

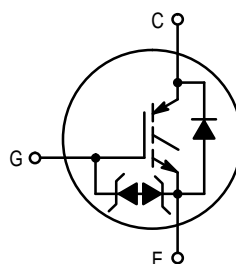
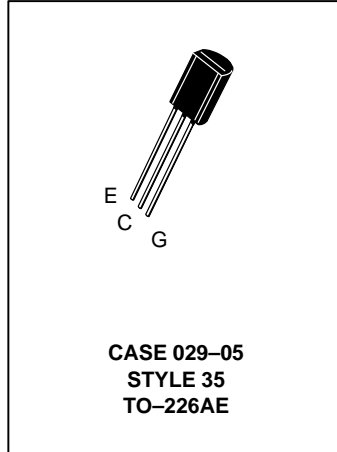
*Designer's™ Data Sheet*  
**Insulated Gate Bipolar Transistor**  
**N-Channel Enhancement-Mode Silicon Gate**

**MGS05N60D**

This IGBT contains a built-in free wheeling diode and a gate protection zener diodes. Fast switching characteristics result in efficient operation at higher frequencies. This device is ideally suited for high frequency electronic ballasts.

**IGBT**  
**0.5 A @ 25°C**  
**600 V**

- Built-In Free Wheeling Diodes
- Built-In Gate Protection Zener Diode
- Industry Standard Package (TO92 — 1.0 Watt)
- High Speed  $E_{off}$ : Typical 6.5  $\mu$ s @  $I_C = 0.3$  A;  $T_C = 125^\circ$ C and  $dV/dt = 1000$  V/ $\mu$ s
- Robust High Voltage Termination
- Robust Turn-Off SOA



**MAXIMUM RATINGS** ( $T_C = 25^\circ$ C unless otherwise noted)

Parameters	Symbol	Value	Unit
Collector-Emitter Voltage	$V_{CES}$	600	Vdc
Collector-Gate Voltage ( $R_{GE} = 1.0$ M $\Omega$ )	$V_{CGR}$	600	Vdc
Gate-Emitter Voltage — Continuous	$V_{GES}$	$\pm 15$	Vdc
Collector Current — Continuous @ $T_C = 25^\circ$ C — Continuous @ $T_C = 90^\circ$ C — Repetitive Pulsed Current (1)	$I_{C25}$ $I_{C90}$ $I_{CM}$	0.5 0.3 2.0	Adc
Total Power Dissipation	$P_D$	1.0	Watt
Operating and Storage Junction Temperature Range	$T_J, T_{stg}$	-55 to 150	$^\circ$ C

**THERMAL CHARACTERISTICS**

Thermal Resistance — Junction to Case – IGBT — Junction to Ambient	$R_{\theta JC}$ $R_{\theta JA}$	25 125	$^\circ$ C/W
Maximum Lead Temperature for Soldering Purposes, 1/8" from case for 5 seconds	$T_L$	260	$^\circ$ C

**UNCLAMPED DRAIN-TO-SOURCE AVALANCHE CHARACTERISTICS** ( $T_C \leq 150^\circ$ C)

Single Pulse Drain-to-Source Avalanche Energy – Starting @ $T_C = 25^\circ$ C @ $T_C = 125^\circ$ C $V_{CE} = 100$ V, $V_{GE} = 15$ V, Peak $I_L = 2.0$ A, $L = 3.0$ mH, $R_G = 25$ $\Omega$	$E_{AS}$	125 40	mJ
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(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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# MGS05N60D

## ELECTRICAL CHARACTERISTICS ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>					
Collector-to-Emitter Breakdown Voltage ( $V_{GE} = 0\text{ Vdc}$ , $I_C = 250\ \mu\text{Adc}$ ) Temperature Coefficient (Positive)	$V_{(BR)CES}$	600 —	680 0.7	— —	Vdc V/ $^\circ\text{C}$
Zero Gate Voltage Collector Current ( $V_{CE} = 600\text{ Vdc}$ , $V_{GE} = 0\text{ Vdc}$ ) ( $V_{CE} = 600\text{ Vdc}$ , $V_{GE} = 0\text{ Vdc}$ , $T_C = 125^\circ\text{C}$ )	$I_{CES}$ $I_{CES}$	— —	0.1 5.0	5.0 50	$\mu\text{Adc}$
Gate-Body Leakage Current ( $V_{GE} = \pm 15\text{ Vdc}$ , $V_{CE} = 0\text{ Vdc}$ )	$I_{GES}$	—	10	100	$\mu\text{Adc}$

