

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed primarily for large-signal output applications at 2450 MHz. Devices are suitable for use in industrial, medical and scientific applications.

- Typical CW Performance at 2450 MHz, $V_{DD} = 28$ Volts, $I_{DQ} = 1200$ mA, $P_{out} = 140$ Watts
 Power Gain — 13.2 dB
 Drain Efficiency — 45%
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2390 MHz, 140 Watts CW Output Power

Features

- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

MRF6S24140HR3
MRF6S24140HSR3

**2450 MHz, 140 W, 28 V
 CW
 LATERAL N-CHANNEL
 RF POWER MOSFETs**

**CASE 465B-03, STYLE 1
 NI-880
 MRF6S24140HR3**

**CASE 465C-02, STYLE 1
 NI-880S
 MRF6S24140HSR3**

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +68	Vdc
Gate-Source Voltage	V_{GS}	-0.5, +12	Vdc
Storage Temperature Range	T_{stg}	-65 to +150	°C
Case Operating Temperature	T_C	150	°C
Operating Junction Temperature (1,2)	T_J	225	°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Case Temperature 82°C, 140 W CW Case Temperature 75°C, 28 W CW	$R_{\theta JC}$	0.29 0.33	°C/W

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1955.

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	2 (Minimum)
Machine Model (per EIA/JESD22-A115)	A (Minimum)
Charge Device Model (per JESD22-C101)	IV (Minimum)

Table 4. Electrical Characteristics ($T_C = 25^\circ\text{C}$ unless otherwise noted)

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

Off Characteristics

Zero Gate Voltage Drain Leakage Current ($V_{DS} = 68\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current ($V_{DS} = 28\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current ($V_{GS} = 5\text{ Vdc}$, $V_{DS} = 0\text{ Vdc}$)	I_{GSS}	—	—	500	nAdc

On Characteristics

Gate Threshold Voltage ($V_{DS} = 10\text{ Vdc}$, $I_D = 300\ \mu\text{Adc}$)	$V_{GS(th)}$	1	2	3	Vdc
Gate Quiescent Voltage ($V_{DD} = 28\text{ Vdc}$, $I_D = 1300\text{ mAdc}$, Measured in Functional Test)	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 3\text{ Adc}$)	$V_{DS(on)}$	0.1	0.21	0.3	Vdc

