4ppm/°C, 100µA, SOT23-6 Series Voltage Reference

1 Features

- Excellent specified drift performance:
  - 7ppm/°C (maximum) at 0°C to +125°C
  - 20ppm/°C (maximum) at –40°C to +125°C
- Microsize Package: SOT23-6
- High output current: ±10mA
- High accuracy: 0.01%
- Low quiescent current: 110µA
- Low dropout: 5mV

2 Applications

- Portable equipment
- Data acquisition systems
- Medical equipment
- Test equipment

3 Description

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

The small size and low power consumption (130µA maximum) of the REF32xx makes the device an excellent choice 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 from –40°C to +125°C.

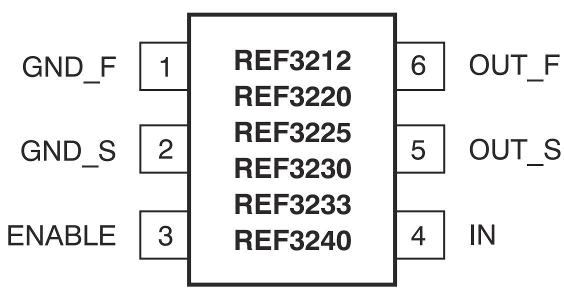
Package Information

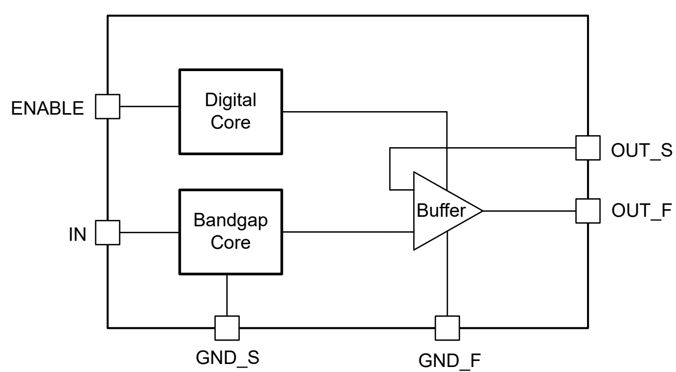
PART NUMBER	PACKAGE[(1)]	PACKAGE SIZE[(2)]
REF3212	DBV (SOT-23, 6)	2.9mm × 2.8mm
REF3220		
REF3225		
REF3230		
REF3233		
REF3240		

(1) For more information, see Section 10.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.

Available Output Voltages

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

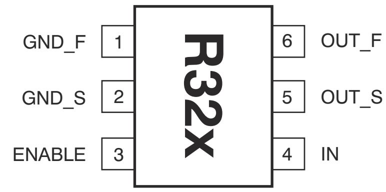




REF32 Functional Block Diagram

Table of Contents

4 Pin Configuration and Functions



The location of pin 1 on the REF32xx is determined by orienting the package marking as shown in Figure 4-1.

Figure 4-1. DBV Package SOT23-6 (Top View)

Table 4-1. Pin Functions

PIN		TYPE	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

5 Specifications

5.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted).(1)

	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

(1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. *Absolute Maximum Ratings* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If used outside the *Recommended Operating Conditions* but within the *Absolute Maximum Ratings*, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.

5.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	4	kV
		Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002(2)	1	kV
		Machine model (MM)	400	V

(1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process.

5.3 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		TEST CONDITIONS	MIN	TYP	MAX	UNIT
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	%

5.3 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		TEST CONDITIONS	MIN	TYP	MAX	UNIT
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}
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[3]	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[2]	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

5.3 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		TEST CONDITIONS	MIN	TYP	MAX	UNIT
Current	I_Q	ENABLE > 1.5V		110	130	μA
Over temperature		0°C ≤ T_A ≤ +125°C		125	145	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) Thermal hysteresis procedure is explained in more detail in Section 7.
(3) Load regulation is using force and sense lines; see Section 6.3.4 for more information.
(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 Section 6.1.1.

5.4 Typical Characteristics

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

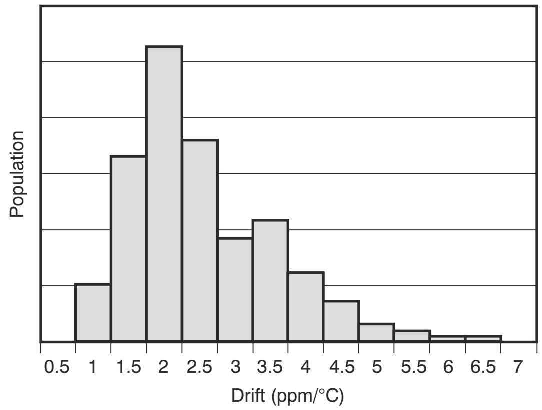


Figure 5-1. Temperature Drift (0°C to +125°C)

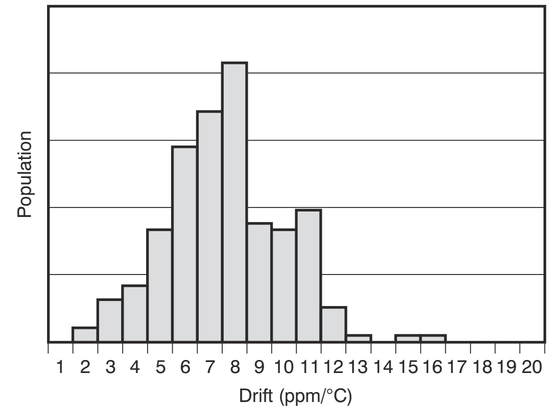


Figure 5-2. Temperature Drift (–40°C to +125°C)

