

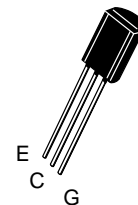
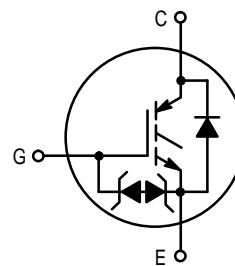
*Designer's™ Data Sheet*  
**Insulated Gate Bipolar Transistor**  
**N-Channel Enhancement-Mode Silicon Gate**

**MGS05N60D**

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

- Built-In Free Wheeling Diode
- Built-In Gate Protection Zener Diode
- Industry Standard Package (TO92 — 1.0 Watt)
- High Speed  $E_{off}$ : Typical  $6.5 \mu\text{s}$  @  $I_C = 0.3 \text{ A}$ ;  $T_C = 125^\circ\text{C}$  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**



**CASE 029-05**  
**TO-226AE**  
**TO92 (1.0 WATT)**

**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	$V_{GES}$	$\pm 15$	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 Power 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 CHARACTERISTICS**

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

**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 $I_L = 2.0 \text{ A}$ , $L = 3.0 \text{ mH}$ , $R_G = 25 \Omega$	$E_{AS}$	125 40	mJ
--	----------	-----------	----

(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.

Designer's is a trademark of Motorola, Inc.

# MGS05N60D

## ELECTRICAL CHARACTERISTICS (T<sub>C</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> = 250 μAdc) Temperature Coefficient (Positive)	B <sub>V</sub> CES	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%.

