REF1112 10ppm/℃、1μA、1.25Vシャント型基準電圧

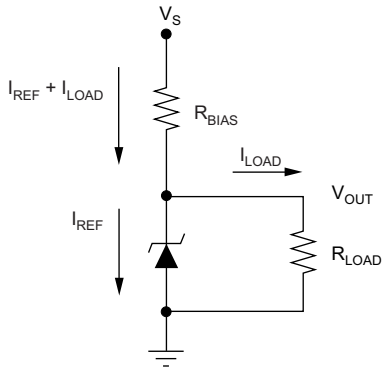
1 特長

- 小型パッケージ: SOT23-3
- 固定逆方向降伏電圧: 1.25V
- 主な仕様
  - 出力電圧許容誤差: ±0.2% (最大値)
  - 低出力ノイズ(0.1Hz～10Hz): 25μV_{pp} (標準値)
  - 温度範囲: －40℃～＋125℃
  - 動作電流範囲: 1.2μA～5mA
  - 0℃～＋70℃での低温度係数: 30ppm/℃(最大値)
  - －40℃～＋85℃での低温度係数: 50ppm/℃(最大値)

2 アプリケーション

- バッテリ駆動計測器
- ビル・セキュリティ・センサ
- 医療用機器
- フィールド・トランスミッタ
- 較正器

シャント基準電圧アプリケーションの回路図



$$R_{BIAS} = \frac{V_S - V_D}{I_{LOAD} + I_{REF}}$$

3 概要

REF1112は、省電力・省スペース・アプリケーション向けに設計された2端子シャント型基準電圧です。SOT23-3パッケージで動作電流1μAを達成しており、現在REF1004やLT1004といった大型パッケージの基準電圧を使用している設計で、性能の向上と消費電力の削減を実現します。REF1112は－40℃～＋85℃で仕様が規定され、－40℃～＋125℃まで動作が拡張されています。

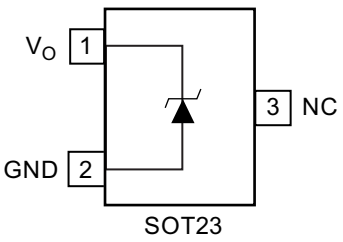
OPA349およびTLV240x低消費電力オペアンプ、TLV349xマイクロパワー電圧コンパレータなど、テキサス・インスツルメンツの他の1μA部品との組み合わせに適しています。

製品情報(1)

型番	パッケージ	本体サイズ(公称)
REF1112	SOT-23 (3)	2.92mm×1.3mm

(1) 提供されているすべてのパッケージについては、このデータシートの末尾にある注文情報を参照してください。

ピン配置



(1) NCはこのピンを未接続のままにするか、GNDに接続する必要があることを示しています。

目次

4 改訂履歴

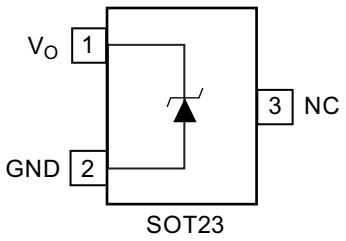
資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

Revision C (March 2008) から **Revision D** に変更 **Page**

- 「*製品情報*」の表、「*ピン構成および機能*」セクション、「*絶対最大定格*」の表、「*ESD定格*」の表、「*推奨動作条件*」の表、「*熱に関する情報*」の表、「*機能説明*」セクション、「*デバイスの機能モード*」、「*アプリケーションと実装*」セクション、「*電源に関する推奨事項*」セクション、「*レイアウト*」セクション、「*デバイスおよびドキュメントのサポート*」セクション、「*メカニカル、パッケージ、および注文情報*」セクションを追加。 ... 1
- 「*特長*」セクションを変更 ... 1
- 主要なグラフィック・テキストの注を「NCはこのピンを未接続のままにする必要があることを示しています。」から「NCはこのピンを未接続のままにするか、GNDに接続する必要があることを示しています。」に変更 ... 1
- 「*パッケージ/注文情報*」の表を削除し、当該情報を「*メカニカル、パッケージ、および注文情報*」セクションに移動 ... 13

5 Pin Configuration and Functions

DBZ Package
3-Pin SOT-23
Top View



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
V_o	1	I/O	Shunt Current/Voltage input
GND	2	O	Ground connection
NC	3	-	Must float or connect to GND

6 Specifications

6.1 Absolute Maximum Ratings

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

	MIN	MAX	UNIT
Reverse breakdown current		10	mA
Forward current		10	mA
Operating temperature	–55	125	°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 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V 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
I_{REF}	Reverse current	0.0012	5	mA
T_A	Operating temperature	–40	125	°C

6.4 Thermal Information

THERMAL METRIC[1]		REF1112 DBZ (SOT-23) 3 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	219	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	99	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	79	°C/W
ψ_{JT}	Junction-to-top characterization parameter	6.7	°C/W
ψ_{JB}	Junction-to-board characterization parameter	79.6	°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

