

1. 特性

- Compliant with AEC-Q100
 - Temperature Grade 1: -40°C to 125°C operating ambient temperature
- 微型封装: SOT23-3
- 低电源电流: 60μA (典型值)
- 极低压差: 2mV (典型值)
- 高输出电流: ±25mA
- 低温漂移: 25ppm/°C (最大值)
- 高初始精度: ±0.15% (最大值)
- 0.1Hz 至 10Hz 噪声: 20μV_{PP} (REF318Q)
- 电压选项: 1.8V、2.048V、2.5V、3V、3.3V、4.096V、4.5V、5V

2. 应用

- 便携式设备
- 平板电脑和智能手机
- 硬盘驱动器
- 传感器模块
- 数据采集系统
- 医用器材
- 测验设备

3. 说明

REF3xxQ 是一种低功耗、精密、低压降电压基准系列，采用 SOT23-3 封装。小尺寸和低功耗使 REF3xxQ 成为各种便携式和电池供电应用的理想选择。

在正常负载条件下，REF3xxQ 可以在比指定输出电压高 2mV 的电源电压下运行。所有型号均指定用于 -40°C 至 125°C 的宽温度范围。有关订购信息，请参见 Table 1。

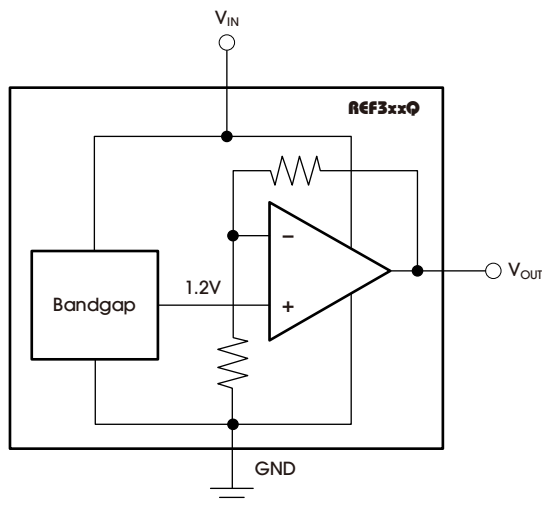


Table 1 lists the order information.

Table 1. Order Information

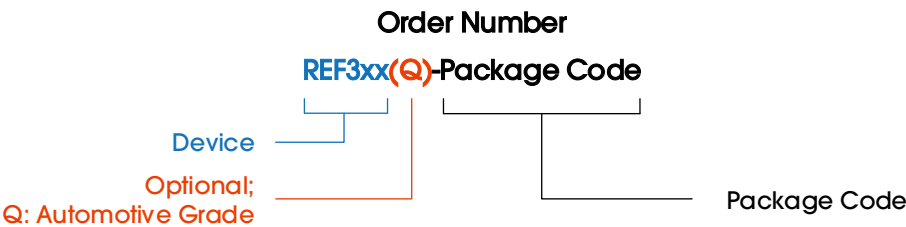
ORDER NUMBER ⁽¹⁾	MARK	OUPUT (V)	I _{CC} (μA)	TEMP DRIFT -40°C-125°C (MAX) (ppm/°C)	PACKAGE	OP. TEMP. (°C)	RATING	MSL	PKG. OPTION
REF318QSOT233	318QXXX ⁽²⁾	1.8	60	25	SOT23-3	-40-125	Auto	1	T/R-3000
REF320QSOT233	320QXXX ⁽²⁾	2.048	60	25	SOT23-3	-40-125	Auto	1	T/R-3000
REF325QSOT233	325QXXX ⁽²⁾	2.5	60	25	SOT23-3	-40-125	Auto	1	T/R-3000
REF330QSOT233	330QXXX ⁽²⁾	3	60	25	SOT23-3	-40-125	Auto	1	T/R-3000
REF333QSOT233	333QXXX ⁽²⁾	3.3	60	25	SOT23-3	-40-125	Auto	1	T/R-3000
REF340QSOT233	340QXXX ⁽²⁾	4.096	60	25	SOT23-3	-40-125	Auto	1	T/R-3000
REF345QSOT233	345QXXX ⁽²⁾	4.5	60	25	SOT23-3	-40-125	Auto	1	T/R-3000
REF350QSOT233	350QXXX ⁽²⁾	5	60	25	SOT23-3	-40-125	Auto	1	T/R-3000

Table 2. Family Selection Guide

ORDER NUMBER ⁽¹⁾	MARK	OUPUT (V)	I _{CC} (μA)	TEMP DRIFT -40°C-125°C (MAX) (ppm/°C)	PACKAGE	OP. TEMP. (°C)	RATING	MSL	PKG. OPTION
REF318SOT233	318XXXX ⁽²⁾	1.8	60	20	SOT23-3	-40-125	Industrial	1	T/R-3000
REF320SOT233	320XXXX ⁽²⁾	2.048	60	20	SOT23-3	-40-125	Industrial	1	T/R-3000
REF325SOT233	325XXXX ⁽²⁾	2.5	60	20	SOT23-3	-40-125	Industrial	1	T/R-3000
REF330SOT233	330XXXX ⁽²⁾	3	60	20	SOT23-3	-40-125	Industrial	1	T/R-3000
REF333SOT233	333XXXX ⁽²⁾	3.3	60	20	SOT23-3	-40-125	Industrial	1	T/R-3000
REF340SOT233	340XXXX ⁽²⁾	4.096	60	20	SOT23-3	-40-125	Industrial	1	T/R-3000
REF345SOT233	345XXXX ⁽²⁾	4.5	60	20	SOT23-3	-40-125	Industrial	1	T/R-3000
REF350SOT233	350XXXX ⁽²⁾	5	60	20	SOT23-3	-40-125	Industrial	1	T/R-3000

- Devices can be ordered via the following two ways:
- Place orders directly on our website (www.analogyssemi.com), or;
 - Contact our sales team by mailing to sales@analogyssemi.com.

Note 1:



Note 2: "XXXX": For internal use.

4. PIN CONFIGURATION AND FUNCTIONS

Figure 1 illustrates the pin configuration.

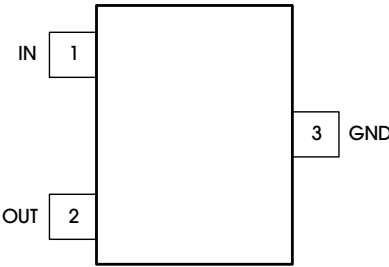


Figure 1. Pin Configuration

Table 3 lists the pin functions.

