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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 $4.8\mu\text{V}_{\text{P-P}}$ at an output voltage of 2.5V, with a temperature drift of $6\text{ppm}/^{\circ}\text{C}$ (max). The device consumes $160\mu\text{A}$ 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 $+125^{\circ}\text{C}$.

Applications

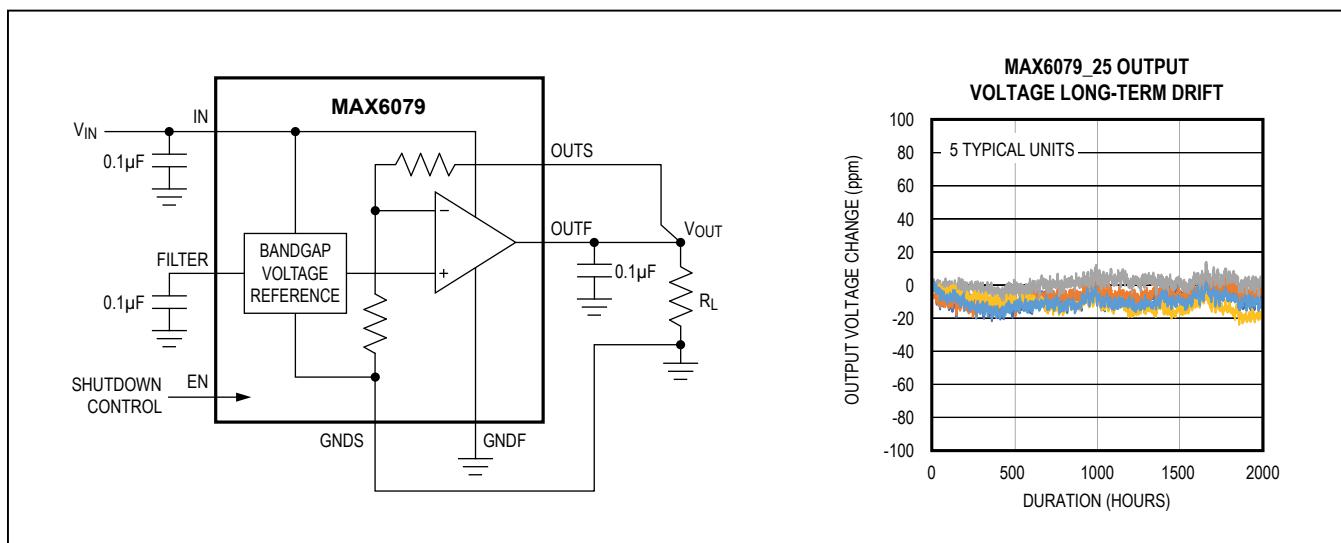
- High-Accuracy Industrial and Process Control
- Precision Instrumentation
- High-Resolution ADCs and DACs
- Precision Current Sources

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 $\pm 0.08\%$ Initial Accuracy
 - Low $1.5\text{ppm}/^{\circ}\text{C}$ (typ), $6\text{ppm}/^{\circ}\text{C}$ (max) Temperature Drift
 - Low $4.8\mu\text{V}_{\text{P-P}}$ Noise (0.1Hz to 10Hz) at 2.5V
 - Low 200mV Dropout Voltage
 - High 85dB Ripple Rejection
- Low $160\mu\text{A}$ 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	Continuous Power Dissipation ($T_A = +70^\circ C$)
OUTS to GNDS, GNDF	-0.3V to +6V	LCC (derate 10.30mW/ $^\circ C$ above $70^\circ C$) 387mW
IN to GNDS, GNDF	-0.3V to +6V	Operating Temperature Range -40 $^\circ C$ to +125 $^\circ C$
EN to GNDS, GNDF	-0.3V to +6V	Junction Temperature +150 $^\circ C$
FILTER to GNDS, GNDF	-0.3V to the lower of ($V_{IN} + 0.3V$), +6V	Storage Temperature Range -65 $^\circ C$ to +150 $^\circ C$
GNDS to GNDF	-0.3V to +0.3V	Soldering Temperature (reflow) +260 $^\circ C$
		Lead Temperature (soldering, 10s) +300 $^\circ C$

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 $^\circ C/W$	Junction-to-Case Thermal Resistance (θ_{JC}) 18.30 $^\circ C/W$

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 ($V_{OUT} = 2.500V$)

