TPREF31xx Series

Precision Low Power SOT23 Series Voltage Reference

WWW.TECHPUBLIC.COM

Product Overview

The TPREF31xx is a family of low power, low dropout, precision bandgap references. These designs are available in 3-pin SOT23 package. The TPREF31xx's small size and low power consumption makes them ideal for use in battery-powered systems where there can be wide variations in supply voltage and a need to minimize power dissipation. The TPREF31xx does not require an output compensation capacitor, yet is stable with capacitive loads and can sink or source up to ±10 mA of output current. Unloaded, the TPREF31xx can operate on supplies down to 1 mV above the output voltage. All models are specified over the temperature range of -40°Ct o +125°C.

Applications

- Data Acquisition Systems
- Medical Equipment
- Hand-Held Test Equipment

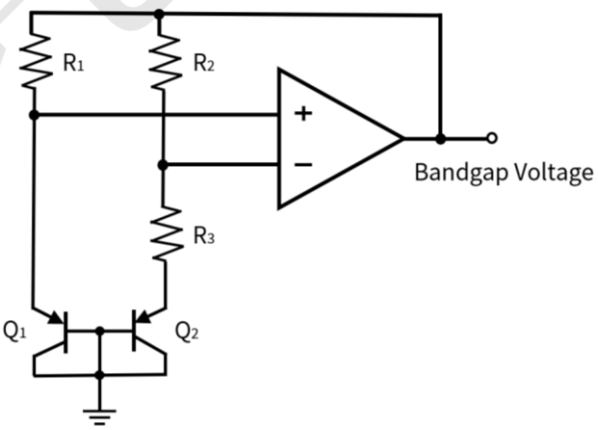
Key Features

- Excellent Specified Drift Performance:
  15 ppm/°C (Maximum) from -40°C to +125°C
- Output Noise (0.1 to 10Hz): 22µVpp of TPREF3125S3
- High Output Current: ±10 mA
- High Accuracy: 0.2% Maximum
- Do Not Require a Load Capacitor to Be Stable
- Low Dropout: 1mV

Device Information

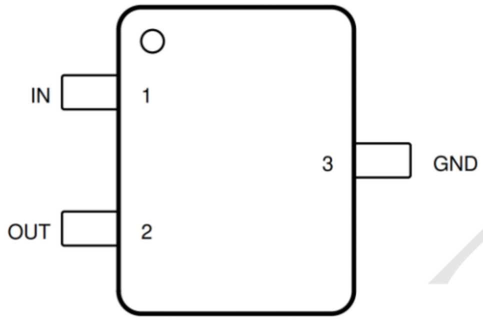
Part Number	Package
TPREF3112S3	SOT23
TPREF3120S3	
TPREF3125S3	
TPREF3130S3	
TPREF3133S3	
TPREF3140S3	

Functional Block Diagram



TPREF31xx Functional Block Diagram

Pin Configuration and Functions



TPREF31xx SOT23 Package Top View

TPREF31xx Pin Configuration and Description

PIN No.	Symbol	Function
1	IN	Input supply voltage
2	OUT	Reference output voltage
3	GND	Ground

INDEX

Absolute Maximum Ratings

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*
Input supply voltage	V_{IN}			6.5	V
Storage temperature	T_{stg}	-65		150	°C
Ambient temperature	T_A	-40		125	°C
Junction temperature	T_J	-40		150	°C

ESD Ratings

Ratings		*Value*	*Unit*
Electrostatic discharge	Human-body model (HBM), per AEC-Q100-002-RevE ● All pins	±8000	V
	Charged-device model (CDM), per AEC-Q100-011-RevD ● All pins	±2000	V

Recommended Operating Conditions

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Comments*
Input voltage	V_{IN}	1.8		5.5	V	TPREF3112S3 Only
		V_{OUT} + 0.05		5.5		Except TPREF3112S3
Load current	I_{LOAD}	-10		10	mA	
Operating temperature	T_A	-40		125	°C	

Thermal Information

Parameters	*Symbol*	*SOT23*	*Unit*
Junction-to-ambient thermal resistance	θ_{JA}	298	°C/W
Junction-to-case(top) thermal resistance	$\theta_{JC（top）}$	97	°C/W
Junction-to-board thermal resistance	θ_{JB}	72	°C/W

Electrical Characteristics

T_A =25°C, V_{IN} = 5V and I_{LOAD} = 0mA (Unless otherwise noted) [1]