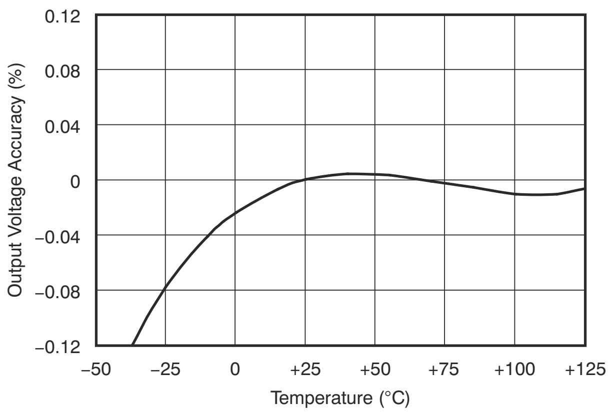


Figure 5-3. Output Voltage Accuracy vs Temperature

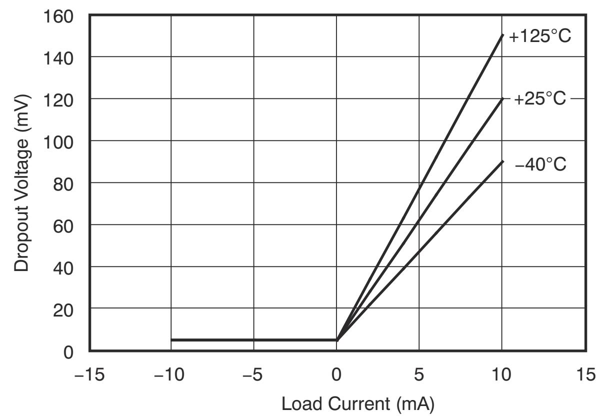


Figure 5-4. Dropout Voltage vs Load Current

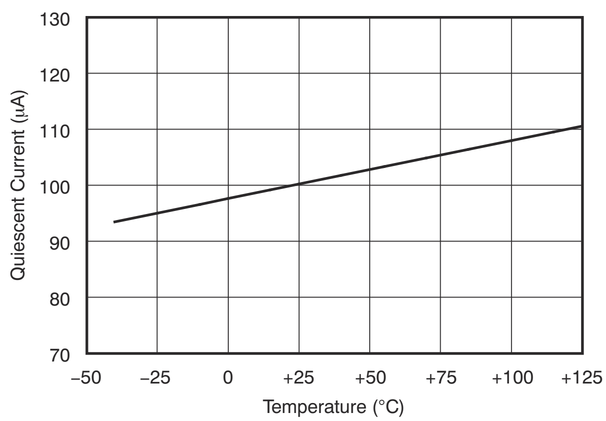


Figure 5-5. Quiescent Current vs Temperature

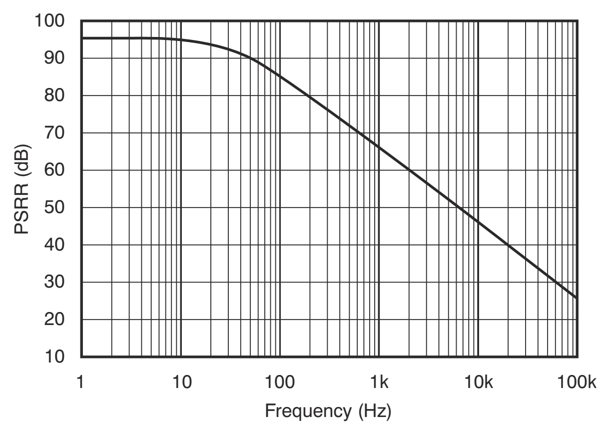


Figure 5-6. Power-supply Rejection Ratio vs Frequency

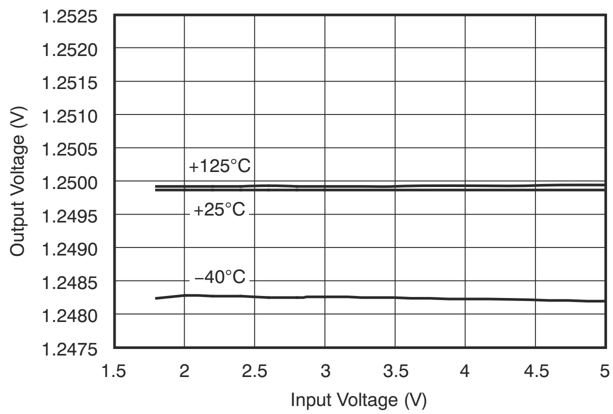


Figure 5-7. Output Voltage vs Input Voltage (REF3212)

