



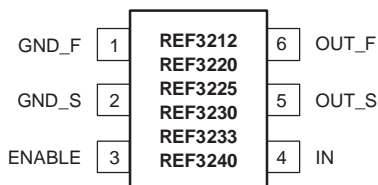
## 4ppm/°C, 100µA, SOT23-6 SERIES VOLTAGE REFERENCE

### FEATURES

- **EXCELLENT SPECIFIED DRIFT PERFORMANCE:**  
7ppm/°C (max) at 0°C to +125°C  
20ppm/°C (max) at –40°C to +125°C
- **MICROSIZE PACKAGE: SOT23-6**
- **HIGH OUTPUT CURRENT: ±10mA**
- **HIGH ACCURACY: 0.01%**
- **LOW QUIESCENT CURRENT: 100µA**
- **LOW DROPOUT: 5mV**

### APPLICATIONS

- PORTABLE EQUIPMENT
- DATA ACQUISITION SYSTEMS
- MEDICAL EQUIPMENT
- TEST EQUIPMENT



### DESCRIPTION

The REF32xx is a very low drift, micropower, low-dropout, precision voltage reference family available in the tiny SOT23-6 package.

The small size and low power consumption (120µA max) of the REF32xx make it ideal for portable and battery-powered applications. This reference is stable with any capacitive load.

The REF32xx can be operated from a supply as low as 5mV above the output voltage, under no load conditions. All models are specified for the wide temperature range of –40°C to +125°C.

### AVAILABLE OUTPUT VOLTAGES

| PRODUCT | VOLTAGE |
|---------|---------|
| REF3212 | 1.25V   |
| REF3220 | 2.048V  |
| REF3225 | 2.5V    |
| REF3230 | 3.0V    |
| REF3233 | 3.3V    |
| REF3240 | 4.096V  |



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.

**ABSOLUTE MAXIMUM RATINGS(1)**

|                       |                 |
|-----------------------|-----------------|
| Input Voltage         | +7.5V           |
| Output Short-Circuit  | Continuous      |
| Operating Temperature | -55°C to +135°C |
| Storage Temperature   | -65°C to +150°C |
| Junction Temperature  | +150°C          |
| ESD Rating            |                 |
| Human Body Model      | 4kV             |
| Charged Device Model  | 1kV             |
| Machine Model         | 400V            |

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

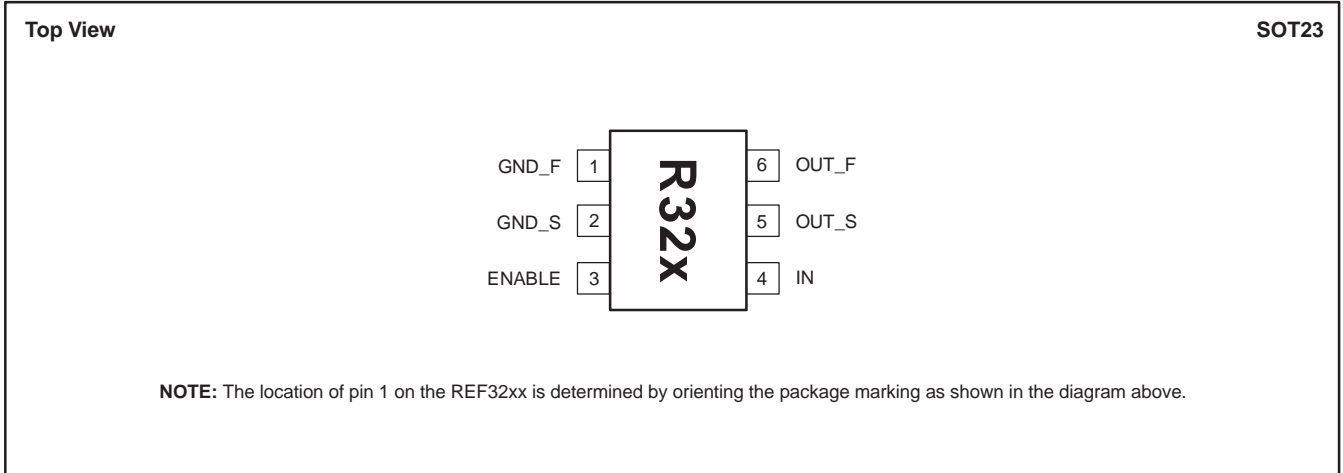
ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

**PACKAGE/ORDERING INFORMATION(1)**

| PRODUCT | OUTPUT VOLTAGE | PACKAGE-LEAD | PACKAGE DESIGNATOR | PACKAGE MARKING |
|---------|----------------|--------------|--------------------|-----------------|
| REF3212 | 1.25V          | SOT23-6      | DBV                | R32A            |
| REF3220 | 2.048V         | SOT23-6      | DBV                | R32B            |
| REF3225 | 2.5V           | SOT23-6      | DBV                | R32C            |
| REF3230 | 3.0V           | SOT23-6      | DBV                | R32D            |
| REF3233 | 3.30V          | SOT23-6      | DBV                | R32E            |
| REF3240 | 4.096V         | SOT23-6      | DBV                | R32F            |

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.

**PIN CONFIGURATION**



**ELECTRICAL CHARACTERISTICS**
**Boldface** limits apply over the listed temperature range.

 At  $T_A = +25^\circ\text{C}$ ,  $I_{\text{LOAD}} = 0\text{mA}$ , and  $V_{\text{IN}} = 5\text{V}$ , unless otherwise noted.

| PARAMETER  | CONDITIONS                             | REF32xx        |               |               | UNIT  |
|--|--|----------------|---------------|---------------|---|
|  |  | MIN            | TYP           | MAX           |   |
| <b>REF3212 (1.25V)</b>   |  |                |               |               |   |
| <b>OUTPUT VOLTAGE, <math>V_{\text{OUT}}</math></b><br>Initial Accuracy |  | 1.2475<br>-0.2 | 1.25<br>0.01  | 1.2525<br>0.2 | V<br>%  |
| <b>NOISE</b><br>Output Voltage Noise<br>Voltage Noise                  | f = 0.1Hz to 10Hz<br>f = 10Hz to 10kHz |                | 17<br>24      |               | $\mu\text{V}_{\text{PP}}$<br>$\mu\text{V}_{\text{RMS}}$ |
| <b>REF3220 (2.048V)</b>  |  |                |               |               |   |
| <b>OUTPUT VOLTAGE, <math>V_{\text{OUT}}</math></b><br>Initial Accuracy |  | 2.044<br>-0.2  | 2.048<br>0.01 | 2.052<br>0.2  | V<br>%  |
| <b>NOISE</b><br>Output Voltage Noise<br>Voltage Noise                  | f = 0.1Hz to 10Hz<br>f = 10Hz to 10kHz |                | 27<br>39      |               | $\mu\text{V}_{\text{PP}}$<br>$\mu\text{V}_{\text{RMS}}$ |
| <b>REF3225 (2.5V)</b>  |  |                |               |               |   |
| <b>OUTPUT VOLTAGE, <math>V_{\text{OUT}}</math></b><br>Initial Accuracy |  | 2.495<br>-0.2  | 2.50<br>0.01  | 2.505<br>0.2  | V<br>%  |
| <b>NOISE</b><br>Output Voltage Noise<br>Voltage Noise                  | f = 0.1Hz to 10Hz<br>f = 10Hz to 10kHz |                | 33<br>48      |               | $\mu\text{V}_{\text{PP}}$<br>$\mu\text{V}_{\text{RMS}}$ |
| <b>REF3230 (3V)</b>  |  |                |               |               |   |
| <b>OUTPUT VOLTAGE, <math>V_{\text{OUT}}</math></b><br>Initial Accuracy |  | 2.994<br>-0.2  | 3<br>0.01     | 3.006<br>0.2  | V<br>%  |
| <b>NOISE</b><br>Output Voltage Noise<br>Voltage Noise                  | f = 0.1Hz to 10Hz<br>f = 10Hz to 10kHz |                | 39<br>57      |               | $\mu\text{V}_{\text{PP}}$<br>$\mu\text{V}_{\text{RMS}}$ |
| <b>REF3233 (3.3V)</b>  |  |                |               |               |   |
| <b>OUTPUT VOLTAGE, <math>V_{\text{OUT}}</math></b><br>Initial Accuracy |  | 3.293<br>-0.2  | 3.3<br>0.01   | 3.307<br>0.2  | V<br>%  |
| <b>NOISE</b><br>Output Voltage Noise<br>Voltage Noise                  | f = 0.1Hz to 10Hz<br>f = 10Hz to 10kHz |                | 43<br>63      |               | $\mu\text{V}_{\text{PP}}$<br>$\mu\text{V}_{\text{RMS}}$ |
| <b>REF3240 (4.096V)</b>  |  |                |               |               |   |
| <b>OUTPUT VOLTAGE, <math>V_{\text{OUT}}</math></b><br>Initial Accuracy |  | 4.088<br>-0.2  | 4.096<br>0.01 | 4.104<br>0.2  | V<br>%  |
| <b>NOISE</b><br>Output Voltage Noise<br>Voltage Noise                  | f = 0.1Hz to 10Hz<br>f = 10Hz to 10kHz |                | 53<br>78      |               | $\mu\text{V}_{\text{PP}}$<br>$\mu\text{V}_{\text{RMS}}$ |

