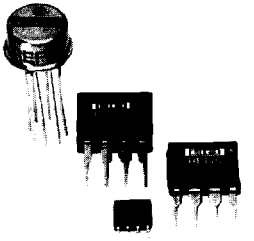
BURR-BROWN®



REF02

+5V Precision VOLTAGE REFERENCE

FEATURES

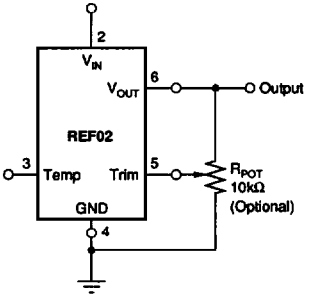
- OUTPUT VOLTAGE: +5V ±0.1% max
- EXCELLENT TEMPERATURE STABILITY:
  8.5ppm/°C max (–40°C to +85°C)
  8.5ppm/°C max (–55°C to +125°C)
- LOW NOISE: 10μVp-p max (0.1Hz to 10Hz)
- EXCELLENT LINE REGULATION:
  0.008%/V max
- EXCELLENT LOAD REGULATION:
  0.005%/mA max
- LOW SUPPLY CURRENT: 1.4mA max
- SHORT-CIRCUIT PROTECTED
- WIDE SUPPLY RANGE: 8V to 40V
- EXTENDED INDUSTRIAL TEMPERATURE RANGE: –40°C to +85°C
- PACKAGE OPTIONS: Hermetic TO-99, Plastic DIP, Cerdip, SOIC, Die

APPLICATIONS

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

DESCRIPTION

The REF02 is a precision 5V voltage reference. The drift is laser trimmed to 8.5ppm/°C max over the extended industrial and military temperature range. The REF02 provides a stable 5V output that can be externally adjusted over a ±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: hermetic TO-99, ceramic DIP, plastic DIP, SOIC, and die. The REF02 is an ideal choice for portable instrumentation, temperature transducers, A/D and D/A converters, and digital voltmeter.



+5V Reference with Trimmed Output

International Airport Industrial Park • Mailing Address: PO Box 11400 • Tucson, AZ 85734 • Street Address: 6730 S. Tucson Blvd. • Tucson, AZ 85706
Tel: (602) 746-1111 • Twx: 910-952-1111 • Cable: BBRCORP • Telex: 066-6491 • FAX: (602) 889-1510 • Immediate Product Info: (800) 548-6132

SPECIFICATIONS

ELECTRICAL

T_A = +25°C and V_{IN} = +15V power supply unless otherwise noted.

PARAMETER	CONDITIONS	REF02A, R, G			REF02B, S, G			REF02C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE	I_{LOAD} = 0mA	4.985	5.0	5.015	4.990	*	5.010	4.995	*	5.005	V
Change with Temperature[1, 2] (ΔV_{OT})											
–40°C to +85°C			0.05	0.19		0.05	0.13		0.05	0.11	%
–55°C to +125°C			0.05	0.27		0.05	0.15				%
OUTPUT VOLTAGE DRIFT[3]											
–40°C to +85°C (TCV_O)			4	15		4	10		4	8.5	±ppm/°C
–55°C to +125°C			4	15		4	8.5				±ppm/°C
OUTPUT ADJUSTMENT RANGE	R_{POT} = 10kΩ[6]	±3	±6		*	*		*	*		%
CHANGE IN V_O TEMP COEFFICIENT WITH OUTPUT ADJUSTMENT (–55°C to +125°C)	R_{POT} = 10kΩ		0.7			*			*		ppm/%
OUTPUT VOLTAGE NOISE	0.1Hz to 10Hz[5]		4	10		*	*		*	*	µVp-p
LINE REGULATION[4]	V_{IN} = 8V to 33V		0.006	0.010		*	*		0.004	0.008	%/V
–40°C to +85°C	V_{IN} = 8.5V to 33V		0.008	0.012		*	*		0.005	0.010	
–55°C to +125°C	V_{IN} = 9V to 33V		0.009	0.015		*	*				
LOAD REGULATION[4]	I_L = 0mA to +10mA		0.005	0.010		*	0.008		0.003	0.005	%/mA
–40°C to +85°C	I_L = 0mA to +10mA		0.007	0.012		*	0.010		0.004	0.005	
–55°C to +125°C	I_L = 0mA to +10mA		0.008	0.015		*	0.012				
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[7]			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
REF02R, S		–55		+125	*		*				°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: $\Delta V_O = \left|\frac{V_{MAX} - V_{MIN}}{5V}\right| \times 100$ (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) 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[1]