V_R = 1.25 V, T_A = +25°C, I_{REF} = 1.2 μA and C_{LOAD} = 10 nF, unless otherwise noted.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_R	Reverse breakdown voltage	I_{REF} = 1.2 μA	1.2475	1.25	1.2525	V
			–0.2%		0.2%	
ΔV_R	Temperature coefficient	1.2 μA ≤ I_{REF} ≤ 5 mA, T_A = 0°C to +70°C		10	30	ppm/°C
		1.5 μA ≤ I_{REF} ≤ 5 mA, T_A = –40°C to +85°C		15	50	
		1.5 μA ≤ I_{REF} ≤ 5 mA, T_A = –40°C to +125°C		15		
I_{RMIN}	Minimum operating current			1	1.2	μA
$\Delta V_R/\Delta I_R$	Reverse breakdown voltage change with current	1.2 μA ≤ I_{REF} ≤ 5 mA		30	100	ppm/mA
Z_R	Reverse dynamic impedance	1.2 μA ≤ I_{REF} ≤ 5 mA		0.037	0.125	Ω
e_N	Low-frequency noise[1]	0.1 Hz ≤ I_{REF} ≤ 10 Hz		25		μV_{PP}
V_{HYST}	Thermal hysteresis[2]			100		ppm
ΔV_R	Long-term stability	+25°C ± 0.1°C		60		ppm/kHr

(1) Peak-to-peak noise is measured with a 2-pole high-pass filter at 0.1 Hz and a 4-pole, low-pass Chebyshev filter at 10 Hz.
(2) Thermal hysteresis 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.

6.6 Typical Characteristics

At T_A = +25°C, I_{REF} = 10 µA and C_{LOAD} = 10 nF, unless otherwise noted.