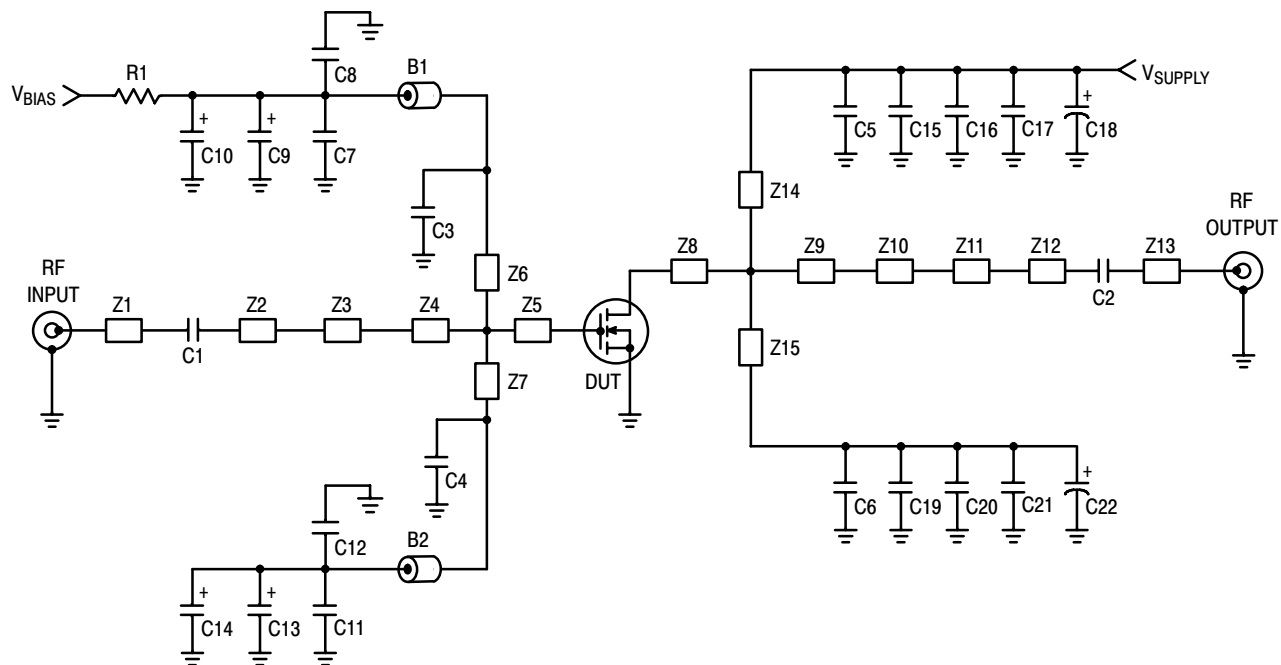
Dynamic Characteristics ⁽¹⁾

Reverse Transfer Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$)	C_{rss}	—	2	—	pF
---	-----------	---	---	---	----

Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 1300\text{ mA}$, $P_{out} = 28\text{ W Avg.}$, $f_1 = 2300\text{ MHz}$, $f_2 = 2310\text{ MHz}$ and $f_1 = 2390\text{ MHz}$, $f_2 = 2400\text{ MHz}$, 2-Carrier W-CDMA, 3.84 MHz Channel Bandwidth Carriers. ACPR measured in 3.84 MHz Channel Bandwidth @ $\pm 5\text{ MHz}$ Offset. IM3 measured in 3.84 MHz Bandwidth @ $\pm 10\text{ MHz}$ Offset. Input Signal PAR = 8.5 dB @ 0.01% Probability on CCDF.

Power Gain	G_{ps}	13	15.2	17	dB
Drain Efficiency	η_D	23	25	—	%
Intermodulation Distortion	IM3	—	-37	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-40	-38	dBc
Input Return Loss	IRL	—	-15	—	dB

