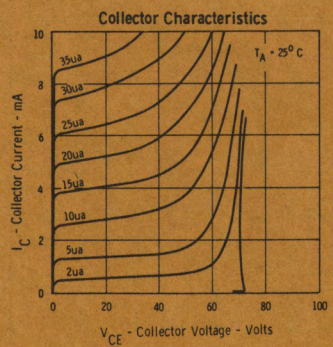
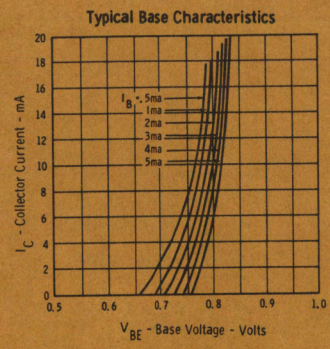
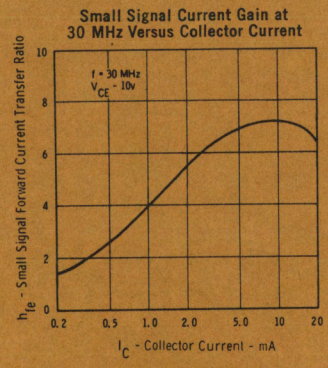
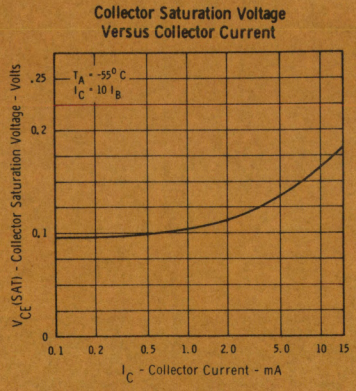
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Base Voltage Differential Drift 2N2453 2N2453A	$\Delta(V_{BE1}-V_{BE2})/\Delta T$	$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$ to $+125°C$		 10 5.0	$\mu V/°C$
Small Signal Current Gain	h_{fe}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1 kHz	150	600	
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = 5.0$ mA, $V_{CE} = 10$ V f = 30 MHz	2.0		
Output Capacitance 2N2453 2N2453A	C_{ob}	$I_E = 0$, $V_{CB} = 10$ V f = 140 kHz		8.0 4.0	pf
Input Capacitance	C_{ib}	$I_C = 0$, $V_{BE} = 0.5$ V f = 140 kHz		10	pf
Voltage Feedback Ratio	h_{rb}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1 kHz		5.0	$x10^{-4}$
Reverse Voltage Feedback Ratio	h_{re}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1 kHz		6.0	$x10^{-4}$
Input Resistance	h_{ib}	$I_C = 1.0$ mA, $V_{CB} = 5.0$ V f = 1 kHz	20	30	ohms
Input Resistance	h_{ie}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1 kHz		5.0	kΩ
Output Conductance	h_{ob}	$I_C = 1.0$ mA, $V_{CB} = 5.0$ V f = 1 kHz		0.2	μmhos
Output Conductance	h_{oe}	$I_C = 1.0$ mA, $V_{CB} = 5.0$ V f = 1 kHz	5.0	30	μmhos
Low Frequency Noise Figure 2N2453 2N2453A	NF	 f = 1 kHz Source resistance = 10 kΩ Equivalent noise power bandwidth = 200 Hz $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V		 7.0 4.0	db

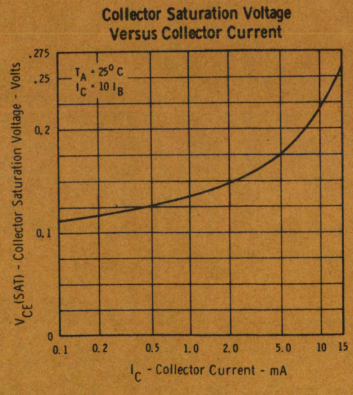
* The lower of the h_{FE} readings is taken as h_{FE1}.
** Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

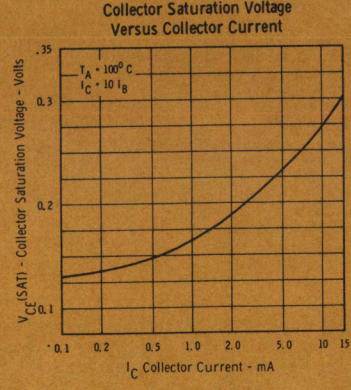




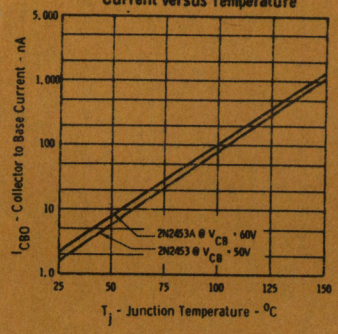




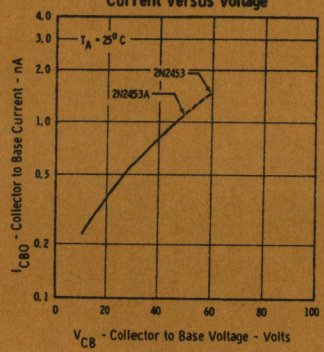




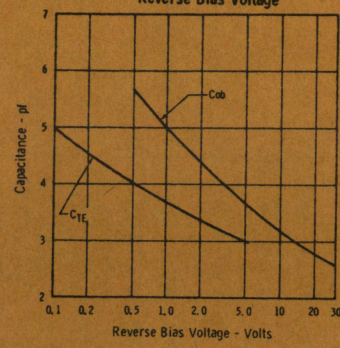
Collector - Base Diode Reverse Current versus Temperature



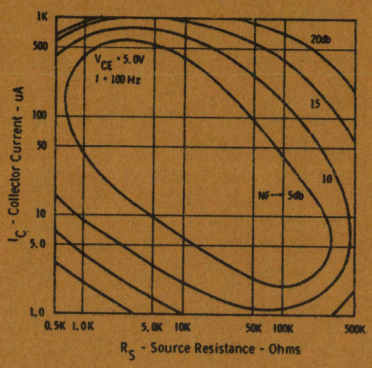
Collector - Base Diode Reverse Current Versus Voltage



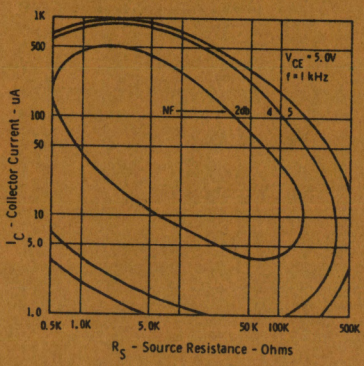
Collector and Emitter Transition Capacitance Versus Reverse Bias Voltage



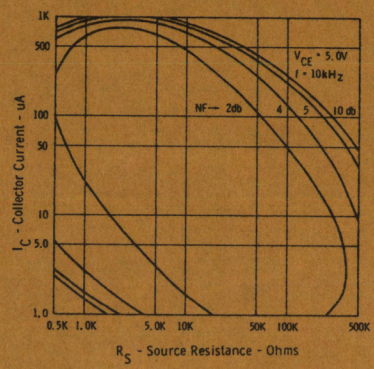
Noise Figure at 100 Hz



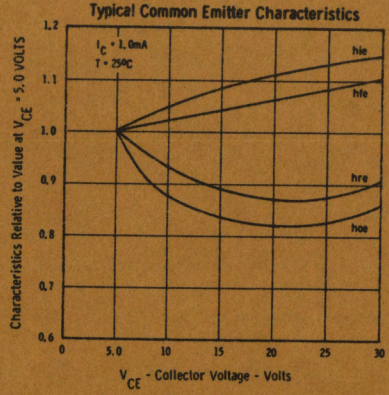
Noise Figure at 1 kHz



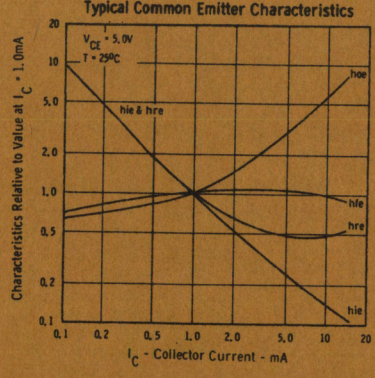
Noise Figure at 10 kHz



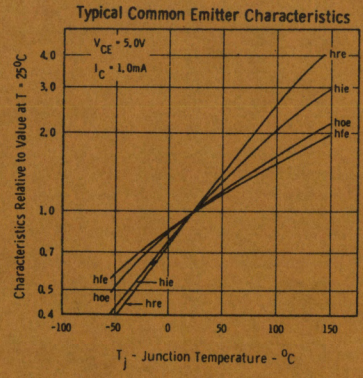
Typical Common Emitter Characteristics



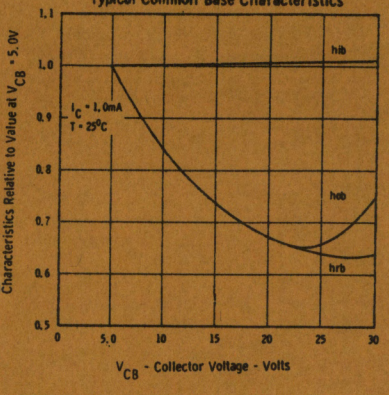
Typical Common Emitter Characteristics



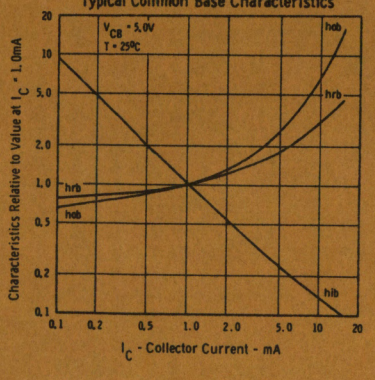
Typical Common Emitter Characteristics



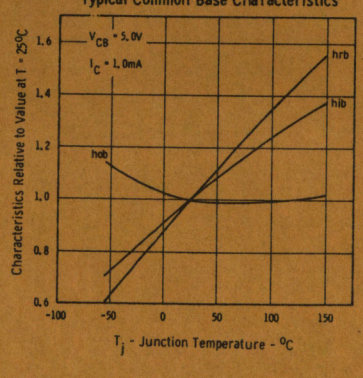
Typical Common Base Characteristics



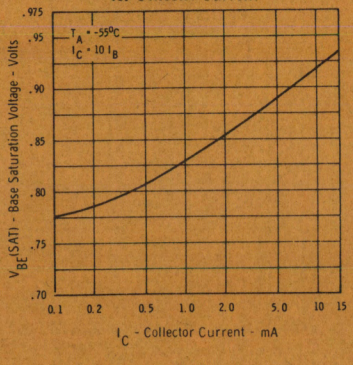
Typical Common Base Characteristics



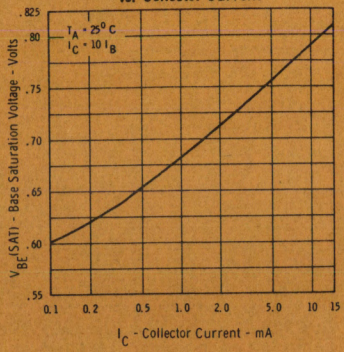
Typical Common Base Characteristics



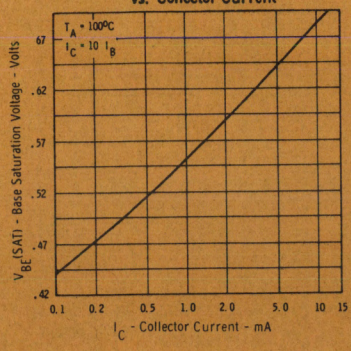
Base Saturation Voltage vs. Collector Current



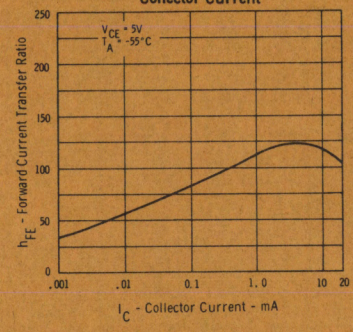
Base Saturation Voltage vs. Collector Current



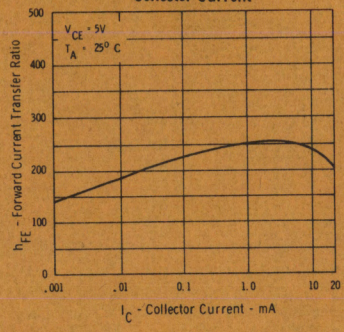
Base Saturation Voltage vs. Collector Current



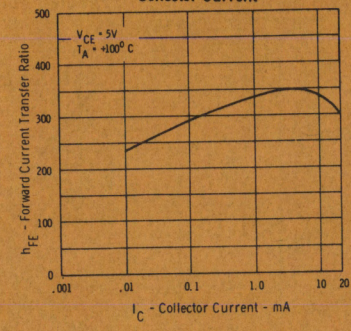
Pulsed DC Current Gain Versus Collector Current



Pulsed DC Current Gain Versus Collector Current



Pulsed DC Current Gain Versus Collector Current



DUAL NPN TRANSISTOR
GENERAL PURPOSE

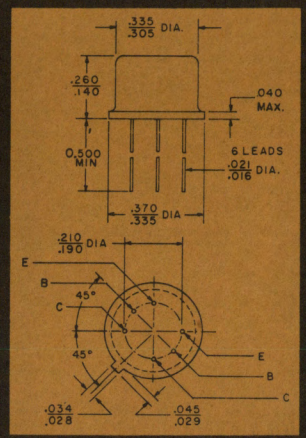
- CLOSELY MATCHED CURRENT GAIN
- VERY LOW DIFFERENTIAL DRIFT
- LOW NOISE

JANUARY 1968

2N2639 THRU 2N2644

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Collector-Base Voltage	V_{CBO}	45		Volts
Collector-Emitter Voltage	V_{CEO}	45		Volts
Emitter-Base Voltage	V_{EBO}	5.0		Volts
Collector Current	I_C	30		mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	One Side 0.3 0.6	Both Sides 0.6 1.2	Watts
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 2.0 4.0	 4.0 8.0	mW/°C
Storage Temperature	T_{stg}	−65 to +300		°C
Junction Temperature	T_J	+175		°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$	45		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 10\ \mu A$	5.0		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$**	$I_C = 10$ mA, $I_B = 0$	45		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 0.5$ mA		1.0	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10$ mA, $I_B = 0.5$ mA	0.6	1.0	Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = 45$ V $I_E = 0$, $V_{CB} = 45$ V, $T_A = 150°C$		10 10	nA μA
Collector-Emitter Cutoff Current	I_{CEO}	$I_B = 0$, $V_{CE} = 5.0$ V		10	nA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0$, $V_{EB} = 5.0$ V		10	nA
DC Current Gain 2N2639-41 2N2642-44	h_{FE}	 $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $I_C = 100\ \mu A$, $V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$ $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $I_C = 100\ \mu A$, $V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$	 50 55 65 10 100 110 130 20	 300 300	
DC Current Gain Ratio 2N2639, 2N2642 2N2640, 2N2643	h_{FE1}/h_{FE2}*	$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V	 0.9 0.8	 1.0 1.0	
Base Voltage Differential 2N2639, 2N2642 2N2640, 2N2643	V_{BE1}-V_{BE2}	$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V		 5.0 10	mV
Base Voltage Differential Drift 2N2639, 2N2642 2N2640, 2N2643	$\Delta(V_{BE1}-V_{BE2})/\Delta T$	 $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$ to $+125°C$		 10 20	μ V/°C
Small Signal Current Gain 2N2639-41 2N2642-44	h_{fe}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V $f = 1.0$ kHz	 65 130	 600 600	

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 20 MHz	4.0		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 5.0$ V f = 1.0 MHz		8.0	pf
Voltage Feedback Ratio	h_{rb}	$I_E = -1.0$ mA, $V_{CB} = 5.0$ V f = 1.0 kHz		6.0	$X\ 10^{-4}$
Input Resistance	h_{ib}	$I_E = -1.0$ mA, $V_{CB} = 5.0$ V f = 1.0 kHz	25	32	Ohms
Output Conductance	h_{ob}	$I_E = -1.0$ mA, $V_{CB} = 5.0$ V f = 1.0 kHz		1.0	μmhos
Noise Figure	NF	f = 10 Hz to 15.7 kHz Source Resistance = 10 kΩ $I_C = 10\ \mu$A, $V_{CE} = 5.0$ V		4.0	db

* The lower h_{FE} reading is taken as h_{FE1}.
** Pulse Conditions: Pulse Width = 300 μsec; Duty Cycle = 1%.

DUAL NPN TRANSISTOR
GENERAL PURPOSE

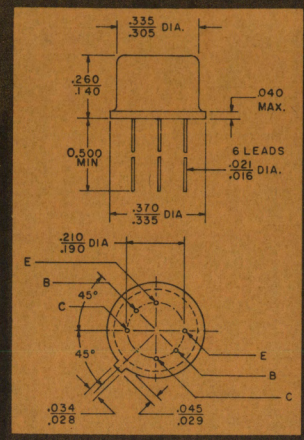
- LOW NOISE
- CLOSELY MATCHED CURRENT GAIN
- HIGH BREAKDOWN VOLTAGE

JANUARY 1968

2N2720
2N2721
2N2722

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Collector-Base Voltage 2N2720, 21 2N2722	V_{CBO}	80 45		Volts
Collector-Emitter Voltage 2N2720, 21 2N2722	V_{CEO}	60 45		Volts
Emitter-Base Voltage 2N2720, 21 2N2722	V_{EBO}	6.0 5.0		Volts
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	One Side 0.3 0.6	Both Sides 0.6 1.2	Watts
Derating Factor above 25°C @ $T_A = 25°C$		1.71	3.4	mW/°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage 2N2720, 21 2N2722	BV_{CBO}	$I_C = 10\ \mu A, I_E = 0$	80 45		Volts
Emitter-Base Breakdown Voltage 2N2720, 21 2N2722	BV_{EBO}	$I_C = 0, I_E = 10\ \mu A$	6.0 5.0		Volts
Collector-Emitter Sustaining Voltage 2N2720, 21 2N2722	$V_{CEO(sus)}$**	$I_C = 10$ mA, $I_B = 0$	60 45		Volts
Collector Saturation Voltage 2N2720, 21 2N2722	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 10$ mA, $I_B = 0.5$ mA		1.0 1.0	Volts
Base Saturation Voltage 2N2720, 21 2N2722	$V_{BE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 10$ mA, $I_B = 0.5$ mA	0.65 0.65	0.85 0.85	Volts
Collector-Base Cutoff Current 2N2720, 21 2N2722 2N2720, 21 2N2722	I_{CBO}	$I_E = 0, V_{CB} = 60$ V $I_E = 0, V_{CB} = 30$ V $I_E = 0, V_{CB} = 60$ V, $T_A = 150°C$ $I_E = 0, V_{CB} = 30$ V, $T_A = 150°C$		10 1.0 10 1.0	nA μA
Collector-Emitter Reverse Current 2N2720, 21 2N2722	I_{CEO}	$I_B = 0, V_{CE} = 5.0$ V		10 2.0	nA
Emitter-Base Cutoff Current 2N2720, 21 2N2722	I_{EBO}	$I_C = 0, V_{EB} = 5.0$ V		10 1.0	nA
DC Current Gain 2N2722 2N2722 2N2720, 21 2N2722 2N2720, 21 2N2720, 21	h_{FE}	$I_C = 1.0\ \mu A, V_{CE} = 5.0$ V $I_C = 10\ \mu A, V_{CE} = 5.0$ V $I_C = 100\ \mu A, V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10$ mA, $V_{CE} = 5.0$ V	50 100 30 125 35 42	250 120 	

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
DC Current Gain Ratio	h_{FE1}/h_{FE2}*				
2N2720		$I_C = 100\ \mu A$, $V_{CE} = 5.0$ V	0.9	1.0	
2N2721			0.8	1.0	
2N2722		$I_C = 1.0\ \mu A$, $V_{CE} = 5.0$ V	0.9	1.0	
Base Voltage Differential	V_{BE1}-V_{BE2}				
2N2720		$I_C = 100\ \mu A$, $V_{CE} = 5.0$ V		5.0	mV
2N2721				10	
2N2722		$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V		5.0	
Base Voltage Differential Change	$\Delta(V_{BE1}$-$V_{BE2})$				
2N2720		$I_C = 100\ \mu A$, $V_{CE} = 5.0$ V		0.8	mV
2N2721		$T_A = -55°C$ to $+25°C$		1.6	
2N2722		$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V		0.8	
		$T_A = -55°C$ to $+25°C$			
2N2720		$I_C = 100\ \mu A$, $V_{CE} = 5.0$ V		1.0	
2N2721		$T_A = 25°C$ to $125°C$		2.0	
2N2722		$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V		1.0	
		$T_A = 25°C$ to $125°C$			
Small Signal Current Gain	h_{fe}				
2N2720, 21		$I_C = 1.0$ mA, $V_{CE} = 5.0$ V	30	200	
		f = 1.0 kHz			
2N2722		$I_C = 0.1$ mA, $V_{CE} = 5.0$ V	100	700	
		f = 1.0 kHz			
High Frequency Current Gain	$\lvert h_{fe} \rvert$				
2N2720, 21		$I_C = 10$ mA, $V_{CE} = 10$ V	4.0		
2N2722		f = 20 MHz	5.0		
Output Capacitance	C_{ob}				
2N2720, 21		$I_E = 0$, $V_{CB} = 5.0$ V		6.0	pf
		f = 1.0 MHz			
2N2722		$I_E = 0$, $V_{CB} = 5.0$ V		6.0	
		f = 140 kHz			
Voltage Feedback Ratio	h_{rb}				
2N2720, 21		$I_E = 1.0$ mA, $V_{CB} = 5.0$ V		5.0	X 10^{-4}
2N2722		f = 1.0 kHz		6.0	
Input Resistance	h_{ib}	$I_E = 1.0$ mA, $V_{CB} = 5.0$ V	25	32	Ohms
		f = 1.0 kHz			
Output Conductance	h_{ob}	$I_E = 1.0$ mA, $V_{CB} = 5.0$ V		1.0	μmhos
		f = 1.0 kHz			
Noise Figure	NF	f = 10 Hz to 15.7 kHz			
2N2722		Source resistance = 10 kΩ		4.0	db
		$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V			

* The lower h_{FE} reading is taken as h_{FE1}.
** Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

DUAL NPN TRANSISTOR
GENERAL PURPOSE

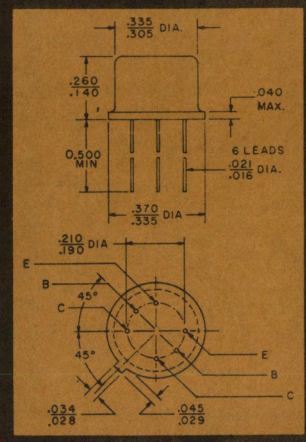
- CLOSELY MATCHED CURRENT GAIN
- VERY LOW DIFFERENTIAL DRIFT
- LOW NOISE

JANUARY 1968

2N2913-20
2N2915A, 16A
2N2919A, 20A

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Collector-Base Voltage 2N2913, 14, 15, 15A, 16, 16A, 17, 18 2N2919, 19A, 20, 20A	V_{CBO}	45 60		Volts
Collector-Emitter Voltage 2N2913, 14, 15, 15A, 16, 16A, 17, 18 2N2919, 19A, 20, 20A	V_{CEO}	45 60		Volts
Emitter-Base Voltage	V_{EBO}	6.0		Volts
Collector Current	I_C	30		mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	One Side 0.30 0.75 0.43	Both Sides 0.6 1.5 0.86	Watts
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		One Side 1.7 4.3	Both Sides 3.4 8.6	mW/°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage 2N2913, 14, 15, 15A, 16, 16A, 17, 18 2N2919, 19A, 20, 20A	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$	45 60		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 10\ \mu A$	6.0		Volts
Collector-Emitter Sustaining Voltage 2N2913, 14, 15, 15A, 16, 16A, 17, 18 2N2919, 19A, 20, 20A	$V_{CEO(sus)}$**	$I_C = 10$ mA, $I_B = 0$	45 60		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 1.0$ mA, $I_B = 0.1$ mA		0.35	Volts
Nonsaturated Base Voltage	$V_{BE(ON)}$	$I_C = 0.1$ mA, $V_{CE} = 5.0$ V		0.7	Volts
Collector-Base Cutoff Current 2N2913, 14, 15, 15A, 16, 16A, 17, 18 2N2919, 19A, 20, 20A	I_{CBO}	$I_E = 0$, $V_{CB} = 45$ V $I_E = 0$, $V_{CB} = 45$ V, $T_A = 150°C$		10 2.0 10	nA μA
Collector-Emitter Reverse Current	I_{CEO}	$I_B = 0$, $V_{CB} = 5.0$ V		2.0	nA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0$, $V_{EB} = 5.0$ V		2.0	nA
DC Current Gain 2N2913, 15, 15A, 17, 19, 19A 2N2914, 16, 16A, 18, 20, 20A 2N2913, 15, 15A, 17, 19, 19A 2N2914, 16, 16A, 18, 20, 20A 2N2913, 15, 15A, 17, 19, 19A 2N2914, 16, 18, 20 2N2916A, 20A	h_{FE}	$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $I_C = 100\ \mu A$, $V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$	60 150 100 225 150 300 15 30 40	240 600	
DC Current Gain Ratio 2N2915, 15A, 16, 16A, 19, 19A, 20, 20A 2N2917, 18 2N2915A, 16A, 19A, 20A	h_{FE1}/h_{FE2}*	$I_C = 100\ \mu A$, $V_{CE} = 5.0$ V $I_C = 100\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$ to $+125°C$	0.9 0.8 0.85	1.0 1.0 1.0	

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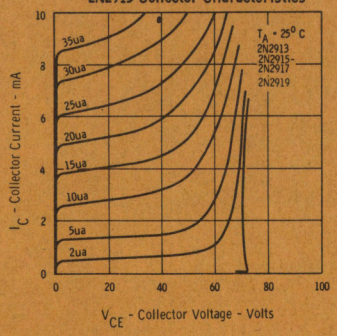
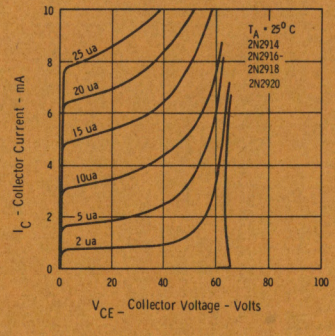
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Base Voltage Differential	V_{BE1}-V_{BE2}				
2N2915, 16, 19, 20		I_C = 10 μA to 1.0 mA, V_{CE} = 5.0 V		5.0	mV
2N2917, 18				10	
2N2915A, 16A, 19A, 20A				2.0	
2N2915, 16, 19, 20		I_C = 100 μA, V_{CE} = 5.0 V		3.0	
2N2917, 18				5.0	
2N2915A, 16A, 19A, 20A				1.5	
Base Voltage Differential Change	$\Delta(V_{BE1}-V_{BE2})$				
2N2915, 16, 19, 20		I_C = 100 μA, V_{CE} = 5.0 V		0.8	mV
2N2915A, 16A, 19A, 20A		T_A = −55°C to 125°C		0.4	
2N2917, 18				1.6	
2N2915, 16, 19, 20		I_C = 100 μA, V_{CE} = 5.0 V		1.0	
2N2915A, 16A, 19A, 20A		T_A = 25°C to 125°C		0.5	
2N2917, 18				2.0	
High Frequency Current Gain	$\lvert h_{fe} \rvert$	I_C = 0.5 mA, V_{CE} = 5.0 V f = 20 MHz	3.0		
Output Capacitance	C_{ob}	I_E = 0, V_{CB} = 5.0 V f = 140 kHz		6.0	pf
Input Capacitance	C_{ib}	I_C = 0, V_{BE} = 5.0 V		10	pf
2N2915A, 16A, 19A, 20A		f = 1.0 MHz			
Input Resistance	h_{ib}	I_C = 1.0 mA, V_{CB} = 5.0 V f = 1.0 kHz	25	32	Ohms
Output Conductance	h_{ob}	I_C = 1.0 mA, V_{CB} = 5.0 V f = 1.0 kHz		1.0	μmhos
Noise Figure	NF	f = 1.0 kHz			
2N2913, 15, 15A, 17, 19, 19A		Source resistance = 10 kΩ		4.0	db
2N2914, 16, 16A, 18, 20, 20A		Equivalent noise power bandwidth = 200 Hz		3.0	
		I_C = 10 μA, V_{CE} = 5.0 V			
2N2913, 15, 15A, 17, 19, 19A		f = 10 Hz to 10 kHz		4.0	
2N2914, 16, 16A, 18, 20, 20A		Source resistance = 10 kΩ		3.0	
		Equivalent noise power bandwidth = 15.7 kHz			
		I_C = 10 μA, V_{CE} = 5.0 V			

* Lowest of the two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.
** Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

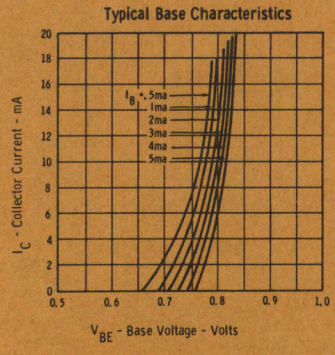
2N2919
2N2915-2N2917
2N2913 Collector Characteristics



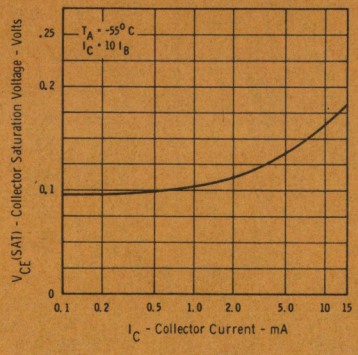
2N2920
2N2916-2N2918
2N2914 Collector Characteristics



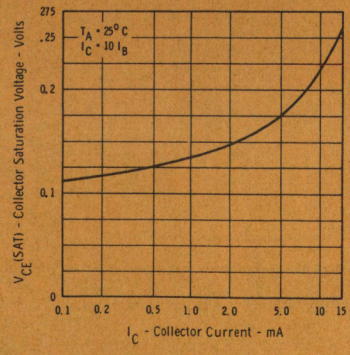
Typical Base Characteristics



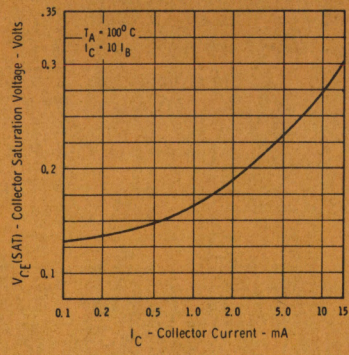
Collector Saturation Voltage
Versus Collector Current



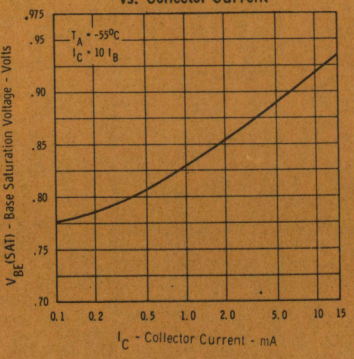
Collector Saturation Voltage
Versus Collector Current



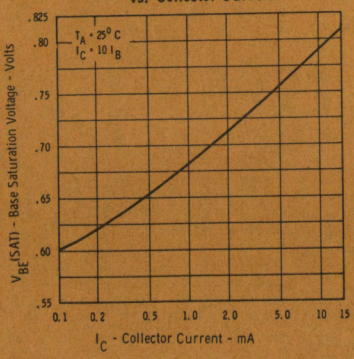
Collector Saturation Voltage
Versus Collector Current



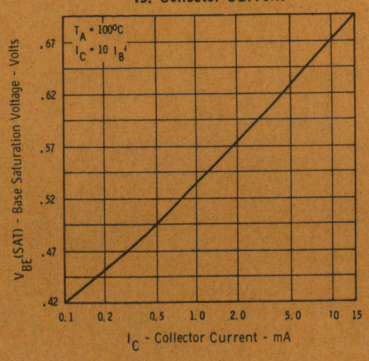
Base Saturation Voltage vs. Collector Current



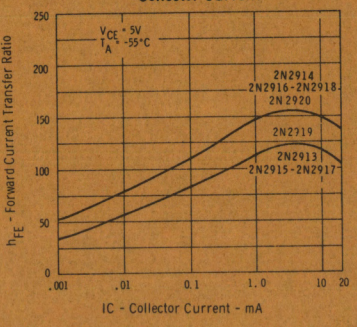
Base Saturation Voltage vs. Collector Current



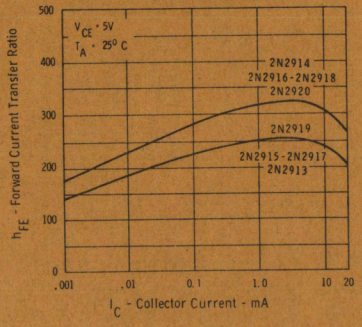
Base Saturation Voltage vs. Collector Current



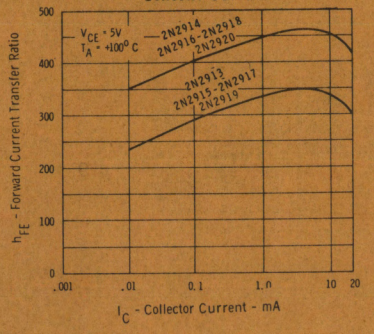
Pulsed DC Current Gain Versus Collector Current



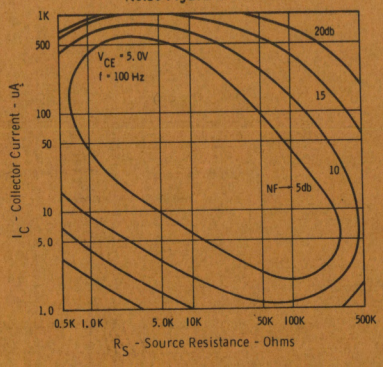
Pulsed DC Current Gain Versus Collector Current



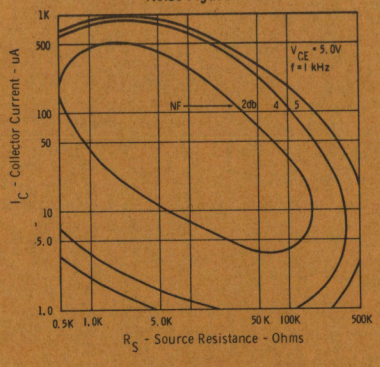
Pulsed DC Current Gain Versus Collector Current



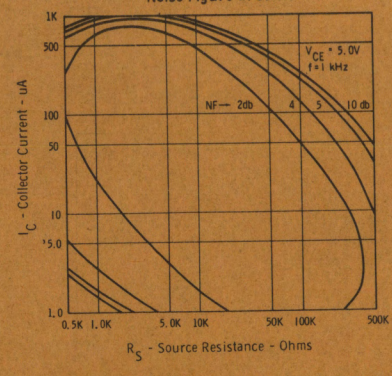
Noise Figure at 100 CPS



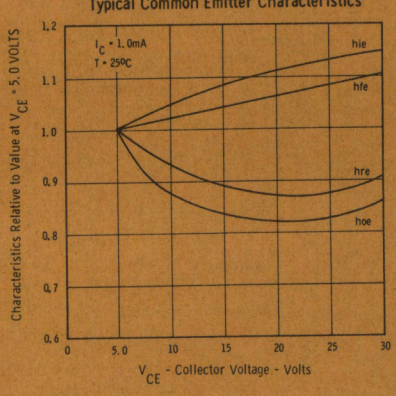
Noise Figure at 1 KC



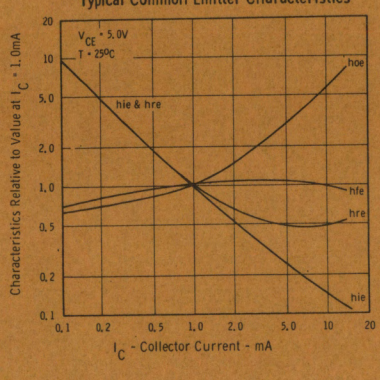
Noise Figure at 10 KC



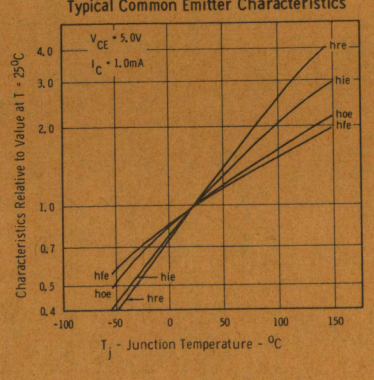
Typical Common Emitter Characteristics



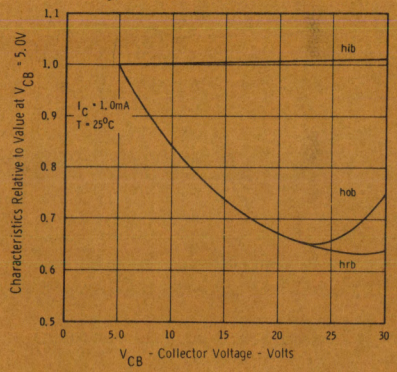
Typical Common Emitter Characteristics



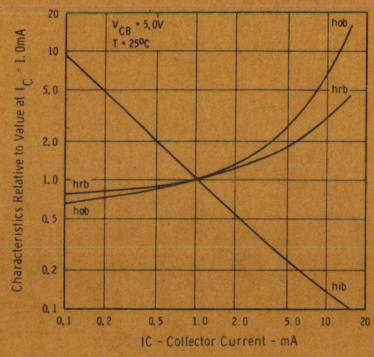
Typical Common Emitter Characteristics



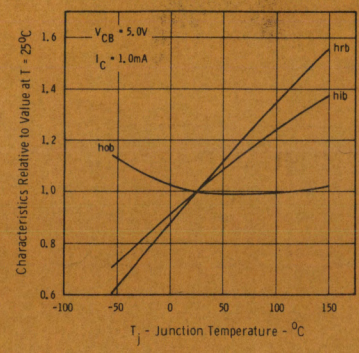
Typical Common Base Characteristics



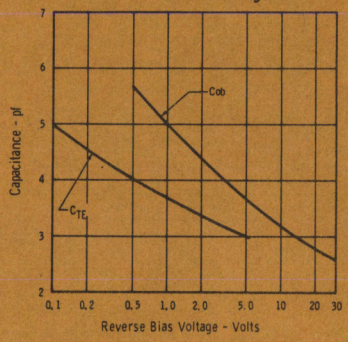
Typical Common Base Characteristics



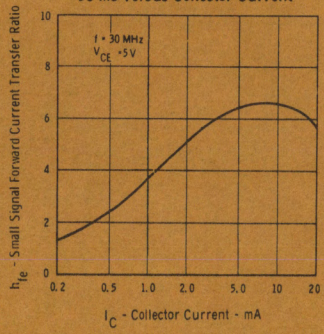
Typical Common Base Characteristics



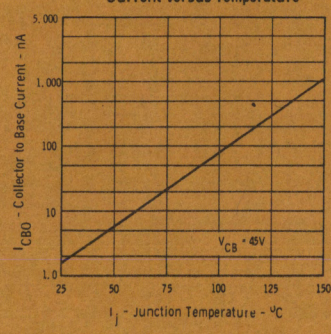
Collector and Emitter Transition Capacitance Versus Reverse Bias Voltage



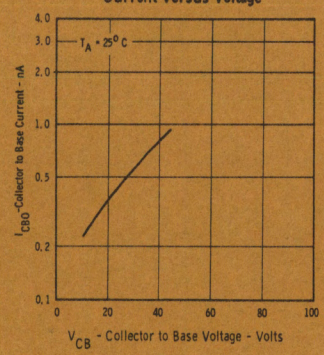
Small Signal Current Gain at 30 mc Versus Collector Current