Input Voltage	+40V
Operating Temperature	
P, U, All Dice	–40°C to +85°C
G, M	–55°C to +125°C
Storage Temperature Range	
P, U	–65°C to +125°
G, M	–65°C to +150°
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
G, M	150°C/W
Lead Temperature (soldering, 10s)	+300°C

NOTE: (1) Absolute maximum ratings apply to both dice and package parts, unless otherwise noted.

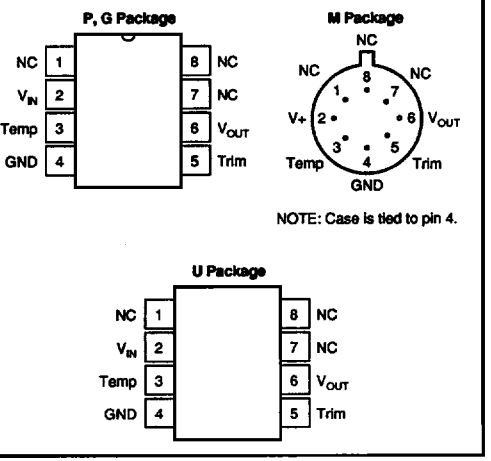
PACKAGE INFORMATION[1]

MODEL	PACKAGE	PACKAGE DRAWING NUMBER
REF02AD	DICE	—
REF02AU	SOIC	182
REF02BU	SOIC	182
REF02AP	Plastic DIP	006
REF02BP	Plastic DIP	006
REF02AG	Cerdip	161
REF02BG	Cerdip	161
REF02AM	Metal TO-99	001
REF02BM	Metal TO-99	001
REF02CM	Metal TO-99	001
REF02RM	Metal TO-99	001
REF02SM	Metal TO-99	001

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

PIN CONFIGURATIONS

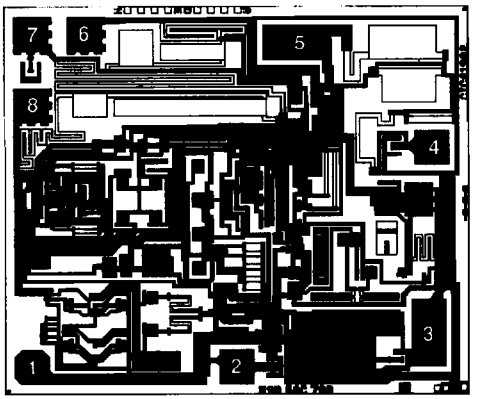
Top View



ORDERING INFORMATION

MODEL	V_{OUT} AT 25°C	MAX DRIFT (ppm/°C)	TEMPERATURE	PACKAGE
REF02AD	5V±15mV	±15	–40°C to +85°C	DICE
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
REF02AG	5V±15mV	±15	–40°C to +85°C	Cerdip
REF02BG	5V±10mV	±10	–40°C to +85°C	Cerdip
REF02AM	5V±15mV	±15	–40°C to +85°C	Metal TO-99
REF02BM	5V±10mV	±10	–40°C to +85°C	Metal TO-99
REF02CM	5V±5mV	±8.5	–40°C to +85°C	Metal TO-99
REF02RM	5V±15mV	±15	–55°C to +125°C	Metal TO-99
REF02SM	5V±10mV	±8.5	–55°C to +125°C	Metal TO-99

DICE INFORMATION



REF02 DIE TOPOGRAPHY

PAD	FUNCTION	PAD	FUNCTION
1	V_{IN}	5	V_{OUT}
2	Temp	6	NC
3	GND	7	NC
4	Trim	8	NC

MECHANICAL INFORMATION

	MILS (0.001")	MILLIMETERS
Die Size	73 x 62	1.85 x 1.57
Die Thickness	14 ±3	0.36 ± 0.08
Min. Pad Size	5 x 5	0.10 x 0.10
Gold Backing		

See "DICE PRODUCTS" Appendix C in Burr-Brown IC Data Book, or contact factory for current information.

