REF33xx 3.9-µA, SC70-3, SOT23-3 and UQFN-8, 30-ppm/°C Drift Voltage Reference

1 Features

- Microsize Packages: SC70-3, SOT23-3, UQFN-8
- Low Supply Current: 3.9 µA (typ)
- Extremely Low Dropout Voltage: 110 mV (typ)
- High Output Current: ±5 mA
- Low Temperature Drift: 30 ppm/°C (max)
- High Initial Accuracy: ±0.15% (max)
- 0.1-Hz to 10-Hz Noise: 35 μV_{PP} (REF3312)
- Voltage Options: 1.2 V, 1.8 V, 2.5 V, 3 V, 3.3 V

2 Applications

- Portable Equipment
- Tablets and Smartphones
- Hard disk drives
- Sensor modules
- Data Acquisition Systems
- Medical Equipment
- Test Equipment

3 Description

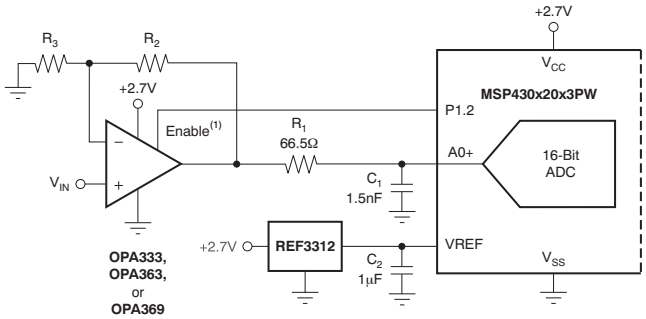
The REF33xx is a low-power, precision, low-dropout voltage reference family available in tiny SC70-3 and SOT-23-3 packages, and in a 1.5-mm × 1.5-mm UQFN-8 package. Small size and low power consumption (5-µA max) make the REF33xx ideal for a wide variety of portable and battery-powered applications.

The REF33xx can be operated at a supply voltage 180 mV above the specified output voltage under normal load conditions, with the exception of the REF3312, which has a minimum supply voltage of 1.8 V. All models are specified for the wide temperature range of –40°C to +125°C.

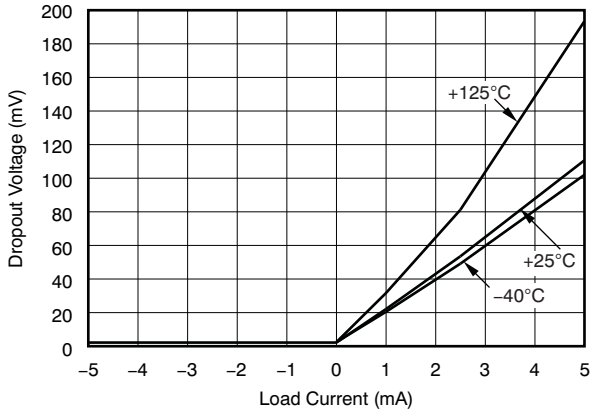
Device Information

ORDER NUMBER	PACKAGE (PIN)	BODY SIZE
REF33xxDBZ	SOT-23 (3)	2,92 mm × 1,3 mm
REF33xxDCK	SC70 (3)	2 mm × 1,25 mm
REF3330RSE	UQFN (8)	1,5 mm × 1,5 mm

REF3312 in a Single-Supply Signal Chain



Dropout Voltage vs Load Current



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4 Revision History

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

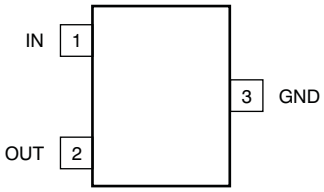
Changes from Revision A (September 2007) to Revision B	Page
• Changed document format to meet latest data sheet standards; added new sections and moved existing sections	1
• Moved package figures from front page to Terminal Configuration and Functions	1
• Added new figures to front page	1
• Deleted Ordering Information table; see Package Option Addendum for most current ordering information	3
• Added RSE terminal configuration	3
• Added Thermal Information table	4
• Deleted Thermal Resistance parameter in Electrical Characteristics; see new Thermal Information table	6

Device Comparison

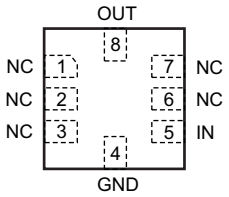
PRODUCT	DESCRIPTION
REF3312	1.25 V
REF3318	1.8 V
REF3320	2.048 V
REF3325	2.5 V
REF3330	3.0 V
REF3333	3.3 V

5 Terminal Configuration and Functions

REF3312, REF3318, REF3320, REF3325, REF3330, REF3333
DBZ Package and DCK Package
SOT-23-3, SC70-3
(Top View)



REF3330
RSE Package
UQFN-8
(Top View)



Terminal Functions

TERMINAL			DESCRIPTION
NAME	DBZ, DCK	RSE	
IN	1	5	Input supply voltage
GND	3	4	Ground
OUT	2	8	Output voltage
NC	—	1, 2, 3, 6, 7	Not connected

6 Specifications

6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Voltage	Input voltage		+7.5	V
	Output voltage		5	V
Current	Output short-circuit, I_{SC}(2)		180	mA
Temperature	Operating temperature	–50	+150	°C
	Junction temperature, T_J		+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.
(2) See the *Power-Supply Recommendations* section of this data sheet.

6.2 Handling Ratings

		MIN	MAX	UNIT
T_{stg}	Storage temperature	–65	+150	°C
V_{ESD}(1)	Human body model (HBM) ESD stress voltage(2)		4000	V
	Charged device model (CDM) ESD stress voltage(3)		1000	V
	Machine model (MM) ESD stress voltage		200	V

(1) Electrostatic discharge (ESD) to measure device sensitivity and immunity to damage caused by assembly line electrostatic discharges in to the device.
(2) Level listed above is the passing level per ANSI, ESDA, and JEDEC JS-001. JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(3) Level listed above is the passing level per EIA-JEDEC JESD22-C101. 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	NOM	MAX	UNIT
V_{IN}	Supply input voltage range	V_{OUT} + 0.2		55	V
I_{OUT}	Output current range	-30		30	mA

6.4 Thermal Information

THERMAL METRIC(1)		REF33xx		REF3330	UNITS
		DCK (SC70)	DBZ (SOT-23)	RSE (UQFN)	
		3 TERMINALS	3 TERMINALS	8 TERMINALS	
θ_{JA}	Junction-to-ambient thermal resistance	279.7	313.1	61.2	°C/W
θ_{JCtop}	Junction-to-case (top) thermal resistance	136.3	144.0	32.6	
θ_{JB}	Junction-to-board thermal resistance	56.9	109.3	16.0	
ψ_{JT}	Junction-to-top characterization parameter	11.0	18.2	1.3	
ψ_{JB}	Junction-to-board characterization parameter	56.1	107.9	16.0	
θ_{JCbot}	Junction-to-case (bottom) thermal resistance	N/A	N/A	N/A	

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.