Collector - Base Diode Reverse Current versus Temperature



Collector - Base Diode Reverse Current Versus Voltage



DUAL NPN TRANSISTOR
GENERAL PURPOSE

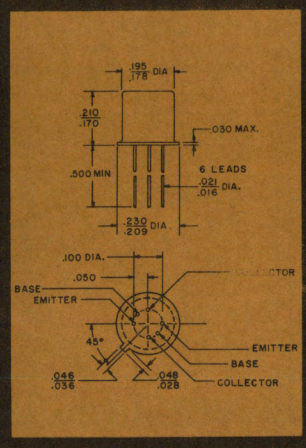
- LOW NOISE
- CLOSELY MATCHED CURRENT GAIN
- VERY CLOSELY MATCHED, V_{BE}

JANUARY 1968

2N2972 THRU 2N2979

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING 2N2972 to 2N2977	RATING 2N2978-2N2979	UNIT
Collector-Base Voltage	V_{CBO}	45	60	Volts
Collector-Emitter Voltage	V_{CEO}	45	60	Volts
Emitter-Base Voltage	V_{EBO}	6.0	6.0	Volts
Collector Current	I_C	30		mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	 0.3 0.75 0.43		Watts
Storage Temperature	T_{stg}	−65 to +200		°C
Junction Temperature	T_J	+200		°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage 2N2972-2N2977 2N2978, 2N2979	BV_{CBO}	$I_C = 10\ \mu A, I_E = 0$	 45 60		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0, I_E = 10\ \mu A$	6.0		Volts
Collector-Emitter Sustaining Voltage 2N2972-2N2977 2N2978, 2N2979	$V_{CEO(sus)}$*	$I_C = 10$ mA, $I_B = 0$	 45 60		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 1.0$ mA, $I_B = 0.1$ mA		0.35	Volts
Nonsaturated Base Voltage	$V_{BE(on)}$	$I_C = 0.1$ mA, $V_{CE} = 5.0$ V		0.7	Volts
Collector-Base Cutoff Current 2N2972-2N2977 2N2978, 2N2979 2N2972-2N2979	I_{CBO}	 $I_E = 0, V_{CB} = 45$ V $I_E = 0, V_{CB} = 45$ V, $T_A = 150°C$	 	 10 2.0 10	 nA μA
Collector-Emitter Cutoff Current	I_{CEO}	$I_B = 0, V_{CE} = 5.0$ V		2.0	nA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0, V_{EB} = 5.0$ V		2.0	nA
DC Current Gain 2N2972, 74, 76, 78 2N2973, 79 2N2975, 77 2N2972, 74, 76, 78 2N2973, 75, 77, 79 2N2972, 74, 76, 78 2N2973, 75, 77, 79 2N2972, 74, 76, 78 2N2973, 75, 77 2N2979	h_{FE}	 $I_C = 10\ \mu A, V_{CE} = 5.0$ V $I_C = 100\ \mu A, V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10\ \mu A, V_{CE} = 5.0$ V $T_A = -55°C$	 60 150 150 100 225 150 300 15 30 40	 240 600	
DC Current Ratio 2N2974, 75, 78, 79 2N2976, 77	h_{FE1}/h_{FE2}*	$I_C = 100\ \mu A, V_{CE} = 5.0$ V	0.9 0.8	1.0 1.0	
Base Voltage Differential 2N2974, 75, 78, 79 2N2976, 77 2N2974, 75, 78, 79 2N2976, 77	V_{BE1}-V_{BE2}	 $I_C = 10\ \mu A$ to 1.0 mA, $V_{CE} = 5.0$ V $I_C = 100\ \mu A, V_{CE} = 5.0$ V	 	 5.0 10 3.0 5.0	 mV

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Base Voltage Differential Change	$\Delta(V_{BE1}-V_{BE2})$				
2N2974, 75, 78, 79		$I_C = 100\ \mu A$, $V_{CE} = 5.0\ V$		0.8	mV
2N2976, 77		$T_A = -55°C$ to $+25°C$		1.6	
2N2974, 75, 78, 79		$I_C = 100\ \mu A$, $V_{CE} = 5.0\ V$		1.0	
2N2976, 77		$T_A = 25°C$ to $125°C$		2.0	
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = 0.5$ mA, $V_{CE} = 5.0$ V f = 20 MHz	3.0		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 5.0$ V f = 140 kHz		6.0	pf
Input Resistance	h_{ib}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1.0 kHz	25	32	Ohms
Output Conductance	h_{ob}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1.0 kHz		1.0	μmhos
Noise Figure	NF	f = 1.0 kHz			
2N2972, 74, 76, 78		Source resistance = 10 kΩ		4.0	db
2N2973, 75, 77, 79		Equivalent noise power bandwidth = 200 Hz		3.0	
		$I_C = 10\ \mu A$, $V_{CE} = 5.0\ V$			
		f = 10 Hz to 10 kHz			
2N2972, 74, 76, 78		Source resistance = 10 kΩ		4.0	
2N2973, 75, 77, 79		Equivalent noise power bandwidth = 15.7 kHz		3.0	
		$I_C = 10\ \mu A$, $V_{CE} = 5.0\ V$			

* Lowest of the two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.
** Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

DUAL NPN TRANSISTOR
GENERAL PURPOSE

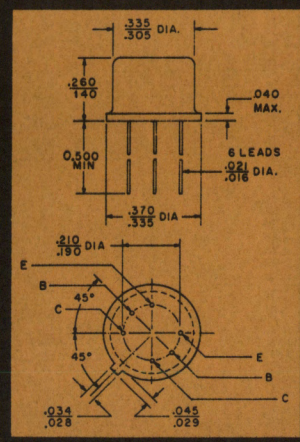
- VERY CLOSELY MATCHED, V_{BE}
- VERY LOW DIFFERENTIAL DRIFT
- CLOSELY MATCHED CURRENT GAIN

JANUARY 1968

2N3680

MAXIMUM RATINGS

CHARACTERISTIC	RATING	RATING		UNIT
Collector-Base Voltage	V_{CBO}	60		Volts
Collector-Emitter Voltage	V_{CEO}	50		Volts
Emitter-Base Voltage	V_{EBO}	6.0		Volts
Collector Current	I_C	Each Side 30	Both Sides —	mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	0.3 0.6	0.6 1.2	Watts
Storage Temperature	T_{stg}	−65 to +200		°C
Junction Temperature	T_J	+175		°C
Derating Factor above 25°C @ $T_A = 25°C$		2.0	4.0	mW/°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$	60		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 10\ \mu A$	60		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$**	$I_C = 10$ mA, $I_B = 0$	50		Volts
Nonsaturated Base Voltage	$V_{BE(on)}$	$I_C = 10$ mA, $V_{CE} = 5.0$ V	0.6	0.8	Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10$ mA, $V_{CE} = 0.5$ V		0.7	Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = 45$ V $I_E = 0$, $V_{CB} = 45$ V, $T_A = 150°C$		10 10	nA μA
Collector-Emitter Cutoff Current	I_{CEO}	$I_B = 0$, $V_{CE} = 5.0$ V		10	nA
DC Current Gain	h_{FE}	$I_C = 1.0\ \mu A$, $V_{CE} = 5.0$ V $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$ $I_C = 100\ \mu A$, $V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V	80 150 45 225 300	 600 	
DC Current Gain Ratio	h_{FE1}/h_{FE2}*	$I_C = 1.0\ \mu A$, $V_{CE} = 5.0$ V $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$ to $+125°C$	0.9 0.85	1.0 1.0	
Base Voltage Differential	V_{BE1}-V_{BE2}	$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V		3.0	mV
Base Voltage Differential Change	$\Delta(V_{BE1}-V_{BE2})/\Delta T$	$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$ to $+25°C$ $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = 25°C$ to $125°C$		0.4 0.5	mV
Small Signal Current Gain	h_{fe}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1 kHz	300	900	
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = 0.5$ mA, $V_{CE} = 5.0$ V f= 30 MHz	2.0	6.0	
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 5.0$ V f = 1 MHz		6.0	pf
Input Capacitance	C_{ib}	$I_C = 0$, $V_{BE} = 0.5$ V f = 1 MHz		6.0	pf

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Reverse Voltage Feedback Ratio	h_{re}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V $f = 1$ kHz		10	$x10^{-4}$
Input Resistance	h_{ie}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V $f = 1$ kHz	7.5	24	k ohms
Output Conductance	h_{oe}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V $f = 1$ kHz		45	μmhos
Noise Figure	NF	$f = 15.7$ kHz Source resistance $= 10$ kΩ $I_E = 10\ \mu$A, $V_{CB} = 5.0$ V		3.0	db

* The lower reading is taken as h_{FE1}.
** Pulse Test: Pulse Width $= 300\ \mu$sec; Duty Cycle $= 1\%$.

DUAL NPN TRANSISTOR
MEDIUM POWER

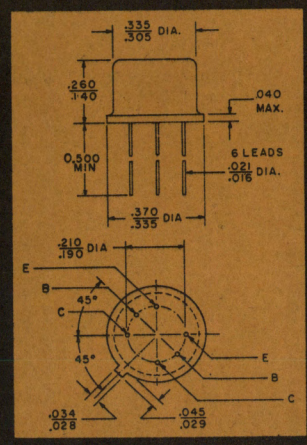
- HIGH VOLTAGE
- LOW VOLTAGE
- HIGH CURRENT GAIN

JANUARY 1968

2N2223
2N2223A

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Collector-Base Voltage	V_{CBO}	100		Volts
Collector-Emitter Voltage	V_{CEO}	60		Volts
Collector-Emitter Voltage ($R_{BE} \leqq 10\Omega$)	V_{CER}	80		Volts
Emitter-Base Voltage	V_{EBO}	7		Volts
Collector Current	I_C	500		mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	One Side 0.5 1.6 0.9	Both Sides 0.6 3.0 1.7	Watt
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		One Side 2.86 9.1	Both Sides 3.43 17.2	mW/°C
Storage Temperature	T_{stg}	−65 to +300		°C
Junction Temperature	T_J	+200		°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 100\ \mu A$, $I_E = 0$	100		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 30$ mA, $I_B = 0$	60		Volts
Collector-Emitter Sustaining Voltage	$V_{CER(sus)}$*	$I_C = 100$ mA, $R_{BE} \leqq 10\Omega$	80		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 100\ \mu A$, $I_C = 0$	7		Volts
Collector-Base Cutoff Current	I_{CBO}	$V_{CB} = 80$ V, $I_E = 0$ $V_{CB} = 80$ V, $I_E = 0$, $T_A = 150°C$		.010 15	μA
Emitter-Base Cutoff Current	I_{EBO}	$V_{EB} = 5$ V, $I_C = 0$		10	nA
DC Current Gain	h_{FE}	$I_C = 10\ \mu A$, $V_{CE} = 5$ V $I_C = 100\ \mu A$, $V_{CE} = 5$ V $I_C = 10$ mA, $V_{CE} = 5$ V	15 25 50	 150 200	
DC Current Gain Ratio 2N2223A 2N2223	h_{FE1}/h_{FE2}**	$I_C = 100\ \mu A$, $V_{CE} = 5$ V	 0.9 0.8	 1.0 1.0	
Base Voltage Differential 2N2223A 2N2223	$\lvert V_{BE1} - V_{BE2} \rvert$	$I_C = 100\ \mu A$, $V_{CE} = 5$ V		 5 15	mV
Base Voltage Differential Drift	$\Delta(V_{BE1}-V_{BE2})/\Delta T$	$I_C = 100\ \mu A$, $V_{CE} = 5$ V $T_A = -55°C$ to $+125°C$		25	$\mu V/°C$
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 50$ mA, $I_B = 5$ mA		1.2	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 50$ mA, $I_B = 5$ mA		0.9	Volts
Small Signal Current Gain	h_{fe}	$I_C = 1$ mA, $V_{CE} = 5$ V, $f = 1$ kHz	40	200	
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = 50$ mA, $V_{CE} = 10$ V, $f = 20$ MHz	2.5		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 10$ V, $f = 140$ kHz		15	pf
Input Capacitance	C_{ib}	$I_C = 0$, $V_{BE} = 0.5$ V, $f = 140$ kHz		85	pf
Input Resistance	h_{ib}	$I_C = 1$ mA, $V_{CB} = 5$ V, $f = 1$ kHz	20	30	Ohms
Output Conductance	h_{ob}	$I_C = 1$ mA, $V_{CB} = 5$ V, $f = 1$ kHz		0.5	μmhos
Voltage Feedback Ratio	h_{rb}	$I_C = 1$ mA, $V_{CB} = 5$ V, $f = 1$ kHz		300	$\times 10^{-6}$

*The lower of the two h_{FE} readings is taken as h_{FE1}.
** Pulse Test: Pulse Width $\leq 300\ \mu$sec; Duty Cycle = 1%.

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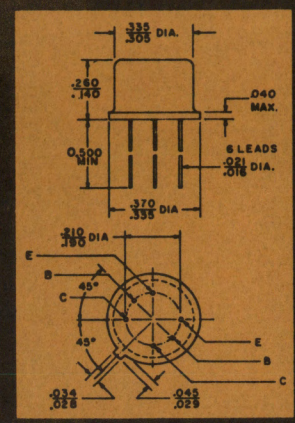
DUAL MONOLITHIC NPN TRANSISTOR
MEDIUM POWER

- HIGH BREAKDOWN VOLTAGE
- LOW SATURATION VOLTAGE
- VERY CLOSELY MATCHED PARAMETERS

SA 2716
SA 2717
SA 2718

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Collector-Base Voltage	V_{CBO}	50		Volts
Collector-Emitter Voltage	V_{CEO}	30		Volts
Collector-Collector Voltage	V_{CCO}	±60		Volts
Emitter-Base Voltage	V_{EBO}	6.0		Volts
Total Device Dissipation	P_D	One Side	Both Sides	Watts
@T_A = 25°C		0.3	0.6	
@T_C = 25°C		0.6	1.2	
@T_C = 100°C		0.25	0.5	
Derating Factor above 25°C				mW/°C
@T_A = 25°C		2.0	4.0	
@T_C = 25°C		4.0	8.0	
Storage Temperature Range	T_{STG}	−65 to +150		°C
Operating Junction Temperature	T_J	+150		°C
Lead Soldering Temperature, 1/16 inch from Case, 10 seconds max		+300		°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTICS	SYMBOL	TEST CONDITIONS	MIN	MAX	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	I_C = 10μA, I_E = 0	50		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$	I_C = 5.0mA, I_B = 0	30		Volts
Base-Emitter Breakdown Voltage	BV_{EBO}	I_C = 0, I_E = 10μA	6.0		Volts
Collector-Collector Breakdown Voltage	BV_{CCO}	I_B = 0, I_E = 0, I_{CC} = 10μA	±60		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	I_C = 1.0mA, I_B = 0.1mA		0.3	Volts
		I_C = 5.0mA, I_B = 0.5mA		0.7	
		I_C = 10mA, I_B = 1.0mA		1.0	
Base Saturation Voltage	$V_{BE(sat)}$	I_C = 1.0mA, I_B = 0.1mA		0.8	Volts
		I_C = 5.0mA, I_B = 0.5mA		0.85	
		I_C = 10mA, I_B = 1.0mA		0.9	
Collector-Base Cutoff Current	I_{CBO}	V_{CB} = 30V, I_E = 0		2.0	nA
		V_{CB} = 30V, I_E = 0, T_A = 150°C		2.0	μA
Emitter-Base Cutoff Current	I_{EBO}	V_{EB} = 5.0V, I_C = 0		2.0	nA
Collector-Emitter Cutoff Current	I_{CEO}	V_{CE} = 5.0V, I_B = 0		2.0	nA
Collector-Collector Leakage Curr.	I_{CCO}	V_{CC} = ±50V, I_B = 0, I_E = 0		2.0	nA
		V_{CC} = ±50V, I_B = 0, I_E = 0, T_A = 150°C		2.0	μA
DC Current Gain	h_{FE}	V_{CE} = 5.0V, I_C = 10μA	150		
		V_{CE} = 5.0V, I_C = 10μA, T_A = −55°C	40		
		V_{CE} = 5.0V, I_C = 100μA	200		
		V_{CE} = 5.0V, I_C = 1.0mA	250		
		V_{CE} = 5.0V, I_C = 10mA	150		
DC Current Gain Ratio	h_{FE1} / h_{FE2}				
SA2716, SA2717		V_{CE} = 5.0V, I_C = 100μA	0.9	1.11	
SA2718			0.8	1.25	
SA2716, SA2717		V_{CE} = 5.0V, I_C = 100μA (T_A = −55°C to +125°C)	0.85	1.17	
Base Voltage Differential	V_{BE1} -V_{BE2}				
SA2716		V_{CE} = 5.0V, I_C = 100μA		2.0	mV
SA2717				3.0	
SA2718				5.0	

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CHARACTERISTICS	SYMBOL	TEST CONDITIONS	MIN	MAX	UNIT
Base Voltage Differential Drift SA2716 SA2717 SA2718	$\frac{\Delta(V_{BE1}-V_{BE2})}{\Delta T}$	V_{CE} = 5.0V, I_C = 100μA T_A = −55°C to +125°C		 3.0 5.0 10.0	μV/°C
High Frequency Current Gain	$\lvert h_{fe} \rvert$	V_{CE} = 5.0V, I_C = 1.0mA, f=30MHz	6.0		
Input Capacitance	C_{ib}	V_{EB} = 0.5V, I_C = 0, f=140kHz		3.0	pf
Output Capacitance	C_{ob}	V_{CB} = 10V, I_E = 0, f=140kHz		3.0	pf
Collector-Collector Capacitance	C_{cc}	V_{CC} = 0V, I_B = 0, I_E = 0, f = 140kHz		3.0	pf
Noise Figure	NF	V_{CE} = 5.0V, I_C = 10μA R_S = 10KΩ, f = 1.0kHz BW = 200Hz		2.0	db

DUAL NPN TRANSISTOR
RF/IF AMPLIFIER

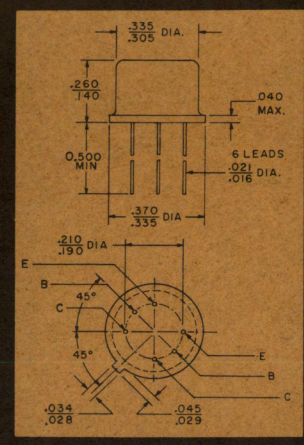
- LOW DIFFERENTIAL DRIFT
- CLOSELY MATCHED CURRENT GAIN
- HIGH FREQUENCY

JANUARY 1968

2N3423
2N3424

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Collector-Base Voltage	V_{CBO}	30		Volts
Collector-Emitter Voltage	V_{CEO}	15		Volts
Emitter-Base Voltage	V_{EBO}	3.0		Volts
Collector Current	I_C	50		mA
Total Device Dissipation	P_D	Each Side	Both Sides	Watts
@ $T_A = 25°C$		0.3	0.6	
@ $T_C = 100°C$		0.25	0.5	
@ $T_C = 25°C$		0.6	1.2	
Derating Factor above 25°C		Each Side	Both Sides	mW/°C
@ $T_A = 25°C$		1.7	3.4	
@ $T_C = 25°C$		3.4	6.8	
Storage Temperature	T_{stg}	−65 to +200		°C
Junction Temperature	T_J	+200		°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 1.0\ \mu A$, $I_E = 0$	30		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 10\ \mu A$	3.0		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 3.0$ mA, $I_B = 0$	15		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA		0.4	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA		1.0	Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = 15$ V		10	nA
		$I_E = 0$, $V_{CB} = 15$ V, $T_A = 150°C$		1.0	μA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0$, $V_{EB} = 3.0$ V		10	μA
DC Pulse Current Gain	h_{FE}*	$I_C = 3.0$ mA, $V_{CE} = 3.0$ V	20	200	
DC Current Gain Ratio	h_{FE1}/h_{FE2}**	$I_C = 3.0$ mA, $V_{CE} = 3.0$ V			
2N3423			0.8	1.0	
2N3424			0.9	1.0	
Base Voltage Differential	V_{BE1}-V_{BE2}				
2N3423		$I_C = 3.0$ mA, $V_{CE} = 3.0$ V		10	mV
2N3424				5.0	
Base Voltage Differential Change	$\Delta(V_{BE1}-V_{BE2})/\Delta T$				
2N3423		$I_C = 3.0$ mA, $V_{CE} = 3.0$ V		3.2	mV
2N3424		$T_A = -55°C$ to $+25°C$		1.6	
2N3423		$I_C = 3.0$ mA, $V_{CE} = 3.0$ V		4.0	
2N3424		$T_A = +25°C$ to $+125°C$		2.0	
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = 4.0$ mA, $V_{CE} = 10$ V, $f = 100$ MHz	6.0	12	
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 10$ V, $f = 140$ kHz		1.7	pf
		$I_E = 0$, $V_{CB} = 0$, $f = 140$ kHz		3.0	
Input Capacitance	C_{ib}	$I_C = 0$, $V_{BE} = 0.5$ V, $f = 140$ kHz		2.0	pf
Input Resistance	h_{ie}	$I_C = 3.0$ mA, $V_{CE} = 3.0$ V, $f = 350$ kHz		45	ohms
Low Frequency Noise Figure	NF	$f = 60$ MHz, Source Resistance $= 400\Omega$, $I_C = 1.0$ mA, $V_{CE} = 6.0$ V		3.5 (typ.)	db

* Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.
** Lowest of the two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.

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DUAL PNP TRANSISTOR
GENERAL PURPOSE

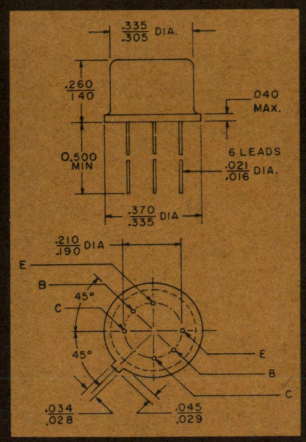
- CLOSELY MATCHED, V_{BE} LOW DIFFERENTIAL DRIFT
- HIGH CURRENT GAIN

JANUARY 1968

2N3347 THRU 2N3352

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	Volts
Collector-Emitter Voltage	V_{CEO}	45	Volts
Emitter-Base Voltage	V_{EBO}	6	Volts
Collector Current	I_C	30	mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	Each Side: 300, 0.6 / Both Sides: 600, 1.2	mW
Storage Temperature	T_{stg}	−65 to +200	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A, I_E = 0$	60		Volts
Collector-Emitter Breakdown Voltage	BV_{CEO}	$I_C = 10$ mA, $I_B = 0$	45		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 10\ \mu A, I_C = 0$	6		Volts
Base-Emitter Voltage	V_{BE}	$I_C = 10$ mA, $V_{CE} = 5$ V		0.9	Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 0.5$mA		0.5	Volts
Collector-Base Cutoff Current	I_{CBO}	$V_{CB} = 45$ V, $I_E = 0$ $V_{CB} = 45$ V, $I_E = 0$, $T_A = 150°C$		10 10	nA μA
Emitter-Base Cutoff Current	I_{EBO}	$V_{EB} = 6$ V, $I_C = 0$		2	nA
DC Current Gain 2N3347, 48, 49 2N3350, 51, 52 2N3347, 48, 49 2N3350, 51, 52	h_{FE}	 $I_C = 10\ \mu A, V_{CE} = 5$ V $I_C = 10\ \mu A, V_{CE} = 5$ V $I_C = 1.0$ mA, $V_{CE} = 5$ V $I_C = 1.0$ mA, $V_{CE} = 5$ V	 40 100 60 150	 300 300	
DC Current Gain Ratio 2N3347, 50 2N3348, 51 2N3349, 52	h_{FE1}/h_{FE2}*	$I_C = 10\ \mu A, V_{CE} = 5$ V	 0.9 0.8 0.6	 1.0 1.0 1.0	
Base-Emitter Voltage Differential 2N3347, 50 2N3348, 51 2N3349, 52	V_{BE1}-V_{BE2}	$I_C = 10\ \mu A, V_{CE} = 5$ V		 5.0 10 20	 mV
Base-Emitter Voltage Differential Change 2N3347, 50 2N3348, 51 2N3349, 52	$\Delta(V_{BE1}-V_{BE2})/\Delta T$	$I_C = 10\ \mu A, V_{CE} = 5$ V $T_1 = 25°C, T_2 = -55°C$		 0.8 1.6 3.2	 mV
Base-Emitter Voltage Differential Change 2N3347, 50 2N3348, 51 2N3349, 52	$\Delta(V_{BE1}-V_{BE2})/\Delta T$	$I_C = 10\ \mu A, V_{CE} = 5$ V $T_1 = 25°C, T_2 = 125°C$		 1.0 2.0 40	 mV
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = 1.0$ mA, $V_{CE} = 5$ V f = 30 MHz	2.0	8.0	

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Small Signal Current Gain 2N3347, 48, 49 2N3350, 51, 52	h_{fe}	$I_C = 10$ mA, $V_{CE} = 5$ V f = 1 kHz	 60 150	 600 600	
Output Capacitance	C_{ob}	$V_{CE} = 5$ V, f = 1 MHz		6	pf
Output Capacitance	C_{ib}	$V_{EB} = 0.5$ V, f = 1 MHz		8	pf
Output Admittance	h_{oe}	$I_C = 1.0$ mA, $V_{CE} = 5$ V f = 1 kHz		100	μmhos
Input Impedance 2N3347, 48, 49 2N3350, 51, 52	h_{ie}	$I_C = 1.0$ mA, $V_{CE} = 5$ V f = 1 kHz	 1.5 3.7	 2.0 2.0	K ohms

* The lowest h_{FE} reading is taken as h_{FEI} for this ratio.

DUAL PNP TRANSISTOR
GENERAL PURPOSE

- LOW NOISE
- VERY LOW DIFFERENTIAL DRIFT
- CLOSELY MATCHED CURRENT GAIN

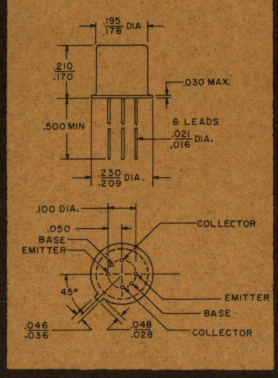
JANUARY 1968

2N3800 THRU 2N3811

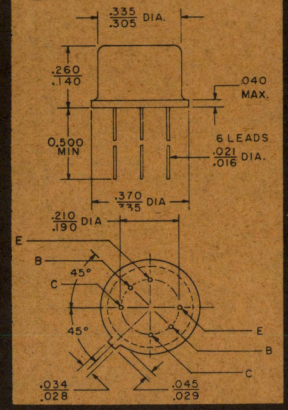
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING				UNIT
Collector-Base Voltage	V_{CBO}	60				Volts
Collector-Emitter Voltage	V_{CEO}	60				Volts
Emitter-Base Voltage	V_{EBO}	5				Volts
Collector Current	I_C	50				mA
		2N3800 thru 2N3805		2N3806 thru 2N3811		
Total Device Dissipation @ $T_A = 25°C$	P_D	Each Side 250	Both Sides 360	Each Side 500	Both Sides 600	mW
Derating Factor above 25°C @ $T_A = 25°C$		1.5	2.1	2.9	3.4	mW/°C
Storage Temperature	T_{stg}	−65 to +200				°C
Junction Temperature	T_J	+200				°C
Lead Temperature 1/16 inch from case, 10 seconds max.		+230				°C

2N3800 thru 2N3805



2N3806 thru 2N3811



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\mu A$, $I_E = 0$	60		Volts
Collector-Emitter Breakdown Voltage	BV_{CEO}	$I_C = 10mA$, $I_B = 0$	60		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 10\mu A$, $I_C = 0$	5		Volts
Base Emitter "ON" Voltage	$V_{BE(ON)}$	$I_C = 100\mu A$, $V_{CE} = 5$ V		0.7	Volts
Collector Saturation Voltage	$V_{CE(sat)}$*	$I_C = 100\mu A$, $I_B = 10\ \mu A$ $I_C = 1$ mA, $I_B = 100\ \mu A$		0.2 0.25	Volts
Base Saturation Voltage	$V_{BE(sat)}$*	$I_C = 100\mu A$, $I_B = 10\ \mu A$ $I_C = 1$ mA, $I_B = 100\ \mu A$		0.7 0.8	Volts
Collector-Base Cutoff Current	I_{CBO}	$V_{CB} = 50$ V, $I_E = 0$ $V_{CB} = 50$ V, $I_E = 0$, $T_A = 150°C$		0.010 10	μA
Emitter-Base Cutoff Current	I_{EBO}	$V_{EB} = 4$ V, $I_C = 0$		20	nA
DC Current Gain	h_{FE}*				
2N3801, 03, 05, 07, 09, 11		$I_C = 1\ \mu A$, $V_{CE} = 5$ V	75		
2N3800, 02, 04, 06, 08, 10		$I_C = 10\ \mu A$, $V_{CE} = 5$ V	100		
2N3801, 03, 05, 07, 09, 11			225		
2N3800, 02, 04, 06, 08, 10		$I_C = 100\ \mu A$, $V_{CE} = 5$ V	150	450	
2N3801, 03, 05, 07, 09, 11			300	900	
2N3800, 02, 04, 06, 08, 10		$I_C = 100\ \mu A$, $V_{CE} = 5$ V	75		
2N3801, 03, 05, 07, 09, 11		$T_A = -55°C$	150		
2N3800, 02, 04, 06, 08, 10		$I_C = 500\ \mu A$, $V_{CE} = 5$ V	150	450	
2N3801, 03, 05, 07, 09, 11			300	900	
2N3800, 02, 04, 06, 08, 10		$I_C = 1$ mA, $V_{CE} = 5$ V	150	450	
2N3801, 03, 05, 07, 09, 11			300	900	
2N3800, 02, 04, 06, 08, 10		$I_C = 10$ mA, $V_{CE} = 5$ V	125		
2N3801, 03, 05, 07, 09, 11			250		
DC Current Gain Ratio	h_{FE1}/h_{FE2}**				
2N3802, 03, 08, 09		$I_C = 100\ \mu A$, $V_{CE} = 5$ V	0.8	1.0	
2N3804, 05, 10, 11			0.9	1.0	

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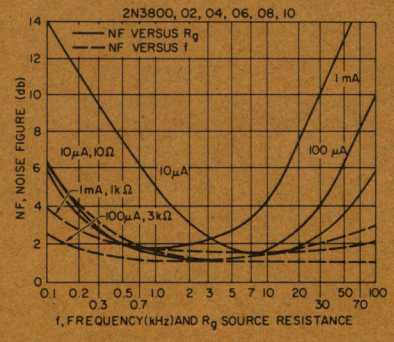
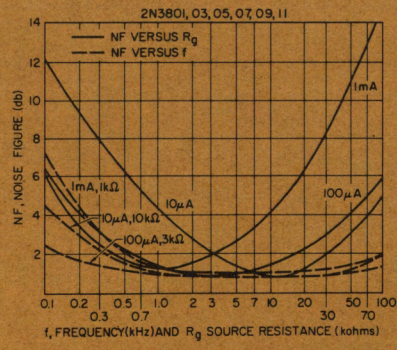
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Base Voltage Differential	$\lvert V_{BE1}-V_{BE2} \rvert$				
2N3802, 03, 08, 09		$I_C = 10\ \mu A$ to 10 mA, $V_{CE} = 5$ V		8	mV
2N3804, 05, 10, 11				5	
2N3802, 03, 08, 09		$I_C = 100\ \mu A$, $V_{CE} = 5$ V		5	
2N3804, 05, 10, 11				3	
Base Voltage Differential Change	$\Delta(V_{BE1}-V_{BE2})/\Delta T$				
2N3802, 03, 08, 09		$I_C = 100\ \mu A$, $V_{CE} = 5$ V		1.6	mV
2N3804, 05, 10, 11		$T_A = -55°C$ to $+25°C$		0.8	
2N3802, 03, 08, 09		$I_C = 100\ \mu A$, $V_{CE} = 5$ V		2.0	
2N3804, 05, 10, 11		$T_A = 25°C$ to $125°C$		1.0	
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = 500\ \mu A$, $V_{CE} = 5$ V, f = 30 MHz	1.0		
		$I_C = 1$ mA, $V_{CE} = 5$ V, f = 100 MHz	1.0	5	
Small Signal Current Gain	h_{fe}				
2N3800, 02, 04, 06, 08, 10		$I_C = 1$ mA, $V_{CE} = 10$ V, f = 1 kHz	150	600	
2N3801, 03, 05, 07, 09, 11			300	900	
Output Capacitance	C_{ob}	$V_{CB} = 5$ V, $I_E = 0$, f = 100 kHz		4	pf
Input Capacitance	C_{ib}	$V_{EB} = 0.5$ V, $I_E = 0$, f = 100 kHz		8	pf
Voltage Feedback Ratio	h_{re}	$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1 kHz		25	$X10^{-4}$
Input Resistance	h_{ie}				
2N3800, 02, 04, 06, 08, 10		$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1 kHz	3	15	K ohms
2N3081, 03, 05, 07, 09, 11			10	40	
Output Conductance	h_{oe}	$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1 kHz	5	60	μ mhos
Noise Figure	NF				
2N3800, 02, 04, 06, 08, 10		$I_C = 100\ \mu A$, $V_{CE} = 10$ V, $R_S = 3\ k\Omega$		7	db
2N3801, 03, 05, 07, 09, 11		f = 100 Hz, BW = 20 Hz		4	
2N3800, 02, 04, 06, 08, 10		f = 1 kHz, BW = 200 Hz		3	
2N3801, 03, 05, 07, 09, 11				1.5	
2N3800, 02, 04, 06, 08, 10		f = 10 kHz, BW = 2 kHz		2.5	
2N3801, 03, 05, 07, 09, 11				1.5	
2N3800, 02, 04, 06, 08, 10		Noise Bandwidth 10 Hz to 10 kHz		3.5	
2N3801, 03, 05, 07, 09, 11		BW = 15.7 kHz		2.5	

* Pulse Test $\leq$ 300μsec, duty cycle $\leq$ 2%

** The lowest h_{FE} reading is taken as h_{FE1} for this ratio

Noise Figure vs Frequency and Source Resistance





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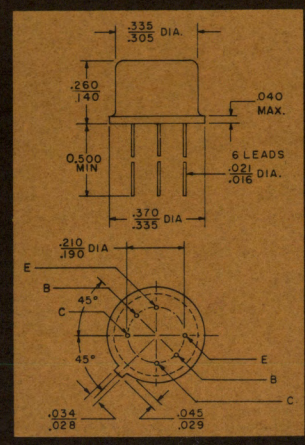
DUAL PNP TRANSISTOR
GENERAL PURPOSE

- LOW NOISE
- LOW SATURATION VOLTAGE
- HIGH BREAKDOWN VOLTAGE

JANUARY 1968

2N4017
2N4018
2N4019



MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING			UNIT
		4017	4018	4019	
Collector-Base Voltage	V_{CBO}	−45	−60	−80	Volts
Collector-Emitter Voltage	V_{CEO}	−45	−60	−80	Volts
Emitter-Base Voltage	V_{EBO}	6	6	6	Volts
		Each Side	Both Sides		
Collector Current	I_C	200			mA
Total Device Dissipation	P_D				
@ $T_A = 25°C$		0.4	0.6		Watts
@ $T_C = 25°C$		0.8	1.3		
Storage Temperature	T_{stg}	−65 to +200			°C
Junction Temperature	T_J	+200			°C
Derating Factor above 25°C					
@ $T_A = 25°C$		2.28	3.4		mW/°C
@ $T_C = 25°C$		4.57	7.4		

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$			
2N4017			80		Volts
2N4018			60		
2N4019			45		
Collector-Emitter Breakdown Voltage	BV_{CEO}	$I_C = 5.0$ mA, $I_B = 0$			
2N4017			80		Volts
2N4018			60		
2N4019			45		
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 10\ \mu A$, $I_C = 0$	6.0		Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10$ mA, $I_B = 0.5$ mA		0.9	Volts
		$I_C = 50$ mA, $I_B = 5.0$ mA		0.95	
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 0.5$ mA		0.25	Volts
		$I_C = 50$ mA, $I_B = 5.0$ mA		0.4	
Collector-Base Cutoff Current	I_{CBO}				
2N4017		$V_{CB} = 70$ V, $I_E = 0$		10	nA
2N4018		$V_{CB} = 50$ V, $I_E = 0$		10	
2N4019		$V_{CB} = 30$ V, $I_E = 0$		10	
2N4017		$V_{CB} = 70$ V, $I_E = 0$, $T_A = 125°C$		10	μA
2N4018		$V_{CB} = 50$ V, $I_E = 0$, $T_A = 125°C$		10	
2N4019		$V_{CB} = 30$ V, $I_E = 0$, $T_A = 125°C$		10	
Emitter-Base Cutoff Current	I_{EBO}	$V_{EB} = 4.0$ V, $I_C = 0$		10	nA
DC Current Gain	h_{FE}				
2N4017, 2N4018		$I_C = 1.0\ \mu A$, $V_{CE} = 5$ V	60		
2N4019			180		
2N4017		$I_C = 10\ \mu A$, $V_{CE} = 5$ V	100	350	
2N4018			100	500	
2N4019			250	500	
2N4017, 2N4018		$I_C = 100\ \mu A$, $V_{CE} = 5$ V	100		
2N4019			250		
2N4017		$I_C = 1.0$ mA, $V_{CE} = 5$ V	100	500	
2N4018			100	600	
2N4019			250	600	
2N4017, 2N4018		$I_C = 10$ mA, $V_{CE} = 5$ V	100		
2N4019			200		

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
DC Current Gain	h_{FE}				
2N4017, 2N4018		$I_C = 50$ mA, $V_{CE} = 5$ V	90		
2N4019			180		
2N4017		$I_C = 1.0$ mA, $V_{CE} = 5$ V		600	
2N4018, 2N4019		$T_A = 100°C$		800	
2N4017, 2N4018		$I_C = 10\ \mu A$, $V_{CE} = 5$ V	40		
2N4019		$T_A = -55°C$	100		
2N4017, 2N4018		$I_C = 50$ mA, $V_{CE} = 5$ V	40		
2N4019		$T_A = -55°C$	80		
2N4017		$I_C = 1.0$ mA, $V_{CE} = 5$ V	100	550	
2N4018		$T_A = -55°C$	100	700	
2N4019			250	700	
High Frequency Current Gain	$\lvert h_{fe} \rvert$				
2N4017, 2N4018		$I_C = 0.5$ mA, $V_{CE} = 5$ V	2.0	8.0	
2N4019		$f = 20$ MHz	2.5	8.0	
Output Capacitance	C_{ob}	$V_{CB} = 5.0$ V, $f = 1.0$ MHz, $I_E = 0$		6.0	pf
Small Signal Feedback Ratio	h_{re}	$I_C = 1.0$ mA, $V_{CE} = 5$ V		10	$X10^{-4}$
		$f = 1$ kHz			
Input Impedance	h_{ie}				
2N4017		$I_C = 1.0$ mA, $V_{CE} = 5$ V	2.5	17	K ohms
2N4018		$f = 1$ kHz	2.5	20	
2N4019			6.0	20	
Output Conductance	h_{oe}				
2N4017		$I_C = 1.0$ mA, $V_{CE} = 5$ V	5	40	μmhos
2N4018, 2N4019		$f = 1$ kHz	5	40	
Noise Figure	NF	$I_C = 20\ \mu A$, $V_{CE} = 5$ V			
2N4017, 2N4018		$f = 1$ kHz, BW = 150 Hz		3	db
2N4019		Rg = 10 kΩ		2	
		$I_C = 20\ \mu A$, $V_{CE} = 5$ V			
2N4017, 2N4018		$f = 100$ Hz, BW = 15 Hz		10	
2N4019		Rg = kΩ		4	
2N4019		$I_C = 20\ \mu A$, $V_{CE} = 5$ V		8	
		$f = 10$ Hz, BW = 2 Hz			
		Rg = 10 kΩ			

N-CHANNEL FIELD EFFECT TRANSISTOR GENERAL PURPOSE

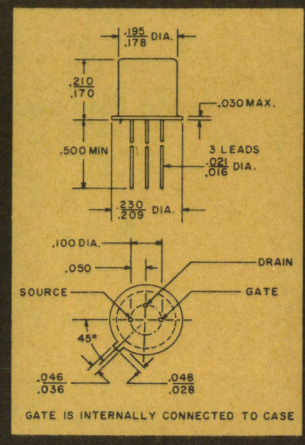
- LOW NOISE
- LOW CAPACITANCE
- HIGH TRANSCONDUCTANCE

