

# Designer's™ Data Sheet

## Insulated Gate Bipolar Transistor

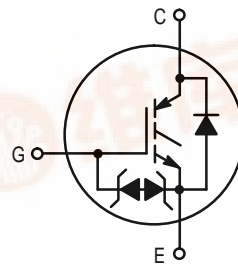
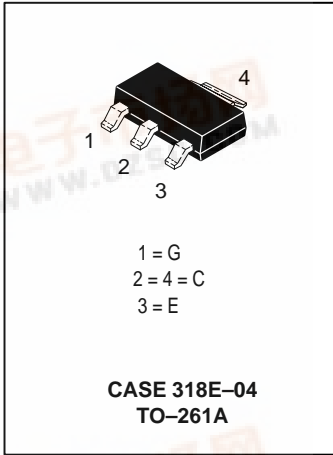
### N-Channel Enhancement-Mode Silicon Gate

**MMG05N60D**

This IGBT contains a built-in free wheeling diode and a gate protection zener. Fast switching characteristics result in efficient operation at higher frequencies.

- Built-In Free Wheeling Diode
- Built-In Gate Protection Zener Diode
- Industry Standard Package (SOT223)
- High Speed  $E_{off}$ : Typical  $6.5 \mu\text{J}$  @  $I_C = 0.3 \text{ A}$ ;  $T_C = 125^\circ\text{C}$  and  $dV/dt = 1000 \text{ V}/\mu\text{s}$
- Robust High Voltage Termination
- Robust Turn-Off SOA

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



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

Parameters	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	$V_{CGR}$	$\pm 15$	Vdc
Collector Current — Continuous @ $T_C = 25^\circ\text{C}$ — Continuous @ $T_C = 90^\circ\text{C}$ — Repetitive Pulsed Current (1)	$I_{C25}$ $I_{C90}$ $I_{CM}$	0.5 0.3 2.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$	$P_D$	1.0	Watt
Operating and Storage Junction Temperature Range	$T_J, T_{stg}$	-55 to 150	$^\circ\text{C}$
Thermal Resistance — Junction to Case – IGBT — Junction to Ambient	$R_{\theta JC}$ $R_{\theta JA}$	30 150	$^\circ\text{C}/\text{W}$
Maximum Lead Temperature for Soldering Purposes, 1/8" from case for 5 seconds	$T_L$	260	

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

Single Pulse Drain-to-Source Avalanche Energy – Starting @ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$ $V_{CE} = 100 \text{ V}$ , $V_{GE} = 15 \text{ V}$ , Peak $I_L = 2.0 \text{ A}$ , $L = 3.0 \text{ mH}$ , $R_G = 25 \Omega$	EAS	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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# MMG05N60D

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

Characteristic	Symbol	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Collector-to-Emitter Breakdown Voltage (V <sub>GE</sub> = 0 Vdc, I <sub>C</sub> = 250 μAdc) Temperature Coefficient (Positive)	B <sub>V</sub> CE <sub>S</sub>	600 —	680 0.7	— —	Vdc V/°C
Zero Gate Voltage Collector Current (V <sub>CE</sub> = 600 Vdc, V <sub>GE</sub> = 0 Vdc, T <sub>C</sub> = 25°C) (V <sub>CE</sub> = 600 Vdc, V <sub>GE</sub> = 0 Vdc, T <sub>C</sub> = 125°C)	I <sub>CES</sub> I <sub>CES</sub>	— —	0.1 5.0	5.0 50	μAdc
Gate-Body Leakage Current (V <sub>GE</sub> = ±15 Vdc, V <sub>CE</sub> = 0 Vdc)	I <sub>GES</sub>	—	10	100	μAdc

