REF31xx-Q1 15ppm/°C Maximum, 100µA, SOT-23 Series Voltage Reference

1 Features

- AEC-Q100 Qualified with the following results:
  - Device T_A range: –40°C to 125°C
  - Device HBM ESD classification level H1C
  - Device CDM ESD classification level C4A
- Functional Safety-Capable
  - Documentation available to aid functional safety system design
- High accuracy: 0.2% maximum
- Excellent specified drift performance:
  - 20ppm/°C (maximum) from –40°C to +125°C
- High output current: ±10mA
- Low dropout: 5mV
- Low I_Q: 115µA maximum
- Low noise: 17µVp-p/V
- No output capacitor required
- Available voltage options : 1.2V, 2V, 2.5V, 3V, 3.3V, 4V
- *Micro* size package: 3-Pin SOT-23

2 Applications

- HEV/EV Powertrain Systems
  - Automotive Battery Management Systems
  - Inverter
  - Electric Power Steering Systems
- Advanced Driver Assistance Systems (ADAS)
  - Radar Systems
  - Night Vision Systems
  - Dynamic Spotlight
  - Front Camera
- Infotainment MCU Attached
- Portable, Battery-Powered Equipment

3 Description

The REF31xx-Q1 is a family of precision, low power, low dropout, series voltage references available in the tiny 3-pin SOT-23 package.

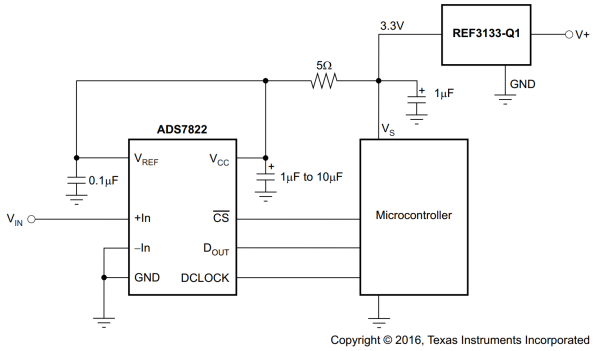
The REF31xx-Q1 small size and low power consumption (100µA typical) make it suitable for portable and battery-powered applications. The REF31xx-Q1 does not require a load capacitor and can sink or source up to 10mA of output current.

Unloaded, the REF31xx-Q1 can operate on supplies down to 5mV above the output voltage. All models are specified for the wide temperature range of –40°C to +125°C.

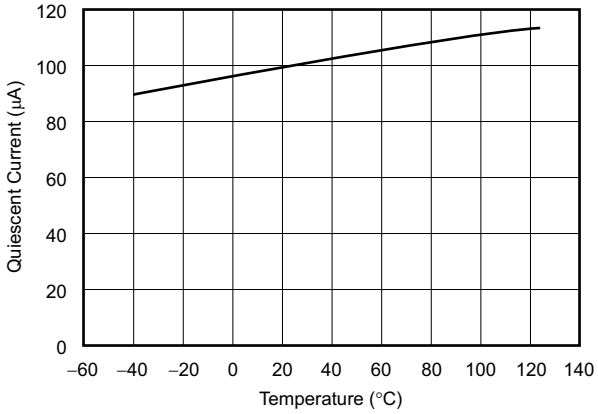
Package Information

PART NUMBER	PACKAGE(1)	PACKAGE SIZE(2)
REF3112-Q1 REF3120-Q1 REF3125-Q1 REF3130-Q1 REF3133-Q1 REF3140-Q1	SOT-23 (3)	2.92mm × 2.37mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.



Typical Application



Quiescent Current vs Temperature

Table of Contents

4 Device Comparison Table

PRODUCT	VOLTAGE (V)
REF3112-Q1	1.25
REF3120-Q1	2.048
REF3125-Q1	2.5
REF3130-Q1	3
REF3133-Q1	3.3
REF3140-Q1	4.096

5 Pin Configuration and Functions

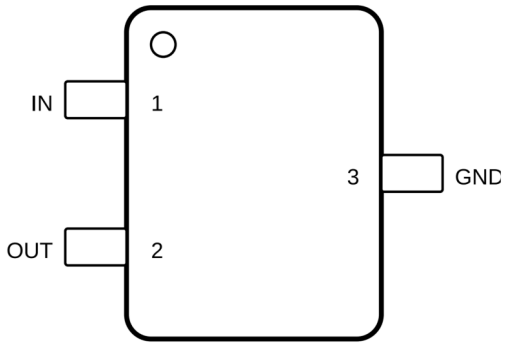


Figure 5-1. DBZ Package 3-Pin SOT-23 Top View

Table 5-1. Pin Functions

PIN		I/O	DESCRIPTION
NO.	NAME		
1	IN	I	Input supply voltage
2	OUT	O	Reference output voltage
3	GND	—	Ground

6 Specifications

6.1 Absolute Maximum Ratings

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

	MIN	MAX	UNIT
Supply voltage, V+ to V–		7	V
Output short circuit	Continuous		
Operating temperature	–55	135	°C
Junction temperature		150	°C
Storage temperature, T_{stg}	–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±2000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101(2)	±1000	

(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.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
V_{IN}	Input voltage	V_{REF} + 0.05(1)	5.5	V
I_{LOAD}	Load current		25	mA
T_A	Operating temperature	–40	125	°C

(1) Minimum supply voltage for the REF3112-Q1 is 1.8V.

6.4 Thermal Information

THERMAL METRIC(1)		REF31xx-Q1 DBZ (SOT-23) 3 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	292.9	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	124.4	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	89	°C/W
ψ_{JT}	Junction-to-top characterization parameter	11.4	°C/W
ψ_{JB}	Junction-to-board characterization parameter	87.6	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	—	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report.

6.5 Electrical Characteristics

at T_A = 25°C, I_{LOAD} = 0mA, and V_{IN} = 5V (unless otherwise noted)

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT
REF3312-Q1[1] — 1.25V							
V_{OUT}	Output voltage			1.2475	1.25	1.2525	V
	Initial accuracy			–0.2%		0.2%	
Output voltage noise			f = 0.1Hz to 10Hz		17		μV_{PP}
			f = 10Hz to 10kHz		24		μV_{RMS}
REF3120-Q1 — 2.048V							
V_{OUT}	Output voltage			2.0439	2.048	2.0521	V
	Initial accuracy			–0.2%		0.2%	
Output voltage noise			f = 0.1Hz to 10Hz		27		μV_{PP}
			f = 10Hz to 10kHz		39		μV_{RMS}
REF3125-Q1 — 2.5V							
V_{OUT}	Output voltage			2.495	2.5	2.505	V
	Initial accuracy			–0.2%		0.2%	
Output voltage noise			f = 0.1Hz to 10Hz		33		μV_{PP}
			f = 10Hz to 10kHz		48		μV_{RMS}
REF3130-Q1 — 3V							
V_{OUT}	Output voltage			2.994	3	3.006	V
	Initial accuracy			–0.2%		0.2%	
Output voltage noise			f = 0.1Hz to 10Hz		39		μV_{PP}
			f = 10Hz to 10kHz		57		μV_{RMS}
REF3133-Q1 — 3.3V							
V_{OUT}	Output voltage			3.2934	3.3	3.3066	V
	Initial accuracy			–0.2%		0.2%	
Output voltage noise			f = 0.1Hz to 10Hz		43		μV_{PP}
			f = 10Hz to 10kHz		63		μV_{RMS}
REF3140-Q1 — 4.096V							
V_{OUT}	Output voltage			4.0878	4.096	4.1042	V
	Initial accuracy			–0.2%		0.2%	
Output voltage noise			f = 0.1Hz to 10Hz		53		μV_{PP}
			f = 10Hz to 10kHz		78		μV_{RMS}
REF31xx-Q1 (REF3112-Q1, REF3120-Q1, REF3125-Q1, REF3130-Q1, REF3133-Q1, REF3140-Q1)							
dV_{OUT}/dT	Output voltage temperature drift[2]		T_A = 0°C to 70°C.		5	15	ppm/°C
			T_A = –40°C to +125°C .		10	20	
	Long-term stability		0 to 1000 hours		70		ppm
	Line regulation		V_{REF} + 0.05[1] ≤ V_{IN} ≤ 5.5 V		20	65	ppm/V
dV_{OUT}/dI_{LOAD}	Load regulation[3]	Sourcing	0 mA < I_{LOAD} < 10 mA, V_{IN} = V_{REF} + 250 mV[1]		10	30	µV/mA
		Sinking	–10 mA < I_{LOAD} < 0 mA, V_{IN} = V_{REF} + 100mV[1]		20	50	
dT	Thermal hysteresis[4]	First Cycle			100		ppm
		Additional Cycles			25		
$V_{IN} – V_{OUT}$	Dropout voltage[1]		T_A = –40°C to +125°C.		5	50	mV
I_{LOAD}	Output current			–10		10	mA
I_{SC}	Short-circuit current	Sourcing			50		mA
		Sinking			40		
	Turnon settling time		To 0.1% at V_{IN} = +5V with C_L = 0µF		400		µs
POWER SUPPLY							
V_S	Voltage		I_{LOAD} = 0, T_A = –40°C to +125°C.	V_{REF} + 0.05[1]		5.5	V