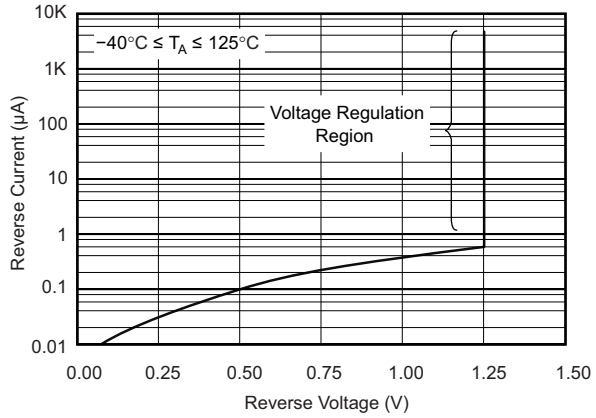


Figure 1. Reverse Characteristics

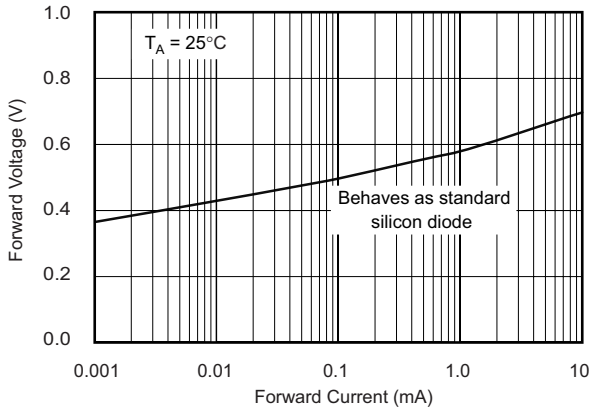


Figure 2. Forward Characteristics

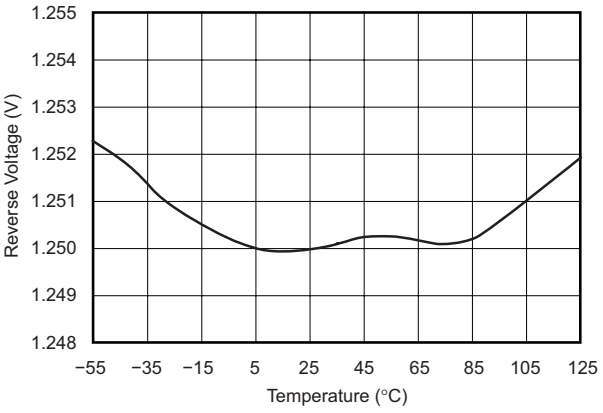


Figure 3. Temperature Drift

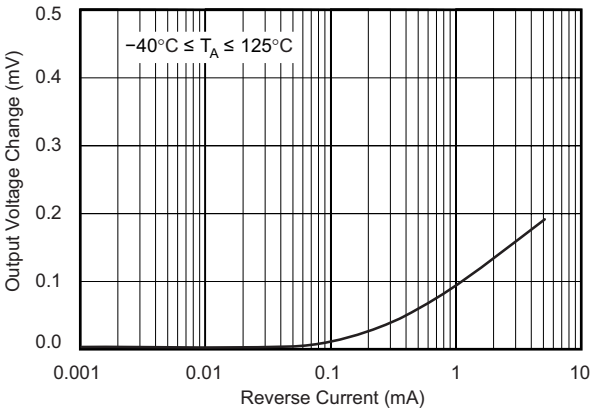


Figure 4. Reverse Voltage Change vs Current

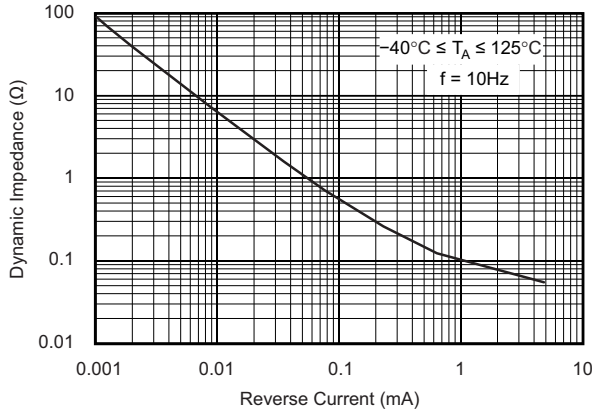


Figure 5. Reverse Dynamic Impedance

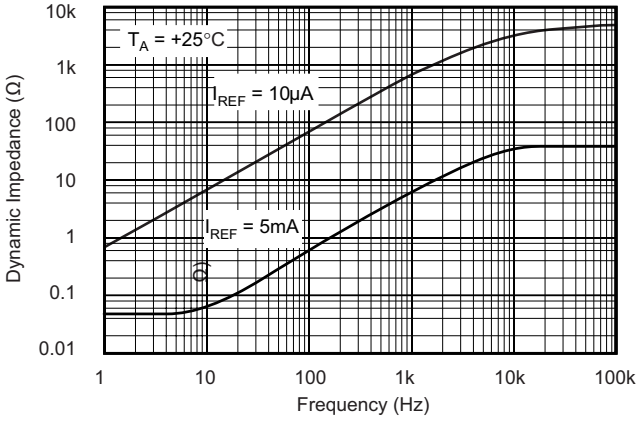


Figure 6. Reverse Dynamic Impedance

Typical Characteristics (continued)

At T_A = +25°C, I_{REF} = 10 µA and C_{LOAD} = 10 nF, unless otherwise noted.

