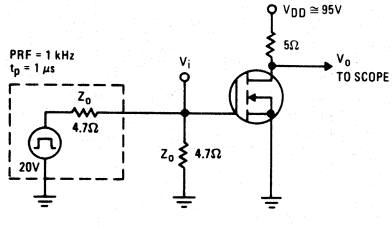
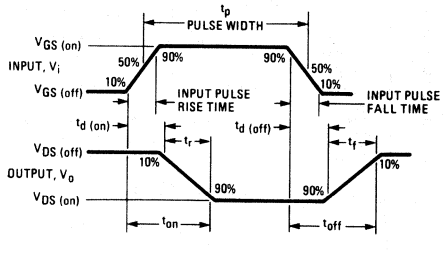


Fig. 14 — Switching Time Waveforms



POWER MOSFET TRANSISTORS

2N6767
J, JTX, JTXV 2N6768

400 Volt, 0.3 Ohm N-Channel

3

FEATURES

- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability
- Qualified to MIL-S-19500/543A

DESCRIPTION

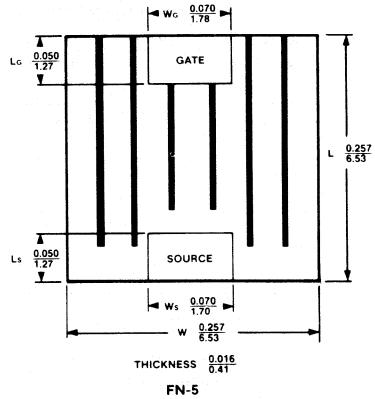
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

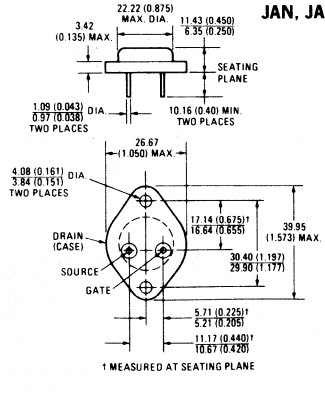
PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6767	350V	0.4Ω	12A
2N6768	400V	0.3Ω	14A



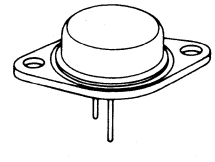
MECHANICAL SPECIFICATIONS

2N6767
JAN, JANTX, & JANTXV 2N6768



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

ABSOLUTE MAXIMUM RATINGS

Parameter		2N6767	2N6768	Units
V_{DS}	Drain – Source Voltage	350*	400*	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ)	350*	400*	V
I_D @ T_C = 25°C	Continuous Drain Current	12*	14*	A
I_D @ T_C = 100°C	Continuous Drain Current	7.75*	9.0*	A
I_{DM}	Pulsed Drain Current	20	25	A
V_{GS}	Gate – Source Voltage	±20*		V
P_D @ T_C = 25°C	Max. Power Dissipation	150* (See Fig. 11)		W
P_D @ T_C = 100°C	Max. Power Dissipation	60* (See Fig. 11)		W
	Linear Derating Factor	1.2* (See Fig. 11)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 1 and 2) L = 100 μH 20 | 25		A
T_J T_{stg}	Operating and Storage Temperature Range	-55* to 150*		°C
	Lead Temperature	300* (0.063 in. (1.6mm) from case for 10s)		°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	2N6767	350	–	–	V	V_{GS} = 0
		2N6768	400	–	–	V	I_D = 1.0 mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	–	4.0*	V	V_{DS} = V_{GS}, I_D = 1 mA
I_{GSSF}	Gate – Body Leakage Forward	ALL	–	–	100*	nA	V_{GS} = 20V
I_{GSSR}	Gate – Body Leakage Reverse	ALL	–	–	100*	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	0.1	1.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0
			–	0.2	4.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0, T_C = 125°C
$V_{DS(on)}$	Static Drain-Source On-State Voltage ①	2N6767	–	–	5.4*	V	V_{GS} = 10V, I_D = 12A
		2N6768	–	–	5.6*	V	V_{GS} = 10V, I_D = 14A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6767	–	0.3	0.4*	Ω	V_{GS} = 10V, I_D = 7.75A
		2N6768	–	0.25	0.3*	Ω	V_{GS} = 10V, I_D = 9.0A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6767	–	–	0.88*	Ω	V_{GS} = 10V, I_D = 7.75A, T_C = 125°C
		2N6768	–	–	0.66*	Ω	V_{GS} = 10V, I_D = 9.0A, T_C = 125°C
g_{fs}	Forward Transconductance ①	ALL	8.0*	11.0	24*	S (℧)	V_{DS} = 15V, I_D = 9.0A
C_{iss}	Input Capacitance	ALL	1000*	2000	3000*	pF	V_{GS} = 0, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	200*	400	600*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	50*	100	200*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	35*	ns	$V_{DD} \cong$ 180V, I_D = 9.0A, Z_o = 4.7Ω (See Figs. 13 and 14) (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	65*	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	150*	ns	
t_f	Fall Time	ALL	–	–	75*	ns	

THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	0.83*	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

BODY-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	2N6767	–	–	12*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		2N6768	–	–	14*		
I_{SM}	Pulsed Source Current (Body Diode)	2N6767	–	–	20	A	
		2N6768	–	–	25		
V_{SD}	Diode Forward Voltage ①	2N6767	0.8*	–	1.6*	V	T_C = 25°C, I_S = 12A, V_{GS} = 0
		2N6768	0.85*	–	1.7*	V	T_C = 25°C, I_S = 14A, V_{GS} = 0
t_{rr}	Reverse Recovery Time	ALL	–	1000	–	ns	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	25	–	μC	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs

*JEDEC registered values. ① Pulse Test: Pulse Width ≤ 300 μsec, Duty Cycle ≤ 2%

Fig. 1 – Clamped Inductive Test Circuit

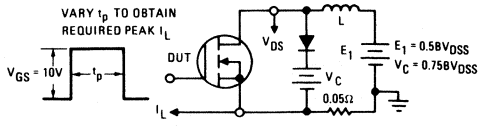
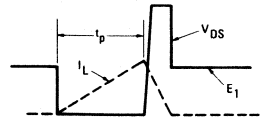


Fig. 2 – Clamped Inductive Waveforms



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 3 – Typical Output Characteristics

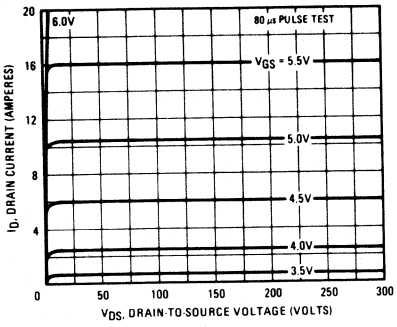


Fig. 4 – Typical Transfer Characteristics

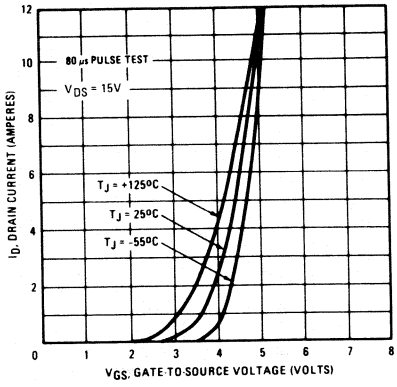


Fig. 5– Typical Saturation Characteristics (2N6767)

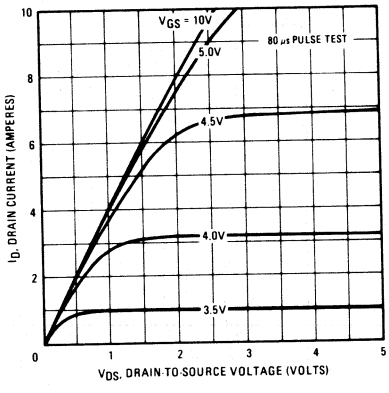


Fig. 6– Typical Saturation Characteristics (2N6768)

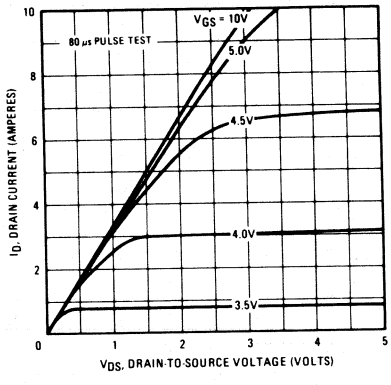


Fig. 7 – Typical Transconductance Vs. Drain Current

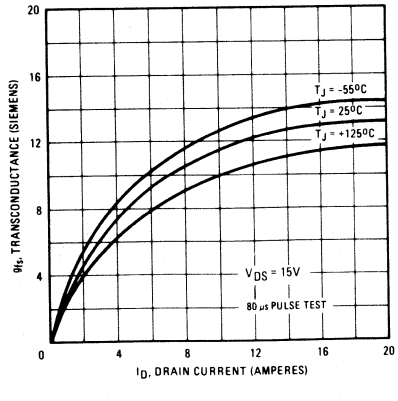


Fig. 8 – Maximum Safe Operating Area

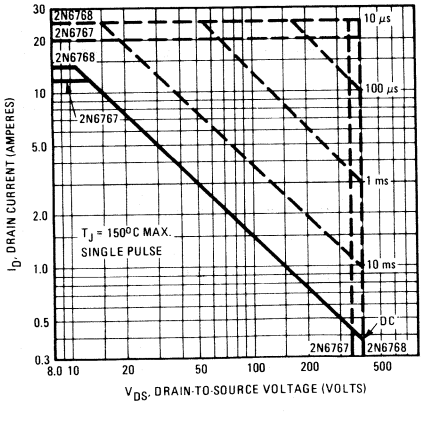


Fig. 9 — Normalized Typical On-Resistance Vs. Temperature

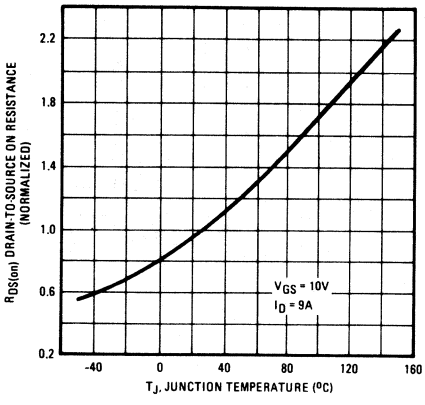


Fig. 10 — Typical Capacitance Vs. Drain-to-Source Voltage

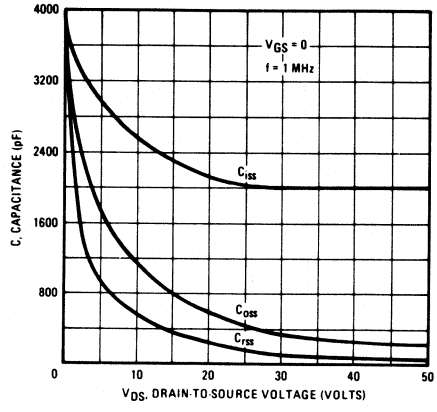


Fig. 11 — Power Vs. Temperature Derating Curve

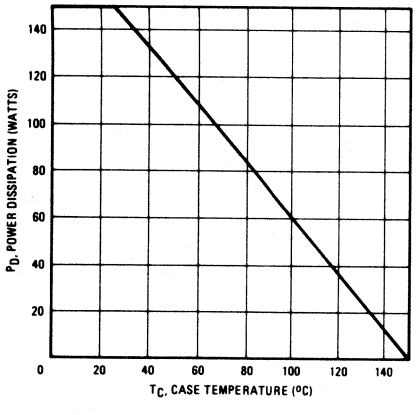


Fig. 12 — Typical Body-Drain Diode Forward Voltage

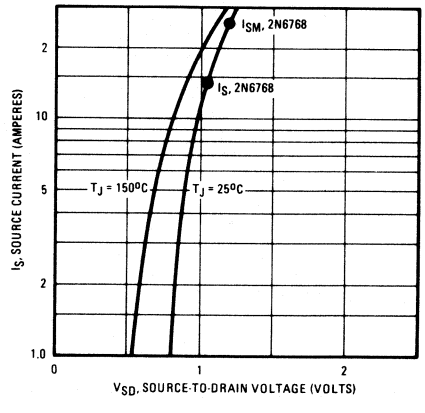


Fig. 13 — Switching Time Test Circuit

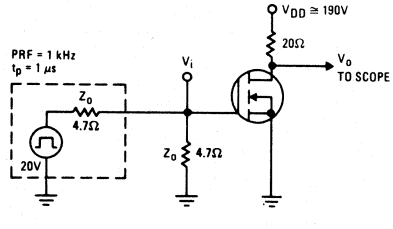
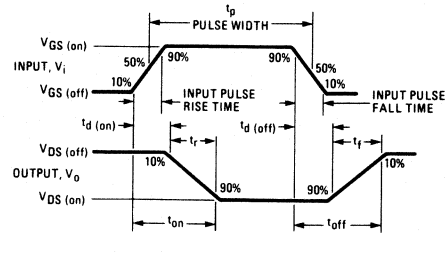


Fig. 14 — Switching Time Waveforms



POWER MOSFET TRANSISTORS

2N6769
J, JTX, JTXV 2N6770

500 Volt, 0.4 Ohm N-Channel

3

FEATURES

- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability
- Qualified to MIL-S-19500/543A

DESCRIPTION

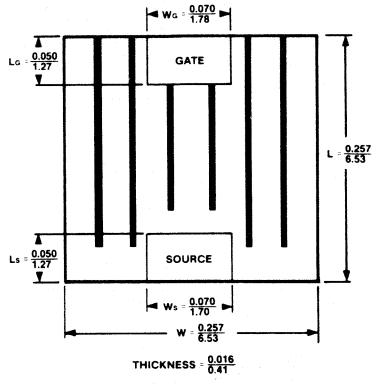
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

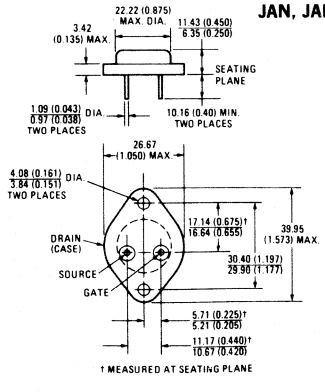
Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6769	450V	0.5Ω	11A
2N6770	500V	0.4Ω	12A



FN-5

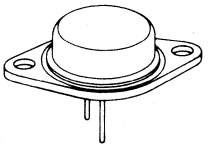
MECHANICAL SPECIFICATIONS

2N6769
JAN, JANTX, & JANTXV 2N6770



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

ABSOLUTE MAXIMUM RATINGS

Parameter		2N6769	2N6770	Units
V_{DS}	Drain – Source Voltage	450*	500*	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ)	450*	500*	V
I_D @ T_C = 25°C	Continuous Drain Current	11*	12*	A
I_D @ T_C = 100°C	Continuous Drain Current	7.0*	7.75*	A
I_{DM}	Pulsed Drain Current	20	25	A
V_{GS}	Gate – Source Voltage	±20*		V
P_D @ T_C = 25°C	Max. Power Dissipation	150* (See Fig. 11)		W
P_D @ T_C = 100°C	Max. Power Dissipation	60* (See Fig. 11)		W
	Linear Derating Factor	1.2* (See Fig. 11)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 1 and 2) L = 100 μH 20 | 25		A
T_J T_{stg}	Operating and Storage Temperature Range	-55* to 150*		°C
	Lead Temperature	300* (0.063 in. (1.6mm) from case for 10s)		°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	2N6769	450	–	–	V	V_{GS} = 0
		2N6770	500	–	–	V	I_D = 4.0 mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	–	4.0*	V	V_{DS} = V_{GS}, I_D = 1 mA
I_{GSSF}	Gate – Body Leakage Forward	ALL	–	–	100*	nA	V_{GS} = 20V
I_{GSSR}	Gate – Body Leakage Reverse	ALL	–	–	100*	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	0.1	1.0*	mA	V_{DS} = 0.8 x Max. Rating, V_{GS} = 0
			–	0.2	4.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0, T_C = 25°C to 125°C
$V_{DS(on)}$	Static Drain-Source On-State Voltage ①	2N6769	–	–	6.0*	V	
		2N6770	–	–	6.0*	V	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6769	–	0.4	0.5*	Ω	V_{GS} = 10V, I_D = 7.0A
		2N6770	–	0.3	0.4*	Ω	V_{GS} = 10V, I_D = 7.75A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ①	2N6769	–	–	1.1*	Ω	V_{GS} = 10V, I_D = 7.0A, T_C = 125°C
		2N6770	–	–	0.88*	Ω	V_{GS} = 10V, I_D = 7.75A, T_C = 125°C
g_{fs}	Forward Transconductance ①	ALL	8.0*	12.0	24*	S (℧)	V_{DS} = 15V, I_D = 7.75A
C_{iss}	Input Capacitance	ALL	1000*	2000	3000*	pF	V_{GS} = 0, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	200*	400	600*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	50*	100	200*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	35*	ns	$V_{DD} \cong 210V$, I_D = 7.75A, Z_o = 4.7Ω
t_r	Rise Time	ALL	–	–	50*	ns	(See Figs. 13 and 14)
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	150*	ns	(MOSFET switching times are essentially
t_f	Fall Time	ALL	–	–	70*	ns	independent of operating temperature.)

THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	0.83*	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

BODY-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	2N6769	–	–	11*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		2N6770	–	–	12*		
I_{SM}	Pulsed Source Current (Body Diode)	2N6769	–	–	20	A	
		2N6770	–	–	25		
V_{SD}	Diode Forward Voltage ①	2N6769	0.75*	–	1.5*	V	T_C = 25°C, I_S = 11A, V_{GS} = 0
		2N6770	0.80*	–	1.6*	V	T_C = 25°C, I_S = 12A, V_{GS} = 0
t_{rr}	Reverse Recovery Time	ALL	–	400	–	ns	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	10	–	μC	T_J = 150°C, I_F = I_{SM}, dI_F/dt = 100 A/μs

*JEDEC registered values. ① Pulse Test: Pulse Width ≤ 300 μsec, Duty Cycle ≤ 2%

Fig. 1 – Clamped Inductive Test Circuit

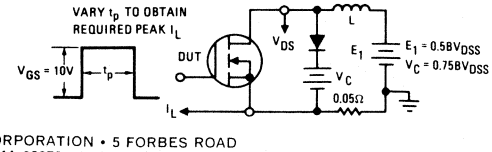
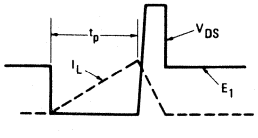


Fig. 2 – Clamped Inductive Waveforms



3

Fig. 3 — Typical Output Characteristics

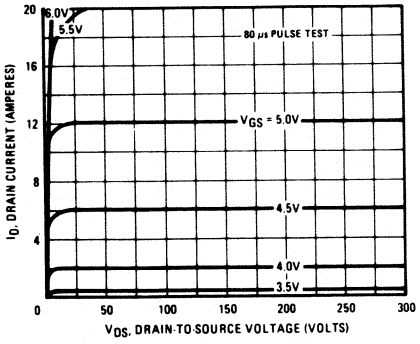


Fig. 4 — Typical Transfer Characteristics

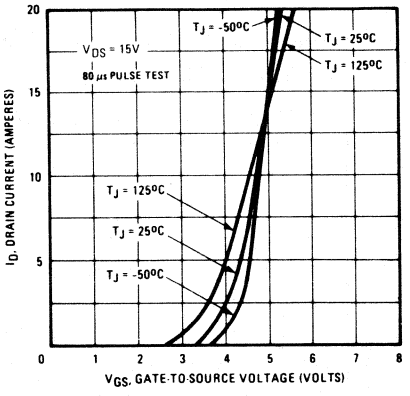


Fig. 5— Typical Saturation Characteristics (2N6769)

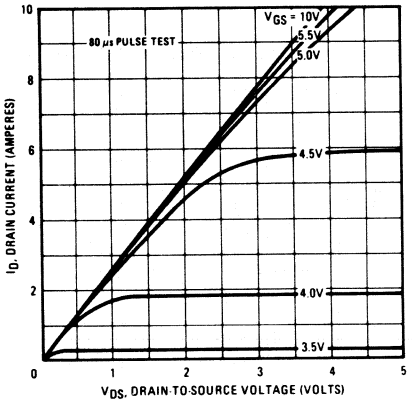


Fig. 6— Typical Saturation Characteristics (2N6770)

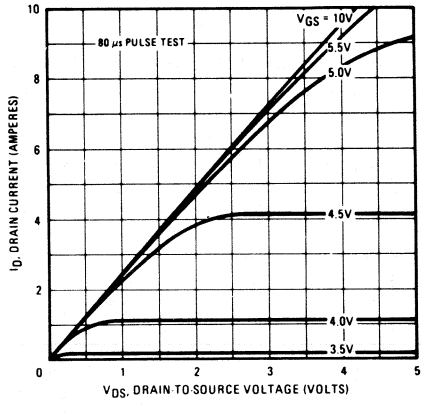


Fig. 7 — Typical Transconductance Vs. Drain Current

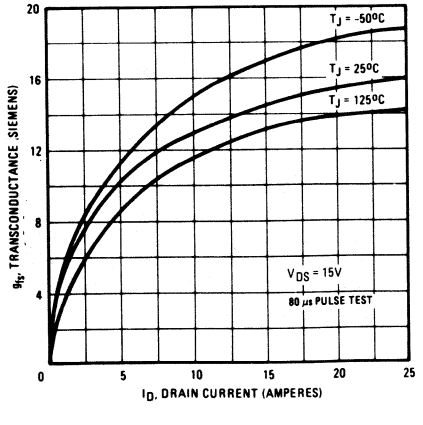


Fig. 8 — Maximum Safe Operating Area

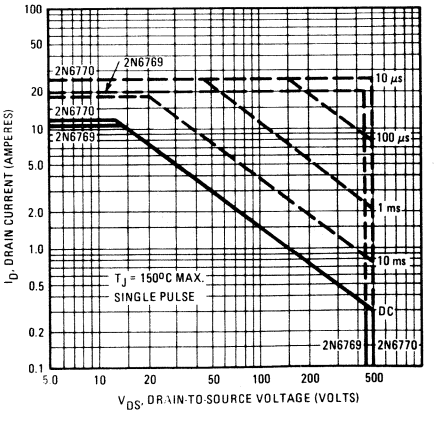


Fig. 9 — Normalized Typical On-Resistance Vs. Temperature

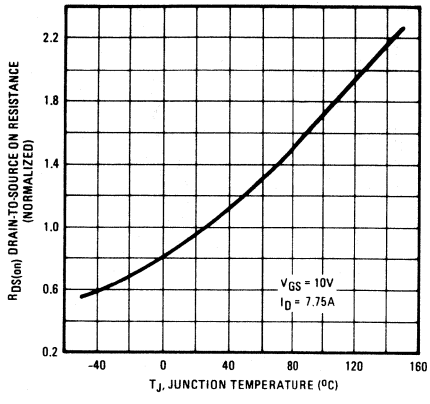


Fig. 10 — Typical Capacitance Vs. Drain-to-Source Voltage

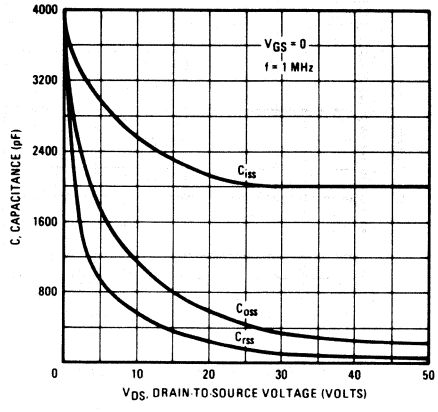


Fig. 11 — Power Vs. Temperature Derating Curve

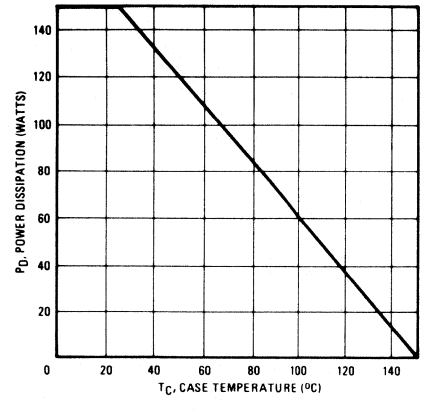


Fig. 12 — Typical Body-Drain Diode Forward Voltage

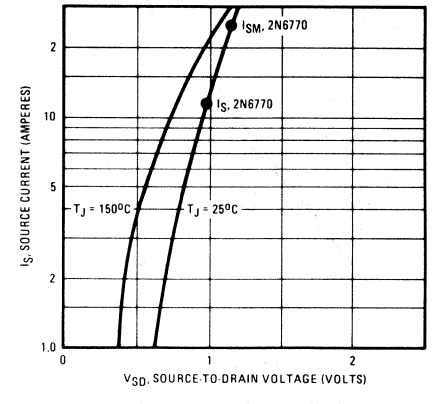


Fig. 13 — Switching Time Test Circuit

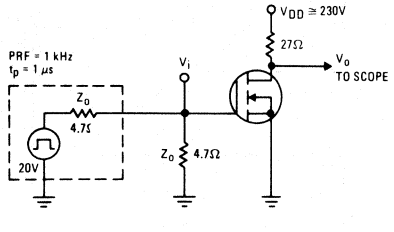
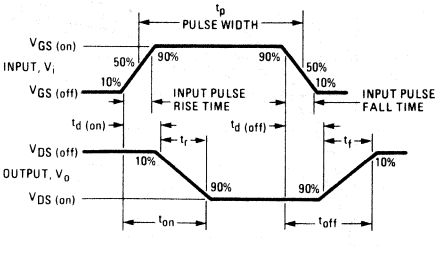


Fig. 14 — Switching Time Waveforms



POWER MOSFET TRANSISTORS

100 Volt, 0.6 Ohm N-Channel

2N6781
2N6782

3

FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

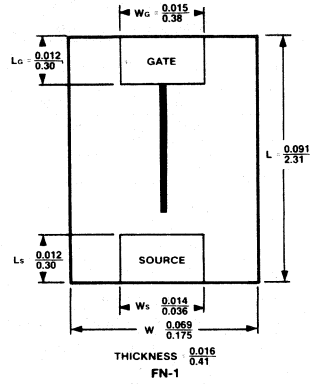
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

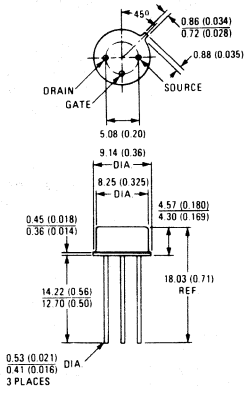
Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6781	60V	0.6Ω	3.5A
2N6782	100V	0.6Ω	3.5A



FN-1

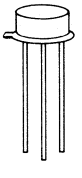
MECHANICAL SPECIFICATIONS

2N6781, 2N6782



All Dimensions in Millimeters and (Inches)

TO-205 AD (TO-39)



UNITRODE

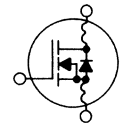
ABSOLUTE MAXIMUM RATINGS

Parameter		2N6781	2N6782			Units
V_{DS}	Drain - Source Voltage ①	60*	100*			V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1MΩ) ①	60*	100*			V
I_D @ T_C = 25°C	Continuous Drain Current	3.5*	3.5*			A
I_{DM}	Pulsed Drain Current ③	14	14			A
V_{GS}	Gate - Source Voltage	±20*				V
P_D @ T_C = 25°C	Max. Power Dissipation	15* (See Fig. 14)				W
	Linear Derating Factor	0.12* (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	14	(See Fig. 15 and 16) L = 100μH 14			A
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150				°C
	Lead Temperature	300(0.063 in. (1.6mm) from case for 10s)*				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	2N6781	60*	—	—	V	V_{GS} = 0V
		2N6782	100*	—	—	V	I_D = 500μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	—	4.0*	V	V_{DS} = V_{GS}, I_D = 500μA
I_{GSS}	Gate-Source Leakage Forward	ALL	—	—	100*	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	—	—	−100*	nA	V_{GS} = −20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	—	—	500*	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			—	—	2000*	μA	V_{DS} = Max. Rating, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	ALL	3.5	—	—	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, V_{GS} = 10V
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	0.6*	Ω	V_{GS} = 10V, I_D = 2.25A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	1.08*	Ω	V_{GS} = 10V, I_D = 2.25A, T_C = 125°C
$V_{DS(on)}$	On-State Drain-Source Voltage ②	ALL	—	—	2.1*	V	V_{GS} = 10V, I_D = 3.5A
g_{fs}	Forward Transconductance ②	ALL	1.0*		3.0*	S(℧)	V_{DS} = 15V, I_D = 2.25A
C_{iss}	Input Capacitance	ALL	60*	—	200*	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	40*	—	100*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	10*	—	25*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	—	—	15*	ns	V_{DD} = 35V, I_D = 2.25A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
T_r	Rise Time	ALL	—	—	25*	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	—	—	25*	ns	
t_f	Fall Time	ALL	—	—	20*	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	—	5.0	7.5	nC	V_{GS} = 10V, I_D = 8.0A, V_{DS} = 0.8 Max. Rating, See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	—	2.0	—	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	—	3.0	—	nC	
L_D	Internal Drain Inductance	ALL	—	5.0	—	nH	Measured from the drain lead. 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	—	15	—	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	—	—	8.33*	K/W	
R_{thJA}	Junction-to Ambient	ALL	—	—	175	K/W	Free Air Operation

*Indicates JEDEC registered values.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	ALL	—	—	3.5*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
I_{SM}	Pulse Source Current (Body Diode) ③	ALL	—	—	14	A	
V_{SD}	Diode Forward Voltage ②	ALL	.75*	—	1.5*	V	T_C = 25°C, I_S = 3.5A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	200	—	ns	T_J = 150°C, I_F = 3.5A, dI_F/dt = 100A/μs
Q_{rr}	Reverse Recovered Charge	ALL	—	1.0	—	μC	T_J = 150°C, I_F = 3.5A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25° to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

*Indicates JEDEC registered values.

Fig. 1 — Typical Output Characteristics

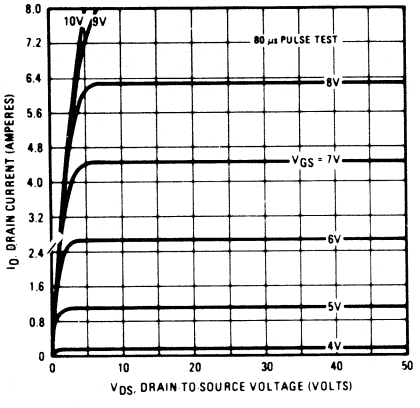


Fig. 2 — Typical Transfer Characteristics

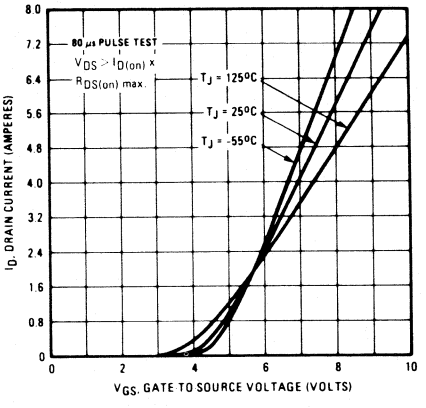


Fig. 3 — Typical Saturation Characteristics

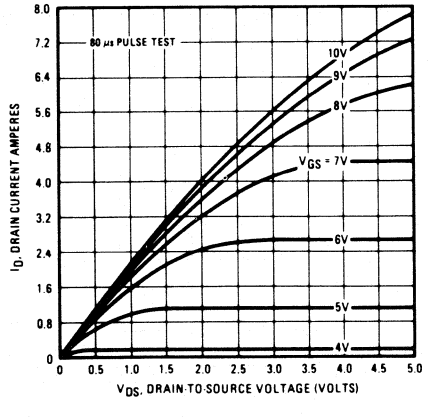
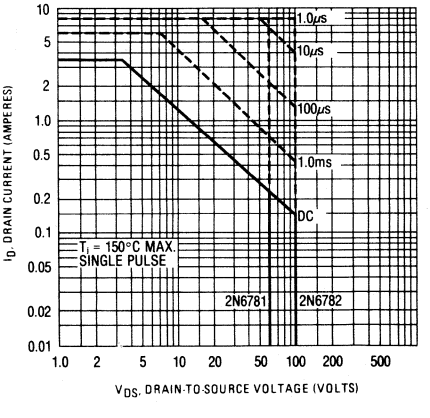


Fig. 4 — Forward Bias Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

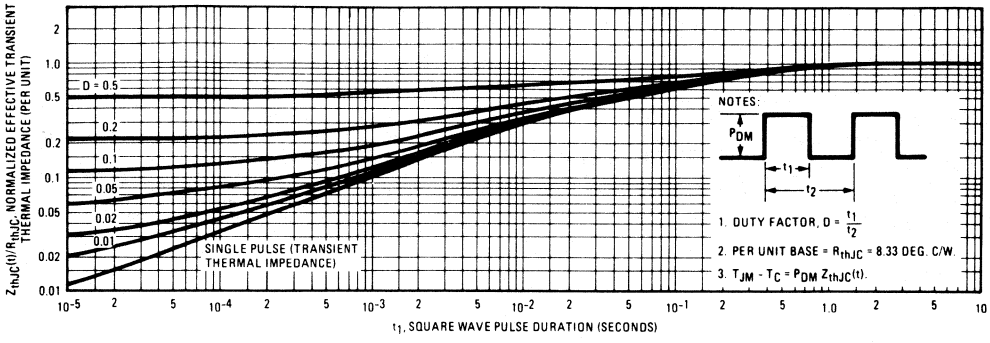


Fig. 6 — Typical Transconductance Vs. Drain Current

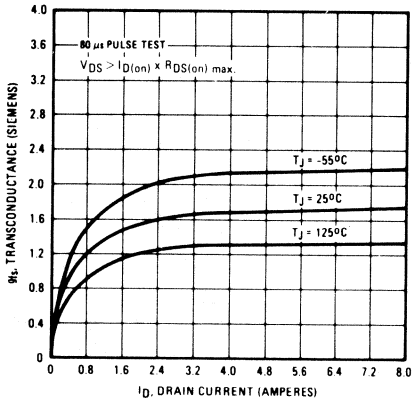


Fig. 7 — Typical Source-Drain Diode Forward Voltage

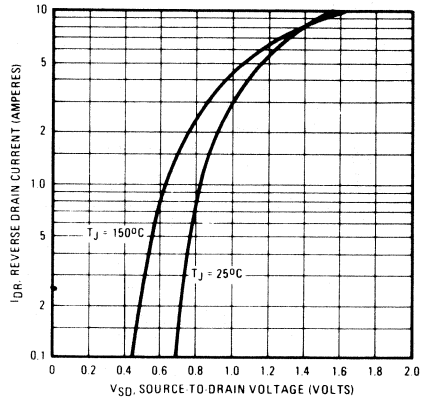


Fig. 8 — Breakdown Voltage Vs. Temperature

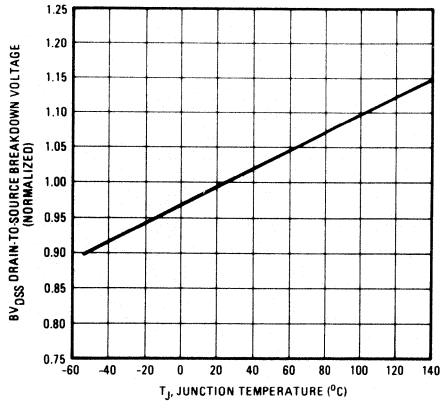


Fig. 9 — Normalized On-Resistance Vs. Temperature

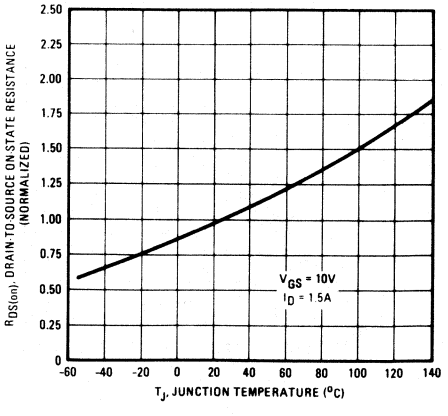


Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

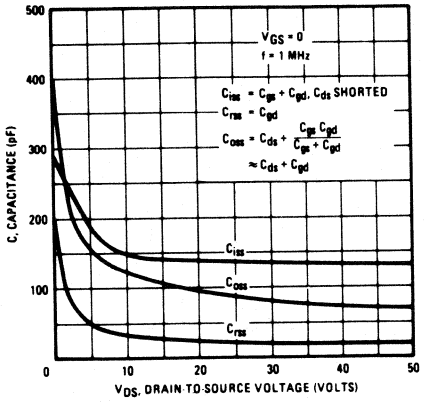


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

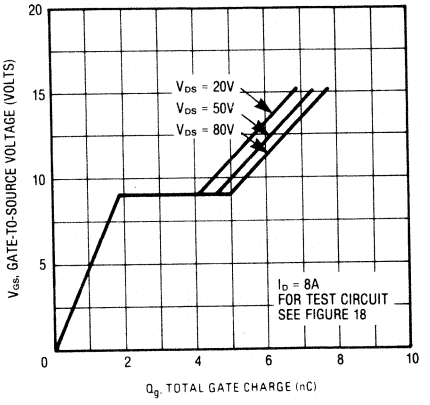


Fig. 12 – Typical On-Resistance Vs. Drain Current

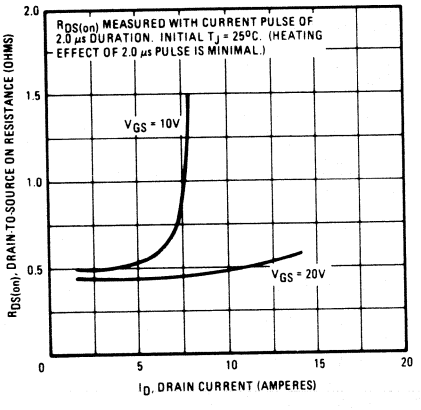


Fig. 13 – Maximum Drain Current Vs. Case Temperature

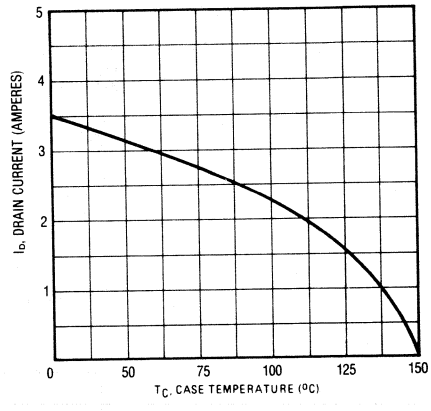
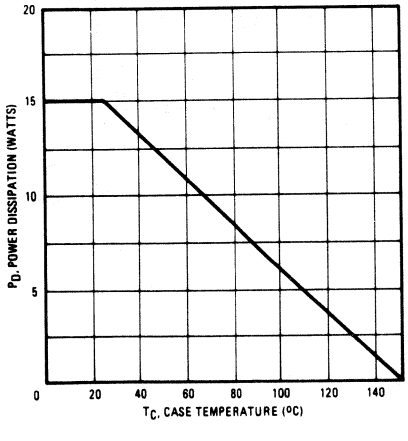


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

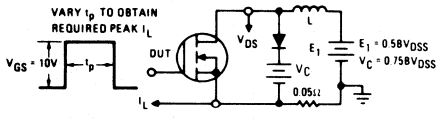


Fig. 16 – Clamped Inductive Waveforms

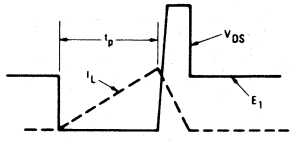


Fig. 17 – Switching Time Test Circuit

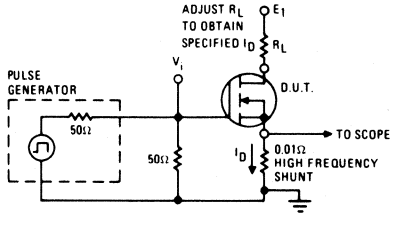
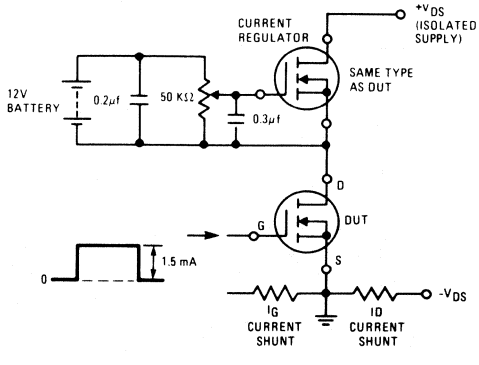


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

200 Volt, 1.5 Ohm N-Channel

2N6783
2N6784

3

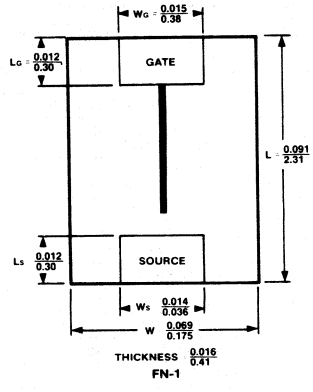
FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



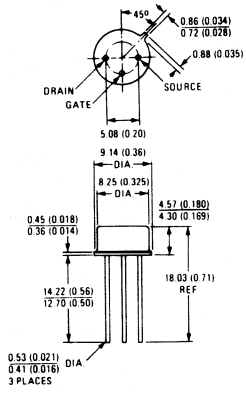
FN-1

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6783	150V	1.5Ω	2.25A
2N6784	200V	1.5Ω	2.25A

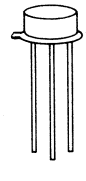
MECHANICAL SPECIFICATIONS

2N6783, 2N6784



All Dimensions in Millimeters and (Inches)

TO-205 AD (TO-39)



UNITRODE

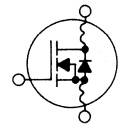
ABSOLUTE MAXIMUM RATINGS

Parameter		2N6783	2N6784			Units
V_{DS}	Drain - Source Voltage ①	150*	200*			V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1MΩ) ①	150*	200*			V
I_D @ T_C = 25°C	Continuous Drain Current	2.25*	2.25*			A
I_{DM}	Pulsed Drain Current ③	9.0	9.0			A
V_{GS}	Gate - Source Voltage	±20*				V
P_D @ T_C = 25°C	Max. Power Dissipation	15* (See Fig. 14)				W
	Linear Derating Factor	0.12* (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	9.0	(See Fig. 15 and 16) L = 100μH 9.0			A
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300(0.063 in. (1.6mm) from case for 10s)*				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS} ****		2N6783	150*	—	—	V	V_{GS} = 0V
		2N6784	200*	—	—	V	I_D = 500μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	—	4.0*	V	V_{DS} = V_{GS}, I_D = 500μA
I_{GSS}	Gate-Source Leakage Forward	ALL	—	—	100*	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	—	—	-100*	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	—	—	500*	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			—	—	2000*	μA	V_{DS} = Max. Rating, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	ALL	2.25	—	—	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, V_{GS} = 10V
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	1.5*	Ω	V_{GS} = 10V, I_D = 1.5A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	2.81	Ω	V_{GS} = 10V, I_D = 1.5A, T_C = 125°C
$V_{DS(on)}$	On-State Drain-Source Voltage ②	ALL	—	—	3.37*	V	V_{GS} = 10V, I_D = 2.25A
g_{fs}	Forward Transconductance ②	ALL	.9*		2.7*	S(℧)	V_{DS} = 15V, I_D = 1.5A
C_{iss}	Input Capacitance	ALL	60*	—	200*	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	20*	—	80*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	5*	—	25*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	—	—	15*	ns	V_{DD} = 75V, I_D = 1.5A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
T_r	Rise Time	ALL	—	—	20*	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	—	—	30*	ns	
t_f	Fall Time	ALL	—	—	20*	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	—	5.0	7.5	nC	V_{GS} = 10V, I_D = 4.5A, V_{DS} = 0.8 Max. Rating, See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	—	2.0	—	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	—	3.0	—	nC	
L_D	Internal Drain Inductance	ALL	—	5.0	—	nH	Measured from the drain lead. 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	—	15	—	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	—	—	8.33*	K/W	
R_{thJA}	Junction-to Ambient	ALL	—	—	175	K/W	Free Air Operation

*Indicates JEDEC registered values.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	ALL	—	—	2.25*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
I_{SM}	Pulse Source Current (Body Diode) ③	ALL	—	—	9	A	
V_{SD}	Diode Forward Voltage ②	ALL	0.7	—	1.5*	V	T_C = 25°C, I_S = 2.25A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	290	—	ns	T_J = 150°C, I_F = 2.25A, dI_F/dt = 100A/μs
Q_{rr}	Reverse Recovered Charge	ALL	—	2.0	—	μC	T_J = 150°C, I_F = 2.25A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25° to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

*Indicates JEDEC registered values.

Fig. 1 – Typical Output Characteristics

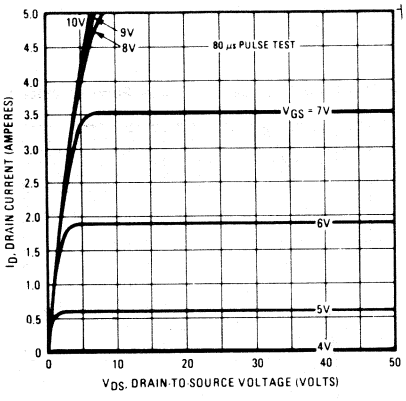


Fig. 2 – Typical Transfer Characteristics

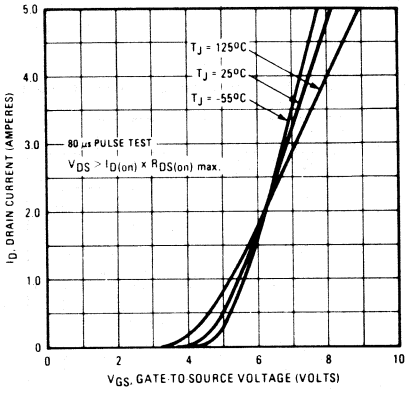


Fig. 3 – Typical Saturation Characteristics

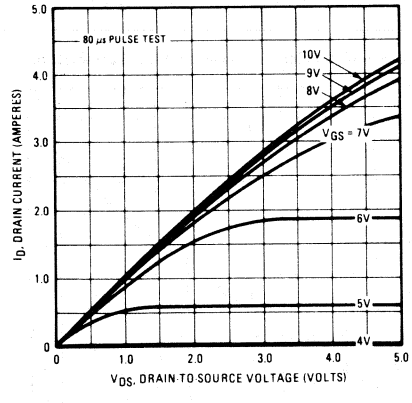
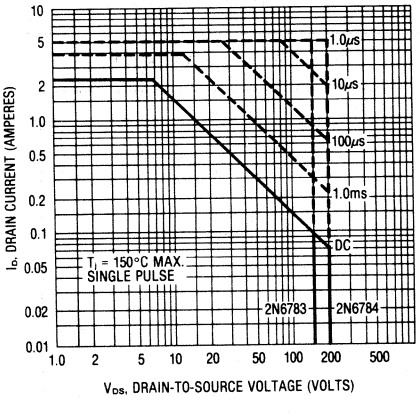


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

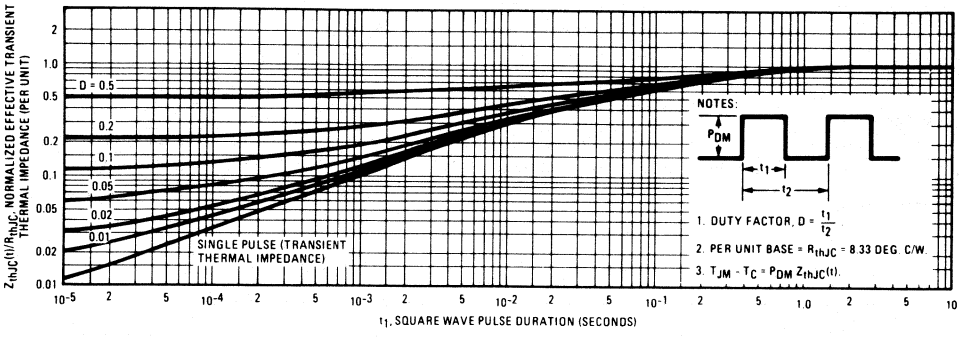


Fig. 6 – Typical Transconductance Vs. Drain Current

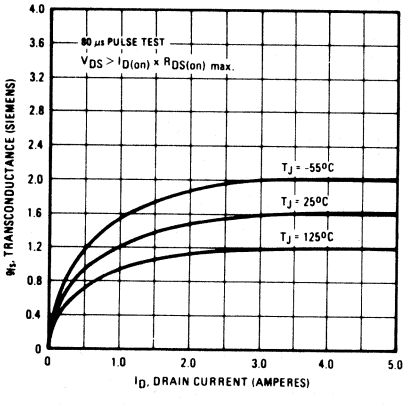


Fig. 7 – Typical Source-Drain Diode Forward Voltage

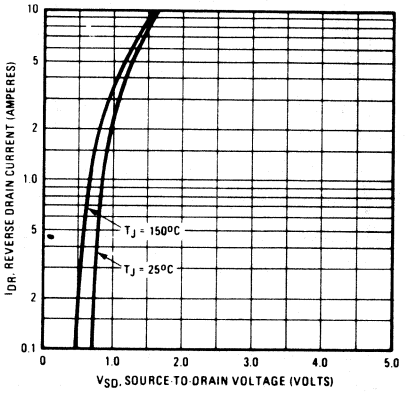


Fig. 8 – Breakdown Voltage Vs. Temperature

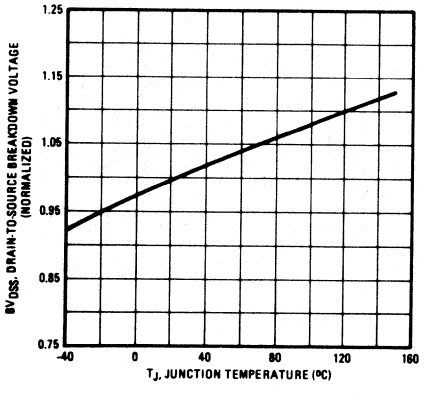
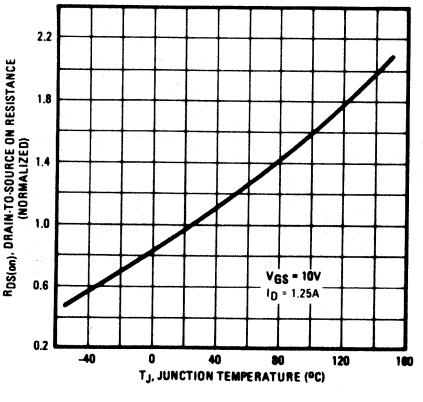


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

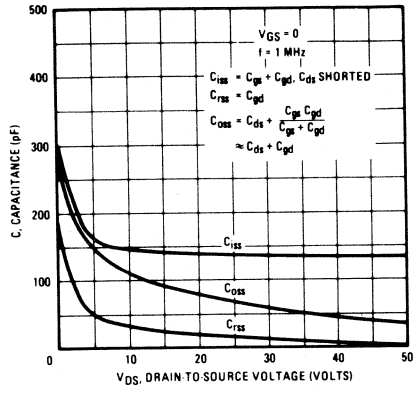


Fig. 11 — Typical Gate Charge vs Gate-to-Source Voltage

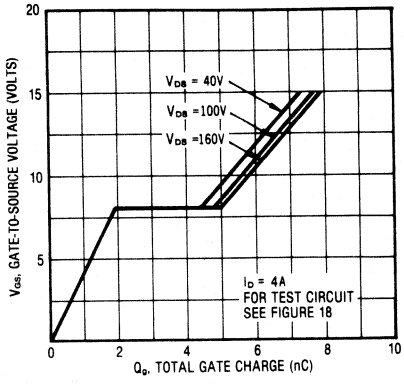


Fig. 12 – Typical On-Resistance Vs. Drain Current

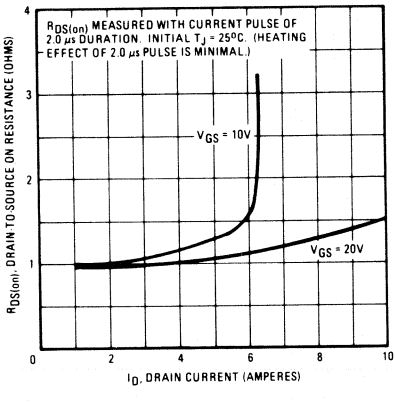


Fig. 13 — Maximum Drain Current vs Case Temperature

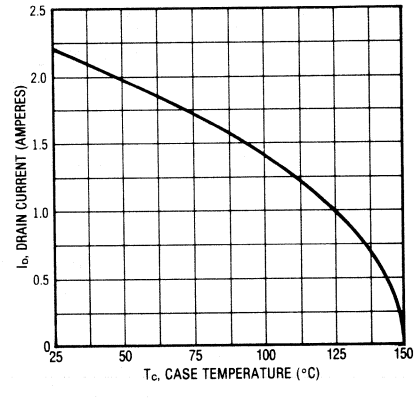
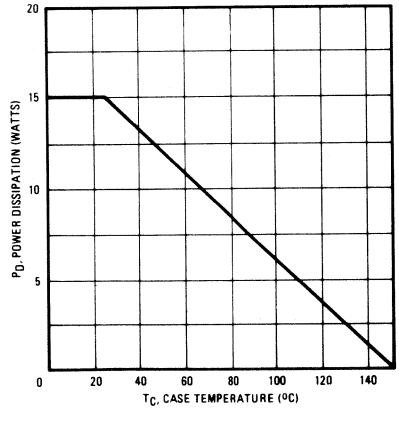


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

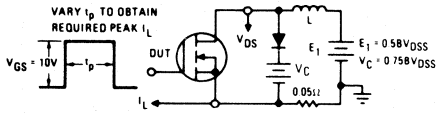


Fig. 16 – Clamped Inductive Waveforms

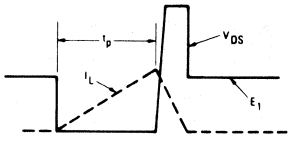


Fig. 17 – Switching Time Test Circuit

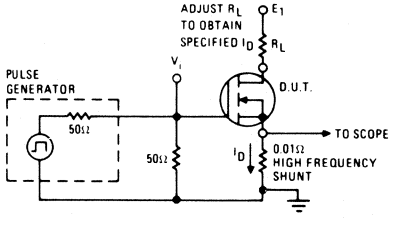
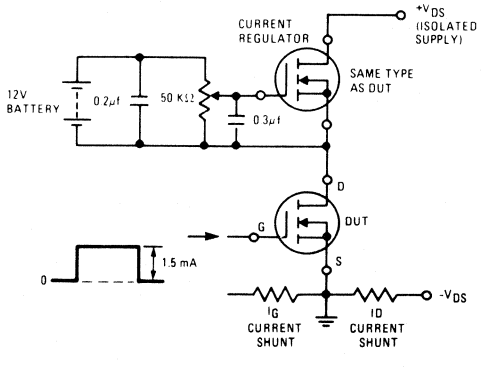


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

400 Volt, 3.6 Ohm N-Channel

2N6785
2N6786

3

FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

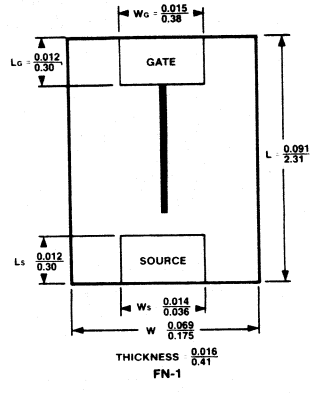
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

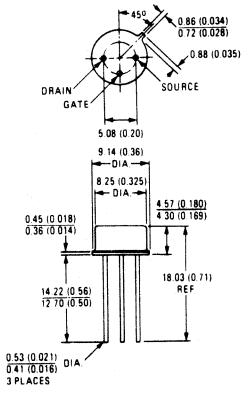
PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6785	350V	3.6Ω	1.25A
2N6786	400V	3.6Ω	1.25A



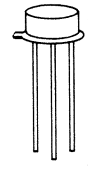
MECHANICAL SPECIFICATIONS

2N6785, 2N6786



All Dimensions in Millimeters and (Inches)

TO-205 AD (TO-39)



UNITRODE

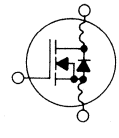
ABSOLUTE MAXIMUM RATINGS

Parameter		2N6785	2N6786			Units
V_{DS}	Drain - Source Voltage ①	350*	400*			V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1MΩ) ①	350*	400*			V
I_D @ T_C = 25°C	Continuous Drain Current	1.25*	1.25*			A
I_{DM}	Pulsed Drain Current ③	5.5	5.5			A
V_{GS}	Gate - Source Voltage	±20*				V
P_D @ T_C = 25°C	Max. Power Dissipation	15* (See Fig. 14)				W
	Linear Derating Factor	0.12* (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	5.5	(See Fig. 15 and 16) L = 100μH 5.5			A
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150				°C
	Lead Temperature	300(0.063 in. (1.6mm) from case for 10s)*				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	2N6785	350*	—	—	V	V_{GS} = 0V
		2N6786	400*	—	—	V	I_D = 500μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	—	4.0*	V	V_{DS} = V_{GS}, I_D = 500μA
I_{GSS}	Gate-Source Leakage Forward	ALL	—	—	100*	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	—	—	−100*	nA	V_{GS} = −20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	—	—	500*	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			—	—	2000*	μA	V_{DS} = Max. Rating, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	ALL	1.25	—	—	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, V_{GS} = 10V
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	3.6*	Ω	V_{GS} = 10V, I_D = .0.8A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	7.92*	Ω	V_{GS} = 10V, I_D = .8A, T_C = 125°C
$V_{DS(on)}$	On-State Drain-Source Voltage ②	ALL	—	—	4.5*	V	V_{GS} = 10V, I_D = 1.25A
g_{fs}	Forward Transconductance ②	ALL	0.7*		2.1*	S(℧)	V_{DS} = 15V, I_D = 0.8A
C_{iss}	Input Capacitance	ALL	60*	—	200*	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	15*	—	50*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	2*	--	15*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	—	—	15*	ns	V_{DD} = 170V, I_D = 0.8A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
T_r	Rise Time	ALL	—	—	20*	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	—	—	35*	ns	
t_f	Fall Time	ALL	—	—	30*	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	—	6.0	7.5	nC	V_{GS} = 10V, I_D = 2.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	—	3.0	—	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	—	3.0	—	nC	
L_D	Internal Drain Inductance	ALL	—	5.0	—	nH	Measured from the drain lead. 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	—	15	—	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	—	—	8.33*	K/W	
R_{thJA}	Junction-to Ambient	ALL	—	—	175	K/W	Free Air Operation

*Indicates JEDEC registered values.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	ALL	—	—	1.25*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
I_{SM}	Pulse Source Current (Body Diode) ③	ALL	—	—	5.5	A	
V_{SD}	Diode Forward Voltage ②	ALL	0.6*	—	1.4*	V	T_C = 25°C, I_S = 1.25A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	380	—	ns	T_J = 150°C, I_F = 1.25A, dI_F/dt = 100A/μs
Q_{rr}	Reverse Recovered Charge	ALL	—	2.7	—	μC	T_J = 150°C, I_F = 1.25A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25° to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

*Indicates JEDEC registered values.

Fig. 1 — Typical Output Characteristics

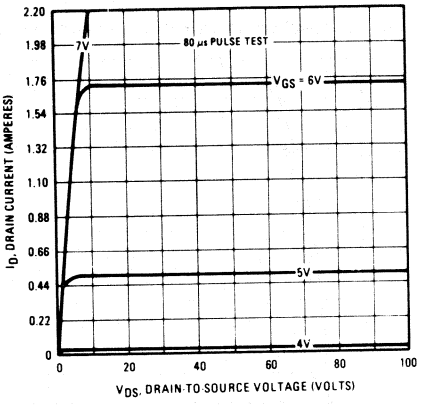


Fig. 2 — Typical Transfer Characteristics

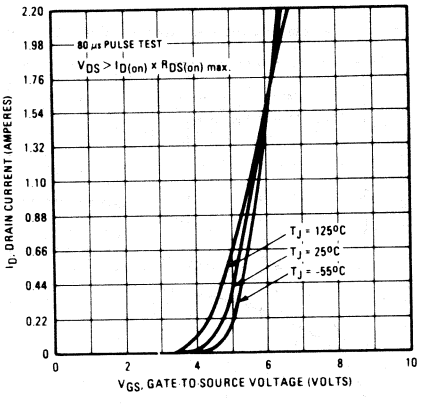


Fig. 3 — Typical Saturation Characteristics

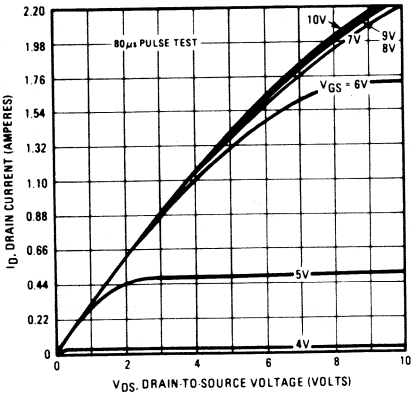
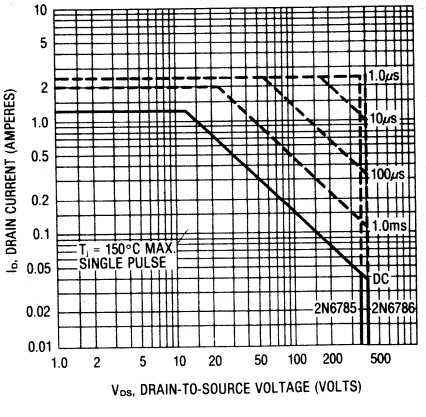


Fig. 4 — Forward Bias Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

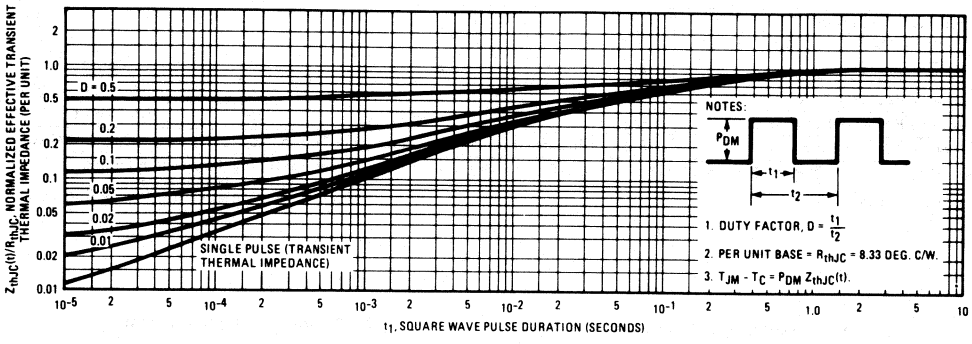


Fig. 6 — Typical Transconductance Vs. Drain Current

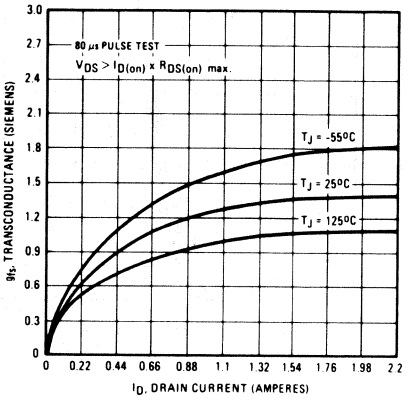


Fig. 7 — Typical Source-Drain Diode Forward Voltage

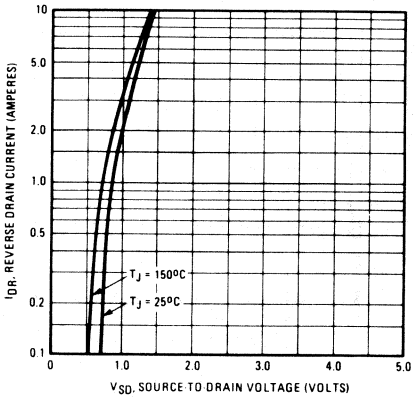


Fig. 8 — Breakdown Voltage Vs. Temperature

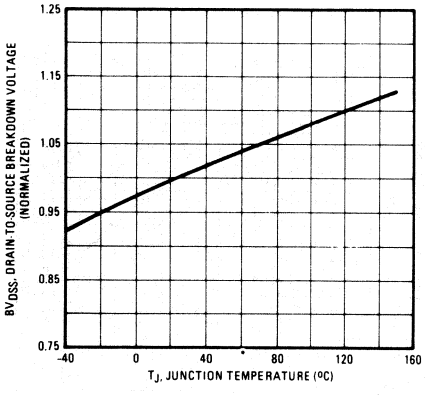
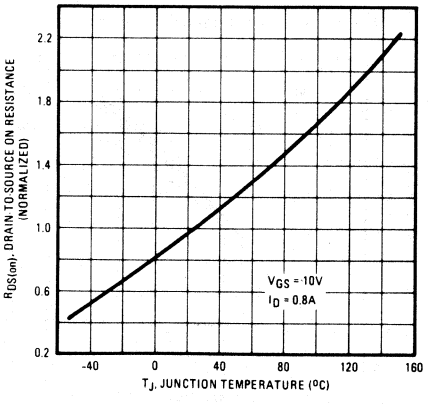


Fig. 9 — Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

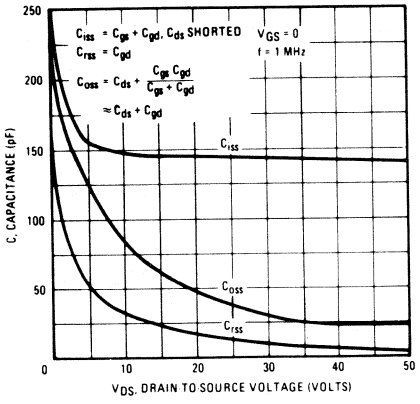


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

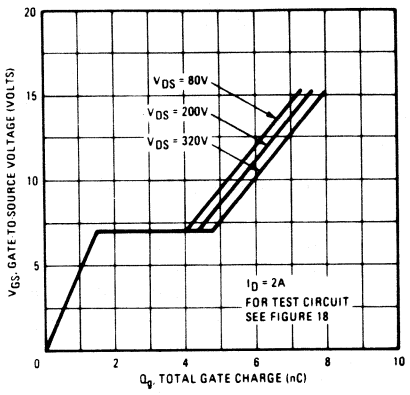


Fig. 12 – Typical On-Resistance Vs. Drain Current

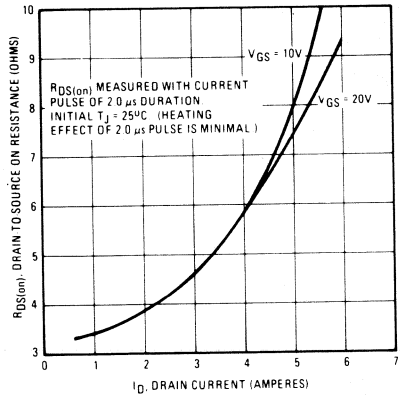


Fig. 13 – Maximum Drain Current Vs. Case Temperature

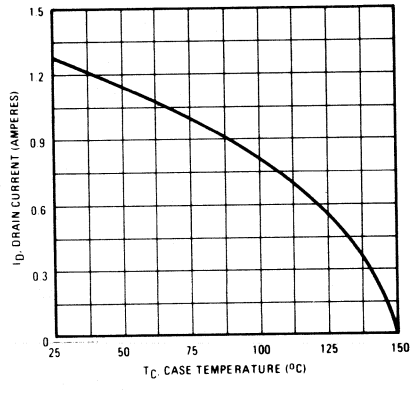
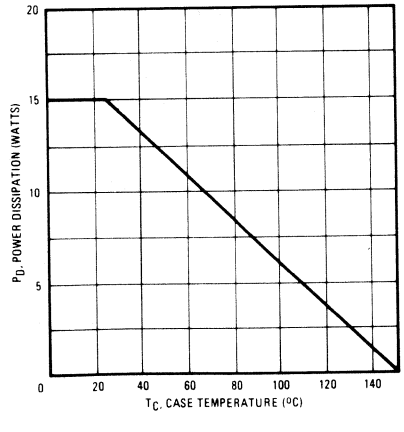


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

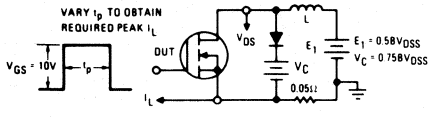


Fig. 16 – Clamped Inductive Waveforms

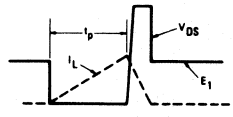


Fig. 17 – Switching Time Test Circuit

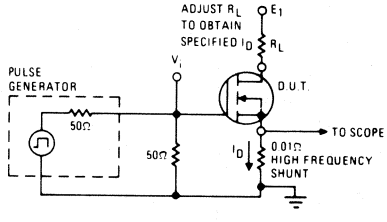
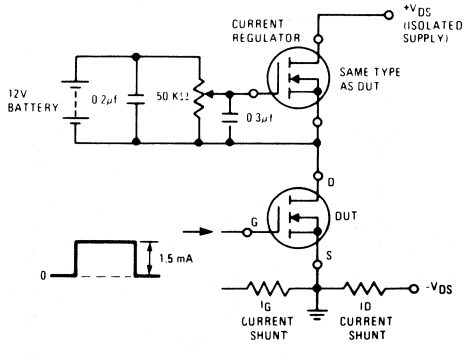


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

100 Volt, 0.30 Ohm N-Channel

2N6787
2N6788

3

FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

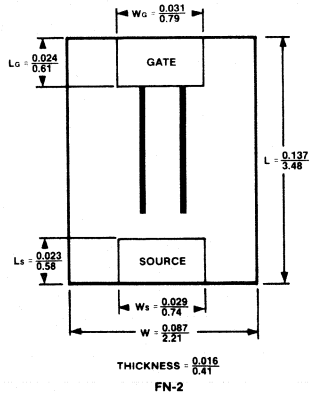
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

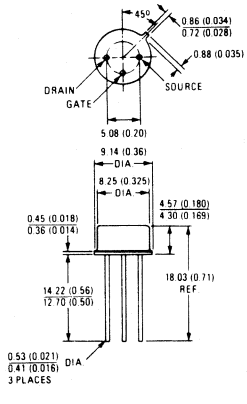
Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6787	60V	0.30Ω	6.0A
2N6788	100V	0.30Ω	6.0A



FN-2

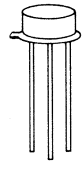
MECHANICAL SPECIFICATIONS

2N6787, 2N6788



All Dimensions in Millimeters and (Inches)

TO-205 AD (TO-39)



UNITRODE

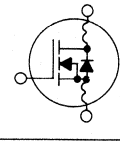
ABSOLUTE MAXIMUM RATINGS

Parameter		2N6787	2N6788			Units
V_{DS}	Drain - Source Voltage	60*	100*			V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1MΩ)	60*	100*			V
I_D @ T_C = 25°C	Continuous Drain Current	6.0*	6.0*			A
I_{DM}	Pulsed Drain Current	24	24			A
V_{GS}	Gate - Source Voltage	±20*				V
P_D @ T_C = 25°C	Max. Power Dissipation	20* (See Fig. 14)				W
	Linear Derating Factor	0.16* (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	24	(See Fig. 15 and 16) L = 100μH 24			A
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150				°C
	Lead Temperature	300(0.063 in. (1.6mm) from case for 10s)*				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	2N6787	60*	—	—	V	V_{GS} = 0V
		2N6788	100*	—	—	V	I_D = 1.0mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	—	4.0*	V	V_{DS} = V_{GS}, I_D = 1.0mA
I_{GSS}	Gate-Source Leakage Forward	ALL	—	—	100*	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	—	—	−100*	nA	V_{GS} = −20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	—	—	1.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0V
			—	—	4.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	ALL	6.0	—	—	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, V_{GS} = 10V
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	0.30*	Ω	V_{GS} = 10V, I_D = 3.5A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	0.54*	Ω	V_{GS} = 10V, I_D = 3.5A, T_C = 125°C
$V_{DS(on)}$	On-State Drain-Source Voltage ②	ALL	—	—	1.80*	V	V_{GS} = 10V, I_D = 6.0A
g_{fs}	Forward Transconductance ②	ALL	1.5*		4.5*	S(℧)	V_{DS} = 15V, I_D = 3.5A
C_{iss}	Input Capacitance	ALL	200*	—	600*	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	100*	—	400*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	20*	—	100*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	—	—	40*	ns	V_{DD} = 35V, I_D = 3.5A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
T_r	Rise Time	ALL	—	—	70*	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	—	—	40*	ns	
t_f	Fall Time	ALL	—	—	70*	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	—	10	15	nC	V_{DD} = 35V, I_D = 2.25A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	—	6.0	—	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	—	4.0	—	nC	
L_D	Internal Drain Inductance	ALL	—	5.0	—	nH	Measured from the drain lead. 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	—	15	—	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	—	—	6.25*	K/W	
R_{thJA}	Junction-to Ambient	ALL	—	—	175	K/W	Free Air Operation

*Indicates JEDEC registered values.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	ALL	—	—	6.0*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
I_{SM}	Pulse Source Current (Body Diode) ③	ALL	—	—	24	A	
V_{SD}	Diode Forward Voltage ②	ALL	0.8*	—	1.8*	V	T_C = 25°C, I_S = 6.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	230	—	ns	T_J = 150°C, I_F = 6.0A, dI_F/dt = 100A/μs
Q_{rr}	Reverse Recovered Charge	ALL	—	1.2	—	μC	T_J = 150°C, I_F = 6.0A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25° to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

*Indicates JEDEC registered values.

Fig. 1 — Typical Output Characteristics

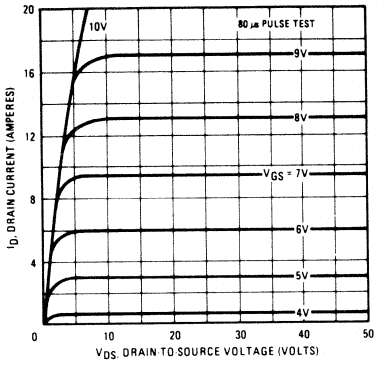


Fig. 2 — Typical Transfer Characteristics

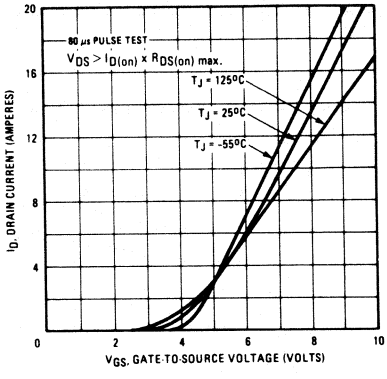


Fig. 3 — Typical Saturation Characteristics

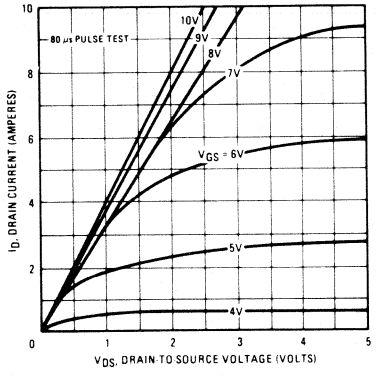


Fig. 4 — Forward Bias Safe Operating Area

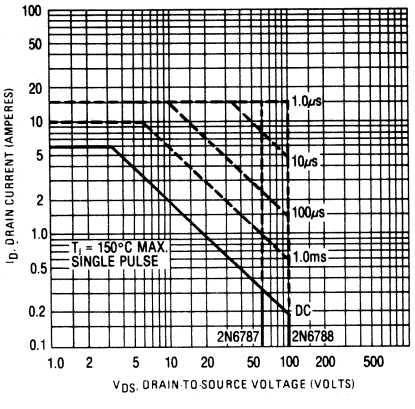


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

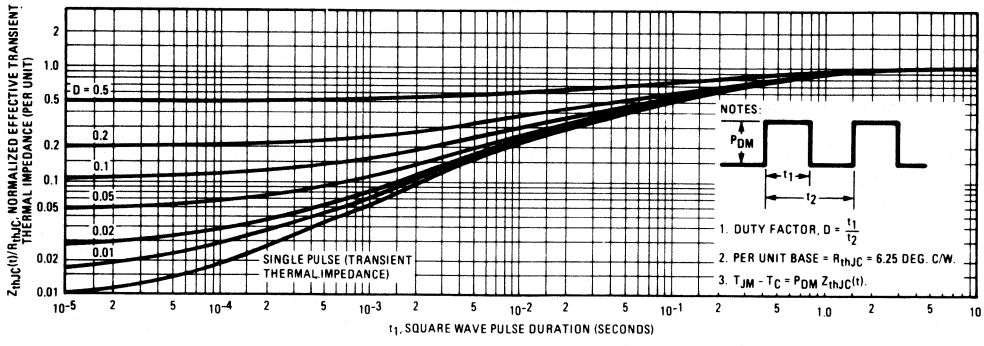


Fig. 6 – Typical Transconductance Vs. Drain Current

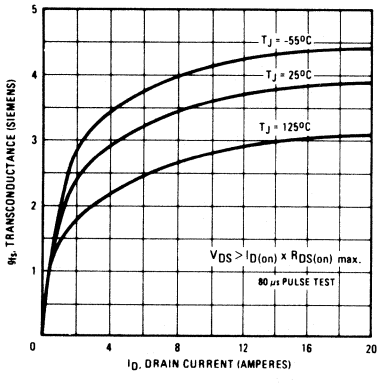


Fig. 7 – Typical Source-Drain Diode Forward Voltage

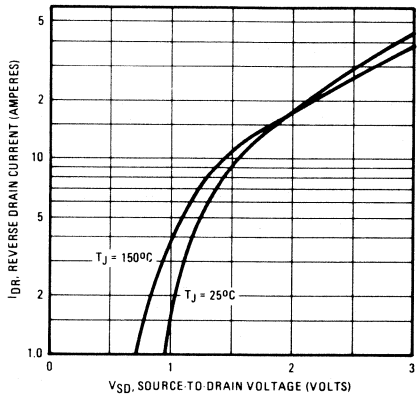


Fig. 8 – Breakdown Voltage Vs. Temperature

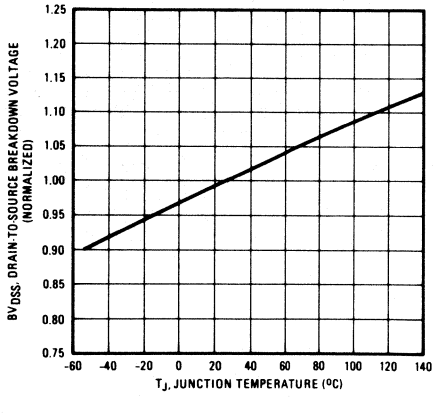
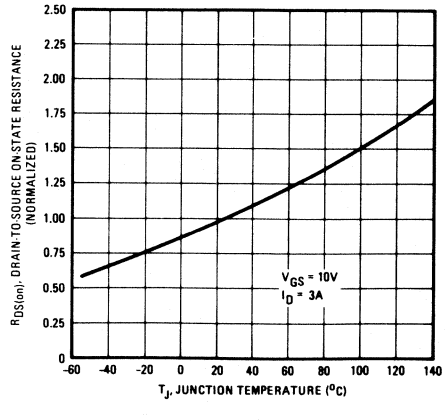


Fig. 9 – Normalized On-Resistance Vs. Temperature



3

Fig. 10 — Typical Capacitance Vs. Drain-to-Source Voltage

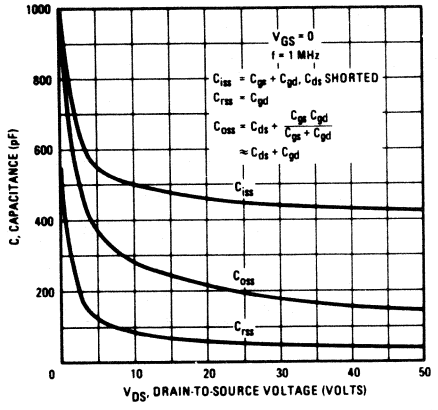


Fig. 11 — Typical Gate Charge vs Gate-to-Source Voltage

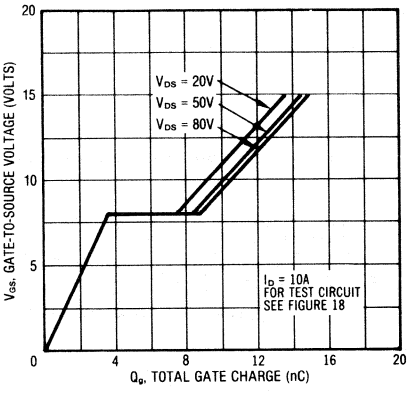


Fig. 12 — Typical On-Resistance Vs. Drain Current

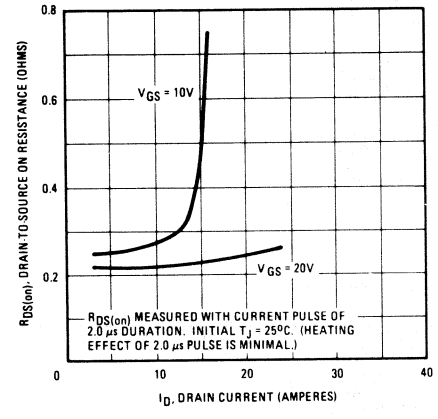


Fig. 13 — Maximum Drain Current vs Case Temperature

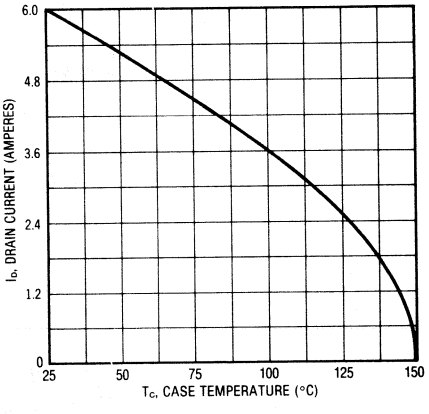
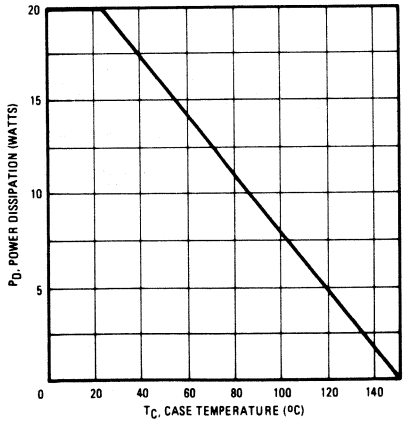


Fig. 14 — Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

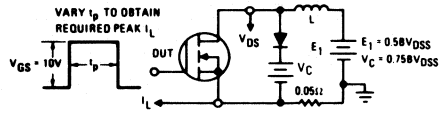


Fig. 16 – Clamped Inductive Waveforms

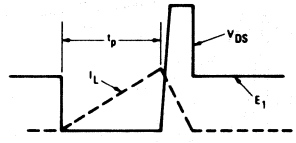


Fig. 17 – Switching Time Test Circuit

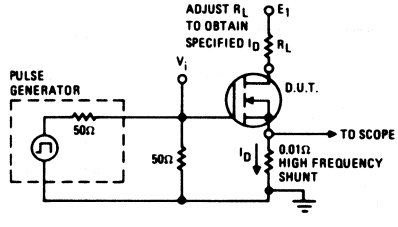
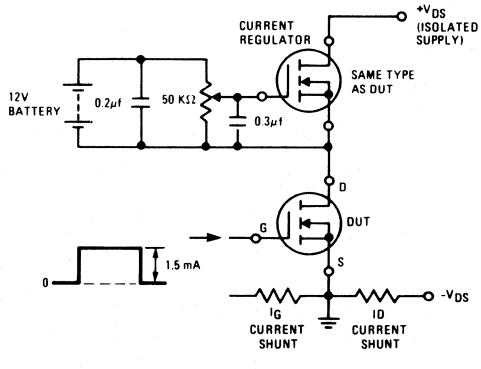


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

200 Volt, 0.80 Ohm N-Channel

2N6789
2N6790

3

FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

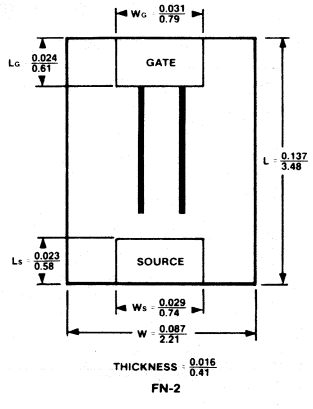
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

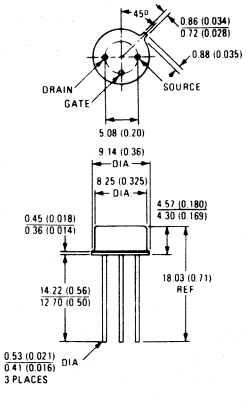
Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6789	150V	0.80Ω	3.5A
2N6790	200V	0.80Ω	3.5A



FN-2

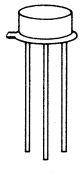
MECHANICAL SPECIFICATIONS

2N6789, 2N6790



All Dimensions in Millimeters and (Inches)

TO-205 AD (TO-39)



UNITRODE

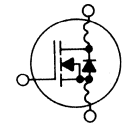
ABSOLUTE MAXIMUM RATINGS

Parameter		2N6789	2N6790			Units
V_{DS}	Drain - Source Voltage ①	150*	200*			V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1MΩ) ①	150*	200*			V
I_D @ T_C = 25°C	Continuous Drain Current	3.5*	3.5*			A
I_{DM}	Pulsed Drain Current ③	14	14			A
V_{GS}	Gate - Source Voltage	±20*				V
P_D @ T_C = 25°C	Max. Power Dissipation	20* (See Fig. 14)				W
	Linear Derating Factor	0.16* (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	14	(See Fig. 15 and 16) L = 100μH 14			A
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150				°C
	Lead Temperature	300(0.063 in. (1.6mm) from case for 10s)*				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	2N6789	150*	—	—	V	V_{GS} = 0V
		2N6790	200*	—	—	V	I_D = 1.0mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	—	4.0*	V	V_{DS} = V_{GS}, I_D = 1.0mA
I_{GSS}	Gate-Source Leakage Forward	ALL	—	—	100*	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	—	—	−100*	nA	V_{GS} = −20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	—	—	1.0*	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			—	—	4.0*	μA	V_{DS} = Max. Rating, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	ALL	3.5	—	—	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, V_{GS} = 10V
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	0.8*	Ω	V_{GS} = 10V, I_D = 2.25A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	1.5*	Ω	V_{GS} = 10V, I_D = 2.25A, T_C = 125°C
$V_{DS(on)}$	On-State Drain-Source Voltage ②	ALL	—	—	2.8*	V	V_{GS} = 10V, I_D = 3.5A
g_{fs}	Forward Transconductance ②	ALL	1.5*		4.5*	S(℧)	V_{DS} = 15V, I_D = 2.25A
C_{iss}	Input Capacitance	ALL	200*	—	600*	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	60*	—	300*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	15*	—	80*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	—	—	40*	ns	V_{DD} = 74V, I_D = 2.25A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
T_r	Rise Time	ALL	—	—	50*	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	—	—	50*	ns	
t_f	Fall Time	ALL	—	—	50*	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	—	11	15	nC	V_{GS} = 10V, I_D = 7.0A, V_{DS} = 0.8 Max. Rating, See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	—	5	—	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	—	6	—	nC	
L_D	Internal Drain Inductance	ALL	—	5.0	—	nH	Measured from the drain lead. 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	—	15	—	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	—	—	6.25*	K/W	
R_{thJA}	Junction-to Ambient	ALL	—	—	175	K/W	Free Air Operation

*Indicates JEDEC registered values.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	ALL	—	—	3.5*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
I_{SM}	Pulse Source Current (Body Diode) ③	ALL	—	—	14	A	
V_{SD}	Diode Forward Voltage ②	ALL	0.7*	—	1.5*	V	T_C = 25°C, I_S = 3.5A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	350	—	ns	T_J = 150°C, I_F = 3.5A, dI_F/dt = 100A/μs
Q_{rr}	Reverse Recovered Charge	ALL	—	2.3	—	μC	T_J = 150°C, I_F = 3.5A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25° to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

*Indicates JEDEC registered values.

Fig. 1 — Typical Output Characteristics

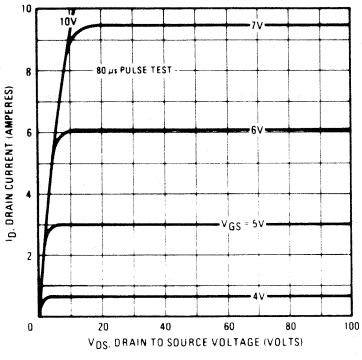


Fig. 2 — Typical Transfer Characteristics

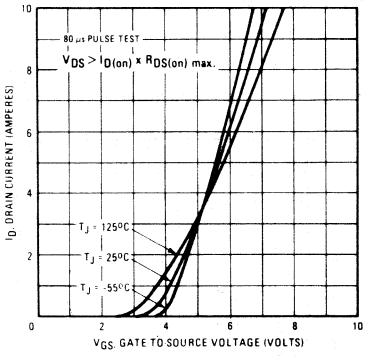


Fig. 3 — Typical Saturation Characteristics

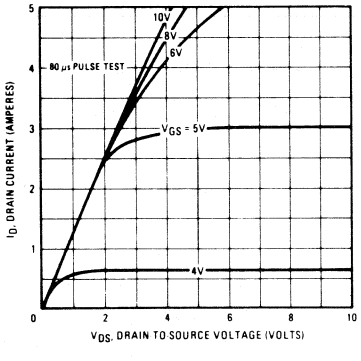


Fig. 4 — Forward Bias Safe Operating Area

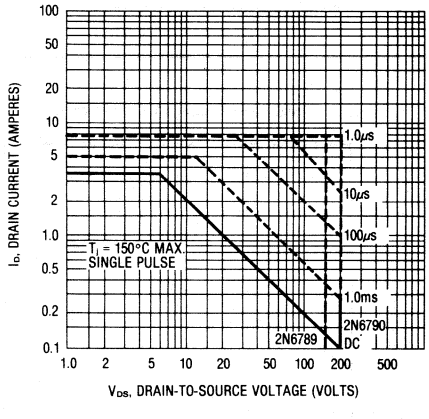


Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

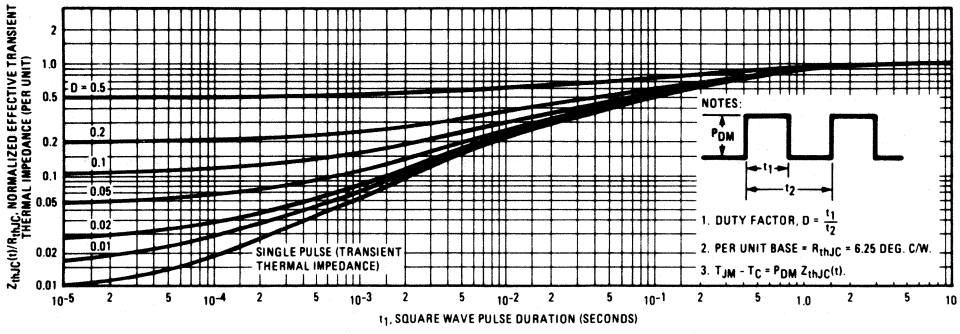


Fig. 6 — Typical Transconductance Vs. Drain Current

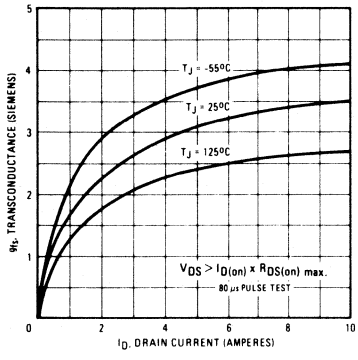


Fig. 7 — Typical Source-Drain Diode Forward Voltage

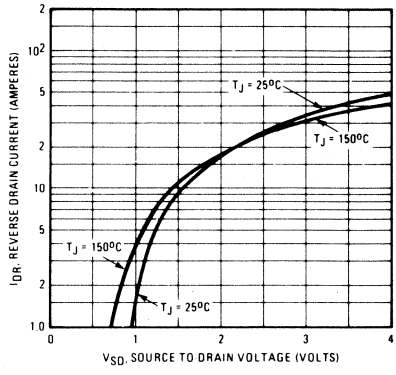


Fig. 8 — Breakdown Voltage Vs. Temperature

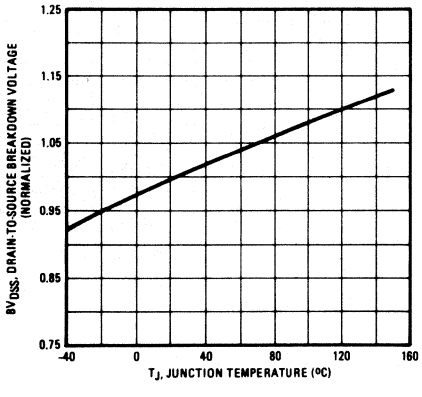
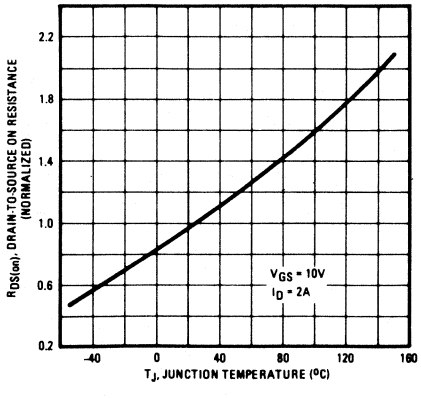


Fig. 9 — Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

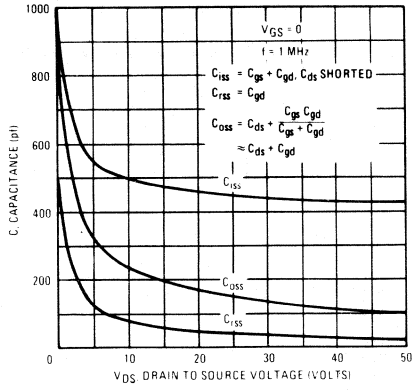


Fig. 11 — Typical Gate Charge vs Gate-to-Source Voltage

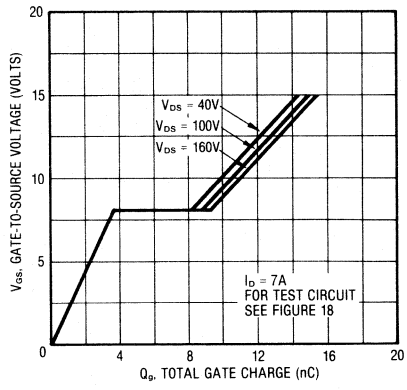


Fig. 12 – Typical On-Resistance Vs. Drain Current

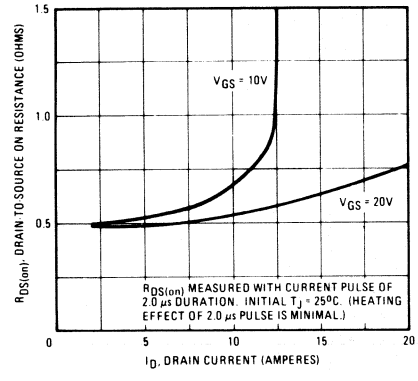


Fig. 13 — Maximum Drain Current vs Case Temperature

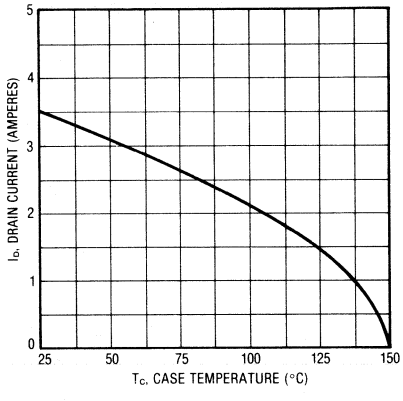


Fig. 14 – Power Vs. Temperature Derating Curve

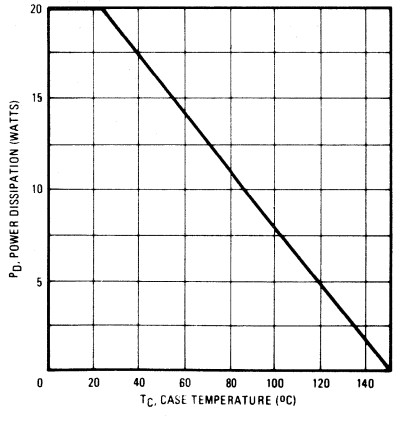


Fig. 15 – Clamped Inductive Test Circuit

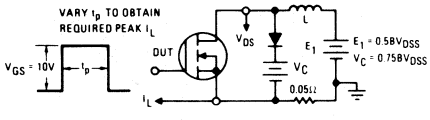


Fig. 16 – Clamped Inductive Waveforms

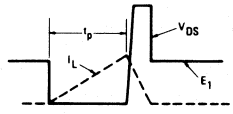


Fig. 17 – Switching Time Test Circuit

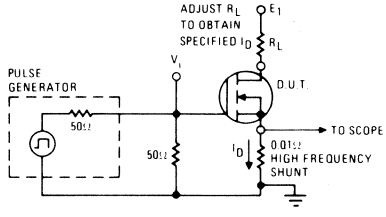
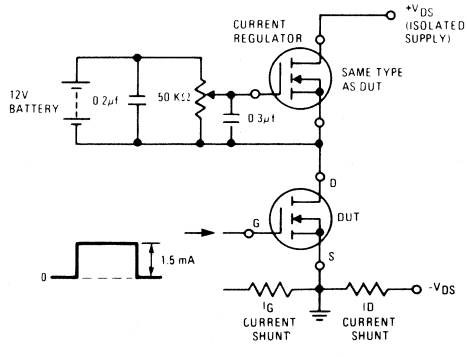


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

400 Volt, 1.8 Ohm N-Channel

2N6791
2N6792

3

FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

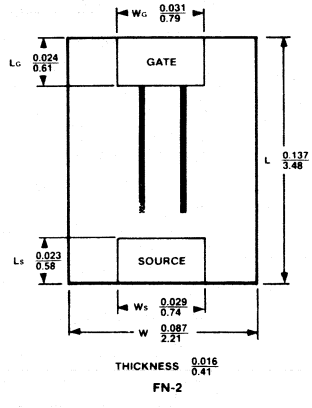
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

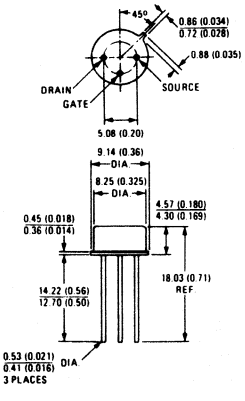
Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6791	350V	1.8Ω	2.0A
2N6792	400V	1.8Ω	2.0A



FN-2

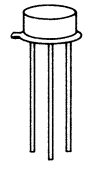
MECHANICAL SPECIFICATIONS

2N6791, 2N6792



All Dimensions in Millimeters and (Inches)

TO-205 AD (TO-39)



UNITRODE

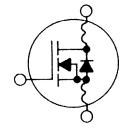
ABSOLUTE MAXIMUM RATINGS

Parameter		2N6791	2N6792			Units
V_{DS}	Drain - Source Voltage ①	350*	400*			V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1MΩ) ①	350*	400*			V
I_D @ T_C = 25°C	Continuous Drain Current	2.0*	2.0*			A
I_{DM}	Pulsed Drain Current ③	10	10			A
V_{GS}	Gate - Source Voltage	±20*				V
P_D @ T_C = 25°C	Max. Power Dissipation	20* (See Fig. 14)				W
	Linear Derating Factor	0.16* (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	10	(See Fig. 15 and 16) L = 100μH 10			A
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150				°C
	Lead Temperature	300(0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	2N6791	350*	—	—	V	V_{GS} = 0V
		2N6792	400*	—	—	V	I_D = 1.0mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	—	4.0*	V	V_{DS} = V_{GS}, I_D = 1.0mA
I_{GSS}	Gate-Source Leakage Forward	ALL	—	—	100*	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	—	—	−100*	nA	V_{GS} = −20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	—	—	1.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0V
			—	—	4.0*	μA	V_{DS} = Max. Rating, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	ALL	2.0	—	—	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, V_{GS} = 10V
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	1.8*	Ω	V_{GS} = 10V, I_D = 1.25A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	4.0*	Ω	V_{GS} = 10V, I_D = 1.25A, T_C = 125°C
$V_{DS(on)}$	On-State Drain-Source Voltage ②	ALL	—	—	3.6*	V	V_{GS} = 10V, I_D = 2.0A
g_{fs}	Forward Transconductance ②	ALL	1.0*		3.0*	S(℧)	V_{DS} = 15V, I_D = 1.25A
C_{iss}	Input Capacitance	ALL	200*	—	600*	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	40*	—	200*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	5*	—	40*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	—	—	40*	ns	V_{DD} = 35V, I_D = 1.25A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
T_r	Rise Time	ALL	—	—	35*	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	—	—	60*	ns	
t_f	Fall Time	ALL	—	—	35*	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	—	12	15	nC	V_{GS} = 10V, I_D = 5.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	—	6.0	—	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	—	6.0	—	nC	
L_D	Internal Drain Inductance	ALL	—	5.0	—	nH	Measured from the drain lead. 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	—	15	—	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	—	—	6.25*	K/W	
R_{thJA}	Junction-to Ambient	ALL	—	—	175	K/W	Free Air Operation

*Indicates JEDEC registered values.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	ALL	—	—	20*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
I_{SM}	Pulse Source Current (Body Diode) ③	ALL	—	—	10	A	
V_{SD}	Diode Forward Voltage ②	ALL	0.6*	—	1.4*	V	T_C = 25°C, I_S = 2.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	450	—	ns	T_J = 150°C, I_F = 2.0A, dI_F/dt = 100A/μs
Q_{rr}	Reverse Recovered Charge	ALL	—	3.1	—	μC	T_J = 150°C, I_F = 2.0A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25° to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

*Indicates JEDEC registered values.

Fig. 1 – Typical Output Characteristics

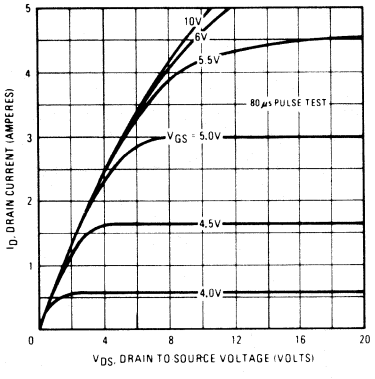


Fig. 2 – Typical Transfer Characteristics

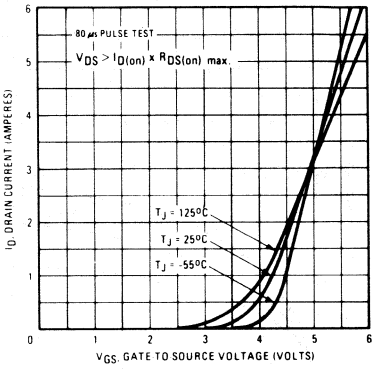


Fig. 3 – Typical Saturation Characteristics

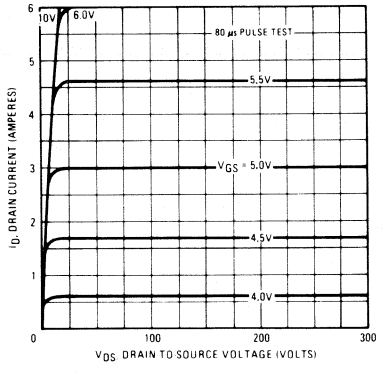
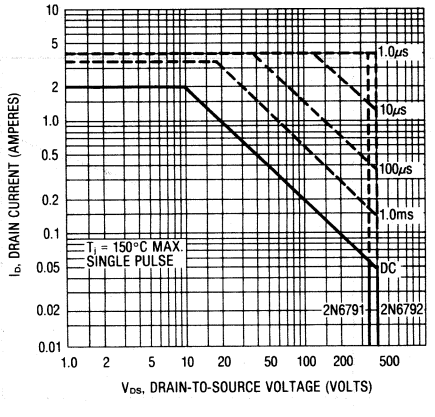


Fig. 4 — Forward Bias Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

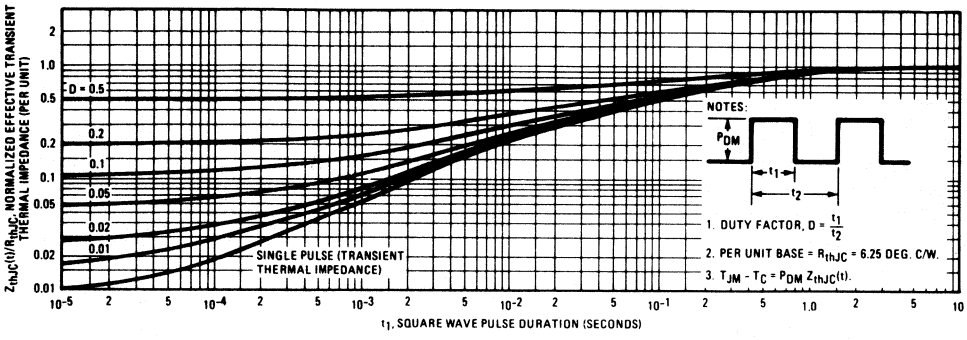


Fig. 6 – Typical Transconductance Vs. Drain Current

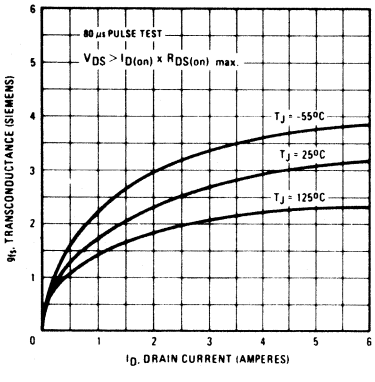


Fig. 7 – Typical Source-Drain Diode Forward Voltage

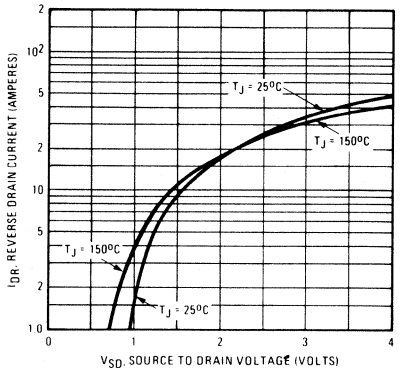


Fig. 8 – Breakdown Voltage Vs. Temperature

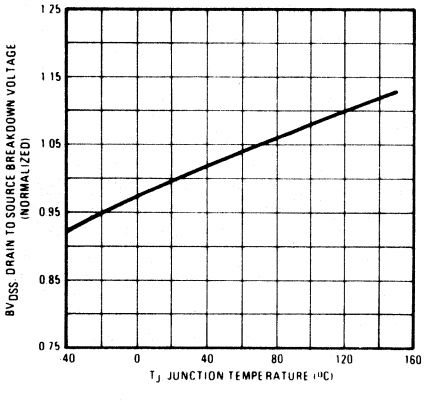
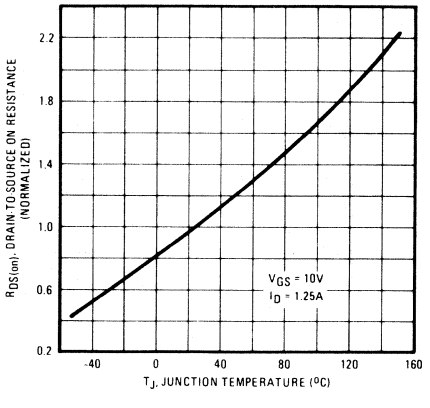


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

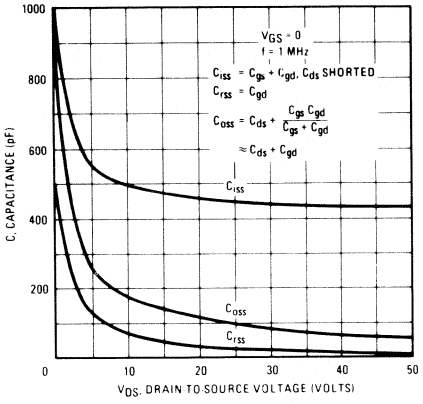


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

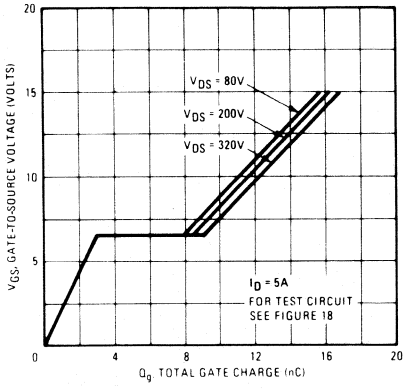


Fig. 12 – Typical On-Resistance Vs. Drain Current

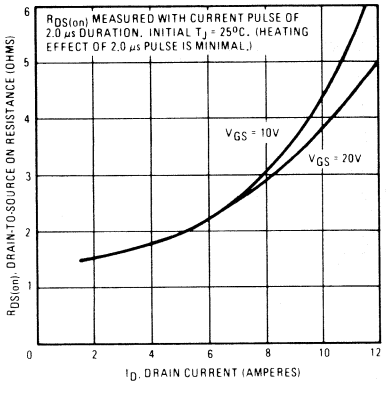


Fig. 13 – Maximum Drain Current Vs. Case Temperature

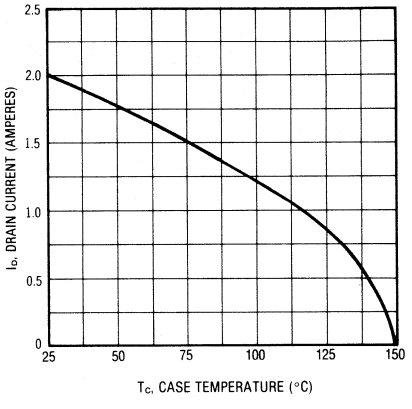


Fig. 14 – Power Vs. Temperature Derating Curve

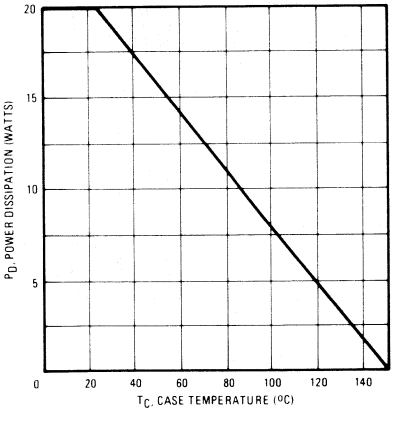


Fig. 15 – Clamped Inductive Test Circuit

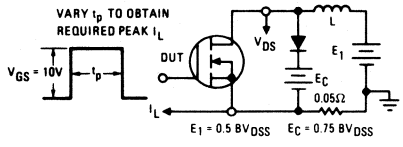


Fig. 16 – Clamped Inductive Waveforms

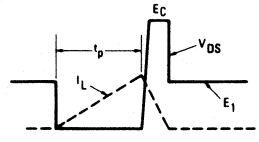


Fig. 17 – Switching Time Test Circuit

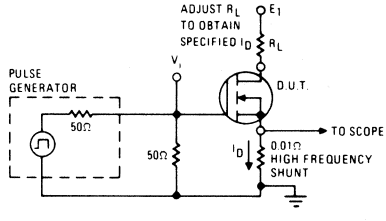
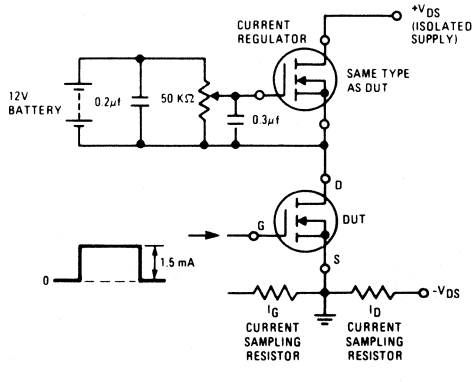


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

500 Volt, 3.0 Ohm N-Channel

2N6793
2N6794

3

FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

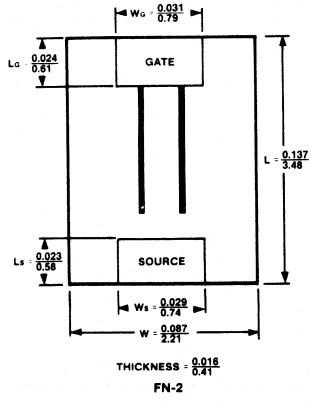
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

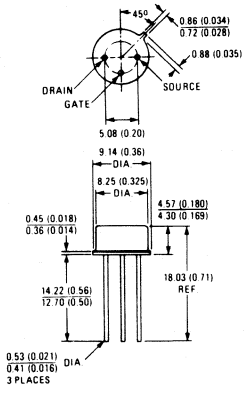
Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6793	450V	3.0Ω	1.5A
2N6794	500V	3.0Ω	1.5A



FN-2

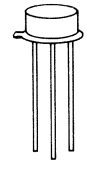
MECHANICAL SPECIFICATIONS

2N6793, 2N6794



All Dimensions in Millimeters and (Inches)

TO-205 AD (TO-39)



UNITRODE

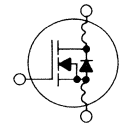
ABSOLUTE MAXIMUM RATINGS

Parameter		2N6793	2N6794			Units
V_{DS}	Drain - Source Voltage ①	450*	500*			V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1MΩ) ①	450*	500*			V
I_D @ T_C = 25°C	Continuous Drain Current	1.5*	1.5*			A
I_{DM}	Pulsed Drain Current ③	6.5	6.5			A
V_{GS}	Gate - Source Voltage	±20*				V
P_D @ T_C = 25°C	Max. Power Dissipation	20* (See Fig. 14)				W
	Linear Derating Factor	0.16* (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	6.5	(See Fig. 15 and 16) L = 100μH 6.5			A
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300(0.063 in. (1.6mm) from case for 10s)*				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	2N6793	450*	—	—	V	V_{GS} = 0V
		2N6794	500*	—	—	V	I_D = 1.0mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	—	4.0*	V	V_{DS} = V_{GS}, I_D = 1.0mA
I_{GSS}	Gate-Source Leakage Forward	ALL	—	—	100*	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	—	—	-100*	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	—	—	1.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0V
			—	—	4.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	ALL	1.5	—	—	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, V_{GS} = 10V
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	3.0*	Ω	V_{GS} = 10V, I_D = 1.0A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	6.6*	Ω	V_{GS} = 10V, I_D = 1.0A, T_C = 125°C
$V_{DS(on)}$	On-State Drain-Source Voltage ②	ALL	—	—	4.5*	V	V_{GS} = 10V, I_D = 1.5A
g_{fs}	Forward Transconductance ②	ALL	1.0*		3.0*	S(℧)	V_{DS} = 15V, I_D = 1.0A
C_{iss}	Input Capacitance	ALL	200*	—	600*	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	30*	—	150*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	5*	—	40*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	—	—	40*	ns	V_{DD} = 225V, I_D = 1.0A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
T_r	Rise Time	ALL	—	—	30*	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	—	—	60*	ns	
t_f	Fall Time	ALL	—	—	30*	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	—	11	15	nC	V_{GS} = 10V, I_D = 3.0A, V_{DS} = 0.8 Max. Rating, See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature
Q_{gs}	Gate-Source Charge	ALL	—	5	—	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	—	6	—	nC	
L_D	Internal Drain Inductance	ALL	—	5.0	—	nH	Measured from the drain lead. 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	—	15	—	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	—	—	6.25*	K/W	
R_{thJA}	Junction-to Ambient	ALL	—	—	175	K/W	Free Air Operation

*Indicates JEDEC registered values.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	ALL	—	—	1.5*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
I_{SM}	Pulse Source Current (Body Diode) ③	ALL	—	—	6.5	A	
V_{SD}	Diode Forward Voltage ②	ALL	0.6*	—	1.2*	V	T_C = 25°C, I_S = 1.5A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	600	—	ns	T_J = 150°C, I_F = 1.5A, dI_F/dt = 100A/μs
Q_{rr}	Reverse Recovered Charge	ALL	—	3.5	—	μC	T_J = 150°C, I_F = 1.5A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25° to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

*Indicates JEDEC registered values.

Fig. 1 — Typical Output Characteristics

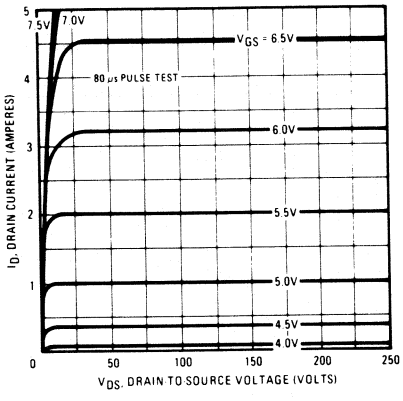


Fig. 2 — Typical Transfer Characteristics

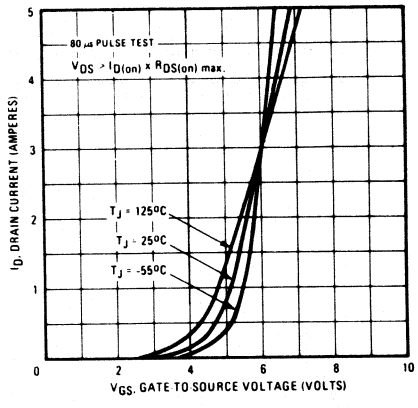


Fig. 3 — Typical Saturation Characteristics

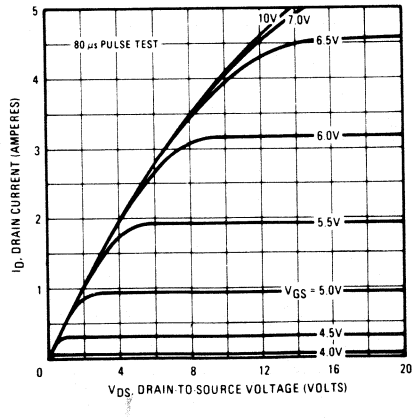
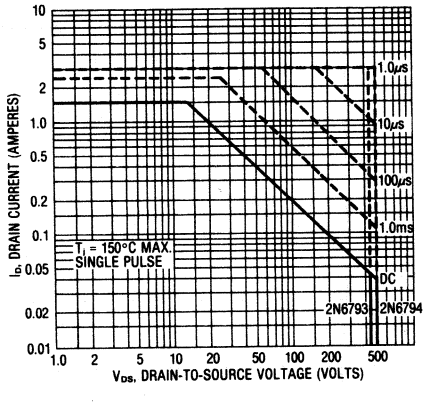


Fig. 1 — Forward Bias Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

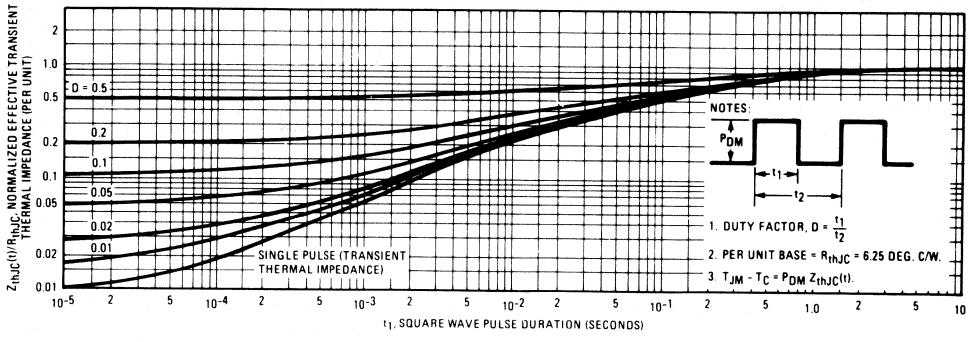


Fig. 6 — Typical Transconductance Vs. Drain Current

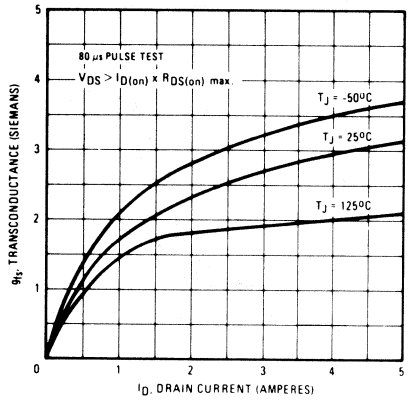


Fig. 7 — Typical Source-Drain Diode Forward Voltage

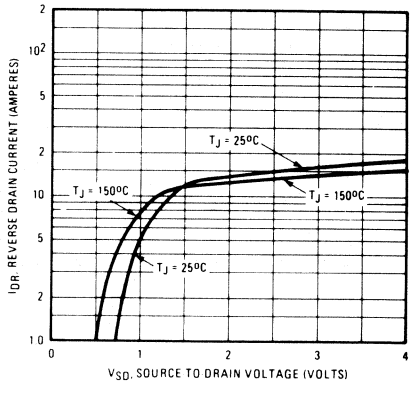


Fig. 8 — Breakdown Voltage Vs. Temperature

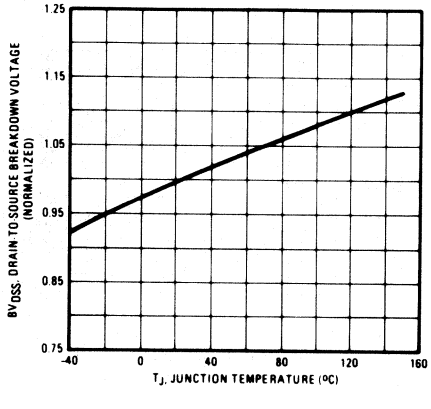
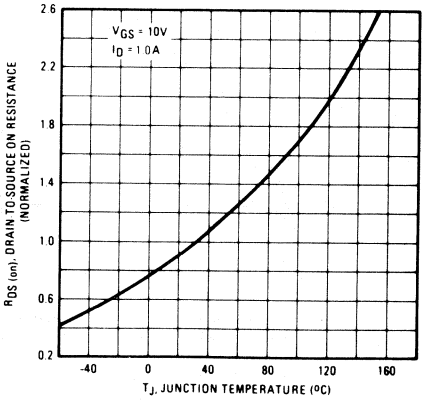


Fig. 9 — Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

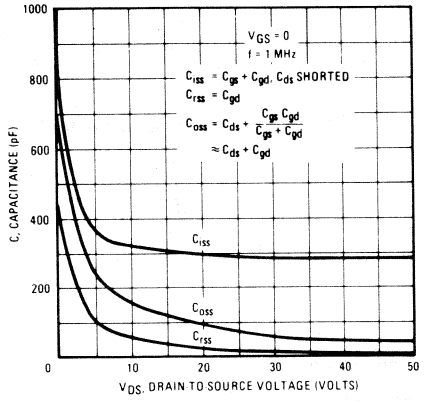


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

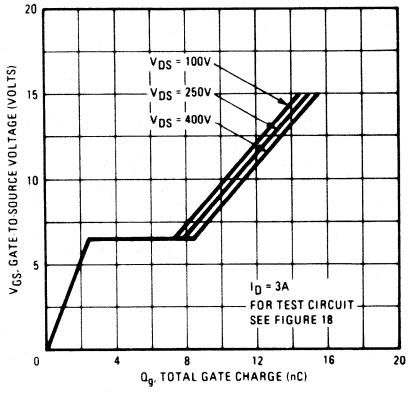


Fig. 12 – Typical On-Resistance Vs. Drain Current

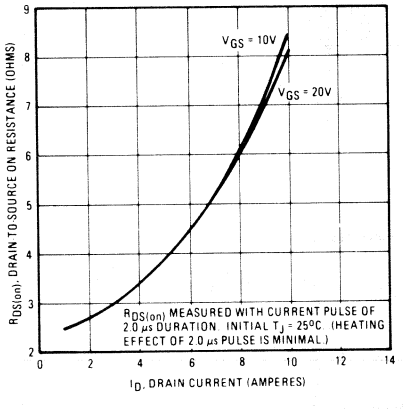


Fig. 13 – Maximum Drain Current Vs. Case Temperature

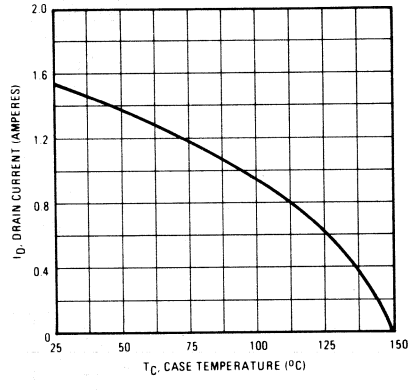


Fig. 14 – Power Vs. Temperature Derating Curve

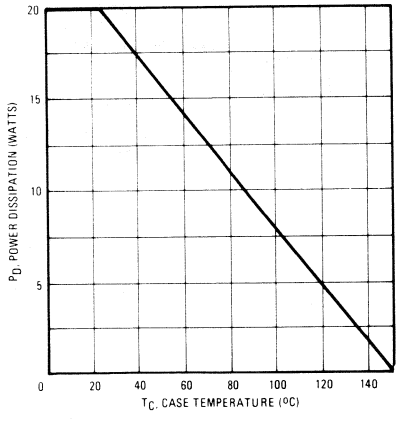


Fig. 15 – Clamped Inductive Test Circuit

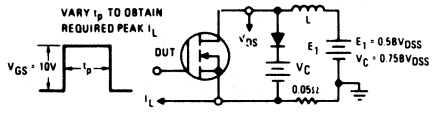


Fig. 16 – Clamped Inductive Waveforms

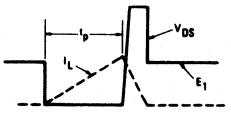


Fig. 17 – Switching Time Test Circuit

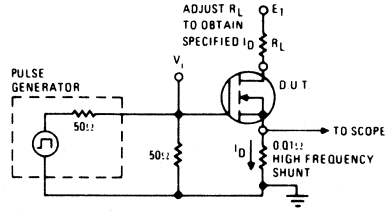
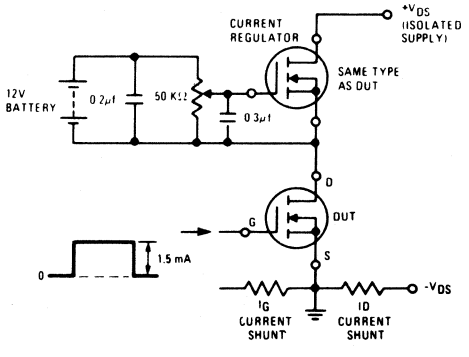


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

100 Volt, 0.18 Ohm N-Channel

2N6795
2N6796

3

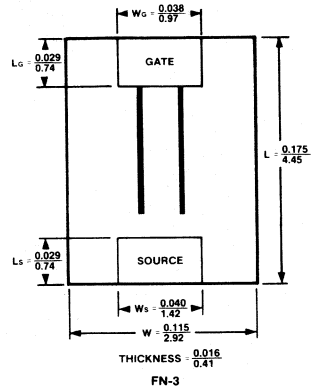
FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



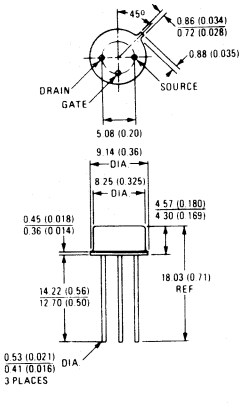
FN-3

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6795	60V	0.18Ω	8.0A
2N6796	100V	0.18Ω	8.0A

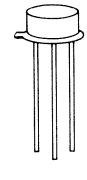
MECHANICAL SPECIFICATIONS

2N6795, 2N6796



All Dimensions in Millimeters and (Inches)

TO-205 AD (TO-39)



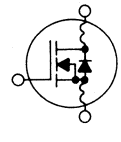
ABSOLUTE MAXIMUM RATINGS

Parameter		2N6795	2N6796			Units
V_{DS}	Drain - Source Voltage ①	60*	100*			V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1MΩ) ①	60*	100*			V
I_D @ T_C = 25°C	Continuous Drain Current	8.0*	8.0*			A
I_{DM}	Pulsed Drain Current ③	32	32			A
V_{GS}	Gate - Source Voltage	±20*				V
P_D @ T_C = 25°C	Max. Power Dissipation	25* (See Fig. 14)				W
	Linear Derating Factor	0.2* (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	32	(See Fig. 15 and 16) L = 100μH 32			A
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300(0.063 in. (1.6mm) from case for 10s)*				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	2N6795	60*	—	—	V	V_{GS} = 0V
		2N6796	100*	—	—	V	I_D = 1.0mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	—	4.0*	V	V_{DS} = V_{GS}, I_D = 1.0mA
I_{GSS}	Gate-Source Leakage Forward	ALL	—	—	100*	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	—	—	-100*	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	—	—	1.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0V
			—	—	4.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	ALL	8.0	—	—	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, V_{GS} = 10V
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	0.18*	Ω	V_{GS} = 10V, I_D = 5.0A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	0.35*	Ω	V_{GS} = 10V, I_D = 5.0A, T_C = 125°C
$V_{DS(on)}$	On-State Drain-Source Voltage ②	ALL	—	—	1.56*	V	V_{GS} = 10V, I_D = 8.0A
g_{fs}	Forward Transconductance ②	ALL	3.0*		9.0*	S(℧)	V_{DS} = 15V, I_D = 5.0A
C_{iss}	Input Capacitance	ALL	350*	—	900*	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	150*	—	500*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	50*	—	150*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	—	—	30*	ns	V_{DD} = 30V, I_D = 5.0A, Z_o = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
T_r	Rise Time	ALL	—	—	75*	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	—	—	40*	ns	
t_f	Fall Time	ALL	—	—	45*	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	—	18	30	nC	V_{GS} = 10V, I_D = 18A, V_{DS} = 0.8 Max. Rating, See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	—	9	—	nC	
O_{gd}	Gate-Drain ("Miller") Charge	ALL	—	9	—	nC	
L_D	Internal Drain Inductance	ALL	—	5.0	—	nH	Measured from the drain lead. 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	—	15	—	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	—	—	5.0*	K/W	
R_{thJA}	Junction-to Ambient	ALL	—	—	175	K/W	Free Air Operation

*Indicates JEDEC registered values.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	ALL	—	—	8*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
I_{SM}	Pulse Source Current (Body Diode) ③	ALL	—	—	32	A	
V_{SD}	Diode Forward Voltage ②	ALL	0.75*	—	1.5*	V	T_C = 25°C, I_S = 8.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	300	—	ns	T_J = 150°C, I_F = 8.0A, dI_F/dt = 100A/μs
Q_{rr}	Reverse Recovered Charge	ALL	—	1.5	—	μC	T_J = 150°C, I_F = 8.0A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25° to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

*Indicates JEDEC registered values.

Fig. 1 — Typical Output Characteristics

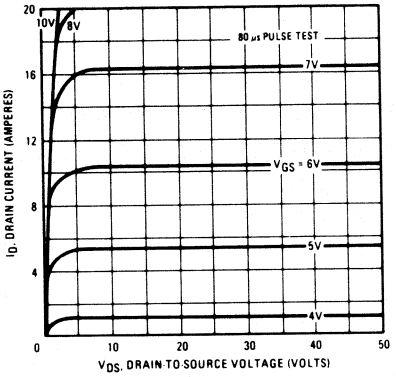


Fig. 2 — Typical Transfer Characteristics

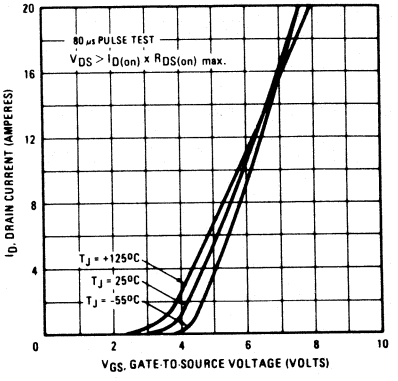


Fig. 3 — Typical Saturation Characteristics

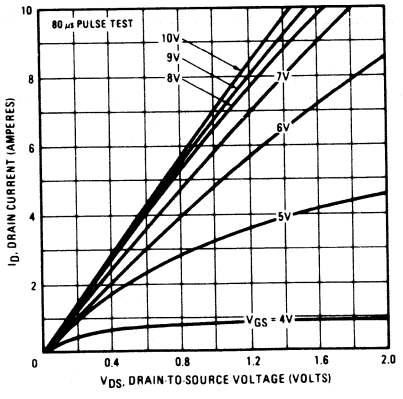
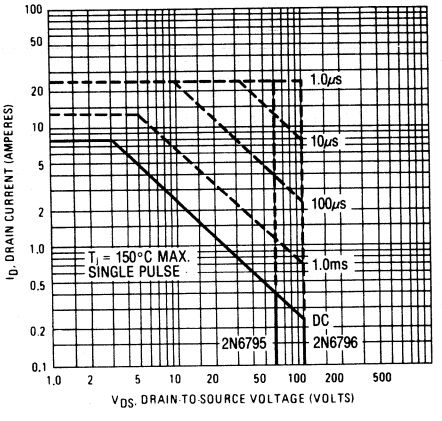


Fig. 4 — Forward Bias Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

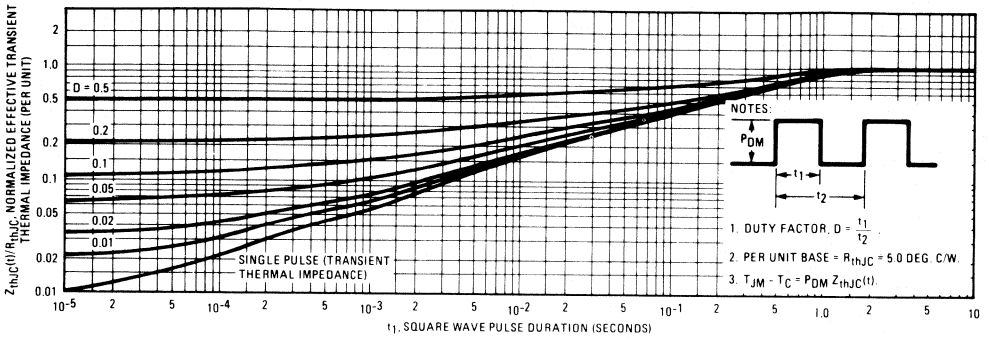


Fig. 6 – Typical Transconductance Vs. Drain Current

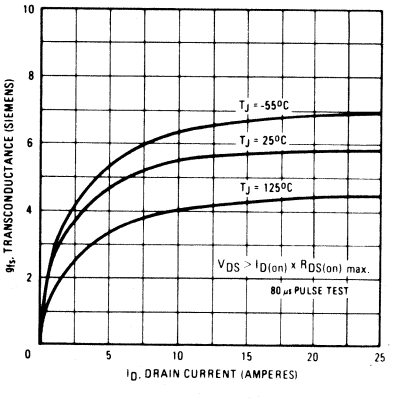


Fig. 7 – Typical Source-Drain Diode Forward Voltage

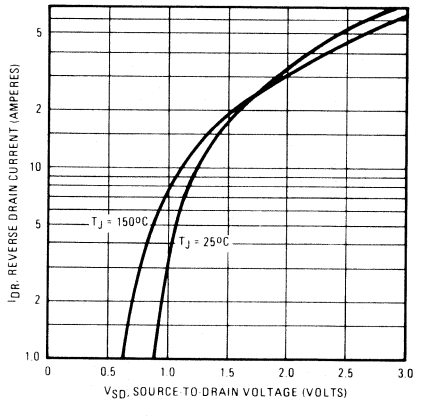


Fig. 8 – Breakdown Voltage Vs. Temperature

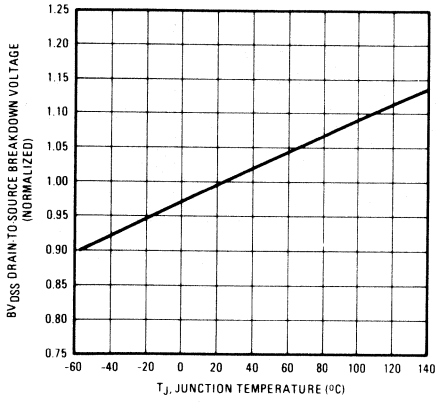
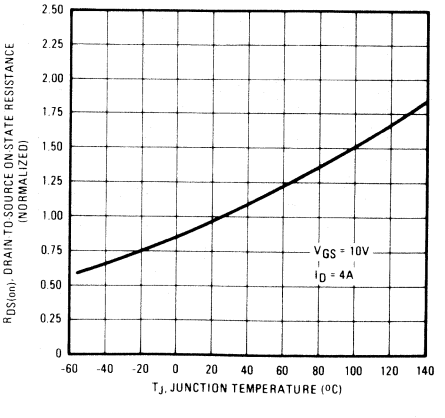


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

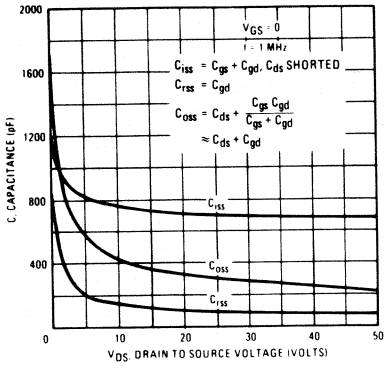


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

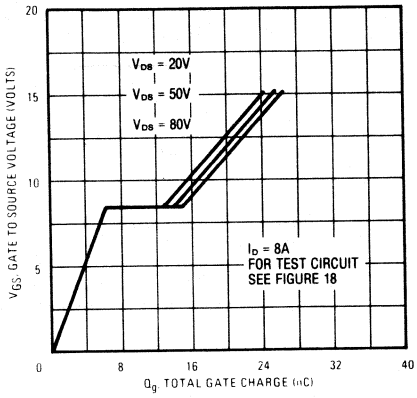


Fig. 12 – Typical On-Resistance Vs. Drain Current

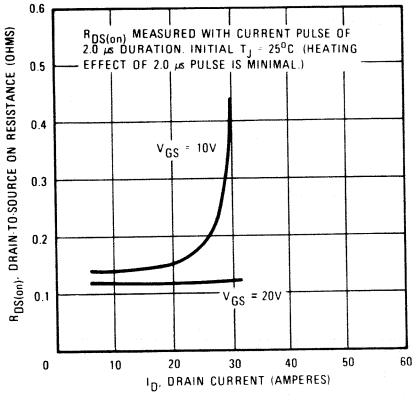


Fig. 13 – Maximum Drain Current Vs. Case Temperature

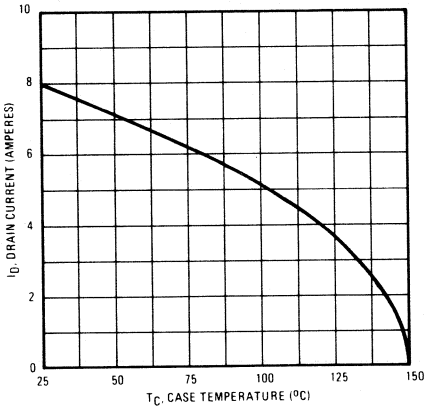
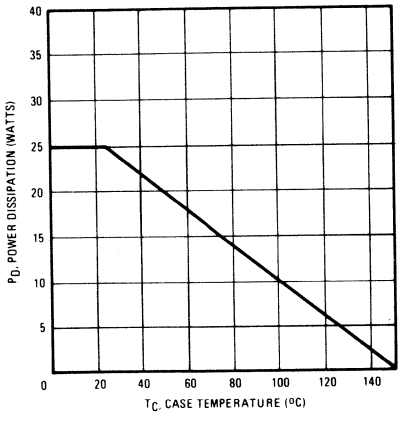


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

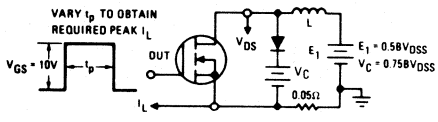


Fig. 16 – Clamped Inductive Waveforms

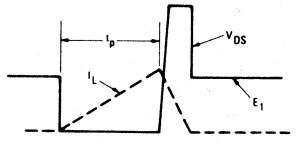


Fig. 17 – Switching Time Test Circuit

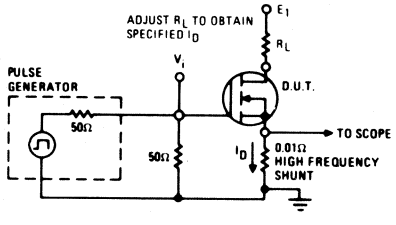
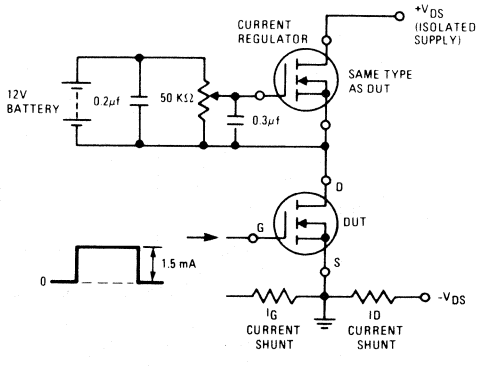


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

200 Volt, 0.4 Ohm N-Channel

2N6797
2N6798

3

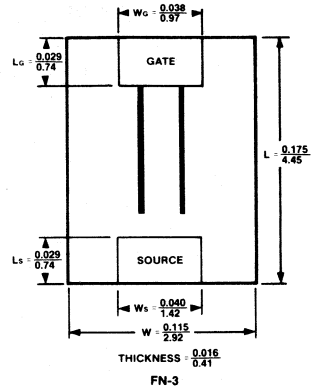
FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



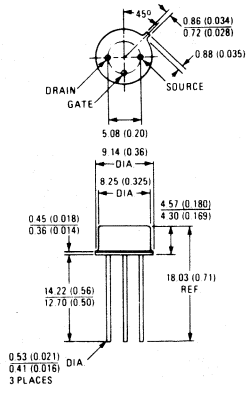
FN-3

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6797	150V	0.4Ω	5.5A
2N6798	200V	0.4Ω	5.5A

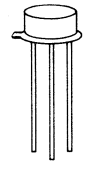
MECHANICAL SPECIFICATIONS

2N6797, 2N6798



All Dimensions in Millimeters and (Inches)

TO-205 AD (TO-39)



UNITRODE

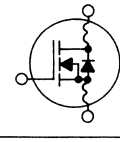
ABSOLUTE MAXIMUM RATINGS

Parameter		2N6797	2N6798			Units
V_{DS}	Drain - Source Voltage ①	150*	200*			V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1MΩ) ①	150*	200*			V
I_D @ T_C = 25°C	Continuous Drain Current	5.5*	5.5*			A
I_{DM}	Pulsed Drain Current ③	22	22			A
V_{GS}	Gate - Source Voltage	±20*				V
P_D @ T_C = 25°C	Max. Power Dissipation	25* (See Fig. 14)				W
	Linear Derating Factor	0.2* (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	22	(See Fig. 15 and 16) L = 100μH 22			A
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150				°C
	Lead Temperature	300(0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	2N6797	150*	—	—	V	V_{GS} = 0V
		2N6798	200*	—	—	V	I_D = 1.0mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	—	4.0*	V	V_{DS} = V_{GS}, I_D = 1.0mA
I_{GSS}	Gate-Source Leakage Forward	ALL	—	—	100*	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	—	—	−100*	nA	V_{GS} = −20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	—	—	1.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0V
			—	—	4.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	ALL	5.5	—	—	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, V_{GS} = 10V
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	0.4*	Ω	V_{GS} = 10V, I_D = 3.5A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	0.75*	Ω	V_{GS} = 10V, I_D = 3.5A, T_C = 125°C
$V_{DS(on)}$	On-State Drain-Source Voltage ②	ALL	—	—	2.2*	V	V_{GS} = 10V, I_D = 5.5A
g_{fs}	Forward Transconductance ②	ALL	2.5*		7.5*	S(℧)	V_{DS} = 15V, I_D = 3.5A
C_{iss}	Input Capacitance	ALL	350*	—	900*	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	100*	—	450*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	40*	—	150*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	—	—	30*	ns	V_{DD} = 77V, I_D = 3.5A, Z_o = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
T_r	Rise Time	ALL	—	—	50*	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	—	—	50*	ns	
t_f	Fall Time	ALL	—	—	40*	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	—	19	30	nC	V_{GS} = 10V, I_D = 11A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	—	10	—	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	—	9	—	nC	
L_D	Internal Drain Inductance	ALL	—	5.0	—	nH	Measured from the drain lead. 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	—	15	—	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	—	—	5.0*	K/W	
R_{thJA}	Junction-to Ambient	ALL	—	—	175	K/W	Free Air Operation

*Indicates JEDEC registered values.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	ALL	—	—	5.5*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
I_{SM}	Pulse Source Current (Body Diode) ③	ALL	—	—	22	A	
V_{SD}	Diode Forward Voltage ②	ALL	0.75*	—	1.5*	V	T_C = 25°C, I_S = 5.5A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	450	—	ns	T_J = 150°C, I_F = 5.5A, dI_F/dt = 100A/μs
Q_{rr}	Reverse Recovered Charge	ALL	—	3.0	—	μC	T_J = 150°C, I_F = 5.5A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25° to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

*Indicates JEDEC registered values.

Fig. 1 – Typical Output Characteristics

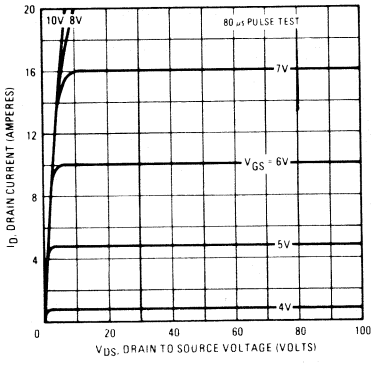


Fig. 2 – Typical Transfer Characteristics

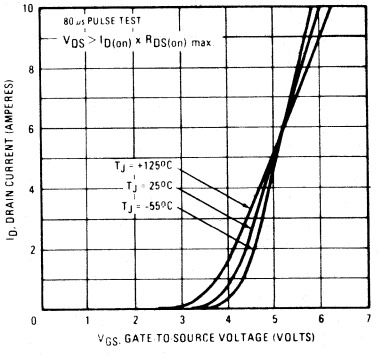


Fig. 3 – Typical Saturation Characteristics

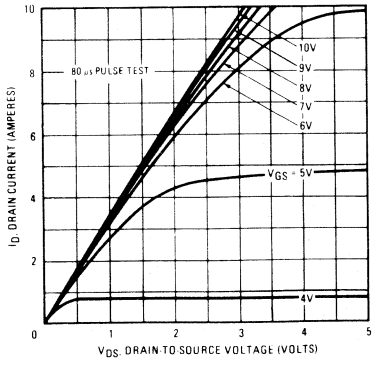


Fig. 4 — Forward Bias Safe Operating Area

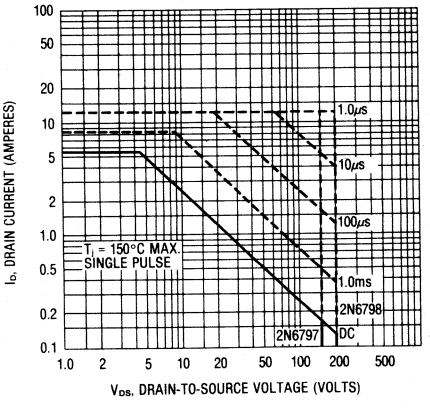


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

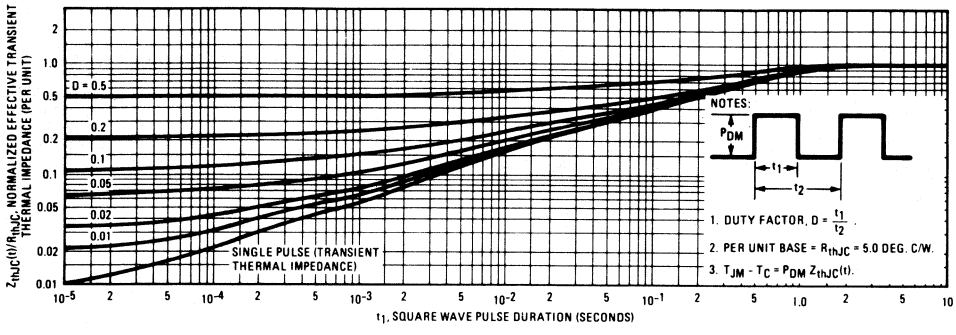


Fig. 6 – Typical Transconductance Vs. Drain Current

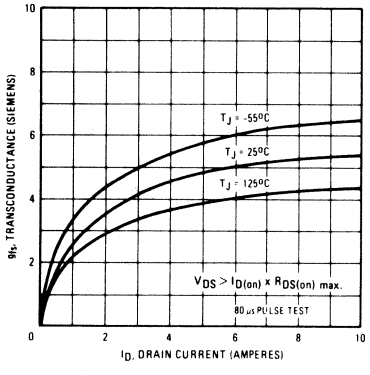


Fig. 7 – Typical Source-Drain Diode Forward Voltage

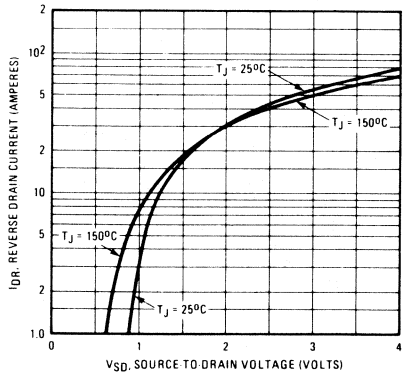


Fig. 8 – Breakdown Voltage Vs. Temperature

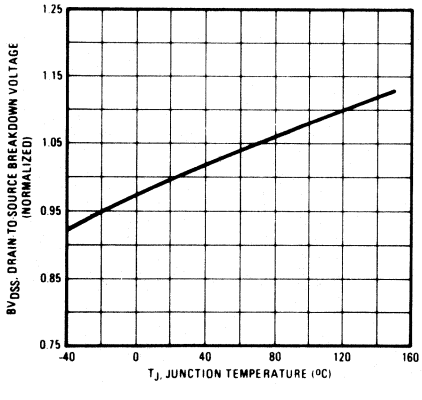
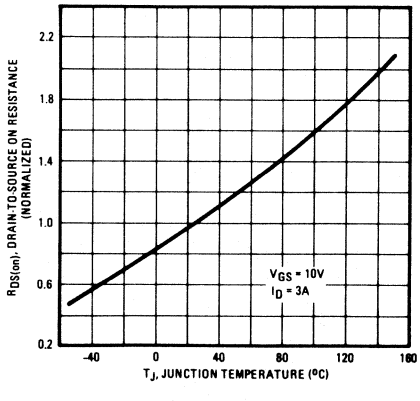


Fig. 9 – Normalized On-Resistance Vs. Temperature



3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

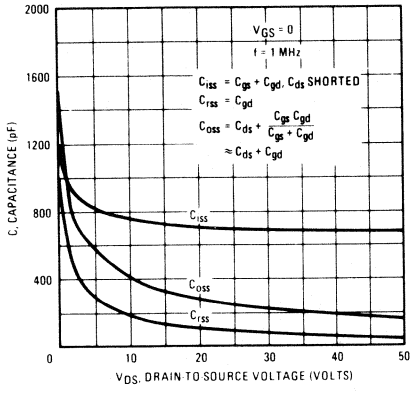


Fig. 11 — Typical Gate Charge vs Gate-to-Source Voltage

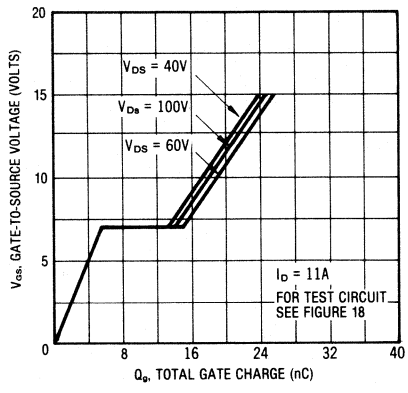


Fig. 12 – Typical On-Resistance Vs. Drain Current

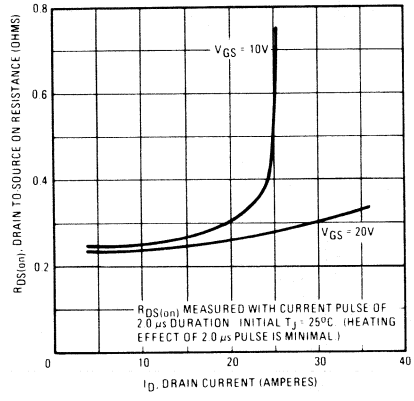


Fig. 13 — Maximum Drain Current vs Case Temperature

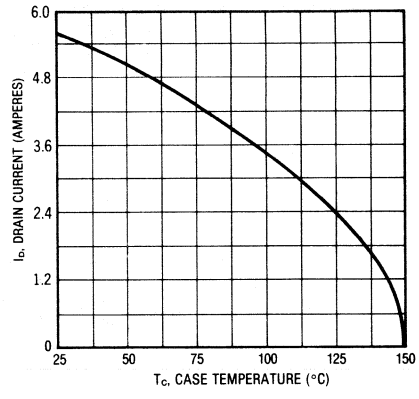


Fig. 14 – Power Vs. Temperature Derating Curve

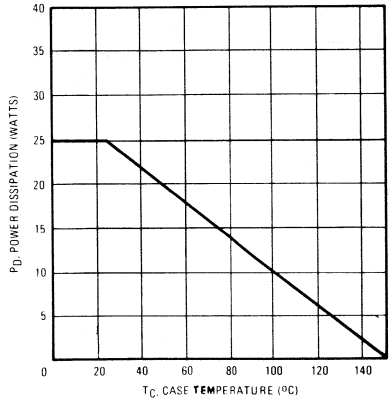


Fig. 15 – Clamped Inductive Test Circuit

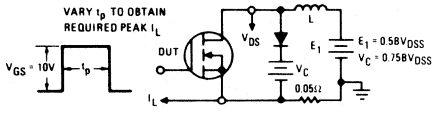


Fig. 16 – Clamped Inductive Waveforms

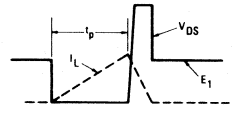


Fig. 17 – Switching Time Test Circuit

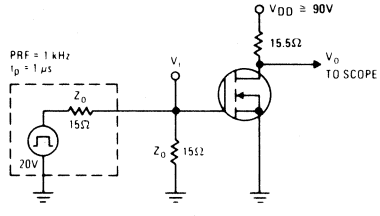
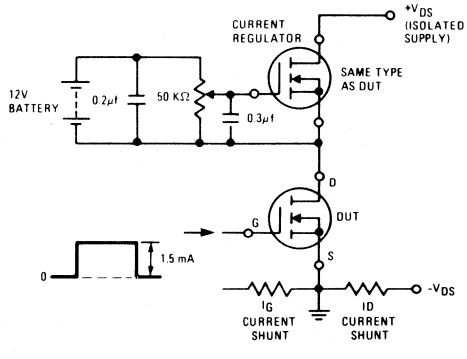


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

400 Volt, 1.0 Ohm N-Channel

2N6799
2N6800

3

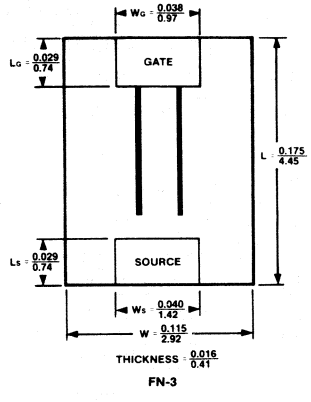
FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



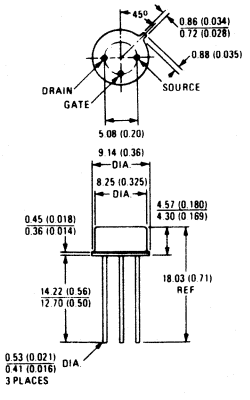
FN-3

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6799	350V	1.0Ω	3.0A
2N6800	400V	1.0Ω	3.0A

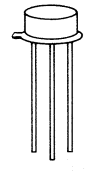
MECHANICAL SPECIFICATIONS

2N6799, 2N6800



All Dimensions in Millimeters and (Inches)

TO-205 AD (TO-39)



UNITRODE

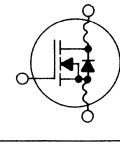
ABSOLUTE MAXIMUM RATINGS

Parameter		2N6799	2N6800			Units
V_{DS}	Drain - Source Voltage ①	350*	400*			V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1MΩ) ①	350*	400*			V
I_D @ T_C = 25°C	Continuous Drain Current	3.0*	3.0*			A
I_{DM}	Pulsed Drain Current ③	14	14			A
V_{GS}	Gate - Source Voltage	±20*				V
P_D @ T_C = 25°C	Max. Power Dissipation	25* (See Fig. 14)				W
	Linear Derating Factor	0.20* (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	14	(See Fig. 15 and 16) L = 100μH 14			A
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150				°C
	Lead Temperature	300(0.063 in. (1.6mm) from case for 10s)*				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	2N6799	350*	—	—	V	V_{GS} = 0V
		2N6800	400*	—	—	V	I_D = 1.0mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	—	4.0*	V	V_{DS} = V_{GS}, I_D = 1.0mA
I_{GSS}	Gate-Source Leakage Forward	ALL	—	—	100*	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	—	—	−100*	nA	V_{GS} = −20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	—	—	1.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0V
			—	—	4.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	ALL	3.0	—	—	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, V_{GS} = 10V
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	1.0*	Ω	V_{GS} = 10V, I_D = 2.0A
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	2.4*	Ω	V_{GS} = 10V, I_D = 2.0A, T_C = 125°C
$V_{DS(on)}$	On-State Drain-Source Voltage ②	ALL	—	—	3.0*	V	V_{GS} = 10V, I_D = 3.0A
g_{fs}	Forward Transconductance ②	ALL	2.0*		6.0*	S(℧)	V_{DS} = 15V, I_D = 2.0A
C_{iss}	Input Capacitance	ALL	350*	—	900*	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	50*	—	300*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	20*	—	80*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	—	—	30*	ns	V_{DD} = 176V, I_D = 2.0A, Z_o = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
T_r	Rise Time	ALL	—	—	35*	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	—	—	55*	ns	
t_f	Fall Time	ALL	—	—	35*	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	—	18	30	nC	V_{GS} = 10V, I_D = 6.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	—	11	—	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	—	7	—	nC	
L_D	Internal Drain Inductance	ALL	—	5.0	—	nH	Measured from the drain lead. 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	—	15	—	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	—	—	5.0*	K/W	
R_{thJA}	Junction-to Ambient	ALL	—	—	175	K/W	Free Air Operation

*Indicates JEDEC registered values.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	ALL	—	—	3.0*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
I_{SM}	Pulse Source Current (Body Diode) ③	ALL	—	—	14	A	
V_{SD}	Diode Forward Voltage ②	ALL	0.7*	—	1.4*	V	T_C = 25°C, I_S = 3.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	600	—	ns	T_J = 150°C, I_F = 3.0A, dI_F/dt = 100A/μs
Q_{rr}	Reverse Recovered Charge	ALL	—	4.0	—	μC	T_J = 150°C, I_F = 3.0A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25° to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

*Indicates JEDEC registered values.

Fig. 1 — Typical Output Characteristics

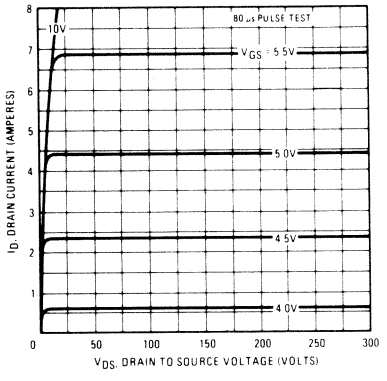


Fig. 2 — Typical Transfer Characteristics

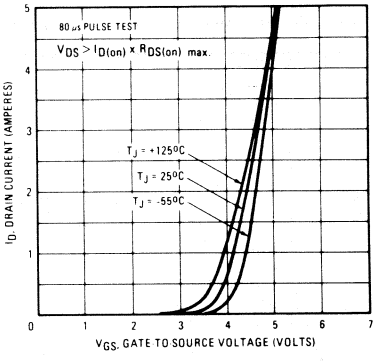


Fig. 3 — Typical Saturation Characteristics

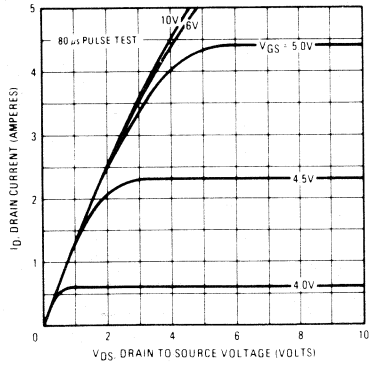


Fig. 4 — Forward Bias Safe Operating Area

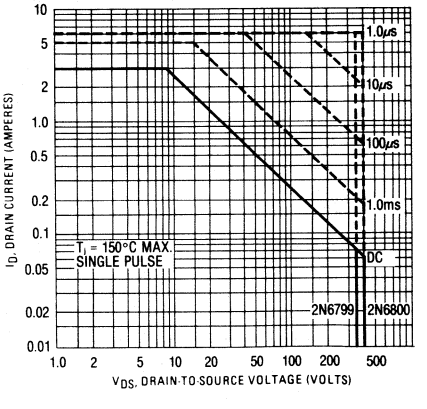


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

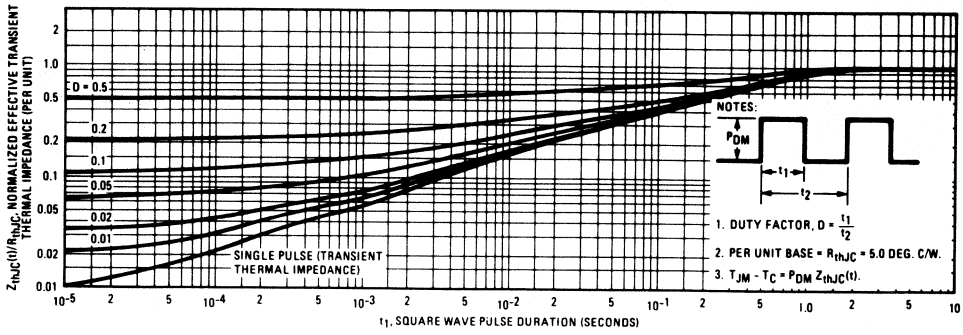


Fig. 6 – Typical Transconductance Vs. Drain Current

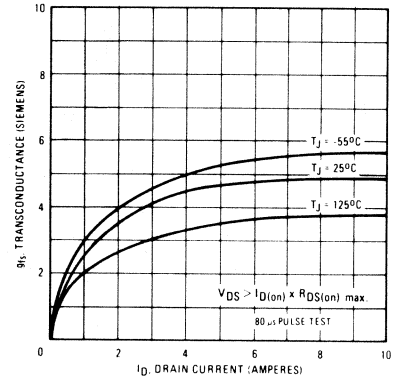


Fig. 7 – Typical Source-Drain Diode Forward Voltage

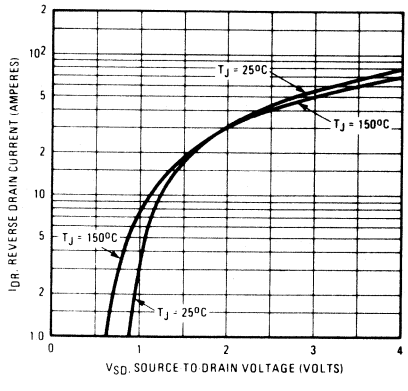


Fig. 8 – Breakdown Voltage Vs. Temperature

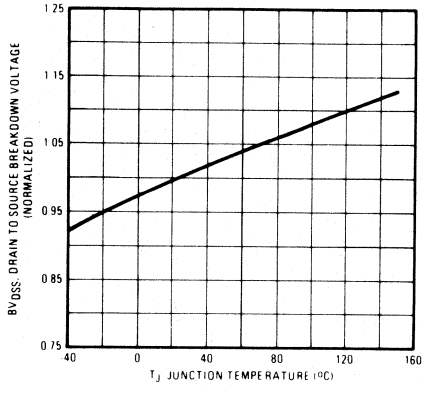
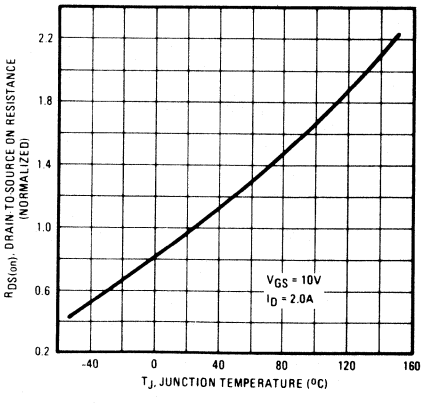


Fig. 9 – Normalized On-Resistance Vs. Temperature



3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

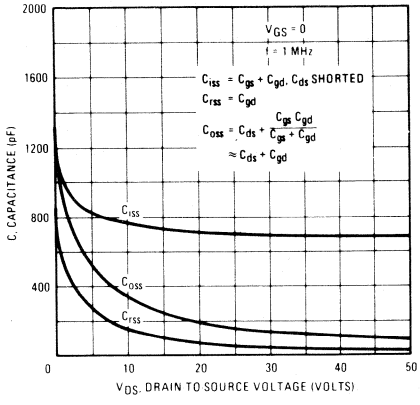


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

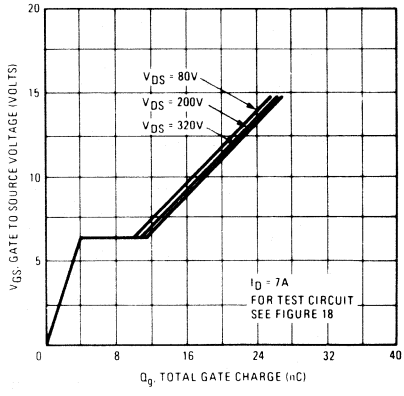


Fig. 12 – Typical On-Resistance Vs. Drain Current

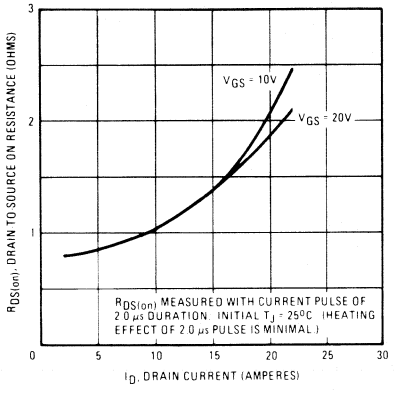


Fig. 13 – Maximum Drain Current Vs. Case Temperature

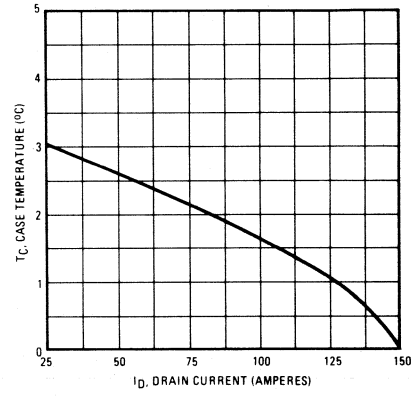


Fig. 14 – Power Vs. Temperature Derating Curve

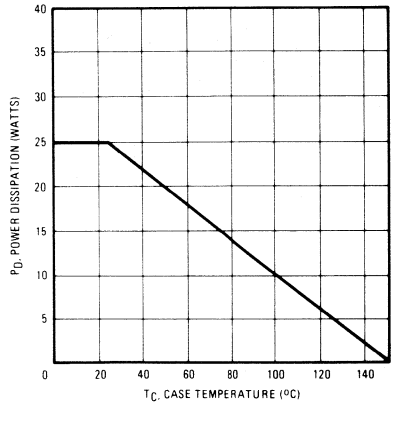


Fig. 15 – Clamped Inductive Test Circuit

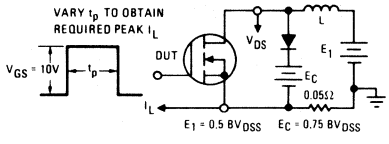


Fig. 16 – Clamped Inductive Waveforms

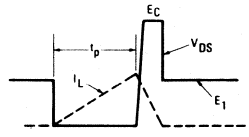


Fig. 17 – Switching Time Test Circuit

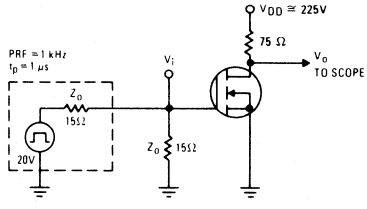
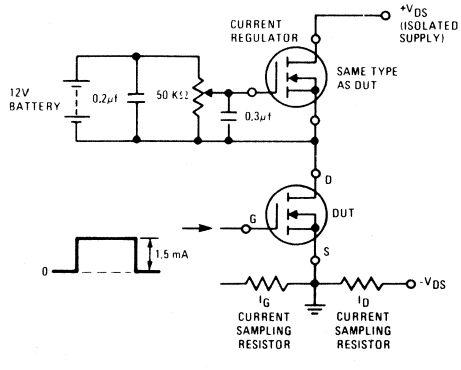


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

500 Volt, 1.5 Ohm N-Channel

2N6801
2N6802

3

FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

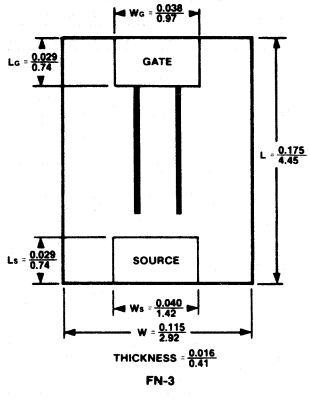
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

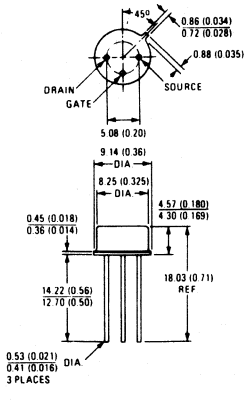
Part Number	V_{DS}	$R_{DS(on)}$	I_D
2N6801	450V	1.5Ω	2.5A
2N6802	500V	1.5Ω	2.5A



FN-3

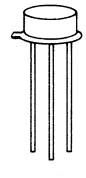
MECHANICAL SPECIFICATIONS

2N6801, 2N6802



All Dimensions in Millimeters and (Inches)

TO-205 AD (TO-39)



UNITRODE

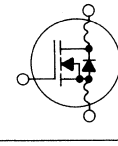
ABSOLUTE MAXIMUM RATINGS

Parameter		2N6801	2N6802			Units
V_{DS}	Drain - Source Voltage ①	450*	500*			V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1MΩ) ①	450*	500*			V
I_D @ T_C = 25°C	Continuous Drain Current	2.5*	2.5*			A
I_{DM}	Pulsed Drain Current ③	11	11			A
V_{GS}	Gate - Source Voltage	±20*				V
P_D @ T_C = 25°C	Max. Power Dissipation	25* (See Fig. 14)				W
	Linear Derating Factor	0.20* (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	11	(See Fig. 15 and 16) L = 100μH 11			A
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150				°C
	Lead Temperature	300(0.063 in. (1.6mm) from case for 10s)*				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	2N6801	450*	—	—	V	V_{GS} = 0V
		2N6802	500*	—	—	V	I_D = 1.0mA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0*	—	4.0*	V	V_{DS} = V_{GS}, I_D = 1.0mA
I_{GSS}	Gate-Source Leakage Forward	ALL	—	—	100*	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	—	—	-100*	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	—	—	1.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0V
			—	—	4.0*	mA	V_{DS} = Max. Rating, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	ALL	2.5	—	—	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	1.5*	Ω	V_{GS} = 10V, I_D = 1.5A, T_C = 25°C
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	ALL	—	—	3.5*	Ω	V_{GS} = 10V, I_D = 1.5A, T_C = 125°C
$V_{DS(on)}$	On-State Drain-Source Voltage ②	ALL	—	—	3.75*	V	V_{GS} = 10V, I_D = 2.5A
g_{fs}	Forward Transconductance ②	ALL	1.5*		4.5*	S(℧)	V_{DS} = 15V, I_D = 1.5A
C_{iss}	Input Capacitance	ALL	350*	—	900*	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	25*	—	200*	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	15*	—	60*	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	—	—	30*	ns	V_{DD} = 225V, I_D = 1.5A, Z_o = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
T_r	Rise Time	ALL	—	—	30*	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	—	—	55*	ns	
t_f	Fall Time	ALL	—	—	30*	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	—	22	30	nC	V_{GS} = 10V, I_D = 6.0A, V_{DS} = 0.8 Max. Rating, See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	—	11	—	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	—	11	—	nC	
L_D	Internal Drain Inductance	ALL	—	5.0	—	nH	Measured from the drain lead. 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	—	15	—	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	—	—	5.0*	K/W	
R_{thJA}	Junction to Ambient	ALL	—	—	175	K/W	Free Air Operation

*Indicates JEDEC registered values.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

I_S	Continuous Source Current (Body Diode)	ALL	—	—	2.5*	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
I_{SM}	Pulse Source Current (Body Diode) ③	ALL	—	—	11	A	
V_{SD}	Diode Forward Voltage ②	ALL	0.7*	—	1.4*	V	T_C = 25°C, I_S = 2.5A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	800	—	ns	T_J = 150°C, I_F = 2.5A, dI_F/dt = 100A/μs
Q_{rr}	Reverse Recovered Charge	ALL	—	4.6	—	μC	T_J = 150°C, I_F = 2.5A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25° to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

*Indicates JEDEC registered values.

Fig. 1 — Typical Output Characteristics

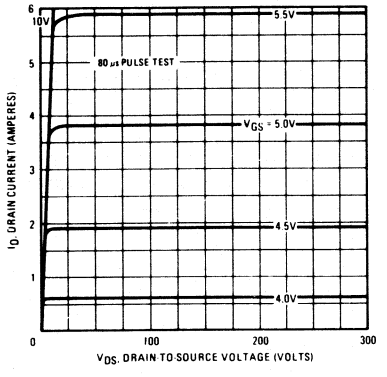


Fig. 2 — Typical Transfer Characteristics

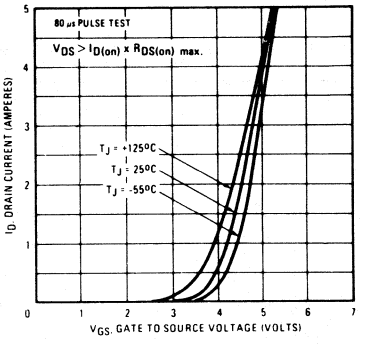


Fig. 3 — Typical Saturation Characteristics

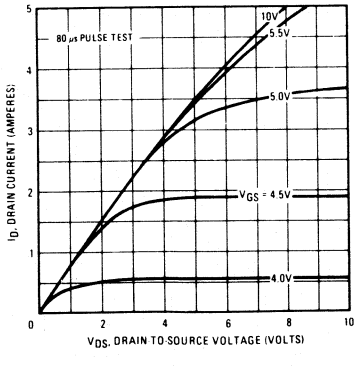
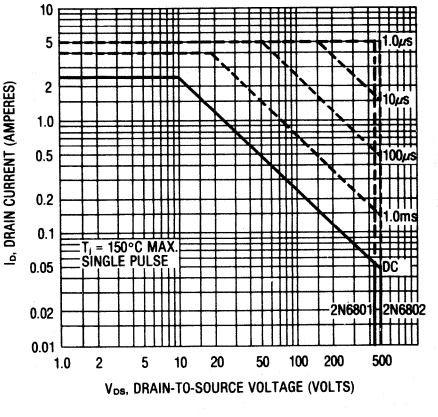


Fig. 4 — Forward Bias Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

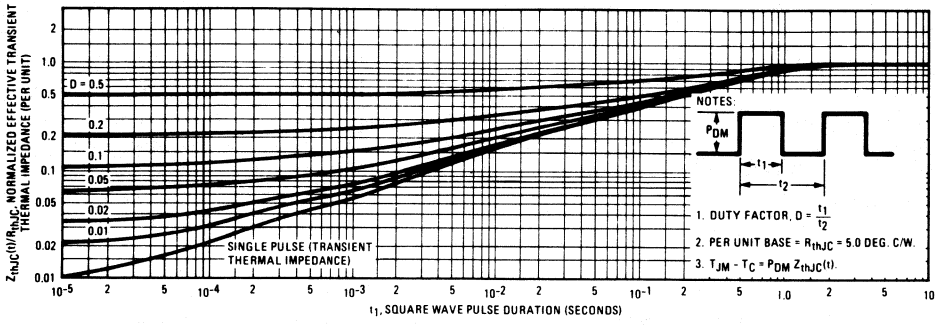


Fig. 6 – Typical Transconductance Vs. Drain Current

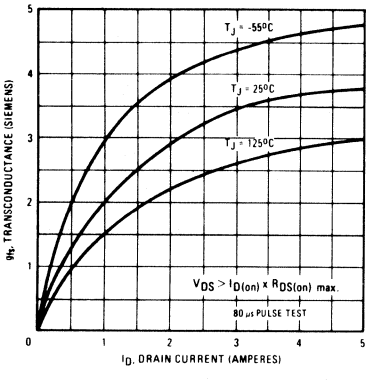


Fig. 7 – Typical Source-Drain Diode Forward Voltage

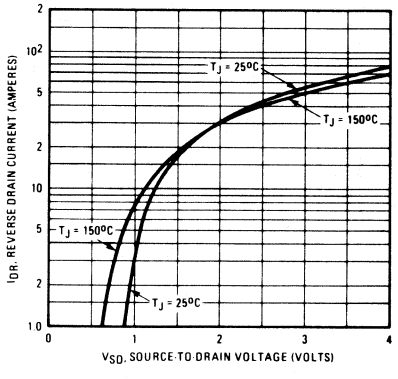


Fig. 8 – Breakdown Voltage Vs. Temperature

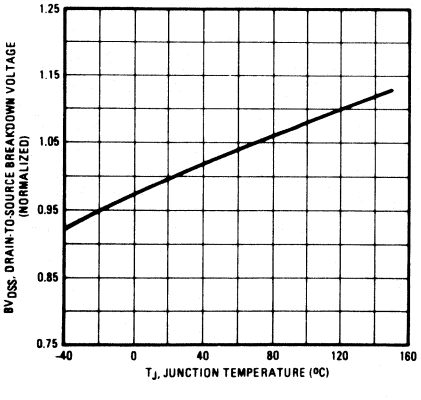
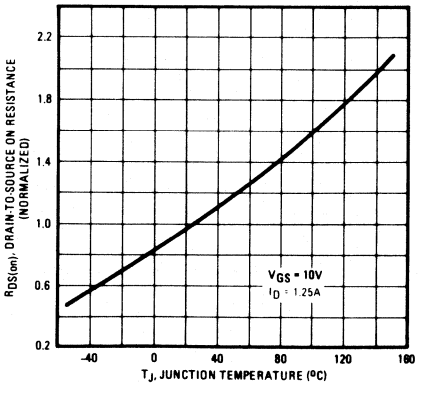


Fig. 9 – Normalized On-Resistance Vs. Temperature



3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

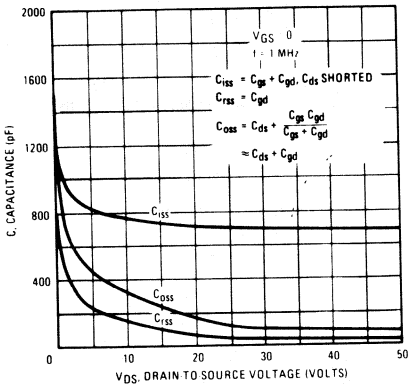


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

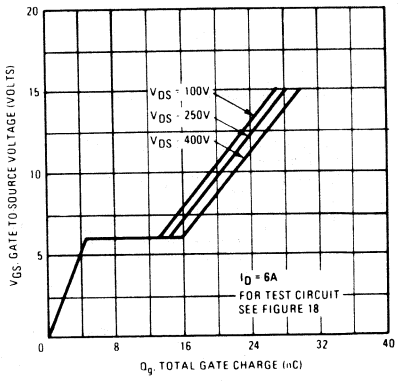


Fig. 12 – Typical On-Resistance Vs. Drain Current

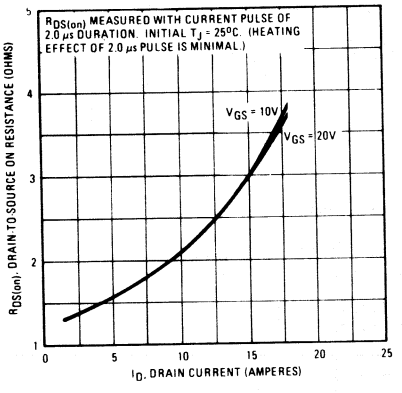


Fig. 13 – Maximum Drain Current Vs. Case Temperature

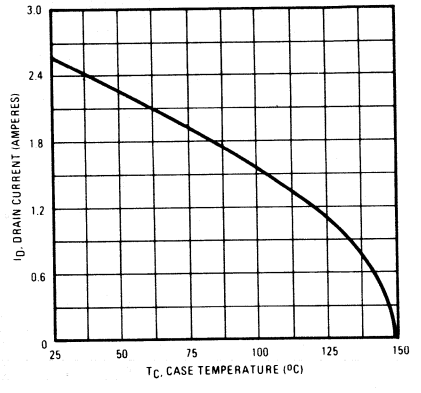


Fig. 14 – Power Vs. Temperature Derating Curve

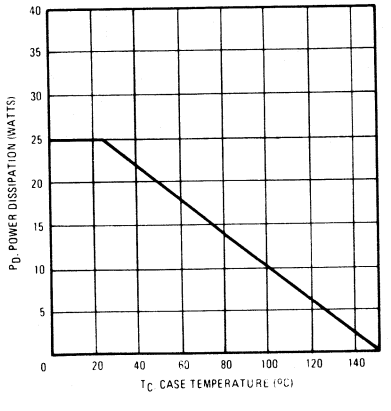


Fig. 15 – Clamped Inductive Test Circuit

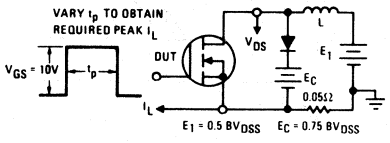


Fig. 16 – Clamped Inductive Waveforms

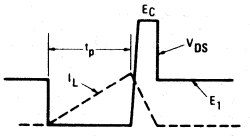


Fig. 17 – Switching Time Test Circuit

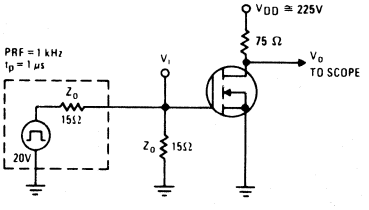
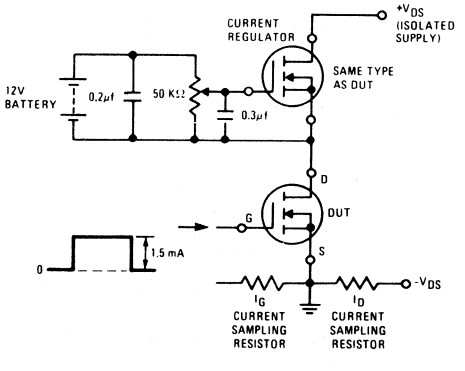


Fig. 18 – Gate Charge Test Circuit



POWER TRANSISTORS

4A, 700V, Fast Switching, Silicon NPN Mesa

MJE13004
MJE13005

3

FEATURES

- Collector Emitter Voltage: up to 700V
- Peak Collector Current: 8A
- Rise Time: ≤.7μS } at $I_C = 2A$
- Fall Time: ≤0.9μS }
- Key Parameters characterized at 100°C
- Economical Plastic Molded Construction

DESCRIPTION

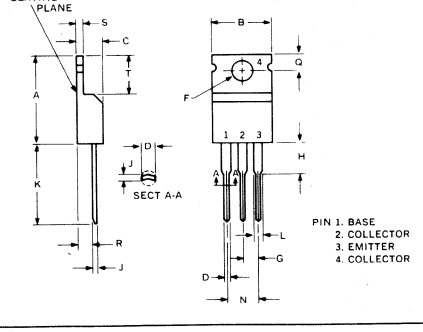
These high voltage glass passivated power transistors, in a plastic TO-220AB package, combine fast switching, low saturation voltage and rugged $E_{S/b}$ capability. They are designed for use in off-line power supplies, high voltage inverters, switching regulators, deflection circuits, motor controls and solenoid/relay drivers.

ABSOLUTE MAXIMUM RATINGS

	MJE13004	MJE13005
Collector Emitter Voltage, V_{CEV}	600V	700V
Collector Emitter Voltage, $V_{CEO\ (SUS)}$	300V	400V
Emitter Base Voltage, V_{EBO}	9V	9V
Collector Current, I_C continuous	4A	4A
Collector Current, I_{CM} peak	8A	8A
Base Current, I_B continuous	2A	2A
Power Dissipation, 25°C Case	75W	75W
Derating Factor	0.59W/°C	0.59W/°C
Operating and Storage Temperature Range	−65 to 150°C	

MECHANICAL SPECIFICATIONS

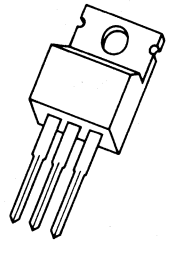
MJE13004, MJE13005



PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.23	15.87	0.560	0.625
B	9.66	10.66	0.380	0.420
C	3.56	4.82	0.140	0.190
D	0.51	1.14	0.020	0.045
F	3.531	3.733	0.139	0.147
G	2.29	2.79	0.090	0.110
H	—	6.35	—	0.250
J	0.38	0.64	0.015	0.025
K	12.70	14.27	0.500	0.562
L	1.14	1.77	0.045	0.070
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.92	0.080	0.115
S	1.14	1.39	0.045	0.055
T	5.85	6.85	0.230	0.270

TO-220AB



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	MJE13004 MIN.	MJE13004 MAX.	MJE13005 MIN.	MJE13005 MAX.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{FE}	10	60	10	60		$I_C = 1.0A, V_{CE} = 5V$
D.C. Current Gain (Note 1)	h_{FE}	8	40	8	40		$I_C = 2.0A, V_{CE} = 5V$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	.5	—	.5	V	$I_C = 1.0A, I_B = 0.2A$
Collector Saturation Voltage (Note 1) $T_C = 25°C$	$V_{CE(sat)}$	—	0.6	—	0.6	V	$I_C = 2.0A, I_B = 0.5A$
Collector Saturation Voltage (Note 1) $T_C = 100°C$		—	1.0	—	1.0		
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	1.0	—	1.0	V	$I_C = 4.0A, I_B = 1.0A$
Base Saturation Voltage (Note 1)	$V_{BE(sat)}$	—	1.2	—	1.2	V	$I_C = 1.0A, I_B = 0.2A$
Base Saturation Voltage (Note 1) $T_C = 25°C$	$V_{BE(sat)}$	—	1.6	—	1.6	V	$I_C = 2.0A, I_B = 0.5A$
Base Saturation Voltage (Note 1) $T_C = 100°C$		—	1.5	—	1.5		
Collector-Emitter Sustaining Voltage (Note 2)	$V_{CEO(sus)}$	300	—	400	—	V	$I_C = 10mA$
Emitter-Base Cutoff Current	I_{EBO}	—	1	—	1	mA	$V_{EB} = 9V$
Collector Cutoff Current	I_{CEV}	—	1	—	—	mA	$V_{CE} = 600V, V_{BE} = -1.5V$
		—	—	—	1		$V_{CE} = 700V, V_{BE} = -1.5V$
Collector Cutoff Current, $T_C = 100°C$	I_{CEV}	—	5	—	—	mA	$V_{CE} = 600V, V_{BE} = -1.5V$
		—	—	—	5		$V_{CE} = 700V, V_{BE} = -1.5V$
Output Capacitance, Common Base	C_{obo}	65 typ.		65 typ.		pF	$V_{CB} = 10V, f = 1 MHz$
Gain-Bandwidth Product	F_T	4	—	4	—	MHz	$V_{CE} = 10V, I_C = .5A, f = 1 MHz$
Resistive Switching Speeds							
Delay Time	t_d	—	0.1	—	0.1		$I_C = 2.0A$
Rise Time	t_r	—	0.7	—	0.7		$V_{CC} = 125V$
Storage Time	t_s	—	3.5	—	3.5	μS	$I_{B1} = I_{B2} = 0.4A$
Fall Time	t_f	—	0.9	—	0.9		$V_{BE(off)} = 5V$, P.W. $= 25\mu S$
Inductive Switching Speeds $T_C = 100°C$							
Storage Time	t_s	—	4.0	—	4.0		$I_C = 2.0A, L = 500\mu H$
Fall Time ($t_{fi} + t_{fv}$)	t_f	—	0.9	—	0.9	μS	$I_{B1} = 0.4A, V_{BE(off)} = 5V$
							V_{CE} clamp = rated $V_{CEX(sus)}$
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	—	1.67	—	1.67	°C/W	
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	—	62.5	—	62.5	°C/W	

Notes:
1. Pulse width 250μS; duty cycle ≤1%.
2. Sustaining Voltage. Measured at a high current point where collector-emitter voltage is lowest. Current pulse length ≅ 50μS; duty cycle ≤ 1%. Voltage clamped at maximum collector-emitter voltage.

Typical Inductive Load Switching Performance

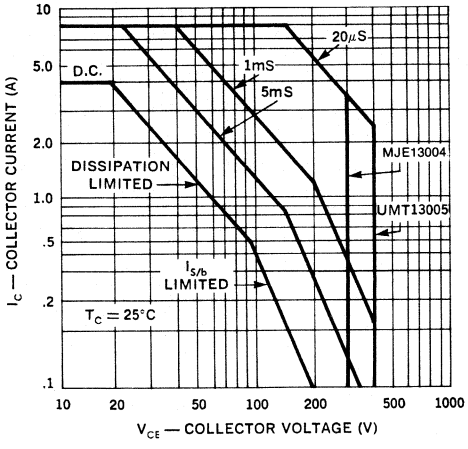
I_C Amps	T_J °C	t_s μS	t_{fv} nS	t_{fi} nS
0.5	25	1.8	180	20
	100	1.2	240	30
1.0	25	1.0	160	21
	100	1.5	220	30
2.0	25	1.2	180	25
	100	1.7	230	35

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

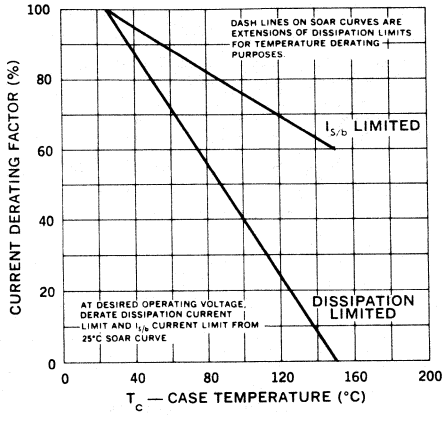
PRINTED IN U.S.A.

3

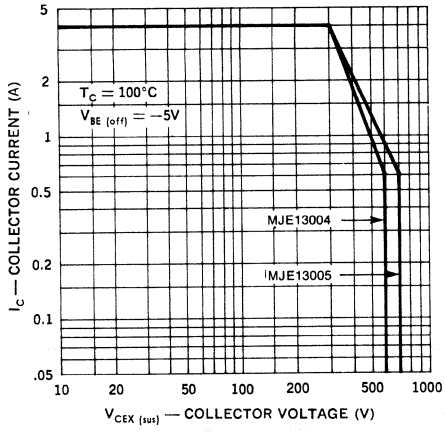
Forward Bias Safe Operating Area



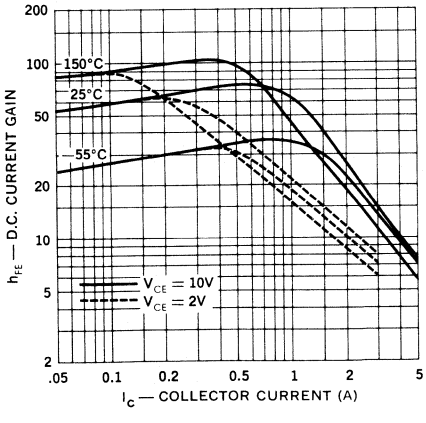
Power Derating



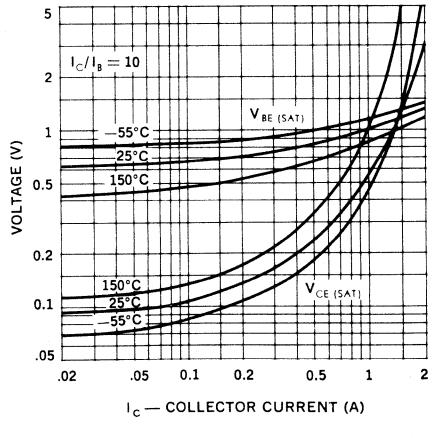
Reverse Biased Safe Operating Area



D.C. Current Gain



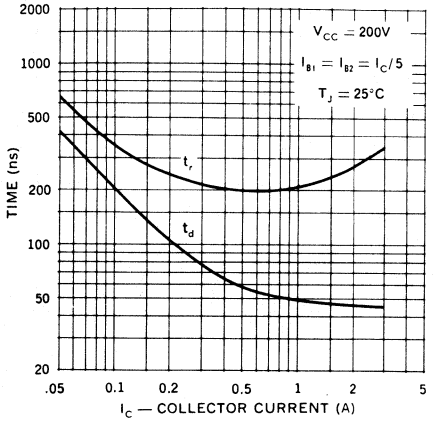
Saturation Voltages



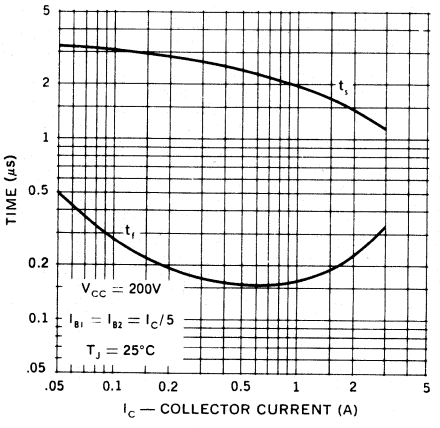
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

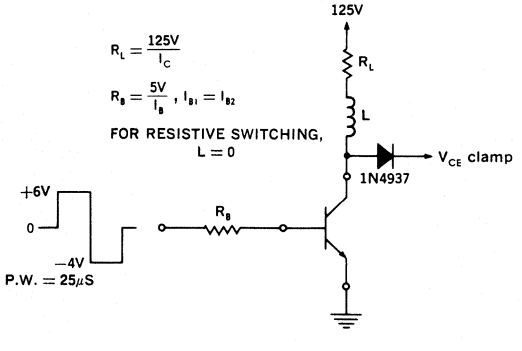
Resistive Turn-On Time



Resistive Turn-Off Time



Switching Time Test Circuit



POWER TRANSISTORS

8A, 700V, Fast Switching, Silicon NPN Mesa

MJE13006
MJE13007

3

FEATURES

- Collector Emitter Voltage: up to 700V
- Peak Collector Current: 16A
- Rise Time: $\leqslant 1.0\mu S$ } at $I_C = 5A$
- Fall Time: $\leqslant 0.7\mu S$ }
- Key Parameters characterized at 100°C
- Economical Plastic Molded Construction

DESCRIPTION

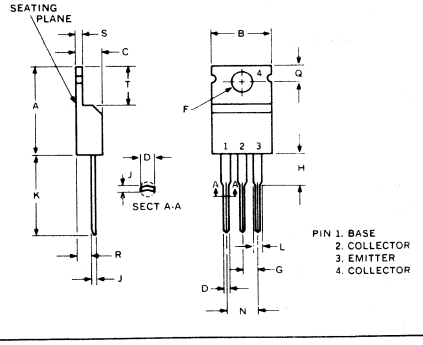
These high voltage glass passivated power transistors, in a plastic TO-220AB package, combine fast switching, low saturation voltage and rugged $E_{s/b}$ capability. They are designed for use in off-line power supplies, high voltage inverters, switching regulators, deflection circuits, motor controls and solenoid/relay drivers

ABSOLUTE MAXIMUM RATINGS

	MJE13006	MJE13007
Collector Emitter Voltage, V_{CEV}	600V	700V
Collector Emitter Voltage, $V_{CEO\ (SUS)}$	300V	400V
Emitter Base Voltage, V_{EBO}	8V	8V
Collector Current, I_C continuous	8A	8A
Collector Current, I_{CM} peak	16A	16A
Base Current, I_B continuous	4A	4A
Power Dissipation, 25°C Case	80W	80W
Derating Factor	0.641W/°C	0.641W/°C
Operating and Storage Temperature Range	−65 to 150°C	

MECHANICAL SPECIFICATIONS

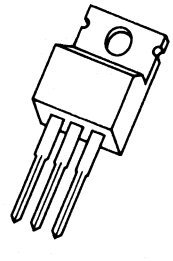
MJE13006 , MJE13007



PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.23	15.87	0.560	0.625
B	9.66	10.66	0.380	0.420
C	3.56	4.82	0.140	0.190
D	0.51	1.14	0.020	0.045
F	3.531	3.733	0.139	0.147
G	2.29	2.79	0.090	0.110
H	—	6.35	—	0.250
J	0.38	0.64	0.015	0.025
K	12.70	14.27	0.500	0.562
L	1.14	1.77	0.045	0.070
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.92	0.080	0.115
S	1.14	1.39	0.045	0.055
T	5.85	6.85	0.230	0.270

TO-220AB



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	MJE13006 MIN.	MJE13006 MAX.	MJE13007 MIN.	MJE13007 MAX.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{FE}	8	40	8	40		$I_C = 2.0A, V_{CE} = 5V$
D.C. Current Gain (Note 1)	h_{FE}	6	30	6	30		$I_C = 5.0A, V_{CE} = 5V$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	1.0	—	1.0	V	$I_C = 2.0A, I_B = 0.4A$
Collector Saturation Voltage (Note 1) $T_C = 25°C$	$V_{CE(sat)}$	—	1.5	—	1.5	V	$I_C = 5.0A, I_B = 1.0A$
Collector Saturation Voltage (Note 1) $T_C = 100°C$		—	2.0	—	2.0		
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	3.0	—	3.0	V	$I_C = 8.0A, I_B = 2.0A$
Base Saturation Voltage (Note 1)	$V_{BE(sat)}$	—	1.2	—	1.2	V	$I_C = 2.0A, I_B = 0.4A$
Base Saturation Voltage (Note 1) $T_C = 25°C$	$V_{BE(sat)}$	—	1.6	—	1.6	V	$I_C = 5.0A, I_B = 1.0A$
Base Saturation Voltage (Note 1) $T_C = 100°C$		—	1.5	—	1.5		
Collector-Emitter Sustaining Voltage (Note 2)	$V_{CEO(sus)}$	300	—	400	—	V	$I_C = 10mA$
Emitter-Base Cutoff Current	I_{EBO}	—	1	—	1	mA	$V_{EB} = 9V$
Collector Cutoff Current	I_{CEV}	—	1.0	—	—	mA	$V_{CE} = 600V, V_{BE} = -1.5V$
		—	—	—	1.0		$V_{CE} = 700V, V_{BE} = -1.5V$
Collector Cutoff Current, $T_C = 100°C$	I_{CEV}	—	5	—	—	mA	$V_{CE} = 600V, V_{BE} = -1.5V$
		—	—	—	5		$V_{CE} = 700V, V_{BE} = -1.5V$
Output Capacitance, Common Base	C_{obo}	110 typ.		110 typ.		pF	$V_{CB} = 10V, f = 1 MHz$
Gain-Bandwidth Product	F_T	4	—	4	—	MHz	$V_{CE} = 10V, I_C = 0.5A, f = 1 MHz$
Resistive Switching Speeds							
Delay Time	t_d	—	0.1	—	0.1	μS	$I_C = 5.0A$
Rise Time	t_r	—	1.0	—	1.0		$V_{CC} = 125V$
Storage Time	t_s	—	3.0	—	3.0		$I_{B1} = I_{B2} = 1A$
Fall Time	t_f	—	0.7	—	0.7		$V_{BE(off)} = 5V$
Inductive Switching Speeds $T_C = 100°C$							
Storage Time	t_s	—	2.3	—	2.3	μS	$I_C = 5.0A, V_{BE(off)} = 5V$
Fall Time ($t_{fi} + t_{fv}$)	t_f	—	0.7	—	0.7		$I_{B1} = 1A$
							V_{CE} clamp = rated $V_{CEX(sus)}$
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	—	1.56	—	1.56	°C/W	
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	—	62.5	—	62.5	°C/W	

Notes:
1. Pulse width = 250μS; duty cycle ≤1%.
2. Sustaining Voltage. Measured at a high current point where collector-emitter voltage is lowest. Current pulse length ≅ 50μS; duty cycle ≤ 1%. Voltage clamped at maximum collector-emitter voltage.

Typical Inductive Load Switching Performance

Conditions:

$\frac{I_C}{I_{B1}} = 5$

V clamp at rated $V_{CEX(sus)}$ (refer to RBSOA curve)

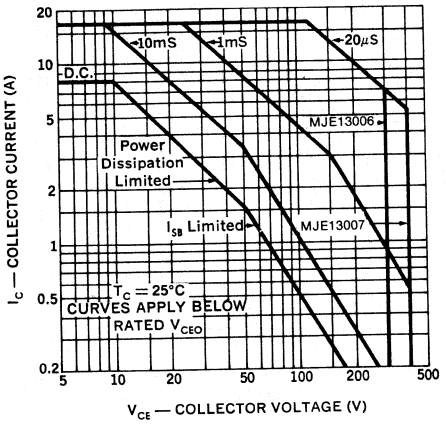
$V_{BE(off)} = -5V$

I_C Amps	T_J °C	t_s μS	t_{fv} nS	t_{fi} nS
3.0	25	.45	70	10
	100	.575	100	20
5.0	25	.475	25	4
	100	.60	45	10
8.0	25	.525	20	10
	100	.625	45	15

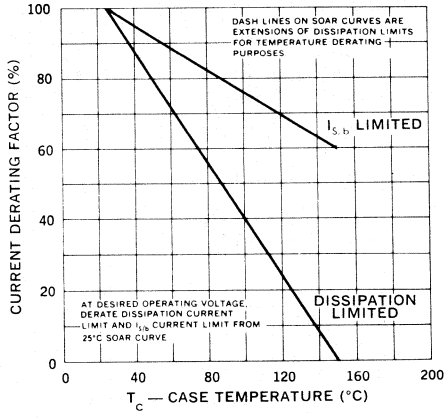
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

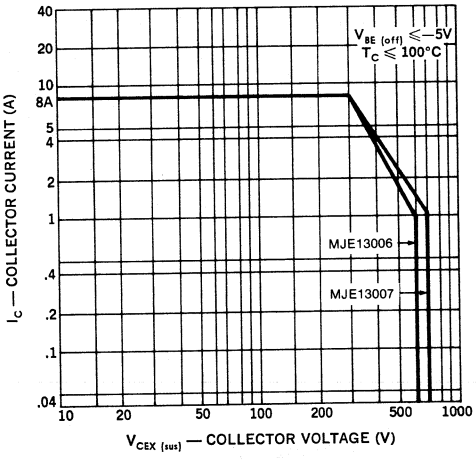
Forward Bias Safe Operating Area



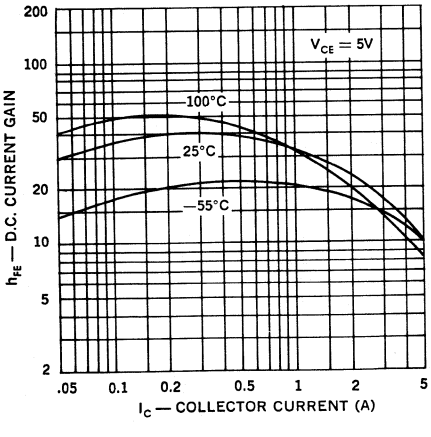
Power Derating



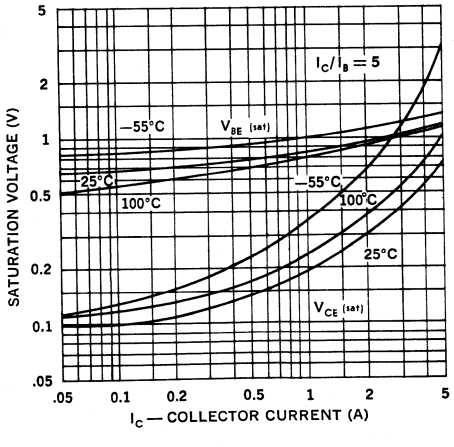
Reverse Biased Safe Operating Area



D.C. Current Gain



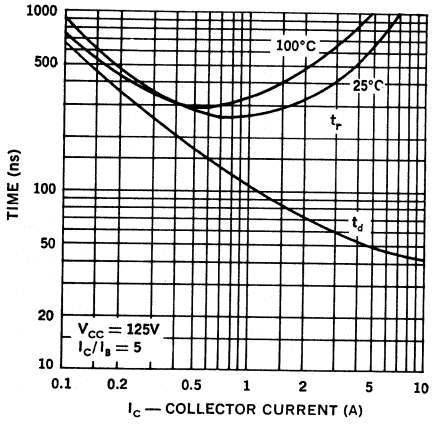
Saturation Voltages



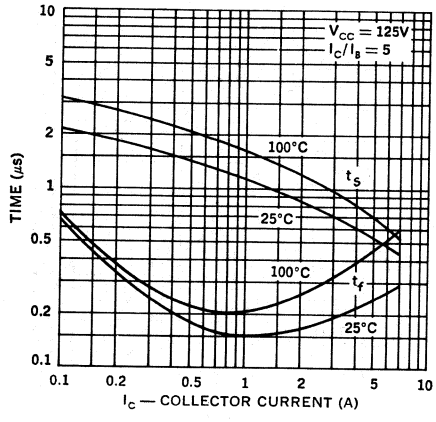
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

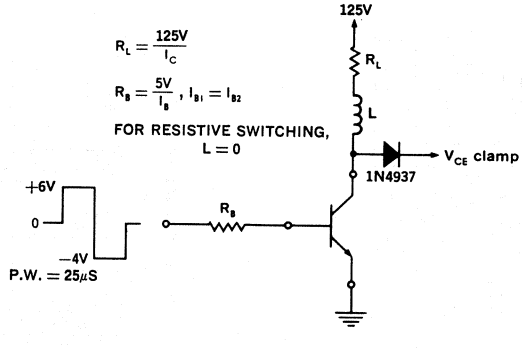
Resistive Turn-On Time



Resistive Turn-Off Time



Switching Time Test Circuit



POWER TRANSISTORS

12A, 700V, Fast Switching, Silicon NPN Mesa

MJE13008
MJE13009

3

FEATURES

- Collector Emitter Voltage: up to 700V
- Peak Collector Current: 24A
- Rise Time: $\leqslant 1.0\mu S$ } at $I_C = 8A$
- Fall Time: $\leqslant 0.7\mu S$ }
- Key Parameters characterized at 100°C
- Economical Plastic Molded Construction

DESCRIPTION

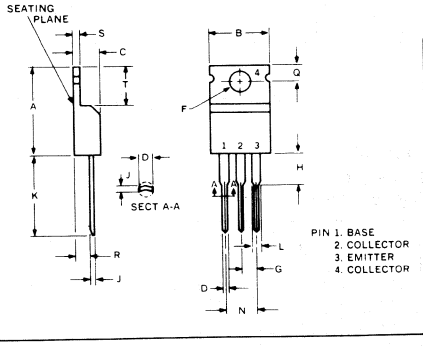
These high voltage glass passivated power transistors, in a plastic TO-220AB package, combine fast switching, low saturation voltage and rugged $E_S/_b$ capability. They are designed for use in off-line power supplies, high voltage inverters, switching regulators, deflection circuits, motor controls and solenoid/relay drivers.

ABSOLUTE MAXIMUM RATINGS

	MJE13008	MJE13009
Collector Emitter Voltage, V_{CEV}	600V	700V
Collector Emitter Voltage, $V_{CEO(SUS)}$	300V	400V
Emitter Base Voltage, V_{EBO}	9V	9V
Collector Current, I_C continuous	12A	12A
Collector Current, I_{CM} peak	24A	24A
Base Current, I_B continuous	6A	6A
Power Dissipation, 25°C Case	100W	100W
Derating Factor	0.80W/°C	0.80W/°C
Operating and Storage Temperature Range	−65 to 150°C	

MECHANICAL SPECIFICATIONS

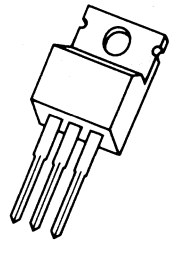
MJE13008 MJE13009



PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.23	15.87	0.560	0.625
B	9.66	10.66	0.380	0.420
C	3.56	4.82	0.140	0.190
D	0.51	1.14	0.020	0.045
F	3.531	3.733	0.139	0.147
G	2.29	2.79	0.090	0.110
H	—	6.35	—	0.250
J	0.38	0.64	0.015	0.025
K	12.70	14.27	0.500	0.562
L	1.14	1.77	0.045	0.070
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.92	0.080	0.115
S	1.14	1.39	0.045	0.055
T	5.85	6.85	0.230	0.270

TO-220AB



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	MJE13008 MIN.	MJE13008 MAX.	MJE13009 MIN.	MJE13009 MAX.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{FE}	8	40	8	40		$I_C = 5.0A, V_{CE} = 5V$
D.C. Current Gain (Note 1)	h_{FE}	6	30	6	30		$I_C = 8.0A, V_{CE} = 5V$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	1.0	—	1.0	V	$I_C = 5.0A, I_B = 1.0A$
Collector Saturation Voltage (Note 1) $T_C = 25°C$	$V_{CE(sat)}$	—	1.5	—	1.5	V	$I_C = 8.0A, I_B = 1.6A$
Collector Saturation Voltage (Note 1) $T_C = 100°C$		—	2.0	—	2.0		
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	3.0	—	3.0	V	$I_C = 12.0A, I_B = 3A$
Base Saturation Voltage (Note 1)	$V_{BE(sat)}$	—	1.2	—	1.2	V	$I_C = 5.0A, I_B = 1.0A$
Base Saturation Voltage (Note 1) $T_C = 25°C$	$V_{BE(sat)}$	—	1.6	—	1.6	V	$I_C = 8.0A, I_B = 1.6A$
Base Saturation Voltage (Note 1) $T_C = 100°C$		—	1.5	—	1.5		
Collector-Emitter Sustaining Voltage (Note 2)	$V_{CEO(sus)}$	300	—	400	—	V	$I_C = 10mA$
Emitter-Base Cutoff Current	I_{EBO}	—	1	—	1	mA	$V_{EB} = 9V$
Collector Cutoff Current	I_{CEV}	—	1.0	—	—	mA	$V_{CE} = 600V, V_{BE} = -1.5V$
		—	—	—	1.0		$V_{CE} = 700V, V_{BE} = -1.5V$
Collector Cutoff Current, $T_C = 100°C$	I_{CEV}	—	5.0	—	—	mA	$V_{CE} = 600V, V_{BE} = -1.5V$
		—	—	—	5.0		$V_{CE} = 700V, V_{BE} = -1.5V$
Output Capacitance, Common Base	C_{obo}	180 typ.		180 typ.		pF	$V_{CB} = 10V, f = 1 MHz$
Gain-Bandwidth Product	F_T	4	—	4	—	MHz	$V_{CE} = 10V, I_C = 0.5A, f = 1 MHz$
Resistive Switching Speeds							
Delay Time	t_d	—	0.1	—	0.1	μS	$I_C = 8.0$
Rise Time	t_r	—	1.0	—	1.0		$V_{CC} = 125V$
Storage Time	t_s	—	3.0	—	3.0		$I_{B1} = I_{B2} = 1.6A$
Fall Time	t_f	—	0.7	—	0.7		$V_{BE(off)} = 5V$
Inductive Switching Speeds $T_C = 100°C$							
Storage Time	t_s	—	2.3	—	2.3	μS	$I_C = 8A, V_{BE(off)} = 5V$
Fall Time ($t_{fi} + t_{fv}$)	t_f	—	0.7	—	0.7		$I_{B1} = 1.6A$
							V_{CE} clamp = rated $V_{CEX(sus)}$
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	—	1.25	—	1.25	°C/W	
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	—	62.5	—	62.5	°C/W	

Notes:
1. Pulse width = 250μS; duty cycle ≤1%.
2. Sustaining Voltage. Measured at a high current point where collector-emitter voltage is lowest. Current pulse length ≅ 50μS; duty cycle ≤ 1%. Voltage clamped at maximum collector-emitter voltage.

Typical Inductive Load Switching Performance

Conditions:

$\frac{I_C}{I_{B1}} = 5$

V clamp at rated $V_{CEX(sus)}$ (refer to RBSOA curve)
$V_{BE(off)} = -5V$

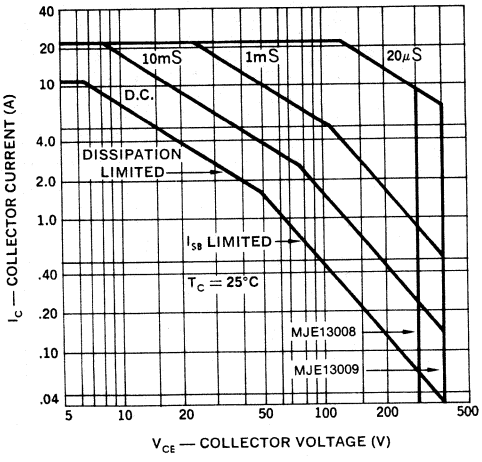
I_C Amps	T_J °C	t_s μS	t_{fv} nS	t_{fi} nS
3.0	25	0.5	100	10
	100	0.85	130	14
5.0	25	0.65	40	10
	100	0.90	50	12
8.0	25	0.72	60	12
	100	.092	65	28
12.0	25	.70	70	25
	100	.78	70	110

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

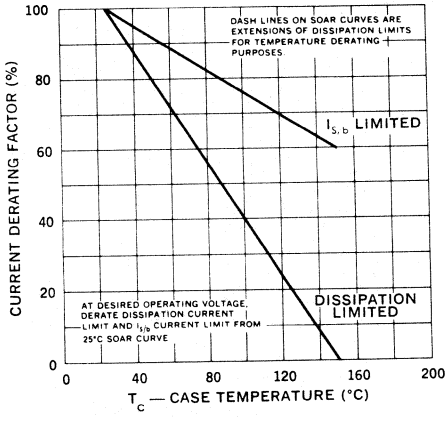
PRINTED IN U.S.A.

3

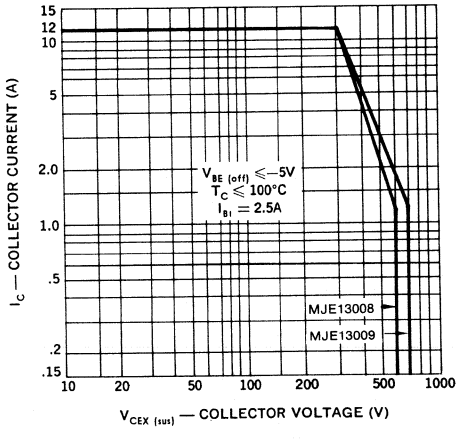
Forward Bias Safe Operating Area



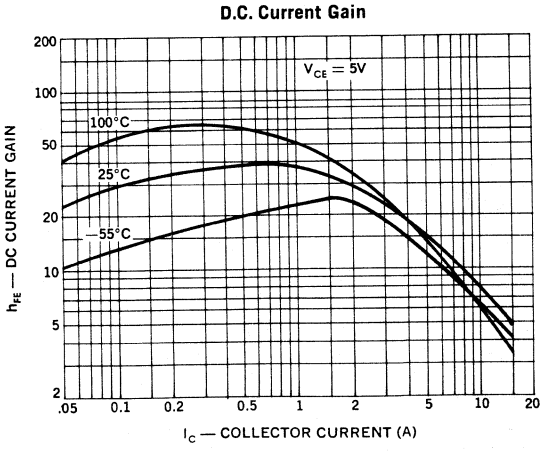
Power Derating



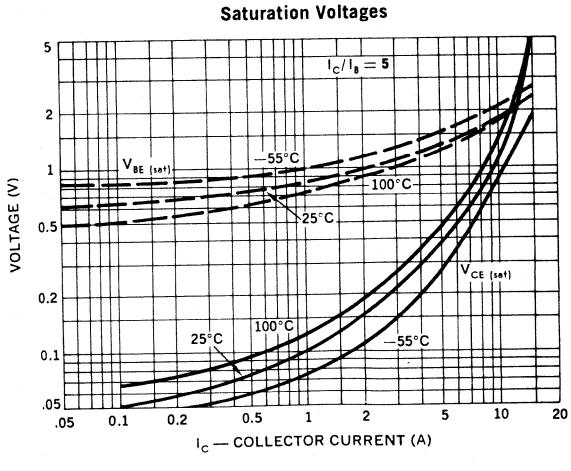
Reverse Biased Safe Operating Area



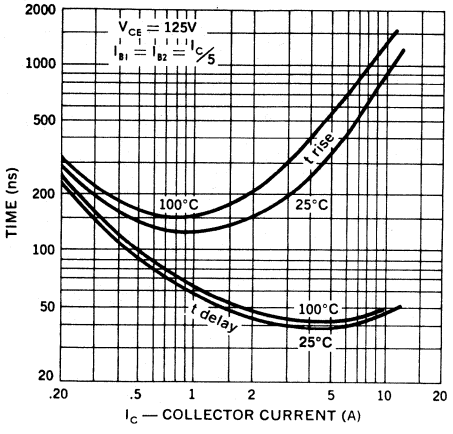
D.C. Current Gain



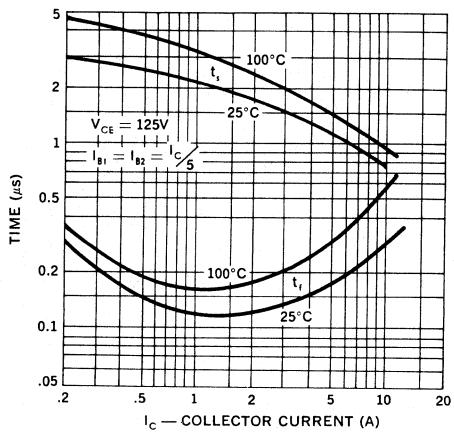
Saturation Voltages



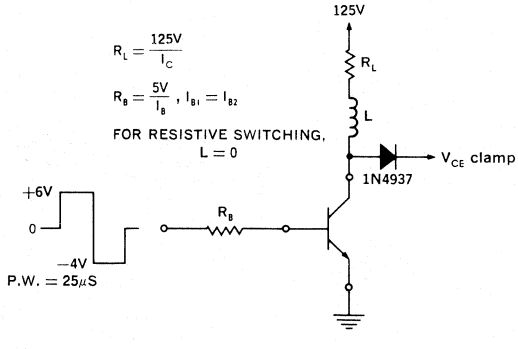
Resistive Turn-On Time



Resistive Turn-Off Time



Switching Time Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER DARLINGTONS

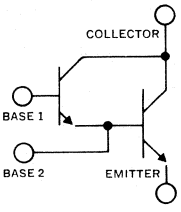
10 Amp, 150V, Planar NPN

U2T101
U2T105
U2T201
U2T205

3

FEATURES

- High Current Gain: up to 2000 min @ $I_C = 5A$
- Low Saturation Voltage: as low as 1.5V max @ $I_C = 5A$
- High Voltage: up to 150V min V_{CER}
- Monolithic Design Incorporating Multiple-Emitter Techniques
- Triple-Diffused Planar Construction



DESCRIPTION

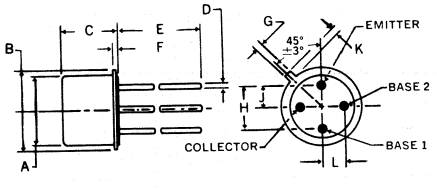
Unitrode NPN Darlingtons consist of a two transistor circuit on a single monolithic planar chip.

ABSOLUTE MAXIMUM RATINGS

	TO-33		3 PIN TO-66	
	U2T101	U2T105	U2T201	U2T205
Collector-Emitter Voltage	80V	150V	80V	150V
Emitter Base Voltages,				
V_{EB2}	6V	6V	6V	6V
V_{EB1}	12V	12V	12V	12V
D.C. Collector Current	5A	5A	5A	5A
Peak Collector Current	10A	10A	10A	10A
Base 1 Current	0.5A	0.5A	0.5A	0.5A
Power Dissipation				
25°C Ambient	1W	1W	2.5W	2.5W
100°C Case	5W	5W	25W	25W
Thermal Resistance, Junction to Case	20°C/W		4°C/W	
Operating and Storage Temperature Range	−65°C to 200°C		−65°C to 200°C	

MECHANICAL SPECIFICATIONS

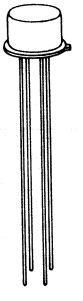
U2T101 U2T105



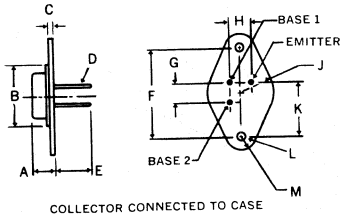
COLLECTOR CONNECTED TO CASE

	ins	mm
A	.305-.335	7.75-8.51
B	.335-.370	8.51-9.40
C	.240-.260	6.10-6.60
D	.017 ± .002 .001	.432 ± .051 .025
E	1.5 MIN	38.10 MIN
F	.018 MAX	0.46 MAX
G	.031 ± .003	0.79 ± .08
H	.200	1.02
J	.100	2.54
K	.029-.045	0.74-1.14
L	.100	2.54

TO-33



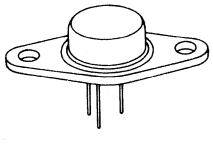
U2T201 U2T205



COLLECTOR CONNECTED TO CASE

	ins	mm
A	.250-.340	6.35-8.64
B	.620 MAX.	15.75 MAX.
C	.050-.075	1.27-1.91
D	.028-.034	0.71-0.86
E	.360 MIN.	9.14 MIN.
F	.958-.962	24.33-24.43
G	.190-.210	4.83-5.33
H	.190-.210	4.83-5.33
J	.350 MAX. RAD.	8.89 MAX. RAD.
K	.570-.590	14.48-14.99
L	.142-.152	3.61-3.86
M	.145 MAX. RAD.	3.68 MAX. RAD.

3 Pin TO-66



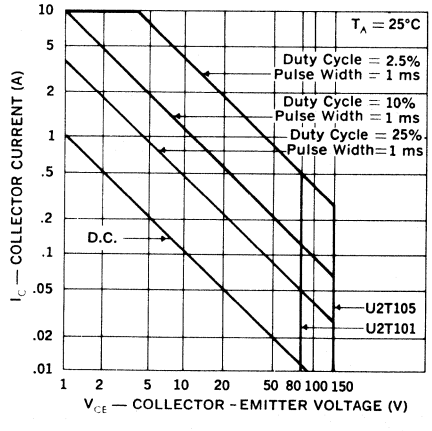
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

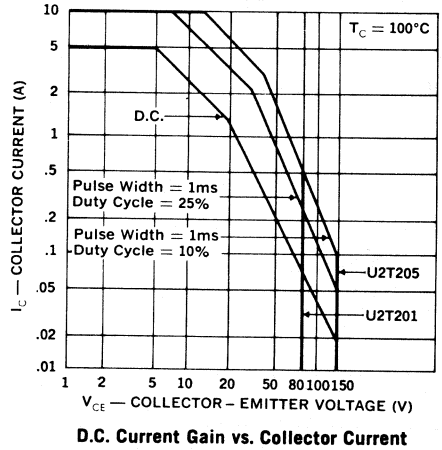
Test	Symbol	U2T101 & U2T201 Min.	U2T101 & U2T201 Max.	U2T105 & U2T205 Min.	U2T105 & U2T205 Max.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{FE}	2000	—	1000	—	—	$I_C = 1.0A$, $V_{CE} = 2V$, $R_{B2E} = 1K$
D.C. Current Gain (Note 1)	h_{FE}	2000	—	1000	—	—	$I_C = 5A$, $V_{CE} = 5V$, $R_{B2E} = 100$
Collector Saturation Voltage (Note 1)	V_{CE} (sat)	—	1.5	—	2.5	V	$I_C = 5A$, $R_{B2E} = 100$ U2T101, 201: $I_{B1} = 5mA$ U2T105, 205: $I_{B1} = 10mA$
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CER}	80	—	150	—	V	$I_C = 25mA$, $R_{B1E} = 2.2K$, $R_{B2E} = 100$
Collector Cutoff Current	I_{CER}	—	1.0	—	1.0	μA	$R_{B1E} = 2.2K$, $R_{B2E} = 100$ U2T101, 201: $V_{CE} = 80V$ U2T105, 205: $V_{CE} = 150V$
Collector Cutoff Current	I_{CER}	—	1.0	—	1.0	mA	$R_{B1E} = 2.2K$, $R_{B2E} = 100$, $T = 150°C$ U2T101, 201: $V_{CE} = 80V$ U2T105, 205: $V_{CE} = 150V$
Collector Capacitance	C_{obo}	—	100	—	100	pf	$V_{CB1} = 10$, $I_E = 0$, $f = 1MHz$
A.C. Current Gain	h_{fe}	5	—	5	—	—	$I_C = 1.0A$, $V_{CE} = 10V$, $f = 10MHz$, $R_{B2E} = 100$
Switching Speeds — Delay Time	t_d	100 Typ.		100 Typ.		ns	$V_{CC} = 30V$,
Switching Speeds — Rise Time	t_r	300 Typ.		400 Typ.		ns	$I_C = 5A$,
Switching Speeds — Storage Time	t_s	600 Typ.		500 Typ.		ns	U2T101, 201: I_B (on) = I_B (off) = 5mA,
Switching Speeds — Fall Time	t_f	500 Typ.		500 Typ.		ns	U2T105, 205: I_B (on) = I_B (off) = 10mA, $R_{B2E} = 100$

Note: 1. Pulse width = 300 μs; duty cycle ≤2%.

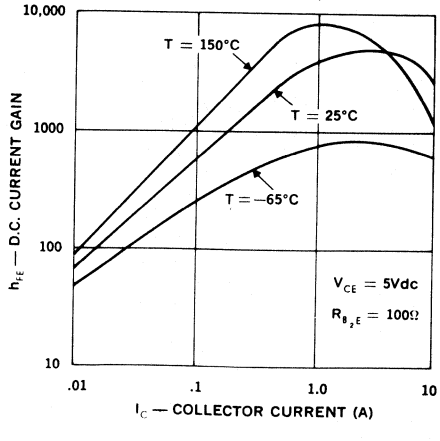
Maximum Safe Operating Area U2T101 & 105



Maximum Safe Operating Area U2T201 & 205



D.C. Current Gain vs. Collector Current U2T101, U2T105, U2T201, U2T205



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

POWER DARLINGTONS

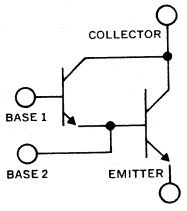
5 Amp, 150V, Planar NPN

U2T301 U2T401
U2T305 U2T405

3

FEATURES

- High Current Gain: 1000 min. @ $I_C = 2A$
- Low Saturation Voltage: as low as 1.5V max. @ $I_C = 2A$
- High Voltage: up to 150V min. V_{CER}
- Monolithic Design Incorporating Multiple-Emitter Techniques
- Triple-Diffused Planar Construction



DESCRIPTION

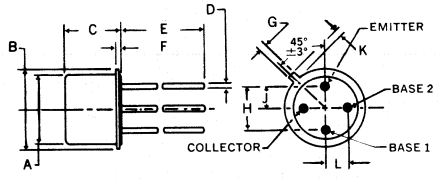
Unitrode NPN Darlingtons consist of a two transistor circuit on a single monolithic planar chip.

ABSOLUTE MAXIMUM RATINGS

	TO-33		3 PIN TO-66	
	U2T301	U2T305	U2T401	U2T405
Collector-Emitter Voltage	60V	150V	60V	150V
Emitter Base Voltages,				
V_{EB2}	6V	6V	6V	6V
V_{EB1}	12V	12V	12V	12V
D.C. Collector Current	2A	2A	2A	2A
Peak Collector Current	5A	5A	5A	5A
Base 1 Current	0.5A	0.5A	0.5A	0.5A
Power Dissipation				
25°C Ambient	1W	1W	2W	2W
100°C Case	4W	4W	16W	16W
Thermal Resistance				
Junction to Case	25°C/W		6°C/W	
Operating and Storage Temperature Range	−65°C to 200°C		−65°C to 200°C	

MECHANICAL SPECIFICATIONS

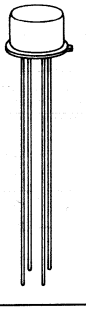
U2T301 U2T305



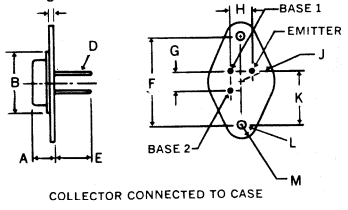
COLLECTOR CONNECTED TO CASE

	ins.	mm
A	305-335	7.75-8.51
B	335-370	8.51-9.40
C	240-260	6.10-6.60
D	017 ± .002 .001	.432 ± .051 .025
E	1.5 MIN.	38.10 MIN.
F	.018 MAX.	0.46 MAX.
G	031 ± .003	0.79 ± .08
H	200	1.02
J	.100	2.54
K	029-045	0.74-1.14
L	100	2.54

TO-33



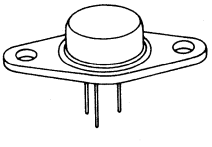
U2T401 U2T405



COLLECTOR CONNECTED TO CASE

	ins	mm
A	250-340	6.35-8.64
B	620 MAX.	15.75 MAX.
C	050-075	1.27-1.91
D	028-034	0.71-0.86
E	360 MIN.	9.14 MIN.
F	958-962	24.33-24.43
G	190-210	4.83-5.33
H	190-210	4.83-5.33
J	350 MAX. RAD.	8.89 MAX. RAD.
K	570-590	14.48-14.99
L	142-152	3.61-3.86
M	145 MAX. RAD.	3.68 MAX. RAD.

3 Pin TO-66



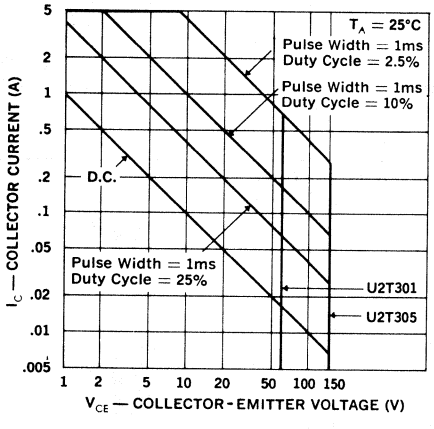
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

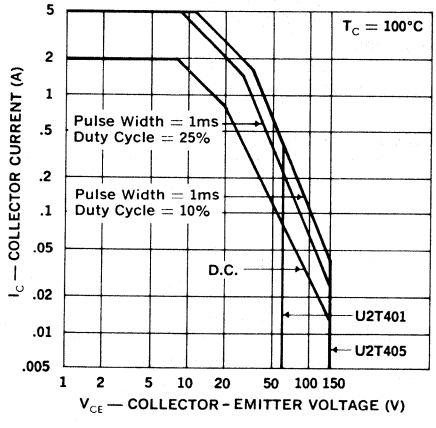
Test	Symbol	U2T301 & U2T401 Min.	U2T301 & U2T401 Max.	U2T305 & U2T405 Min.	U2T305 & U2T405 Max.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{FE}	1000	—	1000	—	—	$I_C = 1A, V_{CE} = 2V, R_{B2E} = 1K$
D.C. Current Gain (Note 1)	h_{FE}	1000	—	1000	—	—	$I_C = 2A, V_{CE} = 5V, R_{B2E} = 100$
Collector Saturation Voltage (Note 1)	V_{CE} (sat)	—	1.5	—	2.5	V	$I_C = 2A, R_{B2E} = 100, I_{B1} = 4mA$
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CER}	60	—	150	—	V	$I_C = 25mA, R_{B1E} = 2.2K, R_{B2E} = 100$
Collector Cutoff Current	I_{CER}	—	1.0	—	1.0	μA	$R_{B1E} = 2.2K, R_{B2E} = 100$ U2T301, 401: $V_{CE} = 60V$ U2T305, 405: $V_{CE} = 150V$
Collector Cutoff Current	I_{CER}	—	1.0	—	1.0	mA	$R_{B1E} = 2.2K, R_{B2E} = 100, T = 150°C$ U2T301, 401: $V_{CE} = 60V$ U2T305, 405: $V_{CE} = 150V$
Collector Capacitance	C_{obo}	—	60	—	60	pf	$V_{CB1} = 10V, I_E = 0, f = 1MHz$
A.C. Current Gain	h_{fe}	5	—	5	—	—	$I_C = 0.5A, V_{CE} = 10V, f = 10MHz, R_{B2E} = 100$
Switching Speeds: Delay Time	t_d	100 Typ.		100 Typ.		ns	$V_{CC} = 30V, I_C = 2A, I_B$ (on) $= I_B$ (off) $= 4mA$ $R_{B2E} = 100$
Switching Speeds: Rise Time	t_r	200 Typ.		300 Typ.		ns	
Switching Speeds: Storage Time	t_s	800 Typ.		800 Typ.		ns	
Switching Speeds: Fall Time	t_f	300 Typ.		300 Typ.		ns	

Note: 1. Pulse width = 300 μs; duty cycle ≤2%.

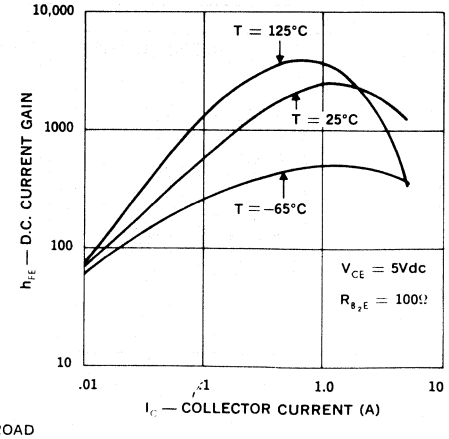
Maximum Safe Operating Area
U2T301 & 305



Maximum Safe Operating Area
U2T401 & 405



D.C. Current Gain vs. Collector Current
U2T301, U2T305, U2T401, U2T405



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER DARLINGTONS

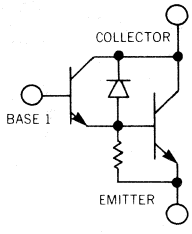
3 Amp, 100V, Planar NPN, Plastic

U2TA506
U2TA508
U2TA510

3

FEATURES

- High Current Gain: 500 min. @ $I_C = 3A$
- Low Saturation Voltage: as low as 1.5V max. @ $I_C = 3A$
- Economic Plastic Molded Construction



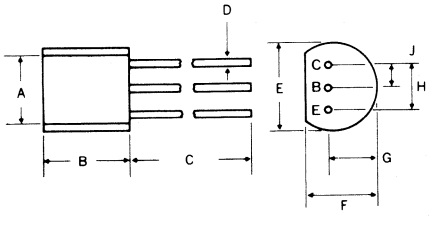
DESCRIPTION

Unitrode NPN Darlingtons consist of a two transistor circuit on a single monolithic planar chip, including integral bias resistance and protective diode. It is ideally suited for pulse power applications in power supplies, printers, solid state relays and displays.

ABSOLUTE MAXIMUM RATINGS

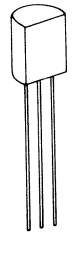
	U2TA506	U2TA508	U2TA510
Collector-Base Voltage, V_{CBO}	80V	100V	120V
Collector-Emitter Voltage, V_{CEO}	60V	80V	100V
Emitter-Base Voltage, V_{EBO}		5V	
D.C. Collector Current, I_C		.75A	
Peak Collector Current, I_C		5A	
Base Current, I_B		.6A	
Power Dissipation			
25°C Case		2.2W	
25°C Ambient		871mW	
Thermal Resistance, Θ_{J-C}		62.5°C/W	
Thermal Resistance, Θ_{J-A}		155°C/W	
Storage Temperature Range		−55 to +150°C	
Maximum Junction Temperature		+175°C	

U2TA506 U2TA508 U2TA510



	INCHES	MILLIMETERS
A	.135 MIN.	3.42 MIN.
B	.170 - .210	4.31 - 5.33
C	.500 MIN.	12.70 MIN.
D	.016 - .019	.406 - .482
E	.175 - .205	4.44 - 5.21
F	.125 - .165	3.17 - 4.19
G	.080 - .105	2.03 - 2.66
H	.095 - .105	2.41 - 2.66
J	.045 - .055	1.14 - 1.40

TO-92



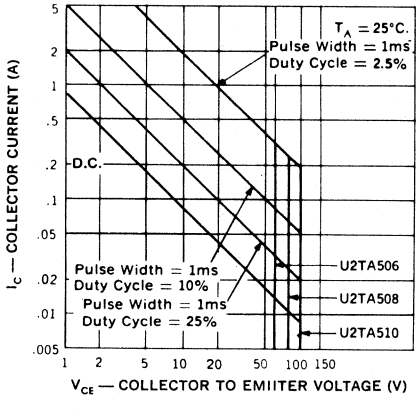
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

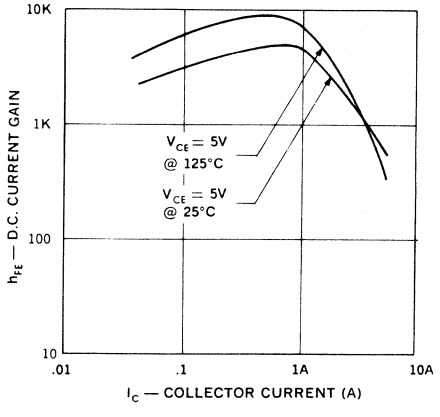
Test	Symbol	Min.	Max.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{FE}	1000	—	—	$I_C = 1A, V_{CE} = 5Vdc$
D.C. Current Gain (Note 1)	h_{FE}	500	—	—	$I_C = 3A, V_{CE} = 5Vdc$
D.C. Current Gain (Note 1)	h_{FE}	300 Typ.		—	$I_C = 5A, V_{CE} = 5Vdc$
Collector Saturation Voltage (Note 1)	V_{CE} (sat)	—	1.5	Vdc	$I_C = 3A, I_B = 30mA$
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CEO}			Vdc	$I_C = 10mAdc$
U2TA506		60	—		
U2TA508		80	—		
U2TA510		100	—		
Collector-Emitter Cutoff Current	I_{CER}	—	10	μAdc	V_{CE} = rating, R = 100Ω
Collector-Emitter Cutoff Current	I_{CER}	—	1	mAdc	V_{CE} = rating, R = 100Ω, $T_A = 125°C$
Emitter-Base Cutoff Current	I_{EBO}	—	50	μAdc	$V_{EB} = 5Vdc$
Output Capacitance	C_{ob}	—	50	pf	$V_{CB} = 10Vdc, I_E = 0, f = 1MHz$
A.C. Current Gain	h_{fe}	4.0 Typ.		—	$I_C = 1Adc, V_{CE} = 5Vdc, f = 10MHz$
Rise Time	t_r	600 Typ.		ns	$I_C = 2A$
Storage Time	t_s	1500 Typ.		ns	V_{CC} = rating, $I_{B\,(on)} = I_{B\,(off)} = 4mA$
Fall Time	t_f	800 Typ.		ns	

Note 1: Pulse width = 300μs; duty cycle ≤ 2%.
Note 2: For thermal considerations for operating U2TA506, U2TA508 and U2TA510, refer to Application Note U-77.

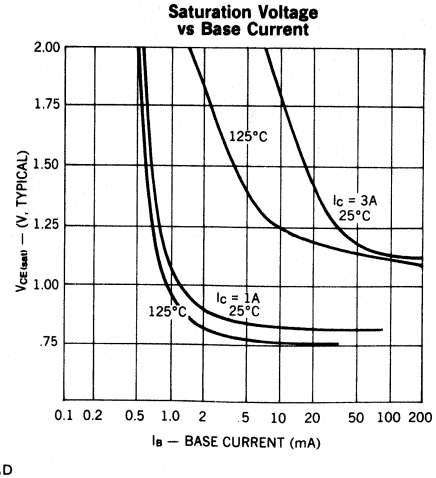
Maximum Safe Operating Area
U2TA506, 508 & 510



D.C. Current Gain vs. Collector Current



Saturation Voltage
vs Base Current



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

LOW VOLTAGE NPN TRANSISTOR

UBT430

40Amp, 50V, Planar NPN
Low Saturation Voltage (.3V @ 30A);
High Efficiency

3

FEATURES

- Very Low On Resistance — Typically 7 milliohms
- Reverse Blocking Voltage — V_{ECS} = 20V
- Low Temperature Coefficient of On Resistance
- Fast Switching Times Make Operation at High Frequency Easy
- High Gain Reduces Base Losses

DESCRIPTION

The UBT430 is a planar NPN bipolar transistor that has been designed to optimize performance for low voltage circuits. It features a very low saturation voltage of only .30V max at 30A, and .10V at 10A. Because of its excellent switching speed (rise and fall times typically under 100ns and storage times under 500ns) it offers excellent performance even in high frequency switching circuits.

This is the ideal transistor to use for emitter switching in off-line switching power supplies. The low drop of this device also makes it the best choice for a battery back-up circuit. Considerable improvement in efficiency can be achieved by using the UBT430 transistor in boost regulators operating off a 5V line and low voltage buck regulators.

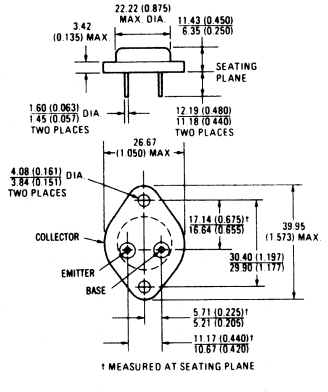
Design Note DN-20 provides additional information on the application of the UBT430 transistor.

ABSOLUTE MAXIMUM RATINGS

Continuous Collector Current	I_C	40A
Peak Emitter Current	I_M	150A
Inductive Collector Current Clamped	I_{LM}	80A
Continuous Base Current	I_B	8A
Peak Base Current	I_{BM}	50A
Collector-Emitter Voltage	V_{CES}	50V
Emitter-Base Voltage	V_{EBO}	20V
Thermal Resistance	$R\theta$	1°C/W
Power Dissipation		150W @ 25°C
Derating Factor		1W/°C
Operating Temperature Range		-65°C to +175°C

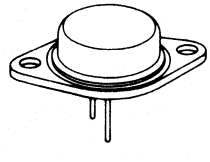
MECHANICAL SPECIFICATIONS

UBT430



Dimensions in Millimeters and (Inches)

TO-204AE (TO-3 modified, 60 mil. pin)

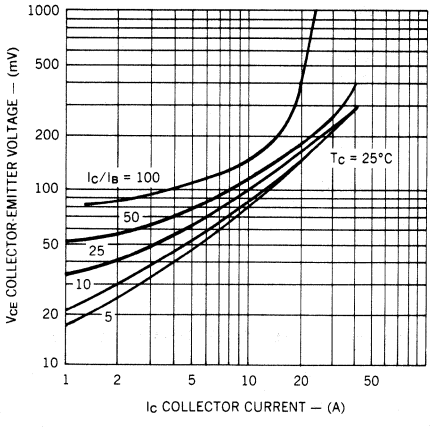


UNITRODE

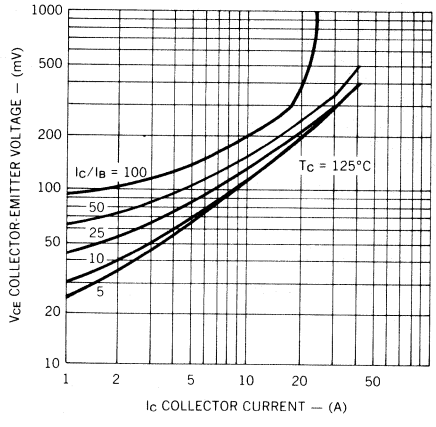
ELECTRICAL CHARACTERISTICS (at 25°C unless noted)

TEST		SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Collector Saturation Voltage		$V_{CE(sat)}$		0.07	0.1	V	I_C = 10A, I_B = .5A
				0.21	0.3		I_C = 30A, I_B = 1.2A
				0.30	0.4		I_C = 30A, I_B = 1.2A, T = 125°C
On-Resistance		$R_{CE(ON)}$		7	10	mΩ	I_C = 30A, I_B = 1.2A
Current Gain		H_{FE}	50	100			I_C = 20A, V_{CE} = .5V
Base Saturation Voltage		$V_{BE(sat)}$		1.2	1.5	V	I_C = 30A, I_B = 1.2A
Collector-Emitter Sustaining Voltage		$V_{CEO(sus)}$	17	20		V	I_C = 100mA
Resistive Switching Speed	Rise Time	t_r		85	120	ns	I_C = 20A, I_{B1} = I_{B2} = 2A, V_{CC} = 10V
	Storage Time	t_s		300	500	ns	I_C = 20A, I_{B1} = I_{B2} = 2A, V_{CC} = 10V
	Fall Time	t_f		75	120	ns	I_C = 20A, I_{B1} = I_{B2} = 2A, V_{CC} = 10V
Inductive Switching Speed	Voltage Storage Time	t_{sv}		400	600	ns	I_C = 20A, I_{B1} = I_{B2} = .8A, V_{CC} = 10V, L = 10μH
	Current Fall Time	t_{fi}		85	120	ns	I_C = 20A, I_{B1} = I_{B2} = .8A, V_{CC} = 10V, L = 10μH
Collector-Emitter Cutoff Current		I_{CES}			100	μA	V_{CE} = 50V
					1	mA	V_{CE} = 50V, T = 125°C
Emitter-Base Cutoff Current		I_{EBO}			200	μA	V_{EB} = 20V
					1	mA	V_{EB} = 20V, T = 125°C

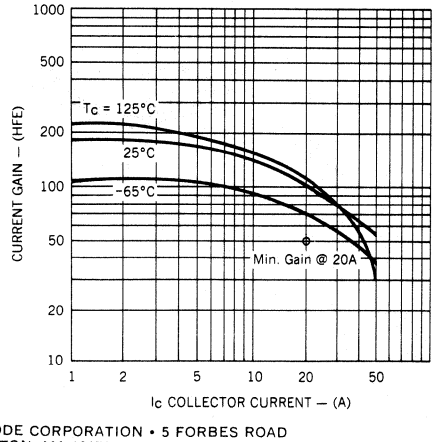
Collector-Emitter Voltage vs Collector Current at Various Forced Gains



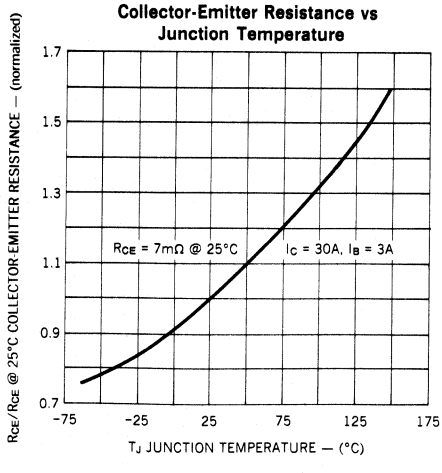
Collector-Emitter Voltage vs Collector Current at Various Forced Gains



Gain vs Collector Current @ V_{CE} = 0.5V at Various Temperatures



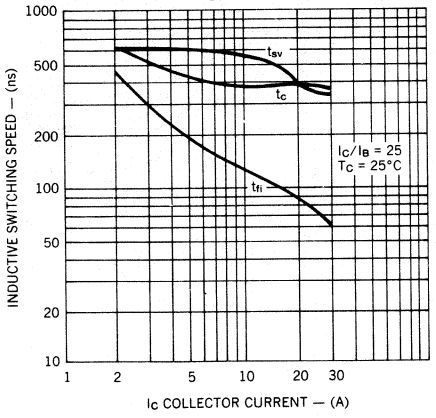
Collector-Emitter Resistance vs Junction Temperature



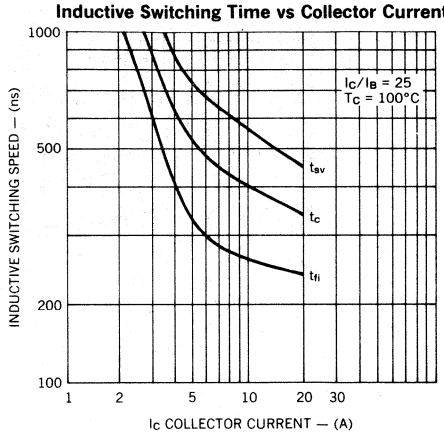
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

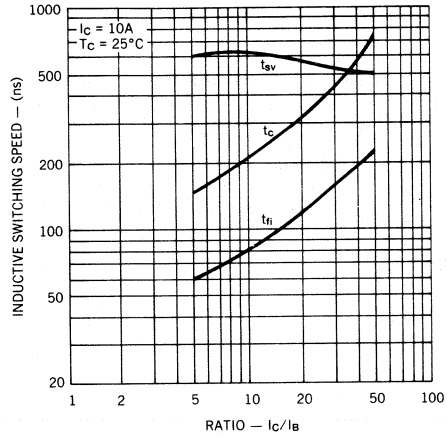
Inductive Switching Time vs Collector Current



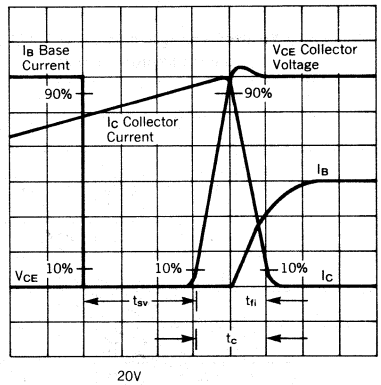
Inductive Switching Time vs Collector Current



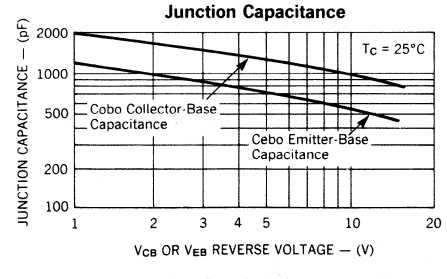
Inductive Switching Time vs Base Drive Current



Clamped Inductive Switching Waveforms and Definitions Inductive Turn Off



Junction Capacitance



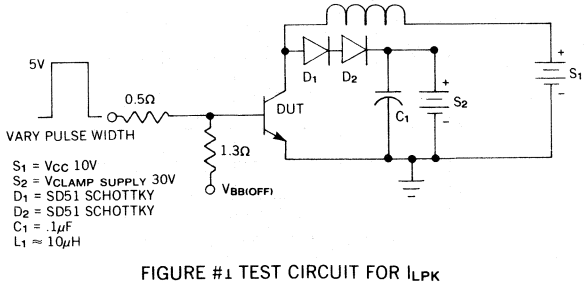
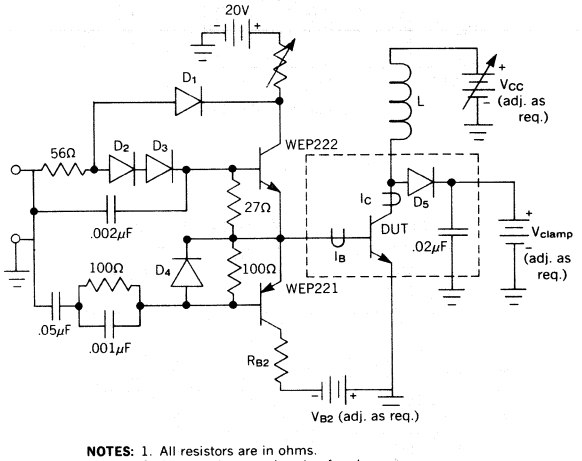


FIGURE #1 TEST CIRCUIT FOR I_{LPK}



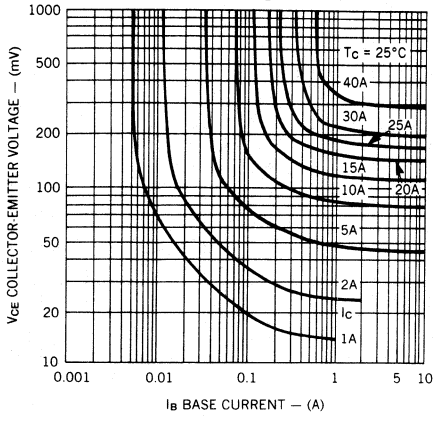
NOTES:
1. All resistors are in ohms.
2. All capacitors are in microfarads.
3. D_1 — D_4 are 1N914 diodes.
4. D_5 is 1N6391 or equivalent.
5. L is selected as required (5 to 15 microhenries).
6. Adjust R_{B2} and/or V_{B2} for desired I_{B2}.
7. Circuit; DUT and adjacent circuit is critical due to fast switching time. Ringing voltage produced by Ldi/dt effects may be reduced by proper layout of PC board.

