



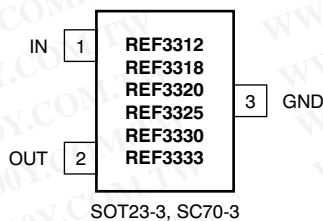
3.9µA, SC70-3, 30ppm/°C Drift VOLTAGE REFERENCE

FEATURES

- **MICROSIZE PACKAGES:** SC70-3, SOT23-3
- **LOW SUPPLY CURRENT:** 3.9µA (typ)
- **HIGH OUTPUT CURRENT:** ±5mA
- **LOW TEMPERATURE DRIFT:** 30ppm/°C (max)
- **HIGH INITIAL ACCURACY:** ±0.15% (max)

APPLICATIONS

- **PORTABLE EQUIPMENT**
- **DATA ACQUISITION SYSTEMS**
- **MEDICAL EQUIPMENT**
- **TEST EQUIPMENT**



SOT23-3, SC70-3

DESCRIPTION

The REF33xx is a low-power, precision, low-dropout voltage reference family available in the tiny SC70-3 and SOT23-3 packages. Small size and low power consumption (5µA max) make the REF33xx ideal for a wide variety of portable and battery-powered applications.

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

REF33xx PRODUCT FAMILY

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



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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.

ORDERING INFORMATION⁽¹⁾

| PRODUCT | DESCRIPTION | PACKAGE | PACKAGE DESIGNATOR | PACKAGE MARKING |
|---------|-------------|---------|--------------------|-----------------|
| REF3312 | 1.25V | SOT23-3 | DBZ | R33A |
| | | SC70-3 | DCK | R12 |
| REF3318 | 1.8V | SOT23-3 | DBZ | R33B |
| | | SC70-3 | DCK | R18 |
| REF3320 | 2.048V | SOT23-3 | DBZ | R33C |
| | | SC70-3 | DCK | R20 |
| REF3325 | 2.5V | SOT23-3 | DBZ | R33D |
| | | SC70-3 | DCK | R25 |
| REF3330 | 3.0V | SOT23-3 | DBZ | R33E |
| | | SC70-3 | DCK | R30 |
| REF3333 | 3.3V | SOT23-3 | DBZ | R33F |
| | | SC70-3 | DCK | R33 |

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

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

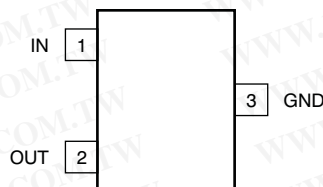
| | VALUE | UNIT |
|---|----------------------------|------|
| Input Voltage (V_{IN}) | +7.5 | V |
| Output Short-Circuit (I_{SC}) | 180 | mA |
| Output Voltage (OUT pin) ⁽²⁾ | 5 | V |
| Operating Temperature | -50 to +150 | °C |
| Storage Temperature | -65 to +150 | °C |
| Junction Temperature (T_J) | +150 | °C |
| ESD Ratings | Human Body Model (HBM) | 4000 |
| | Charged Device Model (CDM) | 1000 |
| | Machine Model (MM) | 200 |

(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.

(2) See the [Applications Information](#) section, [Supply Voltage](#).

PIN CONFIGURATION

REF3312, REF3318, REF3320, REF3325, REF3330, REF3333
 SOT23-3, SC70-3
 TOP VIEW



ELECTRICAL CHARACTERISTICS: $V_{IN} = +5V$
Boldface limits apply over the specified temperature range, $-40^{\circ}C$ to $+125^{\circ}C$.

 At $T_A = +25^{\circ}C$ and $I_{LOAD} = 0mA$, unless otherwise noted.

| PARAMETER | CONDITIONS | REF33xx | | | UNITS |
|-------------------------|-------------------------|--------------|-------|--------------|--------------|
| | | MIN | TYP | MAX | |
| REF3312 (1.25V) | | | | | |
| OUTPUT VOLTAGE | | | | | |
| Initial Accuracy | V_{OUT} $V_{IN} = 5V$ | -0.15 | 1.25 | +0.15 | V % |
| NOISE | | | | | |
| Output Voltage Noise | $f = 0.1Hz$ to $10Hz$ | | 35 | | μV_{PP} |
| REF3318 (1.8V) | | | | | |
| OUTPUT VOLTAGE | | | | | |
| Initial Accuracy | V_{OUT} $V_{IN} = 5V$ | -0.15 | 1.8 | +0.15 | V % |
| NOISE | | | | | |
| Output Voltage Noise | $f = 0.1Hz$ to $10Hz$ | | 50 | | μV_{PP} |
| REF3320 (2.048V) | | | | | |
| OUTPUT VOLTAGE | | | | | |
| Initial Accuracy | V_{OUT} $V_{IN} = 5V$ | -0.15 | 2.048 | +0.15 | V % |
| NOISE | | | | | |
| Output Voltage Noise | $f = 0.1Hz$ to $10Hz$ | | 55 | | μV_{PP} |
| REF3325 (2.5V) | | | | | |
| OUTPUT VOLTAGE | | | | | |
| Initial Accuracy | V_{OUT} $V_{IN} = 5V$ | -0.15 | 2.5 | +0.15 | V % |
| NOISE | | | | | |
| Output Voltage Noise | $f = 0.1Hz$ to $10Hz$ | | 70 | | μV_{PP} |
| REF3330 (3.0V) | | | | | |
| OUTPUT VOLTAGE | | | | | |
| Initial Accuracy | V_{OUT} $V_{IN} = 5V$ | -0.15 | 3.0 | +0.15 | V % |
| NOISE | | | | | |
| Output Voltage Noise | $f = 0.1Hz$ to $10Hz$ | | 84 | | μV_{PP} |
| REF3333 (3.3V) | | | | | |
| OUTPUT VOLTAGE | | | | | |
| Initial Accuracy | V_{OUT} $V_{IN} = 5V$ | -0.15 | 3.3 | +0.15 | V % |
| NOISE | | | | | |
| Output Voltage Noise | $f = 0.1Hz$ to $10Hz$ | | 92 | | μV_{PP} |

ELECTRICAL CHARACTERISTICS: $V_{IN} = +5V$ (continued)

Boldface limits apply over the specified temperature range, $-40^{\circ}C$ to $+125^{\circ}C$.
At $T_A = +25^{\circ}C$ and $I_{LOAD} = 0mA$, unless otherwise noted.

