

Designer's™ Data Sheet

Insulated Gate Bipolar Transistor with Anti-Parallel Diode

N-Channel Enhancement-Mode Silicon Gate

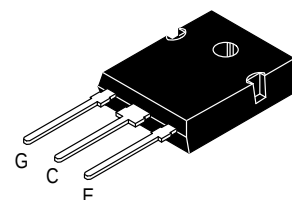
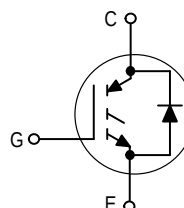
MGW12N120D

Motorola Preferred Device

IGBT & DIODE IN TO-247
12 A @ 90°C
20 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-247 Package with Isolated Mounting Hole
- High Speed E_{off} : 160 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



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

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}	± 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}	20 12 40	Adc Apc
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	123 0.98	Watts W/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to 150	$^\circ\text{C}$
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	μs
Thermal Resistance — Junction to Case – IGBT — Junction to Case – Diode — Junction to Ambient	$R_{\theta JC}$ $R_{\theta JD}$ $R_{\theta JA}$	1.0 1.4 45	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes, 1/8" from case for 5 seconds	T_L	260	$^\circ\text{C}$
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.

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



MGW12N120D**ELECTRICAL CHARACTERISTICS** ($T_J = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-to-Emitter Breakdown Voltage ($V_{GE} = 0\text{ Vdc}$, $I_C = 25\text{ }\mu\text{Adc}$)	BV_{CES}	1200	—	—	Vdc
Temperature Coefficient (Positive)		—	870	—	mV/ $^\circ\text{C}$
Zero Gate Voltage Collector Current ($V_{CE} = 1200\text{ Vdc}$, $V_{GE} = 0\text{ Vdc}$) ($V_{CE} = 1200\text{ Vdc}$, $V_{GE} = 0\text{ Vdc}$, $T_J = 125^\circ\text{C}$)	I_{CES}	—	—	100 2500	μAdc
Gate-Body Leakage Current ($V_{GE} = \pm 20\text{ Vdc}$, $V_{CE} = 0\text{ Vdc}$)	I_{GES}	—	—	250	nAdc

ON CHARACTERISTICS (1)

Collector-to-Emitter On-State Voltage ($V_{GE} = 15\text{ Vdc}$, $I_C = 5.0\text{ Adc}$) ($V_{GE} = 15\text{ Vdc}$, $I_C = 5.0\text{ Adc}$, $T_J = 125^\circ\text{C}$) ($V_{GE} = 15\text{ Vdc}$, $I_C = 10\text{ Adc}$)	$V_{CE(on)}$	— — —	2.71 3.78 3.72	3.37 — 4.42	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/ $^\circ\text{C}$
Forward Transconductance ($V_{CE} = 10\text{ Vdc}$, $I_C = 10\text{ Adc}$)	g_{fe}	—	12	—	Mhos

DYNAMIC CHARACTERISTICS

Input Capacitance	$(V_{CE} = 25\text{ Vdc}$, $V_{GE} = 0\text{ Vdc}$, $f = 1.0\text{ MHz}$)	C_{ies}	—	1003	—	pF
Output Capacitance		C_{oes}	—	126	—	
Transfer Capacitance		C_{res}	—	106	—	

SWITCHING CHARACTERISTICS (1)

Turn-On Delay Time	$(V_{CC} = 720\text{ Vdc}$, $I_C = 10\text{ Adc}$, $V_{GE} = 15\text{ Vdc}$, $L = 300\text{ }\mu\text{H}$ $R_G = 20\text{ }\Omega$, $T_J = 25^\circ\text{C}$) Energy losses include "tail"	$t_{d(on)}$	—	74	—	ns
Rise Time		t_r	—	83	—	
Turn-Off Delay Time		$t_{d(off)}$	—	76	—	
Fall Time		t_f	—	231	—	
Turn-Off Switching Loss		E_{off}	—	0.55	1.33	mJ
Turn-On Switching Loss		E_{on}	—	1.21	1.88	
Total Switching Loss		E_{ts}	—	1.76	3.21	
Turn-On Delay Time	$(V_{CC} = 720\text{ Vdc}$, $I_C = 10\text{ Adc}$, $V_{GE} = 15\text{ Vdc}$, $L = 300\text{ }\mu\text{H}$ $R_G = 20\text{ }\Omega$, $T_J = 125^\circ\text{C}$) Energy losses include "tail"	$t_{d(on)}$	—	66	—	ns
Rise Time		t_r	—	87	—	
Turn-Off Delay Time		$t_{d(off)}$	—	120	—	
Fall Time		t_f	—	575	—	
Turn-Off Switching Loss		E_{off}	—	1.49	—	mJ
Turn-On Switching Loss		E_{on}	—	2.37	—	
Total Switching Loss		E_{ts}	—	3.86	—	
Gate Charge	$(V_{CC} = 720\text{ Vdc}$, $I_C = 10\text{ Adc}$, $V_{GE} = 15\text{ Vdc}$)	Q_T	—	29	—	nC
		Q_1	—	13	—	
		Q_2	—	12	—	

