

# Designer's™ Data Sheet

## Insulated Gate Bipolar Transistor with Anti-Parallel Diode

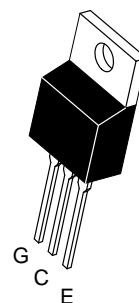
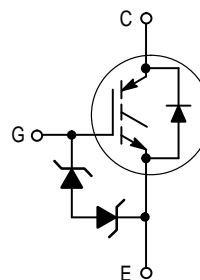
### N-Channel Enhancement-Mode Silicon Gate

**MGP11N60ED**

IGBT & DIODE IN TO-220  
11 A @ 90°C  
15 A @ 25°C  
600 VOLTS  
SHORT CIRCUIT RATED  
LOW 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 600 V 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 rugged short circuit device.

- Industry Standard TO-220 Package
- High Speed:  $E_{off} = 60 \mu J$  per Amp typical at 125°C
- High Voltage Short Circuit Capability – 10  $\mu s$  minimum at 125°C, 400 V
- Low On-Voltage — 2.0 V typical at 8.0 A
- Soft Recovery Free Wheeling Diode is included in the Package
- Robust High Voltage Termination
- ESD Protection Gate-Emitter Zener Diodes



CASE 221A-09  
STYLE 9  
TO-220AB

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

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	$V_{CES}$	600	Vdc
Collector-Gate Voltage ( $R_{GE} = 1.0 M\Omega$ )	$V_{CGR}$	600	Vdc
Gate-Emitter Voltage — Continuous	$V_{GE}$	$\pm 20$	Vdc
Collector Current — Continuous @ $T_C = 25^\circ C$ — Continuous @ $T_C = 90^\circ C$ — Repetitive Pulsed Current (1)	$I_{C25}$ $I_{C90}$ $I_{CM}$	15 11 22	Adc Apk
Total Power Dissipation @ $T_C = 25^\circ C$ Derate above 25°C	$P_D$	96 0.77	Watts W/°C
Operating and Storage Junction Temperature Range	$T_J, T_{stg}$	-55 to 150	°C
Short Circuit Withstand Time ( $V_{CC} = 400 Vdc, V_{GE} = 15 Vdc, T_J = 125^\circ C, R_G = 20 \Omega$ )	$t_{sc}$	10	$\mu s$
Thermal Resistance — Junction to Case — IGBT — Junction to Case — Diode — Junction to Ambient	$R_{\theta JC}$ $R_{\theta JD}$ $R_{\theta JA}$	1.3 2.3 65	°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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**MGP11N60ED****ELECTRICAL CHARACTERISTICS** ( $T_J = 25^\circ\text{C}$  unless otherwise noted)

