

# Designer's™ Data Sheet

## Insulated Gate Bipolar Transistor with Anti-Parallel Diode

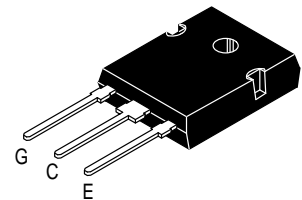
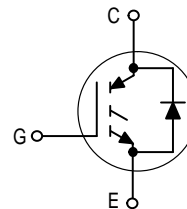
### N-Channel Enhancement-Mode Silicon Gate

**MGW20N60D**  
Motorola Preferred Device

IGBT & DIODE IN TO-247  
20 A @ 90°C  
32 A @ 25°C  
600 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 operations 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  $E_{off}$ : 60  $\mu$ J per Amp typical at 125°C
- High Short Circuit Capability – 10  $\mu$ s minimum
- Soft Recovery Free Wheeling Diode is included in the package
- Robust High Voltage Termination
- Robust RBSOA



CASE 340F-03, Style 4  
TO-247AE

**MAXIMUM RATINGS** ( $T_C = 25^\circ\text{C}$  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 @ $T_C = 25^\circ\text{C}$ — Continuous @ $T_C = 90^\circ\text{C}$ — Repetitive Pulsed Current (1)	$I_{C25}$ $I_{C90}$ $I_{CM}$	32 20 64	Adc Apk
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	142 1.14	Watts W/°C
Operating and Storage Junction Temperature Range	$T_J, T_{stg}$	-55 to 150	°C
Short Circuit Withstand Time ( $V_{CC} = 360 \text{ Vdc}$ , $V_{GE} = 15 \text{ Vdc}$ , $T_J = 25^\circ\text{C}$ , $R_G = 20 \Omega$ )	$t_{sc}$	10	$\mu$ s
Thermal Resistance — Junction to Case – IGBT — Junction to Case – Diode — Junction to Ambient	$R_{\theta JC}$ $R_{\theta Jc}$ $R_{\theta JA}$	0.88 2.00 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.

**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.

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

# MGW20N60D

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

Characteristic	Symbol	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>					
Collector-to-Emitter Breakdown Voltage (V <sub>GE</sub> = 0 Vdc, I <sub>C</sub> = 250 μAdc) Temperature Coefficient (Positive)	BV <sub>CES</sub>	600 —	— 870	— —	Vdc mV/°C
Zero Gate Voltage Collector Current (V <sub>CE</sub> = 600 Vdc, V <sub>GE</sub> = 0 Vdc) (V <sub>CE</sub> = 600 Vdc, V <sub>GE</sub> = 0 Vdc, T <sub>J</sub> = 125°C)	I <sub>CES</sub>	— —	— —	100 2500	μAdc
Gate-Body Leakage Current (V <sub>GE</sub> = ± 20 Vdc, V <sub>CE</sub> = 0 Vdc)	I <sub>GES</sub>	—	—	250	nAdc

## ON CHARACTERISTICS (1)

Collector-to-Emitter On-State Voltage (V <sub>GE</sub> = 15 Vdc, I <sub>C</sub> = 10 Adc) (V <sub>GE</sub> = 15 Vdc, I <sub>C</sub> = 10 Adc, T <sub>J</sub> = 125°C) (V <sub>GE</sub> = 15 Vdc, I <sub>C</sub> = 20 Adc)	V <sub>CE(on)</sub>	— — —	2.30 2.20 2.85	2.85 — 3.65	Vdc
Gate Threshold Voltage (V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1 mAdc) Threshold Temperature Coefficient (Negative)	V <sub>GE(th)</sub>	4.0 —	6.0 10	8.0 —	Vdc mV/°C
Forward Transconductance (V <sub>CE</sub> = 10 Vdc, I <sub>C</sub> = 20 Adc)	g <sub>fe</sub>	—	12	—	Mhos

