DUAL CURRENT SOURCE/CURRENT SINK

FEATURES

● **COMPLETELY FLOATING:**
   No Power Supply or Ground Connections
● **HIGH ACCURACY: 100µA ±0.5%**
● **LOW TEMPERATURE COEFFICIENT:**
   ±25ppm/°C
● **WIDE VOLTAGE COMPLIANCE:**
   2.5V to 40V
● **ALSO INCLUDES CURRENT MIRROR**

APPLICATIONS

● **SENSOR EXCITATION**
● **BIASING CIRCUITRY**
● **OFFSETTING CURRENT LOOPS**
● **LOW VOLTAGE REFERENCES**
● **CHARGE-PUMP CIRCUITRY**
● **HYBRID MICROCIRCUITS**

DESCRIPTION

The REF200 combines three circuit building-blocks on a single monolithic chip—two 100µA current sources and a current mirror. The sections are dielectrically isolated, making them completely independent. Also, since the current sources are two-terminal devices, they can be used equally well as current sinks. The performance of each section is individually measured and laser-trimmed to achieve high accuracy at low cost.

The sections can be pin-strapped for currents of 50µA, 100µA, 200µA, 300µA or 400µA. External circuitry can be used to obtain virtually any current. These and many other circuit techniques are shown in the Applications section of this Data Sheet.

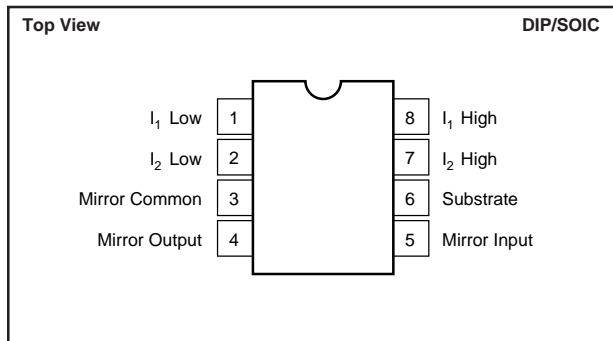The REF200 is available in plastic 8-pin mini-DIP and SOIC packages.

PDS-851D
Printed in U.S.A. October, 1993
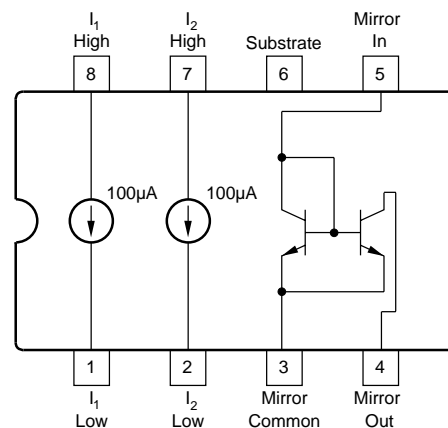
SPECIFICATIONS

ELECTRICAL

At T_A = +25°C, V_S = 15V, unless otherwise noted.

PARAMETER	CONDITION	REF200AP, AU			UNITS
		MIN	TYP	MAX	
CURRENT SOURCES					
Current Accuracy			±0.25	±1	%
Current Match			±0.25	±1	%
Temperature Drift	Specified Temp Range		25		ppm/°C
Output Impedance	2.5V to 40V	20	100		MΩ
	3.5V to 30V	200	500		MΩ
Noise	BW = 0.1Hz to 10Hz		1		nAp-p
	f = 10kHz		20		pA/√Hz
Voltage Compliance (1%)	T_{MIN} to T_{MAX}		See Curves		
Capacitance			10		pF
CURRENT MIRROR	I = 100µA Unless Otherwise Noted				
Gain		0.995	1	1.005	
Temperature Drift			25		ppm/°C
Impedance (output)	2V to 40V	40	100		MΩ
Nonlinearity	I = 0µA to 250µA		0.05		%
Input Voltage			1.4		V
Output Compliance Voltage			See Curves		
Frequency Response (–3dB)	Transfer		5		MHz
TEMPERATURE RANGE					
Specification		−25		+85	°C
Operating		−40		+85	°C
Storage		−40		+125	°C

PIN CONFIGURATION

Top View		DIP/SOIC

I_1 Low — 1 ▢ 8 — I_1 High
I_2 Low — 2 ▢ 7 — I_2 High
Mirror Common — 3 ▢ 6 — Substrate
Mirror Output — 4 ▢ 5 — Mirror Input

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.