6.5 Electrical Characteristics (continued)

at T_A = 25°C, I_{LOAD} = 0mA, and V_{IN} = 5V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_Q	Quiescent current	I_{LOAD} = 0, T_A = 25°C		100	115	µA
		I_{LOAD} = 0, T_A = –40°C to +125°C		115	135	

(1) Minimum supply voltage for the REF3112 is 1.8V.
(2) Box Method used to determine temperature drift.
(3) Typical value of load regulation reflects measurements using force and sense contacts; see *Load Regulation*.
(4) Thermal hysteresis is explained in more detail in *Application and Implementation* of this data sheet.

6.6 Typical Characteristics

At T_A = 25°C, V_{IN} = 5-V power supply, and REF3125-Q1 is used for typical characteristic measurements, unless otherwise noted.

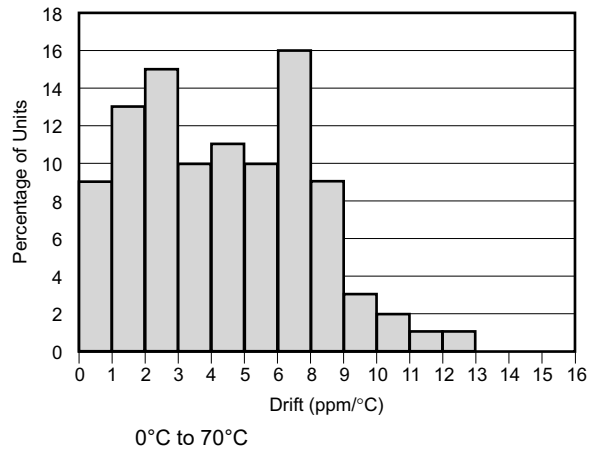


Figure 6-1. Temperature Drift

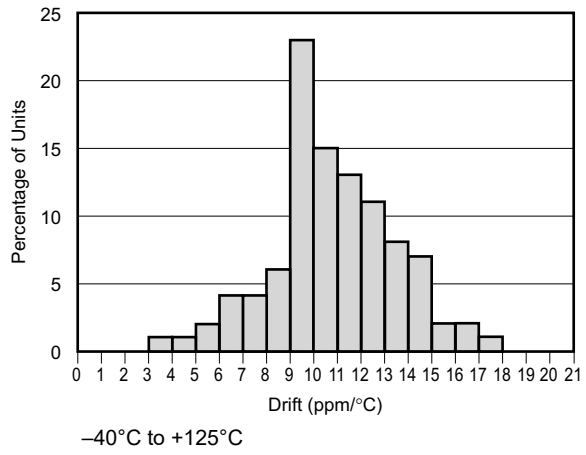


Figure 6-2. Temperature Drift

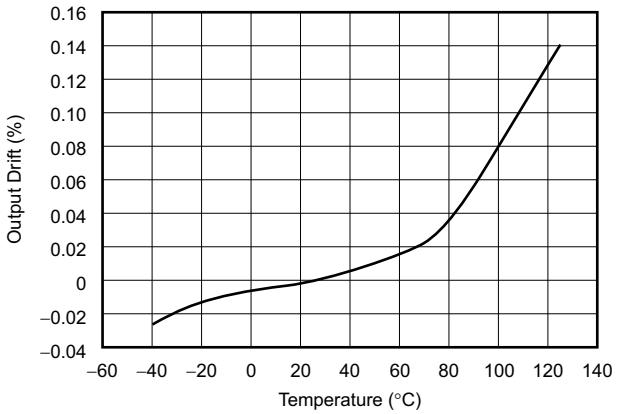


Figure 6-3. Output Voltage vs Temperature

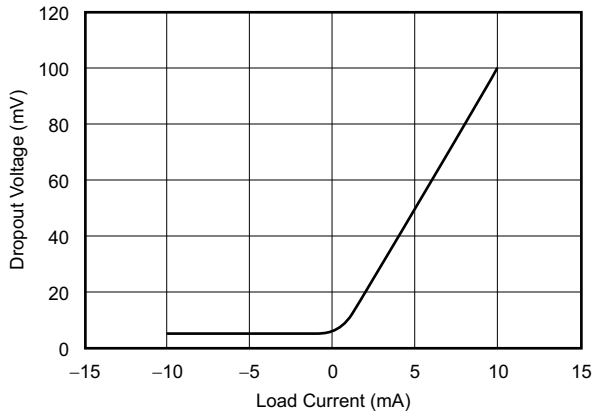


Figure 6-4. Dropout Voltage vs Load Current

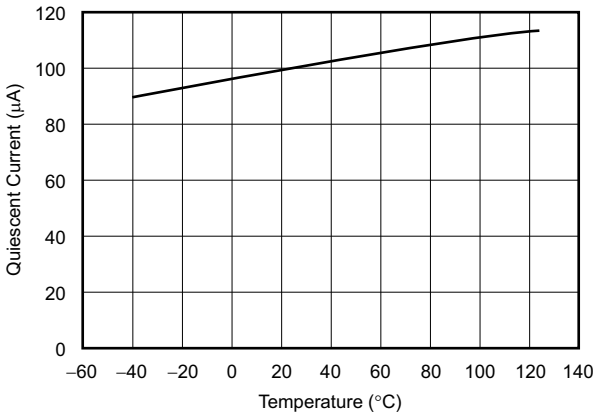


Figure 6-5. Quiescent Current vs Temperature

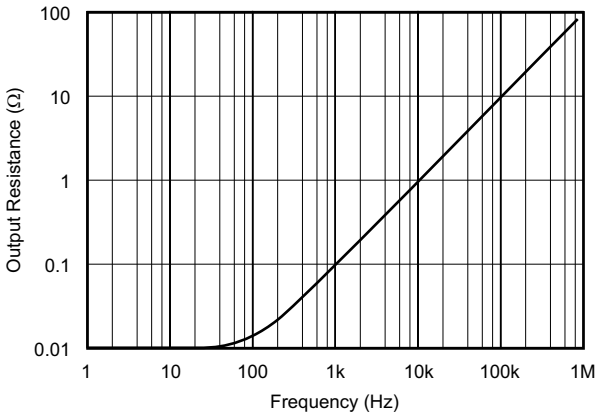


Figure 6-6. Output Impedance vs Frequency

6.6 Typical Characteristics (continued)

At T_A = 25°C, V_{IN} = 5-V power supply, and REF3125-Q1 is used for typical characteristic measurements, unless otherwise noted.

