

REF02

## +5V Precision VOLTAGE REFERENCE

### FEATURES

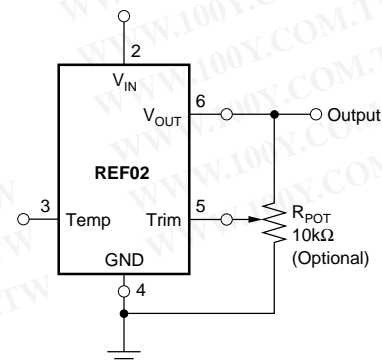
- **OUTPUT VOLTAGE:**  $+5V \pm 0.1\%$  max
- **EXCELLENT TEMPERATURE STABILITY:**  $8.5\text{ppm}/^{\circ}\text{C}$  max ( $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ )
- **LOW NOISE:**  $10\mu\text{Vp-p}$  max (0.1Hz to 10Hz)
- **EXCELLENT LINE REGULATION:**  $0.008\%/V$  max
- **EXCELLENT LOAD REGULATION:**  $0.005\%/mA$  max
- **LOW SUPPLY CURRENT:**  $1.4mA$  max
- **SHORT-CIRCUIT PROTECTED**
- **WIDE SUPPLY RANGE:**  $8V$  to  $40V$
- **EXTENDED INDUSTRIAL TEMPERATURE RANGE:**  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- **PACKAGE OPTIONS:** Plastic DIP, SOIC

### DESCRIPTION

The REF02 is a precision 5V voltage reference. The drift is laser trimmed to  $8.5\text{ppm}/^{\circ}\text{C}$  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. 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 SOIC. The REF02 is an ideal choice for portable instrumentation, temperature transducers, A/D and D/A converters, and digital voltmeter.

### APPLICATIONS

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



+5V Reference with Trimmed Output

# SPECIFICATIONS

## ELECTRICAL

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

PARAMETER	CONDITIONS	REF02A, R			REF02B, S			REF02C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE Change with Temperature <sup>(1, 2)</sup> ( $\Delta V_{OT}$ ) -40°C to +85°C	$I_{LOAD} = 0\text{mA}$	4.985	5.0	5.015	4.990	*	5.010	4.995	*	5.005	V
OUTPUT VOLTAGE DRIFT <sup>(3)</sup> -40°C to +85°C ( $TCV_O$ )			0.05	0.19		0.05	0.13		0.05	0.11	%
OUTPUT VOLTAGE DRIFT <sup>(3)</sup> -40°C to +85°C ( $TCV_O$ )			4	15		4	10		4	8.5	±ppm/°C
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 <sup>(5)</sup>		4	10		*	*		*	*	µVp-p
LINE REGULATION <sup>(4)</sup> -40°C to +85°C	$V_{IN} = 8\text{V}$ to 33V $V_{IN} = 8.5\text{V}$ to 33V		0.006 0.008	0.010 0.012		*	*		0.004 0.005	0.008 0.010	%/V
LOAD REGULATION <sup>(4)</sup> -40°C to +85°C	$I_L = 0\text{mA}$ to +10mA $I_L = 0\text{mA}$ to +10mA		0.005 0.007	0.010 0.012		*	0.008 0.010		0.003 0.004	0.005 0.005	%/mA
TURN-ON SETTLING TIME	To ±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 <sup>(7)</sup>			630			*			*		mV
TEMPERATURE COEFFICIENT of Temperature Pin Voltage -55°C to +125°C			2.1								mV/°C
TEMPERATURE RANGE Specification REF02A, B, C		-40		+85	*		*	*		*	°C

NOTES: (1)  $\Delta V_{OT}$  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:  $\Delta V_O = \frac{V_{MAX} - V_{MIN}}{5V} \times 100$  (2)  $\Delta V_{OT}$  specification applies trimmed to +5.000V or untrimmed. (3)  $TCV_O$  is defined as  $\Delta V_{OT}$  divided by

the temperature range. (4) Line and load regulation specifications include the effect of self heating. (5) Sample tested. (6) 10kΩ 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.

