

The RF MOSFET Line

RF Power Field-Effect Transistor

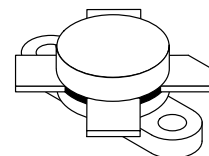
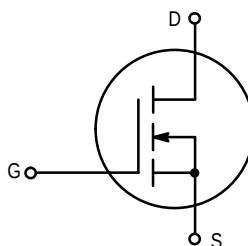
N-Channel Enhancement-Mode

Designed primarily for linear large-signal output stages up to 150 MHz frequency range.

- Specified 28 Volts, 30 MHz Characteristics
 - Output Power = 150 Watts
 - Power Gain = 15 dB (Typ)
 - Efficiency = 40% (Typ)
- Superior High Order IMD
- IMD_(d3) (150 W PEP) — -30 dB (Typ)
- IMD_(d11) (150 W PEP) — -60 dB (Typ)
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR

MRF140

**150 W, to 150 MHz
N-CHANNEL MOS
LINEAR RF POWER
FET**



CASE 211-11, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage	V_{DGO}	65	Vdc
Gate-Source Voltage	V_{GS}	± 40	Vdc
Drain Current — Continuous	I_D	16	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	300 1.7	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	$^\circ\text{C}/\text{W}$

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

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

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS

Drain–Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 100$ mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 28$ Vdc, $V_{GS} = 0$)	I_{DSS}	—	—	5.0	mAdc
Gate–Body Leakage Current ($V_{GS} = 20$ Vdc, $V_{DS} = 0$)	I_{GSS}	—	—	1.0	μAdc

ON CHARACTERISTICS

Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 100$ mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain–Source On–Voltage ($V_{GS} = 10$ V, $I_D = 10$ Adc)	$V_{DS(on)}$	0.1	0.9	1.5	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 5.0$ A)	g_{fs}	4.0	7.0	—	mhos

DYNAMIC CHARACTERISTICS

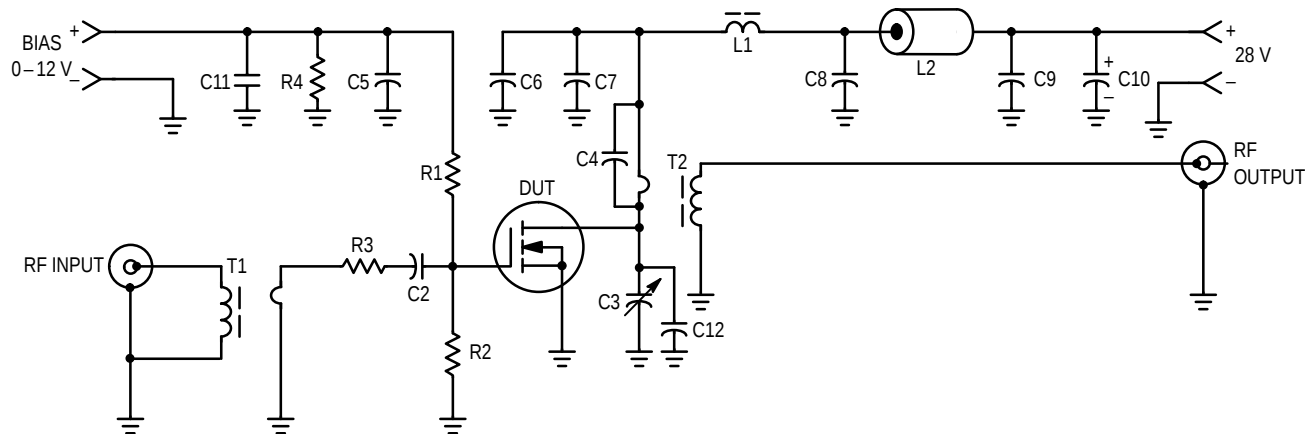
Input Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{iss}	—	450	—	pF
Output Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{oss}	—	400	—	pF
Reverse Transfer Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{rss}	—	75	—	pF

FUNCTIONAL TESTS (SSB)

