1. 特性

- 微型封装：SOT23-3
- AEC-Q100 (仅限 REF3xxQ)
- 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：20ppm/°C (最大值)
- 高初始精度：±0.1% (最大值)
- 0.1Hz 至 10Hz 噪声：20μV$_{PP}$ (REF318)
- 电压选项：1.25V、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

REF3xx 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 REF3xx 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，REF3xx 可以在比指定输出电压高 2mV 的电源电压下运行，但 REF312 除外，它的最小电源电压为 1.8V。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。

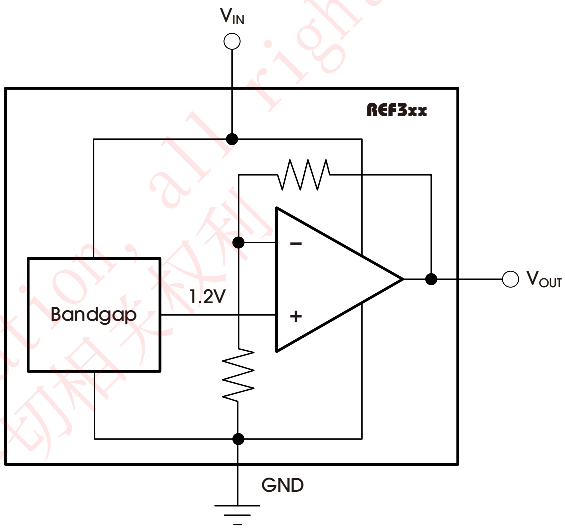


Table 1 lists the order information.

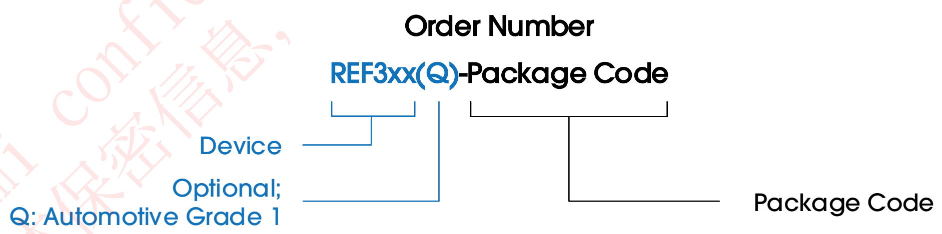
Table 1. Order Information

ORDER NUMBER(1)	OUPUT (V)	I_{CC} (μA)	TEMP DRIFT –40-125°C (MAX) (ppm/°C)	PACKAGE	OP. TEMP. (°C)	RATING	PKG. OPTION
REF312SOT233(2)	1.25	60	20	SOT23-3	–40-125	Industrial	T/R-3000
REF318SOT233	1.8	60	20	SOT23-3	–40-125	Industrial	T/R-3000
REF320SOT233	2.048	60	20	SOT23-3	–40-125	Industrial	T/R-3000
REF325SOT233	2.5	60	20	SOT23-3	–40-125	Industrial	T/R-3000
REF330SOT233	3	60	20	SOT23-3	–40-125	Industrial	T/R-3000
REF333SOT233	3.3	60	20	SOT23-3	–40-125	Industrial	T/R-3000
REF340SOT233	4.096	60	20	SOT23-3	–40-125	Industrial	T/R-3000
REF345SOT233	4.5	60	20	SOT23-3	–40-125	Industrial	T/R-3000
REF350SOT233	5	60	20	SOT23-3	–40-125	Industrial	T/R-3000
REF312QSOT233(2)	1.25	60	20	SOT23-3	–40-125	Auto	T/R-3000
REF318QSOT233(2)	1.8	60	20	SOT23-3	–40-125	Auto	T/R-3000
REF320QSOT233(2)	2.048	60	20	SOT23-3	–40-125	Auto	T/R-3000
REF325QSOT233(2)	2.5	60	20	SOT23-3	–40-125	Auto	T/R-3000
REF330QSOT233(2)	3	60	20	SOT23-3	–40-125	Auto	T/R-3000
REF333QSOT233(2)	3.3	60	20	SOT23-3	–40-125	Auto	T/R-3000
REF340QSOT233(2)	4.096	60	20	SOT23-3	–40-125	Auto	T/R-3000
REF345QSOT233(2)	4.5	60	20	SOT23-3	–40-125	Auto	T/R-3000
REF350QSOT233(2)	5	60	20	SOT23-3	–40-125	Auto	T/R-3000

Devices can be ordered via the following two ways:

1. Place orders directly on our website (www.analogysemi.com), or;
2. Contact our sales team by mailing to sales@analogysemi.com.

Note 1:



Note 2: Available in the future.

4. PIN CONFIGURATION AND FUNCTIONS

Figure 1 illustrates the pin configuration.

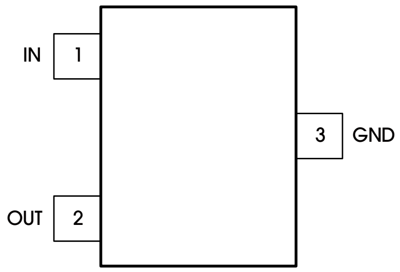


Figure 1. Pin Configuration

Table 2 lists the pin functions.