ABSOLUTE MAXIMUM RATINGS

Applied Voltage .... −6V to +40V
Reverse Current .... −350µA
Voltage Between Any Two Sections .... ±80V
Operating Temperature .... −40°C to +85°C
Storage Temperature ....−40°C to +125°C
Lead Temperature (soldering, 10s) .... +300°C
(SOIC 3s) ....+260°C

PACKAGE/ORDERING INFORMATION

PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER[1]	TEMPERATURE RANGE
REF200AP	8-Pin Plastic DIP	006	−25°C to +85°C
REF200AU	8-Pin SOIC	182	−25°C to +85°C

NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix C of Burr-Brown IC Data Book. (2) Grade designation "A" may not be marked. Absence of grade designation indicates A grade.
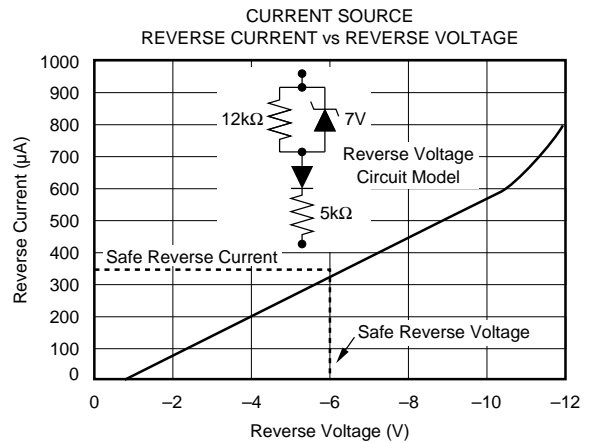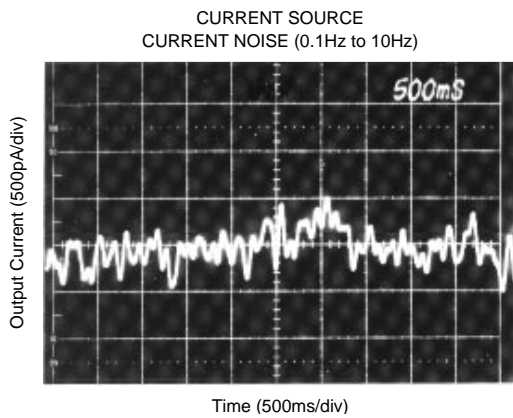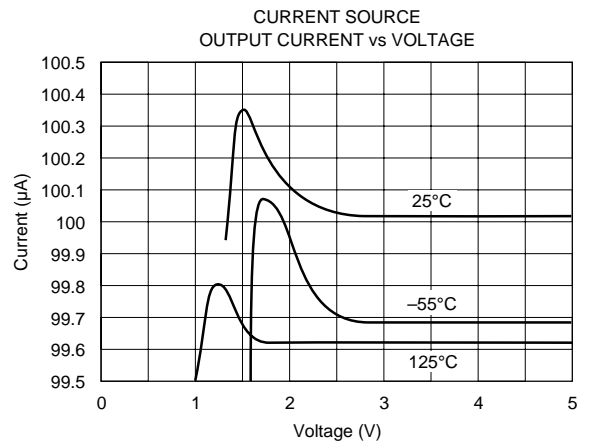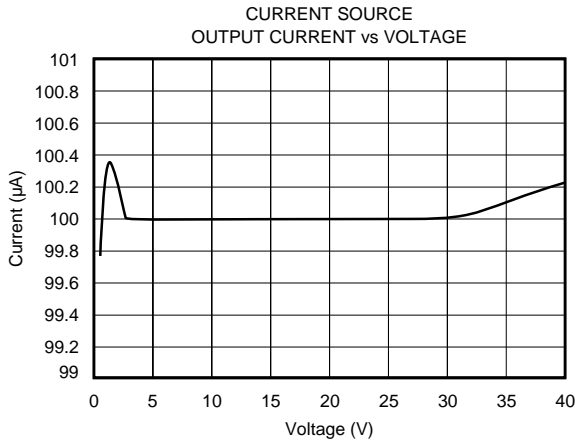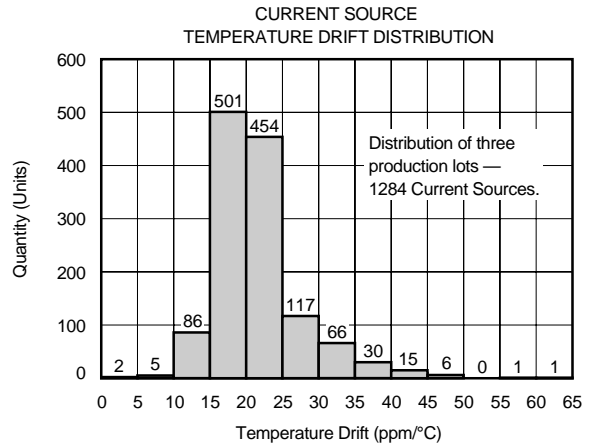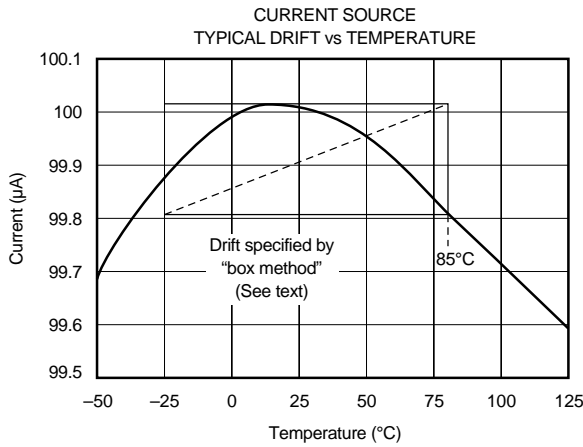
TYPICAL PERFORMANCE CURVES

At T_A = +25°C, V_S = +15V, unless otherwise noted.