| PARAMETER | CONDITIONS | REF33xx | | | UNITS |
|---|--------------------------|--|-----------------------|------------|-----------------------------------|
| | | MIN | TYP | MAX | |
| REF33xx (REF3312, REF3318, REF3320, REF3325, REF3330, REF3333) | | | | | |
| OUTPUT VOLTAGE TEMPERATURE DRIFT | | | | | |
| | dV_{OUT}/dT | $-40^{\circ}C$ to $+85^{\circ}C$ | 9 | 30 | ppm/ $^{\circ}C$ |
| | | $-40^{\circ}C$ to $+125^{\circ}C$ | 8 | 30 | ppm/$^{\circ}C$ |
| LINE REGULATION | | | | | |
| | dV_{OUT}/dV_{IN} | $V_{IN} = V_{OUT} + 200mV$ to $5.5V^{(1)}$ | -50 | 6 | ppm/V |
| | | $0^{\circ}C$ to $+70^{\circ}C$ | 6 | 6 | ppm/V |
| Over Temperature | | $-40^{\circ}C$ to $+85^{\circ}C$ | 8 | 8 | ppm/V |
| | | $-40^{\circ}C$ to $+125^{\circ}C$ | 30 | 30 | ppm/V |
| LOAD REGULATION | | | | | |
| | dV_{OUT}/dI_{LOAD} | $V_{IN} = V_{OUT} + 200mV^{(1)}$ | -50 | 6 | ppm/mA |
| | | $I_{LOAD} = \pm 5mA$, $0^{\circ}C$ to $+70^{\circ}C$ | 10 | 10 | ppm/mA |
| Over Temperature | | $-40^{\circ}C$ to $+85^{\circ}C$ | 20 | 20 | ppm/mA |
| | | $-40^{\circ}C$ to $+125^{\circ}C$ | 20 | 20 | ppm/mA |
| THERMAL HYSTERESIS | $dT^{(2)}$ | | | 90 | ppm |
| MINIMUM DROPOUT VOLTAGE | $V_{IN} - V_{OUT}^{(1)}$ | | | 110 | mV |
| Over Temperature | | $I_{LOAD} = \pm 5mA$ | 120 | 120 | mV |
| | | $0^{\circ}C$ to $+70^{\circ}C$ | 135 | 135 | mV |
| | | $-40^{\circ}C$ to $+85^{\circ}C$ | 180 | 180 | mV |
| | | $-40^{\circ}C$ to $+125^{\circ}C$ | | | |
| | | $I_{LOAD} = \pm 2mA$, $-40^{\circ}C$ to $+85^{\circ}C$ | | 70 | mV |
| SHORT-CIRCUIT CURRENT | | | | | |
| Sourcing/Sinking | I_{SC} | | | 35 | mA |
| CAPACITIVE LOAD | | | 0.1 | 10 | μF |
| TURN-ON SETTLING TIME | | To 0.1% with $C_L = 1\mu F$ | | 2 | ms |
| POWER SUPPLY | | | | | |
| Specified Voltage Range | V_S | | $V_{OUT} + 0.2^{(1)}$ | 5.5 | V |
| Operating Voltage Range | | $I_{LOAD} = 0mA$ | $V_{OUT} + 0.005$ | 5.5 | V |
| Current | I_Q | $V_{IN} = 5V$ | 3.9 | 5 | μA |
| Over Temperature | | $-40^{\circ}C$ to $+85^{\circ}C$ | 4.4 | 6.5 | μA |
| | | $-40^{\circ}C$ to $+125^{\circ}C$ | 4.8 | 8.5 | μA |
| TEMPERATURE RANGE | | | | | |
| Specified Range | T_A | | -40 | +125 | $^{\circ}C$ |
| Operating Range | T_A | | -50 | +150 | $^{\circ}C$ |
| Thermal Resistance | θ_{JA} | | | | |
| SC70-3 | | | | 300 | $^{\circ}C/W$ |
| SOT23-3 | | | | 300 | $^{\circ}C/W$ |

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

(2) The thermal hysteresis procedure is explained in more detail in the [Applications Information](#) section.

TYPICAL CHARACTERISTICS

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

**TEMPERATURE DRIFT
(0°C to $+70^\circ\text{C}$)**

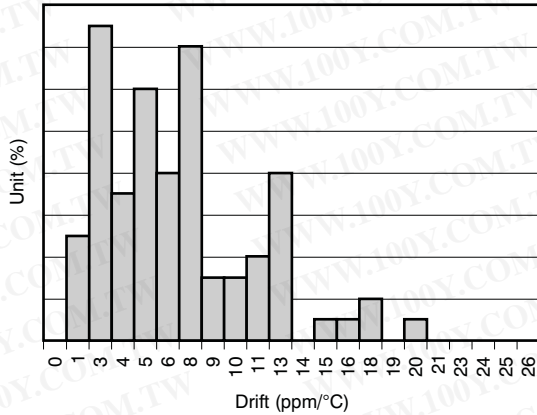


Figure 1.

**TEMPERATURE DRIFT
(-40°C to $+125^\circ\text{C}$)**

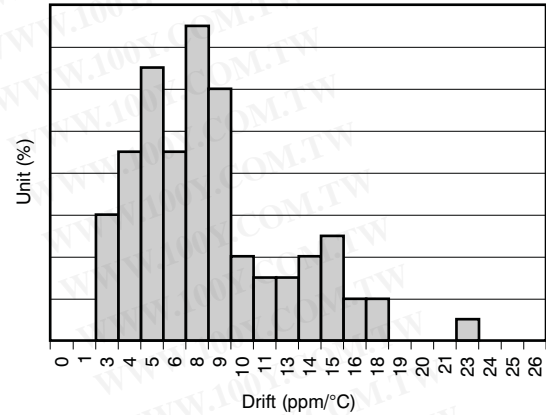


Figure 2.

**OUTPUT VOLTAGE ACCURACY
vs TEMPERATURE**

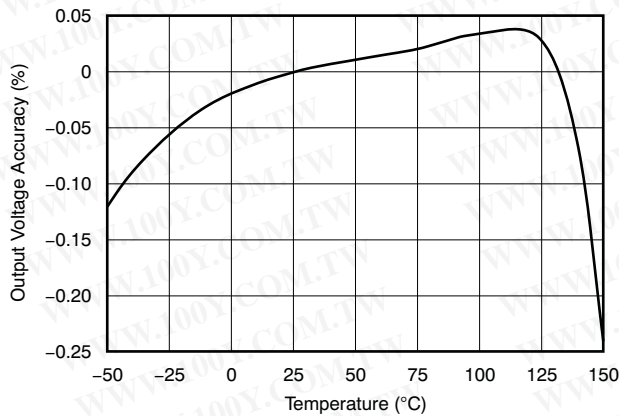


Figure 3.

