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

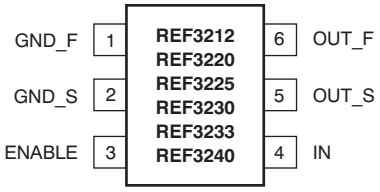
Check for Samples: REF3212, REF3220, REF3225, REF3230, REF3233, REF3240

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	4.096

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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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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 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	3.3V	SOT23-6	DBV	R32E
REF3240	4.096	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 visit the device product folder at www.ti.com.

ABSOLUTE MAXIMUM RATINGS(1)

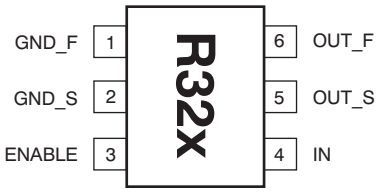
Over operating free-air temperature range (unless otherwise noted).

		REF32xx	UNIT
Input voltage		+7.5	V
Output short-circuit		Continuous	
Operating temperature		–55 to +135	°C
Storage temperature		–65 to +150	°C
Junction temperature		+150	°C
ESD ratings	Human body model (HBM)	4	kV
	Charged device model (CDM)	1	kV
	Machine model (MM)	400	V

(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.

PIN CONFIGURATION

DBV PACKAGE
SOT23-6
(TOP VIEW)



NOTE:: The location of pin 1 on the REF32xx is determined by orienting the package marking as shown in the diagram above.

PIN DESCRIPTIONS

PIN		FUNCTION	DESCRIPTION
NAME	NO.		
ENABLE	3	Digital input	This pin enables and disables the device
GND_F	1	Analog output	Ground connection of the device
GND_S	2	Analog input	Ground sense at the load
IN	4	Analog input	Positive supply voltage
OUT_F	6	Analog output	Output of Reference Voltage
OUT_S	5	Analog input	Sense connection at the load

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ELECTRICAL CHARACTERISTICS

Boldface limits apply over the listed temperature range.
At T_A = +25°C, I_{LOAD} = 0mA, and V_{IN} = 5V, unless otherwise noted.

PARAMETER	CONDITIONS	REF32xx			UNIT
		MIN	TYP	MAX	
REF3212 (1.25V)					
OUTPUT VOLTAGE, V_{OUT}		1.2475	1.25	1.2525	V
Initial accuracy		–0.2	0.01	0.2	%
NOISE					
Output voltage noise	f = 0.1Hz to 10Hz		17		μV_{PP}
Voltage noise	f = 10Hz to 10kHz		24		μV_{RMS}
REF3220 (2.048V)					
OUTPUT VOLTAGE, V_{OUT}		2.044	2.048	2.052	V
Initial accuracy		–0.2	0.01	0.2	%
NOISE					
Output voltage noise	f = 0.1Hz to 10Hz		27		μV_{PP}
Voltage noise	f = 10Hz to 10kHz		39		μV_{RMS}
REF3225 (2.5V)					
OUTPUT VOLTAGE, V_{OUT}		2.495	2.50	2.505	V
Initial accuracy		–0.2	0.01	0.2	%
NOISE					
Output voltage noise	f = 0.1Hz to 10Hz		33		μV_{PP}
Voltage noise	f = 10Hz to 10kHz		48		μV_{RMS}
REF3230 (3V)					
OUTPUT VOLTAGE, V_{OUT}		2.994	3	3.006	V
Initial accuracy		–0.2	0.01	0.2	%
NOISE					
Output voltage noise	f = 0.1Hz to 10Hz		39		μV_{PP}
Voltage noise	f = 10Hz to 10kHz		57		μV_{RMS}
REF3233 (3.3V)					
OUTPUT VOLTAGE, V_{OUT}		3.293	3.3	3.307	V
Initial accuracy		–0.2	0.01	0.2	%
NOISE					
Output voltage noise	f = 0.1Hz to 10Hz		43		μV_{PP}
Voltage noise	f = 10Hz to 10kHz		63		μV_{RMS}
REF3240 (4.096V)					
OUTPUT VOLTAGE, V_{OUT}		4.088	4.096	4.104	V
Initial accuracy		–0.2	0.01	0.2	%
NOISE					
Output voltage noise	f = 0.1Hz to 10Hz		53		μV_{PP}
Voltage noise	f = 10Hz to 10kHz		78		μV_{RMS}

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ELECTRICAL CHARACTERISTICS (continued)

Boldface limits apply over the listed temperature range.
At T_A = +25°C, I_{LOAD} = 0mA, and V_{IN} = 5V, unless otherwise noted.

PARAMETER		CONDITIONS	REF32xx MIN	REF32xx TYP	REF32xx MAX	UNIT
REF3212 / REF3220 / REF3225 / REF3230 / REF3233 / REF3240						
OUTPUT VOLTAGE TEMP DRIFT	**dV_{OUT}/dT**					
		0°C ≤ T_A ≤ +125°C		**4**	**7**	**ppm/°C**
		–40°C ≤ T_A ≤ +125°C		**10.5**	**20**	**ppm/°C**
LONG-TERM STABILITY		0 to 1000h		55		ppm
LINE REGULATION		V_{OUT} + 0.05(1) ≤ V_{IN} ≤ 5.5V	–65	15	+65	ppm/V
LOAD REGULATION(2)	dV_{OUT}/dI_{LOAD}					
Sourcing		0mA < I_{LOAD} < 10mA, V_{IN} = V_{OUT} + 250mV(1)	–40	3	40	µV/mA
Sinking		–10mA < I_{LOAD} < 0mA, V_{IN} = V_{OUT} + 100mV(1)	–60	20	60	µV/mA
THERMAL HYSTERESIS(3)	dT					
First cycle				100		ppm
Additional cycles				25		ppm
DROPOUT VOLTAGE(1)	**V_{IN} – V_{OUT}**	**0°C ≤ T_A ≤ +125°C**		**5**	**50**	**mV**
OUTPUT CURRENT	I_{LOAD}	V_{IN} = V_{OUT} + 250mV(1)	–10		10	mA
SHORT-CIRCUIT CURRENT	**I_{SC}**					
Sourcing				50		mA
Sinking				40		mA
TURN-ON SETTLING TIME		To 0.1% at V_{IN} = 5V with C_L = 0		60		µs
ENABLE/SHUTDOWN(4)						
	V_L	Reference in Shutdown mode	0		0.7	V
	V_H	Reference is active	1.5		V_{IN}	V
POWER SUPPLY		I_L = 0				
Voltage	V_{IN}		V_{OUT} + 0.05(1)		5.5	V
Current	I_Q	ENABLE > 1.5V		100	120	µA
Over temperature		**0°C ≤ T_A ≤ +125°C**		**115**	**135**	**µA**
Shutdown	I_S	ENABLE < 0.7V		0.1	1	µA
TEMPERATURE RANGE						
Specified			–40		+125	°C
Operating			–55		+135	°C
Storage			–65		+150	°C
Thermal resistance, SOT23-6	θ_{JA}			200		°C/W

(1) The minimum supply voltage for the REF3212 is 1.8V.
(2) Load regulation is using force and sense lines; see the *Load Regulation* section for more information.
(3) Thermal hysteresis procedure is explained in more detail in the Applications Information TBD section.
(4) If the rise time of the input voltage is less than or equal to 2ms, the ENABLE and IN pins can be tied together. For rise times greater than 2ms, see the *Supply Voltage* section.