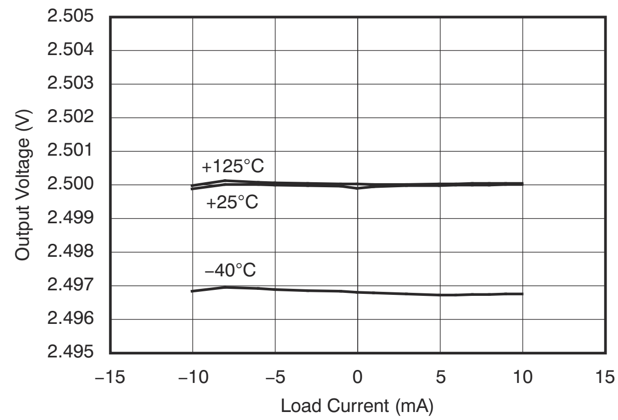


Figure 5-8. Output Voltage vs Load Current

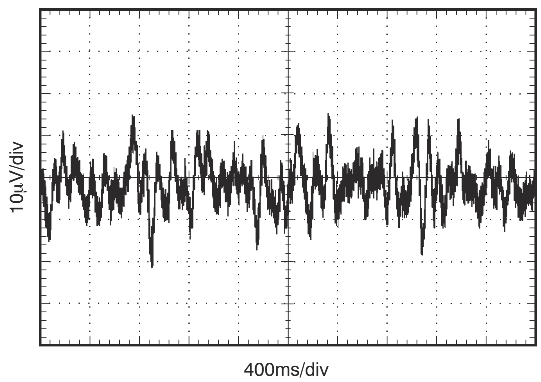


Figure 5-9. 0.1Hz to 10Hz Noise

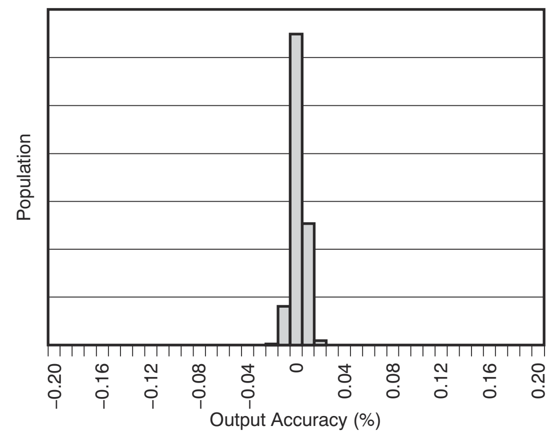


Figure 5-10. Output Voltage Initial Accuracy

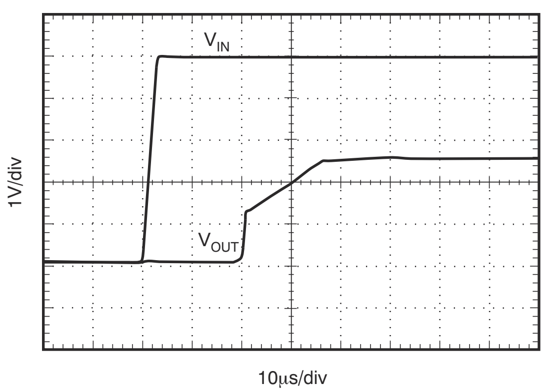


Figure 5-11. Step Response C_L = 0pF, 5V Startup

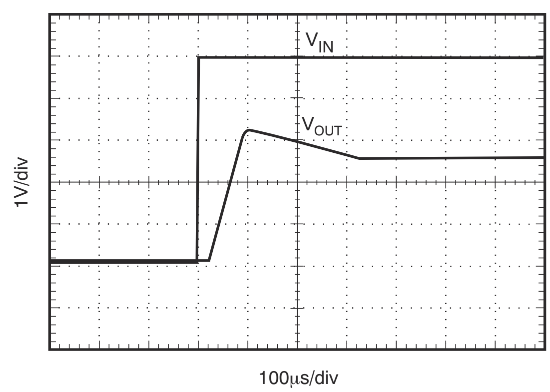


Figure 5-12. Step Response C_L = 1µF

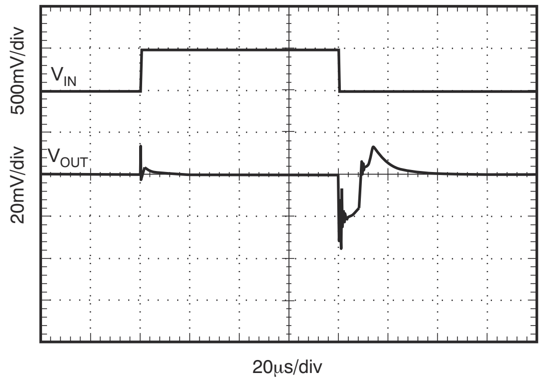


Figure 5-13. Line Transient C_L = 0pF

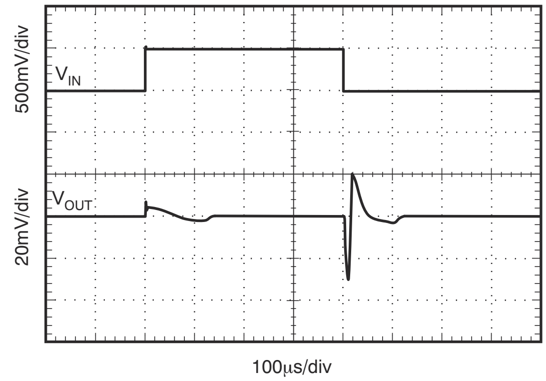


Figure 5-14. Line Transient C_L = 10µF

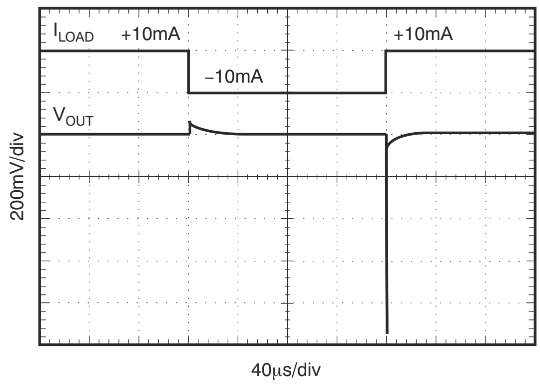


Figure 5-15. Load Transient C_L = 0pF, ±10mA Output Pulse

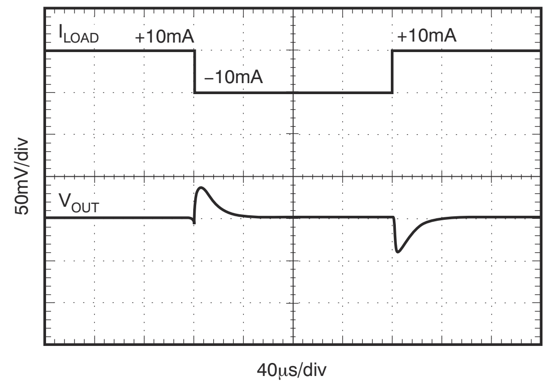


Figure 5-16. Load Transient C_L = 1µF, ±10mA Output Pulse

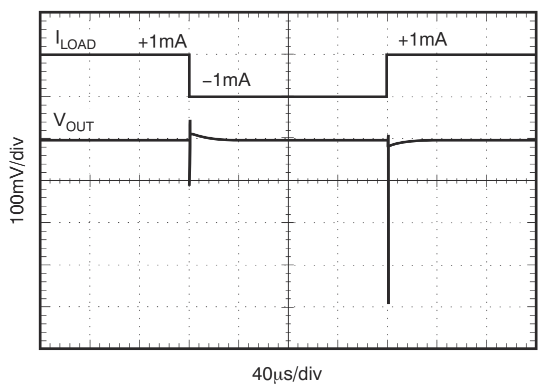


Figure 5-17. Load Transient C_L = 0pF, ±1mA Output Pulse

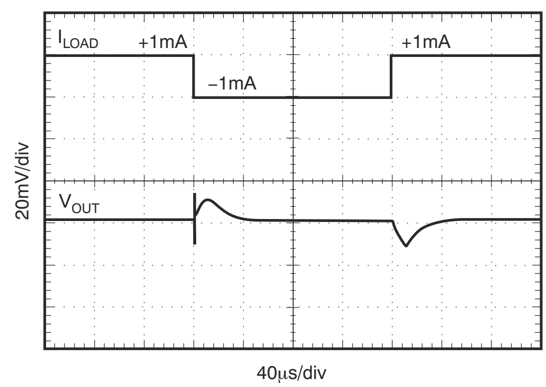


Figure 5-18. Load Transient C_L = 1µF, ±1mA Output Pulse

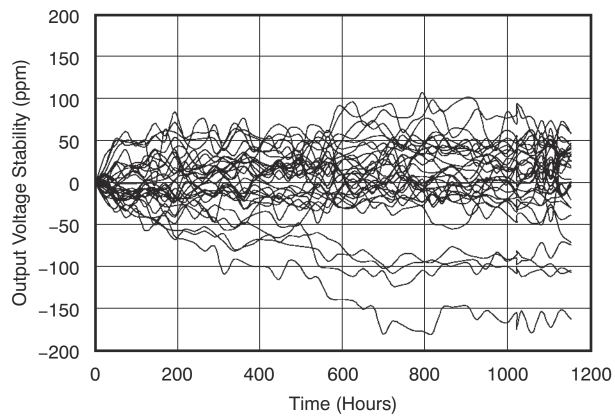


Figure 5-19. Long-Term Stability (32 Units)

6 Detailed Description

6.1 Overview

The REF32xx is a family of CMOS, precision band-gap voltage references. Figure 6-1 shows the basic band-gap 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.

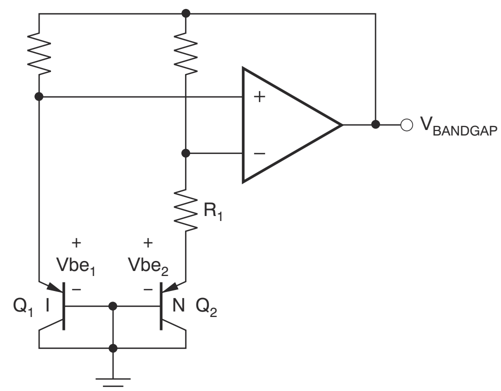


Figure 6-1. Simplified Schematic of Band-gap Reference

6.1.1 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 Section 5.4.

The REF32xx also features a low quiescent current of 110µA, with a maximum quiescent current over temperature of just 145µA. The quiescent current typically changes less than 2µA over the entire supply range, as shown in Figure 6-2.