## DYNAMIC CHARACTERISTICS

Input Capacitance	(V <sub>CE</sub> = 25 Vdc, V <sub>GE</sub> = 0 Vdc, f = 1.0 MHz)	C <sub>ies</sub>	—	2280	—	pF
Output Capacitance		C <sub>oes</sub>	—	165	—	
Transfer Capacitance		C <sub>res</sub>	—	12	—	

## SWITCHING CHARACTERISTICS (1)

Turn-On Delay Time	(V <sub>CC</sub> = 360 Vdc, I <sub>C</sub> = 20 Adc, V <sub>GE</sub> = 15 Vdc, L = 300 μH R <sub>G</sub> = 20 Ω, T <sub>J</sub> = 25°C) Energy losses include "tail"	t <sub>d(on)</sub>	—	59	—	ns
Rise Time		t <sub>r</sub>	—	61	—	
Turn-Off Delay Time		t <sub>d(off)</sub>	—	150	—	
Fall Time		t <sub>f</sub>	—	212	—	mJ
Turn-Off Switching Loss		E <sub>off</sub>	—	0.60	0.85	
Turn-On Switching Loss		E <sub>on</sub>	—	0.75	—	
Total Switching Loss		E <sub>ts</sub>	—	1.35	—	
Turn-On Delay Time	(V <sub>CC</sub> = 360 Vdc, I <sub>C</sub> = 20 Adc, V <sub>GE</sub> = 15 Vdc, L = 300 μH R <sub>G</sub> = 20 Ω, T <sub>J</sub> = 125°C) Energy losses include "tail"	t <sub>d(on)</sub>	—	51	—	ns
Rise Time		t <sub>r</sub>	—	77	—	
Turn-Off Delay Time		t <sub>d(off)</sub>	—	184	—	
Fall Time		t <sub>f</sub>	—	392	—	mJ
Turn-Off Switching Loss		E <sub>off</sub>	—	1.20	—	
Turn-On Switching Loss		E <sub>on</sub>	—	1.50	—	
Total Switching Loss		E <sub>ts</sub>	—	2.70	—	
Gate Charge	(V <sub>CC</sub> = 360 Vdc, I <sub>C</sub> = 20 Adc, V <sub>GE</sub> = 15 Vdc)	Q <sub>T</sub>	—	74	—	nC
		Q <sub>1</sub>	—	19	—	
		Q <sub>2</sub>	—	27	—	

## DIODE CHARACTERISTICS

Diode Forward Voltage Drop (I <sub>EC</sub> = 10 Adc) (I <sub>EC</sub> = 10 Adc, T <sub>J</sub> = 125°C) (I <sub>EC</sub> = 20 Adc)	V <sub>FEC</sub>	— — —	1.50 1.30 1.70	1.90 — 2.15	Vdc
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(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	$(I_F = 20 \text{ A dc}, V_R = 360 \text{ V dc}, dI_F/dt = 200 \text{ A}/\mu\text{s})$	$t_{rr}$	—	117	—	ns
		$t_a$	—	70	—	
		$t_b$	—	47	—	
Reverse Recovery Stored Charge	$Q_{RR}$	—	1.2	—	$\mu\text{C}$	
Reverse Recovery Time	$(I_F = 20 \text{ A dc}, V_R = 360 \text{ V dc}, dI_F/dt = 200 \text{ A}/\mu\text{s}, T_J = 125^\circ\text{C})$	$t_{rr}$	—	166	—	ns
		$t_a$	—	98	—	
		$t_b$	—	68	—	
Reverse Recovery Stored Charge	$Q_{RR}$	—	1.9	—	$\mu\text{C}$	
<b>INTERNAL PACKAGE INDUCTANCE</b>						
Internal Emitter Inductance (Measured from the emitter lead 0.25" from package to emitter bond pad)	$L_E$	—	13	—	nH	