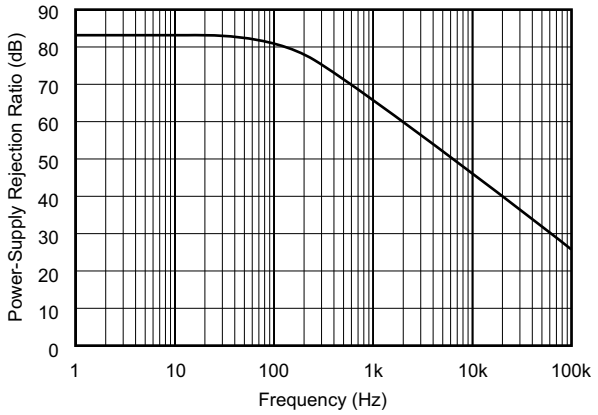


Figure 6-7. PSRR vs Frequency

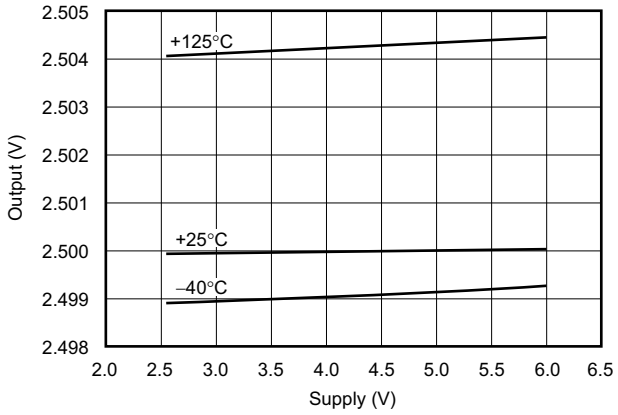


Figure 6-8. Output vs Supply

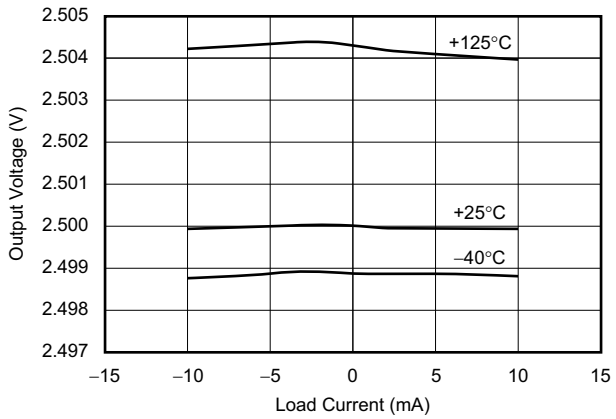


Figure 6-9. Output Voltage vs Load Current

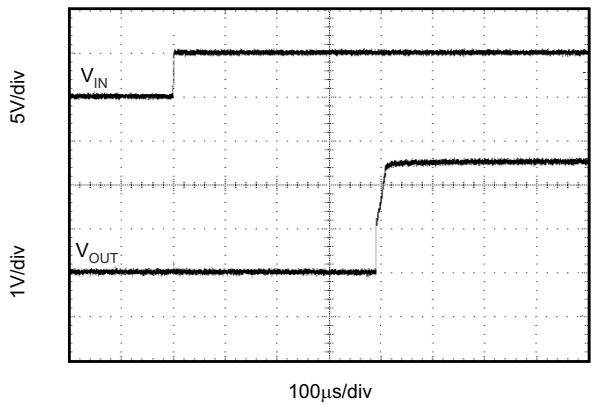


Figure 6-10. Step Response

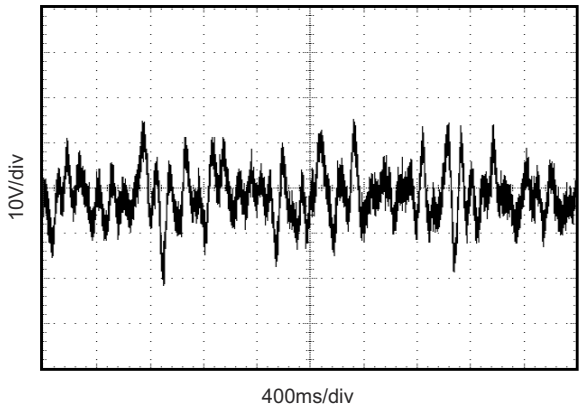


Figure 6-11. 0.1-Hz to 10-Hz Noise

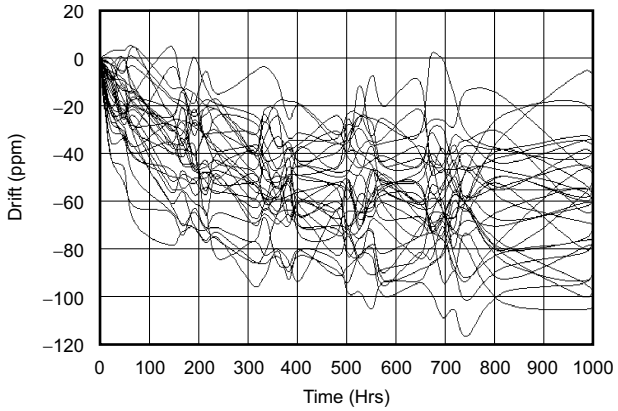
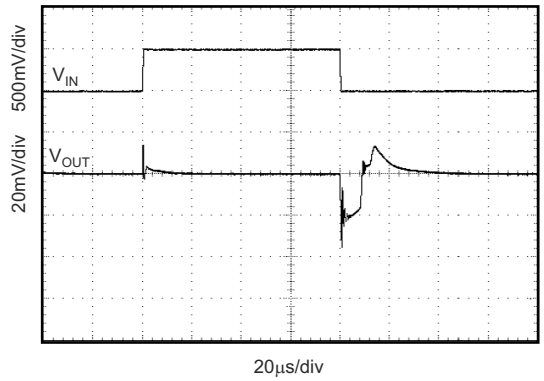


Figure 6-12. REF3112 Long-Term Stability

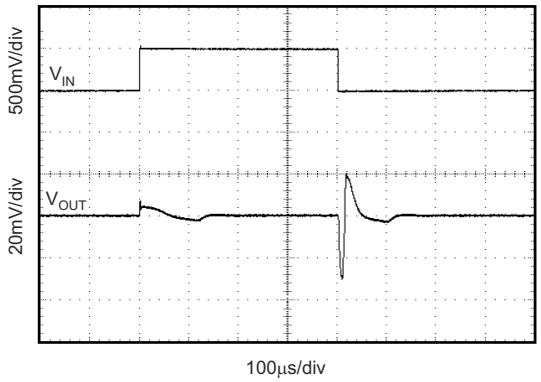
6.6 Typical Characteristics (continued)

At T_A = 25°C, V_{IN} = 5-V power supply, and REF3125-Q1 is used for typical characteristic measurements, unless otherwise noted.



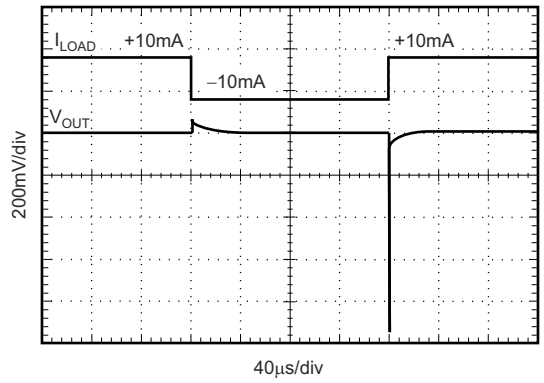
C_L = 0 pF

Figure 6-13. Line Transient



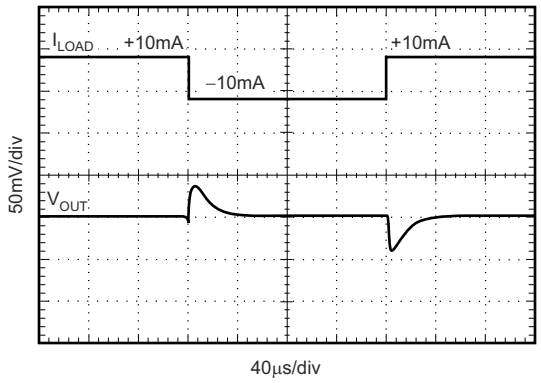
C_L = 10 µF

Figure 6-14. Line Transient



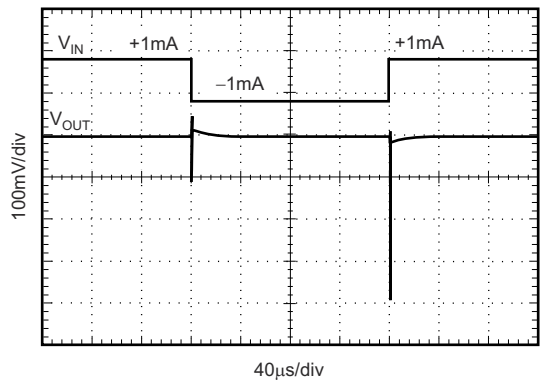
C_L = 0 pF ±10-mA Output Pulse

Figure 6-15. Load Transient



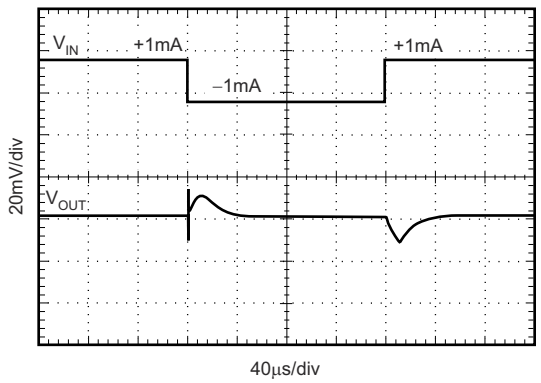
C_L = 1 µF ±10-mA Output Pulse

Figure 6-16. Load Transient



C_L = 0 pF ±1-mA Output Pulse

Figure 6-17. Load Transient



C_L = 1 µF ±1-mA Output Pulse

Figure 6-18. Load Transient

6.6 Typical Characteristics (continued)

At T_A = 25°C, V_{IN} = 5-V power supply, and REF3125-Q1 is used for typical characteristic measurements, unless otherwise noted.

