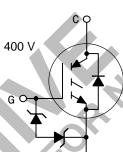
# Designer's™ Data Sheet

# Insulated Gate Bipolar Transistor with Anti-Parallel Diode

## N-Channel Enhancement-Mode Silicon Gate

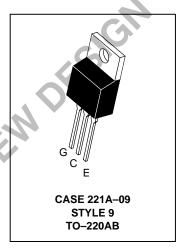
This Insulated Gate Bipolar Transistor (IGBT) is co–packaged with a soft recovery ultra–fast rectifier and uses an advanced termination scheme to provide an enhanced and reliable high voltage–blocking capability. Its new 600 V IGBT technology is specifically suited for applications requiring both a high temperature short circuit capability and a low  $V_{\text{CE(on)}}$ . 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 short circuit rugged device.

- Industry Standard TO-220 Package
- High Speed: E<sub>off</sub> = 70 μJ/A typical at 125°C
- High Voltage Short Circuit Capability 10 μs minimum at 125°C, 400 V
- Low On-Voltage 2.0 V typical at 5.0 A, 125°C
- Soft Recovery Free Wheeling Diode is Included in the Package
- Robust High Voltage Termination
- ESD Protection Gate-Emitter Zener Diodes



# MGP7N60ED

IGBT & DIODE IN TO-220 7.0 A @ 90°C 10 A @ 25°C 600 VOLTS SHORT CIRCUIT RATED LOW ON-VOLTAGE



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

Rating	Symbol	Value	Unit	
Collector–Emitter Voltage	V <sub>CES</sub>	600	Vdc	
Collector–Gate Voltage ( $R_{GE} = 1.0 \text{ M}\Omega$ )	V <sub>CGR</sub>	600	Vdc	
Gate-Emitter Voltage — Continuous	V <sub>GE</sub>	±20	Vdc	
Collector Current — Continuous @ T <sub>C</sub> = 25°C — Continuous @ T <sub>C</sub> = 90°C — Repetitive Pulsed Current (1)	I <sub>C25</sub> I <sub>C90</sub> I <sub>CM</sub>	10 7.0 14	Adc Apk	
Total Power Dissipation @ T <sub>C</sub> = 25°C Derate above 25°C	P <sub>D</sub>	81 0.65	Watts W/°C	
Operating and Storage Junction Temperature Range	T <sub>J</sub> , T <sub>stg</sub>	-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 <sub>sc</sub>	10	μs	
Thermal Resistance — Junction to Case – IGBT  — Junction to Case – Diode  — Junction to Ambient	R <sub>θJC</sub> R <sub>θJC</sub> R <sub>θJA</sub>	1.5 2.7 65	°C/W	
Maximum Lead Temperature for Soldering Purposes, 1/8" from case for 5 seconds	TL	260	°C	
Mounting Torque, 6–32 or M3 screw	10	10 lbf•in (1.13 N•m)		

<sup>(1)</sup> 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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# **ELECTRICAL CHARACTERISTICS** ( $T_J = 25^{\circ}C$ unless otherwise noted)