6.5 Electrical Characteristics

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNITS
REF3312 (1.25 V)						
V_{OUT}	Output voltage			1.25		V
	Initial accuracy		–0.15%		+0.15%	
	Output voltage noise	f = 0.1 Hz to 10 Hz		35		μV_{PP}
REF3318 (1.8 V)						
V_{OUT}	Output voltage			1.8		V
	Initial accuracy		–0.15%		+0.15%	
	Output voltage noise	f = 0.1 Hz to 10 Hz		50		μV_{PP}
REF3320 (2.048 V)						
V_{OUT}	Output voltage			2.048		V
	Initial accuracy		–0.15%		+0.15%	
	Output voltage noise	f = 0.1 Hz to 10 Hz		55		μV_{PP}
REF3325 (2.5 V)						
V_{OUT}	Output voltage			2.5		V
	Initial accuracy		–0.15%		+0.15%	
	Output voltage noise	f = 0.1 Hz to 10 Hz		70		μV_{PP}
REF3330 (3.0 V)						
V_{OUT}	Output voltage			3.0		V
	Initial accuracy		–0.15%		+0.15%	
	Output voltage noise	f = 0.1 Hz to 10 Hz		84		μV_{PP}
REF3333 (3.3 V)						
V_{OUT}	Output voltage			3.3		V
	Initial accuracy		–0.15%		+0.15%	
	Output voltage noise	f = 0.1 Hz to 10 Hz		92		μV_{PP}
REF33xx (REF3312, REF3318, REF3320, REF3325, REF3330, REF3333)						
dV_{OUT}/dT	Output voltage temperature drift	–40°C to +85°C		9	30	ppm/°C
		–40°C to +125°C		8	30	ppm/°C
$\Delta V_{O(\Delta VI)}$	Line regulation	V_{IN} = V_{OUT} + 200 mV to 5.5 V(1)	–50	6	+50	ppm/V
		0°C to +70°C		6		ppm/V
		–40°C to +85°C		8		ppm/V
		–40°C to +125°C		30		ppm/V
$\Delta V_{O(\Delta IL)}$	Load regulation	V_{IN} = V_{OUT} + 200 mV(1)	–50	6	+50	ppm/mA
		I_{LOAD} = ±5 mA, 0°C to +70°C		10		ppm/mA
		–40°C to +85°C		20		ppm/mA
		–40°C to +125°C		20		ppm/mA
dT	Thermal hysteresis(2)			90		ppm
$V_{IN} – V_{OUT}$	Minimum dropout voltage(1)	I_{LOAD} = ±5 mA		110	160	mV
		0°C to +70°C		120		mV
		–40°C to +85°C		135		mV
		–40°C to +125°C		180		mV
		I_{LOAD} = ±2 mA, –40°C to +85°C			70	mV
I_{SC}	Short-circuit current	Sourcing and sinking		35		mA
	Capacitive load		0.1		10	µF
	Turn-on settling time	To 0.1% with C_L = 1 µF		2		ms

(1) The minimum supply voltage for the REF3312 is 1.8 V.
(2) The thermal hysteresis procedure is explained in more detail in the *Thermal Hysteresis* section.

Electrical Characteristics (continued)

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNITS
POWER SUPPLY						
V_S	Specified voltage range		V_{OUT} + 0.2(3)		5.5	V
	Operating voltage range	I_{LOAD} = 0 mA		V_{OUT} + 0.005	5.5	V
I_Q	Current			3.9	5	µA
		–40°C to +85°C		4.4	6.5	µA
		–40°C to +125°C		4.8	8.5	µA
TEMPERATURE						
T_A	Specified range		–40		+125	°C
	Operating range		–50		+150	°C

(3) The minimum supply voltage for the REF3312 is 1.8 V.

6.6 Typical Characteristics

At T_A = +25°C and V_{IN} = +5 V. REF3325 is used for typical characteristic measurements, unless otherwise noted.

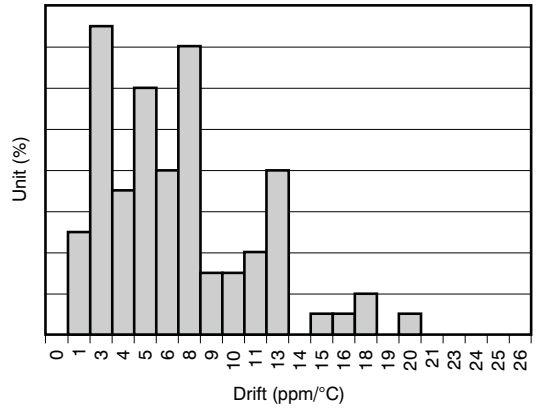


Figure 1. Temperature Drift

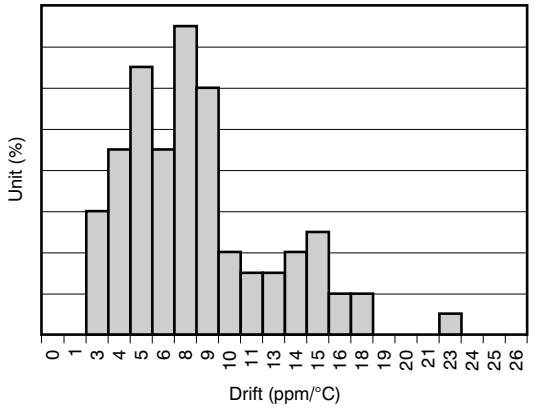


Figure 2. Temperature Drift

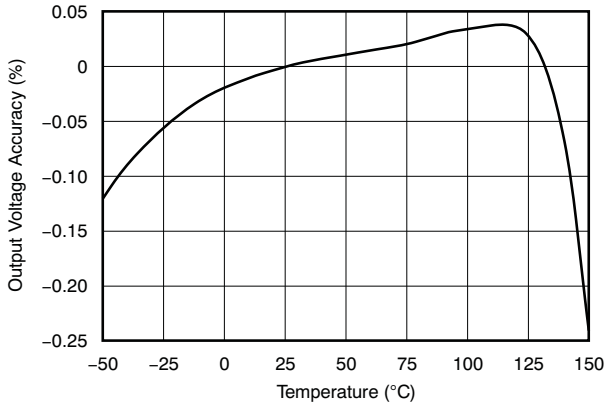


Figure 3. Output Voltage Accuracy vs Temperature

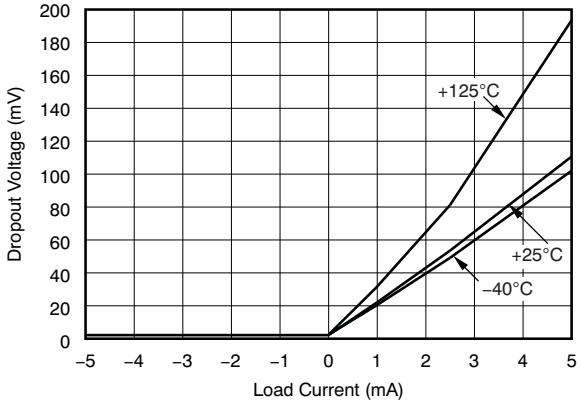


Figure 4. Dropout Voltage vs Load Current

Typical Characteristics (continued)

At T_A = +25°C and V_{IN} = +5 V. REF3325 is used for typical characteristic measurements, unless otherwise noted.