Table 3. Pin Functions

POSITION	NAME	TYPE	DESCRIPTION
1	IN	Power	Input supply voltage
2	OUT	Analog output	Output voltage
3	GND	Ground	Ground

5. SPECIFICATIONS

5.1 ABSOLUTE MAXIMUM RATINGS

Table 4 lists the absolute maximum ratings of the REF3xxQ.

Table 4. Absolute Maximum Ratings

PARAMETER	DESCRIPTION	MIN	MAX	UNITS
Voltage	Input		6.5	V
	Output		5	V
Current	Output short-circuit, $I_{SC}^{(2)}$	Continuous		
Temperature	Operating, T_A	-55	150	°C
	Junction, T_J		150	°C
	Storage, T_{stg}	-65	150	°C

Note 1: Stresses beyond those listed under Table 4 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 Table 6. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Note 2: Junction temperature is limited to 150°C.

5.2 ESD RATINGS

Table 5 lists the ESD ratings of the REF3xxQ.

Table 5. ESD Ratings

PARAMETER	SYMBOL	DESCRIPTION	VALUE	UNITS
Electrostatic Discharge	$V_{(ESD)}$	Human-body model (HBM), per AEC Q100-002 ⁽¹⁾	±8000	V
		Charged-device model (CDM), per AEC Q100-011	±2000	

Note: AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

5.3 RECOMMENDED OPERATING CONDITIONS

Table 6 lists the recommended operating conditions for the REF3xxQ.

Table 6. Recommended Operating Conditions

PARAMETER	SYMBOL	MIN	NOM	MAX	UNITS
Supply Input Voltage ⁽¹⁾	V _{IN}	V _{OUT} + 0.02		5.5	V
Output Current Range	I _{OUT}	–25		25	mA
Operating Temperature	T _A	–55		135	°C

5.4 THERMAL INFORMATION

Table 7 lists the thermal information for the REF3xxQ.

Table 7. Thermal Information

PARAMETER	SYMBOL	SOT23-3	UNITS
Junction-to-Ambient Thermal Resistance	R _{θJA}	176.7	°C/W
Junction-to-Board Thermal Resistance	R _{θJB}	22.9	°C/W
Junction-to-Top Characterization Parameter	ψ _{JT}	4.2	°C/W
Junction-to-Board Characterization Parameter	ψ _{JB}	26.7	°C/W
Junction-to-Case (Top) Thermal Resistance	R _{θJC (top)}	84.9	°C/W

5.5 ELECTRICAL CHARACTERISTICS

Table 8 lists the electrical characteristics of the REF3xxQ. $T_A = 25^\circ\text{C}$, $V_{IN} = 5\text{V}$, $I_{LOAD} = 0\text{mA}$, unless otherwise noted.

Table 8. Electrical Characteristics

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
REF318Q						
Output Voltage	V_{OUT}			1.8		V
Initial Accuracy			-0.15	0.05	0.15	%
Output Voltage Noise		$f = 0.1\text{Hz to } 10\text{Hz}$		20		μV_{PP}
Voltage Noise		$f = 10\text{Hz to } 10\text{kHz}$		35		μV_{RMS}
Noise Density		1kHz		439		$\text{nV}/\sqrt{\text{Hz}}$
Line Regulation		$V_{OUT} + 0.05\text{V} \leq V_{IN} \leq 5.5\text{V}$		± 50	± 180	$\mu\text{V}/\text{V}$
		$-40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$, $V_{OUT} + 0.05\text{V} \leq V_{IN} \leq 5.5\text{V}$			± 230	$\mu\text{V}/\text{V}$
REF320Q						
Output Voltage	V_{OUT}			2.048		V
Initial Accuracy			-0.15	0.05	0.15	%
Output Voltage Noise		$f = 0.1\text{Hz to } 10\text{Hz}$		22		μV_{PP}
Voltage Noise		$f = 10\text{Hz to } 10\text{kHz}$		35		μV_{RMS}
Noise Density		1kHz		460		$\text{nV}/\sqrt{\text{Hz}}$
Line Regulation		$V_{OUT} + 0.05\text{V} \leq V_{IN} \leq 5.5\text{V}$		± 25	± 180	$\mu\text{V}/\text{V}$
		$-40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$, $V_{OUT} + 0.05\text{V} \leq V_{IN} \leq 5.5\text{V}$			± 230	$\mu\text{V}/\text{V}$
REF325Q						
Output Voltage	V_{OUT}			2.5		V
Initial Accuracy			-0.15	0.05	0.15	%
Output Voltage Noise		$f = 0.1\text{Hz to } 10\text{Hz}$		28		μV_{PP}
Voltage Noise		$f = 10\text{Hz to } 10\text{kHz}$		36		μV_{RMS}
Noise Density		1kHz		515		$\text{nV}/\sqrt{\text{Hz}}$
Line Regulation		$V_{OUT} + 0.05\text{V} \leq V_{IN} \leq 5.5\text{V}$		± 45	± 140	$\mu\text{V}/\text{V}$
		$-40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$, $V_{OUT} + 0.05\text{V} \leq V_{IN} \leq 5.5\text{V}$			± 190	$\mu\text{V}/\text{V}$
REF330Q						
Output Voltage	V_{OUT}			3		V
Initial Accuracy			-0.15	0.05	0.15	%
Output Voltage Noise		$f = 0.1\text{Hz to } 10\text{Hz}$		34		μV_{PP}
Voltage Noise		$f = 10\text{Hz to } 10\text{kHz}$		40		μV_{RMS}
Noise Density		1kHz		588		$\text{nV}/\sqrt{\text{Hz}}$
Line Regulation		$V_{OUT} + 0.05\text{V} \leq V_{IN} \leq 5.5\text{V}$		± 60	± 190	$\mu\text{V}/\text{V}$
		$-40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$, $V_{OUT} + 0.05\text{V} \leq V_{IN} \leq 5.5\text{V}$			± 270	$\mu\text{V}/\text{V}$
REF333Q						
Output Voltage	V_{OUT}			3.3		V
Initial Accuracy			-0.15	0.05	0.15	%
Output Voltage Noise		$f = 0.1\text{Hz to } 10\text{Hz}$		36		μV_{PP}
Voltage Noise		$f = 10\text{Hz to } 10\text{kHz}$		41		μV_{RMS}
Noise Density		1kHz		590		$\text{nV}/\sqrt{\text{Hz}}$
Line Regulation		$V_{OUT} + 0.05\text{V} \leq V_{IN} \leq 5.5\text{V}$		± 80	± 230	$\mu\text{V}/\text{V}$
		$-40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$, $V_{OUT} + 0.05\text{V} \leq V_{IN} \leq 5.5\text{V}$			± 270	$\mu\text{V}/\text{V}$