JANUARY 1968

2N3069-71
2N3368-70

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING 2N3069-71	RATING 2N3368-70	UNIT
Total Device Dissipation @ $T_A = 25°C$	P_D	350	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		2.0	2.4	mW/°C
Storage Temperature	T_{stg}	−65 to +300	−65 to +175	°C
Junction Temperature	T_J	200	150	°C



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage 2N3069-71 2N3368-70	BV_{DGO}	$I_D = 1.0\ \mu A$, $I_S = 0$	 50 40		Volts
Total Gate Leakage Current 2N3069-71 2N3368-70 2N3069-71 2N3368-70	I_{GSS}	$V_{GS} = -30$ V, $V_{DS} = 0$ $V_{GS} = -30$ V, $V_{DS} = 0$ $T_A = 150°C$ $V_{GS} = -30$ V, $V_{DS} = 0$ $T_A = 100°C$		 1.0 5.0 1.0 1.5	 nA μA
Saturation Current 2N3068 2N3069 2N3369, 2N3070 2N3370, 2N3071	I_{DSS}	$V_{DS} = 30$ V, $V_{GS} = 0$	 2.0 2.0 0.5 0.1	 10 12 2.5 0.6	mA
Pinch Off Voltage 2N3069 2N3070 2N3071 2N3368 2N3369 2N3370	V_P	$V_{DS} = 30$ V, $I_D = 1.0$ nA		 10 5.0 2.5 12 7.0 3.5	Volts
Transconductance 2N3368 2N3069 2N3070 2N3369 2N3071 2N3370	g_m	$V_{DS} = 30$ V, $V_{GS} = 0$ f = 1.0 kHz	 1000 1000 750 600 500 300	 2500 4000 2500 2500 2500 2500	μmhos
Output Conductance 2N3069 2N3070 2N3071	g_{os}	$V_{DS} = 30$ V, $V_{GS} = 0$		 80 30 7.0	μmhos
Output Capacitance 2N3069-71	C_{os}	$V_{DS} = 30$ V, $V_{GS} = 0$		1.5	pf

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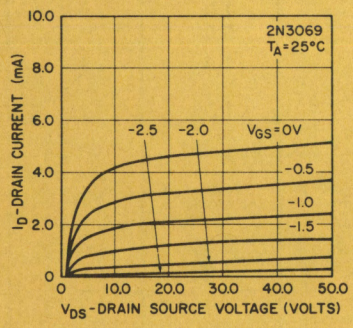
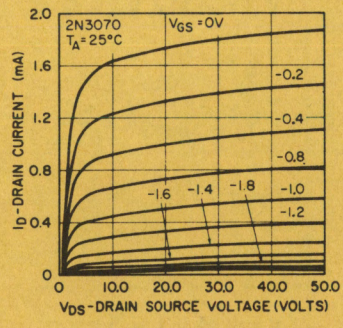
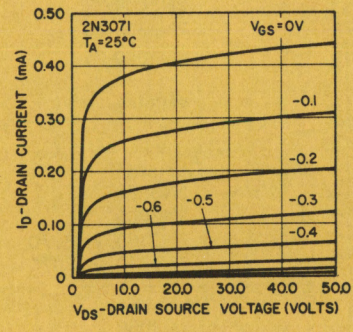
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Input Capacitance	C_{is}				
2N3069		$V_{DS} = 12$ V, $V_{GS} = 0$		15	pf
2N3070		$V_{DS} = 8.0$ V, $V_{GS} = 0$		15	
2N3071		$V_{DS} = 5.0$ V, $V_{GS} = 0$		15	
Drain-Gate Capacitance	C_{DG}				
2N3069		$V_{DG} = 10$ V, $I_S = 0$, f = 140 kHz		2.5	pf
2N3070		$V_{DG} = 8.0$ V, $I_S = 0$, f = 140 kHz		2.5	
2N3071		$V_{DG} = 5.0$ V, $I_S = 0$, f = 140 kHz		2.5	
2N3368		$V_{DG} = 10$ V, $I_S = 0$, f = 140 kHz		3.5	
2N3369		$V_{DG} = 8.0$ V, $I_S = 0$, f = 140 kHz		3.5	
2N3370		$V_{DG} = 5.0$ V, $I_S = 0$, f = 140 kHz		3.5	
Source-Gate Capacitance	C_{SG}				
2N3069		$V_{GS} = -10$ V, $I_D = 0$, f = 140 kHz		5.0	pf
2N3070		$V_{GS} = -8.0$ V, $I_D = 0$, f = 140 kHz		5.0	
2N3071		$V_{GS} = -5.0$ V, $I_D = 0$, f = 140 kHz		5.0	
2N3368		$V_{GS} = -10$ V, $I_D = 0$, f = 140 kHz		6.0	
2N3369		$V_{GS} = -8.0$ V, $I_D = 0$, f = 140 kHz		6.0	
2N3370		$V_{GS} = -5.0$ V, $I_D = 0$, f = 140 kHz		6.0	
Noise Figure	NF				
2N3069		$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1.0 kHz, Rg = 10 MΩ, BW = 200 Hz		4	db
2N3070		$V_{DS} = 10$ V, $V_{GS} = 0$ f = 1.0 kHz, Rg = 10 MΩ, BW = 200 Hz		4	
2N3071		$V_{DS} = 5.0$ V, $V_{GS} = 0$ f = 1.0 kHz, Rg = 10 MΩ, BW = 200 Hz		4	

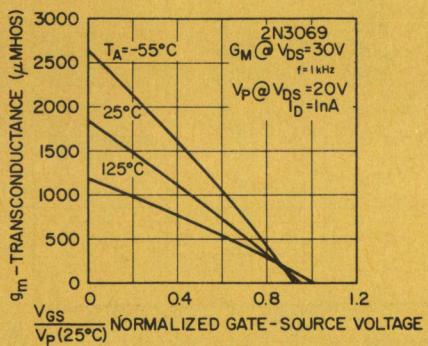
COMMON SOURCE – DRAIN CHARACTERISTICS

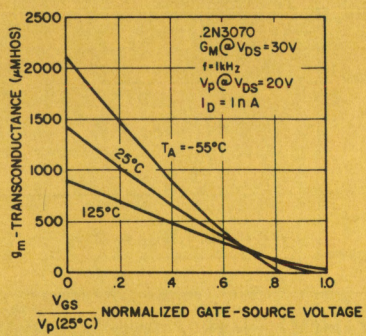


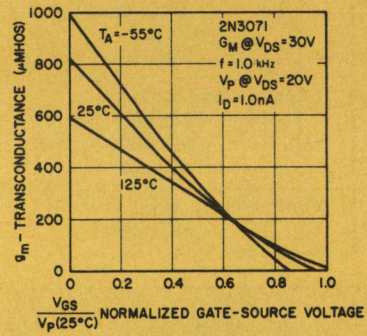




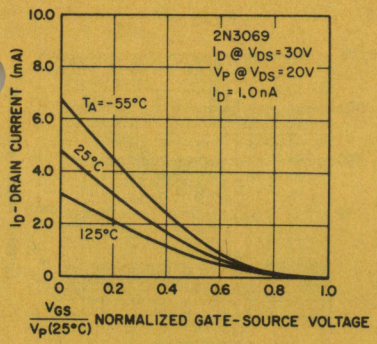
TRANSCONDUCTANCE VS. NORMALIZED GATE-SOURCE VOLTAGE

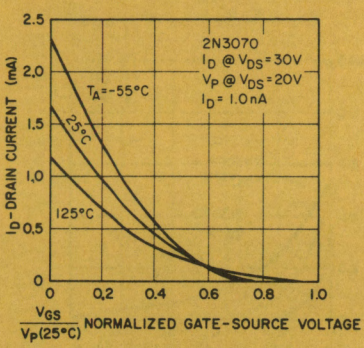


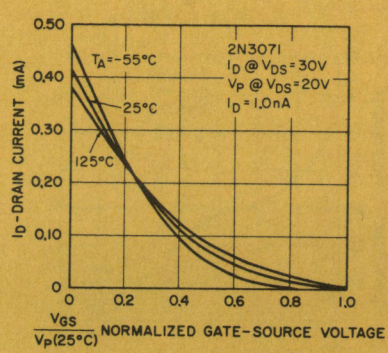




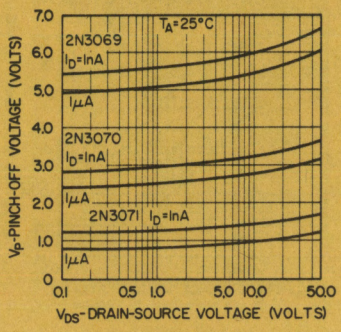
DRAIN CURRENT VS. NORMALIZED GATE-SOURCE VOLTAGE



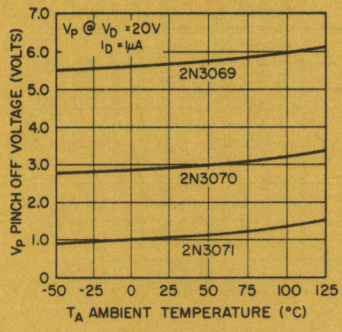




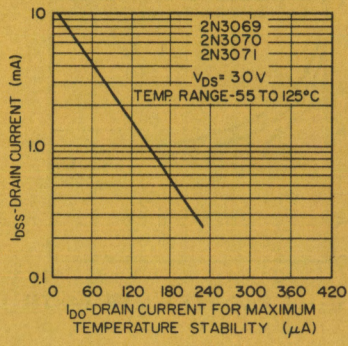
Pinch Off Voltage vs Drain Source Voltage



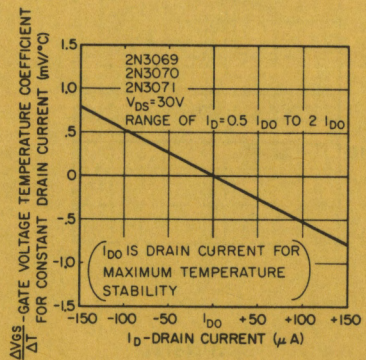
Pinch Off Voltage vs Temperature



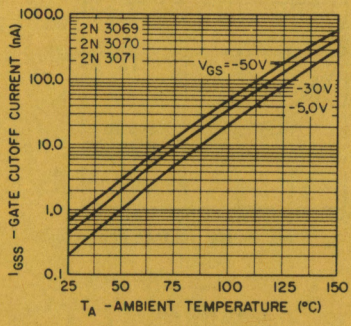
Drain Current For Maximum Temperature Stability vs I_{DSS}



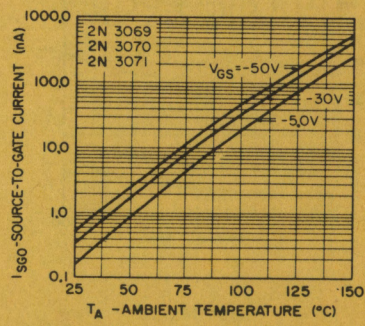
Gate Voltage Temperature Coefficient For Constant Drain Current vs Drain Current



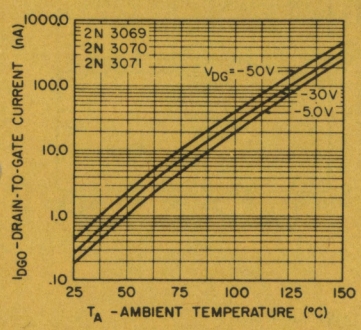
Gate Cutoff Current vs Temperature



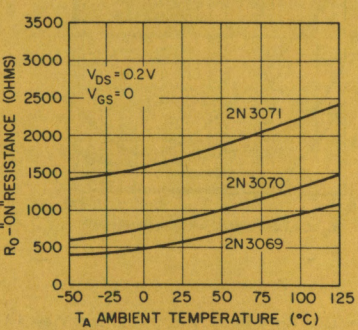
Source – Gate Reverse Current vs Temperature



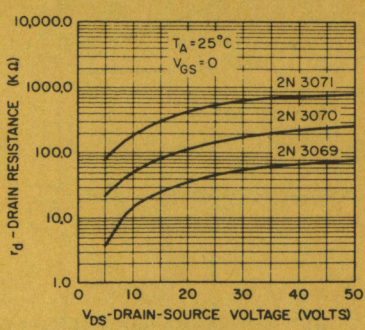
Drain – Gate Reverse Current vs Temperature



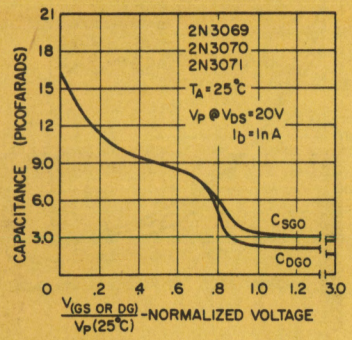
"ON" Resistance vs Temperature



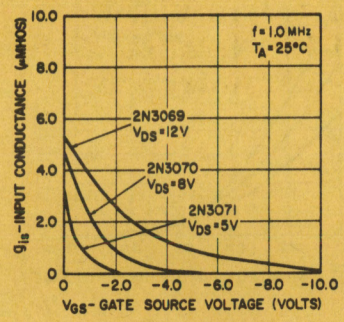
Dynamic Resistance vs Drain – Source Voltage



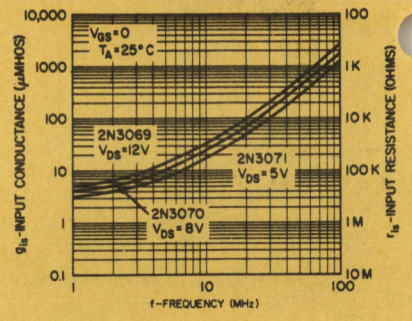
Junction Capacity vs Normalized Bias



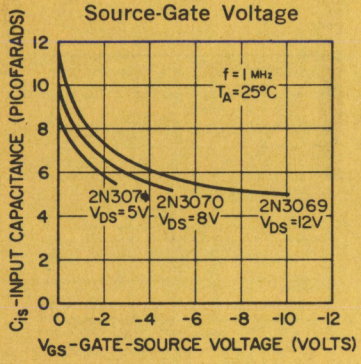
Input Conductance vs Gate – Source Voltage



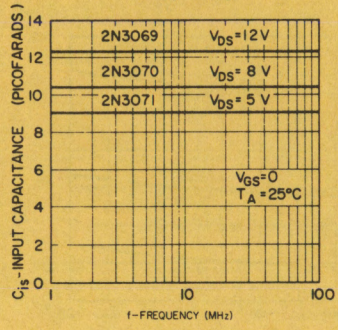
Input Conductance vs Frequency



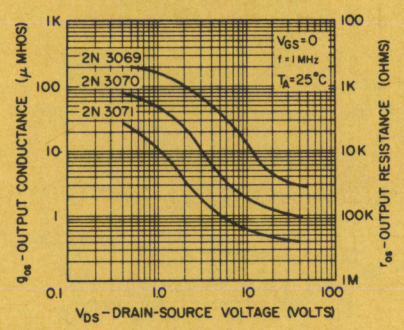
Input Capacitance vs Source-Gate Voltage



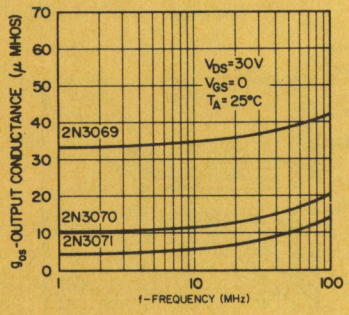
Input Capacitance vs Frequency



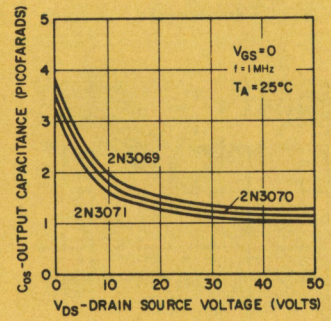
Output Conductance vs Drain Source Voltage



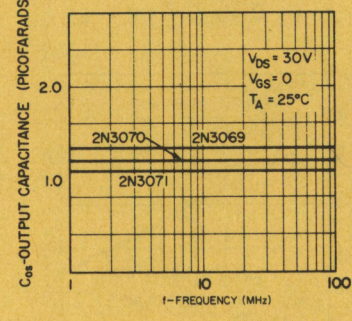
Output Conductance vs Frequency



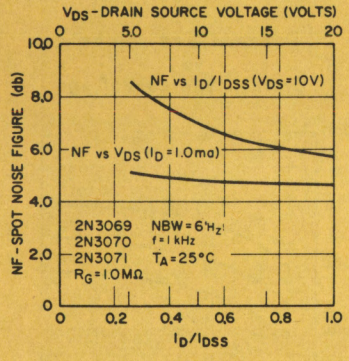
Output Capacitance vs Drain-Source Voltage



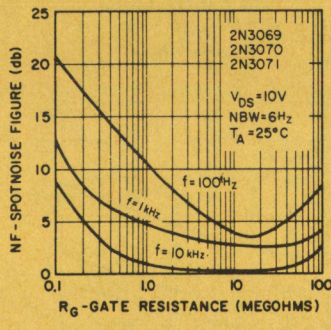
Output Capacitance vs Frequency



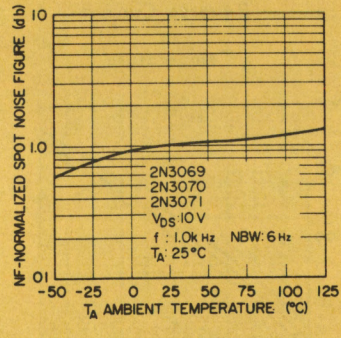
Spot Noise vs Drain – Source Voltage



Spot Noise vs Gate Resistance



Spot Noise vs Temperature



N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE

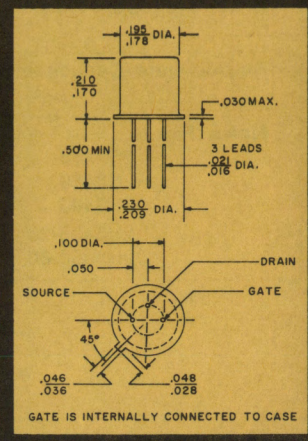
- HIGH TRANSCONDUCTANCE
- HIGH BREAKDOWN VOLTAGE
- LOW NOISE

JANUARY 1968

2N3436-38
2N3458-60

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		1.7	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A$, $I_S = 0$	50		Volts
Total Gate Leakage Current	I_{GSS}				
2N3436-38		$V_{GS} = -30$ V, $V_{DS} = 0$		0.5	nA
2N3458-60				0.25	
2N3436-38		$V_{GS} = -30$ V, $V_{DS} = 0$		1.0	μA
2N3458-60		$T_A = 150°C$		0.5	
Saturation Current	I_{DSS}				
2N3436, 2N3458		$V_{DS} = 20$ V, $V_{GS} = 0$	3.0	15	mA
2N3437, 2N3459			0.8	4.0	
2N3438, 2N3460			0.2	1.0	
Pinch Off Voltage	V_P				
2N3436		$V_{DS} = 20$ V, $I_D = 1.0$ nA		10	Volts
2N3437				5.0	
2N3438				2.5	
2N3458				8.0	
2N3459				4.0	
2N3460				2.0	
Transconductance	g_m				
2N3436, 2N3458		$V_{DS} = 20$ V, $V_{GS} = 0$	2500	10,000	μmhos
2N3437, 2N3459			1500	6000	
2N3438, 2N3460			800	4500	
Input Conductance	G_{is}				
2N3436, 2N3458		$V_{DS} = 10$ V, $V_{GS} = 0$, $f = 1.0$ MHz		4.0	μmhos
2N3437, 2N3459		$V_{DS} = 6.0$ V, $V_{GS} = 0$, $f = 1.0$ MHz		3.5	
2N3438, 2N3460		$V_{DS} = 4.0$ V, $V_{GS} = 0$, $f = 1.0$ MHz		2.5	
Output Conductance	G_{os}				
2N3436, 2N3458		$V_{DS} = 30$ V, $V_{GS} = 0$, $f = 1.0$ MHz		35	μmhos
2N3437, 2N3459				20	
2N3438, 2N3460				5.0	

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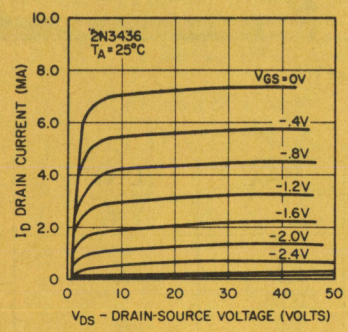
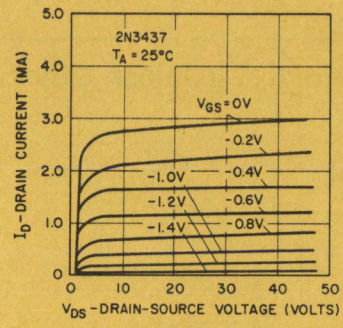
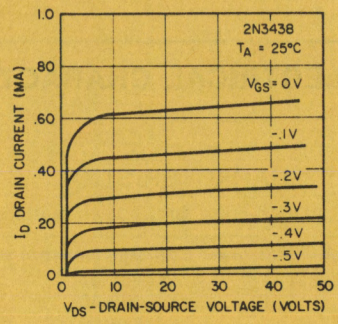
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Input Capacitance	C_{is}				
2N3436, 2N3458		$V_{DS} = 10$ V, $V_{GS} = 0$		18	pf
2N3437, 2N3459		$V_{DS} = 6.0$ V, $V_{GS} = 0$		18	
2N3438, 2N3460		$V_{DS} = 4.0$ V, $V_{GS} = 0$		18	
Output Capacitance	C_{os}				
2N3436-38		$V_{DS} = 30$ V, $V_{GS} = 0$		6.0	pf
2N3458-60		f = 1.0 MHz		5.0	
Drain-Gate Capacitance	C_{DG}	$V_{DG} = 10$ V, $I_S = 0$ f = 140 kHz		5.0	pf
Source-Gate Capacitance	C_{SG}	$V_{GS} = -10$ V, $I_D = 0$ f = 140 kHz		5.0	pf
Noise Figure	NF				
2N3458		$V_{DS} = 10$ V, $R_G = 1.0$ MΩ		6.0	db
2N3459		BW = 6.0 Hz, f = 20 Hz		2.0	
2N3460				1.5	
2N3436-38		$V_{DS} = 10$ V, $R_G = 1.0$ MΩ		2.0	
2N3458-60		BW = 6.0 Hz, f = 1.0 kHz		1.0	

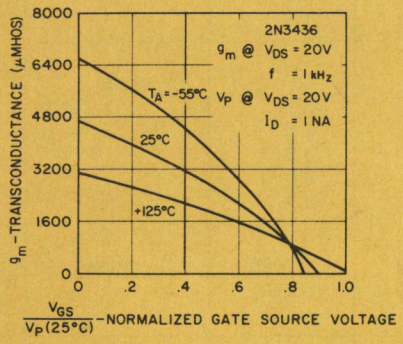
COMMON SOURCE-DRAIN CHARACTERISTICS

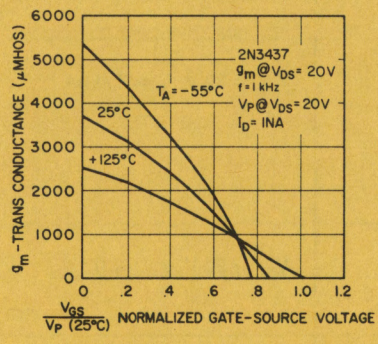


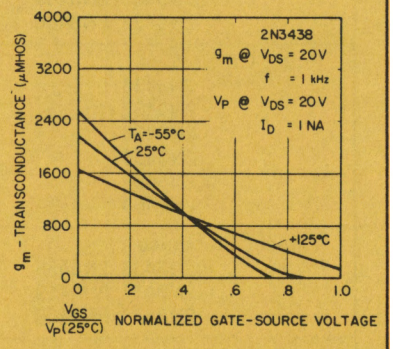




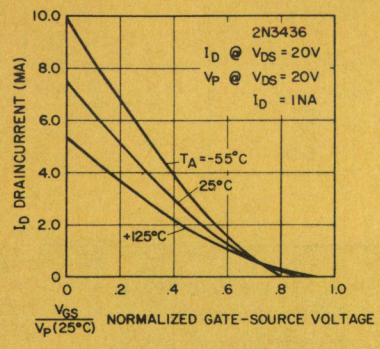
TRANSCONDUCTANCE VS NORMALIZED GATE-SOURCE VOLTAGE

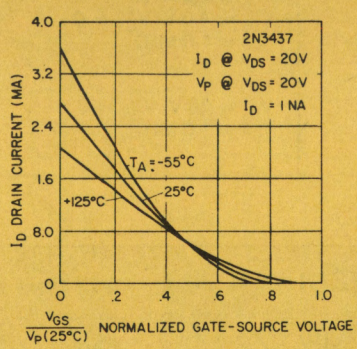


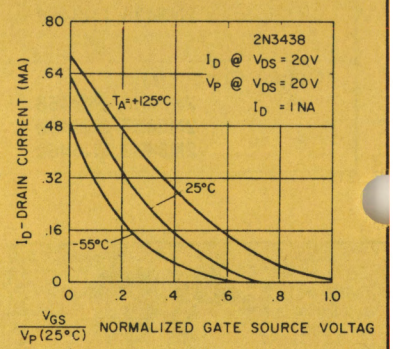




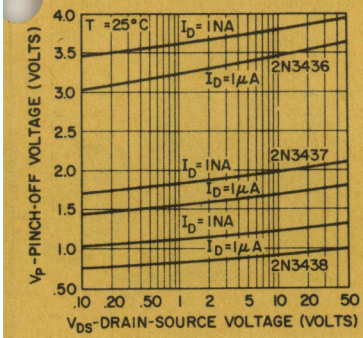
DRAIN CURRENT VS NORMALIZED GATE-SOURCE VOLTAGE



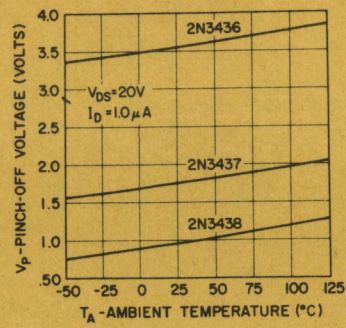




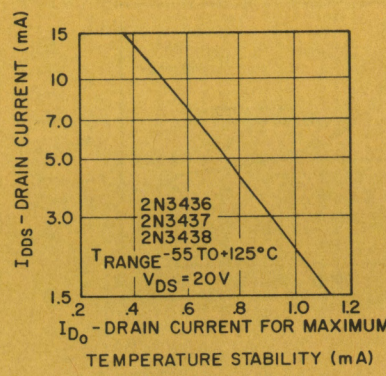
Pinch Off Voltage vs Drain-Source Voltage



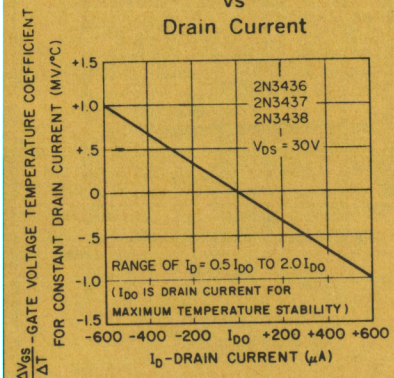
Pinch Off Voltage vs Temperature



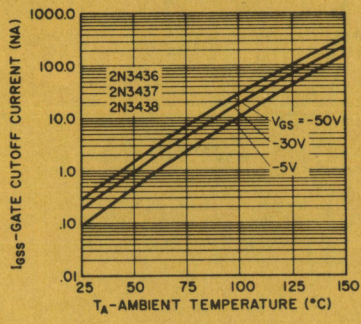
Drain Current for Maximum Temperature Stability vs I_{DSS}



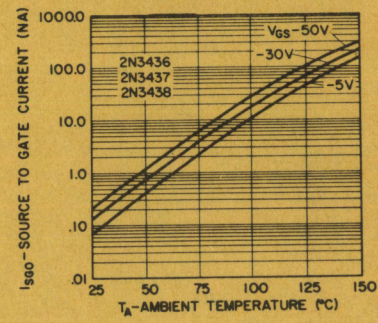
Gate Voltage Temperature Coefficient for Constant Drain Current vs Drain Current



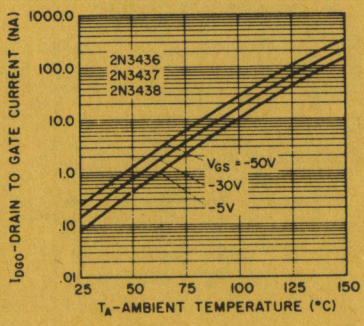
Gate Cutoff Current vs Temperature



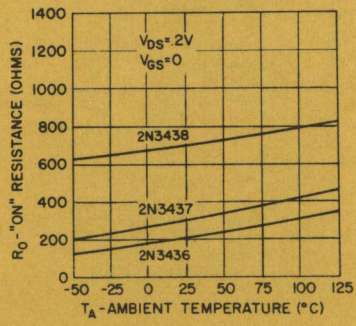
Source-Gate Reverse Current vs Temperature



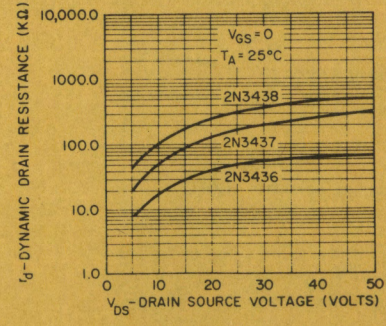
Drain-Gate Reverse Current vs Temperature



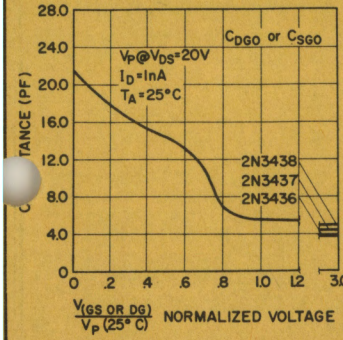
"On" Resistance vs Temperature



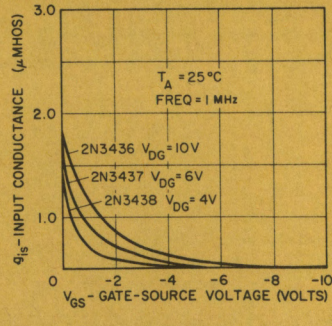
Dynamic Resistance vs Drain-Source Voltage



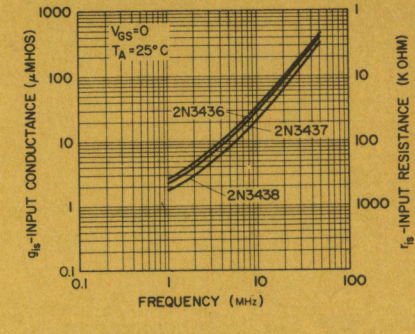
Junction Capacitance vs Normalized Bias



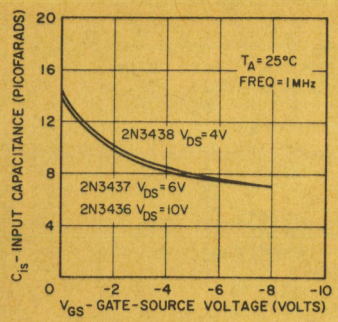
Input Conductance vs Gate-Source Voltage



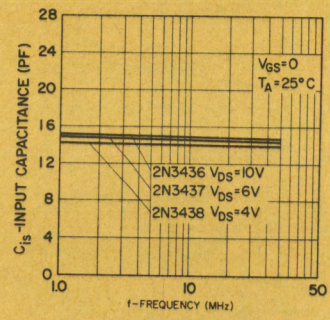
Input Conductance vs Frequency



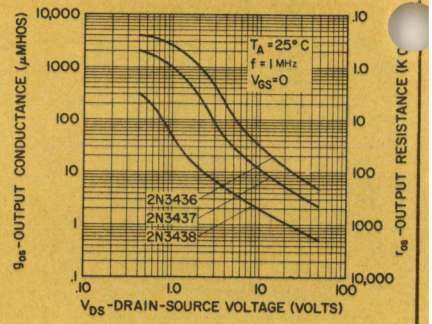
Input Capacitance vs Source-Gate Voltage



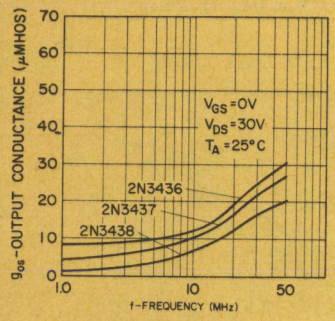
Input Capacitance vs Frequency



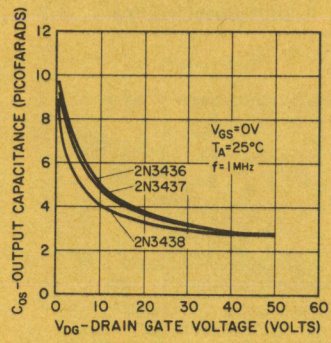
Output Conductance vs Drain-Source Voltage



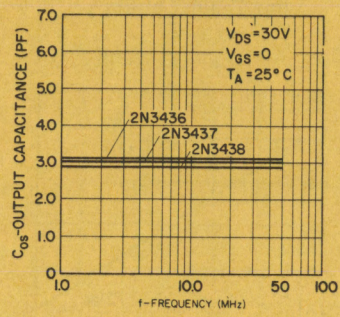
Output Conductance vs Frequency



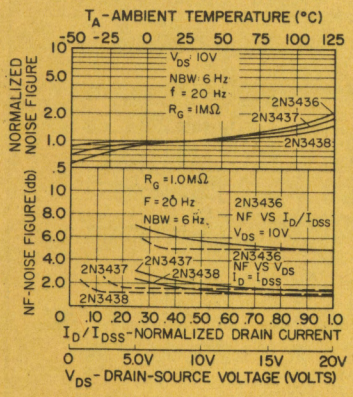
Output Capacitance vs Drain-Source Voltage



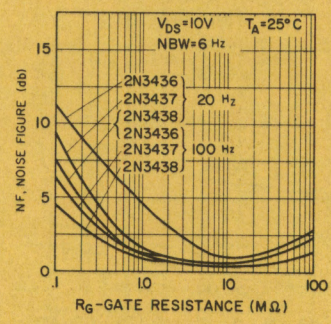
Output Capacitance vs Frequency



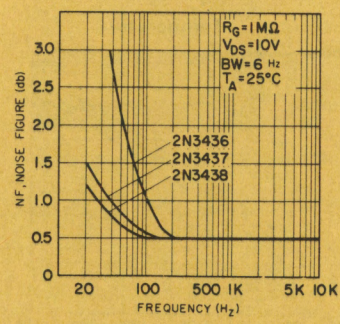
Noise Figure vs Drain Current Drain-Source Voltage and Temperature



Noise Figure vs Gate Resistance



Noise Figure vs Frequency



N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE

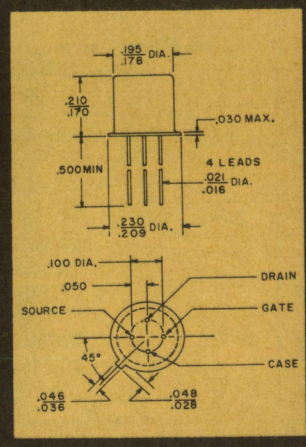
- LOW NOISE
- HIGH BREAKDOWN VOLTAGE
- LOW LEAKAGE

JANUARY 1968

2N3452 THRU 2N3457

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Storage Temperature	T_{stg}	−55 to +200	°C
Junction Temperature	T_J	200	°C
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		1.7	mW/°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A$, $I_S = 0$	50		Volts
Total Gate Leakage Current 2N3452-54 2N3455-57 2N3452-54 2N3455-57	I_{GSS}	$V_{GS} = -30$ V, $V_{DS} = 0$ $V_{GS} = -30$ V, $V_{DS} = 0$ $T_A = 150°C$		0.1 0.04 400 150	nA
Saturation Current 2N3452, 2N3455 2N3453, 2N3456 2N3454, 2N3457	I_{DSS}	$V_{DS} = 30$ V, $V_{GS} = 0$	0.8 0.2 0.05	4.0 1.0 0.25	mA
Pinch Off Voltage 2N3452, 2N3455 2N3453, 2N3456 2N3454, 2N3457	V_P	$V_{DS} = 20$ V, $I_D = 0.5$ nA		10 5.0 2.5	Volts
Transconductance 2N3452 2N3453 2N3454 2N3455 2N3456 2N3457	g_m	$V_{DS} = 30$ V, $V_{GS} = 0$ f = 1.0 kHz	200 150 100 400 300 150	1200 900 600 1200 900 600	μmhos
Input Conductance 2N3452, 2N3455 2N3453, 2N3456 2N3454, 2N3457	g_{is}	$V_{DS} = 12$ V, $V_{GS} = 0$ f = 1.0 MHz $V_{DS} = 8.0$ V, $V_{GS} = 0$ f = 1.0 MHz $V_{DS} = 4.0$ V, $V_{GS} = 0$ f = 1.0 MHz		1.0 1.0 1.0	μmhos
Output Conductance 2N3452, 2N3455 2N3453, 2N3456 2N3454, 2N3457	g_{os}	$V_{DS} = 30$ V, $V_{GS} = 0$ f = 1.0 MHz		15 5.0 3.0	μmhos

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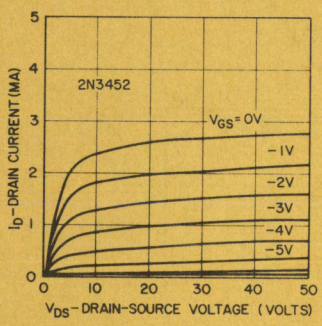
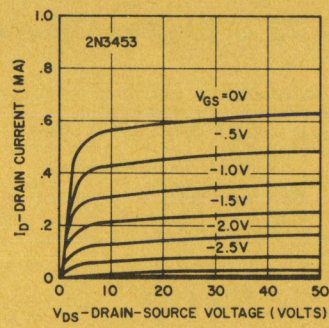
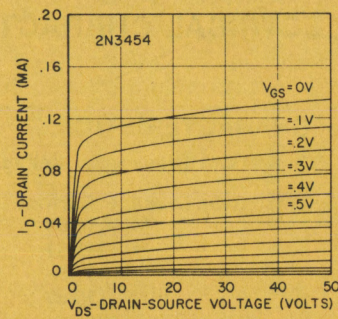
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Input Capacitance	C_{is}				
2N3452		$V_{DS} = 12$ V, $V_{GS} = 0$		6.0	pf
2N3455		f = 1.0 MHz		5.0	
2N3453		$V_{DS} = 8.0$ V, $V_{GS} = 0$		6.0	
2N3456		f = 1.0 MHz		5.0	
2N3454		$V_{DS} = 4.0$ V, $V_{GS} = 0$		6.0	
2N3457		f = 1.0 MHz		5.0	
Output Capacitance	C_{os}	$V_{DS} = 30$ V, $V_{GS} = 0$ f = 1.0 MHz		1.5	pf
Drain-Gate Capacitance	C_{DG}				
2N3452-54		$V_{DG} = 10$ V, $I_S = 0$		1.2	pf
2N3455-57		f = 140 kHz		1.0	
Source-Gate Capacitance	C_{SG}				
2N3452-54		$V_{GS} = -10$ V, $I_D = 0$		1.8	pf
2N3455-57		f = 140 kHz		1.5	
Noise Figure	NF				
2N3455-57		$V_{DS} = 10$ V, $R_G = 1.0$ MΩ		4.0	db
2N3452		BW = 6.0 Hz, f = 20 Hz		6.0 (Typ.)	
2N3453				5.0 (Typ.)	
2N3454				4.0 (Typ.)	
2N3455-57		$V_{DS} = 10$ V, $R_G = 1.0$ MΩ		1.0	
2N3452-54		BW = 6.0 Hz, f = 100 Hz.		2.0	

