SBOS283C – SEPTEMBER 2003 – REVISED MARCH 2008

10ppm/°C, 1μA, 1.25V SHUNT VOLTAGE REFERENCE

FEATURES

- **MICRO-PACKAGE: SOT23-3**
- **WIDE CURRENT RANGE: 1μA to 5mA**
- **HIGH INITIAL ACCURACY: 0.2%**
- **EXCELLENT SPECIFIED DRIFT PERFORMANCE:**
  30ppm/°C (max) from 0°C to +70°C
  50ppm/°C (max) from –40°C to +85°C

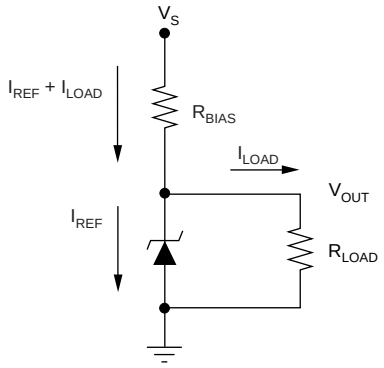
APPLICATIONS

- **BATTERY-POWERED INSTRUMENTS**
- **PORTABLE DEVICES**
- **MEDICAL EQUIPMENT**
- **CURRENT SOURCES**
- **CALIBRATORS**
- **MICROPOWER CURRENT AND VOLTAGE REFERENCE**

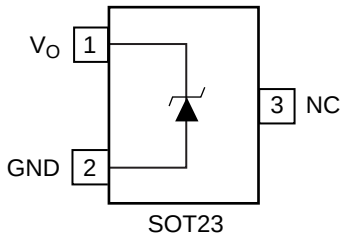
DESCRIPTION

The REF1112 is a two-terminal shunt reference designed for power- and space-sensitive applications. The REF1112 features an operating current of 1mA in a SOT23-3 package and is an improved, lower power solution for designs currently using voltage references in larger packages, such as the REF1004 and LT1004. The REF1112 is specified from –40°C to +85°C with operation extending from –40°C to +125°C.

The REF1112 complements other 1μA components from Texas Instruments including the OPA349 and the TLV240x low-power operational amplifiers, and the TLV349x micropower voltage comparator.



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



NC indicates pin should be left unconnected.

ABSOLUTE MAXIMUM RATINGS(1)

Reverse Breakdown Current	10mA
Forward Current	10mA
Operating Temperature	–55°C to +125°C
Storage Temperature	–65°C to +150°C
Junction Temperature	+150°C

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

ELECTROSTATIC DISCHARGE SENSITIVITY

Electrostatic discharge can cause damage ranging from performance degradation to complete device failure. Texas Instruments recommends that all integrated circuits be handled and stored using appropriate ESD protection methods.

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 published specifications.

PACKAGE/ORDERING INFORMATION(1)

PRODUCT	PACKAGE-LEAD	PACKAGE DESIGNATOR	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER	TRANSPORT MEDIA, QUANTITY
REF1112	SOT23-3	DBZ	–40°C to +125°C	R11A	REF1112AIDBZT	Tape and Reel, 250
"	"	"	"	"	REF1112AIDBZR	Tape and Reel, 3000

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

ELECTRICAL CHARACTERISTICS

Boldface limits apply over the specified temperature range, **T_A = –40°C to +125°C.**

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

PARAMETER	CONDITIONS	REF1112 - 1.25V MIN	REF1112 - 1.25V TYP	REF1112 - 1.25V MAX	UNITS
REVERSE BREAKDOWN VOLTAGE	I_{REF} = 1.2µA	1.2475 –0.2	1.25	1.2525 +0.2	V %
TEMPERATURE COEFFICIENT	1.2µA ≤ I_{REF} ≤ 5mA, **0°C to +70°C** 1.5µA ≤ I_{REF} ≤ 5mA, **–40°C to +85°C** 1.5µA ≤ I_{REF} ≤ 5mA, **–40°C to +125°C**		**10** **15** **15**	**30** **50**	ppm/°C ppm/°C ppm/°C
MINIMUM OPERATING CURRENT			1	1.2	µA
REVERSE BREAKDOWN VOLTAGE CHANGE WITH CURRENT	1.2µA ≤ I_{REF} ≤ 5mA		30	100	ppm/mA
REVERSE DYNAMIC IMPEDANCE	1.2µA ≤ I_{REF} ≤ 5mA		0.037	0.125	Ω
LOW-FREQUENCY NOISE(1) 0.1Hz ≤ I_{REF} ≤ 10Hz			25		μV_{PP}
THERMAL HYSTERESIS(2)			100		ppm
LONG-TERM STABILITY +25°C ± 0.1°C			60		ppm/kHr
TEMPERATURE CHARACTERISTICS					
Specified Range		–40		+125	°C
Operating Range		–40		+125	°C
Storage Range		–40		+150	°C
Thermal Resistance θ_{JA}					
SOT23-3 Surface-Mount			135		°C/W

