

# Designer's™ Data Sheet

## Insulated Gate Bipolar Transistor

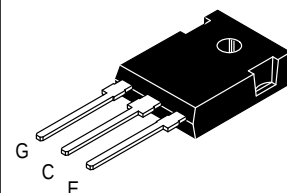
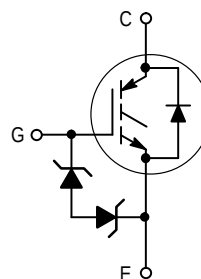
### N-Channel Enhancement-Mode Silicon Gate

**MGW14N60ED**

**IGBT IN TO-247**  
**14 A @ 90°C**  
**18 A @ 25°C**  
**600 VOLTS**  
**SHORT CIRCUIT RATED**  
**ON-VOLTAGE**

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. Its new 600V IGBT technology is specifically suited for applications requiring both a high temperature short circuit capability and a low  $V_{CE(on)}$ . It also provides fast switching characteristics and results in efficient operation at high frequencies. Co-packaged IGBTs save space, reduce assembly time and cost. This new E-series introduces an energy efficient, ESD protected, and short circuit rugged device.

- Industry Standard TO-247 Package
- High Speed:  $E_{off} = 60 \mu\text{J/A}$  typical at 125°C
- High Voltage Short Circuit Capability – 10  $\mu\text{s}$  minimum at 125°C, 400V
- Low On-Voltage — 2.0V typical at 10A, 125°C
- Soft Recovery Free Wheeling Diode is included in the Package
- Robust High Voltage Termination
- ESD Protection Gate-Emitter Zener Diodes



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

#### MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

| Rating                                                                                                                                     | Symbol                                                | Value            | Unit          |
|--------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|------------------|---------------|
| Collector-Emitter Voltage                                                                                                                  | $V_{CES}$                                             | 600              | Vdc           |
| Collector-Gate Voltage ( $R_{GE} = 1.0 \text{ M}\Omega$ )                                                                                  | $V_{CGR}$                                             | 600              | Vdc           |
| Gate-Emitter Voltage — Continuous                                                                                                          | $V_{GE}$                                              | $\pm 20$         | Vdc           |
| Collector Current — Continuous @ $T_C = 25^\circ\text{C}$<br>— Continuous @ $T_C = 90^\circ\text{C}$<br>— Repetitive Pulsed Current (1)    | $I_{C25}$<br>$I_{C90}$<br>$I_{CM}$                    | 18<br>14<br>28   | Adc<br>Apk    |
| Total Power Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate above 25°C                                                                    | $P_D$                                                 | 112<br>0.89      | Watts<br>W/°C |
| Operating and Storage Junction Temperature Range                                                                                           | $T_J, T_{stg}$                                        | -55 to 150       | °C            |
| Short Circuit Withstand Time<br>( $V_{CC} = 400 \text{ Vdc}$ , $V_{GE} = 15 \text{ Vdc}$ , $T_J = 125^\circ\text{C}$ , $R_G = 20 \Omega$ ) | $t_{sc}$                                              | 10               | $\mu\text{s}$ |
| Thermal Resistance — Junction to Case – IGBT<br>— Junction to Case – Diode<br>— Junction to Ambient                                        | $R_{\theta JC}$<br>$R_{\theta JC}$<br>$R_{\theta JA}$ | 1.1<br>1.9<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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# MGW14N60ED

