

Designer's™ Data Sheet

Insulated Gate Bipolar Transistor with Anti-Parallel Diode

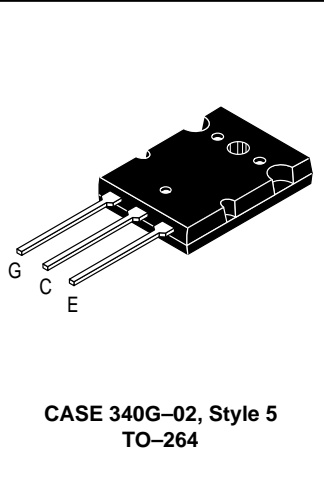
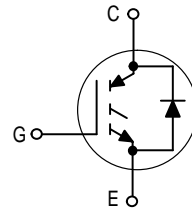
N-Channel Enhancement-Mode Silicon Gate

MGY40N60D
Motorola Preferred Device

IGBT & DIODE IN TO-264
40 A @ 90°C
66 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-264 Package (TO-3PBL)
- High Speed E_{off} : 60 μ J per Amp typical at 125°C
- High Short Circuit Capability – 10 μ s minimum
- Soft Recovery Free Wheeling Diode is included in the package
- Robust High Voltage Termination
- Robust RBSOA



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}	± 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}	66 40 132	Adc Apk
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	260 2.08	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	μ s
Thermal Resistance — Junction to Case – IGBT — Junction to Case – Diode — Junction to Ambient	$R_{\theta JC}$ $R_{\theta JD}$ $R_{\theta JA}$	0.48 1.13 35	°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.

MGY40N60D

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 = 250 μAdc) Temperature Coefficient (Positive)	BV _{CES}	600 —	— 870	— —	Vdc mV/°C
Zero Gate Voltage Collector Current (V _{CE} = 600 Vdc, V _{GE} = 0 Vdc) (V _{CE} = 600 Vdc, V _{GE} = 0 Vdc, T _J = 125°C)	I _{CES}	— —	— —	100 2500	μAdc
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 = 20 Adc) (V _{GE} = 15 Vdc, I _C = 20 Adc, T _J = 125°C) (V _{GE} = 15 Vdc, I _C = 40 Adc)	V _{CE(on)}	— — —	2.20 2.10 2.60	2.80 — 3.25	Vdc
Gate Threshold Voltage (V _{CE} = V _{GE} , I _C = 1 mAdc) Threshold Temperature Coefficient (Negative)	V _{GE(th)}	4.0 —	6.0 10	8.0 —	Vdc mV/°C
Forward Transconductance (V _{CE} = 10 Vdc, I _C = 40 Adc)	g _{fe}	—	12	—	Mhos

DYNAMIC CHARACTERISTICS

Input Capacitance	(V _{CE} = 25 Vdc, V _{GE} = 0 Vdc, f = 1.0 MHz)	C _{ies}	—	6810	—	pF
Output Capacitance		C _{oes}	—	464	—	
Transfer Capacitance		C _{res}	—	15	—	

SWITCHING CHARACTERISTICS (1)

Turn-On Delay Time	(V _{CC} = 360 Vdc, I _C = 40 Adc, V _{GE} = 15 Vdc, L = 300 μH R _G = 20 Ω, T _J = 25°C) Energy losses include "tail"	t _{d(on)}	—	126	—	ns
Rise Time		t _r	—	95	—	
Turn-Off Delay Time		t _{d(off)}	—	530	—	
Fall Time		t _f	—	180	—	mJ
Turn-Off Switching Loss		E _{off}	—	1.50	2.10	
Turn-On Switching Loss		E _{on}	—	2.30	—	
Total Switching Loss		E _{ts}	—	3.80	—	
Turn-On Delay Time	(V _{CC} = 360 Vdc, I _C = 40 Adc, V _{GE} = 15 Vdc, L = 300 μH R _G = 20 Ω, T _J = 125°C) Energy losses include "tail"	t _{d(on)}	—	113	—	ns
Rise Time		t _r	—	104	—	
Turn-Off Delay Time		t _{d(off)}	—	588	—	
Fall Time		t _f	—	346	—	mJ
Turn-Off Switching Loss		E _{off}	—	2.70	—	
Turn-On Switching Loss		E _{on}	—	3.80	—	
Total Switching Loss		E _{ts}	—	6.50	—	
Gate Charge	(V _{CC} = 360 Vdc, I _C = 40 Adc, V _{GE} = 15 Vdc)	Q _T	—	248	—	nC
		Q ₁	—	49	—	
		Q ₂	—	81	—	