**CURRENT SOURCE
TYPICAL DRIFT vs TEMPERATURE**

Current (µA) vs Temperature (°C)

Drift specified by "box method" (See text)

85°C

**CURRENT SOURCE
TEMPERATURE DRIFT DISTRIBUTION**

Quantity (Units) vs Temperature Drift (ppm/°C)

2, 5, 86, 501, 454, 117, 66, 30, 15, 6, 0, 1, 1

Distribution of three production lots — 1284 Current Sources.

**CURRENT SOURCE
OUTPUT CURRENT vs VOLTAGE**

Current (µA) vs Voltage (V)

**CURRENT SOURCE
OUTPUT CURRENT vs VOLTAGE**

Current (µA) vs Voltage (V)

25°C

−55°C

125°C

**CURRENT SOURCE
CURRENT NOISE (0.1Hz to 10Hz)**

Output Current (500pA/div) vs Time (500ms/div)

500mS

**CURRENT SOURCE
REVERSE CURRENT vs REVERSE VOLTAGE**

Reverse Current (µA) vs Reverse Voltage (V)

12kΩ   7V
Reverse Voltage
Circuit Model
5kΩ

Safe Reverse Current

Safe Reverse Voltage

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TYPICAL PERFORMANCE CURVES (CONT)

At T_A = +25°C, V_S = +15V, unless otherwise noted.

MIRROR GAIN ERROR vs CURRENT

Error (%) vs Mirror Current (A)

V_O = 1.25V

V_O = 1V

V_O = 1.5V

MIRROR TRANSFER NONLINEARITY

Nonlinearity (% of 250µA) vs Current (µA)

Data from Three
Representative Units
(Least-square fit)

MIRROR INPUT VOTAGE/OUTPUT
COMPLIANCE VOLTAGE vs CURRENT

Input Voltage (V) vs Current

Input Voltage

Output
Compliance
Voltage
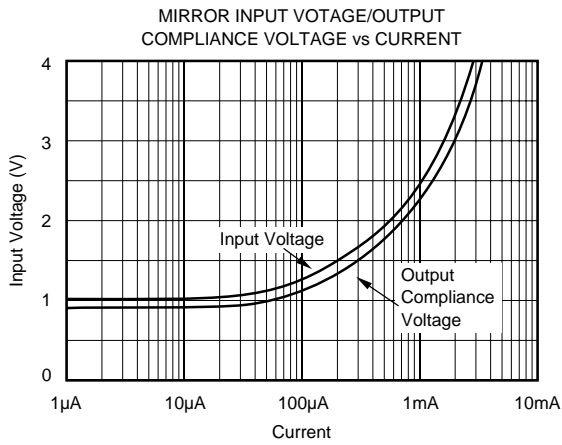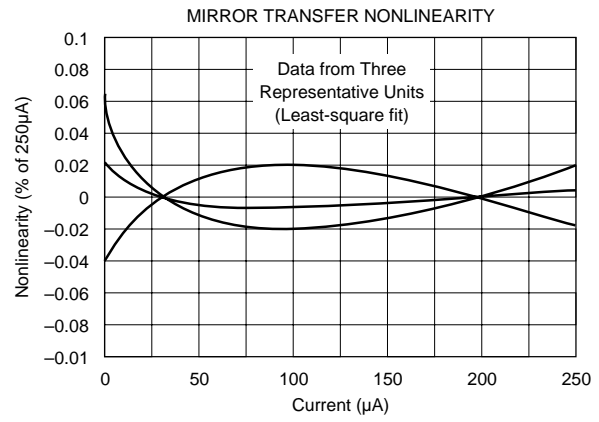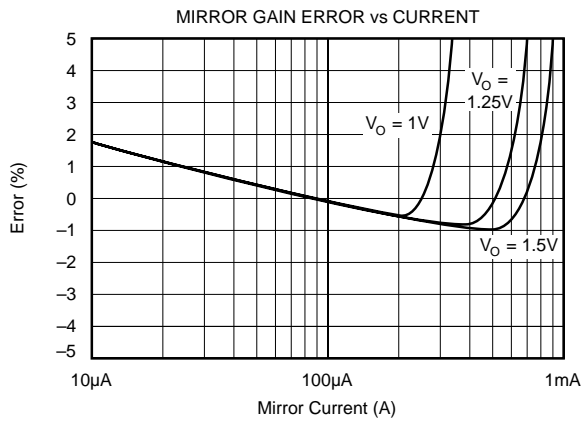
APPLICATIONS INFORMATION

The three circuit sections of the REF200 are electrically isolated from one another using a dielectrically isolated fabrication process. A substrate connection is provided (pin 6), which is isolated from all circuitry. This pin should be connected to a defined circuit potential to assure rated DC performance. The preferred connection is to the most negative constant potential in your system. In most analog systems this would be $-V_S$. For best AC performance, leave pin 6 open and leave unused sections unconnected.