Parameters	*Symbol*	*Condition*	*Min*	*Typ*	*Max*	*Unit*
TPREF3112S3 (1.25V)						
Output voltage	V_{OUT}		1.2475	1.25	1.2525	V
Quiescent current	I_Q			135	165	µA
		T_A = –40°C to +125°C			170	
Output voltage noise	$e_{n\ p\text{-}p}$	f = 0.1Hz to 10Hz		9		$µV_{pp}$
Line regulation		1.8 ≤ V_{IN} ≤ 5.5V		30	90	ppm/V
Turn-on settling time		to 0.1% with C_L = 0		100		µs
TPREF3120S3 (2.048V)						
Output voltage	V_{OUT}		2.044	2.048	2.052	V
Quiescent current	I_Q			140	165	µA
		T_A = –40°C to +125°C			170	
Output voltage noise	$e_{n\ p\text{-}p}$	f = 0.1Hz to 10Hz		20		$µV_{pp}$
Line regulation		V_{OUT} +0.05V ≤ V_{IN} ≤ 5.5V		25	85	ppm/V
Turn-on settling time		to 0.1% with C_L = 0		250		µs
TPREF3125S3 (2.5V)						
Output voltage	V_{OUT}		2.495	2.5	2.505	V
Quiescent current	I_Q			140	165	µA
		T_A = –40°C to +125°C			170	
Output voltage noise	$e_{n\ p\text{-}p}$	f = 0.1Hz to 10Hz		22		$µV_{pp}$
Line regulation		V_{OUT} +0.05V ≤ V_{IN} ≤ 5.5V		15	85	ppm/V
Turn-on settling time		to 0.1% with C_L = 0		380		µs
TPREF3130S3 (3.0V)						
Output voltage	V_{OUT}		2.994	3	3.006	V
Quiescent current	I_Q			145	170	µA
		T_A = –40°C to +125°C			175	
Output voltage noise	$e_{n\ p\text{-}p}$	f = 0.1Hz to 10Hz		28		$µV_{pp}$
Line regulation		V_{OUT} +0.05V ≤ V_{IN} ≤ 5.5V		15	90	ppm/V
Turn-on settling time		to 0.1% with C_L = 0µF		450		µs

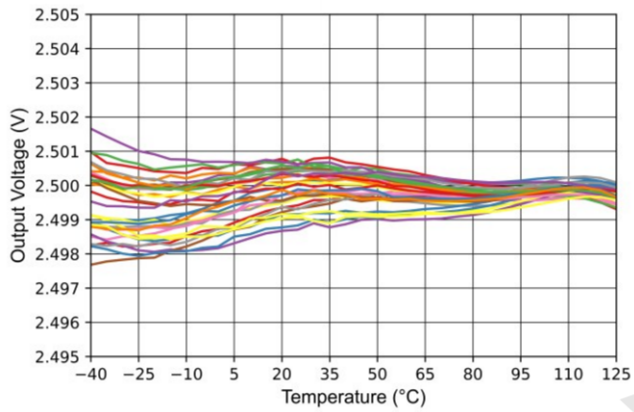
Electrical Characteristics(continued)

T_A =25°C, V_{IN} = 5V and I_{LOAD} = 0mA (Unless otherwise noted) [1]

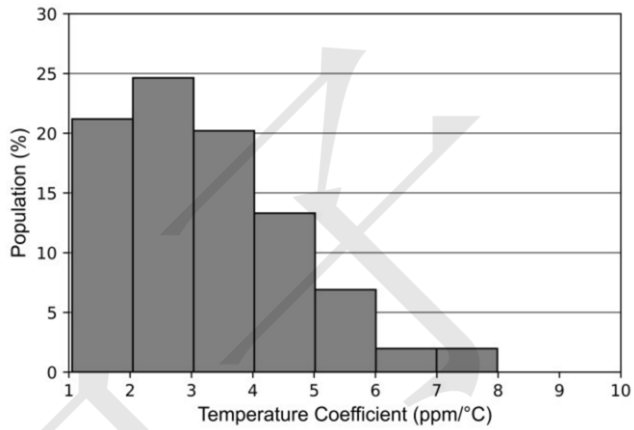
Parameters	*Symbol*	*Condition*	*Min*	*Typ*	*Max*	*Unit*
TPREF3133S3(3.3V)						
Output voltage	V_{OUT}		3.294	3.3	3.306	V
Quiescent current	I_Q			145	170	µA
		T_A = –40°C to +125°C			175	
Output voltage noise	$e_{n\ p\text{-}p}$	f = 0.1Hz to 10Hz		31		μV_{pp}
Line regulation		V_{OUT} +0.05V ≤ V_{IN} ≤ 5.5V		25	100	ppm/V
Turn-on settling time		To 0.1% with C_L = 0		550		µs
TPREF3140S3 (4.096V)						
Output voltage	V_{OUT}		4.088	4.096	4.104	V
Quiescent current	I_Q			145	175	µA
		T_A = –40°C to +125°C			175	
Output voltage noise	$e_{n\ p\text{-}p}$	f = 0.1Hz to 10Hz		33		μV_{pp}
Line regulation		V_{OUT} +0.05V ≤ V_{IN} ≤ 5.5V		50	150	ppm/V
Turn-on settling time		To 0.1% with C_L = 0		680		µs
TPREF31xx (TPREF3112S3, TPREF3120S3, TPREF3125S3, TPREF3130S3, TPREF3133S3, TPREF3140S3)						
Input supply voltage	V_{IN}	TPREF3112S3	1.8		5.5	V
		Except TPREF3112S3	V_{OUT}+0.05		5.5	
Temperature drift [2]	d_{VOUT}/d_T	T_A = -40°C to 125°C		5	15	ppm/°C
Thermal hysteresis		First cycle, T_A cycled from 25°C to 125°C to -40°C to 25°C		100		ppm
Load regulation	$\Delta V_{O(\Delta IL)}$	I_L=0mA to 10mA, V_{IN}=V_{OUT}+0.25V [3]		5	10	µV/mA
		I_L=-10mA to 0mA, V_{IN}=V_{OUT}+0.1V [3]		25	50	
Output current	I_{LOAD}	Guaranteed by Load Regulation	-10		+10	mA
Dropout voltage	V_{IN} – V_{OUT}			1		mV
Short-circuit current	I_{SC}	Sourcing		40		mA
		Sinking		55		
Long-term stability		0 to 1000h at 35°C		100		ppm
		0 to 2000h at 35°C		130		ppm