Table 2. 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 3 lists the absolute maximum ratings of the REF3xx.

Table 3. 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 3 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 5. 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 4 lists the ESD ratings of the REF3xx.

Table 4. ESD Ratings

PARAMETER	SYMBOL	DESCRIPTION	VALUE	UNITS
Electrostatic Discharge	$V_{(ESD)}$	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 (1)	±8000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101 (2)	±2000	

Note 1: The JEDEC document JEP155 indicates that 500V HBM allows safe manufacturing with a standard ESD control process.
Note 2: The JEDEC document JEP157 indicates that 250V CDM allows safe manufacturing with a standard ESD control process.

5.3 RECOMMENDED OPERATING CONDITIONS

Table 5 lists the recommended operating conditions for the REF3xx.

Table 5. 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	IOUT	–25		25	mA
Operating Temperature	T_A	–55		135	°C

Note: The minimum supply voltage for the REF312 is 1.8V.

5.4 THERMAL INFORMATION

Table 6 lists the thermal information for the REF3xx.

Table 6. Thermal Information

PARAMETER	SYMBOL	SOT23-3	UNITS
Junction-to-Ambient Thermal Resistance	$R_{\theta JA}$	176.7	°C/W
Junction-to-Board Thermal Resistance	$R_{\theta JB}$	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	$R_{\theta JC (top)}$	84.9	°C/W

5.5 ELECTRICAL CHARACTERISTICS

Table 7 lists the electrical characteristics of the REF3xx. T_A = 25°C, V_{IN} = 5V, I_{LOAD} = 0mA, unless otherwise noted.

Table 7. Electrical Characteristics

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
REF312						
Output Voltage	V_{OUT}			1.25		V
Initial Accuracy				0.05		%
REF318						
Output Voltage	V_{OUT}			1.8		V
Initial Accuracy			−0.1	0.05	0.1	%
Output Voltage Noise		f = 0.1Hz to 10Hz		20		μV_{PP}
Voltage Noise		f = 10Hz to 10kHz		35		μV_{RMS}
Noise Density		1kHz		439		nV/√Hz
Line Regulation		V_{OUT} + 0.05V ≤ V_{IN} ≤ 5.5V		3	±180	μV/V
		−40°C ≤ T_A ≤ 125°C, V_{OUT} + 0.05V ≤ V_{IN} ≤ 5.5V			±230	μV/V
REF320						
Output Voltage	V_{OUT}			2.048		V
Initial Accuracy			−0.1	0.05	0.1	%
Output Voltage Noise		f = 0.1Hz to 10Hz		22		μV_{PP}
Voltage Noise		f = 10Hz to 10kHz		35		μV_{RMS}
Noise Density		1kHz		460		nV/√Hz
Line Regulation		V_{OUT} + 0.05V ≤ V_{IN} ≤ 5.5V		5	±100	μV/V
		−40°C ≤ T_A ≤ 125°C, V_{OUT} + 0.05V ≤ V_{IN} ≤ 5.5V			±230	μV/V
REF325						
Output Voltage	V_{OUT}			2.5		V
Initial Accuracy			−0.1	0.05	0.1	%
Output Voltage Noise		f = 0.1Hz to 10Hz		28		μV_{PP}
Voltage Noise		f = 10Hz to 10kHz		36		μV_{RMS}
Noise Density		1kHz		515		nV/√Hz
Line Regulation		V_{OUT} + 0.05V ≤ V_{IN} ≤ 5.5V		30	±140	μV/V
		−40°C ≤ T_A ≤ 125°C, V_{OUT} + 0.05V ≤ V_{IN} ≤ 5.5V			±190	μV/V
REF330						
Output Voltage	V_{OUT}			3		V
Initial Accuracy			−0.1	0.05	0.1	%
Output Voltage Noise		f = 0.1Hz to 10Hz		34		μV_{PP}
Voltage Noise		f = 10Hz to 10kHz		40		μV_{RMS}
Noise Density		1kHz		588		nV/√Hz
Line Regulation		V_{OUT} + 0.05V ≤ V_{IN} ≤ 5.5V		35	±170	μV/V
		−40°C ≤ T_A ≤ 125°C, V_{OUT} + 0.05V ≤ V_{IN} ≤ 5.5V			±270	μV/V
REF333						
Output Voltage	V_{OUT}			3.3		V
Initial Accuracy			−0.1	0.05	0.1	%
Output Voltage Noise		f = 0.1Hz to 10Hz		36		μV_{PP}
Voltage Noise		f = 10Hz to 10kHz		41		μV_{RMS}
Noise Density		1kHz		590		nV/√Hz
Line Regulation		V_{OUT} + 0.05V ≤ V_{IN} ≤ 5.5V		45	±180	μV/V
		−40°C ≤ T_A ≤ 125°C, V_{OUT} + 0.05V ≤ V_{IN} ≤ 5.5V			±270	μV/V