Common Source Amplifier Power Gain ($V_{DD} = 28$ V, $P_{out} = 150$ W (PEP), $I_{DQ} = 250$ mA)	(30 MHz) (150 MHz)	G_{ps}	— —	15 6.0	— —	dB
Drain Efficiency ($V_{DD} = 28$ V, $P_{out} = 150$ W (PEP), $f = 30$; 30.001 MHz, I_D (Max) = 6.5 A)		η	—	40	—	%
Intermodulation Distortion (1) ($V_{DD} = 28$ V, $P_{out} = 150$ W (PEP), $f_1 = 30$ MHz, $f_2 = 30.001$ MHz, $I_{DQ} = 250$ mA)		IMD(d3) IMD(d11)	— —	–30 –60	— —	dB
Load Mismatch ($V_{DD} = 28$ V, $P_{out} = 150$ W (PEP), $f = 30$; 30.001 MHz, $I_{DQ} = 250$ mA, VSWR 30:1 at all Phase Angles)		ψ	No Degradation in Output Power			

NOTE:

- To MIL–STD–1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.



C2, C5, C6, C7, C8, C9 — 0.1 μF Ceramic Chip or Monolithic with Short Leads
 C3 — Arco 469
 C4 — 820 pF Unencapsulated Mica or Dipped Mica with Short Leads
 C10 — 10 $\mu\text{F}/100$ V Electrolytic
 C11 — 1 μF , 50 V, Tantalum
 C12 — 330 pF, Dipped Mica (Short leads)

L1 — VK200/4B Ferrite Choke or Equivalent, 3.0 μH
 L2 — Ferrite Bead(s), 2.0 μH
 R1, R2 — 51 $\Omega/1.0$ W Carbon
 R3 — 1.0 $\Omega/1.0$ W Carbon or Parallel Two 2 Ω , 1/2 W Resistors
 R4 — 1 k $\Omega/1/2$ W Carbon
 T1 — 16:1 Broadband Transformer
 T2 — 1:25 Broadband Transformer

Figure 1. 30 MHz Test Circuit (Class AB)