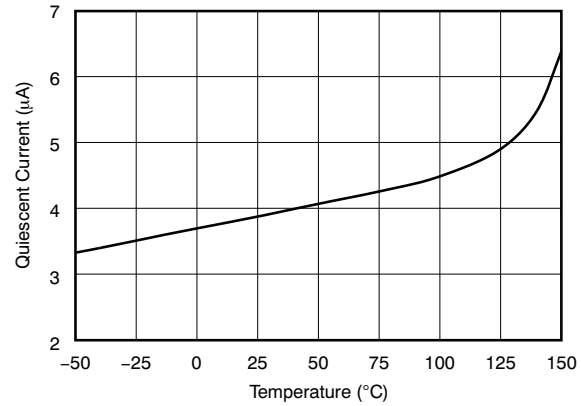


Figure 5. Quiescent Current vs Temperature

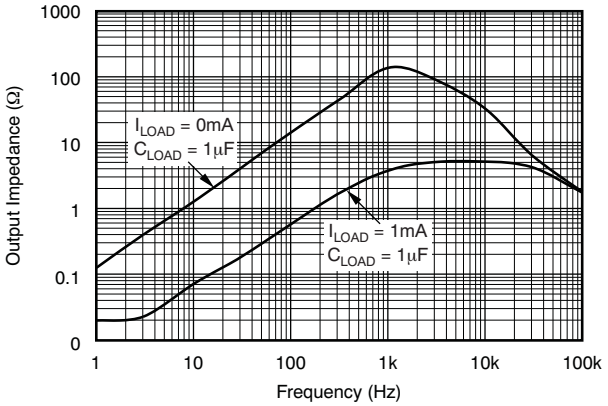


Figure 6. Output Impedance vs Frequency

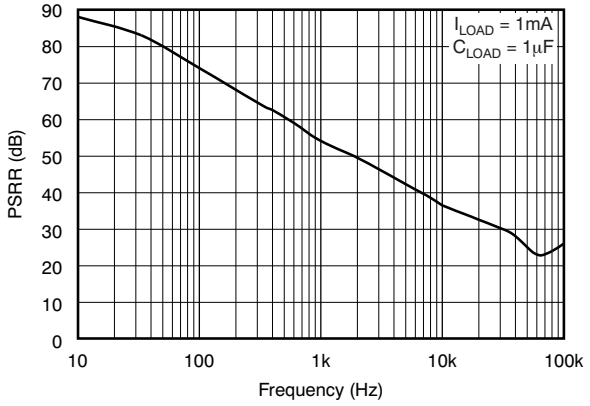


Figure 7. PSRR vs Frequency

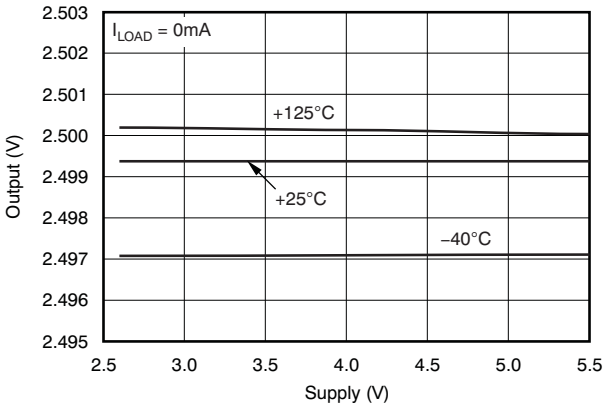


Figure 8. Output vs Supply

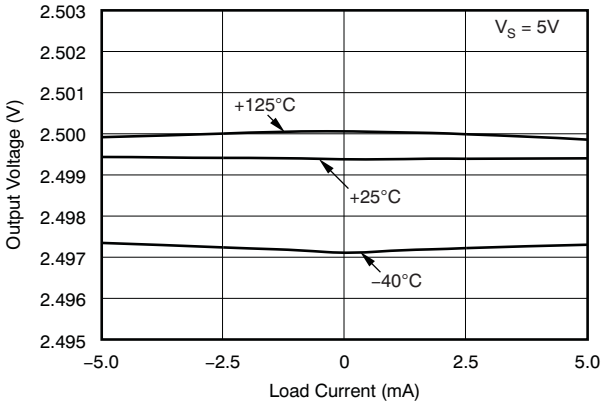
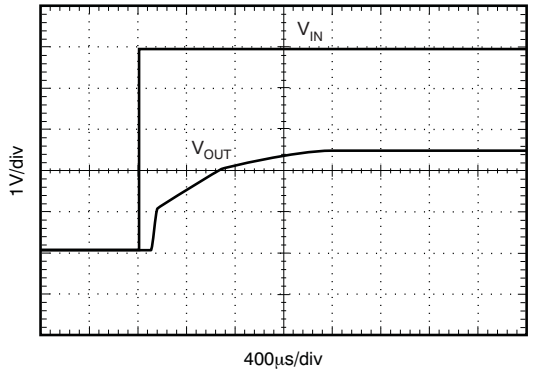


Figure 9. Output Voltage vs Load Current



C_L = 1-µF Startup

Figure 10. Step Response

Typical Characteristics (continued)

At T_A = +25°C and V_{IN} = +5 V. REF3325 is used for typical characteristic measurements, unless otherwise noted.

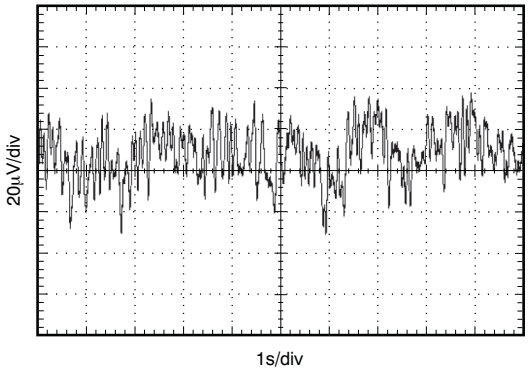
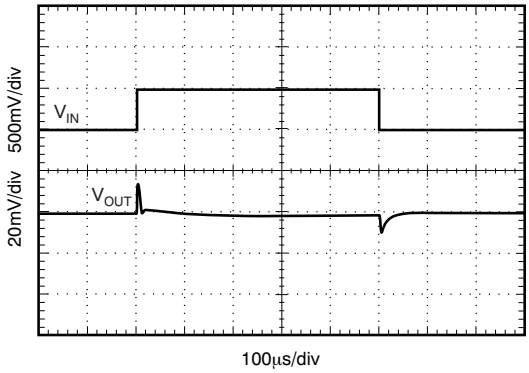
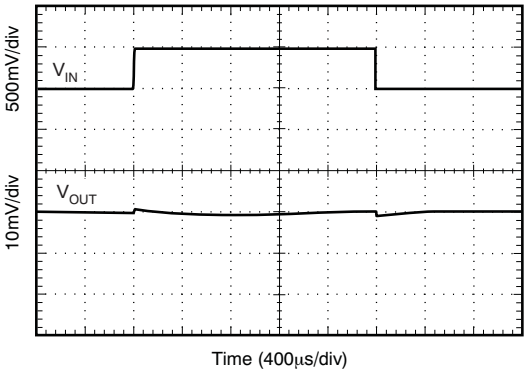


Figure 11. 0.1-Hz to 10-Hz Noise



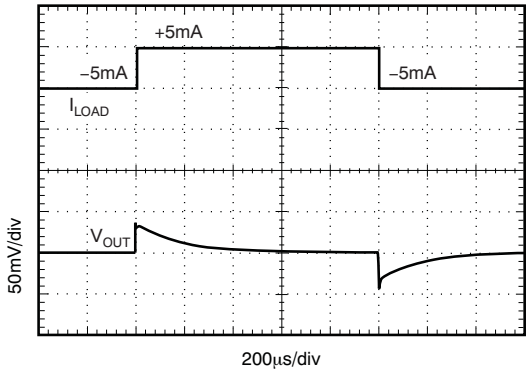
C_L = 1 µF I_{OUT} = 0 mA

Figure 12. Line Transient



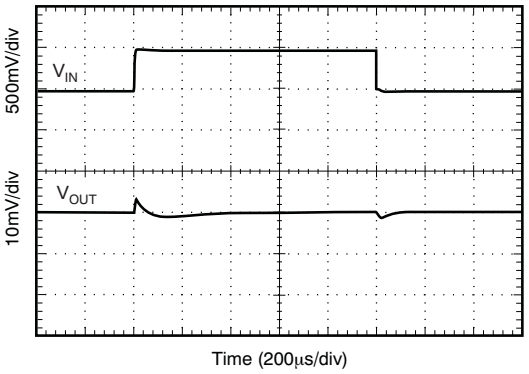
C_{LOAD} = 10 µF I_{OUT} = 0 mA

Figure 13. Line Transient



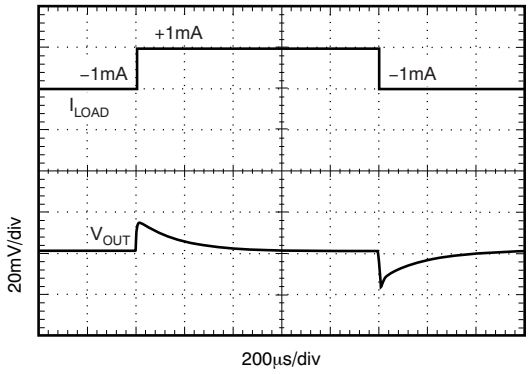
C_L = 1 µF ±5-mA Output Pulse

Figure 14. Load Transient



C_{LOAD} = 10 µF I_{OUT} = 1 mA

Figure 15. Line Transient



C_L = 1 µF ±1-mA Output Pulse

Figure 16. Load Transient

7 Detailed Description

7.1 Overview

The REF33xx is a family of low-power, precision band-gap voltage references that are specifically designed for extremely low dropout, excellent initial voltage accuracy with a high output current. A simplified block diagram of the REF33xx is shown in the *Functional Block Diagram* section. Figure 17 shows the typical connections for the REF33xx. A supply bypass capacitor ranging between 1 µF to 10 µF is recommended. The total capacitive load at the output must be between 0.1 µF to 10 µF to ensure output stability.