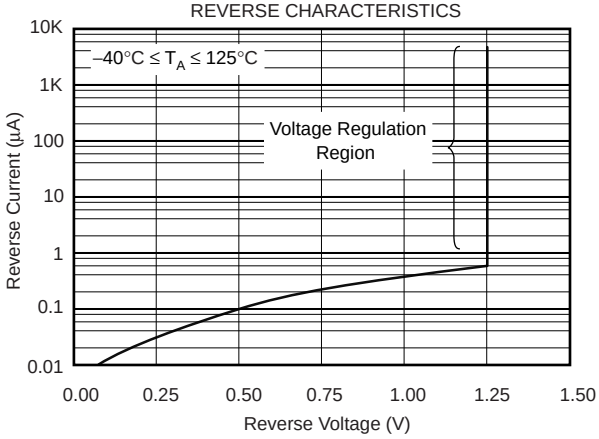
(1) Peak-to-peak noise is measured with a 2-pole high-pass filter at 0.1Hz and a 4-pole, low-pass Chebyshev filter at 10Hz.

(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.

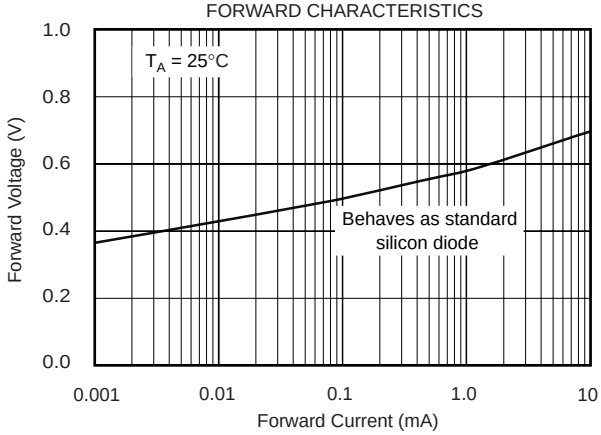
TYPICAL CHARACTERISTICS

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

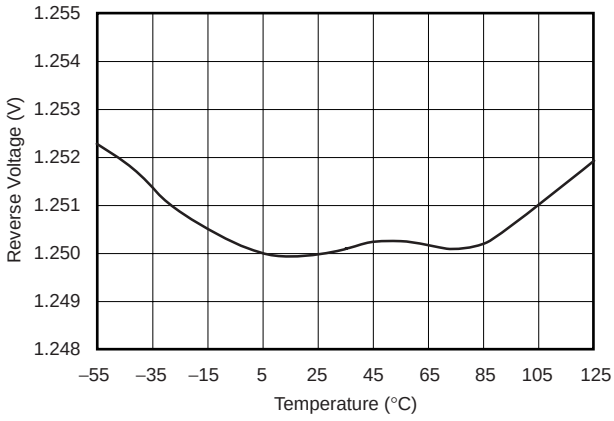
