



# High Accuracy Low g Inertial Sensor

## MEMS Sensing, State Machine ASIC

The MMA6700EG series is a dual axis, Low g, XY-axis sensor based on Freescale's HARMEMES technology with an embedded DSP ASIC allowing for additional processing of the digital or analog signals.

### Features

- XY-axis of sensitivity in one device
- 10- or 11-bit digital data output
- $\pm 3.5$  g or  $\pm 5$  g full-scale range per axis
  - MMA6700EG:  $\pm 3.5$  g (11-bit data sensitivity = 3.43 mg/digit typical at 25°C)
  - MMA6701EG:  $\pm 5$  g (11-bit data sensitivity = 4.91 mg/digit typical at 25°C)
- SPI-compatible serial interface
- Bidirectional internal self-test
- On-chip temperature sensor and voltage regulator
- Support for signed or unsigned output data
- Selection of integrated signal conditioning low-pass filters
- Capture/hold input for system-wide synchronization support
- 3.3 V or 5 V single supply operation
- Ratiometric analog voltage output
- Traceability through programmable registers, 3 8-bit.
- Customer-assigned one-time-programmable Registers (2 8-bit Registration)
- Minimal external component requirements
- Wide operating temperature range from -40°C to +125°C
- 20-pin SOIC wide-body RoHS-compliant package
- Minimum external components, 4 capacitors

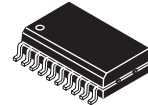
### Typical Applications

- With a +3.5 g or +5 g full scale range, the newly designed, high accuracy sensor enables electronic stability control (ESC) designers to accommodate higher original signal noise level without sacrificing resolution.
- Tilt Measurement

ORDERING INFORMATION			
Device	Temp. Range	Case No.	Package
MMA6700EGR2	- 40 to +125°C	475A-02	SOIC-20, Tape and Reel
MMA6700AEGR2	- 40 to +125°C	475A-02	SOIC-20, Tape and Reel
MMA6701EGR2	- 40 to +125°C	475A-02	SOIC-20, Tape and Reel
MMA6701AEGR2	- 40 to +125°C	475A-02	SOIC-20, Tape and Reel

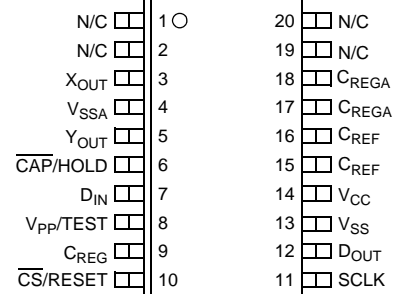
**MMA6700EG**  
**MMA6701EG**

**DUAL AXIS**  
**LOW g INERTIAL SENSOR**



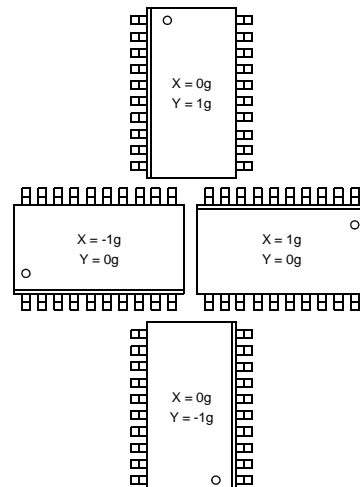
**EG SUFFIX (Pb-free)**  
**20-LEAD SOIC**  
**CASE 475A-02**

### PIN CONNECTIONS



20-PIN SOIC PACKAGE

N/C: NO INTERNAL CONNECTION



This document contains a product under development. Freescale Semiconductor reserves the right to change or discontinue this product without notice.