1. Part internally matched both on input and output.

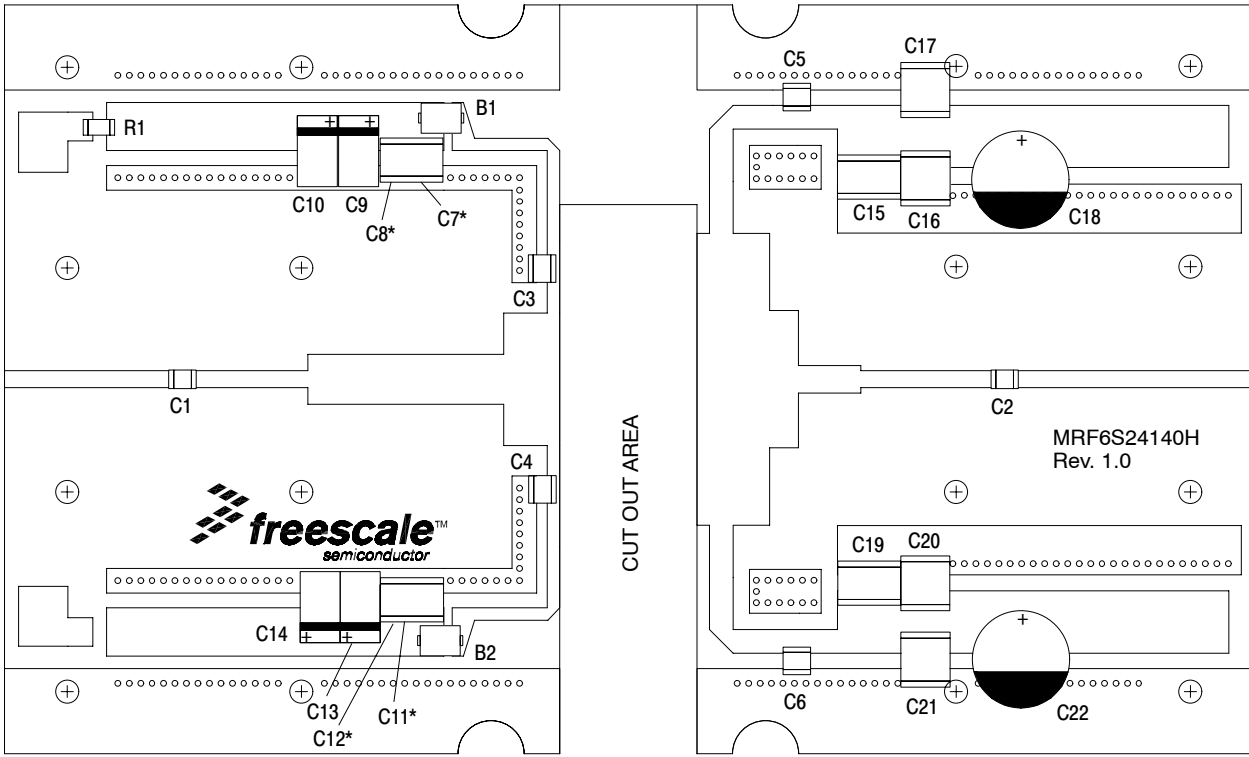


Z1	0.678" x 0.068" Microstrip	Z9	0.193" x 1.170" Microstrip
Z2	0.466" x 0.068" Microstrip	Z10	0.115" x 0.550" Microstrip
Z3	0.785" x 0.200" Microstrip	Z11	0.250" x 0.110" Microstrip
Z4	0.200" x 0.530" Microstrip	Z12	0.538" x 0.068" Microstrip
Z5	0.025" x 0.530" Microstrip	Z13	0.957" x 0.068" Microstrip
Z6, Z7	0.178" x 0.050" Microstrip	Z14, Z15	0.673" x 0.095" Microstrip
Z8	0.097" x 1.170" Microstrip	PCB	Arlon CuClad 250GX-0300-55-22, 0.030", $\epsilon_r = 2.55$

Figure 1. MRF6S24140HR3(SR3) Test Circuit Schematic — 2450 MHz

Table 5. MRF6S24140HR3(SR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1, B2	47 Ω , 100 MHz Short Ferrite Beads, Surface Mount	2743019447	Fair-Rite
C1, C2, C3, C4, C5, C6	5.6 pF Chip Capacitors	ATC600B5R6BT500XT	ATC
C7, C11	0.01 μ F, 100 V Chip Capacitors	C1825C103J1RAC	Kemet
C8, C12, C15, C19	2.2 μ F, 50 V Chip Capacitors	C1825C225J5RAC	Kemet
C9, C13	22 μ F, 25 V Tantalum Capacitors	T491D226M025AT	Kemet
C10, C14	47 μ F, 16 V Tantalum Capacitors	T491D476K016AT	Kemet
C16, C17, C20, C21	10 μ F, 50 V Chip Capacitors	GRM55DR61H106KA88B	Murata
C18, C22	220 μ F, 50 V Electrolytic Capacitors	2222-150-95102	Vishay
R1	240 Ω , 1/4 W Chip Resistor	CRC12062400FKEA	Vishay