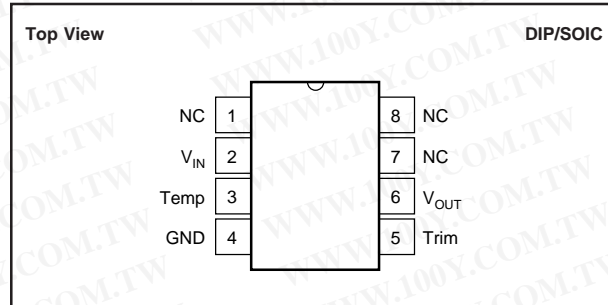
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## ABSOLUTE MAXIMUM RATINGS

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

## PIN CONFIGURATIONS



## 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.

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## PACKAGE INFORMATION

PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER <sup>(1)</sup>
REF02AU	SOIC	182
REF02BU	SOIC	182
REF02AP	Plastic DIP	006
REF02BP	Plastic DIP	006

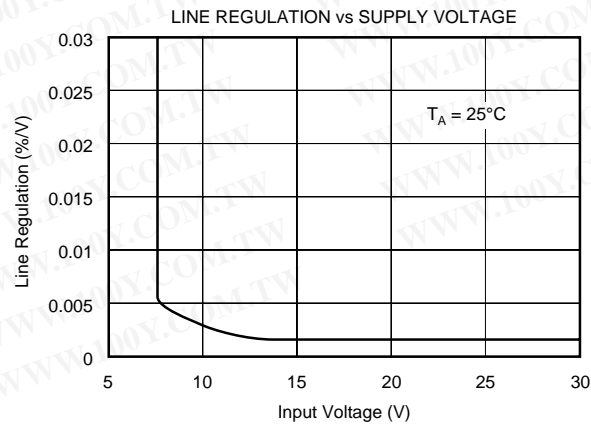
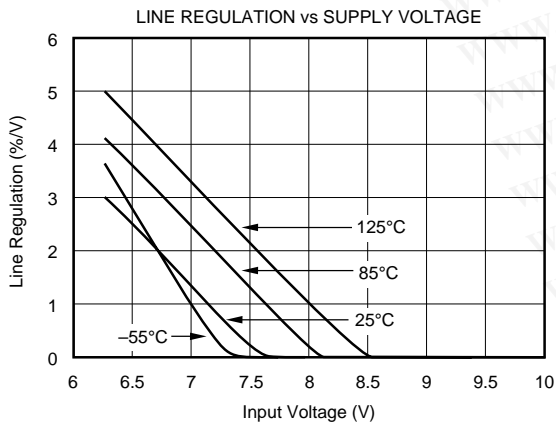
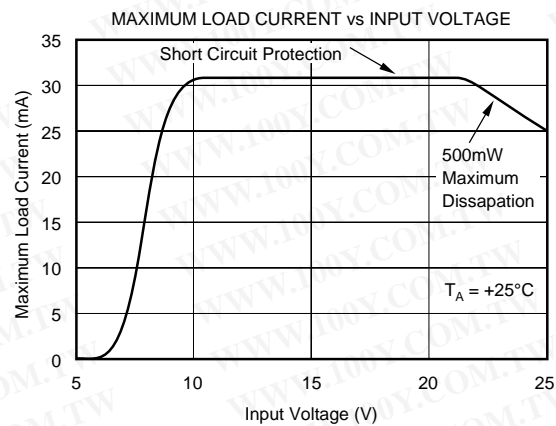
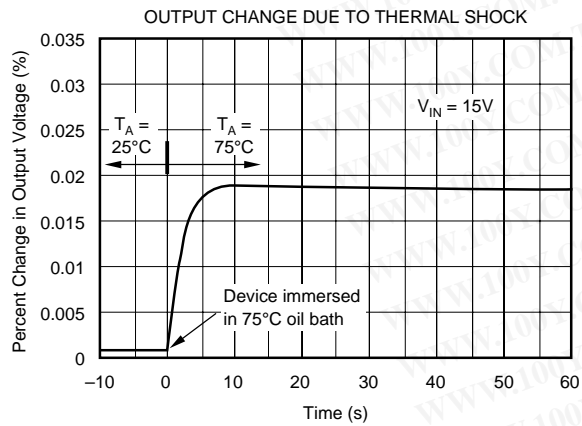
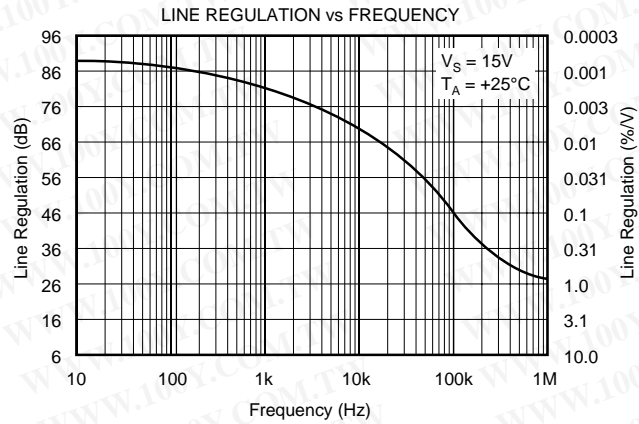
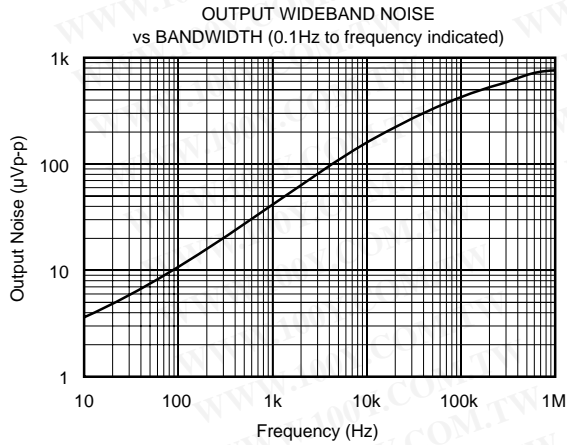
NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix C of Burr-Brown IC Data Book.