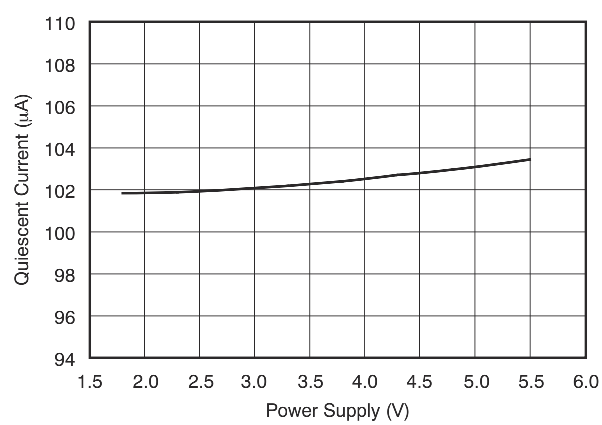


Figure 6-2. Supply Current vs Supply Voltage

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 6-3. 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.

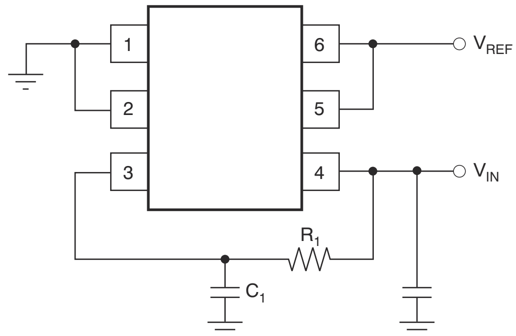


Figure 6-3. Application Circuit to Control the REF32xx ENABLE Pin

The RC filter in Figure 6-3 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 6-1 lists these values. For output voltage options other than 4.096V, the RC filter can be made faster.

Table 6-1. 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 6-1 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 must be used to decide if the IN and ENABLE pins can be tied together. Table 6-2 lists these times.

Table 6-2. 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

Because the leakage current of the EN pin is in the range of a few nA, disregard the leakage current in most applications.

6.2 Functional Block Diagram

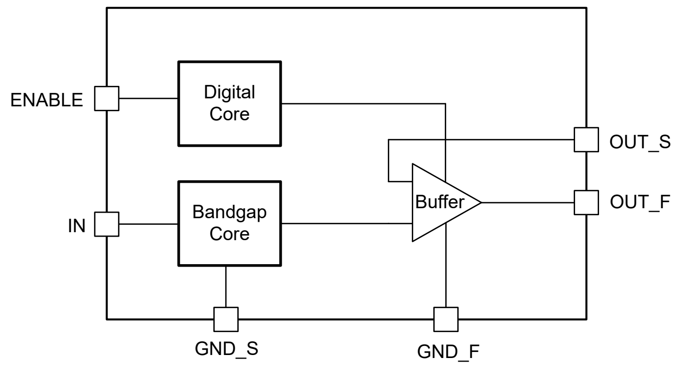


Figure 6-4. REF32 Functional Block Diagram

6.3 Feature Description

6.3.1 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, expressed as:

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

where

- V_{HYST} = thermal hysteresis (in units of ppm)
- V_{NOM} = the specified output voltage
- V_{PRE} = output voltage measured at +25°C pre-temperature 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

6.3.2 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:

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

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.