**ELECTRICAL CHARACTERISTICS (continued)**

**Boldface** limits apply over the listed temperature range.

At  $T_A = +25^\circ\text{C}$ ,  $I_{\text{LOAD}} = 0\text{mA}$ , and  $V_{\text{IN}} = 5\text{V}$ , unless otherwise noted.

| PARAMETER  | CONDITIONS  | REF32xx   |  |                               | UNIT  |
|--|---|---|--|-------------------------------|---|
|  |   | MIN   | TYP  | MAX                           |   |
| <b>REF3212 / REF3220 / REF3225 / REF3230 / REF3233 / REF3240</b> |   |   |  |                               |   |
| <b>OUTPUT VOLTAGE TEMP DRIFT</b><br>$dV_{\text{OUT}}/dT$         | $0^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$<br>$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$  |   | <b>4</b><br>10.5                                       | <b>7</b><br>20                | ppm/ $^\circ\text{C}$<br>ppm/ $^\circ\text{C}$  |
| <b>LONG-TERM STABILITY</b>                                       | 0 to 1000h  |   | 55   |                               | ppm   |
| <b>LINE REGULATION</b>   | $V_{\text{OUT}} + 0.05(1) \leq V_{\text{IN}} \leq 5.5\text{V}$  | -65   | 15   | +65                           | ppm/V   |
| <b>LOAD REGULATION</b><br>$dV_{\text{OUT}}/dI_{\text{LOAD}}$     | $0\text{mA} < I_{\text{LOAD}} < 10\text{mA}$ , $V_{\text{IN}} = V_{\text{OUT}} + 250\text{mV}(1)$<br>$-10\text{mA} < I_{\text{LOAD}} < 0\text{mA}$ , $V_{\text{IN}} = V_{\text{OUT}} + 100\text{mV}(1)$ | -40<br>-60  | 3<br>20  | 40<br>60                      | $\mu\text{V}/\text{mA}$<br>$\mu\text{V}/\text{mA}$                                    |
| <b>THERMAL HYSTERESIS(2)</b><br>$dT$                             |   |   | 100<br>25  |                               | ppm<br>ppm  |
| <b>DROPOUT VOLTAGE(1)</b><br>$V_{\text{IN}} - V_{\text{OUT}}$    | $0^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$  |   | <b>5</b>   | <b>50</b>                     | <b>mV</b>   |
| <b>OUTPUT CURRENT</b><br>$I_{\text{LOAD}}$                       | $V_{\text{IN}} = V_{\text{OUT}} + 250\text{mV}(1)$  | -10   |  | 10                            | mA  |
| <b>SHORT-CIRCUIT CURRENT</b><br>$I_{\text{SC}}$                  |   |   | 50<br>40   |                               | mA<br>mA  |
| <b>TURN-ON SETTLING TIME</b>                                     | to 0.1% at $V_{\text{IN}} = 5\text{V}$ with $C_L = 0$   |   | 60   |                               | $\mu\text{s}$   |
| <b>ENABLE/SHUTDOWN</b>   |   |   |  |                               |   |
|  | $V_L$<br>$V_H$  | Reference in Shutdown mode<br>Reference is active   | 0<br>$0.75 \times V_{\text{IN}}$                       | 0.7<br>$V_{\text{IN}}$        | V<br>V  |
| <b>POWER SUPPLY</b>  |   | $I_L = 0$   |  |                               |   |
| Voltage<br>Current<br><b>Over-temperature</b><br>Shutdown        | $V_{\text{IN}}$<br>$I_Q$<br>$I_S$   | ENABLE > $0.75 \times V_{\text{IN}}$<br>$0^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$<br>ENABLE < 0.7V | $V_{\text{OUT}} + 0.05(1)$<br>100<br><b>115</b><br>0.1 | 5.5<br>120<br><b>135</b><br>1 | V<br>$\mu\text{A}$<br>$\mu\text{A}$<br>$\mu\text{A}$                                  |
| <b>TEMPERATURE RANGE</b>   |   |   |  |                               |   |
| Specified<br>Operating<br>Storage<br>Thermal resistance, SOT23-6 |   |   | -40<br>-55<br>-65<br>200                               | +125<br>+135<br>+150          | $^\circ\text{C}$<br>$^\circ\text{C}$<br>$^\circ\text{C}$<br>$^\circ\text{C}/\text{W}$ |