DIODE CHARACTERISTICS

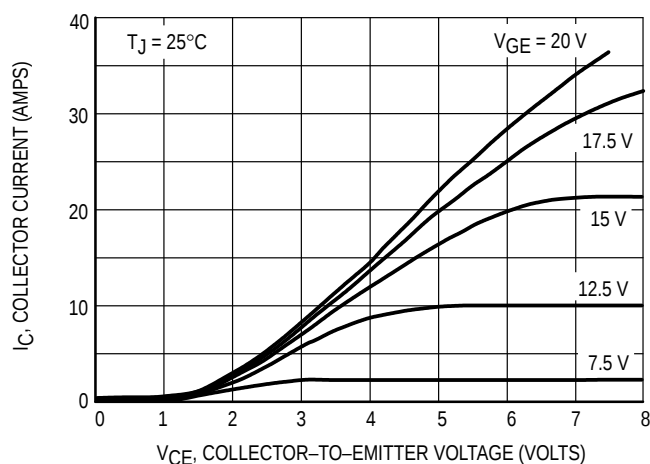
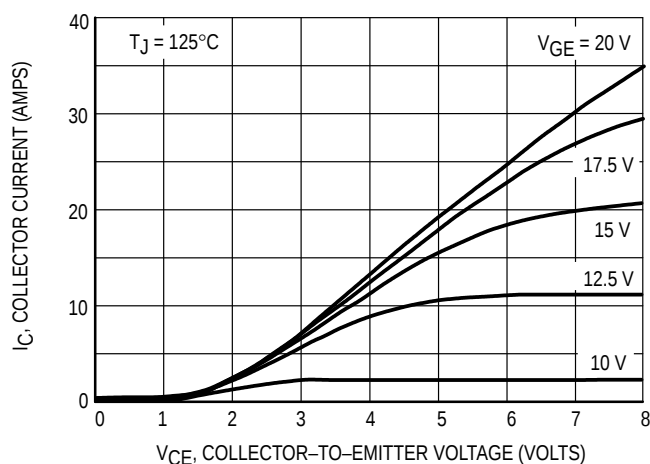
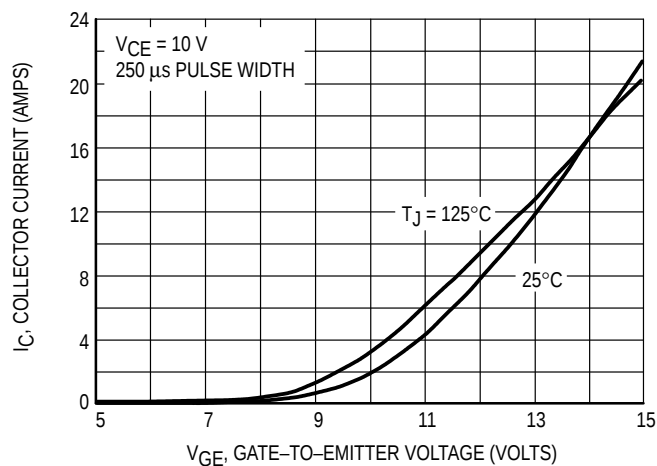
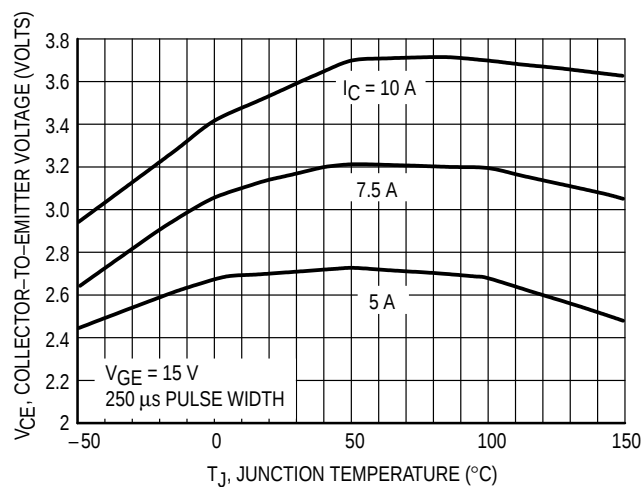
Diode Forward Voltage Drop ($I_{EC} = 5.0\text{ Adc}$) ($I_{EC} = 5.0\text{ Adc}$, $T_J = 125^\circ\text{C}$) ($I_{EC} = 10\text{ Adc}$)	V_{FEC}	— — —	2.26 1.37 2.86	3.32 — 4.18	Vdc
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(1) Pulse Test: Pulse Width $\leq 300\text{ }\mu\text{s}$, Duty Cycle $\leq 2\%$.