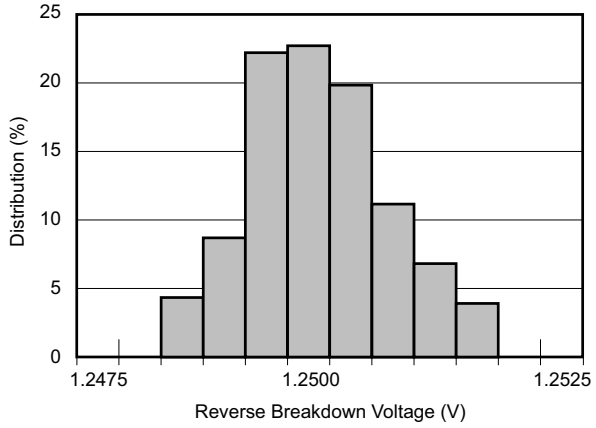


Figure 7. Reverse Breakdown Voltage Distribution

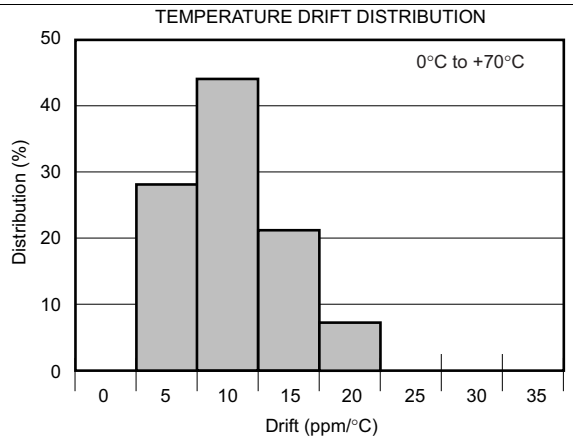


Figure 8. Temperature Drift Distribution

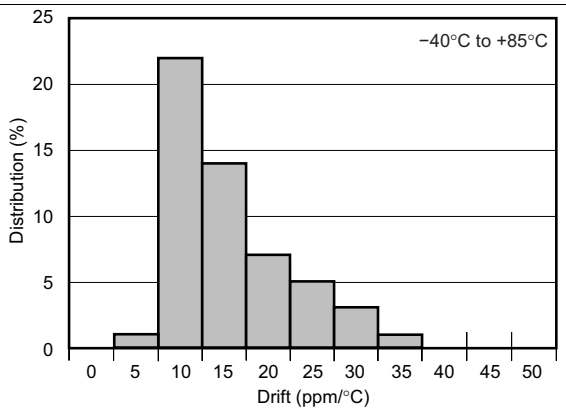


Figure 9. Temperature Drift Distribution

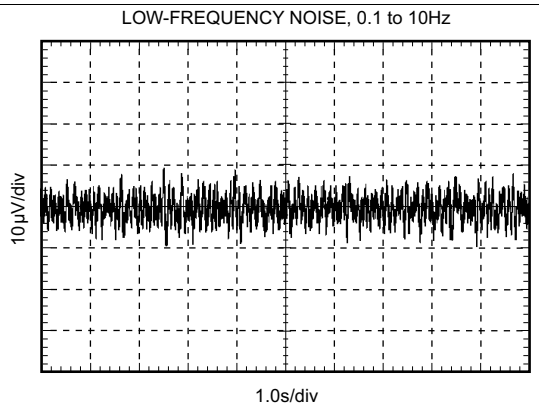


Figure 10. Low-Frequency Noise, 0.1 to 10Hz

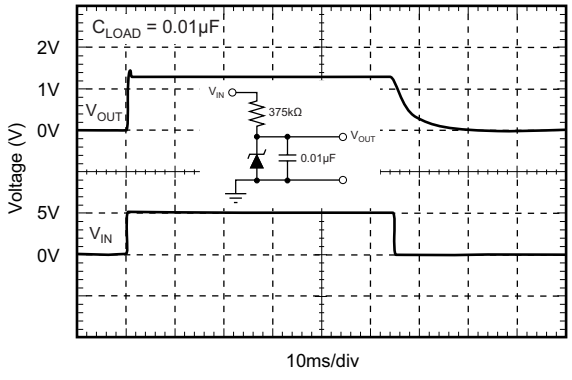


Figure 11. Response Time

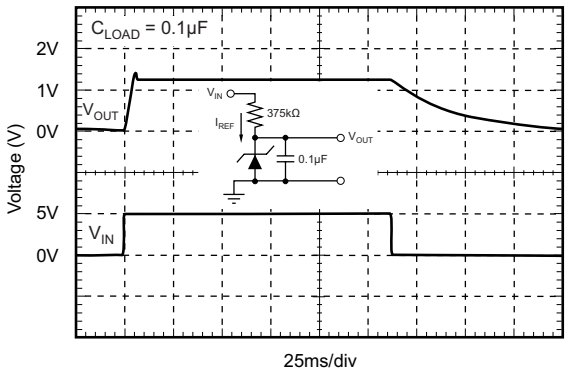


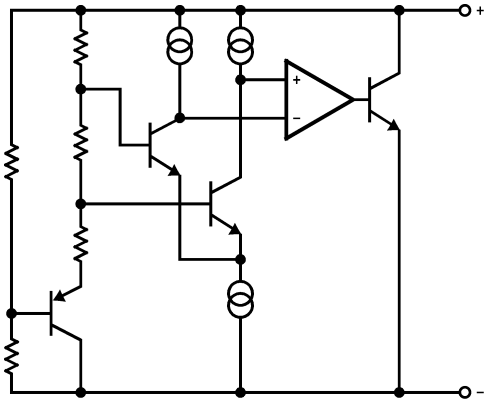
Figure 12. Response Time

7 Detailed Description

7.1 Overview

The REF1112 is a 2-terminal bandgap reference diode designed for high accuracy with outstanding temperature characteristics at low operating currents. Precision thin-film resistors result in 0.2% initial voltage accuracy and 50ppm/°C maximum temperature drift. The REF1112 is specified from –40°C to +85°C, with operation from –40°C to +125°C, and is offered in a SOT23-3 package.

7.2 Functional Block Diagram



7.3 Feature Description

The REF1112 device is effectively a precision Zener diode. The part requires a small quiescent current for regulation, and regulates the output voltage by shunting more or less current to ground, depending on input voltage and load. The only external component requirement are an resistor between the cathode and the input voltage to set the input current and an external capacitor at the output to maintain stability under varying loads.

7.4 Device Functional Modes

The REF1112 device is a fixed output voltage part where the feedback is internal. Therefore, the part can only operate in a closed-loop mode and the output voltage cannot be adjusted. The output voltage will remain in regulation as long as I_{REF} is between I_{REFMIN} (see *Electrical Characteristics*) and I_{REFMAX} is 5 mA. A proper selection of the external resistor for input voltage range and load current range will ensure these conditions are met.

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

Typical connections for the REF1112 are shown in Figure 13. A minimum 1-μA bias current is required to maintain a stable output voltage and can be provided with a resistor connected to the supply voltage. I_{BIAS} depends on the values selected for R_{BIAS} and V_S, and will vary as a sum of the minimum operating current and the load current. To maintain stable operation, the value of R_{BIAS} must be low enough to maintain the minimum operating current at the minimum and maximum load and supply voltage levels.

A 0.1-μF load capacitor is recommended to maintain stability under varying load conditions. A minimum 0.01-μF load capacitor is required for stable operation. Start-up time for the REF1112 will be affected, depending on the value of load capacitance and the bias currents being used. A 1-μF power-supply bypass capacitor is recommended to minimize supply noise within the circuit. The REF1112 shunt voltage reference provides a versatile function for low power and space-conservative applications.

8.2 Typical Applications

8.2.1 Shunt Regulator

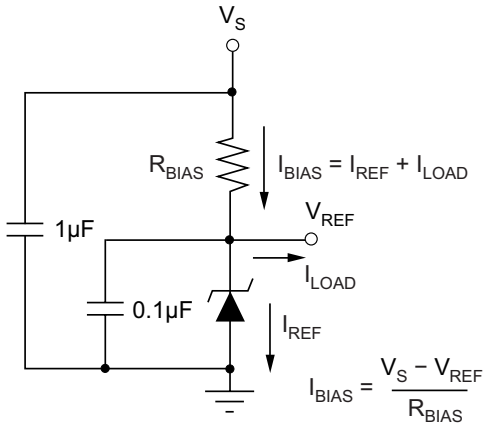


Figure 13. Typical Connections

8.2.1.1 Design Requirements

Table 1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Supply voltage	3 V
Cathode current (I_{REF})	1.2 μA
Load Current (I_{LOAD})	50uA

8.2.1.2 Detailed Design Procedure

When using the REF1112 as a reference, determine the following:

- Supply voltage range
- Current source resistance
- Reference voltage accuracy

To design using the REF1112, is it important to ensure that the V_S is larger than V_{REF}.

The resistor R_{BIAS} sets the cathode current of the REF1112, I_R. Ensure that this current remains in the operational region of the part for the entire V_S and load range.

Using this information, select a R_{BIAS} such that:

$I_{REFMIN} < I_{REF} < I_{REFMAX}$ where $I_{REFMAX} = 5$ mA.

In this application the I_{REF} is the operating current of the REF1112 plus the maximum possible I_{LOAD} under no-load conditions.