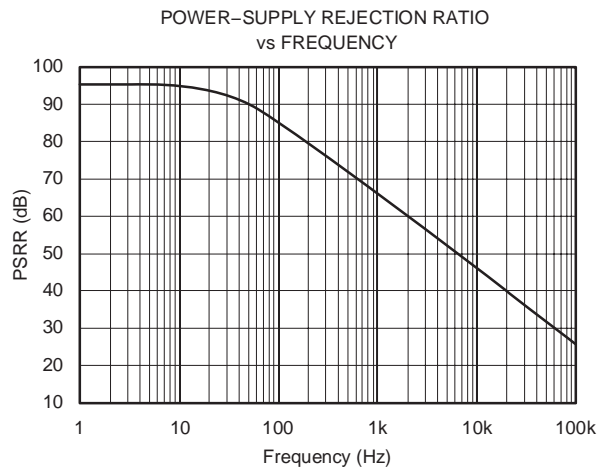
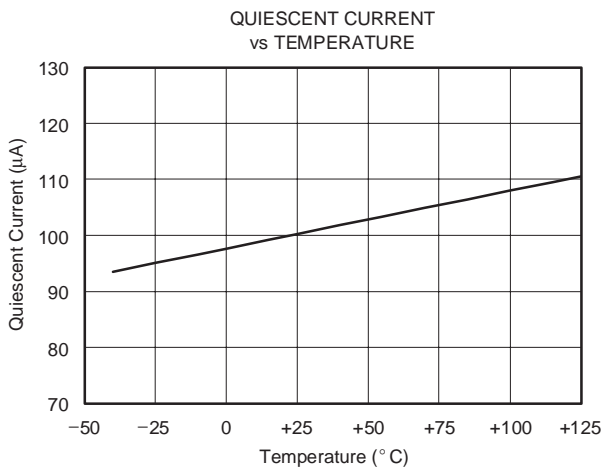
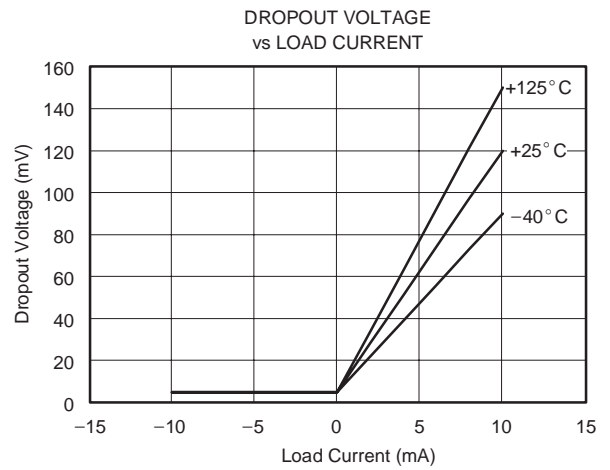
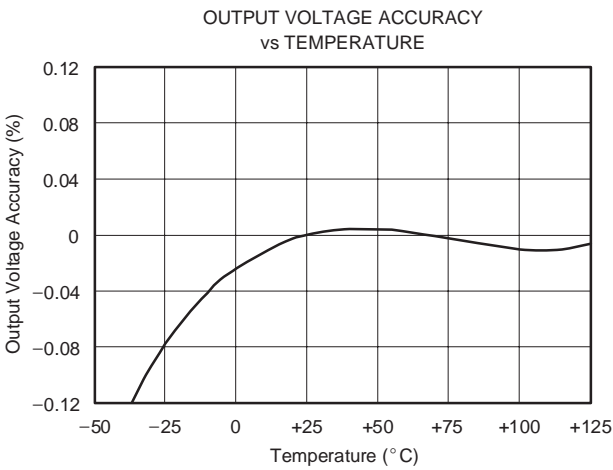
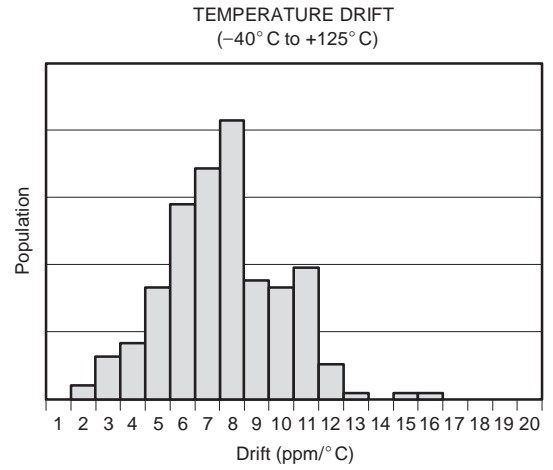
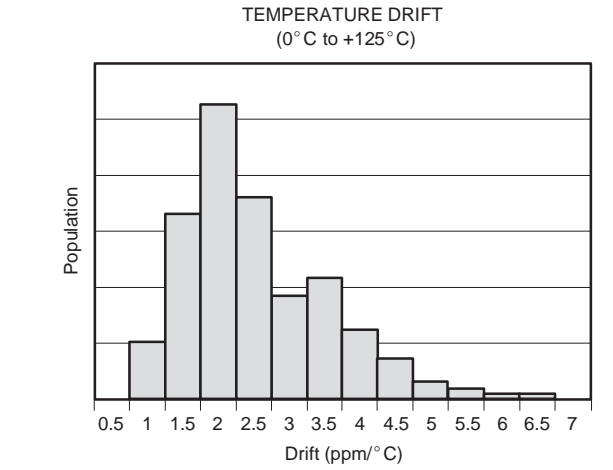
(1) The minimum supply voltage for the REF3212 is 1.8V.

(2) Thermal hysteresis procedure is explained in more detail in the *Applications Information* section.

(3) Load regulation is using force and sense lines; see the *Load Regulation* section for more information.

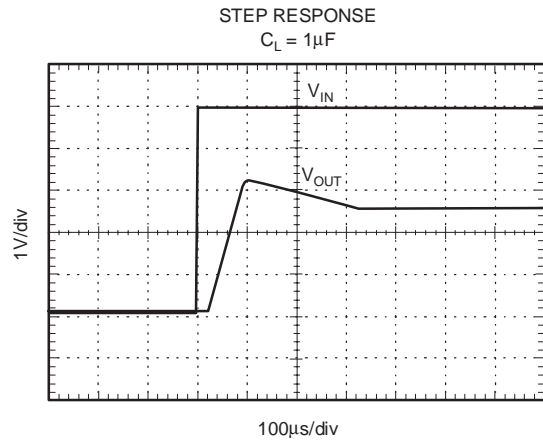
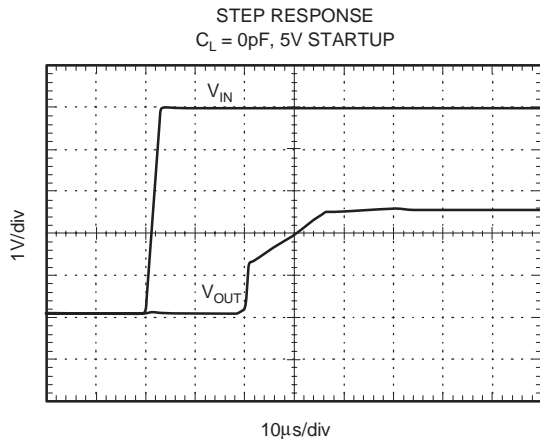
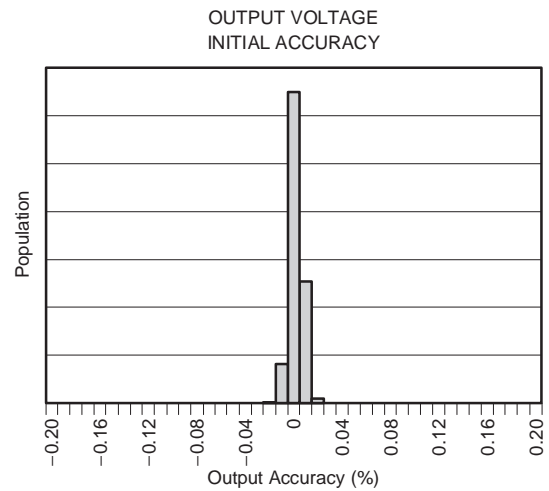
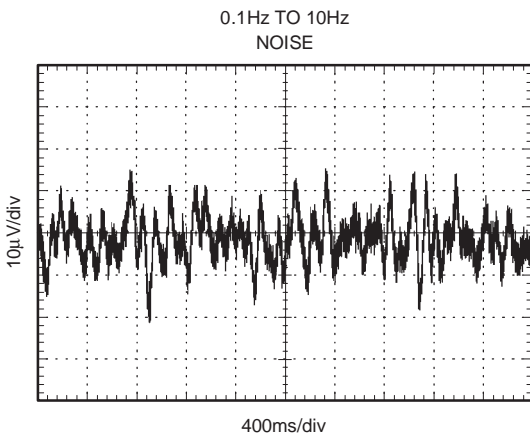
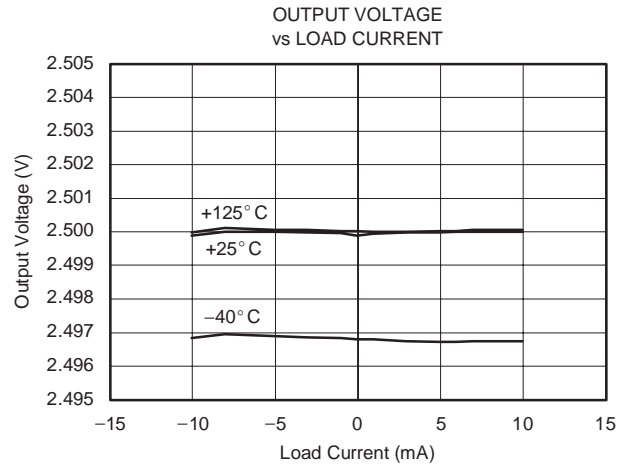
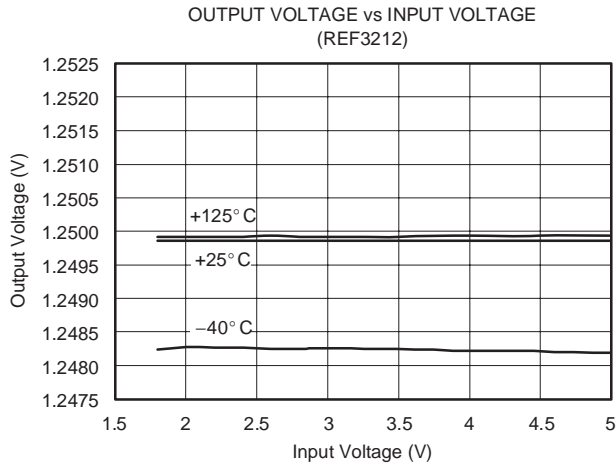
## TYPICAL CHARACTERISTICS

At  $T_A = +25^\circ\text{C}$ ,  $I_{\text{LOAD}} = 0\text{mA}$ ,  $V_{\text{IN}} = +5\text{V}$  power supply, REF3225 is used for typical characteristics, unless otherwise noted.