Typical Performance Characteristics

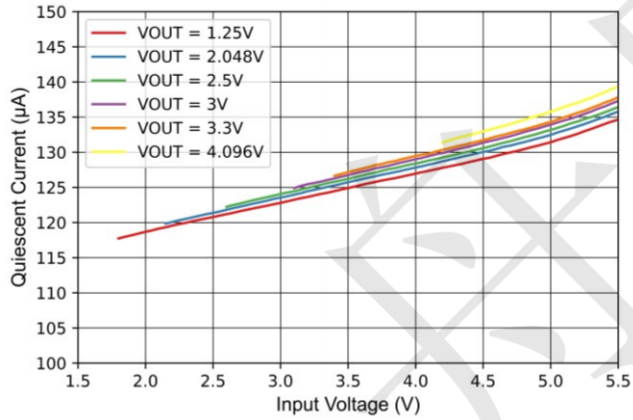
T_A =25°C, V_{IN} = 5V and I_{LOAD} = 0mA (Unless otherwise noted)



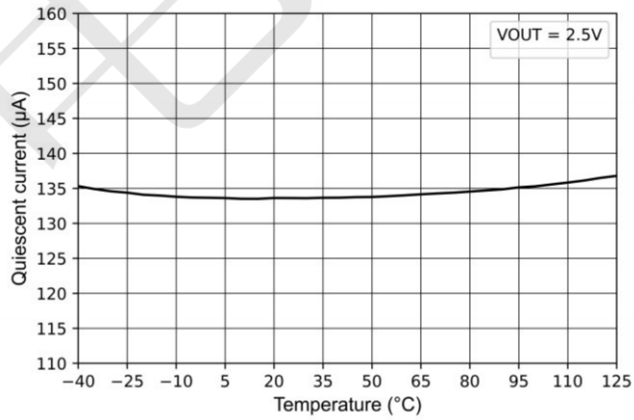
Output Voltage vs Temperature



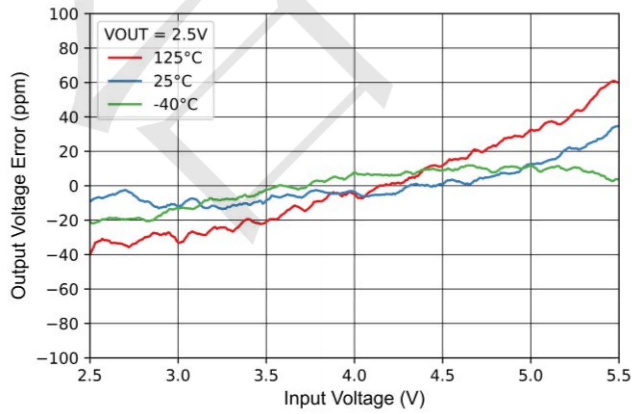
Temperature Drift Histogram



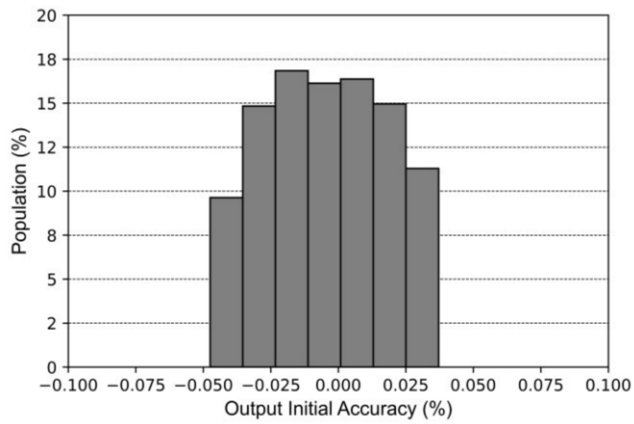
Quiescent Current vs Input Voltage



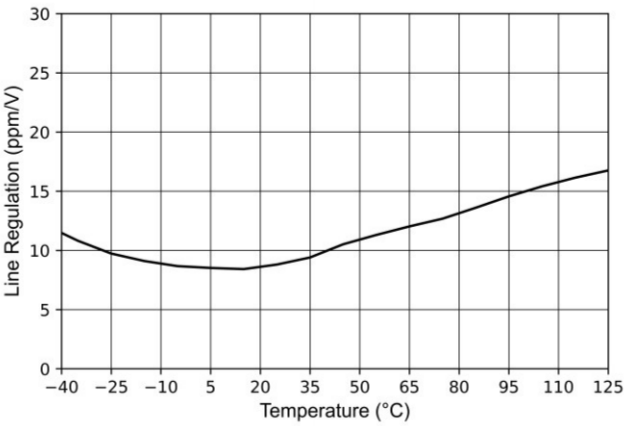
Quiescent Current vs Temperature



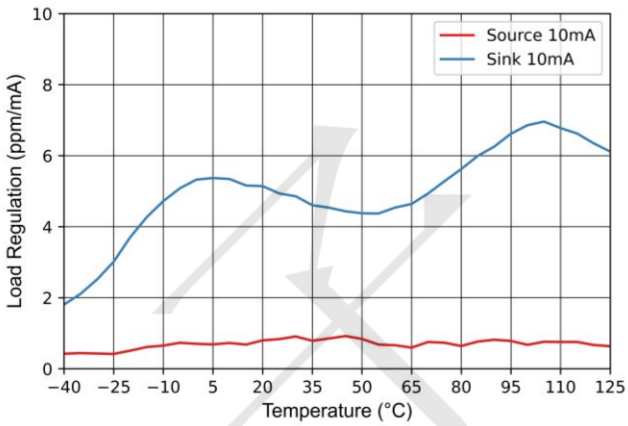