**DROPOUT VOLTAGE
vs LOAD CURRENT**

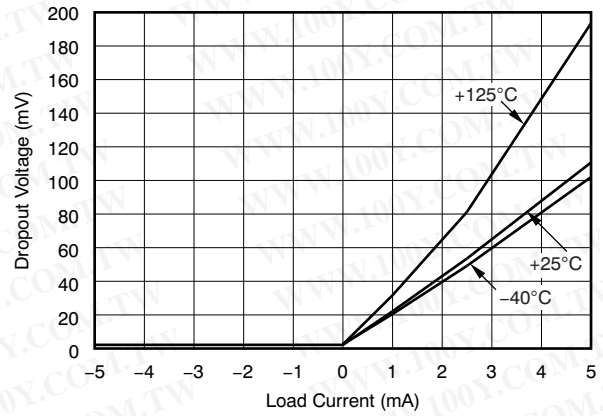


Figure 4.

QUIESCENT CURRENT vs TEMPERATURE

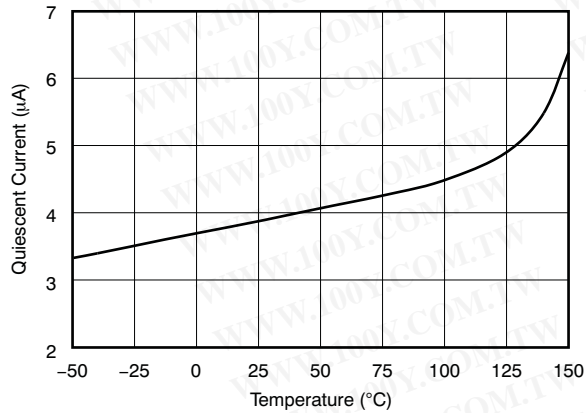


Figure 5.

OUTPUT IMPEDANCE vs FREQUENCY

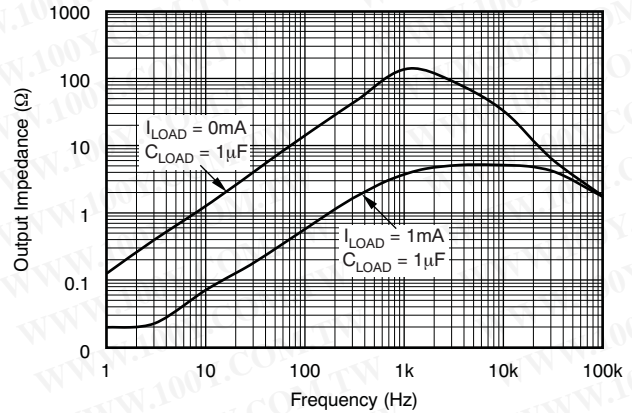


Figure 6.

TYPICAL CHARACTERISTICS (continued)

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

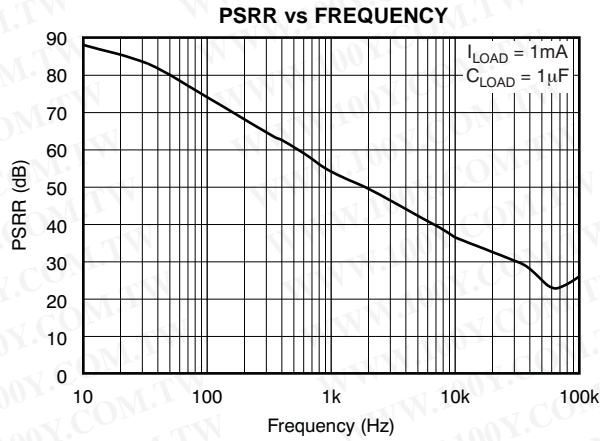


Figure 7.

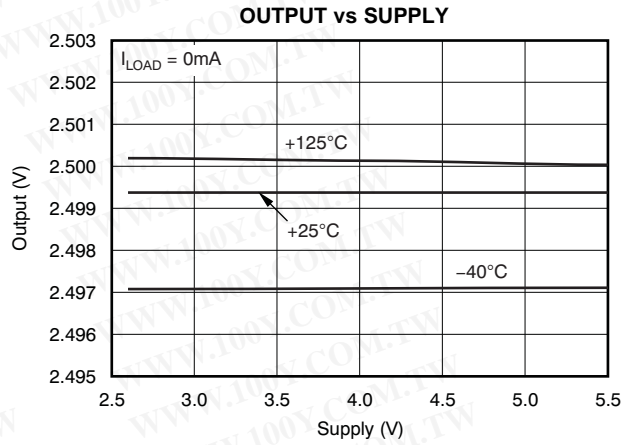


Figure 8.

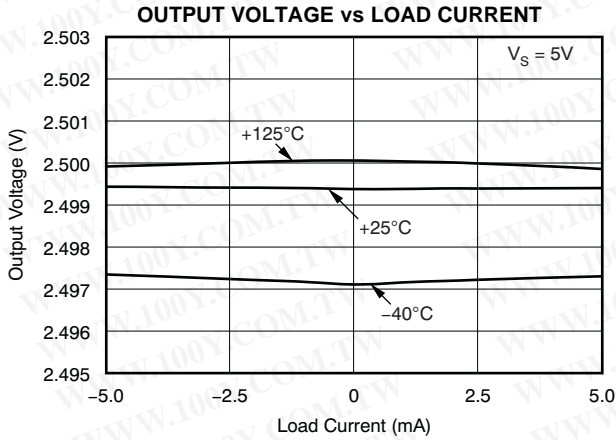


Figure 9.

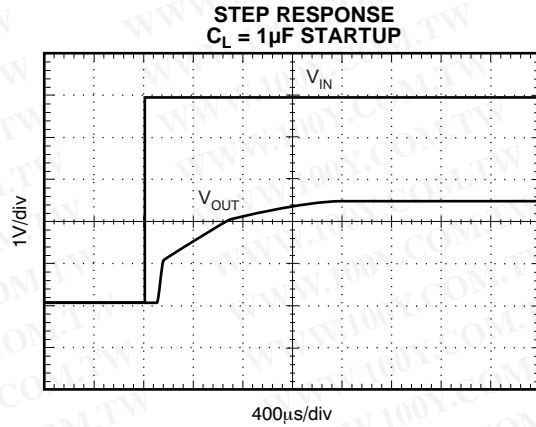


Figure 10.

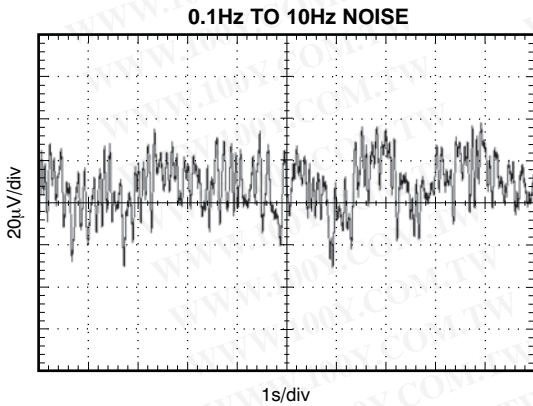


Figure 11.