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
DIODE CHARACTERISTICS — continued					
Reverse Recovery Time	t_{rr}	—	116	—	ns
	t_a	—	69	—	
	t_b	—	47	—	
Reverse Recovery Stored Charge	Q_{RR}	—	0.36	—	μC
Reverse Recovery Time	t_{rr}	—	234	—	ns
	t_a	—	149	—	
	t_b	—	85	—	
Reverse Recovery Stored Charge	Q_{RR}	—	1.40	—	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**

MGW12N120D

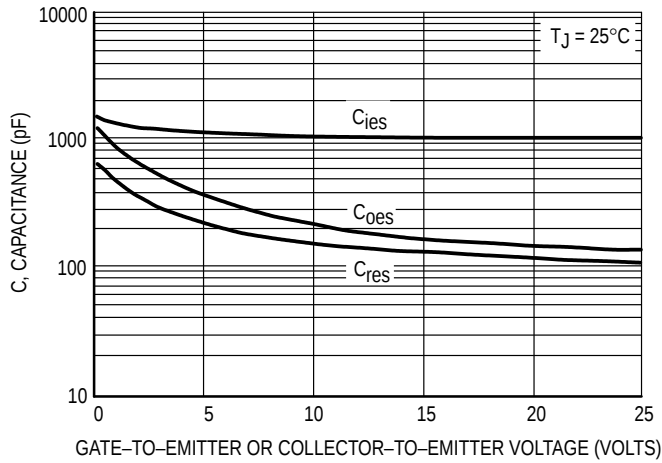


Figure 5. Capacitance Variation

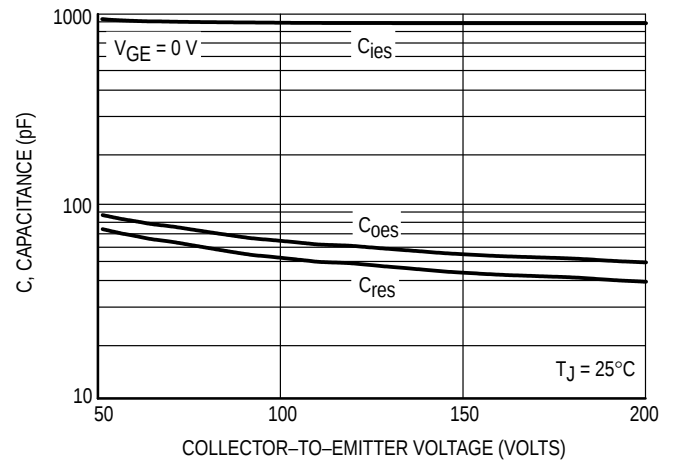