DIODE CHARACTERISTICS

Diode Forward Voltage Drop (I _{EC} = 20 Adc) (I _{EC} = 20 Adc, T _J = 125°C) (I _{EC} = 40 Adc)	V _{FEC}	— — —	1.19 1.04 1.36	1.70 — 2.00	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	
DIODE CHARACTERISTICS — continued						
Reverse Recovery Time	$(I_F = 40 \text{ A dc}, V_R = 360 \text{ V dc}, dI_F/dt = 200 \text{ A}/\mu\text{s})$	t_{rr}	—	138	—	ns
		t_a	—	78	—	
		t_b	—	60	—	
Reverse Recovery Stored Charge	Q_{RR}	—	2.1	—	μC	
Reverse Recovery Time	$(I_F = 40 \text{ A dc}, V_R = 360 \text{ V dc}, dI_F/dt = 200 \text{ A}/\mu\text{s}, T_J = 125^\circ\text{C})$	t_{rr}	—	213	—	ns
		t_a	—	122	—	
		t_b	—	91	—	
Reverse Recovery Stored Charge	Q_{RR}	—	4.9	—	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

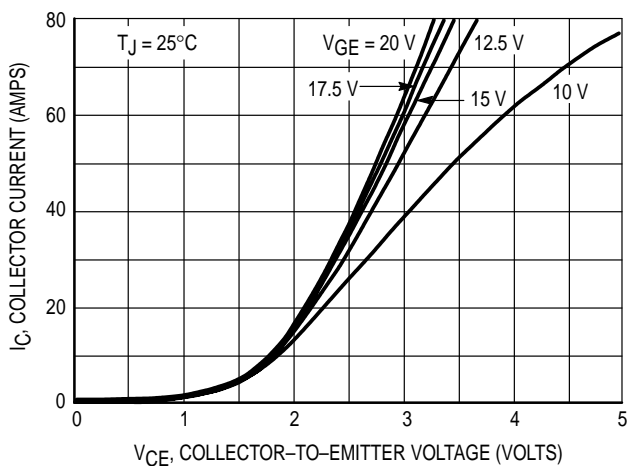


Figure 1. Output Characteristics, $T_J = 25^\circ\text{C}$

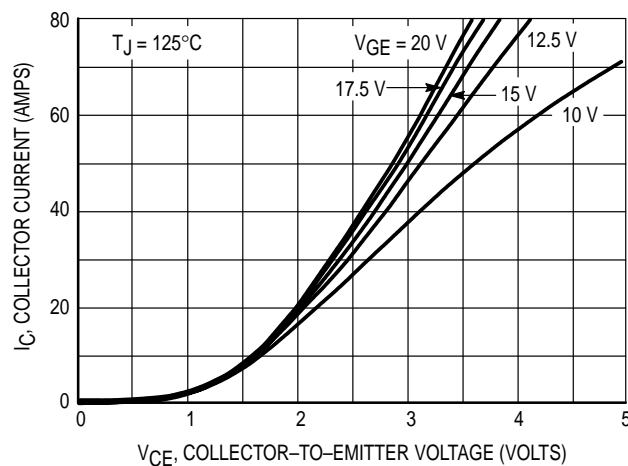