### ON CHARACTERISTICS

Collector-to-Emitter On-State Voltage (V <sub>GE</sub> = 15 Vdc, I <sub>C</sub> = 0.3 Adc, T <sub>C</sub> = 25°C) (V <sub>GE</sub> = 15 Vdc, I <sub>C</sub> = 0.3 Adc, T <sub>C</sub> = 125°C)	V <sub>CE(on)</sub>	— —	1.6 1.5	2.0 —	Vdc
Gate Threshold Voltage (V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250 μAdc) Threshold Temperature Coefficient (Negative)	V <sub>GE(th)</sub>	3.5 —	— 6.0	6.0 —	Vdc mV/°C
Forward Transconductance (V <sub>CE</sub> = 10 Vdc, I <sub>C</sub> = 0.5 Adc)	g <sub>fe</sub>	0.3	0.42	—	Mhos

### DYNAMIC CHARACTERISTICS

Input Capacitance	(V <sub>CE</sub> = 20 Vdc, V <sub>GE</sub> = 0 Vdc, f = 1.0 MHz)	C <sub>ies</sub>	—	75	100	pF
Output Capacitance		C <sub>oes</sub>	—	11	20	
Transfer Capacitance		C <sub>res</sub>	—	1.6	5.0	

### DIODE CHARACTERISTICS

Diode Forward Voltage Drop (I <sub>EC</sub> = 0.3 Adc, T <sub>C</sub> = 25°C) (I <sub>EC</sub> = 0.3 Adc, T <sub>C</sub> = 125°C) (I <sub>EC</sub> = 0.1 Adc, T <sub>C</sub> = 25°C) (I <sub>EC</sub> = 0.1 Adc, T <sub>C</sub> = 125°C)	V <sub>FEC</sub>	— — — —	5.0 5.2 2.3 2.3	6.0 — 3.0 —	Vdc
Reverse Recovery Time @ T <sub>C</sub> = 25°C I <sub>F</sub> = 0.4 Adc, V <sub>R</sub> = 300 Vdc, dI <sub>F</sub> /dt = 10 A/μs	t <sub>rr</sub>	—	150	—	ns
Reverse Recovery Stored Charge I <sub>F</sub> = 0.4 Adc, V <sub>R</sub> = 300 Vdc, dI <sub>F</sub> /dt = 10 A/μs	Q <sub>RR</sub>	—	35	—	μC

### SWITCHING CHARACTERISTICS (1)

Turn-Off Delay Time	(V <sub>CC</sub> = 300 Vdc, I <sub>C</sub> = 0.4 Adc, V <sub>GE</sub> = 15 Vdc, L = 3.0 mH, R <sub>G</sub> = 25 Ω, T <sub>C</sub> = 25°C, dV/dt = 1000 V/μs) Energy losses include "tail"	t <sub>d(off)</sub>	—	28	—	ns
Fall Time		t <sub>f</sub>	—	150	—	
Turn-Off Switching Loss		E <sub>off</sub>	—	3.25	4.25	
Turn-Off Delay Time	(V <sub>CC</sub> = 300 Vdc, I <sub>C</sub> = 0.4 Adc, V <sub>GE</sub> = 15 Vdc, L = 3.0 mH, R <sub>G</sub> = 25 Ω, T <sub>C</sub> = 125°C, dV/dt = 1000 V/μs) Energy losses include "tail"	t <sub>d(off)</sub>	—	21	—	ns
Fall Time		t <sub>f</sub>	—	280	—	
Turn-Off Switching Loss		E <sub>off</sub>	—	8.0	10	
Gate Charge	(V <sub>CC</sub> = 300 Vdc, I <sub>C</sub> = 0.3 Adc, V <sub>GE</sub> = 15 Vdc)	Q <sub>T</sub>	—	6.4	—	nC

