

REF02

For most current data sheet and other product information, visit www.burr-brown.com

+5V Precision VOLTAGE REFERENCE

FEATURES

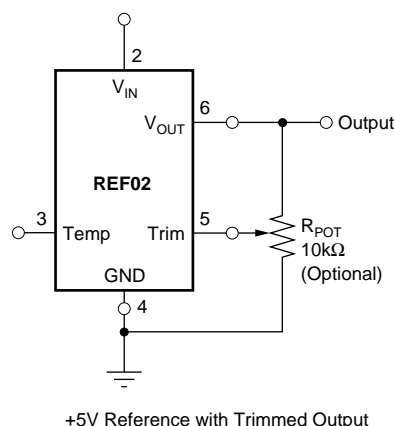
- **OUTPUT VOLTAGE:** +5V $\pm 0.2\%$ max
- **EXCELLENT TEMPERATURE STABILITY:** 10ppm/ $^{\circ}\text{C}$ max (-40°C to $+85^{\circ}\text{C}$)
- **LOW NOISE:** 10 μV p-p max (0.1Hz to 10Hz)
- **EXCELLENT LINE REGULATION:** 0.01%/V max
- **EXCELLENT LOAD REGULATION:** 0.008%/mA max
- **LOW SUPPLY CURRENT:** 1.4mA max
- **SHORT-CIRCUIT PROTECTED**
- **WIDE SUPPLY RANGE:** 8V to 40V
- **INDUSTRIAL TEMPERATURE RANGE:** -40°C to $+85^{\circ}\text{C}$
- **PACKAGE OPTIONS:** DIP-8, SO-8

DESCRIPTION

The REF02 is a precision 5V voltage reference. The drift is laser trimmed to 10ppm/ $^{\circ}\text{C}$ max over the extended industrial and military temperature range. The REF02 provides a stable 5V output that can be externally adjusted over a $\pm 6\%$ range with minimal effect on temperature stability. The REF02 operates from a single supply with an input range of 8V to 40V with a very low current drain of 1mA, and excellent temperature stability due to an improved design. Excellent line and load regulation, low noise, low power, and low cost make the REF02 the best choice whenever a 5V voltage reference is required. All popular package options are available: plastic DIP, and SO. The REF02 is an ideal choice for portable instrumentation, temperature transducers, Analog-to-Digital (A/D) and Digital-to-Analog (D/A) converters, and digital voltmeters.

APPLICATIONS

- PRECISION REGULATORS
- CONSTANT CURRENT SOURCE/SINK
- DIGITAL VOLTMETERS
- V/F CONVERTERS
- A/D AND D/A CONVERTERS
- PRECISION CALIBRATION STANDARD
- TEST EQUIPMENT



SPECIFICATIONS

ELECTRICAL

At $T_A = +25^{\circ}\text{C}$ and $V_{IN} = +15\text{V}$ power supply, unless otherwise noted.