## ON CHARACTERISTICS

Collector-to-Emitter On-State Voltage ( $V_{GE} = 15\text{ Vdc}$ , $I_C = 0.3\text{ Adc}$ ) ( $V_{GE} = 15\text{ Vdc}$ , $I_C = 0.3\text{ Adc}$ , $T_C = 125^\circ\text{C}$ )	$V_{CE(on)}$	— —	1.6 1.5	2.0 —	Vdc
Gate Threshold Voltage ( $V_{CE} = V_{GE}$ , $I_C = 250\ \mu\text{Adc}$ ) Threshold Temperature Coefficient (Negative)	$V_{GE(th)}$	3.5 —	— 6.0	6.0 —	Vdc mV/ $^\circ\text{C}$
Forward Transconductance ( $V_{CE} = 10\text{ Vdc}$ , $I_C = 0.5\text{ Adc}$ )	$g_{fe}$	0.3	0.42	—	Mhos

## DYNAMIC CHARACTERISTICS

Input Capacitance	$(V_{CE} = 20\text{ Vdc}$ , $V_{GE} = 0\text{ Vdc}$ , $f = 1.0\text{ MHz}$ )	$C_{ies}$	—	75	100	pF
Output Capacitance		$C_{oes}$	—	11	20	
Transfer Capacitance		$C_{res}$	—	1.6	5.0	

## DIODE CHARACTERISTICS

Diode Forward Voltage Drop ( $I_{EC} = 0.3\text{ Adc}$ ) ( $I_{EC} = 0.3\text{ Adc}$ , $T_C = 125^\circ\text{C}$ ) ( $I_{EC} = 0.1\text{ Adc}$ ) ( $I_{EC} = 0.1\text{ Adc}$ , $T_C = 125^\circ\text{C}$ )	$V_{FEC}$	— — — —	5.0 5.2 2.3 2.3	6.0 — 3.0 —	Vdc	
Reverse Recovery Time	$(I_F = 0.4\text{ Adc}$ , $V_R = 300\text{ Vdc}$ , $dI_F/dt = 10\text{ A}/\mu\text{s}$ )	$t_{rr}$	—	150	—	ns
Reverse Recovery Stored Charge		$Q_{RR}$	—	35	—	$\mu\text{C}$

## SWITCHING CHARACTERISTICS (1)

Turn-Off Delay Time	$(V_{CC} = 300\text{ Vdc}$ , $I_C = 0.4\text{ Adc}$ , $V_{GE} = 15\text{ Vdc}$ , $L = 3.0\text{ mH}$ , $R_G = 25\ \Omega$ , $dV/dt = 1000\text{ V}/\mu\text{s}$ ) Energy losses include "tail"	$t_{d(off)}$	—	28	—	ns
Fall Time		$t_f$	—	150	—	
Turn-Off Switching Loss		$E_{off}$	—	3.25	4.25	
Turn-Off Delay Time	$(V_{CC} = 300\text{ Vdc}$ , $I_C = 0.4\text{ Adc}$ , $V_{GE} = 15\text{ Vdc}$ , $L = 3.0\text{ mH}$ , $R_G = 25\ \Omega$ , $T_C = 125^\circ\text{C}$ , $dV/dt = 1000\text{ V}/\mu\text{s}$ ) Energy losses include "tail"	$t_{d(off)}$	—	21	—	ns
Fall Time		$t_f$	—	280	—	
Turn-Off Switching Loss		$E_{off}$	—	8.0	10	
Gate Charge	$(V_{CC} = 300\text{ Vdc}$ , $I_C = 0.3\text{ Adc}$ , $V_{GE} = 15\text{ Vdc}$ )	$Q_T$	—	6.4	—	nC