FIGURE #2 INDUCTIVE SWITCHING CIRCUIT WITH CLAMPED COLLECTOR

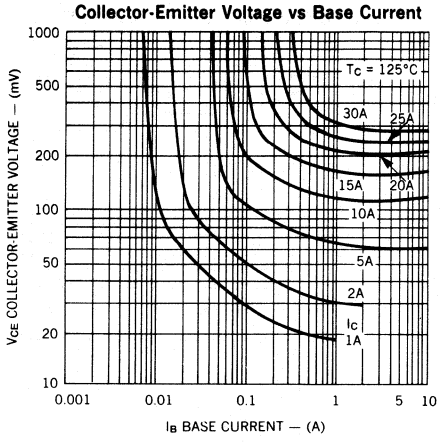
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

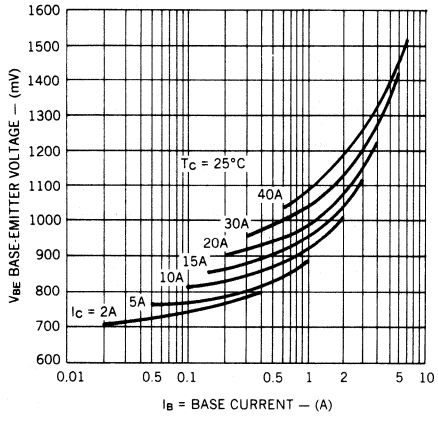
Collector-Emitter Voltage vs Base Current



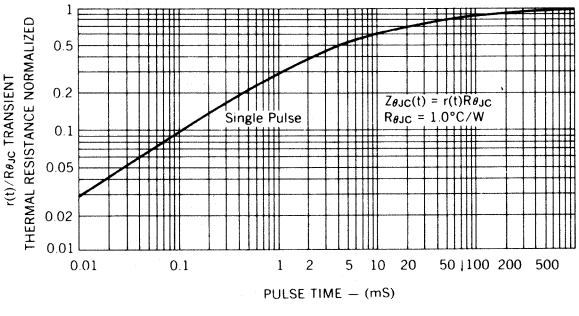
Collector-Emitter Voltage vs Base Current



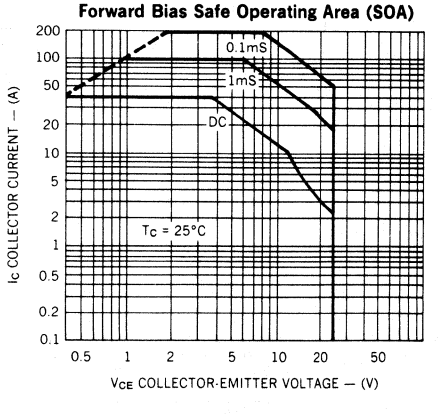
Base Emitter Voltage vs Base Current at Various Collector Currents



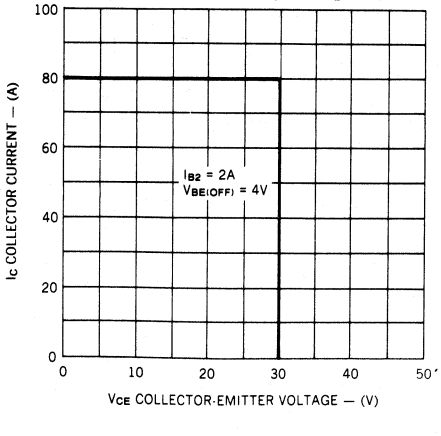
Transient Thermal Resistance vs Time



Forward Bias Safe Operating Area (SOA)



Reverse Bias Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

100 Volt, 0.3 Ohm
N-Channel

UFN120
UFN121
UFN122
UFN123

3

FEATURES

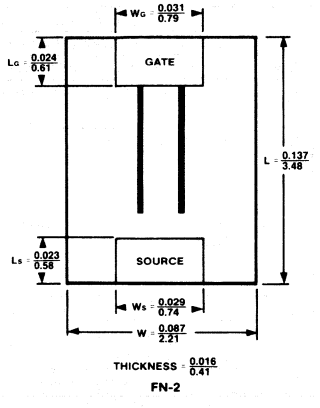
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



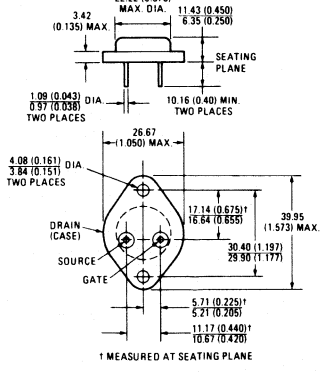
FN-2

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN120	100V	0.30Ω	8.0A
UFN121	60V	0.30Ω	8.0A
UFN122	100V	0.40Ω	7.0A
UFN123	60V	0.40Ω	7.0A

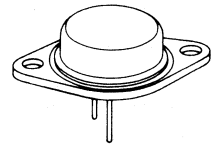
MECHANICAL SPECIFICATIONS

UFN120 UFN121 UFN122 UFN123



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

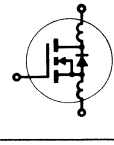
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN120	UFN121	UFN122	UFN123	Units
V_{DS}	Drain - Source Voltage ①	100	60	100	60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	100	60	100	60	V
I_D @ T_C = 25°C	Continuous Drain Current	8.0	8.0	7.0	7.0	A
I_D @ T_C = 100°C	Continuous Drain Current	5.0	5.0	4.0	4.0	A
I_{DM}	Pulsed Drain Current ③	32	32	28	28	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	40 (See Fig. 14)				W
	Linear Derating Factor	0.32 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		32	32	28	28	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN120 UFN122	100	–	–	V	V_{GS} = 0V
		UFN121 UFN123	60	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN120 UFN121	8.0	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN122 UFN123	7.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN120 UFN121	–	0.25	0.30	Ω	V_{GS} = 10V, I_D = 4.0A
		UFN122 UFN123	–	0.30	0.40	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.5	2.9	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 4.0A
C_{iss}	Input Capacitance	ALL	–	450	600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	200	400	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	50	100	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	20	40	ns	$V_{DD} \approx 0.5\ BV_{DSS}$, I_D = 4.0A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	35	70	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	50	100	ns	
t_f	Fall Time	ALL	–	35	70	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	10	15	nC	V_{GS} = 10V, I_D = 10A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	6.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	4.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	3.12	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN120 UFN121	–	–	8.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN122 UFN123	–	–	7.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN120 UFN121	–	–	32	A	
		UFN122 UFN123	–	–	28	A	
V_{SD}	Diode Forward Voltage ②	UFN120 UFN121	–	–	2.5	V	T_C = 25°C, I_S = 8.0A, V_{GS} = 0V
		UFN122 UFN123	–	–	2.3	V	T_C = 25°C, I_S = 7.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	280	–	ns	T_J = 150°C, I_F = 8.0A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	1.6	–	μC	T_J = 150°C, I_F = 8.0A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

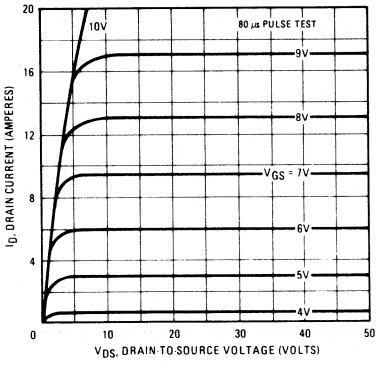


Fig. 2 – Typical Transfer Characteristics

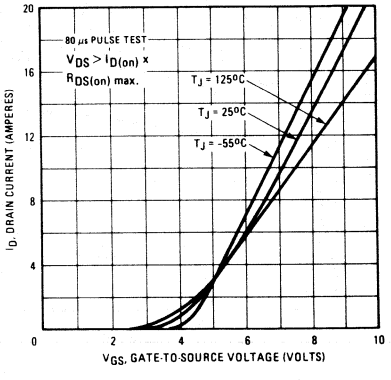


Fig. 3 – Typical Saturation Characteristics

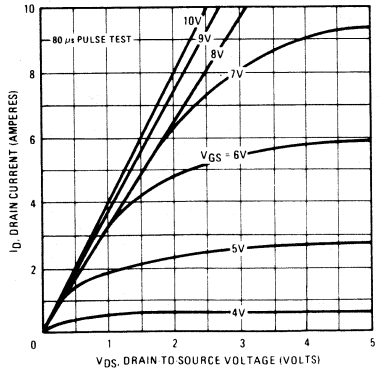


Fig. 4 – Maximum Safe Operating Area

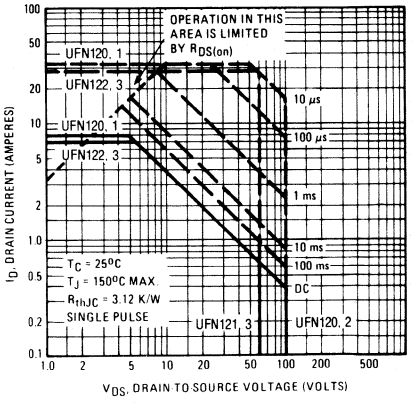


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

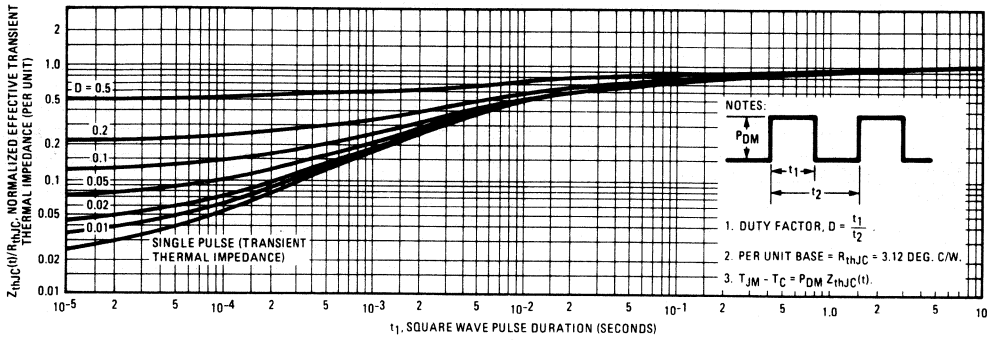


Fig. 6 – Typical Transconductance Vs. Drain Current

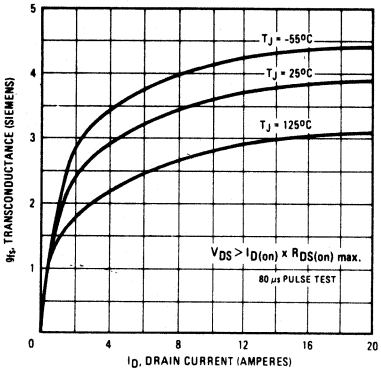


Fig. 7 – Typical Source-Drain Diode Forward Voltage

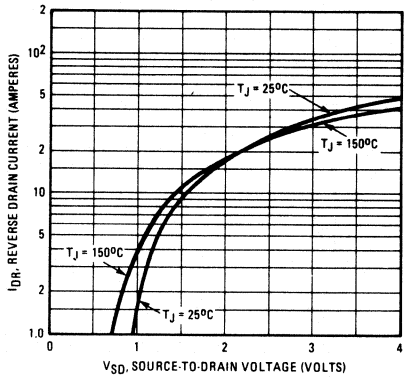


Fig. 8 – Breakdown Voltage Vs. Temperature

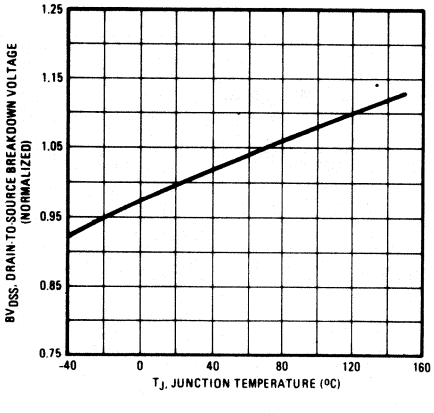
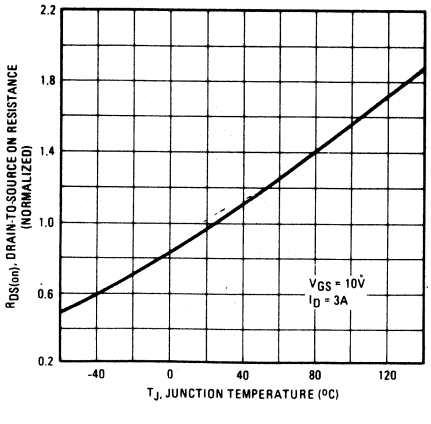


Fig. 9 – Normalized On-Resistance Vs. Temperature



3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

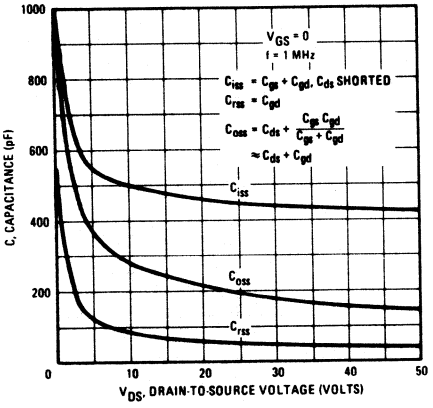


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

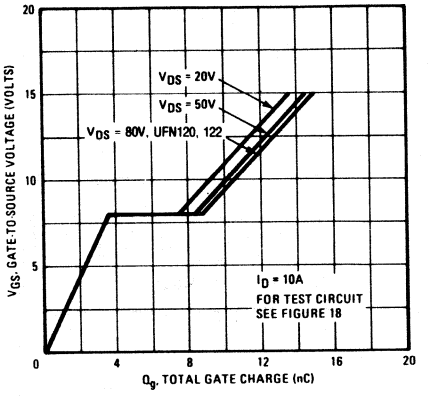


Fig. 12 – Typical On-Resistance Vs. Drain Current

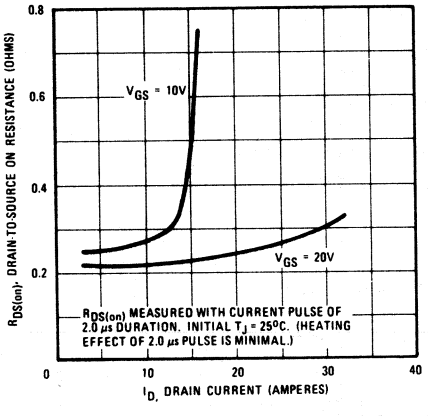


Fig. 13 – Maximum Drain Current Vs. Case Temperature

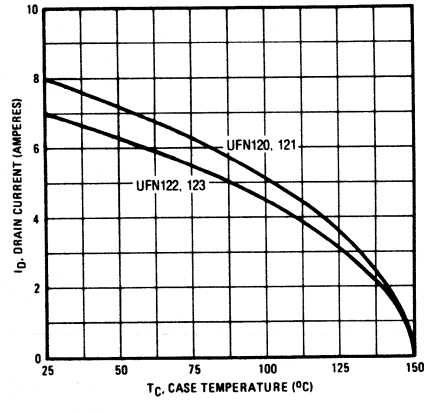
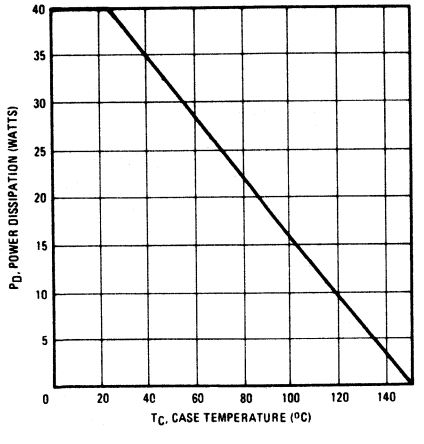


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

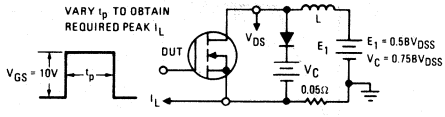


Fig. 16 – Clamped Inductive Waveforms

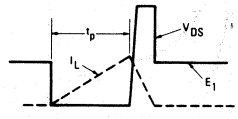


Fig. 17 – Switching Time Test Circuit

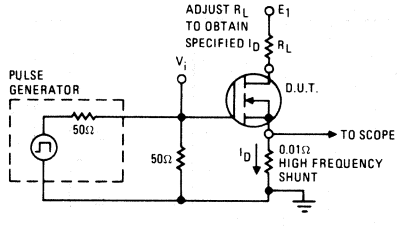
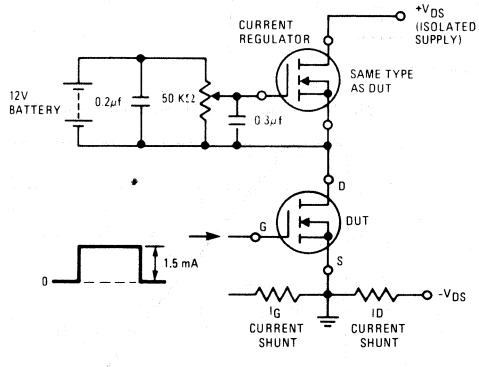


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

100 Volt, 0.18 Ohm N-Channel

UFN130
UFN131
UFN132
UFN133

3

FEATURES

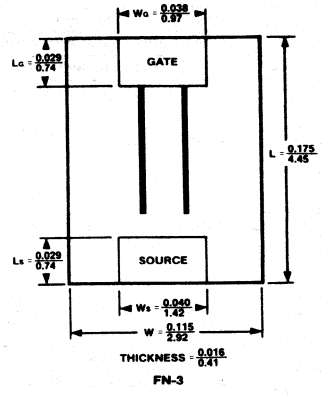
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

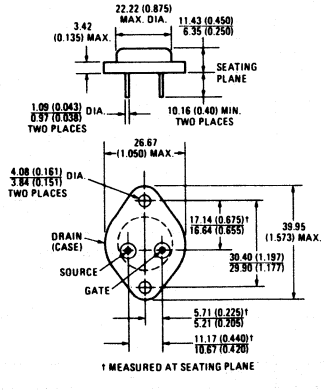


PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN130	100V	0.18Ω	14A
UFN131	60V	0.18Ω	14A
UFN132	100V	0.25Ω	12A
UFN133	60V	0.25Ω	12A

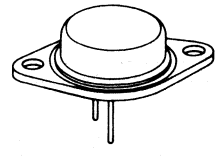
MECHANICAL SPECIFICATIONS

UFN130 UFN131 UFN132 UFN133



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

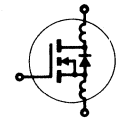
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN130	UFN131	UFN132	UFN133	Units
V_{DS}	Drain - Source Voltage ①	100	60	100	60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	100	60	100	60	V
I_D @ T_C = 25°C	Continuous Drain Current	14	14	12	12	A
I_D @ T_C = 100°C	Continuous Drain Current	9.0	9.0	8.0	8.0	A
I_{DM}	Pulsed Drain Current ③	56	56	48	48	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	75 (See Fig. 14)				W
	Linear Derating Factor	0.6 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		56	56	48	48	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN130 UFN132	100	–	–	V	V_{GS} = 0V
		UFN131 UFN133	60	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN130 UFN131	14	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN132 UFN133	12	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN130 UFN131	–	0.14	0.18	Ω	V_{GS} = 10V, I_D = 8.0A
		UFN132 UFN133	–	0.20	0.25	Ω	
g_{fs}	Forward Transconductance ②	ALL	4.0	5.5	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 8.0A
C_{iss}	Input Capacitance	ALL	–	600	800	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	300	500	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	100	150	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	30	ns	V_{DD} ≈ 36V, I_D = 8.0A, Z_o = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	75	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	40	ns	
t_f	Fall Time	ALL	–	–	45	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	18	30	nC	V_{GS} = 10V, I_D = 18A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	9.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	9.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.67	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN130 UFN131	–	–	14	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN132 UFN133	–	–	12	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN130 UFN131	–	–	56	A	
		UFN132 UFN133	–	–	48	A	
V_{SD}	Diode Forward Voltage ②	UFN130 UFN131	–	–	2.5	V	T_C = 25°C, I_S = 14A, V_{GS} = 0V
		UFN132 UFN133	–	–	2.3	V	T_C = 25°C, I_S = 12A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	360	–	ns	T_J = 150°C, I_F = 14A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	2.1	–	μC	T_J = 150°C, I_F = 14A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

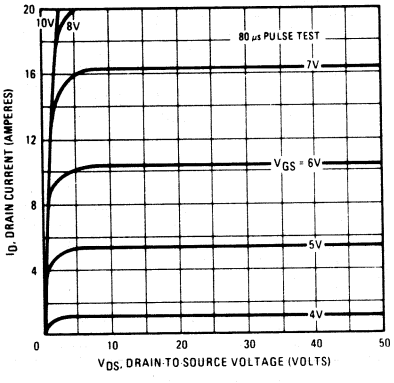


Fig. 2 – Typical Transfer Characteristics

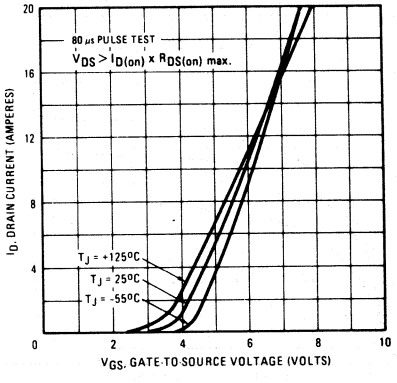


Fig. 3 – Typical Saturation Characteristics

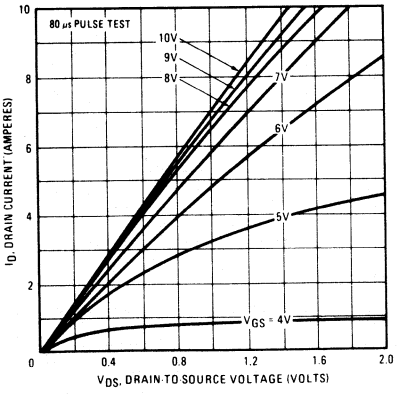
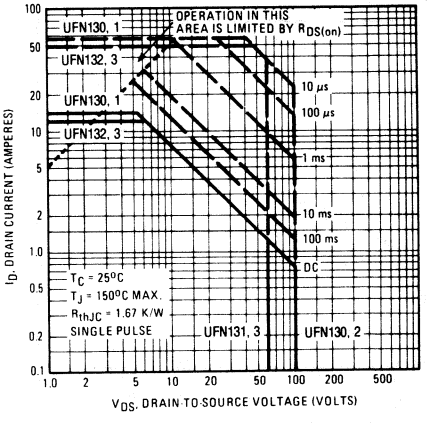


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

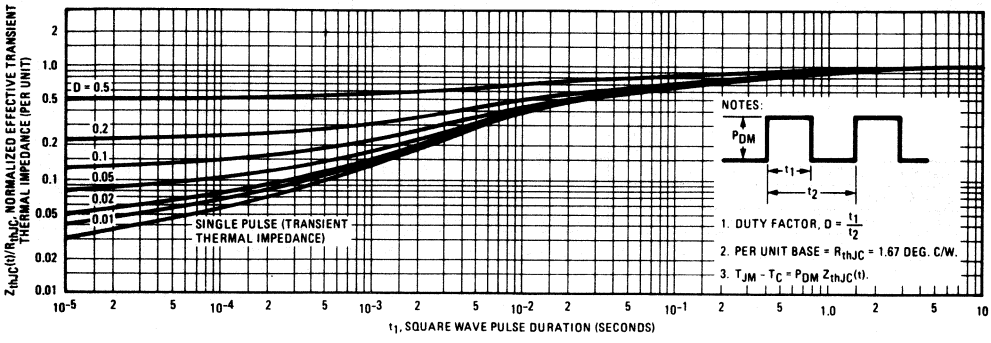


Fig. 6 – Typical Transconductance Vs. Drain Current

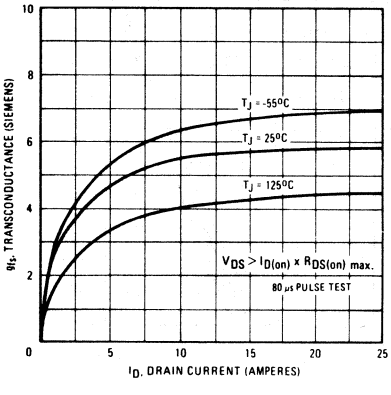


Fig. 7 – Typical Source-Drain Diode Forward Voltage

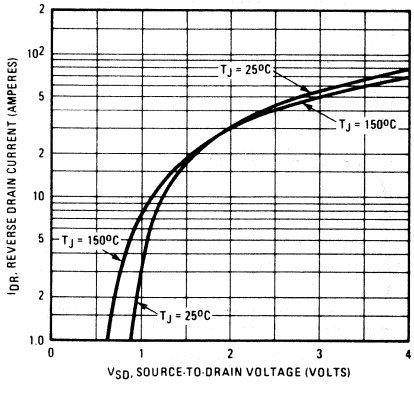


Fig. 8 – Breakdown Voltage Vs. Temperature

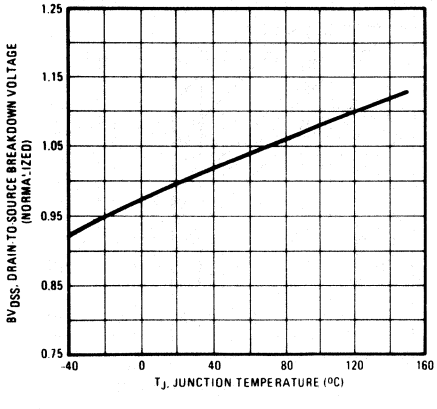
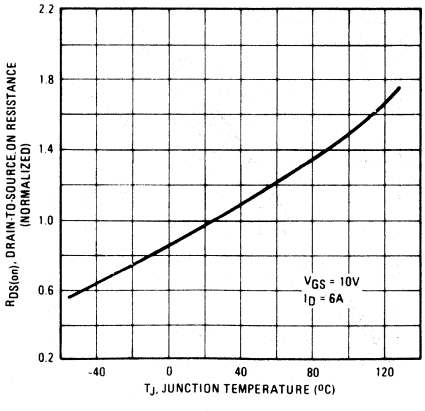


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

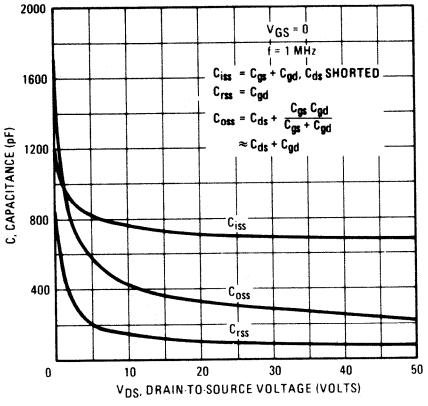


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

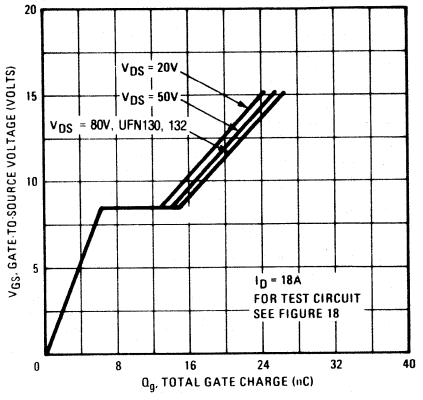


Fig. 12 – Typical On-Resistance Vs. Drain Current

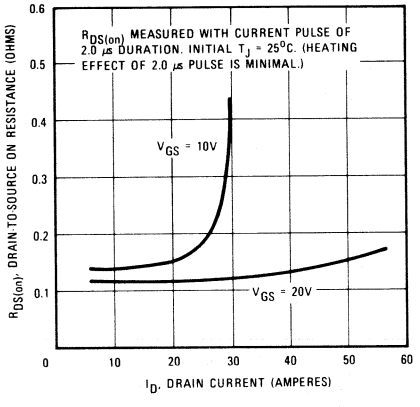


Fig. 13 – Maximum Drain Current Vs. Case Temperature

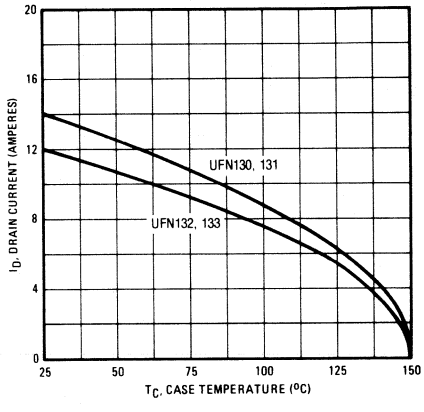


Fig. 14 – Power Vs. Temperature Derating Curve

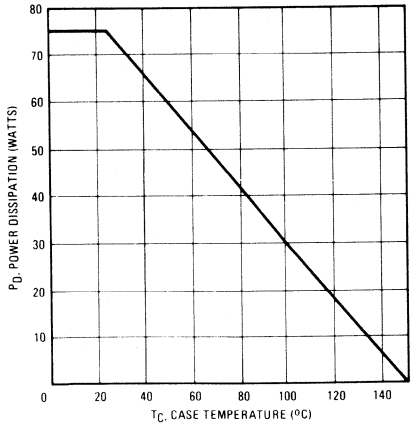


Fig. 15 – Clamped Inductive Test Circuit

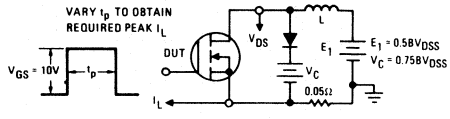


Fig. 16 – Clamped Inductive Waveforms

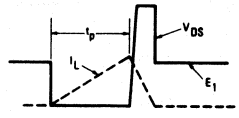


Fig. 17 – Switching Time Test Circuit

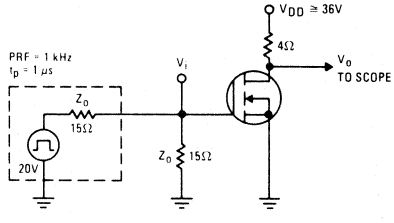
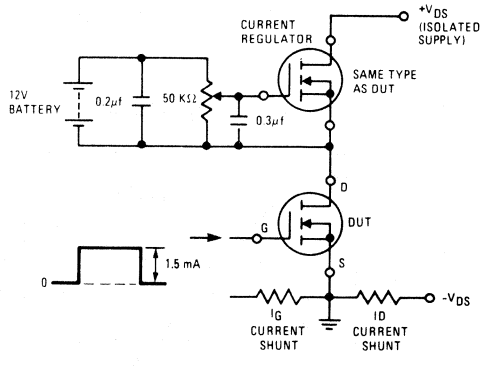


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

100 Volt, 0.085 Ohm N-Channel

UFN140
UFN141
UFN142
UFN143

3

FEATURES

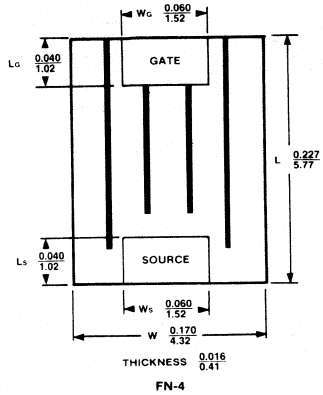
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



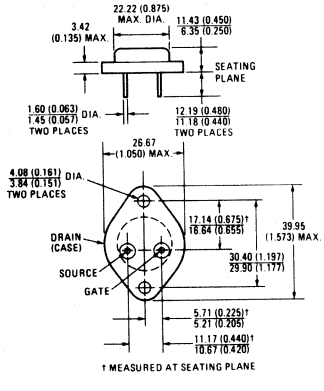
FN-4

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN140	100V	0.085Ω	27A
UFN141	60V	0.085Ω	27A
UFN142	100V	0.11Ω	24A
UFN143	60V	0.11Ω	24A

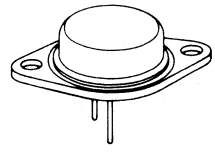
MECHANICAL SPECIFICATIONS

UFN140 UFN141 UFN142 UFN143



Dimensions in Millimeters and (Inches)

TO-204AE (TO-3 modified)



UNITRODE

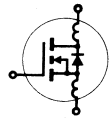
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN140	UFN141	UFN142	UFN143	Units
V_{DS}	Drain - Source Voltage ①	100	60	100	60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	100	60	100	60	V
I_D @ T_C = 25°C	Continuous Drain Current	27	27	24	24	A
I_D @ T_C = 100°C	Continuous Drain Current	17	17	15	15	A
I_{DM}	Pulsed Drain Current ③	108	108	96	96	A
V_{GS}	Gate - Source Voltage	± 20				V
P_D @ T_C = 25°C	Max. Power Dissipation	125 (See Fig. 14)				W
	Linear Derating Factor	1.0 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		108	108	96	96	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN140 UFN142	100	–	–	V	V_{GS} = 0V
		UFN141 UFN143	60	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN140 UFN141	27	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)\,max.}$, V_{GS} = 10V
		UFN142 UFN143	24	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN140 UFN141	–	0.07	0.085	Ω	V_{GS} = 10V, I_D = 15A
		UFN142 UFN143	–	0.09	0.11	Ω	
g_{fs}	Forward Transconductance ②	ALL	6.0	10	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)\,max.}$, I_D = 15A
C_{iss}	Input Capacitance	ALL	–	1275	1600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	550	800	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	160	300	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	16	30	ns	V_{DD} = 30V, I_D = 15A, Z_o = 4.7Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	27	60	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	38	80	ns	
t_f	Fall Time	ALL	–	14	30	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	38	60	nC	V_{GS} = 10V, I_D = 34A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	17	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	21	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.0	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN140 UFN141	–	–	27	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN142 UFN143	–	–	24	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN140 UFN141	–	–	108	A	
		UFN142 UFN143	–	–	96	A	
V_{SD}	Diode Forward Voltage ②	UFN140 UFN141	–	–	2.5	V	T_C = 25°C, I_S = 27A, V_{GS} = 0V
		UFN142 UFN143	–	–	2.3	V	T_C = 25°C, I_S = 24A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	500	–	ns	T_J = 150°C, I_F = 27A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	2.9	–	μC	T_J = 150°C, I_F = 27A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

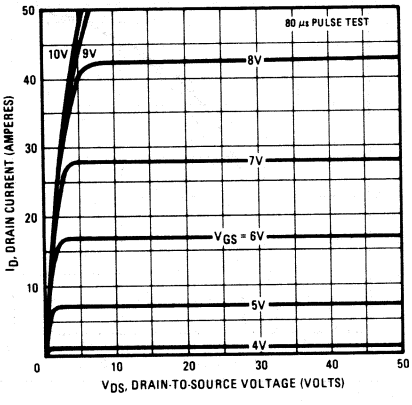


Fig. 2 – Typical Transfer Characteristics

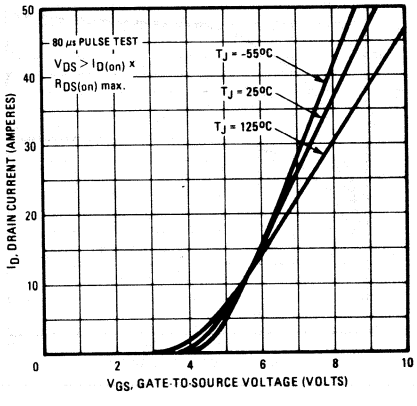


Fig. 3 – Typical Saturation Characteristics

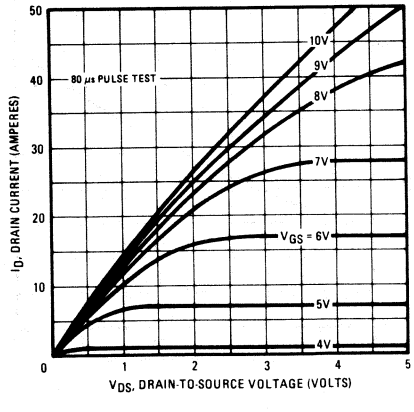
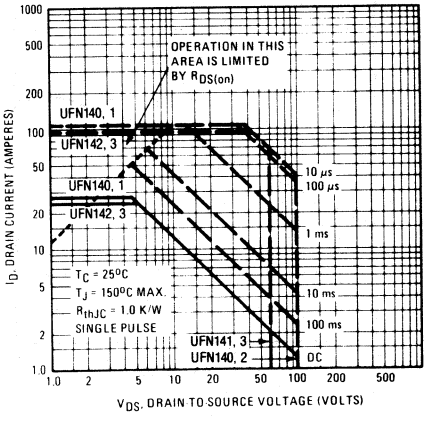


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

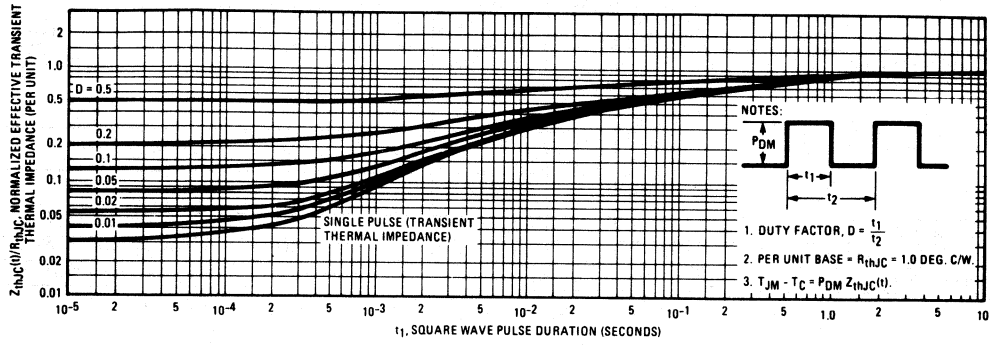


Fig. 6 — Typical Transconductance Vs. Drain Current

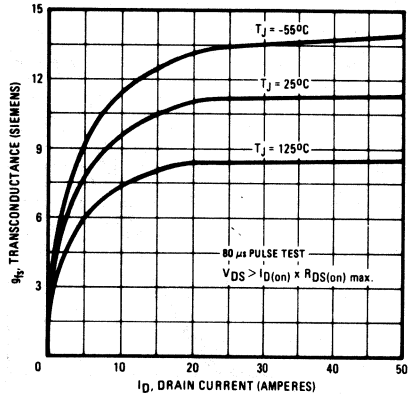


Fig. 7 — Typical Source-Drain Diode Forward Voltage

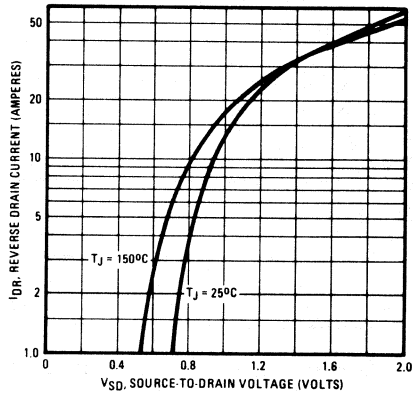


Fig. 8 — Breakdown Voltage Vs. Temperature

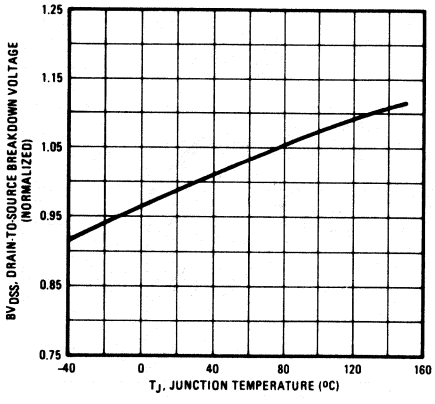
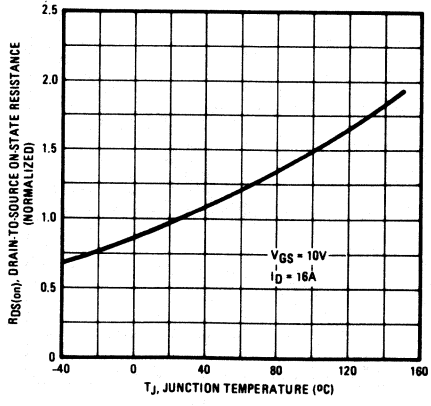


Fig. 9 — Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

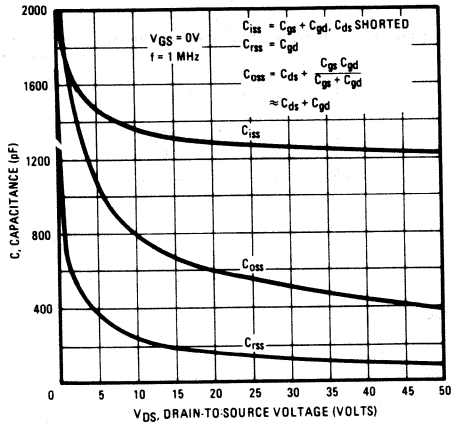


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

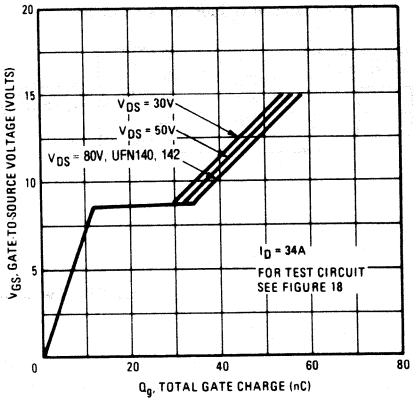


Fig. 12 – Typical On-Resistance Vs. Drain Current

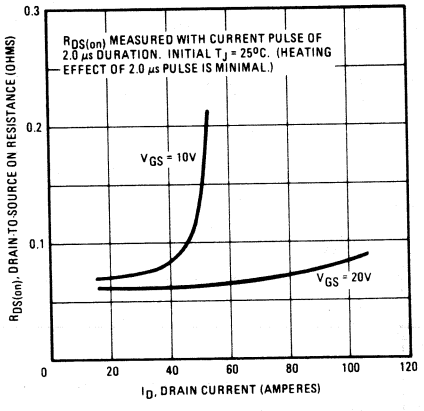


Fig. 13 – Maximum Drain Current Vs. Case Temperature

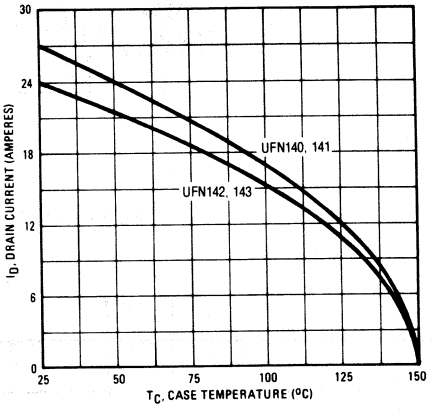
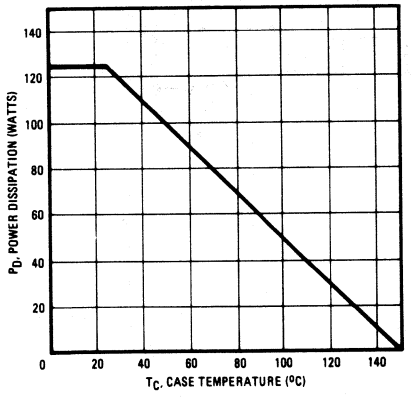


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

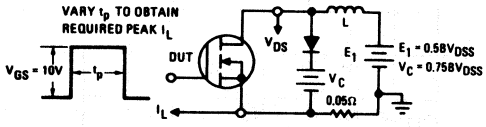


Fig. 16 – Clamped Inductive Waveforms

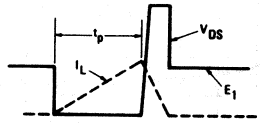


Fig. 17 – Switching Time Test Circuit

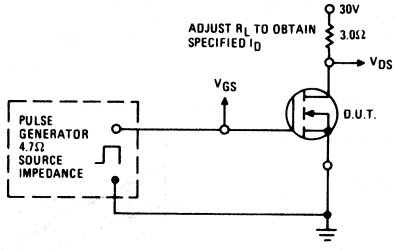
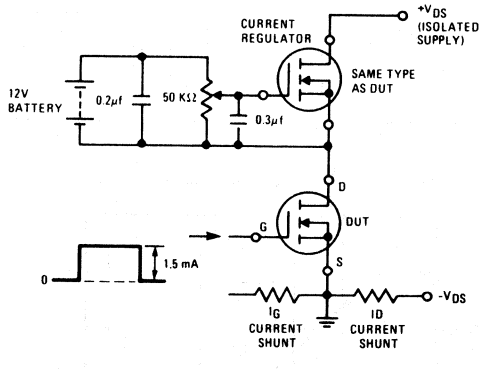


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

100 Volt, 0.055 Ohm N-Channel

UFN150
UFN151
UFN152
UFN153

3

FEATURES

- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

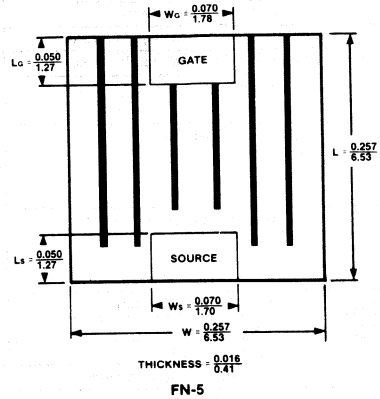
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

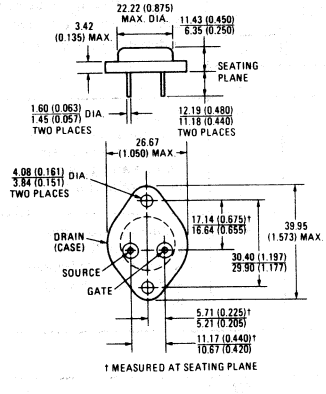
Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN150	100V	0.055Ω	40A
UFN151	60V	0.055Ω	40A
UFN152	100V	0.08Ω	33A
UFN153	60V	0.08Ω	33A



FN-5

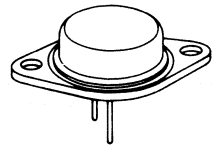
MECHANICAL SPECIFICATIONS

UFN150 UFN151 UFN152 UFN153



Dimensions in Millimeters and (Inches)

TO-204AE (TO-3 modified)



UNITRODE

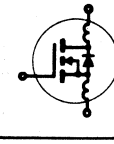
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN150	UFN151	UFN152	UFN153	Units
V_{DS}	Drain - Source Voltage ①	100	60	100	60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	100	60	100	60	V
I_D @ T_C = 25°C	Continuous Drain Current	40	40	33	33	A
I_D @ T_C = 100°C	Continuous Drain Current	25	25	20	20	A
I_{DM}	Pulsed Drain Current ③	160	160	132	132	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	150 (See Fig. 14)				W
	Linear Derating Factor	1.2 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	160	(See Fig. 15 and 16) L = 100μH 160	132	132	A
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN150 UFN152	100	–	–	V	V_{GS} = 0V
		UFN151 UFN153	60	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN150 UFN151	40	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFN152 UFN153	33	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN150 UFN151	–	0.045	0.055	Ω	V_{GS} = 10V, I_D = 20A
		UFN152 UFN153	–	0.06	0.08	Ω	
g_{fs}	Forward Transconductance ②	ALL	9.0	11	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 20A
C_{iss}	Input Capacitance	ALL	–	2000	3000	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	1000	1500	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	350	500	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	35	ns	V_{DD} = 24V, I_D = 20A, Z_o = 4.7Ω See Figure 17. (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	100	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	125	ns	
t_f	Fall Time	ALL	–	–	100	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	63	120	nC	V_{GS} = 10V, I_D = 50A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	27	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	36	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	0.83	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

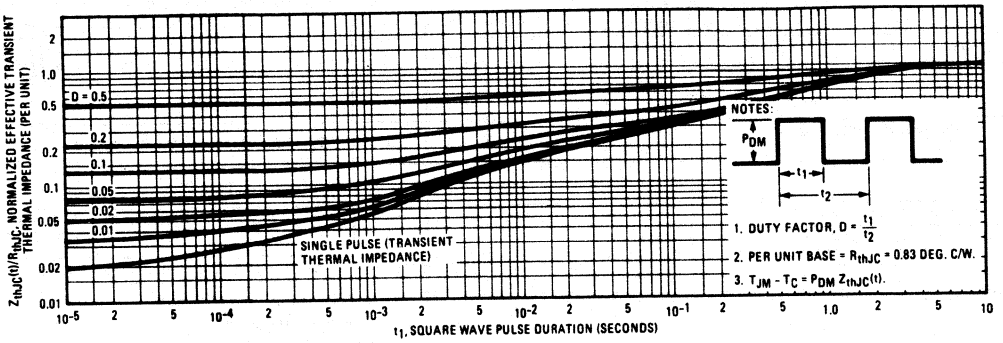


Fig. 6 – Typical Transconductance Vs. Drain Current

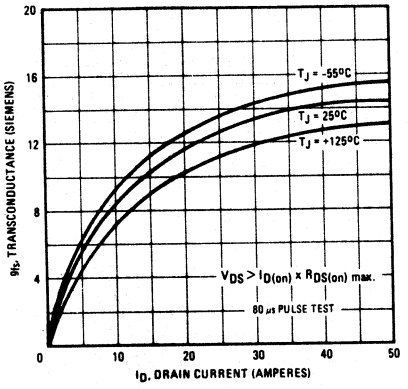


Fig. 7 – Typical Source-Drain Diode Forward Voltage

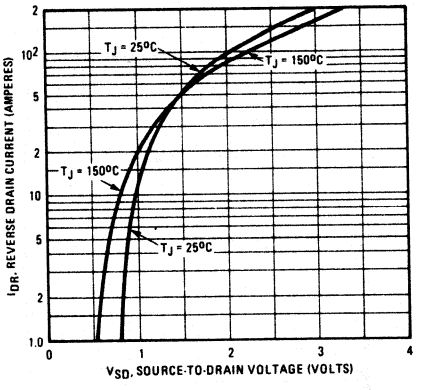


Fig. 8 – Breakdown Voltage Vs. Temperature

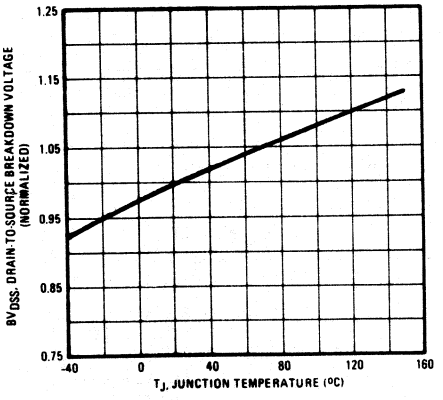
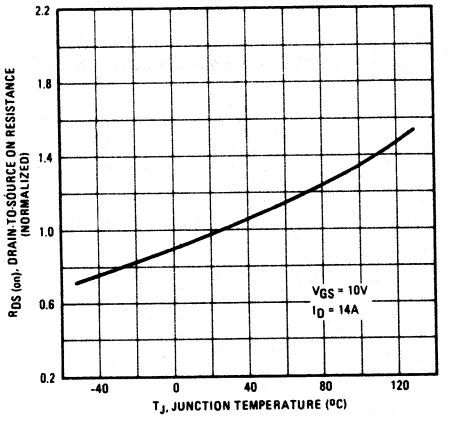


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN150 UFN151	–	–	40	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN152 UFN153	–	–	33	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN150 UFN151	–	–	160	A	
		UFN152 UFN153	–	–	132	A	
V_{SD}	Diode Forward Voltage ②	UFN150 UFN151	–	–	2.5	V	T_C = 25°C, I_S = 40A, V_{GS} = 0V
		UFN152 UFN153	–	–	2.3	V	T_C = 25°C, I_S = 33A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	600	–	ns	T_J = 150°C, I_F = 40A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	3.3	–	μC	T_J = 150°C, I_F = 40A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

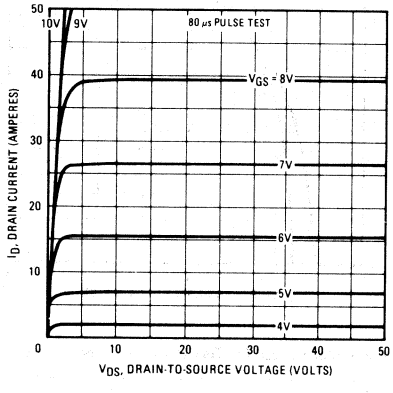


Fig. 2 – Typical Transfer Characteristics

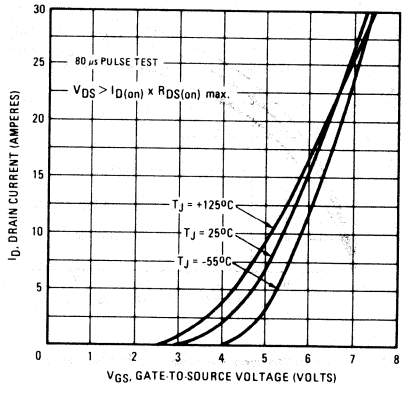


Fig. 3 – Typical Saturation Characteristics

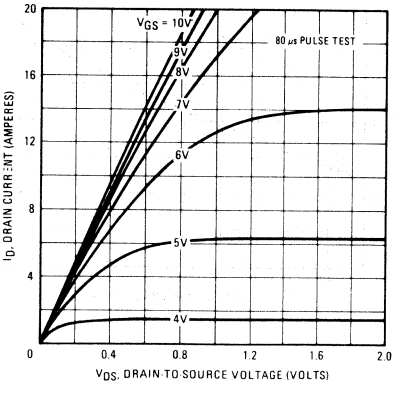
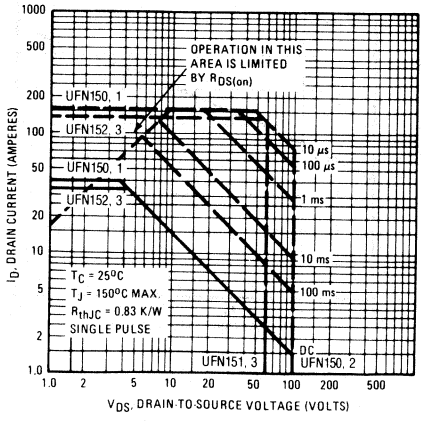


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

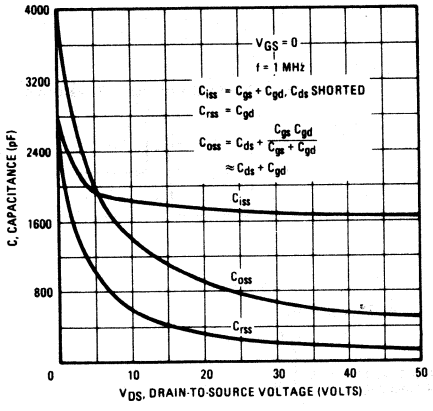


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

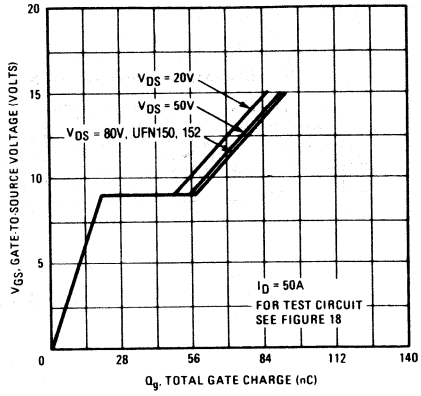


Fig. 12 – Typical On-Resistance Vs. Drain Current

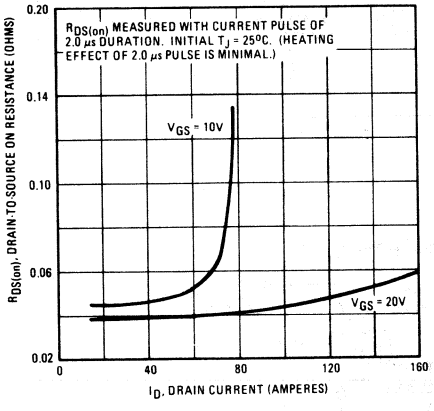


Fig. 13 – Maximum Drain Current Vs. Case Temperature

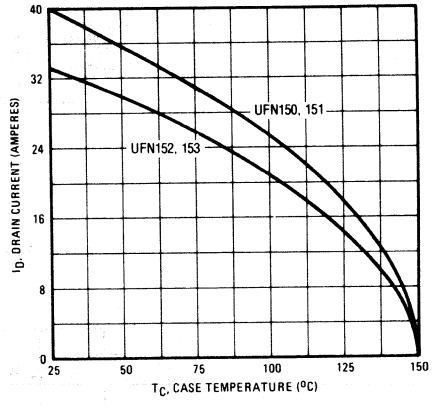


Fig. 14 – Power Vs. Temperature Derating Curve

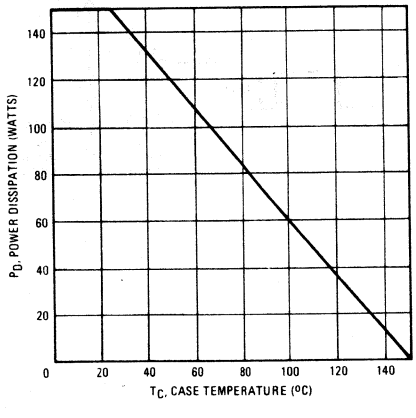


Fig. 15 – Clamped Inductive Test Circuit

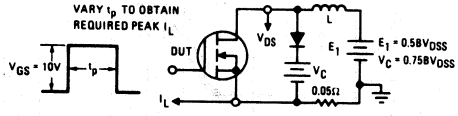


Fig. 16 – Clamped Inductive Waveforms

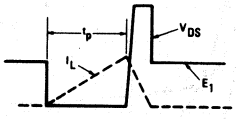


Fig. 17 – Switching Time Test Circuit

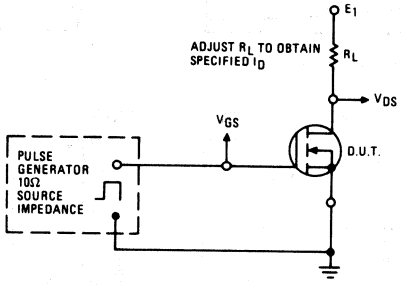
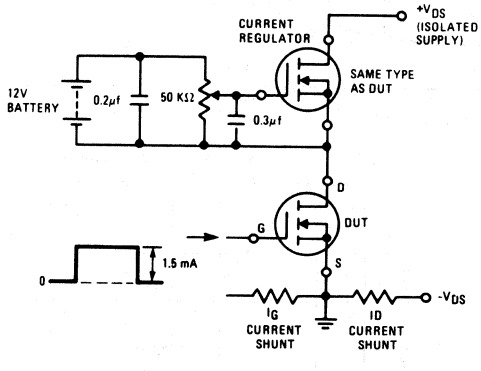


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

200 Volt, 0.8 Ohm N-Channel

UFN220
UFN221
UFN222
UFN223

3

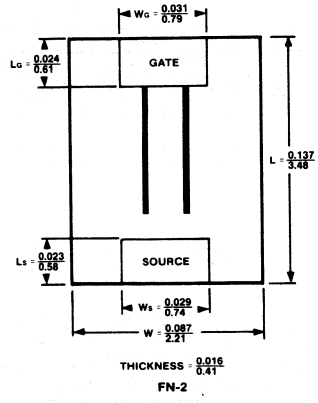
FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



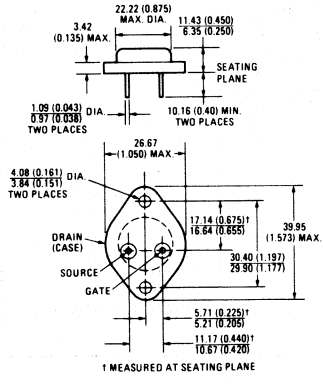
FN-2

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN220	200V	0.8Ω	5.0A
UFN221	150V	0.8Ω	5.0A
UFN222	200V	1.2Ω	4.0A
UFN223	150V	1.2Ω	4.0A

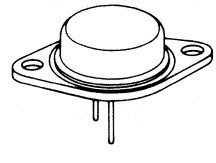
MECHANICAL SPECIFICATIONS

UFN220 UFN221 UFN222 UFN223



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

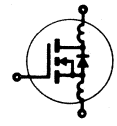
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN220	UFN221	UFN222	UFN223	Units
V_{DS}	Drain - Source Voltage ①	200	150	200	150	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	200	150	200	150	V
I_D @ T_C = 25°C	Continuous Drain Current	5.0	5.0	4.0	4.0	A
I_D @ T_C = 100°C	Continuous Drain Current	3.0	3.0	2.5	2.5	A
I_{DM}	Pulsed Drain Current ③	20	20	16	16	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	40 (See Fig. 14)				W
	Linear Derating Factor	0.32 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		20	20	16	16	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-50 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN220 UFN222	200	–	–	V	V_{GS} = 0V
		UFN221 UFN223	150	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN220 UFN221	5.0	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN222 UFN223	4.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN220 UFN221	–	0.5	0.8	Ω	V_{GS} = 10V, I_D = 2.5A
		UFN222 UFN223	–	0.8	1.2	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.3	2.5	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 2.5A
C_{iss}	Input Capacitance	ALL	–	450	600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	150	300	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	40	80	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	20	40	ns	$V_{DD} \approx 0.5\ BV_{DSS}$, I_D = 2.5A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	30	60	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	50	100	ns	
t_f	Fall Time	ALL	–	30	60	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	11	15	nC	V_{GS} = 10V, I_D = 6.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	5.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	6.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	3.12	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN220 UFN221	–	–	5.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN222 UFN223	–	–	4.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN220 UFN221	–	–	20	A	
		UFN222 UFN223	–	–	16	A	
V_{SD}	Diode Forward Voltage ②	UFN220 UFN221	–	–	2.0	V	T_C = 25°C, I_S = 5.0A, V_{GS} = 0V
		UFN222 UFN223	–	–	1.8	V	T_C = 25°C, I_S = 4.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	350	–	ns	T_J = 150°C, I_F = 5.0A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	2.3	–	μC	T_J = 150°C, I_F = 5.0A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

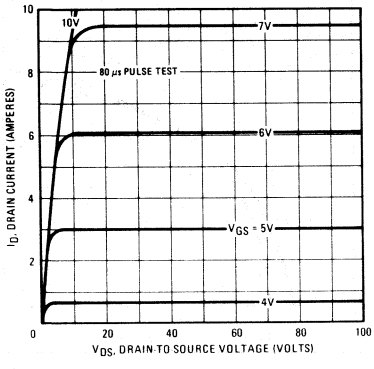


Fig. 2 – Typical Transfer Characteristics

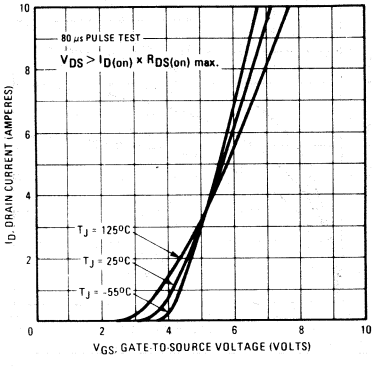


Fig. 3 – Typical Saturation Characteristics

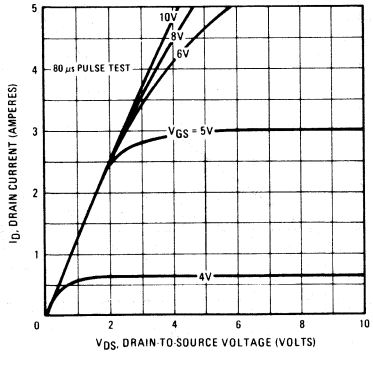


Fig. 4 – Maximum Safe Operating Area

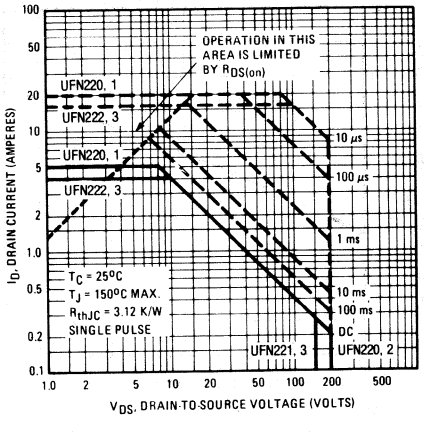


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

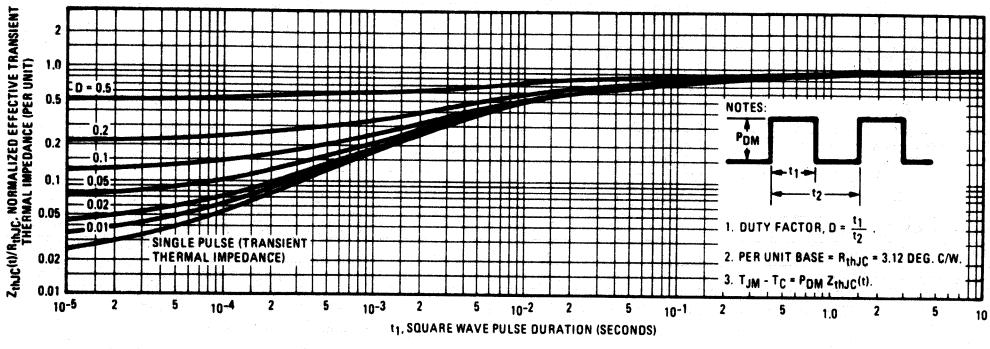


Fig. 6 – Typical Transconductance Vs. Drain Current

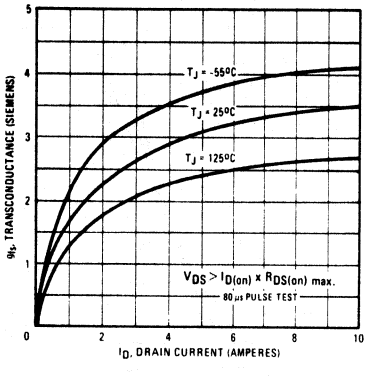


Fig. 7 – Typical Source-Drain Diode Forward Voltage

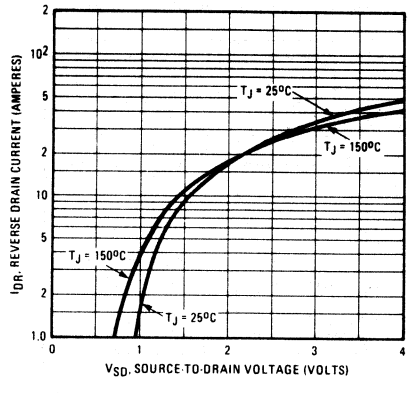


Fig. 8 – Breakdown Voltage Vs. Temperature

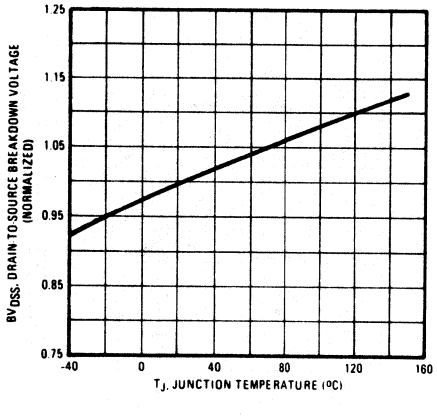
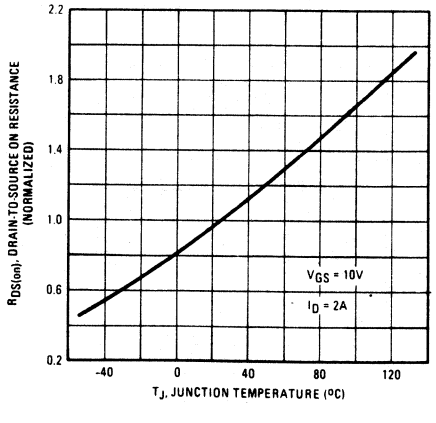


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

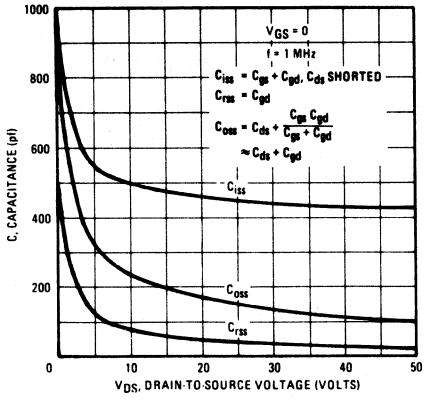


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

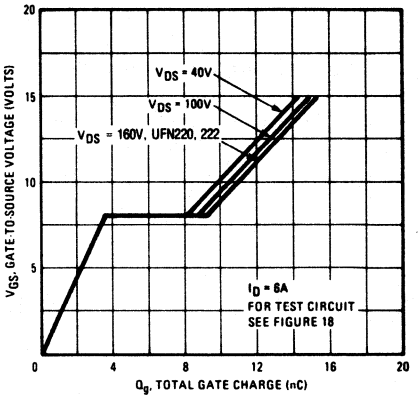


Fig. 12 – Typical On-Resistance Vs. Drain Current

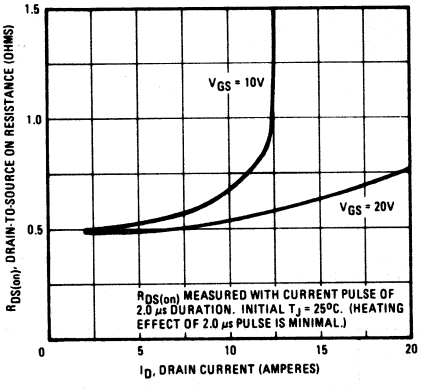


Fig. 13 – Maximum Drain Current Vs. Case Temperature

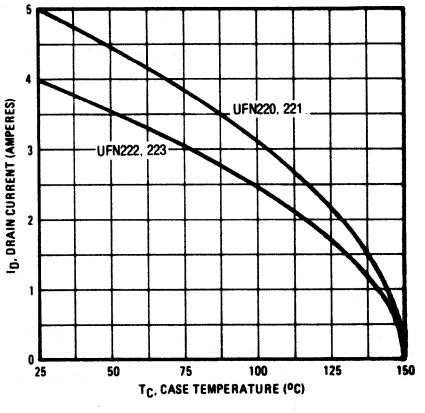
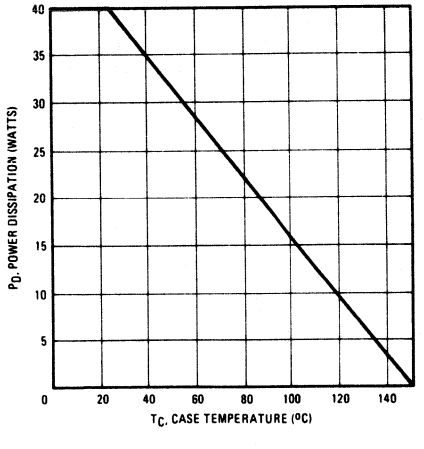


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

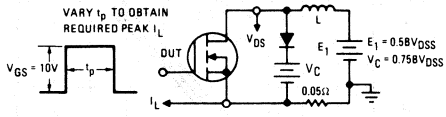


Fig. 16 – Clamped Inductive Waveforms

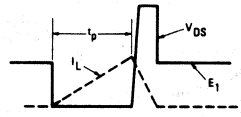


Fig. 17 – Switching Time Test Circuit

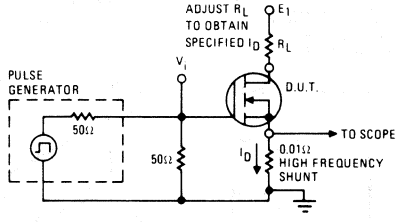
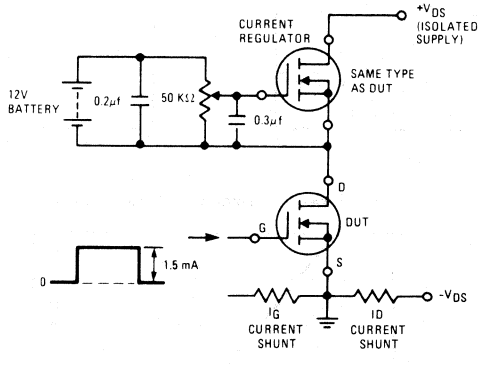


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

200 Volt, 0.4 Ohm N-Channel

UFN230
UFN231
UFN232
UFN233

3

FEATURES

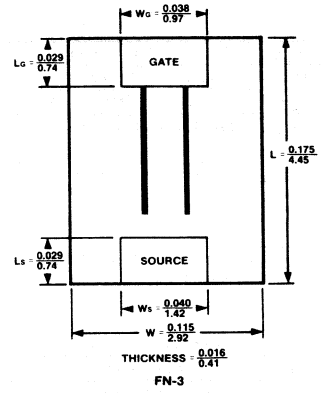
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



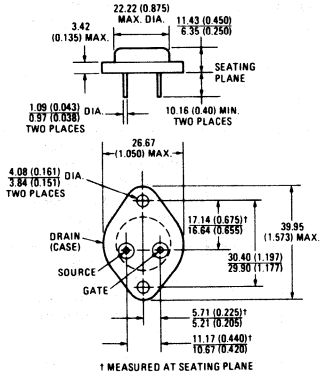
FN-3

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN230	200V	0.4Ω	9.0A
UFN231	150V	0.4Ω	9.0A
UFN232	200V	0.6Ω	8.0A
UFN233	150V	0.6Ω	8.0A

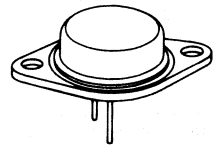
MECHANICAL SPECIFICATIONS

UFN230 UFN231 UFN232 UFN233



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

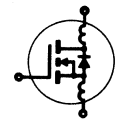
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN230	UFN231	UFN232	UFN233	Units
V_{DS}	Drain - Source Voltage ①	200	150	200	150	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	200	150	200	150	V
I_D @ T_C = 25°C	Continuous Drain Current	9.0	9.0	8.0	8.0	A
I_D @ T_C = 100°C	Continuous Drain Current	6.0	6.0	5.0	5.0	A
I_{DM}	Pulsed Drain Current ③	36	36	32	32	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	75 (See Fig. 14)				W
	Linear Derating Factor	0.6 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	36	(See Fig. 15 and 16) L = 100μH 36	32	32	A
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN230 UFN232	200	–	–	V	V_{GS} = 0V
		UFN231 UFN233	150	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN230 UFN231	9.0	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN232 UFN233	8.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN230 UFN231	–	0.25	0.4	Ω	V_{GS} = 10V, I_D = 5.0A
		UFN232 UFN233	–	0.4	0.6	Ω	
g_{fs}	Forward Transconductance ②	ALL	3.0	4.8	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 5.0A
C_{iss}	Input Capacitance	ALL	–	600	800	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	250	450	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	80	150	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	30	ns	V_{DD} ≈ 90V, I_D = 5.0A, Z_o = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	50	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	50	ns	
t_f	Fall Time	ALL	–	–	40	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	19	30	nC	V_{GS} = 10V, I_D = 12A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	10	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	9.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.67	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN230 UFN231	–	–	9.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN232 UFN233	–	–	8.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN230 UFN231	–	–	36	A	
		UFN232 UFN233	–	–	32	A	
V_{SD}	Diode Forward Voltage ②	UFN230 UFN231	–	–	2.0	V	T_C = 25°C, I_S = 9.0A, V_{GS} = 0V
		UFN232 UFN233	–	–	1.8	V	T_C = 25°C, I_S = 8.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	450	–	ns	T_J = 150°C, I_F = 9.0A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	3.0	–	μC	T_J = 150°C, I_F = 9.0A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

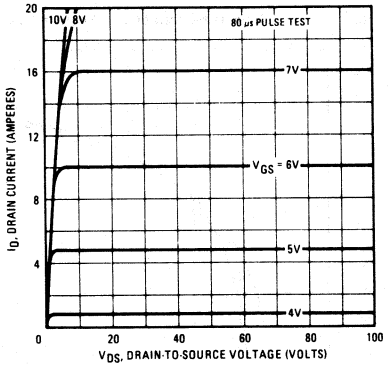


Fig. 2 – Typical Transfer Characteristics

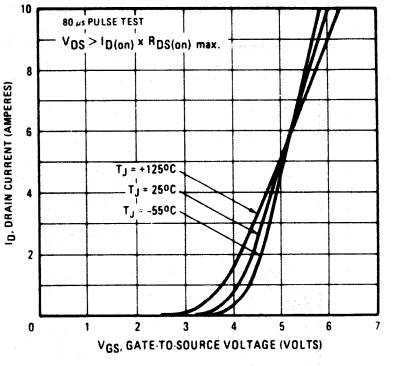


Fig. 3 – Typical Saturation Characteristics

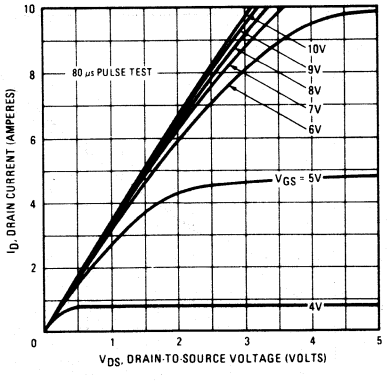
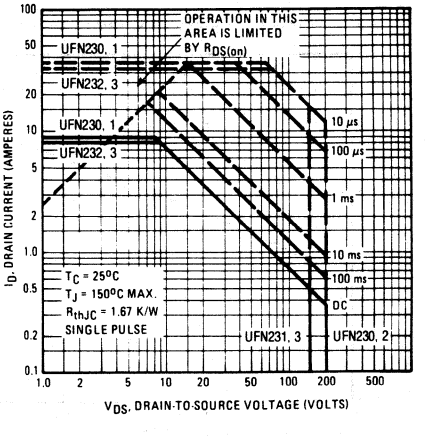


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

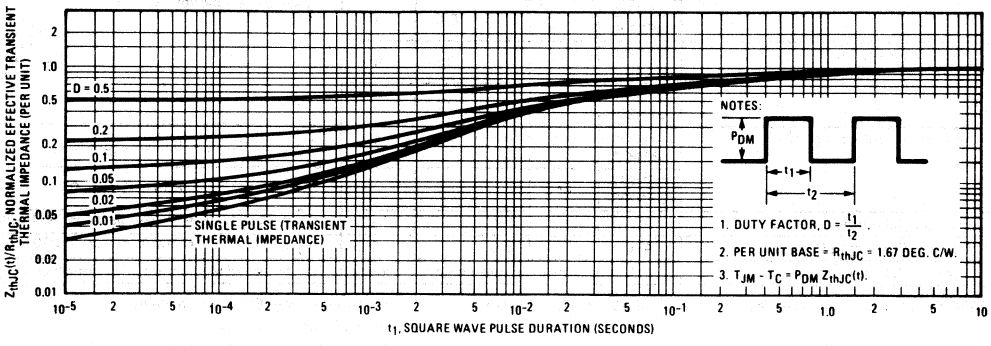


Fig. 6 — Typical Transconductance Vs. Drain Current

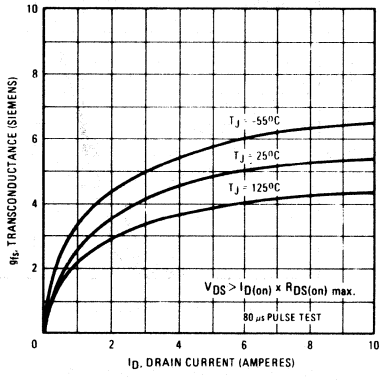


Fig. 7 — Typical Source-Drain Diode Forward Voltage

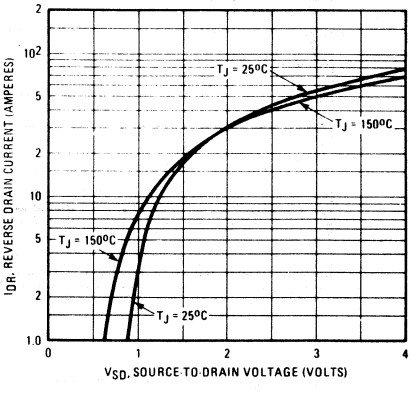


Fig. 8 — Breakdown Voltage Vs. Temperature

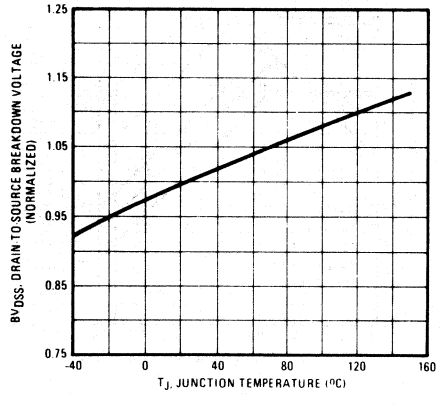
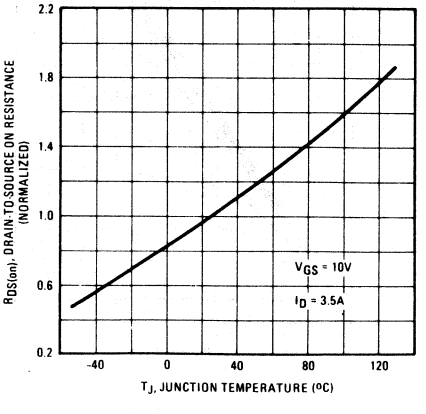


Fig. 9 — Normalized On-Resistance Vs. Temperature



3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

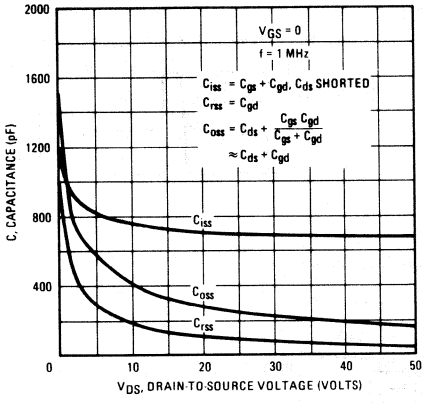


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

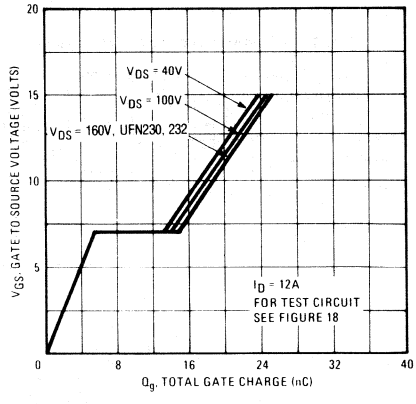


Fig. 12 – Typical On-Resistance Vs. Drain Current

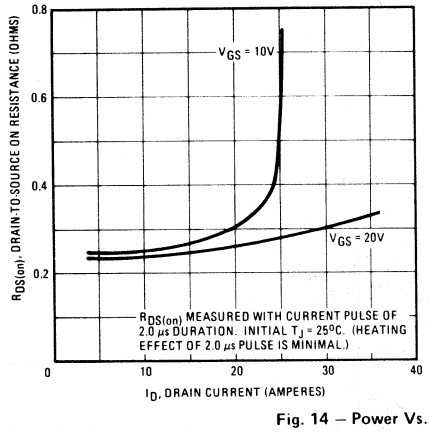


Fig. 13 – Maximum Drain Current Vs. Case Temperature

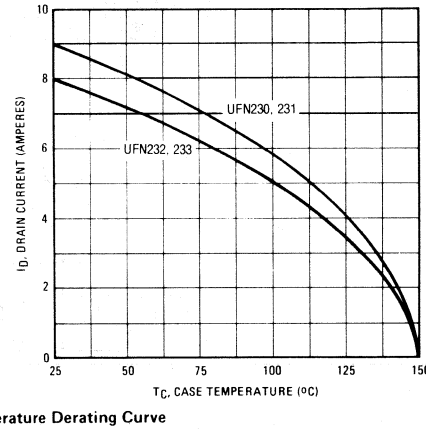
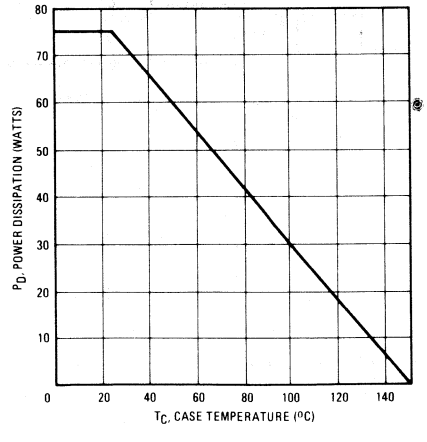


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

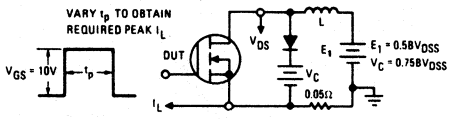


Fig. 16 – Clamped Inductive Waveforms

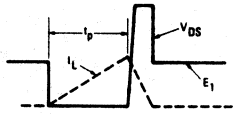


Fig. 17 – Switching Time Test Circuit

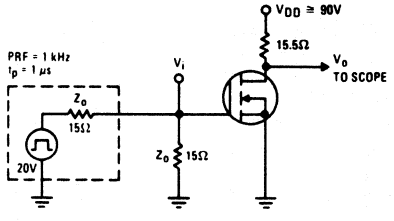
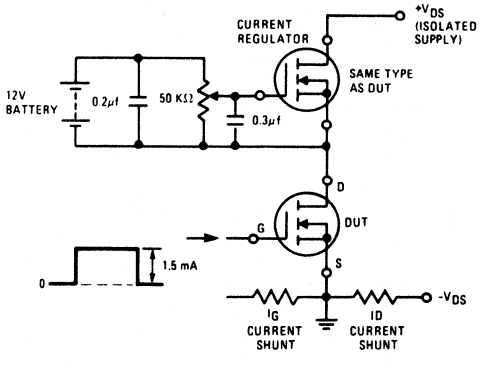


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

200 Volt, 0.2 Ohm N-Channel

UFN240
UFN241
UFN242
UFN243

3

FEATURES

- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

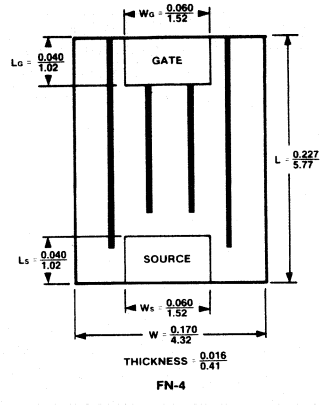
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

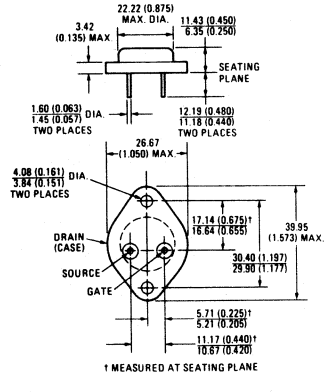
Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN240	200V	0.18Ω	18A
UFN241	150V	0.18Ω	18A
UFN242	200V	0.22Ω	16A
UFN243	150V	0.22Ω	16A



FN-4

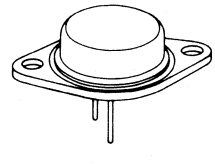
MECHANICAL SPECIFICATIONS

UFN240 UFN241 UFN242 UFN243



Dimensions in Millimeters and (Inches)

TO-204AE (TO-3 modified)



UNITRODE

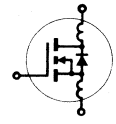
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN240	UFN241	UFN242	UFN243	Units
V_{DS}	Drain - Source Voltage ①	200	150	200	150	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	200	150	200	150	V
I_D @ T_C = 25°C	Continuous Drain Current	18	18	16	16	A
I_D @ T_C = 100°C	Continuous Drain Current	11	11	10	10	A
I_{DM}	Pulsed Drain Current ③	72	72	64	64	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	125 (See Fig. 14)				W
	Linear Derating Factor	1.0 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		72	72	64	64	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN240 UFN242	200	–	–	V	V_{GS} = 0V
		UFN241 UFN243	150	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN240 UFN241	18	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, V_{GS} = 10V
		UFN242 UFN243	16	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN240 UFN241	–	0.14	0.18	Ω	V_{GS} = 10V, I_D = 10A
		UFN242 UFN243	–	0.20	0.22	Ω	
g_{fs}	Forward Transconductance ②	ALL	6.0	9.0	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, I_D = 10A
C_{iss}	Input Capacitance	ALL	–	1275	1600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	500	750	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	160	300	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	16	30	ns	V_{DD} ≈ 75V, I_D = 10A, Z_o = 4.7Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature)
t_r	Rise Time	ALL	–	27	60	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	40	80	ns	
t_f	Fall Time	ALL	–	31	60	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	43	60	nC	V_{GS} = 10V, I_D = 22A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	16	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	27	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.0	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN240 UFN241	–	–	18	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN242 UFN243	–	–	16	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN240 UFN241	–	–	72	A	
		UFN242 UFN243	–	–	64	A	
V_{SD}	Diode Forward Voltage ②	UFN240 UFN241	–	–	2.0	V	T_C = 25°C, I_S = 18A, V_{GS} = 0V
		UFN242 UFN243	–	–	1.9	V	T_C = 25°C, I_S = 16A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	650	–	ns	T_J = 150°C, I_F = 18A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	4.1	–	μC	T_J = 150°C, I_F = 18A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

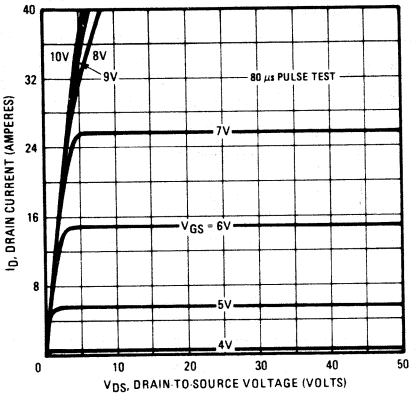


Fig. 2 – Typical Transfer Characteristics

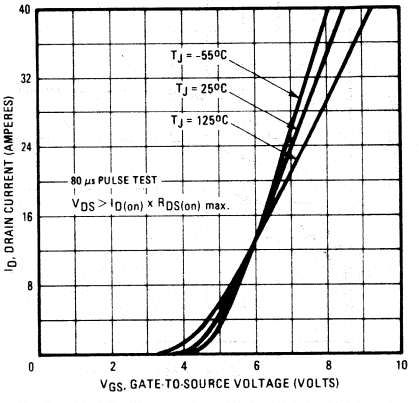


Fig. 3 – Typical Saturation Characteristics

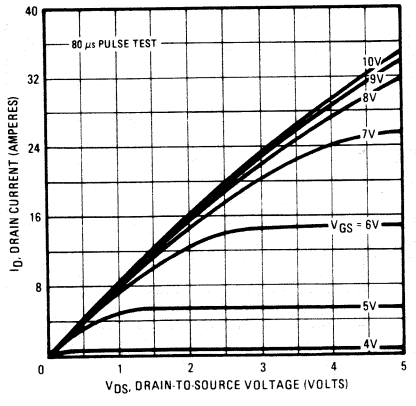
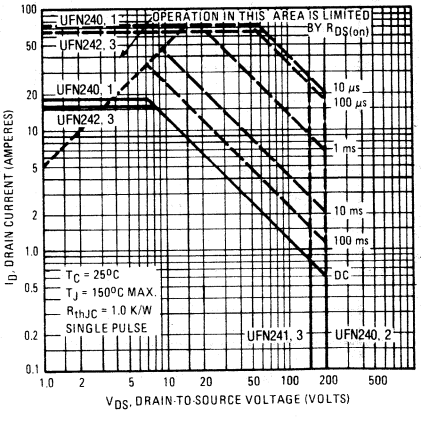


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

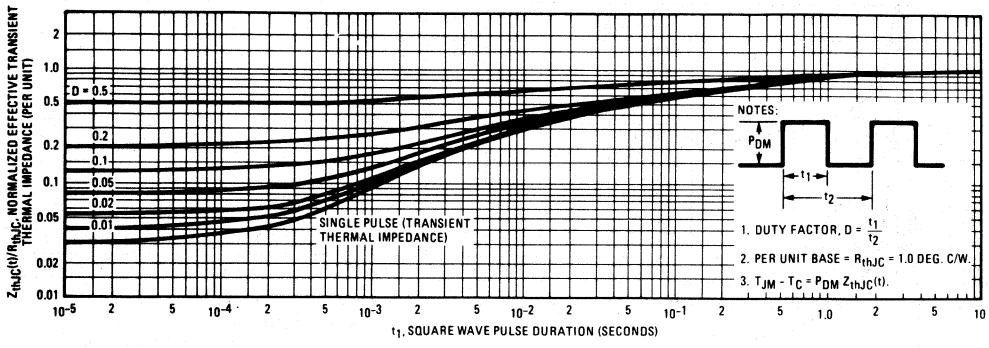


Fig. 6 – Typical Transconductance Vs. Drain Current

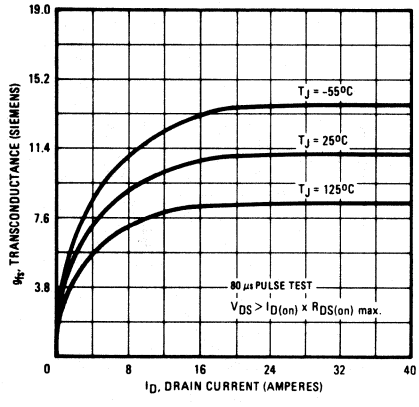


Fig. 7 – Typical Source-Drain Diode Forward Voltage

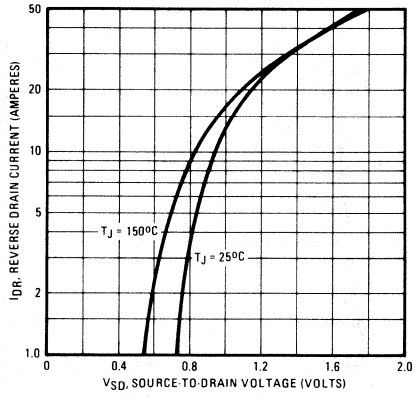


Fig. 8 – Breakdown Voltage Vs. Temperature

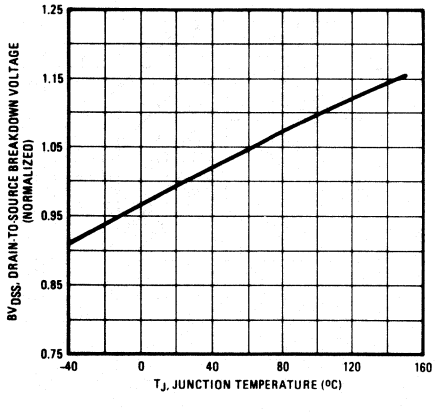
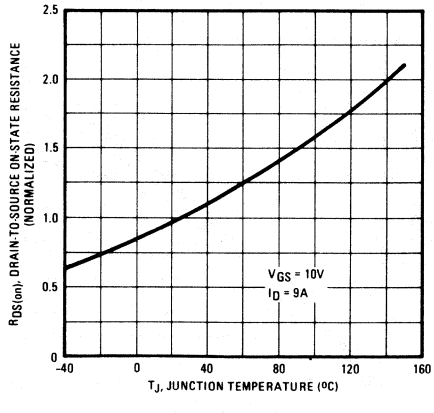


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

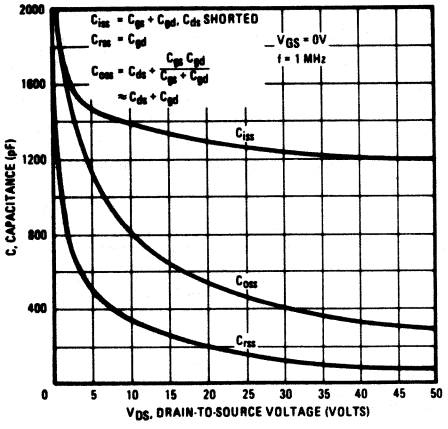


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

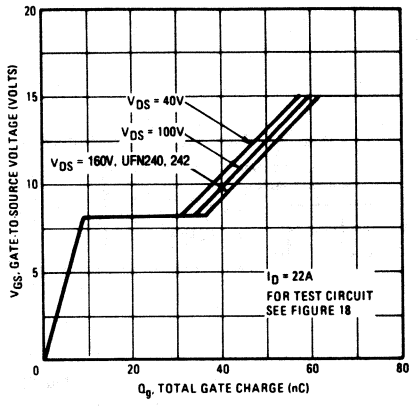


Fig. 12 – Typical On-Resistance Vs. Drain Current

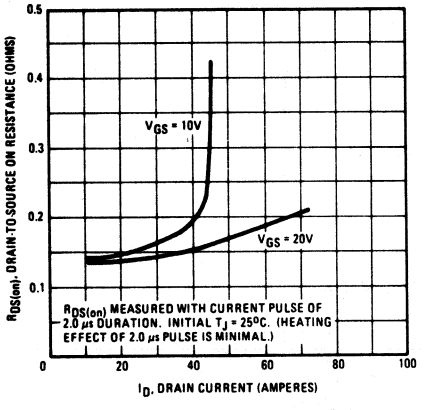


Fig. 13 – Maximum Drain Current Vs. Case Temperature

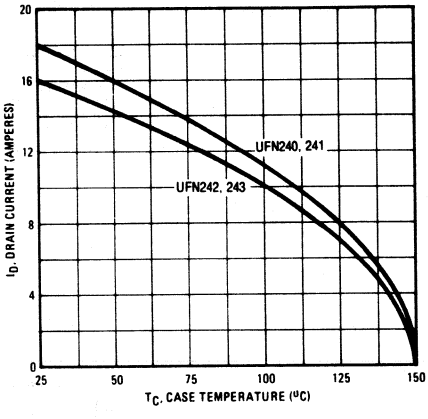
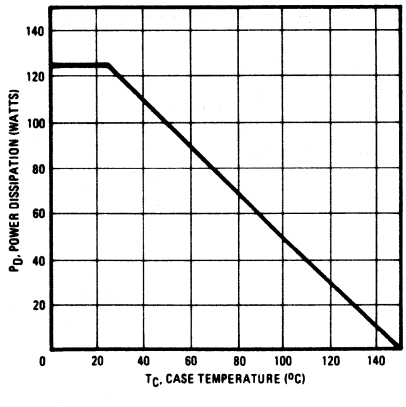


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

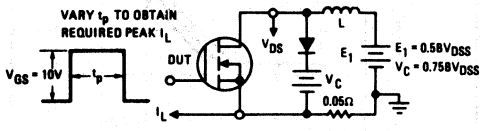


Fig. 16 – Clamped Inductive Waveforms

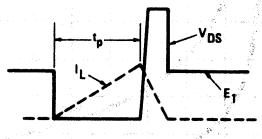


Fig. 17 – Switching Time Test Circuit

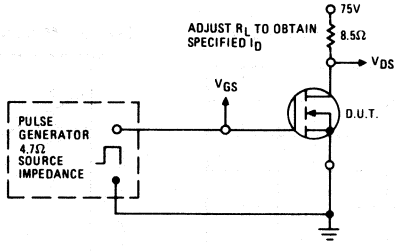
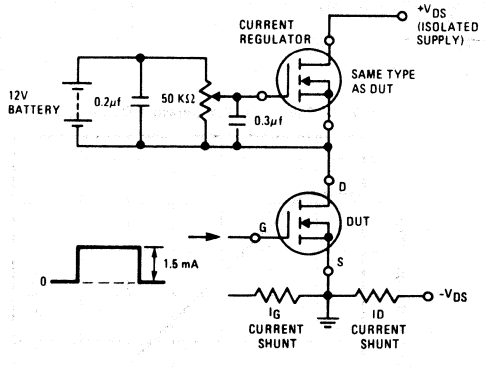


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A

POWER MOSFET TRANSISTORS

200 Volt, 0.085 Ohm N-Channel

UFN250
UFN251
UFN252
UFN253

3

FEATURES

- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

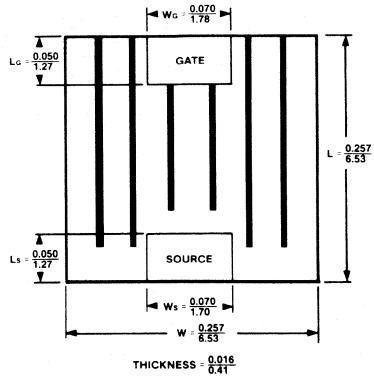
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

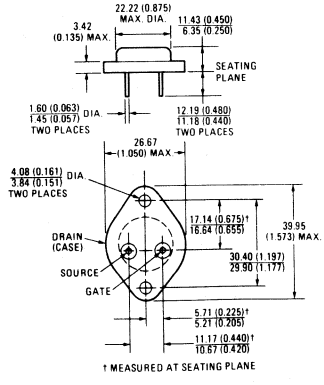
Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN250	200V	0.085Ω	30A
UFN251	150V	0.085Ω	30A
UFN252	200V	0.120Ω	25A
UFN253	150V	0.120Ω	25A



FN-5

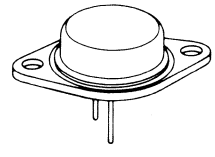
MECHANICAL SPECIFICATIONS

UFN250 UFN251 UFN252 UFN253



Dimensions in Millimeters and (Inches)

TO-204AE (TO-3 modified)



UNITRODE

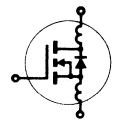
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN250	UFN251	UFN252	UFN253	Units
V_{DS}	Drain - Source Voltage ①	200	150	200	150	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	200	150	200	150	V
I_D @ T_C = 25°C	Continuous Drain Current	30	30	25	25	A
I_D @ T_C = 100°C	Continuous Drain Current	19	19	16	16	A
I_{DM}	Pulsed Drain Current ③	120	120	100	100	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	150 (See Fig. 14)				W
	Linear Derating Factor	1.2 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	120	(See Fig. 15 and 16) L = 100μH 120	100	100	A
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN250 UFN252	200	–	–	V	V_{GS} = 0V
		UFN251 UFN253	150	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN250 UFN251	30	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN252 UFN253	25	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN250 UFN251	–	0.07	0.085	Ω	V_{GS} = 10V, I_D = 16A
		UFN252 UFN253	–	0.09	0.120	Ω	
g_{fs}	Forward Transconductance ②	ALL	8.0	14	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 16A
C_{iss}	Input Capacitance	ALL	–	2000	3000	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	800	1200	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	300	500	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	35	ns	V_{DD} = 95V, I_D = 16A, Z_o = 4.7Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	100	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	125	ns	
t_f	Fall Time	ALL	–	–	100	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	79	120	nC	V_{GS} = 10V, I_D = 38A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	37	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	42	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	0.83	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN250 UFN251	–	–	30	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN252 UFN253	–	–	25	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN250 UFN251	–	–	120	A	
		UFN252 UFN253	–	–	100	A	
V_{SD}	Diode Forward Voltage ②	UFN250 UFN251	–	–	2.0	V	T_C = 25°C, I_S = 30A, V_{GS} = 0V
		UFN252 UFN253	–	–	1.8	V	T_C = 25°C, I_S = 25A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	750	–	ns	T_J = 150°C, I_F = 30A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	4.7	–	μC	T_J = 150°C, I_F = 30A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

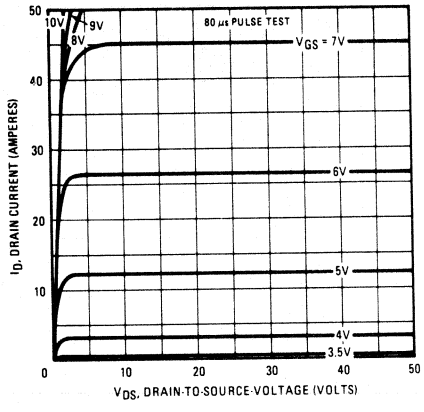


Fig. 2 – Typical Transfer Characteristics

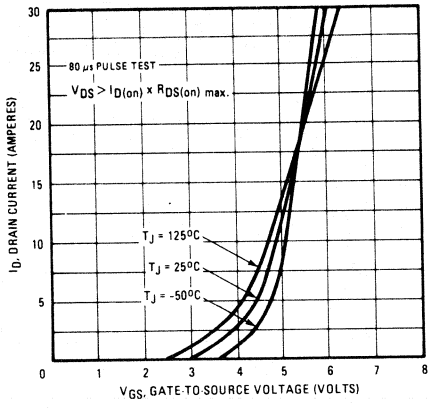


Fig. 3 – Typical Saturation Characteristics

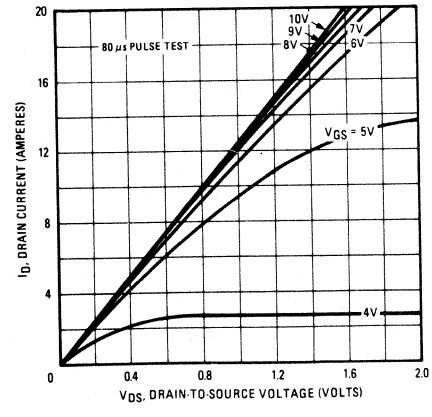
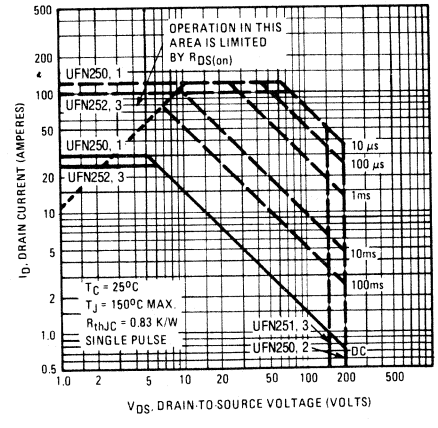


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

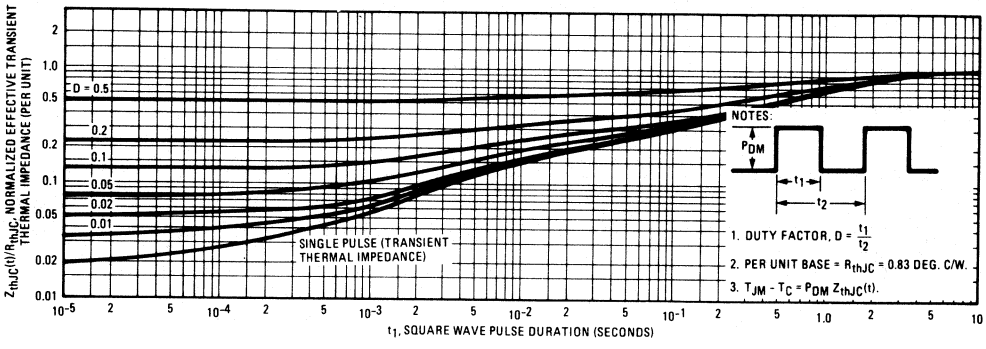


Fig. 6 — Typical Transconductance Vs. Drain Current

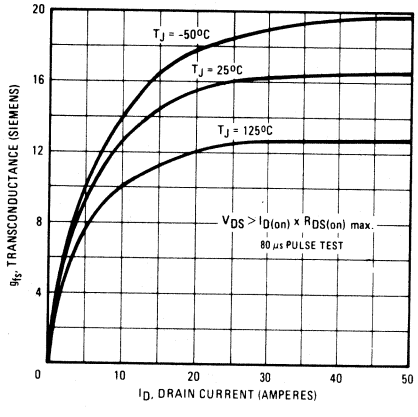


Fig. 7 — Typical Source-Drain Diode Forward Voltage

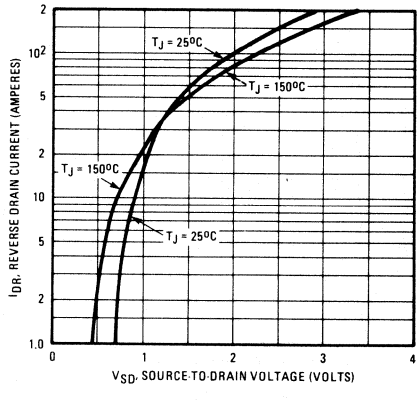


Fig. 8 — Breakdown Voltage Vs. Temperature

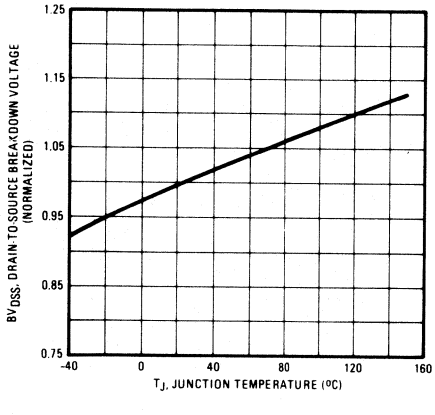
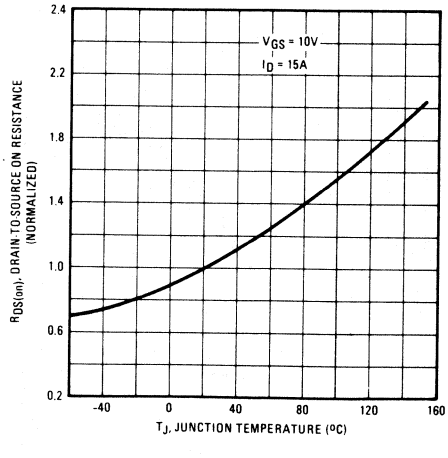


Fig. 9 — Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

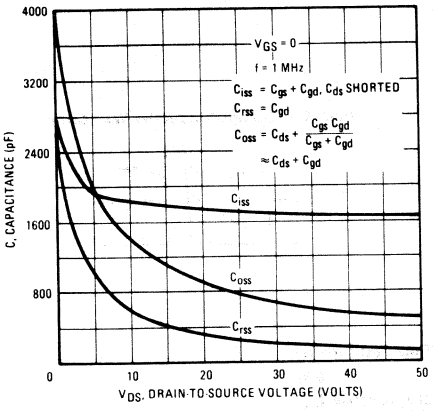


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

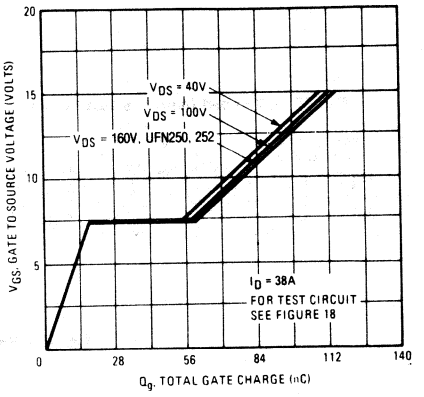


Fig. 12 – Typical On-Resistance Vs. Drain Current

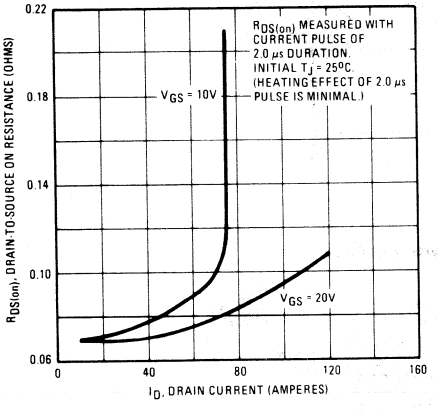


Fig. 13 – Maximum Drain Current Vs. Case Temperature

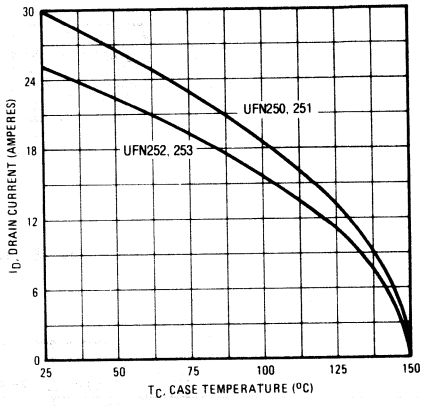
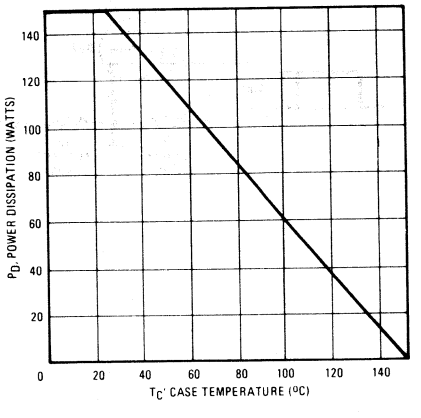


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

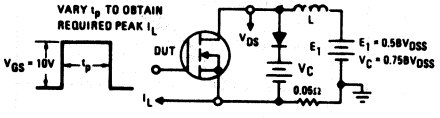


Fig. 16 – Clamped Inductive Waveforms

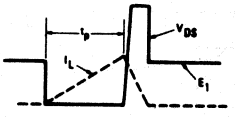


Fig. 17 – Switching Time Test Circuit

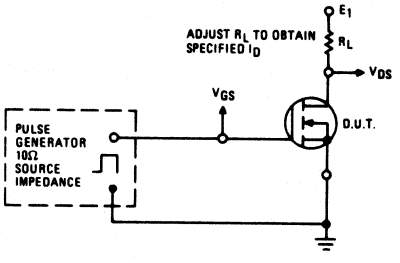
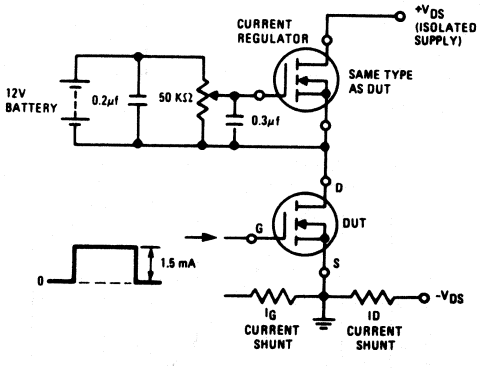


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

400 Volt, 1.8 Ohm
N-Channel

UFN320
UFN321
UFN322
UFN323

3

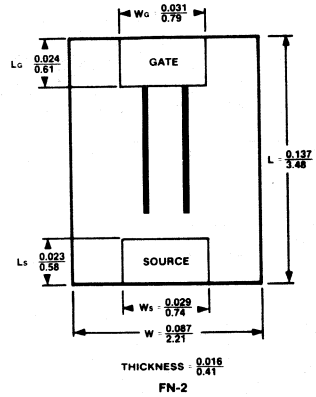
FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



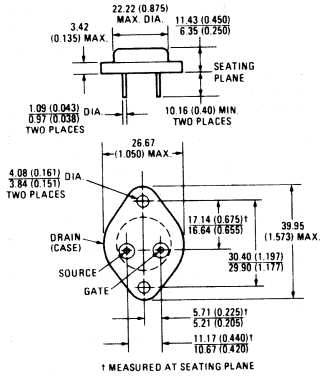
FN-2

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN320	400V	1.8Ω	3.0A
UFN321	350V	1.8Ω	3.0A
UFN322	400V	2.5Ω	2.5A
UFN323	350V	2.5Ω	2.5A

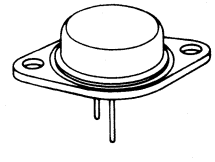
MECHANICAL SPECIFICATIONS

UFN320 UFN321 UFN322 UFN323



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

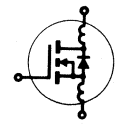
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN320	UFN321	UFN322	UFN323	Units
V_{DS}	Drain - Source Voltage ①	400	350	400	350	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	400	350	400	350	V
I_D @ T_C = 25°C	Continuous Drain Current	3.0	3.0	2.5	2.5	A
I_D @ T_C = 100°C	Continuous Drain Current	2.0	2.0	1.5	1.5	A
I_{DM}	Pulsed Drain Current ③	12	12	10	10	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	40 (See Fig. 14)				W
	Linear Derating Factor	0.32 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		12	12	10	10	
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN320 UFN322	400	–	–	V	V_{GS} = 0V
		UFN321 UFN323	350	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN320 UFN321	3.0	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, V_{GS} = 10V
		UFN322 UFN323	2.5	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN320 UFN321	–	1.5	1.8	Ω	V_{GS} = 10V, I_D = 1.5A
		UFN322 UFN323	–	1.8	2.5	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.0	2.0	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, I_D = 1.5A
C_{iss}	Input Capacitance	ALL	–	450	600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	100	200	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	20	40	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	20	40	ns	V_{DD} = 0.5 BV_{DSS}, I_D = 1.5A, Z_O = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	25	50	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	50	100	ns	
t_f	Fall Time	ALL	–	25	50	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	12	15	nC	V_{GS} = 10V, I_D = 4.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	6.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	6.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	3.12	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN320 UFN321	–	–	3.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN322 UFN323	–	–	2.5	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN320 UFN321	–	–	12	A	
		UFN322 UFN323	–	–	10	A	
V_{SD}	Diode Forward Voltage ②	UFN320 UFN321	–	–	1.6	V	T_C = 25°C, I_S = 3.0A, V_{GS} = 0V
		UFN322 UFN323	–	–	1.5	V	T_C = 25°C, I_S = 2.5A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	450	–	ns	T_J = 150°C, I_F = 3.0A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	3.1	–	μC	T_J = 150°C, I_F = 3.0A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%

③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

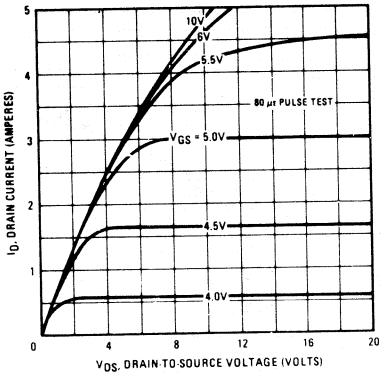


Fig. 2 – Typical Transfer Characteristics

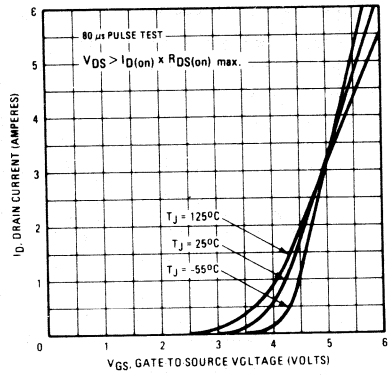


Fig. 3 – Typical Saturation Characteristics

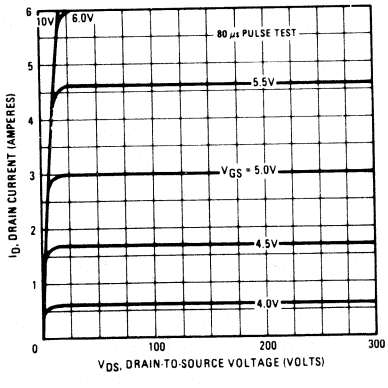


Fig. 4 – Maximum Safe Operating Area

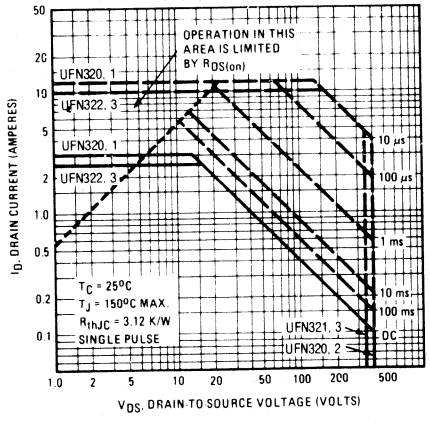


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

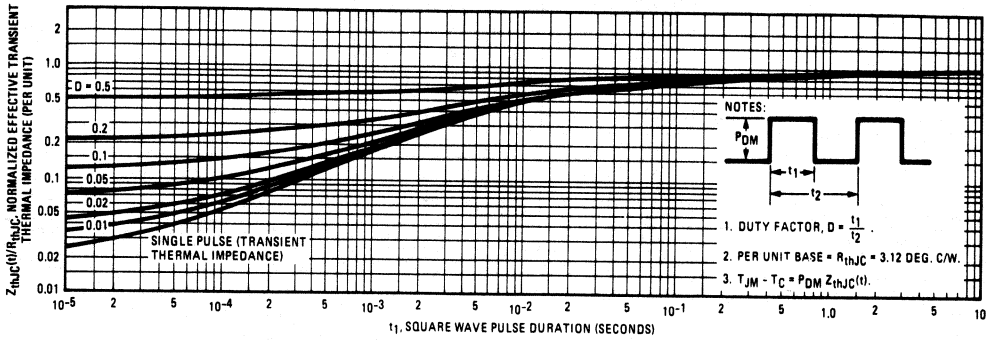


Fig. 6 – Typical Transconductance Vs. Drain Current

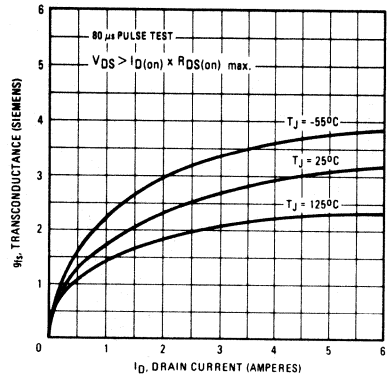


Fig. 7 – Typical Source-Drain Diode Forward Voltage

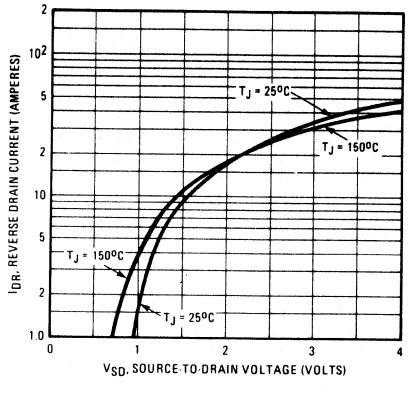


Fig. 8 – Breakdown Voltage Vs. Temperature

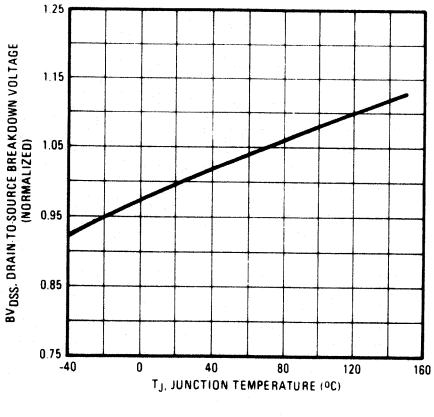
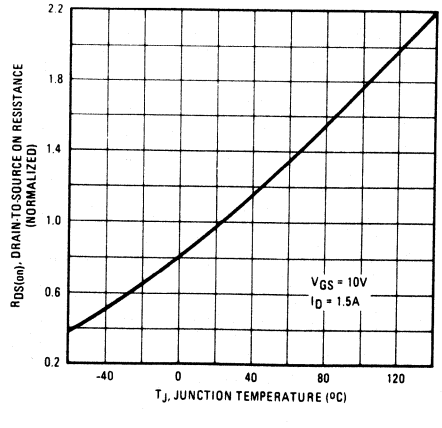


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

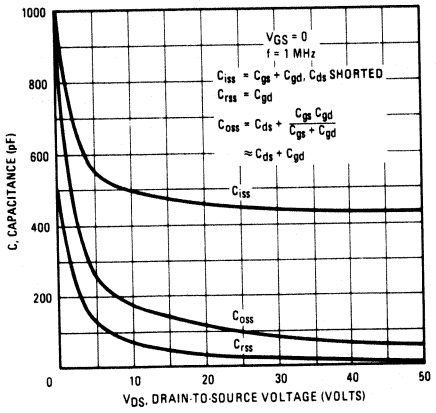


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

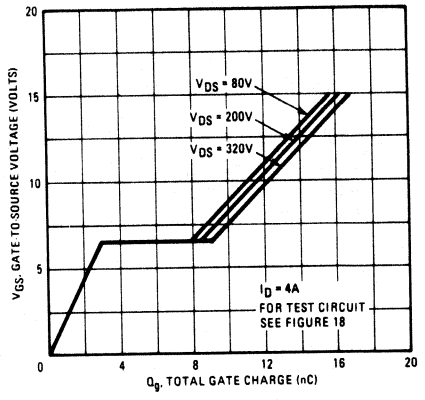


Fig. 12 – Typical On-Resistance Vs. Drain Current

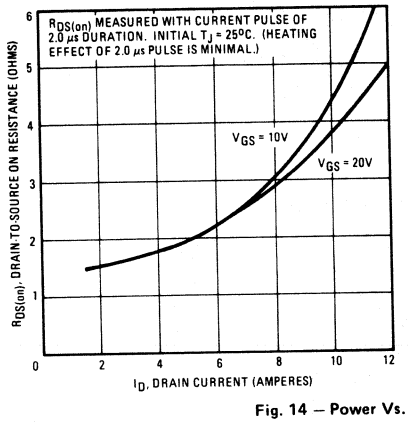


Fig. 13 – Maximum Drain Current Vs. Case Temperature

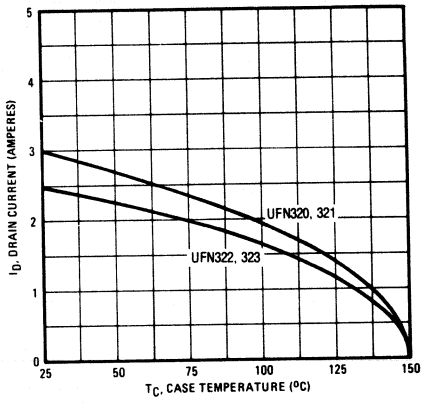


Fig. 14 – Power Vs. Temperature Derating Curve

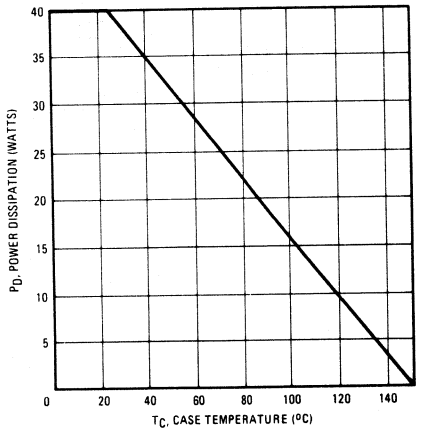


Fig. 15 – Clamped Inductive Test Circuit

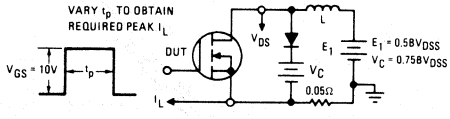


Fig. 16 – Clamped Inductive Waveforms

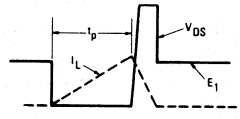


Fig. 17 – Switching Time Test Circuit

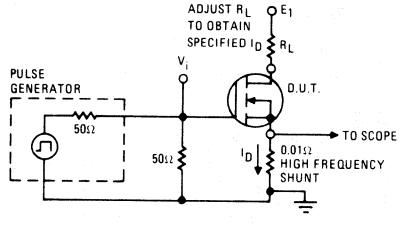
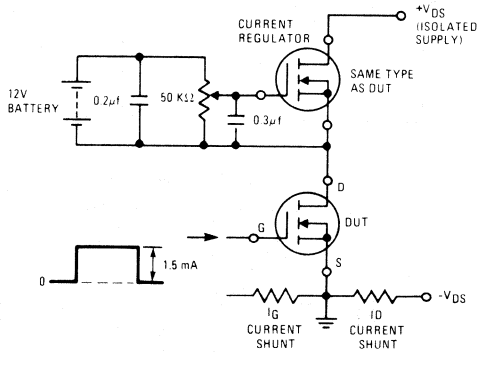


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

400 Volt, 1.0 Ohm N-Channel

UFN330
UFN331
UFN332
UFN333

3

FEATURES

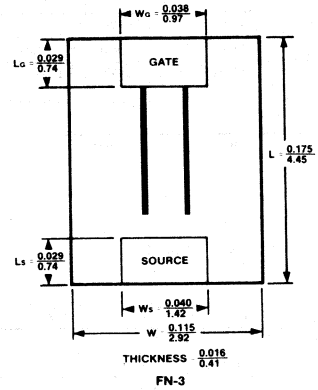
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



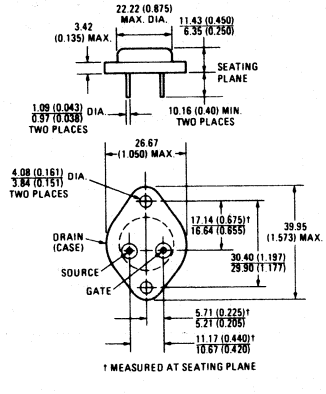
FN-3

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN330	400V	1.0Ω	5.5A
UFN331	350V	1.0Ω	5.5A
UFN332	400V	1.5Ω	4.5A
UFN333	350V	1.5Ω	4.5A

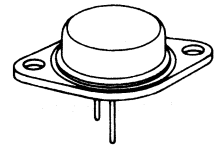
MECHANICAL SPECIFICATIONS

UFN330 UFN331 UFN332 UFN333



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

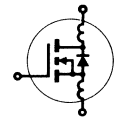
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN330	UFN331	UFN332	UFN333	Units
V_{DS}	Drain - Source Voltage ①	400	350	400	350	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	400	350	400	350	V
I_D @ T_C = 25°C	Continuous Drain Current	5.5	5.5	4.5	4.5	A
I_D @ T_C = 100°C	Continuous Drain Current	3.5	3.5	3.0	3.0	A
I_{DM}	Pulsed Drain Current ③	22	22	18	18	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	75 (See Fig. 14)				W
	Linear Derating Factor	0.6 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		22	22	18	18	
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN330 UFN332	400	–	–	V	V_{GS} = 0V
		UFN331 UFN333	350	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN330 UFN331	5.5	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFN332 UFN333	4.5	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN330 UFN331	–	0.8	1.0	Ω	V_{GS} = 10V, I_D = 3.0A
		UFN332 UFN333	–	1.0	1.5	Ω	
g_{fs}	Forward Transconductance ②	ALL	3.0	4.0	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 3.0A
C_{iss}	Input Capacitance	ALL	–	700	900	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	150	300	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	40	80	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	30	ns	V_{DD} ≈ 175V, I_D = 3.0A, Z_o = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	35	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	55	ns	
t_f	Fall Time	ALL	–	–	35	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	18	30	nC	V_{GS} = 10V, I_D = 7.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	11	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	7.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.67	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN330 UFN331	–	–	5.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN332 UFN333	–	–	4.5	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN330 UFN331	–	–	22	A	
		UFN332 UFN333	–	–	18	A	
V_{SD}	Diode Forward Voltage ②	UFN330 UFN331	–	–	1.6	V	T_C = 25°C, I_S = 5.5A, V_{GS} = 0V
		UFN332 UFN333	–	–	1.5	V	T_C = 25°C, I_S = 4.5A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	600	–	ns	T_J = 150°C, I_F = 5.5A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	4.0	–	μC	T_J = 150°C, I_F = 5.5A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

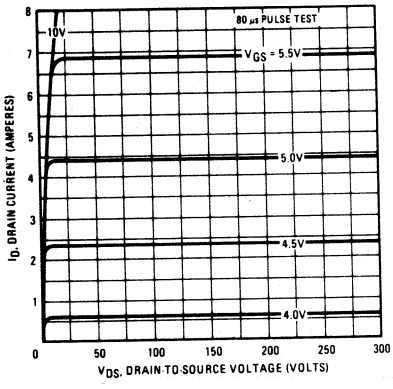


Fig. 2 – Typical Transfer Characteristics

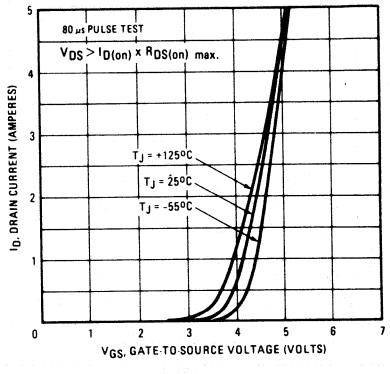


Fig. 3 – Typical Saturation Characteristics

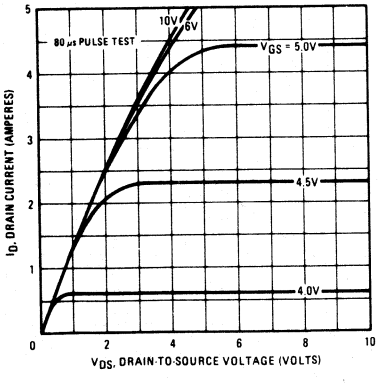


Fig. 4 – Maximum Safe Operating Area

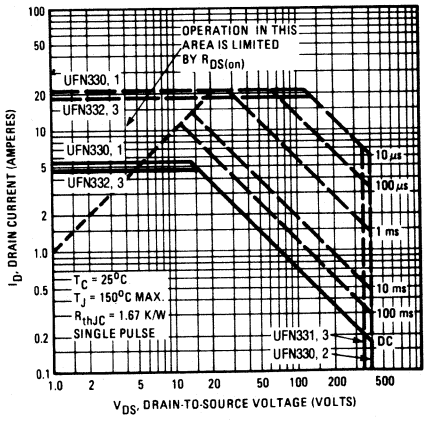


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

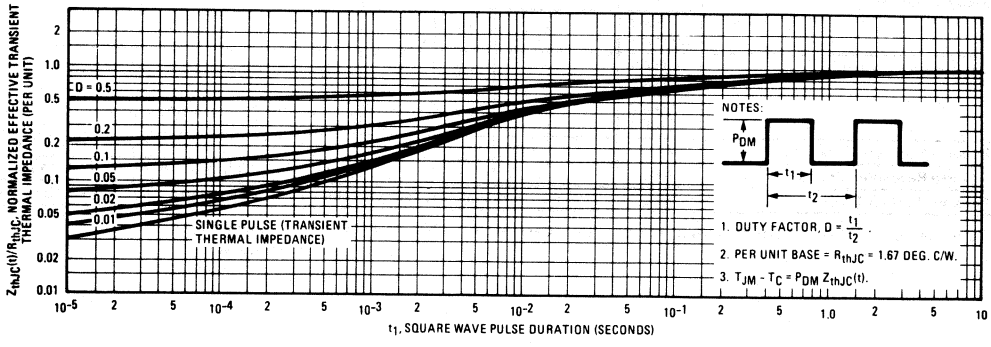


Fig. 6 – Typical Transconductance Vs. Drain Current

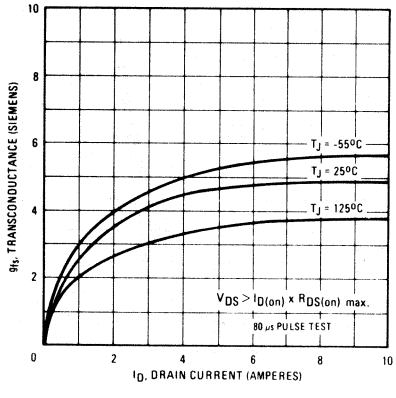


Fig. 7 – Typical Source-Drain Diode Forward Voltage

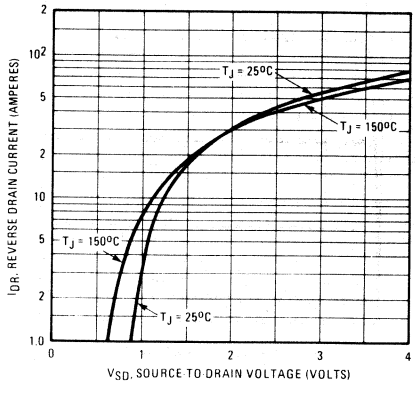


Fig. 8 – Breakdown Voltage Vs. Temperature

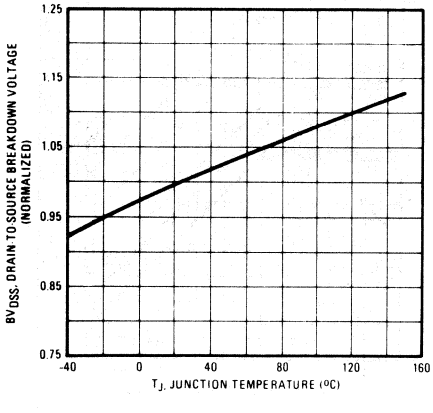
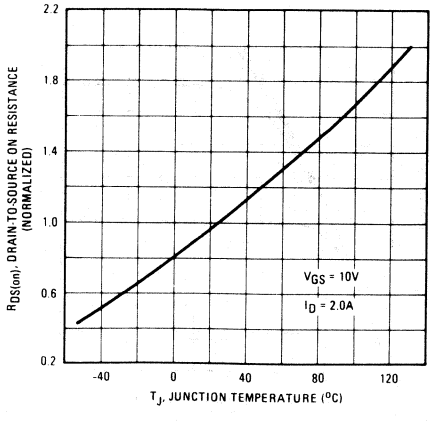


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

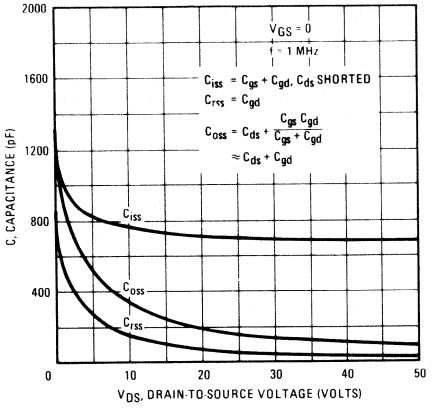


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

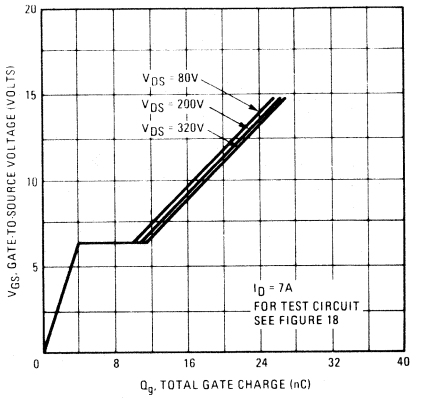


Fig. 12 – Typical On-Resistance Vs. Drain Current

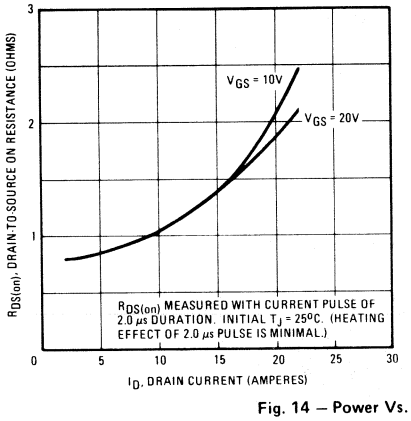


Fig. 13 – Maximum Drain Current Vs. Case Temperature

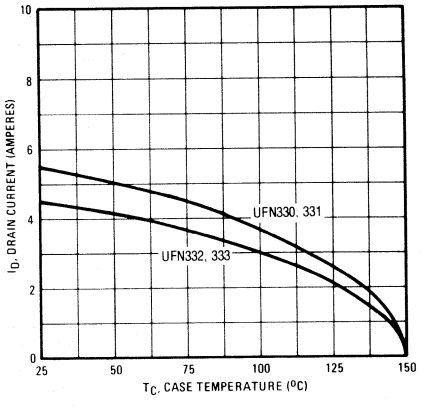
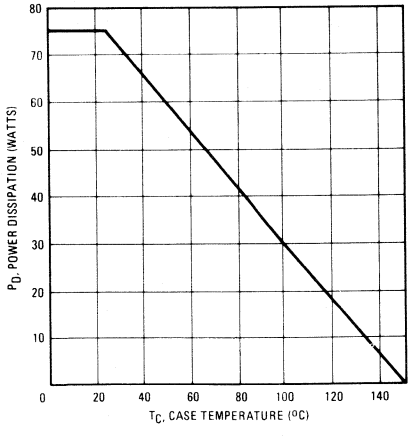


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

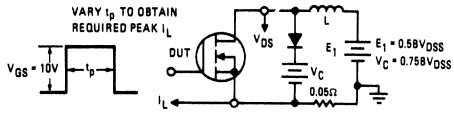


Fig. 16 – Clamped Inductive Waveforms

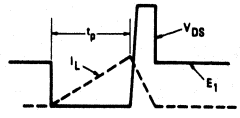


Fig. 17 – Switching Time Test Circuit

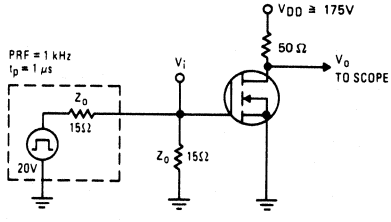
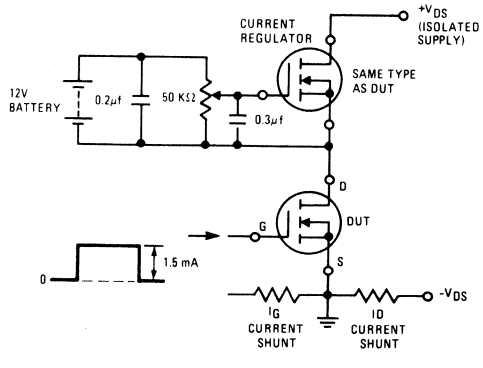


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

400 Volt, 0.55 Ohm N-Channel

UFN340
UFN341
UFN342
UFN343

3

FEATURES

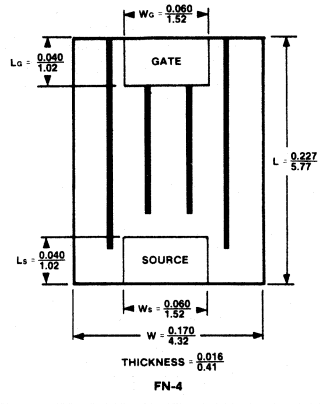
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



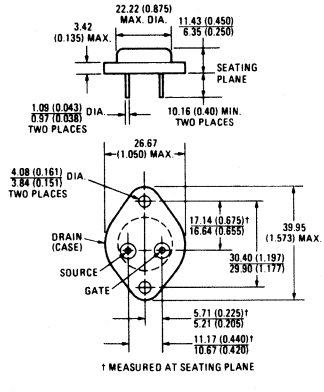
FN-4

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN340	400V	0.55Ω	10A
UFN341	350V	0.55Ω	10A
UFN342	400V	0.80Ω	8.0A
UFN343	350V	0.80Ω	8.0A

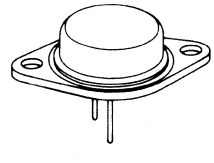
MECHANICAL SPECIFICATIONS

UFN340 UFN341 UFN342 UFN343



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

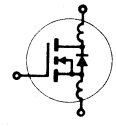
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN340	UFN341	UFN342	UFN343	Units
V_{DS}	Drain - Source Voltage ①	400	350	400	350	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	400	350	400	350	V
I_D @ T_C = 25°C	Continuous Drain Current	10	10	8.0	8.0	A
I_D @ T_C = 100°C	Continuous Drain Current	6.0	6.0	5.0	5.0	A
I_{DM}	Pulsed Drain Current ③	40	40	32	32	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	125 (See Fig. 14)				W
	Linear Derating Factor	1.0 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		40	40	32	32	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN340 UFN342	400	–	–	V	V_{GS} = 0V
		UFN341 UFN343	350	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN340 UFN341	10	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN342 UFN343	8.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN340 UFN341	–	0.47	0.55	Ω	V_{GS} = 10V, I_D = 5.0A
		UFN342 UFN343	–	0.68	0.80	Ω	
g_{fs}	Forward Transconductance ②	ALL	4.0	7.0	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 5.0A
C_{iss}	Input Capacitance	ALL	–	1250	1600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	300	450	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	80	150	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	17	35	ns	V_{DD} = 175V, I_D = 5.0A, Z_o = 4.7Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	5.0	15	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	45	90	ns	
t_f	Fall Time	ALL	–	16	35	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	41	60	nC	V_{GS} = 10V, I_D = 12A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	18	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	23	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.0	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN340 UFN341	–	–	10	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN342 UFN343	–	–	8.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN340 UFN341	–	–	40	A	
		UFN342 UFN343	–	–	32	A	
V_{SD}	Diode Forward Voltage ②	UFN340 UFN341	–	–	2.0	V	T_C = 25°C, I_S = 10A, V_{GS} = 0V
		UFN342 UFN343	–	–	1.9	V	T_C = 25°C, I_S = 8.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	800	–	ns	T_J = 150°C, I_F = 10A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	5.7	–	μC	T_J = 150°C, I_F = 10A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

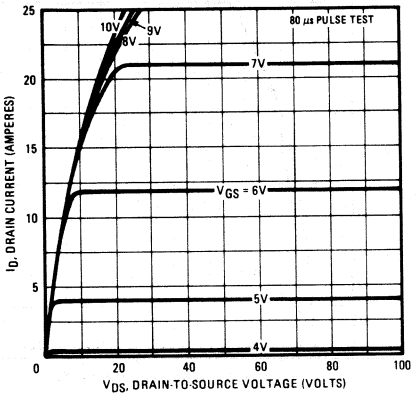


Fig. 2 – Typical Transfer Characteristics

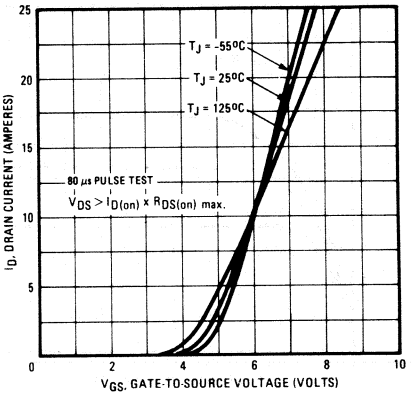


Fig. 3 – Typical Saturation Characteristics

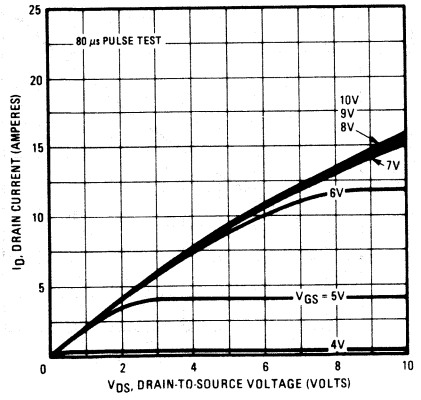


Fig. 4 – Maximum Safe Operating Area

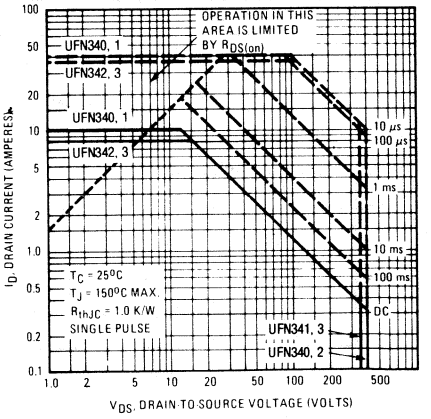


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

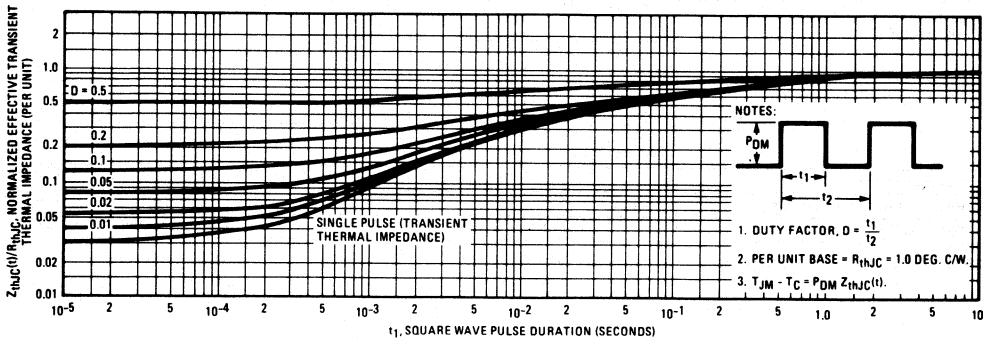


Fig. 6 – Typical Transconductance Vs. Drain Current

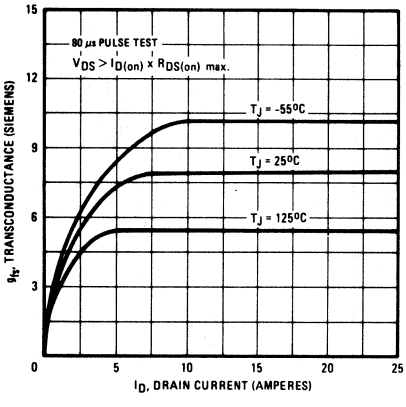


Fig. 7 – Typical Source-Drain Diode Forward Voltage

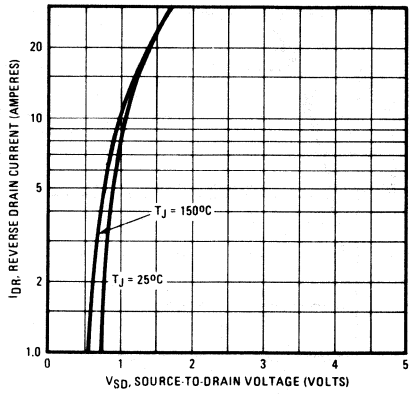


Fig. 8 – Breakdown Voltage Vs. Temperature

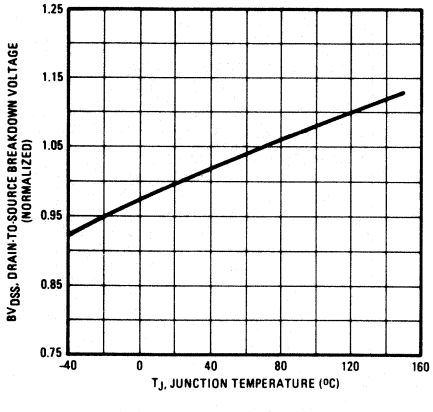
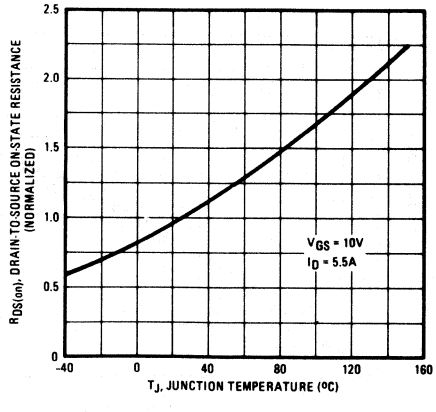


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

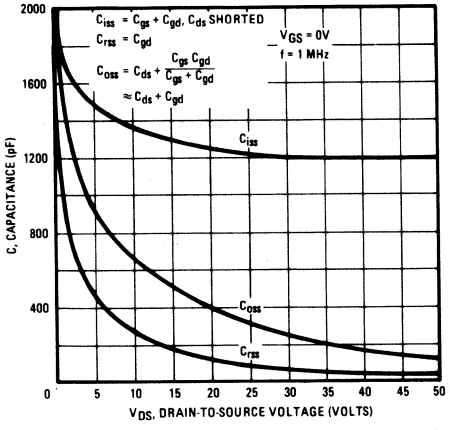


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

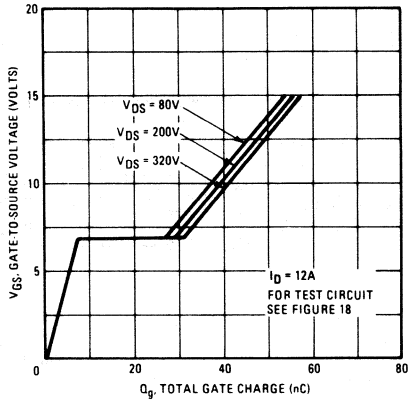


Fig. 12 – Typical On-Resistance Vs. Drain Current

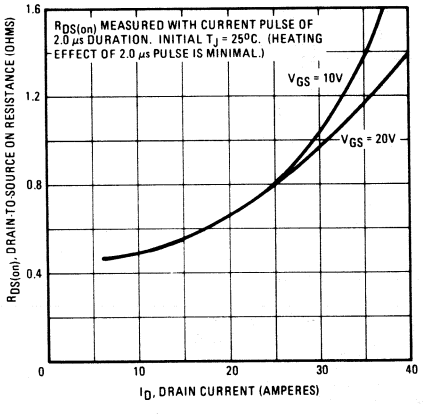


Fig. 13 – Maximum Drain Current Vs. Case Temperature

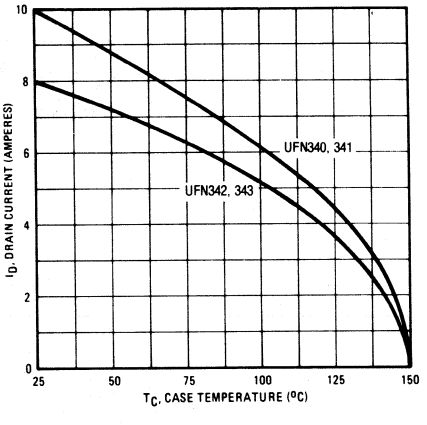


Fig. 14 – Power Vs. Temperature Derating Curve

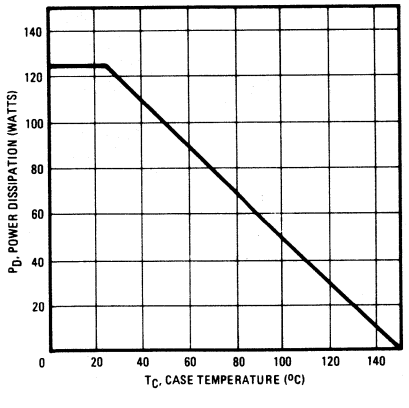


Fig. 15 – Clamped Inductive Test Circuit

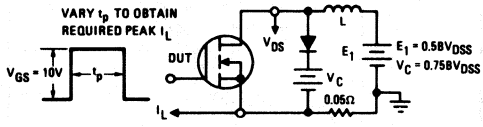


Fig. 16 – Clamped Inductive Waveforms

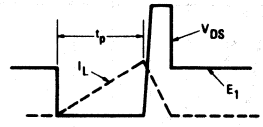


Fig. 17 – Switching Time Test Circuit

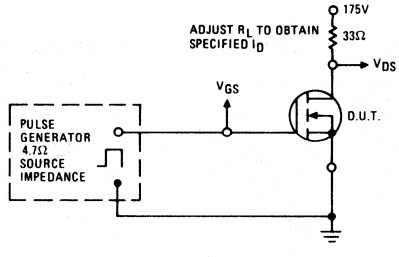
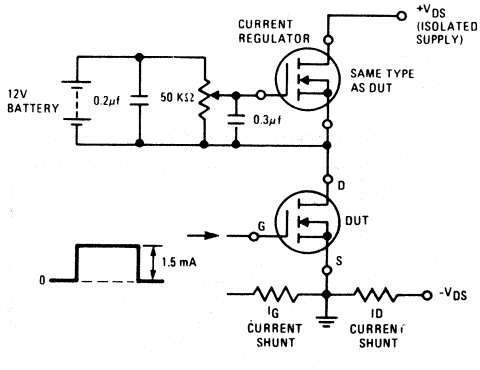


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

400 Volt, 0.3 Ohm N-Channel

UFN350
UFN351
UFN352
UFN353

3

FEATURES

- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

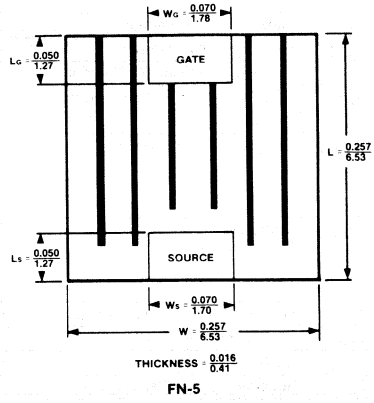
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

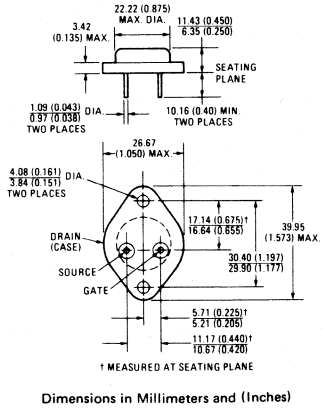
Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN350	400V	0.3Ω	15A
UFN351	350V	0.3Ω	15A
UFN352	400V	0.4Ω	13A
UFN353	350V	0.4Ω	13A



FN-5

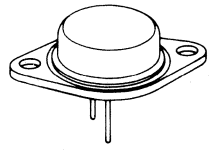
MECHANICAL SPECIFICATIONS

UFN350 UFN351 UFN352 UFN353



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

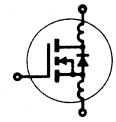
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN350	UFN351	UFN352	UFN353	Units
V_{DS}	Drain - Source Voltage ①	400	350	400	350	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	400	350	400	350	V
I_D @ T_C = 25°C	Continuous Drain Current	15	15	13	13	A
I_D @ T_C = 100°C	Continuous Drain Current	9.0	9.0	8.0	8.0	A
I_{DM}	Pulsed Drain Current ③	60	60	52	52	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	150 (See Fig. 14)				W
	Linear Derating Factor	1.2 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		60	60	52	52	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN350 UFN352	400	–	–	V	V_{GS} = 0V
		UFN351 UFN353	350	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN350 UFN351	15	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN352 UFN353	13	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN350 UFN351	–	0.25	0.3	Ω	V_{GS} = 10V, I_D = 8.0A
		UFN352 UFN353	–	0.3	0.4	Ω	
g_{fs}	Forward Transconductance ②	ALL	8.0	10	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 8.0A
C_{iss}	Input Capacitance	ALL	–	2000	3000	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	400	600	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	100	200	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	35	ns	V_{DD} ≈ 180V, I_D = 8.0A, Z_o = 4.7Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	65	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	150	ns	
t_f	Fall Time	ALL	–	–	75	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	79	120	nC	V_{GS} = 10V, I_D = 18A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	38	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	41	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	0.83	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN350 UFN351	–	–	15	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN352 UFN353	–	–	13	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN350 UFN351	–	–	60	A	
		UFN352 UFN353	–	–	52	A	
V_{SD}	Diode Forward Voltage ②	UFN350 UFN351	–	–	1.6	V	T_C = 25°C, I_S = 15A, V_{GS} = 0V
		UFN352 UFN353	–	–	1.5	V	T_C = 25°C, I_S = 13A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	1000	–	ns	T_J = 150°C, I_F = 15A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	6.6	–	μC	T_J = 150°C, I_F = 15A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

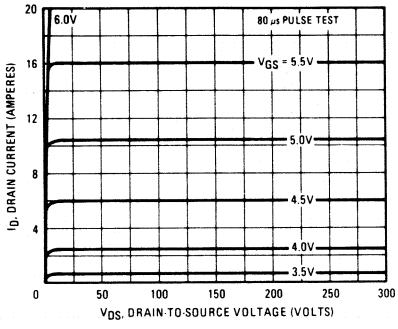


Fig. 2 – Typical Transfer Characteristics

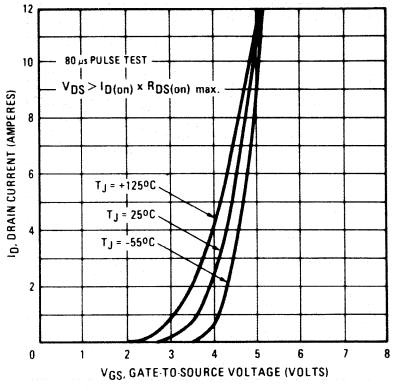


Fig. 3 – Typical Saturation Characteristics

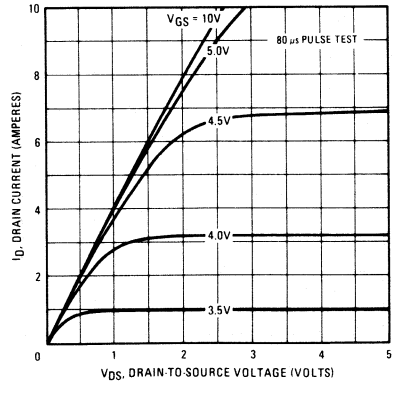


Fig. 4 – Maximum Safe Operating Area

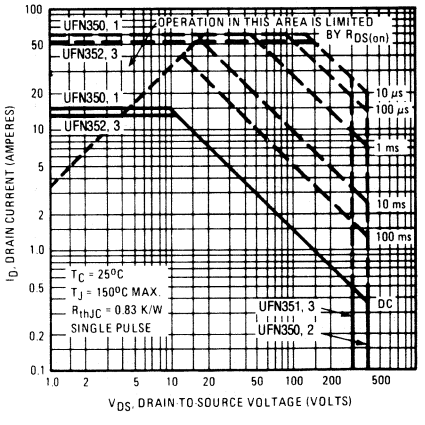


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

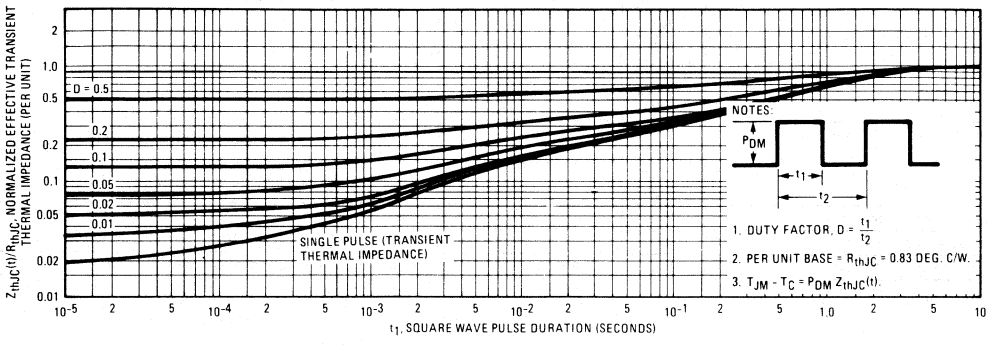


Fig. 6 – Typical Transconductance Vs. Drain Current

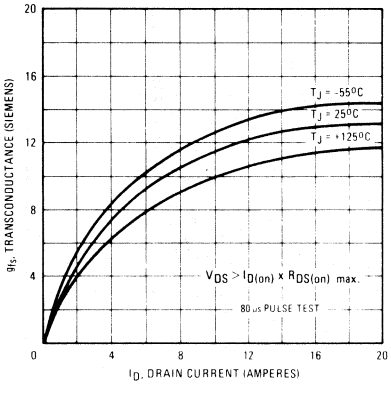


Fig. 7 – Typical Source-Drain Diode Forward Voltage

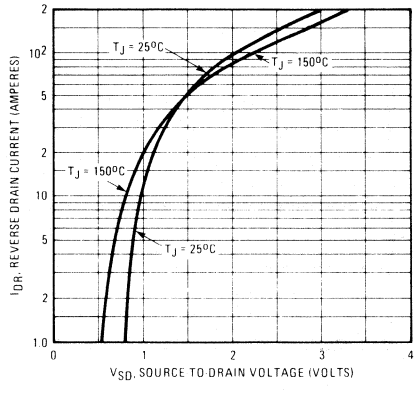


Fig. 8 – Breakdown Voltage Vs. Temperature

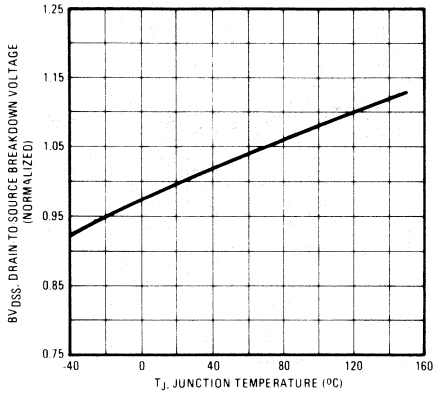
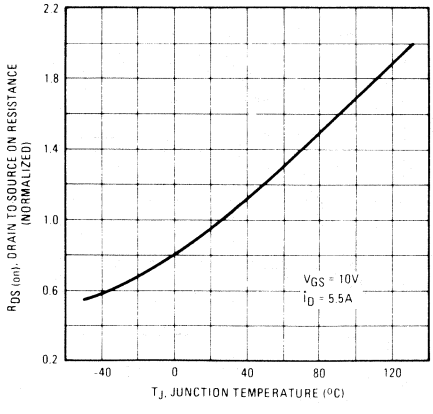


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

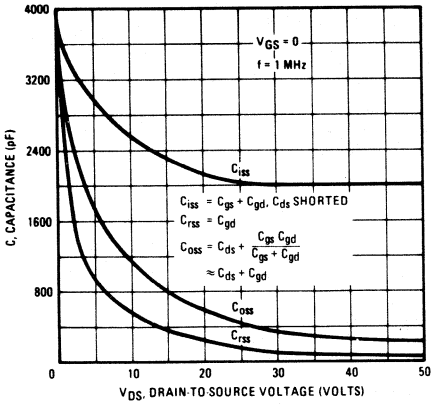


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

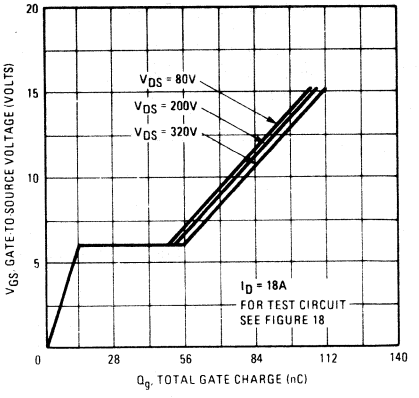


Fig. 12 – Typical On-Resistance Vs. Drain Current

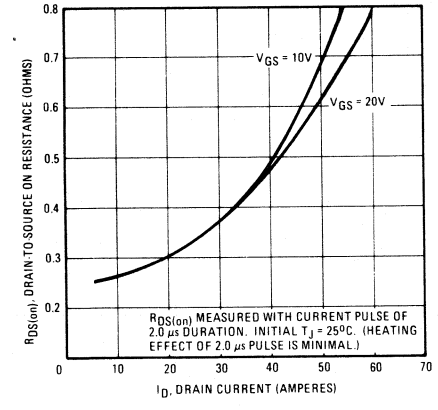


Fig. 13 – Maximum Drain Current Vs. Case Temperature

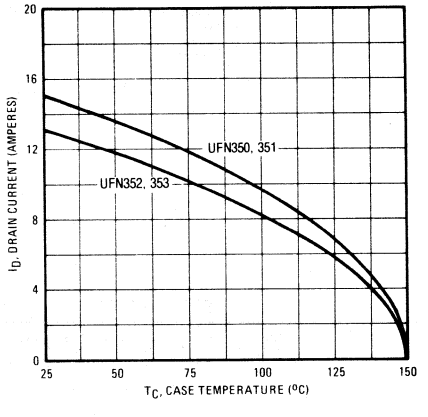
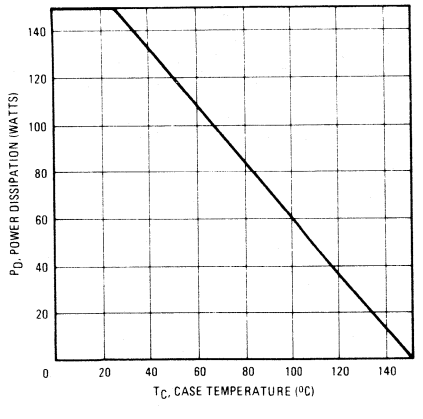


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

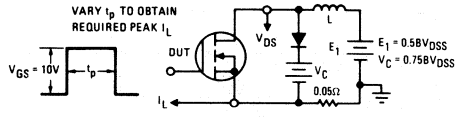


Fig. 16 – Clamped Inductive Waveforms

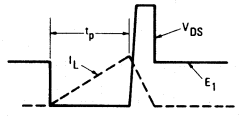


Fig. 17 – Switching Time Test Circuit

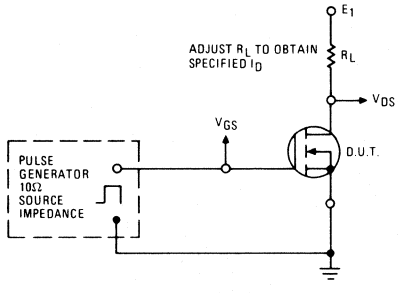
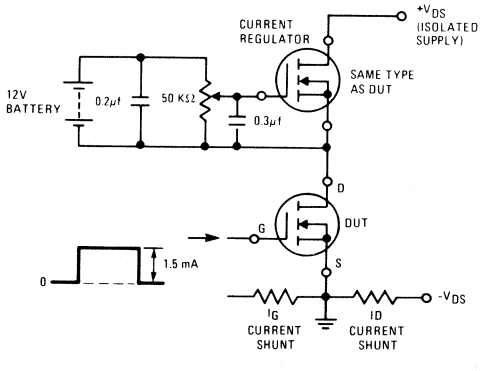


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

500 Volt, 3.0 Ohm N-Channel

UFN420
UFN421
UFN422
UFN423

3

FEATURES

- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

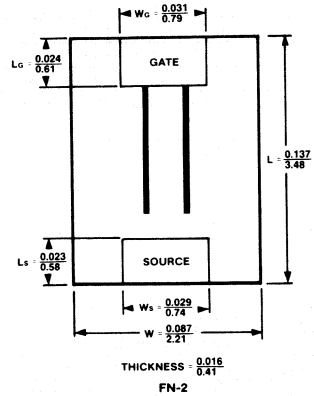
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

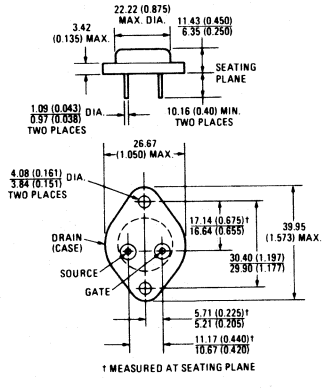
Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN420	500V	3.0Ω	2.5A
UFN421	450V	3.0Ω	2.5A
UFN422	500V	4.0Ω	2.0A
UFN423	450V	4.0Ω	2.0A



FN-2

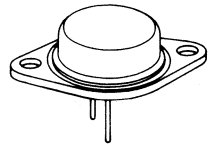
MECHANICAL SPECIFICATIONS

UFN420 UFN421 UFN422 UFN423



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

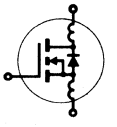
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN420	UFN421	UFN422	UFN423	Units
V_{DS}	Drain - Source Voltage ①	500	450	500	450	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	500	450	500	450	V
I_D @ T_C = 25°C	Continuous Drain Current	2.5	2.5	2.0	2.0	A
I_D @ T_C = 100°C	Continuous Drain Current	1.5	1.5	1.0	1.0	A
I_{DM}	Pulsed Drain Current ③	10	10	8.0	8.0	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	40 (See Fig. 14)				W
	Linear Derating Factor	0.32 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH 10	10	8.0	8.0	A
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN420 UFN422	500	–	–	V	V_{GS} = 0V
		UFN421 UFN423	450	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN420 UFN421	2.5	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, V_{GS} = 10V
		UFN422 UFN423	2.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN420 UFN421	–	2.5	3.0	Ω	V_{GS} = 10V, I_D = 1.0A
		UFN422 UFN423	–	3.0	4.0	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.0	1.75	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, I_D = 1.0A
C_{iss}	Input Capacitance	ALL	–	300	400	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	75	150	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	20	40	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	30	60	ns	V_{DD} = 0.5 BV_{DSS}, I_D = 1.0A, Z_O = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	25	50	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	30	60	ns	
t_f	Fall Time	ALL	–	15	30	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	11	15	nC	V_{GS} = 10V, I_D = 3.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	5.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	6.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	3.12	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN420 UFN421	–	–	2.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		UFN422 UFN423	–	–	2.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN420 UFN421	–	–	10	A	
		UFN422 UFN423	–	–	8.0	A	
V_{SD}	Diode Forward Voltage ②	UFN420 UFN421	–	–	1.4	V	T_C = 25°C, I_S = 2.5A, V_{GS} = 0V
		UFN422 UFN423	–	–	1.3	V	T_C = 25°C, I_S = 2.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	600	–	ns	T_J = 150°C, I_F = 2.5A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	3.5	–	μC	T_J = 150°C, I_F = 2.5A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

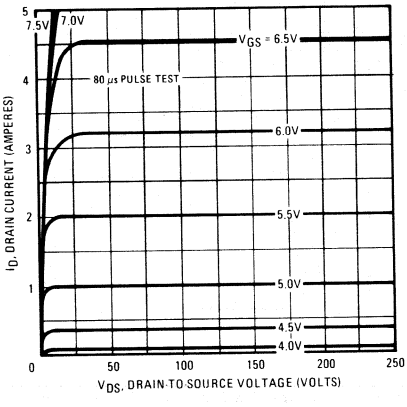


Fig. 2 – Typical Transfer Characteristics

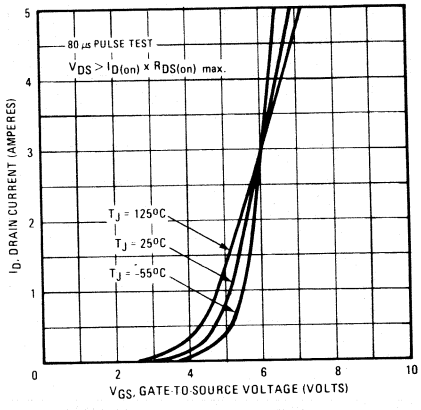


Fig. 3 – Typical Saturation Characteristics

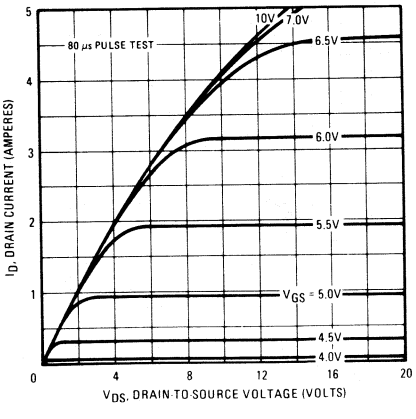
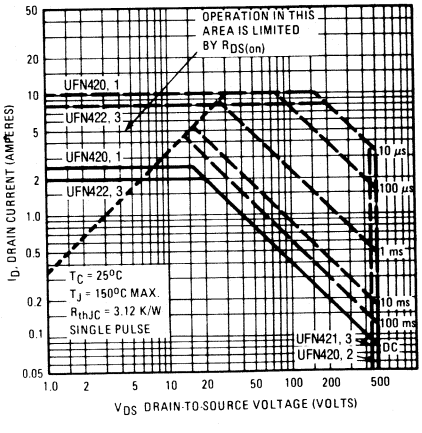


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

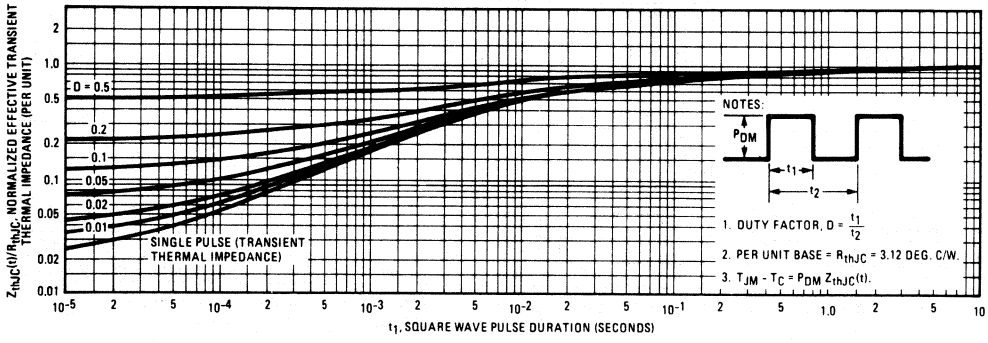


Fig. 6 — Typical Transconductance Vs. Drain Current

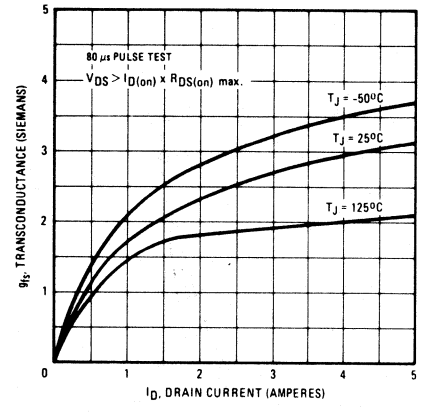


Fig. 7 — Typical Source-Drain Diode Forward Voltage

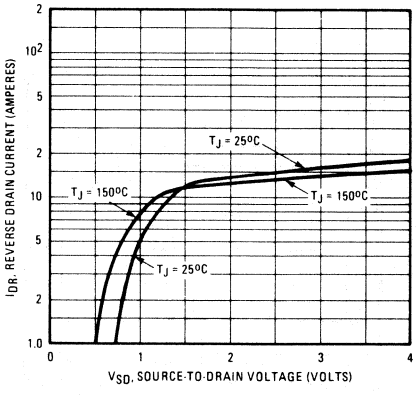


Fig. 8 — Breakdown Voltage Vs. Temperature

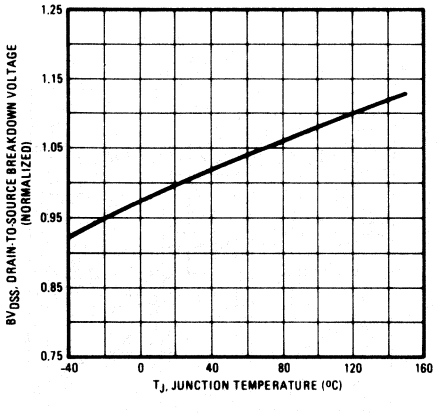
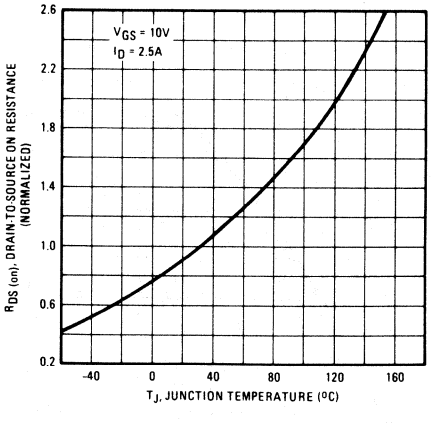


Fig. 9 — Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

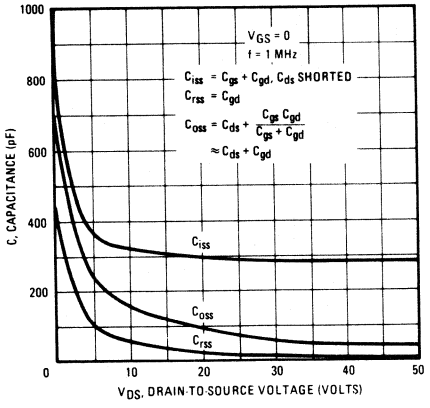


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

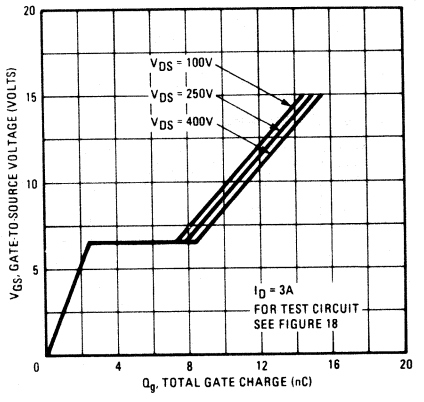


Fig. 12 – Typical On-Resistance Vs. Drain Current

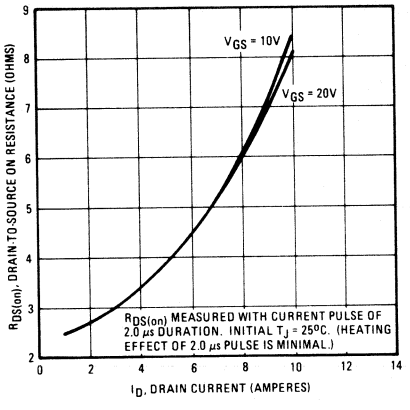


Fig. 13 – Maximum Drain Current Vs. Case Temperature

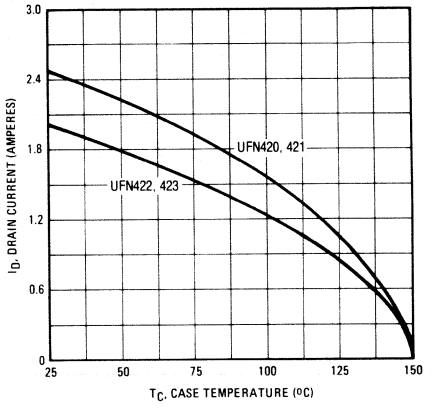


Fig. 14 – Power Vs. Temperature Derating Curve

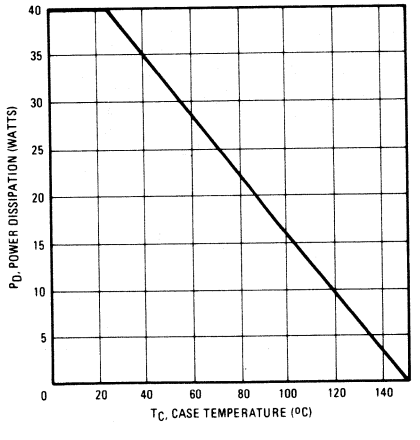


Fig. 15 – Clamped Inductive Test Circuit

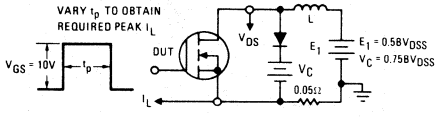


Fig. 16 – Clamped Inductive Waveforms

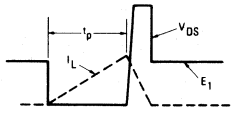


Fig. 17 – Switching Time Test Circuit

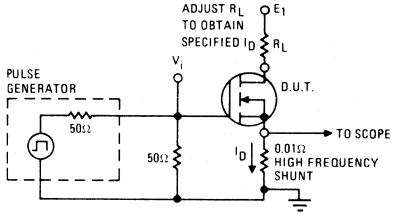
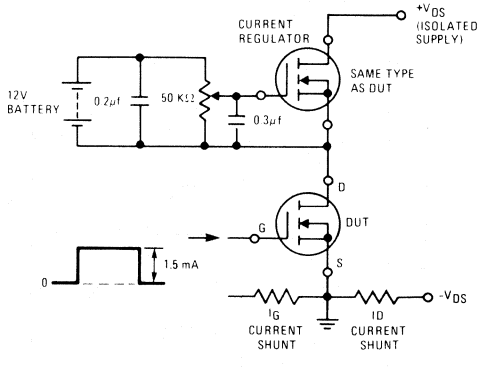


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

500 Volt, 1.5 Ohm
N-Channel

UFN430
UFN431
UFN432
UFN433

3

FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

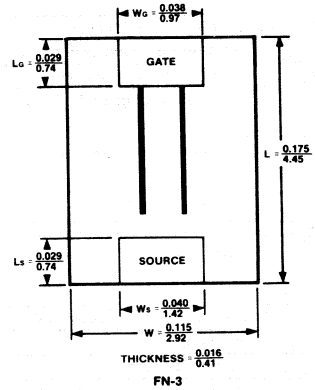
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

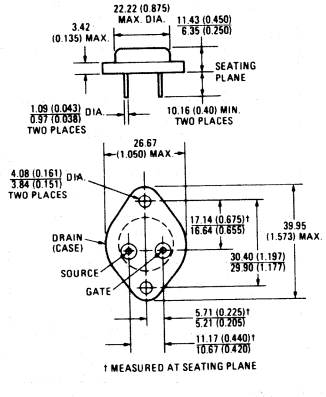
Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN430	500V	1.5Ω	4.5A
UFN431	450V	1.5Ω	4.5A
UFN432	500V	2.0Ω	4.0A
UFN433	450V	2.0Ω	4.0A



FN-3

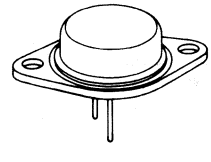
MECHANICAL SPECIFICATIONS

UFN430 UFN431 UFN432 UFN433



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

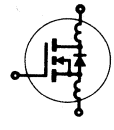
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN430	UFN431	UFN432	UFN433	Units
V_{DS}	Drain - Source Voltage ①	500	450	500	450	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	500	450	500	450	V
I_D @ T_C = 25°C	Continuous Drain Current	4.5	4.5	4.0	4.0	A
I_D @ T_C = 100°C	Continuous Drain Current	3.0	3.0	2.5	2.5	A
I_{DM}	Pulsed Drain Current ③	18	18	16	16	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	75 (See Fig. 14)				W
	Linear Derating Factor	0.6 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		18	18	16	16	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN430 UFN432	500	–	–	V	V_{GS} = 0V
		UFN431 UFN433	450	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN430 UFN431	4.5	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFN432 UFN433	4.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN430 UFN431	–	1.3	1.5	Ω	V_{GS} = 10V, I_D = 2.5A
		UFN432 UFN433	–	1.5	2.0	Ω	
g_{fs}	Forward Transconductance ②	ALL	2.5	3.2	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 2.5A
C_{iss}	Input Capacitance	ALL	–	600	800	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	100	200	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	30	60	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	30	ns	V_{DD} ≈ 225V, I_D = 2.5A, Z_0 = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	30	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	55	ns	
t_f	Fall Time	ALL	–	–	30	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	22	30	nC	V_{GS} = 10V, I_D = 6.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	11	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	11	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.67	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN430 UFN431	–	–	4.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN432 UFN433	–	–	4.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN430 UFN431	–	–	18	A	
		UFN432 UFN433	–	–	16	A	
V_{SD}	Diode Forward Voltage ②	UFN430 UFN431	–	–	1.4	V	T_C = 25°C, I_S = 4.5A, V_{GS} = 0V
		UFN432 UFN433	–	–	1.3	V	T_C = 25°C, I_S = 4.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	800	–	ns	T_J = 150°C, I_F = 4.5A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	4.6	–	μC	T_J = 150°C, I_F = 4.5A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

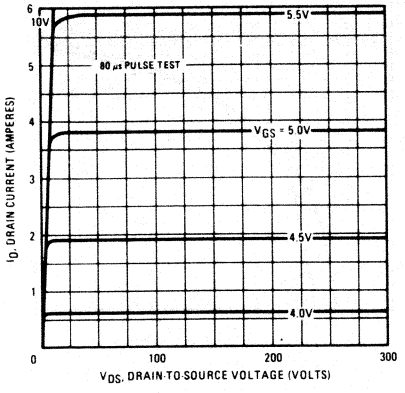


Fig. 2 – Typical Transfer Characteristics

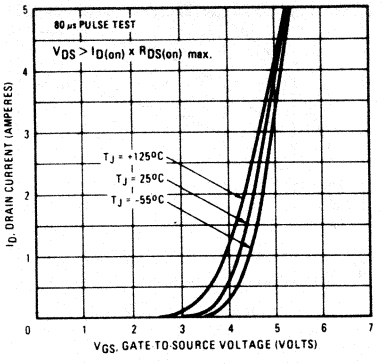


Fig. 3 – Typical Saturation Characteristics

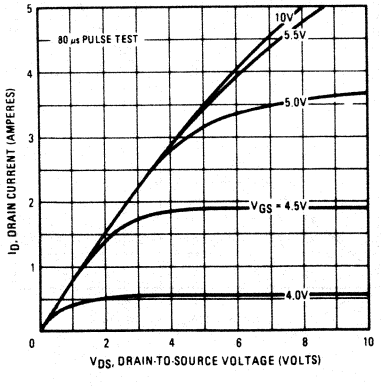


Fig. 4 – Maximum Safe Operating Area

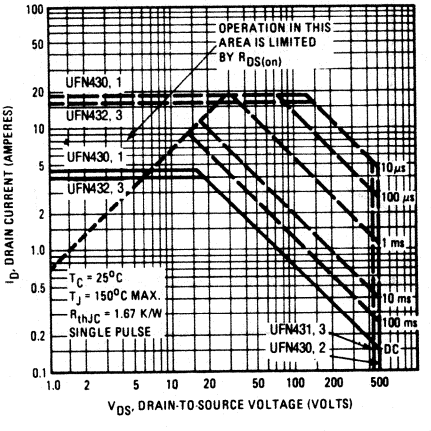


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

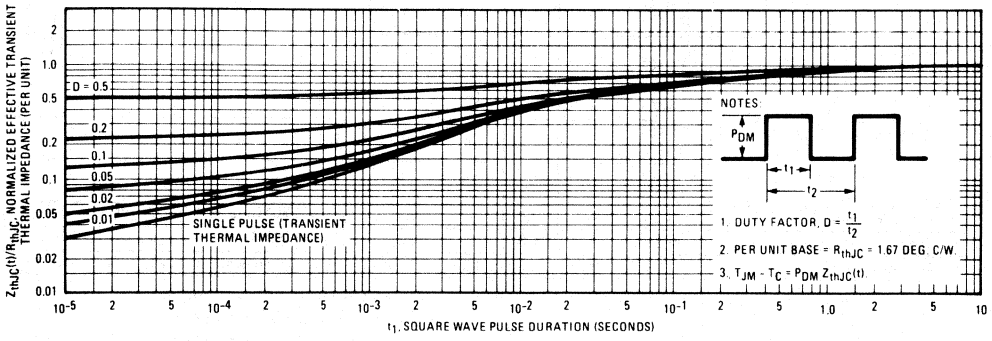


Fig. 6 – Typical Transconductance Vs. Drain Current

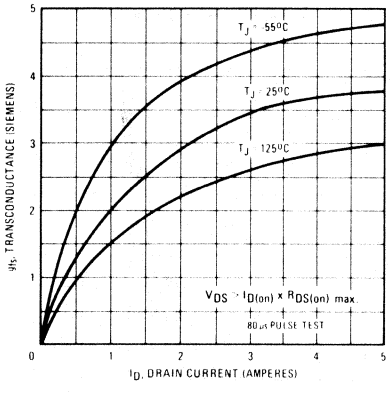


Fig. 7 – Typical Source-Drain Diode Forward Voltage

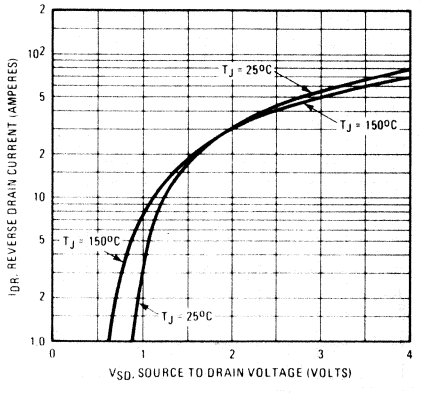


Fig. 8 – Breakdown Voltage Vs. Temperature

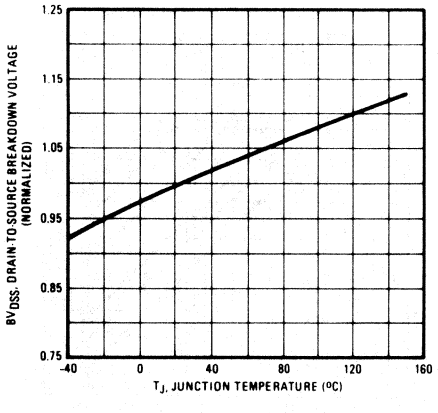
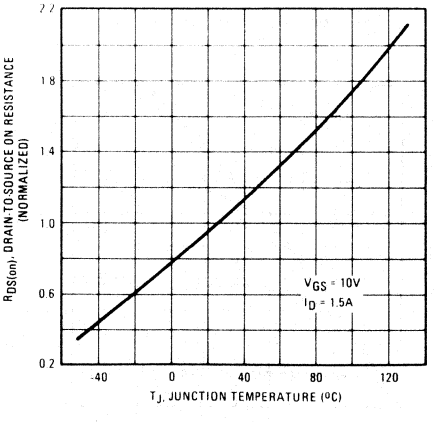


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

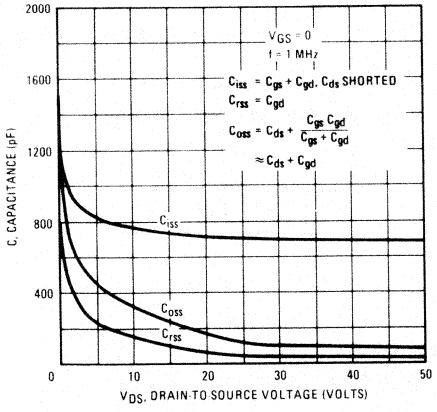


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

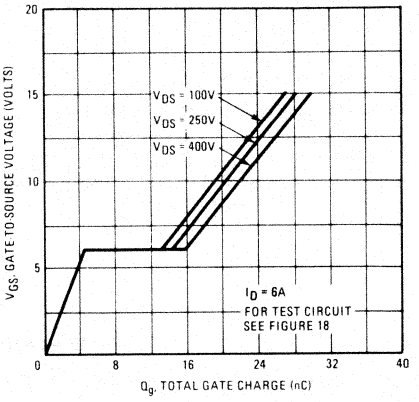


Fig. 12 – Typical On-Resistance Vs. Drain Current

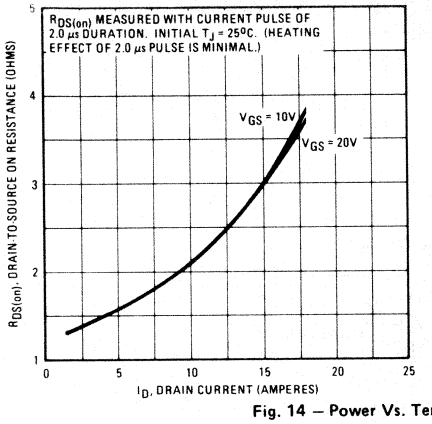


Fig. 13 – Maximum Drain Current Vs. Case Temperature

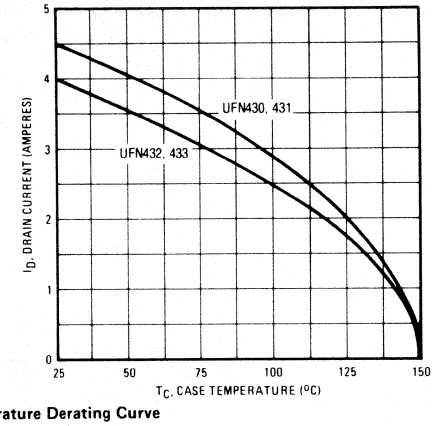
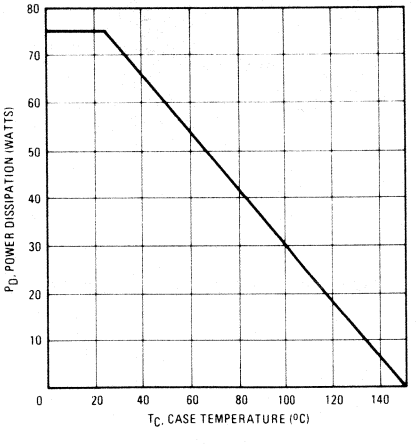


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

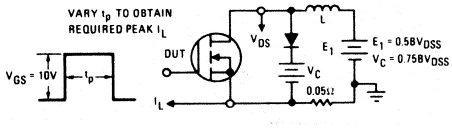


Fig. 16 – Clamped Inductive Waveforms

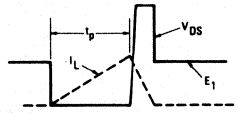


Fig. 17 – Switching Time Test Circuit

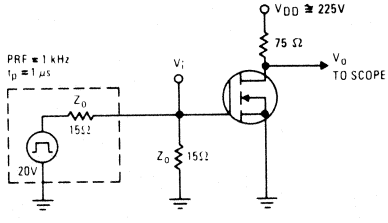
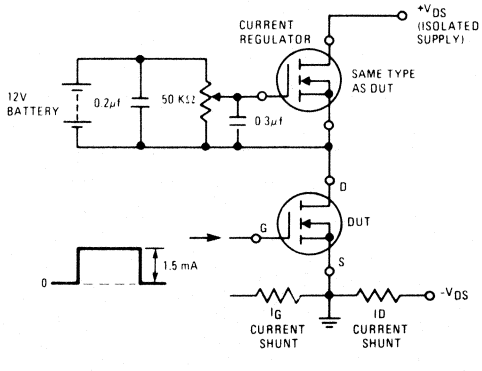


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

500 Volt, 0.85 Ohm N-Channel

UFN440
UFN441
UFN442
UFN443

3

FEATURES

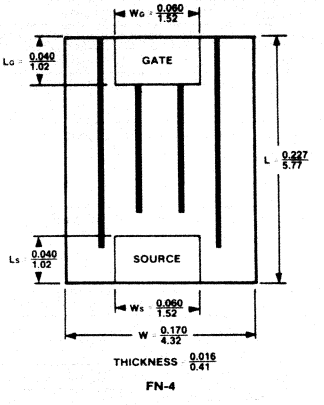
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



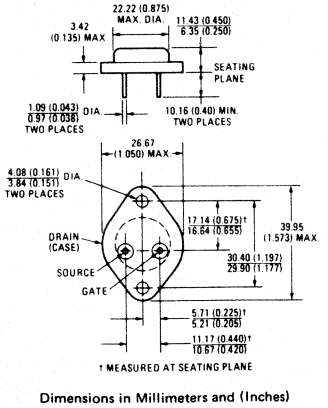
FN-4

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN440	500V	0.85Ω	8.0A
UFN441	450V	0.85Ω	8.0A
UFN442	500V	1.10Ω	7.0A
UFN443	450V	1.10Ω	7.0A

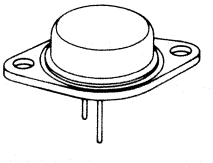
MECHANICAL SPECIFICATIONS

UFN440 UFN441 UFN442 UFN443



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

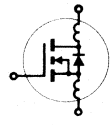
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN440	UFN441	UFN442	UFN443	Units
V_{DS}	Drain - Source Voltage ①	500	450	500	450	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	500	450	500	450	V
I_D @ T_C = 25°C	Continuous Drain Current	8.0	8.0	7.0	7.0	A
I_D @ T_C = 100°C	Continuous Drain Current	5.0	5.0	4.0	4.0	A
I_{DM}	Pulsed Drain Current ③	32	32	28	28	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	125 (See Fig. 14)				W
	Linear Derating Factor	1.0 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		32	32	28	28	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN440 UFN442	500	–	–	V	V_{GS} = 0V
		UFN441 UFN443	450	–		V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–		250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN440 UFN441	8.0	–		A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFN442 UFN443	7.0	–		A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN440 UFN441	–	0.8	0.85	Ω	V_{GS} = 10V, I_D = 4.0A
		UFN442 UFN443	–	1.0	1.1	Ω	
g_{fs}	Forward Transconductance ②	ALL	4.0	6.5	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 4.0A
C_{iss}	Input Capacitance	ALL	–	1225	1600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	200	350	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	85	150	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	17	35	ns	V_{DD} = 200V, I_D = 4.0A, Z_O = 4.7Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	5	15	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	42	90	ns	
t_f	Fall Time	ALL	–	14	30	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	42	60	nC	V_{GS} = 10V, I_D = 10A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	20	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	22	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.0	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN440 UFN441	–	–	8.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN442 UFN443	–	–	7.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN440 UFN441	–	–	32	A	
		UFN442 UFN443	–	–	28	A	
V_{SD}	Diode Forward Voltage ②	UFN440 UFN441	–	–	2.0	V	T_C = 25°C, I_S = 8.0A, V_{GS} = 0V
		UFN442 UFN443	–	–	1.9	V	T_C = 25°C, I_S = 7.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	1100	–	ns	T_J = 150°C, I_F = 8.0A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	6.4	–	μC	T_J = 150°C, I_F = 8.0A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 — Typical Output Characteristics

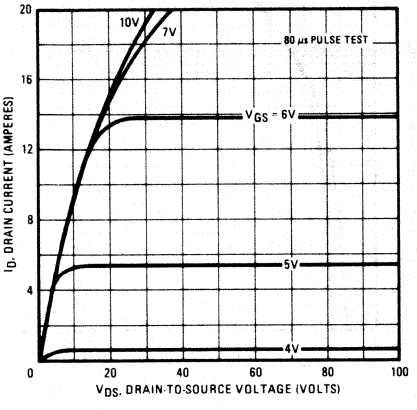


Fig. 2 — Typical Transfer Characteristics

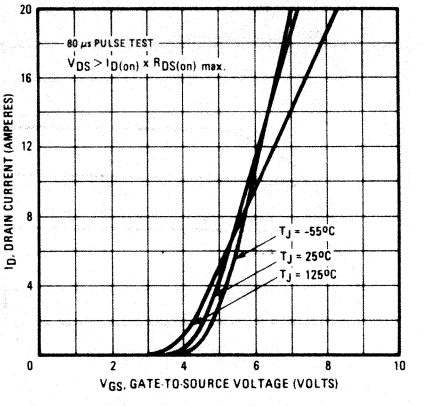


Fig. 3 — Typical Saturation Characteristics

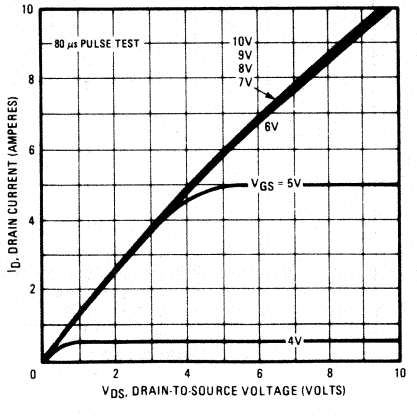
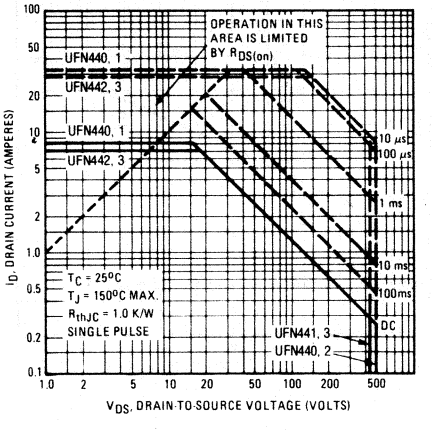


Fig. 4 — Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

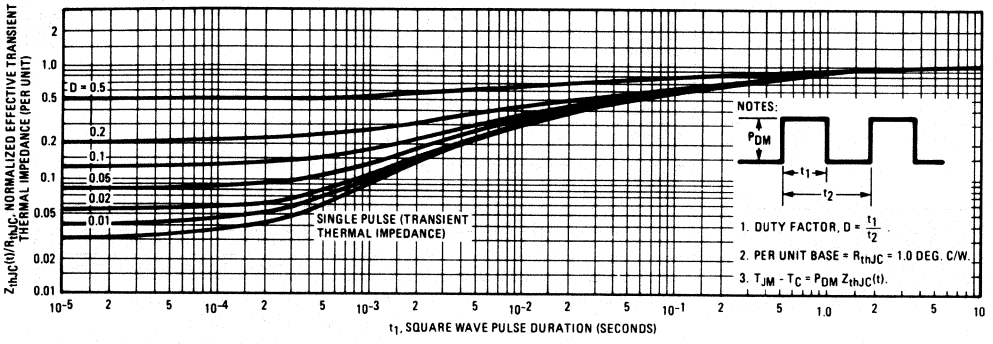


Fig. 6 – Typical Transconductance Vs. Drain Current

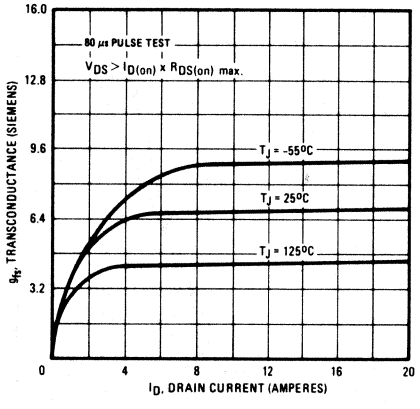


Fig. 7 – Typical Source-Drain Diode Forward Voltage

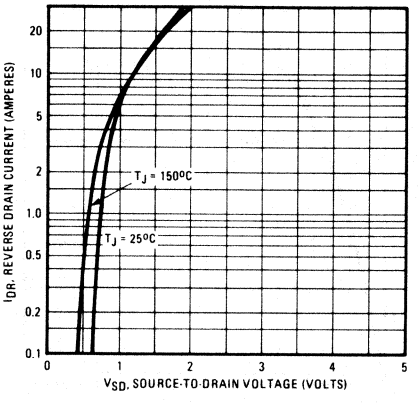


Fig. 8 – Breakdown Voltage Vs. Temperature

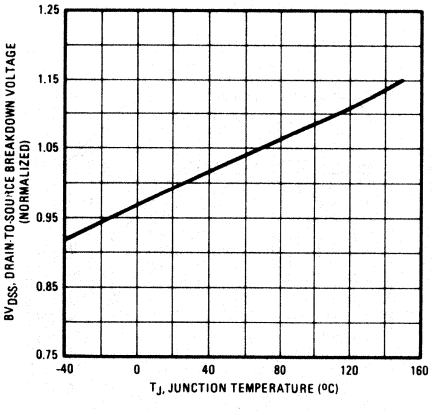
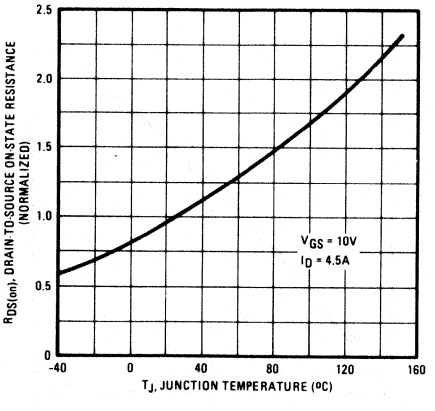


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

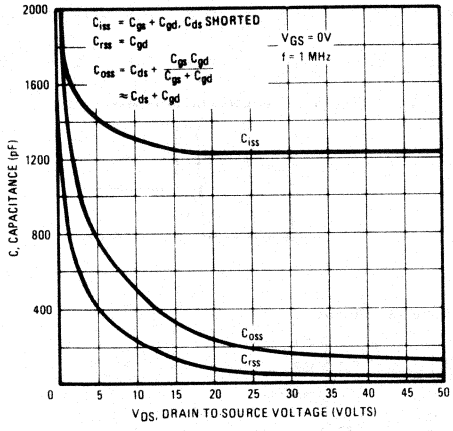


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

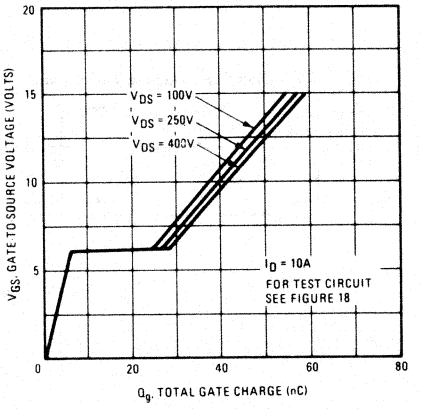


Fig. 12 – Typical On-Resistance Vs. Drain Current

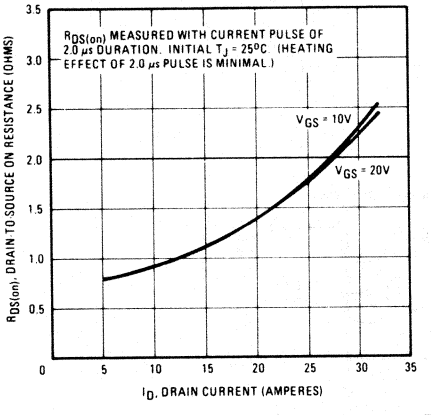


Fig. 13 – Maximum Drain Current Vs. Case Temperature

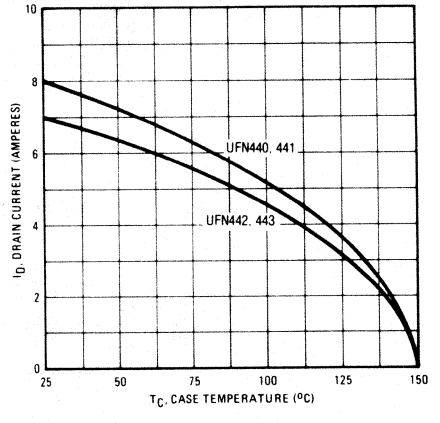
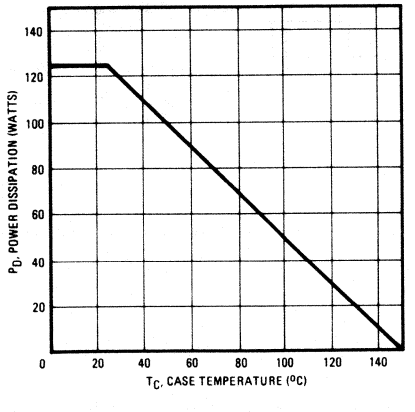


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

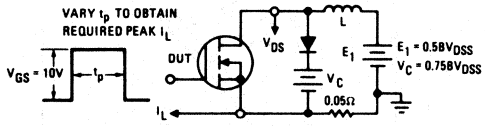


Fig. 16 – Clamped Inductive Waveforms

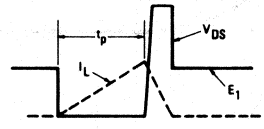


Fig. 17 – Switching Time Test Circuit

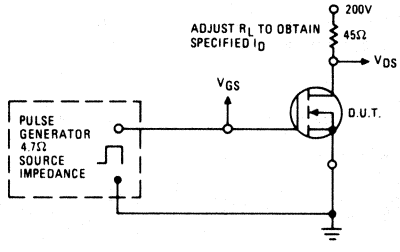
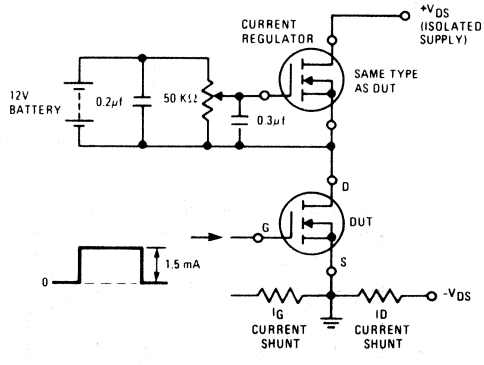


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

500 Volt, 0.4 Ohm N-Channel

UFN450
UFN451
UFN452
UFN453

3

FEATURES

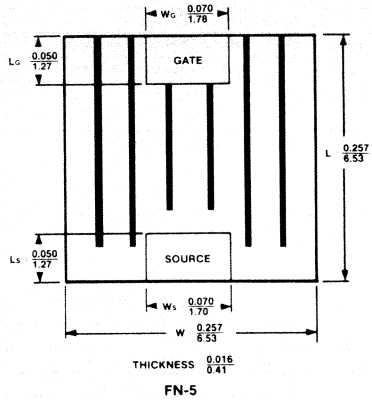
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



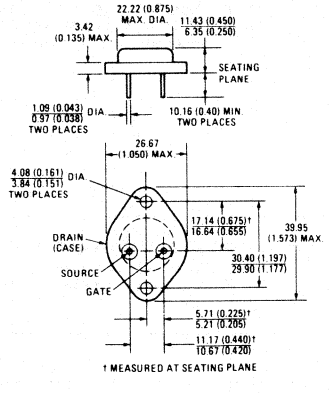
FN-5

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN450	500V	0.4Ω	13A
UFN451	450V	0.4Ω	13A
UFN452	500V	0.5Ω	12A
UFN453	450V	0.5Ω	12A

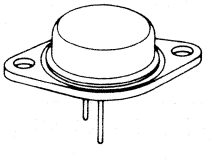
MECHANICAL SPECIFICATIONS

UFN450 UFN451 UFN452 UFN453



Dimensions in Millimeters and (Inches)

TO-204AA (TO-3)



UNITRODE

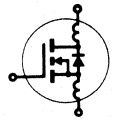
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN450	UFN451	UFN452	UFN453	Units
V_{DS}	Drain - Source Voltage ①	500	450	500	450	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	500	450	500	450	V
I_D @ T_C = 25°C	Continuous Drain Current	13	13	12	12	A
I_D @ T_C = 100°C	Continuous Drain Current	8.0	8.0	7.0	7.0	A
I_{DM}	Pulsed Drain Current ③	52	52	48	48	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	150 (See Fig. 14)				W
	Linear Derating Factor	1.2 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 14 and 15) L = 100μH				A
		52	52	48	48	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN450 UFN452	500	–	–	V	V_{GS} = 0V
		UFN451 UFN453	450	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN450 UFN451	13	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFN452 UFN453	12	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN450 UFN451	–	0.3	0.4	Ω	V_{GS} = 10V, I_D = 7.0A
		UFN452 UFN453	–	0.4	0.5	Ω	
g_{fs}	Forward Transconductance ②	ALL	6.0	11	–	S(℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 7.0A
C_{iss}	Input Capacitance	ALL	–	2000	3000	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	400	600	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	100	200	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	35	ns	V_{DD} ≃ 210V, I_D = 7.0A, Z_O = 4.7Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	50	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	150	ns	
t_f	Fall Time	ALL	–	–	70	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	82	120	nC	V_{GS} = 10V, I_D = 16A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	40	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	42	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L_S	Internal Source Inductance	ALL	–	12.5	–	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	.83	K/W	
R_{thCS}	Case-to-Sink	ALL	–	0.1	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN450 UFN451	—	—	13	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN452 UFN453	—	—	12	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN450 UFN451	—	—	52	A	
		UFN452 UFN453	—	—	48	A	
V_{SD}	Diode Forward Voltage ②	UFN450 UFN451	—	—	1.4	V	T_C = 25°C, I_S = 13A, V_{GS} = 0V
		UFN452 UFN453	—	—	1.3	V	T_C = 25°C, I_S = 12A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	1300	—	ns	T_J = 150°C, I_F = 13A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	7.4	—	μC	T_J = 150°C, I_F = 13A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 — Typical Output Characteristics

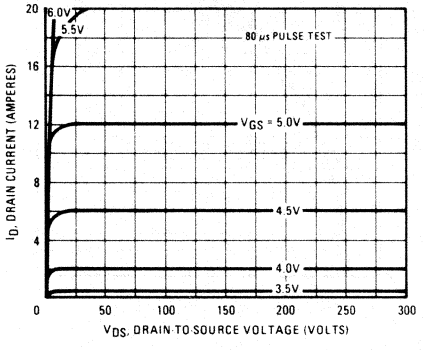


Fig. 2 — Typical Transfer Characteristics

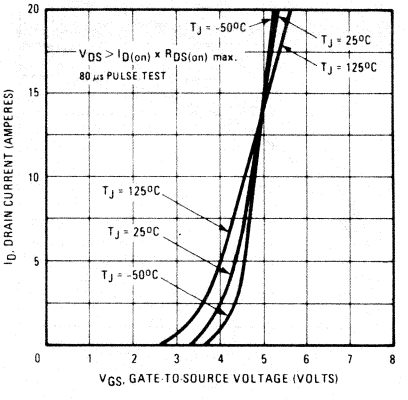


Fig. 3 — Typical Saturation Characteristics

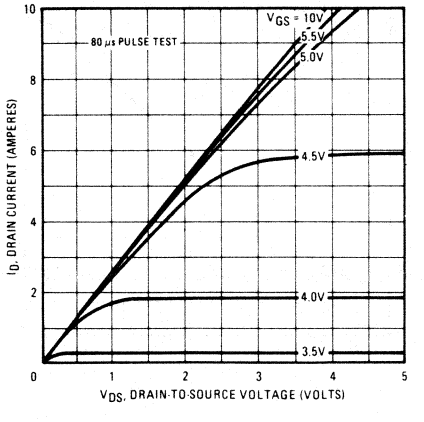
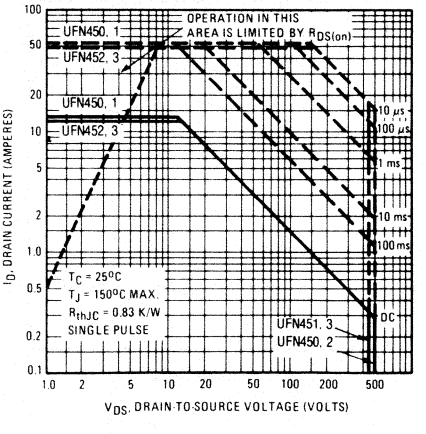


Fig. 4 — Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

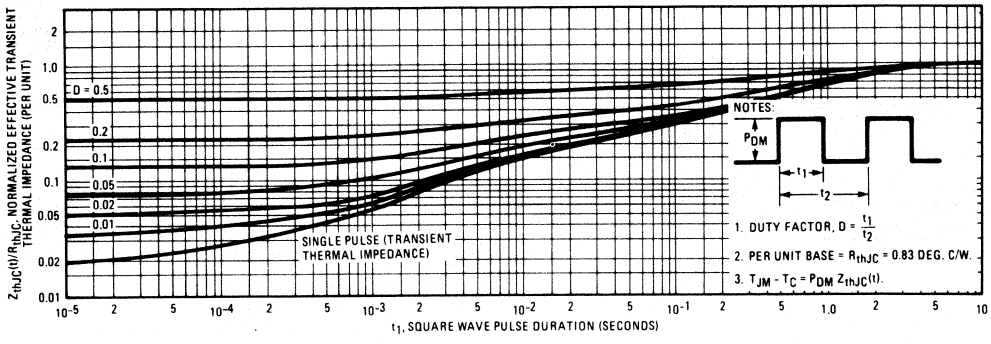


Fig. 6 – Typical Transconductance Vs. Drain Current

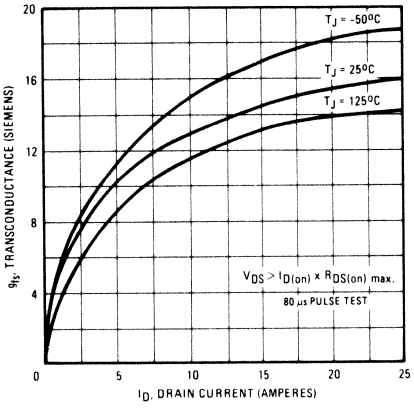


Fig. 7 – Typical Source-Drain Diode Forward Voltage

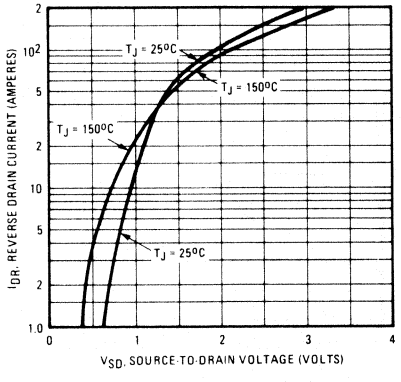


Fig. 8 – Breakdown Voltage Vs. Temperature

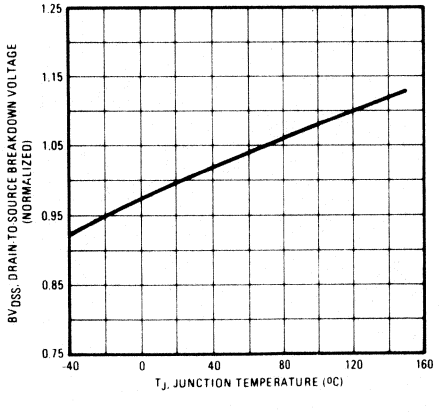


Fig. 9 – Normalized On-Resistance Vs. Temperature

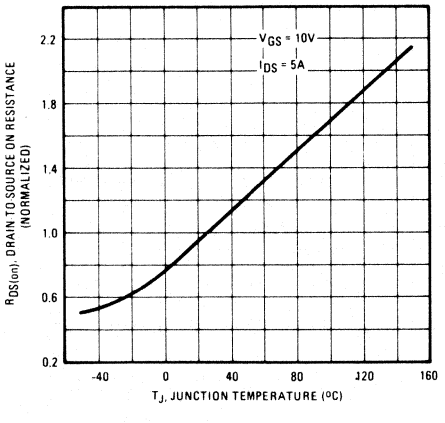


Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

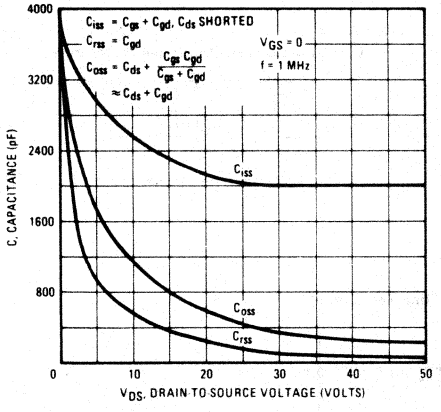


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

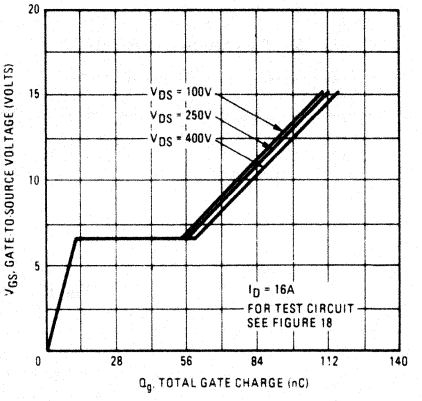


Fig. 12 – Typical On-Resistance Vs. Drain Current

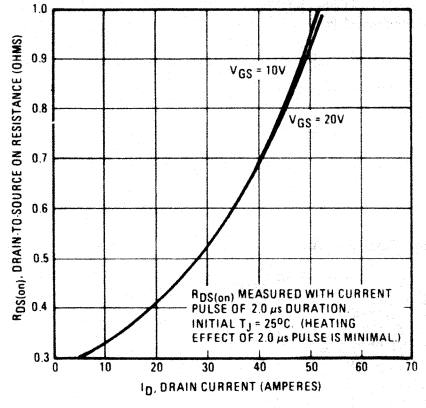


Fig. 13 – Maximum Drain Current Vs. Case Temperature

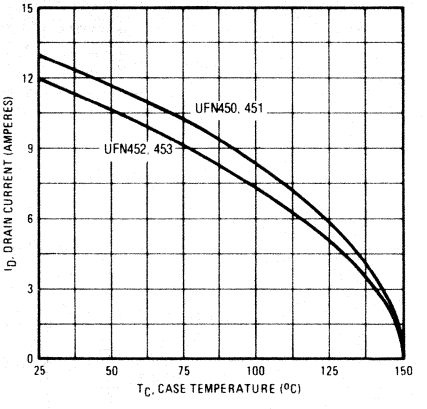
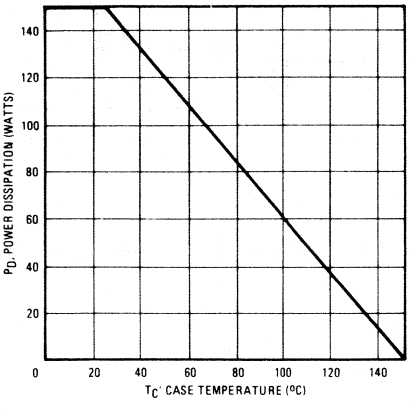


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

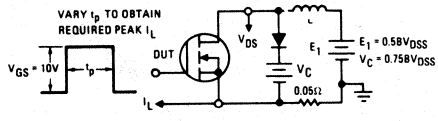


Fig. 16 – Clamped Inductive Waveforms

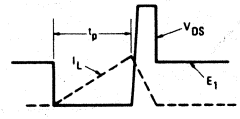


Fig. 17 – Switching Time Test Circuit

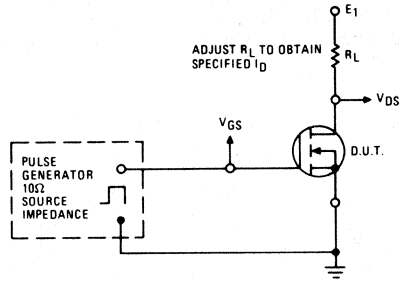
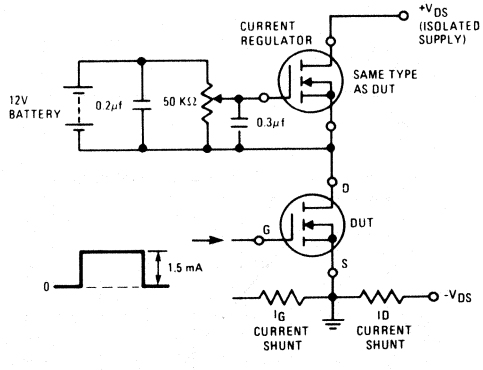


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

100 Volt, 0.6 Ohm N-Channel

UFN510
UFN511
UFN512
UFN513

3

FEATURES

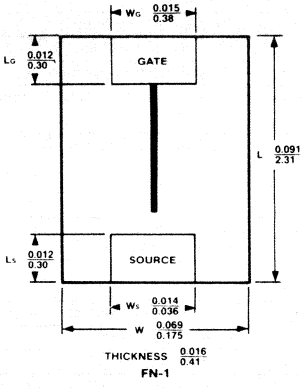
- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



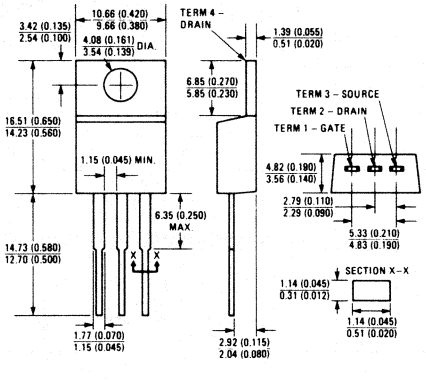
FN-1

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN510	100V	0.6Ω	4.0A
UFN511	60V	0.6Ω	4.0A
UFN512	100V	0.8Ω	3.5A
UFN513	60V	0.8Ω	3.5A

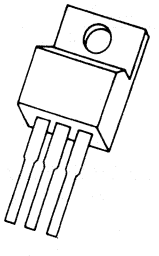
MECHANICAL SPECIFICATIONS

UFN510 UFN511 UFN512 UFN513



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

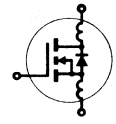
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN510	UFN511	UFN512	UFN513	Units
V_{DS}	Drain - Source Voltage ①	100	60	100	60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	100	60	100	60	V
I_D @ T_C = 25°C	Continuous Drain Current	4.0	4.0	3.5	3.5	A
I_D @ T_C = 100°C	Continuous Drain Current	2.5	2.5	2.0	2.0	A
I_{DM}	Pulsed Drain Current ③	16	16	14	14	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	20 (See Fig. 14)				W
	Linear Derating Factor	0.16 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		16	16	14	14	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN510 UFN512	100	–	–	V	V_{GS} = 0V
		UFN511 UFN513	60	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN510 UFN511	4.0	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFN512 UFN513	3.5	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN510 UFN511	–	0.5	0.6	Ω	V_{GS} = 10V, I_D = 2.0A
		UFN512 UFN513	–	0.6	0.8	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.0	1.5	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 2.0A
C_{iss}	Input Capacitance	ALL	–	135	150	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	80	100	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	20	25	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	10	20	ns	V_{DD} ≈ 0.5 BV_{DSS}, I_D = 2.0A, Z_0 = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	15	25	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	15	25	ns	
t_f	Fall Time	ALL	–	10	20	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	5.0	7.5	nC	V_{GS} = 10V, I_D = 8.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	2.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	3.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	6.4	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN510 UFN511	—	—	4.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN512 UFN513	—	—	3.5	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN510 UFN511	—	—	16	A	
		UFN512 UFN513	—	—	14	A	
V_{SD}	Diode Forward Voltage ②	UFN510 UFN511	—	—	2.5	V	T_C = 25°C, I_S = 4.0A, V_{GS} = 0V
		UFN512 UFN513	—	—	2.0	V	T_C = 25°C, I_S = 3.5A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	230	—	ns	T_J = 150°C, I_F = 4.0A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	1.4	—	μC	T_J = 150°C, I_F = 4.0A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 — Typical Output Characteristics

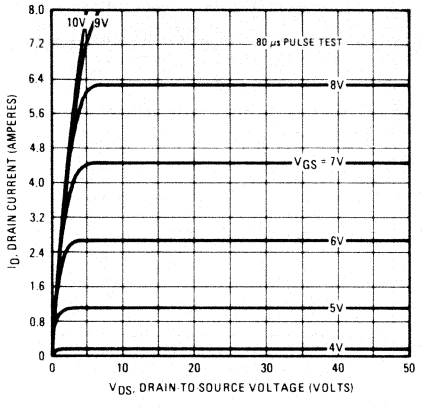


Fig. 2 — Typical Transfer Characteristics

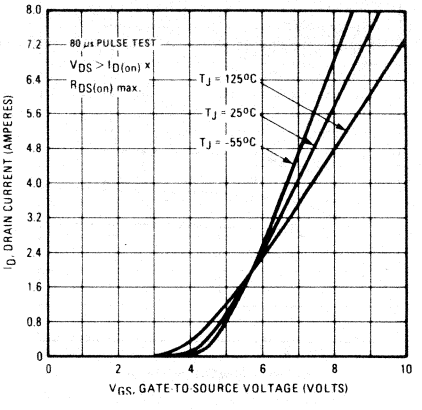


Fig. 3 — Typical Saturation Characteristics

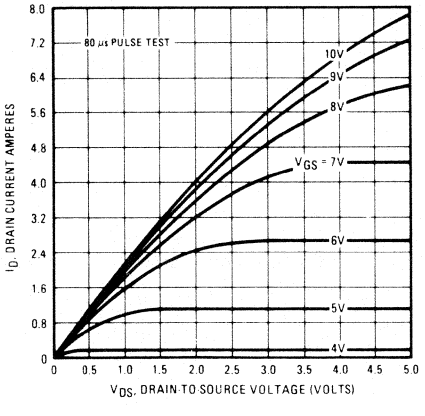


Fig. 4 — Maximum Safe Operating Area

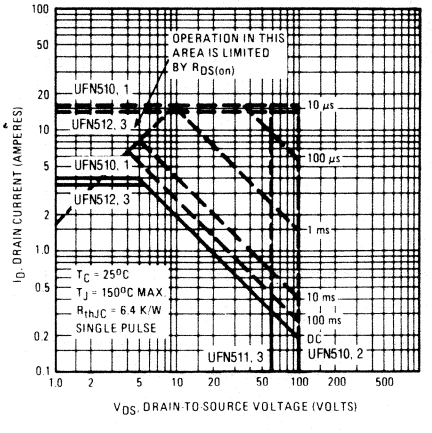


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

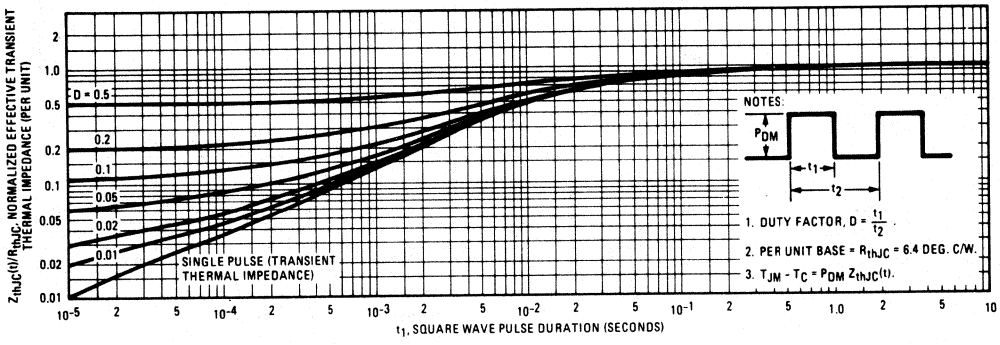


Fig. 6 – Typical Transconductance Vs. Drain Current

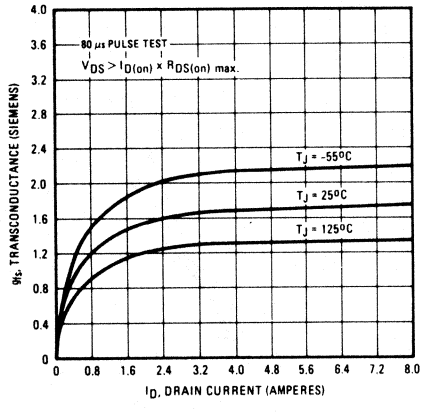


Fig. 7 – Typical Source-Drain Diode Forward Voltage

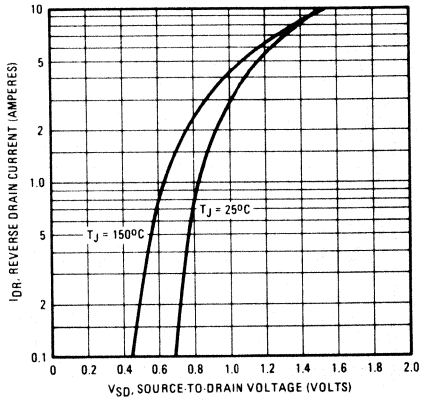


Fig. 8 – Breakdown Voltage Vs. Temperature

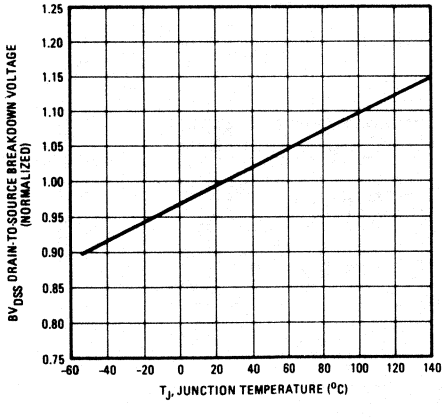
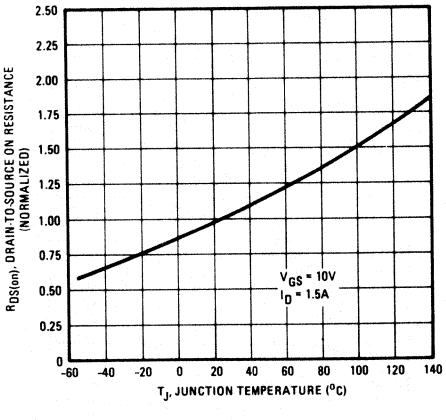


Fig. 9 – Normalized On-Resistance Vs. Temperature



3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

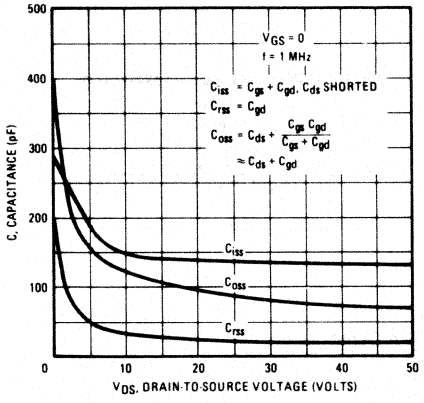


Fig 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

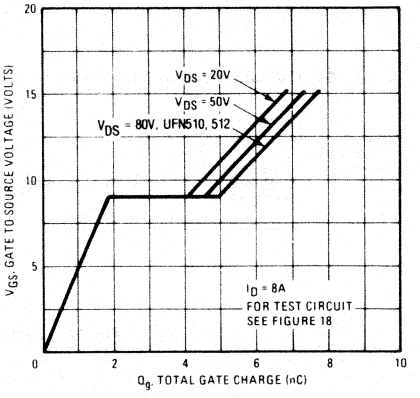


Fig. 12 – Typical On-Resistance Vs. Drain Current

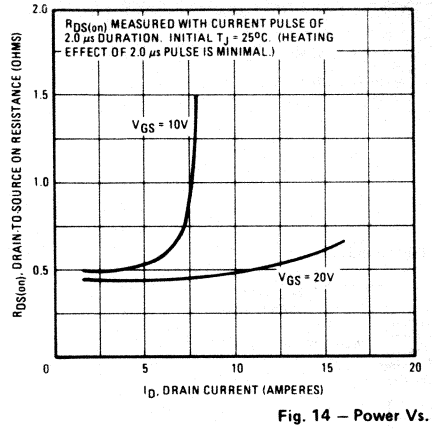


Fig. 13 – Maximum Drain Current Vs. Case Temperature

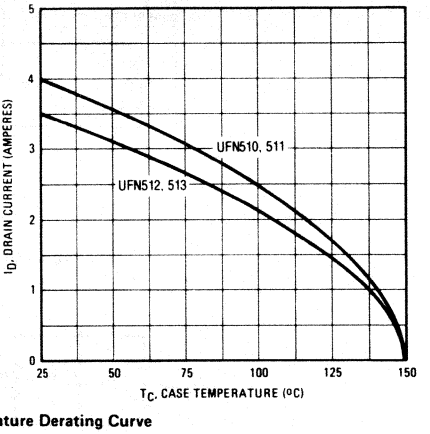
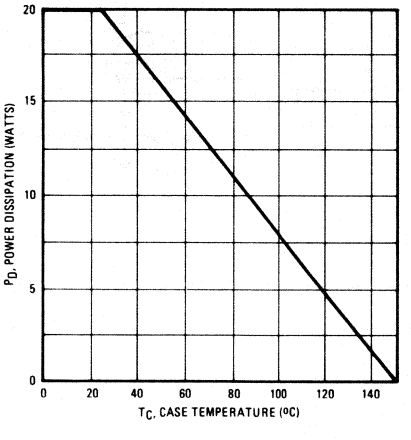


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

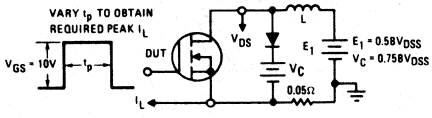


Fig. 16 – Clamped Inductive Waveforms

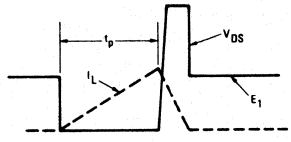


Fig. 17 – Switching Time Test Circuit

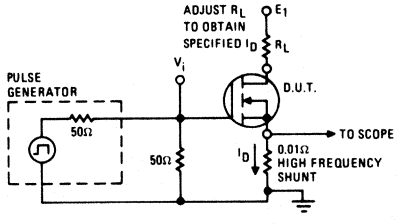
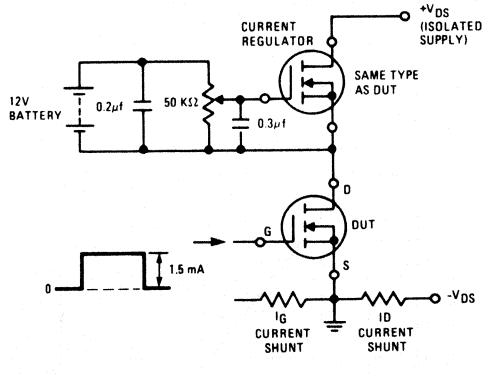


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

100 Volt, 0.3 Ohm N-Channel

UFN520
UFN521
UFN522
UFN523

3

FEATURES

- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

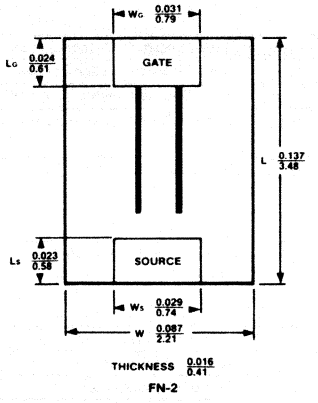
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

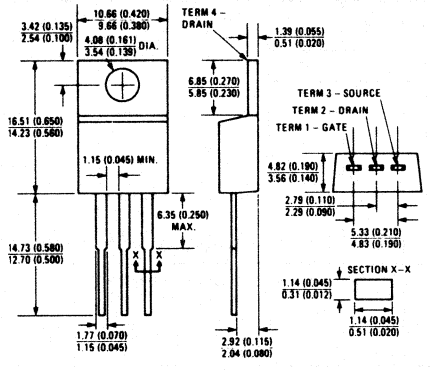
PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN520	100V	0.30Ω	8.0A
UFN521	60V	0.30Ω	8.0A
UFN522	100V	0.40Ω	7.0A
UFN523	60V	0.40Ω	7.0A

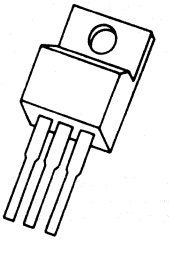


MECHANICAL SPECIFICATIONS

UFN520 UFN521 UFN522 UFN523



TO-220AB



UNITRODE

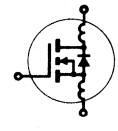
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN520	UFN521	UFN522	UFN523	Units
V_{DS}	Drain - Source Voltage ①	100	60	100	60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	100	60	100	60	V
I_D @ T_C = 25°C	Continuous Drain Current	8.0	8.0	7.0	7.0	A
I_D @ T_C = 100°C	Continuous Drain Current	5.0	5.0	4.0	4.0	A
I_{DM}	Pulsed Drain Current ③	32	32	28	28	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	40 (See Fig. 14)				W
	Linear Derating Factor	0.32 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		32	32	28	28	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN520 UFN522	100	–	–	V	V_{GS} = 0V
		UFN521 UFN523	60	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN520 UFN521	8.0	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN522 UFN523	7.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN520 UFN521	–	0.25	0.30	Ω	V_{GS} = 10V, I_D = 4.0A
		UFN522 UFN523	–	0.30	0.40	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.5	2.9	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 4.0A
C_{iss}	Input Capacitance	ALL	–	450	600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	200	400	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	50	100	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	20	40	ns	V_{DD} ≈ 0.5 BV_{DSS}, I_D = 4.0A, Z_O = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	35	70	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	50	100	ns	
t_f	Fall Time	ALL	–	35	70	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	10	15	nC	V_{GS} = 15V, I_D = 10A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	6.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	4.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	3.12	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN520 UFN521	–	–	8.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN522 UFN523	–	–	7.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN520 UFN521	–	–	32	A	
		UFN522 UFN523	–	–	28	A	
V_{SD}	Diode Forward Voltage ②	UFN520 UFN521	–	–	2.5	V	T_C = 25°C, I_S = 8.0A, V_{GS} = 0V
		UFN522 UFN523	–	–	2.3	V	T_C = 25°C, I_S = 7.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	280	–	ns	T_J = 150°C, I_F = 8.0A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	1.6	–	μC	T_J = 150°C, I_F = 8.0A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

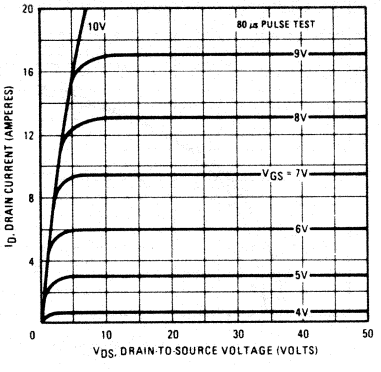


Fig. 2 – Typical Transfer Characteristics

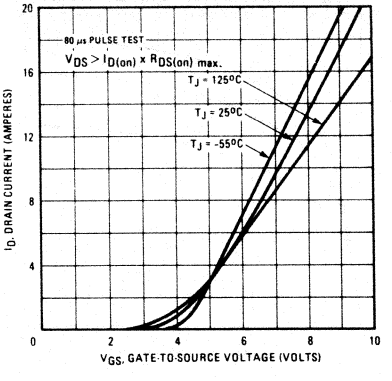


Fig. 3 – Typical Saturation Characteristics

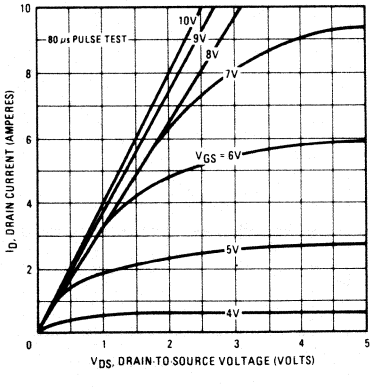


Fig. 4 – Maximum Safe Operating Area

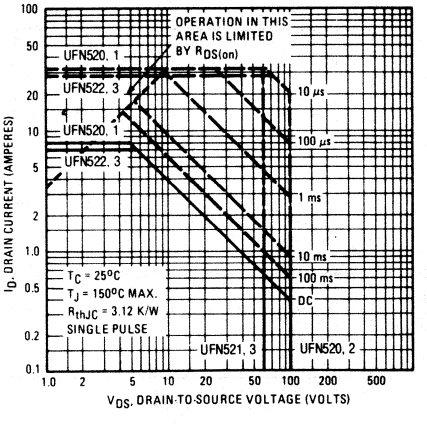


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

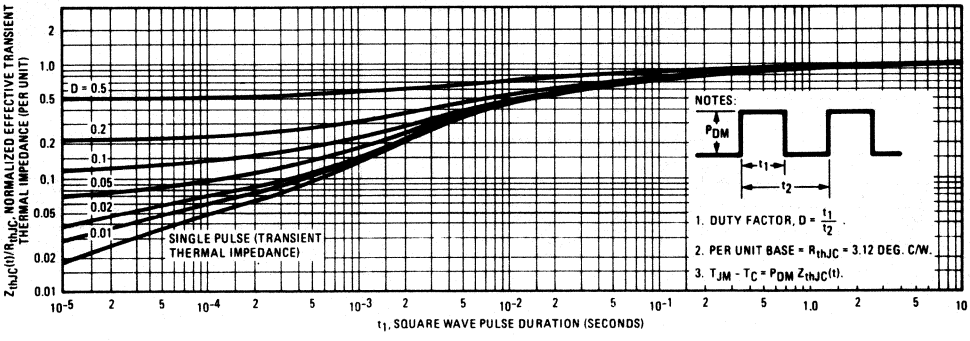


Fig. 6 – Typical Transconductance Vs. Drain Current

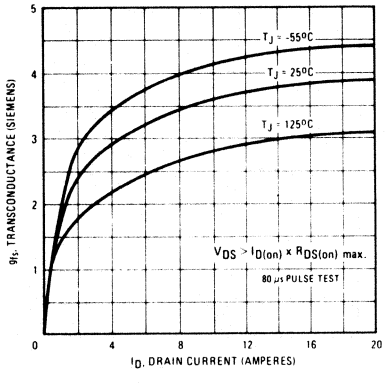


Fig. 7 – Typical Source-Drain Diode Forward Voltage

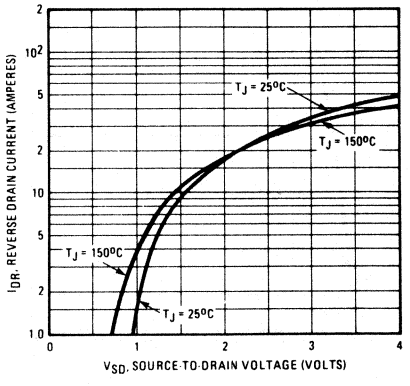


Fig. 8 – Breakdown Voltage Vs. Temperature

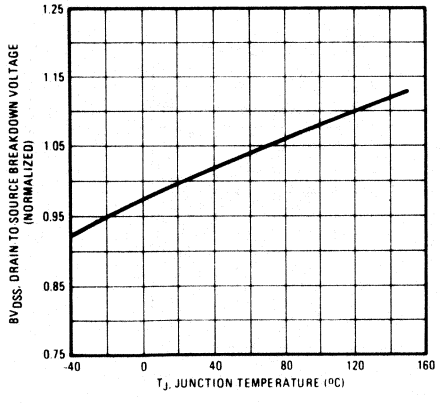
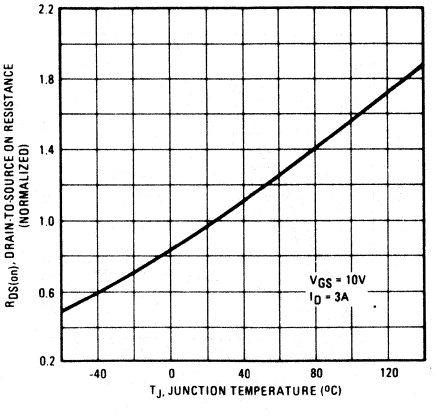


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

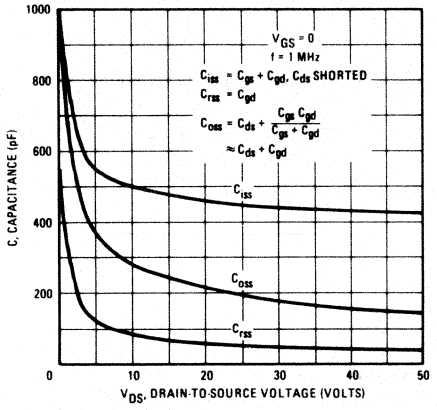


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

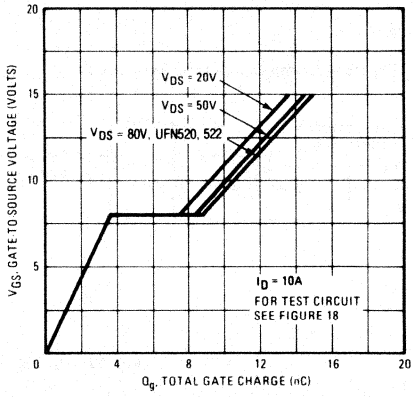


Fig. 12 – Typical On-Resistance Vs. Drain Current

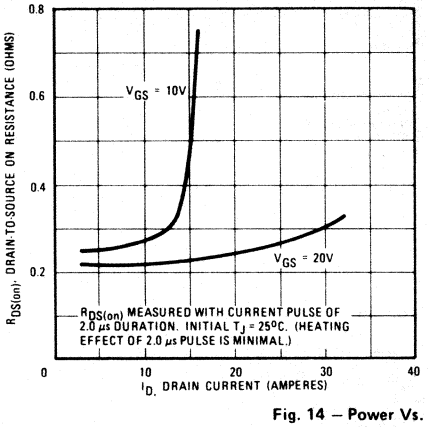


Fig. 13 – Maximum Drain Current Vs. Case Temperature

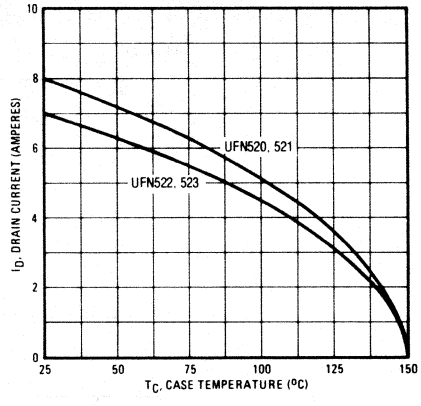


Fig. 14 – Power Vs. Temperature Derating Curve

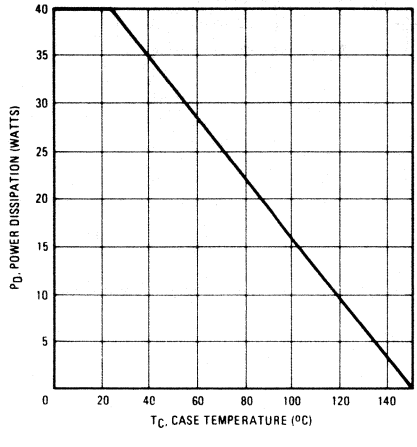


Fig. 15 – Clamped Inductive Test Circuit

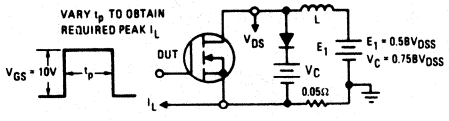


Fig. 16 – Clamped Inductive Waveforms

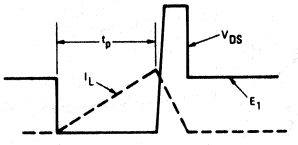


Fig. 17 – Switching Time Test Circuit

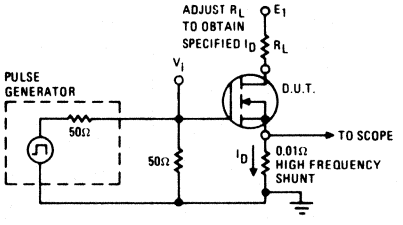
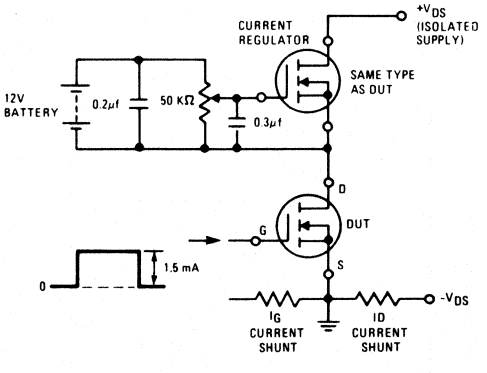


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

100 Volt, 0.18 Ohm N-Channel

UFN530
UFN531
UFN532
UFN533

3

FEATURES

- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

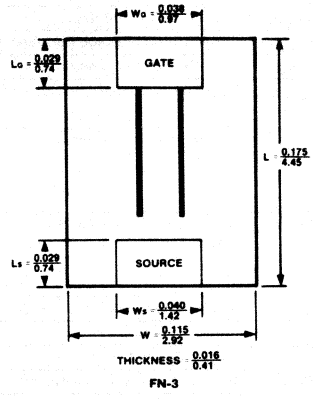
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

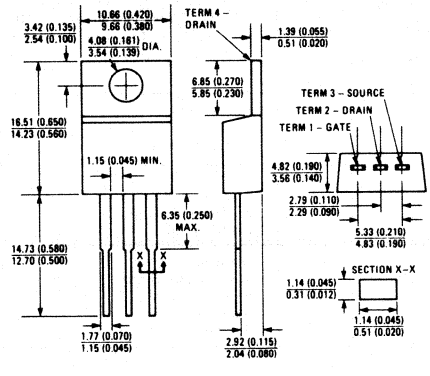
Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN530	100V	0.18Ω	14A
UFN531	60V	0.18Ω	14A
UFN532	100V	0.25Ω	12A
UFN533	60V	0.25Ω	12A



FN-3

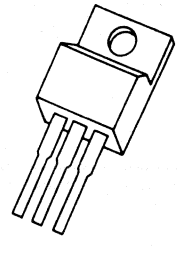
MECHANICAL SPECIFICATIONS

UFN530 UFN531 UFN532 UFN533



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

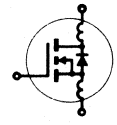
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN530	UFN531	UFN532	UFN533	Units
V_{DS}	Drain - Source Voltage ①	100	60	100	60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	100	60	100	60	V
I_D @ T_C = 25°C	Continuous Drain Current	14	14	12	12	A
I_D @ T_C = 100°C	Continuous Drain Current	9.0	9.0	8.0	8.0	A
I_{DM}	Pulsed Drain Current ③	56	56	48	48	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	75 (See Fig. 14)				W
	Linear Derating Factor	0.6 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	56	(See Fig. 15 and 16) L = 100μH 56	48	48	A
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN530 UFN532	100	–	–	V	V_{GS} = 0V
		UFN531 UFN533	60	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN530 UFN531	14	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFN532 UFN533	12	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN530 UFN531	–	0.14	0.18	Ω	V_{GS} = 10V, I_D = 8.0A
		UFN532 UFN533	–	0.20	0.25	Ω	
g_{fs}	Forward Transconductance ②	ALL	4.0	5.5	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 8.0A
C_{iss}	Input Capacitance	ALL	–	600	800	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	300	500	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	100	150	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	30	ns	V_{DD} ≈ 36V, I_D = 8.0A, Z_o = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	75	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	40	ns	
t_f	Fall Time	ALL	–	–	45	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	18	30	nC	V_{GS} = 10V, I_D = 18A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	9.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	9.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.67	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN530 UFN531	–	–	14	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		UFN532 UFN533	–	–	12	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN530 UFN531	–	–	56	A	
		UFN532 UFN533	–	–	48	A	
V_{SD}	Diode Forward Voltage ②	UFN530 UFN531	–	–	2.5	V	T_C = 25°C, I_S = 14A, V_{GS} = 0V
		UFN532 UFN533	–	–	2.3	V	T_C = 25°C, I_S = 12A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	360	–	ns	T_J = 150°C, I_F = 14A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	2.1	–	μC	T_J = 150°C, I_F = 14A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

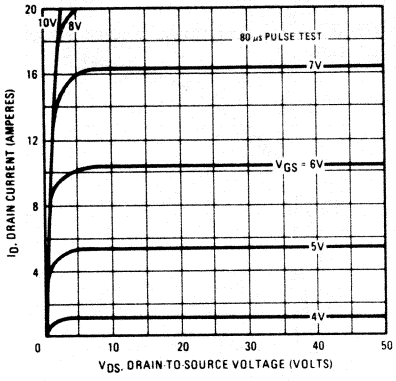


Fig. 2 – Typical Transfer Characteristics

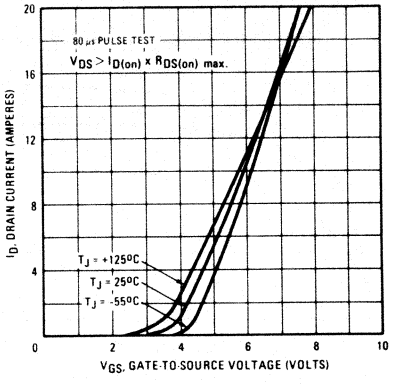


Fig. 3 – Typical Saturation Characteristics

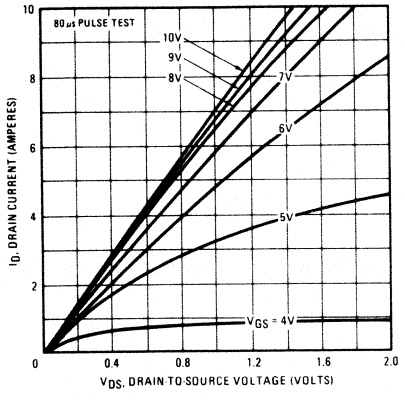


Fig. 4 – Maximum Safe Operating Area

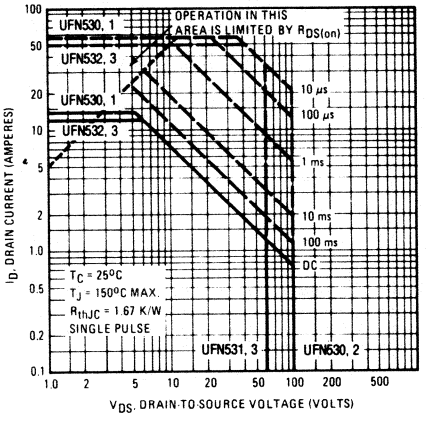


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

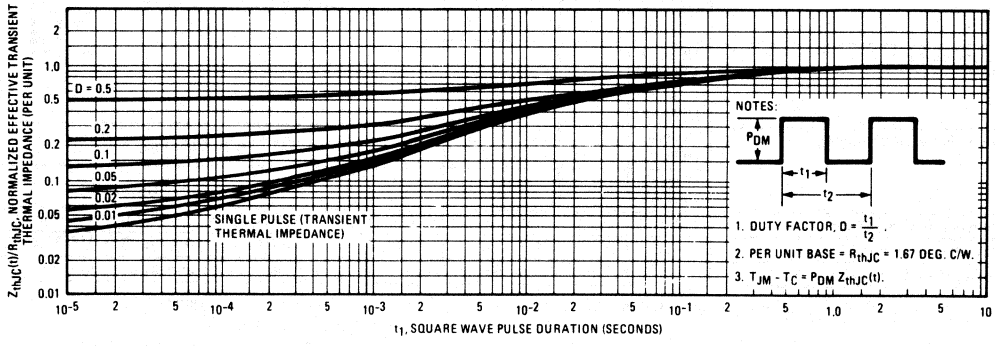


Fig. 6 – Typical Transconductance Vs. Drain Current

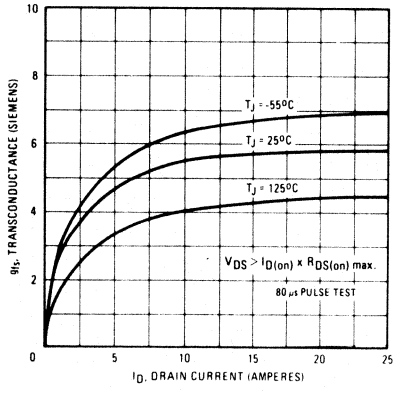


Fig. 7 – Typical Source-Drain Diode Forward Voltage

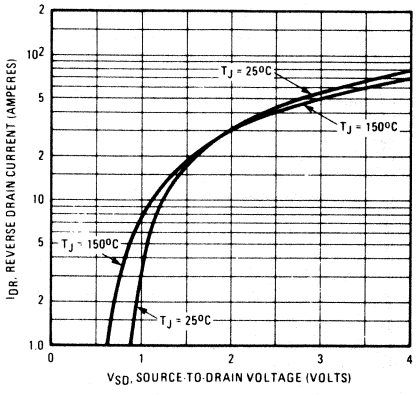


Fig. 8 – Breakdown Voltage Vs. Temperature

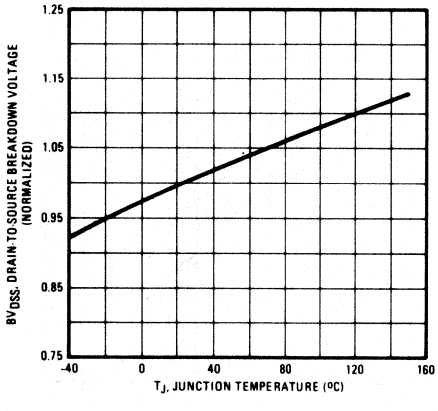
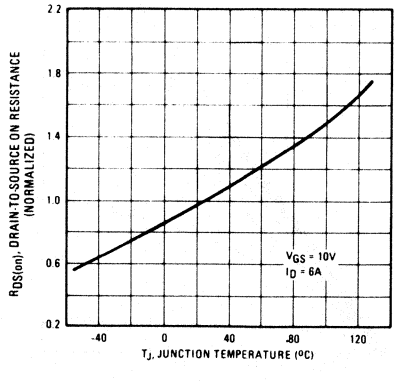


Fig. 9 – Normalized On-Resistance Vs. Temperature



3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

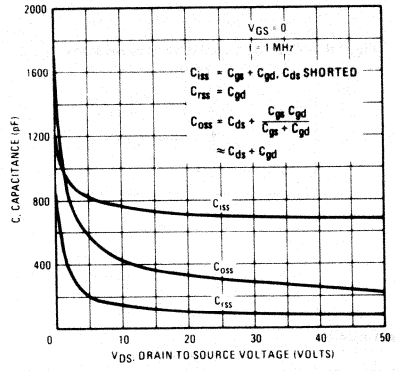


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

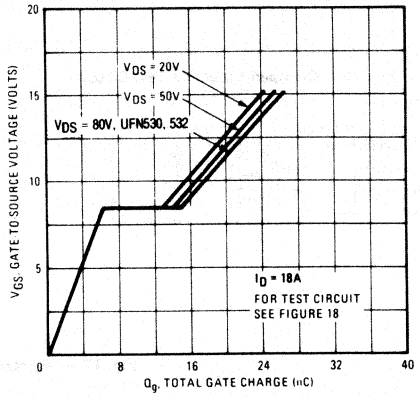


Fig. 12 – Typical On-Resistance Vs. Drain Current

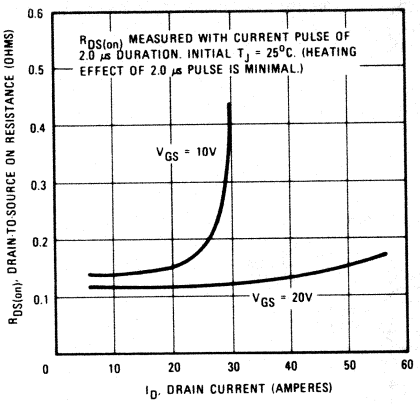


Fig. 13 – Maximum Drain Current Vs. Case Temperature

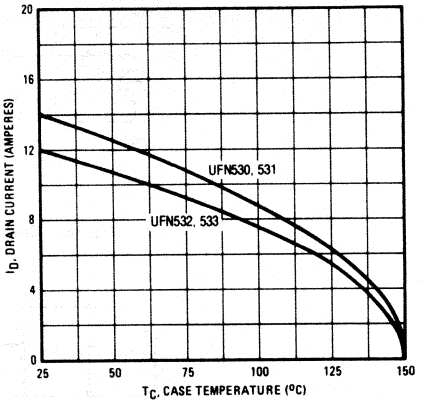
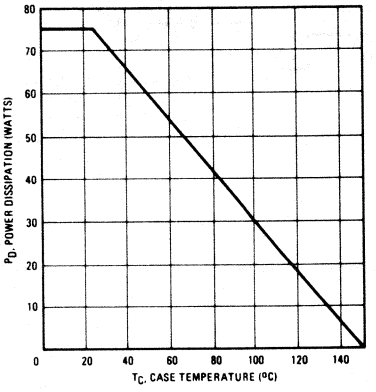


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

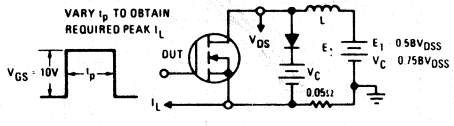


Fig. 16 – Clamped Inductive Waveforms

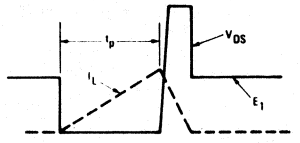


Fig. 17 – Switching Time Test Circuit

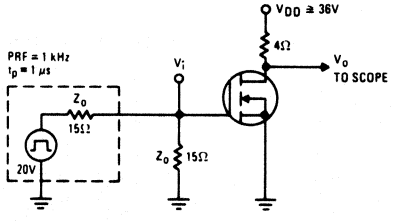
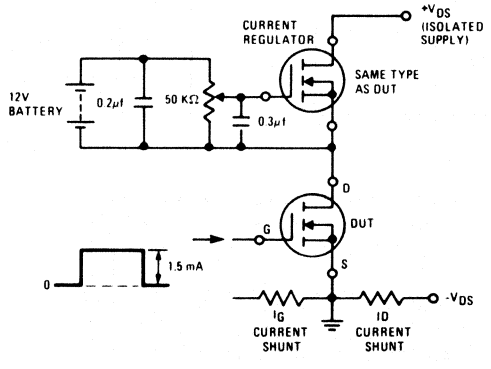


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

100 Volt, 0.085 Ohm N-Channel

UFN540
UFN541
UFN542
UFN543

3

FEATURES

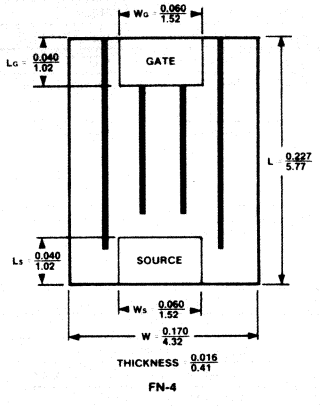
- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

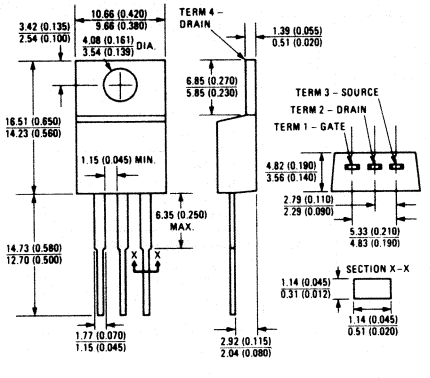


PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN540	100V	0.085Ω	27A
UFN541	60V	0.085Ω	27A
UFN542	100V	0.11Ω	24A
UFN543	60V	0.11Ω	24A

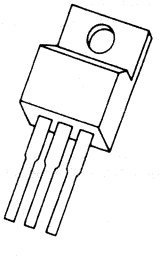
MECHANICAL SPECIFICATIONS

UFN540 UFN541 UFN542 UFN543



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

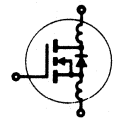
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN540	UFN541	UFN542	UFN543	Units
V_{DS}	Drain - Source Voltage ①	100	60	100	60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	100	60	100	60	V
I_D @ T_C = 25°C	Continuous Drain Current	27	27	24	24	A
I_D @ T_C = 100°C	Continuous Drain Current	17	17	15	15	A
I_{DM}	Pulsed Drain Current ③	108	108	96	96	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	125 (See Fig. 14)				W
	Linear Derating Factor	1.0 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	108	(See Fig. 15 and 16) L = 100μH 108	96	96	A
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN540 UFN542	100	–	–	V	V_{GS} = 0V
		UFN541 UFN543	60	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN540 UFN541	27	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN542 UFN543	24	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN540 UFN541	–	0.07	0.085	Ω	V_{GS} = 10V, I_D = 15A
		UFN542 UFN543	–	0.09	0.11	Ω	
g_{fs}	Forward Transconductance ②	ALL	6.0	10	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 15A
C_{iss}	Input Capacitance	ALL	–	1275	1600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	550	800	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	160	300	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	16	30	ns	V_{DD} ≈ 30V, I_D = 15A, Z_o = 4.7Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	27	60	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	38	80	ns	
t_f	Fall Time	ALL	–	14	30	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	38	60	nC	V_{GS} = 10V, I_D = 34A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	17	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	21	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.0	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN540 UFN541	–	–	27	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN542 UFN543	–	–	24	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN540 UFN541	–	–	108	A	
		UFN542 UFN543	–	–	96	A	
V_{SD}	Diode Forward Voltage ②	UFN540 UFN541	–	–	2.5	V	T_C = 25°C, I_S = 27A, V_{GS} = 0V
		UFN542 UFN543	–	–	2.3	V	T_C = 25°C, I_S = 24A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	500	–	ns	T_J = 150°C, I_F = 27A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	2.9	–	μC	T_J = 150°C, I_F = 27A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

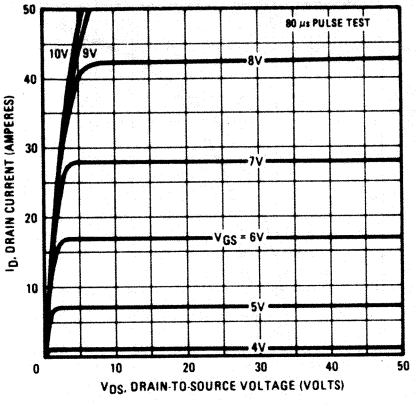


Fig. 2 – Typical Transfer Characteristics

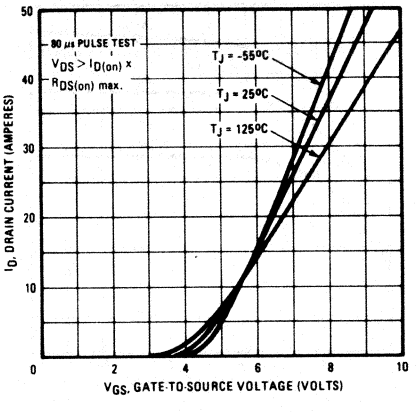


Fig. 3 – Typical Saturation Characteristics

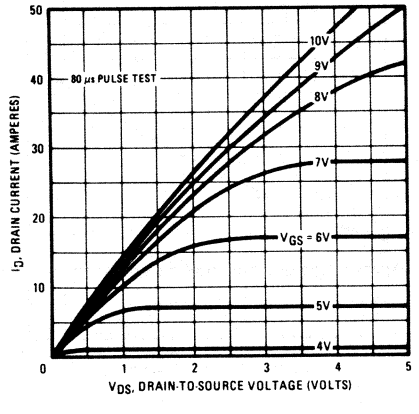
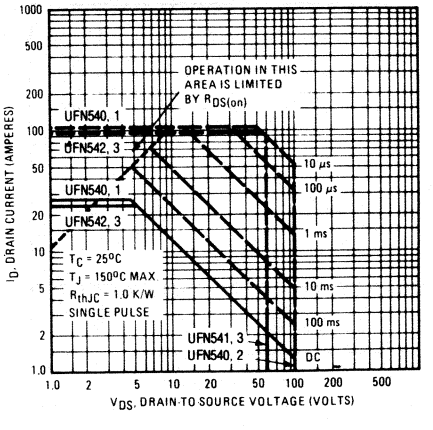


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

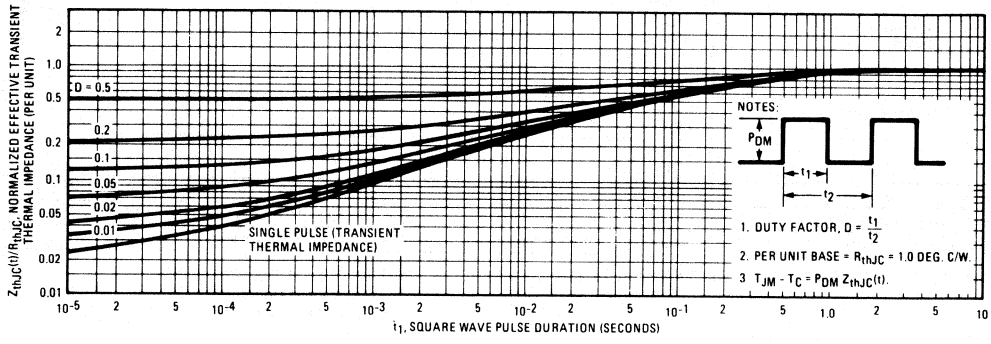


Fig. 6 – Typical Transconductance Vs. Drain Current

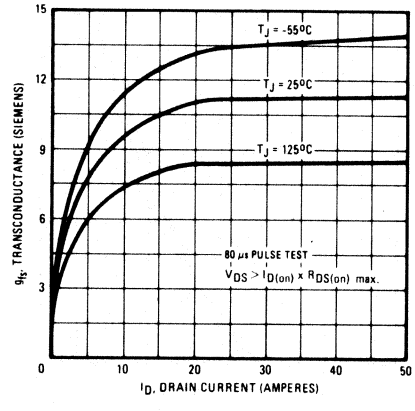


Fig. 7 – Typical Source-Drain Diode Forward Voltage

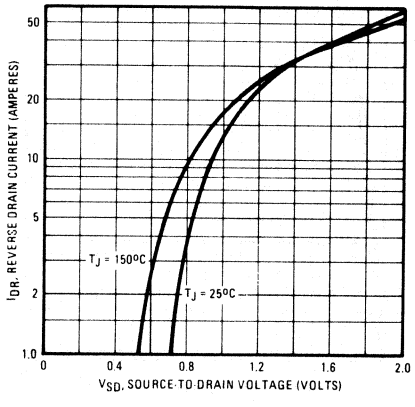


Fig. 8 – Breakdown Voltage Vs. Temperature

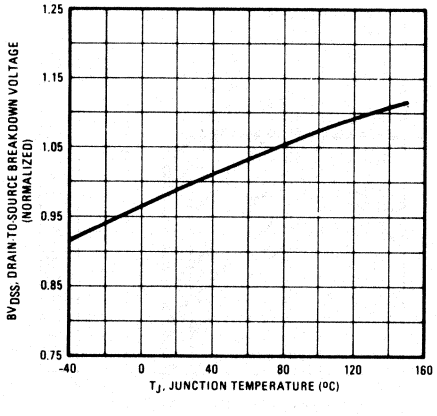
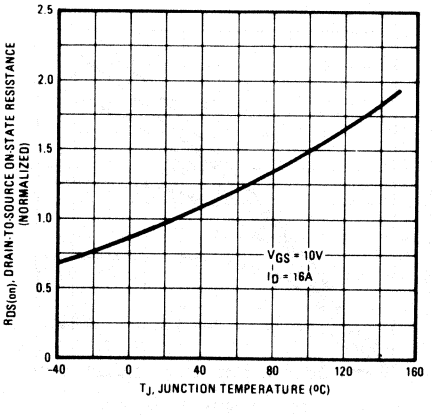


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

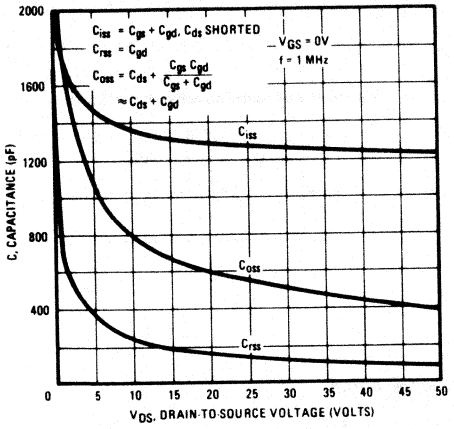


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

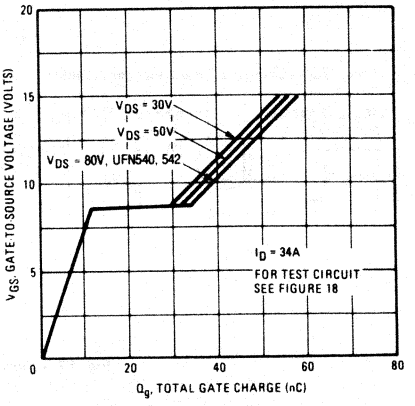


Fig. 12 – Typical On-Resistance Vs. Drain Current

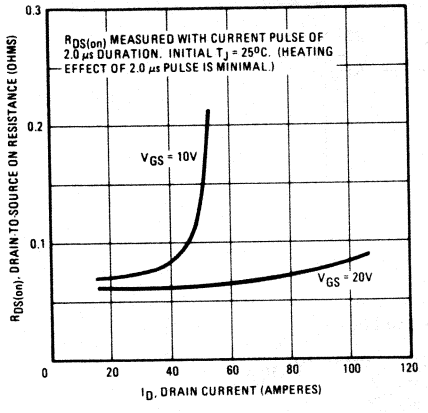


Fig. 13 – Maximum Drain Current Vs. Case Temperature

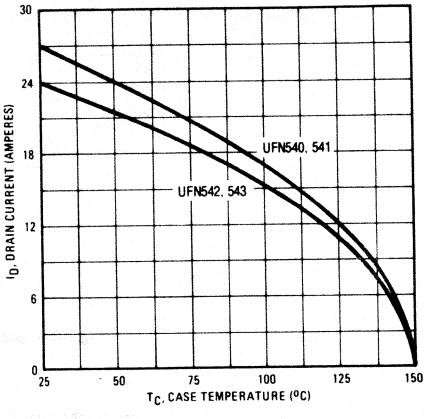
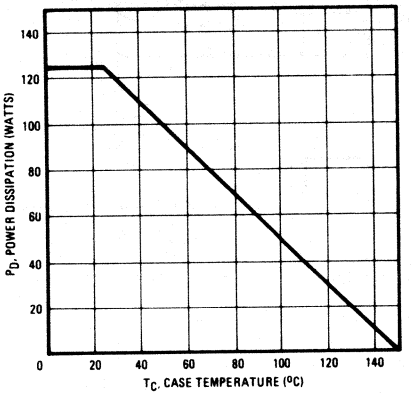


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

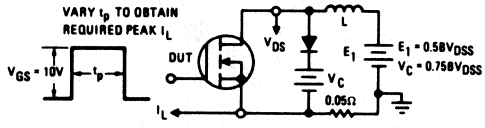


Fig. 16 – Clamped Inductive Waveforms

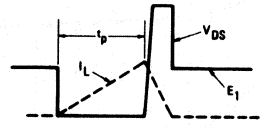


Fig. 17 – Switching Time Test Circuit

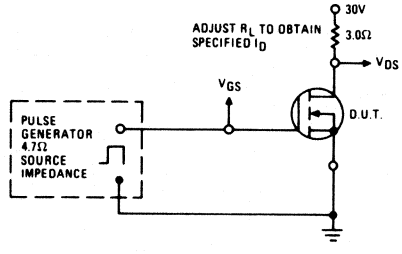
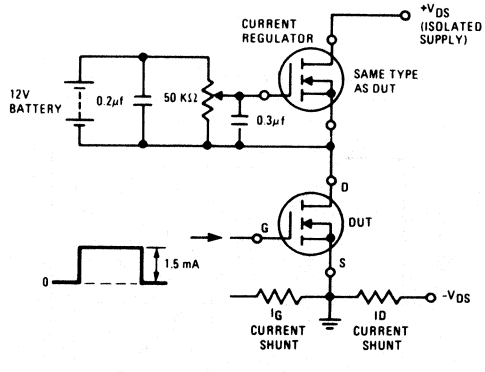


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

200 Volt, 1.5 Ohm
N-Channel

UFN610
UFN611
UFN612
UFN613

3

FEATURES

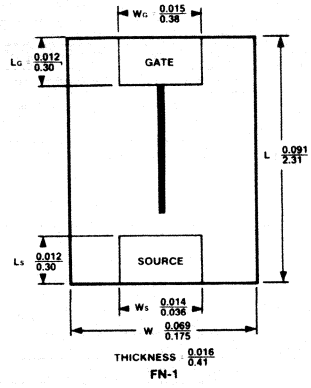
- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

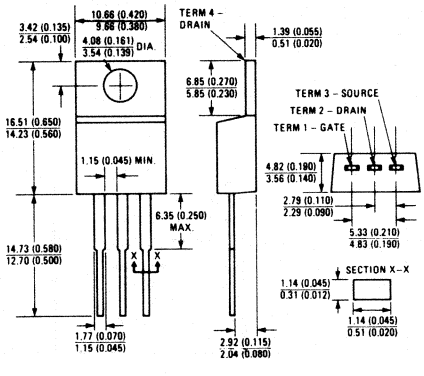


PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN610	200V	1.5Ω	2.5A
UFN611	150V	1.5Ω	2.5A
UFN612	200V	2.4Ω	2.0A
UFN613	150V	2.4Ω	2.0A

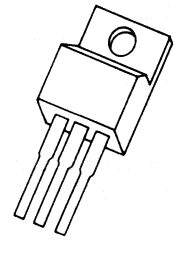
MECHANICAL SPECIFICATIONS

UFN610 UFN611 UFN612 UFN613



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

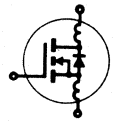
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN610	UFN611	UFN612	UFN613	Units
V_{DS}	Drain - Source Voltage ①	200	150	200	150	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	200	150	200	150	V
I_D @ T_C = 25°C	Continuous Drain Current	2.5	2.5	2.0	2.0	A
I_D @ T_C = 100°C	Continuous Drain Current	1.5	1.5	1.25	1.25	A
I_{DM}	Pulsed Drain Current ③	10	10	8.0	8.0	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	20 (See Fig. 14)				W
	Linear Derating Factor	0.16 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		10	10	8.0	8.0	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN610 UFN612	200	–	–	V	V_{GS} = 0V
		UFN611 UFN613	150	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN610 UFN611	2.5	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN612 UFN613	2.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN610 UFN611	–	1.0	1.5	Ω	V_{GS} = 10V, I_D = 1.25A
		UFN612 UFN613	–	1.5	2.4	Ω	
g_{fs}	Forward Transconductance ②	ALL	0.8	1.3	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 1.25A
C_{iss}	Input Capacitance	ALL	–	135	150	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	60	80	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	16	25	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	8.0	15	ns	V_{DD} = 0.5 BV_{DSS}, I_D = 1.25A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	15	25	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	10	15	ns	
t_f	Fall Time	ALL	–	8.0	15	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	5.0	7.5	nC	V_{GS} = 10V, I_D = 3.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	2.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	3.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	6.4	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN610 UFN611	—	—	2.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		UFN612 UFN613	—	—	2.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN610 UFN611	—	—	10	A	
		UFN612 UFN613	—	—	8.0	A	
V_{SD}	Diode Forward Voltage ②	UFN610 UFN611	—	—	2.0	V	T_C = 25°C, I_S = 2.5A, V_{GS} = 0V
		UFN612 UFN613	—	—	1.8	V	T_C = 25°C, I_S = 2.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	290	—	ns	T_J = 150°C, I_F = 2.5A, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	2.0	—	μC	T_J = 150°C, I_F = 2.5A, dI_F/dt = 100 A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 — Typical Output Characteristics

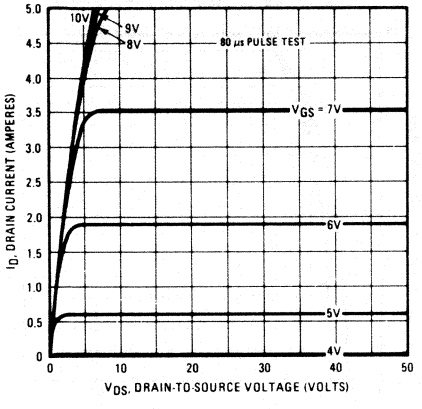


Fig. 2 — Typical Transfer Characteristics

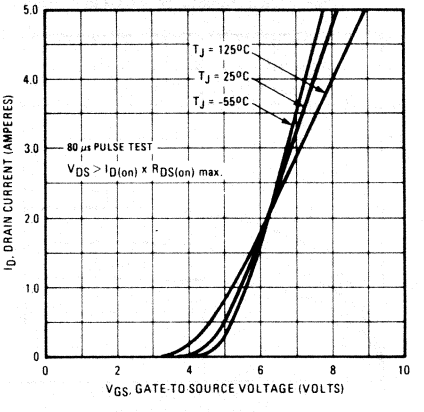


Fig. 3 — Typical Saturation Characteristics

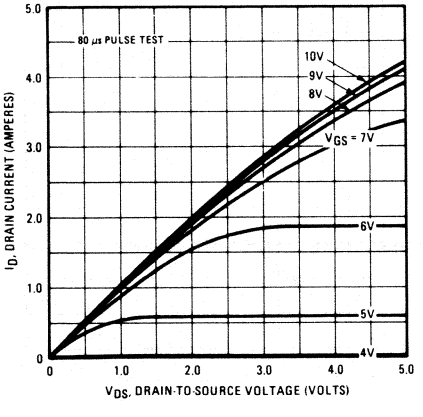
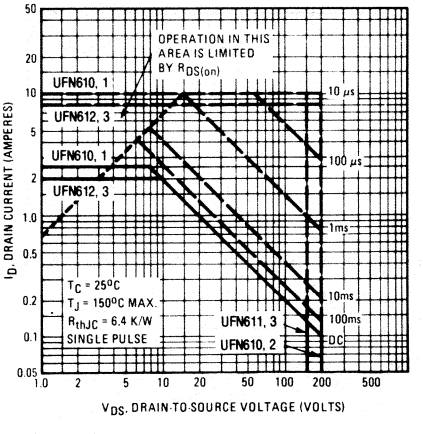


Fig. 4 — Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

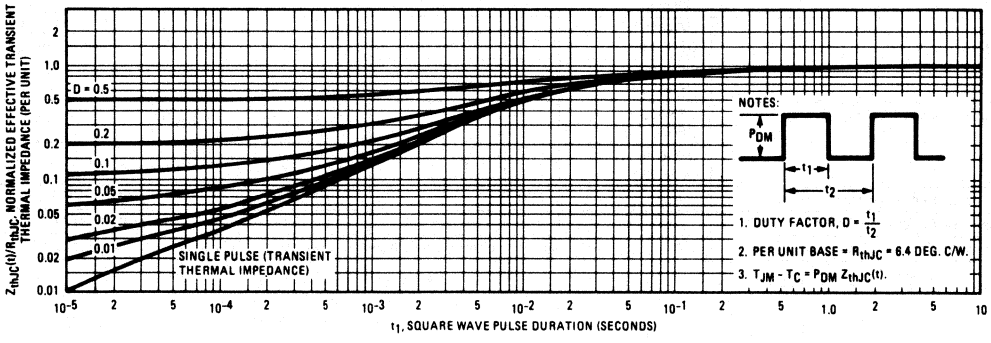


Fig. 6 – Typical Transconductance Vs. Drain Current

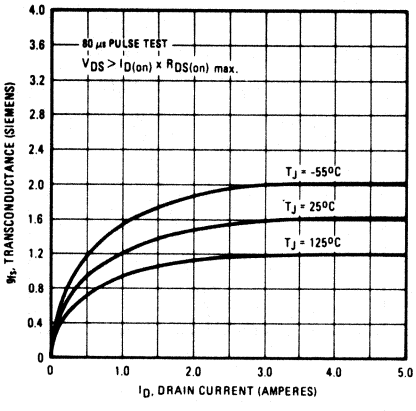


Fig. 7 – Typical Source-Drain Diode Forward Voltage

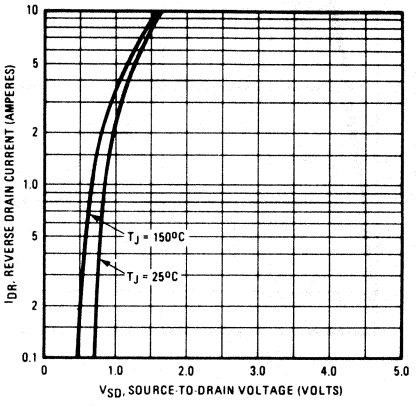


Fig. 8 – Breakdown Voltage Vs. Temperature

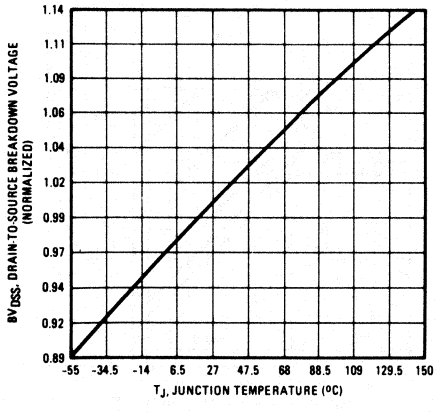


Fig. 9 – Normalized On-Resistance Vs. Temperature

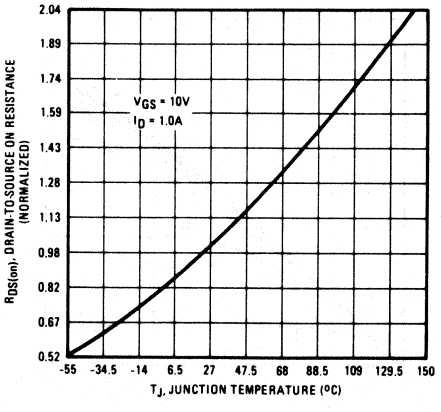


Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

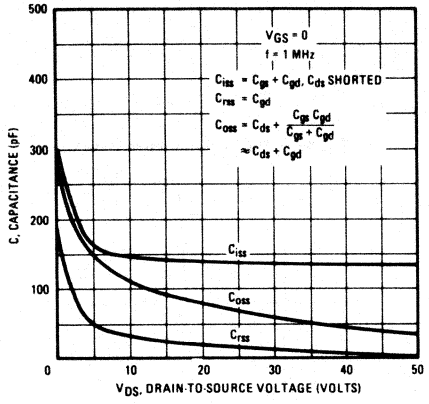


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

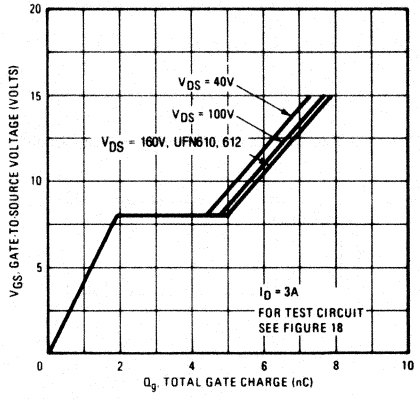


Fig. 12 – Typical On-Resistance Vs. Drain Current

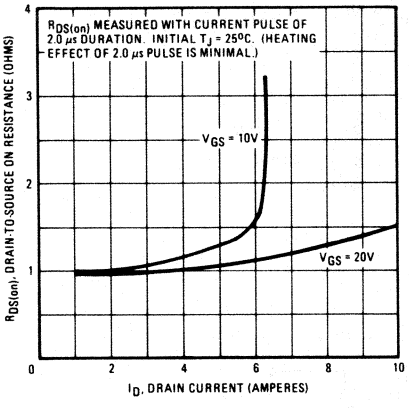


Fig. 13 – Maximum Drain Current Vs. Case Temperature

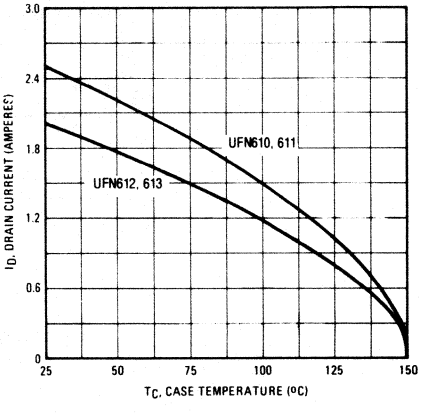


Fig. 14 – Power Vs. Temperature Derating Curve

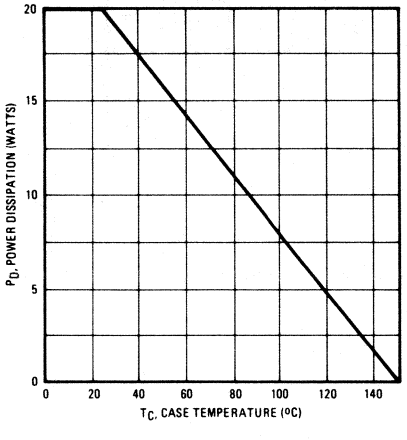


Fig. 15 – Clamped Inductive Test Circuit

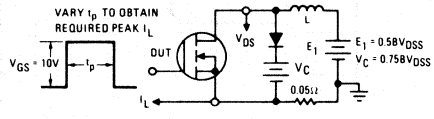


Fig. 16 – Clamped Inductive Waveforms

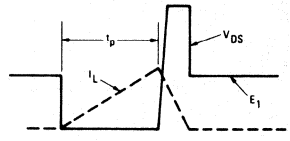


Fig. 17 – Switching Time Test Circuit

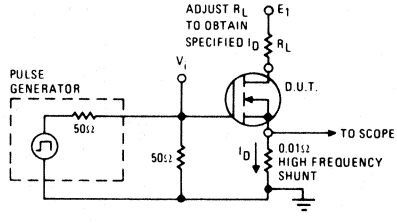
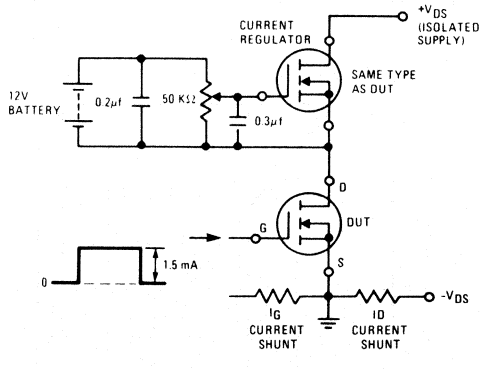


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

200 Volt, 0.8 Ohm N-Channel

UFN620
UFN621
UFN622
UFN623

3

FEATURES

- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

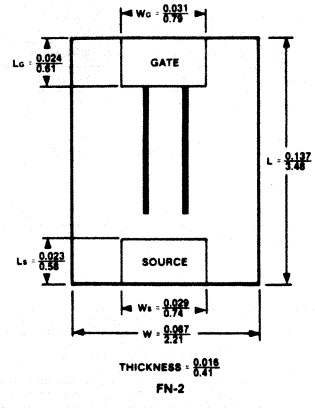
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

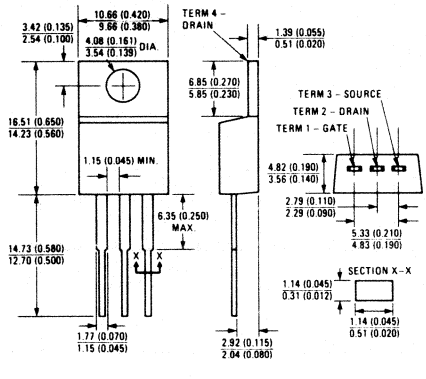
PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN620	200V	0.8Ω	5.0A
UFN621	150V	0.8Ω	5.0A
UFN622	200V	1.2Ω	4.0A
UFN623	150V	1.2Ω	4.0A



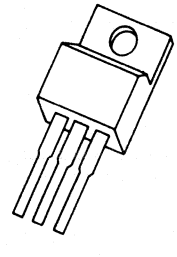
MECHANICAL SPECIFICATIONS

UFN620 UFN621 UFN622 UFN623



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

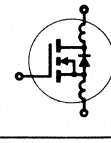
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN620	UFN621	UFN622	UFN623	Units
V_{DS}	Drain - Source Voltage ①	200	150	200	150	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	200	150	200	150	V
I_D @ T_C = 25°C	Continuous Drain Current	5.0	5.0	4.0	4.0	A
I_D @ T_C = 100°C	Continuous Drain Current	3.0	3.0	2.5	2.5	A
I_{DM}	Pulsed Drain Current ③	20	20	16	16	A
V_{GS}	Gate - Source Voltage	± 20				V
P_D @ T_C = 25°C	Max. Power Dissipation	40 (See Fig. 14)				W
	Linear Derating Factor	0.32 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		20	20	16	16	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN620 UFN622	200	–	–	V	V_{GS} = 0V
		UFN621 UFN623	150	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN620 UFN621	5.0	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN622 UFN623	4.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN620 UFN621	–	0.5	0.8	Ω	V_{GS} = 10V, I_D = 2.5A
		UFN622 UFN623	–	0.8	1.2	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.3	2.5	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 2.5A
C_{iss}	Input Capacitance	ALL	–	450	600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	150	300	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	40	80	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	20	40	ns	V_{DD} ≈ 2.5 BV_{DSS}, I_D = 2.5A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	30	60	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	50	100	ns	
t_f	Fall Time	ALL	–	30	60	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	11	15	nC	V_{GS} = 50V, I_D = 6.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	5.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	6.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	3.12	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN620 UFN621	—	—	5.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN622 UFN623	—	—	4.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN620 UFN621	—	—	20	A	
		UFN622 UFN623	—	—	16	A	
V_{SD}	Diode Forward Voltage ②	UFN620 UFN621	—	—	1.8	V	T_C = 25°C, I_S = 5.0A, V_{GS} = 0V
		UFN622 UFN623	—	—	1.4	V	T_C = 25°C, I_S = 4.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	350	—	ns	T_J = 150°C, I_F = 5.0A, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	2.3	—	μC	T_J = 150°C, I_F = 5.0A, dI_F/dt = 100 A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 — Typical Output Characteristics

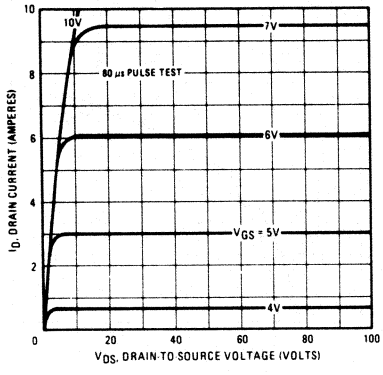


Fig. 2 — Typical Transfer Characteristics

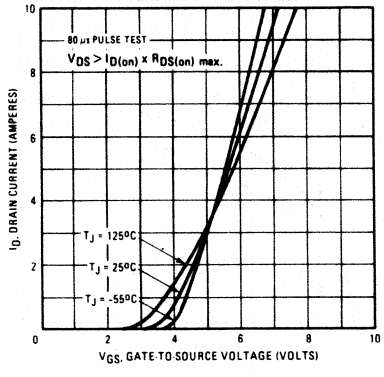


Fig. 3 — Typical Saturation Characteristics

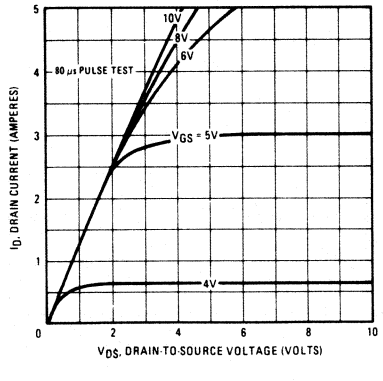


Fig. 4 — Maximum Safe Operating Area

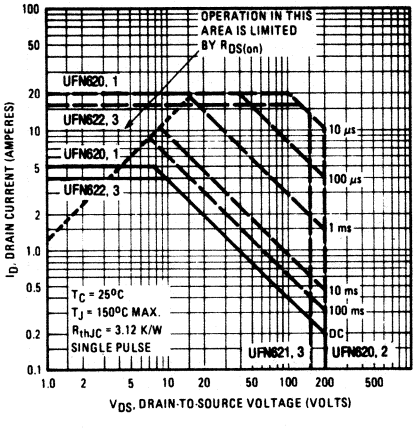


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

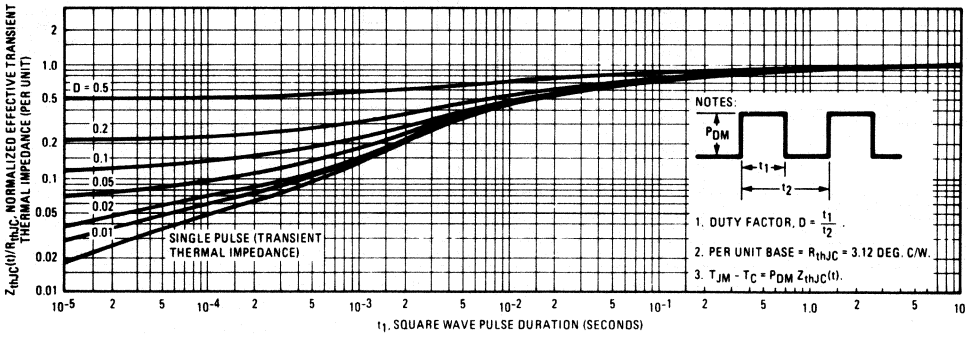


Fig. 6 – Typical Transconductance Vs. Drain Current

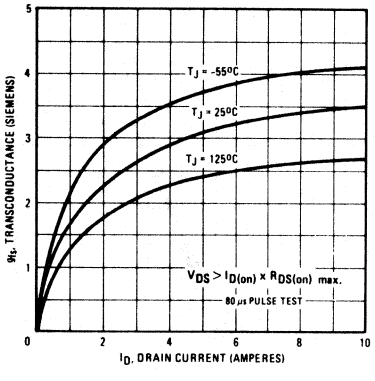


Fig. 7 – Typical Source-Drain Diode Forward Voltage

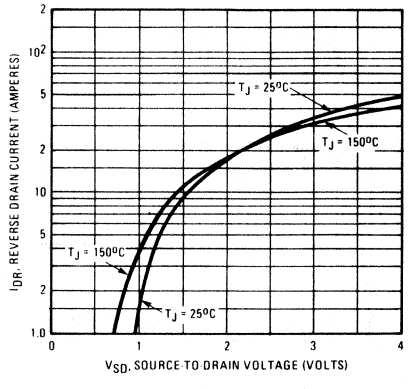


Fig. 8 – Breakdown Voltage Vs. Temperature

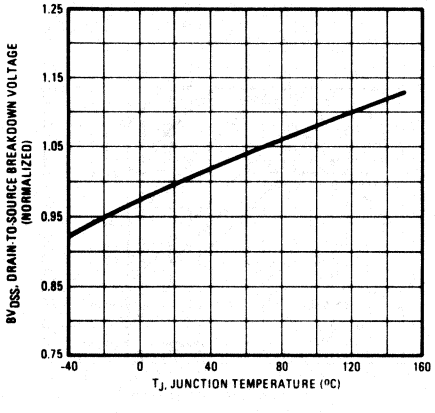
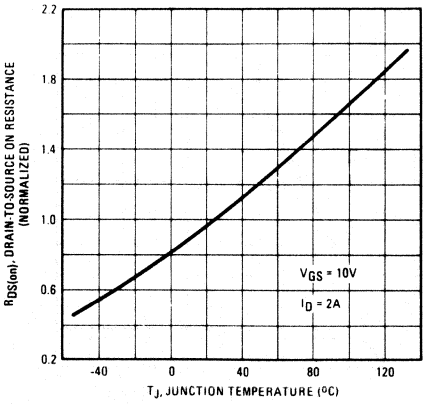


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

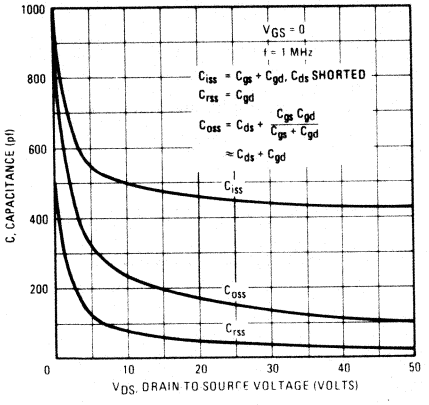


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

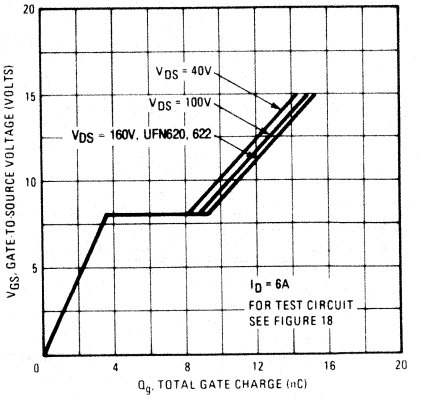


Fig. 12 – Typical On-Resistance Vs. Drain Current

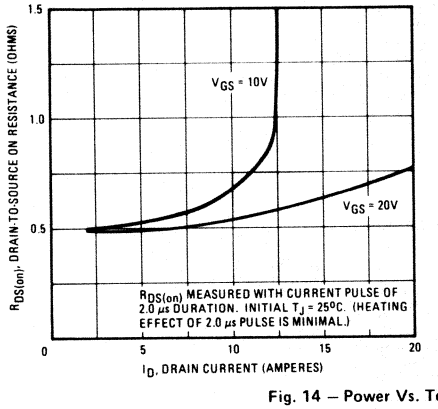


Fig. 13 – Maximum Drain Current Vs. Case Temperature

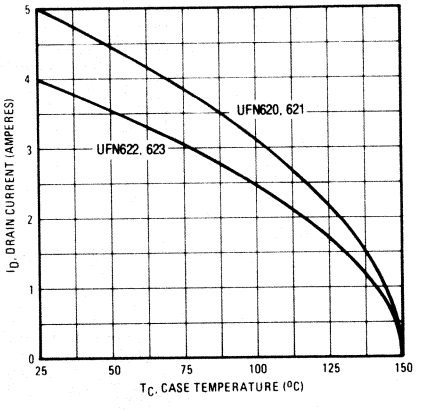


Fig. 14 – Power Vs. Temperature Derating Curve

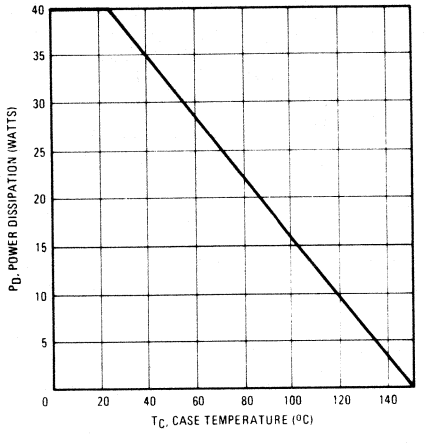


Fig. 15 – Clamped Inductive Test Circuit

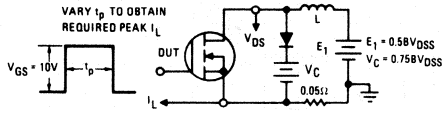


Fig. 16 – Clamped Inductive Waveforms

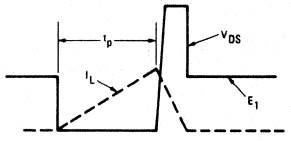


Fig. 17 – Switching Time Test Circuit

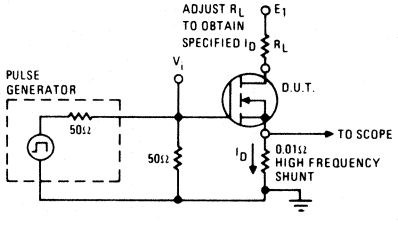
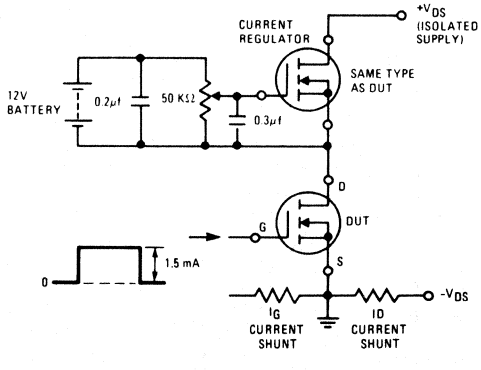


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

200 Volt, 0.4 Ohm
N-Channel

UFN630
UFN631
UFN632
UFN633

3

FEATURES

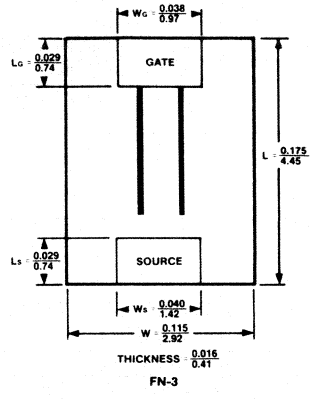
- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



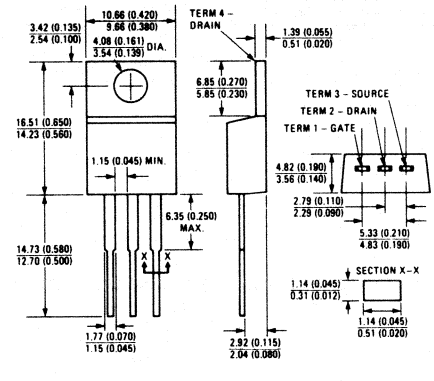
FN-3

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN630	200V	0.4Ω	9.0A
UFN631	150V	0.4Ω	9.0A
UFN632	200V	0.6Ω	8.0A
UFN633	150V	0.6Ω	8.0A

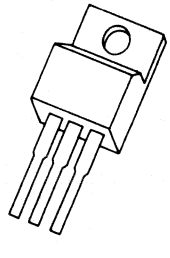
MECHANICAL SPECIFICATIONS

UFN630 UFN631 UFN632 UFN633



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

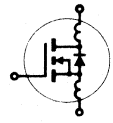
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN630	UFN631	UFN632	UFN633	Units
V_{DS}	Drain - Source Voltage ①	200	150	200	150	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	200	150	200	150	V
I_D @ T_C = 25°C	Continuous Drain Current	9.0	9.0	8.0	8.0	A
I_D @ T_C = 100°C	Continuous Drain Current	6.0	6.0	5.0	5.0	A
I_{DM}	Pulsed Drain Current ③	36	36	32	32	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	75 (See Fig. 14)				W
	Linear Derating Factor	0.6 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		36	36	32	32	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN630 UFN632	200	–	–	V	V_{GS} = 0V
		UFN631 UFN633	150	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN630 UFN631	9.0	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN632 UFN633	8.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN630 UFN631	–	0.25	0.4	Ω	V_{GS} = 10V, I_D = 5.0A
		UFN632 UFN633	–	0.4	0.6	Ω	
g_{fs}	Forward Transconductance ②	ALL	3.0	4.8	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 5.0A
C_{iss}	Input Capacitance	ALL	–	600	800	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	250	450	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	80	150	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	30	ns	V_{DD} = 90V, I_D = 5.0A, Z_o = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	50	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	50	ns	
t_f	Fall Time	ALL	–	–	40	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	19	30	nC	V_{GS} = 10V, I_D = 12A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	10	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	9.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.67	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN630 UFN631	–	–	9.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN632 UFN633	–	–	8.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN630 UFN631	–	–	36	A	
		UFN632 UFN633	–	–	32	A	
V_{SD}	Diode Forward Voltage ②	UFN630 UFN631	–	–	2.0	V	T_C = 25°C, I_S = 9.0A, V_{GS} = 0V
		UFN632 UFN633	–	–	1.8	V	T_C = 25°C, I_S = 8.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	450	–	ns	T_J = 150°C, I_F = 9.0A, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	3.0	–	μC	T_J = 150°C, I_F = 9.0A, dI_F/dt = 100 A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

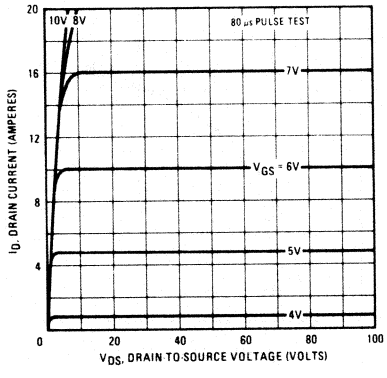


Fig. 2 – Typical Transfer Characteristics

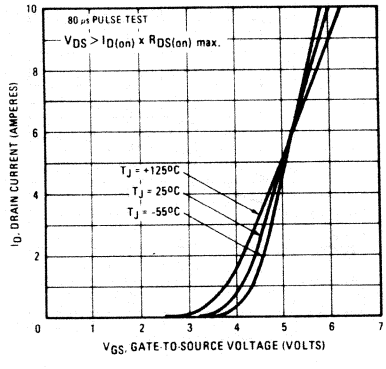


Fig. 3 – Typical Saturation Characteristics

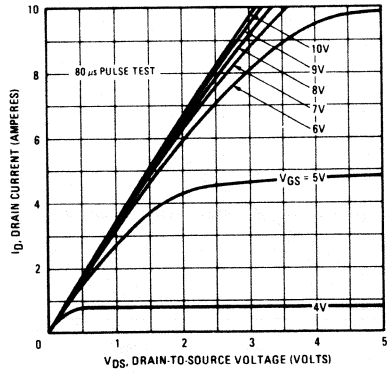
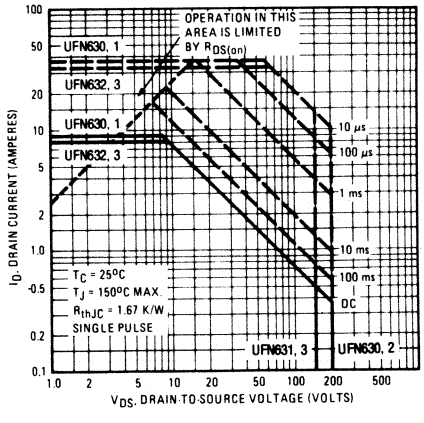


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

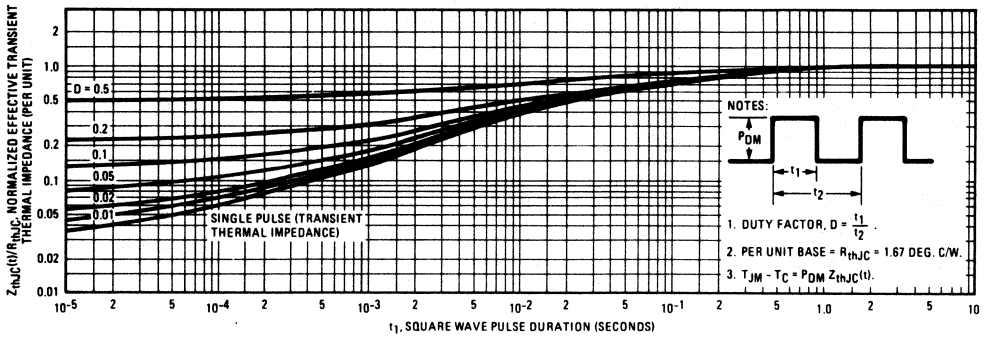


Fig. 6 – Typical Transconductance Vs. Drain Current

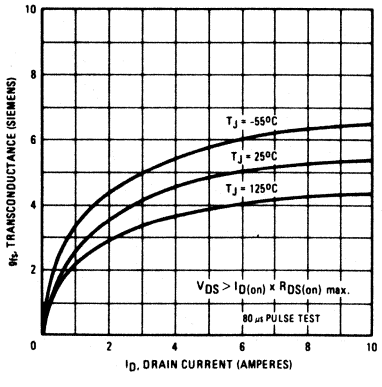


Fig. 7 – Typical Source-Drain Diode Forward Voltage

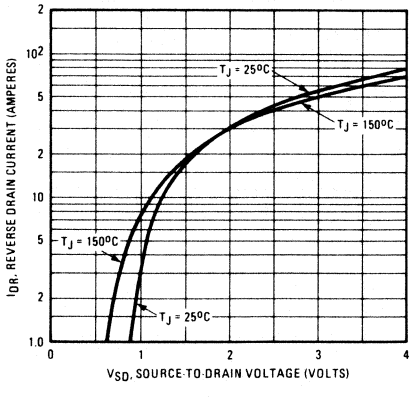


Fig. 8 – Breakdown Voltage Vs. Temperature

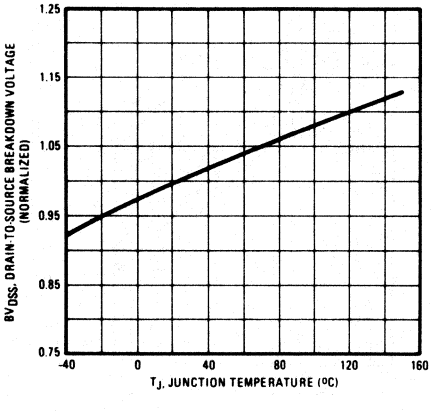
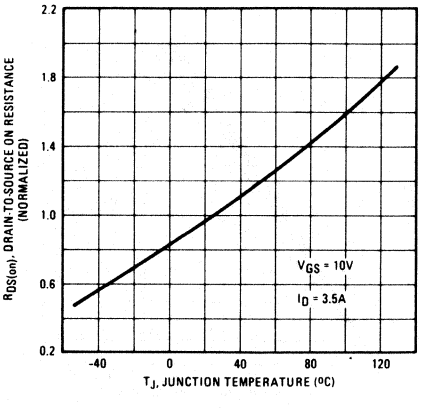


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

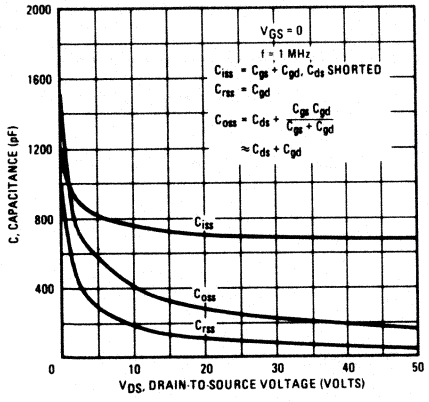


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

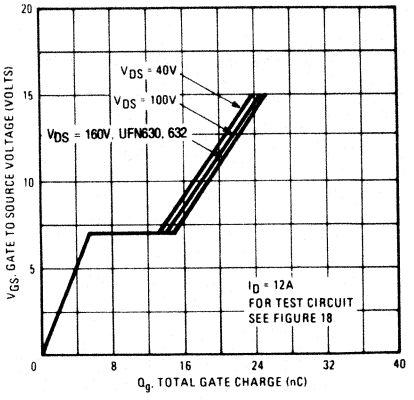


Fig. 12 – Typical On-Resistance Vs. Drain Current

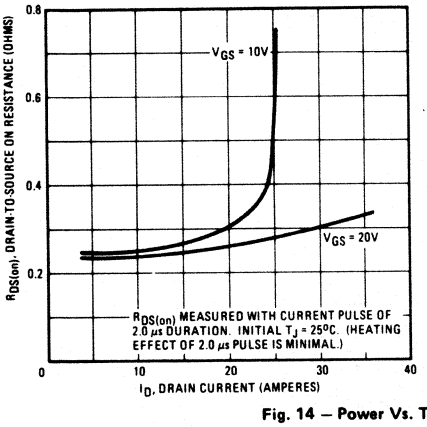


Fig. 13 – Maximum Drain Current Vs. Case Temperature

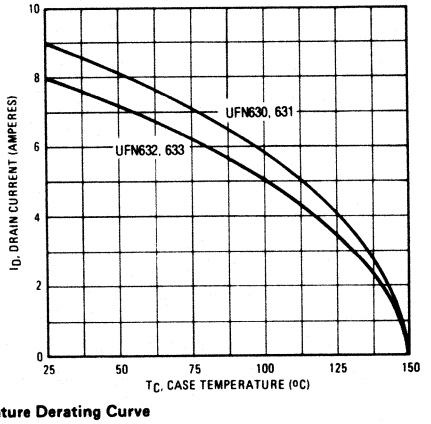


Fig. 14 – Power Vs. Temperature Derating Curve

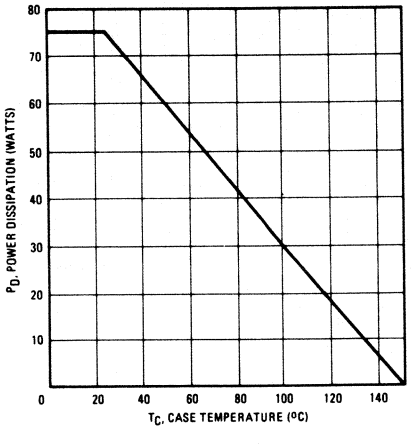


Fig. 15 – Clamped Inductive Test Circuit

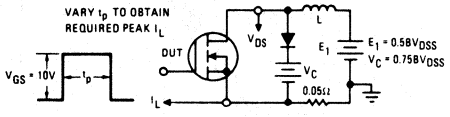


Fig. 16 – Clamped Inductive Waveforms

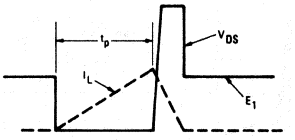


Fig. 17 – Switching Time Test Circuit

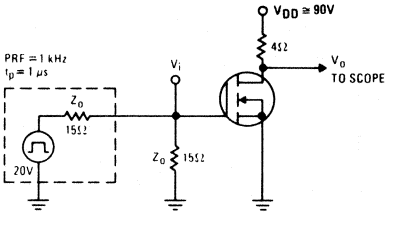
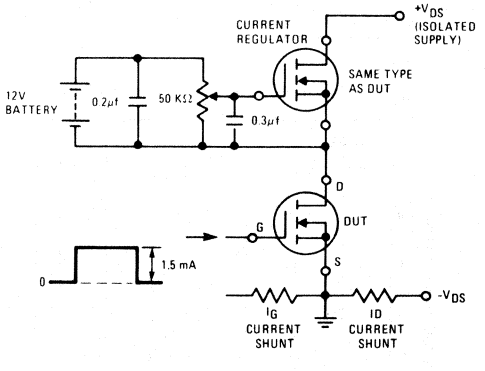


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

200 Volt, 0.2 Ohm
N-Channel

UFN640
UFN641
UFN642
UFN643

3

FEATURES

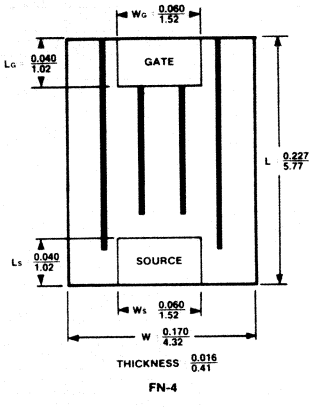
- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



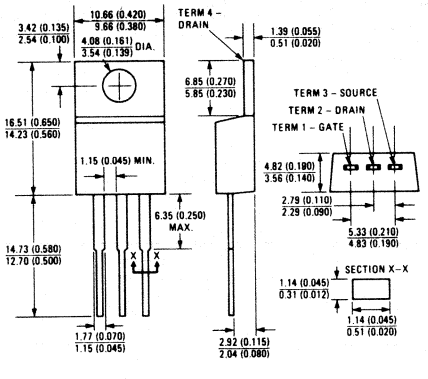
FN-4

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN640	200V	0.18Ω	18A
UFN641	150V	0.18Ω	18A
UFN642	200V	0.22Ω	16A
UFN643	150V	0.22Ω	16A

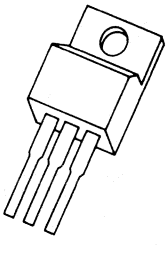
MECHANICAL SPECIFICATIONS

UFN640 UFN641 UFN642 UFN643



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

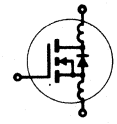
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN640	UFN641	UFN642	UFN643	Units
V_{DS}	Drain - Source Voltage ①	200	150	200	150	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	200	150	200	150	V
I_D @ T_C = 25°C	Continuous Drain Current	18	18	16	16	A
I_D @ T_C = 100°C	Continuous Drain Current	11	11	10	10	A
I_{DM}	Pulsed Drain Current ③	72	72	64	64	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	125 (See Fig. 14)				W
	Linear Derating Factor	1.0 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		72	72	64	64	
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150°C				°C
	Lead Temperature	300 (0.064 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN640 UFN642	200	–	–	V	V_{GS} = 0V
		UFN641 UFN643	150	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN640 UFN641	18	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN642 UFN643	16	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN640 UFN641	–	0.14	0.18	Ω	V_{GS} = 10V, I_D = 10A
		UFN642 UFN643	–	0.20	0.22	Ω	
g_{fs}	Forward Transconductance ②	ALL	6.0	10	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 10A
C_{iss}	Input Capacitance	ALL	–	1275	1600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	500	750	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	160	300	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	16	30	ns	V_{DD} ≈ 75V, I_D = 10A, Z_o = 4.7Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	27	60	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	40	80	ns	
t_f	Fall Time	ALL	–	31	60	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	43	60	nC	V_{GS} = 10V, I_D = 22A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	16	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	27	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.0	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN640 UFN641	–	–	18	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN642 UFN643	–	–	16	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN640 UFN641	–	–	72	A	
		UFN642 UFN643	–	–	64	A	
V_{SD}	Diode Forward Voltage ②	UFN640 UFN641	–	–	2.0	V	T_C = 25°C, I_S = 18A, V_{GS} = 0V
		UFN642 UFN643	–	–	1.9	V	T_C = 25°C, I_S = 16A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	650	–	ns	T_J = 150°C, I_F = 18A, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	4.1	–	μC	T_J = 150°C, I_F = 18A, dI_F/dt = 100 A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

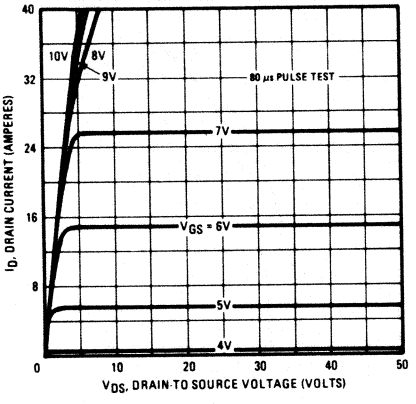


Fig. 2 – Typical Transfer Characteristics

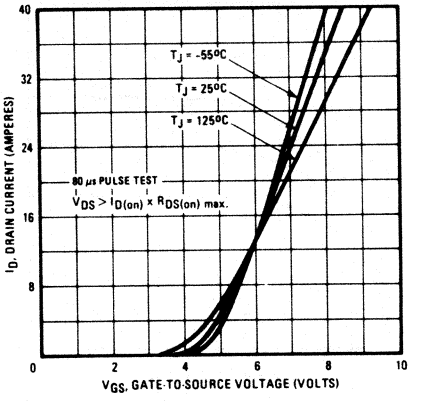


Fig. 3 – Typical Saturation Characteristics

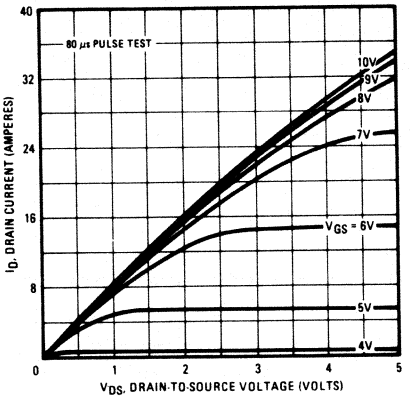
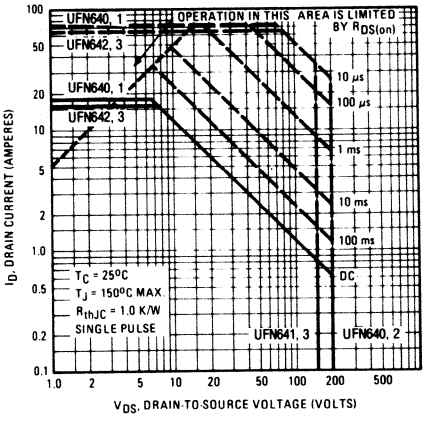


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

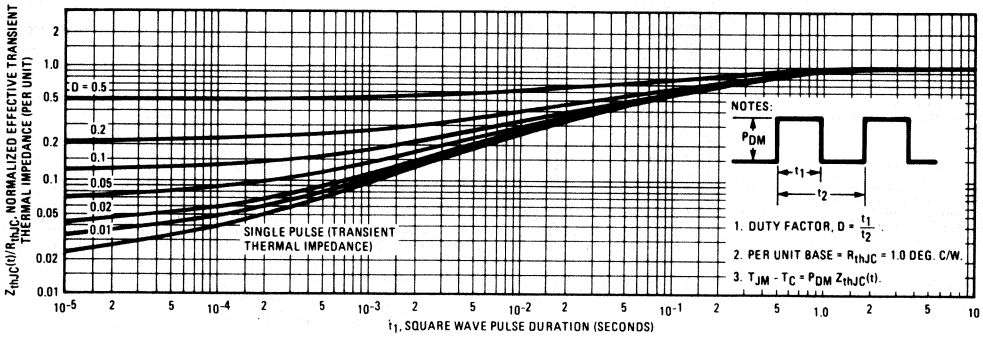


Fig. 6 — Typical Transconductance Vs. Drain Current

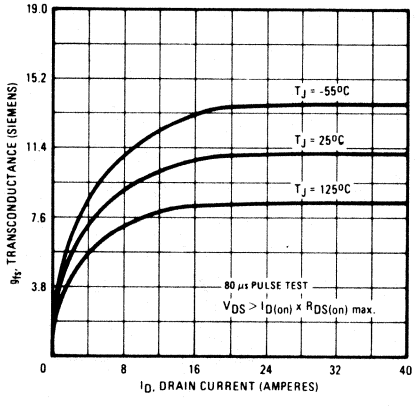


Fig. 7 — Typical Source-Drain Diode Forward Voltage

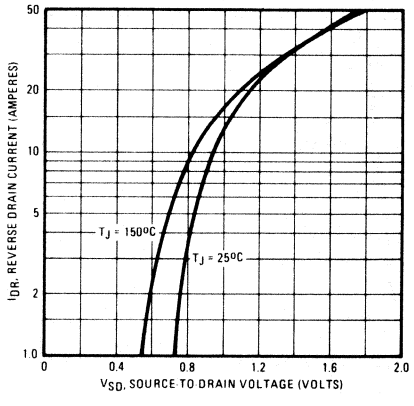


Fig. 8 — Breakdown Voltage Vs. Temperature

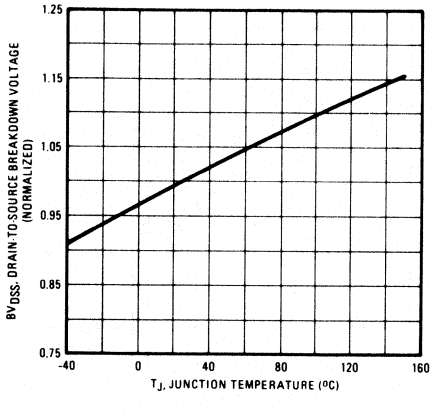
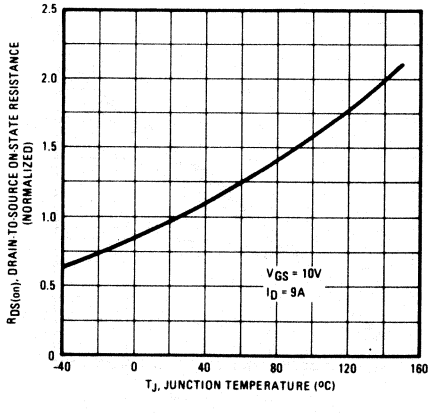


Fig. 9 — Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

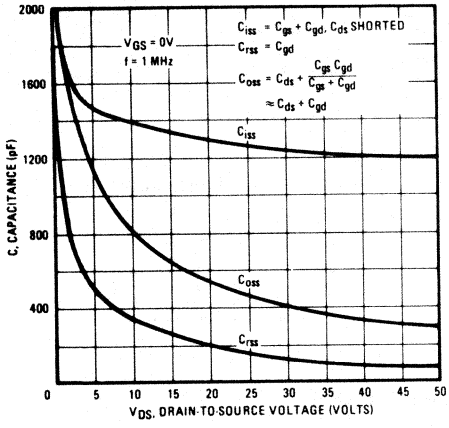


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

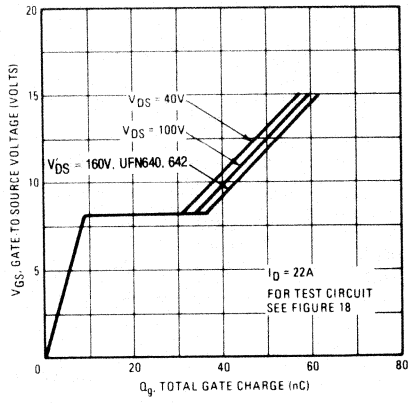


Fig. 12 – Typical On-Resistance Vs. Drain Current

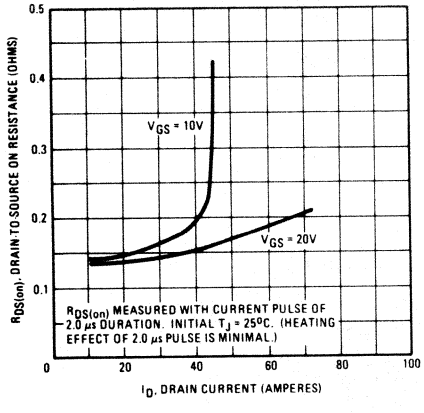


Fig. 13 – Maximum Drain Current Vs. Case Temperature

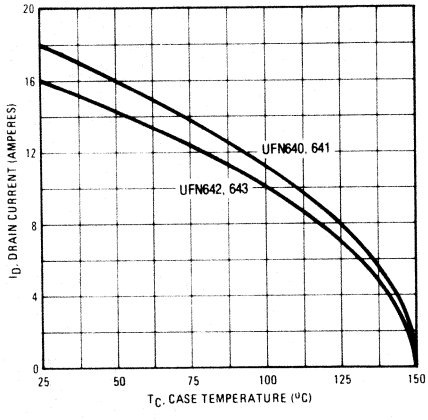
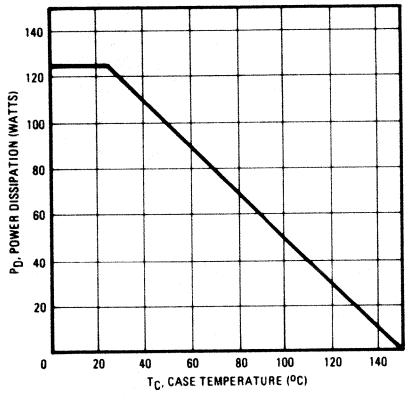


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

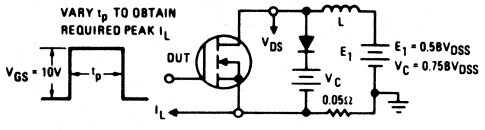


Fig. 16 – Clamped Inductive Waveforms

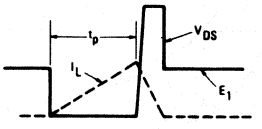


Fig. 17 – Switching Time Test Circuit

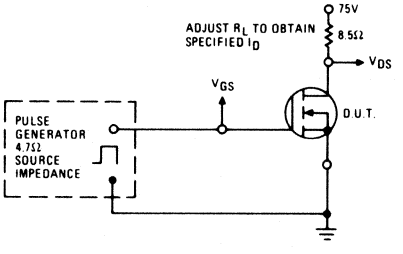
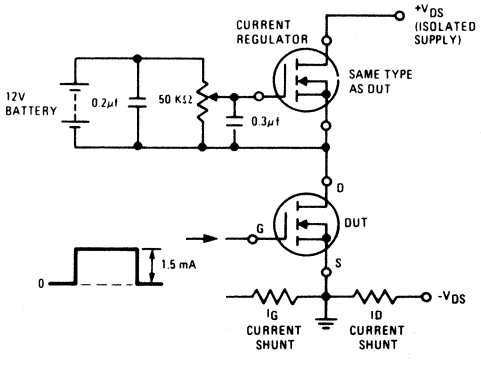


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

400 Volt, 3.6 Ohm
N-Channel

UFN710
UFN711
UFN712
UFN713

3

FEATURES

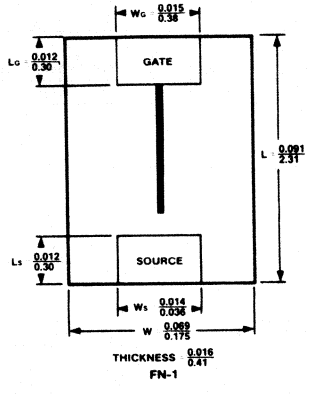
- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

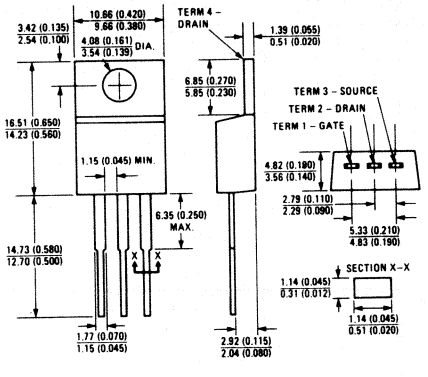


PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN710	400V	3.6Ω	1.5A
UFN711	350V	3.6Ω	1.5A
UFN712	400V	5.0Ω	1.3A
UFN713	350V	5.0Ω	1.3A

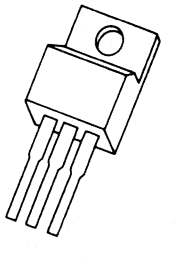
MECHANICAL SPECIFICATIONS

UFN710 UFN711 UFN712 UFN713



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

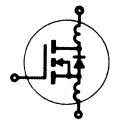
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN710	UFN711	UFN712	UFN713	Units
V_{DS}	Drain - Source Voltage ①	400	350	400	350	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	400	350	400	350	V
I_D @ T_C = 25°C	Continuous Drain Current	1.5	1.5	1.3	1.3	A
I_D @ T_C = 100°C	Continuous Drain Current	1.0	1.0	0.8	0.8	A
I_{DM}	Pulsed Drain Current ③	6.0	6.0	5.0	5.0	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	20 (See Fig. 14)				W
	Linear Derating Factor	0.16 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		6.0	6.0	5.0	5.0	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN710 UFN712	400	–	–	V	V_{GS} = 0V
		UFN711 UFN713	350	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN710 UFN711	1.5	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN712 UFN713	1.3	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN710 UFN711	–	3.3	3.6	Ω	V_{GS} = 10V, I_D = 0.8A
		UFN712 UFN713	–	3.6	5.0	Ω	
g_{fs}	Forward Transconductance ②	ALL	0.5	1.2	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 0.8A
C_{iss}	Input Capacitance	ALL	–	135	150	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	35	50	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	8.0	15	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	3.0	10	ns	V_{DD} = 0.5 BV_{DSS}, I_D = 0.8A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	10	20	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	5.0	10	ns	
t_f	Fall Time	ALL	–	8.0	15	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	6.0	7.5	nC	V_{GS} = 10V, I_D = 2.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	3.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	3.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	6.4	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN710 UFN711	–	–	1.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN712 UFN713	–	–	1.3	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN710 UFN711	–	–	6.0	A	
		UFN712 UFN713	–	–	5.0	A	
V_{SD}	Diode Forward Voltage ②	UFN710 UFN711	–	–	1.6	V	T_C = 25°C, I_S = 1.5A, V_{GS} = 0V
		UFN712 UFN713	–	–	1.5	V	T_C = 25°C, I_S = 1.3A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	380	–	ns	T_J = 150°C, I_F = 1.5A, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	2.7	–	μC	T_J = 150°C, I_F = 1.5A, dI_F/dt = 100 A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