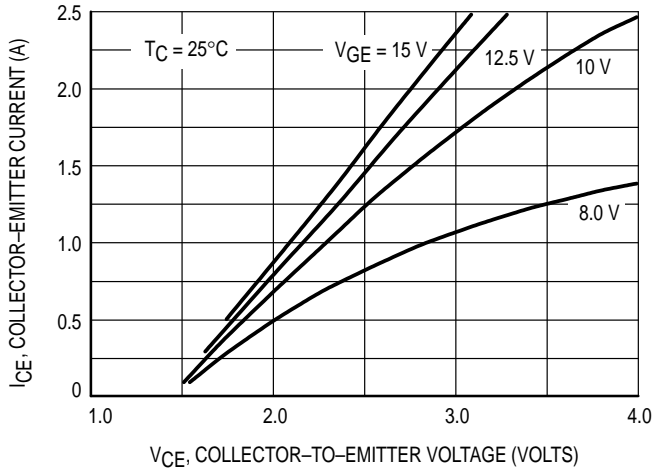


Figure 1. Saturation Characteristics

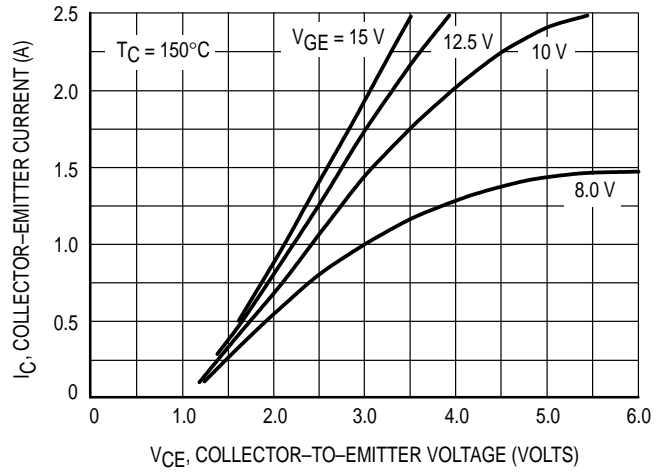


Figure 2. Saturation Characteristics

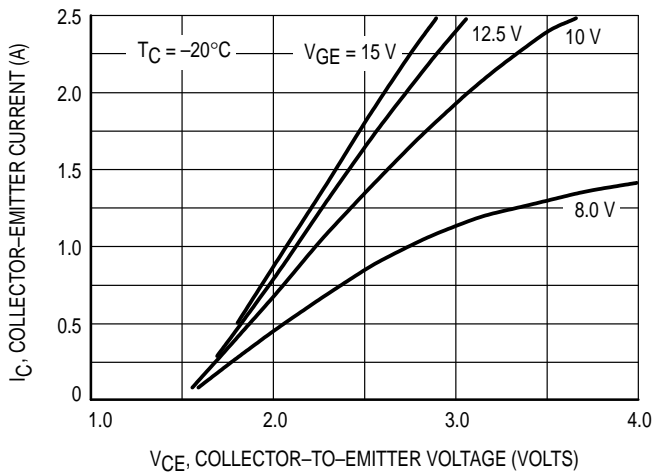


Figure 3. Saturation Characteristics

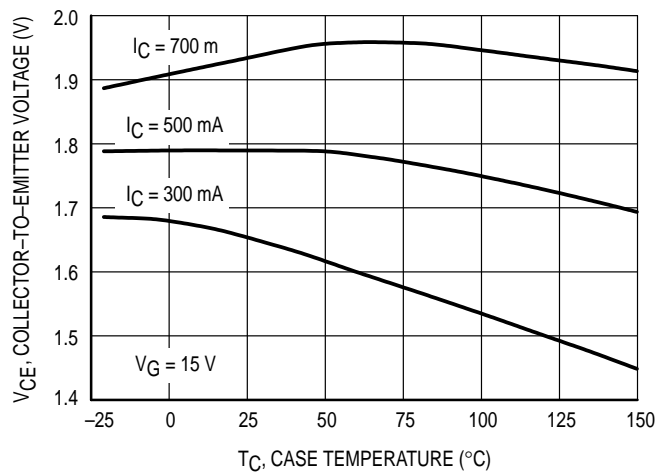


Figure 4. Collector-To-Emitter Saturation Voltage versus Case Temperature

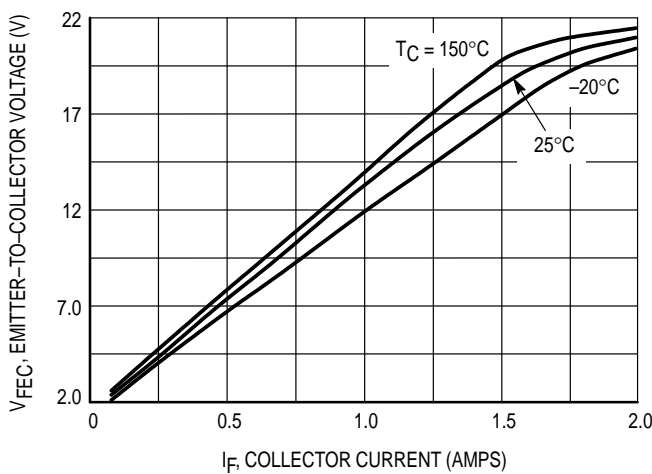


Figure 5. Diode Forward Voltage

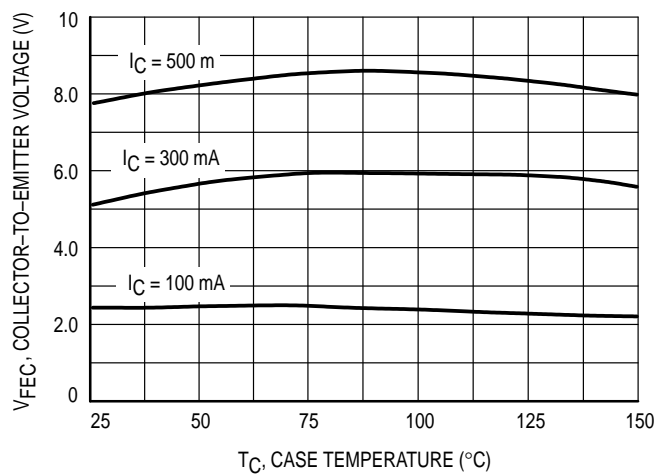
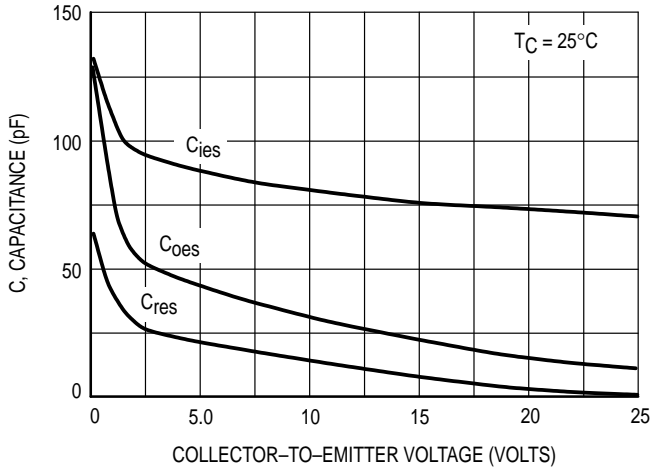
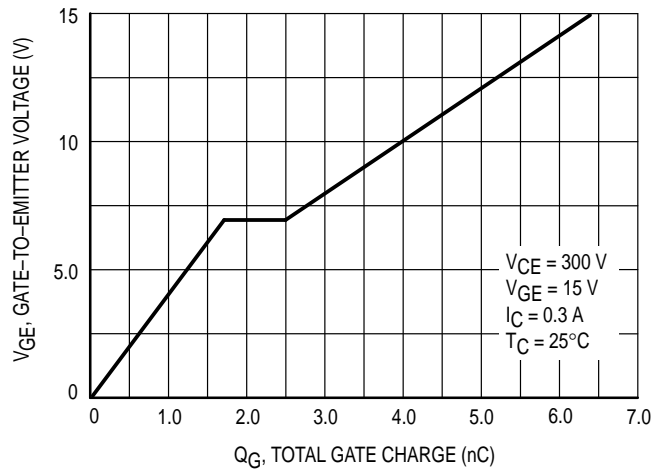


