*Designer's™ Data Sheet*
# Insulated Gate Bipolar Transistor with Anti-Parallel Diode
## N–Channel Enhancement–Mode Silicon Gate

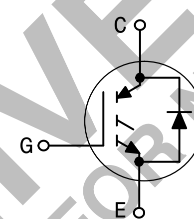
**MGW12N120D**

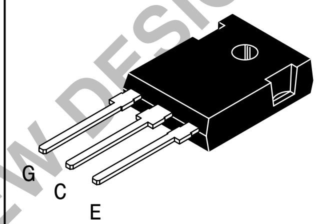
**Motorola Preferred Device**

**IGBT & DIODE IN TO–247**
**12 A @ 90°C**
**20 A @ 25°C**
**1200 VOLTS**
**SHORT CIRCUIT RATED**

This Insulated Gate Bipolar Transistor (IGBT) is co–packaged with a soft recovery ultra–fast rectifier and uses an advanced termination scheme to provide an enhanced and reliable high voltage–blocking capability. Short circuit rated IGBT's are specifically suited for applications requiring a guaranteed short circuit withstand time such as Motor Control Drives. Fast switching characteristics result in efficient operation at high frequencies. Co–packaged IGBT's save space, reduce assembly time and cost.

- Industry Standard High Power TO–247 Package with Isolated Mounting Hole
- High Speed $E_{off}$: 150 μJ/A typical at 125°C
- High Short Circuit Capability – 10 μs minimum
- Soft Recovery Free Wheeling Diode is included in the package
- Robust High Voltage Termination
- Robust RBSOA




**CASE 340K–01**
**STYLE 4**
**TO–247AE**



**MAXIMUM RATINGS** ($T_J$ = 25°C unless otherwise noted)

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector–Emitter Voltage | $V_{CES}$ | 1200 | Vdc |
| Collector–Gate Voltage ($R_{GE}$ = 1.0 MΩ) | $V_{CGR}$ | 1200 | Vdc |
| Gate–Emitter Voltage — Continuous | $V_{GE}$ | ±20 | Vdc |
| Collector Current — Continuous @ $T_C$ = 25°C<br>— Continuous @ $T_C$ = 90°C<br>— Repetitive Pulsed Current (1) | $I_{C25}$<br>$I_{C90}$<br>$I_{CM}$ | 20<br>12<br>40 | Adc<br><br>Apk |
| Total Power Dissipation @ $T_C$ = 25°C<br>Derate above 25°C | $P_D$ | 125<br>0.98 | Watts<br>W/°C |
| Operating and Storage Junction Temperature Range | $T_J$, $T_{stg}$ | –55 to 150 | °C |
| Short Circuit Withstand Time<br>($V_{CC}$ = 720 Vdc, $V_{GE}$ = 15 Vdc, $T_J$ = 125°C, $R_G$ = 20 Ω) | $t_{sc}$ | 10 | μs |
| Thermal Resistance — Junction to Case – IGBT<br>— Junction to Case – Diode<br>— Junction to Ambient | $R_{\theta JC}$<br>$R_{\theta JC}$<br>$R_{\theta JA}$ | 1.0<br>1.4<br>45 | °C/W |
| Maximum Lead Temperature for Soldering Purposes, 1/8″ from case for 5 seconds | $T_L$ | 260 | °C |
| Mounting Torque, 6–32 or M3 screw | 10 lbf•in (1.13 N•m) | | |

(1) Pulse width is limited by maximum junction temperature. Repetitive rating.

**Designer's Data for "Worst Case" Conditions** — The Designer's Data Sheet permits the design of most circuits entirely from the information presented. SOA Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

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**Preferred** devices are Motorola recommended choices for future use and best overall value.