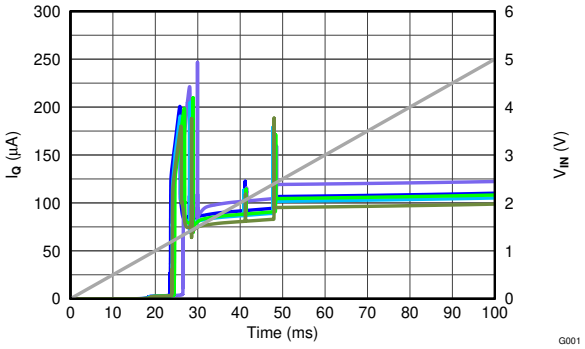


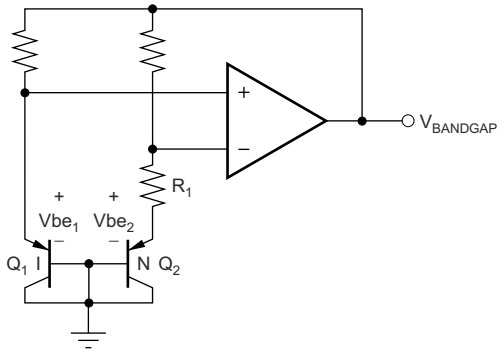
Figure 6-19. REF3125-Q1 Start-Up

7 Detailed Description

7.1 Overview

The REF31xx-Q1 is a family of series, CMOS, precision bandgap voltage references. The basic bandgap topology is shown in *Functional Block Diagram*. Transistors Q_1 and Q_2 are biased such 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 gained up 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. The curvature of the bandgap voltage, as shown in Figure 6-3, is due to the slightly nonlinear temperature coefficient of the base-emitter voltage of Q_2.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Supply Voltage

The REF31xx-Q1 family of references features an extremely low dropout voltage. With the exception of the REF3112, which has a minimum supply requirement of 1.8 V, these references can be operated with a supply of only 5 mV above the output voltage in an unloaded condition. For loaded conditions, a typical dropout voltage versus load is shown in *Typical Characteristics*.

The REF31xx-Q1 features a low quiescent current that is extremely stable over changes in both temperature and supply. The typical room temperature quiescent current is 100 µA, and the maximum quiescent current over temperature is just 135 µA. The quiescent current typically changes less than 2 µA over the entire supply range, as shown in Figure 7-1.

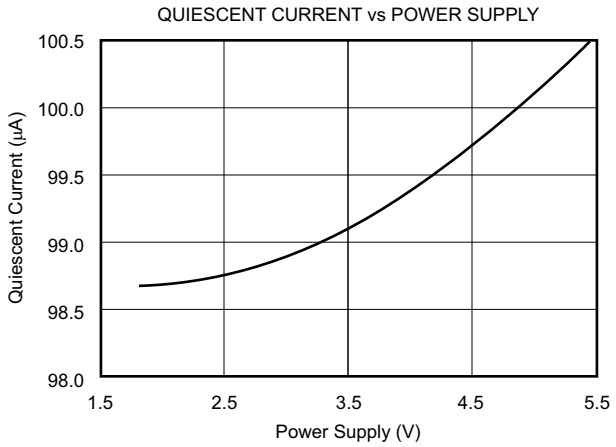


Figure 7-1. Supply Current vs Supply Voltage

Supply voltages below the specified levels can cause the REF31xx-Q1 to momentarily draw currents greater than the typical quiescent current. This can be prevented by using a power supply with a fast rising edge and low output impedance.

7.3.2 Thermal Hysteresis

Thermal hysteresis for the REF31xx-Q1 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:

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

Where:

V_{HYST} = Thermal hysteresis.

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.

7.3.3 Temperature Drift

The REF31xx-Q1 is designed to exhibit minimal drift error, defined as the change in output voltage over varying temperature. The drift is calculated using the *box* method, which is described in 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 REF31xx-Q1 features a typical drift coefficient of 5 ppm from 0°C to 70°C, the primary temperature range for many applications. For the industrial temperature range of –40°C to +125°C, the REF31xx-Q1 family drift increases to a typical value of 10 ppm.

7.3.4 Noise Performance

Typical 0.1-Hz to 10-Hz voltage noise can be seen in Figure 7-2. The noise voltage of the REF31xx-Q1 increases with output voltage and operating temperature. Additional filtering may be used to improve output noise levels, although take care to ensure the output impedance does not degrade the AC performance.

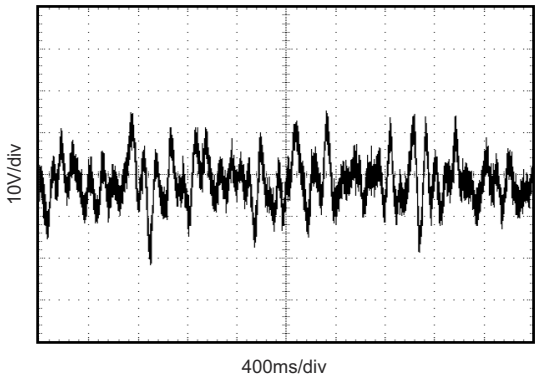


Figure 7-2. 0.1-Hz to 10-Hz Noise

7.3.5 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 curves. The typical drift value for the REF31xx-Q1 is 70 ppm from 0 to 1000 hours. This parameter is characterized by measuring 30 units at regular intervals for a period of 1000 hours.

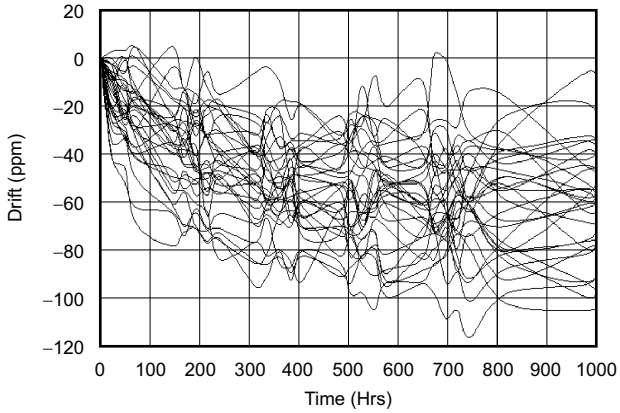


Figure 7-3. REF3112 Long-Term Stability

7.3.6 Load Regulation

Load regulation is defined as the change in output voltage due to changes in load current. The load regulation of the REF31xx-Q1 is measured using force and sense contacts as pictured in Figure 7-4. The force and sense lines reduce the impact of contact and trace resistance, resulting in accurate measurement of the load regulation contributed solely by the REF31xx-Q1. For applications requiring improved load regulation, force and sense lines must be used.