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
OUTPUT						
Output Voltage Accuracy		$T_A = +25^\circ C$	-0.08	+0.08		%
Output Voltage Temperature Drift (Note 3)	TCV_{OUT}			1	6	$\mu\text{V}/^\circ C$
Line Regulation		Over specified V_{IN} range	90	300		$\mu\text{V}/V$
		$T_A = +25^\circ C$		350		
Load Regulation		$T_A = T_{MIN} \text{ to } T_{MAX}$				
		0mA < I_{OUT} < 10mA, sink	80	160		$\mu\text{V}/\text{mA}$
		0mA < I_{OUT} < 10mA, source	75	145		
Dropout Voltage		$I_{OUT} = 10mA$, $T_A = T_{MIN} \text{ to } T_{MAX}$ (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 $T_A = +25^\circ C$	10			ppm
Thermal Hysteresis		(Note 5)	10			ppm

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

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

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

Note 2: Limits are 100% production tested at $T_A = +25^\circ C$. Specifications where $T_A < +25^\circ C$ or $T_A > +25^\circ C$ 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 $ppm/^\circ C$.

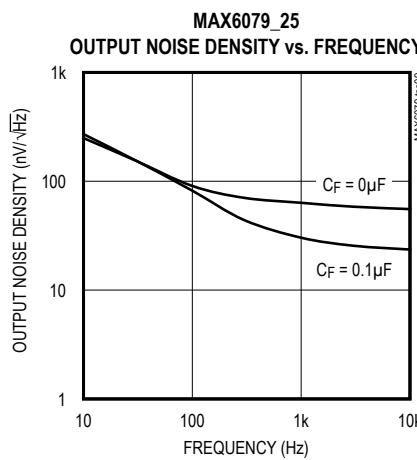
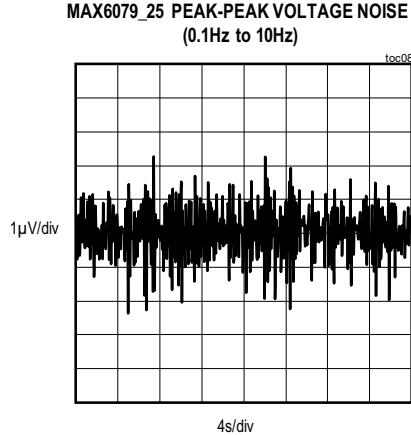
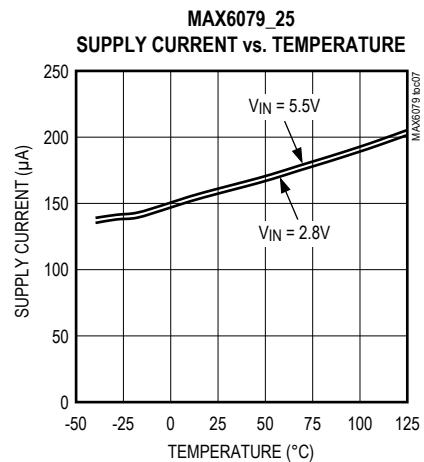
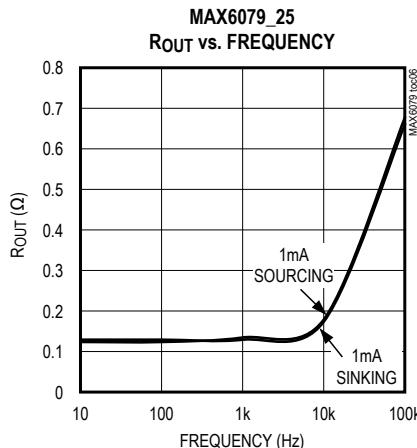
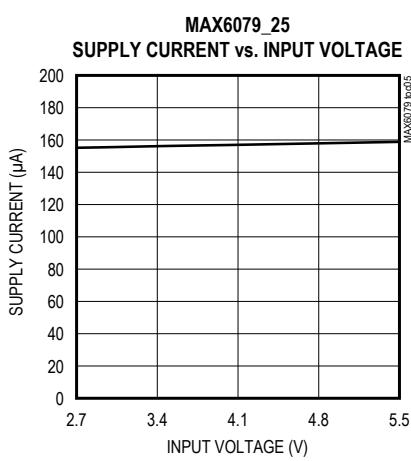
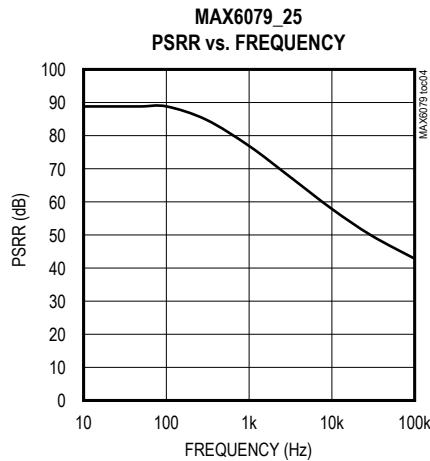
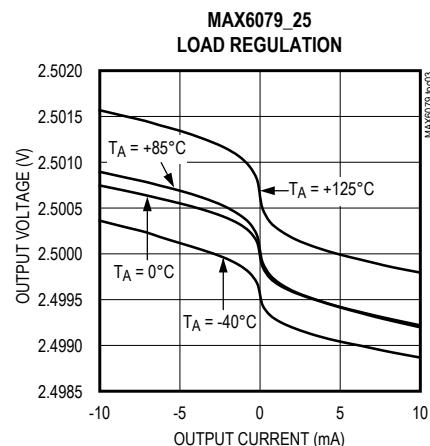
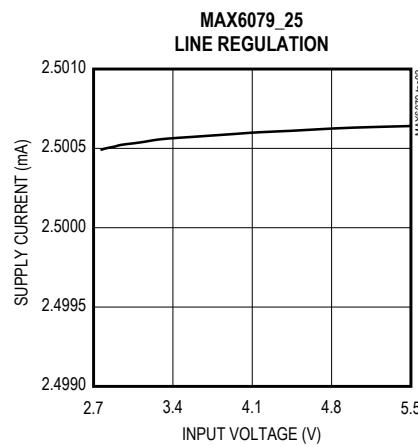
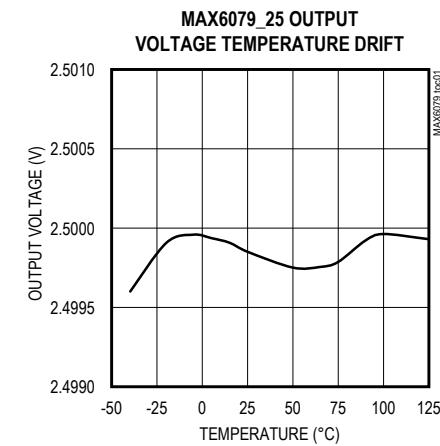
Note 4: Dropout voltage is defined as the minimum differential voltage ($V_{IN} - V_{OUT}$) at which V_{OUT} decreases by 0.2% from its original value at $V_{IN} = 5.0V$.

