MAX6079 Low-Noise Precision Ceramic Voltage Reference

General Description

The MAX6079 offers a very low noise and low-drift voltage reference in a small 8-pin Ceramic package. The device provides a 1/f noise voltage of only 4.8µV_{P-P} at an output voltage of 2.5V, with a temperature drift of 6ppm/°C (max). The device consumes 160µA of supply current and can sink and source up to 10mA of load current. The low-drift and low-noise specifications enable enhanced system accuracy, making these devices ideal for high-precision industrial applications. The MAX6079 offers a noise filter option for wideband applications.

The MAX6079 is available in an 8-pin Ceramic package and is specified over the extended industrial temperature range of -40°C to +125°C.

Applications

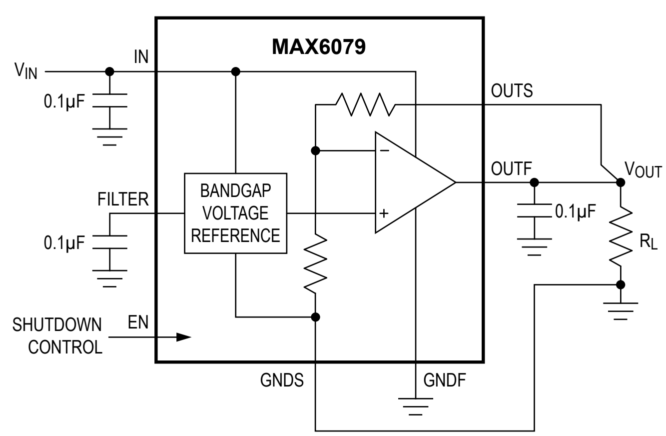
- High-Accuracy Industrial and Process Control
- Precision Instrumentation
- High-Resolution ADCs and DACs
- Precision Current Sources

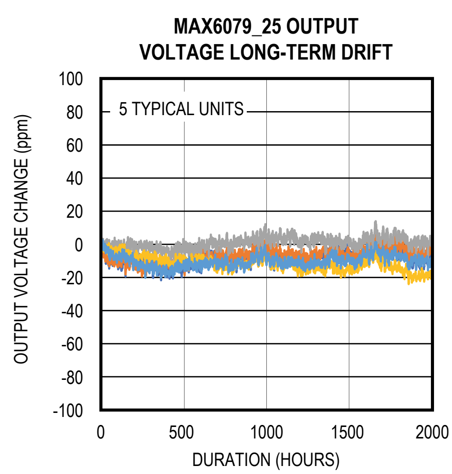
Benefits and Features

- 8-pin Ceramic Package Reduces System Board Space
- Hermetically Sealed Ceramic Package Offers Stable Results vs. Time, Humidity and Temperature
- Stable Performance Over Temperature and Time Improves System Accuracy
  - High ±0.08% Initial Accuracy
  - Low 1.5ppm/°C (typ), 6ppm/°C (max) Temperature Drift
  - Low 4.8µV_{P-P} Noise (0.1Hz to 10Hz) at 2.5V
  - Low 200mV Dropout Voltage
  - High 85dB Ripple Rejection
- Low 160µA Supply Current Reduces Power Consumption
- Filter Option Lowers High-Frequency Noise

***Ordering Information** and **Selector Guide** appears at end of data sheet.*

Typical Operating Circuits





Absolute Maximum Ratings

OUTF to GNDS, GNDF .... -0.3V to the lower of (V_{IN} + 0.3V), +6V
OUTS to GNDS, GNDF..-0.3V to +6V
IN to GNDS, GNDF ....-0.3V to +6V
EN to GNDS, GNDF...-0.3V to +6V
FILTER to GNDS, GNDF........................... -0.3V to the lower of (V_{IN} + 0.3V), +6V
GNDS to GNDF...-0.3V to +0.3V
Continuous Power Dissipation (T_A = +70°C)
LCC (derate 10.30mW/°C above 70°C 387mW
Operating Temperature Range........................ -40°C to +125°C
Junction Temperature ....+150°C
Storage Temperature Range........................... -65°C to +150°C
Soldering Temperature (reflow).....................................+260°C
Lead Temperature (soldering, 10s) ....+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Package Thermal Characteristics (Note 1)

LCC
Junction-to-Ambient Thermal Resistance (θ_{JA}).........96.90°C/W
Junction-to-Case Thermal Resistance (θ_{JC}).............18.30°C/W

Note 1: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to www.maximintegrated.com/thermal-tutorial.