REV 3

**ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Collector–to–Emitter Breakdown Voltage ($V_{GE}$ = 0 Vdc, $I_C$ = 25 µAdc) | $V_{(BR)CES}$ | 1200 | — | — | Vdc |
| Temperature Coefficient (Positive) | | — | 870 | — | mV/°C |
| Zero Gate Voltage Collector Current ($V_{CE}$ = 1200 Vdc, $V_{GE}$ = 0 Vdc) | $I_{CES}$ | — | — | 100 | µAdc |
| ($V_{CE}$ = 1200 Vdc, $V_{GE}$ = 0 Vdc, $T_J$ = 125°C) | | — | — | 2500 | |
| Gate–Body Leakage Current ($V_{GE}$ = ± 20 Vdc, $V_{CE}$ = 0 Vdc) | $I_{GES}$ | — | — | 250 | nAdc |
| **ON CHARACTERISTICS (1)** | | | | | |
| Collector–to–Emitter On–State Voltage ($V_{GE}$ = 15 Vdc, $I_C$ = 5.0 Adc) | $V_{CE(on)}$ | — | 2.71 | 3.37 | Vdc |
| ($V_{GE}$ = 15 Vdc, $I_C$ = 5.0 Adc, $T_J$ = 125°C) | | — | 3.78 | — | |
| ($V_{GE}$ = 15 Vdc, $I_C$ = 10 Adc) | | — | 3.5 | 4.42 | |
| Gate Threshold Voltage ($V_{CE}$ = $V_{GE}$, $I_C$ = 1.0 mAdc) | $V_{GE(th)}$ | 4.0 | 6.0 | 8.0 | Vdc |
| Threshold Temperature Coefficient (Negative) | | — | 10 | — | mV/°C |
| Forward Transconductance ($V_{CE}$ = 10 Vdc, $I_C$ = 10 Adc) | $g_{fe}$ | — | 12 | — | Mhos |

**DYNAMIC CHARACTERISTICS**

| Characteristic | Conditions | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Input Capacitance | ($V_{CE}$ = 25 Vdc, $V_{GE}$ = 0 Vdc, f = 1.0 MHz) | $C_{ies}$ | — | 1003 | — | pF |
| Output Capacitance | | $C_{oes}$ | — | 126 | — | |
| Transfer Capacitance | | $C_{res}$ | — | 106 | — | |

**SWITCHING CHARACTERISTICS (1)**

| Characteristic | Conditions | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Turn–On Delay Time | ($V_{CC}$ = 720 Vdc, $I_C$ = 10 Adc, $V_{GE}$ = 15 Vdc, L = 300 µH, $R_G$ = 20 Ω) Energy losses include “tail” | $t_{d(on)}$ | — | 74 | — | ns |
| Rise Time | | $t_r$ | — | 83 | — | |
| Turn–Off Delay Time | | $t_{d(off)}$ | — | 76 | — | |
| Fall Time | | $t_f$ | — | 231 | — | |
| Turn–Off Switching Loss | | $E_{off}$ | — | 0.55 | 1.33 | mJ |
| Turn–On Switching Loss | | $E_{on}$ | — | 1.21 | 1.88 | |
| Total Switching Loss | | $E_{ts}$ | — | 1.76 | 3.21 | |
| Turn–On Delay Time | ($V_{CC}$ = 720 Vdc, $I_C$ = 10 Adc, $V_{GE}$ = 15 Vdc, L = 300 µH, $R_G$ = 20 Ω, $T_J$ = 125°C) Energy losses include “tail” | $t_{d(on)}$ | — | 66 | — | ns |
| Rise Time | | $t_r$ | — | 87 | — | |
| Turn–Off Delay Time | | $t_{d(off)}$ | — | 120 | — | |
| Fall Time | | $t_f$ | — | 575 | — | |
| Turn–Off Switching Loss | | $E_{off}$ | — | 1.49 | — | mJ |
| Turn–On Switching Loss | | $E_{on}$ | — | 2.37 | — | |
| Total Switching Loss | | $E_{ts}$ | — | 3.86 | — | |
| Gate Charge | ($V_{CC}$ = 720 Vdc, $I_C$ = 10 Adc, $V_{GE}$ = 15 Vdc) | $Q_T$ | — | 29 | — | nC |
| | | $Q_1$ | — | 13 | — | |
| | | $Q_2$ | — | 12 | — | |

**DIODE CHARACTERISTICS**

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Diode Forward Voltage Drop ($I_{EC}$ = 5.0 Adc) | $V_{FEC}$ | — | 2.26 | 3.32 | Vdc |
| ($I_{EC}$ = 5.0 Adc, $T_J$ = 125°C) | | — | 1.37 | — | |
| ($I_{EC}$ = 10 Adc) | | — | 2.86 | 4.18 | |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2%.