REVERSE CHARACTERISTICS



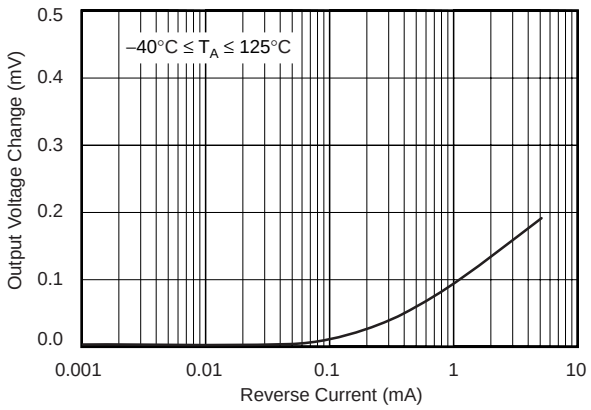
FORWARD CHARACTERISTICS



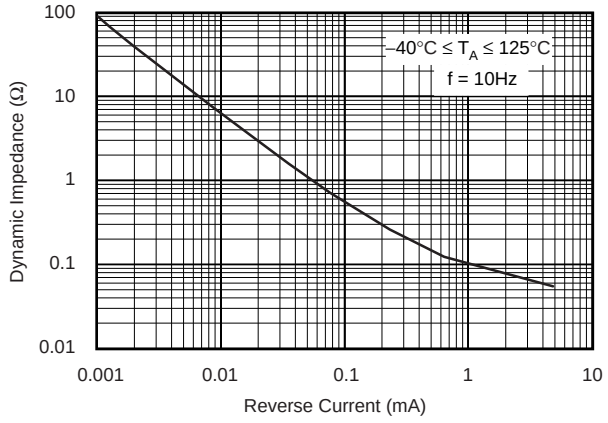
TEMPERATURE DRIFT



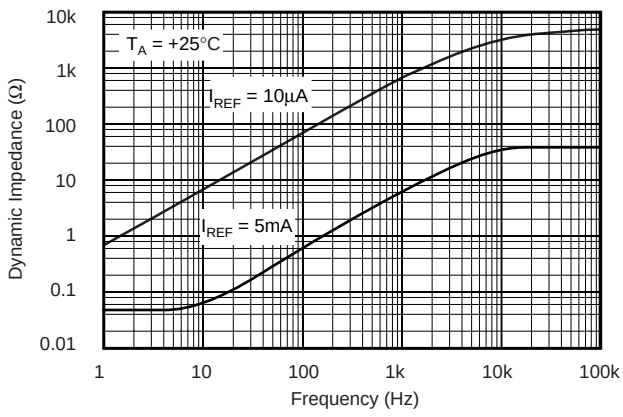
REVERSE VOLTAGE CHANGE vs CURRENT



REVERSE DYNAMIC IMPEDANCE



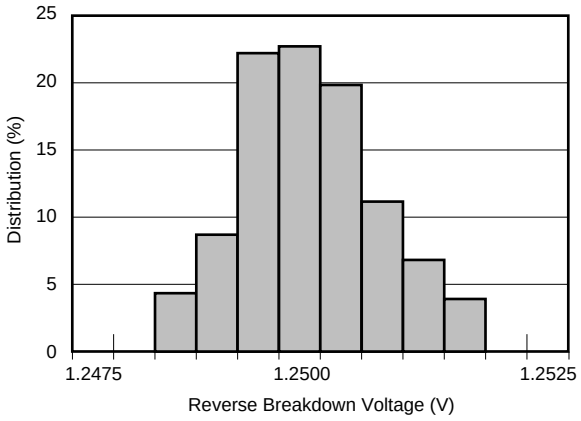
REVERSE DYNAMIC IMPEDANCE



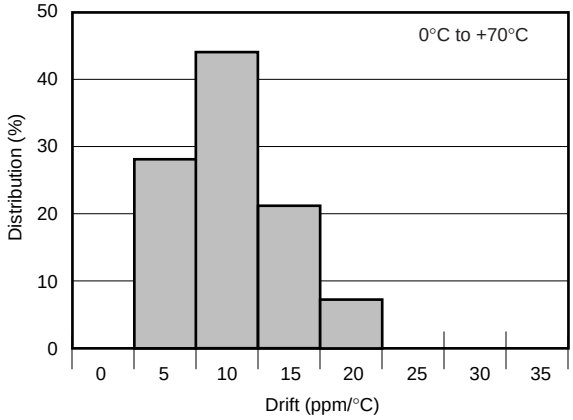
TYPICAL CHARACTERISTICS (Continued)