Figure 5b. High Voltage Capacitance Variation

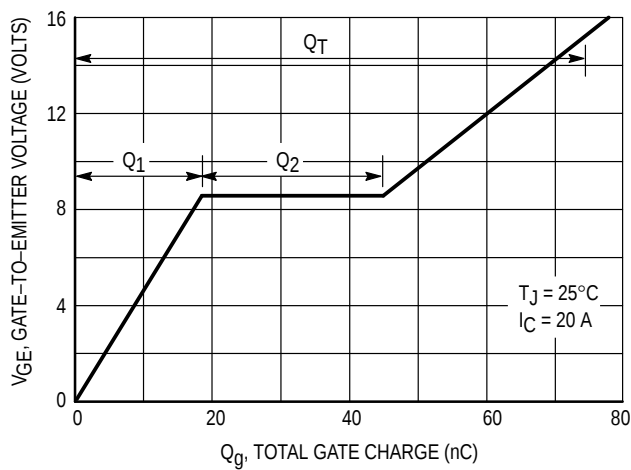


Figure 6. Gate-to-Emitter and Collector-to-Emitter Voltage versus Total Charge

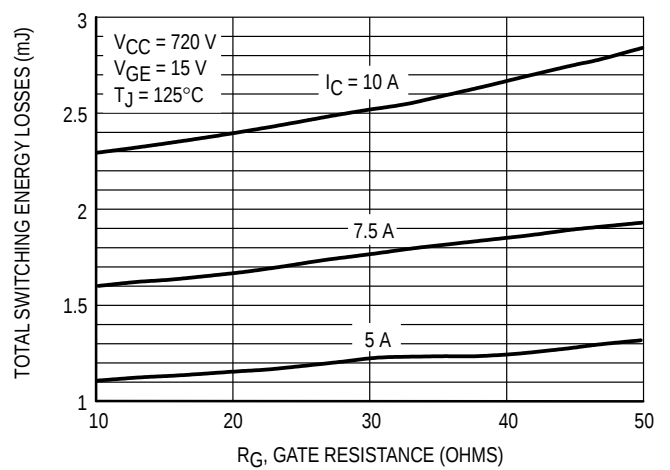


Figure 7. Total Switching Losses versus Gate Resistance

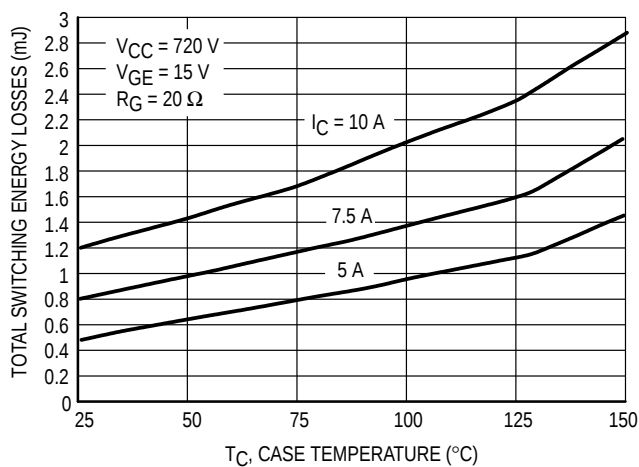


Figure 8. Total Switching Losses versus Case Temperature

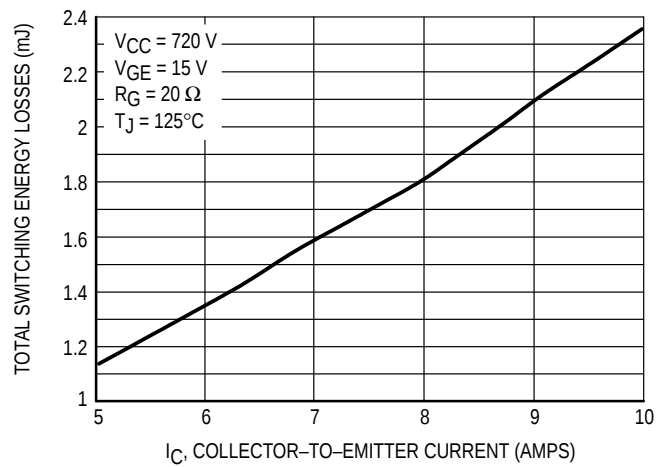


Figure 9. Total Switching Losses versus Collector-to-Emitter Current