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TYPICAL CHARACTERISTICS

At T_A = +25°C, I_{LOAD} = 0mA, V_{IN} = +5V power supply, and REF3225 used for typical characteristics, unless otherwise noted.

TEMPERATURE DRIFT (0°C to +125°C)

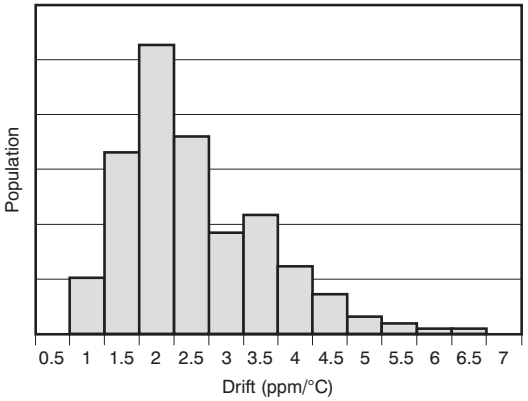

Figure 1.

TEMPERATURE DRIFT (–40°C to +125°C)

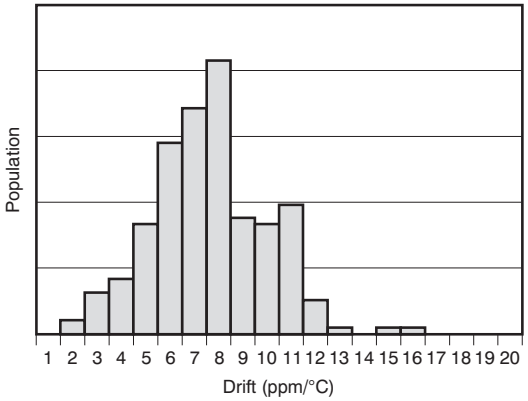

Figure 2.

OUTPUT VOLTAGE ACCURACY vs TEMPERATURE

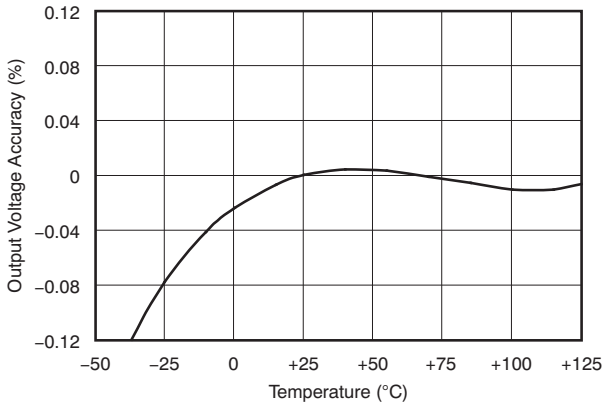

Figure 3.

DROPOUT VOLTAGE vs LOAD CURRENT

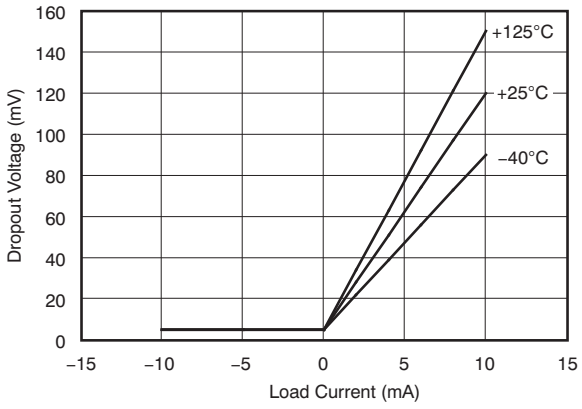

Figure 4.

QUIESCENT CURRENT vs TEMPERATURE

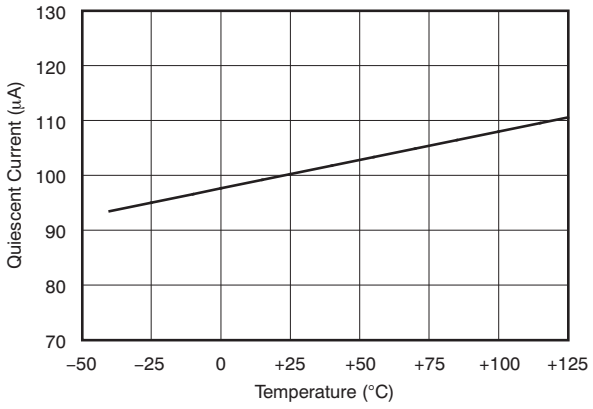

Figure 5.

POWER-SUPPLY REJECTION RATIO vs FREQUENCY

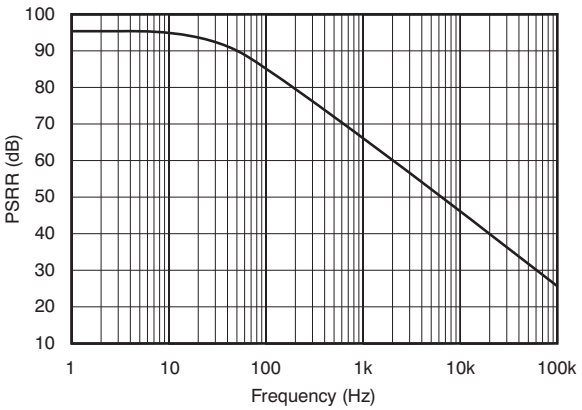

Figure 6.

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TYPICAL CHARACTERISTICS (continued)

At T_A = +25°C, I_{LOAD} = 0mA, V_{IN} = +5V power supply, and REF3225 used for typical characteristics, unless otherwise noted.

OUTPUT VOLTAGE vs INPUT VOLTAGE (REF3212)

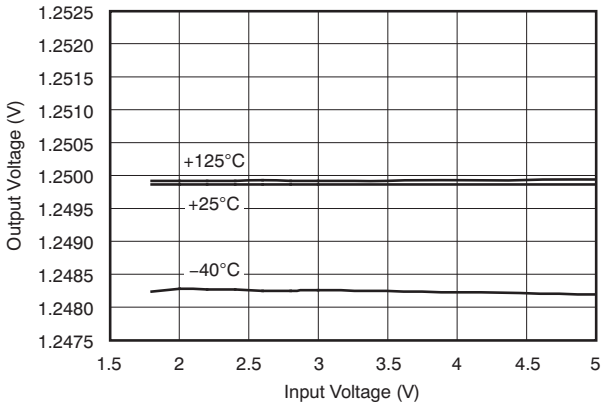

Figure 7.