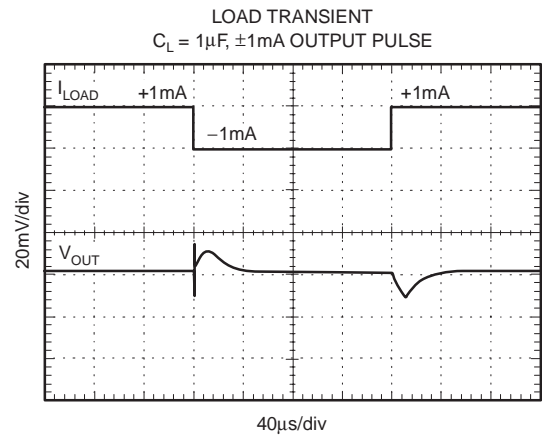
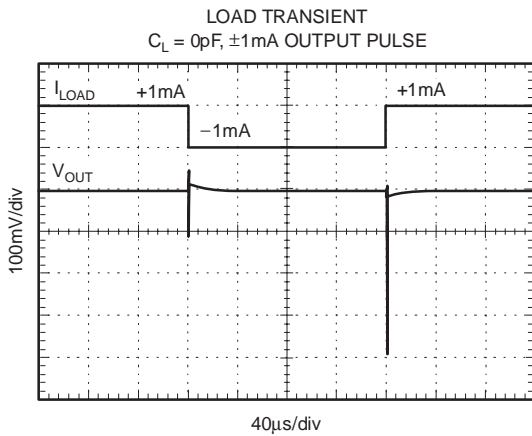
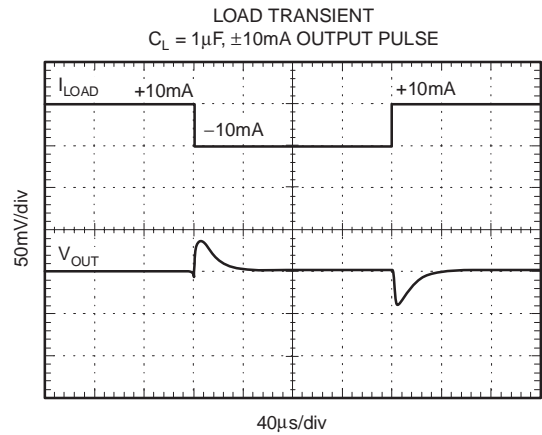
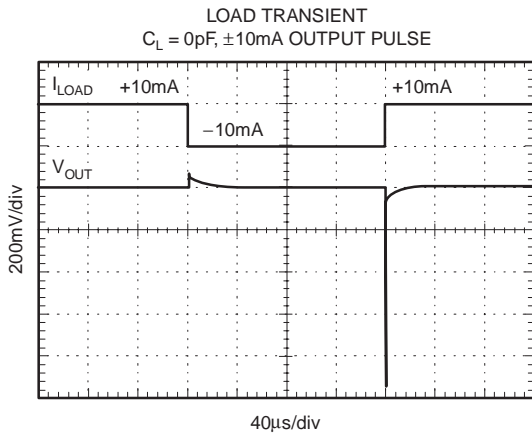
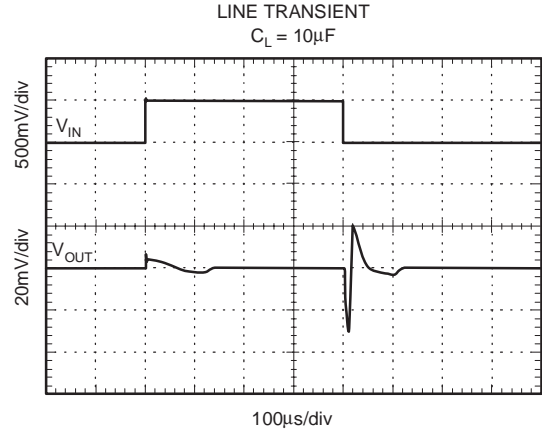
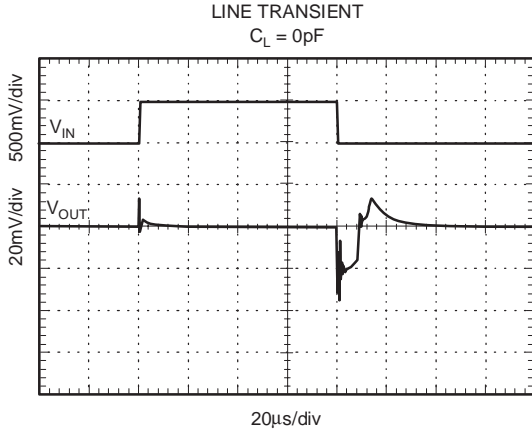
**TYPICAL CHARACTERISTICS (continued)**

At  $T_A = +25^\circ\text{C}$ ,  $I_{\text{LOAD}} = 0\text{mA}$ ,  $V_{\text{IN}} = +5\text{V}$  power supply, REF3225 is used for typical characteristics, unless otherwise noted.



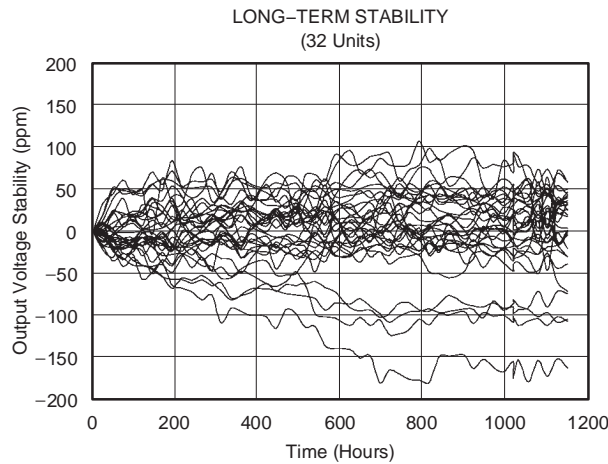
## TYPICAL CHARACTERISTICS (continued)

At  $T_A = +25^\circ\text{C}$ ,  $I_{\text{LOAD}} = 0\text{mA}$ ,  $V_{\text{IN}} = +5\text{V}$  power supply, REF3225 is used for typical characteristics, unless otherwise noted.



## TYPICAL CHARACTERISTICS (continued)

At  $T_A = +25^\circ\text{C}$ ,  $I_{\text{LOAD}} = 0\text{mA}$ ,  $V_{\text{IN}} = +5\text{V}$  power supply, REF3225 is used for typical characteristics, unless otherwise noted.