TYPICAL ELECTRICAL CHARACTERISTICS (DICE)

T_A = 25°C, V_{IN} = +15V, unless otherwise noted.

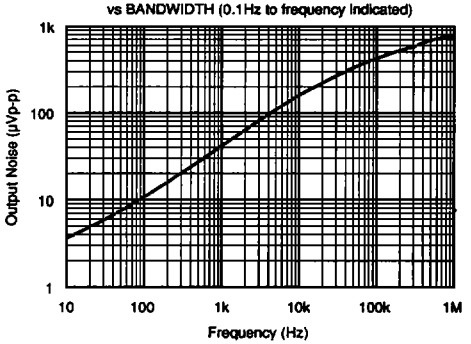
PARAMETER	CONDITIONS	REF02AD MIN	REF02AD TYP	REF02AD MAX	UNIT
OUTPUT VOLTAGE[1]	No Load	4.975	5.0	5.025	V
OUTPUT ADJUSTMENT RANGE[1]	R_P = 10kΩ	±3	—	—	%
LINE REGULATION[1]	V_{IN} = 8V to 33V		0.010		%/V
LOAD REGULATION T_A = +125°C	I_L = 0 to 10mA		0.005		%/mA
OUTPUT VOLTAGE NOISE	0.1Hz to 10Hz		10		µVp-p
TURN-ON SETTLING TIME T_A = +125°C	To ±0.1% of Final Value		5		µs
QUIESCENT CURRENT	No Load at +125°C		1.1		mA
MAX LOAD CURRENT			21		mA
SINK CURRENT			–0.5		mA
SHORT CIRCUIT CURRENT	V_{OUT} = 0		30		mA
OUTPUT VOLTAGE TEMPERATURE COEFFICIENT			10		ppm/°C
TEMPERATURE VOLTAGE OUTPUT[2]			630		mV

NOTES: (1) Electrical tests are performed at wafer probe to the limits shown above. Due to variations in assembly methods and normal yield loss, yield after packaging is not guaranteed for standard product dice. Consult factory to negotiate specifications based on dice lot qualification through sample lot assembly and testing. (2) Pin 3 is insensitive to capacitive loading. The temperature voltage will be modified by 7mV for each µA of loading.

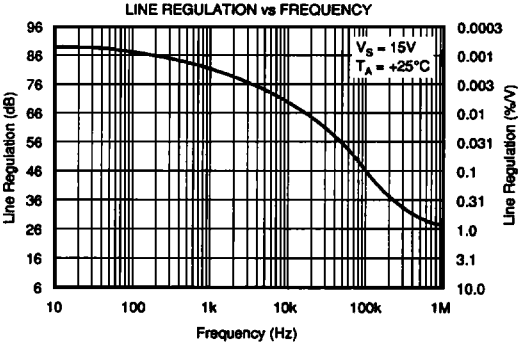
TYPICAL PERFORMANCE CURVES

T_A = +25°C unless otherwise noted.

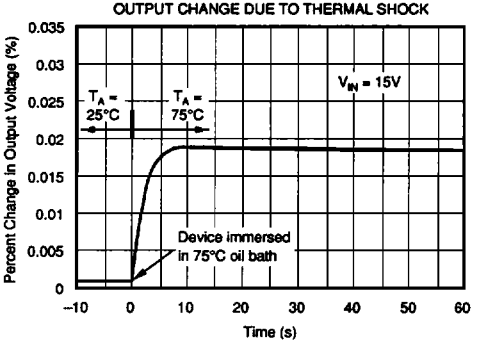
OUTPUT WIDEBAND NOISE
vs BANDWIDTH (0.1Hz to frequency indicated)