OUTPUT VOLTAGE vs LOAD CURRENT

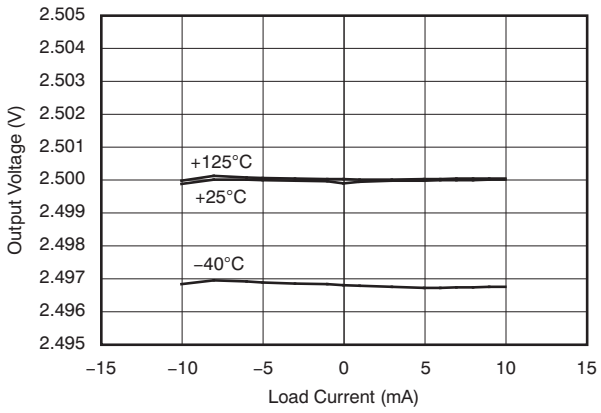

Figure 8.

0.1Hz TO 10Hz NOISE

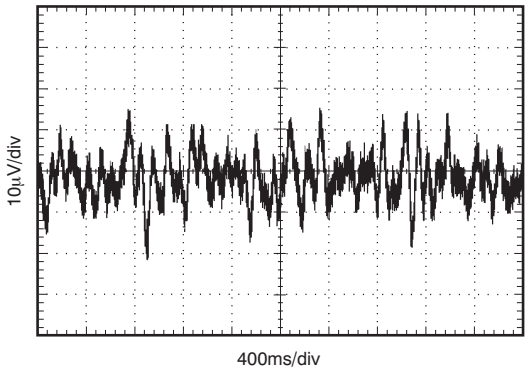

Figure 9.

OUTPUT VOLTAGE INITIAL ACCURACY

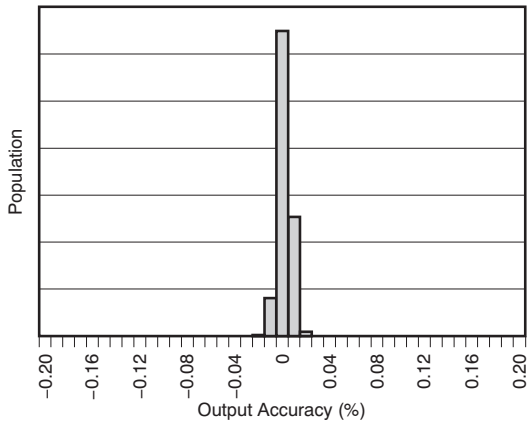

Figure 10.

STEP RESPONSE C_L = 0pF, 5V STARTUP

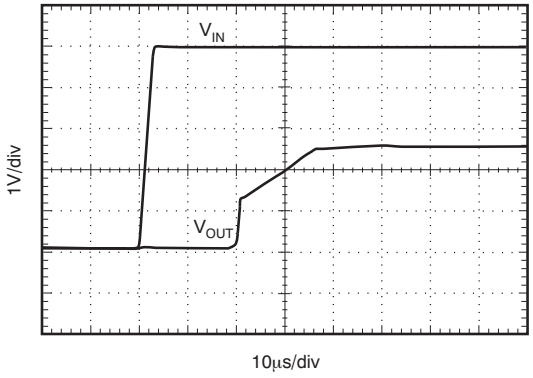

Figure 11.

STEP RESPONSE C_L = 1μF

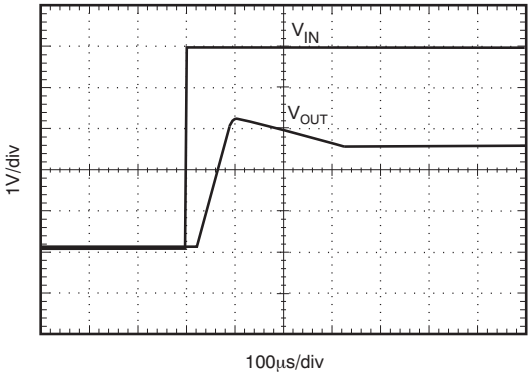

Figure 12.

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TYPICAL CHARACTERISTICS (continued)

At T_A = +25°C, I_{LOAD} = 0mA, V_{IN} = +5V power supply, and REF3225 used for typical characteristics, unless otherwise noted.

LINE TRANSIENT
C_L = 0pF

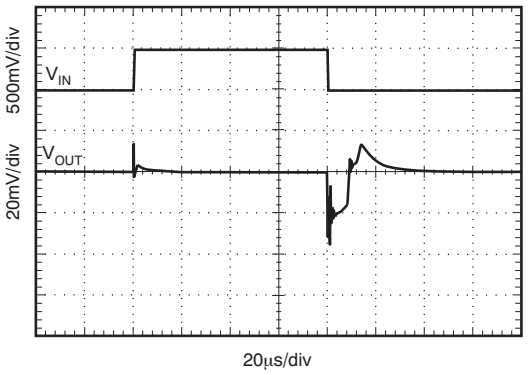

Figure 13.

LINE TRANSIENT
C_L = 10µF

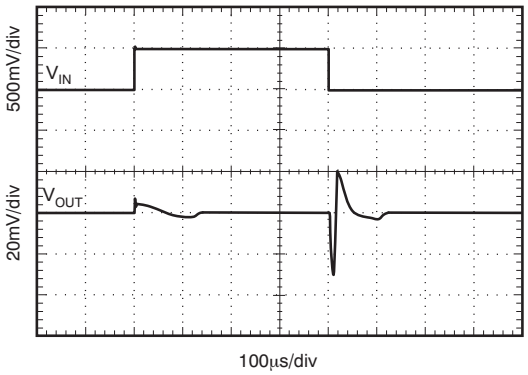

Figure 14.

LOAD TRANSIENT
C_L = 0pF, ±10mA OUTPUT PULSE

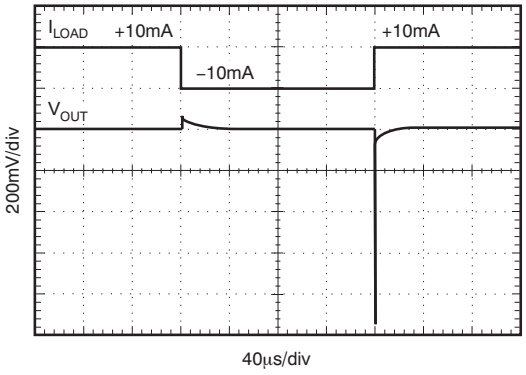

Figure 15.