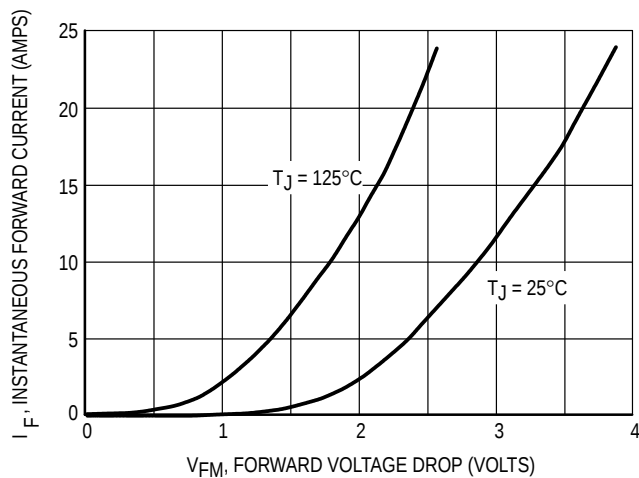


Figure 10. Maximum Forward Drop versus Instantaneous Forward Current

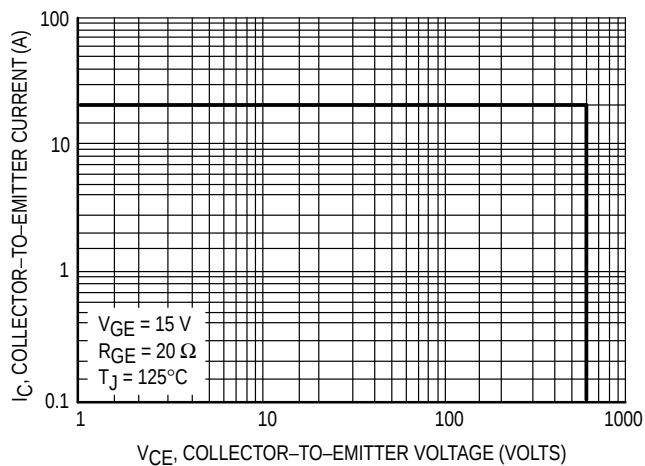


Figure 11. Reverse Biased Safe Operating Area

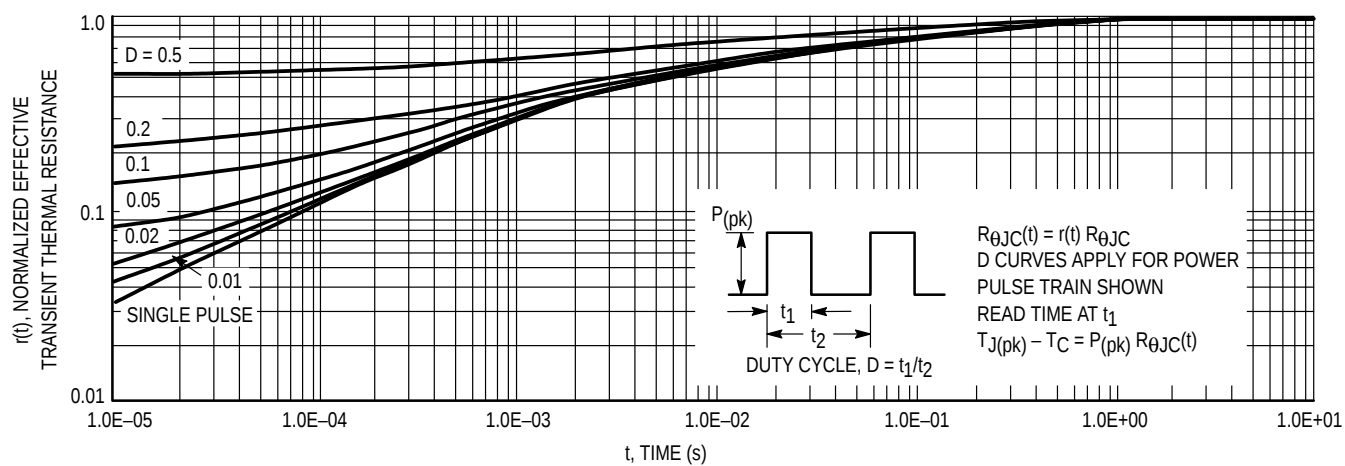
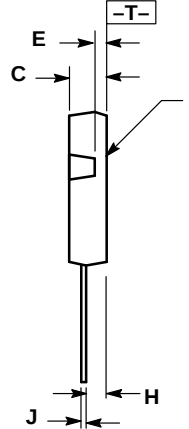
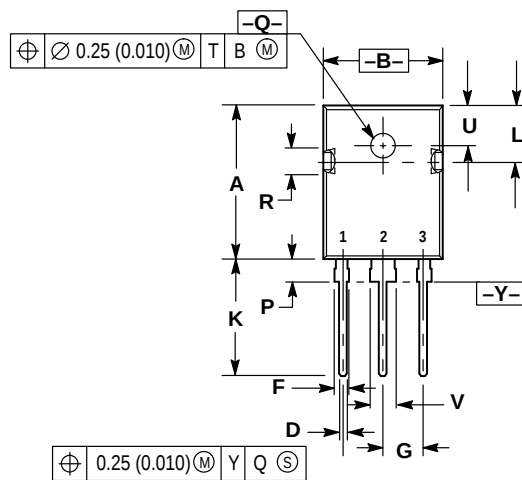


Figure 12. Thermal Response

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

**CASE 340F-03
TO-247AE
ISSUE E**

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