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
REF340Q						
Output Voltage	V _{OUT}			4.096		V
Initial Accuracy			-0.15	0.05	0.15	%
Output Voltage Noise		f = 0.1Hz to 10Hz		43		μV _{PP}
Voltage Noise		f = 10Hz to 10kHz		45		μV _{RMS}
Noise Density		1kHz		620		nV/√Hz
Line Regulation		V _{OUT} + 0.05V ≤ V _{IN} ≤ 5.5V		±115	±360	μV/V
		-40°C ≤ T _A ≤ 125°C, V _{OUT} + 0.05V ≤ V _{IN} ≤ 5.5V			±380	μV/V
REF345Q						
Output Voltage	V _{OUT}			4.5		V
Initial Accuracy			-0.15	0.05	0.15	%
Output Voltage Noise		f = 0.1Hz to 10Hz		50		μV _{PP}
Voltage Noise		f = 10Hz to 10kHz		48		μV _{RMS}
Noise Density		1kHz		680		nV/√Hz
Line Regulation		V _{OUT} + 0.05V ≤ V _{IN} ≤ 5.5V		±150	±450	μV/V
		-40°C ≤ T _A ≤ 125°C, V _{OUT} + 0.05V ≤ V _{IN} ≤ 5.5V			±550	μV/V
REF350Q						
Output Voltage	V _{OUT}	V _{IN} = 5.25V		5		V
Initial Accuracy			-0.15	0.05	0.15	%
Output Voltage Noise		f = 0.1Hz to 10Hz		61		μV _{PP}
Voltage Noise		f = 10Hz to 10kHz		52		μV _{RMS}
Noise Density		1kHz		750		nV/√Hz
Line Regulation		V _{OUT} + 0.05V ≤ V _{IN} ≤ 5.5V		±280	±1050	μV/V
		-40°C ≤ T _A ≤ 125°C, V _{OUT} + 0.05V ≤ V _{IN} ≤ 5.5V			±2500	μV/V
REF3xxQ						
Ripple Rejection Ratio		100mV, 1kHz		-53		dB
Output Voltage Temperature Drift	dV _{OUT} /dT	-40°C ≤ T _A ≤ 125°C		5	25	ppm/°C
Solder Heat Resistance Shift				0.02		%
Load Regulation ⁽²⁾	dV _{OUT} /dI _{LOAD}	Sourcing, 0mA < I _{LOAD} < 25mA, V _{IN} = V _{OUT} + 250mV	-30	-5	30	ppm/mA
		-40°C ≤ T _A ≤ 125°C, sourcing, 0mA < I _{LOAD} < 10mA, V _{IN} = V _{OUT} + 250mV	-35		35	ppm/mA
		Sinking, -10mA < I _{LOAD} < 0mA, V _{IN} = V _{OUT} + 100mV	-100	-60	100	ppm/mA
		-40°C ≤ T _A ≤ 125°C, sinking, -10mA < I _{LOAD} < 0mA, V _{IN} = V _{OUT} + 100mV	-170		170	ppm/mA
Thermal Hysteresis	d _T	First Cycle		±300		ppm
		Additional Cycles		±60		ppm
Dropout Voltage		I _{LOAD} = 50μA, output > 2.048V		2	11	mV
		I _{LOAD} = 10mA, output > 2.048V			100	mV
		I _{LOAD} = 50μA, output ≤ 2.048V		5	50	mV
		I _{LOAD} = 10mA, output ≤ 2.048V			250	mV
Output Current	I _{LOAD}	output > 2.048V, V _{IN} = V _{OUT} + 250mV; output ≤ 2.048V, V _{IN} = V _{OUT} + 400mV	-25		25	mA
Short-Circuit Current	I _{SC}	Sourcing		50		mA
		Sinking		50		mA

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Turn-On Settling Time		To 0.1% at $V_{IN} = 5V$ with $C_L = 0$		20		ms
Load Capacitance			0.1		100K	nF
POWER SUPPLY, $I_L = 0$						
Voltage	V_{IN}		$V_{OUT} + 0.002$		5.5	V
Current	I_Q			60	75	μA
		Overtemperature, $0^{\circ}C \leq T_A \leq 125^{\circ}C$			85	μA
TEMPERATURE RANGE						
Specified			-40		+125	$^{\circ}C$
Operating			-55		+135	$^{\circ}C$
Storage			-65		+150	$^{\circ}C$

6. TYPICAL CHARACTERISTICS

$T_A = 25^\circ\text{C}$, $V_{IN} = 5\text{V}$, and REF330Q is used for typical characteristics measurements, unless otherwise noted.