Drift performance is specified by the "box method," as illustrated in the Current vs Temperature plot of the typical performance curves. The upper and lower current extremes measured over temperature define the top and bottom of the box. The sides are determined by the specified temperature range of the device. The drift of the unit is the slope of the diagonal—typically 25ppm/°C from –25°C to +85°C.

If the current sources are subjected to reverse voltage, a protection diode may be required. A reverse voltage circuit model of the REF200 is shown in the Reverse Current vs Reverse Voltage curve. If reverse voltage is limited to less than 6V *or* reverse current is limited to less than 350μA, no protection circuitry is required. A parallel diode (Figure 2a) will protect the device by limiting the reverse voltage across the current source to approximately 0.7V. In some applications, a series diode may be preferable (Figure 2b) because it allows no reverse current. This will, however, reduce the compliance voltage range by one diode drop.

Applications for the REF200 are limitless. Application Bulletin AB-165 shows additional REF200 circuits as well as other related current source techniques. A collection of circuits is shown to illustrate some techniques. Also, see AB-165A.
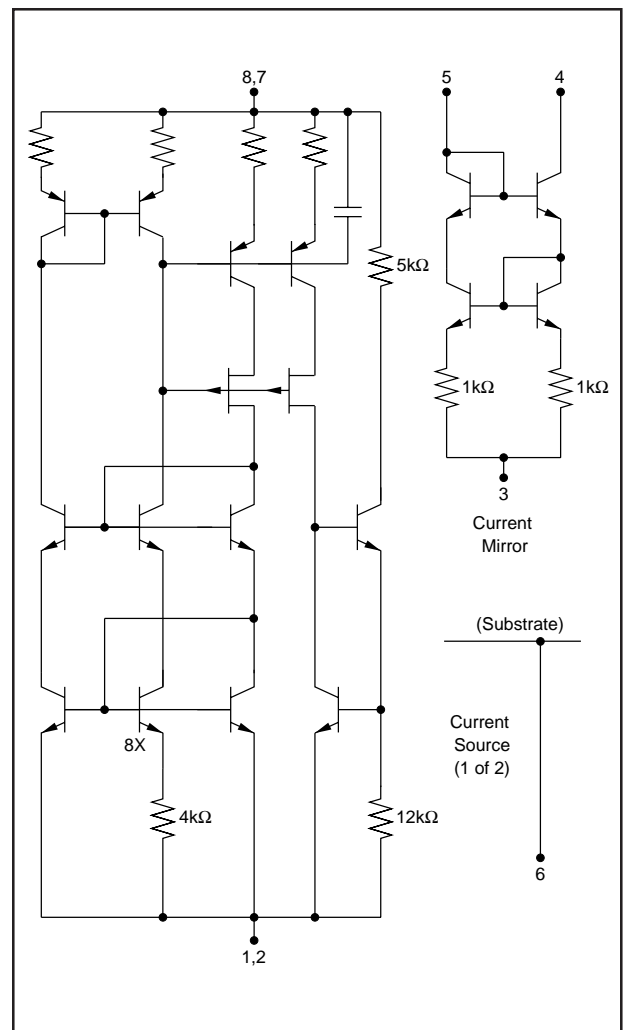

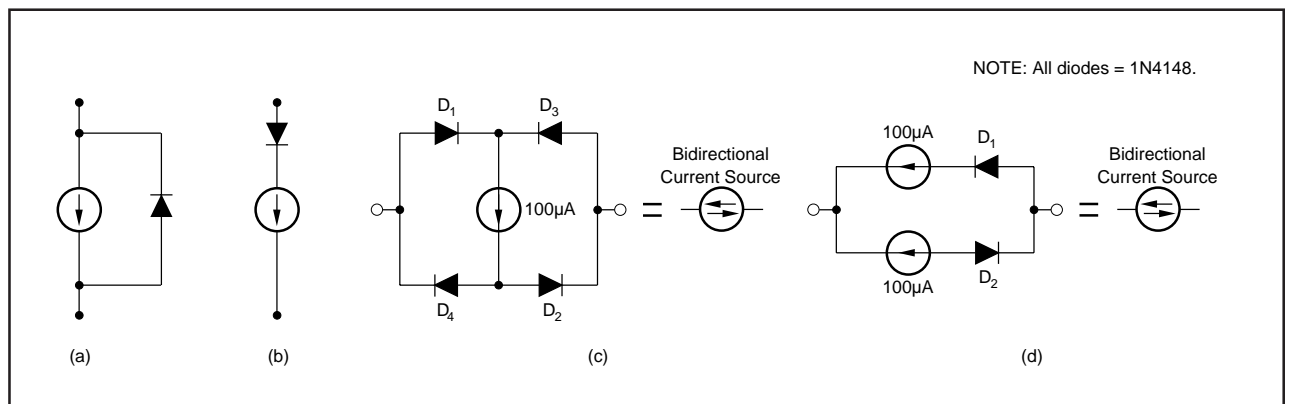FIGURE 1. Simplified Circuit Diagram.
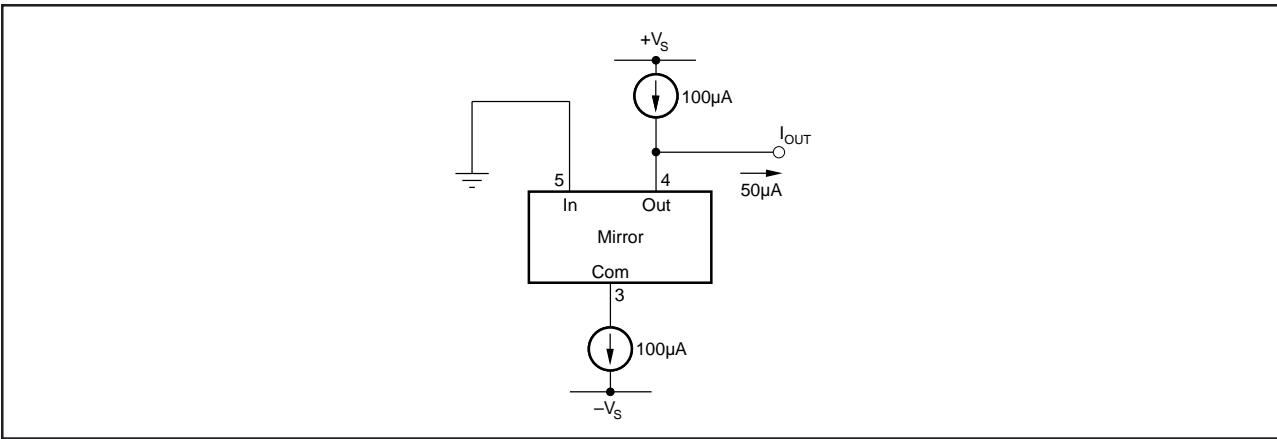