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



# BLOCK DIAGRAM

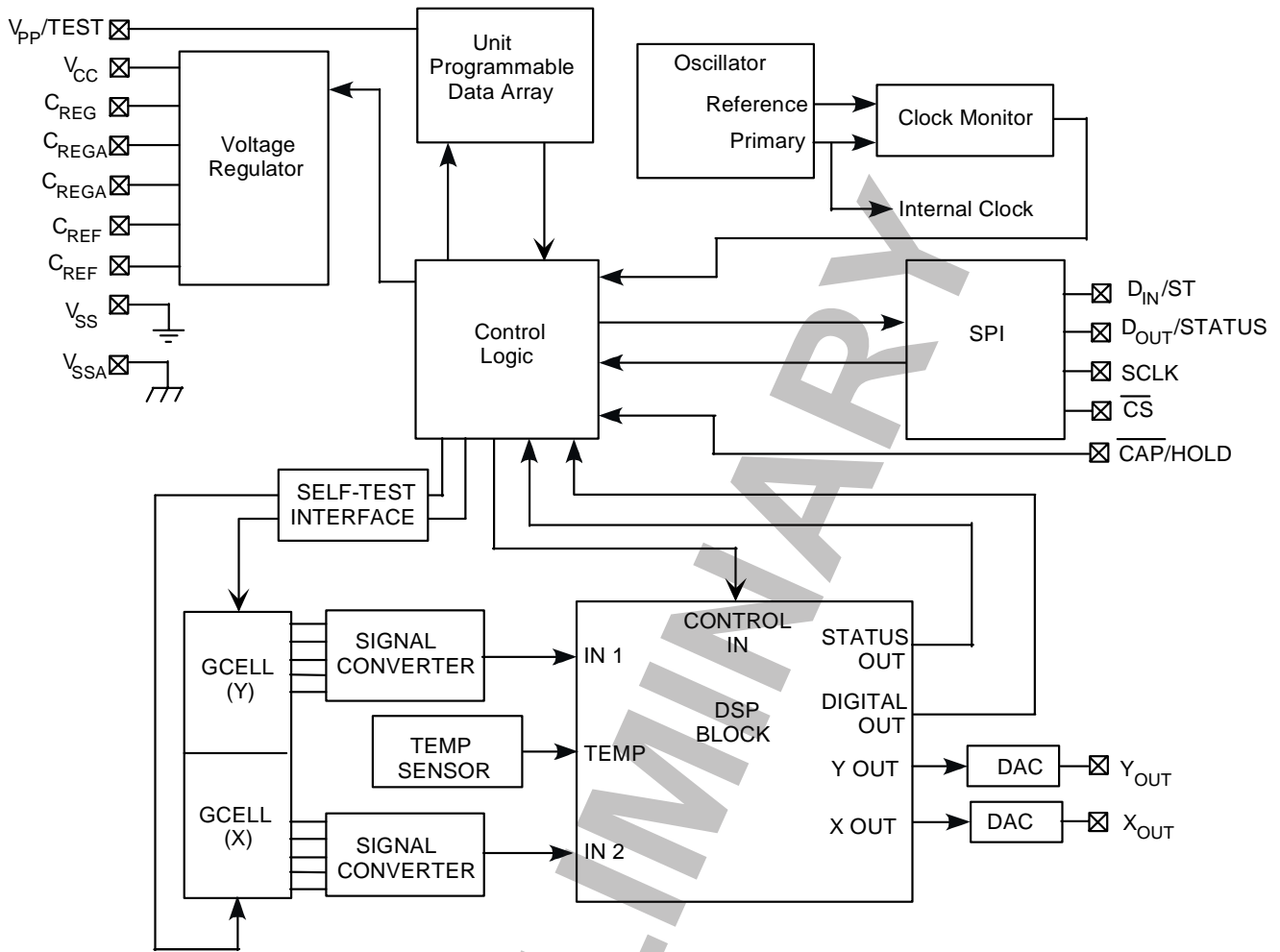


Figure 1. Block Diagram

## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	$V_{CC}$	-0.3 to 7.0	Vdc
$C_{REG}$ , $C_{REGA}$ , $V_{REF}$	$V_{REG}$	-0.3 to 3.0	Vdc
$V_{PP}/TEST$	$V_{PP}$	-0.3 to 11.0	Vdc
SCLK, CS, $D_{IN}/ST,CAP/HOLD$	$V_{IN}$	-0.3 to $V_{CC} + 0.3$	Vdc
$D_{OUT}/STATUS$ (high impedance state)	$V_{OUT}$	-0.3 to $V_{CC} + 0.3$	Vdc
$X_{OUT}, Y_{OUT}$ (DACEN=0)	$V_{DAC}$	-0.3 to $V_{CC} + 0.3$	Vdc
Current Drain Per Pin Excluding $V_{CC}$ and $V_{SS}$	I	10	mAmps
Powered Shock (six sides, 0.5 ms duration)	$g_{pms}$	$\pm 1500$	g
Unpowered Shock (six sides, 0.5 ms duration)	$g_{shock}$	$\pm 2000$	g
Drop Shock (to concrete surface)	$h_{drop}$	1.2	m
Electrostatic Discharge			
Human Body Model (HBM)	$V_{ESD}$	$\pm 2000$	V
Charge Device Model (CDM)	$V_{ESD}$	$\pm 500$	V
Machine Model (MM)	$V_{ESD}$	$\pm 200$	V
Storage Temperature Range	$T_{stg}$	-40°C to +125°C	°C

## PERFORMANCE CHARACTERISTICS

Parameter	Symbol	Min	Typ	MAX	UNITS
Supply Voltage Standard Operating Voltage, 3.3 V Standard Operating Voltage, 5V	$V_{CC}$ $V_{CC}$	$V_L$ +3.15 +4.75	+3.3 +5.0	$V_H$ +3.45 +5.25	V V
Operating Temperature Range	$T_A$	$T_L$ -40	-	$T_H$ +125	°C
Supply Current Standard Operating Voltage, 5.0 V (Digital with Analog Enabled)	$I_{dd}$	-	-	+9.5	mAmp
Programming Voltage Applied to $V_{PP}/TEST$	$V_{PP}$	+7.5	+8.0	+8.5	V
Programming Current Applied to $V_{PP}/TEST$	$I_{PP}$	-	-	160	mAmp
Test Mode Activation Voltage Applied to $V_{PP}/TEST$	$V_{TEST}$	+6.5	+7.2	+7.5	V