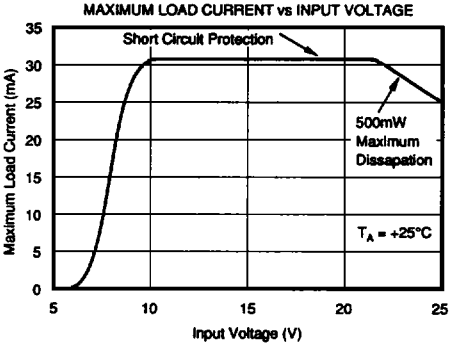
LINE REGULATION vs FREQUENCY



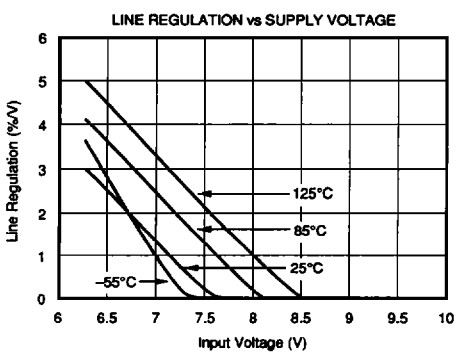
OUTPUT CHANGE DUE TO THERMAL SHOCK



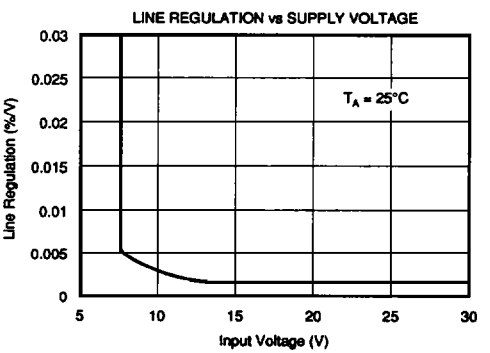
MAXIMUM LOAD CURRENT vs INPUT VOLTAGE



LINE REGULATION vs SUPPLY VOLTAGE



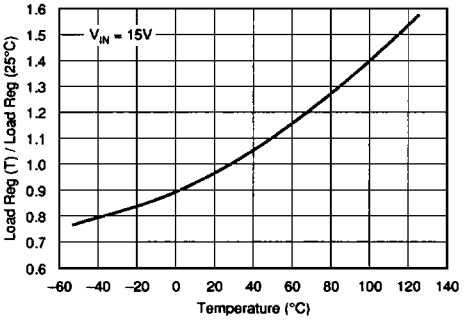
LINE REGULATION vs SUPPLY VOLTAGE



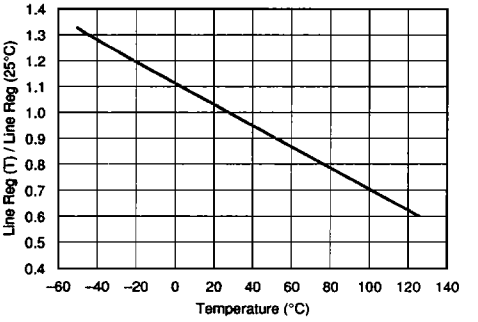
TYPICAL PERFORMANCE CURVES (CONT)

T_A = +25°C unless otherwise noted.

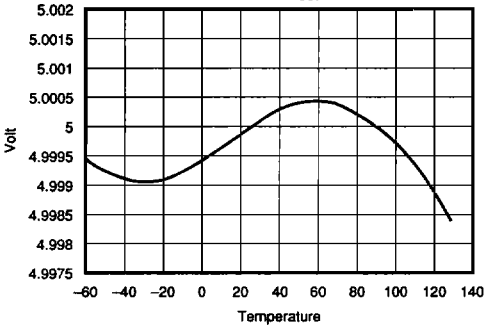
NORMALIZED LOAD REGULATION (ΔIL = 10mA) vs TEMPERATURE