FIGURE 2. Reverse Voltage Protection.

REF200

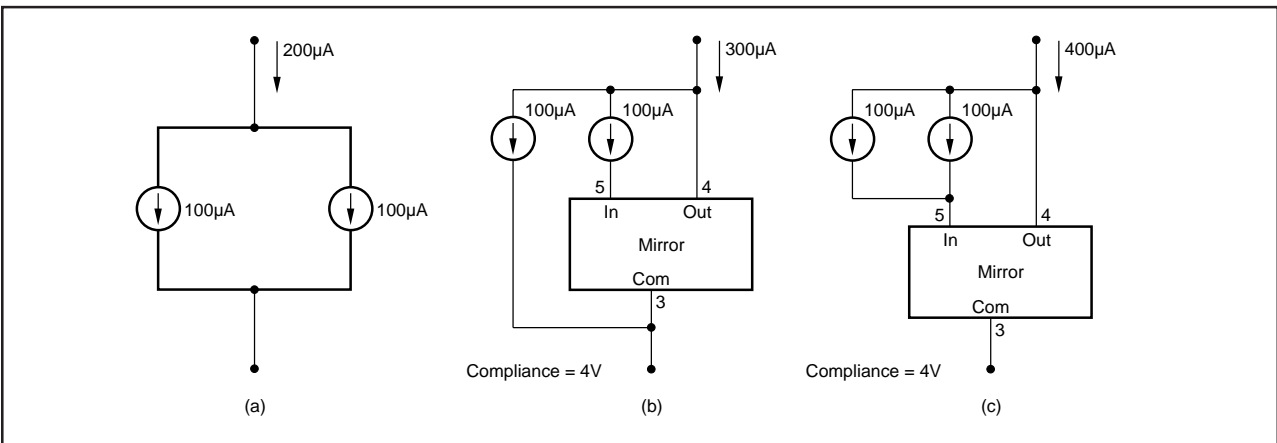FIGURE 3. 50µA Current Source.