## ELECTRICAL CHARACTERISTICS (T<sub>J</sub> = 25°C unless otherwise noted)

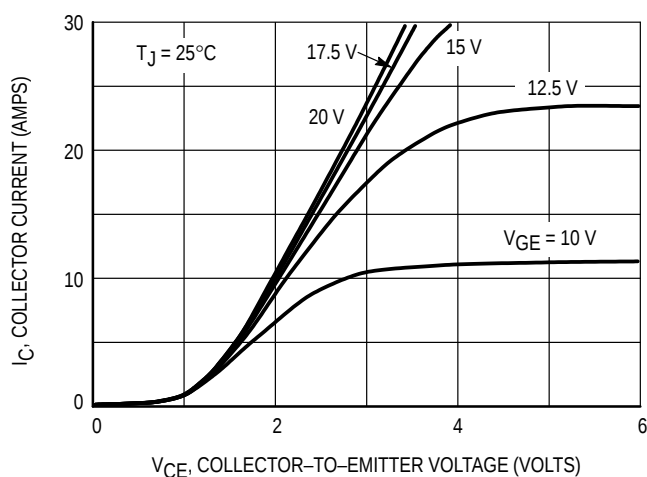
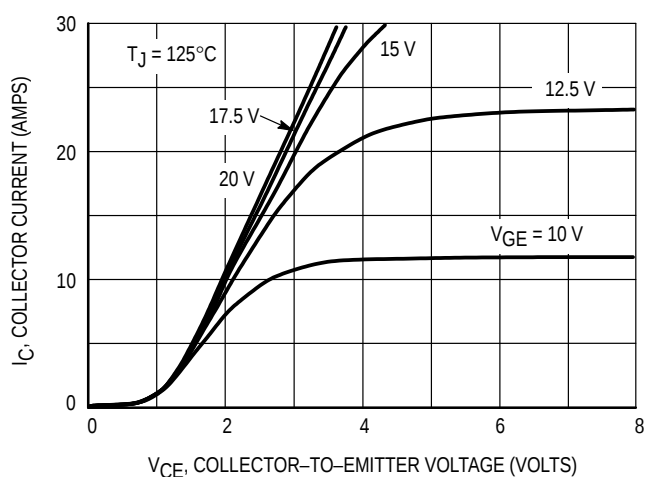
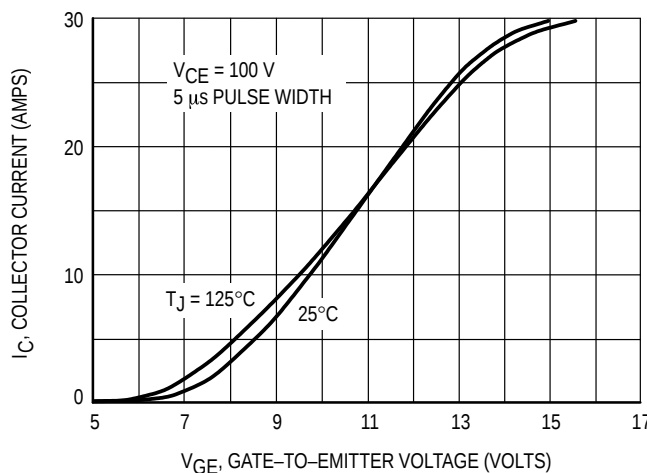
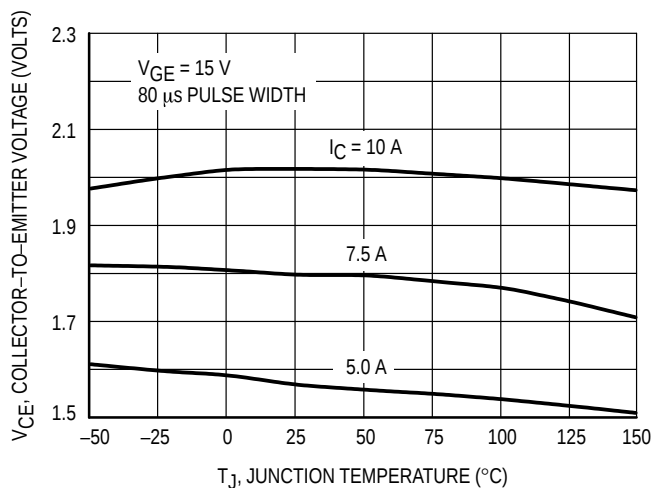
| Characteristic                                                                                                                                                                                                                       | Symbol                                                                                                                                                                          | Min                 | Typ               | Max             | Unit         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-------------------|-----------------|--------------|
| OFF CHARACTERISTICS                                                                                                                                                                                                                  |                                                                                                                                                                                 |                     |                   |                 |              |
| Collector-to-Emitter Breakdown Voltage<br>(V <sub>GE</sub> = 0 Vdc, I <sub>C</sub> = 25 μAdc)<br>Temperature Coefficient (Positive)                                                                                                  | V <sub>(BR)CES</sub>                                                                                                                                                            | 600<br>—            | —<br>870          | —<br>—          | Vdc<br>mV/°C |
| Emitter-to-Collector Breakdown Voltage (V <sub>GE</sub> = 0 Vdc, I <sub>EC</sub> = 100 mAdc)                                                                                                                                         | V <sub>(BR)ECS</sub>                                                                                                                                                            | 15                  | —                 | —               | Vdc          |
| Zero Gate Voltage Collector Current<br>(V <sub>CE</sub> = 600 Vdc, V <sub>GE</sub> = 0 Vdc)<br>(V <sub>CE</sub> = 600 Vdc, V <sub>GE</sub> = 0 Vdc, T <sub>J</sub> = 125°C)                                                          | I <sub>CES</sub>                                                                                                                                                                | —<br>—              | —<br>—            | 10<br>200       | μAdc         |
| Gate-Body Leakage Current (V <sub>GE</sub> = ± 20 Vdc, V <sub>CE</sub> = 0 Vdc)                                                                                                                                                      | I <sub>GES</sub>                                                                                                                                                                | —                   | —                 | 50              | μAdc         |
| ON CHARACTERISTICS(1)                                                                                                                                                                                                                |                                                                                                                                                                                 |                     |                   |                 |              |
| Collector-to-Emitter On-State Voltage<br>(V <sub>GE</sub> = 15 Vdc, I <sub>C</sub> = 5.0 Adc)<br>(V <sub>GE</sub> = 15 Vdc, I <sub>C</sub> = 5.0 Adc, T <sub>J</sub> = 125°C)<br>(V <sub>GE</sub> = 15 Vdc, I <sub>C</sub> = 10 Adc) | V <sub>CE(on)</sub>                                                                                                                                                             | —<br>—<br>—         | 1.6<br>1.5<br>2.0 | 1.9<br>—<br>2.4 | Vdc          |
| Gate Threshold Voltage<br>(V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1.0 mAdc)<br>Threshold Temperature Coefficient (Negative)                                                                                            | V <sub>GE(th)</sub>                                                                                                                                                             | 4.0<br>—            | 6.0<br>10         | 8.0<br>—        | Vdc<br>mV/°C |
| Forward Transconductance (V <sub>CE</sub> = 10 Vdc, I <sub>C</sub> = 10 Adc)                                                                                                                                                         | g <sub>fe</sub>                                                                                                                                                                 | —                   | 5.0               | —               | Mhos         |
| DYNAMIC CHARACTERISTICS                                                                                                                                                                                                              |                                                                                                                                                                                 |                     |                   |                 |              |
| Input Capacitance                                                                                                                                                                                                                    | (V <sub>CE</sub> = 25 Vdc, V <sub>GE</sub> = 0 Vdc,<br>f = 1.0 MHz)                                                                                                             | C <sub>ies</sub>    | —                 | 1020            | pF           |
| Output Capacitance                                                                                                                                                                                                                   |                                                                                                                                                                                 | C <sub>oes</sub>    | —                 | 104             |              |
| Transfer Capacitance                                                                                                                                                                                                                 |                                                                                                                                                                                 | C <sub>res</sub>    | —                 | 17              |              |
| SWITCHING CHARACTERISTICS(1)                                                                                                                                                                                                         |                                                                                                                                                                                 |                     |                   |                 |              |
| Turn-On Delay Time                                                                                                                                                                                                                   | (V <sub>CC</sub> = 360 Vdc, I <sub>C</sub> = 10 Adc,<br>V <sub>GE</sub> = 15 Vdc, L = 300 μH,<br>R <sub>G</sub> = 20 Ω)<br>Energy losses include “tail”                         | t <sub>d(on)</sub>  | —                 | 38              | ns           |
| Rise Time                                                                                                                                                                                                                            |                                                                                                                                                                                 | t <sub>r</sub>      | —                 | 40              |              |