(1) Pulse Test: Pulse Width  $\leq 300\ \mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

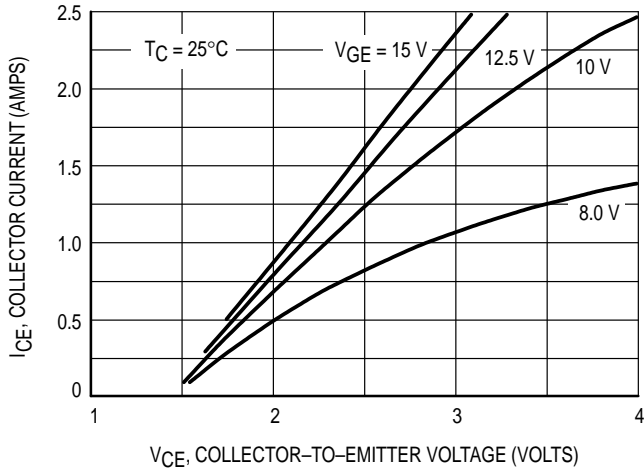


Figure 1. Saturation Characteristics

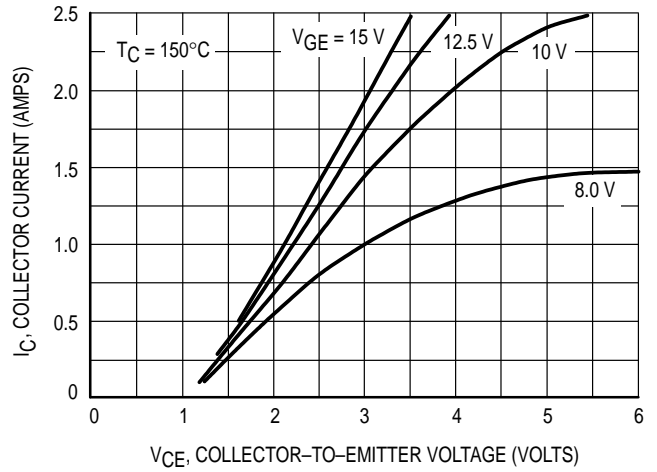


Figure 2. Saturation Characteristics

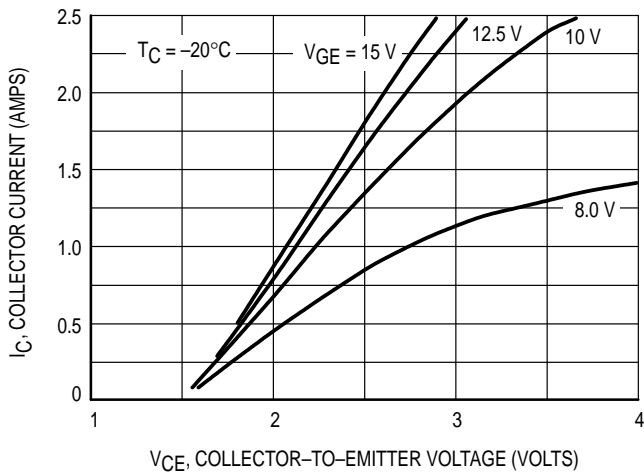


Figure 3. Saturation Characteristics

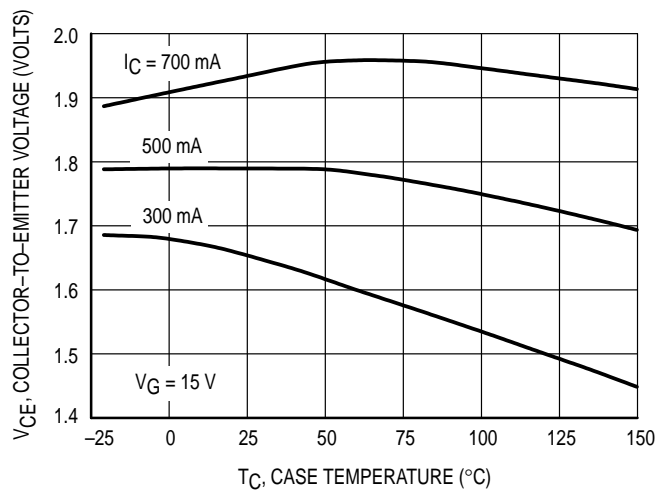


Figure 4. Collector-To-Emitter Saturation Voltage versus Case Temperature