PARAMETER	CONDITIONS	REF02A			REF02B			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE Change with Temperature ^(1, 2) (ΔV_{OT}) -40°C to +85°C	$I_{LOAD} = 0\text{mA}$	4.985	5.0 0.05	5.015 0.19	4.990	* 0.05	5.010 0.13	V %
OUTPUT VOLTAGE DRIFT⁽³⁾ -40°C to +85°C (TCV_O)			4	15		4	10	$\pm\text{ppm}/^{\circ}\text{C}$
LONG-TERM STABILITY First 1000h Second 1000h	2000h Test		100 50			100 50		$\pm\text{ppm}$ $\pm\text{ppm}$
OUTPUT ADJUSTMENT RANGE	$R_{POT} = 10\text{k}\Omega^{(6)}$	± 3	± 6		*	*		%
CHANGE IN V_O TEMP COEFFICIENT WITH OUTPUT ADJUSTMENT (-55°C to +125°C)	$R_{POT} = 10\text{k}\Omega$		0.7			*		ppm/%
OUTPUT VOLTAGE NOISE	0.1Hz to 10Hz ⁽⁵⁾		4	10		*	*	$\mu\text{Vp-p}$
LINE REGULATION⁽⁴⁾ -40°C to +85°C	$V_{IN} = 8\text{V to } 33\text{V}$ $V_{IN} = 8.5\text{V to } 33\text{V}$		0.006 0.008	0.010 0.012		* *	* *	%/V
LOAD REGULATION⁽⁴⁾ -40°C to +85°C	$I_L = 0\text{mA to } +10\text{mA}$ $I_L = 0\text{mA to } +10\text{mA}$		0.005 0.007	0.010 0.012		* *	0.008 0.010	%/mA
TURN-ON SETTLING TIME	$T_o \pm 0.1\%$ of Final Value		5			*		μs
QUIESCENT CURRENT	No Load		1.0	1.4		*	*	mA
LOAD CURRENT (SOURCE)		10	21		*	*		mA
LOAD CURRENT (SINK)		-0.3	-0.5		*	*		mA
SHORT-CIRCUIT CURRENT	$V_{OUT} = 0$		30			*		mA
POWER DISSIPATION	No Load		15	21		*	*	mW
TEMPERATURE VOLTAGE OUTPUT⁽⁷⁾			630			*		mV
TEMPERATURE COEFFICIENT of Temperature Pin Voltage -55°C to +125°C			2.1					mV/ $^{\circ}\text{C}$
TEMPERATURE RANGE Specification REF02A, B, C		-40		+85	*		*	$^{\circ}\text{C}$

NOTES: (1) ΔV_{OT} is defined as the absolute difference between the maximum output and the minimum output voltage over the specified temperature range expressed as a percentage of 5V: $\Delta V_O = \frac{|V_{MAX} - V_{MIN}|}{5\text{V}} \times 100$ (2) ΔV_{OT} specification applies trimmed to +5.000V or untrimmed. (3) TCV_O is defined as ΔV_{OT} divided by

the temperature range. (4) Line and load regulation specifications include the effect of self heating. (5) Sample tested. (6) 10k Ω potentiometer connected between V_{OUT} and ground with wiper connected to Trim pin. See Figure on page 1. (7) Pin 3 is insensitive to capacitive loading. The temperature voltage will be modified by 7mV for each μA of loading.

The information provided herein is believed to be reliable; however, BURR-BROWN assumes no responsibility for inaccuracies or omissions. BURR-BROWN assumes no responsibility for the use of this information, and all use of such information shall be entirely at the user's own risk. Prices and specifications are subject to change without notice. No patent rights or licenses to any of the circuits described herein are implied or granted to any third party. BURR-BROWN does not authorize or warrant any BURR-BROWN product for use in life support devices and/or systems.

ABSOLUTE MAXIMUM RATINGS

Input Voltage	+40V
Operating Temperature	
P, U	–40°C to +85°C
Storage Temperature Range	
P, U	–65°C to +125°
Output Short Circuit Duration (to Ground or V_{IN})	Indefinite
Junction Temperature	–65°C to +150°
θ_{JA} P	120°C/W
U	80°C/W
Lead Temperature (soldering, 60s)	+300°C

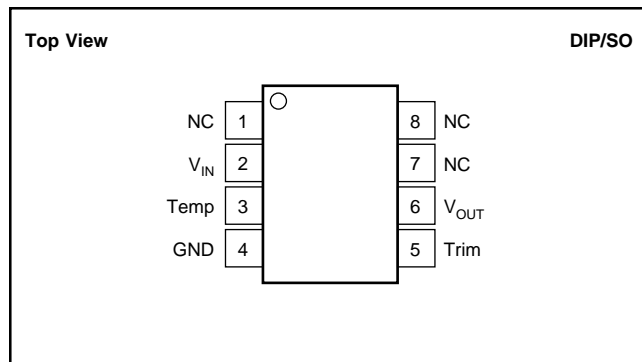


ELECTROSTATIC DISCHARGE SENSITIVITY

This integrated circuit can be damaged by ESD. Burr-Brown recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