Ch	Symbol	Min	Тур	Max	Unit	
OFF CHARACTERISTICS						
Collector–to–Emitter Breakdown Voltage $(V_{GE}=0\ Vdc,\ I_C=25\ \mu Adc)$ Temperature Coefficient (Positive)			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}) $				_ _	10 200	μAdc
Gate-Body Leakage Current (V <sub>GE</sub>	$_{\rm E} = \pm 20  \text{Vdc},  \text{V}_{\text{CE}} = 0  \text{Vdc})$	I <sub>GES</sub>	_	_	50	μAdc
ON CHARACTERISTICS (1)						
Collector-to-Emitter On-State Voltage ( $V_{GE} = 15 \text{ Vdc}$ , $I_{C} = 2.5 \text{ Adc}$ ) ( $V_{GE} = 15 \text{ Vdc}$ , $I_{C} = 2.5 \text{ Adc}$ , $T_{J} = 125^{\circ}\text{C}$ ) ( $V_{GE} = 15 \text{ Vdc}$ , $I_{C} = 5.0 \text{ Adc}$ )			 	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)			4.0 —	6.0 10	8.0	Vdc mV/°C
Forward Transconductance (V <sub>CE</sub>	= 10 Vdc, I <sub>C</sub> = 5.0 Adc)	9 <sub>fe</sub>		2.5	_	Mhos
DYNAMIC CHARACTERISTICS		. 37	A .\$			
Input Capacitance		C <sub>ies</sub>		610	_	pF
Output Capacitance	$(V_{CE} = 25 \text{ Vdc}, V_{GE} = 0 \text{ Vdc}, f = 1.0 \text{ MHz})$	C <sub>oes</sub>	ZV	60	_	
Transfer Capacitance		C <sub>res</sub>		10		
SWITCHING CHARACTERISTICS	(1)			-	-	
Turn-On Delay Time		t <sub>d(on)</sub>	_	22	_	ns
Rise Time		t <sub>r</sub>	_	24	_	
Turn-Off Delay Time	$(V_{CC} = 360 \text{ Vdc}, I_{C} = 5.0 \text{ Adc},$	t <sub>d(off)</sub>		64	_	
Fall Time	$V_{GE} = 15 \text{ Vdc}, L = 300 \mu\text{H}, \\ R_{G} = 20 \Omega)$	t <sub>f</sub>	_	196	_	
Turn-Off Switching Loss	Energy losses include "fail"	E <sub>off</sub>	_	200	340	μJ
Turn-On Switching Loss		E <sub>on</sub>	_	71	_	
Total Switching Loss		E <sub>ts</sub>	_	271	_	
Turn-On Delay Time		t <sub>d(on)</sub>	_	31	_	ns
Rise Time		t <sub>r</sub>	_	24	_	
Turn-Off Delay Time	$(V_{CC} = 360 \text{ Vdc}, I_C = 5.0 \text{ Adc},$	$t_{d(off)}$		195	_	
Fall Time	$V_{GE}$ = 15 Vdc, L = 300 $\mu$ H, R <sub>G</sub> = 20 $\Omega$ , T <sub>J</sub> = 125°C)	t <sub>f</sub>	_	220	_	
Turn-Off Switching Loss	Energy losses include "tail"	E <sub>off</sub>	_	350	_	μJ
Turn-On Switching Loss		E <sub>on</sub>	_	135	_	
Total Switching Loss		E <sub>ts</sub>		485		
Gate Charge	0/ 000//: 1 50.11	Q <sub>T</sub>	_	27.2	_	nC
	$(V_{CC} = 360 \text{ Vdc}, I_{C} = 5.0 \text{ Adc}, V_{GE} = 15 \text{ Vdc})$	Q <sub>1</sub>	_	7.0		
		$Q_2$		13.7	_	

### **DIODE CHARACTERISTICS**

Diode Forward Voltage Drop (I <sub>EC</sub> = 2.3 Adc) (I <sub>EC</sub> = 2.3 Adc, T <sub>J</sub> = 125°C) (I <sub>EC</sub> = 4.6 Adc)		V <sub>FEC</sub>	_ _ _	1.7 1.3 2.0	_ _ 2.3	Vdc
Reverse Recovery Time	ery Time		_	40	_	ns
$(I_{F} = 4.6 \text{ Adc}, \ V_{R} = 360 \text{ Vdc}, \ dI_{F}/dt = 200 \text{ A}/\mu\text{s})$	t <sub>a</sub>	_	17	_		
		t <sub>b</sub>	_	23	_	
Reverse Recovery Stored Charge		Q <sub>RR</sub>	_	60	_	nC
Reverse Recovery Time		t <sub>rr</sub>	_	105	_	ns
		t <sub>a</sub>	_	36	_	
	$dI_F/dt = 200 \text{ A/}\mu\text{s},$ $T_{.I} = 125^{\circ}\text{C})$	t <sub>b</sub>	_	69	_	
Reverse Recovery Stored Charge	1j = 123 O)	Q <sub>RR</sub>	_	247	-	nC

### INTERNAL PACKAGE INDUCTANCE

Internal Emitter Inductance	LE			nΗ
(Measured from the emitter lead 0.25" from package to emitter bond pad)		_	7.5	ĺ

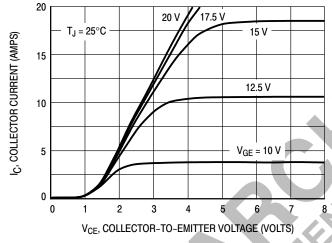


Figure 1. Output Characteristics

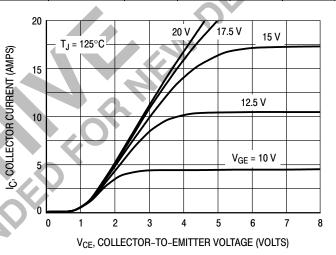


Figure 2. Output Characteristics

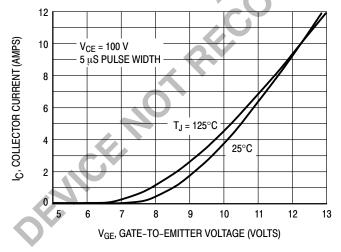


Figure 3. Transfer Characteristics

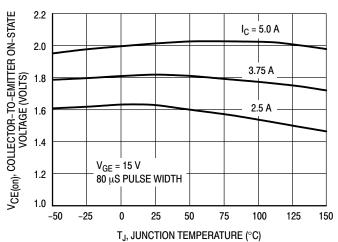


Figure 4. Collector–To–Emitter Saturation Voltage versus Junction Temperature

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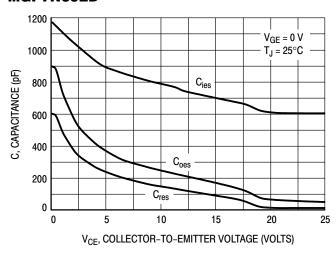