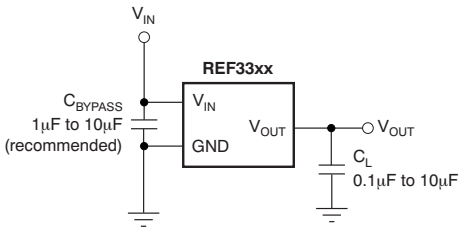
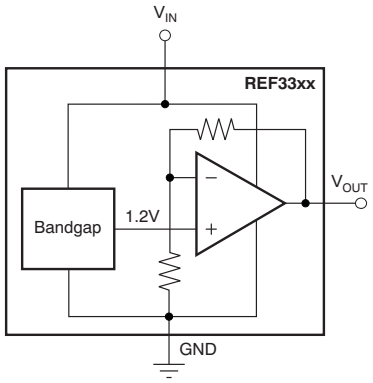


Figure 17. Basic Connections

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Start-Up Time

The REF33xx features an advanced start-up circuit. Start-up time is almost independent of load (with a 0.1-µF to 10-µF load). Upon startup, the current boost circuit forces the output voltage. When the preset voltage is reached, the REF33xx switches to the second stage of output circuitry to precisely set the output voltage. Figure 18 shows the start-up time of the REF3325 for three different capacitive loads. In all three cases, the output voltage settles within 2 ms.

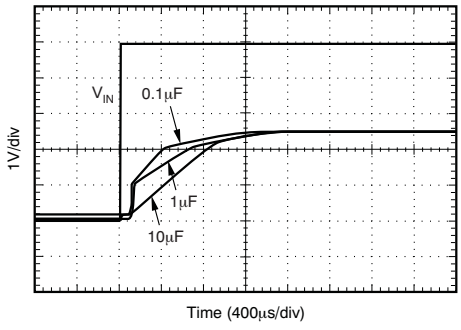


Figure 18. Start-Up Time

Feature Description (continued)

7.3.2 Temperature Drift

The REF33xx is designed for minimal drift error, defined as the change in output voltage over temperature. The drift is calculated using the box method, as described in Equation 1:

$$\text{Drift} = \left(\frac{V_{OUTMAX} - V_{OUTMIN}}{V_{OUT} \times \text{Temp Range}} \right) \times 10^6 (\text{ppm}) \quad (1)$$

7.3.3 Power Dissipation

The REF33xx family is specified to deliver current loads of ±5 mA over the specified input voltage range. The temperature of the device increases according to Equation 2:

$$T_J = T_A + P_D \times \theta_{JA}$$

where

- T_J = junction temperature (°C)
- T_A = ambient temperature (°C)
- P_D = power dissipation (W) = $V_{IN} \times I_Q + (V_{IN} - V_{OUT})\ I_{OUT}$
- θ_{JA} = Junction-to-ambient thermal resistance (°C/W) (2)

The REF33xx junction temperature must not exceed the absolute maximum rating of +150°C.

7.3.4 Noise Performance

Typical 0.1-Hz to 10-Hz voltage noise for each member of the REF33xx family is specified in the *Electrical Characteristics* table. The noise voltage increases with output voltage and operating temperature. Use additional filtering to improve output noise levels. Give special attention to ensure that the output impedance does not degrade output voltage accuracy.

7.3.5 Thermal Hysteresis

Thermal hysteresis for the REF33xx 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 Equation 3:

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

where

- V_{HYST} = thermal hysteresis (in units of ppm).
- V_{NOM} = the specified output voltage.
- V_{PRE} = output voltage measured at +25°C pretemperature cycling.
- V_{POST} = output voltage measured after the device has been cycled from +25°C through the specified temperature range of –40°C to +125°C and returned to +25°C. (3)

8 Applications and Implementation

8.1 Application Information

The REF33xx is a family of low-power, precision band-gap voltage references that are specifically designed for extremely low dropout, excellent initial voltage accuracy with a high output current. The extremely small size of the SC70-3, SOT23-3 and UQFN-8 make these references very attractive for space constrained applications. Two very common applications are explained below.

8.2 Typical Applications

8.2.1 REF3312 in a Unipolar Signal-Chain Configuration

Figure 19 shows a simple application circuit where low-power components are used to create a signal chain. The analog input signal is buffered with either a zero-drift OPA333 or zero-crossover OPA363. The reference voltage created from REF3312 provides a stable, high-accuracy, low-drift reference voltage to the MSP430 using much less power than the MSP430 internal reference. The reference voltage is used by the internal, 16-bit analog-to-digital converter (ADC) to accurately convert the analog input signal. The configuration in Figure 19 presents an example of a unipolar signal chain.

8.2.1.1 REF3312 Application Schematic

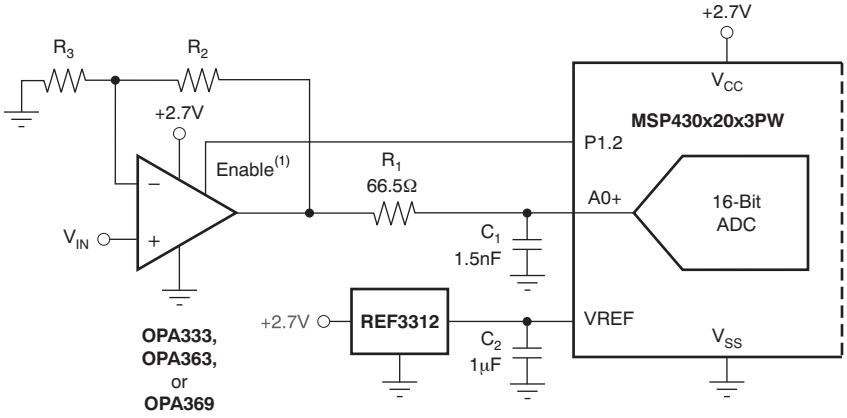


Figure 19. Unipolar Signal-Chain Configuration

Typical Applications (continued)

8.2.2 REF3312 in a Bipolar Signal-Chain Configuration

An example of a bipolar configuration is illustrated in REF3312 Application Schematic. The analog input signal (±2.5 V) is offset and attenuated so that it matches the analog input of the 16-bit ADC on the MSP430. The negative input of the ADC is offset by 0.62 V, creating a digital code that corresponds to the analog input voltage. In this configuration, two reference voltages are used. The REF3312 creates a 1.25-V reference input to the ADC and is an offset point for the INA159. The same voltage is used to create the offset voltage to the negative input to the ADC. The REF3330 creates a precise analog supply voltage of 3 V. In this way, the high PSRR of the REF3330 helps to filter unwanted noise from the 3.3-V digital supply.