8.2.2 MicroPOWER 3-µA, 1-V Voltage Reference

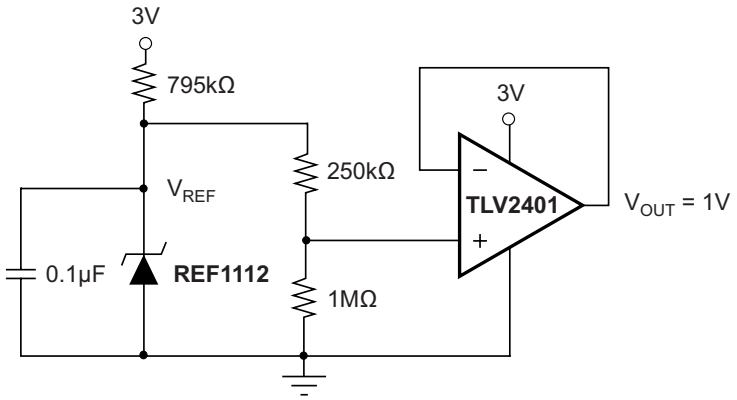


Figure 14. MicroPOWER 3-µA, 1-V Voltage Reference

8.2.2.1 Design Requirements

The REF1112 can be scaled to provide extremely low power reference voltages. Figure 14 shows the REF1112 used as a 1-V V_{OUT}, 3-µA voltage reference.

8.2.2.2 Detailed Design Procedure

Set R_{BIAS} such that the current through the shunt reference, I_{REF}, is greater than $I_{REFMIN} + I_{LOAD}$.

Use a resistor divider to set the required voltage to the input of the amplifier. The TLV2401 requires an input bias current maximum of 350 pA which allows the use of larger resistor values to save power.

8.2.3 2.5-V Reference on 1 µA

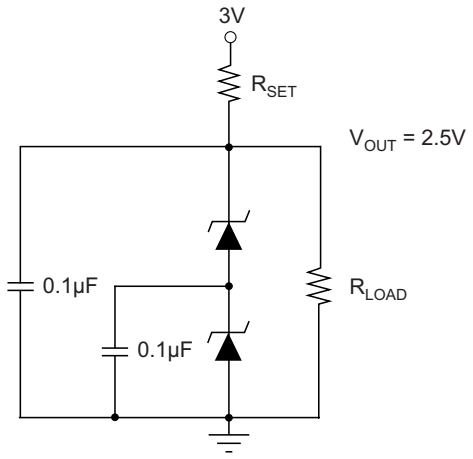


Figure 15. 2.5-V Reference on 1 µA

8.2.3.1 Design Requirements

Create a 2.5-V reference that consumes 1 µA of I_{REF}.

8.2.3.2 Detailed Design Procedure

Figure 15 shows the REF1112 used as a 2.5-V reference on 1 µA. This is done by stacking the REF1112 in series.

$$V_{OUT} = 2 \times V_{REF} \quad (1)$$

where

- V_{REF} is the reference voltage

In this case, V_{OUT} = 2 × 1.25 V = 2.5 V

The I_{BIAS} is still 1 µA because the stacked REF1112 are in series.

8.2.4 Adjustable Voltage Shunt Reference

For applications requiring a stable voltage reference capable of sinking higher than 5 mA of current, a REF1112 combined with an OPA347 can sink up to 10 mA of current. This configuration is shown in Figure 16, and through appropriate selection of R1 and R2, can be used to provide a wide range of stable reference voltages.

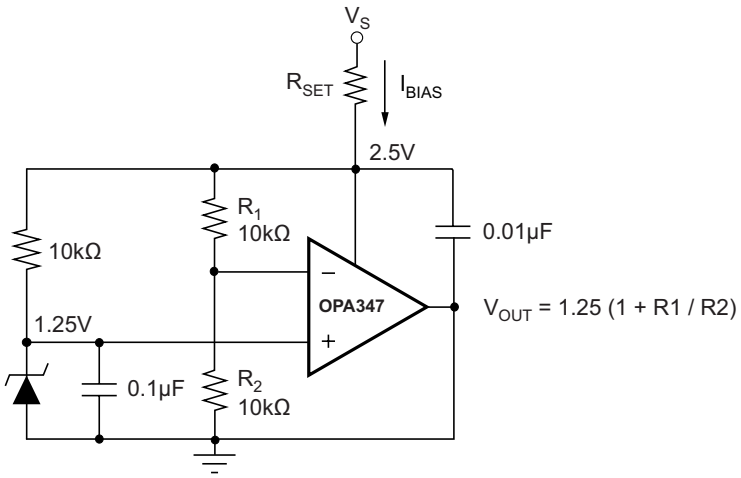


Figure 16. Adjustable Voltage Shunt Reference

8.2.5 Level Shift to Achieve Full ADC Input Range

The REF1112 is also useful for level shifting, and as shown in Figure 17, can be used to achieve the full input range of an analog-to-digital converter (ADC).