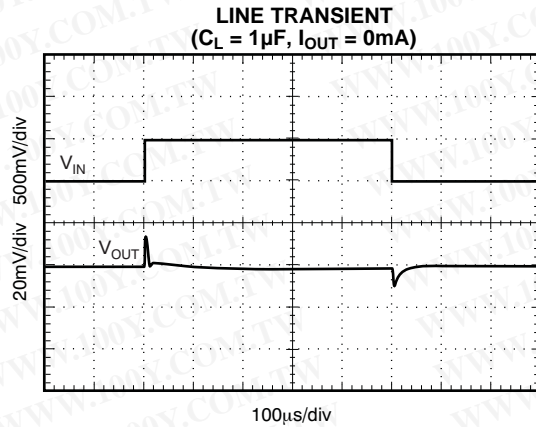
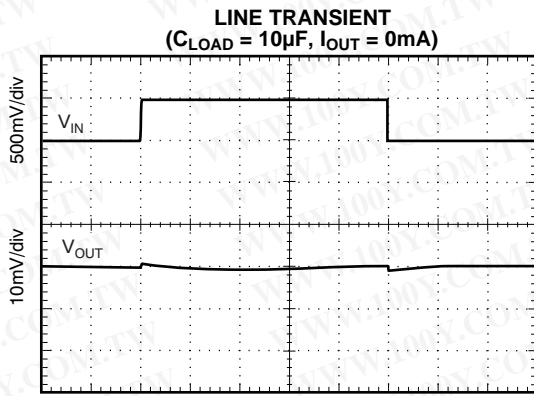


Figure 12.

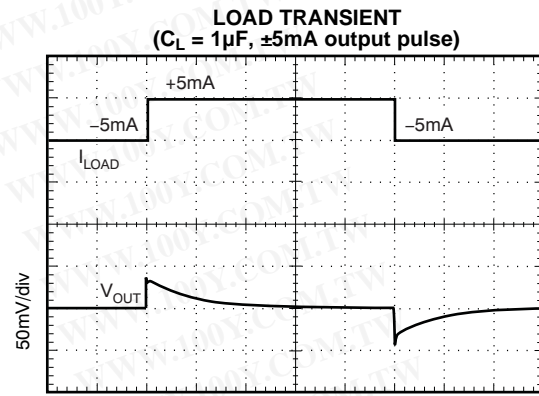
TYPICAL CHARACTERISTICS (continued)

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



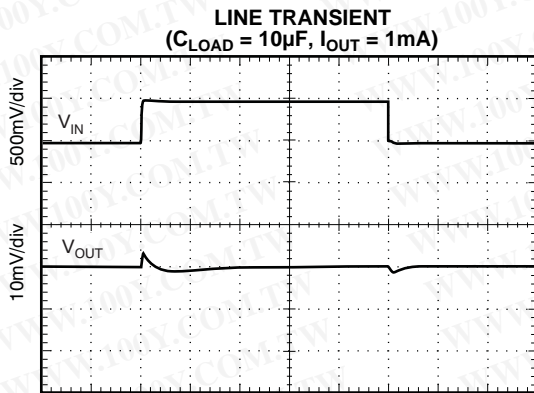
Time (400µs/div)

Figure 13.



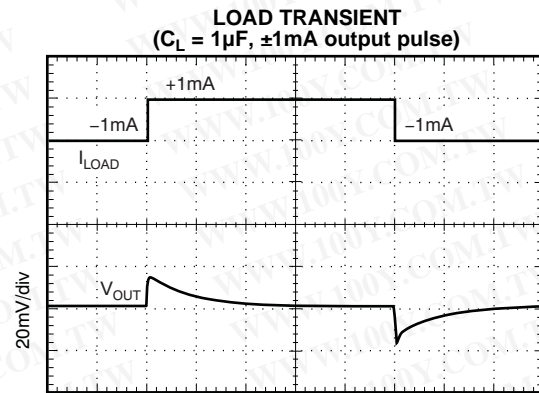
200µs/div

Figure 14.



Time (200µs/div)

Figure 15.



200µs/div

Figure 16.

APPLICATIONS INFORMATION

The REF33xx is a family of low-power, precision bandgap voltage references that are specifically designed for excellent initial voltage accuracy with a high output current. Figure 17 shows a simplified block diagram of the REF33xx.

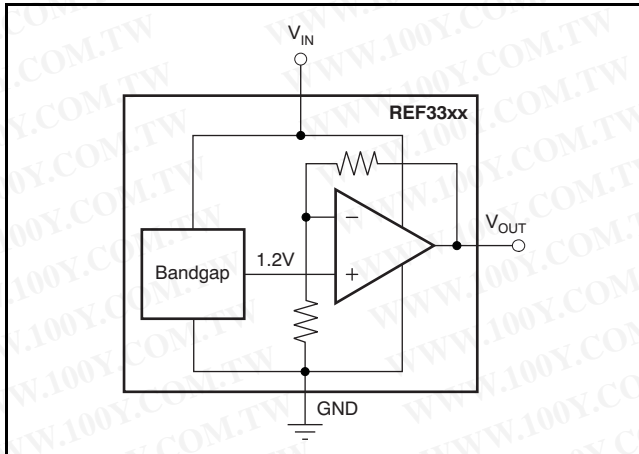


Figure 17. REF33xx Simplified Block Diagram

BASIC CONNECTIONS

Figure 18 shows the typical connections for the REF33xx. A recommended supply bypass capacitor ranging between 1µF to 10µF is recommended. The total capacitive load at the output must be between 0.1µF to 10µF to ensure output stability.

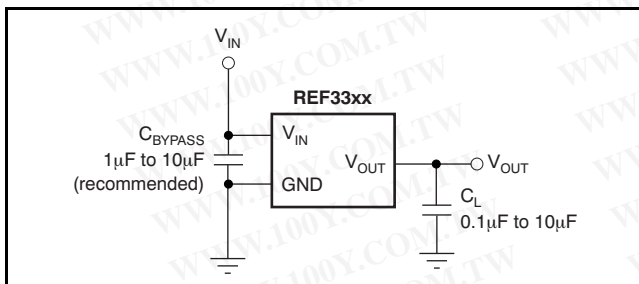


Figure 18. Basic Connections

SUPPLY VOLTAGE

The REF33xx family of voltage references features extremely low dropout voltage, except for the REF3312. The REF3312 has a minimum supply requirement of 1.8V. These references can be operated with a supply 110mV above the output voltage with a 5mA 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 pin is rapidly moved while the REF33xx is connected to a capacitive load, a reverse voltage may discharge through the OUT pin and into the REF33xx device. This voltage will not damage the REF33xx, provided that it is less than or equal to 5V.