PIN CONFIGURATIONS

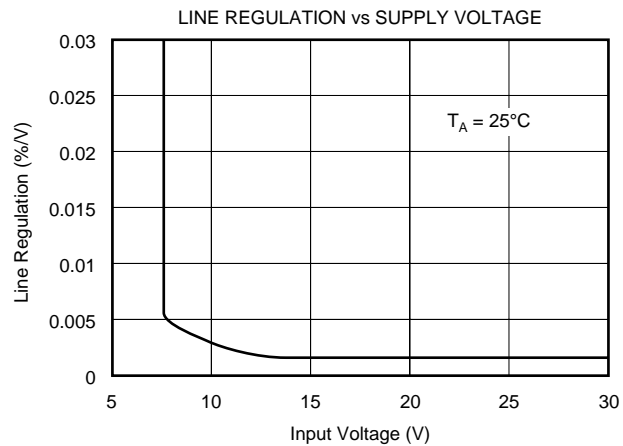
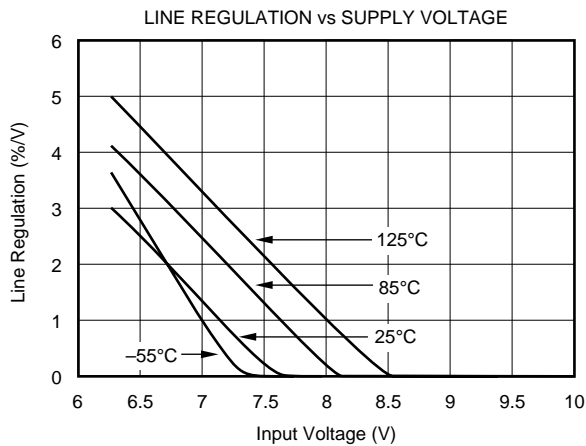
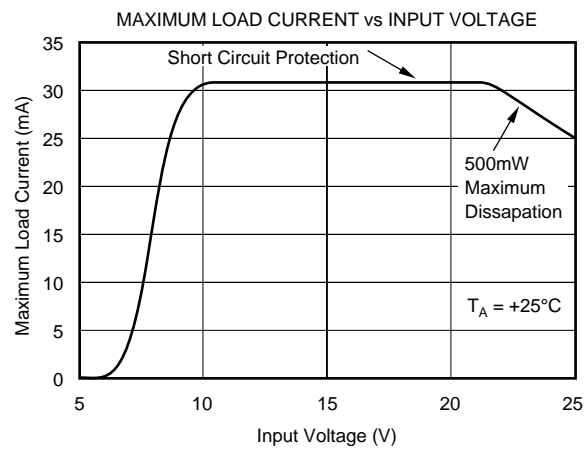
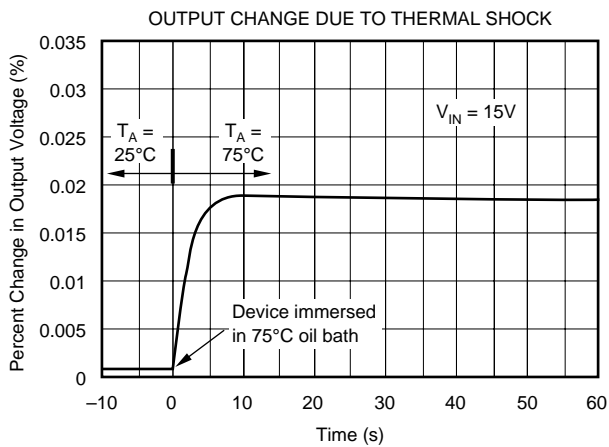
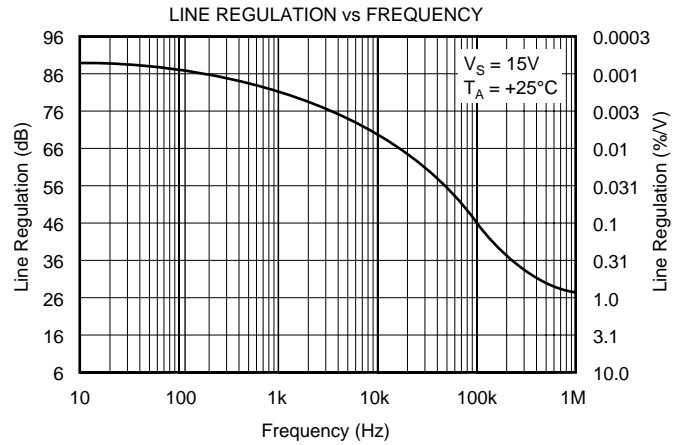
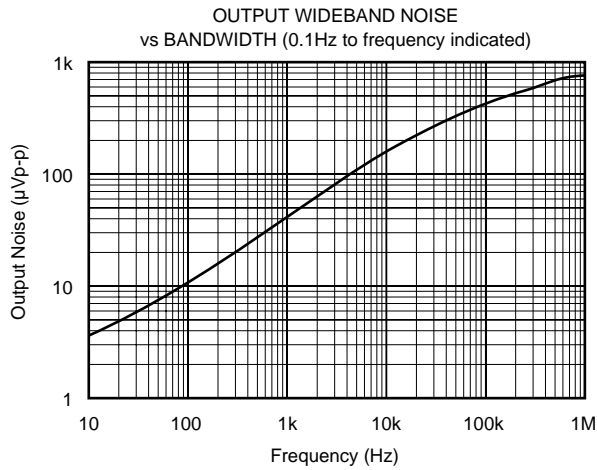