6.3.3 Noise Performance

Typical voltage noise from 0.1Hz to 10Hz is in Figure 5-9. The noise voltage of the REF32xx increases with output voltage and operating temperature. Additional filtering can be used to improve output noise levels, although take care to verify the output impedance does not degrade AC performance.

6.3.4 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 6-5.

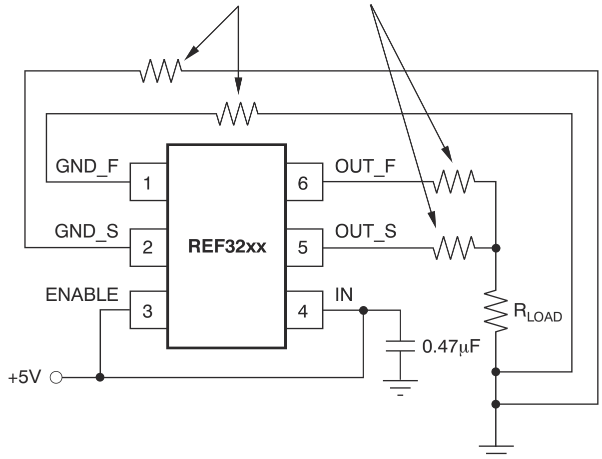


Figure 6-5. Accurate Load Regulation of REF32xx

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 diodes from unintentionally turning on.

6.4 Device Functional Modes

6.4.1 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.

7 Application and Implementation

Note

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

7.1 Application Information

The REF32xx does not require a load capacitor and is stable with any capacitive load. Figure 7-1 shows typical connections required for operation of the REF32xx. A supply bypass capacitor of 0.47μF is recommended.

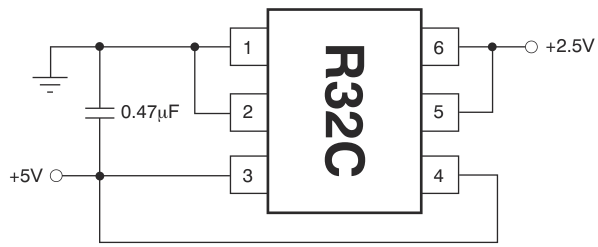


Figure 7-1. Typical Operating Connections for the REF3225

7.1.1 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.

7.2 Typical Application

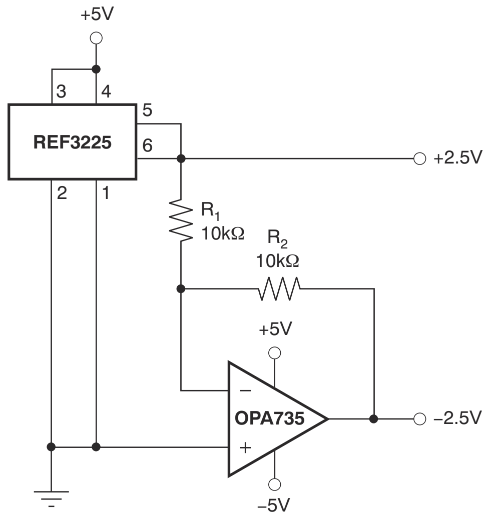
7.2.1 Detailed Design Procedure

7.2.1.1 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 7-2 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. Take care to match the temperature coefficients of R_1 and R_2.

7.2.1.2 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 7-3, Figure 7-4, and Figure 7-5 show basic data acquisition systems.



Bypass capacitor is not shown.

Figure 7-2. REF3225 Combined with OPA735 to Create Positive and Negative Reference Voltages