LOAD TRANSIENT
C_L = 1µF, ±10mA OUTPUT PULSE

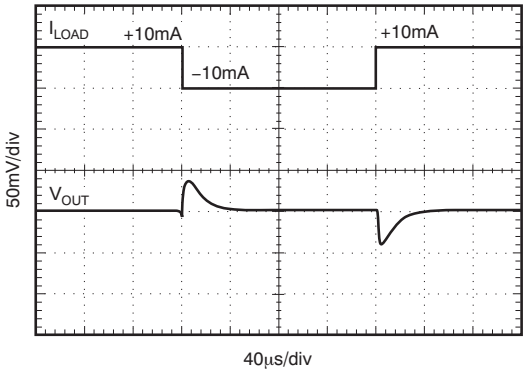

Figure 16.

LOAD TRANSIENT
C_L = 0pF, ±1mA OUTPUT PULSE

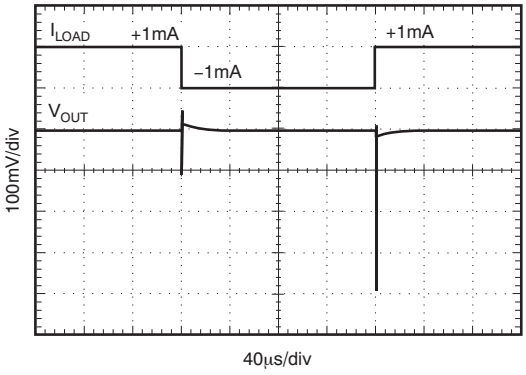

Figure 17.

LOAD TRANSIENT
C_L = 1µF, ±1mA OUTPUT PULSE

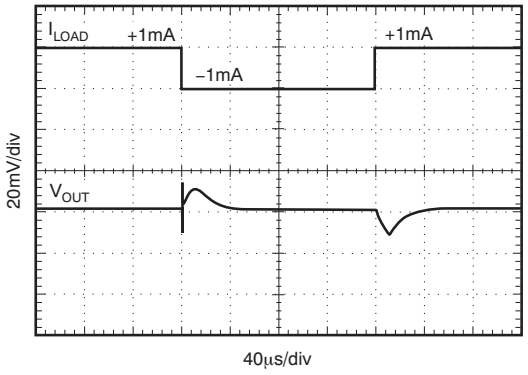

Figure 18.

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TYPICAL CHARACTERISTICS (continued)

At T_A = +25°C, I_{LOAD} = 0mA, V_{IN} = +5V power supply, and REF3225 used for typical characteristics, unless otherwise noted.

LONG-TERM STABILITY
(32 Units)

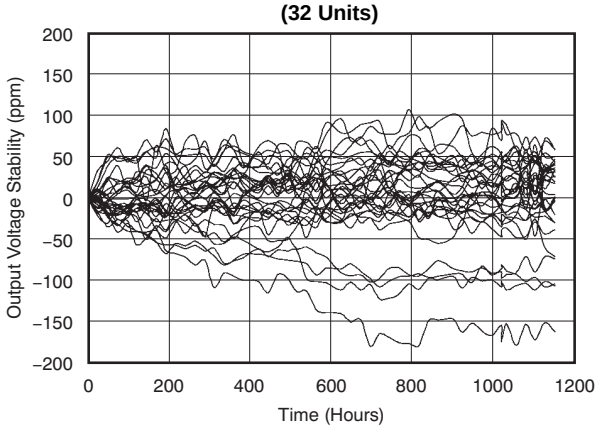

Figure 19.

THEORY OF OPERATION

GENERAL DESCRIPTION

The REF32xx is a family of CMOS, precision bandgap voltage references. Figure 20 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 ($Vbe_1 – Vbe_2$) 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.

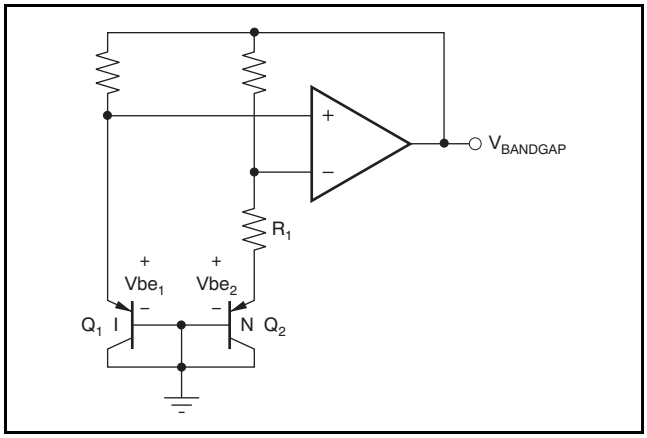

Figure 20. Simplified Schematic of Bandgap Reference

APPLICATION INFORMATION

The REF32xx does not require a load capacitor and is stable with any capacitive load. Figure 21 shows typical connections required for operation of the REF32xx. A supply bypass capacitor of 0.47µF is recommended.

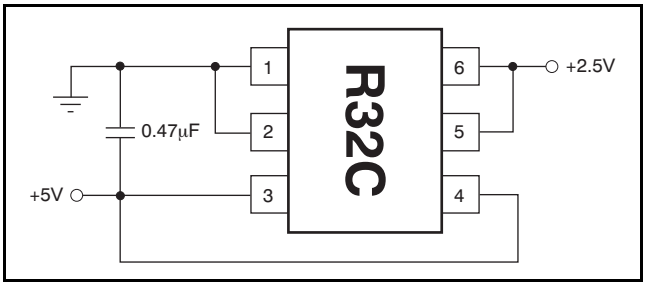

Figure 21. Typical Operating Connections for the REF3225

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.

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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 22.

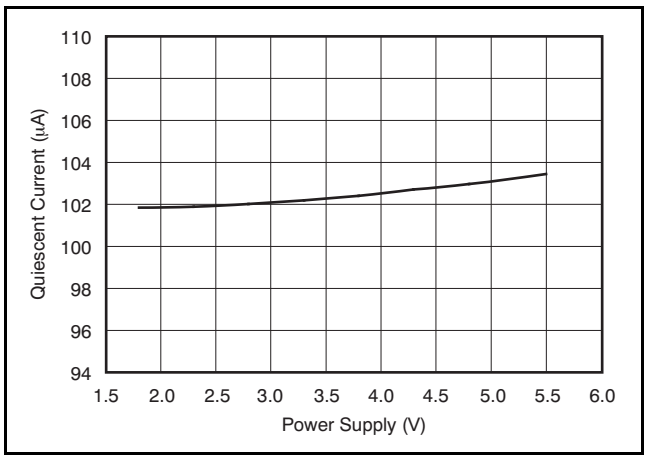

Figure 22. Supply Current vs Supply Voltage

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.