8.2.2.1 REF3312 Application Schematic

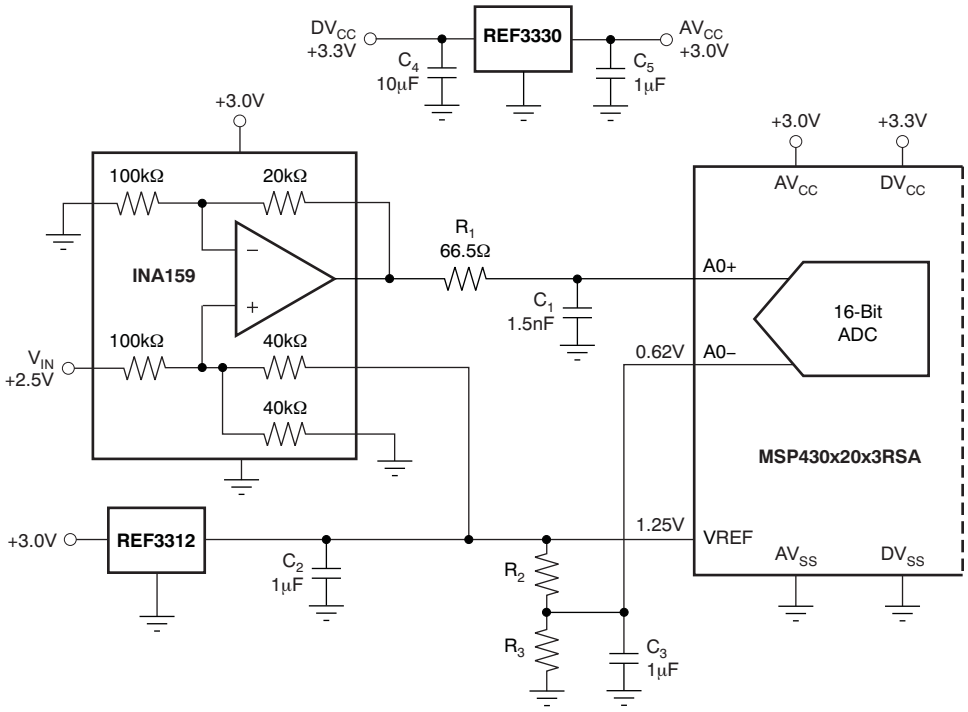


Figure 20. Bipolar Signal-Chain Configuration

9 Power-Supply Recommendations

The REF33xx family of voltage references features extremely low dropout voltage, except for the REF3312. The REF3312 has a minimum supply requirement of 1.8 V. These references can be operated with a supply 110 mV above the output voltage with a 5-mA load (typical). For loaded conditions, a typical dropout voltage versus load graph is illustrated in Figure 4 of the *Typical Characteristics*.

If the supply voltage connected to the IN terminal is rapidly moved while the REF33xx is connected to a capacitive load, a reverse voltage may discharge through the OUT terminal and into the REF33xx device. This voltage will not damage the REF33xx, provided that it is less than or equal to 5 V.

10 Device and Documentation Support

10.1 Related Links

Table 1 lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 1. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
REF3312	Click here	Click here	Click here	Click here	Click here
REF3318	Click here	Click here	Click here	Click here	Click here
REF3320	Click here	Click here	Click here	Click here	Click here
REF3325	Click here	Click here	Click here	Click here	Click here
REF3330	Click here	Click here	Click here	Click here	Click here
REF3333	Click here	Click here	Click here	Click here	Click here

10.2 Trademarks

All trademarks are the property of their respective owners.

10.3 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.

10.4 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms and definitions.

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 Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
REF3312AIDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33A	Samples
REF3312AIDBZRG4	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33A	Samples
REF3312AIDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33A	Samples
REF3312AIDBZTG4	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33A	Samples
REF3312AIDCKR	ACTIVE	SC70	DCK	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R12	Samples
REF3312AIDCKRG4	ACTIVE	SC70	DCK	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R12	Samples
REF3312AIDCKT	ACTIVE	SC70	DCK	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R12	Samples
REF3312AIDCKTG4	ACTIVE	SC70	DCK	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R12	Samples
REF3318AIDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33B	Samples
REF3318AIDBZRG4	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33B	Samples
REF3318AIDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33B	Samples
REF3318AIDBZTG4	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33B	Samples
REF3318AIDCKR	ACTIVE	SC70	DCK	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R18	Samples
REF3318AIDCKRG4	ACTIVE	SC70	DCK	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R18	Samples
REF3318AIDCKT	ACTIVE	SC70	DCK	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R18	Samples
REF3318AIDCKTG4	ACTIVE	SC70	DCK	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R18	Samples
REF3320AIDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33C	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
REF3320AIDBZRG4	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33C	Samples
REF3320AIDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33C	Samples
REF3320AIDBZTG4	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33C	Samples
REF3320AIDCKR	ACTIVE	SC70	DCK	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R20	Samples
REF3320AIDCKRG4	ACTIVE	SC70	DCK	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R20	Samples
REF3320AIDCKT	ACTIVE	SC70	DCK	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R20	Samples
REF3320AIDCKTG4	ACTIVE	SC70	DCK	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R20	Samples
REF3325AIDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33D	Samples
REF3325AIDBZRG4	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33D	Samples
REF3325AIDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33D	Samples
REF3325AIDBZTG4	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33D	Samples
REF3325AIDCKR	ACTIVE	SC70	DCK	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R25	Samples
REF3325AIDCKRG4	ACTIVE	SC70	DCK	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R25	Samples
REF3325AIDCKT	ACTIVE	SC70	DCK	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R25	Samples
REF3325AIDCKTG4	ACTIVE	SC70	DCK	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R25	Samples
REF3330AIDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33E	Samples
REF3330AIDBZRG4	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33E	Samples
REF3330AIDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33E	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
REF3330AIDBZTG4	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33E	Samples
REF3330AIDCKR	ACTIVE	SC70	DCK	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R30	Samples
REF3330AIDCKRG4	ACTIVE	SC70	DCK	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R30	Samples
REF3330AIDCKT	ACTIVE	SC70	DCK	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R30	Samples
REF3330AIDCKTG4	ACTIVE	SC70	DCK	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R30	Samples
REF3330AIRSER	ACTIVE	UQFN	RSE	8	5000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125		Samples
REF3333AIDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33F	Samples
REF3333AIDBZRG4	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33F	Samples
REF3333AIDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33F	Samples
REF3333AIDBZTG4	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33F	Samples
REF3333AIDCKR	ACTIVE	SC70	DCK	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33	Samples
REF3333AIDCKRG4	ACTIVE	SC70	DCK	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33	Samples
REF3333AIDCKT	ACTIVE	SC70	DCK	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33	Samples
REF3333AIDCKTG4	ACTIVE	SC70	DCK	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	R33	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.

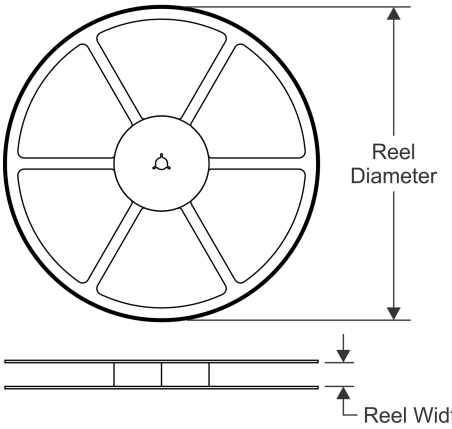
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

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

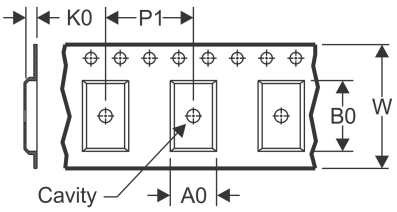
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