Note 5: Thermal hysteresis is defined as the change in $+25^\circ C$ 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 $V_{IN} = 5.5V$.

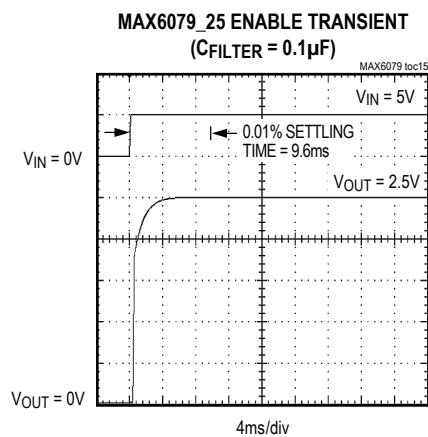
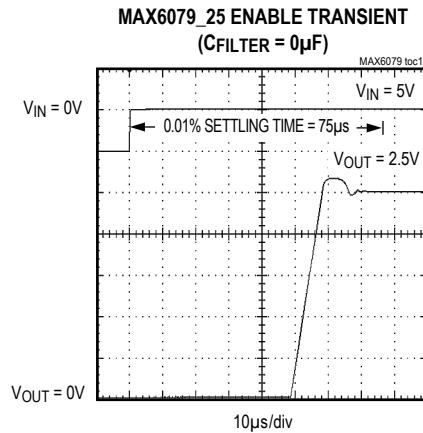
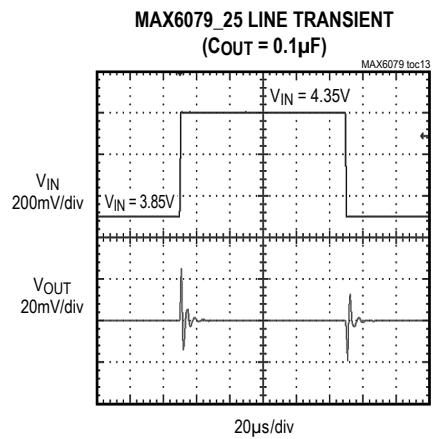
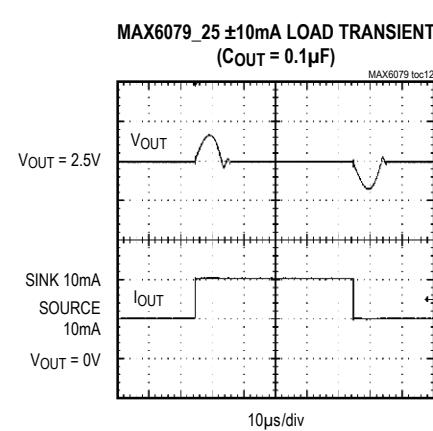
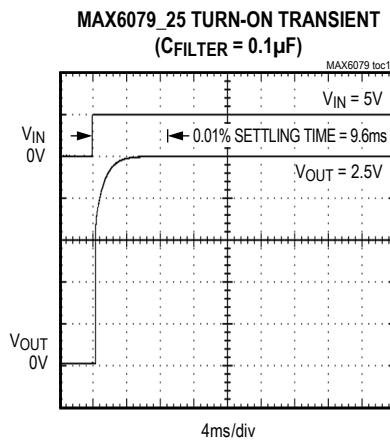
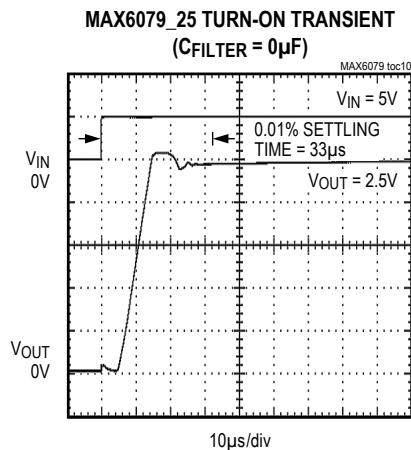
Typical Operating Characteristics