For optimal startup when the IN pin and ENABLE pin are tied together, keep the input voltage rise time less than or equal to 2ms. For rise times greater than 2ms, the ENABLE pin must be kept below 0.7V until the voltage at the IN pin has reached the minimum operating voltage. One way to control the voltage at the ENABLE pin is with an additional RC filter, such as that shown in Figure 23. The RC filter must hold the voltage at the ENABLE pin below the threshold voltage until the voltage at the input pin has reached the minimum operating voltage.

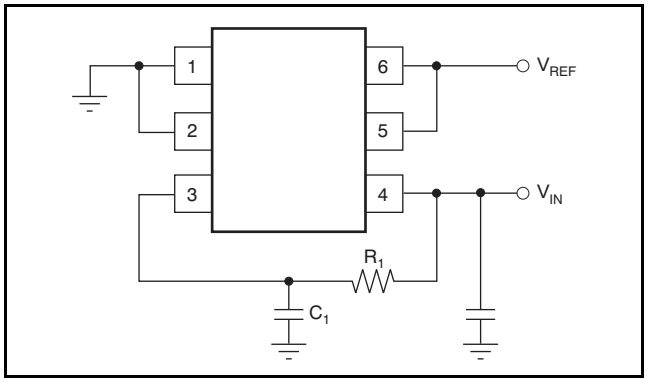

Figure 23. Application Circuit to Control the REF32xx ENABLE Pin

The RC filter in Figure 23 can be used as a starting point for the REF3240. The values for R_1 and C_1 have been calculated so that the voltage at the ENABLE pin reaches 0.7V after the input voltage has reached 4.15V; Table 1 lists these values. For output voltage options other than 4.096V, the RC filter can be made faster.

Table 1. Recommended R_1 and C_1 Values for the REF3240

RISE TIME	R_1 VALUE	C_1 VALUE
2ms	150kΩ	100nF
5ms	150kΩ	220nF
10ms	330kΩ	220nF
20ms	390kΩ	330nF
50ms	680kΩ	470nF
100ms	680kΩ	1000nF

In this document, rise time is defined as the time until an exponential input signal reaches 90% of its final voltage. For example, the 2ms value shown in Table 1 is valid for an end value of 5V.

If the input voltage has a different shape or the end value is not 5V, then the time until the minimum dropout voltage has been reached should be used to decide if the IN and ENABLE pins can be tied together. Table 2 lists these times.

Table 2. Minimum Dropout Voltage Times

DEVICE	TIME
REF3212	0.4ms
REF3220	0.5ms
REF3225	0.7ms
REF3230	0.9ms
REF3233	1.0ms
REF3240	1.6ms

Note that because the leakage current of the EN pin is in the range of a few nA, it can be disregarded in most applications.

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.

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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:

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

Where:

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

V_{NOM} = the specified output voltage.

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

V_{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. (1)

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 Equation 2:

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

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, 0.1Hz 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 24.

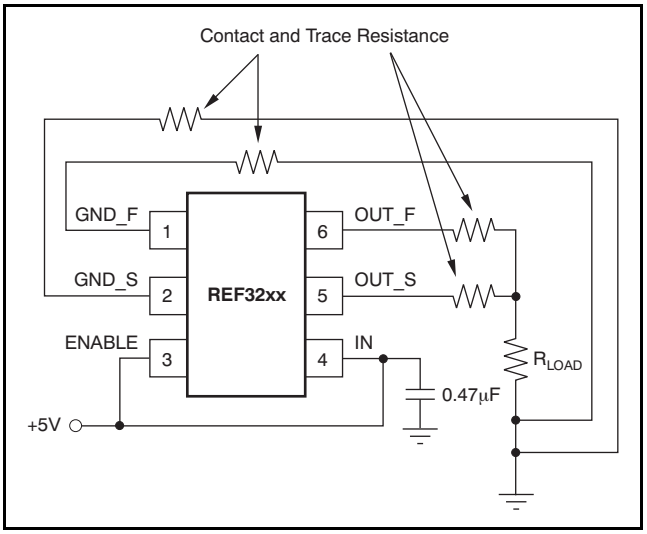

Figure 24. Accurate Load Regulation of REF32xx

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.

The GND_S pin is connected to the internal ground of the device through ESD protection diodes. Because of that connection, the maximum differential voltage between the GND_S and GND_F pins must be kept below 200mV to prevent these dioes from unintentionally turning on.

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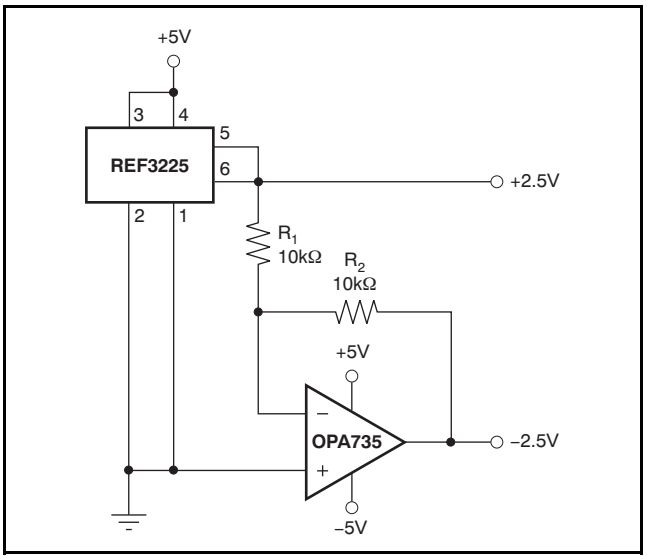
APPLICATION CIRCUITS

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 ±5V supply. Figure 25 shows the REF3225 used to provide a ±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.

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 26, Figure 27, and Figure 28 show basic data acquisition systems.



NOTE:: Bypass capacitor is not shown.