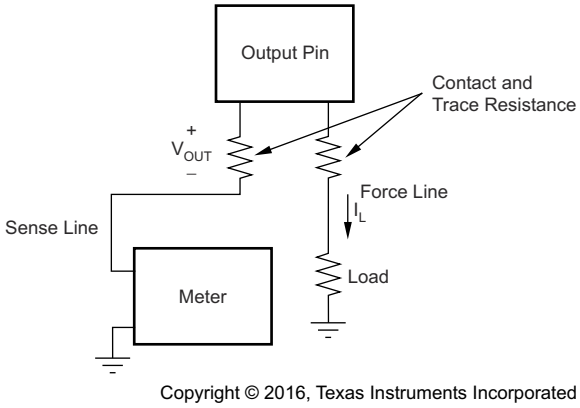


Figure 7-4. Accurate Load Regulation of REF31xx-Q1

7.4 Device Functional Modes

7.4.1 Negative Reference Voltage

For applications requiring a negative and positive reference voltage, the REF31xx-Q1 and OPA703 can be used to provide a dual-supply reference from a ±5-V supply. Figure 7-5 shows the REF3125-Q1 used to provide a ±2.5-V supply reference voltage. The low drift performance of the REF31xx-Q1 complements the low offset voltage and low drift of the OPA703 to provide an accurate solution for split-supply applications.

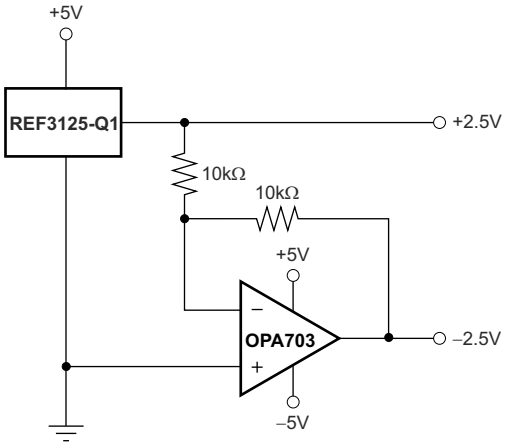


Figure 7-5. REF3125-Q1 Combined With OPA703 to Create Positive and Negative Reference Voltages

7.4.2 Data Acquisition

Data acquisition systems often require stable voltage references to maintain accuracy. The REF31xx-Q1 family features stability and a wide range of voltages suitable for most microcontrollers and data converters. Figure 7-6, Figure 7-7, and Figure 7-8 show basic data acquisition systems.