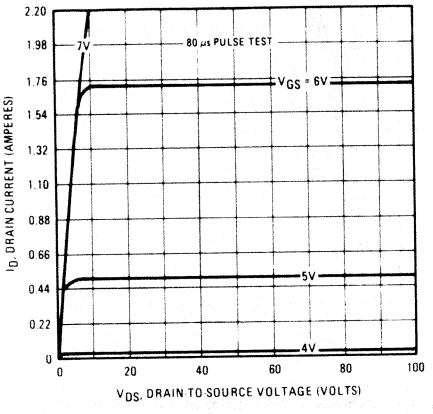


Fig. 2 – Typical Transfer Characteristics

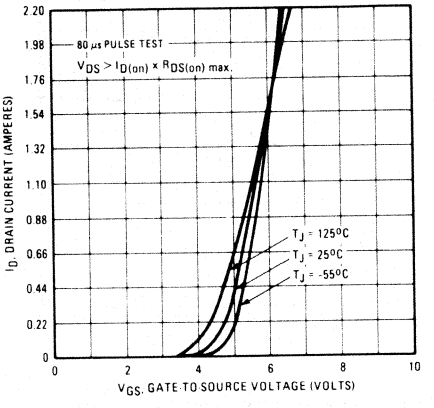


Fig. 3 – Typical Saturation Characteristics

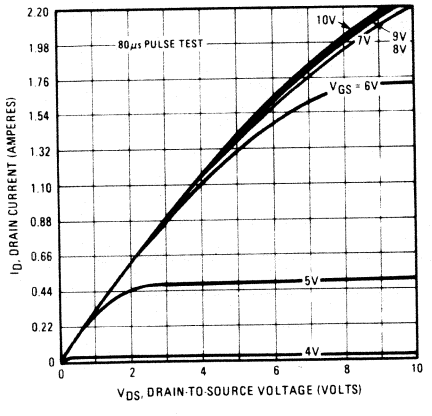
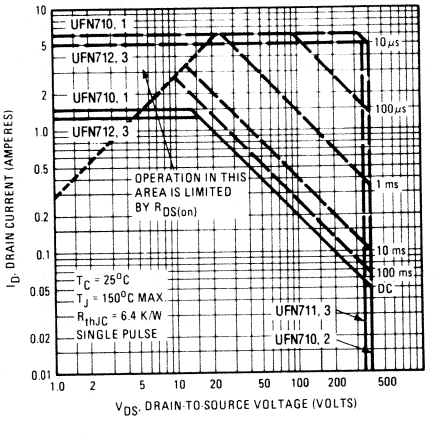


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

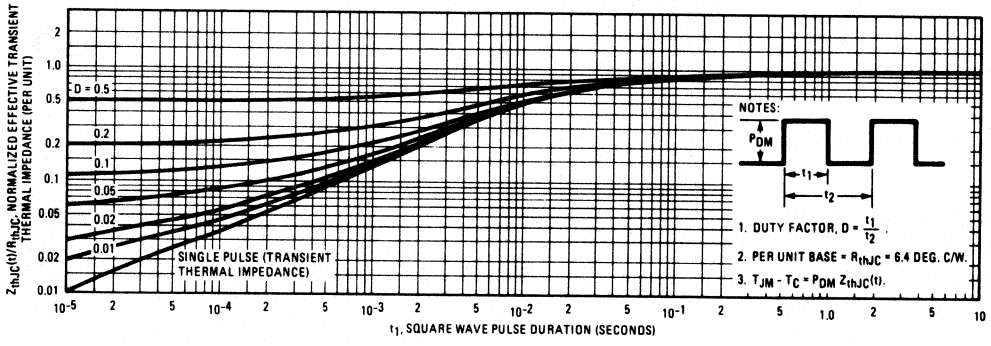


Fig. 6 – Typical Transconductance Vs. Drain Current

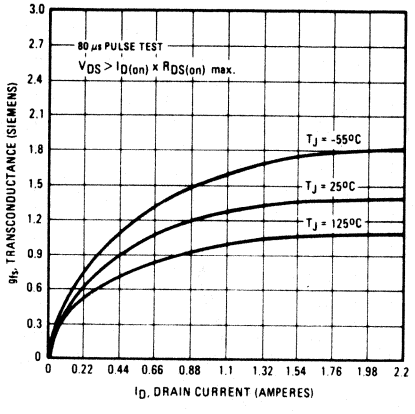


Fig. 7 – Typical Source-Drain Diode Forward Voltage

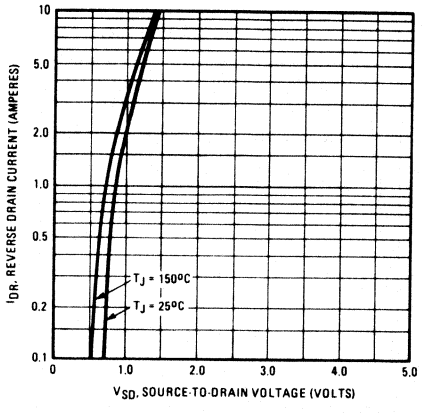


Fig. 8 – Breakdown Voltage Vs. Temperature

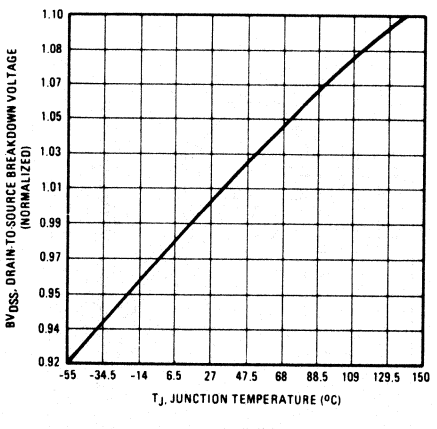
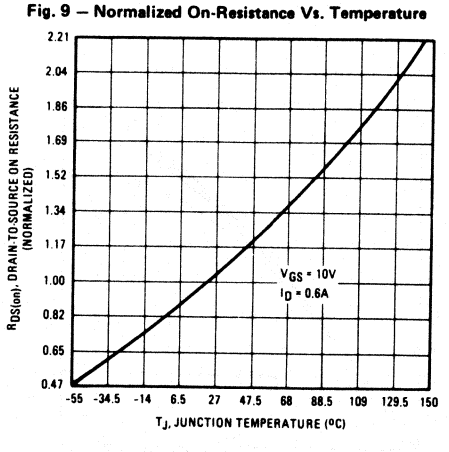


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

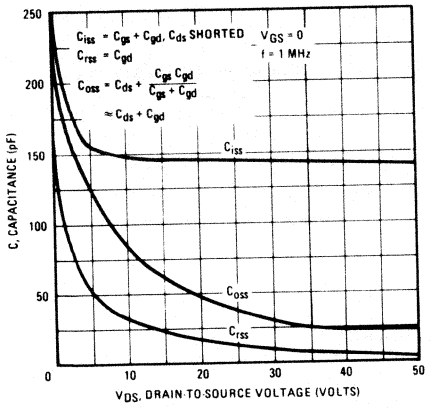


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

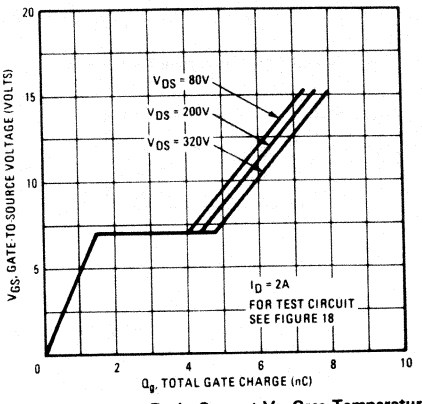


Fig. 12 – Typical On-Resistance Vs. Drain Current

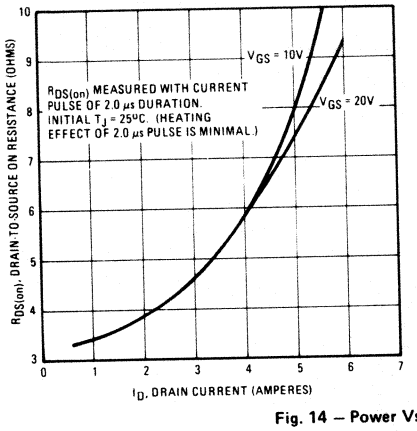


Fig. 13 – Maximum Drain Current Vs. Case Temperature

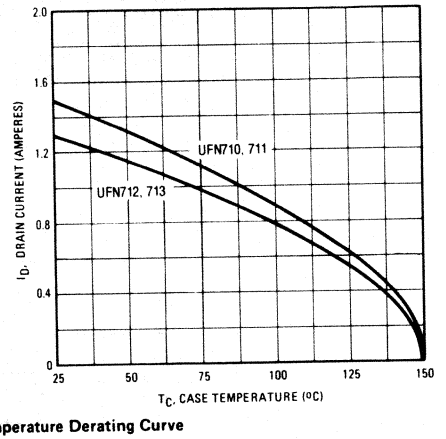
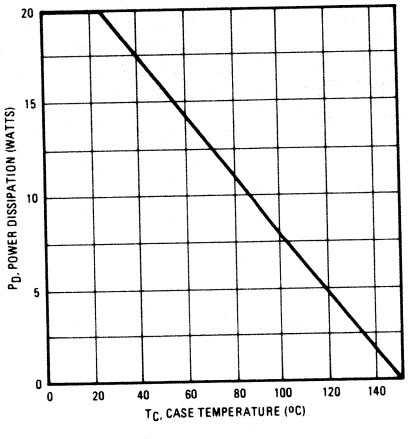


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

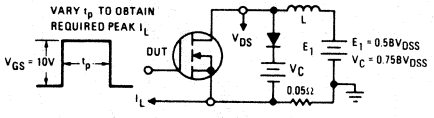


Fig. 16 – Clamped Inductive Waveforms

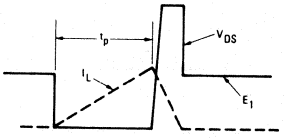


Fig. 17 – Switching Time Test Circuit

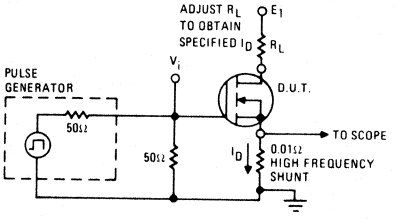
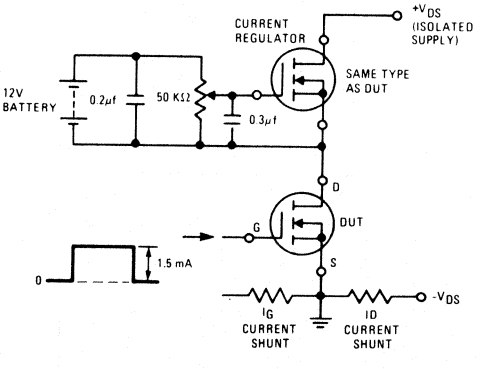


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

400 Volt, 1.8 Ohm
N-Channel

UFN720
UFN721
UFN722
UFN723

3

FEATURES

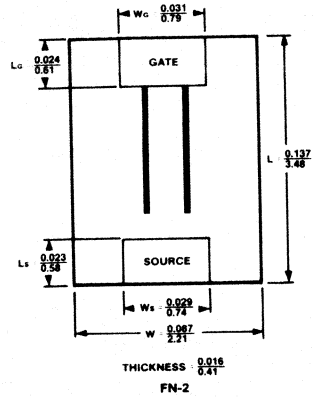
- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



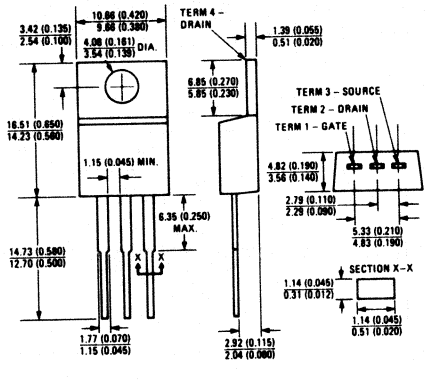
FN-2

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN720	400V	1.8Ω	3.0A
UFN721	350V	1.8Ω	3.0A
UFN722	400V	2.5Ω	2.5A
UFN723	350V	2.5Ω	2.5A

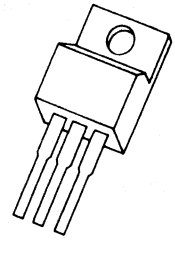
MECHANICAL SPECIFICATIONS

UFN720 UFN721 UFN722 UFN723



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

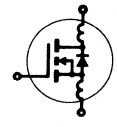
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN720	UFN721	UFN722	UFN723	Units
V_{DS}	Drain - Source Voltage ①	400	350	400	350	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	400	350	400	350	V
I_D @ T_C = 25°C	Continuous Drain Current	3.0	3.0	2.5	2.5	A
I_D @ T_C = 100°C	Continuous Drain Current	2.0	2.0	1.5	1.5	A
I_{DM}	Pulsed Drain Current ③	12	12	10	10	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	40 (See Fig. 14)				W
	Linear Derating Factor	0.32 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		12	12	10	10	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN720 UFN722	400	–	–	V	V_{GS} = 0V
		UFN721 UFN723	350	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN720 UFN721	3.0	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN722 UFN723	2.5	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN720 UFN721	–	1.5	1.8	Ω	V_{GS} = 10V, I_D = 1.5A
		UFN722 UFN723	–	1.8	2.5	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.0	2.0	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 1.5A
C_{iss}	Input Capacitance	ALL	–	450	600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	100	200	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	20	40	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	20	40	ns	V_{DD} ≈ 0.5 BV_{DSS}, I_D = 1.5A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	25	50	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	50	100	ns	
t_f	Fall Time	ALL	–	25	50	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	12	15	nC	V_{GS} = 10V, I_D = 4.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	6.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	6.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	3.12	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN720 UFN721	–	–	3.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN722 UFN723	–	–	2.5	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN720 UFN721	–	–	12	A	
		UFN722 UFN723	–	–	10	A	
V_{SD}	Diode Forward Voltage ②	UFN720 UFN721	–	–	1.6	V	T_C = 25°C, I_S = 3.0A, V_{GS} = 0V
		UFN722 UFN723	–	–	1.5	V	T_C = 25°C, I_S = 2.5A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	450	–	ns	T_J = 150°C, I_F = 3.0A, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	3.1	–	μC	T_J = 150°C, I_F = 3.0A, dI_F/dt = 100 A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

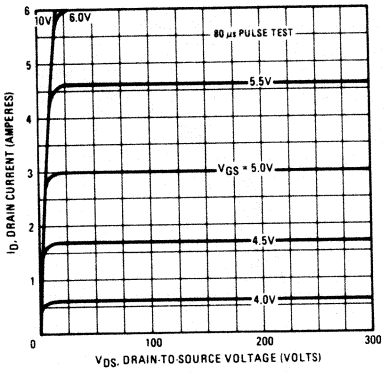


Fig. 2 – Typical Transfer Characteristics

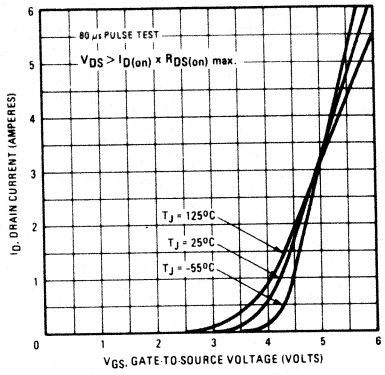


Fig. 3 – Typical Saturation Characteristics

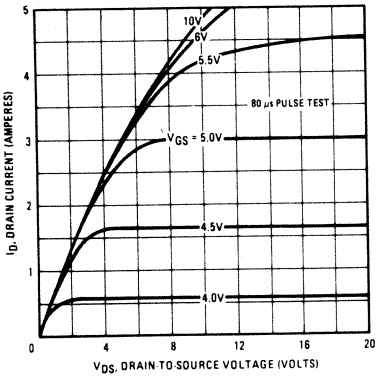


Fig. 4 – Maximum Safe Operating Area

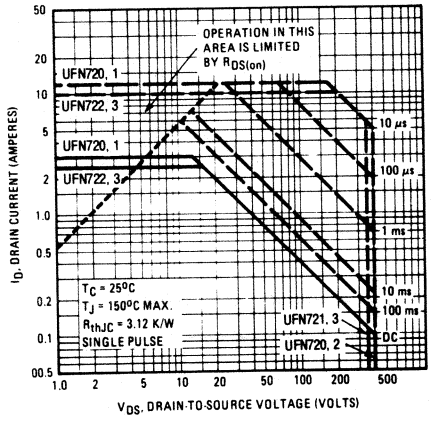


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

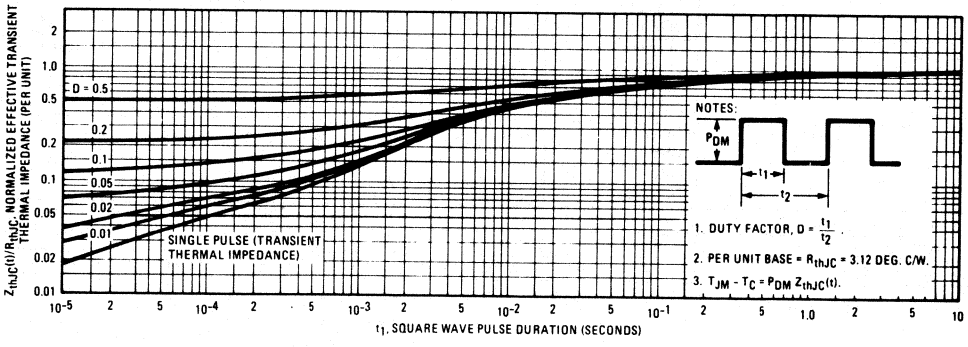


Fig. 6 – Typical Transconductance Vs. Drain Current

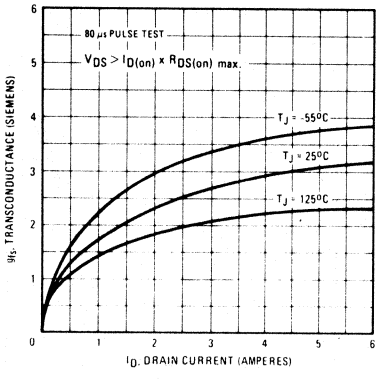


Fig. 7 – Typical Source-Drain Diode Forward Voltage

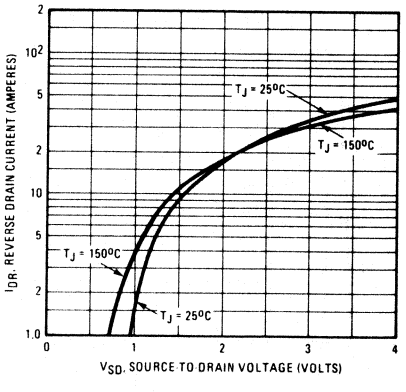


Fig. 8 – Breakdown Voltage Vs. Temperature

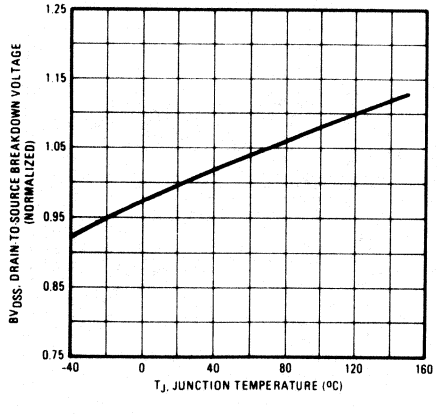
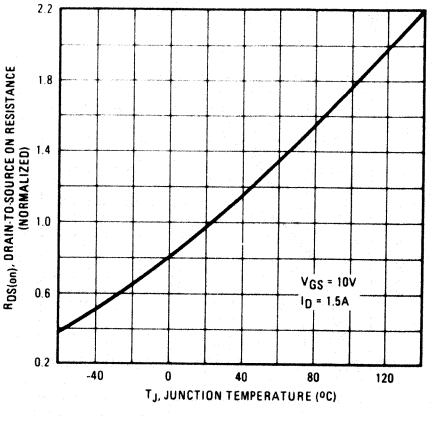


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

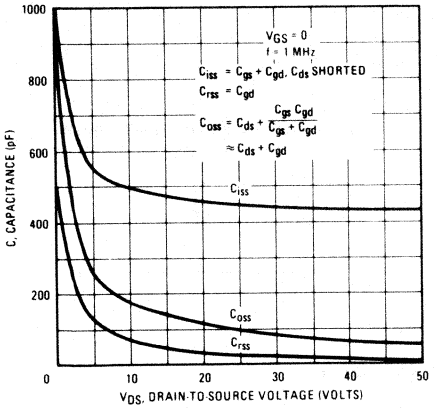


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

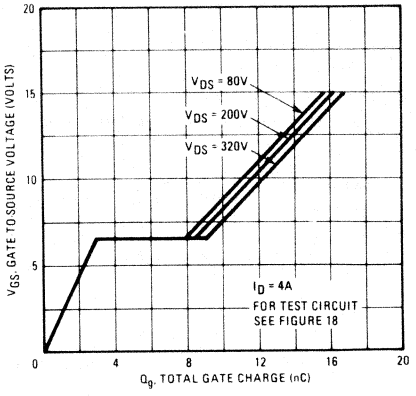


Fig. 12 – Typical On-Resistance Vs. Drain Current

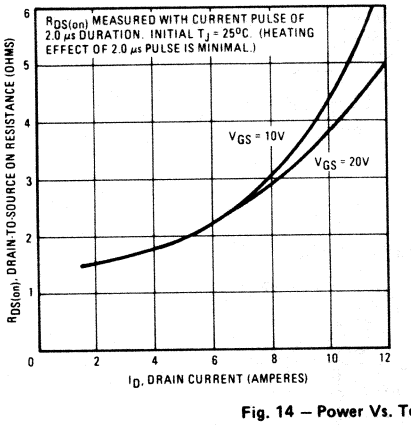


Fig. 13 – Maximum Drain Current Vs. Case Temperature

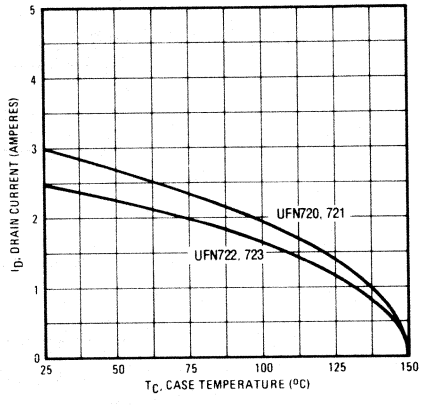
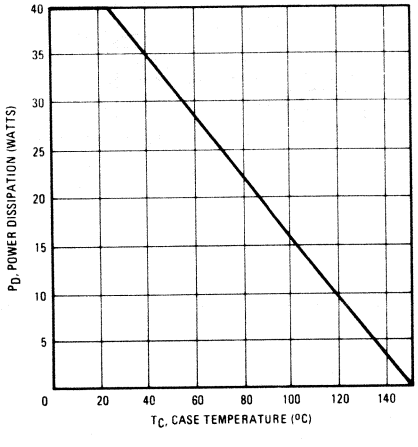


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

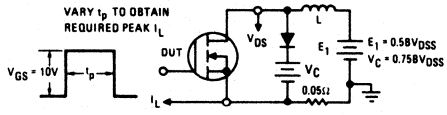


Fig. 16 – Clamped Inductive Waveforms

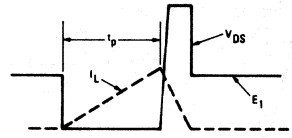


Fig. 17 – Switching Time Test Circuit

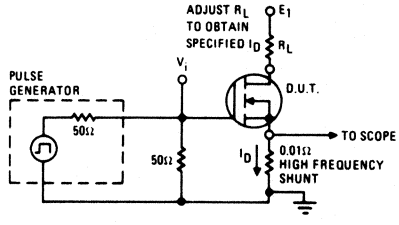
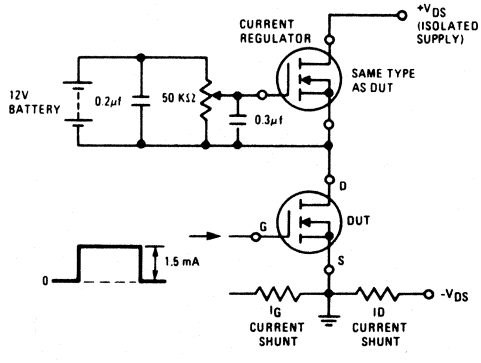


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

400 Volt, 1.0 Ohm
N-Channel

UFN730
UFN731
UFN732
UFN733

3

FEATURES

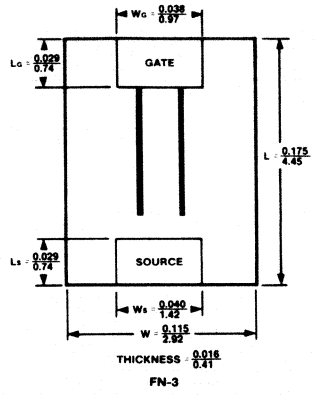
- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

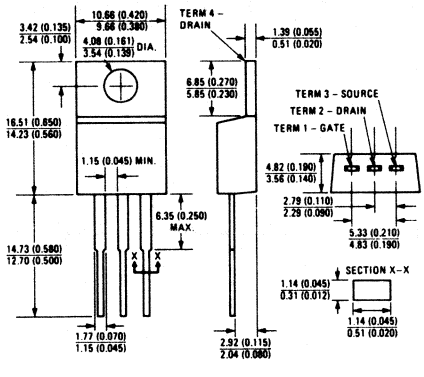


PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN730	400V	1.0Ω	5.5A
UFN731	350V	1.0Ω	5.5A
UFN732	400V	1.5Ω	4.5A
UFN733	350V	1.5Ω	4.5A

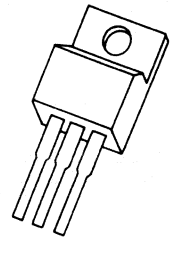
MECHANICAL SPECIFICATIONS

UFN730 UFN731 UFN732 UFN733



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

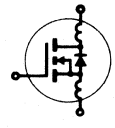
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN730	UFN731	UFN732	UFN733	Units
V_{DS}	Drain - Source Voltage ①	400	350	400	350	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	400	350	400	350	V
I_D @ T_C = 25°C	Continuous Drain Current	5.5	5.5	4.5	4.5	A
I_D @ T_C = 100°C	Continuous Drain Current	3.5	3.5	3.0	3.0	A
I_{DM}	Pulsed Drain Current ③	22	22	18	18	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	75 (See Fig. 14)				W
	Linear Derating Factor	0.6 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		22	22	18	18	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN730 UFN732	400	–	–	V	V_{GS} = 0V
		UFN731 UFN733	350	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN730 UFN731	5.5	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN732 UFN733	4.5	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN730 UFN731	–	0.8	1.0	Ω	V_{GS} = 10V, I_D = 3.0A
		UFN732 UFN733	–	1.0	1.5	Ω	
g_{fs}	Forward Transconductance ②	ALL	3.0	4.0	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 3.0A
C_{iss}	Input Capacitance	ALL	–	600	800	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	150	300	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	40	80	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	30	ns	V_{DD} ≈ 175V, I_D = 3.0A, Z_o = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	35	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	55	ns	
t_f	Fall Time	ALL	–	–	35	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	18	30	nC	V_{GS} = 10V, I_D = 7.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	11	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	7.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.67	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN730 UFN731	—	—	5.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN732 UFN733	—	—	4.5	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN730 UFN731	—	—	22	A	
		UFN732 UFN733	—	—	18	A	
V_{SD}	Diode Forward Voltage ②	UFN730 UFN731	—	—	1.6	V	T_C = 25°C, I_S = 5.5A, V_{GS} = 0V
		UFN732 UFN733	—	—	1.5	V	T_C = 25°C, I_S = 4.5A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	600	—	ns	T_J = 150°C, I_F = 5.5A, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	4.0	—	μC	T_J = 150°C, I_F = 5.5A, dI_F/dt = 100 A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 — Typical Output Characteristics

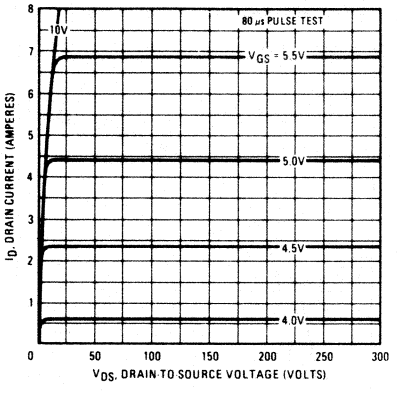


Fig. 2 — Typical Transfer Characteristics

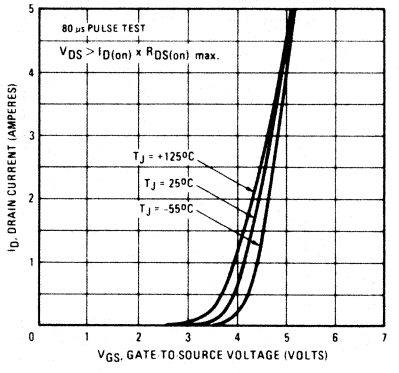


Fig. 3 — Typical Saturation Characteristics

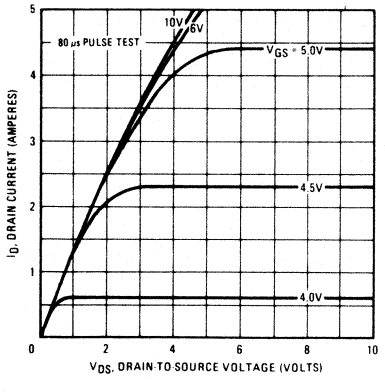
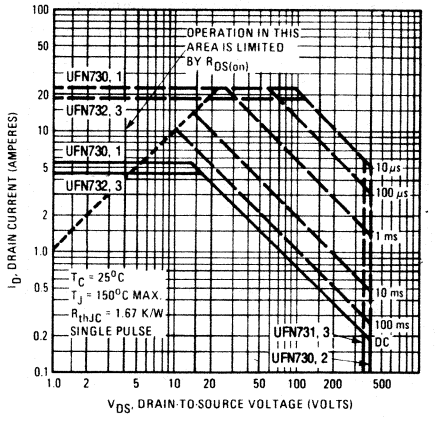


Fig. 4 — Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

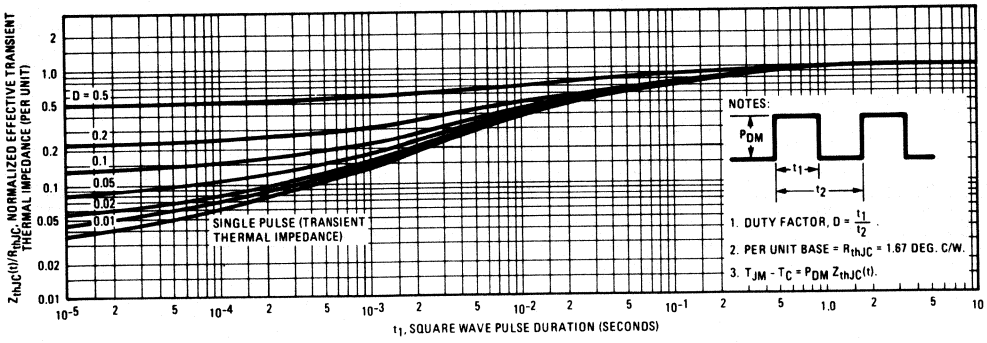


Fig. 6 – Typical Transconductance Vs. Drain Current

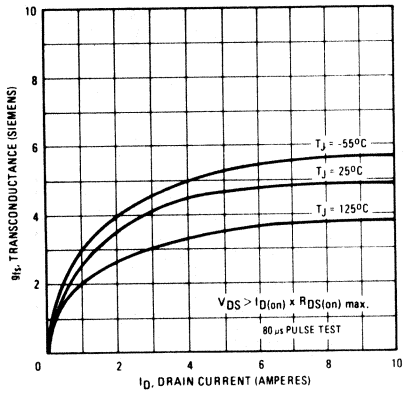


Fig. 7 – Typical Source-Drain Diode Forward Voltage

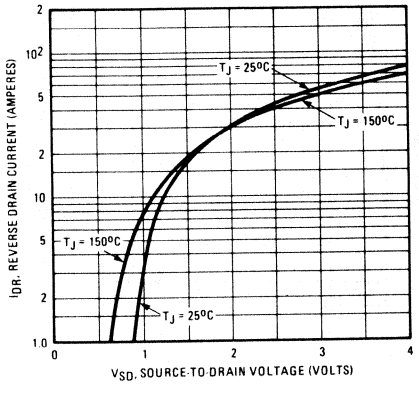


Fig. 8 – Breakdown Voltage Vs. Temperature

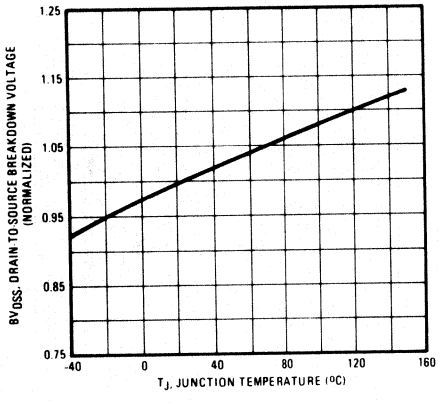
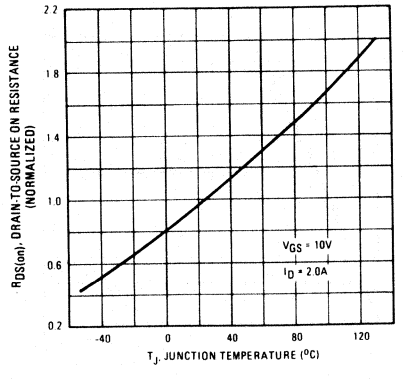


Fig. 9 – Normalized On-Resistance Vs. Temperature



3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

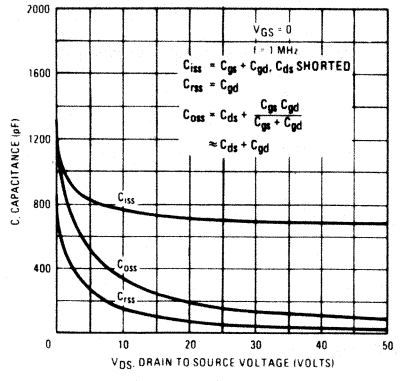


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

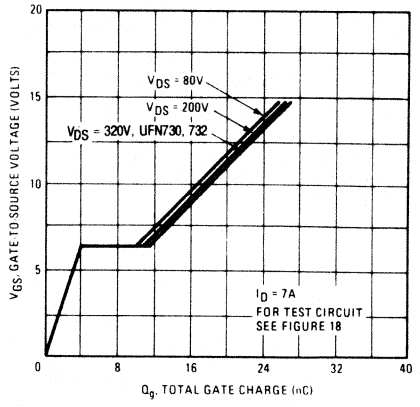


Fig. 12 – Typical On-Resistance Vs. Drain Current

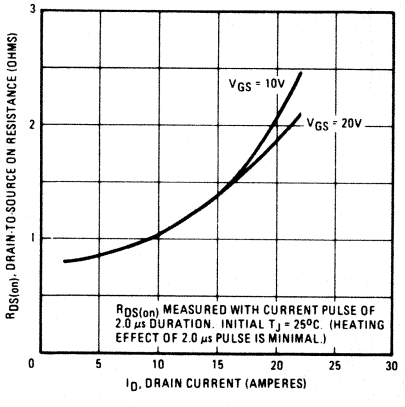


Fig. 13 – Maximum Drain Current Vs. Case Temperature

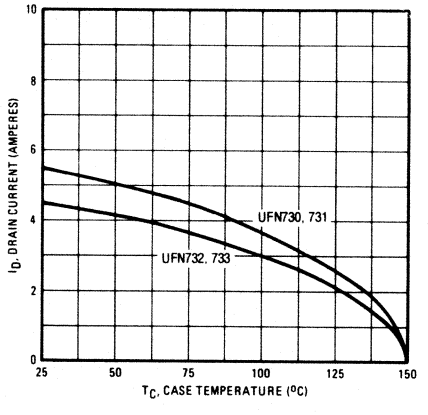
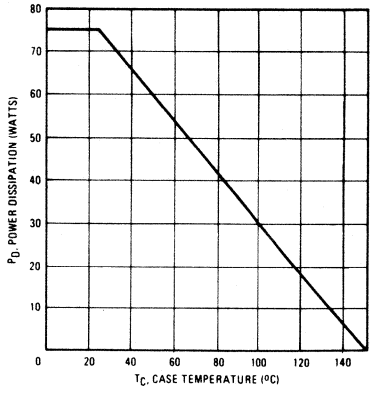


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

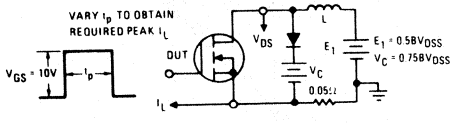


Fig. 16 – Clamped Inductive Waveforms

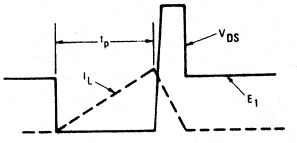


Fig. 17 – Switching Time Test Circuit

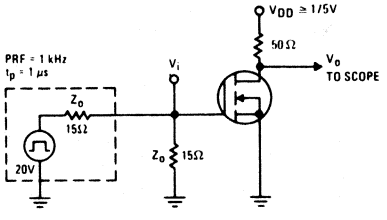
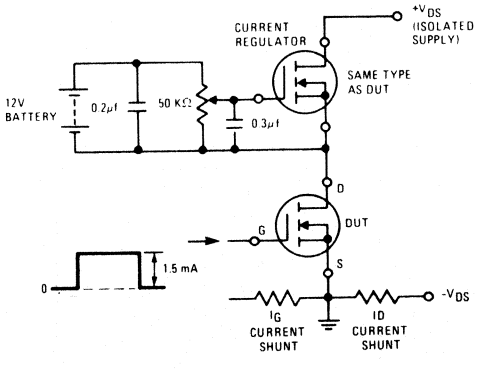


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

400 Volt, 0.55 Ohm N-Channel

UFN740
UFN741
UFN742
UFN743

3

FEATURES

- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

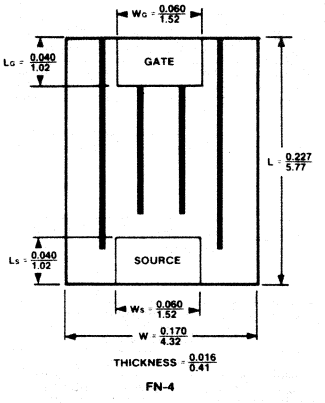
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

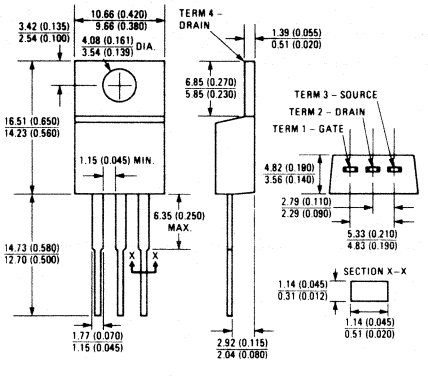
Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN740	400V	0.55Ω	10A
UFN741	350V	0.55Ω	10A
UFN742	400V	0.80Ω	8.0A
UFN743	350V	0.80Ω	8.0A



FN-4

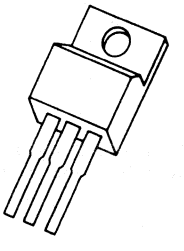
MECHANICAL SPECIFICATIONS

UFN740 UFN741 UFN742 UFN743



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

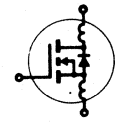
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN740	UFN741	UFN742	UFN743	Units
V_{DS}	Drain - Source Voltage ①	400	350	400	350	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	400	350	400	350	V
I_D @ T_C = 25°C	Continuous Drain Current	10	10	8.0	8.0	A
I_D @ T_C = 100°C	Continuous Drain Current	6.0	6.0	5.0	5.0	A
I_{DM}	Pulsed Drain Current ③	40	40	32	32	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	125 (See Fig. 14)				W
	Linear Derating Factor	1.0 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		40	40	32	32	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN740 UFN742	400	–	–	V	V_{GS} = 0V
		UFN741 UFN743	350	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN740 UFN741	10	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFN742 UFN743	8.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN740 UFN741	–	0.47	0.55	Ω	V_{GS} = 10V, I_D = 5.0A
		UFN742 UFN743	–	.68	.80	Ω	
g_{fs}	Forward Transconductance ②	ALL	4.0	7.0	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 5.0A
C_{iss}	Input Capacitance	ALL	–	1250	1600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	300	450	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	80	150	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	17	35	ns	V_{DD} ≈ 175V, I_D = 5.0A, Z_o = 4.7Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	5.0	15	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	45	90	ns	
t_f	Fall Time	ALL	–	16	35	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	41	60	nC	V_{GS} = 10V, I_D = 12A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	18	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	23	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.0	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN740 UFN741	–	–	10	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN742 UFN743	–	–	8.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN740 UFN741	–	–	40	A	
		UFN742 UFN743	–	–	32	A	
V_{SD}	Diode Forward Voltage ②	UFN740 UFN741	–	–	2.0	V	T_C = 25°C, I_S = 10A, V_{GS} = 0V
		UFN742 UFN743	–	–	1.9	V	T_C = 25°C, I_S = 8.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	800	–	ns	T_J = 150°C, I_F = 10A, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	5.7	–	μC	T_J = 150°C, I_F = 10A, dI_F/dt = 100 A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

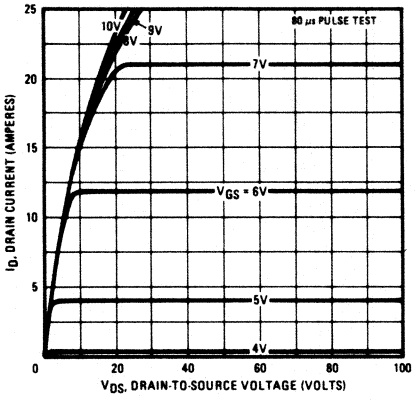


Fig. 2 – Typical Transfer Characteristics

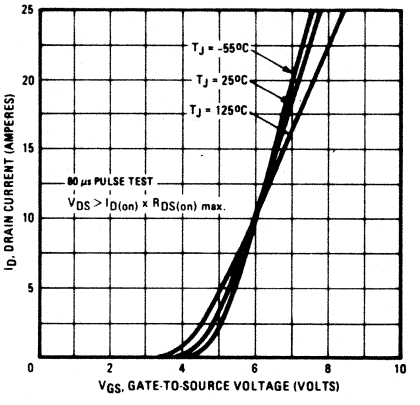


Fig. 3 – Typical Saturation Characteristics

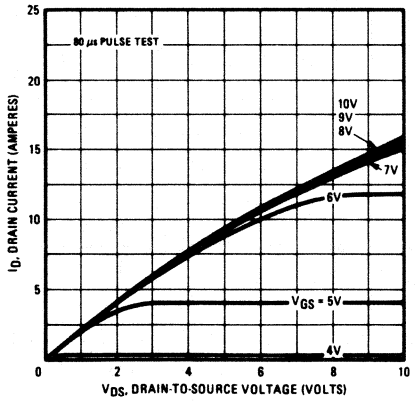
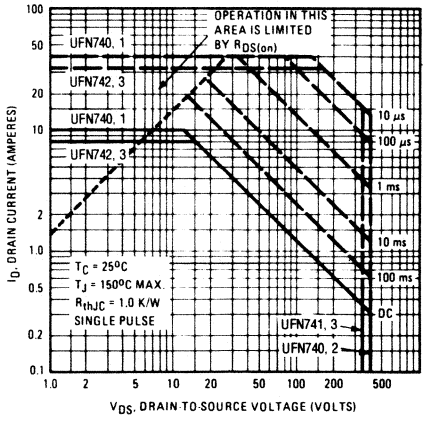


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

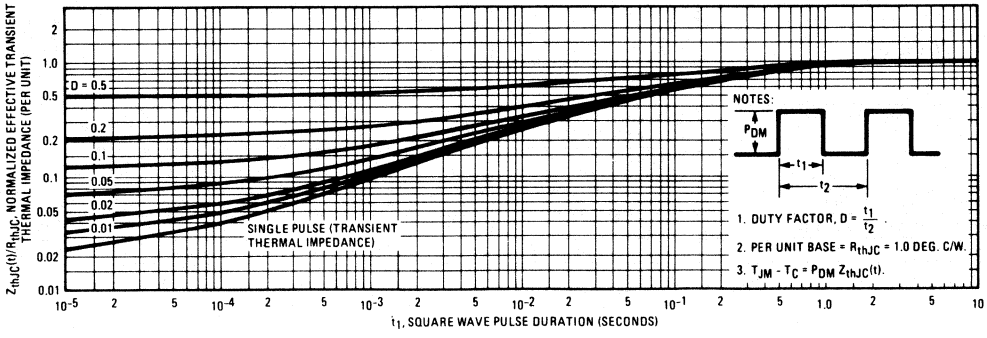


Fig. 6 — Typical Transconductance Vs. Drain Current

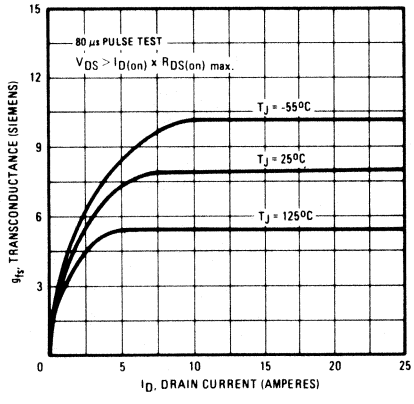


Fig. 7 — Typical Source-Drain Diode Forward Voltage

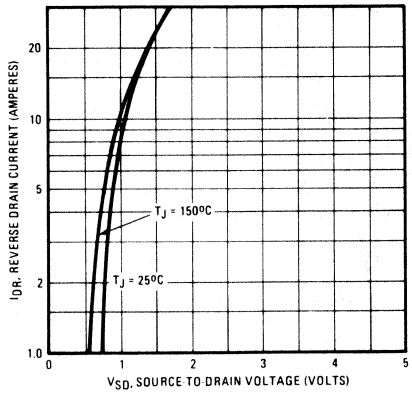


Fig. 8 — Breakdown Voltage Vs. Temperature

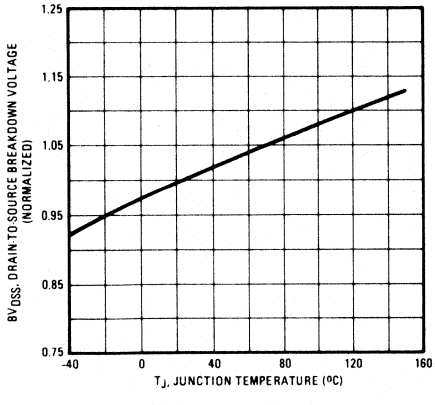


Fig. 9 — Normalized On-Resistance Vs. Temperature

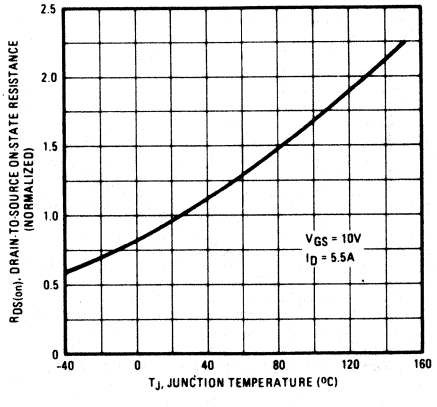


Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

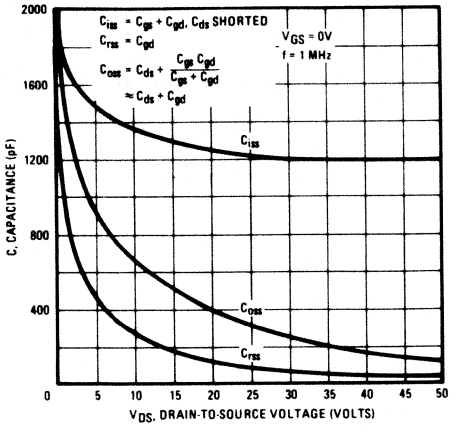


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

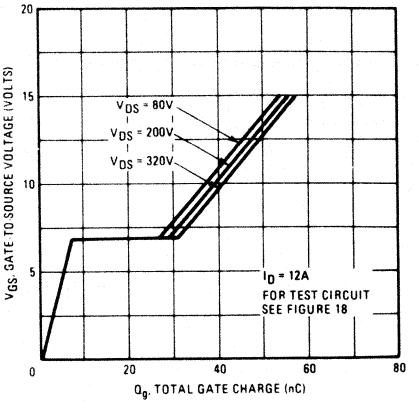


Fig. 12 – Typical On-Resistance Vs. Drain Current

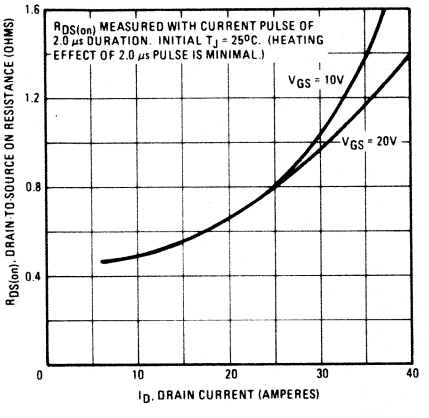


Fig. 13 – Maximum Drain Current Vs. Case Temperature

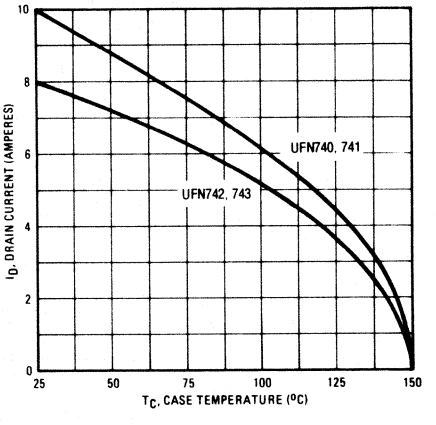
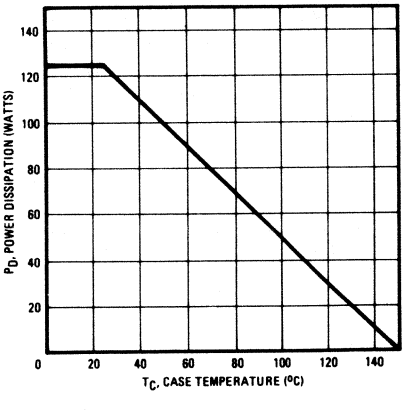


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

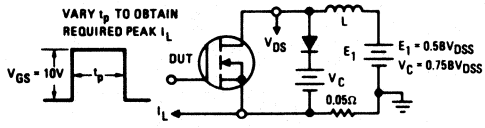


Fig. 16 – Clamped Inductive Waveforms

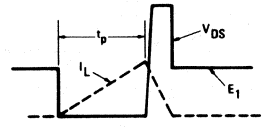


Fig. 17 – Switching Time Test Circuit

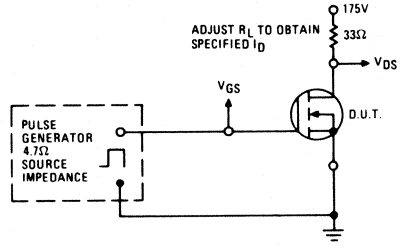
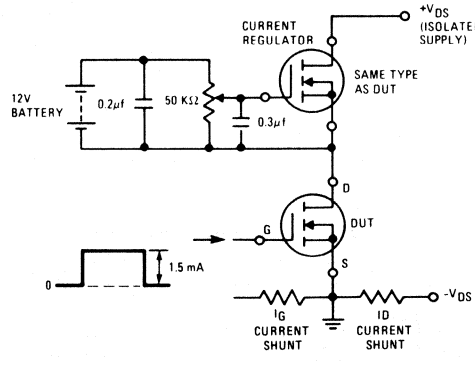


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

500 Volt, 3.0 Ohm
N-Channel

UFN820
UFN821
UFN822
UFN823

3

FEATURES

- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

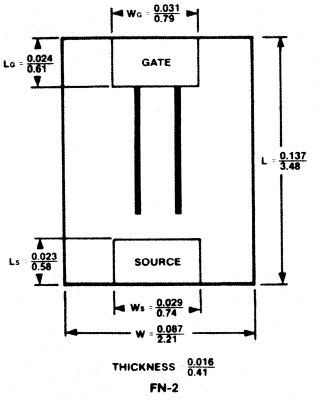
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

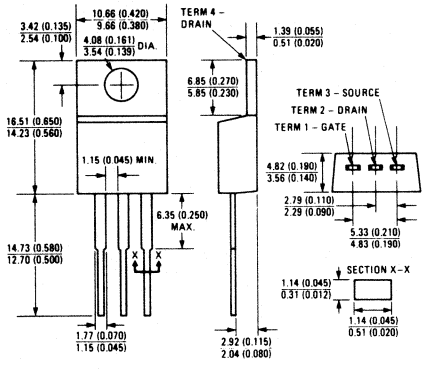
PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN820	500V	3.0Ω	2.5A
UFN821	450V	3.0Ω	2.5A
UFN822	500V	4.0Ω	2.0A
UFN823	450V	4.0Ω	2.0A



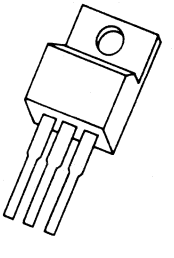
MECHANICAL SPECIFICATIONS

UFN820 UFN821 UFN822 UFN823



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

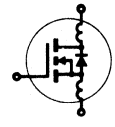
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN820	UFN821	UFN822	UFN823	Units
V_{DS}	Drain - Source Voltage ①	500	450	500	450	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	500	450	500	450	V
I_D @ T_C = 25°C	Continuous Drain Current	2.5	2.5	2.0	2.0	A
I_D @ T_C = 100°C	Continuous Drain Current	1.5	1.5	1.0	1.0	A
I_{DM}	Pulsed Drain Current ③	10	10	8.0	8.0	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	40 (See Fig. 14)				W
	Linear Derating Factor	0.32 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		10	10	8.0	8.0	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN820 UFN822	500	–	–	V	V_{GS} = 0V
		UFN821 UFN823	450	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN820 UFN821	2.5	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)\ max.}$, V_{GS} = 10V
		UFN822 UFN823	2.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN820 UFN821	–	2.5	3.0	Ω	V_{GS} = 10V, I_D = 1.0A
		UFN822 UFN823	–	3.0	4.0	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.0	1.75	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)\ max.}$, I_D = 1.0A
C_{iss}	Input Capacitance	ALL	–	300	400	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	75	150	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	20	40	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	30	60	ns	V_{DD} = 0.5 BV_{DSS}, I_D = 1.0A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	25	50	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	30	60	ns	
t_f	Fall Time	ALL	–	15	30	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	11	15	nC	V_{GS} = 10V, I_D = 3.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	5.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	6.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	3.12	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN820 UFN821	–	–	2.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN822 UFN823	–	–	2.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN820 UFN821	–	–	10	A	
		UFN822 UFN823	–	–	8.0	A	
V_{SD}	Diode Forward Voltage ②	UFN820 UFN821	–	–	1.6	V	T_C = 25°C, I_S = 2.5A, V_{GS} = 0V
		UFN822 UFN823	–	–	1.5	V	T_C = 25°C, I_S = 2.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	600	–	ns	T_J = 150°C, I_F = 2.5A, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	3.5	–	μC	T_J = 150°C, I_F = 2.5A, dI_F/dt = 100 A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

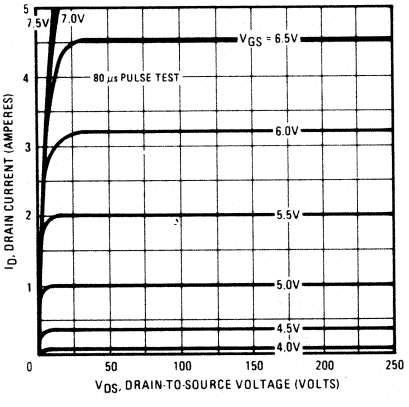


Fig. 2 – Typical Transfer Characteristics

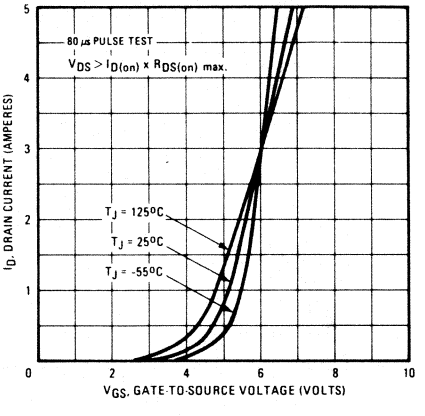


Fig. 3 – Typical Saturation Characteristics

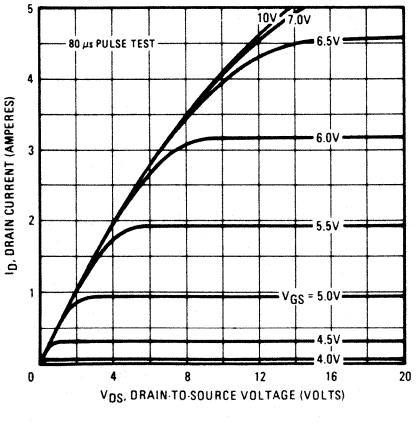
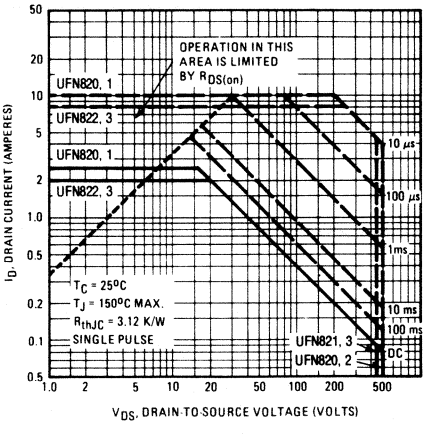


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

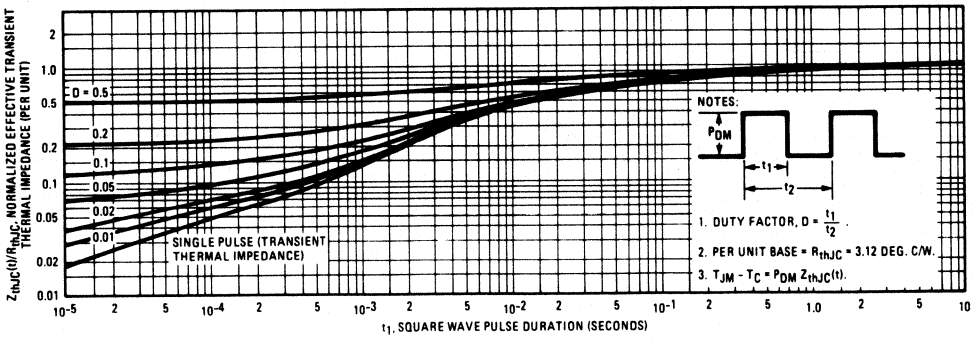


Fig. 6 – Typical Transconductance Vs. Drain Current

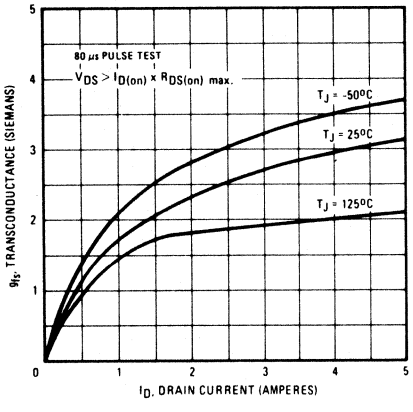


Fig. 7 – Typical Source-Drain Diode Forward Voltage

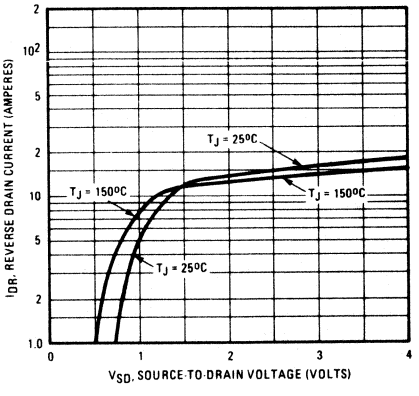


Fig. 8 – Breakdown Voltage Vs. Temperature

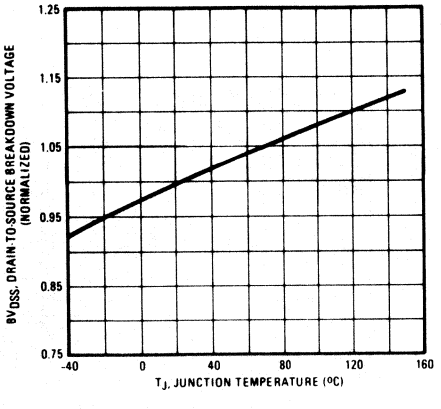
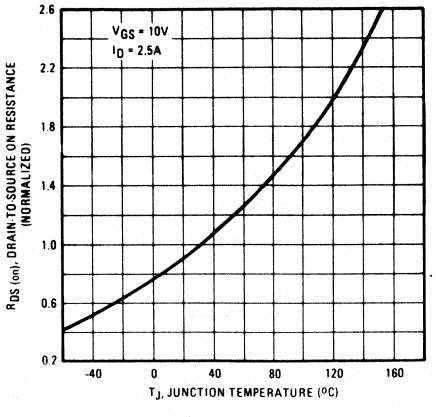


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

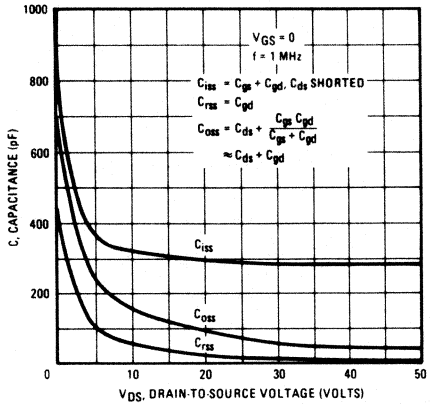


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

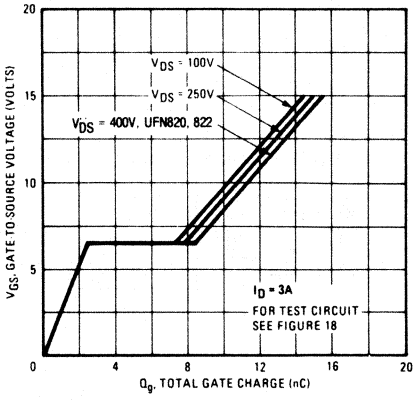


Fig. 12 – Typical On-Resistance Vs. Drain Current

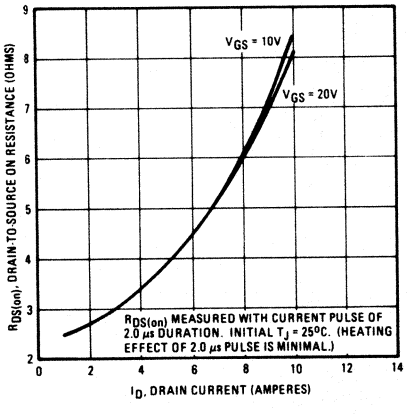


Fig. 13 – Maximum Drain Current Vs. Case Temperature

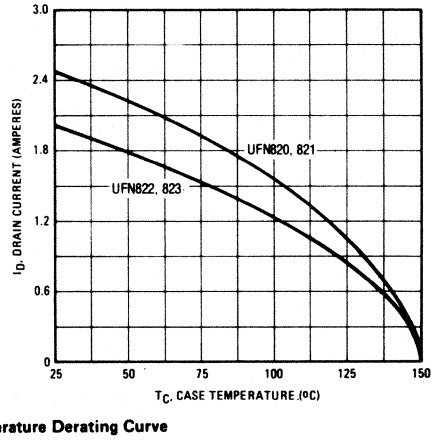
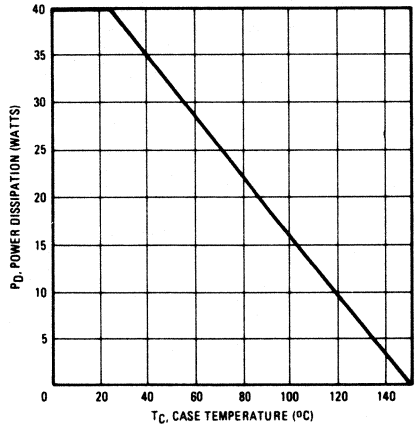


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

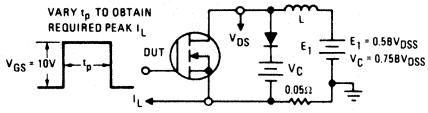


Fig. 16 – Clamped Inductive Waveforms

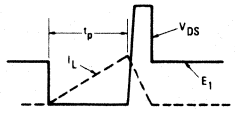


Fig. 17 – Switching Time Test Circuit

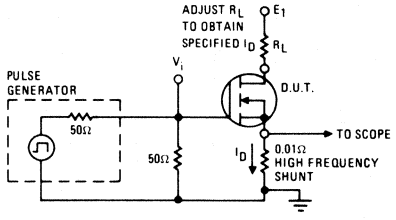
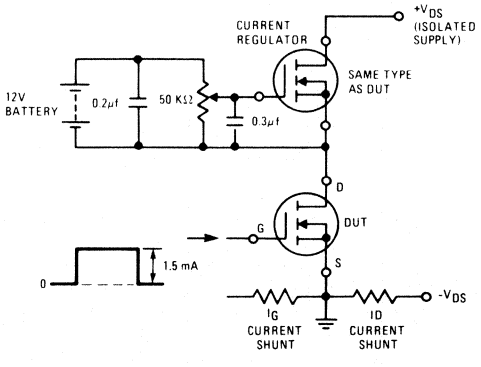


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

500 Volt, 1.5 Ohm N-Channel

UFN830
UFN831
UFN832
UFN833

3

FEATURES

- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

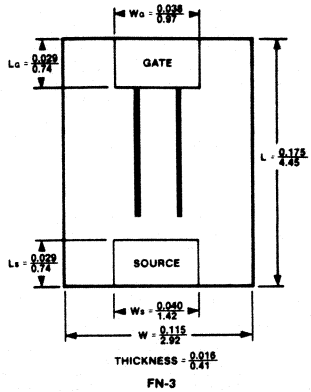
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

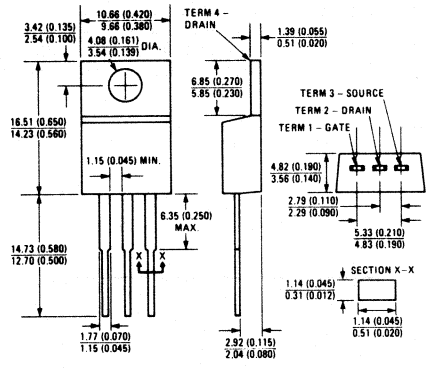
Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN830	500V	1.5Ω	4.5A
UFN831	450V	1.5Ω	4.5A
UFN832	500V	2.0Ω	4.0A
UFN833	450V	2.0Ω	4.0A



FN-3

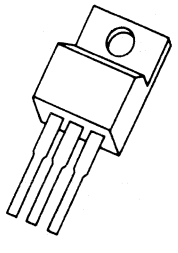
MECHANICAL SPECIFICATIONS

UFN830 UFN831 UFN832 UFN833



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

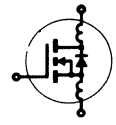
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN830	UFN831	UFN832	UFN833	Units
V_{DS}	Drain - Source Voltage ①	500	450	500	450	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	500	450	500	450	V
I_D @ T_C = 25°C	Continuous Drain Current	4.5	4.5	4.0	4.0	A
I_D @ T_C = 100°C	Continuous Drain Current	3.0	3.0	2.5	2.5	A
I_{DM}	Pulsed Drain Current ③	18	18	16	16	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	75 (See Fig. 14)				W
	Linear Derating Factor	0.6 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		18	18	16	16	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN830 UFN832	500	–	–	V	V_{GS} = 0V
		UFN831 UFN833	450	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN830 UFN831	4.5	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN832 UFN833	4.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN830 UFN831	–	1.3	1.5	Ω	V_{GS} = 10V, I_D = 2.5A
		UFN832 UFN833	–	1.5	2.0	Ω	
g_{fs}	Forward Transconductance ②	ALL	2.5	3.25	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 2.5A
C_{iss}	Input Capacitance	ALL	–	600	800	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	100	200	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	30	60	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	30	ns	V_{DD} ≈ 225V, I_D = 2.5A, Z_o = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	30	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	55	ns	
t_f	Fall Time	ALL	–	–	30	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	22	30	nC	V_{GS} = 10V, I_D = 6.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	11	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	11	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.67	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN830 UFN831	–	–	4.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN832 UFN833	–	–	4.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN830 UFN831	–	–	18	A	
		UFN832 UFN833	–	–	16	A	
V_{SD}	Diode Forward Voltage ②	UFN830 UFN831	–	–	1.6	V	T_C = 25°C, I_S = 4.5A, V_{GS} = 0V
		UFN832 UFN833	–	–	1.5	V	T_C = 25°C, I_S = 4.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	800	–	ns	T_J = 150°C, I_F = 4.5A, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	4.6	–	μC	T_J = 150°C, I_F = 4.5A, dI_F/dt = 100 A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

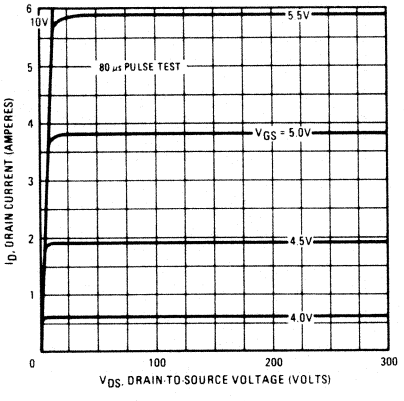


Fig. 2 – Typical Transfer Characteristics

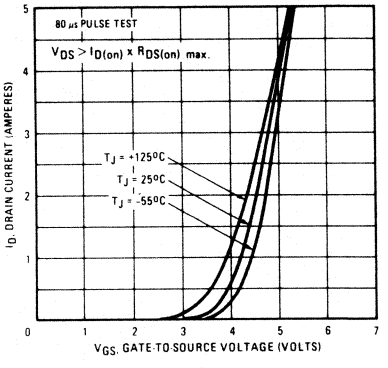


Fig. 3 – Typical Saturation Characteristics

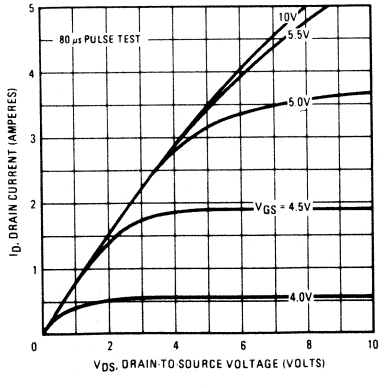
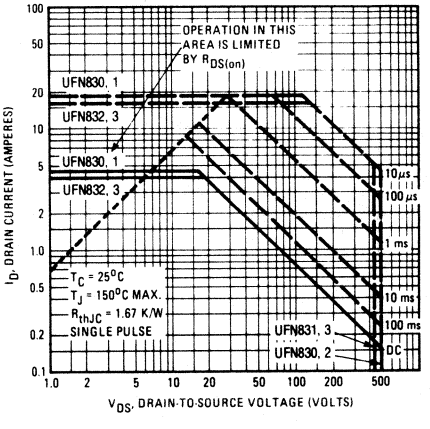


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

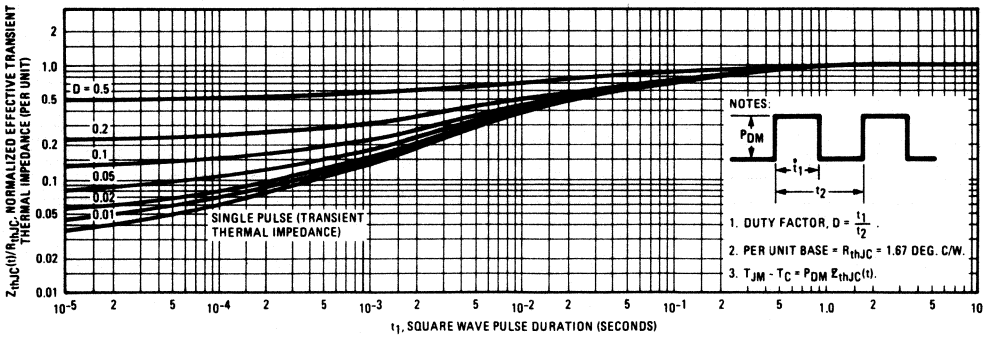


Fig. 6 – Typical Transconductance Vs. Drain Current

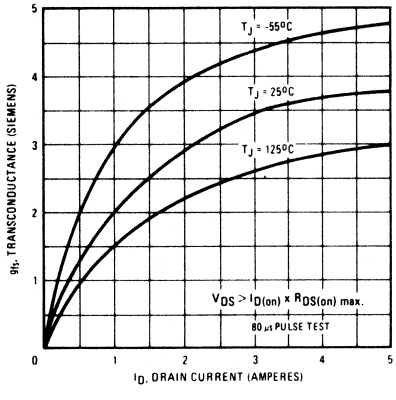


Fig. 7 – Typical Source-Drain Diode Forward Voltage

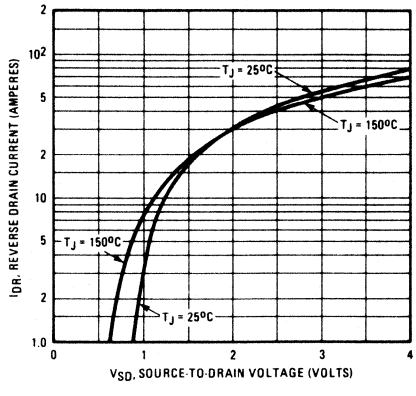


Fig. 8 – Breakdown Voltage Vs. Temperature

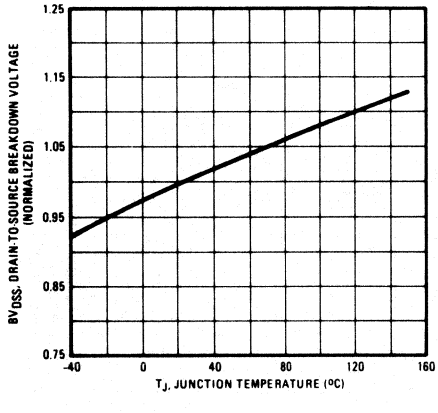
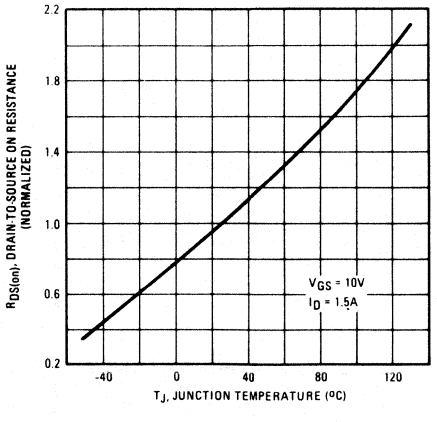


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

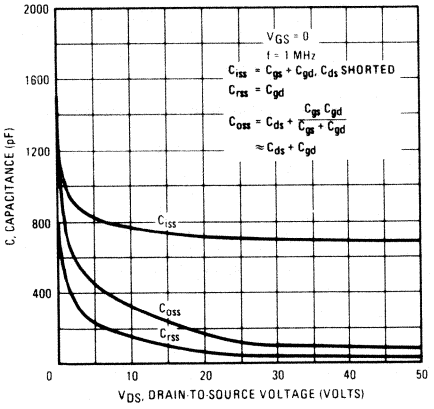


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

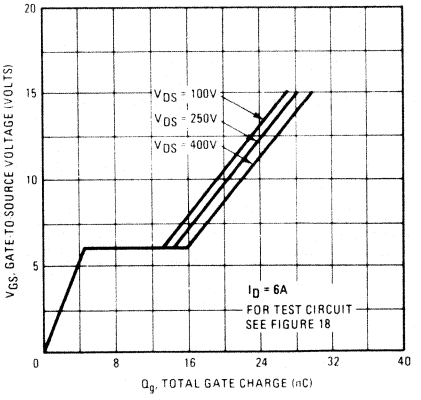


Fig. 12 – Typical On-Resistance Vs. Drain Current

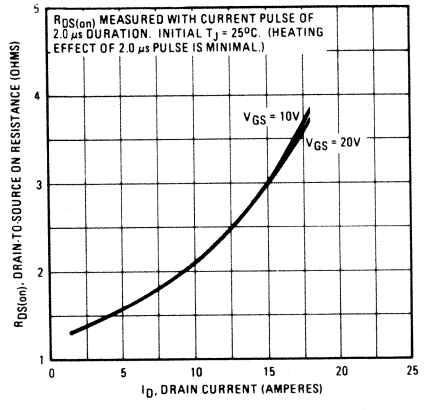


Fig. 13 – Maximum Drain Current Vs. Case Temperature

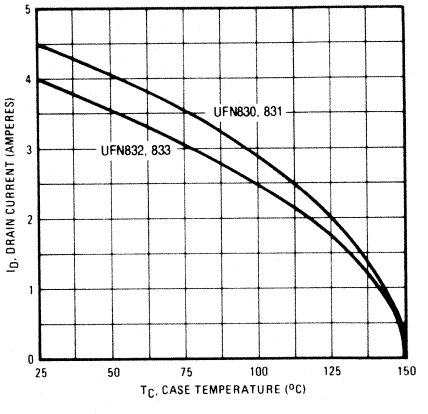
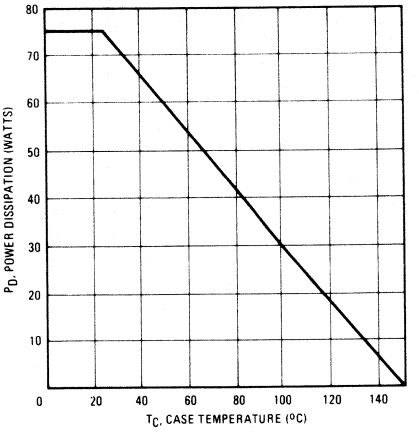


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

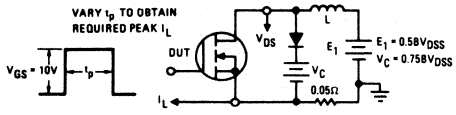


Fig. 16 – Clamped Inductive Waveforms

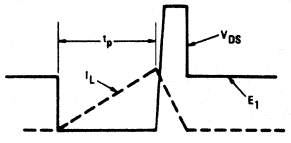


Fig. 17 – Switching Time Test Circuit

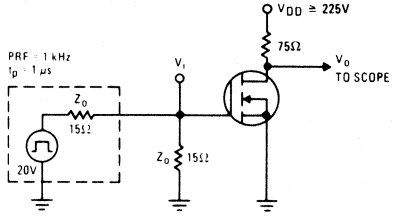
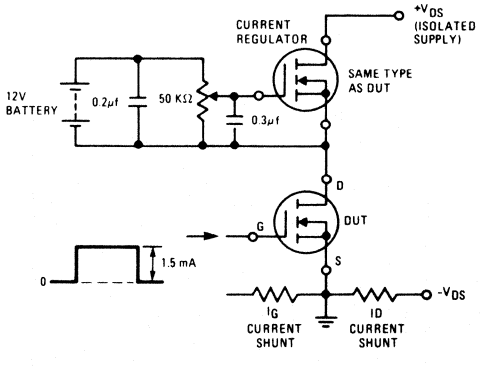


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

500 Volt, 0.85 Ohm N-Channel

UFN840
UFN841
UFN842
UFN843

3

FEATURES

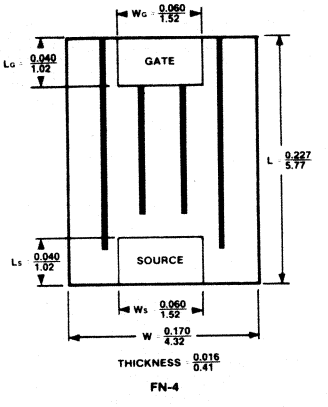
- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



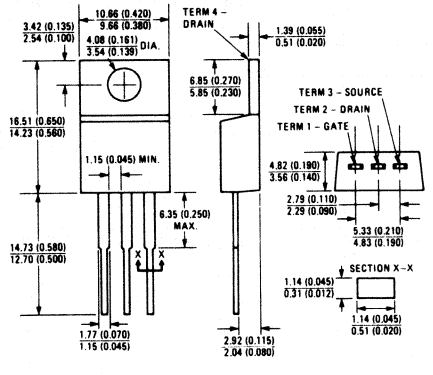
FN-4

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN840	500V	0.85Ω	8.0A
UFN841	450V	0.85Ω	8.0A
UFN842	500V	1.10Ω	7.0A
UFN843	450V	1.10Ω	7.0A

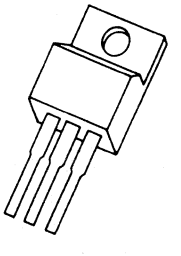
MECHANICAL SPECIFICATIONS

UFN840 UFN841 UFN842 UFN843



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

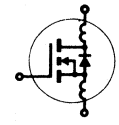
ABSOLUTE MAXIMUM RATINGS

Parameter		UFN840	UFN841	UFN842	UFN843	Units
V_{DS}	Drain - Source Voltage ①	500	450	500	450	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	500	450	500	450	V
I_D @ T_C = 25°C	Continuous Drain Current	8.0	8.0	7.0	7.0	A
I_D @ T_C = 100°C	Continuous Drain Current	5.0	5.0	4.0	4.0	A
I_{DM}	Pulsed Drain Current ③	32	32	28	28	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	125 (See Fig. 14)				W
	Linear Derating Factor	1.0 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		32	32	28	28	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN840 UFN842	500	–	–	V	V_{GS} = 0V
		UFN841 UFN843	450	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN840 UFN841	8.0	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN842 UFN843	7.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN840 UFN841	–	0.8	0.85	Ω	V_{GS} = 10V, I_D = 4.0A
		UFN842 UFN843	–	1.0	1.1	Ω	
g_{fs}	Forward Transconductance ②	ALL	4.0	6.5	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 4.0A
C_{iss}	Input Capacitance	ALL	–	1225	1600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	200	350	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	85	150	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	17	35	ns	V_{DD} ≈ 200V, I_D = 4.0A, Z_o = 4.7Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	5	15	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	42	90	ns	
t_f	Fall Time	ALL	–	14	30	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	42	60	nC	V_{GS} = 10V, I_D = 10A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	20	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	22	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.0	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN840 UFN841	–	–	8.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFN842 UFN843	–	–	7.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN840 UFN841	–	–	32	A	
		UFN842 UFN843	–	–	28	A	
V_{SD}	Diode Forward Voltage ②	UFN840 UFN841	–	–	2.0	V	T_C = 25°C, I_S = 8.0A, V_{GS} = 100A/μs
		UFN842 UFN843	–	–	1.9	V	T_C = 25°C, I_S = 7.0A, V_{GS} = 100A/μs
t_{rr}	Reverse Recovery Time	ALL	–	1100	–	ns	T_J = 150°C, I_F = 8.0A, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	6.4	–	μC	T_J = 150°C, I_F = 8.0A, dI_F/dt = 100 A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

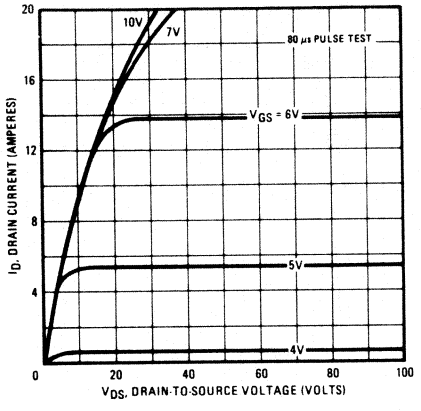


Fig. 2 – Typical Transfer Characteristics

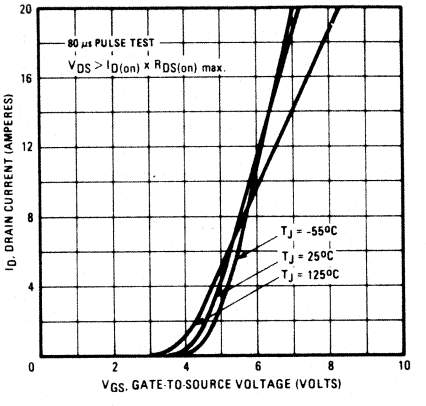


Fig. 3 – Typical Saturation Characteristics

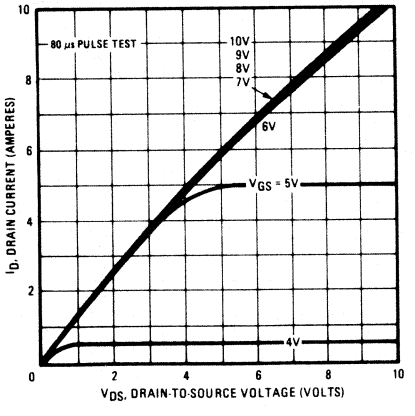
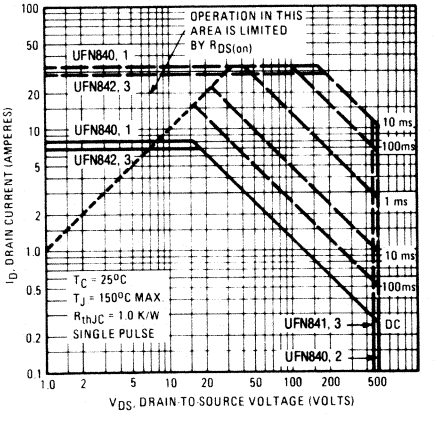


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

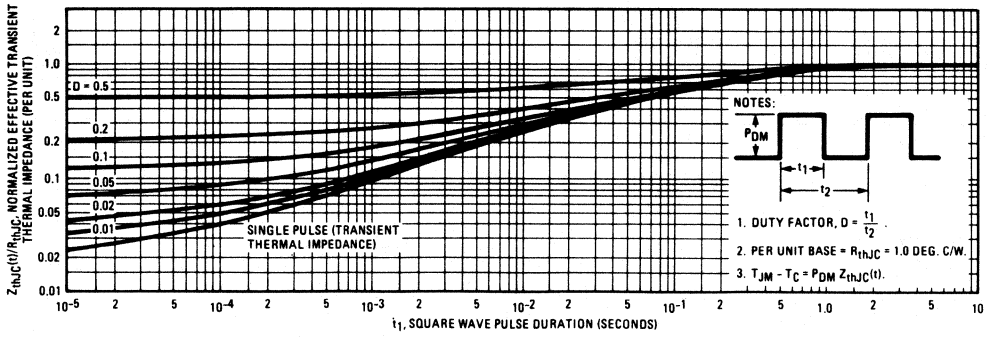


Fig. 6 – Typical Transconductance Vs. Drain Current

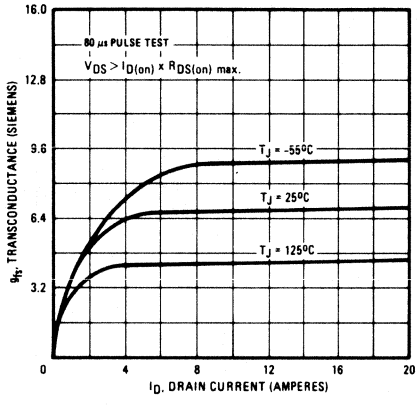


Fig. 7 – Typical Source-Drain Diode Forward Voltage

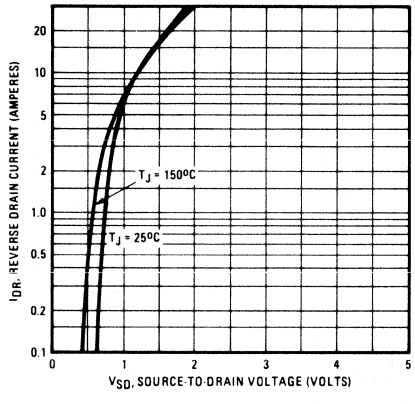


Fig. 8 – Breakdown Voltage Vs. Temperature

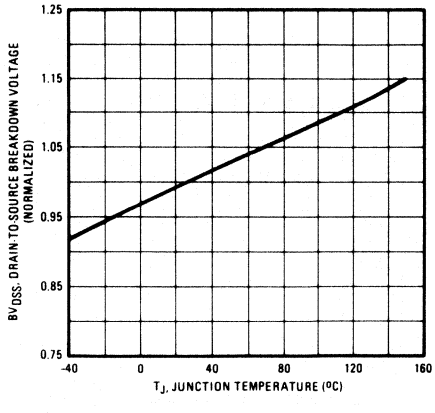
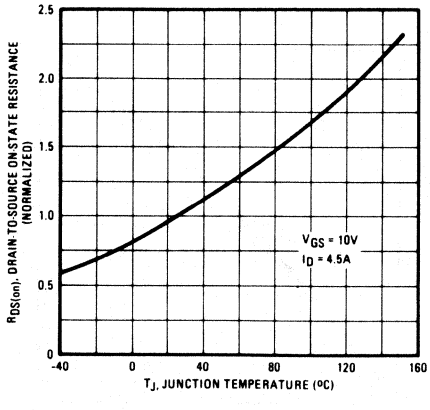


Fig. 9 – Normalized On-Resistance Vs. Temperature



3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

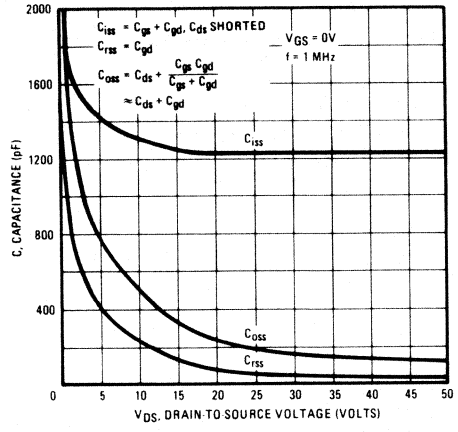


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

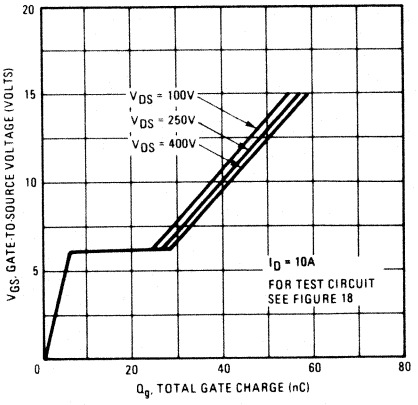


Fig. 12 – Typical On-Resistance Vs. Drain Current

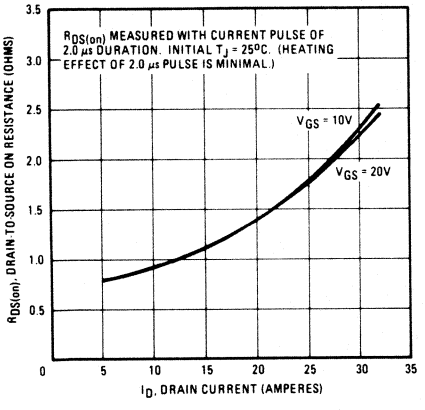


Fig. 13 – Maximum Drain Current Vs. Case Temperature

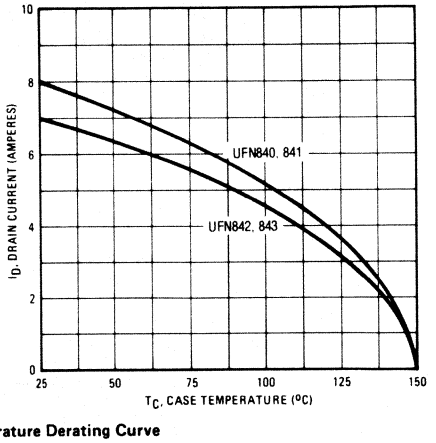


Fig. 14 – Power Vs. Temperature Derating Curve

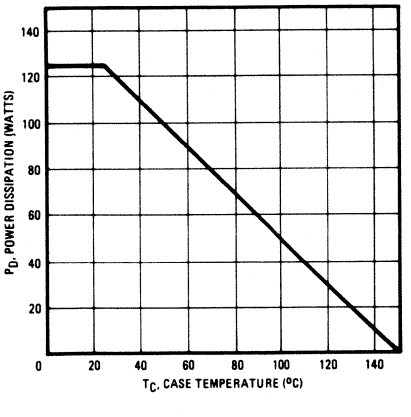


Fig. 15 – Clamped Inductive Test Circuit

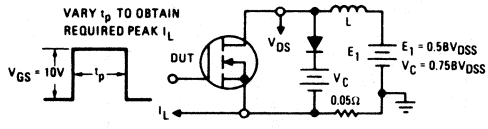


Fig. 16 – Clamped Inductive Waveforms

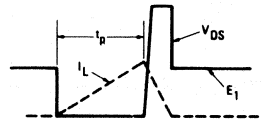


Fig. 17 – Switching Time Test Circuit

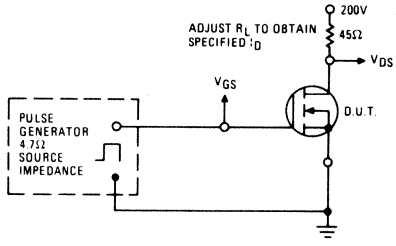
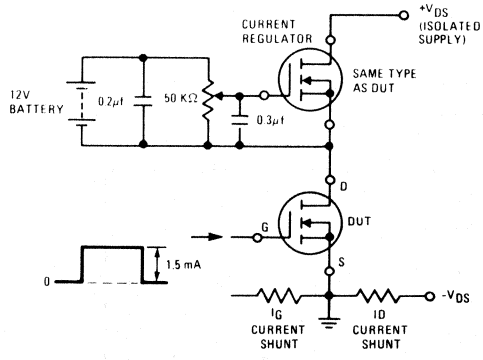


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

100 Volt, 2.4 Ohm N-Channel

UFND1Z0
UFND1Z3

3

FEATURES

- For Automatic Insertion
- Compact, End Stackable
- Fast Switching
- Low Drive Current
- Easily Paralleled
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

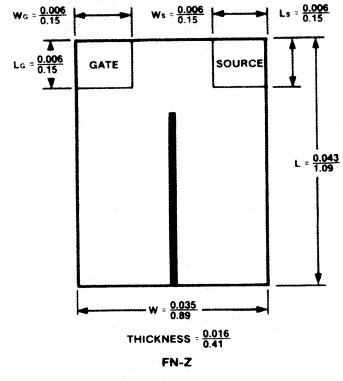
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

When packaged in the low profile, end stackable 4 pin dual-in-line package, the Unitrode power MOSFET devices can be used in high volume applications where automatic insertion is a must such as computer circuit boards, telecommunication equipment, consumer equipment, and printers.

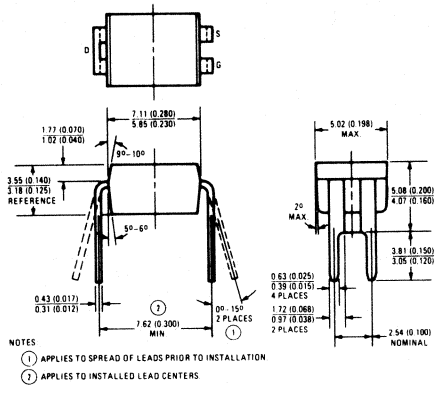
PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFND1Z0	100V	2.4Ω	0.5A
UFND1Z3	60V	3.2Ω	0.4A



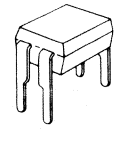
MECHANICAL SPECIFICATIONS

UFND1Z0 UFND1Z3



Nominal Dimensions in Millimeters and (Inches)

DIL-4



UNITRODE

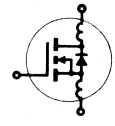
ABSOLUTE MAXIMUM RATINGS

Parameter		UFND1Z0	UFND1Z3	Units
V_{DS}	Drain - Source Voltage ①	100	60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	100	60	V
I_D @ T_C = 25°C	Continuous Drain Current	0.5	0.4	A
I_{DM}	Pulsed Drain Current	4.0	3.2	A
V_{GS}	Gate - Source Voltage	±20		V
P_D @ T_C = 25°C	Max. Power Dissipation	1.0 (See Fig. 13)		W
	Linear Derating Factor	0.008 (See Fig. 13)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 14 and 15) L = 100μH		A
		4.0	3.2	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150		°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFND1Z0	100	–	–	V	V_{GS} = 0V
		UFND1Z3	60	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFND1Z0	0.5	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFND1Z3	0.4	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFND1Z0	–	2.2	2.4	Ω	V_{GS} = 10V, I_D = 0.25A
		UFND1Z3	–	2.8	3.2	Ω	
g_{fs}	Forward Transconductance ②	ALL	–	0.35	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 0.25A
C_{iss}	Input Capacitance	ALL	–	50	70	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 9
C_{oss}	Output Capacitance	ALL	–	20	30	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	5.0	10	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	10	20	ns	V_{DD} = 0.5 BV_{DSS}, I_D = 0.25A, Z_O = 50Ω See Fig. 16 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	15	25	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	15	25	ns	
t_f	Fall Time	ALL	–	10	20	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	2.0	3.0	nC	V_{GS} = 10V, I_D = 1.2A, V_{DS} = 0.8 Max. Rating. See Fig. 17 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	1.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	1.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	4.0	–	nH	Measured from the drain lead, 2.0mm (0.08 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	6.0	–	nH	Measured from the source lead, 2.0mm (0.08 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJA}	Junction-to-Ambient	ALL	–	–	120	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFND1Z0	–	–	0.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFND1Z3	–	–	0.4	A	
I_{SM}	Pulse Source Current (Body Diode)	UFND1Z0	–	–	4.0	A	
		UFND1Z3	–	–	3.2	A	
V_{SD}	Diode Forward Voltage ②	UFND1Z0	–	–	1.4	V	T_C = 25°C, I_S = 0.5A, V_{GS} = 0V
		UFND1Z3	–	–	1.3	V	T_C = 25°C, I_S = 0.4A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	100	–	ns	T_J = 150°C, I_F = 0.5A, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	0.2	–	μC	T_J = 150°C, I_F = 0.5A, dI_F/dt = 100 A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%.

Fig. 1 – Typical Output Characteristics

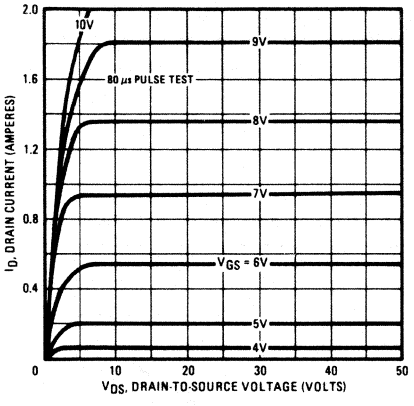


Fig. 2 – Typical Transfer Characteristics

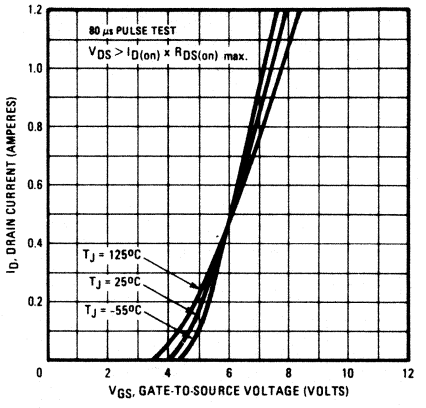


Fig. 3 – Typical Saturation Characteristics

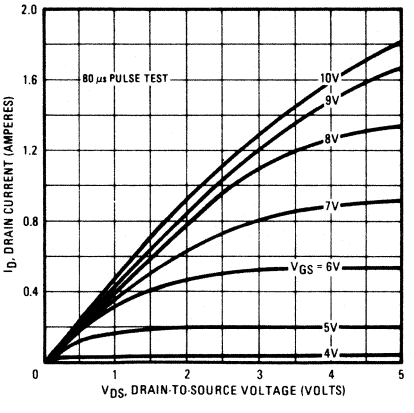
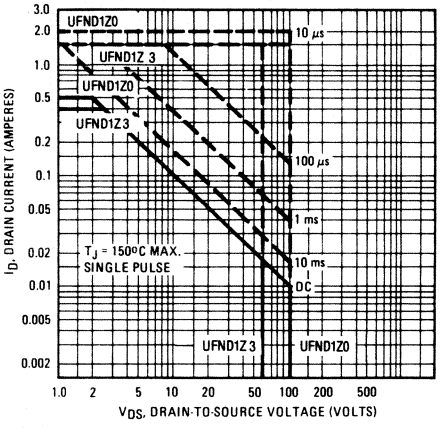


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Typical Transconductance Vs. Drain Current

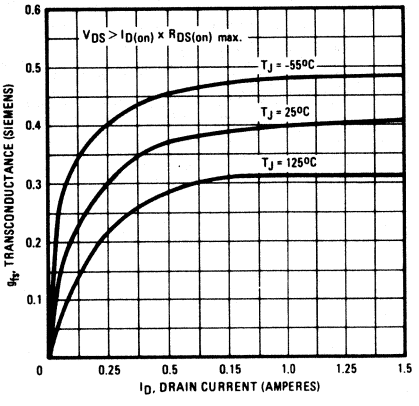


Fig. 6 – Typical Source-Drain Diode Forward Voltage

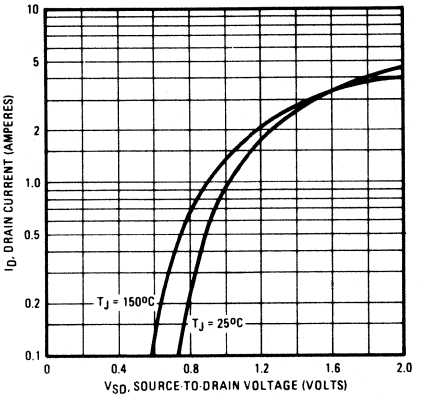


Fig. 7 – Breakdown Voltage Vs. Temperature

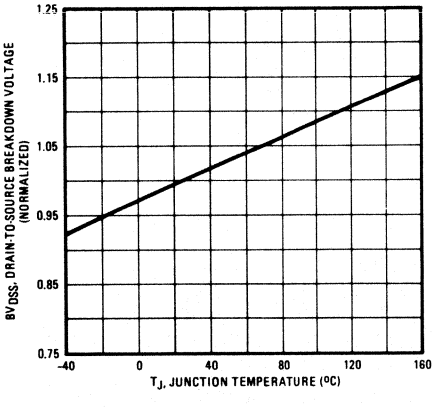
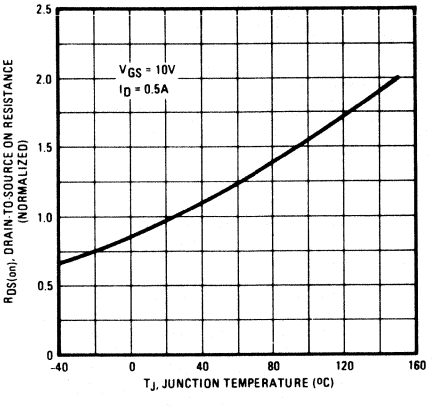


Fig. 8 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 9 – Typical Capacitance Vs. Drain-to-Source Voltage

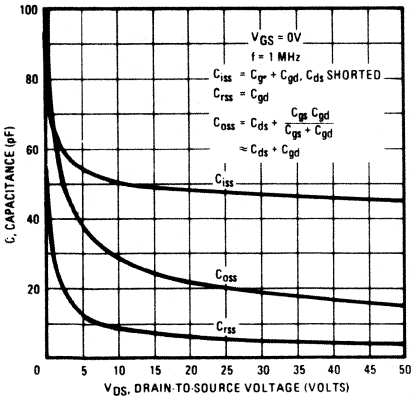


Fig. 10 – Typical Gate Charge Vs. Gate-to-Source Voltage

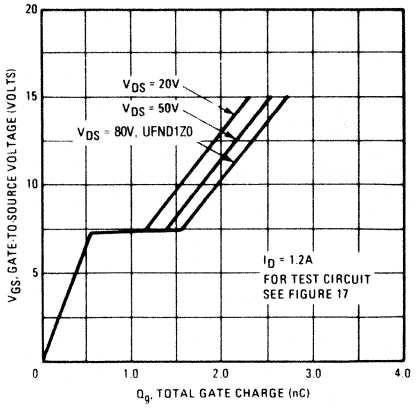


Fig. 11 – Typical On-Resistance Vs. Drain Current

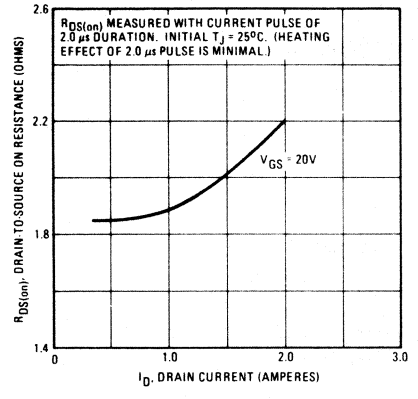


Fig. 12 – Maximum Drain Current Vs. Case Temperature

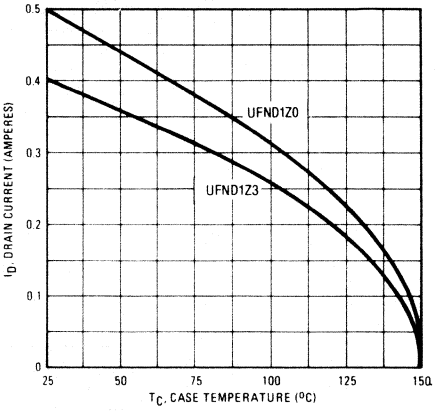


Fig. 13 – Power Vs. Temperature Derating Curve

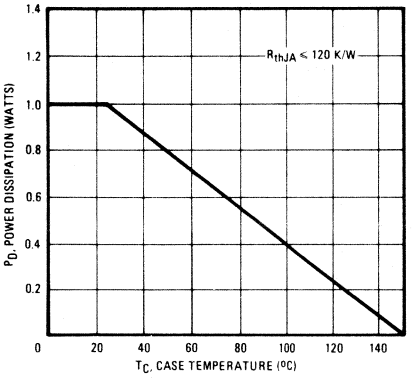


Fig. 14 – Clamped Inductive Test Circuit

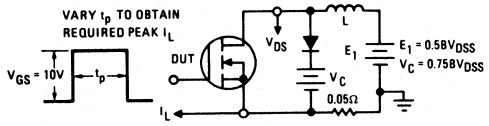


Fig. 15 – Clamped Inductive Waveforms

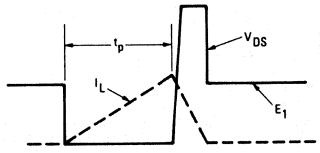


Fig. 16 – Switching Time Test Circuit

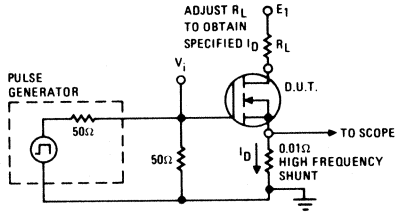
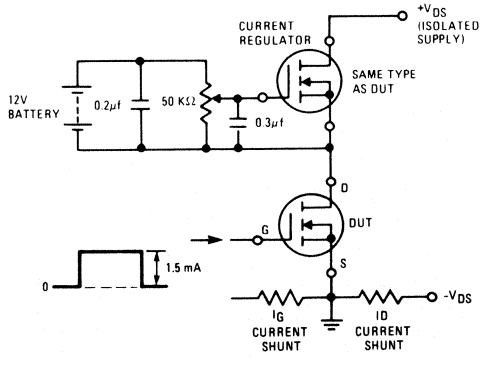


Fig. 17 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

100 Volt, 0.6 Ohm N-Channel

UFND110
UFND113

3

FEATURES

- For Automatic Insertion
- Compact, End Stackable
- Fast Switching
- Low Drive Current
- Easily Paralleled
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

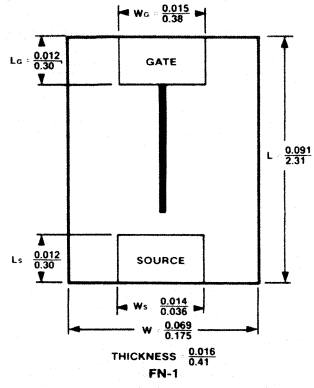
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

When packaged in the low profile, end stackable 4 pin dual-in-line package, the Unitrode power MOSFET devices can be used in high volume applications where automatic insertion is a must such as computer circuit boards, consumer equipment, and printers.

PRODUCT SUMMARY

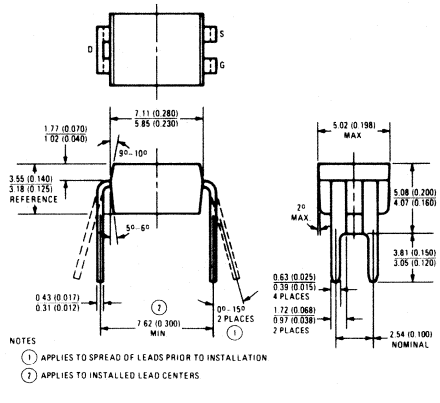
Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFND110	100V	0.6Ω	1.0A
UFND113	60V	0.8Ω	0.8A



FN-1

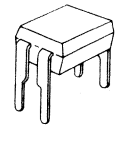
MECHANICAL SPECIFICATIONS

UFND110 UFND113



Nominal Dimensions in Millimeters and (Inches)

DIL-4



UNITRODE

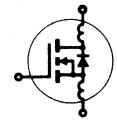
ABSOLUTE MAXIMUM RATINGS

Parameter		UFND110	UFND113	Units
V_{DS}	Drain - Source Voltage ①	100	60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	100	60	V
I_D @ T_C = 25°C	Continuous Drain Current	1.0	0.8	A
I_{DM}	Pulsed Drain Current	8.0	6.4	A
V_{GS}	Gate - Source Voltage	±20		V
P_D @ T_C = 25°C	Max. Power Dissipation	1.0 (See Fig. 13)		W
	Linear Derating Factor	0.008 (See Fig. 13)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 14 and 15) L = 100μH		A
		8.0	6.4	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150		°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFND110	100	–	–	V	V_{GS} = 0V
		UFND113	60	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFND110	1.0	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFND113	0.8	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFND110	–	0.5	0.6	Ω	V_{GS} = 10V, I_D = 0.8A
		UFND113	–	0.6	0.8	Ω	
g_{fs}	Forward Transconductance ②	ALL	0.8	1.2	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 0.8A
C_{iss}	Input Capacitance	ALL	–	135	200	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 9
C_{oss}	Output Capacitance	ALL	–	80	100	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	20	25	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	10	20	ns	V_{DD} ≈ 0.5 BV_{DSS}, I_D ≈ 0.8A, Z_o = 50Ω See Fig. 16 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	15	25	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	15	25	ns	
t_f	Fall Time	ALL	–	10	20	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	5.0	7.0	nC	V_{GS} = 10V, I_D = 4.0A, V_{DS} = 0.8 Max. Rating. See Fig. 17 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	2.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	7.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	4.0	–	nH	Measured from the drain lead, 2.0mm (0.08 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	6.0	–	nH	Measured from the source lead, 2.0mm (0.08 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJA}	Junction-to-Ambient	ALL	–	–	120	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFND110	–	–	1.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFND113	–	–	0.8	A	
I_{SM}	Pulse Source Current (Body Diode)	UFND110	–	–	8.0	A	
		UFND113	–	–	6.4	A	
V_{SD}	Diode Forward Voltage ②	UFND110	–	–	2.5	V	T_C = 25°C, I_S = 1.0A, V_{GS} = 0V
		UFND112	–	–	2.0	V	T_C = 25°C, I_S = 0.8A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	100	–	ns	T_J = 150°C, I_F = 1.0A, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	0.2	–	μC	T_J = 150°C, I_F = 1.0A, dI_F/dt = 100 A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%.

Fig. 1 – Typical Output Characteristics

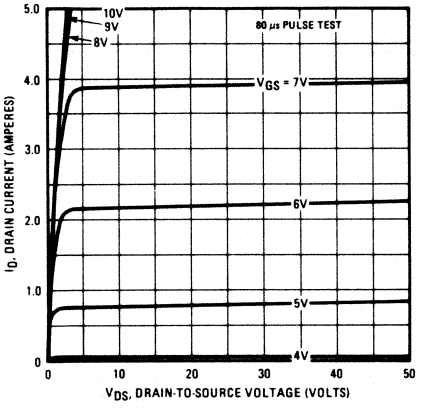


Fig. 2 – Typical Transfer Characteristics

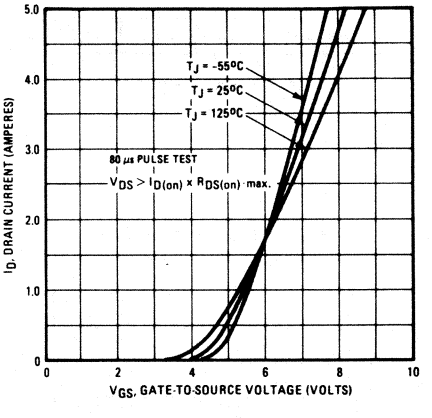


Fig. 3 – Typical Saturation Characteristics

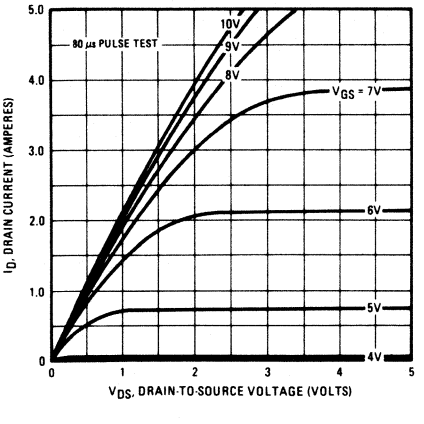
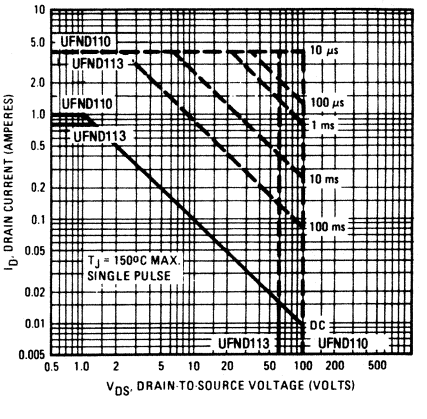


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Typical Transconductance Vs. Drain Current

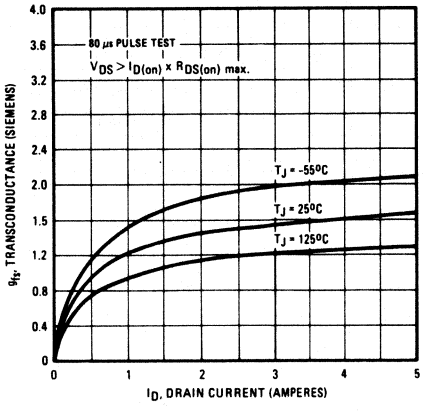


Fig. 6 – Typical Source-Drain Diode Forward Voltage

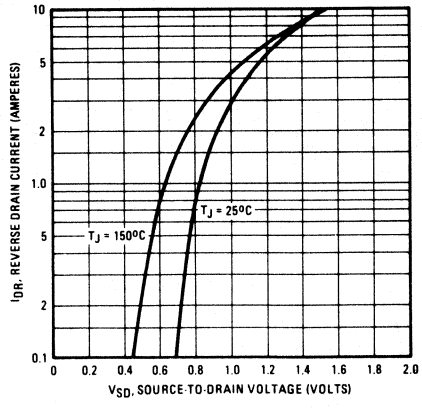


Fig. 7 – Breakdown Voltage Vs. Temperature

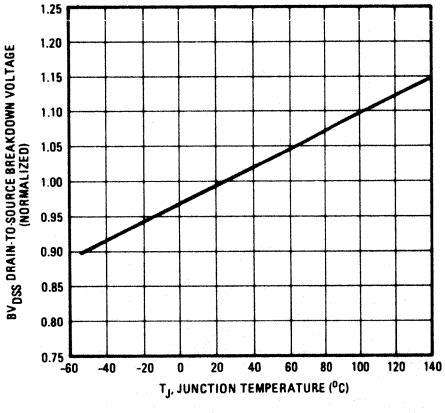


Fig. 8 – Normalized On-Resistance Vs. Temperature

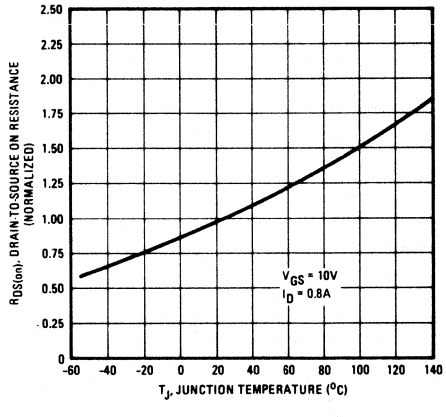


Fig. 9 – Typical Capacitance Vs. Drain-to-Source Voltage

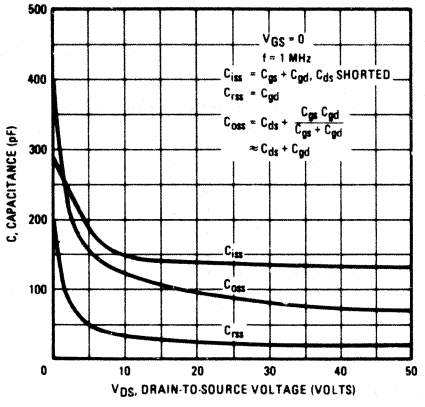


Fig. 10 – Typical Gate Charge Vs. Gate-to-Source Voltage

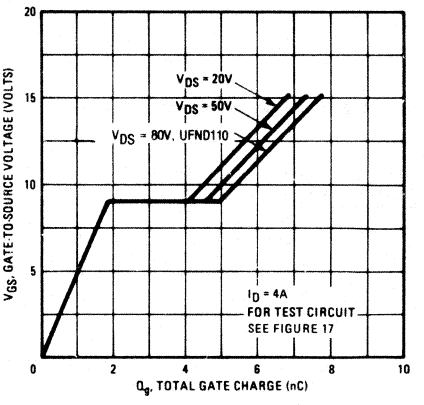


Fig. 11 – Typical On-Resistance Vs. Drain Current

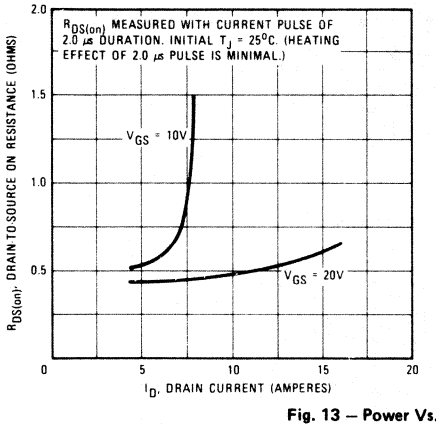


Fig. 12 – Maximum Drain Current Vs. Case Temperature

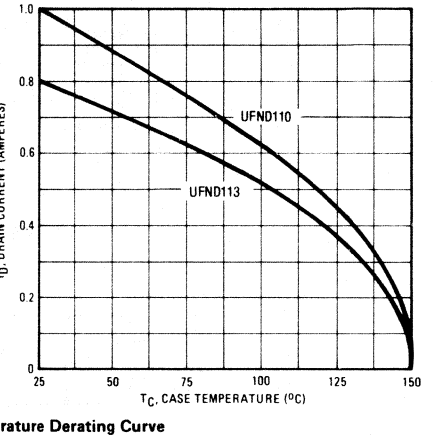
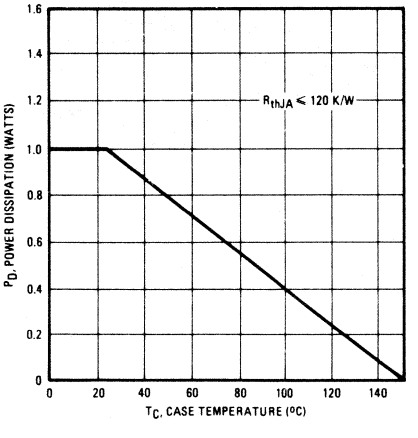


Fig. 13 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 14 – Clamped Inductive Test Circuit

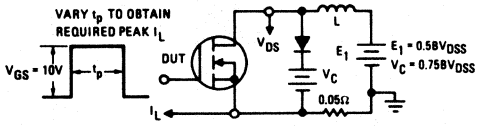


Fig. 15 – Clamped Inductive Waveforms

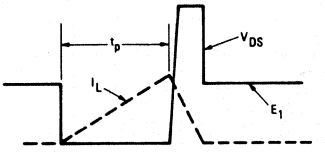


Fig. 16 – Switching Time Test Circuit

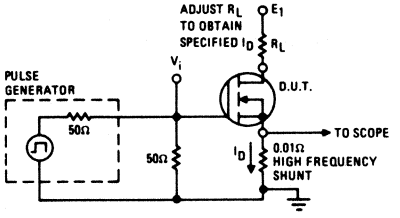
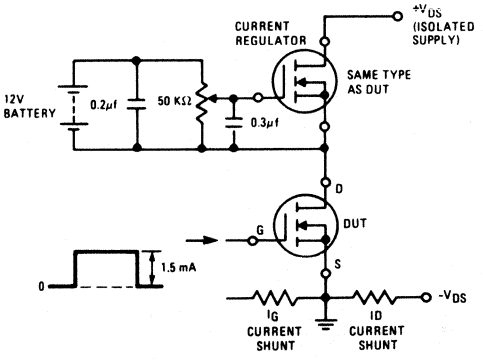


Fig. 17 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

100 Volt, 0.3 Ohm N-Channel

UFND120
UFND123

3

FEATURES

- For Automatic Insertion
- Compact, End Stackable
- Fast Switching
- Low Drive Current
- Easily Paralleled
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

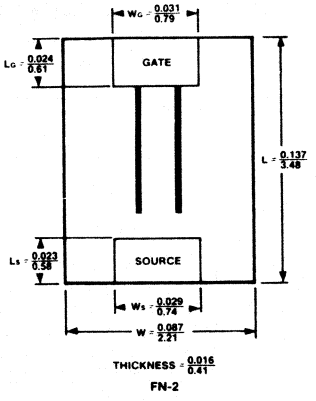
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

When packaged in the low profile, end stackable 4 pin dual-in-line package, the Unitrode power MOSFET devices can be used in high volume applications where automatic insertion is a must such as computer circuit boards, telecommunication equipment, consumer equipment, and printers.

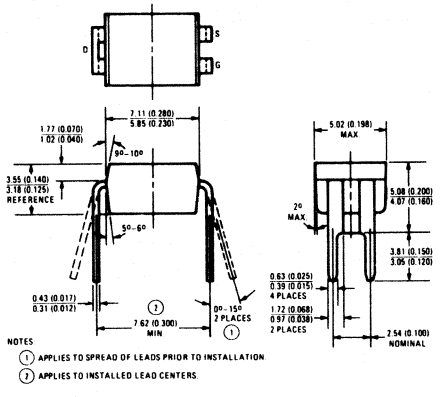
PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFND120	100V	0.3Ω	1.3A
UFND123	60V	0.4Ω	1.1A



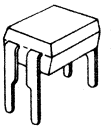
MECHANICAL SPECIFICATIONS

UFND120 UFND123



Nominal Dimensions in Millimeters and (Inches)

DIL-4



UNITRODE

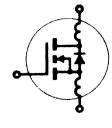
ABSOLUTE MAXIMUM RATINGS

Parameter		UFND120	UFND123	Units
V_{DS}	Drain – Source Voltage ①	100	60	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ) ①	100	60	V
I_D @ T_A = 25°C	Continuous Drain Current	1.3	1.1	A
I_{DM}	Pulsed Drain Current	5.2	4.4	A
V_{GS}	Gate – Source Voltage	±20		V
P_D @ T_A = 25°C	Max. Power Dissipation	1.0 (See Fig. 13)		W
	Linear Derating Factor	0.008 (See Fig. 13)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 14 and 15) L = 100μH 5.21	4.4	A
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150		°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)		°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	UFND120	100	–	–	V	V_{GS} = 0V
		UFND123	60	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate – Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate – Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFND120	1.3	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFND123	1.1	–	–	A	
$R_{DS(on)}$	Static Drain – Source On-State Resistance ②	UFND120	–	0.25	0.30	Ω	V_{GS} = 10V, I_D = 0.6A
		UFND123	–	0.30	0.40	Ω	
g_{fs}	Forward Transconductance ②	ALL	0.9	1.0	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 0.6A
C_{iss}	Input Capacitance	ALL	–	450	600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 9
C_{oss}	Output Capacitance	ALL	–	200	400	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	50	100	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	20	40	ns	V_{DD} = 0.5 BV_{DSS}, I_D = 0.6A, Z_o = 50Ω See Fig. 16 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	35	70	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	50	100	ns	
t_f	Fall Time	ALL	–	35	70	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	11	15	nC	V_{GS} = 10V, I_D = 5.2A, V_{DS} = 0.8 Max. Rating. See Fig. 17 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	6.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	5.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	4.0	–	nH	Measured from the drain lead, 2.0mm (0.08 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	6.0	–	nH	Measured from the source lead, 2.0mm (0.08 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJA}	Junction-to-Ambient	ALL	–	–	120	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFND120	—	—	1.3	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		UFND123	—	—	1.1	A	
I_{SM}	Pulse Source Current (Body Diode)	UFND120	—	—	5.2	A	
		UFND123	—	—	4.4	A	
V_{SD}	Diode Forward Voltage ②	UFND120	—	—	2.5	V	T_C = 25°C, I_S = 1.3A, V_{GS} = 0V
		UFND123	—	—	2.3	V	T_C = 25°C, I_S = 1.1A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	280	—	ns	T_J = 150°C, I_F = 1.3A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	1.6	—	μC	T_J = 150°C, I_F = 1.3A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%.

Fig. 1 – Typical Output Characteristics

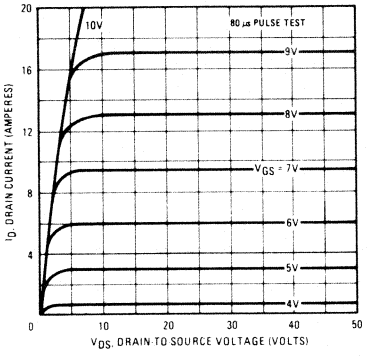


Fig. 2 – Typical Transfer Characteristics

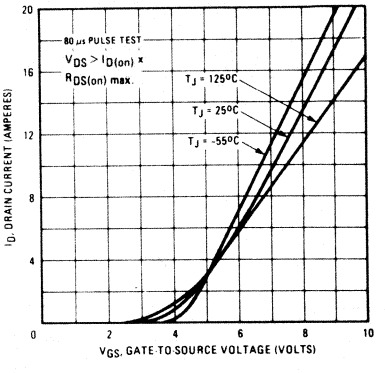


Fig. 3 – Typical Saturation Characteristics

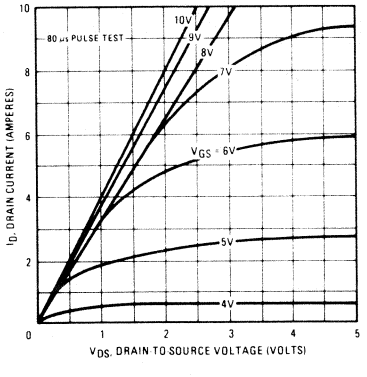
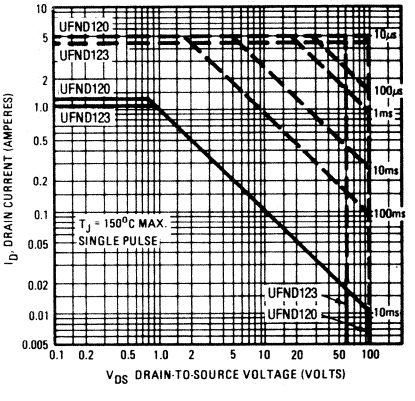


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Typical Transconductance Vs. Drain Current

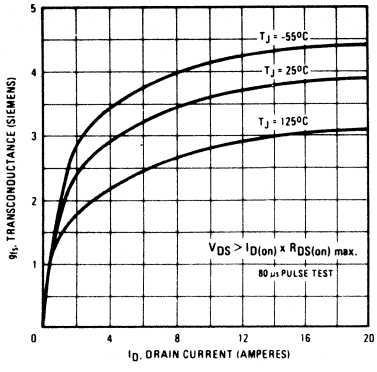


Fig. 6 – Typical Source-Drain Diode Forward Voltage

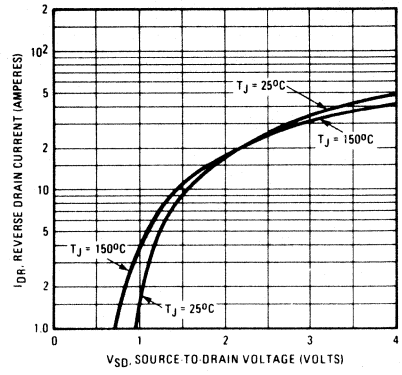


Fig. 7 – Breakdown Voltage Vs. Temperature

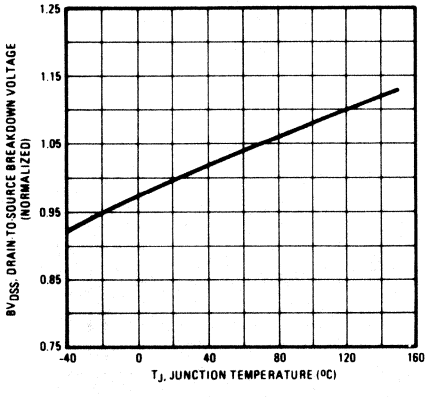
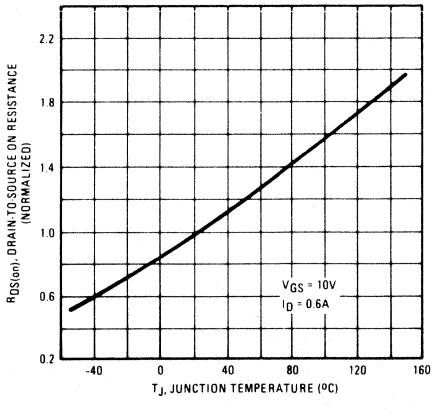


Fig. 8 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 9 – Typical Capacitance Vs. Drain-to-Source Voltage

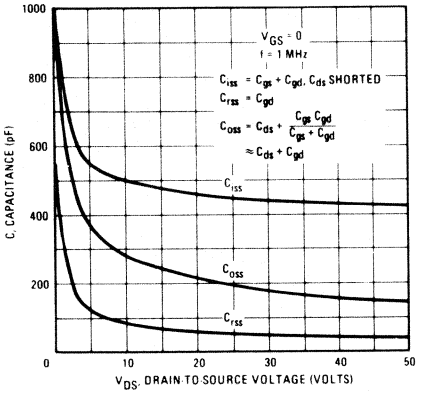


Fig. 10 – Typical Gate Charge Vs. Gate-to-Source Voltage

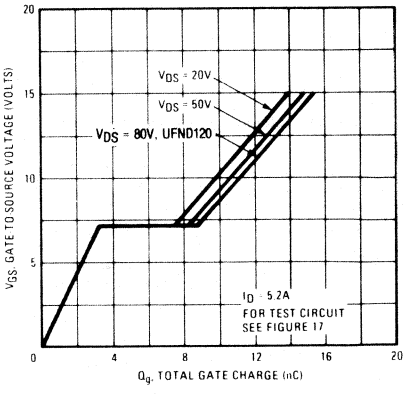


Fig. 11 – Typical On-Resistance Vs. Drain Current

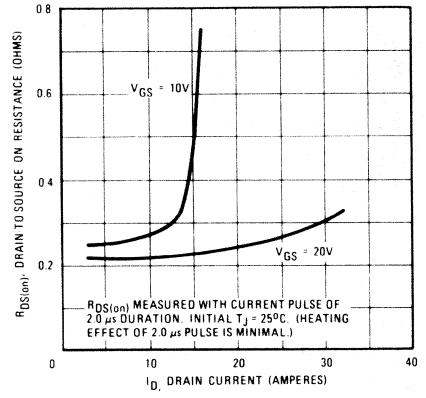


Fig. 12 – Maximum Drain Current Vs. Case Temperature

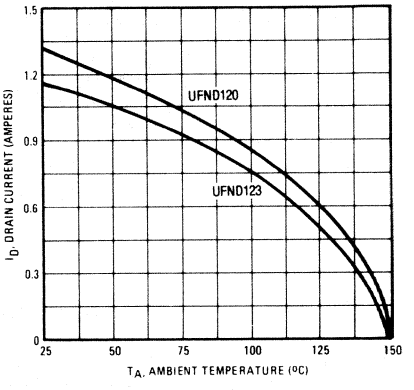


Fig. 13 – Power Vs. Temperature Derating Curve

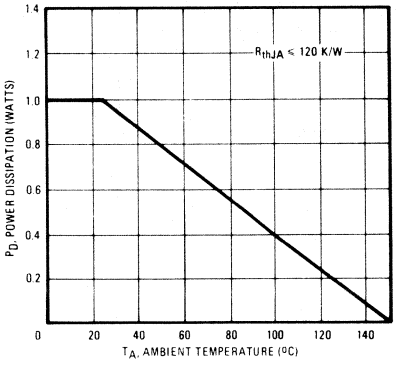


Fig. 14 – Clamped Inductive Test Circuit

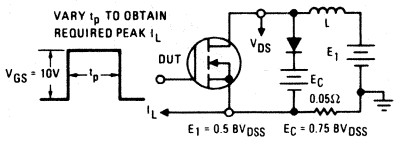


Fig. 15 – Clamped Inductive Waveforms

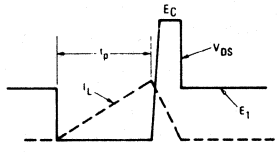


Fig. 16 – Switching Time Test Circuit

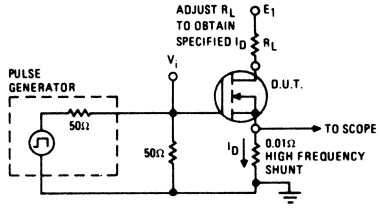
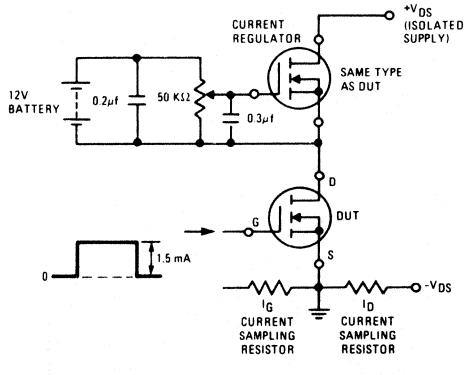


Fig. 17 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

200 Volt, 1.5 Ohm N-Channel

UFND210
UFND213

3

FEATURES

- For Automatic Insertion
- Compact, End Stackable
- Fast Switching
- Low Drive Current
- Easily Paralleled
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

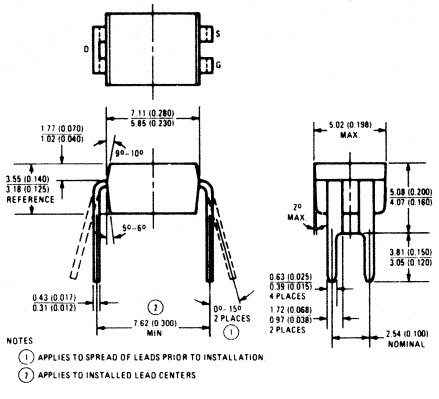
When packaged in the low profile, end stackable 4 pin dual-in-line package, the Unitrode power MOSFET devices can be used in high volume applications where automatic insertion is a must such as computer circuit boards, telecommunication equipment, consumer equipment, and printers.

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFND210	200V	1.5Ω	0.6A
UFND213	150V	2.4Ω	0.45A

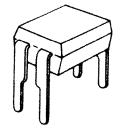
MECHANICAL SPECIFICATIONS

UFND210 UFND213



Nominal Dimensions in Millimeters and (Inches)

DIL-4



UNITRODE

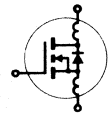
ABSOLUTE MAXIMUM RATINGS

Parameter		UFND210	UFND213	Units
V_{DS}	Drain – Source Voltage ①	200	150	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ) ①	200	150	V
I_D @ T_A = 25°C	Continuous Drain Current	0.6	0.45	A
I_{DM}	Pulsed Drain Current	2.5	1.8	A
V_{GS}	Gate – Source Voltage	±20		V
P_D @ T_A = 25°C	Max. Power Dissipation	1.0 (See Fig. 13)		W
	Linear Derating Factor	0.008 (See Fig. 13)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 14 and 15) L = 100μH	2.5 | 1.8	A
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150		°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)		°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	UFND210	200	–	–	V	V_{GS} = 0V
		UFND213	150	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate – Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate – Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFND210	0.6	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFND213	0.45	–	–	A	
$R_{DS(on)}$	Static Drain – Source On-State Resistance ②	UFND210	–	1.0	1.5	Ω	V_{GS} = 10V, I_D = 0.3A
		UFND213	–	1.5	2.4	Ω	
g_{fs}	Forward Transconductance ②	ALL	0.5	0.8	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 0.3A
C_{iss}	Input Capacitance	ALL	–	135	150	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 9
C_{oss}	Output Capacitance	ALL	–	60	80	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	16	25	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	8.0	15	ns	V_{DD} = 0.5 BV_{DSS}, I_D = 0.3A, Z_o = 50Ω See Fig. 16 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	15	25	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	10	15	ns	
t_f	Fall Time	ALL	–	8.0	15	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	5.0	7.5	nC	V_{GS} = 10V, I_D = 2.5A, V_{DS} = 0.8 Max. Rating. See Fig. 17 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	2.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	3.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	4.0	–	nH	Measured from the drain lead, 2.0mm (0.08 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	6.0	–	nH	Measured from the source lead, 2.0mm (0.08 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJA}	Junction-to-Ambient	ALL	–	–	120	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFND210	–	–	0.6	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		UFND213	–	–	0.45	A	
I_{SM}	Pulse Source Current (Body Diode)	UFND210	–	–	2.5	A	
		UFND213	–	–	1.8	A	
V_{SD}	Diode Forward Voltage ②	UFND210	–	–	2.0	V	T_A = 25°C, I_S = 0.6A, V_{GS} = 0V
		UFND213	–	–	1.8	V	T_A = 25°C, I_S = 0.45A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	290	–	ns	T_J = 150°C, I_F = 0.6A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	2.0	–	μC	T_J = 150°C, I_F = 0.6A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%.

Fig. 1 – Typical Output Characteristics

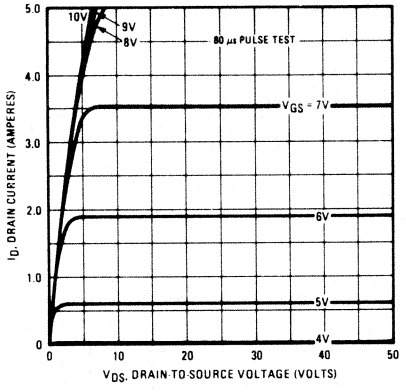


Fig. 2 – Typical Transfer Characteristics

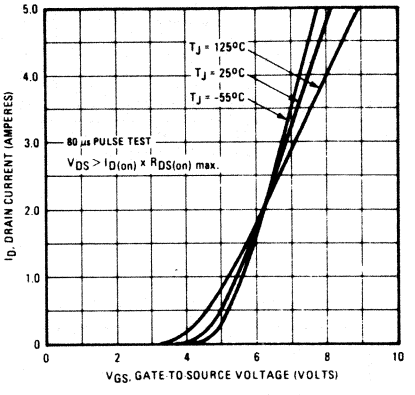


Fig. 3 – Typical Saturation Characteristics

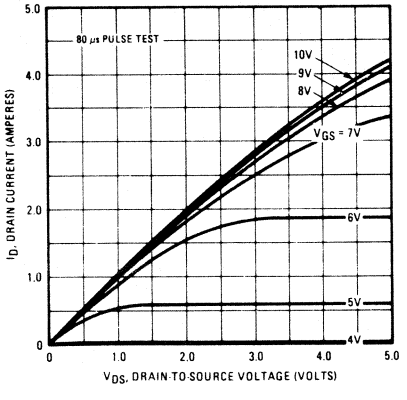


Fig. 4 – Maximum Safe Operating Area

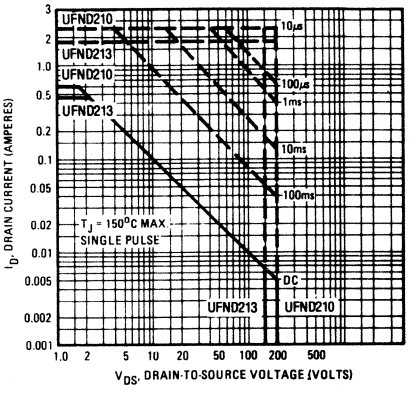


Fig. 5 – Typical Transconductance Vs. Drain Current

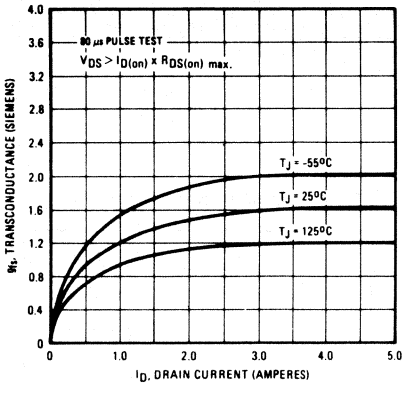


Fig. 6 – Typical Source-Drain Diode Forward Voltage

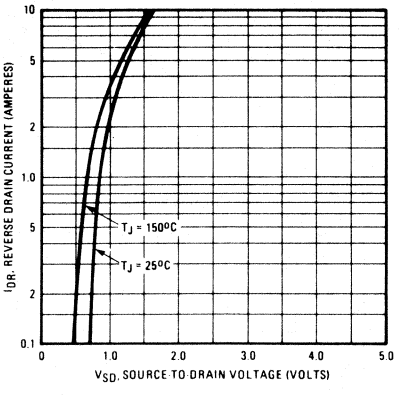


Fig. 7 – Breakdown Voltage Vs. Temperature

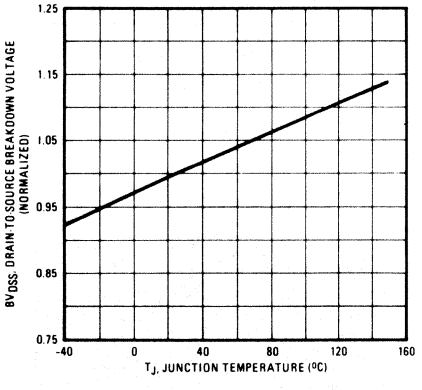
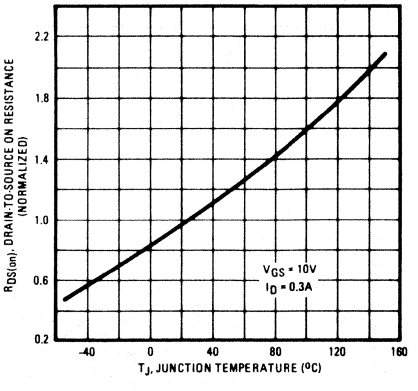


Fig. 8 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 9 – Typical Capacitance Vs. Drain-to-Source Voltage

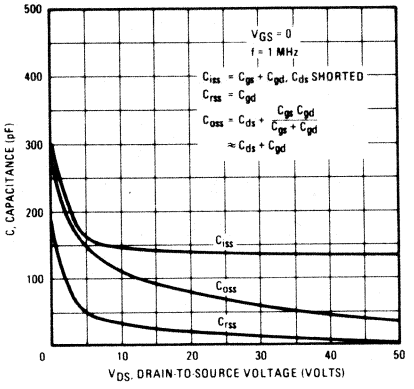


Fig. 10 – Typical Gate Charge Vs. Gate-to-Source Voltage

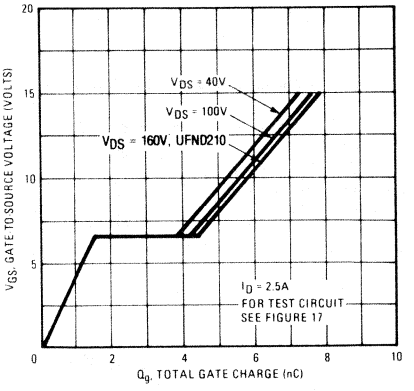


Fig. 11 – Typical On-Resistance Vs. Drain Current

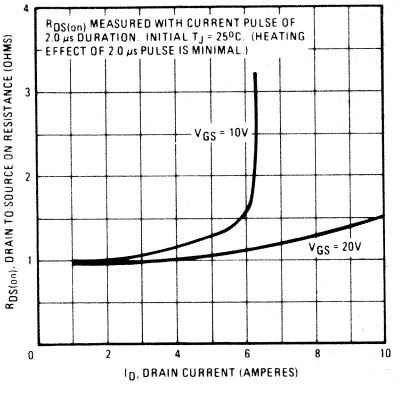


Fig. 12 – Maximum Drain Current Vs. Case Temperature

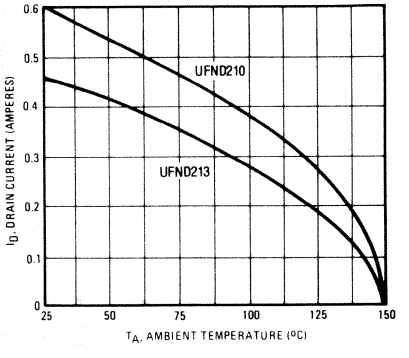
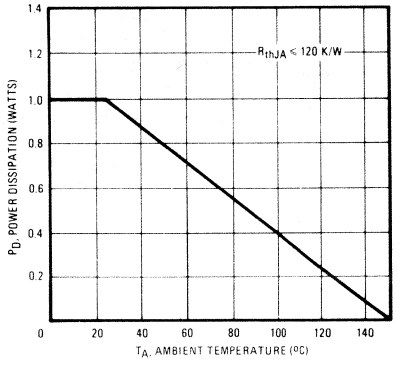


Fig. 13 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 14 – Clamped Inductive Test Circuit

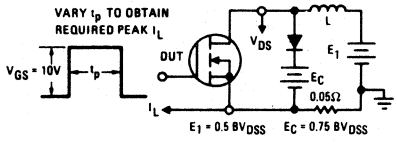


Fig. 15 – Clamped Inductive Waveforms

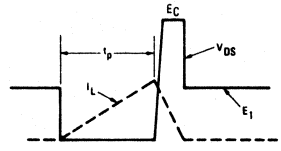


Fig. 16 – Switching Time Test Circuit

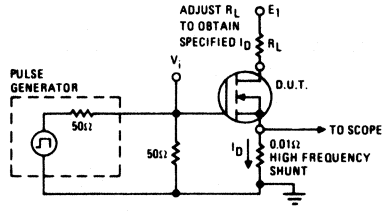
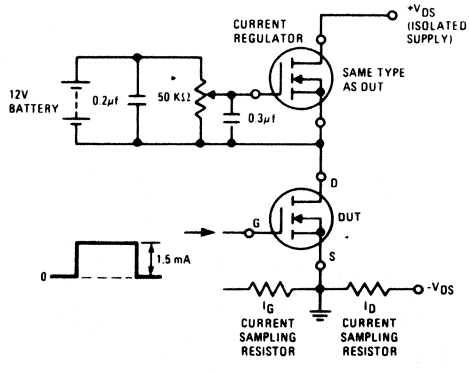


Fig. 17 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

UFND220
UFND223

200 Volt, 0.8 Ohm
N-Channel

3

FEATURES

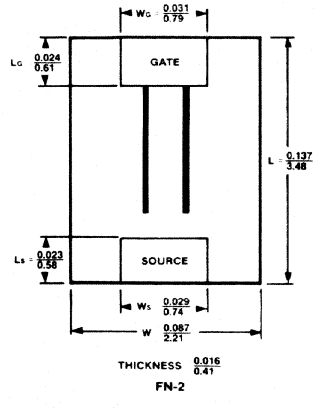
- For Automatic Insertion
- Compact, End Stackable
- Fast Switching
- Low Drive Current
- Easily Paralleled
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(ON)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

When packaged in the low profile, end stackable 4 pin dual-in-line package, the Unitrode power MOSFET devices can be used in high volume applications where automatic insertion is a must such as computer circuit boards, telecommunication equipment, consumer equipment, and printers.



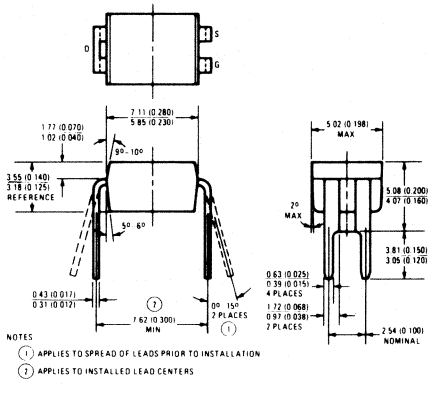
FN-2

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(ON)}$	I_D
UFND220	200V	0.8Ω	0.8A
UFND223	150V	1.2Ω	0.7A

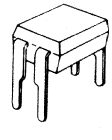
MECHANICAL SPECIFICATIONS

UFND220 UFND223



Nominal Dimensions in Millimeters and (Inches)

DIL-4



UNITRODE

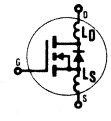
Absolute Maximum Ratings

Parameter		UFND220	UFND223	Units
V_{DS}	Drain - Source Voltage ①	200	150	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 20 KΩ) ①	200	150	V
I_D @ T_A = 25°C	Continuous Drain Current	0.8	0.7	A
I_{DM}	Pulsed Drain Current	6.4	5.6	A
V_{GS}	Gate - Source Voltage	±20		V
P_D @ T_A = 25°C	Max. Power Dissipation	1.0 (See Fig. 13)		W
	Linear Derating Factor	0.008 (See Fig. 13)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 14 and 15) L = 100μH		A
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150		°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)		°C

Electrical Characteristics @T_C = 25°C (Unless Otherwise Specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFND220	200	–	–	V	V_{GS} = 0V
		UFND223	150	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate - Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate - Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFND220	0.8	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, V_{GS} = 10V
		UFND223	0.7	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFND220	–	0.5	0.8	Ω	V_{GS} = 10V, I_D = 0.4A
		UFND223	–	0.8	1.2	Ω	
g_{fs}	Forward Transconductance ②	ALL	0.5	1.1	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, I_D = 0.4A
C_{iss}	Input Capacitance	ALL	–	450	600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 9
C_{oss}	Output Capacitance	ALL	–	150	300	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	40	80	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	20	40	ns	V_{DD} ≈ 0.5BV_{DSS}, I_D = 0.4A, Z_o = 50Ω See Fig. 16 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	30	60	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	50	100	ns	
t_f	Fall Time	ALL	–	30	60	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	11	15	nC	V_{GS} = 10V, I_D = 5.6A, V_{DS} ≈ 0.8 Max. Rating. See Fig. 17 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	6.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	5.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	4.0	–	nH	Measure from the drain lead, 2.0mm (0.08 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	6.0	–	nH	Measured from the source lead, 2.0mm (0.08 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



Thermal Resistance

R_{thJA}	Junction-to-Ambient	ALL	–	–	120	K/W	Free Air Operation

Source-Drain Diode Ratings and Characteristics

I_S	Continuous Source Current (Body Diode)	UFND220	–	–	0.8	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFND223	–	–	0.7	A	
I_{SM}	Pulse Source Current (Body Diode)	UFND220	–	–	6.4	A	
		UFND223	–	–	5.6	A	
V_{SD}	Diode Forward Voltage ②	UFND220	–	–	2.0	V	T_A = 25°C, I_S = 0.8A, V_{GS} = 0V
		UFND223	–	–	1.8	V	T_A = 25°C, I_S = 0.7A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	150	–	ns	T_J = 150°C, I_F = 0.8A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	0.6	–	μC	T_J = 150°C, I_F = 0.8A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				



①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 1 – Typical Output Characteristics

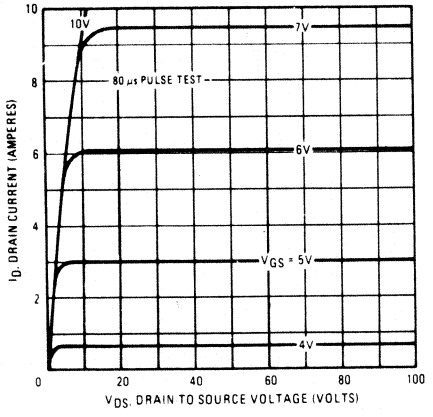


Fig. 2 – Typical Transfer Characteristics

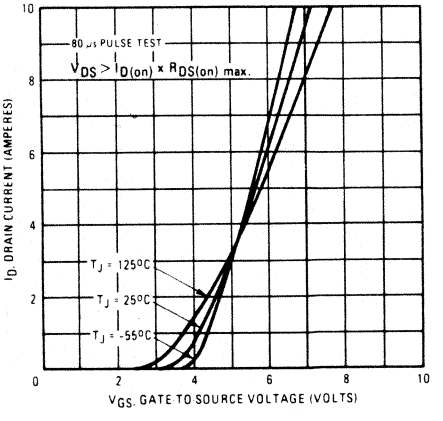


Fig. 3 – Typical Saturation Characteristics

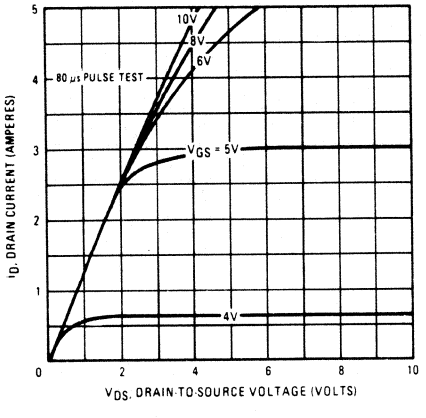
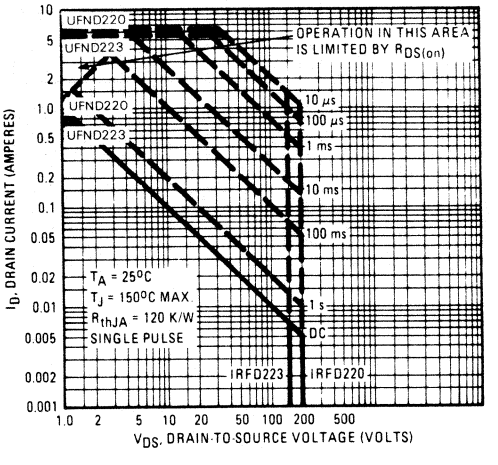


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Typical Transconductance Vs. Drain Current

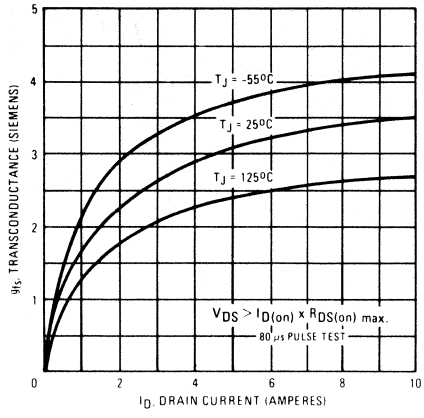


Fig. 6 – Typical Source-Drain Diode Forward Voltage

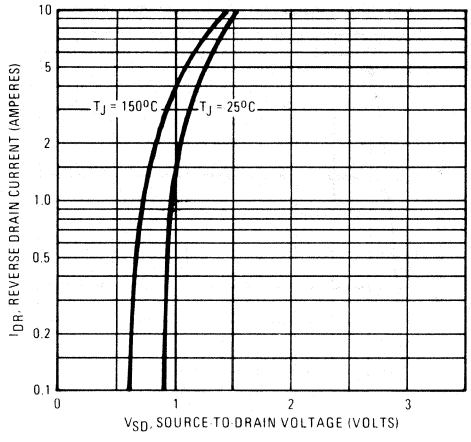


Fig. 7 – Breakdown Voltage Vs. Temperature

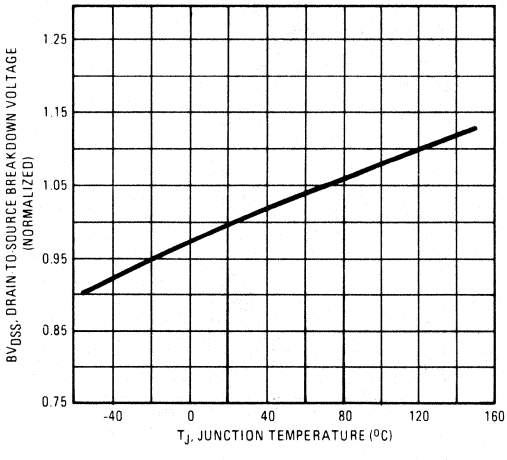
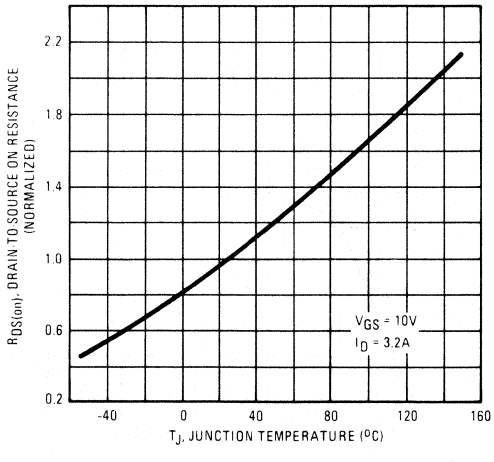


Fig. 8 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 9 – Typical Capacitance Vs. Drain-to-Source Voltage

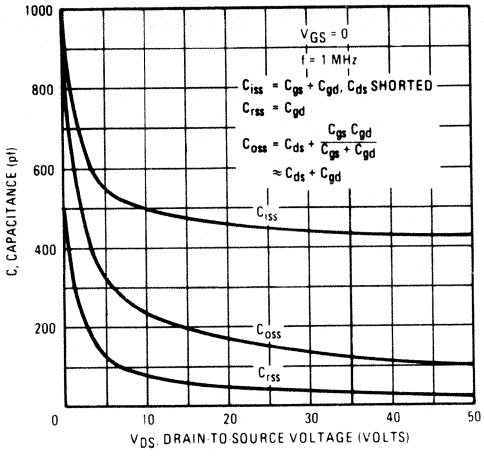


Fig. 10 – Typical Gate Charge Vs. Gate-to-Source Voltage

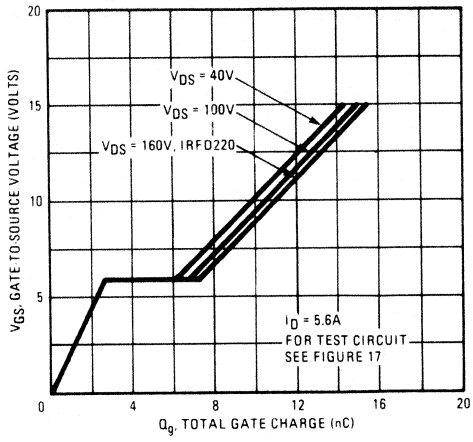


Fig. 11 – Typical On-Resistance Vs. Drain Current

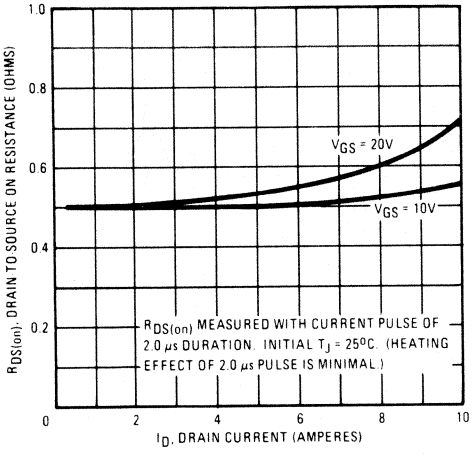


Fig. 12 – Maximum Drain Current Vs. Case Temperature

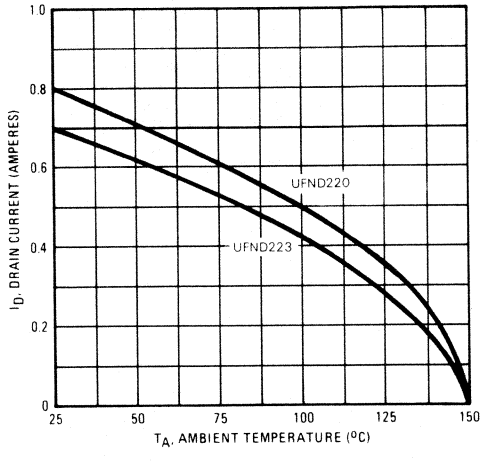
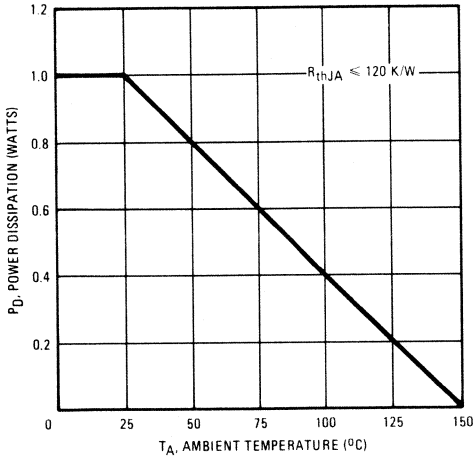


Fig. 13 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 14 — Clamped Inductive Test Circuit

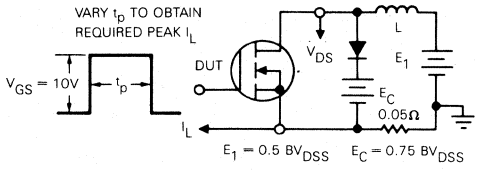


Fig. 15 — Clamped Inductive Waveforms

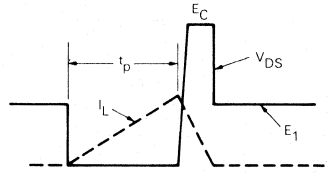


Fig. 16 — Switching Time Test Circuit

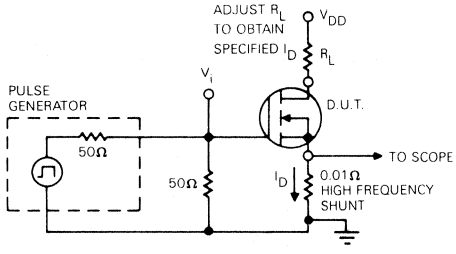
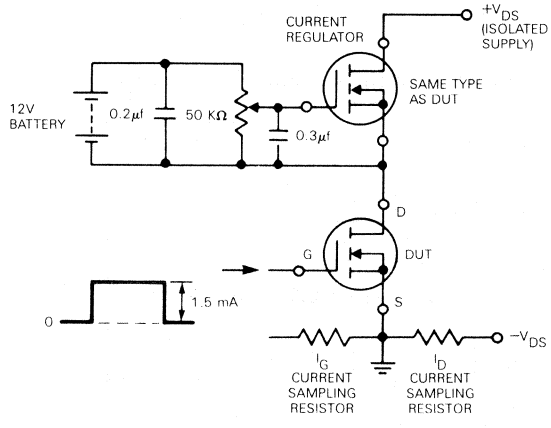


Fig. 17 — Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

100 Volt, 0.60 Ohm
N-Channel

UFNF110
UFNF111
UFNF112
UFNF113

3

FEATURES

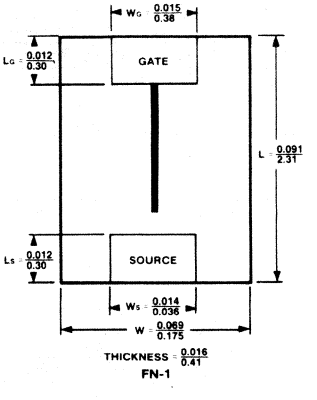
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



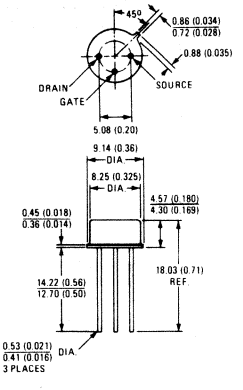
FN-1

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFNF110	100V	0.6Ω	3.5A
UFNF111	60V	0.6Ω	3.5A
UFNF112	100V	0.8Ω	3.0A
UFNF113	60V	0.8Ω	3.0A

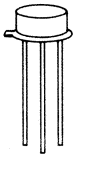
MECHANICAL SPECIFICATIONS

UFNF110 UFNF111 UFNF112 UFNF113



All Dimensions in Millimeters and (Inches)

TO-205AD (TO-39)



UNITRODE

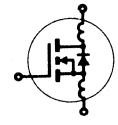
ABSOLUTE MAXIMUM RATINGS

Parameter		UFNF110	UFNF111	UFNF112	UFNF113	Units
V_{DS}	Drain - Source Voltage ①	100	60	100	60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	100	60	100	60	V
I_D @ T_C = 25°C	Continuous Drain Current	3.5	3.5	3.0	3.0	A
I_{DM}	Pulsed Drain Current ③	14	14	12	12	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	15 (See Fig. 14)				W
	Linear Derating Factor	0.12 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		14	14	12	12	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFNF110 UFNF112	100	–	–	V	V_{GS} = 0V
		UFNF111 UFNF113	60	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFNF110 UFNF111	3.5	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFNF112 UFNF113	3.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFNF110 UFNF111	–	0.5	0.6	Ω	V_{GS} = 10V, I_D = 1.5A
		UFNF112 UFNF113	–	0.6	0.8	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.0	1.5	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 1.5A
C_{iss}	Input Capacitance	ALL	–	135	200	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	80	100	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	20	25	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	10	20	ns	$V_{DD} \approx 0.5\ BV_{DSS}$, I_D = 1.5A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	15	25	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	15	25	ns	
t_f	Fall Time	ALL	–	10	20	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	5.0	7.5	nC	V_{GS} = 10V, I_D = 8.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	2.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	3.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured from the drain lead, 5 mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	–	15	–	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	8.33	K/W	
R_{thJA}	Junction-to-Ambient	ALL	–	–	175	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFNF110 UFNF111	–	–	3.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFNF112 UFNF113	–	–	3.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFNF110 UFNF111	–	–	14	A	
		UFNF112 UFNF113	–	–	12	A	
V_{SD}	Diode Forward Voltage ②	UFNF110 UFNF111	–	–	2.5	V	T_C = 25°C, I_S = 3.5A, V_{GS} = 0V
		UFNF112 UFNF113	–	–	2.0	V	T_C = 25°C, I_S = 3.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	200	–	ns	T_J = 150°C, I_F = 3.5A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	1.0	–	μC	T_J = 150°C, I_F = 3.5A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

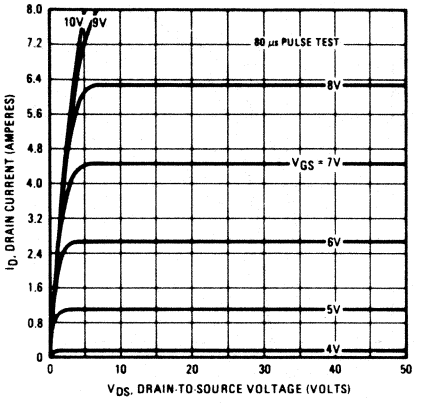


Fig. 2 – Typical Transfer Characteristics

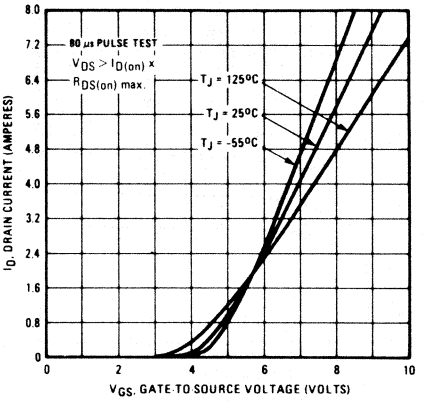


Fig. 3 – Typical Saturation Characteristics

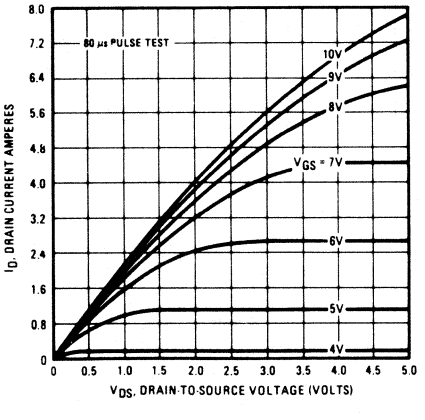


Fig. 4 – Maximum Safe Operating Area

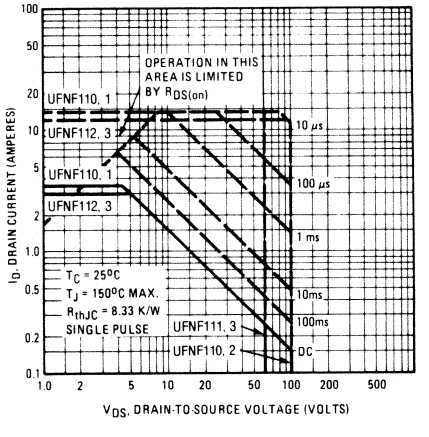


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

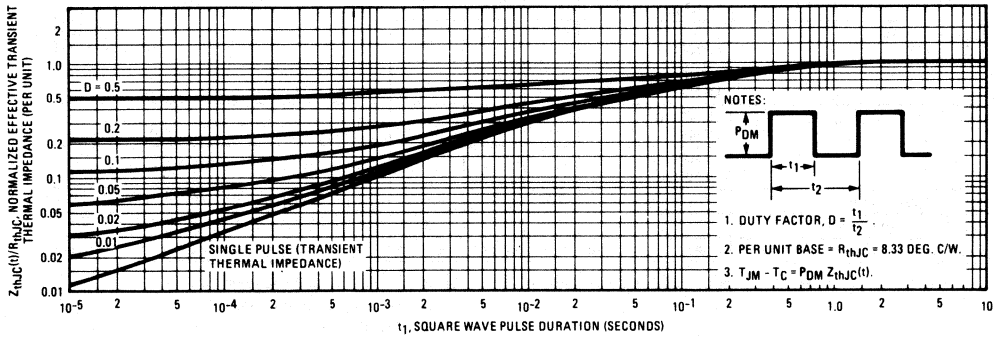


Fig. 6 – Typical Transconductance Vs. Drain Current

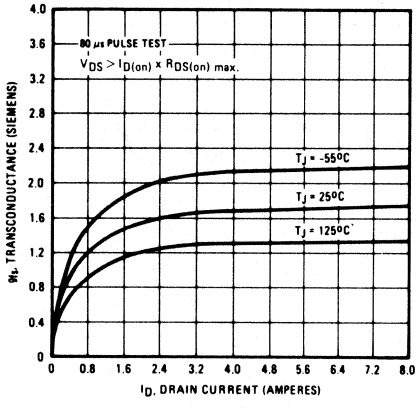


Fig. 7 – Typical Source-Drain Diode Forward Voltage

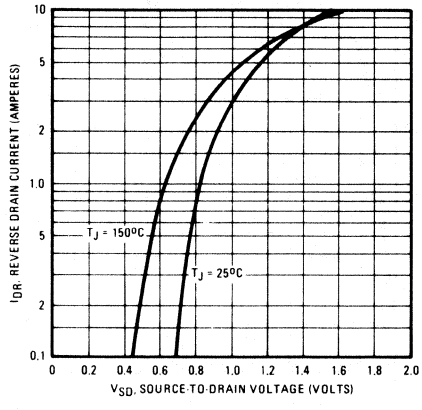


Fig. 8 – Breakdown Voltage Vs. Temperature

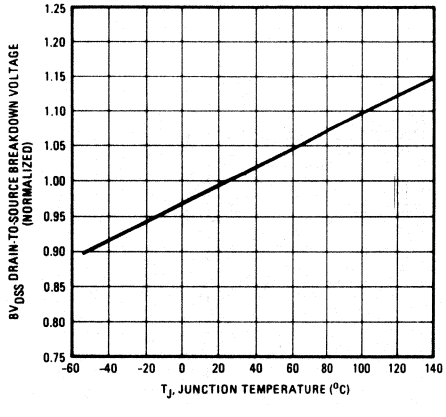


Fig. 9 – Normalized On-Resistance Vs. Temperature

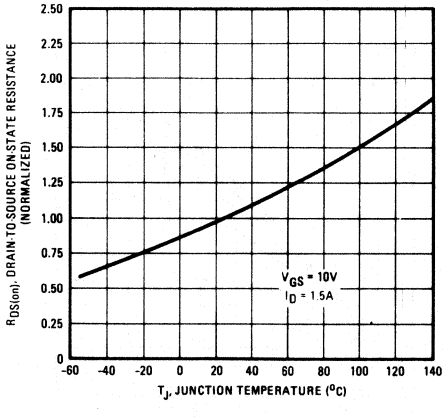


Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

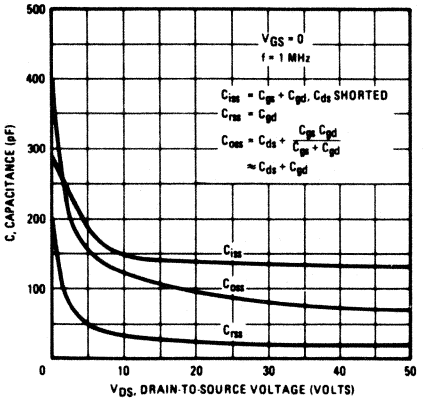


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

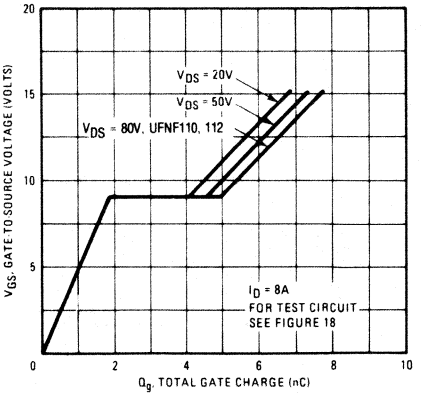


Fig. 12 – Typical On-Resistance Vs. Drain Current

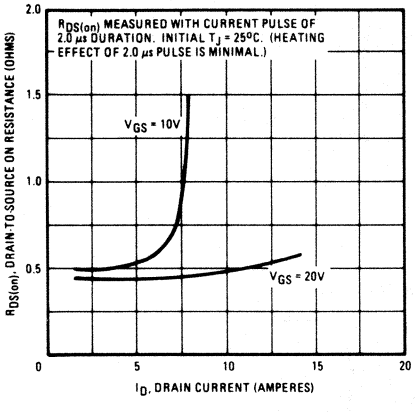


Fig. 13 – Maximum Drain Current Vs. Case Temperature

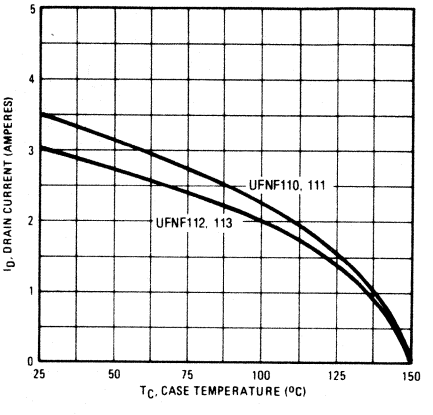
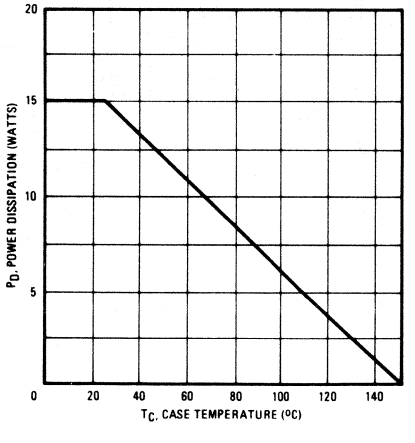


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

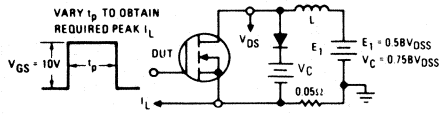


Fig. 16 – Clamped Inductive Waveforms

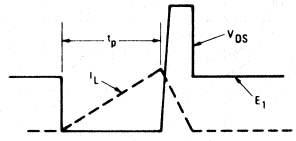


Fig. 17 – Switching Time Test Circuit

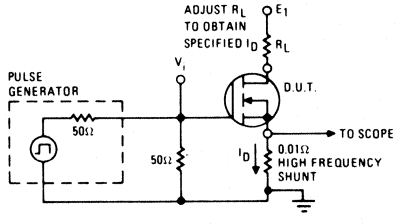
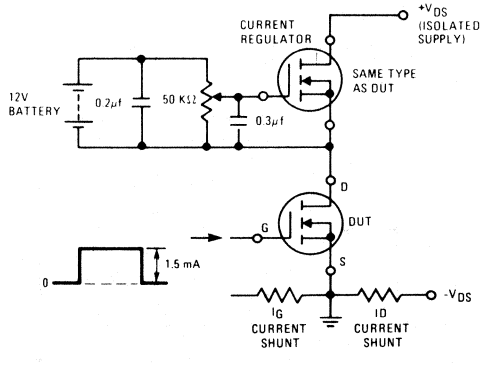


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

100 Volt, 0.30 Ohm
N-Channel

UFNF120
UFNF121
UFNF122
UFNF123

3

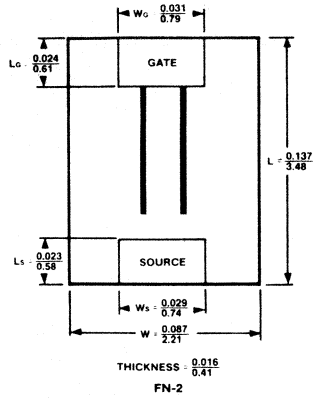
FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



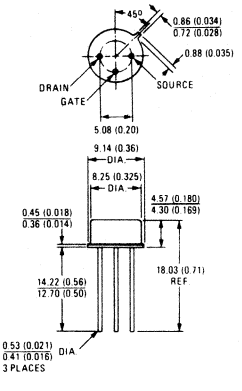
FN-2

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFNF120	100V	0.30Ω	6.0A
UFNF121	60V	0.30Ω	6.0A
UFNF122	100V	0.40Ω	5.0A
UFNF123	60V	0.40Ω	5.0A

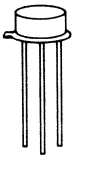
MECHANICAL SPECIFICATIONS

UFNF120 UFNF121 UFNF122 UFNF123



All Dimensions in Millimeters and (Inches)

TO-205AD (TO-39)



UNITRODE

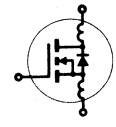
ABSOLUTE MAXIMUM RATINGS

Parameter		UFNF120	UFNF121	UFNF122	UFNF123	Units
V_{DS}	Drain - Source Voltage ①	100	60	100	60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	100	60	100	60	V
I_D @ T_C = 25°C	Continuous Drain Current	6.0	6.0	5.0	5.0	A
I_{DM}	Pulsed Drain Current ③	24	24	20	20	A
V_{GS}	Gate - Source Voltage	± 20				V
P_D @ T_C = 25°C	Max. Power Dissipation	20 (See Fig. 14)				W
	Linear Derating Factor	0.16 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		24	24	20	20	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFNF120 UFNF122	100	–	–	V	V_{GS} = 0V
		UFNF121 UFNF123	60	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFNF120 UFNF121	6.0	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFNF122 UFNF123	5.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFNF120 UFNF121	–	0.25	0.30	Ω	V_{GS} = 10V, I_D = 3.0A
		UFNF122 UFNF123	–	0.30	0.40	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.5	2.9	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 3.0A
C_{iss}	Input Capacitance	ALL	–	450	600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	200	400	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	50	100	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	20	40	ns	$V_{DD} \approx 0.5\ BV_{DSS}$, I_D = 3.0A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	37	70	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	50	100	ns	
t_f	Fall Time	ALL	–	35	70	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	10	15	nC	V_{GS} = 10V, I_D = 10A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	6.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	4.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured from the drain lead, 5 mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	–	15	–	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	6.25	K/W	
R_{thJA}	Junction-to-Ambient	ALL	–	–	175	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFNF120 UFNF121	—	—	6.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		UFNF122 UFNF123	—	—	5.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFNF120 UFNF121	—	—	24	A	
		UFNF122 UFNF123	—	—	20	A	
V_{SD}	Diode Forward Voltage ②	UFNF120 UFNF121	—	—	2.5	V	T_C = 25°C, I_S = 6.0A, V_{GS} = 0V
		UFNF122 UFNF123	—	—	2.3	V	T_C = 25°C, I_S = 5.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	230	—	ns	T_J = 150°C, I_F = 6.0A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	1.2	—	μC	T_J = 150°C, I_F = 6.0A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

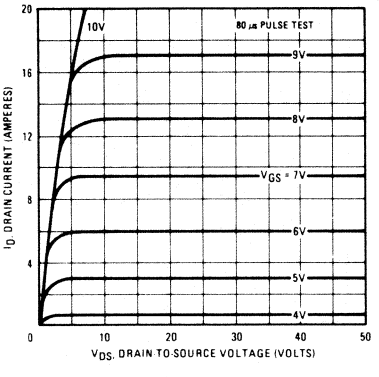


Fig. 2 – Typical Transfer Characteristics

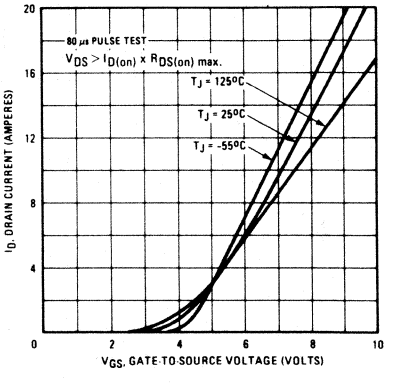


Fig. 3 – Typical Saturation Characteristics

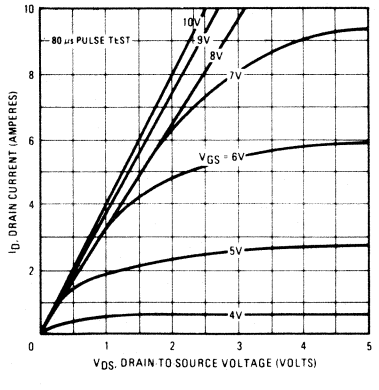
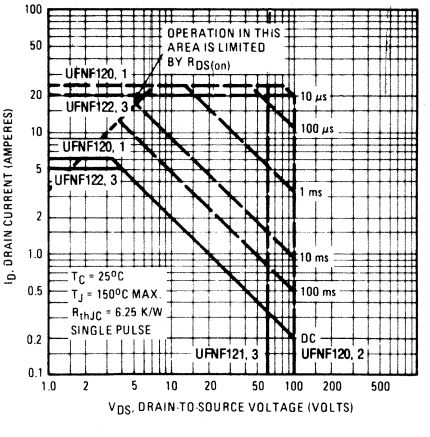


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

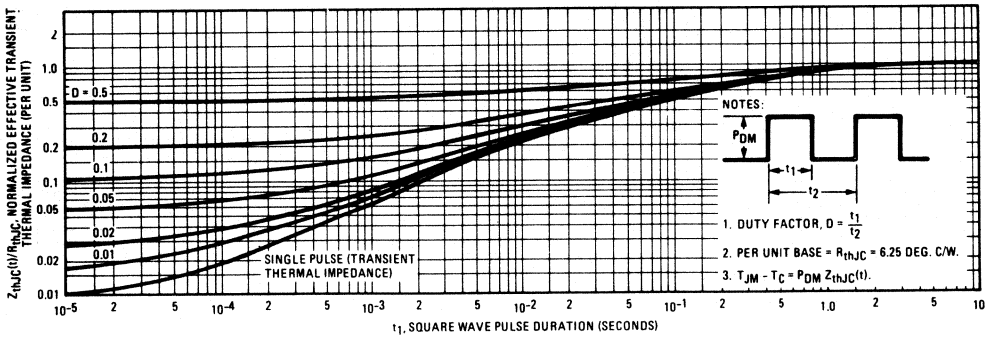


Fig. 6 – Typical Transconductance Vs. Drain Current

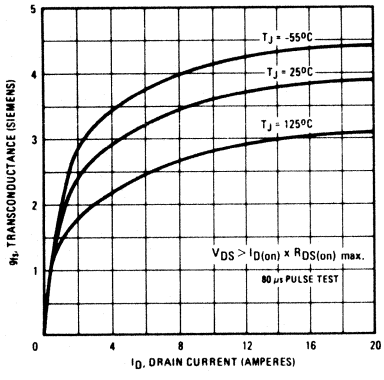


Fig. 7 – Typical Source-Drain Diode Forward Voltage

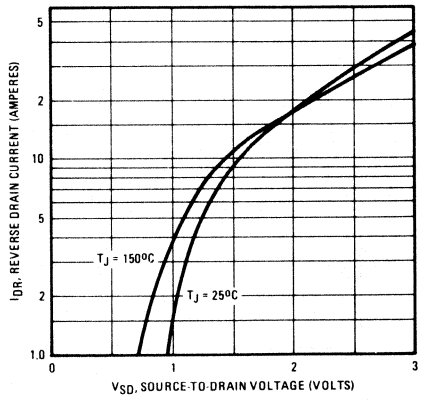


Fig. 8 – Breakdown Voltage Vs. Temperature

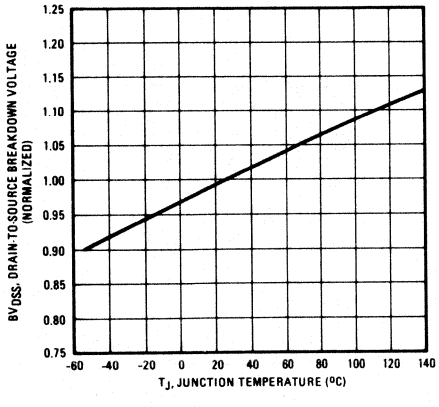
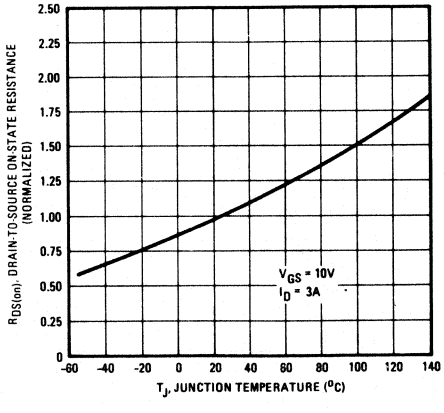


Fig. 9 – Normalized On-Resistance Vs. Temperature



3

Fig. 10 — Typical Capacitance Vs. Drain-to-Source Voltage

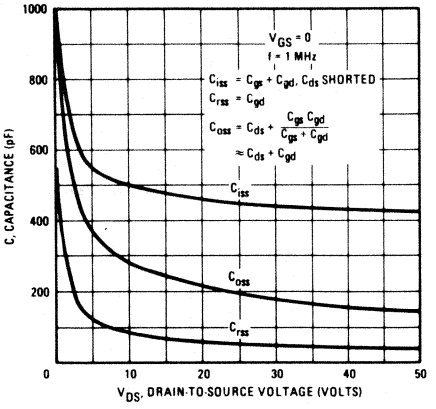


Fig. 11 — Typical Gate Charge Vs. Gate-to-Source Voltage

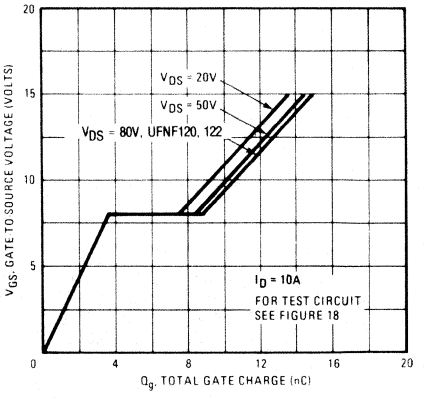


Fig. 12 — Typical On-Resistance Vs. Drain Current

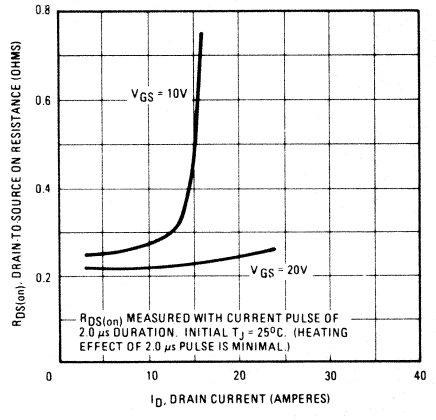


Fig. 13 — Maximum Drain Current Vs. Case Temperature

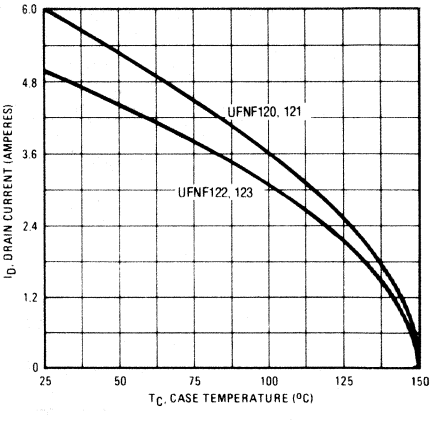
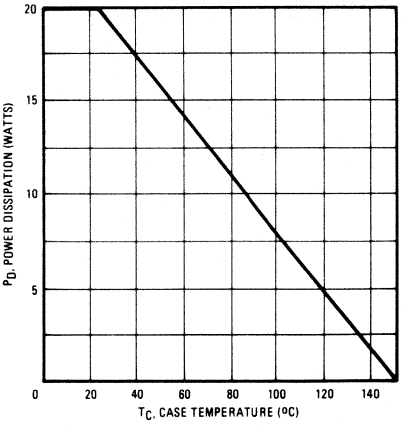


Fig. 14 — Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

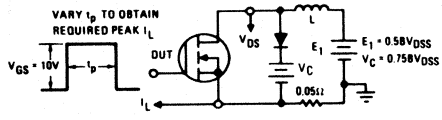


Fig. 16 – Clamped Inductive Waveforms

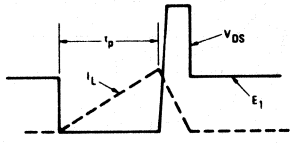


Fig. 17 – Switching Time Test Circuit

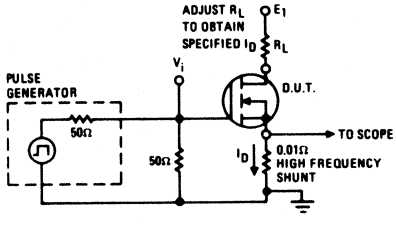
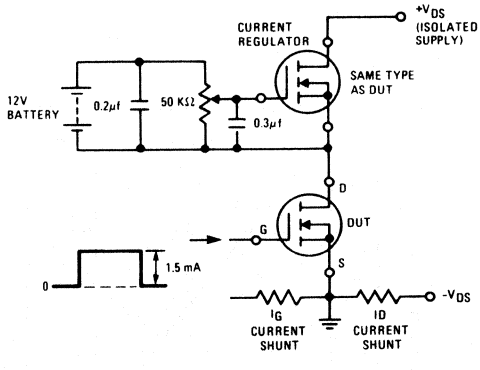


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

100 Volt, 0.18 Ohm
N-Channel

UFNF130
UFNF131
UFNF132
UFNF133

3

FEATURES

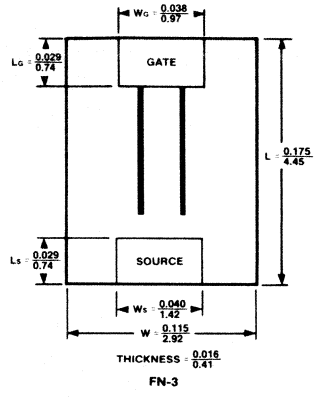
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



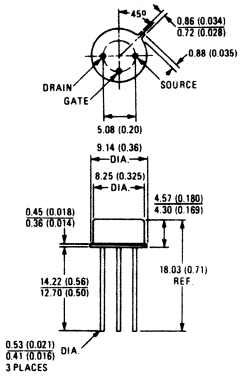
FN-3

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFNF130	100V	0.18Ω	8.0A
UFNF131	60V	0.18Ω	8.0A
UFNF132	100V	0.25Ω	7.0A
UFNF133	60V	0.25Ω	7.0A

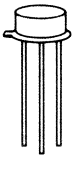
MECHANICAL SPECIFICATIONS

UFNF130 UFNF131 UFNF132 UFNF133



All Dimensions in Millimeters and (Inches)

TO-205AD (TO-39)



UNITRODE

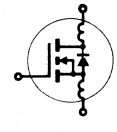
ABSOLUTE MAXIMUM RATINGS

Parameter		UFNF130	UFNF131	UFNF132	UFNF133	Units
V_{DS}	Drain - Source Voltage ①	100	60	100	60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	100	60	100	60	V
I_D @ T_C = 25°C	Continuous Drain Current	8.0	8.0	7.0	7.0	A
I_{DM}	Pulsed Drain Current ③	32	32	28	28	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	25 (See Fig. 14)				W
	Linear Derating Factor	0.2 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		32	32	28	28	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFNF130 UFNF132	100	–	–	V	V_{GS} = 0V
		UFNF131 UFNF133	60	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFNF130 UFNF131	8.0	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFNF132 UFNF133	7.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFNF130 UFNF131	–	0.14	0.18	Ω	V_{GS} = 10V, I_D = 4.0A
		UFNF132 UFNF133	–	0.20	0.25	Ω	
g_{fs}	Forward Transconductance ②	ALL	4.0	5.5	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 4.0A
C_{iss}	Input Capacitance	ALL	–	600	800	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	300	500	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	100	150	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	30	50	ns	$V_{DD} \approx 0.5\ BV_{DSS}$, I_D = 4.0A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	80	150	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	50	100	ns	
t_f	Fall Time	ALL	–	80	150	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	18	30	nC	V_{GS} = 10V, I_D = 18A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	9.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	9.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured from the drain lead, 5 mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	–	15	–	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	5.0	K/W	
R_{thJA}	Junction-to-Ambient	ALL	–	–	175	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFNF130 UFNF131	–	–	8.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFNF132 UFNF133	–	–	7.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFNF130 UFNF131	–	–	32	A	
		UFNF132 UFNF133	–	–	28	A	
V_{SD}	Diode Forward Voltage ②	UFNF130 UFNF131	–	–	2.5	V	T_C = 25°C, I_S = 8.0A, V_{GS} = 0V
		UFNF132 UFNF133	–	–	2.3	V	T_C = 25°C, I_S = 7.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	300	–	ns	T_J = 150°C, I_F = 8.0A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	1.5	–	μC	T_J = 150°C, I_F = 8.0A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by $L_S + L_D$.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

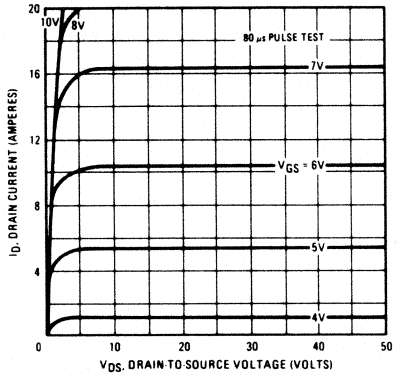


Fig. 2 – Typical Transfer Characteristics

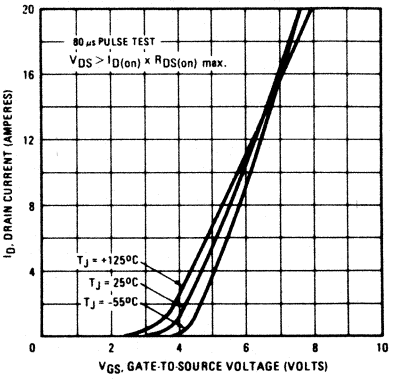


Fig. 3 – Typical Saturation Characteristics

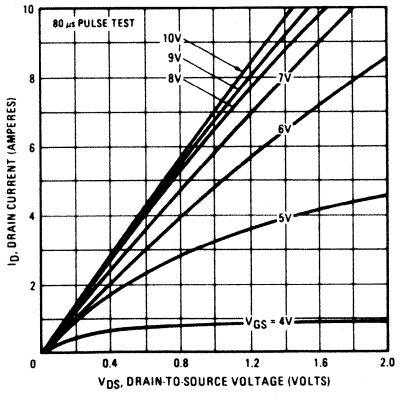
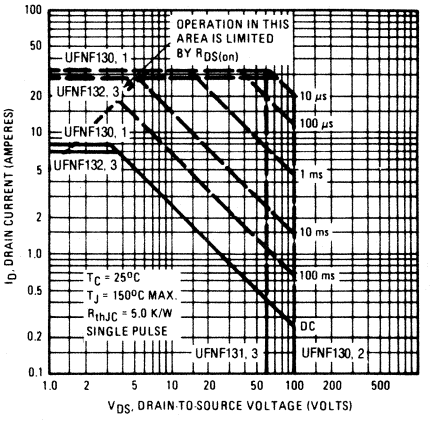


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

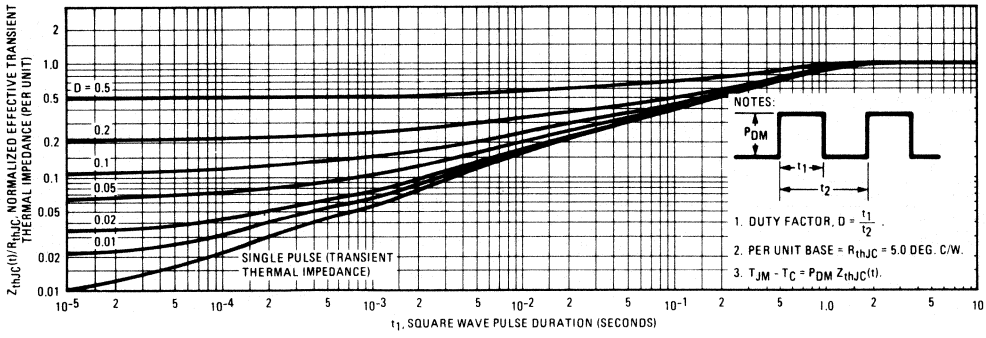


Fig. 6 — Typical Transconductance Vs. Drain Current

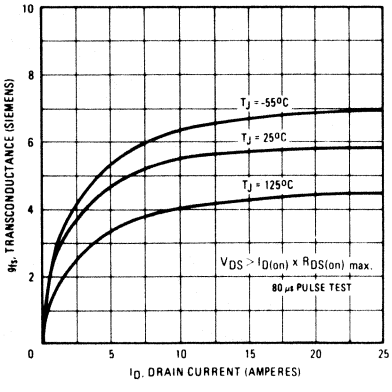


Fig. 7 — Typical Source-Drain Diode Forward Voltage

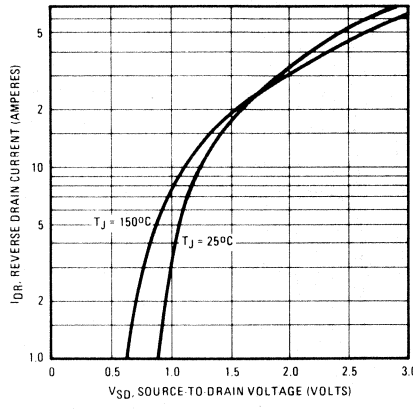


Fig. 8 — Breakdown Voltage Vs. Temperature

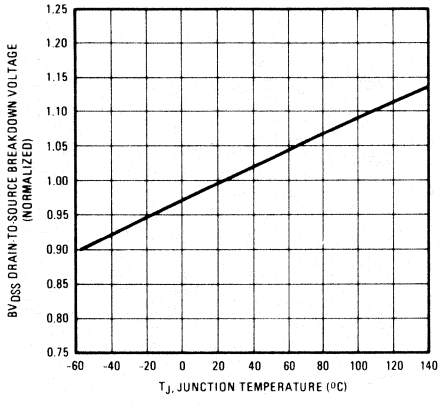
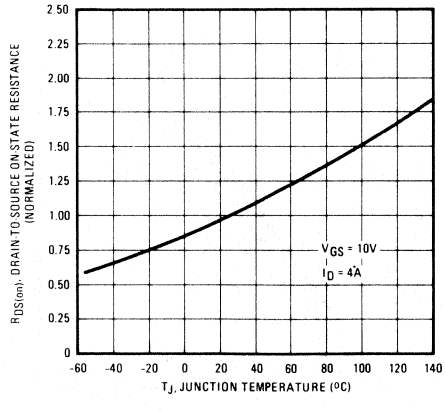


Fig. 9 — Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

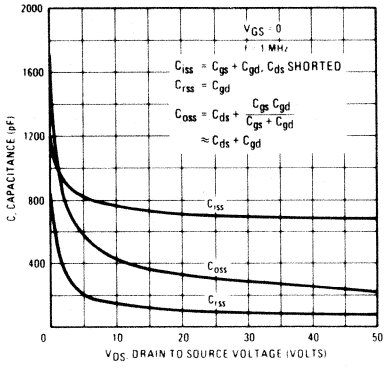


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

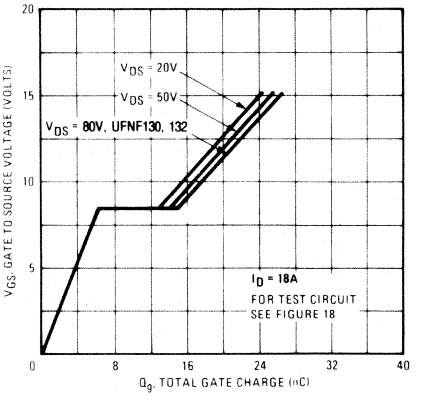


Fig. 12 – Typical On-Resistance Vs. Drain Current

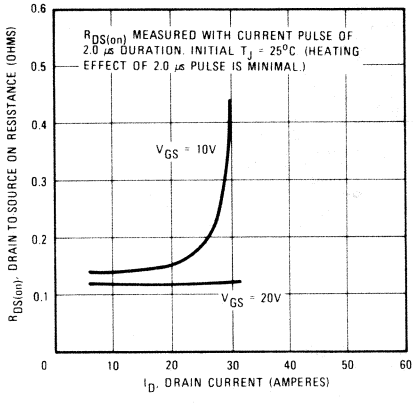


Fig. 13 – Maximum Drain Current Vs. Case Temperature

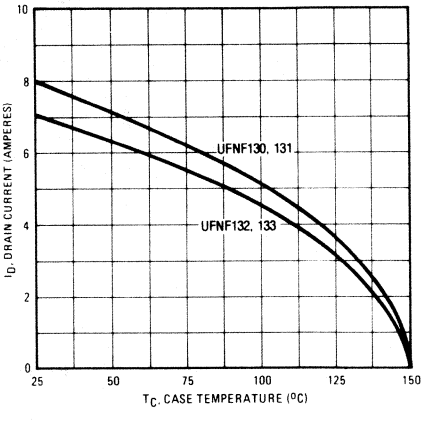
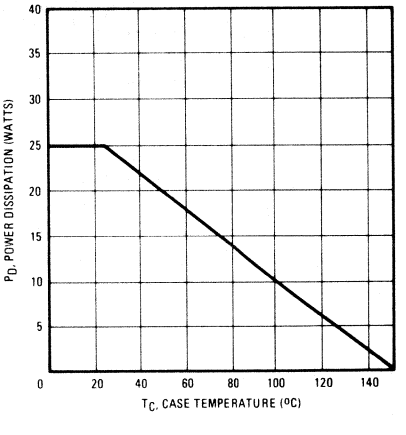


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

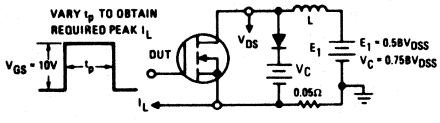


Fig. 16 – Clamped Inductive Waveforms

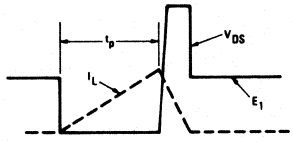


Fig. 17 – Switching Time Test Circuit

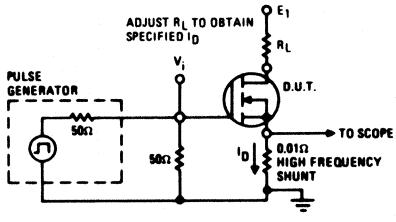
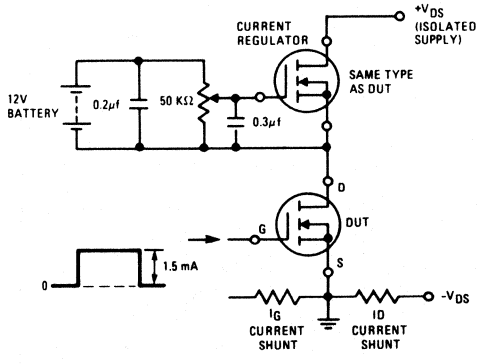


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

200 Volt, 1.5 Ohm N-Channel

UFNF210
UFNF211
UFNF212
UFNF213

3

FEATURES

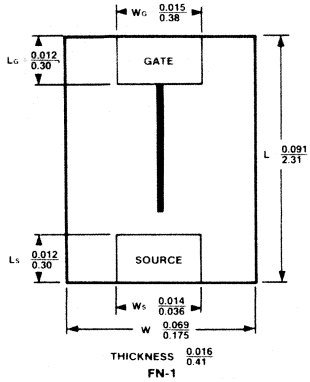
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



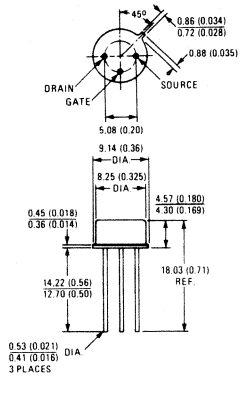
FN-1

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFNF210	200V	1.5Ω	2.2A
UFNF211	150V	1.5Ω	2.2A
UFNF212	200V	2.4Ω	1.8A
UFNF213	150V	2.4Ω	1.8A

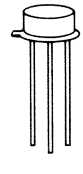
MECHANICAL SPECIFICATIONS

UFNF210 UFNF211 UFNF212 UFNF213



All Dimensions in Millimeters and (Inches)

TO-205AD (TO-39)



UNITRODE

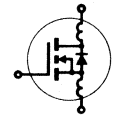
ABSOLUTE MAXIMUM RATINGS

Parameter		UFNF210	UFNF211	UFNF212	UFNF213	Units
V_{DS}	Drain – Source Voltage ①	200	150	200	150	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ) ①	200	150	200	150	V
I_D @ T_C = 25°C	Continuous Drain Current	2.2	2.2	1.8	1.8	A
I_{DM}	Pulsed Drain Current ③	9.0	9.0	7.5	7.5	A
V_{GS}	Gate – Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	15 (See Fig. 14)				W
	Linear Derating Factor	0.12 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		9.0	9.0	7.5	7.5	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	UFNF210 UFNF212	200	–	–	V	V_{GS} = 0V
		UFNF211 UFNF213	150	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate – Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate – Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFNF210 UFNF211	2.2	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFNF212 UFNF213	1.8	–	–	A	
$R_{DS(on)}$	Static Drain – Source On-State Resistance ②	UFNF210 UFNF211	–	1.0	1.5	Ω	V_{GS} = 10V, I_D = 1.25A
		UFNF212 UFNF213	–	1.5	2.4	Ω	
g_{fs}	Forward Transconductance ②	ALL	0.8	1.3	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 1.25A
C_{iss}	Input Capacitance	ALL	–	135	150	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	60	80	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	16	25	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	8.0	15	ns	V_{DD} = 0.5 BV_{DSS}, I_D = 1.25A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	15	25	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	10	15	ns	
t_f	Fall Time	ALL	–	8.0	15	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	5.0	7.5	nC	V_{GS} = 10V, I_D = 4.5A, V_{DS} = 0.8V Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	2.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	3.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured from the drain lead, 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	–	15	–	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	8.33	K/W	
R_{thJA}	Junction-to-Ambient	ALL	–	–	175	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFNF210 UFNF211	—	—	2.2	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFNF212 UFNF213	—	—	1.8	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFNF210 UFNF211	—	—	9.0	A	
		UFNF212 UFNF213	—	—	7.5	A	
V_{SD}	Diode Forward Voltage ②	UFNF210 UFNF211	—	—	2.0	V	T_C = 25°C, I_S = 2.2A, V_{GS} = 0V
		UFNF212 UFNF213	—	—	1.8	V	T_C = 25°C, I_S = 1.8A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	290	—	ns	T_J = 150°C, I_F = 2.2A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	2.0	—	μC	T_J = 150°C, I_F = 2.2A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

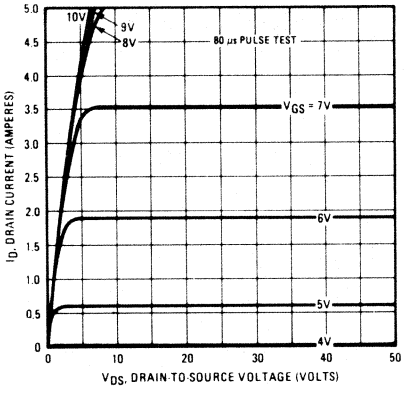


Fig. 2 – Typical Transfer Characteristics

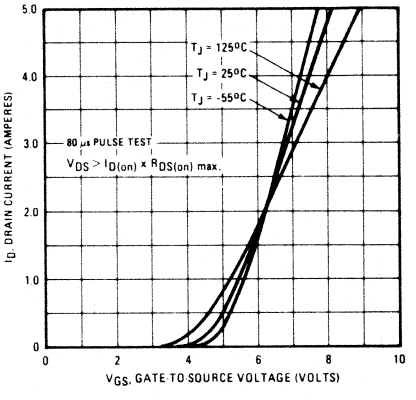


Fig. 3 – Typical Saturation Characteristics

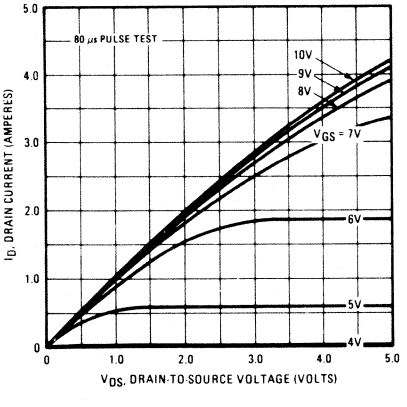
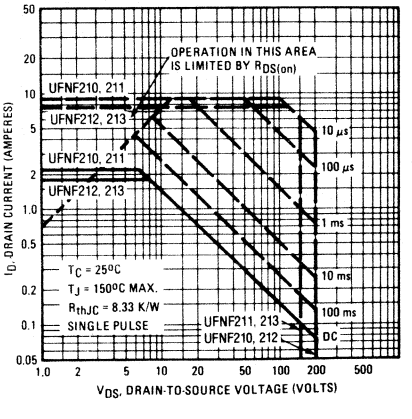


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

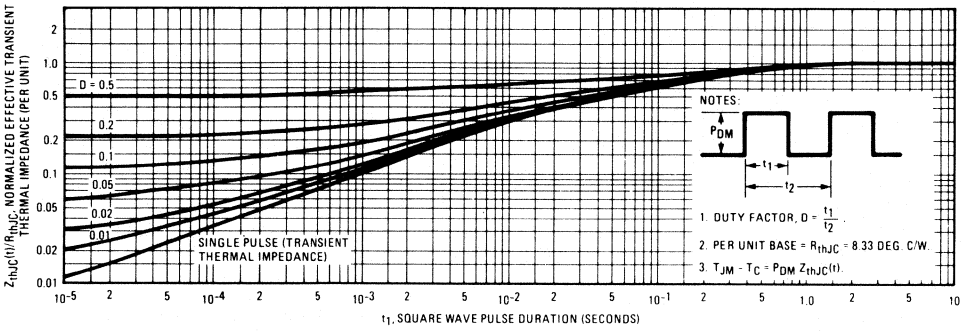


Fig. 6 – Typical Transconductance Vs. Drain Current

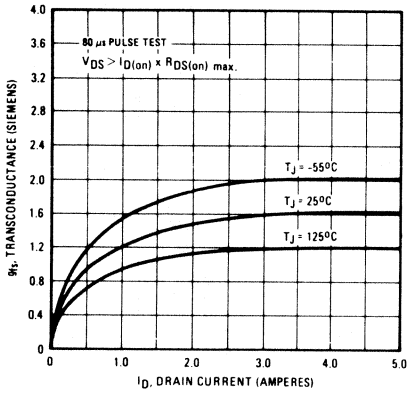


Fig. 7 – Typical Source-Drain Diode Forward Voltage

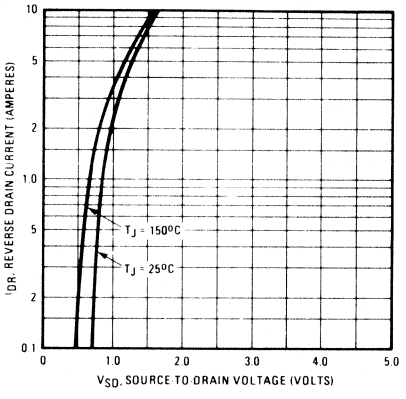


Fig. 8 – Breakdown Voltage Vs. Temperature

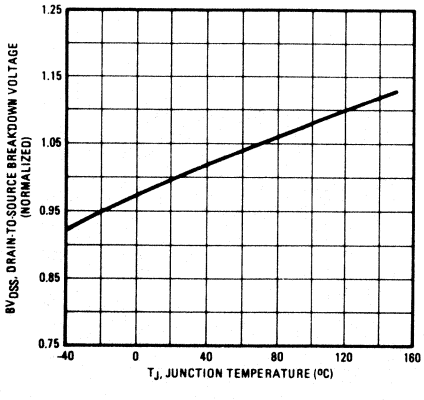
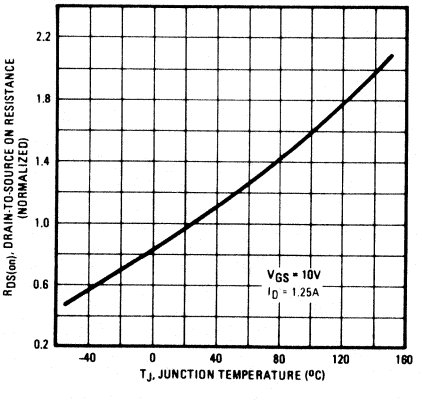


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

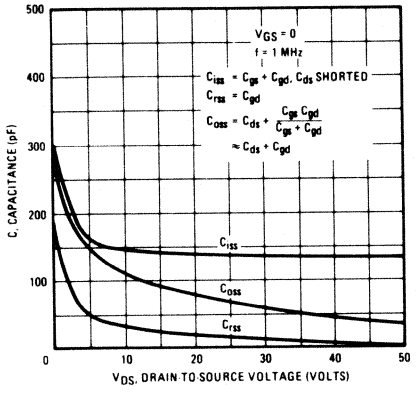


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

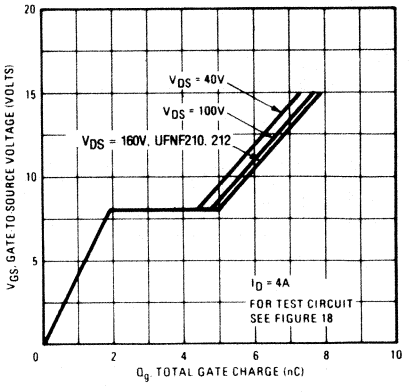


Fig. 12 – Typical On-Resistance Vs. Drain Current

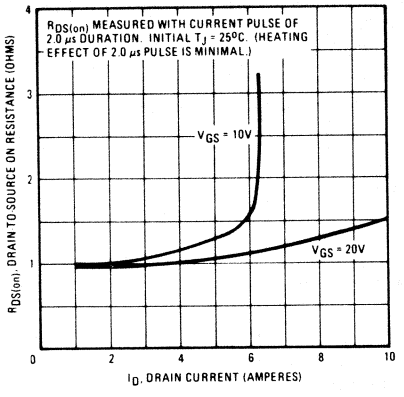


Fig. 13 – Maximum Drain Current Vs. Case Temperature

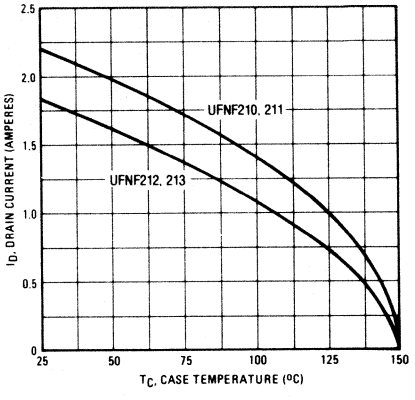
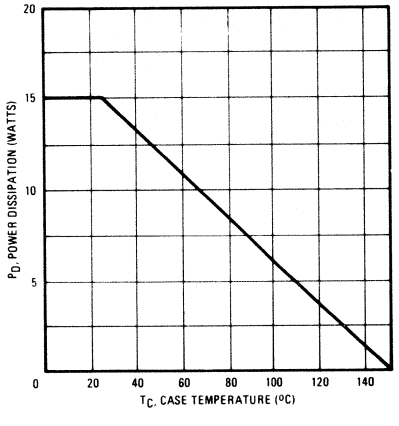


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

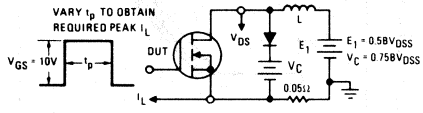


Fig. 16 – Clamped Inductive Waveforms

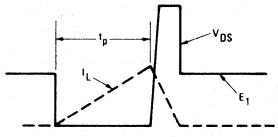


Fig. 17 – Switching Time Test Circuit

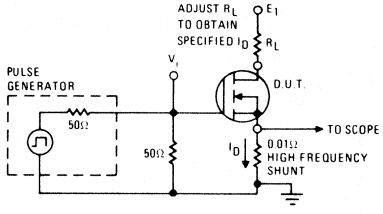
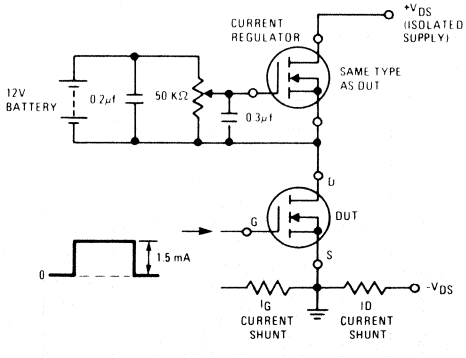


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

200 Volt, 0.8 Ohm N-Channel

UFNF220
UFNF221
UFNF222
UFNF223

3

FEATURES

- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

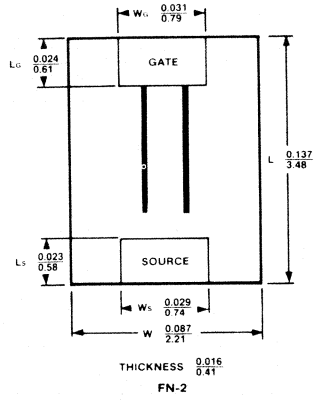
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

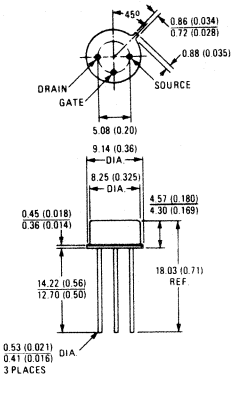
Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFNF220	200V	0.8Ω	3.5A
UFNF221	150V	0.8Ω	3.5A
UFNF222	200V	1.2Ω	3.0A
UFNF223	150V	1.2Ω	3.0A



FN-2

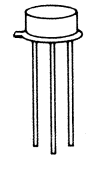
MECHANICAL SPECIFICATIONS

UFNF220 UFNF221 UFNF222 UFNF223



All Dimensions in Millimeters and (Inches)

TO-205AD (TO-39)



UNITRODE

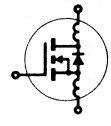
ABSOLUTE MAXIMUM RATINGS

Parameter		UFNF220	UFNF221	UFNF222	UFNF223	Units
V_{DS}	Drain – Source Voltage ①	200	150	200	150	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ) ①	200	150	200	150	V
I_D @ T_C = 25°C	Continuous Drain Current	3.5	3.5	3.0	3.0	A
I_{DM}	Pulsed Drain Current ③	14	14	12	12	A
V_{GS}	Gate – Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	20 (See Fig. 14)				W
	Linear Derating Factor	0.16 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		14	14	12	12	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	UFNF220 UFNF222	200	--	--	V	V_{GS} = 0V
		UFNF221 UFNF223	150	--	--	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	--	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate – Source Leakage Forward	ALL	--	--	100	nA	V_{GS} = 20V
I_{GSS}	Gate – Source Leakage Reverse	ALL	--	--	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	--	--	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			--	--	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFNF220 UFNF221	3.5	--	--	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFNF222 UFNF223	3.0	--	--	A	
$R_{DS(on)}$	Static Drain – Source On-State Resistance ②	UFNF220 UFNF221	--	0.5	0.8	Ω	V_{GS} = 10V, I_D = 2.0A
		UFNF222 UFNF223	--	0.8	1.2	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.5	2.25	--	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 2.0A
C_{iss}	Input Capacitance	ALL	--	450	600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	--	150	300	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	--	40	80	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	--	20	40	ns	V_{DD} = 0.5 BV_{DSS}, I_D = 2.0A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	--	30	60	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	--	50	100	ns	
t_f	Fall Time	ALL	--	30	60	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	--	11	15	nC	V_{GS} = 10V, I_D = 7.0A, V_{DS} = 0.8V Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	--	5.0	--	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	--	6.0	--	nC	
L_D	Internal Drain Inductance	ALL	--	5.0	--	nH	Measured from the drain lead, 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	--	15	--	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	--	--	6.25	K/W	
R_{thJA}	Junction-to-Ambient	ALL	--	--	175	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFNF220 UFNF221	—	—	3.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		UFNF222 UFNF223	—	—	3.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFNF220 UFNF221	—	—	14	A	
		UFNF222 UFNF223	—	—	12	A	
V_{SD}	Diode Forward Voltage ②	UFNF220 UFNF221	—	—	2.0	V	T_C = 25°C, I_S = 3.5A, V_{GS} = 0V
		UFNF222 UFNF223	—	—	1.8	V	T_C = 25°C, I_S = 3.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	350	—	ns	T_J = 150°C, I_F = 3.5A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	2.3	—	μC	T_J = 150°C, I_F = 3.5A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

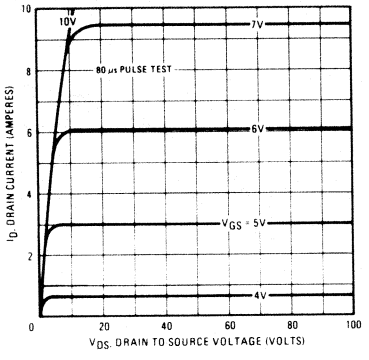


Fig. 2 – Typical Transfer Characteristics

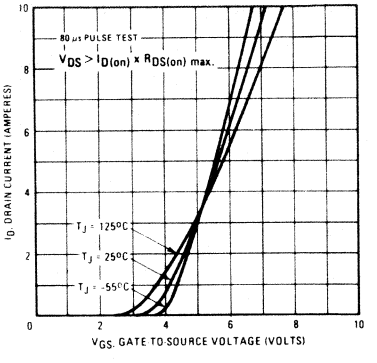


Fig. 3 – Typical Saturation Characteristics

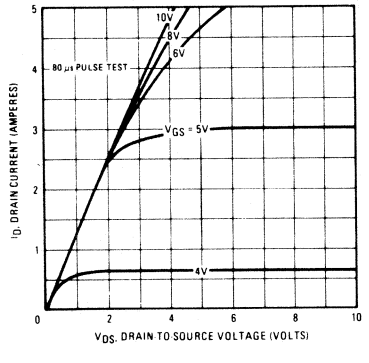
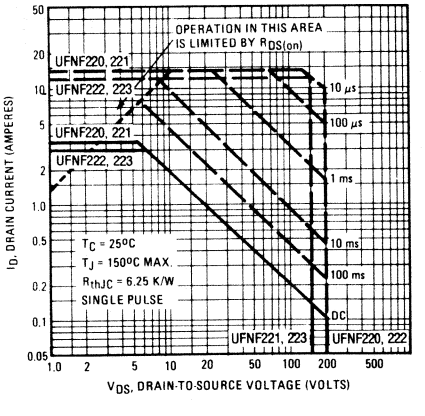


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

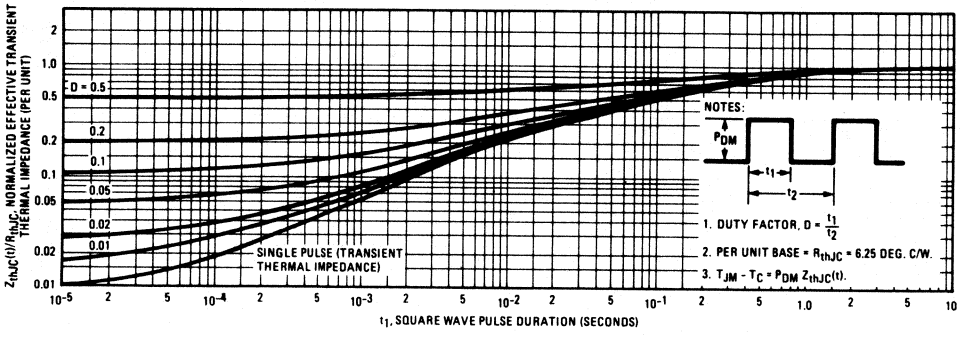


Fig. 6 – Typical Transconductance Vs. Drain Current

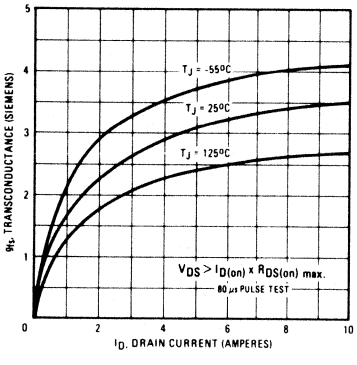


Fig. 7 – Typical Source-Drain Diode Forward Voltage

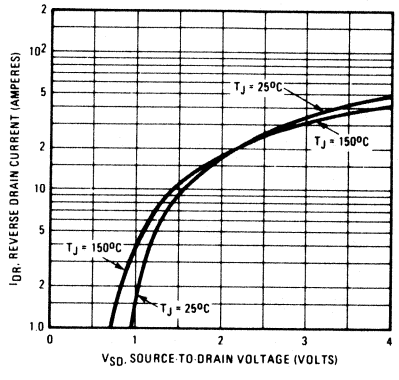


Fig. 8 – Breakdown Voltage Vs. Temperature

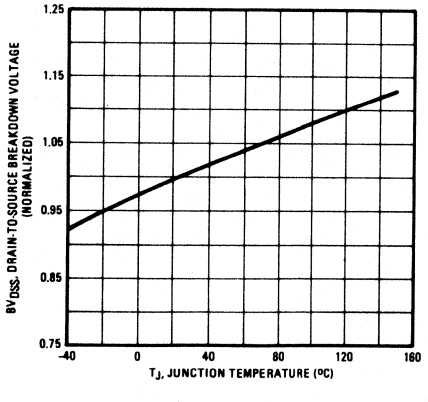
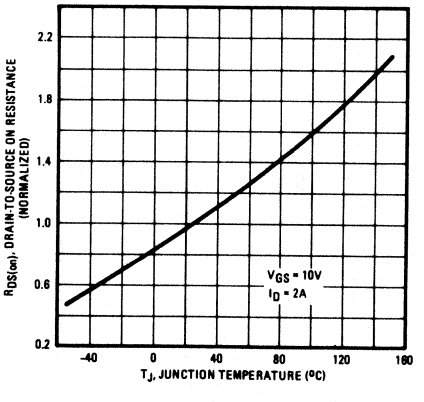


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

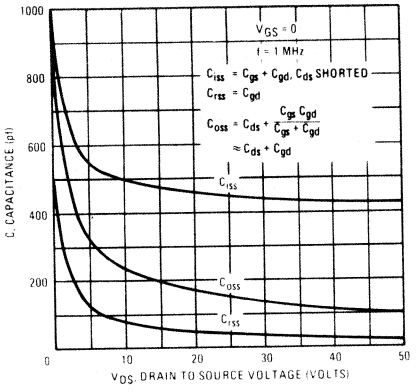


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

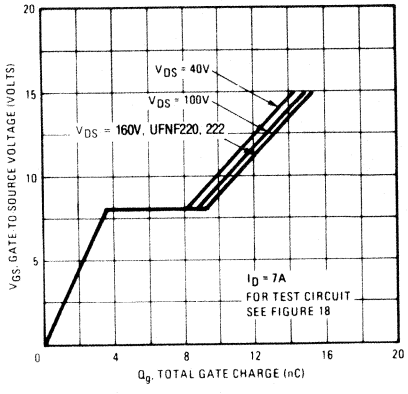


Fig. 12 – Typical On-Resistance Vs. Drain Current

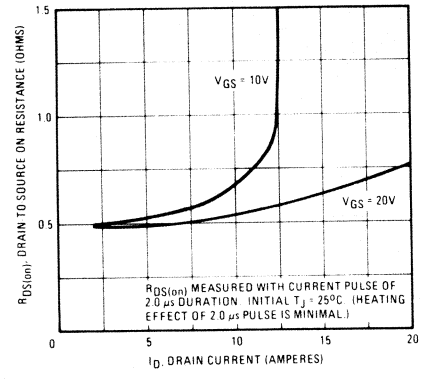


Fig. 13 – Maximum Drain Current Vs. Case Temperature

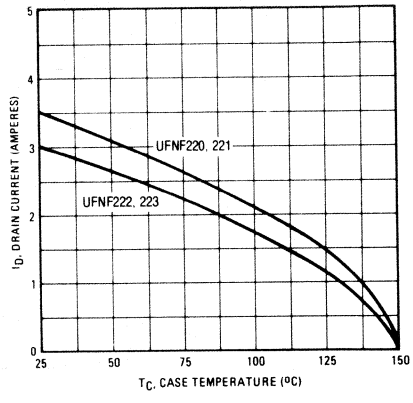


Fig. 14 – Power Vs. Temperature Derating Curve

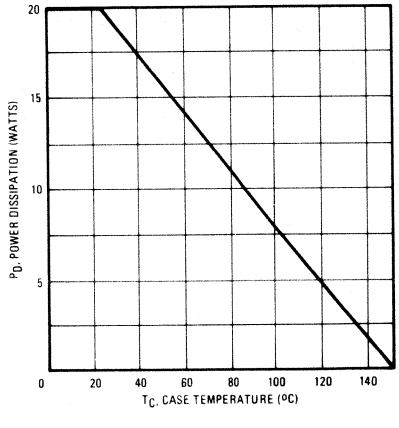


Fig. 15 – Clamped Inductive Test Circuit

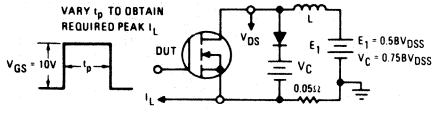


Fig. 16 – Clamped Inductive Waveforms

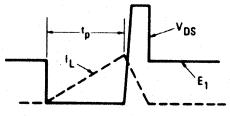


Fig. 17 – Switching Time Test Circuit

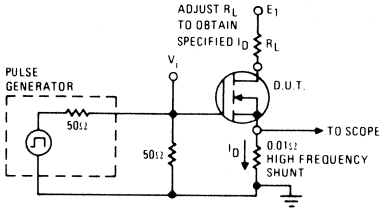
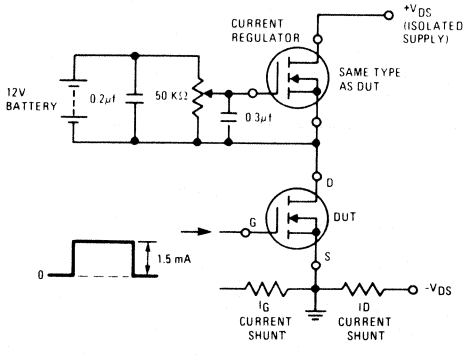


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

200 Volt, 0.4 Ohm
N-Channel

UFNF230
UFNF231
UFNF232
UFNF233

3

FEATURES

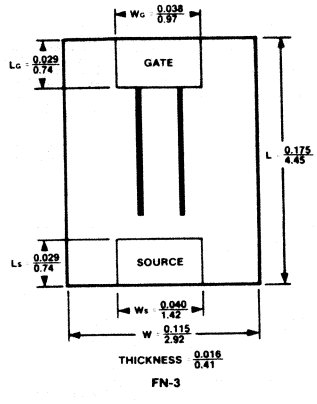
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



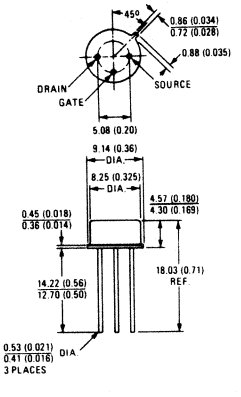
FN-3

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFNF230	200V	0.4Ω	5.5A
UFNF231	150V	0.4Ω	5.5A
UFNF232	200V	0.6Ω	4.5A
UFNF233	150V	0.6Ω	4.5A

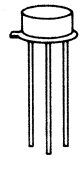
MECHANICAL SPECIFICATIONS

UFNF230 UFNF231 UFNF232 UFNF233



All Dimensions in Millimeters and (Inches)

TO-205AD (TO-39)



UNITRODE

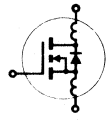
ABSOLUTE MAXIMUM RATINGS

Parameter		UFNF230	UFNF231	UFNF232	UFNF233	Units
V_{DS}	Drain – Source Voltage ①	200	150	200	150	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ) ①	200	150	200	150	V
I_D @ T_C = 25°C	Continuous Drain Current	5.5	5.5	4.5	4.5	A
I_{DM}	Pulsed Drain Current ③	22	22	18	18	A
V_{GS}	Gate – Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	25 (See Fig. 14)				W
	Linear Derating Factor	0.2 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		22	22	18	18	
T_J T_{stg}	Operating Junction and Storage Temperature Range	–55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	UFNF230 UFNF232	200	–	–	V	V_{GS} = 0V
		UFNF231 UFNF233	150	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate – Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate – Source Leakage Reverse	ALL	–	–	–100	nA	V_{GS} = –20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFNF230 UFNF231	5.5	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFNF232 UFNF233	4.5	–	–	A	
$R_{DS(on)}$	Static Drain – Source On-State Resistance ②	UFNF230 UFNF231	–	0.25	0.4	Ω	V_{GS} = 10V, I_D = 3.0A
		UFNF232 UFNF233	–	0.4	0.6	Ω	
g_{fs}	Forward Transconductance ②	ALL	2.5	4.5	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 3.0A
C_{iss}	Input Capacitance	ALL	–	600	800	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	250	450	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	80	150	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	30	ns	V_{DD} = 90V, I_D = 3.0A, Z_o = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	50	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	50	ns	
t_f	Fall Time	ALL	–	–	40	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	19	30	nC	V_{GS} = 10V, I_D = 11A, V_{DS} = 0.8V Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	10	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	9.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured from the drain lead, 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	–	15	–	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	5.0	K/W	
R_{thJA}	Junction-to-Ambient	ALL	–	–	175	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFNF230 UFNF231	—	—	5.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFNF232 UFNF233	—	—	4.5	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFNF230 UFNF231	—	—	22	A	
		UFNF232 UFNF233	—	—	18	A	
V_{SD}	Diode Forward Voltage ②	UFNF230 UFNF231	—	—	2.0	V	T_C = 25°C, I_S = 5.5A, V_{GS} = 0V
		UFNF232 UFNF233	—	—	1.8	V	T_C = 25°C, I_S = 4.5A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	450	—	ns	T_J = 150°C, I_F = 5.5A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	3.0	—	μC	T_J = 150°C, I_F = 5.5A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

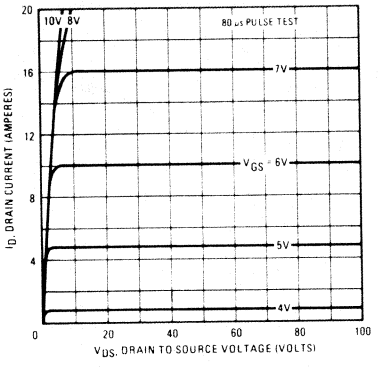


Fig. 2 – Typical Transfer Characteristics

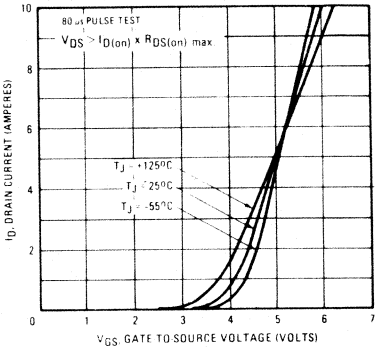


Fig. 3 – Typical Saturation Characteristics

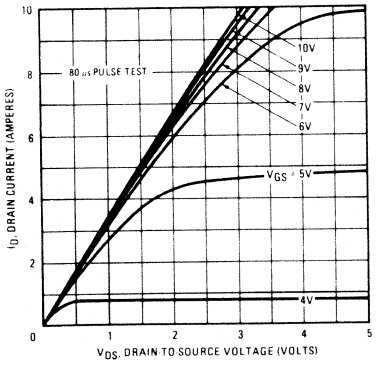
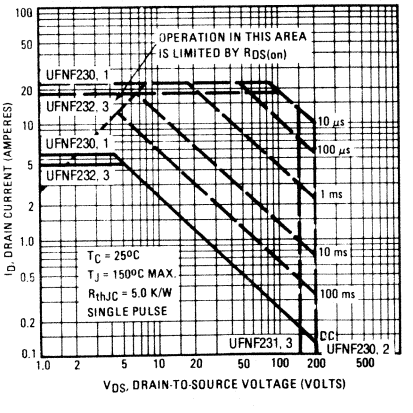


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

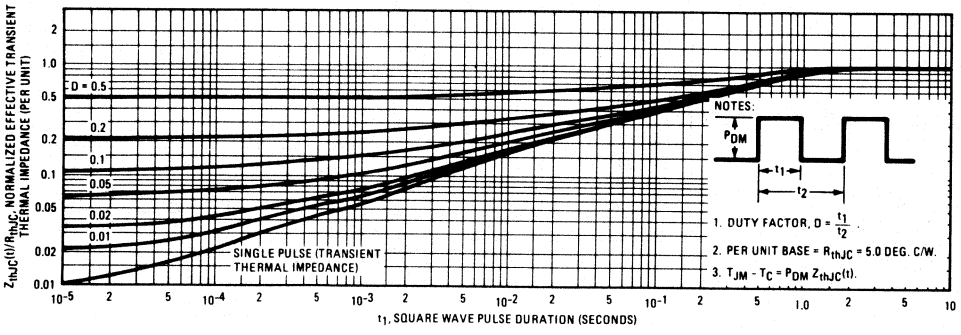


Fig. 6 – Typical Transconductance Vs. Drain Current

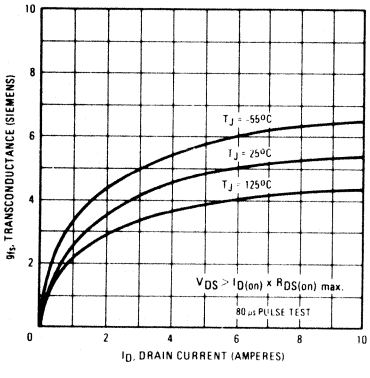


Fig. 7 – Typical Source-Drain Diode Forward Voltage

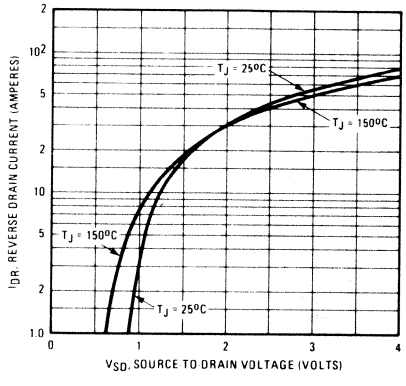


Fig. 8 – Breakdown Voltage Vs. Temperature

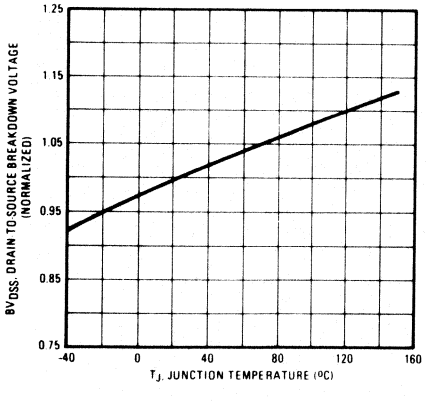
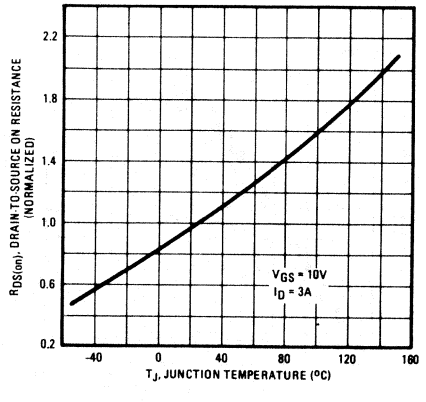


Fig. 9 – Normalized On-Resistance Vs. Temperature



3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

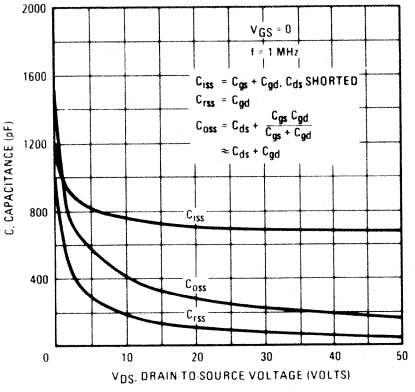


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

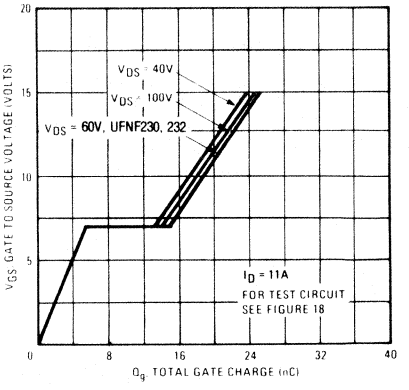


Fig. 12 – Typical On-Resistance Vs. Drain Current

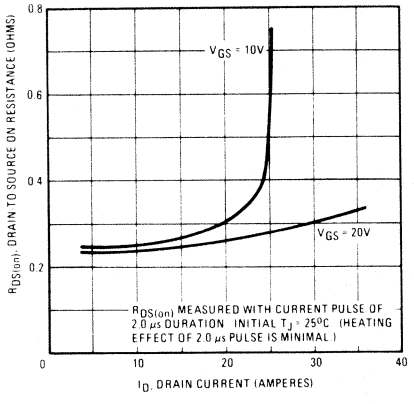


Fig. 13 – Maximum Drain Current Vs. Case Temperature

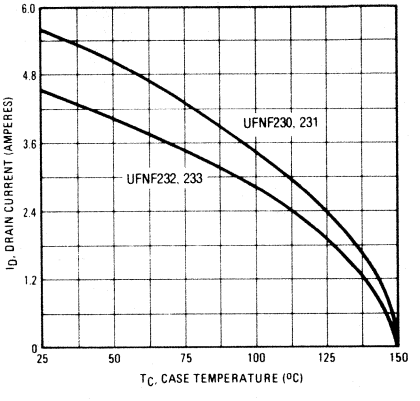
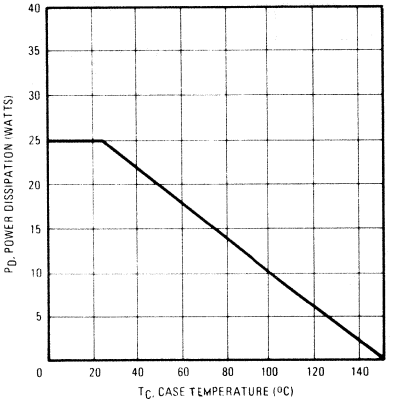


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

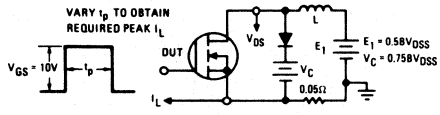


Fig. 16 – Clamped Inductive Waveforms

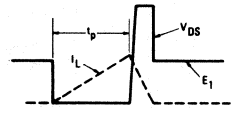


Fig. 17 – Switching Time Test Circuit

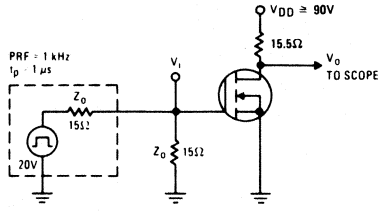
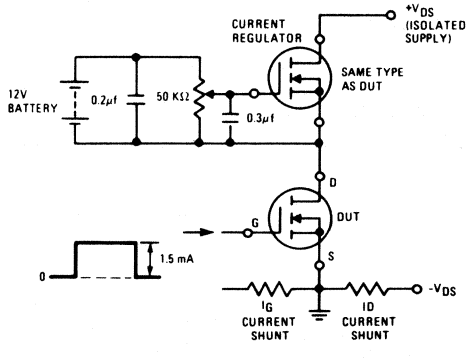


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS
400 Volt, 3.6 Ohm

UFNF310
UFNF311
UFNF312
UFNF313

3

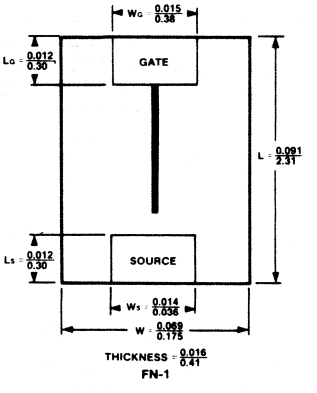
FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

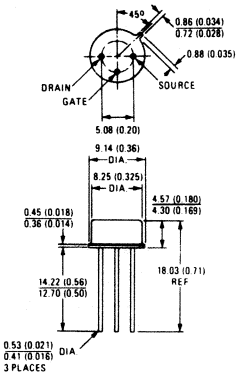


PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFNF310	400V	3.6Ω	1.35A
UFNF311	350V	3.6Ω	1.35A
UFNF312	400V	5.0Ω	1.15A
UFNF313	350V	5.0Ω	1.15A

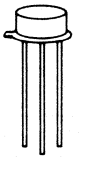
MECHANICAL SPECIFICATIONS

UFNF310 UFNF311 UFNF312 UFNF313



All Dimensions in Millimeters and (Inches)

TO-205AD (TO-39)



UNITRODE

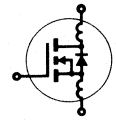
ABSOLUTE MAXIMUM RATINGS

Parameter		UFNF310	UFNF311	UFNF312	UFNF313	Units
V_{DS}	Drain – Source Voltage ①	400	350	400	350	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ) ①	400	350	400	350	V
I_D @ T_C = 25°C	Continuous Drain Current	1.35	1.35	1.15	1.15	A
I_{DM}	Pulsed Drain Current ③	5.5	5.5	4.5	4.5	A
V_{GS}	Gate – Source Voltage	± 20				V
P_D @ T_C = 25°C	Max. Power Dissipation	15 (See Fig. 14)				W
	Linear Derating Factor	0.12 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		5.5	5.5	4.5	4.5	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ TC = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	UFNF310 UFNF312	400	–	–	V	V_{GS} = 0V
		UFNF311 UFNF313	350	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate – Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate – Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFNF310 UFNF311	1.35	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, V_{GS} = 10V
		UFNF312 UFNF313	1.15	–	–	A	
$R_{DS(on)}$	Static Drain – Source On-State Resistance ②	UFNF310 UFNF311	–	3.3	3.6	Ω	V_{GS} = 10V, I_D = 0.8A
		UFNF312 UFNF313	–	3.6	5.0	Ω	
g_{fs}	Forward Transconductance ②	ALL	0.5	1.2	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)\ max.}$, I_D = 0.8A
C_{iss}	Input Capacitance	ALL	–	135	150	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	35	50	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	8.0	15	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	3.0	10	ns	V_{DD} ≈ 0.5 BV_{DSS}, I_D = 0.8A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	10	20	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	5.0	10	ns	
t_f	Fall Time	ALL	–	8.0	15	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	6.0	7.5	nC	V_{GS} = 10V, I_D = 2.0A, V_{DS} = 0.8V Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	3.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	3.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured from the drain lead, 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	–	15	–	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	8.33	K/W	
R_{thJA}	Junction-to-Ambient	ALL	–	–	175	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFNF310 UFNF311	—	—	1.35	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFNF312 UFNF313	—	—	1.15	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFNF310 UFNF311	—	—	5.5	A	
		UFNF312 UFNF313	—	—	4.5	A	
V_{SD}	Diode Forward Voltage ②	UFNF310 UFNF311	—	—	1.6	V	T_C = 25°C, I_S = 1.35A, V_{GS} = 0V
		UFNF312 UFNF313	—	—	1.5	V	T_C = 25°C, I_S = 1.15A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	380	—	ns	T_J = 150°C, I_F = 1.35A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	2.7	—	μC	T_J = 150°C, I_F = 1.35A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

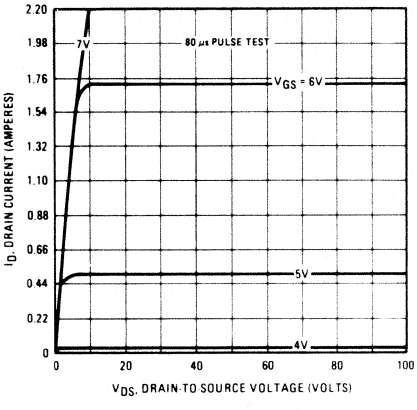


Fig. 2 – Typical Transfer Characteristics

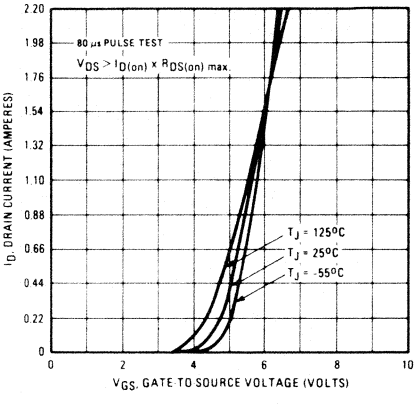


Fig. 3 – Typical Saturation Characteristics

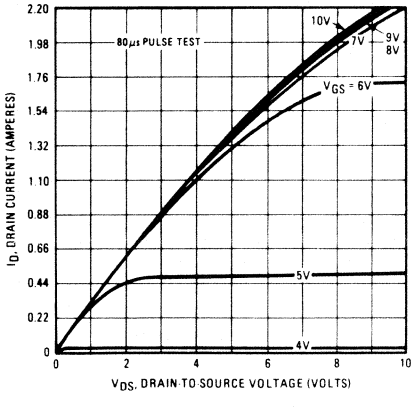


Fig. 4 – Maximum Safe Operating Area

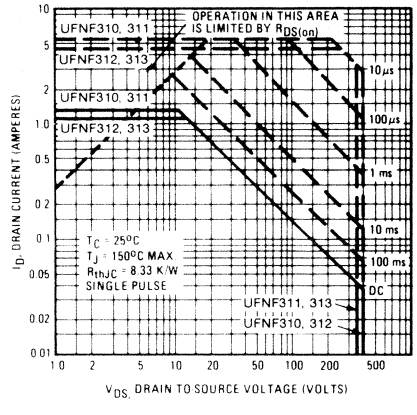


Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

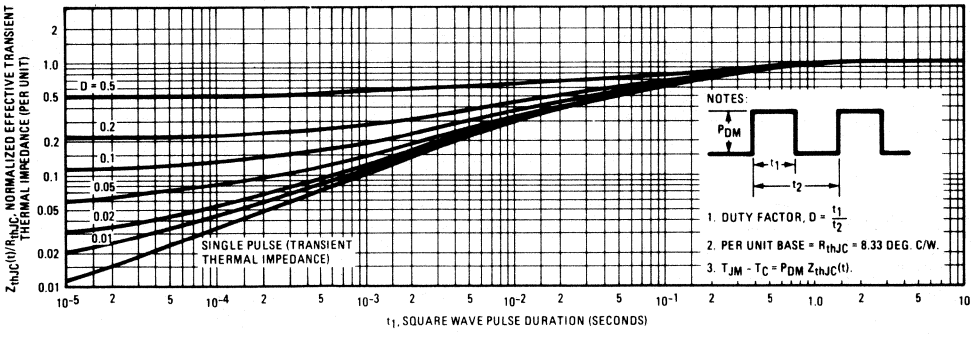


Fig. 6 — Typical Transconductance Vs. Drain Current

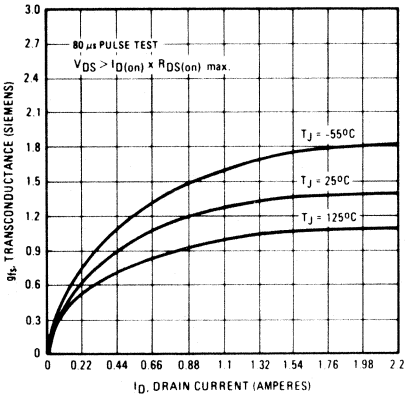


Fig. 7 — Typical Source-Drain Diode Forward Voltage

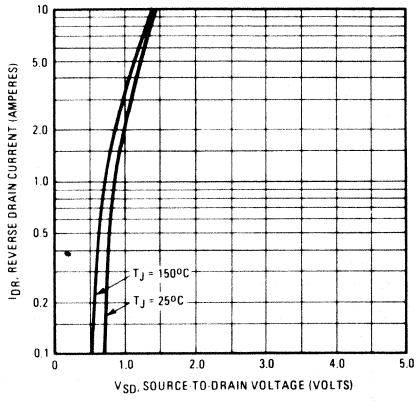


Fig. 8 — Breakdown Voltage Vs. Temperature

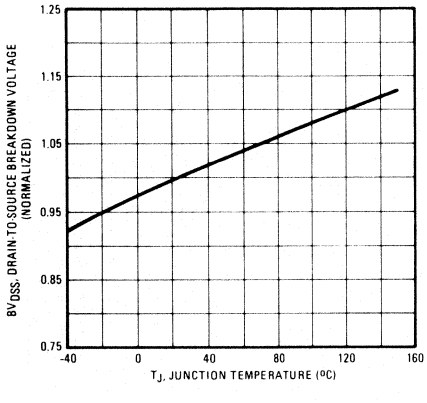


Fig. 9 — Normalized On-Resistance Vs. Temperature

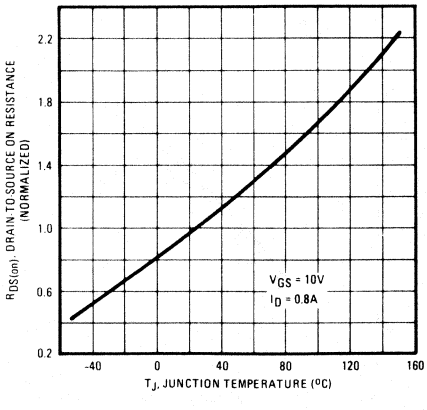


Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

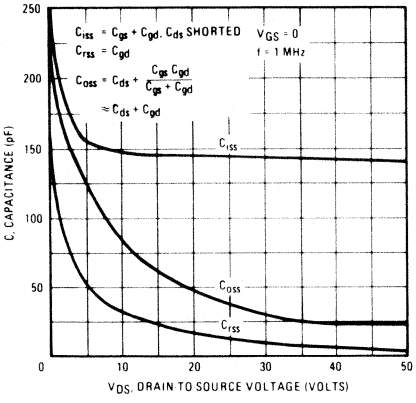


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

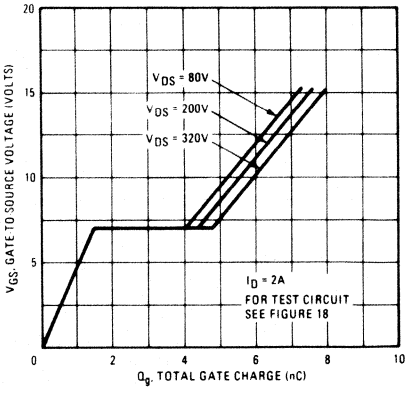


Fig. 12 – Typical On-Resistance Vs. Drain Current

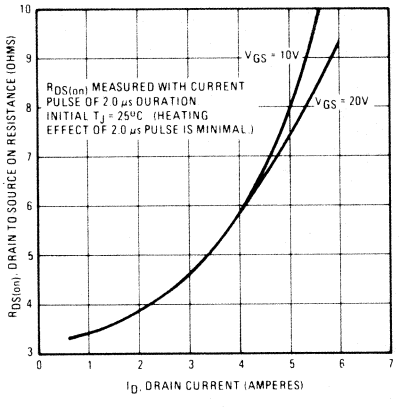


Fig. 13 – Maximum Drain Current Vs. Case Temperature

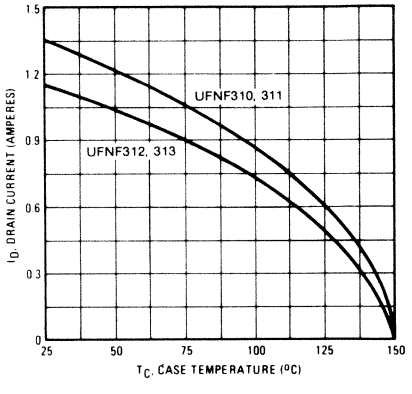
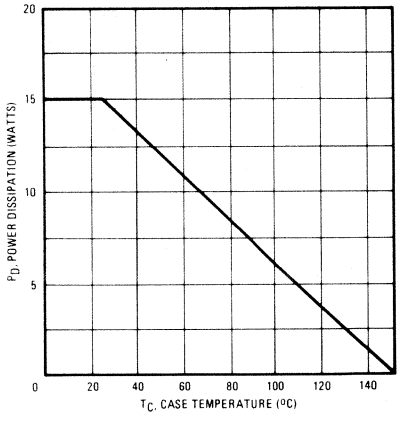


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

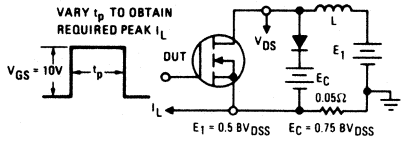


Fig. 16 – Clamped Inductive Waveforms

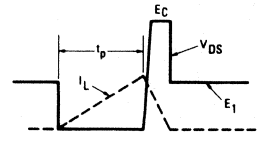


Fig. 17 – Switching Time Test Circuit

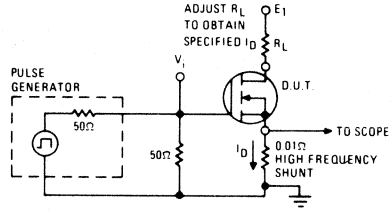
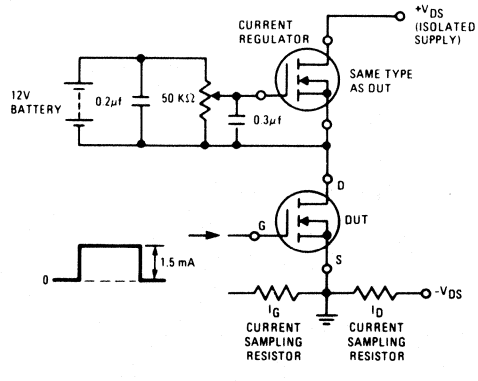


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS
400 Volt, 1.8 Ohm

UFNF320
UFNF321
UFNF322
UFNF323

3

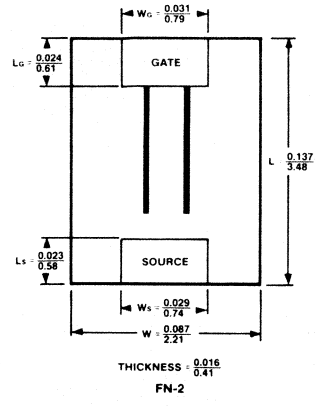
FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



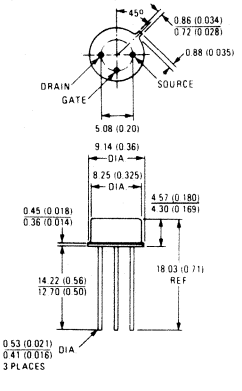
FN-2

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFNF320	400V	1.8Ω	2.5A
UFNF321	350V	1.8Ω	2.5A
UFNF322	400V	2.5Ω	2.0A
UFNF323	350V	2.5Ω	2.0A

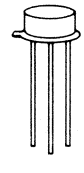
MECHANICAL SPECIFICATIONS

UFNF320 UFNF321 UFNF322 UFNF323



All Dimensions in Millimeters and (Inches)

TO-205AD (TO-39)



UNITRODE

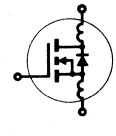
ABSOLUTE MAXIMUM RATINGS

Parameter		UFNF320	UFNF321	UFNF322	UFNF323	Units
V_{DS}	Drain – Source Voltage ①	400	350	400	350	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ) ①	400	350	400	350	V
I_D @ T_C = 25°C	Continuous Drain Current	2.5	2.5	2.0	2.0	A
I_{DM}	Pulsed Drain Current ③	10	10	8.0	8.0	A
V_{GS}	Gate – Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	20 (See Fig. 14)				W
	Linear Derating Factor	0.16 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		10	10	8.0	8.0	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ TC = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	UFNF320 UFNF322	400	–	–	V	V_{GS} = 0V
		UFNF321 UFNF323	350	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate – Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate – Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFNF320 UFNF321	2.5	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFNF322 UFNF323	2.0	–	–	A	
$R_{DS(on)}$	Static Drain – Source On-State Resistance ②	UFNF320 UFNF321	–	1.5	1.8	Ω	V_{GS} = 10V, I_D = 1.25A
		UFNF322 UFNF323	–	1.8	2.5	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.0	2.0	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 1.25A
C_{iss}	Input Capacitance	ALL	–	450	600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	100	200	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	20	40	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	20	40	ns	V_{DD} ≈ 0.5 BV_{DSS}, I_D = 2.0A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	25	50	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	50	100	ns	
t_f	Fall Time	ALL	–	25	50	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	12	15	nC	V_{GS} = 10V, I_D = 5.0A, V_{DS} = 0.8V Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	6.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	6.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured from the drain lead, 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	–	15	–	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	6.25	K/W	
R_{thJA}	Junction-to-Ambient	ALL	–	–	175	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFNF320 UFNF321	—	—	2.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFNF322 UFNF323	—	—	2.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFNF320 UFNF321	—	—	10	A	
		UFNF322 UFNF323	—	—	8.0	A	
V_{SD}	Diode Forward Voltage ②	UFNF320 UFNF321	—	—	1.6	V	T_C = 25°C, I_S = 2.5A, V_{GS} = 0V
		UFNF322 UFNF323	—	—	1.5	V	T_C = 25°C, I_S = 2.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	450	—	ns	T_J = 150°C, I_F = 2.5A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	3.1	—	μC	T_J = 150°C, I_F = 2.5A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 — Typical Output Characteristics

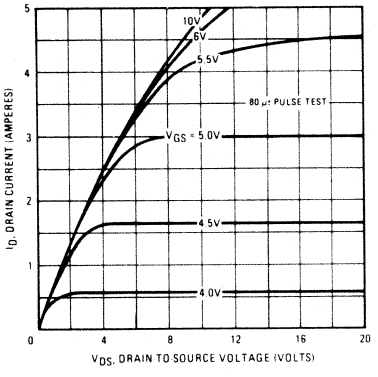


Fig. 2 — Typical Transfer Characteristics

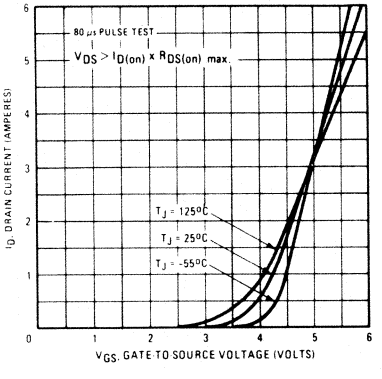


Fig. 3 — Typical Saturation Characteristics

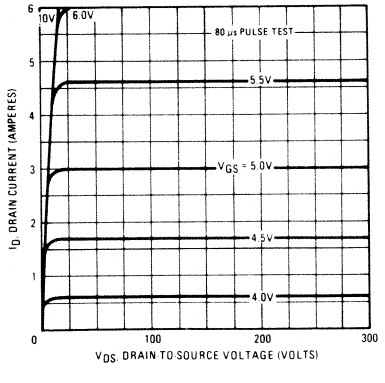
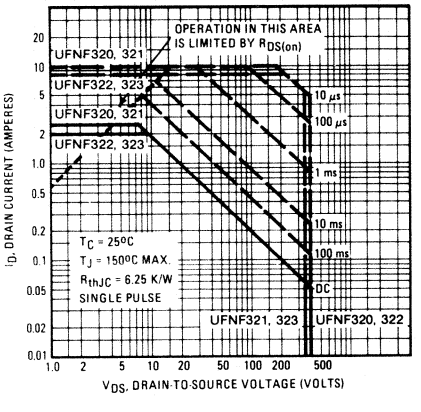


Fig. 4 — Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

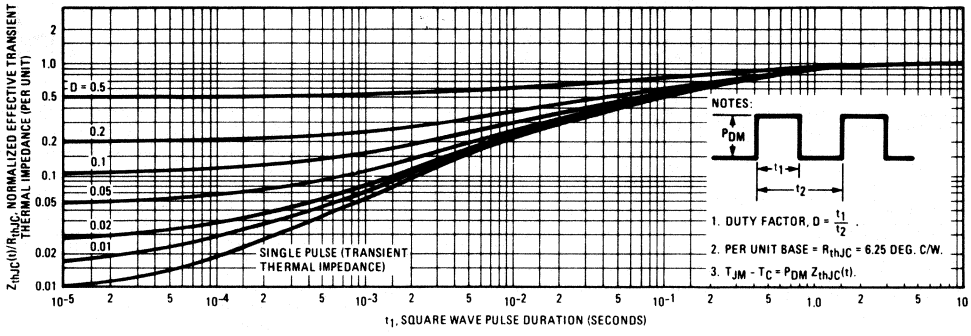


Fig. 6 – Typical Transconductance Vs. Drain Current

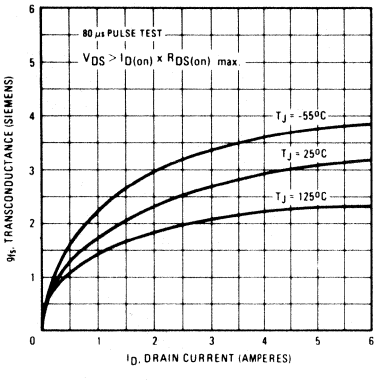


Fig. 7 – Typical Source-Drain Diode Forward Voltage

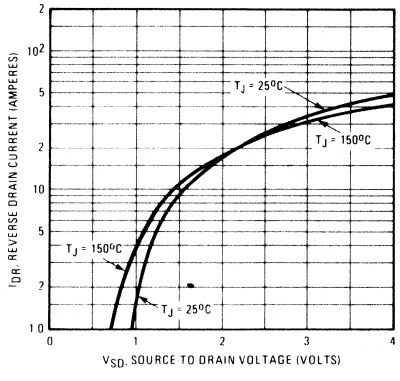


Fig. 8 – Breakdown Voltage Vs. Temperature

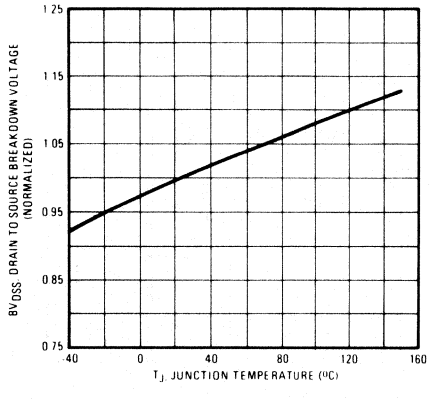


Fig. 9 – Normalized On-Resistance Vs. Temperature

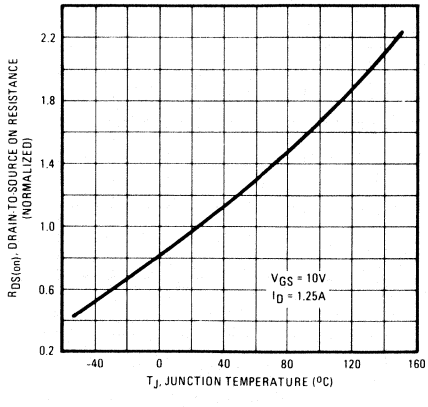


Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

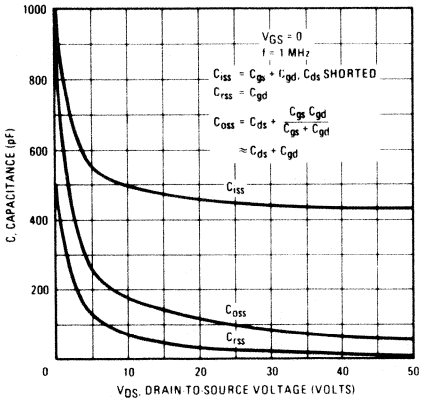


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

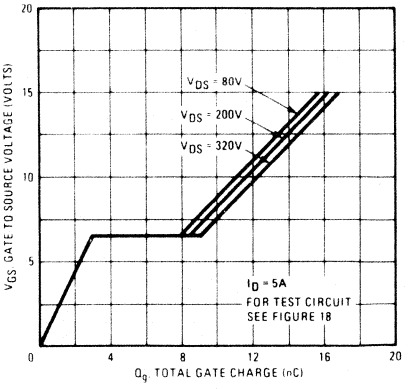


Fig. 12 – Typical On-Resistance Vs. Drain Current

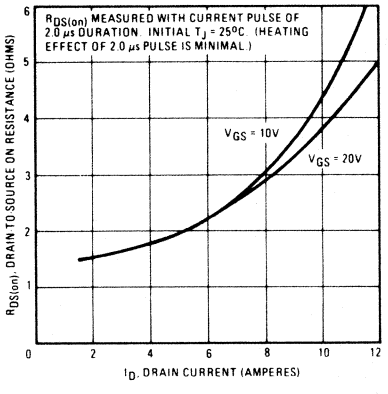


Fig. 13 – Maximum Drain Current Vs. Case Temperature

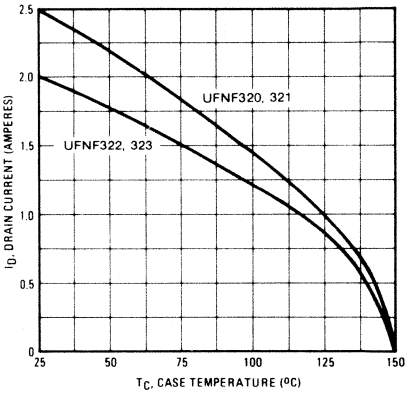


Fig. 14 – Power Vs. Temperature Derating Curve

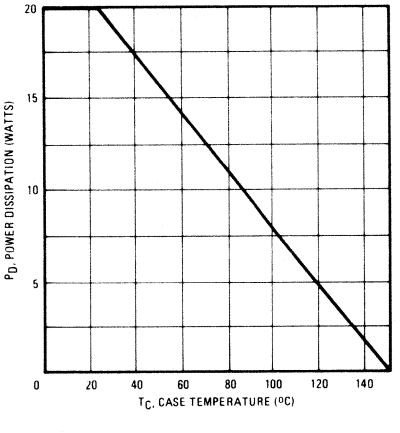


Fig. 15 – Clamped Inductive Test Circuit

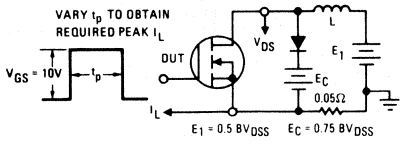


Fig. 16 – Clamped Inductive Waveforms

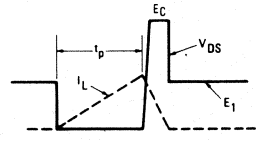


Fig. 17 – Switching Time Test Circuit

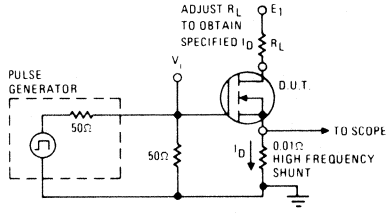
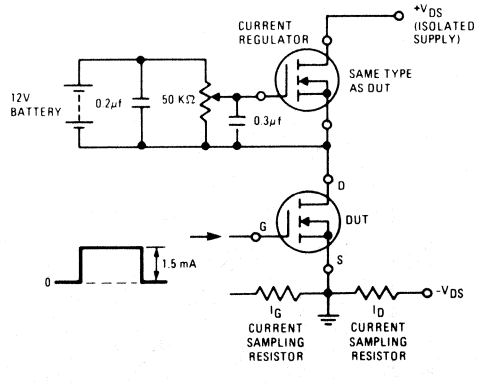


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS
400 Volt, 1.0 Ohm

UFNF330
UFNF331
UFNF332
UFNF333

3

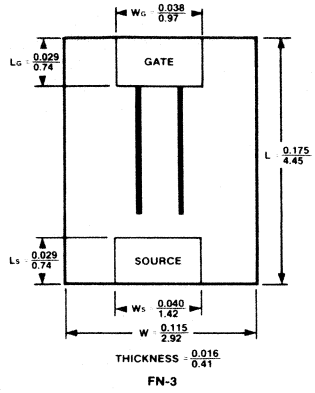
FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



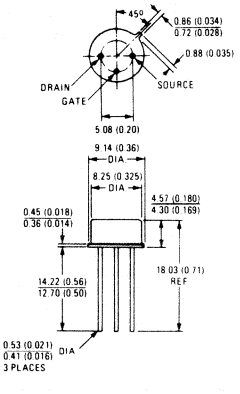
FN-3

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFNF330	400V	1.0Ω	3.5A
UFNF331	350V	1.0Ω	3.5A
UFNF332	400V	1.5Ω	3.0A
UFNF333	350V	1.5Ω	3.0A

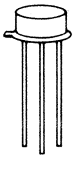
MECHANICAL SPECIFICATIONS

UFNF330 UFNF331 UFNF332 UFNF333



All Dimensions in Millimeters and (Inches)

TO-205AD (TO-39)



UNITRODE

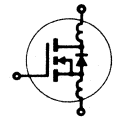
ABSOLUTE MAXIMUM RATINGS

Parameter		UFNF330	UFNF331	UFNF332	UFNF333	Units
V_{DS}	Drain – Source Voltage ①	400	350	400	350	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ) ①	400	350	400	350	V
I_D @ T_C = 25°C	Continuous Drain Current	3.5	3.5	3.0	3.0	A
I_{DM}	Pulsed Drain Current ③	14	14	12	12	A
V_{GS}	Gate – Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	25 (See Fig. 14)				W
	Linear Derating Factor	0.2 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH 14	14	12	12	A
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ TC = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	UFNF330 UFNF332	400	–	–	V	V_{GS} = 0V
		UFNF331 UFNF333	350	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate – Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate – Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFNF330 UFNF331	3.5	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFNF332 UFNF333	3.0	–	–	A	
$R_{DS(on)}$	Static Drain – Source On-State Resistance ②	UFNF330 UFNF331	–	0.8	1.0	Ω	V_{GS} = 10V, I_D = 2.0A
		UFNF332 UFNF333	–	1.0	1.5	Ω	
g_{fs}	Forward Transconductance ②	ALL	2.0	3.5	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 2.0A
C_{iss}	Input Capacitance	ALL	–	700	900	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	150	300	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	40	80	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	30	ns	V_{DD} ≈ 175V, I_D = 2.0A, Z_o = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	35	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	55	ns	
t_f	Fall Time	ALL	–	–	35	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	18	30	nC	V_{GS} = 10V, I_D = 7.0A, V_{DS} = 0.8V Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	11	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	7.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured from the drain lead, 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	–	15	–	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	5.0	K/W	
R_{thJA}	Junction-to-Ambient	ALL	–	–	175	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFNF330 UFNF331	—	—	3.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		UFNF332 UFNF333	—	—	3.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFNF330 UFNF331	—	—	14	A	
		UFNF332 UFNF333	—	—	12	A	
V_{SD}	Diode Forward Voltage ②	UFNF330 UFNF331	—	—	1.6	V	T_C = 25°C, I_S = 3.5A, V_{GS} = 0V
		UFNF332 UFNF333	—	—	1.5	V	T_C = 25°C, I_S = 3.0A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	600	—	ns	T_J = 150°C, I_F = 3.5A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	4.0	—	μC	T_J = 150°C, I_F = 3.5A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 — Typical Output Characteristics

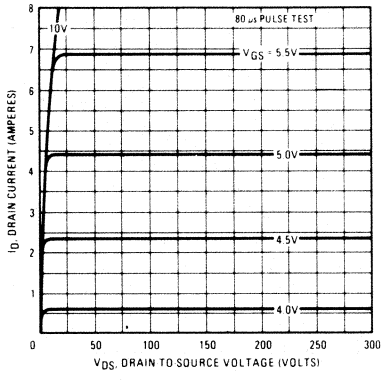


Fig. 2 — Typical Transfer Characteristics

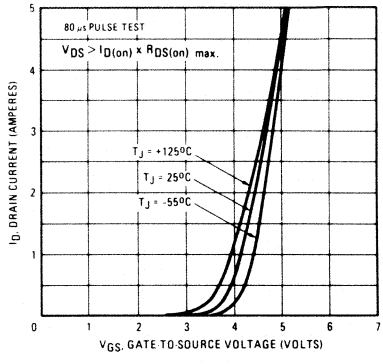


Fig. 3 — Typical Saturation Characteristics

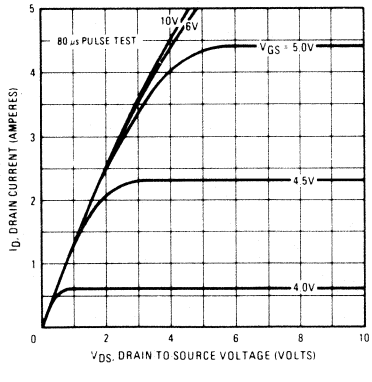


Fig. 4 — Maximum Safe Operating Area

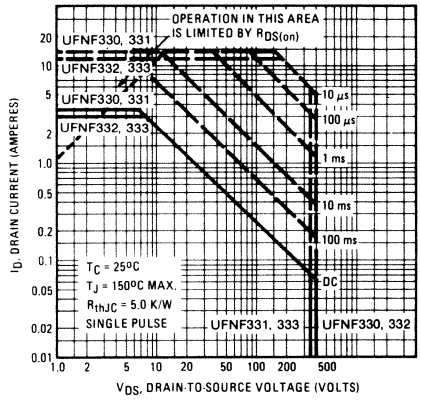


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

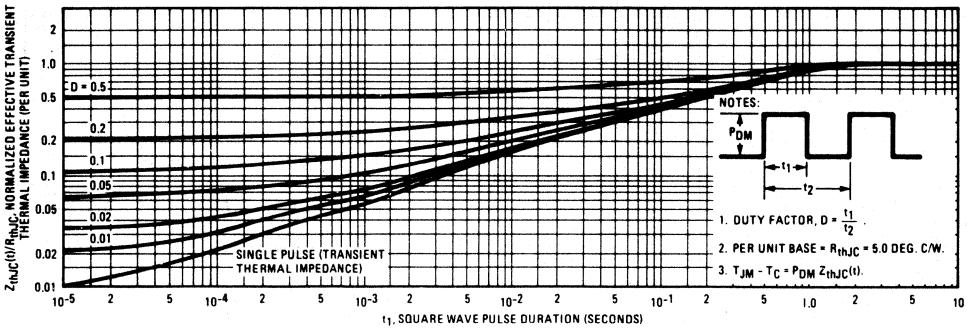


Fig. 6 – Typical Transconductance Vs. Drain Current

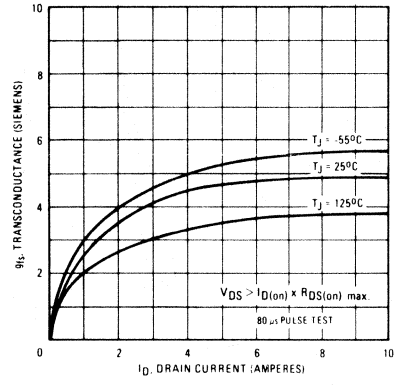


Fig. 7 – Typical Source-Drain Diode Forward Voltage

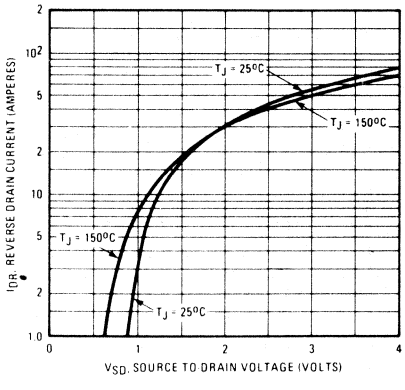


Fig. 8 – Breakdown Voltage Vs. Temperature

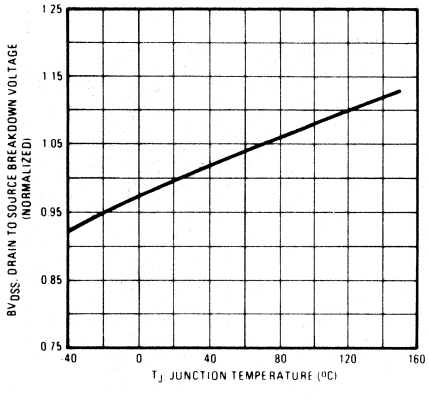
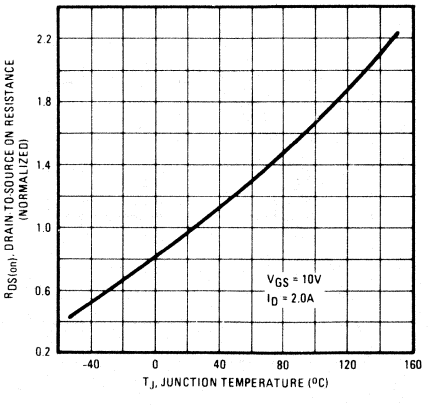


Fig. 9 – Normalized On-Resistance Vs. Temperature



3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

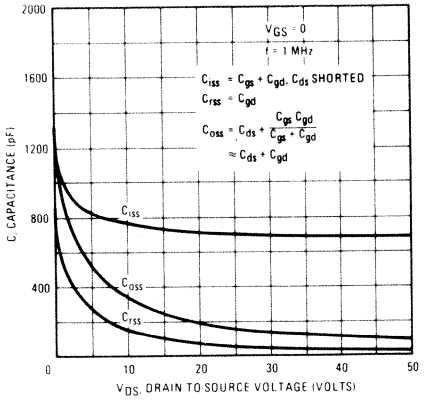


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

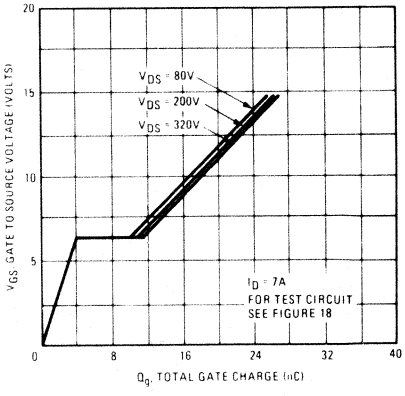


Fig. 12 – Typical On-Resistance Vs. Drain Current

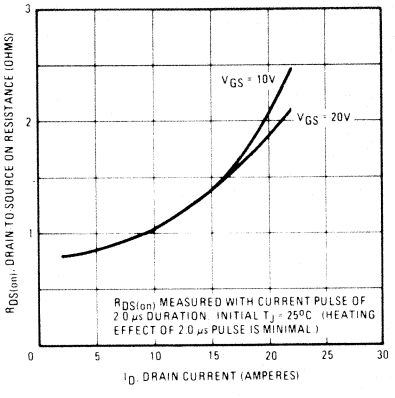


Fig. 13 – Maximum Drain Current Vs. Case Temperature

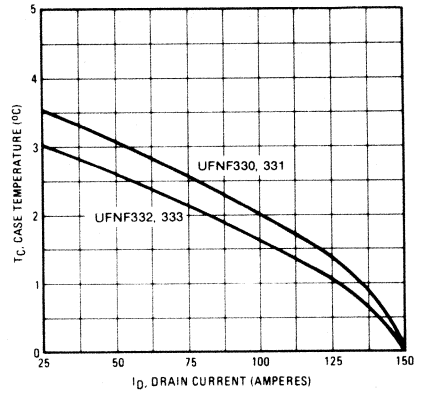


Fig. 14 – Power Vs. Temperature Derating Curve

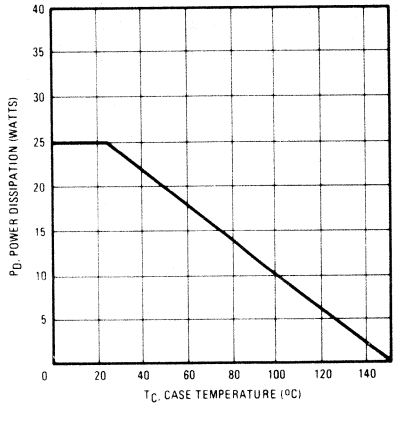


Fig. 15 – Clamped Inductive Test Circuit

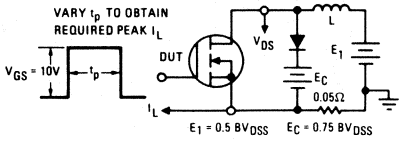


Fig. 16 – Clamped Inductive Waveforms

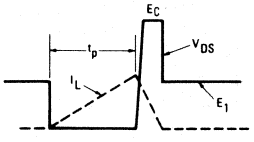


Fig. 17 – Switching Time Test Circuit

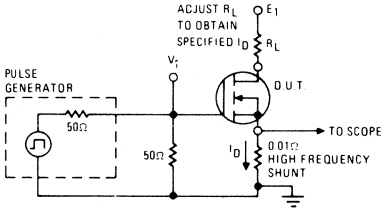
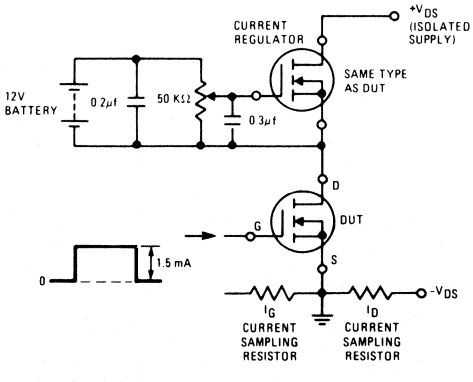


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS
500 Volt, 3.0 Ohm

UFNF420
UFNF421
UFNF422
UFNF423

3

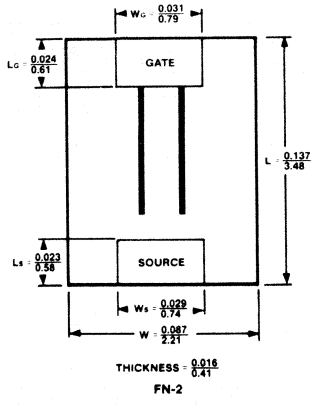
FEATURES
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



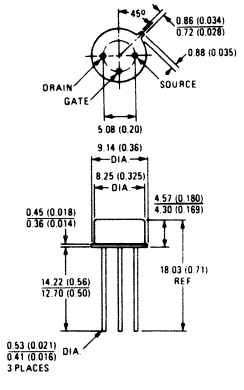
FN-2

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFNF420	500V	3.0Ω	1.6A
UFNF421	450V	3.0Ω	1.6A
UFNF422	500V	4.0Ω	1.4A
UFNF423	450V	4.0Ω	1.4A

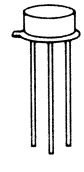
MECHANICAL SPECIFICATIONS

UFNF420 UFNF421 UFNF422 UFNF423



All Dimensions in Millimeters and (Inches)

TO-205AD (TO-39)



UNITRODE

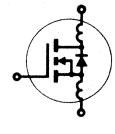
ABSOLUTE MAXIMUM RATINGS

Parameter		UFNF420	UFNF421	UFNF422	UFNF423	Units
V_{DS}	Drain – Source Voltage ①	500	450	500	450	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ) ①	500	450	500	450	V
I_D @ T_C = 25°C	Continuous Drain Current	1.6	1.6	1.4	1.4	A
I_{DM}	Pulsed Drain Current ③	6.5	6.5	5.5	5.5	A
V_{GS}	Gate – Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	20 (See Fig. 14)				W
	Linear Derating Factor	0.16 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		6.5	6.5	5.5	5.5	
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ TC = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	UFNF420 UFNF422	500	–	–	V	V_{GS} = 0V
		UFNF421 UFNF423	450	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate – Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate – Source Leakage Reverse	ALL	–	–	-100	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFNF420 UFNF421	1.6	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFNF422 UFNF423	1.4	–	–	A	
$R_{DS(on)}$	Static Drain – Source On-State Resistance ②	UFNF420 UFNF421	–	2.5	3.0	Ω	V_{GS} = 10V, I_D = 1.0A
		UFNF422 UFNF423	–	3.0	4.0	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.0	1.75	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max. I_D = 1.0A
C_{iss}	Input Capacitance	ALL	–	300	400	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	75	150	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	20	40	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	30	60	ns	V_{DD} = 0.5 BV_{DSS}, I_D = 1.0A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	25	50	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	30	60	ns	
t_f	Fall Time	ALL	–	15	30	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	11	15	nC	V_{GS} = 10V, I_D = 3.0A, V_{DS} = 0.8V Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	5.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	6.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured from the drain lead, 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	–	15	–	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	6.25	K/W	
R_{thJA}	Junction-to-Ambient	ALL	–	–	175	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFNF420 UFNF421	—	—	1.6	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		UFNF422 UFNF423	—	—	1.4	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFNF420 UFNF421	—	—	6.5	A	
		UFNF422 UFNF423	—	—	5.5	A	
V_{SD}	Diode Forward Voltage ②	UFNF420 UFNF421	—	—	1.4	V	T_C = 25°C, I_S = 1.6A, V_{GS} = 0V
		UFNF422 UFNF423	—	—	1.3	V	T_C = 25°C, I_S = 1.4A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	600	—	ns	T_J = 150°C, I_F = 1.6A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	3.5	—	μC	T_J = 150°C, I_F = 1.6A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

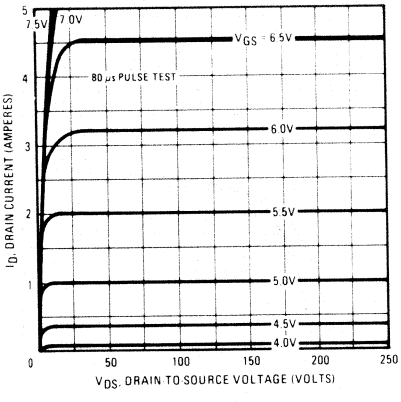


Fig. 2 – Typical Transfer Characteristics

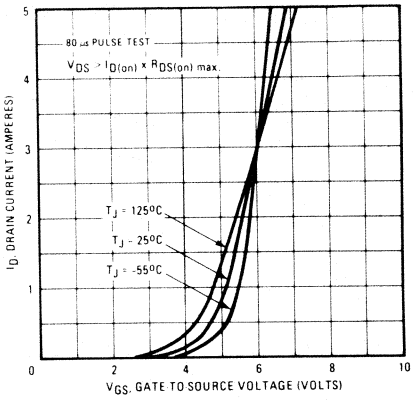


Fig. 3 – Typical Saturation Characteristics

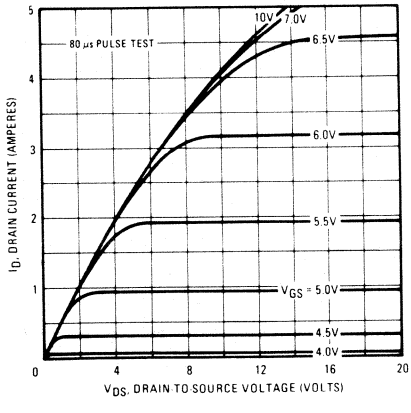


Fig. 4 – Maximum Safe Operating Area

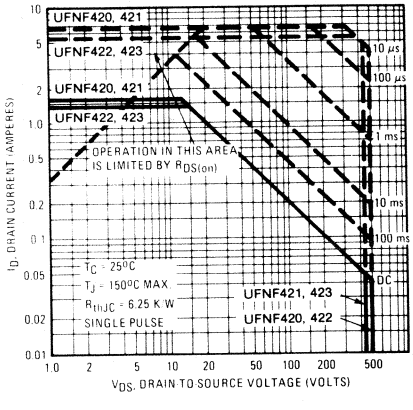


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

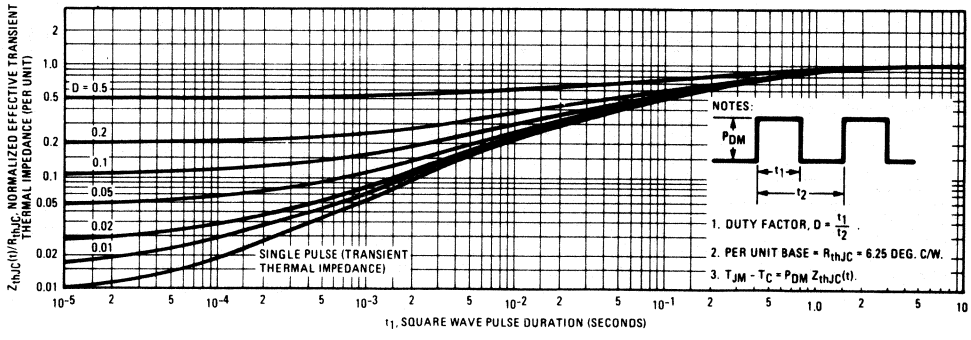


Fig. 6 – Typical Transconductance Vs. Drain Current

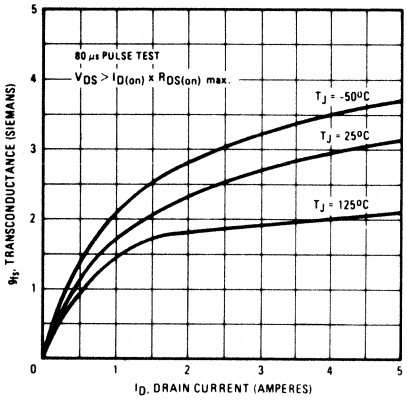


Fig. 7 – Typical Source-Drain Diode Forward Voltage

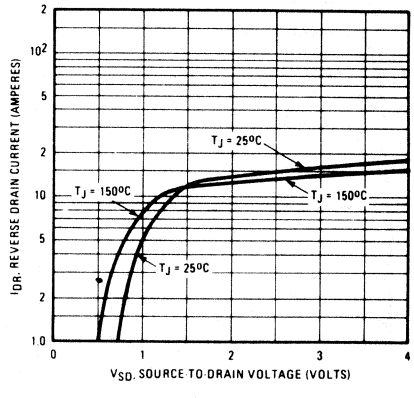


Fig. 8 – Breakdown Voltage Vs. Temperature

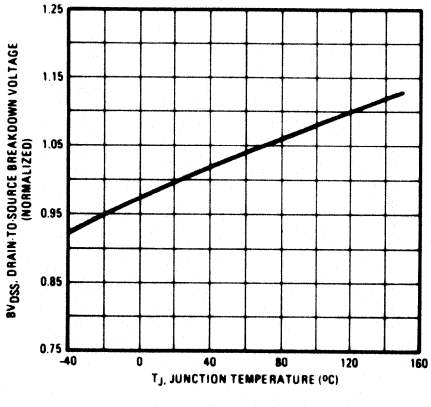
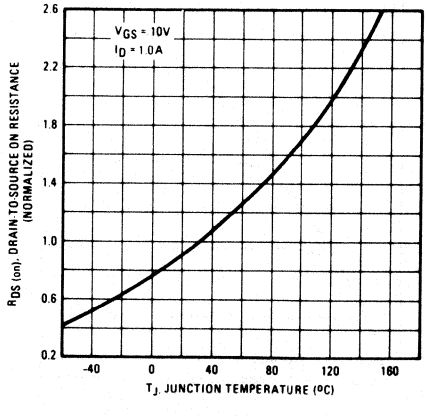


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

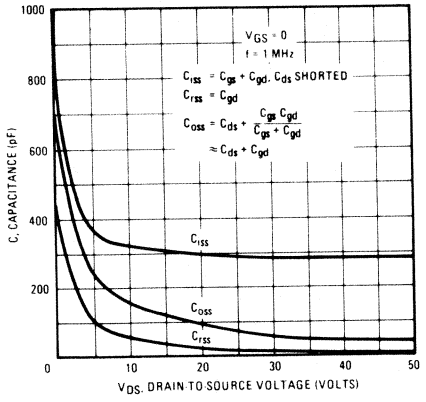


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

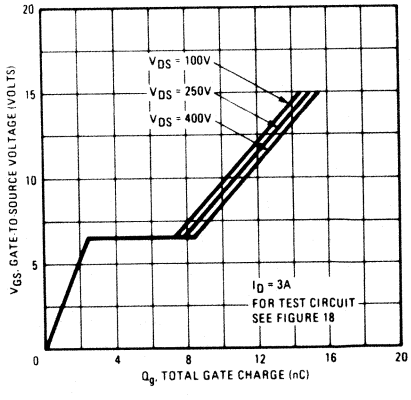


Fig. 12 – Typical On-Resistance Vs. Drain Current

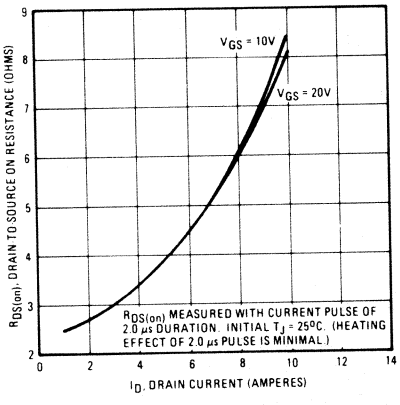


Fig. 13 – Maximum Drain Current Vs. Case Temperature

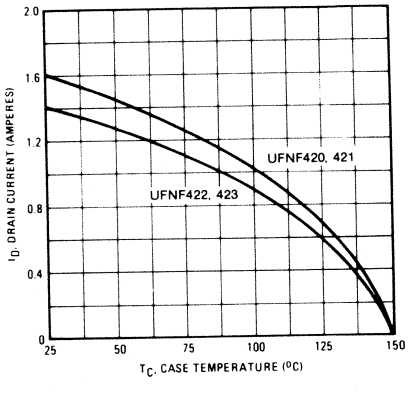
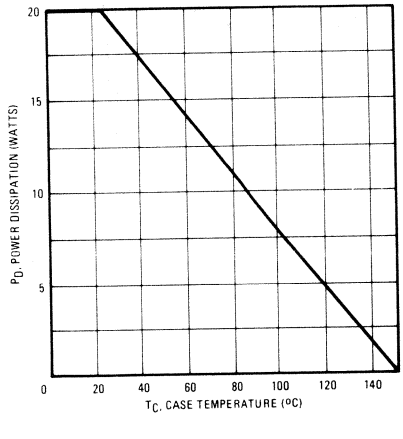


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 – Clamped Inductive Test Circuit

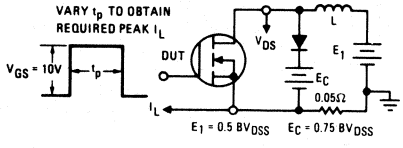


Fig. 16 – Clamped Inductive Waveforms

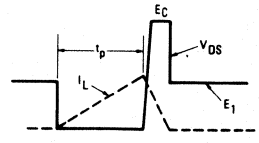


Fig. 17 – Switching Time Test Circuit

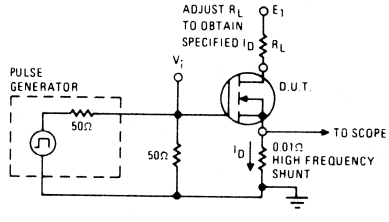
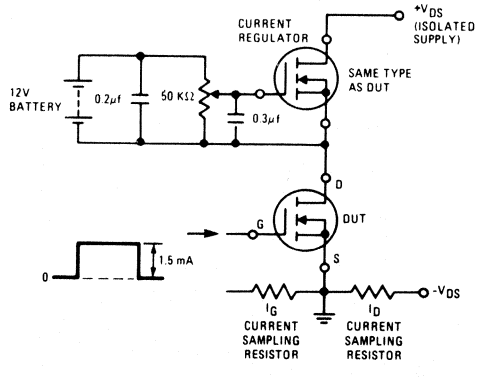


Fig. 18 – Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

500 Volt, 1.5 Ohm N-Channel

UFNF430
UFNF431
UFNF432
UFNF433

3

FEATURES

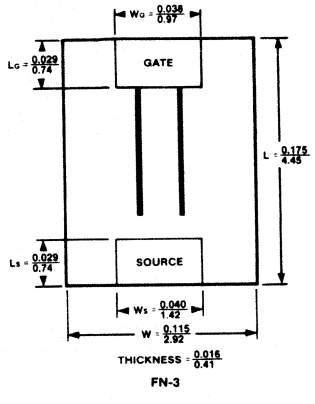
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.