| Turn-Off Delay Time                                                                                                                                                                                                                  |                                                                                                                                                                                 | t <sub>d(off)</sub> | —                 | 120             |              |
| Fall Time                                                                                                                                                                                                                            |                                                                                                                                                                                 | t <sub>f</sub>      | —                 | 204             |              |
| Turn-Off Switching Loss                                                                                                                                                                                                              |                                                                                                                                                                                 | E <sub>off</sub>    | —                 | 0.35            | mJ           |
| Turn-On Switching Loss                                                                                                                                                                                                               |                                                                                                                                                                                 | E <sub>on</sub>     | —                 | 0.27            |              |
| Total Switching Loss                                                                                                                                                                                                                 |                                                                                                                                                                                 | E <sub>ts</sub>     | —                 | 0.62            |              |
| Turn-On Delay Time                                                                                                                                                                                                                   | (V <sub>CC</sub> = 360 Vdc, I <sub>C</sub> = 10 Adc,<br>V <sub>GE</sub> = 15 Vdc, L = 300 μH,<br>R <sub>G</sub> = 20 Ω, T <sub>J</sub> = 125°C)<br>Energy losses include “tail” | t <sub>d(on)</sub>  | —                 | 32              | ns           |
| Rise Time                                                                                                                                                                                                                            |                                                                                                                                                                                 | t <sub>r</sub>      | —                 | 30              |              |
| Turn-Off Delay Time                                                                                                                                                                                                                  |                                                                                                                                                                                 | t <sub>d(off)</sub> | —                 | 208             |              |
| Fall Time                                                                                                                                                                                                                            |                                                                                                                                                                                 | t <sub>f</sub>      | —                 | 212             |              |
| Turn-Off Switching Loss                                                                                                                                                                                                              |                                                                                                                                                                                 | E <sub>off</sub>    | —                 | 0.63            | mJ           |
| Turn-On Switching Loss                                                                                                                                                                                                               |                                                                                                                                                                                 | E <sub>on</sub>     | —                 | 0.40            |              |
| Total Switching Loss                                                                                                                                                                                                                 |                                                                                                                                                                                 | E <sub>ts</sub>     | —                 | 1.03            |              |
| Gate Charge                                                                                                                                                                                                                          | (V <sub>CC</sub> = 360 Vdc, I <sub>C</sub> = 10 Adc,<br>V <sub>GE</sub> = 15 Vdc)                                                                                               | Q <sub>T</sub>      | —                 | 57              | nC           |
|                                                                                                                                                                                                                                      |                                                                                                                                                                                 | Q <sub>1</sub>      | —                 | 12              |              |
|                                                                                                                                                                                                                                      |                                                                                                                                                                                 | Q <sub>2</sub>      | —                 | 25              |              |
| DIODE CHARACTERISTICS                                                                                                                                                                                                                |                                                                                                                                                                                 |                     |                   |                 |              |
| Diode Forward Voltage Drop<br>(I <sub>EC</sub> = 5.0 Adc)<br>(I <sub>EC</sub> = 5.0 Adc, T <sub>J</sub> = 125°C)<br>(I <sub>EC</sub> = 10 Adc)                                                                                       | V <sub>FEC</sub>                                                                                                                                                                | —<br>—<br>1.7       | 1.6<br>1.3<br>2.0 | 1.9<br>—<br>2.3 | Vdc          |