FIGURE 4. 200µA, 300µA, and 400µA Floating Current Sources.
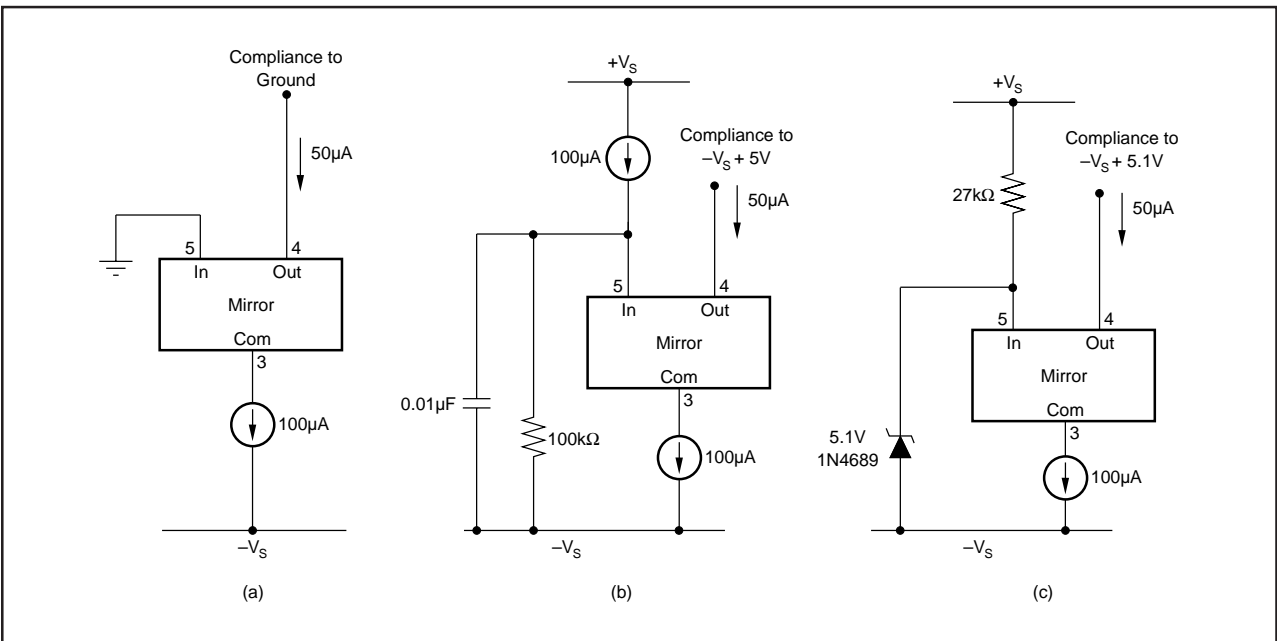
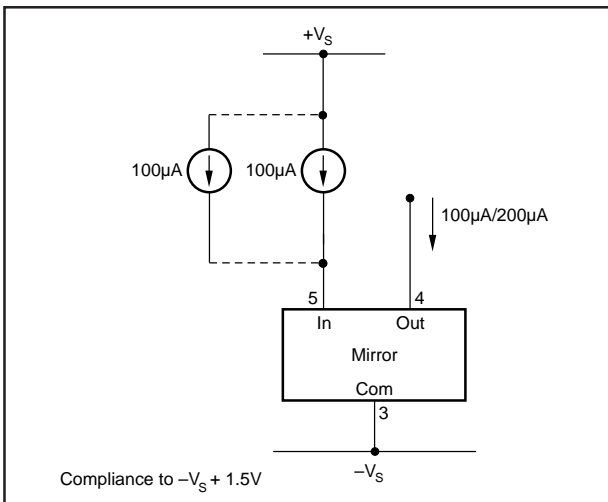FIGURE 5. 50µA Current Sinks.

FIGURE 6. Improved Low-Voltage Compliance.

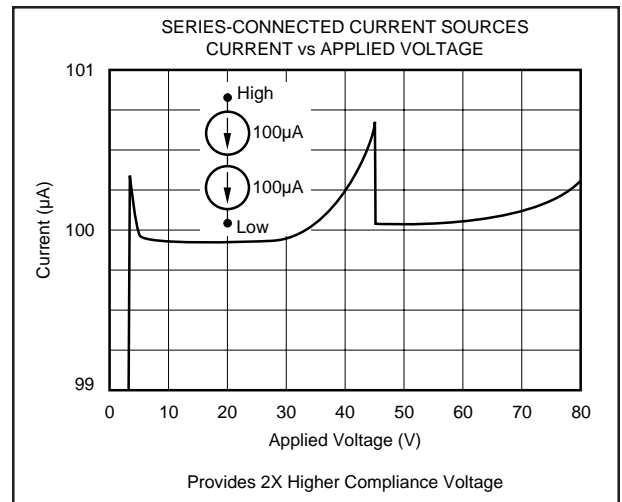FIGURE 7. 100µA Current Source—80V Compliance.