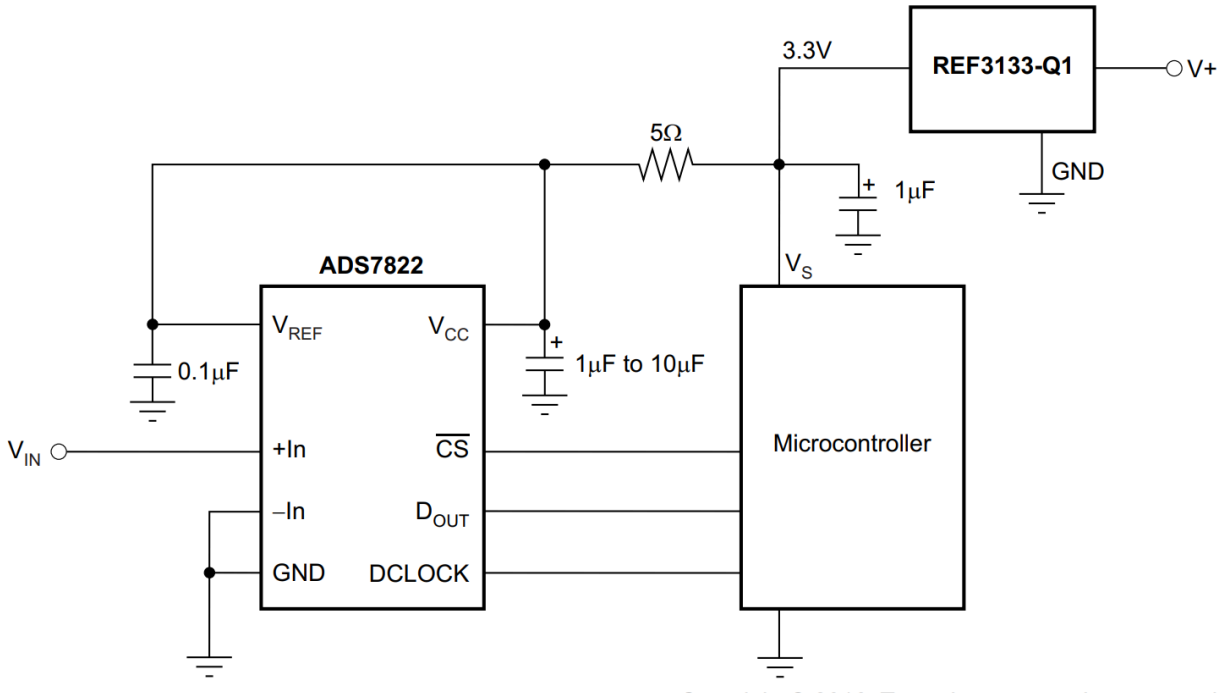


Figure 7-6. Basic Data Acquisition System 1

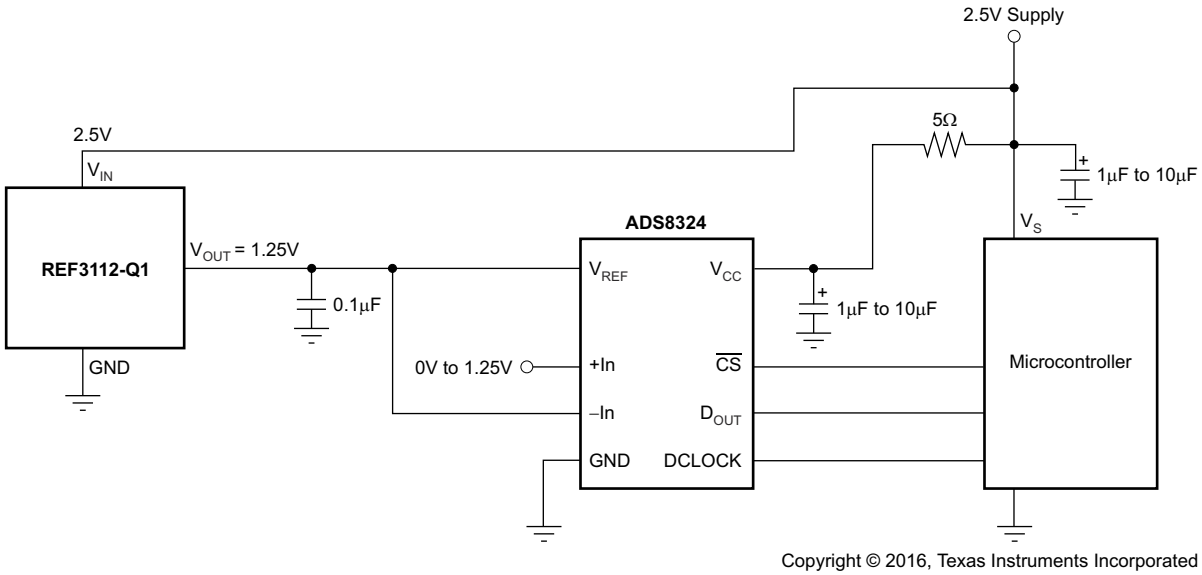


Figure 7-7. Basic Data Acquisition System 2

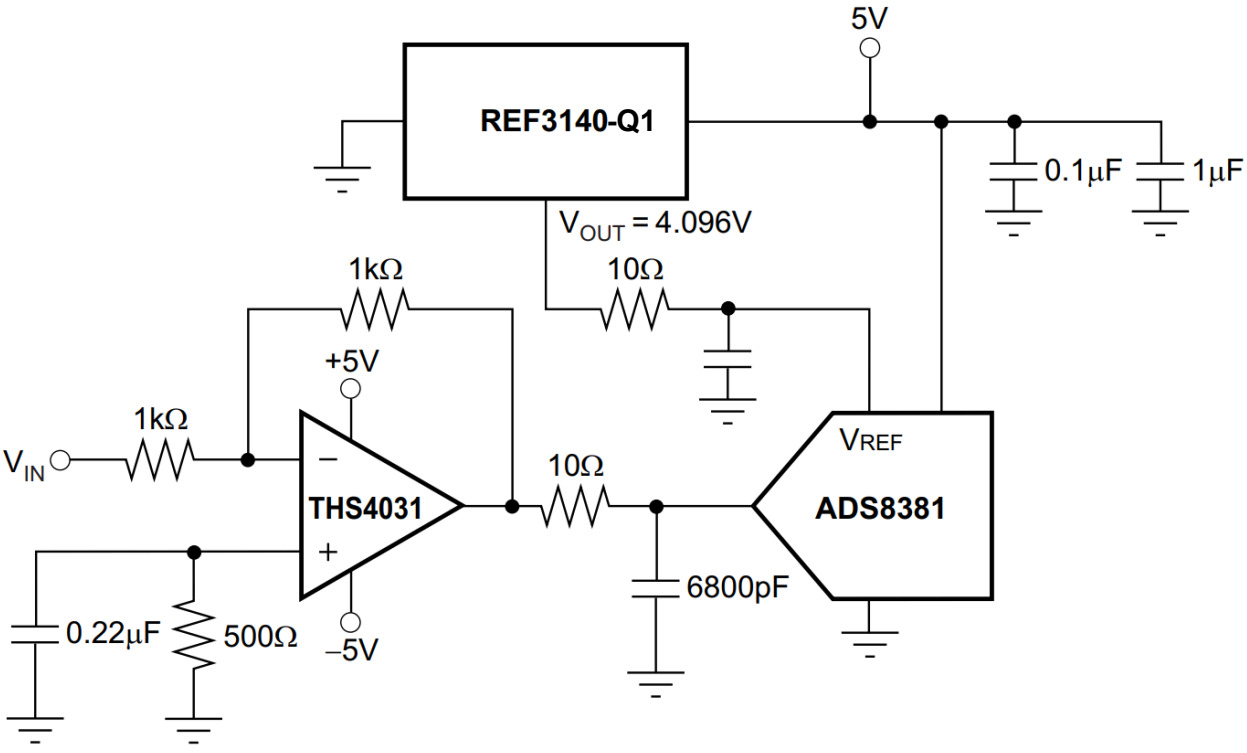


Figure 7-8. REF3140-Q1 Provides an Accurate Reference for Driving the ADS8381

8 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. Customers should validate and test their design implementation to confirm system functionality.

8.1 Application Information

The REF31xx-Q1 does not require a load capacitor. If a load capacitor is used, it is recommended to use one with an ESR of at least 0.5Ω. Figure 8-1 shows typical connections required for operation of the REF31xx-Q1. TI recommends a supply bypass capacitor of 0.47µF.

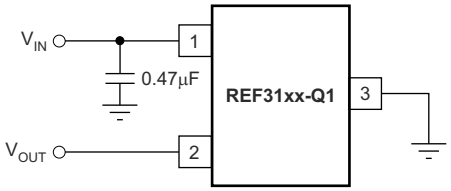


Figure 8-1. Typical Connections for Operating REF31xx-Q1

8.2 Typical Application

Figure 8-2 shows a low-power reference and conditioning circuit. This circuit attenuates and level-shifts a bipolar input voltage within the proper input range of a single-supply, low-power, 16-bit ΔΣ ADC, such as the one inside the MSP430™ or other similar single-supply ADCs. Precision reference circuits are used to level-shift the input signal, provide the ADC reference voltage, and to create a well-regulated supply voltage for the low-power analog circuitry. A low-power, zero-drift, op-amp circuit is used to attenuate and level-shift the input signal.

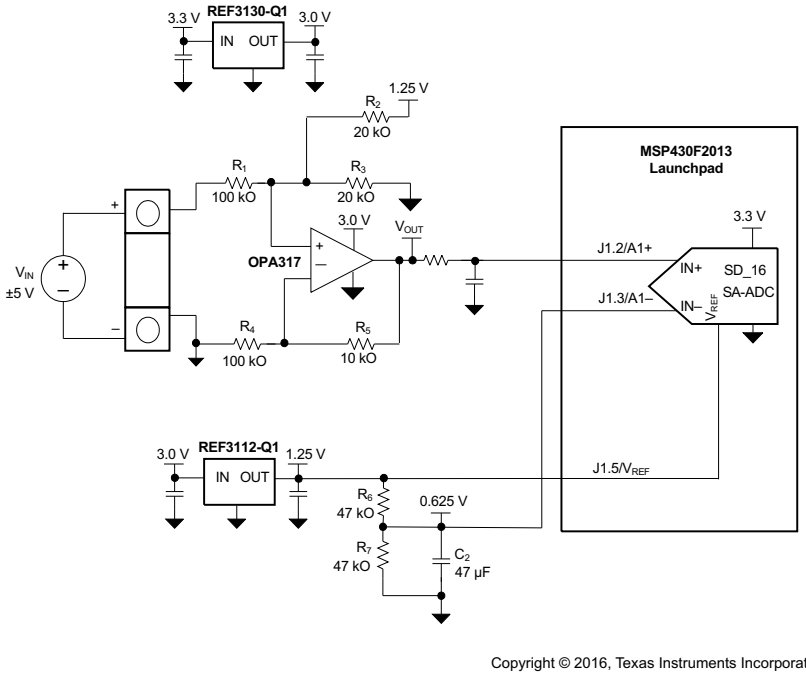


Figure 8-2. Low-Power Reference and Bipolar Voltage Conditioning Circuit for Low-Power ADCs

8.2.1 Design Requirements

For typical REF31xx-Q1 applications, use these parameters:

- Supply voltage: 3.3 V
- Maximum input voltage: ±6 V
- Specified input voltage: ±5 V
- ADC reference voltage: 1.25 V

The goal for this design is to accurately condition a ±5-V bipolar input voltage into a voltage suitable for conversion by a low-voltage ADC with a 1.25-V reference voltage, V_{REF}, and an input voltage range of V_{REF} / 2. The circuit must function with reduced performance over a wider input range of at least ±6 V to protect from overvoltage conditions.

8.2.2 Detailed Design Procedure

Figure 8-2 depicts a simplified schematic for this design showing the MSP430 ADC inputs and full input conditioning circuitry. The ADC is configured for a bipolar measurement where final conversion result is the differential voltage between the voltage at the positive and negative ADC inputs. The bipolar, GND-referenced input signal must be level-shifted and attenuated by the operational amplifier so that the output is biased to VREF/2 and has a differential voltage that is within the ±VREF/2 input range of the ADC.

8.2.3 Application Curves

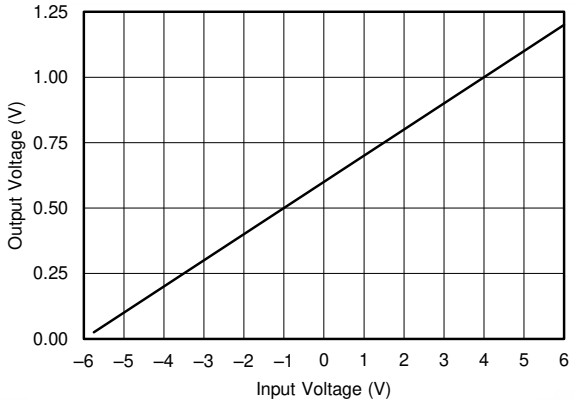


Figure 8-3. OPA317 Output Voltage vs Input Voltage

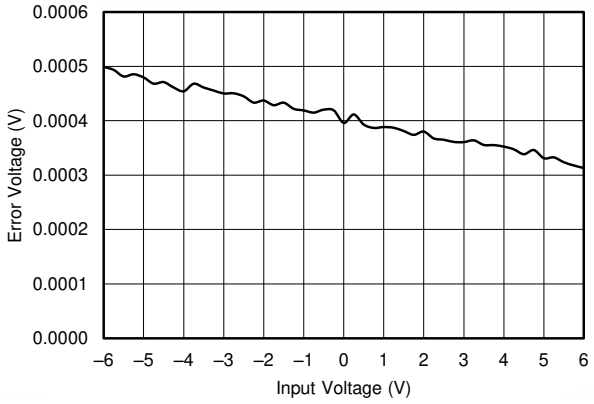


Figure 8-4. OPA317 Output Voltage Error vs Input Voltage

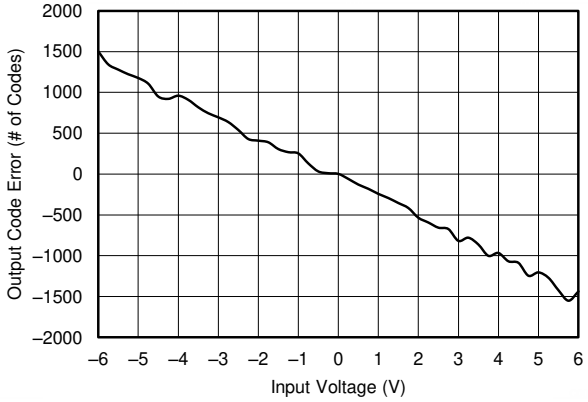


Figure 8-5. Output Code Error vs Input Voltage

8.3 Power Supply Recommendations

The REF31xx-Q1 family of references features an extremely low dropout voltage. With the exception of the REF3112, which has a minimum supply requirement of 1.8 V, these references can be operated with a supply of only 5 mV above the output voltage in an unloaded condition. For loaded conditions see Figure 6-4. TI recommends a supply bypass capacitor greater than 0.47 µF.