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
REF340						
Output Voltage	V_{OUT}			4.096		V
Initial Accuracy			–0.1	0.05	0.1	%
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		70	±264	μV/V
		–40°C ≤ T_A ≤ 125°C, V_{OUT} + 0.05V ≤ V_{IN} ≤ 5.5V			±380	μV/V
REF345						
Output Voltage	V_{OUT}			4.5		V
Initial Accuracy			–0.1	0.05	0.1	%
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		60	±400	μV/V
		–40°C ≤ T_A ≤ 125°C, V_{OUT} + 0.05V ≤ V_{IN} ≤ 5.5V			±550	μV/V
REF350						
Output Voltage	V_{OUT}	V_{IN} = 5.25V		5		V
Initial Accuracy			–0.1	0.05	0.1	%
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		140	±850	μV/V
		–40°C ≤ T_A ≤ 125°C, V_{OUT} + 0.05V ≤ V_{IN} ≤ 5.5V			±2500	μV/V
REF3xx						
Ripple Rejection Ratio		100mV, 1kHz		–53		dB
Output Voltage Temperature Drift	dV_{OUT}/dT	–40°C ≤ T_A ≤ 125°C		5	20	ppm/°C
Solder Heat Resistance Shift				0.015		%
Long-Term Stability		0h to 100h		80		ppm
		0h to 1000h		130		ppm
Load Regulation(2)	dV_{OUT}/dI_{LOAD}	Sourcing, 0mA < I_{LOAD} < 25mA, V_{IN} = V_{OUT} + 250mV	–30	–2	30	ppm/mA
		–40°C ≤ T_A ≤ 125°C, sourcing, 0mA < I_{LOAD} < 10mA, V_{IN} = V_{OUT} + 250mV	–30		30	ppm/mA
		Sinking, –10mA < I_{LOAD} < 0mA, V_{IN} = V_{OUT} + 100mV	–100	–57	100	ppm/mA
		–40°C ≤ T_A ≤ 125°C, sinking, –10mA < I_{LOAD} < 0mA, V_{IN} = V_{OUT} + 100mV	–150		150	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	10	mV
		I_{LOAD} = 10mA, output ≤ 2.048V			150	mV
Output Current	I_{LOAD}	output > 2.048V, V_{IN} = V_{OUT} + 250mV; output ≤ 2.048V, V_{IN} = V_{OUT} + 400mV	–25		25	mA

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Short-Circuit Current	I_{SC}	Sourcing		50		mA
		Sinking		50		mA
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	80	µA
		Overtemperature, 0°C ≤ T_A ≤ 125°C			85	µA
TEMPERATURE RANGE						
Specified			–40		+125	°C
Operating			–55		+135	°C
Storage			–65		+150	°C

Note: The long-term stability number reduces as the time increases.

6. TYPICAL CHARACTERISTICS

T_A = 25°C, V_{IN} = 5V, and REF330 is used for typical characteristics measurements, unless otherwise noted.