Electrical Characteristics—MAX6079ALA25 (V_{OUT} = 2.500V)

(V_{IN} = +5.0V, I_{OUT} = 0mA, C_{OUT} = 0.1µF, T_A = -40°C to +125°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
OUTPUT							
Output Voltage Accuracy		T_A = +25°C		-0.08		+0.08	%
Output Voltage Temperature Drift (Note 3)	TCV_{OUT}				1	6	ppm/°C
Line Regulation		Over specified V_{IN} range	T_A = +25°C		90	300	µV/V
			T_A = T_{MIN} to T_{MAX}			350	
Load Regulation		0mA < I_{OUT} < 10mA, sink			80	160	µV/mA
		0mA < I_{OUT} < 10mA, source			75	145	
Dropout Voltage		I_{OUT} = 10mA, T_A = T_{MIN} to T_{MAX} (Note 4)			110	240	mV
Output Current	I_{OUT}	Guaranteed by load regulation		-10		+10	mA
Short-Circuit Current	I_{SC}	Sourcing to ground			25		mA
		Sinking from V_{IN}			25		
Long-Term Stability		1000 hours at T_A = +25°C			10		ppm
Thermal Hysteresis		(Note 5)			10		ppm

Electrical Characteristics—MAX6079ALA25 (V_{OUT} = 2.500V) (continued)

(V_{IN} = +5.0V, I_{OUT} = 0mA, C_{OUT} = 0.1µF, T_A = -40°C to +125°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DYNAMIC CHARACTERISTICS							
Noise Voltage	e_{OUT}	1/f noise, 0.1Hz to 10Hz, C_{OUT} = 0.1µF			4.8		$µV_{P-P}$
		Thermal noise, 10Hz to 10kHz, C_{OUT} = 0.1µF			6		$µV_{RMS}$
		Thermal noise, 10Hz to 10kHz, C_{OUT} = 0.1µF, C_{FILTER} = 0.1µF			3		
Noise Spectral Density		Thermal noise, f = 1kHz, C_{OUT} = 0.1µF			60		$nV/\sqrt{Hz}$
		Thermal noise, f = 1kHz, C_{OUT} = 0.1µF, C_{FILTER} = 0.1µF			30		
Ripple Rejection		Frequency = 60Hz			84		dB
Turn-On Settling Time	t_R	Settling to 0.01%, C_{OUT} = 0.1µF	C_{FILTER} = 0.1µF		10		ms
			C_{FILTER} = 0µF		30		µs
Enable Settling Time	t_{EN}	Settling to 0.01%, C_{OUT} = 0.1µF	C_{FILTER} = 0.1µF		10		ms
			C_{FILTER} = 0µF		75		µs
Capacitive-Load Stability Range		I_{OUT} ≤ 10mA		0.1		10	µF
INPUT							
Supply Voltage	V_{IN}	Guaranteed by line regulation		2.8		5.5	V
Quiescent Supply Current	I_{IN}	T_A = +25°C			160	245	µA
		T_A = T_{MIN} to T_{MAX}				330	
Shutdown Supply Current	I_{SD}				0.6	6	µA
ENABLE/SHUTDOWN							
Enable Input Current	I_{EN}			-1		+1	µA
Enable Logic-High	V_{IH}			0.7 x V_{IN}			V
Enable Logic-Low	V_{IL}					0.3 x V_{IN}	

Note 2: Limits are 100% production tested at T_A = +25°C. Specifications where T_A < +25°C or T_A > +25°C are guaranteed by design and characterization.

Note 3: Temperature coefficient is calculated using the "box method" which measures temperature drift as the maximum voltage variation over a specified temperature range. The unit of measurement is ppm/°C.