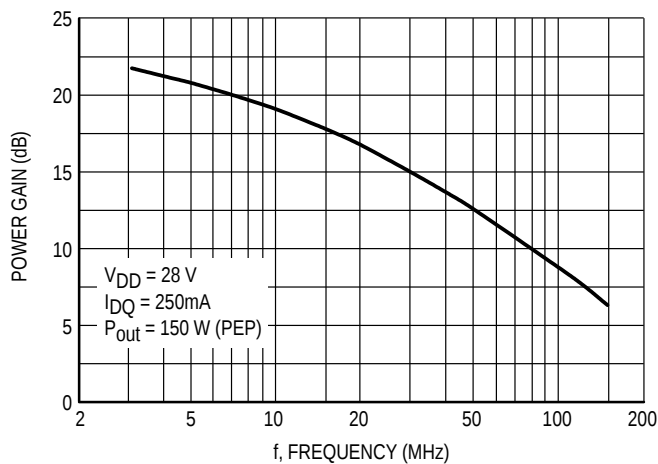


Figure 2. Power Gain versus Frequency

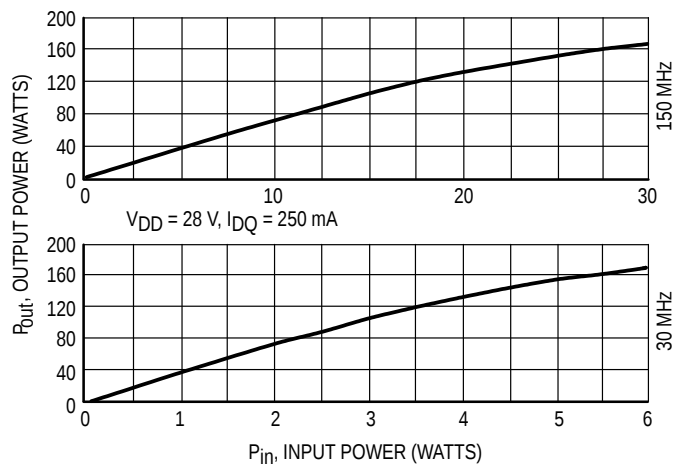


Figure 3. Output Power versus Input Power

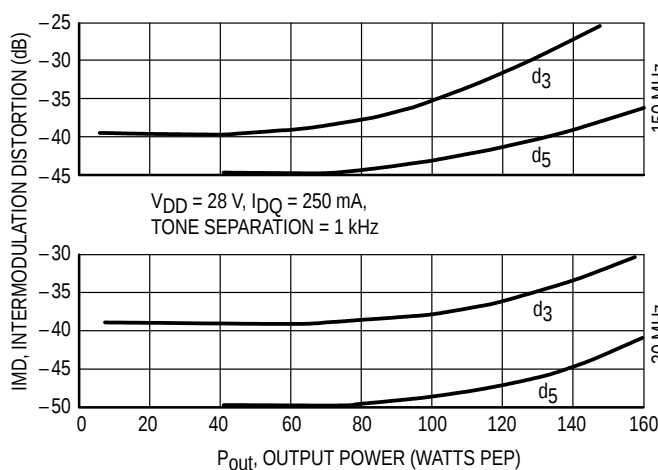


Figure 4. IMD versus Pout

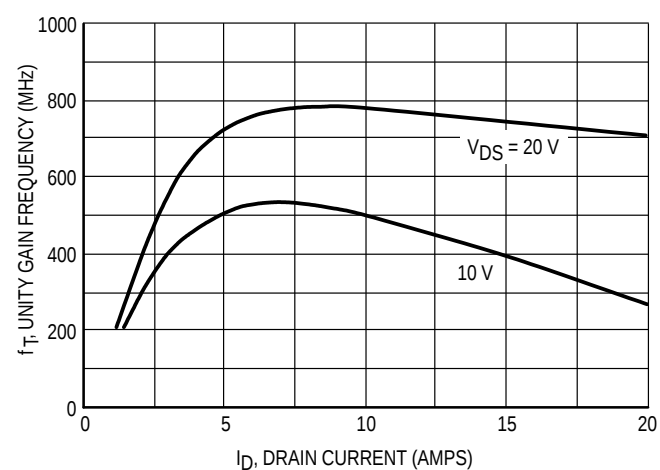