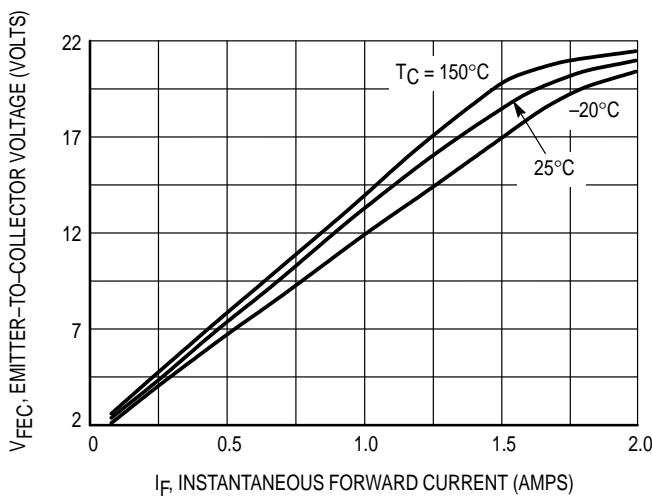


Figure 5. Diode Forward Voltage Drop

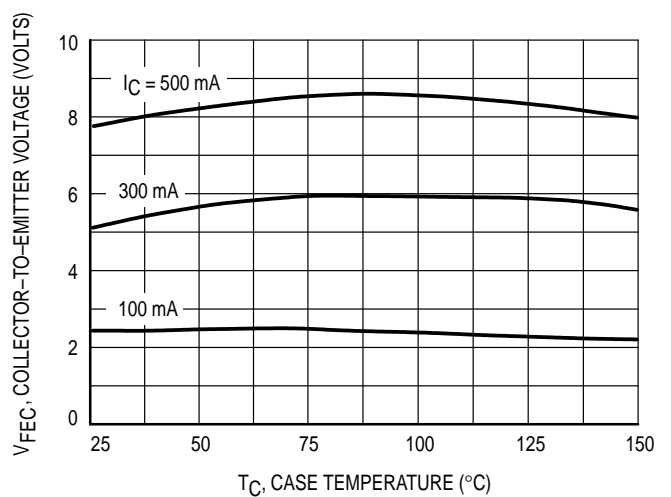


Figure 6. Diode Forward Voltage versus Case Temperature

# MGS05N60D

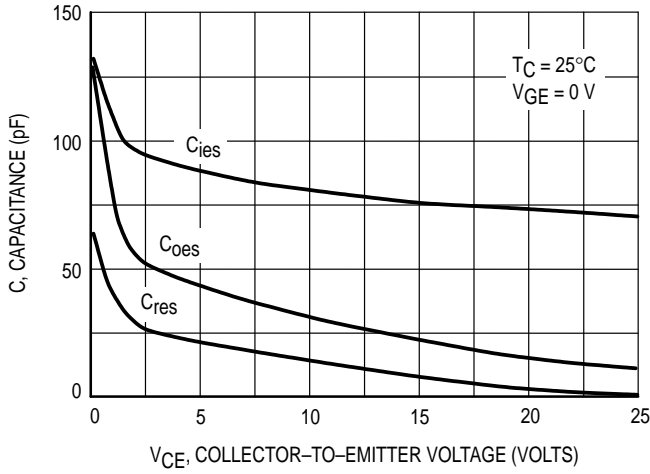


Figure 7. Capacitance Variation

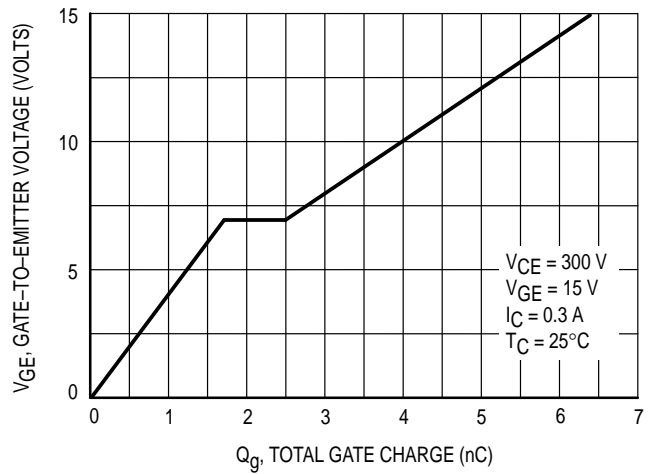


Figure 8. Gate-To-Emitter Voltage versus Total Charge

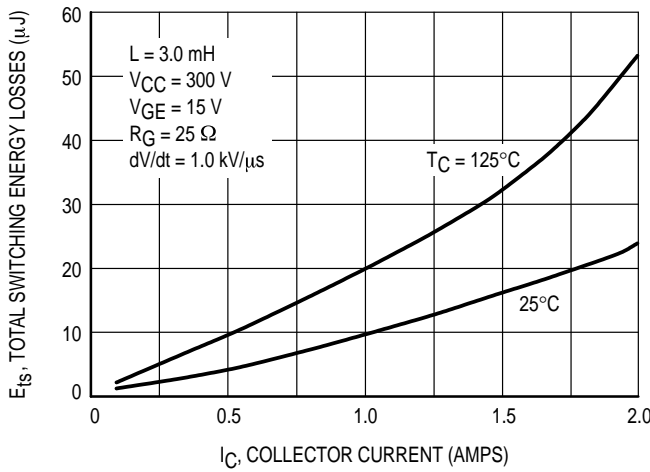


Figure 9. Total Switching Losses versus Collector Current

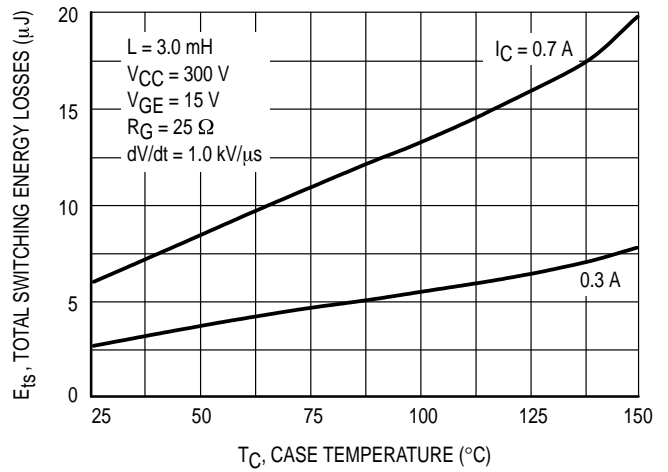