($T_A = +25^\circ\text{C}$, unless otherwise noted.)

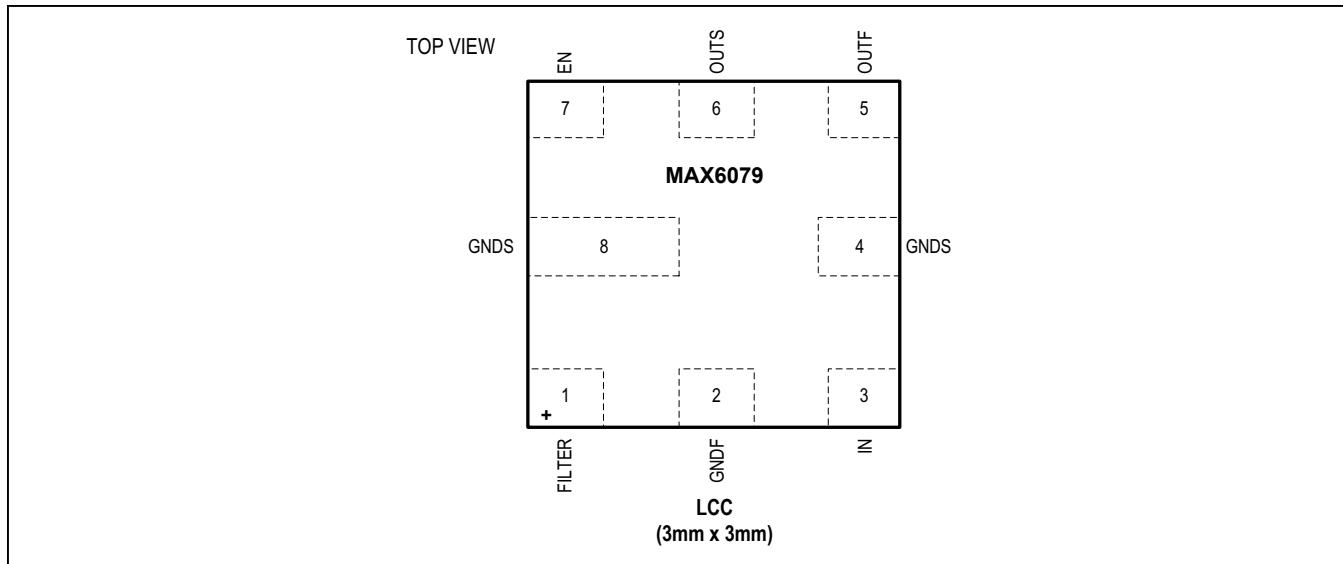


Typical Operating Characteristics (continued)

($T_A = +25^\circ\text{C}$, unless otherwise noted.)