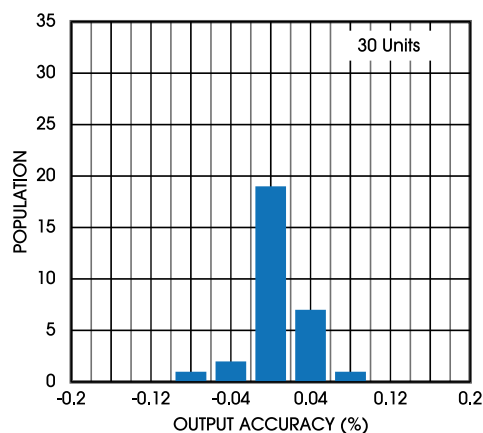


Figure 2. Initial Output Accuracy

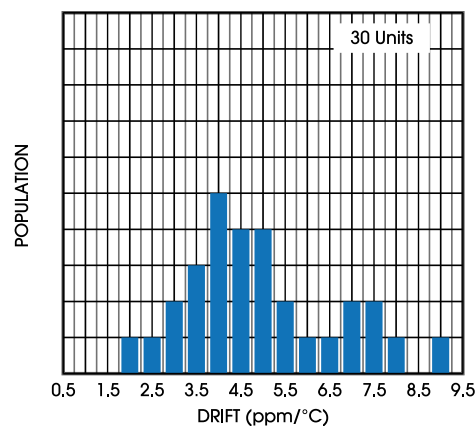


Figure 3. Temperature Drift, -40°C to 125°C

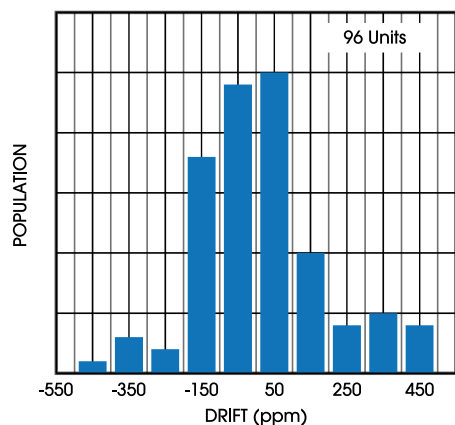


Figure 4. Solder Heat Resistance Shift

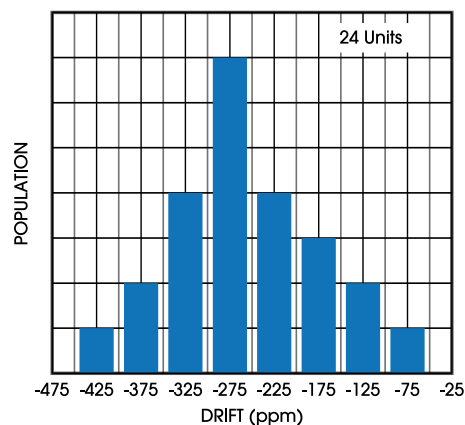


Figure 5. Thermal Hysteresis First Cycle

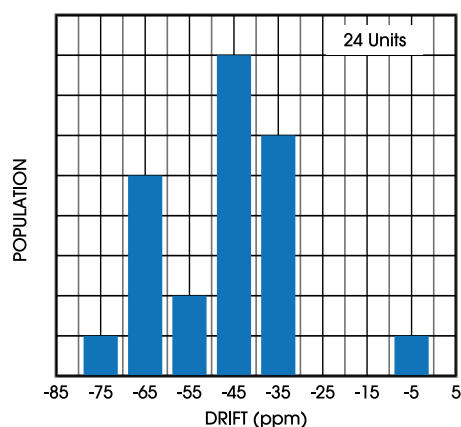


Figure 6. Thermal Hysteresis Additional Cycle

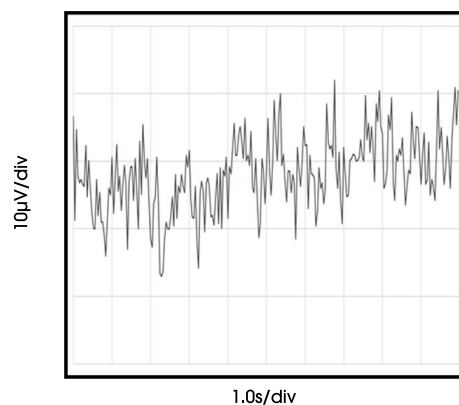


Figure 7. 0.1Hz-10Hz Noise

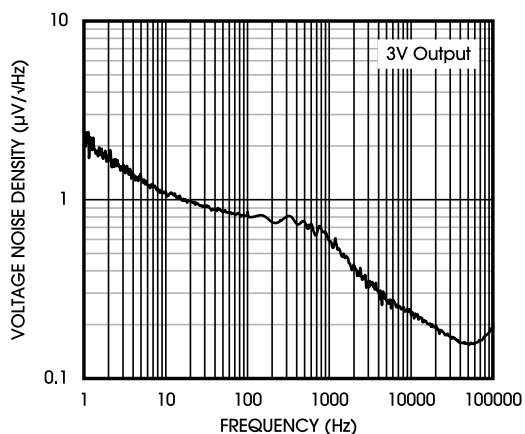


Figure 8. Noise Spectrum

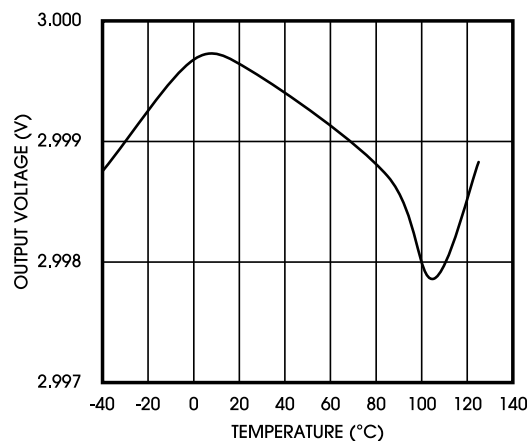


Figure 9. Output Voltage vs. Temperature

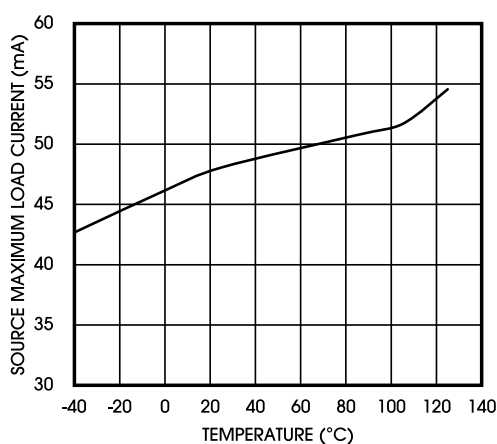


Figure 10. Source Maximum Load Current vs. Temperature

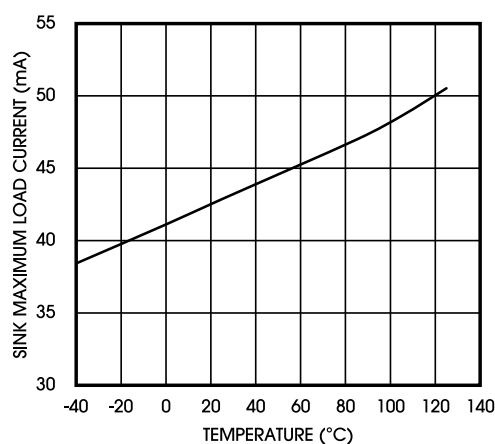


Figure 11. Sink Maximum Load Current vs. Temperature

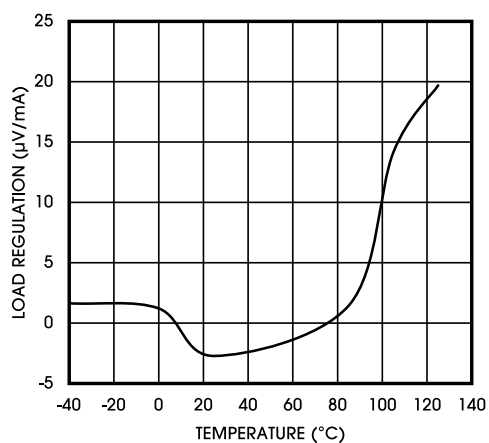


Figure 12. Load Regulation vs. Temperature