Measurement Range, XY axis	g	-3.5	-	+3.5	g
Digital Sensitivity ( $D_{OUT}$ )	SENS		3.43		mg/digit
Analog Sensitivity ( $X_{OUT}$ , $Y_{OUT}$ ) Ratiometric to $V_{CC}$	SENS		115		mV/V/g
Sensitivity Error ( $D_{OUT}$ ) $T_A = +25^\circ\text{C}$ $-40^\circ\text{C} \leq T_A \leq +105^\circ\text{C}$ $+105^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	SENS SENS SENS	-3.0 -4.0 -6.0	- - -	+3.0 +4.0 +6.0	% % %
Offset at 0g, SPI, 11-Bit unsigned data Analog Output	$D_{OUT}$ $A_{OUT}$	- -	1024 0.5 $V_{CC}$	-	Digit V
Offset Error at 0g, SPI, 11-Bit Unsigned Data $T_A = +25^\circ\text{C}$ $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	$D_{OUT}$ $D_{OUT}$	-15 -22	- -	+15 +22	Digit Digit
Offset Error at 0g, analog output $T_A = +25^\circ\text{C}$ $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	$A_{OUT}$ $A_{OUT}$	-3 -5	- -	+3 +5	Digit Digit
DSP Low-Pass Filter (2 <sup>nd</sup> or 4 <sup>th</sup> Order Selectable) Filter Option \$00, \$13 Filter Option \$01, \$14 Filter Option \$03, \$16 Filter Option \$02, \$15 Filter Option \$04, \$17 Filter Option \$06, \$19 Filter Option \$05, \$18 Filter Option \$07 Filter Option \$1A	$f_C(LPF)$ $f_C(LPF)$ $f_C(LPF)$ $f_C(LPF)$ $f_C(LPF)$ $f_C(LPF)$ $f_C(LPF)$ $f_C(LPF)$ $f_C(LPF)$	8.4 12.4 41.9 47.5 62.8 66.5 83.9 95 134	8.8 13.1 44.1 50.0 66.1 70.0 88.3 100 141	9.2 13.8 46.3 52.5 69.4 73.5 92.7 105 148	Hz Hz Hz Hz Hz Hz Hz Hz Hz
Cross- Axis Sensitivity		-4.0	-	+4.0	%
SPI Clock Rate	$t_{SCLK}$	8.33	-	-	MHz
Noise (1Hz – 1kHz)	$n_{SD}$	-	-	140	µg/Hz
Output Loading ( $D_{OUT}/STATUS$ ) Load Resistance Load Capacitance	$Z_{OUT}$ $C_{OUT}$	47 -	- -	- 35	k pF