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

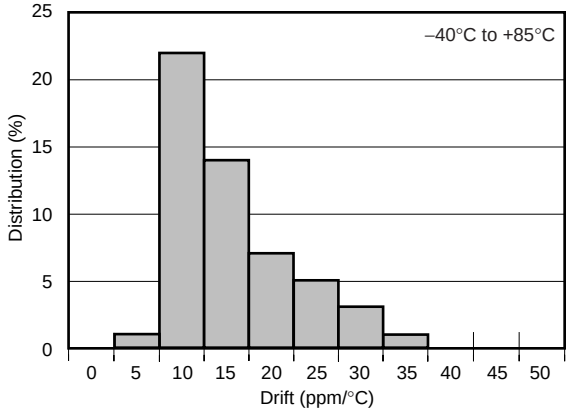
REVERSE BREAKDOWN VOLTAGE DISTRIBUTION



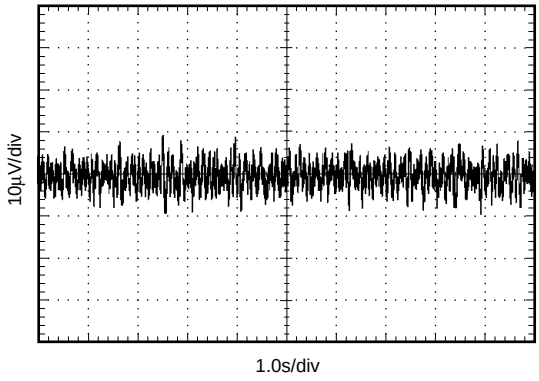
TEMPERATURE DRIFT DISTRIBUTION



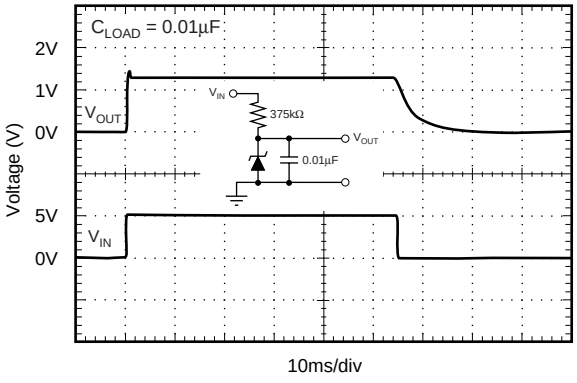
TEMPERATURE DRIFT DISTRIBUTION



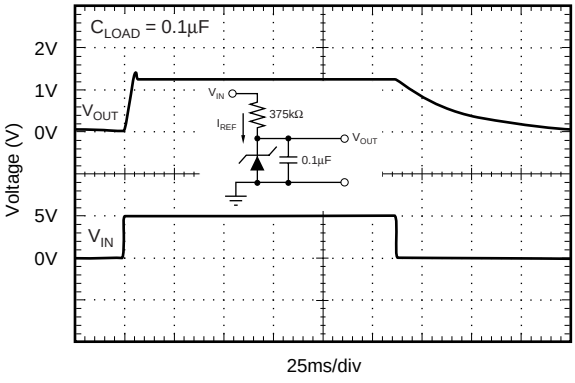
LOW-FREQUENCY NOISE, 0.1 to 10Hz



RESPONSE TIME



RESPONSE TIME



APPLICATIONS INFORMATION

The REF1112 is a two-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.

Typical connections for the REF1112 are shown in Figure 1. A minimum 1µA 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.

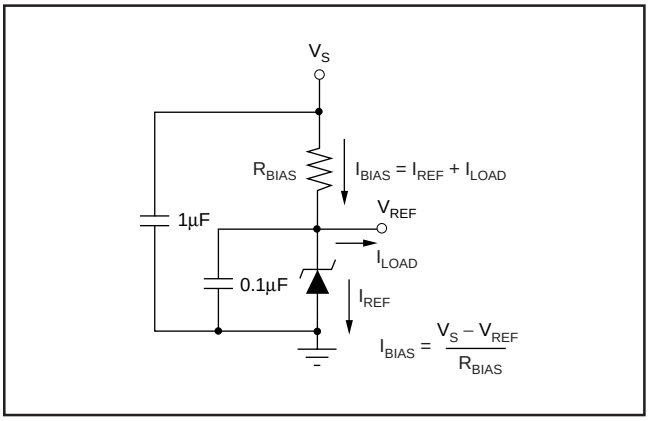


FIGURE 1. Typical Connections.

A 0.1µF load capacitor is recommended to maintain stability under varying load conditions. A minimum 0.01µF 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 1µF 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. The REF1112 can be configured with an additional diode and NPN transistor to provide a temperature compensated current reference as shown in Figure 2. The REF112 can be scaled to provide extremely low power reference voltages. Figure 3 shows the REF1112 used as a 1V out, 3µA voltage reference, and in Figure 4 as a 2.5V reference on 1µA.

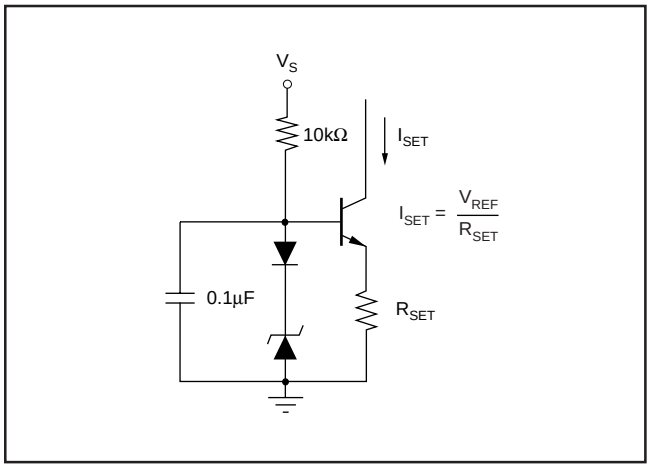


FIGURE 2. REF1112 Provides a Stable Current Source.