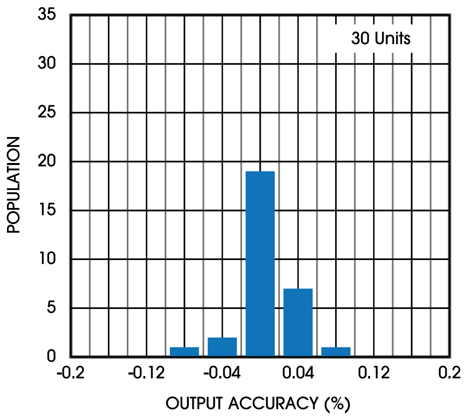


Figure 2. Initial Output Accuracy

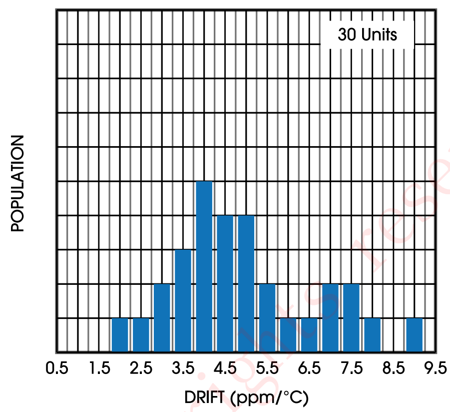


Figure 3. Temperature Drift, –40°C to 125°C

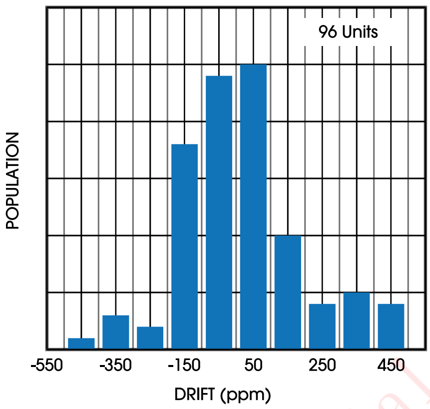


Figure 4. Solder Heat Resistance Shift

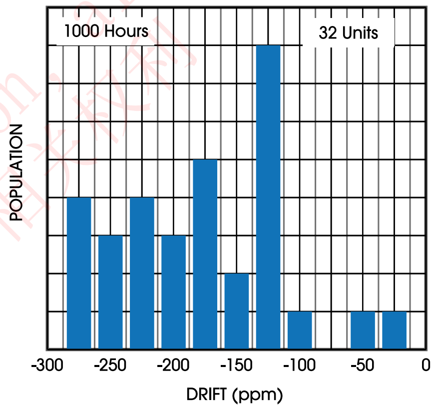


Figure 5. Long Term stability

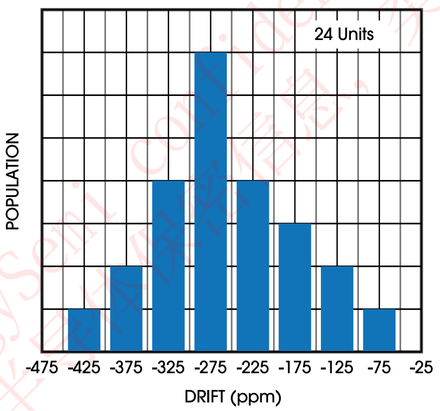


Figure 6. Thermal Hysteresis First Cycle

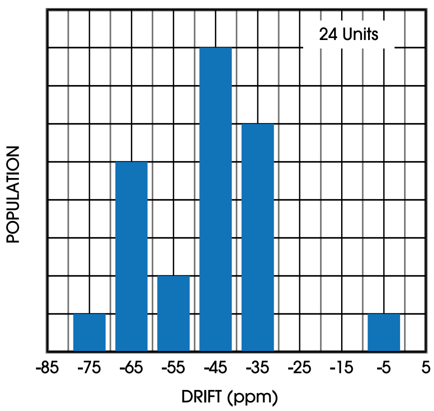


Figure 7. Thermal Hysteresis Additional Cycle

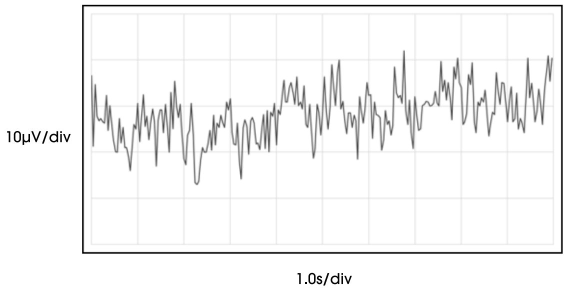


Figure 8. 0.1Hz-10Hz Noise

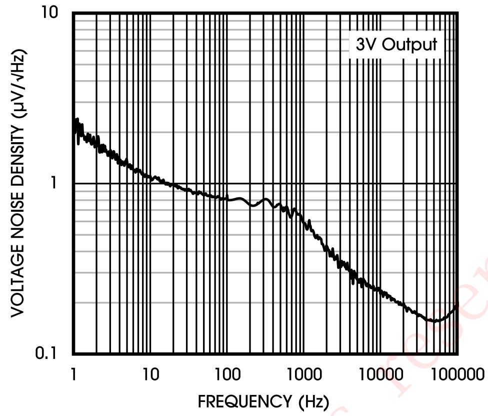


Figure 9. Noise Spectrum

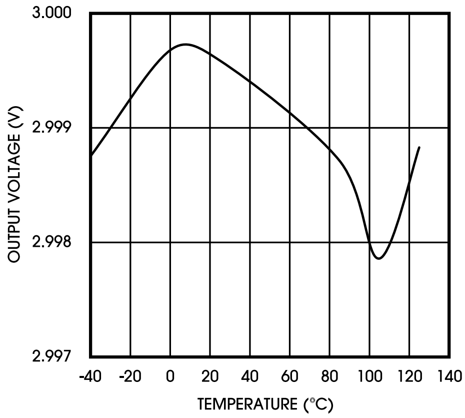


Figure 10. Output Voltage vs. Temperature

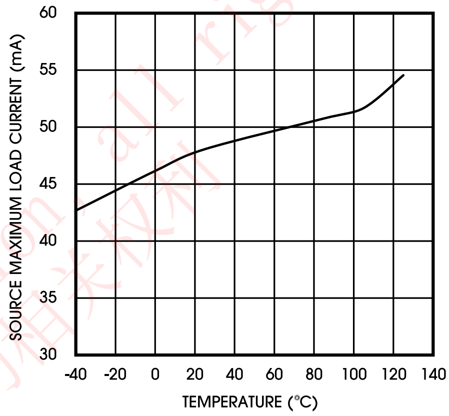


Figure 11. Source Maximum Load Current vs. Temperature

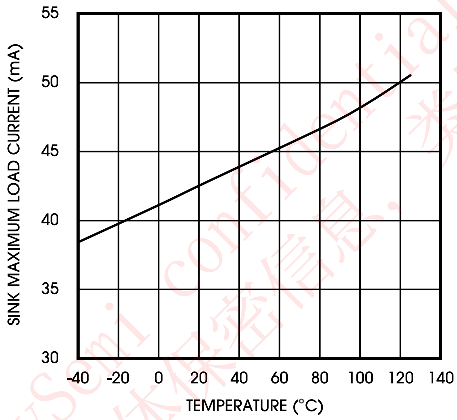


Figure 12. Sink Maximum Load Current vs. Temperature