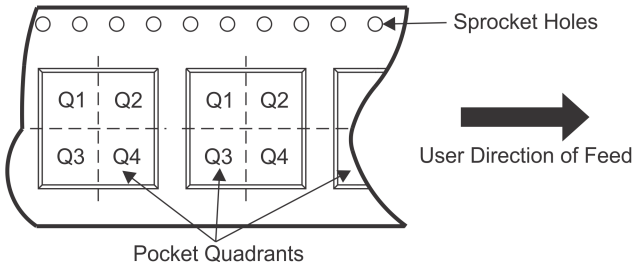


TAPE DIMENSIONS



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

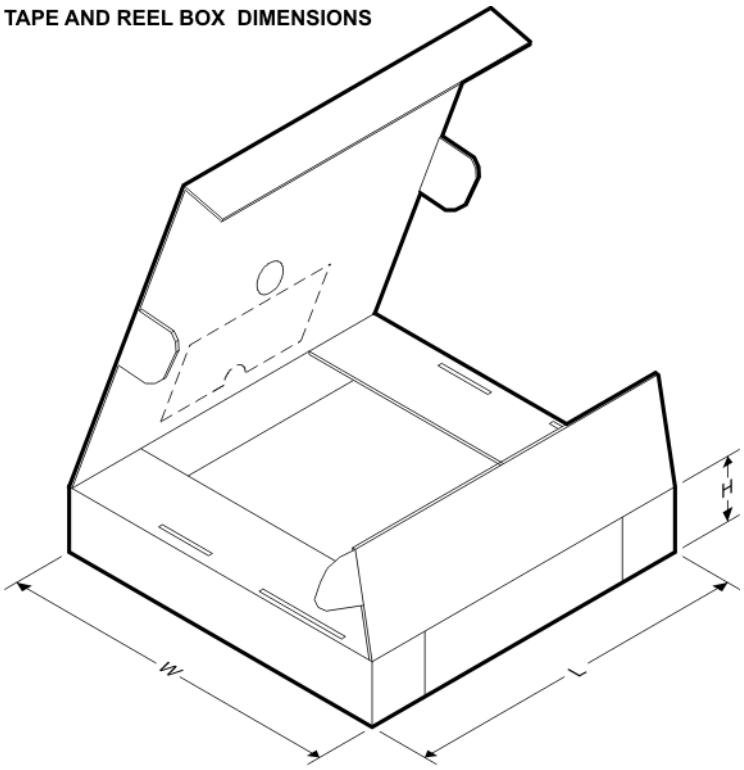


*All dimensions are nominal

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
REF3312AIDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
REF3312AIDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
REF3312AIDCKR	SC70	DCK	3	3000	179.0	8.4	2.4	2.4	1.19	4.0	8.0	Q3
REF3312AIDCKT	SC70	DCK	3	250	179.0	8.4	2.4	2.4	1.19	4.0	8.0	Q3
REF3318AIDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
REF3318AIDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
REF3318AIDCKR	SC70	DCK	3	3000	179.0	8.4	2.4	2.4	1.19	4.0	8.0	Q3
REF3318AIDCKT	SC70	DCK	3	250	179.0	8.4	2.4	2.4	1.19	4.0	8.0	Q3
REF3320AIDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
REF3320AIDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
REF3320AIDCKR	SC70	DCK	3	3000	179.0	8.4	2.4	2.4	1.19	4.0	8.0	Q3
REF3320AIDCKT	SC70	DCK	3	250	179.0	8.4	2.4	2.4	1.19	4.0	8.0	Q3
REF3325AIDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
REF3325AIDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
REF3325AIDCKR	SC70	DCK	3	3000	179.0	8.4	2.4	2.4	1.19	4.0	8.0	Q3
REF3325AIDCKT	SC70	DCK	3	250	179.0	8.4	2.4	2.4	1.19	4.0	8.0	Q3
REF3330AIDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
REF3330AIDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3

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
REF3330AIDCKR	SC70	DCK	3	3000	179.0	8.4	2.4	2.4	1.19	4.0	8.0	Q3
REF3330AIDCKT	SC70	DCK	3	250	179.0	8.4	2.4	2.4	1.19	4.0	8.0	Q3
REF3330AIRSER	UQFN	RSE	8	5000	180.0	9.5	1.7	2.3	0.75	4.0	8.0	Q2
REF3333AIDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
REF3333AIDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
REF3333AIDCKR	SC70	DCK	3	3000	179.0	8.4	2.4	2.4	1.19	4.0	8.0	Q3
REF3333AIDCKT	SC70	DCK	3	250	179.0	8.4	2.4	2.4	1.19	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS

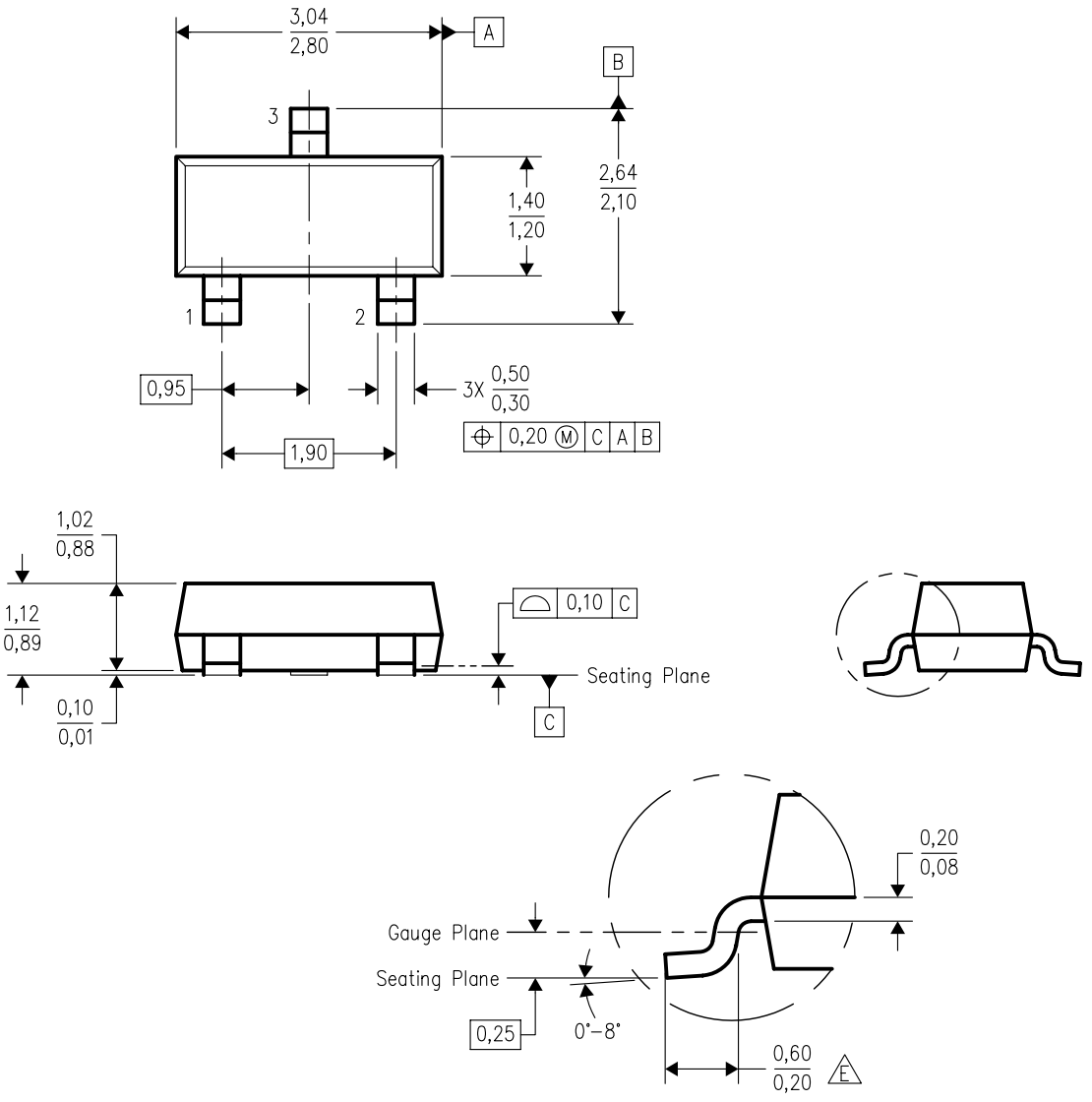


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
REF3312AIDBZR	SOT-23	DBZ	3	3000	195.0	200.0	45.0
REF3312AIDBZT	SOT-23	DBZ	3	250	195.0	200.0	45.0
REF3312AIDCKR	SC70	DCK	3	3000	195.0	200.0	45.0
REF3312AIDCKT	SC70	DCK	3	250	195.0	200.0	45.0
REF3318AIDBZR	SOT-23	DBZ	3	3000	195.0	200.0	45.0
REF3318AIDBZT	SOT-23	DBZ	3	250	195.0	200.0	45.0
REF3318AIDCKR	SC70	DCK	3	3000	195.0	200.0	45.0
REF3318AIDCKT	SC70	DCK	3	250	195.0	200.0	45.0
REF3320AIDBZR	SOT-23	DBZ	3	3000	195.0	200.0	45.0
REF3320AIDBZT	SOT-23	DBZ	3	250	195.0	200.0	45.0