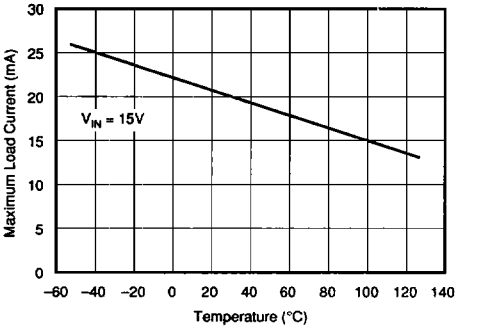
NORMALIZED LINE REGULATION vs TEMPERATURE



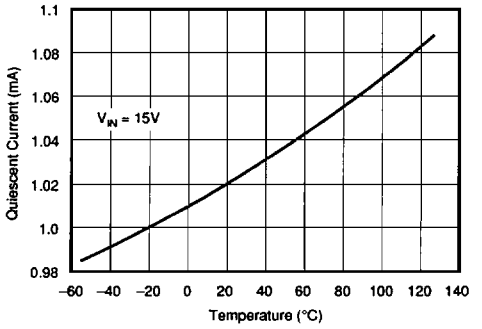
REF02 V_{OUT}



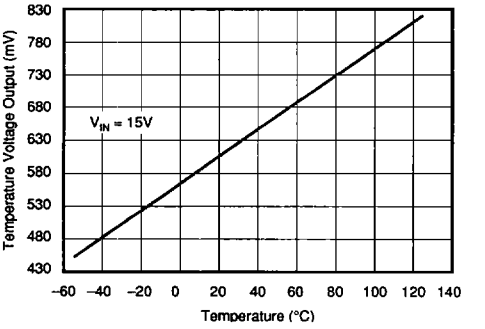
MAXIMUM LOAD CURRENT vs TEMPERATURE



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 ±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/°C for 100mV of output adjustment.

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

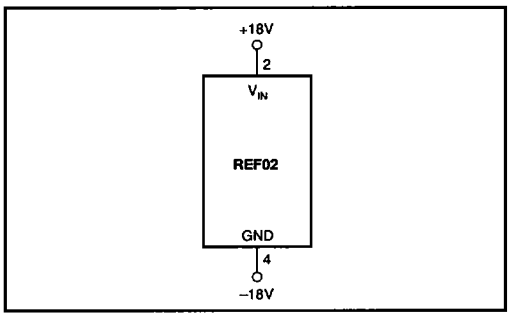


FIGURE 1. Burn-In Circuit.

TYPICAL APPLICATIONS

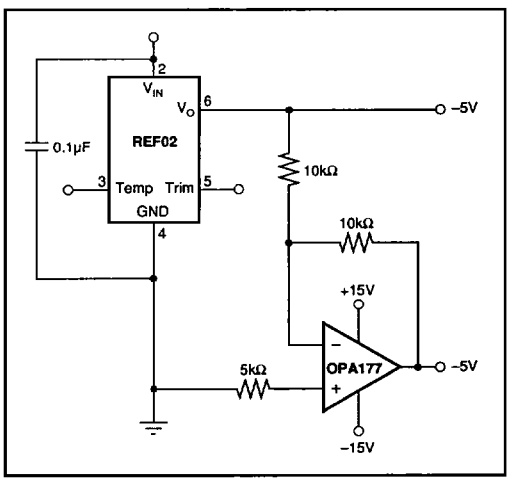


FIGURE 2. ±5V Precision Reference.

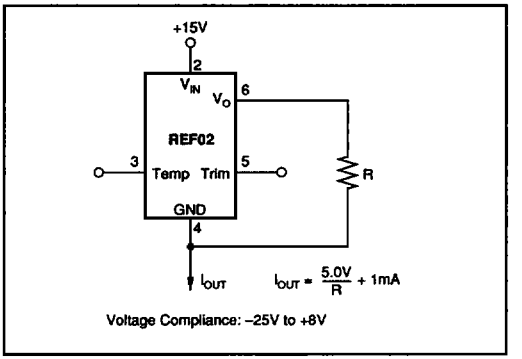


FIGURE 3. Current Source.