Output Voltage Error vs Input Voltage



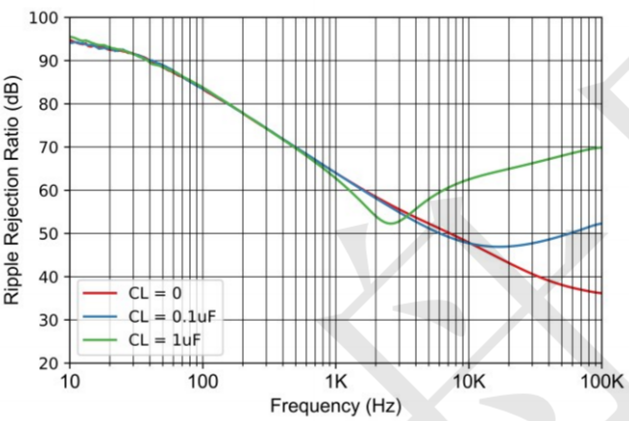
Accuracy Distribution



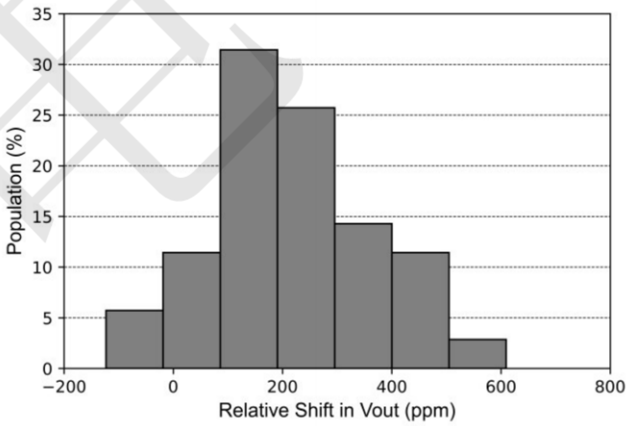
FLine Regulation vs Temperature



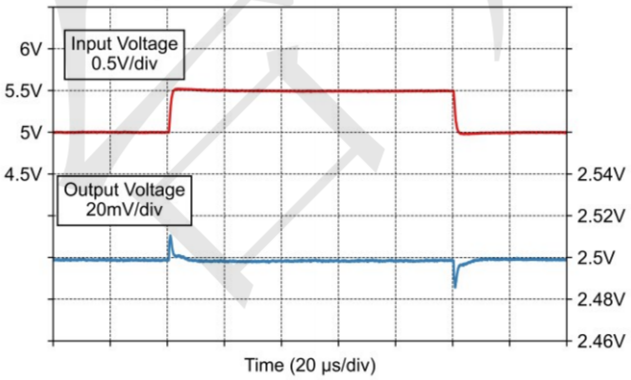
Load Regulation vs Temperature



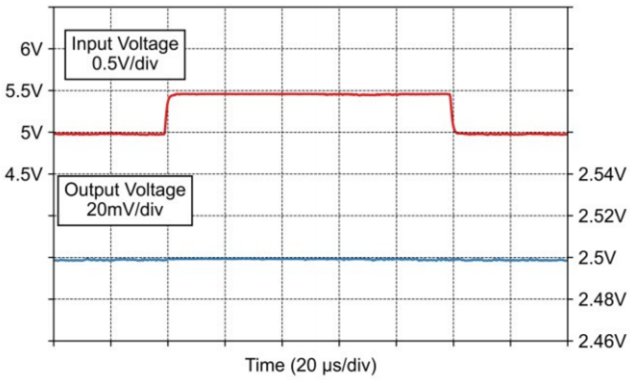
Ripple Rejection Ratio vs Frequency



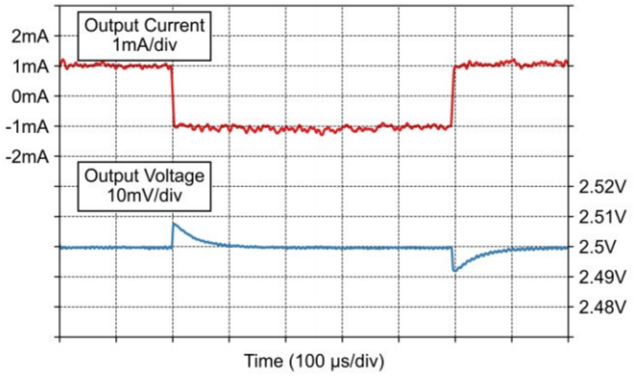
Solder Heat Reflow Shift Histogram



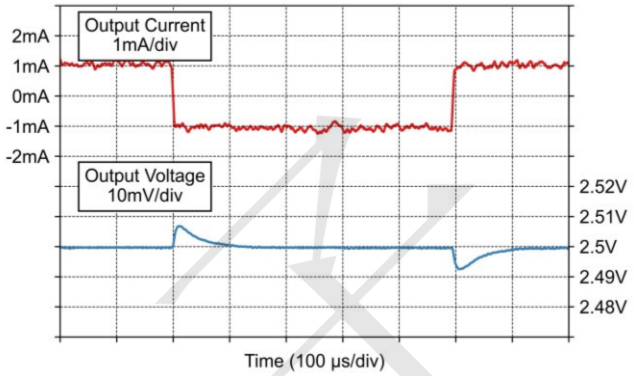
Line Transient Response (C_L=0)