8.4 Layout

8.4.1 Layout Guidelines

Figure 8-6 shows an example of a printed-circuit board (PCB) layout using the REF31xx-Q1. Some key considerations are:

- Connect low-ESR, 0.47-µF ceramic bypass capacitors at V_{IN} of the REF31xx-Q1.
- Decouple other active devices in the system per the device specifications.
- Use a solid ground plane to help distribute heat and reduces electromagnetic interference (EMI) noise pickup.
- Place the external components as close as possible to the device. This configuration prevents parasitic errors (such as the Seebeck effect) from occurring.
- Minimize trace length between the reference and bias connections to the INA and ADC to reduce noise pickup.
- Do not run sensitive analog traces in parallel with digital traces. Avoid crossing digital and analog traces if possible, and only make perpendicular crossings when absolutely necessary.

8.4.2 Layout Example

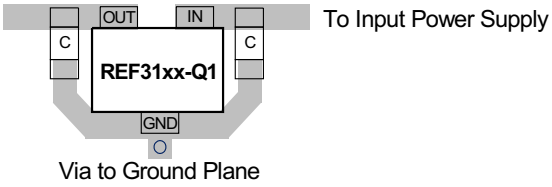


Figure 8-6. Layout Example

9 Device and Documentation Support

9.1 Device Support

For device support, see the following:

Voltage References Forum

9.2 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.

9.3 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.

9.4 Trademarks

MSP430™ and TI E2E™ are trademarks of Texas Instruments.
All trademarks are the property of their respective owners.

9.5 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.

9.6 Glossary

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

10 Revision History

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

Changes from Revision * (April 2017) to Revision A (September 2024)	Page
• Updated the numbering format for tables, figures, and cross-references throughout the document	1
• Updated load capacitor information in the *Description* and *Typical Application* figure	1
• Changed the Device Information table to the *Package Information* table	1
• Updated bypass capacitor values for consistency across data sheet	1
• Updated Figure 7-6 and Figure 7-8 to reflect best capacitor selection	14
• Updated the first paragraph of the *Application Information* for load capacitor recommendations	16
• Changed: Connect low-ESR, 0.1-µF to: Connect low-ESR, 047-µF in the *Layout Guidelines*	18

11 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)
REF3112AQDBZRQ1	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	(31AQ, R31A)
REF3112AQDBZRQ1.B	Active	Production	null (null) |	3000 | LARGE T&R	-	NIPDAUAG	Level-2-260C-1 YEAR	See REF3112AQDBZRQ1	(31AQ, R31A)
REF3120AQDBZRQ1	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	31BQ
REF3120AQDBZRQ1.B	Active	Production	null (null) |	3000 | LARGE T&R	-	NIPDAUAG	Level-2-260C-1 YEAR	See REF3120AQDBZRQ1	31BQ
REF3125AQDBZRQ1	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	31CQ
REF3125AQDBZRQ1.B	Active	Production	null (null) |	3000 | LARGE T&R	-	NIPDAUAG	Level-2-260C-1 YEAR	See REF3125AQDBZRQ1	31CQ
REF3130AQDBZRQ1	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	31EQ
REF3130AQDBZRQ1.B	Active	Production	null (null) |	3000 | LARGE T&R	-	NIPDAUAG	Level-2-260C-1 YEAR	See REF3130AQDBZRQ1	31EQ
REF3133AQDBZRQ1	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	(31FQ, R31A)
REF3133AQDBZRQ1.B	Active	Production	null (null) |	3000 | LARGE T&R	-	NIPDAUAG	Level-2-260C-1 YEAR	See REF3133AQDBZRQ1	(31FQ, R31A)
REF3140AQDBZRQ1	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	31DQ
REF3140AQDBZRQ1.B	Active	Production	null (null) |	3000 | LARGE T&R	-	NIPDAUAG	Level-2-260C-1 YEAR	See REF3140AQDBZRQ1	31DQ

(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.

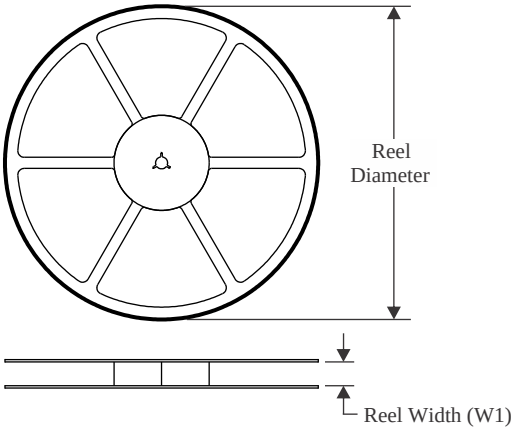
(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will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

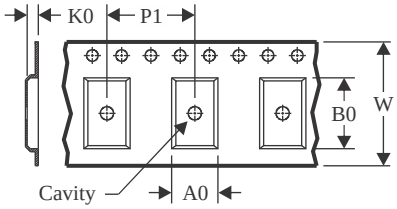
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

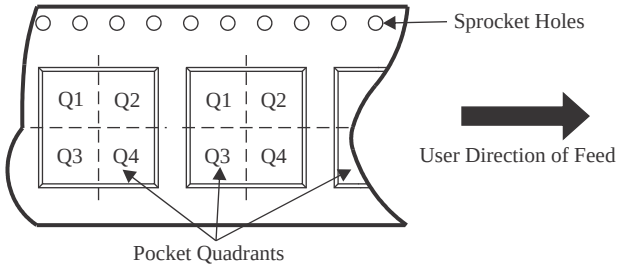


TAPE DIMENSIONS



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

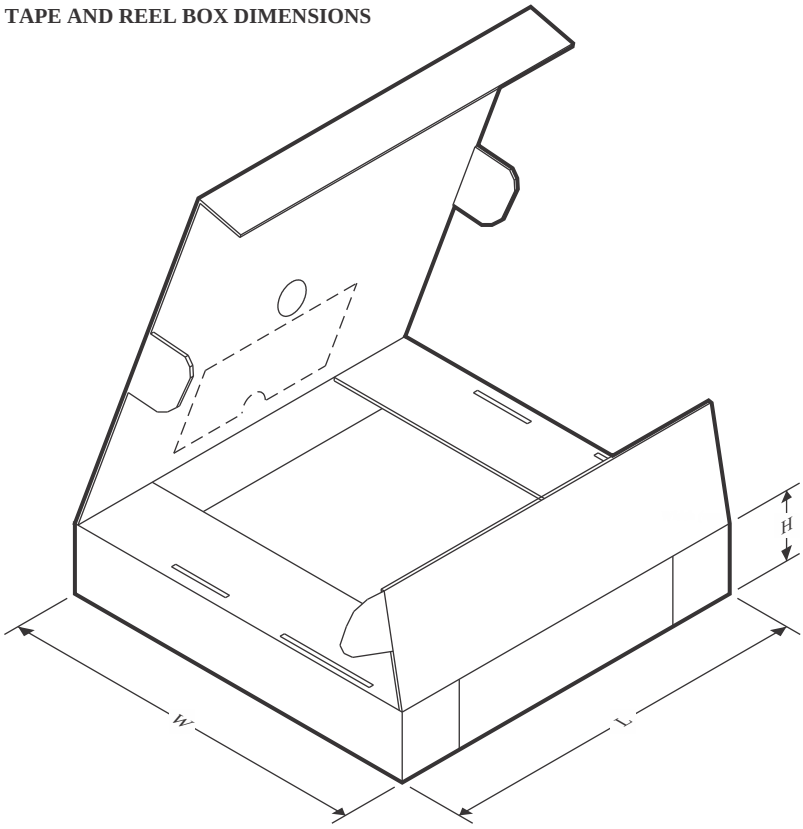
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
REF3112AQDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
REF3120AQDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
REF3125AQDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
REF3130AQDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
REF3133AQDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
REF3140AQDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