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

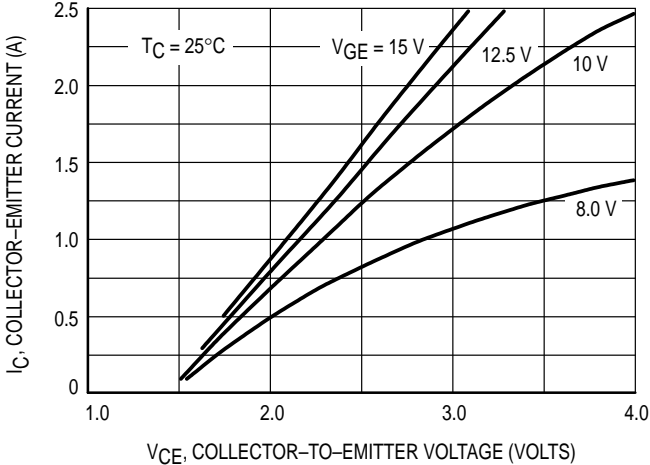


Figure 1. Saturation Characteristics

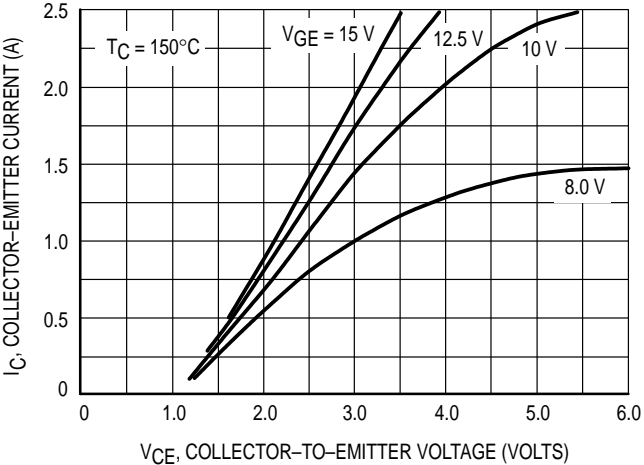


Figure 2. Saturation Characteristics

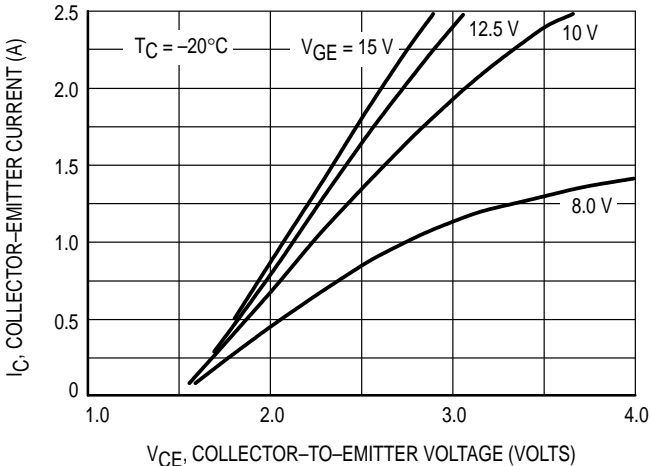


Figure 3. Saturation Characteristics

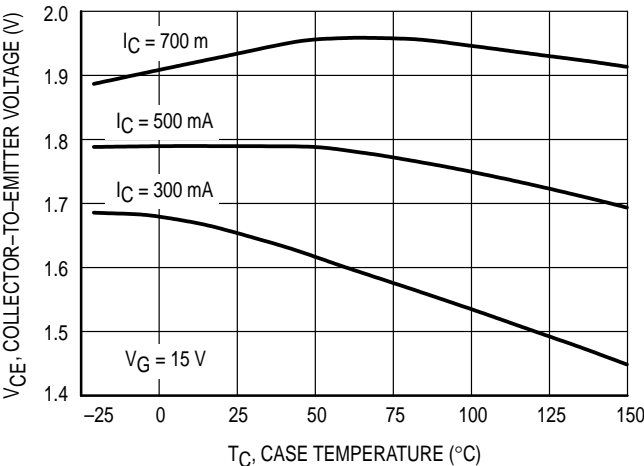