**TYPICAL ELECTRICAL CHARACTERISTICS**

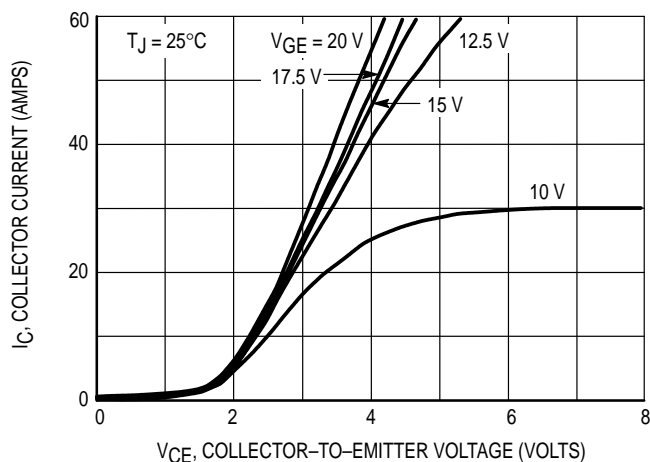


Figure 1. Output Characteristics,  $T_J = 25^\circ\text{C}$

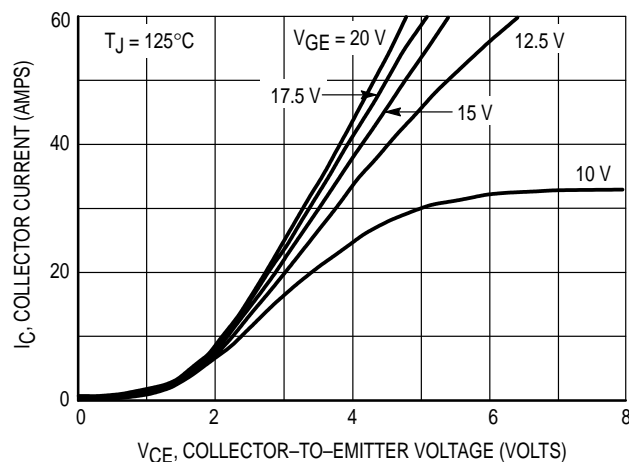


Figure 2. Output Characteristics,  $T_J = 125^\circ\text{C}$