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

(continued)

**ELECTRICAL CHARACTERISTICS — continued** ( $T_J = 25^\circ\text{C}$  unless otherwise noted)

| Characteristic                                                                                         | Symbol   | Min | Typ  | Max | Unit          |
|--------------------------------------------------------------------------------------------------------|----------|-----|------|-----|---------------|
| <b>DIODE CHARACTERISTICS — continued</b>                                                               |          |     |      |     |               |
| Reverse Recovery Time                                                                                  | $t_{rr}$ | —   | 75   | —   | ns            |
|                                                                                                        | $t_a$    | —   | 31   | —   |               |
|                                                                                                        | $t_b$    | —   | 44   | —   |               |
| Reverse Recovery Stored Charge                                                                         | $Q_{RR}$ | —   | 0.16 | —   | $\mu\text{C}$ |
| Reverse Recovery Time                                                                                  | $t_{rr}$ | —   | 139  | —   | ns            |
|                                                                                                        | $t_a$    | —   | 45   | —   |               |
|                                                                                                        | $t_b$    | —   | 94   | —   |               |
| Reverse Recovery Stored Charge                                                                         | $Q_{RR}$ | —   | 0.40 | —   | $\mu\text{C}$ |
| <b>INTERNAL PACKAGE INDUCTANCE</b>                                                                     |          |     |      |     |               |
| Internal Emitter Inductance<br>(Measured from the emitter lead 0.25" from package to emitter bond pad) | $L_E$    | —   | 7.5  | —   | nH            |