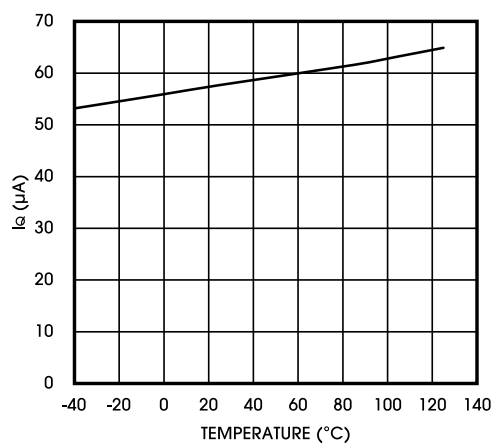


Figure 13. Supply Current vs. Temperature

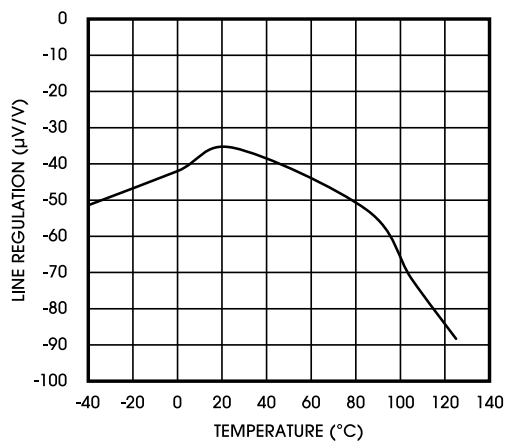


Figure 14. Line Regulation vs. Temperature

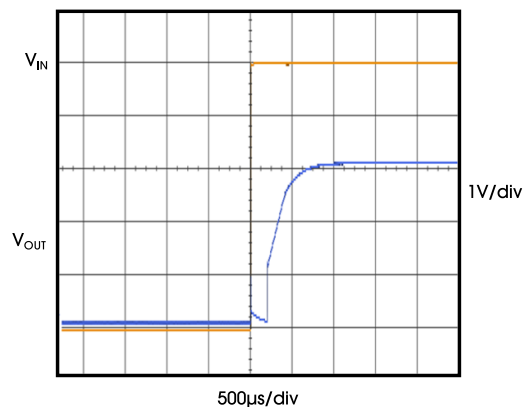


Figure 15. Power-Up

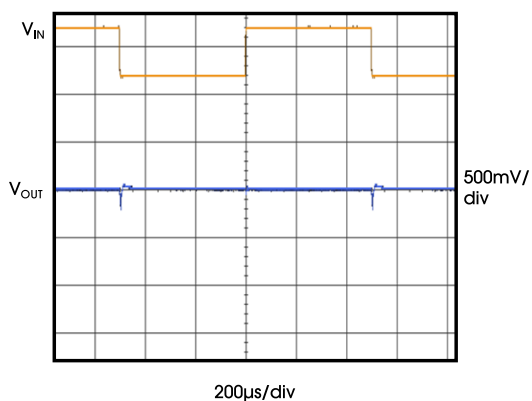


Figure 16. Line Transient

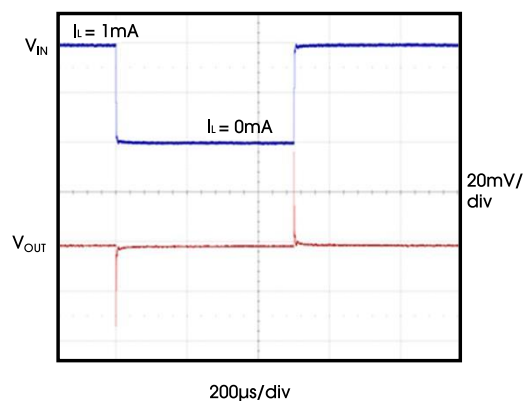


Figure 17. Load Transient

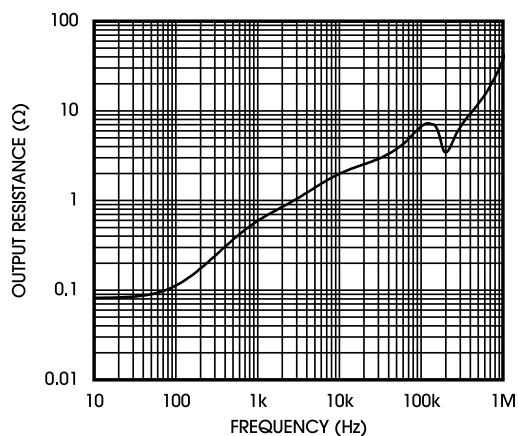


Figure 18. Output Impedance

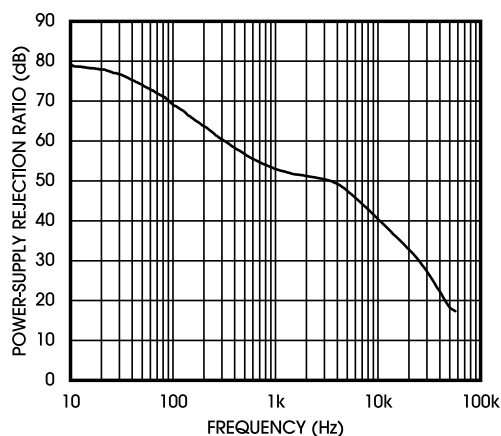


Figure 19. PSRR

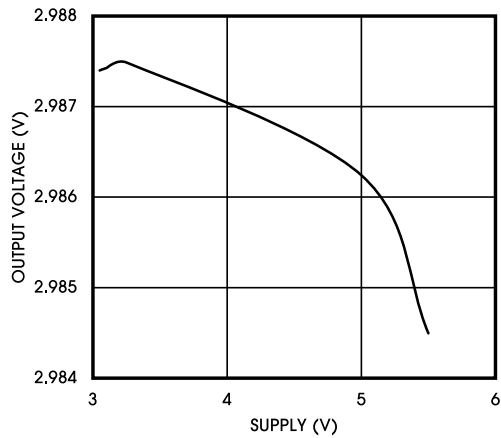


Figure 20. Output Voltage vs. Supply Voltage

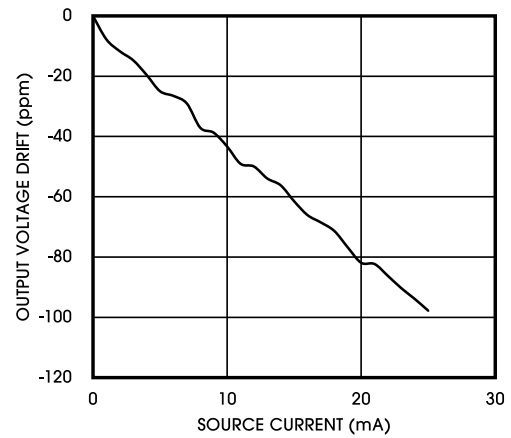


Figure 21. Source Current vs. Output Voltage

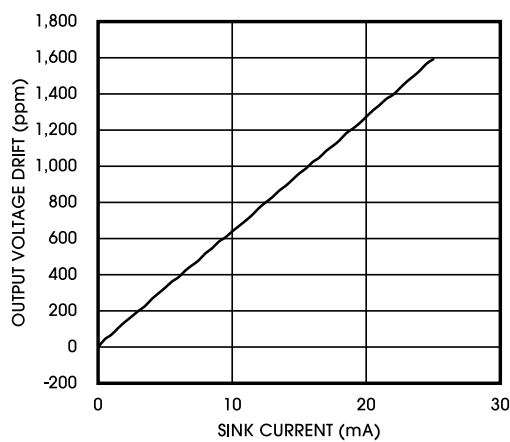


Figure 22. Sink Current vs. Output Voltage

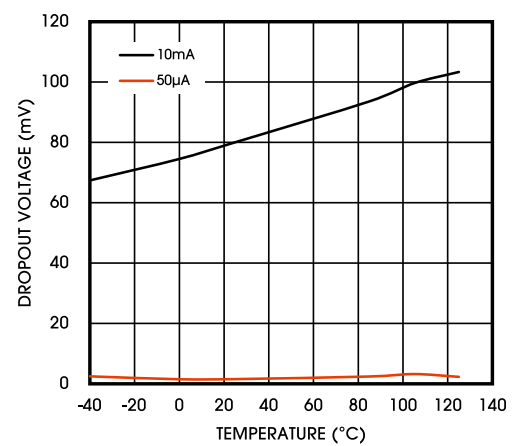


Figure 23. Drop-Out Voltage vs. Load Current

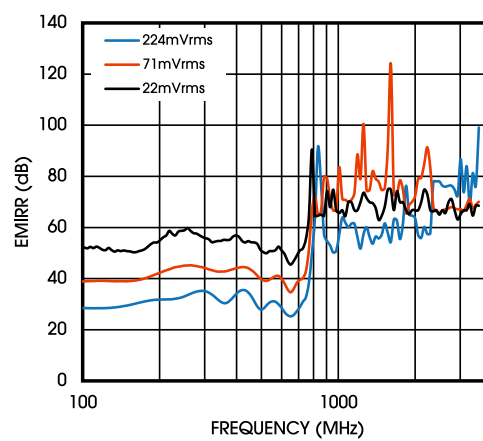