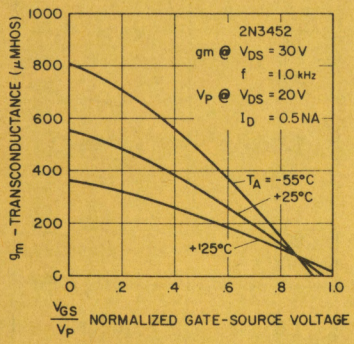
COMMON SOURCE — DRAIN CHARACTERISTICS

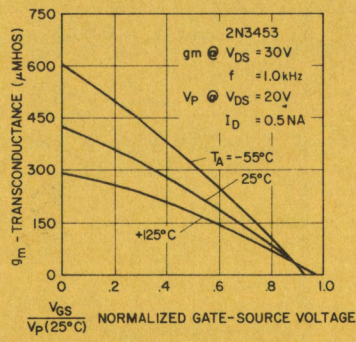


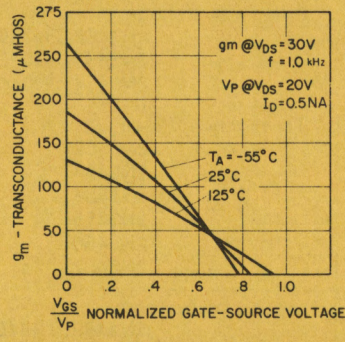




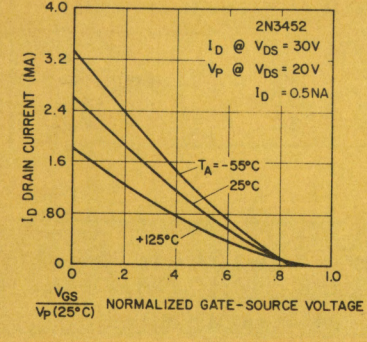
TRANSCONDUCTANCE VS NORMALIZED GATE - SOURCE VOLTAGE

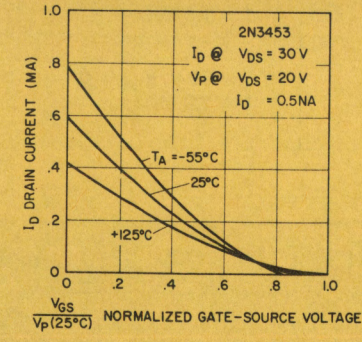


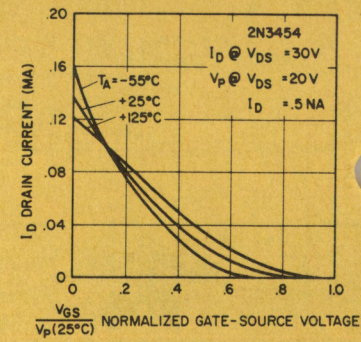




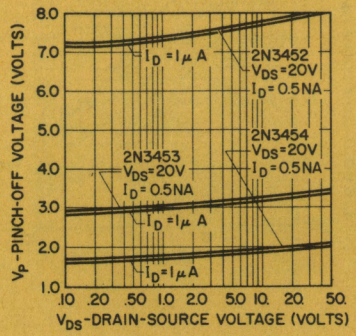
DRAIN CURRENT VS NORMALIZED GATE - SOURCE VOLTAGE



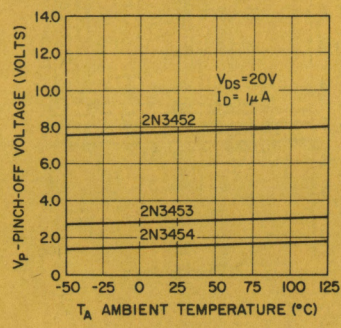




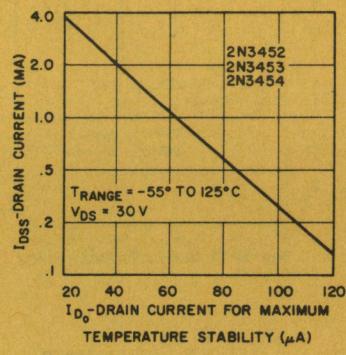
Pinch Off Voltage vs Drain-Source Voltage



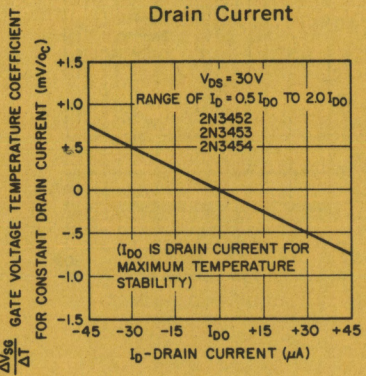
Pinch Off Voltage vs Temperature



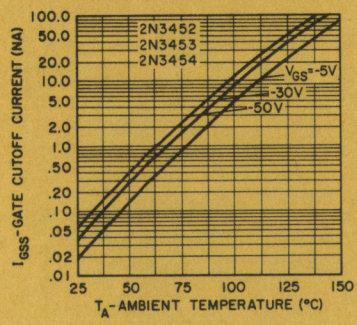
Drain Current for Maximum Temperature Stability vs I_{DSS}



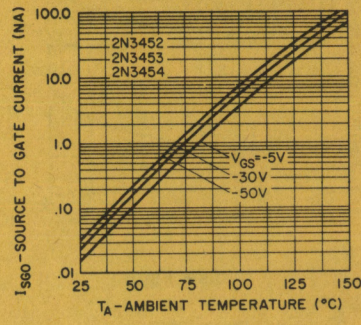
Gate Voltage Temperature Coefficient for Constant Drain Current vs Drain Current



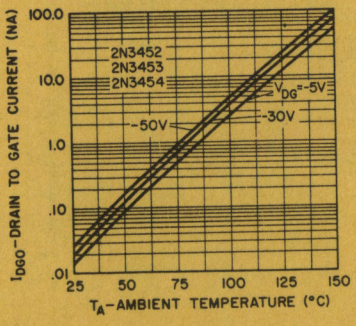
Gate Cutoff Current vs Temperature



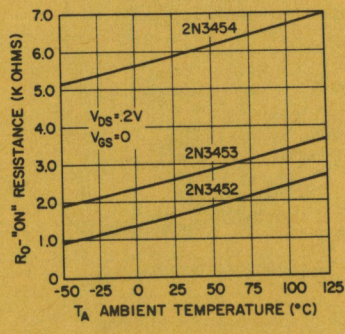
Source-Gate Reverse Current vs Temperature



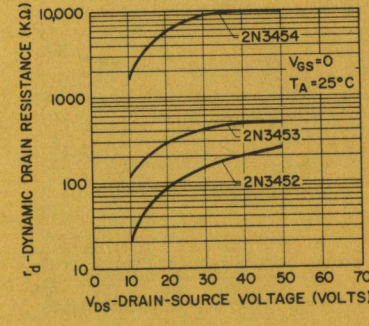
Drain-Gate Reverse Current vs Temperature



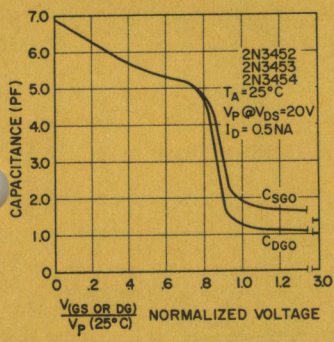
"On" Resistance vs Temperature



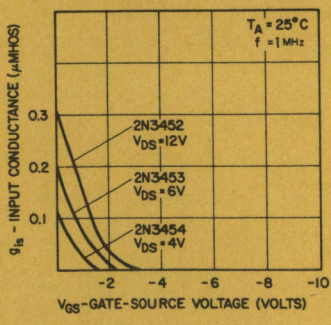
Dynamic Resistance vs Drain-Source Voltage



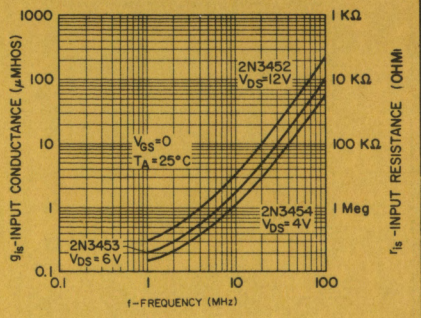
Junction Capacitance vs Normalized Bias



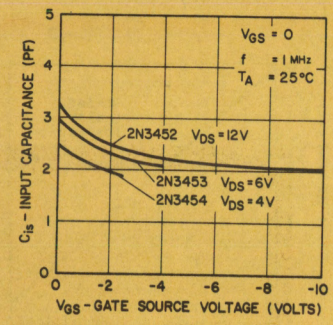
Input Conductance vs Gate-Source Voltage



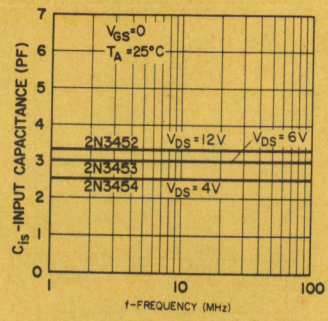
Input Conductance vs Frequency



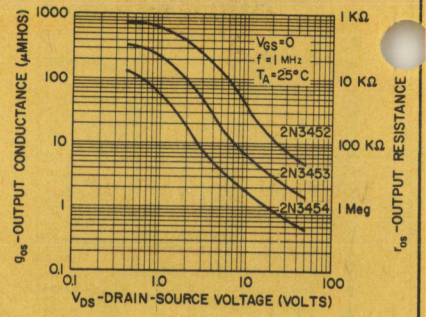
Input Capacitance vs Source-Gate Voltage



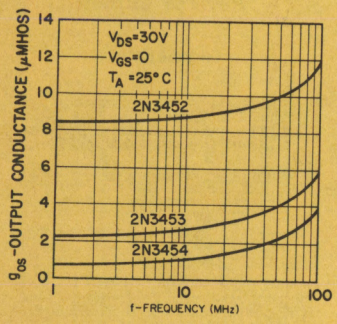
Input Capacitance vs Frequency



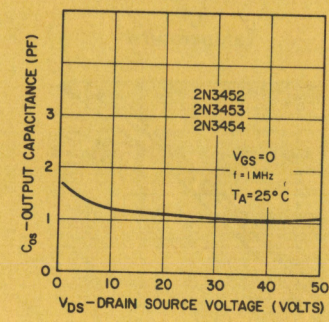
Output Conductance vs Drain-Source Voltage



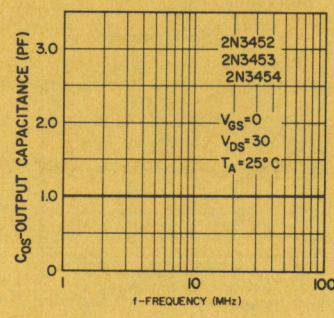
Output Conductance vs Frequency



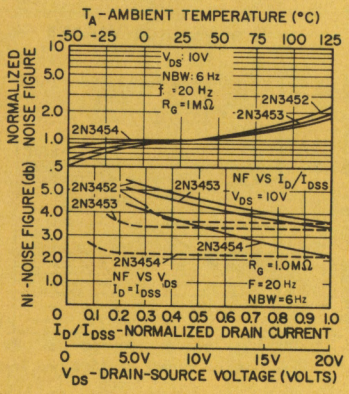
Output Capacitance vs Drain-Source Voltage



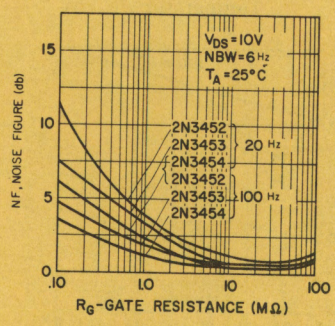
Output Capacitance vs Frequency



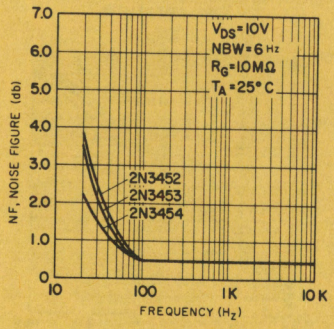
Noise Figure vs Drain Current Drain-Source Voltage and Temperature



Noise Figure vs Gate Resistance



Noise Figure vs Frequency



N-CHANNEL FIELD EFFECT TRANSISTOR
RF/IF AMPLIFIER

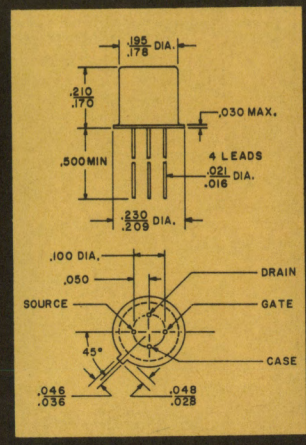
- LOW NOISE
- HIGH TRANSCONDUCTANCE
- LOW CAPACITANCE

JANUARY 1968

2N3823

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gate Voltage	V_{DG}	30	Volts
Gate-Source Voltage	V_{GS}	30	Volts
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		2.0	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	175	°C
Lead Temperature, 1/16 inch from case, 10 seconds max.		300	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	30		Volts
Gate-Source Cutoff Voltage	$V_{GS(OFF)}$	$I_D = 50$ nA, $V_{DS} = 15$ V		8.0	Volts
Gate-Source Voltage	V_{GS}	$I_D = 0.4$ mA, $V_{DS} = 15$ V	1.0	7.5	Volts
Gate Reverse Current	I_{GSS}	$V_{GS} = 20$ V, $V_{DS} = 0$ $V_{GS} = 20$ V, $V_{DS} = 0$, $T_A = 150°C$		0.50 500	nA
Zero-Gate-Voltage Current	I_{DSS}*	$V_{DS} = 15$ V, $V_{GS} = 0$	4.0	20	mA
Input Capacitance	C_{iss}	$V_{DS} = 15$ V, $V_{GS} = 0$ $f = 1.0$ MHz		6.0	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 15$ V, $V_{GS} = 0$ $f = 1.0$ MHz		2.0	pf
Forward Transfer Admittance	$\lvert Y_{fs} \rvert$*	$V_{DS} = 15$ V, $V_{GS} = 0$ $f = 1.0$ kHz $V_{DS} = 15$ V, $V_{GS} = 0$ $f = 200$ MHz	3500 3200	6500	μmhos
Input Admittance	Y_{is}	$V_{DS} = 15$ V, $V_{GS} = 0$ $f = 200$ MHz		800	μmhos
Output Admittance	$\lvert Y_{os} \rvert$*	$V_{DS} = 15$ V, $V_{GS} = 0$ $f = 1.0$ kHz $V_{DS} = 15$ V, $V_{GS} = 0$ $f = 200$ MHz		35 200	μmhos
Noise Figure	NF	$V_{DS} = 15$ V, $V_{GS} = 0$ $R_S = 1000\ \Omega$, $f = 100$ MHz		2.5	db

* Pulse Test: Pulse Width = 100 ms; Duty Cycle = 10%.

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3104

N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE

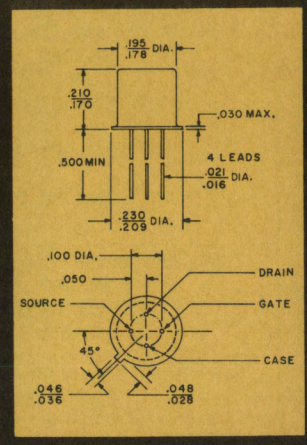
- LOW NOISE
- LOW CAPACITANCE
- FAST SWITCHING SPEEDS

JANUARY 1968

2N3966-69 THRU 2N3967A-69A

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gain Voltage	V_{DG}	30	Volts
Reverse Gate-Source Voltage	V_{GS}	30	Volts
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	0.3	Watts
Derating Factor Above 25°C @ $T_A = 25°C$		1.71	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	30		Volts
Gate-Source Voltage	V_{GS}				
2N3967, 2N3967A		$V_{DS} = 20$ V, $I_D = 0.25$ mA	1.0	4.5	Volts
2N3968, 2N3968A		$V_{DS} = 20$ V, $I_D = 0.10$ mA	0.5	2.8	
2N3969, 2N3969A		$V_{DS} = 20$ V, $I_D = 0.04$ mA	0.3	1.6	
Gate-Source Cutoff Voltage	$V_{GS(OFF)}$				
2N3966		$V_{DS} = 10$ V, $I_D = 10$ nA	4.0	6.0	Volts
2N3967, 2N3967A		$V_{DS} = 20$ V, $I_D = 1.0$ nA	2.0	5.0	
2N3968, 2N3968A				3.0	
2N3969, 2N3969A				1.7	
Drain Cutoff Current	$I_{D(OFF)}$				
2N3966		$V_{DS} = 10$ V, $V_{GS} = -7.0$ V		1.0	nA
2N3966		$V_{DS} = 10$ V, $V_{GS} = -7.0$ V, $T_A = 150°C$		2.0	μA
Gate-Drain Leakage Current	I_{DGO}				
2N3966		$V_{DG} = 20$ V, $I_S = 0$		0.1	nA
2N3966		$V_{DG} = 20$ V, $I_D = 0$, $T_A = 150°C$		0.2	μA
Gate Reverse Current	I_{GSS}	$V_{GS} = 20$ V, $V_{DS} = 0$		0.1	nA
		$V_{GS} = 20$ V, $V_{DS} = 0$, $T_A = 150°C$		0.2	μA
Zero-Gate-Voltage Drain Current	I_{DSS}	$V_{DS} = 20$ V, $V_{GS} = 0$			mA
2N3966			2.0	10	
2N3967, 2N3967A			2.5	5.0	
2N3968, 2N3968A			1.0	2.0	
2N3969, 2N3969A			0.4		
Drain-Source "ON" Resistance	$r_{ds(ON)}$				
2N3966		$V_{DS} = 0$, $V_{GS} = 0$		220	Ohms
2N3967, 2N3967A		$f = 1.0$ kHz		400	
2N3968, 2N3968A				700	
Rise Time	t_r				
2N3966		See Figures 1 & 2		100	nsec
Turn-on Delay Time	t_d				
2N3966		See Figures 1 & 2		20	nsec
Turn-off Time	t_{off}				
2N3966		See Figures 1 & 2		100	nsec

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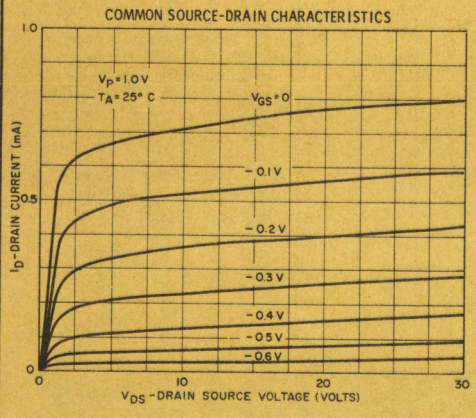
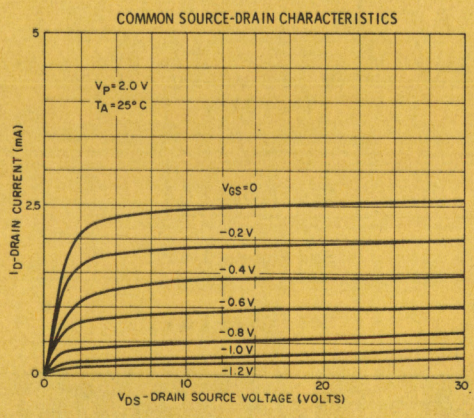
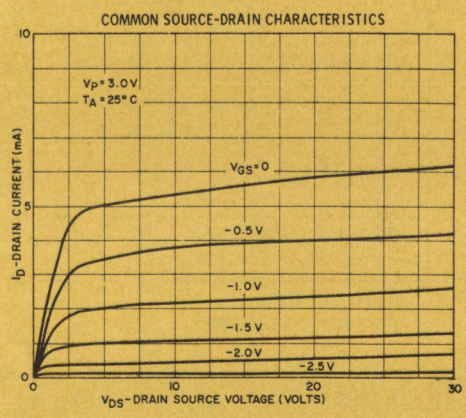
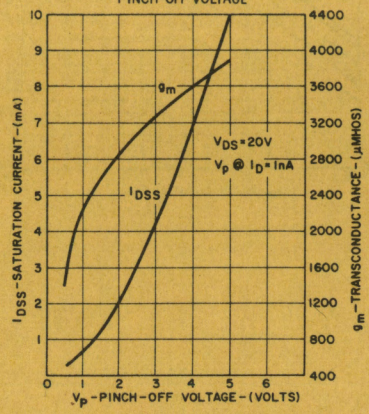
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Input Capacitance	C_{iss}				
2N3966		$V_{DS} = 20$ V, $V_{GS} = 0$ $f = 1.0$ MHz		6.0	pf
2N3967A		$V_{DS} = 20$ V, $I_D = 0.25$ mA $f = 1.0$ MHz		5.0	
2N3968A		$V_{DS} = 20$ V, $I_D = 0.10$ mA $f = 1.0$ MHz		5.0	
2N3969, 2N3969A		$V_{DS} = 20$ V, $I_D = 0.04$ mA $f = 1.0$ MHz		5.0	
Reverse Transfer Capacitance	C_{rss}				
2N3966		$V_{DS} = 0$, $V_{GS} = 7.0$ V $f = 1.0$ MHz		1.5	pf
2N3967, 2N3967A		$V_{DS} = 20$ V, $I_D = 1.0$ mA $f = 1.0$ MHz		1.3	
2N3968, 2N3968A		$V_{DS} = 20$ V, $I_D = 0.5$ mA $f = 1.0$ MHz		1.3	
2N3969, 2N3969A		$V_{DS} = 20$ V, $I_D = 0.2$ mA $f = 1.0$ MHz		1.3	
Transadmittance	Y_{fs}				
2N3967, 2N3967A		$V_{DS} = 20$ V, $V_{GS} = 0$ $f = 1.0$ kHz	2500		μmhos
2N3968, 2N3968A			2000		
2N3969, 2N3969A			1300		
Forward Transadmittance	Y_{fs}				
2N3967, 2N3967A		$V_{DS} = 20$ V, $I_D = 0.25$ mA	1600	2400	μmhos
2N3968, 2N3968A		$V_{DS} = 20$ V, $I_D = 0.10$ mA	1400	2000	
2N3969, 2N3969A		$V_{DS} = 20$ V, $I_D = 0.04$ mA	950	1450	
Forward Transadmittance	Y_{fs}				
2N3967, 2N3967A		$V_{DS} = 20$ V, $V_{GS} = 0$ $f = 10$ MHz	1600		μmhos
2N3968, 2N3968A			1400		
2N3969, 2N3969A			950		
Output Admittance	Y_{os}				
2N3967, 2N3967A		$V_{DS} = 20$ V, $I_D = 0.25$ mA $f = 1.0$ MHz		35	μmhos
2N3968, 2N3968A		$V_{DS} = 20$ V, $I_D = 0.10$ mA $f = 1.0$ MHz		15	
2N3969, 2N3969A		$V_{DS} = 20$ V, $I_D = 0.04$ mA $f = 1.0$ MHz		5.0	
Noise Figure	NF				
2N3967-2N3969A		$V_{DS} = 20$ V, $V_{GS} = 0$ $R_G = 1.0$ MΩ $f = 100$ Hz BW = 6 Hz		1.5	db
2N3967A, 68A, 69A		$V_{DS} = 10$ V, $V_{GS} = 0$ $R_G = 1.0$ MΩ $f = 10$ Hz BW = 6 Hz		4.0	
2N3967A, 68A, 69A		$V_{DS} = 10$ V, $V_{GS} = 0$ $R_G = 1.0$ MΩ $f = 1.0$ kHz BW = 200 Hz		1.0	



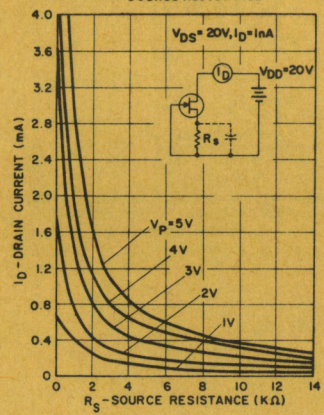




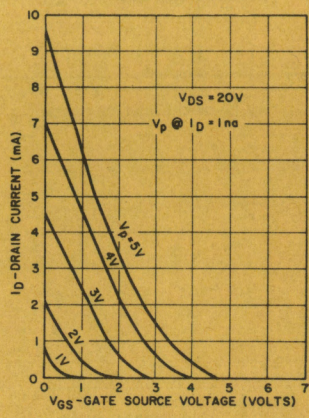
TRANSCONDUCTANCE
AND DRAIN CURRENT
VS
PINCH-OFF VOLTAGE



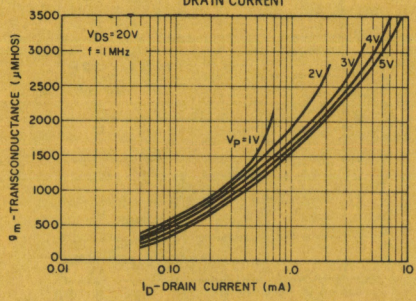
SOURCE FOLLOWER
DRAIN CURRENT
VS
SOURCE RESISTANCE



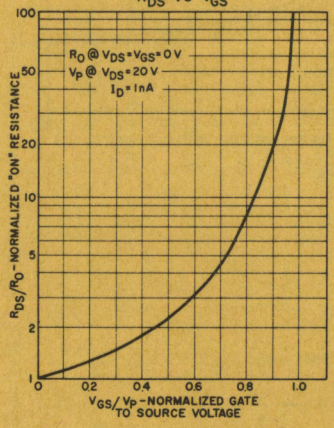
DRAIN CURRENT
VS
GATE-SOURCE BIAS



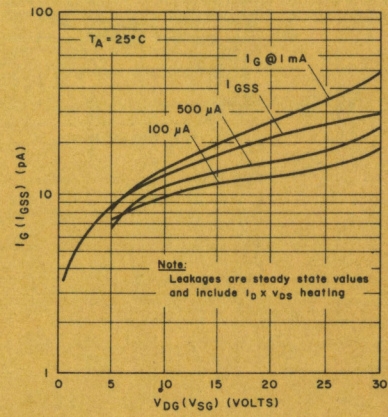
TRANSCONDUCTANCE
VS
DRAIN CURRENT



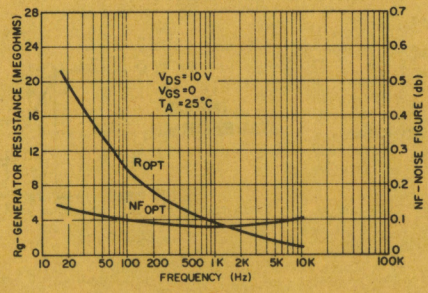
NORMALIZED
R_{DS} VS V_{GS}



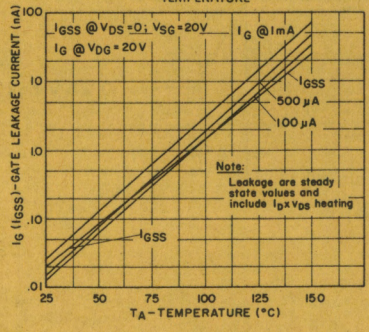
GATE LEAKAGE CURRENT
VS
VOLTAGE



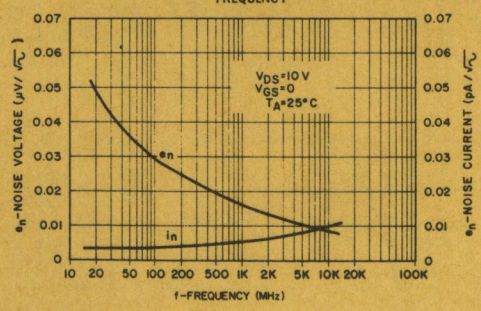
OPTIMUM GENERATOR RESISTANCE
AND
NOISE FIGURE



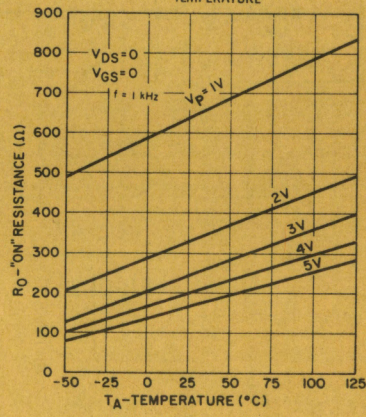
GATE LEAKAGE CURRENT
VS
TEMPERATURE

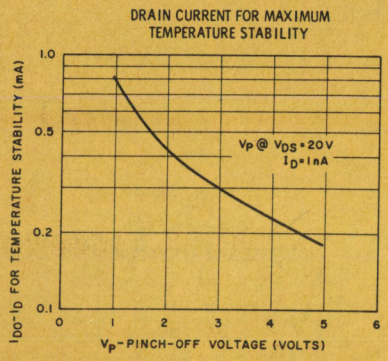


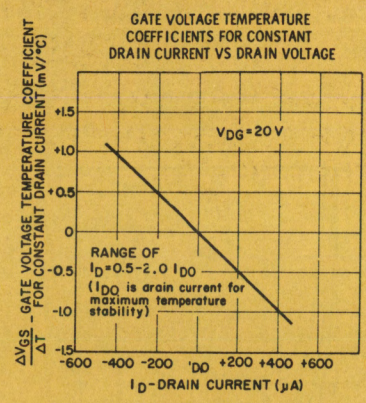
NOISE VOLTAGE/CURRENT
VS
FREQUENCY

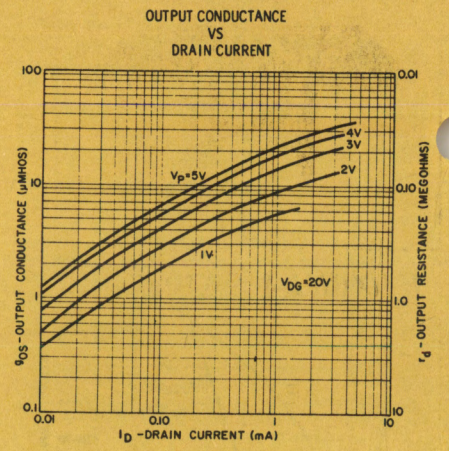


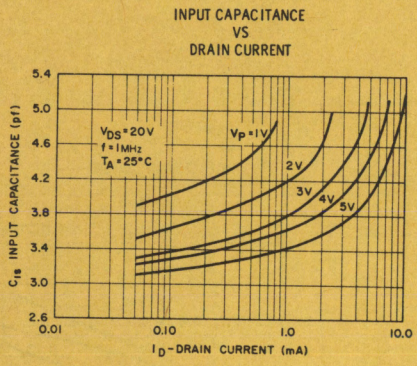
"ON" RESISTANCE
VS
TEMPERATURE

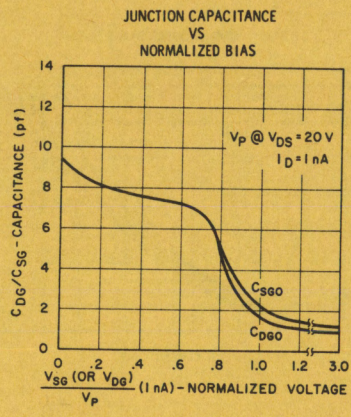


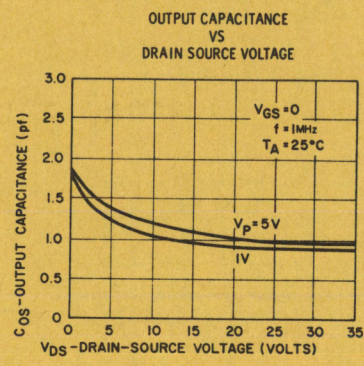












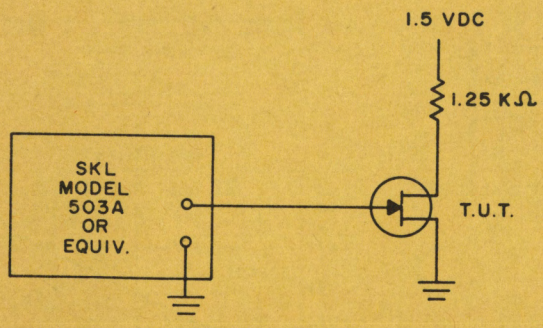


FIGURE 1

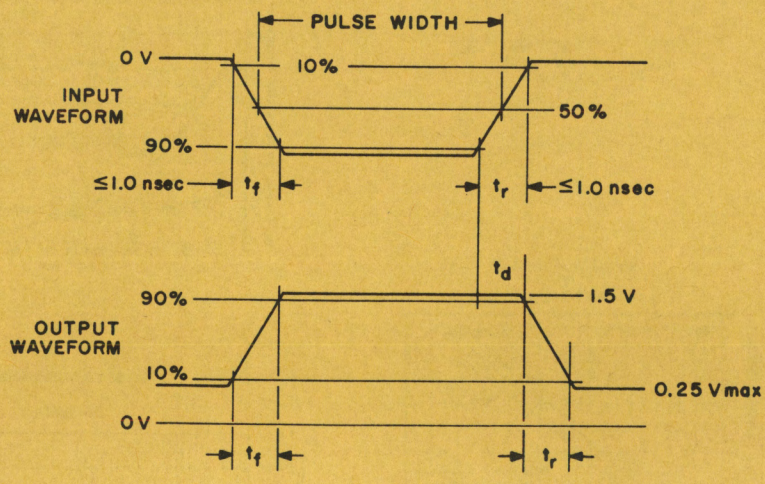


FIGURE 2

N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE

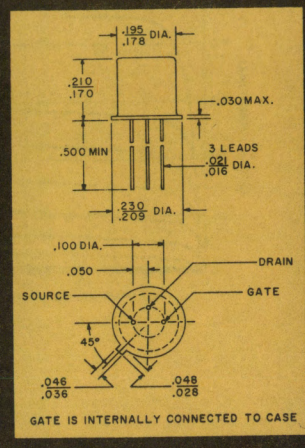
- HIGH TRANSCONDUCTANCE
- LOW LEAKAGE
- LOW NOISE

JANUARY 1968

2N4139

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor Above 25°C @ $T_A = 25°C$		1.7	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A$, $I_S = 0$	50		Volts
Source-Gate Breakdown Voltage	BV_{SGO}	$I_S = 1.0\ \mu A$, $I_D = 0$	50		Volts
Total Gate Leakage Current	I_{GSS}	$V_{GS} = -30$ V, $V_{DS} = 0$ $V_{GS} = -30$ V, $V_{DS} = 0$, $T_A = 125°C$		1.0 1.0	nA μA
Saturation Current	I_{DSS}	$V_{DS} = 20$ V, $V_{GS} = 0$	8.0	11	mA
Pinch Off Voltage	V_P	$V_{DS} = 20$ V, $I_D = 1.0$ nA	2.0	8.0	Volts
Transconductance	g_m	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1.0 kHz $V_{DS} = 20$ V, $V_{GS} = 0$ f = 1.0 MHz	3500 3000	7000	μmhos
Short-circuit, common-source input conductance	G_{is}	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1.0 MHz		4.0	μmhos
Output Conductance	g_{os}	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1.0 MHz		35	μmhos
Input Capacitance	C_{is}	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1.0 MHz		18	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 140 kHz		5.0	pf
Drain to Gate Capacitance	C_{DG}	$V_{DG} = 10$ V, $I_S = 0$ f = 140 kHz		5.0	pf
Noise Figure	NF	$V_{DS} = 20$ V, $V_{gs} = 0$, $R_G = 1.0$ MΩ f = 1.0 kHz, BV = 6.0 Hz		2.0	db

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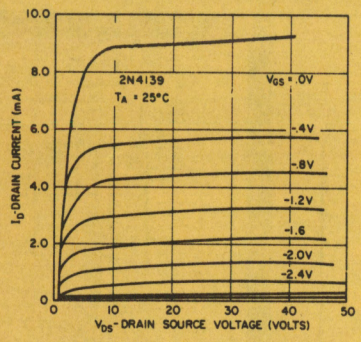
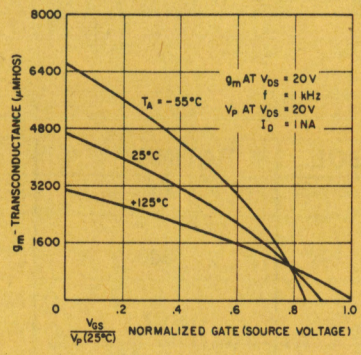
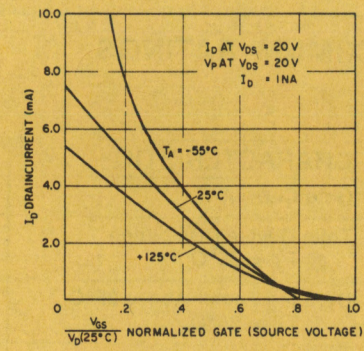
Common Source-Drain Characteristics



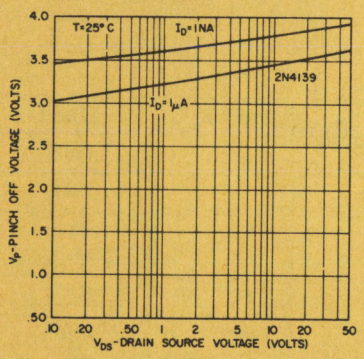
Transconductance vs Normalized Gate-Source Voltage



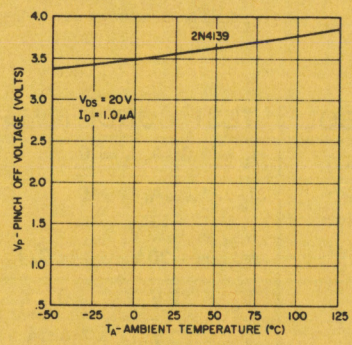
Drain Current vs Normalized Gate-Source Voltage



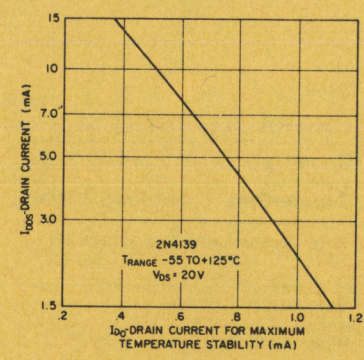
Pinch Off Voltage vs Drain-Source Voltage



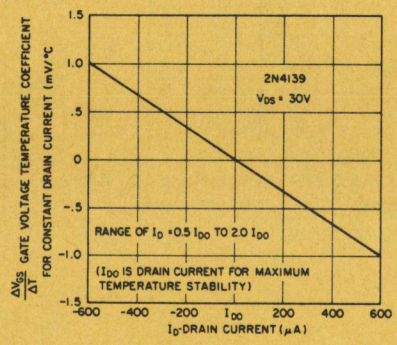
Pinch Off Voltage vs Temperature



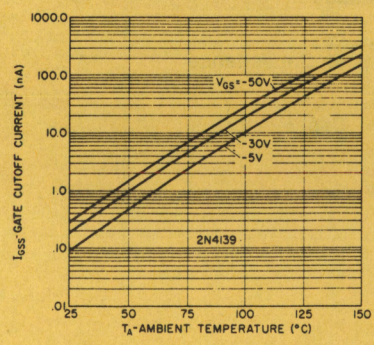
Drain Current for Maximum Temperature Stability vs I_{DSS}



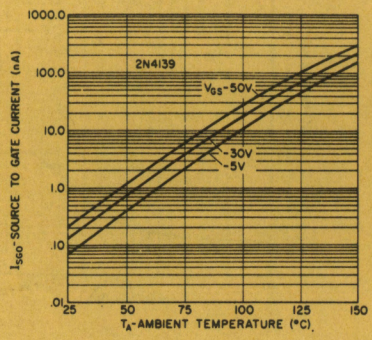
Gate Voltage Temperature Coefficient for Constant Drain Current vs Drain Current



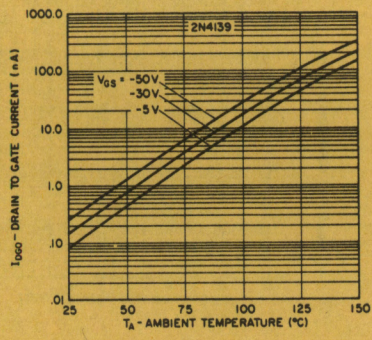
Gate Cutoff Current vs Temperature



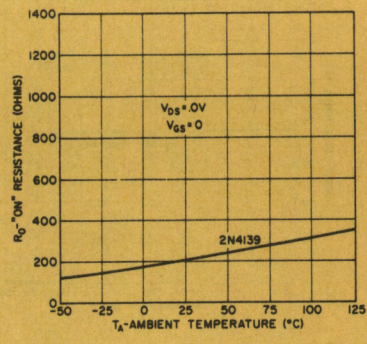
Source-Gate Reverse Current vs Temperature