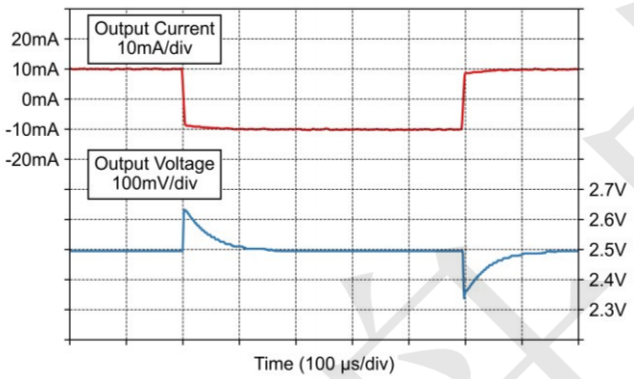
Line Transient Response (C_L=1uF)



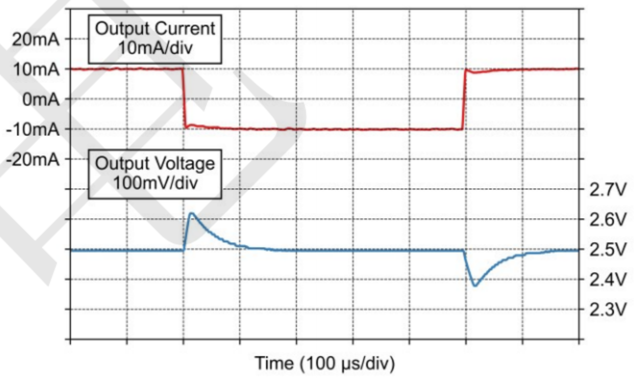
Load Transient Response ±1mA (C_L=0)



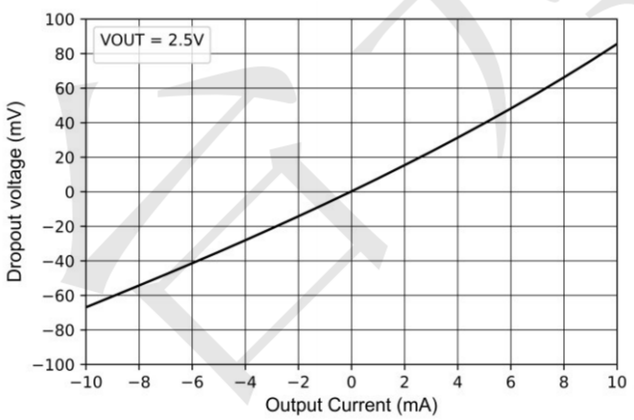
Load Transient Response ±1mA (C_L=1uF)



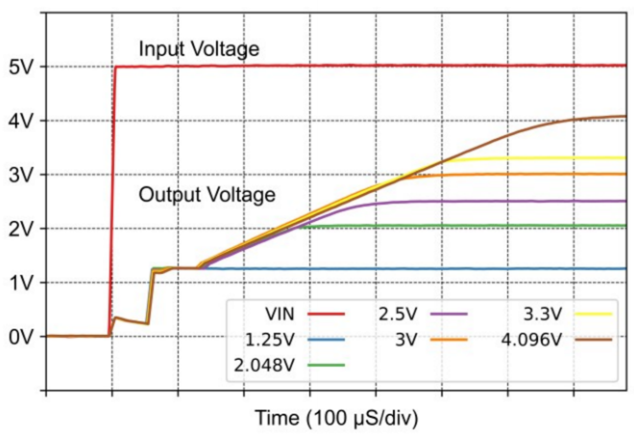
Load Transient Response ±10mA (C_L=0)



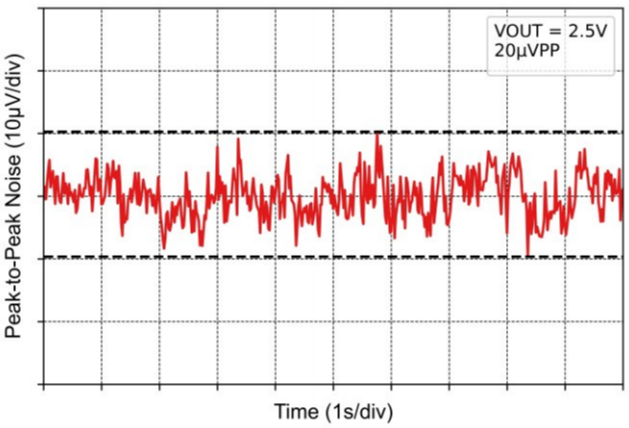
Load Transient Response ±10mA (C_L=1uF)