Figure 24. EMIRR

7. 参数测量信息

7.1 热滞后

REF3xxQ 的热滞后定义为在 25°C 下运行器件、在指定温度范围内循环器件并返回到 25°C 后输出电压的变化。它可以表示为 Equation 1:

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

其中:

- V_{HYST} = 热滞后(单位为 ppm)。
- V_{PRE} = 在 25°C 预热循环时测得的输出电压。
- V_{POST} = 器件从 25°C 循环通过 -40°C 至 125°C 的指定温度范围并返回到 25°C 后测得的输出电压。
- V_{NOM} = 指定的输出电压。

8. 详细说明

8.1 概述

REF3xxQ 是低功耗、精密带隙电压基准系列，专为极低压降、出色的初始电压精度和高输出电流而设计。Figure 25 显示了 REF3xxQ 的典型连接。建议使用 1μF 至 10μF 的电源旁路电容器。输出端的容性负载没有限制。通常建议使用 0.1μF 至 10μF 之间的电容器。

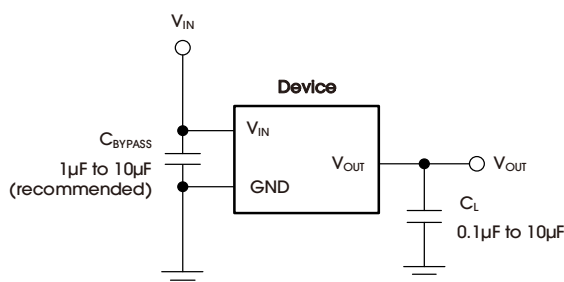


Figure 25. Basic Connections

8.2 功能模块框图

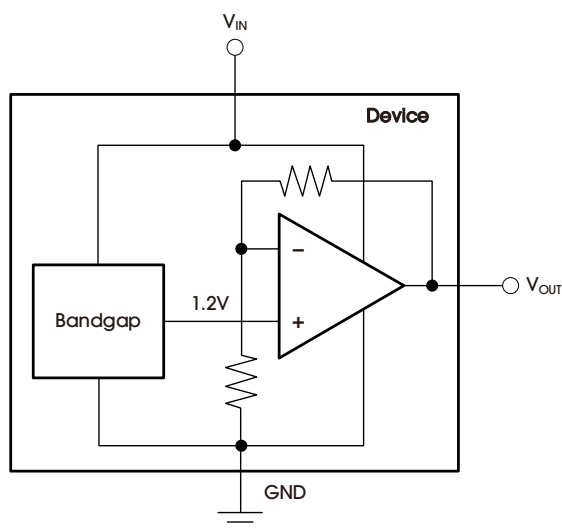


Figure 26. Functional Block Diagram

8.3 特性描述

8.3.1 低温漂移

REF3xxQ 专为实现最小漂移误差而设计，漂移误差定义为输出电压随温度的变化。漂移是使用盒法计算的，如 [Equation 2](#) 中所述：

$$\text{Drift} = \left(\frac{V_{\text{OUTMAX}} - V_{\text{OUTMIN}}}{V_{\text{OUT}} \times \text{Temperature Range}} \right) \times 10^6 \text{ (ppm)} \quad (2)$$