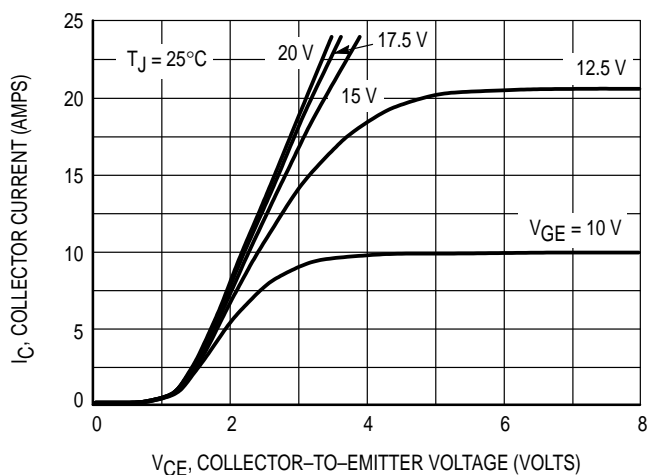
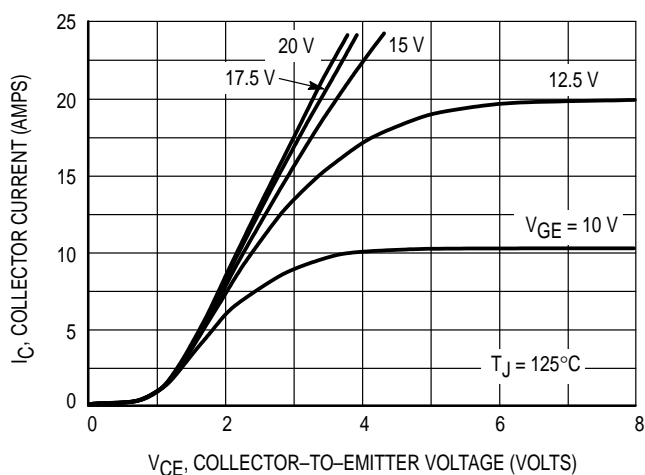
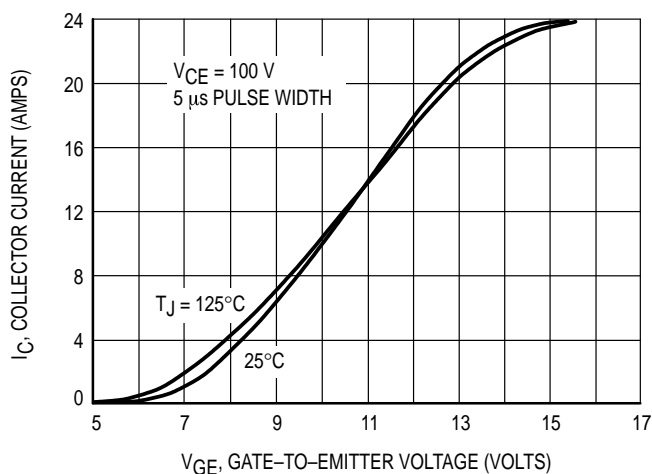
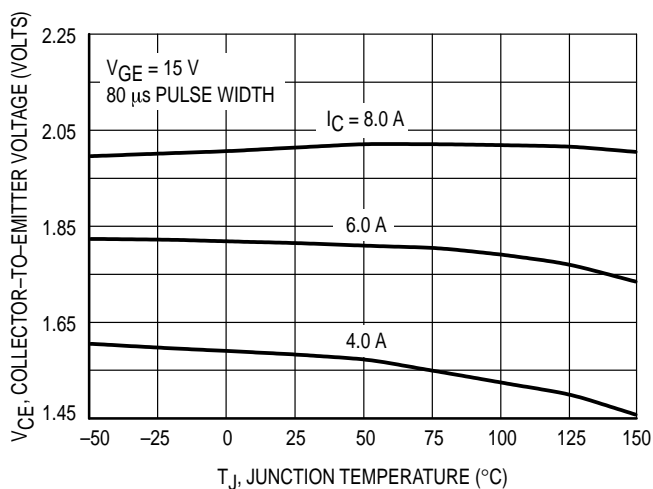
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-to-Emitter Breakdown Voltage ( $V_{GE} = 0\text{ Vdc}$ , $I_C = 250\text{ }\mu\text{Adc}$ ) Temperature Coefficient (Positive)	$V_{(BR)CES}$	600 —	— 870	— —	Vdc mV/°C
Zero Gate Voltage Collector Current ( $V_{CE} = 600\text{ Vdc}$ , $V_{GE} = 0\text{ Vdc}$ ) ( $V_{CE} = 600\text{ Vdc}$ , $V_{GE} = 0\text{ Vdc}$ , $T_J = 125^\circ\text{C}$ )	$I_{CES}$	— —	— —	10 200	$\mu\text{Adc}$
Gate-Body Leakage Current ( $V_{GE} = \pm 20\text{ Vdc}$ , $V_{CE} = 0\text{ Vdc}$ )	$I_{GES}$	—	—	50	$\mu\text{Adc}$
ON CHARACTERISTICS (1)					
Collector-to-Emitter On-State Voltage ( $V_{GE} = 15\text{ Vdc}$ , $I_C = 4.0\text{ Adc}$ ) ( $V_{GE} = 15\text{ Vdc}$ , $I_C = 4.0\text{ Adc}$ , $T_J = 125^\circ\text{C}$ ) ( $V_{GE} = 15\text{ Vdc}$ , $I_C = 8.0\text{ Adc}$ )	$V_{CE(on)}$	— — —	1.6 1.5 2.0	1.9 — 2.4	Vdc
Gate Threshold Voltage ( $V_{CE} = V_{GE}$ , $I_C = 1.0\text{ mAdc}$ ) Threshold Temperature Coefficient (Negative)	$V_{GE(th)}$	4.0 —	6.0 10	8.0 —	Vdc mV/°C
Forward Transconductance ( $V_{CE} = 10\text{ Vdc}$ , $I_C = 8.0\text{ Adc}$ )	$g_{fe}$	—	3.5	—	Mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance	$(V_{CE} = 25\text{ Vdc}$ , $V_{GE} = 0\text{ Vdc}$ , $f = 1.0\text{ MHz}$ )	$C_{ies}$	—	779	pF