Figure 6. Diode Forward Voltage versus Case Temperature

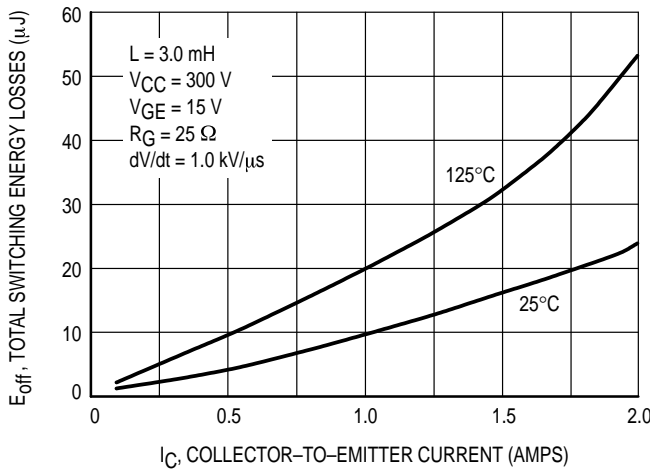
**MGS05N60D**



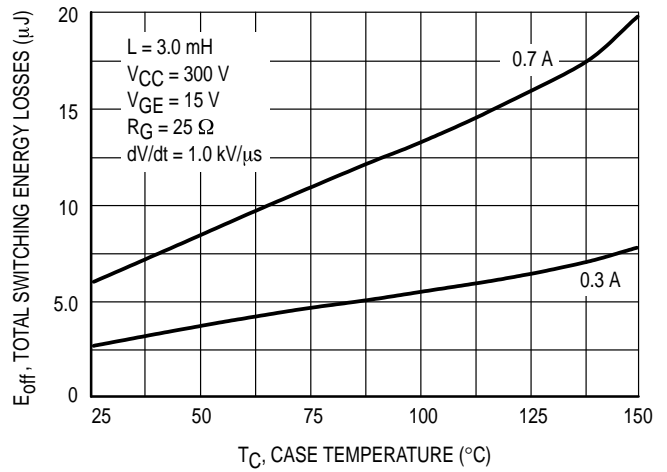
**Figure 7. Capacitance Variation**



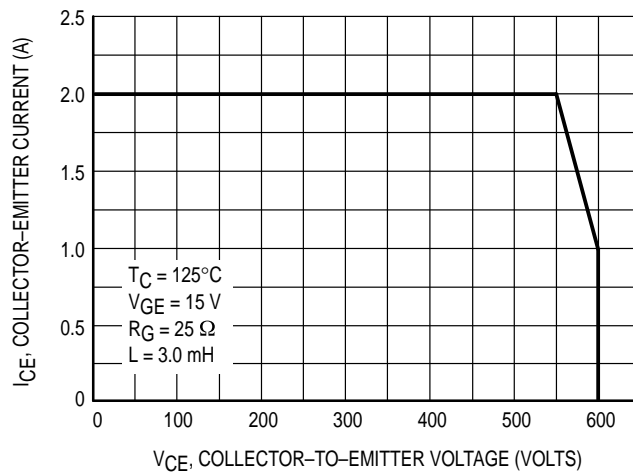
**Figure 8. Gate-To-Emitter Voltage versus Total Charge**