FIGURE 8. FET Cascode Circuits.
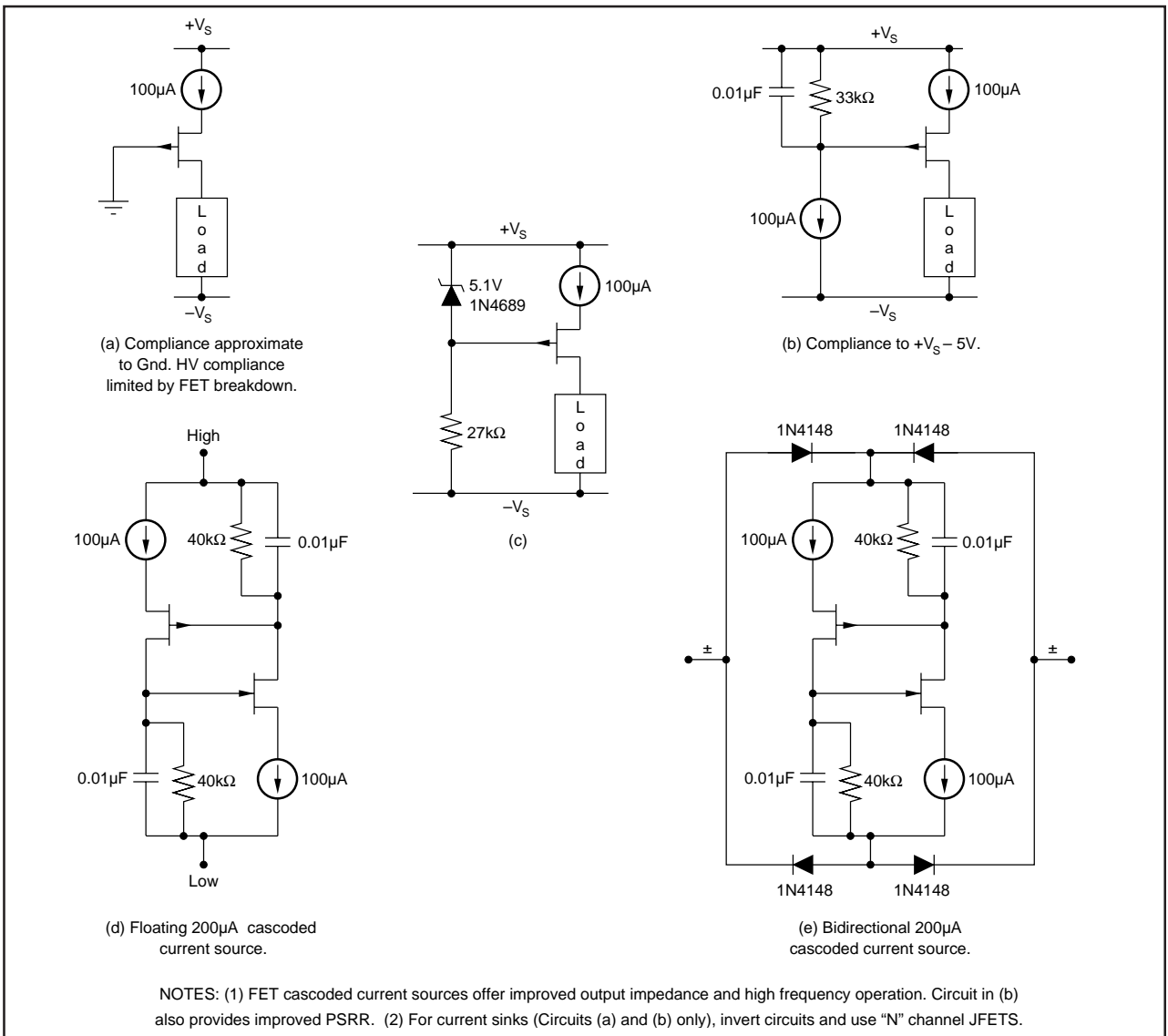
REF200

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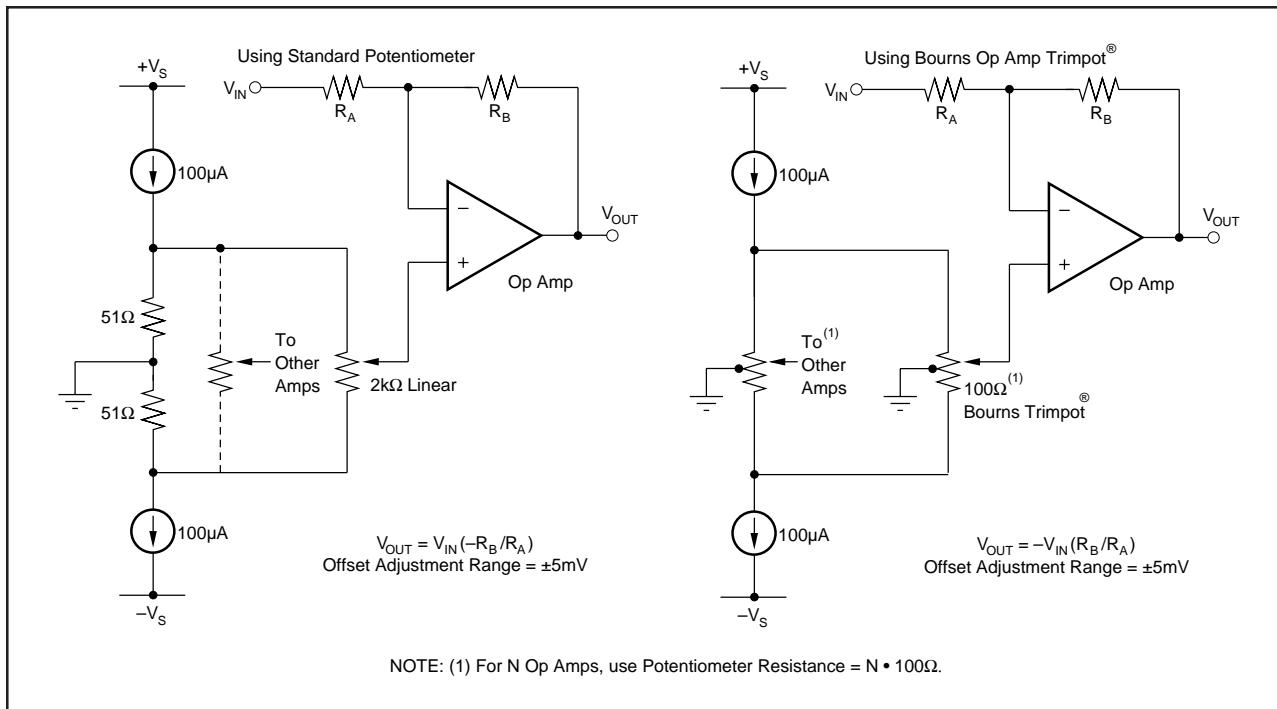BB

FIGURE 9. Op Amp Offset Adjustment Circuits.