(continued)

**ELECTRICAL CHARACTERISTICS — continued** ($T_J$ = 25°C unless otherwise noted)

| Characteristic | | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **DIODE CHARACTERISTICS — continued** | | | | | | |
| Reverse Recovery Time | ($I_F$ = 10 Adc, $V_R$ = 720 Vdc, $dI_F/dt$ = 100 A/µs) | $t_{rr}$ | — | 116 | — | ns |
| | | $t_a$ | — | 69 | — | |
| | | $t_b$ | — | 47 | — | |
| Reverse Recovery Stored Charge | | $Q_{RR}$ | — | 0.36 | — | µC |
| Reverse Recovery Time | ($I_F$ = 10 Adc, $V_R$ = 720 Vdc, $dI_F/dt$ = 100 A/µs, $T_J$ = 125°C) | $t_{rr}$ | — | 234 | — | ns |
| | | $t_a$ | — | 149 | — | |
| | | $t_b$ | — | 85 | — | |
| Reverse Recovery Stored Charge | | $Q_{RR}$ | — | 1.40 | — | µC |
| **INTERNAL PACKAGE INDUCTANCE** | | | | | | |
| Internal Emitter Inductance (Measured from the emitter lead 0.25″ from package to emitter bond pad) | | $L_E$ | — | 13 | — | nH |