8.3.2 功耗

REF3xxQ 系列指定在指定输入电压范围内提供±25mA 的电流负载。器件的温度根据 [Equation 3](#) 升高：

$$T_J = T_A + P_D \times R_{\theta JA} \quad (3)$$

其中：

- T_J = 结温(°C)。
- T_A = 环境温度(°C)。
- P_D = 功耗(W) = $V_{IN} \times I_Q + (V_{IN} - V_{OUT}) \times I_{OUT}$ 。
- $R_{\theta JA}$ = 结至环境热阻(°C/W)。

REF3xxQ 结温不得超过 150°C 的绝对最大额定值。

8.3.3 噪声性能

[ELECTRICAL CHARACTERISTICS](#) 中指定了 REF3xxQ 系列每个成员的典型 0.1Hz 至 10Hz 电压噪声。噪声电压随着输出电压和工作温度的增加而增加。使用额外的过滤来改善输出噪声水平。请特别注意确保输出阻抗不会降低输出电压精度。

8.3.4 器件功能模式

当 IN 引脚上的电压大于 V_{OUT} 时，REF3xxQ 通电。REF3xxQ 的最大输入电压为 5.5V。使用 1μF 至 10μF 的电源旁路电容器。建议输出端的总容性负载介于 0.1μF 至 10μF 之间。

9. 电源供电推荐

REF3xxQ 系列电压基准具有极低压差电压。这些基准可在高于输出电压 2mV 的电源下工作。

10. 布局

10.1 布局指南

为获得此设计的最佳性能，请遵循标准印刷电路板(PCB)布局指南，包括在所有集成电路附近进行适当的去耦以及使用大量覆铜进行足够的电源和接地连接。

Figure 27 显示了使用 REF3xxQ 的数据采集系统的 PCB 布局示例。一些关键的考虑因素是：

- 在 REF3xxQ 的 IN 引脚连接一个低 ESR、1 μ F 的陶瓷电容器用于旁路，在 OUT 引脚连接一个 0.1 μ F 至 10 μ F 的陶瓷电容器。
- 根据设备规范去耦系统中的其他有源设备。
- 使用坚固的接地层有助于散发热量并减少 EMI 噪声拾取。
- 将外部组件尽可能靠近设备放置。此配置可防止发生寄生错误(例如塞贝克效应)。
- 最小化 ADC 的参考和偏置连接之间的走线长度以减少噪声拾取。
- 不要将敏感的模拟轨迹与数字轨迹并行运行。尽可能避免交叉数字和模拟走线，只有在绝对必要时才进行垂直交叉。

10.2 布局示例

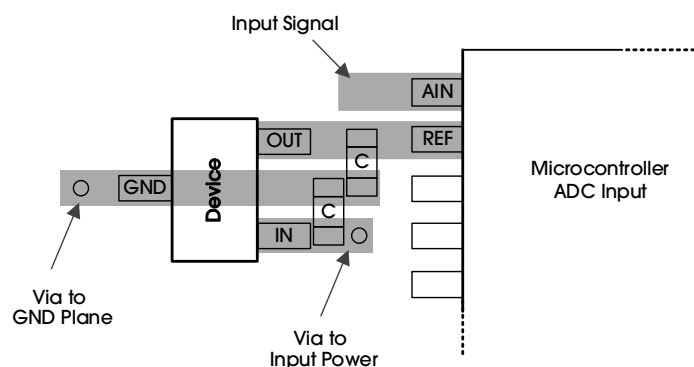


Figure 27. Layout Example

11. PACKAGE INFORMATION

The REF3xxQ is available in the SOT23-3 package. Figure 28 shows the package view.