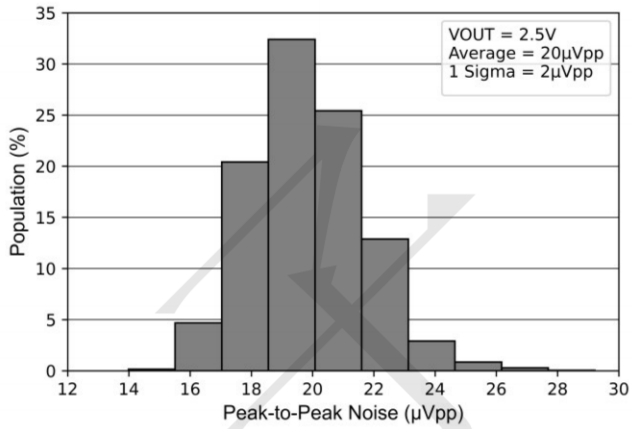
Dropout Voltage vs Load Current



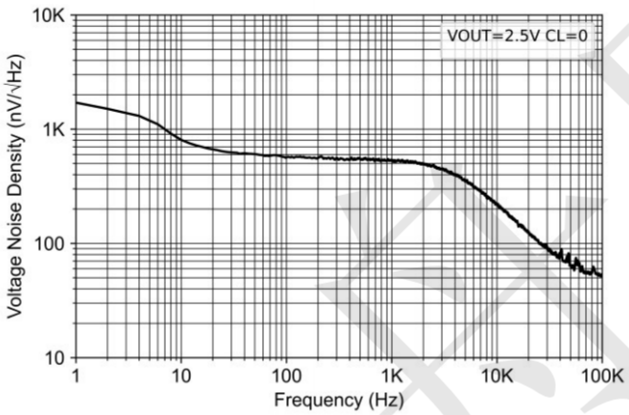
Startup Response



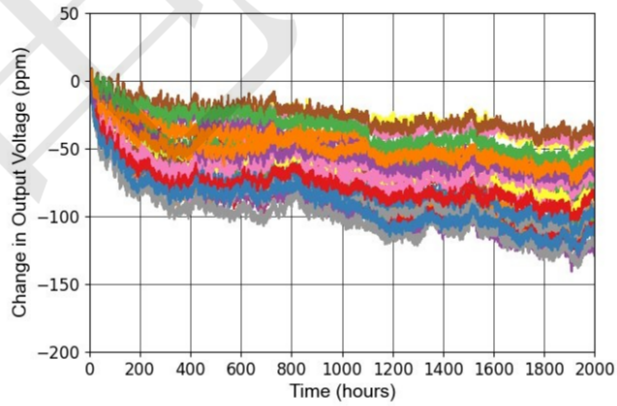
0.1Hz to 10Hz Voltage Noise



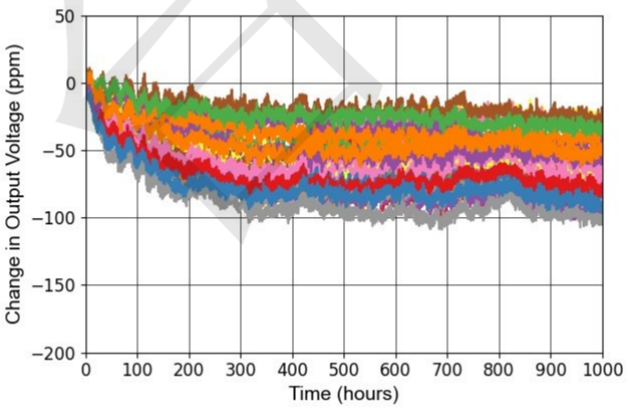
0.1Hz to 10Hz Noise Histogram



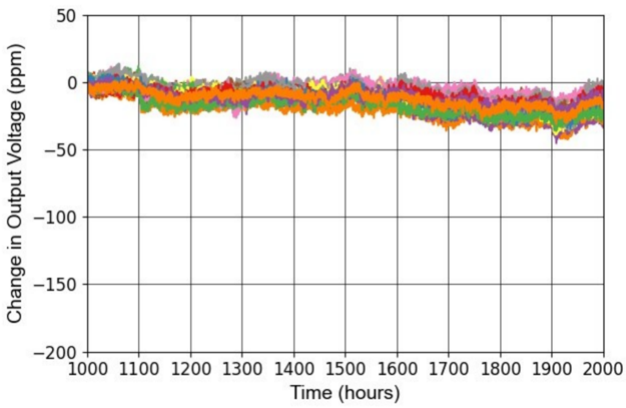
Noise Density vs Frequency



Long Term Drift 0 to 2000 hours, T_A=35°C



Long Term Drift 0 to 1000 hours, T_A=35°C



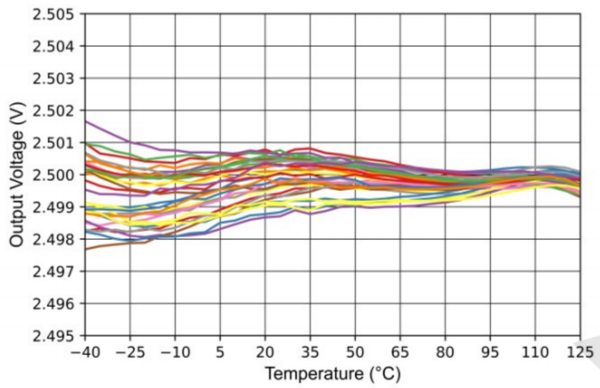
Long Term Drift 1000 to 2000 hours, T_A=35°C