**Figure 1. Output Characteristics**

**Figure 2. Output Characteristics**

**Figure 3. Transfer Characteristics**

**Figure 4. Collector-To-Emitter Saturation Voltage versus Junction Temperature**

# MGW14N60ED

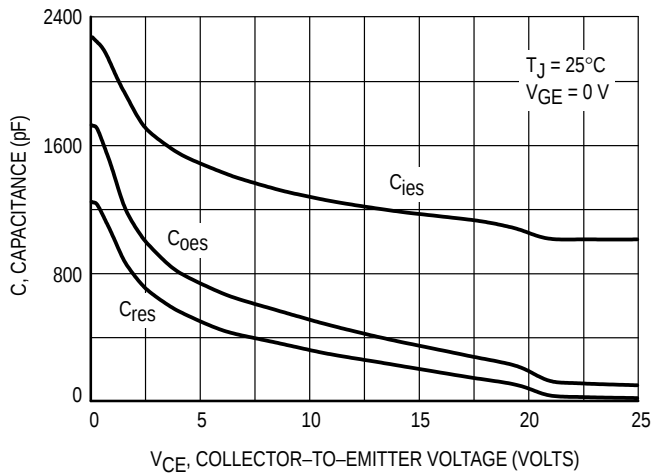


Figure 5. Capacitance Variation

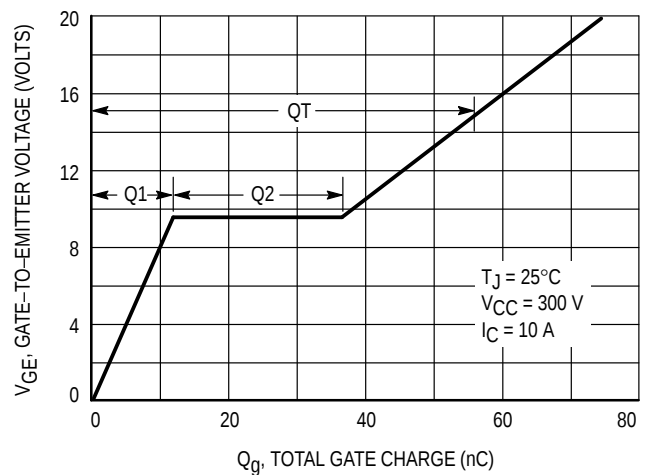


Figure 6. Gate-to-Emitter Voltage versus Total Charge

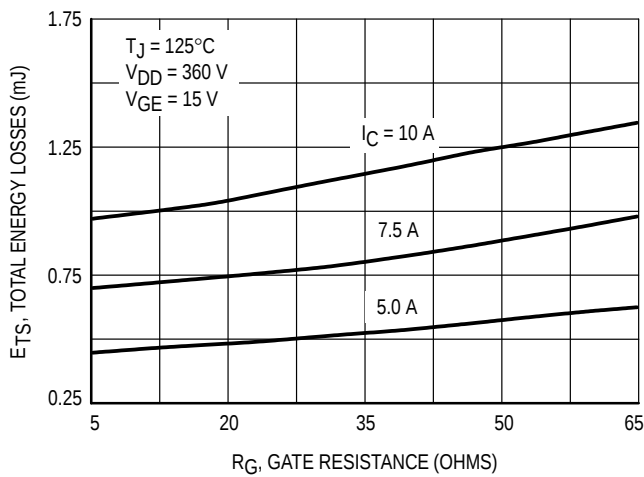


Figure 7. Total Energy Losses versus Gate Resistance