Figure 2. Output Characteristics, $T_J = 125^\circ\text{C}$

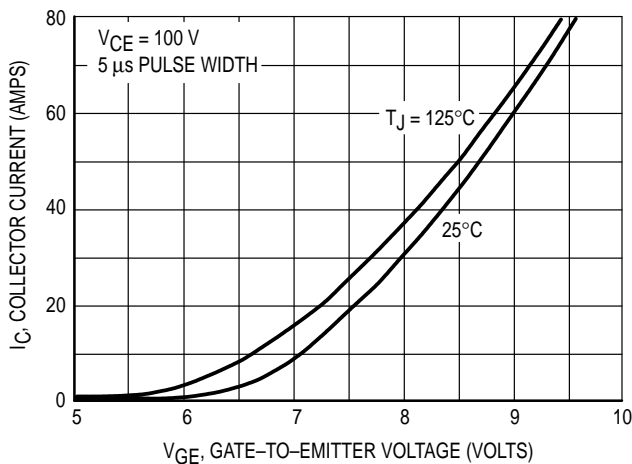


Figure 3. Transfer Characteristics

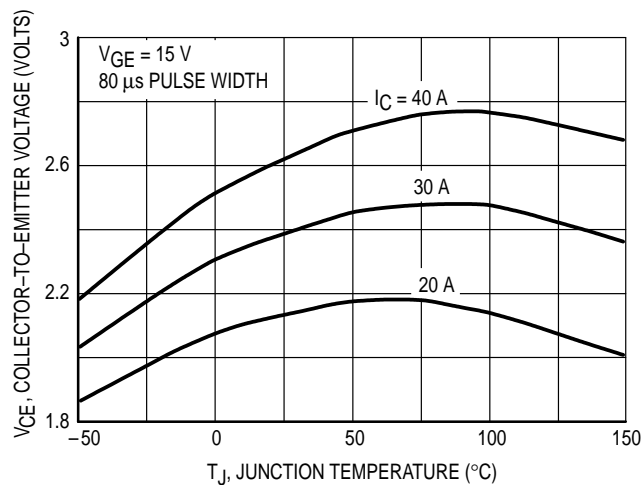


Figure 4. Collector-to-Emitter Saturation Voltage versus Junction Temperature

MGY40N60D

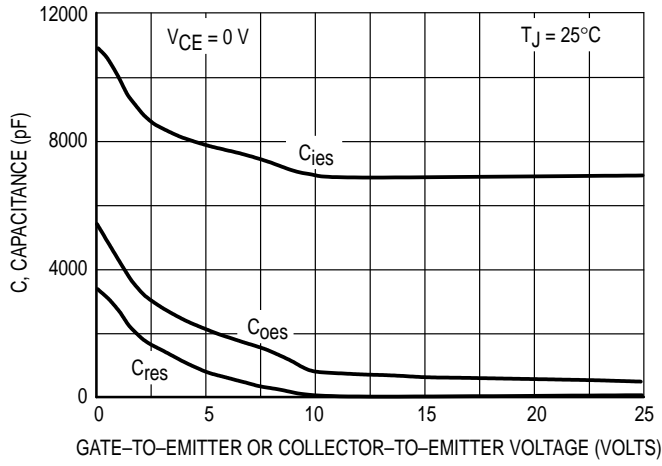


Figure 5. Capacitance Variation

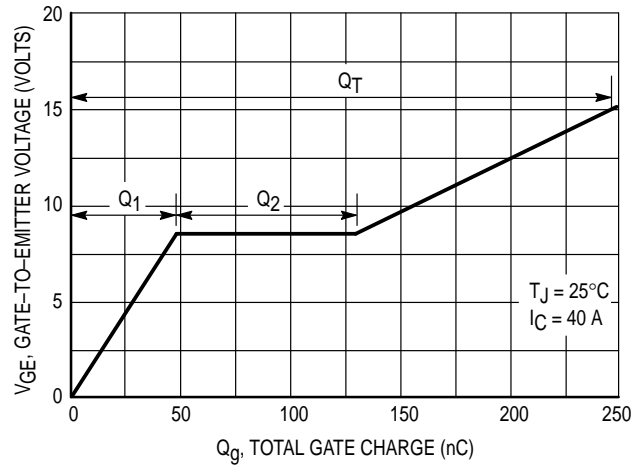


Figure 6. Gate-to-Emitter Voltage versus Total Charge

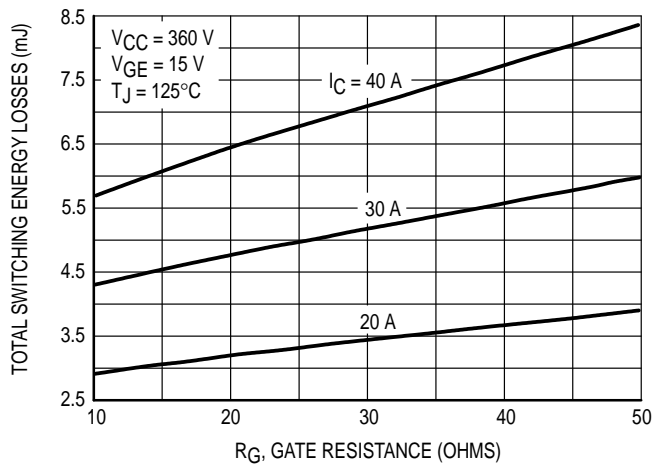