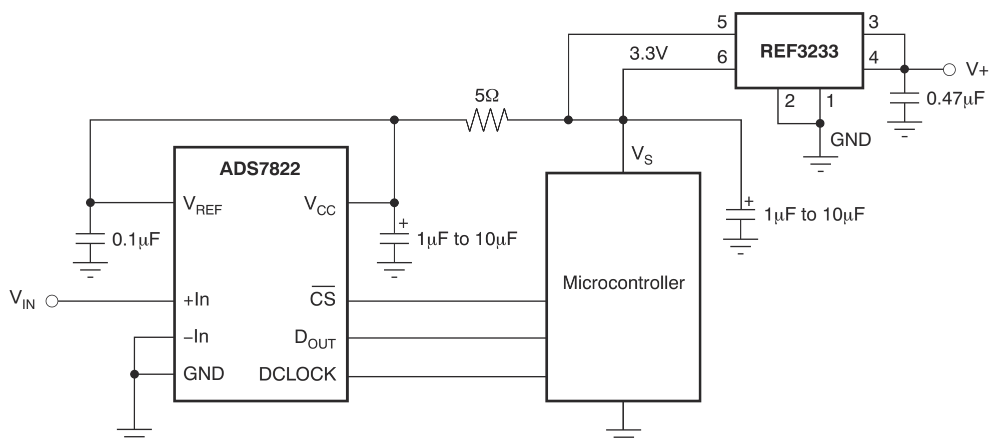


Figure 7-3. Basic Data Acquisition System 1

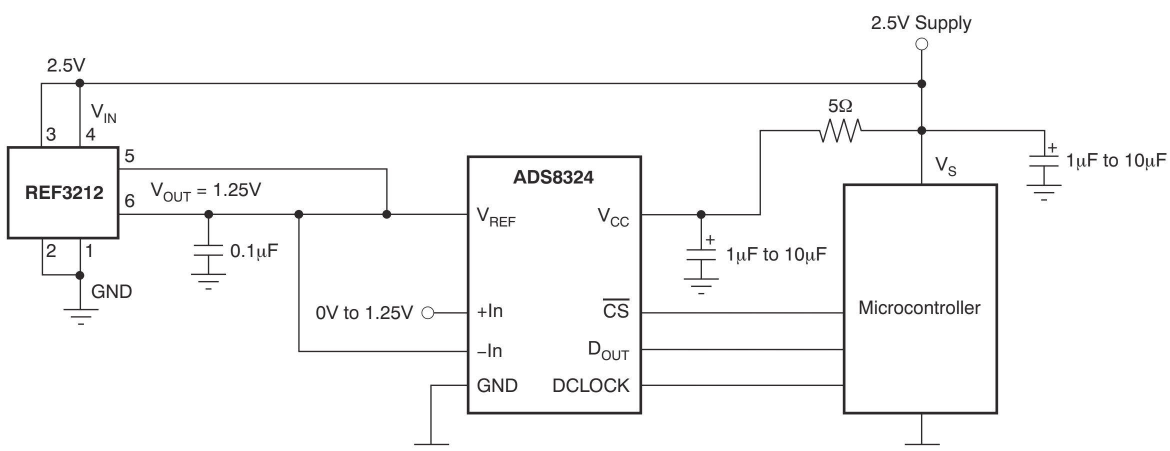


Figure 7-4. Basic Data Acquisition System 2

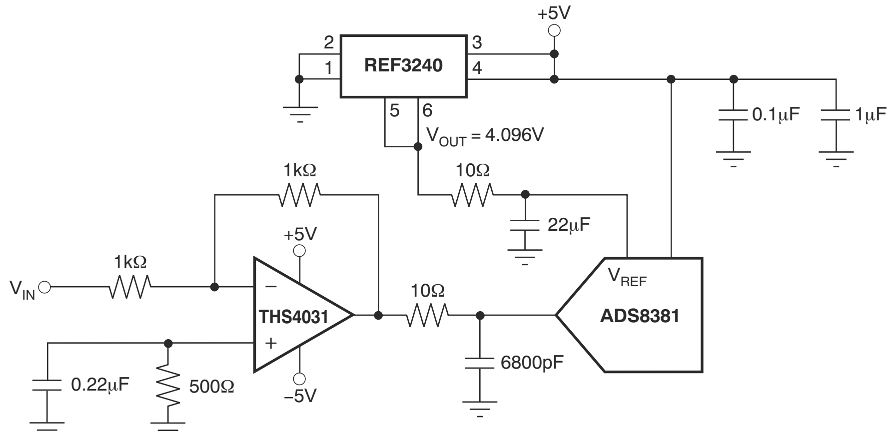


Figure 7-5. REF3240 Provides an Accurate Reference for Driving the ADS8381

8 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

8.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

8.2 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

8.3 Trademarks

TI E2E™ is a trademark of Texas Instruments.
All trademarks are the property of their respective owners.

8.4 Electrostatic Discharge Caution

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.

8.5 Glossary

TI Glossary This glossary lists and explains terms, acronyms, and definitions.

9 Revision History

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

Changes from Revision C (July 2011) to Revision D (April 2026) **Page**

- Updated the numbering format for tables, figures, and cross-references throughout the document................. 1
- Updated low quiescent current from: 100μA to: 110μA... 1
- Updated quiescent current from: 120μA to: 130μA... 1
- Moved Electrostatic discharge data from *Absolute Maximum Ratings* to *ESD Ratings* 4
- Added *ESD Ratings* 4
- Increased typical and maximum quiescent current values by 10μA..4
- Increased quiescent current values by 10μA..11

Changes from Revision B (February 2006) to Revision C (July 2011) **Page**

- 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 (0.75 × V_{IN}) to (1.5V).............. 4
- Added text, two tables, and one figure to Supply Voltage section.............. 11
- Changed pin 3 in Figure 6-5 from SHDN to ENABLE (typo).............. 13
- Added paragraph to Load Regulation section.............. 13

10 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
REF3212AIDBVR	Active	Production	SOT-23 (DBV) | 6	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32A
REF3212AIDBVR.B	Active	Production	SOT-23 (DBV) | 6	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32A
REF3212AIDBVT	Active	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32A
REF3212AIDBVT.B	Active	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32A
REF3212AIDBVT1G4	Active	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32A
REF3212AIDBVT1G4.B	Active	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32A
REF3220AIDBVR	Active	Production	SOT-23 (DBV) | 6	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32B
REF3220AIDBVR.B	Active	Production	SOT-23 (DBV) | 6	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32B
REF3220AIDBVT	Active	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32B
REF3220AIDBVT.B	Active	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32B
REF3220AIDBVT1G4	Active	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32B
REF3220AIDBVT1G4.B	Active	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32B
REF3225AIDBVR	NRND	Production	SOT-23 (DBV) | 6	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32C
REF3225AIDBVR.B	NRND	Production	SOT-23 (DBV) | 6	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32C
REF3225AIDBVT	NRND	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32C
REF3225AIDBVT.B	NRND	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32C
REF3230AIDBVR	NRND	Production	SOT-23 (DBV) | 6	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32D
REF3230AIDBVR.B	NRND	Production	SOT-23 (DBV) | 6	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32D
REF3230AIDBVT	NRND	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32D
REF3230AIDBVT.B	NRND	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32D
REF3233AIDBVR	NRND	Production	SOT-23 (DBV) | 6	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32E
REF3233AIDBVR.B	NRND	Production	SOT-23 (DBV) | 6	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32E
REF3233AIDBVT	NRND	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32E
REF3233AIDBVT.B	NRND	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32E
REF3240AIDBVR	NRND	Production	SOT-23 (DBV) | 6	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32F
REF3240AIDBVR.B	NRND	Production	SOT-23 (DBV) | 6	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32F
REF3240AIDBVT	NRND	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32F
REF3240AIDBVT.B	NRND	Production	SOT-23 (DBV) | 6	250 | SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R32F

[1] **Status:** For more details on status, see our product life cycle.