## TYPICAL ELECTRICAL CHARACTERISTICS

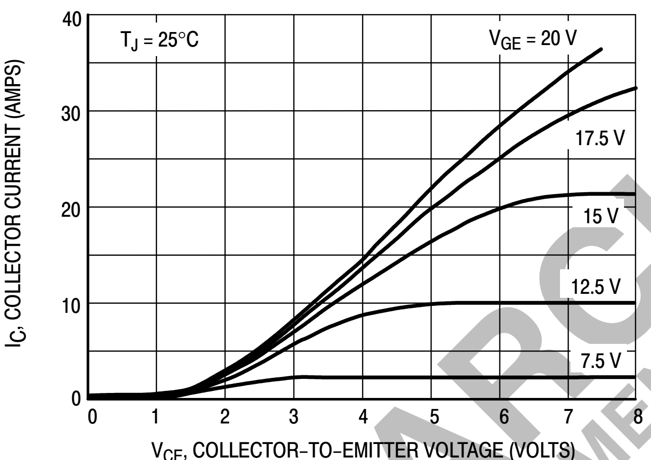



**Figure 1. Output Characteristics**

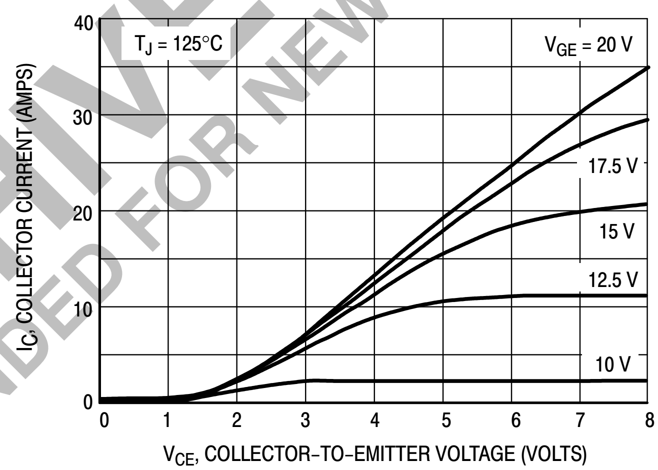



**Figure 2. Output Characteristics**

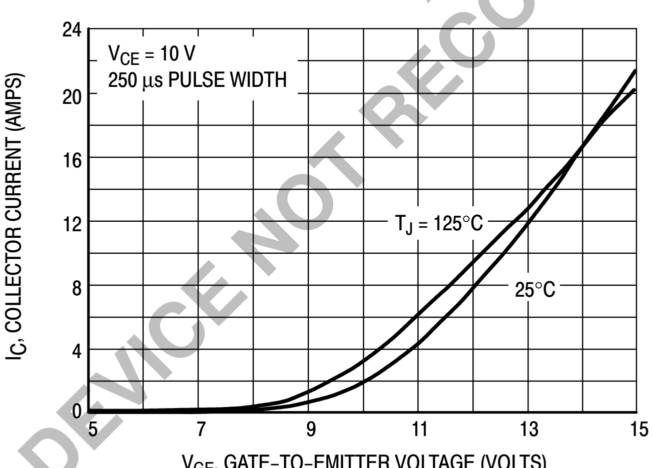



**Figure 3. Transfer Characteristics**

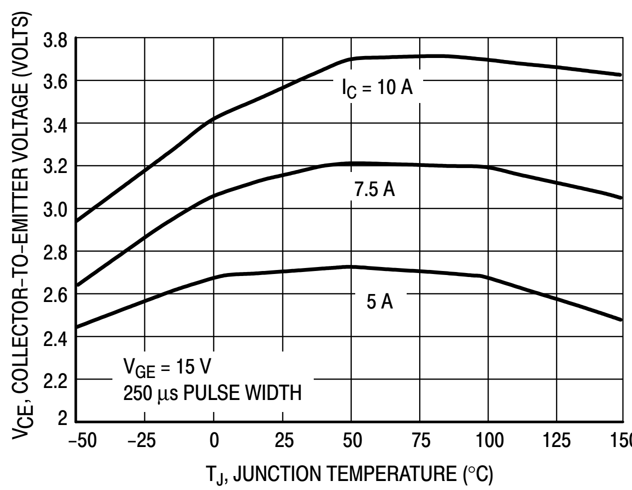



**Figure 4. Collector–to–Emitter Saturation Voltage versus Junction Temperature**

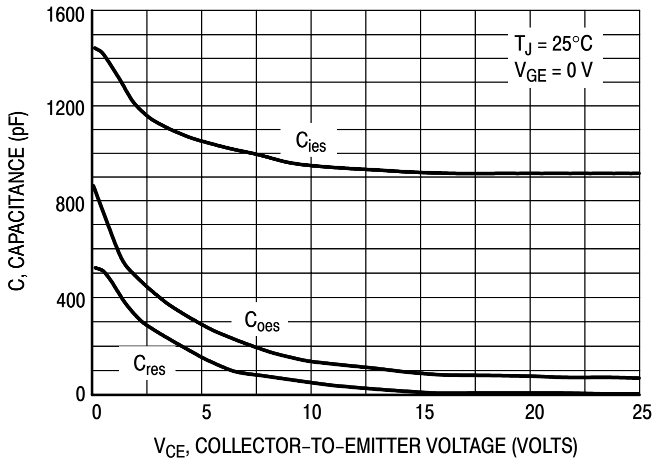



**Figure 5. Capacitance Variation**

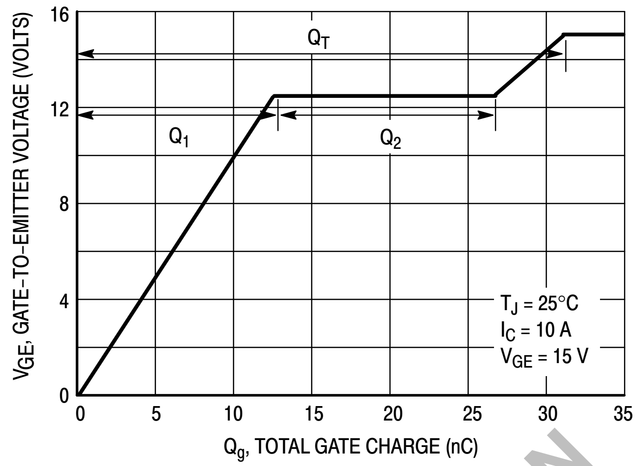



**Figure 6. Gate–to–Emitter Voltage versus Total Charge**

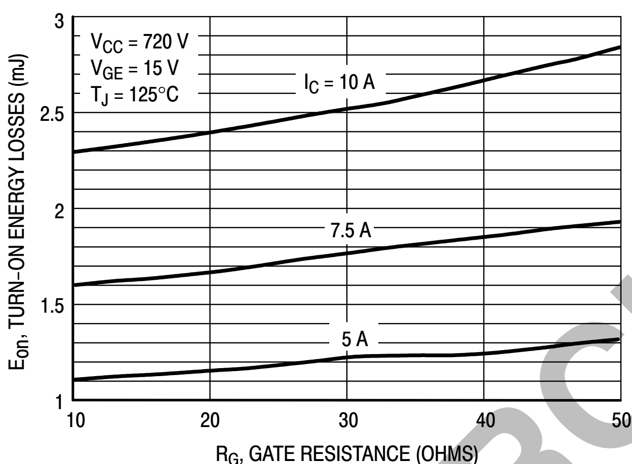



**Figure 7. Turn–On Losses versus Gate Resistance**

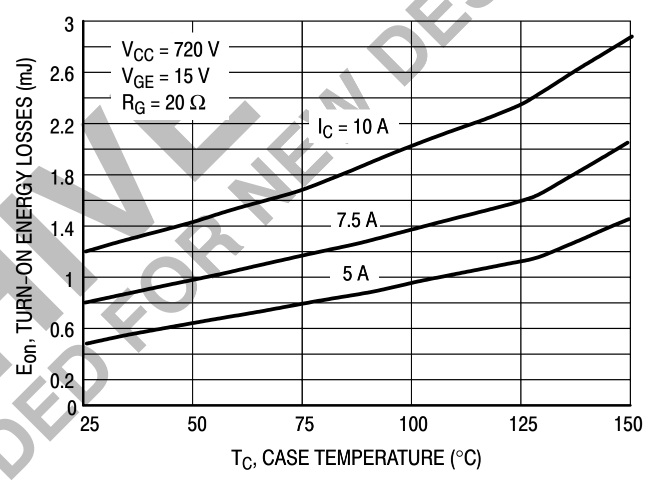