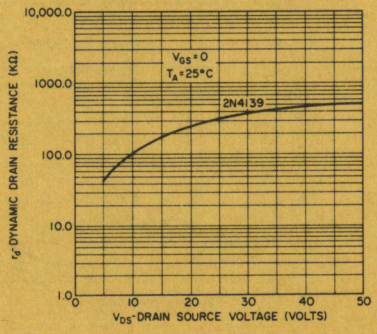
Drain-Gate Reverse Current vs Temperature



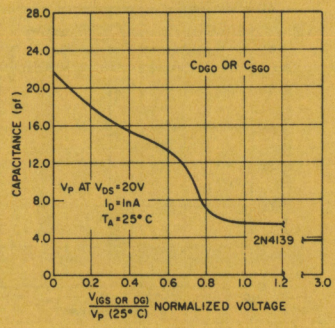
"On" Resistance vs Temperature



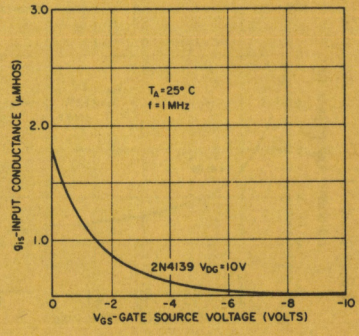
Dynamic Resistance vs Drain-Source Voltage



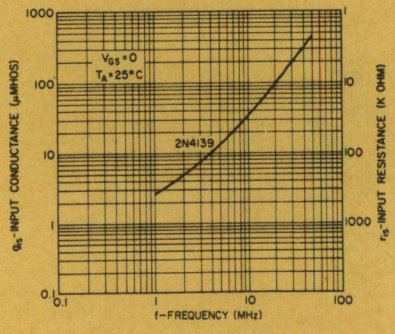
Junction Capacity vs Normalized Bias



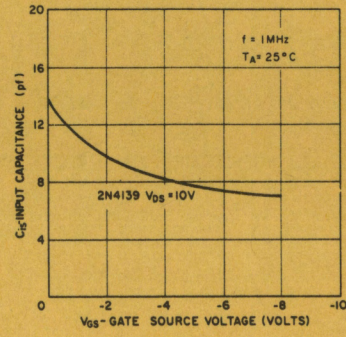
Input Conductance vs Gate-Source Voltage



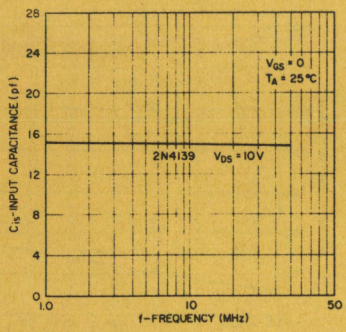
Input Conductance vs Frequency



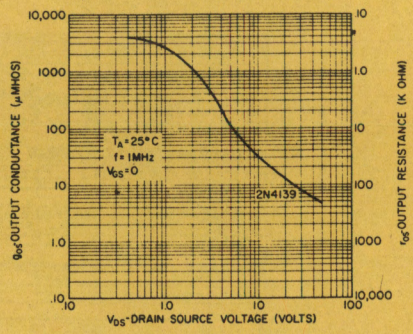
Input Capacity vs Source-Gate Voltage



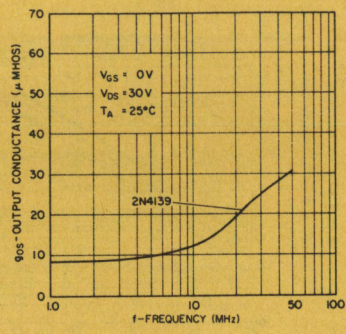
Input Capacity vs Frequency



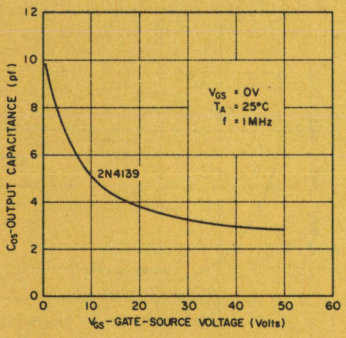
Output Conductance vs Drain-Source Voltage



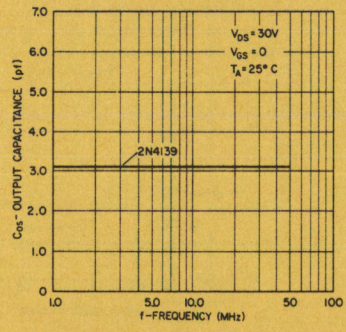
Output Conductance vs Frequency



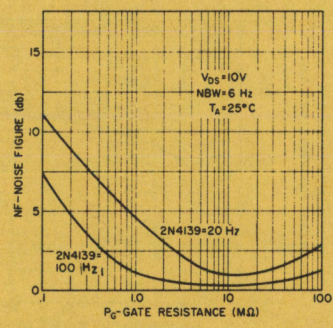
Output Capacitance vs Drain-Source Voltage



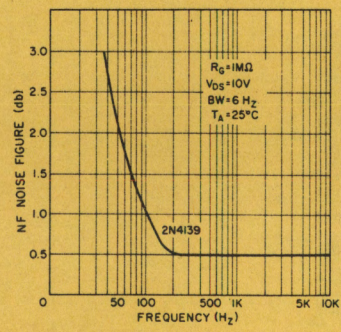
Output Capacitance vs Frequency



Noise Figure vs Gate Resistance



Noise Figure vs Frequency



N-CHANNEL FIELD EFFECT TRANSISTOR

RF/IF AMPLIFIER

- HIGH TRANSCONDUCTANCE
- LOW LEAKAGE
- LOW NOISE

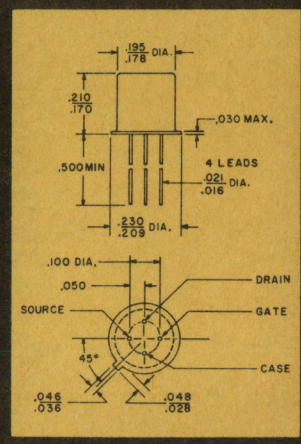
JANUARY 1968

2N4223

2N4224

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gate Voltage	V_{DG}	30	Volts
Gate-Source Voltage	V_{GS}	−30	Volts
Drain Current	I_D	20	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		2	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+175	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)\,GSS}$	$I_G = 10\ \mu A$, $V_{DS} = 0$	−30		Volts
Gate-Source Cutoff Voltage	$V_{GS(off)}$				
2N4223		$I_D = 0.25$ nA, $V_{DS} = 15$ V		−8	Volts
2N4224		$I_D = 0.50$ nA, $V_{DS} = 15$ V		−8	
Gate-Source Voltage	V_{GS}				
2N4223		$I_D = 0.3$ mA, $V_{DS} = 15$ V	−1.0	−7.0	Volts
2N4224		$I_D = 0.2$ mA, $V_{DS} = 15$ V	−1.0	−7.5	
Gate Reverse Current	I_{GSS}				
2N4223		$V_{GS} = -20$ V, $V_{DS} = 0$		−0.25	nA
2N4224				−0.50	
2N4223		$V_{GS} = -20$ V, $V_{DS} = 0$, $T_A = 100°C$		−250	
2N4224				−500	
Zero-Gate-Voltage Drain Current	I_{DSS}*				
2N4223		$V_{DS} = 15$ V, $V_{GS} = 0$	3	18	mA
2N4224			2	20	
Input Conductance	Y_{is}	$V_{DS} = 15$ V, $V_{GS} = 0$, $f = 200$ MHz		800	μmhos
Output Conductance	Y_{os}	$V_{DS} = 15$ V, $V_{GS} = 0$, $f = 200$ MHz		200	μmhos
Small-Signal Power Gain	G_{ps}	$V_{DS} = 15$ V, $V_{GS} = 0$			
2N4223		$f = 200$ MHz (Figure 1)	10		db
Input Capacitance	C_{iss}	$V_{DS} = 15$ V, $V_{GS} = 0$, $f = 1$ MHz		6	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 15$ V, $V_{GS} = 0$, $f = 1$ MHz		2	pf
Forward Transfer Admittance	$\lvert y_{fs} \rvert$				
2N4223		$V_{DS} = 15$ V, $V_{GS} = 0$	3000	7000	μmhos
2N4224		$f = 1$ kHz	2000	7500	
2N4223		$V_{DS} = 15$ V, $V_{GS} = 0$	2700		
2N4224		$f = 200$ MHz	1700		
Noise Figure	NF	$V_{DS} = 15$ V, $V_{GS} = 0$, $R_S = 1$ kΩ			
2N4223		$f = 200$ MHz (Figure 1)		5	db

* Pulse Test: Pulse Width ≦ 630 ms, Duty Cycle ≦ 10%

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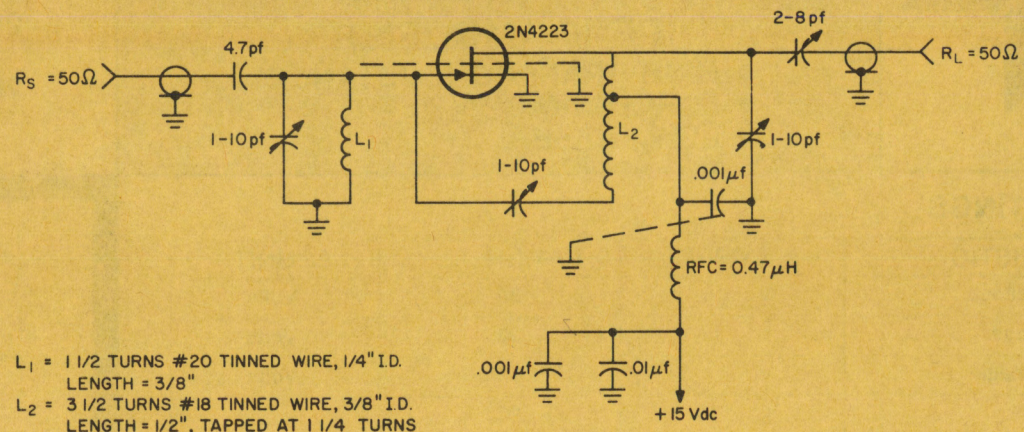
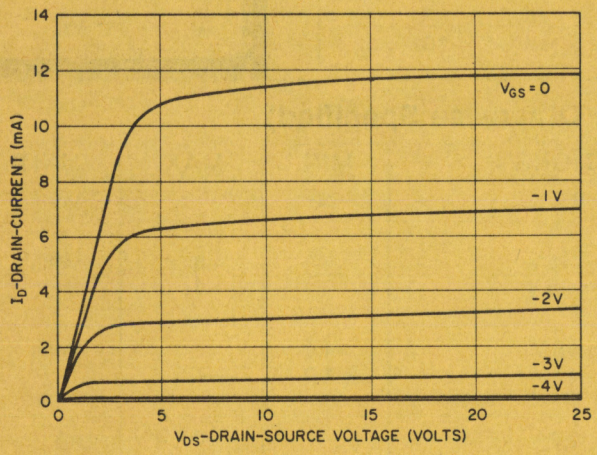
Figure 1. Noise Figure and Power Gain Test Circuit



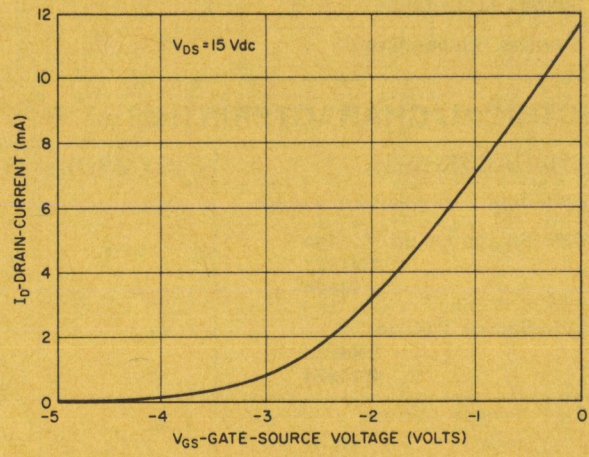
L_1 = 1 1/2 TURNS #20 TINNED WIRE, 1/4" I.D.
LENGTH = 3/8"

L_2 = 3 1/2 TURNS #18 TINNED WIRE, 3/8" I.D.
LENGTH = 1/2", TAPPED AT 1 1/4 TURNS FROM DRAIN

Drain Characteristics



Common Source Transfer Characteristics



N-CHANNEL FIELD EFFECT TRANSISTOR

GENERAL PURPOSE

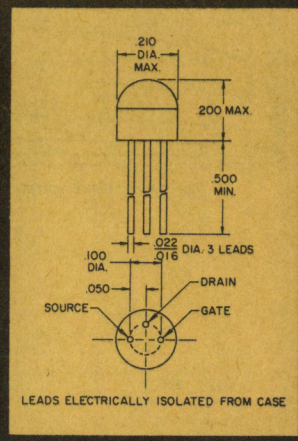
- LOW NOISE
- LOW LEAKAGE
- LOW CAPACITANCE

JANUARY 1968

2N4302
2N4303
2N4304

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gate Voltage	V_{DG}	30	Volts
Reverse-Gate-Source Voltage	V_{GS}	20	Volts
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor Above 25°C @ $T_A = 25°C$		2.5	mW/°C
Storage Temperature	T_{stg}	−55 to +125	°C
Junction Temperature	T_J	125	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	30		Volts
Total Gate Leakage Current	I_{GSS}	$V_{GS} = -10$ V, $V_{DS} = 0$ $V_{GS} = -10$ V, $V_{DS} = 0$, $T_A = 85°C$		1.0 0.1	nA μA
Saturation Current 2N4302 2N4303 2N4304	I_{DSS}	$V_{DS} = 20$ V, $V_{GS} = 0$	0.5 4.0 0.5	5.0 10 15	mA
Pinch Off Voltage 2N4302 2N4303 2N4304	V_P	$V_{DS} = 20$ V, $I_D = 10$ nA		4.0 6.0 10	Volts
Transconductance 2N4302 2N4303 2N4304	g_m	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1.0 kHz	1000 2000 1000		μmhos
Output Conductance	g_{os}	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1.0 kHz		50	μmhos
Input Capacitance	C_{iss}	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1.0 MHz		6.0	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1.0 MHz		3.0	pf
Drain-Gate Capacitance	C_{DG}	$V_{DG} = 10$ V, $I_S = 0$ f = 140 kHz		2.0	pf
Magnitude of Small Signal, Common Source, Short Circuit, forward Transadmittance 2N4302 2N4303 2N4304	Y_{fs}	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 10 MHz	700 1400 700		μmhos
Noise Figure 2N4302 2N4303 2N4304	NF	$V_{DS} = 10$ V, $R_G = 1.0$ MΩ f = 1.0 kHz $V_{GS} = 0$, BW = 200 Hz		2.0 2.0 3.0	db

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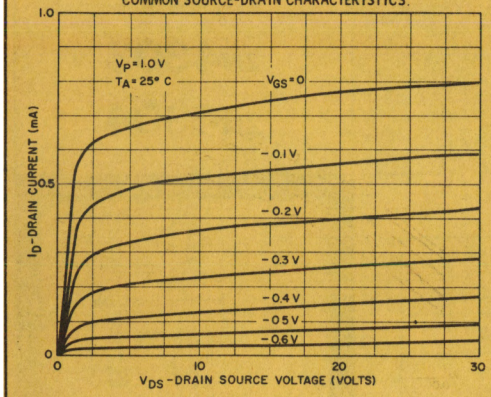
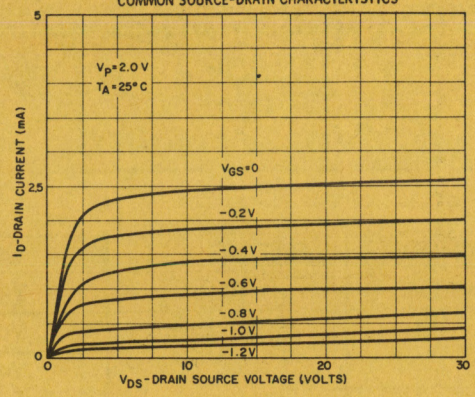
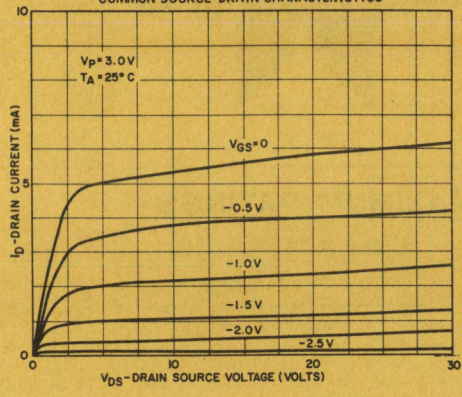
COMMON SOURCE-DRAIN CHARACTERISTICS



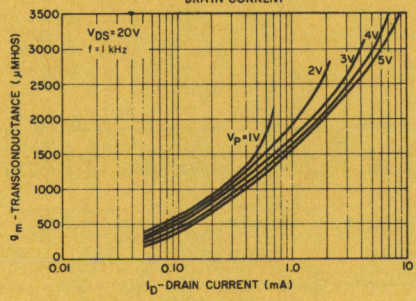
COMMON SOURCE-DRAIN CHARACTERISTICS



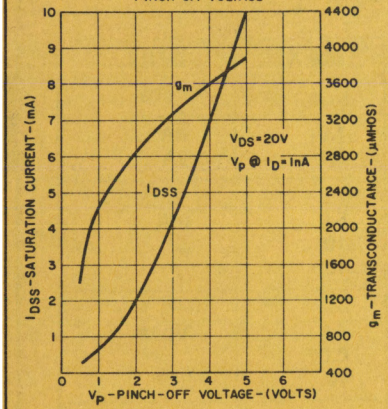
COMMON SOURCE-DRAIN CHARACTERISTICS



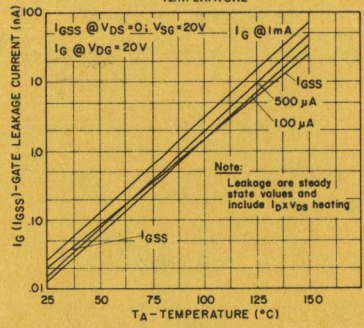
TRANSCONDUCTANCE VS DRAIN CURRENT



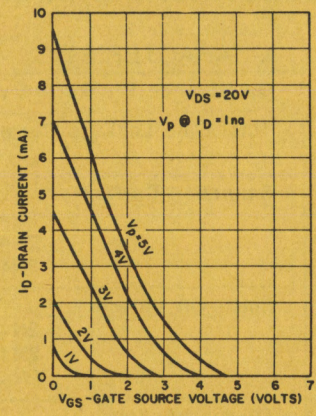
TRANSCONDUCTANCE AND DRAIN CURRENT VS PINCH-OFF VOLTAGE



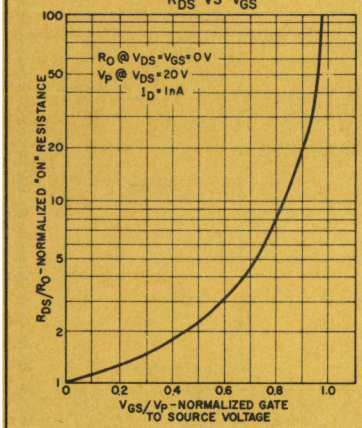
GATE LEAKAGE CURRENT VS TEMPERATURE



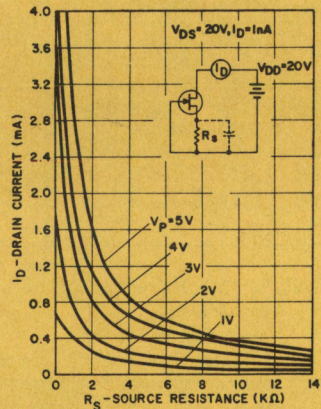
DRAIN CURRENT VS GATE-SOURCE BIAS



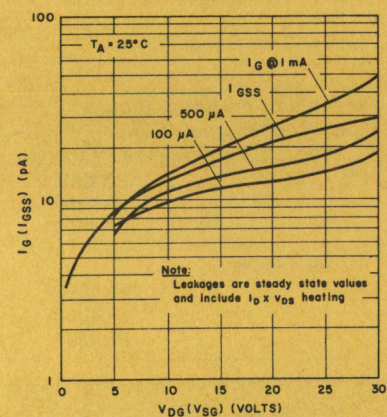
NORMALIZED R_{DS} VS V_{GS}



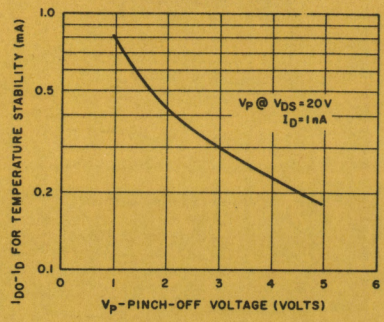
SOURCE FOLLOWER DRAIN CURRENT VS SOURCE RESISTANCE



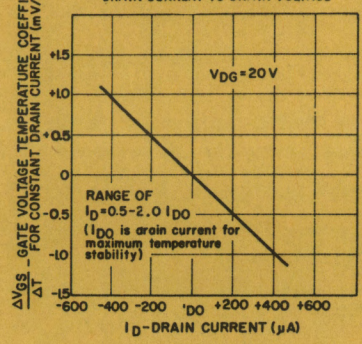
GATE LEAKAGE CURRENT VS VOLTAGE



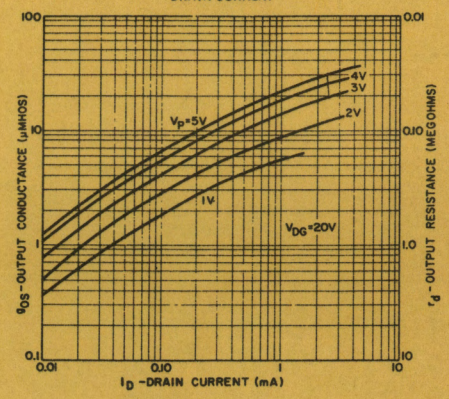
DRAIN CURRENT FOR MAXIMUM TEMPERATURE STABILITY



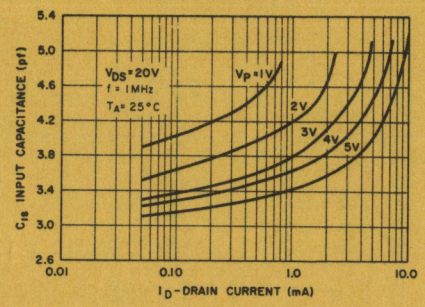
GATE VOLTAGE TEMPERATURE COEFFICIENTS FOR CONSTANT DRAIN CURRENT VS DRAIN VOLTAGE



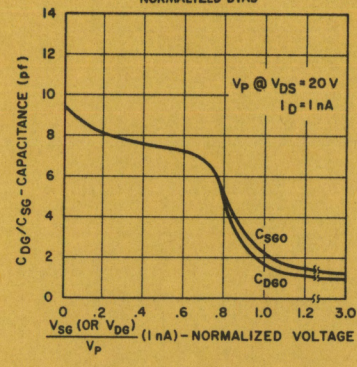
OUTPUT CONDUCTANCE VS DRAIN CURRENT



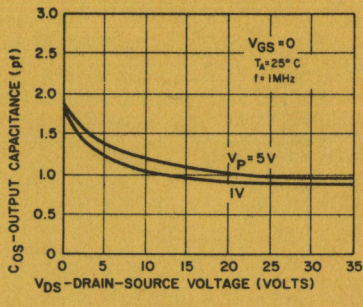
INPUT CAPACITANCE VS DRAIN CURRENT



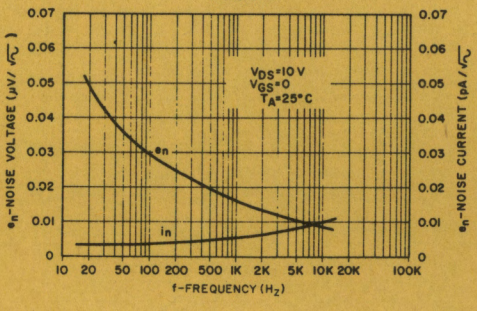
JUNCTION CAPACITANCE VS NORMALIZED BIAS



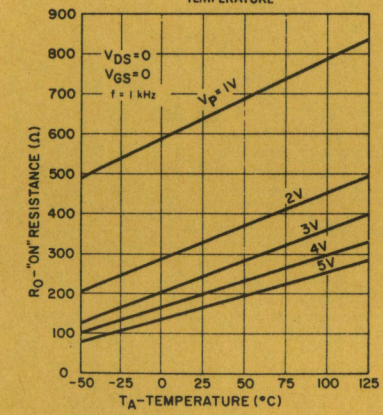
OUTPUT CAPACITANCE VS DRAIN SOURCE VOLTAGE



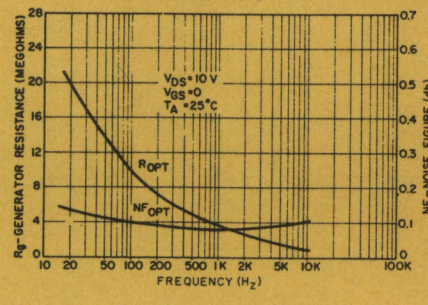
NOISE VOLTAGE/CURRENT VS FREQUENCY



"ON" RESISTANCE VS TEMPERATURE



OPTIMUM GENERATOR RESISTANCE AND NOISE FIGURE



N-CHANNEL FIELD EFFECT TRANSISTOR
RF/IF AMPLIFIER

- HIGH TRANSCONDUCTANCE
- LOW CAPACITANCE
- LOW NOISE

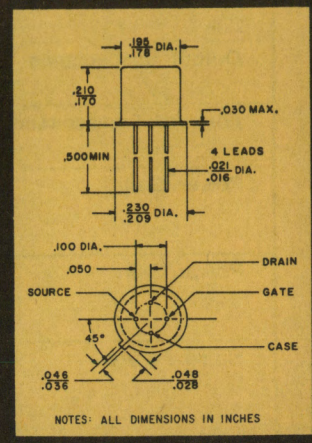
NOVEMBER 1968

2N4416

2N4416A

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
		2N4416	2N4416A	
Reverse Gate-Source Voltage	V_{GS}	−30	−35	Volts
Drain-Source Voltage	V_{DS}	30	35	Volts
Drain-Gate Voltage	V_{DG}	30	35	Volts
Drain Current	I_D	30		mA
Total Device Dissipation @ $T_A = 25°C$	P_D	0.3		Watts
Derating Factor above 25°C @ $T_A = 25°C$		1.7		mW/°C
Storage Temperature	T_{stg}	−65 to +200		°C
Junction Temperature	T_J	+200		°C
Lead Temperature, 1/16 inch from case, 10 seconds max.		+300		°C



NOTES: ALL DIMENSIONS IN INCHES

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage 2N4416 2N4416A	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	 30 35		Volts
Gate-Source Cutoff Voltage 2N4416 2N4416A	$V_{GS(off)}$	$V_{DS} = 15$ V, $I_D = 1.0$ nA	 −2.5	 −6.0 −6.0	Volts
Gate-Source Voltage	V_{GS}	$V_{DS} = 15$ V, $I_D = 0.5$ mA	−1.0	−5.5	Volts
Gate Reverse Current	I_{GSS}	$V_{GS} = -20$ V, $V_{DS} = 0$ $V_{GS} = -20$ V, $V_{DS} = 0$, $T_A = 150°C$		−0.1 −0.2	nA μA
Zero-Gate-Voltage Drain Current	I_{DSS}	$V_{DS} = 15$ V, $V_{GS} = 0$	5.0	15	mA
Input Capacitance	C_{iss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		4.0	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		0.8	pf
Output Capacitance	C_{oss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		2.0	pf
Forward Transadmittance	$\|Y_{fs}\|$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 kHz	4500	7500	μmhos
Output Admittance	$\|Y_{os}\|$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 kHz		50	μmhos
Input Conductance	$RE(Y_{is})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 400 MHz		1000	μmhos
Input Susceptance	$IM(Y_{is})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 400 MHz		10000	μmhos
Input Conductance	$RE(Y_{is})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 100 MHz		100	μmhos
Input Susceptance	$IM(Y_{is})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 100 MHz		2500	μmhos

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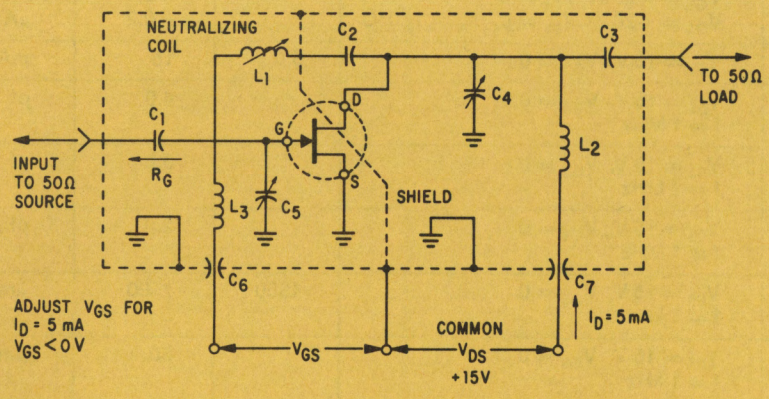
3109

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Output Conductance	$RE(Y_{os})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 400 MHz		100	μmhos
Output Susceptance	$IM(Y_{os})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 400 MHz		4000	μmhos
Output Conductance	$RE(Y_{os})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 100 MHz		75	μmhos
Output Susceptance	$IM(Y_{os})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 100 MHz		1000	μmhos
Forward Transconductance	$RE(Y_{fs})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 400 MHz	4000		μmhos
Power Gain	G_{ps}	$V_{DS} = 15$ V, $I_D = 5$ mA f = 100 MHz (figure 1)	18		db
Power Gain	G_{ps}	$V_{DS} = 15$ V, $I_D = 5$ mA f = 400 MHz (figure 1)	10		db
Noise Figure	NF	$V_{DS} = 15$ V, $I_D = 5$ mA $R_S = 1$ kΩ, f = 100 MHz (figure 1) $V_{DS} = 15$ V, $I_D = 5$ mA $R_S = 1$ kΩ, f = 400 MHz (figure 1)		2.0 4.0	db



REF. DESIG.	VALUE	
	100 MHz	400 MHz
C1	7.0 pF	1.8 pF
C2	1000 pF	27 pF
C3	3.0 pF	1.0 pF
C4	1.0-12 pF	0.8–8 pF
C5	1.0-12 pF	0.8–8 pF
C6	0.0015 μF	0.001 μF
C7	0.0015 μF	0.001 μF
L1	3.0 μh	0.2 μh
L2	0.25 μh	0.03 μh
L3	0.14 μh	0.022 μh

100 MHz & 400 MHz NEUTRALIZED AMPLIFIER

Figure 1

N-CHANNEL FIELD EFFECT TRANSISTOR
HIGH VOLTAGE AMPLIFIER

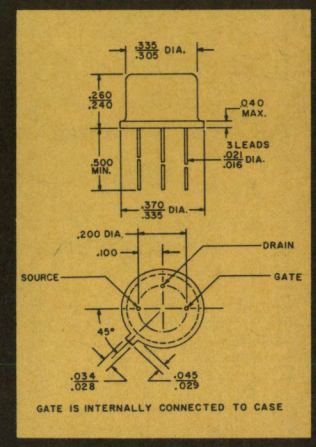
- HIGH BREAKDOWN VOLTAGE
- LOW LEAKAGE
- LOW CAPACITANCE

JANUARY 1968

2N4881 THRU 2N4886

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING			UNIT
		2N4881-2	2N4883-4	2N4885-6	
Drain-Source Voltage	V_{DS}	300	200	125	Volts
Drain-Gate Voltage	V_{DG}	300	200	125	Volts
Reverse Gate-Source Voltage	V_{GS}	100	100	75	Volts
Gate Current	I_G	10			mA
Total Device Dissipation @ $T_A = 25°C$	P_D	800			mW
Derating Factor Above 25°C @ $T_A = 25°C$		4.57			mW/°C
Storage Temperature	T_{stg}	−65 to +200			°C
Junction Temperature	T_J	200			°C
Lead Temperature, 1/16 inch from case, 10 sec. max.		300			°C



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage 2N4881-4 2N4885-6	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	 100 75		Volts
Gate-Source Cutoff Voltage 2N4881-2 2N4883-6	$V_{GS(OFF)}$	 $V_{DS} = 50$ V, $I_D = 2.0$ nA $V_{DS} = 50$ V, $I_D = 1.0$ nA	 0.5 0.5	 15 10	Volts
Gate-Source Voltage 2N4881 2N4882 2N4883, 5 2N4884, 6	V_{GS}	 $V_{DS} = 50$ V, $I_D = 40\ \mu A$ $V_{DS} = 50$ V, $I_D = 150\ \mu A$ $V_{DS} = 50$ V, $I_D = 40\ \mu A$ $V_{DS} = 50$ V, $I_D = 150\ \mu A$	 0.5 0.5 0.5 0.5	 14.5 14.5 9.5 9.5	Volts
Gate Reverse Current 2N4881-2 2N4883-6 2N4881-2 2N4883-6	I_{GSS}	 $V_{GS} = 50$ V, $V_{DS} = 0$ $V_{GS} = 50$ V, $V_{DS} = 0$, $T_A = 150°C$		 2.0 1.0 4.0 2.0	 nA μA
Zero-Gate-Voltage Drain Current 2N4881, 3, 5 2N4882, 4, 6	I_{DSS}*	$V_{DS} = 50$ V, $V_{GS} = 0$	0.4 1.5	2.0 7.5	mA
Drain-Source "ON" Resistance 2N4881, 3, 5 2N4882, 4, 6	r_{DS}	$I_D = 100\ \mu A$, $V_{GS} = 0$		5000 3000	Ohms
Input Capacitance	C_{iss}	$V_{DS} = 50$ V, $V_{GS} = 0$ f = 1.0 MHz		15	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 50$ V, $V_{GS} = 0$ f = 1.0 MHz		1.5	pf
Drain-Gate Capacitance	C_{dgo}	$V_{DG} = 50$ V, $I_S = 0$ f = 1.0 MHz		1.5	pf
Forward Transfer Admittance 2N4881, 3, 5 2N4882, 4, 6	$\lvert Y_{fs} \rvert$	$V_{DS} = 50$ V, $V_{GS} = 0$ f = 1.0 kHz	350 600	1000 1500	μmhos

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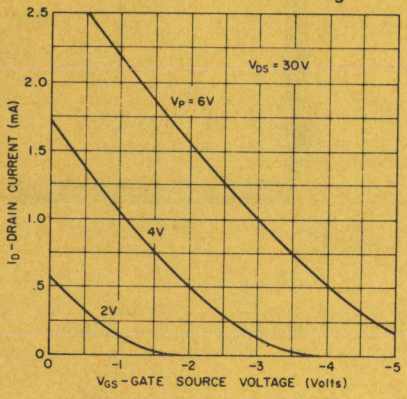
3110

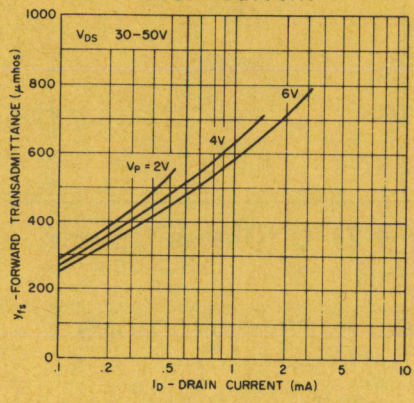
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Forward Transfer Admittance 2N4881, 3, 5 2N4882, 4, 6	$\lvert Y_{fs} \rvert$	$V_{DS} = 50$ V, $V_{GS} = 0$ $f = 1.0$ MHz	300 550		μmhos
Output Admittance 2N4881, 3, 5 2N4882, 4, 6 2N4881, 3, 5 2N4882, 4, 6	$\lvert Y_{os} \rvert$	$V_{DS} = 50$ V, $V_{GS} = 0$ $f = 1.0$ kHz $V_{DS} = 50$ V, $I_D = 0.2$ mA $f = 1.0$ kHz		10 20 2.5 5.0	μmhos
Noise Figure	NF	$V_{DS} = 50$ V, $V_{GS} = 0$ $R_G = 1.0$ MΩ $f = 1.0$ kHz BW = 200 Hz		3.0	db

* Pulse Test: Pulse Width = 300μsec; Duty Cycle = 1%.