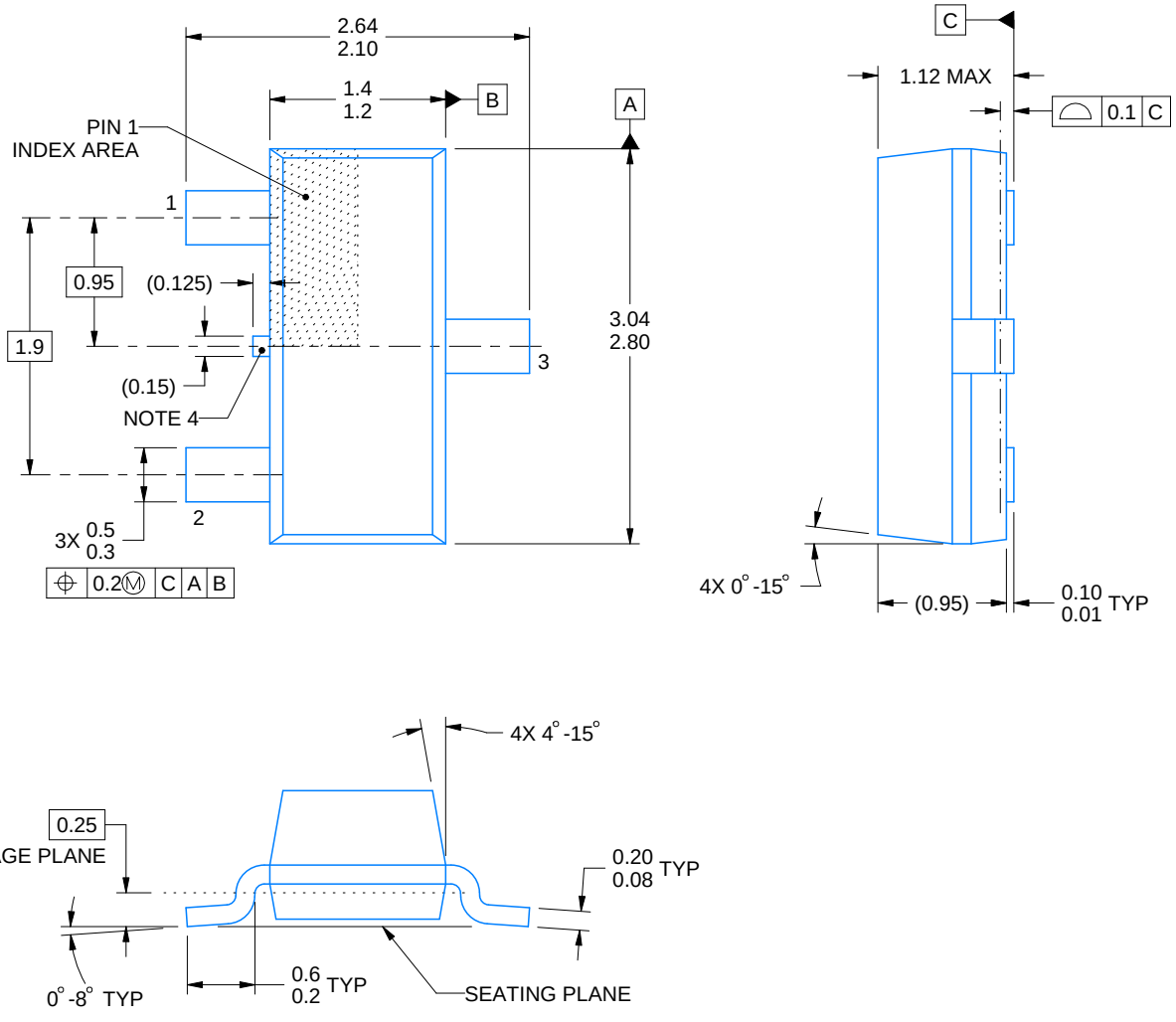
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
REF3112AQDBZRQ1	SOT-23	DBZ	3	3000	213.0	191.0	35.0
REF3120AQDBZRQ1	SOT-23	DBZ	3	3000	213.0	191.0	35.0
REF3125AQDBZRQ1	SOT-23	DBZ	3	3000	213.0	191.0	35.0
REF3130AQDBZRQ1	SOT-23	DBZ	3	3000	213.0	191.0	35.0
REF3133AQDBZRQ1	SOT-23	DBZ	3	3000	213.0	191.0	35.0
REF3140AQDBZRQ1	SOT-23	DBZ	3	3000	213.0	191.0	35.0

PACKAGE OUTLINE

DBZ0003A

SOT-23 - 1.12 mm max height

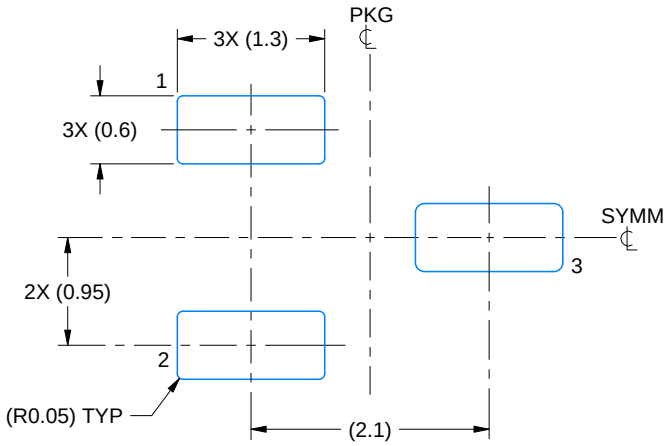
SMALL OUTLINE TRANSISTOR



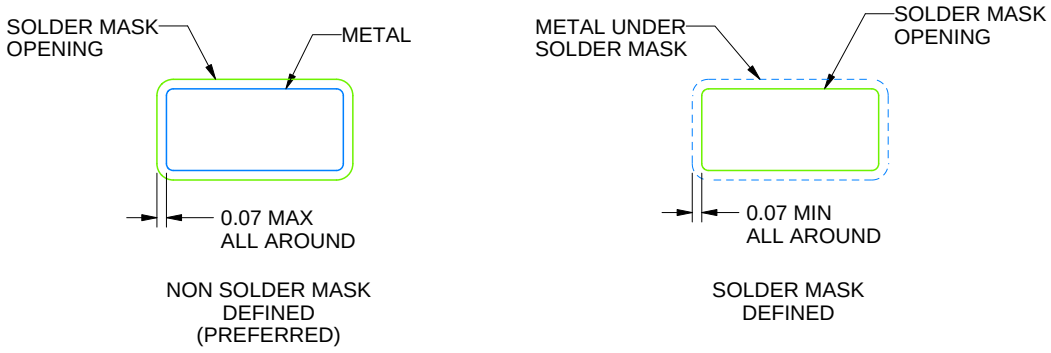
4214838/F 08/2024

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. Reference JEDEC registration TO-236, except minimum foot length.
4. Support pin may differ or may not be present.
5. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25mm per side



LAND PATTERN EXAMPLE
SCALE:15X

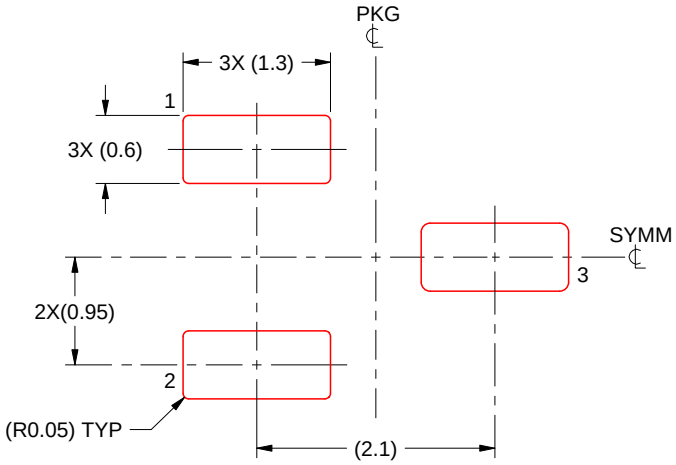


SOLDER MASK DETAILS

4214838/F 08/2024

NOTES: (continued)

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



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

4214838/F 08/2024

NOTES: (continued)

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

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265