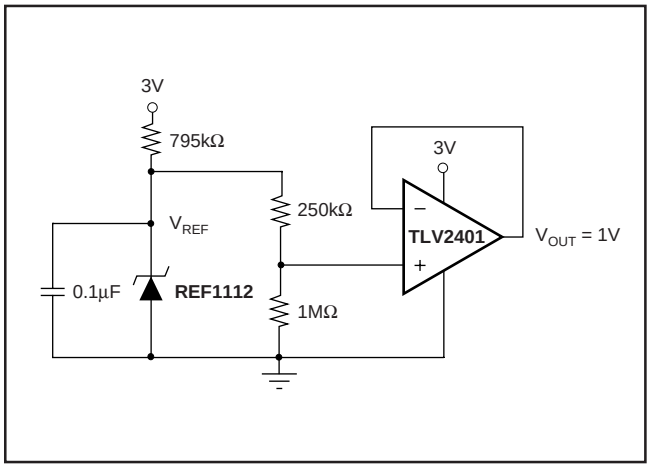


FIGURE 3. MicroPOWER 3µA 1V Voltage Reference.

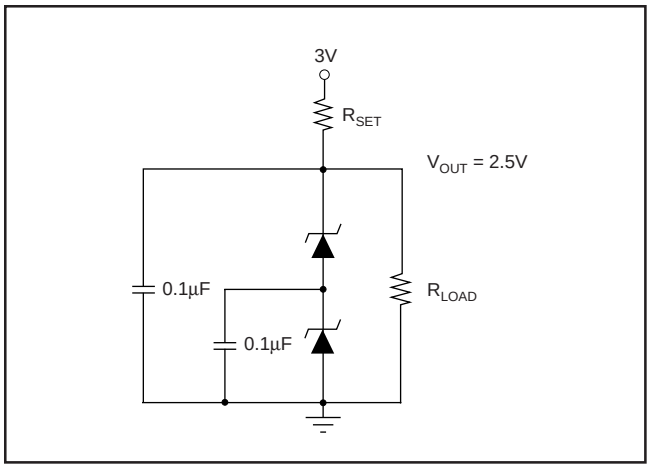


FIGURE 4. 2.5V Reference on 1µA.

For applications requiring a stable voltage reference capable of sinking higher than 5mA of current, a REF1112 combined with an OPA347 can sink up to 10mA of current. This configuration is shown in Figure 5, and through appropriate selection of R1 and R2, can be used to provide a wide range of stable reference voltages. The REF1112 is also useful for level shifting, and as shown in Figure 6, can be used to achieve the full input range of an analog-to-digital converter (ADC).

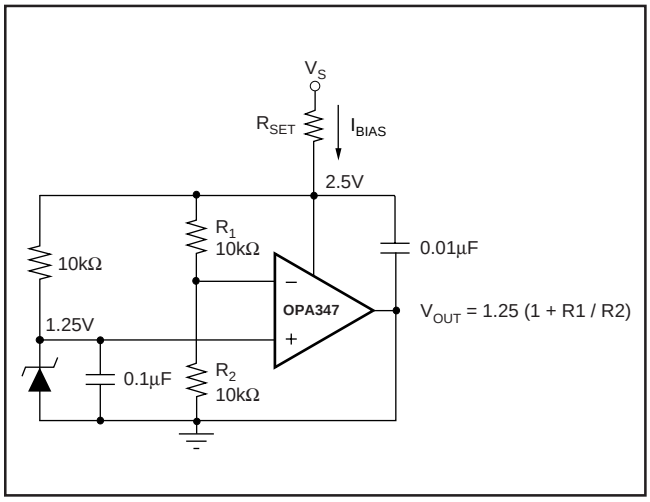


FIGURE 5. Adjustable Voltage Shunt Reference.