Figure 5. Common Source Unity Gain Frequency versus Drain Current

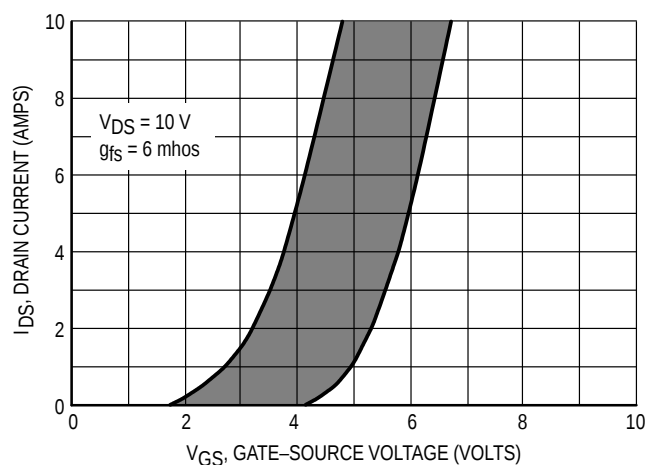


Figure 6. Gate Voltage versus Drain Current

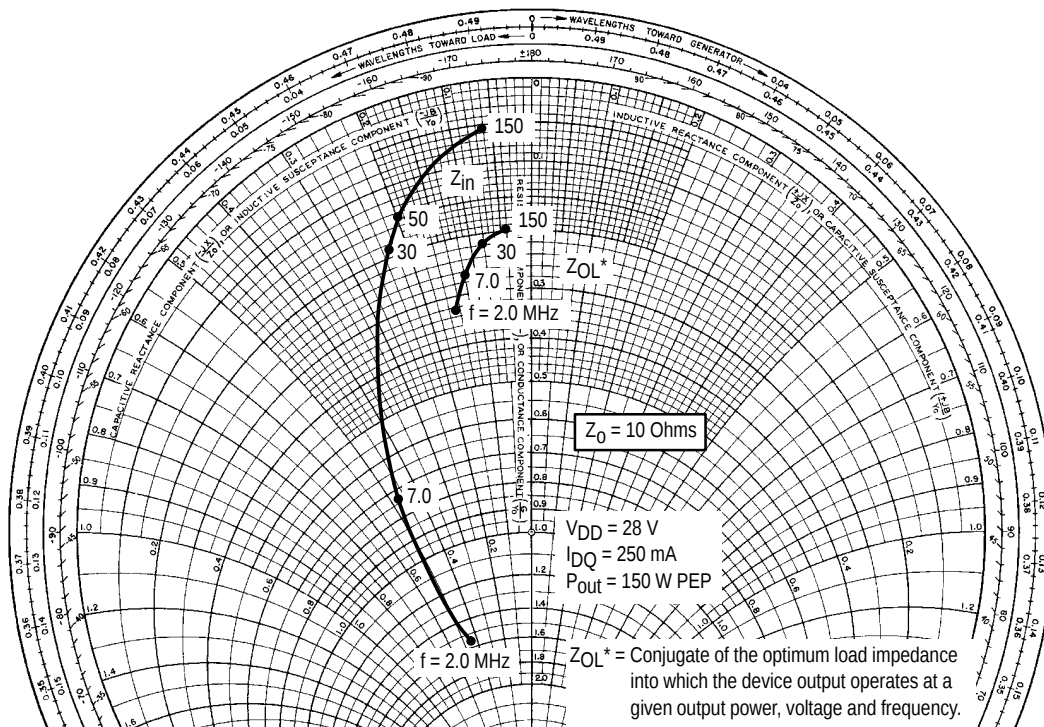
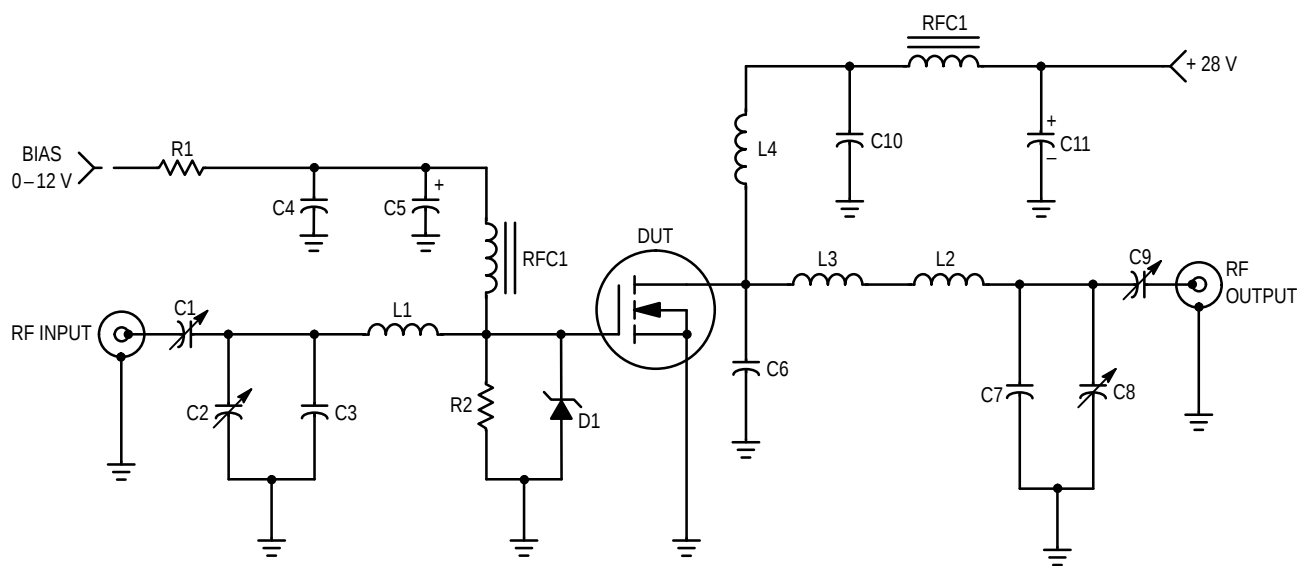