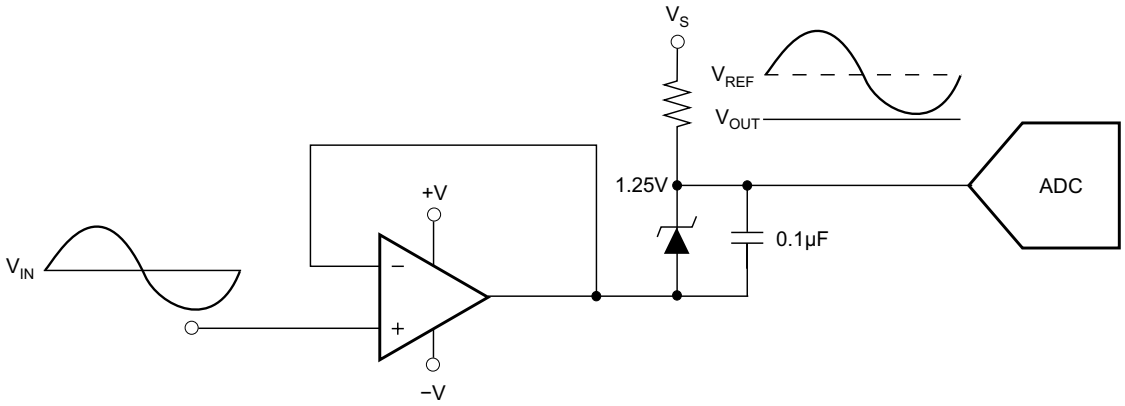


Figure 17. REF1112 Provides a Level Shift to Achieve Full ADC Input Range

8.2.6 Stable Current Source

The REF1112 can be configured with an additional diode and NPN transistor to provide a temperature compensated current reference as shown in Figure 18.

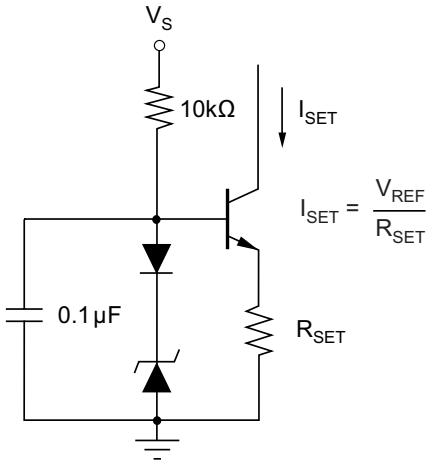


Figure 18. REF1112 as a Stable Current Source

9 Power Supply Recommendations

While a bypass capacitor is not required on the input voltage line, TI recommends reducing noise on the input which could affect the output. A 0.1-μF ceramic capacitor or larger is recommended.

10 Layout

10.1 Layout Guidelines

Place decoupling capacitors as close to the device as possible. Use appropriate widths for traces when shunting high currents to avoid excessive voltage drops.

10.2 Layout Example

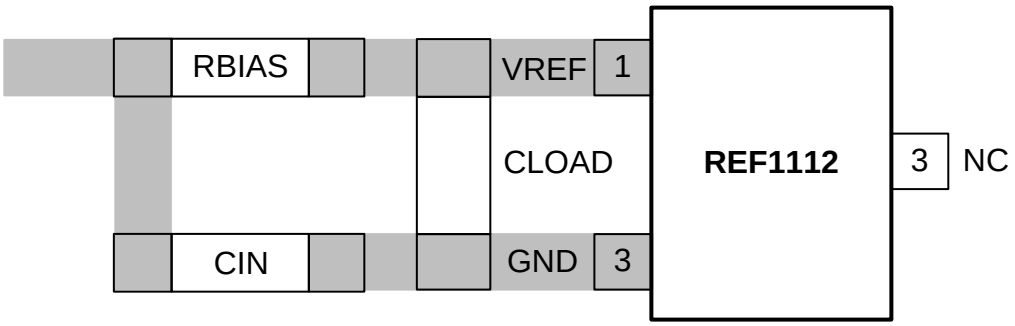


Figure 19. Layout Example

11 デバイスおよびドキュメントのサポート

11.1 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、ti.comのデバイス製品フォルダを開いてください。右上の隅にある「*通知を受け取る*」をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取れます。変更の詳細については、修正されたドキュメントに含まれている改訂履歴をご覧ください。

11.2 コミュニティ・リソース

The following links connect to TI community resources. Linked contents are 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.

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設計サポート ***TIの設計サポート*** **役に立つE2Eフォーラムや、設計サポート・ツールをすばやく見つけることができます。技術サポート用の連絡先情報も参照できます。**

11.3 商標

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All other trademarks are the property of their respective owners.

11.4 静電気放電に関する注意事項

すべての集積回路は、適切なESD保護方法を用いて、取扱いと保存を行うようにして下さい。

静電気放電はわずかな性能の低下から完全なデバイスの故障に至るまで、様々な損傷を与えます。高精度の集積回路は、損傷に対して敏感であり、極めてわずかなパラメータの変化により、デバイスに規定された仕様に適合しなくなる場合があります。

11.5 Glossary

SLYZ022 — *TI Glossary*.

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

12 メカニカル、パッケージ、および注文情報

以降のページには、メカニカル、パッケージ、および注文に関する情報が記載されています。この情報は、そのデバイスについて利用可能な最新のデータです。このデータは予告なく変更されることがあり、ドキュメントが改訂される場合もあります。本データシートのブラウザ版を使用されている場合は、画面左側の説明をご覧ください。

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
REF1112AIDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	R11A	Samples
REF1112AIDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	R11A	Samples

(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.

