

# Designer's™ Data Sheet

## Insulated Gate Bipolar Transistor with Anti-Parallel Diode

### N-Channel Enhancement-Mode Silicon Gate

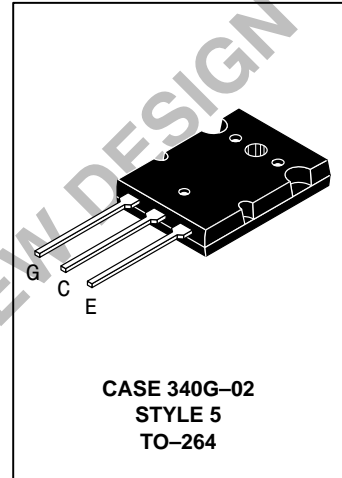
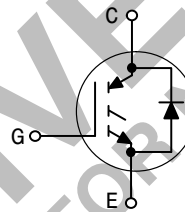
**MGY20N120D**

Motorola Preferred Device

IGBT & DIODE IN TO-264  
20 A @ 90°C  
28 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-264 Package (TO-3PBL)
- High Speed  $E_{off}$ : 160  $\mu$ 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



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

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	$V_{CES}$	1200	Vdc
Collector-Gate Voltage ( $R_{GE} = 1.0 \text{ M}\Omega$ )	$V_{CGR}$	1200	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)	$I_{C25}$ $I_{C90}$ $I_{CM}$	28 20 56	Adc Adc Apk
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	$P_D$	174 1.39	Watts W/°C
Operating and Storage Junction Temperature Range	$T_J, T_{stg}$	-55 to 150	°C
Short Circuit Withstand Time ( $V_{CC} = 720 \text{ Vdc}$ , $V_{GE} = 15 \text{ Vdc}$ , $T_J = 125^\circ\text{C}$ , $R_G = 20 \Omega$ )	$t_{sc}$	10	$\mu$ s
Thermal Resistance — Junction to Case – IGBT — Junction to Case – Diode — Junction to Ambient	$R_{\theta JC}$ $R_{\theta JC}$ $R_{\theta JA}$	0.7 1.1 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. 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 2

# MGY20N120D

## 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> = 25 μAdc) Temperature Coefficient (Positive)	V <sub>(BR)CES</sub>	1200 —	— 870	— —	Vdc mV/°C
Zero Gate Voltage Collector Current (V <sub>CE</sub> = 1200 Vdc, V <sub>GE</sub> = 0 Vdc) (V <sub>CE</sub> = 1200 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>	— — —	2.42 2.36 2.90	3.54 — 4.99	Vdc
Gate Threshold Voltage (V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1.0 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>	—	1876	—	pF
Output Capacitance		C <sub>oes</sub>	—	208	—	
Transfer Capacitance		C <sub>res</sub>	—	31	—	

## SWITCHING CHARACTERISTICS (1)

Turn-On Delay Time	(V <sub>CC</sub> = 720 Vdc, I <sub>C</sub> = 20 Adc, V <sub>GE</sub> = 15 Vdc, L = 300 μH R <sub>G</sub> = 20 Ω) Energy losses include "tail"	t <sub>d(on)</sub>	—	88	—	ns
Rise Time		t <sub>r</sub>	—	103	—	
Turn-Off Delay Time		t <sub>d(off)</sub>	—	190	—	
Fall Time		t <sub>f</sub>	—	284	—	mJ
Turn-Off Switching Loss		E <sub>off</sub>	—	1.65	2.75	
Turn-On Switching Loss		E <sub>on</sub>	—	2.42	3.75	
Total Switching Loss		E <sub>ts</sub>	—	4.07	6.50	
Turn-On Delay Time	(V <sub>CC</sub> = 720 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>	—	83	—	ns
Rise Time		t <sub>r</sub>	—	107	—	
Turn-Off Delay Time		t <sub>d(off)</sub>	—	216	—	
Fall Time		t <sub>f</sub>	—	494	—	mJ
Turn-Off Switching Loss		E <sub>off</sub>	—	3.19	—	
Turn-On Switching Loss		E <sub>on</sub>	—	4.26	—	
Total Switching Loss		E <sub>ts</sub>	—	7.45	—	
Gate Charge	(V <sub>CC</sub> = 720 Vdc, I <sub>C</sub> = 20 Adc, V <sub>GE</sub> = 15 Vdc)	Q <sub>T</sub>	—	63	—	nC
		Q <sub>1</sub>	—	20	—	
		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>	— — —	2.92 1.73 3.67	3.59 — 4.57	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	$(I_F = 20 \text{ Adc}, V_R = 720 \text{ Vdc}, \text{d}I_F/\text{d}t = 150 \text{ A}/\mu\text{s})$	$t_{rr}$	—	114	—	ns
		$t_a$	—	74	—	
		$t_b$	—	40	—	
Reverse Recovery Stored Charge	$Q_{RR}$	—	0.68	—	$\mu\text{C}$	
Reverse Recovery Time	$(I_F = 20 \text{ Adc}, V_R = 720 \text{ Vdc}, \text{d}I_F/\text{d}t = 150 \text{ A}/\mu\text{s}, T_J = 125^\circ\text{C})$	$t_{rr}$	—	224	—	ns
		$t_a$	—	149	—	
		$t_b$	—	75	—	
Reverse Recovery Stored Charge	$Q_{RR}$	—	2.40	—	$\mu\text{C}$	
<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**