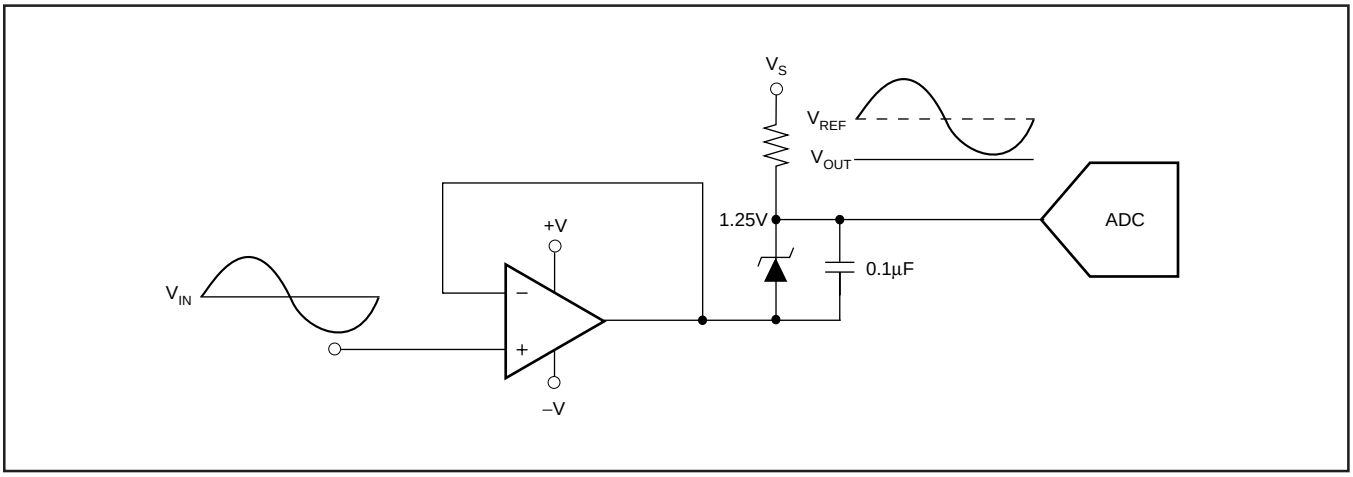


FIGURE 6. REF1112 Provides a Level Shift to Achieve Full ADC Input Range.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
REF1112AIDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	R11A	Samples
REF1112AIDBZRG4	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	R11A	Samples
REF1112AIDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	R11A	Samples
REF1112AIDBZTG4	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	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.

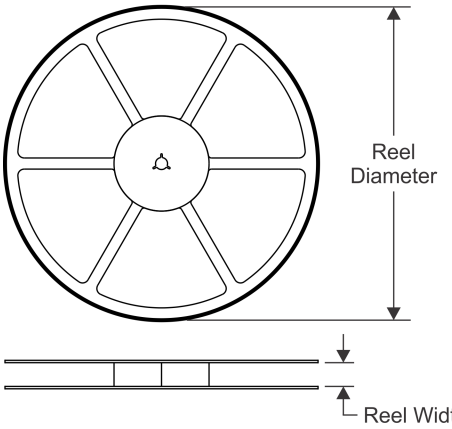
(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

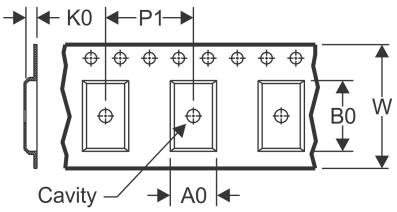
(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

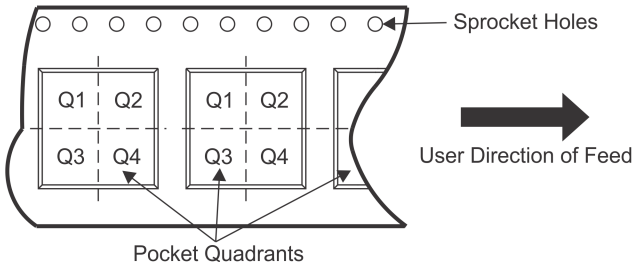


TAPE DIMENSIONS



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

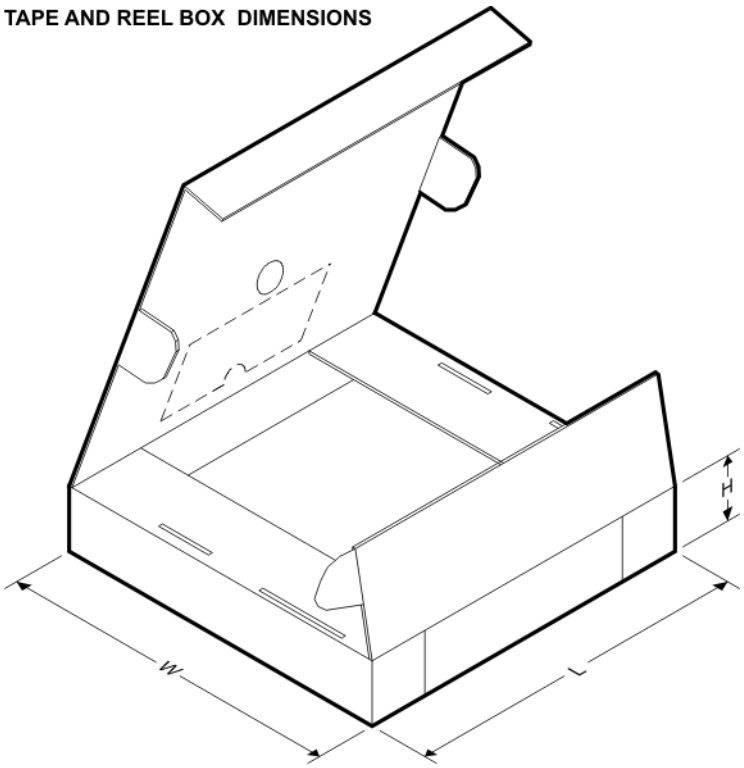
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
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