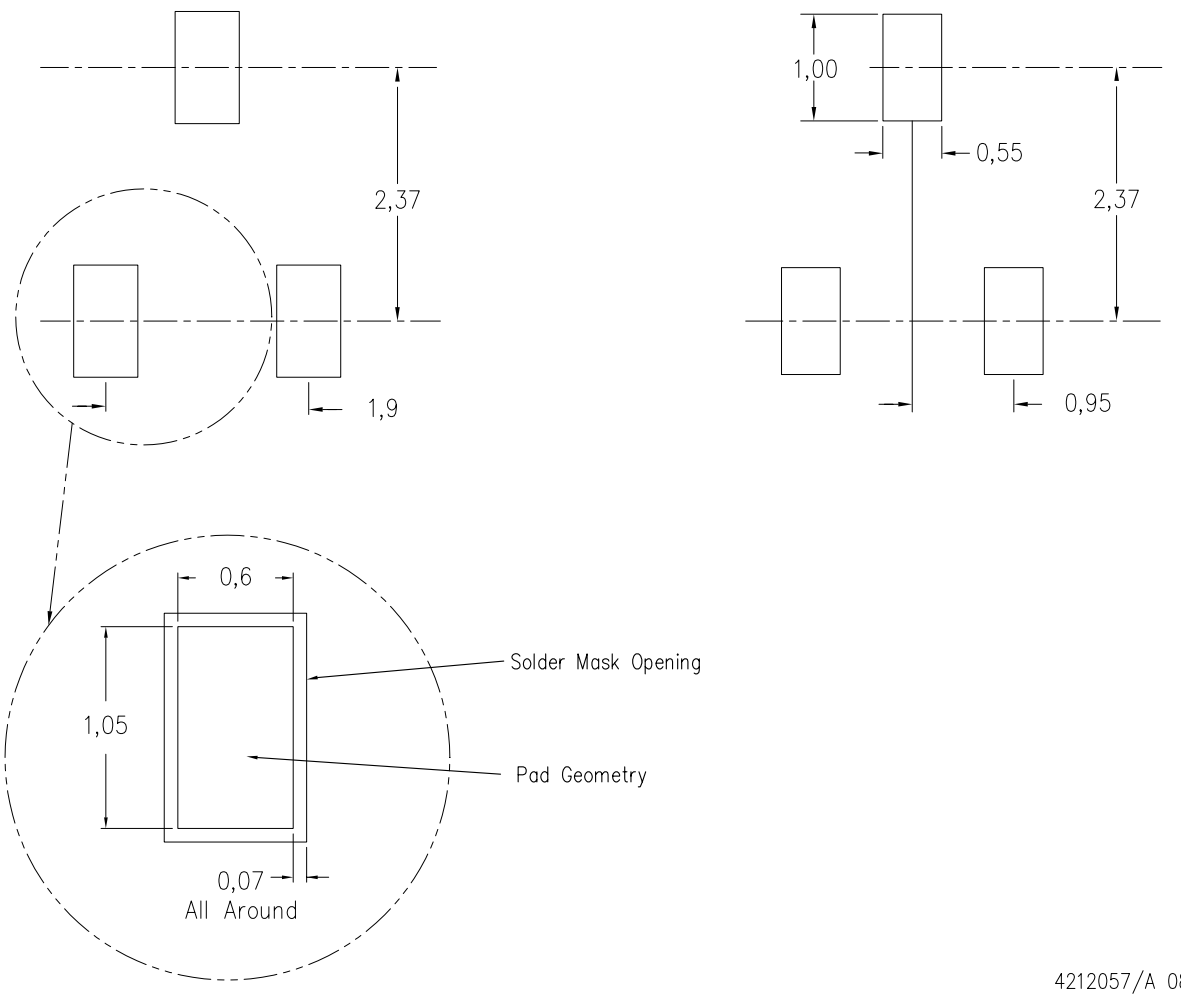
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
REF3320AIDCKR	SC70	DCK	3	3000	195.0	200.0	45.0
REF3320AIDCKT	SC70	DCK	3	250	195.0	200.0	45.0
REF3325AIDBZR	SOT-23	DBZ	3	3000	195.0	200.0	45.0
REF3325AIDBZT	SOT-23	DBZ	3	250	195.0	200.0	45.0
REF3325AIDCKR	SC70	DCK	3	3000	195.0	200.0	45.0
REF3325AIDCKT	SC70	DCK	3	250	195.0	200.0	45.0
REF3330AIDBZR	SOT-23	DBZ	3	3000	195.0	200.0	45.0
REF3330AIDBZT	SOT-23	DBZ	3	250	195.0	200.0	45.0
REF3330AIDCKR	SC70	DCK	3	3000	195.0	200.0	45.0
REF3330AIDCKT	SC70	DCK	3	250	195.0	200.0	45.0
REF3330AIRSER	UQFN	RSE	8	5000	180.0	180.0	30.0
REF3333AIDBZR	SOT-23	DBZ	3	3000	195.0	200.0	45.0
REF3333AIDBZT	SOT-23	DBZ	3	250	195.0	200.0	45.0
REF3333AIDCKR	SC70	DCK	3	3000	195.0	200.0	45.0
REF3333AIDCKT	SC70	DCK	3	250	195.0	200.0	45.0

DBZ (R–PDSO–G3) PLASTIC SMALL–OUTLINE



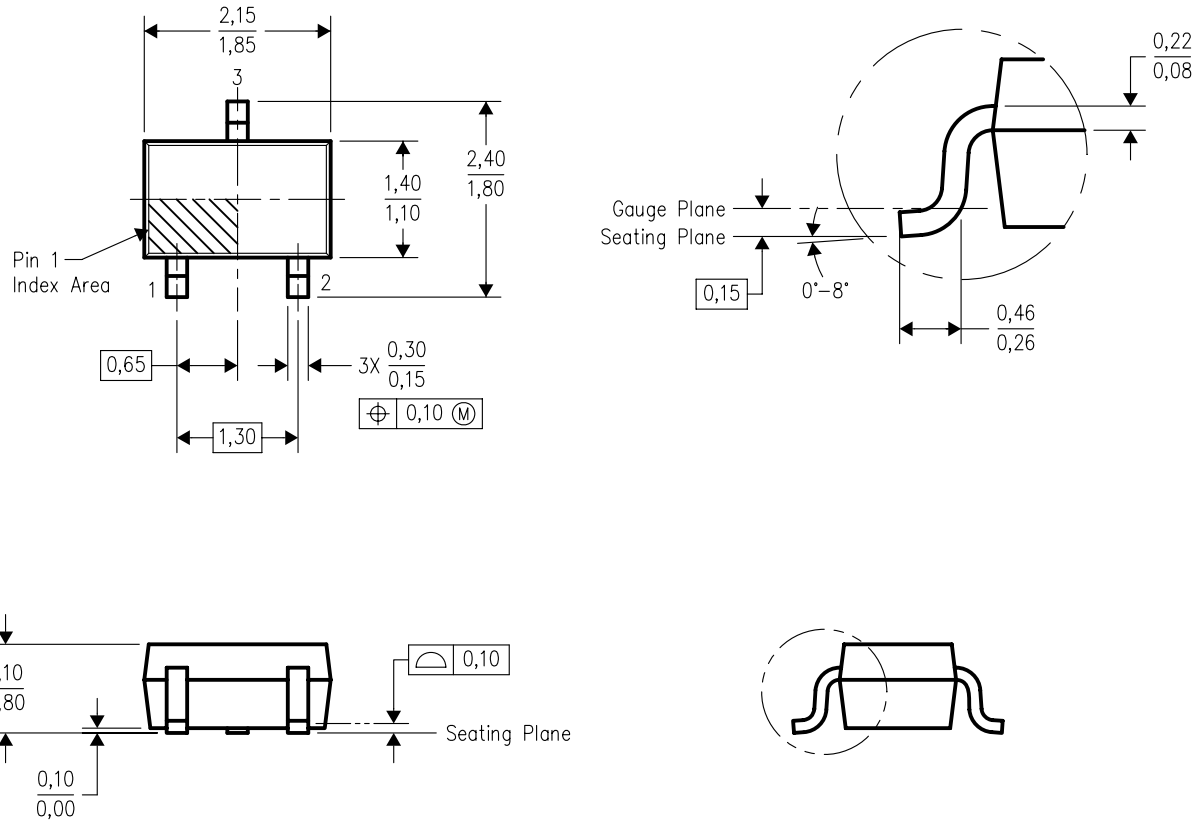
NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Lead dimensions are inclusive of plating.
D. Body dimensions are exclusive of mold flash and protrusion. Mold flash and protrusion not to exceed 0.25 per side.
E. Falls within JEDEC TO–236 variation AB, except minimum foot length.