## EXTERNAL COMPONENTS

The MMA6700EG requires minimum external components. Aside from a supply bypass capacitor, two 1  $\mu\text{F}$  capacitors provide filtering for the internal analog and digital power supply rails, while a third, 100 nF filter capacitor is required for the internal voltage reference. This circuit configuration is illustrated in Figure 2. Redundant pins are provided for the internal voltage reference and analog supply rails. In safety critical applications, these pins may be connected to separate external capacitors to guard against circuit malfunction in the event of a fault such as an open filter capacitor connection. An internal monitor detects an open digital supply rail filter capacitor condition, which puts the device into reset should this fault occur.

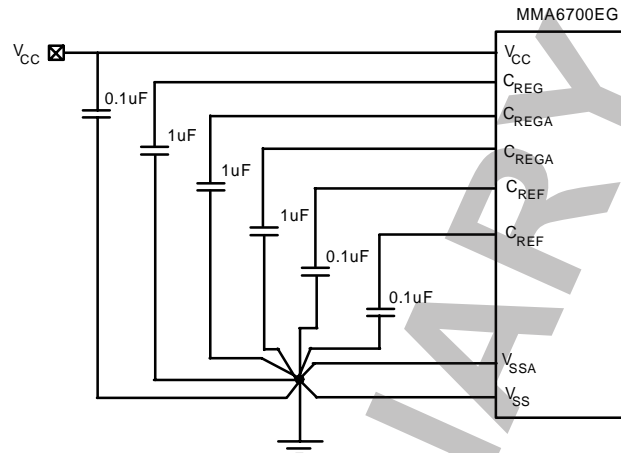
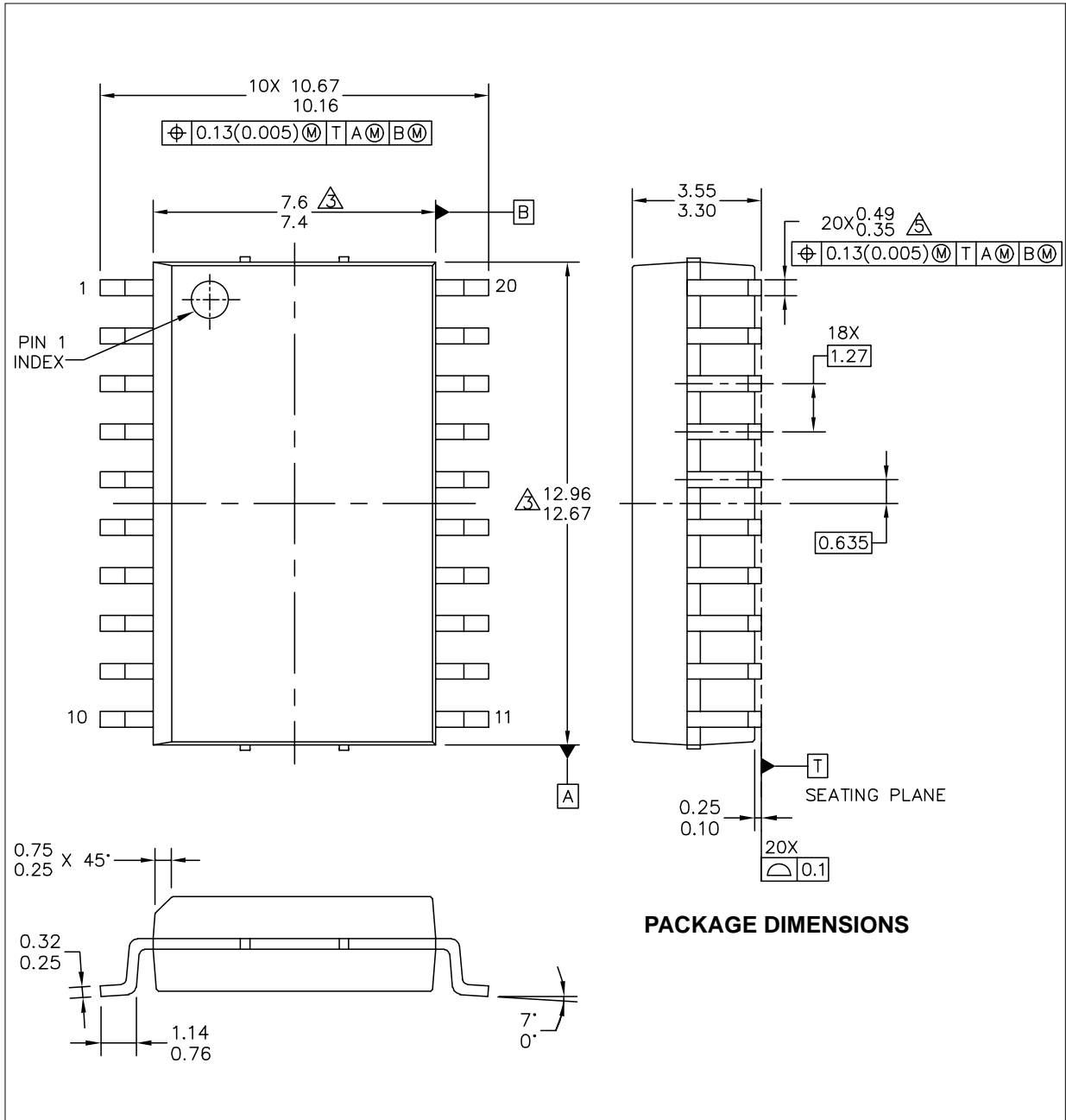