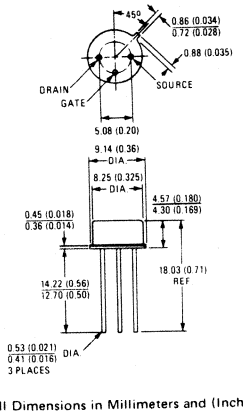
FN-3

PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFNF430	500V	1.5Ω	2.75A
UFNF431	450V	1.5Ω	2.75A
UFNF432	500V	2.0Ω	2.25A
UFNF433	450V	2.0Ω	2.25A

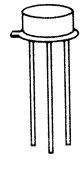
MECHANICAL SPECIFICATIONS

UFNF430 UFNF431 UFNF432 UFNF433



All Dimensions in Millimeters and (Inches)

TO-205AD (TO-39)



UNITRODE

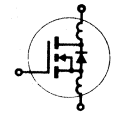
ABSOLUTE MAXIMUM RATINGS

Parameter		UFNF430	UFNF431	UFNF432	UFNF433	Units
V_{DS}	Drain – Source Voltage ①	500	450	500	450	V
V_{DGR}	Drain – Gate Voltage (R_{GS} = 1 MΩ) ①	500	450	500	450	V
I_D @ T_C = 25°C	Continuous Drain Current	2.75	2.75	2.25	2.25	A
I_{DM}	Pulsed Drain Current ③	11	11	9.0	9.0	A
V_{GS}	Gate – Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	25 (See Fig. 14)				W
	Linear Derating Factor	0.2 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		11	11	9.0	9.0	
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain – Source Breakdown Voltage	UFNF430 UFNF432	500	–	–	V	V_{GS} = 0V
		UFNF431 UFNF433	450	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate – Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate – Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFNF430 UFNF431	2.75	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		UFNF432 UFNF433	2.25	–	–	A	
$R_{DS(on)}$	Static Drain – Source On-State Resistance ②	UFNF430 UFNF431	–	1.3	1.5	Ω	V_{GS} = 10V, I_D = 1.5A
		UFNF432 UFNF433	–	1.5	2.0	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.5	2.5	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 1.5A
C_{iss}	Input Capacitance	ALL	–	600	800	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	100	200	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	30	60	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	30	ns	V_{DD} = 225V, I_D = 1.5A, Z_o = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	30	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	55	ns	
t_f	Fall Time	ALL	–	–	30	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	22	30	nC	V_{GS} = 10V, I_D = 6.0A, V_{DS} = 0.8V Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	11	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	11	–	nC	
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured from the drain lead, 5mm (0.2 in.) from header to center of die.
L_S	Internal Source Inductance	ALL	–	15	–	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	5.0	K/W	
R_{thJA}	Junction-to-Ambient	ALL	–	–	175	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFNF430 UFNF431	—	—	2.75	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		UFNF432 UFNF433	—	—	2.25	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFNF430 UFNF431	—	—	11	A	
		UFNF432 UFNF433	—	—	9.0	A	
V_{SD}	Diode Forward Voltage ②	UFNF430 UFNF431	—	—	1.4	V	T_C = 25°C, I_S = 2.75A, V_{GS} = 0V
		UFNF432 UFNF433	—	—	1.3	V	T_C = 25°C, I_S = 2.25A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	800	—	ns	T_J = 150°C, I_F = 2.75A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	4.6	—	μC	T_J = 150°C, I_F = 2.75A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 — Typical Output Characteristics

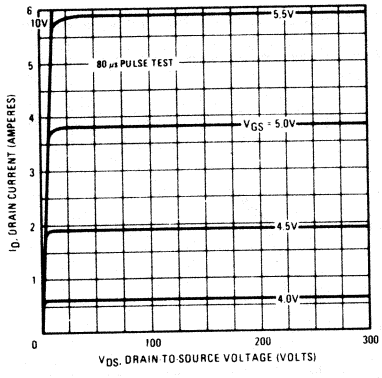


Fig. 2 — Typical Transfer Characteristics

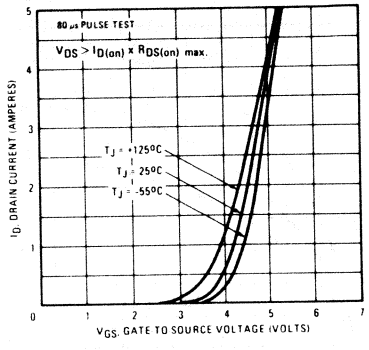


Fig. 3 — Typical Saturation Characteristics

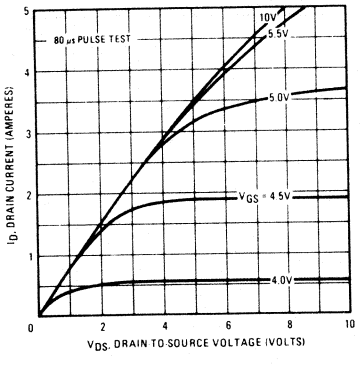
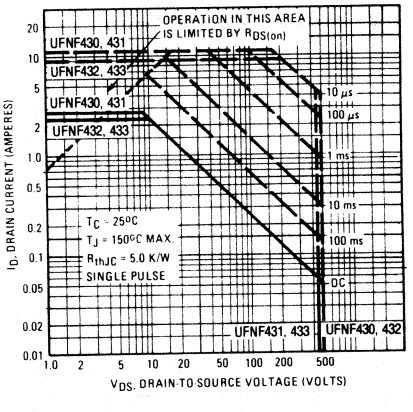


Fig. 4 — Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

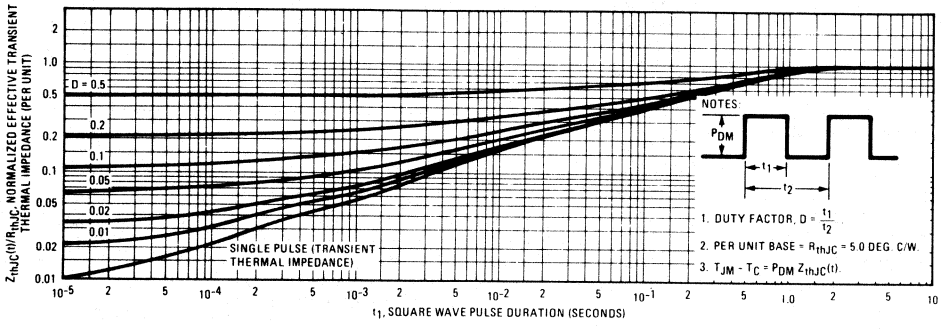


Fig. 6 – Typical Transconductance Vs. Drain Current

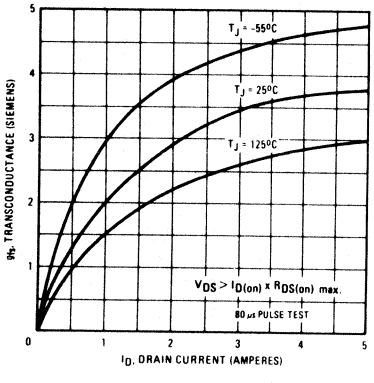


Fig. 7 – Typical Source-Drain Diode Forward Voltage

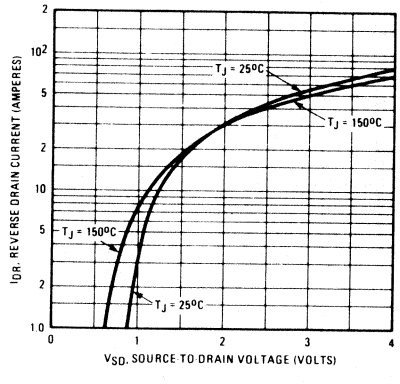


Fig. 8 – Breakdown Voltage Vs. Temperature

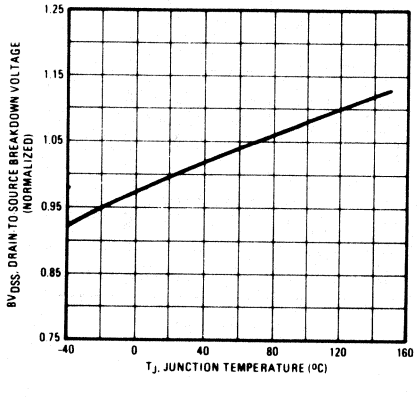
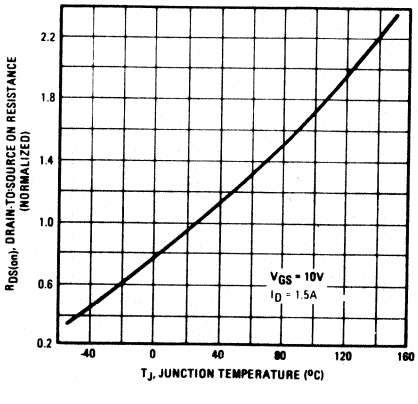


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

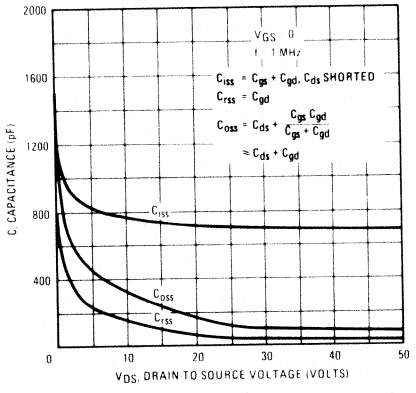


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

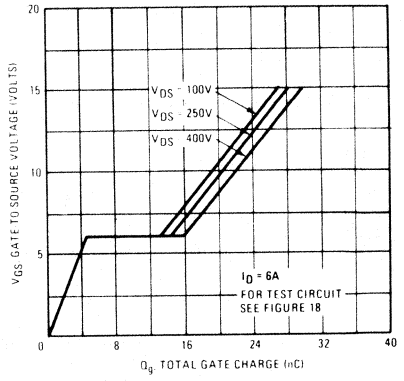


Fig. 12 – Typical On-Resistance Vs. Drain Current

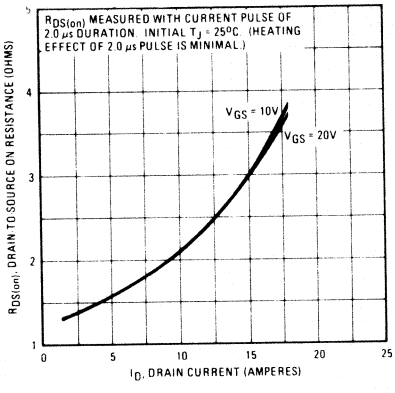


Fig. 13 – Maximum Drain Current Vs. Case Temperature

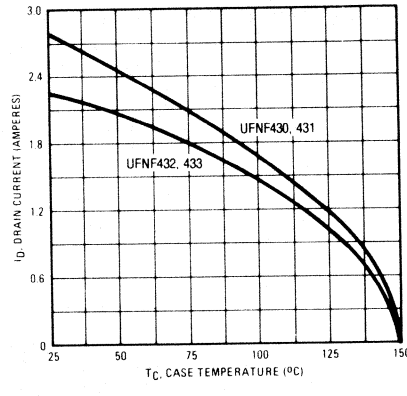


Fig. 14 – Power Vs. Temperature Derating Curve

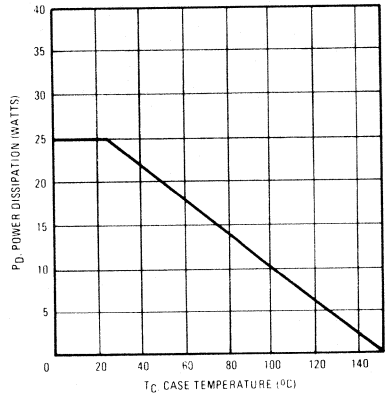


Fig. 15 – Clamped Inductive Test Circuit

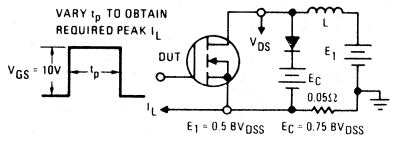


Fig. 16 – Clamped Inductive Waveforms

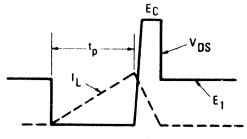


Fig. 17 – Switching Time Test Circuit

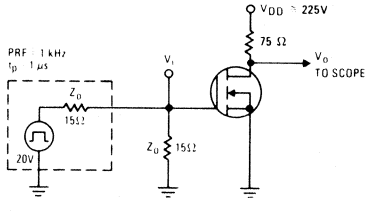
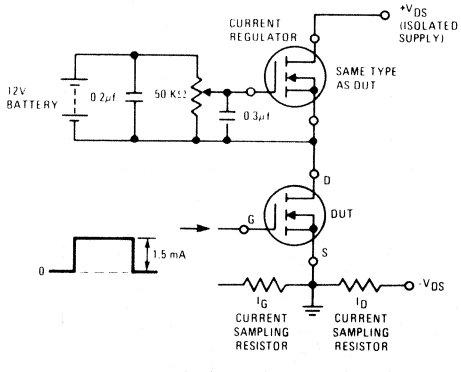


Fig. 18 – Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

50 Volt, 0.1 Ohm
N-Channel

UFNZ20
UFNZ22

3

FEATURES

- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

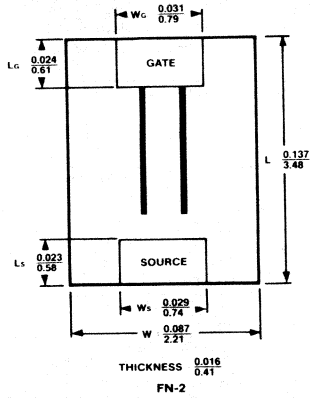
These low voltage power MOSFETS have been designed for optimum performance in low voltage applications. They utilize the most advanced technology available. The efficient geometry and controlled processing of these MOSFETS have been combined to create devices with the lowest $R_{DS(ON)}$ per unit area of any power MOSFET.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These devices are ideally suited for many high speed, high power switching applications such as switching power supplies, motor controls, choppers, inverters and any high energy pulse circuits. They are also well suited for systems that operate from low voltage batteries such as automotive and portable equipment applications.

PRODUCT SUMMARY

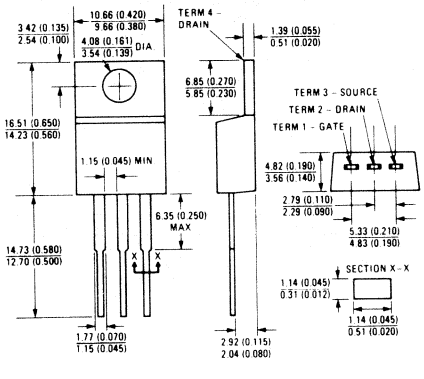
Part Number	V_{DS}	$R_{DS(ON)}$	I_D
UFNZ20	50V	0.10Ω	15A
UFNZ22	50V	0.12Ω	14A



FN-2

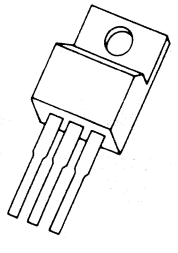
MECHANICAL SPECIFICATIONS

UFNZ20 UFNZ22



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

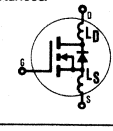
Absolute Maximum Ratings

Parameter		UFNZ20	UFNZ22	Units
V_{DS}	Drain - Source Voltage ①	50	50	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 20 KΩ) ①	50	50	V
I_D @ T_C = 25°C	Continuous Drain Current	15	14	A
I_D @ T_C = 100°C	Continuous Drain Current	10	9.0	A
I_{DM}	Pulsed Drain Current ③	60	56	A
V_{GS}	Gate - Source Voltage	±20		V
P_D @ T_C = 25°C	Max. Power Dissipation	40 (See Fig. 14)		W
	Linear Derating Factor	0.32 (See Fig. 14)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH		A
		60	56	
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150		°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)		°C

Electrical Characteristics @ T_C = 25°C (Unless Otherwise Specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFNZ20	50	–	–	V	V_{GS} = 0V
		UFNZ22	50	–	–	V	I_D = 250 μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250 μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	−500	nA	V_{GS} = −20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating × 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFNZ20	15	–	–	A	V_{DS} > $I_{D(on)}$ × $R_{DS(on)max.}$, V_{GS} = 10V
		UFNZ22	14	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFNZ20	–	0.080	0.100	Ω	V_{GS} = 10V, I_D = 9.0A
		UFNZ22	–	0.110	0.120	Ω	
g_{fs}	Forward Transconductance ②	ALL	5.0	6.0	–	S(℧)	V_{DS} > $I_{D(on)}$ × $R_{DS(on)}$ max., I_D = 9.0A
C_{iss}	Input Capacitance	ALL	–	560	850	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz
C_{oss}	Output Capacitance	ALL	–	250	350	pF	See Fig. 10
C_{rss}	Reverse Transfer Capacitance	ALL	–	60	100	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	15	30	ns	V_{DD} ≅ 25V, I_D = 9.0A, Z_o = 50Ω
t_r	Rise Time	ALL	–	45	90	ns	See Fig. 17
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	20	40	ns	(MOSFET switching times are essentially independent of
t_f	Fall Time	ALL	–	15	30	ns	operating temperature.)
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	12	17	nC	V_{GS} = 10V, I_D = 20A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	9.0	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	3.0	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



Thermal Resistance

R_{thJC}	Junction-to-Case	ALL	–	–	3.12	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Source-Drain Diode Ratings and Characteristics

I_S	Continuous Source Current (Body Diode)	UFNZ20	–	–	15	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		UFNZ22	–	–	14	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFNZ20	–	–	60	A	
		UFNZ22	–	–	56	A	
V_{SD}	Diode Forward Voltage ②	UFNZ20	–	–	1.25	V	T_C = 25°C, I_S = 15A, V_{GS} = 0V
		UFNZ22	–	–	1.1	V	T_C = 25°C, I_S = 14A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	100	–	ns	T_J = 150°C, I_F = 15A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	0.4	–	μC	T_J = 150°C, I_F = 15A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

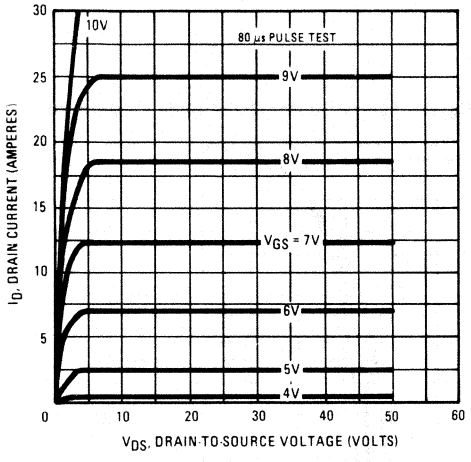


Fig. 2 – Typical Transfer Characteristics

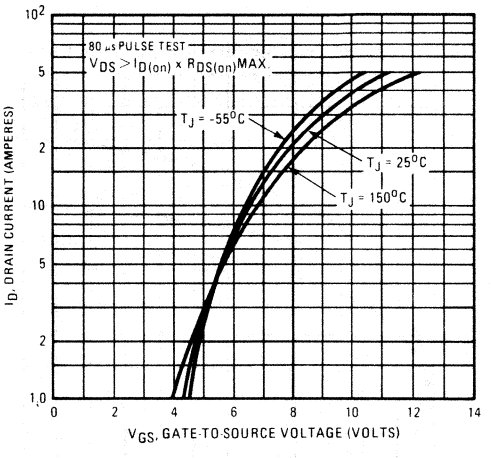


Fig. 3 – Typical Saturation Characteristics

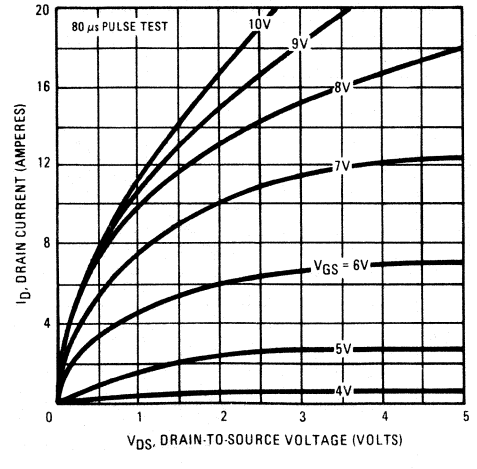
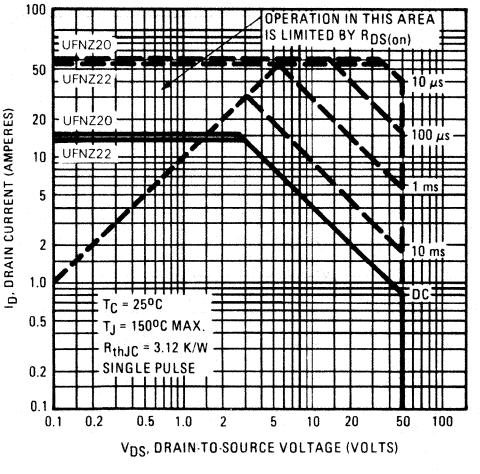


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

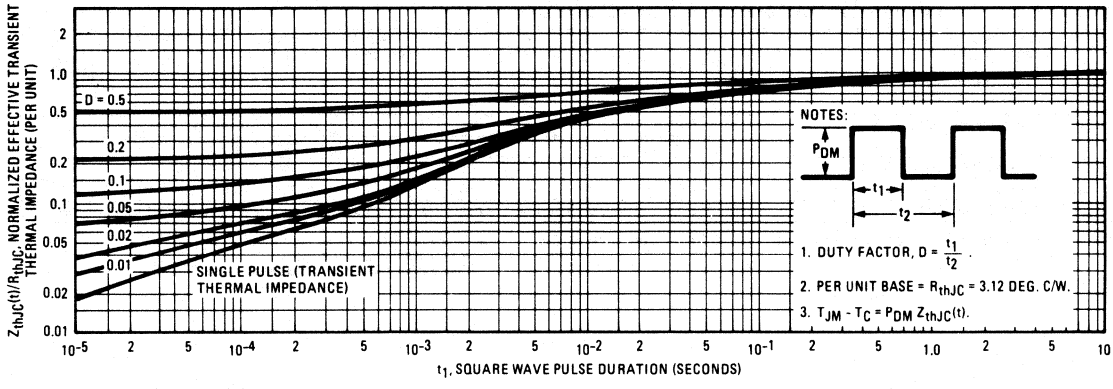


Fig. 6 – Typical Transconductance Vs. Drain Current

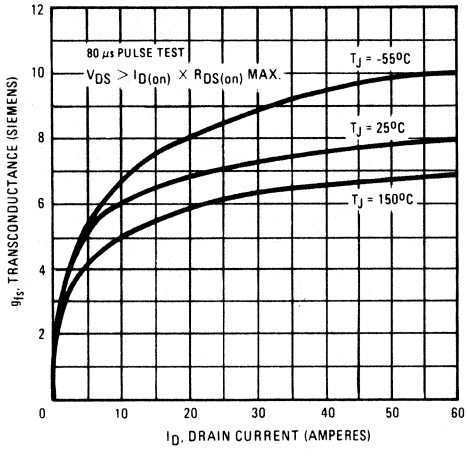


Fig. 7 – Typical Source-Drain Diode Forward Voltage

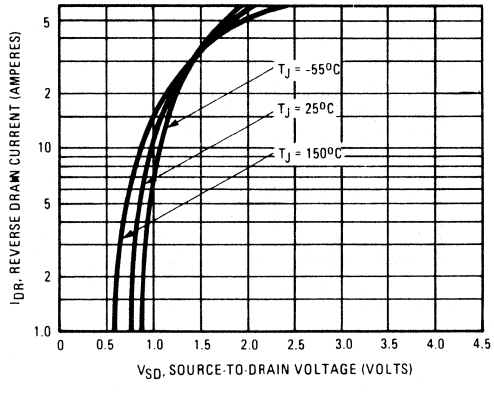


Fig. 8 – Breakdown Voltage Vs. Temperature

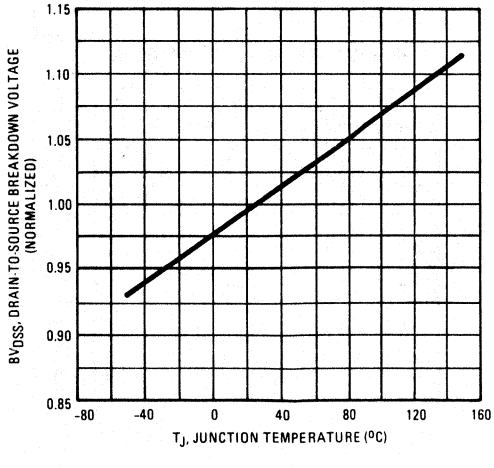
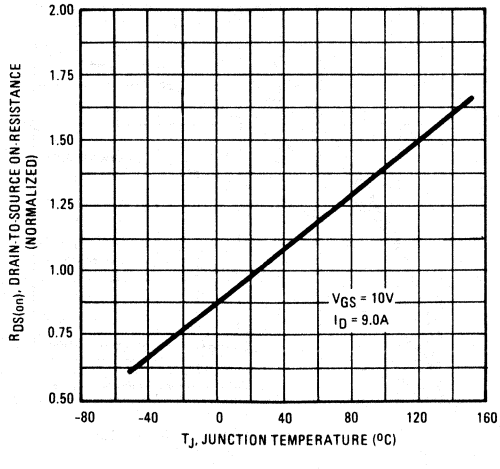


Fig. 9 – Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 10 — Typical Capacitance Vs. Drain-to-Source Voltage

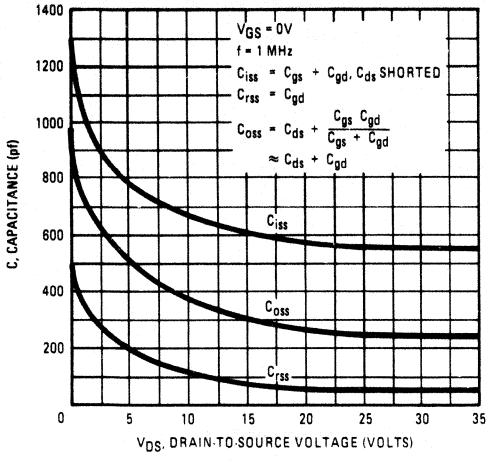


Fig. 11 — Typical Gate Charge Vs. Gate-to-Source Voltage

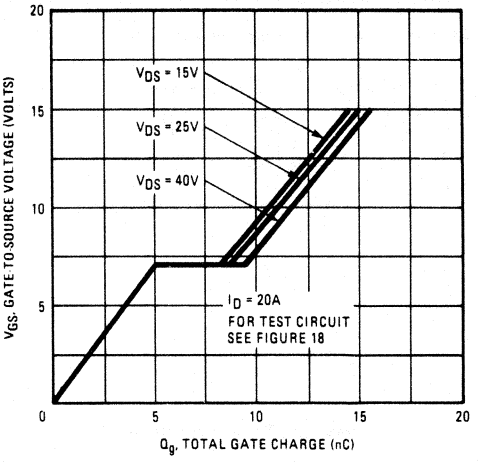


Fig. 12 — Typical On-Resistance Vs. Drain Current

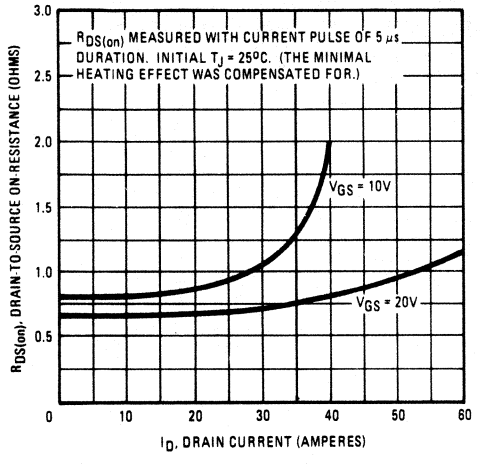


Fig. 13 — Maximum Drain Current Vs. Case Temperature

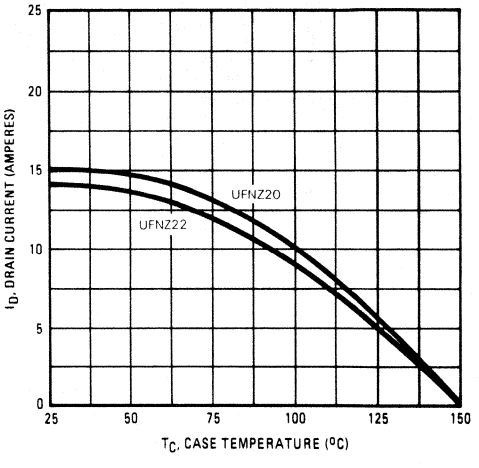
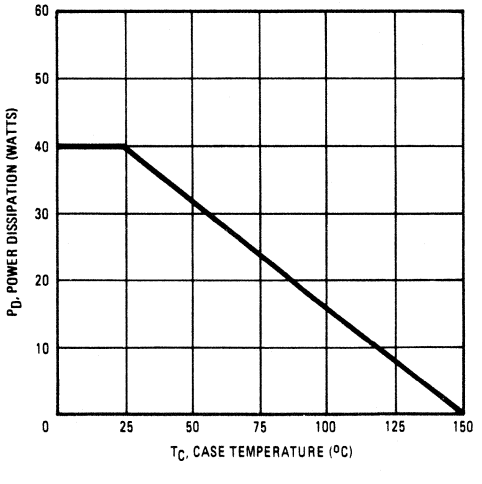


Fig. 14 — Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 — Clamped Inductive Test Circuit

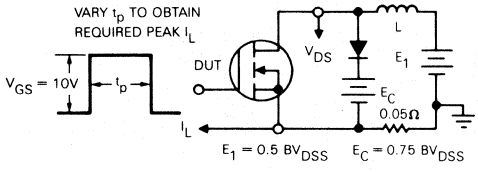


Fig. 16 — Clamped Inductive Waveforms

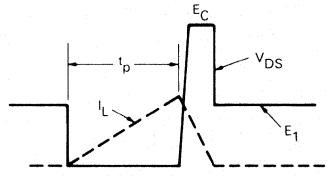


Fig. 17 — Switching Time Test Circuit

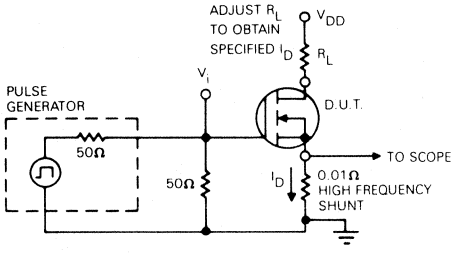
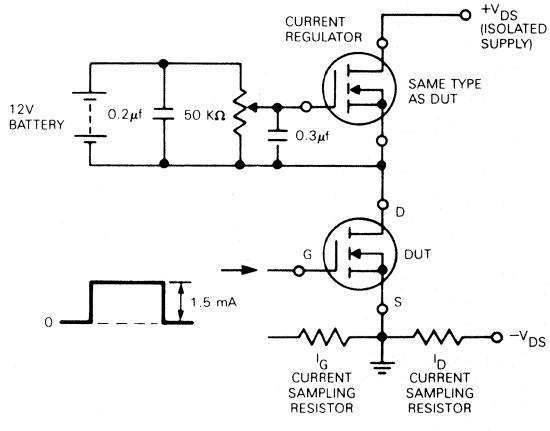


Fig. 18 — Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER MOSFET TRANSISTORS

50 Volt, 0.05 Ohm
N-Channel

UFNZ30
UFNZ32

3

FEATURES

- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

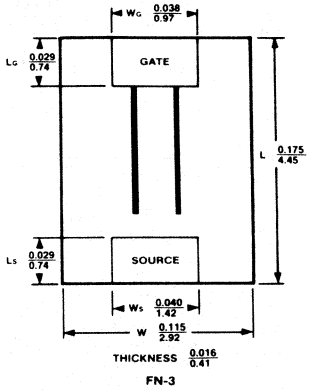
These low voltage power MOSFETS have been designed for optimum performance in low voltage applications. They utilize the most advanced technology available. The efficient geometry and controlled processing of these MOSFETS have been combined to create devices with the lowest $R_{DS(ON)}$ per unit area of any power MOSFET.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These devices are ideally suited for many high speed, high power switching applications such as switching power supplies, motor controls, choppers, inverters and any high energy pulse circuits. They are also well suited for systems that operate from low voltage batteries such as automotive and portable equipment applications.

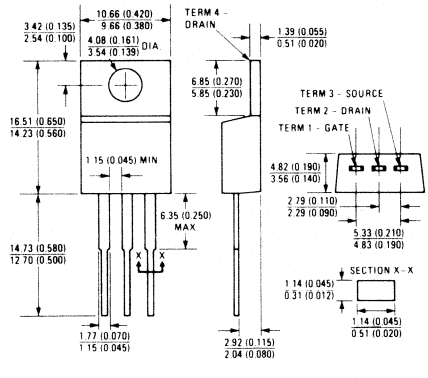
PRODUCT SUMMARY

Part Number	V_{DS}	$R_{DS(ON)}$	I_D
UFNZ30	50V	0.05Ω	30A
UFNZ32	50V	0.07Ω	25A



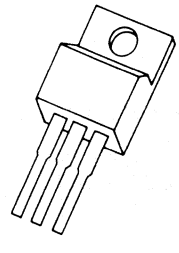
MECHANICAL SPECIFICATIONS

UFNZ30 UFNZ32



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

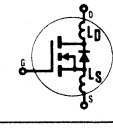
Absolute Maximum Ratings

Parameter		UFNZ30	UFNZ32	Units
V_{DS}	Drain - Source Voltage ①	50	50	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 20 KΩ) ①	50	50	V
I_D @ T_C = 25°C	Continuous Drain Current	30	25	A
I_D @ T_C = 100°C	Continuous Drain Current	19	16	A
I_{DM}	Pulsed Drain Current ③	80	60	A
V_{GS}	Gate - Source Voltage	±20		V
P_D @ T_C = 25°C	Max. Power Dissipation	75 (See Fig. 14)		W
	Linear Derating Factor	0.6 (See Fig. 14)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH		A
		80	60	
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150		°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)		°C

Electrical Characteristics @ T_C = 25°C (Unless Otherwise Specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFNZ30	50	–	–	V	V_{GS} = 0V
		UFNZ32	50	–	–	V	I_D = 250 μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250 μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	−500	nA	V_{GS} = −20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating × 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFNZ30	30	–	–	A	V_{DS} > $I_{D(on)}$ × $R_{DS(on)max.}$, V_{GS} = 10V
		UFNZ32	25	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFNZ30	–	0.045	0.050	Ω	V_{GS} = 10V, I_D = 16A
		UFNZ32	–	0.065	0.070	Ω	
g_{fs}	Forward Transconductance ②	ALL	9.0	12	–	S(℧)	V_{DS} > $I_{D(on)}$ × $R_{DS(on)}$ max., I_D = 16A
C_{iss}	Input Capacitance	ALL	–	1250	1600	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz
C_{oss}	Output Capacitance	ALL	–	550	800	pF	See Fig. 10
C_{rss}	Reverse Transfer Capacitance	ALL	–	130	200	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	12	25	ns	V_{DD} ≅ 25V, I_D = 16A, Z_o = 50Ω
t_r	Rise Time	ALL	–	16	35	ns	See Fig. 17
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	23	45	ns	(MOSFET switching times are essentially independent of
t_f	Fall Time	ALL	–	16	35	ns	operating temperature.)
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	26	30	nC	V_{GS} = 10V, I_D = 38A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	14	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	12	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



Thermal Resistance

R_{thJC}	Junction-to-Case	ALL	–	–	1.67	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Source-Drain Diode Ratings and Characteristics

I_S	Continuous Source Current (Body Diode)	UFNZ30	–	–	30	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		UFNZ32	–	–	25	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFNZ30	–	–	80	A	
		UFNZ32	–	–	60	A	
V_{SD}	Diode Forward Voltage ②	UFNZ30	–	–	1.6	V	T_C = 25°C, I_S = 30A, V_{GS} = 0V
		UFNZ32	–	–	1.5	V	T_C = 25°C, I_S = 25A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	160	–	ns	T_J = 150°C, I_F = 30A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	1.5	–	μC	T_J = 150°C, I_F = 30A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

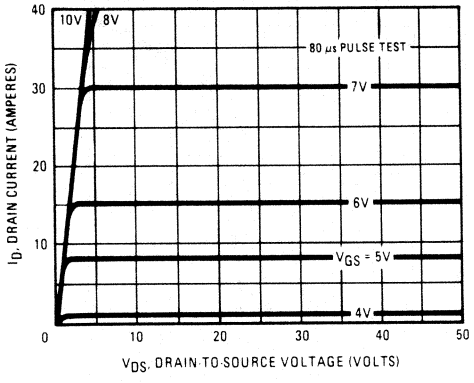


Fig. 2 – Typical Transfer Characteristics

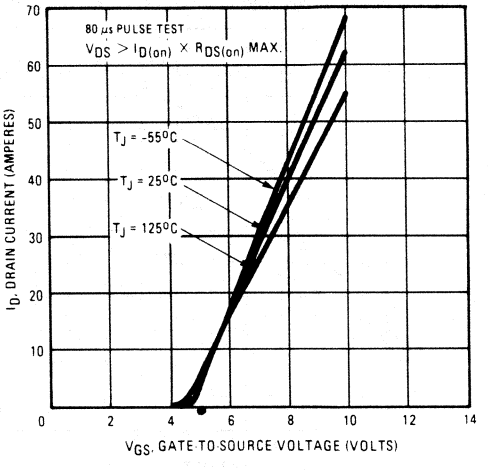


Fig. 3 – Typical Saturation Characteristics

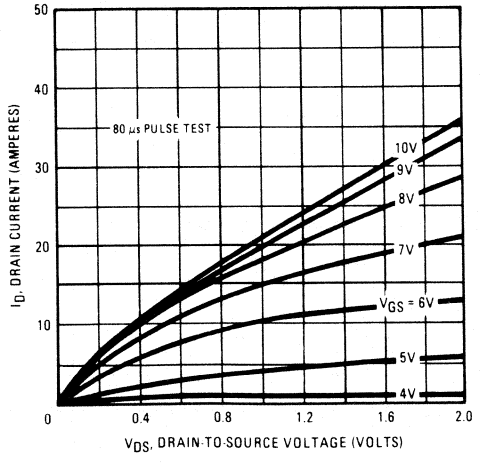
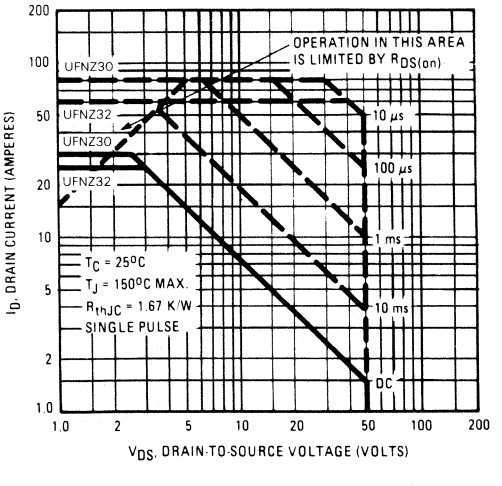


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

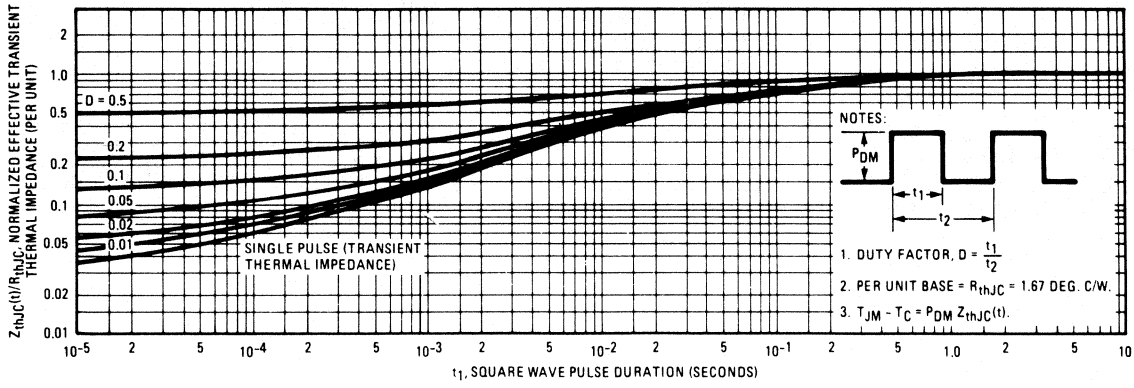


Fig. 6 Typical Transconductance Vs. Drain Current

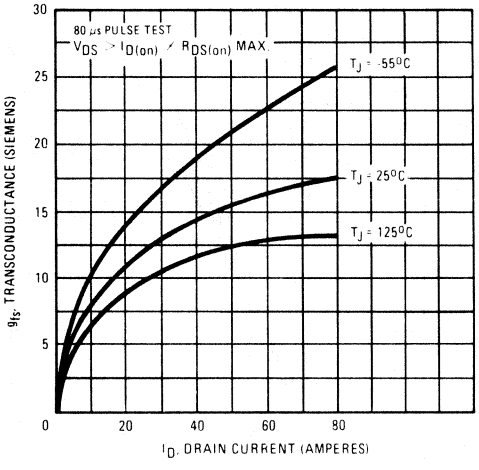


Fig. 7 — Typical Source-Drain Diode Forward Voltage

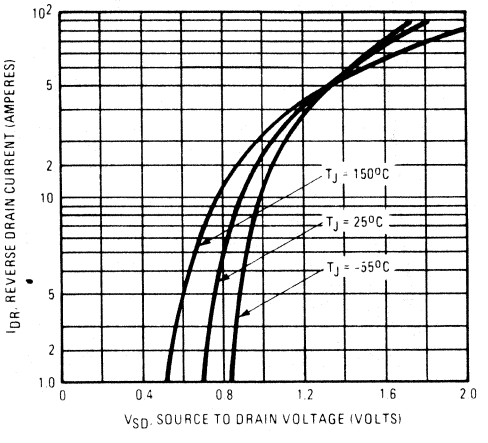


Fig. 8 — Breakdown Voltage Vs. Temperature

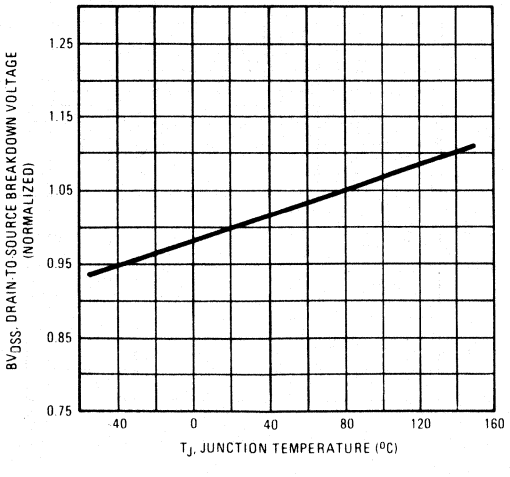
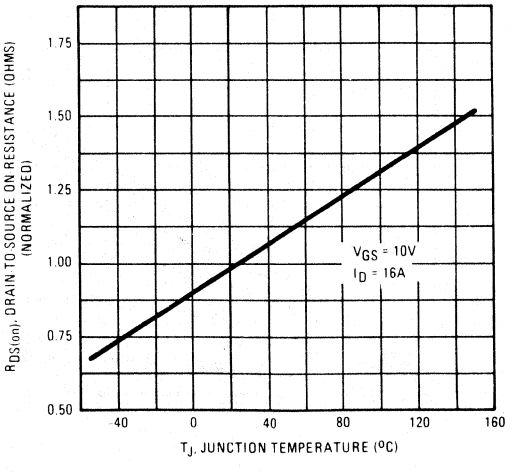


Fig. 9 — Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

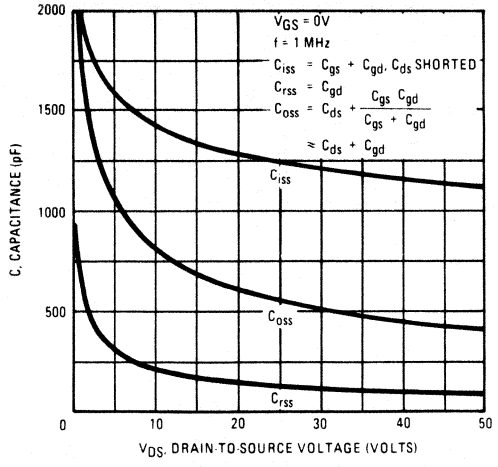


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

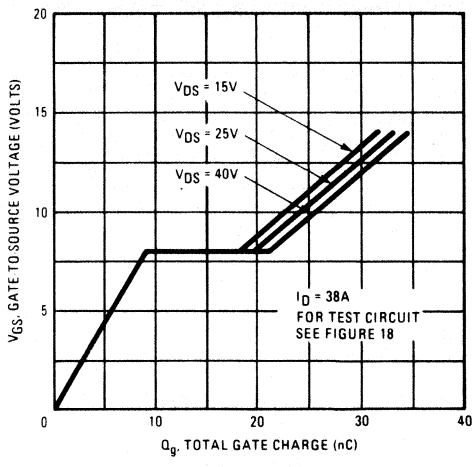


Fig. 12 – Typical On-Resistance Vs. Drain Current

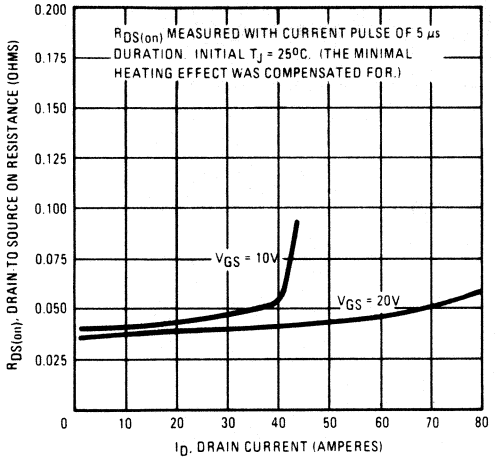


Fig. 13 – Maximum Drain Current Vs. Case Temperature

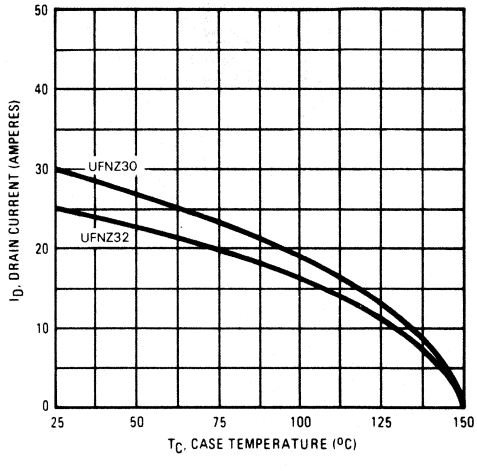
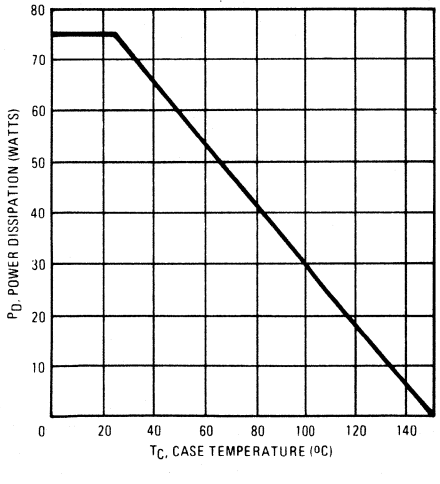


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 — Clamped Inductive Test Circuit

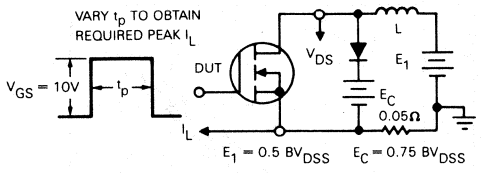


Fig. 16 — Clamped Inductive Waveforms

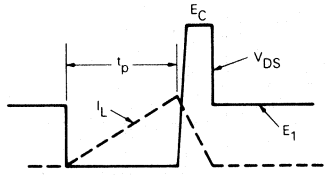


Fig. 17 — Switching Time Test Circuit

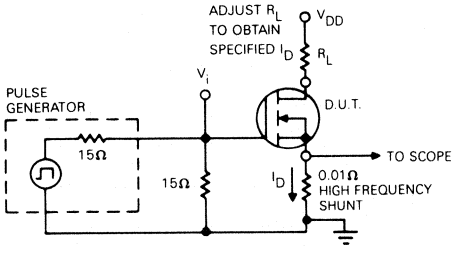
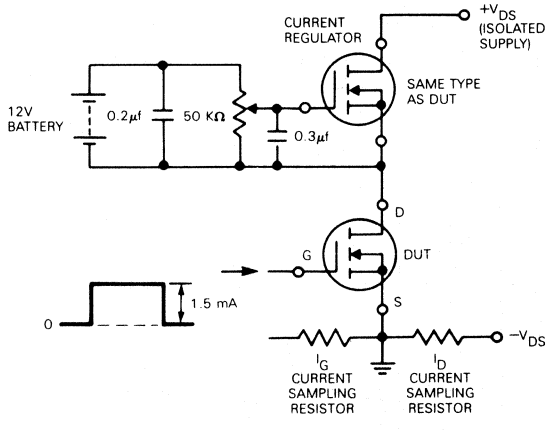


Fig. 18 — Gate Charge Test Circuit



POWER MOSFET TRANSISTORS

50 Volt, 0.028 Ohm
N-Channel

UFNZ40
UFNZ42

3

FEATURES

- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

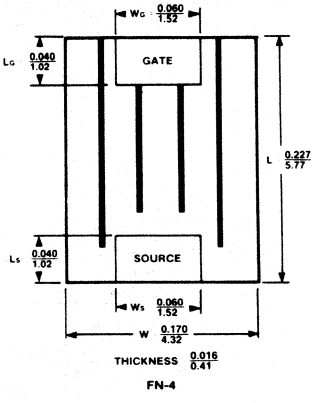
These low voltage power MOSFETS have been designed for optimum performance in low voltage applications. They utilize the most advanced technology available. The efficient geometry and controlled processing of these MOSFETS have been combined to create devices with the lowest $R_{DS(ON)}$ per unit area of any power MOSFET.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These devices are ideally suited for many high speed, high power switching applications such as switching power supplies, motor controls, choppers, inverters and any high energy pulse circuits. They are also well suited for systems that operate from low voltage batteries such as automotive and portable equipment applications.

PRODUCT SUMMARY

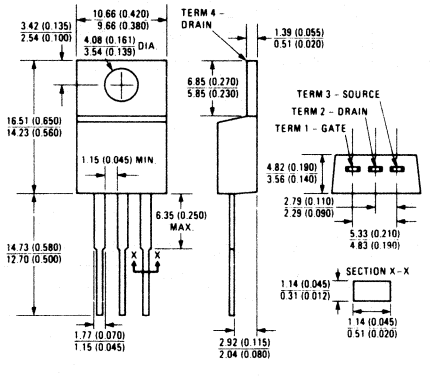
Part Number	V_{DS}	$R_{DS(ON)}$	I_D
UFNZ40	50V	0.028Ω	51A
UFNZ42	50V	0.035Ω	46A



FN-4

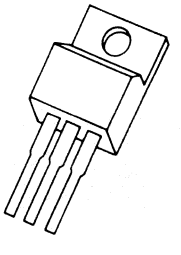
MECHANICAL SPECIFICATIONS

UFNZ40 UFNZ42



Dimensions in Millimeters and (Inches)

TO-220AB



UNITRODE

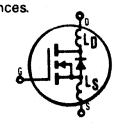
Absolute Maximum Ratings

Parameter		UFNZ40	UFNZ42	Units
V_{DS}	Drain - Source Voltage ①	50	50	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 20 KΩ) ①	50	50	V
I_D @ T_C = 25°C	Continuous Drain Current	51	46	A
I_D @ T_C = 100°C	Continuous Drain Current	32	29	A
I_{DM}	Pulsed Drain Current ③	160	145	A
V_{GS}	Gate - Source Voltage	±20		V
P_D @ T_C = 25°C	Max. Power Dissipation	125 (See Fig. 14)		W
	Linear Derating Factor	1.0 (See Fig. 14)		W/K
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH		A
		160	145	
T_J T_{stg}	Operating Junction and Storage Temperature Range	−55 to 150		°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)		°C

Electrical Characteristics @ T_C = 25°C (Unless Otherwise Specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFNZ40	50	–	–	V	V_{GS} = 0V
		UFNZ42	50	–	–	V	I_D = 250 μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250 μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	−500	nA	V_{GS} = −20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating × 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFNZ40	51	–	–	A	V_{DS} > $I_{D(on)}$ × $R_{DS(on)max.}$, V_{GS} = 10V
		UFNZ42	45	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFNZ40	–	0.024	0.028	Ω	V_{GS} = 10V, I_D = 29A
		UFNZ42	–	0.030	0.035	Ω	
g_{fs}	Forward Transconductance ②	ALL	17	22	–	S(℧)	V_{DS} > $I_{D(on)}$ × $R_{DS(on)\ max.}$, I_D = 29A
C_{iss}	Input Capacitance	ALL	–	2350	3000	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz
C_{oss}	Output Capacitance	ALL	–	920	1200	pF	See Fig. 10
C_{rss}	Reverse Transfer Capacitance	ALL	–	250	400	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	18	25	ns	V_{DD} ≅ 25V, I_D = 29A, Z_o = 4.7Ω
t_r	Rise Time	ALL	–	25	60	ns	See Fig. 17
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	35	70	ns	(MOSFET switching times are essentially independent of
t_f	Fall Time	ALL	–	12	25	ns	operating temperature.)
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	40	60	nC	V_{GS} = 10V, I_D = 64A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	22	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	18	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



Thermal Resistance

R_{thJC}	Junction-to-Case	ALL	–	–	1.0	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

3

Source-Drain Diode Ratings and Characteristics

I_S	Continuous Source Current (Body Diode)	UFNZ40	–	–	51	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		UFNZ42	–	–	46	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFNZ40	–	–	160	A	
		UFNZ42	–	–	145	A	
V_{SD}	Diode Forward Voltage ②	UFNZ40	–	–	2.5	V	T_C = 25°C, I_S = 51A, V_{GS} = 0V
		UFNZ42	–	–	2.2	V	T_C = 25°C, I_S = 46A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	350	–	ns	T_J = 150°C, I_F = 51A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	2.1	–	μC	T_J = 150°C, I_F = 51A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 – Typical Output Characteristics

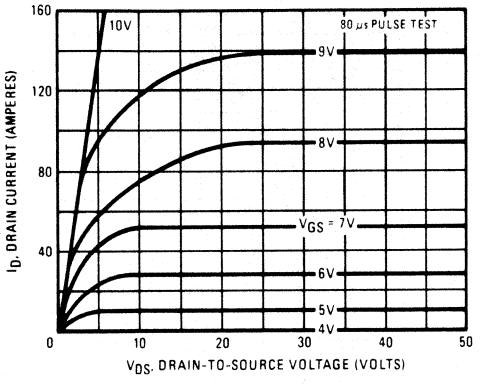


Fig. 2 – Typical Transfer Characteristics

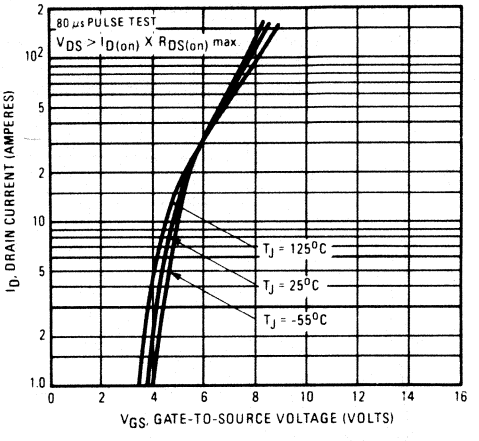


Fig. 3 – Typical Saturation Characteristics

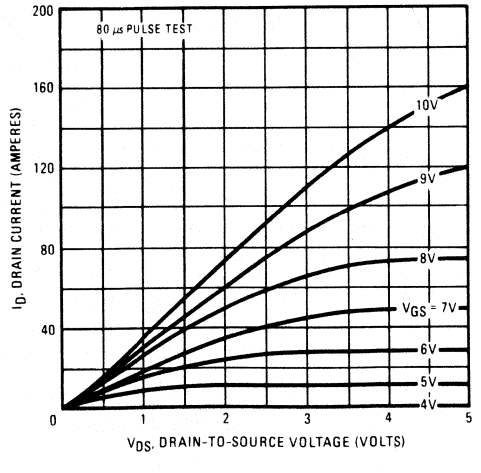
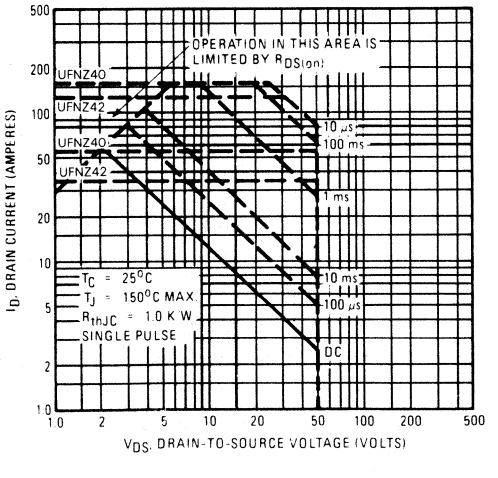


Fig. 4 – Maximum Safe Operating Area



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to Case Vs. Pulse Duration

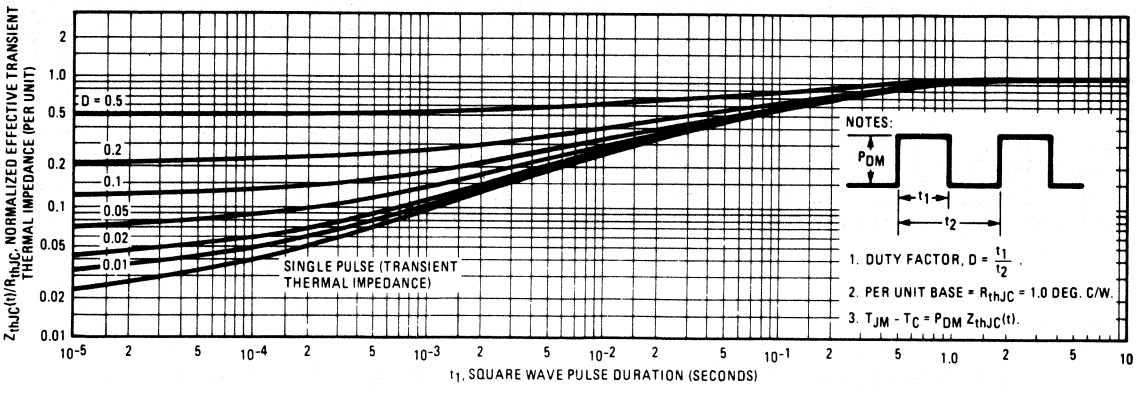


Fig. 6 — Typical Transconductance Vs. Drain Current

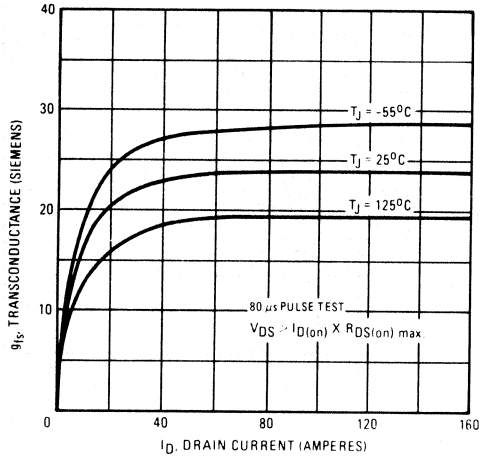


Fig. 7 — Typical Source-Drain Diode Forward Voltage

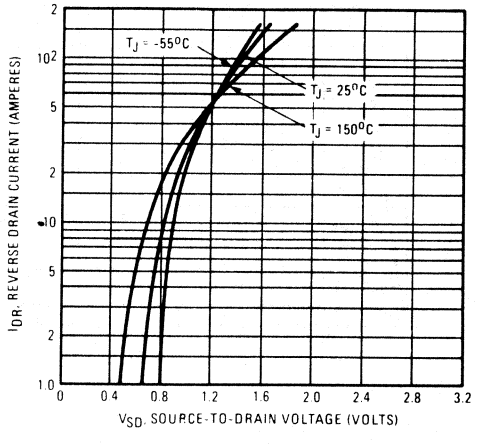


Fig. 8 — Breakdown Voltage Vs. Temperature

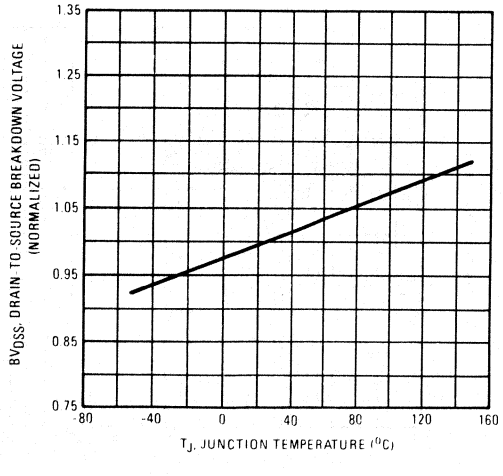
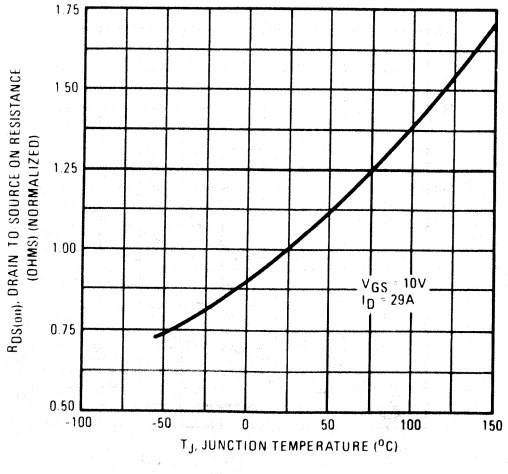


Fig. 9 — Normalized On-Resistance Vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

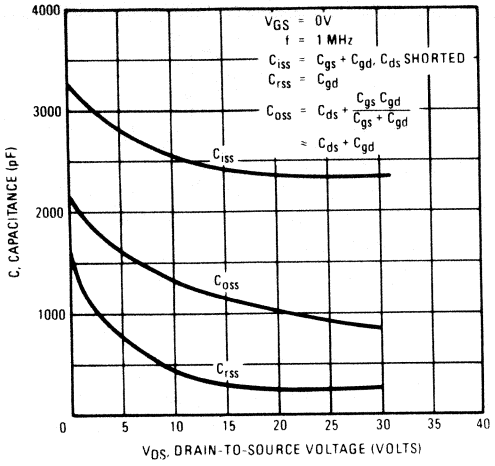


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

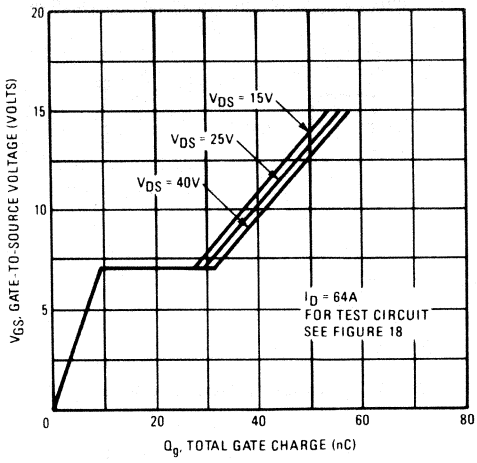


Fig. 12 – Typical On-Resistance Vs. Drain Current

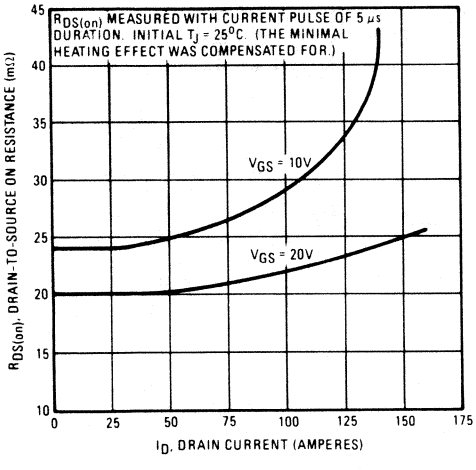


Fig. 13 – Maximum Drain Current Vs. Case Temperature

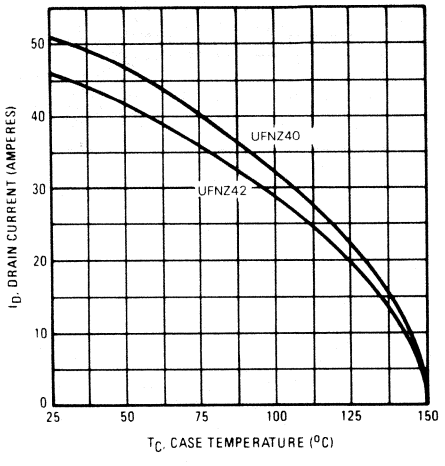
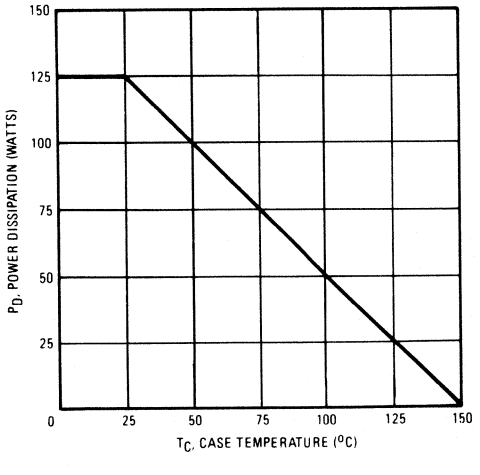


Fig. 14 – Power Vs. Temperature Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Fig. 15 — Clamped Inductive Test Circuit

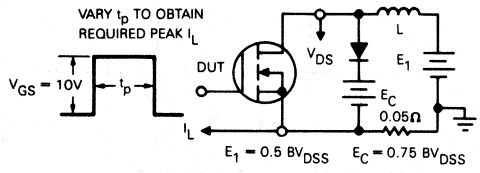


Fig. 16 — Clamped Inductive Waveforms

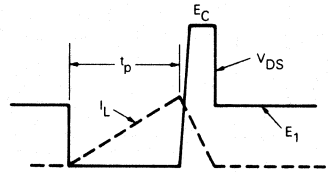


Fig. 17 — Switching Time Test Circuit

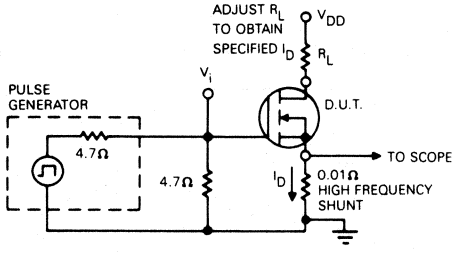
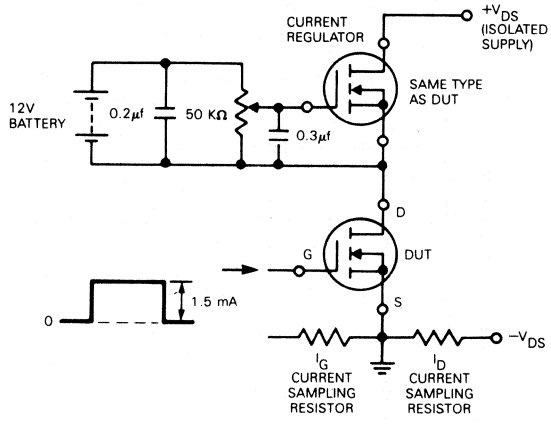


Fig. 18 — Gate Charge Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER TRANSISTORS

5A, 500V, Fast Switching, High $E_{S/b}$ Silicon NPN Mesa

UMT1006
UMT1007

3

FEATURES

- Rise Time: 0.4μS } $I_C = 3A$
- Fall Time: 0.4μS }
- High Second Breakdown Energy: 540μJ
- Collector Emitter Voltage: up to 500V
- Peak Collector Current: 10A
- Key Parameters characterized at 100°C

DESCRIPTION

These high voltage glass passivated power transistors combine fast switching, low saturation voltage and rugged $E_{S/b}$ capability. They are designed for use in off-line power supplies, high voltage inverters, switching regulators, ignition systems and deflection circuits.

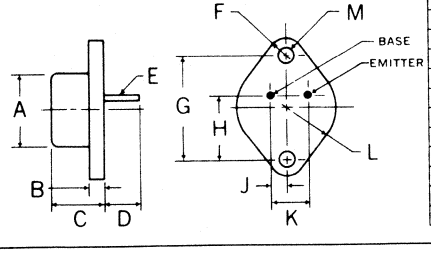
ABSOLUTE MAXIMUM RATINGS

	UMT1006	UMT1007
Collector Emitter Voltage, V_{CEV}	400V	500V
Collector Emitter Voltage, $V_{CEO\ (SUS)}$	300V	400V
Emitter Base Voltage, V_{EBO}	7V	7V
Collector Current, I_C continuous	5A	5A
Collector Current, I_C peak	10A	10A
Base Current, I_B continuous	5A	5A
Power Dissipation, 25°C Case	100W	100W
Derating Factor	.571W/°C	.571W/°C
Operating and Storage Temperature Range	—65 to 200°C	

MECHANICAL SPECIFICATIONS

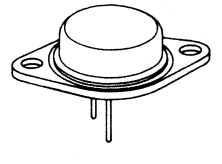
NOTE:
Leads may be soldered to within $^1/_{16}$" of base provided temperature-time exposure is less than 260°C for 10 seconds.

UMT1006 UMT1007



	ins.	mm.
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA (TO-3)



ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	UMT1006 MIN.	UMT1006 MAX.	UMT1007 MIN.	UMT1007 MAX.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{FE}	12	60	12	60		$I_C = 1.5A$, $V_{CE} = 2V$
D.C. Current Gain (Note 1)	h_{FE}	7	35	7	35		$I_C = 3.0A$, $V_{CE} = 2V$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	1.0	—	1.0	V	$I_C = 3.0A$, $I_B = 0.6A$
Collector Saturation Voltage, $T_C = 100°C$ (Note 1)	$V_{CE(sat)}$	—	2.0	—	2.0	V	$I_C = 3.0A$, $I_B = 0.6A$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	5.0	—	5.0	V	$I_C = 5.0A$, $I_B = 1.0A$
Base Saturation Voltage (Note 1)	$V_{BE(sat)}$	—	1.4	—	1.4	V	$I_C = 3.0A$, $I_B = 0.6A$
Base Saturation Voltage, $T_C = 100°C$ (Note 1)	$V_{BE(sat)}$	—	1.4	—	1.4	V	$I_C = 3.0A$, $I_B = 0.6A$
Collector-Emitter Sustaining Voltage (Note 2)	$V_{CEO(sus)}$	300	—	400	—	V	$I_C = 0.1A$, $I_B = 0$
Collector-Emitter Sustaining Voltage $T_C = 100°C$ (Note 2)	$V_{CEX(sus)}$	350	—	450	—	V	$I_C = 3.0A$, $L = 180\mu H$ $I_{B1} = I_{B2} = 0.6A$ V_{CE} clamp = rated $V_{CEX(sus)}$
Emitter-Base Cutoff Current	I_{EBO}	—	1	—	1	mA	$V_{EB} = 9V$
Collector Cutoff Current	I_{CEV}	— —	0.5 —	— —	— 0.5	mA	$V_{CE} = 400V$, $V_{BE} = -1.5V$ $V_{CE} = 500V$, $V_{BE} = -1.5V$
Collector Cutoff Current, $T_C = 100°C$	I_{CEV}	— —	2.5 —	— —	— 2.5	mA	$V_{CE} = 400V$, $V_{BE} = -1.5V$ $V_{CE} = 500V$, $V_{BE} = -1.5V$
Collector Cutoff Current, $T_C = 100°C$	I_{CER}	— —	3.0 —	— —	— 3.0	mA	$V_{CE} = 400V$, $R_{BE} = 50\Omega$ $V_{CE} = 500V$, $R_{BE} = 50\Omega$
Output Capacitance, Common Base	C_{obo}	50	150	50	150	pF	$V_{CB} = 10V$, $f = 1$ MHz
Gain-Bandwidth Product	F_T	6	24	6	24	MHz	$V_{CE} = 10V$, $I_C = 0.2A$, $f = 1$ MHz
Energy Second Breakdown (unclamped)	E_S/I_b	540	—	540	—	μJ	$I_C = 3.0A$, $V_{BE(off)} = 4V$ $L = 120\mu H$ unclamped
Resistive Switching Speeds Delay Time Rise Time Storage Time Fall Time	 t_d t_r t_s t_f	 — — — —	 .05 0.4 4.0 0.4	 — — — —	 .05 0.4 4.0 0.4	μS	$I_C = 3.0A$ $V_{CC} = 200V$ $I_{B1} = I_{B2} = 0.6A$ $V_{BE(off)} = 5V$
Inductive Switching Speeds $T_C = 100°C$ Storage Time Fall Time	 t_s t_f	 — —	 4.0 0.4	 — —	 4.0 0.4	μS	$I_C = 3.0A$, $L = 180\mu H$ $I_{B1} = I_{B2} = 0.6A$ V_{CE} clamp = rated $V_{CEX(sus)}$
Thermal Resistance, Junction-to-Case	$R\Theta_{JC}$	—	1.75	—	1.75	°C/W	

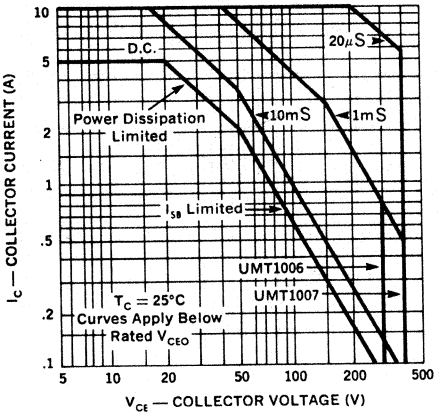
Notes:
1. Pulse width = 250μS; duty cycle ≤1%.
2. Sustaining Voltage. Measured at a high current point where collector-emitter voltage is lowest. Current pulse length ≅ 50μS; duty cycle ≤ 1%. Voltage clamped at maximum collector-emitter voltage.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

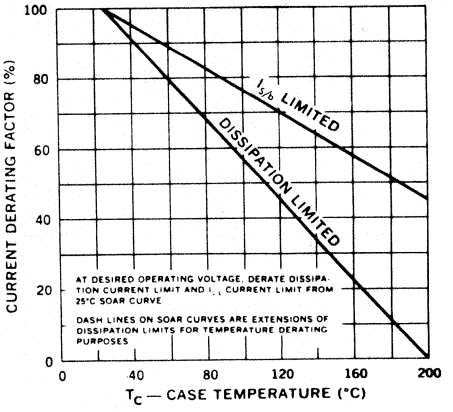
PRINTED IN U.S.A.

3

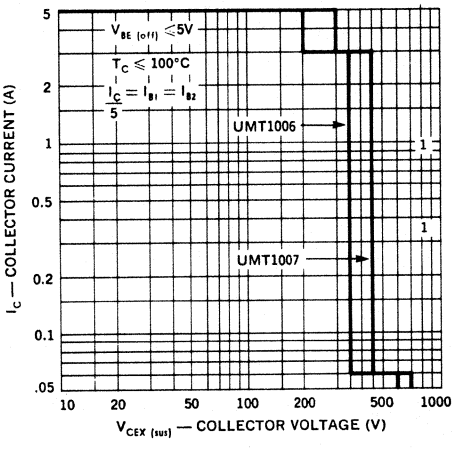
Forward Bias Safe Operating Area



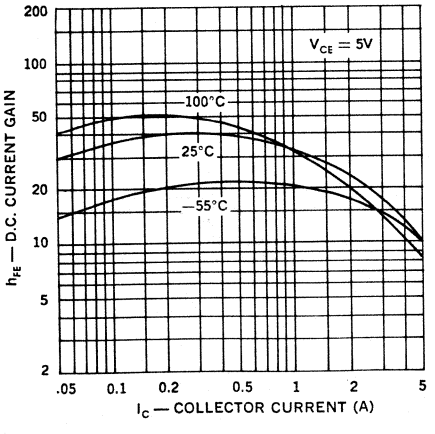
Power Derating



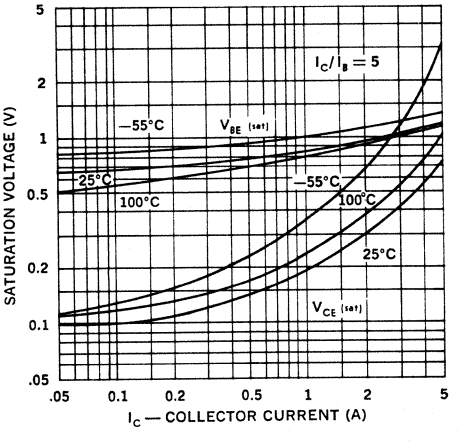
Reverse Biased Safe Operating Area



D.C. Current Gain



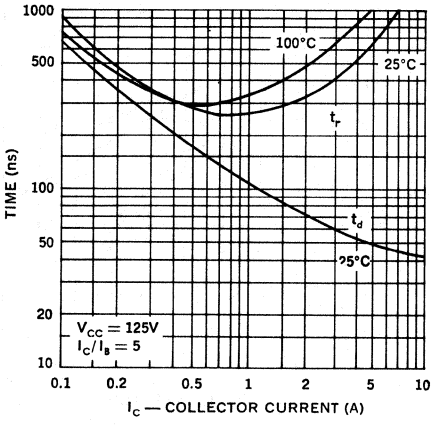
Saturation Voltages



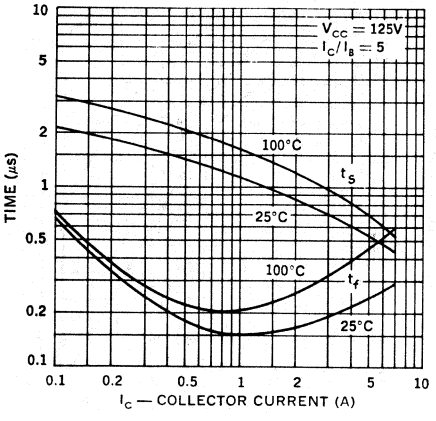
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

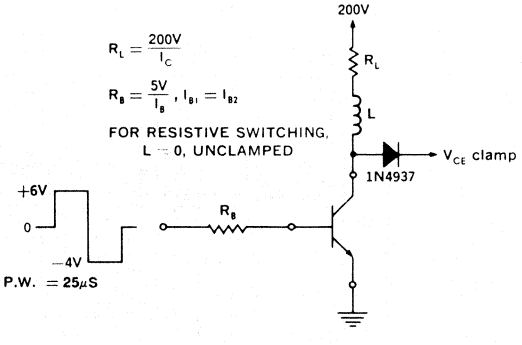
Resistive Turn-On Time



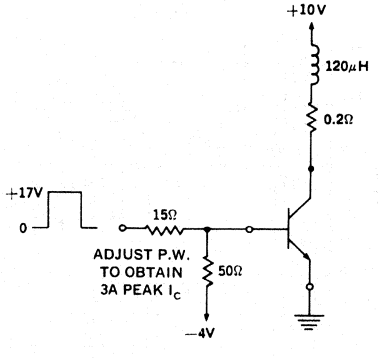
Resistive Turn-Off Time



Switching Time, $V_{CEX\ (sus)}$ Test Circuit



$E_{S/b}$ Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER TRANSISTORS

8 Amp, 500V Fast Switching, High $E_{S/b}$ Silicon NPN Mesa

UMT1008
UMT1009

3

FEATURES

- Rise Time: 0.4μs } $I_C = 5A$
- Fall Time: 0.4μs }
- High Second Breakdown Energy: 1500μJ
- Collector Emitter Voltage: up to 500V
- Peak Collector Current: 16A
- Key Parameters characterized at 100°C

DESCRIPTION

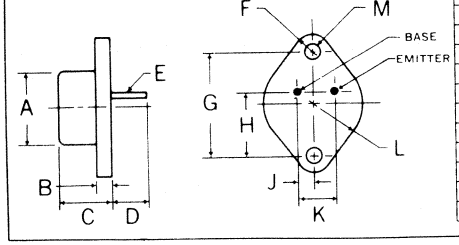
These high voltage triple diffused glass passivated power transistors combine fast switching, low saturation voltage and rugged $E_{S/b}$ capability. They are designed for use in off-line power supplies, high voltage inverters, switching regulators, ignition systems and deflection circuits.

ABSOLUTE MAXIMUM RATINGS

	UMT1008	UMT1009
Collector Emitter Voltage, V_{CEV}	400V	500V
Collector Emitter Voltage, $V_{CEO(SUS)}$	300V	400V
Emitter Base Voltage, V_{EBO}	7V	7V
Collector Current, I_C continuous	8A	8A
Collector Current, I_C peak	16A	16A
Base Current, I_B continuous	8A	8A
Power Dissipation, 25°C Case	125W	125W
Derating Factor	.714W/°C	.714W/°C
Operating and Storage Temperature Range	—65 to 200°C	

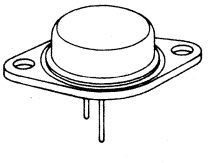
MECHANICAL SPECIFICATIONS

NOTE:
Loads may be soldered to within $^1/_{16}$" of base provided temperature-time exposure is less than 260°C for 10 seconds.



	ins.	mm.
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA (TO-3)



ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

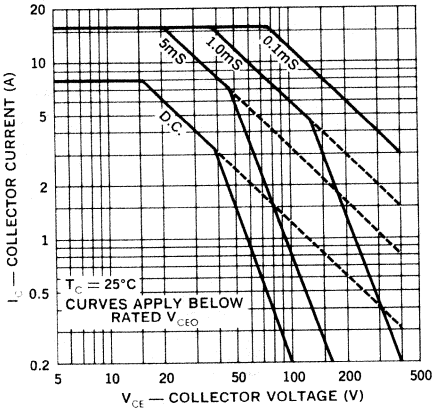
Test	Symbol	UMT1008 MIN.	UMT1008 MAX.	UMT1009 MIN.	UMT1009 MAX.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{FE}	12	60	12	60		$I_C = 2.5A$, $V_{CE} = 3V$
D.C. Current Gain (Note 1)	h_{FE}	7	35	7	35		$I_C = 5.0A$, $V_{CE} = 3V$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	1.5	—	1.5	V	$I_C = 5.0A$, $I_B = 1.0A$
Collector Saturation Voltage, $T_C = 100°C$ (Note 1)	$V_{CE(sat)}$	—	2.5	—	2.5	V	$I_C = 5.0A$, $I_B = 1.0A$
Collector Saturation Voltage (Note 1)	$V_{CE(sat)}$	—	5.0	—	5.0	V	$I_C = 8.0A$, $I_B = 2.0A$
Base Saturation Voltage (Note 1)	$V_{BE(sat)}$	—	1.6	—	1.6	V	$I_C = 5.0A$, $I_B = 1.0A$
Base Saturation Voltage, $T_C = 100°C$ (Note 1)	$V_{BE(sat)}$	—	1.6	—	1.6	V	$I_C = 5.0A$, $I_B = 1.0A$
Collector-Emitter Sustaining Voltage (Note 2)	$V_{CEO(sus)}$	300	—	400	—	V	$I_C = 0.1A$
Collector-Emitter Sustaining Voltage $T_C = 100°C$ (Note 2)	$V_{CEX(sus)}$	350	—	450	—	V	$I_C = 5.0A$, $L = 180\mu H$ $I_{B1} = I_{B2} = 1A$ V_{CE} clamp = rated $V_{CEX(SUS)}$
Emitter-Base Cutoff Current	I_{EBO}	—	1	—	1	mA	$V_{EB} = 9V$
Collector Cutoff Current	I_{CEV}	— —	0.5 —	— —	— 0.5	mA	$V_{CE} = 400V$, $V_{BE} = -1.5V$ $V_{CE} = 500V$, $V_{BE} = -1.5V$
Collector Cutoff Current, $T_C = 100°C$	I_{CEV}	— —	2.5 —	— —	— 2.5	mA	$V_{CE} = 400V$, $V_{BE} = -1.5V$ $V_{CE} = 500V$, $V_{BE} = -1.5V$
Collector Cutoff Current, $T_C = 100°C$	I_{CER}	— —	3.0 —	— —	— 3.0	mA	$V_{CE} = 400V$, $R_{BE} = 50\Omega$ $V_{CE} = 500V$, $R_{BE} = 50\Omega$
Output Capacitance, Common Base	C_{obo}	100	200	100	200	pF	$V_{CB} = 10V$, $f = 1$ MHz
Gain-Bandwidth Product	F_T	6	30	6	30	MHz	$V_{CE} = 10V$, $I_C = 0.3A$, $f = 1$ MHz
Energy Second Breakdown (unclamped)	$E_S/_b$	1500	—	1500	—	μJ	$I_C = 5.0A$ $I_{B1} = 1A$ $L = 120\mu H$ unclamped
Resistive Switching Speeds Delay Time Rise Time Storage Time Fall Time	 t_d t_r t_s t_f	 — — — —	 0.1 0.4 4.0 0.4	 — — — —	 0.1 0.4 4.0 0.4	μS	$I_C = 5.0A$ $V_{CC} = 200V$ $I_{B1} = I_{B2} = 1.0A$ $V_{BE(off)} = 5V$
Inductive Switching Speeds $T_C = 100°C$ Storage Time Fall Time	 t_s t_f	 — —	 4.0 0.4	 — —	 4.0 0.4	μS	$I_C = 5.0A$, $L = 180\mu H$ $I_{B1} = I_{B2} = 1A$ V_{CE} clamp = rated $V_{CEX(SUS)}$
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	—	1.4	—	1.4	°C/W	

Notes:
1. Pulse width = 250μS; duty cycle ≤1%.
2. Sustaining Voltage. Measured at a high current point where collector-emitter voltage is lowest. Current pulse length ≅ 50μS; duty cycle ≤ 1%. Voltage clamped at maximum collector-emitter voltage.

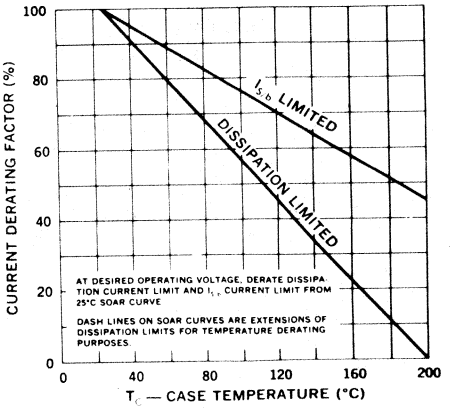
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

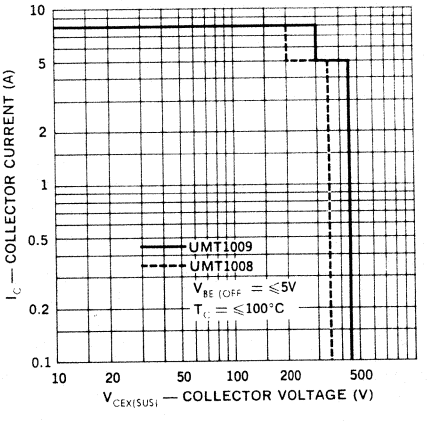
Forward Bias Safe Operating Area



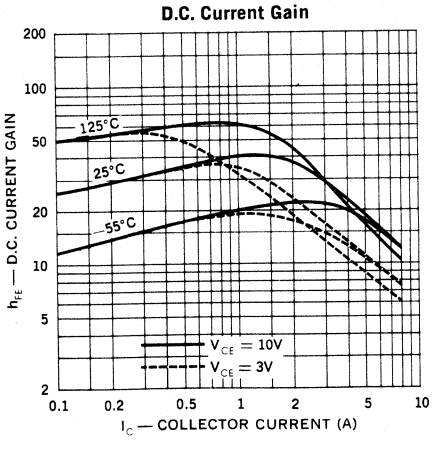
Power Derating



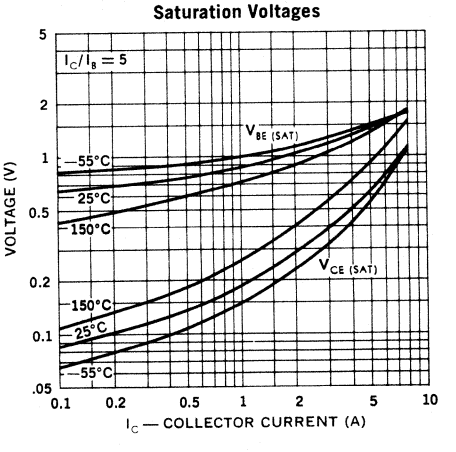
Reverse Biased Safe Operating Area



D.C. Current Gain



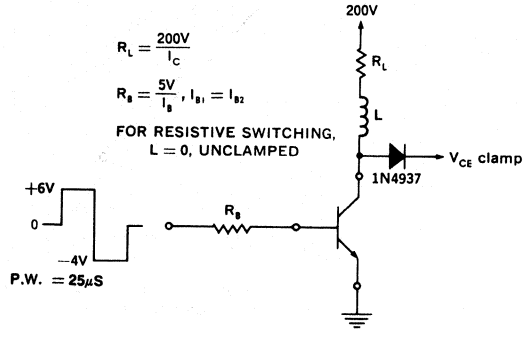
Saturation Voltages



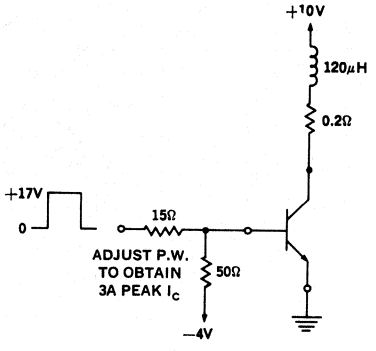
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

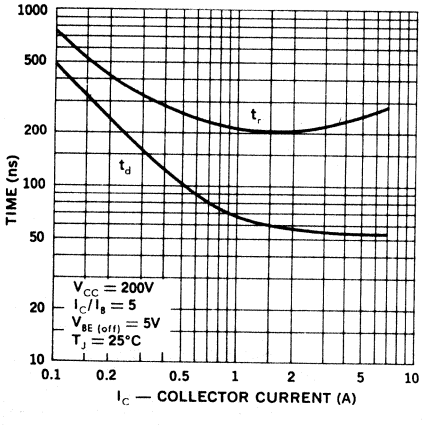
Switching Time, $V_{CEX\ (sus)}$ Test Circuit



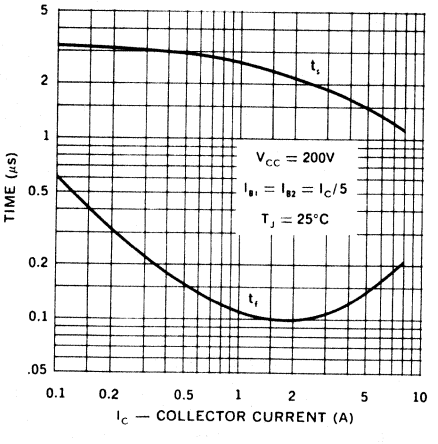
$E_S/_b$ Test Circuit



Turn-On Time



Turn-Off Time



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER TRANSISTORS

15A, 500V, Fast Switching, High $E_{S/b}$ Silicon NPN Mesa

UMT1011
UMT1012

3

FEATURES

- Rise Time: 0.4μS } $I_C = 10A$
- Fall Time: 0.4μS }
- High Second Breakdown Energy: 6000μJ
- Low Saturation Voltage
- Collector Emitter Voltage: up to 500V
- Peak Collector Current: 30A
- Key Parameters characterized at 100°C

DESCRIPTION

These high voltage glass passivated power transistors combine fast switching, low saturation voltage and rugged $E_{S/b}$ capability. They are designed for use in off-line power supplies, high voltage inverters, switching regulators, ignition systems and deflection circuits.

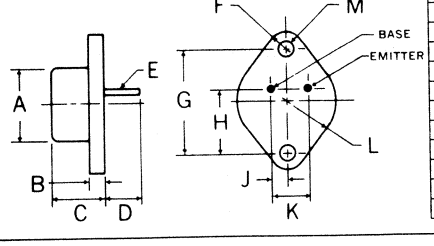
ABSOLUTE MAXIMUM RATINGS

	UMT1011	UMT1012
Collector Emitter Voltage, V_{CEV}	400V	500V
Collector Emitter Voltage, $V_{CEO\ (SUS)}$	300V	400V
Emitter Base Voltage, V_{EBO}	9V	9V
Collector Current, I_C continuous	15A	15A
Collector Current, I_C peak	30A	30A
Base Current, I_B continuous	10A	10A
Power Dissipation, 25°C Case	175W	175W
Derating Factor	1.0W/°C	1.0W/°C
Operating and Storage Temperature Range	—65 to 200°C	

MECHANICAL SPECIFICATIONS

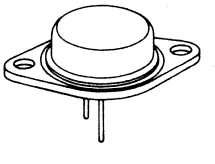
NOTE:
Leads may be soldered to within 1/16" of base provided temperature-time exposure is less than 260°C for 10 seconds.

UMT1011 UMT1012



	ins.	mm.
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA (TO-3)



ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	UMT1011 MIN.	UMT1011 MAX.	UMT1012 MIN.	UMT1012 MAX.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{FE}	12	60	12	60		$I_C = 5.0A, V_{CE} = 2.0V$
D.C. Current Gain (Note 1)	h_{FE}	6	30	6	30		$I_C = 10A, V_{CE} = 2.0V$
Collector Saturation Voltage (Note 1)	$V_{CE\ (sat)}$	—	1.0	—	1.0	V	$I_C = 10A, I_B = 2.0A$
Collector Saturation Voltage, $T_C = 100°C$ (Note 1)	$V_{CE\ (sat)}$	—	2.0	—	2.0	V	$I_C = 10A, I_B = 2.0A$
Collector Saturation Voltage (Note 1)	$V_{CE\ (sat)}$	—	5.0	—	5.0	V	$I_C = 15A, I_B = 3.0A$
Base Saturation Voltage (Note 1)	$V_{BE\ (sat)}$	—	1.6	—	1.6	V	$I_C = 10A, I_B = 2.0A$
Base Saturation Voltage, $T_C = 100°C$ (Note 1)	$V_{BE\ (sat)}$	—	1.6	—	1.6	V	$I_C = 10A, I_B = 2.0A$
Collector-Emitter Sustaining Voltage (Note 2)	$V_{CEO\ (sus)}$	300	—	400	—	V	$I_C = 0.1A, I_B = 0$
Collector-Emitter Sustaining Voltage $T_C = 100°C$ (Note 2)	$V_{CEX\ (sus)}$	350	—	450	—	V	$I_C = 8.0A, L = 180\mu H$ $I_{B1} = I_{B2} = 2.0A$ V_{CE} clamp = rated $V_{CEX\ (sus)}$
Emitter-Base Cutoff Current	I_{EBO}	—	1	—	1	mA	$V_{EB} = 9V$
Collector Cutoff Current	I_{CEV}	— —	1.0 —	— —	— 1.0	mA	$V_{CE} = 400V, V_{BE} = -1.5V$ $V_{CE} = 500V, V_{BE} = -1.5V$
Collector Cutoff Current, $T_C = 100°C$	I_{CEV}	— —	3.0 —	— —	— 3.0	mA	$V_{CE} = 400V, V_{BE} = -1.5V$ $V_{CE} = 500V, V_{BE} = -1.5V$
Collector Cutoff Current, $T_C = 100°C$	I_{CER}	— —	3.0 —	— —	— 3.0	mA	$V_{CE} = 400V, R_{BE} = 50\Omega$ $V_{CE} = 500V, R_{BE} = 50\Omega$
Output Capacitance, Common Base	C_{obo}	180	360	180	360	pF	$V_{CB} = 10V, f = 1\ MHz$
Gain-Bandwidth Product	F_T	6	24	6	24	MHz	$V_{CE} = 10V, I_C = 0.5A, f = 1\ MHz$
Energy Second Breakdown (unclamped)	$E_S/_b$	6000	—	6000	—	μJ	$I_C = 10A, V_{BE\ (off)} = -4V$ $L = 120\mu H$ unclamped
Resistive Switching Speeds Delay Time Rise Time Storage Time Fall Time	 t_d t_r t_s t_f	 — — — —	 .05 0.4 4.0 0.4	 — — — —	 .05 0.4 4.0 0.4	μS	$I_C = 10A$ $V_{CC} = 200V$ $I_{B1} = I_{B2} = 2.0A$ $V_{BE\ (off)} = 5V$
Inductive Switching Speeds $T_C = 100°C$ Storage Time Fall Time	 t_s t_f	 — —	 4.0 0.4	 — —	 4.0 0.4	μS	$I_C = 10A, L = 180\mu H$ $I_{B1} = I_{B2} = 2.0A$ V_{CE} clamp = rated $V_{CEX\ (sus)}$
Thermal Resistance, Junction-to-Case	$R_{\Theta JC}$	—	1.0	—	1.0	°C/W	

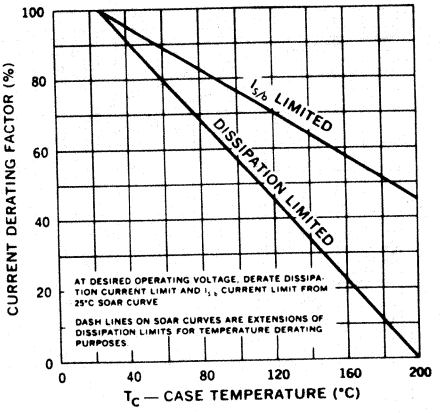
Notes:
1. Pulse width = 250μS; duty cycle ≤1%.
2. Sustaining Voltage. Measured at a high current point where collector-emitter voltage is lowest. Current pulse length ≅ 50μS; duty cycle ≤ 1%. Voltage clamped at maximum collector-emitter voltage.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

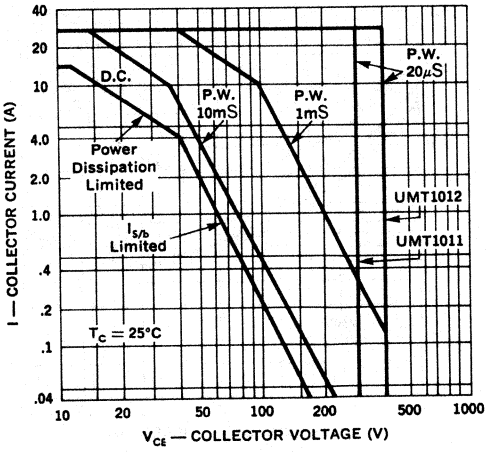
PRINTED IN U.S.A.

3

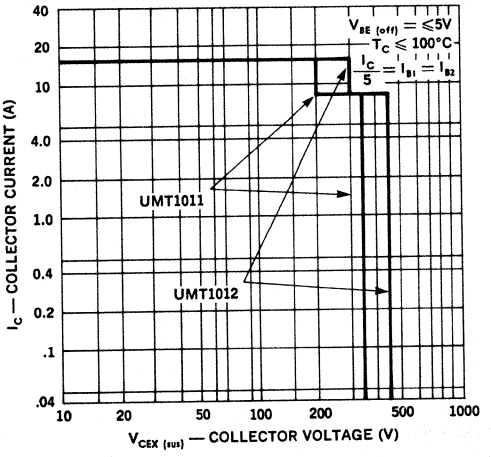
Power Derating



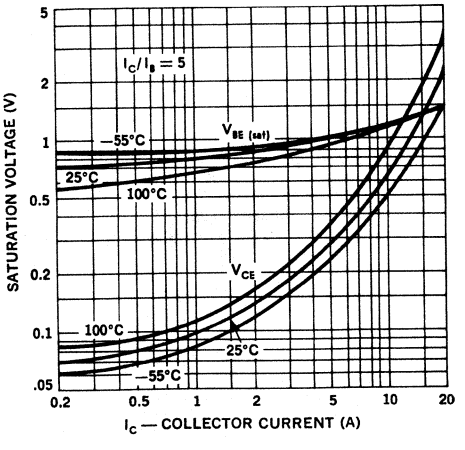
Forward Bias Safe Operating Area



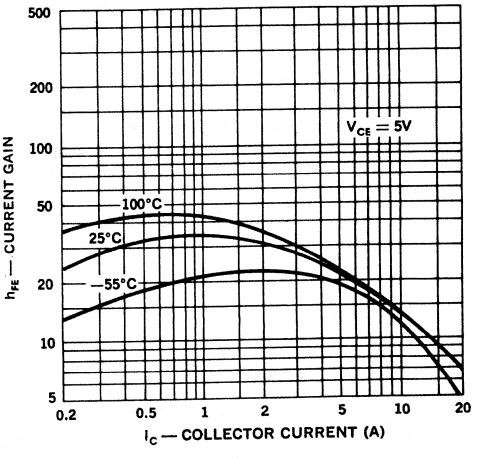
Reverse Biased Safe Operating Area



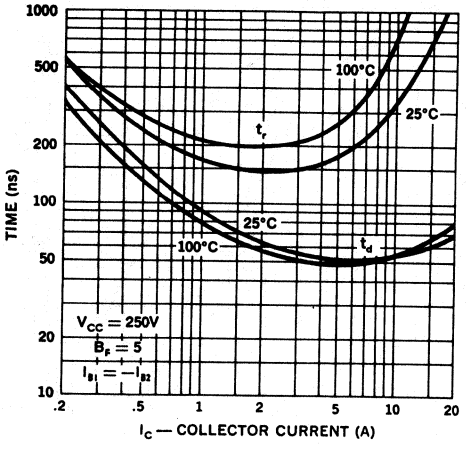
Saturation Voltages



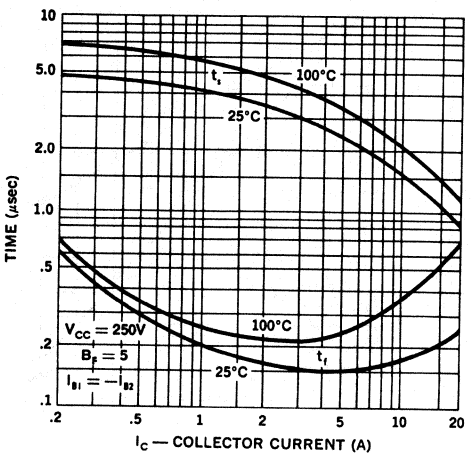
Current Gain



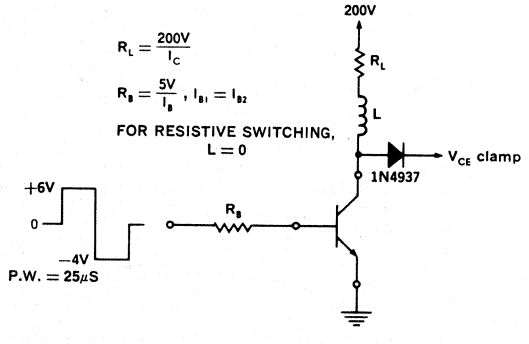
Resistive Turn-On Time



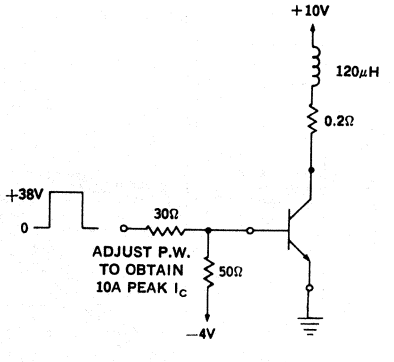
Resistive Turn-Off Time



Switching Time, $V_{CEX\ (sus)}$ Test Circuit



$E_{s/b}$ Test Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER TRANSISTORS

3 Amp, 500V, Fast Switching Silicon NPN Mesa

UMT1203
UMT1204

3

FEATURES

- Collector Emitter Voltage: up to 500V
- Peak Collector Current: 5A
- Rise Time: $\leqslant 1.0\mu s$ } at $I_C = 2A$
- Fall Time: $\leqslant 0.7\mu s$ }
- Key Parameters characterized at 100°C
- Economical Plastic Molded Construction

DESCRIPTION

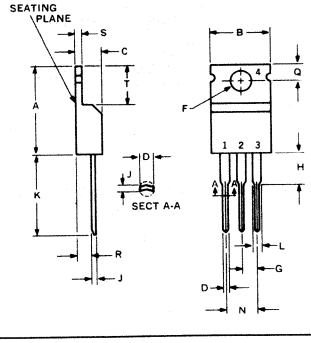
These high voltage triple diffused glass passivated power transistors, in a plastic TO-220AB package, combine fast switching, low saturation voltage and rugged $E_s/_b$ capability. They are designed for use in off-line power supplies, high voltage inverters, switching regulators, deflection circuits, motor controls and solenoid/relay drivers.

ABSOLUTE MAXIMUM RATINGS

	UMT1203	UMT1204
Collector Emitter Voltage, V_{CEV}	400V	500V
Collector Emitter Voltage, $V_{CEO\ (SUS)}$	300V	400V
Emitter Base Voltage, V_{EBO}	7V	7V
Collector Current, I_C continuous	3A	3A
Collector Current, I_{CM} peak	5A	5A
Base Current, I_B continuous	1A	1A
Power Dissipation, 25°C Case	40W	40W
Derating Factor	0.32W/°C	0.32W/°C
Operating and Storage Temperature Range	−65 to 150°C	

MECHANICAL SPECIFICATIONS

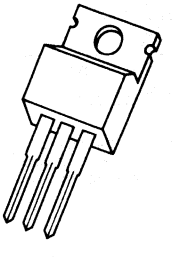
UMT1203, UMT1204



PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.23	15.87	0.560	0.625
B	9.66	10.66	0.380	0.420
C	3.56	4.82	0.140	0.190
D	0.51	1.14	0.020	0.045
F	3.531	3.733	0.139	0.147
G	2.29	2.79	0.090	0.110
H	—	6.35	—	0.250
J	0.38	0.64	0.015	0.025
K	12.70	14.27	0.500	0.562
L	1.14	1.77	0.045	0.070
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.92	0.080	0.115
S	1.14	1.39	0.045	0.055
T	5.85	6.85	0.230	0.270

TO-220AB



ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

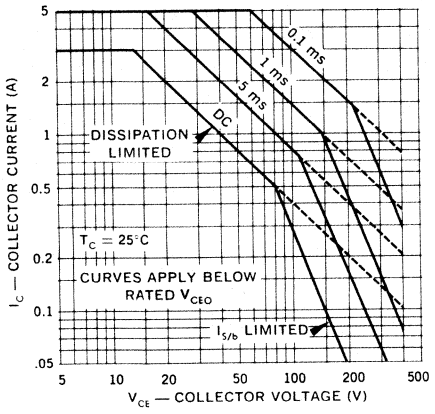
Test	Symbol	UMT1203 MIN.	UMT1203 MAX.	UMT1204 MIN.	UMT1204 MAX.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{FE}	12	60	12	60		$I_C = 1.0A$, $V_{CE} = 3V$
D.C. Current Gain (Note 1)	h_{FE}	7	35	7	35		$I_C = 2.0A$, $V_{CE} = 3V$
Collector Saturation Voltage (Note 1)	$V_{CE\ (sat)}$	—	1.2	—	1.2	V	$I_C = 2.0A$, $I_B = 0.4A$
Collector Saturation Voltage, $T_C = 100°C$ (Note 1)	$V_{CE\ (sat)}$	—	1.5	—	1.5	V	$I_C = 2.0A$, $I_B = 0.4A$
Collector Saturation Voltage (Note 1)	$V_{CE\ (sat)}$	—	3.0	—	3.0	V	$I_C = 3.0A$, $I_B = 0.75A$
Base Saturation Voltage (Note 1)	$V_{BE\ (sat)}$	—	1.3	—	1.3	V	$I_C = 2.0A$, $I_B = 0.4A$
Base Saturation Voltage, $T_C = 100°C$ (Note 1)	$V_{BE\ (sat)}$	—	1.5	—	1.5	V	$I_C = 2.0A$, $I_B = 0.4A$
Collector-Emitter Sustaining Voltage (Note 2)	$V_{CEO\ (sus)}$	300	—	400	—	V	$I_C = 0.1A$
Collector-Emitter Sustaining Voltage $T_C = 100°C$ (Note 2)	$V_{CEX\ (sus)}$	350	—	450	—	V	$I_C = 2.0A$, $L = 500\mu H$ $I_{B1} = I_{B2} = 0.4A$ V_{CE} clamp = rated $V_{CEX\ (sus)}$
Emitter-Base Cutoff Current	I_{EBO}	—	1	—	1	mA	$V_{EB} = 7V$
Collector Cutoff Current	I_{CEV}	— —	0.5 —	— —	— 0.5	mA	$V_{CE} = 400V$, $V_{BE} = -1.5V$ $V_{CE} = 500V$, $V_{BE} = -1.5V$
Collector Cutoff Current, $T_C = 100°C$	I_{CEV}	— —	2.5 —	— —	— 2.5	mA	$V_{CE} = 400V$, $V_{BE} = -1.5V$ $V_{CE} = 500V$, $V_{BE} = -1.5V$
Collector Cutoff Current, $T_C = 100°C$	I_{CER}	— —	3.0 —	— —	— 3.0	mA	$V_{CE} = 400V$, $R = 50\Omega$ $V_{CE} = 500V$, $R = 50\Omega$
Output Capacitance, Common Base	C_{obo}	35	100	35	100	pF	$V_{CB} = 10V$, $f = 1$ MHz
Gain-Bandwidth Product	F_T	6	30	6	30	MHz	$V_{CE} = 10V$, $I_C = 0.3A$, $f = 1$ MHz
Energy Second Breakdown (unclamped)	$E_{S/b}$	80	—	80	—	μJ	$I_C = 2.0A$ $I_{B1} = 0.4A$ $L = 40\mu H$ unclamped
Resistive Switching Speeds Delay Time Rise Time Storage Time Fall Time	 t_d t_r t_s t_f	 — — — —	 0.1 1.0 4.0 0.7	 — — — —	 0.1 1.0 4.0 0.7	μs	$I_C = 2.0A$ $V_{CC} = 200V$ $I_{B1} = I_{B2} = 0.4A$ $V_{BE\ (off)} = 5V$
Inductive Switching Speeds $T_C = 100°C$ Storage Time Fall Time	 t_s t_f	 — —	 4.0 0.9	 — —	 4.0 0.9	μs	$I_C = 2.0A$, $L = 500\mu H$ $I_{B1} = I_{B2} = 0.4A$ V_{CE} clamp = rated $V_{CEX\ (sus)}$
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	—	3.12	—	3.12	°C/W	

Notes:
1. Pulse width = 250μS; duty cycle ≤1%.
2. Sustaining Voltage. Measured at a high current point where collector-emitter voltage is lowest. Current pulse length ≅ 50μS; duty cycle ≤ 1%. Voltage clamped at maximum collector-emitter voltage.

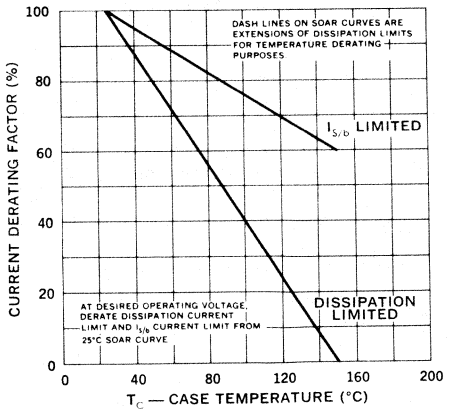
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

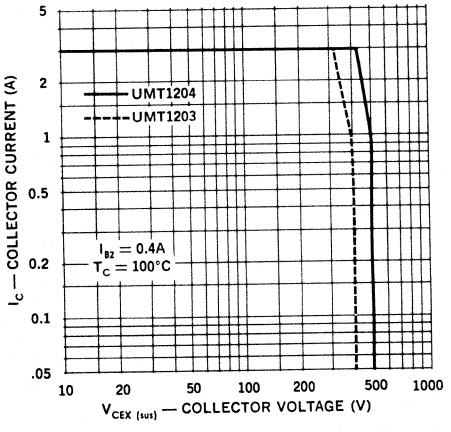
Forward Bias Safe Operating Area



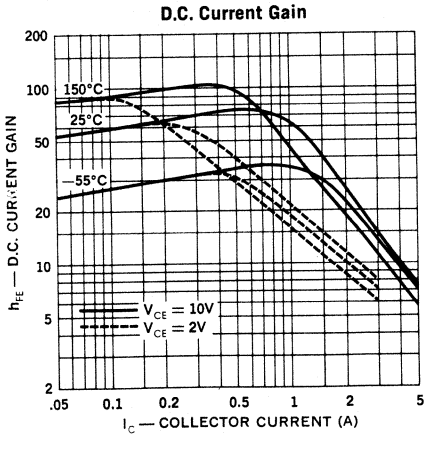
Power Derating



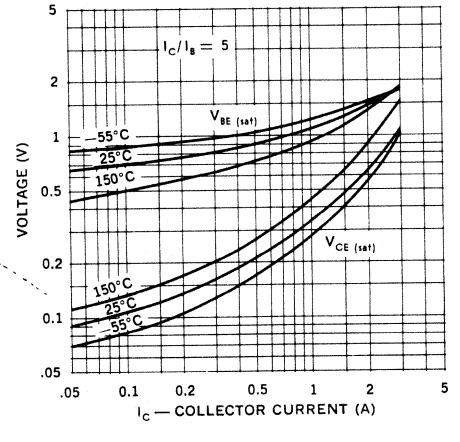
Reverse Biased Safe Operating Area



D.C. Current Gain



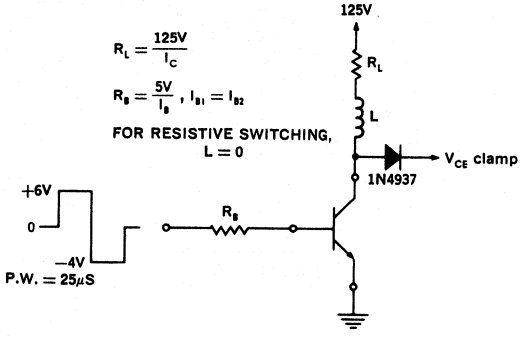
Saturation Voltages



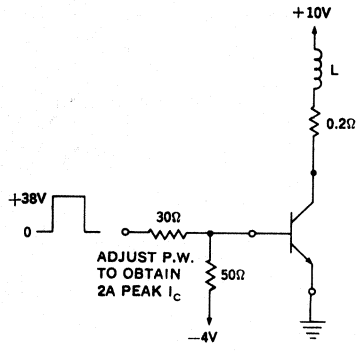
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

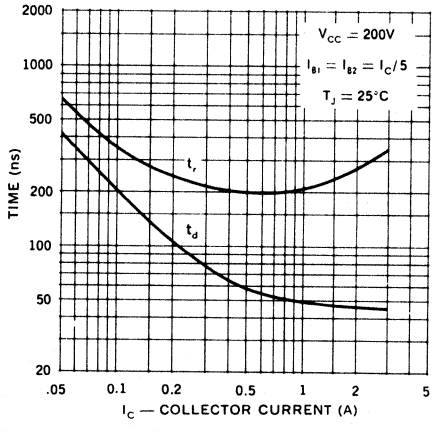
Switching Time Test Circuit



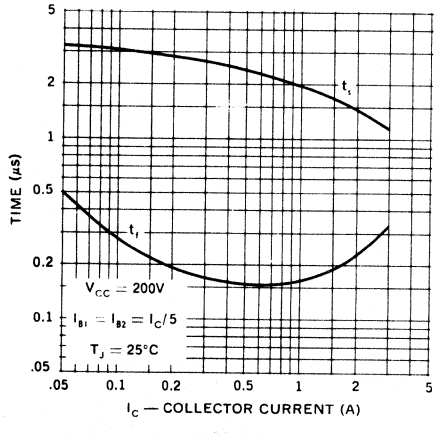
$E_S/_b$ Test Circuit



Resistive Turn-On Time



Resistive Turn-Off Time



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER TRANSISTORS
15A, 450V NPN Mesa

UMT2000

3

FEATURES
- Collector Emitter Voltage: 850V
- Peak Collector Current: 20A
- Storage Time ≤ 800ns
- Fall Time ≤ 70ns

} at I_C = 10A

DESCRIPTION
These high voltage, multiple layer epitaxial, glass passivated power transistors combine fast switching, low saturation voltage and rugged second-breakdown capability. They are designed for use in off-line power supplies, high voltage inverters and switching regulators.

ABSOLUTE MAXIMUM RATINGS

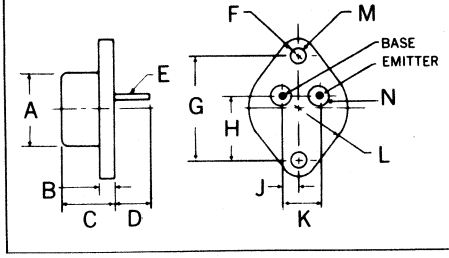
Collector Emitter Voltage, V_{CEV}	850V
Collector Emitter Voltage, $V_{CEO(sus)}$	450V
Emitter Base Voltage, V_{EBO}	6V
Collector Current, I_C continuous	15A
Collector Current, I_{CM} peak (Note 1)	20A
Base Current, I_B continuous	10A
Base Current, I_{BM} peak	15A
Power Dissipation, 25°C Case	175W
100°C Case	100W
above 25°C, derate linearly	1W/°C
Operating and Storage Temperature Range	-65°C to +200°C
Thermal Resistance, Junction to Case, $R_{\theta JC}$	1°C/W

Note: 1. Pulse Test - Pulse Width = 5ms; Duty Cycle ≤ 10%

MECHANICAL SPECIFICATIONS

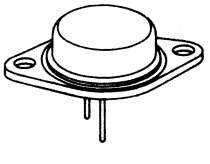
NOTE:
Leads may be soldered to within 1/16" of base provided temperature-time exposure is less than 260°C for 10 seconds.

UMT2000



	INCHES	MILLIMETERS
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.043 DIA.	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-.17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.
N	.190-.210	4.83-5.33

TO-204AA (TO-3)



ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Off Characteristics						
Collector Emitter Sustaining Voltage	$V_{CEO(sus)}$	450	—	—	V	I_C = 100mA, I_B = 0, L = 10mH
Collector Cutoff Current	I_{CEV}	—	—	0.25	mA	V_{CEV} = 850V, $V_{BE(off)}$ = 1.5V
Collector Cutoff Current T_C = 100°C	I_{CEV}	—	—	2.5	mA	V_{CEV} = 850V, $V_{BE(off)}$ = 1.5V
Collector Cutoff Current T_C = 100°C	I_{CER}	—	—	1.5	mA	V_{CE} = 850V, R_{BE} = 50Ω
Emitter Cutoff Current	I_{EBO}	—	—	1.0	mA	V_{EB} = 6V, I_C = 0
On Characteristics (Note 1)						
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	—	—	2.5	V	I_C = 5A, I_B = 0.5A
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	—	—	3.0	V	I_C = 10A, I_B = 1A
Collector Emitter Saturation Voltage T_C = 100°C	$V_{CE(sat)}$	—	3.0	—	V	I_C = 10A, I_B = 1A
Base Emitter Saturation Voltage	$V_{BE(sat)}$	—	—	1.5	V	I_C = 10A, I_B = 1A
Base Emitter Saturation Voltage T_C = 100°C	$V_{BE(sat)}$	—	1.5	—	V	I_C = 10A, I_B = 1A
DC Current Gain	h_{FE}	5.0	—	—		I_C = 15A, V_{CE} = 5V
Dynamic Characteristics						
Output Capacitance	C_{obo}	—	—	400	pF	V_{CB} = 10V, I_E = 0, f test = 1.0kHz
Switching Characteristics						
Resistive Switching Speeds Turn on Time Storage Time (Note 2) Fall Time (Note 2)	 t_{on} t_s t_f	 — — —	 220 900 150	 — — —	 ns ns ns	 I_C = 10A V_{CC} = 250V I_{B1} = 1A I_{B2} = 2A, R_B = 1.6Ω
Storage Time (Note 2) Fall Time (Note 2)	t_s t_f	— —	500 40	— —	ns ns	I_C = 10A V_{CC} = 250V I_{B1} = 1A I_{B2} = 2A, R_B = 1.6Ω $V_{BE(off)}$ = 5V
Inductive Switching Speeds T_C = 100°C Storage Time Fall Time Crossover Time	 t_{sv} t_{fi} t_c	 — — —	 650 30 50	 1500 150 200	 ns ns ns	 I_C = 10A I_{B1} = 1A $V_{BE(off)}$ = 5V $V_{CE(pk)}$ = 400V
T_C = 150°C Storage Time Fall Time Crossover Time	 t_{sv} t_{fi} t_c	 — — —	 850 30 70	 — — —	 ns ns ns	 I_C = 10A I_{B1} = 1A $V_{BE(off)}$ = 5V $V_{CE(pk)}$ = 400V

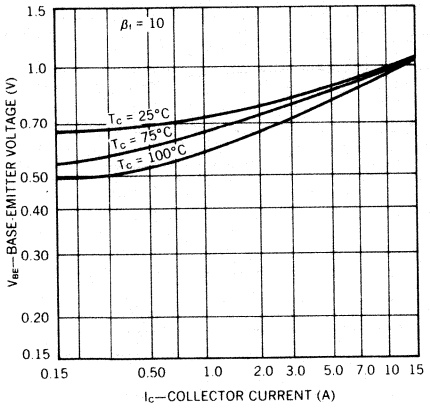
Notes: 1. Pulse Test — Pulse Width = 300μs, Duty Cycle < 2%.
2. Pulse Test — Pulse Width = 30μs, Duty Cycle < 2%.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

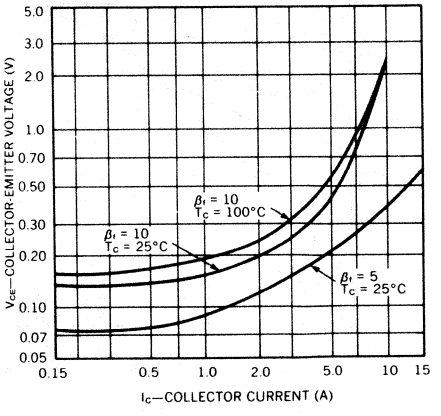
PRINTED IN U.S.A.

TYPICAL DYNAMIC CHARACTERISTICS

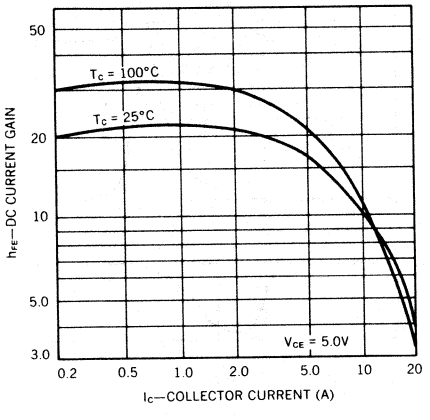
Base-Emitter Voltage



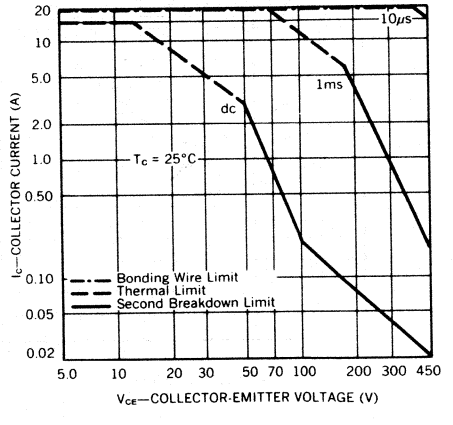
Collector-Emitter Saturation Voltage



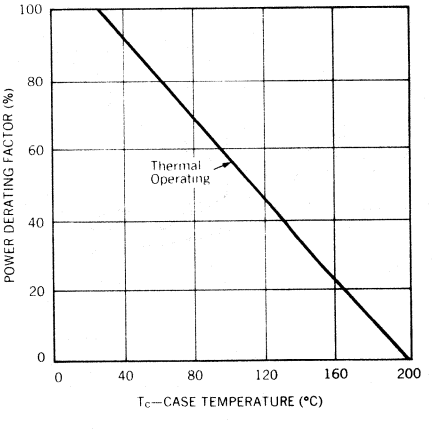
DC Current Gain



Maximum Forward Bias Safe Operating Area



Power Derating

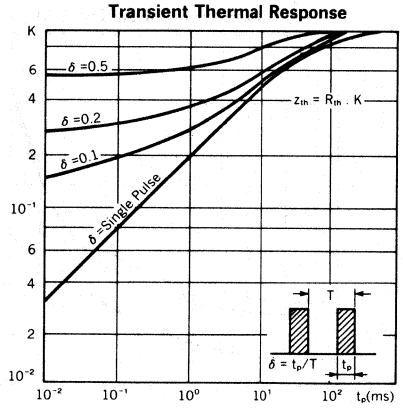


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

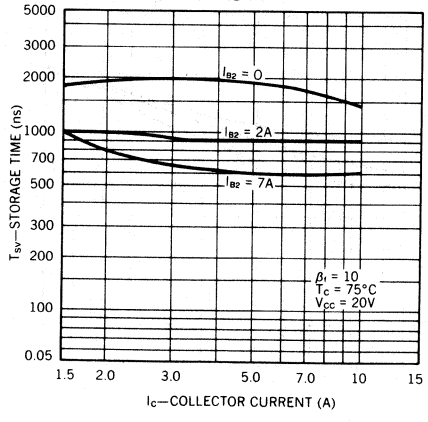
PRINTED IN U.S.A.

TYPICAL DYNAMIC CHARACTERISTICS

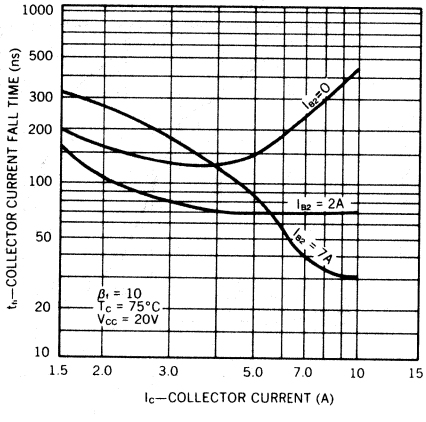
Transient Thermal Response



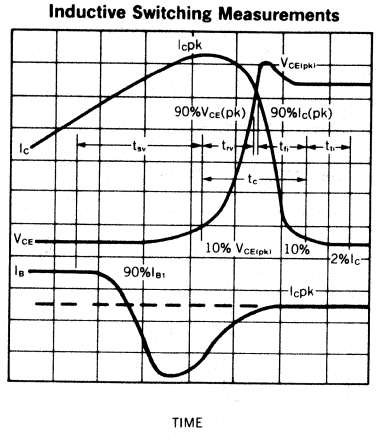
Typical Storage Time



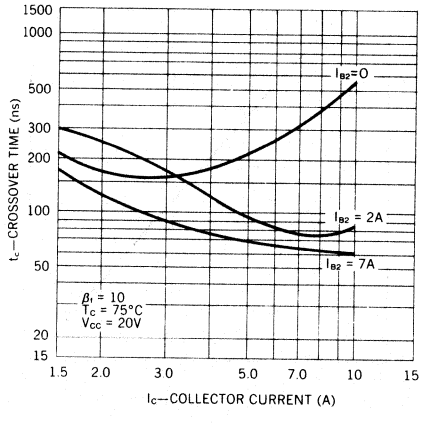
Collector Current Fall Time



Inductive Switching Measurements



Crossover Time



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER TRANSISTORS
0.5 Amp, 300V, Planar NPN, Plastic

UPTA510
UPTA520
UPTA530

3

FEATURES
- Designed for High Speed Switching Applications
- Collector-Emitter Voltage: up to 300V
- Peak Collector Current: 1A
- Economical Plastic Molded Construction

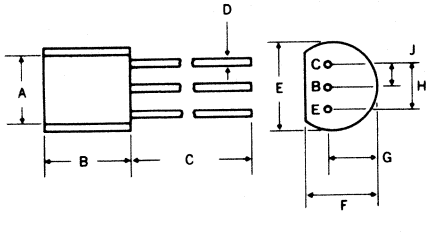
DESCRIPTION
Unitrode high voltage transistors provide a unique combination of low saturation voltage, fast switching, and excellent gain. They are ideally suited for off-line power supply designs and other applications where the increased voltage rating adds to system reliability.

ABSOLUTE MAXIMUM RATINGS

	UPTA510	UPTA520	UPTA530
Collector-Base Voltage, V_{CBO}	150V	250V	350V
Collector-Emitter Voltage, V_{CEO}	100V	200V	300V
Emitter-Base Voltage, V_{EBO}	5V	5V	5V
D.C. Collector Current, I_C	.5A	.5A	.5A
Peak Collector Current, I_C	1A	1A	1A
Base Current, I_B	.5A	.5A	.5A
Power Dissipation			
25°C Case	2.4W		
25°C Ambient	750mW		
Thermal Resistance, Θ_{J-C}	62.5°C/W		
Thermal Resistance, Θ_{J-A}	200°C/W		
Storage Temperature Range	−55°C to +150°C		
Maximum Junction Temperature	+175°C		

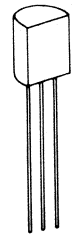
MECHANICAL SPECIFICATIONS

UPTA510 UPTA520 UPTA530



	INCHES	MILLIMETERS
A	.135 MIN.	3.42 MIN.
B	.170 - .210	4.31 - 5.33
C	.500 MIN.	12.70 MIN.
D	.016 - .019	.406 - .482
E	.175 - .205	4.44 - 5.21
F	.125 - .165	3.17 - 4.19
G	.080 - .105	2.03 - 2.66
H	.095 - .105	2.41 - 2.66
J	.045 - .055	1.14 - 1.40

TO-92



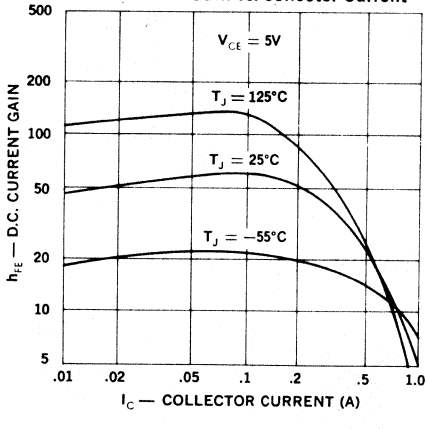
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

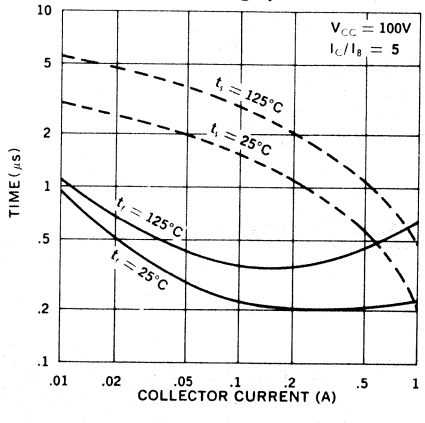
Test	Symbol	Min.	Max.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{FE}	20	—	—	$I_C = .1A, V_{CE} = 5Vdc$
D.C. Current Gain (Note 1)	h_{FE}	8	—	—	$I_C = .5A, V_{CE} = 5Vdc$
D.C. Current Gain (Note 1)	h_{FE}	5 Typ.		—	$I_C = 1A, V_{CE} = 5Vdc$
Collector Saturation Voltage (Note 1)	V_{CE} (sat)	—	1.0	Vdc	$I_C = .5A, I_B = .1A$
	V_{CE} (sat)		.5	Vdc	$I_C = .2A, I_B = .02A$
Base Saturation Voltage (Note 1)	V_{BE} (sat)	—	1.5	Vdc	$I_C = .5A, I_B = .1A$
Collector-Base Breakdown Voltage (Note 1)	BV_{CBO}			Vdc	$I_C = 10\mu Adc$
UPTA510		150	—		
UPTA520		250	—		
UPTA530		350	—		
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CEO}			Vdc	$I_C = 10mAdc$
UPTA510		100	—		
UPTA520		200	—		
UPTA530		300	—		
Collector-Emitter Cutoff Current	I_{CES}	—	10	μAdc	V_{CE} = rated BV_{CEO}, $V_{BE} = 0$
Collector-Emitter Cutoff Current	I_{CES}	—	1	mAdc	V_{CE} = rated BV_{CEO}, $T = 125°C$, $V_{BE} = 0$
Emitter-Base Cutoff Current	I_{EBO}	—	50	μAdc	$V_{EB} = 5Vdc$
Output Capacitance	C_{ob}	—	50	pf	$V_{CB} = 10Vdc, I_E = 0, f = 1MHz$
Gain-Bandwidth Product	f_T	15	—	MHz	$I_C = 1Adc, V_{CE} = 5Vdc, f = 10MHz$
Rise Time	t_r	100 Typ.		ns	$I_C = .5A$
Delay Time	t_d	50 Typ.		ns	
Storage Time	t_s	500 Typ.		ns	
Fall Time	t_f	200 Typ.		ns	

Note: 1. Pulse width = 300μs; duty cycle ≤ 2%.
Note: 2. For thermal considerations for operating UPTA510, UPTA520 and UPTA530, refer to Application Note U-77.

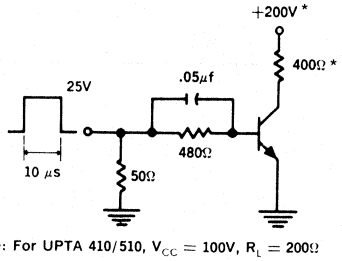
D.C. Current Gain vs. Collector Current



Switching Speeds



Switching Speed Circuit



*Note: For UPTA 410/510, V_{CC} = 100V, $R_L = 200\Omega$

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER TRANSISTORS
0.1 Amp, 500V, Planar NPN, Plastic

UPTB520
UPTB530
UPTB540
UPTB550

3

FEATURES
- Designed for High Speed Switching Applications
- Collector-Emitter Voltage: up to 500V
- Peak Collector Current: to .2A
- Economical Plastic Molded Construction

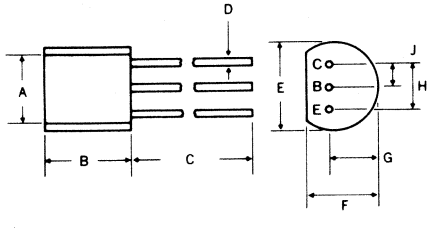
DESCRIPTION
Unitrode high voltage power transistors provide a unique combination of low saturation voltage, high gain and fast switching. They are ideally suited for pulse power applications in power supplies, thermal printers, solid state relays and pulse amplifiers.

ABSOLUTE MAXIMUM RATINGS

	UPTB520	UPTB530	UPTB540	UPTB550
Collector-Base Voltage, V_{CBO}	250V	350V	450V	550V
Collector-Emitter Voltage, V_{CEO}	200V	300V	400V	500V
Emitter-Base Voltage, V_{EBO}	5V	5V	5V	5V
D.C. Collector Current, I_C	.1A	.1A	.1A	.1A
Peak Collector Current, I_C	.2A	.2A	.2A	.2A
Base Current, I_B	.1A	.1A	.1A	.1A
Power Dissipation				
25°C Case	2.4W			
25°C Ambient	750mW			
Thermal Resistance, Θ_{J-C}	62.5°C/W			
Thermal Resistance, Θ_{J-A}	200°C/W			
Storage Temperature Range	−55°C to +150°C			
Maximum Junction Temperature	+175°C			

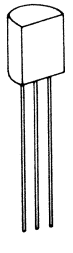
MECHANICAL SPECIFICATIONS

UPTB520 UPTB530 UPTB540 UPTB550



	INCHES	MILLIMETERS
A	.135 MIN.	3.42 MIN.
B	.170 - .210	4.31 - 5.33
C	.500 MIN.	12.70 MIN.
D	.016 - .019	.406 - .482
E	.175 - .205	4.44 - 5.21
F	.125 - .165	3.17 - 4.19
G	.080 - .105	2.03 - 2.66
H	.095 - .105	2.41 - 2.66
J	.045 - .055	1.14 - 1.40

TO-92



UNITRODE

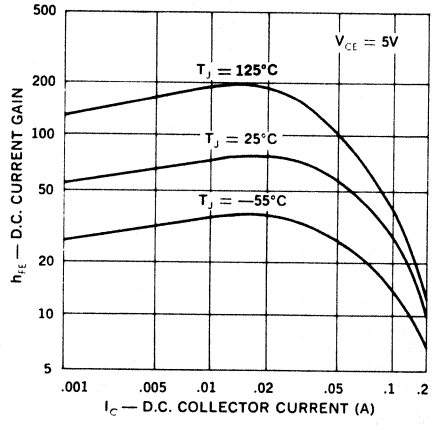
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	Min.	Max.	Units	Test Conditions
D.C. Current Gain (Note 1)	h_{FE}	20	—	—	$I_C = 25mA, V_{CE} = 5Vdc$
D.C. Current Gain (Note 1)	h_{FE}	5	—	—	$I_C = 100mA, V_{CE} = 5Vdc$
Collector Saturation Voltage (Note 1)	V_{CE} (sat)	—	1.2	Vdc	$I_C = 50mA, I_B = 10mA$
	V_{CE} (sat)		1.0	Vdc	$I_C = 20mA, I_B = 2mA$
Base Saturation Voltage (Note 1)	V_{BE} (sat)	—	1.5	Vdc	$I_C = 50mA, I_B = 10mA$
Collector-Base Breakdown Voltage (Note 1)	BV_{CBO}			Vdc	$I_C = 10\mu Adc$
UPTB520		250	—		
UPTB530		350	—		
UPTB540		450	—		
UPTB550		550	—		
Collector-Emitter Breakdown Voltage (Note 1)	BV_{CEO}			Vdc	$I_C = 1mAdc$
UPTB520		200	—		
UPTB530		300	—		
UPTB540		400	—		
UPTB550		500	—		
Collector-Emitter Cutoff Current	I_{CES}	—	10	μAdc	V_{CE} = rated BV_{CEO}, $V_{BE} = 0$
Collector-Emitter Cutoff Current	I_{CES}	—	1	mAdc	V_{CE} = rated BV_{CEO}, T = 125°C, $V_{BE} = 0$
Emitter-Base Cutoff Current	I_{EBO}	—	50	μAdc	$V_{EB} = 5Vdc$
Output Capacitance	C_{ob}	—	50	pf	$V_{CB} = 10Vdc, I_E = 0, f = 1MHz$
Gain-Bandwidth Product	f_T	15	—	MHz	$I_C = 1Adc, V_{CE} = 5Vdc, f = 10MHz$
Rise Time	t_r	100 Typ.		ns	$I_C = 100mA$
Delay Time	t_d	50 Typ.		ns	
Storage Time	t_s	200 Typ.		ns	
Fall Time	t_f	1000 Typ.		ns	

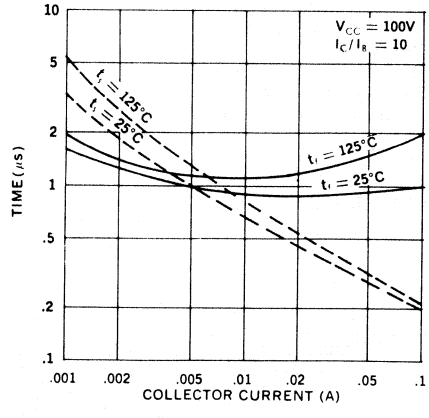
Note: 1. Pulse width = 300μs; duty cycle ≤ 2%.

Note: 2. For thermal considerations for operating UPTB520, UPTB530, UPTB540 and UPTB550, refer to Application Note U-77.

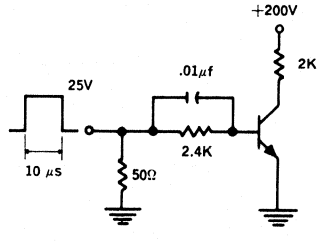
D.C. Current Gain vs. Collector Current



Switching Speeds



Switching Speed Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

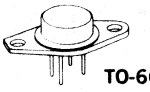
POWER HYBRIDS 4

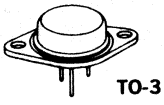
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER HYBRIDS

PRODUCT SELECTION GUIDE


TO-66


TO-3

4

Type	Output Current, Pk.	Input/Output Voltage	Polarity	Fall Time Volt (ns)	Fall Time Cur. (ns)	On-State Voltage (V) @ (A)	Pkg.
PIC600 PIC601 PIC602 PIC610 PIC611 PIC612	5A	60 80 100 60 80 100	Pos. Pos. Pos. Neg. Neg. Neg.	75	150	1.5 @ 2	**4 PIN TO-66 (Isolated)**
PIC660 PIC661 PIC662 PIC670 PIC671 PIC672	10A	60 80 100 60 80 100	Pos. Pos. Pos. Neg. Neg. Neg.	150 250	250 250	1.5 @ 5	**4 PIN TO-66 (Isolated)**
PIC625 PIC626 PIC627 PIC635 PIC636 PIC637	15A	60 80 100 60 80 100	Pos. Pos. Pos. Neg. Neg. Neg.	175 300	300 300	1.5 @ 7	**4 PIN TO-66 (Isolated)**
PIC645 PIC646 PIC647 PIC655 PIC656 PIC657	20A	60 80 100 60 80 100	Pos. Pos. Pos. Neg. Neg. Neg.	150 300	300 300	1.5 @ 7	**3 PIN TO-3**

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER INTEGRATED CIRCUIT

Switching Regulator 5 Amp Positive and Negative Power Output Stages

PIC600
PIC601
PIC602
PIC610
PIC611
PIC612

FEATURES

- Designed and characterized for switching regulator applications
- Cost saving design reduces size, improves efficiency, reduces noise and RFI (See note 4.)
- High operating frequency (to > 100kHz) results in smaller inductor-capacitor filter and improved power supply response time
- High operating efficiency: Typical 2A circuit performance — Rise and Fall time <75ns Efficiency >85%
- No reverse recovery spike generated by commutating diode (See note 4. and Fig. 2.)
- Electrically isolated, 4-Pin, TO-66 hermetic case

DESCRIPTION

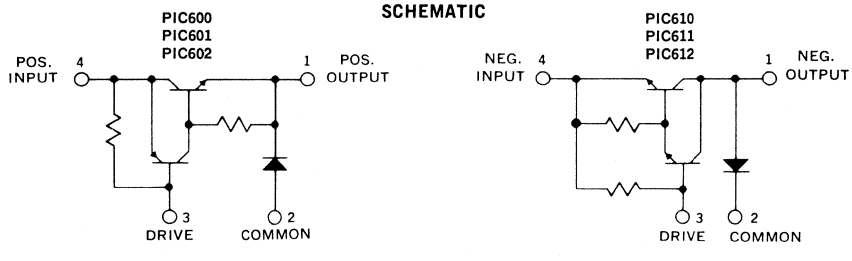
The Unitrode ESP Switching Regulator is a unique hybrid transistor circuit, specifically designed, constructed and specified for use in high current switching regulator applications. The designer is thus relieved of one of the most time consuming, tedious and critical aspects of switching regulator design: choosing the appropriate switching transistors and commutating diode, and empirically determining the optimum drive and bias conditions.

Switching regulators, when compared to conventional regulators, result in significant reductions in size, weight, and internal power losses and a major decrease in overall cost. Using the Unitrode PIC600 series, the designer can achieve further improvements in size, weight, efficiency, and costs. At the same time, because of the PIC600 series design and packaging, the designer is aided in overcoming two of the most significant drawbacks to switching regulators: noise generation and slow response time; there is, in fact, no diode reverse recovery spike (see note 4.).

The PIC600 series switching regulators are designed and characterized to be driven with standard integrated circuit voltage regulators. They are completely characterized over their entire operating range of —55°C to +125°C. The devices are enclosed in a special 4-pin TO-66 package, hermetically sealed for high reliability. The hybrid circuit construction utilizes thick film resistors on a beryllia substrate for maximum thermal conductivity and resultant low thermal impedance. All of the active elements in the hybrid are fully passivated.

Application Notes U-68 and U-76 provide a detailed description of the hybrid circuit and design guidance for specific circuit applications.

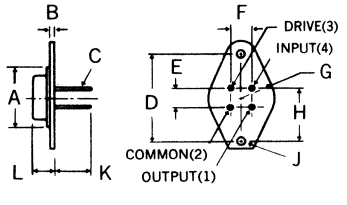
SCHEMATIC



MECHANICAL SPECIFICATIONS

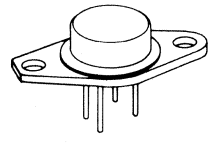
PIC600 PIC601 PIC602 PIC610 PIC611 PIC612

NOTES:
1. Case is electrically isolated.
2. Loads may be soldered to within $^1/_{16}$" of base provided temperature-time exposure is less than 260°C for 10 seconds.



	ins.	mm
A	.620 MAX.	15.75 MAX.
B	.050-.075	1.27-1.91
C	.028-.034	0.71-0.86
D	.958-.962	24.33-24.43
E	.190-.210	4.83-5.33
F	.190-.210	4.83-5.33
G	.350 MAX. RAD.	8.89 MAX. RAD.
H	.570-.590	14.48-14.99
J	.142-.152 DIA.	3.61-3.86 DIA.
K	.360 MIN.	9.14 MIN.
L	.250-.340	6.35-8.64

4-Pin TO-66



UNITRODE

ABSOLUTE MAXIMUM RATINGS

	PIC600	PIC601	PIC602	PIC610	PIC611	PIC612
Input Voltage, V_{4-2}	60V	80V	100V	—60V	—80V	—100V
Output Voltage, V_{1-2}	60V	80V	100V	—60V	—80V	—100V
Drive-Input Reverse Voltage, V_{3-4}	5V	5V	5V	—5V	—5V	—5V
Output Current, I_1	5A	5A	5A	—5A	—5A	—5A
Drive Current, I_3	—0.2A	—0.2A	—0.2A	0.2A	0.2A	0.2A

Thermal Resistance

Junction to Case, Θ_{J-C}

Power Switch 4.0°C/W

Commutating Diode 4.0°C/W

Case to Ambient, Θ_{C-A} 60.0°C/W

Operating Temperature Range, T_C —55°C to +125°C

Maximum Junction Temperature, T_j +150°C

Storage Temperature Range —65°C to +150°C

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	PIC600, 601, 602 Min.	Typ.	Max.	PIC610, 611, 612 Min.	Typ.	Max.	Units	Conditions
Current Delay Time	t_{di}	—	20	40	—	20	40	ns	V_{in} = 25V(—25V)
Current Rise Time	t_{ri}	—	50	75	—	50	75	ns	V_{out} = 5V(—5V)
Voltage Rise Time	t_{rv}	—	30	50	—	30	50	ns	I_{out} = 2A(—2A)
Voltage Storage Time	t_{sv}	—	450	—	—	450	—	ns	I_3 = —20mA(20mA) NOTE 5
Voltage Fall Time	t_{fv}	—	50	75	—	50	75	ns	See Figure 2.
Current Fall Time	t_{fi}	—	70	150	—	70	150	ns	See notes 1., 2., 4.
Efficiency (Notes 2. & 4.)	η	—	85	—	—	85	—	%	
On-State Voltage (Note 3.)	$V_{4-1(on)}$	—	1.0	1.5	—	—1.0	—1.5	V	I_4 = 2A(—2A), I_3 = —.02A(.02A) NOTE 5
On-State Voltage (Note 3.)	$V_{4-1(on)}$	—	2.5	3.5	—	—2.5	—3.5	V	I_4 = 5A(—5A), I_3 = —.02A(.02A) NOTE 5
Diode Forward Voltage (Note 3.)	$V_{2-1(on)}$	—	.8	1.0	—	—.8	—1.0	V	I_2 = 2A(—2A)
Diode Forward Voltage (Note 3.)	$V_{2-1(on)}$	—	1.0	1.5	—	—1.0	—1.5	V	I_2 = 5A(—5A)
Off-State Current	I_{4-1}	—	0.1	10	—	—0.1	—10	μA	V_4 = Rated input voltage
Off-State Current	I_{4-1}	—	10	—	—	—10	—	μA	V_4 = Rated input voltage, T_A = 100°C
Diode Reverse Current	I_{1-2}	—	1.0	10	—	—1.0	—10	μA	V_1 = Rated output voltage
Diode Reverse Current	I_{1-2}	—	500	—	—	500	—	μA	V_1 = Rated output voltage, T_A = 100°C

NOTES:

1. In switching an inductive load, the current will lead the voltage on turn on and lag the voltage on turn-off (see Figure 2.). Therefore, Voltage Delay Time (t_{DV}) ≅ t_{di} + t_{ri} and Current Storage Time (t_{si}) ≅ t_{sv} + t_{fv}.
2. The efficiency is a measure of internal power losses and is equal to Output Power divided by Input Power. The switching speed circuit of Figure 1., in which the efficiency is measured, is representative of typical operating conditions for the PIC600 switching regulators.
3. Pulse test: Duration = 300μs, Duty Cycle ≤ 2%.
4. As can be seen from the switching waveforms shown in Figure 2., no reverse of forward recovery spike is generated by the commutating diode during switching! This reduces self-generated noise, since no current spike is fed through the switching regulator. It also improves efficiency and reliabilty, since the power switch only carries current during turn-on.
5. To insure safe operation I_3 should be ≥|20mA| during T_{ON}. Operation at I_3 <|20mA| can permanently damage device.

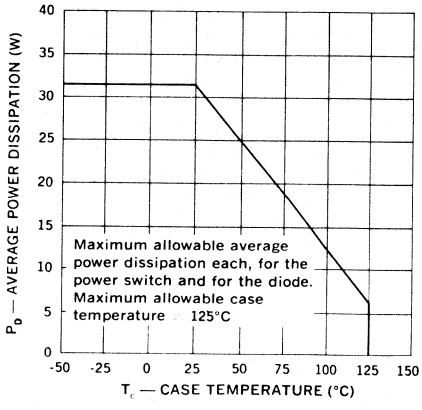
POWER DISSIPATION CONSIDERATIONS

The total power losses in the switching regulator is the sum of the switching losses, and the power switch and diode D.C. losses. Once total power dissipation has been determined, the Power Dissipation curve, or thermal resistance data may be used to determine the allowable case or ambient temperature for any operating condition.

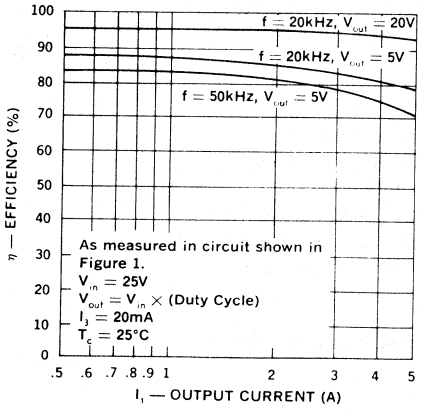
The switching losses curve presents data for a frequency of 20KHz. To find losses at any other frequency, multiply by f/20KHz.
The D.C. losses curve presents data for a duty cycle of .2. To find D.C. losses at any other duty cycle, multiply by D/.2 for the power switch and by (1-D)/.8 for the diode.

At frequencies much below 10KHz the above method for determining the allowable case or ambient temperature becomes invalid and a detailed transient thermal analysis must be performed. Please see Design Note 6 (DN-6) for further information.

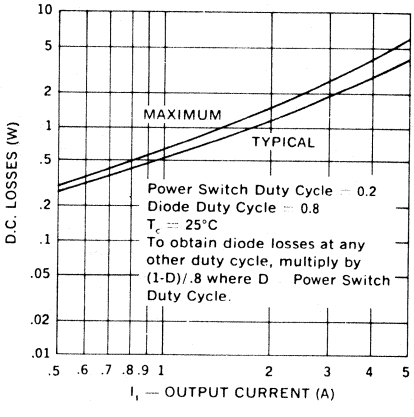
Power Dissipation



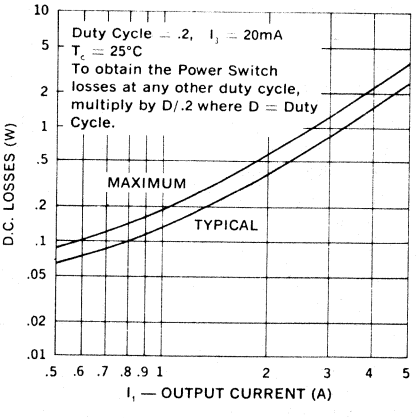
Efficiency



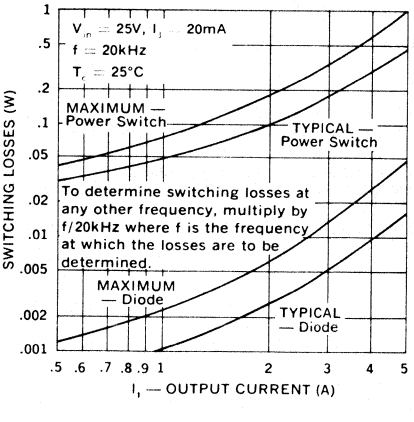
Diode D.C. Losses



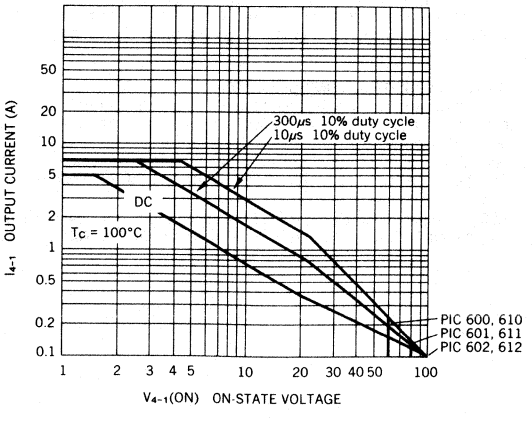
Power Switch D.C. Losses



Switching Losses



Maximum Safe Operating Area
PIC 600, 601, 602-610, 611, 612



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

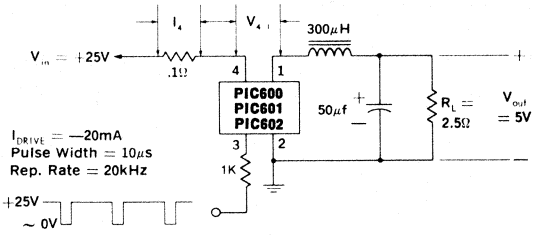


Figure 1. PIC600, 601, 602 Switching Speed Circuit

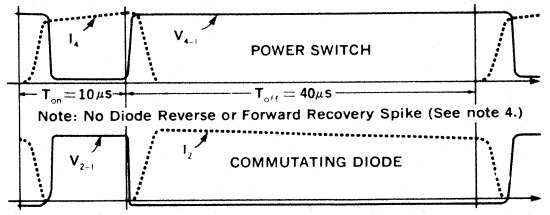
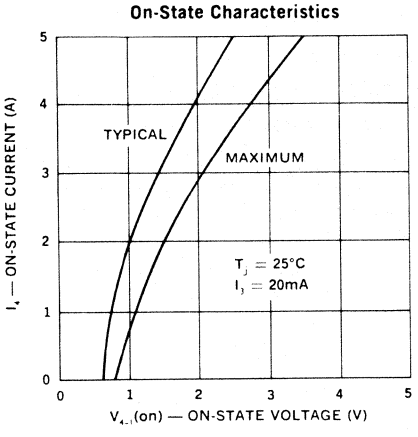
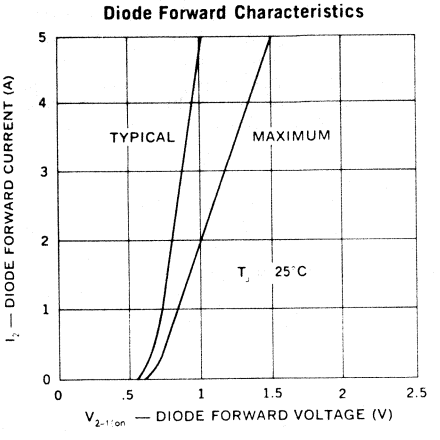
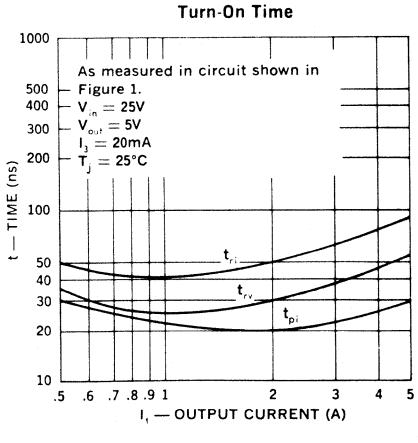


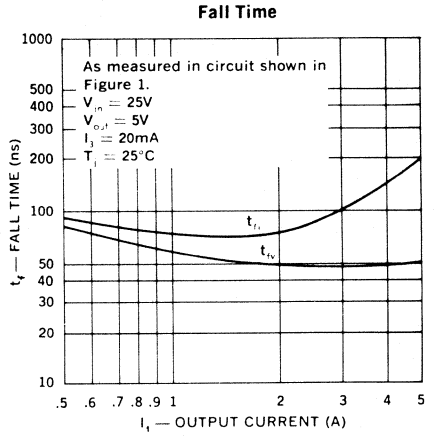
Figure 2. PIC600, PIC601, PIC602 Switching Waveforms

Note: PIC610, PIC611, PIC612 Test Circuit and waveforms are identical but of opposite polarity (V_{in} = −25V, V_{out} = −5V, I_{DRIVE} = +20mA).









POWER INTEGRATED CIRCUIT

Switching Regulator 15 Amp Positive and Negative Power Output Stages

PIC625
PIC626
PIC627
PIC635
PIC636
PIC637

FEATURES

- Designed and characterized for switching regulator applications
- Cost saving design reduces size, improves efficiency, reduces noise and RFI (See note 4.)
- High operating frequency (to >100kHz) results in smaller inductor-capacitor filter and improved power supply response time
- High operating efficiency: Typical 7A circuit performance —
  Rise and Fall time <300 ns
  Efficiency >85%
- No reverse recovery spike generated by commutating diode (See note 4. and Fig. 2.)
- Electrically isolated, 4-Pin, TO66 hermetic case

DESCRIPTION

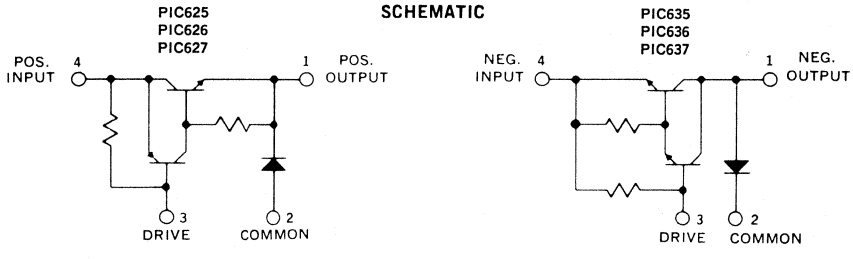
The Unitrode ESP Switching Regulator is a unique hybrid transistor circuit, specifically designed, constructed and specified for use in high current switching regulator applications. The designer is thus relieved of one of the most time consuming, tedious and critical aspects of switching regulator design: choosing the appropriate switching transistors and commutating diode, and empirically determining the optimum drive and bias conditions.

Switching regulators, when compared to conventional regulators, result in significant reductions in size, weight, and internal power losses and a major decrease in overall cost. Using the Unitrode PIC600 series the designer can achieve further improvements in size, weight, efficiency, and costs. At the same time, because of the PIC600 series design and packaging, the designer is aided in overcoming two of the most significant drawbacks to switching regulators: noise generation and slow response time; there is, in fact, no diode reverse recovery spike (See note 4.).

The PIC600 series switching regulators are designed and characterized to be driven wih standard integrated circuit voltage regulators. They are completely characterized over their entire operating range of −55°C to +125°C. The devices are enclosed in a special 4-pin TO66 package, hermetically sealed for high reliability. The hybrid circuit construction utilizes thick film resistors on a beryllia substrate for maximum thermal conductivity and resultant low thermal impedance. All of the active elements in the hybrid are fully passivated.

Application Notes U-68 and U-76 provide a detailed description of the hybrid circuit and design guidance for specific circuit applications.

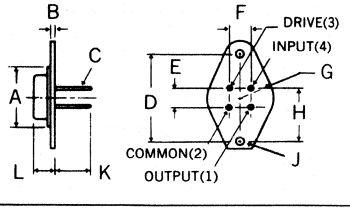
SCHEMATIC



MECHANICAL SPECIFICATIONS

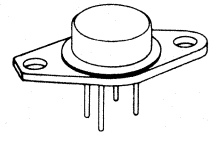
PIC625 PIC626 PIC627 PIC635 PIC636 PIC637

NOTES:
1. Case is electrically isolated.
2. Loads may be soldered to within 1/16" of base provided temperature-time exposure is less than 260°C for 10 seconds.



	ins.	mm
A	620 MAX	15.75 MAX
B	050-075	1.27-1.91
C	028-034	0.71-0.86
D	958-962	24.33-24.43
E	190-210	4.83-5.33
F	190-210	4.83-5.33
G	350 MAX. RAD	8.89 MAX. RAD
H	570-590	14.48-14.99
J	142-152 DIA	3.61-3.86 DIA
K	360 MIN	9.14 MIN
L	250-340	6.35-8.64

4-Pin TO-66



ABSOLUTE MAXIMUM RATINGS

	PIC625	PIC626	PIC627	PIC635	PIC636	PIC637
Input Voltage, V_{4-2}	60V	80V	100V	−60V	−80V	−100V
Output Voltage, V_{1-2}	60V	80V	100V	−60V	−80V	−100V
Drive-Input Reverse Voltage, V_{3-4}	5V	5V	5V	−5V	−5V	−5A
Output Current, I_1	15A	15A	15A	−15A	−15A	−15A
Drive Current, I_3	−0.4A	−0.4A	−0.4A	0.4A	0.4A	0.4A

Thermal Resistance

Junction to Case, Θ_{J-C}

Power Switch 4.0°C/W

Commutating Diode 4.0°C/W

Case to Ambient, Θ_{C-A} 60.0°C/W

Operating Temperature Range, T_C −55°C to +125°C

Maximum Junction Temperature, T_j +150°C

Storage Temperature Range −65°C to +150°C

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	PIC625/626/627 Min.	Typ.	Max.	PIC635/636/637 Min.	Typ.	Max.	Units	Conditions
Current Delay Time	t_{di}	—	35	60	—	35	60	ns	V_{in} = 25V(−25V)
Current Rise Time	t_{ri}	—	65	150	—	65	175	ns	V_{out} = 5V(−5V)
Voltage Rise Time	t_{rv}	—	40	60	—	40	60	ns	I_{out} = 7A(−7A)
Voltage Storage Time	t_{sv}	—	700	—	—	700	—	ns	I_3 = −30mA(30mA) NOTE 5
Voltage Fall Time	t_{fv}	—	70	175	—	100	300	ns	See Figure 2
Current Fall Time	t_{fi}	—	175	300	—	175	300	ns	See notes 1, 2, 4
Efficiency (Notes 2 and 4)	η	—	85	—	—	85	—	%	
On-State Voltage (Note 3)	$V_{4-1(on)}$	—	1.0	1.5	—	−1.0	−1.5	V	I_4 = 7A(−7A), I_3 = −.03A(.03A) NOTE 5
On-State Voltage (Note 3)	$V_{4-1(on)}$	—	2.5	3.5	—	−2.5	−3.5	V	I_4 = 15A(−15A), I_3 = −.03A(.03A) NOTE 5
Diode Fwd. Voltage (Note 3)	$V_{2-1(on)}$	—	.85	1.25	—	−.85	−1.25	V	I_2 = 7A(−7A)
Diode Fwd. Voltage (Note 3)	$V_{2-1(on)}$	—	.95	1.75	—	−.95	−1.75	V	I_2 = 15A(−15A)
Off-State Current	I_{4-1}	—	0.1	10	—	−0.1	−10	μA	V_4 = Rated input voltage
Off-State Current	I_{4-1}	—	10	—	—	−10	—	μA	V_4 = Rated input voltage, T_A = 100°C
Diode Reverse Current	I_{1-2}	—	1.0	10	—	−1.0	−10	μA	V_1 = Rated output voltage
Diode Reverse Current	I_{1-2}	—	500	—	—	500	—	μA	V_1 = Rated output voltage, T_A = 100°C

NOTES:

1. In switching an inductive load, the current will lead the voltage on turn-on and lag the voltage on turn-off (see Figure 2). Therefore, Voltage Delay Time (t_{DV}) ≅ t_{di} + t_{ri} and Current Storage Time (t_{si}) ≅ t_{sv} + t_{fv}.
2. The efficiency is a measure of internal power losses and is equal to Output Power divided by Input Power. The switching speed circuit of Figure 1, in which the efficiency is measured, is representative of typical operating conditions for the PIC600 series switching regulators.
3. Pulse test: Duration = 300μs, Duty Cycle ≤ 2%.
4. As can be seen from the switching waveforms shown in Figure 2, no reverse of forward recovery spike is generated by the commutating diode during switching! This reduces self-generated noise, since no current spike is fed through the switching regulator. It also improves efficiency and reliability, since the power switch only carries current during turn-on.
5. To insure safe operation I_3 should be ≥|30mA| during T_{ON}. Operation at I_3 <|30mA| can permanently damage device.

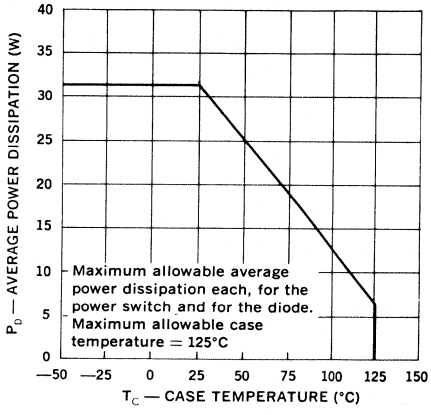
POWER DISSIPATION CONSIDERATIONS

The total power losses in the switching regulator is the sum of the switching losses, and the power switch and diode D.C. losses. Once total power dissipation has been determined, the Power Dissipation curve, or thermal resistance data may be used to determine the allowable case or ambient temperature for any operating condition.

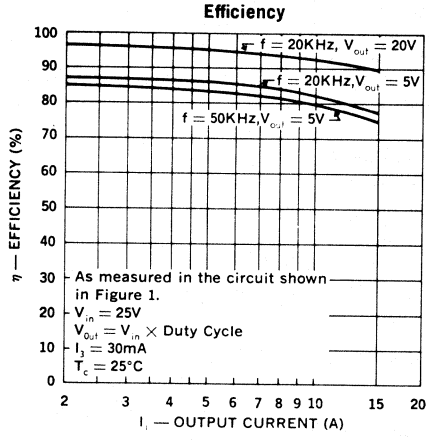
The switching losses curve presents data for a frequency of 20KHz. To find losses at any other frequency, multiply by f/20KHz.
The D.C. losses curve presents data for a duty cycle of .2. To find D.C. losses at any other duty cycle, multiply by D/.2 for the power switch and by (1-D)/.8 for the diode.

At frequencies much below 10KHz the above method for determining the allowable case or ambient temperature becomes invalid and a detailed transient thermal analysis must be performed. Please see Design Note 6 (DN-6) for further information.

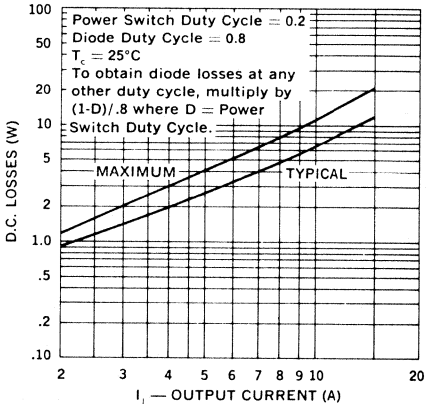
Power Dissipation



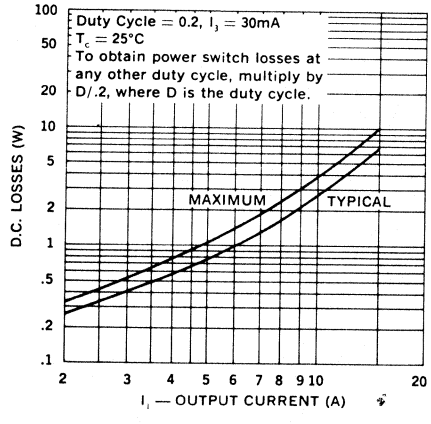
Efficiency



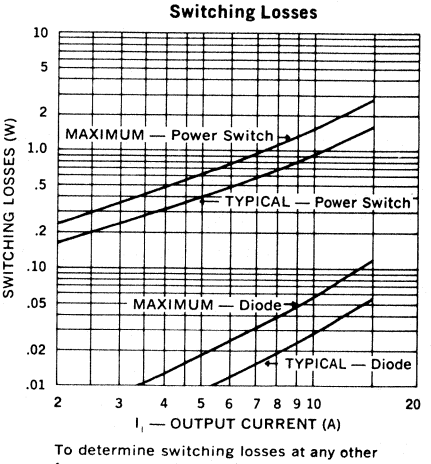
Diode D.C. Losses



Power Switch D.C. Losses



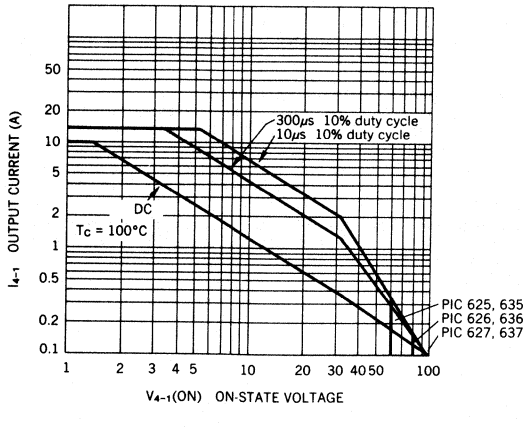
Switching Losses



V_{in} = 25V,
I_J = 30mA
f = 20KHz
T_C = 25°C

To determine switching losses at any other frequency, multiply by f/20KHz where f is the frequency at which the losses are to be determined.

Maximum Safe Operating Area
PIC 625, 626, 627-635, 636, 637



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A

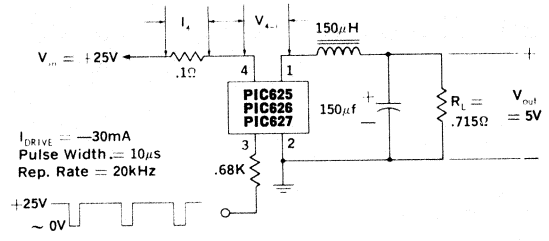


Figure 1. PIC625, 626, 627 Switching Speed Circuit

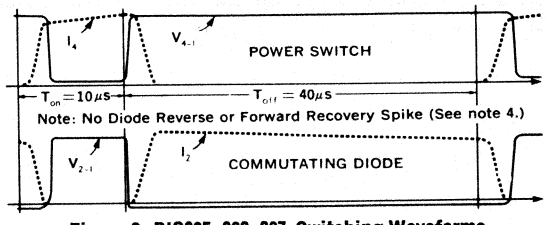
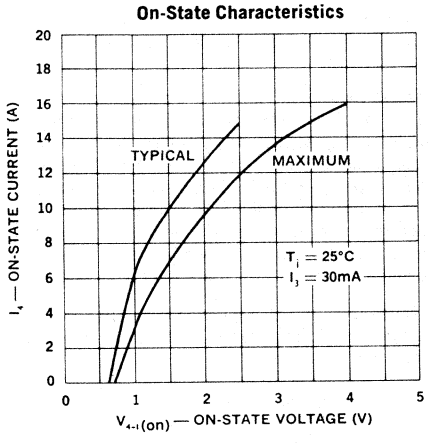
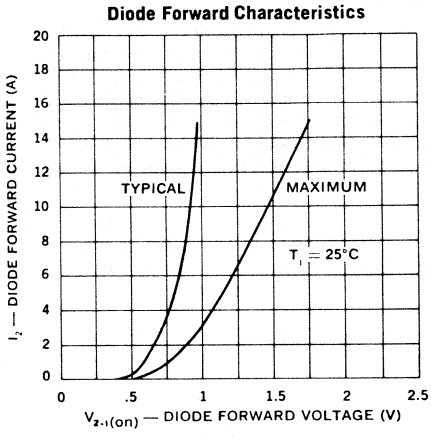
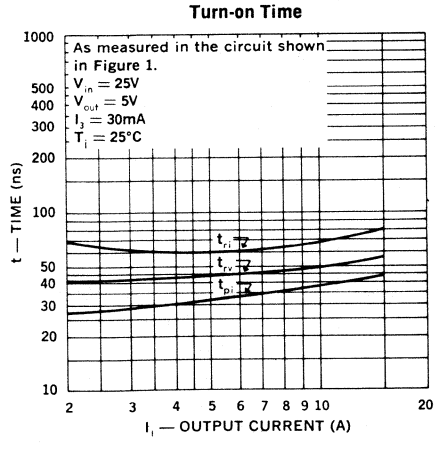


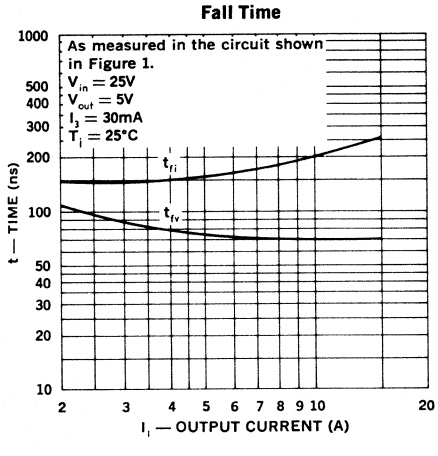
Figure 2. PIC625, 626, 627 Switching Waveforms

Note: PIC635, PIC636, PIC637 Circuit and waveforms are identical but of opposite polarity (V_{in} = −25V, V_{out} = −5V, I_{DRIVE} = +30mA.)









UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER INTEGRATED CIRCUIT

Switching Regulator 15 Amp Positive and Negative Power Output Stages

PIC645
PIC646
PIC647
PIC655
PIC656
PIC657

FEATURES

- Designed and characterized for switching regulator applications
- Cost saving design reduces size, improves efficiency, reduces noise and RFI (See note 4.)
- High operating frequency (to >100kHz) results in smaller inductor-capacitor filter and improved power supply response time
- High operating efficiency: Typical 7A circuit performance —
  Rise and Fall time <300 ns
  Efficiency >85%
- No reverse recovery spike generated by commutating diode (See note 4. and Fig. 2.)

DESCRIPTION

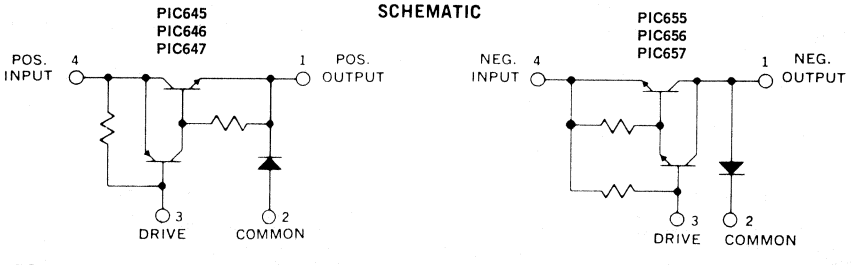
The Unitrode ESP Switching Regulator is a unique hybrid transistor circuit, specifically designed, constructed and specified for use in high current switching regulator applications. The designer is thus relieved of one of the most time consuming, tedious and critical aspects of switching regulator design: choosing the appropriate switching transistors and commutating diode, and empirically determining the optimum drive and bias conditions.

Switching regulators, when compared to conventional regulators, result in significant reductions in size, weight, and internal power losses and a major decrease in overall cost. Using the Unitrode PIC600 series the designer can achieve further improvements in size, weight, efficiency, and costs. At the same time, because of the PIC600 series design and packaging, the designer is aided in overcoming two of the most significant drawbacks to switching regulators: noise generation and slow response time; there is, in fact, no diode reverse recovery spike (See note 4.).

The PIC600 series switching regulators are designed and characterized to be driven with standard integrated circuit voltage regulators. They are completely characterized over their entire operating range of −55°C to +125°C. The devices are enclosed in a special 3 pin TO-3 package, hermetically sealed for high reliability. The hybrid circuit construction utilizes thick film resistors on a beryllia substrate for maximum thermal conductivity and resultant low thermal impedance. All of the active elements in the hybrid are fully passivated.

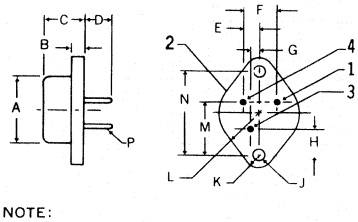
Application Notes U-68 and U-76 provide a detailed description of the hybrid circuit and design guidance for specific circuit applications.

SCHEMATIC



MECHANICAL SPECIFICATIONS

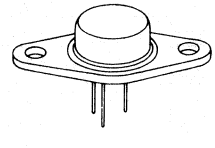
PIC645 PIC646 PIC647 PIC655 PIC656 PIC657



	ins.	mm
A	.875 MAX.	22.23 MAX.
B	.135	3.43
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.205-.225	5.21-5.72
F	.420-.440	10.67-11.18
G	.145-.165	3.68-4.19
H	.395-.405	10.03-10.29
J	.151-.161 DIA.	3.84-4.09 DIA.
K	.188 MAX. RAD.	4.78 MAX. RAD.
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.708-.728	17.98-18.49
N	1.177-1.197	29.90-30.40
P	.038-.043 DIA.	.97-1.09 DIA.

NOTE:
Loads may be soldered to within $^1/_{16}$" of base provided temperature-time exposure is less than 260°C for 10 seconds.

3 Pin TO-3



UNITRODE

ABSOLUTE MAXIMUM RATINGS

	PIC645	PIC646	PIC647	PIC655	PIC656	PIC657
Input Voltage, V_{4-2}	60V	80V	100V	−60V	−80V	−100V
Output Voltage, V_{1-2}	60V	80V	100V	−60V	−80V	−100V
Drive-Input Reverse Voltage, V_{3-4}	5V	5V	5V	−5V	−5V	−5V
Continuous Output Current, I_1	15A	15A	15A	−15A	−15A	−15A
Peak Output Current	20A	20A	20A	−20A	−20A	−20A
Drive Current, I_3	−0.4A	−0.4A	−0.4A	0.4A	0.4A	0.4A

Thermal Resistance

Junction to Case, Θ_{J-C}

Power Switch 2°C/W

Commutating Diode 2°C/W

Case to Ambient, Θ_{C-A} 30.0°C/W

Operating Temperature Range, T_C −55°C to +125°C

Maximum Junction Temperature, T_j +150°C

Storage Temperature Range −65°C to +150°C

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	PIC645/646/647 Min.	Typ.	Max.	PIC655/656/657 Min.	Typ.	Max.	Units	Conditions
Current Delay Time	t_{di}	—	35	60	—	35	60	ns	V_{in} = 25V(−25V)
Current Rise Time	t_{ri}	—	65	150	—	65	175	ns	V_{out} = 5V(−5V)
Voltage Rise Time	t_{rv}	—	40	60	—	40	60	ns	I_{out} = 7A(−7A)
Voltage Storage Time	t_{sv}	—	700	—	—	700	—	ns	I_3 = −30mA(30mA) NOTE 5
Voltage Fall Time	t_{fv}	—	70	175	—	100	300	ns	See Figure 2
Current Fall Time	t_{fi}	—	175	300	—	175	300	ns	See notes 1, 2, 4
Efficiency (Notes 2 and 4)	η	—	85	—	—	85	—	%	
On-State Voltage (Note 3)	$V_{4-1(on)}$	—	1.0	1.5	—	−1.0	−1.5	V	I_4 = 7A(−7A), I_3 = −.03A(.03A) NOTE 5
On-State Voltage (Note 3)	$V_{4-1(on)}$	—	2.5	3.5	—	−2.5	−3.5	V	I_4 = 15A(−15A), I_3 = −.03A(.03A) NOTE 5
Diode Fwd. Voltage (Note 3)	$V_{2-1(on)}$	—	.85	1.25	—	−.85	−1.25	V	I_2 = 7A(−7A)
Diode Fwd. Voltage (Note 3)	$V_{2-1(on)}$	—	.95	1.75	—	−.95	−1.75	V	I_2 = 15A(−15A)
Off-State Current	I_{4-1}	—	0.1	10	—	−0.1	−10	μA	V_4 = Rated input voltage
Off-State Current	I_{4-1}	—	10	—	—	−10	—	μA	V_4 = Rated input voltage, T_A = 100°C
Diode Reverse Current	I_{1-2}	—	1.0	10	—	−1.0	−10	μA	V_1 = Rated output voltage
Diode Reverse Current	I_{1-2}	—	500	—	—	500	—	μA	V_1 = Rated output voltage, T_A = 100°C

NOTES:

1. In switching an inductive load, the current will lead the voltage on turn-on and lag the voltage on turn-off (see Figure 2). Therefore, Voltage Delay Time (t_{DV}) ≅ t_{di} + t_{ri} and Current Storage Time (t_{si}) ≅ t_{sv} + t_{fv}.
2. The efficiency is a measure of internal power losses and is equal to Output Power divided by Input Power. The switching speed circuit of Figure 1, in which the efficiency is measured, is representative of typical operating conditions for the PIC600 series switching regulators.
3. Pulse test: Duration = 300μs, Duty Cycle ≤ 2%.
4. As can be seen from the switching waveforms shown in Figure 2, no reverse of forward recovery spike is generated by the commutating diode during switching! This reduces self-generated noise, since no current spike is fed through the switching regulator. It also improves efficiency and reliability, since the power switch only carries current during turn-on.
5. To insure safe operation I_3 should be ≥ |30mA| during T_{ON}. Operation at I_3 < |30mA| can permanently damage device.

POWER DISSIPATION CONSIDERATIONS

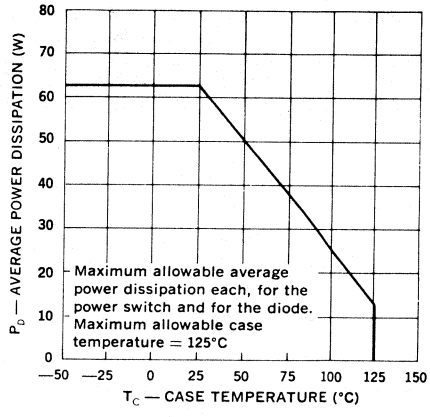
The total power losses in the switching regulator is the sum of the switching losses, and the power switch and diode D.C. losses. Once total power dissipation has been determined, the Power Dissipation curve, or thermal resistance data may be used to determine the allowable case or ambient temperature for any operating condition.

The switching losses curve presents data for a frequency of 20KHz. To find losses at any other frequency, multiply by f/20KHz.

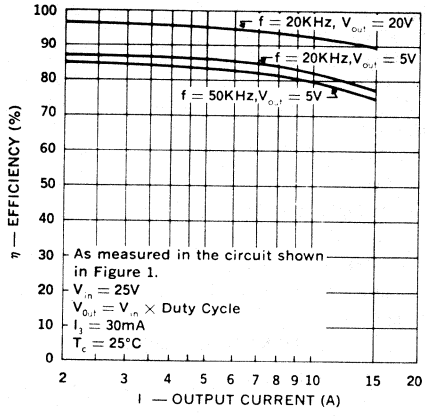
The D.C. losses curve presents data for a duty cycle of .2. To find D.C. losses at any other duty cycle, multiply by D/.2 for the power switch and by (1-D)/.8 for the diode.

At frequencies much below 10KHz the above method for determining the allowable case or ambient temperature becomes invalid and a detailed transient thermal analysis must be performed. Please see Design Note 6 (DN-6) for further information.

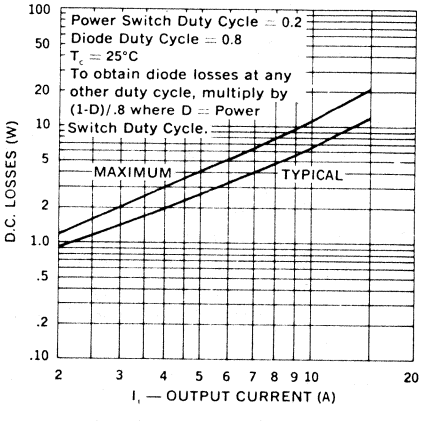
Power Dissipation



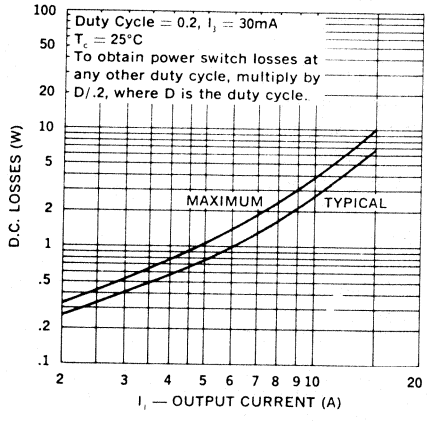
Efficiency



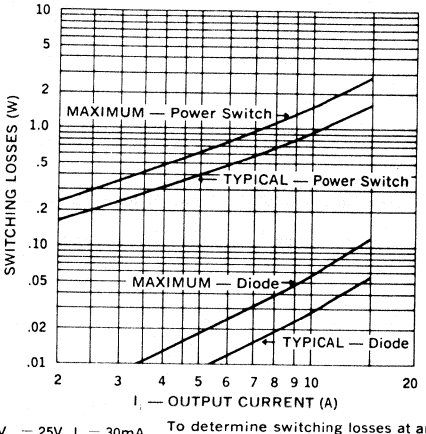
Diode D.C. Losses



Power Switch D.C. Losses



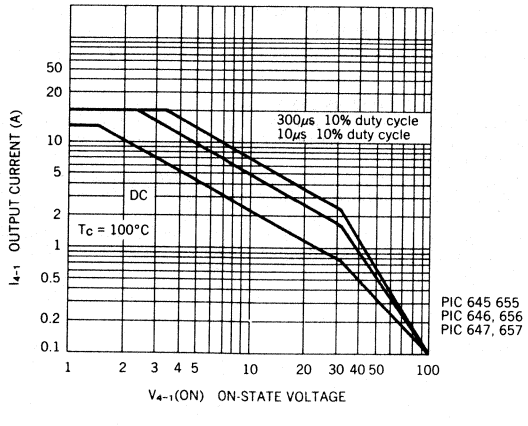
Switching Losses



V_{in} = 25V, I_J = 30mA
f = 20KHz
T_C = 25°C

To determine switching losses at any other frequency, multiply by f/20KHz where f is the frequency at which the losses are to be determined.

Maximum Safe Operating Area
PIC 645, 646, 647-655, 656, 657



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

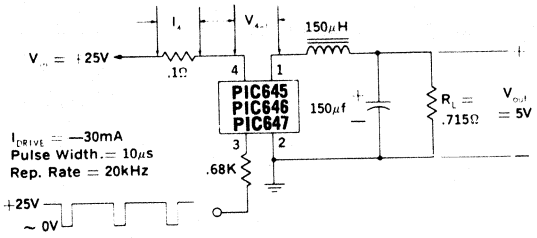


Figure 1. PIC645, 646, 647 Switching Speed Circuit

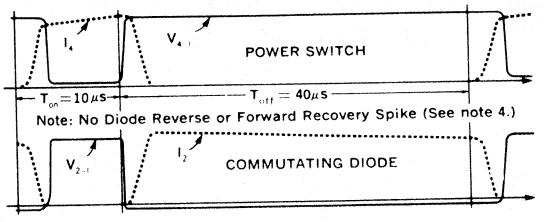
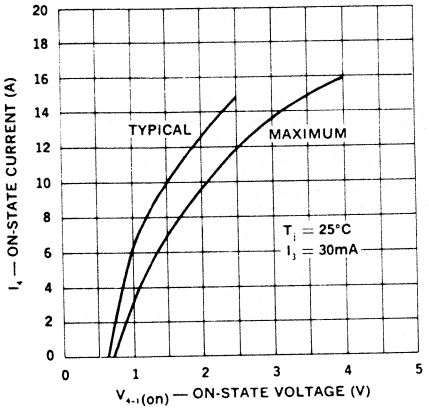


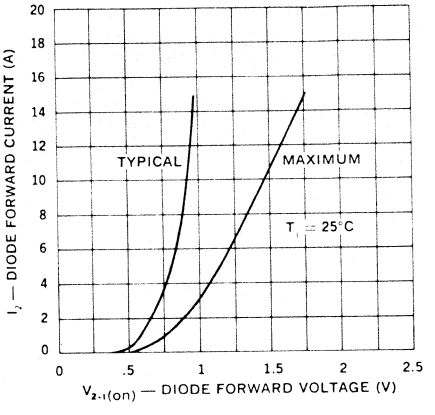
Figure 2. PIC645, 646, 647 Switching Waveforms

Note: PIC655, PIC656, PIC657 Circuit and waveforms are identical but of opposite polarity ($V_{in} = -25V$, $V_{out} = -5V$, $I_{DRIVE} = +30mA$.)

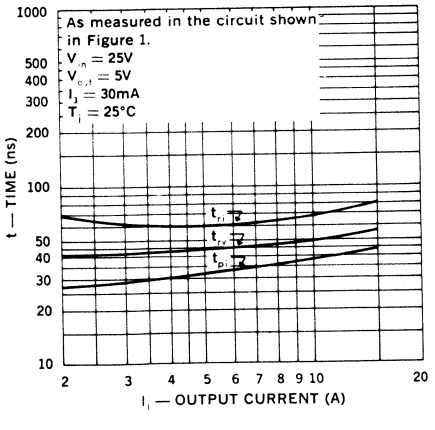
On-State Characteristics



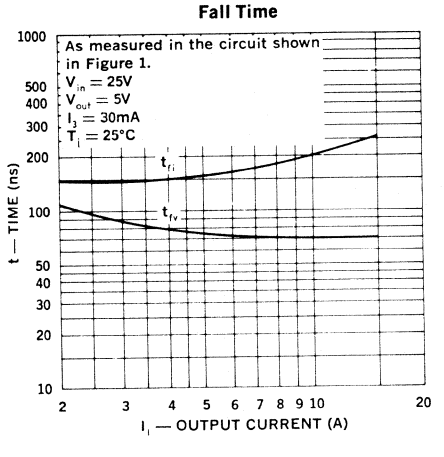
Diode Forward Characteristics



Turn-on Time



Fall Time



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER INTEGRATED CIRCUIT

Switching Regulator 10 Amp Positive and Negative Power Output Stages

PIC660
PIC661
PIC662
PIC670
PIC671
PIC672

FEATURES

- Designed and characterized for switching regulator applications
- Cost saving design reduces size, improves efficiency, reduces noise and RFI (See note 4.)
- High operating frequency (to >100kHz) results in smaller inductor-capacitor filter and improved power supply response time
- High operating efficiency: Typical 5A circuit performance —
  Rise and Fall time <300ns
  Efficiency >85%
- No reverse recovery spike generated by commutating diode (See note 4. and Fig. 2.)
- Electrically isolated, 4-Pin, TO-66 hermetic case

DESCRIPTION

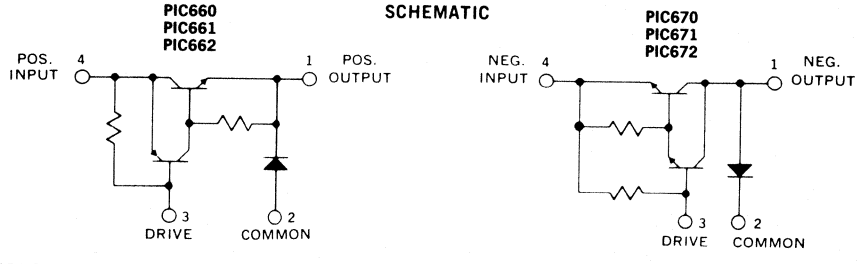
The Unitrode Switching Regulator is a unique hybrid transistor circuit, specifically designed, constructed and specified for use in high current switching regulator applications. The designer is thus relieved of one of the most time consuming, tedious and critical aspects of switching regulator design: choosing the appropriate switching transistors and commutating diode, and empirically determining the optimum drive and bias conditions.

Switching regulators, when compared to conventional regulators, result in significant reductions in size, weight, and internal power losses and a major decrease in overall cost. Using the Unitrode PIC600 series the designer can achieve further improvements in size, weight, efficiency, and costs. At the same time, because of the PIC600 series design and packaging, the designer is aided in overcoming two of the most significant drawbacks to switching regulators: noise generation and slow response time; there is, in fact, no diode reverse recovery spike (See note 4.).

The PIC600 series switching regulators are designed and characterized to be driven with standard integrated circuit voltage regulators. They are completely characterized over their entire operating range of −55°C to +125°C. The devices are enclosed in a special 4-Pin TO-66 package, hermetically sealed for high reliability. The hybrid circuit construction utilizes thick film resistors on a beryllia substrate for maximum thermal conductivity and resultant low thermal impedance. All of the active elements in the hybrid are fully passivated.

Application Notes U-68 and U-76 provide a detailed description of the hybrid circuit and design guidance for specific circuit applications.

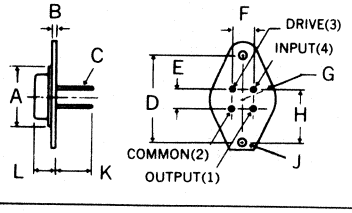
SCHEMATIC



MECHANICAL SPECIFICATIONS

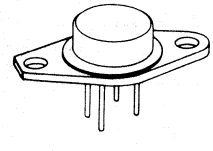
PIC660 PIC661 PIC662 PIC670 PIC671 PIC672

NOTES:
1. Case is electrically isolated.
2. Loads may be soldered to within 1/16" of base provided temperature-time exposure is less than 260°C for 10 seconds.



	ins.	mm
A	620 MAX	15.75 MAX
B	050-075	1.27-1.91
C	028-034	0.71-0.86
D	958-962	24.33-24.43
E	190-210	4.83-5.33
F	190-210	4.83-5.33
G	350 MAX RAD	8.89 MAX RAD
H	570-590	14.48-14.99
J	142-152 DIA	3.61-3.86 DIA
K	360 MIN	9.14 MIN
L	250-340	6.35-8.64

4-Pin TO-66



UNITRODE

ABSOLUTE MAXIMUM RATINGS

	PIC660	PIC661	PIC662	PIC670	PIC671	PIC672
Input Voltage, V_{4-2}	60V	80V	100V	-60V	-80V	-100V
Output Voltage, V_{1-2}	60V	80V	100V	-60V	-80V	-100V
Drive-Input Reverse Voltage, V_{3-4}	5V	5V	5V	-5V	-5V	-5V
Output Current, I_1	10A	10A	10A	-10A	-10A	-10A
Drive Current, I_3	-0.4A	-0.4A	-0.4A	0.4A	0.4A	0.4A

Thermal Resistance
- Junction to Case, θ_{J-C}
  - Power Switch ..... 4.0°C/W
  - Commutating Diode ..... 4.0°C/W
- Case to Ambient, θ_{C-A} ..... 60.0°C/W

Operating Temperature Range, T_C ..... −55°C to +125°C
Maximum Junction Temperature, T_j ..... +150°C
Storage Temperature Range ..... −65°C to +150°C

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	PIC660/661/662 Min.	PIC660/661/662 Typ.	PIC660/661/662 Max.	PIC670/671/672 Min.	PIC670/671/672 Typ.	PIC670/671/672 Max.	Units	Conditions
Current Delay Time	t_{di}	—	35	60	—	35	60	ns	$V_{in} = 25V(-25V)$
Current Rise Time	t_{ri}	—	65	150	—	65	175	ns	$V_{out} = 5V(-5V)$
Voltage Rise Time	t_{rv}	—	40	60	—	40	60	ns	$I_{out} = 5A(-5A)$
Voltage Storage Time	t_{sv}	—	700	—	—	700	—	ns	$I_3 = -30mA(30mA)$ NOTE 5
Voltage Fall Time	t_{fv}	—	70	175	—	100	300	ns	See Figure 2
Current Fall Time	t_{fi}	—	175	300	—	175	300	ns	See notes 1, 2, 4
Efficiency (Notes 2 and 4)	η	—	85	—	—	85	—	%	
On-State Voltage (Note 3)	$V_{4-1(on)}$	—	1.0	1.5	—	−1.0	−1.5	V	$I_4 = 5A(-5A)$, $I_3 = -.03A(.03A)$ NOTE 5
On-State Voltage (Note 3)	$V_{4-1(on)}$	—	2.5	3.5	—	−2.5	−3.5	V	$I_4 = 10A(-10A)$, $I_3 = -.03A(.03A)$ NOTE 5
Diode Fwd. Voltage (Note 3)	$V_{2-1(on)}$	—	.85	1.25	—	−.85	−1.25	V	$I_2 = 5A(-5A)$
Diode Fwd. Voltage (Note 3)	$V_{2-1(on)}$	—	.95	1.75	—	−.95	−1.75	V	$I_2 = 10A(-10A)$
Off-State Current	I_{4-1}	—	0.1	10	—	−0.1	−10	μA	V_4 = Rated input voltage
Off-State Current	I_{4-1}	—	10	—	—	−10	—	μA	V_4 = Rated input voltage, $T_A = 100°C$
Diode Reverse Current	I_{1-2}	—	1.0	10	—	−1.0	−10	μA	V_1 = Rated output voltage
Diode Reverse Current	I_{1-2}	—	500	—	—	500	—	μA	V_1 = Rated output voltage, $T_A = 100°C$

NOTES:
1. In switching an inductive load, the current will lead the voltage on turn-on and lag the voltage on turn-off (see Figure 2). Therefore, Voltage Delay Time $(t_{DV}) \cong t_{di} + t_{ri}$ and Current Storage Time $(t_{si}) \cong t_{sv} + t_{tv}$.
2. The efficiency is a measure of internal power losses and is equal to Output Power divided by Input Power. The switching speed circuit of Figure 1, in which the efficiency is measured, is representative of typical operating conditions for the PIC600 series switching regulators.
3. Pulse test: Duration = 300μs, Duty Cycle ≤ 2%.
4. As can be seen from the switching waveforms shown in Figure 2, no reverse of forward recovery spike is generated by the commutating diode during switching! This reduces self-generated noise, since no current spike is fed through the switching regulator. It also improves efficiency and reliability, since the power switch only carries current during turn-on.
5. To insure safe operation I_3 should be $\geq |30mA|$ during T_{ON}. Operation at $I_3 < |30mA|$ can permanently damage device.

POWER DISSIPATION CONSIDERATIONS

The total power losses in the switching regulator is the sum of the switching losses, and the power switch and diode D.C. losses. Once total power dissipation has been determined, the Power Dissipation curve, or thermal resistance data may be used to determine the allowable case or ambient temperature for any operating condition.

The switching losses curve presents data for a frequency of 20KHz. To find losses at any other frequency, multiply by f/20KHz.

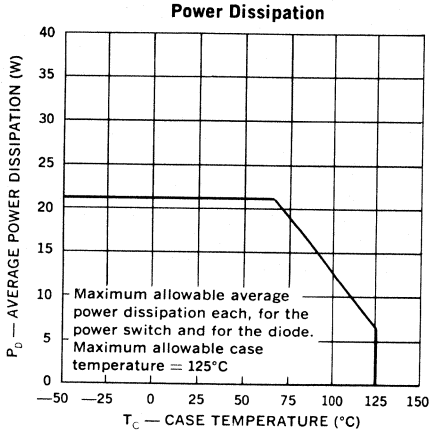
The D.C. losses curve presents data for a duty cycle of .2. To find D.C. losses at any other duty cycle, multiply by D/.2 for the power switch and by (1-D)/.8 for the diode.

At frequencies much below 10KHz the above method for determining the allowable case or ambient temperature becomes invalid and a detailed transient thermal analysis must be performed. Please see Design Note 6 (DN-6) for further information.

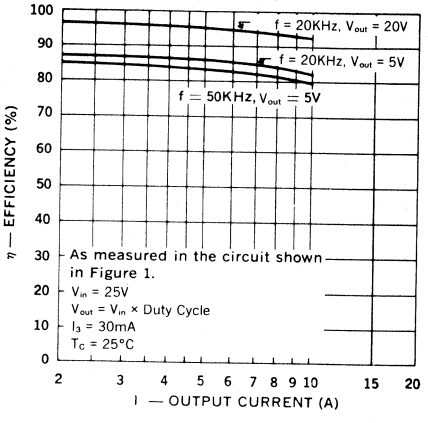
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

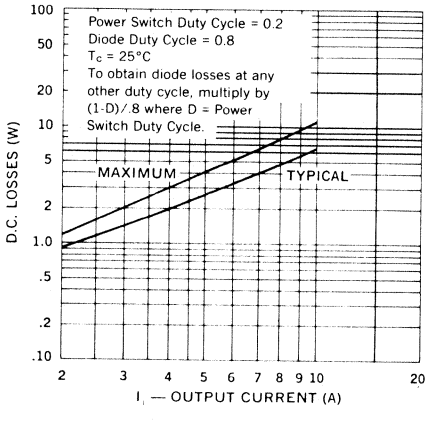
Power Dissipation



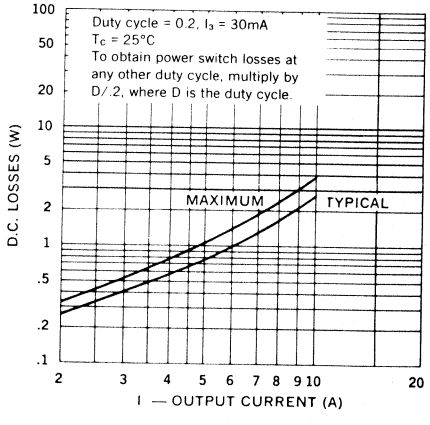
Efficiency



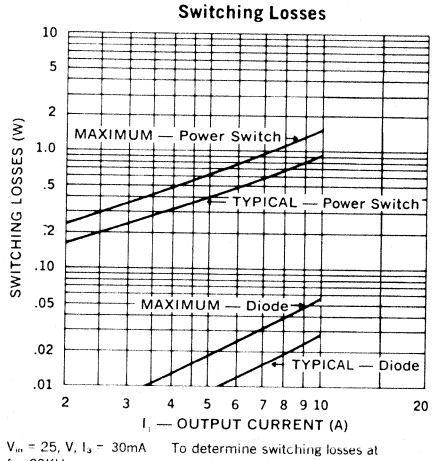
Diode D.C. Losses



Power Switch D.C. Losses



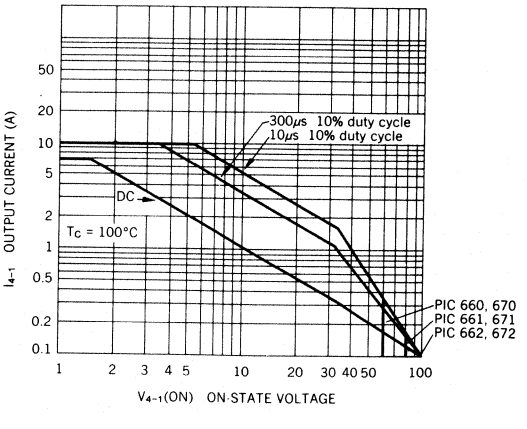
Switching Losses



V_{in} = 25, V, I_3 = 30mA
f = 20KHz
T_C = 25°C

To determine switching losses at any other frequency, multiply by f/20KHz where f is the frequency at which the losses are to be determined.

Maximum Safe Operating Area PIC 660, 661, 662-670, 671, 672



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

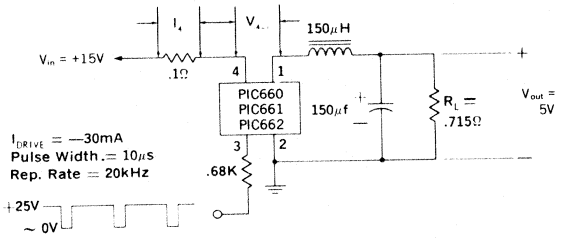


Figure 1. PIC660, 661, 662 Switching Speed Circuit

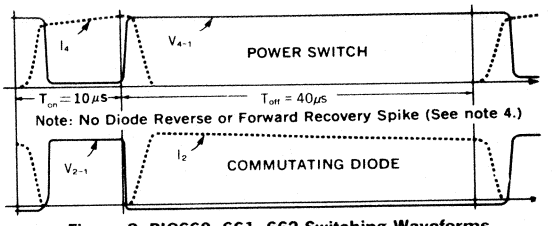
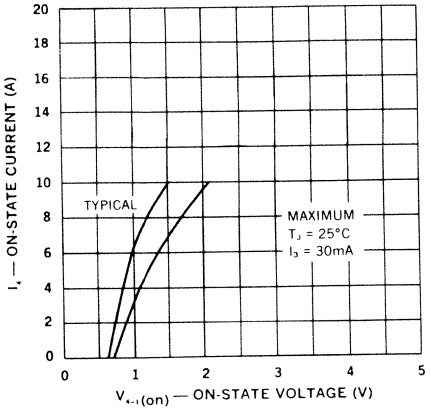


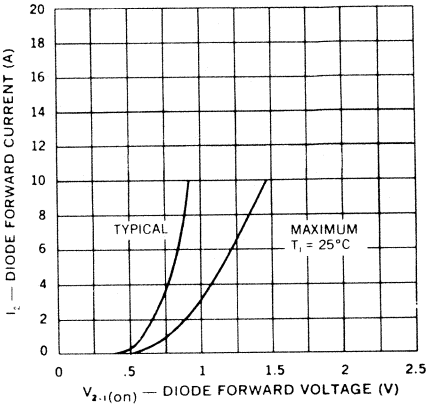
Figure 2. PIC660, 661, 662 Switching Waveforms

Note: PIC670, PIC671, PIC672 Circuit and waveforms are identical but of opposite polarity (V_{in} = −15V, V_{out} = −5V, I_{DRIVE} = +30mA.)

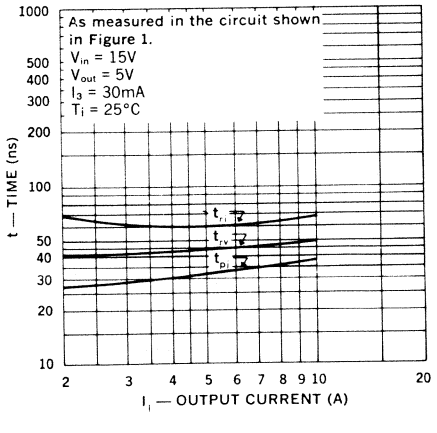
On-State Characteristics



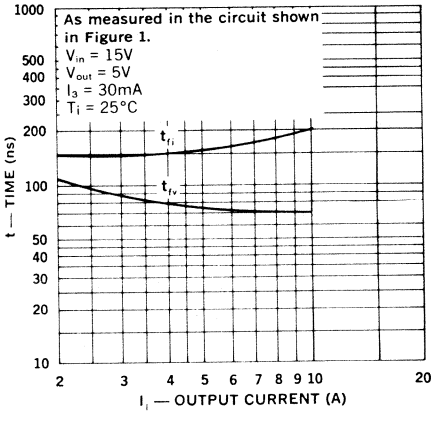
Diode Forward Characteristics



Turn-on Time



Fall Time



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

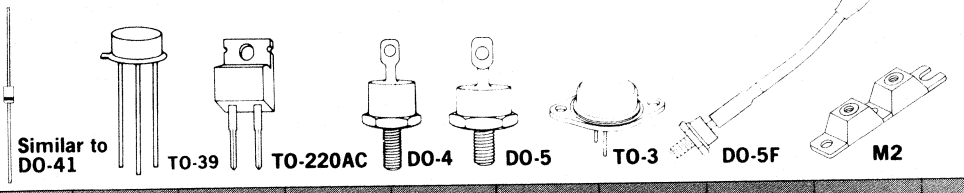
RECTIFIERS & RECTIFIER ASSEMBLIES 5

Schottky Rectifiers - Product Selection Guide 5-3
Ultra-Fast Recovery Rectifiers - Product Selection Guide 5-4
Super-Fast Recovery Rectifiers - Product Selection Guide 5-6
Fast Recovery Rectifiers - Product Selection Guide 5-7
Standard Recovery Rectifiers - Product Selection Guide 5-8
High Voltage Rectifiers & Rectifier Modules - Product Selection Guide 5-9
Rectifier Bridges - Product Selection Guide 5-15
Data Sheets 5-18

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SCHOTTKY RECTIFIERS



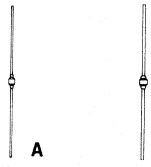
AVERAGE DC OUTPUT CURRENT		1A	1A	3A	4A	6A	8A	12A[1]	12A	16A[2]
PEAK REVERSE VOLTAGE	PKG	Similar to DO-41 (ASA)	Similar to DO-41 (ASA)	Similar to DO-201AD (ASB)	TO-39 PLASTIC (3 LEAD)	TO-220 PLASTIC (2 LEAD)	TO-220 PLASTIC (2 LEAD)	TO-220 PLASTIC (3 LEAD)	TO-220 PLASTIC (2 LEAD)	TO-220 PLASTIC (3 LEAD)
20V	TYPE V_F I_{FSM}	1N5817 .45 @ 1A 25A	USD1120 .45 @ 1A 50A	1N5820 .475 @ 3A 80A		USD620 .55 @ 6A 150A	USD720 .55 @ 8A 200A	USD620C .65 @ 12A 150A	USD820 .45 @ 12A 200A	USD720C .65 @ 16A 200A
30V	TYPE V_F I_{FSM}	1N5818 .55 @ 1A 25A	USD1130 .475 @ 1A 50A	1N5821 .50 @ 3A 80A						
35V	TYPE V_F I_{FSM}					USD635 .55 @ 6A 150A	USD735 .55 @ 8A 200A	USD635C .65 @ 12A 150A	USD835 .45 @ 12A 200A	USD735C .65 @ 16A 200A
40V	TYPE V_F I_{FSM}	1N5819 .60 @ 1A 25A	USD1140 .50 @ 1A 50A	1N5822 .525 @ 3A 80A		USD640 .55 @ 6A 150A	USD740 .55 @ 8A 200A	USD640C .65 @ 12A 150A	USD840 .45 @ 12A 200A	USD740C .65 @ 16A 200A
45V	TYPE V_F I_{FSM}				USD245/HR .68 @ 4A 80A	USD645 .55 @ 6A 150A	USD745 .55 @ 8A 200A	USD645C .65 @ 12A 150A	USD845 .45 @ 12A 200A	USD745C .65 @ 16A 200A

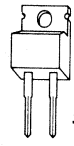
AVERAGE DC OUTPUT CURRENT		16A	25A	30A[3]	50A	60A	75A	100A	200A
PEAK REVERSE VOLTAGE	PKG	TO-220 PLASTIC (2 LEAD)	DO-4 STUD	TO-3	DO-5 STUD	DO-5 DO-5F STUD	DO-5 DO-5F STUD	POWER TAB	POWER BLOCK M2
20V	TYPE V_F I_{FSM}	USD920 .50 @ 16A 250A		USD320C[6] .6 @ 20A 400A			USD520 .6 @ 60A 1000A		
30V	TYPE V_F I_{FSM}				1N6097 .86 @ 157A 800A				
35V	TYPE V_F I_{FSM}	USD935 .50 @ 16A 250A		USD335C[6] .6 @ 20A 400A		USD6035 .6 @ 60A 800A	USD535 .6 @ 60A 1000A		
40V	TYPE V_F I_{FSM}	USD940 .50 @ 16A 250A			1N6098 .86 @ 157A 800A			USM140C .775 @ 100A 1000A	USM20040C .745 @ 200A 2000A
45V	TYPE V_F I_{FSM}	USD945 .50 @ 16A 250A	1N6391[5] .68 @ 50A 600A	USD345C[6] SD241[6] .6 @ 20A 400A		1N6392[5] USD6045 SD51[4] .6 @ 60A 800A	USD545 .6 @ 60A 1000A	USM145C .775 @ 100A 1000A	USM20045C .745 @ 200A 2000A
50V	TYPE V_F I_{FSM}						USD550 .6 @ 60A 1000A	USM150C .775 @ 100A 1000A	USM20050C .745 @ 200A 2000A

NOTES: 1. Center-tap 6A per leg.
2. Center-tap 8A per leg.
3. Center-tap 15A per leg.
4. V_{RRM} @ 25°C is 45V, V_{RRM} @ 150°C is 35V.
5. Available as JAN, JANTX, JANTXV.
6. Available with High-Reliability (HR) Screening. See individual datasheets.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

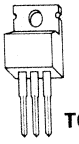


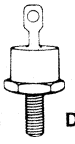

TO-220AC

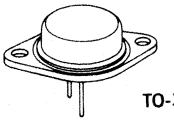
ULTRA-FAST RECOVERY (t_{rr} — 25 to 50ns)

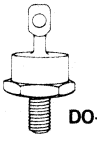
Average D.C. Output Current		1A	2A	2.5A	5A	6A	8A	16A
Package Style		A	A	A	B	B	TO-220AC	TO-220AC
Peak Inverse Voltage 50V	V_F t_{rr}	UES1001 .895 @ 1A 25ns		1N5802* UES1101 .895 @ 2A 25ns		1N5807* UES1301 .850 @ 6A 30ns	UES1401 .895 @ 8A 35ns	UES1501 .975 @ 16A 35ns
75V	V_F t_{rr}			1N5803 .895 @ 1A 25ns		1N5808 .850 @ 6A 30ns		
100V	V_F t_{rr}	UES1002 .895 @ 1A 25ns		1N5804* UES1102 .895 @ 2A 25ns		1N5809* UES1302 .850 @ 6A 30ns	UES1402 .895 @ 8A 35ns	UES1502 .975 @ 16A 35ns
125V	V_F t_{rr}			1N5805 .895 @ 1A 25ns		1N5810 .850 @ 6A 30ns		
150V	V_F t_{rr}	UES1003 .895 @ 1A 25ns		1N5806* UES1103 .895 @ 2A 25ns		1N5811* UES1303 .850 @ 6A 30ns	UES1403 .895 @ 8A 35ns	UES1503 .975 @ 16A 35ns
200V	V_F t_{rr}		UES1104[1] 1.15 @ 1A 50ns		UES1304[1] 1.15 @ 3A 50ns		UES1404 .895 @ 8A 35ns	UES1504 .975 @ 16A 35ns
300V	V_F t_{rr}		UES1105[1] 1.15 @ 1A 50ns		UES1305[1] 1.15 @ 3A 50ns			
400V	V_F t_{rr}		UES1106[1] 1.15 @ 1A 50ns		UES1306[1] 1.15 @ 3A 50ns			

* Available as JAN, JANTX, JANTXV.
1. Available with High Reliability (HR) Screening. See individual datasheets.


TO-220AB


DO-4

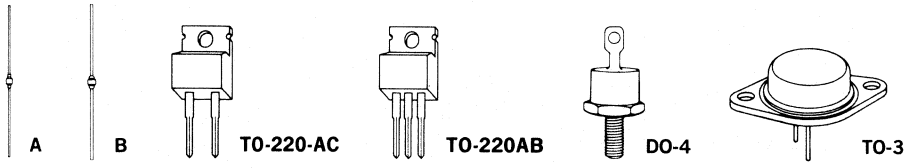

TO-3


DO-5

ULTRA-FAST RECOVERY (t_{rr} — 25 to 50ns)

Average D.C. Output Current			16A Center-Tap	20A	25A	30A Center-Tap	50A	70A
Peak Inverse Voltage	Package Style		TO-220AB	DO-4	DO-4	TO-3	DO-5	DO-5
	50V	V_F	UES2401 .895 @ 8A		1N5812* UES701 .825 @ 25A	UES2601[1] .825 @ 15A		1N6304* UES801 .84 @ 70A
		t_{rr}	35ns		35ns	35ns		50ns
	75V	V_F			1N5813 .825 @ 25A			
		t_{rr}			35ns			
	100V	V_F	UES2402 .895 @ 8A		1N5814* UES702 .825 @ 25A	UES2602[1] .825 @ 15A		1N6305* UES802 .84 @ 70A
		t_{rr}	35ns		35ns	35ns		50ns
	125V	V_F			1N5815 .825 @ 25A			
		t_{rr}			35ns			
	150V	V_F	UES2403 .895 @ 8A		1N5816* UES703 .825 @ 25A	UES2603[1] .825 @ 15A		1N6306* UES803 .84 @ 70A
		t_{rr}	35ns		35ns	35ns		50ns
	200V	V_F	UES2404 .895 @ 8A	UES704[1] 1.15 @ 20A		UES2604[1] 1.15 @ 15A	UES804[1] 1.15 @ 50A	
		t_{rr}	35ns	50ns		50ns	50ns	
	300V	V_F		UES705[1] 1.15 @ 20A		UES2605[1] 1.15 @ 15A	UES805[1] 1.15 @ 50A	
		t_{rr}		50ns		50ns	50ns	
	400V	V_F		UES706[1] 1.15 @ 20A		UES2606[1] 1.15 @ 15A	UES806[1] 1.15 @ 50A	
		t_{rr}		50ns		50ns	50ns	

* Available as JAN, JANTX, JANTXV.
1. Available with High Reliability (HR) Screening. See individual datasheets.



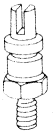
SUPER-FAST RECOVERY (t_{rr} - 75 to 100ns)

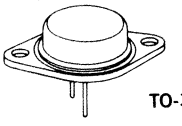
Average D.C. Output Current			1A	2A	2A	3A	4A
Package Style			A	A	A	B	B
Peak Inverse Voltage	50V	V_F t_{rr}	UTX105 1.00 @ .5A 75ns	UTX205 1.0V @ 1A 75ns	SES5001 .975 @ 1A 100ns	UTX3105 1V @ 2A 100ns	UTX4105 1V @ 3A 100ns
	100V	V_F t_{rr}	UTX110 1.0V @ .5A 75ns	UTX210 1.0V @ 1A 75ns	SES5002 .975 @ 1A 100ns	UTX3110 1.0V @ 2A 100ns	UTX4110 1.0V @ 3A 100ns
	150V	V_F t_{rr}	UTX115 1.00 @ .5A 75ns	UTX215 1.0V @ 1A 75ns	SES5003 .975 @ 1A 100ns	UTX3115 1.0V @ 2A 100ns	UTX4115 1.0V @ 3A 100ns
	200V	V_F t_{rr}	UTX120 1.00 @ 1A 75ns	UTX220 1.0V @ 1A 75ns		UTX3120 1.0V @ 2A 100ns	UTX4120 1.0V @ 3A 100ns
	250V	V_F t_{rr}	UTX125 1.00 @ .5A 75ns	UTX225 1.0V @ 1A 75ns			

Average D.C. Output Current			5A	8A	16A Center-Tap	16A	20A	25A Center-Tap	60A
Package Style			B	TO-220AB	TO-220AC	TO-220AC	DO-4	TO-3	DO-5
Peak Inverse Voltage	50V	V_F t_{rr}	SES5301 .975 @ 5A 100ns	SES5401 1.025 @ 8A 100ns	SES5401C 1.025 @ 8A 100ns	SES5501 1.025 @ 16A 100ns	SES5701 .83 @ 20A 100ns	SES5601C .83 @ 12.5A 100ns	SES5801 .85 @ 60A 100ns
	100V	V_F t_{rr}	SES5302 .975 @ 5A 100ns	SES5402 1.025 @ 8A 100ns	SES5402C 1.025 @ 8A 100ns	SES5502 1.025 @ 16A 100ns	SES5702 .83 @ 20A 100ns	SES5602C .83 @ 12.5A 100ns	SES5802 .85 @ 60A 100ns
	150V	V_F t_{rr}	SES5303 .975 @ 5A 100ns	SES5403 1.025 @ 8A 100ns	SES5403C 1.025 @ 8A 100ns	SES5503 1.02 @ 16A 100ns	SES5703 .83 @ 20A 100ns	SES5603C .83 @ 12.5A 100ns	SES5803 .85 @ 60A 100ns
	200V	V_F t_{rr}		SES5404 1.025 @ 8A 100ns	SES5404C 1.025 @ 8A 100ns	SES5504 1.02 @ 16A 100ns			

A


B


C


TO-3

FAST RECOVERY (t_{rr} — 150 to 500ns)

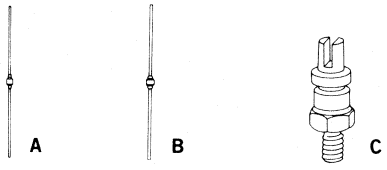
Average D.C. Output Current			1A	1A	2A	3A	3A	4A	6-9A
Package Style			**A**	**A**	**A**	**B**	**B**	**B**	**C**
Peak Inverse Voltage	50V	V_F t_{rr}	UTR01 1.1V @ .5A 250ns		UTR02 1.1V @ 1A 250ns	UTR3305 1.1V @ 3A 250ns	1N5415* 1.5V @ 9A 150ns	UTR4305 1.1V @ 4A 250ns	UTR4405[1] UTR5405[1] UTR6405[1] 1.1V @ 6A 300ns
	100V	V_F t_{rr}	UTR11 1.1V @ .5A 250ns		UTR12 1.1V @ 1A 250ns	UTR3310 1.1V @ 3A 250ns	1N5416* 1N5186** 1.5V @ 9A 150ns	UTR4310 1.1V @ 4A 250ns	UTR4410[1] UTR5410[1] UTR6410[1] 1.1V @ 6A 300ns
	200V	V_F t_{rr}	UTR21 1.1V @ .5A 250ns	1N4942* 1N5615* 1.3V @ 1A 150ns	UTR22 1.1V @ 1A 250ns	UTR3320 1.1V @ 3A 250ns	1N5417* 1N5187** 1.5V @ 9A 150ns	UTR4320 1.1V @ 4A 250ns	UTR4420[1] UTR5420[1] UTR6420[1] 1.1V @ 6A 400ns
	300V	V_F t_{rr}	UTR31 1.1V @ .5A 300ns		UTR32 1.1V @ 1A 300ns				
	400V	V_F t_{rr}	UTR41 1.1V @ .5A 350ns	1N4944* 1N5617* 1.3V @ 1A 150ns	UTR42 1.1V @ 1A 350ns	UTR3340 1.1V @ 3A 300ns	1N5418* 1N5188** 1.5V @ 9A 150ns	UTR4340 1.1V @ 4A 400ns	UTR4440[1] UTR5440[1] UTR6440[1] 1.1V @ 6A 500ns
	500V	V_F t_{rr}	UTR51 1.1V @ .5A 400ns		UTR52 1.1V @ 1A 400ns	UTR3350 1.1V @ 3A 350ns	1N5419* 1.5V @ 9A 250ns	UTR4350 1.1V @ 4A 400ns	
	600V	V_F t_{rr}	UTR61 1.1V @ .5A 400ns	1N4946* 1N5619* 1.3V @ 1A 250ns	UTR62 1.1V @ 1A 400ns	UTR3360 1.1V @ 3A 400ns	1N5420* 1N5190** 1.5V @ 9A 400ns	UTR4360 1.1V @ 4A 400ns	

* Available as JAN, JANTX, JANTXV.
** Available as JAN, JANTX.
1. Available with High Reliability (HR) Screening. See individual datasheets.

BI-SYNCHRONOUS RECTIFIER

Continuous Forward Current		40A
Package Style		**TO-3**
Forward Blocking Voltage, V_{CES}	50V	UBS430
h_{FE}		50
$R_{CE(ON)}$		7mΩ Typical
$V_{BE(SAT)}$		1.2V Typical

RECTIFIERS



STANDARD RECOVERY

Average D.C. Output Current		1A	2A	3A	4A	7.5A	9A	12A
Package Style		A	A	B	B	C	C	C
Peak Inverse Voltage	50V	UR105†	UR205	UT3005	UT4005	UT5105[1]	UT6105[1]	UT8105[1]
	100V	UT236 UT110†	UT261 UT210†	UT3010	UT4010	UT5110[1]	UT6110[1]	UT8110[1]
	150V	UR115†	UR215†					
	200V	UT234 UR120† 1N4245* 1N5614*	UT262 UR220† 1N3611**	UT3020	UT4020 1N5550*	UT5120[1]	UT6120[1]	UT8120[1]
	250V	UR125†	UR225†					
	400V	UT235 1N4246* 1N5616*	UT264 1N3612**	UT3040	UT4040 1N5551*	UT5140[1]	UT6140[1]	UT8140[1]
	600V	UT238 1N4247* 1N5618*	UT267 1N3613**	UT3060	UT4060 1N5552*	UT5160[1]	UT6160[1]	UT8160[1]
	800V	UT361 1N4248* 1N5620*	UT268 1N3614**		1N5553*			
	1000V	UT347 1N4249*	UT364					

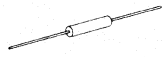
* Available as JAN, JANTX, JANTXV.
** Available as JAN, JANTX.
† Radiation Tolerant
1. Available with High Reliability (HR) Screening. See individual datasheets.

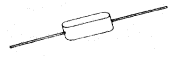
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

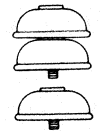
Printed in U.S.A.

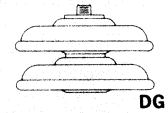
HIGH VOLTAGE RECTIFIERS & RECTIFIER MODULES

PRODUCT SELECTION GUIDE


SA — SM


PC


DD


DG

STANDARD RECOVERY

Peak Inverse Voltage	AVERAGE D.C. OUTPUT CURRENT											
	025- 050A	050- 100A	100- 250A	250- 50A	50- 75A	75- 1A	1- 1.5A	1.5- 2A	2- 3A			
1.0kV			HVE10 **SJ** HS10 **SK** 1N3643 **SJ**			SXS10 **SL**						
1.2kV							(US12) **SA**					
1.5kV			HS15 **SK** HVE15 **SJ** 1N3644 **SJ**			SXS15 **SL** (US15) **SA**				KXS15 **SM**		
1.8kV					(US18) **SA**							
2.0kV			HS20 **SK** HVE20 **SJ** 1N3645 **SJ**		(US20) **SA**	SXS20 **SL**				KXS20 **SM**		
2.5kV			HS25 **SK** HVE25 **SJ** 1N3646 **SJ**		(US25) **SB**	SXS25 **SL**	(USB2.5) **DH**		HVHS 2500 **PC**	KXS25 **SM** (UDB2.5) **DD**	(UDE2.5) **DD**	(UGE2.5) **DG**
3.0kV			HS30 **SK** HVE30 **SJ** 1N3647 **SJ**		SXS30 **SL** (US30) **SB**				KXS30 **SM**			
3.5kV				(US35) **SC**								
4.0kV		HS40 **SK** HVE40 **SJ** 1N5181 **SJ**		(US40) **SC**	SXS40 **SL**				KXS40 **SM**			
4.5kV				(US45A) **SD**								

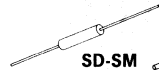
Parentheses ( ) designates product using fused-in-glass single chip rectifiers; all others use stacked chips.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

HIGH VOLTAGE RECTIFIERS & RECTIFIER MODULES

PRODUCT SELECTION GUIDE



Peak Inverse Voltage	AVERAGE D.C. OUTPUT CURRENT											
	.050-.100A	.100-.250A	.250-.50A	.50-.75A	.75-1A	1-1.5A	1.5-2A	2-2.5A	2.5-3A	3-4A	4-5A	5-6A
5.0kV	HS50 **SK** HVE50 **SJ** 1N5182 **SJ**		HVH 5000 **PB** HVHF 5000 **PB** (US50A) **SD**	SXS50 **SL** (USB5) **DH** (USS5) **DH**			(UDA5) **DD** (UDB5) **DD** (1N5600)* **DE**	KXS50 **SM** HVHS 5000 **PC**			(UDE5) **DG** (UGB5) **DD**	(UGE5) **DG** (1N5603)* **DF**
6.0kV			SXS60 **SL** (US60A) **SD**			KXS60 **SM**						
7.0kV			(US70A) **SD**									
7.5kV	HS75 **SK** HVF75 **SJ** 1N5183 **SJ**		HVH 7500 **PB** HVHF 7500 **PB** (USS7.5) **DH**	(USB7.5) **DH**		(UDA7.5) **DD** (UDB7.5) **DD**		HVHS 7500 **PC**	(UGB7.5) **DG**	(UGE7.5) **DG**		
8.0kV		(US80A) **SE**	SXS80 **SL**			KXS80 **SM**						
10kV	HS100 **SK** HVE100 **SJ** 1N5184 **SJ**	(US100A) **SE**	HVH 10000 **PB** HVHF 10000 **PB** SXS100 **SL** (USB10) **DH** (USS10) **DH**	(688-10) **BE**	(UDA10) **DD** * (1N5597) **DE**	KXS100 **SM**		HVHS 10000 **PC** (UGB10) **DG**				
12kV		(US120A) **SE**	(688-12) **BE**									
12.5kV			HVH 12500 **PB** HVHF 12500 **PB**					HVHS 12500 **PC**				

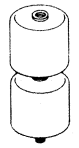
Parentheses ( ) designates product using fused-in-glass single chip rectifiers; all others use stacked chips.
*Available as JAN

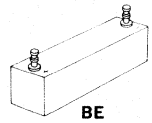
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

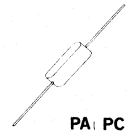
PRINTED IN U.S.A.

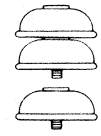
HIGH VOLTAGE RECTIFIERS & RECTIFIER MODULES


DF DG


DH


BE


PA PC


DD DE

STANDARD RECOVERY

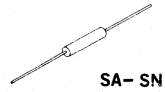
Peak Inverse Voltage	AVERAGE D.C. OUTPUT CURRENT					
	.025-.050A	.050-.100A	.100-.250A	.250-.50A	.50-.75A	2-2.5A
15kV	HVHJ 15K **PA**		(US150A) **SF** (USS15) **DH**	HVH 15000 **PB** HVHF 15000 **PB** (688-15) **BE**	(UDA15) **DD**	HVHS 15000 **PC**
17.5kV						HVHS 17500 **PC**
18kV			(US180A) **SF**	(688-18) **BE**		
20kV	HVHJ 20K **PA**		(US200A) **SF**	HVH 20000 **PB** HVHF 20000 **PB** (688-20) **BE**		HVHS 20000 **PC**
22.5kV	HVHJ 22.5K **PA**					
25kV	HVHJ 25K **PA**		(688-25) **BE**	HVH 25000 **PB** HVHF 25000 **PB**		
30kV	HVHJ 30K **PA**					
35kV	HVHJ 35K **PA**					
37.5kV	HVHJ 37.5K **PA**					
40kV	HVHJ 40K **PA**					
45kV	HVHJ 45K **PA**					
50kV						
60kV						

Parentheses ( ) designates product using fused-in-glass single chip rectifiers; all others use stacked chips.

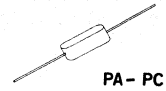
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

HIGH VOLTAGE RECTIFIERS & RECTIFIER MODULES



SA– SN



PA– PC

FAST RECOVERY

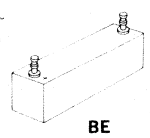
Peak Inverse Voltage	AVERAGE D.C. OUTPUT CURRENT								
	.050-.100A	.100-.250A	.250-.50A	.50-.75A	.75-1.5A	1.5-2A	2-2.5A	2.5-4A	4-6A
1.0kV		HA10* **SK** HVX10* **SJ**			SX10* **SL**				
1.2kV					(USR12) **SA**				
1.5kV		HA15* **SK** HVX15 **SJ**		(USR15) **SA**	SX15* **SL**			KX15* **SM**	
1.8kV				(USR18) **SA**					
2.0kV		HA20* **SK** HVX20* **SJ**		(USR20) **SB**	SX20* **SL**			KX20* **SM**	
2.5kV		HA25* **SK** HVX25* **SJ**	HVF 2500† **PB** (USR25) **SB**		SX25* **SL** (UFB2.5) **DH**		HVFS 2500† **PC** (UDD2.5) **DD**	KX25* **SM**	(UDF2.5) **DD** (UGF2.5) **DG**
3.0kV		HA30* **SK** HVX30* **SJ**	(USR30) **SC**	SX30* **SL**			KX30* **SM**		
3.5kV			(USR35) **SC**						
4.0kV	HA40* **SK** HVX40* **SJ**		(USR40A) **SD**	SX40* **SL**			KX40* **SM**		
4.5kV		(USR45A) **SD**							
Reverse Recovery Time (Max.)	300ns 250ns*	500ns 250ns*	500ns 250ns†	500ns 250ns*	500ns 250ns*	500ns 250ns	500ns 250ns* 150ns†	250ns*	500ns

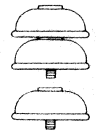
Parentheses ( ) designates product using fused-in-glass single chip rectifiers; all others use stacked chips.

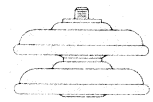
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

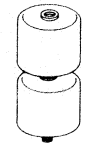
PRINTED IN U.S.A.

HIGH VOLTAGE RECTIFIERS & RECTIFIER MODULES


BE


DD


DG


DH

FAST RECOVERY

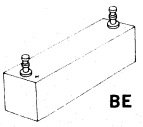
Peak Inverse Voltage	AVERAGE D.C. OUTPUT CURRENT								
	.050-.100A	.100-.250A	.250-.50A	.50-.75A	.75-1A	1-1.5A	1.5-2A	2-2.5A	2.5-4A
5.0kV	HA50 **SK** MVX50 **SJ**	(USR50A) **SD**	HVF 5000† **PB** (UFS5) **DH**	SX50* **SL** (UFB5) **DH**		(UDC5) **DD** (UDD5) **DD**		HVFS 5000† **PC** KX50* **SM**	(UDF5) **DD** (UGD5) **DG** (UGF5) **DG**
6.0kV		(USR60A) **SD**	SX60* **SL**			KX60* **SM**			
7.0kV		(USR70A) **SE**							
7.5kV	HA75 **SK** HVX75 **SJ**		HVF 7500† **PB** (UFB7.5) **DH** (UFS7.5) **DH**		(UDC7.5) **DD** (UDD7.5) **DD**			HVFS 7500† **PC** (UGD7.5) **DG** (UGF7.5) **DG**	
8.0kV		(USR80A) **SE**	SX80* **SL**			KX80* **SM**			
10kV	HA100 **SK** HVX100 **SJ**	(USR100A) **SE**	HVF 10000† **PB** SX100* **SL** (UFS10) **DH**	(UDC10) **DD** (688-10R) **BE**		KX100* **SM**	(UGD10) **DG**	HVFS 10000† **PC**	
12kV		(USR120A) **SF**	(688-12R) **BE**						
12.5kV			HVF 12500† **PB**						HVFS 12500† **PC**
Reverse Recovery Time (Max.)	250ns	500ns	500ns 250ns* 150ns†	500ns 250ns*	500ns 250ns*	500ns 250ns*	500ns 250ns*	500ns 250ns* 150ns†	500ns

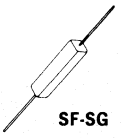
Parentheses ( ) designates product using fused-in-glass single chip rectifiers; all others use stacked chips.

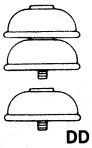
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

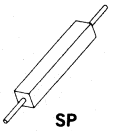
PRINTED IN U.S.A.

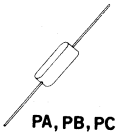
HIGH VOLTAGE RECTIFIERS & RECTIFIER MODULES


BE


SF-SG


DD


SP


PA, PB, PC

FAST RECOVERY

Peak Inverse Voltage	AVERAGE D.C. OUTPUT CURRENT					
	025-.100A	100-.250A	250-.75A	.75-1.5A	1.5-2A	2-2.5A
15kV	HVJX 15K **PA**	(USR150A) **SF**	HVF 15000† **PB** (UDC15) **DD** (688-15R) **BE**			HVFS 15000 **PC**
17.5kV						HVFS 17500 **PC**
18kV		(USR180A) **SF**	(688-18R) **BE**			
20kV	HVJX 20K **PA**	(688-20R) **BE**	HVF 20000† **PB**			HVFS 20000 **PC**
22.5kV	HVJX 22.5K **PA**					
25kV	HVJX 25K **PA**	(688-25R) **BE**	HVF 25000† **PB**			
30kV	HVJX 30K **PA**					
35kV	HVJX 35K **PA**					
37.5kV	HVJX 37.5K **PA**					
40kV	HVJX 40K **PA**					
45kV	HVJX 45K **PA**					
50kV						
60kV						
Reverse Recovery Time (Max.)	250ns	500ns	500ns 150ns†	250ns	250ns	150ns

Parentheses ( ) designates product using fused-in-glass single chip rectifiers; all others use stacked chips.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER BRIDGES

Single Phase Full-Wave Bridges

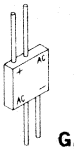
PRODUCT SELECTION GUIDE



HJ, HK, HL, HM, HN, HO, HP



S



G, GA, GH

STANDARD RECOVERY

Peak Inverse Voltage Per Leg	AVERAGE D.C. OUTPUT CURRENT					
	≤.25A	.25—.75A	.75—1.5A	1.5—2.5A	4—10A	10—25A
100V			673-1 **G or S**	697-1 **GA**	680-1 **NA**	679-1 **NB** SPA25* **MC**
200V			673-2 **G or S**	697-2 **GA**	680-2 **NA** 469-1** **MD**	679-2 **NB** SPB25* **MC**
300V			673-3 **G or S**	697-3 **GA**	680-3 **NA**	679-3 **NB**
400V			673-4 **G or S**	697-4 **GA**	680-4 **NA** 469-2** **MD**	679-4 **NB** SPC25* **MC**
500V			673-5 **G or S**	697-5 **GA**	680-5 **NA**	679-5 **NB**
600V			673-6 **G or S**	697-6 **GA**	680-6 **NA** 469-3** **MD**	679-6 **NB** SPD25* **MC**
1.2kV		673-7 **GH**				
1.8kV		673-75 **HJ**				
2.4kV		673-8 **HK**				
2.5kV						
3.0kV		673-85 **HL**				
3.6kV	673-9 **HM**					
4.0kV						
4.2kV	673-10 **HN**					
4.8kV	673-11 **HO**					
5.0kV	673-12 **HO**					
7.5kV						
10kV						
15kV						

*Available as JAN

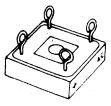
**Available as JAN, JANTX

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

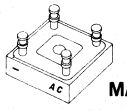
PRINTED IN U.S.A.

RECTIFIER BRIDGES

Single Phase Full-Wave Bridges



NA, NB



MA, MB, MC, MD

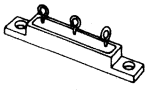
FAST RECOVERY

Peak Inverse Voltage Per Leg	AVERAGE D.C. OUTPUT CURRENT							
	≤.25A	.25—.75A	.75—1.5A	1.5—2.5A	4—10A	10—25A		25—35A
50V							803-1 **MB**	802-1 **MA**
100V			676-1 **G or S**	698-1 **GA**	684-1 **NA**	683-1 **NB**	803-2 **MB**	802-2 **MA**
125V							803-3 **MB**	802-3 **MA**
150V							803-4 **MB**	802-4 **MA**
200V			676-2 **G or S**	698-2 **GA**	684-2 **NA**	683-2 **NB**		
300V			676-3 **G or S**	698-3 **GA**	684-3 **NA**	683-3 **NB**		
400V			676-4 **G or S**	698-4 **GA**	684-4 **NA**	683-4 **NB**		
500V			676-5 **G or S**	698-5 **GA**	684-5 **NA**	683-5 **NB**		
600V			676-6 **G or S**	698-6 **GA**	684-6 **NA**	683-6 **NB**		
1.2kV		676-12 **HJ**						
1.8kV		676-18 **HK**						
2.4kV		676-24 **HL**						
2.5kV								
3.0kV		676-30 **HM**						
3.6kV	676-36 **HN**							
4.0kV								
4.2kV	676-42 **HO**							
4.8kV	676-48 **HP**							
5.0kV	676-50 **HP**							
7.5kV								
10kV								
15kV								
Reverse Recovery Time (max.)	500ns	500ns	500ns	500ns	500ns	500ns	50ns	50ns

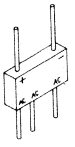
PRINTED IN U.S.A.

RECTIFIER BRIDGES

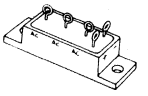
Three Phase Full-Wave Bridge



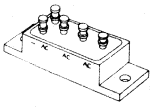
ND



F



NC



ME

ANDARD RECOVERY

Peak Inverse Voltage Per Leg	AVERAGE D.C. OUTPUT CURRENT			
	1–3A	4.5–15A	15–25A	
50V				
100V	700-1 **F**	695-1 **NC**	678-1 **NC**	
125V				
150V				
200V	700-2 **F**	695-2 **NC**	678-2 **NC**	483-1* **ME**
300V	700-3 **F**	695-3 **NC**	678-3 **NC**	
400V	700-4 **F**	695-4 **NC**	678-4 **NC**	483-2* **ME**
500V	700-5 **F**	695-5 **NC**	678-5 **NC**	
600V	700-6 **F**	695-6 **NC**	678-6 **NC**	483-3* **ME**
2.5kV				
5.0kV				
7.5kV				
10kV				

vailable as JANTX

FAST RECOVERY

Peak Inverse Voltage Per Leg	AVERAGE D.C. OUTPUT CURRENT				
	1–3A	4.5–15A	15–25A		25–40A
50V				801-1 **ME**	800-1 **ME**
100V	701-1 **F**	696-1 **NC**	682-1 **NC**	801-2 **ME**	800-2 **ME**
125V				801-3 **ME**	800-3 **ME**
150V				801-4 **ME**	800-4 **ME**
200V	701-2 **F**	696-2 **NC**	682-2 **NC**		
300V	701-3 **F**	696-3 **NC**	682-3 **NC**		
400V	701-4 **F**	696-4 **NC**	682-4 **NC**		
500V	701-5 **F**	696-5 **NC**	682-5 **NC**		
600V	701-6 **F**	696-6 **NC**	682-6 **NC**		
2.5kV					
3.0kV					
4.0kV					
5.0kV					
Reverse Recovery Time (max.)	500ns	500ns	500ns	50ns	50ns

DOUBLERS & CENTER-TAP RECTIFIERS

STANDARD RECOVERY ND

Peak Inverse Voltage Per Leg	Average D.C. Output Current
	2–15A
100V	681-1 **ND**
200V	681-2 **ND**
300V	681-3 **ND**
400V	681-4 **ND**
500V	681-5 **ND**
600V	681-6 **ND**

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

Single Phase Bridges, 10 Amp, Military Approved

JAN & JANTX 469-1
JAN & JANTX 469-2
JAN & JANTX 469-3

FEATURES

- Qualified to MIL-S-19500/469
- Current Rating: to 10A
- PIV: from 200 to 600V
- Surge Ratings: to 100A
- Only Fused-in-Glass Diodes Used
- Controlled Avalanche Characteristics
- Aluminum Heat Sink Case, Electrically Insulated

DESCRIPTION

This series of military high-current single-phase bridge offer the utmost in reliability as required in military system designs. The TX series is assembled with diodes which have been subjected to 100% screening tests.

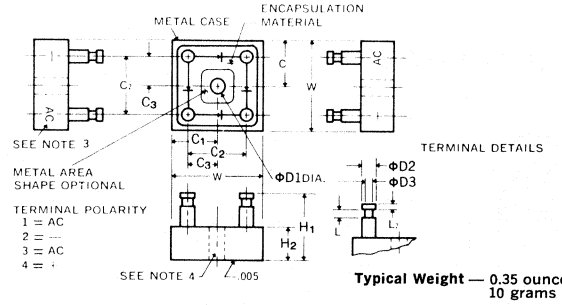
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	200 to 600V
Maximum Average D.C. Output Current	
@ $T_C = +55°C$	10A
@ $T_C = +100°C$	6A
Non-Repetitive Sinusoidal Surge (8.3ms)	
@ $T_C = +55°C$	100A
Operating and Storage Temperature Range	−65°C to +150°C
Thermal Resistance Junction to Ambient	25°C/W
Junction to Case	5°C/W

Ltr	Dimensions			
	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
C_1	.367	.375	9.32	9.53
C_2	.350	.450	8.89	11.43
C_3	.175	.225	4.45	5.72
ϕD_1	.139	.149	3.53	3.78
ϕD_2	.091	.101	2.31	2.57
ϕD_3	.066	.076	1.68	1.93
H_1		.570		14.48
H_2		.370		9.40
L_1	.088	.098	2.24	2.49
L_2	.020	.030	.51	.76
W	.735	.750	18.67	19.05

MECHANICAL SPECIFICATIONS

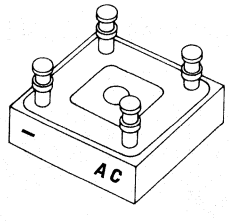
JAN & JANTX 469-1, JAN & JANTX 469-2, JAN & JANTX 469-3



See table above

Typical Weight — 0.35 ounces 10 grams

MD



NOTES:

1. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.
2. Terminals shall be tinned.
3. Polarity shall be marked on the bridge body adjacent to terminals. Terminal numbers are for reference and do not have to be marked on the bridge; however, terminal (1) shall be indicated by a mechanical index such as a line, flattened corner, etc., visible from the top (terminal surface) of the device.
4. Point at which T_C is read shall be in metal part of a case as shown on drawing.

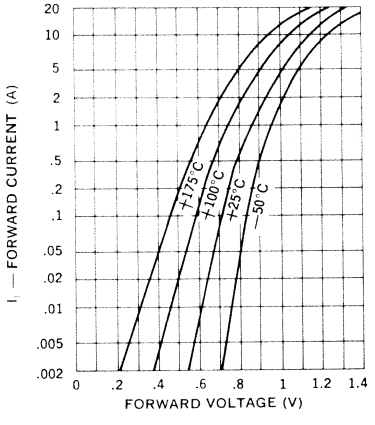
UNITRODE

Electrical Specification (at 25°C unless noted)

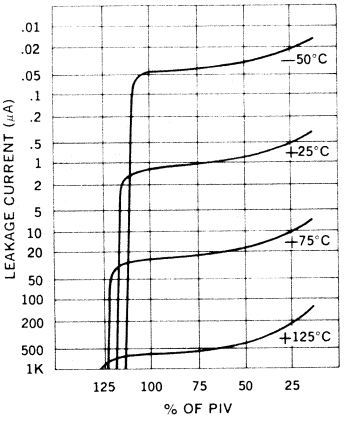
Type	PIV Per Leg	Minimum Reverse Breakdown Voltage Per Leg @ 50 μA	Maximum Forward Voltage Drop Per Leg*	Maximum Reverse Recovery Time†	Maximum Leakage Current Per Leg @ PIV	
					T_c = 25°C	T_c = 100°C
	Volts	Volts		μS	μA	μA
JAN & JANTX 469-1	200	240	1.35V @ 15.7A(pk)	2	2	125
JAN & JANTX 469-2	400	460				
JAN & JANTX 469-3	600	660				

*Maximum forward voltage drop is measured at a pulse width of 8.3ms.
†Measured in a reverse-recovery circuit switching from 0.5A forward to 1.0A reverse current recovering to 0.25A.

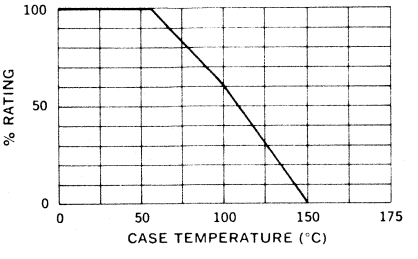
Typical Forward Voltage Per Leg vs. Forward Current

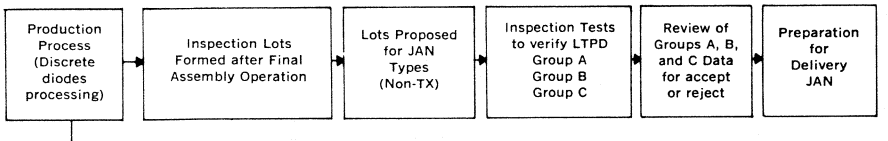


Typical Leakage Current vs. PIV



Current Derating Curve





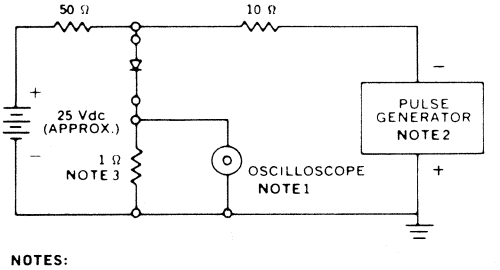
100 Percent Process Conditioning

1. High temperature storage
2. Thermal shock
3. Acceleration
4. Hermetic seal tests

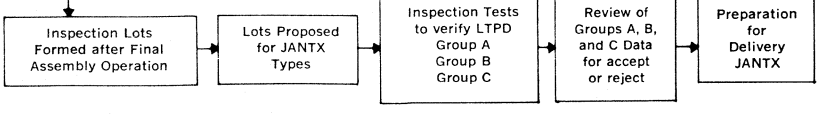
100 Percent Power Conditioning

1. Measurement of specified parameters
2. Burn-in
3. Measurement of specified parameters to determine delta and other rejects
4. Scope display evaluation
5. Lot rejection criteria based on rejects from burn-in test

Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ⩽ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ⩽ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

Three Phase Bridges, 25 Amp, Military Approved

JANTX 483-1
JANTX 483-2
JANTX 483-3

FEATURES

- Qualified to MIL-S-19500/483
- Current Rating: 25A
- PIV: from 200 to 600V
- Surge Ratings: 150A
- Only Fused-in-Glass Diodes Used
- Controlled Avalanche Characteristics
- Aluminum Heat Sink Case, Electrically Insulated

DESCRIPTION

This military high-current three phase bridge series is assembled with diodes which have been subjected to TX type screening tests. This series of bridges offers the utmost in high reliability as normally required in military system design.

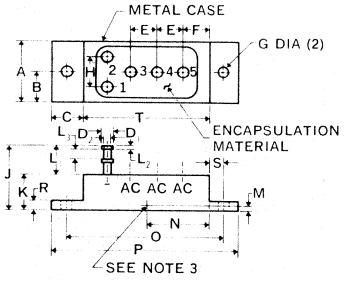
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	200 to 600V
Maximum Average D.C. Output Current	
@ T_C = 55°C	25A
@ T_C = 100°C	18.5A
Non-Repetitive Sinusoidal Surge (8.3ms)	
@ T_C = 55°C	150A
Operating and Storage Temperature Range	−65°C to +150°C
Thermal Resistance Junction to Ambient	20°C/W
Junction to Case	2.5°C/W

LTR	DIMENSIONS			
	INCH		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.730	.770	18.54	19.56
B	.355	.395	9.02	10.03
C	.355	.395	9.02	10.03
D_1	.141	.151	3.58	3.84
D_2	.108	.118	2.74	3.00
E	.355	.395	9.02	10.03
F	.230	.270	5.84	6.86
G	.149	.189	3.78	4.80
H	.355	.395	9.02	10.03
J		.82		20.83
K	.39	.51	9.91	12.95
L_1	.240	.320	6.10	8.13
L_2	.015	.030	.38	.76
L_3	.100	.125	2.54	3.18
M	.040	.060	1.02	1.52
N	.72	.78	18.29	19.81
O	1.84	1.90	46.74	48.26
P	2.22	2.28	56.39	57.91
R	.09	.15	2.29	3.81
S	.168	.208	4.27	5.28
T	1.47	1.53	37.34	38.86

MECHANICAL SPECIFICATIONS

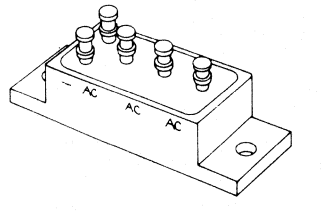
JANTX 483-1 JANTX 483-2 JANTX 483-3



See Table Above

Typical Weight — 1.0 ounces 30 grams

ME



NOTES:
1. Terminals shall be tinned.
2. Polarity shall be marked as shown on drawing.
3. Point at which T_C is read (shall be in metal part of case).

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

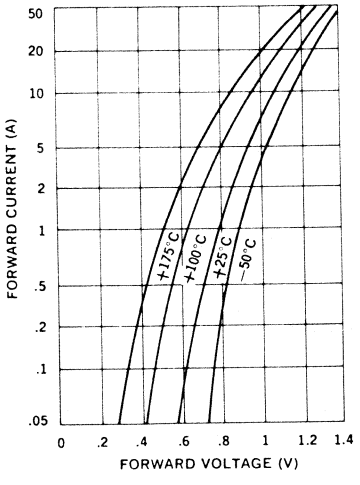
PRINTED IN U.S.A.

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

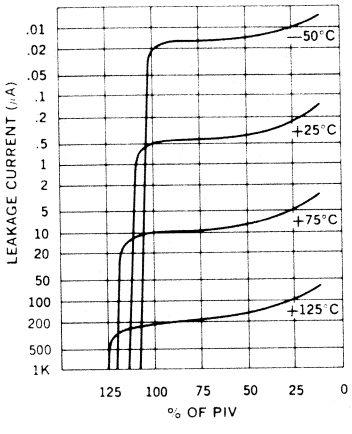
Type	PIV Per Leg	Breakdown Voltage Per Leg @ 50μA	Maximum Forward Voltage Drop Per Leg*	Maximum Leakage Current Per Leg @ PIV	
				$T_C = 25°C$	$T_C = 100°C$
	Volts	Volts		μA	μA
JANTX 483-1	200	240	1.3V @ 39A (pk)	2	200
JANTX 483-2	400	480			
JANTX 483-3	600	660			

* Maximum forward voltage drop is measured at a pulse width of 8.3ms, duty cycle ≤2%.

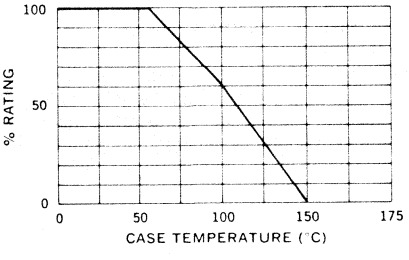
Typical Forward Voltage Per Leg vs. Forward Current

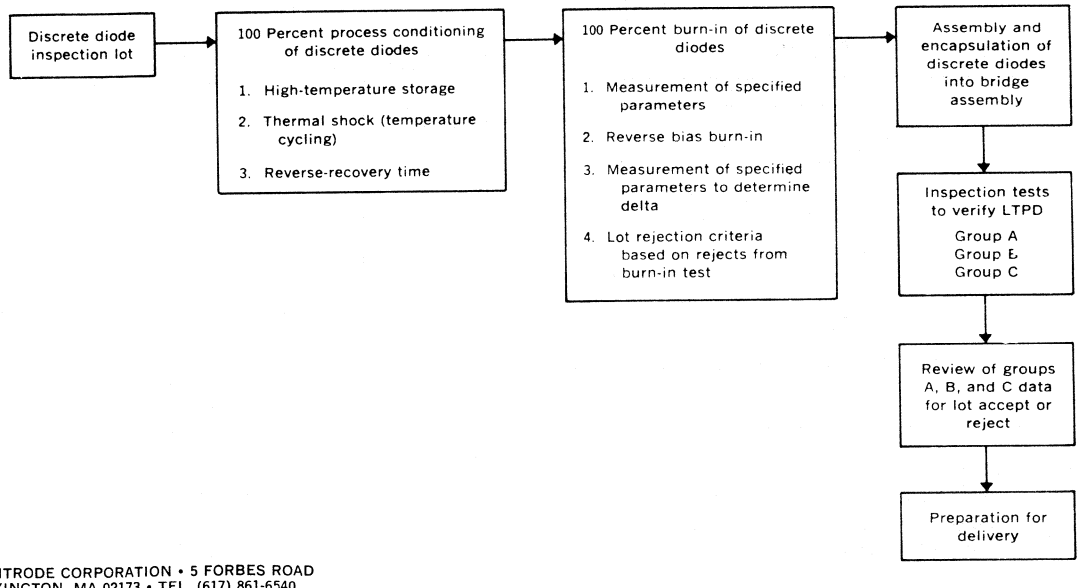


Typical Leakage Current vs. PIV



Current Derating Curve





UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

673, 676 SERIES

Single Phase Bridges, 1.5Amp, Standard and Fast Recovery

FEATURES

- Miniature Package
- Surge Ratings: to 25A
- PIV's: from 100 to 600V
- Recovery Times: to 500ns
- Controlled Avalanche Characteristics
- Only Fused-in-Glass Diodes Used

DESCRIPTION

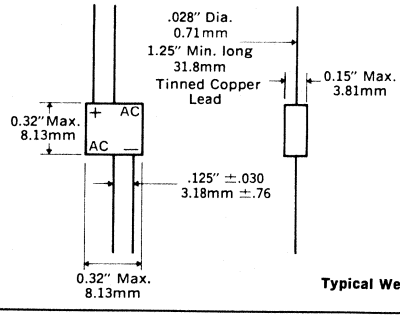
These miniature transfer-molded single-phase power bridges are designed for universal application in power supplies. One basic bridge assembly comes in a choice of lead configurations for mounting in wired chassis or on printed boards.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	100 to 600V
Maximum Average D.C. Output Current	See Electrical Specifications
Non-Repetitive Sinusoidal Surge (8.3mS)	See Electrical Specifications
Operating and Storage Temperature Range	—65°C to +150°C
Thermal Resistance Junction to Ambient	50°C/W

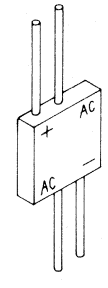
MECHANICAL SPECIFICATIONS

673, 676 SERIES

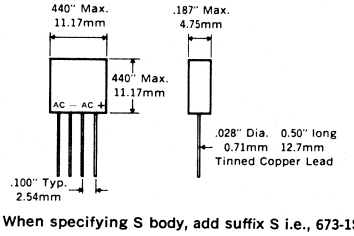


Typical Weight G: 0.05 ounces 1.4 grams

G BODY



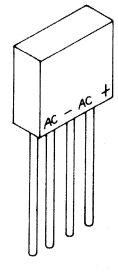
673, 676 SERIES



When specifying S body, add suffix S i.e., 673-1S

Typical Weight S: 0.11 ounces 3.1 grams

S BODY



MARKING

Alternating Current Input	A.C.
Cathode — Positive Output	+
Anode — Negative	—

Part number is printed on the body.

UNITRODE

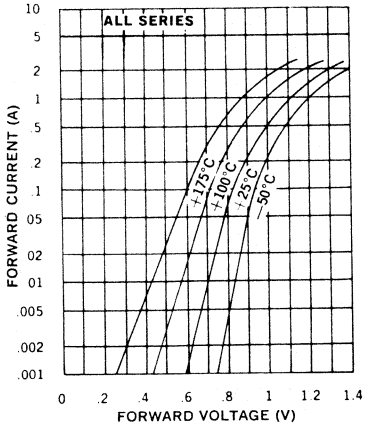
Type		PIV Per Leg	Maximum Forward Drop Per Leg	Leakage Current Per Leg $T_A = 25°C$	Leakage Current Per Leg $T_A = 100°C$	Maximum Reverse Recovery Time†	Maximum Ratings: Maximum Average D.C. Output Current $T_A = 25°C$	Maximum Ratings: Non-Repetitive Sinusoidal Surge (8.3mS)
		Volts		μA	μA	nS	Amps	Amps
Standard Recovery	673-1	100	1.1V @ 1.0A	2	100	—	1.5	25
	673-2	200						
	673-3	300						
	673-4	400						
	673-5	500						
	673-6	600						
Fast Recovery	676-1	100	1.1V @ 0.5A	3	150	500	1.0	20
	676-2	200						
	676-3	300						
	676-4	400						
	676-5	500						
	676-6	600						

Electrical Specifications (at 25°C unless noted) | **Maximum Ratings**

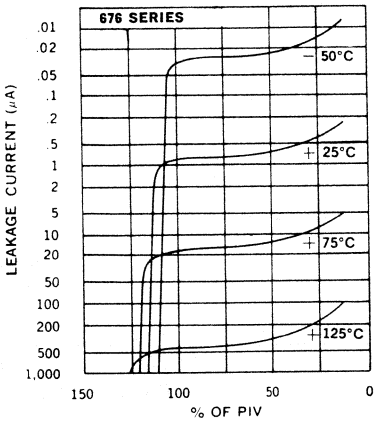
†Measured in a reverse recovery circuit switching from 10mA forward to 10mA reverse current recovering to 5mA.

5

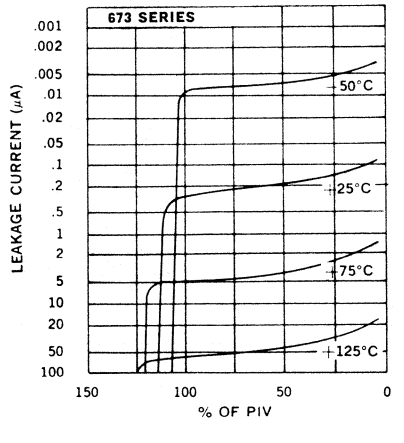
Typical Forward Voltage Per Leg vs. Forward Current



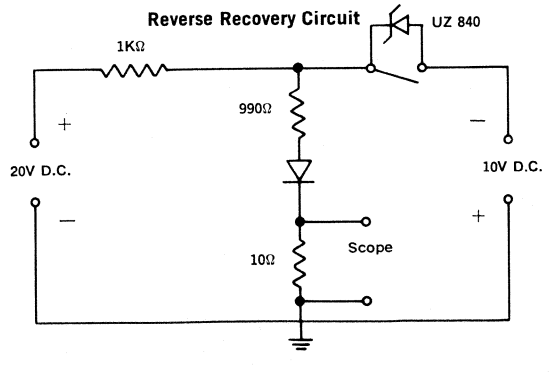
Typical Leakage Current vs. PIV



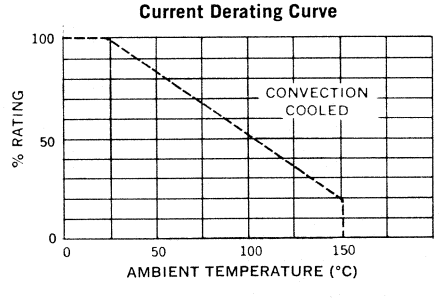
Typical Leakage Current vs. PIV



Reverse Recovery Circuit



Current Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

Single Phase Bridges, High Voltage
0.125-0.6 Amp, Standard and Fast Recovery

673, 676 SERIES
(1200-5000V)

FEATURES

- Miniature High Voltage Bridges
- Continuous Ratings: to 0.6A
- Surge Ratings: to 15A
- PIV's: from 1200 to 5000V
- Recovery Times: to 500ns
- Controlled Avalanche Characteristics
- Only Fused in Glass Diodes Used

DESCRIPTION

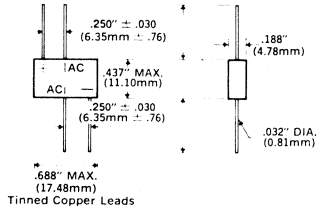
These miniature molded high-voltage single phase bridges are designed for universal application in power supplies. The miniature package is shatterproof and is capable of handling extremes in temperature, vibration and shock. These bridges, therefore are ideally suited for miniaturized, tightly packaged equipment operating in extreme environments.

ABSOLUTE MAXIMUM RATINGS

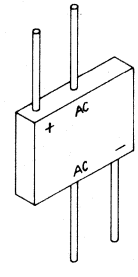
Peak Inverse Voltage	1200 to 5000V
Maximum Average D.C. Output Current	See Electrical Specifications
Non-repetitive Sinusoidal Surge (8.3ms)	See Electrical Specifications
Operating and Storage Temperature Range	−65°C to +150°C
Thermal Resistance Junction-to-Ambient	50°C/W

MECHANICAL SPECIFICATIONS

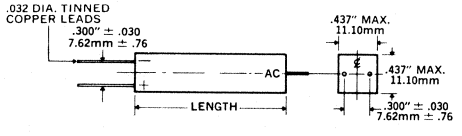
673-7



Body H



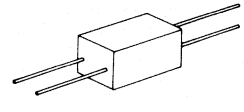
673, 676 SERIES



MAX. LENGTHS

J	K	L	M	N	O	P
.562" 14.27mm	.688" 17.48mm	.875" 22.23mm	1.125" 28.58mm	1.25" 31.75mm	1.375" 34.92mm	1.625" 41.28mm

BODY J through P



MARKING

Alternating Current Input	A.C.
Cathode — Positive Output	+
Anode — Negative Output	—

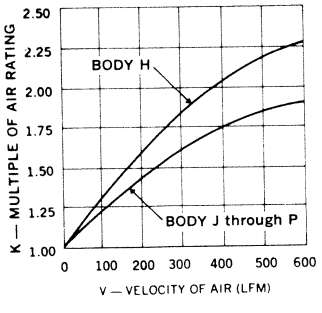
Part number is printed on the body.

UNITRODE

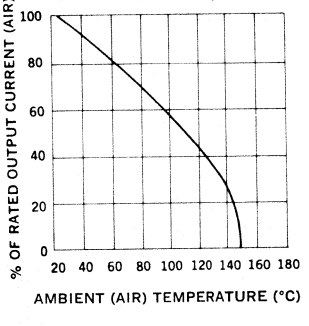
Type		Electrical Specifications at 25°C						Maximum Ratings		
		PIV Per Leg	Maximum Forward Voltage Drop Per Leg	Leakage Current Per Leg @ PIV		Maximum Reverse Recovery Time*	Body Size	Maximum Average D.C. Output Current		Non-repetitive Sinusoidal Surge (8.3ms)
				$T_A = 25°C$	$T_A = 100°C$			$T_A = 25°C$ Air	$T_A = 50°C$ Oil	
		Volts		μA	μA	ns		Amps	Amps	Amps
Standard Recovery	673-7	1200	2.2V @ 0.4A	2	100		H	0.6	1.5	15
	673-75	1800	3.3V @ 0.4A				J	0.5	1.25	
	673-8	2400	4.4V @ 0.4A				K	0.4	1.0	
	673-85	3000	5.5V @ 0.3A				L	0.3	0.75	
	673-9	3600	6.6V @ 0.2A				M	0.2	0.5	
	673-10	4200	7.7V @ 0.2A				N	0.18	0.45	
	673-11	4800	8.8V @ 0.15A				O	0.16	0.4	
	673-12	5000	9.0V @ 0.15A				O	0.16	0.4	
Fast Recovery	676-12	1200	3.3V @ 0.3A	5	150	500	J	0.4	1.0	10
	676-18	1800	4.4V @ 0.2A				K	0.35	0.85	
	676-24	2400	5.5V @ 0.2A				L	0.325	0.8	
	676-30	3000	7.7V @ 0.2A				M	0.25	0.625	
	676-36	3600	8.8V @ 0.15A				N	0.175	0.425	
	676-42	4200	9.9V @ 0.15A				O	0.15	0.375	
	676-48	4800	11V @ 0.15A				P	0.135	0.325	
	676-50	5000	11V @ 0.15A				P	0.125	0.3	

†Measured in a reverse recovery circuit switching from 10mA forward to 10mA reverse current recovering to 5mA.

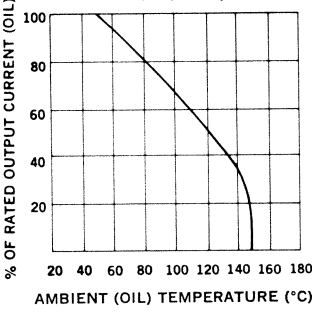
Output Current Ratio vs Velocity of Air Flow



Output Current vs Ambient (Air) Temperature

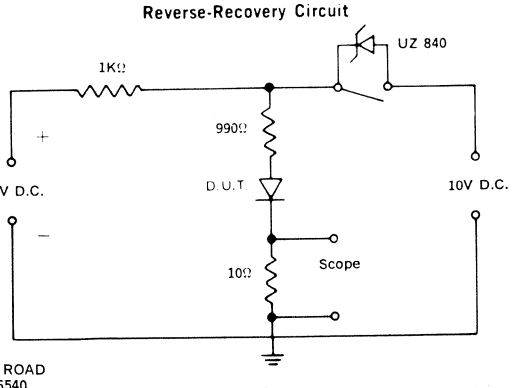


Output Current vs Ambient (Oil) Temperature



Application example: The rectifier is to be used in a cabinet at 60°C with ambient air moving at 400 LFM. The rating is reduced (Fig. 2) by a factor of 0.81 due to the elevated temperature, but is enhanced by 2.X (Fig. 1) due to the air flow. Hence the DC output current is 0.81 x 2, or 1.6 times the 25°C air rating.

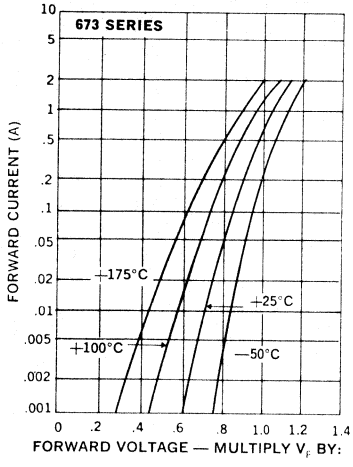
Reverse-Recovery Circuit



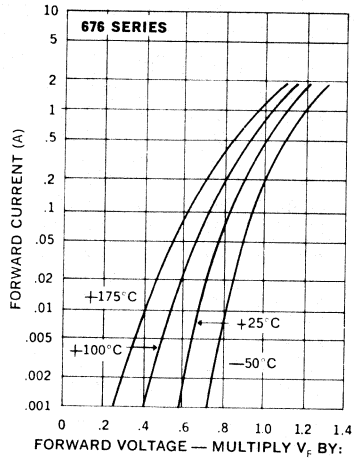
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

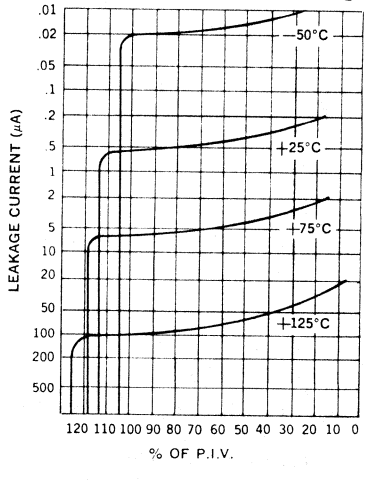
Typical Forward Voltage vs Forward Current



Typical Forward Voltage vs Forward Current



Typical Leakage Current vs. Voltage



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

Three Phase Bridges, 15-25 Amp, Standard and Fast Recovery Magnum®

678, 682, 695
696 SERIES

5

FEATURES

- Current Rating: to 25A
- PIVs: from 100 to 600V
- Only Fused-in-Glass Diodes Used
- Recovery Times: to 500ns
- Controlled Avalanche Characteristics
- Surge Ratings: to 150A
- Aluminum Heat Sink Case, Electrically Insulated

DESCRIPTION

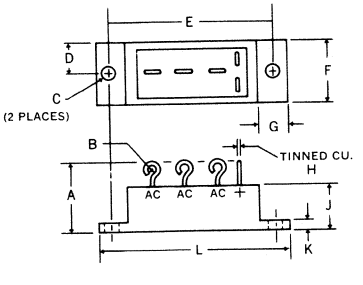
This series of three phase MAGNUM® bridges offer the ultimate in high current power supply applications. The fast recovery series allows operation at full power at high frequencies (up to 40KHz squarewave), often used in choppers, inverters and converters in aircraft, missiles, etc., equipment.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	100 to 600V
Maximum Average D.C. Output Current	See Electrical Specifications
Non-Repetitive Sinusoidal Surge (8.3ms)	See Electrical Specifications
Operating and Storage Temperature Range	—65°C to +150°C
Thermal Resistance Junction to Ambient, All Series	20°C/W
Junction to Case, 678, 682 Series	1.5°C/W
Junction to Case, 695, 696 Series	3.0°C/W

MECHANICAL SPECIFICATIONS

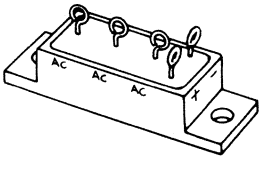
678, 682, 695, 696 SERIES



	ins.	mm.
A	.820 MAX.	20.83 MAX.
B	.09 DIA. TYP.	2.29 DIA. TYP.
C	.164-.174 DIA.	4.17-4.42 DIA.
D	.365-.385	9.27-9.78
E	1.870-1.880	47.50-47.75
F	.740-.760	18.80-19.30
G	.370-.390	9.40-9.91
H	.040 TYP.	1.02 TYP
J	.486-.506	12.34-12.85
K	.115-.135	2.92-3.43
L	2.240-2.260	56.90-57.40

Typical Weight — 30 grams

NC



MARKING

Alternating Current Input	A.C.
Cathode — Positive Output	+
Anode — Negative	—

Part number is printed on the body.

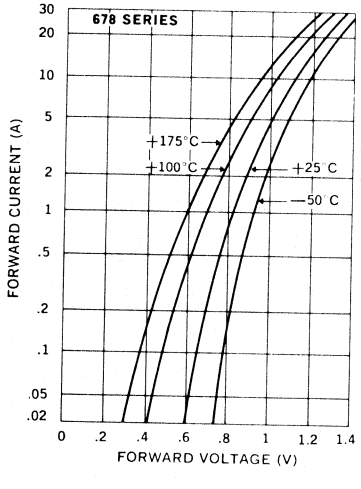
Magnum® is a registered trademark of Unitrode Corporation

UNITRODE

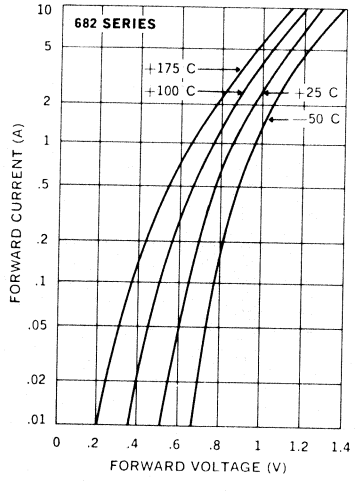
Electrical Specifications (at 25°C unless noted)							Maximum Ratings		
Type		PIV Per Leg	Maximum Forward Voltage Drop Per Leg	Maximum Leakage Current Per Leg @ PIV		Maximum Reverse Recovery Time*	Maximum Average D.C. Output Current		Non-Repetitive Sinusoidal Surge (8.3ms)
				$T_A = 25°C$	$T_A = 100°C$		$T_C = 55°C$	$T_C = 100°C$	$T_A = 100°C$
		Volts		μA	μA	ns	Amps	Amps	Amps
Standard Recovery	678-1	100	1.2V @ 10A	10	200	—	25	18.5	150
	678-2	200							
	678-3	300							
	678-4	400							
	678-5	500							
	678-6	600							
Standard Recovery	695-1	100	1.2V @ 2A	5	150	—	15	9	80
	695-2	200							
	695-3	300							
	695-4	400							
	695-5	500							
	695-6	600							
Fast Recovery	682-1	100	1.2V @ 6A	10	200	500	20	14	150
	682-2	200							
	682-3	300							
	682-4	400							
	682-5	500							
	682-6	600							
Fast Recovery	696-1	100	1.2V @ 2A	5	150	500	15	9	60
	696-2	200							
	696-3	300							
	696-4	400							
	696-5	500							
	696-6	600							

*Measured in a reverse recovery circuit switching from 1.0A forward to 1.0A reverse current recovering to 0.5A.

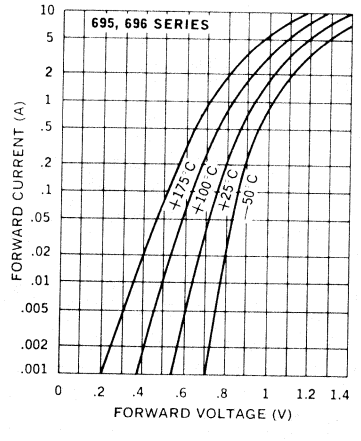
Typical Forward Voltage Per Leg vs. Forward Current



Typical Forward Voltage Per Leg vs. Forward Current



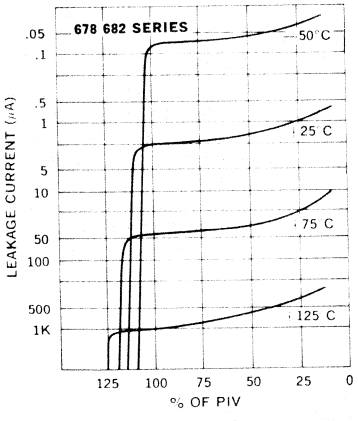
Typical Forward Voltage Per Leg vs. Forward Current



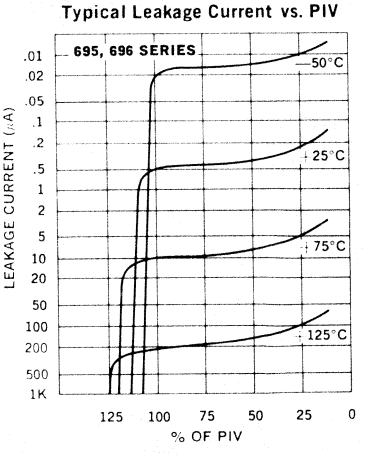
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

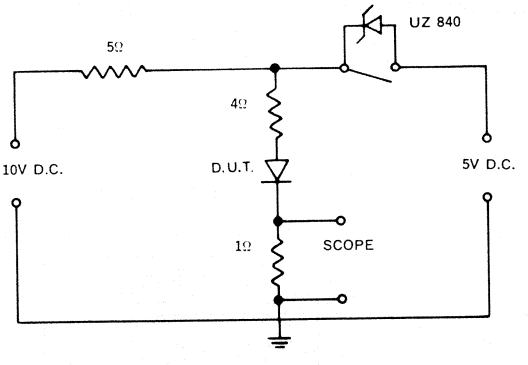
Typical Leakage Current vs. PIV



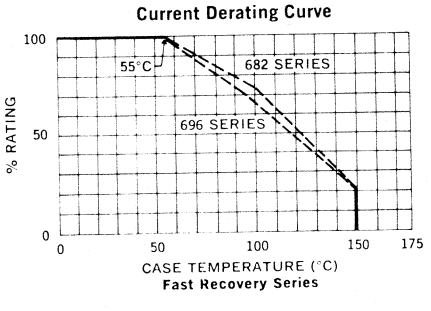
Typical Leakage Current vs. PIV



Reverse Recovery Circuit

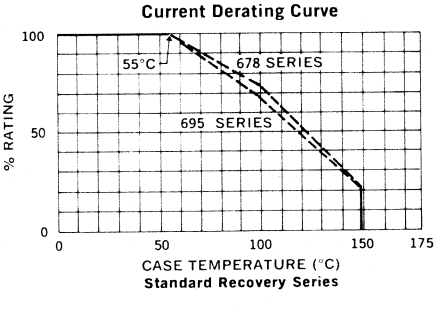


Current Derating Curve



Fast Recovery Series

Current Derating Curve



Standard Recovery Series

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

679, 680, 683, 684 SERIES

Single Phase Bridges, 10-25 Amp, Standard and Fast Recovery Magnum™

FEATURES

- Current Ratings: to 25A
- Recovery Time: to 500ns
- PIVs: from 100 to 600V
- Surge Ratings: to 150A
- Only Fused-in-Glass Diodes Used
- Controlled Avalanche Characteristics
- Aluminum Heat Sink Case, Electrically Insulated

DESCRIPTION

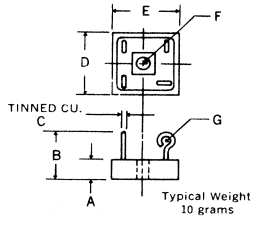
This series of single phase MAGNUM™ bridge offers the designer the ultimate in high current power supply applications. The fast recovery series allows operation at full power at high frequencies, up to 40kHz square wave, which is often used in chopper, inverters and converters in aircraft, missiles, etc., equipment.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	100 to 600V
Maximum Average D.C. Output Current	See Electrical Specifications
Non-Repetitive Sinusoidal Surge (8.3ms)	See Electrical Specifications
Operating and Storage Temperature Range	−65°C to +150°C
Thermal Resistance Junction to Ambient, 679, 683 Series	20°C/W
Junction to Ambient, 680, 684 Series	25°C/W
Junction to Case, 679, 683 Series	2.0°C/W
Junction to Case, 680, 684 Series	4.0°C/W

MECHANICAL SPECIFICATIONS

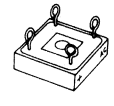
680, 684 SERIES



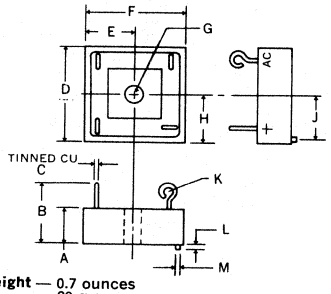
	ins.	mm.
A	.240 MAX.	6.10 MAX.
B	.57 MAX.	14.45 MAX.
C	.040 TYP.	1.02 TYP.
D	.750 MAX.	19.05 MAX.
E	.750 MAX.	19.05 MAX.
F	.140 DIA.	3.56 DIA.
G	.09 DIA. TYP.	2.29 DIA. TYP.

Typical Weight — 0.35 ounces
10 grams

NA



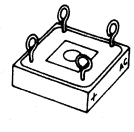
679, 683 SERIES



	ins.	mm.
A	.328 MAX.	8.33 MAX.
B	.750 MAX.	19.05 MAX.
C	.040 TYP.	1.02 TYP.
D	1.125 MAX.	28.58 MAX.
E	.562	14.27
F	1.125 MAX.	28.58 MAX.
G	.193	4.90
H	.562	14.27
J	.500	12.70
K	.09 DIA. TYP.	2.29 DIA. TYP.
L	.062	1.57
M	.062	1.57

Typical Weight — 0.7 ounces
20 grams

NB



MARKING

Alternating Current Input	A.C.
Cathode — Positive Output	+
Anode — Negative	—

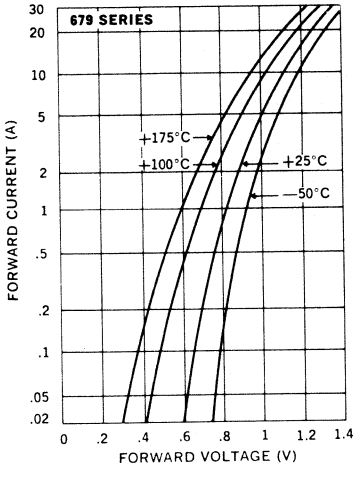
Part number is printed on the body.

UNITRODE

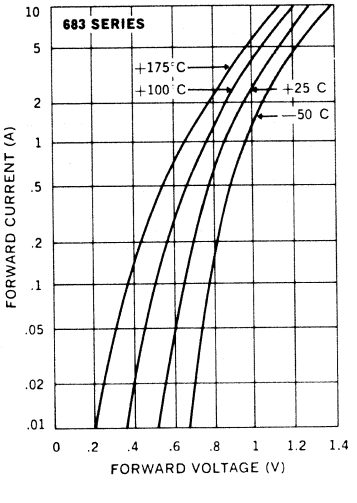
Electrical Specifications (at 25°C unless noted)							Maximum Ratings		
Type		PIV Per Leg	Maximum Forward Voltage Drop Per Leg	Maximum Leakage Current Per Leg @ PIV		Maximum Reverse Recovery Time*	Maximum Average D.C. Output Current		Non-Repetitive Sinusoidal Surge (8.3ms)
				$T_A = 25°C$	$T_A = 100°C$		$T_C = 55°C$	$T_C = 100°C$	$T_A = 100°C$
		Volts		μA	μA	ns	Amps	Amps	Amps
Standard Recovery	679-1	100	1.2V @ 10A	10	200	—	25	18.5	150
	679-2	200							
	679-3	300							
	679-4	400							
	679-5	500							
	679-6	600							
Standard Recovery	680-1	100	1.2V @ 2A	2	50	—	10	6	50
	680-2	200							
	680-3	300							
	680-4	400							
	680-5	500							
	680-6	600							
Fast Recovery	683-1	100	1.2V @ 6A	10	200	500	20	14	150
	683-2	200							
	683-3	300							
	683-4	400							
	683-5	500							
	683-6	600							
Fast Recovery	684-1	100	1.2V @ 2A	5	100	500	10	6	50
	684-2	200							
	684-3	300							
	684-4	400							
	684-5	500							
	684-6	600							

*Measured in a reverse recovery circuit switching from 1.0A forward to 1.0A reverse current recovering to 0.5A.

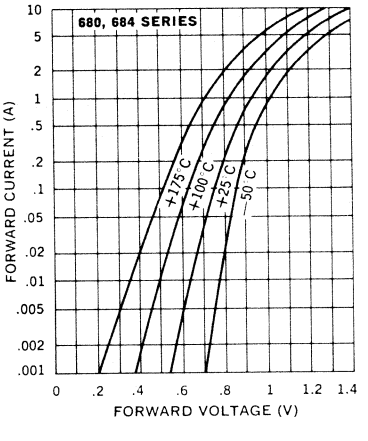
Typical Forward Voltage Per Leg vs. Forward Current



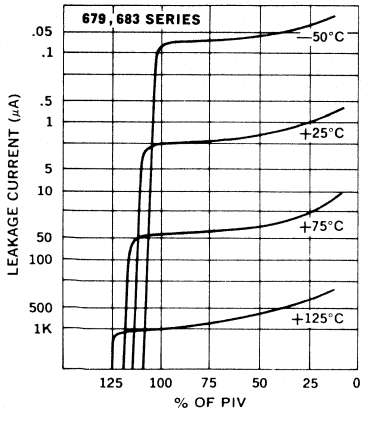
Typical Forward Voltage Per Leg vs. Forward Current



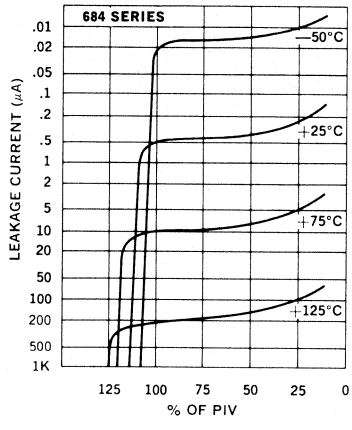
Typical Forward Voltage Per Leg vs. Forward Current



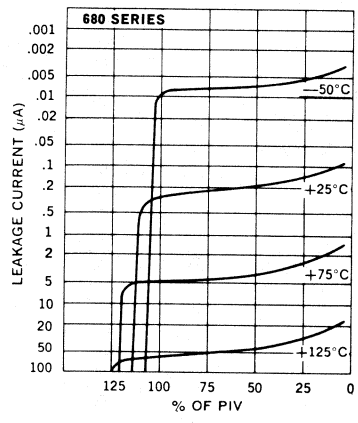
Typical Leakage Current vs. PIV



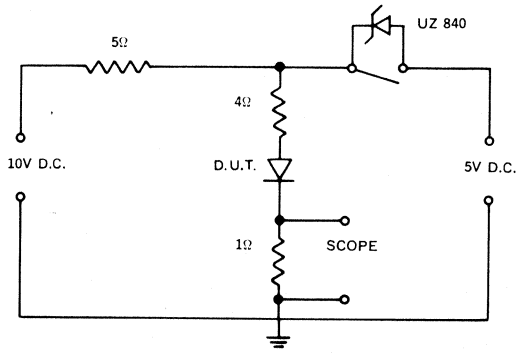
Typical Leakage Current vs. PIV



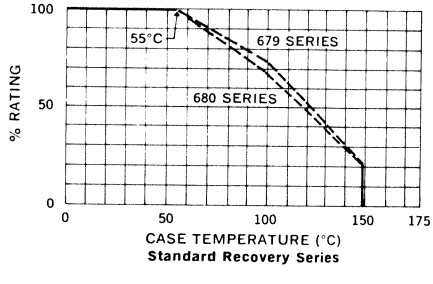
Typical Leakage Current vs. PIV



Reverse Recovery Circuit

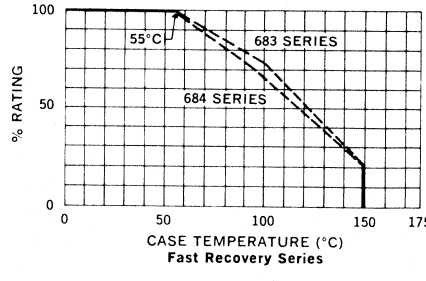


Current Derating Curve



Standard Recovery Series

Current Derating Curve



Fast Recovery Series

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

Doubler and Center Tap, 15 Amp, Standard and Fast Recovery, Magnum®

FEATURES

- Current Ratings: to 15A
- Aluminum Heat Sink Case, Electrically Insulated
- Only Fused-in-Glass Diodes Used
- Controlled Avalanche Characteristics
- PIV: 100 to 600V
- Surge Ratings: to 150A

DESCRIPTION

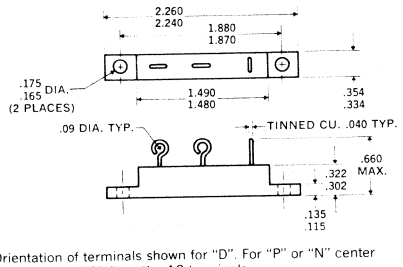
This series of MAGNUM® doublers and center tap rectifiers offers high current and high thermal conductivity needed in high current power supply applications. The MAGNUM® package is virtually indestructable and lends its use to high environmental stresses, as seen in aircraft, missile and satellite equipment.

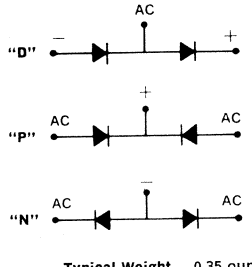
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltages	100 to 600V
Maximum Average D.C. Output Current	
@ $T_C = +55°C$	15A
@ $T_C = +100°C$	10A
Non-Repetitive Sinusoidal Surge (8.3ms)	
@ $T_A = +100°C$	150A
Operating and Storage Temperature Range	−65°C to +150°C
Thermal Resistance Junction to Ambient	20°C/W
Junction to Case	6.0°C/W

MECHANICAL SPECIFICATIONS

681, 689 SERIES

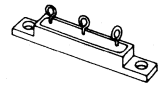




Orientation of terminals shown for "D". For "P" or "N" center terminal is at 90° from the AC terminals.

Typical Weight — 0.35 ounces 10 grams

ND



MARKING

Alternating Current Input	A.C.
Cathode — Positive Output	+
Anode — Negative	—

Part number is printed on the body.

† Add suffix P, N, or D for terminal configuration P, N, or D. For example, for center tap configuration, P, order 681-IP.

Magnum® is a registered trademark of Unitrode Corporation

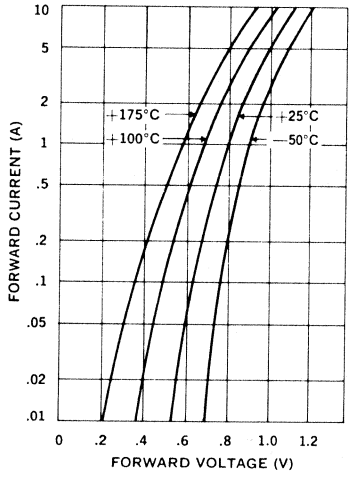
UNITRODE

Electrical Specifications (at 25°C unless noted)

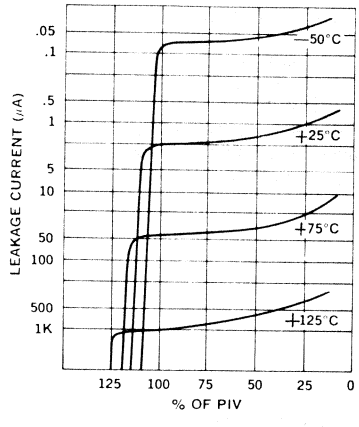
Type		PIV Per Leg	Maximum Forward Voltage Drop Per Leg	Maximum Reverse Recovery Time*	Maximum Leakage Current Per Leg @ PIV	
					$T_A = 25°C$	$T_A = 100°C$
		Volts		nS	μA	μA
Standard Recovery	681-1	100	1.2V @ 10A		10	200
	681-2	200				
	681-3	300				
	681-4	400				
	681-5	500				
	681-6	600				
Fast Recovery	689-1	100	1.2V @ 10A	500	10	200
	689-2	200				
	689-3	300				
	689-4	400				
	689-5	500				
	689-6	600				

*Measured in a reverse recovery circuit from 1A forward to 1A reverse current recovery to 0.5A.