DBZ (R–PDSO–G3) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
D. Publication IPC–7351 is recommended for alternate designs.
E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC–7525 for other stencil recommendations.

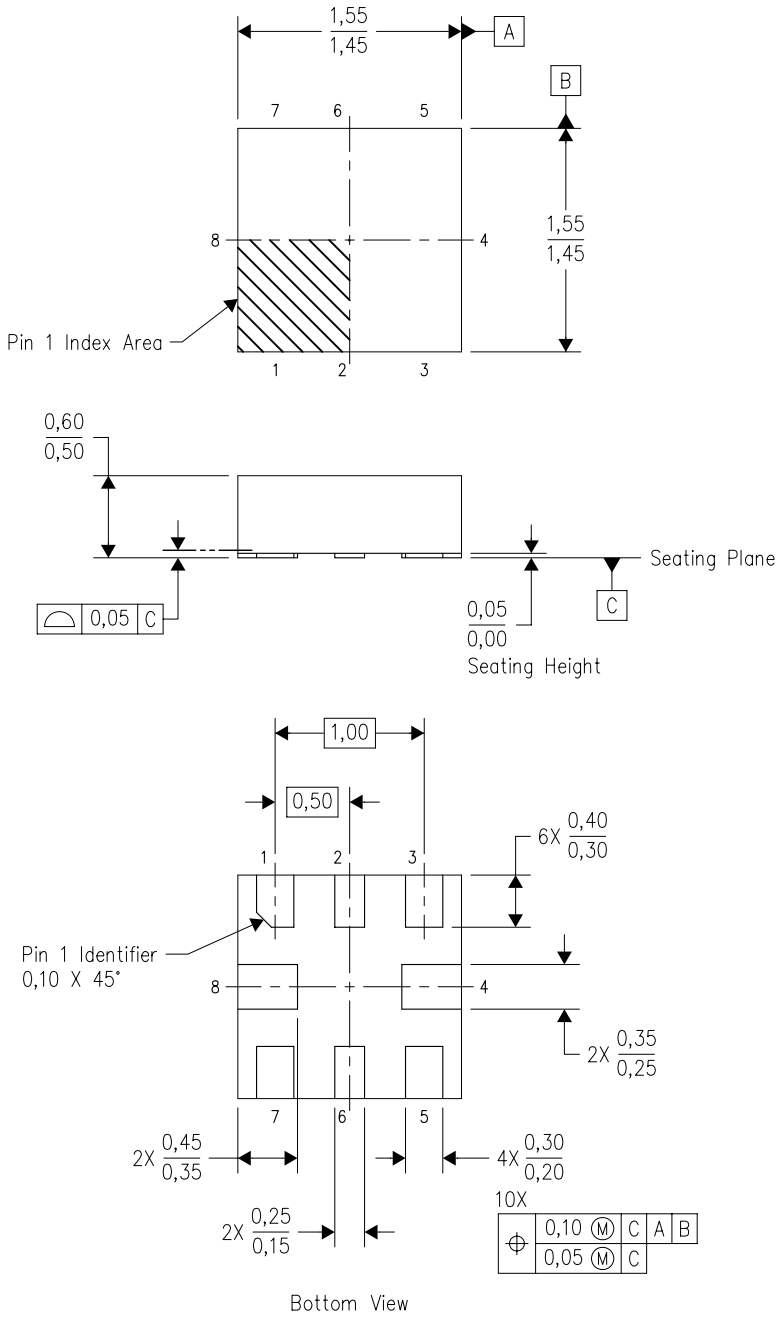
DCK (R–PDSO–G3) PLASTIC SMALL–OUTLINE PACKAGE



4093553–2/G 01/2007

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.

RSE (S–PUQFN–N8) PLASTIC QUAD FLATPACK NO–LEAD

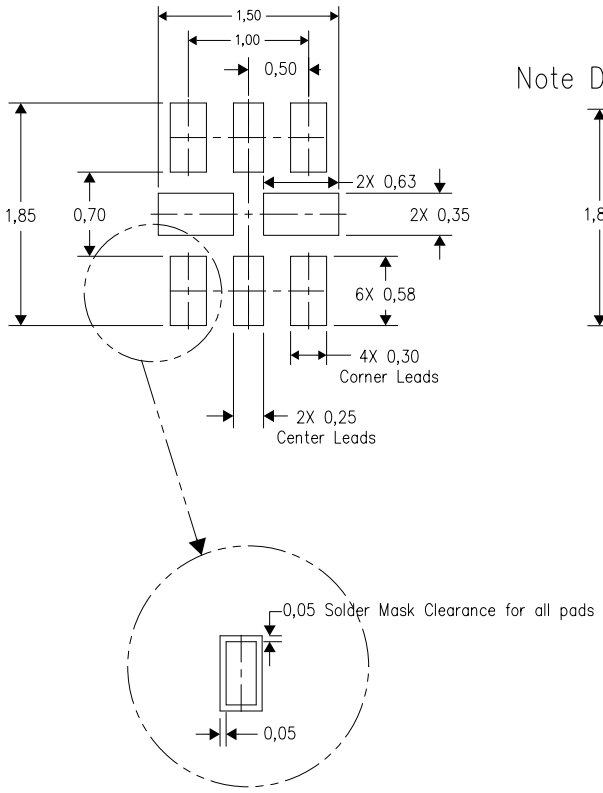


4207268–2/D 01/11

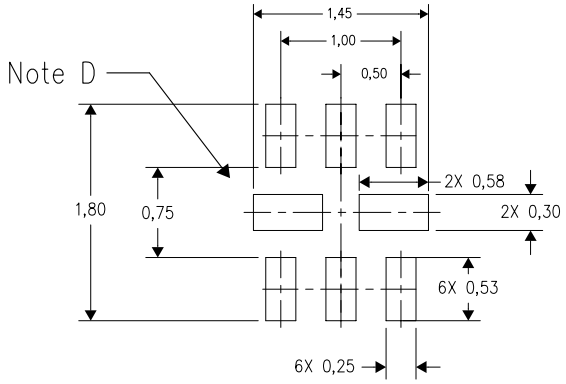
NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. QFN (Quad Flatpack No–Lead) package configuration.
D. This package complies to JEDEC MO–288 variation UECD.

RSE (S–PUQFN–N8) PLASTIC QUAD FLATPACK NO–LEAD

Example Board Layout



Example Stencil Design
(Note E)



4208106–2/E 01/12

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.
E. Maximum stencil thickness 0,127 mm (5 mils). All linear dimensions are in millimeters.
F. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
G. Side aperture dimensions over–print land for acceptable area ratio > 0.66. Customer may reduce side aperture dimensions if stencil manufacturing process allows for sufficient release at smaller opening.

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