## THEORY OF OPERATION

The REF32xx is a family of CMOS, precision bandgap voltage references. Figure 1 shows the basic bandgap topology. Transistors  $Q_1$  and  $Q_2$  are biased so that the current density of  $Q_1$  is greater than that of  $Q_2$ . The difference of the two base-emitter voltages ( $V_{be1} - V_{be2}$ ) has a positive temperature coefficient and is forced across resistor  $R_1$ . This voltage is amplified and added to the base-emitter voltage of  $Q_2$ , which has a negative temperature coefficient. The resulting output voltage is virtually independent of temperature.

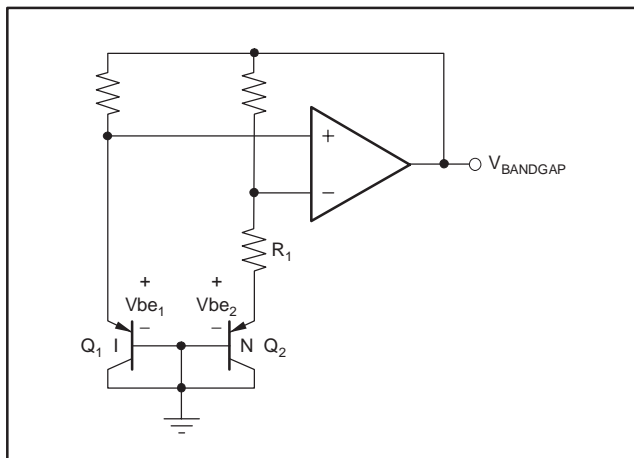


Figure 1. Simplified Schematic of Bandgap Reference

## APPLICATION INFORMATION

The REF32xx does not require a load capacitor and is stable with any capacitive load. Figure 2 shows typical connections required for operation of the REF32xx. A supply bypass capacitor of  $0.47\mu\text{F}$  is recommended.

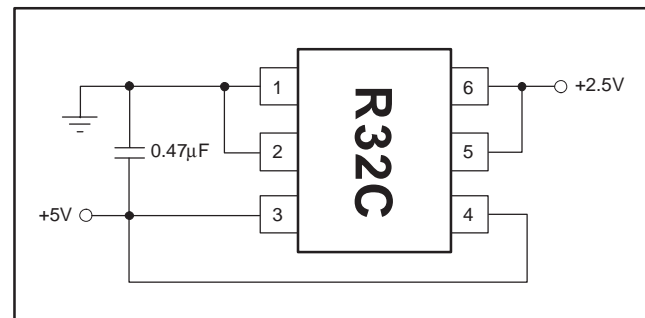


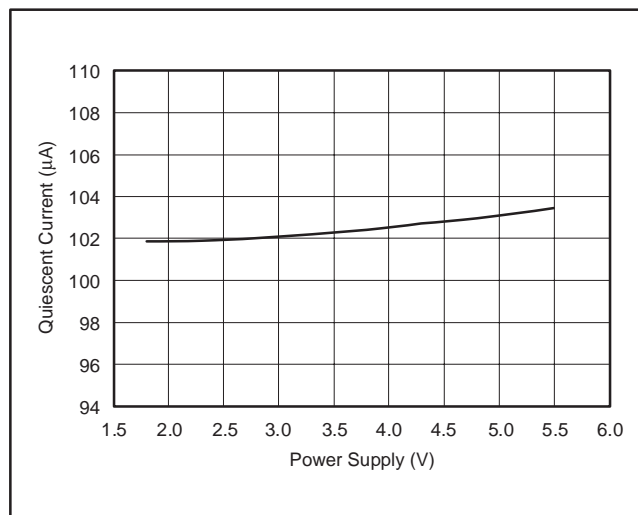
Figure 2. Typical Operating Connections for the REF3225

## SUPPLY VOLTAGE

The REF32xx family of references features an extremely low dropout voltage. With the exception of the REF3212, which has a minimum supply requirement of 1.8V, these references can be operated with a supply of only 5mV above the output voltage in an unloaded condition. For loaded conditions, a typical dropout voltage versus load is shown in the Typical Characteristic curves.



The REF32xx also features a low quiescent current of 100µA, with a maximum quiescent current over temperature of just 135µA. The quiescent current typically changes less than 2µA over the entire supply range, as shown in Figure 3.



**Figure 3. Supply Current vs Supply Voltage**

Supply voltages below the specified levels can cause the REF32xx to momentarily draw currents greater than the typical quiescent current. This momentary current draw can be prevented by using a power supply with a fast rising edge and low output impedance.

## SHUTDOWN

The REF32xx can be placed in a low-power mode by pulling the ENABLE/SHUTDOWN pin low. When in Shutdown mode, the output of the REF32xx becomes a resistive load to ground. The value of the load depends on the model, and ranges from approximately 100kΩ to 400kΩ.

## THERMAL HYSTERESIS

Thermal hysteresis for the REF32xx is defined as the change in output voltage after operating the device at +25°C, cycling the device through the specified temperature range, and returning to +25°C. It can be expressed as:

$$V_{\text{HYST}} = \left( \frac{|V_{\text{PRE}} - V_{\text{POST}}|}{V_{\text{NOM}}} \right) \times 10^6 (\text{ppm}) \quad (1)$$

Where:

$V_{\text{HYST}}$  = thermal hysteresis (in units of ppm).

$V_{\text{NOM}}$  = the specified output voltage.

$V_{\text{PRE}}$  = output voltage measured at +25°C pretemperature cycling.

$V_{\text{POST}}$  = output voltage measured after the device has been cycled through the specified temperature range of –40°C to +125°C and returned to +25°C.

## TEMPERATURE DRIFT

The REF32xx is designed to exhibit minimal drift error, which is defined as the change in output voltage over varying temperature. The drift is calculated using the box method, as described by the following equation:

$$\text{Drift} = \left( \frac{V_{\text{OUTMAX}} - V_{\text{OUTMIN}}}{V_{\text{OUT}} \times \text{Temp Range}} \right) \times 10^6 (\text{ppm}) \quad (2)$$

The REF32xx features a typical drift coefficient of 4ppm/°C from 0°C to +125°C—the primary temperature range for many applications. For the extended industrial temperature range of –40°C to +125°C, the REF32xx family drift increases to a typical value of 10.5ppm/°C.

## NOISE PERFORMANCE

Typical 0.1Hz to 10Hz voltage noise can be seen in the Typical Characteristic curve, *0.1 to 10Hz Voltage Noise*. The noise voltage of the REF32xx increases with output voltage and operating temperature. Additional filtering can be used to improve output noise levels, although care should be taken to ensure the output impedance does not degrade AC performance.

## LONG-TERM STABILITY

Long-term stability refers to the change of the output voltage of a reference over a period of months or years. This effect lessens as time progresses, as is shown by the long-term stability Typical Characteristic curves. The typical drift value for the REF32xx is 55ppm from 0 to 1000 hours. This parameter is characterized by measuring 30 units at regular intervals for a period of 1000 hours.

## LOAD REGULATION

Load regulation is defined as the change in output voltage as a result of changes in load current. The load regulation of the REF32xx is measured using force and sense contacts, as shown in Figure 4. The force and sense lines can be used to effectively eliminate the impact of contact and trace resistance, resulting in accurate voltage at the load. By connecting the force and sense lines at the load, the REF32xx compensates for the contact and trace resistances because it measures and adjusts the voltage actually delivered at the load.