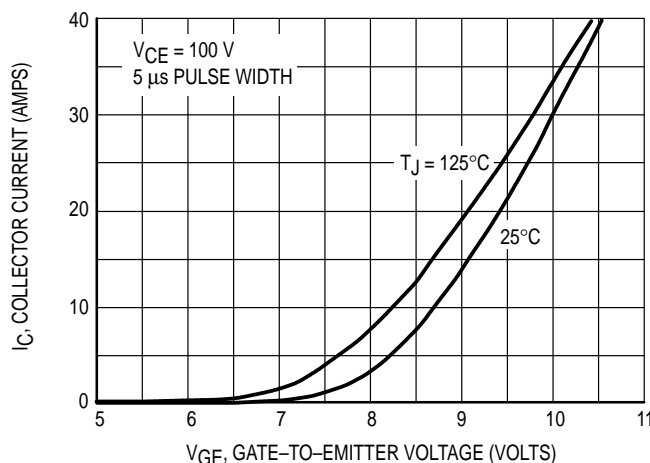


Figure 3. Transfer Characteristics

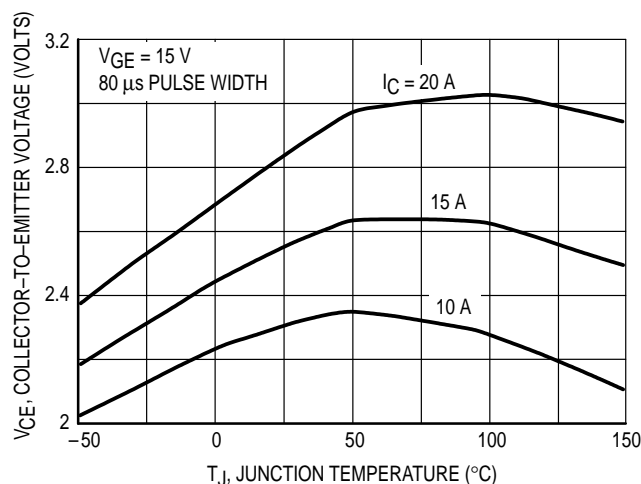
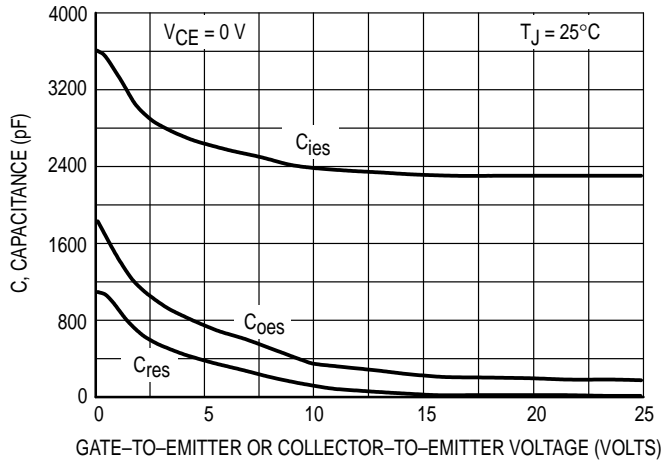
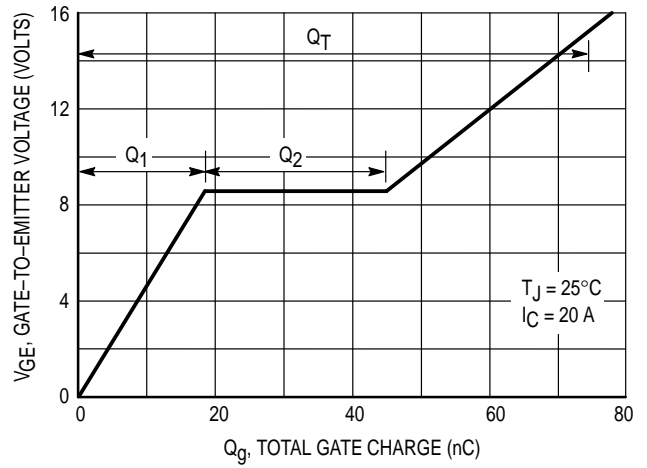