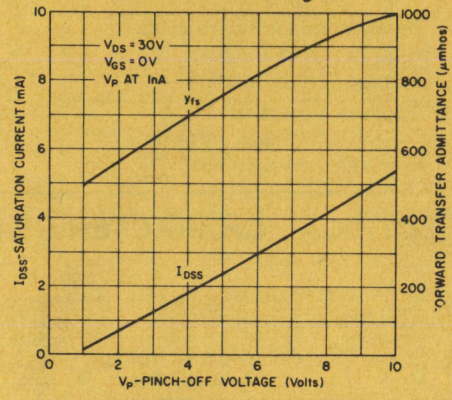
Drain Current vs Drain-Source Voltage



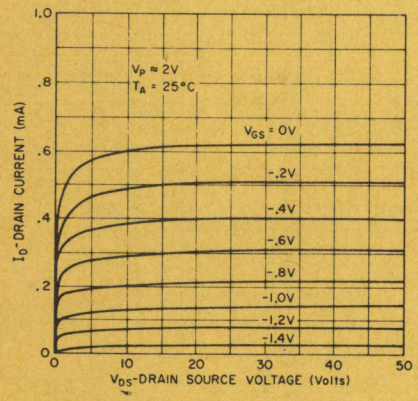
Forward Transadmittance vs Drain Current



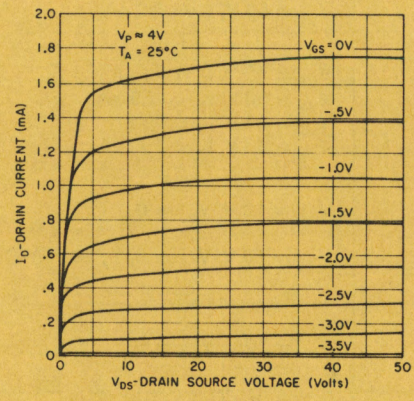
Forward Transfer Admittance And Drain Current vs Pinch-Off Voltage



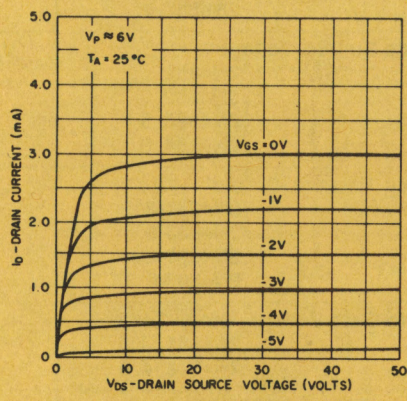
Common Source Drain Characteristics



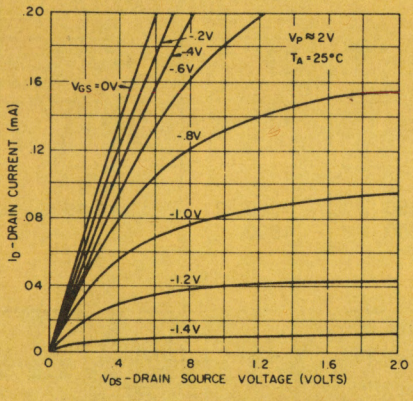
Common Source Drain Characteristics



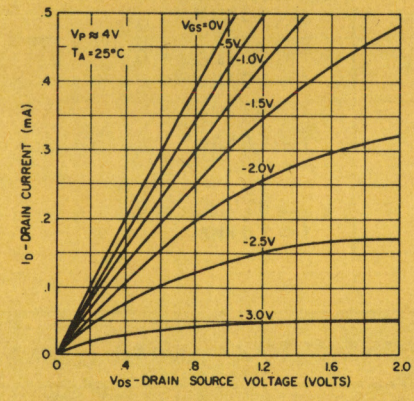
Common Source Drain Characteristics



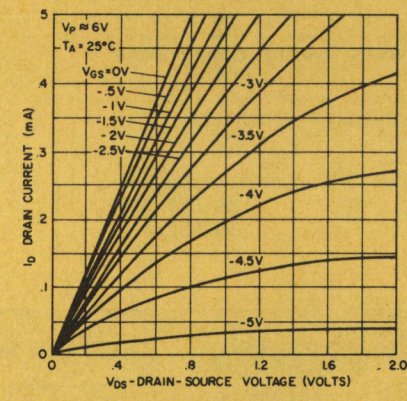
Common Source Drain Characteristics



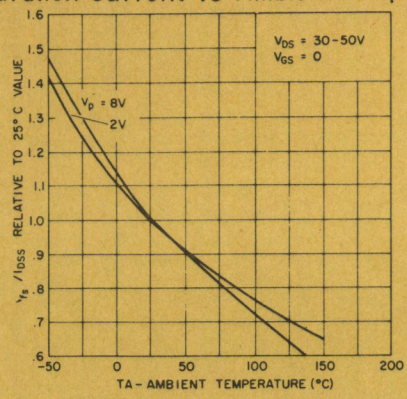
Common Source Drain Characteristics



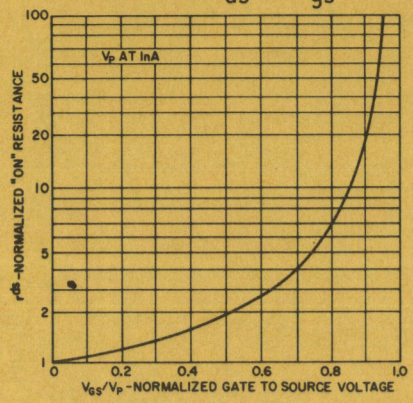
Common Source Drain Characteristics



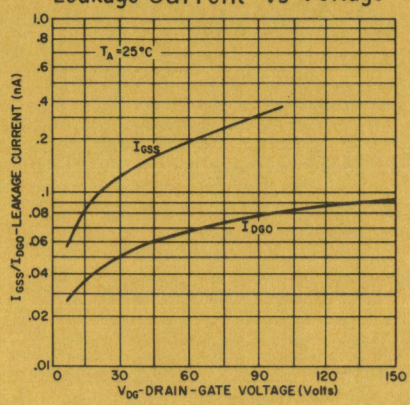
Normalized Forward Transfer Admittance/ Saturation Current vs Ambient Temperature



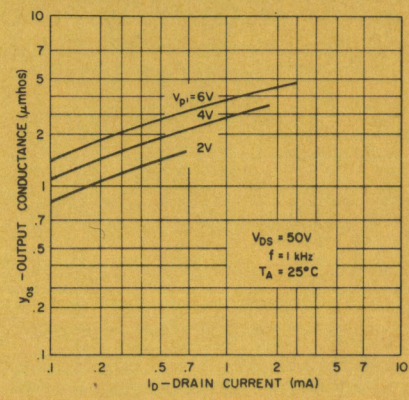
Normalized r_{ds} vs V_{gs}



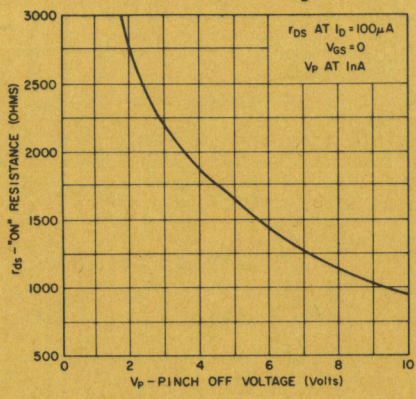
Leakage Current vs Voltage



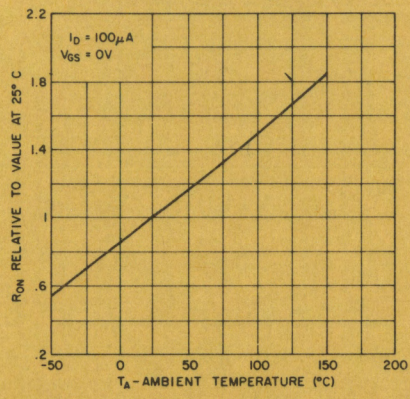
Output Conductance vs Drain Current



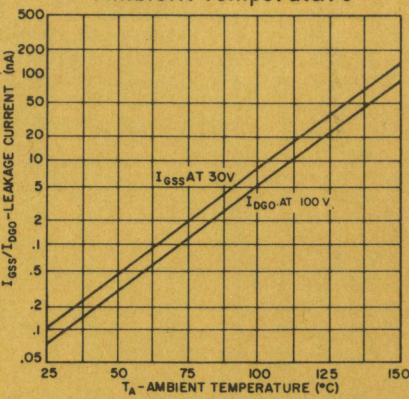
"On" Resistance vs Pinch Off Voltage



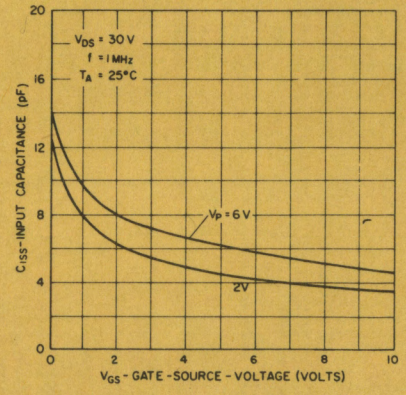
Normalized "On" Resistance vs Ambient Temperature



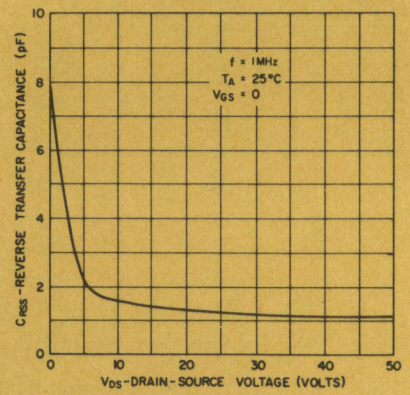
Leakage Current vs Ambient Temperature



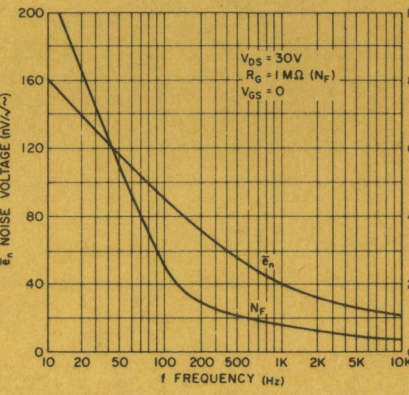
Short Circuit Input Capactance vs Gate Source Voltage



Reverse Transfer Capacitance vs Drain Source Voltage



Noise Voltage/Noise Figure vs Frequency



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N-CHANNEL FIELD EFFECT TRANSISTOR

RF/IF AMPLIFIER

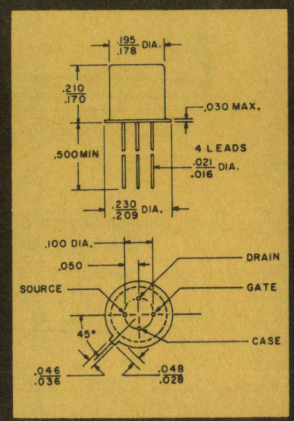
- HIGH TRANSCONDUCTANCE
- LOW LEAKAGE
- LOW NOISE

JANUARY 1968

2N5078

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Reverse Gate-Source Voltage	V_{GS}	−30	Volts
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gain Voltage	V_{DG}	30	Volts
Drain Current	I_D	30	mA
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	0.3	Watts
Derating Factor above 25°C @ $T_A = 25°C$		1.7	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+200	°C
Lead Temperature, 1/16 inch from case, 10 seconds max.		+300	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	30		Volts
Gate-Source Cutoff Voltage	$V_{GS(off)}$	$V_{DS} = 15$ V, $I_D = 1.0\ \mu A$	−0.5	−8.0	Volts
Gate-Source Voltage	V_{GS}	$V_{DS} = 15$ V, $I_D = 0.4$ mA	−0.5	−7.0	Volts
Gate Reverse Current	I_{GSS}	$V_{GS} = -20$ V, $V_{DS} = 0$ $V_{GS} = -20$ V, $V_{DS} = 0$, $T_A = 150°C$		−0.25 −0.25	nA μA
Zero-Gate-Voltage Drain Current	I_{DSS}	$V_{DS} = 15$ V, $V_{GS} = 0$	4.0	25	mA
Power Gain	G_{ps}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz (figure 1)	15		db
Power Gain	G_{ps}	$V_{DS} = 15$ V, $I_D = 4$ mA f = 400 MHz (figure 2)	12		db
Input Capacitance	C_{iss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		6.0	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 2 MHz		2.0	pf
Forward Transadmittance	$\lvert Y_{fs} \rvert$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 kHz $V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz	4500 4000	10000	μmhos
Input Conductance	Y_{is}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz		800	μmhos
Output Admittance	Y_{os}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz		150	μmhos
Noise Figure	NF	$V_{DS} = 15$ V, $V_{GS} = 0$ $R_S = 1$ MΩ, f = 10 Hz BW = 5 Hz $V_{DS} = 15$ V, $V_{GS} = 0$ $R_S = 1$ kΩ f = 200 MHz (figure 1) $V_{DS} = 15$ V, $I_D = 4$ mA f = 400 MHz, $R_S = 1$ kΩ (figure 2)		5.0 3.0 4.0	db

NOTE: Case Lead Grounded During All Electric Tests

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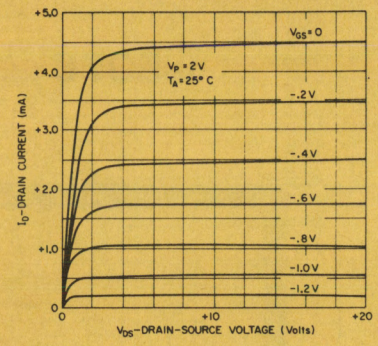
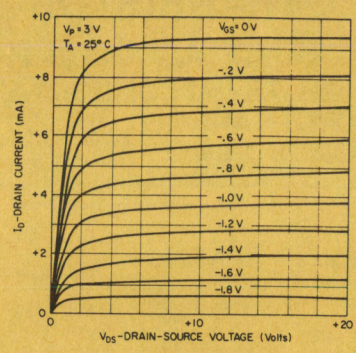
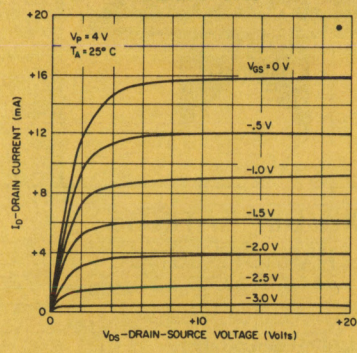
Common Source-Drain Characteristics



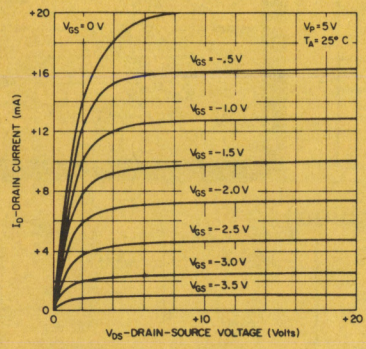
Common Source-Drain Characteristics



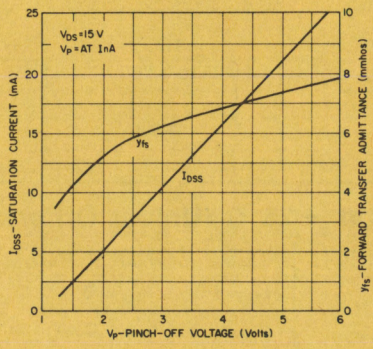
Common Source-Drain Characteristics



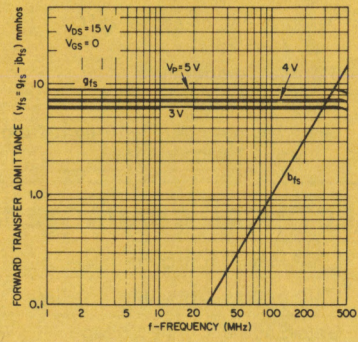
Common Source-Drain Characteristics



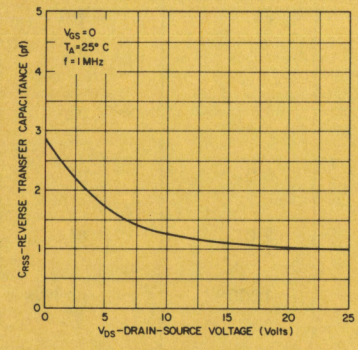
Forward Transfer Admittance and Drain Current vs Pinch Off Voltage



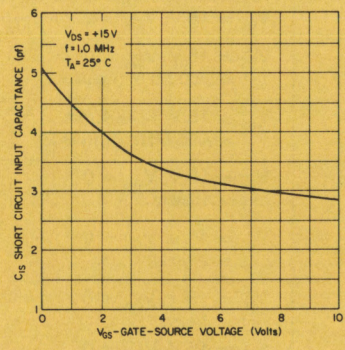
Forward Transfer Admittance vs Frequency



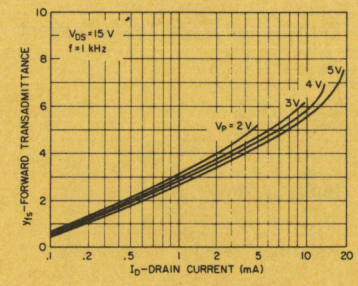
Reverse Transfer Capacitance vs Drain-Source Voltage



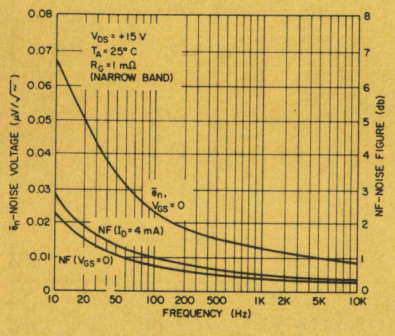
Short Circuit Input Capacitance vs Gate-Source Voltage



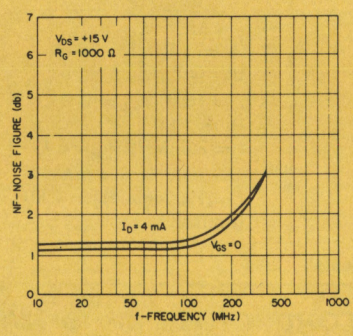
Forward Transadmittance vs Drain Current



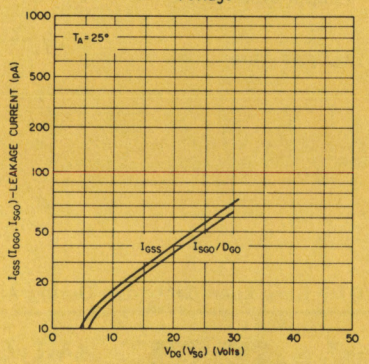
Noise Voltage/Noise Figure vs Frequency



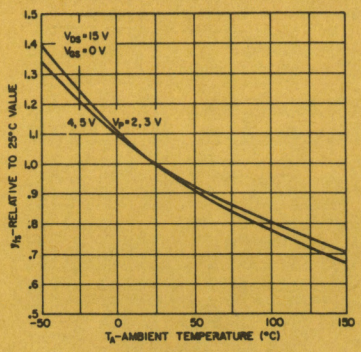
Noise Figure vs Frequency



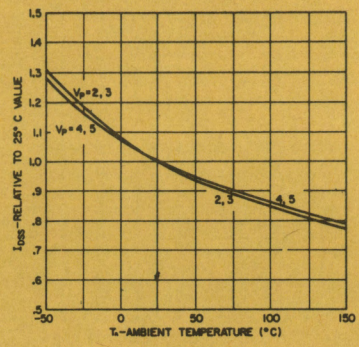
Leakage Current vs Voltage



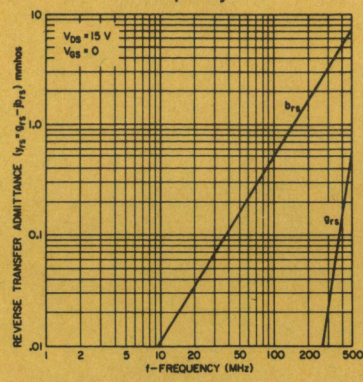
Normalized Forward Transfer Admittance
vs
Ambient Temperature



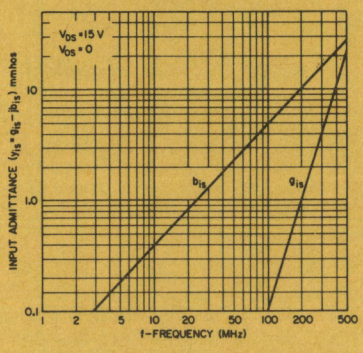
Normalized Drain Saturation Current
vs
Ambient Temperature



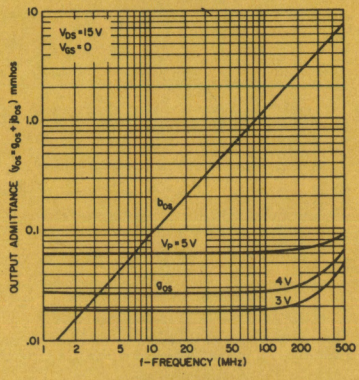
Reverse Transfer Admittance
vs
Frequency



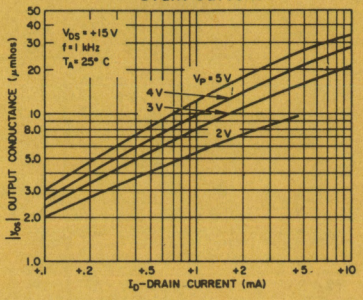
Input Admittance
vs
Frequency



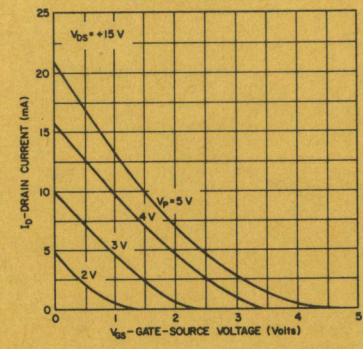
Output Admittance
vs
Frequency



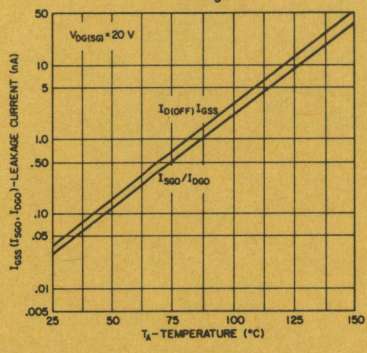
Output Conductance
vs
Drain Current



Drain Current
vs
Gate-Source Voltage



Gate Leakage
vs
Voltage



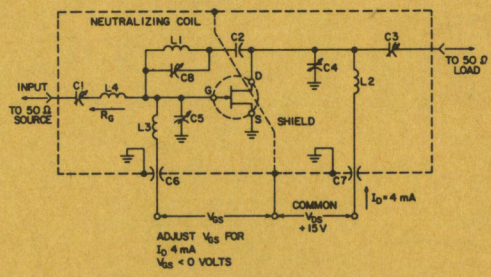
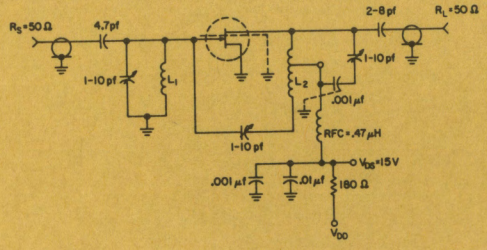


Figure 2.

C_1	Arco 400 .9-7 pf
C_2	27 pf
C_3	Arco 420 1-12 pf
C_4	Johansen 2954 .8-10 pf
C_5	Johansen 2954 .8-10 pf
C_6	.001 μF
C_7	.001 μF
C_8	Arco 420 1-12 pf
L_1	5/16 dia x 3/8 long, #14 Copper wire
L_2	5/8" Straight, #12 Copper wire
L_3	3/8" Straight, #18 Copper wire
L_4	3 turns 1/4 ID, 1/4" long x 14 Copper wire



L_1	1-1/2 turns, #20 tinned wire, 1/4 ID, Length = 3/8"
L_2	3-1/2 turns, #18 tinned wire, 3/8" ID, Length = 1/2" Tapped at 1-1/4 turns from drain

Figure 1.

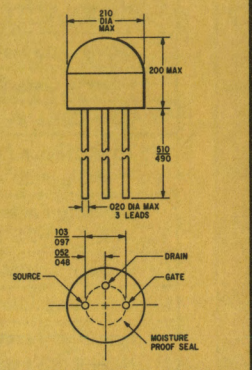
N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE AMPLIFIER

NOVEMBER 1968

2N5163

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	25	Volts
Drain-Gate Voltage	V_{DG}	25	Volts
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor Above 25°C @ $T_A = 25°C$		2.5	mW/°C
Storage Temperature	T_{stg}	−55 to +125	°C
Junction Temperature	T_J	+125	°C



NOTES: ALL LEADS ELECTRICALLY ISOLATED FROM CASE
ALL DIMENSIONS IN INCHES

ELECTRICAL CHARACTERISTICS at 25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = -10\ \mu A$, $V_{DS} = 0$	25		Volts
Gate Reverse Current	I_{GSS}	$V_{GS} = -15$ V, $V_{DS} = 0$		10	nA
Gate Reverse Current	I_{GSS} (85°C)	$V_{GS} = -15$ V, $V_{DS} = 0$		0.6	μA
Zero-Gate-Voltage Drain Current	I_{DSS}	$V_{DS} = 15$ V, $V_{GS} = 0$	1.0	40	mA
Gate-Source Cutoff Voltage	$V_{GS(off)}$	$V_{DS} = 15$ V, $I_D = 1.0\ \mu A$	−0.4	−8.0	Volts
Forward Transadmittance	$\lvert Y_{fs} \rvert$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 kHz	1800		μmhos
Output Admittance	Y_{os}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 kHz		200	μmhos
Input Capacitance	C_{iss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		12	pF
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		3.0	pF
Noise Figure	NF	$V_{DS} = 15$ V, $I_D = 1$ mA $R_S = 150$ K ohm, f = 1 kHz BW = 150 Hz		3.0	dB

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3112

MAY 1968

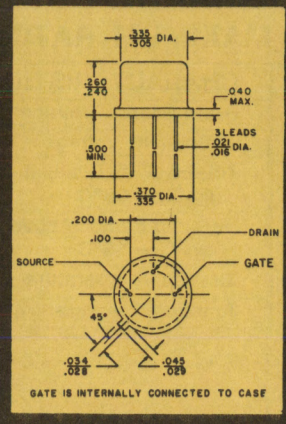
N-CHANNEL FIELD EFFECT TRANSISTOR HIGH VOLTAGE AMPLIFIER

2N5277

2N5278

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Gate Voltage	V_{DG}	200	Volts
Reverse Gate-Source Voltage	$V_{GS(r)}$	−150	Volts
Gate Current	I_G	10	mA
Total Device Power Dissipation @ $T_A = 25°C$	P_D	800	mW
Derating Factor above 25°C @ $T_A = 25°C$		4.57	mW/°C
Storage Temperature Range		−55° to +200°	°C
Operating Junction Temperature		200	°C
Lead Temperature, 1/16 inch from case, 10 seconds maximum		300	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	150		Volts
Gate-Source Cutoff Voltage 2N5277 2N5278	$V_{GS(OFF)}$	$V_{DS} = 30V$, $I_D = 10$ nA	0.5 2.0	7.0 10	Volts
Gate Reverse Current	I_{GSS}	$V_{GS} = -75V$, $V_{DS} = 0$ $V_{GS} = -75V$, $V_{DS} = 0$, $T_A = 150°C$		5.0 5.0	nA μA
Zero Gate Voltage Drain Current 2N5277 2N5278	I_{DSS}	$V_{DS} = 30V$, $V_{GS} = 0$	2.5 10	12.5 25	mA
Forward Transadmittance 2N5277 2N5278	$\lvert Y_{fs} \rvert$	$V_{DS} = 30V$, $V_{GS} = 0$, f = 1 kHz	2000 3000	5000 6000	μmhos
Output Admittance 2N5277 2N5278	$\lvert Y_{os} \rvert$	$V_{DS} = 30V$, $V_{GS} = 0$, f = 1 kHz		25 60	μmhos
Input Capacitance	C_{iss}	$V_{DS} = 30V$, $V_{GS} = 0$, f = 1 MHz		25	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 30V$, $V_{GS} = 0$, f = 1 MHz		5.0	pf
Noise Figure	NF	$V_{DS} = 30V$, $V_{GS} = 0$ f = 1 KHz, BW = 200 Hz $R_G = 1$ MΩ		3.0	db

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N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE

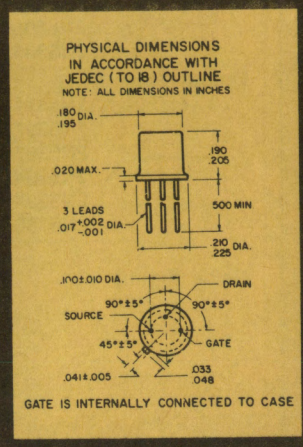
- LOW NOISE
- HIGH VOLTAGE
- HIGH TRANSCONDUCTANCE

SEPTEMBER 1968

2N5391 THRU 2N5396

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Gain Voltage	V_{DG}	70	Volts
Reverse Gate-Source Voltage	V_{GS}	70	Volts
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		1.71	mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C
Operating Junction Temperature	T_J	200	°C
Lead Temperature, 1/16 inch from case, 10 seconds max.		300	°C



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	70		Volts
Gate-Source Cutoff Voltage	$V_{GS(OFF)}$	$V_{DS} = 20$ V, $I_D = 1.0$ nA			Volts
2N5391			0.5	2.0	
2N5392			0.5	2.5	
2N5393			1.0	3.0	
2N5394			1.0	4.0	
2N5395			1.5	4.0	
2N5396			2.0	5.0	
Gate-Source Voltage	V_{GS}	$V_{DS} = 20$ V, $I_D = (**)$			Volts
2N5391			0.1	1.1	
2N5392			0.3	1.4	
2N5393			0.5	1.6	
2N5394			0.7	1.8	
2N5395			1.0	2.1	
2N5396			1.2	2.6	
Gate Reverse Current	I_{GSS}	$V_{GS} = -35$ V, $V_{DS} = 0$		0.2	nA
		$V_{GS} = -10$ V, $V_{DS} = 0$		0.1	
Zero-Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 20$ V, $V_{GS} = 0$			mA
2N5391			0.5	1.5	
2N5392			1.0	3.0	
2N5393			2.5	4.5	
2N5394			4.0	6.0	
2N5395			5.5	8.0	
2N5396			7.5	10	
Forward Transadmittance	$\lvert Y_{fs} \rvert$	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1 kHz			μmhos
2N5391			1500	4500	
2N5392			2000	6000	
2N5393			3000	6500	
2N5394			4000	7000	
2N5395			4500	7000	
2N5396			4500	7500	
Forward Transadmittance	$\lvert Y_{fs} \rvert$	$V_{DS} = 20$ V, $I_D = ***$ f = 1 kHz			μmhos
2N5391			1000		
2N5392			1000		
2N5393			1000		
2N5394			2000		
2N5395			1900		
2N5396			1800		

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Input Capacitance	C_{iss}	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 0.14-1.0 MHz		18	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 0.14-1.0 MHz		5.0	pf
Output Admittance	$\lvert Y_{os} \rvert$				
2N5391		$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1 kHz		4.0	μmhos
2N5392				7.0	
2N5393				10	
2N5394				15	
2N5395				20	
2N5396				25	
Output Admittance	$\lvert Y_{os} \rvert$				
2N5391		$V_{DS} = 20$ V, $I_D = (***)$ f = 1 kHz		2.0	μmhos
2N5392				2.5	
2N5393				3.0	
2N5394				8.0	
2N5395				10	
2N5396				12	
Noise Figure	NF	$V_{DS} = 20$ V, $V_{GS} = 0$, $R_G = 1$ MΩ, f = 100 Hz, NBW = 6 Hz		1.0	db
		$V_{DS} = 20$ V, $V_{GS} = 0$, $R_G = 10$ KΩ, f = 100 Hz, NBW = 6 Hz		2.5	
		$V_{DS} = 20$ V, $V_{GS} = 0$, $R_G = 10$ KΩ, f = 1 kHz, NBW = 200 Hz		1.5	
		$V_{DS} = 20$ V, $V_{GS} = 0$, $R_G = 1$ KΩ, f = 1 kHz, NBW = 200 Hz		5.0	
		$V_{DS} = 20$ V, $V_{GS} = 0$, $R_G = 1$ MΩ, f = 10 Hz, NBW = 6 Hz		2.0	
Equivalent Input Noise Voltage	En	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 10 Hz, NBW = 6 Hz		17.5	nv/ $\sqrt{Hz}$
		$V_{DS} = 20$ V, $V_{GS} = 0$ f = 100 Hz, NBW = 6 Hz		10	

Notes: (**) 2N5391 $I_D = 0.05$ mA
Notes: (**) 2N5392 $I_D = 0.10$ mA
Notes: (**) 2N5393 $I_D = 0.25$ mA
Notes: (**) 2N5394 $I_D = 0.40$ mA
Notes: (**) 2N5395 $I_D = 0.55$ mA
Notes: (**) 2N5396 $I_D = 0.75$ mA

(***) 2N5391 $I_D = 200$ μA
(***) 2N5392 $I_D = 200$ μA
(***) 2N5393 $I_D = 200$ μA
(***) 2N5394 $I_D = 700$ μA
(***) 2N5395 $I_D = 700$ μA
(***) 2N5396 $I_D = 700$ μA

N-CHANNEL FIELD EFFECT TRANSISTOR
LOW LEAKAGE AMPLIFIER

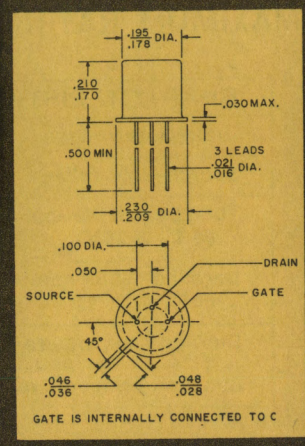
- VERY LOW LEAKAGE
- LOW NOISE
- LOW CAPACITANCE

JANUARY 1968

U1714

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Gate Voltage		25	Volts
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		1.71	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{GSS}	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	25		Volts
Total Gate Leakage Current	I_{GSS}	$V_{GS} = -10$ V, $V_{DS} = 0$		5.0	pA
Saturation Current	I_{DSS}	$V_{DS} = 10$ V, $V_{GS} = 0$	0.5	5.0	mA
Source-Gate Cutoff Voltage	$V_{GS(off)}$	$V_{DS} = 10$ V, $I_D = 1.0$ nA		5.0	Volts
Transconductance	gm	$V_{DS} = 10$ V, $V_{GS} = 0$ f = 1.0 kHz	400		μmhos
Input Capacitance	C_{iss}	$V_{DS} = 10$ V, $V_{GS} = 0$ f = 1.0 MHz		3.0	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 10$ V, $I_S = 0$ f = 140 kHz		1.2	pf
Noise Figure	NF	$V_{DS} = 10$ V, $V_{GS} = 0$ f = 100 Hz, BW = 6.0 Hz $R_G = 1.0$ MΩ		3.0	db

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N-CHANNEL FIELD EFFECT TRANSISTOR
HIGH VOLTAGE AMPLIFIER

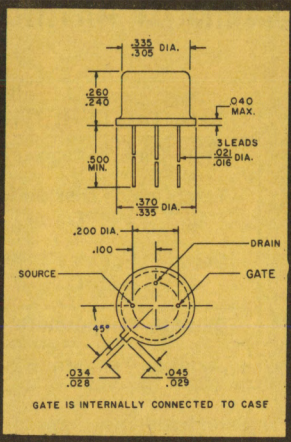
- HIGH BREAKDOWN VOLTAGE
- LOW NOISE
- LOW R_{ON} RESISTANCE

JANUARY 1968

U1715

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Gate Voltage		200	Volts
Source-Gate Voltage		125	Volts
Total Device Dissipation @ $T_A = 25°C$	P_D	800	mW
Derating Factor above 25°C @ $T_A = 25°C$		4.57	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+200	°C



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{GSS}	$I_G = 1.0\ \mu A$, $I_S = 0$	200		Volts
Source-Gate Breakdown Voltage	BV_{SGO}	$I_S = 1.0\ \mu A$, $I_G = 0$	125		Volts
Total Gate Leakage Current	I_{GSS}	$V_{GS} = 75$ V, $V_{DS} = 0$		5.0	nA
Drain-Gate Leakage Current	I_{DGO}	$V_{DG} = 150$ V		3.0	nA
Saturation Current	I_{DSS}	$V_{DS} = 50$ V, $V_{GS} = 0$	10	50	mA
Source-Gate Cutoff Voltage	$V_{GS(off)}$	$V_{DS} = 50$ V, $I_D = 10$ nA		15	Volts
Drain-Source "ON" Resistance	R_O	$I_D = 100\ \mu A$, $V_{GS} = 0$		400	Ohms
Input Capacitance	C_{iss}	$V_{DS} = 50$ V, $V_{GS} = 0$ f = 1.0 MHz		25	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 50$ V, $V_{GS} = 0$ f = 1.0 MHz		4.0	pf
Noise Figure	NF	$V_{DS} = 30$ V, $V_{GS} = 0$ f = 1.0 kHz, BW = 200 Hz $R_G = 1.0$ MΩ		3.0	db

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N-CHANNEL FIELD EFFECT TRANSISTOR

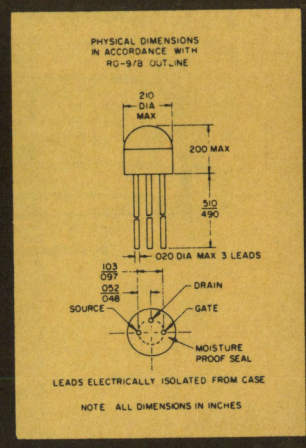
- RF/IF AMPLIFIER
- HIGH TRANSCONDUCTANCE
- LOW LEAKAGE
- LOW NOISE

SEPTEMBER 1968

u1837E

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gain Voltage	V_{DG}	30	Volts
Reverse Gate-Source Voltage	V_{GS}	−30	Volts
Gate Current	I_G	10	mA
Drain Current	I_D	30	mA
Total Device Dissipation @ T_A = 25°C @ T_C = 25°C @ T_C = 100°C	P_D	300	mWatts
Derating Factor above 25°C @T_A = 25°C		2.5	mW/°C
Storage Temperature Range	T_{stg}	−55 to +125	°C
Operating Junction Temperature	T_J	+125	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = -1.0\ \mu A$, $V_{DS} = 0$	30		Volts
Gate-Source Cutoff Voltage	$V_{GS(OFF)}$	$V_{DS} = 15$ V, $I_D = 1.0\ \mu A$	−0.5	−8.0	Volts
Gate Reverse Current	I_{GSS}	$V_{GS} = -20$ V, $V_{DS} = 0$ $V_{GS} = -20$ V, $V_{DS} = 0$, $T_A = +85$°C		−0.25 −15	nA nA
Zero-Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 15$ V, $V_{GS} = 0$	4.0	25	
Forward Transadmittance	$\lvert Y_{fs} \rvert$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 kHz	4500	10000	μmhos
Forward Transadmittance	$\lvert Y_{fs} \rvert$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz	4000		μmhos
Drain-Source "ON" Resistance	$r_{DS(ON)}$	$I_D = 1$ mA, $V_{GS} = 0$		300	Ohms
Input Capacitance	C_{iss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		6.0	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		2.0	pf
Input Admittance	$\lvert Y_{is} \rvert$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz		800	μmhos
Output Admittance	$\lvert Y_{os} \rvert$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz		150	μmhos
Power Gain	G_{ps}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz (Figure 1)	15		db
Noise Figure	NF	$V_{DS} = 15$ V, $R_G = 1$ MΩ, $V_{GS} = 0$, f = 10 Hz, BW = 5 Hz		5.0	db
Noise Figure	NF	$V_{DS} = 15$ V, $R_G = 1$ KΩ, $V_{GS} = 0$, f = 200 MHz, (Figure 1)		3.0	db

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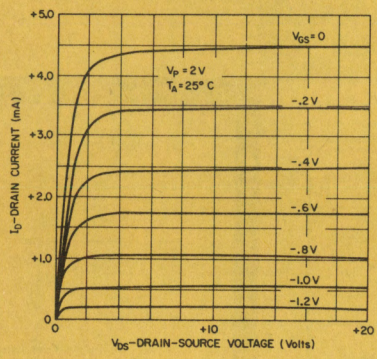
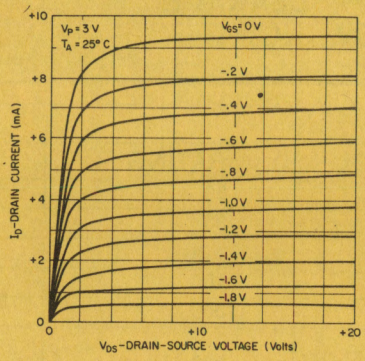
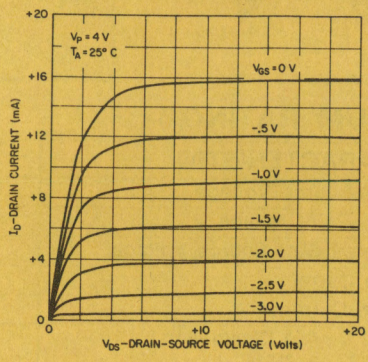
Common Source-Drain Characteristics



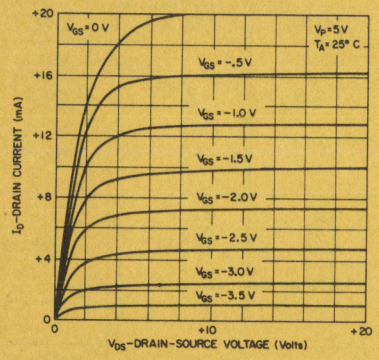
Common Source-Drain Characteristics



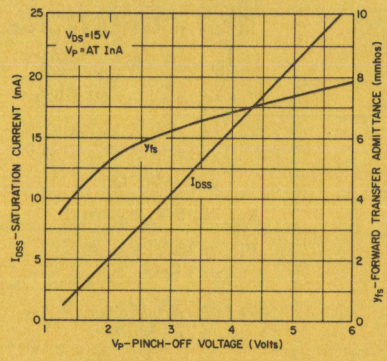
Common Source-Drain Characteristics



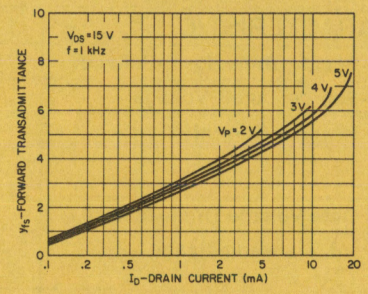
Common Source-Drain Characteristics



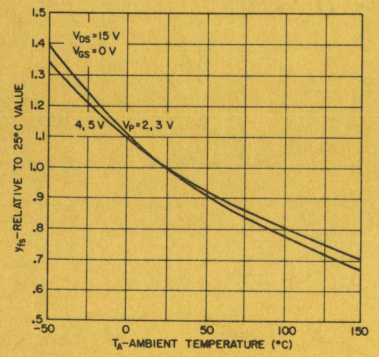
Forward Transfer Admittance and Drain Current vs Pinch Off Voltage



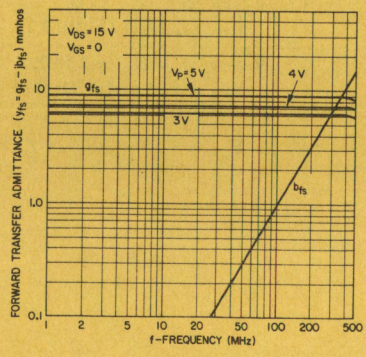
Forward Transadmittance vs Drain Current