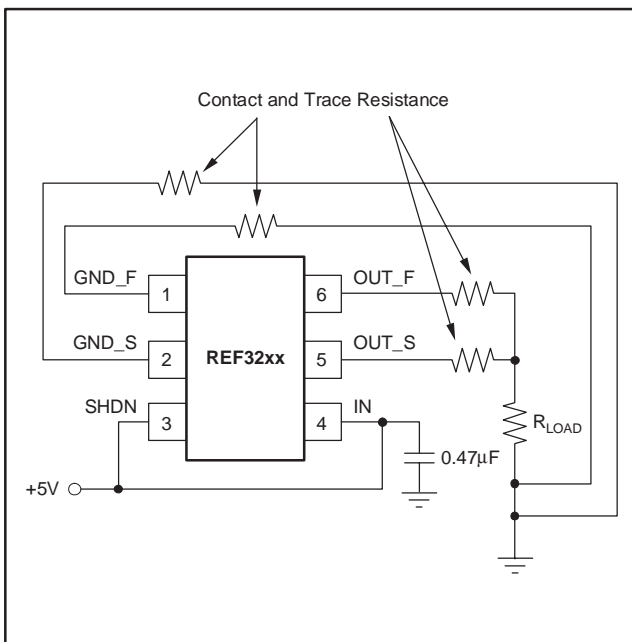


Figure 4. Accurate Load Regulation of REF32xx

## APPLICATION CIRCUITS

### NEGATIVE REFERENCE VOLTAGE

For applications requiring a negative and positive reference voltage, the REF32xx and OPA735 can be used to provide a dual-supply reference from a  $\pm 5V$  supply. Figure 5 shows the REF3225 used to provide a  $\pm 2.5V$  supply reference voltage. The low drift performance of the REF32xx complements the low offset voltage and zero drift of the OPA735 to provide an accurate solution for split-supply applications. Care must be taken to match the temperature coefficients of  $R_1$  and  $R_2$ .

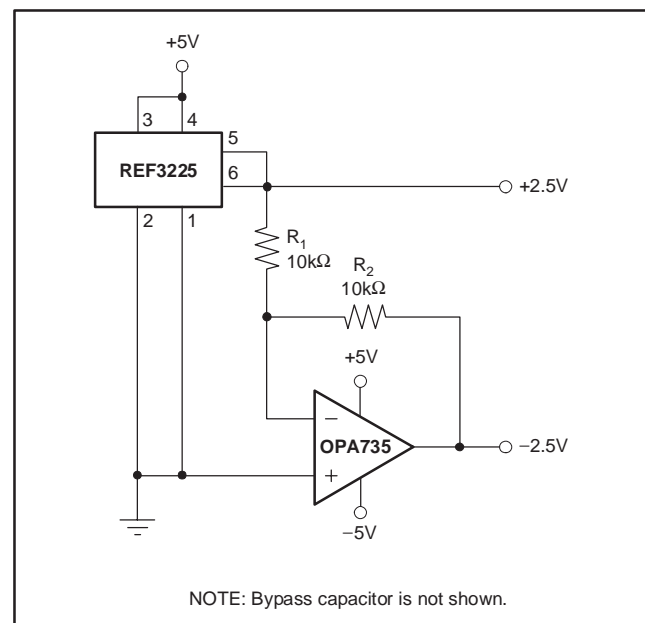
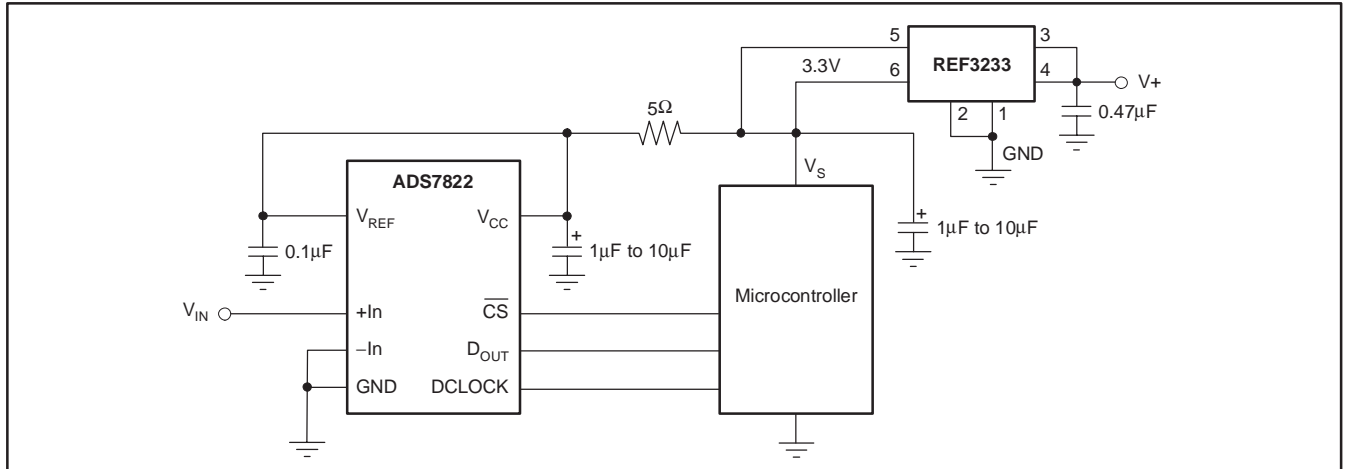


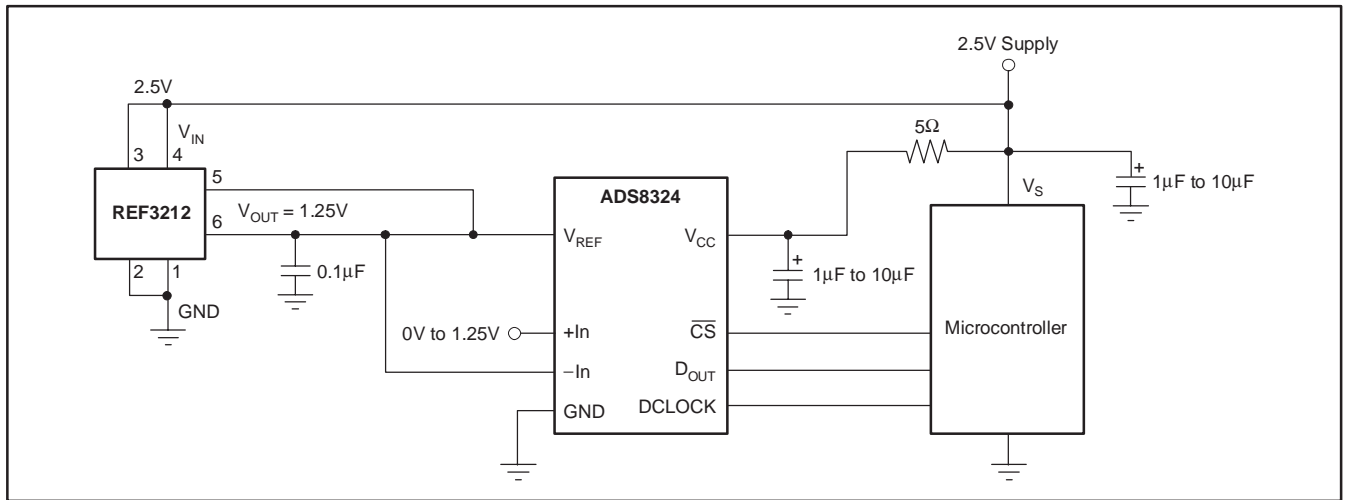
Figure 5. REF3225 Combined with OPA735 to Create Positive and Negative Reference Voltages