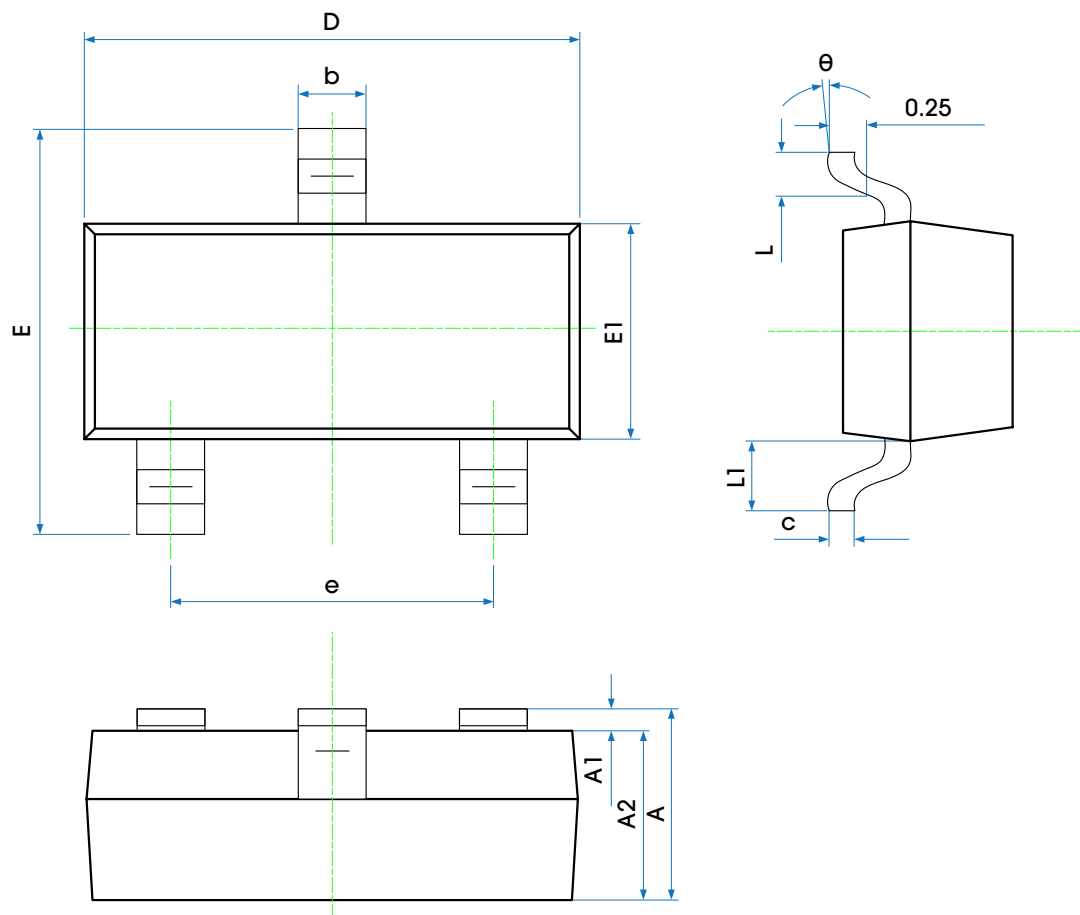


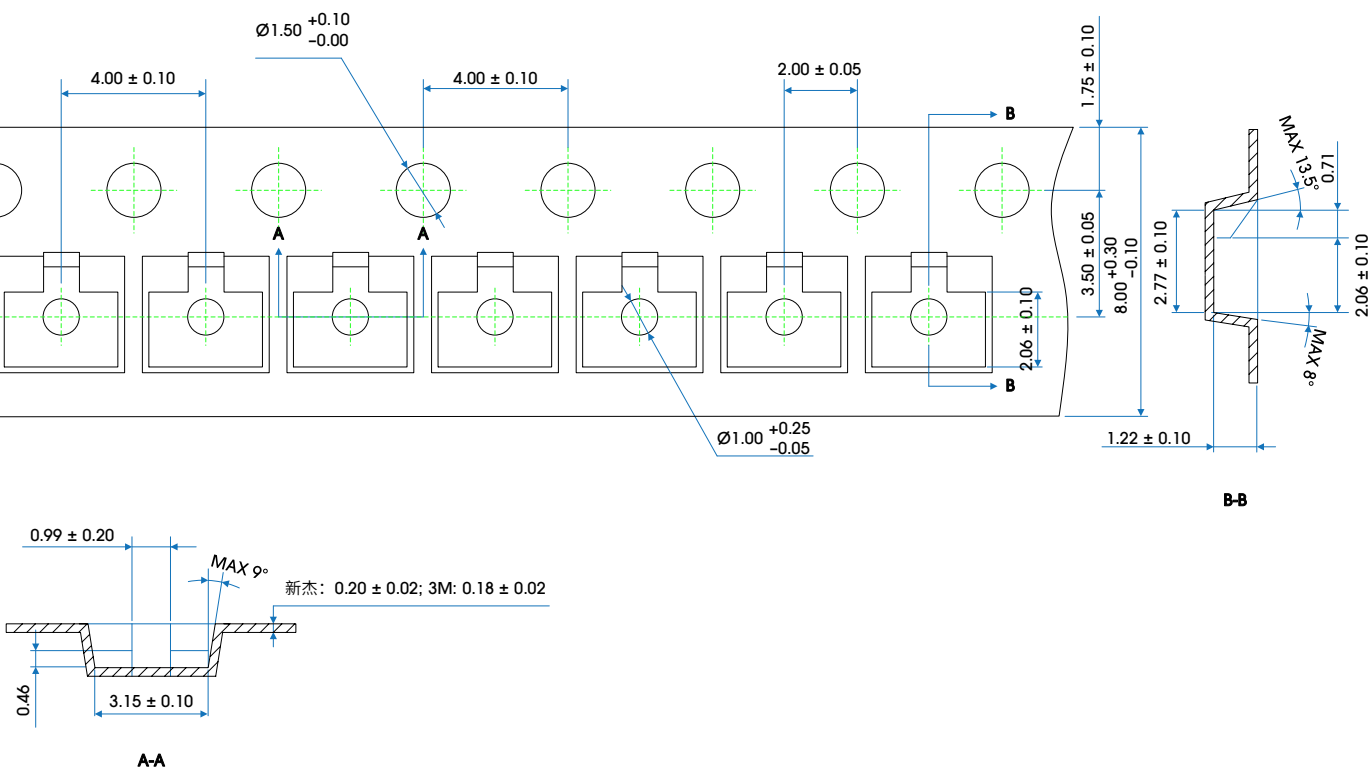
Figure 28. Package View

Table 9 provides detailed information about the dimensions.

Table 9. Dimensions

SYMBOL	DIMENSIONS IN MILLIMETERS		DIMENSIONS IN INCHES	
	MIN	MAX	MIN	MAX
A		1.15		0.045
A1	0.000	0.100	0.000	0.004
A2	0.900	1.100	0.035	0.043
b	0.300	0.500	0.012	0.020
c	0.132	0.202	0.005	0.008
D	2.800	3.000	0.110	0.118
E	2.250	2.550	0.089	0.100
E1	1.200	1.400	0.047	0.055
e	1.800	2.000	0.071	0.079
L	0.300	0.500	0.012	0.020
L1	0.550 REF.		0.022 REF.	
θ	0°	8°	0°	8°

Figure 29 illustrates the carrier tape.



1. Cover tape width: 5.50 ± 0.10 .
2. Cumulative tolerance of 10 sprocket hole pitch: ± 0.20 (max).
3. Camber: not to exceed 2mm in 250mm.
4. Mold#: SOT23-3.
5. All dimensions: mm.
6. Direction of view:

Figure 29. Carrier Tape Drawing

Table 10 provides information about tape and reel.

Table 10. Tape and Reel Information

PACKAGE TYPE	REEL	QTY/REEL	REEL/ INNER BOX	INNER BOX/ CARTON	QTY/CARTON	INNER BOX SIZE (mm)	CARTON SIZE (mm)
SOT23-3	7"	3000	1	18	54000	215*200*40	442*410*224

Figure 30 shows the product loading orientation—pin 1 is assigned at Q3.

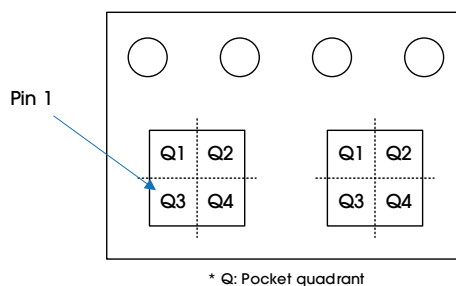


Figure 30. Product Loading Orientation

REVISION HISTORY

REVISION	DATE	DESCRIPTION
Rev A	22 November 2024	Rev A release.