## ORDERING INFORMATION

PRODUCT	$V_{OUT}$ AT 25°C	MAX DRIFT (ppm/°C)	TEMPERATURE	PACKAGE
REF02AU	5V±15mV	±15	-40°C to +85°C	SOIC
REF02BU	5V±10mV	±10	-40°C to +85°C	SOIC
REF02AP	5V±15mV	±15	-40°C to +85°C	Plastic DIP
REF02BP	5V±10mV	±10	-40°C to +85°C	Plastic DIP

# TYPICAL PERFORMANCE CURVES

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



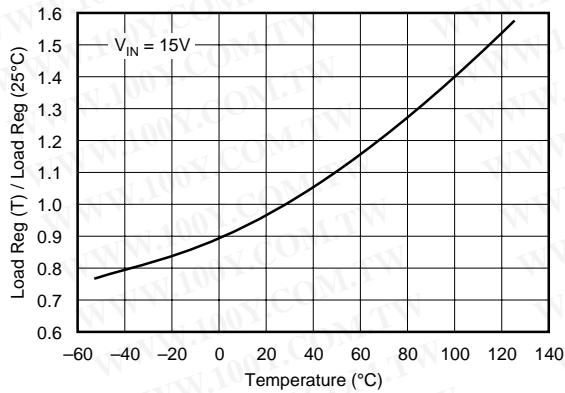


# TYPICAL PERFORMANCE CURVES (CONT)

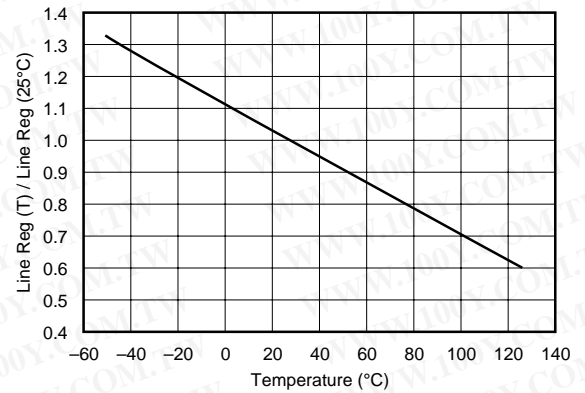
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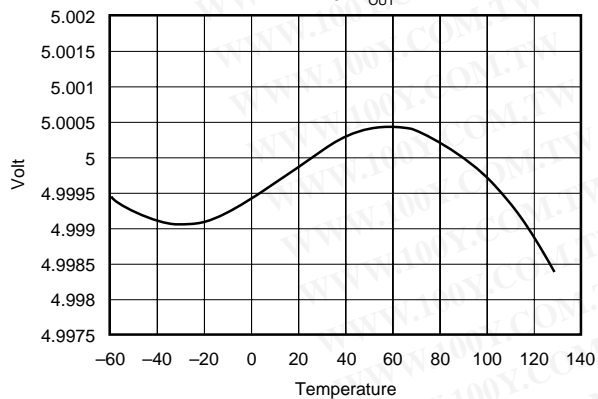
NORMALIZED LOAD REGULATION ( $\Delta I_L = 10\text{mA}$ )  
 vs TEMPERATURE