Application Information

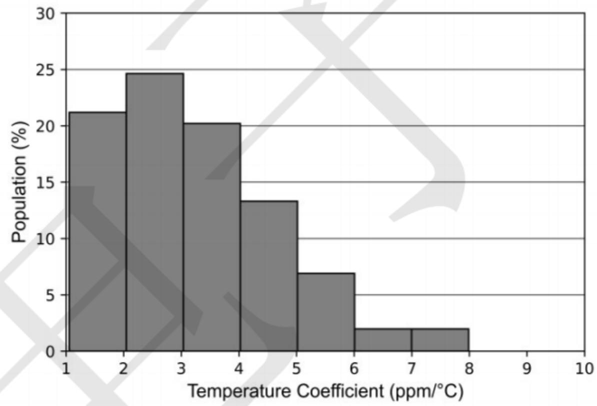
Temperature Coefficient

The temperature coefficient is defined as the change in output voltage over temperature. The temperature coefficient is calculated using the box method in which a box is formed by the minimum and maximum values for the nominal output voltage over the operating temperature range. TPREF31xx series have a low maximum temperature coefficient of 15 ppm/°C from –40°C to +125°C.

$$Temperature\ \text{Coefficient} = \left(\frac{(V_{OUT\_MAX} - V_{OUT\_MIN})}{V_{OUT\_NOMINAL} \times \text{Temperature Range}}\right) \times 10^6$$



Output Voltage vs Temperature

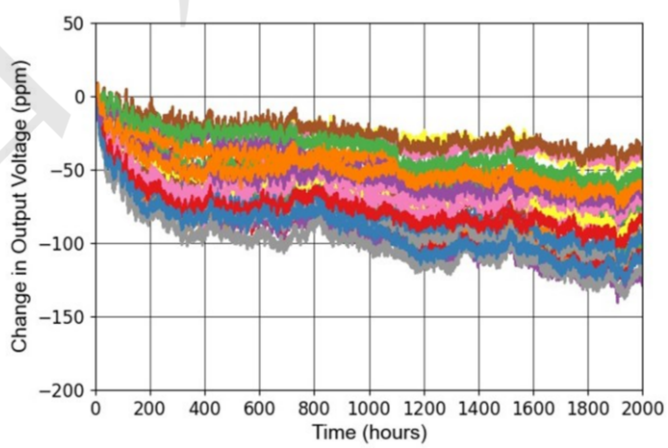


Temperature Drift Histogram

The box method specifies limits for the temperature error but does not specify the exact shape and slope of the devices under test. Due to temperature curvature correction to achieve low-temperature drift, the temperature drift is expected to be non-linear. Use for the box method.

Long-Term Stability

The long-term stability value is tested in a setup that reflects standard PCB board manufacturing practices. The boards are made of standard FR4 material and the board does not have special cuts or grooves around the devices to relieve the mechanical stress of the PCB. The devices and boards in this test do not undergo high temperature burn in post-soldering prior to testing. These conditions replicate real-world system performance and common manufacturing techniques. During the long-term stability testing, the devices under test are maintained at T_A=35°C in an ultra-stable oil bath, their outputs were scanned regularly and measured with an 8.5 digit DVM.

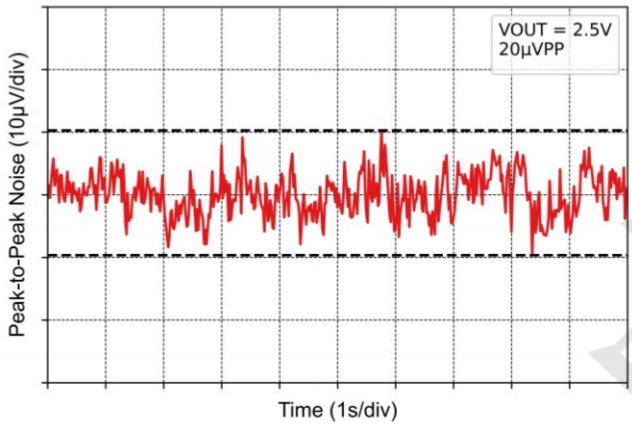


Long Term Drift 0 to 2000 hours, T_A=35°C

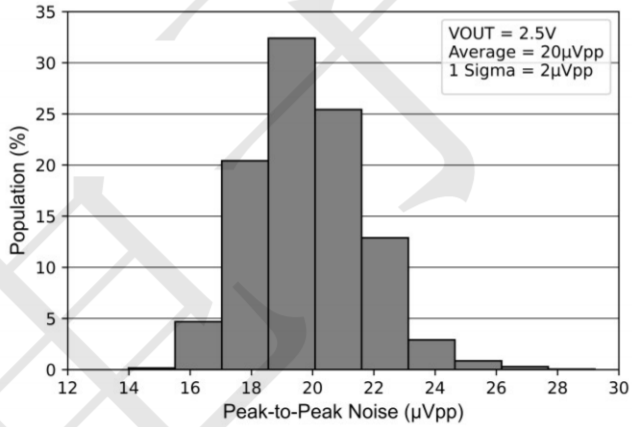
shows that the typical drift value for the TPREF31xx series is 130 ppm from 0 to 2000 hours. It is important to understand that long-term stability is not ensured by design and that the value is typical. The first 250 hours account most drift, Thus, the early life drift is the dominant contributor, whereas the drift after 250 hours is significantly lower.

Noise Performance

Flicker noise, also known as 1/f noise, is a low-frequency noise that affects the device output voltage which can affect precision measurements in a data acquisition system. This noise increases proportionally with output voltage and operating temperature. TPREF31xx series peak-to-peak flicker noise is measured with a 2-pole high-pass filter at 0.1Hz and 2-pole low-pass filter at 10Hz, and the test time is 10 seconds. Due to the statistical nature of noise, repeating noise measurements will yield larger and smaller peak values in a given measurement interval. By repeating the measurement for 2000 intervals, each 10 seconds long, it is shown that there are time intervals during which the noise is higher than in a typical single interval, as predicted by statistical theory. For the 1000 interval test, a typical unit will exhibit noise that is less than the typical value listed in the Electrical Characteristics table in more than 80% of all units.