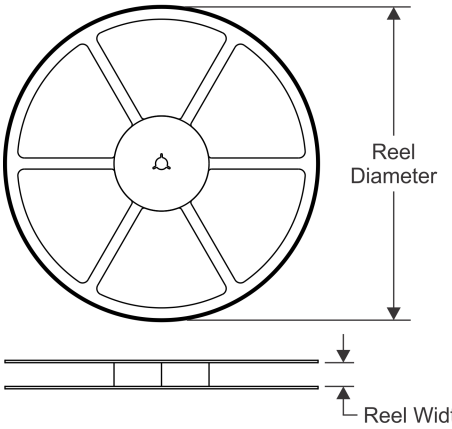
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

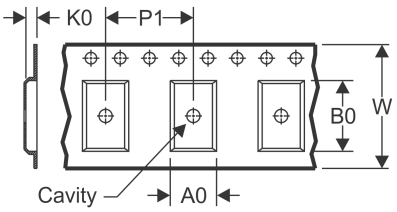
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

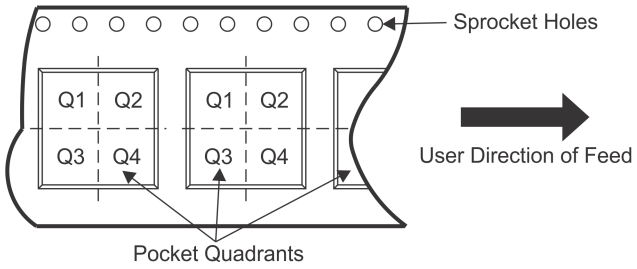


TAPE DIMENSIONS



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

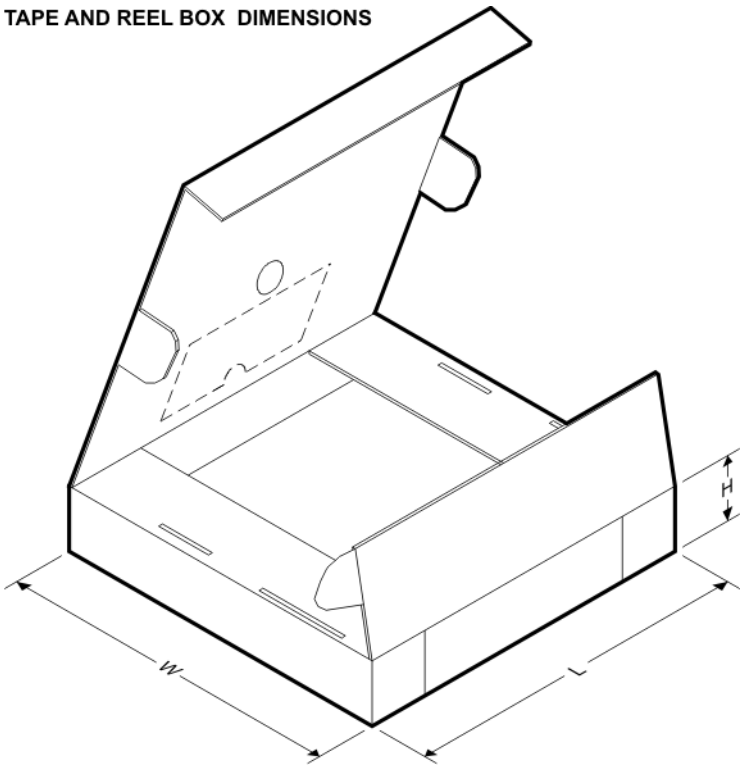
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
REF1112AIDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
REF1112AIDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

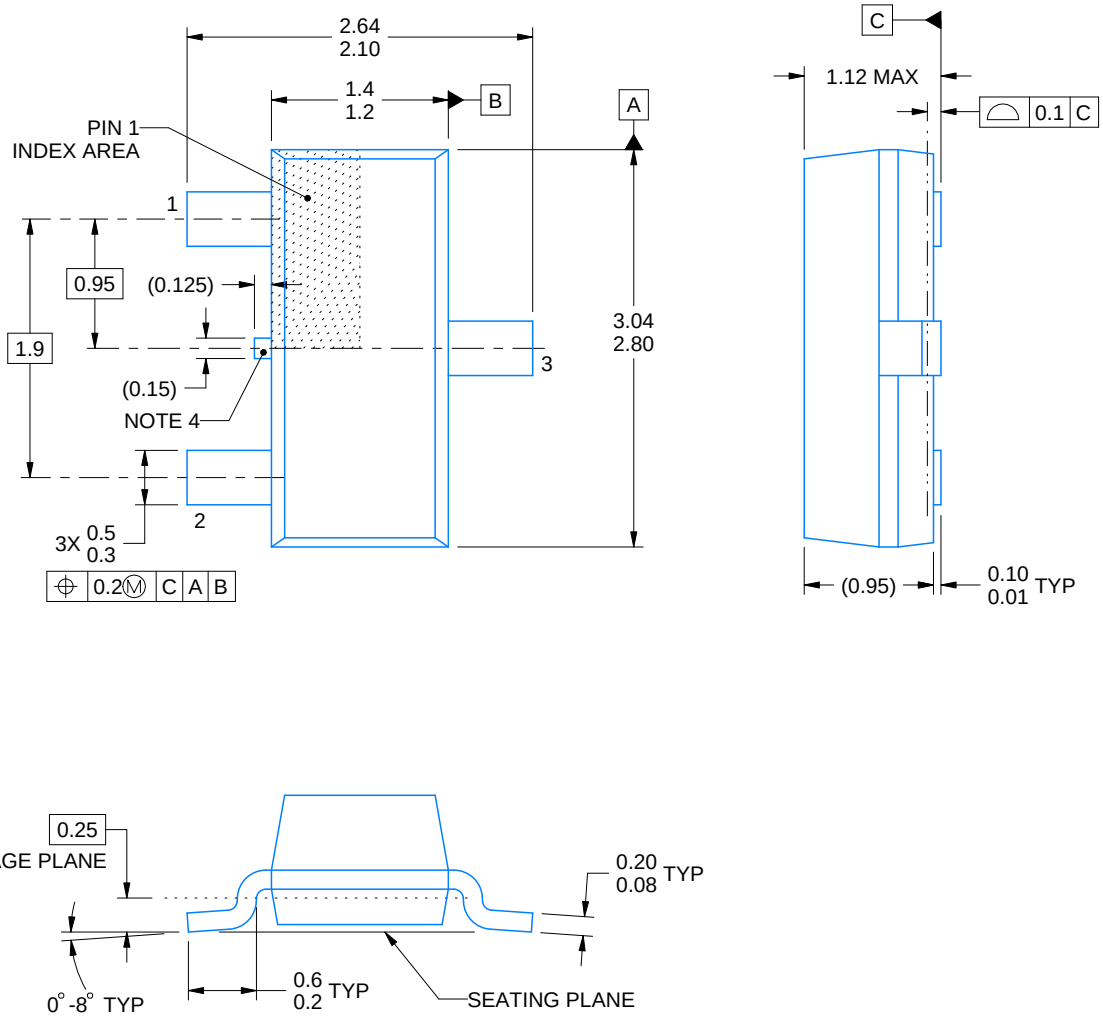
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
REF1112AIDBZR	SOT-23	DBZ	3	3000	200.0	183.0	25.0
REF1112AIDBZT	SOT-23	DBZ	3	250	200.0	183.0	25.0