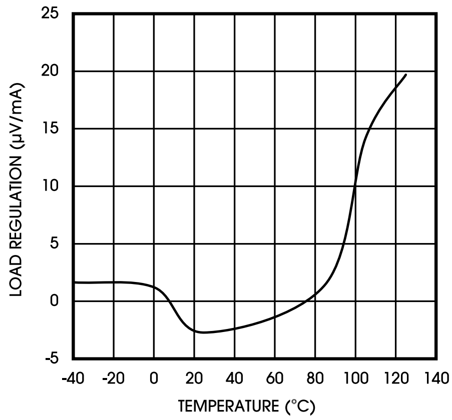


Figure 13. Load Regulation vs. Temperature

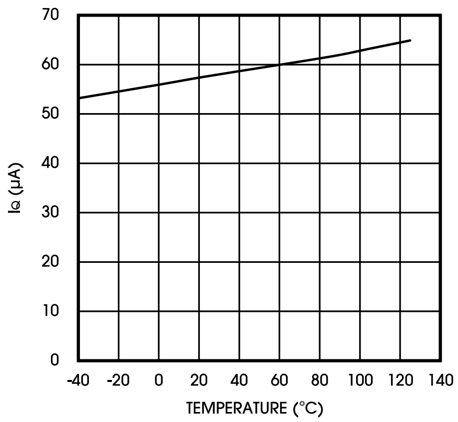


Figure 14. Supply Current vs. Temperature

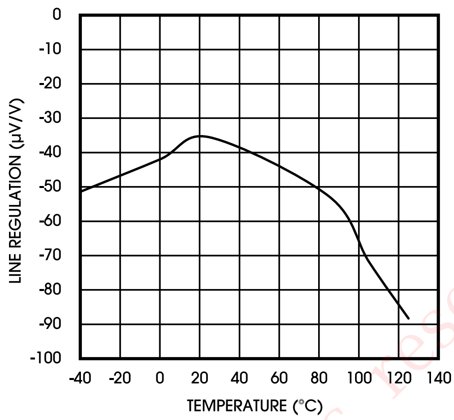


Figure 15. Line Regulation vs. Temperature

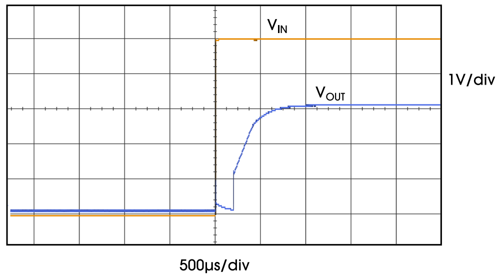


Figure 16. Power-Up

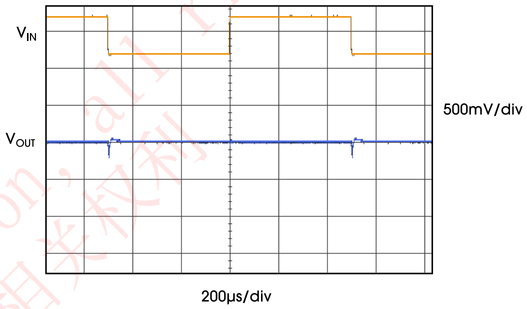


Figure 17. Line Transient

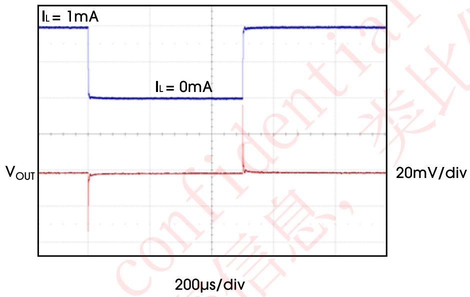


Figure 18. Load Transient

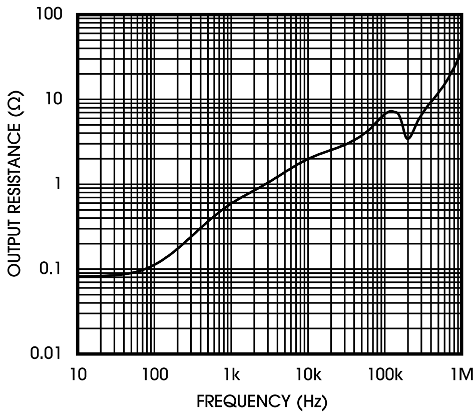


Figure 19. Output Impedance

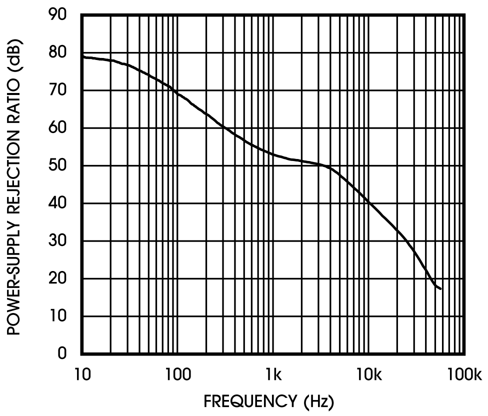


Figure 20. PSRR

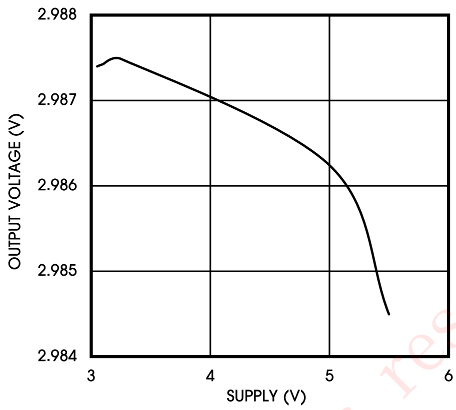


Figure 21. Output Voltage vs. Supply Voltage

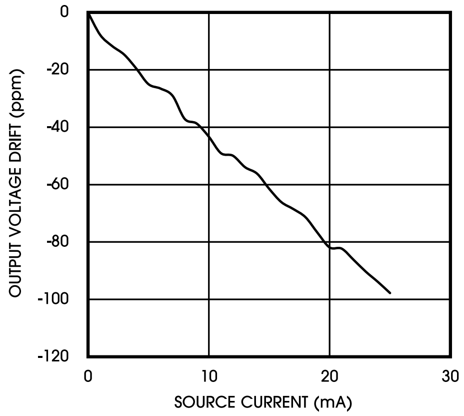


Figure 22. Source Current vs. Output Voltage

Figure 23. Sink Current vs. Output Voltage

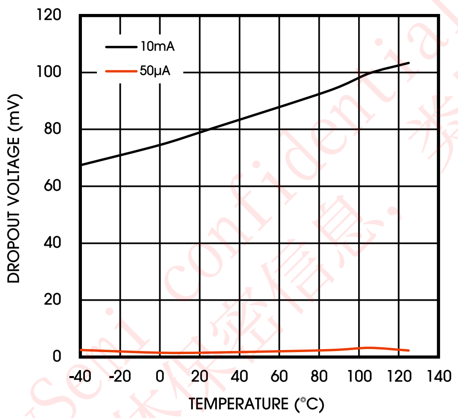


Figure 24. Drop-Out Voltage vs. Load Current

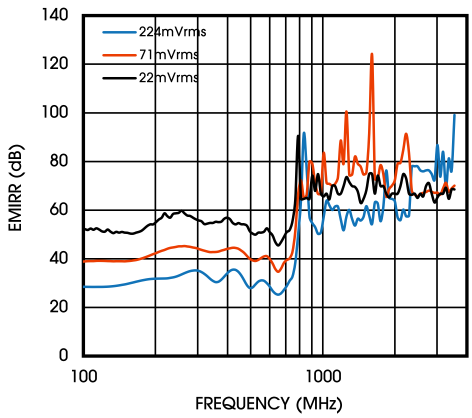