PACKAGE/ORDERING INFORMATION

PRODUCT	V_{OUT} at 25°C	MAX DRIFT (ppm/°C)	PACKAGE	PACKAGE DRAWING NUMBER	SPECIFICATION TEMPERATURE RANGE	ORDERING NUMBER	TRANSPORT MEDIA
REF02AU	5V±15mV	±15	SO-8	182	–40°C to +85°C	—	—
REF02BU	5V±10mV	±10	SO-8	182	–40°C to +85°C	—	—
REF02AP	5V±15mV	±15	DIP-8	006	–40°C to +85°C	—	—
REF02BP	5V±10mV	±10	DIP-8	006	–40°C to +85°C	—	—

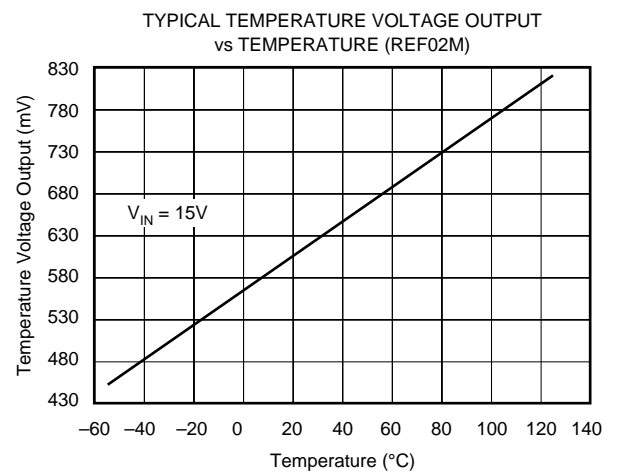
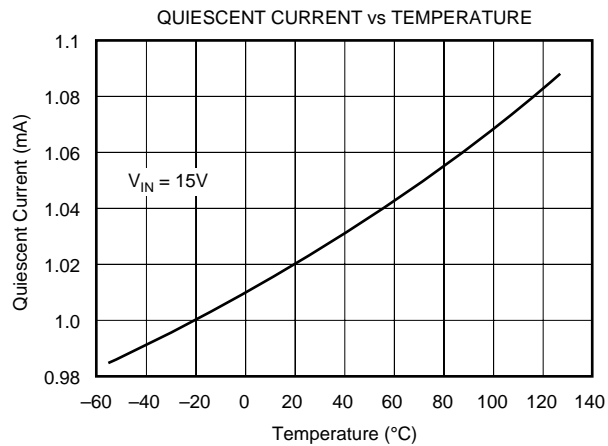
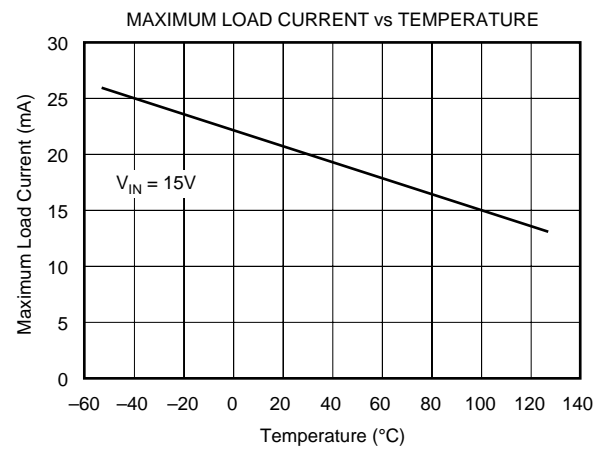
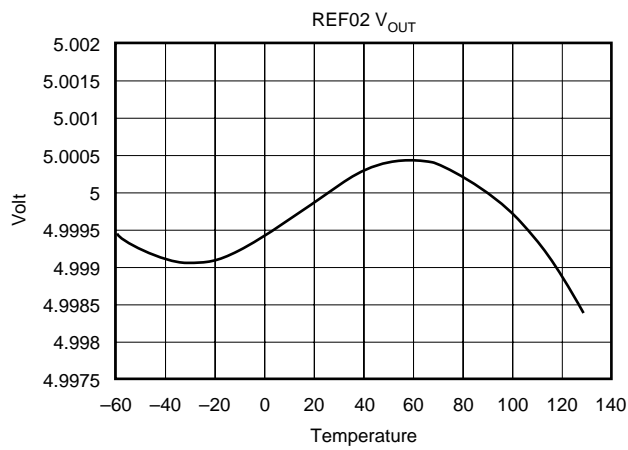
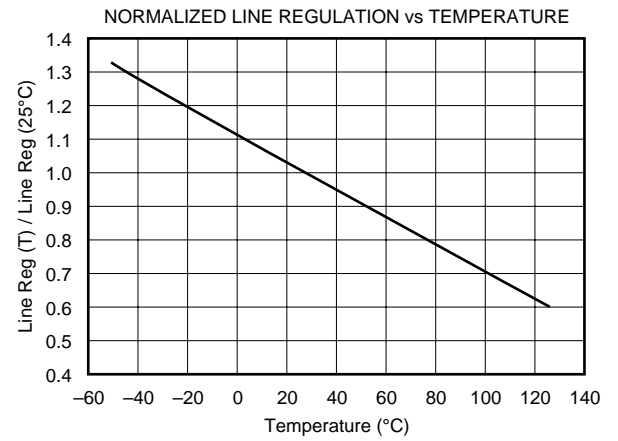
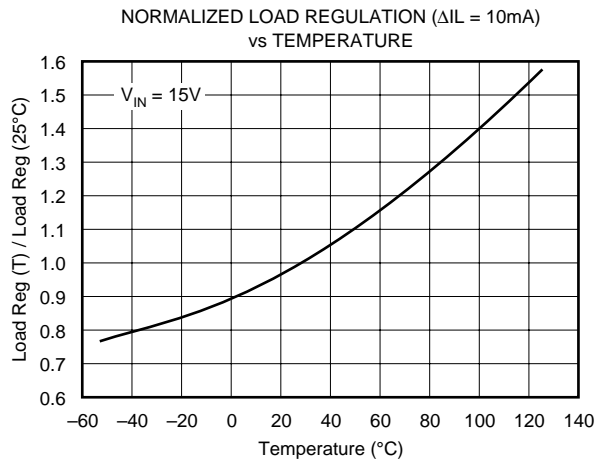
TYPICAL PERFORMANCE CURVES