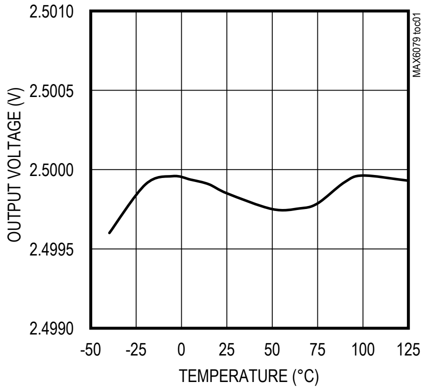
Note 4: Dropout voltage is defined as the minimum differential voltage (V_{IN} - V_{OUT}) at which V_{OUT} decreases by 0.2% from its original value at V_{IN} = 5.0V.

Note 5: Thermal hysteresis is defined as the change in +25°C output voltage before and after cycling the device from T_{MAX} to T_{MIN}.

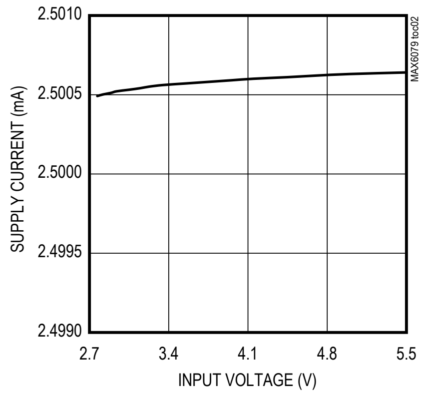
Note 6: Dropout voltage is defined as the minimum differential voltage (V_{IN} – V_{OUT}) at which V_{OUT} decreases by 0.2% from its original value at V_{IN} = 5.5V.

Typical Operating Characteristics

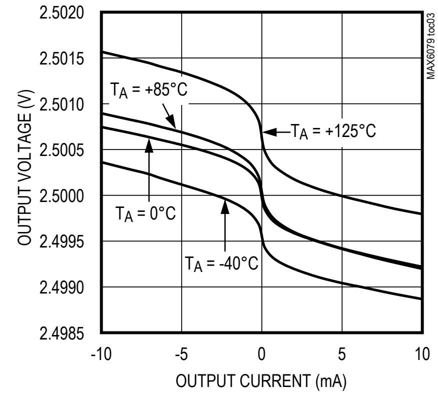
(T_A = +25°C, unless otherwise noted.)



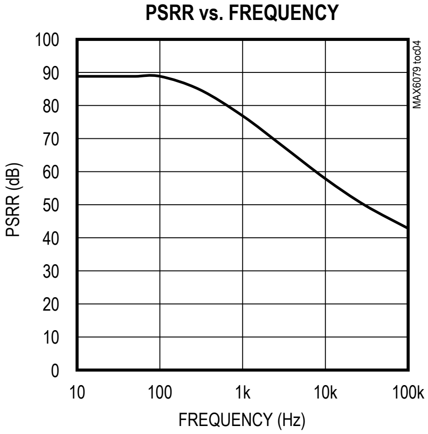
MAX6079_25 OUTPUT VOLTAGE TEMPERATURE DRIFT