Figure 2. Recommended External Component Configuration

# PACKAGE DIMENSIONS



**PACKAGE DIMENSIONS**

© FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED.	<b>MECHANICAL OUTLINE</b>	PRINT VERSION NOT TO SCALE	
TITLE: 20LD SOIC W/B, 1.27 PITCH 7.5 X 12.8, ACCELEROMETER CASE-OUTLINE	DOCUMENT NO: 98ASB17933C	REV: C	
	CASE NUMBER: 475A-02	06 JUL 2006	
	STANDARD: NON-JEDEC		

## PACKAGE DIMENSIONS

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.

2. DIMENSIONS ARE IN MILLIMETERS.

3. THIS DIMENSION DO NOT INCLUDE MOLD PROTRUSION.

4. MAXIMUM MOLD PROTRUSION 0.15(0.006) PER SIDE.

5. THIS DIMENSION DOES NOT INCLUDE DAM BAR PROTRUSION ALLOWABLE DAM BAR PROTRUSION SHALL BE 0.13(0.005) TOTAL IN EXCESS OF THIS DIMENSION AT MAXIMUM MATERIAL CONDITION.

© FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED.	<b>MECHANICAL OUTLINE</b>	PRINT VERSION NOT TO SCALE	
TITLE: 20LD SOIC W/B, 1.27 PITCH 7.5 X 12.8, ACCLEROMETER CASE-OUTLINE	DOCUMENT NO: 98ASB17933C	REV: C	
	CASE NUMBER: 475A-02	06 JUL 2006	
	STANDARD: NON-JEDEC		

## **How to Reach Us:**

### **Home Page:**

[www.freescale.com](http://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](http://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](http://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](mailto:support.japan@freescale.com)

### **Asia/Pacific:**

Freescale Semiconductor China Ltd.  
Exchange Building 23F  
No. 118 Jianguo Road  
Chaoyang District  
Beijing 100022  
China  
+86 10 5879 8000  
[support.asia@freescale.com](mailto: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 +1-303-675-2140  
Fax: +1-303-675-2150  
[LDCForFreescaleSemiconductor@hibbertgroup.com](mailto: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., 2008. All rights reserved.

RoHS-compliant and/or Pb-free versions of Freescale products have the functionality and electrical characteristics of their non-RoHS-compliant and/or non-Pb-free counterparts. For further information, see <http://www.freescale.com> or contact your Freescale sales representative.

For information on Freescale's Environmental Products program, go to <http://www.freescale.com/epp>.