[2] **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

[3] **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

[4] **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

[5] **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

[6] **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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, REF3240 :

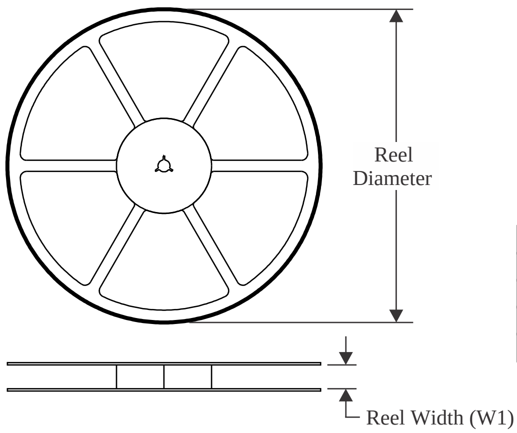
- Enhanced Product : REF3212-EP, REF3220-EP, REF3225-EP, REF3230-EP, REF3240-EP

NOTE: Qualified Version Definitions:

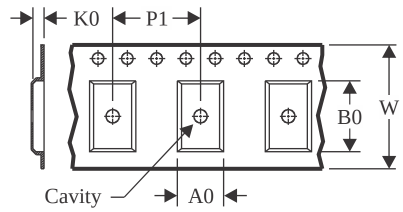
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS

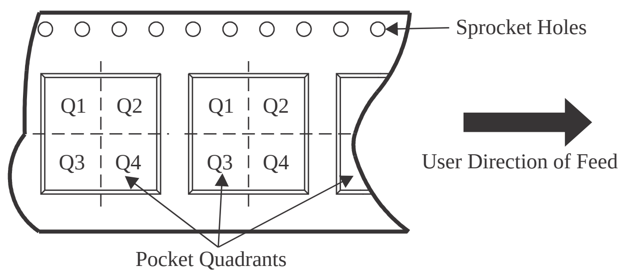


TAPE DIMENSIONS



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

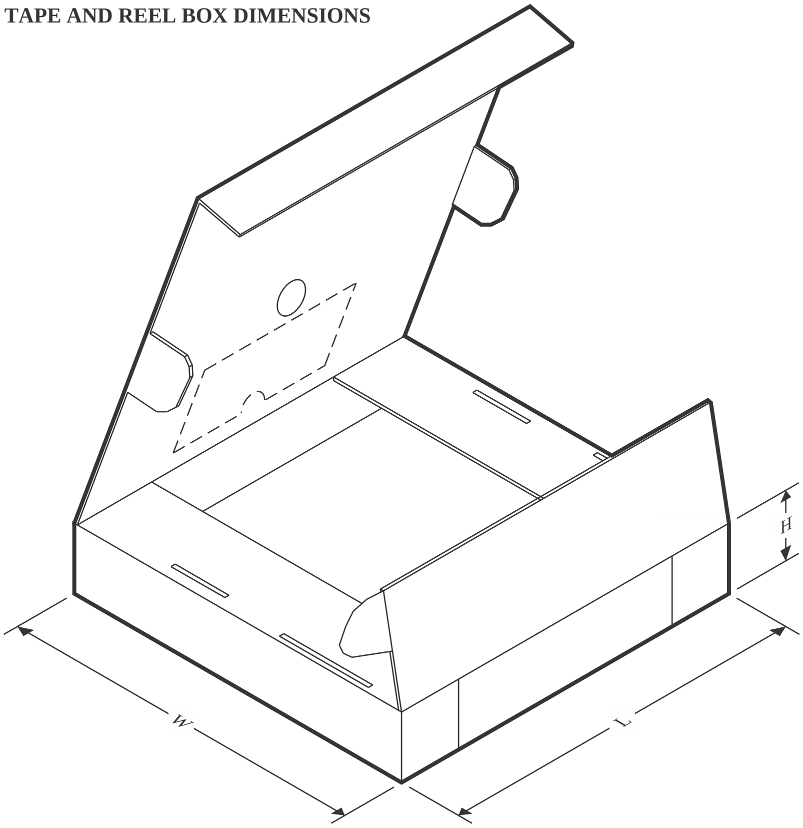
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