Figure 4. Collector-to-Emitter Saturation Voltage versus Junction Temperature

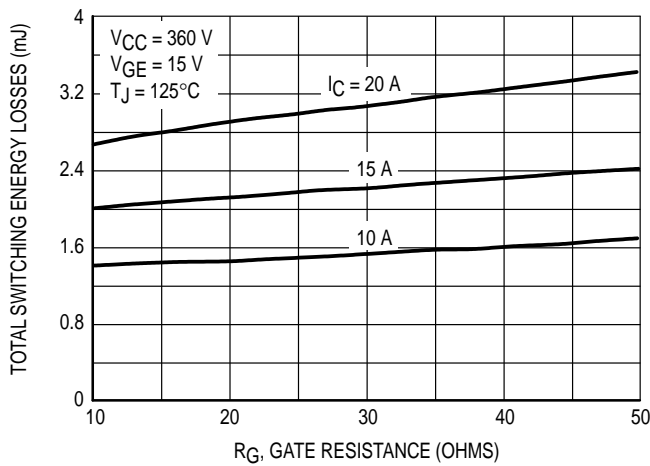
# MGW20N60D



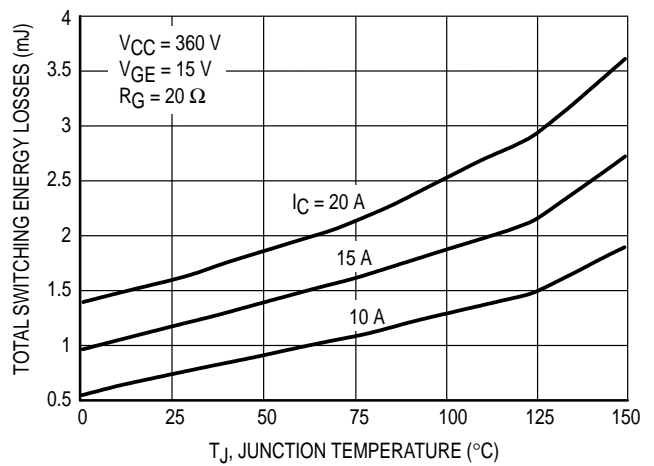
**Figure 5. Capacitance Variation**



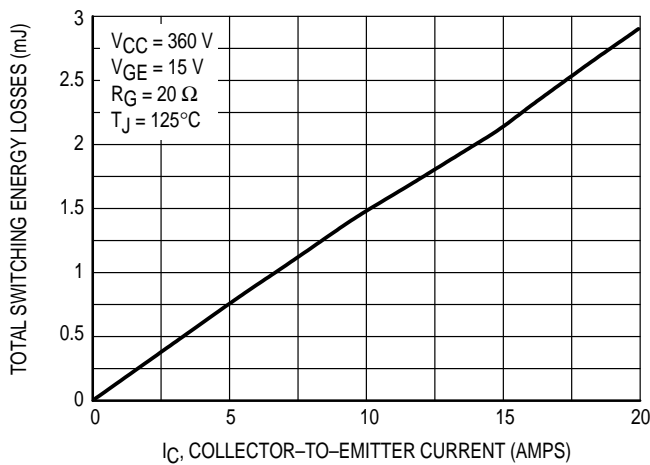
**Figure 6. Gate-to-Emitter Voltage versus Total Charge**



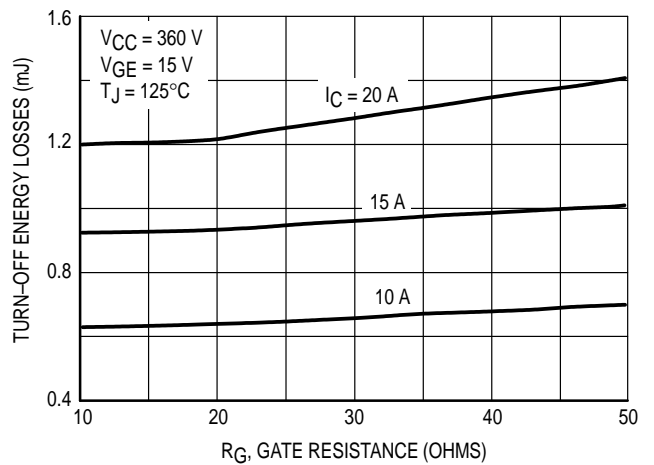
**Figure 7. Total Switching Losses versus Gate Resistance**