Figure 25. REF3225 Combined with OPA735 to Create Positive and Negative Reference Voltages

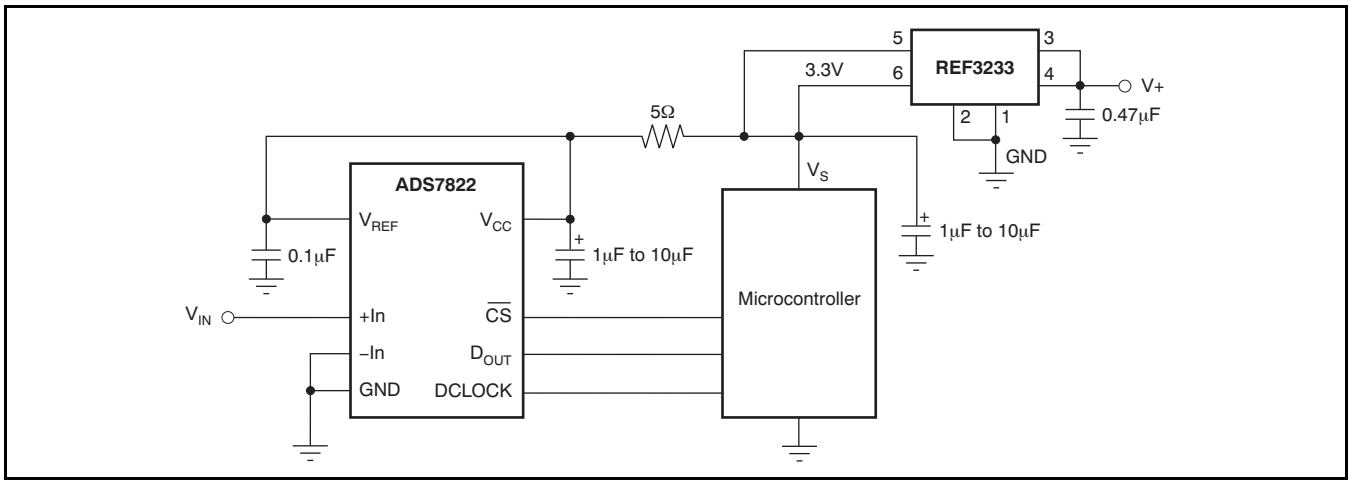


Figure 26. Basic Data Acquisition System 1

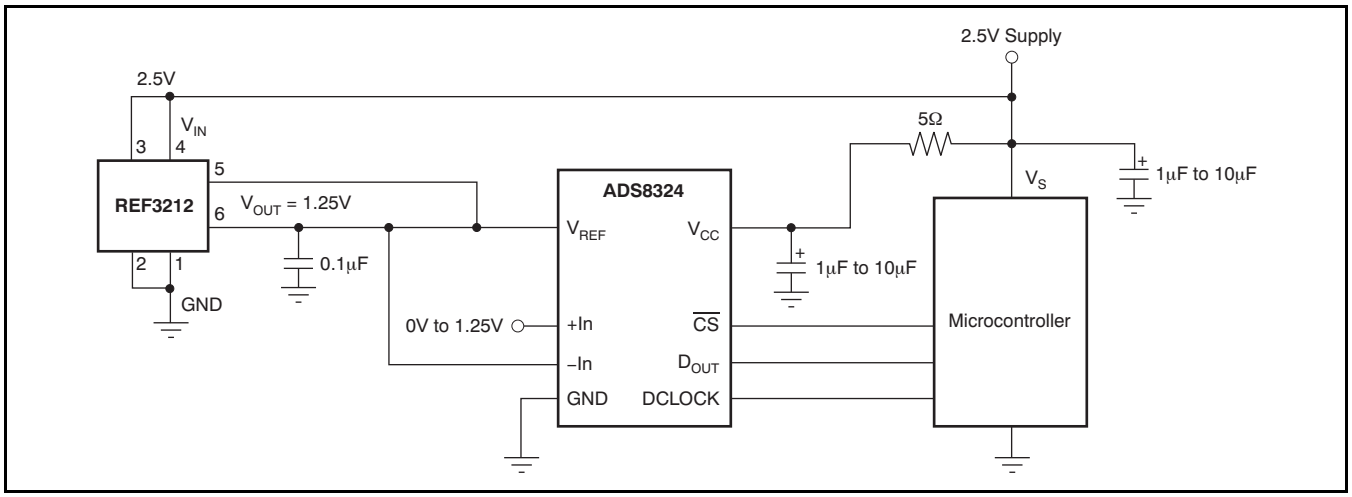


Figure 27. Basic Data Acquisition System 2

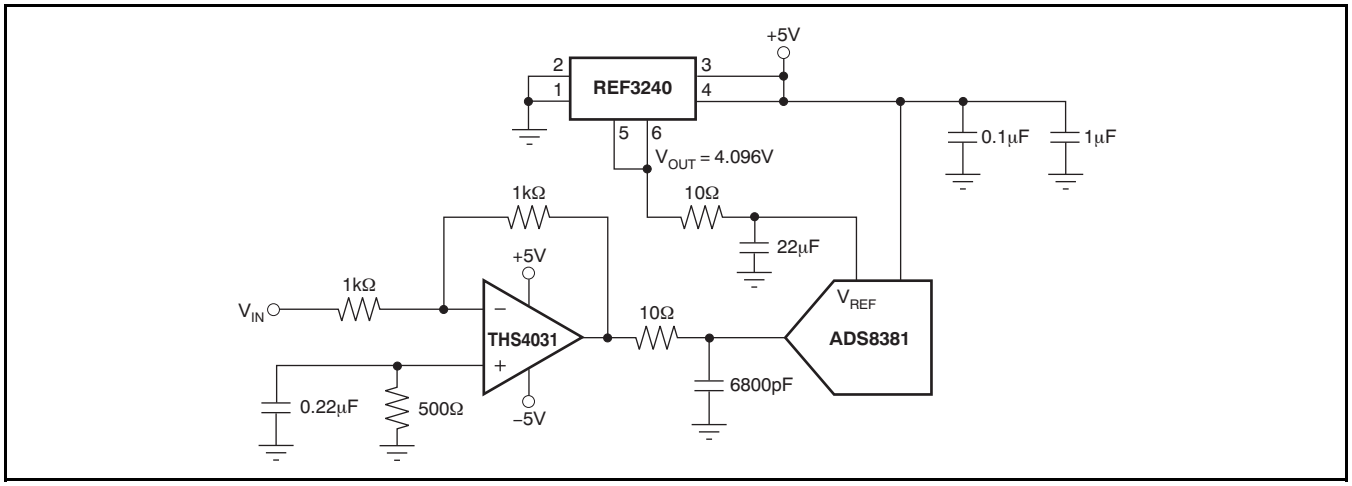


Figure 28. REF3240 Provides an Accurate Reference for Driving the ADS8381

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REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision B (February 2006) to Revision C **Page**

- Added Pin Descriptions table 2
- Added note to Enable/Shutdown parameter 4
- Changed the minimum voltage for Enable/Shutdown with reference active from (0.75 × V_{IN}) to 1.5 4
- Changed Current test condition from from (0.75 × V_{IN}) to (1.5V) 4
- Added text, two tables, and one figure to Supply Voltage section 8
- Changed pin 3 in Figure 24 from SHDN to ENABLE (typo) 10
- Added paragraph to Load Regulation section 10