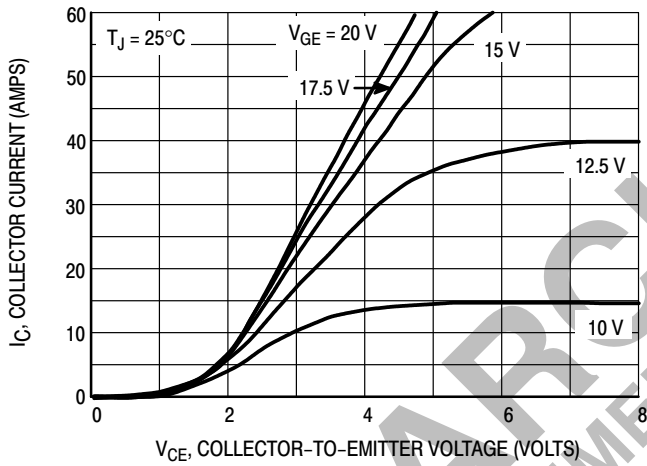


Figure 1. Output Characteristics

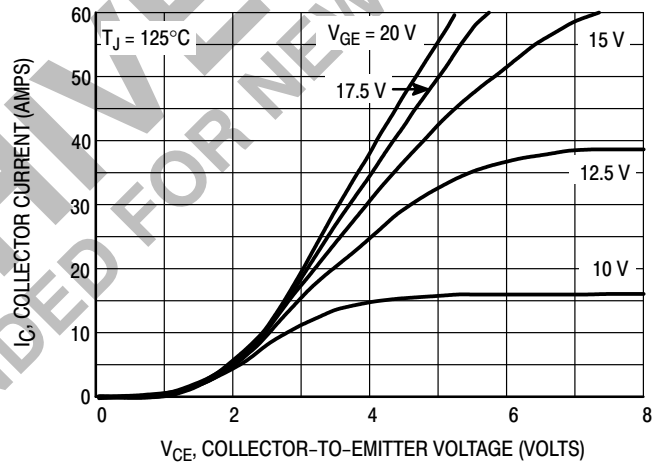


Figure 2. Output Characteristics

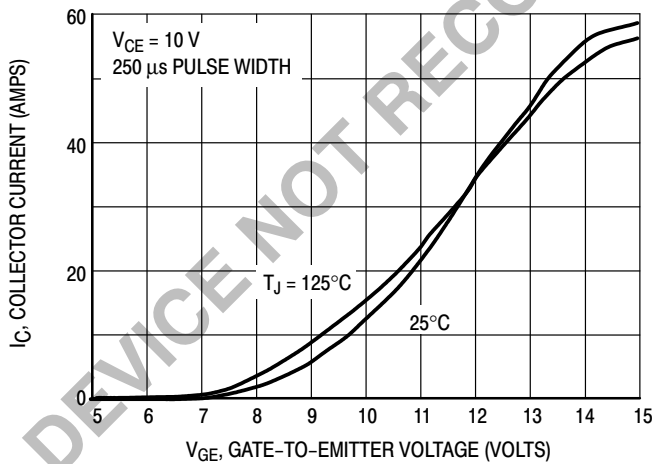


Figure 3. Transfer Characteristics

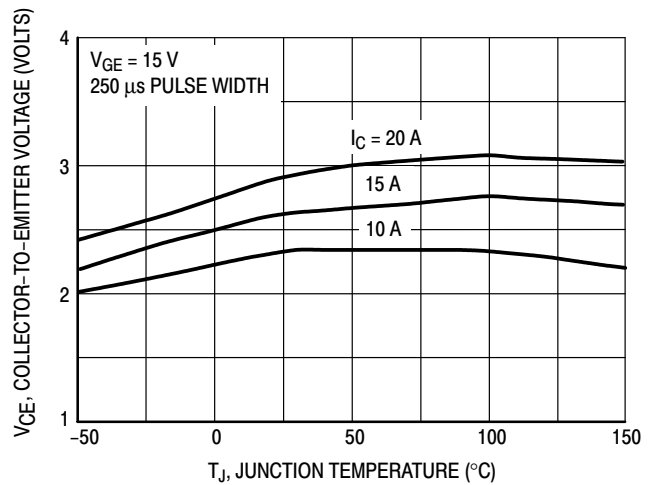
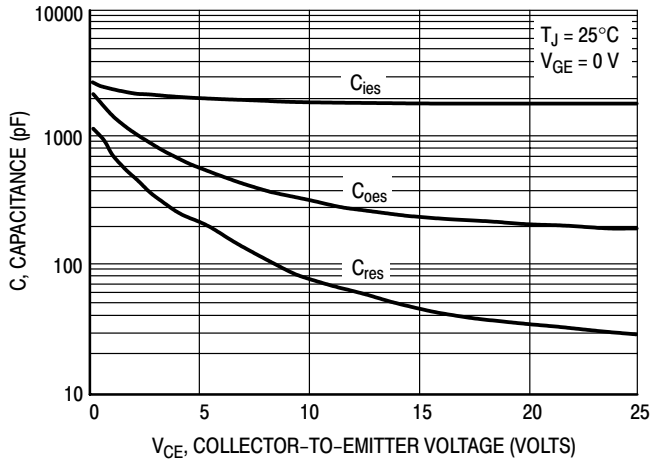