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



**Figure 9. Total Switching Losses versus Collector-to-Emitter Current**



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

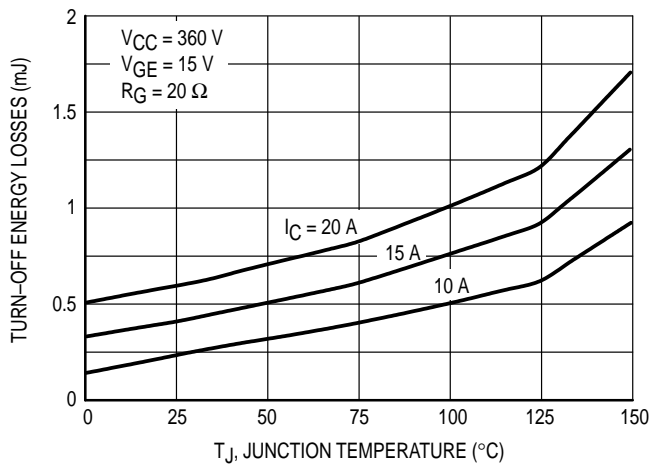


Figure 11. Turn-Off Losses versus Junction Temperature

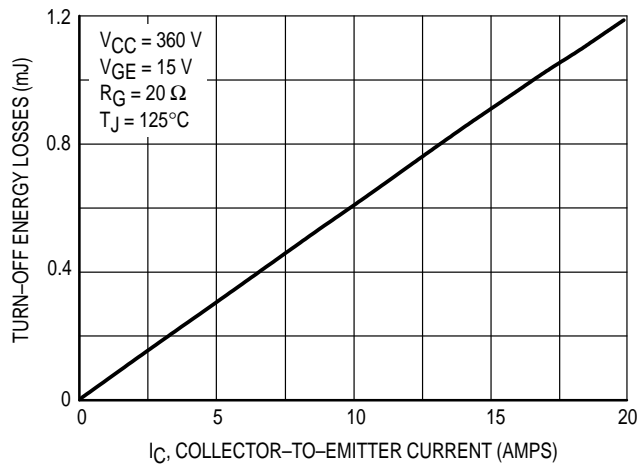


Figure 12. Turn-Off Losses versus Collector-to-Emitter Current

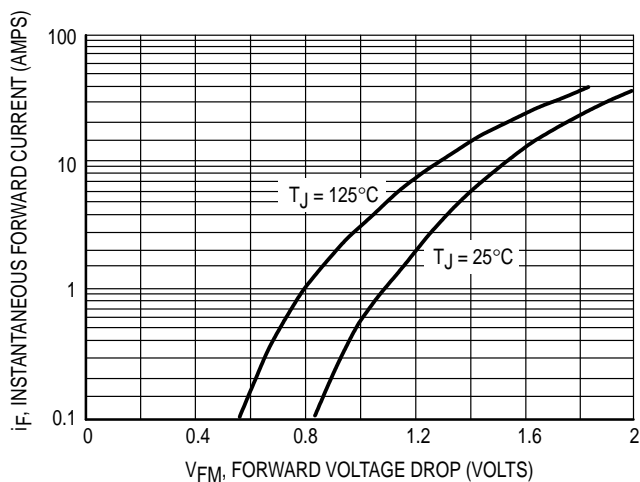


Figure 13. Typical Diode Forward Drop versus Instantaneous Forward Current

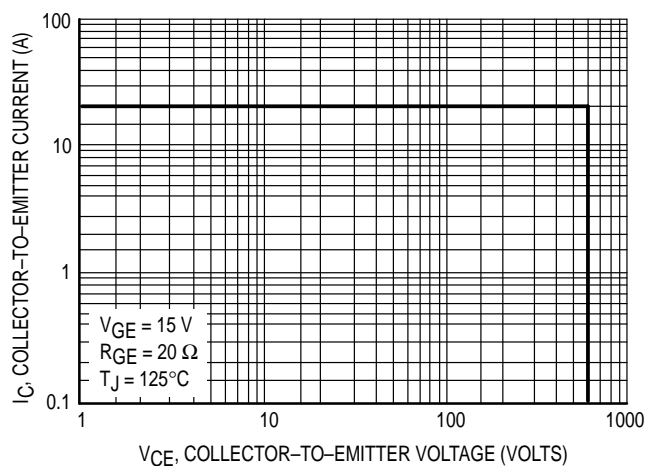
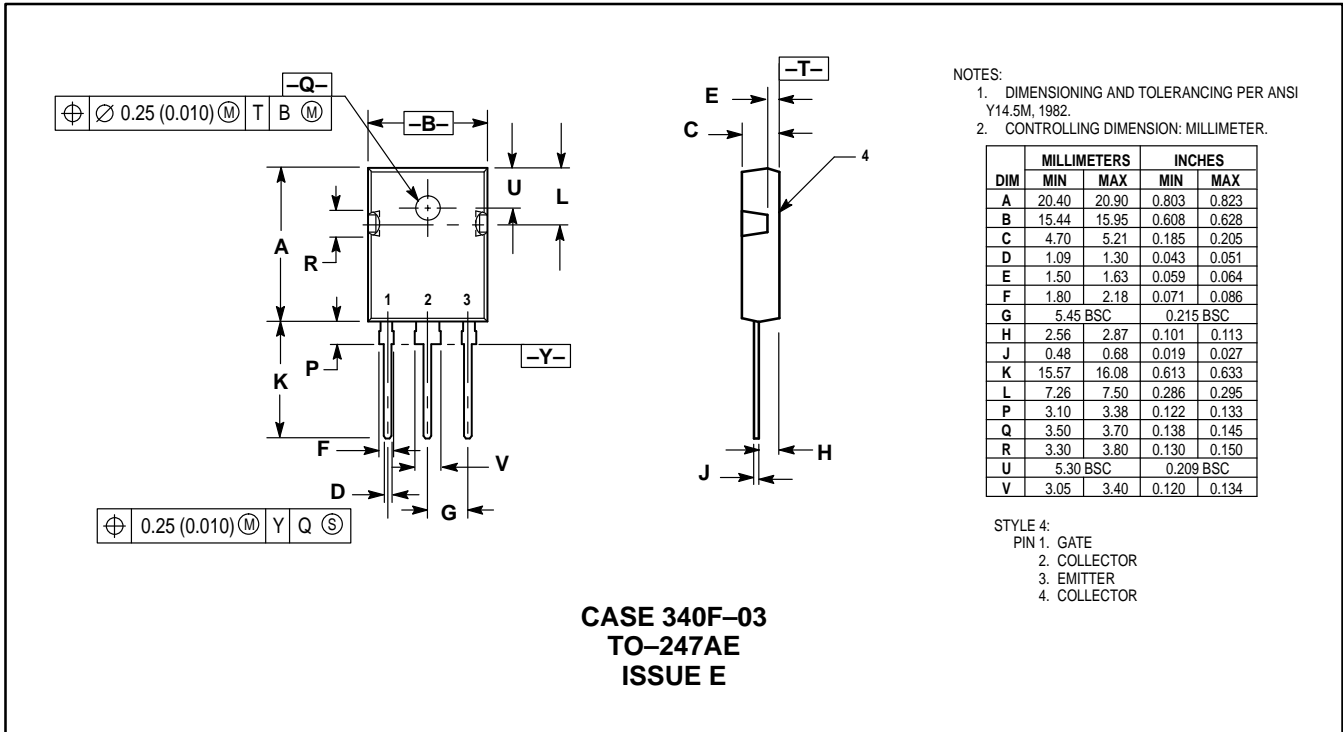


Figure 14. Reverse Biased Safe Operating Area

PACKAGE DIMENSIONS



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

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.40	20.90	0.803	0.823
B	15.44	15.95	0.608	0.628
C	4.70	5.21	0.185	0.205
D	1.09	1.30	0.043	0.051
E	1.50	1.63	0.059	0.064
F	1.80	2.18	0.071	0.086
G	5.45 BSC		0.215 BSC	
H	2.56	2.87	0.101	0.113
J	0.48	0.68	0.019	0.027
K	15.57	16.08	0.613	0.633
L	7.26	7.50	0.286	0.295
P	3.10	3.38	0.122	0.133
Q	3.50	3.70	0.138	0.145
R	3.30	3.80	0.130	0.150
U	5.30 BSC		0.209 BSC	
V	3.05	3.40	0.120	0.134

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

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