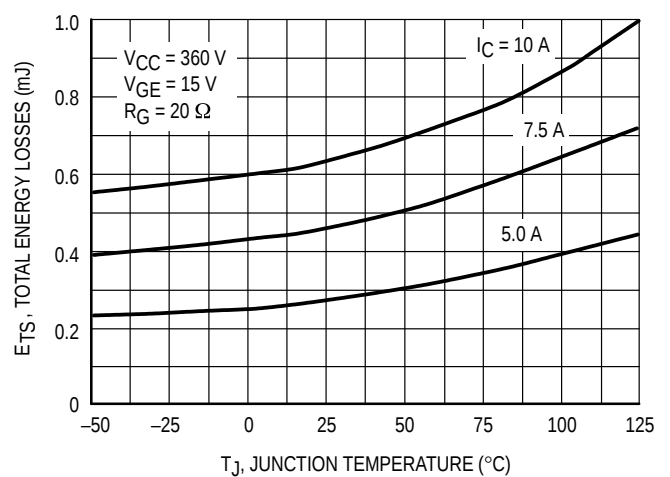


Figure 8. Total Energy Losses versus Junction Temperature

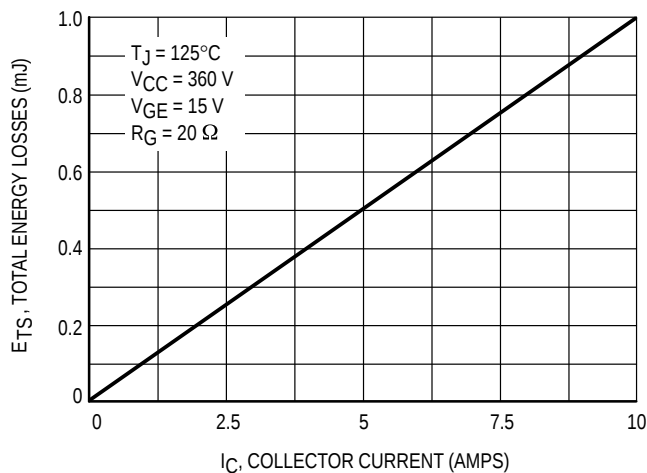


Figure 9. Total Energy Losses versus Collector Current

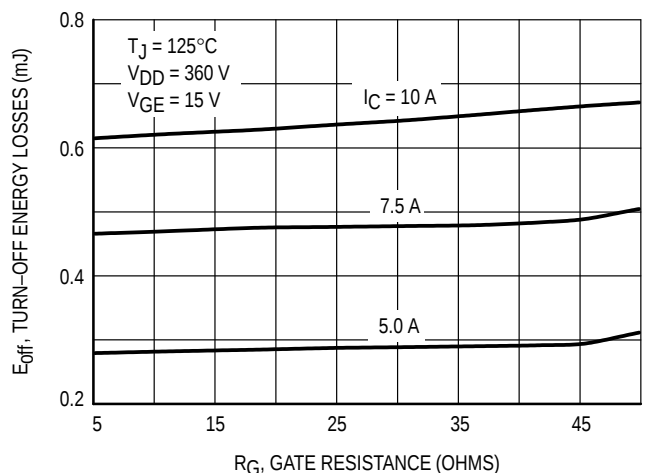


Figure 10. Turn-Off Energy Losses versus Gate Resistance

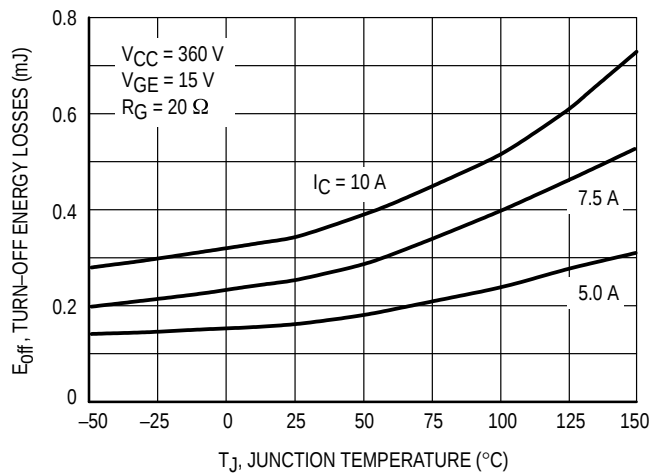


Figure 11. Turn-Off Energy Losses versus Junction Temperature

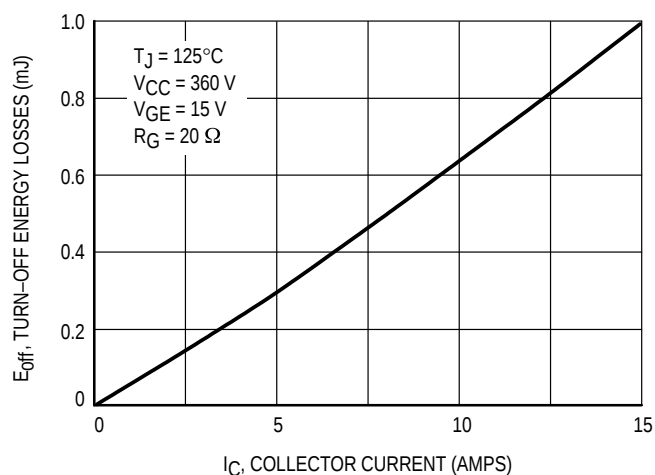


Figure 12. Turn-Off Energy Losses versus Collector Current