Output Capacitance		$C_{oes}$	—	81	
Transfer Capacitance		$C_{res}$	—	13	
SWITCHING CHARACTERISTICS (1)					
Turn-On Delay Time	$(V_{CC} = 360\text{ Vdc}$ , $I_C = 8.0\text{ Adc}$ , $V_{GE} = 15\text{ Vdc}$ , $L = 300\text{ }\mu\text{H}$ , $R_G = 20\text{ }\Omega$ ) Energy losses include “tail”	$t_{d(on)}$	—	46	ns
Rise Time		$t_r$	—	34	
Turn-Off Delay Time		$t_{d(off)}$	—	102	
Fall Time		$t_f$	—	226	
Turn-Off Switching Loss		$E_{off}$	—	0.32	mJ
Turn-On Switching Loss		$E_{on}$	—	0.11	
Total Switching Loss		$E_{ts}$	—	0.43	
Turn-On Delay Time	$(V_{CC} = 360\text{ Vdc}$ , $I_C = 8.0\text{ Adc}$ , $V_{GE} = 15\text{ Vdc}$ , $L = 300\text{ }\mu\text{H}$ , $R_G = 20\text{ }\Omega$ , $T_J = 125^\circ\text{C}$ ) Energy losses include “tail”	$t_{d(on)}$	—	42	ns
Rise Time		$t_r$	—	26	
Turn-Off Delay Time		$t_{d(off)}$	—	214	
Fall Time		$t_f$	—	228	
Turn-Off Switching Loss		$E_{off}$	—	0.48	mJ
Turn-On Switching Loss		$E_{on}$	—	0.16	
Total Switching Loss		$E_{ts}$	—	0.64	
Gate Charge	$(V_{CC} = 360\text{ Vdc}$ , $I_C = 8.0\text{ Adc}$ , $V_{GE} = 15\text{ Vdc}$ )	$Q_T$	—	39.2	nC
		$Q_1$	—	8.7	
		$Q_2$	—	17.4	
DIODE CHARACTERISTICS					
Diode Forward Voltage Drop ( $I_{EC} = 3.25\text{ Adc}$ ) ( $I_{EC} = 3.25\text{ Adc}$ , $T_J = 125^\circ\text{C}$ ) ( $I_{EC} = 6.5\text{ Adc}$ )	$V_{FEC}$	— — 1.7	1.63 1.24 2.0	— — 2.3	Vdc