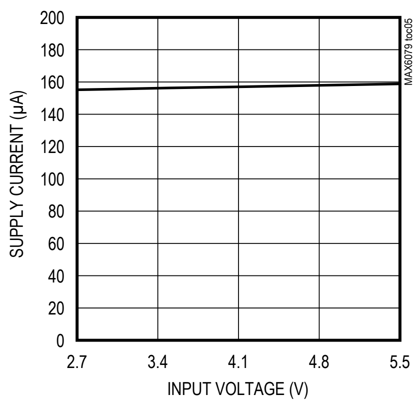
MAX6079_25 LINE REGULATION



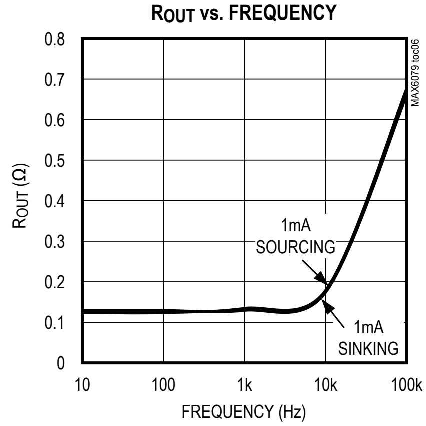
MAX6079_25 LOAD REGULATION



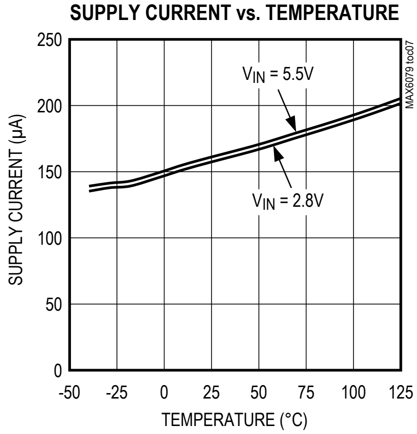
MAX6079_25 PSRR vs. FREQUENCY



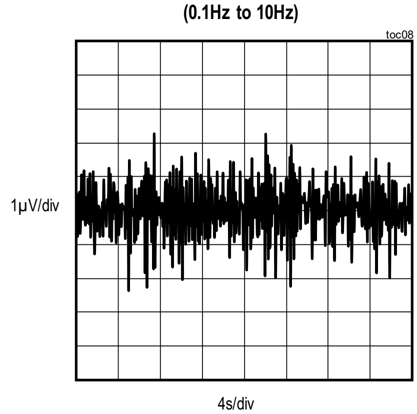
MAX6079_25 SUPPLY CURRENT vs. INPUT VOLTAGE



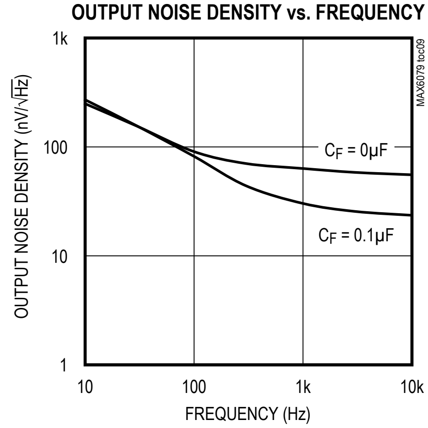
MAX6079_25 R_{OUT} vs. FREQUENCY



MAX6079_25 SUPPLY CURRENT vs. TEMPERATURE



MAX6079_25 PEAK-PEAK VOLTAGE NOISE (0.1Hz to 10Hz)

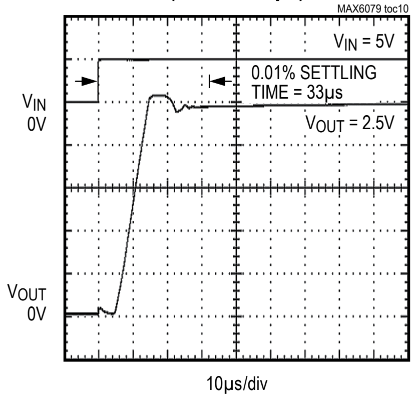


MAX6079_25 OUTPUT NOISE DENSITY vs. FREQUENCY

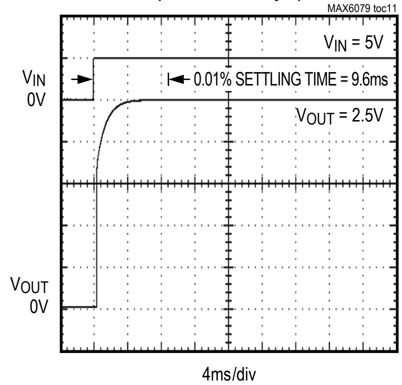
Typical Operating Characteristics (continued)

(T_A = +25°C, unless otherwise noted.)