Figure 25. EMIRR

7. 参数测量信息

7.1 热滞后

REF3xx 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：

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

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

REF3xx 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 26 显示了 REF3xx 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。

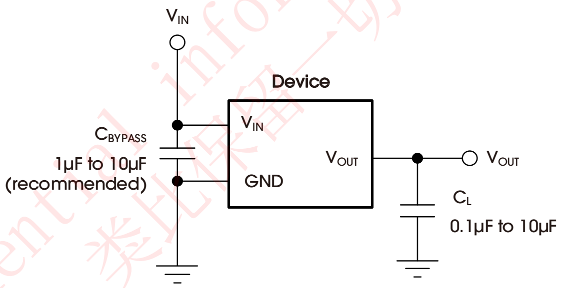


Figure 26. Basic Connections

8.2 功能模块框图

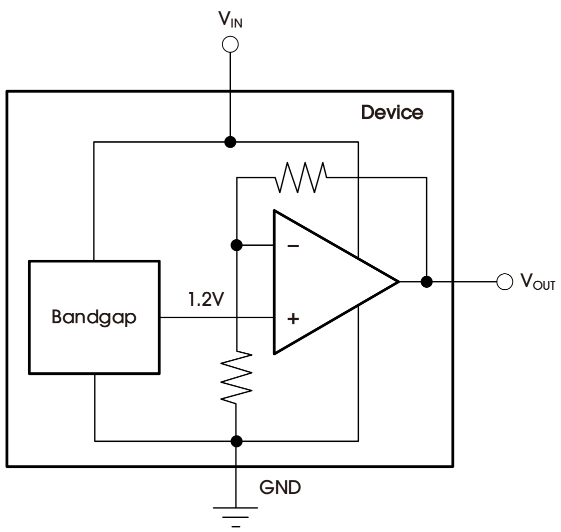


Figure 27. Functional Block Diagram

8.3 特性描述

8.3.1 低温漂移

REF3xx 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：

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

8.3.2 功耗

REF3xx 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)。

REF3xx 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 REF3xx 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，REF3xx 通电，REF312 除外，其最小电源电压为 1.8V。REF3xx 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