Figure 4. Collector-To-Emitter Saturation Voltage versus Case Temperature

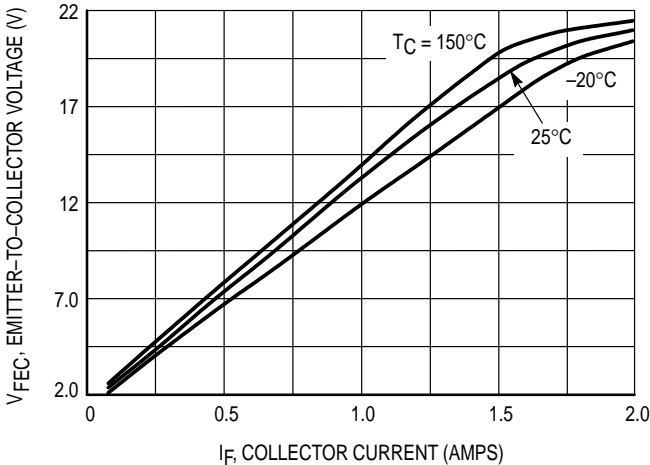


Figure 5. Diode Forward Voltage

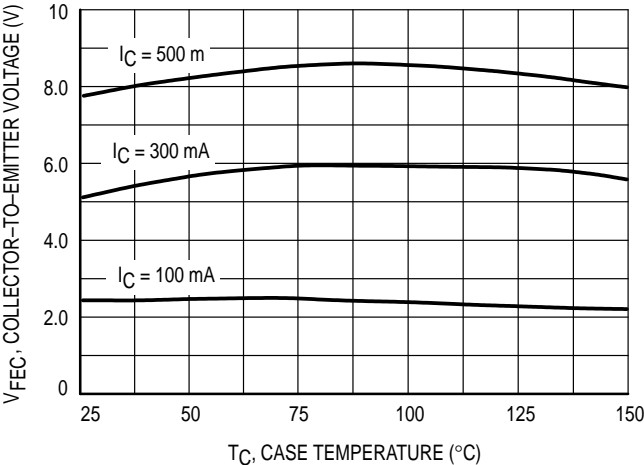


Figure 6. Diode Forward Voltage versus Case Temperature

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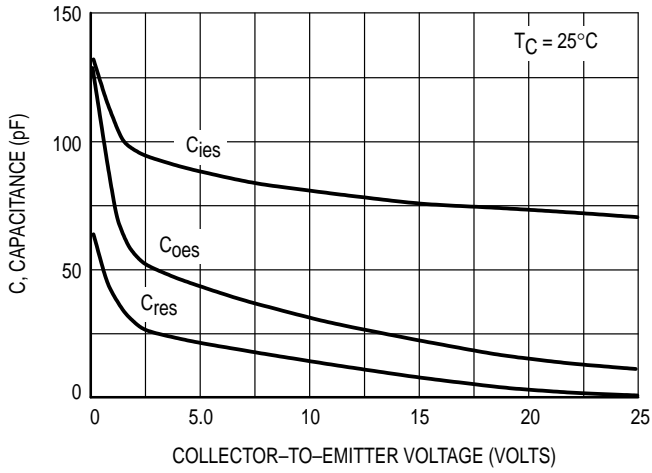