**Figure 8. Turn–On Losses versus Case Temperature**

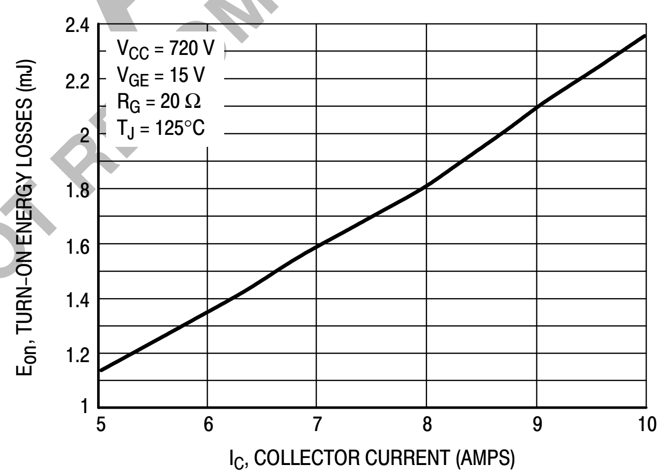



**Figure 9. Turn–On Losses versus Collector Current**

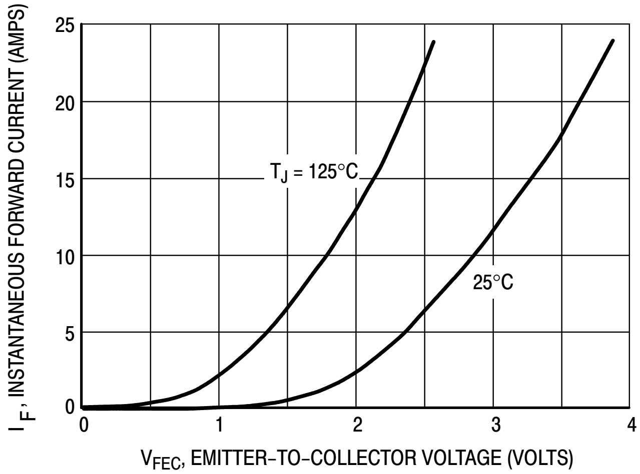



**Figure 10. Diode Forward Voltage Drop**

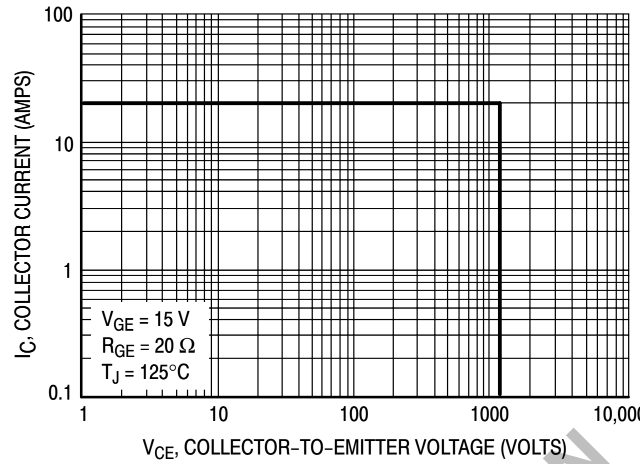



**Figure 11. Reverse Biased Safe Operating Area**

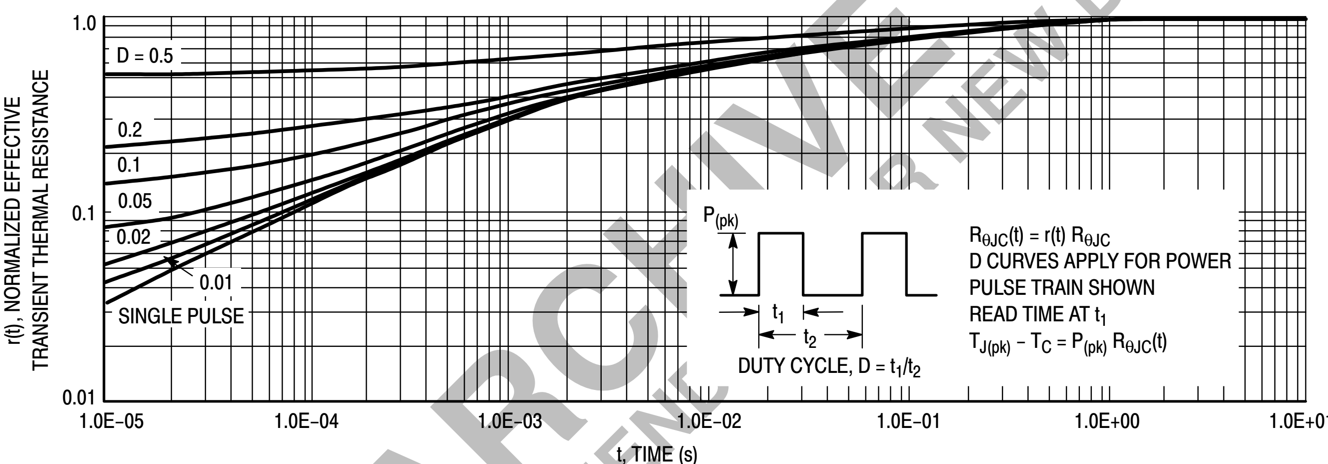
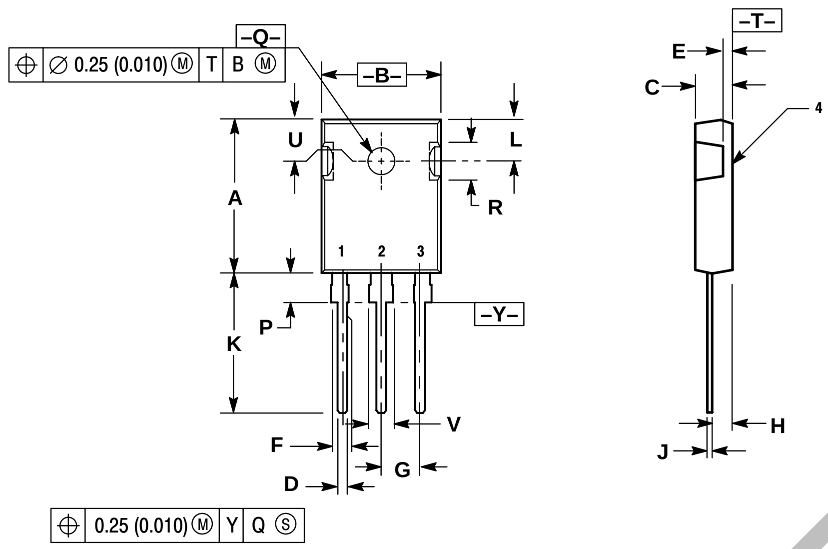



**Figure 12. Thermal Response**

## PACKAGE DIMENSIONS




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.

| DIM | MILLIMETERS MIN | MILLIMETERS MAX | INCHES MIN | INCHES MAX |
|---|---|---|---|---|
| A | 19.7 | 20.3 | 0.776 | 0.799 |
| B | 15.3 | 15.9 | 0.602 | 0.626 |
| C | 4.7 | 5.3 | 0.185 | 0.209 |
| D | 1.0 | 1.4 | 0.039 | 0.055 |
| E | 1.27 REF | | 0.050 REF | |
| F | 2.0 | 2.4 | 0.079 | 0.094 |
| G | 5.5 BSC | | 0.216 BSC | |
| H | 2.2 | 2.6 | 0.087 | 0.102 |
| J | 0.4 | 0.8 | 0.016 | 0.031 |
| K | 14.2 | 14.8 | 0.559 | 0.583 |
| L | 5.5 NOM | | 0.217 NOM | |
| P | 3.7 | 4.3 | 0.146 | 0.169 |
| Q | 3.55 | 3.65 | 0.140 | 0.144 |
| R | 5.0 NOM | | 0.197 NOM | |
| U | 5.5 BSC | | 0.217 BSC | |
| V | 3.0 | 3.4 | 0.118 | 0.134 |

STYLE 4:
PIN 1. GATE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

**CASE 340K–01**
**TO–247AE**
**ISSUE A**





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