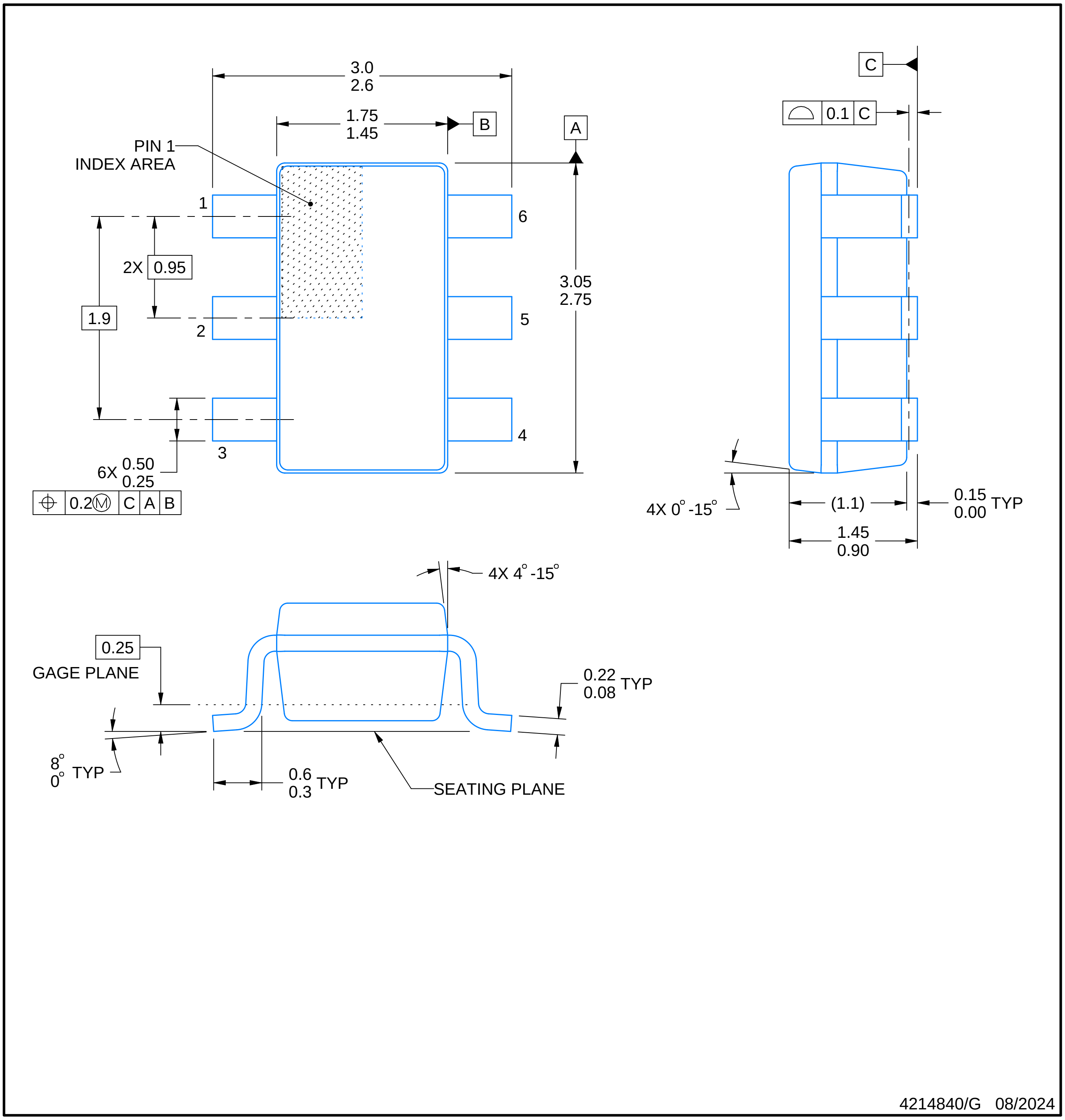
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
REF3212AIDBVR	SOT-23	DBV	6	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
REF3212AIDBVT	SOT-23	DBV	6	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
REF3212AIDBVT1G4	SOT-23	DBV	6	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
REF3220AIDBVT1G4	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



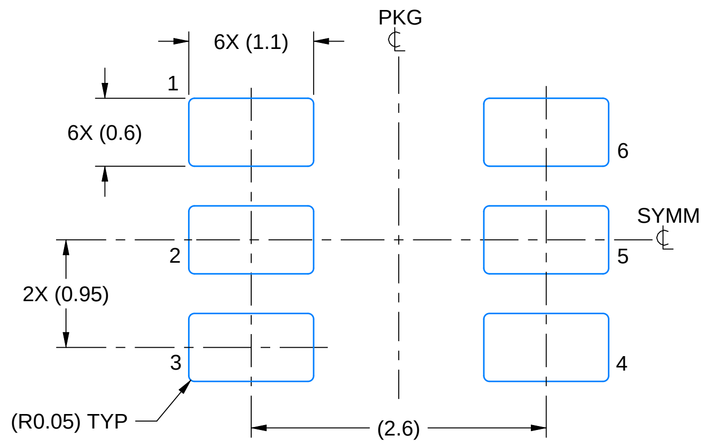
*All dimensions are nominal

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
REF3212AIDBVT1G4	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
REF3220AIDBVT1G4	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

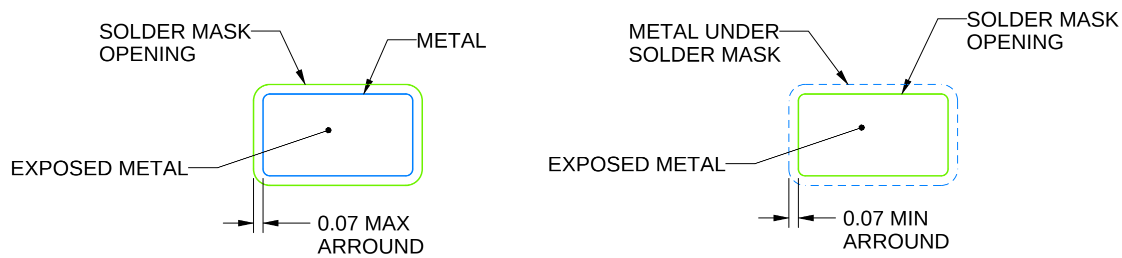


NOTES:

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 0.25 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



NON SOLDER MASK DEFINED (PREFERRED)

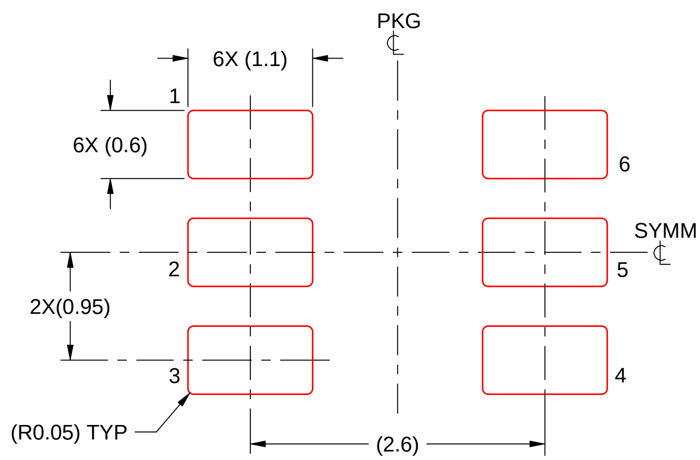
SOLDER MASK DEFINED

SOLDER MASK DETAILS

4214840/G 08/2024

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

4214840/G 08/2024

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.