* Stacked

Figure 2. MRF6S24140HR3(SR3) Test Circuit Component Layout — 2450 MHz

TYPICAL CHARACTERISTICS — 2450 MHz

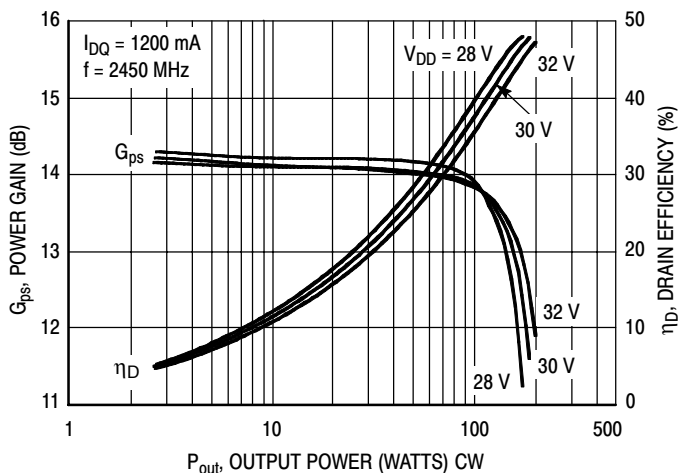


Figure 3. Power Gain and Drain Efficiency versus CW Output Power as a Function of V_{DD}

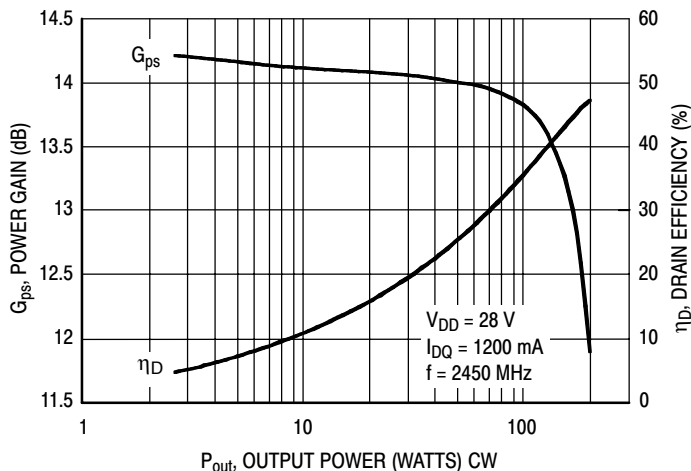


Figure 4. Power Gain and Drain Efficiency versus CW Output Power

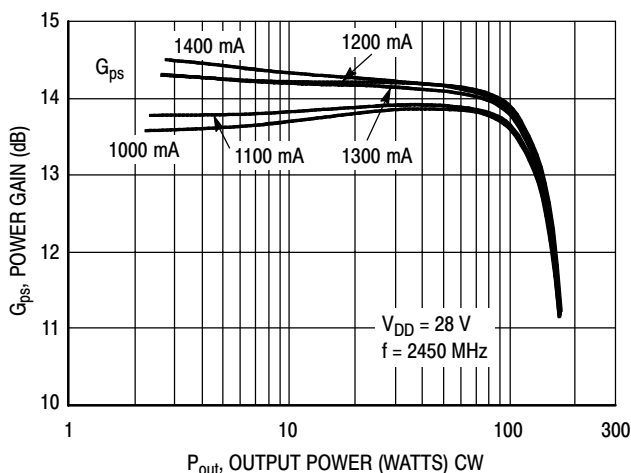
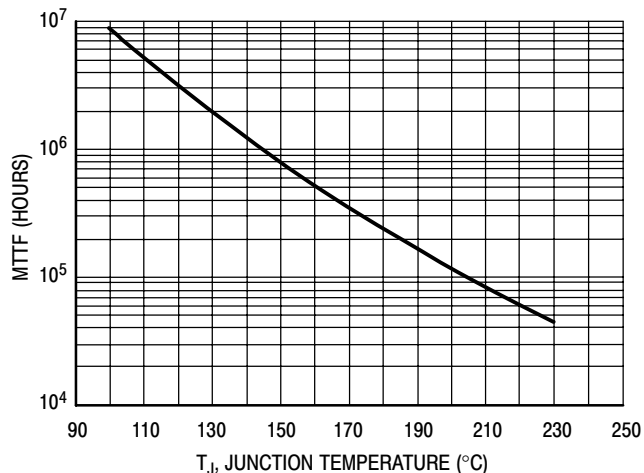