START-UP TIME

The REF33xx features an advanced start-up circuit. Start-up time is almost independent of load (with a 0.1µF to 10µF load). Upon start-up, 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 19 shows the start-up time of the REF3325 for three different capacitive loads. In all three cases, the output voltage settles within 2ms.

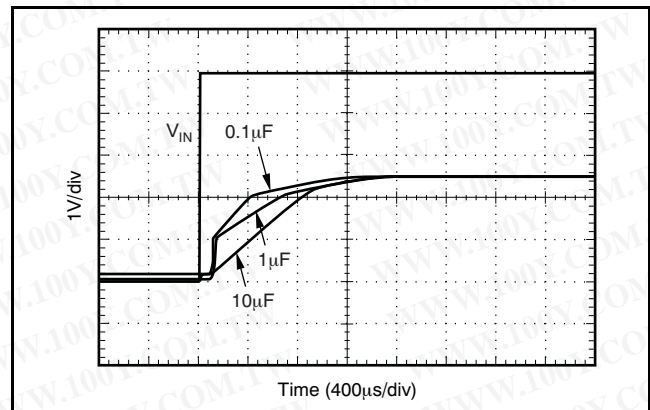


Figure 19. Start-Up Time

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:

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

POWER DISSIPATION

The REF33xx family is specified to deliver current loads of $\pm 5\text{mA}$ over the specified input voltage range. The temperature of the device increases according to Equation 2:

$$T_J = T_A + P_D \times \theta_{JA} \quad (2)$$

Where:

T_J = Junction temperature ($^{\circ}\text{C}$)

T_A = Ambient temperature ($^{\circ}\text{C}$)

P_D = Power dissipation (W)

Where $P_D = V_{IN} \times I_{Q} + (V_{IN} - V_{OUT}) I_{OUT}$

θ_{JA} = Junction-to-ambient thermal resistance ($^{\circ}\text{C}/\text{W}$)

The REF33xx junction temperature must not exceed the absolute maximum rating of $+150^{\circ}\text{C}$.

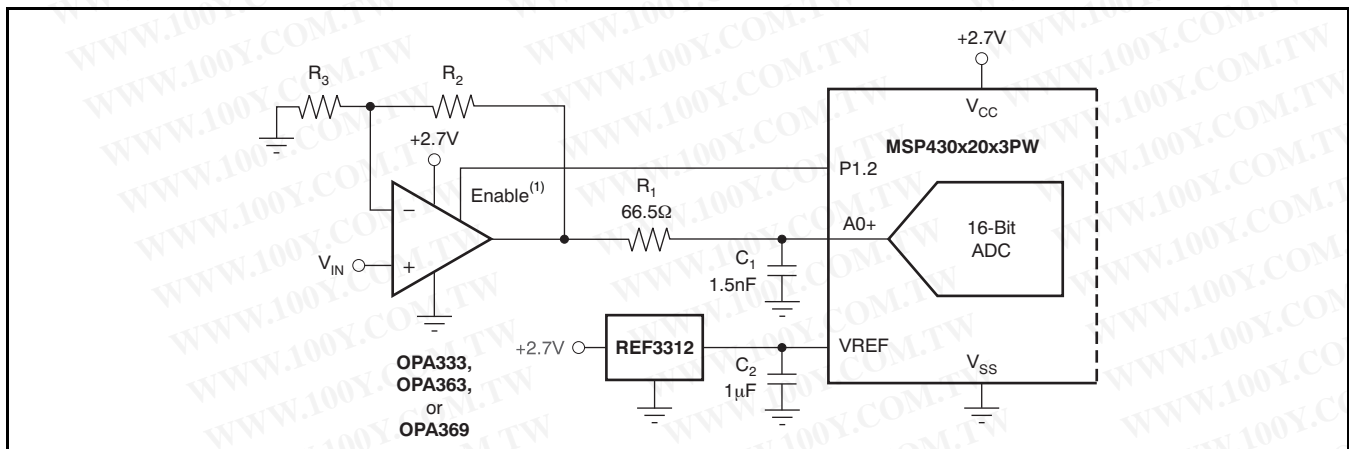
NOISE PERFORMANCE

Typical 0.1Hz to 10Hz 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. Additional filtering can be used to improve output noise levels. Special attention should be taken to ensure that the output impedance does not degrade output voltage accuracy.

APPLICATION CIRCUITS

Figure 20 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 20 presents an example of a unipolar signal chain.

An example of a bipolar configuration is illustrated in Figure 21. The analog input signal ($\pm 2.5\text{V}$) 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 0.62V , creating a digital code that corresponds to the analog input voltage. In this configuration, two reference voltages are used. The REF3312 creates a 1.25V 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 3V . In this way, the high PSRR of the REF3330 helps to filter unwanted noise from the 3.3V digital supply.



(1) Enable is a function of the OPA363 not available on the OPA333.