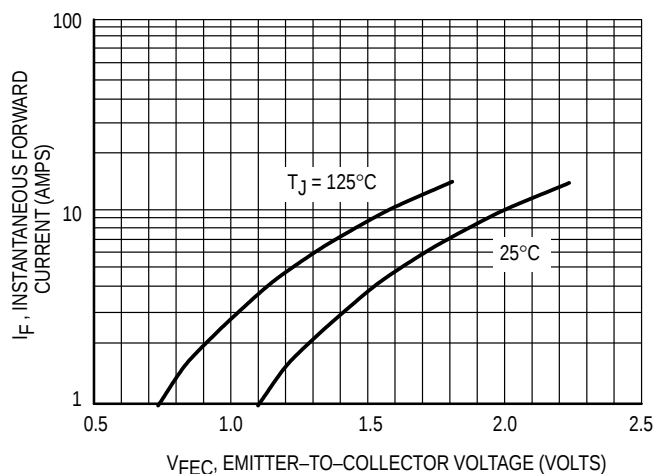


Figure 13. Forward Characteristics versus Current

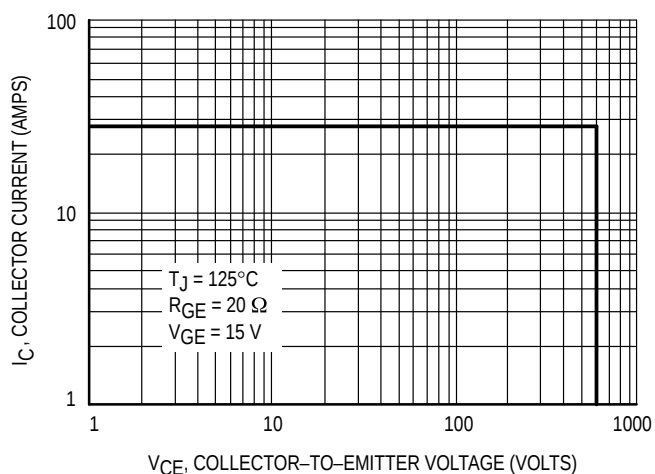
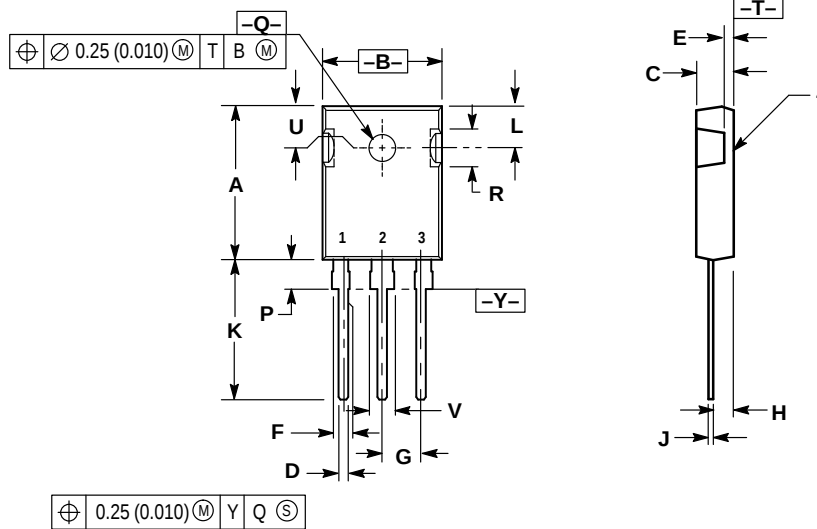


Figure 14. Reverse Biased Safe Operating Area

## PACKAGE DIMENSIONS



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

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | 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**  
**ISSUE A**

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