REF3xx 系列电压基准具有极低压差电压，REF312 除外。REF312 的最低电源要求为 1.8V。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 28 显示了使用 REF3xx 的数据采集系统的 PCB 布局示例。一些关键的考虑因素是：

- 在 REF3xx 的 IN 引脚连接一个低 ESR、1μF 的陶瓷电容器用于旁路，在 OUT 引脚连接一个 0.1μF 至 10μF 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

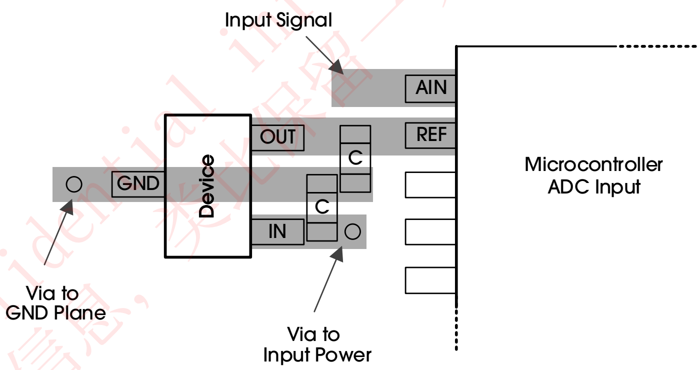


Figure 28. Layout Example

 Public

11. PACKAGE INFORMATION

The REF3xx is available in the SOT23-3 package. Figure 29 shows the package view.