Figure 20. Unipolar Signal Chain Configuration

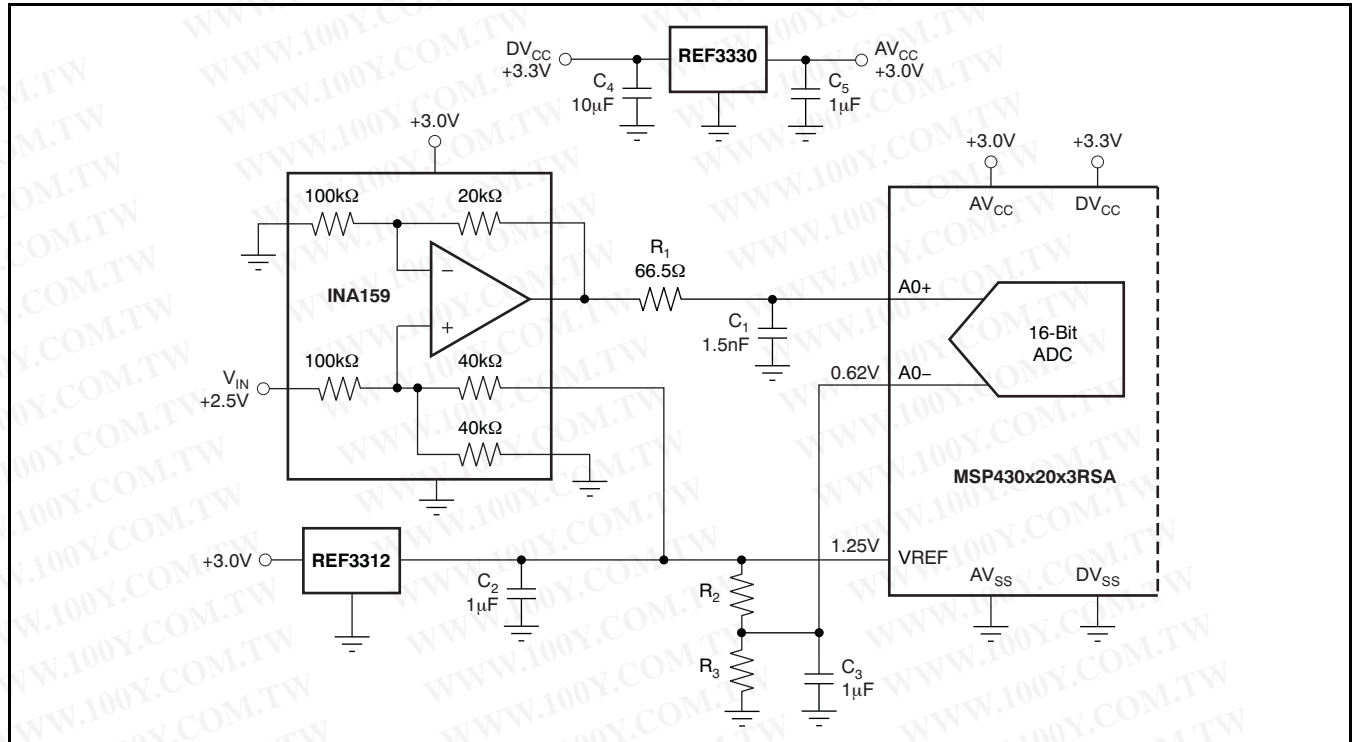


Figure 21. Bipolar Signal Chain Configuration

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/ Ball Finish | MSL Peak Temp ⁽³⁾ | Samples (Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|-----------------------------|
| REF3312AIDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3312AIDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3312AIDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3312AIDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3312AIDCKR | ACTIVE | SC70 | DCK | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3312AIDCKRG4 | ACTIVE | SC70 | DCK | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3312AIDCKT | ACTIVE | SC70 | DCK | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3312AIDCKTG4 | ACTIVE | SC70 | DCK | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3318AIDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3318AIDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3318AIDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3318AIDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3318AIDCKR | ACTIVE | SC70 | DCK | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3318AIDCKRG4 | ACTIVE | SC70 | DCK | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3318AIDCKT | ACTIVE | SC70 | DCK | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3318AIDCKTG4 | ACTIVE | SC70 | DCK | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3320AIDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/ Ball Finish | MSL Peak Temp ⁽³⁾ | Samples (Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|----------------------|------------------------------|-----------------------------|
| REF3320AIDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3320AIDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3320AIDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3320AIDCKR | ACTIVE | SC70 | DCK | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3320AIDCKRG4 | ACTIVE | SC70 | DCK | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3320AIDCKT | ACTIVE | SC70 | DCK | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3320AIDCKTG4 | ACTIVE | SC70 | DCK | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3325AIDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3325AIDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3325AIDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3325AIDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3325AIDCKR | ACTIVE | SC70 | DCK | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3325AIDCKRG4 | ACTIVE | SC70 | DCK | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3325AIDCKT | ACTIVE | SC70 | DCK | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3325AIDCKTG4 | ACTIVE | SC70 | DCK | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3330AIDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3330AIDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3330AIDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/ Ball Finish | MSL Peak Temp ⁽³⁾ | Samples (Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|----------------------|------------------------------|-----------------------------|
| REF3330AIDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3330AIDCKR | ACTIVE | SC70 | DCK | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3330AIDCKRG4 | ACTIVE | SC70 | DCK | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3330AIDCKT | ACTIVE | SC70 | DCK | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3330AIDCKTG4 | ACTIVE | SC70 | DCK | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3333AIDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3333AIDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3333AIDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3333AIDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3333AIDCKR | ACTIVE | SC70 | DCK | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3333AIDCKRG4 | ACTIVE | SC70 | DCK | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3333AIDCKT | ACTIVE | SC70 | DCK | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| REF3333AIDCKTG4 | ACTIVE | SC70 | DCK | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |

⁽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.

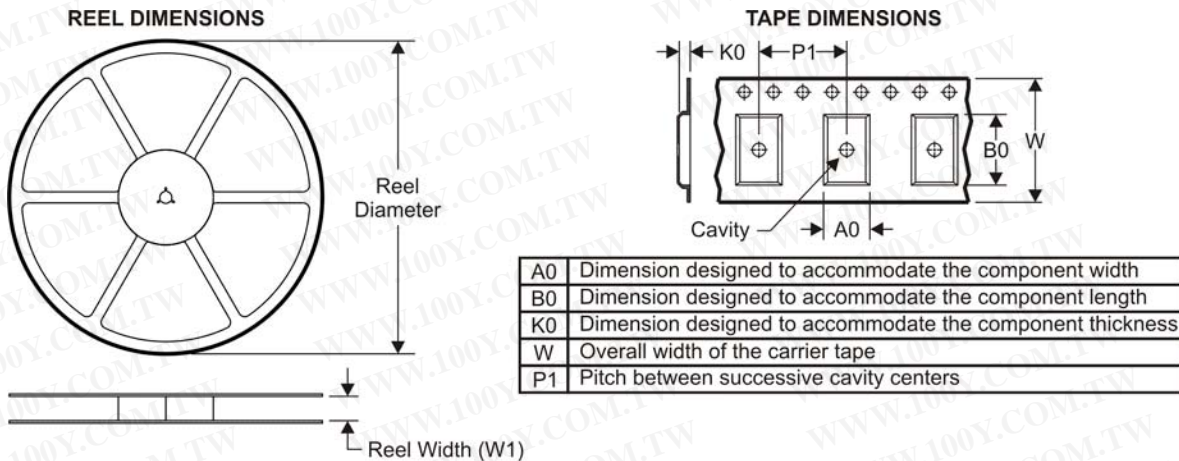
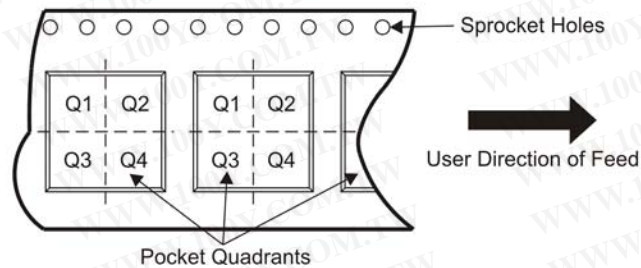
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

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.