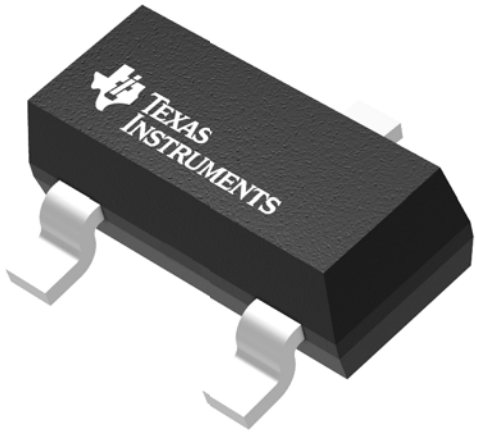
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
REF1112AIDBZR	SOT-23	DBZ	3	3000	203.0	203.0	35.0
REF1112AIDBZT	SOT-23	DBZ	3	250	203.0	203.0	35.0

GENERIC PACKAGE VIEW

DBZ 3 SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



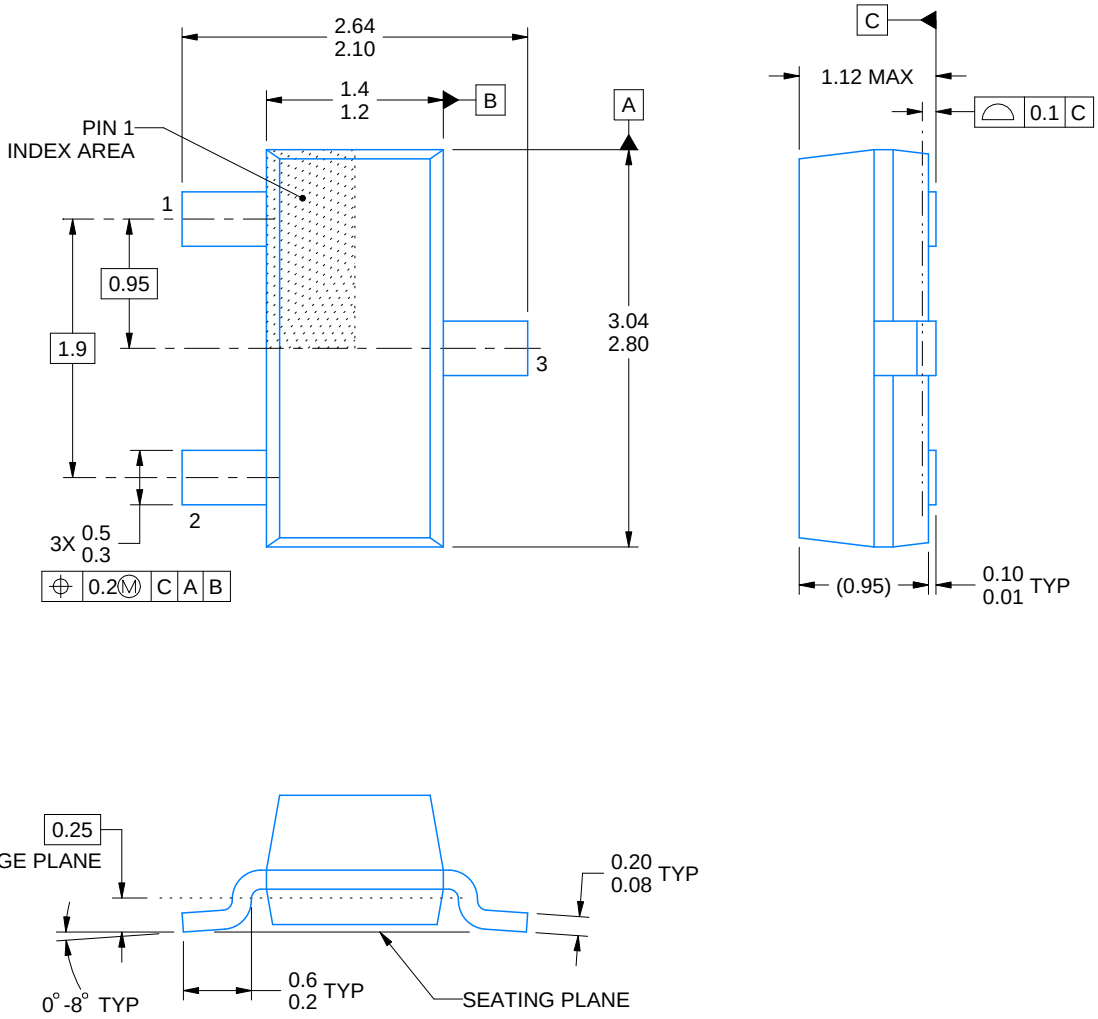
Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