Figure 7. Total Switching Losses versus Gate Resistance

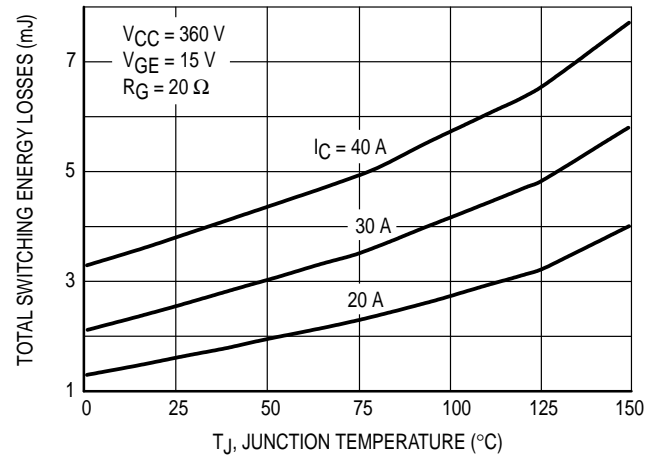


Figure 8. Total Switching Losses versus Junction Temperature

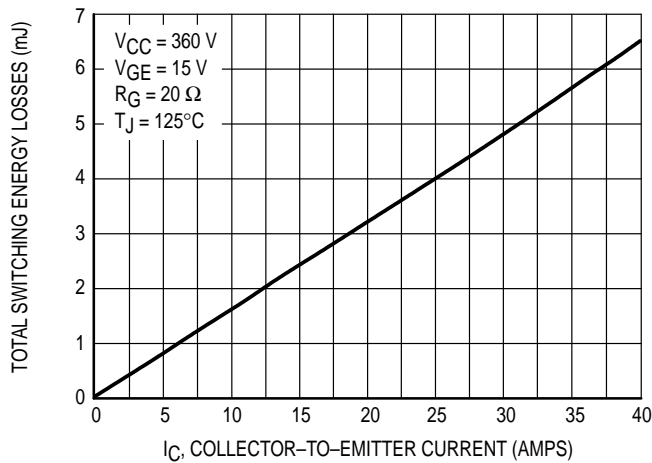


Figure 9. Total Switching Losses versus Collector-to-Emitter Current

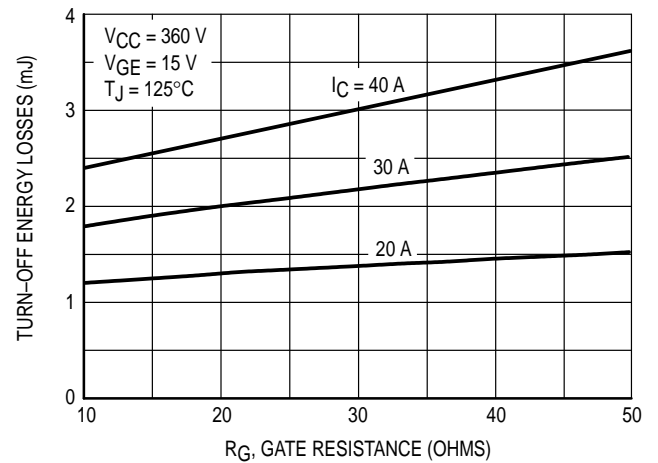


Figure 10. Turn-Off Losses versus Gate Resistance

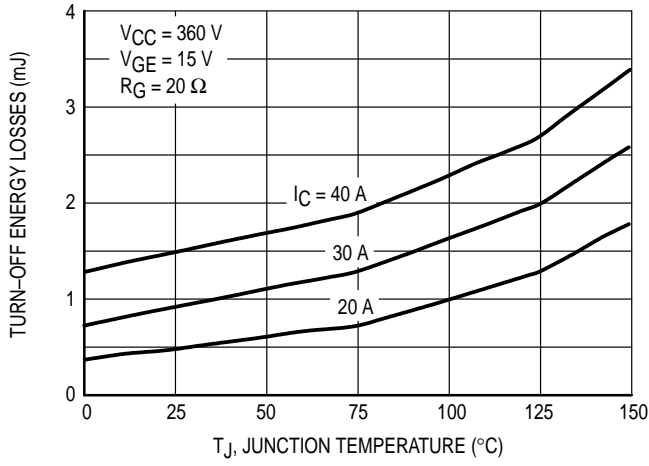


Figure 11. Turn-Off Losses versus Junction Temperature