Figure 10. Total Switching Losses versus Case Temperature

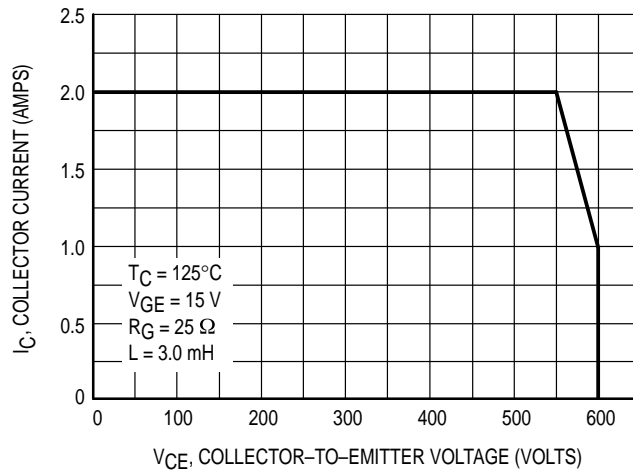


Figure 11. Minimum Turn-Off Safe Operating Area

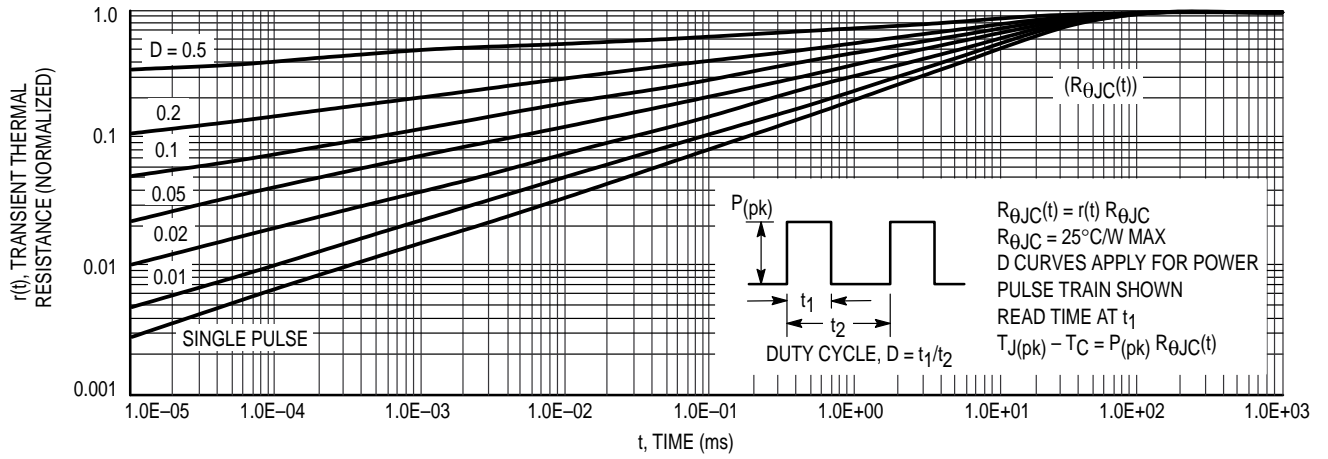
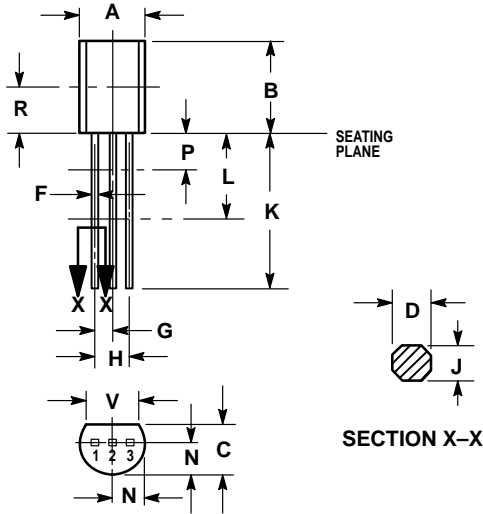


Figure 12. Typical Thermal Response

PACKAGE DIMENSIONS



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
  4. DIMENSION F APPLIES BETWEEN P AND L. DIMENSIONS D AND J APPLY BETWEEN L AND K MINIMUM. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.175	0.205	4.44	5.21
B	0.290	0.310	7.37	7.87
C	0.125	0.165	3.18	4.19
D	0.018	0.022	0.46	0.56
F	0.016	0.019	0.41	0.48
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.018	0.024	0.46	0.61
K	0.500	—	12.70	—
L	0.250	—	6.35	—
N	0.080	0.105	2.04	2.66
P	—	0.100	—	2.54
R	0.135	—	3.43	—
V	0.135	—	3.43	—

- STYLE 35:
- PIN 1. GATE
  - COLLECTOR
  - EMITTER

CASE 029-05  
TO-226AE  
ISSUE AD

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