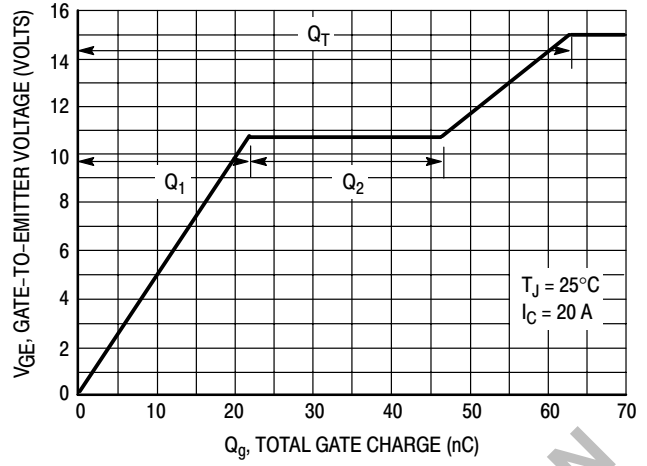


Figure 4. Collector-to-Emitter Saturation Voltage versus Junction Temperature

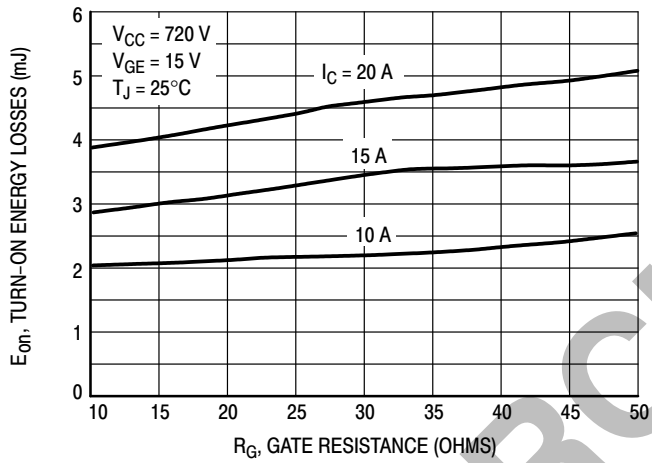
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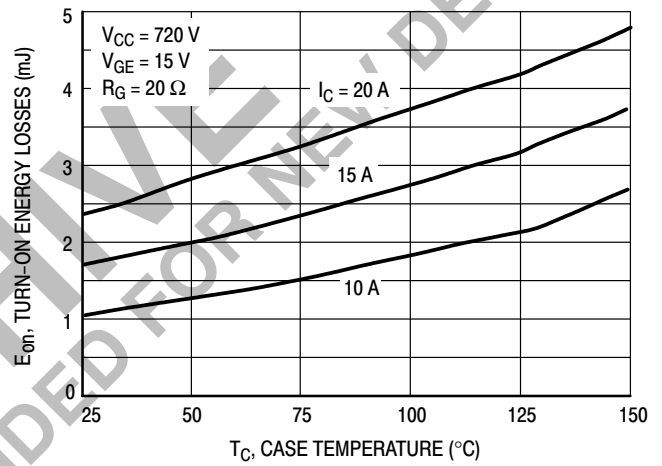
**Figure 5. Capacitance Variation**