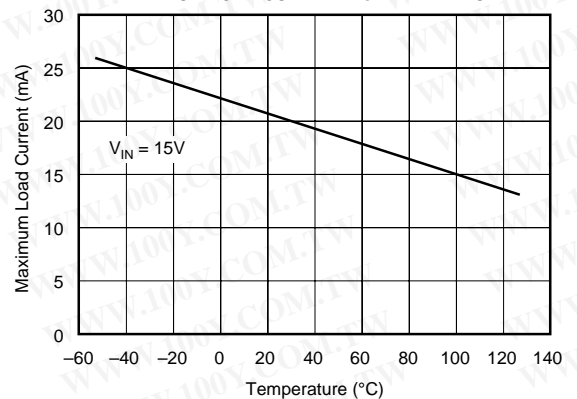
NORMALIZED LINE REGULATION vs TEMPERATURE



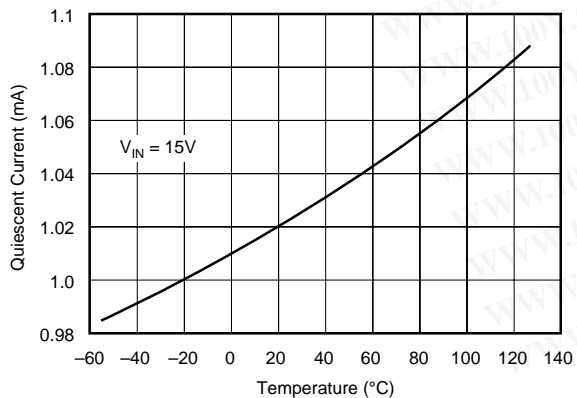
REF02  $V_{OUT}$



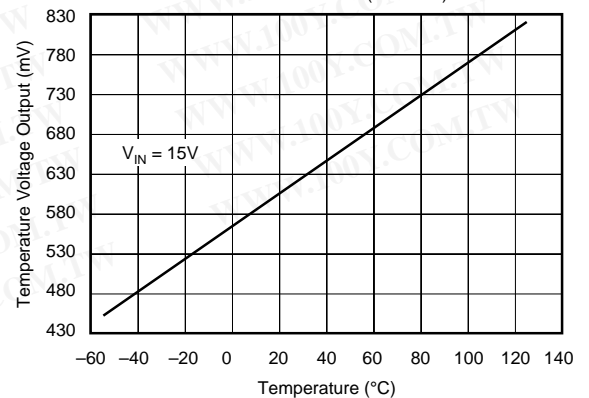
MAXIMUM LOAD CURRENT vs TEMPERATURE



QUIESCENT CURRENT vs TEMPERATURE



TYPICAL TEMPERATURE VOLTAGE OUTPUT  
 vs TEMPERATURE (REF02M)



## 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.

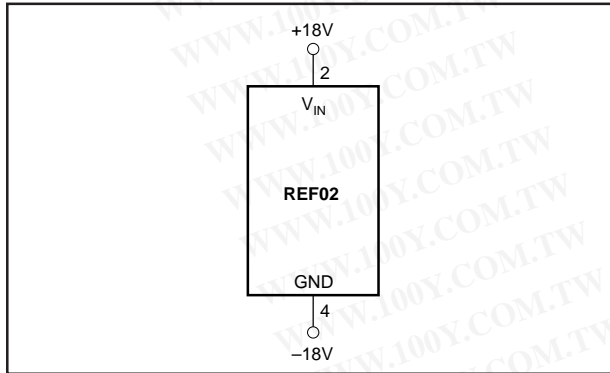


FIGURE 1. Burn-In Circuit.

## 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. If ten devices can be stacked in this configuration, for example, 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

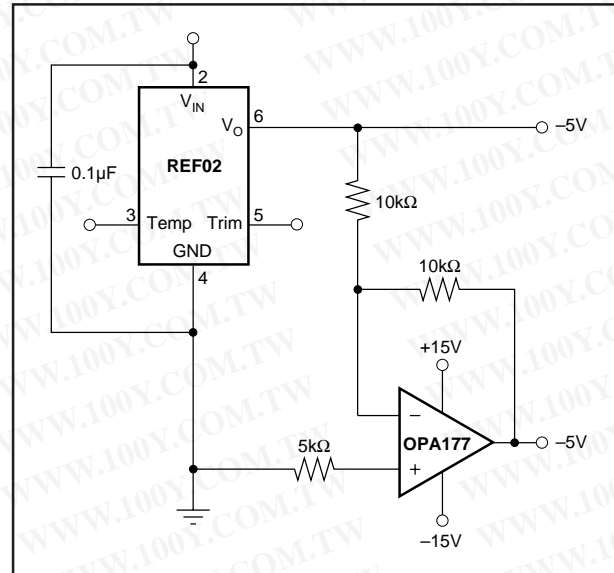


FIGURE 2.  $\pm 5V$  Precision Reference.

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