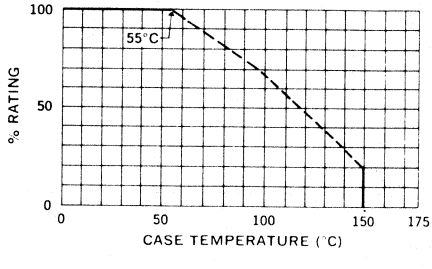
Typical Forward Voltage Per Leg vs. Forward Current



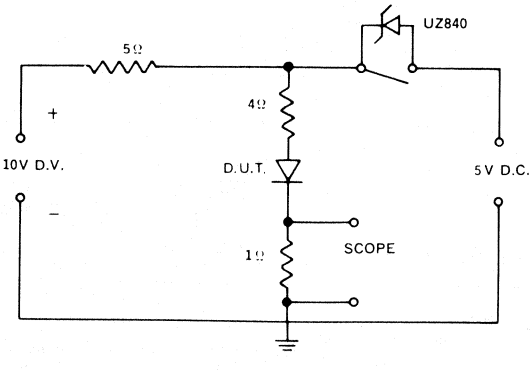
Typical Leakage Current vs. PIV



Current Derating Curve



Reverse-Recovery Circuit



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

High Voltage Stacks, Standard and Fast Recovery

FEATURES

- PIV: from 10kV to 25kV
- Surge Rating: to 20A
- Recovery Time Available: to 500ns
- Current Ratings: to 0.6A
- Bonded Plate for Maximum Heat Transfer
- Controlled Avalanche Characteristics
- Only Fused-in-Glass Diodes Used

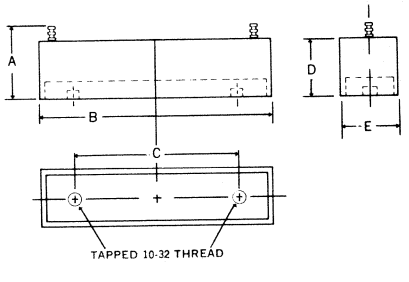
DESCRIPTION

This series of high power stacks has a unique packaging design that provides characteristics not obtainable in conventional molded epoxy packages. This series, therefore, is ideally suited for high-voltage, high-power applications.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	10kV to 25kV
Maximum Average D.C. Output Current	See Electrical Specifications
Non-repetitive Sinusoidal Surge (8.3ms)	20A
Operating and Storage Temperature Range	−65°C to +150°C
Thermal Resistance Junction to Ambient	25°C/W
Junction to Case	10°C/W

688 SERIES

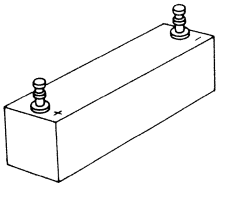


	ins.	mm.
A	1.140 MAX.	28.96 MAX.
B	2.985–3.015	75.82–76.58
C	2.110–2.140	53.59–54.36
D	.740–.770	18.80–19.56
E	.720–.750	18.29–19.05

dd suffix R to denote Fast Recovery version. For example, for recovery time, t_{rr} = 500ns; order 688-10R.

Typical Weight — 2.5 ounces 70 grams

BE



MARKING

Cathode — Positive Output	+
Anode — Negative	—

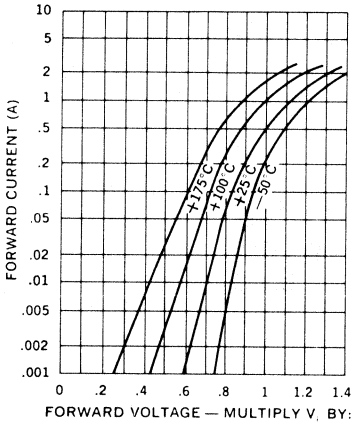
Part number is printed on the body.

UNITRODE

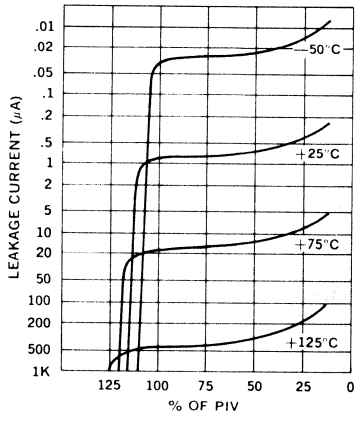
Electrical Specifications (at 25°C unless noted)						Maximum Ratings
Type		PIV	Maximum Forward Voltage Drop	Maximum Leakage Current @ PIV		Maximum Average D.C. Output Current
				$T_A = 25°C$	$T_A = 100°C$	$T_C = 100°C$
		kV		μA	μA	Amps
Standard And Fast Recovery*	688-10	10	17V @ 0.4A	2	100	0.60
	688-12	12	20V @ 0.4A			0.50
	688-15	15	25V @ 0.4A			0.40
	688-18	18	30V @ 0.4A			0.35
	688-20	20	34V @ 0.4A			0.30
	688-25	25	42V @ 0.4A			0.20

*Add suffix R to denote Fast Recovery version.

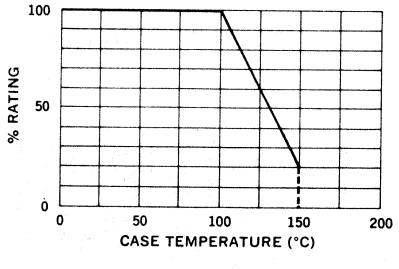
Typical Forward Voltage Per Leg vs. Forward Current



Typical Leakage Current vs. PIV



Current Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

697, 698 SERIES

Single Phase Bridges, 7.5 Amp, Standard and Fast Recovery

5

FEATURES

- Miniature High Current Assemblies
- Continuous Ratings: to 7.5A
- Surge Ratings: to 80A
- PIV's: from 100V to 600V
- Recovery Times: to 500ns
- Only Fused-in-Glass Diodes Used
- Controlled Avalanche Characteristics

DESCRIPTION

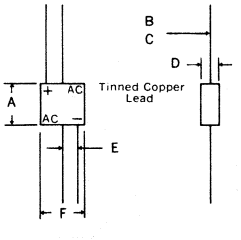
These miniature molded high-current single-phase bridges are designed for universal application in power supplies. One basic bridge fills current requirements up to 7.5A, with PIV's from 100 to 600 volts and recovery times of standard, and 500ns max.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	100 to 600V
Maximum Average D.C. Output Current	See Electrical Specifications
Non-Repetitive Sinusoidal Surge (8.3ms)	See Electrical Specifications
Operating and Storage Temperature Range	—65°C to +150°C
Thermal Resistance Junction to Ambient	32°C/W
Junction to Case	10°C/W

MECHANICAL SPECIFICATIONS

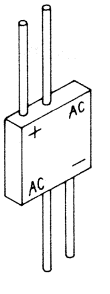
697, 698 SERIES



	ins.	mm.
A	0.50±.01	12.70±.25
B	.032 DIA.	0.81 DIA.
C	1.0 MIN.	25.4 MIN.
D	.250 MAX.	6.35 MAX.
E	.150 TYP.	3.81 TYP.
F	0.50±.01	12.70±.25

Typical Weight — 0.14 ounce
4.0 grams

GA



MARKING

Alternating Current Input	A.C.
Cathode — Positive Output	+
Anode — Negative	—

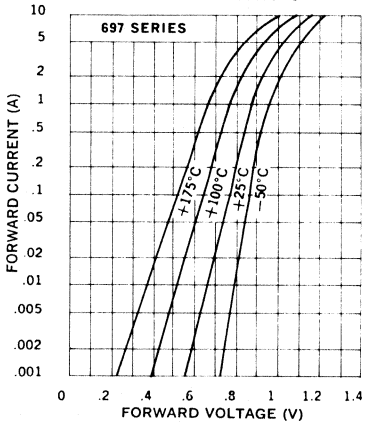
Part number is printed on the body.

UNITRODE

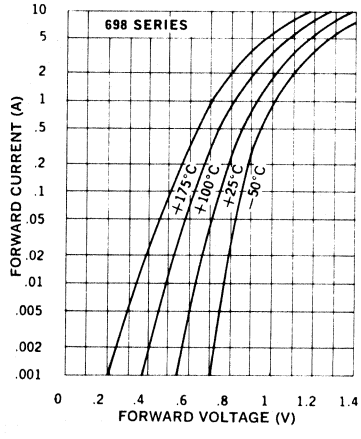
Electrical Specifications (at 25°C unless noted)						Maximum Ratings		
Type		PIV Per Leg	Maximum Forward Voltage Drop Per Leg	Leakage Current Per Leg @ PIV		Maximum Reverse Recovery Time†	Maximum Average D.C. Output Current		Non-Repetitive Sinusoidal Surge (8.3ms)
				T_A = 25°C	T_A = 100°C		T_A = 25°C	T_C = 55°C	
		Volts		μA	μA	ns	Amps	Amps	Amps
Standard Recovery	697-1	100	1.0V @ 2A	5	200		2.5	7.5	80
	697-2	200							
	697-3	300							
	697-4	400							
	697-5	500							
	697-6	600							
Fast Recovery	698-1	100	1.1V @ 2A	5	200	500	2.25	7.0	70
	698-2	200							
	698-3	300							
	698-4	400							
	698-5	500							
	698-6	600							

†Measured in a reverse recovery circuit switching from 1A forward to 1A reverse current recovering to .5A.

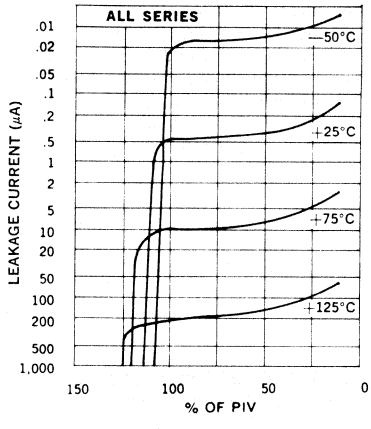
Typical Forward Voltage Per Leg vs. Forward Current



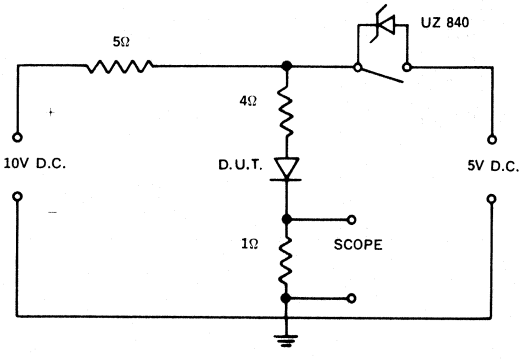
Typical Forward Voltage Per Leg vs. Forward Current



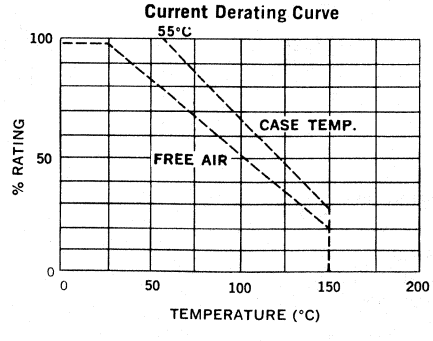
Typical Leakage Current vs. PIV



Reverse Recovery Circuit



Current Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

700, 701 SERIES

Three Phase Bridges, 2.5 Amp, Standard and Fast Recovery

FEATURES
- Miniature Package
- Recovery Time: to 500ns
- Surge Ratings: to 25A
- PIV: from 100 to 600V
- Controlled Avalanche Characteristics
- Only Fused-in-Glass Diodes Used

DESCRIPTION
These miniature transfer-molded high-voltage three-phase power bridges are designed for universal application in power supplies. One basic bridge fills current requirements up to 2.5A, with PIV's from 100 to 600 volts and recovery times of standard and 500ns.

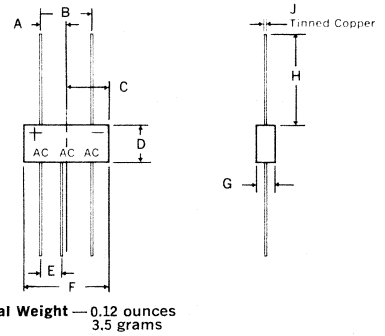
5

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	100 to 600V
Maximum Average D.C. Output Current	See Electrical Specifications
Non-Repetitive Sinusoidal Surge (8.3ms)	See Electrical Specifications
Operating and Storage Temperature Range	—65°C to +150°C
Thermal Resistance Junction-to-Ambient	25°C/W

MECHANICAL SPECIFICATIONS

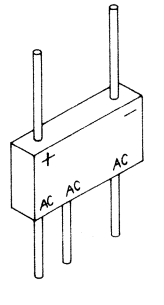
700, 701 SERIES



	ins.	mm.
A	.310	7.87
B	.621	15.77
C	.512 REF.	13.0 REF.
D	.460 MAX.	11.68 MAX.
E	.255	6.48
F	1.030 MAX.	26.16 MAX.
G	.220 MAX.	5.59 MAX.
H	.875	22.23
J	.028 DIA.	0.71 DIA.

Typical Weight — 0.12 ounces
3.5 grams

F



MARKING

Alternating Current Input	A.C.
Cathode — Positive Output	+
Anode — Negative	—

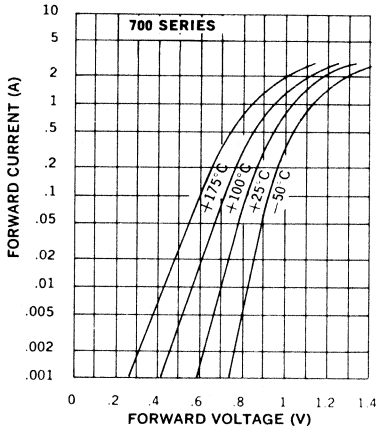
Part number is printed on the body.

UNITRODE

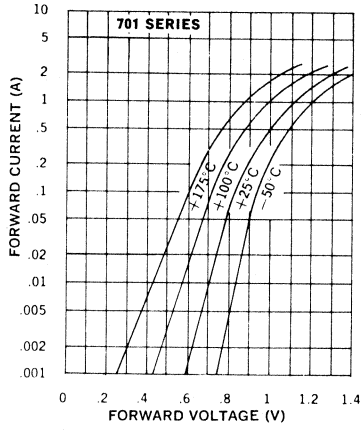
Electrical Specifications (at 25°C unless noted)							Maximum Ratings	
Type		PIV Per Leg	Maximum Forward Voltage Drop Per Leg	Leakage Current Per Leg @ PIV		Maximum Reverse Recovery Time†	Maximum Average D.C. Output Current	Non-Repetitive Sinusoidal Surge (8.3ms)
				T_A = 25°C	T_A = 100°C		T_A = 55°C	
		Volts		μA	μA	ns	Amps	Amps
Standard Recovery	700-1	100	1.0V @ 0.5A	2	100		2.5	25
	700-2	200						
	700-3	300						
	700-4	400						
	700-5	500						
	700-6	600						
Fast Recovery	701-1	100	1.1V @ 0.5A	2	100	500	2.25	20
	701-2	200						
	701-3	300						
	701-4	400						
	701-5	500						
	701-6	600						

†Measured in a reverse recovery circuit switching from 10mA forward to 10mA reverse current recovering to 5mA.

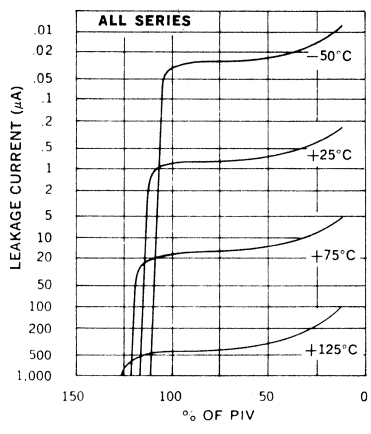
Typical Forward Voltage Per Leg vs. Forward Current



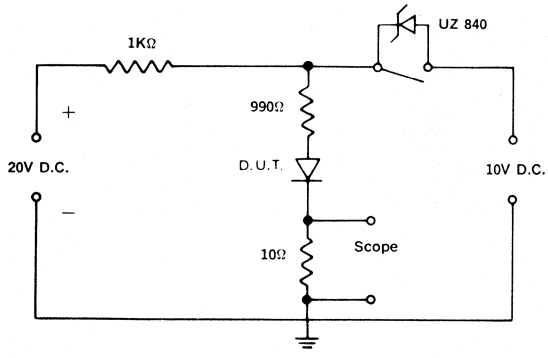
Typical Forward Voltage Per Leg vs. Forward Current



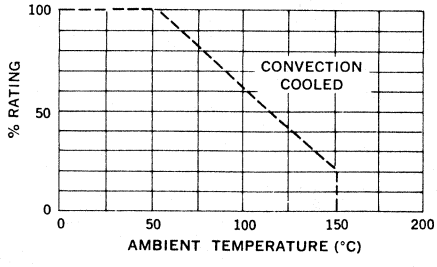
Typical Leakage Current vs. PIV



Reverse Recovery Circuit



Current Derating Curve



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

Three Phase Bridges, 20-40 Amp, High Efficiency, ESP

FEATURES

- Current Ratings: to 40A
- Recovery Time: 50ns
- Surge Ratings: to 250A
- PIVs: from 50 to 150V
- Only Fused-in-Glass Diodes Used
- Exceptionally High Efficiency
- Aluminum Heat Sink Case, Electrically Insulated

DESCRIPTION

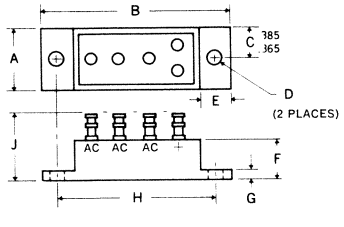
This series of three phase bridges offers the highest efficiency possible for applications where nothing else will do. The series allows operation at full power at high frequencies.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltages	50 to 150V
Maximum Average D.C. Output Current	See Electrical Specifications
Non-Repetitive Sinusoidal Surge (8.3ms)	See Electrical Specifications
Operating and Storage Temperature Range	—65°C to +150°C
Thermal Resistance Junction to Ambient, All Series	20°C/W
Junction to Case, 800 Series	1.5°C/W
Junction to Case, 801 Series	3.0°C/W

MECHANICAL SPECIFICATIONS

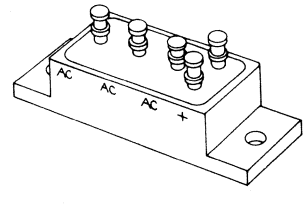
800, 801 SERIES



	ins.	mm.
A	.740-.760	18.80-19.30
B	2.240-2.260	56.90-57.40
C	.365-.385	9.27-9.78
D	.164-.174 DIA.	4.17-4.42 DIA.
E	.370-.390	9.40-9.91
F	.486-.506	12.34-12.85
G	.115-.135	2.92-3.43
H	1.870-1.880	47.50-47.75
J	.820 MAX.	20.83 MAX.

Typical Weight — 1.0 ounce
30 grams

ME



MARKING

Alternating Current Input	A.C.
Cathode — Positive Output	+
Anode — Negative	—

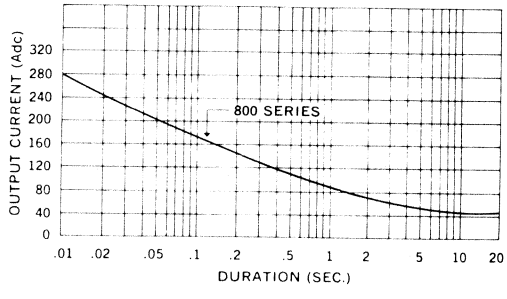
Part number is printed on the body.

UNITRODE

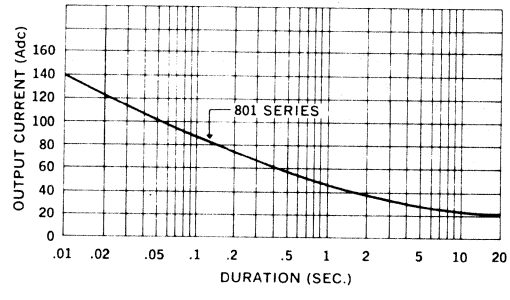
Electrical Specifications (at 25°C unless noted)							Maximum Ratings		
Type		PIV Per Leg	Maximum Forward Voltage Drop Per Leg	Maximum Reverse Leakage Current Per Leg @ PIV		Maximum Reverse Recovery Time*	Maximum Average D.C. Output Current		Non-Repetitive Sinusoidal Surge (8.3ms)
				$T_A = 25°C$	$T_A = 100°C$		$T_C = 55°C$	$T_C = 100°C$	$T_A = 100°C$
		Volts		μA	μA	ns	Amps	Amps	Amps
ESP Recovery	800-1	50	.95V @ 10A	20	1000	50	40	25	250
	800-2	100							
	800-3	125							
	800-4	150							
ESP Recovery	801-1	50	.95V @ 6A	10	300	50	20	16	125
	801-2	100							
	801-3	125							
	801-4	150							

*Measured in a reverse recovery circuit switching from 1A forward to 1A reverse current recovering to 0.5A.

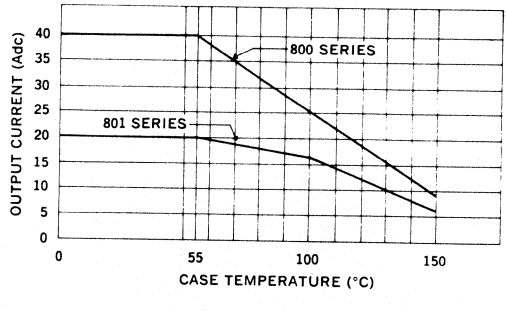
Forward Surge Current vs. Duration



Forward Surge Current vs. Duration



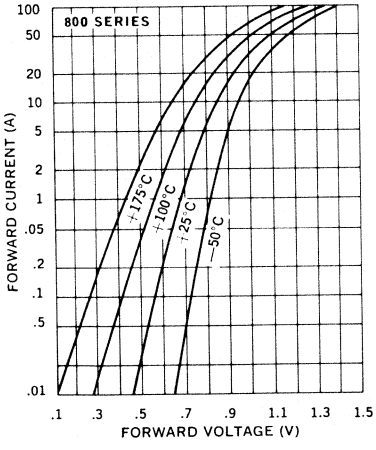
Current Derating Curve



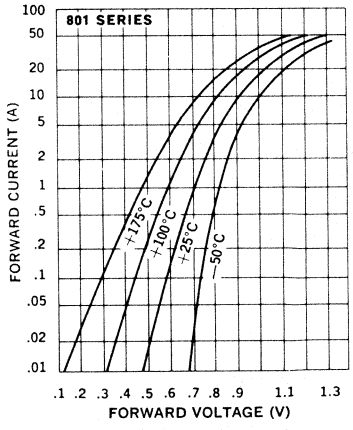
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

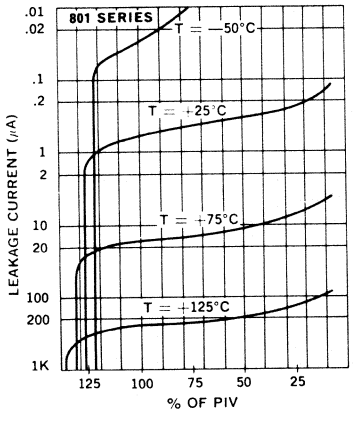
Typical Forward Voltage Per Leg vs. Forward Current



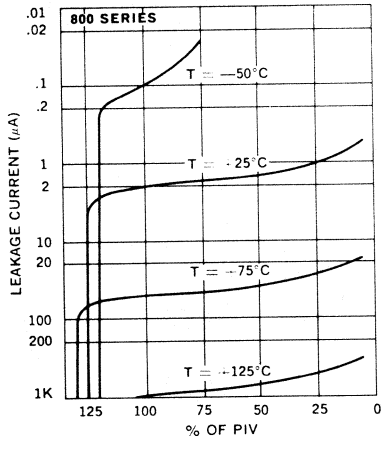
Typical Forward Voltage Per Leg vs. Forward Current



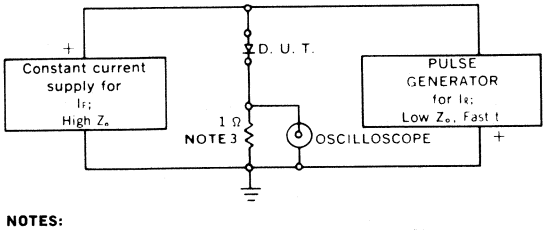
Typical Leakage Current vs. PIV



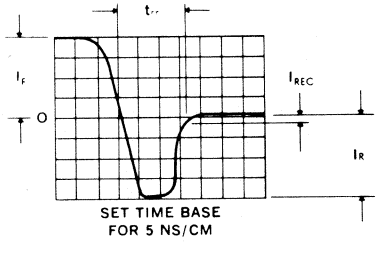
Typical Leakage Current vs. PIV



Reverse-Recovery Circuit



Characteristic Waveform



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

Single Phase Bridges, 20-35 Amp, High Efficiency ESP Series

FEATURES

- Current Ratings: to 35A
- Recovery Time: 50ns
- Surge Ratings: to 250A
- PIVs: from 50 to 150V
- Only Fused-in-Glass Diodes Used
- Exceptional High Efficiency
- Aluminum Heat Sink Case, Electrically Insulated

DESCRIPTION

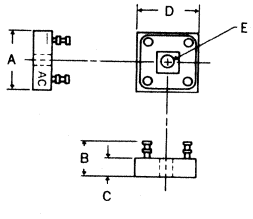
This series of single phase bridges offer the highest efficiency possible for applications where nothing else will do. The series allow operation at full power at very high frequency.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	50 to 150V
Maximum Average D.C. Output Current	See Electrical Specifications
Non-Repetitive Sinusoidal Surge (8.3ms)	See Electrical Specifications
Operating and Storage Temperature Range	−65°C to +150°C
Thermal Resistance Junction to Ambient, 802 Series	20°C/W
803 Series	25°C/W
Junction to Case, 802 Series	2.0°C/W
803 Series	4.0°C/W

MECHANICAL SPECIFICATIONS

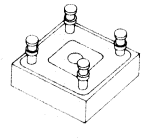
803 SERIES



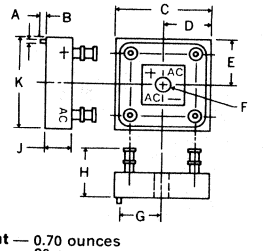
	ins.	mm.
A	.735-.755	18.67-19.18
B	.570 MAX.	14.48 MAX.
C	.226-.246	5.74-6.25
D	.735-.755	18.67-19.18
E	.130-.150 DIA.	3.30-3.81

Typical Weight — 0.35 ounces
10 grams

MA



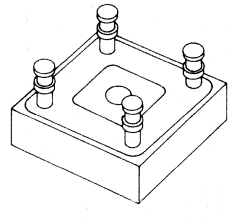
802 SERIES



	ins.	mm.
A	.056-.066	1.42-1.68
B	.052-.072	1.32-1.83
C	1.115-1.135	28.32-28.83
D	.552-.572	14.02-14.53
E	.552-.572	14.02-14.53
F	.180-.200 DIA.	4.57-5.08 DIA.
G	.490-.510	12.45-12.95
H	.750 MAX.	19.05 MAX.
J	.302-.322	7.67-8.18
K	1.115-1.135	28.32-28.83

Typical Weight — 0.70 ounces
20 grams

MB



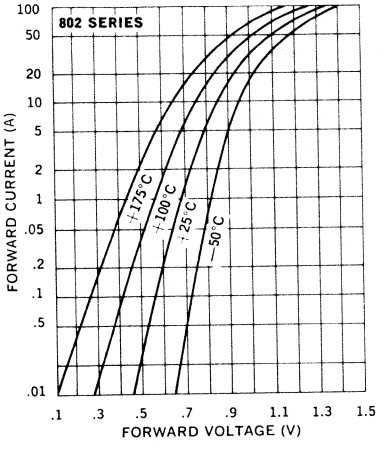
UNITRODE

Type		Electrical Specifications (at 25°C unless noted) PIV Per Leg	Maximum Forward Voltage Drop Per Leg	Maximum Reverse Leakage Current Per Leg @ PIV $T_A = 25°C$	Maximum Reverse Leakage Current Per Leg @ PIV $T_A = 100°C$	Maximum Reverse Recovery Time*	Maximum Ratings: Maximum Average D.C. Output Current $T_C = 55°C$	Maximum Average D.C. Output Current $T_C = 100°C$	Non-Repetitive Sinusoidal Surge (8.3ms) $T_A = 100°C$
		Volts		μA	μA	ns	Amps	Amps	Amps
ESP Recovery	802-1	50	.95V @ 10A	20	1000	50	35	22.5	250
	802-2	100							
	802-3	125							
	802-4	150							
ESP Recovery	803-1	50	.95V @ 6A	10	300	50	20	16	125
	803-2	100							
	803-3	125							
	803-4	150							

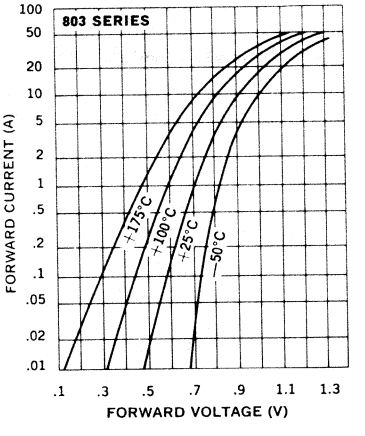
*Measured in a reverse recovery circuit switching from 1A forward to 1A reverse current recovering to 0.5A.

5

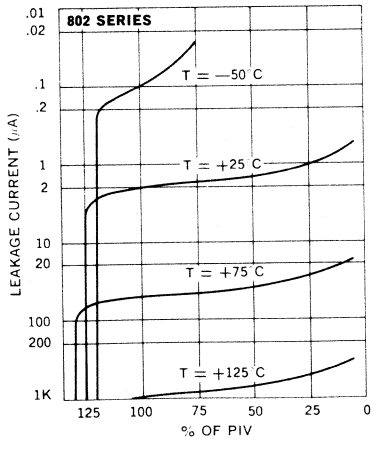
Typical Forward Voltage Per Leg vs. Forward Current



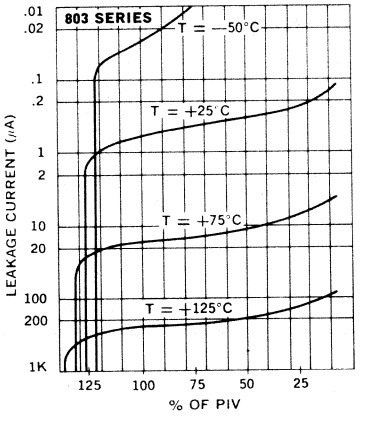
Typical Forward Voltage Per Leg vs. Forward Current



Typical Leakage Current vs. PIV



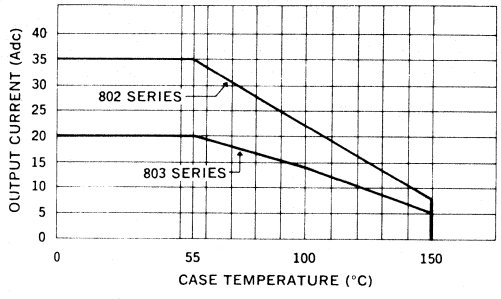
Typical Leakage Current vs. PIV



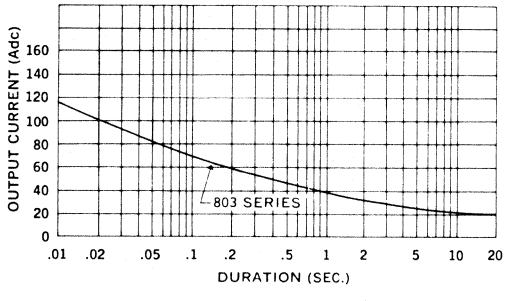
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

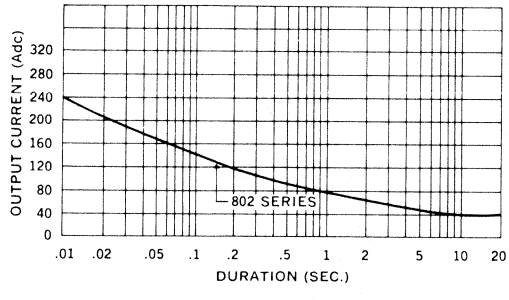
Current Derating Curve



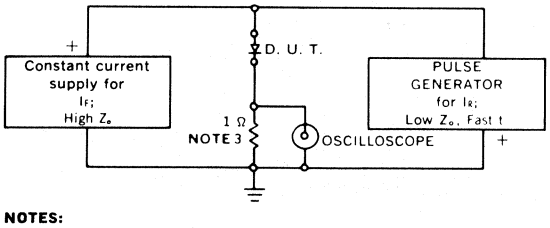
Forward Surge Current vs. Duration



Forward Surge Current vs. Duration

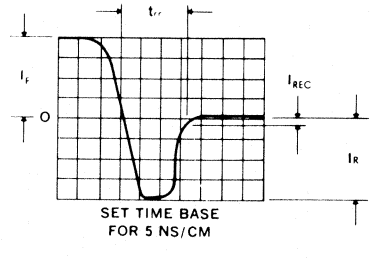


Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ⩽ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ⩽ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

Characteristic Waveform



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

Doublers and Center Tap, 20 Amp, High Efficiency, ESP

FEATURES

- Current Rating: to 20A
- Aluminum Heat Sink Case, Electrically Insulated
- Recovery Time: 50ns
- Surge Rating: to 250A
- PIVs: from 50 to 150V
- Only Fused-in-Glass Diodes Used
- Exceptional High Efficiency

DESCRIPTION

This series of doublers and center tap rectifiers offer the ultimate in high efficiency application. The rectifiers are particularly suited to switching regulator supplies where very fast recovery time and low forward drop are of prime importance.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	50 to 150V
Maximum Average D.C. Output Current	
@ $T_C = +55°C$	20A
@ $T_C = +100°C$	14A
Non-Repetitive Sinusoidal Surge (8.3ms)	
@ $T_A = +100°C$	250A
Operating and Storage Temperature Range	−65°C to +150°C
Thermal Resistance Junction to Ambient	20°C/W
Junction to Case	6.0°C/W

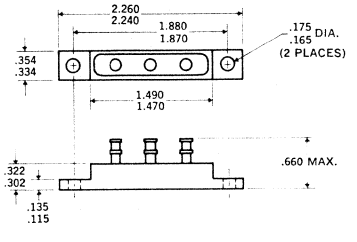
Electrical Specifications (at 25°C unless noted)

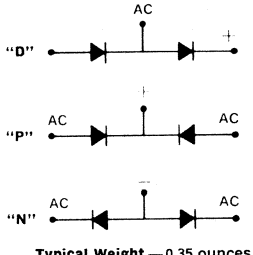
Type		PIV Per Leg	Maximum Forward Voltage Drop Per Leg	Maximum Leakage Current (μA) Per Leg @ PIV		Maximum Reverse Recovery Time*
				$T_A = 25°C$	$T_A = 100°C$	
		Volts		μA	μA	ns
ESP Recovery	804-1	50	.95V @ 10A	10	500	50
	804-2	100				
	804-3	125				
	804-4	150				

*Measured in a reverse recovery circuit switching from 1A forward to 1A reverse current recovering to 0.5A.

MECHANICAL SPECIFICATIONS

804 SERIES

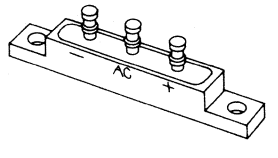




Typical Weight — 0.35 ounces 10 grams

Dimensions in inches.

MF



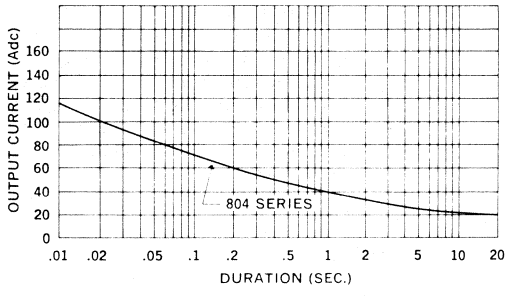
MARKING

Alternating Current Input	A.C.
Cathode — Positive Output	+
Anode — Negative	—

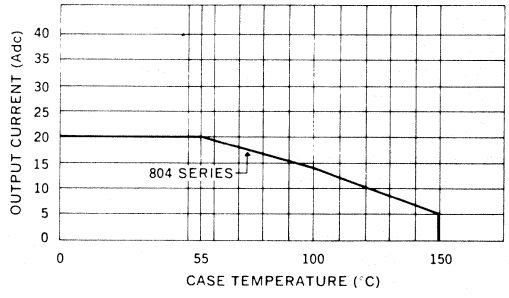
Part number is printed on the body.

† Add suffix P, N, or D for terminal configuration P, N, or D. For example, for center tap configuration, P, order 804-IP

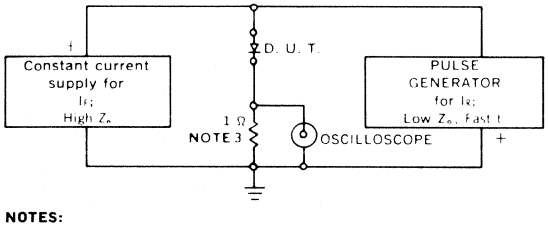
Forward Surge Current vs. Duration



Current Derating Curve

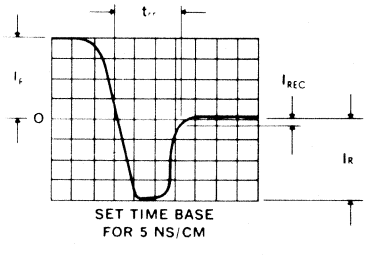


Reverse-Recovery Circuit

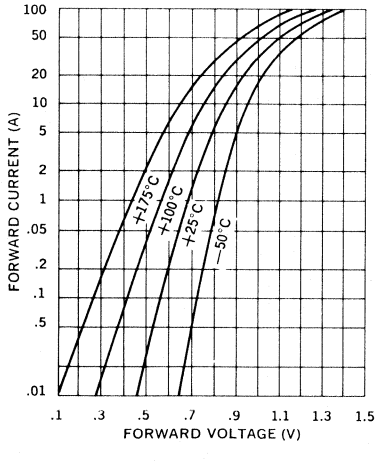


NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

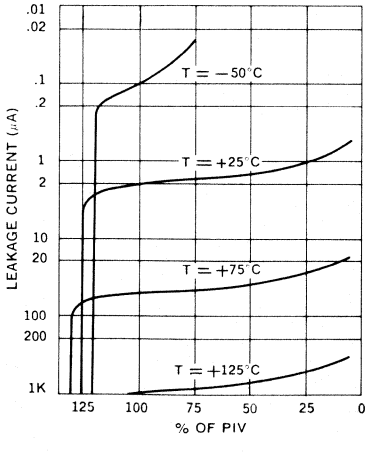
Characteristic Waveform



Typical Forward Voltage Per Leg vs. Forward Current



Typical Leakage Current vs. PIV



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS

Military Approved, 1 Amp, General Purpose

FEATURES

- Qualified to MIL-S-19500/228
- Continuous Rating: 1A
- Surge Rating: 30A
- PIV: to 800V

DESCRIPTION

This series of MIL approved JAN and JANTX general purpose 1 amp rectifiers are useful in many high rel applications.

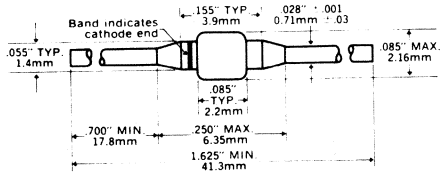
ABSOLUTE MAXIMUM RATINGS

Peak Reverse Voltage Min.	Reverse Working Voltage	Type
240V	200V	JAN & JANTX 1N3611
480V	400V	JAN & JANTX 1N3612
720V	600V	JAN & JANTX 1N3613
920V	800V	JAN & JANTX 1N3614

Maximum Average D.C. Output Current
@ T_A = 100°C 1.0A
@ T_A = 150°C 0.3A
Non-Repetitive Sinusoidal
Surge Current (8.3ms) 30A
Operating Temperature Range ..... −65°C to +175°C
Storage Temperature Range ..... −65°C to +200°C
Thermal Resistance ..... See Lead Temperature Derating Curve

MECHANICAL SPECIFICATIONS

JAN & JANTX1N3611-1N3614



BODY A

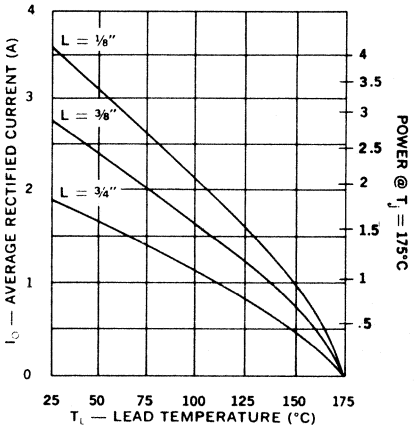


UNITRODE

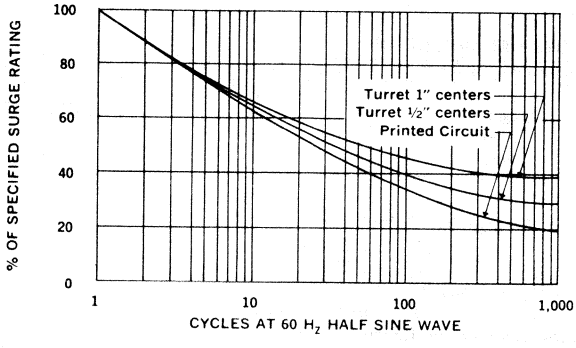
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	Peak Reverse D.C. Voltage	Minimum Reverse Breakdown Voltage @ 100μA	Peak Forward Voltage		Maximum D.C. Reverse Current at D.C. Voltage	
			Min.	Max.	25°C	150°C
JAN & JANTX 1N3611	200V	240V	0.6V	1.1V(pk) @ 1.0A	1μA	300μA
JAN & JANTX 1N3612	400V	480V				
JAN & JANTX 1N3613	600V	720V				
JAN & JANTX 1N3614	800V	920V				

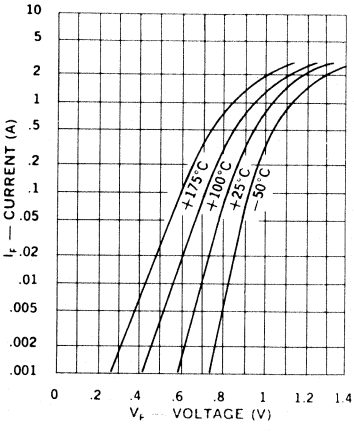
Maximum Current vs Lead Temperature



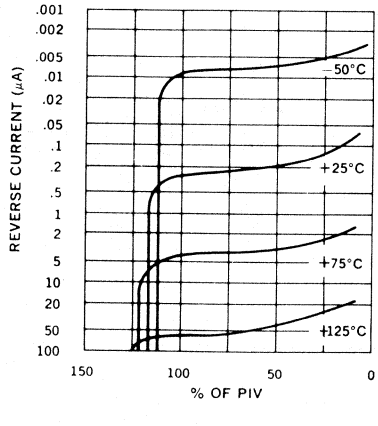
Allowable Forward Surge vs Number of Cycles



Typical Forward Current vs Forward Voltage



Typical Reverse Current vs PIV



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A

RECTIFIERS

Military Approved, 1 Amp, General Purpose

1N4245-1N4249
JAN, JANTX & JANTXV

FEATURES

- Qualified to MIL-S-19500/286
- Surge Rating: 25A
- PIV: to 1000 V
- Controlled Avalanche
- No Plastic, Epoxy, Silicone, Oxides, Gases or Solder are used

DESCRIPTION

This series of general purpose power rectifiers are available as JAN, JANTX or JANTXV for many power supply applicatons.

5

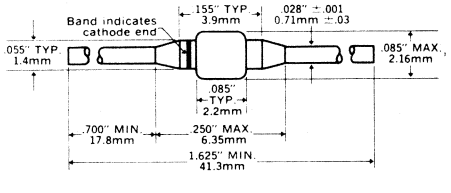
ABSOLUTE MAXIMUM RATINGS

Maximum Reverse Voltage	Type
200V	JAN, JANTX, JANTXV 1N4245
400V	JAN, JANTX, JANTXV 1N4246
600V	JAN, JANTX, JANTXV 1N4247
800V	JAN, JANTX, JANTXV 1N4248
1000V	JAN, JANTX, JANTXV 1N4249

Maximum Average D.C. Output Current
@ T_A = 100°C 1.0A
@ T_A = 150°C 0.333A
Non-Repetitive Sinusoidal
Surge Current 25A
Operating Temperature Range ..... −65°C to +175°C
Storage Temperature Range ..... −65°C to +175°C
Thermal Resistance ..... See Lead Temperature Derating Curve

MECHANICAL SPECIFICATIONS

J, JTX, JTXV 1N4245-1N4249



BODY A

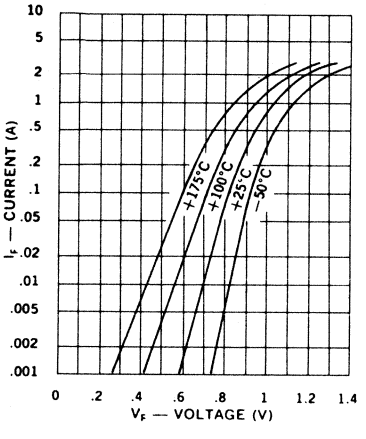


ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

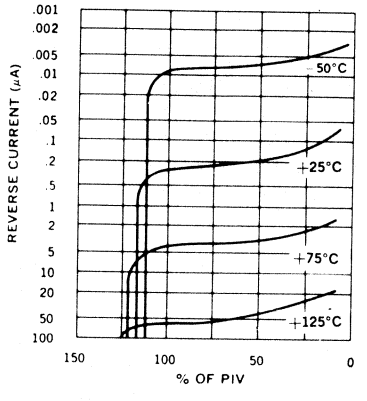
Type	PIV	Minimum Reverse Breakdown Voltage @ 100μA	Forward Voltage		Maximum Reverse Current		Maximum Reverse Recovery Time*
			Min.	Max.	25°C	150°C	
J, JTX, JTXV 1N4245	200V	240V	0.6V	1.3V(pk) @ 3.0A(pk)	1.0μA	150μA	5.0μs
J, JTX, JTXV 1N4246	400V	480V					
J, JTX, JTXV 1N4247	600V	720V					
J, JTX, JTXV 1N4248	800V	960V					
J, JTX, JTXV 1N4249	1000V	1150V					

*Measured in circuit $I_F = ½A$, $I_R = 1.0A$, $I_{REC} = ¼A$

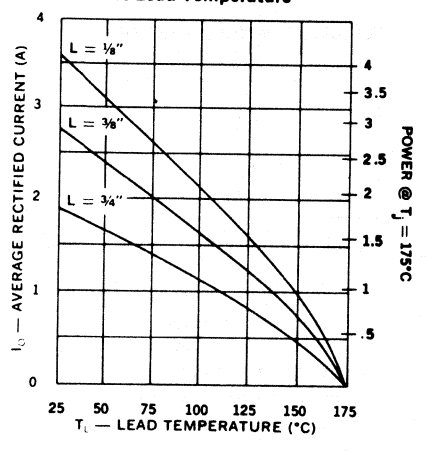
Typical Forward Current vs Forward Voltage



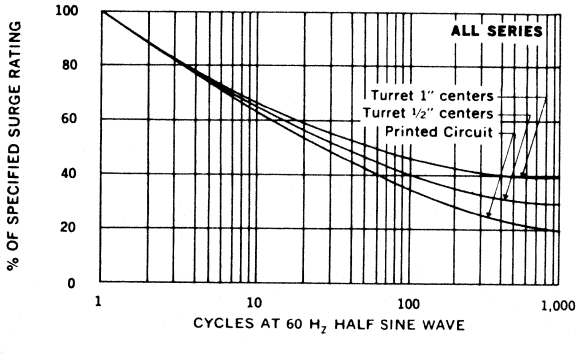
Typical Reverse Current vs PIV



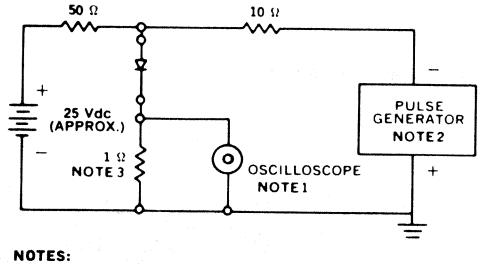
Maximum Current vs Lead Temperature



Allowable Forward Surge vs Number of Cycles



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS

Military Approved, 1 Amp, Fast Recovery

JAN, JANTX, & JANTXV 1N4942
JAN, JANTX, & JANTXV 1N4944
JAN, JANTX, & JANTXV 1N4946

FEATURES

- Qualified to MIL-S-19500/359
- Surge Rating: 15A
- PIV: to 600V
- Controlled Avalanche

DESCRIPTION

These fast recovery rectifiers are suitable for use as power devices for many applications. Devices are available as JAN, JANTX or JANTXV.

5

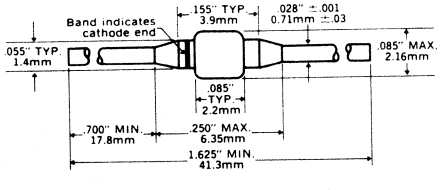
ABSOLUTE MAXIMUM RATINGS

Maximum Reverse Voltage	Type
200V	JAN, JANTX, & JANTXV 1N4942
400V	JAN, JANTX, & JANTXV 1N4944
600V	JAN, JANTX, & JANTXV 1N4946

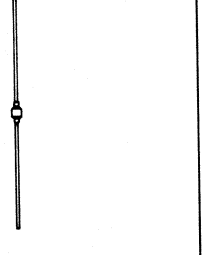
Maximum Average D.C. Output Current
@ T_A = 55°C 1.0A
@ T_A = 100°C 0.75A
Non-Repetitive Sinusoidal
Surge Current (8.3ms) 15A
Operating Temperature Range ..... −65°C to +175°C
Storage Temperature Range ..... −65°C to +175°C
Thermal Resistance ..... See Lead Temperature Derating Curve

MECHANICAL SPECIFICATIONS

JAN, JANTX, & JANTXV 1N4942, 1N4944, 1N4946



BODY A



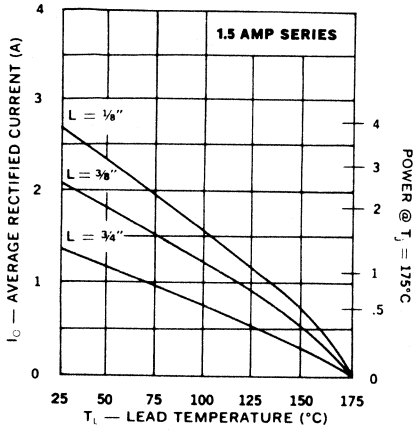
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

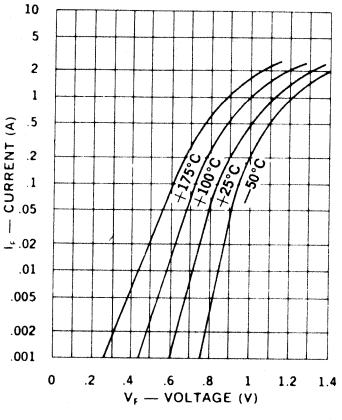
Type	Peak Inverse Voltage	Minimum Reverse Breakdown Voltage @ 50μA	Forward Voltage		Maximum Reverse Current		Maximum Reverse Recovery Time*	Capacitance @ V_R = 12V f = 1MHz
			Min.	Max.	25°C	150°C		
J, JTX, JTXV 1N4942	200V	220V	0.6V	1.3Vdc	1.0μA	200μA	150ns	45pf
J, JTX, JTXV 1N4944	400V	440V	@ 1 Adc				150ns	35pf
J, JTX, JTXV 1N4946	600V	660V					250ns	25pf

*Measured in circuit I_F = ½A, I_R = 1.0A, I_{REC} = ¼A

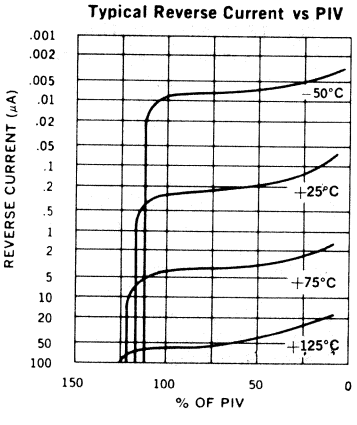
Maximum Current vs Lead Temperature



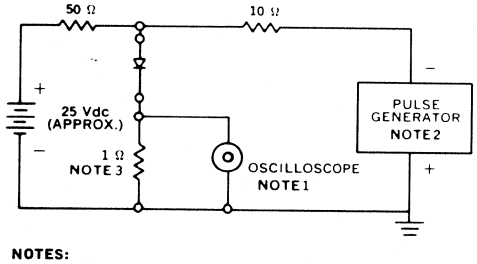
Typical Forward Current vs Forward Voltage



Typical Reverse Current vs PIV

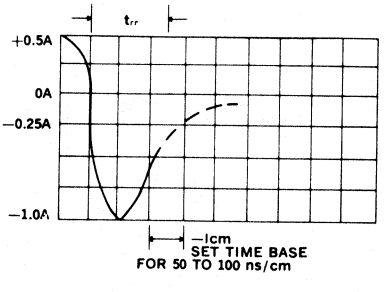


Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

Characteristic Waveform.



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS

Military Approved, 3 Amp, Fast Recovery

1N5186-1N5190
JAN & JANTX

5

FEATURES

- Continuous Rating: 3A
- Qualified to MIL-S-19500/424
- PIV : to 600V
- Recovery Time: 150ns
- Miniature Size
- Controlled Avalanche

DESCRIPTION

These miniature fast recovery rectifiers permit operation at full power at frequencies as high as 100kHz sine wave. They are qualified to military specification and available as JAN, JANTX

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	Type
100V	JAN & JANTX 1N5186
200V	JAN & JANTX 1N5187
400V	JAN & JANTX 1N5188
600V	JAN & JANTX 1N5190

Maximum Average D.C. Output Current

@ T_A = 25°C 3.0A
@ T_A = 150°C 0.7A

Non-Repetitive Sinusoidal
Surge Current (8.3ms) 80A

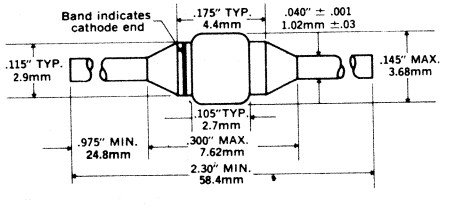
Operating Temperature Range ..... —65°C to +175°C

Storage Temperature Range ..... —65°C to +200°C

Thermal Resistance ..... See Lead Temperature Derating Curve

MECHANICAL SPECIFICATIONS

JAN & JANTX 1N5186-1N5190



BODY B



UNITRODE

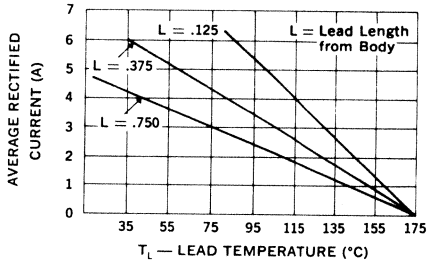
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	Peak Inverse Voltage	Minimum Reverse Breakdown Voltage @ 100μA	Peak Forward Voltage		Maximum Reverse D.C. Current @ PIV	
			Min.	Max.	25°C	100°C
J, JTX 1N5186	100V	120V	0.9V	1.5V	2μA	100μA
J, JTX 1N5187	200V	240V	@ 9A(pk)			
J, JTX 1N5188	400V	480V	(8.3ms)			
J, JTX 1N5190	600V	660V				

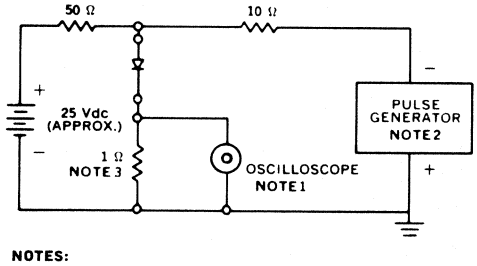
Type	Reverse Recovery Time*	Capacitance @ $V_R = 0V$ f = 1MHz	Capacitance @ $V_R = 4V$ f = 1MHz
J, JTX 1N5186	150ns	300pf	200pf
J, JTX 1N5187	200ns	300pf	170pf
J, JTX 1N5188	250ns	230pf	120pf
J, JTX 1N5190	400ns	180pf	90pf

*Recovery time measured from $I_F = 0.5A$ to $I_R = 1.0A$, $I_{REC} = 0.25A$

Maximum Current vs. Lead Temperature

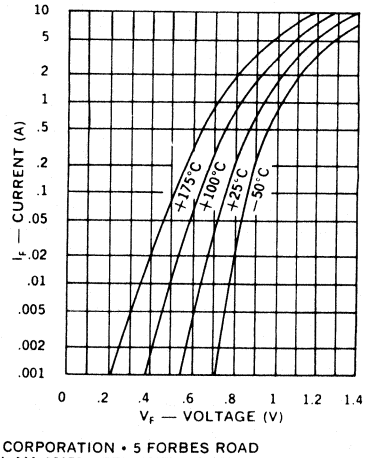


Reverse-Recovery Circuit

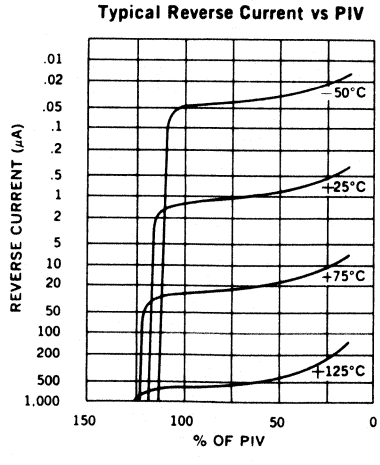


NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

Typical Forward Current vs Forward Voltage



Typical Reverse Current vs PIV



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
Military Approved, Fast Recovery, 3 Amp

1N5415-1N5420
JAN, JANTX & JANTXV

FEATURES
- Qualified to MIL-S-19500/411
- PIV: to 600V
- Controlled Avalanche

DESCRIPTION
This series of devices as designed to meet the need for high speed, power rectifiers in military high-rel power supplies.

5

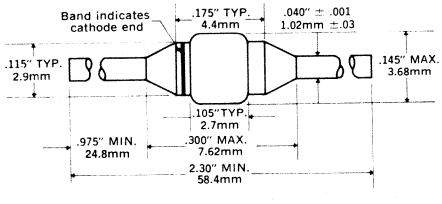
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	Type
50V	JAN, JANTX, JANTXV 1N5415
100V	JAN, JANTX, JANTXV 1N5416
200V	JAN, JANTX, JANTXV 1N5417
400V	JAN, JANTX, JANTXV 1N5418
500V	JAN, JANTX, JANTXV 1N5419
600V	JAN, JANTX, JANTXV 1N5420

Maximum Average D.C. Output Current
@ T_A = 55°C 3.0A
@ T_A = 100°C 2.0A
Non-Repetitive Sinusoidal
Surge Current (8.3ms) 80A
Operating Temperature Range ..... −65°C to +175°C
Storage Temperature Range ..... −65°C to +200°C
Thermal Resistance Θ_{JL} @ L = 3/8" ..... 20°C/W
See Lead Temperature Derating Curve

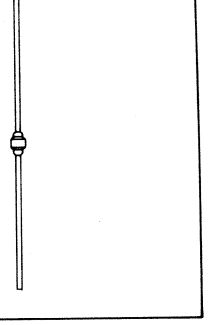
MECHANICAL SPECIFICATIONS

J, JTX, JTXV 1N5415-1N5420



Dimensions in inches.

BODY B



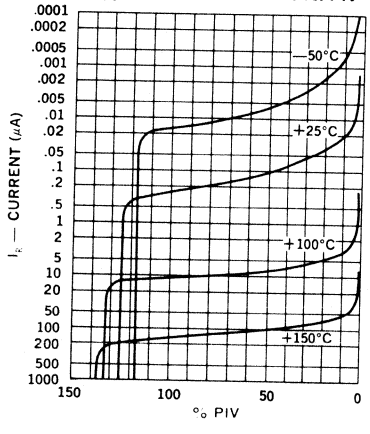
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

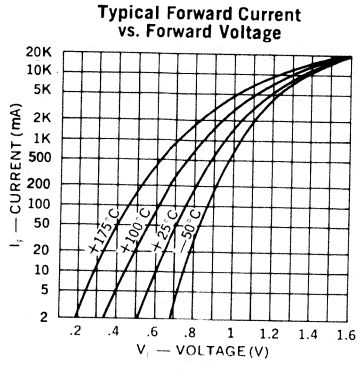
Type	PIV	Minimum Reverse Breakdown Voltage @ 50μA	Forward Voltage Min.	Forward Voltage Max.	Maximum Reverse Current 25°C	Maximum Reverse Current 100°C	Maximum Reverse Recovery Time*
J, JTX, JTXV 1N5415	50V	55V	0.6V	1.5V(pk) @ 9Adc tp = 300μs	1.0μA	20μA	150
J, JTX, JTXV 1N5416	100V	110V					150
J, JTX, JTXV 1N5417	200V	220V					150
J, JTX, JTXV 1N5418	400V	440V					150
J, JTX, JTXV 1N5419	500V	550V					250
J, JTX, JTXV 1N5420	600V	660V					400

*Measured in circuit $I_F = 0.5$ A, $I_R = 1$A, $I_{REC} = 0.25$ A.

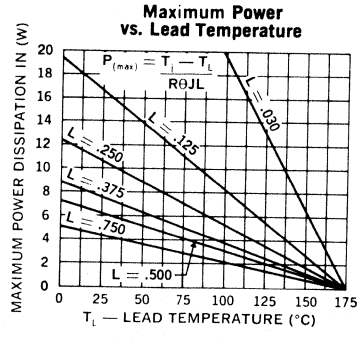
Typical Reverse Current vs. PIV



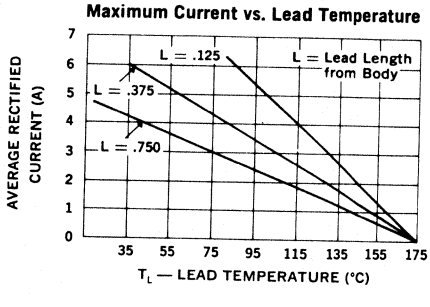
Typical Forward Current vs. Forward Voltage



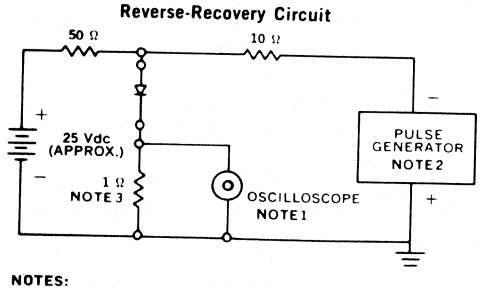
Maximum Power vs. Lead Temperature



Maximum Current vs. Lead Temperature



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS

Military Approved, 5 Amp, General Purpose

1N5550-1N5553
JAN, JANTX & JANTXV

5

FEATURES

- Qualified to MIL-S-19500/420A
- Continuous Rating: 5A
- PIV: to 800V
- TX Parts 100% Screened
- Miniature Size
- Controlled Avalanche

DESCRIPTION

This series of military approved rectifiers is useful in many military applications. The 100% screening requirements in the "TX" version combined with the unique Unitrode construction assures the highest degree of reliability.

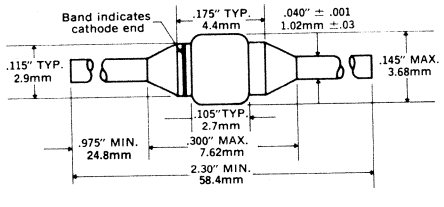
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	Type
200V	JAN, JANTX & JANTXV 1N5550
400V	JAN, JANTX & JANTXV 1N5551
600V	JAN, JANTX & JANTXV 1N5552
800V	JAN, JANTX & JANTXV 1N5553

Maximum Average D.C. Output Current
@ T_A = 55°C 3.0A
@ T_L = 55°C 5.0A
Non-Repetitive Sinusoidal
Surge Current (8.3ms) 100A
Operating Temperature Range ..... —65°C to +175°C
Storage Temperature Range ..... —65°C to +200°C
Thermal Resistance ..... See Lead Temperature Derating Curve

MECHANICAL SPECIFICATIONS

J, JTX, JTXV 1N5550-1N5553



BODY B



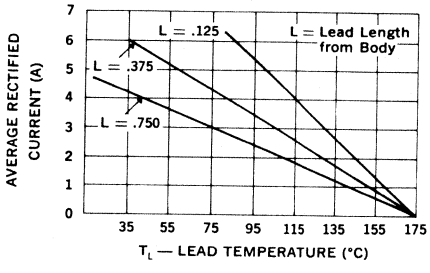
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

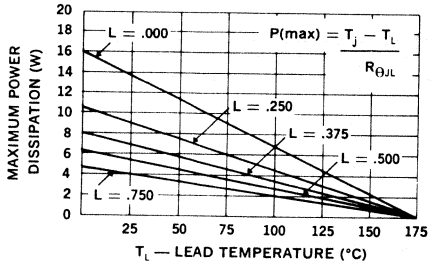
Type	Peak Inverse Voltage	Minimum Reverse Breakdown Voltage @ 50μA	Peak Forward Voltage		Maximum Leakage Current @ PIV		Maximum Reverse Recovery Time*
			Min.	Max.	25°C	100°C	
J, JTX, JTXV 1N5550	200V	240V	0.6V @ I_F = 9A(pk) (8.3ms)	1.2V	1.0μA	75μA	2.0μs
J, JTX, JTXV 1N5551	400V	460V					
J, JTX, JTXV 1N5552	600V	660V					
J, JTX, JTXV 1N5553	800V	880V		1.3V			

*Measured in a test circuit I_F =0.5A, I_R = 1.0A, I_{REC} = 0.25A

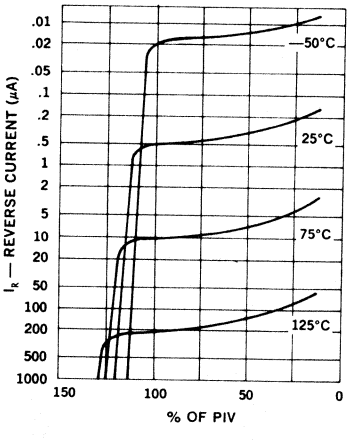
Maximum Current vs. Lead Temperature



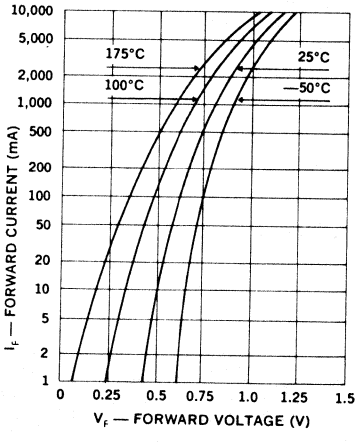
Maximum Power Dissipation vs. Lead Temperature



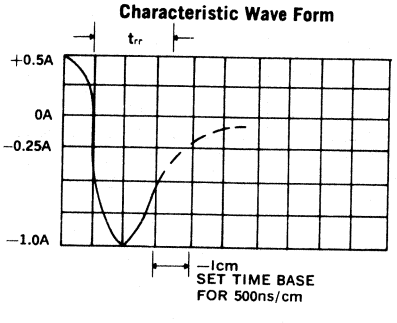
Typical Reverse Current vs. PIV



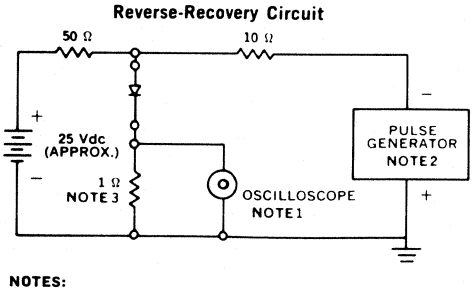
Typical Forward Current vs. Forward Voltage



Characteristic Wave Form



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

High Voltage Stacks, 1 Amp to 5 Amp, Military Approved

JAN 1N5597
JAN 1N5600
JAN 1N5603

5

FEATURES

- Qualified to MIL-S-19500/404A
- PIV: to 10kV
- Surge Ratings: to 200A
- Current Ratings: to 5A
- Only Fused-in-Glass Diodes Used
- Controlled Avalanche Characteristics
- Modular Package For Easy Stacking

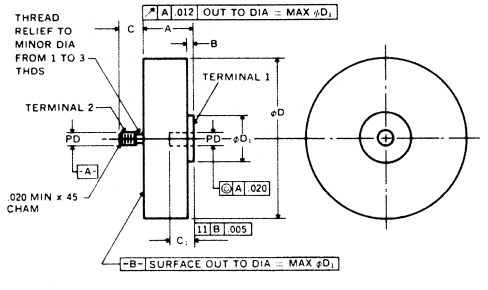
DESCRIPTION

This series of military high-voltage high-current stacks offers the utmost in reliability as required in military system designs. The rectifiers are assembled with diodes which have been subjected to TX type screening tests.

ABSOLUTE MAXIMUM RATINGS

	JAN 1N5597	JAN 1N5600	JAN 1N5603
Peak Inverse Voltage	10kV	5kV	5kV
Maximum Average D.C. Output Current @ T_C = 75°C	1A	2A	5A
Non-Repetitive Sinusoidal Surge (8.3ms) @ T_C = 75°C	30A	80A	200A
Operating and Storage Temperature Range	−65°C to +150°C		

MECHANICAL SPECIFICATIONS



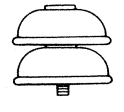
JAN 1N5597 JAN 1N5600

Ltr	Dimensions in inches with metric equivalents (mm) in parentheses		NOTES
	Minimum	Maximum	
A	.73 (18.54)	.83 (21.08)	8
B		.080 (2.03)	
C	.240 (6.10)	.264 (6.71)	2,6
C_1	.265 (6.73)	.400 (10.16)	4
φD	1.85 (46.99)	1.95 (49.53)	
$φD_1$	.57 (14.48)	.67 (17.02)	

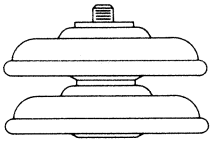
JAN 1N5603

Ltr	Dimensions in inches with metric equivalents (mm) in parentheses		NOTES
	Minimum	Maximum	
A	.970 (24.64)	1.020 (25.91)	8
B	.050 (1.27)	.080 (2.03)	
C	.307 (7.80)	.317 (8.05)	3
C_1	.318 (8.08)	.400 (10.16)	5,7
φD	3.450 (87.63)	3.650 (92.71)	
$φD_1$	.95 (24.13)	1.250 (31.75)	

DE



DF



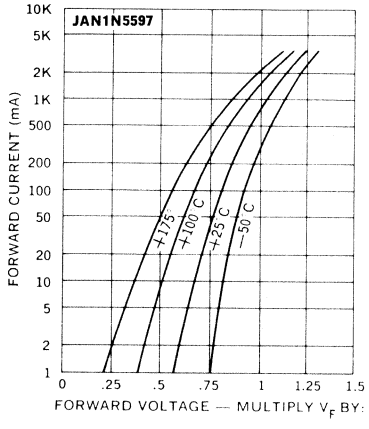
1. All marking shall be on cathode side of module.
2. Threaded stud ¼-28UNF-2A.
3. Threaded stud ⅜-24UNF-2A.
4. Threaded insert ¼-28UNF-2B.
5. Threaded insert ⅜-24UNF-2B.
6. Cathode connected to terminal 2.
7. Cathode connected to terminal 1.
8. Module contour within dimension A is not specified.

UNITRODE

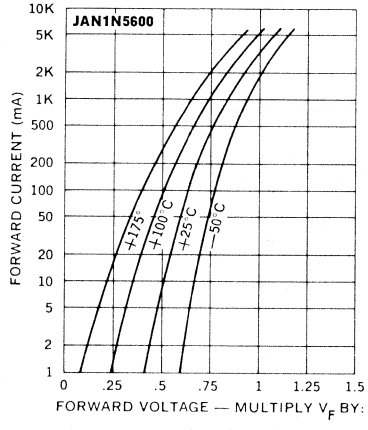
Electrical Specifications (at 25°C unless noted)

Type	PIV	Forward Voltage Drop		Maximum Leakage Current @ PIV		Capacitance @ V_R = 100V		Maximum Reverse Transient Energy Absorption
		Min.	Max.	T_A = 25°C	T_A = 100°C	Min.	Max.	
	kV			μA	μA	pf	pf	joules
JAN 1N5597	10	13V @ 1A	19V @ 1A	1	75	5	30	2
JAN 1N5600	5	6V @ 2A	10V @ 2A	5	100	7	30	6
JAN 1N5603	5	6V @ 5A	10V @ 5A	5	100	15	40	12

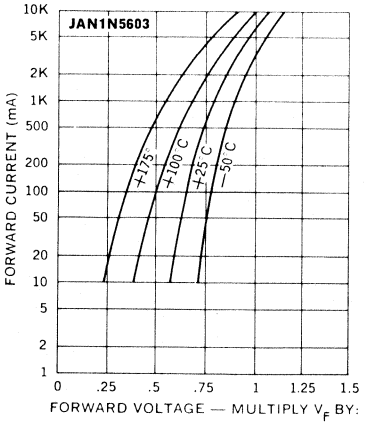
Typical Forward Voltage vs. Forward Current



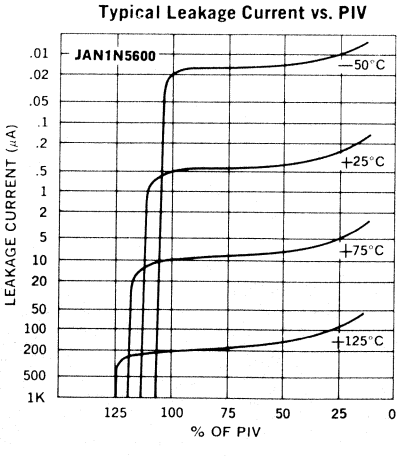
Typical Forward Voltage vs. Forward Current



Typical Forward Voltage vs. Forward Current



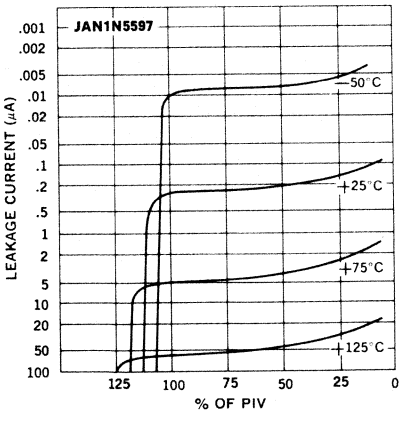
Typical Leakage Current vs. PIV



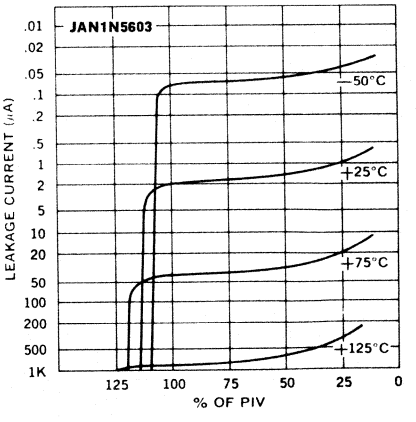
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

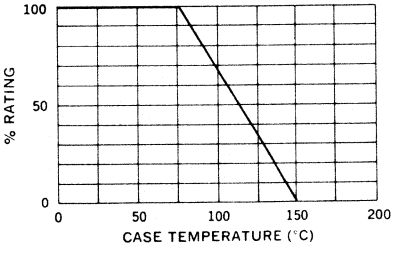
Typical Leakage Current vs. PIV

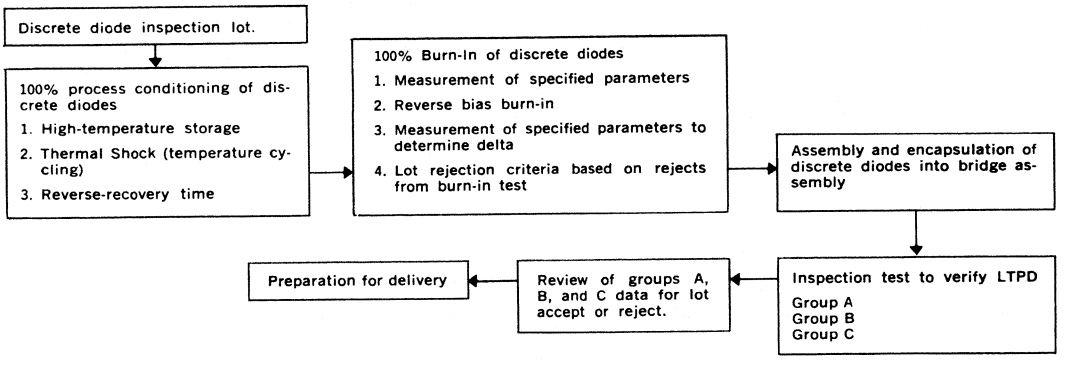


Typical Leakage Current vs. PIV



Current Derating Curve





RECTIFIERS

Standard Recovery, 1 Amp Military Approved

1N5614, 1N5616, 1N5618, 1N5620, JAN, JANTX & JANTXV

FEATURES

- Qualified to MIL-S-19500/427
- PIV: to 800V
- Controlled Avalanche

DESCRIPTION

This series of medium power general purpose rectifiers can be used in the most demanding military supplies. Rugged mechanical integrity and tight electrical parameters make them particularly useful.

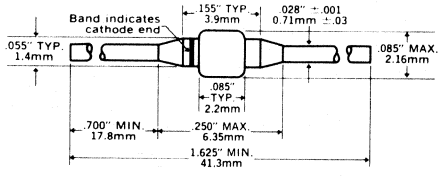
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	Type
200V	JAN, JANTX & JANTXV 1N5614
400V	JAN, JANTX & JANTXV 1N5616
600V	JAN, JANTX & JANTXV 1N5618
800V	JAN, JANTX & JANTXV 1N5620

Maximum Average D.C. Output Current
@ $T_A = 55°C$ 1.0A
@ $T_A = 100°C$ 0.75A
Non-Repetitive Sinusoidal
Surge Current (8.3ms) 30A
Operating Temperature Range ..... −65°C to +175°C
Storage Temperature Range ..... −65°C to +200°C
Thermal Resistance θ_{JL} @ L = 3/8" ..... 38°C/W
See Lead Temperature Derating Curve

MECHANICAL SPECIFICATIONS

J, JTX, JTXV 1N5614, 1N5616, 1N5618, 1N5620



BODY A



UNITRODE

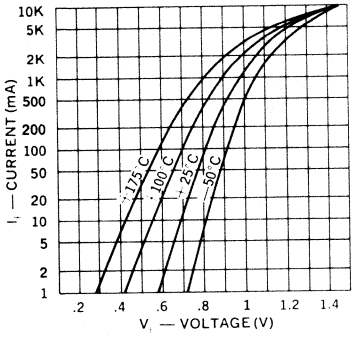
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	PIV	Minimum Reverse Breakdown Voltage @ 50μA	Forward Voltage Min.	Forward Voltage Max.	Maximum Reverse Current 25°C	Maximum Reverse Current 100°C	Maximum Reverse Recovery Time*
J, JTX, JTXV 1N5614	200V	220V	0.8	1.3V(pk) @ 3.0A tp = 300μs	0.5μA	25μA	2.0μs
J, JTX, JTXV 1N5616	400V	440V					
J, JTX, JTXV 1N5618	600V	660V					
J, JTX, JTXV 1N5620	800V	880V					

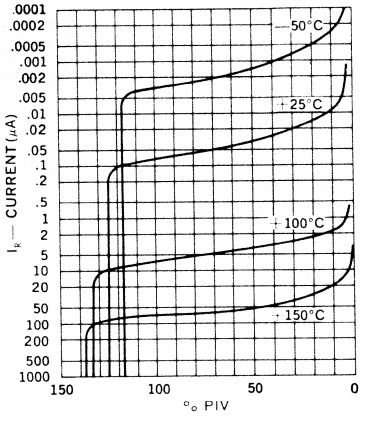
*Measured in Circuit $I_F = ½A$, $I_R = 1.0A$, $I_{REC} = ¼A$

5

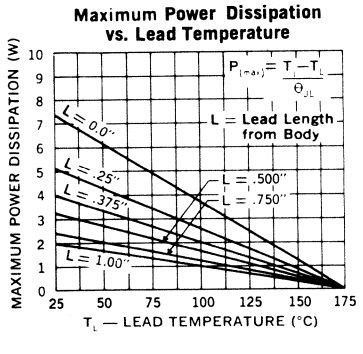
Typical Forward Voltage vs. Forward Current



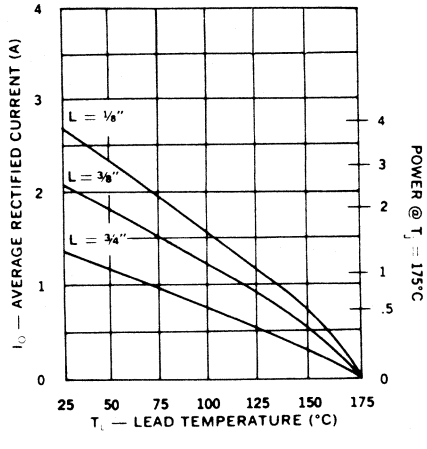
Typical Reverse Current vs. PIV



Maximum Power Dissipation vs. Lead Temperature



Maximum Current vs Lead Temperature



RECTIFIERS
Military Approved, Fast Recovery, 1 Amp

1N5615, 1N5617, 1N5619
JAN, JANTX & JANTXV

FEATURES
- Qualified to MIL-S-19500/429
- PIV: to 600V
- Controlled Avalanche

DESCRIPTION
This series of military approved rectifiers is useful in many military applications where fast recovery and medium power are required. The 100% screening requirements in the "TX" version combined with the unique Unitrode construction assures the highest degree of reliability.

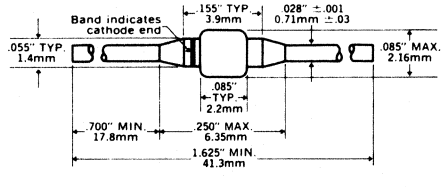
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	Type
200V	JAN, JANTX, JANTXV 1N5615
400V	JAN, JANTX, JANTXV 1N5617
600V	JAN, JANTX, JANTXV 1N5619

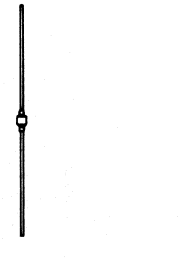
Maximum Average D.C. Output Current
@ $T_A = 55°C$ 1.0A
@ $T_A = 100°C$ 0.75A
Non-Repetitive Sinusoidal
Surge Current (8.3ms) 25A
Operating Temperature Range ..... −65°C to +175°C
Storage Temperature Range ..... −65°C to +200°C
Thermal Resistance θ_{JL} ..... 38°C/W
See Lead Temperature Derating Curve

MECHANICAL SPECIFICATIONS

J, JTX, JTXV 1N5615, 1N5617, 1N5619



BODY A



UNITRODE

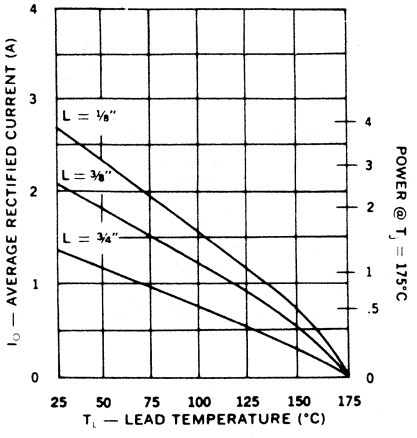
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	PIV	Minimum Reverse Breakdown Voltage @ 50μA	Forward Voltage Min.	Forward Voltage Max.	Maximum Reverse Current 25°C	Maximum Reverse Current 100°C	Maximum Reverse Recovery Time*	Capacitance @ V_R = 12V f = 1MHz
J, JTX, JTXV 1N5615	200V	220V	0.8V	1.6V(pk) @ 3.0 Adc tp = 300μs	0.5μA	25μA	150ns	45pf
J, JTX, JTXV 1N5617	400V	440V					150ns	35pf
J, JTX, JTXV 1N5619	600V	660V					250ns	25pf

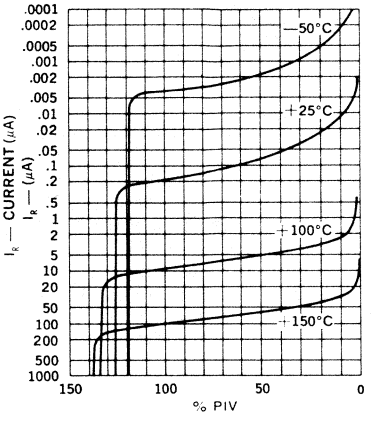
*Measured in Circuit I_F = ½A, I_R = 1A, I_{REC} = ¼A

5

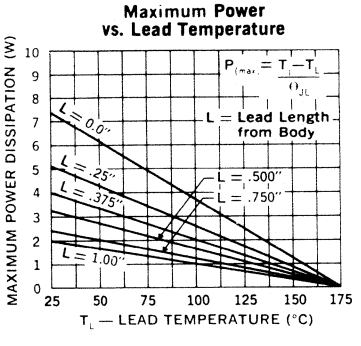
Maximum Current vs Lead Temperature



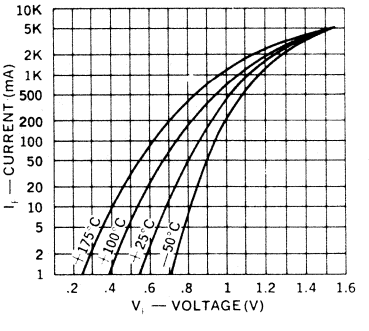
Typical Reverse Current vs. PIV



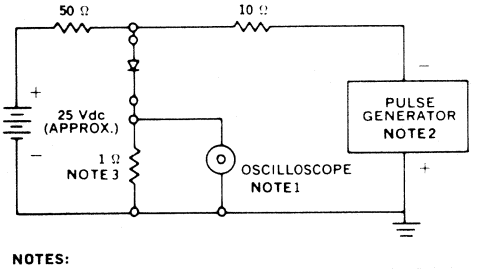
Maximum Power vs. Lead Temperature



Typical Forward Voltage vs. Forward Current



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS

High Efficiency, ESP, 2.5 Amp to 20 Amp

1N5802-1N5806
1N5807-1N5811
1N5812-1N5816

FEATURES

- Exceptional Efficiency
- Low Forward Voltage
- Extremely Fast Reverse Recovery Time
- Extremely Fast Forward Recovery Time
- High Surge
- Small Size
- Rugged, High Current Termination
- Radiation Tolerant

DESCRIPTION

This series of High Efficiency Power Rectifiers allows circuit designers to design high current, high frequency supplies to 500 kHz with very low diode losses. The high forward surge capability makes these devices useful in protective circuits.

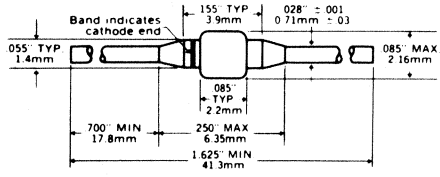
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	2.5 Amp Series	6 Amp Series	20 Amp Series
50V	1N5802	1N5807	1N5812
75V	1N5803	1N5808	1N5813
100V	1N5804	1N5809	1N5814
125V	1N5805	1N5810	1N5815
150V	1N5806	1N5811	1N5816

	2.5 AMP SERIES	6.0 AMP SERIES	20 AMP SERIES
Maximum Average D.C. Output Current			
@ T_L = 75°C, L = 3/8"	2.5A	6.0A	—
@ T_C = 100°C			20.0A
Non-Repetitive Sinusoidal Surge Current (8.3ms)	35A	125A	250A
Operating and Storage Temperature Range		−65°C to +175°C	
Thermal Resistance 2.5A and 6A Series		See Lead Temperature Derating Curve	
20A Series			3.0°C/W

MECHANICAL SPECIFICATIONS

1N5802-1N5806

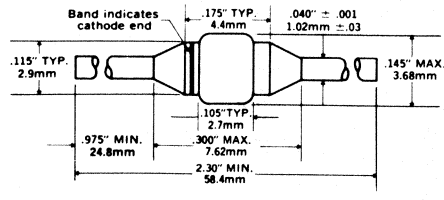


Typical Weight — 0.22 grams

BODY A



1N5807-1N5811



Typical Weight — 0.75 grams

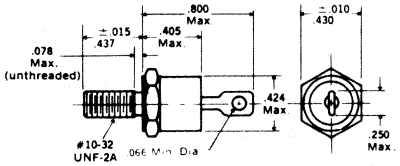
BODY B



UNITRODE

MECHANICAL SPECIFICATIONS

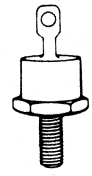
1N5812-1N5816



Part Identification: Type number printed on metal case.
Polarity: Cathode to stud end
Max. Weight: 7.0 Grams
Installation Precautions: Maximum unlubricated stud torque: 10 inch pounds
Thermal Resistance: 3.0°C/W

Dimensions in inches.

DO-4



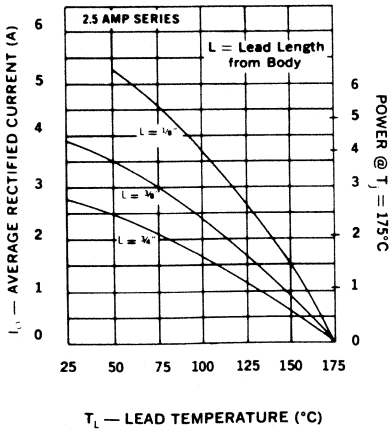
5

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

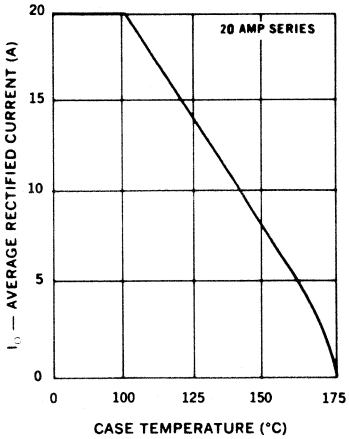
Type	PIV	Maximum Forward Voltage Drop*	Leakage Current @ PIV		Maximum Reverse Recovery Time I_F, I_R, I_{REC}	Typical Forward Recovery Time @ 1A Recover to 1V	Typical Forward Recovery Voltage @ 1A tr = 8ns	Typical Junction Capacitance @ —10V
			25°C	100°C				
1N5802 1N5803 1N5804 1N5805 1N5806	50V 75V 100V 125V 150V	.875 @ 1A	1μA	50μA	25ns, 0.5A-0.5A-0.05A	15ns	1.5V	15pf
1N5807 1N5808 1N5809 1N5810 1N5811	50V 75V 100V 125V 150V	.875 @ 4A	5μA	150μA	30ns, 1.0-1.0-0.1A	15ns	1.5V	45pf
1N5812 1N5813 1N5814 1N5815 1N5816	50V 75V 100V 125V 150V	.900 @ 10A	10μA	750μA	35ns, 1.0-1.0-0.1A	15ns	1.5V	200pf

*Pulse width = 250ms

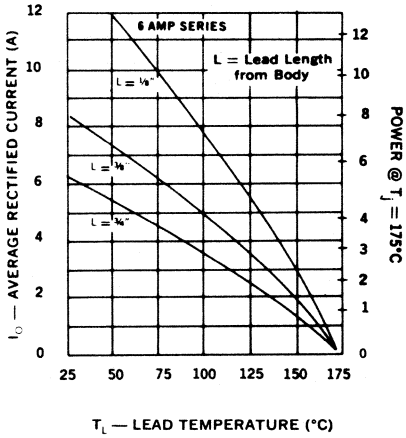
Output Current vs. Lead Temp.



Output Current vs. Case Temp.



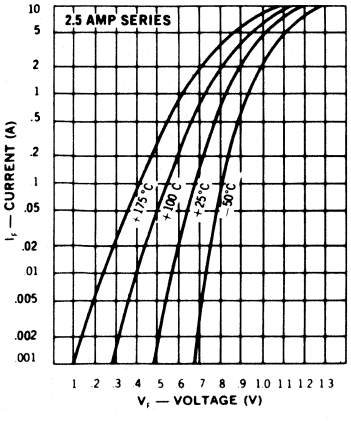
Output Current vs. Lead Temp.



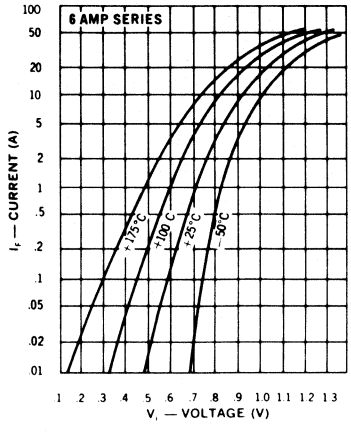
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

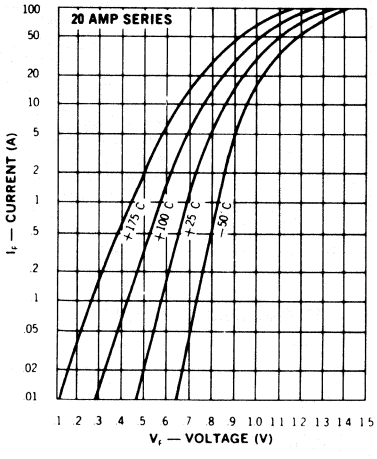
Typical Forward Current vs. Forward Voltage



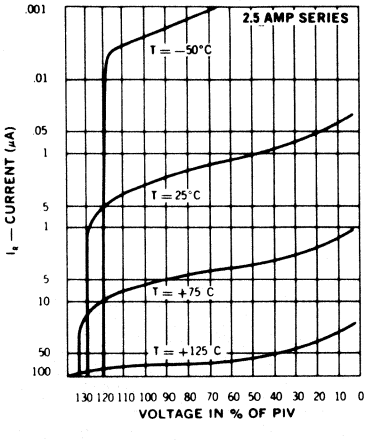
Typical Forward Current vs. Forward Voltage



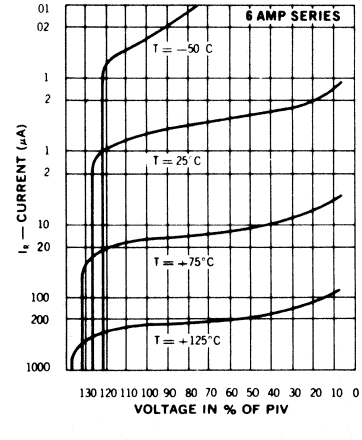
Typical Forward Current vs. Forward Voltage



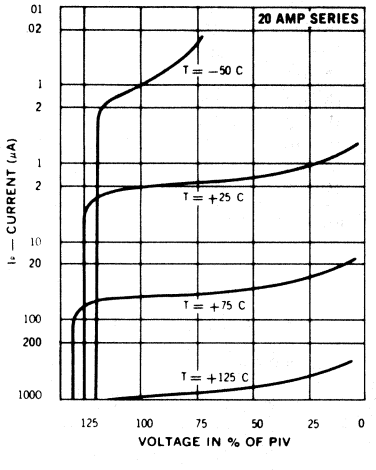
Typical Reverse Current vs. Voltage



Typical Reverse Current vs. Voltage



Typical Reverse Current vs. Voltage

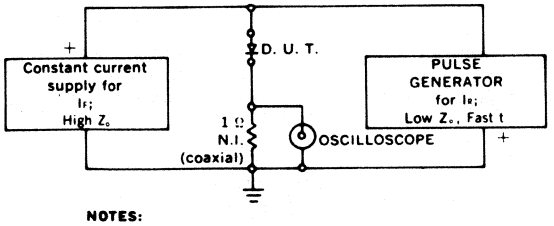


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

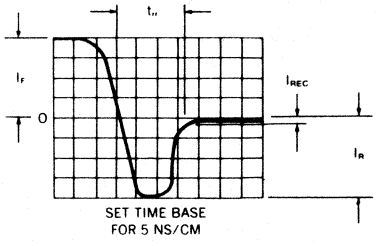
5

Reverse-Recovery Time Circuit

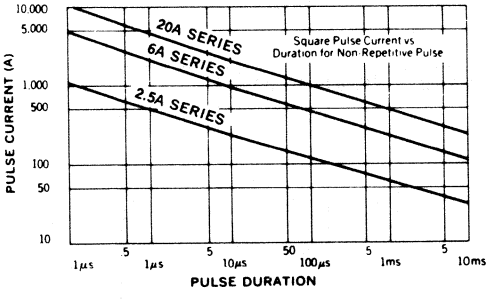


NOTES:
1. Oscilloscope: Rise time ≤ 3 ns; input impedance = 50 Ω.
2. Pulse Generator: Rise time ≤ 8 ns; source impedance 10 Ω.

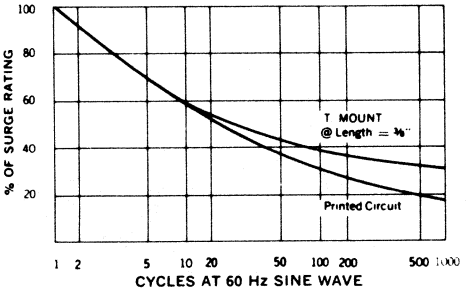
Characteristic Waveform



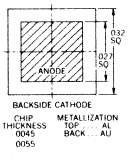
Forward Pulse Current vs. Duration



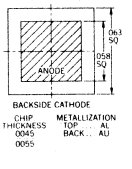
Multiple Surge Current vs. Duration



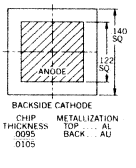
1N5804, 1N5806



1N5809, 1N5811



1N5814, 1N5816



RECTIFIERS

Military Approved, High Efficiency, 2.5 Amp and 6.0 Amp

1N5802, 1N5804, 1N5806, 1N5807, 1N5809, 1N5811 JAN, JANTX & JANTXV

FEATURES

- Qualified to MIL-S-19500/477
- PIV: to 150V
- Low Forward Voltage

DESCRIPTION

This series of high efficiency power rectifiers are particularly applicable to switching regulator power supplies where extremely fast switching and low forward losses are most important.

ABSOLUTE MAXIMUM RATINGS

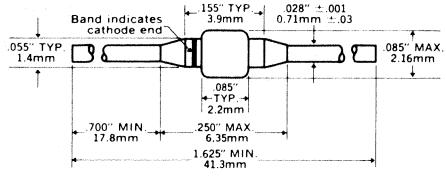
Peak Inverse Voltage	2.5A Series	6.A Series
50V	JAN, JANTX & JANTXV 1N5802	JAN, JANTX & JANTXV 1N5807
100V	JAN, JANTX & JANTXV 1N5804	JAN, JANTX & JANTXV 1N5809
150V	JAN, JANTX & JANTXV 1N5806	JAN, JANTX & JANTXV 1N5811

	2.5A SERIES	6A SERIES
Maximum Average D.C. Output Current		
@ T_L = 75°C, L = 3/8"	2.5A	6.0A
@ T_A = 55°C	1.0A	3.0A
Non-Repetitive Sinusoidal Surge Current (8.3ms)	35A	125A
Operating Temperature Range	−65°C to +175°C	
Storage Temperature Range	−65°C to +200°C	
Thermal Resistance, Θ_{JL} @ L = 3/4"	59°C/W	35.5°C/W

See lead temperature derating curve

MECHANICAL SPECIFICATIONS

J, JTX, JTXV 1N5802-1N5806

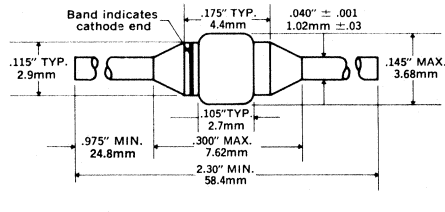


Dimensions in inches.

BODY A



J, JTX, JTXV 1N5807-1N5811



Dimensions in inches.

BODY B



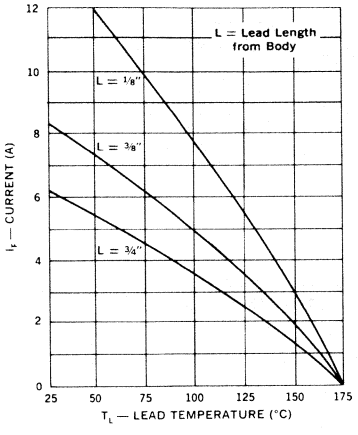
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

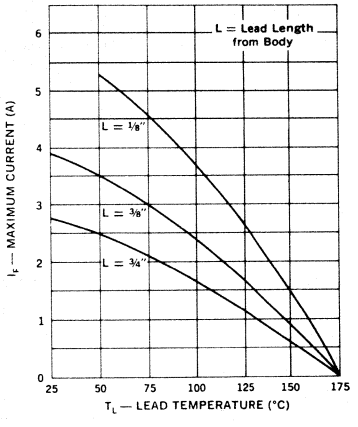
Type	PIV	Minimum Breakdown Voltage @ 100μA	Forward Voltage @ 25°C	Forward Voltage @ 100°C	Maximum Reverse Current @ PIV 25°C	Maximum Reverse Current @ PIV 100°C	Maximum Reverse Recovery Time
J, JTX, JTXV 1N5807 J, JTX, JTXV 1N5809 J, JTX, JTXV 1N5811	50V 100V 150V	60V 110V 160V	.875V Max. @ 4A (pk) .925V Max. @ 6A (pk)	.8V Max. @ 4A (pk)	5μA	150μA	30ns $I_F = I_R = 1.0A$ $I_{REC} = 0.1A$ $di/dt = 100A/\mu s$ min.
J, JTX, JTXV 1N5802 J, JTX, JTXV 1N5804 J, JTX, JTXV 1N5806	50V 100V 150V	60V 110V 160V	.875V Max. @ 1A (pk) .975V Max. @ 2.5A (pk)	.8V Max. @ 1A (pk)	1μA	50μA	25ns $I_F = I_R = 0.5A$ $I_{REC} = 0.05A$ $di/dt = 65A/\mu s$ min.

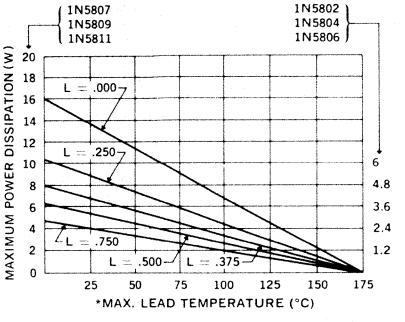
5

Output Current vs. Lead Temperature
1N5807-5811



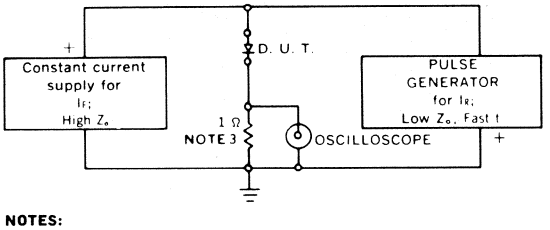
Output Current vs. Lead Temperature
1N5802-5806



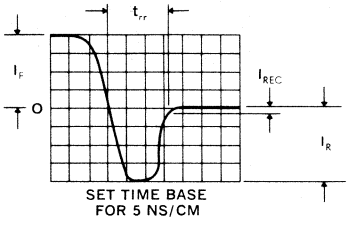


*Maximum lead temperature in °C (T_L) at point "L" from body. (For maximum operating junction temperature of 175°C with equal two-lead conditions.)

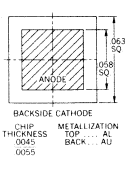
Reverse-Recovery Circuit

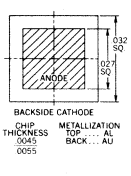


Characteristic Waveform



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

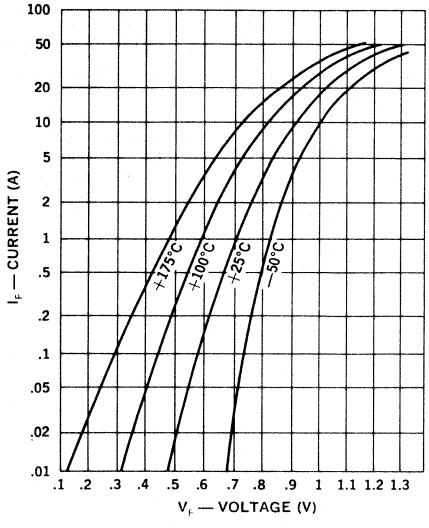




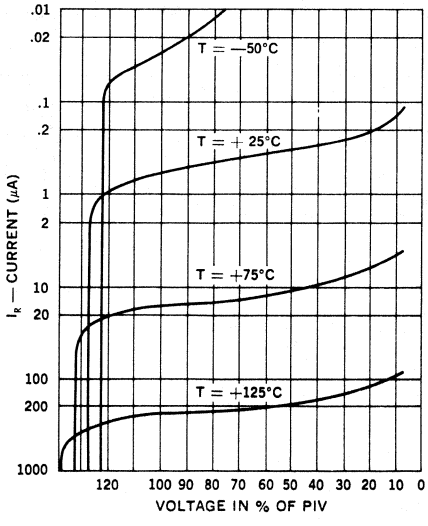
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

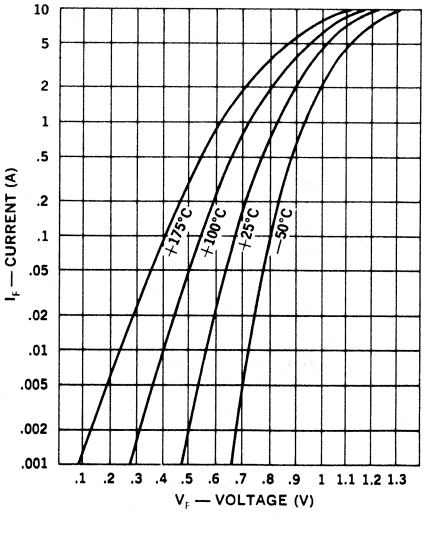
Typical Forward Current vs. Forward Voltage
JAN & JANTX 1N5807-5811



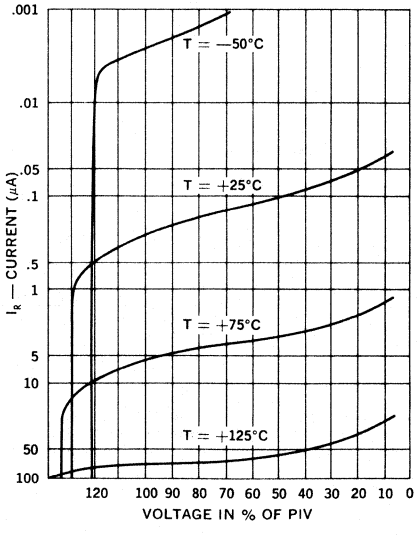
Typical Reverse Current vs. Voltage
JAN & JANTX 1N5807-5811



Typical Forward Current vs. Forward Voltage
JAN & JANTX 1N5802-5806



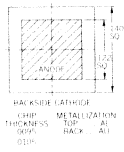
Typical Reverse Current vs. Voltage
JAN & JANTX 1N5802-5806



RECTIFIERS
Military Approved
High Efficiency, 20 Amp

1N5812, 1N5814, 1N5816
JAN, JANTX & JANTXV

FEATURES
- Qualified to MIL-S-19500/478
- Exceptional Efficiency
- Mechanically Rugged
- Low Thermal Resistance
- JAN, JANTX and JANTXV Available



DESCRIPTION
This series is suited for use as a power rectifier in switching regulator and high frequency inverter/converter and other appropriate equipment circuits where low voltage drop and fast recovery times are important.

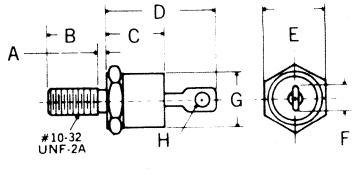
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	Type
50V	JAN, JANTX, JANTXV 1N5812
100V	JAN, JANTX, JANTXV, 1N5814
150V	JAN, JANTX, JANTXV 1N5816

Maximum Average D.C. Output Current
@ $T_C = 100°C$ 20A
@ $T_A = 55°C$ 5A
Non-Repetitive Sinusoidal
Surge Current @ 8.3mSec 400A
Thermal Resistance, Junction to Case ..... 1.5°C/W
Operating Junction Temperature ..... −65°C to +175°C
Storage Ambient Temperature ..... −65°C to +200°C

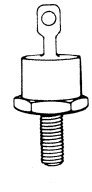
MECHANICAL SPECIFICATIONS

J, JTX, JTXV 1N5812, 1N5814, 1N5816



	ins.	mm
A	.078 MAX.	1.98 MAX.
B	.437 ± .015	11.10 ± 0.38
C	.405 MAX.	10.29 MAX.
D	.800 MAX.	20.32 MAX.
E	.430 ± .010	10.92 ± 0.25
F	.250 MAX.	6.35 MAX.
G	.424 MAX.	10.77 MAX.
H	.066 MIN. DIA.	1.68 MIN. DIA.

DO-4



Notes:
1. Polarity is cathode-to-stud.
2. All metal surfaces tin plated.
3. Maximum unlubricated stud torque: 15 inch pounds.
4. Angular orientation of terminal is undefined.

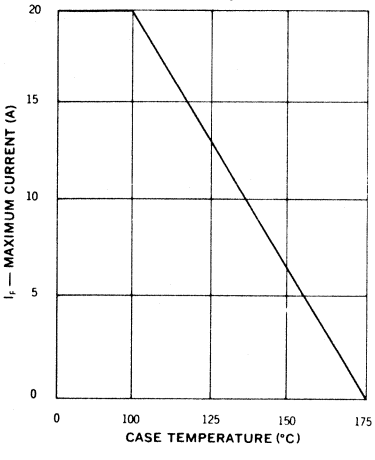
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

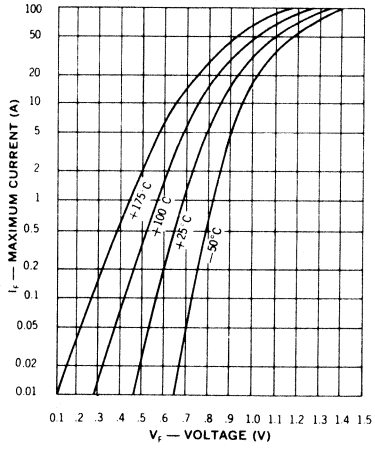
Type	Peak Inverse Voltage	Minimum Reverse Breakdown Voltage @ 100μA	Peak Forward Voltage		Maximum Leakage Current @ PIV	
			@ 10Apk	@ 20Apk	25°C	100°C
J, JTX, JTXV 1N5812	50V	60V	.86V MAX.	.95V MAX.	10μA	750μA
J, JTX, JTXV 1N5814	100V	110V				
J, JTX, JTXV 1N5816	150V	160V				

Maximum Reverse Recovery Time @ I_F, I_R, I_{REC}	Maximum Forward Recovery Time @ 1A Recovery to 1V	Maximum Forward Recovery Voltage @ 1A tr = 8nsec	Maximum Junction Capacitance @ −10V
35nsec 1.0A −1.0A −0.1A	15nsec	2.2V	300pf

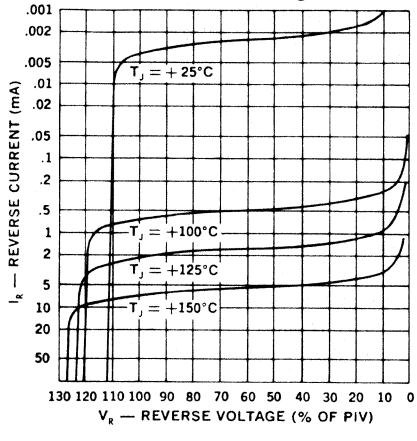
Output Current vs. Case Temperature



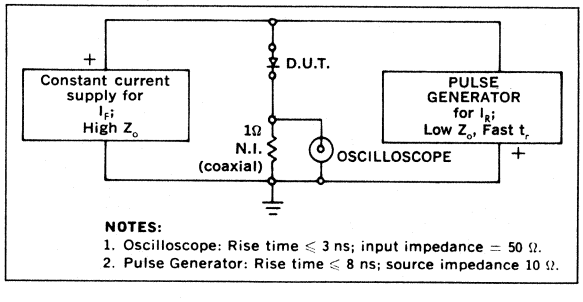
Typical Forward Current vs. Forward Voltage



Typical Reverse Current vs. Reverse Voltage

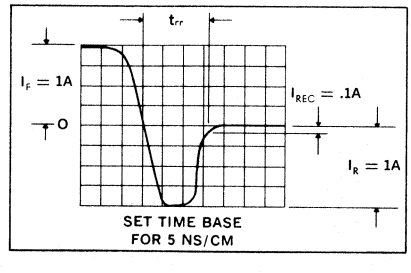


Reverse-Recovery Time Test Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3 ns; input impedance = 50 Ω.
2. Pulse Generator: Rise time ≤ 8 ns; source impedance 10 Ω.

Characteristic Waveform



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER SCHOTTKY RECTIFIERS

1A, Up to 40V

1N5817
1N5818
1N5819

5

FEATURES

- Very Low Forward Voltage (0.45V max @ 1A for the 1N5817)
- Low Stored Charge, Majority Carrier Conduction
- Economical, Convenient Plastic Package
- Small Size

DESCRIPTION

The 1N5817, 1N5818 and 1N5819 series of Schottky barrier rectifiers are ideally suited for use as rectifiers in low voltage, high frequency inverters, as free wheeling diodes and as polarity protection diodes.

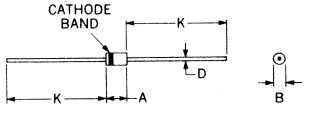
ABSOLUTE MAXIMUM RATINGS*

	1N5817	1N5818	1N5819
Peak Repetitive Reverse Voltage, V_{RRM}	20V	30V	40V
Working Peak Reverse Voltage, V_{RWM}	20V	30V	40V
DC Blocking Voltage, V_R	20V	30V	40V
Non-Repetitive Peak Reverse Voltage, V_{RSM}	24V	36V	48V
RMS Reverse Voltage, $V_{R(RMS)}$	14V	21V	28V
Average Rectified Forward Current, I_O ($V_{R(equiv)} \leq 0.2\ V_R(DC)$, $T_L = 90°C$, $R_{\theta JA} = 80°C/W$, PC Board Mounting, see Note 1, $T_A = 55°C$)		1.0A	
Ambient Temperature, T_A Rated $V_R(DC)$, $P_{F(AV)} = 0$, $R_{\theta JA} = 80°C/W$)	85°C	80°C	75°C
Non-Repetitive Peak Surge Current, I_{FSM} (Surge applied at rated load conditions, half-wave, single phase 60Hz, $T_L = 70°C$)		25A (for one cycle)	
Operating and Storage Junction Temperature Range, (Reverse Voltage Applied)		−65°C to +125°C	
Peak Operating Junction Temperature, $T_{j(pk)}$ (Forward Current Applied)		150°C	
Thermal Resistance, Junction to Ambient (Note 1), $R_{\theta JA}$		80°C/W Max.	

* JEDEC registered values.
Note 1: Lead Temperature reference is cathode lead 1/32" from case.

MECHANICAL SPECIFICATIONS

1N5817 1N5818 1N5819



	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.160	0.260	4.06	6.60
B	0.110	0.120	2.79	3.05
D	0.030	0.034	0.76	0.86
K	1.0	—	25.4	—

Soldering 220°C, 1/16" from case for ten seconds.

ASA



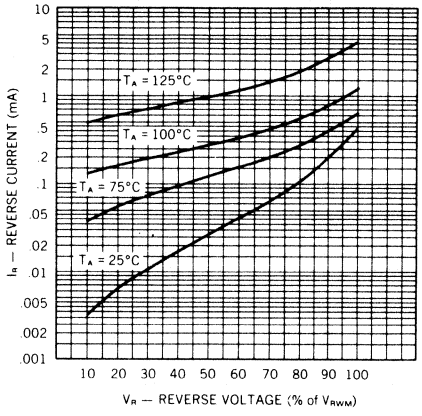
UNITRODE

ELECTRICAL CHARACTERISTICS (T_L = 25°C unless noted)*

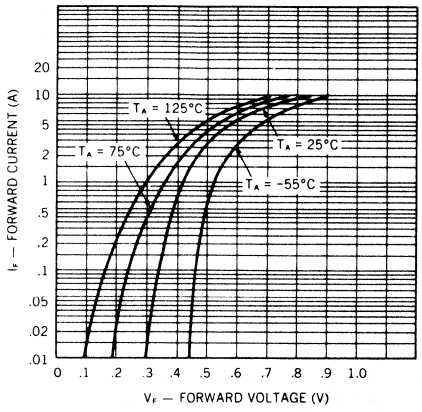
CHARACTERISTIC	SYMBOL	1N5817	1N5818	1N5819	UNITS	CONDITIONS
Maximum Instantaneous Forward Voltage (Note 2)	V_F	0.450	0.550	0.600	V	i_F = 1.0A
		0.750	0.875	0.900	V	i_F = 3.0A
Maximum Instantaneous Reverse Current @ Rated DC Voltage (Note 2)	i_R	1.0	1.0	1.0	mA	T_L = 25°C
		10	10	10	mA	T_L = 100°C

* JEDEC registered values.
Note 2: Pulse width = 300μs; duty cycle = 2%.

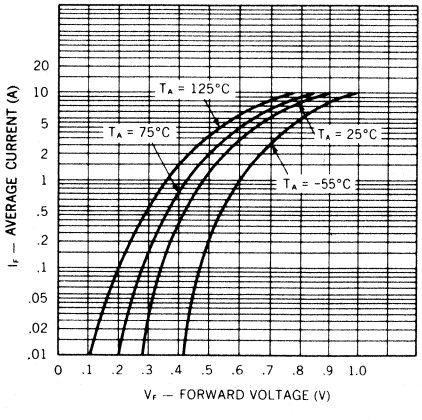
Typical Reverse Current vs Reverse Voltage



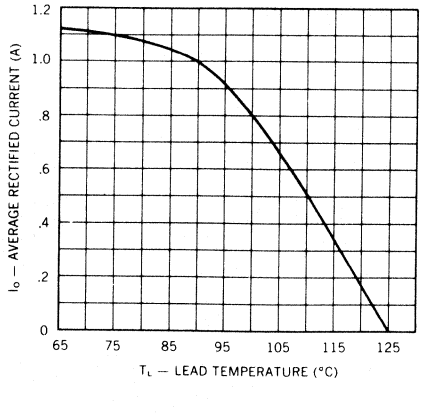
Typical Forward Voltage vs Forward Current (1N5817)



Typical Forward Voltage vs Forward Current (1N5818, 1N5819)



Output Current vs Lead Temperature (L = 3/8")



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER SCHOTTKY RECTIFIERS
3A, Up to 40V

1N5820
1N5821
1N5822

5

FEATURES
- Very Low Forward Voltage (0.475V max @ 3A for the 1N5820)
- Low Stored Charge, Majority Carrier Conduction
- Economical, Convenient Plastic Package
- Small Size

DESCRIPTION
The 1N5820, 1N5821 and 1N5822 series of Schottky barrier rectifiers are ideally suited for use as rectifiers in low voltage, high frequency inverters, as free wheeling diodes and as polarity protection diodes.

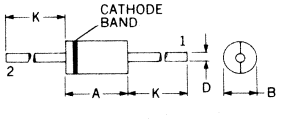
ABSOLUTE MAXIMUM RATINGS*

	1N5820	1N5821	1N5822
Peak Repetitive Reverse Voltage, V_{RRM}	20V	30V	40V
Working Peak Reverse Voltage, V_{RWM}	20V	30V	40V
DC Blocking Voltage, V_R	20V	30V	40V
Non-Repetitive Peak Reverse Voltage, V_{RSM}	24V	36V	48V
RMS Reverse Voltage, $V_{R(RMS)}$	14V	21V	28V
Average Rectified Forward Current, I_O ($V_{R(equiv)} \leq 0.2\ V_R(DC)$, T_L = 95°C, $R_{\theta JA}$ = 28°C/W, PC Board Mounting, see Note 1, T_A = 55°C)		3.0A	
Ambient Temperature, T_A (Rated $V_R(DC)$, $P_{F(AV)}$ = 0, $R_{\theta JA}$ = 28°C/W)	90°C	85°C	80°C
Non-Repetitive Peak Surge Current, I_{FSM} (Surge applied at rated load conditions, half-wave, single phase 60Hz, T_L = 75°C)		80A (for one cycle)	
Operating and Storage Junction Temperature Range, (Reverse Voltage Applied)		-65°C to +125°C	
Peak Operating Junction Temperature, $T_{j(pk)}$ (Forward Current Applied)		150°C	
Thermal Resistance, Junction to Ambient (Note 1), $R_{\theta JA}$		28°C/W Max.	

* JEDEC registered values.
Note 1: Lead Temperature reference is cathode lead 1/32" from case.

MECHANICAL SPECIFICATIONS

1N5820 1N5821 1N5822



	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.370	0.380	9.40	9.65
B	0.190	0.210	4.83	5.33
D	0.048	0.052	1.22	1.32
K	1.0	1.072	25.4	—

Soldering: 220°C, 1/16" from case for ten seconds.

ASB



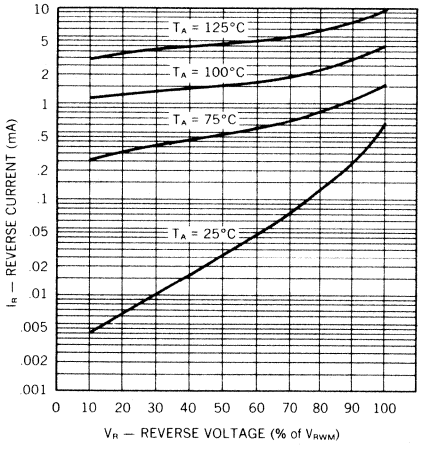
UNITRODE

ELECTRICAL CHARACTERISTICS (T_L = 25°C unless noted)*

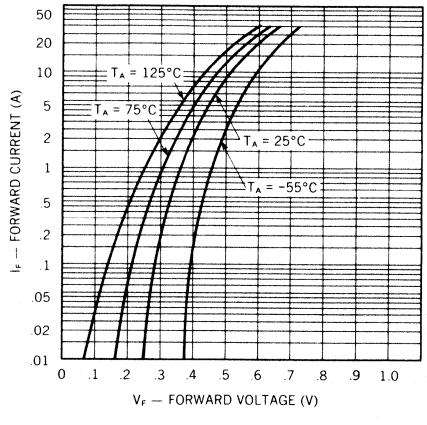
CHARACTERISTIC	SYMBOL	1N5820	1N5821	1N5822	UNITS	CONDITIONS
Maximum Instantaneous Forward Voltage (Note 2)	V_F	0.475	0.500	0.525	V	i_F = 3.0A
		0.850	0.900	0.950	V	i_F = 9.4A
Maximum Instantaneous Reverse Current @ Rated DC Voltage (Note 2)	i_R	2.0	2.0	2.0	mA	T_L = 25°C
		2.0	2.0	2.0	mA	T_L = 100°C

* JEDEC registered values.
Note 2: Pulse width = 300μs; duty cycle = 2%

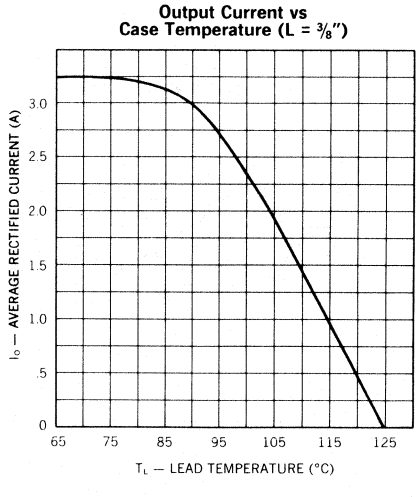
Typical Reverse Current vs Reverse Voltage



Typical Forward Voltage vs Forward Current



Output Current vs Case Temperature (L = 3/8")



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER SCHOTTKY RECTIFIERS

50 Amp, 30 and 40 Volts

1N6097
1N6098

5

FEATURES

- Very Low Forward Voltage
- Low Recovered Charge
- Rugged Package Design (DO-5)
- Low Thermal Resistance
- High Surge Current
- Reverse Energy Tested (2A pk)

DESCRIPTION

Unitrode's series of Schottky barrier power rectifiers is ideally suited for output rectifiers and catch diodes in low voltage power supplies. The Unitrode high conductivity design, using a heavy copper top post and 4 point crimp, ensures cool thermal operation and low dynamic impedance. Rugged design absorbs stress that can damage glass-to-metal seal during installation and use.

ABSOLUTE MAXIMUM RATINGS

	1N6097	1N6098
Working Peak Reverse Voltage, V_{RWM}	30V	40V
DC Blocking Voltage, V_R	30V	40V
Repetitive Peak Reverse Voltage, V_{RRM}	30V	40V
Non-repetitive Peak Reverse Voltage, V_{RSM}	36V	48V
Average Rectified Forward Current, I_O	50A ($T_C = 70°C$) 20A ($T_C = 105°C$)	
Non-repetitive Peak Surge Current (8.3 mS), I_{FSM}	800A	
Storage Temperature Range, T_{stg}	−65 to + 125°C	
Peak Operating Junction Temperature, $T_{j(pk)}$	+150°C	
Thermal Resistance Junction to Case, $R_{\theta JC}$	1°C/WMax.	

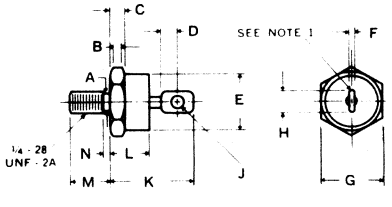
ELECTRICAL CHARACTERISTICS ($T_{CASE} = 25°C$)

Characteristic	Symbol	Both Types	Units	Conditions
Maximum Instantaneous Reverse Current	I_{RRM}	250	mA	V_{RWM} = Rated, $T_C = 125°C$ Pulse Width = 300μs, Duty Cycle ≤ 2 percent
Maximum Reverse Current	I_R	250	mA	V_R = Rated, T_C = 115°C
Maximum Instantaneous Forward Voltage	V_{FM}	0.86	V	I_O = 50A* T_C = 70°C
	V_{FM}	0.60	V	$I_F = 10A$ Pulse Width 300μs Duty Cycle ≤ 2 percent
Capacitance	C_t	7000	pF	$V_R = 1.0V$

*I_{FM} = 157A

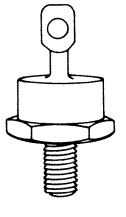
MECHANICAL SPECIFICATIONS

1N6097, 1N6098



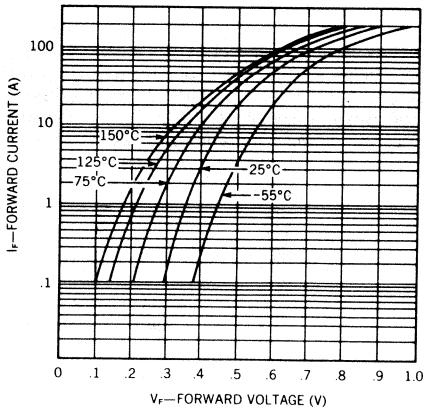
	ins.	mm
A	.225 ± .005	5.72 ± 0.13
B	.060 MIN.	1.52 MIN.
C	.156 ± .020	3.96 ± 0.51
D	.156 MIN. FLAT	3.96 MIN. FLAT
E	.667 DIA. MAX.	16.94 DIA. MAX.
F	.090 MAX.	2.29 MAX.
G	.677 ± .010	17.20 ± 0.25
H	.375 MAX.	9.53 MAX.
J	.140 MIN. DIA.	3.56 MIN. DIA.
K	1.000 MAX.	25.40 MAX.
L	.450 MAX.	11.43 MAX.
M	.438 ± .015	11.13 ± 0.38
N	.078 MAX.	1.98 MAX.

DO-5

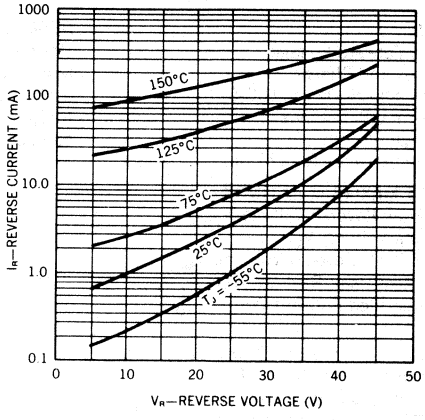


Notes:
1. Cathode is stud.
2. Maximum unlubricated stud torque: 30 inch pounds.
3. Angular orientation of terminal is undefined.
4. Maximum tension (90°) anode terminal 15 pounds for 30 seconds.

Typical Forward Current vs Forward Voltage



Typical Reverse Current vs Reverse Voltage

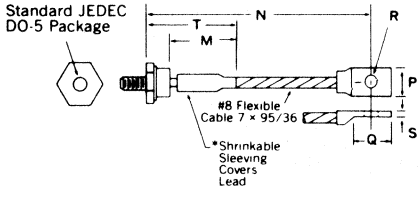


MECHANICAL SPECIFICATIONS

FLEXIBLE TOP LEAD (OPTIONAL)
Add an "F" Suffix to Part Number.

1N6097, 1N6098

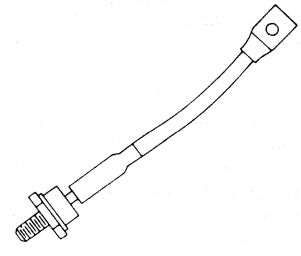
Standard JEDEC DO-5 Package



	INCHES	MILLIMETERS
M	.718 MAX.	18.24 MAX.
N	4.50 ± .250	114.3 ± 6.35
P	.525 MAX.	13.23 MAX.
Q	.675 ± .035	17.15 ± 0.89
R	.205 ± .005	5.21 ± 0.13
S	.075 ± .010	1.91 ± 0.25
T	1.125 MAX.	28.58 MAX.

*To 125°C (Ambient)

DO-5 with Flexible Lead



Note: Consult Factory for Non-standard Lead Lengths

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

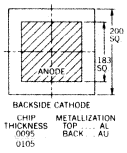
PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 70A

1N6304—1N6306
JAN, JANTX, JANTXV

5

FEATURES
- High Continuous Current Rating
- Very Low Forward Voltage
- Very Fast Switching Speeds
- High Surge Capability
- Low Thermal Resistance
- Mechanically Rugged
- Both Polarities Available
- Qualified to MIL-S-19500/550



DESCRIPTION
The 1N6304 Series is specifically designed for operation in power switching circuits operating at frequencies of at least 20KHz. The very low forward voltage and very fast recovery time make them particularly suited for switching type power supplies.

ABSOLUTE MAXIMUM RATINGS
Peak Inverse Voltage, 1N6304 ..... 50V
Peak Inverse Voltage, 1N6305 ..... 100V
Peak Inverse Voltage, 1N6306 ..... 150V
Maximum Average D.C. Output Current at T_C = 100°C 70A
Non-Repetitive Sinusodal Surge Current 8.3ms 800A
Thermal Resistance, Junction to Case ..... 0.8°C/W
Operating and Storage Temperature Range ..... -65°C to +175°C
Operating and Storage Temperature Range (JEDEC types) ..... -55°C to +175°C

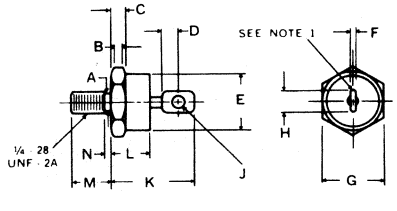
POWER CYCLING
These devices possess the unique ability to pass many thousands of cycles of a stress test designed to evaluate the integrity of the bonding systems used in the construction of power rectifiers.

In this stress test, the case of the device is not heat sunk. Full rated forward current is supplied to force a case temperature increase at least 75°C, at which time, the current is removed and the case allowed to cool. The cycle is repeated a minimum of 5,000 times to simulate equipment being turned on and off. Extended power cycling tests demonstrate a product capability in excess of 25,000 cycles.

SWITCHING CHARACTERISTICS
The switching times of these ultra-fast rectifiers increase relatively little, with temperature or at different currents. Even in severe applications, such as catch diodes for switching regulators and output rectifiers for high frequency square wave inverters, these devices switch many times faster than the fastest associated transistors. Thus, the stresses on and powers dissipated in the switching transistors are substantially less than when using other rectifiers.

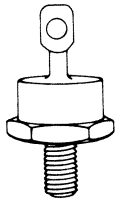
MECHANICAL SPECIFICATIONS

1N6304-1N6306



	ins.	mm
A	.225 ± .005	5.72 ± 0.13
B	.060 MIN.	1.52 MIN.
C	.156 ± .020	3.96 ± 0.51
D	.156 MIN. FLAT	3.96 MIN. FLAT
E	.667 DIA. MAX.	16.94 DIA. MAX.
F	.090 MAX.	2.29 MAX.
G	.677 ± .010	17.20 ± 0.25
H	.375 MAX.	9.53 MAX.
J	.140 MIN. DIA.	3.56 MIN. DIA.
K	1.000 MAX.	25.40 MAX.
L	.450 MAX.	11.43 MAX.
M	.438 ± .015	11.13 ± 0.38
N	.078 MAX.	1.98 MAX.

DO-203AB
(DO-5)



Notes:
1. Standard polarity is cathode-to-stud.
   For reverse polarity (anode-to-stud) add suffix "R", ie. 1N6304R.
2. All metal surfaces tin plated.
3. Maximum unlubricated stud torque: 20 inch pounds (20 kg. cm).
4. Angular orientation of terminal is undefined.

UNITRODE

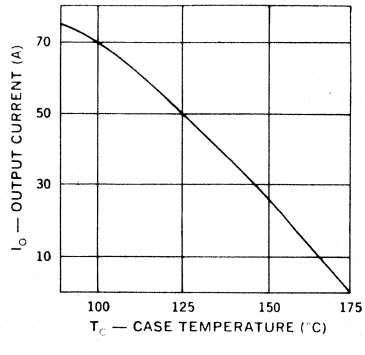
ELECTRICAL SPECIFICATIONS

Type	V_R	Maximum Forward Voltage V_F		Maximum Reverse Current I_R		Maximum Reverse Recovery Time t_{rr}
		T_C = 25°C	T_C = 150°C	T_C = 25°C	T_C = 150°C	
1N6304 1N6305 1N6306	50V 100V 150V	.975V @ 70A t_P = 300μS	.840V @ 70A t_P = 300μS	25μA	30mA	50ns 1A-1A-0.1A
J, JTX, JTXV 1N6304 J, JTX, JTXV 1N6305 J, JTX, JTXV 1N6306	50V 100V 150V	.975V @ 70A t_P = 300μs	.840V @ 70A t_P = 300μs	25μA	30mA	50ns[1]
		1.18V @ 150A t_P = 300μs				60ns[2]

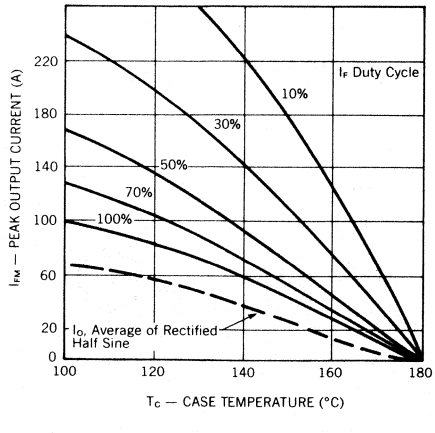
[1] I_F = 0.5A, I_R = 1A, I_{REC} = 0.25A, $di/_{dt}$ = 85A/μs (min.).
[2] I_{FM} = 70A, $di/_{dt}$ = 130A/μs.

Type	V_R	Maximum Forward Recovery Time	Maximum Forward Voltage	Maximum Junction Capacitance
J, JTX, JTXV 1N6304 J, JTX, JTXV 1N6305 J, JTX, JTXV 1N6306	50V 100V 150V	15ns I_{FM} = 1A, t_r = 8ns	2.2V I_{FM} = 1A, t_r = 8ns	@ −10V 600pF

Output Current vs. Case Temperature



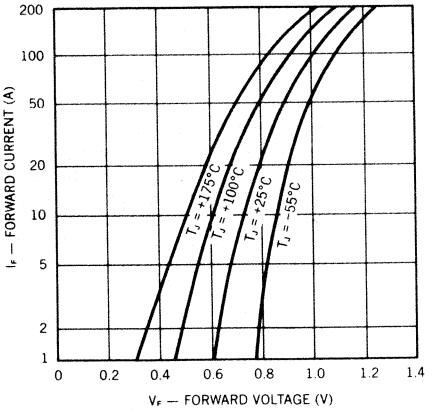
Peak Output Current vs. Case Temperature



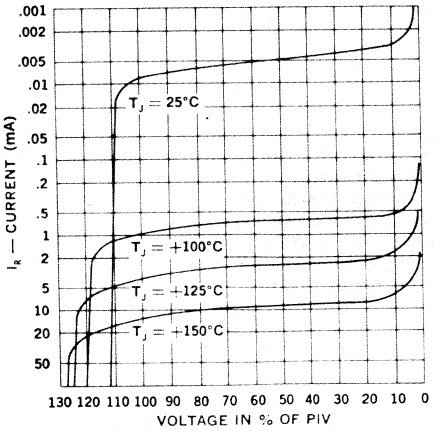
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

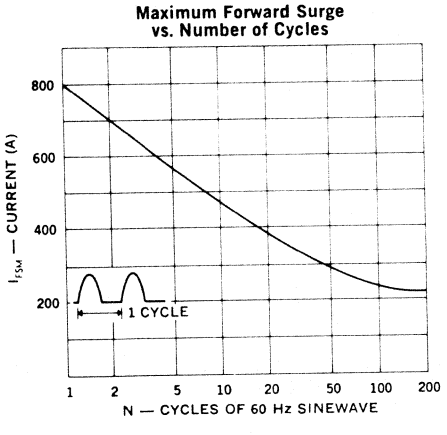
Forward Current vs. Forward Voltage



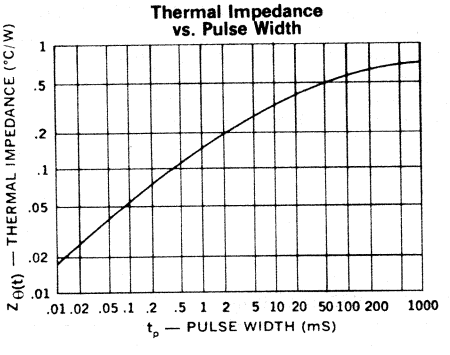
Typical Reverse Current vs. Reverse Voltage



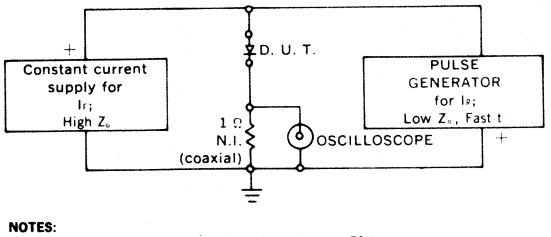
Maximum Forward Surge vs. Number of Cycles



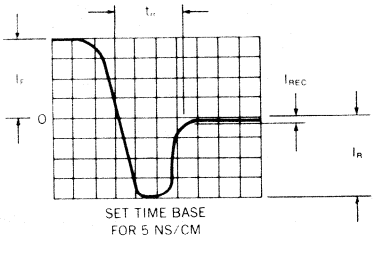
Thermal Impedance vs. Pulse Width



Reverse-Recovery Circuit



Characteristic Waveform



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance = 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

POWER SCHOTTKY RECTIFIERS
50A Pk, 45V

1N6391
JAN, JANTX, JANTXV

FEATURES
- Very Low Forward Voltage
- Low Recovered Charge
- Rugged Package Design (DO-4)
- High Efficiency for Low Voltage Supplies
- 45V Blocking @ Rated T_{jmax}
- 54V Repetitive Surge Voltage
- Qualified to MIL-S-19500/553

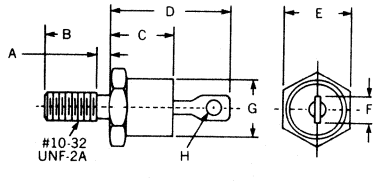
DESCRIPTION
The 1N6391 has a Schottky barrier junction and is ideally suited for output rectifiers and catch diodes in low voltage power supplies. Rugged design absorbs stress that can damage glass-to-metal seal during installation and use.

ABSOLUTE MAXIMUM RATINGS

Working Peak Reverse Voltage, V_{RWM} 45V
DC Blocking Voltage, V_R 45V
Peak Repetitive Surge Voltage, V_{RSM} @ I_{RM} 54V
Average Rectified Forward Current, I_O @ T_C = 125°C 25A
Peak Repetitive Forward Current
(Rated V_R, Square Wave, 20kHz, 50% Duty Cycle),
I_{FRM} @ T_C = 125°C 50A
Non-Repetitive Peak Surge Current (8.3ms), I_{FSM} 600A
Peak Reverse Transient Current, I_{RM} 2A
Operating and Storage Temperature Range ..... -55°C to +175°C
Thermal Resistance, Junction to Case, $R_{\theta JC}$ ..... 2.0°C/W

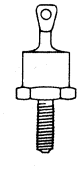
MECHANICAL SPECIFICATIONS

JAN, JANTX, JANTXV 1N6391



	INCHES	MILLIMETERS
A	.078 MAX.	1.98 MAX.
B	.437 ± .015	11.10 ± 0.38
C	.405 MAX.	10.29 MAX.
D	.800 MAX.	20.32 MAX.
E	.430 ± .010	10.92 ± 0.25
F	.250 MAX.	6.35 MAX.
G	.424 MAX.	10.77 MAX.
H	.066 MIN. DIA.	1.68 MIN. DIA.

DO-4



NOTES:
1. Cathode is stud.
2. All metal surfaces tin plated.
3. Maximum unlubricated stud torque: 10 inch pounds.
4. Angular orientation of terminal is undefined.

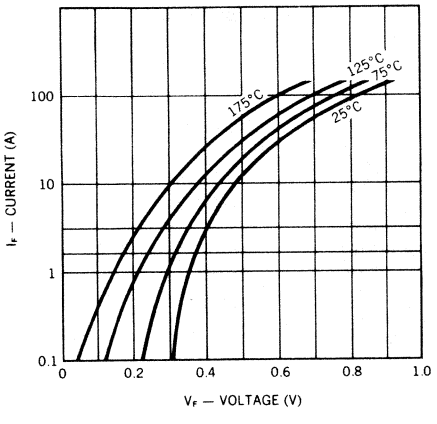
UNITRODE

ELECTRICAL CHARACTERISTICS (T_{CASE} = 25°C)

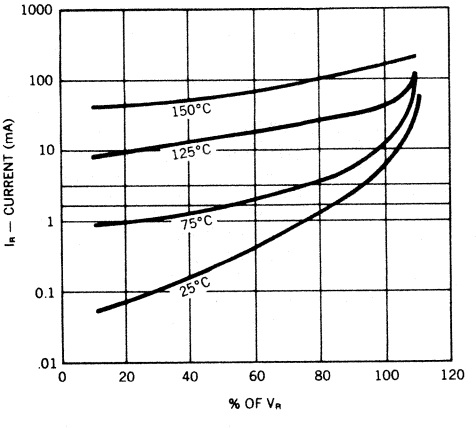
Characteristic	Symbol	Limit	Units	Conditions
Maximum Instantaneous Reverse Current	i_R	15 40 400	mA mA mA	T_C = 25°C, V_R = V_{RWM} T_C = 125°C T_C = 175°C Pulse Width = 400μs Duty Cycle = 1%
Maximum Instantaneous Forward Voltage	V_F	0.44 0.68	V V	i_F = 5A, T_C = 25°C i_F = 50A, T_C = 25°C Pulse Width = 300μs Duty Cycle = 1%
Capacitance	C_t	2000	pF	V_R = 5.0V

5

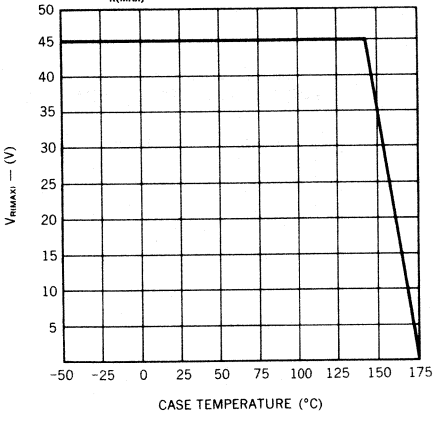
Typical Forward Current vs Forward Voltage



Typical Reverse Current vs Reverse Voltage



$V_{R(MAX)}$ Rating vs Case Temperature



POWER SCHOTTKY RECTIFIERS
120A Pk

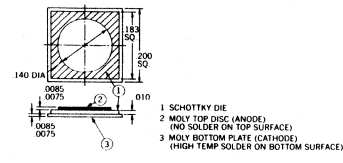
1N6392
JAN, JANTX, JANTXV

FEATURES
- Very Low Forward Voltage (0.6 at 60A, 125°C)
- Low Recovered Charge
- Rugged Package Design (DO-5)
- High Efficiency for Low Voltage Supplies
- Low Thermal Resistance (1.0°C/W)
- High Surge Current (800A)
- Low Reverse Current (60mA at rated V_R at 125°C)
- Qualified to MIL-S-19500/554

DESCRIPTION
The 1N6392 Schottky barrier power rectifier is ideally suited for output rectifiers and catch diodes in low voltage power supplies. The Unitrode high conductivity design, using a heavy copper top post and 4 point crimp, ensures cool thermal operation and low dynamic impedance. Rugged design absorbs stress that can damage glass-to-metal seal during installation and use.

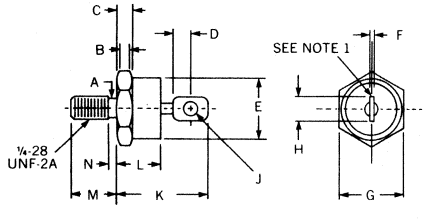
ABSOLUTE MAXIMUM RATINGS

Working Peak Reverse Voltage, V_{RWM} 45V
DC Blocking Voltage, V_R 45V
Peak Repetitive Surge Voltage, V_{RSM} @ I_{RM} 54V
Peak Repetitive Forward Current
(Rated V_R, Square Wave, 20kHz, 50% Duty Cycle), I_{FRM} ..... 120A (at T_C = 115°C)
Average Rectified Forward Current, $I_{F(AV)}$ ..... 60A (at T_C = 115°C)
Non-Repetitive Peak Surge Current (8.3ms), I_{FSM} 800A
Peak Reverse Transient Current, I_{RM} 2A
Operating and Storage Temperature Range ..... -55°C to +175°C
Thermal Resistance, Junction to Case, $R_{\theta JC}$ ..... 1.0°C/W



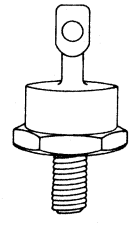
MECHANICAL SPECIFICATIONS

JAN, JANTX, JANTXV 1N6392



	INCHES	MILLIMETERS
A	.225 ± .005	5.72 ± 0.13
B	.060 MIN.	1.52 MIN.
C	.156 ± .020	3.96 ± 0.51
D	.156 MIN. FLAT	3.96 MIN. FLAT
E	.667 DIA. MAX.	16.94 DIA. MAX.
F	.090 MAX.	2.29 MAX.
G	.677 ± .010	17.20 ± 0.25
H	.375 MAX.	9.53 MAX.
J	.140 MIN. DIA.	3.56 MIN. DIA.
K	1.000 MAX.	25.40 MAX.
L	.450 MAX.	11.43 MAX.
M	.438 ± .015	11.13 ± 0.38
N	.078 MAX.	1.98 MAX.

DO-5



NOTES:
1. Cathode is stud.
2. All metal surfaces tin plated.
3. Maximum unlubricated stud torque: 30 inch pounds (35 kg. cm).
4. Angular orientation of terminal is undefined.

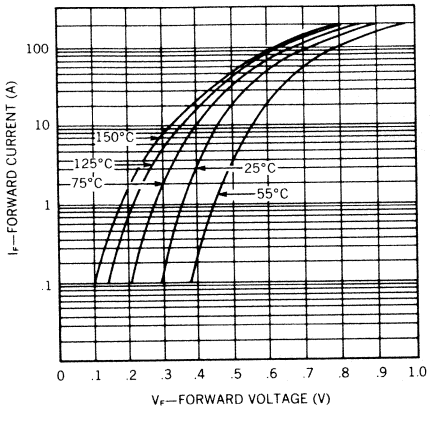
UNITRODE

ELECTRICAL CHARACTERISTICS (T_{CASE} = 25°C)

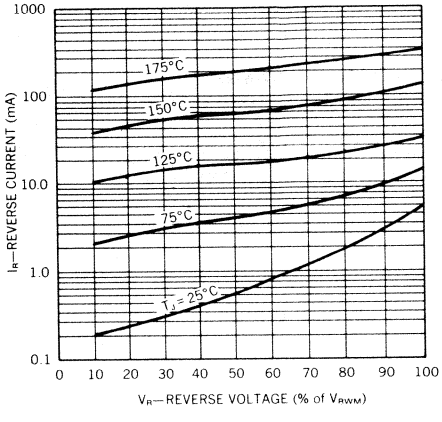
Characteristic	Symbol	Limit	Units	Conditions
Maximum Instantaneous Reverse Current	i_R	20 60 600	mA mA mA	$V_R = V_{RWM}$ T_C = 125°C T_C = 175°C Pulse Width = 400μs Duty Cycle = 1%
Maximum Instantaneous Forward Voltage	v_F	0.47 0.68 0.82	V V V	i_F = 10A, T_C = 25°C i_F = 60A, T_C = 25°C i_F = 120A, T_C = 125°C Pulse Width = 300μs Duty Cycle = 1%
Maximum Capacitance	C_t	3000	pF	V_R = 5.0V

5

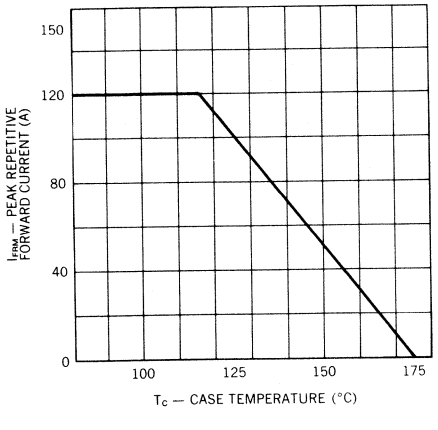
Typical Forward Current vs Forward Voltage



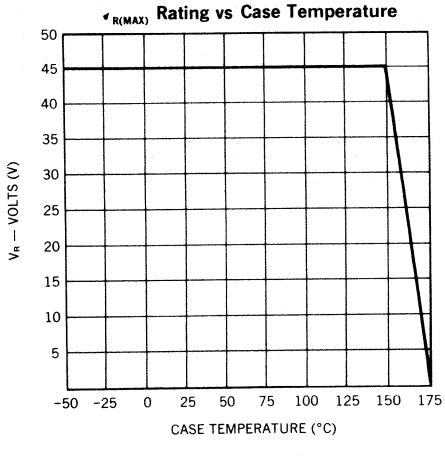
Typical Reverse Current vs Reverse Voltage



Maximum Current vs Case Temperature



$\blacktriangleleft_{R(MAX)}$ Rating vs Case Temperature



HIGH VOLTAGE SILICON RECTIFIERS

100-250mA

Fast Recovery, Miniature

HA10-100
HVX10-100

FEATURES

- PIV: From 1.0kV to 10kV
- 250nS Reverse Recovery
- High Surge Current Ratings
- Low Reverse Leakage
- Corona Free

DESCRIPTION

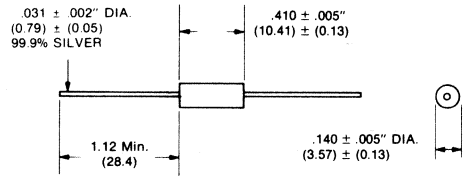
The HVX/HA silicon rectifier series combine a medium rectified current capability and high reliabilty in a miniature package for commercial, industrial and military applications. The use of cylindrical die construction and metallurgical bonds minimize electrical and mechanical stress, contributing to long life. The fast reverse recovery characteristics enhance applications in high frequency power conversion and control circuits.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	1.0kV to 10kV
Maximum Average Rectified Current	See Electrical Specifications
Maximum One Cycle Surge 8.3mS	See Electrical Specifications
Maximum Recurrent Peak Current Surge	See Electrical Specifications
Operating and Storage Temperature Range	−65°C to +150°C

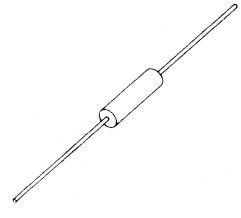
MECHANICAL SPECIFICATIONS

HVX10-100

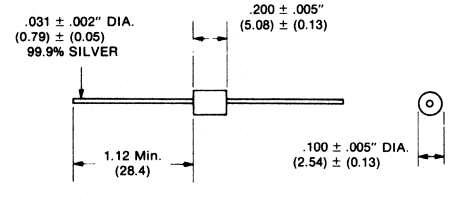


Dimensions in inches and (millimeters)

SJ

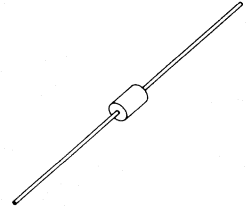


HA10-100



Dimensions in inches and (millimeters)

SK

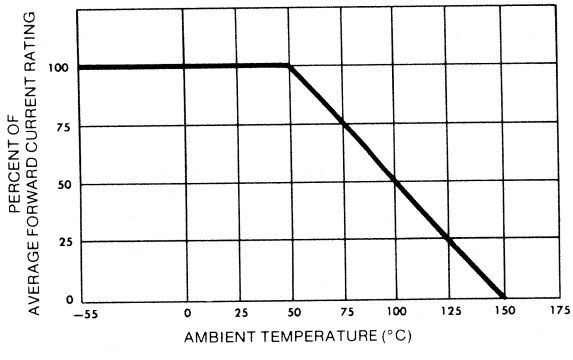


UNITRODE

Type	Type	ELECTRICAL SPECIFICATIONS (at 25°C unless noted)					MAXIMUM RATINGS				
		Peak Inverse Voltage*	Maximum Reverse Current @ PIV		Maximum Forward Voltage @ 100mA	Maximum Reverse Recovery Time	Maximum Average Rectified Current†			Maximum Recurrent Peak Current	Maximum One Cycle Surge 8.3mS Surge
		PIV	I_R		V_F	T_{RR}	I_O			I_F	I_F(surge)
		V	25°C μA	100°C μA	V	nS	50°C mA	100°C mA	125°C mA	A	A
HVX10	HA10	1000	1	20	5	250	250	125	62.5	2.5	14
HVX15	HA15	1500	1	20	5	250	250	125	62.5	2.5	14
HVX20	HA20	2000	1	20	5	250	250	125	62.5	2.5	14
HVX25	HA25	2500	1	20	5	250	250	125	62.5	2.5	14
HVX30	HA30	3000	1	20	5	250	250	125	62.5	2.5	14
HVX40	HA40	4000	1	20	12	250	100	50	25	1.0	4
HVX50	HA50	5000	1	20	12	250	100	50	25	1.0	4
HVX75	HA75	7500	1	20	12	250	100	50	25	1.0	4
HVX100	HA100	10000	1	20	12	250	100	50	25	1.0	4

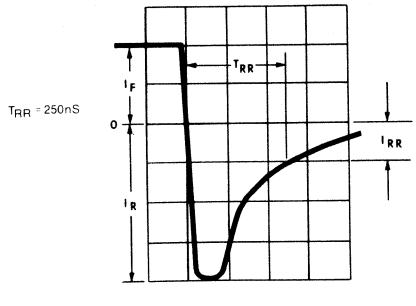
*Operation and testing of devices over 10,000 V/inch may require re-encapsulation or immersion in a suitable dielectric material.
† The stated, AVERAGE RECTIFIED CURRENT ratings require no heat sinking, special mounting or forced air across the body of the device.
NOTE: Maximum lead temperature for soldering is 250°C, 3/8" (9.5mm) from case for 5 seconds maximum.

MAXIMUM FORWARD CURRENT VS. AMBIENT TEMPERATURE

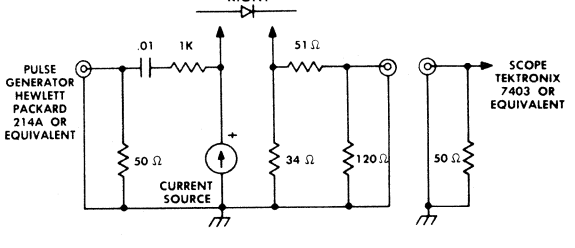


REVERSE RECOVERY TEST CONDITIONS: I_F = 50 mA, I_R = 100 mA, I_{RR} = 25 mA

REVERSE RECOVERY WAVE FORM



REVERSE RECOVERY TEST CIRCUIT



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

HIGH VOLTAGE SILICON RECTIFIERS

100-250mA

Standard Recovery, Miniature

HS10-100
HVE10-30 (1N3643-47)
HVE40-100 (1N5181-84)

FEATURES

- PIV: From 1.0kV to 10kV
- JEDEC Types
- High Surge Current Ratings
- Low Reverse Leakage
- Corona Free

DESCRIPTION

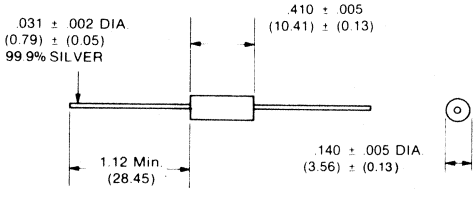
The HVE/HS silicon rectifier series combine a medium average rectified current capability and high reliability in a miniature package for commercial, industrial and military applications. The use of cylindrical die construction and metallurgical bonds minimize electrical and mechanical stress, contributing to long life. A 2 microsecond reverse recovery characteristic improves the circuit efficiency of power conversion and control systems.

ABSOLUTE MAXIMUM RATINGS

	HS	HVE
Peak Inverse Voltage	1.0kV	10kV
Maximum Average Rectified Current	See Electrical Specifications.	
Maximum One Cycle Surge 8.3mS	See Electrical Specifications.	
Maximum Recurrent Peak Current Surge	See Electrical Specifications.	
Operating and Storage Temperature Range	−65°C to +175°C	

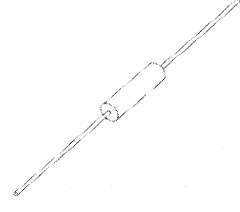
MECHANICAL SPECIFICATIONS

HVE10-30 (1N3643-47)
HVE40-100 (1N5181-84)

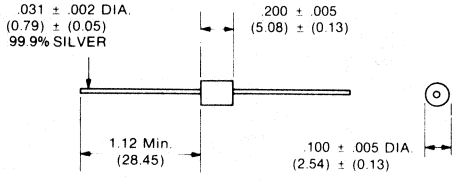


Dimensions in inches and (millimeters)

SJ

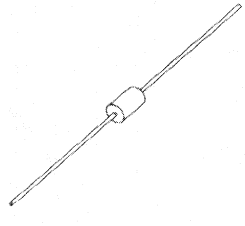


HS10-100



Dimensions in inches and (millimeters)

SK

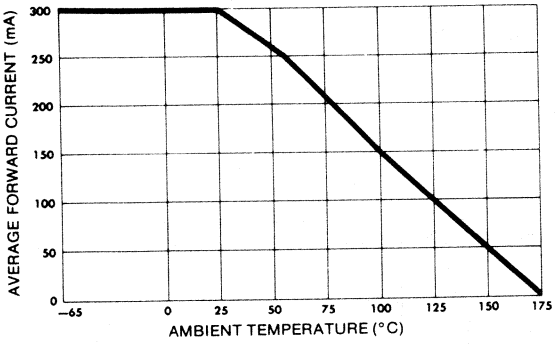


ELECTRICAL SPECIFICATIONS (at 25°C unless noted)						MAXIMUM RATINGS				
Maximum Reverse Recovery Time		Peak Inverse Voltage*	Maximum Reverse Current @ PIV		Maximum Forward Voltage @ 100mA Max.	Maximum Average Rectified Current†			Maximum Recurrent Peak Current Surge	Maximum One Cycle Surge 8.3mS
		PIV	I_R		V_F	I_O			I_F	I_F(surge)
2μS	2μS		25°C	100°C	25°C	50°C	100°C	150°C		
Type	Type	V	μA	μA	V	mA	mA	mA	A	A
HS10	HVE10 (1N3643)	1000	1	20	3.5	250	150	50	2.5	14
HS15	HVE15 (1N3644)	1500	1	20	3.5	250	150	50	2.5	14
HS20	HVE20 (1N3645)	2000	1	20	3.5	250	150	50	2.5	14
HS25	HVE25 (1N3646)	2500	1	20	3.5	250	150	50	2.5	14
HS30	HVE30 (1N3647)	3000	1	20	3.5	250	150	50	2.5	14
HS40	HVE40 (1N5181)	4000	1	20	10.0	100	60	20	1.0	4
HS50	HVE50 (1N5182)	5000	1	20	10.0	100	60	20	1.0	4
HS75	HVE75 (1N5183)	7500	1	20	10.0	100	60	20	1.0	4
HS100	HVE100 (1N5184)	10000	1	20	10.0	100	60	20	1.0	4

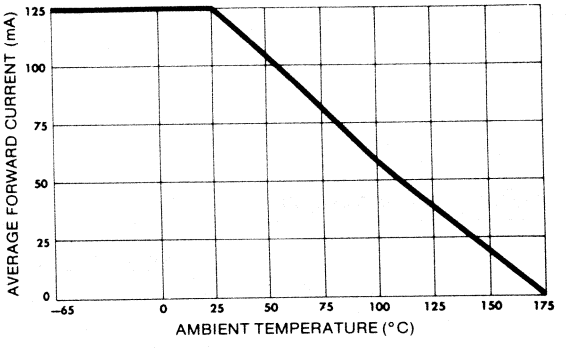
*Operation and testing of devices over 10,000 V/inch may require re-encapsulation or immersion in a suitable dielectric material.
†The stated, AVERAGE RECTIFIED CURRENT ratings require no heat sinking, special mounting or forced air across the body of the device.
NOTE: Maximum lead temperature for soldering is 250°C 3/8" (9.5mm) from case for 5 seconds maximum.

5

HVE/HVE10-30/1N3643-47

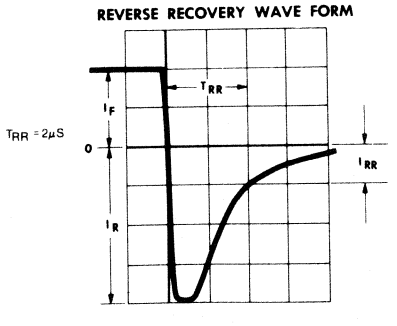


HVE/HVE40-100/1N5181-84)

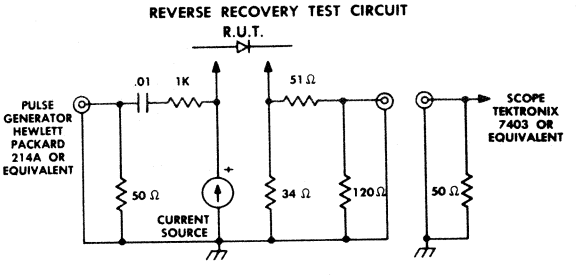


REVERSE RECOVERY TEST CONDITIONS: I_F = 50 mA, I_R = 100 mA, I_{RR} = 25 mA

REVERSE RECOVERY WAVE FORM



REVERSE RECOVERY TEST CIRCUIT



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

HIGH VOLTAGE SILICON RECTIFIERS

MULTISTAC

Fast Recovery, High Current

HVF2500-25000

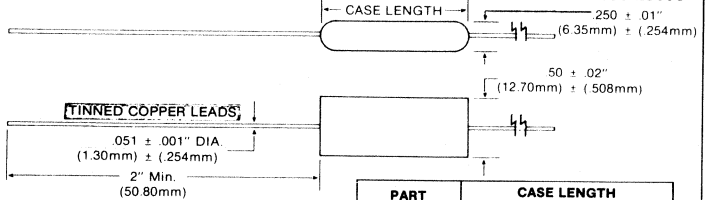
FEATURES
- PIV: From 2.5kV to 25kV
- 150nS Reverse Recovery
- High Surge Current Ratings
- Low Reverse Leakage
- Corona Free

DESCRIPTION
The HVF MULTISTAC high current, high voltage silicon rectifier's convenient size and high power capability meets the reliability requirements of commercial, industrial and military applications. Reliability with economy are obtained through the use of proprietary innovations in manufacturing technique. Cylindrical die construction and metallurgical bonds minimize electrical and mechanical stress, contributing to long life.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	2.5kV to 25kV
Maximum Average Rectified Current	See Electrical Specifications
Maximum One Cycle Surge 8.3mS	See Electrical Specifications
Operating and Storage Temperature Range	-55°C to +150°C

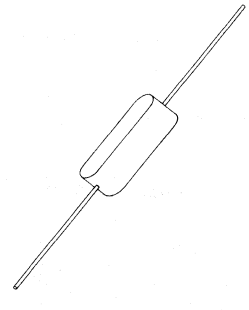
MECHANICAL SPECIFICATIONS



PART NUMBER	CASE LENGTH	
	INCHES	MILLIMETERS
HVF2500	1.125 ± .02	28.58 ± .508
HVF5000	2.000 ± .02	50.80 ± .508
HVF7500	2.750 ± .02	69.85 ± .508
HVF10000	3.500 ± .02	88.90 ± .508
HVF12500	4.250 ± .02	107.95 ± .508
HVF15000	4.250 ± .02	107.95 ± .508
HVF20000	4.250 ± .02	107.95 ± .508
HVF25000	4.250 ± .02	107.95 ± .508

Dimensions in inches and (millimeters)

PB



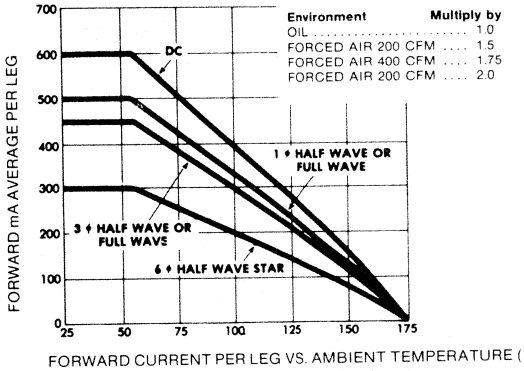
UNITRODE

Type	ELECTRICAL SPECIFICATIONS (at 25°C unless noted)					MAXIMUM RATINGS				Case Length	
	Peak Inverse Voltage*	Maximum Reverse Current @ PIV		Maximum Forward Voltage @ I_O Max.	Maximum Reverse Recovery Time	Maximum Average Rectified Current†		Maximum One Cycle Surge 8.3mS			
	PIV	I_R		V_F	T_{RR}	I_O		I_F(surge)			
	V	25°C μA	100°C μA	V	nS	55°C A	100°C A	25°C A	100°C A	Ins.	MM
HVF2500	2500	0.1	15	5.5	150	.5	.33	40	20	1.125	28.58
HVF5000	5000	0.1	15	11.0	150	.5	.33	40	20	2.000	50.80
HVF7500	7500	0.1	15	16.5	150	.5	.33	40	20	2.750	69.85
HVF10000	10000	0.1	15	22.0	150	.5	.33	40	20	3.500	88.90
HVF12500	12500	0.1	15	27.5	150	.5	.33	40	20	4.250	107.95
HVF15000	15000	0.1	15	33.0	150	.5	.33	40	20	4.250	107.95
HVF20000	20000	0.1	15	38.5	150	.5	.33	40	20	4.250	107.95
HVF25000	25000	0.1	15	44.0	150	.5	.33	40	20	4.250	107.95

5

* Operation and testing of devices over 10,000 V/inch may require re-encapsulation or immersion in a suitable dielectric material.
† The stated, AVERAGE RECTIFIED CURRENT ratings require no heat sinking, special mounting or forced air across the body of the device.
NOTE: Maximum lead temperature for soldering is 250°C 3/8" (9.5mm) from case for 5 seconds.

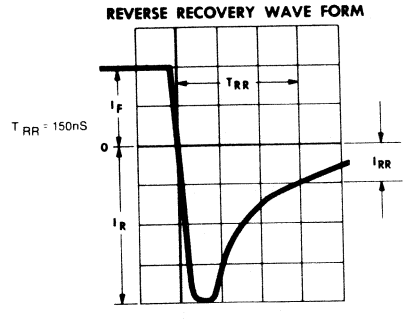
MAXIMUM FORWARD CURRENT VS. AMBIENT TEMPERATURE



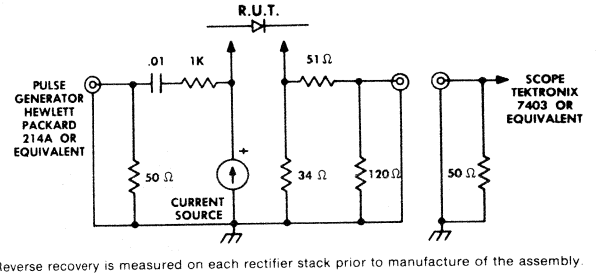
FORWARD CURRENT PER LEG VS. AMBIENT TEMPERATURE (°C)

REVERSE RECOVERY TEST CONDITIONS: I_F = 0.1A, I_R = 0.2A, I_{RR} = 0.05A

REVERSE RECOVERY WAVE FORM



REVERSE RECOVERY TEST CIRCUIT



Reverse recovery is measured on each rectifier stack prior to manufacture of the assembly.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

HIGH VOLTAGE SILICON RECTIFIERS

MULTISTAC

Fast Recovery, High Current

HVFS2500-20000

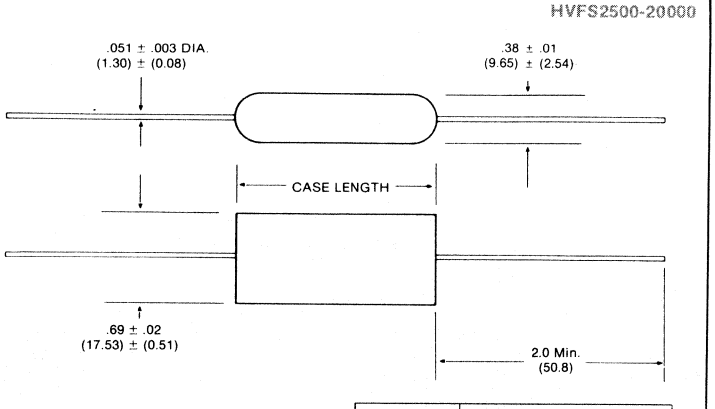
FEATURES
- PIV: From 2.5kV to 20kV
- 150nS Reverse Recovery
- High Surge Current Ratings
- Low Reverse Leakage
- Corona Free

DESCRIPTION
The HVFS MULTISTAC high current, high voltage silicon rectifier's convenient size and high power capability meets the reliability requirements of commercial, industrial and military applications. Reliability with economy are obtained through the use of proprietary innovations in manufacturing technique. Cylindrical die construction and metallurgical bonds minimize electrical and mechanical stress, contributing to long life.

ABSOLUTE MAXIMUM RATINGS

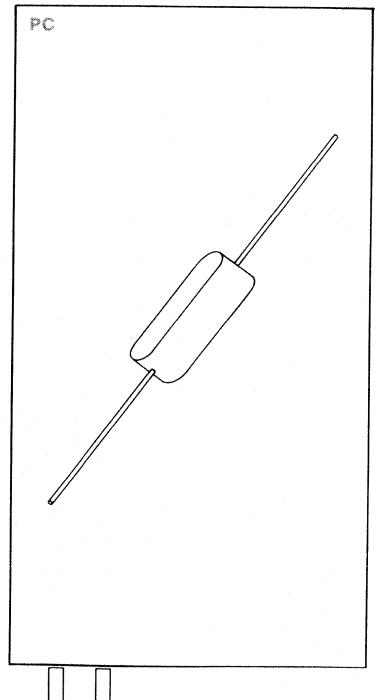
Peak Inverse Voltage	2.5kV to 20kV
Maximum Average Rectified Current	See Electrical Specifications
Maximum One Cycle Surge 8.3mS	See Electrical Specifications
Operating and Storage Temperature Range	−55°C to +150°C

MECHANICAL SPECIFICATIONS



PART NUMBER	CASE LENGTH	
	INCHES	MILLIMETERS
HVS2500	1.5 ± .03	38.1 ± 0.76
HVS5000	2.5 ± .03	63.5 ± 0.76
HVS7500	3.5 ± .03	88.9 ± 0.76
HVS10000	4.5 ± .03	114.3 ± 0.76
HVS12500	5.5 ± .03	139.7 ± 0.76
HVS15000	6.5 ± .03	165.1 ± 0.76
HVS17500	6.5 ± .03	165.1 ± 0.76
HVS20000	6.5 ± .03	165.1 ± 0.76

Dimensions in inches and (millimeters)

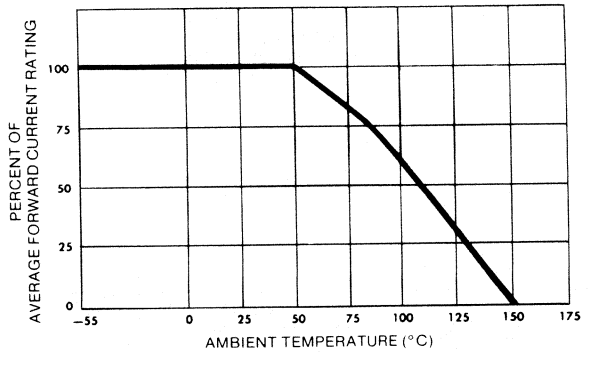


UNITRODE

Type	ELECTRICAL SPECIFICATIONS (at 25°C unless noted)					MAXIMUM RATINGS				Case Length	
	Peak Inverse Voltage*	Maximum Reverse Current @ PIV		Maximum Forward Voltage @ I_O	Maximum Reverse Recovery Time	Maximum Average Rectified Current†		Maximum One Cycle Surge 8.3mS			
	PIV	I_R		V_F	T_{RR}	I_O		I_F(surge)			
	V	25°C	100°C	V	nS	55°C	100°C	25°C	100°C		
		μA	μA			A	A	A	A	Ins.	MM
HVFS2500	2500	10	120	8	150	2.2	1.3	200	100	1.5	38.1
HVFS5000	5000	10	120	16	150	2.2	1.3	200	100	2.5	63.5
HVFS7500	7500	10	120	21	150	2.2	1.3	200	100	3.5	88.9
HVFS10000	10000	10	120	29	150	2.2	1.3	200	100	4.5	114.9
HVFS12500	12500	10	120	36	150	2.2	1.3	200	100	5.5	139.7
HVFS15000	15000	10	120	44	150	2.2	1.3	200	100	6.5	165.1
HVFS17500	17500	10	120	51	150	2.2	1.3	200	100	6.5	165.1
HVFS20000	20000	10	120	58	150	2.2	1.3	200	100	6.5	165.1

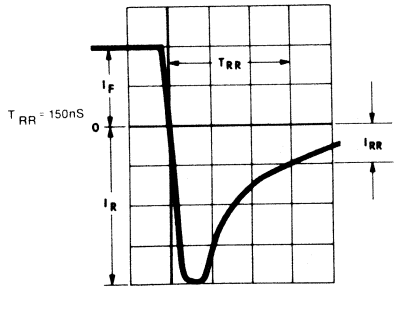
*Operation and testing of devices over 10,000 V/inch may require re-encapsulation or immersion in a suitable dielectric material.
† The stated, AVERAGE RECTIFIED CURRENT ratings require no heat sinking, special mounting or forced air across the body of the device.
NOTE: Maximum lead temperature for soldering is 250°C 3/8" (9.5mm) from case for 5 seconds.

MAXIMUM FORWARD CURRENT VS AMBIENT TEMPERATURE

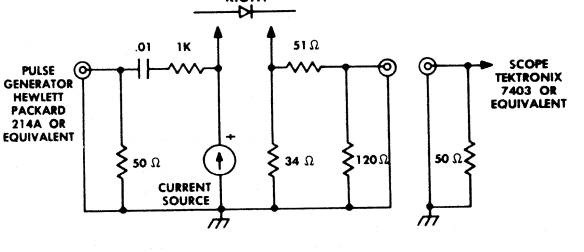


REVERSE RECOVERY TEST CONDITIONS: I_F = 12.5A, I_R = 25A, I_{RR} = 6.25A

REVERSE RECOVERY WAVE FORM



REVERSE RECOVERY TEST CIRCUIT



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

HIGH VOLTAGE SILICON RECTIFIERS

MULTISTAC

Standard Recovery

HVH5000-25000

FEATURES

- PIV: From 5kV to 25kV
- 2μS Reverse Recovery
- High Surge Current Ratings
- Low Reverse Leakage
- Corona Free

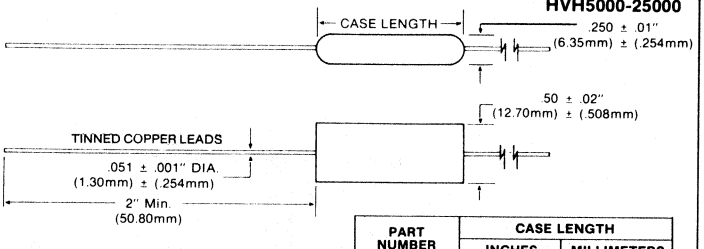
DESCRIPTION

The HVH MULTISTAC silicon rectifier assemblies meet the stringent reliability requirements of commercial, industrial and military users through the use of proprietary innovations in manufacturing technique. Cylindrical die construction and metallurgical bonds minimize electrical and mechanical stress, contributing to long life. The 2 microsecond reverse recovery time improves the circuit efficiency of power conversion and control systems.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage ..... 5kV to 25kV
Maximum Average Rectified Current ..... See Electrical Specifications
Maximum One Cycle Surge 8.3mS ..... See Electrical Specifications
Operating and Storage Temperature Range ..... −55°C to +150°C

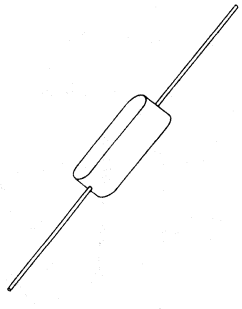
MECHANICAL SPECIFICATIONS



PART NUMBER	CASE LENGTH	
	INCHES	MILLIMETERS
HVH5000	1.125 ± .02	28.58 ± .508
HVH7500	1.625 ± .02	41.28 ± .508
HVH10000	2.000 ± .02	50.80 ± .508
HVH12500	2.375 ± .02	60.33 ± .508
HVH15000	2.750 ± .02	69.85 ± .508
HVH20000	3.500 ± .02	88.90 ± .508
HVH25000	4.250 ± .02	107.95 ± .508

Dimensions in inches and (millimeters)

PB



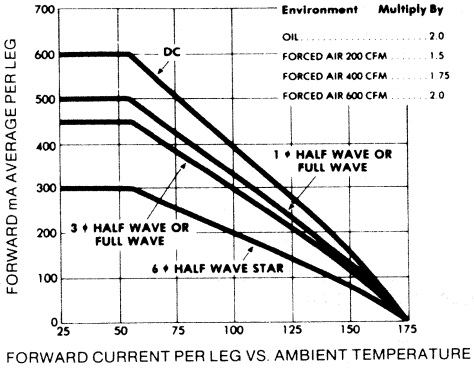
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)					MAXIMUM RATINGS					
Maximum Reverse Recovery Time	Peak Inverse Voltage*	Maximum Reverse Current @ PIV		Maximum Forward Voltage @ I_O	Maximum Average Rectified Current†		Maximum One Cycle Surge		Case Length	
2μS	PIV	I_R		V_F	I_O		I_F(surge)			
Type	V	25°C	100°C	25°C	55°C	100°C	25°C	100°C		
		μA	μA	V	A	A	A	A	Ins.	MM
HVH 5000	5000	0.1	15	7	.5	.33	60	30	1.125	28.58
HVH 7500	7500	0.1	15	10	.5	.33	60	30	1.625	41.28
HVH10000	10000	0.1	15	14	.5	.33	60	30	2.000	50.80
HVH12500	12500	0.1	15	17	.5	.33	60	30	2.375	60.33
HVH15000	15000	0.1	15	20	.5	.33	60	30	2.750	69.85
HVH20000	20000	0.1	15	27	.5	.33	60	30	3.500	88.90
HVH25000	25000	0.1	15	33	.5	.33	60	30	4.250	107.95

5

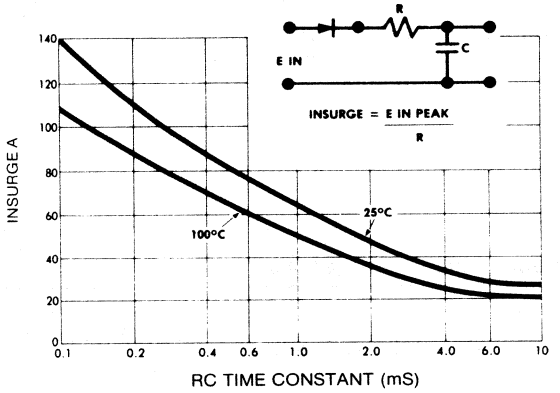
*Operation and testing of devices over 10,000 V/inch may require re-encapsulation or immersion in a suitable dielectric material.
†The stated, AVERAGE RECTIFIED CURRENT ratings require no heat sinking, special mounting or forced air across the body of the device.
NOTE: Maximum lead temperature for soldering is 250°C 3/8" (9.5mm) from case for 5 seconds.

MAXIMUM FORWARD CURRENT VS. AMBIENT TEMPERATURE



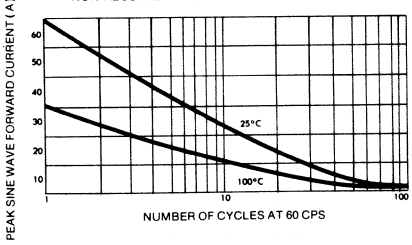
FORWARD CURRENT PER LEG VS. AMBIENT TEMPERATURE (°C)

MAXIMUM RATINGS FOR CAPACITY LOADS



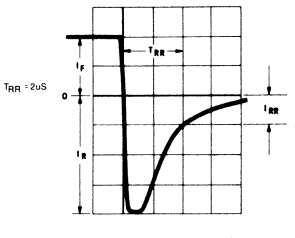
RC TIME CONSTANT (mS)

NON-RECURRENT FORWARD CURRENT SURGE CURVE

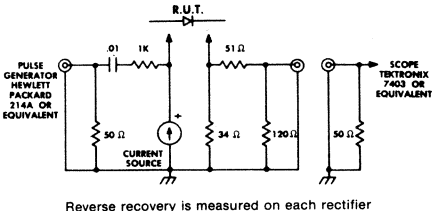


NUMBER OF CYCLES AT 60 CPS

REVERSE RECOVERY WAVE FORM



REVERSE RECOVERY TEST CIRCUIT



Reverse recovery is measured on each rectifier stack prior to manufacture of the assembly.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

HIGH VOLTAGE SILICON RECTIFIERS

HVHF5000-25000

MULTISTAC

Standard Recovery, High Current

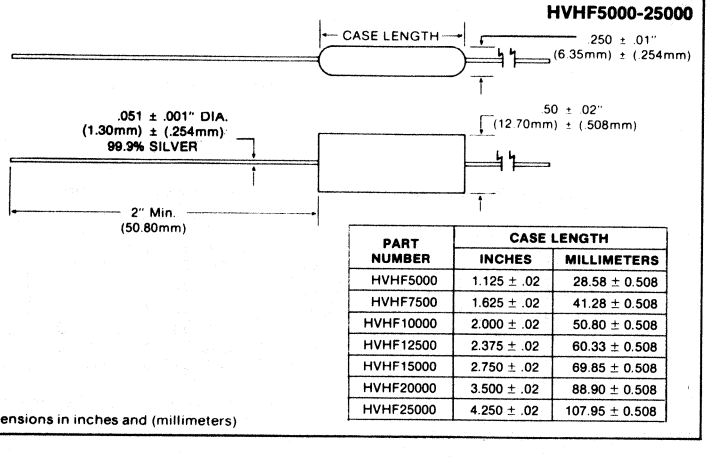
FEATURES
- PIV: From 5kV to 25kV
- 1μS Reverse Recovery
- High Surge Current Ratings
- Low Reverse Leakage
- Corona Free

DESCRIPTION
The HVHF MULTISTAC high current, high voltage silicon rectifier's convenient size and high power capability meets the reliability requirements of commercial, industrial and military applications. Reliability with economy are obtained through the use of proprietary innovations in manufacturing technique. Cylindrical die construction and metallurgical bonds minimize electrical and mechanical stress, contributing to long life.

ABSOLUTE MAXIMUM RATINGS

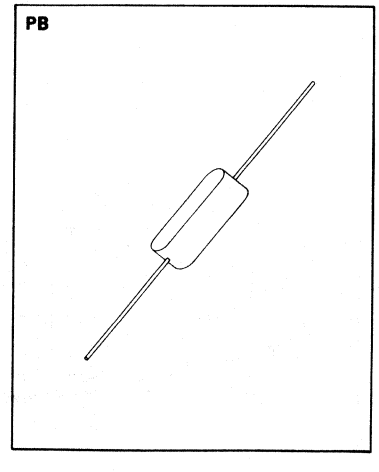
Peak Inverse Voltage	5kV to 25kV
Maximum Average Rectified Current	See Electrical Specifications
Maximum One Cycle Surge 8.3mS	See Electrical Specifications
Operating and Storage Temperature Range	−55°C to +150°C

MECHANICAL SPECIFICATIONS



PART NUMBER	CASE LENGTH	
	INCHES	MILLIMETERS
HVHF5000	1.125 ± .02	28.58 ± 0.508
HVHF7500	1.625 ± .02	41.28 ± 0.508
HVHF10000	2.000 ± .02	50.80 ± 0.508
HVHF12500	2.375 ± .02	60.33 ± 0.508
HVHF15000	2.750 ± .02	69.85 ± 0.508
HVHF20000	3.500 ± .02	88.90 ± 0.508
HVHF25000	4.250 ± .02	107.95 ± 0.508

Dimensions in inches and (millimeters)



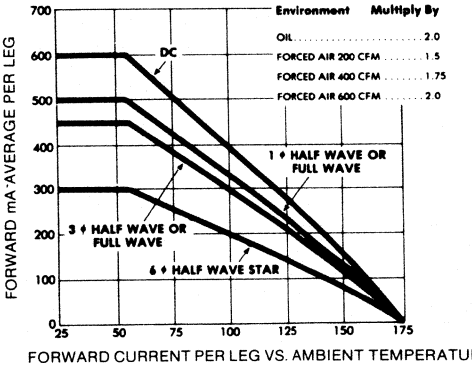
UNITRODE

Type	ELECTRICAL SPECIFICATIONS (at 25° C unless noted)					MAXIMUM RATINGS				Case Length	
	Peak Inverse Voltage*	Maximum Reverse Current @ PIV		Maximum Forward Voltage @ I_O	Maximum Reverse Recovery Time	Maximum Average Rectified Current†		Maximum One Cycle Surge 8.3mS			
	PIV	I_R		V_F	T_{RR}	I_O		I_F(surge)			
	V	25° C	100° C	V	μS	55° C	100° C	25° C	100° C		
		μA	μA			A	A	A	A	Ins.	MM
HVHF5000	5000	0.1	15	7	1	.5	.33	60	30	1.125	28.58
HVHF7500	7500	0.1	15	10	1	.5	.33	60	30	1.625	41.28
HVHF10000	10000	0.1	15	14	1	.5	.33	60	40	2.000	50.80
HVHF12500	12500	0.1	15	17	1	.5	.33	60	40	2.375	60.33
HVHF15000	15000	0.1	15	20	1	.5	.33	60	40	2.750	69.85
HVHF20000	20000	0.1	15	27	1	.5	.33	60	40	3.500	88.90
HVHF25000	25000	0.1	15	33	1	.5	.33	60	40	4.250	107.95

*Operation and testing of devices over 10,000 V/inch may require re-encapsulation or immersion in a suitable dielectric material.
† The stated, AVERAGE RECTIFIED CURRENT ratings require no heat sinking, special mounting or forced air across the body of the device.
NOTE: Maximum lead temperature for soldering is 250° C 3/8" (9.5mm) from case for 5 seconds.

5

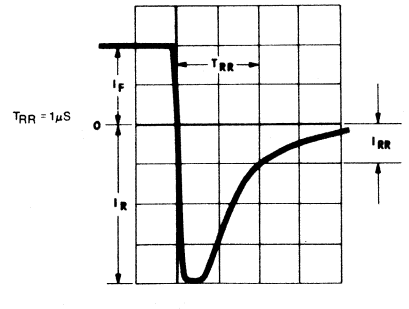
MAXIMUM FORWARD CURRENT VS. AMBIENT TEMPERATURE



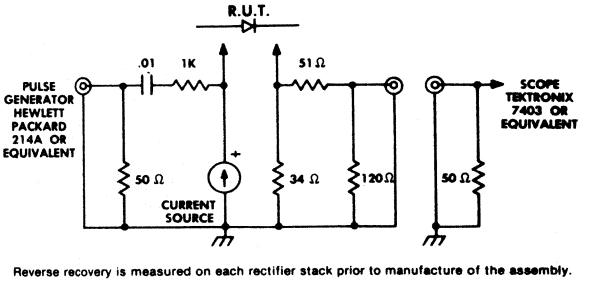
FORWARD CURRENT PER LEG VS. AMBIENT TEMPERATURE (°C)

REVERSE RECOVERY TEST CONDITIONS: I_F = 100mA, I_R = 200mA, I_{RR} = 50mA

REVERSE RECOVERY WAVE FORM



REVERSE RECOVERY TEST CIRCUIT



Reverse recovery is measured on each rectifier stack prior to manufacture of the assembly.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

HIGH VOLTAGE SILICON RECTIFIERS

HVHJ15K-45K

MULTISTAC

Medium Recovery, Medium Current

FEATURES

- PIV: From 15kV to 45kV
- 2μS Reverse Recovery
- High Surge
- Low Reverse Leakage
- Corona Free

DESCRIPTION

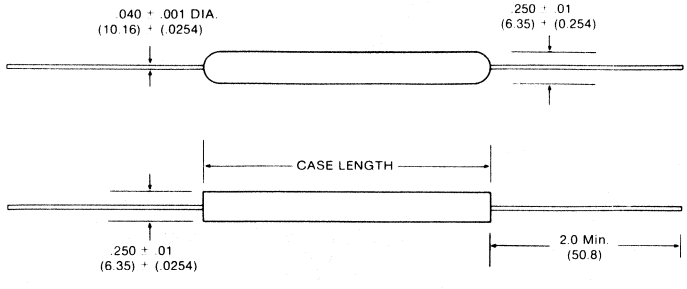
The HVHJ MULTISTAC medium current, high voltage silicon rectifier assembly's small size and high power capability meets the stringent reliability requirements of commercial, industrial and military applications. Reliabilty with economy are obtained through the use of proprietary innovations in manufacturing technique. Cylindrical die construction and metallurgical bonds minimize electrical and mechanical stress, contributing to long life.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage ..... 15kV to 45kV
Maximum Average Rectified Current ..... See Electrical Specifications
Maximum One Cycle Surge 8.3mS ..... See Electrical Specifications
Operating and Storage Temperature Range ..... −55°C to +150°C

MECHANICAL SPECIFICATIONS

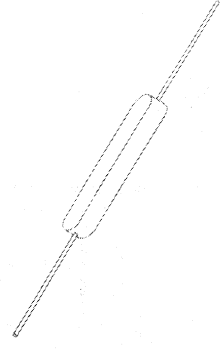
HVHJ15K-45K



PART NUMBER	CASE LENGTH	
	INCHES	MILLIMETERS
HVHJ15K	1.5 ± .02	38.1 ± .508
HVHJ20K	2.0 ± .02	50.8 ± .508
HVHJ22.5K	2.0 ± .02	50.8 ± .508
HVHJ25K	2.5 ± .02	63.5 ± .508
HVHJ30K	2.5 ± .02	63.5 ± .508
HVHJ35K	3.0 ± .02	76.2 ± .508
HVHJ37.5K	3.0 ± .02	76.2 ± .508
HVHJ40K	3.5 ± .02	88.9 ± .508
HVHJ45K	3.5 ± .02	88.9 ± .508

Dimensions in inches and (millimeters)

PA

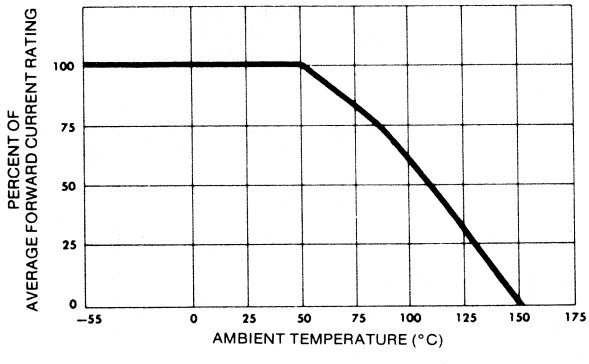


Type	ELECTRICAL SPECIFICATIONS (at 25°C unless noted)					MAXIMUM RATINGS				Case Length	
	Peak Inverse Voltage*	Maximum Reverse Current @ PIV		Maximum Forward Voltage @ I_O	Maximum Reverse Recovery Time	Maximum Average Rectified Current†		Maximum One Cycle Surge 8.3mS			
	PIV	I_R		V_F	T_{RR}	I_O		I_F(surge)			
	V	25°C	100°C	V	μS	55°C	100°C	25°C	100°C		
		μA	μA			mA	mA	A	A	Ins.	MM
HVHJ15K	15000	0.1	25	20	2	50	30	5	2.5	1.5	38.1
HVHJ20K	20000	0.1	25	30	2	50	30	5	2.5	2.0	50.8
HVHJ22.5K	22500	0.1	25	30	2	50	30	5	2.5	2.0	50.8
HVHJ25K	25000	0.1	25	40	2	50	30	5	2.5	2.5	63.5
HVHJ30K	30000	0.1	25	40	2	50	30	5	2.5	2.5	63.5
HVHJ35K	35000	0.1	25	50	2	50	30	5	2.5	3.0	76.2
HVHJ37.5K	37500	0.1	25	50	2	50	30	5	2.5	3.0	76.2
HVHJ40K	40000	0.1	25	60	2	50	30	5	2.5	3.5	88.9
HVHJ45K	45000	0.1	25	60	2	50	30	5	2.5	3.5	88.9

5

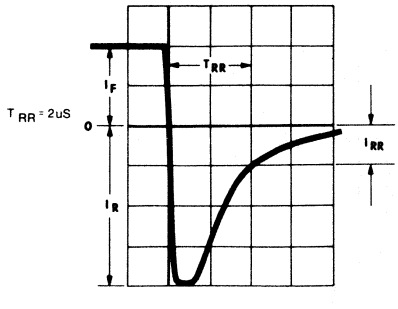
*Operation and testing of devices over 10,000 V/inch may require re-encapsulation or immersion in a suitable dielectric material.
† The stated, AVERAGE RECTIFIED CURRENT ratings require no heat sinking, special mounting or forced air across the body of the device.
NOTE: Maximum lead temperature for soldering is 250°C 3/8" (9.5mm) from case for 5 seconds.

MAXIMUM FORWARD CURRENT VS. AMBIENT TEMPERATURE

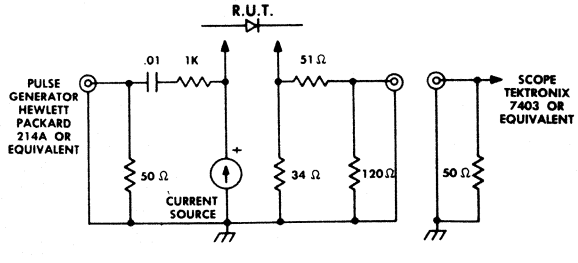


REVERSE RECOVERY TEST CONDITIONS: I_F = 50mA, I_R = 100mA, I_{RR} = 25mA

REVERSE RECOVERY WAVE FORM



REVERSE RECOVERY TEST CIRCUIT



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

HIGH VOLTAGE SILICON RECTIFIERS

HVHS2500-20000

MULTISTAC

Medium Recovery, High Current

FEATURES

- PIV: From 2.5kV to 20kV
- 2μS Reverse Recovery
- High Surge Current Ratings
- Low Reverse Leakage
- Corona Free

DESCRIPTION

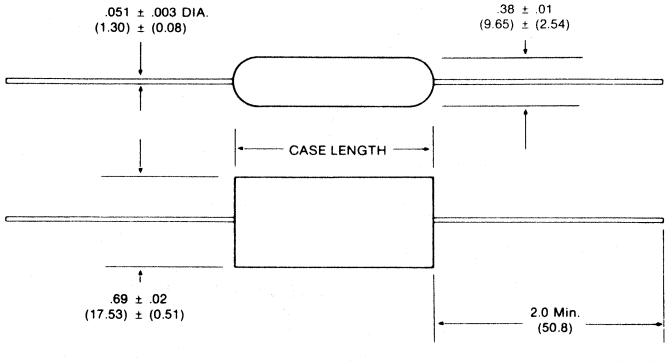
The HVHS MULTISTAC high current, high voltage silicon rectifier's convenient size and high power capability meets the reliability requirements of commercial, industrial and military applications. Reliability with economy are obtained through the use of proprietary innovations in manufacturing technique. Cylindrical die construction and metallurgical bonds minimize electrical and mechanical stress, contributing to long life.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage ..... 2.5kV to 20kV
Maximum Average Rectified Current ..... See Electrical Specifications
Maximum One Cycle Surge 8.3 mS ..... See Electrical Specifications
Operating and Storage Temperature Range ..... −55°C to +150°C

MECHANICAL SPECIFICATIONS

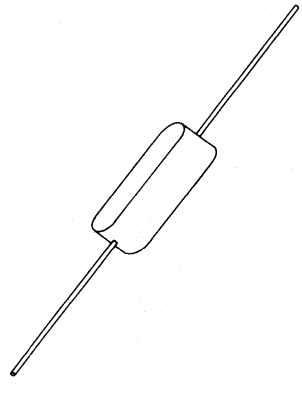
HVHS2500-20000



PART NUMBER	CASE LENGTH	
	INCHES	MILLIMETERS
HVHS2500	1.5 ± .03	38.1 ± 0.76
HVHS5000	2.5 ± .03	63.5 ± 0.76
HVHS7500	3.5 ± .03	88.9 ± 0.76
HVHS10000	4.5 ± .03	114.3 ± 0.76
HVHS12500	5.5 ± .03	139.7 ± 0.76
HVHS15000	6.5 ± .03	165.1 ± 0.76
HVHS17500	6.5 ± .03	165.1 ± 0.76
HVHS20000	6.5 ± .03	165.1 ± 0.76

Dimensions in inches and (millimeters)

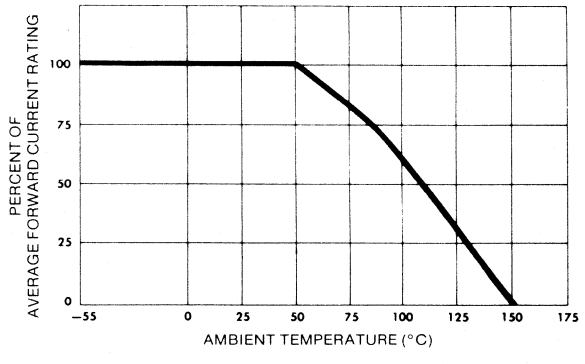
PC



Type	ELECTRICAL SPECIFICATIONS (at 25°C unless noted)					MAXIMUM RATINGS				Case Length	
	Peak Inverse Voltage*	Maximum Reverse Current @ PIV		Maximum Forward Voltage @ I_O	Maximum Reverse Recovery Time	Maximum Average Rectified Current†		Maximum One Cycle Surge 8.3mS			
	PIV	I_R		V_F	T_{RR}	I_O		I_F(surge)			
	V	25°C	100°C	V	μS	55°C	100°C	25°C	100°C		
		μA	μA			A	A	A	A	Ins.	MM
HVHS2500	2500	10	120	5	2	2.2	1.3	200	100	1.5	38.1
HVHS5000	5000	10	120	10	2	2.2	1.3	200	100	2.5	63.5
HVHS7500	7500	10	120	15	2	2.2	1.3	200	100	3.5	88.9
HVHS10000	10000	10	120	20	2	2.2	1.3	200	100	4.5	114.9
HVHS12500	12500	10	120	25	2	2.2	1.3	200	100	5.5	139.7
HVHS15000	15000	10	120	30	2	2.2	1.3	200	100	6.5	165.1
HVHS17500	17500	10	120	35	2	2.2	1.3	200	100	6.5	165.1
HVHS20000	20000	10	120	40	2	2.2	1.3	200	100	6.5	165.1

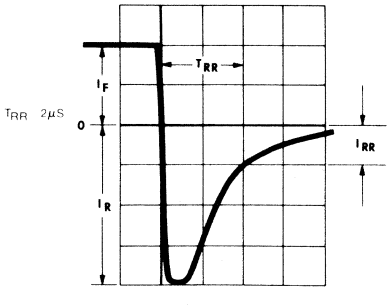
*Operation and testing of devices over 10,000 V/inch may require re-encapsulation or immersion in a suitable dielectric material.
† The stated, AVERAGE RECTIFIED CURRENT ratings require no heat sinking, special mounting or forced air across the body of the device.
NOTE: Maximum lead temperature for soldering is 250°C 3/8" (9.5mm) from case for 5 seconds.

MAXIMUM FORWARD CURRENT VS AMBIENT TEMPERATURE

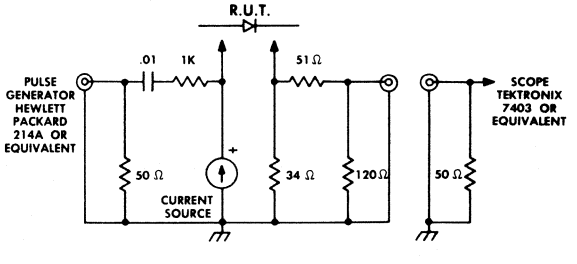


REVERSE RECOVERY TEST CONDITIONS: I_F = 0.4A, I_R = 0.8A, I_{RR} = 0.2A

REVERSE RECOVERY WAVE FORM



REVERSE RECOVERY TEST CIRCUIT



Reverse recovery is measured on each rectifier stack prior to manufacture of the assembly.

HIGH VOLTAGE SILICON RECTIFIERS

HVJX15K-45K

MULTISTAC

Fast Recovery, Medium Current

FEATURES

- PIV: From 15kV to 45kV
- 200nS Reverse Recovery
- High Surge Current Ratings
- Low Reverse Leakage
- Corona Free

DESCRIPTION

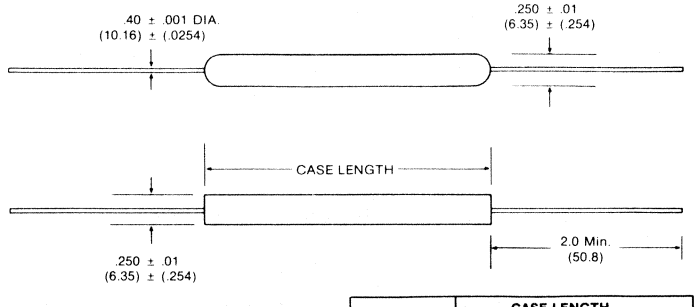
The HVJX MULTISTAC medium current high voltage silicon rectifier assembly's small size and high power capabilty meets the stringent reliabilty requirements of commercial, industrial and military applications. Reliability with economy are obtained through the use of proprietary innovations in manufacturing technique. Cylindrical die construction and metallurgical bonds minimize electrical and mechanical stress, contributing to long life.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage ..... 15kV to 45kV
Maximum Average Rectified Current ..... See Electrical Specifications
Maximum One Cycle Surge 8.3 mS ..... See Electrical Specifications
Operating and Storage Temperature Range ..... −55°C to +150°C

MECHANICAL SPECIFICATIONS

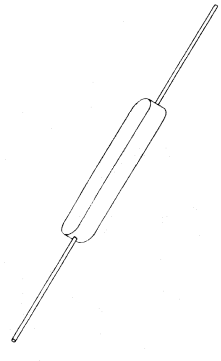
HVJX15K-45K



PART NUMBER	CASE LENGTH	
	INCHES	MILLIMETERS
HVJX15K	1.5 ± .02	38.1 ± .508
HVJX20K	2.0 ± .02	50.8 ± .508
HVJX22.5K	2.0 ± .02	50.8 ± .508
HVJX25K	2.5 ± .02	63.5 ± .508
HVJX30K	2.5 ± .02	63.5 ± .508
HVJX35K	3.0 ± .02	76.2 ± .508
HVJX37.5K	3.0 ± .02	76.2 ± .508
HVJX40K	3.5 ± .02	88.9 ± .508
HVJX45K	3.5 ± .02	88.9 ± .508

Dimensions in inches and (millimeters)

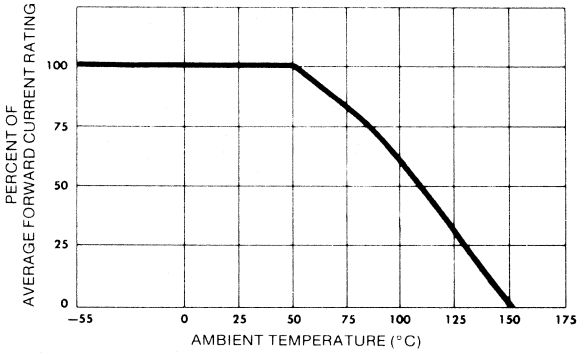
PA



Type	ELECTRICAL SPECIFICATIONS (at 25°C unless noted)					MAXIMUM RATINGS				Case Length	
	Peak Inverse Voltage*	Maximum Reverse Current @ PIV		Maximum Forward Voltage @ I_O	Maximum Reverse Recovery Time	Maximum Average Rectified Current†		Maximum One Cycle Surge 8.3mS			
	PIV	I_R		V_F	T_{RR}	I_O		I_F(surge)			
	V	25°C	100°C	V	nS	55°C	100°C	25°C	100°C		
		μA	μA			mA	mA	A	A	Ins.	MM
HVJX15K	15000	0.1	25	24	200	50	30	5	2.5	1.5	38.1
HVJX20K	20000	0.1	25	36	200	50	30	5	2.5	2.0	50.8
HVJX22.5K	22500	0.1	25	36	200	50	30	5	2.5	2.0	50.8
HVJX25K	25000	0.1	25	48	200	50	30	5	2.5	2.5	63.5
HVJX30K	30000	0.1	25	48	200	50	30	5	2.5	2.5	63.5
HVJX35K	35000	0.1	25	60	200	50	30	5	2.5	3.0	76.2
HVJX37.5K	37500	0.1	25	60	200	50	30	5	2.5	3.0	76.2
HVJX40K	40000	0.1	25	72	200	50	30	5	2.5	3.5	88.9
HVJX45K	45000	0.1	25	72	200	50	30	5	2.5	3.5	88.9

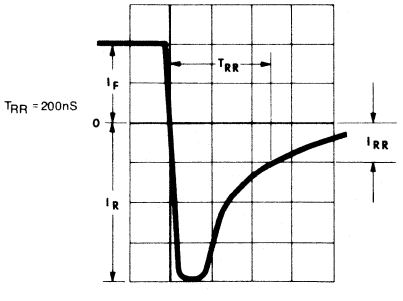
*Operation and testing of devices over 10,000 V/inch may require re-encapsulation or immersion in a suitable dielectric material.
† The stated, AVERAGE RECTIFIED CURRENT ratings require no heat sinking, special mounting or forced air across the body of the device.
NOTE: Maximum lead temperature for soldering is 250°C 3/8" (9.5mm) from case for 5 seconds.

MAXIMUM FORWARD CURRENT VS AMBIENT TEMPERATURE

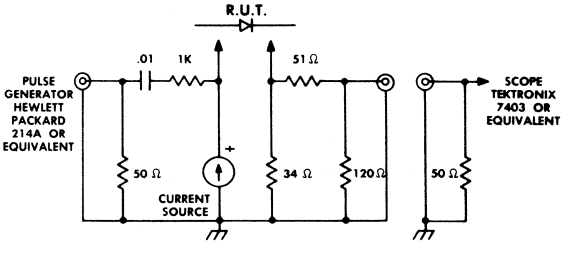


REVERSE RECOVERY TEST CONDITIONS: I_F = 50mA, I_R = 100mA, I_{RR} = 25mA

REVERSE RECOVERY WAVE FORM



REVERSE RECOVERY TEST CIRCUIT



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

HIGH VOLTAGE SILICON RECTIFIERS

POWERSTACK

1.5 to 3.0A

Very High Current, Miniature

KX15-100
KXS15-100

FEATURES

- PIV: From 1.5kV to 10kV
- 1.5 to 3.0A
- 250nS Reverse Recovery
- High Surge Ratings
- Low Reverse Leakage
- Corona Free

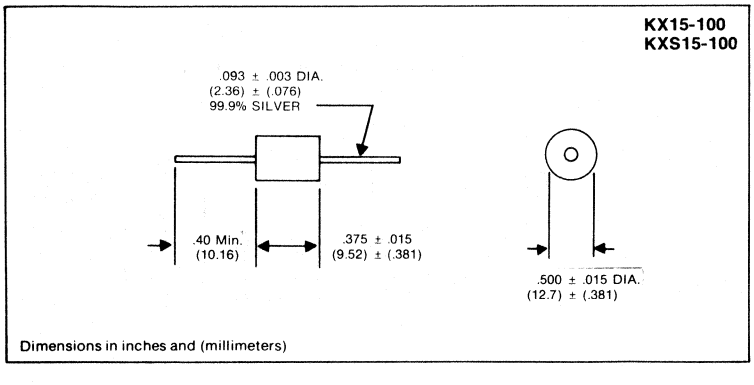
DESCRIPTION

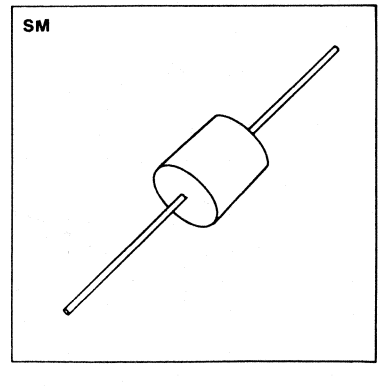
The KX/KXS silicon rectifier series is a unique concept for high current high voltage applications. Matched junction characteristics and low stray capacitance due to metallurgically bonded junctions eliminates the need for external compensation networks. These rectifiers utilize HVD's cylindrical die construction, which minimizes electrical and mechanical stress, insuring long life for commercial, military and industrial applications.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	1.5kV to 10kV
Maximum Average Rectified Current	See Electrical Specifications
Maximum One Cycle Surge 8.3mS	See Electrical Specifications
Operating Temperature Range	-55°C to +150°C
Storage Temperature Range	-55°C to +175°C

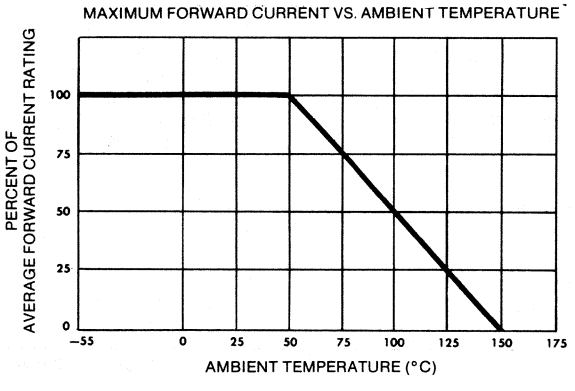
MECHANICAL SPECIFICATIONS



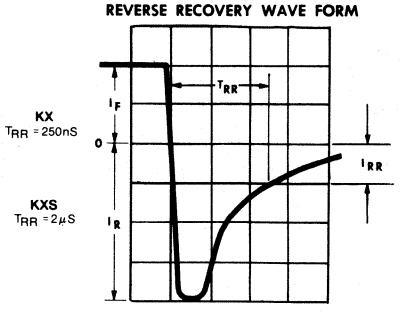


ELECTRICAL SPECIFICATIONS (at 25°C unless noted)						MAXIMUM RATINGS				
Maximum Reverse Recovery Time		Peak Inverse Voltage*	Maximum Reverse Current @ PIV		Maximum Forward Voltage @ I_O	Maximum Average Rectified Current†			Maximum One Cycle Surge 8.3mS	Typical Thermal Impedance††
250nS	2uS	PIV	I_R		V_F	I_O			I_F(surge)	$R_{\theta JL}$
Type	Type	V	25°C	100°C	V	50°C	100°C	120°C		
			μA	μA		A	A	A	A	°C/Watt
KX15	KXS15	1500	2.0	100	5.0	3.00	1.50	.75	200	2.0
KX20	KXS20	2000	2.0	100	5.0	3.00	1.50	.75	200	2.0
KX25	KXS25	2500	2.0	100	5.0	3.00	1.50	.75	200	2.0
KX30	KXS30	3000	2.0	100	7.0	2.20	1.10	.55	150	2.5
KX40	KXS40	4000	2.0	100	7.0	2.20	1.10	.55	150	2.5
KX50	KXS50	5000	2.0	100	7.0	2.20	1.10	.55	150	2.5
KX60	KXS60	6000	2.0	100	11.0	1.50	.75	.37	100	3.0
KX80	KXS80	8000	2.0	100	11.0	1.50	.75	.37	100	3.0
KX100	KXS100	10000	2.0	100	11.0	1.50	.75	.37	100	3.0

*Operation and testing of devices over 10,000 V/inch may require re-encapsulation or immersion in a suitable dielectric material.
† The stated, AVERAGE RECTIFIED CURRENT ratings require no heat sinking, special mounting or forced air across the body of the device.
††Typical thermal impedance determined with rectifier mounted on infinite heat sinks 0.10" from device body using temperature of center junction and lead temperature adjacent to body.
NOTE: Maximum lead temperature for soldering is 250°C 3/8" (9.5mm) from case for 5 seconds.



REVERSE RECOVERY TEST CONDITIONS: I_F = 400mA, I_R = 800mA, I_{RR} = 200mA



POWER SCHOTTKY RECTIFIERS

SD51

120 Amp Pk, 45V

FEATURES

- Very Low Forward Voltage
- Low Recovered Charge
- Rugged Package Design (DO-5)
- High Efficiency for Low Voltage Supplies
- Available with Flexible Top Lead

DESCRIPTION

The SD51 has a Schottky barrier junction and is ideally suited for output rectifiers and catch diodes in low voltage power supplies. The Unitrode high conductivity design, using a heavy copper top post and a 4 point crimp, ensures cool terminal operation and low dynamic impedance. Rugged design absorbs stress that can damage glass-to-metal seal during installation and use.

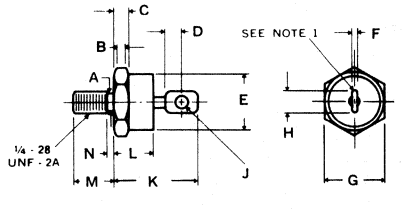
ABSOLUTE MAXIMUM RATINGS (T_{CASE} = 25°C)

Peak Repetitive Reverse Voltage, V_{RRM} 45V*
Working Peak Reverse Voltage, V_{RWM} 35V*
Peak Repetitive Forward
Current (Rated V_R, Square Wave, 20 KHz,
50 percent Duty Cycle), I_{FRM} 120A
Non-repetitive Peak
Surge Current (8.3 mS), I_{FSM} 800A
Peak Reverse Transient Current, I_{RM} 2A
Storage Temperature Range, T_{stg} ..... −55°C to +165°C
Junction Operating Temperature Range, T_j ..... −55°C to +150°C
Thermal Resistance, Junction-to-Case, $R_{\theta JC}$ ..... 1.0°C/W

*See curve of V_{RRM} Rating vs Case Temperature

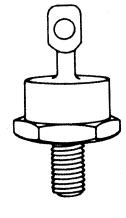
MECHANICAL SPECIFICATIONS

SD51



	ins.	mm
A	.225 ± .005	5.72 ± 0.13
B	.060 MIN.	1.52 MIN.
C	.156 ± .020	3.96 ± 0.51
D	.156 MIN. FLAT	3.96 MIN. FLAT
E	.667 DIA. MAX.	16.94 DIA. MAX.
F	.090 MAX.	2.29 MAX.
G	.677 ± .010	17.20 ± 0.25
H	.375 MAX.	9.53 MAX.
J	.140 MIN. DIA.	3.56 MIN. DIA.
K	1.000 MAX.	25.40 MAX.
L	.450 MAX.	11.43 MAX.
M	.438 ± .015	11.13 ± 0.38
N	.078 MAX.	1.98 MAX.

DO-5



Notes:
1. Cathode is stud.
2. All metal surfaces tin plated.
3. Maximum unlubricated stud torque: 30 inch pounds (35 kg. cm).
4. Angular orientation of terminal is undefined.

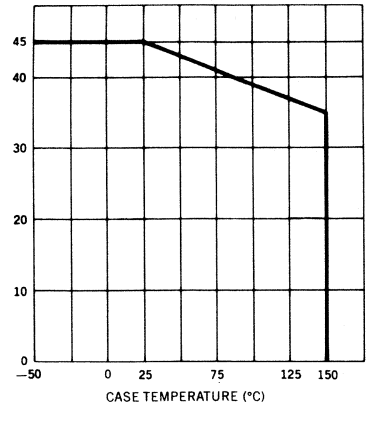
UNITRODE

ELECTRICAL CHARACTERISTICS (T_{CASE} = 25°C)

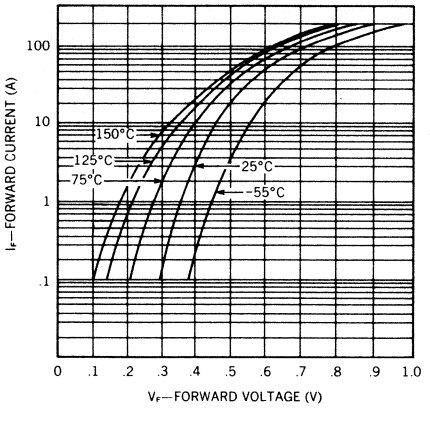
Characteristic	Symbol	Limit	Units	Conditions
Maximum Instantaneous Reverse Current	i_R	50 200	mA mA	T_C = 25°C, V_R = 35V T_C = 125°C Pulse Width = 400μS Duty Cycle = 1 percent
Maximum Instantaneous Forward Voltage	V_F	0.60	V	i_F = 60A T_c = 125°C Pulse Width = 300μS Duty Cycle = 1 percent
Flexible Top Lead Option	V_F	0.65	V	
Maximum Capacitance	C_t	4000	pF	V_R = 5.0V
Maximum Voltage Rate of Change	dv/dt	700	V/μS	V_R = 35V

5

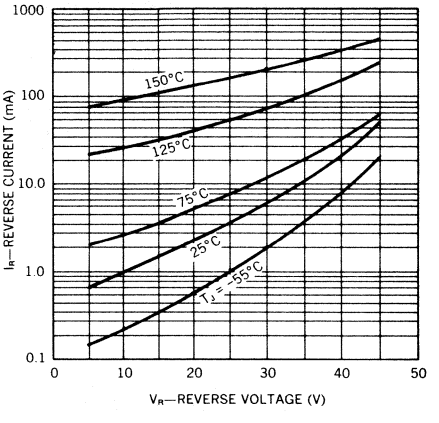
V_{RRM} Rating vs Case Temperature



Typical Forward Current vs Forward Voltage



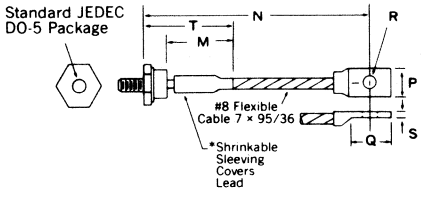
Typical Reverse Current vs Reverse Voltage



MECHANICAL SPECIFICATIONS

FLEXIBLE TOP LEAD (OPTIONAL)
Add an "F" Suffix to Part Number.

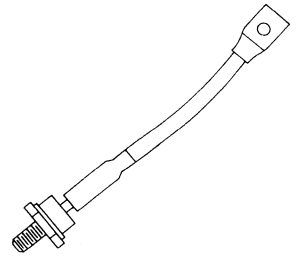
SD51F



	INCHES	MILLIMETERS
M	.718 MAX.	18.24 MAX.
N	4.50 ± .250	114.3 ± 6.35
P	.525 MAX.	13.23 MAX.
Q	.675 ± .035	17.15 ± 0.89
R	.205 ± .005	5.21 ± 0.13
S	.075 ± .010	1.91 ± 0.25
T	1.125 MAX.	28.58 MAX.

*To 125°C (Ambient)

DO-5 with Flexible Lead



Note: Consult Factory for Non-standard Lead Lengths.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

DUAL POWER SCHOTTKY RECTIFIERS

SD241
SD241HR

30 Amp Pk per diode, 45V

FEATURES
- Very Low Forward Voltage
- Low Recovered Charge
- Rugged Packaged Design (TO-3)
- High Efficiency for Low Voltage Supplies
- Dual Schottky Rectifiers in a Single Package

DESCRIPTION
The SD241 has two Schottky barrier junctions arranged in a common cathode configuration and is ideally suited for output rectifiers and catch diodes in low voltage supplies.

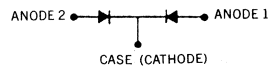
ABSOLUTE MAXIMUM RATINGS (T_{CASE} = 25°C) Per Diode

Peak Repetitive Reverse Voltage, V_{RRM} 45V*
Working Peak Reverse Voltage, V_{RWM} 35V
Average Rectified Forward Current, I_O 30A
Non-repetitive Peak
Surge current (8.3 mS), I_{FSM} 400A
Peak Reverse Transient Current, I_{RM} 2A
Storage Temperature Range, T_{stg} ..... -55°C to +175°C
Junction Operating Temperature Range, T_j ..... -55°C to +150°C
Package Thermal Resistance, Junction to Case, $R_{\theta JC}$ ..... 1.4°C/W

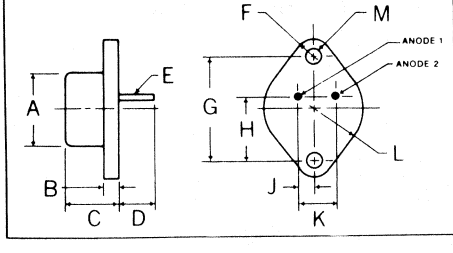
* See curve of V_{RRM} Rating vs Case Temperature.

MECHANICAL SPECIFICATIONS

NOTE:
Leads may be soldered to within 1/16" of base provided temperature-time exposure is less than 260°C for 10 seconds.

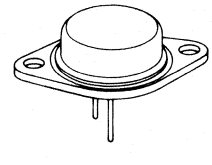


SD241
SD241HR



	ins.	mm.
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA (TO-3)



Notes: All metal surfaces tin plated.

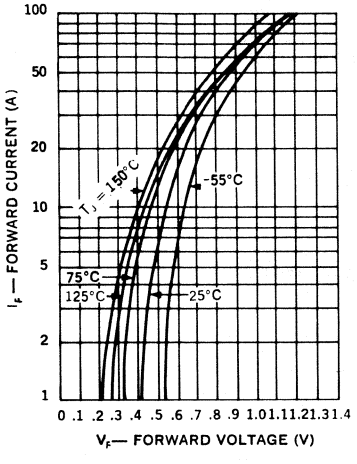
UNITRODE

ELECTRICAL CHARACTERISTICS (T_{CASE} = 25°C) Per Diode

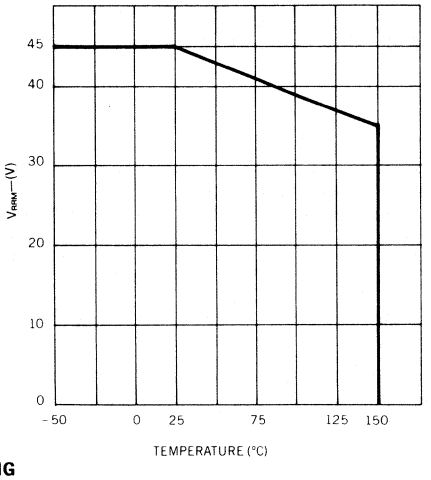
Characteristic	Symbol	Limit	Units	Conditions
Maximum Instantaneous Reverse Current	i_R	25 100	mA mA	T_C = 25°C, V_R = 35V T_C = 125°C Pulse Width = 400μS Duty Cycle = 1 percent
Maximum Instantaneous Forward Voltage	v_F	.47	V	i_F = 10A Pulse Width = 300μS Duty Cycle = 1 percent T_c = 125°C
		.60	V	i_F = 20A Pulse Width = 300μS Duty Cycle = 1 percent T_c = 125°C
Maximum Capacitance	C_t	2000	pF	V_R = 5.0V
Maximum Voltage Rate of Change	dv/dt	1000	v/μS	v_R = 35V

5

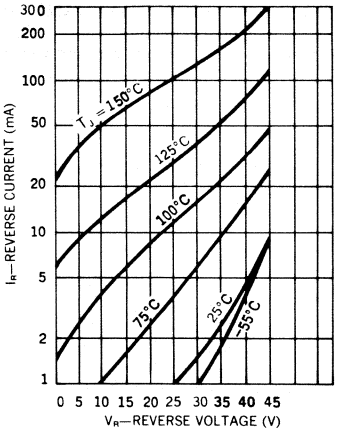
Typical Forward Current vs Forward Voltage



V_{RRM} Rating vs Case Temperature



Typical Reverse Current vs Reverse Voltage



OPTIONAL HIGH RELIABILITY SCREENING

The following tests are performed on 100% of the devices specified SD241HR.

SCREEN	MIL-STD-750 METHOD	CONDITIONS
1. High Temperature Life (Stabilization Bake)	1032	24 Hours @ T_A = 175°C
2. Thermal Shock (Temperature Cycling)	1051	10 Cycles @ T_A = (−55°C to +150°C)
3. Hermetic Seal a. Fine b. Gross	1071	 G or H A, C or D
4. Reverse Energy Test	MIL-S-19500/553 Para 4.5.2	2 Amps
5. Interim Electrical Parameters	—	V_F and I_R @ 25°C
6. High Temperature Reverse Bias (HTRB)	1038	48 Hours @ T_C = 125°C V_R = 80% Rated
7. Final Electrical and Delta Parameters	Go/No Go	ΔI_R ± 100% ΔV_F ± 2%

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 2A

SES5001-SES5003

FEATURES
- Fast Recovery Times
- Low Forward Voltage
- Small Size
- Convenient Package

DESCRIPTION
An axial leaded power rectifier useful in many switching applications. Particularly suited where very fast recovery and low forward voltage are required.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage, SES5001 ..... 50V
Peak Inverse Voltage, SES5002 ..... 100V
Peak Inverse Voltage, SES5003 ..... 150V
Maximum Average D.C. Output Current at T_L = 75°C, L = 3/8" 2A
Non-Repetitive Surge Current at 8.3mS 35A
Thermal Resistance, @ L = 3/8" ..... 38°C/W
Operating and Storage Temperature Range ..... −55°C +175°C

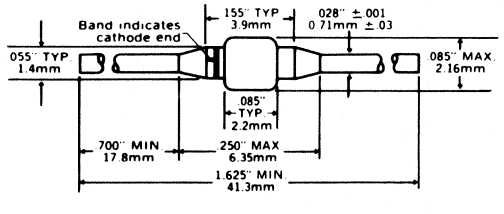
ELECTRICAL SPECIFICATIONS

Type	PIV	Maximum Forward Voltage (V_F) @		Maximum Reverse Current (I_R) @PIV		Maximum Reverse Recovery Time*
		T_J = 25°C	T_J = 100°C	@ T_J = 25°C	@ T_J = 100°C	
SES5001 SES5002 SES5003	50V 100V 150V	.975V @ 1A	.895V @ 1A	2μA	50μA	100nS

*Measured in circuit I_F = .5A, I_R = 1.0A, I_{REC} = .25A

MECHANICAL SPECIFICATIONS

SES5001-SES5003



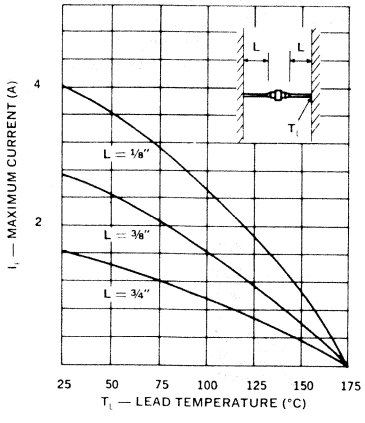
BODY A



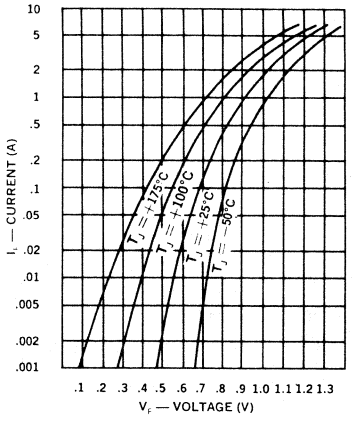
UNITRODE

5

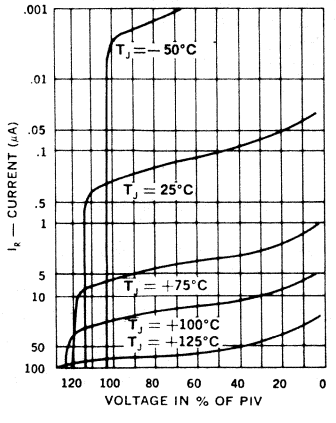
Output Current vs. Lead Temperature



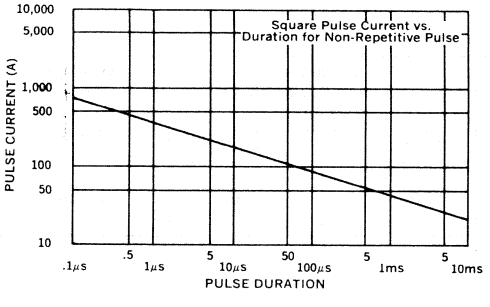
Typical Forward Current vs. Forward Voltage



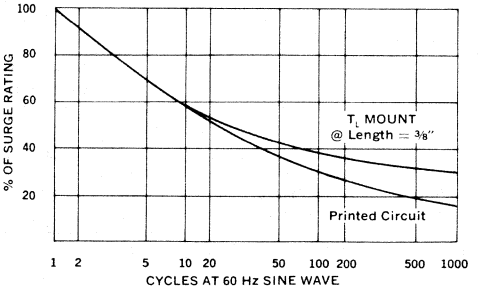
Typical Reverse Current vs. Voltage



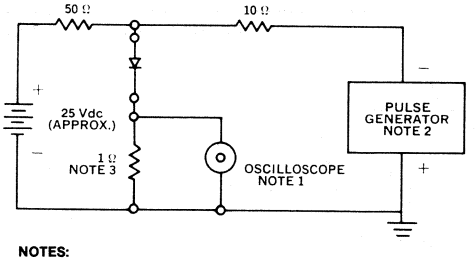
Forward Pulse Current vs. Duration



Multiple Surge Current vs. Duration



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time≤3nS; input impedance = 50Ω.
2. Pulse Generator: Rise time≤8nS; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

RECTIFIERS
High Efficiency, 5A

SES5301-SES5303

FEATURES
- Low Forward Voltage
- Fast Recovery Times
- Small Size
- High Surge

DESCRIPTION
An axial leaded power rectifier useful in many switching applications. Particularly suited where very fast recovery and low forward voltage are required.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage, SES5301 ..... 50V
Peak Inverse Voltage, SES5302 ..... 100V
Peak Inverse Voltage, SES5303 ..... 150V
Maximum Average D.C. Output Current at T_L = 75°C, L = 3/8" 5A
Non-Repetitive Sinusoidal Surge Current at 8.3mS 110A
Thermal Resistance at L = 3/8" ..... 20°C/W
Operating and Storage Temperature Range ..... −55°C to +170°C

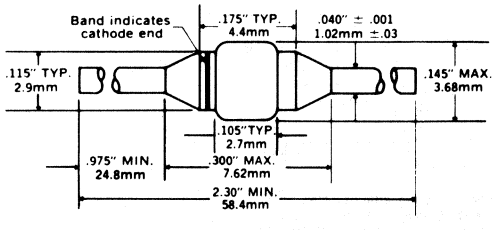
ELECTRICAL SPECIFICATIONS

Type	PIV	Maximum Forward Voltage (V_F) @		Maximum Reverse Current (I_R) @PIV		Maximum Reverse Recovery Time*
		T_J = 25°C	T_J = 100°C	@T_J = 25°C	@T_J = 100°C	
SES5301 SES5302 SES5303	50V 100V 150V	0.975V @ 5A	0.895V @ 5A	5μA	150μA	100ns

*Measured in circuit I_F = 0.5A, I_R = 1.0A, I_{REC} = 0.25A

MECHANICAL SPECIFICATIONS

SES5301-SES5303

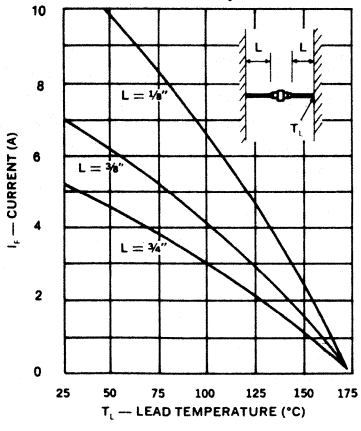


BODY B

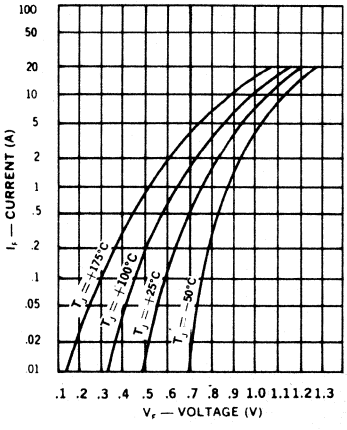


UNITRODE

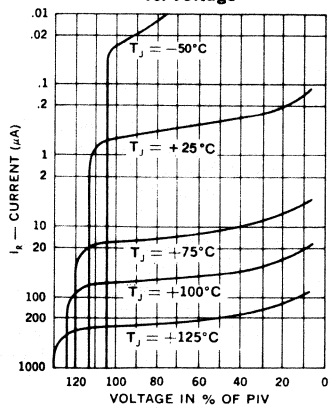
Output Current vs. Lead Temperature



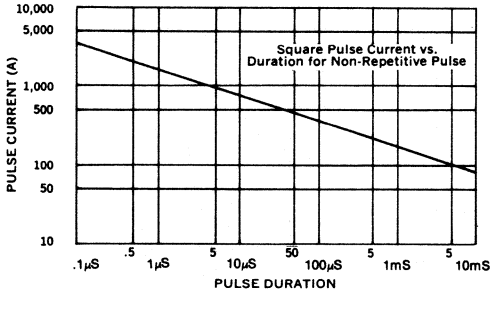
Typical Forward Current vs. Forward Voltage



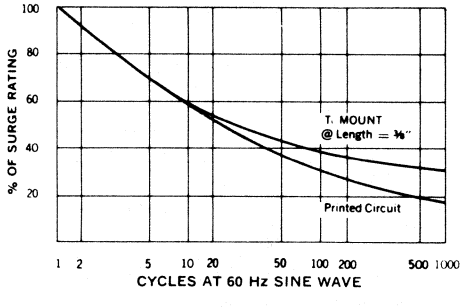
Typical Reverse Current vs. Voltage



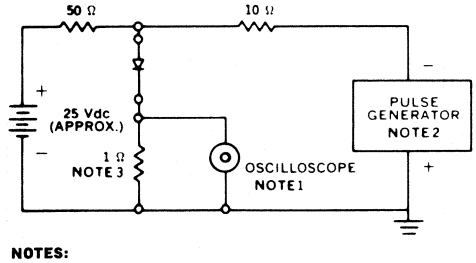
Forward Pulse Current vs. Duration



Multiple Surge Current vs. Duration



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3nS; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8nS; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

RECTIFIERS
High Efficiency, 8A

SES5401-SES5404

FEATURES
- Low Forward Voltage
- Fast Recovery Times
- Economical, Convenient TO-220 Package
- Low Thermal Resistance
- Mechanically Rugged
- PIV up to 200V

DESCRIPTION
The SES5401 Series, in the economical, convenient TO-220 package, is specifically designed for operation in power switching circuits to frequencies in excess of 100kHz. The very low forward voltage and very fast recovery time make them particularly suited for switching type power supplies.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage, SES5401 ..... 50V
Peak Inverse Voltage, SES5402 ..... 100V
Peak Inverse Voltage, SES5403 ..... 150V
Peak Inverse Voltage, SES5404 ..... 200V
Maximum Average D.C. Output Current
@ T_C = 125°C 8.0A
@ T_A = 25°C 3.0A
@ T_A = 25°C (Note 1) 8.0A
Non-Repetitive Sinusoidal Surge Current, 8.3mS 70A
Thermal Resistance, Junction to Case, Θ_{J-C} ..... 2.5°C/W
Thermal Resistance, Junction to Ambient, Θ_{J-A} ..... 60°C/W
Operating and Storage Temperature Range ..... −55°C to +150°C

NOTE 1. Using Wakefield Type 295 heatsink with convection cooling. For more definitive data refer to the Output Current vs. Temperature Curves on this datasheet.

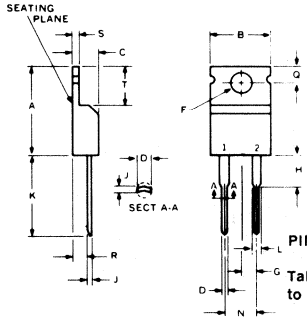
ELECTRICAL SPECIFICATIONS

Type	PIV	Maximum Forward Voltage (V_F) @		Maximum Reverse Current (I_R) @ PIV		Maximum Reverse Recovery Time*	Typical Forward Recovery Voltage @ 1A t_r = 8ns
		T_J = 25°C	T_J = 100°C	@ T_J = 25°C	@ T_J = 100°C		
SES5401	50V	1.025V @ 8A	0.945V @ 8A	5μA	150μA	100ns	1.4V
SES5402	100V				150μA		
SES5403	150V				150μA		
SES5404	200V				500μA		

*Measured in circuit I_F = 0.50A, I_R = 1.0A, I_{REC} = 0.25A

MECHANICAL SPECIFICATIONS

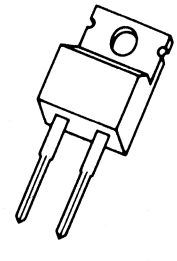
SES5401-SES5404



PIN 1. Cathode
2. Anode
Tab is connected to Cathode.

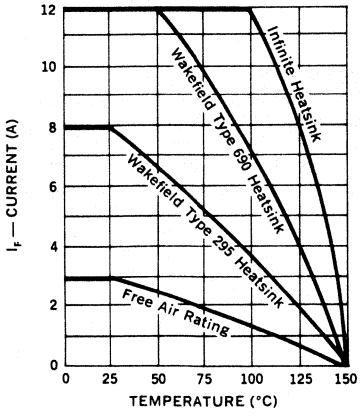
	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.560	0.625	14.23	15.87
B	0.380	0.420	9.66	10.66
C	0.140	0.190	3.56	4.82
D	0.020	0.045	0.51	1.14
F	0.139	0.147	3.531	3.733
G	0.090	0.110	2.29	2.79
H	—	0.250	—	6.35
J	0.015	0.025	0.38	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.070	1.14	1.77
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.115	2.04	2.92
S	0.045	0.055	1.14	1.39
T	0.230	0.270	5.85	6.85

TO-220AC

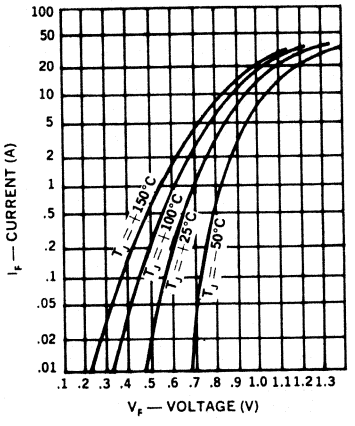


UNITRODE

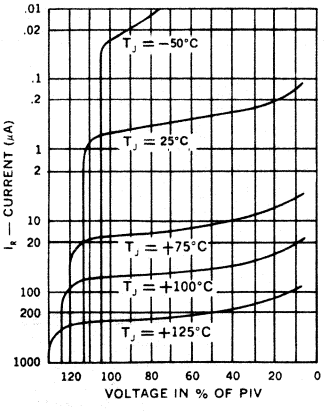
Output Current vs. Temperature



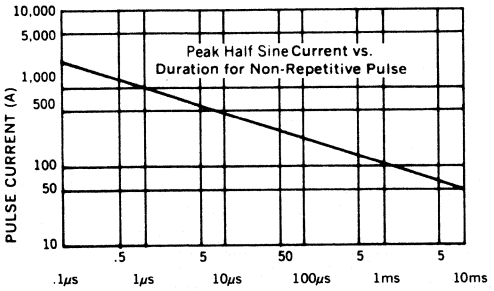
Typical Forward Current vs. Forward Voltage



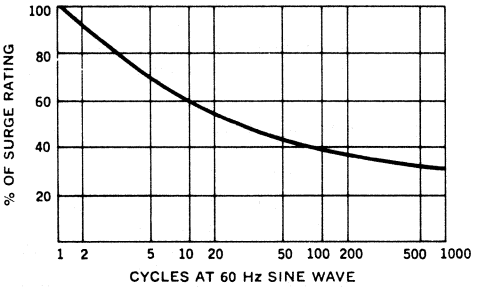
Typical Reverse Current vs. Voltage



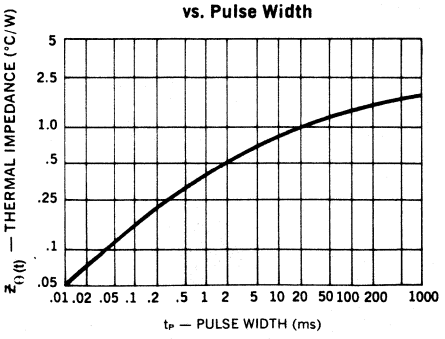
Forward Pulse Current vs. Duration



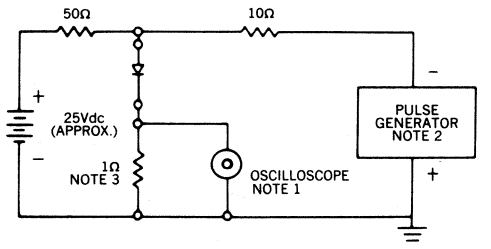
Multiple Surge Current vs. Duration



Thermal Impedance vs. Pulse Width



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

RECTIFIERS

SES5401C-SES5404C

High Efficiency, 16A Center-Tap

FEATURES
- Low Forward Voltage
- Fast Recovery Times
- Economical, Convenient TO-220AB Package
- Low Thermal Resistance
- Mechanically Rugged
- PIV up to 200V

DESCRIPTION
The SES5401C Series in the economical, convenient TO-220AB package, is specifically designed for operation in power switching circuits to frequencies in excess of 100kHz. The series combines two high efficiency devices into one package, simplifying installation, reducing heatsink requirements and the need to purchase matched components.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage, SES5401C 50V
Peak Inverse Voltage, SES5402C 100V
Peak Inverse Voltage, SES5403C 150V
Peak Inverse Voltage, SES5404C 200V
Maximum Average D.C. Output Current
@ T_C = 125°C 16A
@ T_A = 25°C 3A
@ T_A = 25°C (Note 1) 10A
Non-Repetitive Sinusoidal Surge Current, 8.3mS 70A
Thermal Resistance, Junction to Case, $\Theta_{J\text{-}C}$ ..... 1.75°C/W
Thermal Resistance, Junction to Ambient, $\Theta_{J\text{-}A}$ ..... 60°C/W
Operating and Storage Temperature Range ..... −55°C to +150°C

NOTE 1. Using Wakefield Type 295 heatsink with convection cooling. For more definitive data refer to the Output Current vs. Temperature Curves on this datasheet.

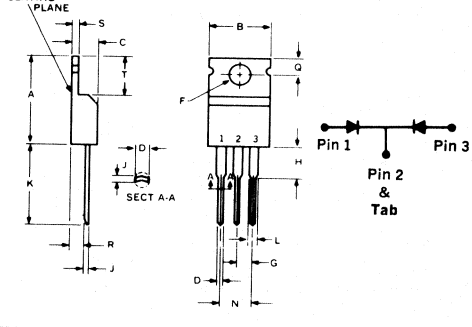
ELECTRICAL SPECIFICATIONS

Type	PIV	Maximum Forward Voltage (V_F) @		Maximum Reverse Current (I_R) @ PIV		Maximum Reverse Recovery Time*	Typical Forward Recovery Voltage @ 1A t_r = 8ns
		T_J = 25°C	T_J = 100°C	@ T_J = 25°C	@ T_J = 100°C		
SES5401C	50V	1.025V @ 8A	0.945V @ 8A	5μA	150μA	100ns	1.4V
SES5402C	100V				150μA		
SES5403C	150V				150μA		
SES5404C	200V				500μA		

*Measured in circuit I_F = 0.50A, I_R = 1.0A, I_{REC} = 0.25A

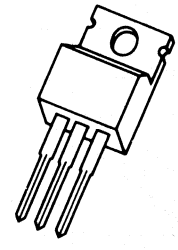
MECHANICAL SPECIFICATIONS

SES5401C-SES5404C



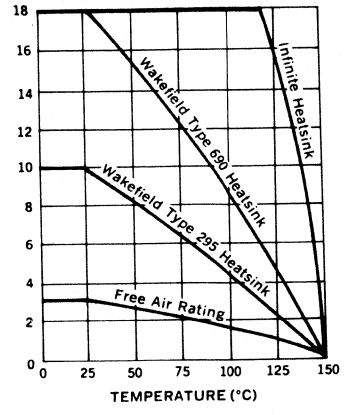
	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.560	0.625	14.23	15.87
B	0.380	0.420	9.66	10.66
C	0.140	0.190	3.56	4.82
D	0.020	0.045	0.51	1.14
F	0.139	0.147	3.531	3.733
G	0.090	0.110	2.29	2.79
H	—	0.250	—	6.35
J	0.015	0.025	0.38	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.070	1.14	1.77
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.115	2.04	2.92
S	0.045	0.055	1.14	1.39
T	0.230	0.270	5.85	6.85

TO-220AB

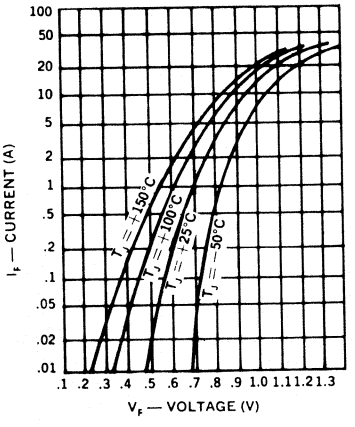


UNITRODE

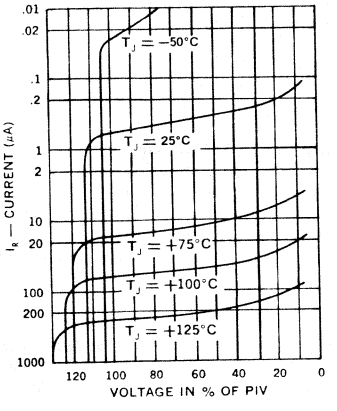
Output Current vs. Temperature



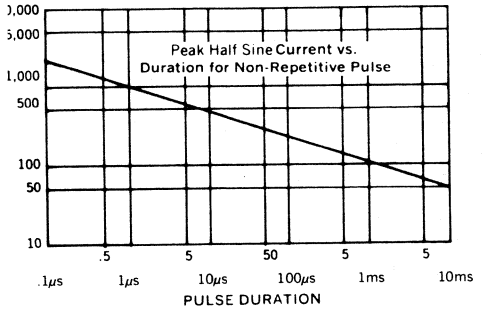
Typical Forward Current vs. Forward Voltage



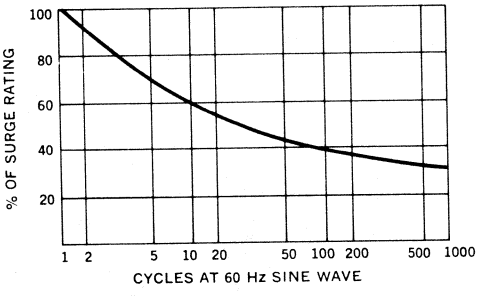
Typical Reverse Current vs. Voltage



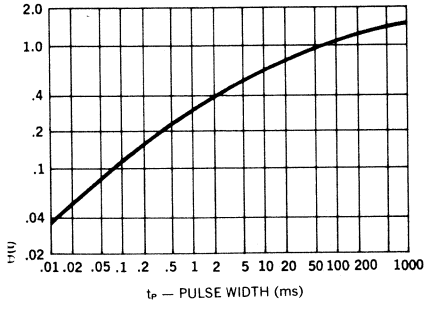
Forward Pulse Current vs. Duration



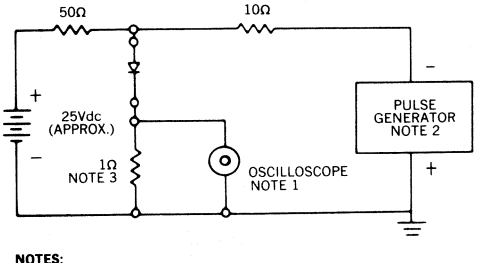
Multiple Surge Current vs. Duration



Thermal Impedance vs. Pulse Width



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

RECTIFIERS
High Efficiency, 16A

SES5501
SES5502
SES5503
SES5504

FEATURES
- Very Low Forward Voltage
- Very Fast Recovery Times
- Economical, Convenient TO-220 Package
- Low Thermal Resistance
- Mechanically Rugged

DESCRIPTION
The SES5500 Series, in the economical, convenient TO-220 package, is specifically designed for operation in power switching circuits to frequencies in excess of 100kHz. The very low forward voltage and very fast recovery time make them particularly suited for switching type power supplies.

ABSOLUTE MAXIMUM RATINGS
Peak Inverse Voltage, SES5501 ..... 50V
Peak Inverse Voltage, SES5502 ..... 100V
Peak Inverse Voltage, SES5503 ..... 150V
Peak Inverse Voltage, SES5504 ..... 200V
Maximum Average D.C. Output Current
@ T_C = 95°C 16A
@ T_A = 25°C 3.3A
@ T_A = 25°C (Note 1) 9.0A
Non-Repetitive Sinusoidal Surge Current, 8.3ms 250A
Thermal Resistance, Junction to Case, θ_{J-C} ..... 1.5°C/W
Thermal Resistance, Junction to Ambient, θ_{J-A} ..... 60°C/W
Operating and Storage Temperature ..... −55°C to +150°C

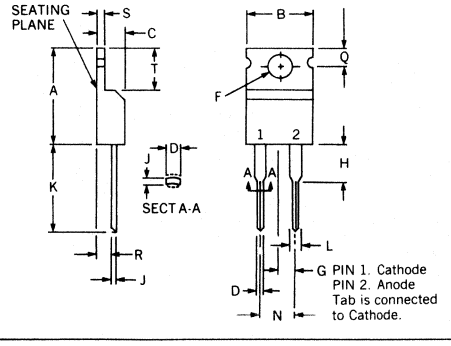
Note: 1. Using Wakefield Type 295 heatsink with convection cooling. For more definitive data refer to the Output Current vs Temperature Curve on this data sheet.

ELECTRICAL SPECIFICATIONS

Type	PIV	Maximum Forward Voltage		Maximum Reverse Current @ PIV		Maximum Reverse Recovery Time*	Typical Forward Recovery Voltage @ 1A t_r = 8ns
		T_J = 25°C	T_J = 100°C	T_J = 25°C	T_J = 100°C		
SES5501 SES5502 SES5503 SES5504	50V 100V 150V 200V	1.025V @ 16A	.945V @ 16A	10μA	800μA	100ns	2.0V

* Measured in circuit I_F = 1/2A, I_R = 1.0A, I_{REC} = 1/4A

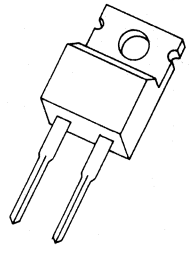
MECHANICAL SPECIFICATIONS



SES5501-SES5504

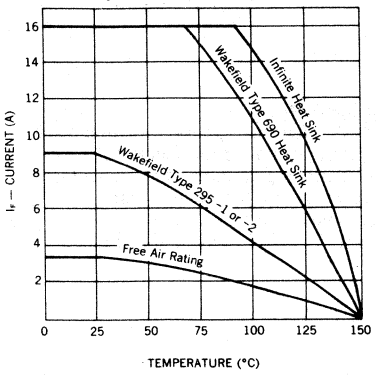
	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.560	0.625	14.23	15.87
B	0.380	0.420	9.66	10.66
C	0.140	0.190	3.56	4.82
D	0.020	0.045	0.51	1.14
F	0.139	0.147	3.531	3.733
G	0.090	0.110	2.29	2.79
H	—	0.250	—	6.35
J	0.015	0.025	0.38	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.070	1.14	1.77
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.115	2.04	2.92
S	0.045	0.055	1.14	1.39
T	0.230	0.270	5.85	6.85

TO-220AC

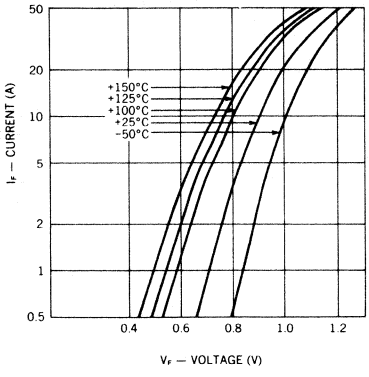


UNITRODE

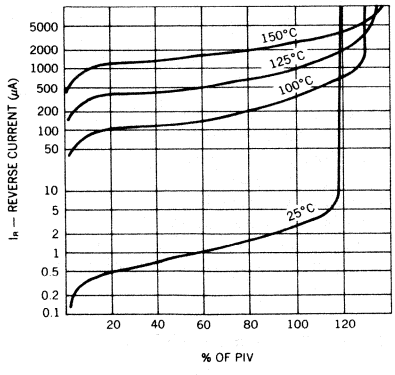
Output Current vs Temperature



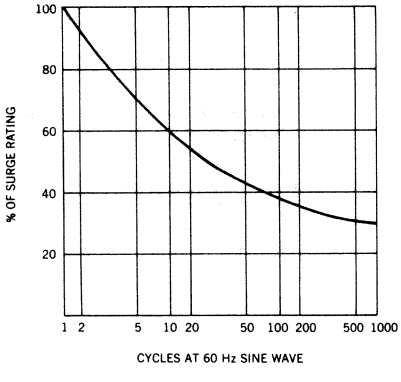
Typical Forward Current vs Forward Voltage



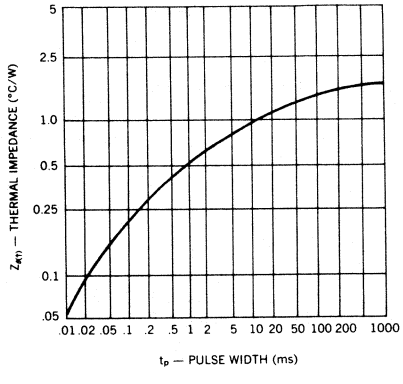
Typical Reverse Current vs Voltage



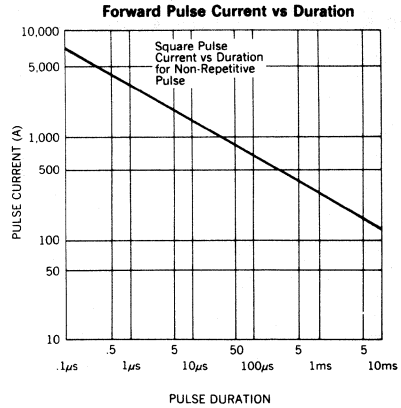
Multiple Surge Current vs Duration



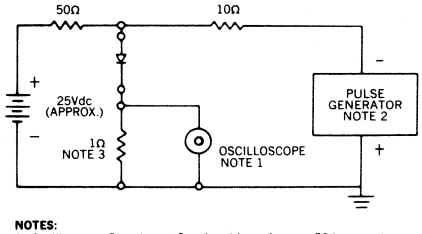
Thermal Impedance vs Pulse Width



Forward Pulse Current vs Duration



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 25A Center-Tap

SES5601C
SES5602C
SES5603C

FEATURES
- Low Forward Voltage
- Fast Switching Speed
- Convenient Package
- High Surge Capability
- Low Thermal Resistance
- Mechanically Rugged TO-3 Package
- Available as Positive or Negative Center-Tap

DESCRIPTION
The SES, super-fast recovery, rectifiers are specifically designed for operation in power switching circuits. Their super-fast recovery time and very low forward voltage make them particularly efficient in most switching applications.

ABSOLUTE MAXIMUM RATINGS

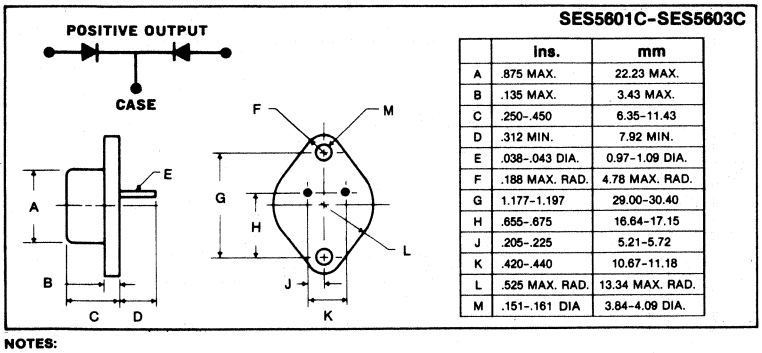
Peak Inverse Voltage, SES5601C 50V
Peak Inverse Voltage, SES5602C 100V
Peak Inverse Voltage, SES5603C 150V
Maximum Average D.C. Output Current at $T_c = 100°C$ 25A
Non-Repetitive Sinusoidal Surge Current 8.3 mS 400A
Thermal Resistance, Junction to Case ..... 1 °C/W
Operating and Storage Temperature Range ..... −55 °C to +175 °C

ELECTRICAL SPECIFICATIONS PER DIODE

Type	PIV	Maximum Forward Voltage (V_F) @		Maximum Reverse Current (I_R) @PIV		Maximum Reverse Recovery Time*
		$T_C = 25°C$	$T_C = 125°C$	$@T_C = 25°C$	$@T_C = 125°C$	
SES5601C SES5602C SES5603C	50V 100V 150V	0.990V @ 12.5A $t_p = 300\mu S$	0.830V @ 12.5A $t_p = 300\mu S$	20μA	4mA	100nS

*Measured in circuit $I_F = 0.5A$, $I_R = 1.0A$, $I_{REC} = 0.25A$

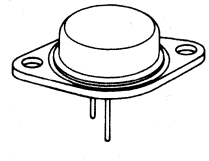
MECHANICAL SPECIFICATIONS



SES5601C-SES5603C

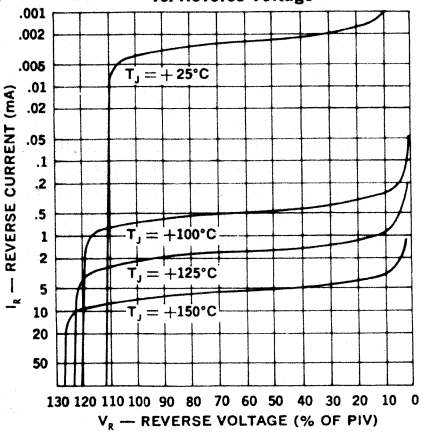
	Ins.	mm
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.00-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA	3.84-4.09 DIA.

TO-204AA (TO-3)

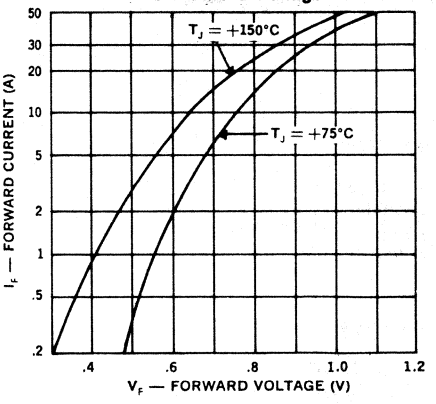


NOTES:
1. Standard polarity is positive output.
   For reverse polarity (negative output) add suffix "R", ie, SES5601CR.
2. All metal surfaces tin plated.

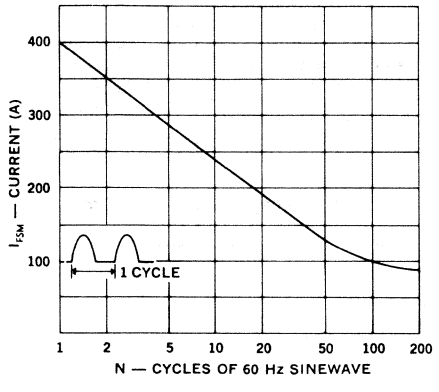
Typical Reverse Current vs. Reverse Voltage



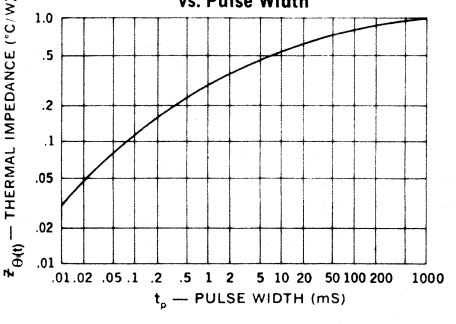
Typical Forward Current vs. Forward Voltage



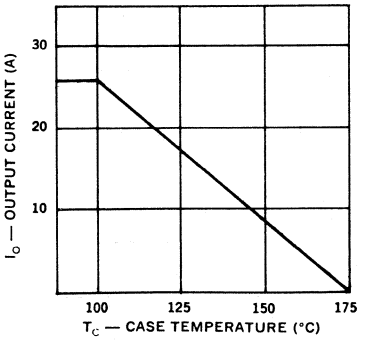
Maximum Forward Surge vs. Number of Cycles



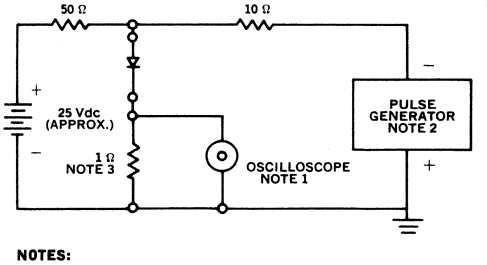
Thermal Impedance vs. Pulse Width



Output Current vs. Case Temperature



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ⩽ 3nS; input impedance = 50Ω.
2. Pulse Generator: Rise time ⩽ 8nS; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 20A

SES5701
SES5702
SES5703

FEATURES
- Low Forward Voltage
- Fast Switching
- Low Thermal Resistance
- High Surge Capability
- Mechanically Rugged DO-4 Package
- Reverse Polarity Available

DESCRIPTION
The SES, super-fast recovery, rectifiers are specifically designed for operation in power switching circuits. Their super-fast recovery time and very low forward voltage drop make them particularly efficient in most switching applications.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage, SES5701 ..... 50V
Peak Inverse Voltage, SES5702 ..... 100V
Peak Inverse Voltage, SES5703 ..... 150V
Maximum Average D.C. Output Current at $T_c = 100°C$ 20A
Non-Repetitive Sinusoidal Surge Current 8.3 mS 400A
Thermal Resistance, Junction to Case ..... 1.5 °C/W
Operating and Storage Temperature Range ..... −55 °C to +175 °C

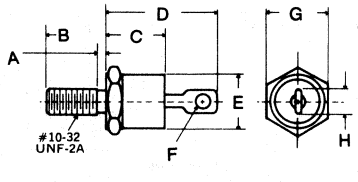
ELECTRICAL SPECIFICATIONS

Type	PIV	Maximum Forward Voltage (V_F) @		Maximum Reverse Current (I_R) @PIV		Maximum Reverse Recovery Time*
			$T_C = 125°C$		$@T_C = 125°C$	
SES5701 SES5702 SES5703	50V 100V 150V	.990V @ 20A $t_p = 300\mu S$	.830 @ 20A $t_p = 300\mu S$	20μA	4mA	100nS

*Measured in circuit I_F = .5A, I_R = 1.0A, I_{REC} = .25A

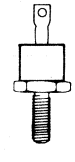
MECHANICAL SPECIFICATIONS

SES5701-SES5703



	ins.	mm
A	.078 MAX.	1.98 MAX.
B	±.437 ±.015	11.10 ±0.38
C	.405 MAX.	10.29 MAX.
D	.800 MAX.	20.32 MAX.
E	.424 MAX.	10.77 MAX.
F	.066 MIN. DIA.	1.68 MIN. DIA.
G	.430 ±.010	10.92 ±0.25
H	.250 MAX.	6.35 MAX.

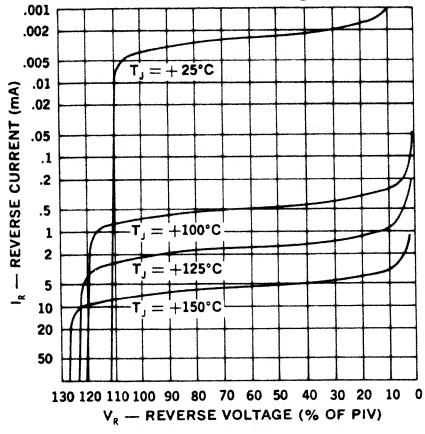
DO-4



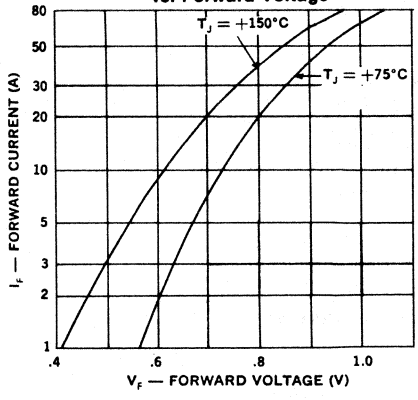
NOTES:
1. Standard polarity is cathode-to-stud.
   For reverse Polarity (anode-to-stud) add suffix "R", ie. SES5701R.
2. All metal surfaces tin plated.
3. Maximum unlubricated stud torque: 10 inch pounds.
4. Angular orientation of terminal is undefined.

5

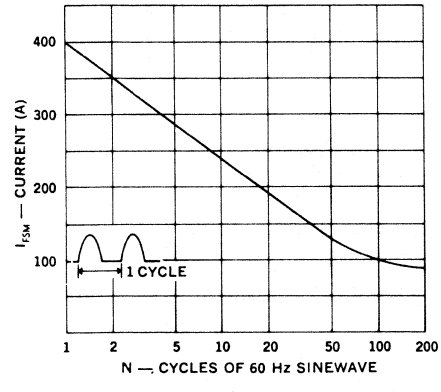
Typical Reverse Current vs. Reverse Voltage



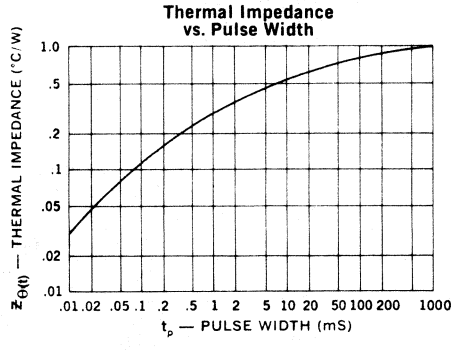
Typical Forward Current vs. Forward Voltage



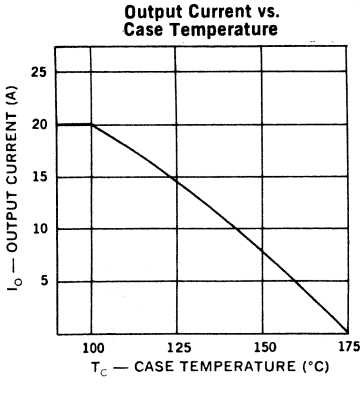
Maximum Forward Surge vs. Number of Cycles



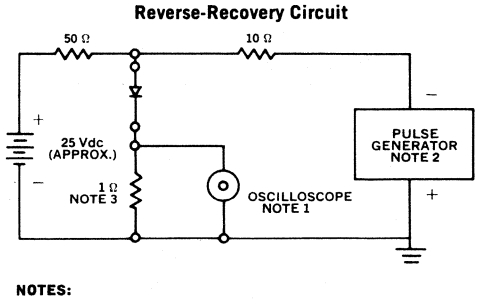
Thermal Impedance vs. Pulse Width



Output Current vs. Case Temperature



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time $\leqslant 3nS$; input impedance = 50Ω.
2. Pulse Generator: Rise time $\leqslant 8nS$; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

RECTIFIERS
High Efficiency, 60A

SES5801
SES5802
SES5803

FEATURES
- Low Forward Voltage
- Fast Switching Speeds
- High Surge Capability
- Low Thermal Resistance
- Mechanically Rugged DO-5 Package
- Reverse Polarity Available

DESCRIPTION
The SES, super-fast recovery, rectifiers are specifically designed for operation in power switching circuits. Their super-fast recovery time and very low forward voltage drop make them particularly efficient in most switching applications.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage, SES5801 ..... 50V
Peak Inverse Voltage, SES5802 ..... 100V
Peak Inverse Voltage, SES5803 ..... 150V
Maximum Average D.C. Output Current at $T_c = 100°C$ 60A
Non-Repetitive Sinusoidal Surge Current 8.3 mS 800A
Thermal Resistance, Junction to Case ..... 0.8 °C/W
Operating and Storage Temperature Range ..... −55 °C to +175 °C

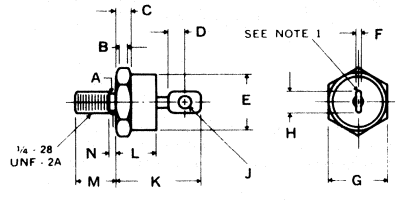
ELECTRICAL SPECIFICATIONS

Type	PIV	Maximum Forward Voltage (V_F) @		Maximum Reverse Current (I_R) @PIV		Maximum Reverse Recovery Time*
		$T_C = 25°C$	$T_C = 150°C$	@$T_C = 25°C$	@$T_C = 150°C$	
SES5801 SES5802 SES5803	50V 100V 150V	0.990V @ 60A $t_p = 300\mu S$	0.850V @ 60A $t_p = 300\mu S$	25μA	30mA	100nS

*Measured in circuit $I_F = 0.5A$, $I_R = 1.0A$, $I_{REC} = 0.25A$

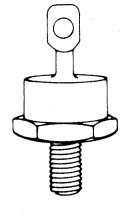
MECHANICAL SPECIFICATIONS

SES5801-SES5803



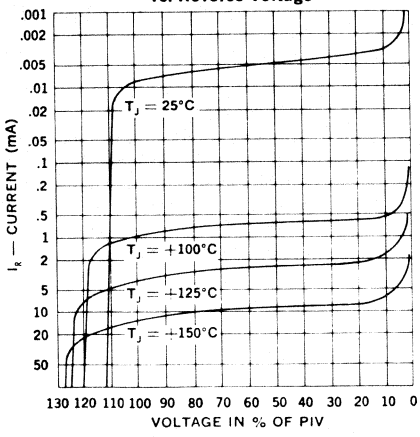
	ins.	mm
A	.225 ± .005	5.72 ± 0.13
B	.060 MIN.	1.52 MIN.
C	.156 ± .020	3.96 ± 0.51
D	.156 MIN. FLAT	3.96 MIN. FLAT
E	.667 DIA. MAX.	16.94 DIA. MAX.
F	.090 MAX.	2.29 MAX.
G	.667 ± .010	16.94 ± 0.25
H	.375	9.53
J	.140 MIN. DIA.	3.56 MIN. DIA.
K	1.000 MAX.	25.40 MAX.
L	.450 MAX.	11.43 MAX.
M	.438 ± .015	11.13 ± 0.38
N	.078 MAX.	1.98 MAX.

DO-5

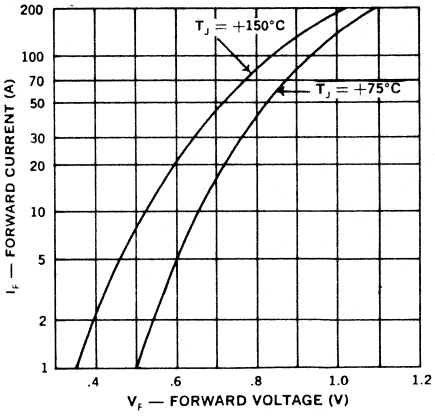


Notes:
1. Standard polarity is cathode-to-stud.
   For reverse polarity (anode-to-stud) add suffix "R", ie. SES5801R.
2. All metal surfaces tin plated.
3. Maximum unlubricated stud torque: 20 inch pounds.
4. An angular orientation of terminal is undefined.

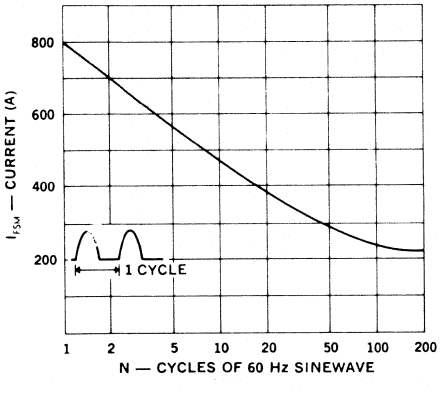
Typical Reverse Current vs. Reverse Voltage



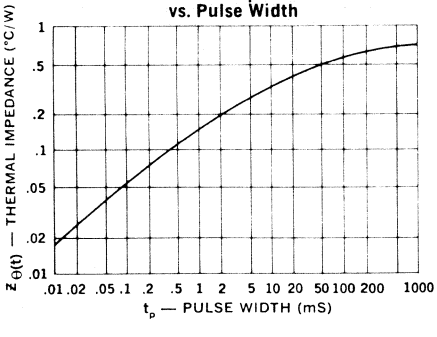
Forward Current vs. Forward Voltage



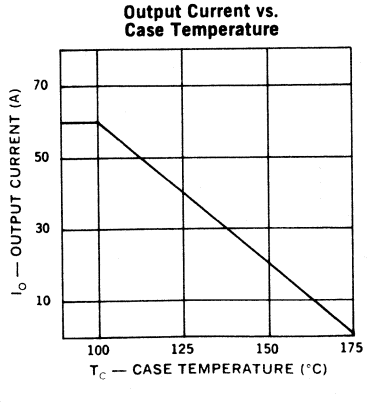
Maximum Forward Surge vs. Number of Cycles



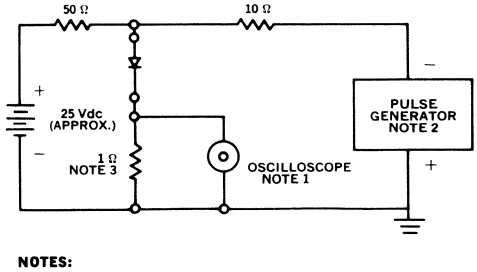
Thermal Impedance vs. Pulse Width



Output Current vs. Case Temperature



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3nS; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8nS; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

Single Phase Bridges, 25 Amp, Military Approved

JAN SPA25
JAN SPB25
JAN SPC25
JAN SPD25

FEATURES

- Qualified to MIL-S-19500/446
- Current Rating: to 25A
- PIV: from 100 to 600V
- Surge Ratings: to 150A
- Only Fused-in-Glass Diodes Used
- Controlled Avalanche Characteristics
- Aluminum Heat Sink Case, Electrically Insulated

DESCRIPTION

This series of military high-current single-phase bridges offer the utmost in reliability as required in military system designs. This series is assembled with diodes which have been subjected to 100% screening tests.

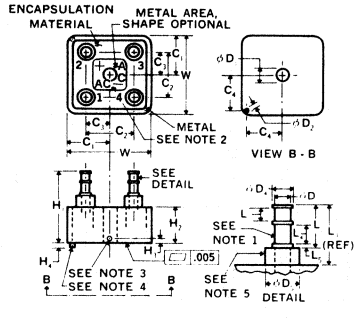
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	100 to 600V
Maximum Average D.C. Output Current	
@ T_C = 55°C	25A
@ T_C = 100°C	15A
Non-Repetitive Sinusoidal Surge (8.3ms)	
@ T_C = 55°C	150A
Operating and Storage Temperature Range	−65°C to +150°C
Thermal Resistance Junction to Ambient	20°C/W
Junction to Case	2.5°C/W

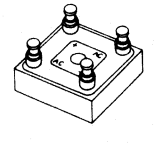
Ltr	Dimensions			
	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
C_1	.552	.572	14.02	14.53
C_2	.624	.760	15.85	19.30
C_3	.312	.380	7.92	9.65
C_4	.495	.512	12.57	13.00
ϕD_1	.189	.195	4.80	4.95
ϕD_2	.057	.067	1.45	1.70
ϕD_3	.108	.118	2.74	3.00
ϕD_4	.141	.151	3.58	3.84
ϕD_5	.225	.235	5.72	5.97
H_1	.669	1.060	17.53	26.92
H_2	.300	.500	7.62	12.70
H_3	.040	.060	1.02	1.52
H_4	.042	.062	1.07	1.57
L_1	.370	.560	9.40	14.22
L_2	.307	.365	7.80	9.27
L_3	.089	.099	2.26	2.49
L_4	.132	.142	3.35	3.61
L_5	.026	.036	.66	.91
W	1.104	1.144	28.04	29.06

MECHANICAL SPECIFICATIONS

SPA25 SPB25 SPC25 SPD25



MC



NOTES:

1. Terminals shall be hot tin dipped or silver plated.
2. Polarity shall be marked on terminal side of device.
3. Point at which T_C is read (must be in metal part of case).
4. Locating pin shall be adjacent to positive terminal.
5. Insulating sleeve shall be alumina (AL_2O_3) or equivalent.

UNITRODE

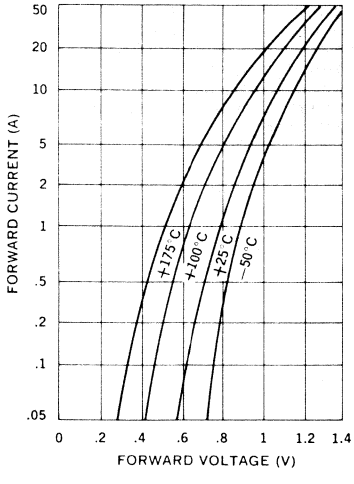
Electrical Specifications (at 25°C unless noted)

Type	PIV Per Leg	Peak Forward Voltage Drop*		Maximum Reverse Recovery Time†	Maximum Leakage Current Per Leg @ PIV	
					T_C = 25°C	T_C = 100°C
	Volts	Minimum	Maximum	μS	μA	μA
JAN SPA25 JAN SPB25 JAN SPC25 JAN SPD25	100 200 400 600	0.9V @ 39A(pk)	1.4V	2	2	150

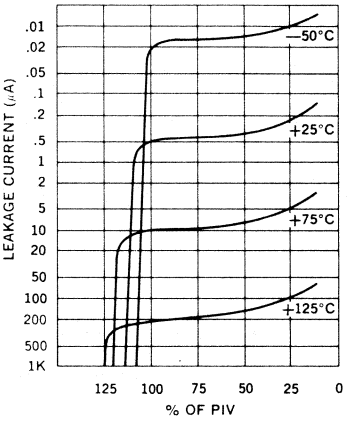
*Peak forward voltage drop is measured at a pulse width of 8.3ms.
†Measured in a reverse recovery circuit switching from 0.5A forward to 1.0A reverse current recovery to 0.5A.

5

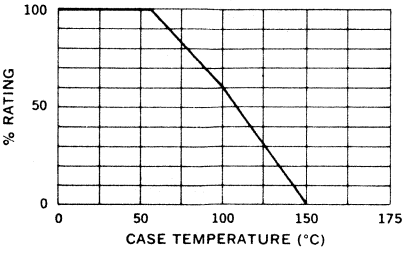
Typical Forward Voltage Per Leg vs. Forward Current

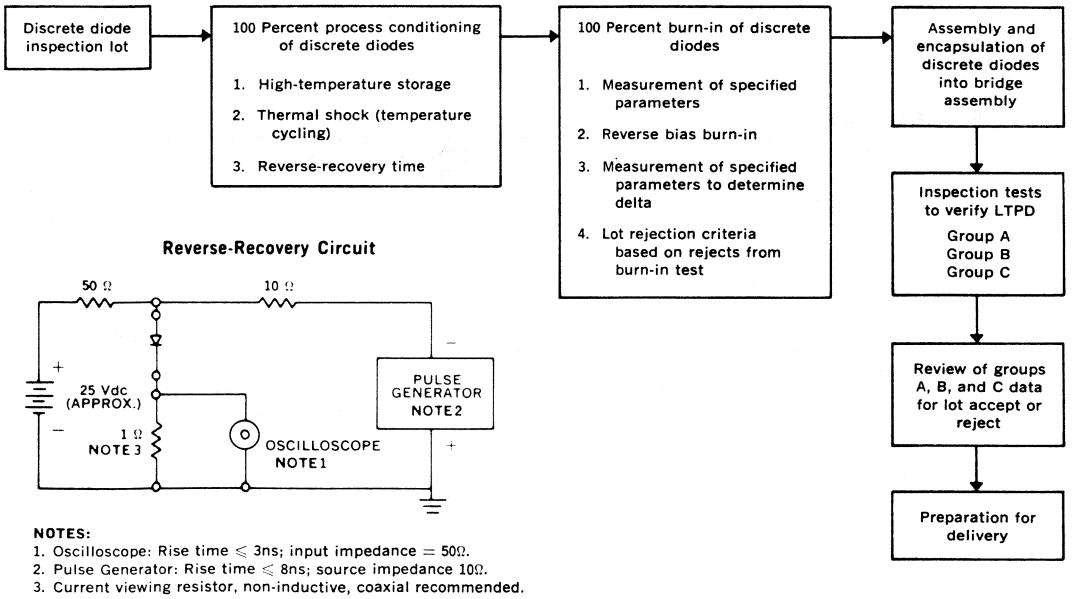


Typical Leakage Current vs. PIV



Current Derating Curve





Reverse-Recovery Circuit

NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

HIGH VOLTAGE SILICON RECTIFIERS

POWERSTACK

400mA-1.0A

High Current, Miniature

SX10-100
SXS10-100

FEATURES

- PIV: From 1kV to 10kV
- 400mA to 1.0A
- 250nS Reverse Recovery
- High Surge Ratings
- Low Reverse Leakage
- Corona Free

DESCRIPTION

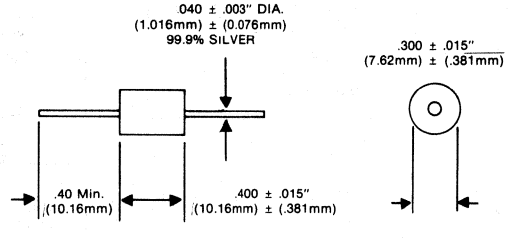
The SX/SXS silicon rectifier series is a unique concept for high current high voltage applications. Matched junction characteristics and low stray capacitance due to metallurgically bonded junctions eliminate the need for external compensation networks. These rectifiers utilize HVD's cylindrical die construction, which minimizes electrical and mechanical stress, insuring long life for commercial, military and industrial applications.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	1kV to 10kV
Maximum Average Rectified Current	See Electrical Specifications
Maximum One Cycle Surge 8.3mS	See Electrical Specifications
Operating and Storage Temperature Range	−65°C to +150°C

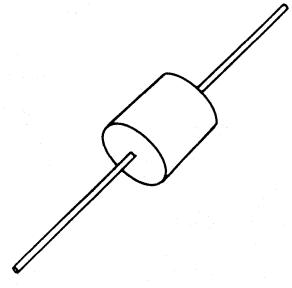
MECHANICAL SPECIFICATIONS

SX10-100
SXS10-100



Dimensions in inches and (millimeters)

SL

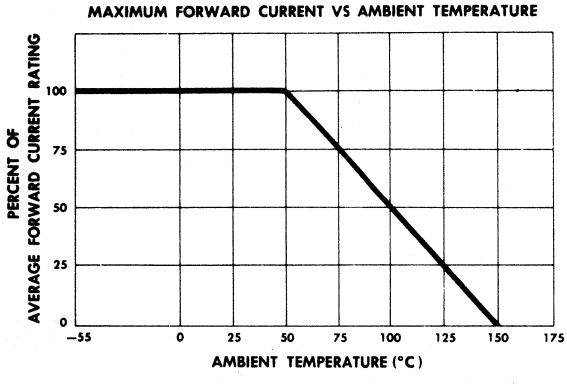


UNITRODE

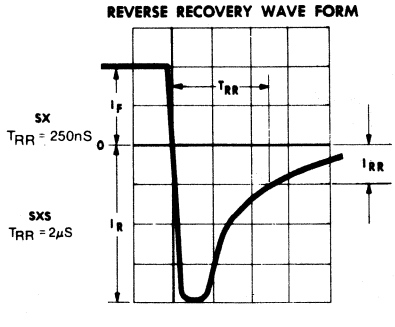
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)						MAXIMUM RATINGS			
Maximum Reverse Recovery Time §		Peak Inverse Voltage*	Maximum Reverse Current @ PIV		Maximum Forward Voltage @ I_O	Maximum Average Rectified Current†			Maximum One Cycle Surge 8.3mS
250nS	2μS	PIV	I_R		V_F	I_O			I_F(surge)
Type	Type	V	25°C	100°C	25°C	50°C	100°C	125°C	A
			μA	μA	V	mA	mA	mA	
SX10	SXS10	1000	1.0	25	5.5	1000	500	250	60
SX15	SXS15	1500	1.0	25	5.5	1000	500	250	60
SX20	SXS20	2000	1.0	25	5.5	1000	500	250	60
SX25	SXS25	2500	1.0	25	5.5	1000	500	250	60
SX30	SXS30	3000	1.0	25	7.5	600	300	150	40
SX40	SXS40	4000	1.0	25	7.5	600	300	150	40
SX50	SXS50	5000	1.0	25	7.5	600	300	150	40
SX60	SXS60	6000	1.0	25	11.0	400	200	100	25
SX80	SXS80	8000	1.0	25	11.0	400	200	100	25
SX100	SXS100	10000	1.0	25	11.0	400	200	100	25

5

*Operation and testing of devices over 10,000 V/inch may require re-encapsulation or immersion in a suitable dielectric material.
† The stated, AVERAGE RECTIFIED CURRENT ratings require no heat sinking, special mounting or forced air across the body of the device.
NOTE: Maximum lead temperature for soldering is 250°C 3/8" (9.5mm) from case for 5 seconds.



Reverse recovery test conditions: I_F = 100mA, I_R = 200mA, I_{RR} = 50mA



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

BISYN™ SYNCHRONOUS RECTIFIER

UBS430

For Low-Voltage (<5.0V) Loads

FEATURES

- Very Low On Resistance — Typically 7 milliohms
- High Reverse Blocking Voltage — V_{ECS} = 40V
- Can be PWM Controlled to Provide Regulated Voltage to Load
- Low Temperature Coefficient of On Resistance
- Fast Switching Times Make Operation at High Frequency Easy
- High Gain Reduces Base Losses

DESCRIPTION

The BISYN is a bipolar junction transistor that is specifically designed to perform the rectifying function in the secondary of a switching power supply. Unlike a conventional bipolar, the BISYN has a much higher emitter-base breakdown voltage (typically 50V) which is needed for full-wave rectifier circuits. Base drive losses are kept at a minimum by the relatively high current gain of the BISYN.

The BISYN's most significant specification feature is its very low V_F, 0.3V at 30A, compared with 0.6V for a Schottky and only 0.1V at 10A. Its most significant functional feature is its programmability.

The very low V_F of this product reduces the rectifier power loss in a power supply secondary, improving its efficiency. This becomes particularly significant as load voltages drop below 5V. For example, with a 3V load the power loss associated with the Schottky contributes to a 20% reduction in efficiency, while with a synchronous rectifier this loss is reduced to 10% or less.

The programmability feature gives the designer a new way to provide regulation to a load. Its main advantage is the reduced power component count as compared with a buck regulator and the resulting improvement in efficiency.

PRELIMINARY

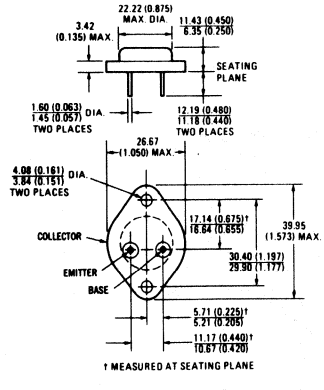
ABSOLUTE MAXIMUM RATINGS

Continuous Forward Current	I_F	40A
Peak Forward Emitter Current*	I_{ERM}	150A
Inductive Forward Current Clamped	I_{FLM}	80A**
Continuous Base Current*	I_B	8A
Peak Base Current*	I_{BRM}	50A
Forward Blocking Voltage	V_{CES}	50V
Reverse Blocking Voltage	V_{ECS}	40V
Thermal Resistance	R_θ	1.0°C/W
Power Dissipation		150W @ 25°C
Derating Factor		1.0W/°C
Operating Temperature Range		−65°C to +175°C

Notes: *1msec pulse.
**See Figure 1.

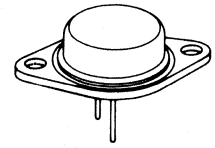
MECHANICAL SPECIFICATIONS

UBS430



Dimensions in Millimeters and (Inches)

TO-204AE (TO-3 modified, 60 mil. pin)



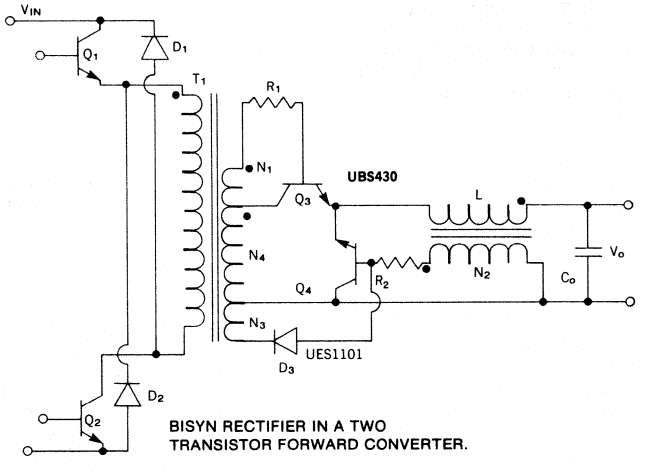
UNITRODE

ELECTRICAL CHARACTERISTICS (at 25°C unless noted)

TEST	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITIONS
On Resistance	$R_{CE(ON)}$		7	10	mΩ	I_C = 30A, I_B = 1.2A
			10	13	mΩ	I_C = 30A, I_B = 1.2A, T = 125°C
Current Gain	h_{FE}	50	100			I_C = 20A, V_{CE} = 0.5V
Base Saturation Voltage	$V_{BE(sat)}$		1.2	1.5	V	I_C = 30A, I_B = 1.2A
Rise Time	t_r		85	120	nS	I_C = 20A, I_B = 2A, V_{CC} = 10V
Storage Time	t_s		300	500	nS	I_C = 20A, I_B = 2A, V_{CC} = 10V
Fall Time	t_f		75	120	nS	I_C = 20A, I_B = 2A, V_{CC} = 10V
Forward Leakage Current	I_{CES}			100	μA	V_{CE} = 50V
				1	mA	V_{CE} = 50V, T = 125°C
Reverse Leakage Current	I_{ECS}			200	μA	V_{EC} = 40V
				1	mA	V_{CE} = 40V, T = 125°C
Collector Capacitance	C_{OBO}		1000	1500	pf	V_{EC} = 10V, f = 1MHz

5

A RECOMMENDED DRIVE CIRCUIT



BISYN RECTIFIER IN A TWO TRANSISTOR FORWARD CONVERTER.

THE OPERATION OF THE CIRCUIT IS AS FOLLOWS:

During the on-time of transistors Q_1 and Q_2 , BISYN Q_3 is biased on and delivers output load current through filter inductor L. The polarity of voltage developed across winding N_2 is such that BISYN Q_4 remains in a blocking state. Diode D_3 is also biased off. When transistors Q_1 and Q_2 turn-off; some of the energy stored in the magnetizing and leakage inductance enhances the recovery process of BISYN Q_3. The recovery time (300-400nS) of BISYN Q_3 extends the reset time of the core. However, in a typical design, half of the switching period is allocated for core reset time. Thus, the storage time has no significant effect on operation. The BISYN Q_4 starts conducting filter inductor current as soon as the voltage across the secondary collapses. BISYN Q_4 receives base drive energy from the filter inductor L, through winding N_2. The diode D_3 still remains reverse biased.

When transistors Q_1 and Q_2 turn-on again, the voltage across winding N_3 is clamped to approximately zero by diode D_3 and the forward biased collector to base junction of BISYN Q_4. This junction acts as a voltage source (≈0.7V) as long as BISYN Q_4 is conducting during the storage time. The turn-on of BISYN Q_3 is held off due to lack of base drive because winding N_3 is shorted, through diode D_3 and the collector-base junction of BISYN Q_4. Meanwhile, the current through the shorted turns (the rate of rise of which is limited by leakage inductance) is utilized to rapidly commutate BISYN Q_4 off. Diode D_3 is then reverse biased and BISYN Q_3 turns on through winding N_1.

The effect of the turn-off circuit, consisting of winding N_3 and D_3 is to eliminate high peak currents in the secondary. You will also find that with this circuit there are practically no switching losses.

Application Note U-103 contains additional design information and circuits for the BISYN.

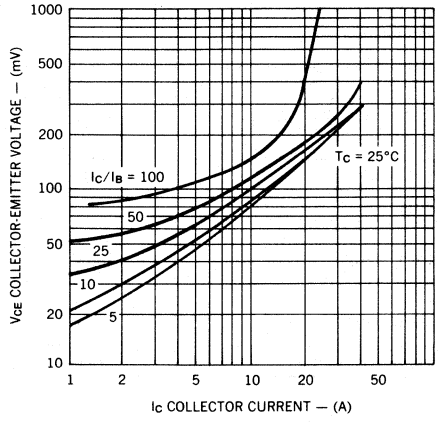
DESIGNING FOR MINIMUM POWER DISSIPATION

Although used as a rectifier the BISYN is a three terminal device. Therefore, the power dissipation due to the On Resistance and also the dissipation due to the base current must be taken into consideration. You will notice on curves 1 and 2 that the change in On Voltage (V_{CE}) at a particular collector current is small even with large changes in base current. As a result, achieving the lowest On Voltage for a particular load current does not result in the lowest overall power loss.

It has been determined that operating at a base current that achieves an On Voltage that is 110% of the On Voltage at a circuit gain of ten gives a result that is very close to optimum power dissipation. Curve 3 gives you the appropriate base current to achieve 110% of this On Voltage. This same curve shows that the appropriate base drive for optimum power dissipation at any particular load current is virtually the same throughout the operating temperature range.

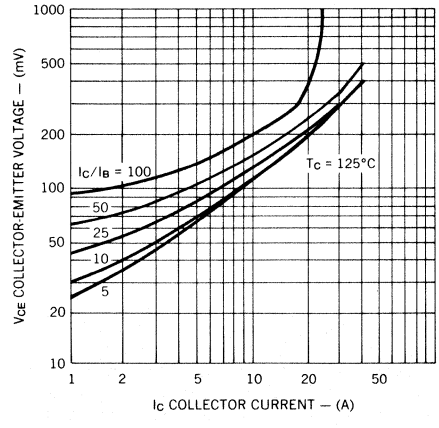
To calculate the power dissipation first estimate the operating temperature of the BISYN. Then using the appropriate temperature curve determine the On Voltage at a circuit gain of 10 for your load. Multiply this voltage by 1.1 and then by the load current to determine On Resistance power dissipation. Base current power dissipation is calculated by finding the base drive current on curve 3 and then going to the applicable temperature curve for Base Emitter Voltage vs Base Current (curves 4 and 5). Multiplying the Base Emitter Voltage by Base Current will give you the power dissipation due to base current.