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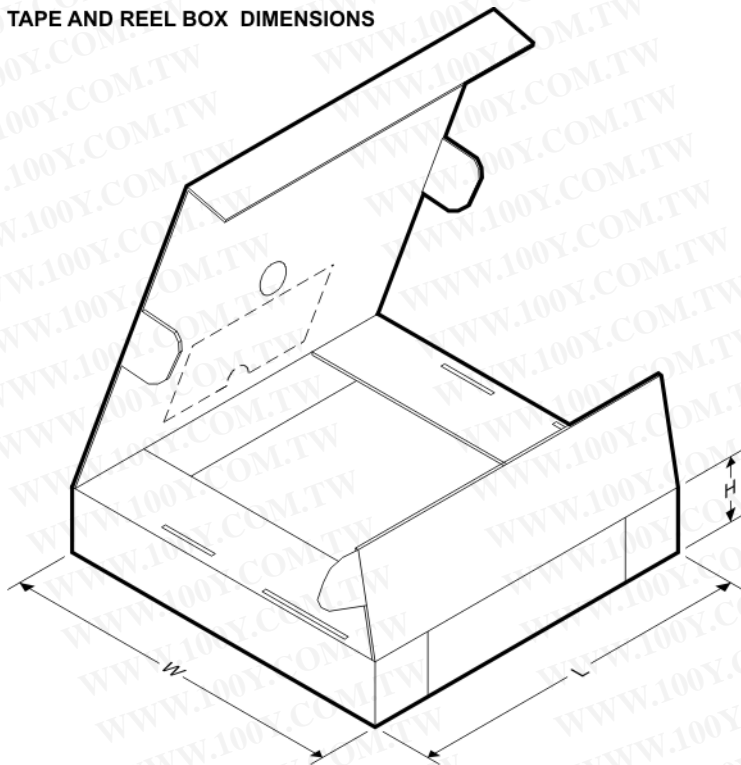
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TAPE AND REEL INFORMATION

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 |
| 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


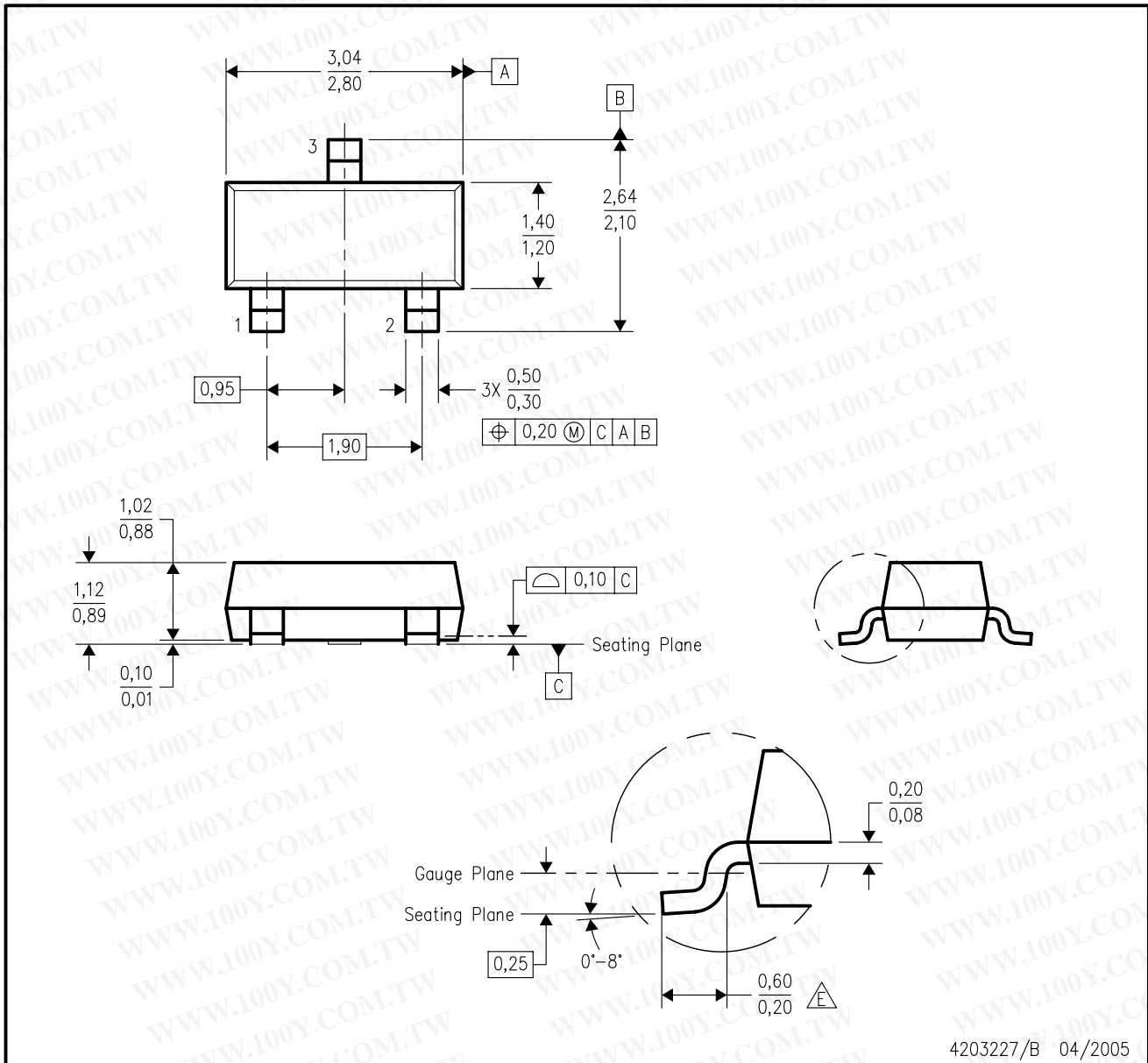
*All dimensions are nominal


| 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 |
| REF3320AIDCKR | SC70 | DCK | 3 | 3000 | 195.0 | 200.0 | 45.0 |

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| 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 |
| 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)