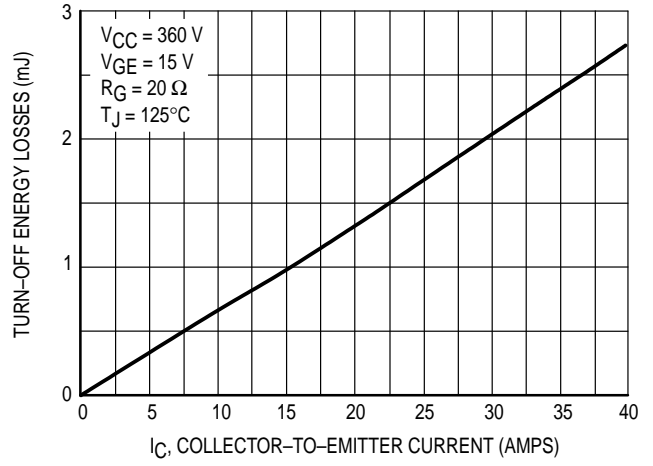


Figure 12. Turn-Off Losses versus Collector-to-Emitter Current

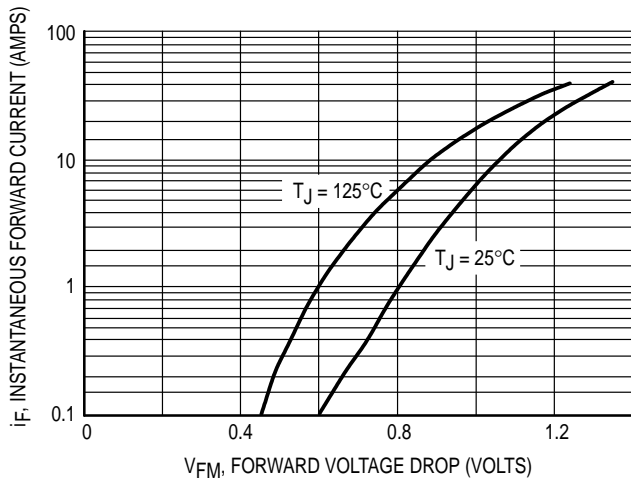


Figure 13. Typical Diode Forward Drop versus Instantaneous Forward Current

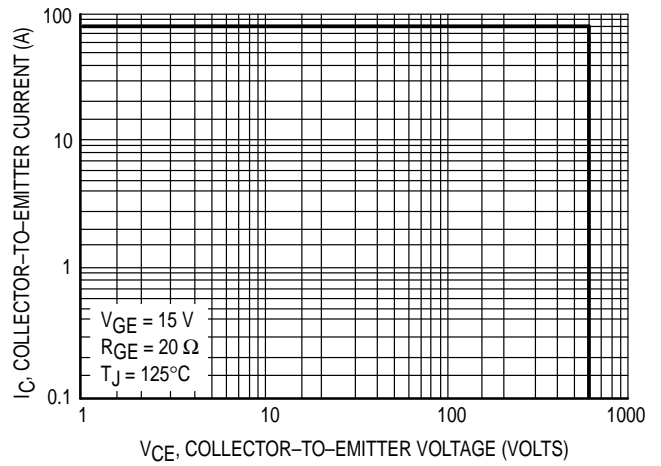
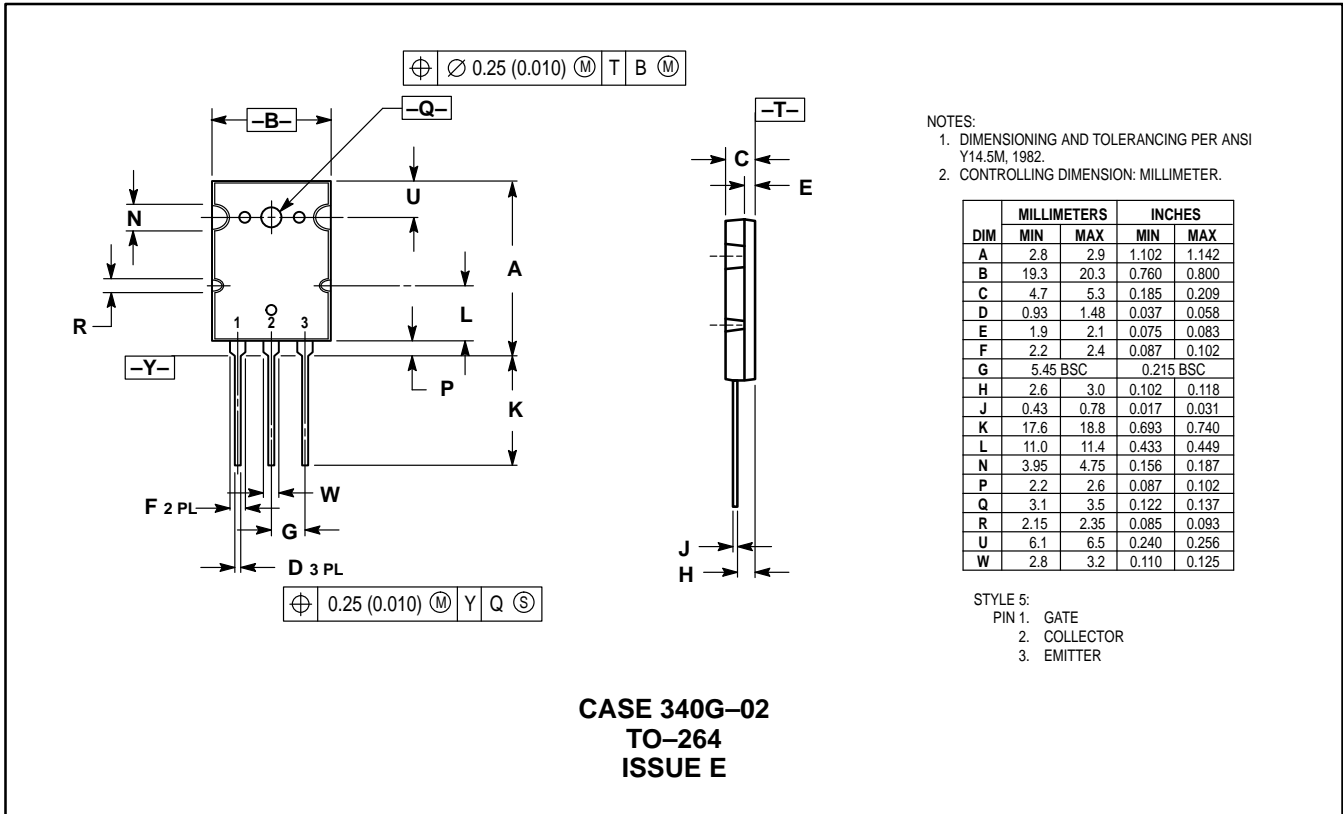


Figure 14. Reverse Biased Safe Operating Area

PACKAGE DIMENSIONS



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