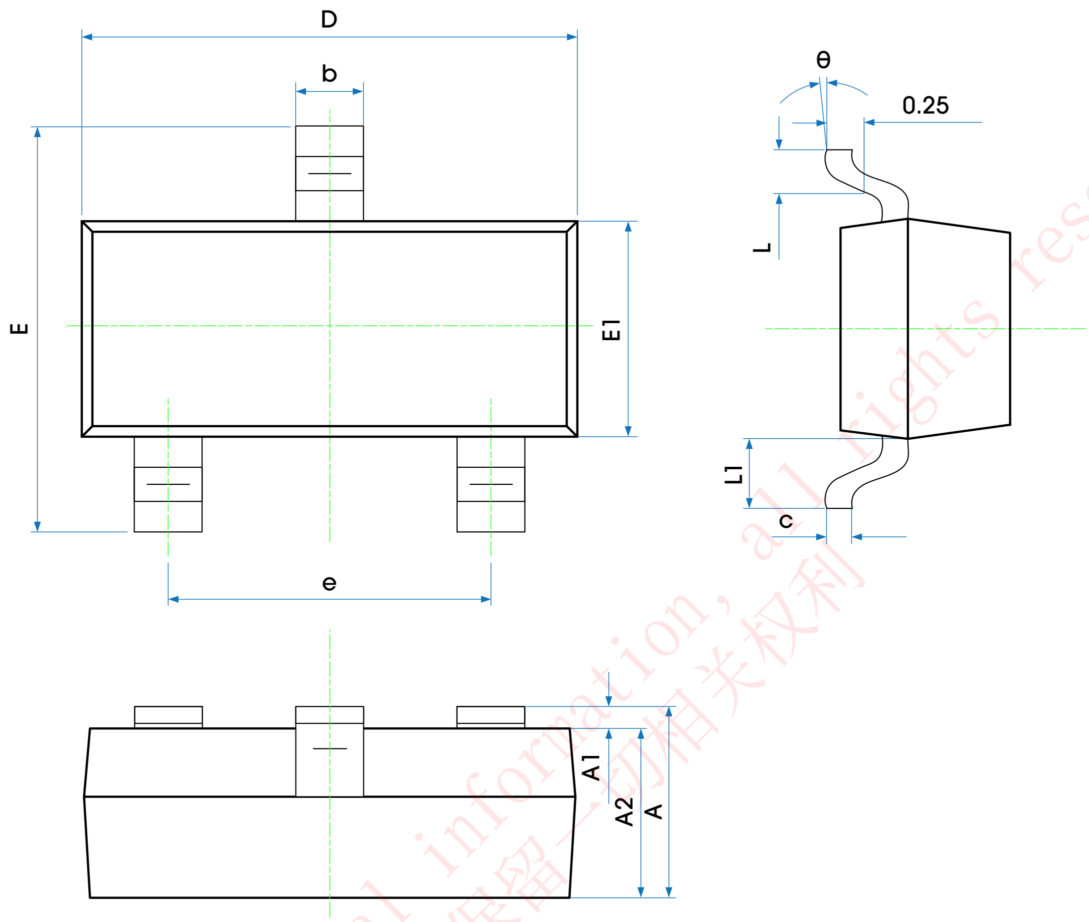


Figure 29. Package View

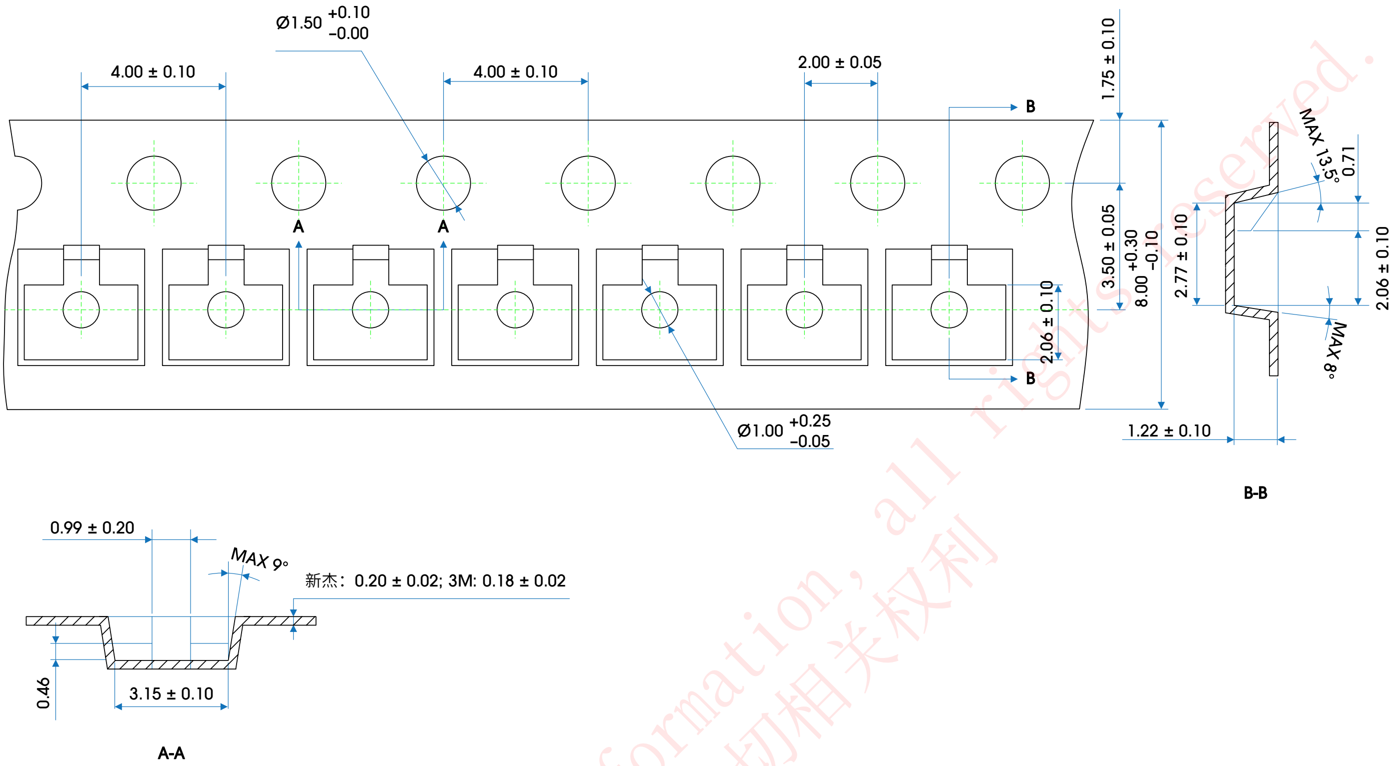
Table 8 provides detailed information about the dimensions.

Table 8. 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°

12. TAPE AND REEL INFORMATION

Figure 30 illustrates the carrier tape.



Notes:
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:

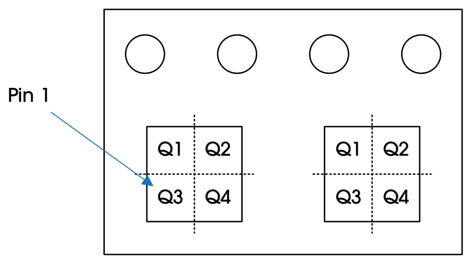
Figure 30. Carrier Tape Drawing

Table 9 provides information about tape and reel.

Table 9. 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 31 shows the product loading orientation—pin 1 is assigned at Q3.



* Q: Pocket quadrant

Figure 31. Product Loading Orientation

REVISION HISTORY

REVISION	DATE	DESCRIPTION
Rev A	02 June 2023	Rev A release.
Rev B	30 August 2023	1. Updated the order information. 2. Updated the electrical characteristics table.
Rev C	18 October 2023	1. Updated the electrical characteristics table. 2. Updated the TYPICAL CHARACTERISTICS section.