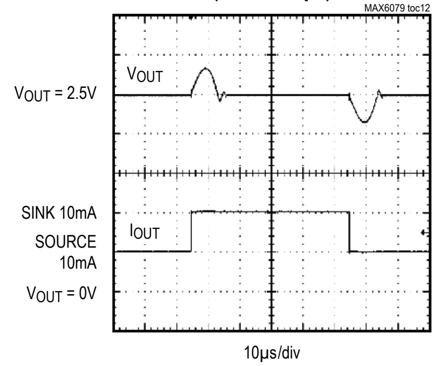
MAX6079_25 TURN-ON TRANSIENT (C_{FILTER} = 0µF)



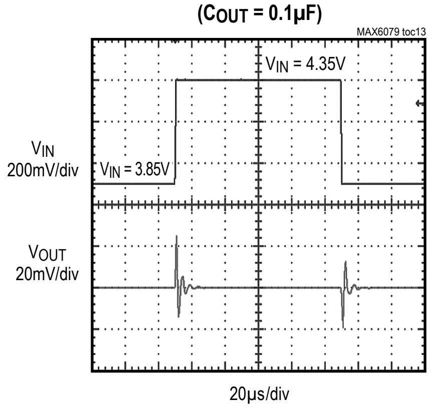
MAX6079_25 TURN-ON TRANSIENT (C_{FILTER} = 0.1µF)



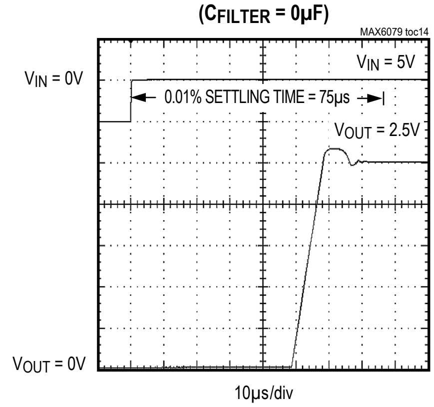
MAX6079_25 ±10mA LOAD TRANSIENT (C_{OUT} = 0.1µF)



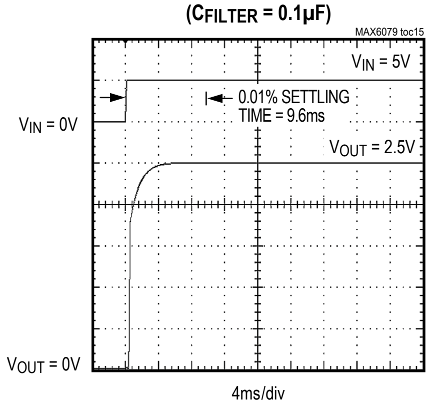
MAX6079_25 LINE TRANSIENT (C_{OUT} = 0.1µF)



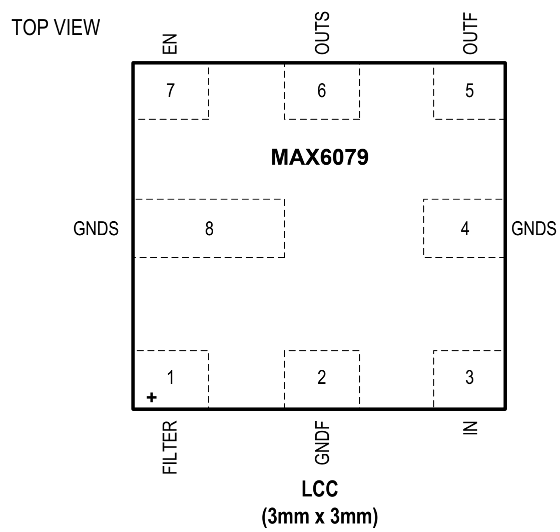
MAX6079_25 ENABLE TRANSIENT (C_{FILTER} = 0µF)



MAX6079_25 ENABLE TRANSIENT (C_{FILTER} = 0.1µF)



Pin Configuration



Pin Description

PIN	NAME	FUNCTION
1	FILTER	Filter Input. Connect a 0.1µF capacitor from FILTER to ground to provide high-frequency bypass. Leave unconnected, if not used.
2	GNDF	Ground Force
3	IN	Supply Input
4, 8	GNDS	Ground Sense. Connect to ground connection at the load.
5	OUTF	Voltage Reference Force Output. Short OUTF to OUTS as close as possible to the load. Bypass OUTF with a capacitor (0.1µF to 10µF) to GND.
6	OUTS	Voltage Reference Sense Output
7	EN	Enable. Drive high to enable the device. Drive low to disable the device.