Collector-Emitter Voltage vs Collector Current at Various Forced Gains



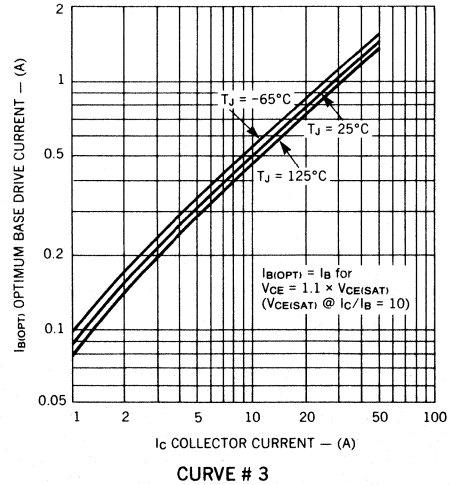
CURVE # 1

Collector-Emitter Voltage vs Collector Current at Various Forced Gains



CURVE # 2

Optimum Base Drive Current vs Collector Current



CURVE # 3

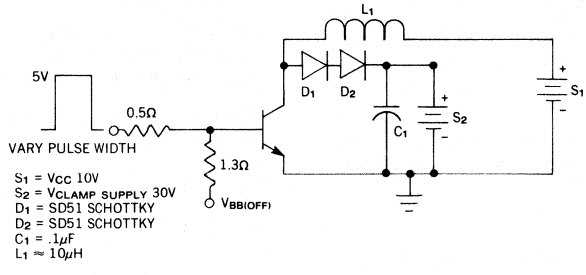
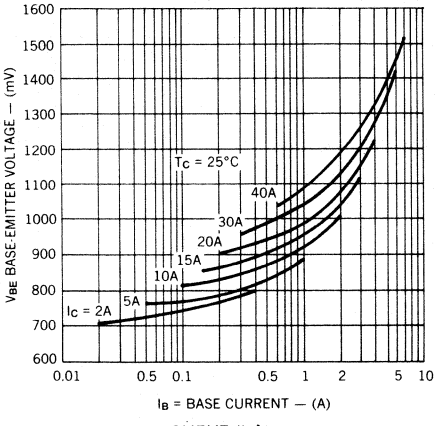


FIGURE 1. TEST CIRCUIT FOR I_{LPK}.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

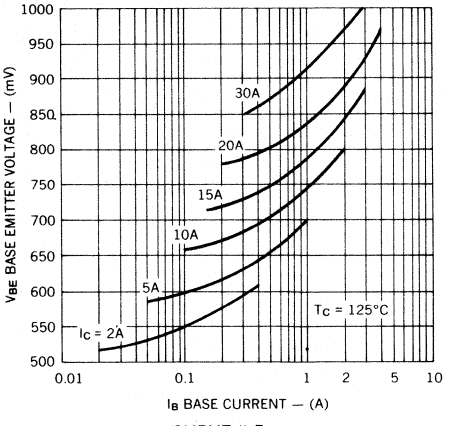
PRINTED IN U.S.A.

Base Emitter Voltage vs Base Current at Various Collector Currents



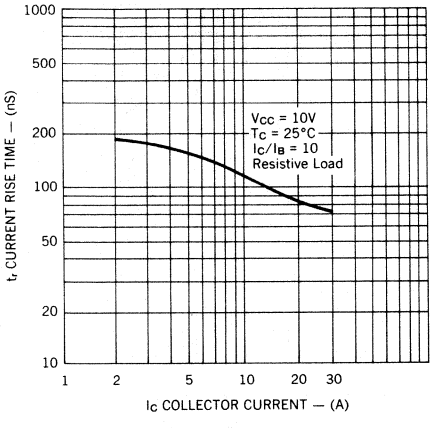
CURVE # 4

Base Emitter Voltage vs Base Current at Various Collector Currents



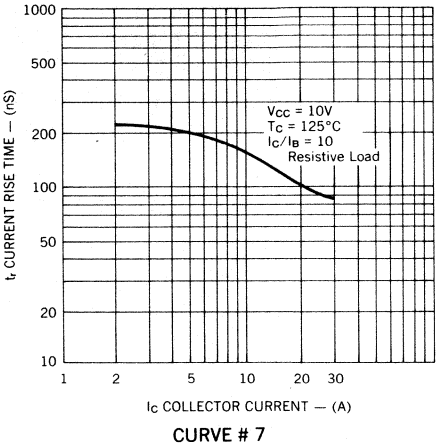
CURVE # 5

Current Rise Time vs Collector Current



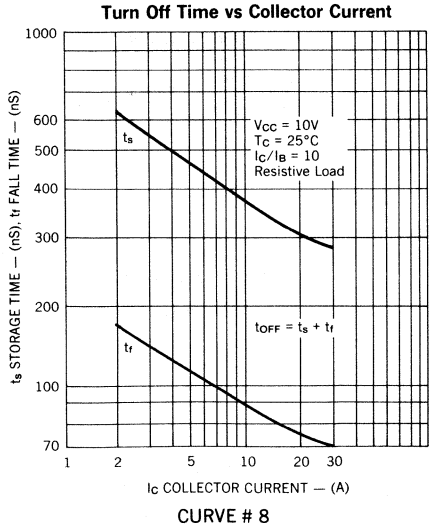
CURVE # 6

Current Rise Time vs Collector Current



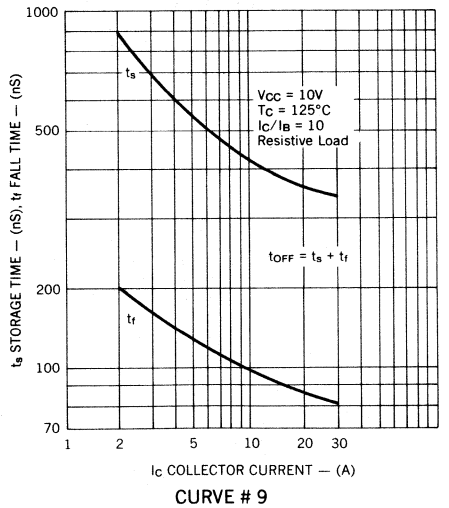
CURVE # 7

Turn Off Time vs Collector Current



CURVE # 8

Turn Off Time vs Collector Current

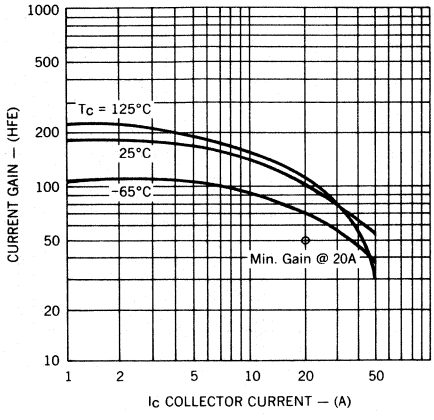


CURVE # 9

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

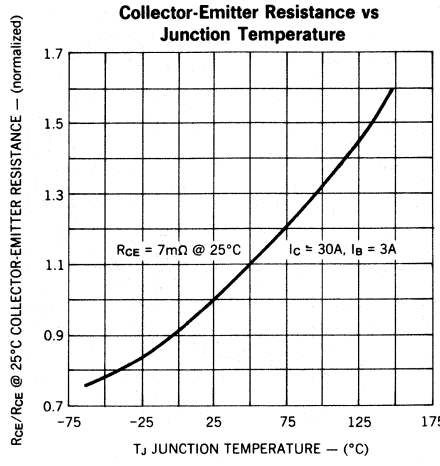
PRINTED IN U.S.A.

Gain vs Collector Current @ V_{CE} = 0.5V at Various Temperatures



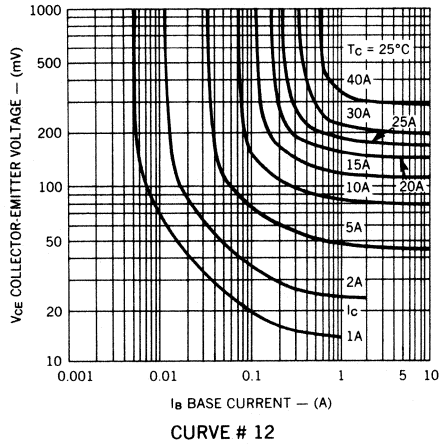
CURVE # 10

Collector-Emitter Resistance vs Junction Temperature



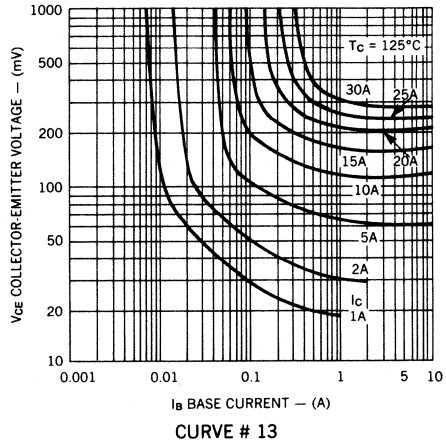
CURVE # 11

Collector-Emitter Voltage vs Base Current



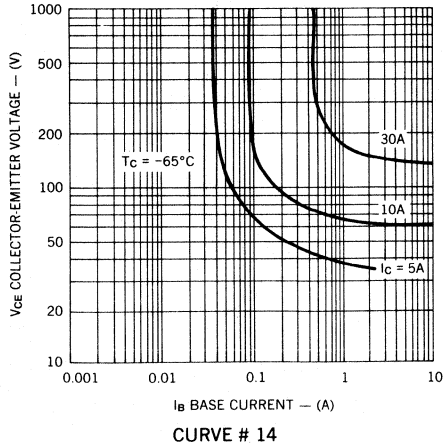
CURVE # 12

Collector-Emitter Voltage vs Base Current



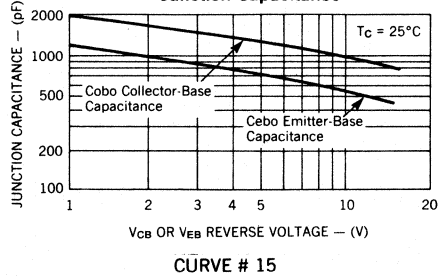
CURVE # 13

Collector-Emitter Voltage vs Base Current at Various Collector Currents



CURVE # 14

Junction Capacitance

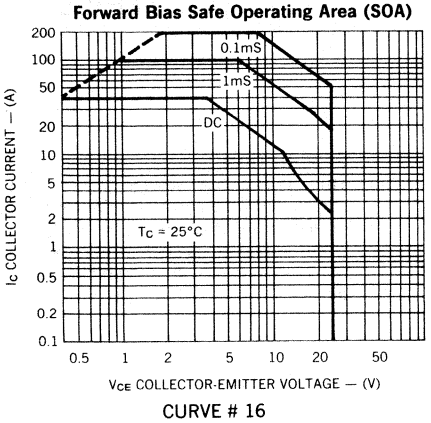


CURVE # 15

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

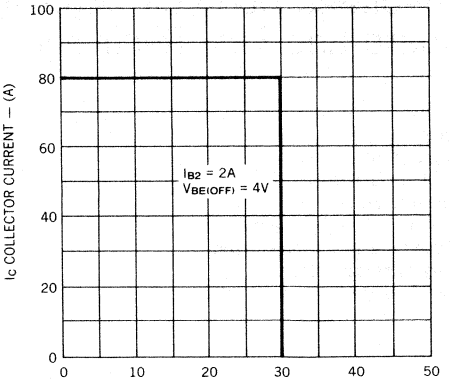
PRINTED IN U.S.A.

Forward Bias Safe Operating Area (SOA)



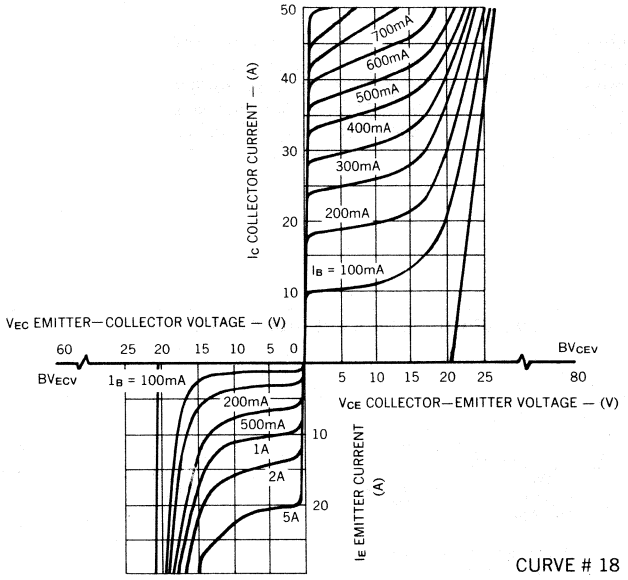
CURVE # 16

Reverse Bias Safe Operating Area



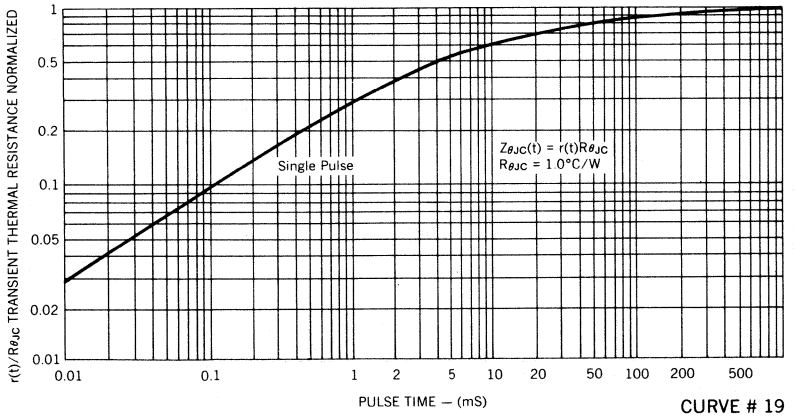
CURVE # 17

Common-Emitter Collector Characteristics



CURVE # 18

Transient Thermal Resistance vs Time



CURVE # 19

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

BISYN™ is a trademark of Unitrode Corporation.

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

High Voltage Doorbell® Modules, Standard and Fast Recovery

UDA, UDB, UDC, UDD , UDE, UDF SERIES

FEATURES

- PIV: from 2.5kV to 15kV
- Stackable to 600kV
- Current Ratings: to 7.7A
- Controlled Avalanche Characteristics
- Only Fused-in-Glass Diodes Used
- Recovery Time: to 500ns
- Modular Package For Easy Stacking

DESCRIPTION

This series of high-voltage, high-current stacks that incorporate a unique modular design makes it ideally suited for high power applications such as in radar systems as charger, hold-off and clipper diodes.

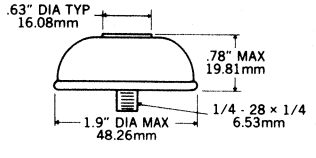
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage

UDA, UDC Series	5kV to 15kV
UDB, UDD Series	2.5 kV to 7.5kV
UDE, UDF Series	2.5 kV to 5kV
Maximum Average D.C. Output Current	See Electrical Specifications
Non-Repetitive Sinusoidal Surge (8.3ms)	See Electrical Specifications
Operating and Storage Temperature Range	—65°C to +150°C

MECHANICAL SPECIFICATIONS

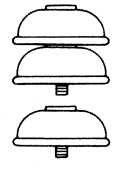
UDA, UDB, UDC, UDD, UDE, UDF SERIES



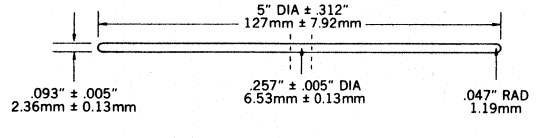
1. Polarity — Cathode connected to base.
2. Part Number — On base of unit.

Typical Weight — 2.1 ounces
60 grams

DD



EXTENDER PLATE D



Typical Weight — 2.75 ounces
78 grams

Doorbell® is a registered trademark of Unitrode Corporation

UNITRODE

Electrical Specifications (at 25°C unless noted) — **Maximum Ratings**

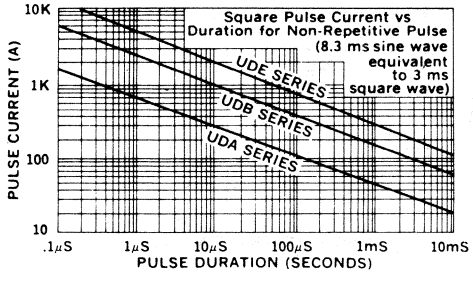
Type		PIV	Maximum Forward Voltage Drop	Maximum Leakage Current @ PIV	Maximum Reverse Recovery Time	Maximum Average D.C. Output Current			Non-Repetitive Sinusoidal Surge (8.3ms) $T_C = 100°C$	Maximum Reverse Transient Energy Absorption
						$T_C = 75°C$ Air	$T_C = 60°C$ Air with Extender Plate**	$T_C = 50°C$ Oil		
		kV		μA	ns	Amps	Amps	Amps	Amps	joules
Standard Recovery	UDE-2.5	2.5	5V @ 3.00A	10		‡ 6.00	7.00	7.70	200	8
	UDB-2.5	2.5	4V @ 1.50A	5		3.00	3.75	4.25	100	4
	UDE-5	5	10V @ 2.20A	10		‡ 4.50	5.00	5.50	200	14
	UDB-5	5	8V @ 1.00A	5		2.00	2.50	2.75	100	8
	UDA-5	5	8V @ 0.82A	2	—	1.65	2.00	2.20	30	1.5
	UDB-7.5	7.5	12V @ 0.70A	5		1.33	1.65	2.00	100	12
	UDA 7.5	7.5	12V @ 0.60A	2		1.25	1.55	1.75	30	2.5
	UDA-10	10	16V @ 0.50A	2		1.00	1.25	1.40	30	3
	UDA-15	15	25V @ 0.33A	2		0.67	0.80	0.90	30	5
Fast Recovery	UDF-2.5	2.5	6V @ 2.20A	10		4.50	5.00	5.30	150	8
	UDD-2.5	2.5	6V @ 1.20A	5		2.25	2.80	3.30	80	4
	UDF-5	5	11V @ 1.60A	10		3.30	4.00	4.40	150	14
	UDD-5	5	11V @ 0.75A	5		1.50	1.85	2.00	80	8
	UDC-5	5	10V @ 0.70A	2	500*	1.20	1.50	1.70	25	1.5
	UDD-7.5	7.5	17V @ 0.50A	5	350†	1.00	1.25	1.50	80	12
	UDC-7.5	7.5	15V @ 0.50A	2		0.90	1.10	1.25	25	2.5
	UDC-10	10	20V @ 0.37A	2		0.75	0.90	1.00	25	3
	UDC-15	15	30V @ 0.25A	2		0.50	0.60	0.70	25	5

***Measured in a reverse recovery circuit switching from 1.0A forward to 1.0A reverse current recovering to 0.5A.**
†Measured in a reverse recovery circuit switching from 0.5A forward to 1.0A reverse current recovering to 0.25A.

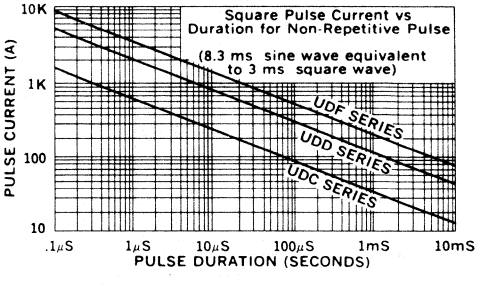
**These ratings are based on using "extender plates" that provide additional surface area to radiate heat. Because of possible corona effects caused by scratches on these plates, extreme care is necessary in their handling and they are not recommended where the working voltage exceeds 7.5KV/module. They should be carefully polished prior to installation.

‡These ratings are based on $T_C = 100°C$.

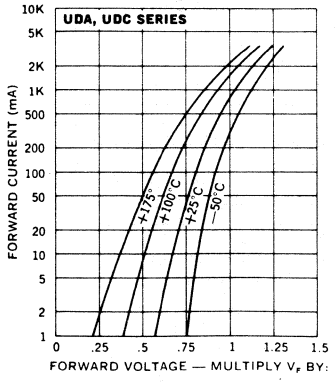
Forward Pulse Current vs. Pulse Duration



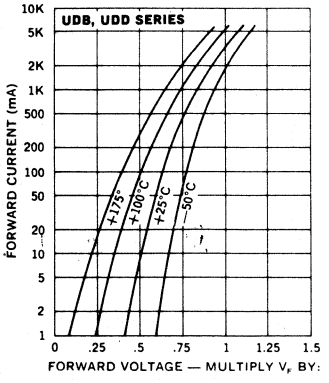
Forward Pulse Current vs. Pulse Duration



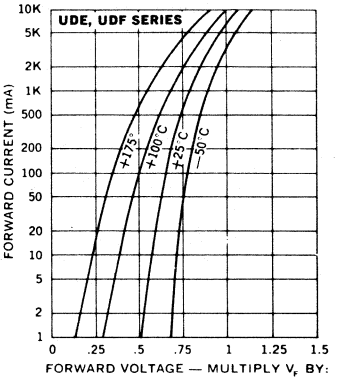
Typical Forward Voltage vs. Forward Current



Typical Forward Voltage vs. Forward Current



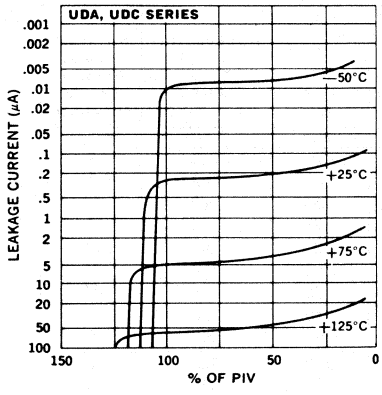
Typical Forward Voltage vs. Forward Current



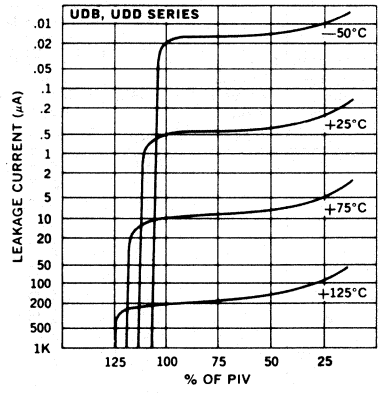
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

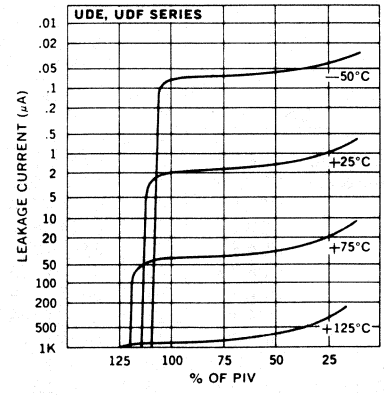
Typical Leakage Current vs. PIV



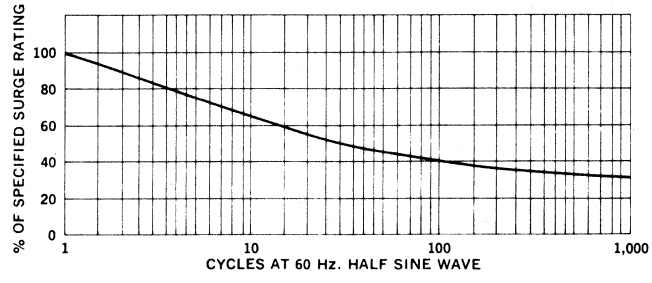
Typical Leakage Current vs. PIV



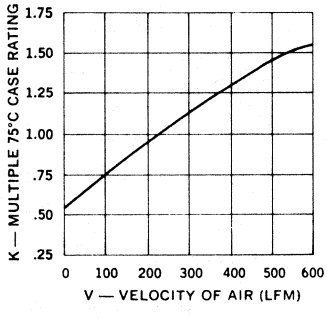
Typical Leakage Current vs. PIV



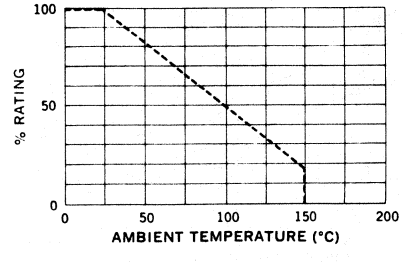
Multiple Surge Rating vs. Duration



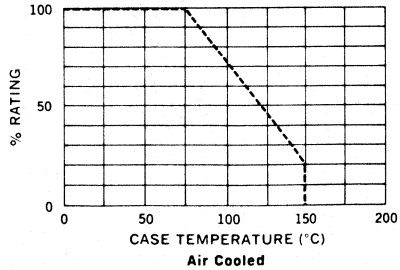
Output Current Ratio vs. Velocity of Air Flow



Current Derating Curve

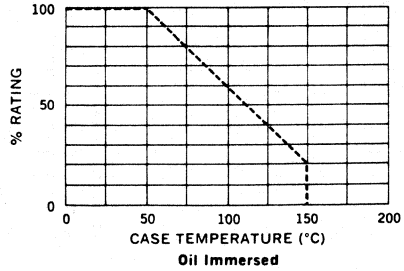


Current Derating Curve



Air Cooled

Current Derating Curve



Oil Immersed

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 25 A

UES701 BYW31-50 BYW77-50
UES702 BYW31-100 BYW77-100
UES703 BYW31-150 BYW77-150

FEATURES
- Low Forward Voltage
- Very Fast Switching
- Low Thermal Resistance
- High Surge Capability
- Mechanically Rugged
- Both Polarities Available

DESCRIPTION
Designed to meet the efficiency demand of switching type power supplies, these devices are useful in many switching applications.
The low thermal resistance and forward voltage drop of this series allows the user to replace DO-5 size devices in many applications.

5

ABSOLUTE MAXIMUM RATINGS

	UES701	UES702	UES703
Peak Inverse Voltage, V_R	50V	100V	150V
Repetitive Peak Inverse Voltag, V_{RRM}	50V	100V	150V
Non-Repetitive Peak Inverse Voltage, V_{RSM}	50V	100V	150V
Maximum Average D.C. Output Current I_o @ T_C	25A @ 100°C		
RMS Forward Current, $I_{F\ (RMS)}$	40A		
Non-Repetitive Sinusoidal Surge Current (8.3mS), I_{FSM}	400A		
Thermal Resistance, Junction to Case, $R_{\theta JC}$	1.5°C/W		
Storage Temperature Range, T_{STG}	−55°C to +175°C		
Maximum Operating Junction Temperature, $T_{J\ MAX}$	+175°C		

ABSOLUTE MAXIMUM RATINGS

	BYW31-50	BYW31-100	BYW31-150	BYW77-50	BYW77-100	BYW77-150
Peak Inverse Voltage, V_R	50V	100V	150V	50V	100V	150V
Repetitive Peak Inverse Voltage, V_{RRM}	50V	100V	150V	50V	100V	150V
Non-Repetitive Peak Inverse Voltage, V_{RSM}	50V	100V	150V	50V	100V	150V
Maximum Average D.C. Output Current, I_o @ T_C = 100°C	25A @ 100°C			30A @ 107°C		
RMS Forward Current, $I_{F\ (RMS)}$	40A			50A		
Non-Repetitive Sinusoidal Surge Current (8.3mS), I_{FSM}	320A			500A		
Thermal Resistance, Junction to Case, $R_{\theta JC}$	1.5°C/W			1.5°C/W		
Storage Temperature Range, T_{STG}	−55°C to +150°C			−55°C to +150°C		
Maximum Operating Junction Temperature, $T_{J\ MAX}$	+150°C			+150°C		

ELECTRICAL SPECIFICATIONS

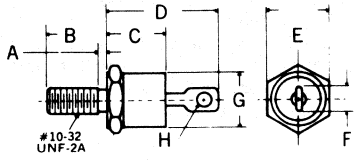
Type	Maximum Reverse Voltage V_R	Maximum Forward Voltage V_F			Maximum Reverse Current I_R		Maximum Reverse Recovery Time t_{RR}
		T_C = 25°C	T_C = 125°C		T_C = 25°C	T_C = 125°C	
UES701 UES702 UES703	50V 100V 150V	0.95V @ I_F = 25A	0.825V @ I_F = 25A		20μA @ Rated V_R	4mA @ Rated V_R	35ns(1)
		T_C = 25°C	T_C = 100°C		T_C = 25°C	T_C = 100°C	
BYW31-50 BYW31-100 BYW31-150	50V 100V 150V	1.3V @ I_F = 100A	0.85V @ I_F = 20A		20μA @ Rated V_R	2.5mA @ Rated V_R	50ns(2)
		T_C = 25°C	T_C = 100°C		T_C = 25°C	T_C = 100°C	
			V_F	I_F			
BYW77-50 BYW77-100 BYW77-150	50V 100V 150V	1.1V @ I_F = 63A	0.75V 0.85V 1.2V	10A 20A 100A	25μA @ Rated V_R	2.5mA @ Rated V_R	50ns(2)

(1) Measured in circuit I_F = 0.5A, I_R = 1A, I_{REC} = 0.25A
(2) Measured in circuit I_F = 1A to V_R > 30V $dI_F/_{dt}$ = 20A/μs

UNITRODE

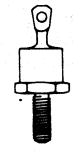
MECHANICAL SPECIFICATIONS

UES701 SERIES
BYW31 SERIES
BYW77 SERIES



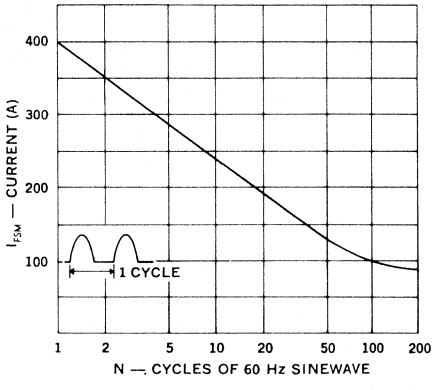
	ins.	mm
A	.078 MAX.	1.98 MAX.
B	.437 ± .015	11.10 ±0.38
C	.405 MAX.	10.29 MAX.
D	.800 MAX.	20.32 MAX.
E	.430 ± .010	10.92 ± 0.25
F	.250 MAX.	6.35 MAX.
G	.424 MAX.	10.77 MAX.
H	.066 MIN. DIA.	1.68 MIN. DIA.

DO-4

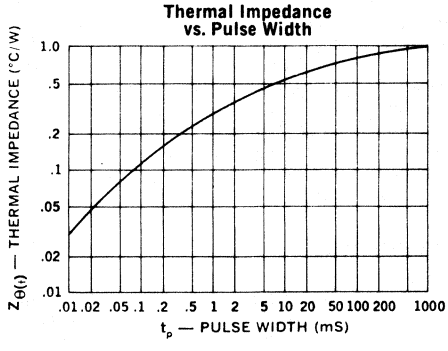


Notes:
1. Cathode is stud.
2. All metal surfaces tin plated.
3. Maximum unlubricated stud torque: 10 inch pounds.
4. Angular Orientation of terminal is undefined.

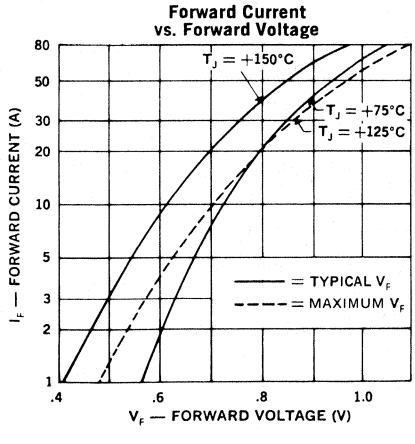
Maximum Forward Surge vs. Number of Cycles



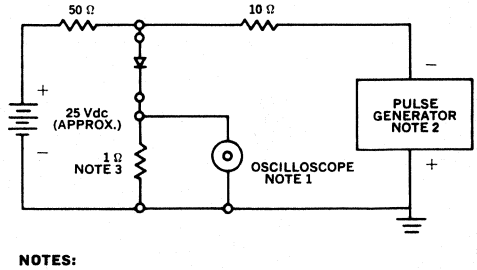
Thermal Impedance vs. Pulse Width



Forward Current vs. Forward Voltage

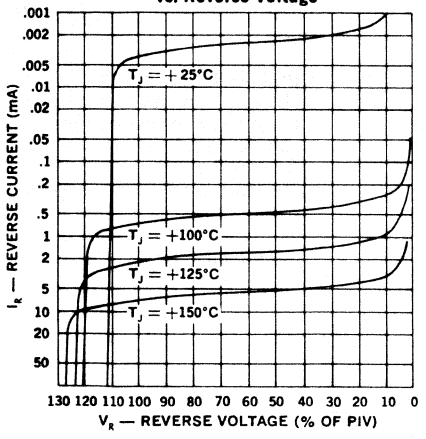


Reverse-Recovery Circuit

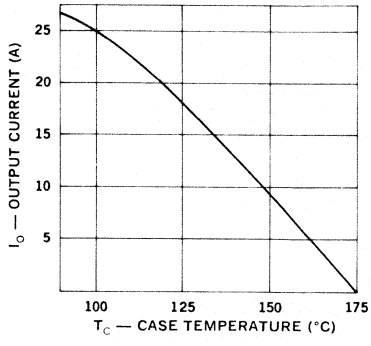


NOTES:
1. Oscilloscope: Rise time ⩽ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ⩽ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

Typical Reverse Current vs. Reverse Voltage

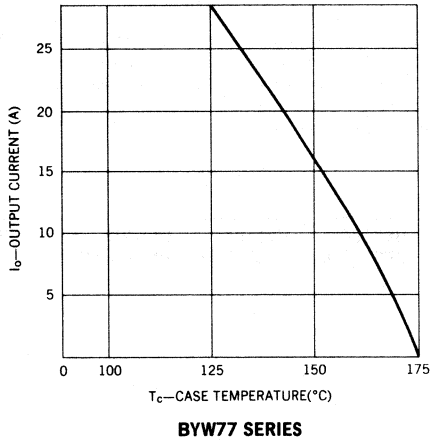


Output Current vs. Case Temperature



UES701 SERIES
BYW31 SERIES

Output Current vs Case Temperature



BYW77 SERIES

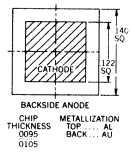
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 20A

UES704
UES705
UES706
UES704HR
UES705HR
UES706HR

FEATURES
- Very Low Forward Voltage (1.15V)
- Very Fast Recovery Times (50nSec)
- Low Thermal Resistance
- High Surge Capability
- Mechanically Rugged
- Both Polarities Available



DESCRIPTION
The UES704 series is specifically designed for operation in power switching circuits operating at frequencies of at least 20 KHz.
The low thermal resistance and forward voltage drop of this series allows the user to replace DO-5 size devices in many applications.

ABSOLUTE MAXIMUM RATINGS
Peak Inverse Voltage, UES704, UES704HR 200V
Peak Inverse Voltage, UES705, UES705HR 300V
Peak Inverse Voltage, UES706, UES706HR 400V
Ave. D.C. Output Current, I_O @ $T_C = 100°C$ 20A
Surge Current, 8.3mSec 300A
Thermal Resistance, Junction to Case ..... 1.5°C/W
Operating and Storage Temperature Range ..... −55°C to +150°C

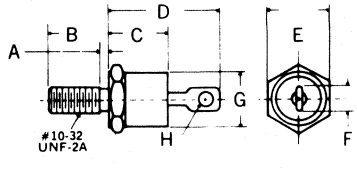
POWER CYCLING
These devices possess the unique ability to pass many thousands of cycles of a stress test designed to evaluate the integrity of the bonding systems used in the construction of power rectifiers.

In this stress test, the case of the device is not heat sunk. Full rated forward current is supplied to force a case temperature increase at least 75°C, at which time, the current is removed and the case allowed to cool. The cycle is repeated a minimum of 5,000 times to simulate equipment being turned on and off. Extended power cycling tests demonstrate a product capability in excess of 25,000 cycles.

SWITCHING CHARACTERISTICS
The switching times of these ultra-fast rectifiers increase relatively little, with temperature or at different currents. Even in severe applications, such as catch diodes for switching regulators and output rectifiers for high frequency square wave inverters, these devices switch many times faster than the fastest associated transistors. Thus, the stresses on and powers dissipated in the switching transistors are substantially less than when using other rectifiers.

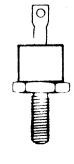
MECHANICAL SPECIFICATIONS

UES704 UES705 UES706
UES704HR UES705HR UES706HR



	ins.	mm
A	.078 MAX.	1.98 MAX.
B	.437 ± .015	11.10 ±0.38
C	.405 MAX.	10.29 MAX.
D	.800 MAX.	20.32 MAX.
E	.430 ± .010	10.92 ± 0.25
F	.250 MAX.	6.35 MAX.
G	.424 MAX.	10.77 MAX.
H	.066 MIN. DIA.	1.68 MIN. DIA.

DO-4



Notes:
1. Standard polarity is cathode-to-stud.
   For reverse Polarity (anode-to-stud) add suffix "R", ie. UES704R.
2. All metal surfaces tin plated.
3. Maximum unlubricated stud torque: 15 inch pounds.
4. Angular orientation of terminal is undefined.

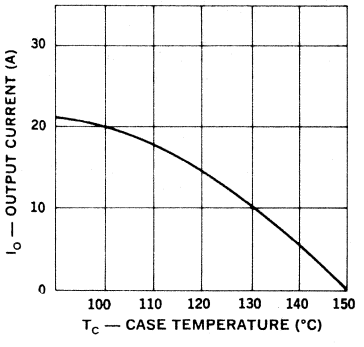
ELECTRICAL SPECIFICATIONS

Type	PIV	Maximum Forward Voltage		Maximum Reverse Current		Maximum Reverse Recovery Time*
		$T_C = 25°C$	$T_C = 125°C$	$T_C = 25°C$	$T_C = 125°C$	
UES704/704HR UES705/705HR UES706/706HR	200V 300V 400V	1.25V @ 20A $t_p = 300\mu S$	1.15V @ 20A $t_p = 300\mu S$	50μA	10mA	50nS

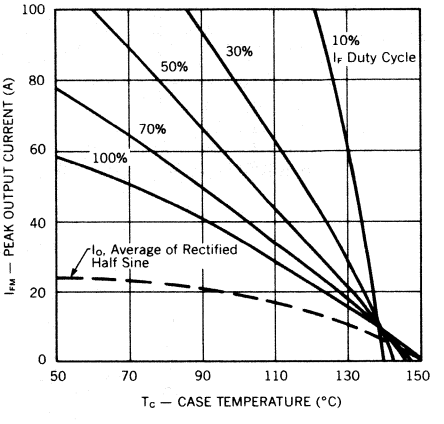
* Measured in circuit $I_F = 0.5A$, $I_R = 1A$, $I_{REC} = 0.25A$

5

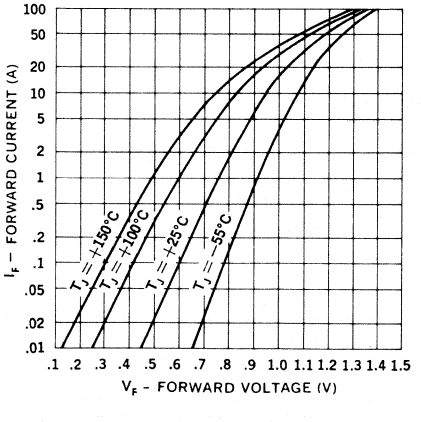
Output Current vs. Case Temperature



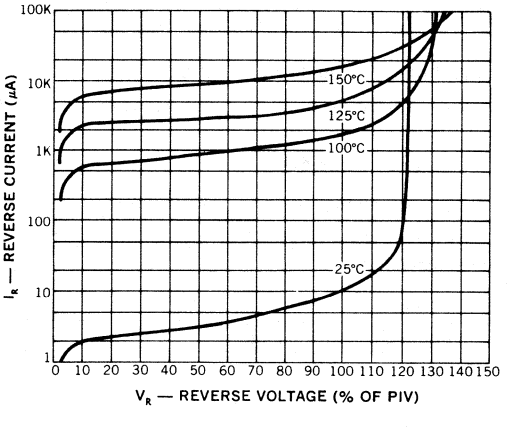
Peak Output Current vs. Case Temperature



Typical Forward Current vs. Forward Voltage



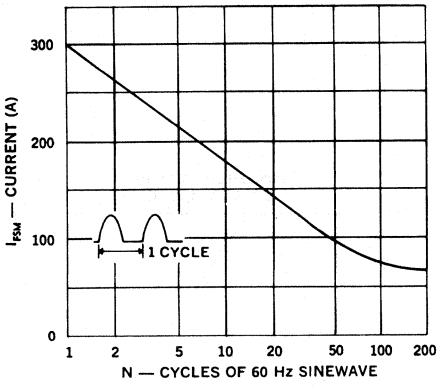
Typical Reverse Current vs. Reverse Voltage



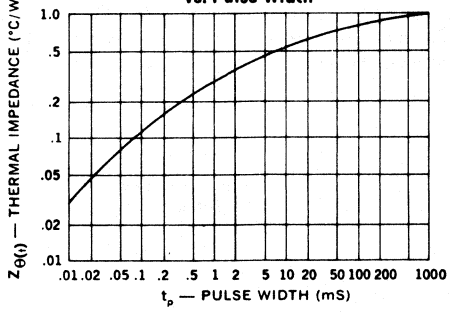
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

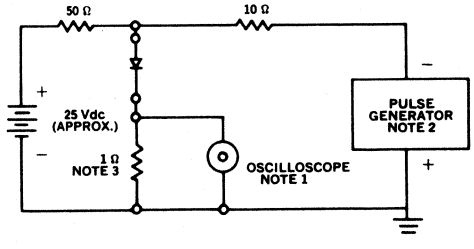
Maximum Forward Surge vs. Number of Cycles



Thermal Impedance vs. Pulse Width



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ⩽ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ⩽ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

OPTIONAL HIGH RELIABILITY SCREENING

The following tests are performed on 100% of the devices specified UES704, 5, 6HR.

SCREEN	MIL-STD-750 METHOD	CONDITIONS
1. High Temperature Life (Stabilization Bake)	1032	24 Hours @ T_A = 175°C
2. Thermal Shock (Temperature Cycling)	1051	10 Cycles @ T_A = (−55°C to +150°C)
3. Hermetic Seal a. Fine b. Gross	1071	 G or H A, C or D
4. Interim Electrical Parameters	—	V_F and I_R @ 25°C
5. Power Burn-In	1038	96 Hours @ T_C = 150°C, I_O = 0 V_R @ Rated
6. Final Electrical and Delta Parameters	Go/No Go	ΔI_R ± 100% or 5μA (whichever is greater) ΔV_F ± 2%

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 50A and 70A

UES801 BYW78-50
UES802 BYW78-100
UES803 BYW78-150

FEATURES
- High Continuous Current Rating
- Very Low Forward Voltage
- Very Fast Switching Speeds
- High Surge Capability
- Low Thermal Resistance
- Mechanically Rugged DO-5 Package

DESCRIPTION
This Series is specifically designed for operation in power switching circuits operating at frequencies of at least 20KHz. The very low forward voltage and very fast recovery time make them particularly suited for switching type power supplies.

5

ABSOLUTE MAXIMUM RATINGS

	UES801	UES801	UES803	BYW78-50	BYW78-100	BYW78-150
Peak Inverse Voltage, V_R	50V	100V	150V	50V	100V	150V
Repetitive Peak Inverse Voltage, V_{RRM}	50V	100V	150V	50V	100V	150V
Non-Repetitive Peak Inverse Voltage, V_{RSM}	50V	100V	150V	50V	100V	150V
Maximum Average D.C. Output Current, I_o @ T_C = 100°C	70A				50A	
Non-Repetitive Sinusoidal Surge Current (8.3mS), I_{FSM}	800A				1500A	
Thermal Resistance, Junction to Case, $R_{\theta JC}$	0.8°C/W					
Storage Temperature Range, T_{STG}	-55°C to +175°C					
Maximum Operating Junction Temperature, $T_{J\ MAX}$	+175°C					

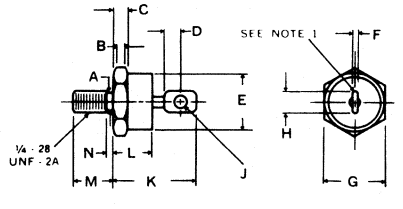
ELECTRICAL SPECIFICATIONS

Type	Maximum Reverse Voltage V_R	Maximum Forward Voltage V_F		Maximum Reverse Current I_R		Maximum Reverse Recovery Time t_{RR}
		T_C = 25°C	T_C = 150°C	T_C = 25°C	T_C = 150°C	
UES801 UES802 UES803	50V 100V 150V	0.975V @ I_F = 70A	0.84V @ I_F = 70A	25μA @ Rated V_R	30mA @ Rated V_R	50ns(1)
		T_C = 25°C	T_C = 100°C	T_C = 25°C	T_C = 100°C	
BYW78-50 BYW78-100 BYW78-150	50V 100V 150V	1.1V @ I_F = 160A	0.85V @ I_F = 50A	50μA @ Rated V_R	5mA @ Rated V_R	60ns(2)

(1) Measured in circuit I_F = 0.5A, I_R = IA, I_{REC} = 0.25A
(2) Measured in circuit I_F = 1A, V_R = 30V, $dI_F/_{dt}$ = 50A/μs

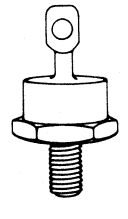
MECHANICAL SPECIFICATIONS

UES800 SERIES
BYW78 SERIES



	ins.	mm
A	.225 ÷ .005	5.72 ÷ 0.13
B	.060 MIN.	1.52 MIN.
C	.156 ÷ .020	3.96 ÷ 0.51
D	.156 MIN. FLAT	3.96 MIN. FLAT
E	.667 DIA. MAX.	16.94 DIA. MAX.
F	.090 MAX.	2.29 MAX.
G	.677 ÷ .010	17.20 ÷ 0.25
H	.375 MAX.	9.53 MAX.
J	.140 MIN. DIA.	3.56 MIN. DIA.
K	1.000 MAX.	25.40 MAX.
L	.450 MAX.	11.43 MAX.
M	.438 ÷ .015	11.13 ÷ 0.38
N	.078 MAX.	1.98 MAX.

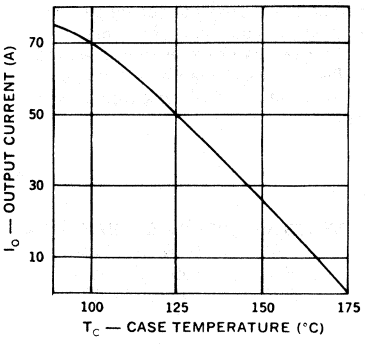
DO-5



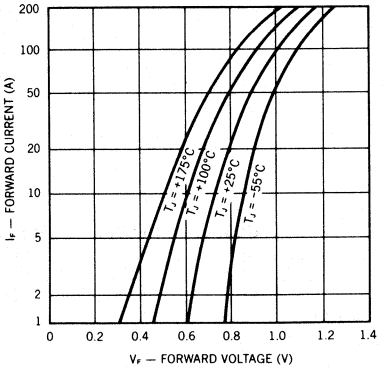
Notes:
1. **Standard polarity is cathode-to-stud.**
2. **All metal surfaces tin plated.**
3. **Maximum unlubricated stud torque: 20 inch pounds (20 kg. cm).**
4. **Angular orientation of terminal is undefined.**

UNITRODE

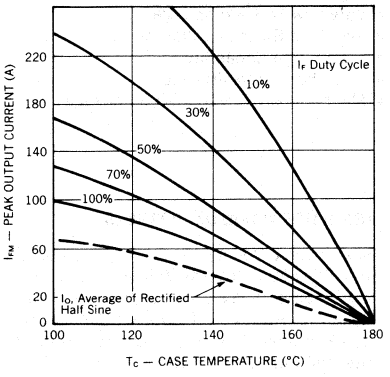
Output Current vs. Case Temperature



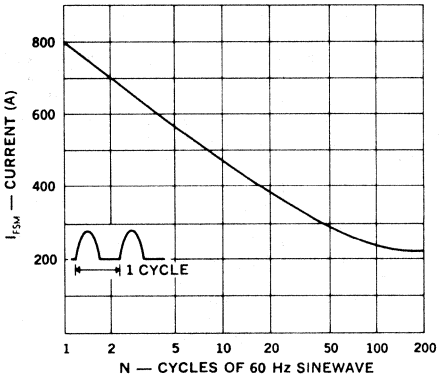
Forward Current vs. Forward Voltage



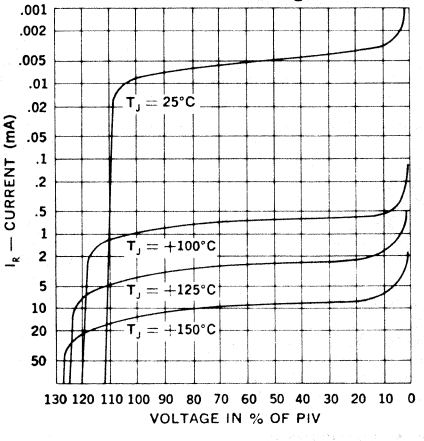
Peak Output Current vs. Case Temperature



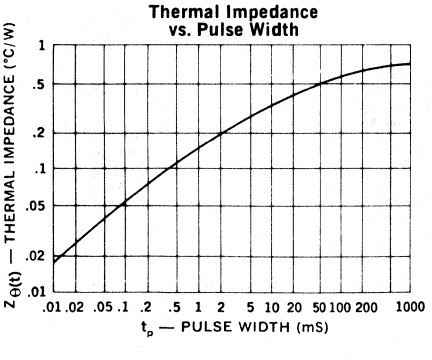
Maximum Forward Surge vs. Number of Cycles



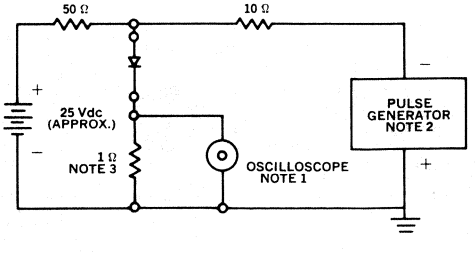
Typical Reverse Current vs. Reverse Voltage



Thermal Impedance vs. Pulse Width



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ⩽ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ⩽ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

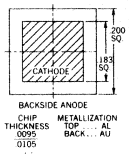
PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 50A

UES804
UES805
UES806
UES804HR
UES805HR
UES806HR

5

FEATURES
- Very Low Forward Voltage (1.15V)
- Very Fast Recovery Times (50nSec)
- High Surge Capability
- Low Thermal Resistance
- Mechanically Rugged
- Both Polarities Available



DESCRIPTION
The UES804 is specifically designed for operation in power switching circuits operating at frequencies of at least 20 KHz.

ABSOLUTE MAXIMUM RATINGS
Peak Inverse Voltage, UES804, UES804HR 200V
Peak Inverse Voltage, UES805, UES805HR 300V
Peak Inverse Voltage, UES806, UES806HR 400V
Maximum Average D.C. Output Current @ $T_C = 100°C$ 50A
Surge Current, 8.3mSec 600A
Thermal Resistance, Junction to Case ..... .8°C/W
Operating and Storage Temperature Range ..... −55°C to +150°C

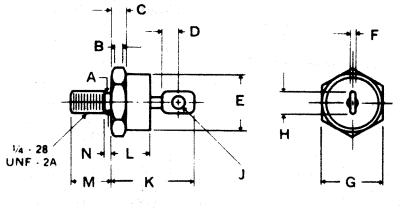
POWER CYCLING
These devices possess the unique ability to pass many thousands of cycles of a stress test designed to evaluate the integrity of the bonding systems used in the construction of power rectifiers.

In this stress test, the case of the device is not heat sunk. Full rated forward current is supplied to force a case temperature increase at least 75°C, at which time, the current is removed and the case allowed to cool. The cycle is repeated a minimum of 5,000 times to simulate equipment being turned on and off. Extended power cycling tests demonstrate a product capability in excess of 25,000 cycles.

SWITCHING CHARACTERISTICS
The switching times of these ultra-fast rectifiers increase relatively little, with temperature or at different currents. Even in severe applications, such as catch diodes for switching regulators and output rectifiers for high frequency square wave inverters, these devices switch many times faster than the fastest associated transistors. Thus, the stresses on and powers dissipated in the switching transistors are substantially less than when using other rectifiers.

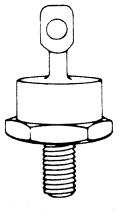
MECHANICAL SPECIFICATIONS

UES804 UES804HR UES805 UES805HR UES806 UES806HR



	ins.	mm
A	.225 ± .005	5.72 ± 0.13
B	.060 MIN.	1.52 MIN.
C	.156 ± .020	3.96 ± 0.51
D	.156 MIN. FLAT	3.96 MIN. FLAT
E	.667 DIA. MAX.	16.94 DIA. MAX.
F	.090 MAX.	2.29 MAX.
G	.677 ± .010	17.20 ± 0.25
H	.375 MAX.	9.53 MAX.
J	.140 MIN. DIA.	3.56 MIN. DIA.
K	1.000 MAX.	25.40 MAX.
L	.450 MAX.	11.43 MAX.
M	.438 ± .015	11.13 ± 0.38
N	.078 MAX.	1.98 MAX.

DO-5



Notes:
1. Standard polarity is cathode-to-stud.
   For reverse polarity (anode-to-stud) add suffix "R", ie. UES804R.
2. All metal surfaces tin plated.
3. Maximum unlubricated stud torque: 30 inch pounds.
4. Angular orientation of terminal is undefined.

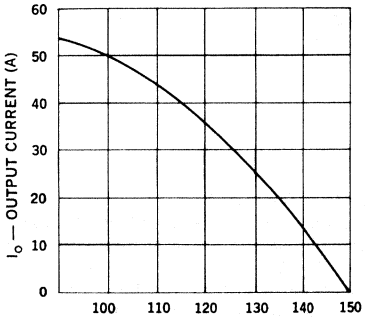
UNITRODE

ELECTRICAL SPECIFICATIONS

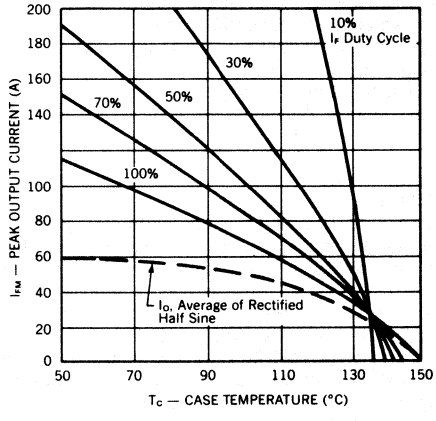
Type	PIV	Maximum Forward Voltage		Maximum Reverse Curent		Maximum Reverse Recovery Time*
		$T_C = 25°C$	$T_C = 125°C$	$T_C = 25°C$	$T_C = 125°C$	
UES804/804HR UES805/805HR UES806/806HR	200V 300V 400V	1.25V @ $I_F = 50A$ $t_p = 300\mu S$	1.15V @ $I_F = 50A$ $t_p = 300\mu S$	70μA	30mA	50nS

* Measured in circuit $I_F = 0.5A$, $I_R = 1A$, $I_{REC} = 0.25A$

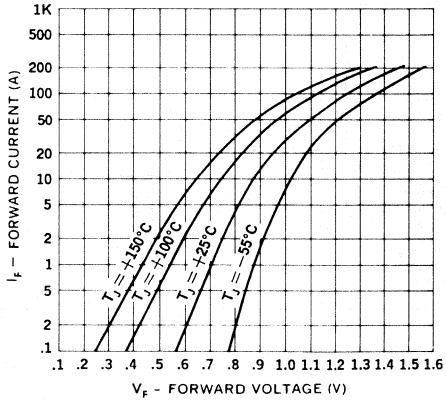
Output Current vs. Case Temperature



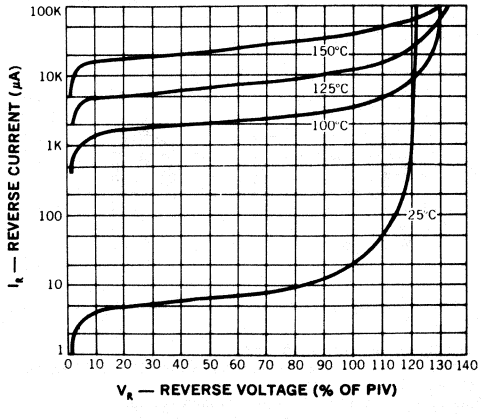
Peak Output Current vs. Case Temperature



Typical Forward Current vs. Forward Voltage



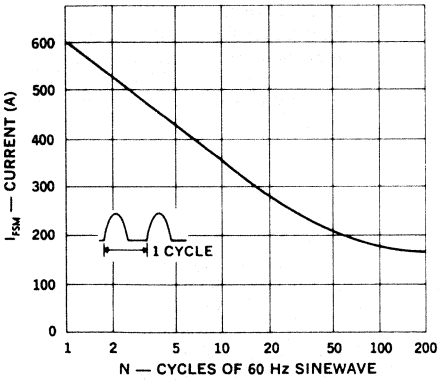
Typical Reverse Current vs. Reverse Voltage



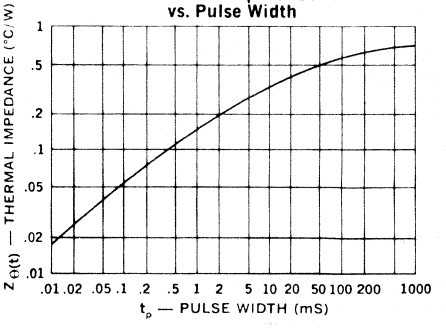
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

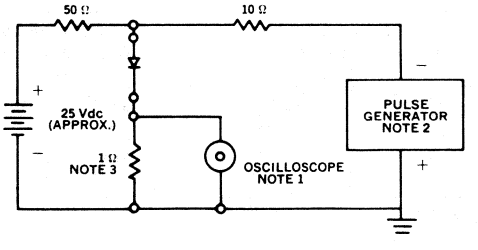
Maximum Forward Surge vs. Number of Cycles



Thermal Impedance vs. Pulse Width



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

OPTIONAL HIGH RELIABILITY SCREENING

The following tests are performed on 100% of the devices specified UES804, 5, 6HR.

SCREEN	MIL-STD-750 METHOD	CONDITIONS
1. High Temperature Life (Stabilization Bake)	1032	24 Hours @ T_A = 175°C
2. Thermal Shock (Temperature Cycling)	1051	10 Cycles @ T_A = (−55°C to +150°C)
3. Hermetic Seal a. Fine b. Gross	1071	 G or H A, C or D
4. Interim Electrical Parameters	—	V_F and I_R @ 25°C
5. Power Burn-In	1038	96 Hours @ T_C = 150°C, I_O = 0 V_R @ Rated
6. Final Electrical and Delta Parameters	Go/No Go	ΔI_R ± 100% or 5μA (whichever is greater) ΔV_F ± 2%

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 1A

UES1001-UES1003

FEATURES
- Very Fast Recovery Times
- Very Low Forward Voltage
- Small Size
- Convenient Package

DESCRIPTION
An axial leaded power rectifier useful in many switching applications. Particularly suited where very fast recovery and low forward voltage are required.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage, UES1001 ..... 50V
Peak Inverse Voltage, UES1002 ..... 100V
Peak Inverse Voltage, UES1003 ..... 150V
Maximum Average D.C. Output Current at T_L = 75°C, L = 3/8" 1A
Non-Repetitive Surge Current at 8.3mS 30A
Thermal Resistance at L = 3/8" ..... 75°C/W
Operating and Storage Temperature Range ..... −55°C +175°C

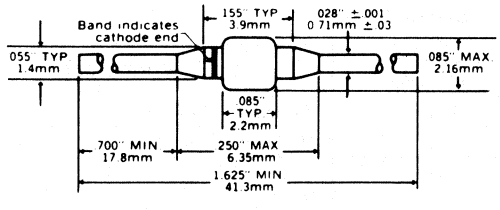
ELECTRICAL SPECIFICATIONS

Type	PIV	Maximum Forward Voltage (V_F) @		Maximum Reverse Current (I_R) @PIV		Maximum Reverse Recovery Time*
		T_J = 25°C	T_J = 100°C	@ T_J = 25°C	@ T_J = 100°C	
UES1001 UES1002 UES1003	50V 100V 150V	.975V @ 1A	.895V @ 1A	2μA	50μA	25nS

*Measured in circuit I_F = .5A, I_R = 1.0A, I_{REC} = .25A

MECHANICAL SPECIFICATIONS

UES1001-UES1003



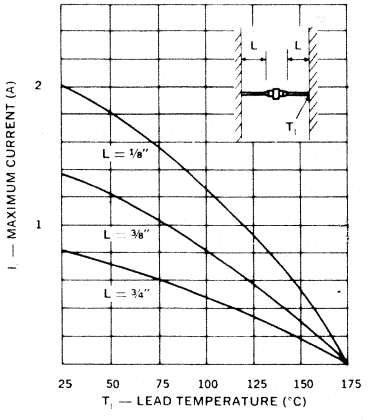
BODY A



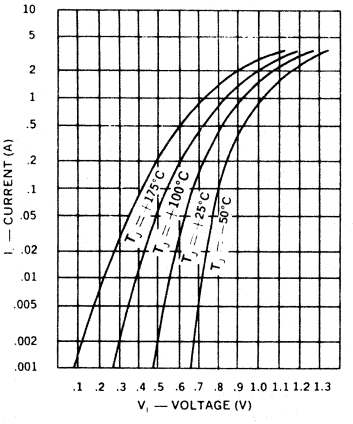
UNITRODE

5

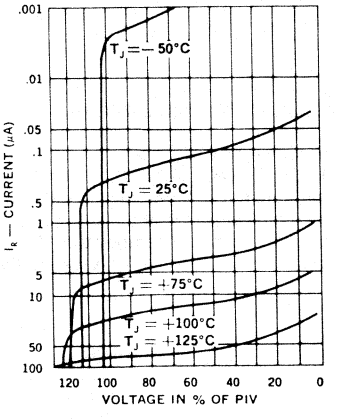
Output Current vs. Lead Temperature



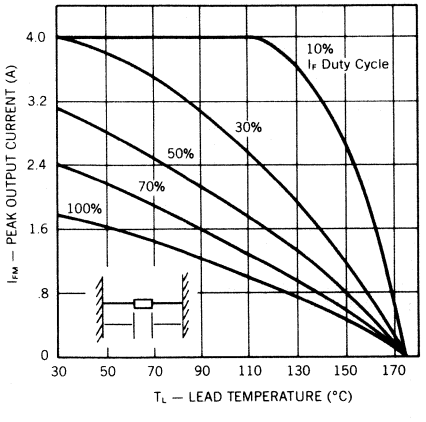
Typical Forward Current vs. Forward Voltage



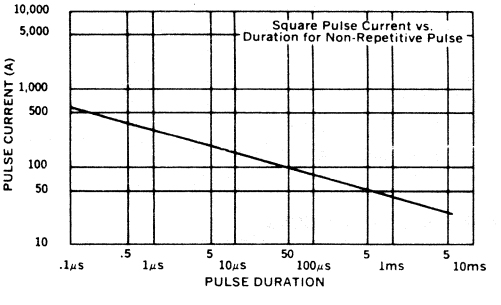
Typical Reverse Current vs. Voltage



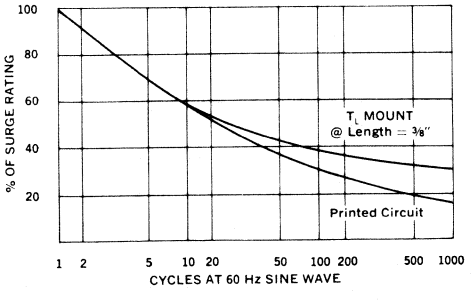
Peak Output Current vs. Lead Temperature



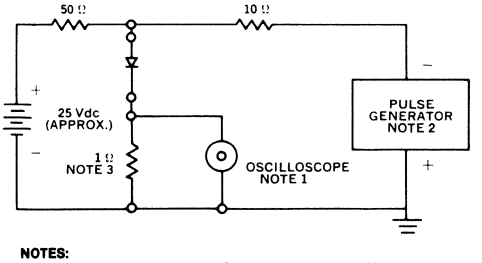
Forward Pulse Current vs. Duration



Multiple Surge Current vs. Duration



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time≤3nS; input impedance = 50Ω.
2. Pulse Generator: Rise time≤8nS; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 2.5A

UES1101 BYV27-50
UES1102 BYV27-100
UES1103 BYV27-150

FEATURES
- Very Fast Recovery Times
- Very Low Forward Voltage
- Small Size
- Convenient Package

DESCRIPTION
An axial leaded power rectifier useful in many switching applications. Particularly suited where very fast recovery and low forward voltage are required.

ABSOLUTE MAXIMUM RATINGS

	UES1101	UES1102	UES1103	BYV27-50	BYV27-100	BYV27-150
Peak Inverse Voltage, V_R	50V	100V	150V	50V	100V	150V
Maximum Average D.C. Output at T_L = 75°C, L = 3/8", I_O	2.5A			2.0A		
Non-Repetitive Surge Current at 8.3ms, I_{FSM}	35A			50A		
Thermal Resistance at L = 3/8", $R_{\theta JC}$	38°C/W			46°C/W		
Junction Operating Temperature, T_j	175°C			165°C		
Operating and Storage Temperature Range	-55°C to +175°C					

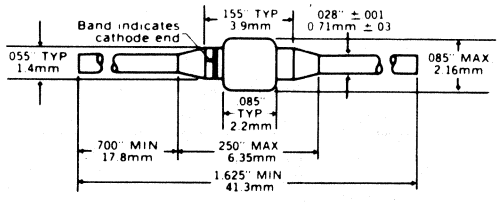
ELECTRICAL SPECIFICATIONS

Type	Maximum Reverse Voltage V_R	Maximum Forward Voltage @		Maximum Reverse Current @ Rated V_R		Maximum Reverse Recovery Time*
		T_J = 25°C	T_J = 100°C	T_J = 25° C	T_J = 100°C	
UES1101 UES1102 UES1103	50V 100V 150V	.975V @ 2A	.895V @ 2A	2μA	50μA	25nS
		T_J = 25°C	T_J = 165°C	T_J = 25°C	T_J = 165°C	
BYV27-50 BYV27-100 BYV27-150	50V 100V 150V	1.25V @ 5A	.85V @ 2.5A	1μA	150μA	25nS

*Measured in circuit I_F = ½A, I_R 1.0A, I_{REC} = ¼A

MECHANICAL SPECIFICATIONS

UES1100 SERIES
BYV27 SERIES



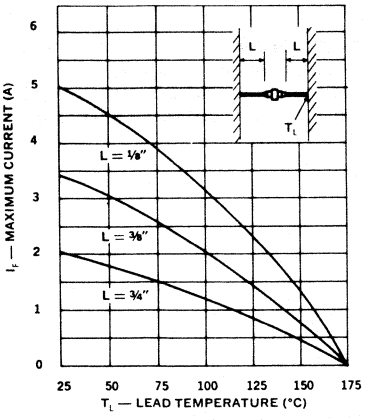
BODY A



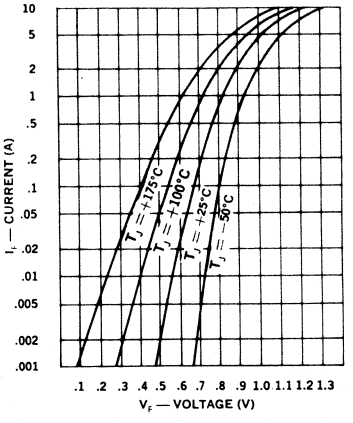
UNITRODE

5

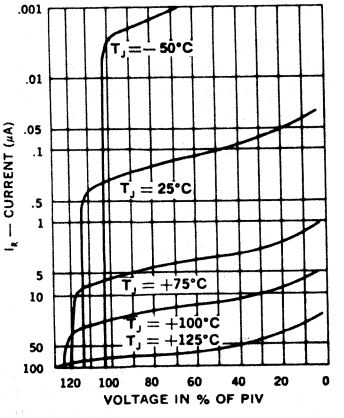
Output Current vs. Lead Temperature



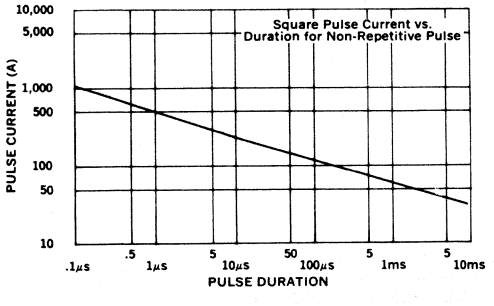
Typical Forward Current vs. Forward Voltage



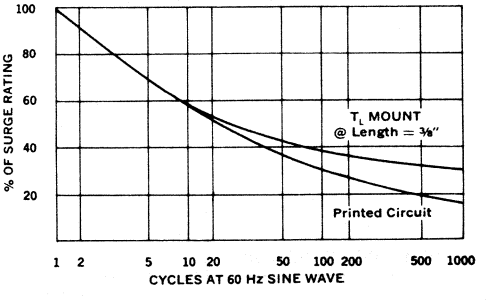
Typical Reverse Current vs. Voltage



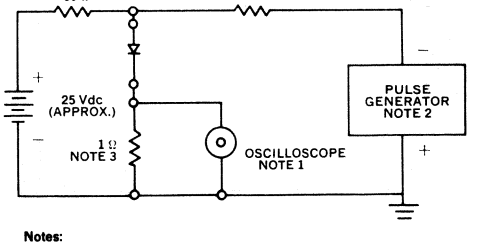
Forward Pulse Current vs. Duration



Multiple Surge Current vs. Duration



Reverse-Recovery Circuit

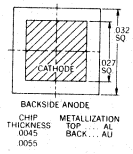


Notes:
1. Oscilloscope: Rise time ≤ 3nS; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8nS; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

RECTIFIERS
High Efficiency, 2A

UES1104
UES1105
UES1106
UES1104HR
UES1105HR
UES1106HR

FEATURES
- Very Low Forward Voltage (1.15V)
- Very Fast Recovery Times (50nSec)
- Small Size
- Convenient Package

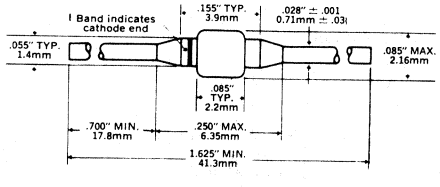


DESCRIPTION
The UES1104 series is specifically designed for operation in power switching circuits operating at frequencies of at least 20 KHz.

ABSOLUTE MAXIMUM RATINGS
Peak Inverse Voltage, UES1104, UES1104HR 200V
Peak Inverse Voltage, UES1105, UES1105HR 300V
Peak Inverse Voltage, UES1106, UES1106HR 400V
Maximum Average D.C. Output Current, I_O
@ T_A = 25°C (Free Air) 1A
@ T_L = 50°C, L= ⅜" 2A
Surge Current, 8.3mSec 20A
Thermal Resistance @ L = ⅜" ..... 38°C/W
Operating and Storage Temperature Range ..... −55°C to +150°C

MECHANICAL SPECIFICATIONS

UES1104 UES1105 UES1106
UES1104HR UES1105HR UES1106HR



BODY A



UNITRODE

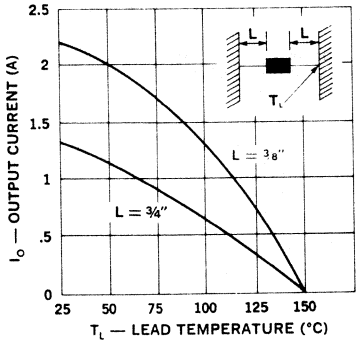
ELECTRICAL SPECIFICATIONS

Type	PIV	Maximum Forward Voltage		Maximum Reverse Current		Maximum Reverse Recovery Time*
		$T_J = 25°C$	$T_J = 100°C$	@ PIV, $T_J = 25°C$	$T_J = 100°C$	
UES1104/1104HR UES1105/1105HR UES1106/1106HR	200V 300V 400V	1.25V @ 1A tp = 300μS	1.15V @ 1A tp = 300μS	10μA	200μA	50nS

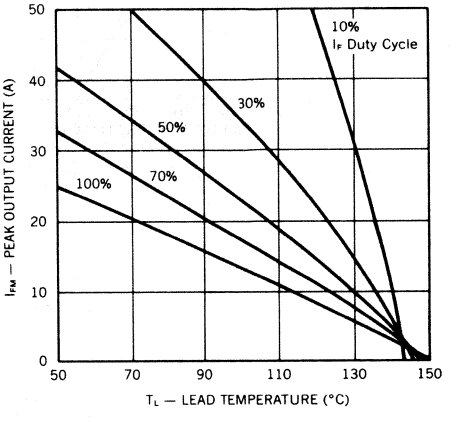
* Measured in circuit $I_F = 0.5A$, $I_R = 1A$, $I_{REC} = 0.25A$

5

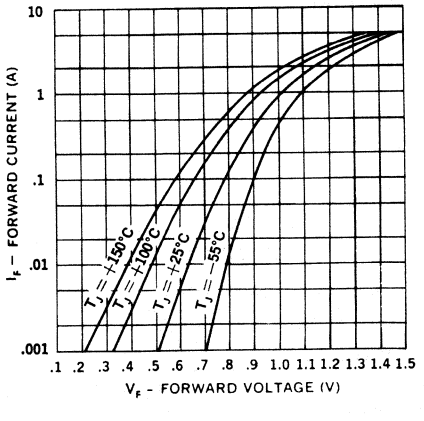
Output Current vs. Lead Temperature



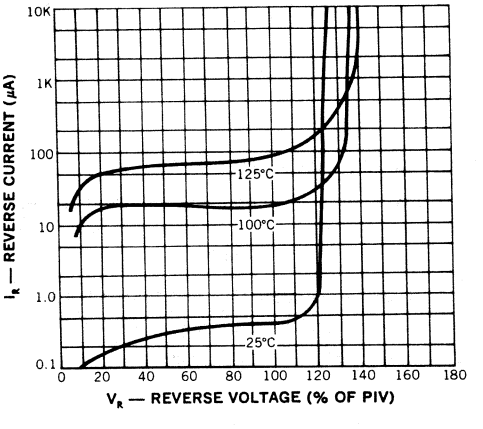
Peak Output Current vs. Lead Temperature



Typical Forward Current vs. Forward Voltage



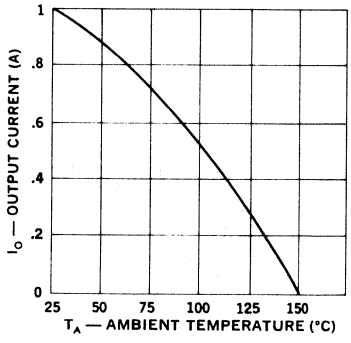
Typical Reverse Current vs. Reverse Voltage



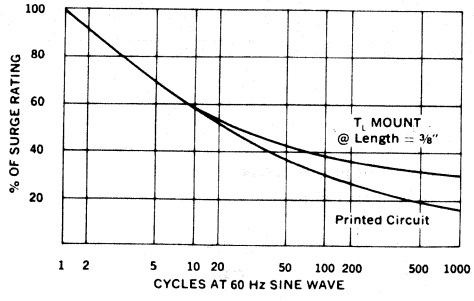
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

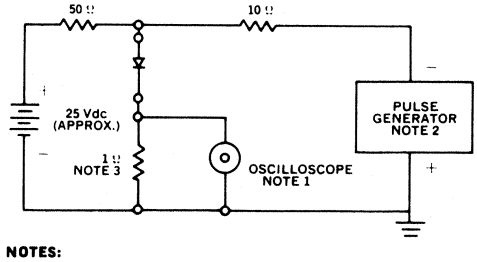
Output Current vs. Ambient Temperature



Multiple Surge Current vs. Duration



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

OPTIONAL HIGH RELIABILITY SCREENING

The following tests are performed on 100% of the devices specified UES1104, 5, 6HR.

SCREEN	MIL-STD-750 METHOD	CONDITIONS
1. High Temperature Life (Stabilization Bake)	1032	24 Hours @ T_A = 175°C
2. Thermal Shock (Temperature Cycling)	1051	10 Cycles @ T_A = (−55°C to +150°C)
3. Interim Electrical Parameters	—	V_F and I_R @ 25°C
4. Power Burn-In	1038	96 Hours @ T_A = 25°C, I_O = 50% Rating V_R @ Rated
5. Final Electrical and Delta Parameters	Go/No Go	ΔI_R ± 100% or 1μA (whichever is greater) ΔV_F ± 2%

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 3.5A

UES1301 BYV28-50
UES1302 BYV28-100
UES1303 BYV28-150

FEATURES
- Very Fast Recovery Times
- Very Low Forward Voltage
- Small Size
- Convenient Package

DESCRIPTION
An axial leaded power rectifier useful in many switching applications. Particularly suited where very fast recovery and low forward voltage are required.

5

ABSOLUTE MAXIMUM RATINGS

	UES1301	UES1302	UES1303	BYV28-50	BYV28-100	BYV28-150
Peak Inverse Voltage, V_R	50V	100V	150V	50V	100V	150V
Maximum Average D.C. Output at T_L = 75°C, L = ⅜" I_O	6.0A				3.5A	
Non-Repetitive Surge Current at 8.3ms, I_{FSM}	125A				80A	
Thermal Resistance at L = ⅜", $R_{\theta JC}$	20°C/W				25°C/W	
Junction Operating Temperature, T_j	175°C				165°C	
Operating and Storage Temperature Range	−55°C to +175°C					

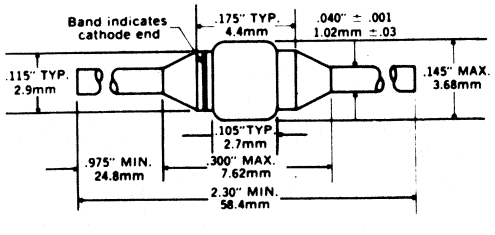
ELECTRICAL SPECIFICATIONS

Type	Maximum Reverse Voltage V_R	Maximum Forward Voltage @			Maximum Reverse Current @ Rated V_R		Maximum Reverse Recovery Time*
		T_J = 25°C	T_J = 100°C		T_J = 25°C	T_J = 100°C	
UES1301 UES1302 UES1303	50V 100V 150V	.925V @ 6A	.850V @ 6A		5μA	150μA	30ns
		T_J = 25°C	T_J = 165°C		T_J = 25°C	T_J = 100°C	
BYV28-50 BYV28-100 BYV28-150	50V 100V 150V	1.10V @ 5A	.75V @ 3A	.90V @ 5A	1μA	150μA	30ns

*Measured in circuit I_F = 0.5A, I_R = 1.0A, I_{REC} = .25A

MECHANICAL SPECIFICATIONS

UES1300 SERIES
BYV28 SERIES

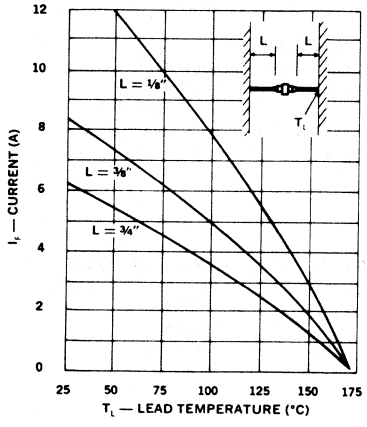


BODY B

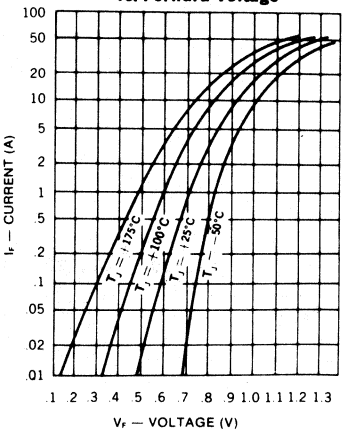


UNITRODE

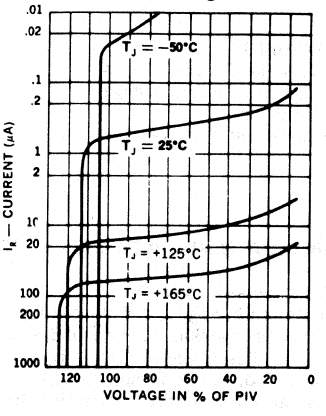
Output Current vs. Lead Temperature



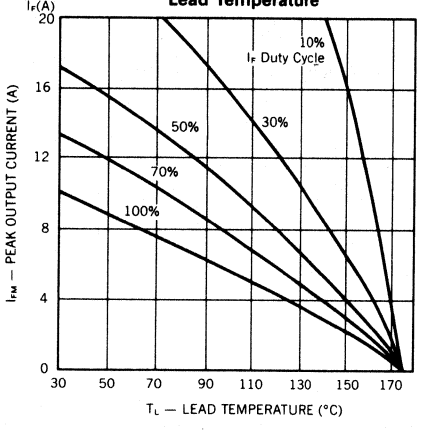
Typical Forward Current vs. Forward Voltage



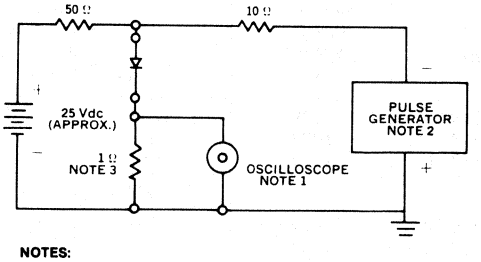
Typical Reverse Current vs. Voltage



Peak Output Current vs. Lead Temperature

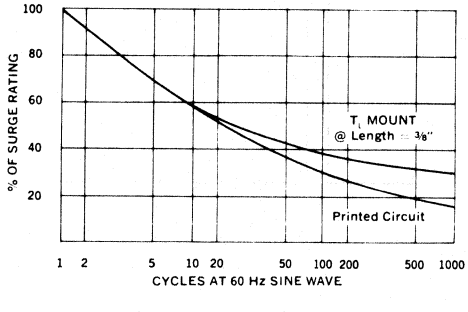


Reverse-Recovery Circuit

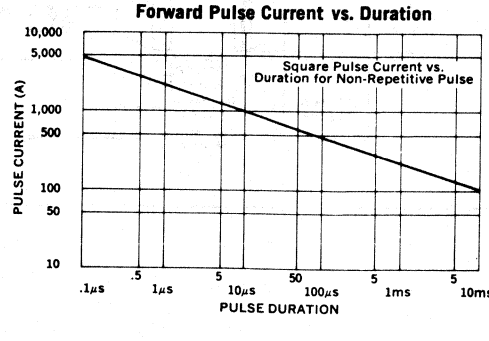


NOTES:
1. Oscilloscope: Rise time≤3nS; input impedance = 50Ω.
2. Pulse Generator: Rise time≤ 8nS; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

Multiple Surge Current vs. Duration



Forward Pulse Current vs. Duration



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

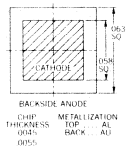
PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 5A

UES1304
UES1305
UES1306
UES1304HR
UES1305HR
UES1306HR

5

FEATURES
- Very Low Forward Voltage (1.15V)
- Very Fast Recovery Times (50nSec)
- Small Size
- High Surge

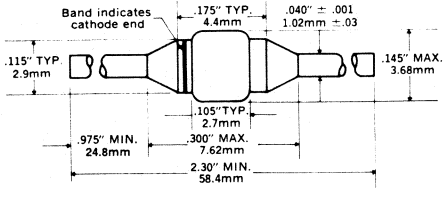


DESCRIPTION
The UES1304 series is specifically designed for operation in power switching circuits operating at frequencies of at least 20 KHz.

ABSOLUTE MAXIMUM RATINGS
Peak Inverse Voltage, UES1304, UES1304HR 200V
Peak Inverse Voltage, UES1305, UES1305HR 300V
Peak Inverse Voltage, UES1306, UES1306HR 400V
Maximum Average D.C. Output Current, I_O
@ T_A = 25°C (Free Air) 3A
@ T_L = 50°C, L = ⅜" 5A
Surge Current, 8.3mSec 70A
Thermal Resistance @ L — ⅜" ..... 20°C/W
Operating and Storage Temperature Range ..... −55°C to +150°C

MECHANICAL SPECIFICATIONS

UES1304 UES1305 UES1306
UES1304HR UES1305HR UES1306HR



BODY B



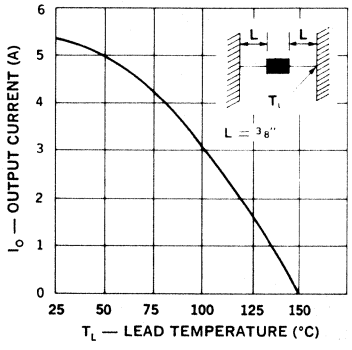
UNITRODE

ELECTRICAL SPECIFICATIONS

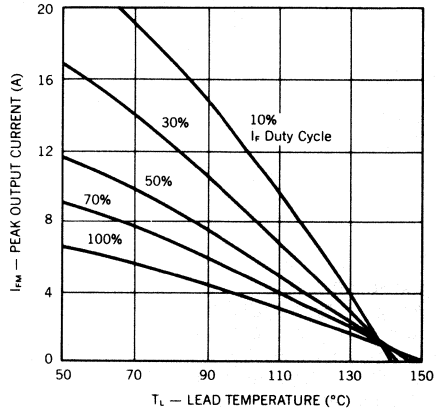
Type	PIV	Maximum Forward Voltage		Maximum Reverse Current		Maximum Reverse Recovery Time*
		$T_J = 25°C$	$T_J = 100°C$	@ PIV, $T_J = 25°C$	$T_J = 100°C$	
UES1304/1304HR UES1305/1305HR UES1306/1306HR	200V 300V 400V	1.25V @ 3A tp = 300μS	1.15V @ 3A tp = 300μS	20μA	500μA	50nS

* Measured in circuit $I_F = 0.5A$, $I_R = 1A$, $I_{REC} = 0.25A$

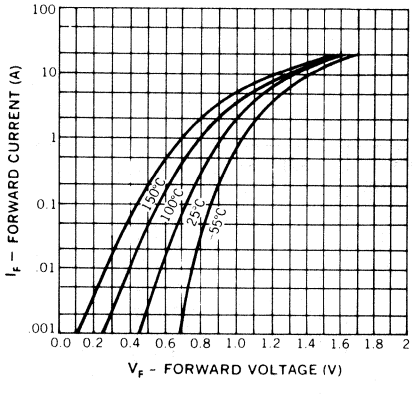
Output Current vs. Lead Temperature



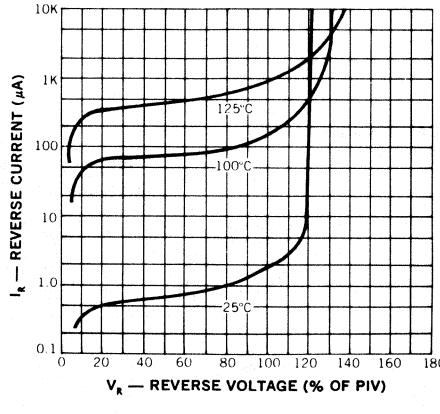
Peak Output Current vs. Lead Temperature



Typical Forward Current vs. Forward Voltage



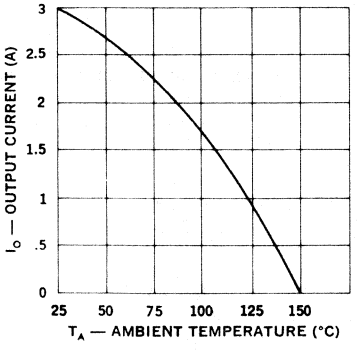
Typical Reverse Current vs. Reverse Voltage



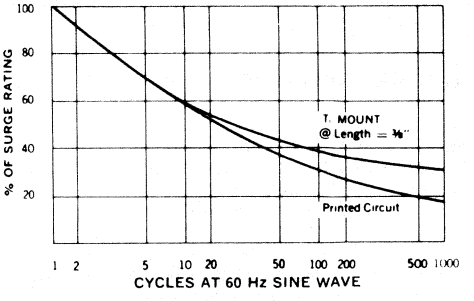
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

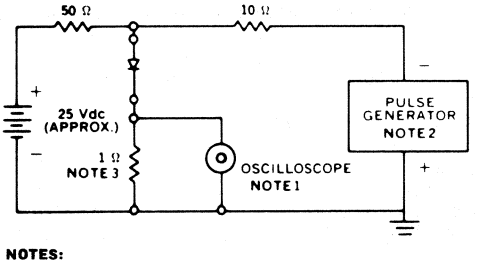
Output Current vs Ambient Temperature



Multiple Surge Current vs. Duration



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

OPTIONAL HIGH RELIABILITY SCREENING

The following tests are performed on 100% of the devices specified UES1304, 5, 6HR.

SCREEN	MIL-STD-750 METHOD	CONDITIONS
1. High Temperature Life (Stabilization Bake)	1032	24 Hours @ T_A = 175°C
2. Thermal Shock (Temperature Cycling)	1051	10 Cycles @ T_A = (−55°C to +150°C)
3. Interim Electrical Parameters	—	V_F and I_R @ 25°C
4. Power Burn-In	1038	96 Hours @ T_A = 25°C, I_O = 50% Rating V_R @ Rated
5. Final Electrical and Delta Parameters	Go/No Go	ΔI_R ± 100% or 1μA (whichever is greater) ΔV_F ± 2%

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 7A and 8A

UES1401 BYW29-50 BYW80-50
UES1402 BYW29-100 BYW80-100
UES1403 BYW29-150 BYW80-150
UES1404 BYW29-200 BYW80-200

FEATURES
- Very Low Forward Voltage
- Very Fast Recovery Times
- Economical, Convenient Plastic Package
- Low Thermal Resistance
- Mechanically Rugged

DESCRIPTION
The UES1400/BYW29/BYW80 Series, in a plastic package similar to the TO-220, is specifically designed for operation in power switching circuits to frequencies in excess of 100KHz. The very low forward voltage and very fast recovery time make them particularly suited for switching type power supplies.

ABSOLUTE MAXIMUM RATINGS

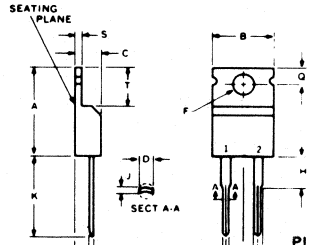
	UES1401	UES1402	UES1403	UES1404
Peak Inverse Voltage, V_R	50V	100V	150V	200V
Repetitive Peak Inverse Voltage, V_{RWM}	50V	100V	150V	200V
Non-Repetitive Peak Inverse Voltage, V_{RSM}	50V	100V	150V	200V
Maximum Average D.C. Output Current, I_O				
@ T_C = 125°C, (Note 1)	8.0A			
@ T_A = 25°C	3.0A			
@ T_A = 25°C, (Note 2)	8.0A			
Non-Repetitive Sinusoidal Surge Current at 8.3 ms, I_{FSM}	80A			
Thermal Resistance, Junction to Case, $R_{\theta JC}$	2.5°C/W			
Thermal Resistance, Junction to Ambient, $R_{\theta JA}$	60°C/W			
Storage Temperature Range, T_{STG}	−55°C to +150°C			
Maximum Operating Junction Temperature, T_{jmax}	+150°C			

Note 1. Above 100°C use the tab for electrical connection.
Note 2. Using Wakefield Type 295 heatsink with convection cooling. For more definitive data refer to the Output Current vs. Temperature Curves on this datasheet.

	BYW29-50	BYW29-100	BYW29-150	BYW29-200	BYW80-50	BYW80-100	BYW80-150	BYW80-200
Peak Inverse Voltage, V_R	50V	100V	150V	200V	50V	100V	150V	200V
Repetitive Peak Inverse Voltage, V_{RWM}	50V	100V	150V	200V	50V	100V	150V	200V
Non-Repetitive Peak Inverse Voltage, V_{RSM}	50V	100V	150V	200V	50V	100V	150V	200V
Maximum Average D.C. Output Current @ T_C = 125°C, (Note 1)	7.0A				7.0A			
Non-Repetitive Sinusoidal Surge Current at 8.3ms,	80A				100A			
Thermal Resistance, Junction to Case, $R_{\theta JC}$	2.5°C/W							
Thermal Resistance, Junction to Ambient, $R_{\theta JA}$	60°C/W							
Operating and Storage Temperature Range	−55°C to +150°C							
Maximum Operating Junction Temperature, T_{jmax}	+150°C							

Note 1. Above 100°C use the tab for electrical connection.

MECHANICAL SPECIFICATIONS

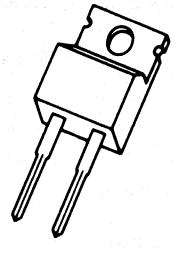


PIN 1. Cathode
2. Anode
Tab is connected to Cathode.

UES1401 SERIES
BYW29 SERIES
BYW80 SERIES

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.23	15.87	0.560	0.625
B	9.66	10.66	0.380	0.420
C	3.56	4.82	0.140	0.190
D	0.51	1.14	0.020	0.045
F	3.531	3.733	0.139	0.147
G	2.29	2.79	0.090	0.110
H	—	6.35	—	0.250
J	0.38	0.64	0.015	0.025
K	12.70	14.27	0.500	0.562
L	1.14	1.77	0.045	0.070
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.92	0.080	0.115
S	1.14	1.39	0.045	0.055
T	5.85	6.85	0.230	0.270

TO-220AC



UNITRODE

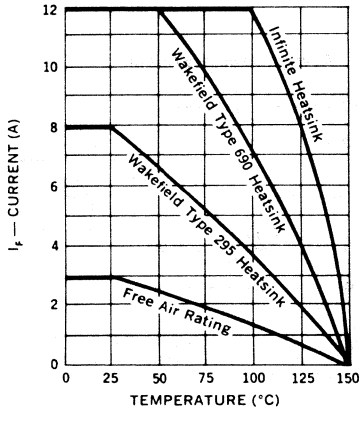
UES1401	BYW29-50	BYW80-50
UES1402	BYW29-100	BYW80-100
UES1403	BYW29-150	BYW80-150
UES1404	BYW29-200	BYW80-200

ELECTRICAL SPECIFICATIONS

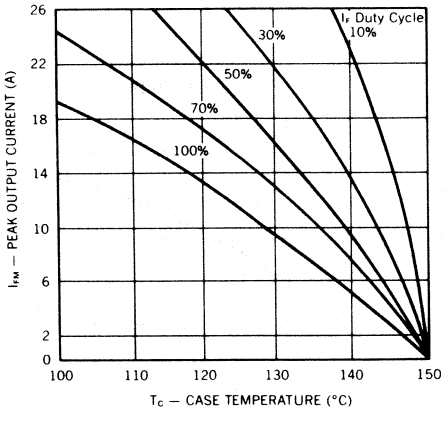
Type	Maximum Reverse Voltage V_R	Maximum Forward Voltage, V_F		Maximum Reverse Current, I_R @ rated V_R		Maximum Reverse Recovery Time	Typical Forward Recovery Voltage @ 1A	Typical Forward Recovery Charge
		T_J = 25°C	T_J = 100°C	T_J = 25°C	T_J = 100°C	T_{rr}	T_R = 8nS	Q_{RR} @ 25°
UES1401 UES1402 UES1403 UES1404	50V 100V 150V 200V	0.9V @ 4A 0.975V @ 8A tp = 300μS	0.8V @ 4A 0.895V @ 8A	5μA	150μA 150μA 150μA 500μA	35nS[1]	1.4V	—
BYW29-50 BYW29-100 BYW29-150 BYW29-200	50V 100V 150V 200V	1.300V @ 20A	0.850V @ 5A	—	600μA	35nS[2]	1.4V	—
BYW80-50 BYW80-100 BYW80-150 BYW80-200	50V 100V 150V 200V	1.25V @ 22A	0.850V @ 7A	10μA	1mA	35nS[2]	—	15nc[3]

NOTES: 1. Measured in circuit I_F = 0.5A, I_R = 1.0A, I_{REC} = 0.25A
2. Measured in circuit I_F = 1A to $V_R \geq$ 30V, di_F/dt = 50A/μS
3. Measured in circuit I_F = 2A, $V_R \leq$ 30V, di_F/dt = −20A/μS

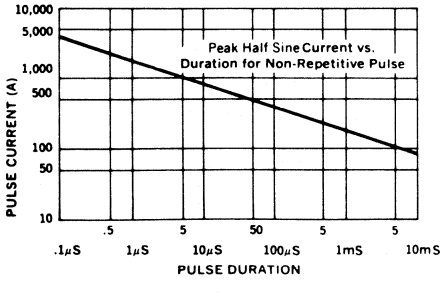
Output Current vs Temperature



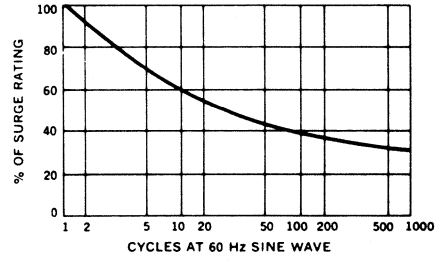
Peak Output Current vs Case Temperature



Forward Pulse Current vs. Duration

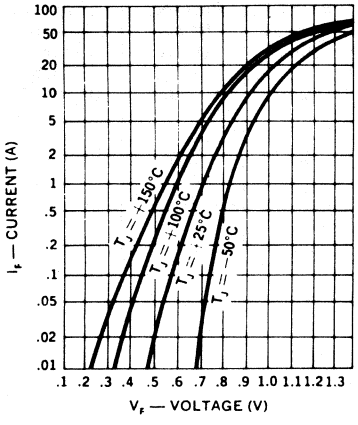


Multiple Surge Current vs. Duration

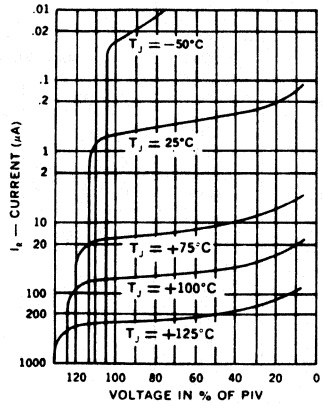


UES1401	BYW29-50	BYW80-50
UES1402	BYW29-100	BYW80-100
UES1403	BYW29-150	BYW80-150
UES1404	BYW29-200	BYW80-200

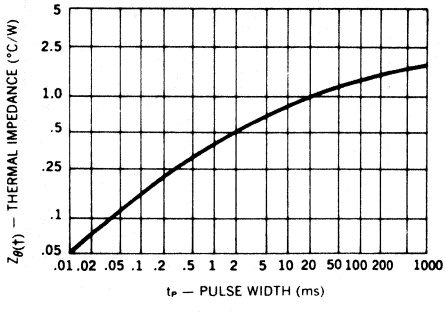
Typical Forward Current vs Forward Voltage



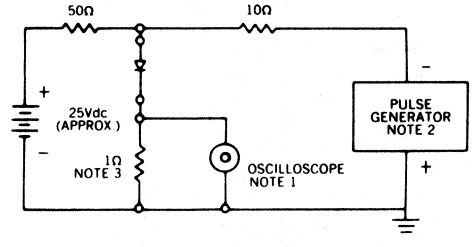
Typical Reverse Current vs Voltage



Thermal Impedance vs Pulse Width



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns, input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns, source impedance 10Ω.
3. Current viewing resistor, non inductive, coaxial recommended.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 8A

UES1420-UES1423

FEATURES
- Low dynamic forward voltage
- Very fast recovery times
- Economical, convenient plastic package
- Low thermal resistance
- Mechanically rugged

DESCRIPTION
The UES1420 Series, in a plastic package similar to the TO-220, is specifically designed for operation in power switching circuits to frequencies in excess of 100kHz. The low peak dynamic forward voltage and very fast recovery time are consistent with the requirements for high voltage power MOSFETs and are particularly suited for off-line switch-mode power supplies.

5

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage, UES1420 ..... 600V
Peak Inverse Voltage, UES1421 ..... 700V
Peak Inverse Voltage, UES1422 ..... 800V
Peak Inverse Voltage, UES1423 ..... 900V
Maximum Average D.C. Output Current
@ T_C = 125°C (Note 1) 8.0A
@ T_C = 25°C 30A
@ T_C = 25°C (Note 2) 8.0A
Non-Repetitive Sinusoidal Surge Current, 8.3ms 100A
Thermal Resistance, Junction to Case, θ_{J-C} ..... 1.6°C/W
Thermal Resistance, Junction to Ambient, θ_{J-A} ..... 60°C/W
Operating and Storage Temperature Range ..... -55°C to +150°C

Notes: 1. Above 100°C use the tab for electrical connection.
2. Using Wakefield Type 295 heatsink with convection cooling. For more definitive data refer to the Output Current vs Temperature Curves on this datasheet.

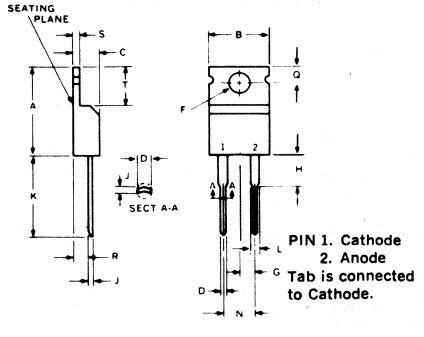
ELECTRICAL SPECIFICATIONS

Type	PIV	Maximum Forward Voltage @		Maximum Reverse Current @ PIV		Maximum Reverse Recovery Time*	Typical Forward Recovery Voltage @ 1A t_r = 8ns
		T_J = 25°C	T_J = 100°C	T_J = 25°C	T_J = 100°C		
UES1420 UES1421 UES1422 UES1423	600V 700V 800V 900V	1.7V @ 8A tp = 300μs	1.4V @ 8A tp = 300μs	20μA	150μA	50ns	6V

*Measured in circuit I_F = 0.5A, I_R = 1.0A, I_{REC} = 0.25A

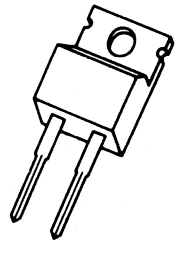
MECHANICAL SPECIFICATIONS

UES1420-1423



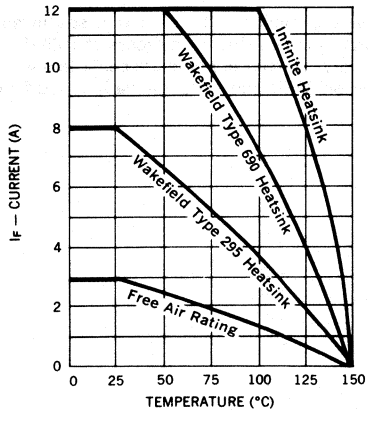
	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.560	0.625	14.23	15.87
B	0.380	0.420	9.66	10.66
C	0.140	0.190	3.56	4.82
D	0.020	0.045	0.51	1.14
F	0.139	0.147	3.531	3.733
G	0.090	0.110	2.29	2.79
H	—	0.250	—	6.35
J	0.015	0.025	0.38	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.070	1.14	1.77
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.115	2.04	2.92
S	0.045	0.055	1.14	1.39
T	0.230	0.270	5.85	6.85

TO-220AC

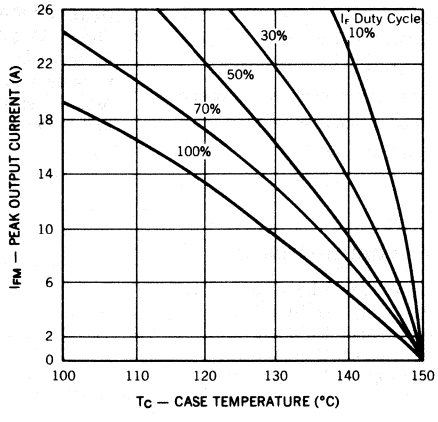


PRELIMINARY

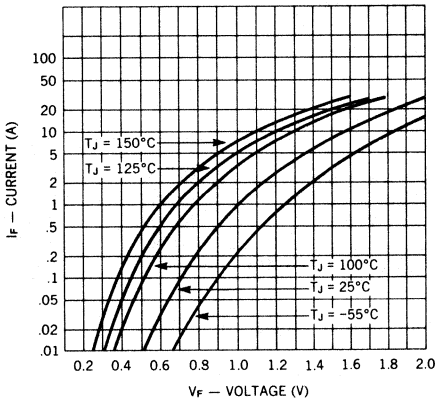
Output Current vs Temperature



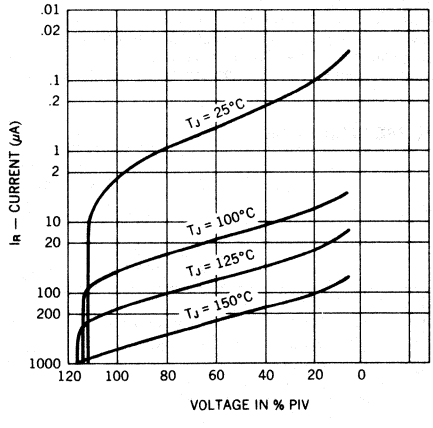
Peak Output Current vs Case Temperature



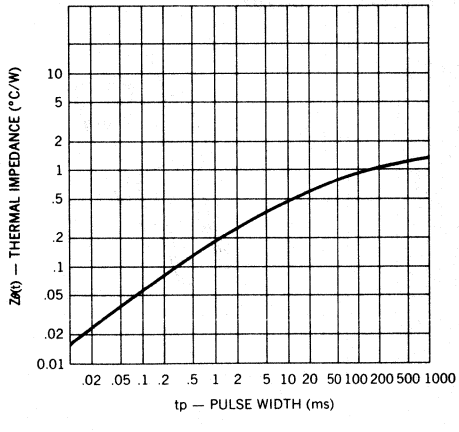
Typical Forward Current vs Forward Voltage



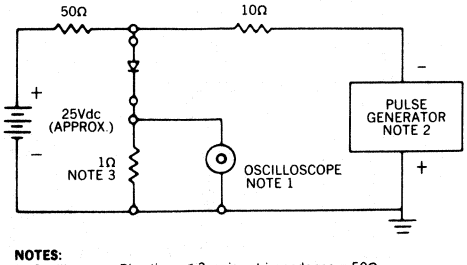
Typical Reverse Current vs Voltage



Thermal Impedance vs Pulse Width



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 16A

UES1501
UES1502
UES1503
UES1504

5

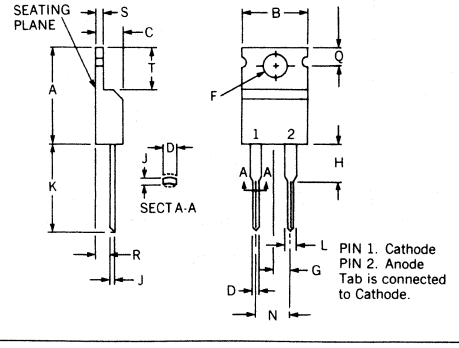
FEATURES
- Very Low Forward Voltage
- Very Fast Recovery Times
- Economical, Convenient TO-220 Package
- Low Thermal Resistance
- Mechanically Rugged

DESCRIPTION
The UES1500 Series, in the economical, convenient TO-220 package, is specifically designed for operation in power switching circuits to frequencies in excess of 100kHz. The very low forward voltage and very fast recovery time make them particularly suited for switching type power supplies.

ABSOLUTE MAXIMUM RATINGS
Peak Inverse Voltage, UES1501 ..... 50V
Peak Inverse Voltage, UES1502 ..... 100V
Peak Inverse Voltage, UES1503 ..... 150V
Peak Inverse Voltage, UES1504 ..... 200V
Maximum Average D.C. Output Current
@ T_C = 100°C 16A
@ T_A = 25°C 3.3A
@ T_A = 25°C (Note 1) 10.0A
Non-Repetitive Sinusoidal Surge Current, 8.3ms 300A
Thermal Resistance, Junction to Case, θ_{J-C} ..... 1.5°C/W
Thermal Resistance, Junction to Ambient, θ_{J-A} ..... 60°C/W
Operating and Storage Temperature ..... -55°C to +150°C

Note: 1. Using Wakefield Type 295 heatsink with convection cooling. For more definitive data refer to the Output Current vs Temperature Curve on this data sheet.

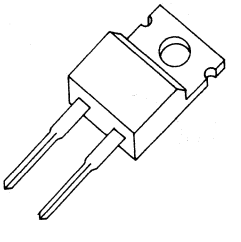
MECHANICAL SPECIFICATIONS



UES1501-UES1504

	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.560	0.625	14.23	15.87
B	0.380	0.420	9.66	10.66
C	0.140	0.190	3.56	4.82
D	0.020	0.045	0.51	1.14
F	0.139	0.147	3.531	3.733
G	0.090	0.110	2.29	2.79
H	—	0.250	—	6.35
J	0.015	0.025	0.38	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.070	1.14	1.77
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.115	2.04	2.92
S	0.045	0.055	1.14	1.39
T	0.230	0.270	5.85	6.85

TO-220AC



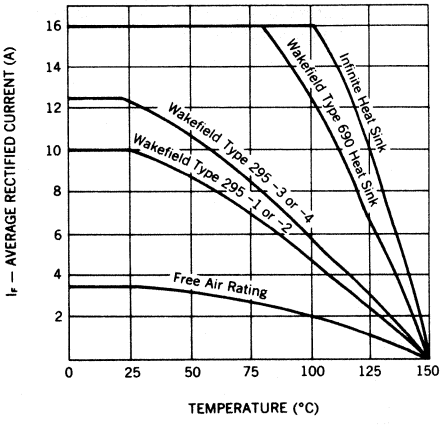
UNITRODE

ELECTRICAL SPECIFICATIONS

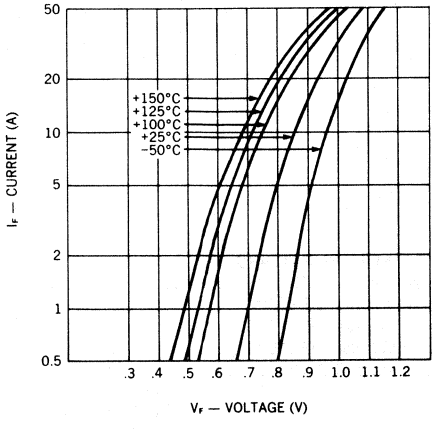
Type	PIV	Maximum Forward Voltage		Maximum Reverse Current @ PIV		Maximum Reverse Recovery Time*	Typical Forward Recovery Voltage @ 1A t_r = 8ns
		T_J = 25°C	T_J = 100°C	T_J = 25°C	T_J = 100°C		
UES1501 UES1502 UES1503 UES1504	50V 100V 150V 200V	.975V @ 16A 1.10V @ 32A	.895V @ 16A 1.0V @ 32A	10μA	800μA	35ns	2.0V

* Measured in circuit I_F = ½A, I_R = 1.0A, I_{REC} = ¼A

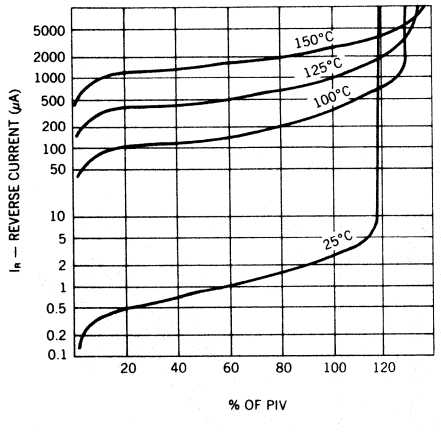
Output Current vs Temperature



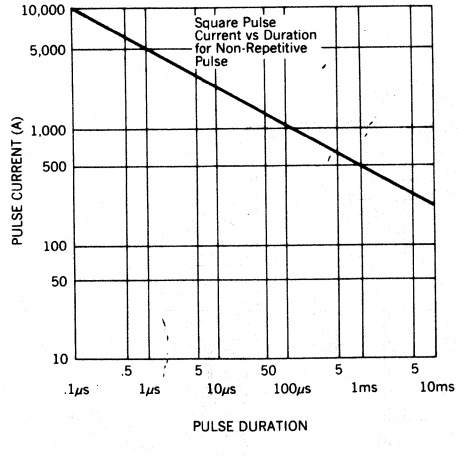
Typical Forward Current vs Forward Voltage



Typical Reverse Current vs Voltage



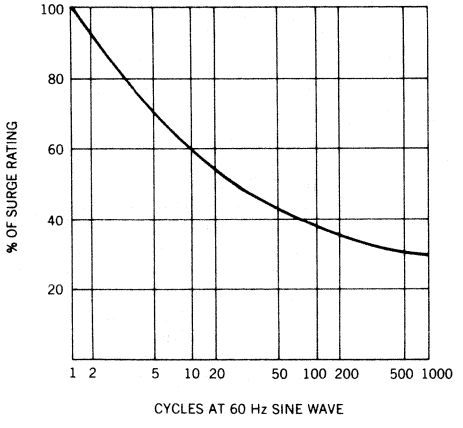
Forward Pulse Current vs Duration



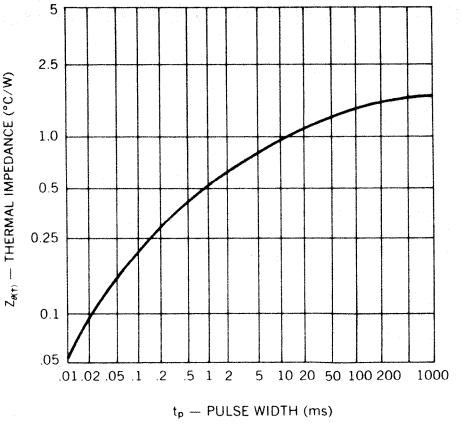
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

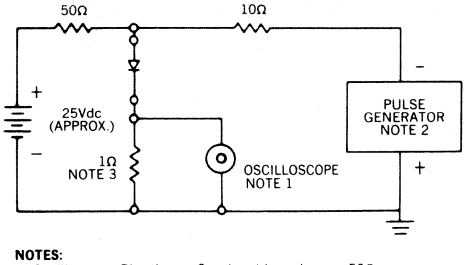
Multiple Surge Current vs Duration



Thermal Impedance vs Pulse Width



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

RECTIFIERS
High Efficiency, 16A Center-Tap

UES2401-UES2404

FEATURES
- Very Low Forward Voltage
- Very Fast Recovery Times
- Economical, Convenient TO-220AB Package
- Low Thermal Resistance
- Mechanically Rugged
- PIV up to 200V

DESCRIPTION
The UES2401 Series in the economical, convenient TO-220AB package, is specifically designed for operation in power switching circuits to frequencies in excess of 100kHz. The series combines two high efficiency devices into one package, simplifying installation, reducing heatsink requirements and the need to purchase matched components.

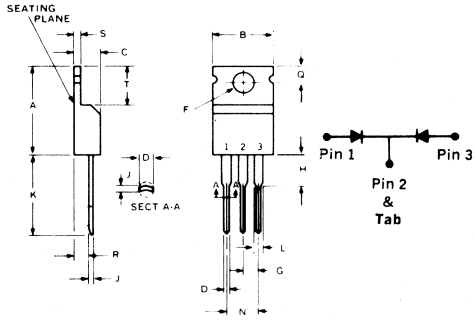
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage, UES2401	50V
Peak Inverse Voltage, UES2402	100V
Peak Inverse Voltage, UES2403	150V
Peak Inverse Voltage, UES2404	200V
Maximum Average D.C. Output Current	
@ T_C = 125°C (Note 1)	16A
@ T_A = 25°C	3A
@ T_A = 25°C (Note 2)	10A
Non-Repetitive Sinusoidal Surge Current, 8.3ms	80A
Thermal Resistance, Junction to Case, θ_{J-C}	1.75°C/W
Thermal Resistance, Junction to Ambient, θ_{J-A}	60°C/W
Operating and Storage Temperature Range	−55°C to +150°C

Note 1. Above 8A use the tab for electrical connection.
Note 2. Using Wakefield Type 295 heatsink with convection cooling. For more definitive data refer to the Output Current vs. Temperature Curves on this datasheet.

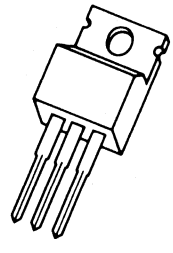
MECHANICAL SPECIFICATIONS

UES2401-2404



	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.560	0.625	14.23	15.87
B	0.380	0.420	9.66	10.66
C	0.140	0.190	3.56	4.82
D	0.020	0.045	0.51	1.14
F	0.139	0.147	3.531	3.733
G	0.090	0.110	2.29	2.79
H	—	0.250	—	6.35
J	0.015	0.025	0.38	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.070	1.14	1.77
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.115	2.04	2.92
S	0.045	0.055	1.14	1.39
T	0.230	0.270	5.85	6.85

TO-220AB



UNITRODE

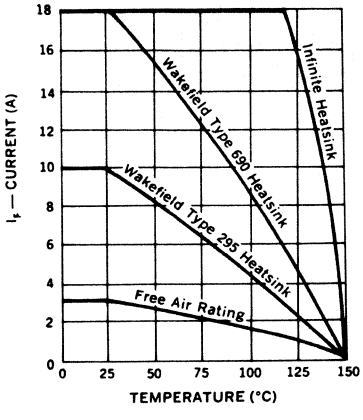
ELECTRICAL SPECIFICATIONS

Type	PIV	Maximum Forward Voltage @		Maximum Reverse Current @ PIV		Maximum Reverse Recovery Time*	Typical Forward Recovery Voltage @ 1A t_r = 8ns
		T_J = 25°C	T_J = 100°C	T_J = 25°C	T_J = 100°C		
UES2401 UES2402 UES2403 UES2404	50V 100V 150V 200V	0.9V@ 4A 0.975 @ 8A tp = 300μs	0.8V @ 4A 0.895 @ 8A	5μA	150μA 150μA 150μA 500μA	35ns	1.4V

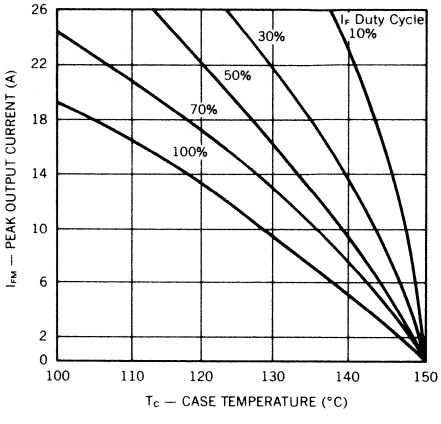
*Measured in circuit I_F = 0.5A, I_R = 1.0A, I_{REC} = 0.25A

5

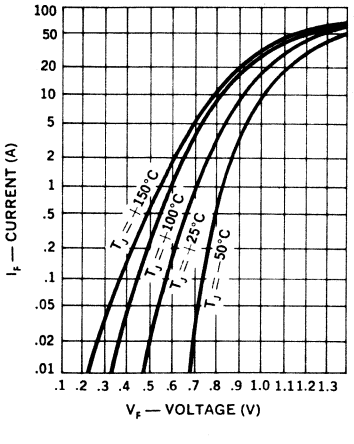
Output Current vs Temperature



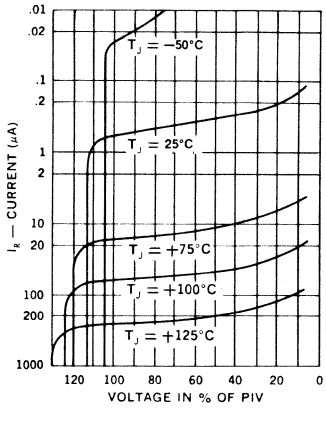
Peak Output Current vs Case Temperature



Typical Forward Current vs Forward Voltage



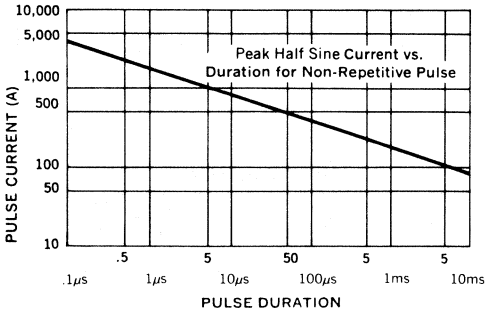
Typical Reverse Current vs Voltage



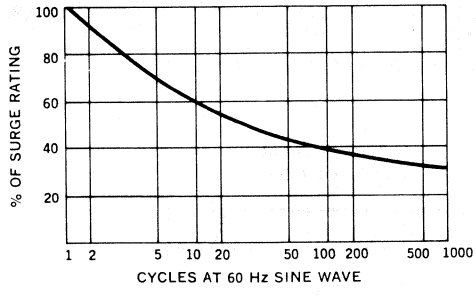
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

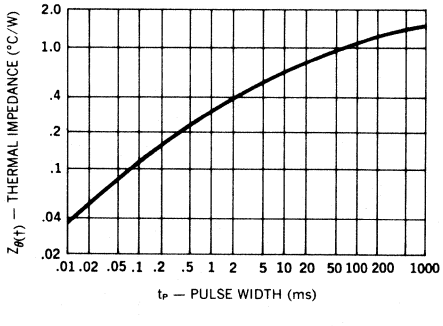
Forward Pulse Current vs Duration



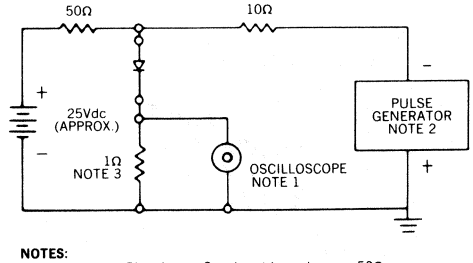
Multiple Surge Current vs Duration



Thermal Impedance vs Pulse Width



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
High Efficiency, 30A Center-Tap

UES2601
UES2602
UES2603
UES2601HR
UES2602HR
UES2603HR

5

FEATURES
- Very Low Forward Voltage
- Very Fast Switching Speed
- Convenient Package
- High Surge
- Low Thermal Resistance
- Mechanically Rugged
- Both Polarities Available

DESCRIPTION
This series combines two high efficiency devices into one package, simplifying installation, reducing heat sink requirements and the need to purchase matched components.

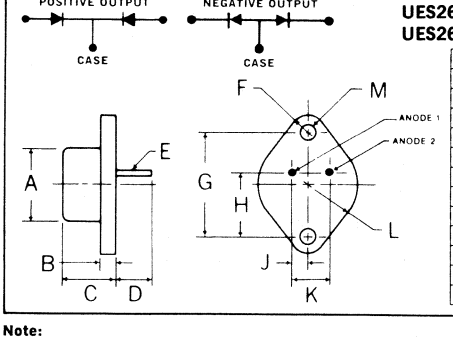
ABSOLUTE MAXIMUM RATINGS
Peak Inverse Voltage, UES2601, UES2601HR 50V
Peak Inverse Voltage, UES2602, UES2602HR 100V
Peak Inverse Voltage, UES2603, UES2603HR 150V
Maximum Average D.C. Output Current at $T_C = 100°C$ 30A
Non-Repetitive Sinusoidal Surge Current 8.3 ms 400A
Thermal Resistance, Junction to Case ..... 1°C/W
Operating and Storage Temperature Range ..... −55°C to +175°C

POWER CYCLING
These devices possess the unique ability to pass many thousands of cycles of a stress test designed to evaluate the integrity of the bonding systems used in the construction of power rectifiers.

In this stress test, the case of the device is not heat sunk. Full rated forward current is supplied to force a case temperature increase at least 75°C, at which time, the current is removed and the case allowed to cool. The cycle is repeated a minimum of 5,000 times to simulate equipment being turned on and off. Extended power cycling tests demonstrate a product capability in excess of 25,000 cycles.

SWITCHING CHARACTERISTICS
The switching times of these ultra-fast rectifiers increase relatively little, with temperature or at different currents. Even in severe applications, such as catch diodes for switching regulators and output rectifiers for high frequency square wave inverters, these devices switch many times faster than the fastest associated transistors. Thus, the stresses on and powers dissipated in the switching transistors are substantially less than when using other rectifiers.

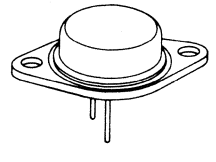
MECHANICAL SPECIFICATIONS



UES2601 UES2602 UES2603
UES2601HR UES2602HR UES2603HR

	ins.	mm.
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA (TO-3)



Note:
Standard polarity is positive output.
For reverse polarity (negative output) add suffix "R", ie. UES2601R.

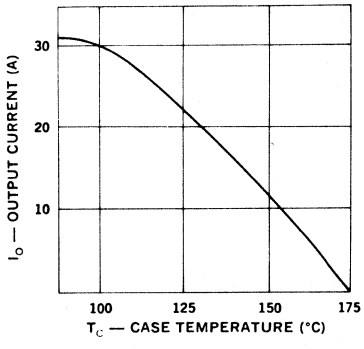
UNITRODE

ELECTRICAL SPECIFICATIONS

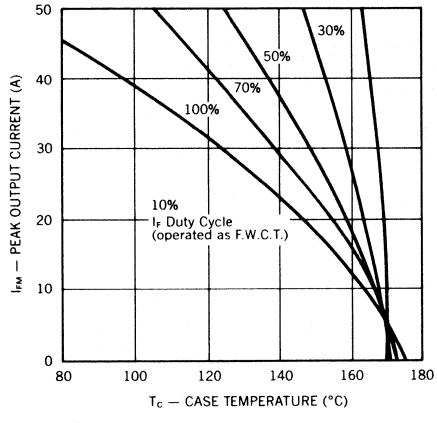
Type	PIV	Maximum Forward Voltage @		Maximum Reverse Current @		Maximum Reverse Recovery Time*
		$T_C = 25°C$	$T_C = 125°C$	$T_C = 25°C$	$T_C = 125°C$	
UES2601/2601HR UES2602/2602HR UES2603/2603HR	50V 100V 150V	.930V @ 15A $t_p = 300\mu S$	.825V @ 15A $t_p = 300\mu S$	20μA	4mA	35nS

* Measured in circuit $I_F = 0.5A$, $I_R = 1A$, $I_{REC} = 0.25A$

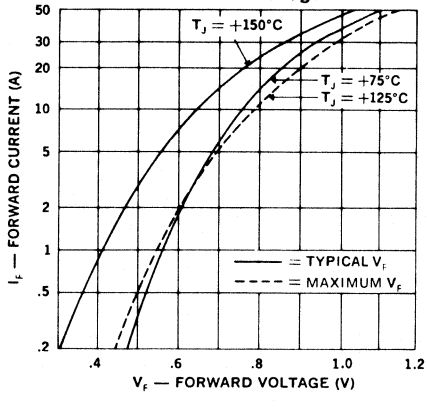
Output Current vs. Case Temperature



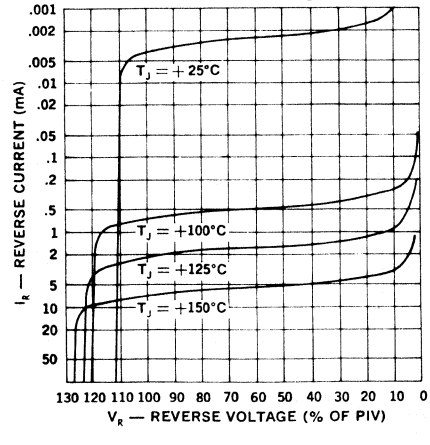
Peak Output Current vs. Case Temperature



Forward Current vs. Forward Voltage



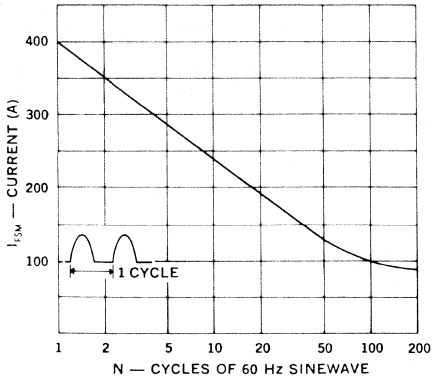
Typical Reverse Current vs. Reverse Voltage



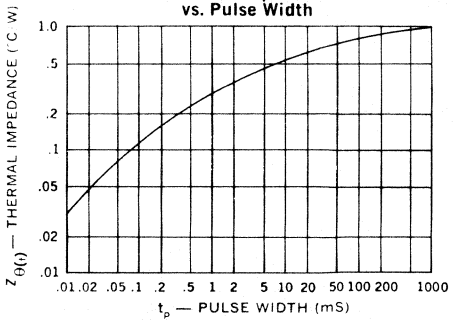
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

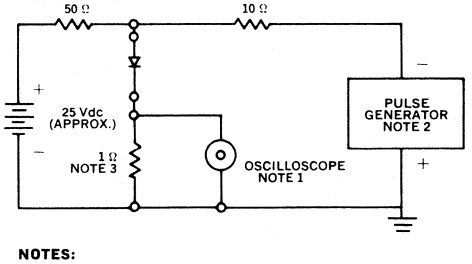
Maximum Forward Surge vs. Number of Cycles



Thermal Impedance vs. Pulse Width



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ≤ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ≤ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

OPTIONAL HIGH RELIABILITY SCREENING

The following tests are performed on 100% of the devices specified UES2601, 2, 3HR.

SCREEN	MIL-STD-750 METHOD	CONDITIONS
1. High Temperature Life (Stabilization Bake)	1032	24 Hours @ T_A = 175°C
2. Thermal Shock (Temperature Cycling)	1051	10 Cycles @ T_A = (−55°C to +150°C)
3. Hermetic Seal a. Fine b. Gross	1071	 G or H A, C or D
4. Interim Electrical Parameters	—	V_F and I_R @ 25°C
5. High Temperature Reverse Bias (HTRB)	1038	48 Hours @ T_C = 125°C V_R = 80% Rated
6. Final Electrical and Delta Parameters	Go/No Go	ΔI_R ± 100% or 5μA (whichever is greater) V_R = Rated

RECTIFIERS
High Efficiency, 30A Center-Tap

UES2604
UES2605
UES2606
UES2604HR
UES2605HR
UES2606HR

FEATURES
- Very Low Forward Voltage (1.15V)
- Very Fast Recovery Times (50nSec)
- Low Profile Package
- High Surge Capability
- Low Thermal Resistance
- Mechanically Rugged
- Both Polarities Available

DESCRIPTION
The UES2604 series is specifically designed for operation in power switching circuits operating at frequencies of at least 20 KHz.
This series combines two high efficiency devices into one package, simplifying installation, reducing heat sink requirements and the need to purchase matched components.

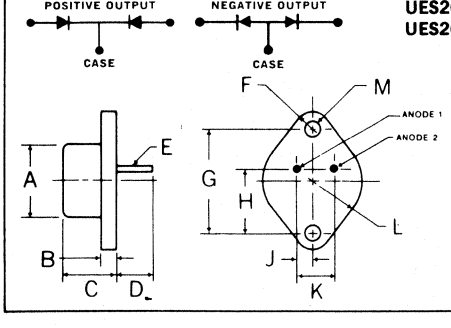
ABSOLUTE MAXIMUM RATINGS
Peak Inverse Voltage, UES2604, UES2604HR 200V
Peak Inverse Voltage, UES2605, UES2605HR 300V
Peak Inverse Voltage, UES2606, UES2606HR 400V
Maximum Average D.C. Output Current @ $T_C = 100°C$ 30A
Surge Current, 8.3mSec 300A
Thermal Resistance, Junction to Case ..... 1°C/W
Operating and Storage Temperature Range ..... −55°C to +150°C

POWER CYCLING
These devices possess the unique ability to pass many thousands of cycles of a stress test designed to evaluate the integrity of the bonding systems used in the construction of power rectifiers.

In this stress test, the case of the device is not heat sunk. Full rated forward current is supplied to force a case temperature increase at least 75°C, at which time, the current is removed and the case allowed to cool. The cycle is repeated a minimum of 5,000 times to simulate equipment being turned on and off. Extended power cycling tests demonstrate a product capability in excess of 25,000 cycles.

SWITCHING CHARACTERISTICS
The switching times of these ultra-fast rectifiers increase relatively little, with temperature or at different currents. Even in severe applications, such as catch diodes for switching regulators and output rectifiers for high frequency square wave inverters, these devices switch many times faster than the fastest associated transistors. Thus, the stresses on and powers dissipated in the switching transistors are substantially less than when using other rectifiers.

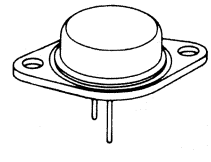
MECHANICAL SPECIFICATIONS



UES2604 UES2605 UES2606
UES2604HR UES2605HR UES2606HR

	ins.	mm.
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

TO-204AA (TO-3)



Note:
Standard polarity is positive output.
For reverse polarity (negative output) add suffix "R", ie. UES2604R.

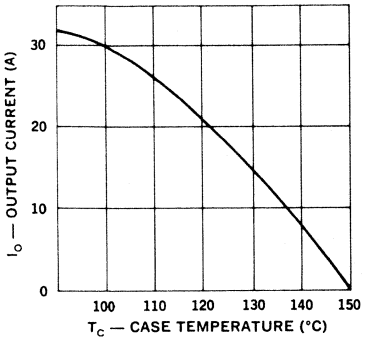
ELECTRICAL SPECIFICATIONS, PER LEG

Type	PIV	Maximum Forward Voltage		Maximum Reverse Current		Maximum Reverse Recovery Time*
		$T_C = 25°C$	$T_C = 125°C$	$T_C = 25°C$	$T_C = 125°C$	
UES2604/2604HR UES2605/2605HR UES2606/2606HR	200V 300V 400V	1.25V @ 15A $t_p = 300\mu S$	1.15V @ 15A $t_p = 300\mu S$	50μA	10mA	50nS

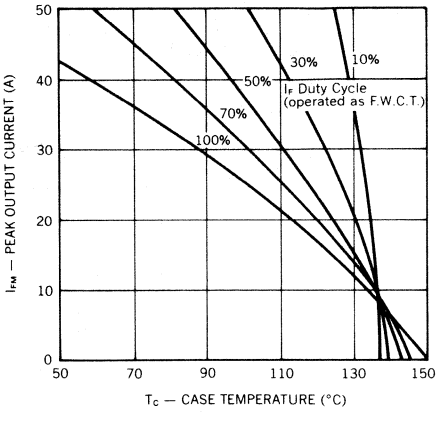
*Measured in circuit I_F = .5A, I_R = 1A, I_{REC} = .25A

5

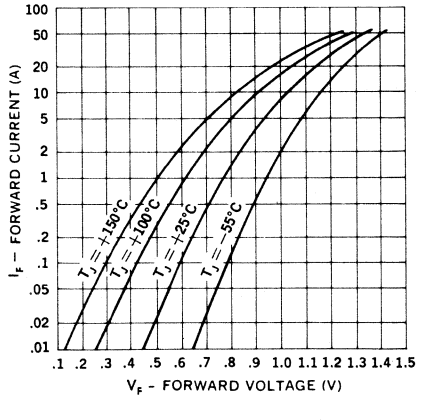
Output Current vs. Case Temperature



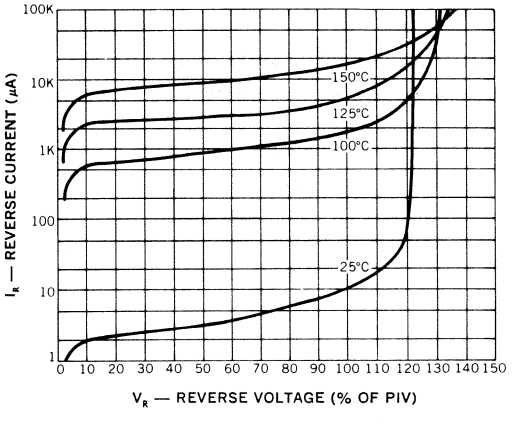
Peak Output Current vs. Case Temperature



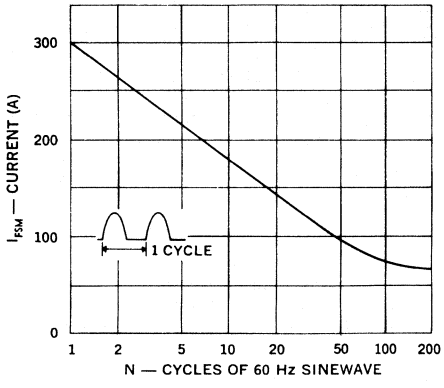
Forward Current vs. Forward Voltage



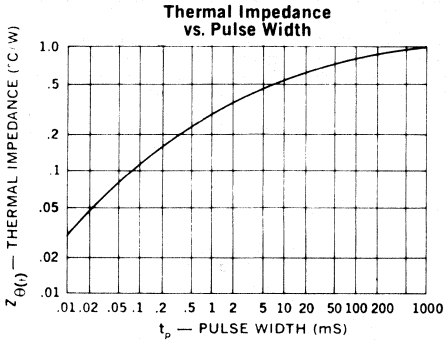
Typical Reverse Current vs. Reverse Voltage



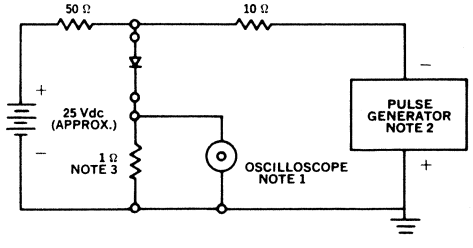
Maximum Forward Surge vs. Number of Cycles



Thermal Impedance vs. Pulse Width



Reverse-Recovery Circuit



NOTES:
1. Oscilloscope: Rise time ⩽ 3ns; input impedance = 50Ω.
2. Pulse Generator: Rise time ⩽ 8ns; source impedance 10Ω.
3. Current viewing resistor, non-inductive, coaxial recommended.

OPTIONAL HIGH RELIABILITY SCREENING

The following tests are performed on 100% of the devices specified UES2604, 5, 6HR.

SCREEN	MIL-STD-750 METHOD	CONDITIONS
1. High Temperature Life (Stabilization Bake)	1032	24 Hours @ T_A = 175°C
2. Thermal Shock (Temperature Cycling)	1051	10 Cycles @ T_A = (−55°C to +150°C)
3. Hermetic Seal a. Fine b. Gross	1071	 G or H A, C or D
4. Interim Electrical Parameters	—	V_F and I_R @ 25°C
5. High Temperature Reverse Bias (HTRB)	1038	48 Hours @ T_C = 125°C V_R = 80% Rated
6. Final Electrical and Delta Parameters	Go/No Go	ΔI_R ± 100% or 5μA (whichever is greater) V_R = Rated

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

High Voltage Stacks, Standard and Fast Recovery

UFB, UFS, USB, USS SERIES

5

FEATURES

- Controlled Avalanche Characteristics
- Only Fused-in-Glass Diodes Used
- High Forward and Reverse Surge Capability
- Transfer Molded for Voidless Construction
- Modular for Easy Stacking
- PIV: from 2.5 kV to 15 kV
- Recovery Times: to 500ns
- Continuous Ratings: to 2.3A

DESCRIPTION

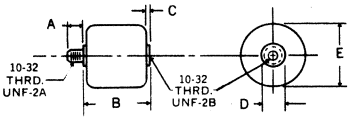
These assemblies uniquely combine a versatile stackable design with all the requirements for reliable high voltage operation. All modules are suitable for bridge or series operations.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage, USS Series	5.0 kV to 15kV
Peak Inverse Voltage, USB Series	2.5 kV to 10kV
Peak Inverse Voltage, UFS Series	5.0 kV to 10 kV
Peak Inverse Voltage, UFB Series	2.5 kV to 7.5 kV
Maximum Average D.C. Output Current	See Electrical Specifications
Non-Repetitive Sinusoidal Surge (8.3ms)	See Electrical Specifications
Operating and Storage Temperature Range	—65°C to +150°C

MECHANICAL SPECIFICATIONS

UFB, UFS, USB, USS SERIES

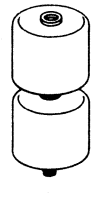


	ins.	mm.
A	.230-.235	5.84-5.97
B	.980-1.10	24.89-27.94
C	.020-.040	0.51-1.02
D	.320-.330	8.13-8.38
E	.97-1.00	24.64-25.40

Typical Weight: USS & UFS Series — 1.0 ounce 28 grams

USB & UFB Series — 1.1 ounce 31 grams

DH



MARKING

Type number marked on unit.

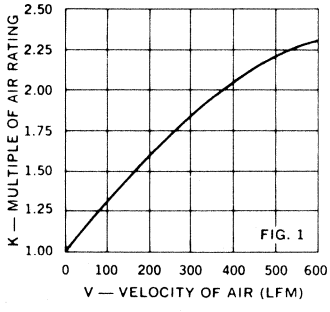
Polarity — Cathode connected to stud.

UNITRODE

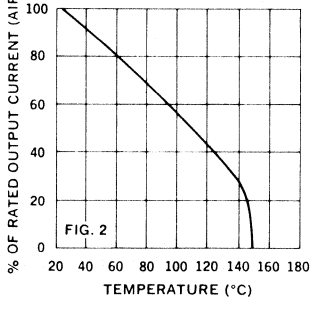
Electrical Specifications (at 25°C unless noted)							Maximum Ratings		
Type		PIV	Maximum Forward Voltage Drop	Leakage Current @ PIV	Maximum Reverse Recovery Time	Maximum Reverse Transient Energy Absorption	Maximum Average D.C. Output Current $T_A = 25°C$ AIR	Maximum Average D.C. Output Current $T_A = 50°C$ OIL	Non-Repetitive Sinusoidal Surge (8.3ms)
		kV		μA	ns	joules	Amps	Amps	Amps
Standard Recovery	USS 5	5.0	9V @ 0.6A	5	—	1.5	0.60	1.1	25
	USS 7.5	7.5	13V @ 0.5A			2.5	0.45	0.91	
	USS 10	10	17V @ 0.3A			3.0	0.35	0.71	
	USS 15	15	25V @ 0.2A			5.0	0.25	0.51	
Standard Recovery	USB 2.5	2.5	5V @ 1.1A	10	—	3.0	1.1	2.3	80
	USB 5	5.0	9V @ 0.7A			6.0	0.68	1.5	
	USB 7.5	7.5	13V @ 0.5A			9.0	0.53	1.2	
	USB 10	10	17V @ 0.4A			12	0.43	1.0	
Fast Recovery	UFS 5	5.0	12V @ 0.5A	5	500* 350†	1.5	0.50	0.90	20
	UFS 7.5	7.5	18V @ 0.4A			2.5	0.38	0.75	
	UFS 10	10	23V @ 0.3A			3.0	0.30	0.58	
Fast Recovery	UFB 2.5	2.5	6V @ 0.9A	10	500* 350†	3.0	0.90	2.0	70
	UFB 5	5.0	12V @ 0.6A			6.0	0.58	1.3	
	UFB 7.5	7.5	18V @ 0.4A			9.0	0.45	1.0	

*Measured in a reverse recovery circuit switching from 1A forward to 1A reverse current recovering to 0.5A.
†Measured in a reverse recovery circuit switching from .5A foward current to 1A reverse current, recovery to .25A.

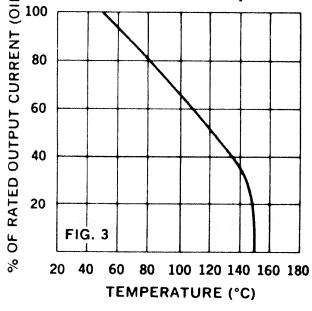
Output Current Ratio vs. Velocity of Air Flow



Output Current vs. Ambient (Air) Temperature

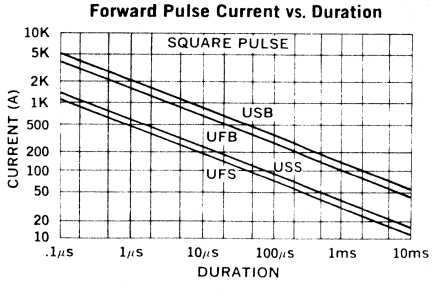


Output Current vs. Ambient (Oil) Temperature

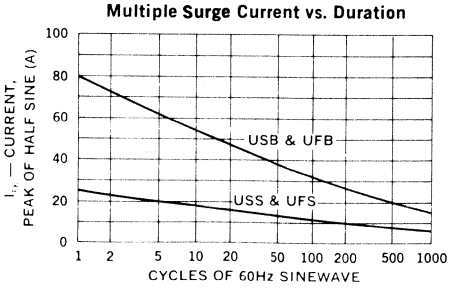


Application example: The rectifier is to be used in a cabinet at 60°C with ambient air moving at 400 LFM. The rating is reduced (Fig. 2) by a factor of 0.81 due to the elevated temperature, but it is enhanced by 2X (Fig. 1) due to the air flow. Hence the DC output current is 0.81 x 2, or 1.6 times the 25°C air rating.

Forward Pulse Current vs. Duration



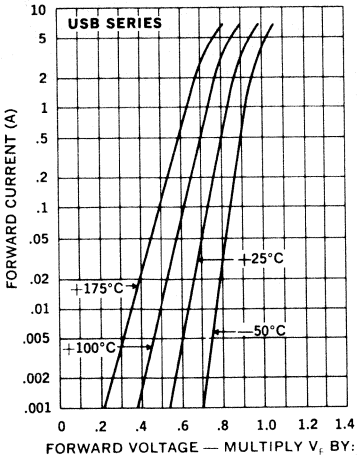
Multiple Surge Current vs. Duration



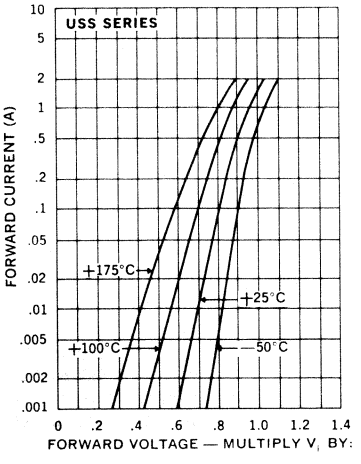
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

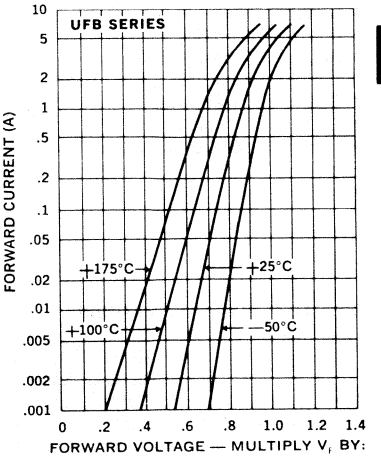
Typical Forward Voltage vs. Forward Current



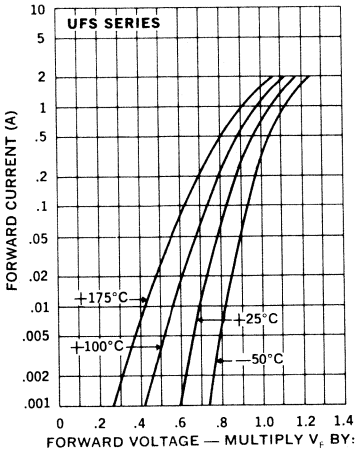
Typical Forward Voltage vs. Forward Current



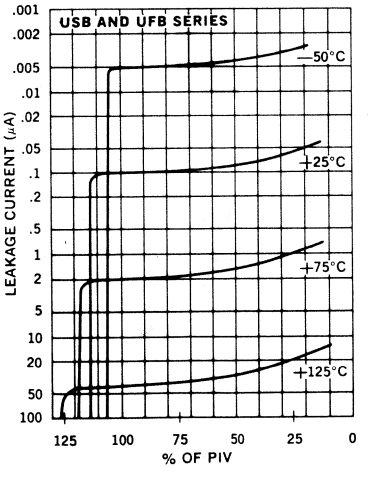
Typical Forward Voltage vs. Forward Current



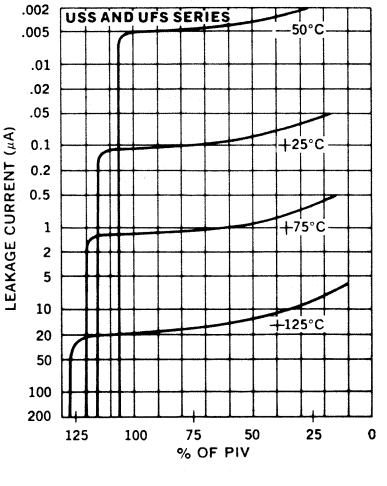
Typical Forward Voltage vs. Forward Current



Typical Leakage Current vs. PIV



Typical Leakage Current vs. PIV



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

UGB, UGD, UGE, UGF SERIES

High Voltage Doorbell® Modules
Standard and Fast Recovery

FEATURES
- Current Ratings: to 10A
- PIV: 2.5 kV to 10kV
- Recovery Times: to 500ns
- Only Fused-in-Glass Diodes Used
- Controlled Avalanche Characteristics
- Stackable to 600kV
- Modular Package for Easy Stacking

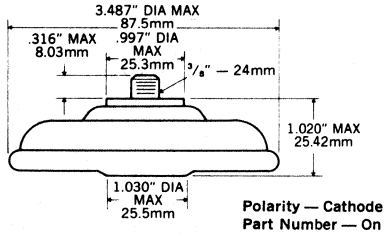
DESCRIPTION
This series of high-voltage, high-current stacks that incorporate a unique modular design makes it particularly well-suited for high power applications such as in radar systems as charge, hold-off and clipper diodes.

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	
UGB, UGD Series	5kV to 10 kV
UGS, UGF Series	2.5kV to 7.5kV
Maximum Average D.C. Output Current	See Electrical Specifications
Non-repetitive Sinusoidal Surge (8.3ms)	See Electrical Specifications
Operating and Storage Temperature Range	−65°C to +150°C

MECHANICAL SPECIFICATIONS

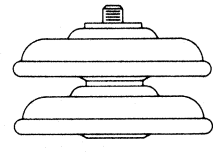
UGB, UGD, UGE, UGF SERIES



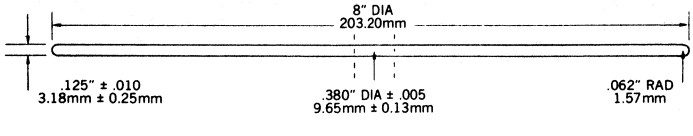
Polarity — Cathode connected to base.
Part Number — On base of unit.

Typical Weight — 7.0 ounces 200 grams

DG



EXTENDER PLATE G



Typical Weight — 9.25 ounces 265 grams

Doorbell® is a registered trademark of Unitrode Corporation

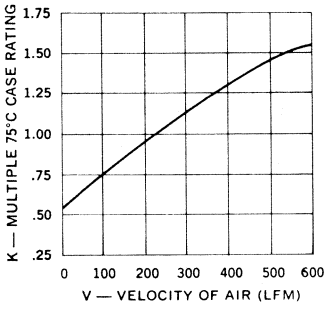
UNITRODE

Electrical Specifications (at 25°C unless noted)						Maximum Ratings				
Type		PIV	Maximum Forward Voltage Drop	Maximum Leakage Current @ PIV	Maximum Reverse Recovery Time	Maximum Average D.C. Output Current $T_C = 75°C$ Air	Maximum Average D.C. Output Current $T_C = 60°C$ Air with Extender Plate**	Maximum Average D.C. Output Current $T_C = 50°C$ Oil	Non-repetitive Sinusoidal Surge (8.3ms) $T_C = 100°C$	Maximum Reverse Transient Energy Absorption
		kV		μA	ns	Amps	Amps	Amps	Amps	joules
Standard Recovery	UGE-2.5	2.5	5V @ 3.30A	10		6.60	8.25	10.00	200	8
	UGE-5	5	10V @ 2.50A	15		5.00	6.25	7.50	200	14
	UGB-5	5	9V @ 2.20A	5	—	4.40	5.50	6.60	100	7
	UGE-7.5	7.5	13V @ 1.60A	10		3.30	4.10	5.00	200	20
	UGB-7.5	7.5	13V @ 1.50A	5		3.00	3.75	5.00	100	10
	UGB-10	10	17V @ 1.10A	5		2.30	2.85	3.50	100	14
Fast Recovery	UGF-2.5	2.5	6V @ 2.50A	10		5.00	6.25	8.00	150	8
	UGF-5	5	11V @ 1.80A	10		3.75	4.70	6.00	150	14
	UGD-5	5	11V @ 1.60A	5	500*	3.30	4.10	4.80	80	7
	UGF-7.5	7.5	17V @ 1.20A	10	350†	2.50	3.10	4.00	150	20
	UGD-7.5	7.5	17V @ 1.10A	5		2.25	2.80	3.50	80	10
	UGD-10	10	22V @ 0.85A	5		1.75	2.20	2.50	80	14

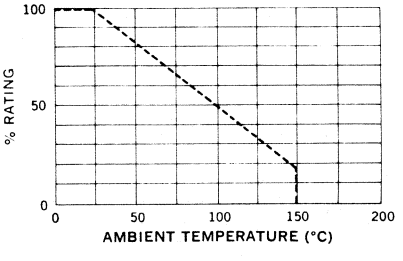
*Measured in a reverse recovery circuit switching from 1.0A forward to 1.0A reverse current recovering to 0.5A.
†Measured in a reverse recovery circuit switching from 0.5A forward to 1.0A reverse current recovering to 0.25A.

**These ratings are based on using "extender plates" that provide additional surface area to radiate heat. Because of possible corona effects caused by scratches on these plates, extreme care is necessary in their handling and they are not recommended where the working voltage exceeds 7.5KV/module. They should be carefully polished prior to installation.

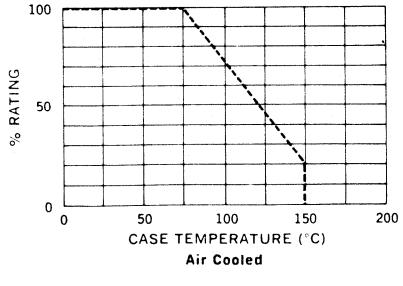
Output Current Ratio vs. Velocity of Air Flow



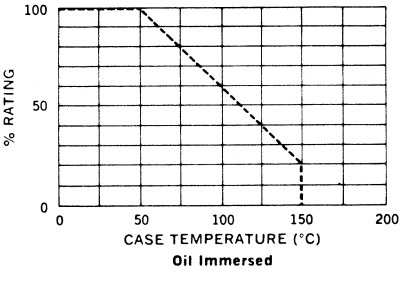
Current Derating Curve



Current Derating Curve



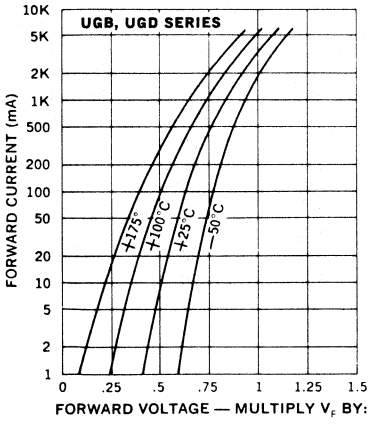
Current Derating Curve



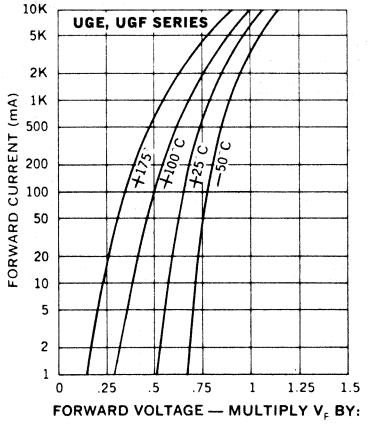
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

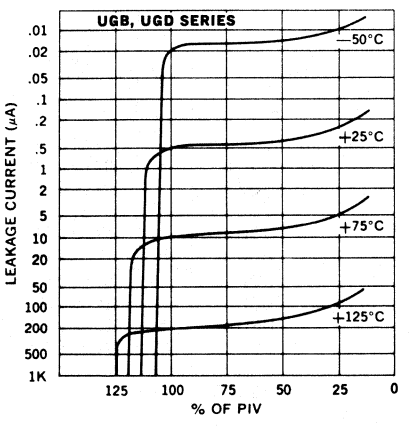
Typical Forward Voltage vs. Forward Current



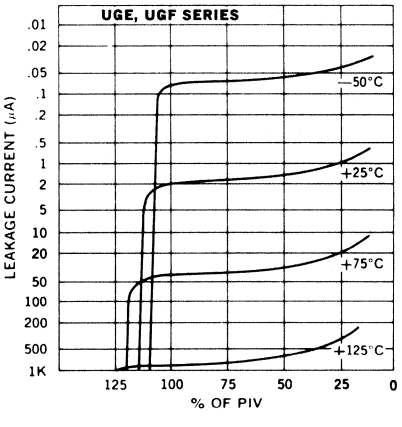
Typical Forward Voltage vs. Forward Current



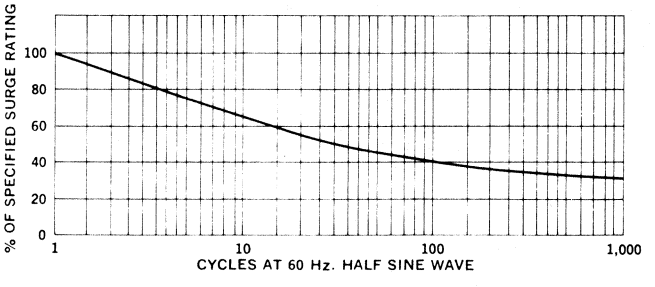
Typical Leakage Current vs. PIV



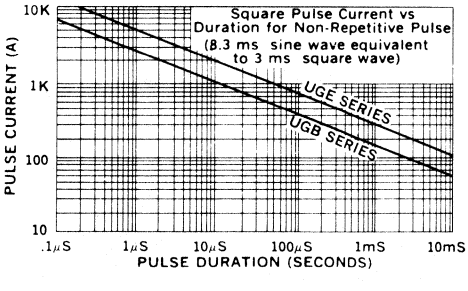
Typical Leakage Current vs. PIV



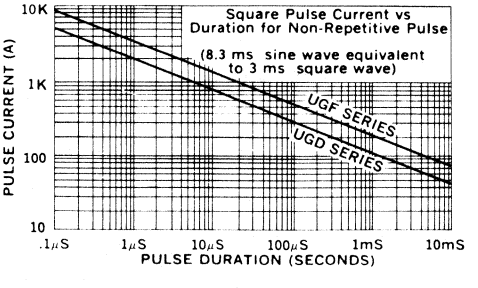
Multiple Surge Rating vs. Duration



Forward Pulse Current vs. Pulse Duration



Forward Pulse Current vs. Pulse Duration



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
Radiation Tolerant, 1 Amp-2 Amp

UR105-UR125
UR205-UR225

FEATURES
- Radiation Tolerant: to 10^{16} NVT
- Continuous Rating: to 2A
- Controlled Avalanche
- Surge Rating: to 25A
- Miniature Package

DESCRIPTION
These devices are particularly suited to applications where radiation is present. These units have unique ability to withstand high levels of neutron, gamma and electron radiation.

5

ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	1 Amp Series	2 Amp Series
50V	UR105	UR205
100V	UR110	UR210
150V	UR115	UR215
200V	UR120	UR220
250V	UR125	UR225

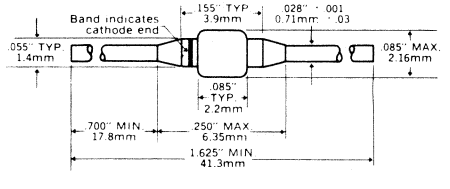
	1 AMP SERIES	2 AMP SERIES
Maximum Average D.C. Output Current		
@ $T_A = 25°C$	1A	2A
@ $T_A = 100°C$	0.5A	1A
Non-Repetitive Sinusoidal Surge Current (8.3ms)	20A	25A
Operating Temperature Range	−195°C to +175°C	
Storage Temperature Range	−195°C to +200°C	
Thermal Resistance	See Lead Temperature Derating Curve	

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	PIV	Maximum Forward Voltage Drop	Maximum Leakage Current @ PIV		Maximum Radiation Tolerance
			25°C	100°C	
UR205	50V	1.0V @ 1A	3μA	50μA	10^{16} NVT
UR210	100V				10^{16}
UR215	150V				10^{15}
UR220	200V				10^{14}
UR225	250V				10^{14}
UR105	50V	1.0V @ 0.5A	3μA	50μA	10^{16}
UR110	100V				10^{16}
UR115	150V				10^{15}
UR120	200V				10^{14}
UR125	250V				10^{14}

MECHANICAL SPECIFICATIONS

UR105-UR125 UR205-UR225



Part Identification: White band indicates "UR." Part number printed on body.

Polarity: Denoted by white band.

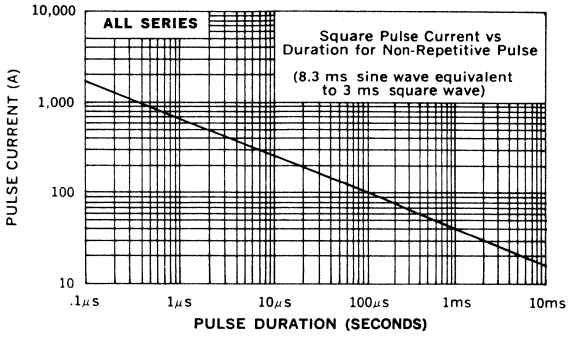
Weight: 0.26 grams, typical.

BODY A

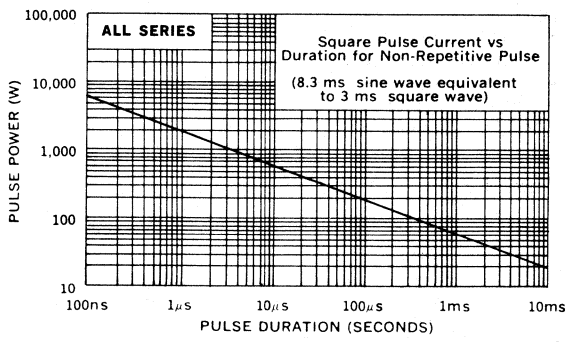


UNITRODE

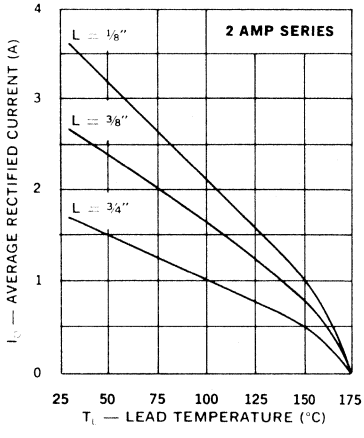
Forward Pulse Current vs Pulse Duration



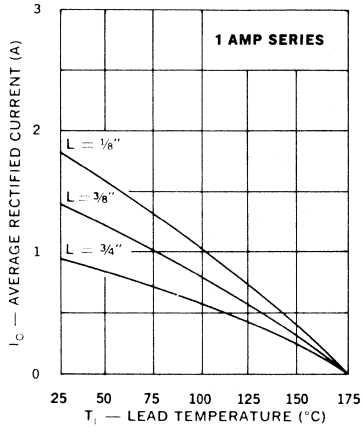
Reverse Pulse Power vs Pulse Duration



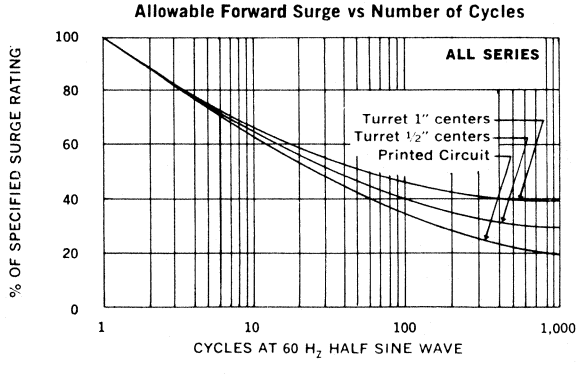
Maximum Current vs Lead Temperature



Maximum Current vs Lead Temperature



Allowable Forward Surge vs Number of Cycles



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIER ASSEMBLIES

High Voltage Stacks, .125 Amp to 1 Amp, Standard and Fast Recovery

US12–US200A
USR12–USR180A

5

FEATURES

- Controlled Avalanche Characteristics
- Recovery Times: to 500ns
- Transfer Molded for Voidless Encapsulation
- High Forward and Reverse Surge Capability
- PIV: from 1200 to 20,000V
- Only Fused-in-Glass Diodes Used

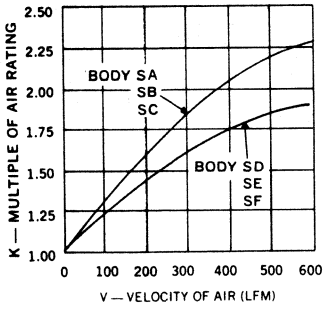
DESCRIPTION

This series of High Voltage, Medium Current Stacks are assembled from hermetically sealed, controlled avalanche individual diodes. Therefore, they offer the ultimate in reliability for such applications as clipper diodes, back swing diodes and hold-off diodes in pulse modulators.

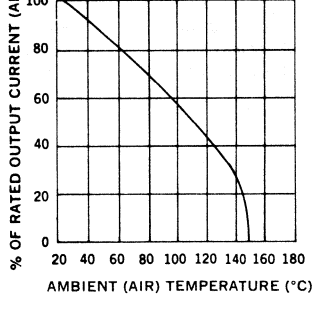
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	1200 to 20,000V
Maximum Average D.C. Output Current	See Electrical Specifications
Non-Repetitive Sinusoidal Surge (8.3ms)	20A
Operating and Storage Temperature Range	−65°C to +150°C

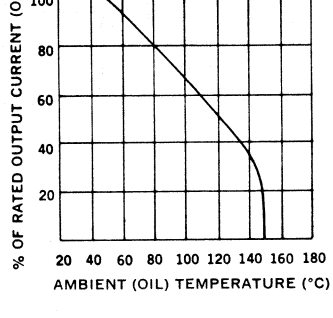
Output Current Ratio vs Velocity of Air Flow



Output Current vs Ambient (Air) Temperature



Output Current vs Ambient (Oil) Temperature

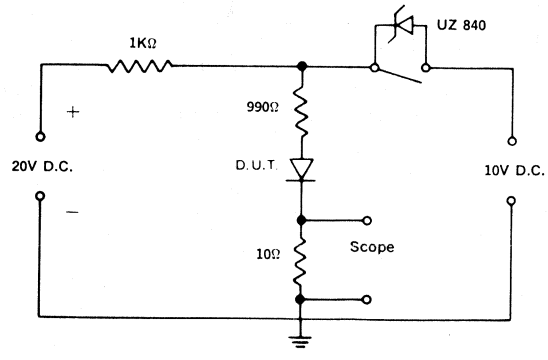


UNITRODE

Electrical Specifications (at 25°C unless noted)							Maximum Ratings	
Type	PIV	Maximum Leakage Current at PIV		Maximum Forward Voltage Drop	Maximum Reverse Recovery Time†	Body Size	Max. Avg. D.C. Output Current	
		$T_A = 25°C$	$T_A = 100°C$				$T_A = 25°C$ (Air)	$T_A = 50°C$ (Oil)
	V	μA	μA		ns		mA	mA
Standard Recovery								
US 12	1200	2	100	2.0V @ 400mA		SA	1000	2500
US 15	1500	2	100	3.0V @ 400mA		SA	800	2000
US 18	1800	2	100	3.0V @ 400mA	——	SA	700	1750
US 20	2000	2	100	4.0V @ 400mA		SA	600	1500
US 25	2500	2	100	5.0V @ 400mA		SB	600	1500
US 30	3000	2	100	6.0V @ 400mA	——	SB	500	1250
US 35	3500	2	100	7.0V @ 200mA		SC	400	1000
US 40	4000	2	100	7.0V @ 200mA	——	SC	350	850
US 45A	4500	2	100	8.0V @ 200mA		SD	330	750
US 50A	5000	2	100	9.0V @ 200mA		SD	330	750
US 60A	6000	2	100	10.0V @ 200mA	——	SD	300	620
US 70A	7000	2	100	12.0V @ 200mA		SD	300	620
US 80A	8000	2	100	14.0V @ 100mA		SE	250	500
US 100A	10000	2	100	17.0V @ 100mA	——	SE	250	500
US 120A	12000	2	100	21.0V @ 100mA		SE	200	400
US 150A	15000	2	100	26.0V @ 100mA		SF	200	400
US 180A	18000	2	100	31.0V @ 100mA	——	SF	180	360
US 200A	20000	2	100	34.0V @ 100mA		SF	180	360
Fast Recovery								
USR 12	1200	5	150	3.3V @ 400mA	500	SA	750	1850
USR 15	1500	5	150	4.0V @ 400mA	500	SA	600	1500
USR 20	2000	5	150	5.5V @ 400mA	500	SB	500	1250
USR 25	2500	5	150	6.6V @ 400mA	500	SB	400	1000
USR 30	3000	5	150	7.7V @ 400mA	500	SC	400	1000
USR 35	3500	5	150	8.8V @ 200mA	500	SC	350	850
USR 40A	4000	5	150	9.9V @ 200mA	500	SD	300	750
USR 45A	4500	5	150	11.0V @ 100mA	500	SD	250	625
USR 50A	5000	5	150	13.0V @ 100mA	500	SD	250	625
USR 60A	6000	5	150	15.4V @ 100mA	500	SD	220	500
USR 70A	7000	5	150	17.6V @ 100mA	500	SE	220	500
USR 80A	8000	5	150	20.0V @ 100mA	500	SE	200	400
USR 100A	10000	5	150	24.0V @ 100mA	500	SE	200	400
USR 120A	12000	5	150	31.0V @ 100mA	500	SF	150	300
USR 150A	15000	5	150	33.0V @ 100mA	500	SF	150	300
USR 180A	18000	5	150	35.0V @ 100mA	500	SF	125	250

†Measured in a reverse recovery circuit switching from 10mA forward to 10mA reverse current recovering to 5mA.

Reverse Recovery Circuit

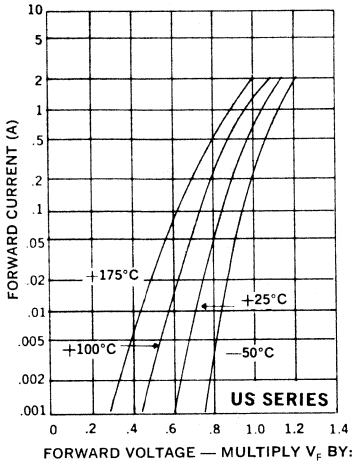


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

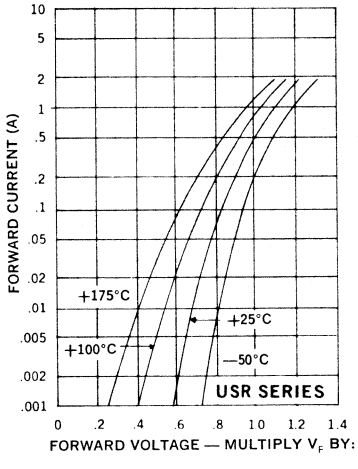
PRINTED IN U.S.A.

5

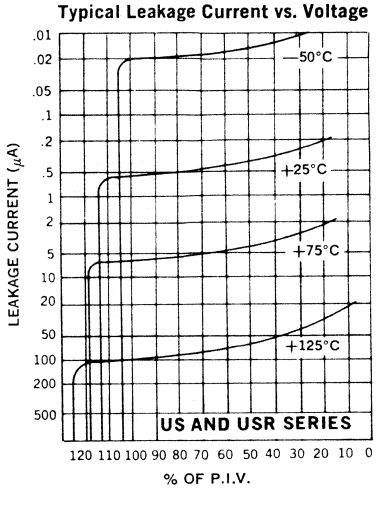
Typical Forward Current vs. Forward Voltage



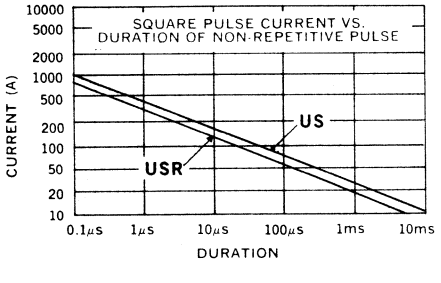
Typical Forward Current vs. Forward Voltage



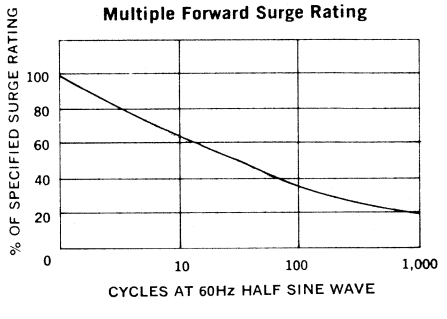
Typical Leakage Current vs. Voltage



Forward Pulse Current vs Duration



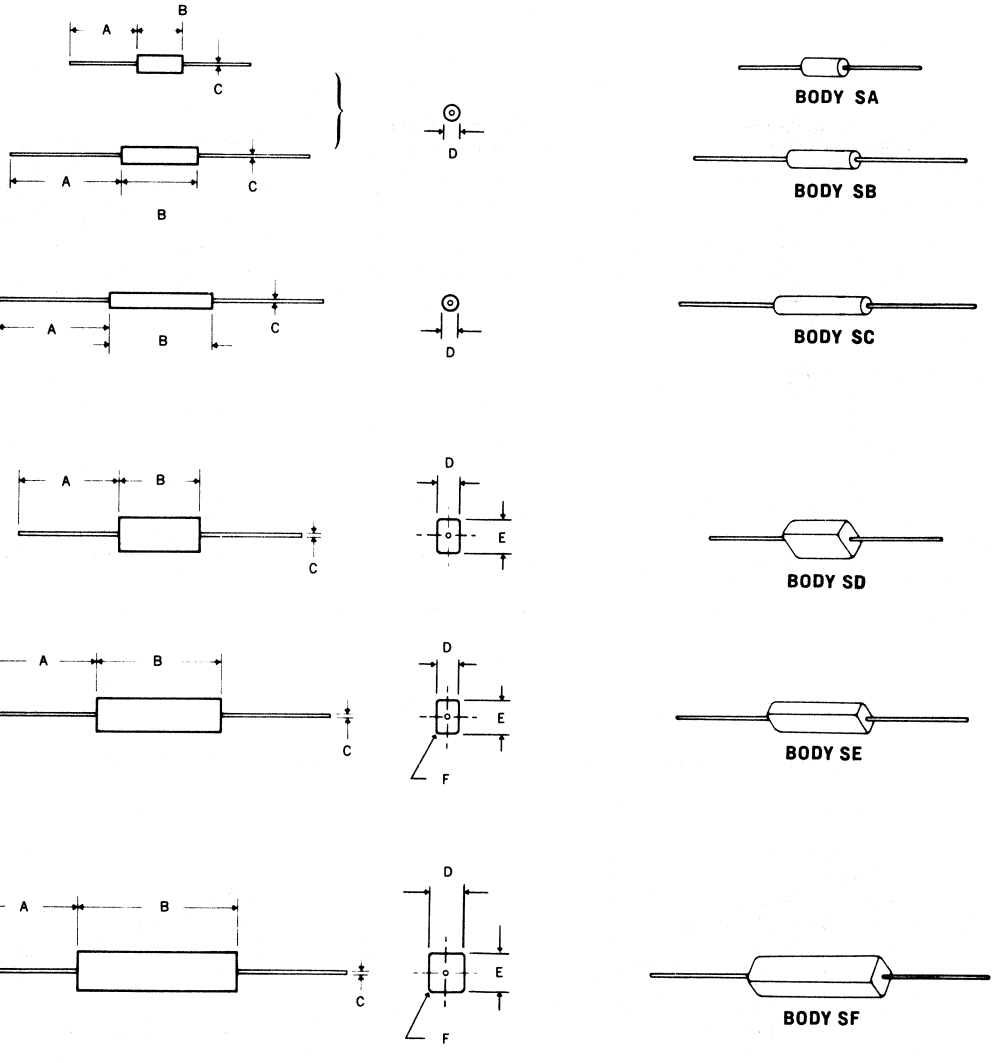
Multiple Forward Surge Rating



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

MECHANICAL SPECIFICATIONS



	SA		SB		SC		SD		SE		SF	
	ins.	mm.	ins.	mm.	ins.	mm.	ins.	mm.	ins.	mm.	ins.	mm.
A	.75 MIN.	19.05 MIN.	1.25 MIN.	31.75 MIN.	1.25 MIN.	31.75 MIN.	1.25 MIN.	31.75 MIN.	1.25 MIN.	31.75 MIN.	1.25 MIN.	31.75 MIN.
B	.50 MAX.	12.70 MAX.	0.85 MAX.	21.59 MAX.	1.125 MAX.	28.58 MAX.	.875 MAX.	22.23 MAX.	1.375 MAX.	34.93 MAX.	1.75 MAX.	44.45 MAX.
C	.028 DIA.	.71 DIA.	.032 DIA.	.81 DIA.	.032 DIA.	.81 DIA.	.032 DIA.	.81 DIA.	.032 DIA.	.81 DIA.	.032 DIA.	.81 DIA.
D	.187 MAX.	4.75 MAX.	.187 MAX.	4.75 MAX.	.187 MAX.	4.75 MAX.	.250 MAX.	6.35 MAX.	.250 MAX.	6.35 MAX.	.400 MAX.	10.16 MAX.
E							.375 MAX.	9.53 MAX.	.375 MAX.	9.53 MAX.	.400 MAX.	10.16 MAX.
F									.078	1.98	.078	1.98

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

HERMETIC SCHOTTKY RECTIFIERS

4 Amp, 45 Volts

USD245
USD245HR

5

FEATURES

- MIL-S-19500 Type Screening Available
- Extremely Low V_F and I_R
- High Surge Capability
- Low Recovered Charge
- Rugged Hermetic Package, No Pressure Contacts

DESCRIPTION

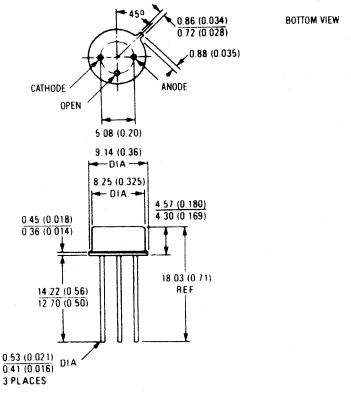
The USD245 hermetic Schottky rectifier is ideally suited for output rectifiers and catch diodes in high efficiency, low voltage, high reliability switching power supplies.

ABSOLUTE MAXIMUM RATINGS

Peak Repetitive Reverse Voltage, V_{RRM} 45V
Working Peak Reverse Voltage, V_{RWM} 45V
DC Blocking Voltage, V_R 45V
Non-Repetitive Peak Reverse Voltage, V_{RSM} 54V
Average Forward Current (50% Duty Cycle), $I_{F(AV)}$ (Note 1) 2A
$R_{\theta C-A}$ = 68°C/W, T_A = 25°C
V_{RWM} = 45V
PC Board Mounting
Average Forward Current (50% Duty Cycle), $I_{F(AV)}$ 4A
T_{CASE} = 100°C
V_{RWM} = 45V
Non-Repetitive Peak Surge Current, I_{FSM} 80A
8.3ms, Half Sine Wave
Operating and Storage Junction Temperature Range ..... -65°C to +175°C
Thermal Resistance, Junction to Ambient, $R_{\theta J-A}$ ..... 175°C/W
Thermal Resistance, Junction to Case, $R_{\theta J-C}$ ..... 12°C/W

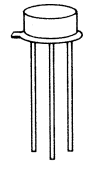
Note: 1.Using Wakefield Type 205 heatsink with convection cooling.
For more definitive data refer to the Output vs Temperature curves on this data sheet.

MECHANICAL SPECIFICATIONS



All Dimensions in Millimeters and Inches

TO-205AF (TO-39)



UNITRODE

ELECTRICAL CHARACTERISTICS (T_j = 25°C)

CHARACTERISTICS	SYMBOL	LIMIT	UNITS	CONDITIONS	
Maximum Instantaneous Reverse Current	i_R	2	mA	V_R = 45V Pulse Width = 400μs Duty Cycle = 1%	
Maximum Instantaneous Reverse Current	i_R	20	mA	V_R = 45V Pulse Width = 400μs Duty Cycle = 1% T_C = 125°C	
Maximum Instantaneous Forward Voltage (Note 1)	V_F	0.48 0.56 0.68	V	i_F = 1A i_F = 2A i_F = 4A	Pulse Width = 400μs Duty Cycle = 1%
		0.45		i_F = 2A T_j = 125°C	
Capacitance	C_t	450	pF	V_R = 5V	
Voltage Rate of Change	dv/dt	1000	V/μs	V_R = 45V	

NOTE: 1. Measured with anode and cathode lead length of 0.2" from case.

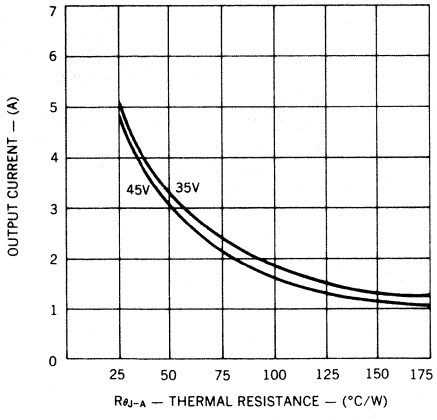
OPTIONAL HIGH RELIABILITY SCREENING

The following tests are performed on 100% of the devices specified USD245HR.

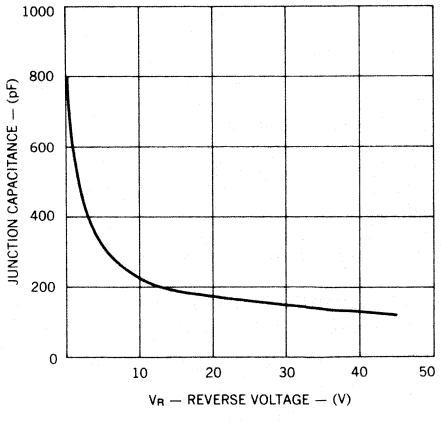
SCREEN	MIL-STD-750 METHOD	CONDITIONS
1. High Temperature Life (Stabilization Bake)	1032	24 Hours, T_A = 175°C
2. Thermal Shock (Temperature Cycling)	1051	Condition F. −55°C to +175°C 10 Cycles
3. Hermetic Seal a. Fine b. Gross	1071	 G or H A, C, D, E or F
4. Reverse Energy Test	MIL-S-19500 /554 PARA. 4.5.2	2A
5. Interim Electrical Parameters		V_F and I_R @ 25°C
6. Power Burn-In	1038	T_A = 25°C, V_R = 45V, I_o = .75A, t = 96 Hours
7. Final Electrical and Delta Parameters		ΔV_F ± 0.05V ΔI_R ± 100% or 500μA, whichever is greater

5

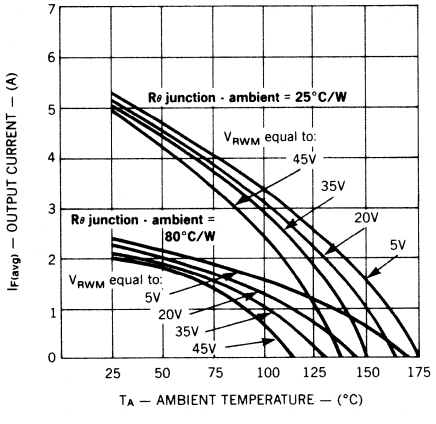
Output Current vs $R_{\theta J\text{-}A}$
$T_{ambient}$ = 25°C, 50% Duty Cycle



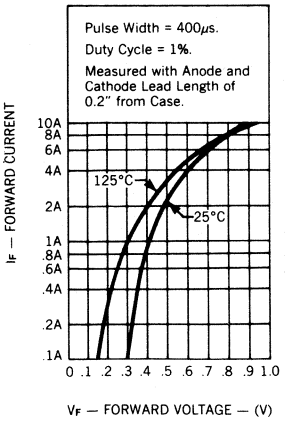
Typical Junction Capacitance vs Reverse Voltage



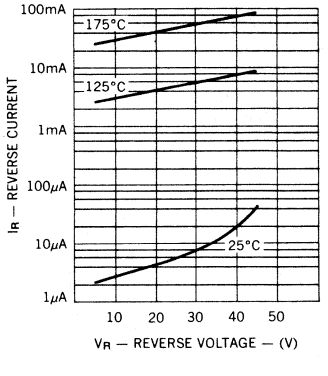
Output Current vs Ambient Temperature
50% Duty Cycle Application ($I_{F(avg)}$ and V_{RRM})



Typical Forward Current vs Forward Voltage



Typical Reverse Current vs Reverse Voltage



DUAL POWER SCHOTTKY RECTIFIERS

60A Pk, 45V

USD320C
USD335C
USD345C
USD320CHR
USD335CHR
USD345CHR

FEATURES

- Very Low Forward Voltage
- Low Recovered Charge
- Rugged Package Design (TO-3)
- High Efficiency for Low Voltage Supplies
- 45V Blocking @ Rated T_{jmax}
- 50V Repetitive Surge Voltage
- Dual Schottky Rectifier in a Single Package

DESCRIPTION

The USD320C series has two Schottky barriers arranged in a common cathode configuration and is ideally suited for a full wave output rectifier in low voltage switching power supplies.

ABSOLUTE MAXIMUM RATINGS (Total for USD300C Series)	**USD320C USD320CHR**	**USD335C USD335CHR**	**USD345C USD345CHR**
Average Rectified Forward Current, I_O @ T_C = 100°C	30A		

ABSOLUTE MAXIMUM RATINGS (Per Diode)			
Working Peak Reverse Voltage V_{RWM}	20V	35V	45V
DC Blocking Voltage, V_R	20V	35V	45V
Peak Repetitive Surge Voltage, V_{RSM} @ I_{RM}	24V	42V	54V
Average Rectified Forward Current, I_O	30A in full wave configuration*		
Non-repetitive Peak Surge current (8.3 mS), I_{FSM}	500A		
Peak Reverse Transient Current, I_{RM}	2A		
Storage Temperature Range, T_{stg}	−55°C to +200°C		
Peak Operating Junction Temperature, $T_{j\,max}$	175°C		
Thermal Resistance, Junction to Case, $R_{\theta JC}$	1.4°C/W		

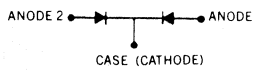
* Each Anode Pin Limited to 18A Average.
Package Capability 30A Average.

ELECTRICAL CHARACTERISTICS (T_{CASE} = 25°C)

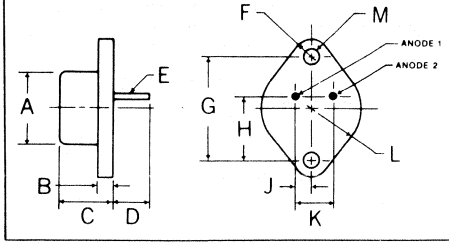
Characteristic	Symbol	Limit	Units	Conditions
Maximum Instantaneous Reverse Current	i_R	10 50	mA mA	T_C = 25°C, V_R = V_{RWM} T_C = 125°C Pulse Width = 400μS Duty Cycle = 1 percent
Maximum Instantaneous Forward Voltage	V_F	0.57 0.66 0.60	V V V	i_F = 10A, T_C = 25°C i_F = 20A, T_C = 25°C i_F = 20A, T_C = 125°C Pulse Width = 300μS Duty Cycle = 1 percent
Capacitance	C_t	2000	pF	V_R = 5.0V
Voltage Rate of Change	dv/dt	1000	v/μS	V_R = V_{RWM}

MECHANICAL SPECIFICATIONS

NOTE:
Leads may be soldered to within 1/16" of base provided temperature-time exposure is less than 260°C for 10 seconds.

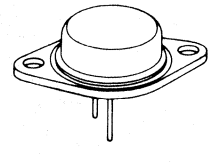


USD320C SERIES
USD320CHR SERIES



	ins.	mm.
A	.875 MAX.	22.23 MAX.
B	.135 MAX.	3.43 MAX.
C	.250-.450	6.35-11.43
D	.312 MIN.	7.92 MIN.
E	.038-.043 DIA.	0.97-1.09 DIA.
F	.188 MAX. RAD.	4.78 MAX. RAD.
G	1.177-1.197	29.90-30.40
H	.655-.675	16.64-17.15
J	.205-.225	5.21-5.72
K	.420-.440	10.67-11.18
L	.525 MAX. RAD.	13.34 MAX. RAD.
M	.151-.161 DIA.	3.84-4.09 DIA.

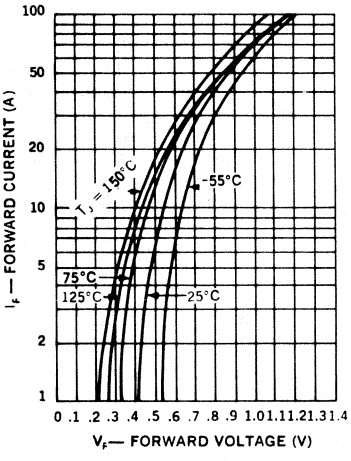
TO-204AA (TO-3)



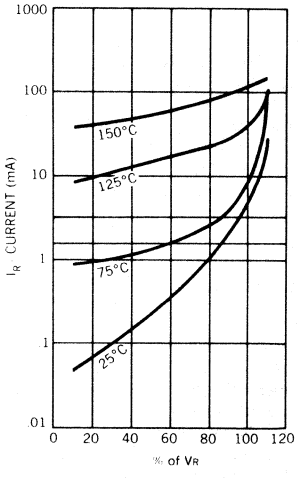
Notes: All metal surfaces tin plated.

UNITRODE

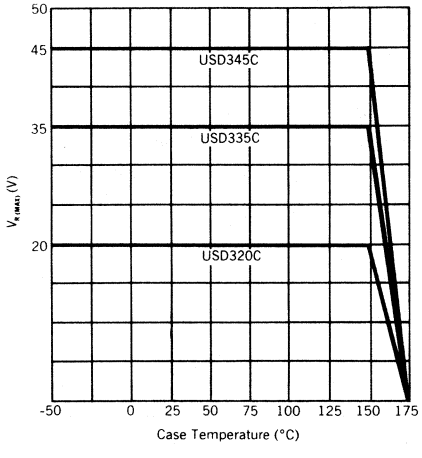
Typical Forward Current vs Forward Voltage



Typical Reverse Current vs. Reverse Voltage



$V_{R(MAX)}$ Rating vs. Case Temperature



OPTIONAL HIGH RELIABILITY SCREENING

The following tests are performed on 100% of the devices specified USD320C, 335C, 345CHR.

SCREEN	MIL-STD-750 METHOD	CONDITIONS
1. High Temperature Life (Stabilization Bake)	1032	24 Hours @ T_A = 175°C
2. Thermal Shock (Temperature Cycling)	1051	10 Cycles @ T_A = (−55°C to +150°C)
3. Hermetic Seal a. Fine b. Gross	1071	 G or H A, C or D
4. Reverse Energy Test	MIL-S-19500/553 Para 4.5.2	2 Amps
5. Interim Electrical Parameters		V_F and I_R @ 25°C
6. High Temperature Reverse Bias (HTRB)	1038	48 Hours @ T_C = 125°C V_R = 80% Rated
7. Final Electrical and Delta Parameters	Go/No Go	ΔI_R ± 100% ΔV_F ± 2%

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER SCHOTTKY RECTIFIERS

150 Amp Pk, Up to 45V

USD520
USD535
USD545
USD550

FEATURES

- Very Low Forward Voltage (0.6V at 60A, 125°C)
- Low Recovered Charge
- Rugged Package Design (DO-5)
- High Efficiency for Low Voltage Supplies
- Low Thermal Resistance (0.8°C/W)
- High Surge Current (1000A)
- Low Reverse Current (<50mA at rated V_R at 125°C)
- Available with Flexible Top Lead

DESCRIPTION

This series of Schottky barrier power rectifiers is ideally suited for output rectifiers and catch diodes in low voltage power supplies. The Unitrode high conductivity design, using a heavy copper top post and 4 point crimp, ensures cool thermal operation and low dynamic impedance. Rugged design absorbs stress that can damage glass-to-metal seal during installation and use.

ABSOLUTE MAXIMUM RATINGS

	USD520	USD535	USD545	USD550
Working Peak Reverse Voltage, V_{RWM}	20V	35V	45V	50V
DC Blocking Voltage, V_R	20V	35V	45V	50V
Peak Repetitive Surge Voltage, V_{RSM} @ I_{RM}	24V	42V	54V	60V

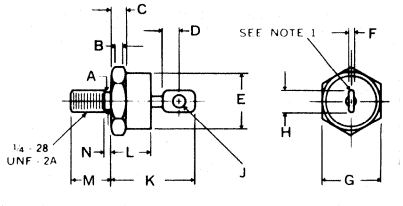
Peak Repetitive Forward Current
(Rated V_R, Square Wave, 20KHz,
50 percent Duty Cycle), I_{FRM} ..... 150A (at T_c = 115°C)
Average Rectified Forward Current, $I_{F(AV)}$ ..... 75A (at T_c = 115°C)
Non-repetitive Peak Surge Current (8.3mS), I_{FSM} 1000A
Peak Reverse Transient Current, I_{RM} 2A
Storage Temperature Range, T_{stg} ..... -55° to +200°C
Operating Junction Temperature, T_j ..... +175°C
Thermal Resistance Junction-to-Case, $R_{\theta JC}$ ..... 0.8°C/W

ELECTRICAL CHARACTERISTICS (T_{CASE} = 25°C)

Characteristic	Symbol	Limit		Units	Conditions
		USD520-545	USD550		
Maximum Instantaneous Reverse Current	i_R	20 (50)	20 (75)	mA	$V_R = V_{RWM}$ (T_C = 125°C) Pulse Width = 300μs, Duty Cycle = 1 percent
Maximum Instantaneous Forward Voltage	V_F	0.50 0.68 0.60		V V V	i_F = 10A, T_C = 25°C i_F = 60A, T_C = 25°C i_F = 60A, T_C = 125°C
Flexible Top Lead Option	V_F	(0.63)		V	i_F = 60A, (T_C = 125°C)
Maximum Capacitance	C_t	4000		pF	V_R = 5.0V
Maximum Voltage Rate of Change	dv/dt	1000		V/μS	V_R = rated

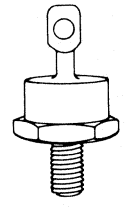
MECHANICAL SPECIFICATIONS

USD520
USD535
USD545
USD550



	ins.	mm
A	.225 ± .005	5.72 ± 0.13
B	.060 MIN.	1.52 MIN.
C	.156 ± .020	3.96 ± 0.51
D	.156 MIN. FLAT	3.96 MIN. FLAT
E	.667 DIA. MAX.	16.94 DIA. MAX.
F	.090 MAX.	2.29 MAX.
G	.677 ± .010	17.20 ± 0.25
H	.375 MAX.	9.53 MAX.
J	.140 MIN. DIA.	3.56 MIN. DIA.
K	1.000 MAX.	25.40 MAX.
L	.450 MAX.	11.43 MAX.
M	.438 ± .015	11.13 ± 0.38
N	.078 MAX.	1.98 MAX.

DO-5

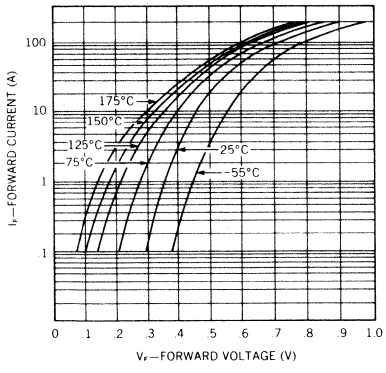


Notes:
1. Cathode is stud.
2. All metal surfaces tin plated.
3. Maximum unlubricated stud torque: 30 inch pounds (35 kg. cm).
4. Angular orientation of terminal is undefined.

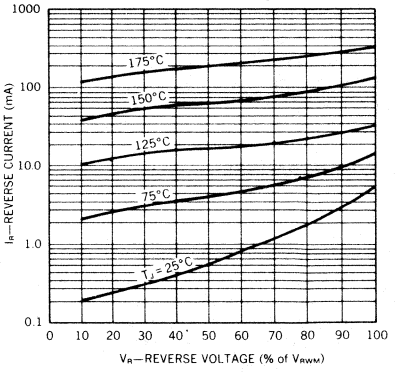
UNITRODE

5

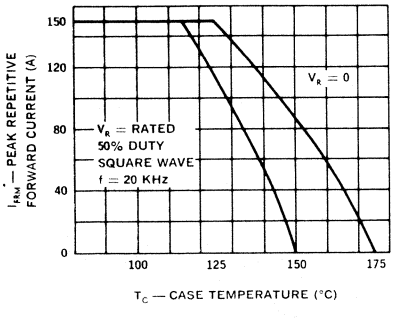
Typical Forward Current vs Forward Voltage



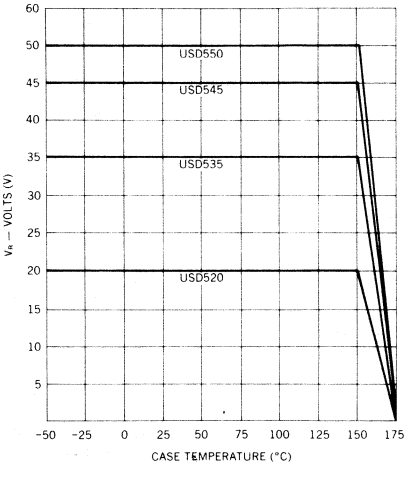
Typical Reverse Current vs Reverse Voltage



Maximum Current vs Case Temperature



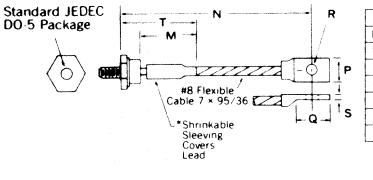
$V_{R(MAX)}$ Rating vs Case Temperature



MECHANICAL SPECIFICATIONS

FLEXIBLE TOP LEAD (OPTIONAL)
Add an "F" Suffix to Part Number.

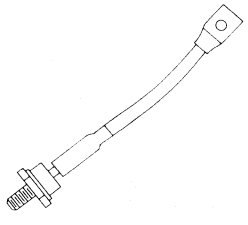
USD520F
USD535F
USD545F
USD550F



	INCHES	MILLIMETERS
M	.718 MAX	18.24 MAX
N	4.50 ± .250	114.3 ± 6.35
P	.525 MAX	13.23 MAX
Q	.675 ± .035	17.15 ± 0.89
R	.205 ± .005	5.21 ± 0.13
S	.075 ± .010	1.91 ± 0.25
T	1.125 MAX	28.58 MAX

*To 125°C (Ambient)

DO-5 with Flexible Lead



Note: Consult Factory for Non-standard Lead Lengths.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER SCHOTTKY RECTIFIERS

12A Pk, up to 45V

USD620
USD635
USD640
USD645

FEATURES

- Very Low Forward Voltage
- Reverse Transient Capability
- Economical Convenient Plastic Package
- Mechanically Rugged
- 45V Working Voltage @ Rated $T_{j(max)}$

DESCRIPTION

The USD600 series of Schottky power rectifiers is ideally suited for output rectifiers and catch diodes in high frequency low voltage power supplies.

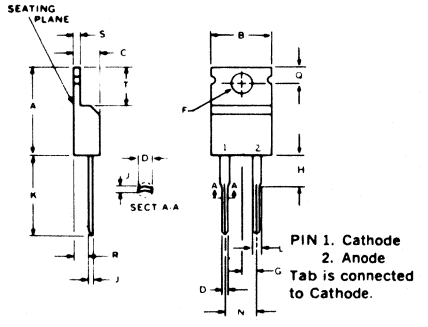
ABSOLUTE MAXIMUM RATINGS

	USD620	USD635	USD640	USD645
Working Peak Reverse Voltage, V_{RWM}	20V	35V	40V	45V
DC Blocking Voltage, V_R	20V	35V	40V	45V
Peak Repetitive Surge Voltage, V_{RSM} @ I_{RM}	24V	42V	48V	54V
Average Rectified Forward Current @ T_C = 115°C, $I_{F(AV)}$	6A			
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 KHz, 50% Duty Cycle, @ T_C = 115°C), I_{FRM}	12A			
Non-repetitive Peak Surge Current (8.3ms), I_{FSM}	150A			
Peak Reverse Transient Current, I_{RM}	1A			
Operating Junction Temperature, T_j	150°C			
Storage Temperature Range, T_{stg}	−55°C to +150°C			
Thermal Resistance, Junction to Case, $R_{\theta JC}$	3.0°C/W			

ELECTRICAL CHARACTERISTICS (T_{CASE} = 25°C)

CHARACTERISTIC	SYMBOL	LIMIT	UNITS	CONDITIONS
Maximum Instantaneous Reverse Current	i_R	5	mA	$V_R = V_{RWM}$ Pulse Width = 400μs Duty Cycle = 1 percent
Maximum Instantaneous Reverse Current	i_R	50	mA	$V_R = V_{RWM}$ Pulse Width = 400μs Duty Cycle = 1 percent T_C = 125°C
Maximum Instantaneous Forward Voltage	V_F	0.55 0.65	V	i_F = 6A i_F = 12A
		0.48 0.60	V	i_F = 6A i_F = 12A } T_C = 125°C
Capacitance	C_t	1000	pF	V_R = 5V
Voltage Rate of Change	dv/dt	1000	V/μs	$V_R = V_{RWM}$

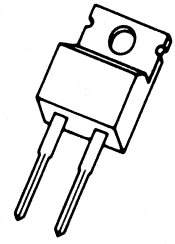
MECHANICAL SPECIFICATIONS



USD600 SERIES

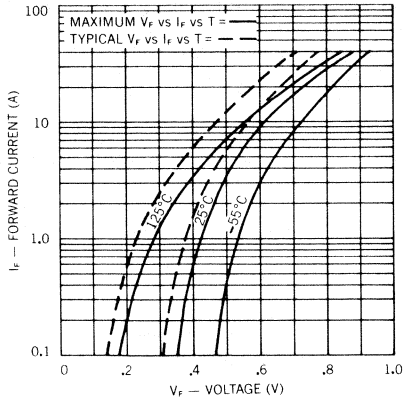
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.23	15.87	0.560	0.625
B	9.66	10.66	0.380	0.420
C	3.56	4.82	0.140	0.190
D	0.51	1.14	0.020	0.045
F	3.531	3.733	0.139	0.147
G	2.29	2.79	0.090	0.110
H	—	6.35	—	0.250
J	0.38	0.64	0.015	0.025
K	12.70	14.27	0.500	0.562
L	1.14	1.77	0.045	0.070
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.92	0.080	0.115
S	1.14	1.39	0.045	0.055
T	5.85	6.85	0.230	0.270

TO-220AC

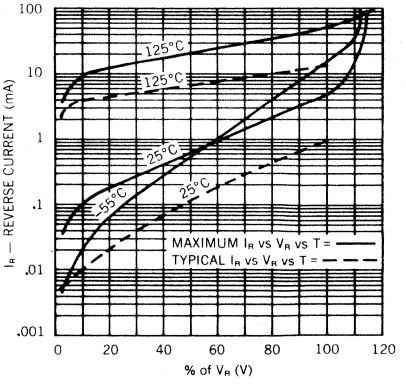


UNITRODE

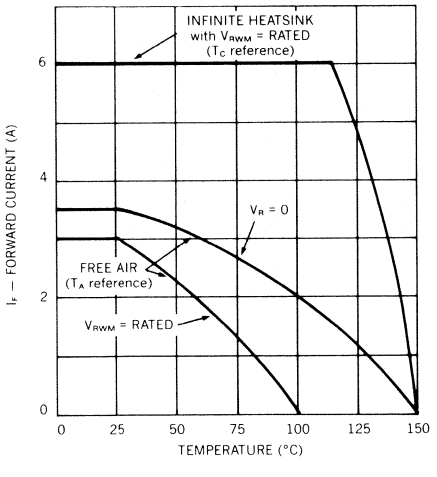
Forward Current vs. Forward Voltage



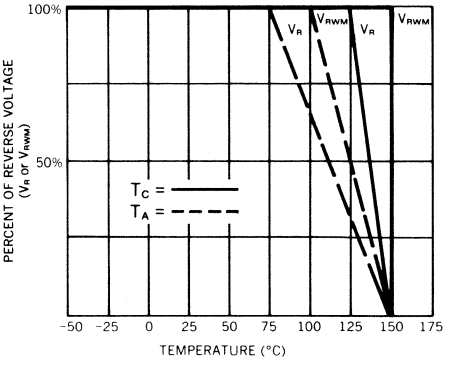
Reverse Current vs. Voltage



Average Forward Current vs. Temperature



V_R Rating vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

DUAL POWER SCHOTTKY RECTIFIERS

12A Av, up to 45V

USD620C
USD635C
USD640C
USD645C

FEATURES

- Very Low Forward Voltage
- Reverse Transient Capability
- Economical Convenient Plastic Package
- Mechanically Rugged
- 45V Working Voltage @ Rated $T_{j(max)}$

DESCRIPTION

The USD600C series of power Schottky rectifiers, in the industry standard TO-220 package, is specifically designed for operation in power switching circuits to frequencies in excess of 100 KHz. The series combines Schottky rectifiers in one convenient package; thus, simplifying installation, reducing heatsink requirements and component parts count.

ABSOLUTE MAXIMUM RATINGS (Per Diode Unless Otherwise Noted)

	USD620C	USD635C	USD640C	USD645C
Working Peak Reverse Voltage, V_{RWM}	20V	35V	40V	45V
DC Blocking Voltage, V_R	20V	35V	40V	45V
Peak Repetitive Surge Voltage, V_{RSM} @ I_{RM}	24V	42V	48V	54V
Average Rectified Forward Current @ T_C = 115°C, I_o*	12A			
Non-repetitive Peak Surge Current (8.3ms), I_{FSM}	150A			
Peak Reverse Transient Current, I_{RM}	1A			
Operating Junction Temperature, T_j	150°C			
Storage Temperature Range, T_{stg}	−55°C to +150°C			
Thermal Resistance, Junction to Case, $R_{\theta JC}$	3.0°C/W			

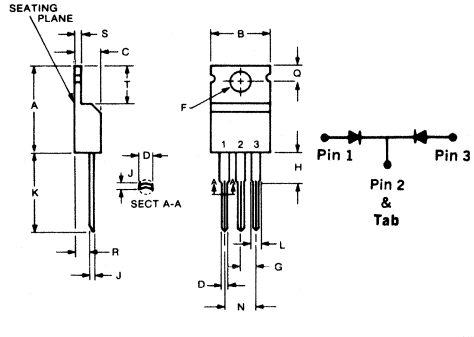
*Full Wave Center-Tap; $I_{o\ (AV)}$ 20 KHz Square Wave

ELECTRICAL CHARACTERISTICS (T_{CASE} = 25°C) (Per Diode)

CHARACTERISTIC	SYMBOL	LIMIT	UNITS	CONDITIONS
Maximum Instantaneous Reverse Current	i_R	5	mA	$V_R = V_{RWM}$ Pulse Width = 400μs Duty Cycle = 1 percent
Maximum Instantaneous Reverse Current	i_R	50	mA	$V_R = V_{RWM}$ Pulse Width = 400μs Duty Cycle = 1 percent T_C = 125°C
Maximum Instantaneous Forward Voltage	V_F	0.55 0.65	V	i_F = 6A i_F = 12A
		0.48 0.60	V	i_F = 6A i_F = 12A } T_C = 125°C
Capacitance	C_t	1000	pF	V_R = 5V
Voltage Rate of Change	dv/dt	1000	V/μs	$V_R = V_{RWM}$

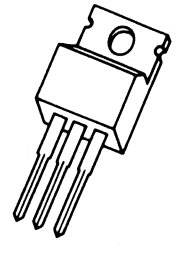
MECHANICAL SPECIFICATIONS

USD600C SERIES



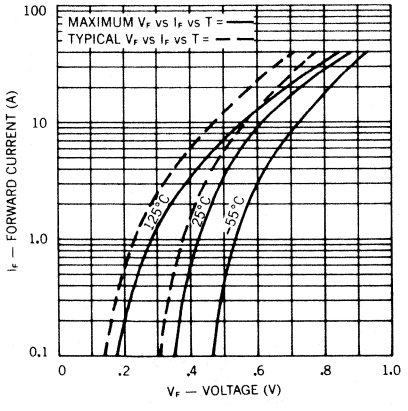
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.23	15.87	0.560	0.625
B	9.66	10.66	0.380	0.420
C	3.56	4.82	0.140	0.190
D	.0.51	1.14	0.020	0.045
F	3.531	3.733	0.139	0.147
G	2.29	2.79	0.090	0.110
H	—	6.35	—	0.250
J	0.38	0.64	0.015	0.025
K	12.70	14.27	0.500	0.562
L	1.14	1.77	0.045	0.070
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.92	0.080	0.115
S	1.14	1.39	0.045	0.055
T	5.85	6.85	0.230	0.270

TO-220AB

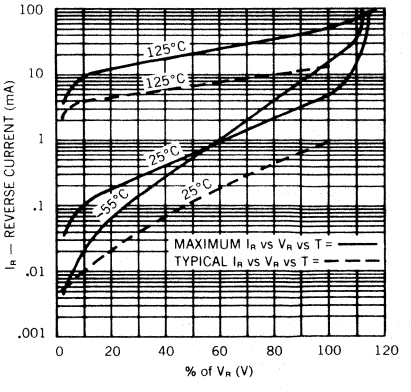


UNITRODE

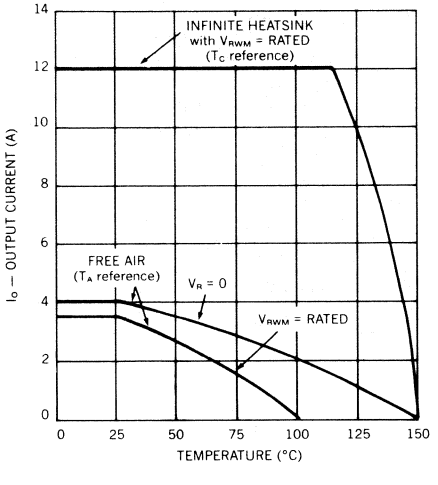
Forward Current vs. Forward Voltage



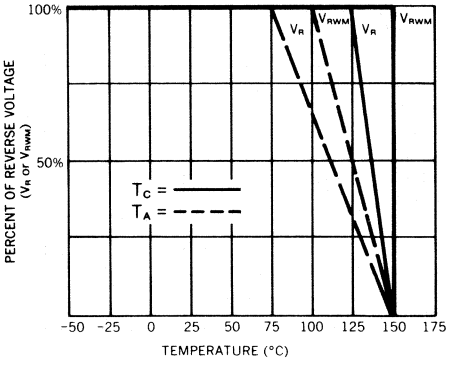
Reverse Current vs. Voltage



Average Output Current vs. Temperature



V_R Rating vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER SCHOTTKY RECTIFIERS

16A Pk, up to 45V

USD720
USD735
USD740
USD745

FEATURES

- Very Low Forward Voltage
- Reverse Transient Capability
- Economical Convenient Plastic Package
- Mechanically Rugged
- 45V Working Voltage @ Rated $T_{j(max)}$

DESCRIPTION

The USD700 series of Schottky power rectifiers is ideally suited for output rectifiers and catch diodes in high frequency low voltage power supplies.

ABSOLUTE MAXIMUM RATINGS

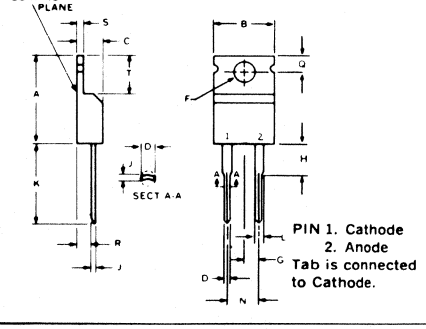
	USD720	USD735	USD740	USD745
Working Peak Reverse Voltage, V_{RWM}	20V	35V	40V	45V
DC Blocking Voltage, V_R	20V	35V	40V	45V
Peak Repetitive Surge Voltage, V_{RSM} @ I_{RM}	24V	42V	48V	54V
Average Rectified Forward Current @ T_C = 115°C, $I_{F(AV)}$	8A			
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 KHz, 50% Duty Cycle, @ T_C = 115°C), I_{FRM}	16A			
Non-repetitive Peak Surge Current (8.3ms), I_{FSM}	200A			
Peak Reverse Transient Current, I_{RM}	1A			
Operating Junction Temperature, T_j	150°C			
Storage Temperature Range, T_{stg}	−55°C to +150°C			
Thermal Resistance, Junction to Case, $R_{\theta JC}$	2.8°C/W			

ELECTRICAL CHARACTERISTICS (T_{CASE} = 25°C)

CHARACTERISTIC	SYMBOL	LIMIT	UNITS	CONDITIONS
Maximum Instantaneous Reverse Current	i_R	5	mA	$V_R = V_{RWM}$ Pulse Width = 400μs Duty Cycle = 1 percent
Maximum Instantaneous Reverse Current	i_R	50	mA	$V_R = V_{RWM}$ Pulse Width = 400μs Duty Cycle = 1 percent T_C = 125°C
Maximum Instantaneous Forward Voltage	V_F	0.55 0.65	V	i_F = 8A i_F = 16A
		0.48 0.60	V	i_F = 8A i_F = 16A } T_C = 125°C
Capacitance	C_t	1000	pF	V_R = 5V
Voltage Rate of Change	dv/dt	1000	V/μs	$V_R = V_{RWM}$

MECHANICAL SPECIFICATIONS

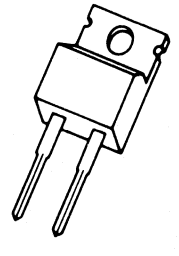
USD700 SERIES



PIN 1. Cathode
2. Anode
Tab is connected to Cathode.

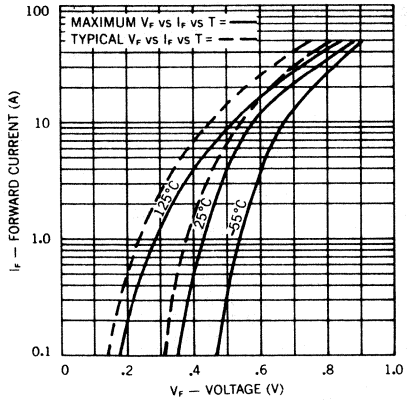
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.23	15.87	0.560	0.625
B	9.66	10.66	0.380	0.420
C	3.56	4.82	0.140	0.190
D	0.51	1.14	0.020	0.045
F	3.531	3.733	0.139	0.147
G	2.29	2.79	0.090	0.110
H	—	6.35	—	0.250
J	0.38	0.64	0.015	0.025
K	12.70	14.27	0.500	0.562
L	1.14	1.77	0.045	0.070
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.92	0.080	0.115
S	1.14	1.39	0.045	0.055
T	5.85	6.85	0.230	0.270

TO-220AC

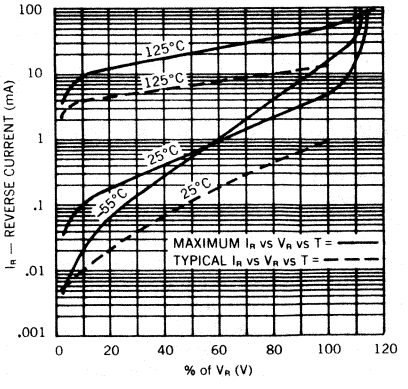


UNITRODE

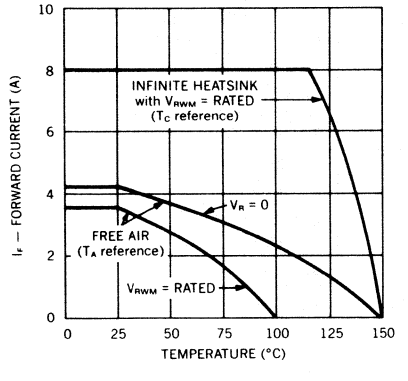
Forward Current vs. Forward Voltage



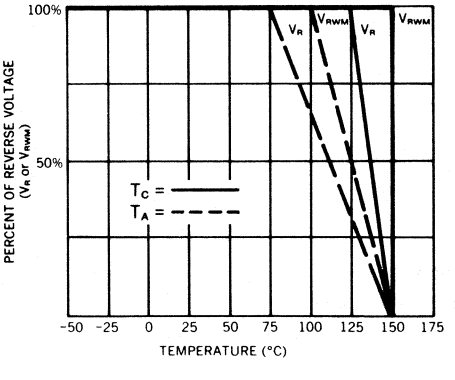
Reverse Current vs. Voltage



Average Forward Current vs. Temperature



V_R Rating vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

DUAL POWER SCHOTTKY RECTIFIERS

16A Av, up to 45V

USD720C
USD735C
USD740C
USD745C

FEATURES

- Very Low Forward Voltage
- Reverse Transient Capability
- Economical Convenient Plastic Package
- Mechanically Rugged
- 45V Working Voltage @ Rated $T_{j(max)}$

DESCRIPTION

The USD700C series of power Schottky rectifiers, in the industry standard TO-220 package, is specifically designed for operation in power switching circuits to frequencies in excess of 100 KHz. The series combines Schottky rectifiers in one convenient package; thus, simplifying installation, reducing heatsink requirements and component parts count.

ABSOLUTE MAXIMUM RATINGS (Per Diode Unless Otherwise Noted)

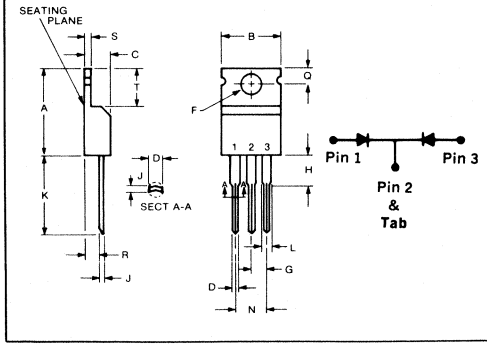
	USD720C	USD735C	USD740C	USD745C
Working Peak Reverse Voltage, V_{RWM}	20V	35V	40V	45V
DC Blocking Voltage, V_R	20V	35V	40V	45V
Peak Repetitive Surge Voltage, V_{RSM} @ I_{RM}	24V	42V	48V	54V
Average Rectified Forward Current @ T_C = 115°C, I_o*	16A			
Non-repetitive Peak Surge Current (8.3ms), I_{FSM}	200A			
Peak Reverse Transient Current, I_{RM}	1A			
Operating Junction Temperature, T_j	150°C			
Storage Temperature Range, T_{Stg}	-55°C to +150°C			
Thermal Resistance, Junction to Case, $R_{\theta JC}$	2.8°C/W			

*Full Wave Center-Tap; $I_{O\ (AV)}$ 20KHz Square Wave

ELECTRICAL CHARACTERISTICS (T_{CASE} = 25°C) (Per Diode)

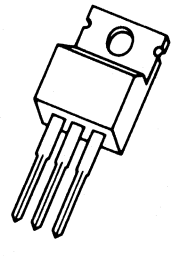
CHARACTERISTIC	SYMBOL	LIMIT	UNITS	CONDITIONS
Maximum Instantaneous Reverse Current	i_R	5	mA	$V_R = V_{RWM}$ Pulse Width = 400μs Duty Cycle = 1 percent
Maximum Instantaneous Reverse Current	i_R	50	mA	$V_R = V_{RWM}$ Pulse Width = 400μs Duty Cycle = 1 percent T_C = 125°C
Maximum Instantaneous Forward Voltage	V_F	0.55 0.65	V	i_F = 8A i_F = 16A
		0.48 0.60	V	i_F = 8A i_F = 16A } T_C = 125°C
Capacitance	C_t	1000	pF	V_R = 5V
Voltage Rate of Change	dv/dt	1000	V/μs	$V_R = V_{RWM}$

MECHANICAL SPECIFICATIONS



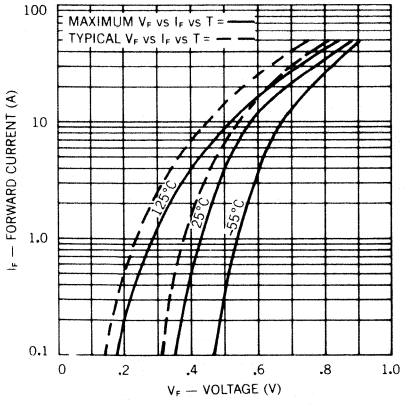
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.23	15.87	0.560	0.625
B	9.66	10.66	0.380	0.420
C	3.56	4.82	0.140	0.190
D	0.51	1.14	0.020	0.045
F	3.531	3.733	0.139	0.147
G	2.29	2.79	0.090	0.110
H	—	6.35	—	0.250
J	0.38	0.64	0.015	0.025
K	12.70	14.27	0.500	0.562
L	1.14	1.77	0.045	0.070
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.92	0.080	0.115
S	1.14	1.39	0.045	0.055
T	5.85	6.85	0.230	0.270

TO-220AB

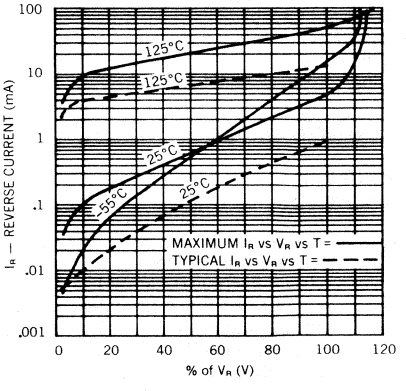


UNITRODE

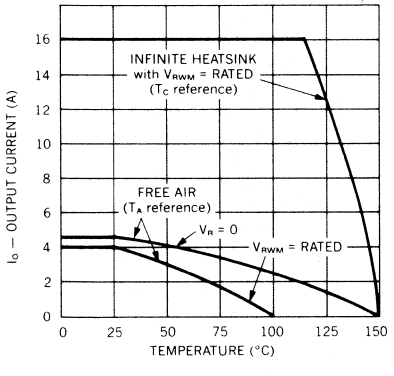
Forward Current vs. Forward Voltage



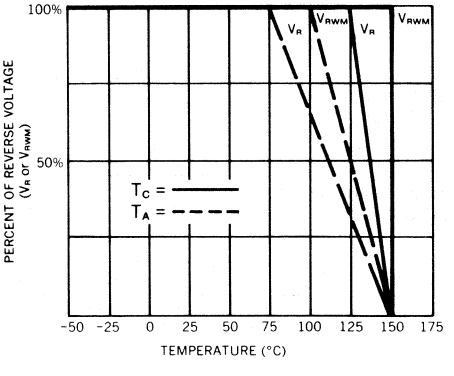
Reverse Current vs. Voltage



Average Output Current vs. Temperature



V_R Rating vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER SCHOTTKY RECTIFIERS
24A Pk, up to 45V

USD820
USD835
USD840
USD845

FEATURES
- Very Low Forward Voltage (0.45V max @ 12A)
- Reverse Transient Capability
- Economical Convenient Plastic Package
- Mechanically Rugged
- 45V Blocking Voltage @ Rated T_{jmax}

DESCRIPTION
The USD800 series of Schottky barrier power rectifiers is ideally suited for output rectifiers and catch diodes in low voltage power supplies.

ABSOLUTE MAXIMUM RATINGS

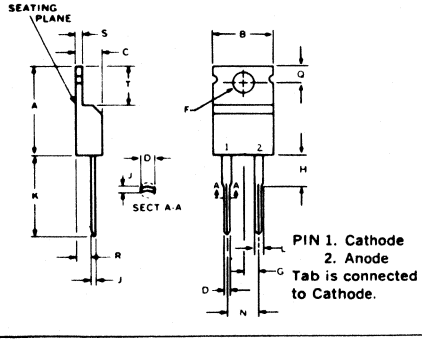
	USD820	USD835	USD840	USD845
Working Peak Reverse Voltage, V_{RWM}	20V	35V	40V	45V
DC Blocking Voltage, V_R	20V	35V	40V	45V
Peak Repetitive Surge Voltage, V_{RSM} @ I_{RM}	24V	42V	48V	54V
Average Rectified Forward Current @ T_C = 115°C, I_O	12A			
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20KHz, 50% Duty Cycle, @ T_C = 115°C), I_{FRM}	24A			
Non-repetitive Peak Surge Current (8.3mS), I_{FSM}	200A			
Peak Reverse Transient Current, I_{RM}	1A			
Operating Junction Temperature, T_j	150°C			
Storage Temperature Range, T_{stg}	−55°C to +150°C			
Thermal Resistance, Junction to Case, $R_{\theta JC}$	2.4°C/W			

ELECTRICAL CHARACTERISTICS (T_{CASE} = 25°C)

CHARACTERISTIC	SYMBOL	LIMIT	UNITS	CONDITIONS
Maximum Instantaneous Reverse Current	i_R	20	mA	$V_R = V_{RWM}$ Pulse Width = 400μS Duty Cycle = 1 percent
Typical Instantaneous Reverse Current	i_R	50	mA	$V_R = V_{RWM}$ Pulse Width = 400μS Duty Cycle = 1 percent T_C = 125°C
Maximum Instantaneous Forward Voltage	V_F	0.59	V	i_F = 12A
		0.51	V	i_F =12A T_C = 125°C
Capacitance	C_t	2000	pF	V_R = 5V
Voltage Rate of Change	dv/dt	1000	V/μS	$V_R = V_{RWM}$

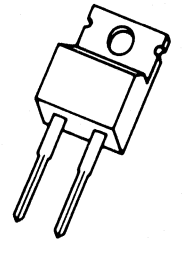
MECHANICAL SPECIFICATIONS

USD800 SERIES



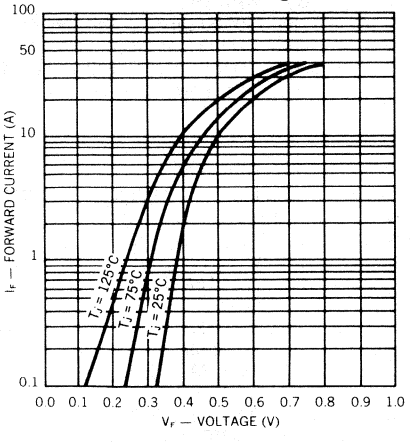
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.23	15.87	0.560	0.625
B	9.66	10.66	0.380	0.420
C	3.56	4.82	0.140	0.190
D	0.51	1.14	0.020	0.045
F	3.531	3.733	0.139	0.147
G	2.29	2.79	0.090	0.110
H	—	6.35	—	0.250
J	0.38	0.64	0.015	0.025
K	12.70	14.27	0.500	0.562
L	1.14	1.77	0.045	0.070
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.92	0.080	0.115
S	1.14	1.39	0.045	0.055
T	5.85	6.85	0.230	0.270

TO-220AC

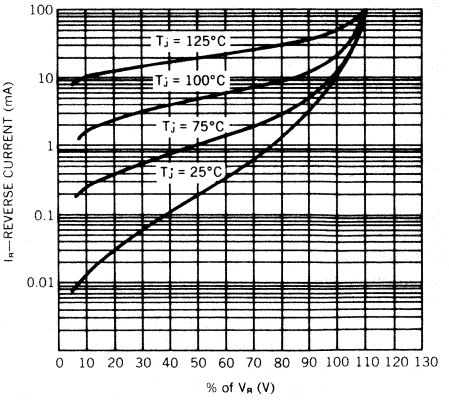


UNITRODE

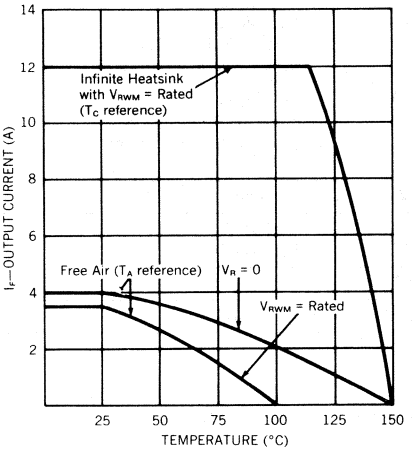
Typical Forward Current vs. Forward Voltage



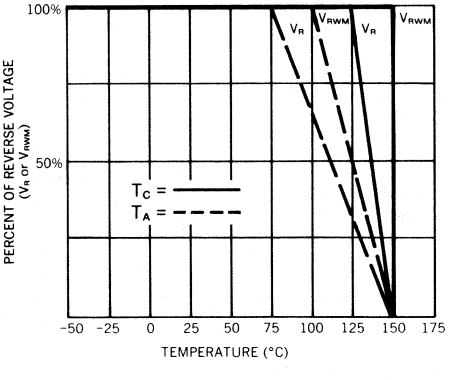
Typical Reverse Current vs. Voltage



Output Current vs. Temperature



V_R Rating vs. Temperature



POWER SCHOTTKY RECTIFIERS

32A Pk, up to 45V

USD920
USD935
USD940
USD945

FEATURES

- Very Low Forward Voltage (0.5V max @ 16A)
- Reverse Transient Capability
- Economical Convenient Plastic Package
- Mechanically Rugged
- 45V Blocking Voltage @ Rated T_{jmax}

DESCRIPTION

The USD900 series of Schottky barrier power rectifiers is ideally suited for output rectifiers and catch diodes in low voltage power supplies.

ABSOLUTE MAXIMUM RATINGS

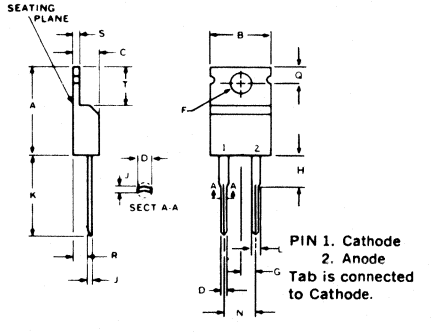
	USD920	USD935	USD940	USD945
Working Peak Reverse Voltage, V_{RWM}	20V	35V	40V	45V
DC Blocking Voltage, V_R	20V	35V	40V	45V
Peak Repetitive Surge Voltage, V_{RSM} @ I_{RM}	24V	42V	48V	54V
Average Rectified Forward Current @ T_C = 115°C, I_O	16A			
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20KHz, 50% Duty Cycle, @ T_C = 115°C), I_{FRM}	32A			
Non-repetitive Peak Surge Current (8.3mS), I_{FSM}	250A			
Peak Reverse Transient Current, I_{RM}	2A			
Operating Junction Temperature, T_j	150°C			
Storage Temperature Range, T_{stg}	−55°C to +150°C			
Thermal Resistance, Junction to Case, $R_{\theta JC}$	2°C/W			

ELECTRICAL CHARACTERISTICS (T_{CASE} = 25°C)

CHARACTERISTIC	SYMBOL	LIMIT	UNITS	CONDITIONS
Maximum Instantaneous Reverse Current	i_R	20	mA	$V_R = V_{RWM}$ Pulse Width = 400μS Duty Cycle = 1 percent
Typical Instantaneous Reverse Current	i_R	50	mA	$V_R = V_{RWM}$ Pulse Width = 400μS Duty Cycle = 1 percent T_C = 125°C
Maximum Instantaneous Forward Voltage	V_F	0.6	V	i_F = 16A
		0.53	V	i_F =16A T_C = 125°C
Capacitance	C_t	2000	pF	V_R = 5V
Voltage Rate of Change	dv/dt	1000	V/μS	$V_R = V_{RWM}$

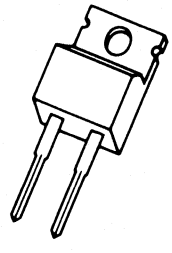
MECHANICAL SPECIFICATIONS

USD900 SERIES



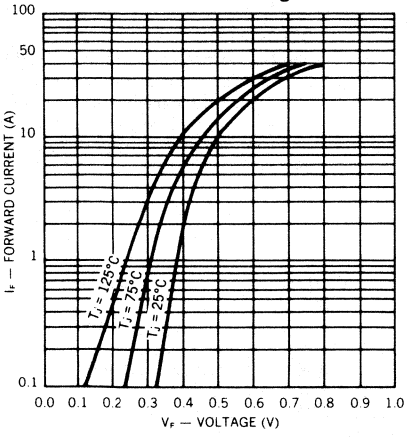
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.23	15.87	0.560	0.625
B	9.66	10.66	0.380	0.420
C	3.56	4.82	0.140	0.190
D	0.51	1.14	0.020	0.045
F	3.531	3.733	0.139	0.147
G	2.29	2.79	0.090	0.110
H	—	6.35	—	0.250
J	0.38	0.64	0.015	0.025
K	12.70	14.27	0.500	0.562
L	1.14	1.77	0.045	0.070
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.92	0.080	0.115
S	1.14	1.39	0.045	0.055
T	5.85	6.85	0.230	0.270

TO-220AC

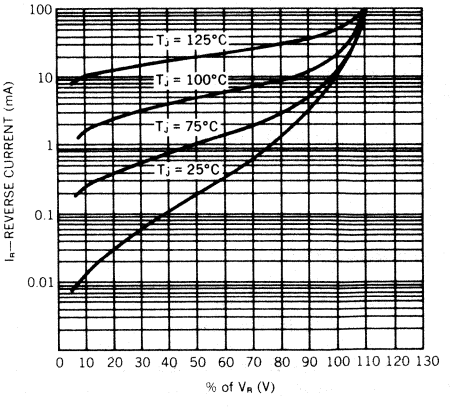


UNITRODE

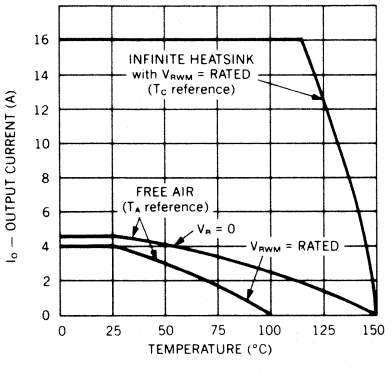
Typical Forward Current vs. Forward Voltage



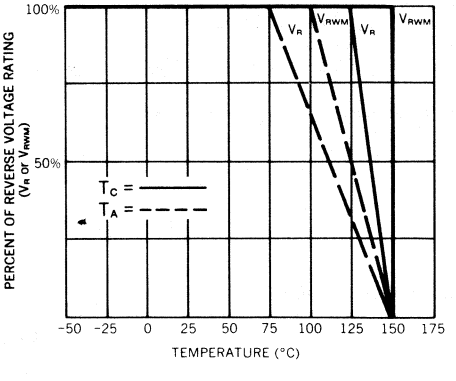
Typical Reverse Current vs. Voltage



Output Current vs. Temperature



V_R Rating vs. Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER SCHOTTKY RECTIFIERS
1A, Up to 40V

USD1120
USD1130
USD1140

FEATURES
- Very Low Forward Voltage (0.45V max @ 1A for the USD1120)
- Low Stored Charge, Majority Carrier Conduction
- Economical, Convenient Plastic Package
- Small Size

DESCRIPTION
The USD1120, USD1130 and USD1140 series of Schottky barrier rectifiers are ideally suited for use as rectifiers in low voltage, high frequency inverters, as free wheeling diodes and as polarity protection diodes.

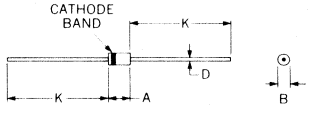
ABSOLUTE MAXIMUM RATINGS

	USD1120	USD1130	USD1140
Peak Repetitive Reverse Voltage, V_{RRM}	20V	30V	40V
Working Peak Reverse Voltage, V_{RWM}	20V	30V	40V
DC Blocking Voltage, V_R	20V	30V	40V
Non-Repetitive Peak Reverse Voltage, V_{RSM}	24V	36V	48V
RMS Reverse Voltage, $V_{R(RMS)}$	14V	21V	28V
Average Rectified Forward Current, I_O ($V_{R(equiv)} \leq 0.2\ V_R(DC)$, T_L = 90°C, $R_{\theta JA}$ = 80°C/W, PC Board Mounting, see Note 1, T_A = 55°C)		1.0A	
Ambient Temperature, T_A (Rated $V_R(DC)$, $P_{F(AV)}$ = 0, $R_{\theta JA}$ = 80°C/W)	85°C	80°C	75°C
Non-Repetitive Peak Surge Current, I_{FSM} (Surge applied at rated load conditions, half-wave, single phase 60Hz, T_L = 70°C)		50A (for one cycle)	
Operating and Storage Junction Temperature Range, (Reverse Voltage Applied)		−65°C to +150°C	
Thermal Resistance, Junction to Ambient (Note 1), R_{JA}		80°C/W Max.	

Note 1: Lead Temperature reference is cathode lead 1/32" from case.

MECHANICAL SPECIFICATIONS

USD1120 USD1130 USD1140



	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.160	0.260	4.06	6.60
B	0.110	0.120	2.79	3.05
D	0.030	0.034	0.76	0.86
K	1.0	—	25.4	—

Soldering 220°C, 1/16" from case for ten seconds

ASA



UNITRODE

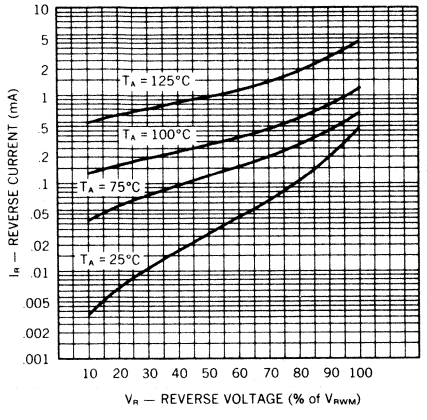
ELECTRICAL SPECIFICATIONS (T_L = 25°C unless noted)

CHARACTERISTIC	SYMBOL	USD1120	USD1130	USD1140	UNITS	CONDITIONS
Maximum Instantaneous Forward Voltage (Note 2)	V_F	0.450	0.475	0.500	V	i_F = 1.0A
		0.600	0.625	0.650	V	i_F = 3.1A
Maximum Instantaneous Reverse Current @ Rated DC Voltage (Note 2)	i_R	1.0	1.0	1.0	mA	T_L = 25°C
		10	10	10	mA	T_L = 100°C

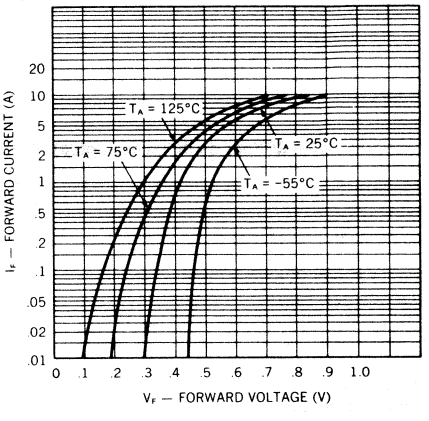
Note 2: Pulse width = 300μs; duty cycle = 2%.

5

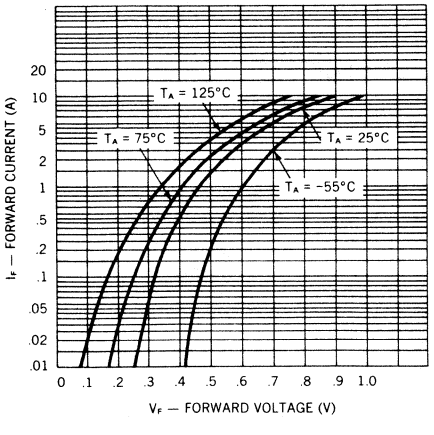
Typical Reverse Current vs Reverse Voltage



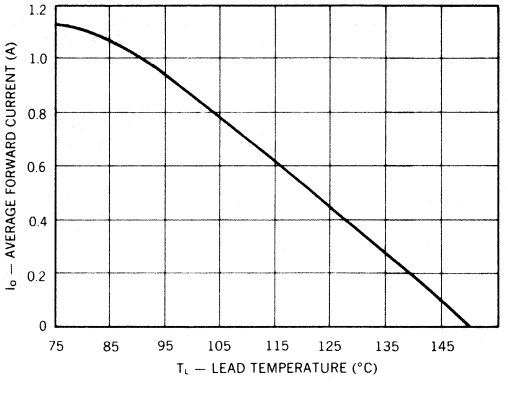
Typical Forward Voltage vs Forward Current (USD1120)



Typical Forward Voltage vs Forward Current (USD1130, USD1140)



Output Current vs Lead Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER SCHOTTKY MODULES

100A, Up to 50V

USM140C
USM145C
USM150C

FEATURES

- Low Forward Voltage
- Low Recovered Charge
- High Reverse Transient Capability
- High Surge Current
- High Efficiency for Low Voltage Designs

DESCRIPTION

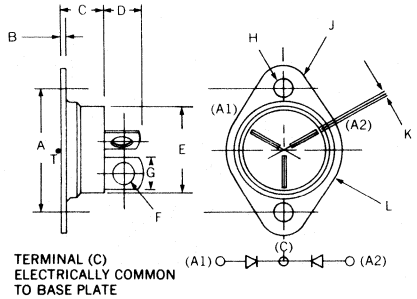
The Unitrode Schottky Module utilizes high current Schottky rectifiers, in a convenient single package, arranged in a common cathode configuration. The combination of low thermal resistance and high conductance terminals makes this device ideally suited for high current full wave center-tap rectification or feed-forward applications.

ABSOLUTE MAXIMUM RATINGS (per diode unless noted)

	USM140C	USM145C	USM150C
Working Peak Reverse Voltage, V_{RWM}	40V	45V	50V
DC Blocking Voltage, V_R	40V	45V	50V
Peak Repetitive Surge Voltage, V_{RSM}	48V	54V	60V
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20KHz 50 Percent Duty Cycle), I_{FRM}	100A		
Average Rectified Forward Current, I_O	100A (@ T_C = 115°C Fullwave Configuration)		
Non-repetitive Peak Surge Current, I_{FSM}	1000A		
Peak Reverse Transient Current, I_{RM}	2A		
Storage Temperature Range, T_{STG}	-40°C to + 150°C		
Operating Temperature Range, T_J	-40°C to + 175°C		
Thermal Resistance, $R_{\theta JBP}$	0.7°C/W per module		

MECHANICAL SPECIFICATIONS

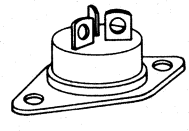
USM140C USM145C USM150C



TERMINAL (C) ELECTRICALLY COMMON TO BASE PLATE

	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	1.177	1.197	20.39	30.40
B	.030	.035	.762	.889
C	.365	.385	9.27	9.78
D	.370	.390	9.40	9.91
E	—	.880	—	22.35
F	.160	.180	4.06	4.57
G	.270	.290	6.87	7.37
H	.151	.161	3.84	4.09
J	—	.188 RAD.	—	4.78 RAD.
K	.030	.035	.762	.889
L	—	.525 RAD.	—	13.34 RAD.
T	T_{BP} Ref. Point - Geometric Center of Base Plate			

M1

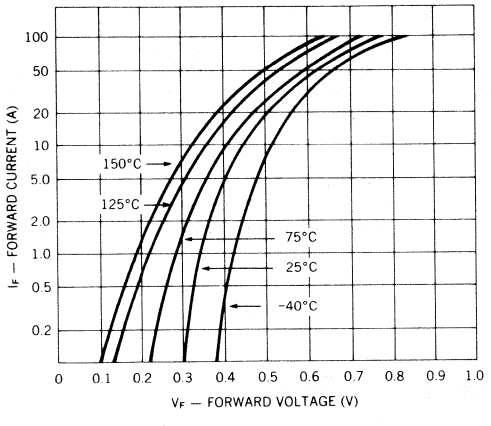


UNITRODE

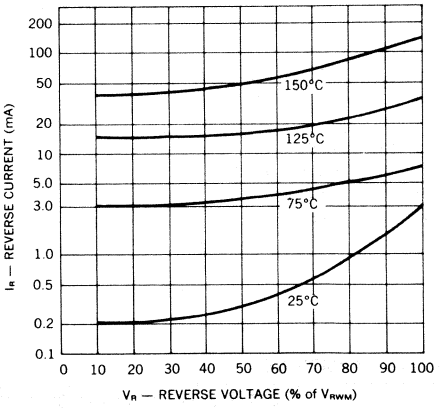
ELECTRICAL CHARACTERISTICS (T_{BP} = 25°C unless noted) (Per Diode)

CHARACTERISTICS	SYMBOL	CONDITIONS	LIMIT	UNITS
Maximum Instantaneous Reverse Current	i_R	$V_R = V_{RWM}$ (T_{BP} = 125°C) Pulsewidth = 400μs Duty Cycle = 1%	20 (75)	mA
Maximum Instantaneous Forward Voltage	V_F	I_F = 60A (T_{BP} = 125°C) Pulsewidth = 300μs Duty Cycle = 1%	.690 (.630)	V
Maximum Instantaneous Forward Voltage	V_F	I_F = 100A (T_{BP} = 125°C) Pulsewidth = 300μs Duty Cycle = 1%	.860 (.775)	V
Capacitance	C_t	V_R = 5V	3000	pF
Voltage Rate of Change	dv/dt	$V_R = V_{RWM}$	1000	V/μs
Reverse Energy	I_{RM}	See Reverse Energy Circuit	2	A

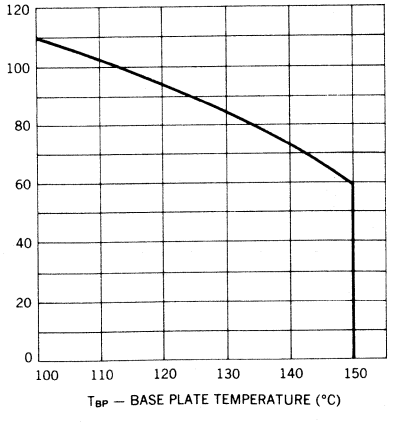
Typical Forward Current vs Forward Voltage



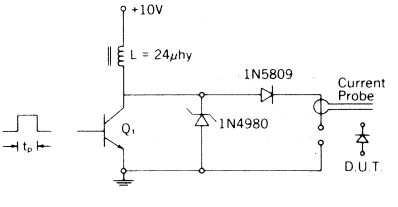
Typical Reverse Current vs Reverse Voltage



Output Current vs Case Temperature



Reverse Energy Circuit



t_p adjust for desired peak current in D.U.T. when Q turns off.
Q_1 must have fall time t_f of 100ns max.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
Standard Recovery, 1 Amp to 2 Amp

UT236-UT347
UT249-UT363
UT251-UT364
UT261-UT268

FEATURES
- Continuous Rating: to 2A
- Controlled Avalanche
- Surge Rating: to 30A
- PIV: to 1000V
- Miniature Package

DESCRIPTION
These miniature power rectifiers offer the user extreme reliability for high-rel military supplies.

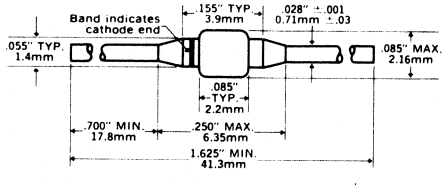
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	1 Amp Series	1.25 Amp Series	1.5 Amp Series	2 Amp Series
100V	UT236	UT249	UT251	UT261
200V	UT234	UT242	UT252	UT262
400V	UT235	UT244	UT254	UT264
500V	UT237	UT245	UT255	UT265
600V	UT238	UT247	UT257	UT267
800V	UT361	UT362	UT258	UT268
1000V	UT347	UT363	UT364	

	1 AMP SERIES	1.25 AMP SERIES	1.5 AMP SERIES	2 AMP SERIES
Maximum Average D.C. Output Current				
@ T_A = 25°C	1.0A	1.25A	1.5A	2.0A
@ T_A = 100°C	0.5A	0.65A	0.75A	1.0A
Non-Repetitive Sinuosoidal Surge (8.3ms)	20A	20A	25A	30A
Operating Temperature Range	—195°C to +175°C			
Storage Temperature Range	—195°C to +175°C			
Thermal Resistance	See lead temperature derating curve			

MECHANICAL SPECIFICATIONS

UT236-UT347 UT249-UT363 UT251-UT364 UT261-UT268



Part Identification: Orange band indicates "UT." Part number printed on body.

Polarity: Denoted by orange band.

Weight: 0.26 grams, typical.

BODY A



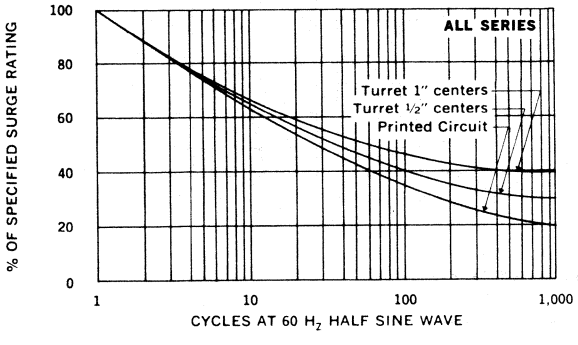
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

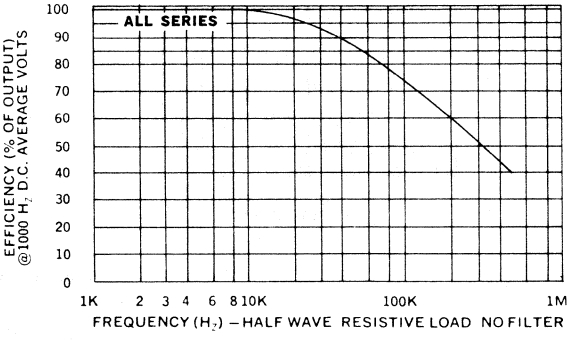
Type	PIV	Maximum Forward Voltage Drop	Maximum Leakage Current @ PIV	
			25°C	100°C
UT261 UT262 UT264 UT265 UT267 UT268	100V 200V 400V 500V 600V 800V	1V @ 900mA	2μA	75μA
UT251 UT252 UT254 UT255 UT257 UT258 UT364	100V 200V 400V 500V 600V 800V 1000V	1V @ 750mA	2μA	75μA
UT249 UT242 UT244 UT245 UT247 UT362 UT363	100V 200V 400V 500V 600V 800V 1000V	1V @ 500mA	2μA	75μA
UT236 UT234 UT235 UT237 UT238 UT361 UT347	100V 200V 400V 500V 600V 800V 1000V	1V @ 400mA	2μA	75μA

5

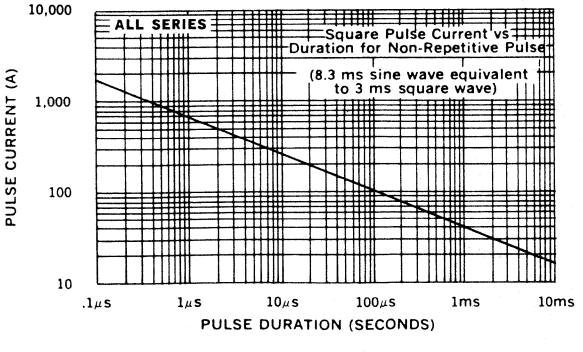
Allowable Forward Surge vs Number of Cycles



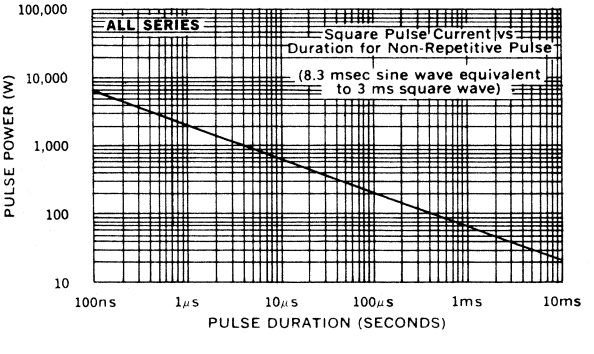
Efficiency vs Frequency at Rated Current (Sine Wave)



Forward Pulse Current vs Pulse Duration



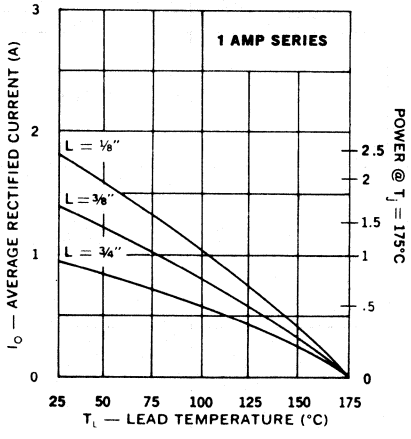
Reverse Pulse Power vs Pulse Duration



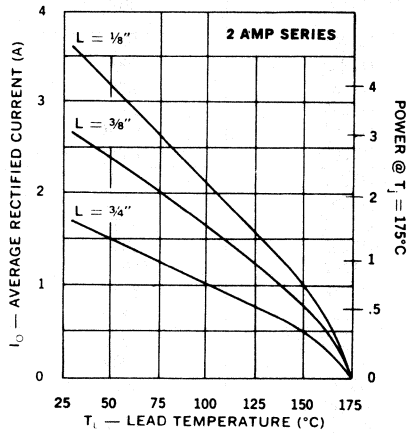
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

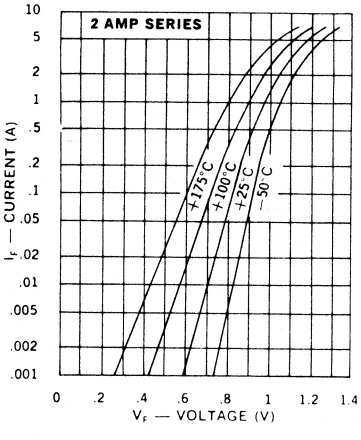
Maximum Current vs Lead Temperature



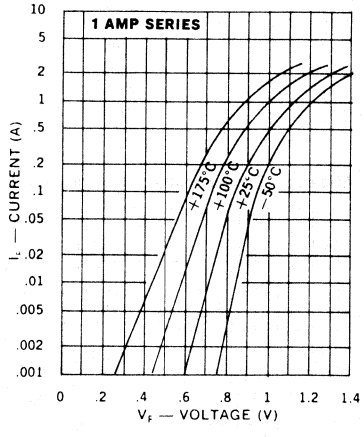
Maximum Current vs Lead Temperature



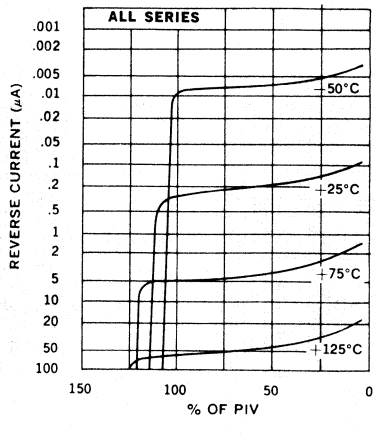
Typical Forward Current vs Forward Voltage



Typical Forward Current vs Forward Voltage



Typical Leakage Current vs. PIV



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
Standard Recovery, 2 Amp to 4 Amp

UT2005-UT2060
UT3005-UT3060
UT4005-UT4060

5

FEATURES
- Continuous Rating: to 4A
- Controlled Avalanche
- Surge Rating: to 100A
- PIV: to 600 V
- Miniature Package

DESCRIPTION
High average power and surge capability make these series of devices attractive in many high-rel applications.

All Unitrode rectifiers have a sleeve of pure hard glass fused to the silicon junction. Since the silicon sees only this glass, electrical characteristics are permanently stable. This voidless, monolithic package is totally unaffected by the most severe moisture or temperature testing.

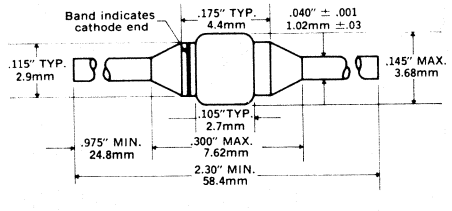
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	2 Amp Series	3 Amp Series	4 Amp Series
50V	UT2005	UT3005	UT4005
100V	UT2010	UT3010	UT4010
200V	UT2020	UT3020	UT4020
400V	UT2040	UT3040	UT4040
600V	UT2060	UT3060	UT4060

	2 AMP SERIES	3 AMP SERIES	4 AMP SERIES
Maximum Average D.C. Output Current			
@ T_A = 25°C	2.0A	3.0A	4.0A
@ T_A = 100°C	1.0A	1.5A	2.0A
Non-Repetitive Sinusoidal Surge Current (8.3ms)	60A	80A	100A
Operating Temperature Range	−195°C to +175°C		
Storage Temperature Range	−195°C to +200°C		
Thermal Resistance	See lead temperature derating curve		

MECHANICAL SPECIFICATIONS

UT2005-UT2060 UT3005-UT3060 UT4005-UT4060



Part Identification: Orange band indicates "UT." Part number printed on body.

Polarity: Denoted by orange band.

Weight: 0.75 grams, typical.

BODY B

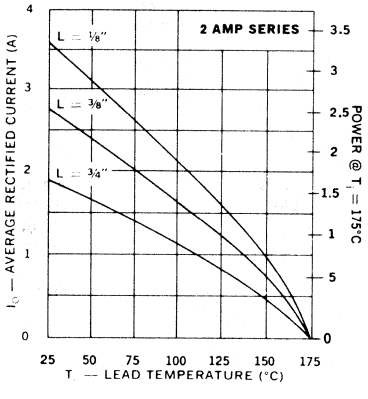


UNITRODE

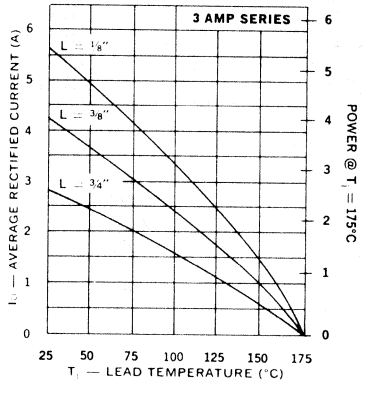
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	PIV	Maximum Forward Voltage Drop	Maximum Leakage Current @ PIV	
			25°C	100°C
UT4005 UT4010 UT4020 UT4040 UT4060	50V 100V 200V 400V 600V	1V @ 3A	5μA	100μA
UT3005 UT3010 UT3020 UT3040 UT3060	50V 100V 200V 400V 600V	1V @ 2A	5μA	100μA
UT2005 UT2010 UT2020 UT2040 UT2060	50V 100V 200V 400V 600V	1V @ 1A	5μA	100μA

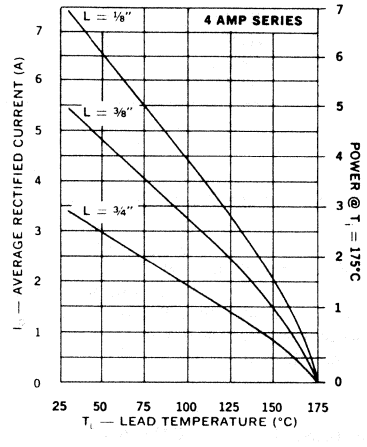
Maximum Current vs Lead Temperature



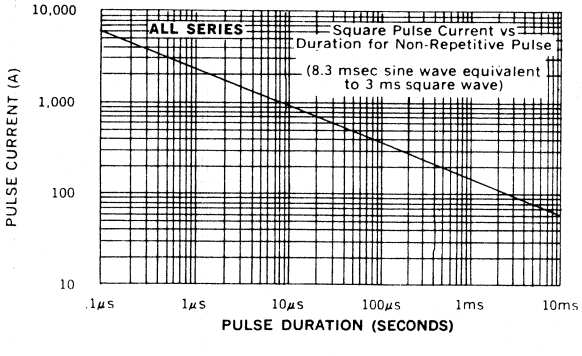
Maximum Current vs Lead Temperature



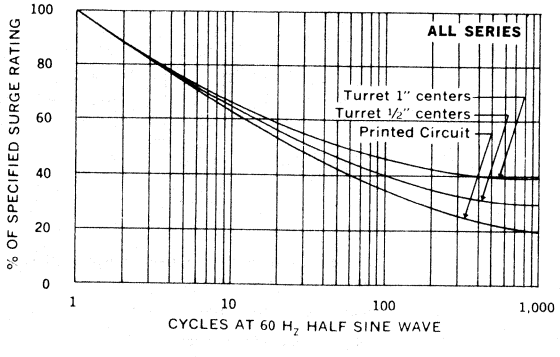
Maximum Current vs Lead Temperature



Forward Pulse Current vs Pulse Duration



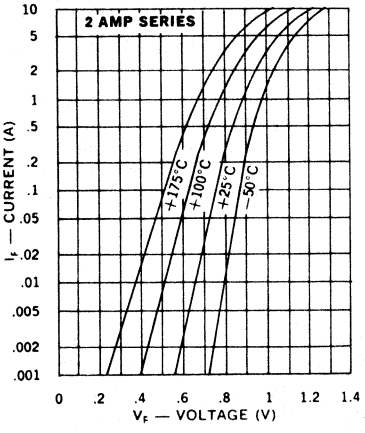
Allowable Forward Surge vs Number of Cycles



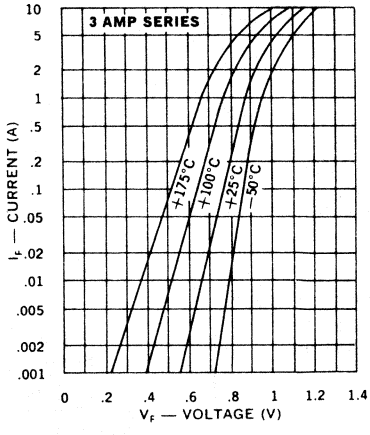
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

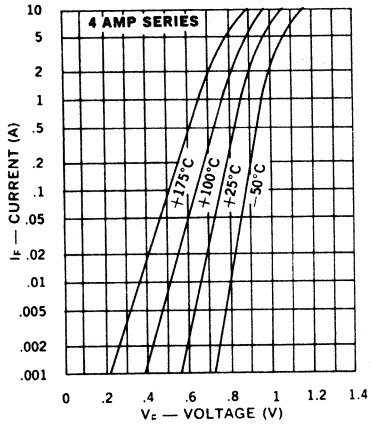
Typical Forward Current vs Forward Voltage



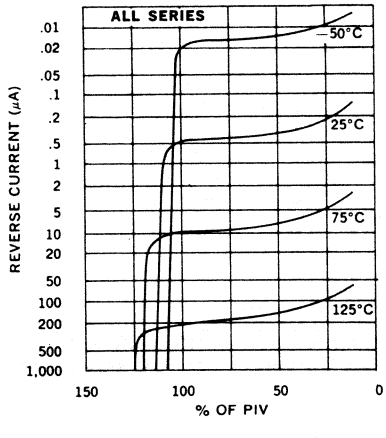
Typical Forward Current vs Forward Voltage



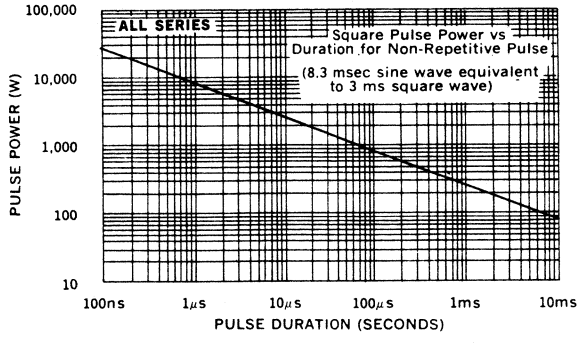
Typical Forward Current vs Forward Voltage



Typical Reverse Current vs PIV



Reverse Pulse Power vs Pulse Duration



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS

Standard Recovery, 7.5 Amp to 12 Amp

UT5105-UT5160
UT6105-UT6160
UT8105-UT8160
UT5105HR-UT5160HR
UT6105HR-UT6160HR
UT8105HR-UT8160HR

FEATURES

- Rating: 12A
- Controlled Avalanche
- Miniature Package
- Surge Rating: 200A

DESCRIPTION

These series of high current rectifiers offers opportunity for size and weight reduction in high power supplies.

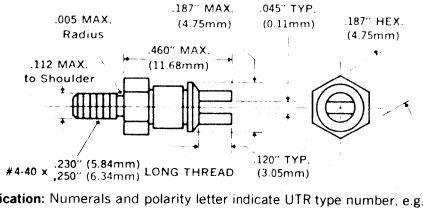
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	12 Amp Series	9 Amp Series	7.5 Amp Series
50V	UT8105/8105HR	UT6105/6105HR	UT5105/5105HR
100V	UT8110/8110HR	UT6110/6110HR	UT5110/5110HR
200V	UT8120/8120HR	UT6120/6120HR	UT5120/5120HR
400V	UT8140/8140HR	UT6140/6140HR	UT5140/5140HR
600V	UT8160/8160HR	UT6160/6160HR	UT5160/5160HR

	12 AMP SERIES	9 AMP SERIES	7.5 AMP SERIES
Maximum Average D.C. Output Current @ T_C = 100°C	12.0A	9.0A	7.5A
Non-Repetitive Sinusoidal Surge Current (8.3ms)	200A	175A	150A
Operating and Storage Temperature Range	−65°C to +175°C		
Thermal Resistance, Junction to Case	7.5°C/Watt		
Current Derating	See current vs. case temperature curve		

MECHANICAL SPECIFICATIONS

UT5105-UT5160 UT6105-UT6160 UT8105-UT8160
UT5105HR-UT5160HR UT6105HR-UT6160HR UT8105HR-UT8160HR



Part Identification: Numerals and polarity letter indicate UTR type number, e.g., UTR 4405.

Polarity: Cathode to Stud is standard. Reverse polarity denoted by "R" suffix.

Finish: Metal parts gold plated per MIL-G-45204, Type II.

Weight: 1.5 grams, typical.

Also available with insulated stud. Reference Design Note 17.

Installation
Maximum unlubricated stud torque: 28 inch-ounces.
Mounting hardware supplied.
Do not use a screwdriver in the turret slot for installation purposes, or damage may result.

BODY C — Stud Mount

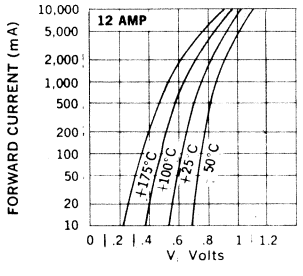


UNITRODE

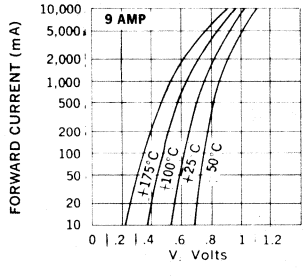
ELECTRICAL SPECIFICATIONS (at 25 C unless noted)

Type	Peak Inverse Voltage	Maximum Forward Voltage	Max. Reverse Current at PIV	
			25°C	100°C
UT8105/8105HR UT8110/8110HR UT8120/8120HR UT8140/8140HR UT8160/8160HR	50V 100V 200V 400V 600V	1V @ 8A	10μA	300μA
UT6105/6105HR UT6110/6110HR UT6120/6120HR UT6140/8140HR UT6160/8160HR	50V 100V 200V 400V 600V	1V @ 6A	10μA	300μA
UT5105/5105HR UT5110/5110HR UT5120/5120HR UT5140/5140HR UT5160/5160HR	50V 100V 200V 400V 600V	1V @ 5A	10μA	300μA

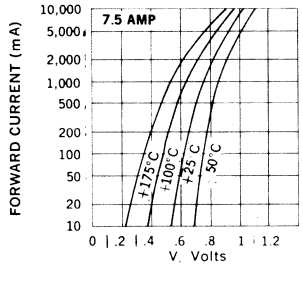
Typical Forward Voltage vs Forward Current



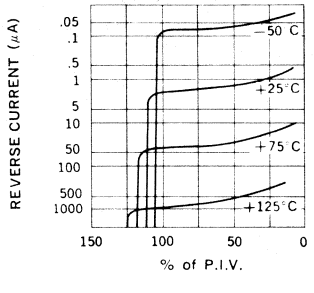
Typical Forward Voltage vs Forward Current



Typical Forward Voltage vs Forward Current



Typical P.I.V. vs Reverse Current



OPTIONAL HIGH RELIABILITY SCREENING

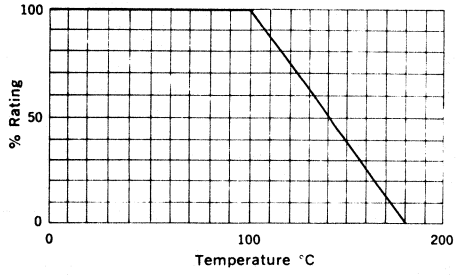
The following tests are performed on 100% of the devices specified UT5105 through UT8160HR.

SCREEN	MIL-STD-750 METHOD	CONDITIONS
1. High Temperature Life (Stabilization Bake)	1032	24 Hours @ T_A = 175°C
2. Thermal Shock (Temperature Cycling)	1051	10 Cycles @ T_A = (−55°C to +150°C)
3. Interim Electrical Parameters	—	V_F and I_R @ 25°C
4. Power Burn-In	1038	96 Hours @ T_C = 100°C, I_O = 50% Rated V_R = Rated
5. Final Electrical and Delta Parameters	Go/No Go	ΔI_R ± 100% or 1μA (whichever is greater) ΔV_F ± 2%

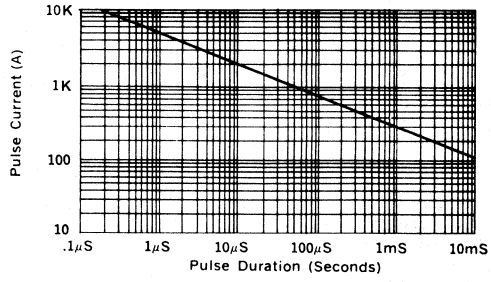
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

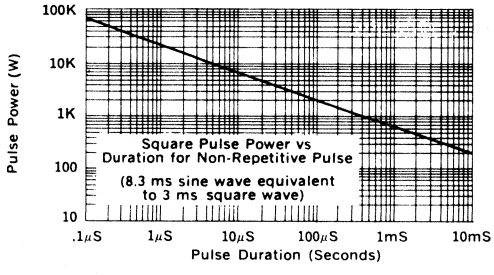
Current Rating vs Case Temperature



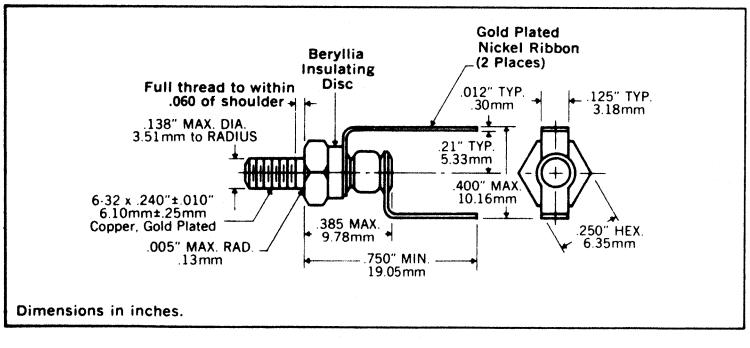
Forward Pulse Current vs. Pulse Duration



Reverse Pulse Power vs. Pulse Duration



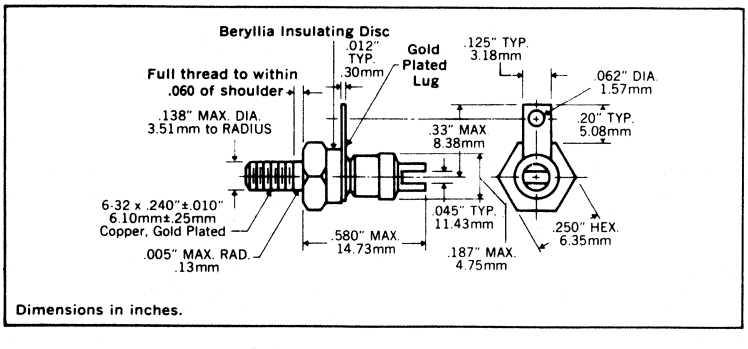
MECHANICAL SPECIFICATIONS



Dimensions in inches.

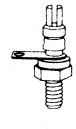
Style W





Dimensions in inches.

Style V



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
Fast Recovery, 0.5 Amp to 2 Amp

UTR10-UTR60
UTR01-UTR61
UTR02-UTR62

FEATURES
- Continuous Rating: to 2A
- Controlled Avalanche
- Surge Rating: to 25A
- Fast Recovery 40kHz Operation
- PIV: to 600V
- Miniature Package

DESCRIPTION
These miniature fast recovery rectifiers permit operation at full frequencies as high as 40kHz square wave. They have the unique Unitrode Fused in Glass construction.

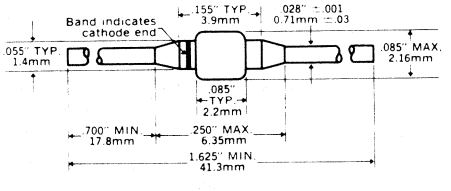
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	½ Amp Series	1 Amp Series	2 Amp Series
50V		UTR01	UTR02
100V	UTR10	UTR11	UTR12
200V	UTR20	UTR21	UTR22
300V	UTR30	UTR31	UTR32
400V	UTR40	UTR41	UTR42
500V	UTR50	UTR51	UTR52
600V	UTR60	UTR61	UTR62

	½ AMP SERIES	1 AMP SERIES	2 AMP SERIES
Maximum Average D.C. Output Current			
@ T_A = 25°C	0.5A	1.0A	2.0A
@ T_A = 100°C	0.25A	0.5A	1.0A
Non-Repetitive Sinusoidal Surge Current (8.3ms)	15A	20A	25A
Operating Temperature Range		−195°C to +175°C	
Storage Temperature Range		−195°C to +200°C	
Thermal Resistance		See lead temperature derating curves	

MECHANICAL SPECIFICATIONS

UTR10-UTR60 UTR01-UTR61 UTR02-UTR62



Part Identification: Green band indicates "UTR." Part number printed on body.
Polarity: Denoted by Green band.
Weight: 0.26 grams, typical.

BODY A



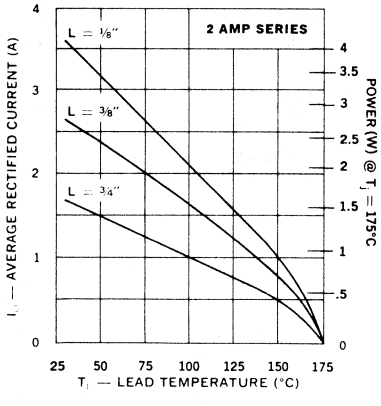
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

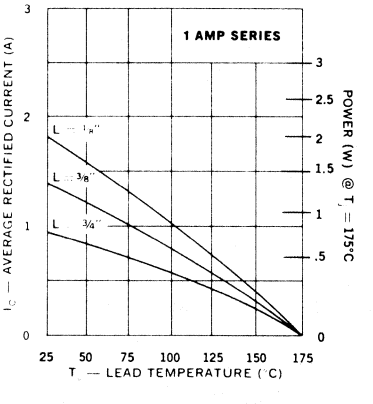
Type	PIV	Maximum Forward Voltage Drop	Maximum Leakage Current @ PIV		Maximum Reverse Recovery Time*	Maximum Junction Capacitance @ 25°C	
			25°C	100°C		0V	—10V
UTR02	50V	1.1V @ 1000mA	3μA	100μA	250ns	150pf	60pf
UTR12	100V				250ns	100pf	40pf
UTR22	200V				250ns	80pf	32pf
UTR32	300V				300ns	70pf	28pf
UTR42	400V				350ns	60pf	24pf
UTR52	500V				400ns	50pf	20pf
UTR62	600V				400ns	40pf	16pf
UTR01	50V	1.1V @ 500mA	3μA	100μA	250ns	150pf	60pf
UTR11	100V				250ns	100pf	40pf
UTR21	200V				250ns	80pf	32pf
UTR31	300V				300ns	70pf	28pf
UTR41	400V				350ns	60pf	24pf
UTR51	500V				400ns	50pf	20pf
UTR61	600V				400ns	40pf	16pf
UTR10	100V	1.1V @ 200mA	3μA	100μA	250ns	100pf	40pf
UTR20	200V				250ns	80pf	32pf
UTR30	300V				300ns	70pf	28pf
UTR40	400V				350ns	60pf	24pf
UTR50	500V				400ns	50pf	20pf
UTR60	600V				400ns	40pf	16pf

*Recovery time is measured from 10.0mA to 10.0mA recovery to 5.0mA

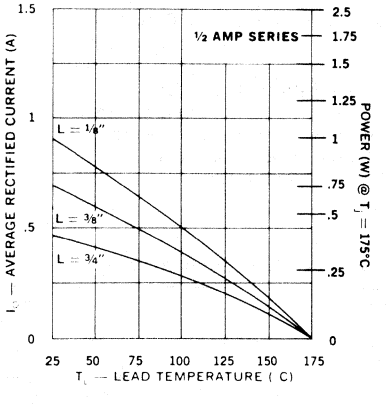
Maximum Current vs Lead Temperature



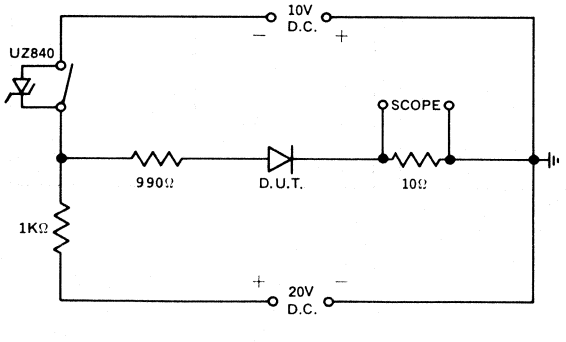
Maximum Current vs Lead Temperature



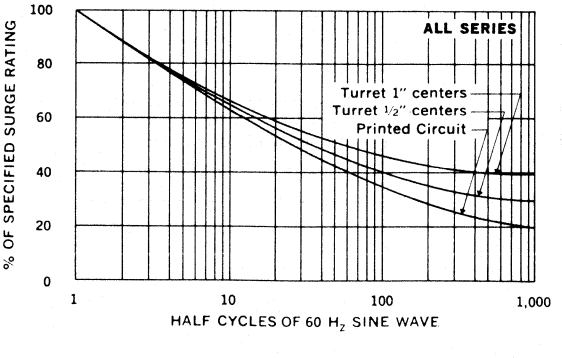
Maximum Current vs Lead Temperature



Reverse-Recovery Circuit



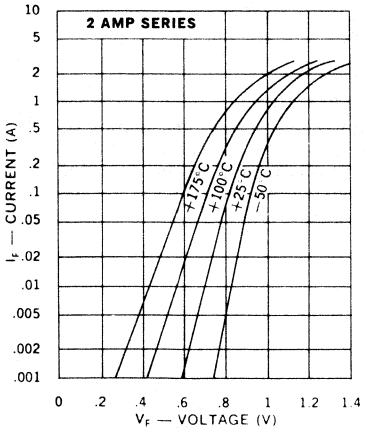
Allowable Forward Surge vs Number of Cycles



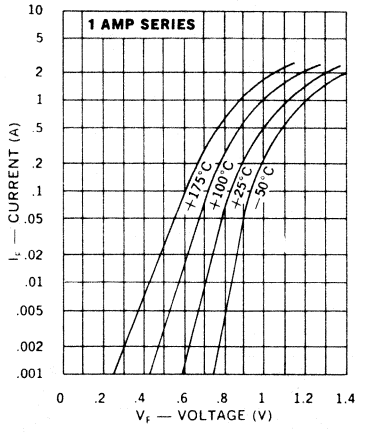
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

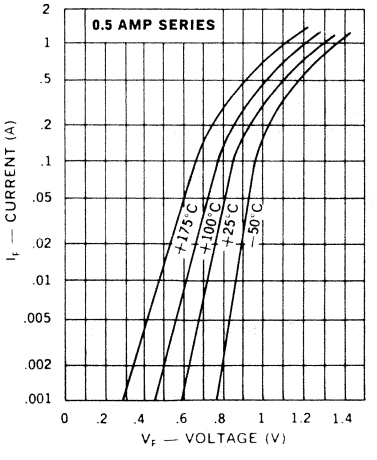
Typical Forward Current vs Forward Voltage



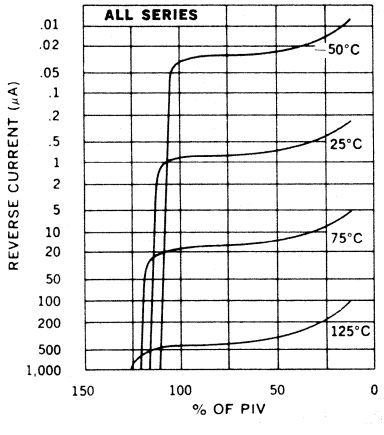
Typical Forward Current vs Forward Voltage



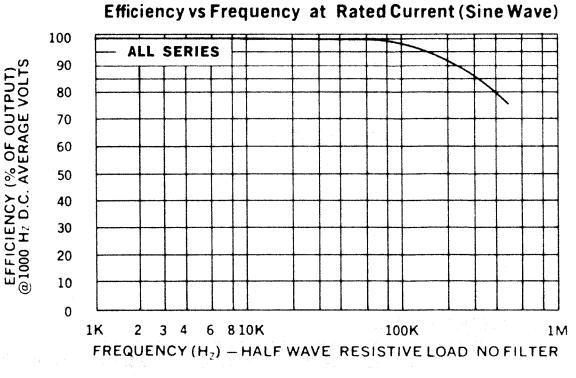
Typical Forward Current vs Forward Voltage



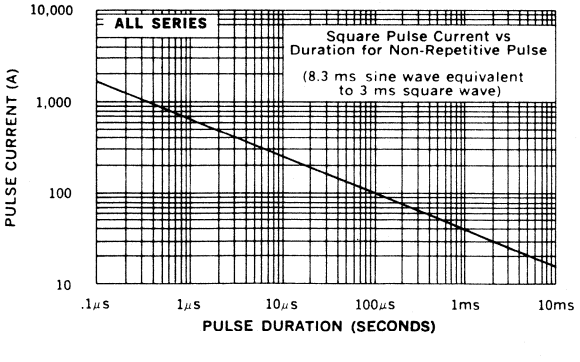
Typical Reverse Current vs PIV



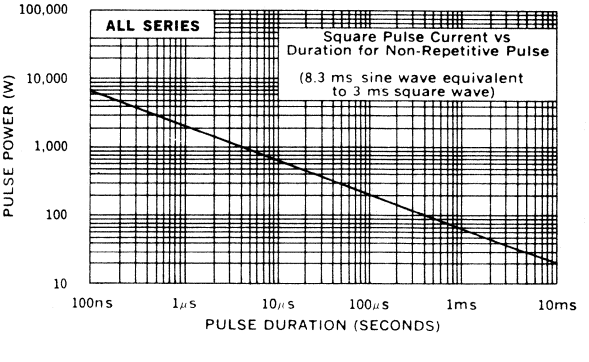
Efficiency vs Frequency at Rated Current (Sine Wave)



Forward Pulse Current vs Pulse Duration



Reverse Pulse Power vs Pulse Duration



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS

Fast Recovery, 2 Amp to 4 Amp

UTR2305-UTR2360
UTR3305-UTR3360
UTR4305-UTR4360

FEATURES

- Continuous Rating: to 4A
- Controlled Avalanche
- Surge Rating: to 100A
- PIV: to 600V
- Miniature Package

DESCRIPTION

Small size and high surge capability make this series of power switching rectifiers desirable for power supplies where size, weight and reliability are important.

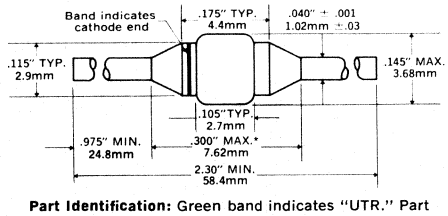
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	2 Amp Series	3 Amp Series	4 Amp Series
50V	UTR2305	UTR3305	UTR4305
100V	UTR2310	UTR3310	UTR4310
200V	UTR2320	UTR3320	UTR4320
400V	UTR2340	UTR3340	UTR4340
500V	UTR2350	UTR3350	UTR4350
600V	UTR2360	UTR3360	UTR4360

	2 AMP SERIES	3 AMP SERIES	4 AMP SERIES
Maximum Average D.C. Output Current			
@ $T_A = 25°C$	2.0A	3.0A	4.0A
@ $T_A = 100°C$	1.0A	1.5A	2.0A
Non-Repetitive Sinusoidal Surge Current (8.3ms)	60A	80A	100A
Operating Temperature Range	—195°C to +175°C		
Storage Temperature Range	—195°C to +200°C		
Thermal Resistance	See lead temperature derating curve		

MECHANICAL SPECIFICATIONS

UTR4305-UTR4360 UTR3305-UTR3360 UTR2305-UTR2360



Part Identification: Green band indicates "UTR." Part number printed on body.

Polarity: Denoted by Green band.

Weight: 0.75 grams, typical.

BODY B



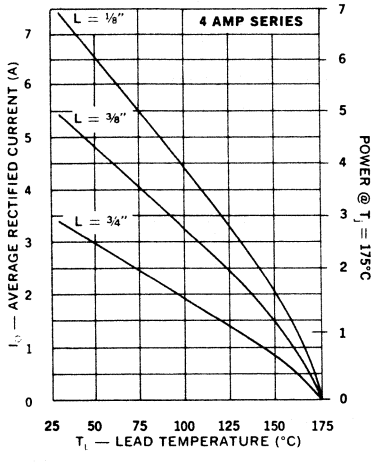
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

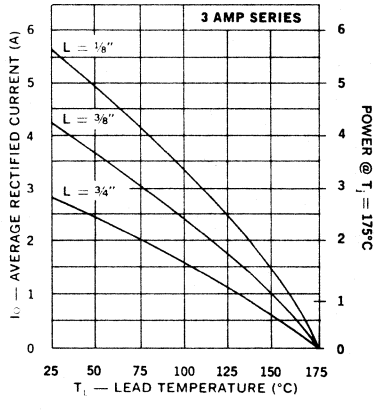
Type	PIV	Maximum Forward Voltage Drop	Maximum Leakage Current @ PIV		Maximum Reverse Recovery Time*	Maximum Junction Capacitance @ 25°C	
			25°C	100°C		0V	—10V
UTR4305	50V	1.1V @ 4A	5μA	100μA	250ns	600pf	240pf
UTR4310	100V				250ns	400pf	160pf
UTR4320	200V				250ns	320pf	128pf
UTR4340	400V				400ns	240pf	96pf
UTR4350	500V				400ns	200pf	80pf
UTR4360	600V				400ns	160pf	64pf
UTR3305	50V	1.1V @ 3A	5μA	100μA	250ns	600pf	240pf
UTR3310	100V				250ns	400pf	160pf
UTR3320	200V				250ns	320pf	128pf
UTR3340	400V				300ns	240pf	96pf
UTR3350	500V				350ns	200pf	80pf
UTR3360	600V				400ns	160pf	64pf
UTR2305	50V	1.1V @ 2A	5μA	100μA	250ns	600pf	240pf
UTR2310	100V				250ns	400pf	160pf
UTR2320	200V				250ns	320pf	128pf
UTR2340	400V				300ns	240pf	96pf
UTR2350	500V				350ns	200pf	80pf
UTR2360	600V				400ns	160pf	64pf

*Recovery time is measured from 1A to 1A recovering to 0.5A.

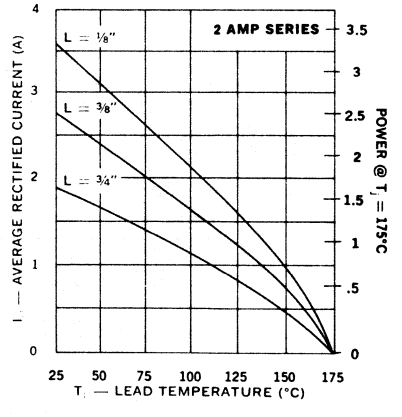
Maximum Current vs Lead Temperature



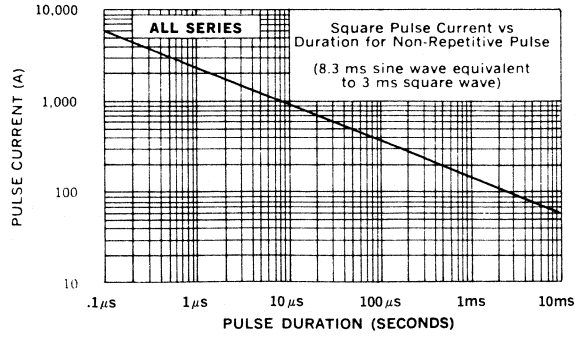
Maximum Current vs Lead Temperature



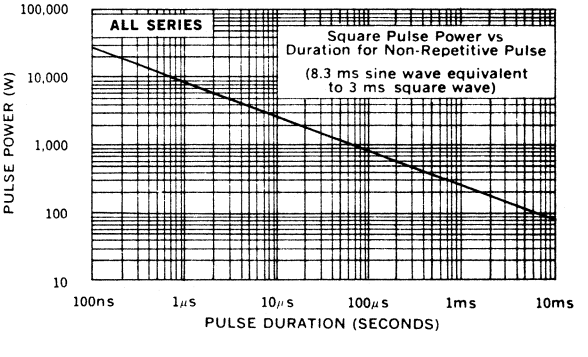
Maximum Current vs Lead Temperature



Forward Pulse Current vs Pulse Duration



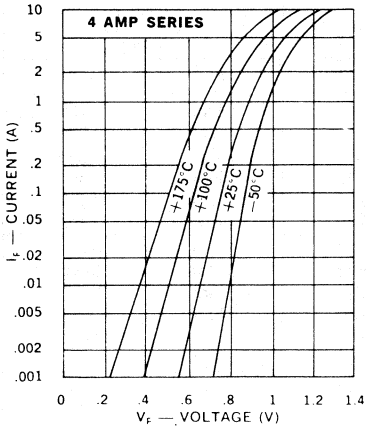
Reverse Pulse Power vs Pulse Duration



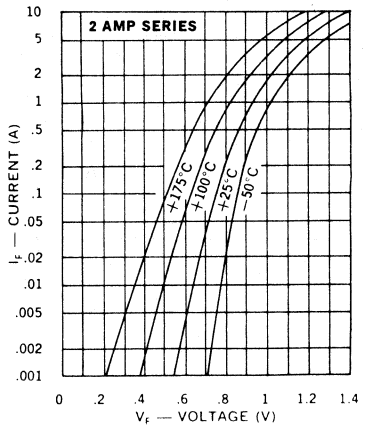
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

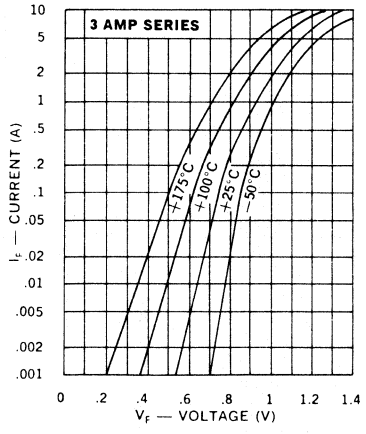
Typical Forward Current vs Forward Voltage



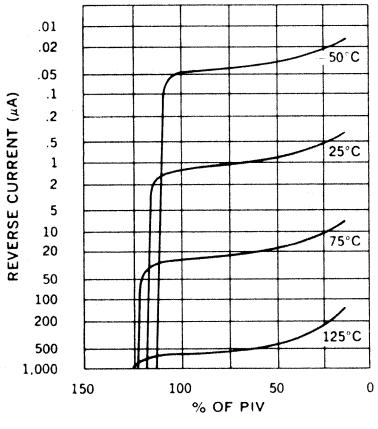
Typical Forward Current vs Forward Voltage



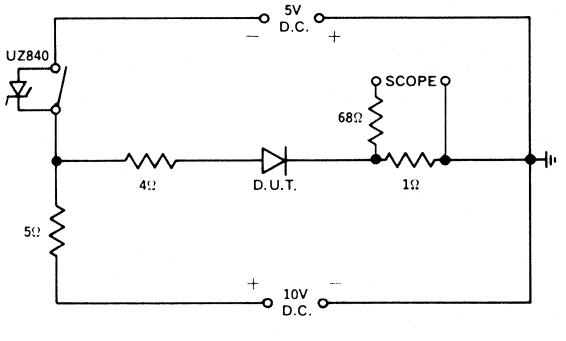
Typical Forward Current vs Forward Voltage



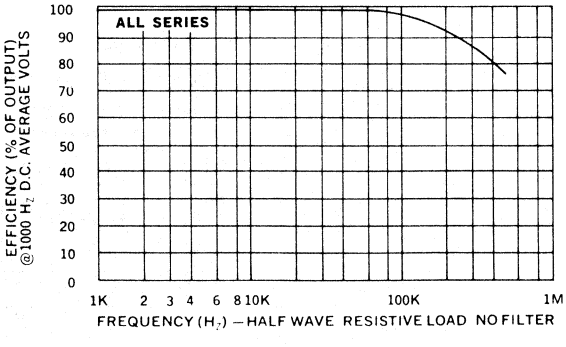
Typical Reverse Current vs PIV



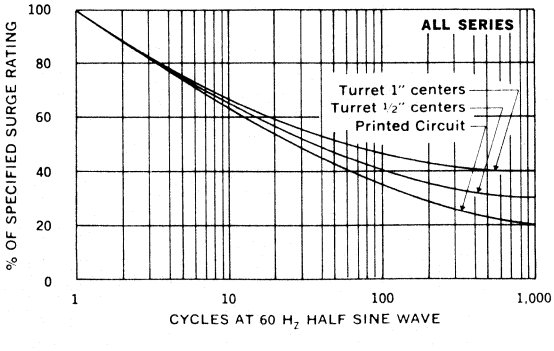
Reverse Recovery Circuit



Efficiency vs Frequency at Rated Current (Sine Wave)



Allowable Forward Surge vs Number of Cycles



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
Fast Recovery, 6 Amp to 9 Amp

UTR4405-UTR4440
UTR5405-UTR5440
UTR6405-UTR6440
UTR4405HR-UTR4440HR
UTR5405HR-UTR5440HR
UTR6405HR-UTR6440HR

FEATURES
- Continuous Rating: to 9A
- Controlled Avalanche
- Surge Rating: to 150A
- Fast Recovery, 40kHz Operation
- PIV: to 400V
- Miniature Package

DESCRIPTION
The same basic construction as all Unitrode diodes, but using a miniature stud mounting and larger junction area, provides a 9 Amp continuous and 150 Amp surge rating in a package only one fifth the weight and one quarter the volume of conventional types.

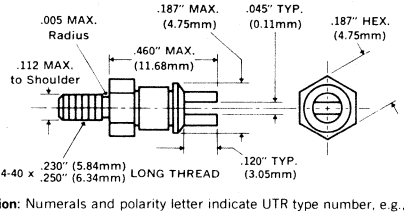
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	6 Amp Series	7.5 Amp Series	9 Amp Series
50V	UTR4405/4405HR	UTR5405/5405HR	UTR6405/6405HR
100V	UTR4410/4410HR	UTR5410/5410HR	UTR6410/6410HR
200V	UTR4420/4420HR	UTR5420/5420HR	UTR6420/6420HR
400V	UTR4440/4440HR	UTR5440/5440HR	UTR6440/6440HR

	6 Amp Series	7.5 Amp Series	9.0 Amp Series
Maximum Average D.C. Output Current @ T_C = 100°C	6.0A	7.5A	9.0A
Non-Repetitive Sinusoidal Surge Current (8.3ms)	120A	135A	150A
Operating Temperature Range		-195°C to +175°C	
Storage Temperature Range		-195°C to +200°C	
Thermal Resistance		7.5°C/W	

MECHANICAL SPECIFICATIONS

UTR4405-UTR4440 UTR5405-UTR5440 UTR6405-UTR6440
UTR4405HR-UTR4440HR UTR5405HR-UTR5440HR UTR6405HR-UTR6440HR



Part Identification: Numerals and polarity letter indicate UTR type number, e.g., UTR 4405.

Polarity: Cathode to Stud is standard. Reverse polarity denoted by "R" suffix.

Finish: Metal parts gold plated per MIL-G-45204, Type II.

Weight: 1.5 grams, typical.

Also available with insulated stud. Reference Design Note 17.

Installation
Maximum unlubricated stud torque: 28 inch-ounces.
Mounting hardware supplied.
Do not use a screwdriver in the turret slot for installation purposes, or damage may result.