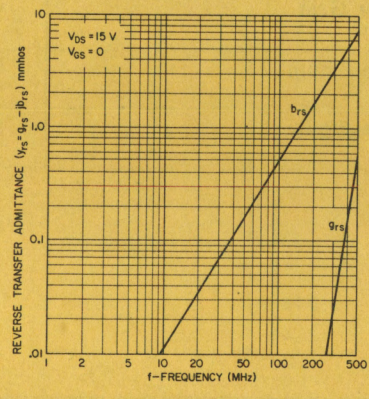
Normalized Forward Transfer Admittance vs Ambient Temperature



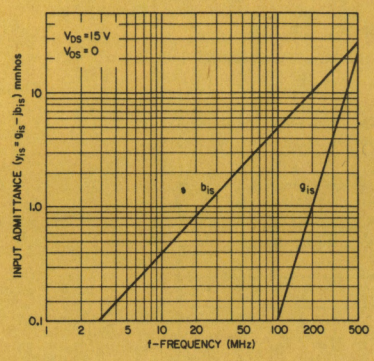
Forward Transfer Admittance vs Frequency



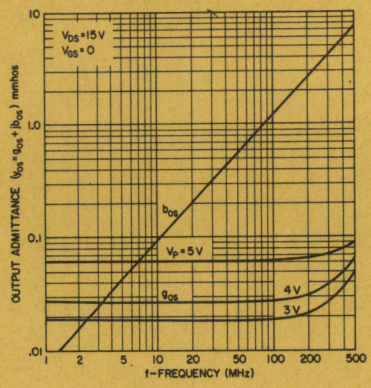
Reverse Transfer Admittance vs Frequency



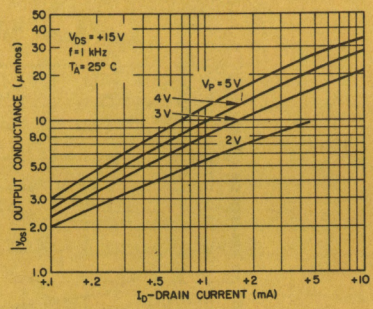
Input Admittance vs Frequency



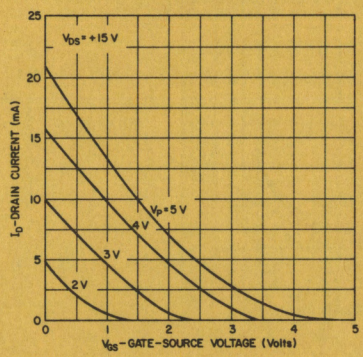
Output Admittance vs Frequency



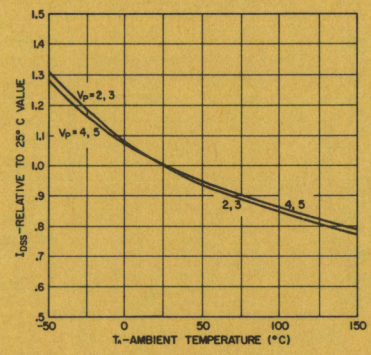
Output Conductance vs Drain Current



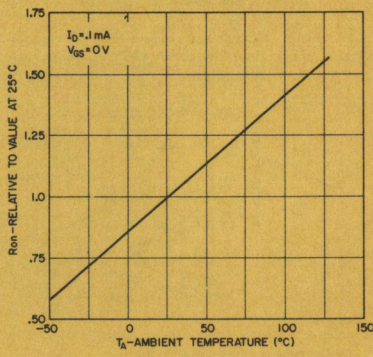
Drain Current vs Gate-Source Voltage



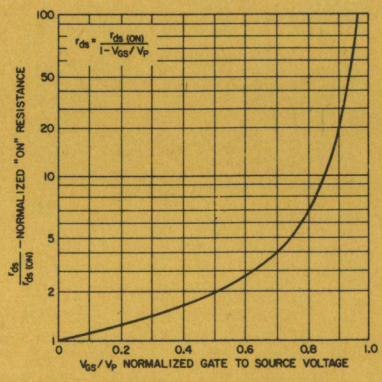
Normalized Drain Saturation Current vs Ambient Temperature



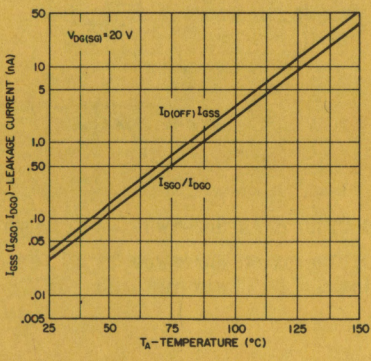
Normalized "On" Resistance vs Ambient Temperature



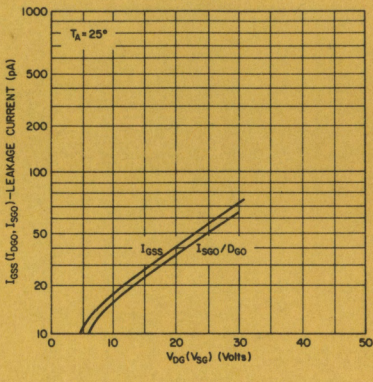
Normalized r_{ds} vs V_{GS}



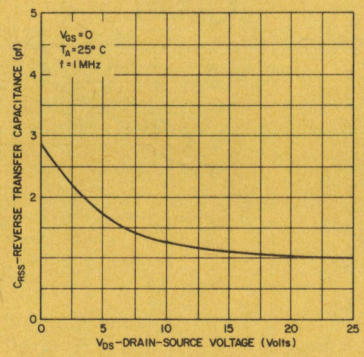
Gate Leakage vs Voltage



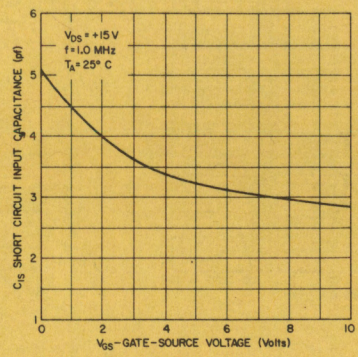
Leakage Current vs Voltage



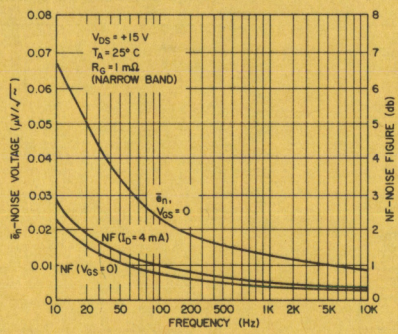
Reverse Transfer Capacitance vs Drain-Source Voltage



Short Circuit Input Capacitance vs Gate-Source Voltage



Noise Voltage/Noise Figure vs Frequency



Noise Figure vs Frequency

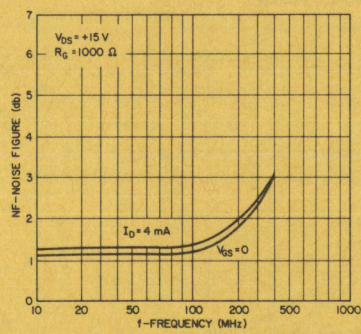
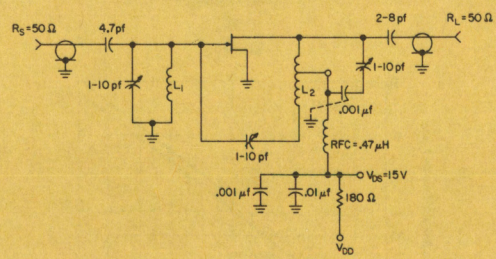


Figure 1.



L_1 1-1/2 turns, #20 tinned wire, 1/4 ID, Length = 3/8"

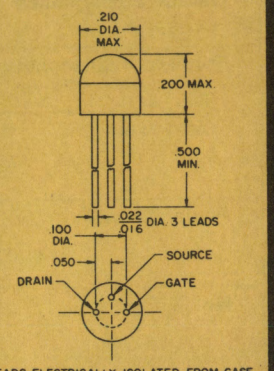
L_2 3-1/2 turns, #18 tinned wire, 3/8" ID, Length = 1/2"
Tapped at 1-1/4 turns from drain

N-CHANNEL FIELD EFFECT TRANSISTOR
RF/IF AMPLIFIER

- HIGH TRANSCONDUCTANCE
- LOW CAPACITANCE
- LOW NOISE

JANUARY 1969

U1994E



LEADS ELECTRICALLY ISOLATED FROM CASE

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Reverse Gate-Source Voltage	V_{GS}	−30	Volts
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gate Voltage	V_{DG}	30	Volts
Drain Current	I_D	30	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	0.3	Watts
Derating Factor above 25°C @ $T_A = 25°C$		2.5	mW/°C
Storage Temperature	T_{stg}	−55 to +125	°C
Junction Temperature	T_J	+125	°C

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	30		Volts
Gate-Source Cutoff Voltage	$V_{GS(off)}$	$V_{DS} = 15$ V, $I_D = 1.0$ nA		−6.0	Volts
Gate-Source Voltage	V_{GS}	$V_{DS} = 15$ V, $I_D = 0.5$ mA	−1.0	−5.5	Volts
Gate Reverse Current	I_{GSS}	$V_{GS} = -20$ V, $V_{DS} = 0$ $V_{GS} = -20$ V, $V_{DS} = 0$, $T_A = 100°C$		−0.1 −10	nA nA
Zero-Gate-Voltage Drain Current	I_{DSS}	$V_{DS} = 15$ V, $V_{GS} = 0$	5.0	15	mA
Input Capacitance	C_{iss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		4.0	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		1.0	pf
Output Capacitance	C_{oss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		2.0	pf
Forward Transadmittance	$\|Y_{fs}\|$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 kHz	4500	7500	μmhos
Output Admittance	$\|Y_{os}\|$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 kHz		50	μmhos
Input Conductance	$RE(Y_{is})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 400 MHz		1000	μmhos
Input Susceptance	$IM(Y_{is})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 400 MHz		10000	μmhos
Input Conductance	$RE(Y_{is})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 100 MHz		100	μmhos
Input Susceptance	$IM(Y_{is})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 100 MHz		2500	μmhos

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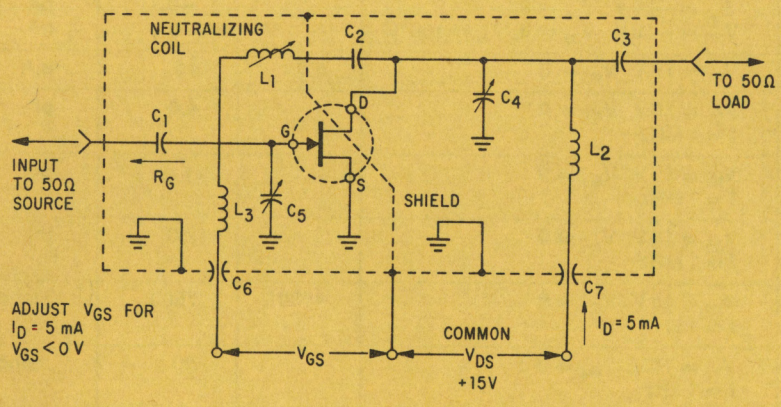
ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Output Conductance	$RE(Y_{os})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 400 MHz		100	μmhos
Output Susceptance	$IM(Y_{os})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 400 MHz		4000	μmhos
Output Conductance	$RE(Y_{os})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 100 MHz		75	μmhos
Output Susceptance	$IM(Y_{os})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 100 MHz		1000	μmhos
Forward Transconductance	$RE(Y_{fs})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 400 MHz	4000		μmhos
Power Gain	G_{ps}	$V_{DS} = 15$ V, $I_D = 5$ mA f = 100 MHz (figure 1)	18		db
Power Gain	G_{ps}	$V_{DS} = 15$ V, $I_D = 5$ mA f = 400 MHz (figure 1)	10		db
Noise Figure	NF	$V_{DS} = 15$ V, $I_D = 5$ mA $R_S = 1$ kΩ, f = 100 MHz (figure 1) $V_{DS} = 15$ V, $I_D = 5$ mA $R_S = 1$ kΩ, f = 400 MHz (figure 1)		2.0 4.0	db

NOTE: Case lead grounded during all electrical tests.



REF. DESIG.	VALUE	
	100 MHz	400 MHz
C1	7.0 pF	1.8 pF
C2	1000 pF	27 pF
C3	3.0 pF	1.0 pF
C4	1.0-12 pF	0.8–8 pF
C5	1.0-12 pF	0.8–8 pF
C6	0.0015 μF	0.001 μF
C7	0.0015 μF	0.001 μF
L1	3.0 μh	0.2 μh
L2	0.25 μh	0.03 μh
L3	0.14 μh	0.022 μh

100 MHz & 400 MHz NEUTRALIZED AMPLIFIER

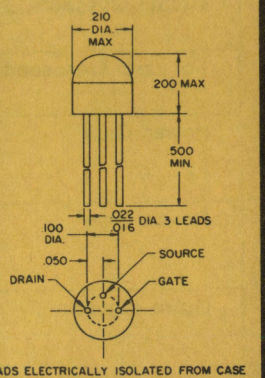
Figure 1

N-CHANNEL FIELD EFFECT TRANSISTOR
RF/IF AMPLIFIER

- HIGH TRANSCONDUCTANCE
- LOW CAPACITANCE
- LOW NOISE

JANUARY 1969

U2047E



MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Reverse Gate-Source Voltage	V_{GS}	−30	Volts
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gate Voltage	V_{DG}	30	Volts
Drain Current	I_D	30	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	0.3	Watts
Derating Factor above 25°C @ $T_A = 25°C$		2.5	mW/°C
Storage Temperature	T_{stg}	−55 to +125	°C
Junction Temperature	T_J	+125	°C

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	30		Volts
Gate-Source Cutoff Voltage	$V_{GS(off)}$	$V_{DS} = 15$ V, $I_D = 1.0$ nA		−8.0	Volts
Gate-Source Voltage	V_{GS}	$V_{DS} = 15$ V, $I_D = 0.4$ mA	−1.0	−7.0	Volts
Gate Reverse Current	I_{GSS}	$V_{GS} = -20$ V, $V_{DS} = 0$ $V_{GS} = -20$ V, $V_{DS} = 0$, $T_A = 100°C$		−.25 −15	nA nA
Zero-Gate-Voltage Drain Current	I_{DSS}	$V_{DS} = 15$ V, $V_{GS} = 0$	4.0	25	mA
Input Capacitance	C_{iss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		4.0	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		1.3	pf
Output Capacitance	C_{oss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		2.0	pf
Forward Transadmittance	$\|Y_{fs}\|$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 kHz	4500		μmhos
Output Admittance	$\|Y_{os}\|$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 kHz		50	μmhos
Input Conductance	$RE(Y_{is})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 400 MHz		1000	μmhos
Input Susceptance	$IM(Y_{is})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 400 MHz		10000	μmhos
Input Conductance	$RE(Y_{is})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 100 MHz		100	μmhos
Input Susceptance	$IM(Y_{is})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 100 MHz		2500	μmhos

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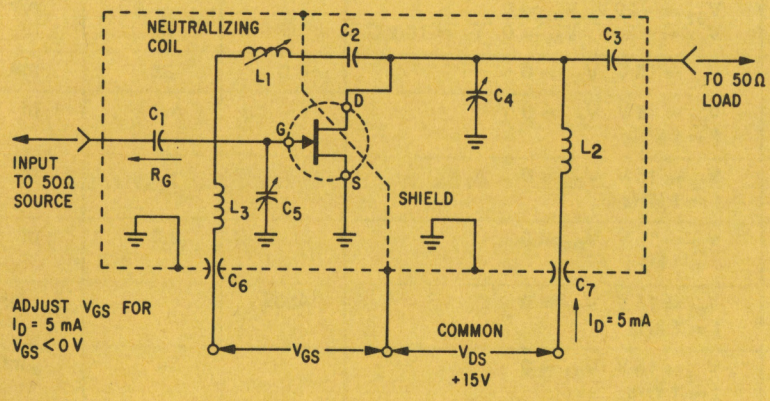
ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Output Conductance	$RE(Y_{os})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 400 MHz		100	μmhos
Output Susceptance	$IM(Y_{os})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 400 MHz		4000	μmhos
Output Conductance	$RE(Y_{os})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 100 MHz		75	μmhos
Output Susceptance	$IM(Y_{os})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 100 MHz		1000	μmhos
Forward Transconductance	$RE(Y_{fs})$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 400 MHz	4000		μmhos
Power Gain	G_{ps}	$V_{DS} = 15$ V, $I_D = 5$ mA f = 100 MHz (figure 1)	18		db
Power Gain	G_{ps}	$V_{DS} = 15$ V, $I_D = 5$ mA f = 400 MHz (figure 1)	10		db
Noise Figure	NF	$V_{DS} = 15$ V, $I_D = 5$ mA $R_S = 1$ kΩ, f = 100 MHz (figure 1) $V_{DS} = 15$ V, $I_D = 5$ mA $R_S = 1$ kΩ, f = 400 MHz (figure 1)		2.0 4.0	db



REF. DESIG.	VALUE	
	100 MHz	400 MHz
C1	7.0 pF	1.8 pF
C2	1000 pF	27 pF
C3	3.0 pF	1.0 pF
C4	1.0-12 pF	0.8–8 pF
C5	1.0-12 pF	0.8–8 pF
C6	0.0015 μF	0.001 μF
C7	0.0015 μF	0.001 μF
L1	3.0 μh	0.2 μh
L2	0.25 μh	0.03 μh
L3	0.14 μh	0.022 μh

100 MHz & 400 MHz NEUTRALIZED AMPLIFIER

Figure 1

N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE SWITCH

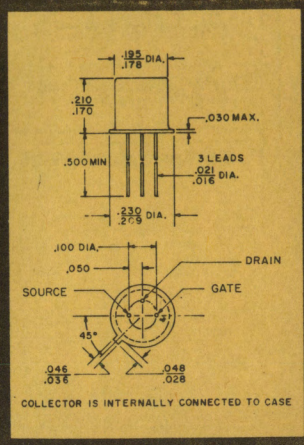
- LOW LEAKAGE
- VERY LOW "ON" RESISTANCE
- FAST SWITCHING SPEEDS

JANUARY 1968

2N3970
2N3971
2N3972

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Total Device Dissipation @ $T_C = 25°C$	P_D	1.8	Watts
Derating Factor above 25°C @ $T_C = 25°C$		10	mW/°C
Storage Temperature	T_{stg}	200	°C
Junction Temperature	T_J	200	°C



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A$, $I_S = 0$	40		Volts
Source-Gate Breakdown Voltage	BV_{SGO}	$I_S = 1.0\ \mu A$, $I_D = 0$	40		Volts
Saturation Current	I_{DSS}*				
2N3970		$V_{DS} = 20$ V, $V_{GS} = 0$	50	150	mA
2N3971			25	75	
2N3972			5.0	30	
Gate-Drain Leakage Current	I_{DGO}	$V_{DG} = 20$ V, $I_S = 0$		0.25	nA
		$V_{DG} = 20$ V, $I_S = 0$, $T_A = 150°C$		0.5	μA
Drain Cutoff Current	$I_{D(OFF)}$	$V_{GS} = -12$ V		0.25	nA
		$V_{GS} = -12$ V, $T_A = 150°C$		0.5	μA
Drain-Source "ON" Voltage	$V_{DS(ON)}$				
2N3970		$I_D = 20$ mA, $V_{GS} = 0$		1.0	Volts
2N3971		$I_D = 10$ mA, $V_{GS} = 0$		1.5	
2N3972		$I_D = 5.0$ mA, $V_{GS} = 0$		2.0	
Pinch Off Voltage	V_P				
2N3970		$V_{DS} = 20$ V, $I_D = 1.0$ nA	4.0	10	Volts
2N3971			2.5	5.0	
2N3972			0.5	3.0	
Small-Signal Drain-Source "ON" Resistance	$r_{ds(ON)}$				
2N3970		$I_D = 0$, $V_{GS} = 0$		30	Ohms
2N3971				60	
2N3972				100	
"ON" Resistance	R_{ON}				
2N3970		$I_D = 1.0$ mA, $V_{GS} = 0$		30	Ohms
2N3971				60	
2N3972				100	
Rise Time	t_r				
2N3970		See Figures 1 & 2		10	nsec
2N3971				15	
2N3972				40	

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Delay Time 2N3970 2N3971 2N3972	t_d	See Figures 1 & 2		 10 15 40	nsec
Turn-Off Time 2N3970 2N3971 2N3972	t_{off}	See Figures 1 & 2		 30 60 100	nsec
Input Capacitance	C_{iss}	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1.0 MHz		25	pf
Drain-Gate Feedback Capacitance	C_{rss}	$V_{DS} = 0$, $V_{GS} = -12$ V f = 1.0 MHz		6.0	pf

* Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 3%.

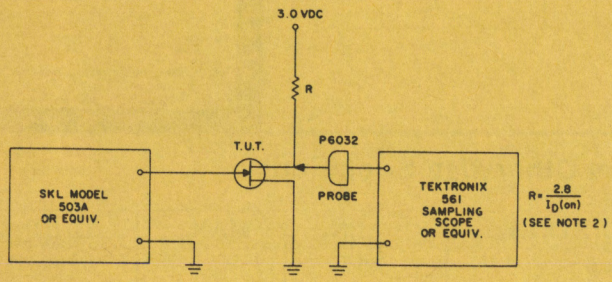


Figure 1

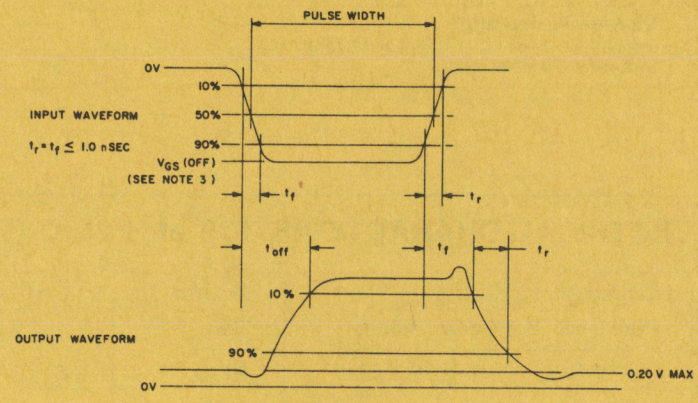


Figure 2

N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE SWITCH

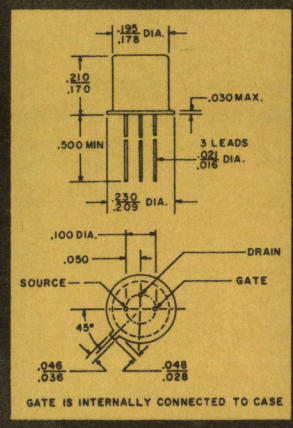
- VERY LOW "ON" RESISTANCE
- FAST SWITCHING SPEEDS
- LOW LEAKAGE

JANUARY 1968

2N4091
2N4092
2N4093

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Dissipation @ $T_C = 25°C$	P_D	1.8	Watt
Derating Temperature @ $T_C = 25°C$		10	mW/°C
Storage Temperature	T_{stg}	−55 to +200	°C
Junction Temperature	T_J	+200	°C



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A$, $I_S = 0$	40		Volts
Source-Gate Breakdown Voltage	BV_{SGO}	$I_S = 1.0\ \mu A$, $I_D = 0$	40		Volts
Drain-Source "ON" Voltage	$V_{DS(ON)}$	$I_D = (**)$, $V_{GS} = 0$		0.2	Volts
Saturation Current 2N4091 2N4092 2N4093	I_{DSS}*	$V_{DS} = 20$ V, $V_{GS} = 0$	 30 15 8.0		mA
Gate-Drain Leakage Current	I_{DGO}	$V_{DG} = 20$ V, $I_S = 0$		0.2	nA
Drain Cutoff Current	$I_{D(OFF)}$	$V_{GS} = (***)$, $V_{DS} = 20$ V $V_{GS} = (***)$, $V_{DS} = 20$ V, $T_A = 150°C$		0.2 0.4	nA μA
Gate-Source Leakage Current	I_{SGO}	$V_{SG} = 20$ V, $I_D = 0$		0.2	nA
Pinch Off Voltage 2N4091 2N4092 2N4093	V_P	$V_{DS} = 20$ V, $I_D = 1.0$ nA	 5.0 2.0 1.0	 10 7.0 5.0	Volts
Small-Signal Drain-Source "ON" Resistance 2N4091 2N4092 2N4093	$r_{ds(ON)}$	$V_{DS} = 0$, $V_{GS} = 0$		 30 50 80	Ohms
"ON" Resistance 2N4091 2N4092 2N4093	R_O	$I_D = 1.0$ mA, $V_{GS} = 0$		 30 50 80	Ohms
Rise Time 2N4091 2N4092 2N4093	t_r	See Figures 1 & 2		 10 20 40	nsec
Delay Time 2N4091 2N4092 2N4093	t_d	See Figures 1 & 2		 15 15 20	nsec

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MAX.	MIN.	UNIT
Turn-Off Time 2N4091 2N4092 2N4093	t_{off}	See Figures 1 & 2		 40 60 80	nsec
Input Capacitance	C_{is}	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1.0 MHz		16	pf
Drain-Gate Capacitance	C_{DG}	$V_{DG} = 20$ V, $I_S = 0$ f = 1.0 MHz		5.0	pf
Source Gate Capacitance	C_{SG}	$V_{SG} = 20$ V, $I_D = 0$ f = 1.0 MHz		5.0	pf

NOTES: * Pulse Test: Pulse Width $\leq$ 300 μsec; Duty Cycle $\leq$ 3%.

** 2N4091 $I_D = 6.6$ mA
2N4092 $I_D = 4.0$ mA
2N4093 $I_D = 2.5$ mA

*** 2N4091 $V_{GS(OFF)} = -12$ V
2N4092 $V_{GS(OFF)} = -8.0$ V
2N4093 $V_{GS(OFF)} = -6.0$ V

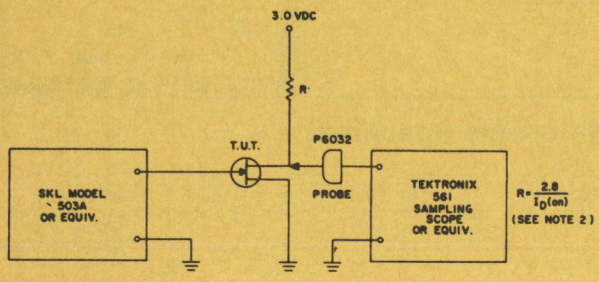


Figure 1

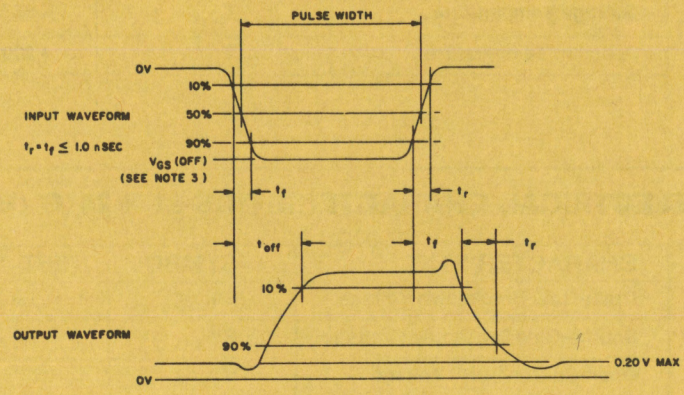
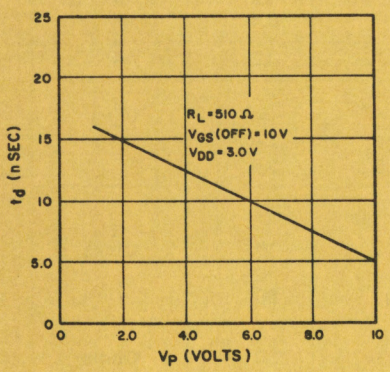
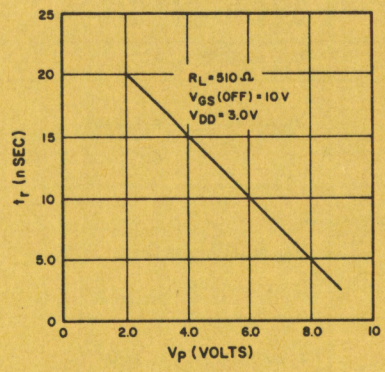
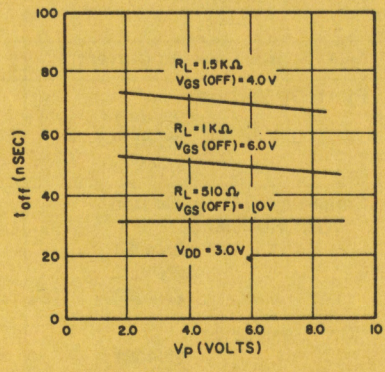


Figure 2

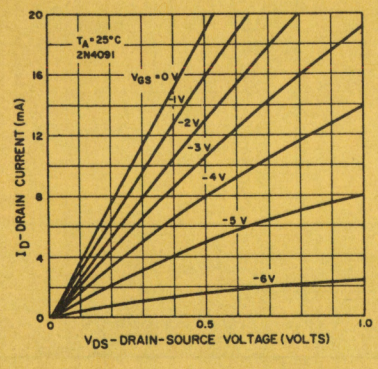
Switching Characteristics

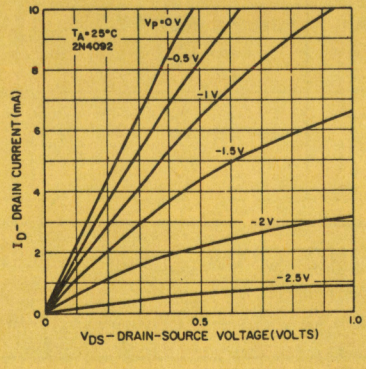


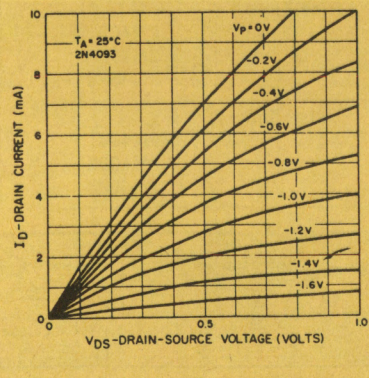




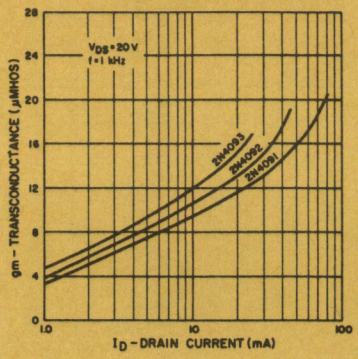
Common Source-Drain Characteristics



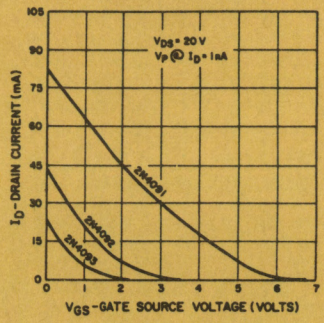




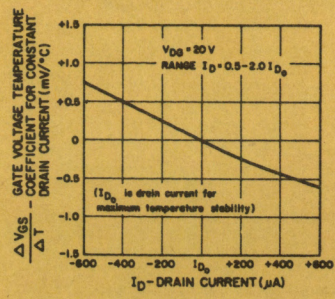
Transconductance vs Drain Current



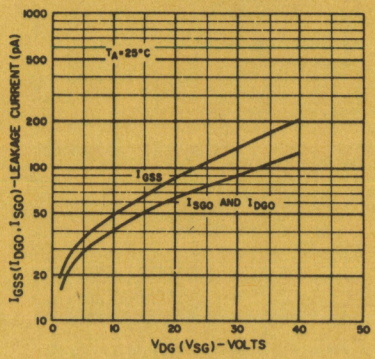
Drain Current vs Gate-Source Bias



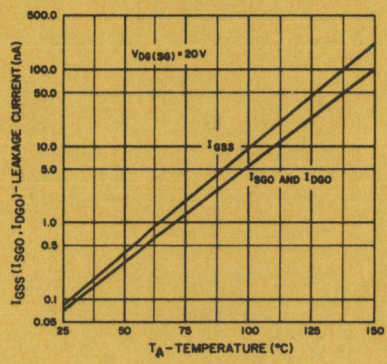
Gate Voltage Temperature Coefficients for Constant Drain Current vs Drain Voltage



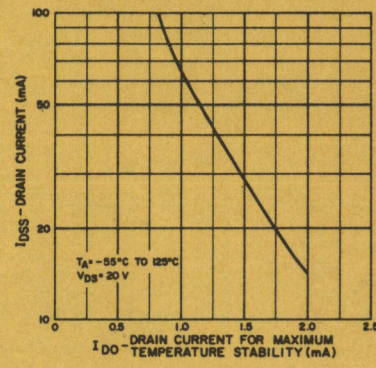
Leakage Current vs Voltage



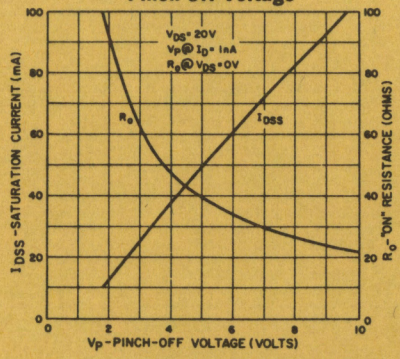
Gate Leakage Current vs Temperature



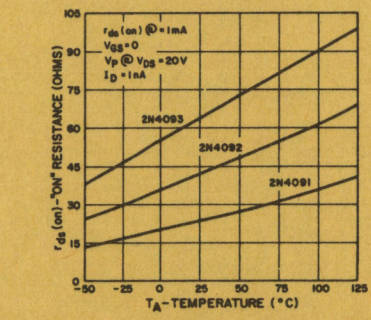
Drain Current for Maximum Temperature Stability



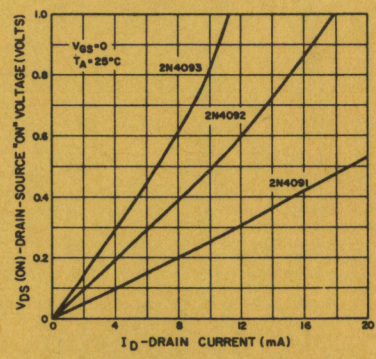
"ON" Resistance And Drain Current vs Pinch-Off Voltage



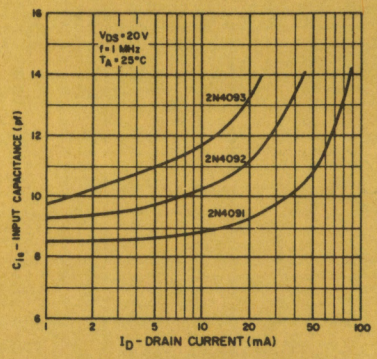
"ON" Resistance vs Temperature



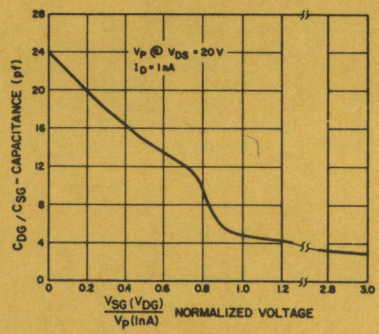
Drain-Source "ON" Voltage vs Drain Current



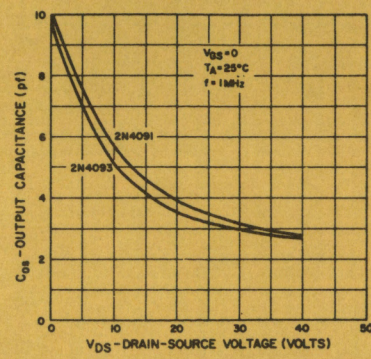
Input Capacitance vs Drain Current



Junction Capacitance vs Normalized Bias



Output Capacitance vs Drain-Source Voltage



N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE SWITCH

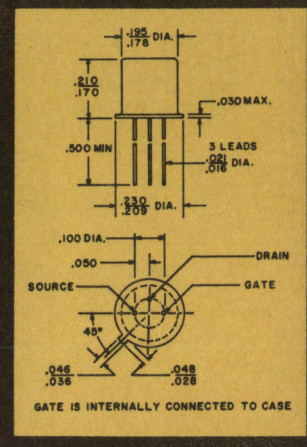
- VERY LOW "ON" RESISTANCE
- FAST SWITCHING SPEEDS
- LOW LEAKAGE

NOVEMBER 1968

2N4856 2N4859
2N4857 2N4860
2N4858 2N4861

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
		2N4856-57-58	2N4859-60-61	
Drain-Source Voltage	V_{DS}	40	30	Volts
Drain-Gate Voltage	V_{DG}	40	30	Volts
Reverse Gate-Source Voltage	V_{GS}	−40	−30	Volts
Power Dissipation @ $T_A = 25°C$	P_D	360		mWatt
Derating Temperature @ $T_A = 25°C$		2.4		mW/°C
Storage Temperature	T_{stg}	−65 to +200		°C
Junction Temperature	T_J	+200		°C
Lead Temperature 1/16" from case for 10 seconds		300		°C



ELECTRICAL CHARACTERISTICS at 25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage 2N4856-57-58 2N4859-60-61	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	 40 30		Volts
Gate-Source Cutoff Voltage 2N4856, 2N4859 2N4857, 2N4860 2N4858, 2N4861	$V_{GS(OFF)}$	$V_{DS} = 15$ V, $I_D = 0.5$ na	 4.0 2.0 0.8	 10 6.0 4.0	Volts
Drain-Source "ON" Voltage 2N4856-59 2N4857-60 2N4858-61	$V_{DS(ON)}$	 $I_D = 20$ mA, $V_{GS} = 0$ $I_D = 10$ mA, $V_{GS} = 0$ $I_D = 5$ mA, $V_{GS} = 0$		 0.75 0.50 0.50	Volts
Saturation Current 2N4856, 2N4859 2N4857, 2N4860 2N4858, 2N4861	I_{DSS}*	$V_{DS} = 15$ V, $V_{GS} = 0$	 50 20 8	 100 80	mA
Gate Reverse Current 2N4856-57-58 2N4859-60-61	I_{GSS}	 $V_{GS} = 20$ V, $V_{DS} = 0$ V $V_{GS} = 20$ V, $V_{DS} = 0$ V, $T_A = 150°C$ $V_{GS} = 15$ V, $V_{DS} = 0$ V $V_{GS} = 15$ V, $V_{DS} = 0$ V, $T_A = 150°C$		 0.25 0.5 0.25 0.5	 nA μA nA μA
Drain Cutoff Current	$I_{D(OFF)}$	$V_{GS} = -10$ V, $V_{DS} = 15$ V $V_{GS} = -10$ V, $V_{DS} = 15$ V, $T_A = 150°C$		0.25 0.5	nA μA
Small Signal Drain Source "ON" Resistance 2N4856, 2N4859 2N4857, 2N4860 2N4858, 2N4861	$r_{ds(ON)}$	$V_{DS} = 0$, $V_{GS} = 0$		 25 40 60	Ohms
"ON" Resistance 2N4856, 2N4859 2N4857, 2N4860 2N4858, 2N4861	R_O	$I_D = 1.0$ mA, $V_{GS} = 0$		 25 40 60	Ohms

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Rise Time 2N4856, 2N4859 2N4857, 2N4860 2N4858, 2N4861	t_r	See Figures 1 & 2		 3 4 10	ns
Delay Time 2N4856, 2N4859 2N4857, 2N4860 2N4858, 2N4861	t_d	See Figures 1 & 2		 6 6 10	ns
Turn-Off Time 2N4856, 2N4859 2N4857, 2N4860 2N4858, 2N4861	t_{off}	See Figures 1 & 2		 25 50 100	ns
Input Capacitance	C_{iss}	$V_{DS} = 0$ V, $V_{GS} = -10$ V f = 1.0 MHz		18	pF
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 0$ V, $V_{GS} = -10$ V f = 1.0 MHz		8.0	pF

*Pulse Test: Pulse Width = 100 msec, Duty Cycle $\leq$ 10%.