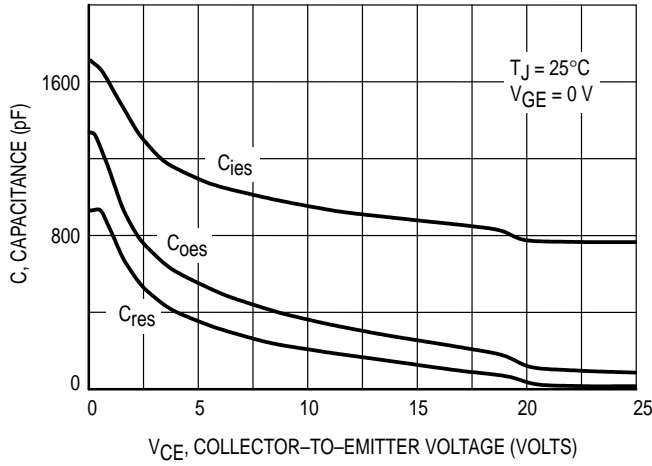
(1) Pulse Test: Pulse Width  $\leq 300\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

(continued)

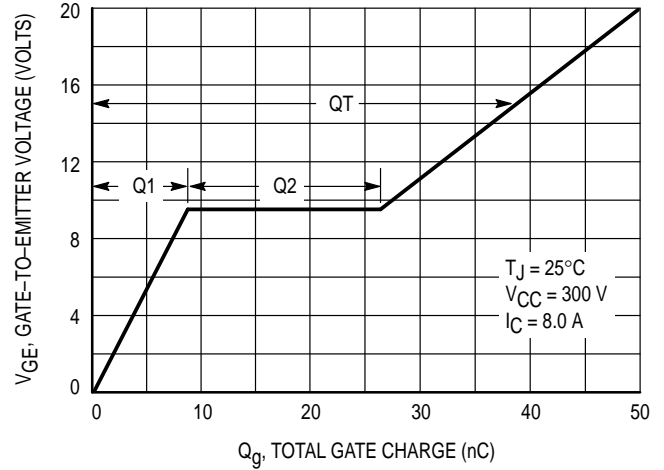
**ELECTRICAL CHARACTERISTICS — continued** ( $T_J = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>DIODE CHARACTERISTICS — continued</b>					
Reverse Recovery Time	$t_{rr}$	—	57	—	ns
	$t_a$	—	18	—	
	$t_b$	—	39	—	
Reverse Recovery Stored Charge	$Q_{RR}$	—	107	—	$\mu\text{C}$
Reverse Recovery Time	$t_{rr}$	—	91	—	ns
	$t_a$	—	28	—	
	$t_b$	—	63	—	
Reverse Recovery Stored Charge	$Q_{RR}$	—	275	—	$\mu\text{C}$
<b>INTERNAL PACKAGE INDUCTANCE</b>					
Internal Emitter Inductance (Measured from the emitter lead 0.25" from package to emitter bond pad)	$L_E$	—	7.5	—	nH

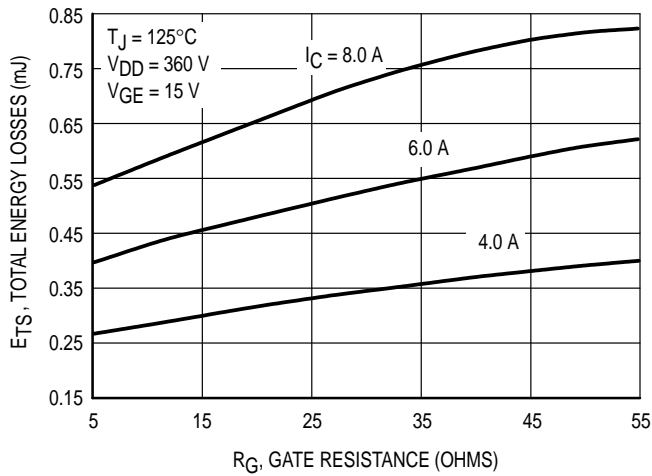
**Figure 1. Output Characteristics****Figure 2. Output Characteristics****Figure 3. Transfer Characteristics****Figure 4. Collector-to-Emitter Saturation Voltage versus Junction Temperature**