BODY C — Stud Mount



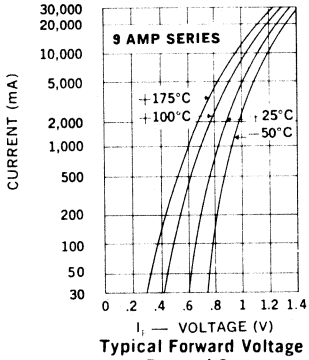
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

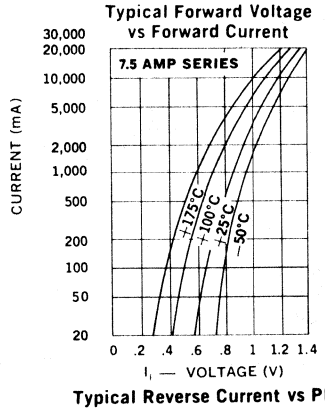
Type	PIV	Maximum Forward Voltage Drop	Maximum Reverse Current @ PIV		Maximum Reverse Recovery Time*
			25°C	100°C	
UTR6405/6405HR	50V	1.1V @ 6.0A	10μA	300μA	300ns
UTR6410/6410HR	100V				300ns
UTR6420/6420HR	200V				400ns
UTR6440/6440HR	400V				500ns
UTR5405/5405HR	50V	1.1V @ 5.0A	10μA	300μA	300ns
UTR5410/5410HR	100V				300ns
UTR5420/5420HR	200V				400ns
UTR5440/5440HR	400V				500ns
UTR4405/4405HR	50V	1.1V @ 4.0A	10μA	300μA	300ns
UTR4410/4410HR	100V				300ns
UTR4420/4420HR	200V				400ns
UTR4440/4440HR	400V				500ns

*Recovery time is measured from 1A to 1A, recovering to 0.5A.

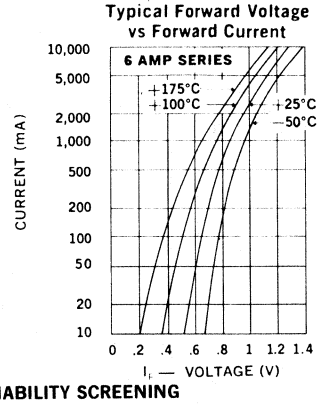
Typical Forward Voltage vs Forward Current



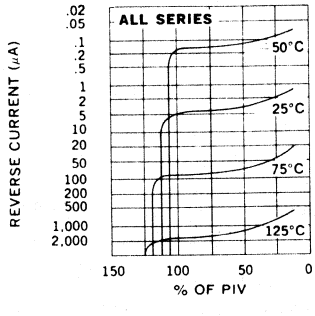
Typical Forward Voltage vs Forward Current



Typical Forward Voltage vs Forward Current



Typical Reverse Current vs PIV



OPTIONAL HIGH RELIABILITY SCREENING

The following tests are performed on 100% of the devices specified UTR4405 through UTR6440HR.

SCREEN	MIL-STD-750 METHOD	CONDITIONS
1. High Temperature Life (Stabilization Bake)	1032	24 Hours @ T_A = 175°C
2. Thermal Shock (Temperature Cycling)	1051	10 Cycles @ T_A = (−55°C to +150°C)
3. Interim Electrical Parameters	—	V_F and I_R @ 25°C
4. Power Burn-In	1038	96 Hours @ T_C = 100°C, I_O = 50% Rated V_R = Rated
5. Final Electrical and Delta Parameters	Go/No Go	ΔI_R ± 100% or 1μA (whichever is greater) ΔV_R ± 2%

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS

Ultra-Fast Recovery, 3 Amp and 4 Amp

UTX 3105-UTX 3120
UTX 4105-UTX 4120

5

FEATURES

- Continuous Rating: to 4A
- Controlled Avalanche
- Surge: to 80A
- Recovery Time less than 100ns
- Miniature Package

DESCRIPTION

These miniature ultra-fast recovery rectifiers permit operation at full power at frequencies as high as 100kHz square wave. They have the same unique Unitrode construction as the familiar 2 amp UTX series, but are scaled up in size to provide higher continuous and surge current capability.

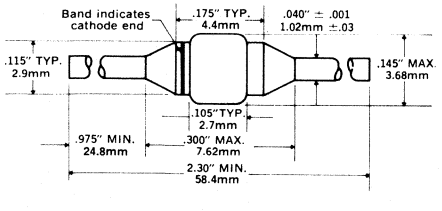
ABSOLUTE MAXIMUM RATINGS

Peak Inverse Voltage	3 Amp Series	4 Amp Series
50V	UTX 3105	UTX 4105
100V	UTX 3110	UTX 4110
150V	UTX 3115	UTX 4115
200V	UTX 3120	UTX 4120

	3 AMP SERIES	4 AMP SERIES
Maximum Average D.C. Output Current		
@ T_A = 25°C	3.0A	4.0A
@ T_A = 100°C	1.5A	2.0A
Non-Repetitive Sinusoidal Surge Current (8.3ms)	60A	80A
Operating Temperature Range	—195°C to +175°C	
Storage Temperature Range	—195°C to +200°C	
Thermal Resistance	See Lead Temperature Derating Curve	

MECHANICAL SPECIFICATIONS

UTX 3105-UTX 3120 UTX 4105-UTX 4120



UTX Prefix is identified by a Green Cathode Band

BODY B



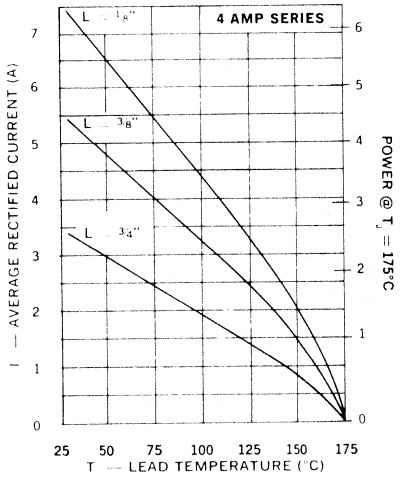
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

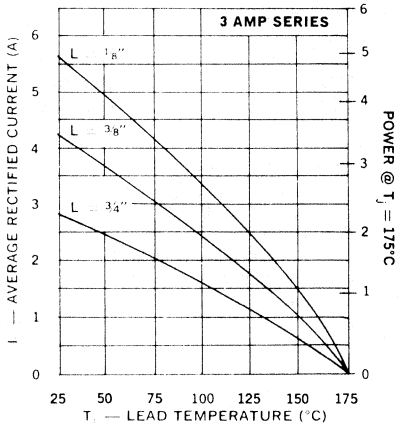
Type	PIV	Maximum Forward Voltage Drop*	Maximum Leakage Current @ PIV		Maximum Reverse Recovery Time**
			25°C	100°C	
UTX 4105 UTX 4110 UTX 4115 UTX 4120	50V 100V 150V 200V	1V @ 3 Adc	5μA	75μA	100ns
UTX 3105 UTX 3110 UTX 3115 UTX 3120	50V 100V 150V 200V	1V @ 2 Adc	5μA	75μA	100ns

*Forward voltage is measured at least 1 second after application of current.
**Recovery time is measured from 1A to 1A recovering to 0.5A.

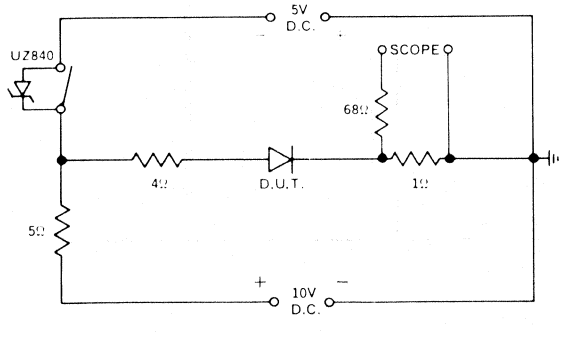
Maximum Current vs Lead Temperature



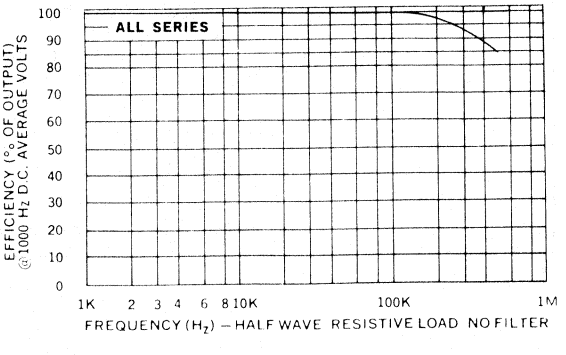
Maximum Current vs Lead Temperature



Reverse Recovery Circuit



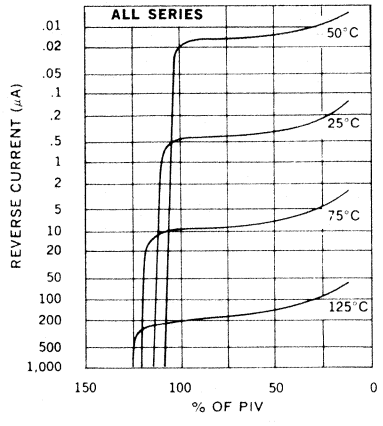
Efficiency vs Frequency at Rated Current (Sine Wave)



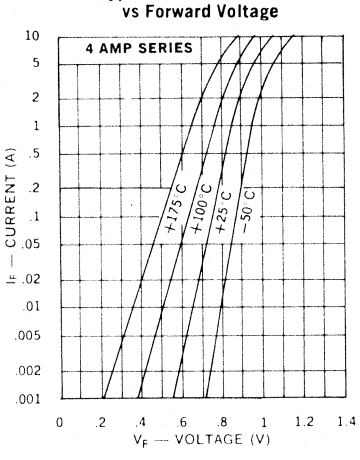
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

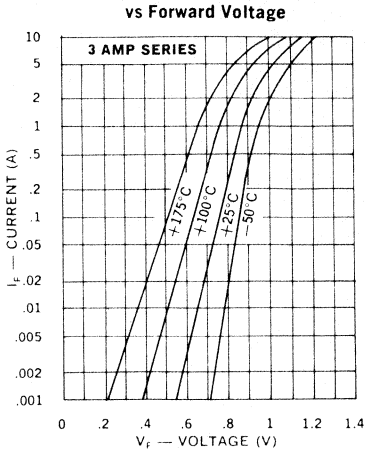
Typical Leakage Current vs PIV



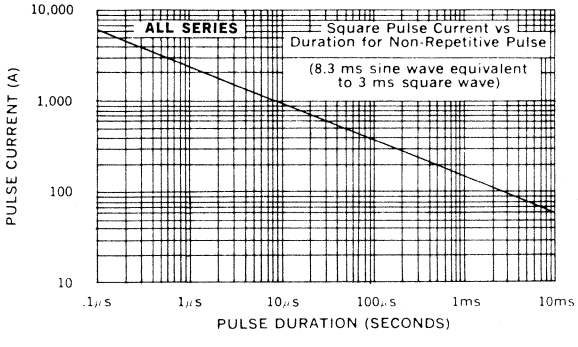
Typical Forward Current vs Forward Voltage



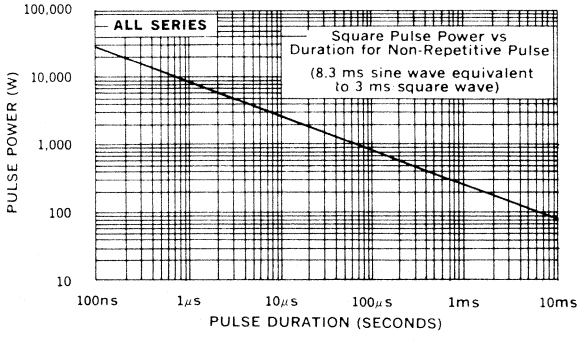
Typical Forward Current vs Forward Voltage



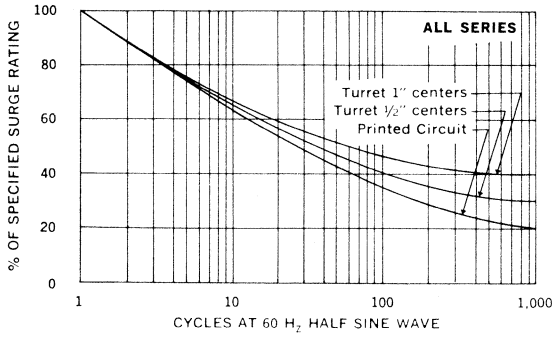
Forward Pulse Current vs Pulse Duration



Reverse Pulse Power vs Pulse Duration



Allowable Forward Surge vs Number of Cycles



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER ZENERS & TRANSIENT VOLTAGE SUPPRESSORS 6

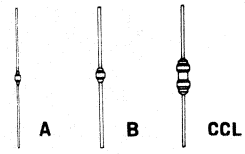
Transient Voltage Suppressors - Product Selection Guide 6-3
Bi-Directional Zeners - Product Selection Guide 6-5
Power Zeners - Product Selection Guide 6-6
Data Sheets 6-8

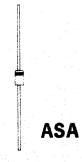
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER ZENERS AND TRANSIENT VOLTAGE SUPPRESSORS

Transient Voltage Suppressors





Package Style		Part No.	Stand-Off Voltage V_R (V)	Min. Breakdown Voltage $BV_{(min)}$ @ 1mA (V)	Max. Peak Pulse Current I_{PP} (A)	Max. Clamping Voltage* V_C @ I_{PP} (V)	Peak Power for 1mS (W)
	A Body	TVS305	5.0	6.0	17	8.7	
		TVS310	10.0	11.1	8.9	16.8	
		TVS312	12.0	13.8	7.1	21.0	
		TVS315	15.0	16.7	5.9	25	
		TVS318	18.0	20.4	4.9	31	
		TVS324	24.0	28.4	3.6	42	150
		TVS328	28.0	30.7	3.2	46	
		TVS348	48.0	54	1.7	82	
		TVS360	60.0	67	1.4	105	
		TVS410	100.0	111	.91	160	
		TVS420	200.0	234	.42	360	
		TVS430	300.0	342	.28	520	
	ASA	SAB5.0	5.0	6.0	53.7	9.3	
		SAB1.0	10.0	11.1	30.3	16.5	
		SAB12	12.0	13.8	23.8	21.0	
		SAB15	15.0	16.7	19.8	25.2	500
		SAB18	18.0	20.4	16.3	30.5	
		SAB24	24.0	28.4	11.9	42.0	
		SAB28	28.0	30.7	10.7	46.5	
	B Body	TVS505	5.0	6.0	53.7	9.3	
		TVS510	10.0	11.1	30.3	16.5	
		TVS512	12.0	13.8	23.8	21.0	
		TVS515	15.0	16.7	19.8	25.2	500
		TVS518	18.0	20.4	16.3	30.5	
		TVS524	24.0	28.4	11.9	42.0	
		TVS528	28.0	30.7	10.7	46.5	
		1N6461**	5.0	5.6 @ 25mA	56	9	
		1N6462**	6.0	6.5 @ 20mA	46	11	
		1N6463**	12.0	13.6 @ 5mA	22	22.6	
		1N6464**	15.0	16.4 @ 5mA	19	26.5	500
		1N6465**	24.0	27.0 @ 2mA	12	41.4	
		1N6466**	30.5	33.0 @ 1mA	11	47.5	
		1N6467**	40.3	43.7 @ 1mA	8	63.5	
		1N6468**	51.6	54.0 @ 1mA	6	78.5	
	CCL	1N5610*		33.0	32.0	47.5	
		1N5611*		43.7	24.0	63.5	1500
		1N5612*		54.0	19.0	79.5	
		1N5613*		191.0	5.7	265.0	
Package Style	ASA Plastic	SA5.0	5.0	6.40	52.0	9.6	
		SA5.0A	5.0	6.40	54.3	9.2	
		SA6.0	6.0	6.67	43.9	11.4	
		SA6.0A	6.0	6.67	48.5	10.3	500
		SA6.5	6.5	7.22	40.7	12.3	
		SA6.5A	6.5	7.22	44.7	11.2	
		SA7.0	7.0	7.78	37.8	13.3	
		SA7.0A	7.0	7.78	41.7	12.0	

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A

POWER ZENERS AND TRANSIENT VOLTAGE SUPPRESSORS

Transient Voltage Suppressors



ASA

Package Style		Part No.	Stand-Off Voltage V_R (V)	Min. Breakdown Voltage $BV_{(min)}$ @ 1mA (V)	Max. Peak Pulse Current I_{PP} (A)	Max. Clamping Voltage* V_C @ I_{PP} (V)	Peak Power for 1mS (W)
ASA Plastic		SA7.5	7.5	8.33	35.0	14.3	500
		SA7.5A	7.5	8.33	38.8	12.9	
		SA8.0	8.0	8.89	33.3	15.0	
		SA8.0A	8.0	8.99	36.7	13.6	
		SA8.5	8.5	9.44	31.4	15.9	
		SA8.5A	8.5	9.44	34.7	14.4	
		SA9.0	9.0	10.0	29.5	16.9	
		SA9.0A	9.0	10.0	32.5	16.4	
		SA10	10.0	11.1	26.6	18.8	
		SA10A	10.0	11.1	29.4	17.0	
		SA11	11.0	12.2	24.9	20.1	
		SA11A	11.0	12.2	27.4	18.2	
		SA12	12.0	13.3	22.7	22.0	
		SA12A	12.0	13.3	25.1	19.9	
		SA13	13.0	14.4	21.0	23.8	
		SA13A	13.0	14.4	23.2	21.5	
		SA14	14.0	15.6	19.4	25.8	
		SA14A	14.0	15.6	21.5	23.2	
		SA15	15.0	16.7	18.8	26.9	
		SA15A	15.0	16.7	20.6	24.4	
		SA16	16.0	17.8	17.6	28.8	
		SA16A	16.0	17.8	19.2	26.0	
		SA17	17.0	18.9	16.4	30.5	
		SA17A	17.0	18.9	18.1	27.6	
		SA18	18.0	20.0	15.5	32.2	
		SA18A	18.0	20.0	17.2	29.2	
		SA20	20.0	22.2	13.9	35.8	
		SA20A	20.0	22.2	15.4	32.4	
		SA22	22.0	24.4	12.7	39.4	
		SA22A	22.0	24.4	14.1	35.5	
		SA24	24.0	26.7	11.6	43.0	
		SA24A	24.0	26.7	12.8	38.9	
		SA25	25.0	28.9	10.7	46.6	
		SA25A	25.0	28.9	11.9	42.1	
		SA28	28.0	31.1	9.9	50.0	
		SA28A	28.0	31.1	11.0	45.4	
		SA30	30.0	33.3	9.3	53.5	
		SA30A	30.0	33.3	10.3	48.4	
		SA33	33.0	36.7	8.5	59.0	
		SA33A	33.0	36.7	9.4	53.3	
		SA36	36.0	40.0	7.8	64.3	
		SA36A	36.0	40.0	8.6	58.1	
		SA40	40.0	44.4	7.0	71.4	
		SA40A	40.0	44.4	7.8	64.5	
		SA43	43.0	47.8	6.5	76.7	
		SA43A	43.0	47.8	7.2	69.4	
		SA45	45.0	50.0	6.2	80.3	
		SA45A	45.0	50.0	6.9	72.7	
		SA48	48.0	53.3	5.8	85.5	
		SA48A	48.0	53.3	6.5	77.4	
		SA51	51.0	56.7	5.5	91.1	
		SA51A	51.0	56.7	6.1	82.4	
		SA54	54.0	60.0	5.2	96.3	
		SA54A	54.0	60.0	5.7	87.1	
		SA58	58.0	64.4	4.9	103.0	
		SA58A	58.0	64.4	5.3	93.6	

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER ZENERS AND TRANSIENT VOLTAGE SUPPRESSORS

Transient Voltage Suppressors

Package Style	Part No.	Stand-Off Voltage V_R (V)	Min. Breakdown Voltage $BV_{(min)}$ @ 1mA (V)	Max. Peak Pulse Current I_{PP} (A)	Max. Clamping Voltage* V_C @ I_{PP} (V)	Peak Power for 1mS (W)
ASA Plastic	SA60	60.0	66.7	4.7	107.0	500
	SA60A	60.0	66.7	5.2	96.8	
	SA64	64.0	71.1	4.4	114.8	
	SA64A	64.0	71.1	4.9	103.0	
	SA70	70.0	77.8	4.0	125	
	SA70A	70.0	77.8	4.4	113	
	SA75	75.0	83.3	3.7	134	
	SA75A	75.0	83.3	4.1	121	
	SA78	78.0	86.7	3.6	139	
	SA78A	78.0	86.7	4.0	126	
	SA85	85.0	94.4	3.3	151	
	SA85A	85.0	94.4	3.6	137	
	SA90	90.0	100.0	3.1	160	
	SA90A	90.0	100.0	3.4	146	
	SA100	100.0	111.0	2.8	179	
	SA100A*	100.0	111.0	3.1	162	
	SA110	110.0	122.0	2.6	196	
	SA110A	110.0	122.0	2.8	177	
	SA120	120.0	133.0	2.3	214	
	SA120A	120.0	133.0	2.0	193	
	SA130	130.0	144.0	2.2	231	
	SA130A	130.0	144.0	2.4	209	
	SA150	150.0	167.0	1.9	268	
	SA150A	150.0	167.0	2.1	243	
	SA160	160.0	178.0	1.7	287	
	SA160A	160.0	178.0	1.9	259	
	SA170	170.0	189.0	1.6	304	
	SA170A	170.0	189.0	1.8	275	

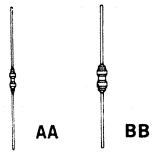


ASA

*Available in JAN & JANTX
**Available in JAN, JANTX and JANTXV

Bi-directional Zeners

Power		1W	3W	5W
Package Style		AA		BB
Voltage, V (10% Tolerance)	7.5	UDZ8807	UDZ807	UDZ5807
	8.2	UDZ8808	UDZ808	UDZ5808
	9.1	UDZ8809	UDZ809	UDZ5809
	10	UDZ8810	UDZ810	UDZ5810
	12	UDZ8812	UDZ812	UDZ5812
	15	UDZ8815	UDZ815	UDZ5815
	18	UDZ8818	UDZ818	UDZ5818
	20	UDZ8820	UDZ820	UDZ5820
	24	UDZ8824	UDZ824	UDZ5824
	27	UDZ8827	UDZ827	UDZ5827
	30	UDZ8830	UDZ830	UDZ5830
	33	UDZ8833	UDZ833	UDZ5833
	36	UDZ8836	UDZ836	UDZ5836
	40	UDZ8840	UDZ840	UDZ5840
	45	UDZ8845	UDZ845	UDZ5845
	60	UDZ8860	UDZ860	UDZ5860

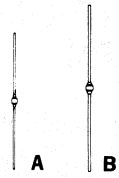


AA BB

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER ZENERS AND TRANSIENT VOLTAGE SUPPRESSORS



POWER ZENERS

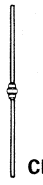
Power		1W	1.5W	3W	3W	3W	5W	5W	6W	10W
Package Style		A	A	A	A	A	B	B	CL	C
VOLTAGE V_Z (5% Tolerance)	5.6V							1N5968*		
	6.2V							1N5969*		
	6.8V	UZ8706	1N4461*	1N5063	UZ706[1]	BZV16C6V8***	UZ4706	1N4954*	UZ7706L	UZ7706[1]
	7.5V	UZ8707	1N4462*	1N5064	UZ707[1]	BZV16C7V5***	UZ4707	1N4955*	UZ7707L	UZ7707[1]
	8.2V	UZ8708	1N4463*	1N5065	UZ708[1]	BZV16C8V2***	UZ4708	1N4956*	UZ7708L	UZ7708[1]
	9.1V	UZ8709	1N4464*	1N5066	UZ709[1]	BZV16C9V1***	UZ4709	1N4957*	UZ7709L	UZ7709[1]
	10V	UZ8710	1N4465*	1N5067	UZ710[1]	BZV16C10***	UZ4710	1N4958*	UZ7710L	UZ7710[1]
	11V	UZ8711	1N4466*	1N5068		BZV16C11****		1N4959*	UZ7711L	UZ7711[1]
	12V	UZ8712	1N4467*	1N4883	UZ712[1]	BZV16C12***	UZ4712	1N4960*	UZ7712L	UZ7712[1]
	13V	UZ8713	1N4468*	1N5069	UZ713[1]	BZV16C13***	UZ4713	1N4961*	UZ7713L	UZ7713[1]
	14V	UZ8714		1N5070	UZ714[1]			1N5118	UZ7714L	UZ7714[1]
	15V	UZ8715	1N4469*	1N5071	UZ715[1]	BZV16C15***	UZ4715	1N4962*	UZ7715L	UZ7715[1]
	16V	UZ8716	1N4470*	1N5072	UZ716[1]	BZV16C16***	UZ4716	1N4963*	UZ7716L	UZ7716[1]
	18V	UZ8718	1N4471*	1N5073	UZ718[1]	BZV16C18***	UZ4718	1N4964*	UZ7718L	UZ7718[1]
	20V	UZ8720	1N4472*	1N4884	UZ720[1]	BZV16C20***	UZ4720	1N4965*	UZ7720L	UZ7720[1]
	22V	UZ8722	1N4473*	1N5074	UZ722[1]	BZV16C22***	UZ4722	1N4966*	UZ7722L	UZ7722[1]
	24V	UZ8724	1N4474*	1N5075	UZ724[1]	BZV16C24***	UZ4724	1N4967*	UZ7724L	UZ7724[1]
	27V	UZ8727	1N4475*	1N5076	UZ727[1]	BZV16C27***	UZ4727	1N4968*	UZ7727L	UZ7727[1]
	30V	UZ8730	1N4476*	1N5077	UZ730[1]	BZV16C30***	UZ4730	1N4969*	UZ7730L	1N7730[1]
	33V	UZ8733	1N4477*	1N5078	UZ733[1]	BZV16C33***	UZ4733	1N4970*	UZ7733L	UZ7733[1]
	36V	UZ8736	1N4478*	1N5079	UZ736[1]	BZV16C36***	UZ4736	1N4971*	UZ7736L	UZ7736[1]
	39V		1N4479*	1N5080		BZV16C39***	UZ4739	1N4972*		
	40V	UZ8740		1N5081	UZ740[1]			1N5119	UZ7740L	UZ7740[1]
	43V		1N4480*	1N5082		BZV16C43***	UZ4743	1N4973*[1]		
	45V	UZ8745		1N5083	UZ745[1]			1N5120	UZ7745L	UZ7745[1]
	47V		1N4481*	1N5084		BZV16C47***	UZ4747	1N4974*		
	50V	UZ8750		1N5085	UZ750[1]			1N5121	UZ7750L	UZ7750[1]
	51V		1N4482*	1N5086		BZV16C51***	UZ4751	1N4975*		
	56V	UZ8756	1N4483*	1N5087	UZ756[1]	BZV16C56***	UZ4756	1N4976*	UZ7756L	UZ7756[1]
	60V	UZ8760		1N5088	UZ760[1]			1N5122	UZ7760L	UZ7760[1]
	62V		1N4484*	1N5089		BZV16C62***	UZ4762	1N4977*		
	68V		1N4485*	1N5090		BZV16C68***	UZ4768	1N4978*		
PULSE POWER **		100W	140W	230W	230W	230W	720W	900W	2000W	2000W

* Available as JAN, JANTX, & JANTXV
** For 100μs pulse width
† 10% and 20% tolerance also available
*** Pro Electron Diodes 7% tolerance
1. Available with High Reliability (HR) Screening. See individual datasheet

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER ZENERS AND TRANSIENT VOLTAGE SUPPRESSORS





POWER ZENERS

Power	1W	1.5W	3W	3W	3W	5W	5W	6W	10W
Package Style	A	A	A	A	A	B	B	CL	C
VOLTAGE V_Z (5% Tolerance) 70V	UZ8770		1N5091	UZ770			1N5123	UZ7770L	UZ7770[1]
75V	UZ8775	1N4486*	1N5092	UZ775	BZV16C75***	UZ4775	1N4979*	UZ7775L	UZ7775[1]
80V	UZ8780		1N5093	UZ780			1N5124	UZ7780L	UZ7780[1]
82V		1N4487*	1N5094		BZV16C82***	UZ4782	1N4980*		
90V	UZ8790		1N4096	UZ790			1N5125	UZ7790L	UZ7790[1]
91V		1N4488*	1N4095		BZV16C91***	UZ4791	1N4981*		
100V	UZ8110	1N4489*	1N4097	UZ110	BZV16C100***	UZ4110	1N4982*	UZ7110L	UZ7110[1]
110V	UZ8111	1N4490*	1N5096	UZ111		UZ4111	1N4983*		
120V	UZ8112	1N4491*	1N5097	UZ112		UZ4112	1N4984*		
130V	UZ8113	1N4492*	1N5098	UZ113		UZ4113	1N4985*		
140V	UZ8114		1N5099	UZ114					
150V	UZ8115	1N4493*	1N4098	UZ115		UZ4115	1V4986*		
160V	UZ8116	1N4494*	1N5100	UZ116		UZ4116	1V4987*		
170V	UZ8117		1N5101	UZ117			1V5127		
180V	UZ8118	1N4495*	1N5102	UZ118		UZ4118	1V4988*		
190V	UZ8119		1N5103	UZ119			1N5128		
200V	UZ8120	1N4496*	1N5104	UZ120		UZ4120	1N4989*		
220V			1N5105	UZ122			1N4990*		
240V			1N5106	UZ124			1N4991*		
260V			1N5107	UZ126			1N5129		
270V			1N5108				1N4992*		
280V			1N5109	UZ128			1N5130		
300V			1N5110	UZ130			1N4993*		
320V			1N5111	UZ132			1N5131		
330V			1N5112				1N4994*		
340V			1N5113	UZ134			1N5132		
360V			1N5114	UZ136			1N4995*		
380V			1N5115	UZ138			1N5133		
390V			1N5116				1N4996		
400V			1N5117	UZ140			1N5134		
PULSE POWER **	100W	140W	230W	230W	230W	720W	900W	2000W	2000W

* Available as JAN, JANTX, & JANTXV
** For 100μs pulse width
† 10% and 20% tolerance also available
*** Pro Electron Diodes 7% tolerance
1. Available with High Reliability (HR) Screening. See individual datasheet

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

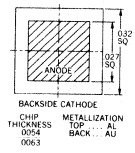
POWER ZENERS
1.5 Watt, Military

1N4461-1N4496
JAN, JANTX & JANTXV

FEATURES
- 5 Times Greater Surge Rating than JAN1N3016 Series
- Low Reverse Current: to 50nA
- ¼ Size of Conventional 1 Watt Zeners

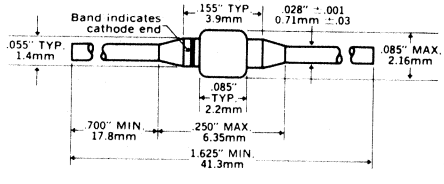
DESCRIPTION
Fused-in-glass, metallurgically bonded 1.5 watt zeners, qualified to MIL-S-19500/406.

ABSOLUTE MAXIMUM RATINGS
Zener Voltage, V_Z	6.8 to 200V
Continuous Current	See Table
Surge Current (8.3ms)	See Table
Surge Power	See Graph
Power	See Lead Temperature Derating Curve
Storage and Operating Temperature	−65°C to +175°C



MECHANICAL SPECIFICATIONS

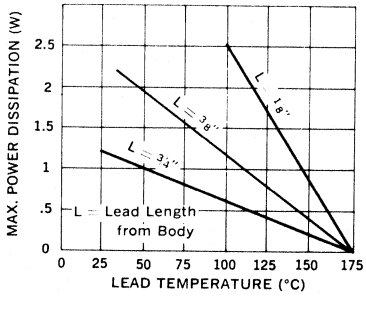
JAN, JANTX & JANTXV 1N4461-1N4496



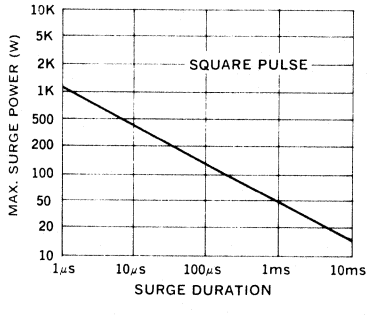
BODY A



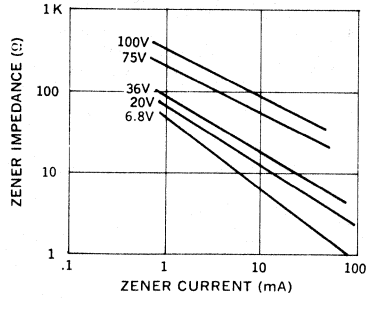
Power Dissipation vs. Lead Temperature Derating Curve



Max. Surge Power vs. Surge Duration



Typical Zener Impedance vs. Zener Current



UNITRODE

Type	Electrical Specifications at 25°C								Maximum Ratings	
	Nominal Zener Voltage † V_Z @ I_{ZT}	Test Current I_{ZT}	Max. Zener Impedance § Z_Z @ I_{ZT}	Z_{ZK} @ I_{ZK}	I_{ZK}	Voltage ** Regulation ΔBV Max	Maximum Reverse Leakage Current I_R @ V_R	V_R	Maximum Cont. Current I_{ZM}	Maximum Surge Current‡ I_S
±5% Tolerance	Volts	mA	Ohms	Ohms	mA	Volts	μA	Volts	mA	Amps
1N4461	6.8	37	2.5	200	1.0	.30	5.0	4.08	210	5.0
1N4462	7.5	34	2.5	400	.5	.35	1.0	4.50	191	4.5
1N4463	8.2	31	3.0	400	.5	.40	.50	4.92	174	3.9
1N4464	9.1	28	4.0	500	.5	.45	.30	5.46	157	3.4
1N4465	10	25	5.0	500	.25	.50	.30	8.0	143	3.0
1N4466	11	23	6.0	550	.25	.55	.30	8.8	130	2.6
1N4467	12	21	7.0	550	.25	.60	.20	9.6	119	2.4
1N4468	13	19	8.0	550	.25	.65	.10	10.4	110	2.2
1N4469	15	17	9.0	600	.25	.75	.05	12.0	95	1.8
1N4470	16	15.5	10.0	600	.25	.80	.05	12.8	90	1.6
1N4471	18	14	11.0	650	.25	.83	.05	14.4	79	1.4
1N4472	20	12.5	12.0	650	.25	.95	.05	16.0	71	1.2
1N4473	22	11.5	14	650	.25	1.0	.05	17.6	65	1.1
1N4474	24	10.5	16	700	.25	1.1	.05	19.2	60	.90
1N4475	27	9.5	18	700	.25	1.3	.05	21.6	53	.80
1N4476	30	8.5	20	750	.25	1.4	.05	24.0	48	.75
1N4477	33	7.5	25	800	.25	1.5	.05	26.4	43	.66
1N4478	36	7.0	27	850	.25	1.7	.05	28.8	40	.60
1N4479	39	6.5	30	900	.25	1.8	.05	31.2	37	.54
1N4480	43	6.0	40	950	.25	1.9	.05	34.4	33	.48
1N4481	47	5.5	50	1000	.25	2.1	.05	37.6	30	.45
1N4482	51	5.0	60	1100	.25	2.3	.05	40.8	28	.42
1N4483	56	4.5	70	1300	.25	2.5	.05	44.8	26	.39
1N4484	62	4.0	80	1500	.25	2.7	.05	49.6	23	.35
1N4485	68	3.7	100	1700	.25	3.0	.05	54.4	21	.32
1N4486	75	3.3	130	2000	.25	3.3	.05	60.0	19	.29
1N4487	82	3.0	160	2500	.25	3.6	.05	65.6	17	.26
1N4488	91	2.8	200	3000	.25	4.0	.05	72.8	16	.23
1N4489	100	2.5	250	3100	.25	4.4	.25	80.0	14	.20
1N4490	110	2.0	300	4000	.25	5.0	.25	88.0	13	.19
1N4491	120	2.0	400	4500	.25	5.5	.25	96.0	12	.18
1N4492	130	1.9	500	5000	.25	6.0	.25	104	11	.16
1N4493	150	1.7	700	6000	.25	7.0	.25	120	9.5	.14
1N4494	160	1.6	1000	6500	.25	8.0	.25	128	8.9	.12
1N4495	180	1.4	1300	7000	.25	10.0	.25	144	7.9	.10
1N4496	200	1.2	1500	8000	.25	12.0	.25	160	7.2	.08

† All Zener voltages are measured with an automated test set using a 35 millisecond test time. Longer or shorter test times will have a corresponding effect on the measured value due to heating effects.

§ Zener impedance is derived from the 60 cycle AC Voltage created when AC current with RMS value of 10% of DC Zener test current is superimposed on the test current.

** ΔBV is obtained by measuring the voltage change when the test current is changed from 10% to 50% of Iz max under DC conditions. During this measurement the leads are heat sunk .375 inch from the body and maintained at 25°C.

‡ Ratings shown are for peak sinusoidal surge current of 8.3 ms duration, non-repetitive. The 8.3 ms square pulse rating is 71% of the value shown. Rating exceeds JEDEC Registered Specification.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER ZENERS
5 Watt, Military

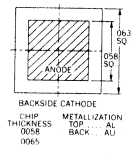
1N4954-1N4995
1N5968-1N5969
JAN, JANTX & JANTXV
1N4996

FEATURES
- 2 Times Greater Surge Rating than Conventional 10 Watt Zeners
- Small Physical Size

DESCRIPTION
Fused-in-glass, metallurgically-bonded 5 watt zeners, qualified to MIL-S-19500/356.

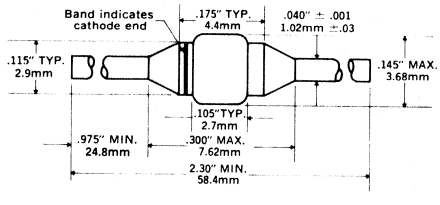
ABSOLUTE MAXIMUM RATINGS

Zener Voltage, V_Z	5.6 to 390V
Continuous Current	See Table
Surge Current (8.3ms)	See Table
Surge Power	See Graph
Power	See Lead Temperature Derating Curve
Storage and Operating Temperature	−65°C to +175°C

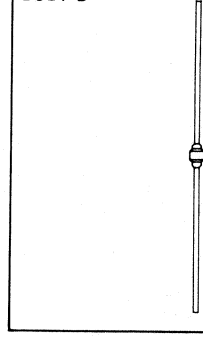


MECHANICAL SPECIFICATIONS

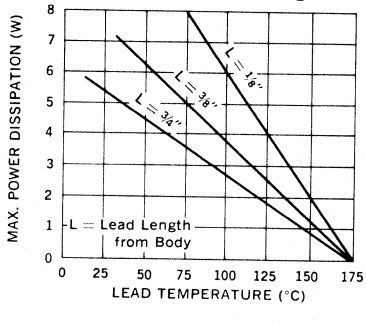
J, JTX, JTXV 1N4954-1N4995
J, JTX, JTXV 1N5968-1N5969
1N4996



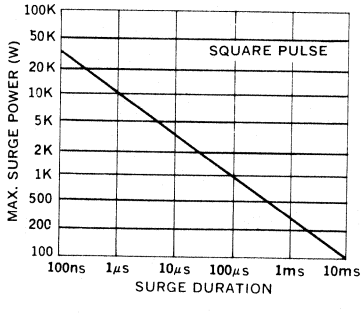
BODY B



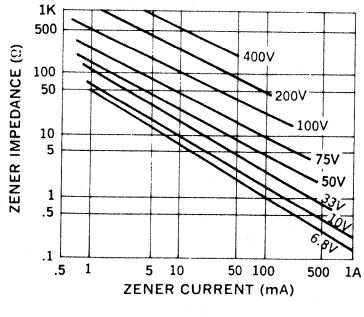
Power Dissipation vs. Lead Temperature Derating Curve



Max. Surge Power vs. Surge Duration



Typical Zener Impedance vs. Zener Current



UNITRODE

Electrical Specifications at 25°C										Maximum Ratings	
Type	Nominal Zener Voltage† V_Z @ I_{ZT}	Test Current I_{ZT}	Maximum Zener Impedance §		Voltage Regulation △BV §§	Maximum Reverse Leakage Current			Maximum Temperature Coeff. T_C @ I_{ZT}	Maximum Continuous Current ★ I_{ZM}	Maximum Surge Current‡ I_S
			Z_Z @ I_{ZT}	Z_{ZK}†† @ I_{ZK} = 1mA		I_R††	I_R	V_R			
±5% Tolerance	Volts	mA	Ohms	Ohms	Volts	μA		Volts	%/°C	mA	Amps
1N5968*	5.6	220	1.0	400	0.4	5000	5000	4.28	.04	865	20
1N5969*	6.2	220	1.0	1000	0.5	1000	1000	4.74	.04	765	20
1N4954*	6.8	175	1.0	1000	0.7	150	300	5.2	.05	700	40
1N4955*	7.5	175	1.5	800	0.7	100	200	5.7	.06	630	32
1N4956*	8.2	150	1.5	600	0.7	50	100	6.2	.06	580	24
1N4957*	9.1	150	2.0	400	0.7	25	50	6.9	.06	520	22
1N4958*	10.0	125	2.0	125	0.8	25	25	7.6	.07	475	20
1N4959*	11	125	2.5	130	0.8	10	15	8.4	.07	430	19
1N4960*	12	100	2.5	140	0.8	10	10	9.1	.07	395	18
1N4961*	13	100	3.0	145	0.8	10	10	9.9	.08	365	16
1N4962*	15	75	3.5	150	1.0	5	5	11.4	.08	315	12
1N4963*	16	75	3.5	155	1.1	5	5	12.2	.08	294	10
1N4964*	18	65	4.0	160	1.2	5	5	13.7	.085	264	9.0
1N4965*	20	65	4.5	165	1.5	2	2	15.2	.085	237	8.0
1N4966*	22	50	5.0	170	1.8	2	2	16.7	.085	216	7.0
1N4967*	24	50	5.0	175	2.0	2	2	18.2	.090	198	6.5
1N4968*	27	50	6.0	180	2.0	2	2	20.6	.090	176	6.0
1N4969*	30	40	8	190	2.5	2	2	22.8	.090	158	5.5
1N4970*	33	40	10	200	2.8	2	2	25.1	.095	144	5.0
1N4971*	36	30	11	220	3.0	2	2	27.4	.095	132	4.5
1N4972*	39	30	14	230	3.0	2	2	29.7	.095	122	4.0
1N4973*	43	30	20	240	3.3	2	2	32.7	.095	110	3.5
1N4974*	47	25	25	250	3.5	2	2	35.8	.095	100	3.2
1N4975*	51	25	27	270	4.0	2	2	38.8	.095	92	3.0
1N4976*	56	20	35	320	4.4	2	2	42.6	.095	84	2.8
1N4977*	62	20	42	400	5.0	2	2	47.1	.100	76	2.5
1N4978*	68	20	50	500	5.5	2	2	51.7	.100	70	2.2
1N4979*	75	20	55	620	6.0	2	2	56.0	.100	63.0	2.0
1N4980*	82	15	80	720	6.6	2	2	62.2	.100	58.0	1.8
1N4981*	91	15	90	760	7.5	2	2	69.2	.100	52.5	1.6
1N4982*	100	12	110	800	8.0	2	2	76.0	.100	47.5	1.4
1N4983*	110	12	125	1000	9.0	2	2	83.6	.100	43.0	1.2
1N4984*	120	10	170	1150	10	2	2	91.2	.100	39.5	1.00
1N4985*	130	10	190	1250	11	2	2	98.8	.105	36.6	0.80
1N4986*	150	8	330	1500	13	2	2	114.0	.105	31.6	0.75
1N4987*	160	8	350	1650	14	2	2	121.6	.105	29.4	0.70
1N4988*	180	5	450	1750	16	2	2	136.8	.110	26.4	0.60
1N4989*	200	5	500	1850	18	2	2	152	.110	23.6	0.50
1N4990*	220	5	550	2000	19	2	2	167	.115	21.6	0.50
1N4991*	240	5	650	2050	22	2	2	182	.115	19.8	0.40
1N4992*	270	5	800	2100	25	2	2	206	.120	17.5	0.35
1N4993*	300	4	950	2150	28	2	2	228	.120	15.6	0.30
1N4994*	330	4	1175	2200	32	2	2	251	.120	14.4	0.25
1N4995*	360	3	1400	2300	35	2	2	274	.120	13.0	0.22
1N4996	390	3	1800	2500	40	2	2	297	.120	12.0	0.20

* Available as JAN, JANTX & JANTXV.

† All zener voltages are measured with an automated test set using a 35 msec test time. Longer or shorter test times will have a corresponding effect on the measured value due to heating effects.

§ Zener impedance is derived from the 60-cycle voltage created when AC current with RMS value of 10% of DC zener test current is superimposed on the test current.

§§ △BV is obtained by measuring the voltage change when the test current is changed from 10% to 50% of Iz max under DC conditions. During this measurement the leads are heat sunk .375 inch from the body and maintained at 25°C.

★ Maximum current based on 5 Watt Rating. See lead temperature derating curves for proper mounting methods.

‡ Figures shown are for peak sinusoidal surge current of 8.3 msec duration, non-repetitive. The 8.3 ms square pulse rating is 71% of the value shown.

†† These specifications apply only to JAN and JANTX

6

POWER ZENERS
Transient Suppressor Diodes

JAN & JANTX 1N5610-1N5613

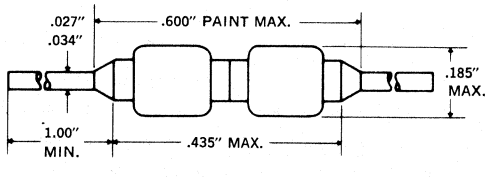
FEATURES
- 1500 Watts for 1ms Pulse Power Capability
- Small Physical Size
- Designed to be Used in Mil-Std-704A Applications

DESCRIPTION
Zener diodes with high surge capability qualified to MIL-S-19500/434.

ABSOLUTE MAXIMUM RATINGS (at 25°C except where otherwise noted)

	1N5610	1N5611	1N5612	1N5613
Zener Voltage	See Electrical Specifications			
Forward Surge Current	200A	200A	200A	200A
Zener Surge Current, at 25°C	32.0A	24.0A	19.0A	5.7A
Surge Current, at 150°C	5.5A	4.8A	3.2A	1.0A
Surge Power	See Graph			
Storage and Operating Temperature	—65°C to +175°C			

JAN & JANTX 1N5610-1N5613



Polarity: Cathode indicated by band.
Weight: 1.5 gram (approximate).
Mounting Position: Any. **Leads:** Tinned Copper.
Marking: Type number marked on unit.

Double C BODY



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	Min. Zener Voltage § Vz @ ImA	Max. Zener Voltage† Vz @ Is		Max. Reverse Leakage Current I_r @ V_r		Max. Forward Voltage‡ @ 100 Amps	Typical Temperature Coefficient
	Volts	Volts	Amps	μA	Volts	Volts	%/°C
1N5610*	33.0	47.5	32.0	5.0	30.5	4.8	.093
1N5611*	43.7	63.5	24.0	5.0	40.3	4.8	.094
1N5612*	54.0	78.5	19.0	5.0	49.0	4.8	.096
1N5613*	191.0	265.0	5.7	5.0	175.0	4.8	.100

Notes: * Available as JAN and JANTX.
§ Duration of applied current ≤ 300ms, duty cycle ≤ 2%.
† Utilizing a pulse which decays exponentially to 50% of the peak value in 1ms. See graph entitled "Pulse Waveform."
‡ Peak Sinusoidal surge current of 8.3ms duration, non-repetitive.

6

APPLICATIONS

Voltage transients can be suppressed with series elements, shunt elements, or a combination of both. These elements may be passive or active. For low and medium power applications, a series resistor and zener clamp offer several attractive features:

1. Simplicity of design
2. High reliability
3. Fast response time

The 1N5610 series of surge suppressors will suppress the following transients defined by *MIL-S-704A* without the use of any series limiting resistance beyond that provided by the source:

1. All 600V transients (category #1 on chart below)
2. All 80V transients except those generated by the main voltage regulator (category #2 on chart below)
3. The overvoltage transients generated by the *main voltage regulator* (category #3 on chart below) will also be suppressed by the 1N5610 series if:
   a. A 20 ohm series limiting resistor is used, or
   b. No series resistance is used but the zener is protected within 500 μs by using, for example, an SCR crowbar

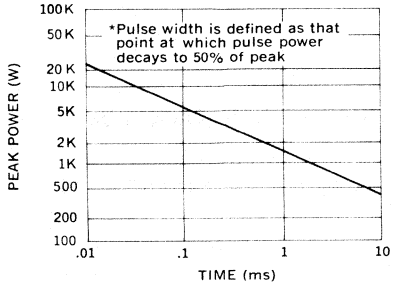
The above statements are based on the source impedances and dv/dt characteristics as given in ARINC* Specification #413. This report entitled "Guidance for Aircraft Electrical Power Utilization and Transient Protection" serves to further define *MIL-STD-704A* for large aircraft electrical systems.

Category	Source of Transient	Maximum Amplitude	Duration	Min. Source Impedance	dv/dt
1.	Inductive Switching	600 V	≤ 10 μs	50 ohms	
2.	BUS Switching	80 V	≤ 10 ms	15 ohms	
3.	Main Voltage Regulator	80 V	≥ 10 ms	0.2 ohms	50V/ms

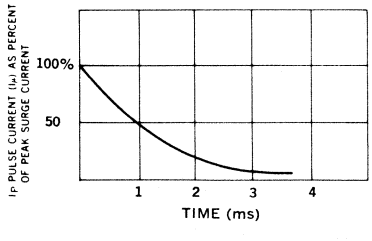
These Surge Suppressors are useful in a variety of other applications where semiconductor devices must function reliably in an environment subject to extremely high but short term surges.

* ARINC stands for Aeronautical Radio, Inc. (Annapolis, Maryland 21401)

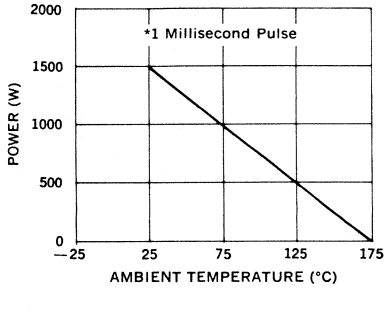
Peak Power Rating vs. Pulse Width*



Pulse Waveform



Peak Power Rating* vs. Ambient Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

TRANSIENT VOLTAGE SUPPRESSORS
500W, Military

1N6461-1N6468
JAN, JANTX & JANTXV

FEATURES
- 500W Power Capability for 1ms pulse
- Glass Encapsulated Device
- Clamping Time in Picoseconds

DESCRIPTION
Transient voltage suppressor of noncavity design and qualified to MIL-S-19500/551. Metallurgically bonded for high reliabilty.

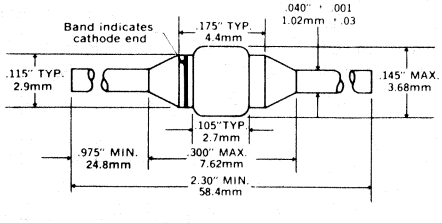
ABSOLUTE MAXIMUM RATINGS @ 25°C

Stand-off Voltage, V_R	5.0V to 51.6V
Peak Pulse Power (1ms)*, P_{PR}	500W
Forward Surge Current @ tp = 8.33ms, I_{FSM}	80A(pk)
Peak Pulse Current	see table
Breakdown Voltage	see table
Power, Continuous (Derate @ 16.7mW/°C above T_A = 25°C), P_R	2.5W
Storage Temperature	-55°C to +200°C
Operating Temperature	-55°C to +175°C

*See Figure 2 for Peak Pulse Power vs. Pulse Duration.

MECHANICAL SPECIFICATIONS

J, JTX & JTXV 1N6461-1N6468



BODY B



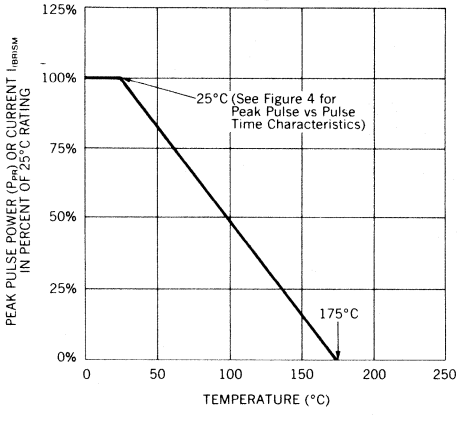
UNITRODE

ELECTRICAL SPECIFICATIONS @ 25°C

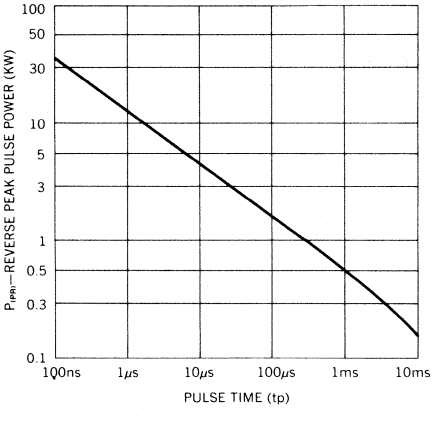
Part No.	Stand-off Voltage V_R	Min. Breakdown Voltage @ I_{BR}	Test Current I_{BR} @ tp = 300ms Duty Cycle ≤ 2%	Max. Leakage Current I_R @ V_R	Max. Peak Pulse Current I_{pp}		Max. Clamping Voltage ($V_{C\ MAX}$) @ Ipp for tp = 1ms	Max. Clamping Voltage @ Ipp (tp = 1ms) Inverse Voltage $-V_{C\ Max.}$	Max. Temperature Coefficient $\propto V_{(BR)}$
					tp = 1ms tr = 10μs (Fig. 3)	tp = 20μs tr = 8μs (Fig. 4)			
	V	V	mA	μA	A(pk)	A(pk)	V	V	%/°C
1N6461	5.0	5.6	25	3000	56	315	9.0	-3.5	0.040
1N6462	6.0	6.5	20	2500	46	258	11.0	-3.2	0.040
1N6463	12.0	13.6	5	500	22	125	22.6	-3.8	0.050
1N6464	15.0	16.4	5	500	19	107	26.5	-3.8	0.060
1N6465	24.0	27.0	2	50	12	69	41.4	-3.6	0.084
1N6466	30.5	33.0	1	3	11	63	47.5	-3.6	0.093
1N6467	40.3	43.7	1	2	8	45	63.5	-3.5	0.094
1N6468	51.6	54.0	1	2	6	35	78.5	-3.4	0.096

6

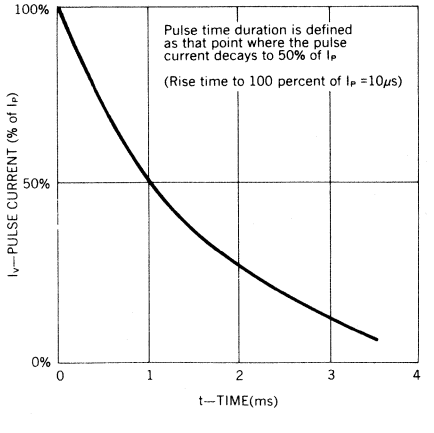
1. Derating Curve



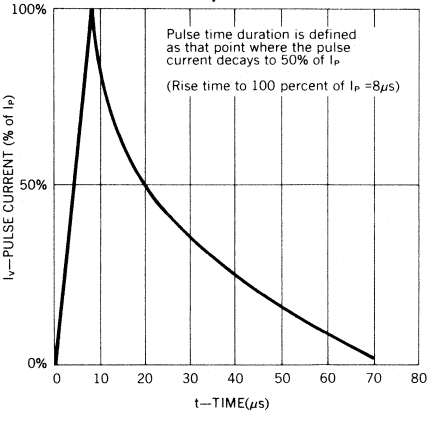
2. Peak Pulse Power vs. Pulse Duration



3. Current Impulse Waveform



4. Current Impulse Waveform



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A

TRANSIENT VOLTAGE SUPPRESSORS

FEATURES

- 500W Peak Pulse Power Dissipation
- Available in Ranges from 5.0V to 170V
- Low Clamping Voltage
- Small Package Size
- Economical Plastic Case
- $t_{clamping}$ (0V to BV min): Less than 1×10^{-12} seconds (theoretical)
- General Semi Compatible

DESCRIPTION

The SA series of transient voltage suppressors is a low cost, 500W commercial and industrial product for use in applications where space is at a premium and where large voltage transients can permanently damage voltage-sensitive components.

This suppressor series has a peak pulse power rating of 500W for one millisecond. The response time of the clamping action is theoretically instantaneous (1×10^{-12} sec); therefore these devices can protect Integrated Circuits, MOS devices, Hybrids, and other voltage-sensitive semiconductors and components. Unitrode suppressors can also be used in series or parallel to increase the peak power ratings.

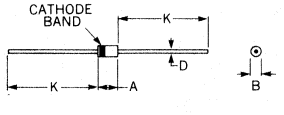
ABSOLUTE MAXIMUM RATINGS @ 25°C

Stand-Off Voltage, V_R ..... 5.0V to 170V
Peak Pulse Power (1ms)* 500W
Forward Surge Current (8.3ms half sinewave) 70A
Peak Pulse Current ..... see Table
Breakdown Voltage ..... see Table
Continuous Power** 1.0W
Storage and Operating Temperature ..... -65 to +175°C

Notes: *See Figure 1 for Peak Pulse Power vs Pulse Duration.
**TL = 75°C, lead length $^3/_8$".

MECHANICAL SPECIFICATIONS

SA5.0 - SA170A



	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.160	0.260	4.06	6.60
B	0.110	0.120	2.79	3.05
D	0.030	0.034	0.76	0.86
K	1.0	—	25.4	—

Soldering 220°C, $^1/_{16}$" from case for ten seconds.

ASA



UNITRODE

Peak Pulse Power vs Pulse Duration

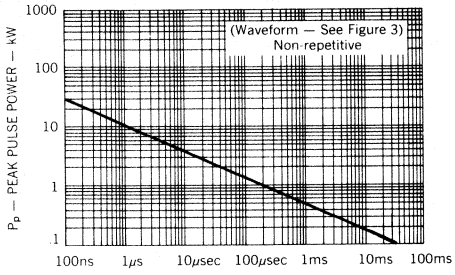


FIGURE 1

Derating Curve

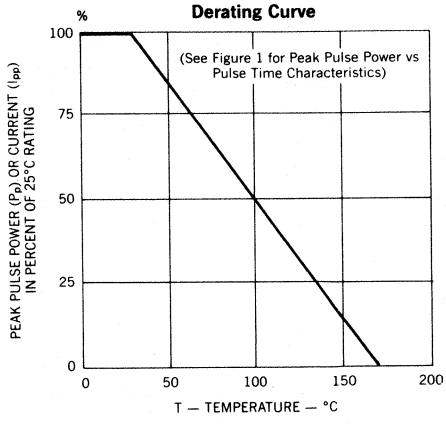


FIGURE 2

Pulse Waveform

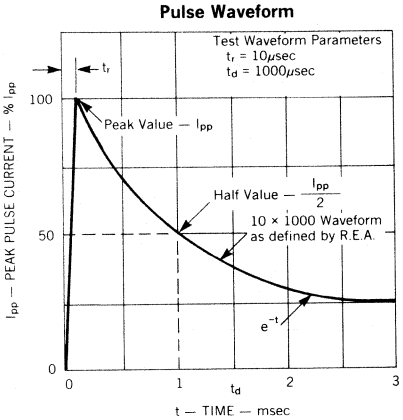


FIGURE 3

Typical Capacitance vs Breakdown Voltage

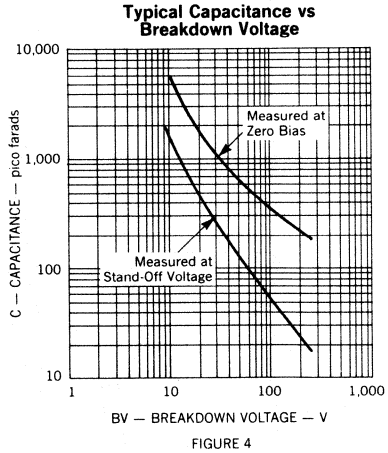


FIGURE 4

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

ELECTRICAL SPECIFICATIONS @ 25°C

Part Number	Reverse Stand-Off Voltage (Note 1) V_R Volts	Breakdown Voltage BV Volts Min.	@ Max.	I_T mA	Maximum Reverse Leakage @ V_R I_R μA	Maximum Clamping Voltage @ I_{pp} (Fig. 3) V_C Volts	Maximum Peak Pulse Current (Fig. 3) I_{pp} A	Maximum Voltage Temperature Variation of BV mV/°C
SA5.0	5.0	6.40	7.30	10	600	9.6	52.0	5.0
SA5.0A	5.0	6.40	7.00	10	600	9.2	54.3	5.0
SA6.0	6.0	6.67	8.15	10	600	11.4	43.9	5.0
SA6.0A	6.0	6.67	7.37	10	600	10.3	48.5	5.0
SA6.5	6.5	7.22	8.22	10	400	12.3	40.7	5.0
SA6.5A	6.5	7.22	7.98	10	400	11.2	44.7	5.0
SA7.0	7.0	7.78	9.51	10	150	13.3	37.8	6.0
SA7.0A	7.0	7.78	8.60	10	150	12.0	41.7	6.0
SA7.5	7.5	8.33	10.2	1	50	14.3	35.0	7.0
SA7.5A	7.5	8.33	9.21	1	50	12.9	38.8	7.0
SA8.0	8.0	8.89	10.9	1	25	15.0	33.3	7.0
SA8.0A	8.0	8.99	9.3	1	25	13.6	36.7	7.0
SA8.5	8.5	9.44	11.5	1	5	15.9	31.4	8.0
SA8.5A	8.5	9.44	10.4	1	5	14.4	34.7	8.0
SA9.0	9.0	10.0	12.2	1	1	16.9	29.5	9.0
SA9.0A	9.0	10.0	11.1	1	1	15.4	32.5	9.0
SA10	10	11.1	13.6	1	1	18.8	26.6	10
SA10A	10	11.1	12.3	1	1	17.0	29.4	10
SA11	11	12.2	14.9	1	1	20.1	24.9	11
SA11A	11	12.2	13.5	1	1	18.2	27.4	11
SA12	12	13.3	16.3	1	1	22.0	22.7	12
SA12A	12	13.3	14.7	1	1	19.9	25.1	12
SA13	13	14.4	17.6	1	1	23.8	21.0	13
SA13A	13	14.4	15.9	1	1	21.5	23.2	13
SA14	14	15.6	19.1	1	1	25.8	19.4	14
SA14A	14	15.6	17.2	1	1	23.2	21.5	14
SA15	15	16.7	20.4	1	1	26.9	18.8	16
SA15A	15	16.7	18.5	1	1	24.4	20.6	16
SA16	16	17.8	21.8	1	1	28.8	17.6	19
SA16A	16	17.8	19.7	1	1	26.0	19.2	17
SA17	17	18.9	23.1	1	1	30.5	16.4	20
SA17A	17	18.9	20.9	1	1	27.6	18.1	19
SA18	18	20.0	24.4	1	1	32.2	15.5	21
SA18A	18	20.0	22.1	1	1	29.2	17.2	20
SA20	20	22.2	27.1	1	1	35.8	13.9	25
SA20A	20	22.2	24.5	1	1	32.4	15.4	23
SA22	22	24.4	29.8	1	1	39.4	12.7	28
SA22A	22	24.4	26.9	1	1	35.5	14.1	25
SA24	24	26.7	32.6	1	1	43.0	11.6	31
SA24A	24	26.7	29.5	1	1	38.9	12.8	28
SA26	26	28.9	35.3	1	1	46.6	10.7	31
SA26A	26	28.9	31.9	1	1	42.1	11.9	30
SA28	28	31.1	38.0	1	1	50.0	9.9	35
SA28A	28	31.1	34.4	1	1	45.4	11.0	31
SA30	30	33.3	40.7	1	1	53.5	9.3	39
SA30A	30	33.3	36.8	1	1	48.4	10.3	36
SA33	33	36.7	44.9	1	1	59.0	8.5	42
SA33A	33	36.7	40.6	1	1	53.3	9.4	39

Note: 1. A transient voltage supressor is normally selected according to the reverse "Stand-Off Voltage" (V_R) which should be equal to or greater than the DC or continuous peak operating voltage level.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

ELECTRICAL SPECIFICATIONS @ 25°C

Part Number	Reverse Stand-Off Voltage (Note 1) V_R Volts	Breakdown Voltage BV Volts Min.	Breakdown Voltage BV Volts Max.	@ I_T mA	Maximum Reverse Leakage @ V_R I_R μA	Maximum Clamping Voltage @ I_{pp} (Fig. 3) V_c Volts	Maximum Peak Pulse Current (Fig. 3) I_{pp} A	Maximum Voltage Temperature Variation of BV mV/°C
SA36	36	40.0	48.9	1	1	64.3	7.8	46
SA36A	36	40.0	44.2	1	1	58.1	8.6	41
SA40	40	44.4	54.3	1	1	71.4	7.0	51
SA40A	40	44.4	49.1	1	1	64.5	7.8	46
SA43	43	47.8	58.4	1	1	76.7	6.5	55
SA43A	43	47.8	52.8	1	1	69.4	7.2	50
SA45	45	50.0	61.1	1	1	80.3	6.2	58
SA45A	45	50.0	55.3	1	1	72.7	6.9	52
SA48	48	53.3	65.1	1	1	85.5	5.8	63
SA48A	48	53.3	58.9	1	1	77.4	6.5	56
SA51	51	56.7	69.3	1	1	91.1	5.5	66
SA51A	51	56.7	62.7	1	1	82.4	6.1	61
SA54	54	60.0	73.3	1	1	96.3	5.2	71
SA54A	54	60.0	66.3	1	1	87.1	5.7	65
SA58	58	64.4	78.7	1	1	103.0	4.9	78
SA58A	58	64.4	71.2	1	1	93.6	5.3	70
SA60	60	66.7	81.5	1	1	107.0	4.7	80
SA60A	60	66.7	73.7	1	1	96.8	5.2	71
SA64	64	71.1	86.9	1	1	114.8	4.4	86
SA64A	64	71.1	78.6	1	1	103.0	4.9	76
SA70	70	77.8	95.1	1	1	125	4.0	94
SA70A	70	77.8	86.0	1	1	113	4.4	85
SA75	75	83.3	102.0	1	1	134	3.7	101
SA75A	75	83.3	92.1	1	1	121	4.1	91
SA78	78	86.7	106.0	1	1	139	3.6	105
SA78A	78	86.7	95.8	1	1	126	4.0	95
SA85	85	94.4	115.0	1	1	151	3.3	114
SA85A	85	94.4	104.0	1	1	137	3.6	103
SA90	90	100	122	1	1	160	3.1	121
SA90A	90	100	111	1	1	146	3.4	110
SA100	100	111	136	1	1	179	2.8	135
SA100A	100	111	123	1	1	162	3.1	123
SA110	110	122	149	1	1	196	2.6	148
SA110A	110	122	135	1	1	177	2.8	133
SA120	120	133	163	1	1	214	2.3	162
SA120A	120	133	147	1	1	193	2.0	146
SA130	130	144	176	1	1	231	2.2	175
SA130A	130	144	159	1	1	209	2.4	158
SA150	150	167	204	1	1	268	1.9	203
SA150A	150	167	185	1	1	243	2.1	184
SA160	160	178	218	1	1	287	1.7	217
SA160A	160	178	197	1	1	259	1.9	196
SA170	170	189	231	1	1	304	1.6	230
SA170A	170	189	209	1	1	275	1.8	208

Note: 1. A transient voltage supressor is normally selected according to the reverse "Stand-Off Voltage" (V_R) which should be equal to or greater than the DC or continuous peak operating voltage level.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

TRANSIENT VOLTAGE SUPPRESSORS

SAB5.0-SAB28

FEATURES

- Voltages from 5.0V to 28V Stand-Off (V_R)
- Small Package Size
- Economical Plastic Case
- Low Clamping Ratio
- $t_{clamping}$ (0V to BV min): Less than 1×10^{-12} seconds (theoretical)

DESCRIPTION

The SAB series is a low cost, 500W transient voltage suppressor designed for board level protection of Bipolar and MOS memories from ESD (Electrostatic Discharge) and other transient voltages.

Because of the low clamping factor, these suppressors provide a high degree of protection of VMOS, HMOS and CMOS circuits susceptible to line transients.

Unitrode transient suppressors are characterized by their high surge capability, extremely fast response time and low series resistance. They are effective in providing protection against pulses generated by electromagnetic switching, electromagnetic coupling, capacitive or inductive load switching, voltage reversals and ESD. MOS circuits are susceptible to damage from these pulses even with various Input Protection Networks.

ABSOLUTE MAXIMUM RATINGS @ 25°C

Stand-Off Voltage, V_R ..... 5.0V to 28V
Peak Pulse Power (1ms)* 500W
Forward Surge Current (8.3ms half sinewave) 70A
Peak Pulse Current ..... see Table
Breakdown Voltage ..... see Table
Continuous Power** 1.0W
Storage and Operating Temperature ..... -65 to +175°C

Notes: *See Figure 1 for Peak Pulse Power vs Pulse Duration.
**TL = 75°C, lead length $^3/_8$".

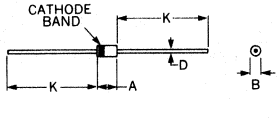
ELECTRICAL SPECIFICATIONS @ 25°C

Part Number	Reverse Stand-Off Voltage (Note 1) V_R Volts	Maximum Reverse Leakage Current I_R @ V_R μA	Minimum Breakdown Voltage Bv(min) @ 1mA Volts	Maximum Clamping Voltage (Fig. 2) V_C @ 1A Volts	Typical Clamping Voltage V_C Volts @ 5A	Typical Clamping Voltage V_C Volts @ 10A	Maximum Clamping Voltage (Fig. 2) V_C @ I_{pp} Volts	Maximum Peak Pulse Current (Fig. 2) I_{pp} Amps
SAB5.0	5.0	300	6.0	7.4	—	7.9	9.3	53.7
SAB10	10.0	2	11.1	13.2	—	14.4	16.5	30.3
SAB12	12.0	2	13.8	16.5	—	18.5	21.0	23.8
SAB15	15.0	2	16.7	19.7	—	22.2	25.2	19.8
SAB18	18.0	2	20.4	23.8	26.0	—	30.5	16.3
SAB24	24.0	2	28.4	32.4	37.0	—	42.0	11.9
SAB28	28.0	2	30.7	35.9	41.0	—	46.5	10.7

Note: 1. A transient voltage supressor is normally selected according to the reverse "Stand-Off Voltage" (V_R) which should be equal to or greater than the DC or continuous peak operating voltage level.

MECHANICAL SPECIFICATIONS

SAB5.0 - SAB28



	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.160	0.260	4.06	6.60
B	0.110	0.120	2.79	3.05
D	0.030	0.034	0.76	0.86
K	1.0	—	25.4	—

Soldering 220°C, $^1/_{16}$" from case for ten seconds.

ASA



UNITRODE

Peak Pulse Power vs Pulse Duration

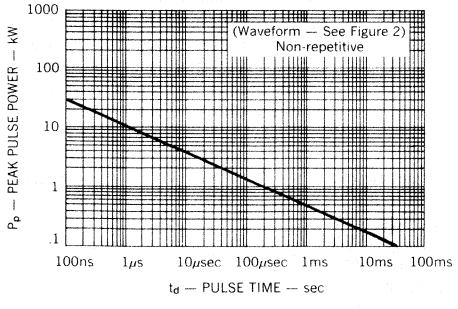


FIGURE 1

Pulse Waveform

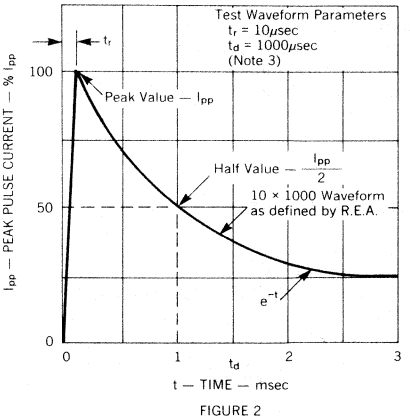


FIGURE 2

TRANSIENT VOLTAGE SUPPRESSORS

TVS305-TVS430
TVS505-TVS528

FEATURES

- Up to 500W for 1mS Pulse Power Capability
- Clamping Time in Picoseconds
- Direct Applicability for all popular Microprocessors and IC families
- Metallurgically bonded assembly system to assure long term reliability
- Miniature glass encased hermetically sealed package

DESCRIPTION

Unitrode's TVS series of transient voltage suppressors feature oxide passivated zener type chips with full-faced metallurgical bonds on both sides to achieve high surge capability and negligible electrical degradation under repeated surge conditions. The series is especially useful in protecting microprocessor, MOS, CMOS, TTL, Schottky TTL, ECL, I^2L and linear integrated circuits from spurious transient disturbances.

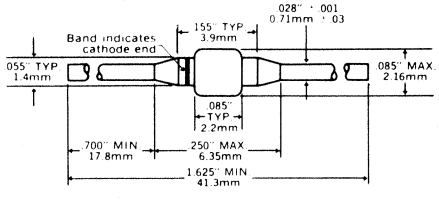
ABSOLUTE MAXIMUM RATINGS @ 25°C

	TVS305-TVS430	TVS505-TVS528
Stand-off Voltage, V_R	5 to 300V	5.0V to 28.0V
Peak Pulse Power (1mS)*	150W	500W
Forward Surge Current (8.3mS half sinewave)	15A	50A
Peak Pulse Current	See Table	See Table
Breakdown Voltage	See Table	See Table
Power, Continuous	3W	5W
Storage and Operating Temperature	−65 to +175°C	−65 to +175°C

*See Figures 3 and 4 for Peak Pulse Power vs Pulse Duration.

MECHANICAL SPECIFICATIONS

TVS305 Series

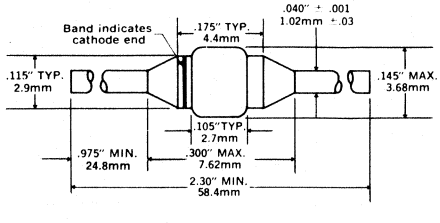


BODY A



MECHANICAL SPECIFICATIONS

TVS505 Series



BODY B



UNITRODE

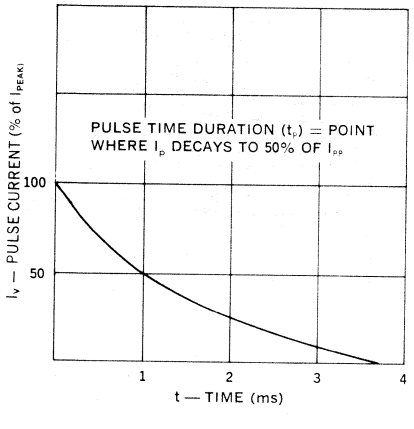
ELECTRICAL SPECIFICATIONS @ 25°C

TVS Part No.	Stand -Off Voltage V_R	Min. Breakdown Voltage $BV_{(min)}$ @ 1mA	Max. Leakage Current I_R @ V_R	Max. Peak Pulse Current* I_{PP}	Max. Clamping Voltage* V_C @ I_{PP}	Max. Clamping Voltage* V_C @ 1A	Max. Clamping Voltage* V_C @ 5A	Max. Clamping Voltage* V_C @ 10A
	V	V	μA	A	V	V	V	
TVS305	5.0	6.0	50	17	8.7	—	—	—
TVS310	10.0	11.1	2	8.9	16.8	—	—	—
TVS312	12	13.8	1	7.1	21.0	—	—	—
TVS315	15	16.7	1	5.9	25	—	—	—
TVS318	18	20.4	1	4.9	31	—	—	—
TVS324	24	28.4	1	3.6	42	—	—	—
TVS328	28	30.7	1	3.2	46	—	—	—
TVS348	48	54	1	1.7	82	—	—	—
TVS360	60	67	1	1.4	105	—	—	—
TVS410	100	111	1	.91	160	—	—	—
TVS420	200	234	1	.42	360	—	—	—
TVS430	300	342	1	.28	520	—	—	—
TVS505	5.0	6.0	300	53.7	9.3	7.4	—	7.9
TVS510	10.0	11.1	5	30.3	16.5	13.2	—	14.4
TVS512	12.0	13.8	5	23.8	21.0	16.5	—	18.5
TVS515	15.0	16.7	5	19.8	25.2	19.7	—	22.2
TVS518	18.0	20.4	5	16.3	30.5	23.8	26.0	—
TVS524	24.0	28.4	5	11.9	42.0	32.4	37.0	—
TVS528	28.0	30.7	5	10.7	46.5	35.9	41.0	—

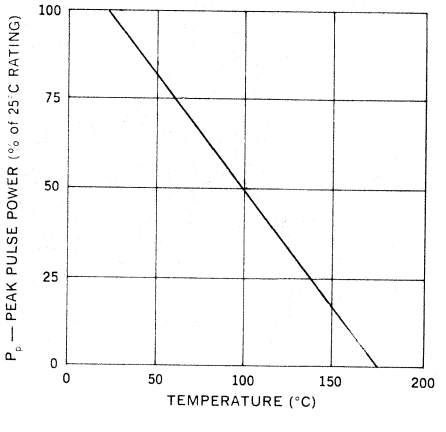
*For 1mS pulse: see Figure 1.

6

1. Pulse Waveform



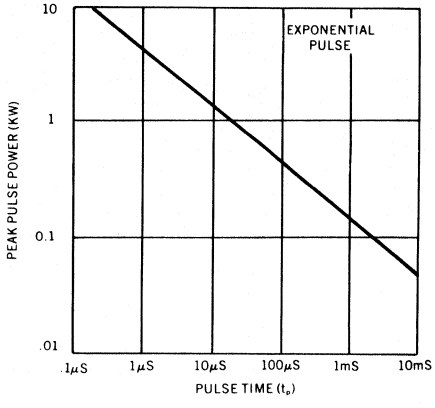
2. Derating Curve



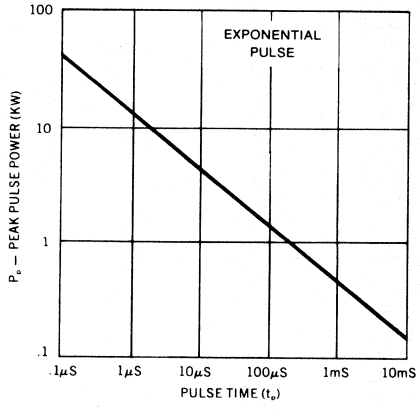
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

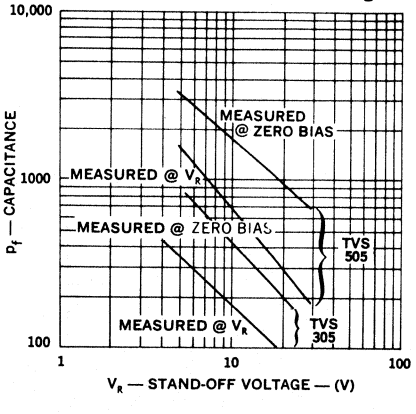
3. Peak Pulse Power vs. Pulse Duration



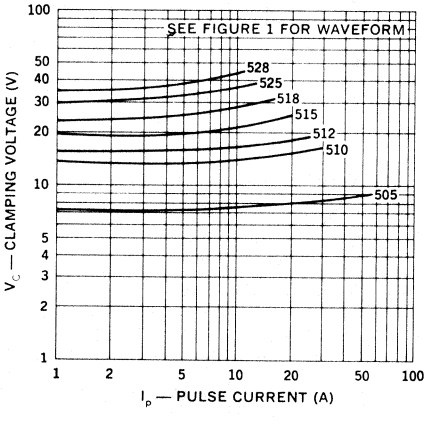
4. Peak Pulse Power vs. Pulse Duration



5. Capacitance vs. Stand-Off Voltage



6. Clamping Voltage vs. Pulse Current



CHOOSING AND SPECIFYING THE PROPER TVS

The following terms are generally used in specifying Transient Voltage Suppressors (TVS):

1. Stand-off Voltage (V_R) is the highest reverse voltage at which the TVS will be non-conducting.
2. Minimum Breakdown Voltage (BV min) is the reverse voltage at which the TVS conducts 1 milli-amp. This is the point where the TVS begins to limit the transient.
3. Maximum Clamping Voltage (V_C max) is the maximum voltage the TVS will allow during a transient "spike."

Figure 7 graphically shows all three terms.

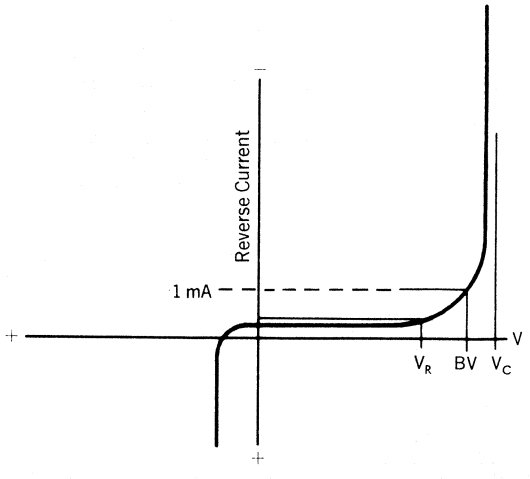


Figure 7

The three most important factors in choosing the appropriate TVS for an application in their order of importance are:

1. Pulse power (P_P) — Choose the TVS series that will handle the Transient Pulse Power. Transient Pulse Power is equal to the clamping voltage (V_C) times the peak pulse current (i_{PP}). The pulse duration vs. pulse power graph on the TVS data sheet can then be used to determine the maximum allowable pulse duration. (Figure 3 or 4).
2. Standoff voltage (V_R) — From the TVS series selected, choose the device with the stand-off voltage equal to or greater than the normal circuit operating voltage.
3. Maximum Clamping Voltage (V_{CMAX}) — Determine the clamping voltage of the device chosen for the transient given and be sure it is below the voltage that might damage any components.

For further information see Unitrode Application Note U-79, "Guidelines for Using Transient Voltage Suppressors."

AC POWER ZENERS
1, 3 and 5 Watt Types

UDZ807 SERIES
UDZ5807 SERIES
UDZ8807 SERIES

FEATURES
- Zener Characteristics in Both Directions
- 7.5 to 60V
- High Surge Ratings
- Small Physical Size

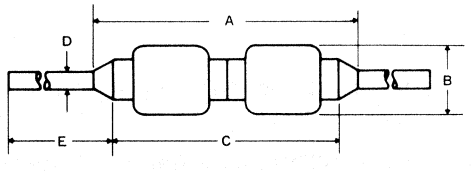
DESCRIPTION
These devices consist of two fused-in-glass zeners brazed cathode to cathode to provide zener action in both directions.

ABSOLUTE MAXIMUM RATINGS

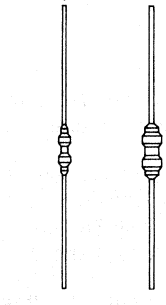
Zener Voltage	7.5 to 60V
Continuous Current	See Tables
Surge Current (8.3ms)	See Tables
Surge Power	See Graph
Power	See Data Sheets for Related Series (UZ8807, UZ807 and UZ5807)
Storage and Operating Temperature	—65°C to +175°C

MECHANICAL SPECIFICATIONS

UDZ807 SERIES UDZ5807 SERIES UDZ8807 SERIES



MARKING: "D," followed by last 3 to 4 digits and part number.
Example: 7.5 volt ±10%, 1 watt type would be marked: "D8807".



Dimensions

1 Watt UDZ8807 Series

	ins.	mm
A	.450 MAX.	11.43 MAX.
B	.085 MAX.	2.16 MAX.
C	.275 TYP.	6.99 TYP.
D	.028 ± .001	.71 ± .03
E	.700 MIN.	17.78 MIN.

3 Watt UDZ807 Series

	ins.	mm
A	.450 MAX.	11.43 MAX.
B	.085 MAX.	2.16 MAX.
C	.275 TYP.	6.99 TYP.
D	.028 ± .001	.71 ± .03
E	.700 MIN.	17.78 MIN.

5 Watt UDZ5807 Series

	ins.	mm
A	.500 MAX.	12.70 MAX.
B	.145 MAX.	3.68 MAX.
C	.325 TYP.	8.26 TYP.
D	.040 ± .001	1.02 ± .03
E	.975 MIN.	24.77 MIN.

UNITRODE

Type	Electrical Specifications at 25°C						Maximum Ratings**	
	Nominal Zener Voltage† V_Z @ I_{ZT}	Test Current I_{ZT}	Max. Zener Imped § Z_Z @ I_{ZT}	Maximum Leakage @ Reverse Voltage · Current	±10%	±5%	Maximum Cont. Current I_{ZM}	Maximum Surge Current‡ I_S
±10% Tolerance*	Volts	mA	Ohms	μA	Volts	Volts	mA	Amps
1 WATT ZENERS — Specifications apply for both directions.								
UDZ8807	7.5	34	6	50	4.9	5.2	125	5
UDZ8808	8.2	31	7	30	5.4	5.7	115	4.5
UDZ8809	9.1	28	8	10	5.9	6.2	105	3.9
UDZ8810	10	25	8.5	3	6.6	6.9	95	3.37
UDZ8812	12	23	9	1	8.6	9.1	85	2.25
UDZ8815	15	17	14	0.5	10.8	11.4	63	1.65
UDZ8818	18	14	20	0.5	12.9	13.7	52	1.12
UDZ8820	20	12.5	23	0.5	14.4	15.2	47	1.12
UDZ8824	24	10.5	25	0.5	17.3	18.2	40	0.825
UDZ8827	27	9.5	35	0.5	19.4	20.6	35	0.825
UDZ8830	30	8.5	40	0.5	21.6	22.8	31	0.825
UDZ8833	33	7.5	45	0.5	23.7	25.1	28	0.675
UDZ8836	36	7.0	50	0.5	25.9	27.4	26	0.562
UDZ8840	40	6.5	62	0.5	28.8	30.4	24	0.562
UDZ8845	45	6	75	0.5	32.4	34.2	22	0.450
UDZ8860	60	4	125	0.5	43.2	45.6	15	0.337
3 WATT ZENERS — Specifications apply for both directions.								
UDZ807	7.5	75	3	500	4.9	5.2	400	10
UDZ808	8.2	75	4	300	5.4	5.7	360	8
UDZ809	9.1	75	4	200	5.9	6.2	330	7
UDZ810	10	75	5	100	6.6	6.9	300	5
UDZ812	12	65	5	10	8.6	9.1	250	4
UDZ815	15	50	6	10	10.8	11.4	200	3
UDZ818	18	40	8	5	12.9	13.7	170	2
UDZ820	20	40	9	5	14.4	15.2	150	2
UDZ824	24	30	10	5	17.3	18.2	125	1.5
UDZ827	27	25	12	1	19.4	20.6	110	1.5
UDZ830	30	25	15	1	21.6	22.8	100	1.5
UDZ833	33	20	21	1	23.7	25.1	90	1.2
UDZ836	36	20	21	1	25.9	27.4	85	1
UDZ840	40	20	27	1	28.8	30.4	75	1
UDZ845	45	15	37	1	32.4	34.7	65	0.8
UDZ860	60	10	70	1	43.2	45.6	50	0.6

*For ±5% voltage tolerance change the 3rd number from the right from 8 to 7 i.e. UDZ8807 to UDZ8707, etc.

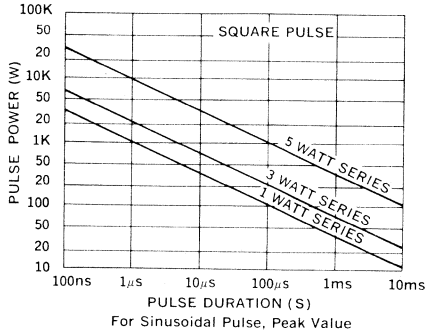
†All zener voltages are measured with an automated test set using a 35ms test time. Longer or shorter test times will have a corresponding effect on the measured value due to heating effects.

§Zener impedance is derived from the 60-cycle voltage created when AC current with RMS value of 10% of DC zener test current is superimposed on the test current.

**D.C. Ratings are based on the lead temperature conditions shown in the data sheets covering the UDZ8807, UDZ807, and UDZ5807 series devices. Other conditions will affect the power ratings of all the families except the 1 watt zener family. However, the surge values given apply for any mounting conditions including printed circuit board mounting.

‡Figures shown are for peak sinusoidal surge current of 8.3ms duration using 60 cycle AC. The 8.3ms square pulse rating is 71% of the value shown.

Typical Reverse Surge Power vs. Surge Duration



For Sinusoidal Pulse, Peak Value is 1.4 Times Value Shown

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Type	Electrical Specifications at 25°C						Maximum Ratings**	
	Nominal Zener Voltage† V_Z @ I_{ZT}	Test Current I_{ZT}	Max. Zener Imped § Zz @ I_{ZT}	Maximum Leakage Current	Reverse Voltage ±10%	Reverse Voltage ±5%	Maximum Cont. Current I_{ZM}	Maximum Surge Current‡ Is
±10% Tolerance*	Volts	mA	Ohms	μA	Volts	Volts	mA	Amps
5 WATT ZENERS — Specifications apply for both directions.								
UDZ5807	7.5	175	1.8	500	4.9	5.2	620	40
UDZ5808	8.2	150	1.8	400	5.4	5.7	570	32
UDZ5809	9.1	150	2.5	200	5.9	6.2	510	24
UDZ5810	10	125	2.5	100	6.6	6.9	470	22
UDZ5812	12	100	2.5	50	8.6	9.1	385	18
UDZ5815	15	75	3.5	15	10.8	11.4	300	12
UDZ5818	18	65	4	10	12.9	13.7	255	9
UDZ5820	20	65	4.5	10	14.4	15.2	220	8
UDZ5824	24	50	5	10	17.3	18.2	180	6.5
UDZ5827	27	50	6	10	19.4	20.6	155	6
UDZ5830	30	40	8	10	21.6	22.8	140	5.5
UDZ5833	33	40	10	5	23.7	25.1	130	5
UDZ5836	36	30	11	5	25.9	27.4	120	4.5
UDZ5840	40	30	14	5	28.8	30.4	105	4
UDZ5845	45	30	20	5	32.4	34.2	95	3.5
UDZ5860	60	20	40	5	43.2	45.6	75	2.5

*For ±5% voltage tolerance change the 3rd number from the right from 8 to 7 i.e. UDZ8807 to UDZ8707, etc.

†All zener voltages are measured with an automated test set using a 35ms test time. Longer or shorter test times will have a corresponding effect on the measured value due to heating effects.

§Zener impedance is derived from the 60-cycle voltage created when AC current with RMS value of 10% of DC zener test current is superimposed on the test current.

**D.C. Ratings are based on the lead temperature conditions shown in the data sheets covering the UDZ8807, UDZ807, and UDZ5807 series devices. Other conditions will affect the power ratings of all the families except the 1 watt zener family. However, the surge values given apply for any mounting conditions including printed circuit board mounting.

‡Figures shown are for peak sinusoidal surge current of 8.3ms duration using 60 cycle AC. The 8.3ms square pulse rating is 71% of the value shown.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER ZENERS
3 Watt

UZ706 SERIES
UZ806 SERIES
UZ706HR SERIES

FEATURES
- 10 Times Greater Surge Rating than Conventional 1 Watt Types
- Small Physical Size

DESCRIPTION
Fused-in-glass metallurgically bonded 3 watt zener diodes.

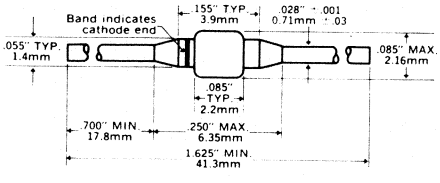
6

ABSOLUTE MAXIMUM RATINGS

Zener Voltage, V_Z	6.8 to 400V
Continuous Current	See Table
Surge Current (8.3ms)	See Table
Surge Power	See Graph
Power	See Lead Temperature Derating Curve
Storage and Operating Temperature	—65°C to +175°C

MECHANICAL SPECIFICATIONS

UZ706 SERIES
UZ806 SERIES
UZ706HR SERIES

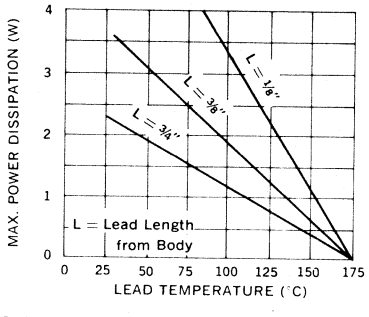


UZ Prefix is identified by a Blue or Red Cathode Band

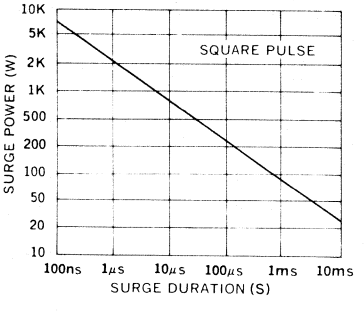
BODY A



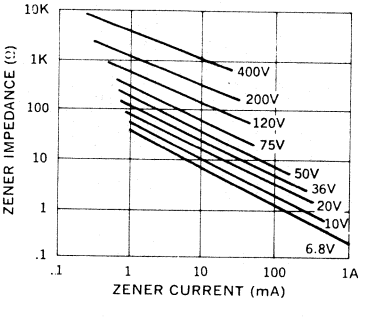
Power Dissipation vs. Lead Temperature Derating Curve



Surge Power vs. Surge Duration



Typical Zener Impedance vs. Zener Current



OPTIONAL HIGH RELIABILITY SCREENING

The following tests are performed on 100% of the devices specified UZ706 through UZ140HR.

SCREEN	MIL-STD-750 METHOD	CONDITIONS
1. High Temperature Life (Stabilization Bake)	1032	24 Hours @ T_A = 175°C
2. Thermal Shock (Temperature Cycling)	1051	10 Cycles @ T_A = (−55°C to +150°C)
3. Interim Electrical Parameters	—	I_R and V_Z @ 25°C
4. Power Burn-In	1038	96 Hours @ T_J = 160°C ± 15°C $T_A \geq$ 25°C, $\leq$ 100°C, $P_D \geq$ 25°C $\leq$ 75% Rating
5. Final Electrical and Delta Parameters	Go/No Go	ΔI_R ± 100% ΔV_Z ± 2.5%

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Type*		Electrical Specifications at 25°C							Maximum Ratings	
		Nominal Zener Voltage † V_Z @ I_{ZT}	Test Current I_{ZT}	Max. Zener Impedance §	Maximum Reverse Leakage Current			Typ. Temp. Coefficient T_C @ I_{ZT}	Maximum Continuous Current ★ I_{ZM}	Maximum Surge Current‡ I_S
				Z_Z @ I_{ZT}	I_R @ V_R	± 5% V_R	± 10% V_R			
±5% Tolerance	Jedec** Registration	Volts	mA	Ohms	μA	Volts	Volts	%/°C	mA	Amps
UZ706/706HR	1N5063	6.8	75	2	500	5.2	4.9	.04	440	10.0
UZ707/707HR	1N5064	7.5	75	2	300	5.7	5.4	.04	400	8.0
UZ708/708HR	1N5065	8.2	75	3	200	6.2	5.9	.05	360	7.0
UZ709/709HR	1N5066	9.1	75	3	100	6.9	6.6	.05	330	6.0
UZ710/710HR	1N5067	10.0	75	4	40	7.6	7.2	.06	300	5.0
UZ712/712HR	1N4883	12	65	5	10	9.1	8.6	.07	250	4.0
UZ713/713HR	1N5069	13	50	6	10	9.9	9.3	.07	230	4.0
UZ714/714HR	1N5070	14	50	6	10	10.6	10.1	.07	210	4.0
UZ715/715HR	1N5071	15	50	6	10	11.4	10.8	.07	200	3.0
UZ716/716HR	1N5072	16	50	7	5	12.2	11.5	.07	185	3.0
UZ718/718HR	1N5073	18	40	8	5	13.7	12.9	.08	170	2.0
UZ720/720HR	1N4884	20	40	9	5	15.2	14.4	.08	150	2.0
UZ722/722HR	1N5074	22	30	10	5	16.7	15.8	.08	135	2.0
UZ724/724HR	1N5075	24	30	10	5	18.2	17.3	.08	125	1.5
UZ727/727HR	1N5076	27	25	12	1	20.6	19.4	.09	110	1.5
UZ730/730HR	1N5077	30	25	15	1	22.8	21.6	.090	100	1.5
UZ733/733HR	1N5078	33	20	21	1	25.1	23.7	.090	90	1.2
UZ736/736HR	1N5079	36	20	21	1	27.4	25.9	.090	85	1.0
UZ740/740HR	1N5081	40	20	27	1	30.4	28.8	.095	75	1.0
UZ745/745HR	1N5083	45	15	37	1	34.2	32.4	.095	65	0.8
UZ750/750HR	1N5085	50	15	50	1	38.0	36.0	.095	60	0.8
UZ756/756HR	1N5087	56	10	70	1	42.6	40.3	.095	55	0.7
UZ760/760HR	1N5088	60	10	70	1	45.7	43.2	.095	50	0.6
UZ770/770HR	1N5091	70	10	90	1	53.3	50.5	.095	45	0.6
UZ775/775HR	1N5092	75	10	100	1	56.0	54.0	.095	40	0.5
UZ780/780HR	1N5093	80	10	115	1	60.8	57.7	.095	35	0.4
UZ790/790HR	1N4096	90	8.0	150	1	68.5	64.8	.095	30	0.4
UZ110/110HR	1N4097	100	5.0	175	1	76.0	72.0	.100	30	0.4
UZ111/111HR	1N5096	110	5.0	250	1	83.6	79.2	.100	25	0.3
UZ112/112HR	1N5097	120	5.0	325	1	91.2	86.4	.100	25	0.2
UZ113/113HR	1N5098	130	5.0	375	1	98.8	93.6	.100	20	0.20
UZ114/114HR	1N5099	140	5.0	550	1	106	101	.100	20	0.20
UZ115/115HR	1N4098	150	5.0	650	1	114	108	.100	20	0.20
UZ116/116HR	1N5100	160	4.0	700	1	122	115	.100	20	0.15
UZ117/117HR	1N5101	170	4.0	750	1	129	122	.100	18	0.15
UZ118/118HR	1N5102	180	4.0	850	1	137	129	.100	18	0.10
UZ119/119HR	1N5103	190	4.0	900	1	144	137	.100	15	0.10
UZ120/120HR	1N5104	200	4.0	950	1	152	144	.100	15	0.10
UZ122/122HR	1N5105	220	3.0	1100	1	167	158	.100	15	0.09
UZ124/124HR	1N5106	240	3.0	1300	1	182	173	.105	12	0.09
UZ126/126HR	1N5107	260	3.0	1500	1	198	187	.105	12	0.08
UZ128/128HR	1N5109	280	3.0	1700	1	213	202	.105	10	0.08
UZ130/130HR	1N5110	300	3.0	1900	1	228	216	.105	10	0.07
UZ132/132HR	1N5111	320	2.0	2100	1	243	230	.105	9	0.07
UZ134/134HR	1N5113	340	2.0	2400	1	258	245	.110	9	0.06
UZ136/136HR	1N5114	360	2.0	2700	1	274	259	.110	8	0.06
UZ138/138HR	1N5115	380	2.0	3000	1	289	274	.110	8	0.06
UZ140/140HR	1N5117	400	2.0	3500	1	304	288	.110	7	0.06

* Specify 20% voltage tolerance by changing first numeral of type number from 7 to 9. (UZ709 becomes UZ909) or from 1 to 3 (UZ111 becomes UZ311).
Specify 10% voltage tolerance by changing first numeral of type number from 7 to 8. (UZ709 becomes UZ809) or from 1 to 2 (UZ111 becomes UZ211).

** Jedec registration applies to ±5% tolerance zeners only.

† All zener voltages are measured with an automated test set using a 35 ms test time. Longer or shorter test times will have a corresponding effect on the measured value due to heating effects.

§ Zener impedance is derived from the 60-cycle AC voltage created when AC current with RMS value of 10% of DC zener test current is superimposed on the test current.

★ Maximum current based on 3 watt rating. See lead temperature derating curves for proper mounting methods.

‡ Figures shown are for a peak sinusoidal surge current of 8.3ms duration using 60 cycle AC. The 8.3ms square pulse rating is 71% of the value shown.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER ZENERS
5 Watt, Industrial

UZ4706 SERIES
UZ4806 SERIES

FEATURES
- 2 Times Greater Surge Rating than Plastic Types
- Small Physical Size
- Impervious to Moisture

DESCRIPTION
Fused-in-glass 5 watt zeners with the same electrical specs as the 1N5342-1N5388 series.

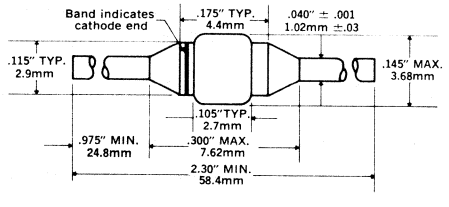
6

ABSOLUTE MAXIMUM RATINGS

Zener Voltage, V_Z	6.8 to 200V
Continuous Current	See Table
Surge Current (8.3ms)	See Table
Surge Power	See Graph
Power	See Lead Temperature Derating Curve
Storage and Operating Temperature	−65°C to +175°C

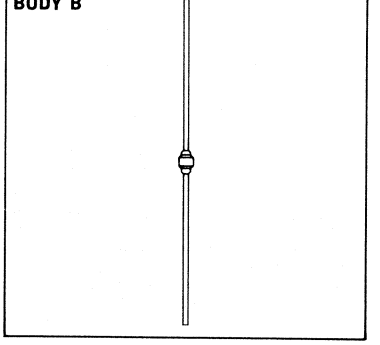
MECHANICAL SPECIFICATIONS

UZ4706 SERIES UZ4806 SERIES

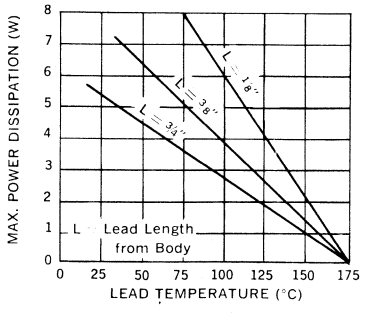


UZ Prefix is identified by a Blue or Red Cathode Band

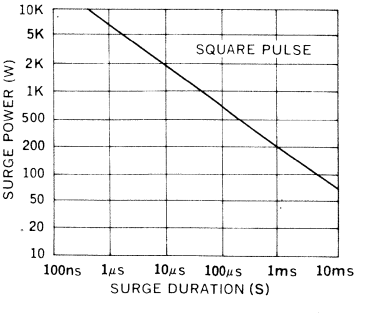
BODY B



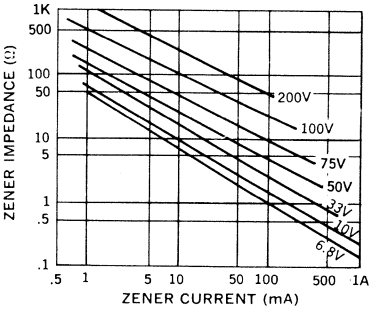
Power Dissipation vs. Lead Temperature Derating Curve



Surge Power vs. Surge Duration



Typical Zener Impedance vs. Zener Current



UNITRODE

Type		Electrical Specifications at 25°C							Maximum Ratings	
		Nominal Zener Voltage † V_Z @ I_{ZT}	Test Current I_{ZT}	Max. Zener Impedance §		Reverse Voltage			Maximum Cont. Current I_{ZM}	Maximum Surge Current ‡ I_S
				Z_Z @ I_{ZT}	Z_{ZK} @ I_{ZK} = 1mA	Maximum Leakage @ Reverse Voltage Current	±10%	±5%		
±5% Tolerance	±10% Tolerance	Volts	mA	Ohms	Ohms	μA	Volts	Volts	mA	Amps
UZ4706	UZ4806	6.8	175	1	1000	500	4.9	5.2	675	32
UZ4707	UZ4807	7.5	175	1.5	800	400	5.4	5.7	620	26.5
UZ4708	UZ4808	8.2	150	1.5	600	200	5.9	6.2	570	19.2
UZ4709	UZ4809	9.1	150	2	400	100	6.6	6.9	510	17.6
UZ4710	UZ4810	10	125	2	125	75	7.2	7.6	470	16
UZ4712	UZ4812	12	100	2.5	140	50	8.6	9.1	385	14.4
UZ4713	UZ4813	13	100	3	145	25	9.3	9.9	350	12.8
UZ4715	UZ4815	15	75	3.5	150	15	10.8	11.4	300	9.6
UZ4716	UZ4816	16	75	3.5	155	10	11.5	12.2	275	8
UZ4718	UZ4818	18	65	4	160	10	12.9	13.7	255	7.2
UZ4720	UZ4820	20	65	4.5	165	10	14.4	15.2	220	6.4
UZ4722	UZ4822	22	50	5	170	10	15.8	16.7	195	5.6
UZ4724	UZ4824	24	50	5	175	10	17.3	18.2	180	5.2
UZ4727	UZ4827	27	50	6	180	10	19.4	20.6	155	4.8
UZ4730	UZ4830	30	40	8	190	10	21.6	22.8	140	4.4
UZ4733	UZ4833	33	40	10	200	5	23.7	25.1	130	4.0
UZ4736	UZ4836	36	30	11	220	5	25.9	27.4	120	3.6
UZ4739	UZ4839	39	30	14	230	5	28.1	29.7	105	3.2
UZ4743	UZ4843	43	30	20	240	5	31	32.7	100	2.8
UZ4747	UZ4847	47	25	25	250	5	33.8	35.8	96	2.6
UZ4751	UZ4851	51	25	27	270	5	36.7	38.8	85	2.4
UZ4756	UZ4856	56	20	35	320	5	40.3	42.6	81	2.2
UZ4762	UZ4862	62	20	42	400	5	44.6	47.1	73	2.0
UZ4768	UZ4868	68	20	50	500	5	49.0	51.7	61	1.8
UZ4775	UZ4875	75	20	55	620	5	54.0	56	60	1.6
UZ4782	UZ4882	82	15	80	720	5	59.0	62.2	55	1.4
UZ4791	UZ4891	91	15	90	760	5	65.5	69.2	50	1.3
UZ4110	UZ4210	100	12	100	800	5	72.0	76.0	45	1.1
UZ4111	UZ4211	110	12	125	1000	5	79.2	83.6	40	1.0
UZ4112	UZ4212	120	10	170	1150	5	86.4	91.2	38	.8
UZ4113	UZ4213	130	10	190	1250	5	93.6	98.8	35	.64
UZ4115	UZ4215	150	8	330	1500	5	108	114.0	31	.60
UZ4116	UZ4216	160	8	350	1650	5	115	121.6	30	.56
UZ4118	UZ4218	180	5	450	1750	5	129	136.8	25	.48
UZ4120	UZ4220	200	5	500	1850	5	144	152.0	22	.40

Maximum V_F @ 1.0 Amp = 1.2 Volts for all types

†All zener voltages are measured with an automated test set using a 35 ms test time. Longer or shorter test times will have a corresponding effect on the measured value due to heating effects.

§Zener impedance is derived from the 60-cycle voltage created when AC current with RMS value of 10% of DC zener test current is superimposed on the test current.

‡Figures shown are for peak sinusoidal surge current of 8.3 ms duration using 60 cycle AC. The 8.3ms square pulse rating is 71% of the value shown.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER ZENERS
5 Watt

UZ5706 SERIES
UZ5806 SERIES

FEATURES
- 2 Times Greater Surge Rating than Conventional 10 Watt Zeners
- Small Physical Size

DESCRIPTION
Fused-in-glass, metallurgically-bonded 5 watt zeners.

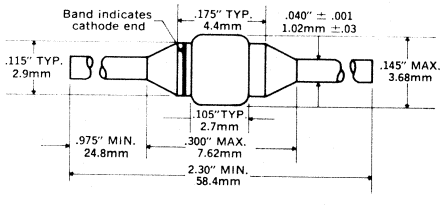
6

ABSOLUTE MAXIMUM RATINGS

Zener Voltage, V_Z	6.8 to 400V
Continuous Current	See Table
Surge Current (8.3ms)	See Table
Surge Power	See Graph
Power	See Lead Temperature Derating Curve
Storage and Operating Temperature	−65°C to +175°C

MECHANICAL SPECIFICATIONS

UZ5706 SERIES UZ5806 SERIES

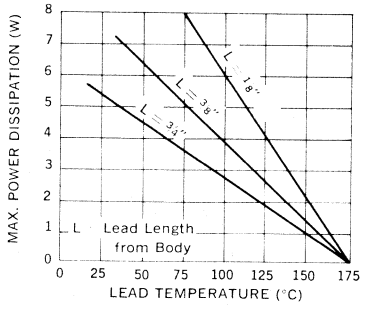


UZ Prefix is identified by a Blue or Red Cathode Band

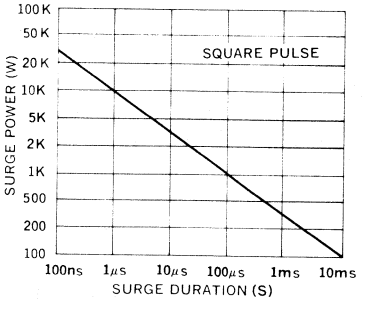
BODY B



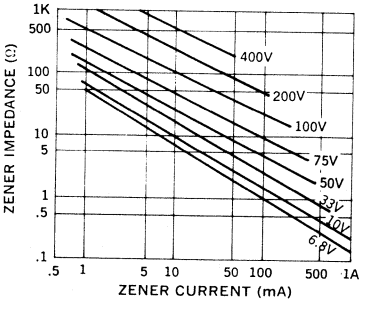
Power Dissipation vs. Lead Temperature Derating Curve



Surge Power vs. Surge Duration



Typical Zener Impedance vs. Zener Current



UNITRODE

Type *		Electrical Specifications at 25°C							Maximum Ratings	
		Nominal Zener Voltage † V_Z @ I_{ZT}	Test Current I_{ZT}	Max. Zener Impedance § Z_Z @ I_{ZT}	Maximum Reverse Leakage Current			Typ. Temp. Coeff. T_C @ I_{ZT}	Maximum Continuous Current ★ I_{ZM}	Maximum Surge Current ‡ I_S
					I_R	± 5% V_R	± 10% V_R			
±5% Tolerance	±10% Tolerance	Volts	mA	Ohms	μA	Volts	Volts	%/°C	mA	Amps
UZ5706	UZ5806	6.8	175	1.0	500	5.2	4.9	.05	675	40
UZ5707	UZ5807	7.5	175	1.5	400	5.7	5.4	.06	620	32
UZ5708	UZ5808	8.2	150	1.5	200	6.2	5.9	.06	570	24
UZ5709	UZ5809	9.1	150	2.0	100	6.9	6.6	.06	510	22
UZ5710	UZ5810	10.0	125	2.0	75	7.6	7.2	.07	470	20
UZ5712	UZ5812	12	100	2.5	50	9.1	8.6	.07	385	18
UZ5713	UZ5813	13	100	3.0	25	9.9	9.3	.08	350	16
UZ5714	UZ5814	14	100	3.0	20	10.6	10.1	.08	320	14
UZ5715	UZ5815	15	75	3.5	15	11.4	10.8	.08	300	12
UZ5716	UZ5816	16	75	3.5	10	12.2	11.5	.08	275	10
UZ5718	UZ5818	18	65	4.0	10	13.7	12.9	.085	255	9.0
UZ5720	UZ5820	20	65	4.5	10	15.2	14.4	.085	220	8.0
UZ5722	UZ5822	22	50	5.0	10	16.7	15.8	.085	195	7.0
UZ5724	UZ5824	24	50	5.0	10	18.2	17.3	.090	180	6.5
UZ5727	UZ5827	27	50	6.0	10	20.6	19.4	.090	155	6.0
UZ5730	UZ5830	30	40	8	10	22.8	21.6	.09	140	5.5
UZ5733	UZ5833	33	40	10	5	25.1	23.7	.09	130	5.0
UZ5736	UZ5836	36	30	11	5	27.4	25.9	.095	120	4.5
UZ5740	UZ5840	40	30	14	5	30.4	28.8	.095	105	4.0
UZ5745	UZ5845	45	30	20	5	34.2	32.4	.095	95	3.5
UZ5750	UZ5850	50	25	25	5	38.0	36.0	.095	85	3.0
UZ5756	UZ5856	56	20	35	5	42.6	40.3	.095	80	2.8
UZ5760	UZ5860	60	20	40	5	45.7	43.2	.100	75	2.5
UZ5770	UZ5870	70	20	50	5	53.3	50.5	.100	65	2.3
UZ5775	UZ5875	75	15	55	5	56.0	54.0	.100	60	2.0
UZ5780	UZ5880	80	15	80	5	60.8	57.7	.100	55	1.8
UZ5790	UZ5890	90	15	90	5	68.5	64.8	.100	50	1.6
UZ5110	UZ5210	100	10	100	5	76.0	72.0	.100	45	1.4
UZ5111	UZ5211	110	10	125	5	83.6	79.2	.100	40	1.2
UZ5112	UZ5212	120	10	170	5	91.2	86.4	.100	38	1.0
UZ5113	UZ5213	130	10	190	5	98.8	93.6	.105	35	0.80
UZ5114	UZ5214	140	8	230	5	106.0	101.0	.105	33	0.80
UZ5115	UZ5215	150	8	330	5	114.0	108.0	.105	31	0.75
UZ5116	UZ5216	160	8	350	5	122.0	115.0	.105	30	0.70
UZ5117	UZ5217	170	8	380	5	129.0	122.0	.105	27	0.65
UZ5118	UZ5218	180	5	450	5	137	129	.110	25	0.60
UZ5119	UZ5219	190	5	470	5	144	137	.110	24	0.55
UZ5120	UZ5220	200	5	500	5	152	144	.110	22	0.50
UZ5122	UZ5222	220	5	550	5	167	158	.115	20	0.45
UZ5124	UZ5224	240	5	650	5	182	173	.115	18	0.40
UZ5126	UZ5226	260	5	750	5	198	187	.120	17	0.35
UZ5128	UZ5228	280	4	850	5	213	202	.120	16	0.30
UZ5130	UZ5230	300	4	950	5	228	216	.120	15	0.25
UZ5132	UZ5232	320	4	1100	5	243	230	.120	14	0.24
UZ5134	UZ5234	340	4	1200	5	258	245	.120	13	0.23
UZ5136	UZ5236	360	3	1400	5	274	259	.120	12	0.22
UZ5138	UZ5238	380	3	1500	5	289	274	.120	12	0.21
UZ5140	UZ5240	400	3	1800	5	304	288	.120	11	0.20

Temperature Range: Operating and Storage −65°C to +175°C.

* Specify 20% tolerance by changing the second numeral of type number from 8 to 9 (UZ5809 becomes UZ5909) or from 2 to 3 (UZ5211 becomes UZ5311).

† All zener voltages are measured with an automated test set using a 35 millisecond test time. Longer or shorter test times will have a corresponding effect on the measured value due to heating effects.

§ Zener impedance is derived from the 60-cycle AC voltage created when AC current with RMS value of 10% of DC zener test current is superimposed on the test current.

★ Maximum current based on 5 watt rating. See lead temperature derating curves for proper mounting methods.

‡ Figures shown are for a peak sinusoidal surge current of 8.3ms duration using 60 cycle AC. The 8.3ms square pulse rating is 71% of the value shown.

Several of the above types now have JEDEC 1N type numbers. The following cross-reference table lists the appropriate 1N numbers; specifications are same as above.

JEDEC #	UNITRODE TYPE	JEDEC #	UNITRODE TYPE	JEDEC #	UNITRODE TYPE
1N5118	UZ5714	1N5124	UZ5780	1N5130	UZ5128
1N5119	UZ5740	1N5125	UZ5790	1N5131	UZ5132
1N5120	UZ5745	1N5126	UZ5114	1N5132	UZ5134
1N5121	UZ5750	1N5127	UZ5117	1N5133	UZ5138
1N5122	UZ5760	1N5128	UZ5119	1N5134	UZ5140
1N5123	UZ5770	1N5129	UZ5126		

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER ZENERS
6 Watt, Military, 10 Watt Military

UZ7706L and UZ7806L SERIES
UZ7706 and UZ7806 SERIES

FEATURES
- High Surge Rating
- Small Physical Size
- Leaded and Stud Packages Available

DESCRIPTION
Fused-in-glass, metallurgically bonded 6 watt leaded zeners and 10 watt stud-type zeners.

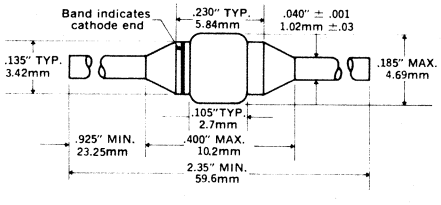
6

ABSOLUTE MAXIMUM RATINGS

Zener Voltage, V_Z	6.8 to 100V
Continuous Current	See Table
Surge Current (8.3ms)	See Table
Surge Power	See Graph
Power — UZ7706L & UZ7806L	See Lead Temperature Derating Curve
UZ7706 & UZ7806 @100°C Case	10W
Storage and Operating Temperature	−65°C to +175°C

MECHANICAL SPECIFICATIONS

UZ7706L and UZ7806L SERIES

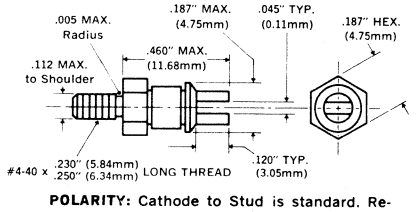


UZ Prefix is identified by a Blue or Red Cathode Band

BODY C — Lead Mount



UZ7706 and UZ7806 SERIES



POLARITY: Cathode to Stud is standard. Reverse polarity denoted by "R" suffix.

FINISH: Metal parts gold plated per MIL-G-45204, Type II.

WEIGHT: 1.5 grams (max.)

INSTALLATION PRECAUTIONS: Maximum unlubricated stud torque: 28 inch-ounces. Do not use a screwdriver in the turret slot for installation purposes, or damage may result.

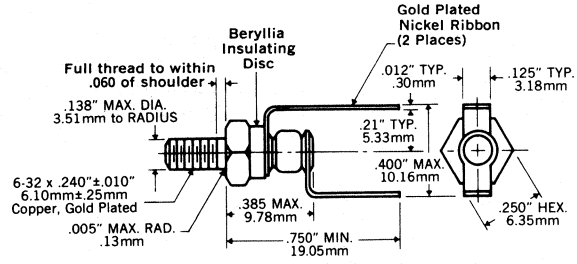
Also available with insulated stud. Reference Design Note-17.

BODY C — Stud Mount



UNITRODE

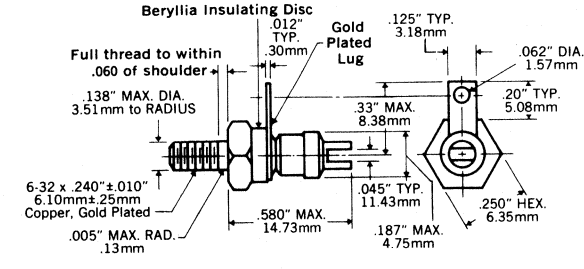
MECHANICAL SPECIFICATIONS



Dimensions in inches.

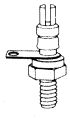
Style W



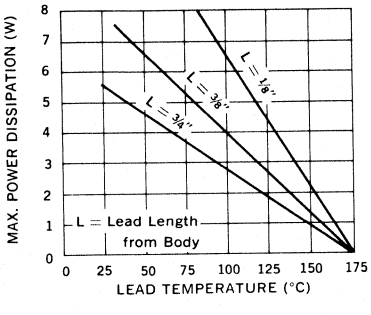


Dimensions in inches.

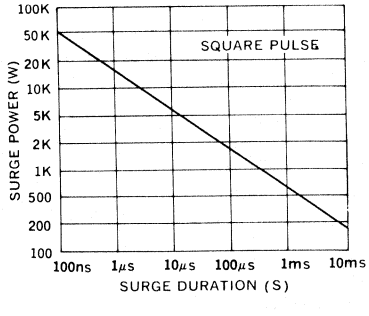
Style V



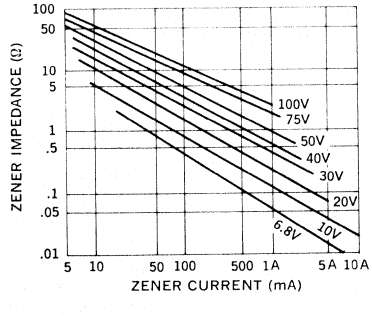
Power Dissipation vs. Lead Temperature Derating Curve



Surge Power vs. Surge Duration



Typical Zener Impedance vs. Zener Current



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Type *		Electrical Specifications at 25°C							Maximum Ratings	
		Nominal Zener Voltage † V_Z @ I_{ZT}	Test Current I_{ZT}	Max. Zener Impedance § Z_Z @ I_{ZT}	Maximum Reverse Leakage Current			Typ. Temp. Coeff. T_C @ I_{ZT}	Maximum Continuous Current ★ I_{ZM}	Maximum Surge Current ‡ I_S
					I_R @ V_R	± 5% V_R	± 10% V_R			
±5% Tolerance	±10% Tolerance	Volts	mA	Ohms	μA	Volts	Volts	%/°C	mA	Amps
UZ7706	UZ7806	6.8	350	0.6	1000	5.2	4.9	.04	1350	50
UZ7707	UZ7807	7.5	325	0.7	800	5.7	5.4	.04	1250	41
UZ7708	UZ7808	8.2	300	0.8	200	6.2	5.9	.05	1150	31
UZ7709	UZ7809	9.1	275	1.0	150	6.9	6.6	.05	1020	29
UZ7710	UZ7810	10.0	250	1.0	100	7.6	7.2	.06	950	26
UZ7712	UZ7812	12	200	1.3	75	9.1	8.6	.07	770	23
UZ7713	UZ7813	13	200	1.5	50	9.9	9.3	.07	700	21
UZ7714	UZ7814	14	175	1.5	40	10.6	10.1	.07	640	20
UZ7715	UZ7815	15	150	2.0	30	11.4	10.8	.07	600	17
UZ7716	UZ7816	16	150	2.5	20	12.2	11.5	.07	550	15
UZ7718	UZ7818	18	130	3.5	20	13.7	12.9	.08	500	13
UZ7720	UZ7820	20	120	4.0	20	15.2	14.4	.08	440	12
UZ7722	UZ7822	22	100	4.5	20	16.7	15.8	.08	390	11
UZ7724	UZ7824	24	100	5.0	20	18.2	17.3	.08	360	10
UZ7727	UZ7827	27	90	6.0	20	20.6	19.4	.09	310	9
UZ7730	UZ7830	30	80	8	20	22.8	21.6	.090	280	8.5
UZ7733	UZ7833	33	70	10	10	25.1	23.7	.090	260	7.5
UZ7736	UZ7836	36	60	12	10	27.4	25.9	.090	240	7.0
UZ7740	UZ7840	40	60	15	10	30.4	28.8	.095	210	6.4
UZ7745	UZ7845	45	50	20	10	34.2	32.4	.095	180	5.5
UZ7750	UZ7850	50	50	22	10	38.0	36.0	.095	170	4.6
UZ7756	UZ7856	56	40	30	10	42.6	40.3	.095	160	4.1
UZ7760	UZ7860	60	40	35	10	45.6	43.2	.095	150	3.7
UZ7770	UZ7870	70	35	40	10	53.2	50.4	.095	130	3.3
UZ7775	UZ7875	75	30	45	10	56.0	54.0	.095	120	3.1
UZ7780	UZ7880	80	30	60	10	60.8	57.6	.095	110	2.9
UZ7790	UZ7890	90	25	75	10	68.4	64.8	.095	100	2.6
UZ7110	UZ7210	100	20	90	10	76.0	72.0	.100	90	2.3

For optional high reliability screening, see UZ706-UZ140HR data sheet.

Power Rating: Stud Mounted: 10 Watts at 100°C Case derate linerally to zero at 175°C Case.
Lead Mounted: See lead temperature derating curve.
Temperature Range: Operating and storage -65°C to 175°C.

★ Specify 20% tolerance by changing the second numeral of type number from 8 to 9 (UZ7809 becomes UZ7909) or from 2 to 3 (UZ7210 becomes UZ7310). Specify leaded version by adding an L suffix (UZ7809 becomes UZ7809L).

† All zener voltages are measured with an automated test set using a 35 msec test time. Longer or shorter test times will have a corresponding effect on the measured value due to heating effects.

§ Zener impedance is derived from the 60-cycle voltage created when AC current with RMS value of 10% of DC zener test current is superimposed on the test current.

★ Ratings Based on 100°C Case temperature; for leaded devices multiply by 0.6.

‡ Figures shown are for a peak sinusoidal surge current of 8.3ms duration, non-repetitive. The 8.3ms square pulse rating is 71% of the value shown.

POWER ZENERS
1 Watt, Industrial

UZ8706 SERIES
UZ8806 SERIES

FEATURES
- High Surge Ratings
- A Quarter the Size of Conventional 1 Watt Zeners
- Impervious to Moisture

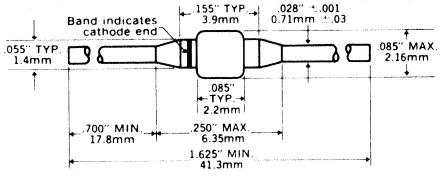
DESCRIPTION
One watt zener diodes, hermetically sealed in glass.

ABSOLUTE MAXIMUM RATINGS

Zener Voltage, V_Z	6.8 to 200V
Continuous Current	See Table
Surge Current (8.3ms)	See Table
Surge Power	See Graph
Power	See Lead Temperature Derating Curve
Storage and Operating Temperature	—65°C to +175°C

MECHANICAL SPECIFICATIONS

UZ8706 SERIES UZ8806 SERIES

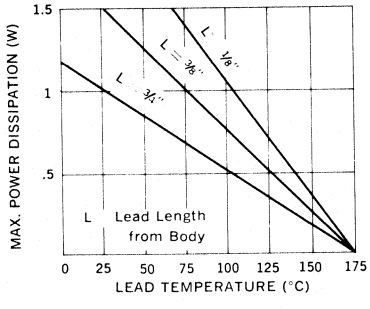


UZ Prefix is identified by a Blue or Red Cathode Band

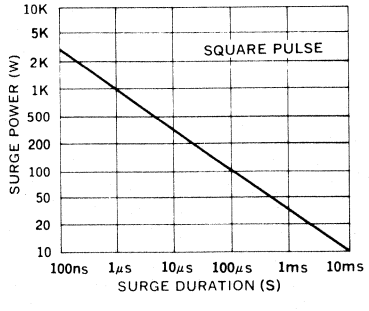
BODY A



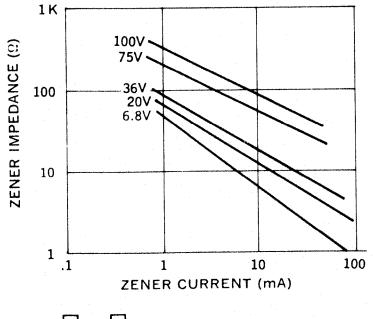
Power Dissipation vs. Lead Temperature Derating Curve



Surge Power vs. Surge Duration



Typical Zener Impedance vs. Zener Current



UNITRODE

Type		Electrical Specifications at 25°C							Maximum Ratings	
		Nominal Zener Voltage †	Test Current	Max. Zener Impedance §	Maximum Reverse Leakage Current			Typ. Temp. Coefficient	Maximum Continuous Current ★	Maximum Surge Current ‡
						± 5%	± 10%			
		V_Z @ I_{ZT}	I_{ZT}	Z_Z @ I_{ZT}	I_R @ V_R	V_R	V_R	T.C. @ I_{ZT}	I_{ZM}	I_S
± 5% Tolerance	± 10% Tolerance	Volts	mA	Ohms	μA	Volts	Volts	%/°C	mA	Amps
UZ 8706	UZ 8806	6.8	37	3.5	50	5.2	4.9	0.04	140	5.00
UZ 8707	UZ 8807	7.5	34	4.0	30	5.7	5.4	0.04	125	4.50
UZ 8708	UZ 8808	8.2	31	4.5	10	6.2	5.9	0.05	115	3.90
UZ 8709	UZ 8809	9.1	28	5.0	3.0	6.9	6.6	0.05	105	3.37
UZ 8710	UZ 8810	10	25	7.0	2.0	7.6	7.2	0.06	95	2.77
UZ 8712	UZ 8812	12	23	9.0	1.0	9.1	8.6	0.07	85	2.25
UZ 8713	UZ 8813	13	21	10	0.5	9.9	9.3	0.07	80	2.25
UZ 8714	UZ 8814	14	19	12	0.5	10.6	10.1	0.07	74	2.25
UZ 8715	UZ 8815	15	17	14	0.5	11.4	10.8	0.07	63	1.65
UZ 8716	UZ 8816	16	15.5	16	0.5	12.1	11.5	0.07	60	1.65
UZ 8718	UZ 8818	18	14.0	20	0.5	13.7	12.9	0.08	52	1.12
UZ 8720	UZ 8820	20	12.5	22	0.5	15.2	14.4	0.08	47	1.12
UZ 8722	UZ 8820	22	11.5	23	0.5	16.7	15.8	0.08	43	1.12
UZ 8724	UZ 8824	24	10.5	25	0.5	18.2	17.3	0.08	40	0.825
UZ 8727	UZ 8827	27	9.5	35	0.5	20.5	19.4	0.09	35	0.825
UZ 8730	UZ 8830	30	8.5	40	0.5	22.8	21.6	0.09	31	0.825
UZ 8733	UZ 8833	33	7.5	45	0.5	25.1	23.7	0.09	28	0.675
UZ 8736	UZ 8836	36	7.0	50	0.5	27.3	25.9	0.09	26	0.562
UZ 8740	UZ 8840	40	6.5	62	0.5	30.4	28.8	0.095	24	0.562
UZ 8745	UZ 8845	45	6.0	75	0.5	34.2	32.4	0.095	22	0.450
UZ 8750	UZ 8850	50	5.0	85	0.5	38.0	36.0	0.095	20	0.450
UZ 8756	UZ 8856	56	4.5	110	0.5	42.5	40.3	0.095	17	0.390
UZ 8760	UZ 8860	60	4.0	125	0.5	45.6	43.2	0.095	15	0.337
UZ 8770	UZ 8870	70	3.7	150	0.5	53.2	50.4	0.095	14	0.337
UZ 8775	UZ 8875	75	3.3	175	0.5	57.0	54.0	0.095	12	0.277
UZ 8780	UZ 8880	80	3.0	200	0.5	60.8	57.6	0.095	11	0.225
UZ 8790	UZ 8890	90	2.8	250	0.5	68.4	64.8	0.095	10	0.225
UZ 8110	UZ 8210	100	2.5	350	0.5	76.0	72.0	0.10	9.5	0.225
UZ 8111	UZ 8211	110	2.3	450	0.5	83.6	79.2	0.10	8.5	0.165
UZ 8112	UZ 8212	120	2.0	550	0.5	91.2	86.4	0.10	8.0	0.112
UZ 8113	UZ 8213	130	1.9	700	0.5	98.8	93.6	0.10	7.2	0.112
UZ 8114	UZ 8214	140	1.8	850	0.5	106	100	0.10	6.8	0.112
UZ 8115	UZ 8215	150	1.7	1000	0.5	114	108	0.10	6.3	0.112
UZ 8116	UZ 8216	160	1.6	1100	0.5	121	115	0.10	5.9	0.082
UZ 8117	UZ 8217	170	1.5	1200	0.5	129	122	0.10	5.6	0.082
UZ 8118	UZ 8218	180	1.4	1300	0.5	137	129	0.10	5.2	0.056
UZ 8119	UZ 8219	190	1.3	1400	0.5	144	137	0.10	5.0	0.056
UZ 8120	UZ 8220	200	1.2	1500	0.5	152	144	0.10	4.7	0.056

†All zener voltages are measured with an automated test set using a 35 millisecond test time. Longer or shorter test times will have a corresponding effect on the measured value due to heating effects.

§Zener impedance is derived from the 60-cycle AC voltage created when AC current with RMS value of 10% of DC zener test current is superimposed on the test current.

★Ratings are based on free air. T_A is 25°C. For use at 1.5 watts see derating curve.

‡Figures shown are for a peak sinusoidal surge current of 8.3 ms duration using 60 cycle AC. The 8.3 ms square pulse rating is 71% of the value shown.

6

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

THYRISTORS (SCRs, PUTs) 7

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

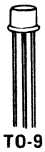
PRINTED IN U.S.A.

THYRISTORS (SCRs & PUTs)



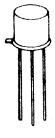
TO-18

SCR	$I_{T(RMS)}$	.5A			
	V_{DRM} (V)				
	30		2N3027*	2N3030*	ID100
	60	AA114	2N3028*	2N3031*	ID101
	100		2N3029*	2N3032*	ID102
	150				ID103
	200	AA116			ID104
	300	AA110			ID105
	400	AA111			ID106
	I_{GT}	200μA	200μA	20μA	200μA
	I_H	2mA	5mA	4mA	5mA



TO-9

SCR	$I_{T(RMS)}$	1.25A	
	V_{DRM} (V)		
	30	2N1876	2N1870A**
	60	2N1877	2N1871A**
	100	2N1878	2N1872A**
	150	2N1879	2N1873A
	200	2N1880	2N1874A**
	I_{GT}	20μA	200μA
	I_H	3mA	5mA



TO-39

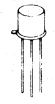
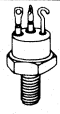
SCR	$I_{T(RMS)}$	1.6A			
	V_{DRM} (V)				
	30			2N2322	
	60	AD100	2N2323A***	2N2323***	ID200
	100	AD101	2N2324A***	2N2324***	ID201
	150		2N2325A	2N2325	ID202
	200	AD102	2N2326A***	2N2326***	ID203
	300	AD103	2N2328A***	2N2328***	ID300
	400	AD104		2N2329***	ID301
	I_{GT}	2μA	20μA	200μA	200μA
	I_H	2mA	2mA	2mA	3mA

*Available as JAN and JANTX types.
**Available as JAN type.
***Available as JAN, JANTX, JANTXV types.
†3mA available from factory

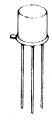
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

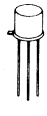
ULTRAFAST SWITCHING

 TO-18	SCR	$I_{T(RMS)}$	4A		
		60V	GA200	GA300	GA200A GA300A
		100V	GA201	GA301	GA201A GA301A
		t_{on}	20ns (TYP.)		20nS (TYP.)
		t_q	2.0μS		.5μS
 TO-59	SCR	$I_{T(RMS)}$	6A		
		60V	GB200	GB300	GB200A GB300A
		100V	GB201	GB301	GB201A GB301A
		t_{on}	20ns (TYP.)		20nS (TYP.)
		t_q	2.0μS		.5μS

RADIATION HARDENED SCRs

 TO-18	On-State Current $I_{T(RMS)}$		0.4A
	Package Style		TO-18
	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} and REVERSE VOLTAGE, V_{RRM}	30V	GA100
		60V	GA101
		80V	GA102
	Key Parameters		I_{GT} (Post 3X10¹⁴ NVT) 20mA
			I_H (Post 3X10¹⁴ NVT) 30mA

PUTs — PROGRAMMABLE UNIJUNCTION TRANSISTORS

 TO-18	Peak Recurrent Forward Current		8A	
	Package Style		TO-18	
	MIN. VALLEY CURRENT, I_v MAX. PEAK POINT CURRENT, I_p	$I_v = 25\mu A$ @ $R_G = 10K$ $I_p = .15\mu A$ @ $R_G = 1Meg$	U13T2	CONSULT FACTORY
		$I_v = 70\mu A$ @ $R_G = 10K$ $I_p = 2\mu A$ @ $R_G = 1Meg$	U13T1	
		$I_v = 1mA$ @ $R_G = 200\Omega$ $I_p = .15\mu A$ @ $R_G = 1Meg$	2N6120	
		$I_v = 1.5mA$ @ $R_G = 200\Omega$ $I_p = 2\mu A$ @ $R_G = 1Meg$	2N6119 2N6137*	
	Forward and Reverse Voltage: V_{AK}, V_{AKR}		40V	100V

* Available as JAN and JANTX types.

SCRs
1.25 Amp, Planar

FEATURES
- Available as Either "JAN" or Standard Types
- Operating D.C. Current Range: 5 to 1250mA
- Pulse Currents: to 30A
- Voltage Ratings: to 200V
- Maximum Trigger Current: 0.2mA
- Maximum Trigger Voltage: 0.8V
- All Leads Isolated from Case
- Maximum Θ_{J-C}: 20°C/W

DESCRIPTION

These are premium PNPN controlled switches intended for use in applications requiring a high degree of reliability assurance. The JAN types are specified under MIL-S-19500/198, and are included in MIL-STD-701 as recommended types for military usage.

This series is useful in a wide variety of applications including: safety, arming and detonating circuits; timing and programming circuits; protective and warning circuits; driving relays; driving indicator lamps, encoding and decoding circuits; replacing relays, thyratrons, and magamps; servo motor control; pulse generation; plus many others.

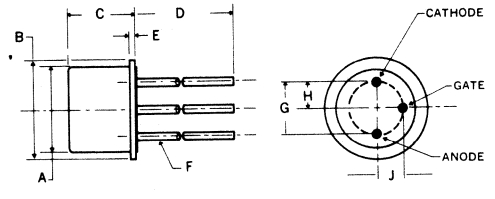
7

ABSOLUTE MAXIMUM RATINGS

	2N1870A JAN2N1870A	2N1871A JAN2N1871A	2N1872A JAN2N1872A	2N1873A —	2N1874A JAN2N1874A
Repetitive Peak Off-State Voltage, V_{DRM}	30V	60V	100V	150V	200V
Repetitive Peak Reverse Voltage, V_{RRM}	30V	60V	100V	150V	200V
D.C. On-State Current, I_T					
100°C Ambient			250mA		
100°C Case			1.25A		
Repetitive Peak On-State Current, I_{TRM}			up to 30A		
Peak One Cycle Surge (Non-Rep.) On-State Current, I_{TSM}			15A		
Peak Gate Current, I_{GM}			250mA		
Average Gate Current, $I_{G(AV)}$			25mA		
Reverse Gate Voltage, V_{GR}			5V		
Thermal Resistance, Junction to Case, $R\Theta_{J-C}$			20°C/W		
Operating and Storage Temperature Range			−65°C to +150°C		

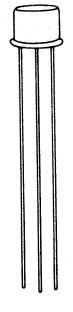
MECHANICAL SPECIFICATIONS

2N1870A-2N1874A



	ins.	mm.
A	275-335	6.99-7.75
B	290-370	7.37-9.40
C	200-260	5.08-6.60
D	1.5 MIN	38.10 MIN
E	010-030	25-76
F	$017 \pm \frac{002}{001}$	$432 \pm \frac{051}{025}$
G	200	5.08
H	100	2.54
J	100	2.54

TO-9



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)†

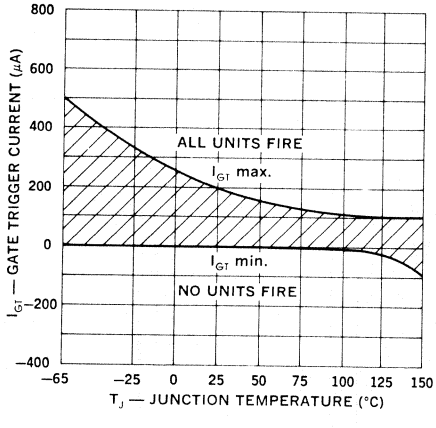
Test	Symbol	Min.	Typical	Max.	Units	Test Conditions
Subgroup 1 (Visual and Mechanical)						
Subgroup 2 (25°C Tests)						
Off-State Current	I_{DRM}	—	0.5	10	μA	R_{GK} = 1K, V_{DRM} = + Rating
Reverse Current	I_{RRM}	—	0.5	10	μA	R_{GK} = 1K, V_{RRM} = − Rating
Gate Trigger Voltage	V_{GT}	0.4	0.55	0.8	V	R_{GS} = 100 ohms, V_D = 5V
Gate Trigger Current	I_{GT}	—	30	200	μA	R_{GS} > 10K ohms, V_D = 5V
On-State Voltage	V_{TM}	—	1.8	2.5	V	I_{TM} = 2A (pulse test)
Off-State Voltage — Critical of Rise	dv_c/dt	100	—	—	V/μs	Specified test circuit
Reverse Gate Current	I_{GR}	—	0.5	10	μA	V_{GRM} = 5V, anode open
Holding Current	I_H	0.3	—	5.0	mA	I_G = − 150μA, V_D = 5V
Subgroup 3 (125°C Tests)						
High Temp. Off-State Current	I_{DRM}	—	15	100	μA	R_{GK} = 1K, V_{DRM} = + Rating
High Temp. Reverse Current	I_{RRM}	—	15	100	μA	R_{GK} = 1K, V_{RRM} = − Rating
High Temp. Gate Non-Trigger Voltage	V_{GD}	0.2	—	—	V	R_{GS} = 100 ohms, V_D = 5V
High Temp. Holding Current	I_H	0.2	—	—	mA	I_G = − 150μA, V_D = 5V
Subgroup 4 (−65°C Tests)						
Low Temp. Gate Trigger Voltage	V_{GT}	—	—	1.0	V	R_{GK} = 100 ohms, V_D = 5V
Low Temp. Gate Trigger Current	I_{GT}	—	—	500	μA	R_{GK} > 10K ohms, V_D = 5V
Low Temp. Holding Current	I_H	—	—	15	mA	I_G = − 150μA, V_{AA} = 5V

†All values in this table are JEDEC registered.

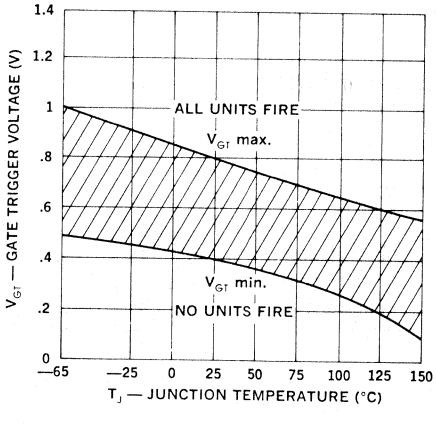
Note: Voltage ratings apply over the full operating temperature range, provided the gate is connected to the cathode through a resistor, 1 K or smaller, or other adequate gate bias is used.

Triggering and Bias Stabilization

1. **Gate Trigger Current**



2. **Gate Trigger Voltage**

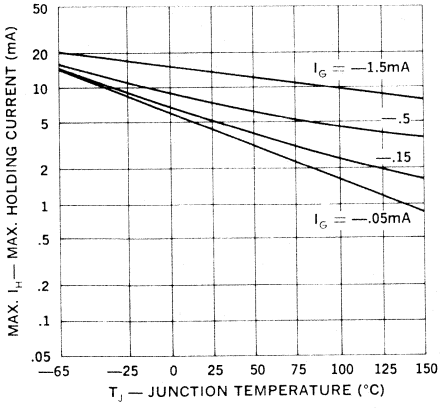


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

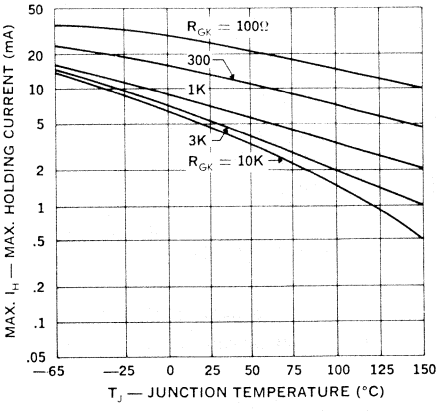
PRINTED IN U.S.A.

Holding Current

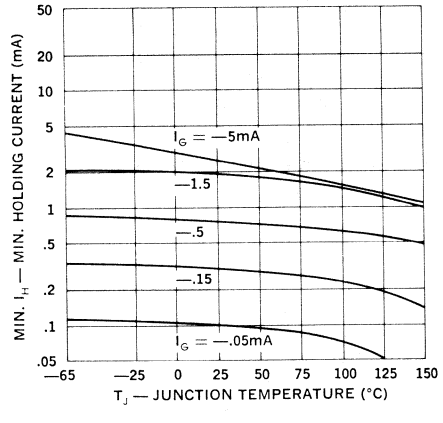
1. Max. Holding Current (Current Bias)



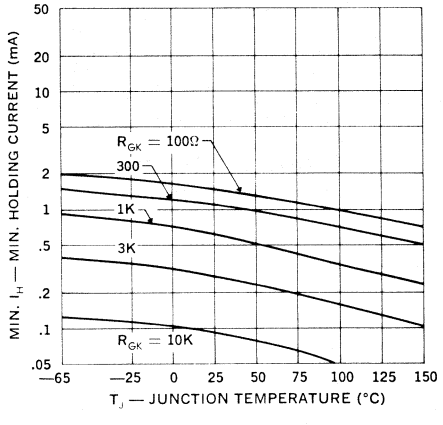
2. Max. Holding Current (Resistor Bias)



3. Min. Holding Current (Current Bias)



4. Min. Holding Current (Resistor Bias)

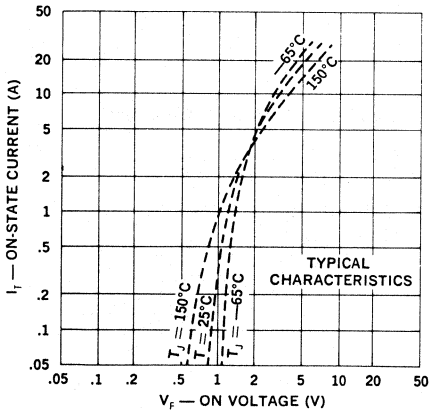


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

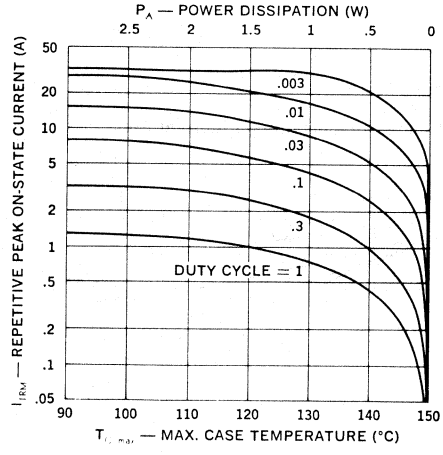
PRINTED IN U.S.A.

Current Ratings — Thermal Design

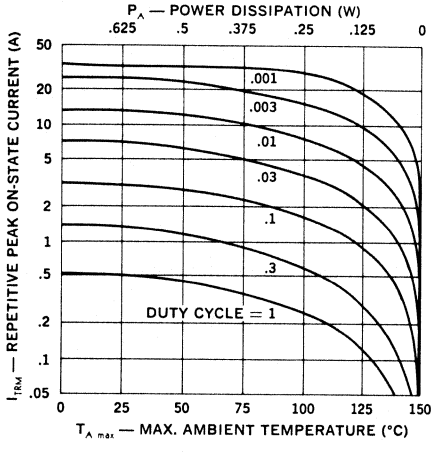
1. On-State Current vs. Voltage



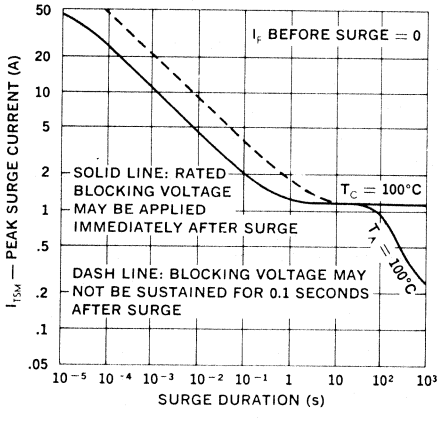
2. Peak Current vs. Case Temperature



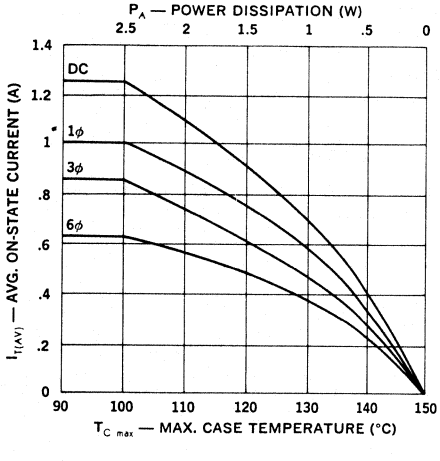
3. Peak Current vs. Ambient Temperature



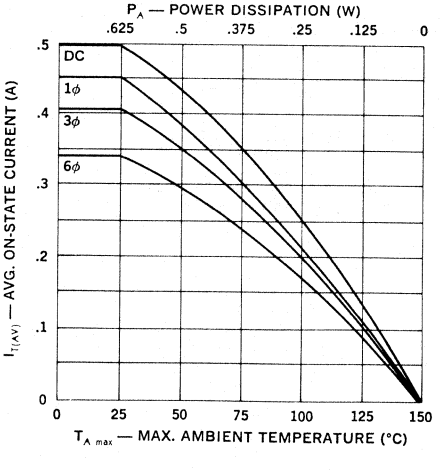
4. Surge Current vs. Time



5. Average Current vs. Case Temperature



6. Average Current vs. Ambient Temperature



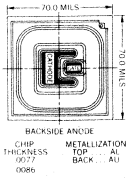
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SCRs
1.6 Amp, Planar

2N2322-2N2329
2N2323A-2N2328A
2N2323S-2N2329S, J, JTX, JTXV
2N2323AS-2N2328AS, J, JTX, JTXV

FEATURES
- Available as JAN, JANTX, & JANTXV Types
- JAN Types Available in TO-5
- 1.6A D.C. Current
- Peak Currents: to 30A
- Voltage Ratings: to 400V
- 20μA Max. Trigger Current ("A" types)
- 0.6V Max. Trigger Voltage ("A" types)



DESCRIPTION
These are premium thyristor switches intended for use in high performance industrial, military and space applications requiring a high degree of reliability assurance. This series is useful in a wide variety of applications including timing and programming circuits, protective and warning circuits, driving relays, driving indicator lamps, encoding and decoding circuits, replacing relays, thyratrons, and magamps, servo motor control, pulse generation, plus many others. The high surge current rating (15A - 1 cycle) makes this series particularly useful for squib firing.

The following JAN, JANTX and JANTXV types are specified under Mil-S-19500/276A and are included in Mil-STD-701 as recommended types for military usage:

2N2322	2N2323 JAN2N2323S JANTX2N2323S JANTXV2N2323S 2N2323A JAN2N2323AS JANTX2N2323AS JANTXV2N2323AS	2N2324 JAN2N2324S JANTX2N2324S JANTXV2N2324S 2N2324A JAN2N2324AS JANTX2N2324AS JANTXV2N2324AS	2N2325	2N2325A	2N2326 JAN2N2326S JANTX2N2326S JANTXV2N2326S 2N2326A JAN2N2326AS JANTX2N2326AS JANTXV2N2326AS	2N2327	2N2327A	2N2328 JAN2N2328S JANTX2N2328S JANTXV2N2328S 2N2328A JAN2N2328AS JANTX2N2328AS JANTXV2N2328AS	2N2329 JAN2N2329S JANTX2N2329S JANTXV2N2329S

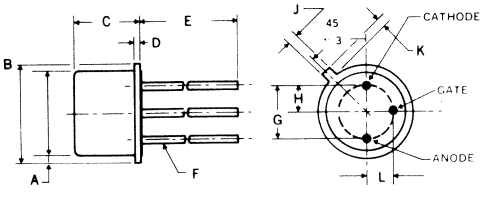
ABSOLUTE MAXIMUM RATINGS

Repetitive Peak Off-State Voltage, V_{DRM}	25V	50V	100V	150V	200V	250V	300V	400V
Repetitive Peak Reverse Voltage, V_{RRM}	25V	50V	100V	150V	200V	250V	300V	400V
Non-Repetitive Peak Reverse Voltage, V_{RSM} (< 5ms)	40V	75V	150V	225V	300V	350V	400V	500V

D.C. On-State Current, I_T	
80°C Ambient	300mA
85°C Case	1.6A
One Cycle Surge (Non-Rep.) On-State Current, I_{TSM}	15A
Repetitive Peak On-State Current, I_{TM}	30A
Gate Power Dissipation, P_{GM}	0.1W
Gate Power Dissipation, $P_{GM(AV)}$	0.01W
Peak Gate Current, I_{GM}	100mA
Peak Gate Voltage, Forward and Reverse	6V
Reverse Gate Current, I_{GR}	3mA
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	−65°C to +125°C

MECHANICAL SPECIFICATIONS

2N2322-2N2329 2N2323S-2N2328S, J, JTX, JTXV
2N2323A-2N2328A 2N2323AS-2N2328AS, J, JTX, JTXV



	INCHES	MILLIMETERS
A	.315-.335	8.00-8.51
B	.350-.370	8.89-9.39
C	.240-.260	6.35-6.60
D	.010-.030	0.25-0.76
E	.5 MIN	12.70 MIN
F	.016-.019	.406-.483
G	.190-.210	4.83-5.33
H	.085-.105	2.16-2.67
J	.028-.034	.711-.864
K	.029-.045	.737-1.14
L	.100	2.54

TO-205AD (TO-39)



UNITRODE

ELECTRICAL SPECIFICATIONS

Test	Symbol	Min.	Typical	Max.	Units	Test Conditions
Visual and Mechanical						MIL-STD-750, Method 2071
25°C						
Off-State Current	I_{DRM}	—	0.1	10	μA	V_{DRM} = Rating, R_{GK} = 1K (2K for "A" Types)
Reverse Current	I_{RRM}	—	0.1	10	μA	V_{RRM} = Rating, R_{GK} = 1K (2K for "A" Types)
Gate Trigger Current	I_{GT}					
"A" Types		—	2	20	μA	V_D = 6V, R_L = 100Ω
non-"A" Types		—	50	200	μA	V_D = 6V, R_L = 100Ω
Gate Trigger Voltage	V_{GT}					
"A" Types		0.35	0.52	0.60	V	V_D = 6V, R_{GK} = 2K, R_L = 100Ω
non-"A" Types		0.35	0.55	0.80	V	V_D = 6V, R_{GK} = 1K, R_L = 100Ω
On-State Voltage	V_{TM}	—	2.0	2.2	V	I_{TM} = 4A (pulse test)
Holding Current	I_H	—	0.3	2.0	mA	V_D = 6V, R_{GK} = 1K (2K for "A" Types)
Reverse Gate Current	I_{GR}	—	1	200*	μA	V_{GR} = 6V
Delay Time	t_d	—	0.6	—	μs	I_G = 10mA, I_T = 1A, V_D = 30V
Rise Time	t_r	—	0.4	—	μs	I_G = 10mA, I_T = 1A, V_D = 30V
Circuit Commutated Turn-Off Time	t_q	—	20	—	μs	I_T = 1A, I_R = 1A, R_{GK} = 1K
125°C						
Off-State Current	I_{DRM}	—	1	100	μA	V_{DRM} = Rating, R_{GK} = 1K (2K for "A" Types)
Reverse Current	I_{RRM}	—	1	100	μA	V_{RRM} = Rating, R_{GK} = 1K (2K for "A" Types)
Gate Trigger Voltage	V_{GT}	0.1	0.3	—	V	V_D = Rated V_D, R_{GK} = 1K (2K for "A" Types)
Holding Current	I_H					
"A" Types		0.1†	—	—	mA	V_D = 6V, R_{GK} = 2K
non-"A" Types		0.15†	—	—	mA	V_D = 6V, R_{GK} = 1K
Off-State Voltage — Critical Rate of Rise	dv/dt					
"A" Types		0.7*			V/μs	V_D = Rating, R_{GK} = 2K
non-"A" Types		1.8*			V/μs	V_D = Rating, R_{GK} = 1K
—65°C						
Off-State Current	I_{DRM}	—	.05	5.0*	μA	V_{DRM} = Rating, R_{GK} = 1K (2K for "A" Types)
Reverse Current	I_{RRM}	—	.05	5.0*	μA	V_{RRM} = Rating, R_{GK} = 1K (2K for "A" Types)
Gate Trigger Current	I_{GT}					
"A" Types		—	50	75	μA	V_D = 6V, R_L = 100Ω
non-"A" Types		—	100	350	μA	V_D = 6V, R_L = 100Ω
Gate Trigger Voltage	V_{GT}					
"A" Types		—	0.7	0.8*	V	V_D = 6V, R_{GK} = 2K, R_L = 100Ω
				0.9†	V	V_D = 6V, R_{GK} = 2K, R_L = 100Ω
non-"A" Types		—	0.75	1.0	V	V_D = 6V, R_{GK} = 1K, R_L = 100Ω
Holding Current	I_H	—	—	3.0†	mA	V_D = 6V, R_{GK} = 1K (2K for "A" Types)

* JAN and JANTX Types only.
† Industrial Types only.

JAN and JANTX Acceptance Tests

100% Screening TX-Types

High Temperature Storage
Temperature Cycling
Constant Acceleration
Fine & Gross Hermetic Seal
Electrical Test
Burn-in
Electrical Test

Group B Tests

Subgroup 1 — Reverse Gate Current
Surge Current
Non-Repetitive Reverse Voltage

Subgroup 2 — Low Temp. Reverse Blocking Current
Low Temp. Forward Blocking Current
Low Temp. Gate Trigger Voltage
Low Temp. Gate Trigger Current

Subgroup 3 — Temperature Cycling
Thermal Shock
Moisture Resistance
Solderability

Subgroup 4 — Blocking Life Test

Group C Tests

Subgroup 1 — Physical Dimensions

Subgroup 2 — Shock
Constant Acceleration
Vibration, Variable Frequency

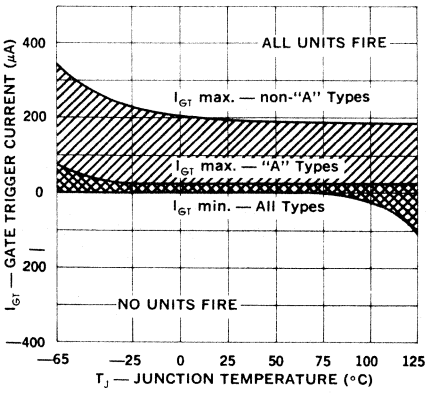
Subgroup 3 — Barometric Pressure, Reduced

Subgroup 4 — Salt Atmosphere

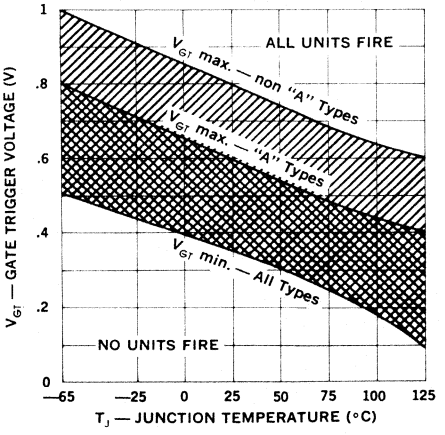
Subgroup 5 — Terminal Strength

Subgroup 6 — Intermittent Operating Life Test

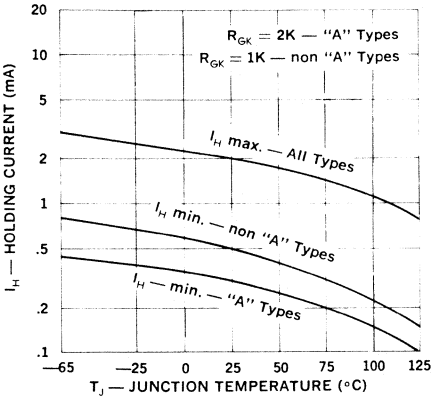
Gate Trigger Current



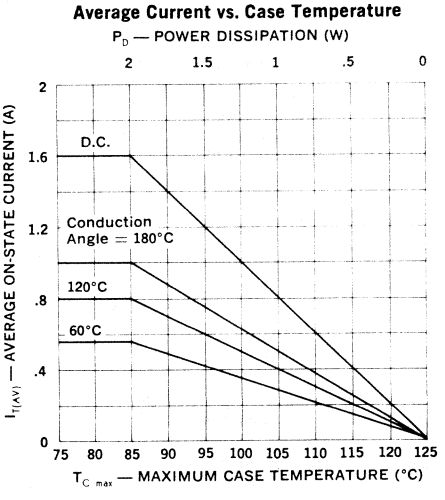
Gate Trigger Voltage



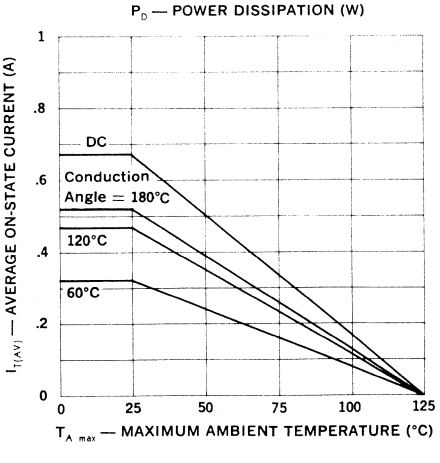
Holding Current



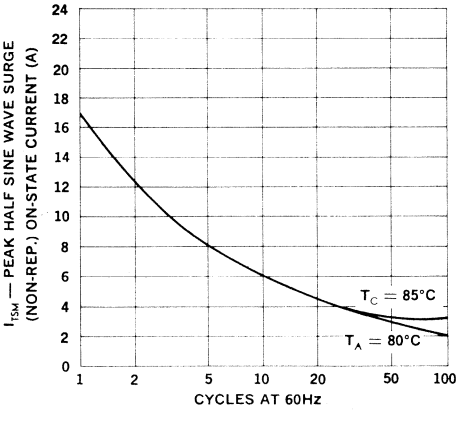
Average Current vs. Case Temperature



Average Current vs. Ambient Temperature



Surge Current

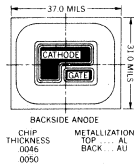


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SCRs

0.5 Amp, Planar



FEATURES

- JAN and JANTX Types Available
- Fully Characterized for "Worst Case" Design
- Passivated Planar Construction for Maximum Reliability and Parameter Uniformity
- Low On-State Voltage and Fast Switching at High Current Levels
- Typical Turn-On Time: 0.12μs
- Typical Recovery Time: 0.7μs
- Pulse Currents: to 30A

DESCRIPTION

The 2N3027 series of planar SCRs (controlled switches) are intended for use in military and space applications requiring a high degree of reliability. They offer a unique combination of extremely fast switching, precise triggering, high pulse power, small size, intrinsic parameter stability, and high radiation tolerance.

The JAN and JANTX types are specified under MIL-S-19500/419, and are included in MIL-STD-701 as recommended types for military usage.

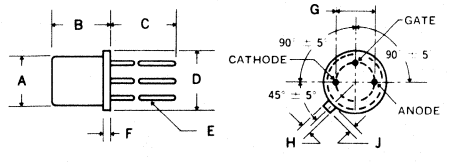
ABSOLUTE MAXIMUM RATINGS

	JAN & JANTX 2N3027 JAN & JANTX 2N3030	JAN & JANTX 2N3028 JAN & JANTX 2N3031	JAN & JANTX 2N3029 JAN & JANTX 2N3032
Repetitive Peak Off-State Voltage, V_{DRM}	30V	60V	100V
Repetitive Peak Reverse Voltage, V_{RRM}	30V	60V	100V
D.C. On-State Current, I_T			
100°C Case		500mA	
75°C Ambient		250mA	
Repetitive Peak On-State Current, I_{TRM}		30A	
Surge (Non-Rep.) On-State Current, I_{TSM}			
50ms		5A	
8ms		8A	
Peak Gate Current, I_{GM}		250mA	
Average Gate Current, $I_{G(AV)}$		25mA	
Reverse Gate Voltage		5V	
Reverse Gate Current		3mA	
Storage Temperature Range		−65°C to +200°C	
Operating Temperature Range		−65°C to +150°C	

Note: Blocking voltage ratings apply over the operating temperature range, provided the gate is connected to the cathode through an appropriate resistor, or adequate gate bias is used. (See section on bias stabilization.)

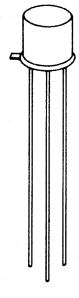
MECHANICAL SPECIFICATIONS

JAN & JANTX 2N3027-2N3032



	INCHES	MILLIMETERS
A	.178-.195 DIA.	4.52-4.95 DIA.
B	.170-.210	4.31-5.33
C	.5 MIN.	12.70 MIN.
D	.209-.230 DIA.	5.31-5.84 DIA.
E	.017 ± .002 DIA. .001 DIA.	.432 ± .051 .025
F	.020 MAX.	.508 MAX.
G	.100±.010 DIA.	2.54±.254 DIA.
H	.041±.005	1.04±.127
J	.028-.048	.711-1.22

TO-18



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

2N3027 — 2N3028 — 2N3029

Parameter	Symbol	Min.	Typical	Max.	Units	Test Conditions
SUBGROUP 1 Visual and Mechanical	—	—	—	—	—	MIL-STD-750 Method 2071
SUBGROUP 2 (25°C Tests)						
Off-State Current	I_{DRM}	—	.002	0.1	μA	R_{GK} = 1K, V_{DRM} = Rating
Reverse Current	I_{RRM}	—	.002	0.1	μA	R_{GK} = 1K, V_{RRM} = Rating
Reverse Gate Voltage	V_{GR}	5	8	—	V	I_{GR} = 0.1mA
Gate Trigger Current	I_{GT}	—5	8	200	μA	R_{GS} = 10K, V_D = 5V
Gate Trigger Voltage	V_{GT}	.40	.55	.80	V	R_{GS} = 100Ω, V_D = 5V
On-State Voltage	V_T	0.8	1.2	1.5	V	i_T = 1A (pulse test)
Holding Current	I_H	0.3	0.7	5.0	mA	R_{GK} = 1K, V_D = 5V
SUBGROUP 3 (25°C Tests)						
Off-State Voltage — Critical Rate of Rise	dv_c/dt	30	60	—	v/μs	R_{GK} = 1K, V_D = 30V
Gate Trigger–on Pulse Width	$t_{pg\,(on)}$	—	.07	0.2	μs	I_G = 10mA, I_T = 1A, V_{DM} = 30V
Delay Time	t_d	—	.08	—	μs	I_G = 10mA, I_T = 1A, V_D = 30V
Rise Time	t_r	—	.04	—	μs	I_G = 10mA, I_T = 1A, V_D = 30V
Circuit Commutated Turn-off Time	t_q	—	0.7	2.0	μs	I_T = 1A, i_R = 1A, R_{GK} = 1K
SUBGROUP 4 (150°C Tests)						
High Temp. Off-State Current	I_{DRM}	—	2	20	μA	R_{GK} = 1K, V_{DRM} = Rating
High Temp. Reverse Current	I_{RRM}	—	20	50	μA	R_{GK} = 1K, V_{RRM} = Rating
High Temp. Gate Trigger Voltage	V_{GT}	.10	.15	0.6	V	R_{GS} = 100Ω, V_D = 5V
High Temp. Holding Current	I_H	.05	.20	1.0	mA	R_{GK} = 1K, V_D = 5V
SUBGROUP 5 (—65°C Tests)						
Low Temp. Gate Trigger Voltage	V_{GT}	0.6	0.75	1.1	V	R_{GS} = 100Ω, V_D = 5V
Low Temp. Gate Trigger Current	I_{GT}	0	150	1.2	mA	R_{GS} = 10K, V_D = 5V
Low Temp. Holding Current	I_H	0.5	3.5	10	mA	R_{GK} = 1K, V_D = 5V

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

2N3030 — 2N3031 — 2N3032

Parameter	Symbol	Min.	Typical	Max.	Units	Test Conditions
SUBGROUP 1 Visual and Mechanical	—	—	—	—	—	MIL-STD-750 Method 2071
SUBGROUP 2 (25°C Tests)						
Off-State Current	I_{DRM}	—	.002	0.1	μA	R_{GK} = 1K, V_{DRM} = Rating
Reverse Current	I_{RRM}	—	.002	0.1	μA	R_{GK} = 1K, V_{RRM} = Rating
Reverse Gate Voltage	V_{GR}	5	8	—	V	I_{GR} = 0.1mA
Gate Trigger Current	I_{GT}	—5		20	μA	R_{GS} = 10K, V_D = 5V
Gate Trigger Voltage	V_{GT}	0.44		0.6	V	R_{GS} = 100Ω, V_D = 5V
On-State Voltage	V_T	0.8	1.2	1.5	V	i_T = 1A (pulse test)
Holding Current	I_H	0.3	1.0	4.0	mA	R_{GK} = 1K, V_D = 5V
SUBGROUP 3 (25°C Tests)						
Off-State Voltage — Critical Rate of Rise	dv_c/dt	30	60	—	v/μs	R_{GK} = 1K, V_D = 30V
Gate Trigger–on Pulse Width	t_{pg}(on)	—	.05	0.1	μs	I_G = 10mA, I_T = 1A, V_D = 30V
Delay Time	t_d	—	0.1	—	μs	I_G = 10mA, I_T = 1A, V_D = 30V
Rise Time	t_r	—	.05	—	μs	I_G = 10mA, I_T = 1A, V_D = 30V
Circuit Commutated Turn-off Time	t_q	—	0.7	2.0	μs	I_T = 1A, i_R = 1A, R_{GK} = 1K
SUBGROUP 4 (150°C Tests)						
High Temp. Off-State Current	I_{DRM}	—	2	20	μA	R_{GK} = 1K, V_{DRM} = Rating
High Temp. Reverse Current	I_{RRM}	—	20	50	μA	R_{GK} = 1K, V_{RRM} = Rating
High Temp. Gate Trigger Voltage	V_{GT}	.10	.15	0.4	V	R_{GS} = 100Ω, V_D = 5V
High Temp. Holding Current	I_H	.05	.30	2.0	mA	R_{GK} = 1K, V_D = 5V
SUBGROUP 5 (—65°C Tests)						
Low Temp. Gate Trigger Voltage	V_{GT}	0.44	0.8	0.95	V	R_{GS} = 100Ω, V_D = 5V
Low Temp. Gate Trigger Current	I_{GT}	0	0.4	0.5	mA	R_{GS} = 10K, V_D = 5V
Low Temp. Holding Current	I_H	0.5	5.0	8	mA	R_{GK} = 1K, V_D = 5V

High Reliability Processing

The 2N3027-2N3032 series provides a complete range of high reliability processing from the standard devices that undergo extensive electrical testing, through JAN and JANTX levels. 100% processing, Group B, and Group C tests for JAN and JANTX devices is shown below. For further details, see MIL-S-19500/419(EL).

100% Screening TX-Types

High Temperature Storage
Temperature Cycling
Constant Acceleration
Fine & Gross Hermetic Seal
Electrical Test
Burn-in
Electrical Test

Group B Tests

Subgroup 1 — Physical Dimensions
Subgroup 2 — Solderability
Temperature Cycling
Thermal Shock
Constant Acceleration
Moisture Resistance
Subgroup 3 — Surge Current
Subgroup 4 — Blocking Life Test
Subgroup 5 — Storage Life Test
Subgroup 6 — Operating Life Test

Group C Tests

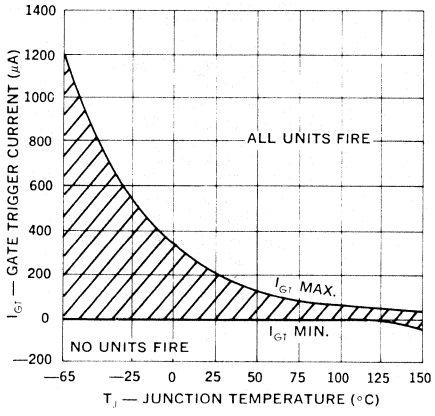
Subgroup 1 — Shock
Vibration, Variable Frequency
Subgroup 2 — Salt Atmosphere
Subgroup 3 — Terminal Strength
Subgroup 4 — High Temp. Anode Voltage — Critical rate or rise
Subgroup 5 — Storage Life Test
Subgroup 6 — Operating Life Test

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

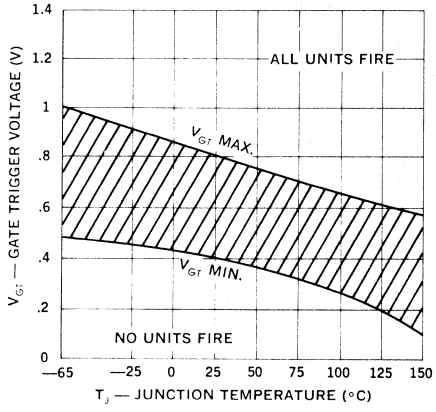
PRINTED IN U.S.A.

TYPICAL CHARACTERISTICS
2N3027 — 2N3028 — 2N3029

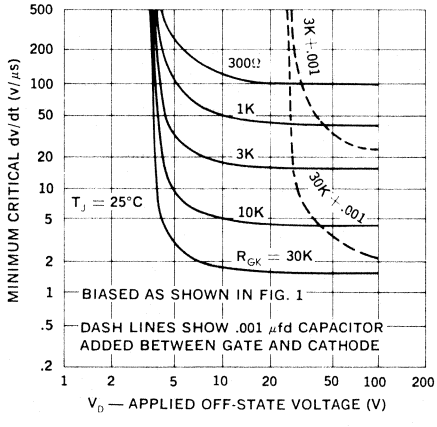
1 Gate Trigger Current



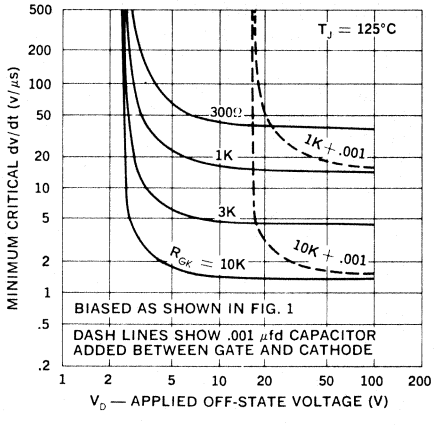
2 Gate Trigger Voltage



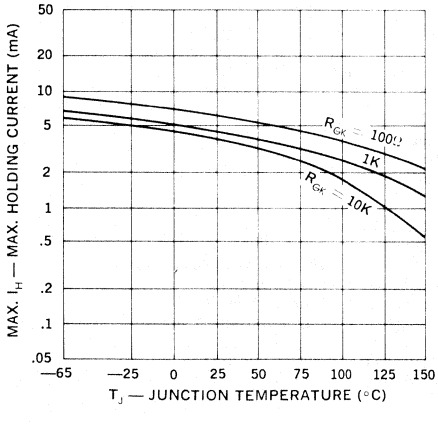
3 Min. Critical dv/dt (25°C — R Bias)



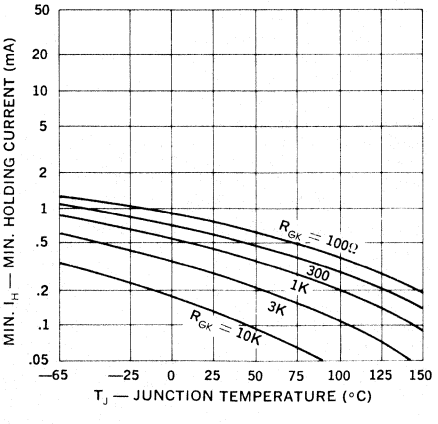
4 Min. Critical dv/dt (125°C — R Bias)



5 Max. Holding Current (Resistor Bias)



6 Min. Holding Current (Resistor Bias)

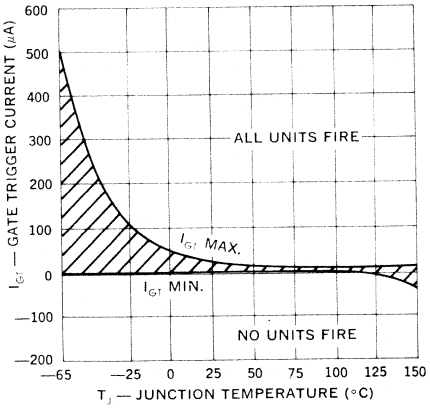


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

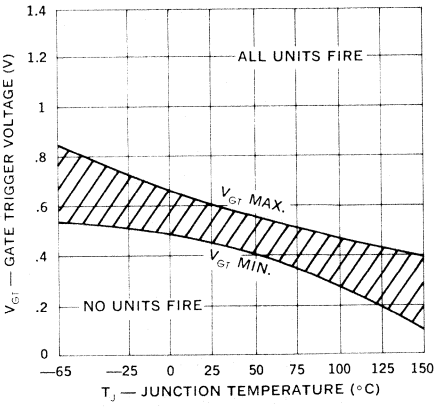
PRINTED IN U.S.A.

TYPICAL CHARACTERISTICS
2N3030 — 2N3031 — 2N3032

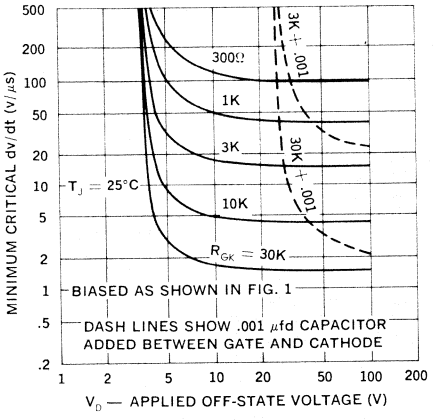
1 Gate Trigger Current



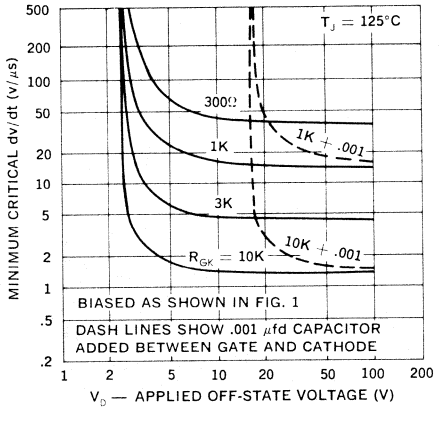
2 Gate Trigger Voltage



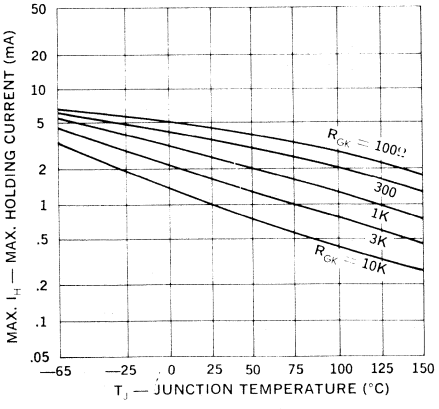
3 Min. Critical dv/dt (25°C — R Bias)



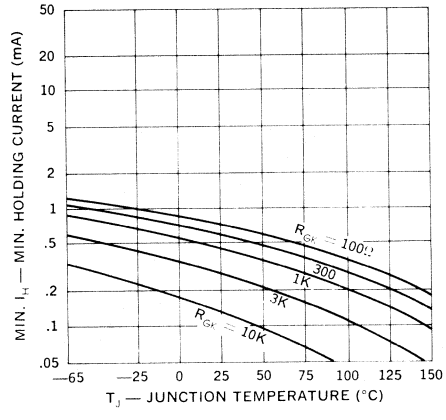
4 Min. Critical dv/dt (125°C — R Bias)



5 Max. Holding Current (Resistor Bias)



6 Min. Holding Current (Resistor Bias)

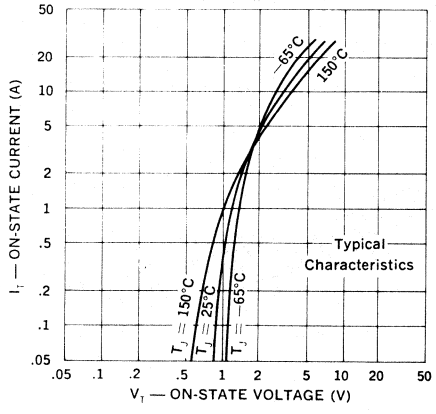


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

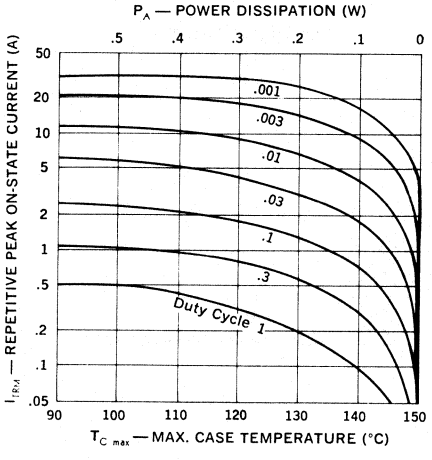
PRINTED IN U.S.A.

CURRENT RATINGS

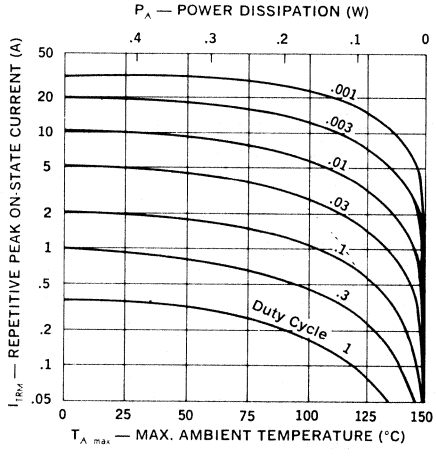
C1 Forward on Current vs. Voltage



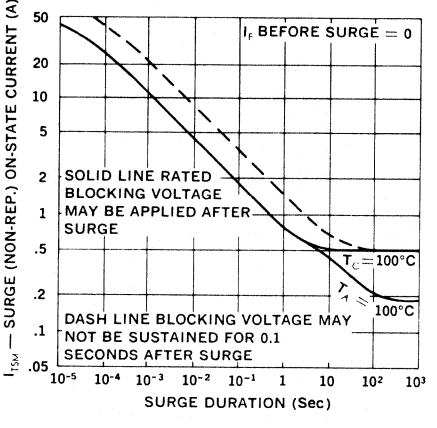
C2 Peak Current vs. Case Temperature



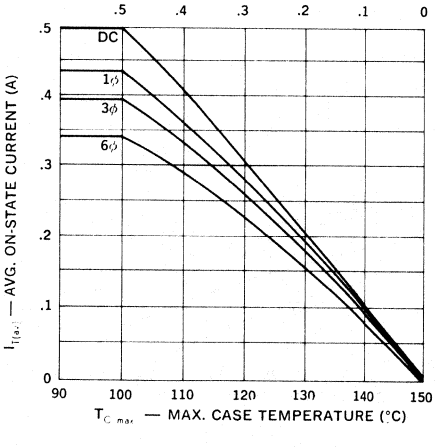
C3 Peak Current vs. Ambient Temperature TO-18 Ratings (see note)



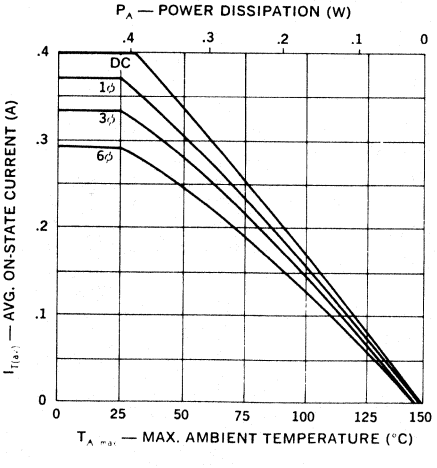
C4 Surge Current vs. Time



C5 Average Current vs. Case Temperature



C6 Average Current vs. Ambient Temperature TO-18 Ratings (see note)

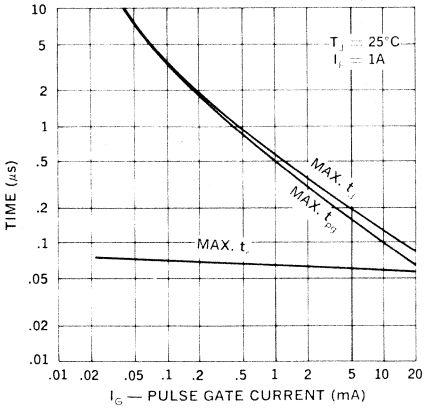


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

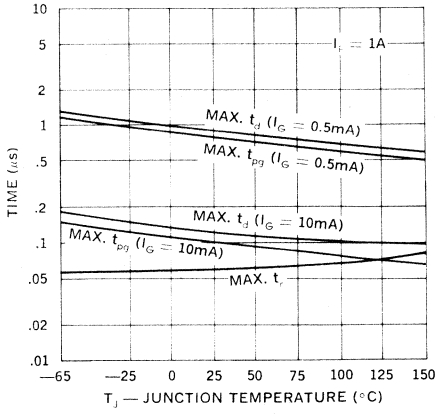
PRINTED IN U.S.A.

SWITCHING SPEEDS

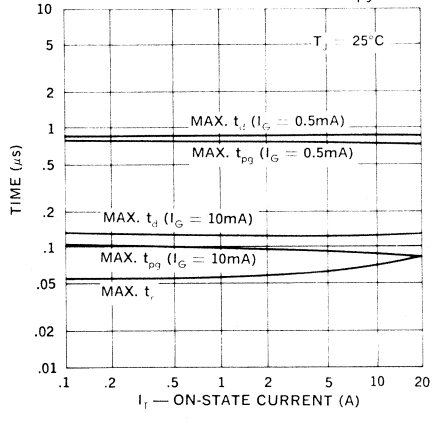
S1 Maximum Delay Time t_d, Rise Time t_r, and Gate Trigger Pulse Width t_{pg} (on)



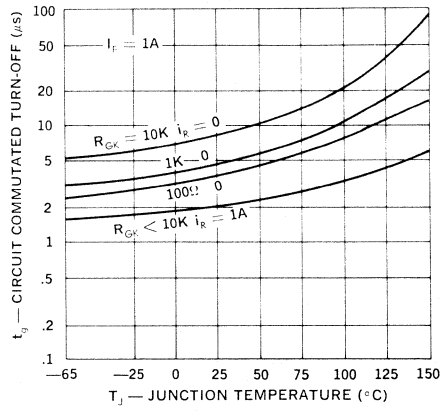
S2 Maximum Delay Time t_d, Rise Time t_r, and Gate Trigger Pulse Width t_{pg} (on)



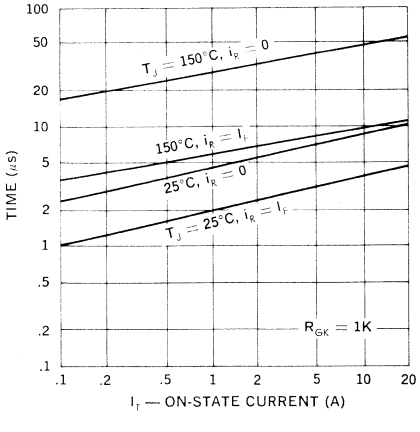
S3 Maximum Delay Time t_d, Rise Time t_r, and Gate Trigger Pulse Width t_{pg} (on)



S4 Maximum Circuit Commutated Turn-off Time t_q



S5 Maximum Circuit Commutated Turn-off Time t_q



7

SCRs
1.6 Amp, Planar

2N5724-2N5728

FEATURES
- Maximum Gate Trigger Current: 20μA
- Closely Controlled Gate Trigger Voltage: .44 to .6V
- Operating Current Range: 2mA to 1.6A
- Voltage Ratings: to 400V
- Low On-State Voltage
- Specified for dv/dt and Switching Time

DESCRIPTION
These devices are intended for general purpose usage in Military/aerospace or severe industrial environments. Major design parameters are specified at the temperature extremes, thus permitting worst case design on the basis of guaranteed values. These devices undergo 100% preconditioning, which includes high temperature storage and temperature cycling followed by a fine leak test as a regular part of the manufacturing procedure.

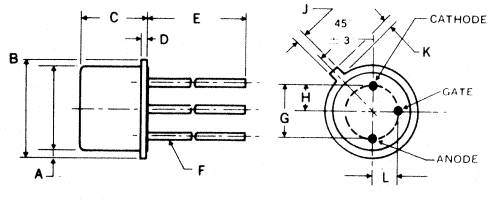
The high voltage types of the 2N5724 series are especially useful as pulse modulator switches in low to medium power pulse modulator applications. Specific parameters such as rise time, delay time, holding current, and recovery time can be selected for optimum performance in a pulse modulator circuit.

ABSOLUTE MAXIMUM RATINGS

	2N5724	2N5725	2N5726	2N5727	2N5728
Repetitive Peak Off-State Voltage, V_{DRM}	60V	100V	200V	300V	400V
Repetitive Peak Reverse Voltage, V_{RRM}	60V	100V	200V	300V	400V
Non-Repetitive Peak Off-State Voltage, V_{DSM}			500V		
D.C. On-State Current, I_T					
75°C Ambient			450mA		
85°C Case			1.6A		
Repetitive Peak On-State Current, I_{TRM}			up to 30A		
Peak One Cycle Surge (Non-Rep.) On-State Current, I_{TSM}			15A		
Peak Gate Current, I_{GM}			250mA		
Average Gate Current, $I_{G(AV)}$			25mA		
Reverse Gate Current, I_{GR}			3mA		
Reverse Gate Voltage, V_{GR}			6V		
Operating and Storage Temperature Range			−65°C to +150°C		

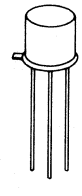
MECHANICAL SPECIFICATIONS

2N5724-2N5728



	ins.	mm.
A	305-335	7.75-8.51
B	335-370	8.51-9.40
C	240-260	6.35-6.60
D	010-030	25-76
E	5 MIN.	12.70 MIN.
F	017 +.002 −.001	432 +.051 −.025
G	200	5.08
H	100	2.54
J	031±003	79±.08
K	029-045	74-1.14
L	100	2.54

TO-205AD (TO-39)



UNITRODE

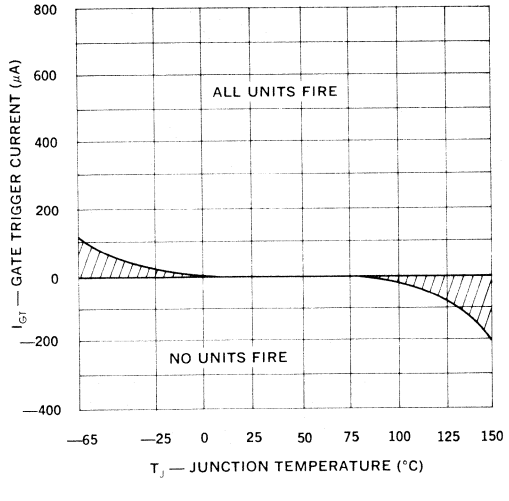
ELECTRICAL SPECIFICATIONS

Test	Symbol	Min.	Typical	Max.	Units	Test Conditions
SUBGROUP 1 Visual and Mechanical	—	—	—	—	—	
SUBGROUP 2 (25°C TESTS) Off-State Current Reverse Current Reverse Gate Voltage Gate Trigger Current Gate Trigger Voltage On-State Voltage Holding Current	 I_{DRM} I_{RRM} V_{GR} I_{GT} V_{GT} V_T I_H	 — — 5 — 0.44 — 0.3	 .05 .05 8 2 0.5 2.3 0.8	 0.1 0.1 — 20 0.6 2.5 2.0	 μA μA V μA V V mA	 $R_{GK} = 1K$, V_{DRM} = Rating $R_{GK} = 1K$, V_{RRM} = Rating $I_{GR} = 0.1mA$ $R_{GS} = 10K$, $V_D = 5V$ $R_{GS} = 100\Omega$, $V_D = 5V$ $I_T = 5A$ (pulse test) $R_{GK} = 1K$, $V_D = 5V$
SUBGROUP 3 (25°C TESTS) Off-State Voltage — Critical Rate of Rise Gate Trigger — on Pulse Width Delay Time Rise Time Circuit Commutated Turn-off Time 2N5724, 2N5725, 2N5726, 2N5727, 2N5728	 dv/dt t_{pg} (on) t_d t_r t_q	 100 — — — — —	 150 0.1 0.1 0.3 15 30	 — 0.5 — — 30 50	 V/μs μs μs μs μs μs	 $R_{GK} = 1K$, $V_D = 30V$ $I_G = 10mA$, $I_T = 1A$, $V_D = 30V$ $I_G = 10mA$, $I_T = 1A$, $V_D = 30V$ $I_G = 10mA$, $I_T = 1A$, $V_D = 30V$ $I_T = 1A$, $i_R = 1A$, $R_{GK} = 1K$
SUBGROUP 4 (150°C TESTS) High Temp. Off-State Current High Temp. Reverse Current High Temp. Gate Trigger Voltage High Temp. Holding Current	 I_{DRM} I_{RRM} V_{GT} I_H	 — — 0.10 0.10	 50 80 0.15 0.15	 200 200 — —	 μA μA V mA	 $R_{GK} = 1K$, V_{DRM} = Rating $R_{GK} = 1K$, V_{RRM} = Rating $R_{GS} = 100\Omega$, $V_D = 5V$ $R_{GK} = 1K$, $V_D = 5V$
SUBGROUP 5 (—65°C TESTS) Low Temp. Gate Trigger Voltage Low Temp. Gate Trigger Current Low Temp. Holding Current	 V_{GT} I_{GT} I_H	 — — —	 0.7 50 1.2	 0.9 125 3.0	 V μA mA	 $R_{GS} = 100\Omega$, $V_D = 5V$ $R_{GS} = 10K$, $V_D = 5V$ $R_{GK} = 1K$, $V_D = 5V$

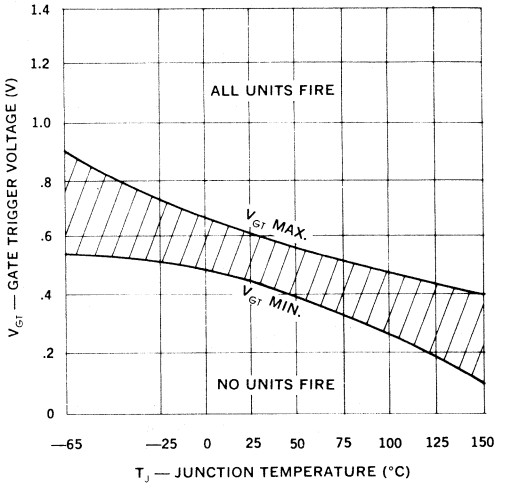
Note 1 See rating curves for full rating information.

Note 2 Blocking voltage ratings apply over the full operating temperature range, provided the gate is connected to the cathode through a resistor, 1K or smaller, or other adequate gate bias is used.

Gate Trigger Current



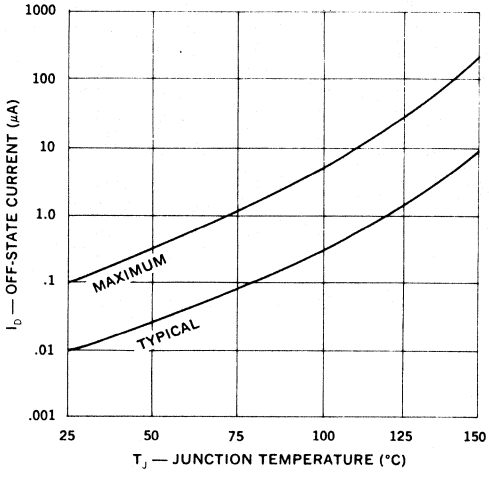
Gate Trigger Voltage



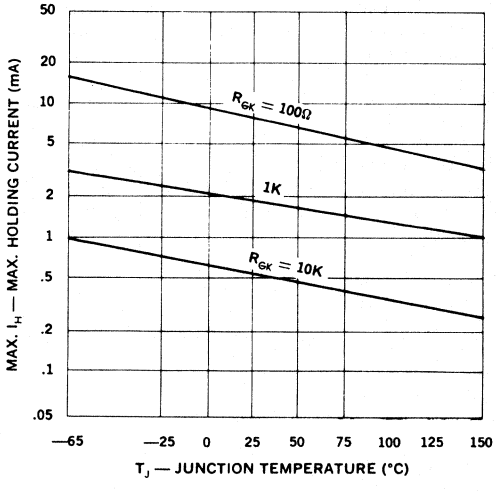
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

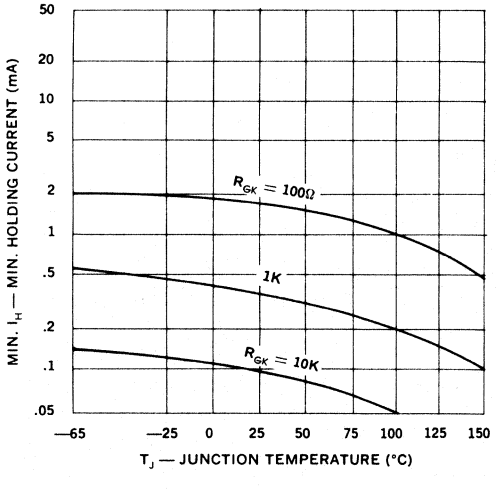
Off-State Current



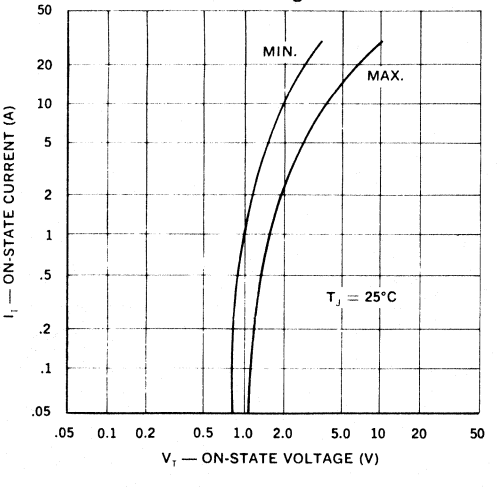
Max. Holding Current



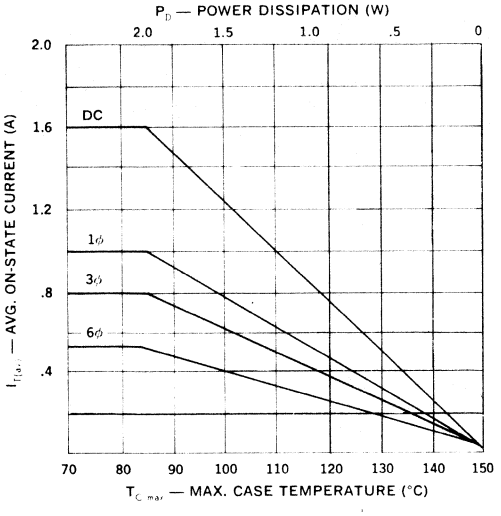
Min. Holding Current



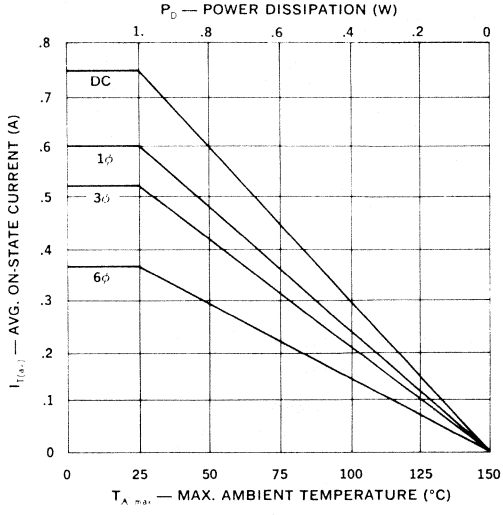
On-State Current vs. Voltage



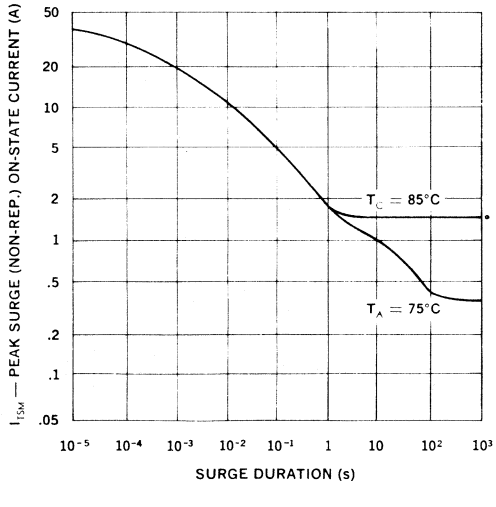
Avg. Current vs. Case Temperature



Avg. Current vs. Ambient Temperature



Surge Current



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PUTs

Planar, TO-18, Hermetic

2N6119-2N6120

FEATURES

- Hermetically Sealed TO-18 Metal Can
- Programmable Eta, R_{BB}, I_P and I_V
- Maximum Peak Point Current: 150nA
- Minimum Valley Current to 1.5mA
- Nano-Amp Leakage
- Passivated Planar Construction for Maximum Reliability and Parameter Uniformity

DESCRIPTION

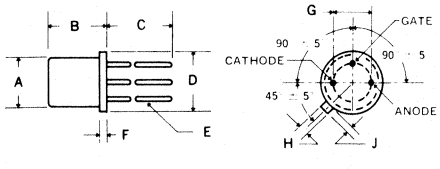
Functionally equivalent to standard unijunction transistors, Unitrode's Programmable Unijunction Transistors offer the distinct advantage of versatile programming. External resistors can be added to meet the designer's needs in programming Eta, R_{BB}, I_P and I_V functions. This series also features a hermetically sealed TO-18 package for optimum reliability in all environmental conditions. Applications include pulse and timing circuits, SCR trigger circuits, relaxation oscillators and sensing circuits. For additional information see Unitrode Application Note U-66.

ABSOLUTE MAXIMUM RATINGS

Anode-to-Cathode Voltage, V_{AK}	±40V
Gate-to-Cathode Forward Voltage, V_{GK}	40V
Gate-to-Anode Reverse Voltage, V_{GAR}	40V
Gate-to-Cathode Reverse Voltage, V_{GKR}	−5V
Peak Recurrent Forward Current	
10μs, 1% Duty Cycle	8A
100μs, 1% Duty Cycle	5A
Power Dissipation	
25°C Ambient	400mW
Derating Factor	3.2mW/°C
Storage Temperature	−55°C to +125°C
Operating Temperature Range	−55°C to +125°C

MECHANICAL SPECIFICATIONS

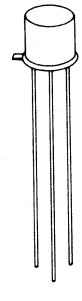
2N6119-2N6120



GATE CONNECTED TO CASE

	INCHES	MILLIMETERS
A	.178-.195 DIA.	4.52-4.95 DIA.
B	.170-.210	4.31-5.33
C	.5 MIN.	12.70 MIN.
D	.209-.230 DIA.	5.31-5.84 DIA.
E	.017 ± .002 DIA. .001 DIA.	.432 ± .051 .025
F	.020 MAX.	.508 MAX.
G	.100±.010 DIA.	2.54±.254 DIA.
H	.041±.005	1.04±.127
J	.028-.048	.711-1.22

TO-18

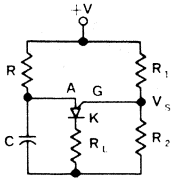


UNITRODE

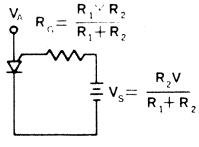
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	Fig.	2N6119 Min.	2N6119 Max.	2N6120 Min.	2N6120 Max.	Units	Test Conditions
Peak Current	I_P	1	—	5	—	1.0	μA	$R_G = 10k, V_S = 10V$
			—	2	—	0.15	μA	$R_G = 1$ Meg.
Valley Current	I_V	1	70	—	25	—	μA	$R_G = 10k, V_S = 10V$
			—	50	—	25	μA	$R_G = 1$ Meg.
			1.5	—	1.0	—	mA	$R_G = 200\Omega$
Offset Voltage	V_T	1	0.2	0.6	0.2	0.6	V	$R_G = 10k, V_S = 10V$
			0.2	1.6	0.2	0.6	V	$R_G = 1$ Meg.
Gate-to-Anode Leakage	I_{GAO}	2	—	10	—	10	nA	$T = 25°C, V_S = 40V$
			—	100	—	100	nA	$T = 75°C$
Gate-to-Cathode Leakage	I_{GKS}	3	—	100	—	100	nA	$V_S = 40V$
Forward Voltage	V_F	4	—	1.0	—	1.0	V	$I_F = 50mA$
Pulse Output Voltage	V_o	5	9	—	9	—	V	
Pulse Output Rate of Rise	t_r	5	—	80	—	80	ns	

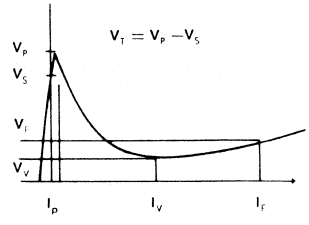
7



a) Typical Circuit



b) Equivalent Test Circuit



c) Characteristic Curve

Figure 1

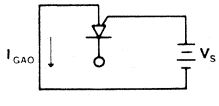


Figure 2

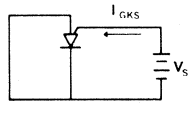


Figure 3

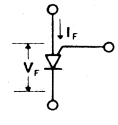
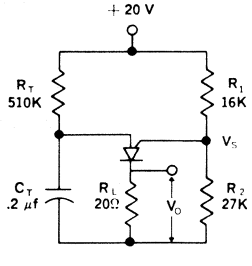


Figure 4



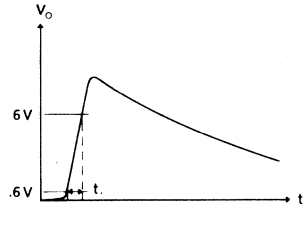
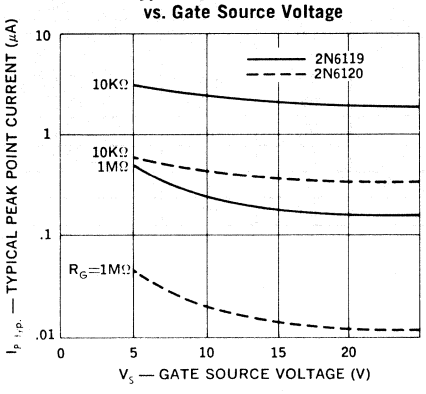
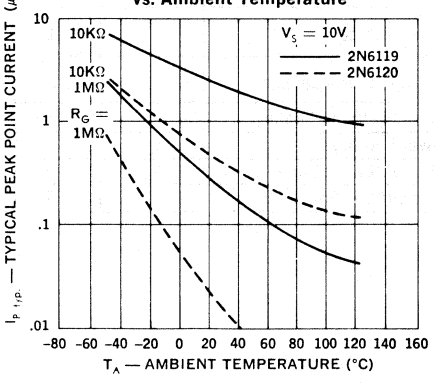


Figure 5

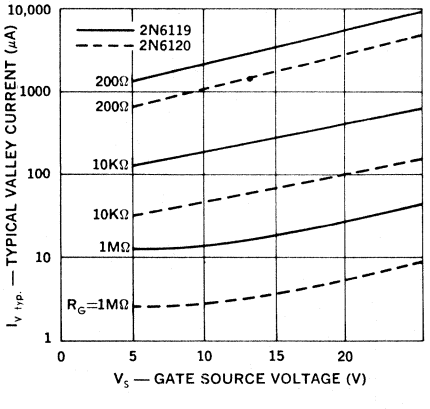
Typical Peak Point Current vs. Gate Source Voltage



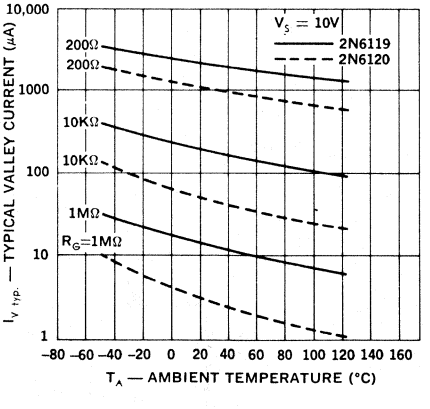
Typical Peak Point Current vs. Ambient Temperature



Typical Valley Current vs. Gate Source Voltage



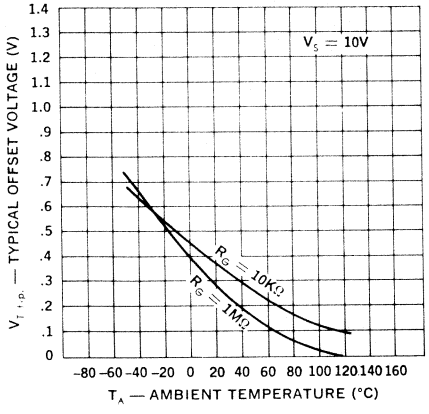
Typical Valley Current vs. Ambient Temperature



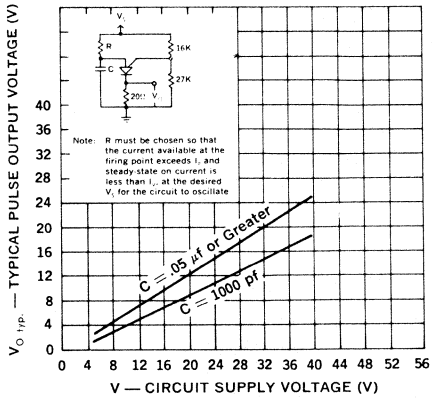
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

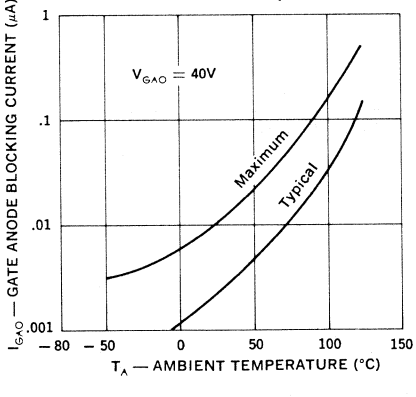
Typical Offset Voltage vs. Ambient Temperature



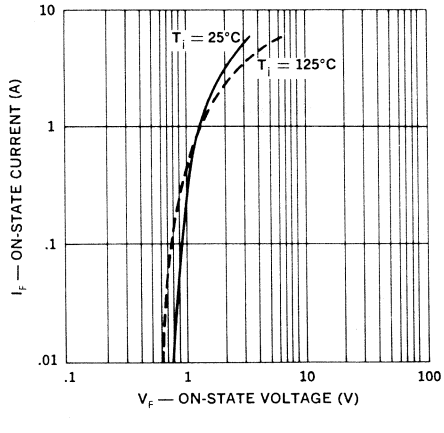
Typical Pulse Output vs. Circuit Supply Voltage



Gate-Anode Blocking Current vs. Ambient Temperature



Typical On-State Current vs. Voltage



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PUTs

2N6137

Military, Planar, TO-18, Hermetic

FEATURES

- Available as JAN and JANTX types per MIL standard 19500/493
- −55°C to +125°C Temperature Range for Timing and Oscillator Circuits
- $I_P \leq 10\mu A$ at T = −55°C
  $I_V \geq 40\mu A$ at T = +125°C
- Programmable η, R_{BB}, I_P and I_V
- Peak Recurrent Current: of 5A
- Low On-State Voltage Drop
- Hermetically Sealed Metal Case and Planar Passivated Construction for Maximum Reliability and Parameter Stability.

DESCRIPTION

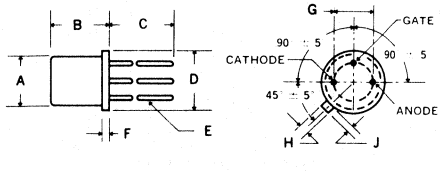
The Programmable Unijunction Transistor is functionally equivalent to a standard unijunction transistor with the advantage that external resistors can be used to program η, R_{BB}, I_P, and I_V, depending upon the designer's needs. The Unitrode device, in addition to allowing programmable versatility, is completely planar passivated and packaged in a TO-18 hermetically sealed package, which offers an order of magnitude improvement in inherent reliability over many similar devices. Applications include pulse and timing circuits, SCR trigger circuits, relaxation oscillators, and sensing circuits. For further application information see Unitrode Application Note U-66.

ABSOLUTE MAXIMUM RATINGS

Anode-to-Cathode Forward Voltage, V_{AK}	40V
Anode-to-Cathode Reverse Voltage, V_{AKR}	40V
Gate-to-Cathode Forward Voltage, V_{GK}	40V
Gate-to-Anode Reverse Voltage, V_{GAR}	40V
Gate-to-Cathode Reverse Voltage, V_{GKR}	5V
Peak Recurrent Forward Current, 10μs 1% Duty Cycle	5A
Peak Gate Current, I_{GM}	250mA
Average Gate Current, $I_{G(AV)}$	50mA
Power Dissipation	
25°C Ambient	300mW
Derating Factor	2.4mW/°C
Storage Temperature Range	−55°C to +125°C
Operating Temperature Range	−55°C to +125°C

MECHANICAL SPECIFICATIONS

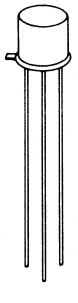
2N6137



ANODE CONNECTED TO CASE

	INCHES	MILLIMETERS
A	.178-.195 DIA.	4.52-4.95 DIA.
B	.170-.210	4.31-5.33
C	.5 MIN.	12.70 MIN.
D	.209-.230 DIA.	5.31-5.84 DIA.
E	.017 ± .002 DIA. .001 DIA.	.432 ± .051 .025
F	.020 MAX.	.508 MAX.
G	.100±.010 DIA.	2.54±.254 DIA.
H	.041±.005	1.04±.127
J	.028-.048	.711-1.22

TO-18

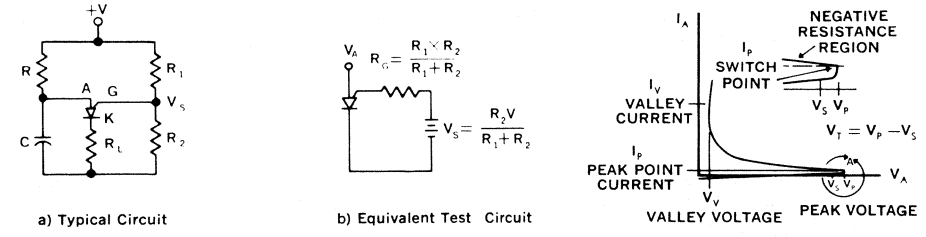


UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)†

Test	Symbol	Figure	Minimum	Typical	Maximum	Units	Test Conditions
SUBGROUP 1 Visual and Mechanical	—	—	—	—	—	—	—
SUBGROUP 2							
Gate-anode blocking current	I_{GAO}	2	—	2	10	nA	V_{GA} = Rating
Gate-cathode blocking current	I_{GKS}	3	—	5	100	nA	V_{GK} = Rating
SUBGROUP 3							
Peak-point anode current	I_P	1	—	1	2	μA	R_G = 1 Meg, V_S = 10V
			—	2.5	5	μA	R_G = 10K, V_S = 10V
Peak-point offset voltage	V_T	1	0.2	0.26	1.6	V	R_G = 1 Meg, V_S = 10V
			0.2	0.35	0.6	V	R_G = 10K, V_S = 10V
Valley-point anode current	I_V	1	—	15	50	μA	R_G = 1 Meg, V_S = 10V
			70	200	—	μA	R_G = 10K, V_S = 10V
			1.5	2	—	mA	R_G = 200Ω, V_S = 10V
SUBGROUP 4							
Forward on-state voltage	V_F	4	—	0.85	1.0	V	I_F = 50mA
Peak pulse voltage	V_o	5	9	12	—	V	
Peak pulse voltage rise time	t_r	5	—	50	80	ns	
SUBGROUP 5							
Gate-anode blocking current (125°C Test)	I_{GAO}	2	—	150	500	nA	V_{GA} = Rating
Valley-point anode current (125°C Test)	I_V	1	40	100	—	μA	R_G = 10K, V_S = 10V
Peak-point anode current (−55°C Test)	I_P	1	—	7.5	10	μA	R_G = 10K, V_S = 10V

† All values in table are JEDEC registered



a) Typical Circuit b) Equivalent Test Circuit

Figure 1

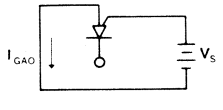


Figure 2

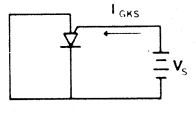


Figure 3

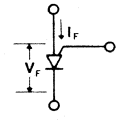


Figure 4

Note: Conditions for oscillation

$$\frac{V_{BB} - V_P}{R} > I_P$$

$$\frac{V_{BB} - V_V}{R} < I_V$$

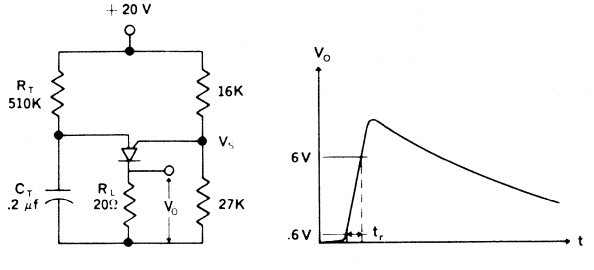
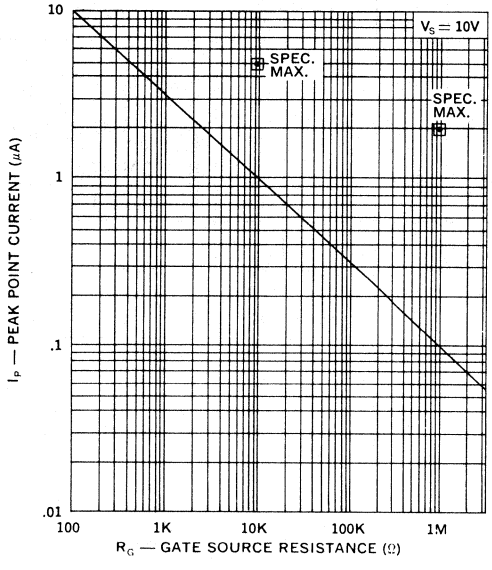


Figure 5

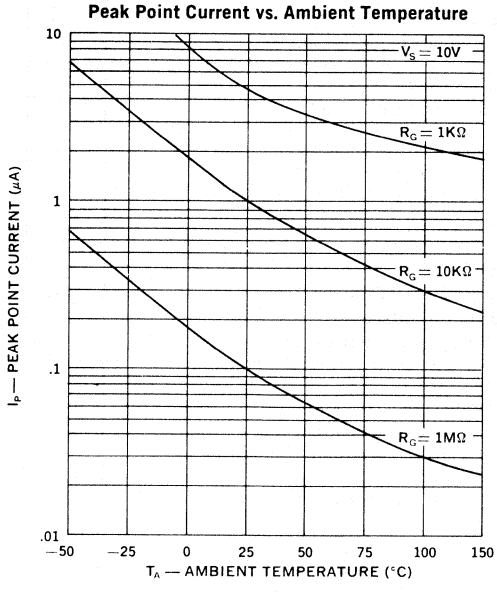
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

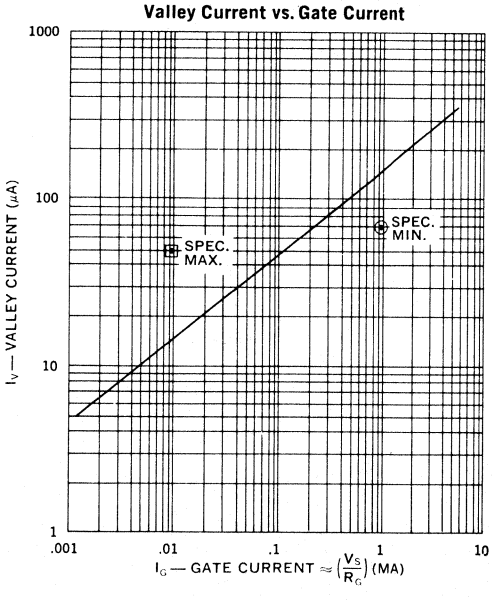
Peak Point Current vs. Gate Source Resistance



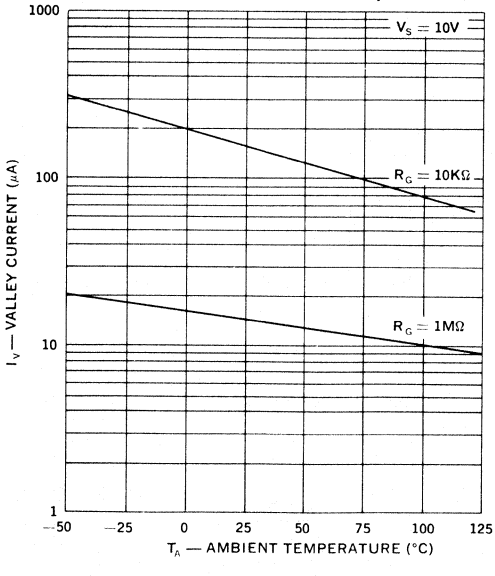
Peak Point Current vs. Ambient Temperature



Valley Current vs. Gate Current



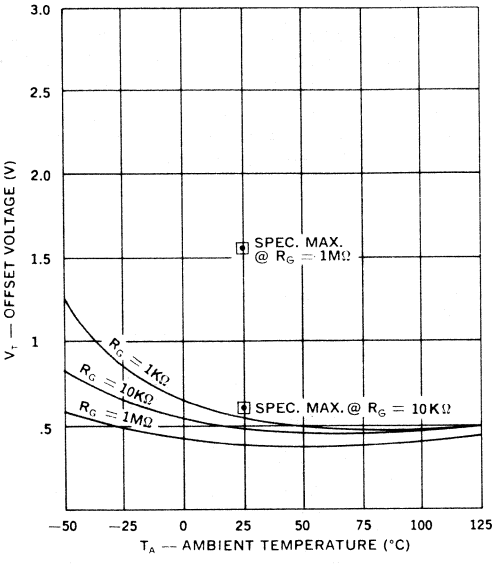
Valley Current vs. Ambient Temperature



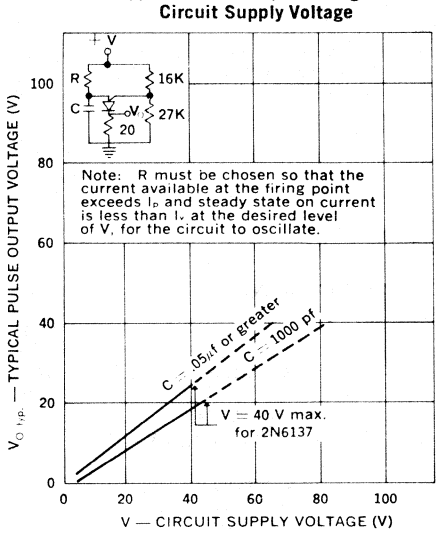
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

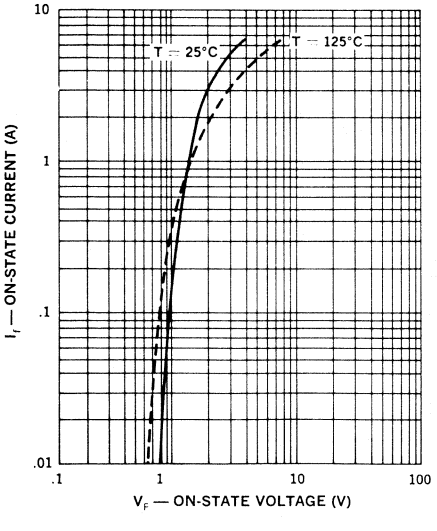
Offset Voltage vs. Ambient Temperature



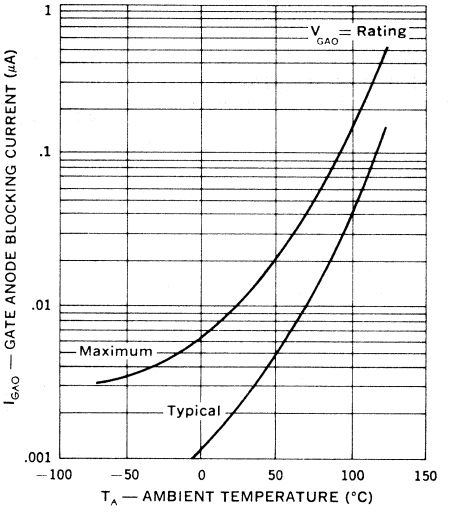
Typical Pulse Output Voltage vs. Circuit Supply Voltage



Typical Current vs. On-State Voltage



Gate-Anode Blocking Current vs. Ambient Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SCRs
.5A, Planar

AA100-AA104
AA107-AA111
AA114-AA118

FEATURES
- Maximum Gate Trigger Current: 2, 20 or 200μA
- Tight Gate Trigger Voltage Range: .44 to .6V
- Voltage Ratings: to 400V
- Specified for dv/dt and Switching Time

DESCRIPTION
This data sheet describes Unitrode's AA Series 0.5A SCRs designed for low-current sensing applications. Units are available in a complete range of blocking voltages from 60 to 400 volts.

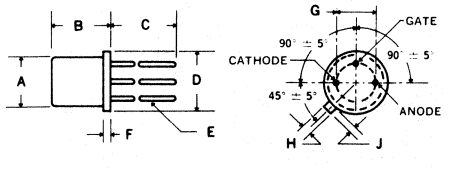
The AA100 series offers a maximum gate trigger current of 2.0 microamps making it the most sensitive device of its type. The AA107 series has a maximum I_{GT} of 20μA while this parameter is specified at 200μA for the AA114 series.

ABSOLUTE MAXIMUM RATINGS

	AA100 AA107 AA114	AA101 AA108 AA115	AA102 AA109 AA116	AA103 AA110 AA117	AA104 AA111 AA118
Repetitive Peak Off-State Voltage, V_{DRM}	60V	100V	200V	300V	400V
Repetitive Peak Reverse Voltage, V_{RRM}	60V	100V	200V	300V	400V
Non-Repetitive Peak Reverse Voltage, V_{RSM}	80V	150V	300V	400V	500V
Non-Repetitive Peak Off-State Voltage, V_{DSM}			500V		
D.C. On-State Current, I_T					
75°C Ambient			250mA		
100°C Case			500mA		
Repetitive Peak On-State Current, I_{TRM}			up to 30A		
Peak One Cycle Surge (Non-Rep.) On-State Current, I_{TSM}			5A		
Peak Gate Current, I_{GM}			250mA		
Average Gate Current, $I_{G(AV)}$			25mA		
Reverse Gate Voltage V_{GR}			6V		
Operating and Storage Temperature Range			−65°C to +150°C		

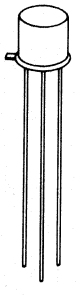
MECHANICAL SPECIFICATIONS

AA100-AA104 AA107-AA111 AA114-AA118



	INCHES	MILLIMETERS
A	.178-.195 DIA.	4.52-4.95 DIA.
B	.170-.210	4.31-5.33
C	.5 MIN.	12.70 MIN.
D	.209-.230 DIA.	5.31-5.84 DIA.
E	.017 ± .002 DIA. .001 DIA.	.432 ± .051 .025
F	.020 MAX.	.508 MAX.
G	.100±.010 DIA.	2.54±.254 DIA.
H	.041±.005	1.04±.127
J	.028-.048	.711-1.22

TO-18



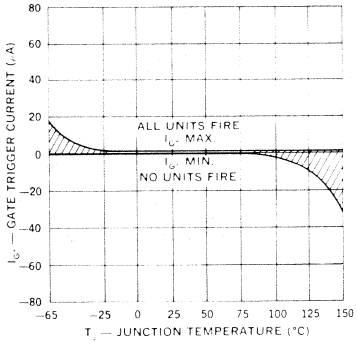
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

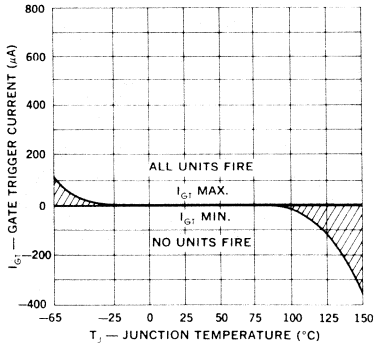
Parameter	Symbol	Min.	Typical	Max.	Units	Test Conditions
SUBGROUP 1						
Visual & Mechanical	—	—	—	—	—	—
SUBGROUP 2 (25°C TESTS)						
Off-State Current	I_{DRM}	—	.01	0.1	μA	R_{GK} = 1K, V_{DRM} = Rating
Reverse Current	I_{RRM}	—	.01	0.1	μA	R_{GK} = 1K, V_{RRM} = Rating
Reverse Gate Current	I_{GR}	—	0.1	0.2	μA	V_{GR} = 2V
Gate Trigger Current	I_{GT}					R_{GS} = 10K, V_D = 5V
AA100-104		—	0.2	2.0	μA	
AA107-111		—	2.0	20	μA	
AA114-118		—	20	200	μA	
Gate Trigger Voltage	V_{GT}	0.44	0.52	0.60	V	R_{GS} = 100Ω, V_D = 5V
On-State Voltage	V_T	—	1.1	1.5	V	I_T = 1.0 A (pulse)
Holding Current	I_H	0.3	0.5	2.0	mA	R_{GK} = 1K
SUBGROUP 3 (25°C TESTS)						
Off-State Voltage — Critical Rate of Rise	dv/dt	50	100	—	V/μs	R_{GK} = 1K, V_D = 30V
Gate Trigger — on Pulse Width	t_{pg} (on)	—	0.5	2.0	μs	I_G = 10mA, I_T = 1A, V_D = 30V
Delay Time	t_d	—	0.6	—	μs	I_G = 10mA, I_T = 1A, V_D = 30V
Rise Time	t_r	—	0.4	—	μs	I_G = 10mA, I_T = 1A, V_D = 30V
Circuit Commutated Turn-off Time	t_q	—	20	50	μs	I_T = 1A, I_R = 1A, R_{GK} = 1K
SUBGROUP 4 (125°C TESTS)						
Off-State Current	I_{DRM}	—	10	20	μA	R_{GK} = 1K, V_{DRM} = Rating
Reverse Current	I_{RRM}	—	30	100	μA	R_{GK} = 1K, V_{RRM} = Rating
Gate Trigger Voltage	V_{GT}	0.15	0.2	—	V	R_{GS} = 100Ω, V_D = 5V
Holding Current	I_H	0.2	0.4	1.5	mA	R_{GK} = 1K

Note: Blocking voltage ratings apply over the full operating temperature range, provided the gate is connected to the cathode through a resistor, 1000 ohms or smaller, or other adequate bias is used.

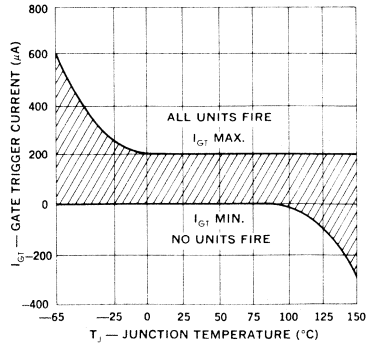
Gate Trigger Current AA100 Series



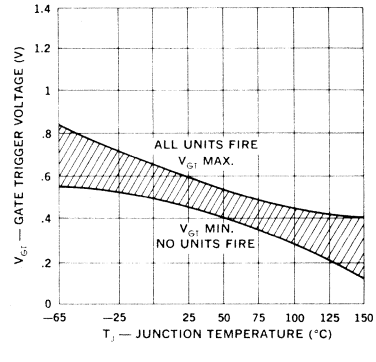
Gate Trigger Current AA107 Series



Gate Trigger Current AA114 Series



Gate Trigger Voltage

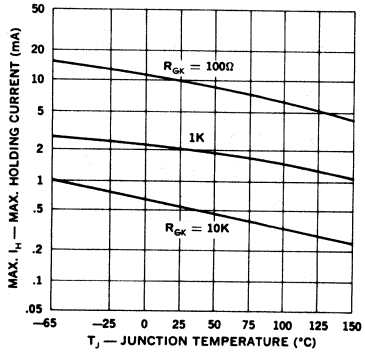


7

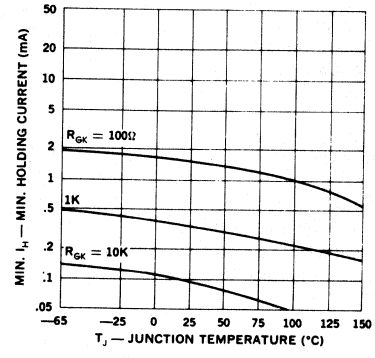
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

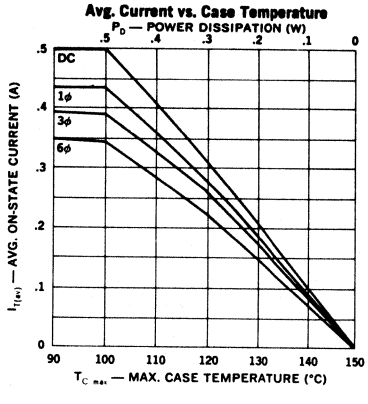
Max. Holding Current



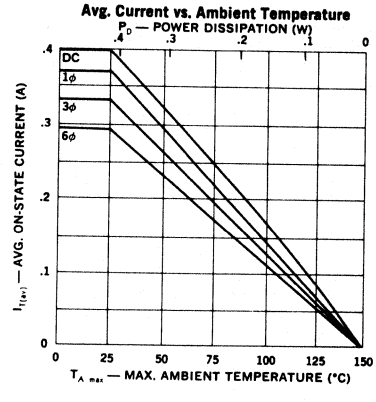
Min. Holding Current



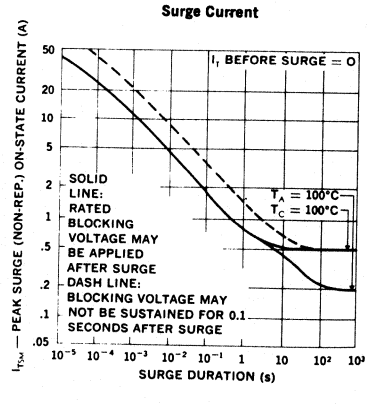
Avg. Current vs. Case Temperature



Avg. Current vs. Ambient Temperature



Surge Current



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SCRs
1.6 Amp, Planar

AD100-AD104
AD107-AD111
AD114-AD118

FEATURES
- Maximum Gate Trigger Current: 2, 20 or 200μA
- Tight Gate Trigger Voltage Range: .44 to .6V
- Voltage Ratings: to 400V
- Specified for dv/dt and Switching Time

DESCRIPTION
This data sheet describes Unitrode's AD Series 1.6A SCRs designed for medium-current control and sensing applications. Units are available in a complete range of blocking voltages from 60 to 400 volts.

The AD100 series offers a maximum gate trigger current of 2.0 microamps making it the most sensitive device of its type. The AD107 series has a maximum I_{GT} of 20μA while this parameter is specified at 200μA for the AD114 series.

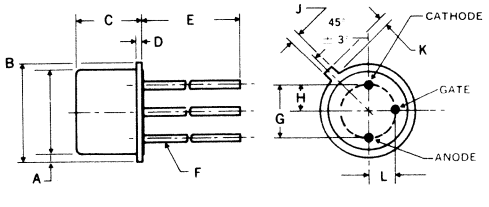
7

ABSOLUTE MAXIMUM RATINGS

	AD100 AD107 AD114	AD101 AD108 AD115	AD102 AD109 AD116	AD103 AD110 AD117	AD104 AD111 AD118
Repetitive Peak Off-State Voltage, V_{DRM}	60V	100V	200V	300V	400V
Repetitive Peak Reverse Voltage, V_{RRM}	60V	100V	200V	300V	400V
Non-Repetitive Peak Reverse Voltage, V_{RSM}	80V	150V	300V	400V	500V
Non-Repetitive Peak Off-State Voltage, V_{DSM}			500V		
D.C. On-State Current, I_T					
75°C Ambient			450mA		
85°C Case			1.6A		
Repetitive Peak On-State Current, I_{TRM}			up to 30A		
Peak One Cycle Surge (Non-Rep.) On-State Current, I_{TSM}			15A		
Peak Gate Current, I_{GM}			250mA		
Average Gate Current, $I_{G(AV)}$			25mA		
Reverse Gate Voltage, V_{GR}			6V		
Operating and Storage Temperature Range			−65°C to +150°C		

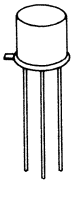
MECHANICAL SPECIFICATIONS

AD100-AD104 AD107-AD111 AD114-AD118



	ins.	mm.
A	.305-.335	7.75-8.51
B	.335-.370	8.51-9.40
C	.240-.260	6.35-6.60
D	.010-.030	.25-.76
E	.5 MIN.	12.70 MIN.
F	.017 +.002 −.001	.432 +.051 −.025
G	.200	5.08
H	.100	2.54
J	.031±.003	.79±.08
K	.029-.045	.74-1.14
L	.100	2.54

TO-205AD (TO-39)



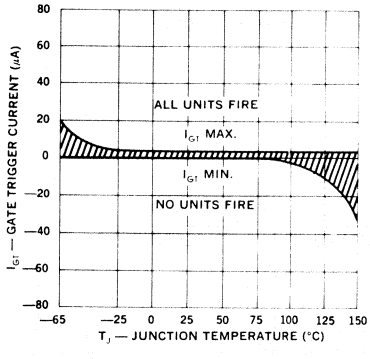
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

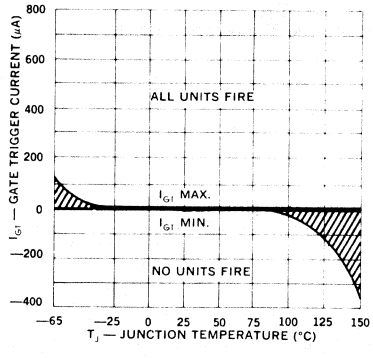
Parameter	Symbol	Min.	Typical	Max.	Units	Test Conditions
SUBGROUP 1 Visual & Mechanical	—	—	—	—	—	
SUBGROUP 2 (25°C TESTS) Off-State Current	I_{DRM}	—	.01	0.1	μA	R_{GK} = 1K, V_{DRM} = Rating
Reverse Current	I_{RRM}	—	.01	0.1	μA	R_{GK} = 1K, V_{RRM} = Rating
Reverse Gate Current	I_{GR}	—	0.1	0.2	μA	V_{GR} = 2V
Gate Trigger Current	I_{GT}					R_{GS} = 10K, V_D = 5V
AD100-104		—	0.2	2.0	μA	
AD107-111		—	2.0	20	μA	
AD114-118		—	20	200	μA	
Gate Trigger Voltage	V_{GT}	0.44	0.52	0.60	V	R_{GS} = 100Ω, V_D = 5V
On-State Voltage	V_T	—	1.1	1.5	V	I_T = 1.0 Amp (pulse)
Holding Current	I_H	0.3	0.5	2.0	mA	R_{GK} = 1K
SUBGROUP 3 (25°C TESTS) On-State Voltage-Critical Rate of Rise	dv/dt	50	100	—	V/μs	R_{GK} = 1K, V_D = 30V
Gate Trigger-on Pulse Width	t_{pg} (on)	—	0.5	2.0	μs	I_G = 10mA, I_T = 1A, V_D = 30V
Delay Time	t_d	—	0.6	—	μs	I_G = 10mA, I_T = 1A, V_D = 30V
Rise Time	t_r	—	0.4	—	μs	I_G = 10mA, I_T = 1A, V_D = 30V
Circuit Commutated Turn-off Time	t_g	—	20	50	μs	I_T = 1A, I_R = 1A, R_{GK} = 1K
SUBGROUP 4 (125°C TESTS) Off-State Current	I_{DRM}	—	10	100	μA	R_{GK} = 1K, V_{DRM} = Rating
Reverse Current	I_{RRM}	—	30	100	μA	R_{GK} = 1K, V_{RRM} = Rating
Gate Trigger Voltage	V_{GT}	0.15	0.2	—	V	R_{GS} = 100Ω, V_D = 5V
Holding Current	I_H	0.2	0.4	1.5	mA	R_{GK} = 1K

Note: Blocking voltage ratings apply over the full operating temperature range, provided the gate is connected to the cathode through a resistor, 1000 ohms or smaller, or other adequate bias is used.

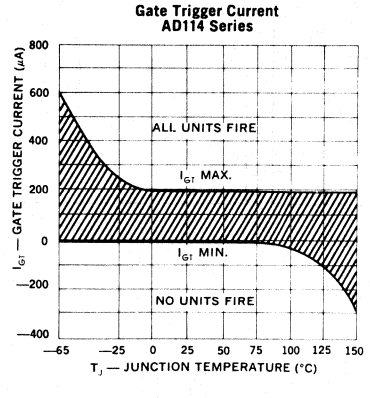
Gate Trigger Current
AD100 Series



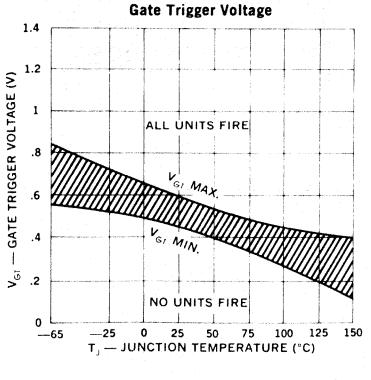
Gate Trigger Current
AD107 Series



Gate Trigger Current
AD114 Series



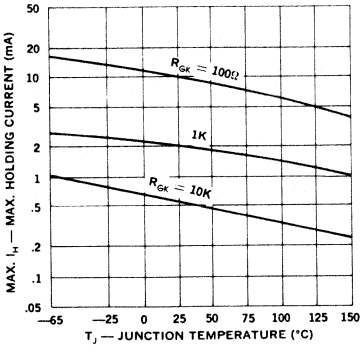
Gate Trigger Voltage



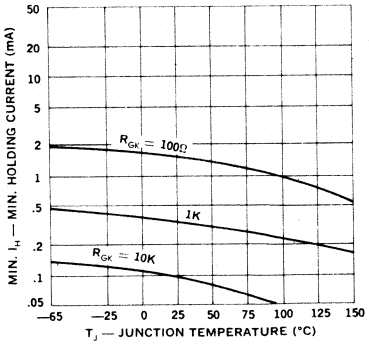
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

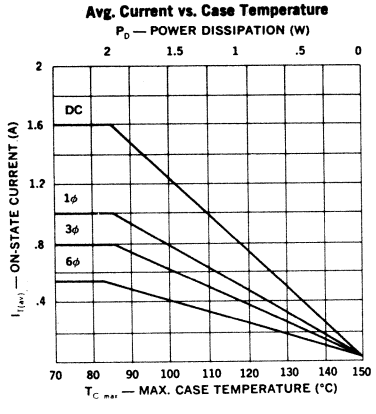
Max. Holding Current



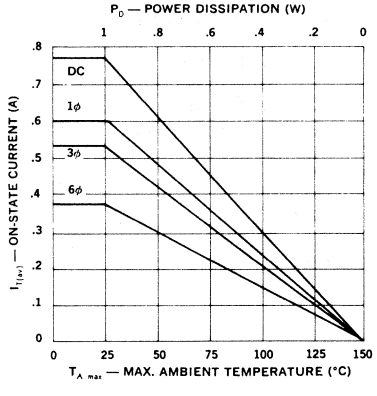
Min. Holding Current



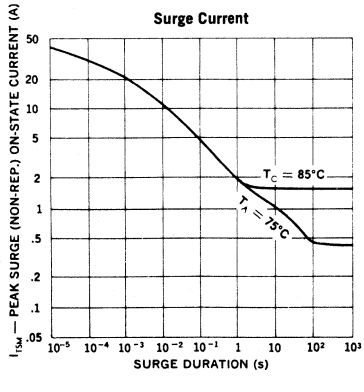
Avg. Current vs. Case Temperature



Avg. Current vs. Ambient Temperature



Surge Current



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SCRs
Nuclear Radiation Resistant, Planar

GA100
GA101
GA102

FEATURES
- Optimized for Radiation Resistance
- Fully Characterized for "Worst Case" Design
- Post Radiation Design Limits Specified
- Passivated Planar Construction for Maximum Reliability and Parameter Uniformity
- Pulse Currents: to 30A
- Max. Trigger Current 20mA after 3 X 10^{14} NVT
- Max. Holding Current 30mA after 3 X 10^{14} NVT

DESCRIPTION
The GA100 Series of Radiation Hard SCRs have been designed to provide significantly greater radiation tolerance than conventional SCRs or Transistors with the same current handling ability. This Series is capable of operation after exposure to 10^{15} NVT.

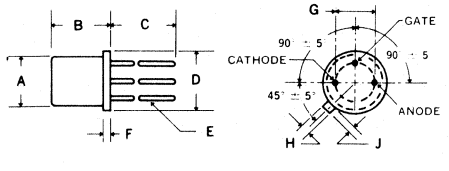
The radiation resistant characteristics of the GA100 series devices make them particularly desirable for use under radiation environments in squib firing circuits; inverters and converters; pulse generators; relay drivers; and modulator discharge switches.

ABSOLUTE MAXIMUM RATINGS

	GA100	GA101	GA102
Repetitive Peak Off-State Voltage, V_{DRM}	30V	60V	80V
D.C. On-State Current, I_T			
75°C Ambient		200mA	
100°C Case		400mA	
Repetitive Peak On-State Current, I_{TRM}		up to 30A	
Surge (non-rep.) On-State Current, I_{TSM} (Sq. Pulse-50ms)		5A	
Peak Gate Current, I_{GM}		250mA	
Average Gate Current, $I_{G(AV)}$		25mA	
Reverse Gate Voltage, V_{GR}		5V	
Reverse Gate Current, I_{GR}		3mA	
Storage Temperature Range		−65°C to +200°C	
Operating Temperature Range		−65°C to +150°C	

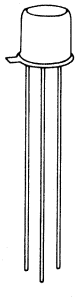
MECHANICAL SPECIFICATIONS

GA100 GA101 GA102



	INCHES	MILLIMETERS
A	.178–.195 DIA.	4.52–4.95 DIA.
B	.170–.210	4.31–5.33
C	.5 MIN.	12.70 MIN.
D	.209–.230 DIA.	5.31–5.84 DIA.
E	.017 ± .002 DIA. .001 DIA.	.432 ± .051 .025
F	.020 MAX.	.508 MAX.
G	.100±.010 DIA.	2.54±.254 DIA.
H	.041±.005	1.04±.127
J	.028–.048	.711–1.22

TO-18



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	Preradiation Limits			Post 3 x 10^{14} NVT Design Limits		Units	Test Conditions
		Min.	Typ.	Max.	Min.	Max.		
SUBGROUP 1 Visual and Mechanical	—	—	—	—	—	—	—	MIL-STD-750 Method 2071
SUBGROUP 2 (25°C Tests)								
Off-State Current	I_{DRM}	—	.005	0.1	—	1.0	μA	$R_{GK} = 220\Omega$, V_{DRM} = Rating
Reverse Gate Current	I_{GR}	—	.01	0.1	—	1.0	μA	$V_{GR} = 2V$
Input Trigger Current (Note 2)	I_{ST}	1.8	2.3	3.5	—	20	mA	$R_{GK} = 220\Omega$, $V_D = 5V$
Gate Trigger Voltage	V_{GT}	0.4	0.5	0.7	—	1.5	V	$R_{GK} = 220\Omega$, $V_D = 5V$
On-State Voltage	V_T	0.8	1.1	1.5	—	3.0	V	$i_T = 1A$ (pulse test)
Holding Current	I_H	0.3	0.7	10	—	30	mA	$R_{GK} = 220\Omega$
SUBGROUP 3 (25°C Tests)								
Off-State Voltage-Critical Rate of Rise	dv_c/dt	20	40	—	—	—	V/μs	$R_{GK} = 220\Omega$, $V_D = 30V$
Gate Trigger-on Pulse Width	t_{pg}(on)	—	.02	.05	—	0.1	μs	$I_G = 25mA$, $I_T = 1A$, $V_D = 30V$
Delay Time	t_d	—	.02	—	—	—	μs	$I_G = 25mA$, $I_T = 1A$, $V_D = 30V$
Rise Time	t_r	—	.05	—	—	—	μs	$I_G = 25mA$, $I_T = 1A$, $V_D = 30V$
Circuit Commutated Turn-off Time	t_q	—	1.5	2.5	—	1.0	μs	$I_T = 1A$, $i_R = 1A$, $R_{GK} = 220\Omega$
SUBGROUP 4 (125°C Tests)								
High Temp Off-State Current	I_{DRM}	—	10	100	—	100	μA	$R_{GK} = 220\Omega$, V_{DRM} = Rating
High Temp Gate Trigger Voltage	V_{GT}	0.1	.17	—	0.1	—	V	$R_{GK} = 220\Omega$, $V_D = 5V$

Notes: 1. Off-State voltage ratings apply over the operating temperature range provided the gate is connected to the cathode through an appropriate resistor, or other adequate bias is used.
2. Total Input Trigger Current, including current required by 220Ω gate bias resistance.

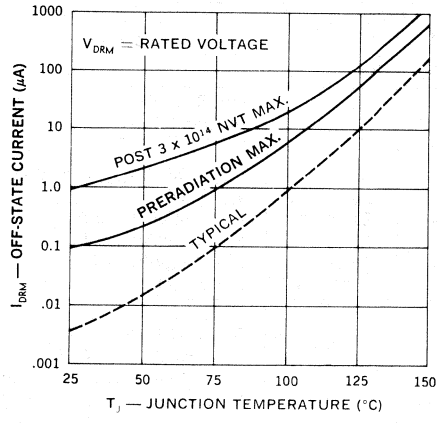
DESIGN CONSIDERATIONS

1. Curve 1 shows the off-state current, I_{DRM} of the SCR as a function of temperature. I_{DRM} is increased by radiation damage, but is not a design consideration at the recommended gate bias levels.
   In order to optimize for radiation tolerance, reverse blocking capability has not been retained as a design feature. Devices with reverse blocking capability can be provided.
2. Minimum critical dv/dt levels are defined in Curve 2. The dv/dt capability is improved after radiation because of reduced triggering sensitivity. dv/dt is therefore a design consideration only prior to radiation.
3. Curves 3 and 4 show the limits of Gate Trigger Voltage and Total Input Trigger Current prior to radiation. Maximum design limits after a total radiation dosage of 3 x 10^{14} NVT is also shown. Curves 5 and 6 show the maximum limits of Gate Trigger Voltage and Total Input Trigger Currents as a junction of neutron dosage. The minimum level of Trigger current prior to radiation is established by the shunting effect of a 220 ohm resistor between gate and cathode. After radiation the device is less sensitive and Total Trigger Current will increase to a level relatively independent of the bias resistance. The 220 ohm resistor is recommended since it raises the minimum preradiation trigger current to a level that is closer to the past radiation limit and minimizes the percentage change in this parameter.
4. Current ratings shown in Curves 10, 11, and 12 apply after the device has been subjected to 3 x 10^{14} NVT. Current ratings prior to radiation are greater than the values indicated.
5. Gamma radiation produces a reversible ionization (leakage) current within the device which is directly proportional to the Gamma flux level. When the Gamma flux level is in the range of 10 to 100 Roentgens per microsecond for burst durations greater than 1 microsecond, the device will self trigger ON. For the radiation bursts associated with nuclear explosions, the Gamma flux level will invariably cause device triggering at radiation levels significantly below the levels that would produce detectable permanent device damage due to cumulative neutron dosage. In applications where the burst effect triggering cannot be tolerated, it is necessary to reset the device after the radiation burst. Special circuit approaches such as additional SCRs to crowbar or otherwise cancel the output function may be used.

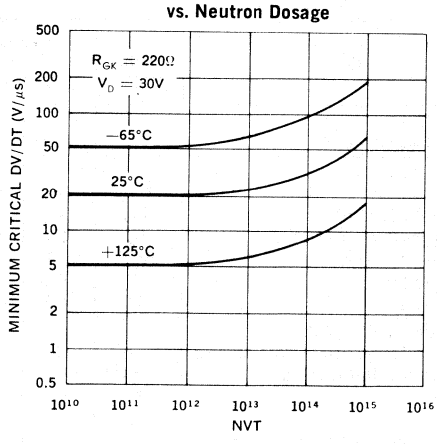
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

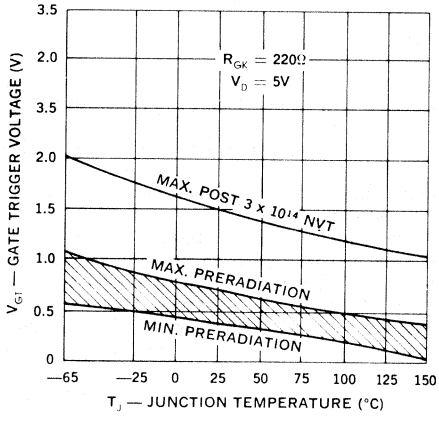
1. **Off-State Current**



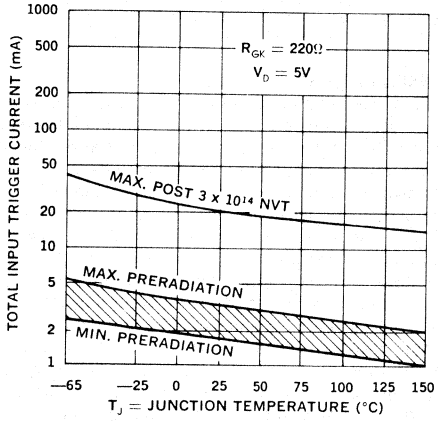
2. **Minimum Critical DV/DT vs. Neutron Dosage**



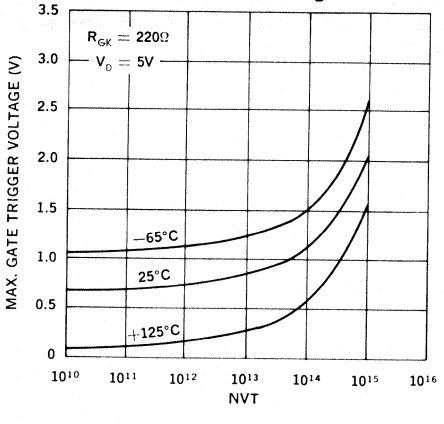
3. **Gate Trigger Voltage**



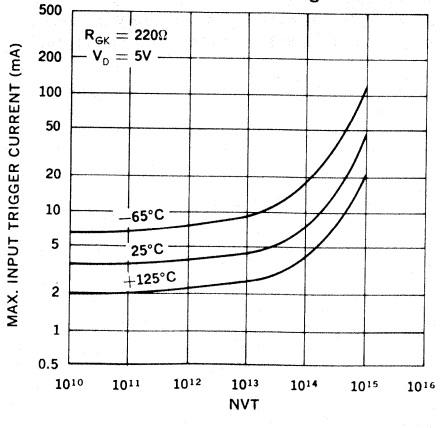
4. **Input Trigger Current**



5. **Max. Gate Trigger Voltage vs. Neutron Dosage**



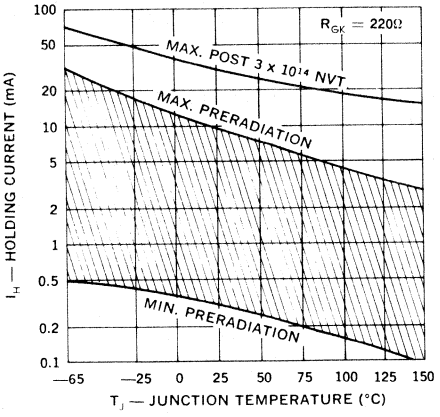
6. **Max. Input Trigger Current vs. Neutron Dosage**



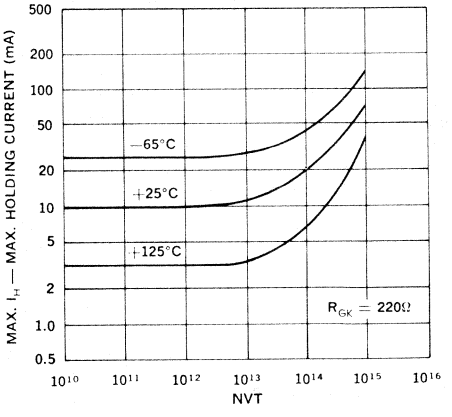
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

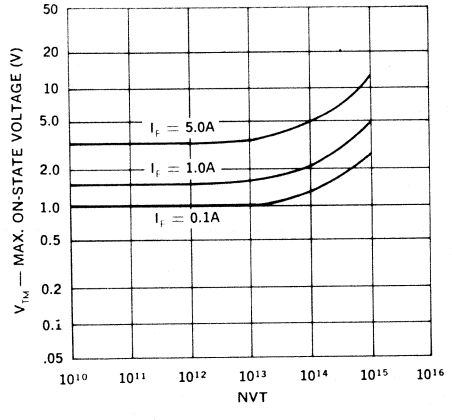
7. Holding Current



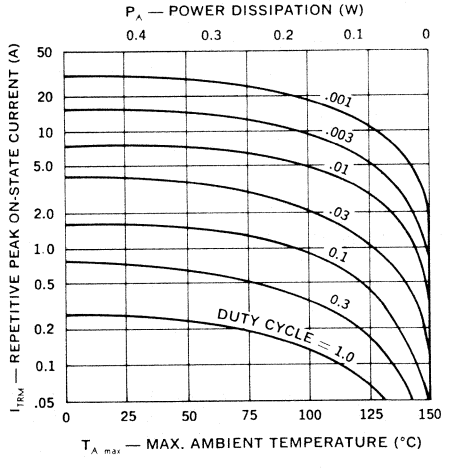
8. Max. Holding Current vs. Neutron Dosage



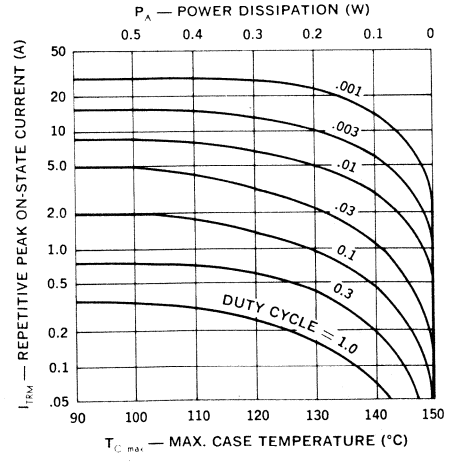
9. Max. On-State Voltage vs. Neutron Dosage



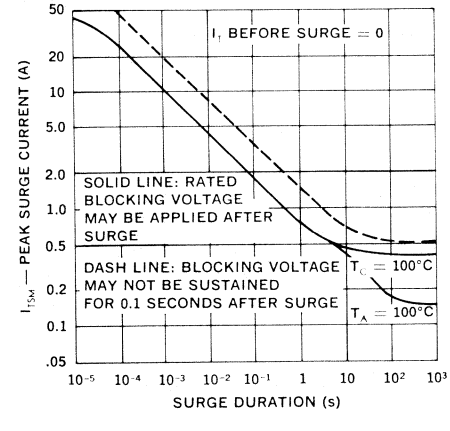
10. Peak Current vs. Ambient Temperature



11. Peak Current vs. Case Temperature



12. Surge Current vs. Time



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SCRs
Nanosecond Switching, Planar

GA200 GB200
GA200A GB200A
GA201 GB201
GA201A GB201A

FEATURES
- Rise Time: 10ns
- Delay Time: 10ns
- Recovery Time: 0.5 μs
- Pulse Current: to 100A
- Turn-on with 20ns, 10 mA Gate Pulse

DESCRIPTION
The Unitrode Nanosecond Thyristor Switch combines the turn-on speed of logic level transistors with the high current switching capability inherent in SCRs. With this device engineers can now design circuits capable of switching pulse currents of 1A in less than 10ns or up to 30A in less than 20ns.

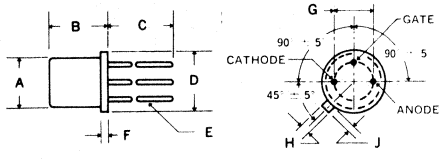
The GA/GB200 series is specifically designed for use as switching elements in high speed, low-to-medium power radar pulse modulators. Other applications include switching elements for phased array radars, laser pulse drivers, harmonic wave-form generators, line drivers and high current replacements for avalanche transistors. For applications requiring higher voltage levels, Unitrode has developed several "series string" circuits which allow the series connection of virtually an unlimited number of devices for voltages as high as 2000V with no significant decrease in speed. These circuits are described in Unitrode's Design Note #14.

ABSOLUTE MAXIMUM RATINGS

	GA200 GA200A	GA201 GA201A	GB200 GB200A	GB201 GB201A
Repetitive Peak Off-State Voltage, V_{DRM}	60V	100V	60V	100V
Repetitive Peak On-State Current, I_{TRM}	up to 100A		up to 100A	
D.C. On-State Current, I_T				
70°C Ambient	200mA		—	
70°C Case	400mA		6A	
Peak Gate Current, I_{GM}	250mA		250mA	
Average Gate Current, $I_{G(AV)}$	25mA		50mA	
Reverse Gate Current, I_{GR}	3mA		3mA	
Reverse Gate Voltage, V_{GR}	5V		5V	
Storage Temperature Range	−65°C to +200°C			
Operating Temperature Range	−65°C to +150°C			

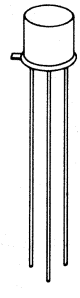
MECHANICAL SPECIFICATIONS

GA200 GA200A GA201 GA201A

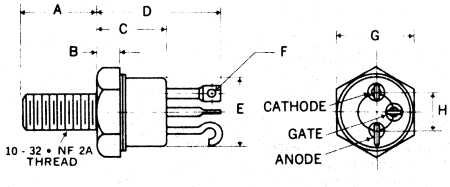


	INCHES	MILLIMETERS
A	.178-.195 DIA.	4.52-4.95 DIA.
B	.170-.210	4.31-5.33
C	.5 MIN.	12.70 MIN.
D	.209-.230 DIA.	5.31-5.84 DIA.
E	.017 ± .002 DIA. .001 DIA.	.432 ± .051 .025
F	.020 MAX.	.508 MAX.
G	.100±.010 DIA.	2.54±.254 DIA.
H	.041±.005	1.04±.127
J	.028-.048	.711-1.22

TO-18



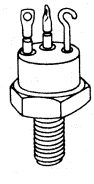
GB200 GB200A GB201 GB201A



	INCHES	MILLIMETERS
A	.400-.455	10.16-11.56
B	.090-.150	2.28-3.81
C	.320-.468	8.13-11.88
D	.570-.763	14.48-19.38
E	.318-.380	8.07-9.65
F	.055 ± .010 .015	1.40 ± .254 .381
G	.424-.437	10.77-11.10
H	.185-.215	4.70-5.46

NOTE: Anode connected to case.

TO-59



UNITRODE

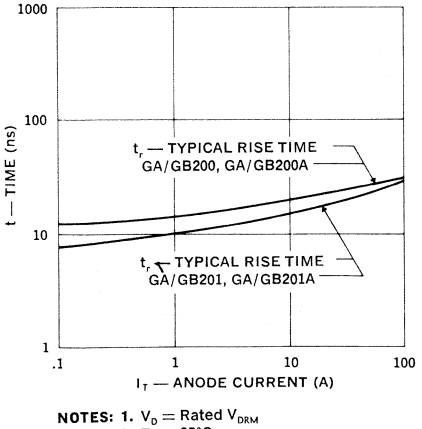
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Delay Time	t_d	— —	20 10	30 —	ns ns	$I_G = 20mA$, $I_T = 1A$ $I_G = 30mA$, $I_T = 1A$
Rise Time GA200, 200A, GB200, 200A	t_r	— —	15 25	25 —	ns ns	$V_D = 60V$, $I_T = 1A$ (1) $V_D = 60V$, $I_T = 30A$ (1)
Rise Time GA201, 201A, GB201, 201A	t_r	— —	10 20	20 —	ns ns	$V_D = 100V$, $I_T = 1A$ (1) $V_D = 100V$, $I_T = 30A$ (1)
Gate Trigger on Pulse Width	$t_{pg(on)}$	—	.02	.05	μs	$I_G = 10mA$, $I_T = 1A$
Circuit Commutated Turn-off Time GA200, 201, GB200, 201	t_q	—	0.8	2.0	μs	$I_T = 1A$, $I_R = 1A$, $R_{GK} = 1K$
GA200A, 201A, GB200A, 201A	t_q	—	0.3	0.5	μs	
Off-State Current	I_{DRM}	—	.01	0.1	μA	V_{DRM} = Rating, $R_{GK} = 1K$
		—	20	100	μA	V_{DRM} = Rating, $R_{GK} = 1K$, 150°C
Reverse Current	I_{RRM}	—	1.0	10	mA	$V_{RRM} = 30V$, $R_{GK} = 1K$ (2)
Reverse Gate Current	I_{GR}	—	.01	0.1	mA	$V_{GRM} = 5V$
Gate Trigger Current	I_{GT}	—	10	200	μA	$V_D = 5V$, $R_{GS} = 10K$
Gate Trigger Voltage	V_{GT}	0.4	.06	0.75	V	$V_D = 5V$, $R_{GS} = 100\Omega$, T = 25°C
		0.10	0.2	—	V	T = +150°C
On-State Voltage	V_T	—	1.1	1.5	V	$I_T = 2A$
Holding Current	I_H	0.3	2.0	5.0	mA	$V_D = 5V$, $R_{GK} = 1K$, T = 25°C
		0.05	0.2	—	mA	T = +150°C
Off-State Voltage-Critical Rate of Rise	dv/dt	20	40	—	V/μs	$V_D = 30V$, $R_{GK} = 1K$

Notes: 1. I_G = 10mA; Pulse Test, Duty Cycle <1%.

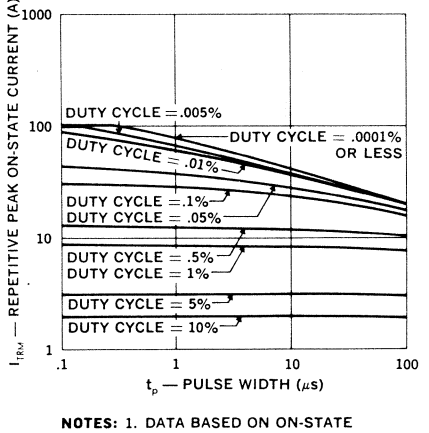
2. Pulse test intended to guarantee reverse anode voltage capability for pulse commutation. Device should not be operated in the Reverse blocking mode on a continuous basis.

Switching Speed (Typical)
GA/GB200 Series



NOTES: 1. V_D = Rated V_{DRM}
2. T_A = 25°C
3. I_G = 20mA
4. t_d = 20ns TYPICALLY FOR ALL TYPES INDEPENDENT OF ANODE CURRENT

Peak Current vs. Pulse Width
GA200 Series

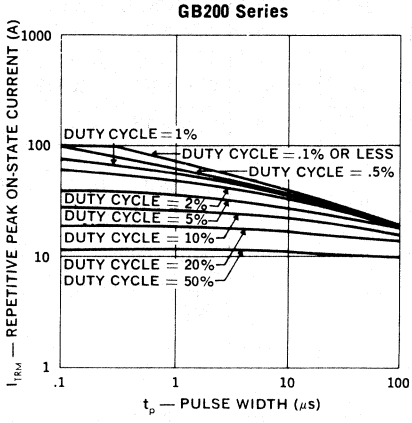


NOTES: 1. DATA BASED ON ON-STATE VOLTAGE GRAPH AT T_j = 150°C. BLOCKING VOLTAGE MAY BE APPLIED IMMEDIATELY AFTER TERMINATION OF CURRENT PULSE.
2. T_A = 75°C

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

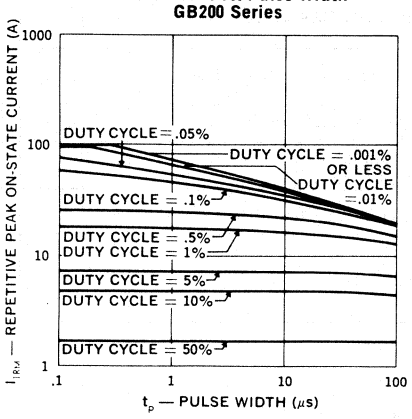
PRINTED IN U.S.A.

Peak Current vs. Pulse Width
GB200 Series



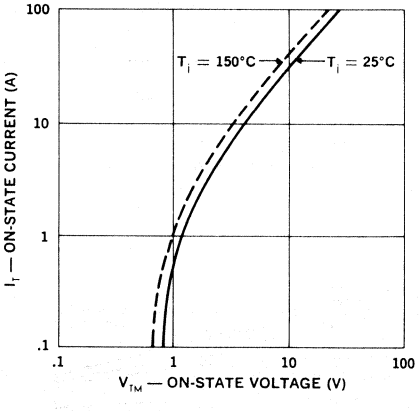
NOTES: 1. DATA BASED ON ON-STATE VOLTAGE GRAPH AT T_j = 150°C. BLOCKING VOLTAGE MAY BE APPLIED IMMEDIATELY AFTER TERMINATION OF CURRENT PULSE.
2. T_C = 75°C

Peak Current vs. Pulse Width
GB200 Series

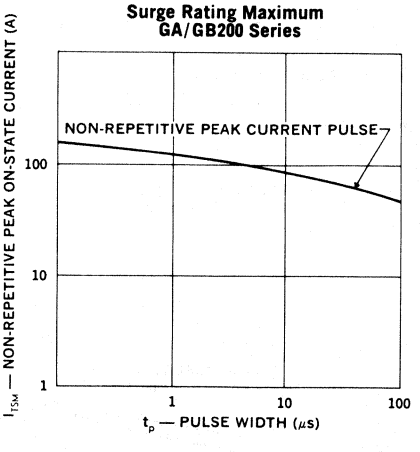


NOTES: 1. DATA BASED ON ON-STATE VOLTAGE GRAPH AT T_j = 150°C. BLOCKING VOLTAGE MAY BE APPLIED IMMEDIATELY AFTER TERMINATION OF CURRENT PULSE.
2. T_A = 75°C

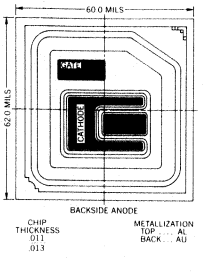
On-State Current vs. Voltage
GA/GB200 Series



Surge Rating Maximum
GA/GB200 Series



NOTES: 1. BLOCKING VOLTAGE MAY NOT BE APPLIED FOR .001 SEC. AFTER TERMINATION OF SURGE PULSE AS JUNCTION TEMPERATURE WILL EXCEED 150°C.
2. T_C = 75°C



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SCRs
Commercial Nanosecond Switching Planar

GA300 GB300
GA300A GB300A
GA301 GB301
GA301A GB301A

FEATURES
- Rise Time: 10ns
- Delay Time: 10ns
- Recovery Time: 0.5μs
- Pulse Current: to 100A
- Turn-on with 20ns, 10mA gate pulse

DESCRIPTION
Unitrode's Nanosecond Thyristor Switch combines the turn-on speed of logic level transistors with the high current switching capability inherent in SCRs. With this device, engineers can now design circuits capable of switching pulse currents of 1A in less than 10ns or up to 30A in less than 20ns.

The GA300, GB300 Series is specifically designed for use as the switching element in high speed laser diode pulse drivers. Other applications include electronic crowbars, harmonic wave-form generators, line drivers and general purpose replacements for avalanche transistors. For applications requiring higher voltage levels, Unitrode has developed several "series string" circuits which allow the series connection of an unlimited number of devices for voltages as high as 2000V with no significant decrease in speed. These circuits are described in Unitrode's Design Note #14.

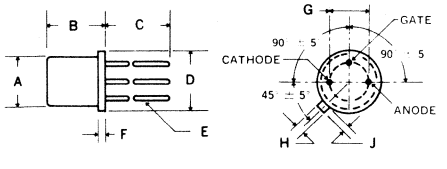
7

ABSOLUTE MAXIMUM RATINGS

	GA300 GA300A	GA301 GA301A	GB300 GB300A	GB301 GB301A
Repetitive Peak Off-State Voltage, V_{DRM}	60V	100V	60V	100V
Repetitive Peak On-State Current, I_{TRM}	up to 100A		up to 100A	
Peak Gate Current, I_{GM}	250mA		250mA	
Average Gate Current, $I_{G(AV)}$	25mA		50mA	
Reverse Gate Current, I_{GR}	3mA		3mA	
Reverse Gate Voltage, V_{GR}	5V		5V	
Storage Temperature Range	−65°C to +150°C			
Operating Temperature Range	0°C to +125°C			

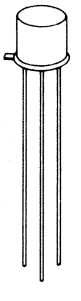
MECHANICAL SPECIFICATIONS

GA300 GA300A GA301 GA301A

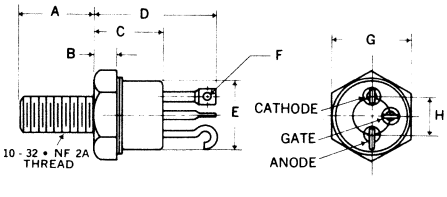


	INCHES	MILLIMETERS
A	.178-.195 DIA.	4.52-4.95 DIA.
B	.170-.210	4.31-5.33
C	.5 MIN.	12.70 MIN.
D	.209-.230 DIA.	5.31-5.84 DIA.
E	.017 ± .002 DIA. .001 DIA.	.432 ± .051 .025
F	.020 MAX.	.508 MAX.
G	.100±.010 DIA.	2.54±.254 DIA.
H	.041±.005	1.04±.127
J	.028-.048	.711-1.22

TO-18



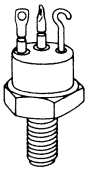
GB300 GB300A GB301 GB301A



	INCHES	MILLIMETERS
A	.400-.455	10.16-11.56
B	.090-.150	2.28-3.81
C	.320-.468	8.13-11.88
D	.570-.763	14.48-19.38
E	.318-.380	8.07-9.65
F	.055 ± .010 .015	1.40 ± .254 .381
G	.424-.437	10.77-11.10
H	.185-.215	4.70-5.46

NOTE: Anode connected to case.

TO-59



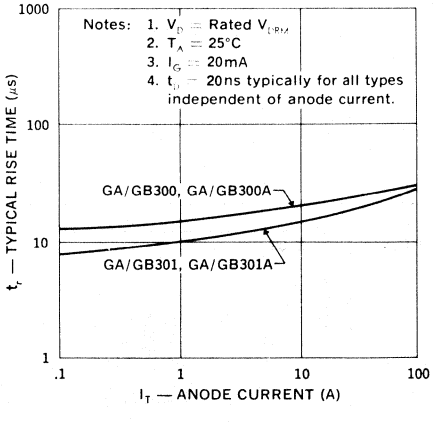
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

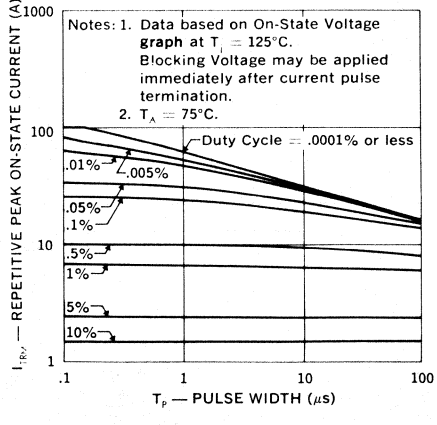
Test	Symbol	Min.	Typical	Max.	Units	Test Conditions
Delay Time	t_d	—	20 10	30 —	ns	$I_G = 20mA, I_T = 1A$ $I_G = 30mA, I_T = 1A$
Rise Time (Note 1) GA300, 300A, GB300, 300A	t_r	—	15 25	25 —	ns	$V_D = 60V, I_T = 1A$ $V_D = 60V, I_T = 30A$ (Note 1)
Rise Time (Note 1) GA301, 301A, GB301, 301A	t_r	—	10 20	20 —	ns	$V_D = 100V, I_T = 1A$ $V_D = 100V, I_T = 30A$ (Note 1)
Circuit Commutated Turn-off Time GA300, 301, GB300, 301	t_q	—	0.8	2.0	μs	$I_T = 1A, I_R = 1A, R_{GK} = 1K$
GA300A, 301A, GB300A, 301A			0.3	0.5	μs	$I_T = 1A, I_R = 1A, R_{GK} = 1K$
Gate Trigger-on Pulse Width	$t_{pg(on)}$	—	0.02	0.05	μs	$I_G = 10mA, I_T = 1A$
Off-state Current	I_{DRM}	— —	0.01 20	0.1 100	μA μA	V_{DRM} = Rating, $R_{GK} = 1K$, T = 25°C V_{DRM} = Rating, $R_{GK} = 1K$, T = 125°C
Reverse Current (Note 2)	I_{RRM}	—	1.0	10	mA	$V_{RRM} = 30V, R_{GK} = 1K$ (Note 2)
Gate Trigger Voltage	V_{GT}	0.4 0.10	0.6 0.2	0.75 —	V V	$V_D = 5V, R_{GS} = 100\Omega$, T = 25°C $V_D = 5V, R_{GS} = 100\Omega$, T = 125°C
Gate Trigger Current	I_{GT}	—	10	200	μA	$V_D = 5V, R_{GS} = 10K$
On-state Voltage	V_T	—	1.1	1.5	V	$I_T = 2A$
Off-state Voltage — Critical Rate of Rise	dv/dt	15	30	—	V/μs	$V_D = 30V, R_{GK} = 1K$
Reverse Gate Current	I_{GR}	—	0.01	0.1	mA	$V_{GR} = 5V$
Holding Current	I_H	0.3 0.05	2.0 0.4	5.0 —	mA mA	$V_D = 5V, R_{GK} = 1K$, T = 25°C $V_D = 5V, R_{GK} = 1K$, T = 125°C

Notes: 1. $I_G = 10mA$; Pulse Test, Duty Cycle < 1%.
2. Pulse test intended to guarantee reverse anode voltage capability for pulse commutation. Device should not be operated in the reverse blocking mode on a continuous basis.

Switching Speed vs. Current
GA/GB300 Series



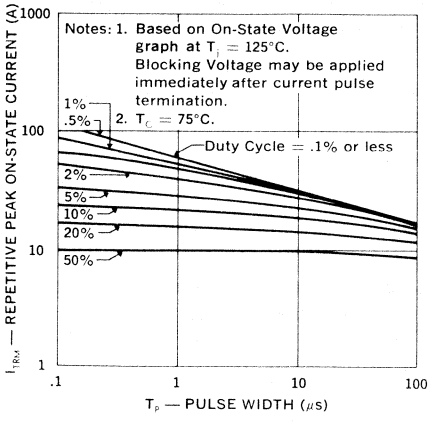
Peak Current vs. Pulse Width
GA300 Series



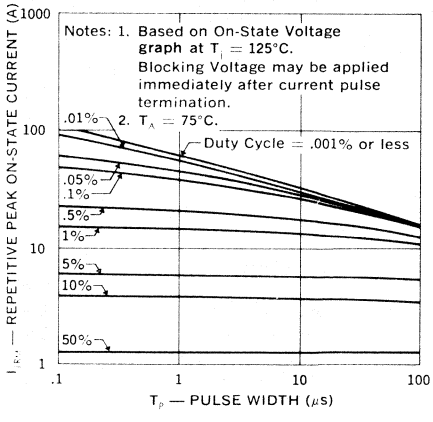
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

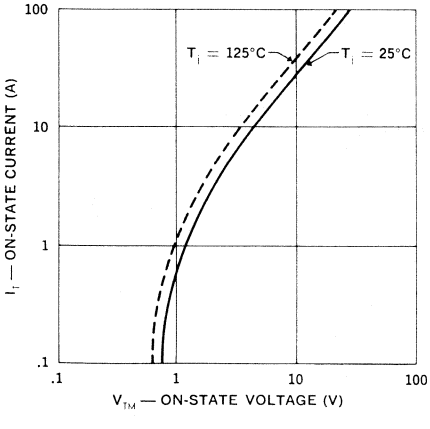
Peak Current vs. Pulse Width
GB300 Series



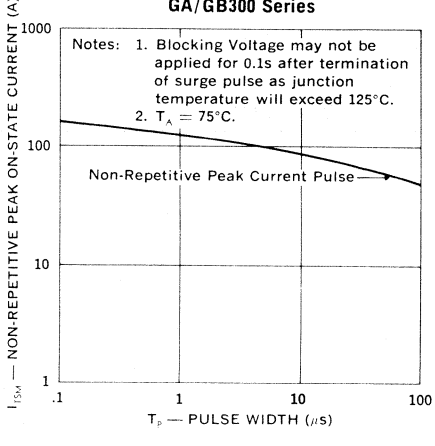
Peak Current vs. Pulse Width
GB300 Series



On-State Voltage vs. Current
GA/GB300 Series



Surge Rating
GA/GB300 Series



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SCRs
.5 Amp, Planar

FEATURES
- Voltage Ratings: to 400V
- Maximum Gate Trigger Current: 200μA
- Hermetically Sealed TO-18 Metal Can
- Planar Passivated Construction

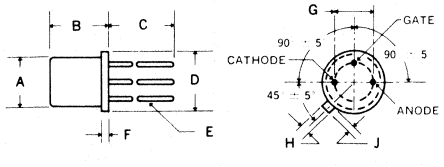
DESCRIPTION
This Data Sheet describes Unitrode's line of hermetically sealed industrial SCRs designed for low-voltage, low-current sensing application. The ID100 Series is packaged in a TO-18 metal case with Unitrode's unique oxide passivated junctions, offering the highest degree of reliability and parameter stability for any device in its price range.
Typical applications include lamp driving, relay driving, sensor, pulse-generating and timing circuits.

ABSOLUTE MAXIMUM RATINGS

	ID100	ID101	ID102	ID103	ID104	ID105	ID106
Repetitive Peak Off-State Voltage, V_{DRM}	30V	60V	100V	150V	200V	300V	400V
Repetitive Peak Reverse Voltage, V_{RRM}	30V	60V	100V	150V	200V	300V	400V
On-State Current, I_T							
75°C Ambient				250mA			
100°C Case				0.5A			
Repetitive Peak On-State Current, I_{TRM}				6A			
Peak One Cycle Surge (Non-Rep.) On-State Current, I_{TSM}				up to 30A			
Peak Gate Current, I_{GM}				250mA			
Average Gate Current, $I_{G(AV)}$				25mA			
Reverse Gate Voltage, V_{GR}				6V			
Storage Temperature Range				−65°C to +150°C			
Operating Temperature Range				−65°C to +125°C			

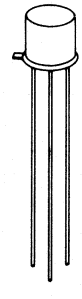
MECHANICAL SPECIFICATIONS

ID100-ID106



	INCHES	MILLIMETERS
A	.178-.195 DIA.	4.52-4.95 DIA.
B	.170-.210	4.31-5.33
C	.5 MIN.	12.70 MIN.
D	.209-.230 DIA.	5.31-5.84 DIA.
E	.017 ± .002 DIA. .001 DIA.	.432 ± .051 .025
F	.020 MAX.	.508 MAX.
G	.100±.010 DIA.	2.54±.254 DIA.
H	.041±.005	1.04±.127
J	.028-.048	.711-1.22

TO-18



UNITRODE

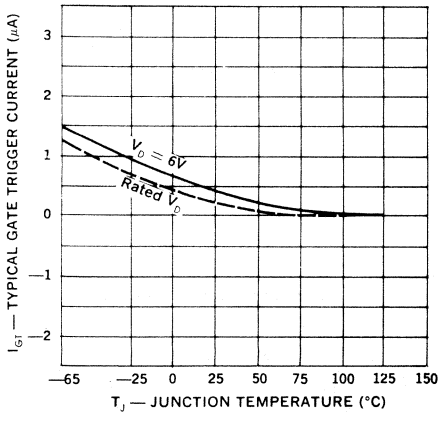
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	Min.	Typical	Max.	Units	Test Conditions
Off-State Current	I_{DRM}	—	5.0	50	μA	V_{DRM} = Rating, R_{GK} = 1K, T = 125°C, ID100-ID104
		—	10.0	100	μA	V_{DRM} = Rating, R_{GK} = 1K, T = 125°C, ID105-ID106
Reversing Current	I_{RRM}	—	10	50	μA	V_{RRM} = Rating, R_{GK} = 1K, T = 125°C, ID100-ID104
		—	15	100	μA	V_{RRM} = Rating, R_{GK} = 1K, T = 125°C, ID105-ID106
Gate Trigger Current	I_{GT}	—	5.0	200	μA	V_D = 5V, R_{GS} = 10K
		—	—	500	μA	V_D = 5V, R_{GS} = 10K, T = −40°C
Gate Trigger Voltage	V_{GT}	0.4	0.55	0.8	V	V_D = 5V, R_{GS} = 100Ω
		—	—	1.0	V	V_D = 5V, R_{GS} = 100Ω, T = −40°C
		0.10	—	—	V	V_D = 5V, R_{GS} = 100Ω, T = 125°C
Peak On-State Voltage	V_{TM}	—	—	1.7	V	I_{TM} = 1 Amp Pulse
Holding Current	I_H	—	1.0	5.0	mA	R_{GK} = 1K
		—	—	10.0	mA	R_{GK} = 1K, T = −40°C
Turn-on Time	t_{on}	—	0.5	—	μs	I_G = 10mA, I_T = 1A, V_D = 30V
Circuit Commutated Turn-off Time	t_q	—	8.0	—	μs	I_T = I_R = 1A, R_{GK} = 1K, ID100-ID104
		—	15.0	—	μs	I_T = I_R = 1A, R_{GK} = 1K, ID105-ID106

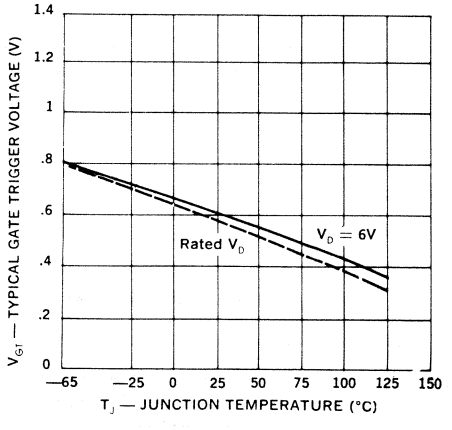
Note: Blocking voltage ratings apply over the full operating temperature range, provided the gate is connected to the cathode through a resistor, 1000 ohms or smaller, or other adequate bias is used.

7

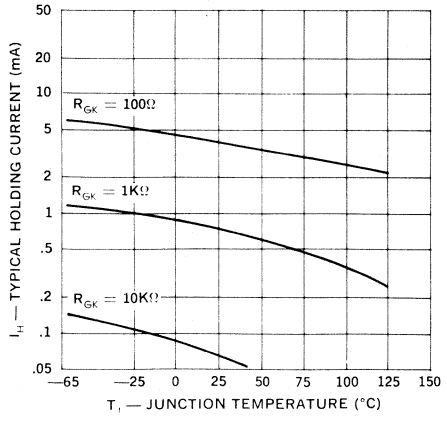
Gate Trigger Current vs. Junction Temp.



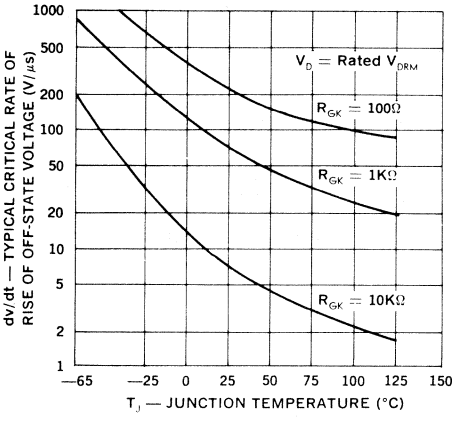
Gate Trigger Voltage vs. Junction Temp.



Holding Current vs. Junction Temp.



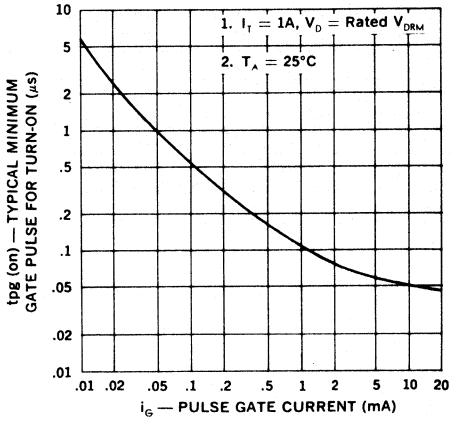
dv/dt vs. Junction Temp.



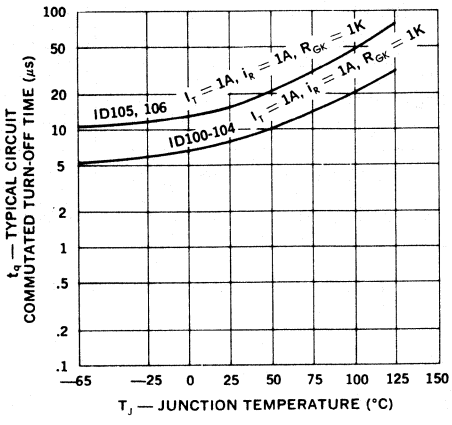
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

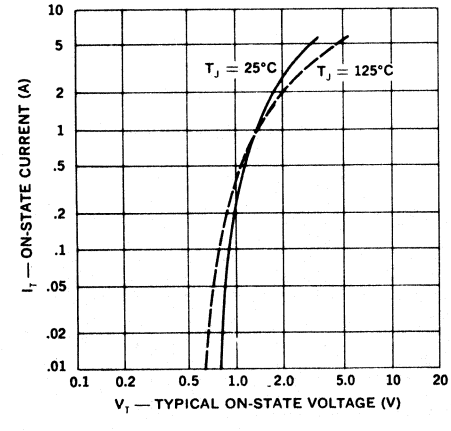
Gate Pulse for Turn-On vs. Pulse Gate Current



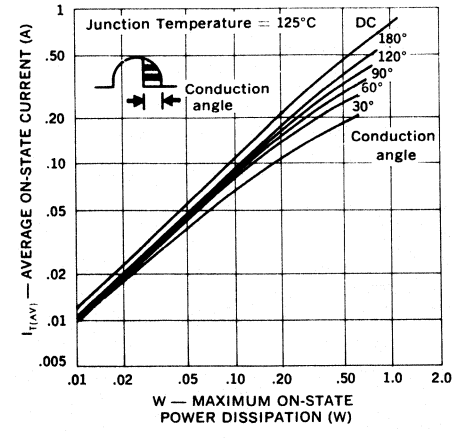
Circuit Commutated Turn-Off Time vs. Junction Temp.



Current vs. On State Voltage



Current vs. Power Dissipation



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SCRs
1.6 Amp, Planar

ID200-ID203
ID300-ID301

FEATURES
- Voltage Rating: to 200V
- Max. Gate Trigger Current: 200μA
- Hermetically Sealed Metal Can
- Planar Passivated Construction

DESCRIPTION
This Data Sheet describes Unitrode's line of hermetically sealed industrial SCRs designed for high-voltage, medium-current control applications. The Series is packaged in a TO-39 metal case with Unitrode's unique oxide passivated junctions to ensure reliability and parameter stability.
Typical applications include relay equipment, motor controls, process controllers and pulse generators.

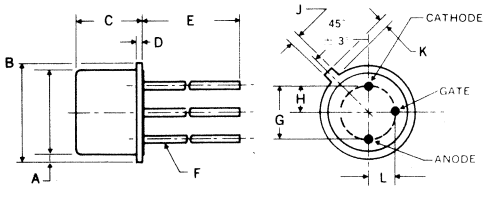
7

ABSOLUTE MAXIMUM RATINGS

	ID200	ID201	ID202	ID203	ID300	ID301
Repetitive Peak Off-State Voltage, V_{DRM}	50V	100V	150V	200V	300V	400V
Repetitive Peak Reverse Voltage, V_{RRM}	50V	100V	150V	200V	300V	400V
Non-Repetitive Peak Reverse Voltage, V_{RSM} (<5ms)	75V	150V	225V	300V	400V	500V
On-State Current, $I_{T(RMS)}$						
70°C Case	1.6A					
75°C Ambient	450mA					
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM}	15A					
Repetitive Peak On-State Current, I_{TRM}	up to 30A					
Rate of Rise of On-State Current, di/dt	100A/μs					
I^2t (for times > 1.5 ms)	0.83A^2s					
Peak Gate Current, I_{GM}	250mA					
Average Gate Current, $I_{G(AV)}$	25mA					
Reverse Gate Voltage, V_{GR}	6V					
Storage Temperature Range	−65°C to +150°C					
Operating Temperature Range	−40°C to +110°C					

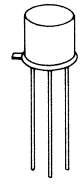
MECHANICAL SPECIFICATIONS

ID200-ID203 ID300-ID301



	ins.	mm.
A	305-335	7.75-8.51
B	335-370	8.51-9.40
C	240-260	6.35-6.60
D	010-030	.25-.76
E	.5 MIN.	12.70 MIN.
F	.017 +.002 −.001	.432 +.051 −.025
G	.200	5.08
H	.100	2.54
J	.031±.003	.79±.08
K	.029-.045	.74-1.14
L	.100	2.54

TO-205AD (TO-39)



UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Off-State Current	I_{DRM}	— —	— 5	10 100	μA μA	V_{DRM} = Rating, R_{GK} = 1K, T = 25°C V_{DRM} = Rating, R_{GK} = 1K, T = 110°C
Reverse Current	I_{RRM}	— —	— 10	10 100	μA μA	V_{RRM} = Rating, R_{GK} = 1K, T = 25°C V_{RRM} = Rating, R_{GK} = 1K, T = 110°C
Gate Trigger Current	I_{GT}	— —	— —	200 500	μA μA	V_D = 5V, R_{GS} = 10K, T = 25°C V_D = 5V, R_{GS} = 10K, T = −40°C
On-State Voltage	V_{GT}	0.4 0.5 0.2	0.52 0.7 —	0.8 1.0 —	V V V	V_D = 5V, R_{GS} = 100Ω, T = 25°C V_D = 5V, R_{GS} = 100Ω, T = −40°C V_D = 5V, R_{GS} = 100Ω, T = 110°C
Peak On — Voltage	V_{TM}	—	—	2.2	V	I_T = 4 Amp Pulse, T = 25°C
Holding Current	I_H	0.3 0.4 0.2	0.7 — —	3.0 6.0 —	mA mA mA	R_{GK} = 1K, T = 25°C R_{GK} = 1K, T = −40°C R_{GK} = 1K, T = 110°C
Off-State Voltage — Critical Rate of Rise	dv/dt	—	20	—	V/μs	V_{DRM} = Rated, R_{GK} = 1K, T = 110°C
Turn-on Time	t_{on}	—	1.0	—	μs	I_G = 10mA, I_T = I_A, V_D = 30V, T = 25°C
Circuit Commutated Turn-off Time	t_q	—	—	40	μs	I_T = i_R = 1A, R_{GK} = 1K, T = 25°C

Note: Blocking voltage ratings apply over the full operating temperature range, provided the gate is connected to the cathode through a resistor, 1000 ohms or smaller, or other adequate bias is used.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PUTs
Planar, TO-18 Hermetic

U13T1-U13T2

FEATURES
- Voltage Ratings: to 100V
- Maximum Peak Current: 150nA
- Valley Current: as low as 25 μA
- Low Forward Voltage Drop
- Nano-Amp Leakage
- Hermetically Sealed TO-18 Metal Can

DESCRIPTION
The Unitrode hermetically sealed TO-18 metal can series of programmable unijunction transistors feature blocking voltages to 100V, the highest available to designers. These PUTs are functionally equivalent to standard unijunction transistors, with the added advantages of programming versatility. External resistors can be added to program η, R_{BB}, I_p and I_v, depending upon your design requirements. All units are fully planar passivated. This series features a hermetically sealed TO-18 package for optimum reliability in all environmental conditions. Applications include pulse and timing circuits, SCR trigger circuits, relaxation oscillators, and sensing circuits. For further application information see Unitrode's Application Note U-66.