**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**

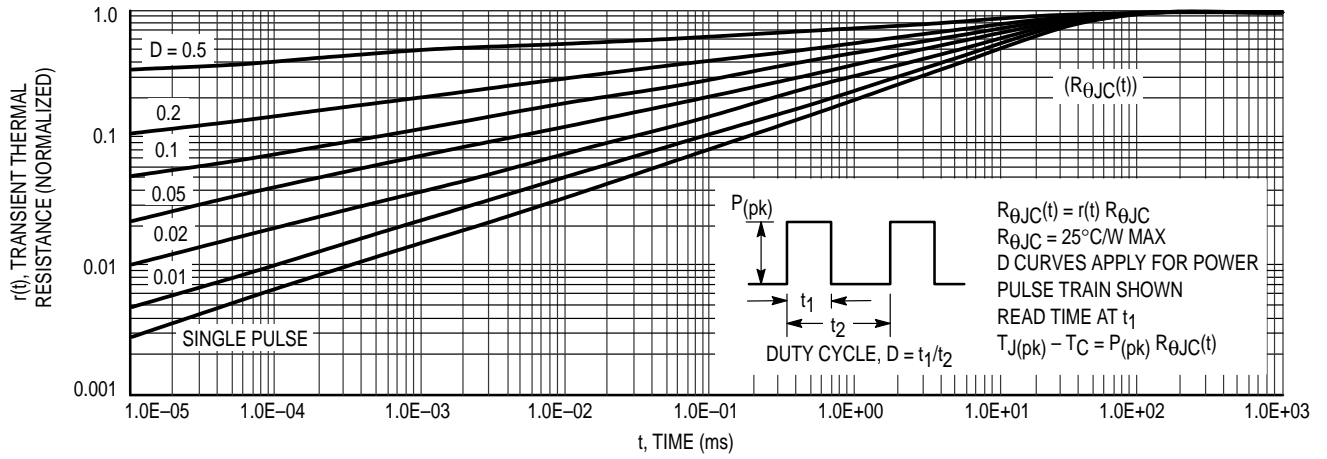
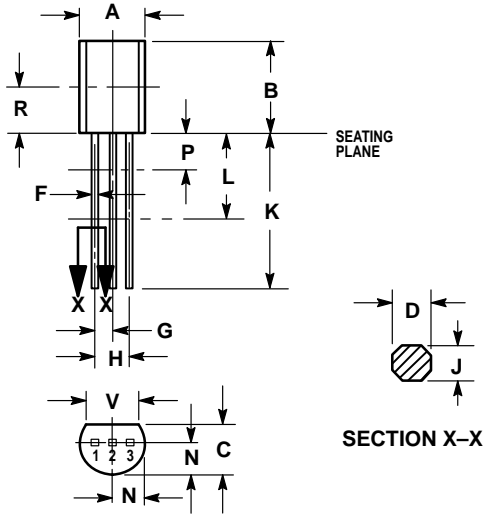


Figure 12. Typical Thermal Response

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 31:  
 PIN 1. GATE  
 2. DRAIN  
 3. SOURCE

CASE 029-05  
 TO-226AE  
 ISSUE AD

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters which may be provided in Motorola data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and  are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

Mfax is a trademark of Motorola, Inc.

How to reach us:

USA/EUROPE/Locations Not Listed: Motorola Literature Distribution;  
 P.O. Box 5405, Denver, Colorado 80217. 303-675-2140 or 1-800-441-2447

JAPAN: Nippon Motorola Ltd.: SPD, Strategic Planning Office, 4-32-1,  
 Nishi-Gotanda, Shinagawa-ku, Tokyo 141, Japan. 81-3-5487-8488

Mfax™: RMFAX0@email.sps.mot.com – TOUCHTONE 602-244-6609  
 – US & Canada ONLY 1-800-774-1848

ASIA/PACIFIC: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,  
 51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298

INTERNET: <http://motorola.com/sps>