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
REF3212AIDBVR	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32A	Samples
REF3212AIDBVT	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32A	Samples
REF3212AIDBVTG4	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32A	Samples
REF3220AIDBVR	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32B	Samples
REF3220AIDBVT	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32B	Samples
REF3220AIDBVTG4	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32B	Samples
REF3225AIDBVR	NRND	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32C	
REF3225AIDBVRG4	NRND	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32C	
REF3225AIDBVT	NRND	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32C	
REF3225AIDBVTG4	NRND	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32C	
REF3230AIDBVR	NRND	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32D	
REF3230AIDBVT	NRND	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32D	
REF3230AIDBVTG4	NRND	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32D	
REF3233AIDBVR	NRND	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32E	
REF3233AIDBVT	NRND	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32E	
REF3233AIDBVTG4	NRND	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32E	
REF3240AIDBVR	NRND	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32F	

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
REF3240AIDBVRG4	NRND	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32F	
REF3240AIDBVT	NRND	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32F	
REF3240AIDBVTG4	NRND	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32F	

(1) 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.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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

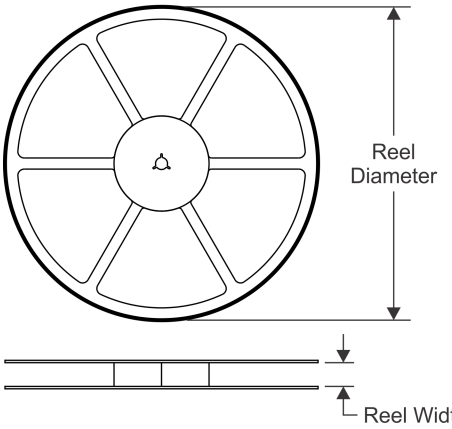
- Enhanced Product: REF3212-EP, REF3220-EP, REF3225-EP, REF3230-EP, REF3240-EP

NOTE: Qualified Version Definitions:

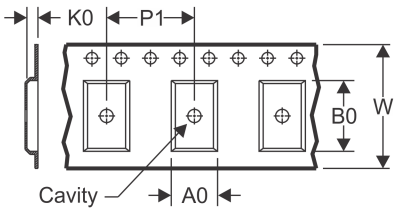
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS

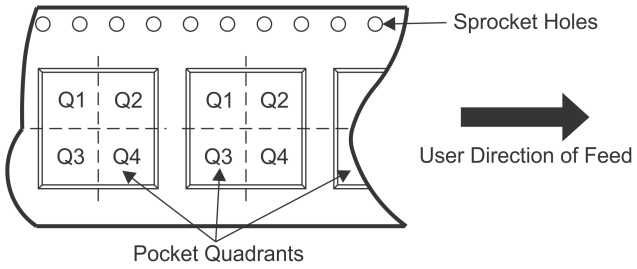


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

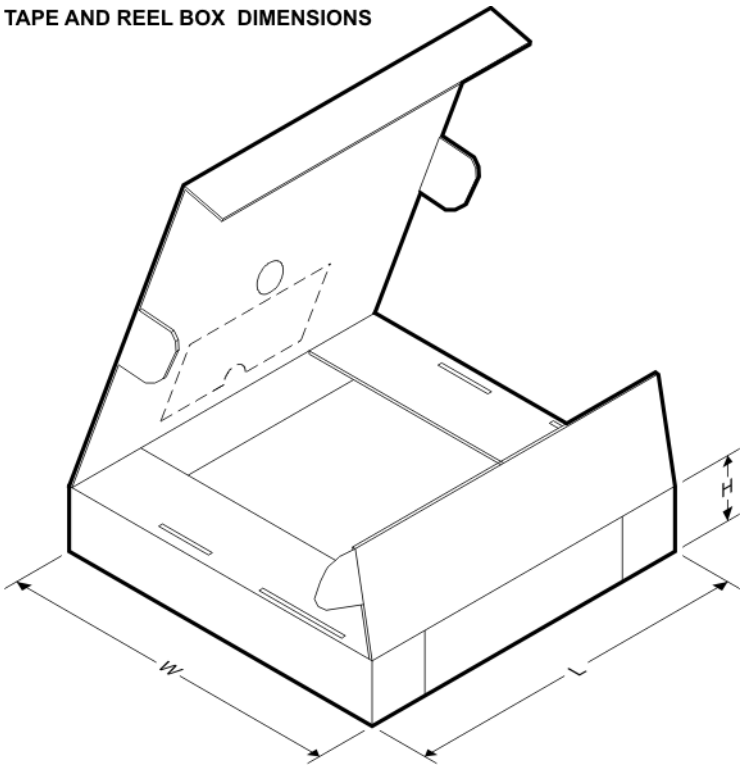
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
REF3212AIDBVT	SOT-23	DBV	6	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
REF3220AIDBVR	SOT-23	DBV	6	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
REF3220AIDBVT	SOT-23	DBV	6	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
REF3225AIDBVR	SOT-23	DBV	6	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
REF3225AIDBVT	SOT-23	DBV	6	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
REF3230AIDBVR	SOT-23	DBV	6	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
REF3230AIDBVT	SOT-23	DBV	6	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
REF3233AIDBVR	SOT-23	DBV	6	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
REF3233AIDBVT	SOT-23	DBV	6	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
REF3240AIDBVR	SOT-23	DBV	6	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
REF3240AIDBVT	SOT-23	DBV	6	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