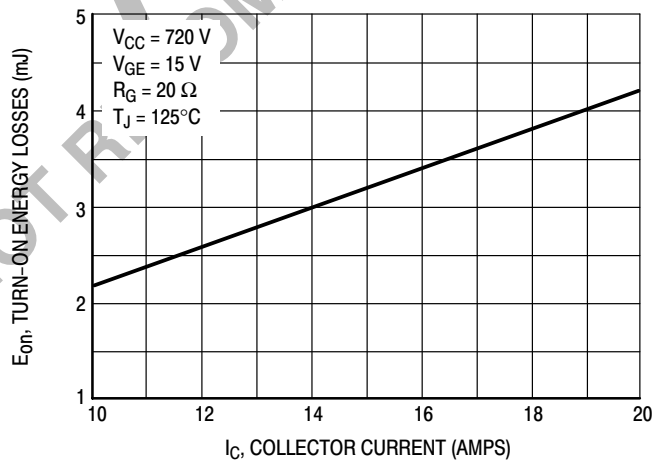
**Figure 6. Gate-to-Emitter Voltage versus Total Charge**



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



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



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

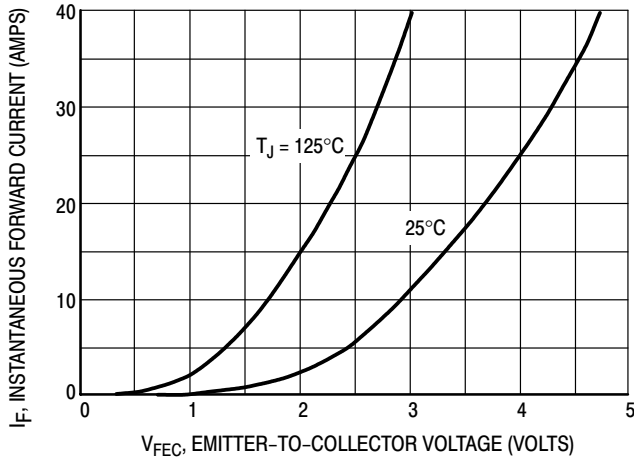