Pin Configuration



Pin Description

PIN	NAME	FUNCTION
1	FILTER	Filter Input. Connect a 0.1 μ F 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 (0.1 μ F to 10 μ F) 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 0.1 μ F capacitor from FILTER to GND (see the [Typical Operating Characteristics](#)). Larger values do not appreciably improve noise reduction. A 0.1 μ F capacitor reduces the spectral noise density at 1kHz from 60nV/ $\sqrt{\text{Hz}}$ to 30nV/ $\sqrt{\text{Hz}}$ 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 0.1 μ F and 10 μ F. Place the output capacitor as close to OUTF as possible. For applications driving switching capacitive loads or rapidly changing load currents, use a 0.1 μ F 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 160 μ A of current and is virtually independent of the supply voltage, with only a 1.6 μ A/V variation with supply voltage.

Thermal Hysteresis

Thermal hysteresis is the change of output voltage at $T_A = +25^\circ\text{C}$ 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 30 μ s. A noise reduction capacitor of 0.1 μ F 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 1 μ A. The value of the load is typically 200 $\text{k}\Omega$. 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.

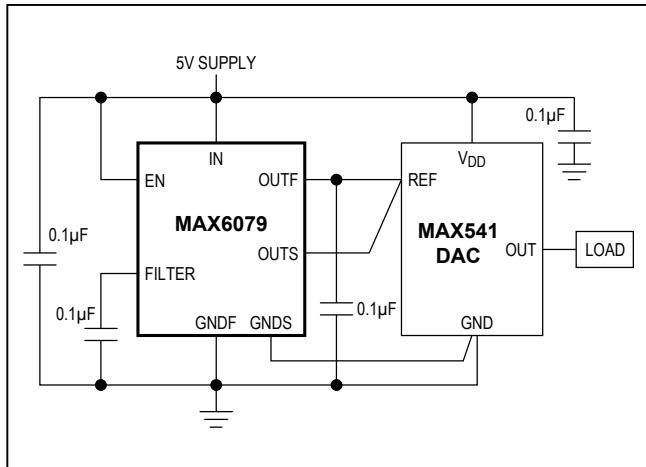


Figure 1. Reference Ground Kelvin Connection

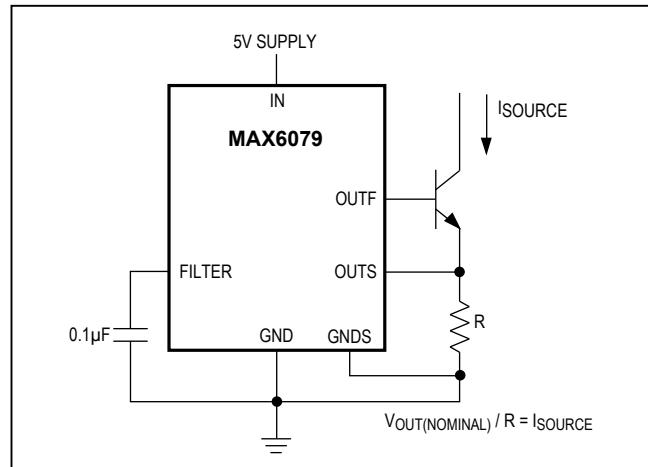


Figure 2. Precision Current Source

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 $T_A = +25^\circ\text{C}$ 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 hermetically-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.

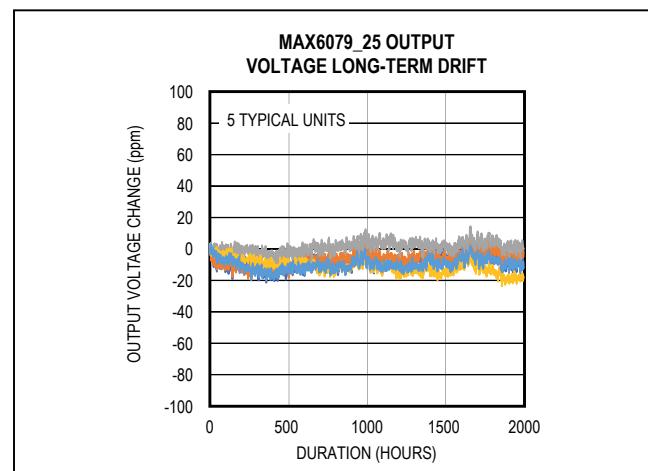


Figure 3. Output Voltage Long-Term Drift of the MAX6079 in Ceramic LCC Package

Selector Guide*

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

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

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