### DATA ACQUISITION

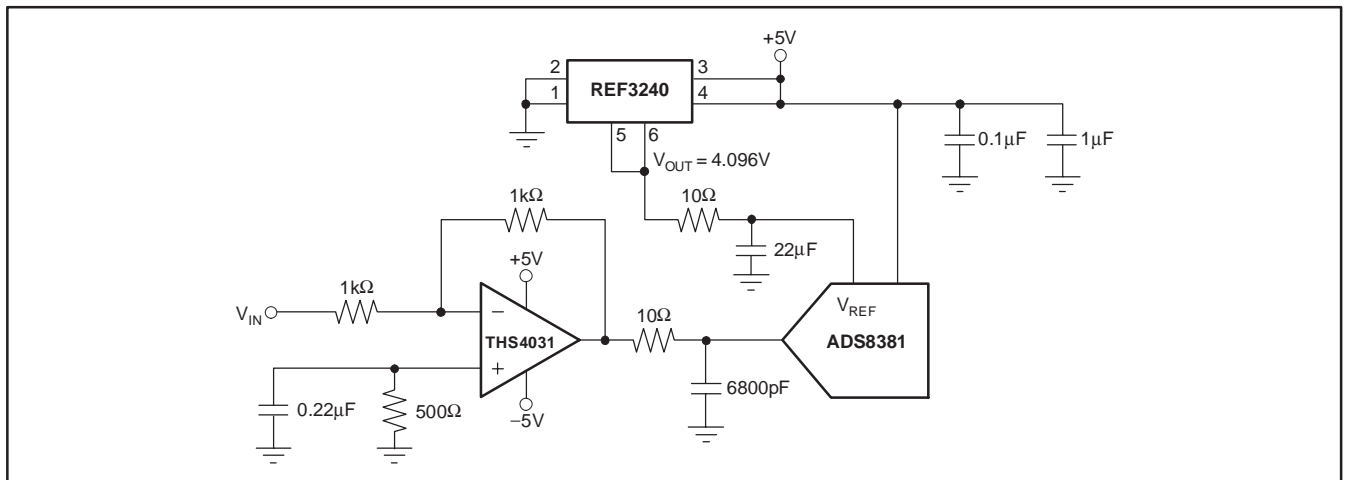
Data acquisition systems often require stable voltage references to maintain accuracy. The REF32xx family features stability and a wide range of voltages suitable for most microcontrollers and data converters. Figure 6, Figure 7, and Figure 8 show basic data acquisition systems.



**Figure 6. Basic Data Acquisition System 1**



**Figure 7. Basic Data Acquisition System 2**



**Figure 8. REF3240 Provides an Accurate Reference for Driving the ADS8381**

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| REF3212AIDBVR    | ACTIVE                | SOT-23       | DBV             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3212AIDBVRG4  | ACTIVE                | SOT-23       | DBV             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3212AIDBVT    | ACTIVE                | SOT-23       | DBV             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3212AIDBVTG4  | ACTIVE                | SOT-23       | DBV             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3220AIDBVR    | ACTIVE                | SOT-23       | DBV             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3220AIDBVRG4  | ACTIVE                | SOT-23       | DBV             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3220AIDBVT    | ACTIVE                | SOT-23       | DBV             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3220AIDBVTG4  | ACTIVE                | SOT-23       | DBV             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3225AIDBVR    | ACTIVE                | SOT-23       | DBV             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3225AIDBVRG4  | ACTIVE                | SOT-23       | DBV             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3225AIDBVT    | ACTIVE                | SOT-23       | DBV             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3225AIDBVTG4  | ACTIVE                | SOT-23       | DBV             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3230AIDBVR    | ACTIVE                | SOT-23       | DBV             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3230AIDBVRG4  | ACTIVE                | SOT-23       | DBV             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3230AIDBVT    | ACTIVE                | SOT-23       | DBV             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3230AIDBVTG4  | ACTIVE                | SOT-23       | DBV             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3233AIDBVR    | ACTIVE                | SOT-23       | DBV             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3233AIDBVRG4  | ACTIVE                | SOT-23       | DBV             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3233AIDBVT    | ACTIVE                | SOT-23       | DBV             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3233AIDBVTG4  | ACTIVE                | SOT-23       | DBV             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3240AIDBVR    | ACTIVE                | SOT-23       | DBV             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3240AIDBVRG4  | ACTIVE                | SOT-23       | DBV             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3240AIDBVT    | ACTIVE                | SOT-23       | DBV             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| REF3240AIDBVTG4  | ACTIVE                | SOT-23       | DBV             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |

<sup>(1)</sup> The marketing status values are defined as follows:

---

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF REF3212, REF3220, REF3225, REF3230, REF3233, REF3240 :**

● Enhanced Product: [REF3212-EP](#), [REF3220-EP](#), [REF3225-EP](#), [REF3230-EP](#), [REF3233-EP](#), [REF3240-EP](#)

NOTE: Qualified Version Definitions:

- Enhanced Product - Supports Defense, Aerospace and Medical Applications

**TAPE AND REEL INFORMATION**



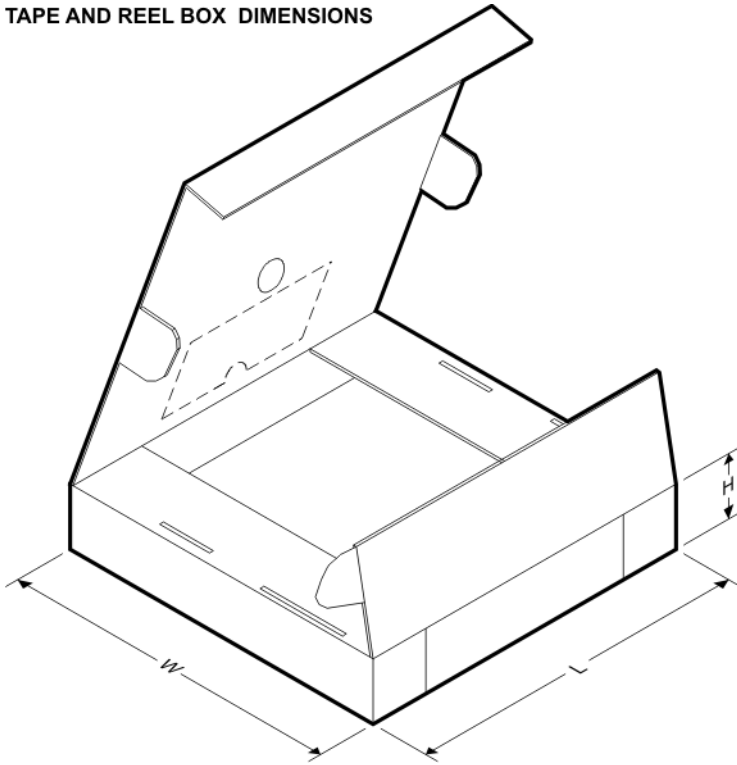
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*All dimensions are nominal

| Device        | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| REF3212AIDBVR | SOT-23       | DBV             | 6    | 3000 | 180.0              | 8.4                | 3.2     | 3.1     | 1.39    | 4.0     | 8.0    | Q3            |
| REF3212AIDBVT | SOT-23       | DBV             | 6    | 250  | 180.0              | 8.4                | 3.2     | 3.1     | 1.39    | 4.0     | 8.0    | Q3            |
| REF3220AIDBVR | SOT-23       | DBV             | 6    | 3000 | 180.0              | 8.4                | 3.2     | 3.1     | 1.39    | 4.0     | 8.0    | Q3            |
| REF3220AIDBVT | SOT-23       | DBV             | 6    | 250  | 180.0              | 8.4                | 3.2     | 3.1     | 1.39    | 4.0     | 8.0    | Q3            |
| REF3225AIDBVR | SOT-23       | DBV             | 6    | 3000 | 180.0              | 8.4                | 3.2     | 3.1     | 1.39    | 4.0     | 8.0    | Q3            |
| REF3225AIDBVT | SOT-23       | DBV             | 6    | 250  | 180.0              | 8.4                | 3.2     | 3.1     | 1.39    | 4.0     | 8.0    | Q3            |
| REF3230AIDBVR | SOT-23       | DBV             | 6    | 3000 | 180.0              | 8.4                | 3.2     | 3.1     | 1.39    | 4.0     | 8.0    | Q3            |
| REF3230AIDBVT | SOT-23       | DBV             | 6    | 250  | 180.0              | 8.4                | 3.2     | 3.1     | 1.39    | 4.0     | 8.0    | Q3            |
| REF3233AIDBVR | SOT-23       | DBV             | 6    | 3000 | 180.0              | 8.4                | 3.2     | 3.1     | 1.39    | 4.0     | 8.0    | Q3            |
| REF3233AIDBVT | SOT-23       | DBV             | 6    | 250  | 180.0              | 8.4                | 3.2     | 3.1     | 1.39    | 4.0     | 8.0    | Q3            |
| REF3240AIDBVR | SOT-23       | DBV             | 6    | 3000 | 180.0              | 8.4                | 3.2     | 3.1     | 1.39    | 4.0     | 8.0    | Q3            |
| REF3240AIDBVT | SOT-23       | DBV             | 6    | 250  | 180.0              | 8.4                | 3.2     | 3.1     | 1.39    | 4.0     | 8.0    | Q3            |