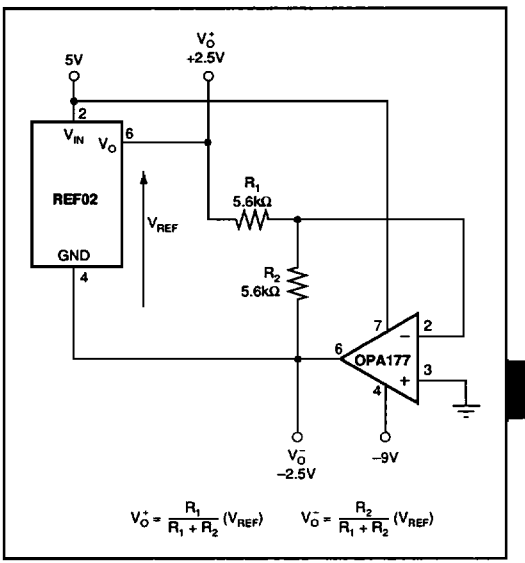


FIGURE 4. ±2.5V Precision Reference.

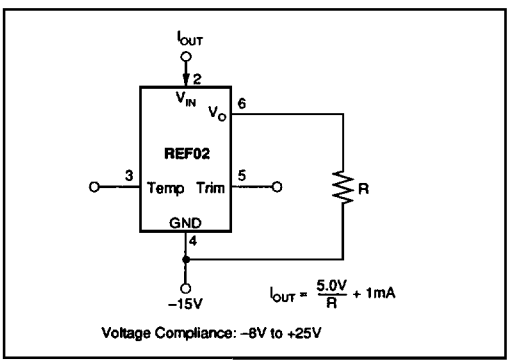


FIGURE 5. Current Sink.

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.

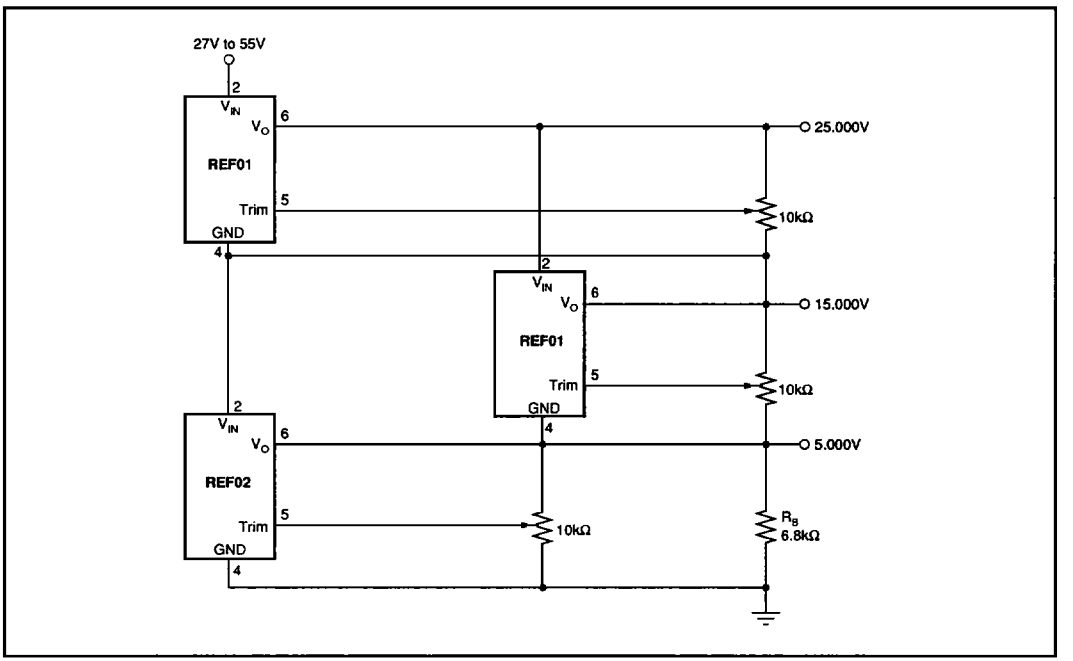


FIGURE 6. Reference Stack.