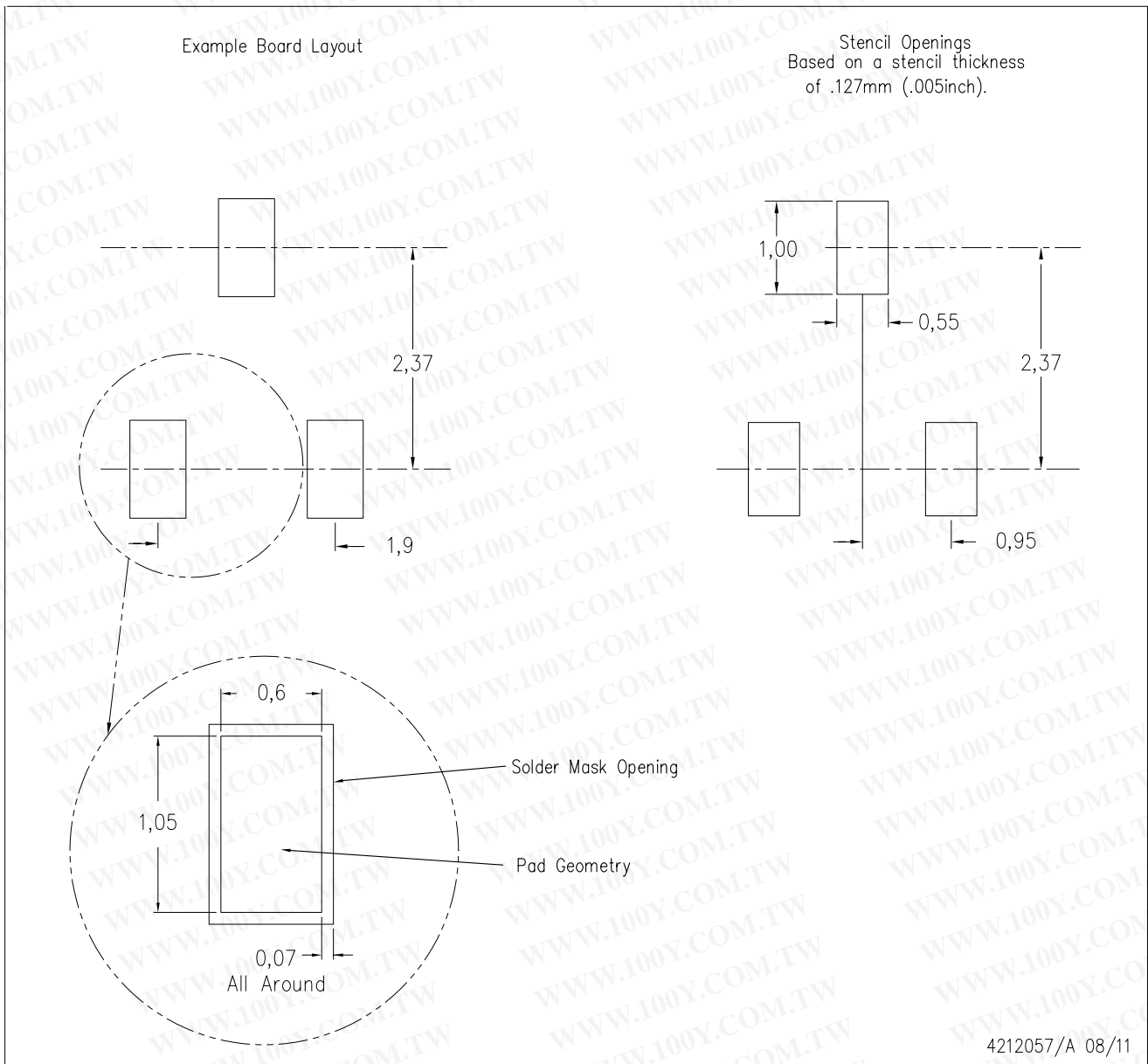
PLASTIC SMALL-OUTLINE



- 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.
-  Falls within JEDEC TO-236 variation AB, except minimum foot length.

DBZ (R-PDSO-G3)

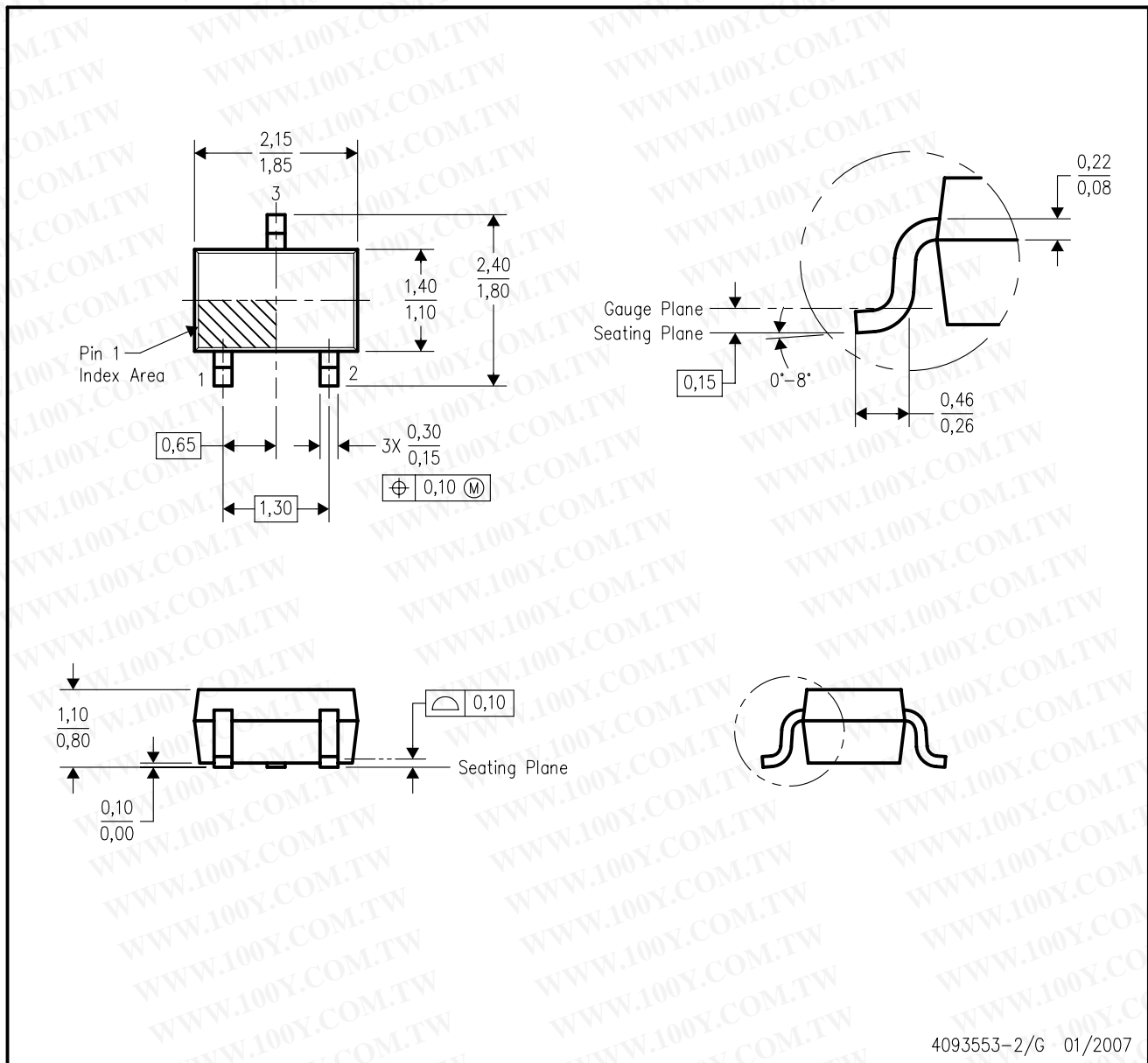
PLASTIC SMALL OUTLINE



- 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



- 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.

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