Figure 5. Power Gain and Drain Efficiency versus CW Output Power as a Function of Total I_{DQ}

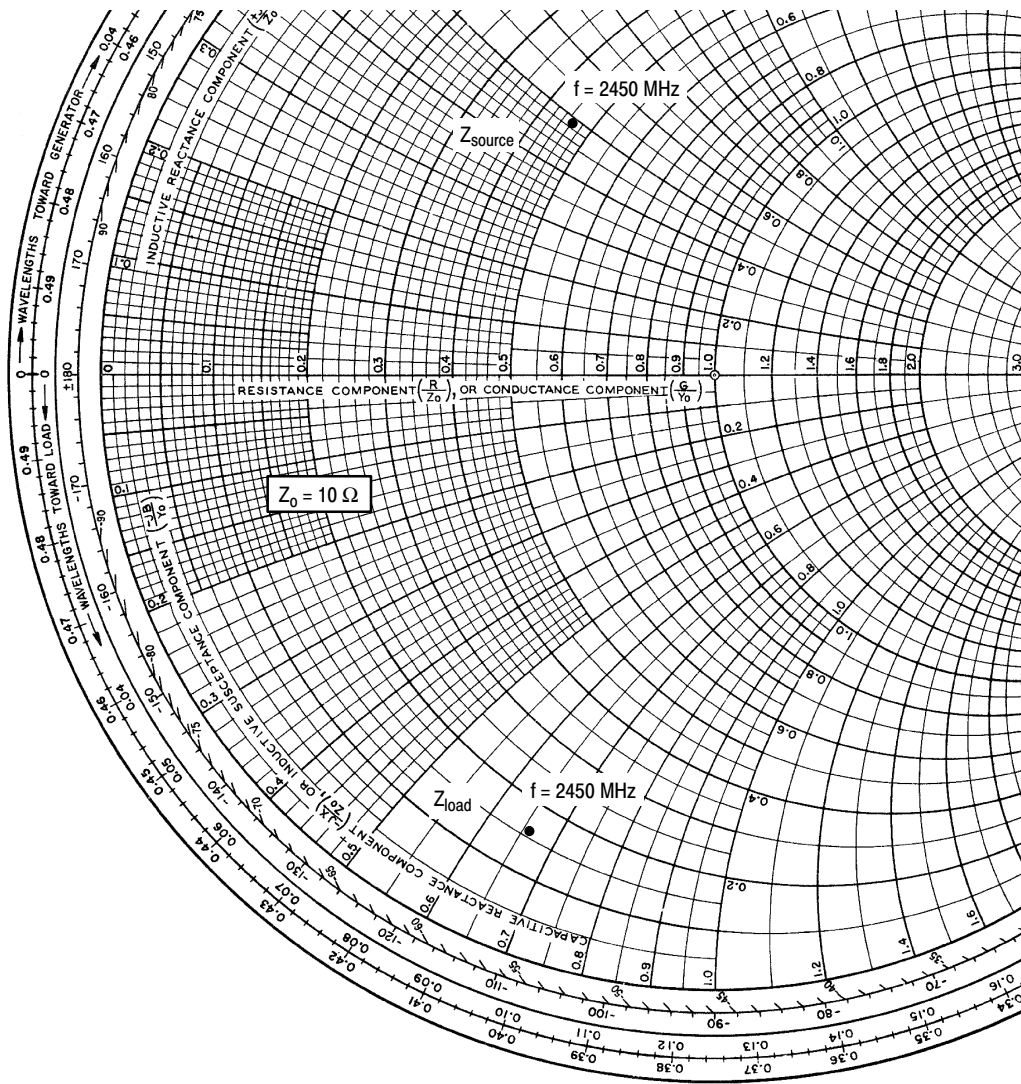


This above graph displays calculated MTTF in hours when the device is operated at $V_{DD} = 28$ Vdc, $P_{out} = 140$ W CW, and $\eta_D = 45\%$.

MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.

Figure 6. MTTF versus Junction Temperature

MRF6S24140HR3 MRF6S24140HSR3



$V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 1200 \text{ mA}$, $P_{out} = 140 \text{ W CW}$

f MHz	Z_{source} Ω	Z_{load} Ω
2450	$4.55 + j4.9$	$1.64 - j6.57$

Z_{source} = Test circuit impedance as measured from gate to ground.

Z_{load} = Test circuit impedance as measured from drain to ground.

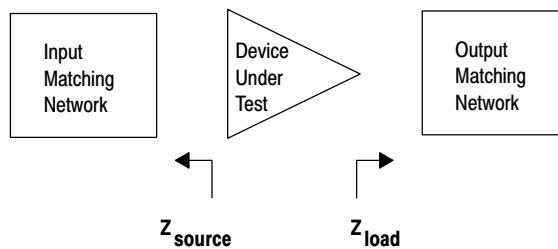


Figure 7. Series Equivalent Source and Load Impedance

PRODUCT DOCUMENTATION

Refer to the following documents to aid your design process.

Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	Mar. 2007	<ul style="list-style-type: none">• Initial Release of Data Sheet
1	Apr. 2008	<ul style="list-style-type: none">• Operating Junction Temperature increased from 200°C to 225°C in Maximum Ratings table and related "Continuous use at maximum temperature will affect MTTF" footnote added, p. 1• Corrected V_{DS} to V_{DD} in the RF test condition voltage callout for $V_{GS(Q)}$, and added "Measured in Functional Test", On Characteristics table, p. 2• Updated PCB information to show more specific material details, Fig. 1, Test Circuit Schematic, p. 3

How to Reach Us:

Home Page:

www.freescale.com

Web Support:

<http://www.freescale.com/support>

USA/Europe or Locations Not Listed:

Freescale Semiconductor, Inc.
Technical Information Center, EL516
2100 East Elliot Road
Tempe, Arizona 85284
+1-800-521-6274 or +1-480-768-2130
www.freescale.com/support

Europe, Middle East, and Africa:

Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
www.freescale.com/support

Japan:

Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:

Freescale Semiconductor Hong Kong Ltd.
Technical Information Center
2 Dai King Street
Tai Po Industrial Estate
Tai Po, N.T., Hong Kong
+800 2666 8080
support.asia@freescale.com

For Literature Requests Only:

Freescale Semiconductor Literature Distribution Center
P.O. Box 5405
Denver, Colorado 80217
1-800-441-2447 or 303-675-2140
Fax: 303-675-2150
LDCForFreescaleSemiconductor@hibbertgroup.com

Information in this document is provided solely to enable system and software implementers to use Freescale Semiconductor products. There are no express or implied copyright licenses granted hereunder to design or fabricate any integrated circuits or integrated circuits based on the information in this document.

Freescale Semiconductor reserves the right to make changes without further notice to any products herein. Freescale Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Freescale Semiconductor 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 that may be provided in Freescale Semiconductor 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. Freescale Semiconductor does not convey any license under its patent rights nor the rights of others. Freescale Semiconductor 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 Freescale Semiconductor product could create a situation where personal injury or death may occur. Should Buyer purchase or use Freescale Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold Freescale Semiconductor 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 Freescale Semiconductor was negligent regarding the design or manufacture of the part.

Freescale™ and the Freescale logo are trademarks of Freescale Semiconductor, Inc. All other product or service names are the property of their respective owners.

© Freescale Semiconductor, Inc. 2007-2008. All rights reserved.