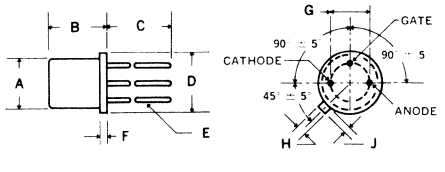
7

ABSOLUTE MAXIMUM RATINGS

Anode-to-Cathode Forward Voltage, V_{AK}	40V
Anode-to-Cathode Reverse Voltage, V_{AKR}	40V
Gate-to-Cathode Forward Voltage, V_{GK}	40V
Gate-to-Anode Reverse Voltage, V_{GAR}	40V
Gate-to-Cathode Reverse Voltage, V_{GKR}	5V
Peak Recurrent Forward Current	
10 μs 1% Duty Cycle	8A
100 μs 1% Duty Cycle	5A
Power Dissipation	
25°C Ambient	400mW
Derating Factor	3.2mW/°C
Storage Temperature Range	−55°C to +150°C
Operating Temperature Range	−55°C to +150°C

MECHANICAL SPECIFICATIONS

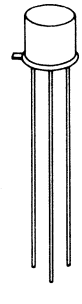
U13T1-U13T2



GATE CONNECTED TO CASE

	INCHES	MILLIMETERS
A	.178-.195 DIA.	4.52-4.95 DIA.
B	.170-.210	4.31-5.33
C	.5 MIN.	12.70 MIN.
D	.209-.230 DIA.	5.31-5.84 DIA.
E	.017 ± .002 DIA. .001 DIA.	.432 ± .051 .025
F	.020 MAX.	.508 MAX.
G	.100±.010 DIA.	2.54±.254 DIA.
H	.041±.005	1.04±.127
J	.028-.048	.711-1.22

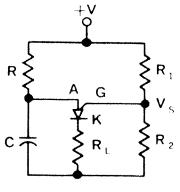
TO-18



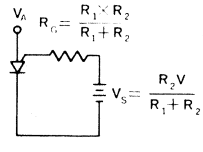
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

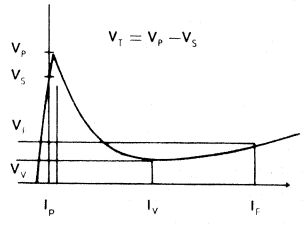
Test	Symbol	Fig.	U13T1 Min.	U13T1 Max.	U13T2 Min.	U13T2 Max.	Units	Test Conditions
Peak Current	I_P	1	— —	5 2	— —	1.0 0.15	μA μA	$R_G = 10k, V_s = 10V$ $R_G = 1$ Meg.
Valley Current	I_V	1	70 —	— 50	25 —	— 25	μA μA	$R_G = 10k, V_s = 10V$ $R_G = 1$ Meg.
Offset Voltage	V_T	1	0.2 0.2	0.6 1.6	0.2 0.2	0.6 0.6	V V	$R_G = 10k, V_s = 10V$ $R_G = 1$ Meg.
Gate-to-Anode Leakage	I_{GAO}	2	— —	10 100	— —	10 100	nA nA	$T = 25°C, V_s$ = rating $T = 75°C$
Gate-to-Cathode Leakage	I_{GKS}	3	—	100	—	100	nA	V_s = rating
Forward Voltage	V_F	4	—	1.5	—	1.5	V	$I_F = 50mA$
Pulse Output Voltage	V_o	5	6	—	6	—	V	
Pulse Output Rate of Rise	t_r	5	—	80	—	80	nS	



a) Typical Circuit



b) Equivalent Test Circuit



c) Characteristic Curve

Figure 1

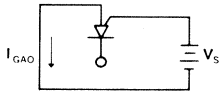


Figure 2

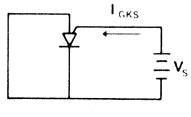


Figure 3

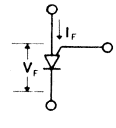
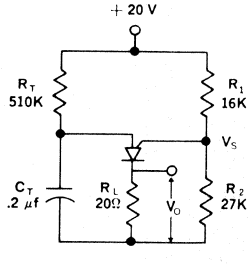


Figure 4



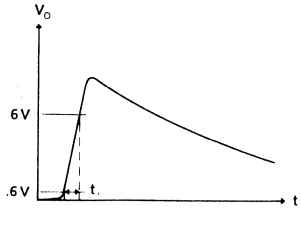


Figure 5

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SWITCHING & GENERAL PURPOSE DIODES 8

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SWITCHING AND GENERAL PURPOSE DIODES

SWITCHING

Type	Reverse Voltage (V)	Average Forward Current (mA)	Forward Voltage (V)	Reverse Recovery Time (ns)	Junction Capacitance (pF)
1N4453	30	200	.51-.63 @ 0.1mA		30
1N4154	35	150	1.0 @ 30mA	2	4
1N251*	40	75	1.0 @ 5mA	150	
1N4152	40	150	.49-.52 @ 0.1mA	2	2
1N4450	40	200	.42-.54 @ 0.1mA	4	4
1N4451	40	200	.4-.5 @ 0.1mA	10	6
1N4452	40	200	.42-.54 @ 0.1mA	50	30
1N4444	70	200	.44-.55 @ 0.1mA	7	2
1N3064**	75	75	1.0 @ 10mA	4	2
1N4532***	75	125	1.0 @ 10mA	4	2
1N4534***	75	150	.74-.88 @ 20mA	4	2
1N4151	75	150	1.0 @ 50mA	2	2
1N4153***	75	150	.49-.55 @ 0.1mA	2	2
1N4305	75	150	.5-.575 @ .25mA	2	2
1N4446	75	150	1.0 @ 20mA	4	4
1N4447	75	150	1.0 @ 20mA	4	2
1N4448	75	150	1.0 @ 100mA	4	4
1N4449	75	150	1.0 @ 30mA	4	2
1N3600***	75	200	.54-.62 @ 1mA	4	2.5
1N4149	75	200	1.0 @ 10mA	4	2
1N4150***	75	200	.54-.62 @ 1mA	4	2.5
1N4454***	75	200	1.0 @ 10mA	2	2
1N4500***	80	300	.64-.72 @ 10mA	6	4
1N4607	85	400	1.1 @ 400mA	10	4
1N662*	100	40	1.0 @ 10mA	500	3
1N663*	100	40	1.0 @ 100mA	500	3
1N914**	100	75	1.0 @ 10mA	5	4
1N4531***	100	125	1.0 @ 10mA	5	4
1N4148***	100	200	1.0 @ 10mA	4	4
1N3070**	200	100	1.0 @ 100mA	50	5
1N4938**	200	150	1.0 @ 10mA	50	5

GENERAL PURPOSE

Type	Reverse Voltage (V)	Average Forward Current (mA)	Forward Voltage (V)	Reverse Recovery Time (ns)	Junction Capacitance (pF)
1N456	30	90	1.0 @ 40mA		
1N457*	70	75	1.0 @ 20mA		
1N483B**	80	200	1.0 @ 100mA		
1N458*	150	55	1.0 @ 7mA		
1N3595***	150	150	.83-1.0 @ 200mA	3μs	2.5
1N459*	200	40	1.0 @ 3mA		
1N643*	200	40	1.0 @ 10mA	300	3
1N485B**	200	200	1.0 @ 100mA		
1N645**	270	400	1.0 @ 400mA		20
1N647**	480	400	1.0 @ 400mA		20

* Available as JAN. ** Available as JAN, JANTX. *** Available as JAN, JANTX, JANTXV.

PROELECTRON SWITCHING DIODES

Type	Reverse Voltage (V)	Average Forward Current (mA)	Forward Voltage (V)	Reverse Recovery Time (ns)	Reverse Current @ 25°C (μA)	Junction Capacitance (pF)
BAY60	25	115	1.0 @ 30mA	4	0.1	4
BAW75	35	300	1.0 @ 30mA	2	5	4
BAY41	40	225	1.0 @ 200mA	8.5	5	5
BAW24	50	600	1.0 @ 50mA	6	0.1	4
BAW25	50	600	0.8 @ 50mA	6	0.1	4
BAY42	60	225	1.0 @ 200mA	15	5	5
BAW26	75	600	1.0 @ 50mA	6	0.1	4
BAW27	75	600	1.0 @ 200mA	6	0.1	4
BAW76	75	300	1.0 @ 100mA	2	5	2
BAY43	80	225	1.0 @ 200mA	15	5	5
BAX12	90	400	1.25 @ 400mA	15	0.1	20

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

COMPUTER DIODE
General Purpose

JAN 1N251

ABSOLUTE MAXIMUM RATINGS, AT 25°C

Peak Reverse Voltage 40V
Reverse Working Voltage 30V
Average Rectified Current 75mAdc
Surge Current, 1ms @ 125°C Free Air Temperature 125mA
Continuous Power Dissipation 150mW
Operating Temperature Range ..... -55°C to +150°C
Storage Temperature Range ..... -55°C to +150°C

FEATURES

- Metallurgical Bond
- Qualified to MIL-S-19500/188
- Planar Passivated Chip
- DO-7 Package
- Non-JAN Available

DESCRIPTION

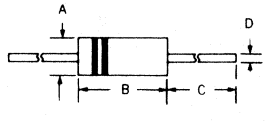
This device is particularly suited to applications where medium speed switching is required. Moisture free stability is ensured through hermetic sealing.

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Reverse Current	Reverse Current	Reverse Current @ 125°C	Forward Voltage	Reverse Recovery Time
20μA @ V_R = 20V	0.1μA @ V_R = 10V	10μA @ 10V	1V @ I_F = 5mA	150ns @ I_F = 5mA, V_R = 10V R_L = 1KΩ, C_L = 10pf, I_{REC} = 0.5mA

MECHANICAL SPECIFICATIONS

JAN 1N251



	INCHES	MILLIMETERS
A	.077 - .130	1.96 - 3.30
B	.195 - .300	4.95 - 7.62
C	1.0 - 1.5	25.4 - 38.1
D	.019 - .021	.48 - .53

DO-7



UNITRODE

DIODE
Low Current

1N456
JAN 1N457
JAN 1N458
JAN 1N459

FEATURES
- Metallurgical Bond
- Qualified to MIL-S-19500/193
- Planar Passivated Chip
- DO-7 Package
- Non-JAN Available

DESCRIPTION
General purpose low current diode with high reliability characteristics

8

ABSOLUTE MAXIMUM RATINGS, AT 25°C

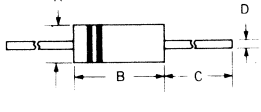
	1N456	JAN 1N457	JAN 1N458	JAN 1N459
Reverse Working Voltage	25V	60V	125V	175V
Peak Reverse Voltage	30V	70V	150V	200V
Average Output Current	90mA	75mA	55mA	40mA
Surge Current, 8.3mS	700mA	225mA	165mA	120mA
Operating Temperature Range	−65°C to +150°C			
Storage Temperature Range	−65°C to +200°C			

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	Forward Voltage	Reverse Current	Reverse Current @T_A = 150°C	Peak Reverse Voltage @100μA
1N456	1.0V @ 40mA	25nA @ 25V	5μA @ 25V	30V
1N457, J	1.0V @ 20mA	25nA @ 60V	5μA @ 60V	70V
1N458, J	1.0V @ 7mA	25nA @ 125V	5μA @ 125V	150V
1N459, J	1.0V @ 3mA	25nA @ 175V	5μA @ 175V	200V

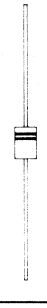
MECHANICAL SPECIFICATIONS

1N456
JAN 1N457, 1N458, 1N459



	INCHES	MILLIMETERS
A	.085 - .130	2.16 - 3.30
B	.230 - .300	5.84 - 7.62
C	1.0 - 1.5	25.40 - 38.10
D	.018 - .022	.46 - .56

DO-7



UNITRODE

DIODE
General Purpose
Low Current

JAN & JANTX 1N483B
JAN & JANTX 1N485B

FEATURES
- Metallurgical Bond
- Qualified to MIL-S-19500/118
- Planar Passivated Chip
- DO-7 Package
- Non-JAN Available

DESCRIPTION
This Series is useful in low current rectifying applications for military, industrial and commercial equipment.

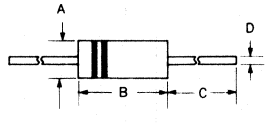
ABSOLUTE MAXIMUM RATINGS, AT 25°C

	1N483B	1N485B
Reverse Breakdown Voltage	80V	200V
Peak Working Voltage	70V	180V

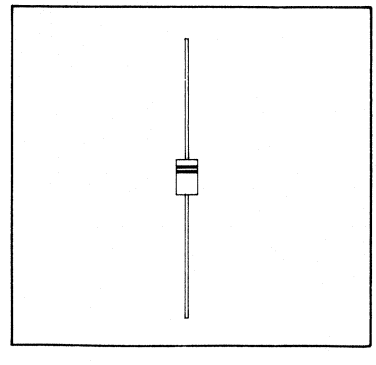
Average Output Current @ T_A = 25°C 200mA
T_A = 150°C 50mA
Current Derating 1.2 mAdc/°C from 25°C to 150°C and 1.0 mAdc/°C from 150°C to 200°C
Surge Current, 8.3mSec ..... 2 Amps
Operating Temperature Range ..... −65°C to +200°C
Storage Temperature Range ..... −65°C to +200°C

MECHANICAL SPECIFICATIONS

J & JTX 1N483B, 1N485B



	INCHES	MILLIMETERS
A	.085 - .125	2.16 - 3.17
B	.230 - .300	5.84 - 7.62
C	1.0 MIN.	25.40 MIN.
D	.018 - .022	.46 - .56

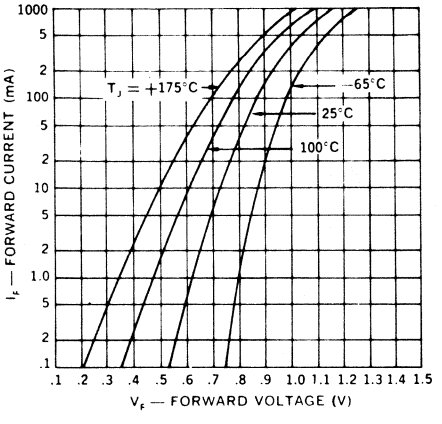


UNITRODE

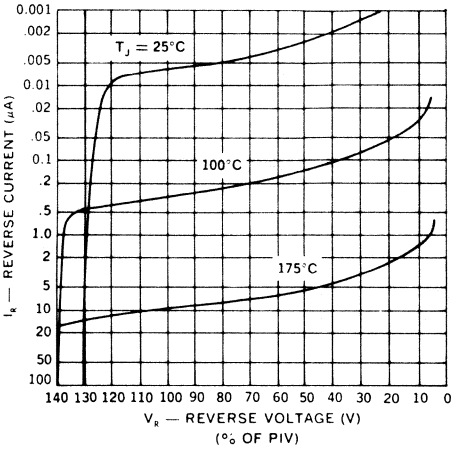
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

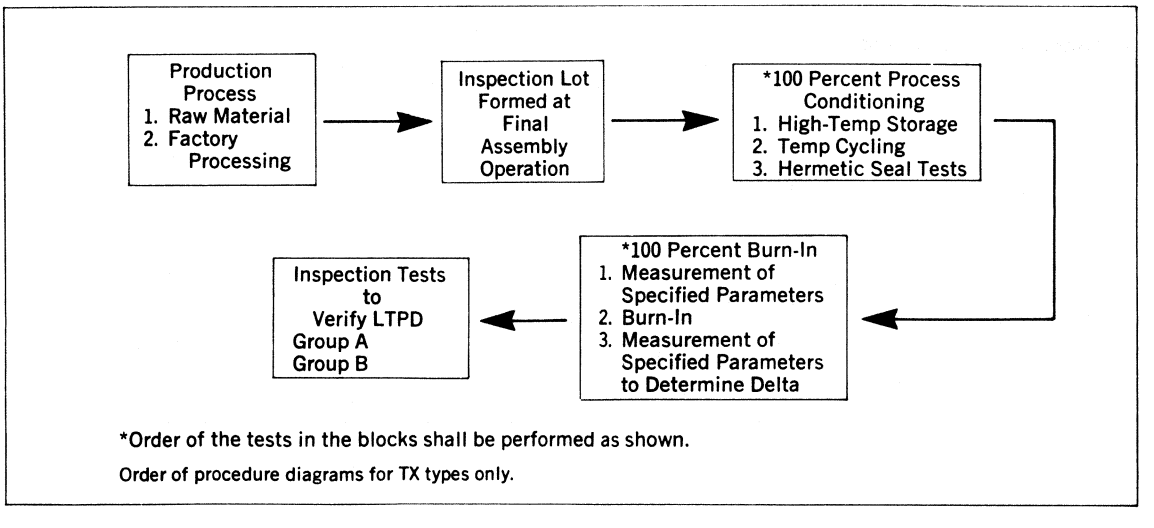
Type	Reverse Current @ 25°C	Reverse Current @ 25°C	Reverse Current @ 150°C	Forward Voltage @ 100mAdc, 8.5msec dc = 2% MAX.
1N483B 1N485B	25nA @ 70Vdc 25nA @ 180Vdc	100 μA(pk) @ 80V(pk) 100 μA(pk) @ 200V(pk)	5.0 μA @ 70Vdc 5.0 μA @ 180Vdc	1.0V(pk)

Forward Voltage vs. Forward Current



Reverse Voltage vs. Reverse Current





*Order of the tests in the blocks shall be performed as shown.

Order of procedure diagrams for TX types only.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

COMPUTER DIODE
Switching

JAN 1N643
JAN 1N662
JAN 1N663

FEATURES
- Metallurgical Bond
- Qualified to MIL-S-19500/256
- Planar Passivated Chip
- DO-7 Package

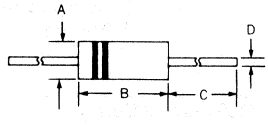
DESCRIPTION
This device is particularly suited to applications where medium speed switching is required. Moisture free stability is ensured through hermetic sealing.

ABSOLUTE MAXIMUM RATINGS, AT 25°C

	1N643	1N662	1N663
Peak Reverse Voltage	200V	100V	100V
Reverse Working Voltage	175V	80V	80V
Average Rectified Current	40mAdc	40mAdc	60mAdc
Surge Current, 8.3ms		500mA	
Operating Temperature Range		-65°C to +150°C	
Storage Temperature Range		-65°C to +175°C	

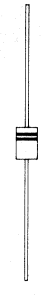
MECHANICAL SPECIFICATIONS

J 1N643, 1N662, 1N663



	INCHES	MILLIMETERS
A	.077 - .130	1.96 - 3.30
B	.195 - .300	4.95 - 7.62
C	1.0 - 1.5	25.4 - 38.1
D	.019 - .021	.48 - .53

DO-7



ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

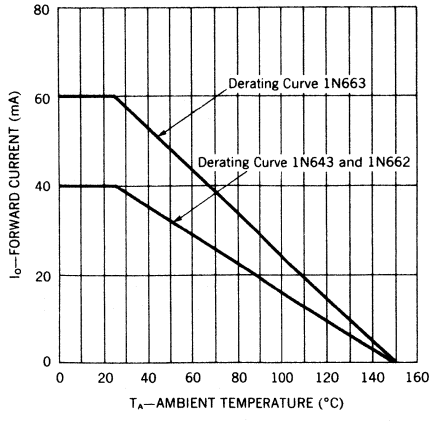
Type	Maximum Reverse Current @ 25°C	Maximum Reverse Current @ 25°C	Maximum Peak Reverse Current @ 25°C	Maximum Reverse Current @ 100°C	Maximum Reverse Current @ -65°C
1N643	25nAdc @ V_R = 10Vdc	1μAdc @ V_R = 100Vdc	100μA$_{PK}$ @ V_R = 200V$_{PK}$	15μAdc @ V_R = 100Vdc	1μAdc @ V_R = 100Vdc
1N662	25nAdc @ V_R = 10Vdc	5μAdc @ V_R = 50Vdc	100μA$_{PK}$ @ V_R = 100V$_{PK}$	100μAdc @ V_R = 50Vdc	5μAdc @ V_R = 50Vdc
1N663	25nAdc @ V_R = 10Vdc	5μAdc @ V_R = 75Vdc	100μA$_{PK}$ @ V_R = 100V$_{PK}$	50μAdc @ V_R = 75Vdc	5μAdc @ V_R = 75Vdc

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	Maximum Forward Voltage @ 25°C	Maximum Forward Voltage @ -65°C	Capacitance	Maximum Reverse Recovery Time
1N643	1.0Vdc @ I_F = 10mAdc	1.2Vdc @ I_F = 10mAdc	3pF @ V_R = 175V	300ns @ I_F = 5mA I_R = 17.5mA I_{REC} = 0.2nA
1N662	1.0Vdc @ I_F = 10mAdc	1.2Vdc @ I_F = 10mAdc	3pF @ V_R = 80V	500ns @ I_F = 5mA I_R = 17.5mA I_{REC} = 0.4nA
1N662	1.0Vdc @ I_F = 100mAdc	1.2Vdc @ I_F = 100mAdc	3pF @ V_R = 80V	500ns @ I_F = 5mA I_R = 17.5mA I_{REC} = 0.4nA

8

Average Rectified Current vs. Ambient Temperature



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

RECTIFIERS
High Voltage, Low Current

JAN, JANTX 1N645, 1N647
JAN, JANTX & JANTXV 1N645-1, 1N647-1

FEATURES
- Metallurgical Bond
- Qualified to MIL-S-19500/240
- Planar Passivated Chip
- DO-35 or DO-7 Package
- Non-JAN Available

DESCRIPTION
These devices are useful in general purpose low current applications in high reliability and military equipment.

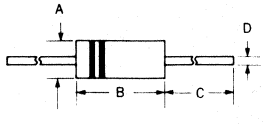
ABSOLUTE MAXIMUM RATINGS, AT 25°C

	1N645 1N645-1	1N647 1N647-1
Reverse Breakdown Voltage	270V	480V
Peak Working Voltage	225V	400V
Average Output Current, 25°C*	400mA	
150°C	150mA	
Surge Current, 8.3ms	5A	
Operating Temperature Range	-65°C to +150°C	
Storage Temperature Range	-65°C to +200°C	

*Derate 2.0mAdc/°C between 25°C and 150°C.

MECHANICAL SPECIFICATIONS

J, JTX 1N645, 1N647
J, JTX, & JTXV 1N645-1, 1N647-1

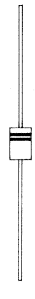


DO-7

	INCHES	MILLIMETERS
A	.085 - .130	2.16 - 3.30
B	.230 - .300	5.84 - 7.62
C	1.0 MIN.	25.40 MIN.
D	.018 - .022	.46 - .56

DO-35 J, JTX, & JTXV 1N645-1, 1N647-1

	INCHES	MILLIMETERS
A	.055 - .130	1.40 - 3.30
B	.140 - .300	3.55 - 7.62
C	1.0 MIN.	25.40 MIN.
D	.018 - .023	.46 - .58

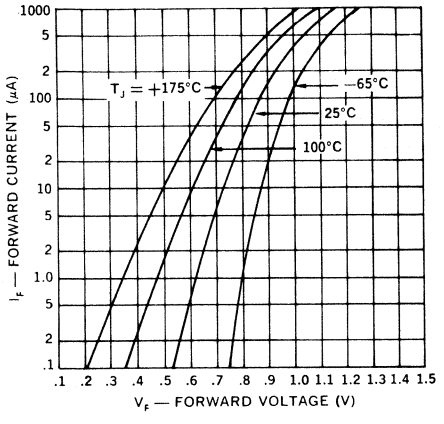


ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

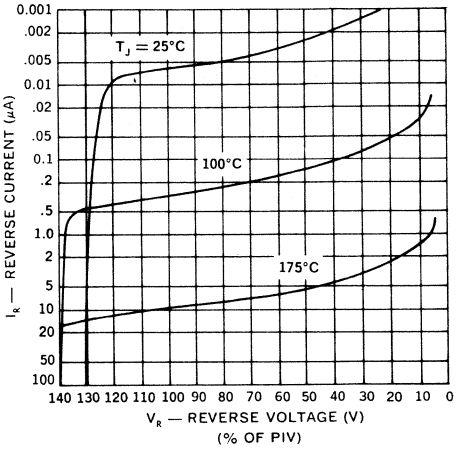
Type	Reverse Current @ 25°C	Reverse Current @ 150°C	Peak Reverse Current @ 25°C	Average Reverse Current @ 150°C	Forward Voltage @ 25°C	Capacitance
1N645	0.025μA @ 225Vdc	15μAdc @ 225Vdc	100μA (pk) @ 270V (pk)	100μAdc @ 225V (pk)	1.0Vdc @ I_F = 400mAdc 8.3ms	20pF V_R = 4 Vdc f = 1MHz V_{sig} = 50mV
1N645-1	0.050μA @ 225Vdc	25μAdc @ 225Vdc	100μA (pk) @ 270V (pk)	100μAdc @ 225V (pk)		
1N647	0.025μA @ 400Vdc	—	100μA (pk) @ 480V (pk)	100μAdc @ 400V (pk)		
1N647-1	0.050μA @ 400Vdc	—	100μA (pk) @ 480V (pk)	100μAdc @ 400V (pk)		

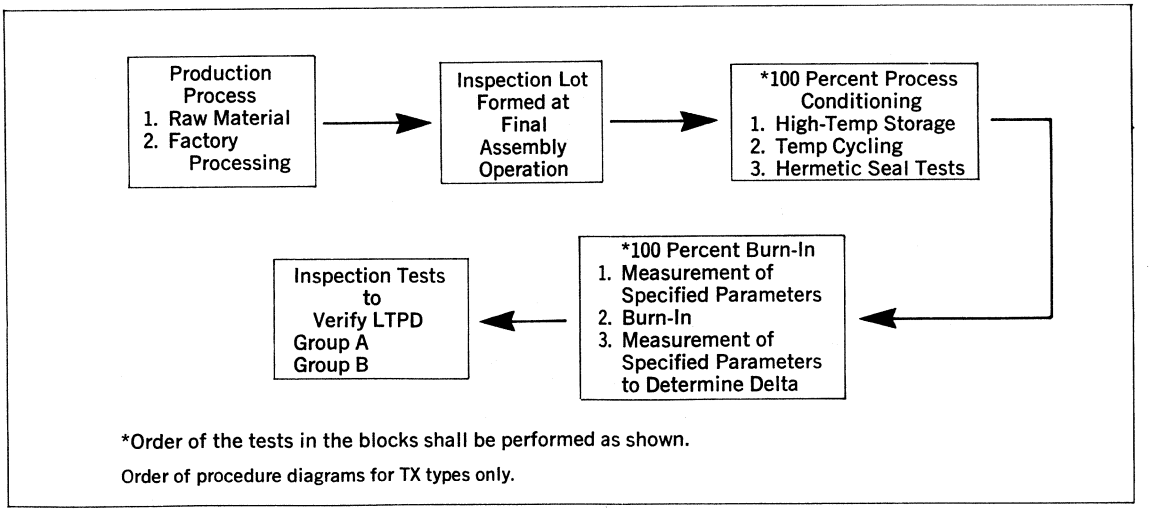
8

Forward Voltage vs. Forward Current



Reverse Voltage vs. Reverse Current





*Order of the tests in the blocks shall be performed as shown.

Order of procedure diagrams for TX types only.

COMPUTER DIODE

General Purpose Switching

JAN, JANTX, 1N914
JAN, JANTX, JANTXV 1N4148
JAN, JANTX, JANTXV 1N4148-1
JAN, JANTX, JANTXV 1N4531

FEATURES
- Metallurgical Bond
- Qualified to MIL-S-19500/116
- Planar Passivated Chip
- DO-34 or DO-35 Package
- Non-JAN Available

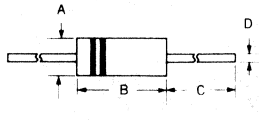
DESCRIPTION
This series is very popular for general purpose switching applications in electronic equipment.

ABSOLUTE MAXIMUM RATINGS, AT 25°C

Reverse Breakdown Voltage	100V
Peak Working Voltage	75V
Average Output Current, 1N914	75mAdc
1N4148	200mAdc
1N4148-1	200mAdc
1N4531	125mAdc
Surge Current, 8.3ms	500mA
Operating Temperature Range	-65°C to +175°C
Storage Temperature Range	-65°C to +200°C

MECHANICAL SPECIFICATIONS

J, JTX 1N914
J, JTX, JTXV 1N4148
J, JTX, JTXV 1N4148-1
J, JTX, JTXV 1N4531

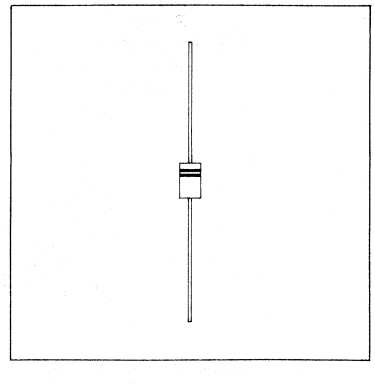


DO-7 J, JTX & JTXV 1N4531

	INCHES	MILLIMETERS
A	.045 - .065	1.14 - 1.65
B	.080 - .110	2.032 - 2.79
C	1.0 MIN.	25.40 MIN.
D	.018 - .022	.46 - .56

DO-35 J,JTX 1N914 J, JTX & JTXV 1N4148,-1

	INCHES	MILLIMETERS
A	.056 - .075	1.42 - 1.90
B	.140 - .180	3.55 - 4.57
C	1.0 MIN.	25.40 MIN.
D	.018 - .022	.46 - .56



UNITRODE

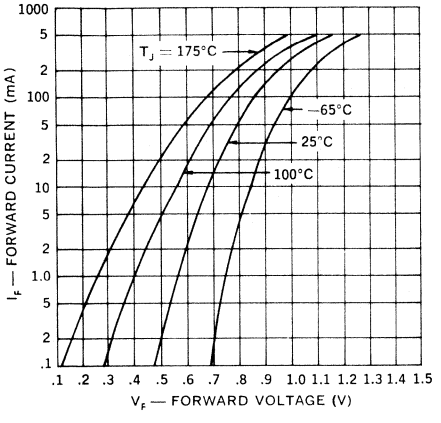
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Reverse Current @ 25°C	Reverse Current @ 25°C	Peak Reverse Current @ 25°C	Reverse Current @ 150°C	Reverse Current @ 150°C
25nAdc @ $V_R = 20$Vdc	0.5μAdc @ $V_R = 75$Vdc	100μA (pk) @ $V_R = 100$V (pk)	50μAdc @ $V_R = 20$Vdc	100μAdc @ $V_R = 75$Vdc

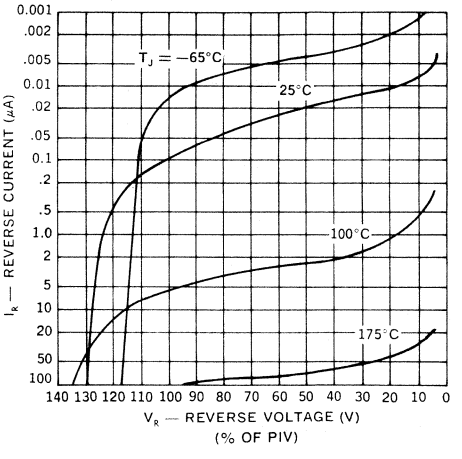
Forward Voltage	Foward Recovery Voltage	Forward Recovery Time	Reverse Recovery Time	Capacitance
1.0Vdc @ $I_F = 10$mAdc	5.0V (pk) @ $I_F = 50$mAdc	20ns @ $I_F = 50$mAdc	5ns @ $I_F = I_R = 10$mA $R_L = 100$ ohms	4.0 pF @ $V_R = 0$V, f = 1 MHz $v_{sig} = 50$mV (pk-pk) 2.8 pF @ $V_R = 1.5$V, f = 1 MHz $v_{sig} = 50$mV (pk-pk)

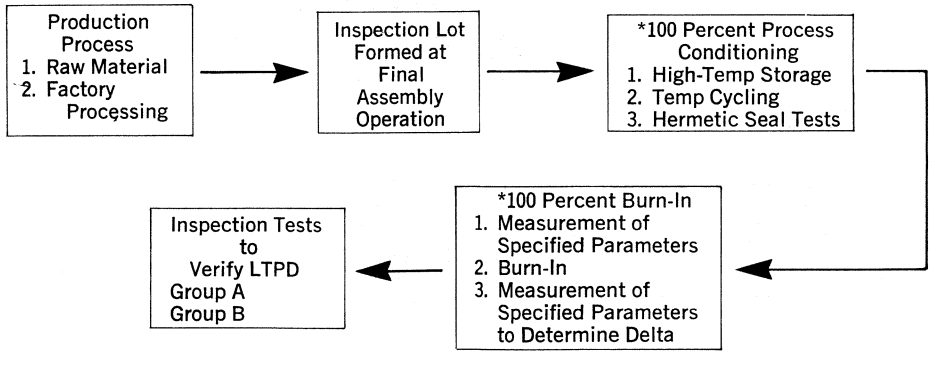
8

Forward Voltage vs. Forward Current



Reverse Voltage vs. Reverse Current





*Order of the tests in the blocks shall be performed as shown.

Order of procedure diagrams for TX types only.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

COMPUTER DIODE

General Purpose
Switching

JAN & JANTX 1N3064
JAN, JANTX & JANTXV 1N4454
JAN, JANTX & JANTXV 1N4454-1
JAN, JANTX & JANTXV 1N4532

ABSOLUTE MAXIMUM RATINGS, AT 25°C

Reverse Breakdown Voltage		75V
Peak Working Voltage		50V
Average Output Current,	1N3064	75mA
	1N4454,-1	200mA
	1N4532	125mA
Surge Current, 1sec	1N3064	0.5A
	1N4454,-1	1A
	1N4532	0.5A
Operating Temperature Range		-65°C to +175°C
Storage Temperature Range		-65°C to +200°C

FEATURES

- Metallurgical Bond
- Qualified to MIL-S-19500/144
- Planar Passivated Chip
- DO-7, DO-34 or DO-35 Package
- Non-JAN Available

DESCRIPTION

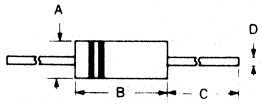
Available in DO-7, DO-34 or DO-35 packages. Unitrode offers high temperature metallurgical bond, making these devices useful in high reliability applications.

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	Reverse Current @ 25°C	Reverse Current @ 150°C	Reverse Breakdown Voltage @ -65°C	Reverse Recovery Time	Capacitance	Forward Voltage	Forward Recovery Voltage	Forward Recovery Time
1N3064 1N4454 1N4454-1 1N4532	0.1μAdc @ V_R = 50V	100μAdc @ V_R = 50V	75Vdc @ I_R = 5μAdc	4ns @ I_F = I_R = 10mAdc R_L = 100Ω c ≤ 3pF	2pF @ V_R = 0Vdc f = 1MHz V_{sig} = 50mV (pk to pk)	1.0Vdc @ I_F = 10mAdc	5.0V (pk) @ I_F = 100mAdc t_r ≤ 0.4ns	30ns I_F = 100mAdc t_r ≤ 0.4ns

MECHANICAL SPECIFICATIONS

J & JTX 1N3064
J, JTX & JTXV 1N4454 & 1N4454-1
J, JTX & JTXV 1N4532



J, JTX & JTXV 1N4532

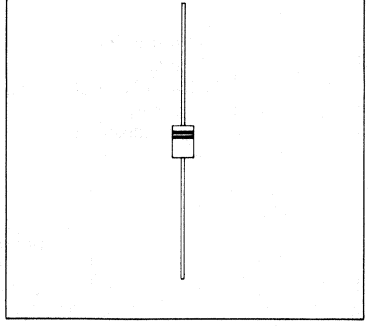
	INCHES	MILLIMETERS
A	.050 - .075	1.20 - 1.80
B	.085 - .120	2.04 - 2.88
C	1.0 MIN.	24.0 MIN.
D	.018 - .022	.0432 - .528

J & JTX 1N3064

	INCHES	MILLIMETERS
A	.078 - .107	1.98 - 2.72
B	.195 - .300	4.95 - 7.62
C	1.0 MIN.	24.0 MIN.
D	.018 - .022	.46 - .56

J, JTX & JTXV 1N4454,-1

	INCHES	MILLIMETERS
A	.056 - .075	1.42 - 1.90
B	.140 - .180	3.55 - 4.57
C	1.0 MIN.	24.0 MIN.
D	.018 - .022	.46 - .56



UNITRODE

COMPUTER DIODE
Switching

JAN, JANTX 1N3070
JAN, JANTX 1N4938

ABSOLUTE MAXIMUM RATINGS, AT 25°C

Reverse Breakdown Voltage 200V
Steady-State Forward Current at (or below) 25°C Free Air Temperature 150mA
Peak Surge Current, 1sec 500mA
Peak Surge Current, 1ms 2A
Continuous Power Dissipation at (or below) 25°C Free Air Temperature 250mW
Operating Temperature Range ..... -65°C to +200°C
Storage Temperature Range ..... -65°C to +200°C

FEATURES

- Double-plug Construction
- Qualified to MIL-S-19500/169
- Available in DO-7 or DO-35 package

DESCRIPTION

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched. Hot solder dipped leads are standard.

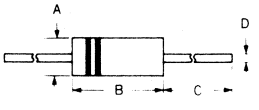
8

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	Maximum Reverse Current @ 25°C	@ 150°C	Maximum Forward Voltage	Maximum Capacitance	Maximum Reverse Recovery Time
1N3070 1N4938	0.1μAdc @ 175Vdc	100μAdc @ 175Vdc	1Vdc @ I_F = 100mAdc	5pF @ V_R = 0, f = 1MHz	50ns @ I_F = 30mA I_R = 30mA I_{REC} = 1mA

MECHANICAL SPECIFICATIONS

J, JTX 1N3070
J, JTX 1N4938

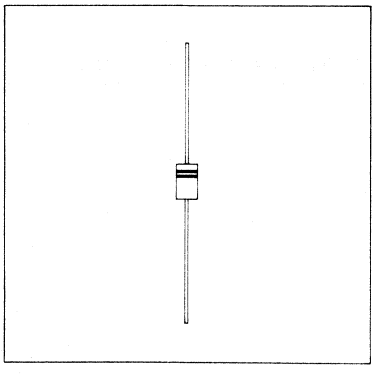


J, JTX 1N4938

	INCHES	MILLIMETERS
A	.065 MAX.	1.65 MAX.
B	.155 MAX.	3.94 MAX.
C	1.0 MIN.	25.4 MIN.
D	.020	0.51

J,JTX 1N3070

	INCHES	MILLIMETERS
A	0.085 MAX.	2.159 MAX.
B	.180 - 0.220	4.572 - 5.588
C	1.0 MIN.	25.4 MIN.
D	.018 - 0.022	0.457 - 0.559



UNITRODE

COMPUTER DIODE
150 mA, Switching

JAN, JANTX, JANTXV 1N3595

ABSOLUTE MAXIMUM RATINGS, AT 25°C

Peak Reverse Voltage	125V
Reverse Breakdown Voltage	150V
Average Output Current	150mAdc
Surge Current, 1S	500mA
1μS	4A
Operating Temperature Range	−65°C to +150°C
Storage Temperature Range	−65°C to +200°C

FEATURES
- Metallurgical Bond
- Qualified to MIL-S-19500/241
- Planar Passivated Chip
- DO-7 Package
- Non-JAN Available

DESCRIPTION
A very useful device for medium current switching applications.

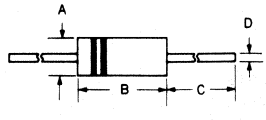
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Limits	V_{F_1} I_F = 200mAdc	V_{F_2} I_F = 100mAdc	V_{F_3} I_F = 50mAdc	V_{F_4} I_F = 10mAdc	V_{F_5} I_F = 5mAdc	V_{F_6} I_F = 1mAdc
Min	0.83Vdc	0.79Vdc	0.74Vdc	0.65Vdc	0.60Vdc	0.52Vdc
Max	1.00Vdc	0.92Vdc	0.88Vdc	0.80Vdc	0.75Vdc	0.68Vdc

Limits	I_{R_1} V_R = 125Vdc	I_{R_2} V_R = 30Vdc T_A = 125°C	I_{R_3} V_R = 125Vdc T_A = 125°C	I_{R_4} V_R = 125Vdc T_A = 150°C	C V_R = 0Vdc f = 1MHz	t_{rr} I_F = 10mAdc V_R = 35Vdc
Min	—	—	—	—	—	—
Max	1.0nAdc	0.3μAdc	0.5μAdc	3.0μAdc	8.0pF	3.0μS

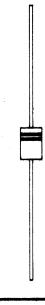
MECHANICAL SPECIFICATIONS

JAN, JANTX, JANTXV 1N3595



	INCHES	MILLIMETERS
A	.092 - .130	2.37 - 3.30
B	.130 - .300	3.30 - 7.62
C	1.0 - 1.5	25.40 - 38.10
D	.018 - .022	.46 - .56

DO-7



UNITRODE

COMPUTER DIODE

200mA
Low Power, Switching

JAN, JANTX & JANTXV 1N3600
JAN, JANTX & JANTXV 1N4150
JAN, JANTX & JANTXV 1N4150-1

FEATURES
- Metallurgical Bond
- Qualified to MIL-S-19500/231
- Planar Passivated Chip
- DO-7 or DO-35 Package
- Non-JAN Available

DESCRIPTION
This series of switching diodes is useful in many computer switching applications, for both military and commercial systems.

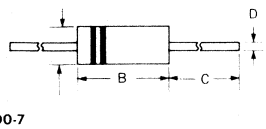
8

ABSOLUTE MAXIMUM RATINGS, AT 25°C

Reverse Breakdown Voltage	75V
Peak Working Voltage	50V
Average Output Current	200mA
Surge Current (1sec)	0.5A
(1μsec)	4.0A
Operating Temperature Range	−65°C to +175°C
Storage Temperature Range	−65°C to +200°C

MECHANICAL SPECIFICATIONS

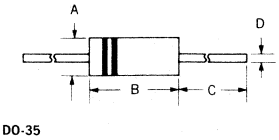
J, JTX & JTXV 1N3600



DO-7

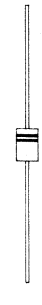
	INCHES	MILLIMETERS
A	.078 - .107	1.98 - 2.72
B	.195 - .300	4.95 - 7.62
C	1.0 MIN.	25.40 MIN.
D	.018 - .022	.46 - .56

J, JTX & JTXV 1N4150, 1N4150-1



DO-35

	INCHES	MILLIMETERS
A	.056 - .075	1.42 - 1.90
B	.140 - .180	3.55 - 4.57
C	1.0 MIN.	25.40 MIN.
D	.018 - .022	.46 - .56

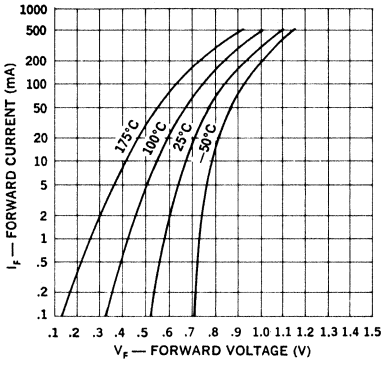


ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

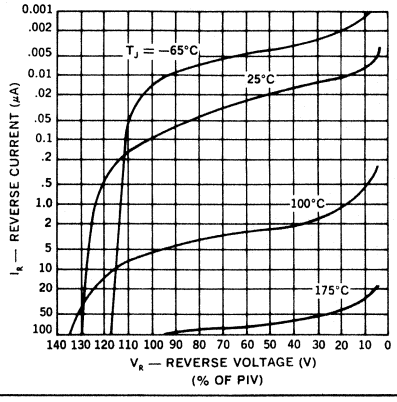
Characteristics	Forward Voltage	Forward Voltage	Forward Voltage	Forward Voltage	Forward Voltage	Reverse Breakdown Voltage
Conditions	V_{F1} $I_F = 1$ mAdc	V_{F2} $I_F = 10$ mAdc	V_{F3} $I_F = 50$ mAdc (pulse)	V_{F4} $I_F = 100$ mAdc (pulse)	V_{F5} $I_F = 200$ mAdc (pulse)	BV $I_R = 5.0$ μAdc
Minimum	0.540 Vdc	0.660 Vdc	0.760 Vdc	0.820 Vdc	0.870 Vdc	75 Vdc
Maximum	0.620 Vdc	0.740 Vdc	0.860 Vdc	0.920 Vdc	1.00 Vdc	—

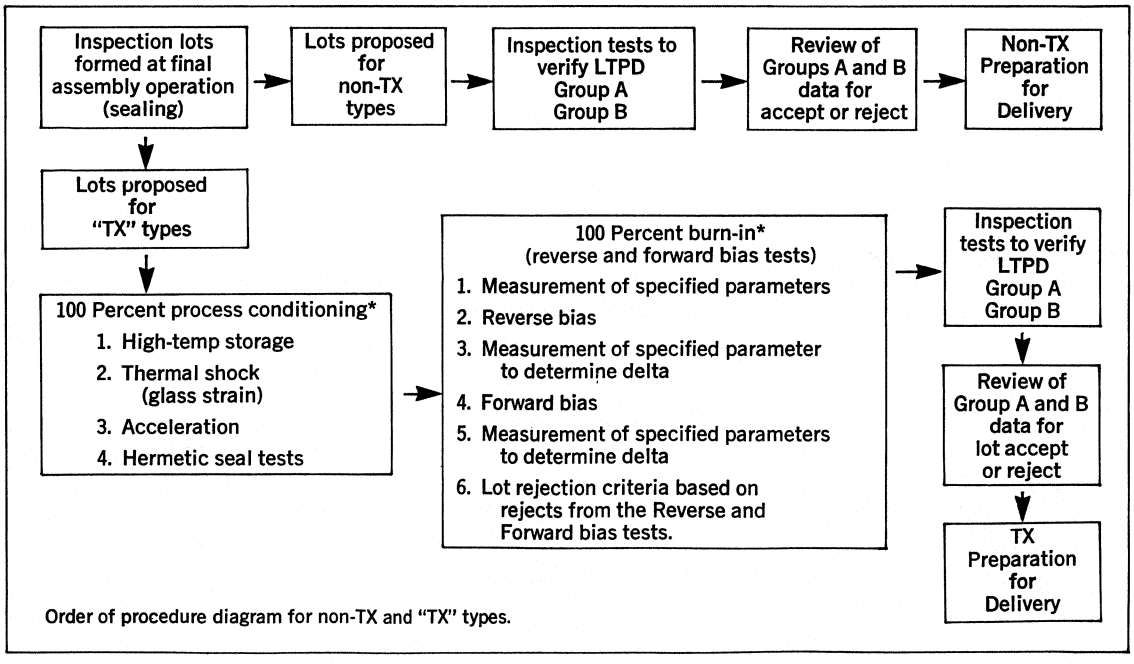
Characteristics	Reverse Current	Reverse Current	Junction Capacitance	Reverse Recovery Time	Reverse Recovery Time	Forward Recovery Time
Conditions	I_R $V_R = 50$ Vdc	I_R $V_R = 50$ Vdc $T_A = 150°C$	C $V_R = 0$ $F = 1$ MHz $V_{sig} = 50$ mv (p-p)	t_{rr1} $I_F = I_R =$ 10 to 200 mAdc; $R_L = 100$ ohms	t_{rr2} $I_F = I_R =$ 200 to 400 mAdc; $R_L = 100$ ohms	t_{fr} $I_F = 200$ mAdc; $t_p = 100$ nsec; $t_r = 0.4$ nsec
Maximum	0.1 μAdc	100 μAdc	2.5 pf	4 nsec	6 nsec	10 nsec

Typical Forward Current vs Voltage



Reverse Voltage vs. Reverse Current





Order of procedure diagram for non-TX and "TX" types.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

COMPUTER DIODE
Switching

1N4149, 1N4151, 1N4154
1N4446, 1N4447, 1N4448
1N4449

FEATURES
- Metallurgical Bond
- Planar Passivated
- DO-35

DESCRIPTION
This series offers Metallurgical Bonding and is very popular for general purpose switching applications.

ABSOLUTE MAXIMUM RATINGS, AT 25°C

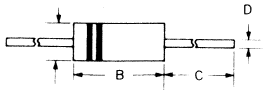
	1N4149	1N4151	1N4154	1N4446	1N4447	1N4448	1N4449
Peak Reverse Voltage	75V	75V	35V	75V	75V	75V	75V
Average Rectified Current	200mAdc						
Surge Current, 8.3 mS	500mA						
Operating Temperature Range	−65°C to +150°C						
Storage Temperature Range	−65°C to +200°C						

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	Peak Inverse Voltage	Forward Voltage @ 10mA	@ 20mA	@ 30mA	@ 50mA	@ 100mA	Reverse Current V_R nA	Reverse Current @ 150°C V_R μA	Junction Capacitance @ 0V	Reverse Recovery Time t_{RR}
1N4149	75	1.0	—	—	—	—	20 25	20 50	4pF	4nS
1N4151	75	—	—	—	1.0	—	50 50	50 50	4pF	2nS
1N4154	35	—	—	1.0	—	—	25 100	25 100	4pF	2nS
1N4446	75	—	1.0	—	—	—	20 25	20 50	4pF	4nS
1N4447	75	—	1.0	—	—	—	20 25	20 50	4pF	4nS
1N4448	75	—	—	—	—	1.0	20 25	20 50	4pF	4nS
1N4449	75	—	—	1.0	—	—	20 25	20 50	2pF	4nS

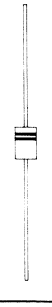
MECHANICAL SPECIFICATIONS

1N4149, 1N4151, 1N4154, 1N4446, 1N4447, 1N4448 1N4449



	INCHES	MILLIMETERS
A	.065	1.65
B	.155	3.94
C	1.0 MIN.	25.4 MIN.
D	.020	.51

DO-35



UNITRODE

COMPUTER DIODE
Switching

1N4152, 1N4305, 1N4444

ABSOLUTE MAXIMUM RATINGS, AT 25°C

	1N4152	1N4305	1N4444
Peak Reverse Voltage	40V	75V	70V
Reverse Working Voltage	30V	50V	50V
Average Rectified Current	200mAdc		
Surge Current, 8.3 mS	500mA		
Operating Temperature Range	−65°C to +150°C		
Storage Temperature Range	−65°C to +200°C		

FEATURES
- Metallurgical Bond
- Planar Passivated
- DO-35 Package

DESCRIPTION
This series offers Metallurgical Bonding and is very popular for general purpose switching applications.

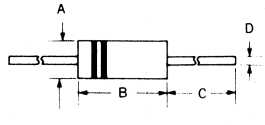
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	Peak Inverse Voltage (V)	Forward Voltage @ 0.1mA		Forward Voltage @ 0.25mA		Forward Voltage @ 1.0mA		Forward Voltage @ 2.0mA		Forward Voltage @ 10mA		Forward Voltage @ 20mA		Forward Voltage @ 100mA	
		min	max	min	max	min	max	min	max	min	max	min	max	min	max
1N4152	40	0.49	0.55	0.53	0.59	0.59	0.67	0.62	0.70	0.70	0.81	0.74	0.88	—	—
1N4305	75	—	—	0.505	0.575	0.55	0.65	0.61	0.71	0.70	0.85	—	—	—	—
1N4444	70	0.44	0.55	—	—	0.56	0.68	—	—	0.69	0.82	—	—	0.85	1.0

Type	Reverse Current V_R	(nA)	Reverse Current @ 150°C V_R	μA	Junction Capacitance @ 0V	Reverse Recovery Time t_{rr}
1N4152	30	50	30	50	2pF	2nS
1N4305	50	100	50	100	2pF	2nS
1N4444	50	50	50	50	2pF	7nS

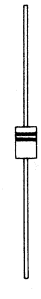
MECHANICAL SPECIFICATIONS

1N4152, 1N4305, 1N4444



	INCHES	MILLIMETERS
A	.065 MAX.	1.65 MAX.
B	.155 MAX.	3.94 MAX.
C	1.0 MIN.	25.40 MIN.
D	.020	.51

DO-35



UNITRODE

COMPUTER DIODE

150mA
Switching Diode

JAN, JANTX & JANTXV 1N4153
JAN, JANTX & JANTXV 1N4534

FEATURES
- Metallurgical Bond
- Qualified to MIL-S-19500/337
- Planar Passivated Chip
- DO-34 or DO-35 Package
- Non-JAN Available

DESCRIPTION
This device is particularly suited to applications where tightly controlled forward characteristics and fast recovery time are important.

8

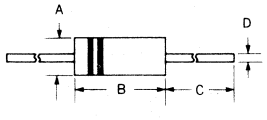
ABSOLUTE MAXIMUM RATINGS, AT 25°C

Reverse Breakdown Voltage	75V
Peak Working Voltage	50V
Average Output Current*	150mA
Surge Current, 1μs	2.0A
Operating Temperature Range	-65°C to +200°C
Storage Temperature Range	-65°C to +200°C

*Derate 0.86mAdc/°C for T_A above 25°C.

MECHANICAL SPECIFICATIONS

J, JTX & JTXV 1N4153
J, JTX & JTXV 1N4534

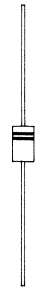


J, JTX & JTXV 1N4534

	INCHES	MILLIMETERS
A	.050 - .065	1.27 - 1.65
B	.080 - .120	2.03 - 3.05
C	1.0 - 1.5	25.4 - 38.1
D	.018 - .022	.46 - .56

J,JTX & JTXV 1N4153

	INCHES	MILLIMETERS
A	.056 - .075	1.42 - 1.90
B	.140 - .180	3.55 - 4.57
C	1.0 MIN.	25.40 MIN.
D	.018 - .022	.46 - .56



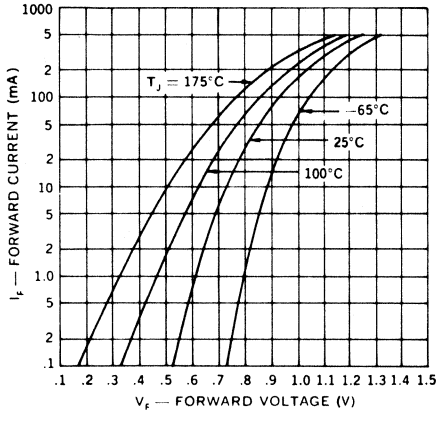
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

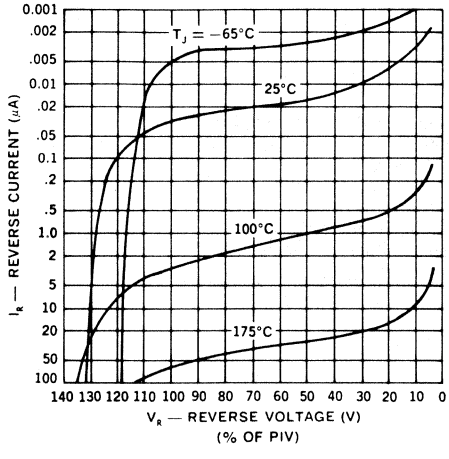
Limit	V_{F1} $I_F = 100\ \mu Adc$	V_{F2} $I_F = 250\ \mu Adc$	V_{F3} $I_F = 1$ mAdc	V_{F4} $I_F = 2$ mAdc	V_{F5} $I_F = 10$ mAdc	V_{F6} $I_F = 20$ mAdc
Min	0.490Vdc	0.530Vdc	0.590Vdc	0.620Vdc	0.700Vdc	0.740Vdc
Max	0.550Vdc	0.590Vdc	0.670Vdc	0.700Vdc	0.810Vdc	0.880Vdc

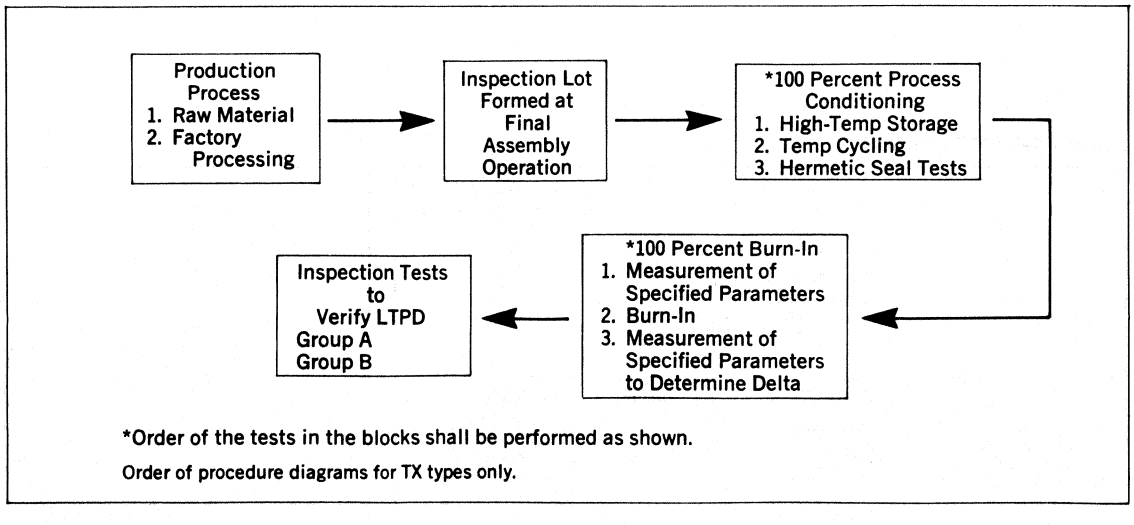
Limit	I_R $V_R = 50V$	I_{R2} $V_R = 50V$ $T_A = 150°C$	C $V_R = 0$ f = 1MHz	t_{rr} $I_F = I_R = 10$mAdc $R_L = 100$ ohms	Reverse Breakdown Voltage $I_R = 5.0\mu Adc$
Min	—	—	—	—	75V
Max	0.05μAdc	50μAdc	2.0pF	4ns	—

Forward Voltage vs. Forward Current



Reverse Voltage vs. Reverse Current





*Order of the tests in the blocks shall be performed as shown.

Order of procedure diagrams for TX types only.

COMPUTER DIODE
Switching

1N4450, 1N4451, 1N4453

ABSOLUTE MAXIMUM RATINGS, AT 25°C

	1N4450	1N4451	1N4453
Peak Reverse Voltage	40V	40V	30V
Reverse Working Voltage	30V	30V	20V
Average Rectified Current	200mAdc		
Surge Current, 8.3 mS	500mA		
Operating Temperature Range	−65°C to +150°C		
Storage Temperature Range	−65°C to +200°C		

FEATURES
- Metallurgical Bond
- Planar Passivated
- DO-35 Package

DESCRIPTION
This series offers Metallurgical Bonding and is very popular for general purpose switching applications.

8

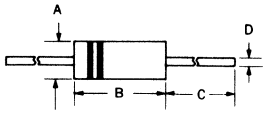
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	Peak Inverse Voltage (V)	Forward Voltage @ 0.01mA		Forward Voltage @ 0.1mA		Forward Voltage @ 1.0mA		Forward Voltage @ 10mA		Forward Voltage @ 100mA		Forward Voltage @ 200mA		Forward Voltage @ 300mA	
		min	max	min	max	min	max	min	max	min	max	min	max	min	max
1N4450	40	—	—	0.42	0.54	0.52	0.64	0.64	0.76	0.80	0.96	—	1.0	—	—
1N4451	40	—	—	0.40	0.50	0.51	0.61	0.62	0.72	0.75	0.875	—	—	—	1.0
1N4453	30	0.43	0.55	0.51	0.63	0.60	0.71	0.69	0.80	0.80	0.92	—	—	—	—

Type	Reverse Current V_R	(nA)	Reverse Current @ 150°C V_R	μA	Junction Capacitance @ 0V	Reverse Recovery Time t_{rr}
1N4450	30	50	30	50	4pF	4nS
1N4451	30	50	30	50	6pF	10nS
1N4453	20	50	20	50	30pF	—

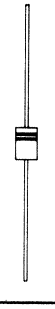
MECHANICAL SPECIFICATIONS

1N4450, 1N4451, 1N4453



	INCHES	MILLIMETERS
A	.065	1.65
B	.155	3.94
C	1.0 MIN.	25.4 MIN.
D	.020	.51

DO-35



UNITRODE

COMPUTER DIODE
High Conductance

1N4452, 1N4607, 1N4608

FEATURES
- Metallurgical Bond
- Planar Passivated
- High Conductance
- DO-35 Package

DESCRIPTION
This series offers Metallurgical Bonding and is specifically designed for high conductance switching applications such as core memories.

ABSOLUTE MAXIMUM RATINGS, AT 25°C

	1N4452	1N4607	1N4608
Peak Reverse Voltage	40V	85V	85V
Reverse Working Voltage	30V	50V	50V
Average Rectified Current	400mAdc		500mAdc
Surge Current, 8.3 mS	1A		
Operating Temperature Range	-65°C to +150°C		
Storage Temperature Range	-65°C to +200°C		

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

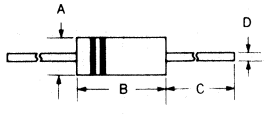
Type	Peak Inverse Voltage	Forward Voltage @ 0.1mA		Forward Voltage @ 1.0mA		Forward Voltage @ 10mA		Forward Voltage @ 100mA		Forward Voltage @ 250mA		Forward Voltage @ 350mA		Forward Voltage @ 400mA		Forward Voltage @ 500mA	
		min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max
1N4452	40V	0.42	0.54	0.51	0.62	0.60	0.71	0.71	0.83	—	—	—	—	—	—	—	—
1N4607	85V	0.39	0.50	0.50	0.60	0.61	0.72	0.74	0.87	0.81	0.95	—	1.0	—	1.1	—	—
1N4608	85V	0.39	0.49	0.50	0.60	0.61	0.71	0.74	0.85	0.81	0.93	0.84	0.96	—	—	—	1.1

Type	Forward Voltage @ 600mA		Forward Voltage @ 1000mA		Reverse Current		Reverse Current @ 100°C		Reverse Current @ 150°C		Junction Capacitance @ 0V	Reverse Recovery Time
	min	max	min	max	V_R	nA	V_R	μA	V_R	μA		t_{rr}
1N4452	—	1.0	0.90	1.2	30	50	—	—	30	50	—	50nS
1N4607	—	—	—	—	50	100	50	25	—	—	4pF	10nS
1N4608	—	—	—	—	50	100	50	25	—	—	4pF	10nS

* t_{rr} @ $I_f = I_r$ = 10mA, I_{rec} = 1mA

MECHANICAL SPECIFICATIONS

1N4452, 1N4607, 1N4608



	INCHES	MILLIMETERS
A	.065	1.65
B	.155	3.94
C	1.0 MIN.	25.4 MIN.
D	.020	.51

DO-35



UNITRODE

COMPUTER DIODE

500mA
Switching Diode

JAN & JANTX 1N4500

FEATURES
- Metallurgical Bond
- Qualified to MIL-S-19500/403
- Planar Passivated Chip
- DO-35 Package
- Non-JAN Available

DESCRIPTION
This device is a fast switching, high conductance diode for military, space, high rel and other systems.

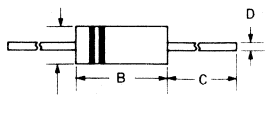
8

ABSOLUTE MAXIMUM RATINGS, AT 25°C

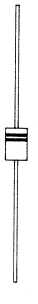
Reverse Breakdown Voltage	80Vdc
Peak Working Voltage	75Vpk
Average Output Current	300mAdc
Surge Current, 1sec	0.5A
1μsec	4.0A
Operating Temperature Range	−65°C to +175°C
Storage Temperature Range	−65°C to +200°C

MECHANICAL SPECIFICATIONS

J & JTX 1N4500



	INCHES	MILLIMETERS
A	.060 - .107	1.52 - 2.72
B	.140 - .300	3.55 - 7.62
C	1.0 MIN.	25.40 MIN.
D	.018 - .022	.46 - .56



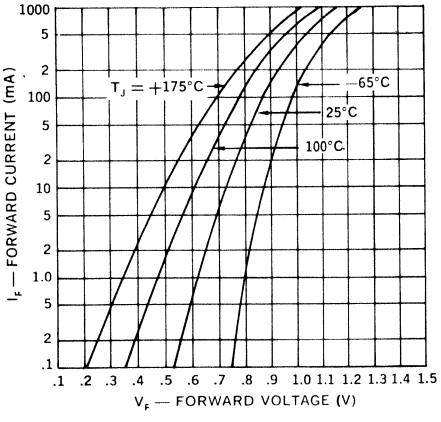
UNITRODE

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

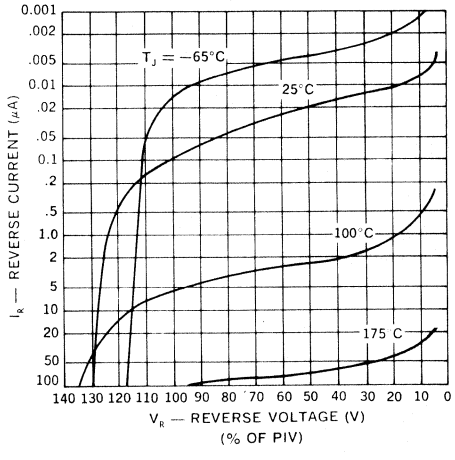
Limits	V_{F1} $I_F = 250\mu$Adc	V_{F2} $I_F = 1.0$mAdc	V_{F3} $_F = 10$mAdc	V_{F4} $I_F = 20$mAdc	V_{F5} 1/ $I_F = 300$mAdc	C $V_R = 0$ 100 kHz ≤ f ≤ 1 MHz $v_{sig} = 50$ mv (p-p)
	mVdc	mVdc	mVdc	mVdc	Vdc	pF
Minimum	470	520	640	670	—	—
Maximum	560	600	720	770	1.10	4.0

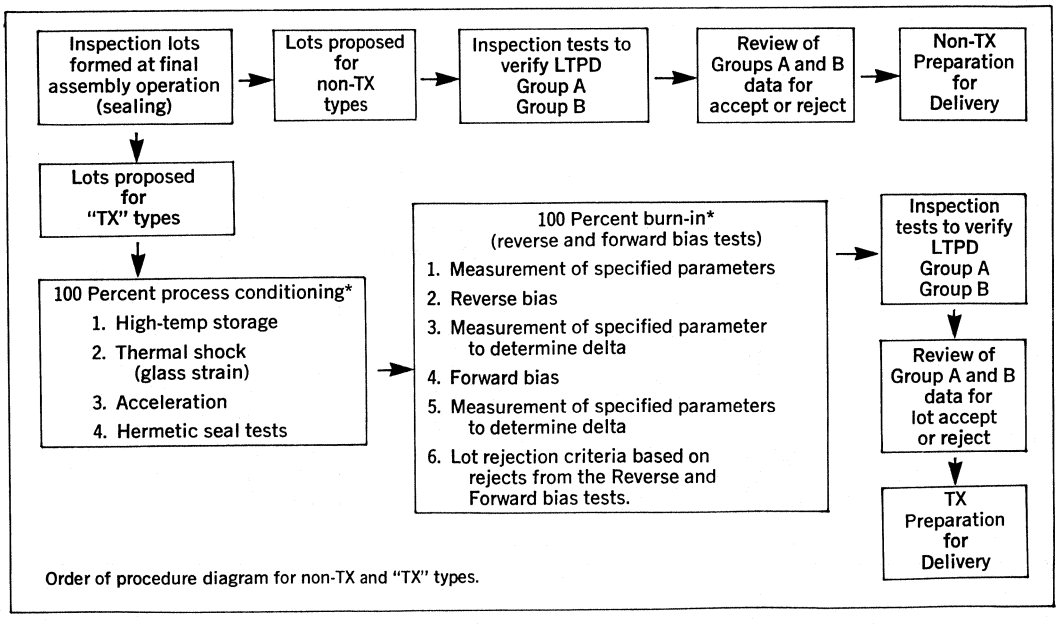
	I_R $V_R = 75$Vdc	B_V $I_R = 5\mu$Adc	I_R $V_R = 75$Vdc $T_A = 150$°C	t_{rr} $I_F = I_R =$ 10 mAdc: $R_L = 100$ ohms
	nAdc	Vdc	μAdc	nsec
Minimum	—	80	—	—
Maximum	100		100	6.0

Forward Voltage vs. Forward Current



Reverse Voltage vs. Reverse Current





Order of procedure diagram for non-TX and "TX" types.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

COMPUTER DIODE
Switching

BAW24-BAW27
BAW75-BAW76

FEATURES
- Metallurgical Bond
- Planar Passivated
- DO-35

DESCRIPTION
This series offers Metallurgical Bonding and is very popular for general purpose switching applications.

ABSOLUTE MAXIMUM RATINGS, AT 25°C

	BAW24	BAW25	BAW26	BAW27	BAW75	BAW76
Peak Reverse Voltage	50V	50V	75V	75V	35V	75V
Average Rectified Current	600mA	600mA	600mA	600mA	300mA	300mA
Peak Forward Current	400mA	400mA	400mA	400mA	500mA	500mA
Operating Temperature Range	—65°C to +150°C					
Storage Temperature Range	—65°C to +200°C					

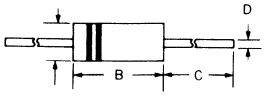
8

ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	Peak Inverse Voltage (V)	Forward Voltage (Max V) @ 30mA	@ 50mA	@ 100mA	@ 200mA	Reverse Current (V_R)	(nA)	Junction Capacitance @ OV (pF)	Reverse Recovery Time t_{RR} (nS)
BAW24	50	—	1.0	—	—	40	0.1	4	6
BAW25	50	—	0.8	—	—	40	0.1	4	6
BAW26	75	—	—	1.0	—	60	0.1	4	6
BAW27	75	—	—	—	1.0	40	0.1	4	6
BAW75	35	1.0	—	—	—	35	5.0	4	4
BAW76	75	—	—	1.0	—	75	5.0	2	4

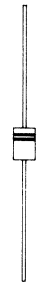
MECHANICAL SPECIFICATIONS

BAW24-BAW27
BAW75-BAW76



	INCHES	MILLIMETERS
A	.065	1.65
B	.155	3.94
C	1.0 MIN.	25.4 MIN.
D	.020	.51

DO-35



UNITRODE

COMPUTER DIODE
Switching

BAY41-BAY43
BAY60
BAX12

FEATURES
- Metallurgical Bond
- Planar Passivated
- DO-35

DESCRIPTION
This series offers Metallurgical Bonding and is very popular for general purpose switching applications.

ABSOLUTE MAXIMUM RATINGS, AT 25°C

	BAY41	BAY42	BAY43	BAY60	BAX12
Peak Reverse Voltage	40V	60V	80V	25V	90V
Average Rectified Current	225mA	225mA	225mA	115mA	400mA
Peak Forward Current	600mA	600mA	600mA	225mA	800mA
Operating Temperature Range	-65°C to +150°C				
Storage Temperature Range	-65°C to +200°C				

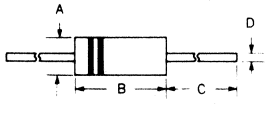
ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Type	Peak Inverse Voltage	Maximum Forward Voltage						Reverse Current		Junction Capacitance @ 0V	Reverse Recovery Time T_{rr}
		@ 10mA	@ 30mA	@ 50mA	@ 100mA	@ 100mA	@ 400mA				
	V	V	V	V	V	V	V	V_R	nA	pF	ns
BAY41	40	—	—	—	—	1.0	—	40	5	5	8.5
BAY42	60	—	—	—	—	1.0	—	60	5	5	15
BAY43	80	—	—	—	—	1.0	—	80	5	5	15
BAY60	25	—	1.0	—	—	—	—	25	.1	4	4
BAX12*	90	.75	—	.84	.90	1.0	1.25	90	100	20	15

*Maximum reverse energy 5mW/second.

MECHANICAL SPECIFICATIONS

BAY41-BAY43
BAY60
BAX12



	INCHES	MILLIMETERS
A	.065	1.65
B	.155	3.94
C	1.0 MIN.	25.4 MIN.
D	.020	.51

DO-35



UNITRODE

PIN DIODES 9

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PIN DIODES

PRODUCT SELECTION GUIDE

For applications information, see PIN Diode Designers' Handbook and Catalog (PD-500B)

SWITCHING PIN DIODES

Type	Voltage Rating Range	Capacitance (0V, 1 GHz) C_T max.	Forward Resistance (100mA, 1 GHz) R_s max.	Parallel Resistance (100V, 1 GHz) R_p min.	Average Thermal Resistance θ_A max.	Average Power Dissipation P_A max.	Peak Power Dissipation P_p max.	Carrier Lifetime I_F = 10mA τ min.
	(V)	(pF)	(Ω)	(KΩ)	(°C/W)	(W)	(KW)	(μS)
UM4000	100-1000	3.0	0.5	2	6	25	100	5.0
UM4900	100-600	3.0	0.5	2	4	37	100	5.0
UM6000	100-1000	0.5	1.7	15	25	6	25	1.0
UM6200	100-400	1.1	0.4	10	25	6	10	0.6
UM6600	100-1000	0.4	2.5	10	35	4	13	1.0
UM7000	100-1000	0.9	1.0	10	15	10	60	2.5
UM7100	100-800	1.2	0.6	8	15	10	35	2.0
UM7200	100-400	2.2	0.25	7	15	10	20	1.5

HIGH POWER ATTENUATOR & MODULATOR PIN DIODES

Type	Voltage Ratings Range	Total Capacitance (0V, 1 GHz) C_T max.	RF Resistance (100mA, 1 GHz) R_s max.	RF Resistance (10μA, 1 GHz) R_s min.	Average Thermal Resistance θ_A max.	Average Power Dissipation P_A max.	Carrier Lifetime I_F = 10mA τ min.
	(V)	(pF)	(Ω)	(Ω)	(°C/W)	(W)	(μs)
UM4300	100-1000	2.2	1.5	1000	8	18	5.0
UM7300	100-1000	0.7	3.0	3000	20	7.5	2.5

GENERAL PURPOSE PIN DIODE

Type	Voltage Rating (I_R=10μA)	Total Capacitance (50V, 1MHz) C_T max.	RF Resistance (10μA, 100 MHz) R_s min.	RF Resistance (20mA, 100 MHz) R_s max.	RF Resistance (100mA, 100MHz) R_s max.	Carrier Lifetime (I_F = 10mA) τ min.
	(V)	(pF)	(Ω)	(Ω)	(Ω)	(μs)
1N5767	100	0.4	1000 3000 typ.	8 4 typ.	2.5 1.5 typ.	1

LOW DISTORTION ATTENUATOR PIN DIODES

Type	Voltage Rating I_R=10μA	Total Capacitance (0V, 100MHz) C_T max.	RF Resistance (100mA, 100MHz) R_s max.	RF Resistance (10μA, 100 MHz) R_s max.	Forward Current (R_s = 75Ω F = 100MHz) Typ.	Carrier Lifetime (I_F=10mA) Typ.
	(V)	(pF)	(Ω)	(Ω)	I_F (mA)	τ (μs)
1N5957	100	0.4	3.5	1500	1.0	2
UM9301	75	0.8	3.0	3000	1.1	4

TWO WAY RADIO ANTENNA SWITCHES

Type	Voltage Rating (I_R=10μA)	Total Capacitance (0V, 100MHz) C_T max.	RF Resistance (50mA, 100MHz) R_s max.	Transmit Harmonic Distortion F = 50MHz I = 20mA	Receive Third Order Distortion (Pin-10mW, 0 Bias) FA=50MHz FB=51MHz Max.	Average Power Dissipation P_A Max.
	(V)	(pF)	(Ω)	(dB)	(dB)	(W)
UM9401 and UM9402	50	1.5	1.0	−80	−60	5.5
UM9415	50	4.0	1.0	−80	60	10

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PIN DIODES

For applications information, see PIN Diode Designers' Handbook and Catalog (PD-500B)

LOW RESISTANCE ANTENNA SWITCHES

Type	Voltage Rating (I_R = 10μA)	Total Capacitance (50V, 1MHz) C_T max	RF Resistance (10mA, 100MHz) R_S max	Forward Bias Third Order I_M Distortion I = 10mA F_a = 43MHz F_b = 44MHz max	Reverse Bias Third Order I_M Distortion V = 50V F_a = 43MHz F_b = 44MHz max	Average Power Dissipation P_A max
	(V)	(pF)	(Ω)	(dB)	(dB)	(W)
UM9701	100	1.8	.8	-90	-90	2.5

MICROSTRIP PACKAGED DIODES

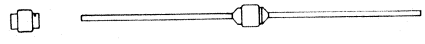
Type	Series Resistance R_S max.	Parallel Resistance R_P min.	Total Capacitance C_T max.	Carrier Lifetime τ min.	Voltage Rating	Forward Voltage V_F typ.
	(Ω)	(KΩ)	(pF)	(μs)	(V)	(V)
UM9601-UM9604	0.6	5	1.2	2.0	100, 400	.85
UM9605-UM9608	1.7	7	0.5	1.0	100, 400	.95

RADIATION DETECTOR

Type	Photocurrent 10^6 Rad (Si), 50V Sec mA min.	Photocurrent Rise Time nS Typ	Reverse Current 50V μA max.	Capacitance F = 1 MHz, V = 50V pF max.
UM9441	4.0	10	1.0	15

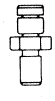
PACKAGE STYLES

For UM4000, 6000 & 7000 Series

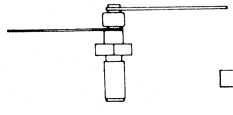


A Style
Basic Diode

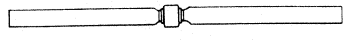
B Style
Round Axial Leads



***C Style**
Stud



***D Style**
Insulated Stud



E Style
Ribbon Axial Leads

*Not available for UM6000, UM6600, UM6200.

For UM9600 Series



Cup
UM9601/2



Cup
UM9605/6



Flange
UM9603/4



Flange
UM9607/8

Drawings are not actual size.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PIN DIODES

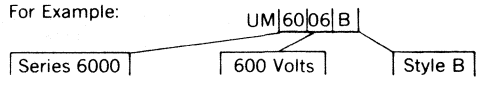
VOLTAGE RATINGS

Series	100V	200V	400V	600V	800V	1000V
UM4000	✓	✓		✓		✓
UM4300	✓	✓		✓		✓
UM4900	✓	✓		✓		
UM6000	✓	✓		✓		✓
UM6200	✓	✓	✓			
UM6600	✓	✓		✓		✓
UM7000	✓	✓		✓		✓
UM7100	✓	✓	✓		✓	
UM7200	✓	✓	✓			
UM7300	✓	✓		✓		✓

ORDERING INFORMATION

Part numbers of Switching and High Power Attenuator PIN diodes consist of the letters UM followed by four digits and one or two letters. The first two digits indicate the diode series, the next two digits specify the voltage rating in hundreds of volts. The remaining letters denote the package style. Reverse polarity is available for C, and D, style and denoted by adding second letter R.

For Example:



9

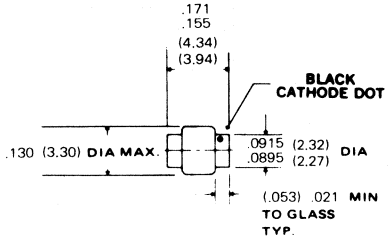
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

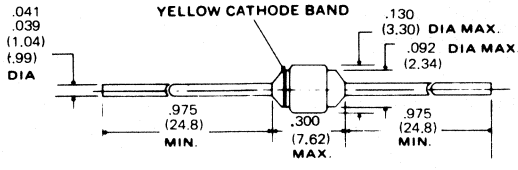
MECHANICAL SPECIFICATIONS
UM4000 SERIES
UM4300 SERIES

Dimensions — English/Metric

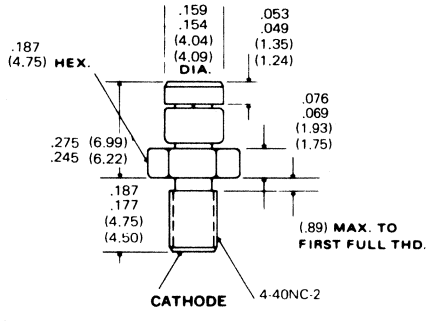
STYLE A



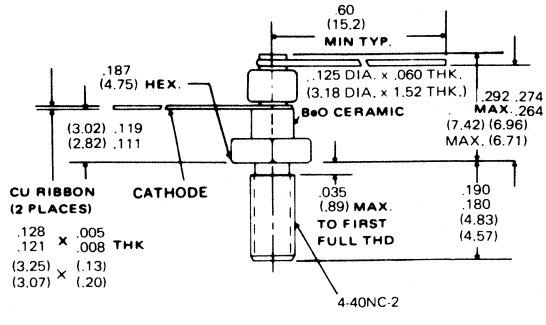
STYLE B



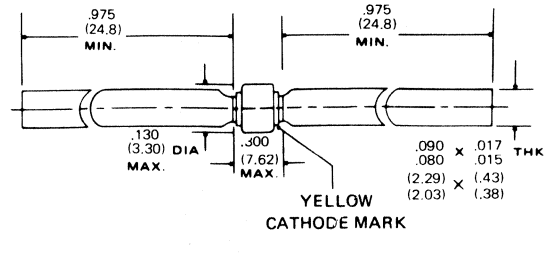
STYLE C
STUD



STYLE D
INSULATED STUD



STYLE E
RIBBON LEADS

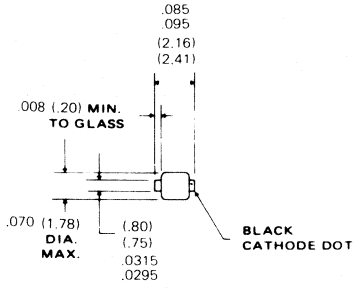


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

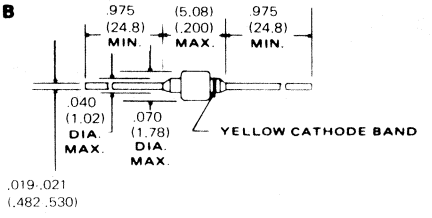
PRINTED IN U.S.A.

MECHANICAL SPECIFICATIONS

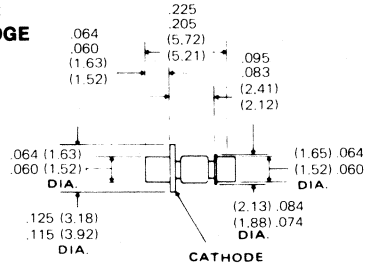
STYLE A



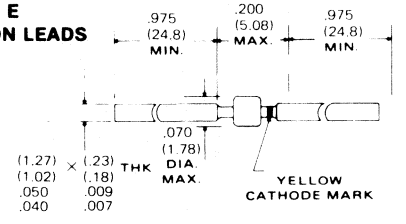
STYLE B



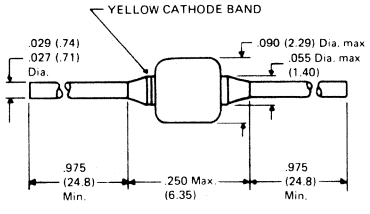
STYLE C
CARTRIDGE



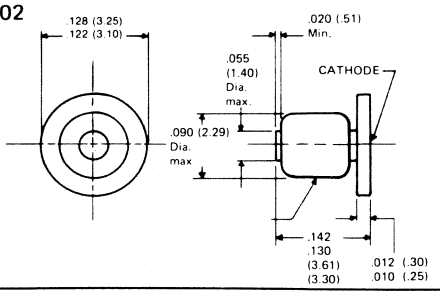
STYLE E
RIBBON LEADS



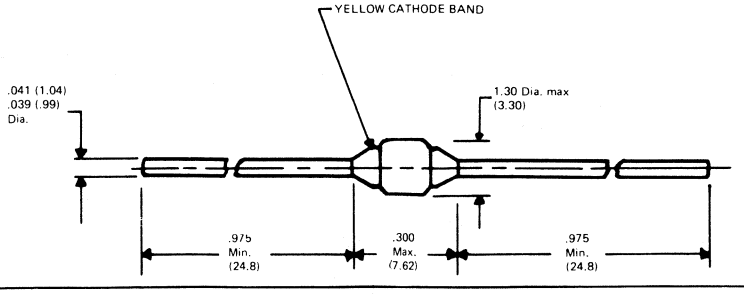
UM9401



UM9402



UM9415



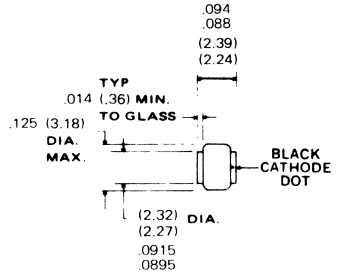
Dimensions: inches (millimeters)

MECHANICAL SPECIFICATIONS (continued)

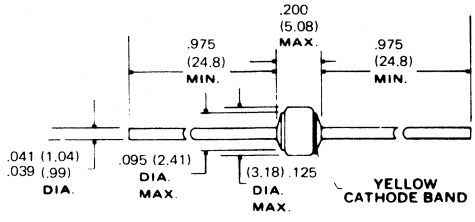
UM 4900 Series

Dimensions — English/Metric

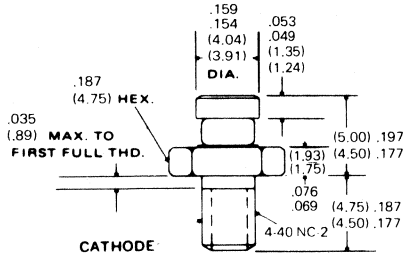
STYLE A



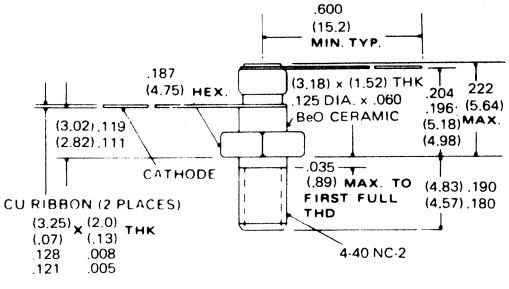
STYLE B



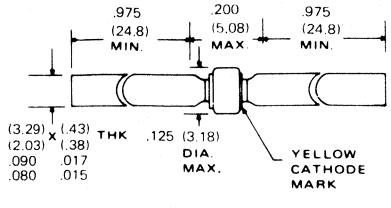
STYLE C
STUD



STYLE D
INSULATED STUD



STYLE E
RIBBON LEADS



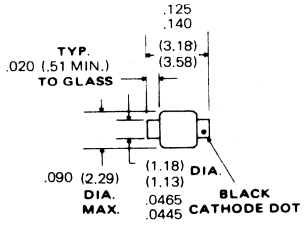
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

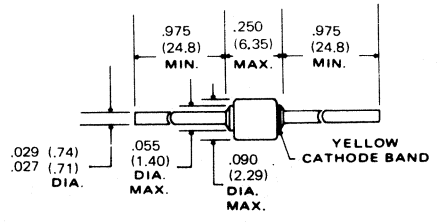
MECHANICAL SPECIFICATIONS (continued)
UM7000 UM7100 UM7200 SERIES
UM7300 SERIES

Dimensions — English/Metric

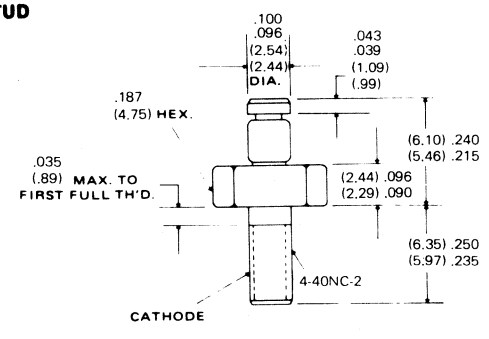
STYLE A



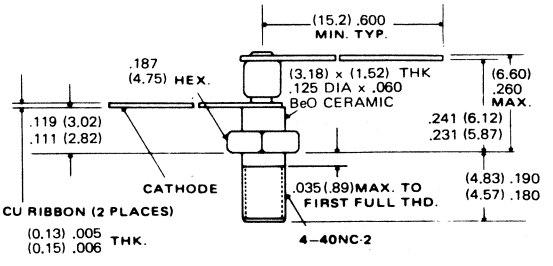
STYLE B



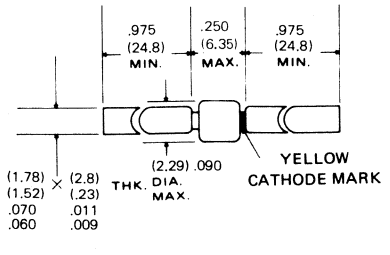
STYLE C
STUD



STYLE D
INSULATED STUD



STYLE E
RIBBON LEADS



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PIN DIODE

Features

- Useful attenuation from 1 μA to 100 mA bias.
- Capacitance below 0.4 pF.
- Low distortion in switches and attenuators.
- Rugged Unitrode construction.

Description

The 1N5767 and 1N5957 PIN diodes are based upon low capacitance PIN chips designed with long minority carrier lifetime, and thick intrinsic width. Thus operation as low as 1 MHz is possible with low distortion. Additionally, the low diode capacitance allows useful operation well into the microwave frequency range.

The 1N5767 (5082-3080) is a general purpose low power PIN diode designed for both switch and attenuator applications.

The 1N5957 is primarily used as an attenuator PIN diode and is particularly suitable wherever current controlled, wide dynamic range resistance elements are required. The 1N5957 has also been characterized for the 75Ω attenuator, commonly employed in CATV systems.

MAXIMUM RATINGS

Reverse Voltage (V_R) — Volts (I_R = 10 μA)	100V
Average Power Dissipation: (25 °C) Free Air (P_A)	400 mW (Derate linearly to 175 °C)
Operating and Storage Temperature Range	−65 °C to +175 °C

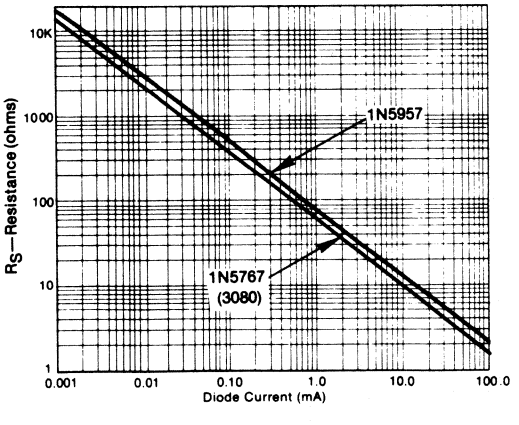
UNITRODE

Electrical Specifications (25 °C)

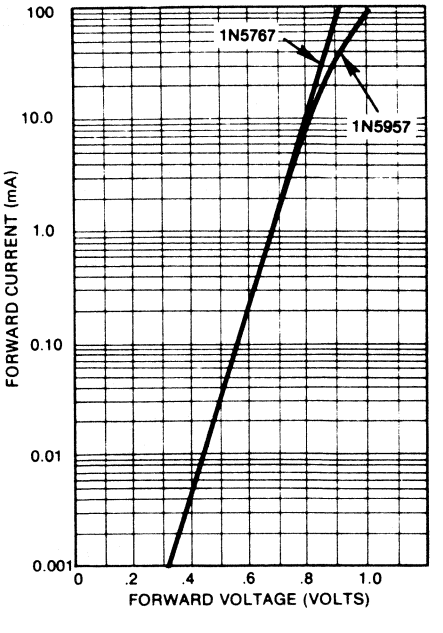
Test	Symbol	1N5767 (5082-3080)	1N5957	Conditions
Total Capacitance (Max)	C_T	0.4 pF	0.4 pF	50V, 1 MHz
Series Resistance	R_S	1000Ω(min) 2000Ω(typ)	1500Ω(min) 3000Ω(typ)	10 μA, 100 MHz
Series Resistance	R_S	8Ω(max) 4Ω(typ)	8Ω(max) 6Ω(typ)	20 mA, 100 MHz
Series Resistance	R_S	2.5Ω(max) 1.5Ω(typ)	3.5Ω(max) 2.0Ω(typ)	100 mA, 100 MHz
Carrier Lifetime (Min)	τ	1.0 μS	1.5(min) 2(typ)	I_F = 10 mA
Reverse Current (Max)	I_R	10 μA	10 μA	V_R = Rating
Current for R_S = 75Ω (typ)	I_{75}	0.7 mA	0.8 mA-1.2 mA	R_S = 75Ω
Return Loss (typ)	—	30 dB	30 dB	Diode terminates 75Ω line
Second Order Distortion (typ)	—	−40 dB	−50 dB	Bridged tee attenuator atten. = 10 dB
Third Order Distortion (typ)	—	−60 dB	−65 dB	P_{in} = 50 dBmV F_1 = 10 MHz, F_2 = 13 MHz

9

RESISTANCE VS FORWARD CURRENT (TYPICAL)

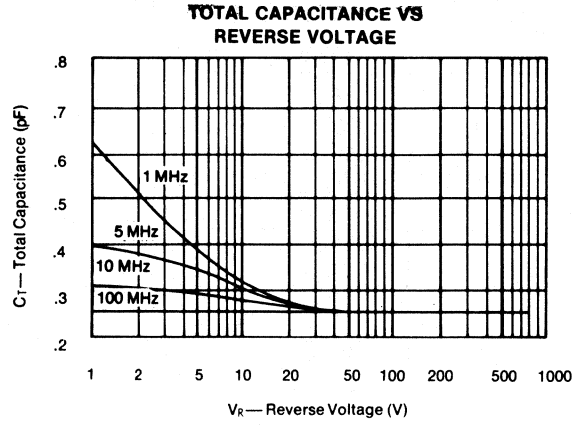


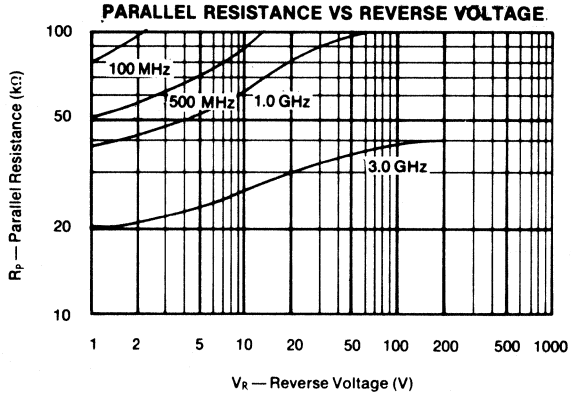
FORWARD VOLTAGE VS FORWARD CURRENT (TYPICAL)



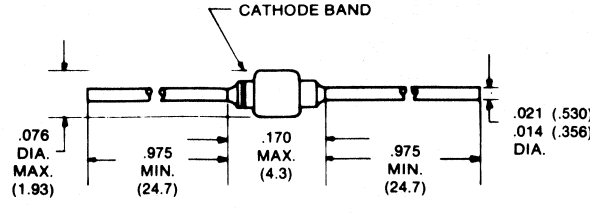
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.





MECHANICAL SPECIFICATIONS



Dimensions: Inches (Millimeters)

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

?IN DIODE

UM4000 SERIES
UM4900 SERIES

eatures

Power dissipation to 37.5W
Voltage ratings to 1000V
Series resistance rated at 0.5Ω
Carrier lifetime greater than 5μs

escription

The UM4000 and UM4900 series feature igh power PIN diodes with long carrier life-imes and thick I-regions. They are especially uitable for use in low distortion switches nd attenuators, in the HF through S band requencies. While both series are electri-ally equivalent, the UM4900 series have igher power ratings due to a shorter thermal ath between chip and package. High charge torage and long carrier lifetime enable high RF levels to be controlled with relatively low bias current. Similarly, peak RF voltages can be handled well in excess of applied reverse bias voltage.

Both series have been fully qualified in high power UHF phase shifters and mega-watt peak-power duplexers, accumulating thousands of hours of proven performance. Both types have been used in the design of antenna selectors and couplers, where induc-tive and capacitive elements are switched in and out of filter or cavity networks.

9

MAXIMUM RATINGS

Average Power Dissipation and Thermal Resistance Ratings

Package	Condition	UM4000		UM4900	
		P_D	θ	P_D	θ
A	25 °C Pin Temperature	25W	6 °C/W	37.5W	4 °C/W
B&E (Axial Leads)	½ in. (12.7mm) Overall Length to 25 °C Contact	12W	12.5 °C/W	12W	12.5 °C/W
B&E (Axial Leads)	Free Air	2.5W	—	2.5W	—
C (Studded)	25 °C Stud Temperature	25W	6 °C/W	37.5W	4 °C/W
D (Insulated Stud)	25 °C Stud Temperature	18.75W	8 °C/W	25W	6 °C/W

Peak Power Dissipation Rating

All Packages	1 μs Pulse (Single) at 25 °C Ambient	100 KW

Operating and Storage Temperature Range: −65 °C to +175 °C

UNITRODE

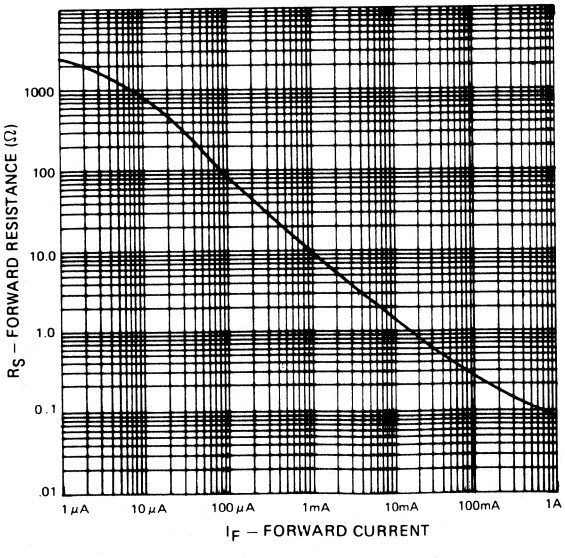
Voltage Ratings (25 °C)

Reverse Voltage (V_R) — Volts (I_R = 10 μ Amps)	Types	
100	UM4001	UM4901
200	UM4002	UM4902
400	—	—
600	UM4006	UM4906
1000	UM4010	—

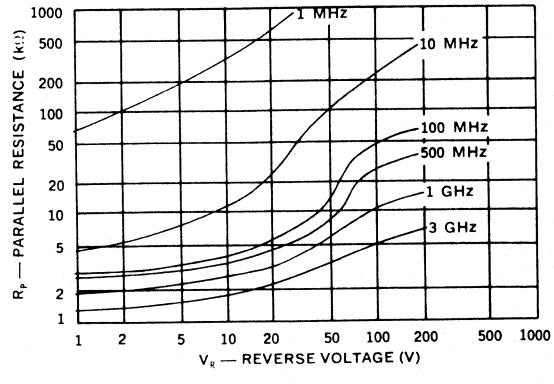
Electrical Specifications (25 °C)

Test	Symbol	UM4000 UM4900	Conditions
Total Capacitance (Max)	C_T	3 pF	0V, 1 GHz
Series Resistance (Max)	R_S	0.5Ω	100 mA, 1 GHz
Parallel Resistance (Min)	R_P	2 KΩ	100V, 1 GHz
Carrier Lifetime (Min)	τ	5μs	I_F = 10 mA
Reverse Current (Max)	I_R	10μA	V_R = Rating
I-Region Width (Min)	W	150μm	—

TYPICAL FORWARD RESISTANCE VS FORWARD CURRENT (F = 100 MHz)



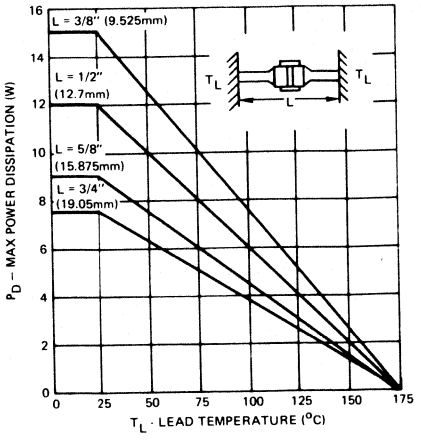
TYPICAL PARALLEL RESISTANCE CHARACTERISTIC



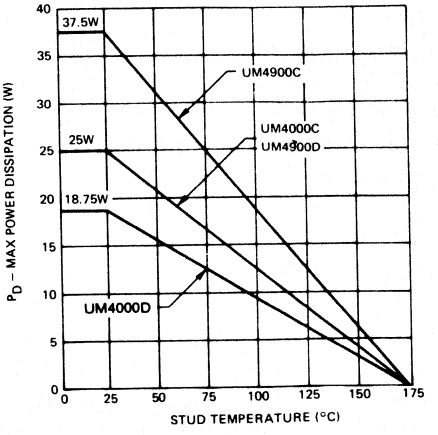
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER RATING AXIAL LEADED DIODE

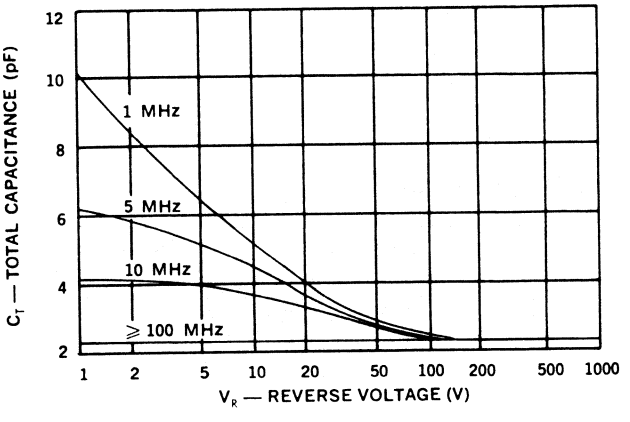


POWER RATING STUD MOUNTED DIODES

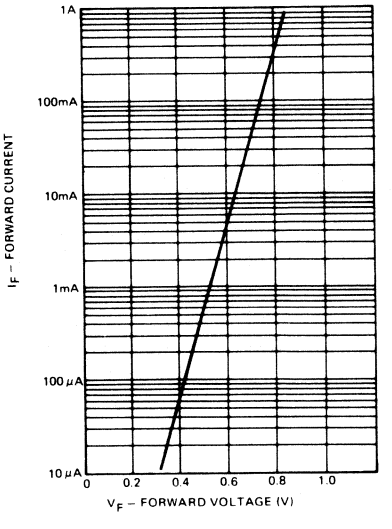


9

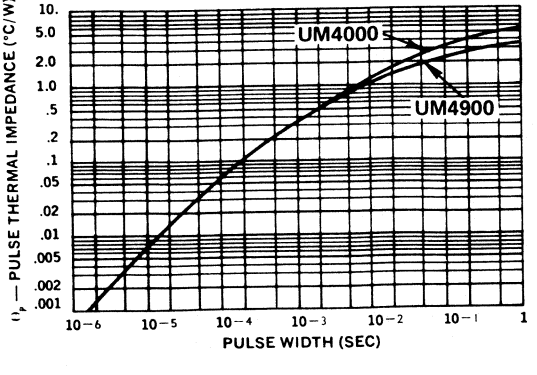
TYPICAL CAPACITANCE CHARACTERISTIC



DC CHARACTERISTICS FORWARD VOLTAGE VS FORWARD CURRENT (TYPICAL)



THERMAL IMPEDANCE



ORDERING INSTRUCTIONS

Part numbers of Unitrode PIN Diodes consist of the letters UM followed by four digits and one or two letters. The first two digits indicate the diode series, the next two digits specify the minimum breakdown voltage in hundreds of volts. The remaining letters denote the package style. Reverse polarity (anode large end cap) is available for the C style and denoted by adding second letter R.

For Example: UM|40|06|CR

- UM|40: Series 4000
- 06: 100 Volts
- CR: Style C, Reverse Polarity

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PIN DIODE

UM4300 SERIES
UM7300 SERIES

For Attenuator Applications

Features

- Extremely low distortion performance
- Useful frequency range extends below 500 KHz
- Power dissipation to 20W (UM4300)
- Capacitance as low as 0.7 pF (UM7300)
- Voltage ratings to 1000V

Description

The UM4300 and UM7300 series combine a diode chip of extremely thick intrinsic region with a low thermal resistance construction. This results in diodes uniquely applicable to very low distortion linear attenuators and specialized switching functions. The UM4300 series, with large cross-sectional chip area offers the highest power capability, of the two series. The UM7300 series offers lower capacitance.

Both diode series are intended for use in linear attenuators operating from HF to beyond 1 GHz. Low distortion at low frequencies is a result of transit time frequencies below 5 MHz.

Operated as RF switches, either diode series can be operated at low dc reverse bias voltages, to hold off much higher RF voltage levels.

MAXIMUM RATINGS

Average Power Dissipation and Thermal Resistance Ratings

Package	Condition	UM4300		UM7300	
		P_D	θ	P_D	θ
A	25 °C Pin Temperature	20W	7.5 °C/W	7.5W	20 °C/W
B&E (Axial Leads)	½ in. Total Length to 25 °C Contact	10W	15 °C/W	4W	37.5 °C/W
B&E (Axial Leads)	Free Air	2.5W	—	1.5W	—
C (Studded)	25 °C Stud	20W	7.5 °C/W	7.5W	20 °C/W
D (Insulated Stud)	25 °C Stud	15W	10 °C/W	6W	25 °C/W

Peak Power Dissipation Rating

All packages	1μs Pulse (Single) at 25 °C Ambient	500 KW	100 KW

Operating and Storage Temperature Range: −65 °C to +175 °C

UNITRODE

Voltage Ratings (25 °C)

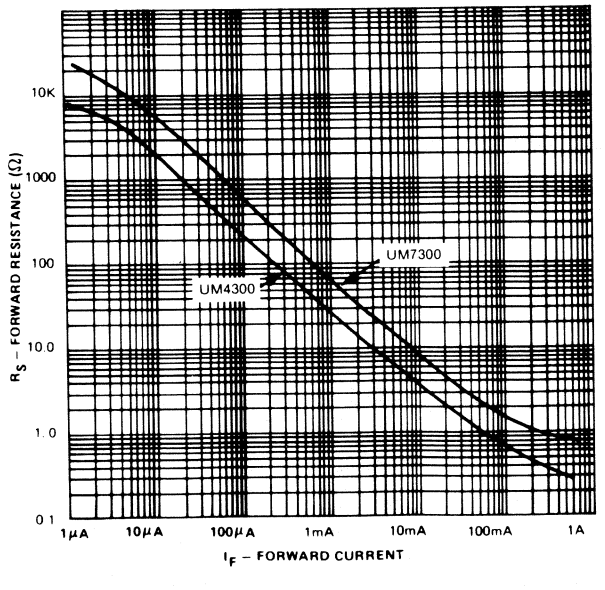
Reverse Voltage (V_R) — Volts (I_R = 10 μA)	Types	
100V	UM4301	UM7301
200V	UM4302	UM7302
600V	UM4306	UM7306
1000V	UM4310	UM7310

Electrical Specifications (25 °C)

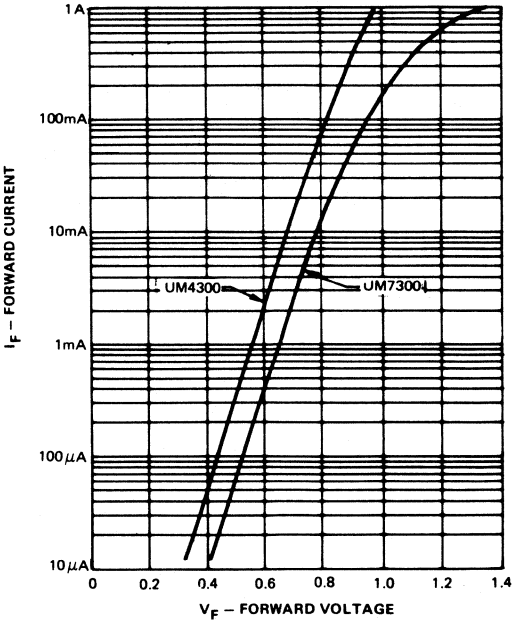
Test	Symbol	UM4300	UM7300	Conditions
Total Capacitance (Max)	C_T	2.2 pF	0.7 pF	0V, 1 GHz
Series Resistance (Max)	R_S	1.5Ω	3.0Ω	100 mA, 1 GHz
Series Resistance (Min)	R_S	1000Ω	3000Ω	10 μA, 100 MHz
Carrier Lifetime (Min)	τ	6μs	4.0μS	I_F = 10 mA
Leakage Current (Max)	I_R	10μA	10μA	V_R = Rating
I-Region Width (Min)	W	250μm	250μm	—

9

TYPICAL FORWARD RESISTANCE
VS FORWARD CURRENT (F = 100 MHz)



TYPICAL DC CHARACTERISTIC
FORWARD VOLTAGE
VS FORWARD CURRENT

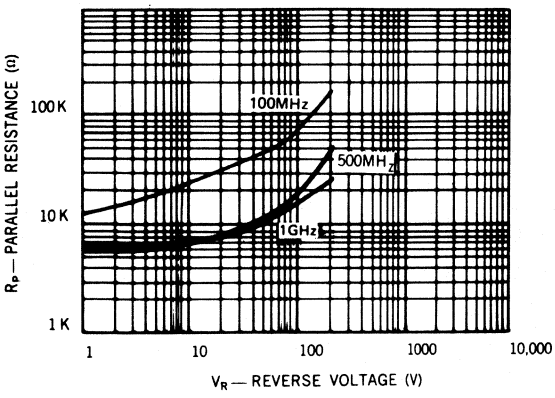


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

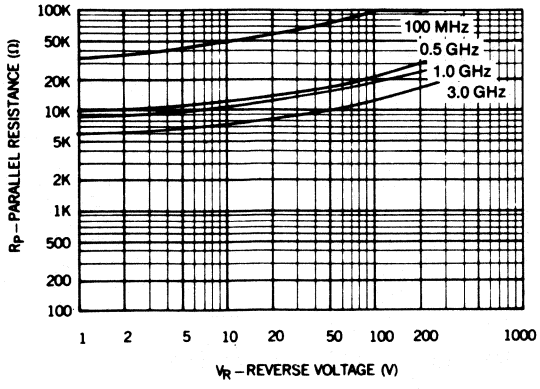
PRINTED IN U.S.A.

PARALLEL RESISTANCE VS REVERSE VOLTAGE

UM4300

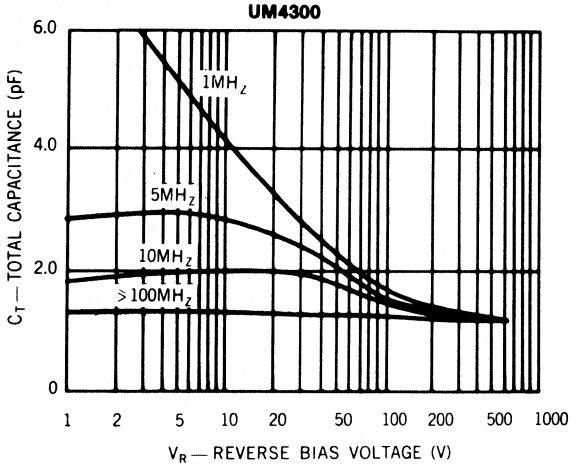


UM7300

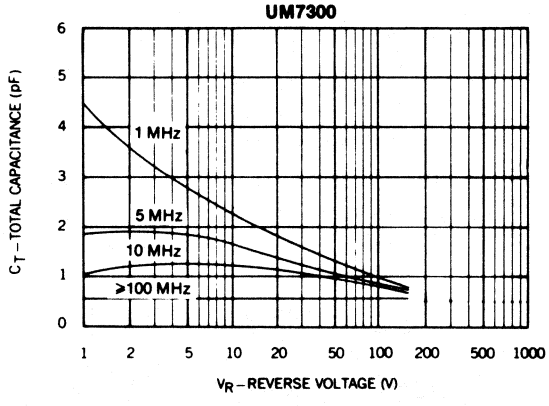


TOTAL CAPACITANCE VS REVERSE VOLTAGE

UM4300

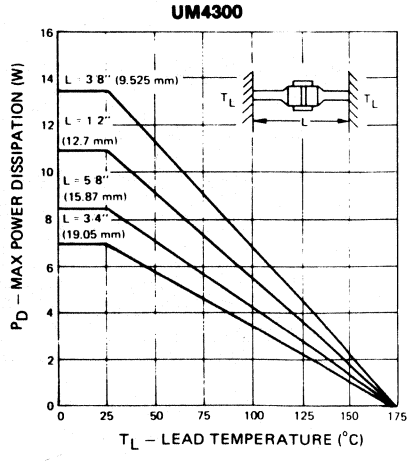


UM7300

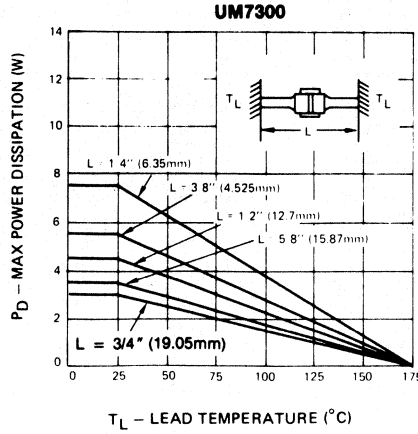


POWER RATING AXIAL LEADED DIODE

UM4300



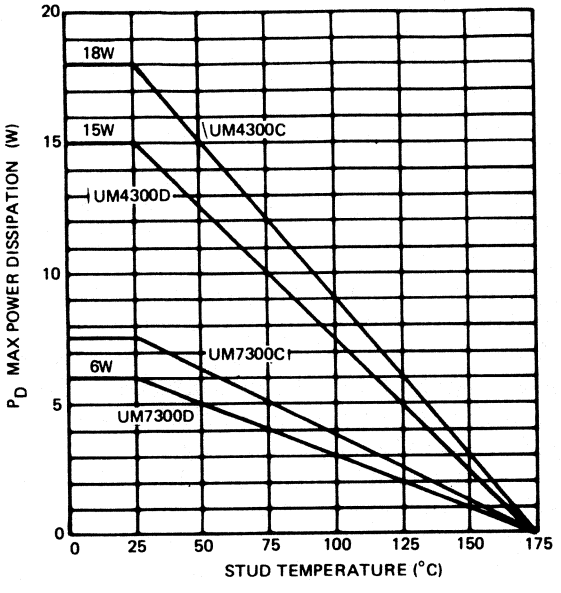
UM7300



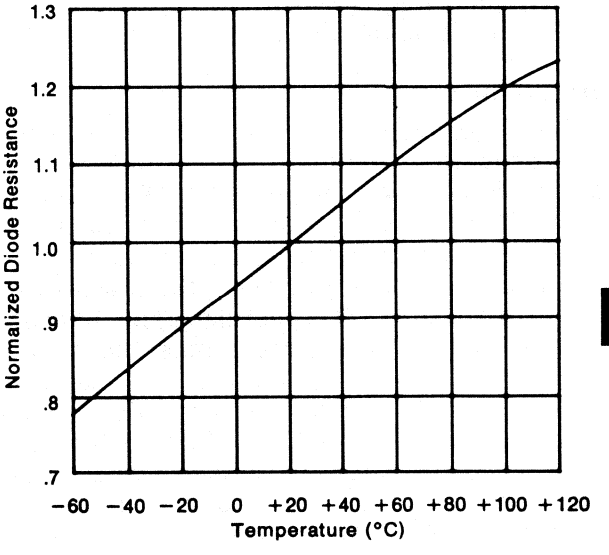
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

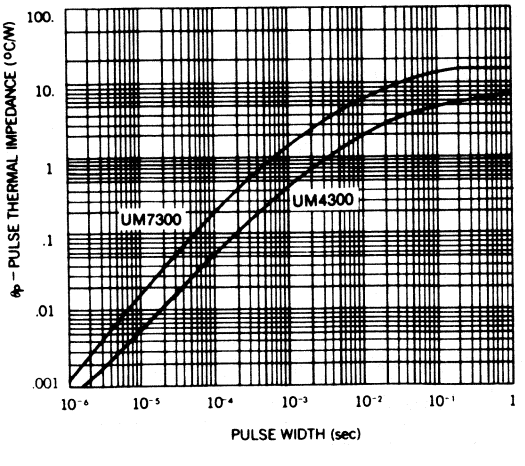
UM4300/UM7300
POWER RATING
STUD MOUNTED DIODES



NORMALIZED R_S VS TEMPERATURE



PULSE THERMAL IMPEDANCE VS PULSE WIDTH



ORDERING INSTRUCTIONS

Part numbers of Unitrode PIN Diodes consist of the letters UM followed by four digits and one or two letters. The first two digits indicate the diode series, the next two digits specify the minimum breakdown voltage in hundreds of volts. The remaining letters denote the package style. Reverse polarity (anode on stud end) is available in C or D Styles and denoted by adding second letter R.

For Example: UM 73 01 C

Series 7300 | 100 volts | Style C

Reverse polarity available in C style. Part number designated by adding R.

9

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PIN DIODE

UM6000 SERIES
UM6200 SERIES
UM6600 SERIES

Features

- Capacitance specified as low as 0.4 pF (UM6600)
- Resistance specified as low as 0.4Ω (UM6200)
- Voltage ratings to 1000V
- Power dissipation to 6W

Description

These series of PIN diodes are designed for applications requiring small package size and moderate average power handling capability. The low capacitance of the UM6000 and UM6600 allows them to be used as series switching elements to 1 GHz. The low resistance of the UM6200 is useful in applications where forward bias current must be minimized.

Because of its thick I-region width and long lifetime the UM6000 and UM6600 have been used in distortion sensitive and high peak power applications, including receiver protectors, TACAN, and IFF equipment. Their low capacitance allows them to be useful as attenuator diodes at frequencies greater than 1 GHz. The UM6200 has been used successfully in switches in which low insertion loss at low bias current is required.

The "A" style package for this series is the smallest Unitrode PIN diode package. It has been used successfully in many microwave applications using coaxial, microstrip, and stripline techniques at frequencies beyond X-Band. The "B" and "E" style, leaded packages offer the highest available power dissipation for a package this small. They have been used extensively as series switch elements in microstrip circuits. The "C" style package duplicates the physical outline available in conventional ceramic-metal packages but incorporates the many reliability advantages of the Unitrode construction.

MAXIMUM RATINGS

Average Power Dissipation and Thermal Resistance Ratings

Package	Condition	UM6000 UM6200		UM6600	
		P_D	θ	P_D	θ
A&C	25 °C Pin Temperature	6W	25 °C/W	4W	37.5 °C/W
B&E (Axial Leads)	½ in. Total Lead Length to (12.7 mm) to 25 °C Contact	2.5W	60 °C/W	2.0W	75 °C/W
B&E (Axial Leads)	Free Air	0.5W	—	0.5W	—

Peak Power Dissipation Rating

All Packages	1 μs Pulse (Single) at 25 °C Ambient	UM6000 - 25 KW UM6200 - 10 KW	UM6600 - 13 KW

Operating and Storage Temperature Range: −65 °C to +175 °C

Voltage Ratings (25 °C)

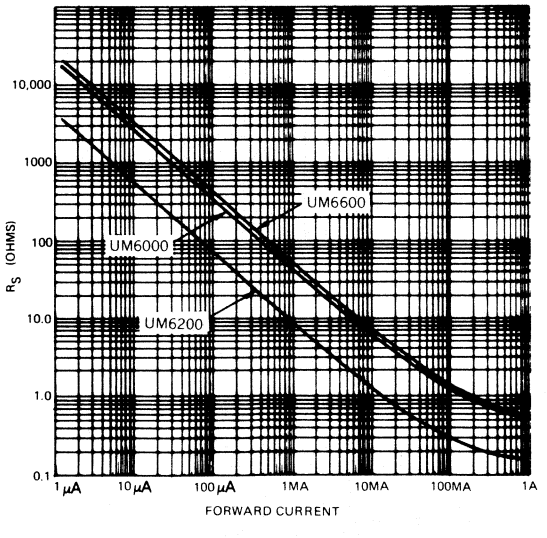
Reverse Voltage (V_R) — Volts (I_R = 10 μA)	Types		
100V	UM6001	UM6201	UM6601
200V	UM6002	UM6202	UM6602
400V	—	UM6204	—
600V	UM6006	—	UM6606
1000V	UM6010	—	UM6610

Electrical Specifications (25 °C)

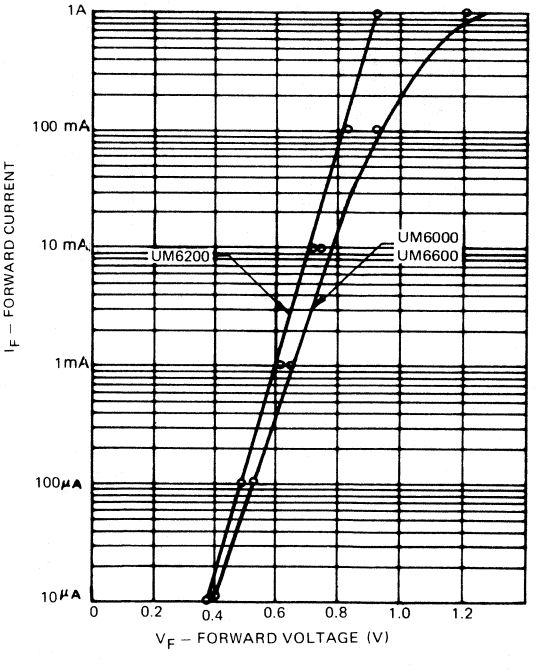
Test	Symbol	UM6600	UM6000	UM6200	Conditions
Total Capacitance (Max)	C_T	0.4 pF	0.5 pF	1.1 pF	0V, 1 GHz
Series Resistance (Max)	R_S	2.5Ω	1.7Ω	0.4Ω	100 mA, 1 GHz
Parallel Resistance (Min)	R_P	10 KΩ	15 KΩ	10 KΩ	100V, 1 GHz
Carrier Lifetime (Min)	τ	1.0 μs	1.0 μs	0.6 μs	I_F = 10 mA
Reverse Current (Max)	I_R	10 μA	10 μA	10 μA	V_R = Rating
I-Region Width (Min)	W	150 μm	150 μm	40 μm	—

9

TYPICAL SERIES RESISTANCE VS FORWARD CURRENT (F = 100MHz)



DC CHARACTERISTICS FORWARD VOLTAGE VS CURRENT

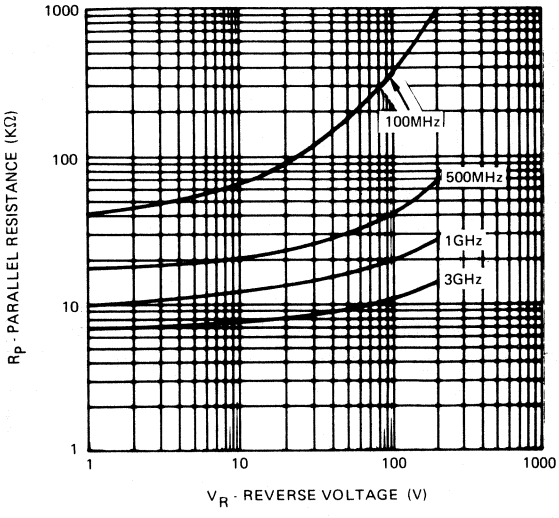


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

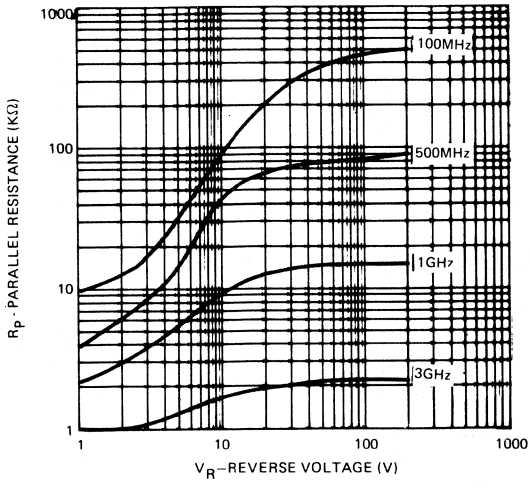
PRINTED IN U S A

TYPICAL R_p VS VOLTAGE & FREQUENCY

UM6000/UM6600

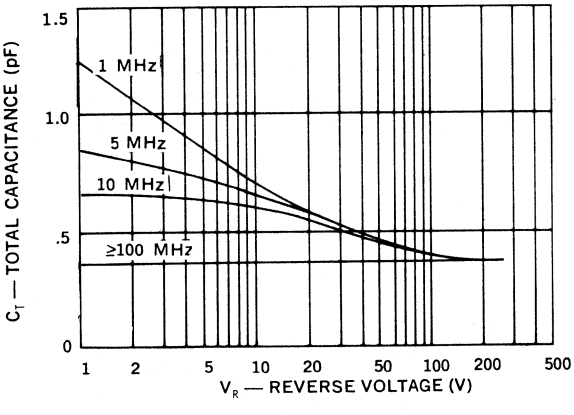


UM6200

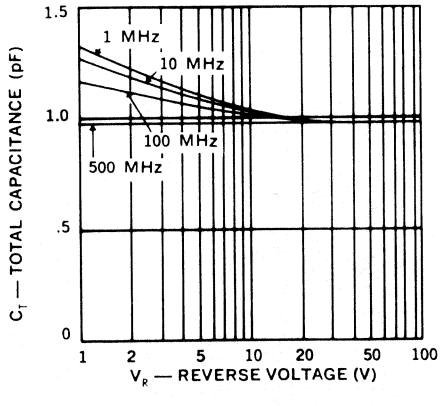


TYPICAL CAPACITANCE VS VOLTAGE AND FREQUENCY

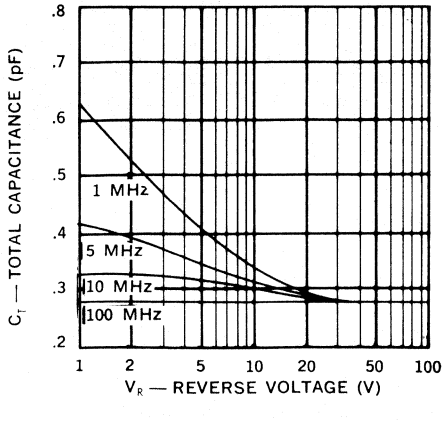
UM6000 SERIES



UM6200 SERIES



UM6600 SERIES



ORDERING INSTRUCTIONS

Part numbers of Unitrode PIN diodes consist of the letters UM followed by four digits and one or two letters. The first two digits indicate the diode series, the next two digits specify the minimum breakdown voltage in hundreds of volts. The remaining letters denote the package style. Reverse polarity (anode large end cap) is available for the C style and denoted by adding second letter R.

For Example: UM | 60 | 06 | CR

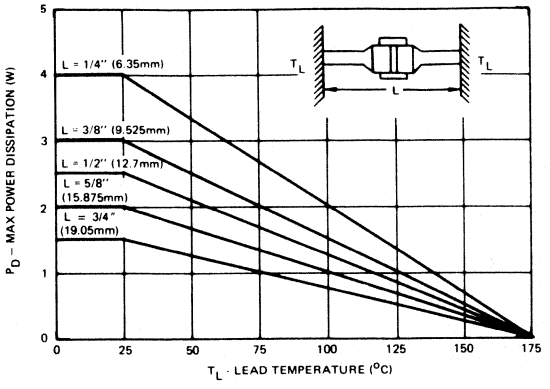
- 60 — Series 6000
- 06 — 600 Volts
- CR — Style C | Reverse Polarity

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

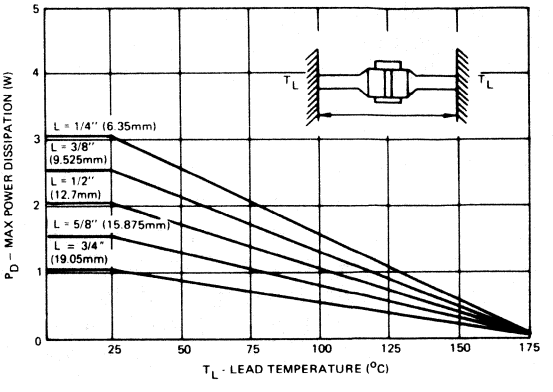
PRINTED IN U.S.A.

POWER RATING — AXIAL LEADED DIODE

UM6000/UM6200

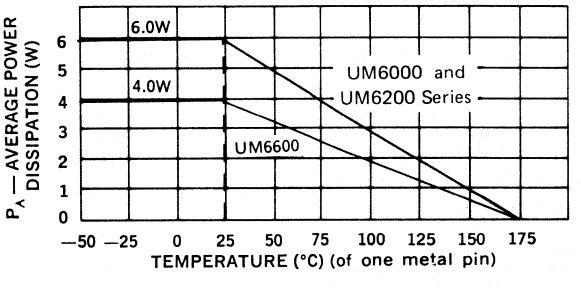


UM6600

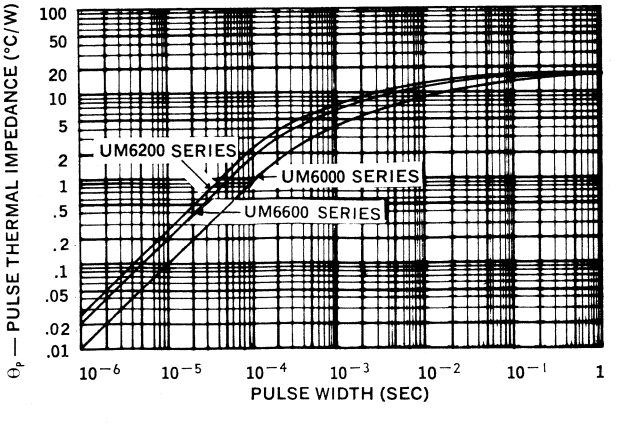


9

POWER RATING



PULSE THERMAL IMPEDANCE VS PULSE WIDTH



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PIN DIODE

UM7000 SERIES
UM7100 SERIES
UM7200 SERIES

Features

- Voltage ratings to 1000V (UM7000)
- Wide variety of package styles
- Rated average power dissipation to 10W
- Cost effective in volume applications

Description

The UM7000 and UM7100 series offer moderately high power handling in combination with reasonably low levels of both series resistance and capacitance. The UM7200 series offers the lowest series resistance, but the highest capacitance of the group. The differences in specified performance, for each of the series, results from different I-region thicknesses. The three series have broad applicability in many RF and microwave switch and attenuator circuits. Additionally, the UM7100 in leaded versions, is usually the most cost-effective diode choice in high volume usage.

MAXIMUM RATINGS

Average Power Dissipation and Thermal Resistance Ratings

Package	Condition	P_D	θ
A	25 °C Pin Temperature	10W	15 °C/W
B&E (Axial Leads)	½ in.(12.7mm) Lead Length to 25 °C Contact	5.5W	27.5 °C/W
B&E (Axial Leads)	Free Air	1.5W	—
C (Studded)	25 °C Stud Temperature	10W	15 °C/W
D (Insulated Stud)	25 °C Stud Temperature	7.5W	20 °C/W

Peak Power Dissipation Rating

All Packages	1 μs Pulse (Single) at 25 °C Ambient	UM7000 - 60 KW UM7100 - 35 KW UM7200 - 20 KW

Operating and Storage Temperature Range: −65 °C to +175 °C

UNITRODE

Voltage Ratings (25 °C)

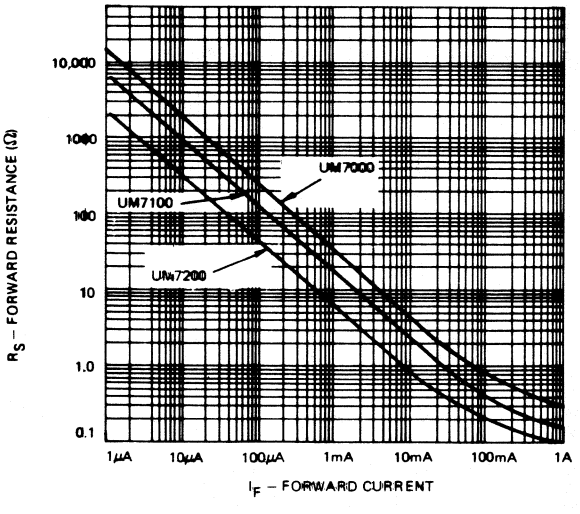
Reverse Voltage (V_R) — Volts (I_R = 10 μA)	Types		
100V	UM7001	UM7101	UM7201
200V	UM7002	UM7102	UM7202
400V	—	UM7104	UM7204
600V	UM7006	—	—
800V	—	UM7108	—
1000V	UM7010	—	—

Electrical Specifications (25 °C)

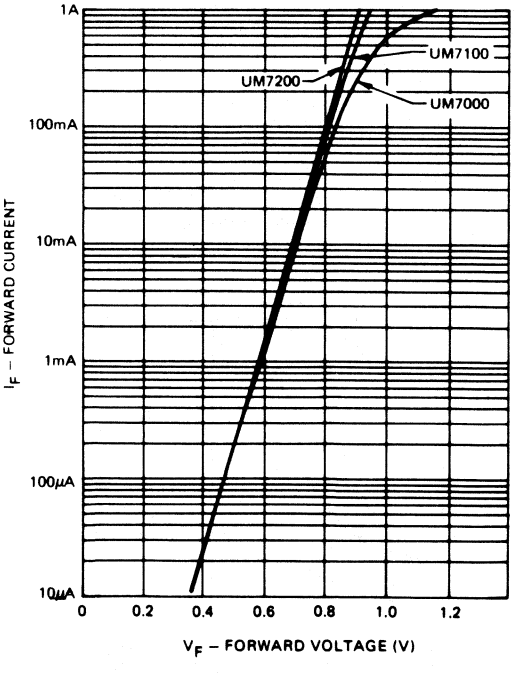
Test	Symbol	UM7000	UM7100	UM7200	Conditions
Total Capacitance (Max)	C_T	0.9 pF	1.2 pF	2.2 pF	0V, 1 GHz
Series Resistance (Max)	R_S	1.0Ω	0.6Ω	0.25Ω	100 mA, 1 GHz
Parallel Resistance (Min)	R_P	10 KΩ	8 KΩ	7 KΩ	100V, 1 GHz
Carrier Lifetime (Min)	τ	2.5 μs	2.0 μs	1.5 μs	I_F = 10 mA
Reverse Current (Max)	I_R	10 μA	10 μA	10 μA	V_R = Rating
I-Region Width (Min)	W	150 μm	80 μm	40 μm	—

9

TYPICAL FORWARD RESISTANCE VS FORWARD CURRENT (F = 100 MHz)



TYPICAL DC CHARACTERISTIC FORWARD VOLTAGE VS FORWARD CURRENT UM7000/UM7100/UM7200

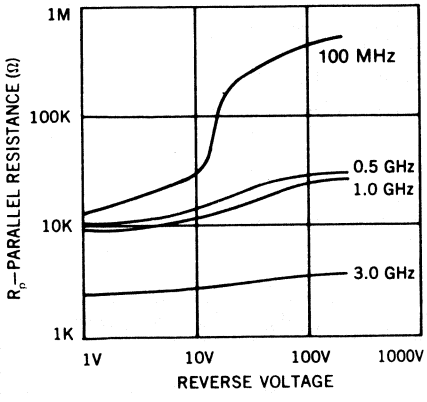


UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

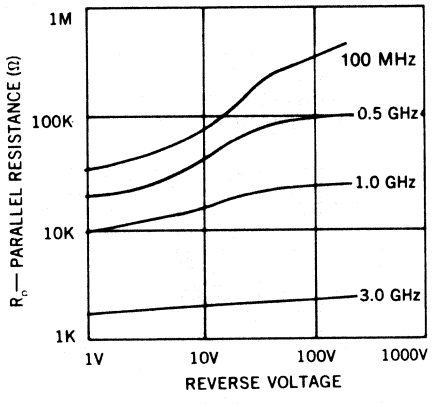
PRINTED IN U.S.A.

TYPICAL R_P CHARACTERISTIC

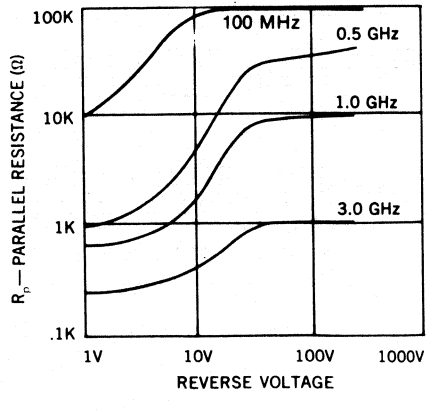
UM 7000 SERIES



UM7100 SERIES

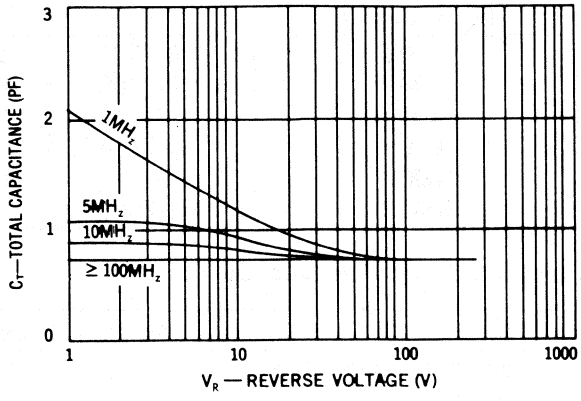


UM 7200 SERIES

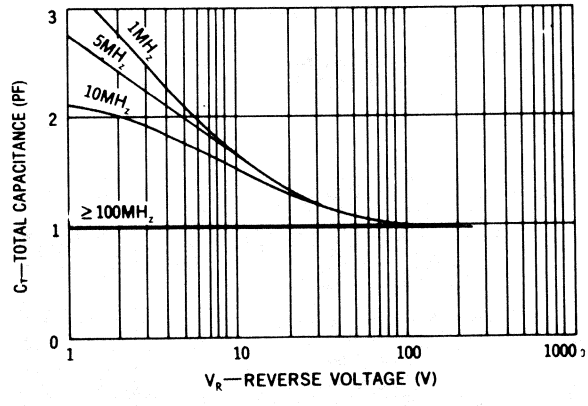


TYPICAL C_T CHARACTERISTIC

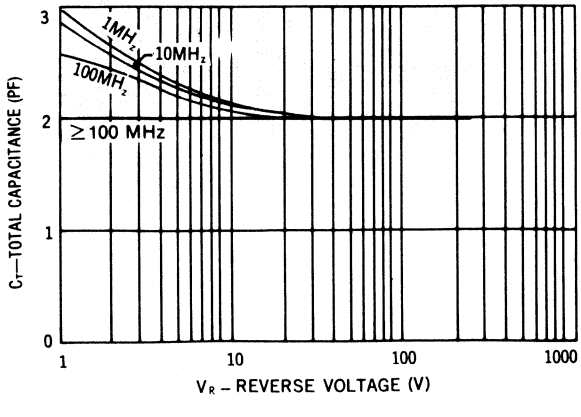
UM 7000 SERIES



UM 7100 SERIES



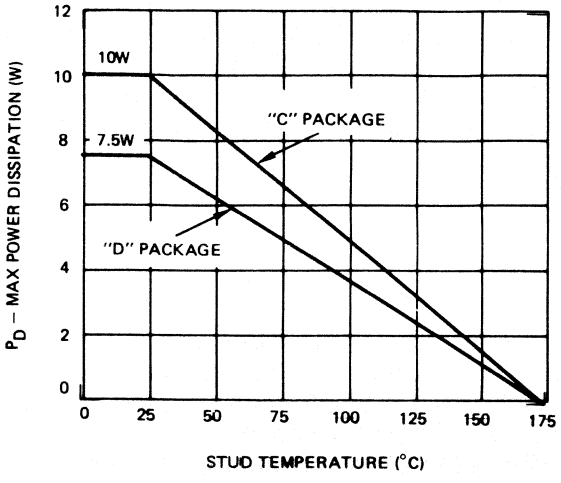
UM 7200 SERIES



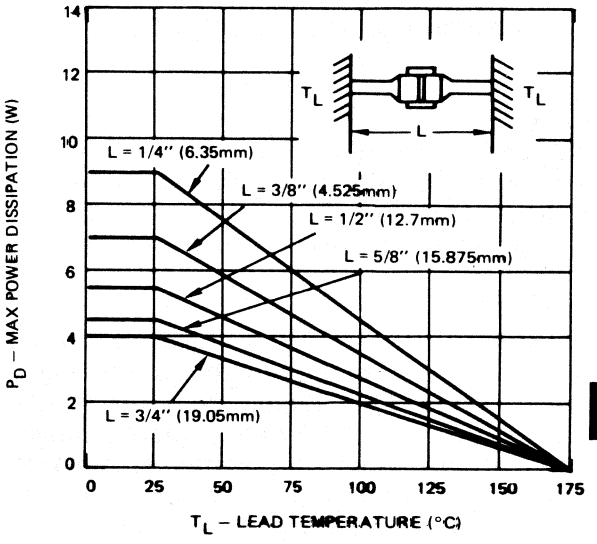
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER RATING STUD MOUNTED DIODES

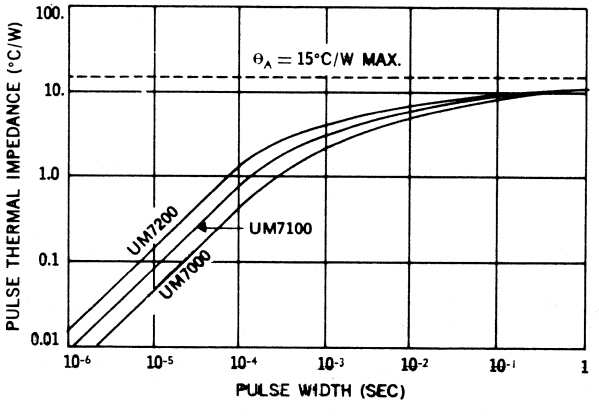


POWER RATING — AXIAL LEADED DIODES



9

PULSE THERMAL IMPEDANCE VS PULSE WIDTH



ORDERING INSTRUCTIONS

Part numbers of Unitrode PIN Diodes consist of the letters UM followed by four digits and one or two letters. The first two digits indicate the diode series, the next two digits specify the minimum breakdown voltage in hundreds of volts. The remaining letters denote the package style. Reverse polarity (anode on stud end) is available in C or D Styles and denoted by adding second letter R.

For Example: UM 7001 C

Series 7000 | 100 volts | Style C

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PIN DIODE

COMMERCIAL ATTENUATOR DIODE

Features

- Specified low distortion
- Low rectification properties at low reverse bias
- Resistance specified at 3 current points
- High reliability fused-in-glass construction

Description

The UM9301 PIN Diode utilizes a special overall chip geometry with an extremely thick intrinsic "I" region, to offer unique capabilities in both RF switch and attenuator applications. Volume production also makes the diode an economical choice suitable for many commercial low power equipments.

The UM9301 has been designed for use in bridged TEE attenuator circuits commonly utilized for gain and slope control in CATV amplifiers. Low distortion and high dynamic range are characteristic of the diodes' outstanding performance.

The UM9301 is also appropriate for switch applications, when little or no bias voltage is available. Frequent applications occur in portable 12 volt-powered communications equipments, operating at frequencies as low as 2 MHz.

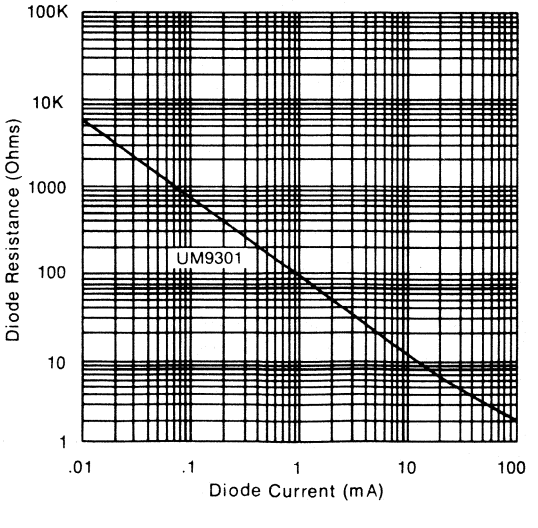
MAXIMUM RATINGS

Reverse Voltage (V_R) — Volts (I_R = 10 μA)	75V
Average Power Dissipation @ (P_A) Leads ½ in. overall to 25 °C Contact	1.0W (Derate linearly to 175 °C)
Operating and Storage Temperature Range	−65 °C to +175 °C

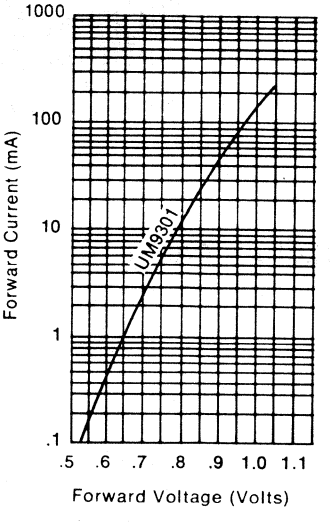
Electrical Specifications (25 °C)

Test	Min	Typ	Max	Units	Conditions
Diode Resistance R_S		1.7	3.0	Ω	I = 100 mA, f = 100 MHz
		80	150	Ω	I = 1 mA, f = 100 MHz
	3000	5000		Ω	I = 0.01 mA, f = 100 MHz
Current for R_S = 75Ω	0.5	1.1	2.0	mA	f = 100 MHz
Capacitance			0.8	pF	V = 0V, f = 100 MHz
Return Loss	25			dB	Frequency Range: 10 - 300MHz R_S = 75Ω @ 100 MHz Diode Terminates 75Ω line
Second Order Distortion		55	50	−dB	f_1 = 10 MHz, f_2 = 13 MHz P = 50 dBmV, See Test Circuit
		70		−dB	F_1 = 67 MHz, F_2 = 77 MHz P = 50 dBmV, See Test Circuit
Third Order Distortion		75	65	−dB	F_1 = 10 MHz, F_2 = 13 MHz P = 50 dBmV, See Test Circuit
		95		−dB	Triple Beat; 205 + 67 − 77 MHz P = 50 dBmV, See Test Circuit
Cross Modulation Distortion		75		−dB	12 Channel Test P = 50 dBmV, See Test Circuit Dix Hills Test Set
Reverse Current			10	μA	V = 75V
Carrier Lifetime	4.0			μs	I = 10 mA

DIODE RESISTANCE VS DIODE CURRENT (TYPICAL)



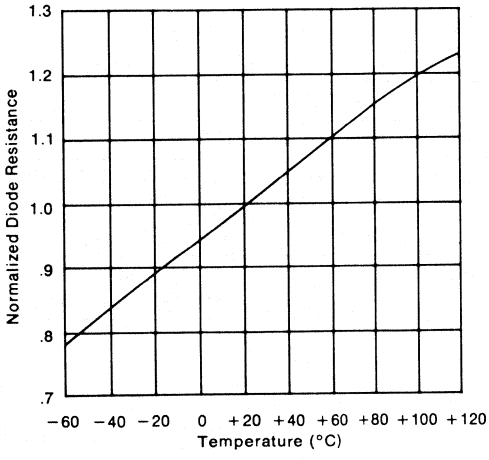
FORWARD CURRENT VS FORWARD VOLTAGE (TYPICAL)



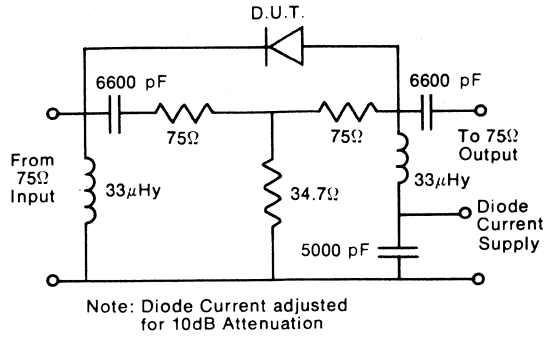
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

NORMALIZED R_S VS TEMPERATURE



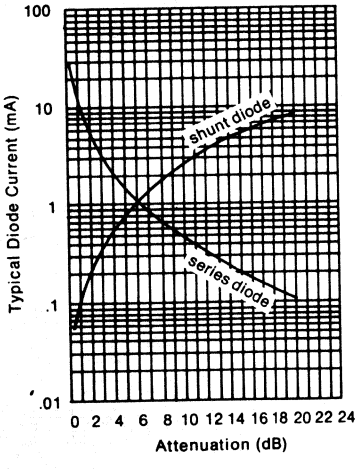
TEST CIRCUIT FOR DISTORTION MEASUREMENTS



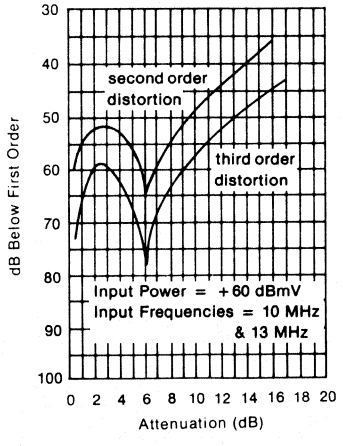
Note: Diode Current adjusted for 10dB Attenuation

TYPICAL BRIDGED TEE ATTENUATOR PERFORMANCE

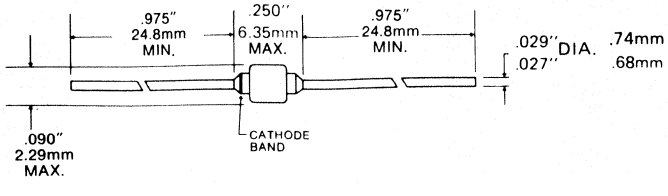
DIODE CURRENT VS ATTENUATION UM9301



DISTORTION ATTENUATION



MECHANICAL SPECIFICATIONS



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PIN DIODE

UM9401 SERIES
UM9402 SERIES
UM9415 SERIES

COMMERCIAL TWO-WAY RADIO ANTENNA SWITCH DIODES

Features

- Specified low distortion
- Unitrode ruggedness and reliability
- Low bias current requirements
- Priced for high quantity applications

Description:

Unitrode offers a series of PIN diodes specifically designed and characterized for solid state antenna switches in commercial two-way radios. Antenna switches using the UM9401 and UM9415 series PIN diodes provide high isolation, low loss and low distortion characteristics formerly possible only with electromechanical relay type switches.

The UM9401 and UM9402 diodes can handle above 100W of transmitter power, while the UM9415 will handle over 1000W. The extensive characterization of these PIN diodes in antenna switch applications has resulted in guaranteed low distortion specifications under transmit and receive conditions. These diodes also feature low forward bias resistance and high zero bias impedance which are required for low loss, high isolation and wide bandwidth antenna switch performance.

9

MAXIMUM RATINGS

	UM9401	UM9402	UM9415
Reverse Voltage (V_R) — Volts (I_R = 10 μA)	50V	50V	50V

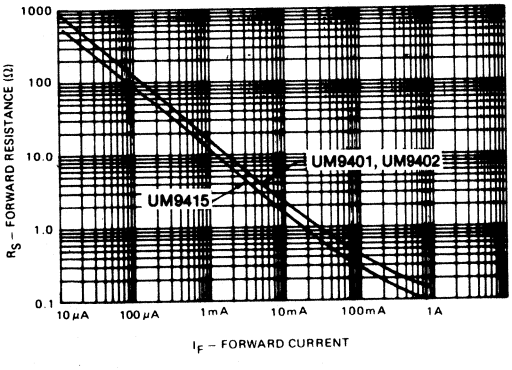
Average Power Dissipation (P_A)			
Leads - ½in. Overall to 25°C Heat Sink	5.5W	—	10W
25°C (Package Flange) Temperature	—	10W	—
Free Air	1.5W		2.5W

Operating and Storage Temperature Range	−65°C to +175°C

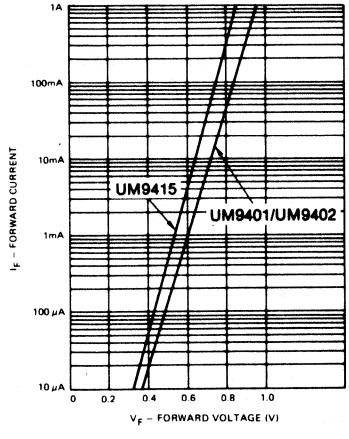
Electrical Specifications (at 25 °C)

Test	Symbol	UM9401/UM9402 Min	UM9401/UM9402 Typ	UM9401/UM9402 Max	UM9415 Min	UM9415 Typ	UM9415 Max	Units	Conditions
Series Resistance	R_S		0.75	1.0		0.75	1.0	Ω	f = 100MHz typical I = 50 mA
Diode Capacitance	C_T		1.1	1.5			4	pF	f = 100 MHz V = 0V
Parallel Resistance	R_P	5K	10K		1K	2K		Ω	f = 100 MHz V = 0V
Carrier Lifetime	τ	1.0	2.0		5			μS	I = 10 mA
Transmit Harmonic Distortion	$\frac{R_{2A}}{A}, \frac{R_{3A}}{A}$			80			80	– dB	P_{IN} = 50W f = 50 MHz, I = 50 mA
Receive Third Order Distortion	$\frac{R_{2AB}}{A}$			60			60	– dB	P_{IN} = 10 mW, 0V Bias f_A = 50 MHz, f_B = 51 MHz
Reverse Leakage Current	I_R			10			10	μA	V = 50V
Forward Voltage	V_F			1.0			1.0	V	I_F = 50 mA

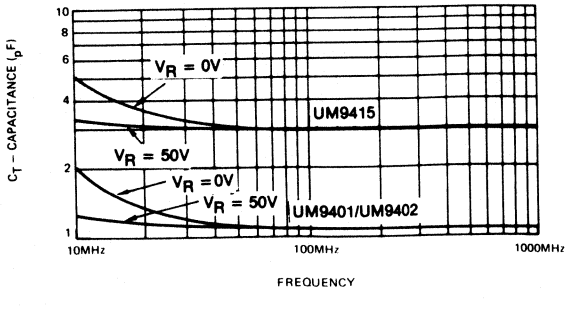
TYPICAL FORWARD RESISTANCE VS FORWARD CURRENT (F = 100 MHz)



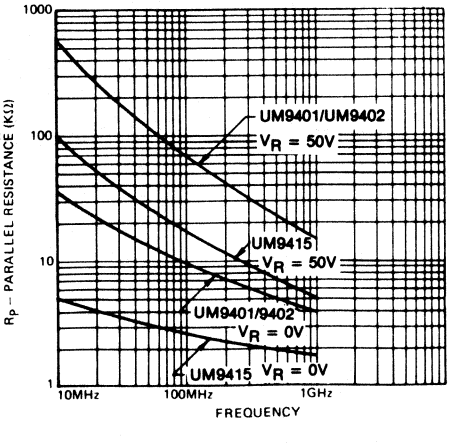
TYPICAL DC CHARACTERISTIC



TYPICAL CAPACITANCE CHARACTERISTIC



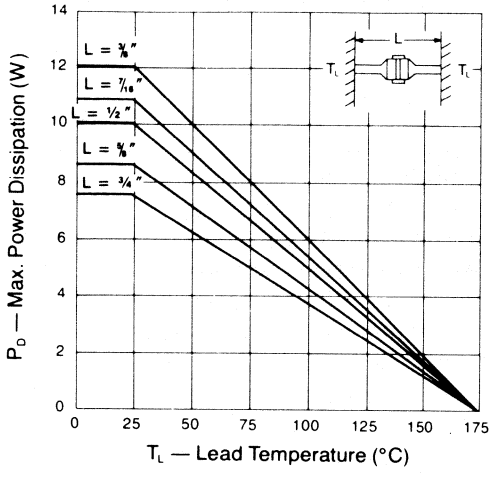
TYPICAL R_p CHARACTERISTICS



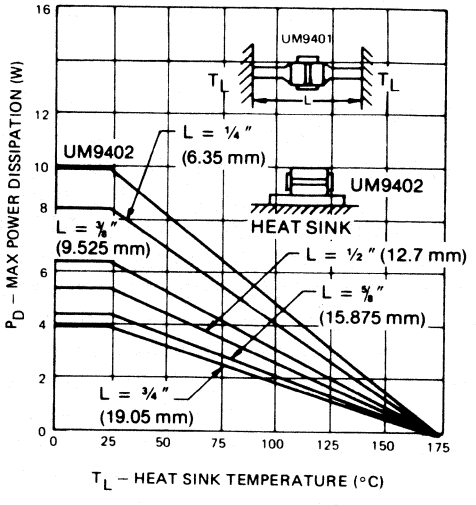
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

POWER RATING
UM9415



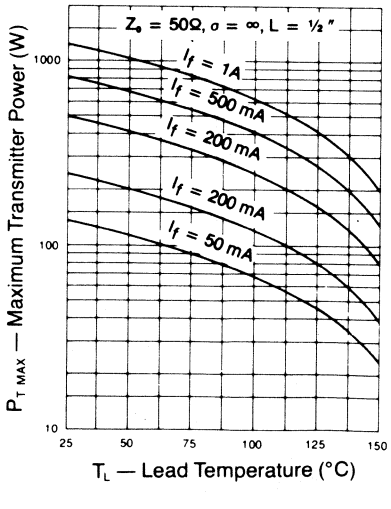
POWER RATING
UM9401/9402



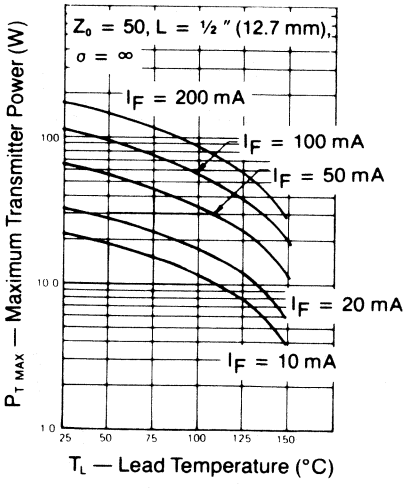
9

MAXIMUM TRANSMITTER POWER

UM9415



UM9401/UM9402



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Maximum Transmitter Power

The maximum CW transmitter power, $P_{T(max)}$, a PIN diode antenna switch can handle depends on the diode resistance, R_S, power dissipation, P_D, antenna SWR, σ, and nominal impedance, Z_0. The expression relating these parameters is as follows:

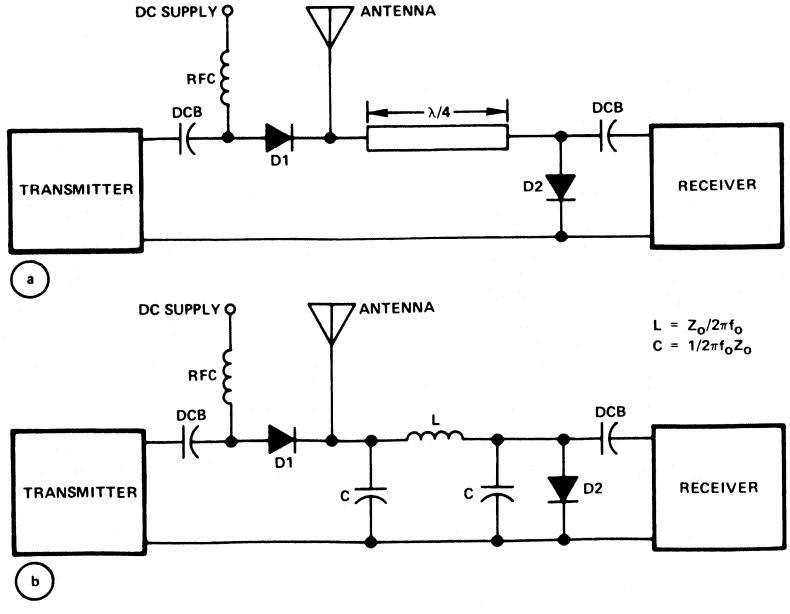
$$P_{T(max)} = \frac{P_D \times Z_0}{R_D} \left(\frac{\sigma + 1}{2\sigma}\right)^2 \text{ [Watts]}$$

Characteristic curves are shown in the data section which give both the maximum and typical diode resistance, R_S as a function of forward current. The maximum power dissipation rating of the PIN diode depends both on the length of the diode leads and the temperature of the contacts to which the leads are connected. A graph defining the maximum power dissipation at various combinations of overall lead length (L) and lead temperature (T_L) is given in the data section. From these curves and the above equation, the power handling capability of the PIN diode may be computed for a specific application.

Curves are also presented which show the maximum transmitter power that an antenna switch using UM9401s and UM9415s can safely handle for various forward currents and lead temperatures. These curves are based on a typical design condition of a ½ in. total overall lead length, 50Ω line impedance and a totally mismatched antenna ($\sigma = \infty$). For the case of a perfectly matched antenna, the maximum transmitter power can be increased by a factor of 4.

Design Information

A circuit configuration for a two-way radio antenna switch using PIN diodes consists of a diode placed in series with the transmitter and a shunt diode placed a quarter wavelength from the antenna in the direction of the receiver as shown. For low frequency operation, the quarter wave line may be simulated by lumped elements. Typical performance of antenna switches using PIN diodes forward biased at 100 mA is less than 0.2 dB insertion loss and 30 dB isolation during transmit; at zero bias the receive insertion loss is less than 0.3 dB. This performance is achievable across a ±20% bandwidth at center frequencies ranging from 10 to 500 MHz.



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PIN RADIATION DETECTORS

UM9441

Features

- High Photocurrent Sensitivity
- High Reliability Construction
- Fast Rise Time
- Wide Dynamic Range
- Hardness to Neutron Bombardment
- Low Operating Voltage

Description

Silicon PIN devices are effective detectors of nuclear and electromagnetic radiation. This includes gamma radiation, electrons, and X-rays. The detectors can be used across the temperature range of −55 °C to +175 °C instead of being restricted to use at low temperatures.

The absorbed radiation produces electron-hole pairs in the space charge region. These charges are swept out by the applied field and result in a current flow proportional to the rate of absorbed radiation.

The Unitrode UM9441 series utilizes high resistivity material and is designed to have a uniform area mesa structure to define the active volume. The current sensitivity of these devices is proportional only to the I-region volume and is independent of temperature so long as applied voltage exceeds the saturation voltage. This structure also minimizes the effects of permanent damage caused by neutrons and other high energy radiation. Experiments on devices of the UM9441 design show no degradation in gamma sensitivity resulting from a total dose of 10^{14} neutrons/cm² of 1 MeV equivalent.

Package

The UM9441 is an axially leaded device constructed by metallurgically bonding the PIN chip in between two molybdenum refractory pins that are typically 0.125 inches in diameter and 0.050 inches long. Hyper-pure glass is then fused over this bond to form a voidless seal. Leads are then brazed to ends of molybdenum pins. This results in a high-reliability package using materials so well thermally matched that the UM9441 can withstand temperature shock or cycling from −196 °C to +300 °C.

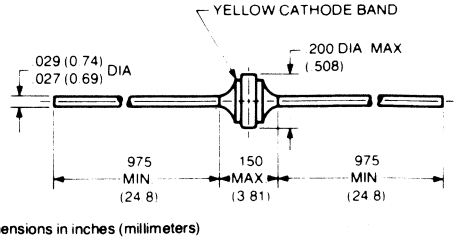
9

ABSOLUTE MAXIMUM RATINGS

Reverse Voltage 100V
Photocurrent 1A
Storage Temperature . . . −55 °C to +200 °C
Operating Temperature . −55 °C to +175 °C

MECHANICAL SPECIFICATIONS

UM9441



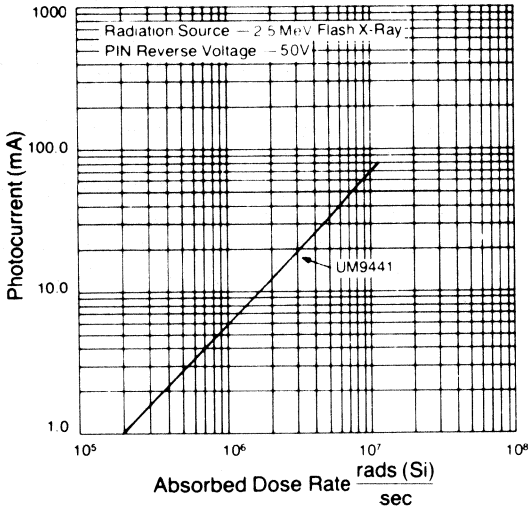
Dimensions in inches (millimeters)

UNITRODE

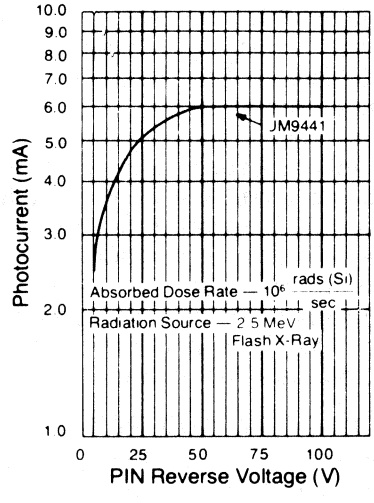
Electrical Specifications (at 25°C)

Test	Min	Typ	Max.	Units	Test Conditions
Photocurrent	4.0	6.0		mA	$V_R = 50V$, $10^6 \frac{\text{rads (Si)}}{\text{sec}}$, 2.5 MeV Flash X-Ray, Ion Physics Corp. FX-25
Photocurrent Rise Time (10%-90%)		10		ns	
Capacitance		10	15	pF	F = 1 MHz, V = 50V
Reverse Current			1.0	μA	V_R = 50V
Minority Carrier Lifetime	2.0			μS	I_f = 10mA

TYPICAL PHOTOCURRENT SENSITIVITY



TYPICAL VOLTAGE SENSITIVITY



RELIABILITY

The UM9441 is consistent with Unitrode's reputation as a manufacturer of high reliability semiconductors. Unitrode is equipped to perform JAN type testing, base-lining and documental conformance to a wide range of reliability testing. This commitment to reliability has enabled Unitrode to be a qualified supplier of semiconductor devices to many high-reliability programs such as:

APOLLO	MINUTEMAN
DRAGON	SPRINT
HAWK	TRIDENT
MARINER	VIKING

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PIN DIODE

For Microstrip 900MHz Antenna Switches and Microwave Applications

Features

- Low Inductance Shunt Mount Package
- Characterized for Microstrip
- Unitrode Ruggedness and Reliability
- High Power Handling Capability
- Low Bias Current Requirement
- Excellent Distortion Properties
- Cost Effective in High Quantity Applications

Description

The UM9601-UM9608 series of PIN diodes was developed for shunt mount applications in microstrip circuits. Good switch performance is demonstrated at frequencies from UHF to 4GHz and higher. This performance is achieved using discrete low inductance Unitrode PIN diodes assembled with special hardware to permit good electrical and mechanical compatibility with microstrip transmission lines.

Design information is presented for preparation of microstrip circuit boards to accommodate these PIN diodes. A detailed design for a 900MHz quarter-wave antenna switch is given. This switch which employs a low cost UM9401 axial leaded PIN diode in conjunction with a UM9601, performs with 30dB receiver isolation over a 100MHz bandwidth and with transmitter insertion loss of less than 0.4dB. This switch can safely handle transmitter power levels up to 100 watts at infinite antenna SWR.

The Unitrode UM9601 series PIN diodes are constructed using a fused-in-glass process which results in a highly reliable, hermetic package. The process utilizes symmetrical, full faced metallurgical bonds to both surfaces of the silicon chip. This construction greatly minimizes the normal parasitic inductance and capacitance found in conventional glass or ceramic packaged diodes which employ straps, springs or whiskers.

The use of discrete UM9601-UM9608 diodes greatly minimizes handling problems commonly associated with passivated PIN diode chips while maintaining good microwave performance. In addition the power handling capibility of the UM9601-UM9608 series is considerably higher than PIN diode chips can provide.

Environmentally, the UM9601-UM9608 series PIN diodes can withstand thermal cycling from −195°C to +300°C and exceed all military environmental specification for shock, vibration, acceleration, and moisture resistance.

9

Typical Microwave Performance

	UM9601-UM9604			UM9605-UM9608		
Frequency	SPST Insertion Loss 0 Bias	SPST Isolation 100mA	SPNT* Isolation 100mA	SPST Insertion Loss 0 Bias	SPST Isolation 100mA	SPNT* Isolation 100mA
GHz	dB	dB	dB	dB	dB	dB
0.5	0.20	30	36	0.20	25	31
1.0	0.25	26	32	0.20	22	28
1.5	0.35	22	28	0.20	20	26
2.0	0.50	18	24	0.25	17	22
3.0	1.00	15	21	0.25	15	21
4.0	1.50	13	19	0.40	14	20

* Performance based on SPST Measurements In 0.025" (.635mm) Microstrip Test Circuit.

Note: All dimensions in inches and (millimeters).

UNITRODE

Maximum Ratings

	UM9601 - UM9604		UM9605 - UM9608	
	P_D	θ	P_D	θ
Flange at 25°C	7.5W	20°C/W	4W	37.5°C/W
Free Air	1.5W	—	0.5W	—

Peak Power 1μS Single Pulse at 25°C Ambient	25KW	10KW

Operating and Storage Temperature	−65°C to +175°C

Reverse Voltage Ratings @ 10μA

100V	400V
UM9601	UM9602
UM9603	UM9604
UM9605	UM9606
UM9607	UM9608

Electrical Specifications (at 25°C)

Test	Symbol	UM9601-UM9604			UM9605-UM9608			Units	Condition
		Min	Typ	Max	Min	Typ	Max		
Series Resistance	R_S	—	0.4	0.6	—	1.5	1.7	Ω	I = 100mA F = 1GHz
Parallel Resistance	R_P	5K	—	—	7K	—	—	Ω	Zero Bias F =1GHz
Total Capacitance	C_T	—	—	1.2	—	—	0.5	pF	Zero Bias F =1GHz
Carrier Lifetime	τ	2.0	—	—	1.0	—	—	μS	I_F = 10mA
Forward Voltage	V_F	—	0.85	—	—	0.95	—	V	I_F = 100mA
I-Region Width	W	80	—	—	150	—	—	μm	

Selection Guide

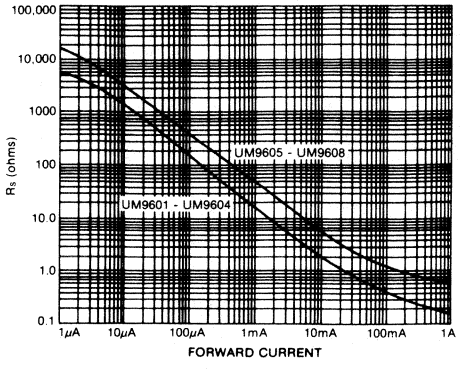
The following chart serves as a general guide for indicating the most likely diode from the series for a given application.

Applications	Recommended Types
1. High isolation switches to 2GHz at low dc drive 2. Quarter-wave antenna switches to 100 watts. 3. Priced for high volume commercial applications.	UM9601 (Affixes to microstrip ground plane.) UM9603 (Affixes to microstrip backing plate.)
High voltage rating version of UM9601 and UM9603 respectively for peak power handling to 3KW.	UM9602, UM9604
1. Low insertion loss switches to 4GHz. 2. Low distortion antenuator applications.	UM9605 (Affixes to microstrip ground plane.) UM9607 (Affixes to microstrip backing plate.)
High voltage version of UM9605 and UM9607 for peak power handling to 10KW.	UM9606, UM9608

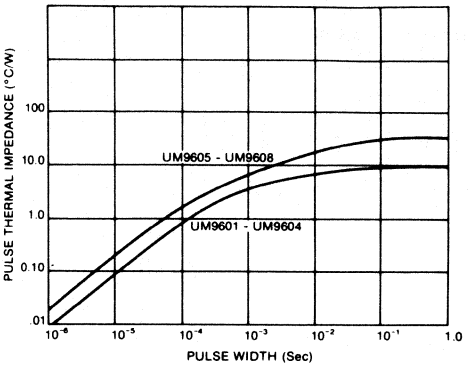
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Typical Series Resistance vs Forward Current (F = 100MHz)

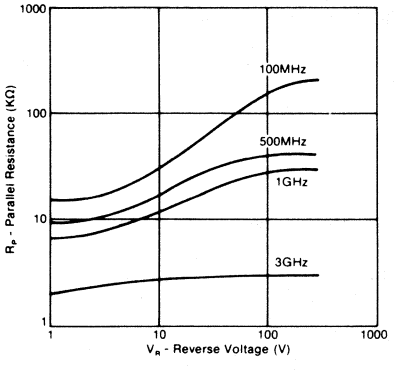


Pulse Thermal Impedance

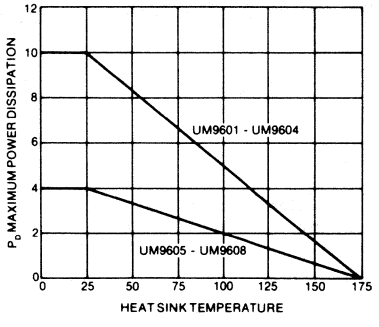


9

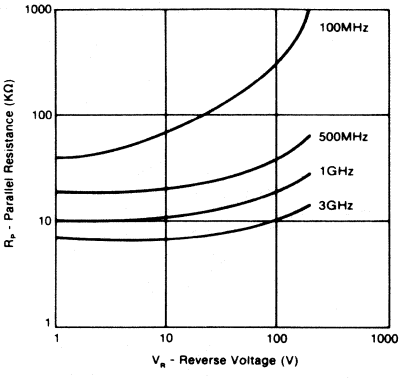
Typical R_P vs Voltage and Frequency UM9601 - UM9604



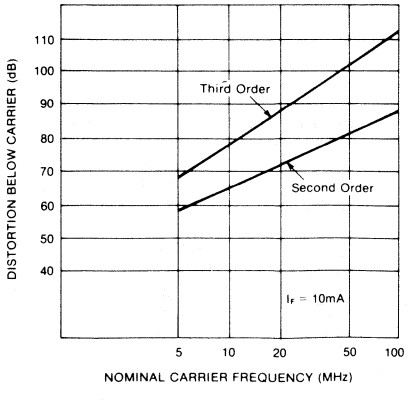
Power Rating



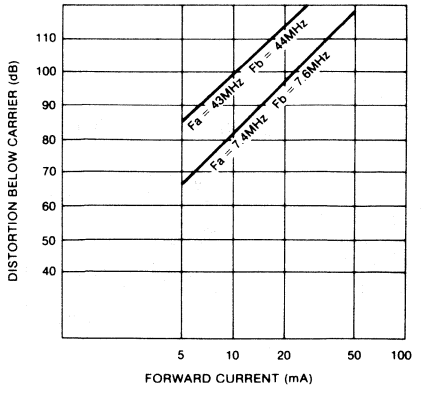
Typical R_P vs Voltage and Frequency UM9605 - UM9608



Typical Forward Bias Intermodulation Distortion vs Nominal Carrier Frequency at 20dBm per Channel



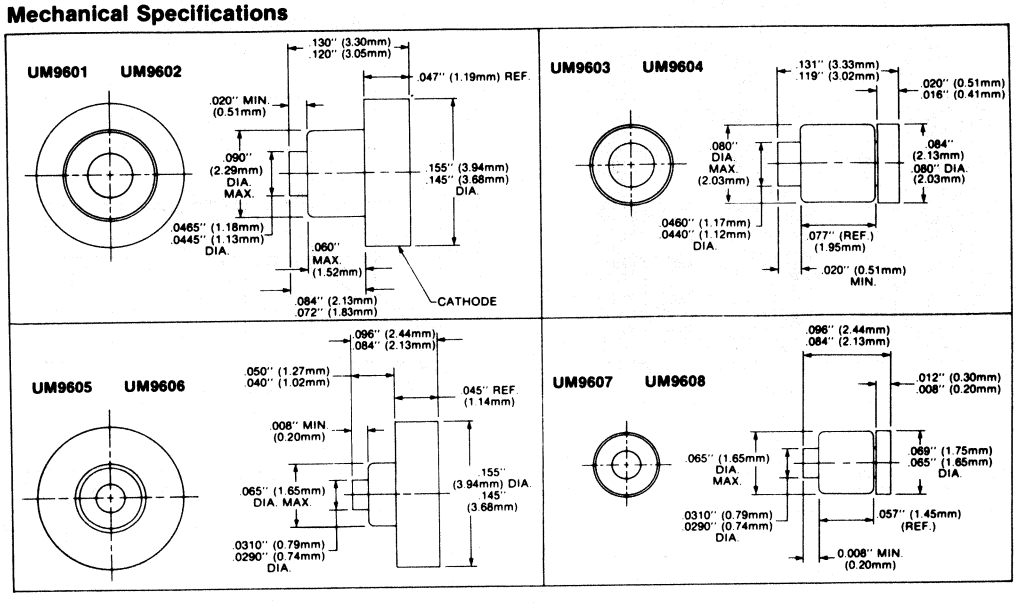
Typical Third Order Intermodulation Distortion $\left(R\ \frac{2ab}{a}\right)$ vs Forward Bias Current at 20dBm per Channel



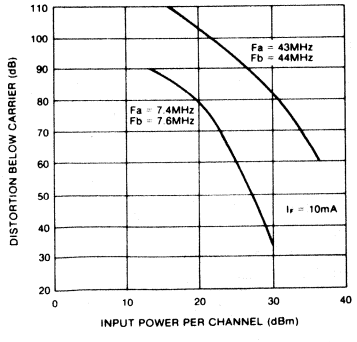
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

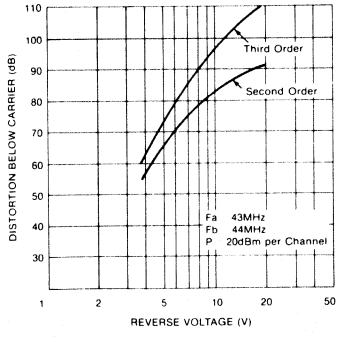
Mechanical Specifications



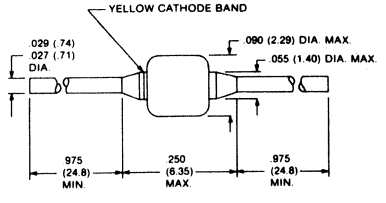
Typical Forward Bias Third Order Intermodulation Distortion $\left(R\ \frac{2ab}{a}\right)$ vs Input Power per Channel



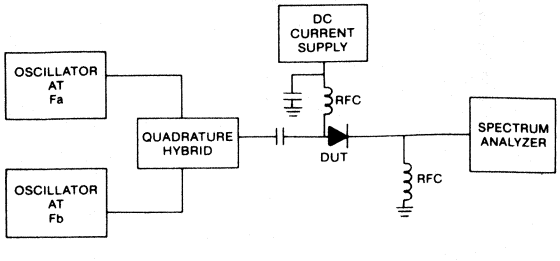
Typical Reverse Bias Intermodulation Distortion



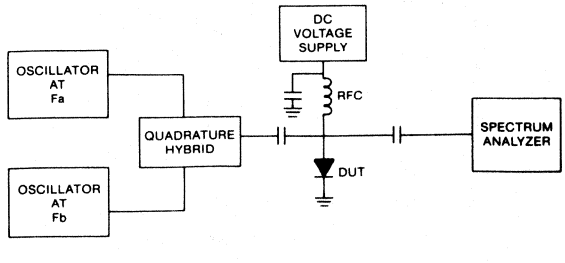
Mechanical Specifications



Forward Bias Distortion Test Set



Reverse Bias Distortion Test Set



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

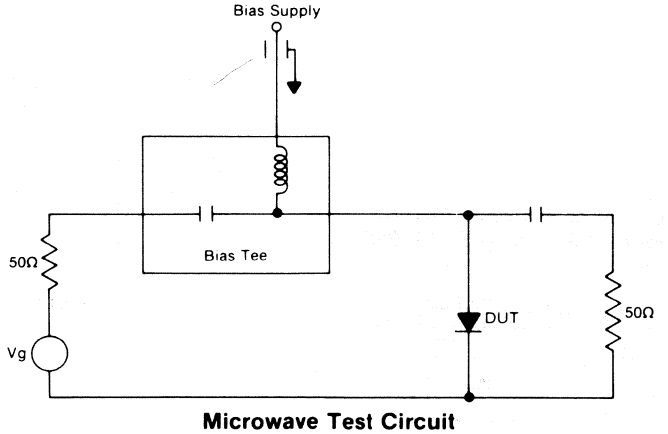
Microwave Characterization

The UM9601-UM9608 series has been designed and characterized as shunt switch elements at frequencies to 4GHz in microstrip circuits. Performance curves are given which demonstrate switch performance in 0.025" (.635mm) alumina microstrip.

The performance data were derived by evaluating externally biased microstrip circuits in which a UM9601 diode was installed. Each circuit consisted of a 1 inch length of 50 ohm nominal impedance 0.025" (.635mm) thick alumina microstrip and two SMA connectors. The data shown include the board and connector loss. Measurements performed using 0.050" (1.27mm) alumina substrates show similar performance at frequencies to 1.5GHz.

These circuits simulate simple SPST switches. Many designs require multithrow switches. It is important to recognize that a multithrow switch will have 6dB higher isolation than indicated for SPST switches. Also, a multithrow switch using shunt mounted PIN diodes require the diodes be placed a quarter-wavelength from the common port.

A further improvement in switch performance may be achieved by using 2 shunt PIN diodes in each arm spaced a quarter-wavelength from each other. In this case the isolation of each section will be twice the dB value of a SPST switch. The insertion loss due to the diodes should be less than twice the insertion loss of an SPST section due to the transforming effect of the quarter-wave line on the capacitance of a single diode.

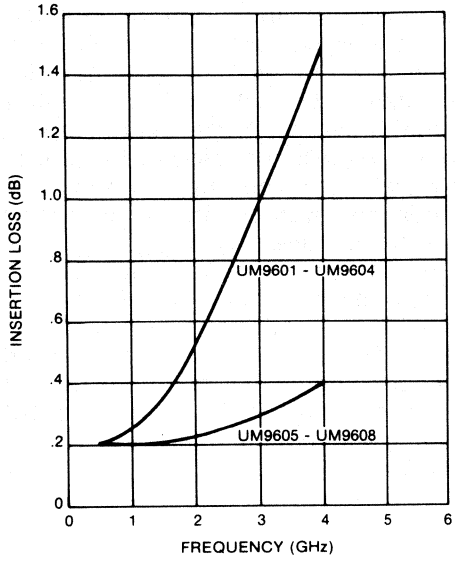


Microwave Test Circuit

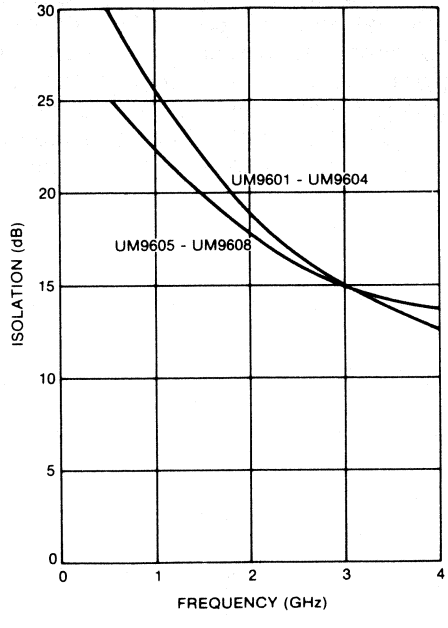
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A

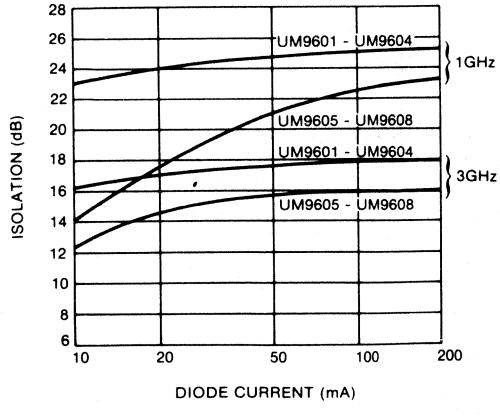
Typical Insertion Loss vs Frequency
0.025" (0.635mm) Alumina Microstrip SPST Switch
Diode at Zero Bias



Typical Isolation vs Frequency
0.025" (0.635mm) Alumina Microstrip SPST Switch
Diode Current = 100mA



Isolation vs Frequency and Diode Current
0.025" (0.635mm) Alumina Microstrip SPST Switch



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

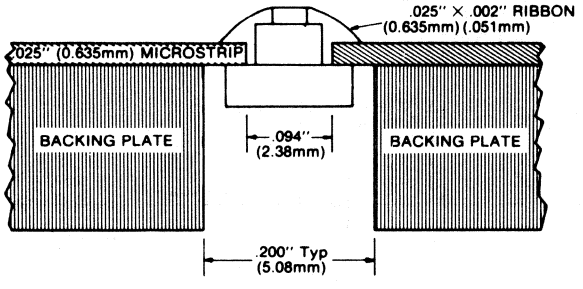
PRINTED IN U.S.A.

Installation in Microstrip

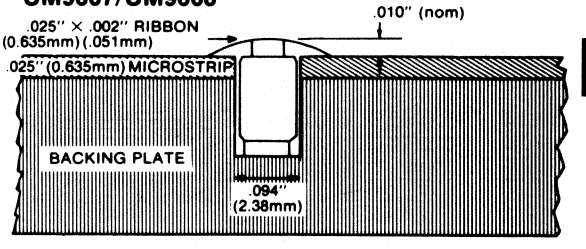
The cup type flange on the UM9601, UM9602, UM9605 and UM9606 is designed to be affixed to the ground plane surface of a microstrip board as shown. The UM9603, UM9604, UM9607 and UM9608 were designed to be affixed to a backing plate as shown. It was experimentally determined that at frequencies greater than 2GHz the anode of the diode should be approximately 0.010" (.254mm) above the top surface of the microstrip for lowest insertion loss.

For solder adhesion the microstrip may be heated to solder melting temperature (up to 300° C) with no damage to the diode. Conductive epoxy may also be employed. The thermal resistance of solder mounted UM9601-UM9604 in their test boards was less than 20° C/W; for the UM9605-UM9608 thermal resistance was less than 30° C/W.

UM9601/UM9602
UM9605/UM9606
Microstrip Mount



UM9603/UM9604
UM9607/UM9608
Microstrip Mount



9

Design Example - 900MHz Antenna Switch

An example of a practical circuit design using a UM9601 diode is a quarter-wave antenna switch covering the frequency of 800-900MHz. The circuit design for this switch is shown and was constructed using 0.025" (0.645mm) alumina microstrip.

This antenna switch uses a series mounted diode and a shunt mounted diode. The UM9601 was selected for the shunt mounted device (SPST performance at 1GHz: 0.2dB insertion loss and 25dB isolation) and because it is the lowest cost diode in the UM9601-UM9608 series. A UM9401 axial lead diode was chosen for the series mounted device.

The performance of this switch is displayed in the graphs and in the following table. It should be noted that the loss values are actual measured numbers including losses due to the capacitors, bias networks, connectors as well as the board. In a typical radio application where the antenna switch circuit board is integrated in the same microstrip board that contains transmitter and receiver elements the connector loss is eliminated. This will result in lower overall insertion loss values than indicated here.

The CW power handling capacity is determined by the allowable power dissipation of the series mounted UM9401. Using a gap in the line of 0.190" (4.82mm) and lead soldered attached spacing of 0.250" (0.635mm) the power rating of the UM9401 is 6 watts at a 25° C ambient. This was determined by performing a thermal resistance measurement on the circuit mounted UM9401. The relationship that derives the maximum transmitter power, P_T, is:

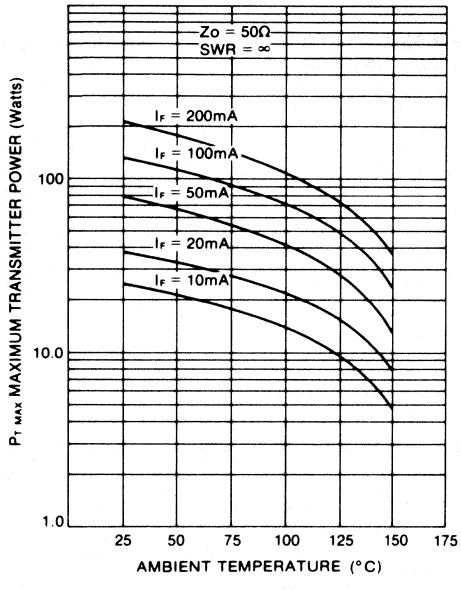
$$P_T = \frac{P_{DISS}}{R^S} \cdot Z_o \left(\frac{\sigma + 1}{2\sigma} \right)^2$$

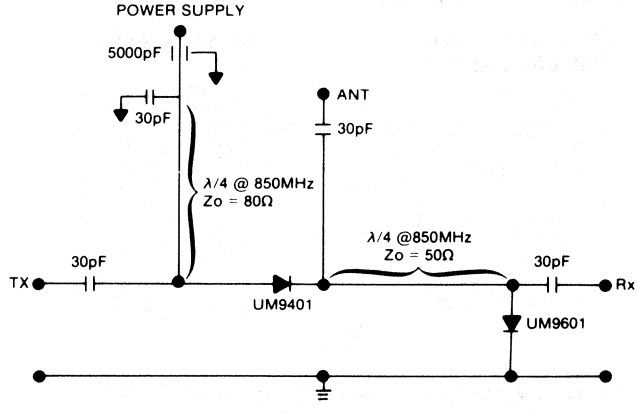
where σ = maximum antenna SWR

Using resistance values for the UM9401 and UM9601 the maximum transmitter power curve is given and shows that this circuit is able to handle 100 watts of transmitter power at 100mA forward biased and totally mismatched antenna at an ambient temperature of 60° C. For a perfectly matched antenna the power handling increases to 400 watts under the same bias and ambient temperature conditions.

Distortion is an important consideration in the selection of a PIN diode antenna switch design. The UM9401 and UM9601 PIN diodes are designed for low distortion applications. The level of distortion produced by this 900MHz antenna switch when operated in the transmit state (forward bias of 100mA) is expected to be at least 90dB below the carrier for a 50 watt transmitter level. In the receiver state (zero bias) the intermodulation distortion caused by two in-band signals at 0dBm are estimated to be at least 100dB below this level.

Maximum Transmitter Power vs Forward Current for UM9601/UM9401 900MHz Microstrip Antenna Switch





Circuit Diagram

Antenna Switch Performance

Frequency Range 800-900MHz

I. Transmit State
(I = 100mA, T_A = 60° C)

A. Maximum Transmitter Power - 100 watts (antenna SWR = ∞)
B. Maximum Transmitter Power - 400 watts (antenna SWR = 1)
C. Transmitter Insertion Loss - 0.4dB
D. Receiver Isolation - 31dB
E. Harmonic Distortion - −90dB (P_T = 100 watts)

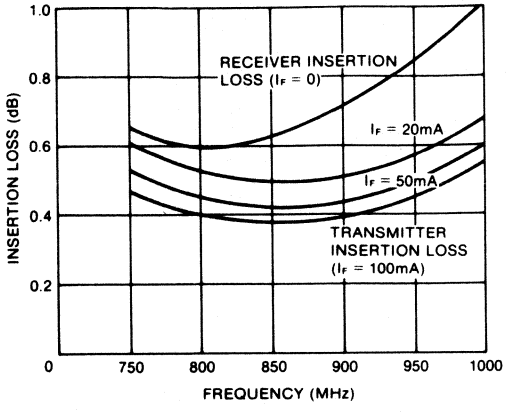
II. Receive State
(Zero Bias)

A. Receiver Insertion Loss - 0.6-0.7dB
B. Intermodulation Distortion - −100dB P_{in} = 0dBm

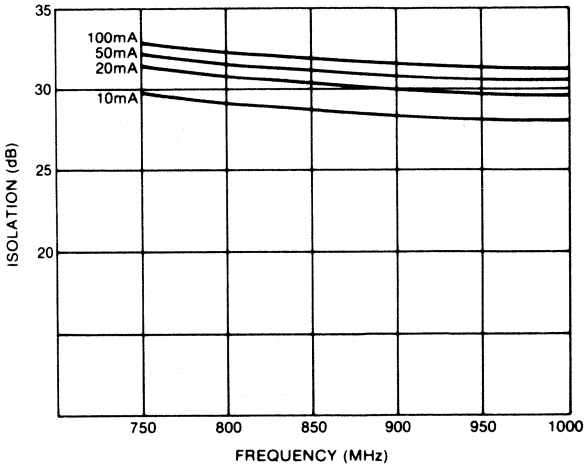
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

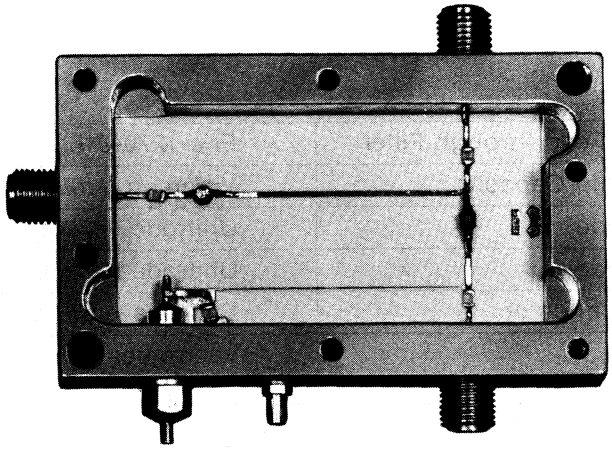
Antenna Switch Insertion Loss



Receiver Isolation vs Frequency and Diode Current



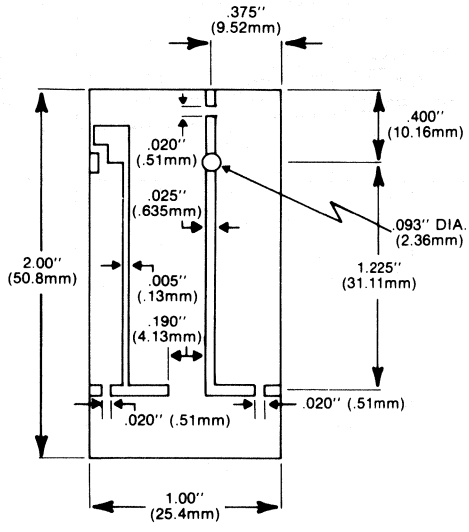
9



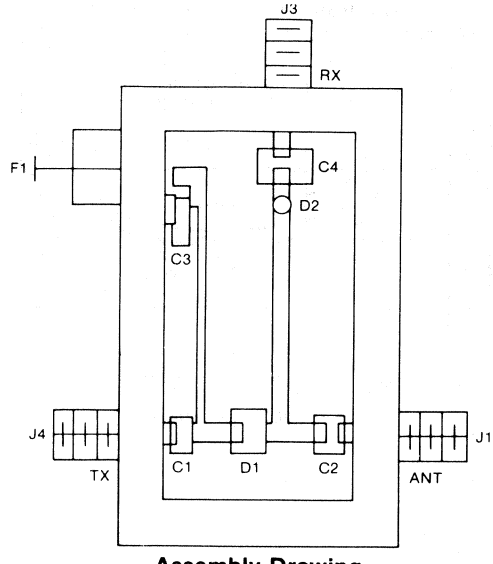
Photograph of 800-900MHz antenna switch test module using UM9401 and UM9601 PIN Diodes. In typical transceiver applications, the antenna switch circuit board is integrated.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.



Substrate Drawing



Assembly Drawing

Parts List

F1	5000pF Feed through Filter	Erie 1270-016
C1-C4	30pF Chip Capacitor	Vitramon VJ0805A300KF
D1	PIN Diode	Unitrode UM9401
D2	PIN Diode	Unitrode UM9601
J1-J3	SMA Connector	Cablewave 971-028
	Substrate	Vectronics Microwave 79-9081-0401

PIN DIODE

UM9701

Low Resistance, Low Distortion, RF Switching Diode

Features

- Low Forward Resistance
- High Reverse Resistance
- Specified Low Distortion
- High Voltage Capability
- Good Power Handling
- Unitrode Ruggedness and Reliability

Description

The UM9701 PIN diode was designed for low resistance at low forward bias current and low reverse bias capacitance. This unique Unitrode design results in both forward and reverse bias.

These PIN diodes are characterized for low current drain RF and microwave switch applications particularly for digital filter switch designs. The construction and geometry of these devices provide good voltage and power handling capability.

These devices are constructed using a metallurgical full face bond to both surfaces of the silicon chip. A glass enclosure houses this bond in a reliable and hermetic package. The axial leads are attached to the refractory pins and do not touch the glass enclosure.

Environmentally these, and all Unitrode PIN diodes, can withstand thermal cycling from −195°C to +300°C and exceed all military environmental specifications for shock, vibration, acceleration, and moisture resistance.

9

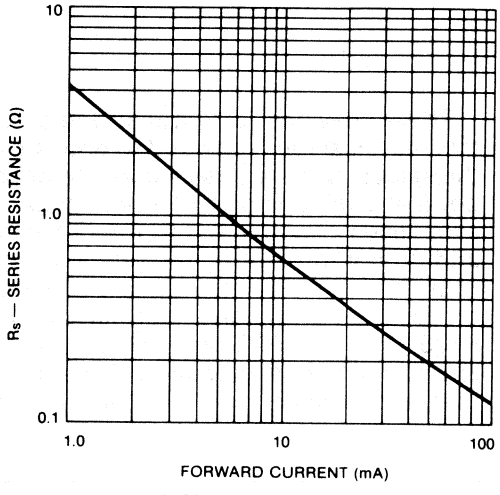
Maximum Ratings

Reverse Voltage	100V
Average Power Dissipation Free Air at 25°C	500mW (Derate linearly to 175°C)
Average Power Dissipation ½" Total Lead Length to 25° C Contacts	2.5W (Derate linearly to 175°C)
Operating and Storage Temperature	−65°C to +175°C

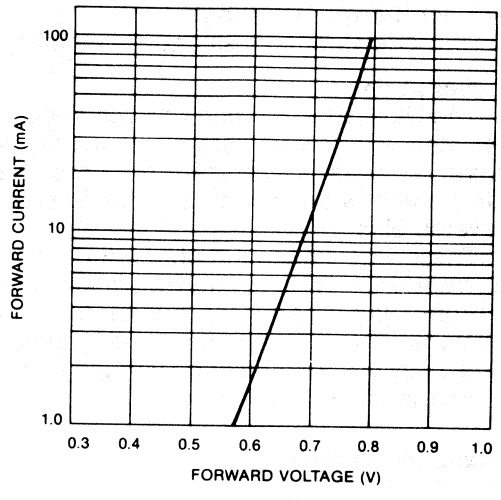
Electrical Specifications

Test	Symbol	UM9701	Condition
Series Resistance (MAX)	R_S	0.8Ω	F = 100MHz, I = 10mA
Total Capacitance (MAX)	C_T	1.8pF	F = 1MHz, I = 50V
Parallel Resistance (MIN)	R_P	100kΩ	F = 100MHz, V = 50V
Carrier Lifetime (MIN)	τ	1.5μs	I = 10mA
Reverse Current (MAX)	I_R	10μA	V = 100V
Forward Voltage (MAX)	V_F	0.8V	I = 10mA
Forward Bias Third Order IM Distortion (MAX)	$R\frac{2ab}{a}$	−90dB	I = 10mA Pa = Pb = +20dBm Fa = 43MHz, Fb = 44MHz
Reverse Bias Third Order IM Distortion (MAX)	$R\frac{2ab}{a}$	−90dB	I = 50V Pa = Pb = +20dBm Fa = 43MHz, Fb = 44MHz

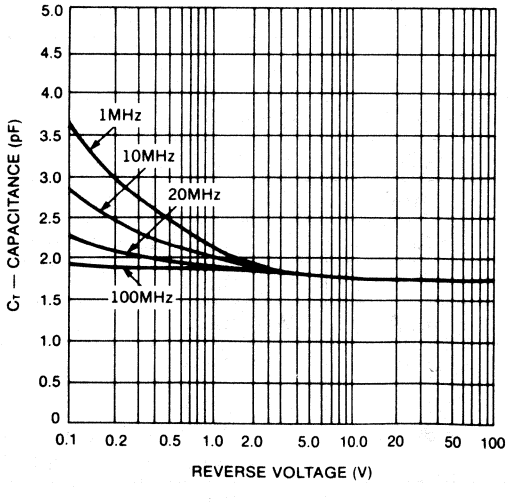
Typical Series Resistance vs Forward Current (F = 100MHz)



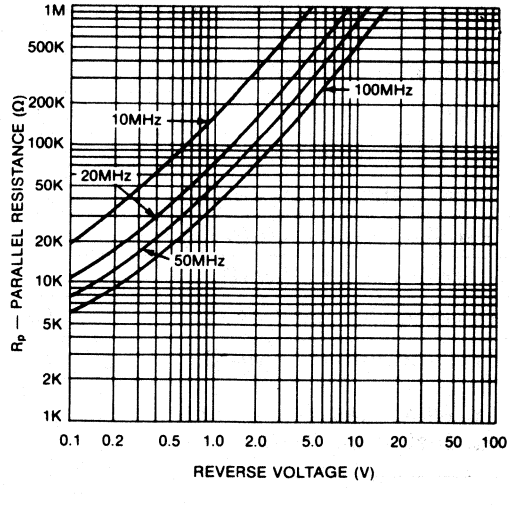
Typical DC Characteristic



Typical Capacitance Characteristic



Typical Parallel Resistance Characteristic



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

PIN DIODE

UM9701

Low Resistance, Low Distortion, RF Switching Diode

Features

- Low Forward Resistance
- High Reverse Resistance
- Specified Low Distortion
- High Voltage Capability
- Good Power Handling
- Unitrode Ruggedness and Reliability

Description

The UM9701 PIN diode was designed for low resistance at low forward bias current and low reverse bias capacitance. This unique Unitrode design results in both forward and reverse bias.

These PIN diodes are characterized for low current drain RF and microwave switch applications particularly for digital filter switch designs. The construction and geometry of these devices provide good voltage and power handling capability.

These devices are constructed using a metallurgical full face bond to both surfaces of the silicon chip. A glass enclosure houses this bond in a reliable and hermetic package. The axial leads are attached to the refractory pins and do not touch the glass enclosure.

Environmentally these, and all Unitrode PIN diodes, can withstand thermal cycling from −195°C to +300°C and exceed all military environmental specifications for shock, vibration, acceleration, and moisture resistance.

9

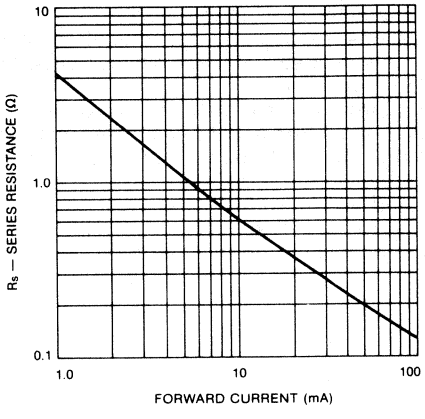
Maximum Ratings

Reverse Voltage	100V
Average Power Dissipation Free Air at 25°C	500mW (Derate linearly to 175°C)
Average Power Dissipation ½" Total Lead Length to 25°C Contacts	2.5W (Derate linearly to 175°C)
Operating and Storage Temperature	−65°C to +175°C

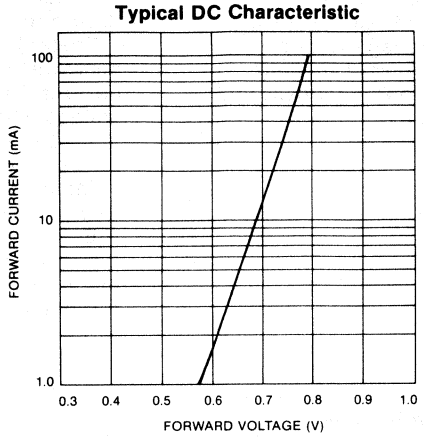
Electrical Specifications

Test	Symbol	UM9701	Condition
Series Resistance (MAX)	R_S	0.8Ω	F = 100MHz, I = 10mA
Total Capacitance (MAX)	C_T	1.8pF	F = 1MHz, V = 50V
Parallel Resistance (MIN)	R_P	100kΩ	F = 100MHz, V = 50V
Carrier Lifetime (MIN)	τ	1.5μs	I = 10mA
Reverse Current (MAX)	I_R	10μA	V = 100V
Forward Voltage (MAX)	V_F	0.8V	I = 10mA
Forward Bias Third Order IM Distortion (MAX)	$R\ \frac{2ab}{a}$	−90dB	I = 10mA Pa = Pb = +20dBm Fa = 43MHz, Fb = 44MHz
Reverse Bias Third Order IM Distortion (MAX)	$R\ \frac{2ab}{a}$	−90dB	V = 50V Pa = Pb = +20dBm Fa = 43MHz, Fb = 44MHz

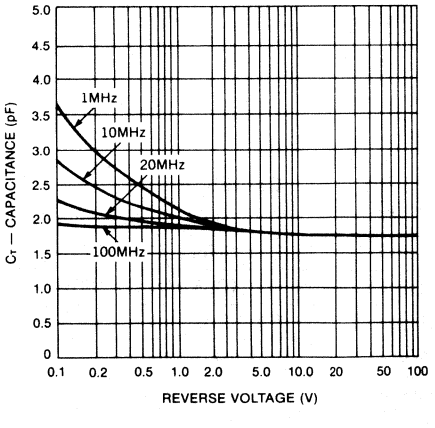
Typical Series Resistance vs Forward Current (F = 100MHz)



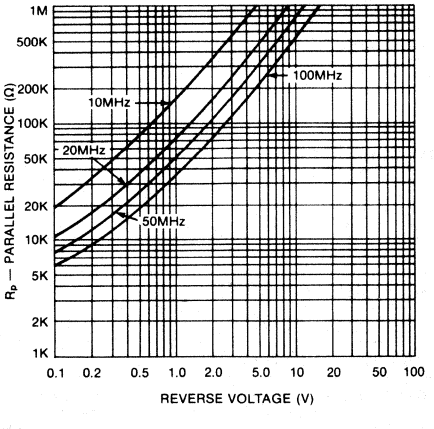
Typical DC Characteristic



Typical Capacitance Characteristic



Typical Parallel Resistance Characteristic



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

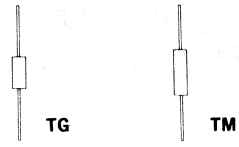
SENSISTORS® 10

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SENSISTORS®

PRODUCT SELECTION GUIDE



Type	Resistance Range (Ω)	Resistance Rating (R25°C/R125°C)	Tolerance	Package
TG1/8-J	10-10K	0.55±15%	5%	TG
TG1/8-K	10-10K	0.55±15%	10%	TG
TM1/8-J	10-39K	0.55±15%	5%	TM
TM1/8-K	10-39K	0.55±15%	10%	TM
RTH22 ES-J	10-10K	.055±15%	5%	TM
RTH22 ES-K	10-10K	.055±15%	10%	TM
RTH42 ES-J	10-2.7K	.055±15%	5%	TG
RTH42 ES-K	10-2.7K	.055±15%	10%	TG

Sensistors® is a registered trademark of Unitrode Corporation.

10

TYPE NUMBER DESIGNATION

TM1/8272K

TM 1/8 272 K

STYLE	WATTAGE	RESISTANCE VALUE CODE	TOLERANCE
TM	1/8	270 = 27Ω	J = 5%
TG		271 = 270Ω	K = 10%
RTH22 ES		272 = 2,700Ω	
RTH42 ES		273 = 27,000Ω	

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SENSISTORS®

Positive – Temperature – Coefficient Silicon Thermistors

TG1/8
TM1/8
RTH42
RTH22

FEATURES

- Qualified to MIL-T-23648A
- TG1/8 – Similar to RTH42 (MIL-T-23648A/19)
- TM1/8 – Similar to RTH22 (MIL-T-23648A/9)
- Large Positive Temperature Coefficient ≙ 0.7%/°C
- Wide Resistance Value Ranges Available in 5% or 10% Tolerances

DESCRIPTION

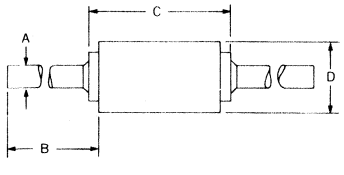
The TG1/8 thermistor is encapsulated in a glass, hermetically sealed package. The TM1/8 thermistor is encapsulated in a molded package. Both have hot solder-dipped leads and are used in temperature sensing and compensation circuits. They meet or exceed all of the requirements of MIL-T-23648A.

ABSOLUTE MAXIMUM RATINGS

	TG1/8 RTH42	TM1/8 RTH22
Power Dissipation at (or below) 25°C Free-Air Temperature (See Figure 1)	300mW	500mW
Power Dissipation at (or below) 100°C Free Air Temperature (See Figure 1)	125mW	
Operating Free-Air Temperature Range	-55°C to +125°C	
Storage Temperature Range	-65°C to +150°C	

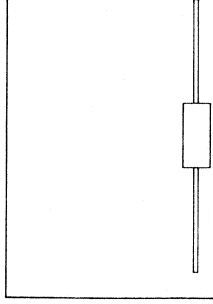
MECHANICAL SPECIFICATIONS

TG1/8 RTH42

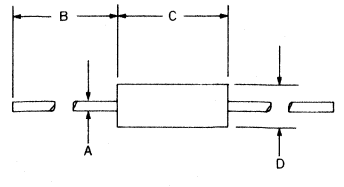


	INCHES	MILLIMETERS
A	.020 ± .002	.508 ± .051
B	1.0 MIN.	25.4 MIN.
C	.285 ± .015	7.239 ± .381
D	.095 ± .01	2.413 ± .254

TG

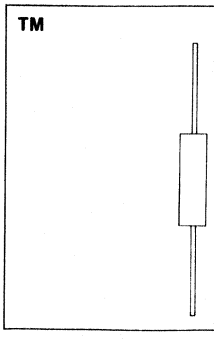


TM1/8 RTH22



	INCHES	MILLIMETERS
A	.025 ± .003	.635 ± .076
B	1.0 MIN.	25.4 MIN.
C	.405 ± .015	10.287 ± .381
D	.14 ± .015	3.556 ± .381

TM



Sensitor® is a registered trademark of Unitrode Corporation

UNITRODE

ELECTRICAL AND THERMAL CHARACTERISTICS

	TG1/8 RTH42 TM1/8 RTH22
Zero Power Resistance Ratio ($R_{25°C}/R_{125°C}$)	0.55 ± 15%
Thermal Time Constant – Typical	35s
Thermal Time Constant – Maximum	60s

NOMINAL RESISTANCE AT VARIOUS TEMPERATURES

Standard Zero Power Resistance Value (Ω) at 25°C Free-Air Temperature	Type No.				Resistance (Ω) of Sensistor® at Temperature other than 25°C						
					-55°	-15°C	0°C	50°C	75°C	100°C	125°C
10	TG1/8	RTH42	TM1/8	RTH22	6.15	7.9	8.63	11.6	13.5	15.45	17.5
12	TG1/8	RTH42	TM1/8	RTH22	7.38	9.48	10.356	13.92	16.2	18.54	21
15	TG1/8	RTH42	TM1/8	RTH22	9.225	11.85	12.945	17.4	20.25	23.175	26.25
18	TG1/8	RTH42	TM1/8	RTH22	11.07	14.22	15.534	20.88	24.3	27.81	31.5
22	TG1/8	RTH42	TM1/8	RTH22	13.53	17.38	18.986	25.52	29.7	33.99	38.5
27	TG1/8	RTH42	TM1/8	RTH22	16.605	21.33	23.301	31.32	36.45	41.715	47.25
33	TG1/8	RTH42	TM1/8	RTH22	20.295	26.07	28.479	38.28	44.55	50.985	57.75
39	TG1/8	RTH42	TM1/8	RTH22	23.985	30.81	33.657	45.24	52.65	60.255	68.25
47	TG1/8	RTH42	TM1/8	RTH22	28.905	37.13	40.561	54.52	63.45	72.615	82.25
50	TG1/8	RTH42	TM1/8	RTH22	30.75	39.5	43.15	58	67.5	77.25	87.5
56	TG1/8	RTH42	TM1/8	RTH22	34.44	44.24	48.328	64.96	75.6	86.52	98
68	TG1/8	RTH42	TM1/8	RTH22	41.82	53.72	58.684	78.88	91.8	105.06	119
82	TG1/8	RTH42	TM1/8	RTH22	47.724	63.14	69.454	95.94	112.34	129.888	147.6
100	TG1/8	RTH42	TM1/8	RTH22	58.2	77	84.7	117	137	158.4	180
120	TG1/8	RTH42	TM1/8	RTH22	69.84	92.4	101.64	140.4	164.4	190.08	216
150	TG1/8	RTH42	TM1/8	RTH22	87.3	115.5	127.05	175.5	205.5	237.6	270
180	TG1/8	RTH42	TM1/8	RTH22	100.8	135.9	150.84	212.4	252	292.14	334.8
220	TG1/8	RTH42	TM1/8	RTH22	123.2	166.1	184.36	259.6	308	357.06	409.2
270	TG1/8	RTH42	TM1/8	RTH22	151.2	203.85	226.26	318.6	378	438.21	502.2
330	TG1/8	RTH42	TM1/8	RTH22	184.8	249.15	276.54	389.4	462	535.59	613.8
390	TG1/8	RTH42	TM1/8	RTH22	218.4	294.45	326.82	460.2	546	632.97	725.4
470	TG1/8	RTH42	TM1/8	RTH22	263.2	354.85	393.86	554.2	658	762.81	874.2
500	TG1/8	RTH42	TM1/8	RTH22	280	377.5	419	590	700	811.5	930
560	TG1/8	RTH42	TM1/8	RTH22	308	414.4	467.6	672	795.2	927.36	1,075.2
680	TG1/8	RTH42	TM1/8	RTH22	374	503.2	567.8	816	965.6	1,126.08	1,305.6

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

NOMINAL RESISTANCE AT VARIOUS TEMPERATURES

Standard Zero Power Resistance Value (Ω) at 25°C Free-Air Temperature	Type No.				Resistance (Ω) of Sensistor® at Temperature other than 25°C						
					-55°	-15°C	0°C	50°C	75°C	100°C	125°C
820	TG1/8	RTH42	TM1/8	RTH22	451	606.8	684.7	984	1,164.4	1,357.92	1,574.4
1,000	TG1/8	RTH42	TM1/8	RTH22	550	740	835	1,200	1,420	1,656	1,920
1,200	TG1/8	RTH42	TM1/8	RTH22	660	888	1,002	1,440	1,704	1,987.2	2,304
1,500	TG1/8	RTH42	—	—	772.5	1,095	1,237.5	1,845	2,175	2,505	2,940
	—	—	TM1/8	RTH22	825	1,110	1,252.5	1,800	2,130	2,484	2,880
1,800	TG1/8	RTH42	TM1/8	RTH22	927	1,314	1,485	2,214	2,610	3,006	3,528
2,200	TG1/8	RTH42	TM1/8	RTH22	1,133	1,606	1,815	2,706	3,190	3,674	4,312
2,700	TG1/8	RTH42	TM1/8	RTH22	1,390.5	1,971	2,227.5	3,321	3,915	4,509	5,292
3,300	TG1/8	—	TM1/8	RTH22	1,699.5	2,409	2,722.5	4,059	4,785	5,511	6,468
3,900	TG1/8	—	TM1/8	RTH22	2,008.5	2,847	3,217.5	4,797	5,655	6,513	7,644
4,700	TG1/8	—	TM1/8	RTH22	2,420.5	3,431	3,877.5	5,781	6,815	7,849	9,212
5,000	TG1/8	—	TM1/8	RTH22	2,575	3,650	4,125	6,150	7,250	8,350	9,800
5,600	TG1/8	—	TM1/8	RTH22	2,884	4,088	4,620	6,888	8,120	9,352	10,976
6,800	TG1/8	—	—	—	3,468	4,964	5,610	8,092	9,520	10,948	12,444
	—	—	TM1/8	RTH22	3,502	4,964	5,610	8,364	9,860	11,356	13,328
8,200	TG1/8	—	TM1/8	RTH22	4,182	5,986	6,765	9,758	11,480	13,202	15,006
	—	—	TM1/8	RTH22	4,223	5,986	6,765	10,086	11,890	13,694	16,072
10,000	TG1/8	—	TM1/8	RTH22	5,100	7,300	8,250	11,900	14,000	16,100	18,300
	—	—	TM1/8	RTH22	5,150	7,300	8,250	12,300	14,500	16,700	19,600
12,000	—	—	TM1/8	—	6,180	8,760	9,900	14,760	17,400	20,040	23,520
15,000	—	—	TM1/8	—	7,215	10,680	12,210	18,150	21,450	25,050	28,500
18,000	—	—	TM1/8	—	8,658	12,816	14,652	21,780	25,740	30,060	34,200
22,000	—	—	TM1/8	—	10,582	15,664	17,908	26,620	31,460	36,740	41,800
27,000	—	—	TM1/8	—	12,987	19,224	21,978	32,670	38,610	45,090	51,300
33,000	—	—	TM1/8	—	15,873	23,496	26,862	39,930	47,190	55,110	62,700
39,000	—	—	TM1/8	—	18,759	27,768	31,746	47,190	55,770	65,130	74,100

DEVICE TOLERANCE

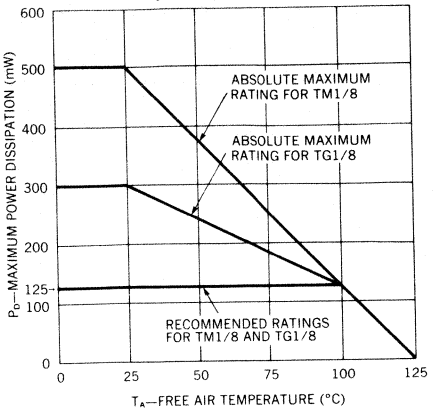
The actual resistance of the thermistor at T/°C may vary from the calculated value by an amount not exceeding the tolerances tabulated below.

Temperature	±5%	±10%
(°C)	(J)	(K)
-55	±15%	±20%
-15	±9%	±14%
0	±7%	±12%
25	±5%	±10%
50	±7%	±12%
75	±9%	±14%
100	±12%	±17%
125	±15%	±20%

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

1. Dissipation Derating Curves

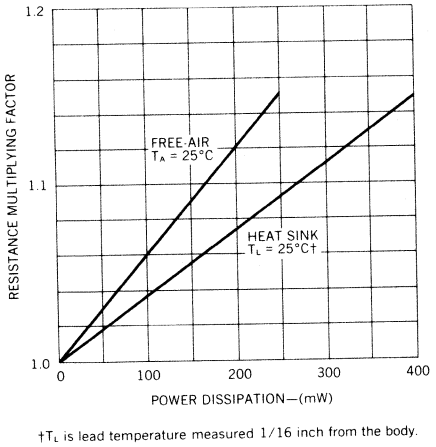


TYPICAL CHARACTERISTICS WITH POWER APPLIED

To determine resistance value with power applied, obtain a multiplying factor from the applicable curve below. The free-air curve is for the condition of heat removal by free-air convection only. The heat sink curve is for the maximum cooling rate condition of a heat sink strap, with leads attached to an infinite heat sink. Actual conditions encountered will be between these two extremes. After selecting an applicable multiplying factor from figure 2 or 3, multiply this by the 25°C zero power resistance. This product is then corrected for the actual ambient temperature by use of the appropriate temperature column in the Nominal Resistance at Various Temperatures table.

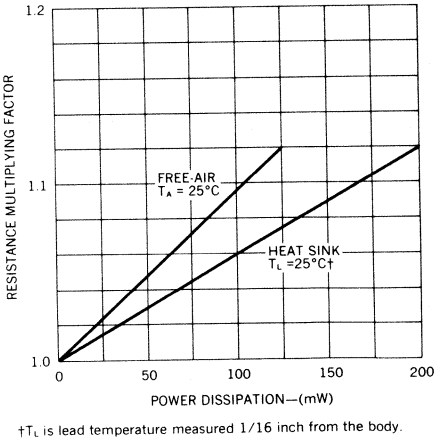
10

2. Percent Resistance Change vs Power Dissipation TM1/8 / RTH22



†T_L is lead temperature measured 1/16 inch from the body.

3. Percent Resistance Change vs Power Dissipation TG1/8 / RTH42



†T_L is lead temperature measured 1/16 inch from the body.

PART NUMBER DESIGNATION

TM1/8272K

TM 1/8 272 K

STYLE	WATTAGE	RESISTANCE VALUE CODE	TOLERANCE
TM	1/8	270 = 27Ω	J = 5%
TG		271 = 270Ω	K = 10%
RTH42 ES		272 = 2,700Ω	
RTH22 ES		273 = 27,000Ω	

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

MONOLITHIC CERAMIC CAPACITORS 11

(Axial & Radial Leaded and Chip Capacitors)
Data Sheets 11-3

Unitrode, long recognized as a worldwide leader in the design, manufacture and marketing of discrete semiconductor components, has established a comparable position of leadership in the manufacture of Multilayer Ceramic Capacitors.

Since 1973, Unitrode has supplied over two billion *Axial Leaded Multilayer Ceramic Capacitors* to computer, general industrial, and commercial customers. Consequently the Company is recognized as a leading supplier of automatically insertable capacitors for high volume applications.

Our modern facilities in San Diego, California; Methuen, Massachusetts; and Ennis, Ireland are producing both Glass Encapsulated and Hybrid Chip Capacitors to service our domestic and international customers.

Our unique manufacturing and sealing process combined with continual emphasis on quality have earned Unitrode a reputation of setting the highest standards of reliability and performance.

Unitrode's Multilayer Ceramic Capacitors are utilized in numerous and varied applications in such end markets as data processing, consumer electronics, communications/telecommunications, automotive regulators and ignition systems, industrial controls, industrial and medical instrumentation, and military electronics.

The Company's corporate Marketing and Sales headquarters are located in Lexington, Massachusetts. Strategically located Area and Regional Sales Offices backed by a worldwide network of the industry's most qualified team of manufacturers' representatives are prepared to provide any assistance you require to solve your capacitor problems and satisfy your requirements.

General Information

Basic Formula

Capacitors are essentially energy storage devices used in a wide variety of applications in the electronics industry. The most common applications are:

- Pulse circuits
- Timing circuits
- Tuning
- Energy Storage
- By-Pass
- Blocking
- Coupling
- Voltage Suppression
- Arc Suppression

The Multilayer Ceramic Capacitor is a parallel plate capacitor with a ceramic material as the dielectric whose capacitance can be calculated by a formula $C = \frac{KAN}{t}$ where:

K = the dielectric constant of the ceramic material utilized.
A = the area of overlap of the plate electrodes in in^2.
N = the number of electrode plates.
t = thickness of the dielectric material separating the electrode plates in inches.

Classes/Characteristics

Multilayer Ceramic Capacitors are generally divided into Class I and Class II categories:

Class I Ceramics

Capacitors of this dielectric type have a dielectric constant range of 6-100 for the temperature compensated series dielectrics and from 100-500 for an extended TC series. Class I devices are used in applications requiring stability and high Q-factor (low loss) over a temperature range of $-55°C$ to $+125°C$ and exhibit the following characteristics:

a. Time does not significantly affect capacitance and dissipation factor. No aging.
b. Capacitance and dissipation factor are not affected by voltage and frequency.
c. Linear temperature coefficient.
d. Dissipation factor is typically $<0.1\%$ @ 1 MHz.

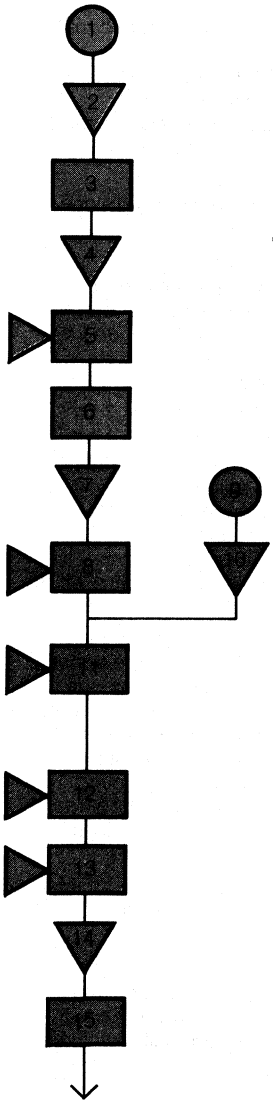
Class II Ceramics

Class II Ceramics are divided into two subgroups, stable and unstable, which are defined by the temperature characteristics. For the stable subgroup, the dielectric constant range is generally 500-3000, and 3000-10000 for the unstable subgroup. BX and X7R dielectrics are examples of the stable subgroup dielectrics. Z5U falls into the unstable subgroup. These higher K dielectrics exhibit non-linear characteristics and less stable properties than the Class I Ceramics, namely:

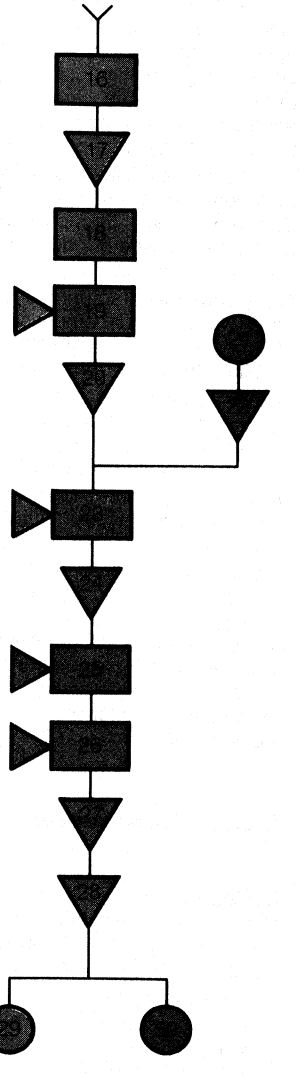
a. Capacitance and dissipation factor are affected by (1) time (aging), (2) voltage (AC & DC), and (3) frequency.
b. Non linear T.C.

Class II Ceramic devices are used in by-pass and coupling applications where some degree of electrical instability can be tolerated to achieve higher volumetric efficiency and lower cost.

Chip Capacitor Production and Inspection Plan



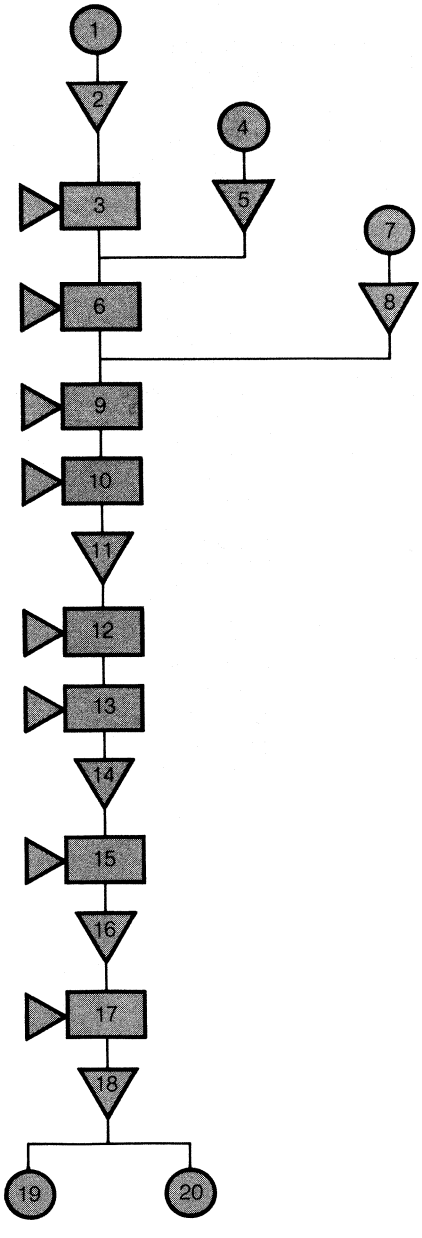
1. Incoming Ceramic and binders
2. Incoming Inspection
3. Mixing Ceramic and Binders
4. QA Sample Inspection
5. Cast
6. Slit
7. Ceramic Film Inspection
8. Block Load
9. Incoming Material—Inks and Screens
10. Incoming Inspection
11. Print
12. Laminate
13. Cut
14. Cut Inspection
15. Dry
16. Tumble
17. Tumble Inspection
18. Bisque Fire
19. Fire
20. Microsection Inspection
21. Incoming Material—Termination Metal
22. Incoming Inspection
23. Termination
24. Termination Inspection
25. Termination Fire
26. Electrical Sort
27. Visual Mechanical Inspection
28. Final QA
29. Chip Storage
30. Transfer for Encapsulation



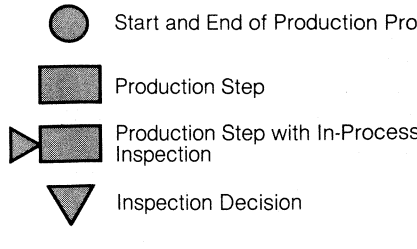
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Glass Encapsulated Capacitor
Production and Inspection Plan



1. Incoming Material — Leads
2. Lead Inspection
3. Lead Loading
4. Incoming Material — Glass
5. Glass Inspection
6. Glass Loading
7. Incoming Material — Chips
8. Chip Inspection
9. Chip Loading
10. Sealing
11. Encapsulated Assembly Inspection
12. Lead Plating
13. Electrical Test
14. Electrical Inspection
15. Marking
16. Inspection
17. Reel and Reel Repair
18. Final Q.C.
19. Stock
20. Ship



UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Unitrode conducts the following tests on all production lots. The tests are monitored or conducted and controlled by the Quality Assurance Department to assure the specification and test limit integrity is maintained.

CAPACITANCE: Capacitance is checked on 100% of each shipment lot with a final check on an AQL basis. Test conditions for NPO and X7R dielectrics are 1 VRMS ± .25 VRMS and .3 VRMS for the Z5U.

DISSIPATION FACTOR: This parameter is also checked on a 100% basis. The limits are .1% for NPO 2.5% for X7R and 3% for Z5U at stated test voltages.

DIELECTRIC WITHSTANDING VOLTAGE: All dielectrics are tested at 250% of rated voltage with charging current limited to 50 mA maximum.

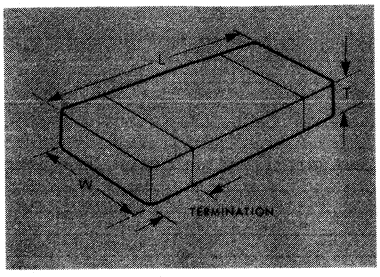
INSULATION RESISTANCE: Capacitors are tested to an AQL level at rated voltage for a maximum two minute charging time. All dielectrics are required to meet 100,000 megohms or 1000 megohm microfarads whichever is the lesser of the two.

All above specifications are at room temperature and humidity.

HIGH RELIABILITY: All Unitrode product is manufactured to meet or exceed MIL-C-55681, MIL-C-11015 and MIL-C-39014 and Unitrode is prepared to offer for a nominal charge, units screened to the following specifications:

Test	MIL-STD-202 Method	Condition	Test Conditions
Burn-In	108	A	200% of rated voltage @ +125°C for NPO and X7R dielectrics. 150% of rated voltage @ +85°C for Z5U dielectric; for 96 hours.
Dielectric Withstanding Voltage	301	—	250% of rated voltage for NPO, X7R and Z5U dielectric with charging current limited to 50 mA.
Insulation Resistance	302	—	Rated voltage applied for 2 minutes maximum.
Thermal Shock	107	B	Exposure at temperature extremes for 30 minutes.
Capacitance	305	—	NPO and X7R dielectrics; 1 VRMS ± .25 VRMS @ 1 KHz. Z5U dielectric; .3 VRMS @ 1 KHz.
Dissipation Factor	305	—	NPO and X7R dielectrics; 1 VRMS ± .25 VRMS @ 1 KHz. Z5U dielectric; .3 VRMS @ 1 KHz.

NPO (COG) Characteristics



SIZE	1	2	3	4	5	6	7	8	9	24
* L	.050 ins. 1.27 (mm)	.080 ins. 2.03 (mm)	.100 ins. 2.54 (mm)	.150 ins. 3.81 (mm)	.125 ins. 3.18 (mm)	.180 ins. 4.57 (mm)	.180 ins. 4.57 (mm)	.175 ins. 4.45 (mm)	.250 ins. 6.35 (mm)	.090 ins. 2.28 (mm)
* W	.040 ins. 1.016 (mm)	.050 ins. 1.27 (mm)	.050 ins. 1.27 (mm)	.050 ins. 1.27 (mm)	.095 ins. 2.41 (mm)	.050 ins. 1.27 (mm)	.080 ins. 2.03 (mm)	.125 ins. 3.18 (mm)	.225 ins. 5.72 (mm)	.070 ins. 1.77 (mm)
T. MAX	.040 ins. 1.016 (mm)	.050 ins. 1.27 (mm)	.050 ins. 1.27 (mm)	.050 ins. 1.27 (mm)	.060 ins. 1.52 (mm)	.050 ins. 1.27 (mm)	.060 ins. 1.52 (mm)	.060 ins. 1.52 (mm)	.060 ins. 1.52 (mm)	.060 ins. 1.52 (mm)
** Termination	.010 ins. .254 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)
*** Capacitance pF	Volts 50 100 200	Volts 50 100 200	Volts 50 100 200	Volts 50 100 200	Volts 50 100 200	Volts 50 100 200	Volts 50 100 200	Volts 50 100 200	Volts 50 100 200	Volts 50 100 200

pF	EIA Capacitance Code
10	100
12	120
15	150
18	180
22	220
27	270
33	330
39	390
47	470
56	560
68	680
82	820
100	101
120	121
150	151
180	181
220	221
270	271
330	331
390	391
470	471
560	561
680	681
820	821
1000	102
1200	122
1500	152
1800	182
2200	222
2700	272
3300	332
3900	392
4700	472
5600	562
6800	682
8200	822
.0100 mF	103
.0120	123
.0150	153
.0180	183
.0220	223
.0270	273
.0330	333
.0390	393
.0470	473
.0560	563

Performance Specifications

MIL Specifications:
Meets or exceeds applicable portions of MIL-C-55681

Insulation Resistance:
Minimum 100,000 megohms or 1,000 megohm microfarads, whichever is less, with rated voltage applied, @ 25°C (see curve for other temperatures).

Flash Test:
2.5 × WVDC

Life Test:
2 × WVDC @ +125°C, 1000 hours.

Temperature Range:
–55°C to +125°C

Temperature Coefficient:
0 ±30 PPM/°C

Dissipation Factor:
.1% max. @ 1 KHz

Capacitance Tolerance:
C (±.25pF, 1pF-10pF), D (±.5pF, 1pF-10pF), F (±1%), G (±2%), J (±5%), K (±10%), M (±20%)

*All L&W values ±.010 (.254)
**All termination measurements ±.010 (.254) except .010 (.254) value which is ±.005 (.127)
***Extended Values Available

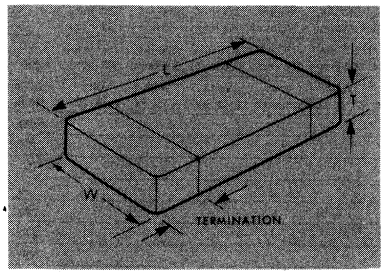
How To Order

SIZE CODE	D VOLTAGE	103 VALUE	K TOLERANCE	B TERMINATION MATERIAL	N TEMPERATURE CHARACTERISTIC
1 .050 x .040	D 50VDC	Capacitance	C ±.25pF (1pF-10pF)	A Ag	N NPO
2 .080 x .050	E 100VDC	Value in pF	D ±.5pF (1pF-10pF)	B PdAg	
3 .100 x .050	F 200VDC	(EIA Code)	F ±1%	C Solder Coat	
4 .150 x .050			G ±2%		
5 .125 x .095			J ±5%		
6 .180 x .050			K ±10%		
7 .180 x .080			M ±20%		
8 .175 x .125					
9 .250 x .225					
24 .090 x .070					

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

X7R (BX) Characteristics



SIZE	1	2	3	4	5	6	7	8	9	24
* L	.050 ins. 1.27 (mm)	.080 ins. 2.03 (mm)	.100 ins. 2.54 (mm)	.150 ins. 3.81 (mm)	.125 ins. 3.18 (mm)	.180 ins. 4.57 (mm)	.180 ins. 4.57 (mm)	.175 ins. 4.45 (mm)	.250 ins. 6.35 (mm)	.090 ins. 2.28 (mm)
* W	.040 ins. 1.016 (mm)	.050 ins. 1.27 (mm)	.050 ins. 1.27 (mm)	.050 ins. 1.27 (mm)	.095 ins. 2.41 (mm)	.050 ins. 1.27 (mm)	.080 ins. 2.03 (mm)	.125 ins. 3.18 (mm)	.225 ins. 5.72 (mm)	.070 ins. 1.77 (mm)
T. MAX	.040 ins. 1.016 (mm)	.050 ins. 1.27 (mm)	.050 ins. 1.27 (mm)	.050 ins. 1.27 (mm)	.060 ins. 1.52 (mm)	.050 ins. 1.27 (mm)	.060 ins. 1.52 (mm)	.060 ins. 1.52 (mm)	.060 ins. 1.52 (mm)	.060 ins. 1.52 (mm)
** Termination	.010 ins. .254 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)
*** Capacitance	Volts	Volts	Volts	Volts	Volts	Volts	Volts	Volts	Volts	Volts
pF	50 100	50 100	50 100	50 100	50 100	50 100	50 100	50 100	50 100	50 100

Capacitance	EIA Capacitance Code
100	101
120	121
150	151
180	181
220	221
270	271
330	331
390	391
470	471
560	561
680	681
820	821
1000	102
1200	122
1500	152
1800	182
2200	222
2700	272
3300	332
3900	392
4700	472
5600	562
6800	682
8200	822
.0100 mF	103
.0120	123
.0150	153
.0180	183
.0220	223
.0270	273
.0330	333
.0390	393
.0470	473
.0560	563
.0680	683
.0820	823
.1000	104
.1200	124
.1500	154
.1800	184
.2200	224
.2700	274
.3300	334
.3900	394
.4700	474
.5600	564
.6800	684
.8200	824
1.000	105
1.200	125
1.5	155

Performance Specifications

MIL Specifications:
Meets or exceeds applicable portions of MIL-C-55681

Insulation Resistance:
Minimum 100,000 megohms or 1,000 megohm microfarads, whichever is less, with rated voltage applied, @ 25°C (see curve for other temperatures).

Flash Test:
2.5 × WVDC

Life Test:
2 × WVDC @ 125°C, 1000 hours.

Temperature Range:
−55°C to +125°C

Temperature Coefficient:
±15%

Dissipation Factor:
2.5% max. @ 1 KHz, 25°C, 1 VRMS

Capacitance Tolerances and Codes:
K (±10%), M (±20%)
Consult Factory for J (±5%) Tolerance

*All L&W values ±.010 (.254)
**All termination measurements ±.010 (.254) except .010 (.254) value which is ±.005 (.127)

***Extended Values Available

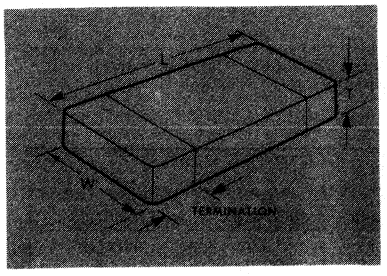
How To Order

SIZE CODE	D VOLTAGE	103 VALUE	K TOLERANCE	B TERMINATION MATERIAL	X TEMPERATURE CHARACTERISTIC
1 .050 x .040 2 .080 x .050 3 .100 x .050 4 .150 x .050 5 .125 x .095 6 .180 x .050	D 50VDC E 100VDC F 200VDC	Capacitance Value in pF (EIA Code)	J ±5% K ±10% M ±20%	A Ag B PdAg C Solder Coat	B BX X X7R

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A

Z5U Characteristics (General Purpose)



Performance Specifications

MIL Specifications:
Meets or exceeds applicable portions of MIL-C-55681

Insulation Resistance:
Minimum 100,000 megohms or 1,000 megohm microfarads, whichever is less, with rated voltage applied, @ 25°C (see curve for other temperatures).

Flash Test:
2.5 × WVDC

Life Test:
2 × WVDC @ 85°C.

Temperature Range:
+10°C to +85°C

Temperature Coefficient:
+22%
−56%

Dissipation Factor:
3.0% max. @ 1 KHz, 25°C, .3 VRMS

Capacitance Tolerances and Codes:
M (±20%) Z (+80%, −20%), V (GMV)

*All L&W values ±.010 (.254)
**All termination measurements ±.010 (.254) except .010 (.254) value which is ±.005 (.127)
***Extended Values Available

SIZE	1	2	3	4	5	6	7	8	9	24
* L	.050 ins. 1.27 (mm)	.080 ins. 2.03 (mm)	.100 ins. 2.54 (mm)	.150 ins. 3.81 (mm)	.125 ins. 3.18 (mm)	.180 ins. 4.57 (mm)	.180 ins. 4.57 (mm)	.175 ins. 4.45 (mm)	.250 ins. 6.35 (mm)	.090 ins. 2.28 (mm)
* W	.040 ins. 1.016 (mm)	.050 ins. 1.27 (mm)	.050 ins. 1.27 (mm)	.050 ins. 1.27 (mm)	.095 ins. 2.41 (mm)	.050 ins. 1.27 (mm)	.080 ins. 2.03 (mm)	.125 ins. 3.18 (mm)	.225 ins. 5.72 (mm)	.070 ins. 1.77 (mm)
T. MAX	.040 ins. 1.016 (mm)	.050 ins. 1.27 (mm)	.050 ins. 1.27 (mm)	.050 ins. 1.27 (mm)	.060 ins. 1.52 (mm)	.050 ins. 1.27 (mm)	.060 ins. 1.52 (mm)	.060 ins. 1.52 (mm)	.060 ins. 1.52 (mm)	.060 ins. 1.52 (mm)
** Termination	.010 ins. .254 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)	.020 ins. .508 (mm)
*** Capacitance pF	Volts 50 100	Volts 50 100	Volts 50 100	Volts 50 100	Volts 50 100	Volts 50 100	Volts 50 100	Volts 50 100	Volts 50 100	Volts 50 100

pF	EIA Capacitance Code
1000	102
1200	122
1500	152
1800	182
2200	222
2700	272
3300	332
3900	392
4700	472
5600	562
6800	682
8200	822
.0100 mF	103
.0120	123
.0150	153
.0180	183
.0220	223
.0270	273
.0330	333
.0390	393
.0470	473
.0560	563
.0680	683
.0820	823
.1000	104
.1200	124
.1500	154
.1800	184
.2200	224
.2700	274
.3300	334
.3900	394
.4700	474
.5600	564
.6800	684
.8200	824
1.000	105
1.200	125
1.500	155
1.800	185
2.200	225
2.700	275
3.300	335
3.900	395

11

How To Order

SIZE CODE	D VOLTAGE	103 VALUE	Z TOLERANCE	B TERMINATION MATERIAL	Z TEMPERATURE CHARACTERISTIC
1 .050 x .040 2 .080 x .050 3 .100 x .050 4 .150 x .050 5 .125 x .095 6 .180 x .050 7 .180 x .080 8 .175 x .125 9 .250 x .225 24 .090 x .070	D 50VDC E 100VDC	Capacitance Value in pF (EIA Code)	M ±20% Z +80%, −20%	A Ag B PdAg C Solder Coat	Z Z5U

Chip Capacitor Tape and Reel Information

General

Table 1 indicates the chip size/capacitance value range of chips available in tape and reel packaging. The 8 mm wide cardboard carrier tape is supplied on 7 inch diameter reels. Each reel contains approximately 4000 devices.

Table 1

EIA SIZE CODE	L	W	T MAX	CAP VALUE RANGE		
				NPO 100 WVDC	X7R 50 WVDC	Z5U 50 WVDC
0805	.080 ± .010 (2.03 ± 0.25)	.050 ± .010 (1.27 ± 0.25)	.050 (1.27)	1.0pF 1000pF	100pF .022MF	1000pF .1MF
1005	.100 ± .010 (2.54 ± 0.25)	.050 ± .010 (1.27 ± 0.25)	.060 (1.52)	10pF 1500pF	100pF .027MF	3300pF .15MF
1206	.126 ± .010 (3.2 ± 0.25)	.063 ± .010 (1.6 ± 0.25)	.050 (1.27)	10pF 2700pF	2200pF .1MF	.015MF .22MF
1210	.125 ± .010 (3.18 ± 0.25)	.095 ± .010 (2.41 ± 0.25)	.065 (1.65)	82pF 6800pF	680pF .18MF	8200pF .47MF
*1812	.175 ± .010 (4.45mm)	.125 ± .010 (3.18mm)	.060 (1.52mm)	270pF .15MF	8200MF .33MF	.047MF 1.0MF
*1825	.175 ± .010 (4.45mm)	.250 ± .010 (6.35mm)	.060 (1.52mm)	561pF .022MF	.022MF .68MF	.12MF 1.8MF

*Available in 12mm wide tape only.

Reel Dimensions and Carrier Tape Dimensions

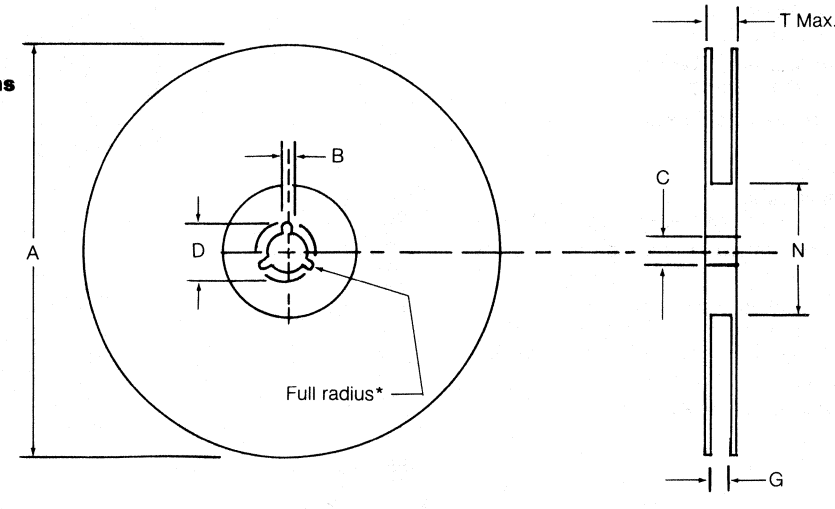


Table 2

A	B	C	D	N	G	T
178 ± 2.0 (7.00 ± 0.079)	2.0 (0.079)	13 ± 0.5 (0.512 ± 0.020)	20.2 MIN. (0.795 MIN.)	50 MIN. (1.969 MIN.)	10.0 ± 1.5 0.394 ± 0.059	14.9 (0.587)

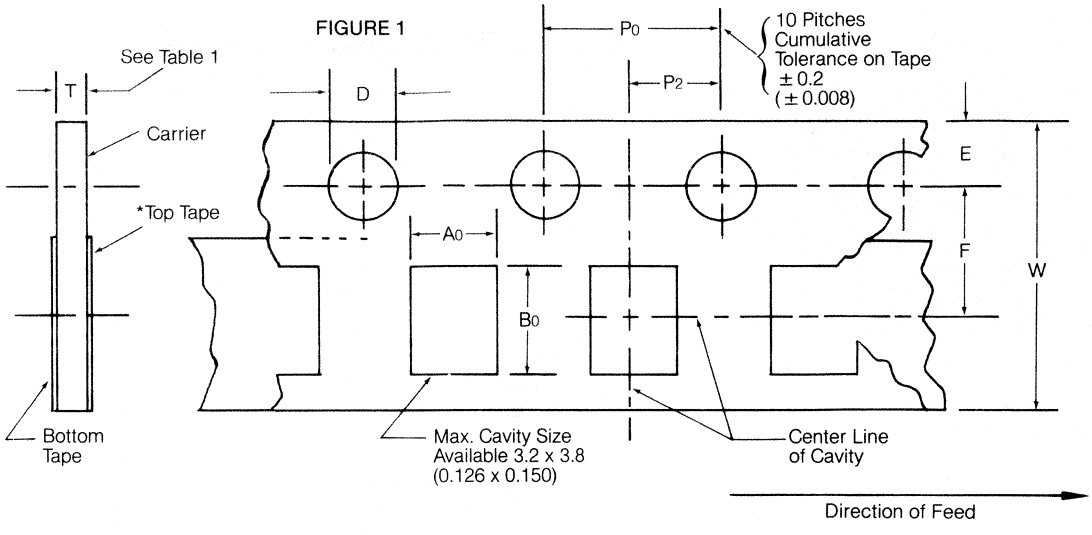
Metric dimensions will govern.
English measurements rounded and for reference only.
Options subject to agreement between vendor and user.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Carrier Dimensions

FIGURE 1



11

Table 3

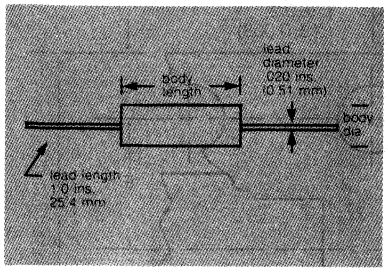
W	F	E	P_2	P_0	D	A_0, B_0	T
8.0 ± 0.2 (0.315 ± 0.008)	3.5 ± 0.05 (0.138 ± 0.002)	1.75 ± 0.05 (0.069 ± 0.002)	2.0 ± 0.05 (0.079 ± 0.002)	4.0 ± 0.1 (0.157 ± 0.004)	$1.5^{+0.1}_{-0.0}$ ($0.059^{+0.004}_{-0.000}$)	See Note: 1	NO. 1 - 0.94 (0.037) NO. 2 - 1.19 (0.047)

Metric dimensions will govern.
English measurements rounded and for reference only.
Options subject to agreement between vendor and user.

NOTE: 1 A_0 & B_0 are determined by maximum specified length and width of components plus 0.4 ± 0.2 (0.016 ± 0.008), plus the additional requirements that components not be allowed to rotate more than 20° within the cavity clearance or whichever condition occurs first.

Unitrode Monolithic
Ceramic Axial Lead
Glass Capacitors

NPO (COG) Characteristics



Performance Specifications

MIL Specifications:
Meets or exceeds applicable portions of MIL-C-11015 and MIL-C-39014.

Insulation Resistance:
Minimum 100,000 megohms or 1,000 megohm microfarads, whichever is less, with rated voltage applied, @ 25°C (see curve for other temperatures).

Dielectric Strength:
2.5 × WVDC

Life Test:
2 × WVDC @ 125°C, 1000 hours.

Lead Material:
Tinned Copper Clad Steel

Temperature Range:
–55°C to +125°C

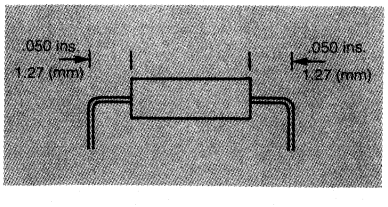
Temperature Coefficient:
0 ±30 PPM/°C

Dissipation Factor:
0.1% max. at 1 MHz @ 1 VRMS (≤100pF)
1 KHz @ 1 VRMS (>100pF)

Capacitance Tolerance:
F (±1%), G (±2%), J (±5%),
K (±10%), M (±20%)

PACKAGE	G	D	D	E	F	
Body Length (max.)	.170 ins. 4.32 (mm)	.200 ins. 5.08 (mm)	.260 ins. 6.60 (mm)	.300 ins. 7.62 (mm)	.400 ins. 10.16 (mm)	
Body Dia. (max.)	.100 ins. 2.54 (mm)	.100 ins. 2.54 (mm)	.100 ins. 2.54 (mm)	.110 ins. 2.79(mm)	.150 ins. 3.81 (mm)	EIA Capacitance Code
Capacitance pF	Voltage 50 100 200	Voltage 50 100 200	Voltage 50 100 200	Voltage 50 100 200	Voltage 50 100 200	
10						100
12						120
15						150
18						180
22						220
27						270
33						330
39						390
47						470
56						560
68						680
82						820
100						101
120						121
150						151
180						181
220						221
270						271
330						331
390						391
470						471
560						561
680						681
820						821
1000						102
1200						122
1500						152
1800						182
2200						222
2700						272
3300						332
3900						392
4700						472
5600						562
6800						682
8200						822
.01 mF						103

Guidelines for Automatic Insertion:



How To Order

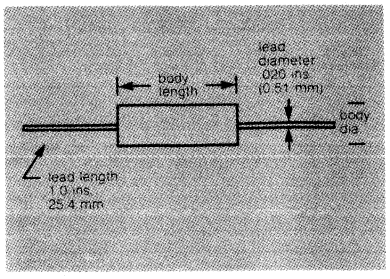
STYLE	PACKAGE	EIA CAPACITANCE CODE	TOLERANCE	VOLTAGE	TEMPERATURE CHARACTERISTIC
CG	A .170 x .075 B .170 x .100 C .200 x .100 D .260 x .100 E .300 x .110 F .400 x .150 *G .300 x .150	Capacitance Value in pF	F ±1% G ±2% J ±5% K ±10%	C 25V D 50V E 100V F 200V	N NPO

*Consult factory for values and voltages

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

X7R (BX) Characteristics



Performance Specifications

MIL Specifications:
Meets or exceeds applicable portions of MIL-C-11015 and MIL-C-39014.

Insulation Resistance:
Minimum 100,000 megohms or 1,000 megohm microfarads, whichever is less, with rated voltage applied, @ 25°C (see curve for other temperatures).

Dielectric Strength:
2.5 × WVDC

Life Test:
2 × WVDC @ 125°C, 1000 hours.

Lead Material:
Tinned Copper Clad Steel

Temperature Range:
−55°C to +125°C

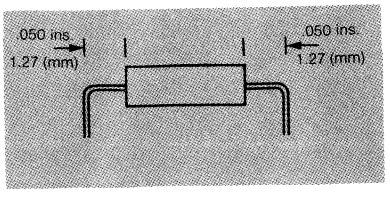
Temperature Coefficient:
±15%

Dissipation Factor:
2.5% @ 1 KHz @ 1 VRMS

Capacitance Tolerance:
K (±10%), M (±20%) Consult Factory for J (±5%) Tolerance

PACKAGE	A	B	C	D	E	F	
Body Length (max.)	.170 ins. 4.32 (mm)	.170 ins. 4.32 (mm)	.200 ins. 5.08 (mm)	.260 ins. 6.60 (mm)	.300 ins. 7.62 (mm)	.400 ins. 10.16 (mm)	
Body Dia. (max.)	.075 ins. 1.91 (mm)	.100 ins. 2.54 (mm)	.100 ins. 2.54 (mm)	.100 ins. 2.54 (mm)	.110 ins. 2.79 (mm)	.150 ins. 3.81 (mm)	
Capacitance pF	Voltage 50 100	Voltage 50 100	Voltage 50 100	Voltage 50 100	Voltage 50 100	Voltage 50 100	EIA Capacitance Code
100							101
120							121
150							151
180							181
220							221
270							271
330							331
390							391
470							471
560							561
680							681
820							821
1000							102
1200							122
1500							152
1800							182
2200							222
2700							272
3300							332
3900							392
4700							472
5600							562
6800							682
8200							822
.01 mF							103
.012							123
.015							153
.018							183
.022							223
.027							273
.033							333
.039							393
.047							473
.056							563
.068							683
.082							823
.10							104
.12							124
.15							154
.18							184
.22							224
.27							274

Guidelines for Automatic Insertion:



How To Order

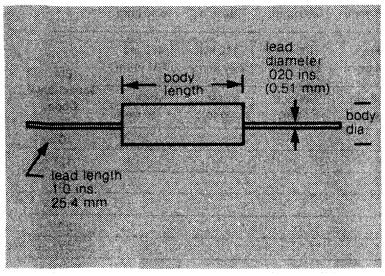
STYLE	PACKAGE	EIA CAPACITANCE CODE	TOLERANCE	VOLTAGE	TEMPERATURE CHARACTERISTIC
CG	A .170 x .075 B .170 x .100 C .200 x .100 D .260 x .100 E .300 x .110 F .400 x .150 *G .300 x .150	Capacitance Value in pF	J ±5% K ±10% M ±20%	C 25V D 50V E 100V F 200V	X X7R

*Consult factory for values and voltages

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Z5U Characteristics (General Purpose)



Performance Specifications

Insulation Resistance:
Minimum 100,000 megohms or 1,000 megohm microfarads, whichever is less, with rated voltage applied, @ 25°C (see curve for other temperatures).

Dielectric Strength:
2.5 × WVDC below .5 mfd; 2.0 × WVDC .5 mfd and above

Life Test:
2 × WVDC @ 85°C, 1000 hours.

Lead Material:
Tinned Copper Clad Steel

Temperature Range:
+10°C to +85°C

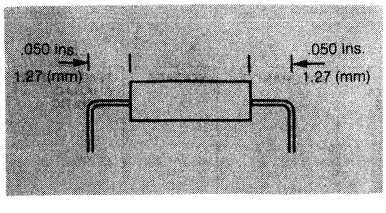
Temperature Coefficient:
+22, −56%

Dissipation Factor:
3.0% max. at 1 KHz., 25°C, @ .3 VRMS

Capacitance Tolerance:
M (±20%), Z (+80%, −20%), GMV (+100%, −0%).

PACKAGE	A	B	C	D	E	F	
Body Length (max.)	.170 ins. 4.32 (mm)	.170 ins. 4.32 (mm)	.200 ins. 5.08 (mm)	.260 ins.	.300 ins. 7.62 (mm)	.400 ins. 10.16 (mm)	
Body Dia. (max.)	.075 ins. 1.91 (mm)	.100 ins. 2.54 (mm)	.100 ins. 2.54 (mm)	.100 ins.	.110 ins. 2.79 (mm)	.150 ins. 3.81 (mm)	
Capacitance pF	Voltage 50 100	Voltage 50 100	Voltage 50 100	Voltage 50 100	Voltage 50 100	Voltage 50 100	EIA Capacitance Code
1000							102
1200							122
1500							152
1800							182
2200							222
2700							272
3300							332
3900							392
4700							472
5600							562
6800							682
8200							822
.01 mF							103
.012							123
.015							153
.018							183
.022							223
.027							273
.033							333
.039							393
.047							473
.056							563
.068							683
.082							823
.10							104
.12							124
.15							154
.18							184
.22							224
.27							274
.33							334
.39							394
.47							474
.56							564
.68							684
.82							824
1.0							105

Guidelines for Automatic Insertion:



How To Order

STYLE	PACKAGE	EIA CAPACITANCE CODE	TOLERANCE	VOLTAGE	TEMPERATURE CHARACTERISTIC
CG	A .170 x .075 B .170 x .100 C .200 x .100 D .260 x .100 E .300 x .110 F .400 x .150 *G .300 x .150	Capacitance Value in pF	M ±20% Z +80%, −20% V GMV	C 25V D 50V E 100V F 200V	Z Z5U

*Consult factory for values and voltages

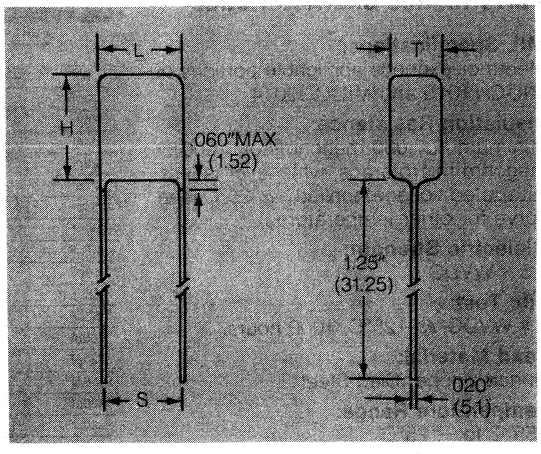
UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Unitrode Monolithic
Epoxy Coated
Radial Leaded
Ceramic Capacitors

Features

- Flame retardant epoxy
- 50 WVDC and 100 WVDC
- NPO, X7R and Z5U Temperature coefficients
- Environmental performance to 39014 and MIL-C-20



11

DIMENSIONS					CAPACITANCE RANGE			
STYLE	H MAX	L MAX	T MAX	S	WVDC	NPO	X7R	Z5U
UR10A	.150" (3.81)	.150" (3.81)	.100" (2.54)	.100" (2.54)	50V 100V	10pF–1000pF 10pF–470pF	820pF–.022μF 820pF–.012μF	1000pF–.1μF 1000pF–.047μF
UR20A	.150" (3.81)	.150" (3.81)	.100" (2.54)	.200" (5.08)	50V 100V	10pF–1000pF 10pF–470pF	820pF–.022μF 820pF–.012μF	1000pF–.1μF 1000pF–.047μF
UR10B	.200" (5.08)	.200" (5.08)	.125" (3.18)	.100" (2.54)	50V 100V	1000pF–6800pF 560pF–3900pF	.027μF–.15μF .015μF–.082μF	.12μF–.47μF .056μF–.22μF
UR20B	.200" (5.08)	.200" (5.08)	.125" (3.18)	.200" (5.08)	50V 100V	1000pF–6800pF 560pF–3900pF	.027μF–.15μF .015μF–.082μF	.12μF–.47μF .056μF–.22μF
UR20C	.300" (7.62)	.300" (7.62)	.150" (3.81)	.200" (5.08)	50V 100V	8200pF–.018μF 4700pF–.01μF	.033μF–.39μF .018μF–.22μF	.15μF–1.0μF .068μF–.47μF
UR20D	.400" (10.16)	.400" (10.16)	.150" (3.81)	.200" (5.08)	50V 100V	.022μF–.039μF .012μF–.027μF	.47μF–1.0μF .27μF–.56μF	1.2μF–2.7μF .56μF–1.5μF

Dimensions in inches and (millimeters)

ENVIRONMENTAL PERFORMANCE

- Accelerated life (MIL 202 Method 108, Condition D)
  Z5U: 150% rated voltage @ 85°C
  X7R & NPO: 200% rated voltage @ 125°C
- Moisture resistance (MIL-STD-202, Method 106)
  Z5U: 10 cycles @ 0V
  X7R & NPO: 20 cycles with voltage first 10 cycles
- Thermal Shock (MIL-STD-202 Method 107, Condition A) at Elevated Temperature
  Z5U: –55°C to +85°C
  X7R & NPO: –55°C to +125°C
- Immersion (MIL-STD-202 Method 104, Condition A)
- Resistance to Solder Heat (MIL-STD-202, Method 210, Condition B)

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Unitrode Monolithic
Epoxy Coated
Radial Leaded
Ceramic Capacitors

Performance Characteristics

MIL Specifications:
Meets or exceeds applicable portions of MIL-C-11015 and MIL-C-39014.

Insulation Resistance:
Minimum 100,000 megohms or 1,000 megohm microfarads, whichever is less, with rated voltage applied, @ 25°C (see curve for other temperatures).

Dielectric Strength:
2.5 × WVDC

Life Test:
2 × WVDC @ 125°C, 1000 hours.

Lead Material:
Tinned Copper Clad Steel

Temperature Range:
−55°C to +125°C

Temperature Coefficient:
0 ±30 PPM/°C

Dissipation Factor:
0.1% max. at 1 MHz @ 1 VRMS (≤100pF)
1 KHz @ 1 VRMS (>100pF)

Capacitance Tolerance:
F (±1%), G (±2%), J (±5%),
K (±10%), M (±20%)

NPO Temperature Coefficient

***Capacitance Value/Package**

	UR10A & UR20A		UR10B & UR20B		UR20C		UR20D	
	50V	100V	50V	100V	50V	100V	50V	100V
10pF								
12pF								
15pF								
18pF								
22pF								
27pF								
33pF								
39pF								
47pF								
56pF								
68pF								
82pF								
100pF								
120pF								
150pF								
180pF								
220pF								
270pF								
330pF								
390pF								
470pF								
560pF								
680pF								
820pF								
1000pF								
1200pF								
1500pF								
1800pF								
2200pF								
2700pF								
3300pF								
3900pF								
4700pF								
5600pF								
6800pF								
8200pF								
.01μF								
.012μF								
.015μF								
.018μF								
.022μF								
.027μF								
.033μF								
.039μF								

*FOR VALUES < 10pF CHECK FACTORY

Marking

A Body
Capacitance (EIA Cap Code)
Tolerance
Voltage: 05 = 50V, 10 = 100V

B, C, D Body
Unitrode Logo
Capacitance (EIA Cap Code)
Tolerance
Voltage: 05 = 50V, 10 = 100V
Temperature Coefficient

Ordering Information

STYLE	LEAD SPACING	PACKAGE	H	L	T	CAPACITANCE	TOLERANCE	VOLTAGE	TEMPERATURE COEFFICIENT
UR	10 = .100 20 = .200	A	.150" (3.81)	.150" (3.81)	.100" (2.54)	STD EIA CAP CODE	**C ±.25pF **D ±.5pF F ±1% G ±2% J ±5% K ±10% M ±20%	D 50V E 100V	N NPO
		B	.200" (5.08)	.200" (5.08)	.125" (3.18)				
		C	.300" (7.62)	.300" (7.62)	.150" (3.81)				
		D	.400" (10.16)	.400" (10.16)	.150" (3.81)				

**Available only on values of 5pF or less

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Unitrode Monolithic
Epoxy Coated
Radial Leaded
Ceramic Capacitors

Performance Characteristics

MIL Specifications:
Meets or exceeds applicable portions of MIL-C-11015 and MIL-C-39014.

Insulation Resistance:
Minimum 100,000 megohms or 1,000 megohm microfarads, whichever is less, with rated voltage applied, @ 25°C (see curve for other temperatures).

Dielectric Strength:
2.5 x WVDC

Life Test:
2 x WVDC @ 125°C, 1000 hours.

Lead Material:
Tinned Copper Clad Steel

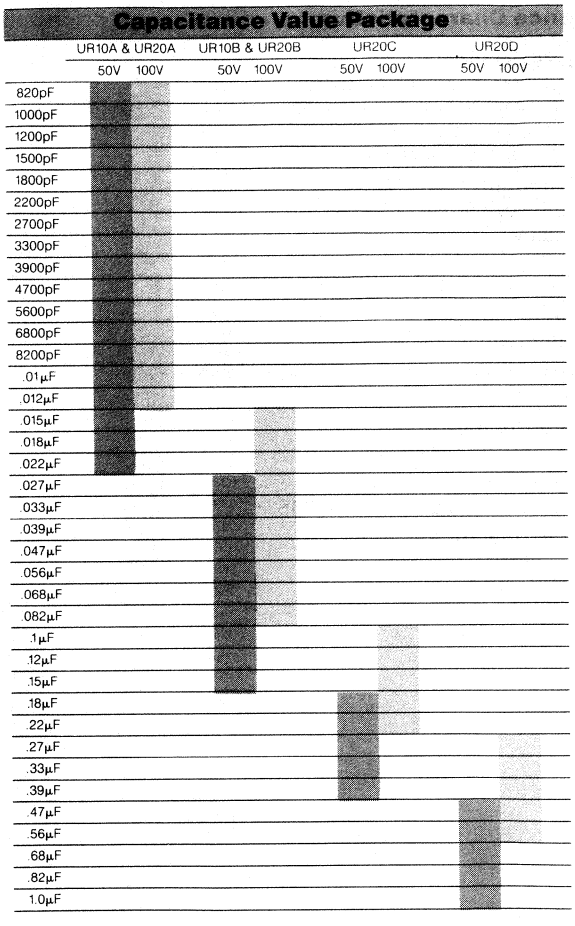
Temperature Range:
−55°C to +125°C

Temperature Coefficient:
±15%

Dissipation Factor:
2.5% @ 1 KHz @ 1 VRMS

Capacitance Tolerance:
K (±10%), M (±20%) Consult Factory for J (±5%) Tolerance

X7R Temperature Coefficient



11

Marking

A Body
Capacitance (EIA Cap Code)
Tolerance
Voltage: 05 = 50V, 10 = 100V

B, C, D Body
Unitrode Logo
Capacitance (EIA Cap Code)
Tolerance
Voltage: 05 = 50V, 10 = 100V
Temperature Coefficient

Ordering Information

STYLE	LEAD SPACING	PACKAGE	H	L	T	CAPACITANCE	TOLERANCE	VOLTAGE	TEMPERATURE COEFFICIENT
UR	10 .100" 20 .200"	A	.150" (3.81)	.150" (3.81)	.100" (2.54)	STD EIA CAP CODE	J ±5% K ±10% M ±20%	D 50V E 100V	X X7R
		B	.200" (5.08)	.200" (5.08)	.125" (3.18)				
		C	.300" (7.62)	.300" (7.62)	.150" (3.81)				
		D	.400" (10.16)	.400" (10.16)	.150" (3.81)				

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

Unitrode Monolithic
Epoxy Coated
Radial Leaded
Ceramic Capacitors

Performance Characteristics

Insulation Resistance:
Minimum 100,000 megohms or 1,000 megohm microfarads, whichever is less, with rated voltage applied, @ 25°C (see curve for other temperatures).

Dielectric Strength:
2.5 × WVDC below .5 mfd; 2.0 × WVDC .5 mfd and above

Life Test:
2 × WVDC @ 85°C, 1000 hours.

Lead Material:
Tinned Copper Clad Steel

Temperature Range:
+10°C to +85°C

Temperature Coefficient:
+22, −56%

Dissipation Factor:
3.0% max. at 1 KHz., 25°C, @ .3 VRMS

Capacitance Tolerance:
M (±20%), Z (+80%, −20%), GMV (+100%, −0%).

Z5U Temperature Coefficient

Capacitance Value/Package

	UR10A & UR20A		UR10B & UR20B		UR20C		UR20D	
	50V	100V	50V	100V	50V	100V	50V	100V
1000pF								
1200pF								
1500pF								
1800pF								
2200pF								
2700pF								
3300pF								
3900pF								
4700pF								
5600pF								
6800pF								
8200pF								
.01μF								
.012μF								
.015μF								
.018μF								
.022μF								
.027μF								
.033μF								
.039μF								
.047μF								
.056μF								
.068μF								
.082μF								
.1μF								
.12μF								
.15μF								
.18μF								
.22μF								
.27μF								
.33μF								
.39μF								
.47μF								
.56μF								
.68μF								
.82μF								
1.0μF								
1.2μF								
1.5μF								
1.8μF								
2.2μF								
2.7μF								

Marking

A Body
Capacitance (EIA Cap Code)
Tolerance
Voltage: 05 = 50V, 10 = 100V

B, C, D Body
Unitrode Logo
Capacitance (EIA Cap Code)
Tolerance
Voltage: 05 = 50V, 10 = 100V
Temperature Coefficient

Ordering Information

STYLE	LEAD SPACING	PACKAGE				CAPACITANCE	TOLERANCE	VOLTAGE	TEMPERATURE COEFFICIENT
			H	L	T				
UR	10 .100 20 .200	A	.150" (3.81)	.150" (3.81)	.100" (2.54)	STD EIA CAP CODE	M ± 20% Z + 80%, -20%	D 50V E 100V	Z Z5U
		B	.200" (5.08)	.200" (5.08)	.125" (3.18)				
		C	.300" (7.62)	.300" (7.62)	.150" (3.81)				
		D	.400" (10.16)	.400" (10.16)	.150" (3.81)				

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

HI-REL SCREENING 12

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

HR201 HI-REL SCREENING

Unitrode semiconductors are inherently high-reliability devices, manufactured with a quality control system that complies to MIL-Q-9858A. Some users, however, want the ultimate assurance of reliability.

In addition to those devices qualified and tested to JANTX and JANTXV specifications we can supply our broad product line of hermetically sealed devices screened to various requirements.

For discrete semiconductor devices we can screen to Table II of MIL-S-19500.

Our linear integrated circuits can be screened to MIL-STD-883 METHOD 5004.6.

Our switching regulator (PIC) series is not covered by a MIL specification and for this series we recommend our own UL101 or UL102 screening program. This includes:

1. Hermetic Seal: Fine and Gross leaks MIL-STD-750 Method 1071.
2. High Temperature Storage, MIL-STD-750 Method 1032.1.
3. Temperature Cycling, MIL-STD-202 Method 107.
4. Reverse Bias Clamp Test, V_{CEO} = Rated V_{IN}, I_C = 5A, f = 25KHz, E_{OUT} = 5V, T_C = 25°C.
5. Power Stress, T_C = 125°C, P = 2.0W, t = 40 hrs.
6. High Temperature Reverse Bias, T_A = 125°C, t = 16 hrs., V_r = 80% of rating.

We have included, for those series of devices not covered by MIL-S-19500, an HR specification. These tests include those most applicable to Unitrode products.

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

SALES OFFICES 13

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A

UNITRODE

UNITRODE REGIONAL OFFICES

Eastern Area Office, Door 7 — Lakeside Office Park, North Avenue, Wakefield, MA 01880, Tel. (617) 245-3010, TWX 710-348-1733
Metropolitan New York Office, 351 Larkfield Road, Suite 4, East Northport, NY 11731, Tel. (516) 368-0956, TWX 510-226-6997
Capitol Region, 10630 Little Patuxent Parkway, Suite 315, Columbia, MD 21044, Tel. (301) 995-0994, 0996 TWX 701-862-1911
Southeast Office, 8001 North Dale Mabry Highway, Suite 801D, Tampa, FL 33614, Tel. (813) 932-5807, TWX 810-876-0886
Mid-America Area Office, 121 South Wilke Road, Suite 103, Arlington Heights, IL 60005, Tel. (312) 394-5240, TWX 910-233-0168
South Central Office, 13999 Goldmark, Suite 460, Dallas, TX 75240, Tel. (214) 231-8700, TWX 910-867-4738
Rocky Mountain Area, 9200 W. Cross Drive, Suite 413, Littleton, CO 80123, Tel. (303) 972-2693, TWX 910-333-2905
Western Area Office, 5530 Corbin Avenue, Suite 328, Tarzana, CA 91356, Tel. (818) 705-8085, TWX 910-494-5964
Southwest Office, 1700 E. Dyer Road, Suite 190, Santa Ana, CA 92705, Tel. (714) 261-1546, TWX 910-595-1999
Northwest Office, 2444 Moorpark Avenue, Suite 319, San Jose, CA 95128, Tel. (408) 294-4210, TWX 910-338-0126

DOMESTIC REPRESENTATIVES

ALABAMA
Advanced Components Mktg.
Huntsville
205-881-5493

ARIZONA
Compass Mktg. & Sales, Inc.
Phoenix
602-996-0635

Compass Mktg. & Sales, Inc.
Tucson
602-293-1220

ARKANSAS
See Texas

CALIFORNIA — NORTHERN
I^2 Inc.
Santa Clara
408-988-3400

CALIFORNIA — SOUTHERN
Centaur Corp.
Irvine
714-261-2123

Centaur Corp.
San Diego
619-278-4950

Centaur Corp.
Woodland Hills
818-704-1655

COLORADO
Component Sales, Inc.
Denver (Englewood)
303-779-8060

CONNECTICUT
Kanan Associates
Brookfield
203-775-0494

DELAWARE
See Pennsylvania-Eastern

DISTRICT OF COLUMBIA
See Maryland

FLORIDA
Delmac Sales, Inc.
Orlando
305-898-4688

Delmac Sales, Inc.
Ft. Lauderdale
305-739-0016

Delmac Sales, Inc.
Clearwater
813-447-5192

Delmac Sales, Inc.
Palm Bay
305-724-8377

GEORGIA
See Alabama

IDAHO
See Washington

ILLINOIS — NORTHERN
Oasis Sales Corp.
Elk Grove Village
312-640-1850

ILLINOIS — SOUTHERN
See Missouri

INDIANA
Shamrock Associates
Carmel
317-848-5265

IOWA
Rush & West Associates
Davenport
319-326-3091

KANSAS
Rush & West Associates
Olathe
913-764-2700

KENTUCKY
See Ohio

LOUISIANA
See Texas

MAINE
See Massachusetts

MARYLAND
New Era Sales, Inc.
Severna Park
301-544-4100

MASSACHUSETTS
Kanan Associates
Needham
617-449-7400

Byrne Associates, (DEC only)
Maynard
617-897-3131

MICHIGAN
Miltimore Sales, Inc.
Novi
313-349-0260

Miltimore Sales, Inc.
Grand Rapids
616-942-9721

MINNESOTA
Aldridge Associates
Eden Prairie
612-944-8433

MISSISSIPPI
See Alabama

MISSOURI
Rush & West Associates
Ballwin
314-394-7271

MONTANA
See Colorado

DOMESTIC REPRESENTATIVES (Continued)

NEBRASKA

See Missouri

NEVADA — NORTHERN

See California — Northern

NEVADA — SOUTHERN

See Arizona

NEW HAMPSHIRE

See Massachusetts

NEW JERSEY — NORTHERN

T.A.M., Inc.
Cedar Knolls
201-285-9094

NEW JERSEY — SOUTHERN

See Pennsylvania — Eastern

NEW MEXICO

Compass Mktg. & Sales, Inc.
Albuquerque
505-888-0800

NEW YORK — METROPOLITAN AND LONG ISLAND

T.A.M., Inc.
South Hauppauge
516-348-0800

NEW YORK — UPSTATE

Reagan/Compar Albany, Inc.
Albany
518-489-7408

Reagan/Compar Albany, Inc.
New Hartford
315-732-3775

Reagan/Compar Albany, Inc.
Fairport
716-271-2230

Reagan/Compar Albany, Inc.
W. Henrietta
716-271-2230

Reagan/Compar Albany, Inc.
Endwell
607-723-8743

Reagan/Compar Albany, Inc.
Endwell
607-754-8946

NORTH CAROLINA

J & B Sales
Raleigh
919-878-8600

NORTH DAKOTA

See Minnesota

OHIO

Thompson and Associates
Dayton
513-435-7733

Thompson and Associates
Beachwood
216-831-6277

Thompson and Associates
Columbus
614-272-2086

OKLAHOMA

See Texas

OREGON

Jas. J. Backer Company
Portland
503-297-8744

PENNSYLVANIA — EASTERN

Omni Sales
Erdenheim
215-233-4600

PENNSYLVANIA — WESTERN

Thompson and Associates
Mars
412-776-6495

RHODE ISLAND

See Massachusetts

SOUTH CAROLINA

See North Carolina

SOUTH DAKOTA

See Minnesota

TENNESSEE

See Alabama

TEXAS

Sundance Sales, Inc.
Dallas (Plano)
214-867-0592

Sundance Sales, Inc.
Austin
512-339-6611

Sundance Sales, Inc.
Houston
713-772-4988

UTAH

Component Sales, Inc.
Salt Lake City
801-268-8440

VERMONT

See Massachusetts

VIRGINIA

See Maryland

WASHINGTON

Jas. J. Backer Company
Seattle
206-285-1300

WEST VIRGINIA

See Western Pennsylvania

WISCONSIN

Oasis Sales Corp.
Brookfield
414-782-6660

WYOMING

See Colorado

CANADA

Kaytronics Limited
Quebec
514-367-0101

Kaytronics Limited
Concord, Ontario
416-669-2262

Kaytronics Limited
Surrey
604-581-5005

Kaytronics Limited
Kanata, Ontario
613-592-6606

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

DOMESTIC DISTRIBUTORS

ALABAMA

Arrow Electronics/Huntsville
205-882-2730

Hall-Mark/Huntsville
205-837-8700

Hamilton/Avnet/Huntsville
205-837-7210

ARIZONA

Arrow Electronics/Phoenix
602-968-4800

Hall-Mark/Phoenix
602-243-6601

Hamilton/Avnet/Tempe
602-275-5100

CALIFORNIA — NORTHERN

Arrow Electronics/Sunnyvale
408-745-6600

Capsco Sales/Sunnyvale
408-734-3020

Hall-Mark/Sunnyvale
408-773-9990

Hall-Mark/Sacramento
916-722-8600

Hamilton/Avnet/Sacramento
916-925-2216

Hamilton/Avnet/Sunnyvale
408-743-3355

Zeus Components/Santa Clara
408-727-0714

CALIFORNIA — SOUTHERN

Arrow Electronics/Chatsworth
818-701-7500

Arrow Electronics/Newport Beach
714-838-5422

Arrow Electronics/San Diego
619-565-4800

Avnet Electronics/Chatsworth
818-700-2600

Avnet Electronics/Costa Mesa
714-754-6111

Avnet Electronics/Los Angeles
213-558-2345

Hamilton/Avnet/Ontario
714-989-4602

Hamilton/Avnet/San Diego
619-571-7510

Hall-Mark/West Los Angeles
213-643-9101

Hall-Mark/San Diego
619-268-1201

Hall-Mark/San Fernando Valley
818-716-7300

Hall-Mark/Orange County
714-669-4700

Hamilton Electro Sales/Costa Mesa
714-641-4152

Hamilton Electro Sales/Culver City
213-558-2121

Hamilton Electro Sales/S.F.V.
818-700-6500

Zeus Components/Anaheim
714-632-6880

COLORADO

Arrow Electronics/Aurora
303-696-1111

Hall-Mark/Denver
303-790-1662

Hamilton/Avnet/Englewood
303-779-9998

CONNECTICUT

Arrow Electronics/Wallingford
203-265-7741

Hall-Mark/Wallingford
203-269-0100

Hamilton/Avnet/Danbury
203-797-2800

FLORIDA

Arrow Electronics/Clearwater
813-576-8995

Arrow Electronics/Palm Bay
305-725-1480

Arrow Electronics/Ft. Lauderdale
305-776-7790

Hall-Mark/Ft. Lauderdale
305-971-9280

Hall-Mark/Orlando
305-855-4020

Hall-Mark/Tampa-St. Petersburg
813-530-4543

Hamilton/Avnet/Ft. Lauderdale
305-971-2900

Hamilton/Avnet/Melbourne
305-725-2700

Hamilton/Avnet/St. Petersburg
813-576-3930

Hamilton/Avnet/Orlando
305-628-3888

Zeus Components/Oviedo
305-365-3000

GEORGIA

Arrow Electronics/Norcross
404-449-8252

Hall-Mark/Norcross
404-447-8000

Hamilton/Avnet/Norcross
404-447-7507

ILLINOIS

Arrow Electronics/Schaumburg
312-397-3440

Hall-Mark/Bensenville
312-860-3800

Hamilton/Avnet/Bensenville
312-860-7700

INDIANA

Arrow Electronics/Indianapolis
317-243-9353

Hamilton/Avnet/Carmel
317-844-9333

IOWA

Arrow Electronics/Cedar Rapids
319-395-7230

Hamilton/Avnet/Cedar Rapids
319-362-4757

KANSAS

Hall-Mark/Lenexa
913-888-4747

Hamilton/Avnet/Overland Park
913-888-8900

MARYLAND

Arrow Electronics/Baltimore
301-995-0003

Hall-Mark/Columbia
301-988-9800

Hamilton/Avnet/Columbia
301-995-3500

Zeus Components/Columbia
301-997-1118

MASSACHUSETTS

Arrow Electronics/Woburn
617-933-8130

Hall-Mark/Billerica
617-935-9777

Hamilton/Avnet/Woburn
617-273-7500

Lionex Corporation/Burlington
617-272-9400

Zeus Components/Burlington
617-863-8800

MICHIGAN

Arrow Electronics/Grand Rapids
616-243-0912

Arrow Electronics/Ann Arbor
313-971-8220

Hamilton/Avnet/Grand Rapids
616-243-8805

Hamilton/Avnet/Livonia
313-522-4700

MINNESOTA

Arrow Electronics/Edina
612-830-1800

DOMESTIC DISTRIBUTORS (Continued)

Hall-Mark/Bloomington
612-854-3223

Hamilton/Avnet/Minnitonka
612-932-0600

MISSOURI

Arrow Electronics/St. Louis
314-567-6888

Hall-Mark/Earth City
314-291-5350

Hamilton/Avnet/Earth City
314-344-1200

NEW HAMPSHIRE

Arrow Electronics/Manchester
603-668-6968

Hamilton/Avnet/Manchester
603-624-9400

NEW JERSEY — NORTHERN

Arrow Electronics/Fairfield
201-575-5300

Hall-Mark/Fairfield
201-575-4415

Hamilton/Avnet/Fairfield
201-575-3390

Lionex Corporation/Fairfield
201-227-7960

NEW JERSEY — SOUTHERN

Arrow Electronics/Marlton
609-596-8000

Hall-Mark/Cherry Hill
609-424-7300

Hamilton/Avnet/Cherry Hill
609-424-0100

NEW MEXICO

Arrow Electronics/Albuquerque
505-243-4566

Hamilton/Avnet/Albuquerque
505-765-1500

NEW YORK

Arrow Electronics/Hauppauge
516-231-1000

Arrow Electronics/Liverpool
315-652-1000

Arrow Electronics/Rochester
716-427-0300

Hall-Mark/Ronkonkoma
516-737-0600

Hamilton/Avnet/Melville
516-231-9800

Hamilton/Avnet/Rochester
716-475-9130

Hamilton/Avnet/Syracuse
315-437-2641

Lionex Corporation/Hauppauge
516-273-1660

Zeus Components/Port Chester
914-937-7400

NORTH CAROLINA

Arrow Electronics/Raleigh
919-876-3132

Arrow Electronics/Winston-Salem
919-725-8711

Hall-Mark/Raleigh
919-872-0712

Hamilton/Avnet/Raleigh
919-878-0810

OHIO

Arrow Electronics/Centerville
513-435-5563

Arrow Electronics/Solon
216-248-3990

Hall-Mark/Cincinnati
513-563-5980

Hall-Mark/Cleveland
216-349-4632

Hall-Mark/Columbus
614-882-7004

Hamilton/Avnet/Cleveland
216-831-3500

Hamilton/Avnet/Dayton
513-433-0610

Hamilton/Avnet/Westerville
614-436-5851

OKLAHOMA

Arrow Electronics/Tulsa
918-665-7700

Hall-Mark/Tulsa
918-665-3200

OREGON

Hamilton/Avnet/Portland
503-635-8831

Arrow Electronics/Portland
503-684-1690

PENNSYLVANIA

Arrow Electronics/Pittsburgh
412-856-7000

Hall-Mark/Philadelphia
215-355-7300

Lionex/Horsham
215-443-5150

RHODE ISLAND

Arrow Electronics/E. Providence
401-431-0980

TEXAS

Arrow Electronics/Austin
512-835-4180

Arrow Electronics/Dallas
214-380-6464

Arrow Electronics/Houston
713-530-4700

Hall-Mark/Austin
512-258-8848

Hall-Mark/Dallas
214-341-1147

Hall-Mark/Houston
713-781-6100

Hamilton/Avnet/Austin
512-837-8911

Hamilton/Avnet/Houston
713-780-1771

Hamilton/Avnet/Irving
214-659-4111

Lenert Co., Inc./Houston
713-225-1465

Zeus Components/Dallas
214-783-7010

UTAH

Arrow Electronics/Salt Lake City
801-972-0404

Hamilton/Avnet/Salt Lake City
801-972-2800

VIRGINIA

Arrow Electronics/Richmond
804-282-0413

WASHINGTON

Arrow Electronics/Bellevue
206-643-4800

Hamilton/Avnet/Seattle
206-453-5844

WISCONSIN

Arrow Electronics/Oak Creek
414-764-6600

Hall-Mark/Oak Creek
414-761-3000

Hamilton/Avnet/New Berlin
414-784-4510

CANADA

Future Electronics/Downsview
416-663-5563

Future Electronics/Ottawa
613-820-8313

Future Electronics/Point Claire
514-694-7710

Future Electonics/Vancouver
604-438-5545

Hamilton/Avnet/Calgary
403-230-3586

Hamilton/Avnet/Montreal
514-335-1000

Hamilton/Avnet/Nepean
613-226-1700

Hamilton/Avnet/Toronto
416-677-7432

Hamilton/Avnet/Vancouver
604-272-4242

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

UNITRODE

UNITRODE SALES OFFICES

Corporate International and Asian Regional Sales Office, 5 Forbes Road, Lexington, MA 02173 Tel. (617) 861-6540, Telex 95-1064
Unitrode Electronics GmbH, Hauptstrasse 68, 8025 Unterhaching, West Germany Tel. 089/6190 04/05/06, Telex 841-05-22-109
Unitrode (U.K.) Limited, 6 Cresswell Park, Blackheath, London SE3 9RD, United Kingdom Tel. 01-318-1431/4, Telex 896270
Unitrode S.R.L., Via Dei Carracci, 5, 20149 Milano, Italy Tel. 439-6831, 434 604, Telex 310085 UNITRD I
Unitrode-Ireland, Ltd., Industrial Estate, Shannon, County Clare, Ireland Tel. 353-61-62377, Telex 26233

INTERNATIONAL AGENTS — DISTRIBUTORS

AUSTRALIA

VSI Electronics (Australia) Pty. Ltd.
P.O. Box 578
Crows Nest N.S.W. 2056
Tel: 439-4655
TELEX: 22846

AUSTRIA

Dahms Elektronik
Wienerstrasse, 287
1-8051 Graz
Tel: (0316) 64.0.30
TELEX: 031099

BELGIUM

J.P. Lemaire
Limburg Stirum 243
1810 Wemmel
Tel: 478 73-08
TELEX: 846-24610

BRAZIL

Hi Tech Comercial & Industrial Ltda.
Av. Eng. Luiz Carlos Berrini,
801, Cj. 121
Cidade Moncors
04 571 Sao Paulo
Tel: (011) 533-9566
TELEX: 11-53288 HT HB BR

DENMARK

Ditz Schweitzer A/S
Vallensbaekvej 41
DK-2600 Glostrup
Tel: 2-45 30 44
TELEX: 855-33257

EASTERN EUROPE

Dahms Elektronik
Wienerstrasse, 287
1-8051 Graz
Tel: (0316) 64.0.30
TELEX: 031099

FINLAND

Turion Oy
P.O. Box 24
SF-00781 Helsinki
Tel: 3580 372144
TELEX: 124388 Eurio SF

FRANCE

Spetelec
Tour Europa, 111
94532 Rungis Cedex
Tel: (1) 686 5665
TELEX: 250 801 F

Spetelec
41, Av. Des Frères Lumiere
69680 Chassieu
Tel: (7) 840 1006
TELEX: 375 444 F

UniRep
Zone d'Activités 'Les Godets'
CE No. 433
91374 Verrierés Le Buisson Cedex
Tel: (6) 920 0364
TELEX: 603 131

C.C.I.
Z. I. - Rue M. Berthelot
92160 Antony Cedex
Tel: (1) 666 2182
TELEX: 203 881 F

C.C.I.
67, Rue Bataille
69008 Lyon
Tel. (7) 874 4456
TELEX: 375456 F

GERMANY

Unitrode Electronics GmbH
Hauptstrasse 68
8025 Unterhaching
Tel: 089/6190 04/05/06
TELEX: 841-05-22-109

EBV Elektronik GmbH
Oberweg 6
8025 Unterhaching
Tel: (089) 611051
TELEX: 524535

EBV Elektronik GmbH
Oststrasse 129
4000 Düsseldorf
Tel: 0211-84-84-6/7
TELEX: 08587267

EBV Elektronik GmbH
Schenckstrasse 90
6000 Frankfurt/Main 99
Tel: 069 785037
TELEX: 413590

EBV Elektronik GmbH
Kibitzrain 18
3006 Burgwedel 1
Tel: 05139/5038
TELEX: 0923694

EBV Elektronik GmbH
Alexanderstrasse 42
7000 Stuttgart 1
Tel: 0711/24 74 81
TELEX: 0722271

Metronik GmbH
Kapellenstrasse 9
8025 Unterhaching
Tel: 089-6114063
TELEX: 0529524

Metronik GmbH
Siemenstr. 92
6803 Heddesheim
Tel: 06203-4701
TELEX: 465035

Metronik GmbH
Lauf am Holz Str. 11
8500 Nürnberg
Tel: 0911/423037/38
TELEX: 626205

Metronik GmbH
Semerteich Str. 92
4600 Dortmund 30
Tel: 0231/423037-38
Telex: 8227082

Frehsdorf GmbH
Carl-Zeiss-Strasse 3
2085 Quickborn
Tel: 04106-71058
TELEX: 0213693

Frehsdorf GmbH
Herbststr. 1
8200 Rosenheim
Tel: 08031/37085-86
TELEX: 525865

Frehsdorf GmbH
Schluterstr. 30
1000 Berlin 12
Tel: 030-8839040
TELEX: 185418

INTERNATIONAL AGENTS — DISTRIBUTORS (Continued)

HONG KONG

CET, Ltd.
10/F, Hua Hsia Building
64-66 Gloucester Road
Tel: 5-200922
TELEX: 85148 CET HX

INDIA

Sujata Sales and
Exports Ltd.
112 Bajaj Bhavan
11th Floor
Nariman Point
Bombay 400 021
Tel: 234658
TELEX: 011-3855

IRELAND

New England Technical Sales Ltd.
Stonehaven, Dublin Road
Malahide, Co. Dublin
Tel: (01) 450-635
TELEX: 31407

New England Technical Sales Ltd.
Castle Roberts
Adare
Co. Limerick
Tel: 061-94301

ISRAEL

S.T.G. International, Ltd.
10 Huberman Street
P.O. Box 1276
Tel-Aviv 61012
Tel: 03-248231
TELEX: 922-342229

ITALY

Unitrode S.R.L.
Via Dei Carracci, 5
20149 Milano
Tel: 431-831
Tel: 434-604
TELEX: 310085 UNITRD 1

Eurelettronica S.R.L.
Via Mascheroni, 20
20145 Milano
Tel: (02) 498 1851
TELEX: 332102

Fanton Milano, S.R.L.
Via Melegnano, 20
20019 Settimo Milanese MI
Tel: (02) 328 7312
TELEX: 350 8531

Dimac Elettronica S.R.L.
Via Santa Maria alle Selve, 4
20046 Biassono MI
Tel: (039) 491514
TELEX: 316518

Fanton Electronic System S.R.L.
Via Savelli, 1
35129 Padova
Tel: 049-77-5822
TELEX: 430192

Fanton Bologna S.R.L.
Via Machiavelli, 16
40069 Riale Di Zola Predosa BO
Tel: (051) 75 1710
TELEX: 216613

Fanton Torino S.R.L.
Via Cimabue, 5
10137 Torino TO
Tel: (011) 309 7347
TELEX: 224129

C.F. SNC
Via Andrea del Castagno, 34
00142 Roma Eur RM
Tel: (6) 541 0947
TELEX: 620035

JAPAN

Rikei Corporation
Shinjuku Nomura Bldg.
1-26-2 Nishi-Shinjuku
Shinjuku-Ku
Tokyo 160
Tel: Tokyo (03) 345-1411
TELEX: J24208, J23772
Cable Address: "RIKEI-GOOD" Tokyo

KOREA R.O.K.

Duksung Trading Co.
P.O. Box 31 Nam-Seoul,
Room 301 Jinwon Bldg.
507-30 Sinrim 4-Dong.
Gwanak-Ku
Tel: 854-5047
TELEX: K23459 Duksung Seoul

NETHERLANDS

Koning en Hartman
Elektrotechniek B.V.
2544 En The Hague
30 Koperwerf
Tel: 70-210101
TELEX: 31528

NEW ZEALAND

Professional Electronics
22 A Milford Road
Auckland
Tel: 493-029, 499-048
TELEX: NZ21084

NORWAY

Neco A/S
Postboks 29-Lindeberg Gard
Jerikoveien 22-Oslo 10
Tel: 30 12 30
TELEX: 19247

SINGAPORE

Desner Electronic PTE, Ltd.
190 Middle Road, #16-07
Fortune Centre
Singapore 0718
Tel: 337-3188
TELEX: RS 39191

SOUTH AFRICA

Electrolink (Pty) Ltd.
Fleetway House
Martin Hammerschlag Way
Foreshore, Capetown
Tel: 215350
TELEX: 5-27320

SPAIN

Monolithic
Calle Fresser, 52
Barcelona - Y
Tel: (3) 347 4155
TELEX: 98 206 E

SWEDEN

AB Betoma
Box 3005
S-171 03 Solna
Tel: 08 820280
TELEX: 854-19389

DISTRIBUTOR

Fertronic AB
Snoermakarvaegen 35
Box 56
161 26 Bromma
Tel: 08252610
TELEX: 11181

SWITZERLAND

Elkom AG
Dorfstrasse 30
CH-5624 Buenzen
Tel: 57-462191
TELEX: 57302

TAIWAN

Holy Stone Enterprise Co.
8-2 Fl. 15 HSIN, 1 Road Section 2
Taipei 106
Tel: 341-2493
TELEX: 13867 HOLYSTON

UNITED KINGDOM

Unitrode (U.K.) Limited
6 Cresswell Park
Blackheath London SE3 9RD
Tel: 01-318-1431/4
TELEX: 896270

REPRESENTATIVE

Candy Electronic Components
Old Mill Lane
Aylesford
Maidstone, Kent ME20 TDT
Tel: 0622-70774/5
TELEX: 965998

INTERNATIONAL AGENTS — DISTRIBUTORS (Continued)

DISTRIBUTORS

The House of Power
(Semiconductors)
Electron House
Cray Avenue, St. Mary Cray
Orpington, Kent BR5 3QJ
Tel: 0689 71531/7
TELEX: 896141

Thame Components Ltd.
(Semiconductors)
Thame Park Road
Thame, Oxon OX9 3XD
Tel: 084-421-4561
TELEX: 837917

Nortronic Associates, Ltd.
(Capacitors)
Gateway, Crewe Gates Industrial Estate
Crewe CW1 1YY
Tel: 0270 586161
TELEX: 36509

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A

NOTES

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

NOTES

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

NOTES

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

NOTES

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.

To ensure receiving a copy of Unitrode's 1986/1987 Semiconductor Databook, please fill in the information below.

Name _____

Title ☐ Design Engineer ☐ Quality Assurance Engineer
☐ Components Engineer ☐ Other _____ (Please specify)
☐ Purchasing Agent

Company _____ Division _____

Address _____ (Street) Mail Stop/Dept. _____

_____
(City) (State) (Country) (Zip)

Telephone _____ (Area Code)

Which of the following most accurately describes your company's business:

☐ Industrial Controls ☐ Radio Communications
☐ Military ☐ Data Processing
☐ Telecommunications ☐ Instrumentation

☐ Other _____ (Please Specify)

Can you list names and job titles of other persons in your organization who would use copies of our Databook?

_____
Name Title

_____
Company Division

_____
Street Mail Stop

_____
City State Country Zip

_____
Name Title

_____
Company Division

_____
Street Mail Stop

_____
City State Country Zip

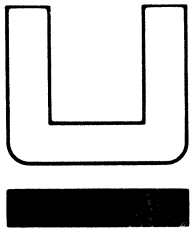
MAIL TO:

Unitrode Corporation
5 Forbes Road
Lexington, MA 02173 U.S.A.

Attn: Advertising Manager

UNITRODE CORPORATION • 5 FORBES ROAD
LEXINGTON, MA 02173 • TEL. (617) 861-6540
TWX (710) 326-6509 • TELEX 95-1064

PRINTED IN U.S.A.



UNITRODE

Unitrode Corporation • 5 Forbes Road • Lexington, MA 02173
Tel (617) 861-6540 • TWX (710) 326-6509 • Telex 95-1064

DB-400

PRINTED IN U.S.A.