Detailed Description

Wideband Noise Reduction (FILTER)

To improve wideband noise and transient power-supply noise with the MAX6079, connect a 0.1µF capacitor from FILTER to GND (*see the Typical Operating Characteristics*). Larger values do not appreciably improve noise reduction. A 0.1µF capacitor reduces the spectral noise density at 1kHz from $60nV/\sqrt{Hz}$ to $30nV/\sqrt{Hz}$ for the 2.5V output. Noise at the input pin can affect output noise, but can be reduced by connecting an optional bypass capacitor between IN and GND as shown in Figure 1.

Output Bypassing

The MAX6079 require an output capacitor between 0.1µF and 10µF. Place the output capacitor as close to OUTF as possible. For applications driving switching capacitive loads or rapidly changing load currents, use a 0.1µF capacitor in parallel with a larger load capacitor to reduce equivalent series resistance (ESR). Larger capacitor values and lower ESR reduce transients on the reference output.

Supply Current

The MAX6079 draw 160µA of current and is virtually independent of the supply voltage, with only a 1.6µA/V variation with supply voltage.

Thermal Hysteresis

Thermal hysteresis is the change of output voltage at T_A = +25°C before and after the device is cycled over its entire operating temperature range. The typical thermal hysteresis value is 10ppm.

Turn-On Time

These devices typically turn on and settle to within 0.01% of their final value in 30µs. A noise reduction capacitor of 0.1µF increases the turn-on time of the MAX6079 to 10ms.

Output Force and Sense

The MAX6079 provides independent connections for the force output (OUTF) supplying current to the load and the circuit input regulating the load voltage via the output sense pin (OUTS). This configuration allows for the cancellation of the voltage drop on the lines connecting the MAX6079 and the load. When using the Kelvin connection made possible by the independent force and sense outputs, connect OUTF to the load and connect OUTS to OUTF at the point where the voltage accuracy is needed (see Figure 1). The MAX6079 features the same type of Kelvin connection to cancel drops in the ground return line. Connect the load to ground and connect GNDS to ground as close as possible to the load ground connection (see Figure 1).

Shutdown

The MAX6079 features an active-high enable pin (EN). Pulling EN low disables the output with a resistive load to ground and forces the quiescent current to less than 1µA. The value of the load is typically 200kΩ. Pulling EN high enables normal operation.

Applications Information

Wideband Noise Reduction

Figure 1 shows a typical noise reduction filter application circuit. Note that the use of the wideband noise filter will increase turn-on time.

High-Resolution DAC and Reference from a Single Supply

Figure 1 shows a typical circuit providing the reference for a high-resolution, 16-bit MAX541 DAC.

Precision Current Source

Figure 2 shows a typical circuit providing a precision current source. The OUTF output provides the bias current for the bipolar transistor. OUTS and GNDS sense the voltage across the resistor and adjust the current sourced by OUTF accordingly.