Figure 7. Series Equivalent Impedance



C1, C2, C8 — Arco 463 or equivalent
 C3 — 25 pF, Unelco
 C4 — 0.1 μ F, Ceramic
 C5 — 1.0 μ F, 15 WV Tantalum
 C6 — 15 pF, Unelco J101
 C7 — 25 pF, Unelco J101
 C9 — Arco 262 or equivalent
 C10 — 0.05 μ F, Ceramic
 C11 — 15 μ F, 35 WV Electrolytic

L1 — 3/4", #18 AWG into Hairpin
 L2 — Printed Line, 0.200" x 0.500"
 L3 — 7/8", #16 AWG into Hairpin
 L4 — 2 Turns, #16 AWG, 5/16 ID
 RFC1 — 5.6 μ H, Molded Choke
 RFC2 — VK200-4B
 R1, R2 — 150 Ω , 1.0 W Carbon

Figure 8. 150 MHz Test Circuit (Class AB)

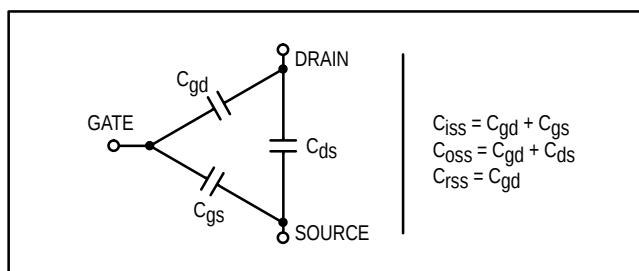
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the RF MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors.

Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the RF MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

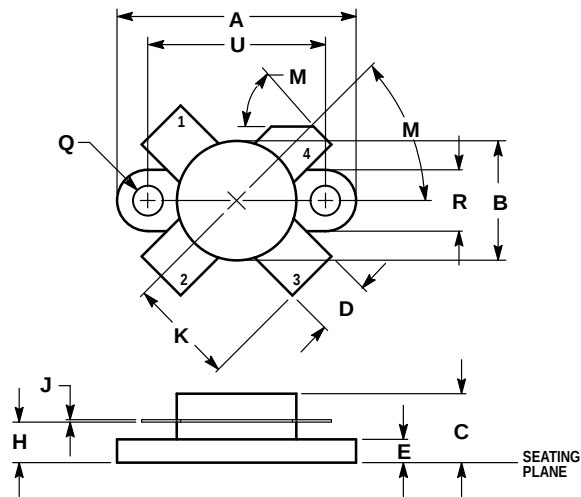
Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
V_{CBO}	V_{DGO}
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

PACKAGE DIMENSIONS



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

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.960	0.990	24.39	25.14
B	0.465	0.510	11.82	12.95
C	0.229	0.275	5.82	6.98
D	0.216	0.235	5.49	5.96
E	0.084	0.110	2.14	2.79
H	0.144	0.178	3.66	4.52
J	0.003	0.007	0.08	0.17
K	0.435	—	11.05	—
M	45°NOM		45°NOM	
Q	0.115	0.130	2.93	3.30
R	0.246	0.255	6.25	6.47
U	0.720	0.730	18.29	18.54

STYLE 2:
 PIN 1. SOURCE
 2. GATE
 3. SOURCE
 4. DRAIN

**CASE 211-11
 ISSUE N**

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>