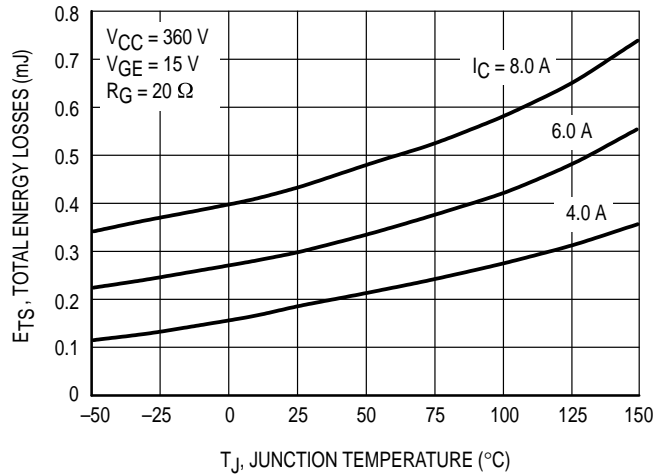
**Figure 5. Capacitance Variation**



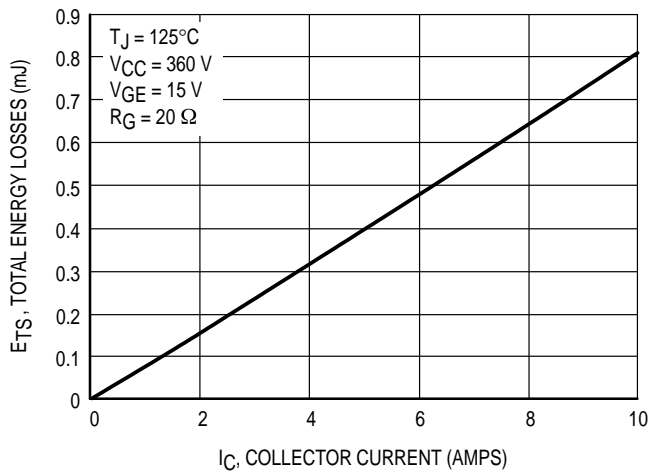
**Figure 6. Gate-To-Emitter Voltage versus Total Charge**



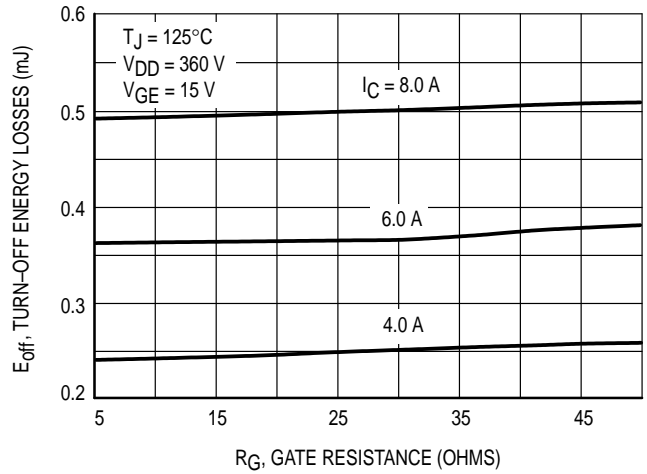
**Figure 7. Total Energy Losses versus Gate Resistance**



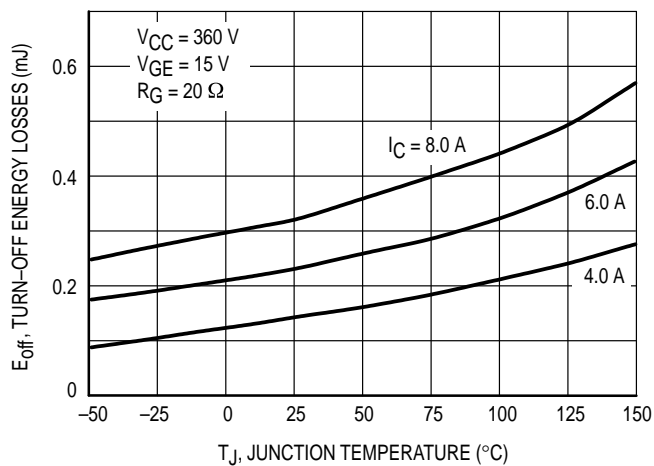
**Figure 8. Total Energy Losses versus Junction Temperature**



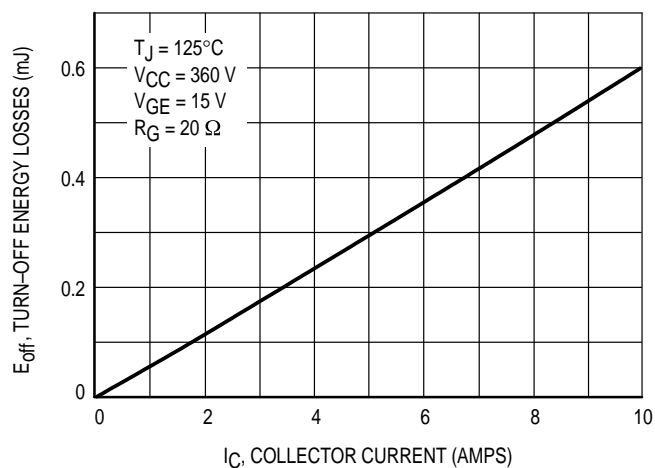
**Figure 9. Total Energy Losses versus Collector Current**