Figure 10. Diode Forward Voltage Drop

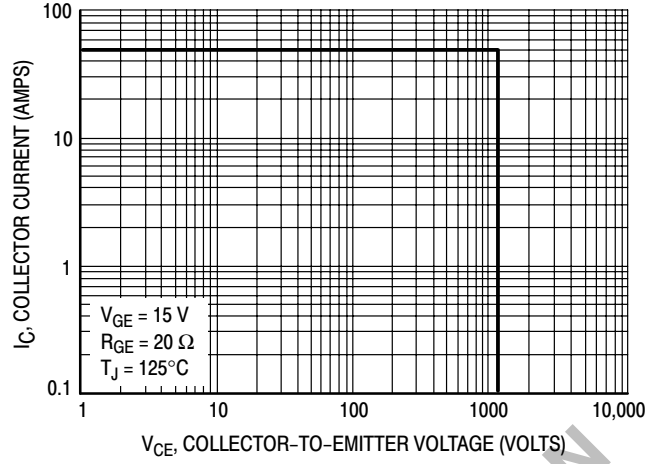


Figure 11. Reverse Biased Safe Operating Area

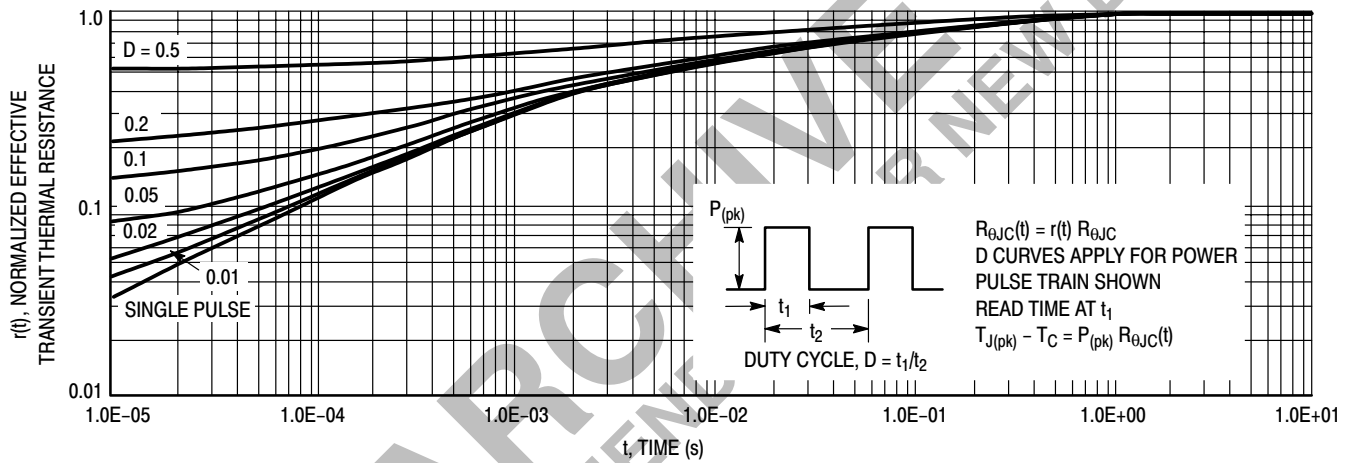
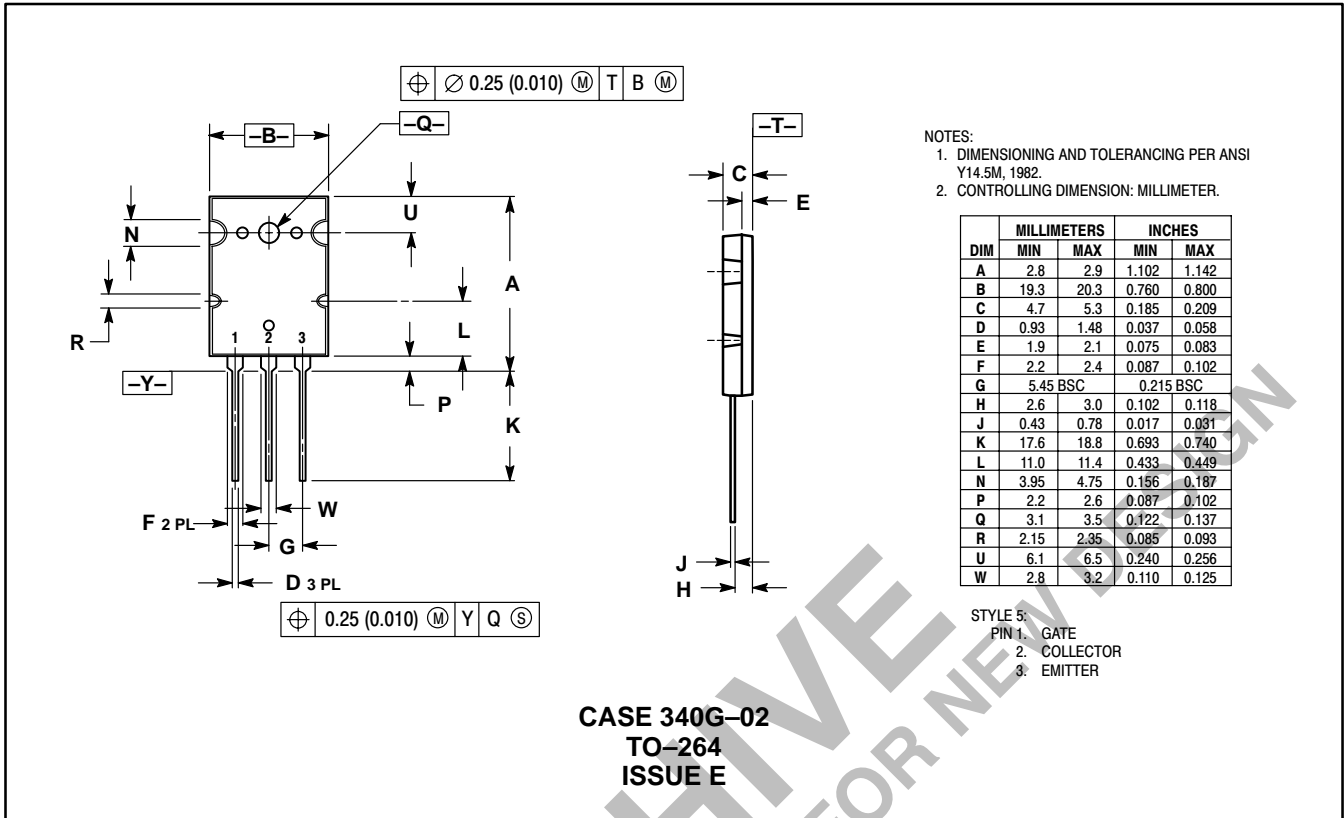


Figure 12. Thermal Response

PACKAGE DIMENSIONS



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