**TAPE AND REEL BOX DIMENSIONS**

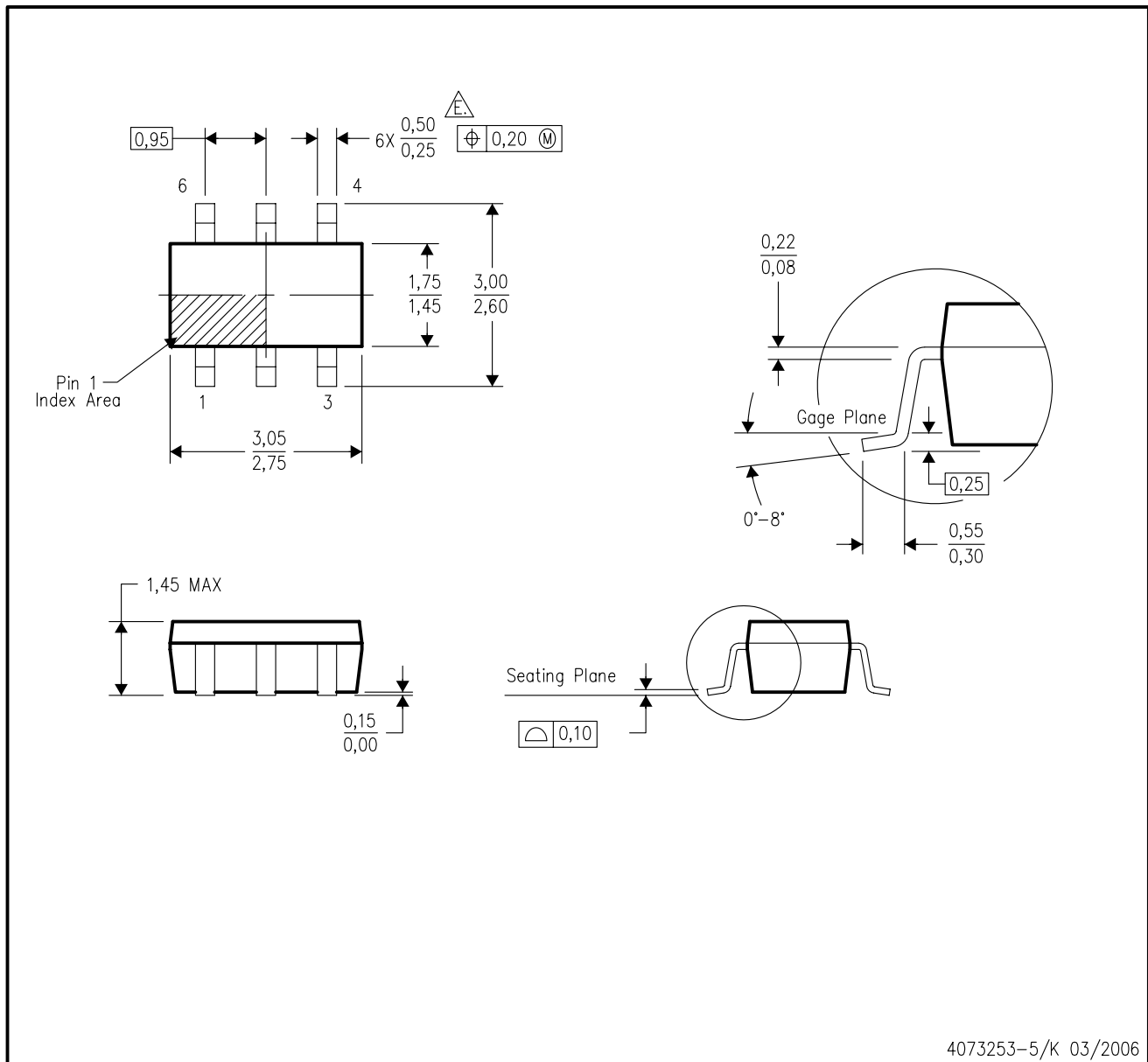


\*All dimensions are nominal

| Device        | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| REF3212AIDBVR | SOT-23       | DBV             | 6    | 3000 | 190.5       | 212.7      | 31.8        |
| REF3212AIDBVT | SOT-23       | DBV             | 6    | 250  | 190.5       | 212.7      | 31.8        |
| REF3220AIDBVR | SOT-23       | DBV             | 6    | 3000 | 190.5       | 212.7      | 31.8        |
| REF3220AIDBVT | SOT-23       | DBV             | 6    | 250  | 190.5       | 212.7      | 31.8        |
| REF3225AIDBVR | SOT-23       | DBV             | 6    | 3000 | 190.5       | 212.7      | 31.8        |
| REF3225AIDBVT | SOT-23       | DBV             | 6    | 250  | 190.5       | 212.7      | 31.8        |
| REF3230AIDBVR | SOT-23       | DBV             | 6    | 3000 | 190.5       | 212.7      | 31.8        |
| REF3230AIDBVT | SOT-23       | DBV             | 6    | 250  | 190.5       | 212.7      | 31.8        |
| REF3233AIDBVR | SOT-23       | DBV             | 6    | 3000 | 190.5       | 212.7      | 31.8        |
| REF3233AIDBVT | SOT-23       | DBV             | 6    | 250  | 190.5       | 212.7      | 31.8        |
| REF3240AIDBVR | SOT-23       | DBV             | 6    | 3000 | 190.5       | 212.7      | 31.8        |
| REF3240AIDBVT | SOT-23       | DBV             | 6    | 250  | 190.5       | 212.7      | 31.8        |

DBV (R-PDSO-G6)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
  - D. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
- $\triangle E$  Falls within JEDEC MO-178 Variation AB, except minimum lead width.



## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

### Products

|                             |  |
|-----------------------------|--|
| Amplifiers                  | <a href="http://amplifier.ti.com">amplifier.ti.com</a>             |
| Data Converters             | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>     |
| DSP                         | <a href="http://dsp.ti.com">dsp.ti.com</a>                         |
| Clocks and Timers           | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>           |
| Interface                   | <a href="http://interface.ti.com">interface.ti.com</a>             |
| Logic                       | <a href="http://logic.ti.com">logic.ti.com</a>                     |
| Power Mgmt                  | <a href="http://power.ti.com">power.ti.com</a>                     |
| Microcontrollers            | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a> |
| RFID                        | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>               |
| RF/IF and ZigBee® Solutions | <a href="http://www.ti.com/lprf">www.ti.com/lprf</a>               |

### Applications

|                    |  |
|--------------------|--|
| Audio              | <a href="http://www.ti.com/audio">www.ti.com/audio</a>                   |
| Automotive         | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>         |
| Broadband          | <a href="http://www.ti.com/broadband">www.ti.com/broadband</a>           |
| Digital Control    | <a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a> |
| Medical            | <a href="http://www.ti.com/medical">www.ti.com/medical</a>               |
| Military           | <a href="http://www.ti.com/military">www.ti.com/military</a>             |
| Optical Networking | <a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a> |
| Security           | <a href="http://www.ti.com/security">www.ti.com/security</a>             |
| Telephony          | <a href="http://www.ti.com/telephony">www.ti.com/telephony</a>           |
| Video & Imaging    | <a href="http://www.ti.com/video">www.ti.com/video</a>                   |
| Wireless           | <a href="http://www.ti.com/wireless">www.ti.com/wireless</a>             |

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2008, Texas Instruments Incorporated