Figure 7. Capacitance Variation

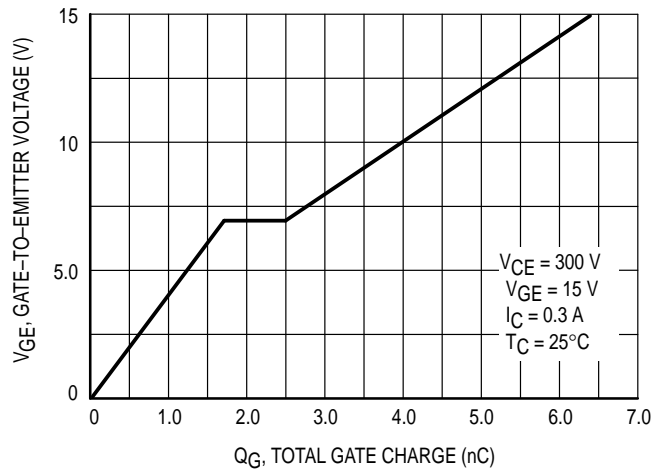


Figure 8. Gate-to-Emitter Voltage versus Total Charge

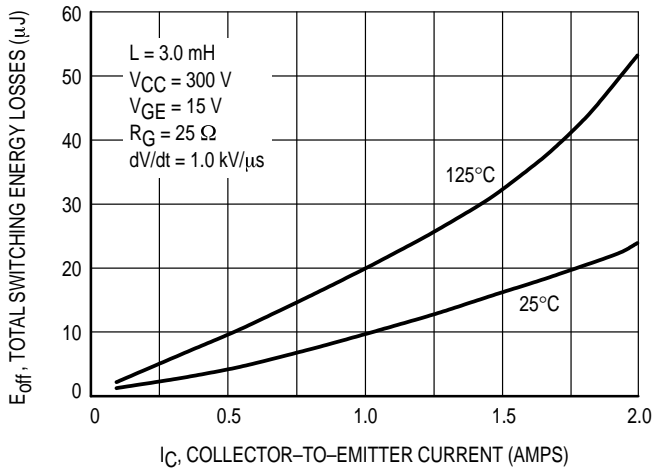


Figure 9. Total Switching Losses versus Collector-to-Emitter Current

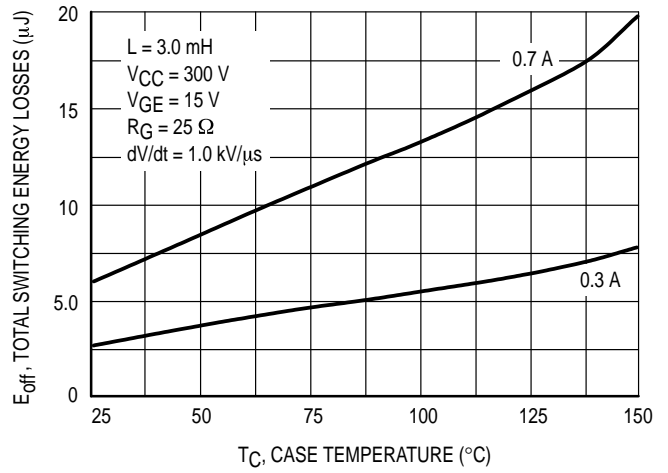


Figure 10. Total Switching Losses versus Case Temperature

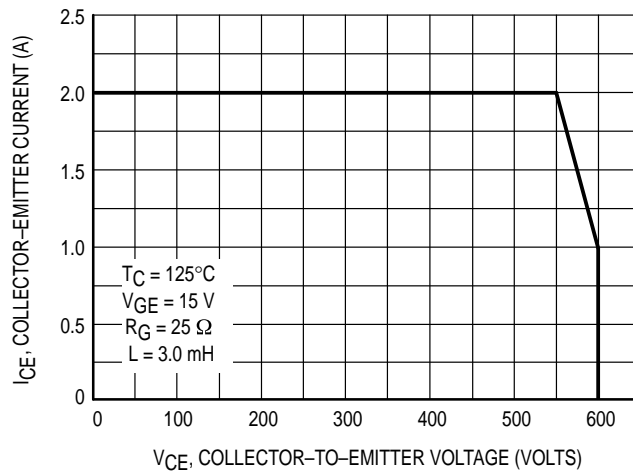


Figure 11. Minimum Turn-Off Safe Operating Area

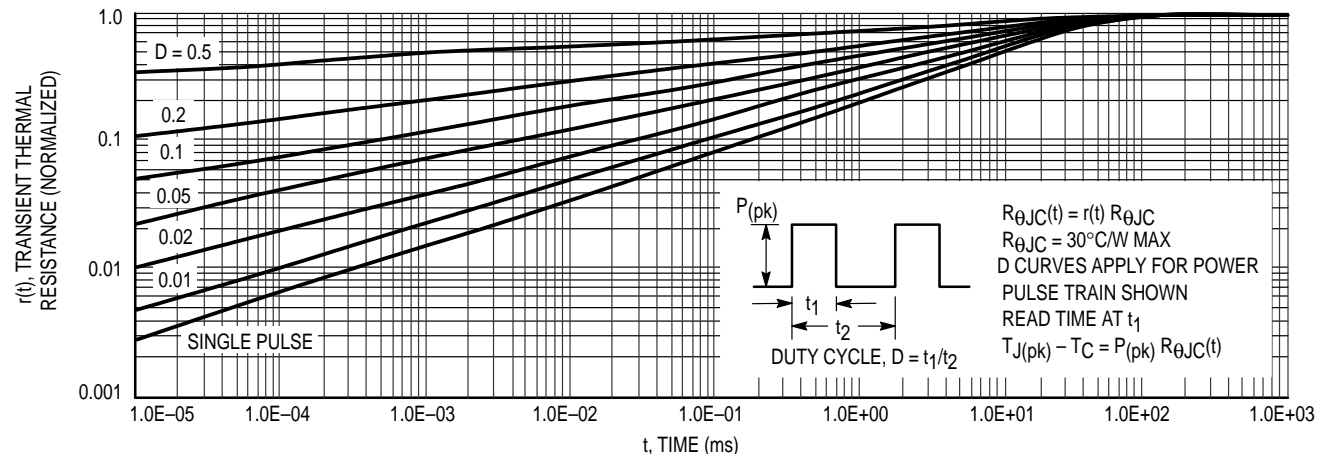
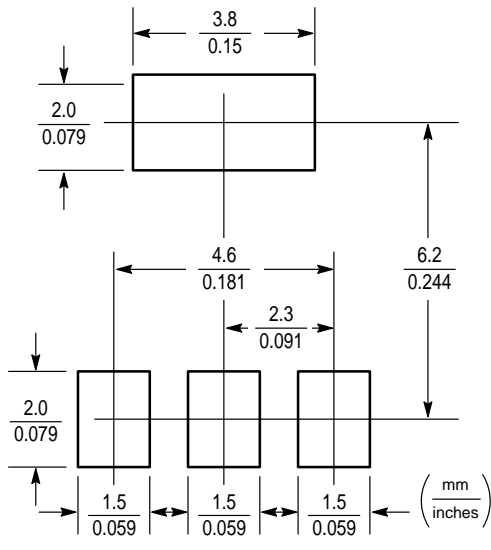
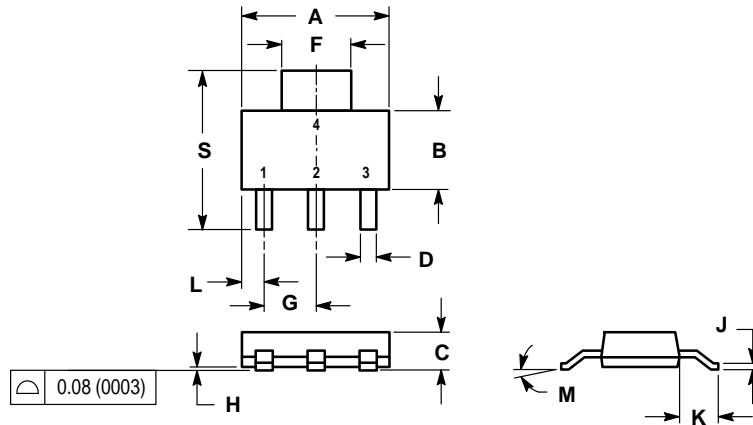


Figure 12. Typical Thermal Response



**MMG05N60D**

**PACKAGE DIMENSIONS**



- NOTES:  
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
 2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.249	0.263	6.30	6.70
B	0.130	0.145	3.30	3.70
C	0.060	0.068	1.50	1.75
D	0.024	0.035	0.60	0.89
F	0.115	0.126	2.90	3.20
G	0.087	0.094	2.20	2.40
H	0.0008	0.0040	0.020	0.100
J	0.009	0.014	0.24	0.35
K	0.060	0.078	1.50	2.00
L	0.033	0.041	0.85	1.05
M	0°	10°	0°	10°
S	0.264	0.287	6.70	7.30

**CASE 318E-04  
 TO-261A  
 ISSUE H**

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