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



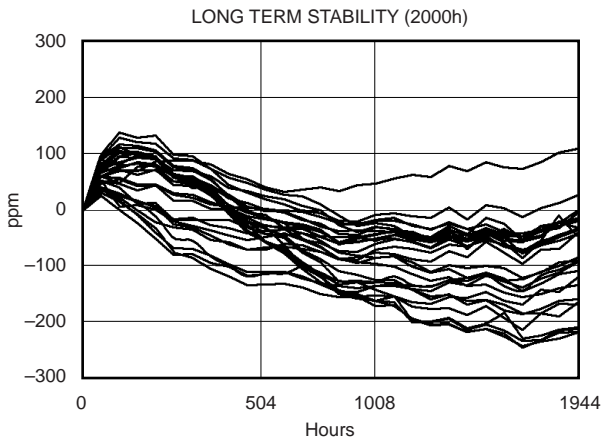
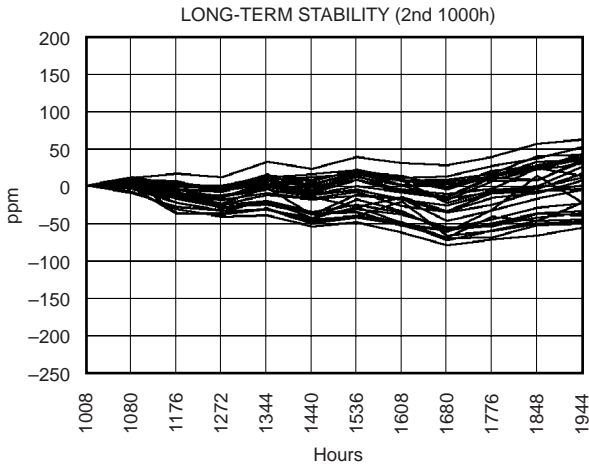
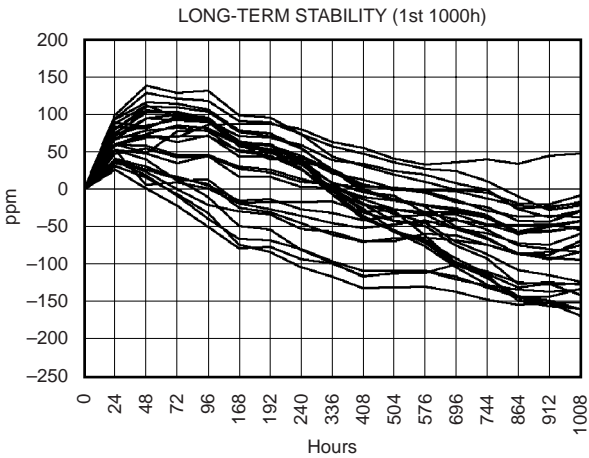
TYPICAL PERFORMANCE CURVES (Cont.)

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



TYPICAL PERFORMANCE CURVES (Cont.)

At T_A = +25°C, unless otherwise noted.



OUTPUT ADJUSTMENT

The REF02 trim terminal can be used to adjust the voltage over a $5V \pm 150mV$ range. This feature allows the system designer to trim system errors by setting the reference to a voltage other than 5V, including $5.12V^{(1)}$ for binary applications (see circuit on page one).