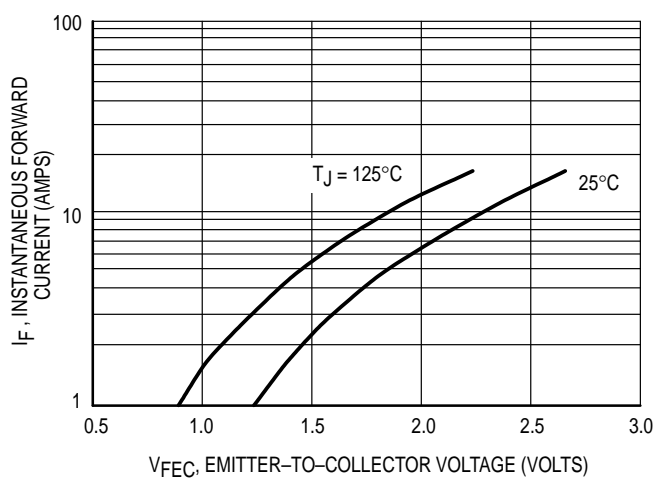
**Figure 10. Turn-Off Losses versus Gate Resistance**



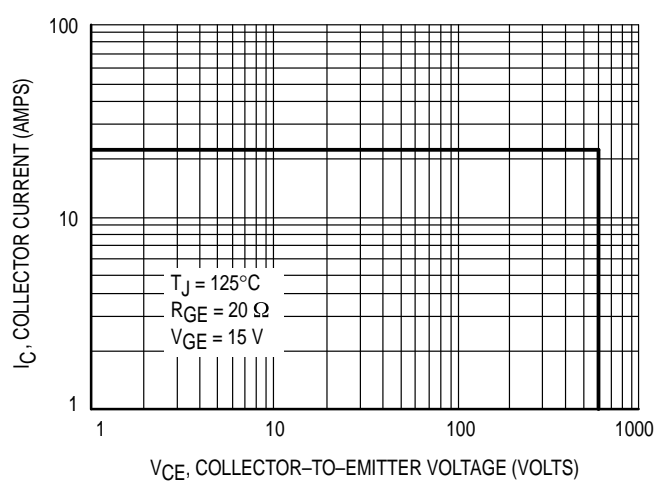
**Figure 11. Turn-Off Losses versus Junction Temperature**



**Figure 12. Turn-Off Losses versus Collector Current**

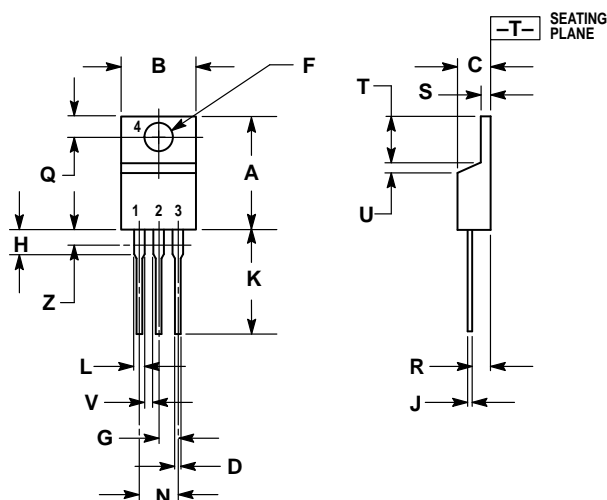


**Figure 13. Forward Characteristics versus Current**



**Figure 14. Reverse Biased Safe Operating Area**

## PACKAGE DIMENSIONS



## NOTES:


1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.570	0.620	14.48	15.75
B	0.380	0.405	9.66	10.28
C	0.160	0.190	4.07	4.82
D	0.025	0.035	0.64	0.88
F	0.142	0.147	3.61	3.73
G	0.095	0.105	2.42	2.66
H	0.110	0.155	2.80	3.93
J	0.018	0.025	0.46	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.060	1.15	1.52
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.110	2.04	2.79
S	0.045	0.055	1.15	1.39
T	0.235	0.255	5.97	6.47
U	0.000	0.050	0.00	1.27
V	0.045	—	1.15	—
Z	—	0.080	—	2.04

**CASE 221A-09  
TO-220AB  
ISSUE Z**

## STYLE 9:

- PIN 1: GATE  
2: COLLECTOR  
3: EMITTER  
4: COLLECTOR

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