PACKAGE OUTLINE

DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



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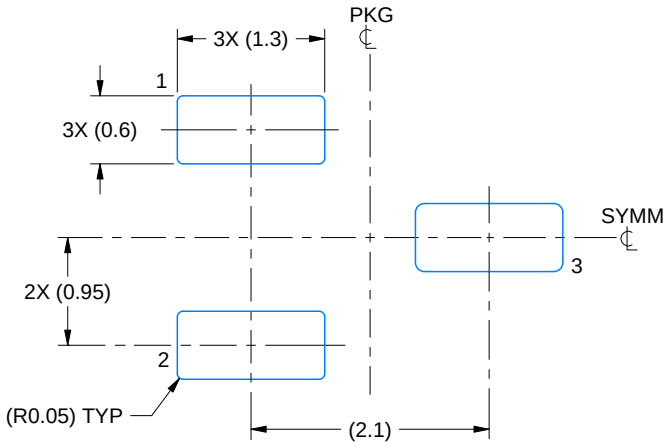
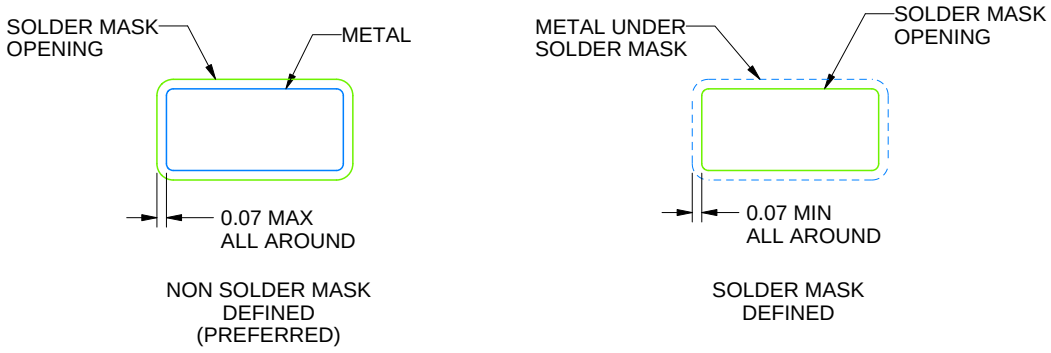
NOTES:

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.



LAND PATTERN EXAMPLE
SCALE:15X



SOLDER MASK DETAILS

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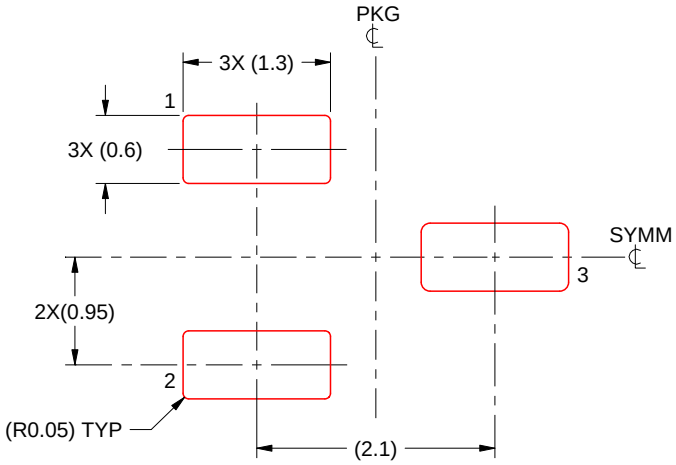
NOTES: (continued)

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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