Adjustment of the output does not significantly affect the temperature performance of the device. The temperature coefficient change is approximately $0.7ppm/^{\circ}C$ for 100mV of output adjustment.

NOTE: (1) 20mV LSB for 8-bit applications.

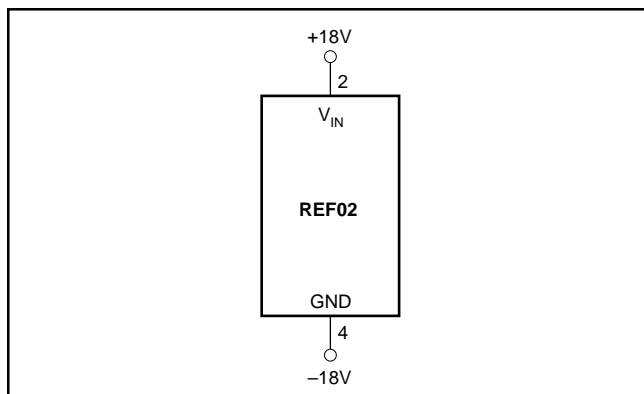


FIGURE 1. Burn-In Circuit.

REFERENCE STACKING PROVIDES OUTSTANDING LINE REGULATION

By stacking two REF01s and one REF02, a systems designer can achieve 5V, 15V, and 25V outputs. One very important advantage of this circuit is the near perfect line regulation at 5V and 15V outputs. This circuit can accept a 27V to 55V change to the input with less than the noise voltage as a change to the output voltage. R_B , a load bypass resistor, supplies current I_{SY} for the 15V regulator.

Any number of REF01s and REF02s can be stacked in this configuration. For example, if ten devices can be stacked in this configuration, ten 5V or five 10V outputs are achieved. The line voltage may range from 100V to 130V. Care should be exercised to insure that the total load currents do not exceed the maximum usable current, which is typically 21mA.

TYPICAL APPLICATIONS

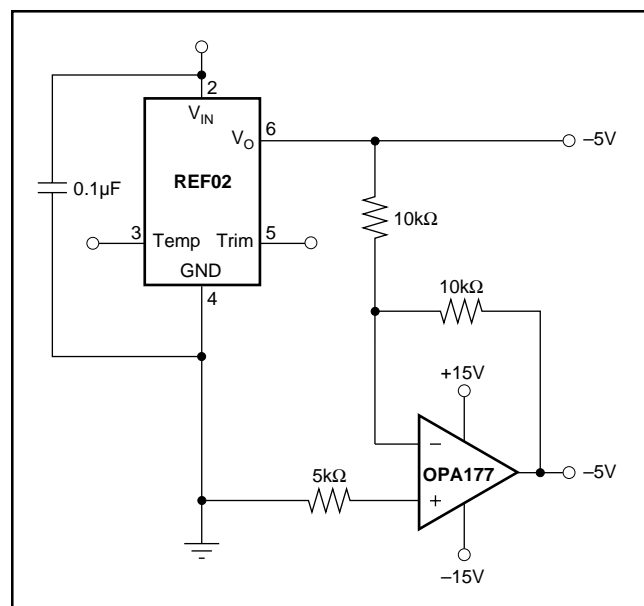


FIGURE 2. $\pm 5V$ Precision Reference.

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

Customers are responsible for their applications using TI components.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, license, warranty or endorsement thereof.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations and notices. Representation or reproduction of this information with alteration voids all warranties provided for an associated TI product or service, is an unfair and deceptive business practice, and TI is not responsible nor liable for any such use.

Resale of TI's products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service, is an unfair and deceptive business practice, and TI is not responsible nor liable for any such use.

Also see: Standard Terms and Conditions of Sale for Semiconductor Products. www.ti.com/sc/docs/stdterms.htm

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265