0.1Hz to 10Hz Voltage Noise



0.1Hz to 10Hz Noise Histogram

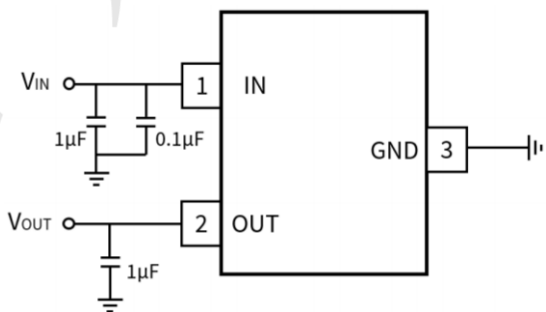
Typical Voltage Reference Connection

Input Capacitors

The TPREF31xx series require a 1µF or larger input capacitor located close to IN pin to improve transient response in applications where the supply voltage may fluctuate. Connect an additional 0.1µF capacitor in parallel to reduce high frequency supply noise.

Load Capacitors

The TPREF31xx series does not require any output capacitance for frequency stability, an additional 1µF to 10µF electrolytic or ceramic capacitor can be added to improve transient performance in response to sudden changes in load current, however, doing so increases the turn-on time of the device.



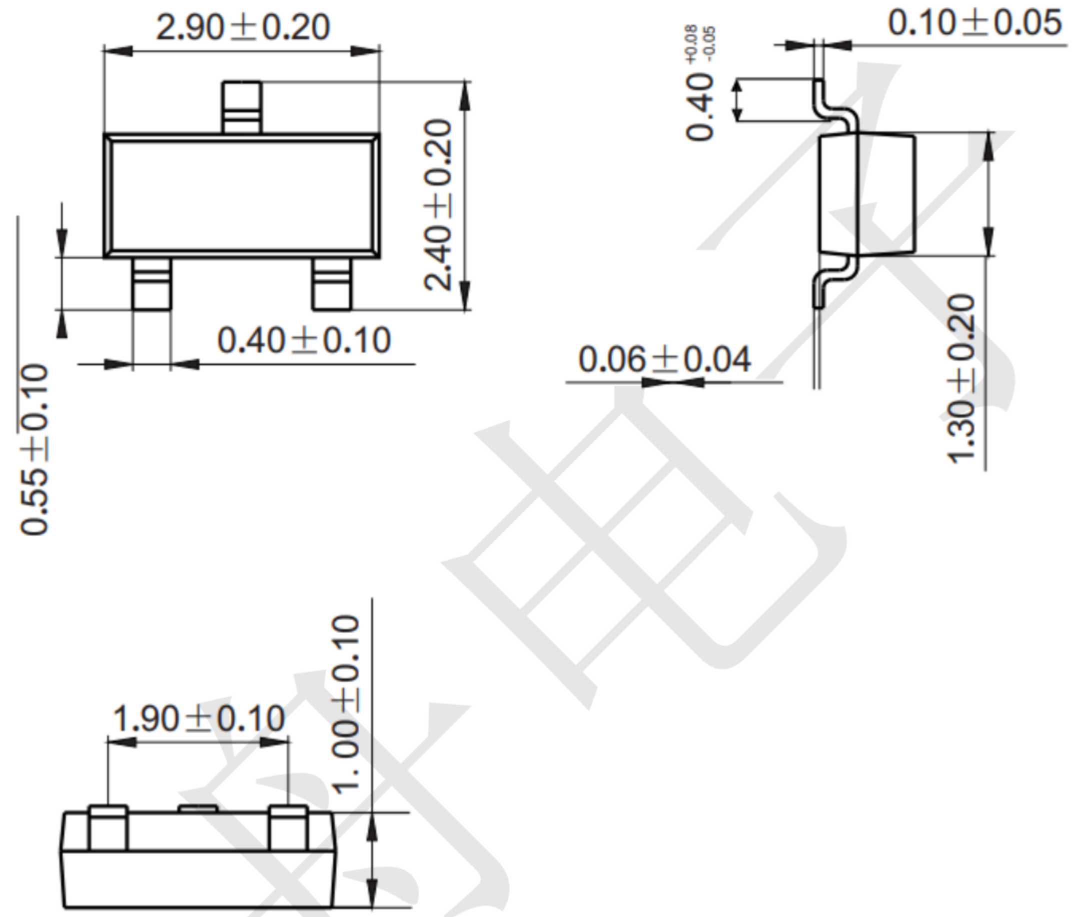
The TPREF31xx Typical Application Circuit

Layout Guidelines

- Connect low-ESR, 0.1-µF ceramic bypass capacitors at IN of the TPREF31xx.
- Connect low-ESR, 1-µF to 10-µF capacitor at OUT of the TPREF31xx.
- Decouple other active devices in the system per the device specifications.
- Using a solid ground plane helps distribute heat and reduces electromagnetic interference (EMI) noise pickup.
- Place the external components as close to the device as possible. This configuration prevents parasitic errors from occurring.

Package informantion (Unit: mm)

SOT23



Mounting Pad Layout (Unit: mm)