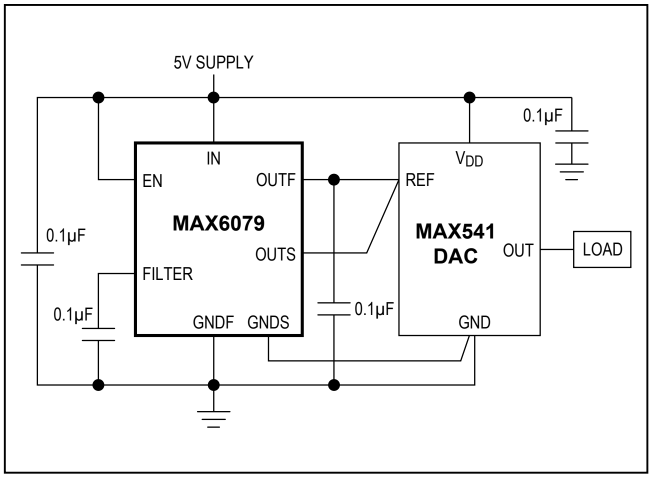


Figure 1. Reference Ground Kelvin Connection

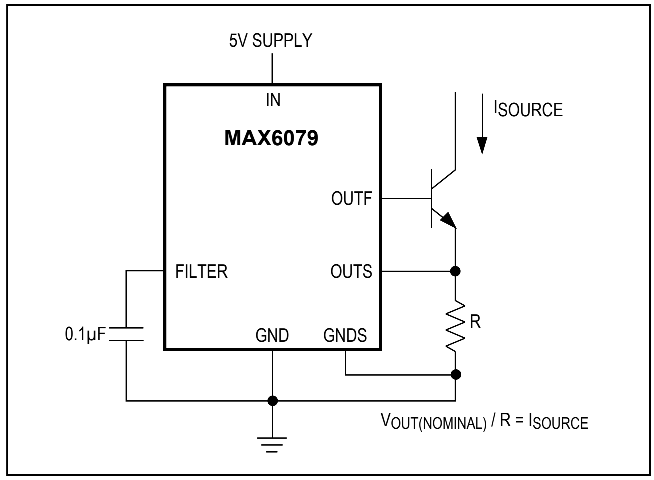


Figure 2. Precision Current Source

The MAX6079 in Ceramic LCC Package

The MAX6079's ceramic LCC package is a hermetic ceramic package that gives substantially better performance than plastic, while at the same time is a small, surface-mount package. The MAX6079 die is packaged in this ceramic 8-LCC package that prevents the reference voltage from getting mechanical disturbances from humid environments, improving long-term drift and thermal hysteresis. The MAX6079's ceramic package shows excellent output long term drift of 10ppm typical (see Figure 3).

Thermal Hysteresis is also improved in the Ceramic LCC package. Hysteresis is the change in the output voltage is created by mechanical stress that applied to the device depending on whether it was previously at a higher or lower temperature. Output voltage is always measured at T_A = +25°C before and after the device is cycled over its entire operating temperature range. The MAX6079 has a typical hysteresis value of 10ppm.

Even though the hermitically-sealed ceramic MAX6079 prevents the reference output from getting mechanical disturbances from humid environments, the PC board can be affected by humidity, and in turn causes mechanical stress to the MAX6079 being mounted on it. Proper board layout is critical for best stability and performance. Refer to the MAX6079 EVKit data sheet for recommended layout guidelines and power supply bypassing.

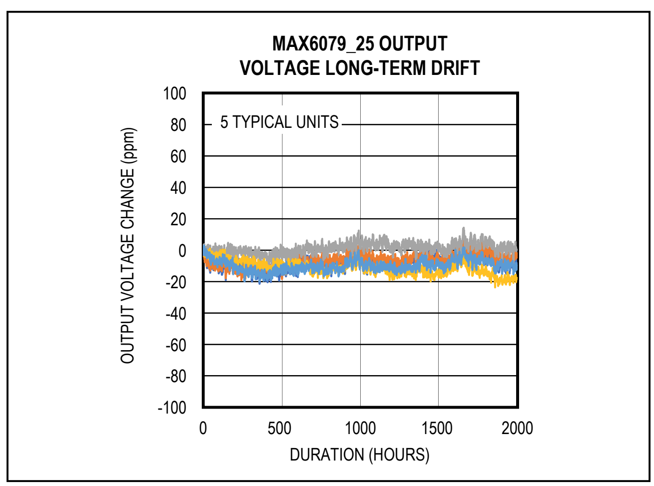


Figure 3. Output Voltage Long-Term Drift of the MAX6079 in Ceramic LCC Package

Selector Guide*

PART	FILTER	V_{OUT} (V)	ACCURACY (%)	TOP MARK
MAX6079ALA25+T	Yes	2.5	0.04	ADZE

/V denotes an automotive qualified part.
+Denotes a lead(Pb)-free/RoHS-compliant package.
T = Tape and reel.
**For other output voltages, contact manufacturer for availibility.*

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX6079ALA25+T	-40°C to +125°C	8 LCC

+Denotes a lead(Pb)-free/RoHS-compliant package.
T = Tape and reel.

Chip Information

PROCESS: BIPOLAR

Package Information

For the latest package outline information and land patterns (footprints), go to **www.maximintegrated.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.	LAND PATTERN NO.
8 LCC	L8+1	21-100203	90-100085

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	3/18	Initial release	—
1	4/18	Updated system accuracy values	1, 2