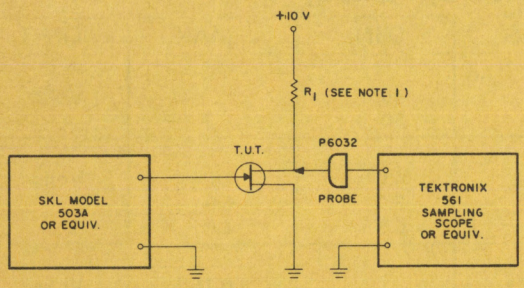


Figure 1

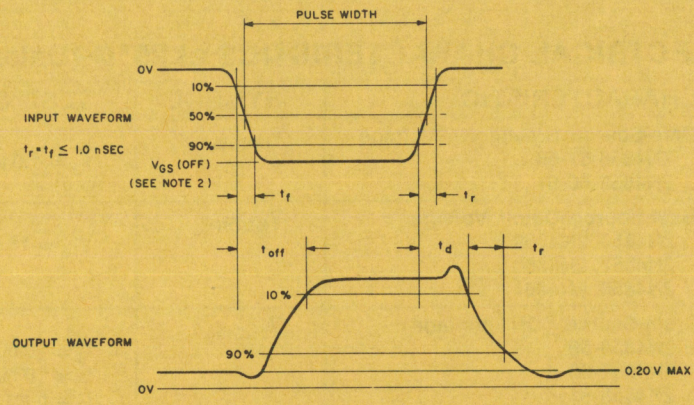


Figure 2

NOTES: 1) 2N4856, 2N4859 R_l = 464 ohms
2N4857, 2N4860 R_l = 953 ohms
2N4858, 2N4861 R_l = 1910 ohms

2) 2N4856, 2N4859 $V_{GS(OFF)} = -10$ V
2N4857, 2N4860 $V_{GS(OFF)} = -6$ V
2N4858, 2N4861 $V_{GS(OFF)} = -4$ V

N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE SWITCH

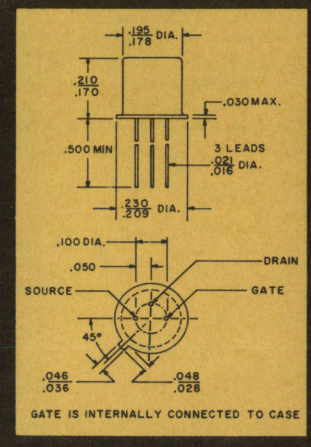
- LOW LEAKAGE
- FAST SWITCHING SPEEDS
- VERY LOW "ON" RESISTANCE

JANUARY 1968

2N4977
2N4978
2N4979

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gate Voltage	V_{DG}	30	Volts
Reverse Gate-Source Voltage	V_{GS}	30	Volts
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_C = 25°C$	P_D	1.8	Watts
Derating Factor Above 25°C @ $T_C = 25°C$		10.3	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C
Lead Temperature, 1/16 inch from case, 10 sec. max.		300	°C



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	30		Volts
Gate-Source Cutoff Voltage	$V_{GS(OFF)}$				
2N4977		$V_{DS} = 15$ V, $I_D = 1.0$ nA	4.0	10	Volts
2N4978			4.0	8.0	
2N4979			0.5	5.0	
Drain-Source "ON" Voltage	$V_{DS(ON)}$				
2N4977		$I_D = 25$ mA, $V_{GS} = 0$		0.4	nA
2N4978		$I_D = 10$ mA, $V_{GS} = 0$		0.4	
2N4979		$I_D = 5$ mA, $V_{GS} = 0$		0.4	
Gate Reverse Current	I_{GSS}	$V_{GS} = 15$ V, $V_{DS} = 0$		0.5	nA
Drain Reverse Current	I_{DGO}	$V_{DG} = 15$ V, $I_S = 0$		0.5	nA
		$V_{DG} = 15$ V, $I_S = 0$, $T_A = 150°C$		1.0	μA
Drain Cutoff Current	$I_{D(OFF)}$	$V_{DS} = 15$ V, $V_{GS} = -12$ V		0.5	nA
		$V_{DS} = 15$ V, $V_{GS} = -12$ V, $T_A = 150°C$		1.0	μA
Zero-Gate-Voltage Drain Current	I_{DSS}				
2N4977		$V_{DS} = 20$ V, $V_{GS} = 0$	50		mA
2N4978			15		
2N4979			7.5		
Drain-Source "ON" Resistance	$r_{DS(ON)}$				
2N4977		$I_D = 1.0$ mA, $V_{GS} = 0$		15	Ohms
2N4978				20	
2N4979				40	
Drain-Source "ON" Resistance	$r_{ds(ON)}$				
2N4977		$V_{GS} = 0$, $I_D = 0$, $f = 1.0$ kHz		15	Ohms
2N4978		$V_{GS} = 0$, $I_D = 0$, $f = 1.0$ kHz		20	
2N4979		$V_{GS} = 0$, $I_D = 0$, $f = 1.0$ kHz		40	
Input Capacitance	C_{iss}	$V_{DS} = 15$ V, $V_{GS} = 0$, $f = 1.0$ MHz		35	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 0$, $V_{GS} = -12$ V, $f = 1.0$ MHz		8.0	pf

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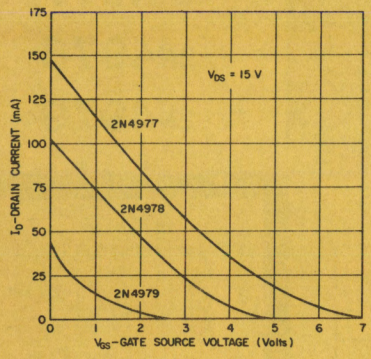
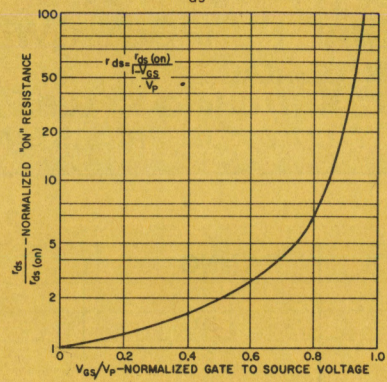
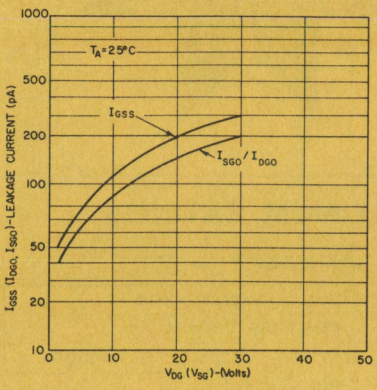
Drain Current vs Gate-Source Bias



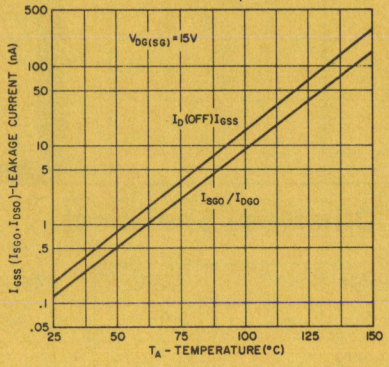
Normalized r_{ds} vs V_{GS}



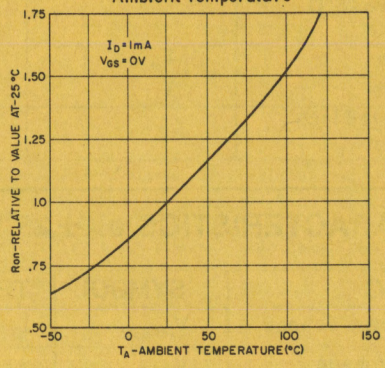
Leakage Current vs Voltage



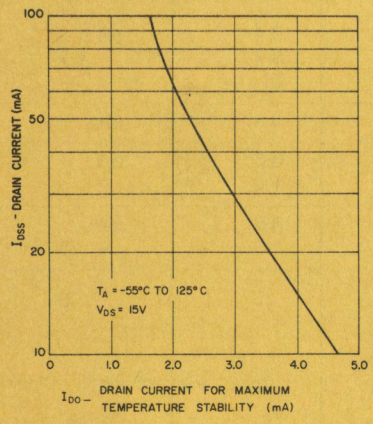
Leakage Gate vs Ambient Temperature



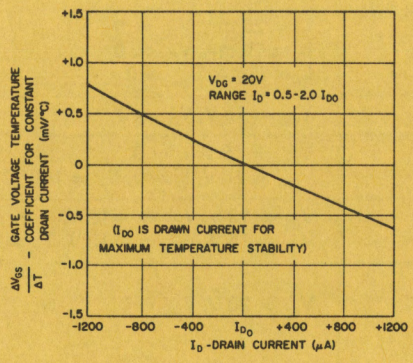
Normalized "On" Resistance vs Ambient Temperature



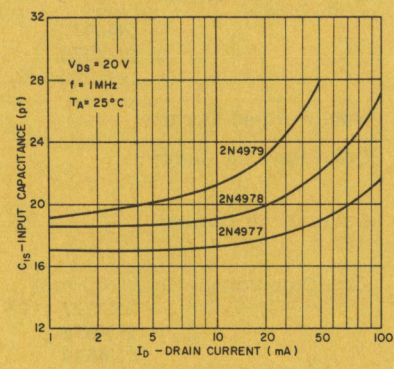
Drain Current for Maximum Temperature Stability



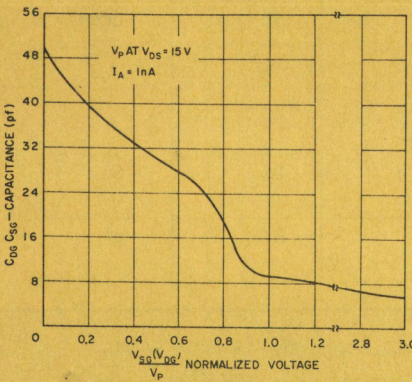
Gate Voltage Temperature Coefficients for Constant Drain Current vs Drain Voltage



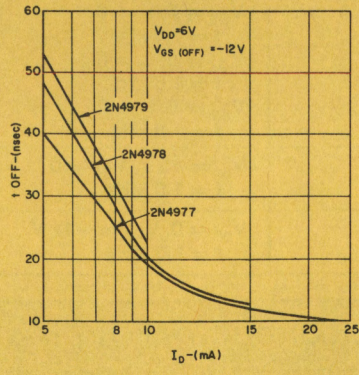
Input Capacitance vs Drain Current



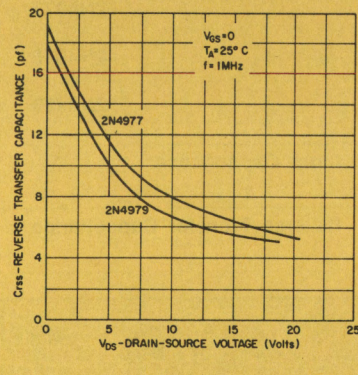
Junction Capacitance vs Normalized Bias



Switching Characteristics Turn-Off Time vs Drain Current

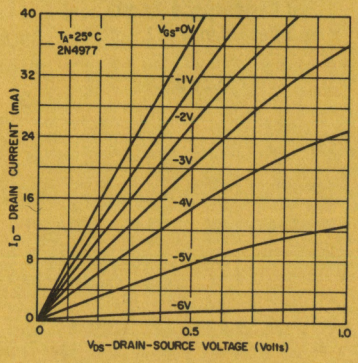


Reverse Transfer Capacitance vs Drain-Source Voltage

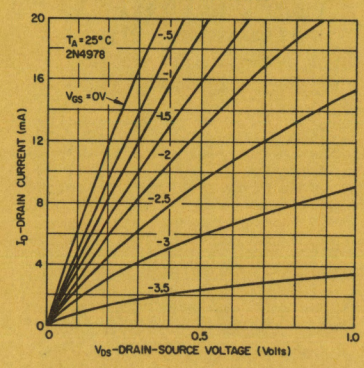


CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Delay Time	t_d				
2N4977		See Figure 1		5	nsec
2N4978		See Figure 2		5	
2N4979		See Figure 3		10	
Rise Time	t_r				
2N4977		See Figure 1		5	nsec
2N4978		See Figure 2		10	
2N4979		See Figure 3		30	
Turn-Off Time	t_{off}				
2N4977		See Figure 1		20	nsec
2N4978		See Figure 2		40	
2N4979		See Figure 3		60	

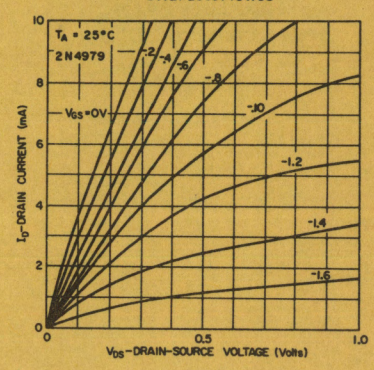
Common Source-Drain Characteristics



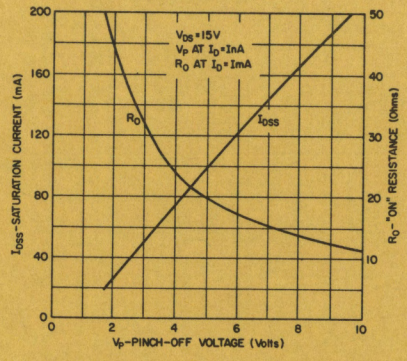
Common Source-Drain Characteristics



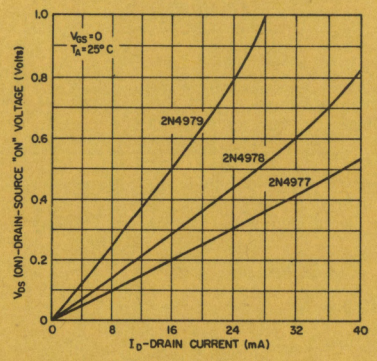
Common Source-Drain Characteristics



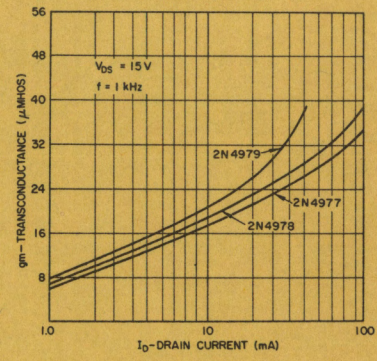
"On" Resistance and Drain Current VS Pinch-Off Voltage



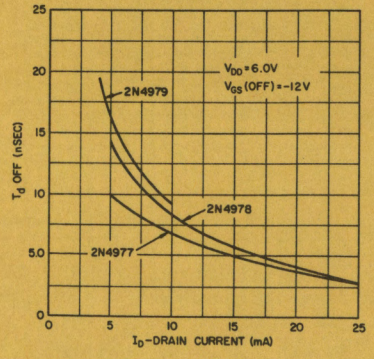
Drain-Source "On" Voltage VS Drain Current



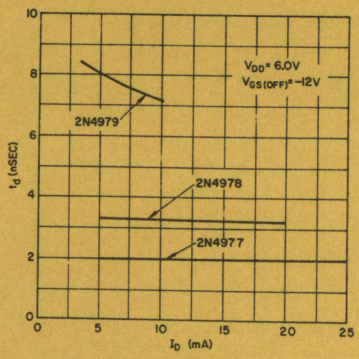
Transconductance VS Drain Current



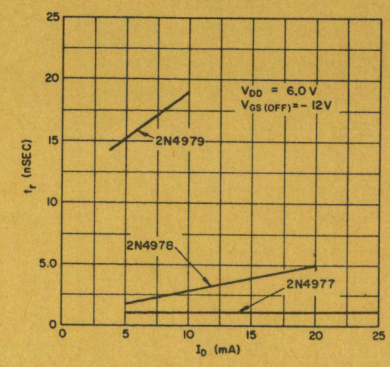
Switching Characteristics Turn-Off Delay Time VS Drain Current

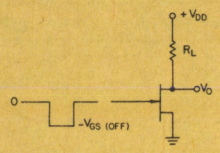


Switching Characteristics Delay Time VS Drain Current



Switching Characteristics Rise Time VS Drain Current



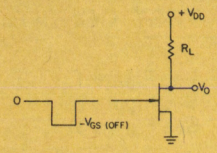


R_L = 220Ω
$I_{D(ON)}$ = 25 mA
$V_{GS(OFF)}$ = -10V
$V_{GS(ON)}$ = 0V
V_{DD} = 6.0V

Input Pulse
Rise Time < 1.0 ns
Fall Time < 1.0 ns
Pulse Width ≤ 110 ns, 10.0% Duty Cycle
Gen. Source Imp. = 50Ω

Oscilloscope
Rise Time ≤ 0.4 nsec
Input Resistance ≥ 9.8 MΩ
Input Capacitance ≤ 1.7 pf

Figure 1.

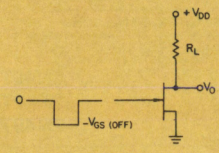


R_L = 560 Ohms
$I_{D(ON)}$ = 10 mA
$V_{GS(OFF)}$ = -8V
$V_{GS(ON)}$ = 0V
V_{DD} = 6.0V

Input Pulse
Rise Time < 1.0 ns
Fall Time < 1.0 ns
Pulse Width ≤ 110 ns, 10.0% Duty Cycle
Gen. Source Imp. = 50Ω

Oscilloscope
Rise Time ≤ 0.4 nsec
Input Resistance ≥ 9.8 MΩ
Input Capacitance ≤ 1.7 pf

Figure 2.



R_L = 1.1 kΩ
$I_{D(ON)}$ = 5.0 mA
$V_{GS(OFF)}$ = -5.0V
$V_{GS(ON)}$ = 0V
V_{DD} = 6.0V

Input Pulse
Rise Time < 1.0 ns
Fall Time < 1.0 ns
Pulse Width ≤ 110 ns, 10.0% Duty Cycle
Gen. Source Imp. = 50Ω

Oscilloscope
Rise Time ≤ 0.4 nsec
Input Resistance ≥ 9.8 MΩ
Input Capacitance ≤ 1.7 pf

Figure 3.

N-CHANNEL FET
GENERAL PURPOSE SWITCH

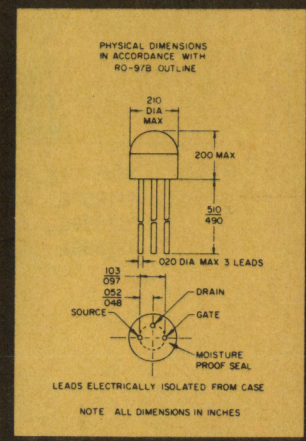
- LOW "ON" RESISTANCE
- FAST SWITCHING SPEEDS
- LOW LEAKAGE

SEPTEMBER 1968

u1897E
u1898E
u1899E

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	40	Volts
Drain-Gain Voltage	V_{DG}	40	Volts
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		2.5	mW/°C
Storage Temperature Range	T_{stg}	−55 to +125	°C
Operating Junction Temperature	T_J	+125	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A,\ I_S = 0$	40		Volts
Source-Gate Breakdown Voltage	BV_{SGO}	$I_S = 1.0\ \mu A,\ I_D = 0$	40		Volts
Gate-Source Cutoff Voltage U1897E U1898E U1899E	$V_{GS(OFF)}$	$V_{DS} = 20$ V, $I_D = 1.0$ nA	5.0 2.0 1.0	10 7.0 5.0	Volts
Drain Source "ON" Voltage	$V_{DS(on)}$	$I_D = (**)$, $V_{GS} = 0$		0.2	Volts
Gate-Drain Leakage Current	I_{DGO}	$V_{DG} = 20$ V, $I_S = 0$		0.2	nA
Gate-Source Leakage Current	I_{SGO}	$V_{SG} = 20$ V, $I_D = 0$		0.2	nA
Drain Cutoff Current	$I_{D(OFF)}$	$V_{GS} = (***)$, $V_{DS} = 20$ V $V_{GS} = (***)$, $V_{DS} = 20$ V, $T_A = +85°C$		0.2 10	nA nA
Zero-Gate Voltage Drain Current U1897E U1898E U1899E	I_{DSS}*	$V_{DS} = 20$ V, $V_{GS} = 0$	30 15 8.0		mA
Drain-Source "ON" Resistance U1897E U1898E U1899E	$r_{DS(ON)}$	$I_D = 1.0$ mA, $V_{GS} = 0$		30 50 80	Ohms
Input Capacitance	C_{iss}	$V_{DS} = 20$ V, $V_{GS} = 0$ $f = 1$ MHz		16	pf
Drain-Gate Capacitance	C_{DG}	$V_{DG} = 20$ V, $I_S = 0$ $f = 1$ MHz		5.0	pf
Source-Gate Capacitance	C_{SG}	$V_{SG} = 20$ V, $I_D = 0$ $f = 1$ MHz		5.0	pf

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Rise Time U1897E U1898E U1899E	t_r	See Figures 1 & 2		10 20 40	nsec
Delay Time U1897E U1898E U1899E	t_d	See Figures 1 & 2		15 15 20	nsec
Turn-OFF Time U1897E U1898E U1899E	t_{off}	See Figures 1 & 2		40 60 80	nsec

NOTES: *Measure under pulse conditions: pulse width $\leq$ 300 μsec; duty cycle $\leq$ 3%.

**U1897E I_D = 6.6 mA
U1898E I_D = 4.0 mA
U1899E I_D = 2.5 mA

***U1897E $V_{GS(OFF)} = -12$ V
U1898E $V_{GS(OFF)} = -8.0$ V
U1899E $V_{GS(OFF)} = -6.0$ V

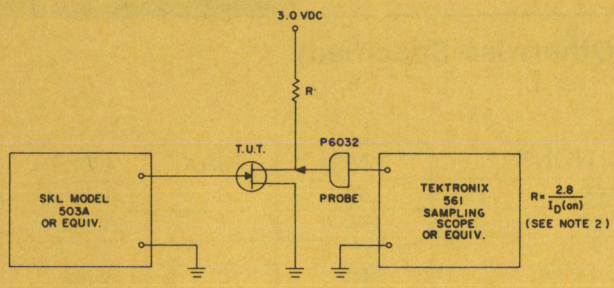


Figure 1

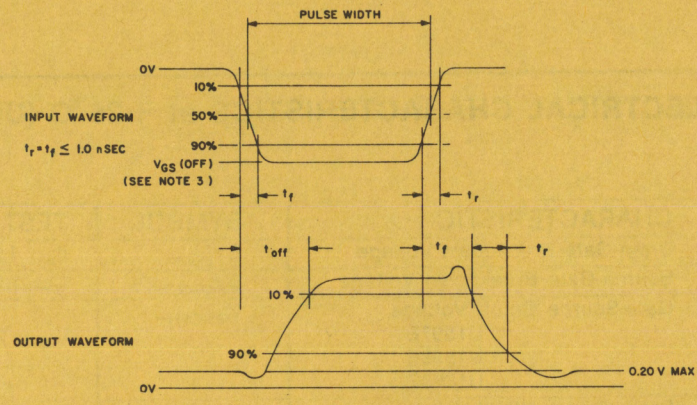
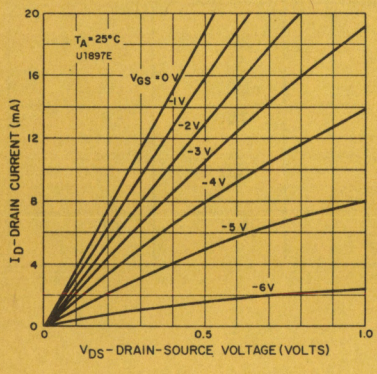
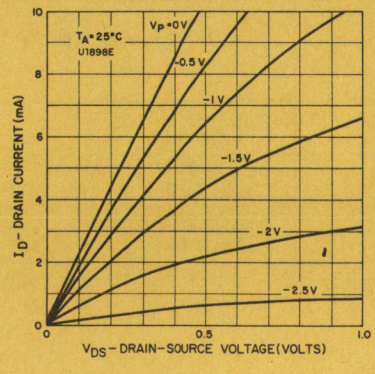
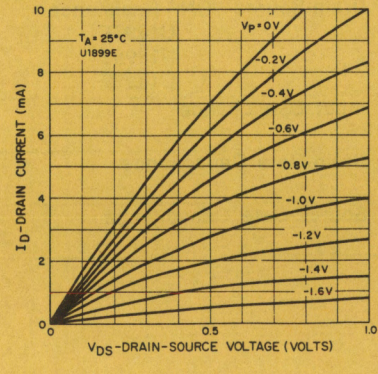


Figure 2

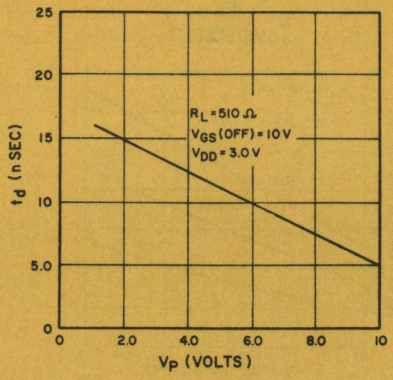
Common Source-Drain Characteristics

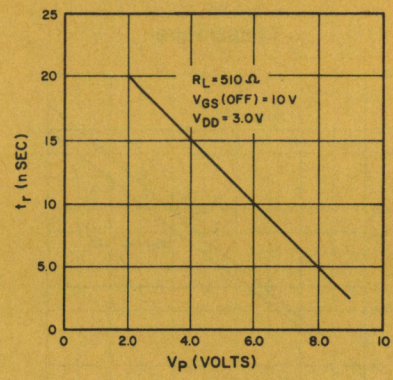


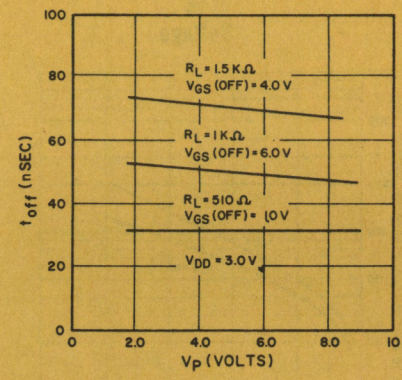




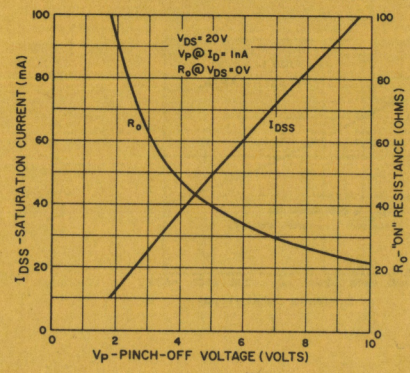
Switching Characteristics



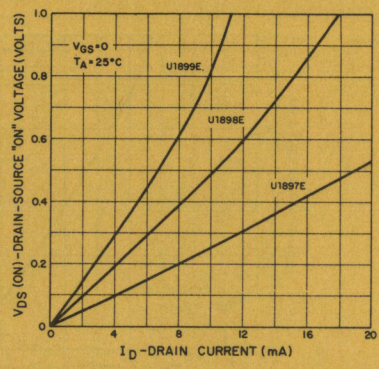




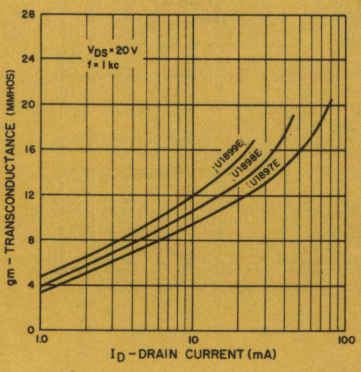
"ON" Resistance And Drain Current vs Pinch-Off Voltage



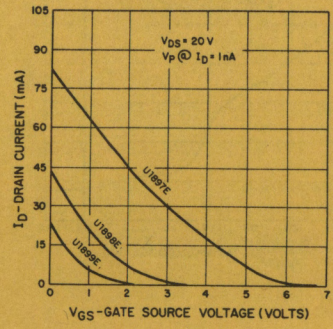
Drain-Source "ON" Voltage vs Drain Current



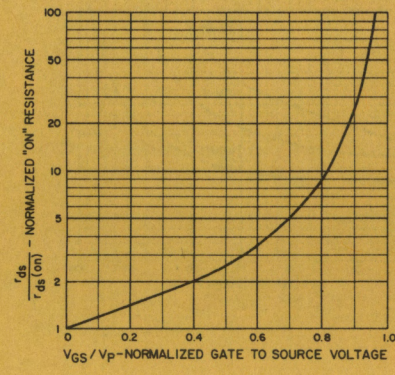
Transconductance vs Drain Current



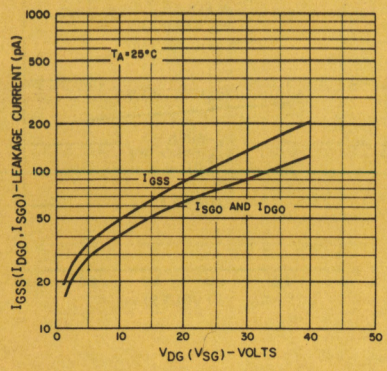
Drain Current vs Gate-Source Bias



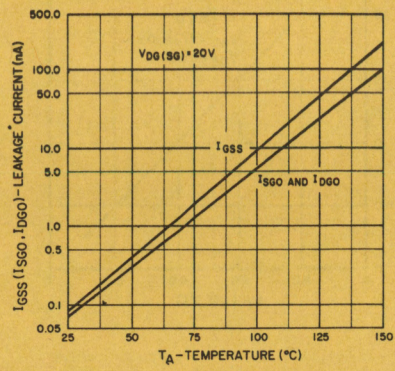
Normalized r_{ds} vs V_{GS}



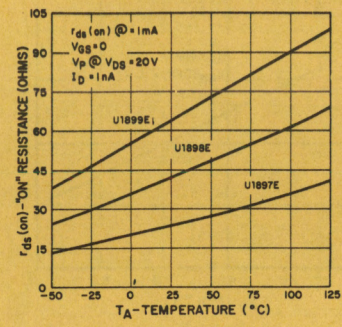
Leakage Current vs Voltage



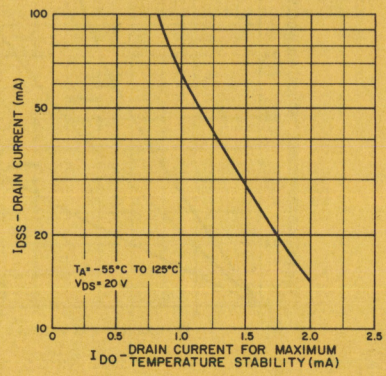
Gate Leakage Current vs Temperature



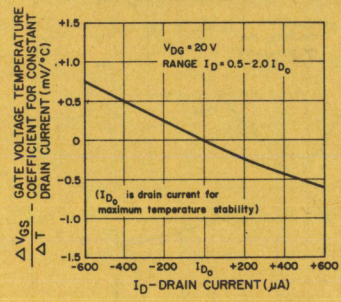
"ON" Resistance vs Temperature



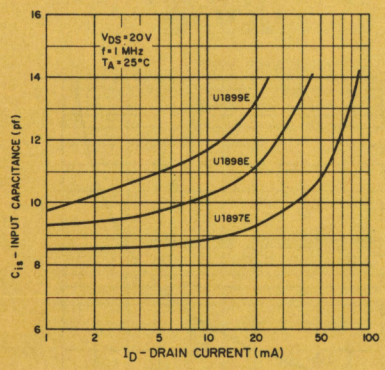
Drain Current for Maximum Temperature Stability



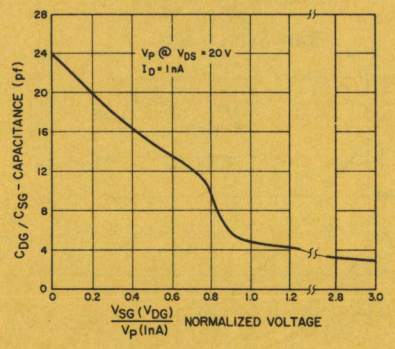
Gate Voltage Temperature Coefficients for Constant Drain Current vs Drain Voltage



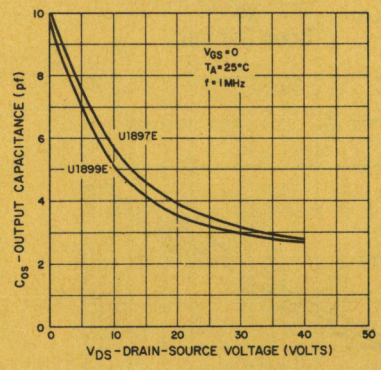
Input Capacitance vs Drain Current



Junction Capacitance vs Normalized Bias



Output Capacitance vs Drain-Source Voltage



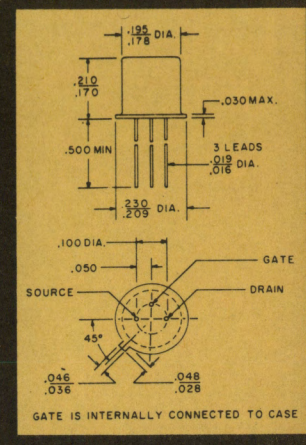
P-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE
- LOW LEAKAGE
- LOW NOISE

JANUARY 1968

2N2606 THRU 2N2609

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+175	°C
Derating Factor above 25°C @ $T_A = 25°C$		2	mW/°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate to Source Breakdown Voltage	BV_{GSS}	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	30		Volts
Total Gate Leakage Current	I_{GSS}				
2N2606		$V_{GS} = 5.0$ V, $V_{DS} = 0$		1.0	nA
2N2607				3.0	
2N2608				10	
2N2609				30	
2N2606		$V_{GS} = 5.0$ V, $V_{DS} = 0$, $T_A = 150°C$		1.0	μA
2N2607				3.0	
2N2608				10	
2N2609				30	
Saturation Current	I_{DSS}				
2N2606		$V_{DS} = -5.0$ V, $V_{GS} = 0$	100	500	μA
2N2607			300	1500	
2N2608			0.9	4.5	mA
2N2609			2.0	10	
Transconductance	g_m				
2N2606		$V_{DS} = -5.0$ V, $V_{GS} = 0$, f = 1 kHz	110		μmhos
2N2607			330		
2N2608			1000		
2N2609			2500		
Input Capacitance	C_{ib}				
2N2606		$V_{DS} = -5.0$ V, $V_{GS} = 1.0$ V, f = 140 kHz		6.0	pf
2N2607				10	
2N2608				17	
2N2609				30	
Pinch Off Voltage	Vp	$V_{DS} = -5.0$ V, $I_D = 1.0\ \mu A$	1.0	4.0	Volts
Noise Figure	NF	$V_{DS} = -5.0$ V, f = 1 kHz, BW = 160 Hz, Rg = 10 MΩ			
2N2606, 2N2607				3.0	db
2N2608, 2N2609		Rg = 1.0 MΩ		3.0	

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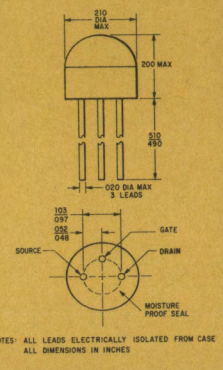
P-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE AMPLIFIER

JANUARY 1969

P1069E

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	−20	Volts
Drain-Gate Voltage	V_{DG}	−20	Volts
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mV
Derating Factor above 25°C @ $T_A = 25°C$		2.5	mW/°C
Storage Temperature Range	T_{stg}	−55 to +125	°C
Junction Temperature	T_J	+125	°C



NOTES: ALL LEADS ELECTRICALLY ISOLATED FROM CASE
ALL DIMENSIONS IN INCHES

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A$, $I_S = 0$	−20		Volts
Gate Leakage Current	I_{GSS}	$V_{GS} = 5.0$ V, $V_{DS} = 0$		3.0	nA
Saturation Current	I_{DSS}	$V_{DS} = -10$ V, $V_{GS} = 0$	−1.0	−5.0	mA
Gate-Source Cutoff Voltage	$V_{GS(Off)}$	$V_{DS} = -10$ V, $I_D = 3.0$ nA	1.0	4.0	Volts
Transconductance	g_{fs}	$V_{DS} = -10$ V, $V_{GS} = 0$, f = 1 kHz	3000	8000	μmhos
Drain-Source "ON" Resistance	$r_{DS(ON)}$	$I_D = 0.1$ mA, $V_{GS} = 0$		600	ohms
Output Conductance	g_{os}	$V_{DS} = -10$ V, $V_{GS} = 0$		100	μmhos
Input Capacitance	C_{iss}	$V_{DS} = -10$ V, $V_{GS} = 0$, f = 140 kHz		40	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = -10$ V, $V_{GS} = 0$ f = 140 kHz		5.0	pf
Noise Figure	NF	$V_{DS} = -10$ V, $V_{GS} = 0$, $R_G = 1.0$ MΩ f = 1.0 kHz, BW = 6.0 Hz		3.0	db

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P-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE SWITCH

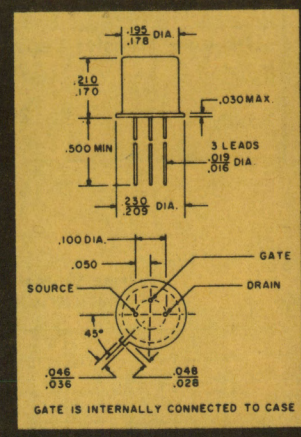
- VERY LOW "ON" RESISTANCE
- FAST SWITCHING SPEEDS
- LOW LEAKAGE

JANUARY 1968

2N5018
2N5019

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	−30	Volts
Drain-Gate Voltage	V_{DG}	−30	Volts
Reverse Gate-Source Voltage	V_{GS}	−30	Volts
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_C = 25°C$	P_D	1.8	Watts
Derating Factor Above 25°C @ $T_A = 25°C$		10	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C
Lead Temperature, 1/16 inch from case, 10 seconds max.		300	°C



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	30		Volts
Gate-Source Cutoff Voltage 2N5018 2N5019	$V_{GS(OFF)}$	 $V_{DS} = -15$ V, $I_D = 1.0\ \mu A$ $V_{DS} = -15$ V, $I_D = 1.0\ \mu A$		 10 5	Volts
Drain-Source "On" Voltage 2N5018 2N5019	$V_{DS(ON)}$	 $I_D = -6.0$ mA, $V_{GS} = 0$ $I_D = -3.0$ mA, $V_{GS} = 0$		 −0.5 −0.5	Volts
Gate Reverse Current	I_{GSS}	$V_{GS} = 15$ V, $V_{DS} = 0$		2.0	nA
Zero-Gate-Voltage Drain Current 2N5018 2N5019	I_{DSS}	 $V_{DS} = -20$ V, $V_{GS} = 0$ $V_{DS} = -20$ V, $V_{GS} = 0$	 −10 −5		mA
Drain Cutoff Current 2N5018 2N5019 2N5018 2N5019	$I_{D(OFF)}$	 $V_{DS} = -15$ V, $V_{GS} = 12$ V $V_{DS} = -15$ V, $V_{GS} = 7.0$ V $V_{DS} = -15$ V, $V_{GS} = 12$ V, $T_A = 150°C$ $V_{DS} = -15$ V, $V_{GS} = 7.0$ V, $T_A = 150°C$		 10 10 10 10	 nA μA
Drain Reverse Current	I_{DGO}	$V_{DG} = -15$ V, $I_S = 0$ $V_{DG} = -15$ V, $I_S = 0$, $T_A = 150°C$		2.0 3.0	nA μA
Drain-Source "ON" Resistance 2N5018 2N5019	$r_{DS(ON)}$	 $I_D = 1.0$ mA, $V_{GS} = 0$ $I_D = 1.0$ mA, $V_{GS} = 0$		 75 150	Ohms
Drain-Source "ON" Resistance 2N5018 2N5019	$r_{ds(ON)}$	 $V_{GS} = 0$, $I_D = 0$ $f = 1.0$ kHz $V_{GS} = 0$, $I_D = 0$ $f = 1.0$ kHz		 75 150	Ohms
Rise Time 2N5018 2N5019	t_r	 See Figure 1 See Figure 2		 20 75	nsec
Delay Time 2N5018 2N5019	t_d	 See Figure 1 See Figure 2		 15 15	nsec

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