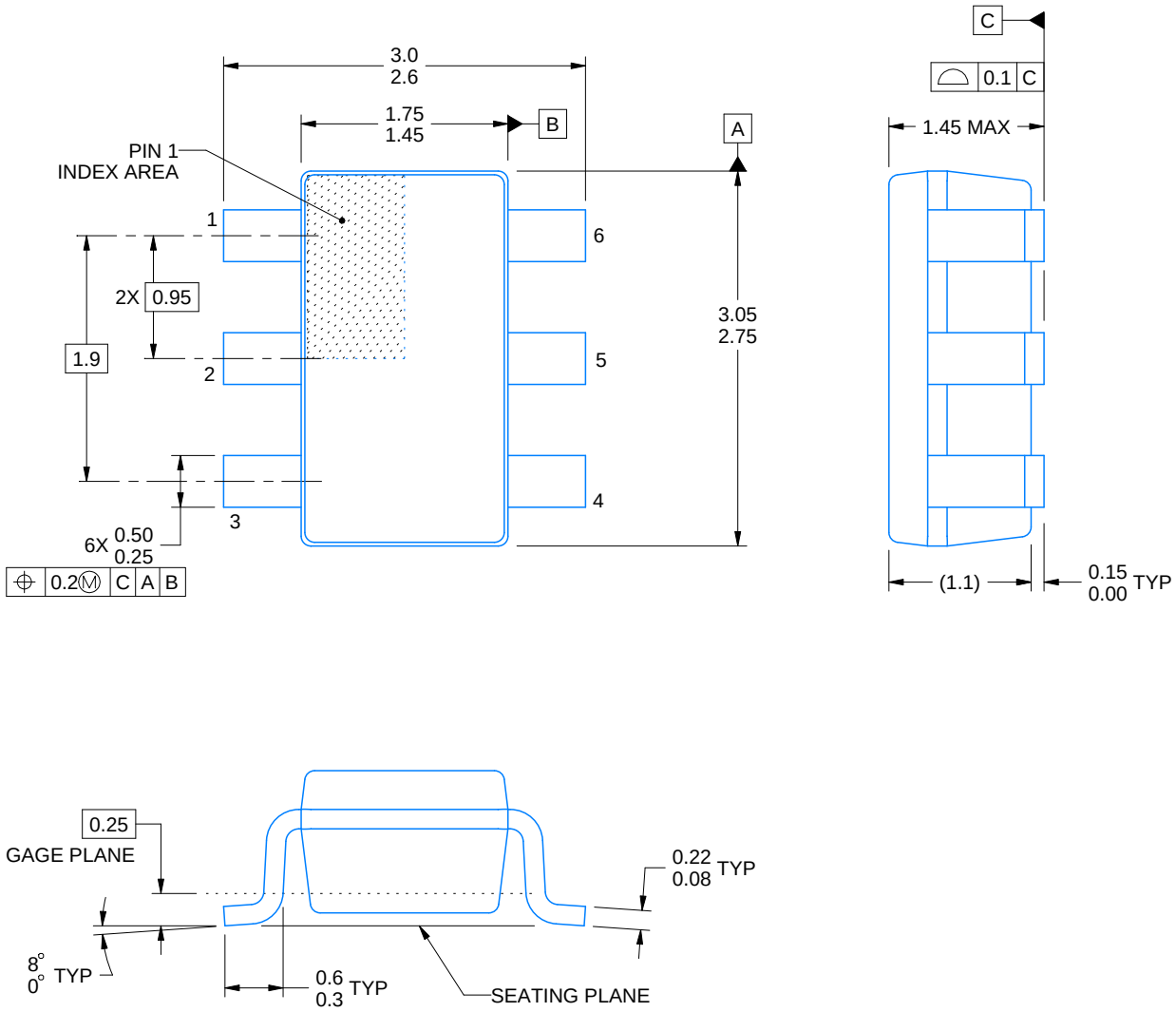
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
REF3212AIDBVR	SOT-23	DBV	6	3000	445.0	220.0	345.0
REF3212AIDBVT	SOT-23	DBV	6	250	445.0	220.0	345.0
REF3220AIDBVR	SOT-23	DBV	6	3000	445.0	220.0	345.0
REF3220AIDBVT	SOT-23	DBV	6	250	445.0	220.0	345.0
REF3225AIDBVR	SOT-23	DBV	6	3000	445.0	220.0	345.0
REF3225AIDBVT	SOT-23	DBV	6	250	445.0	220.0	345.0
REF3230AIDBVR	SOT-23	DBV	6	3000	445.0	220.0	345.0
REF3230AIDBVT	SOT-23	DBV	6	250	445.0	220.0	345.0
REF3233AIDBVR	SOT-23	DBV	6	3000	445.0	220.0	345.0
REF3233AIDBVT	SOT-23	DBV	6	250	445.0	220.0	345.0
REF3240AIDBVR	SOT-23	DBV	6	3000	445.0	220.0	345.0
REF3240AIDBVT	SOT-23	DBV	6	250	445.0	220.0	345.0

PACKAGE OUTLINE

DBV0006A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



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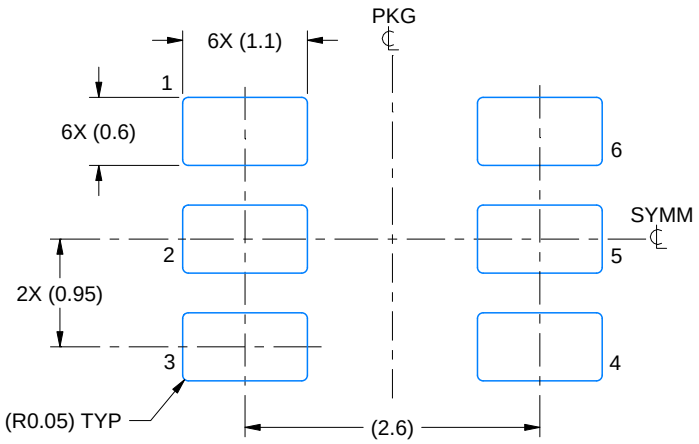
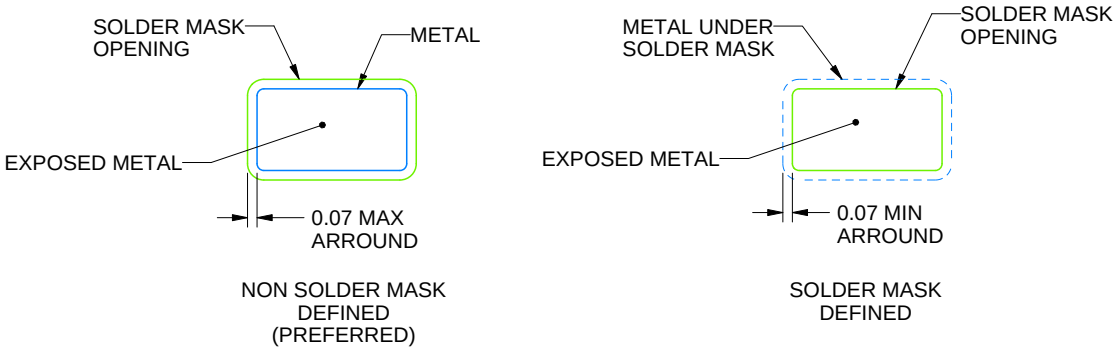
NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
4. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
5. Refernce JEDEC MO-178.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



SOLDER MASK DETAILS

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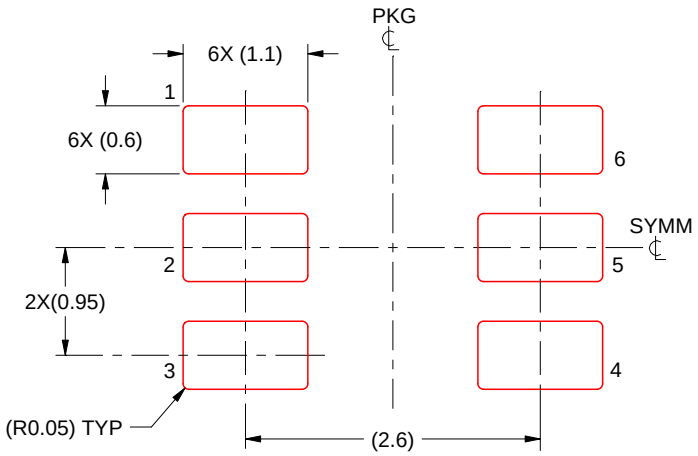
NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

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NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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