PACKAGE OUTLINE

DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



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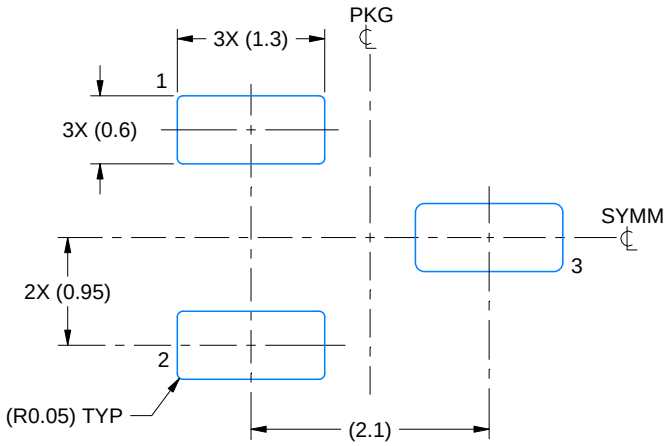
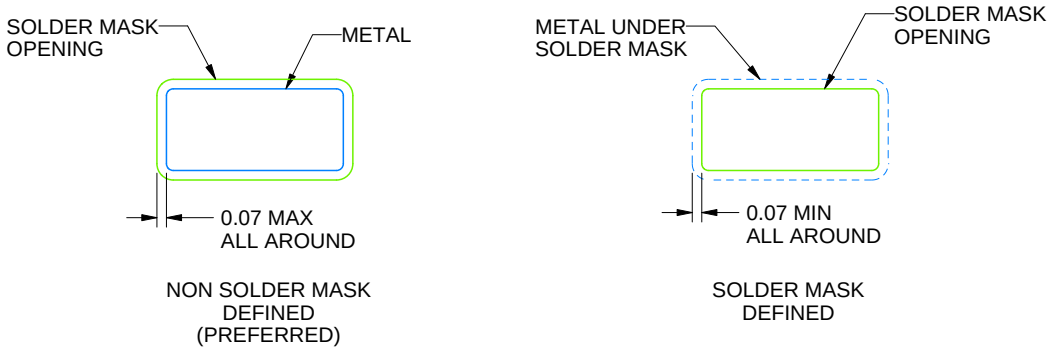
NOTES:

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. Reference JEDEC registration TO-236, except minimum foot length.
4. Support pin may differ or may not be present.



LAND PATTERN EXAMPLE
SCALE:15X



SOLDER MASK DETAILS

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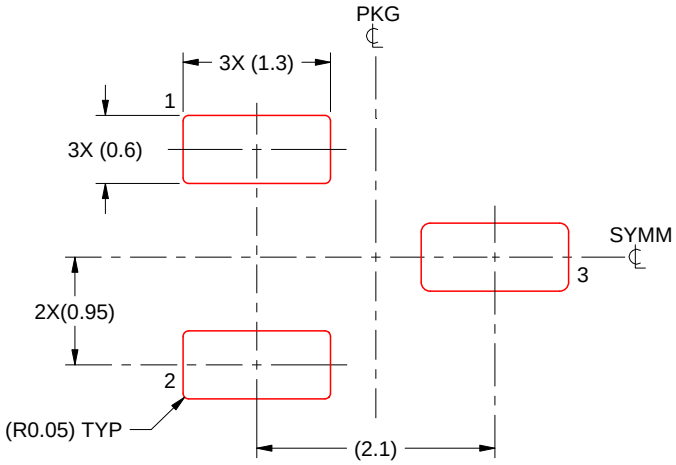
NOTES: (continued)

4. Publication IPC-7351 may have alternate designs.
5. 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

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NOTES: (continued)

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

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