Figure 5. Capacitance Variation

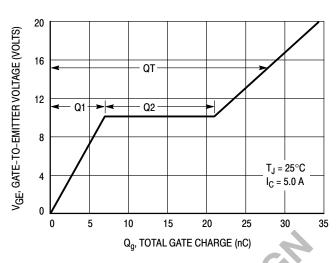


Figure 6. Gate-To-Emitter Voltage versus
Total Charge

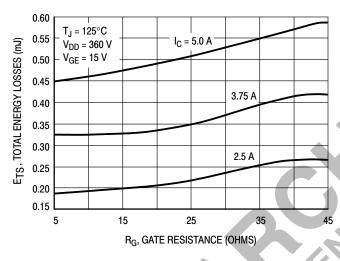


Figure 7. Total Energy Losses versus
Gate Resistance

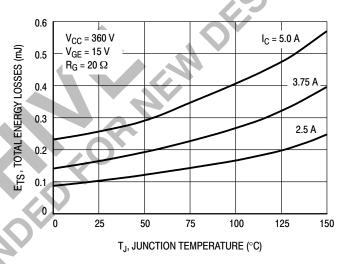


Figure 8. Total Energy Losses versus Junction Temperature

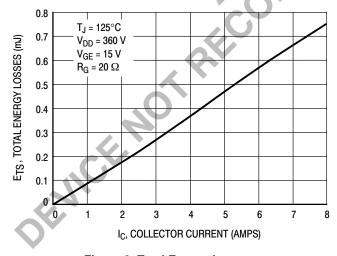


Figure 9. Total Energy Losses versus Collector Current

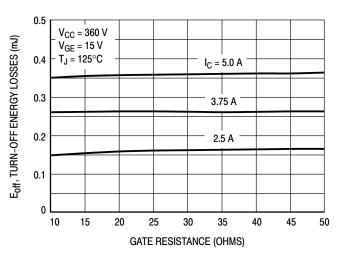


Figure 10. Turn-Off Losses versus
Gate Resistance

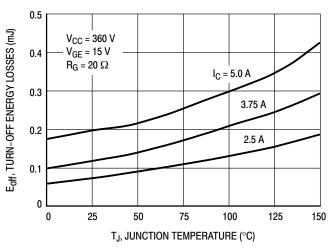


Figure 11. Turn-Off Losses versus **Junction Temperature** 

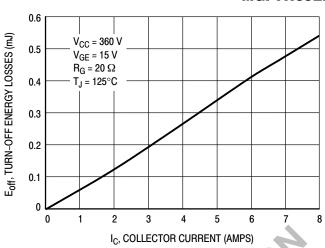
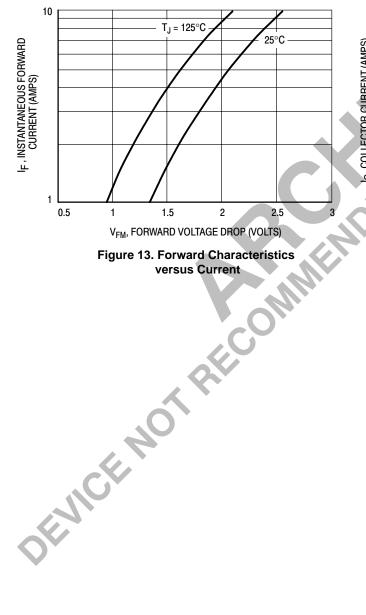


Figure 12. Turn-Off Losses versus **Collector Current** 



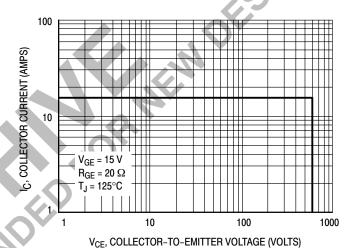
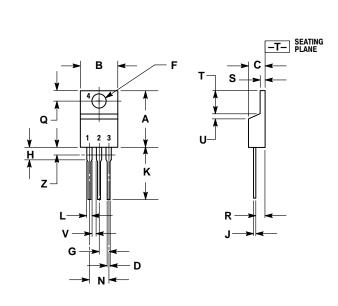


Figure 14. Reverse Biased Safe **Operating Area** 

#### PACKAGE DIMENSIONS



#### NOTES:

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

	INC	HES	MILLIN	IETERS	
DIM	MIN	MAX	MIN	MAX	
Α	0.570	0.620	14.48	15.75	
В	0.380	0.405	9.66	10.28	
С	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	
Н	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	
٧	0.045		1.15		
Z		0.080		2.04	

STYLE 9: PIN 1. GATE

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