The circuits show:

Using Standard Potentiometer

$$V_{OUT} = V_{IN}(-R_B/R_A)$$
Offset Adjustment Range = ±5mV

Using Bourns Op Amp Trimpot®

$$V_{OUT} = -V_{IN}(R_B/R_A)$$
Offset Adjustment Range = ±5mV

NOTE: (1) For N Op Amps, use Potentiometer Resistance = N • 100Ω.

NOTE: (1) Burr Brown® OPA602 or OPA128

EXAMPLES

R_1	R_2	I_{OUT}	
100Ω	10MΩ	1nA	→ Use OPA128
10kΩ	1MΩ	1µA	
10kΩ	1kΩ	1mA	

FEATURES:
(1) Zero volts shunt compliance.
(2) Adjustable only to values above reference value.

NOTE:
Current source/sink swing to the "Load Return" rail is limited only by the op amp's input common mode range and output swing capability. Voltage drop across "R" can be tailored for any amplifier to allow swing to zero volts from rail.

EXAMPLES

R	NR	I_{OUT}
1kΩ	4KΩ	500µA
1kΩ	9kΩ	1mA
100kΩ	9.9kΩ	10mA

FIGURE 10. Adjustable Current Sources.

REF200

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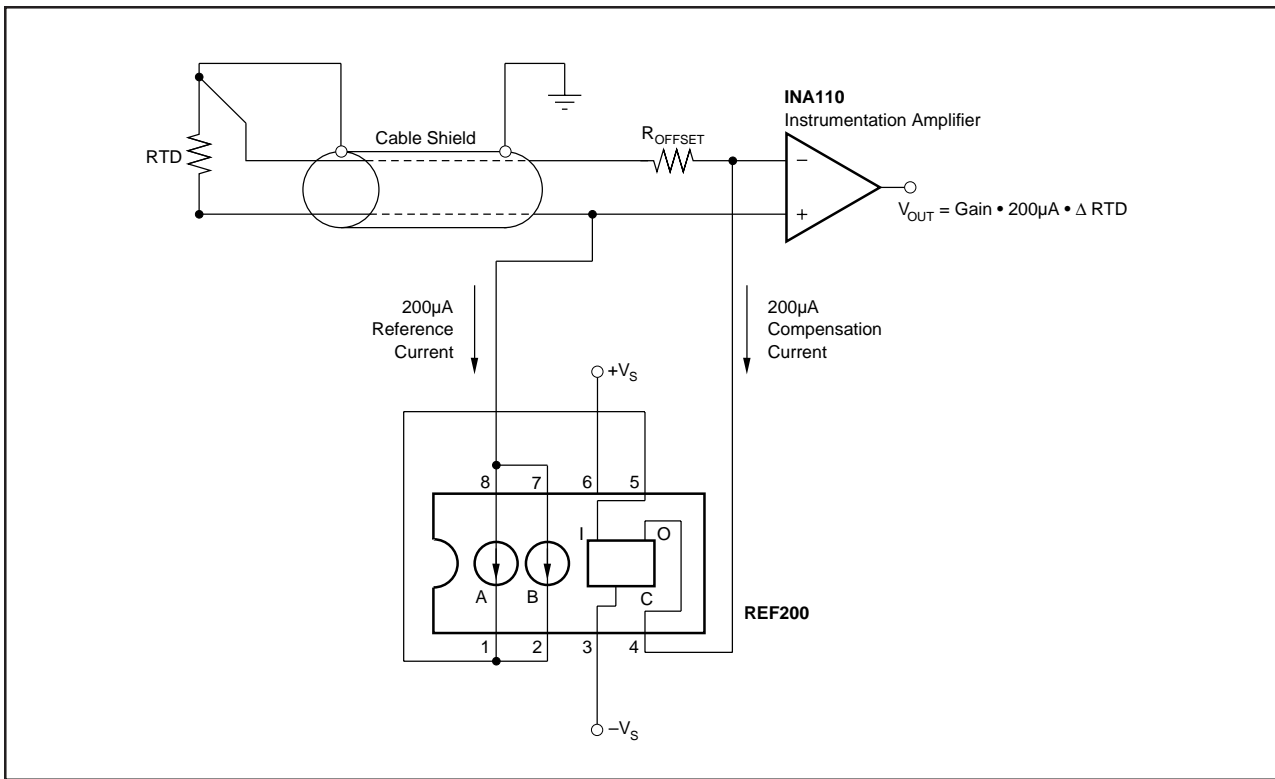
FIGURE 11. RTD Excitation With Three Wire Lead Resistance Compensation.

Frequency = 1/4RC (Hz)
Frequency = 25/C (Hz)
(C is in µF and R = 10kΩ)
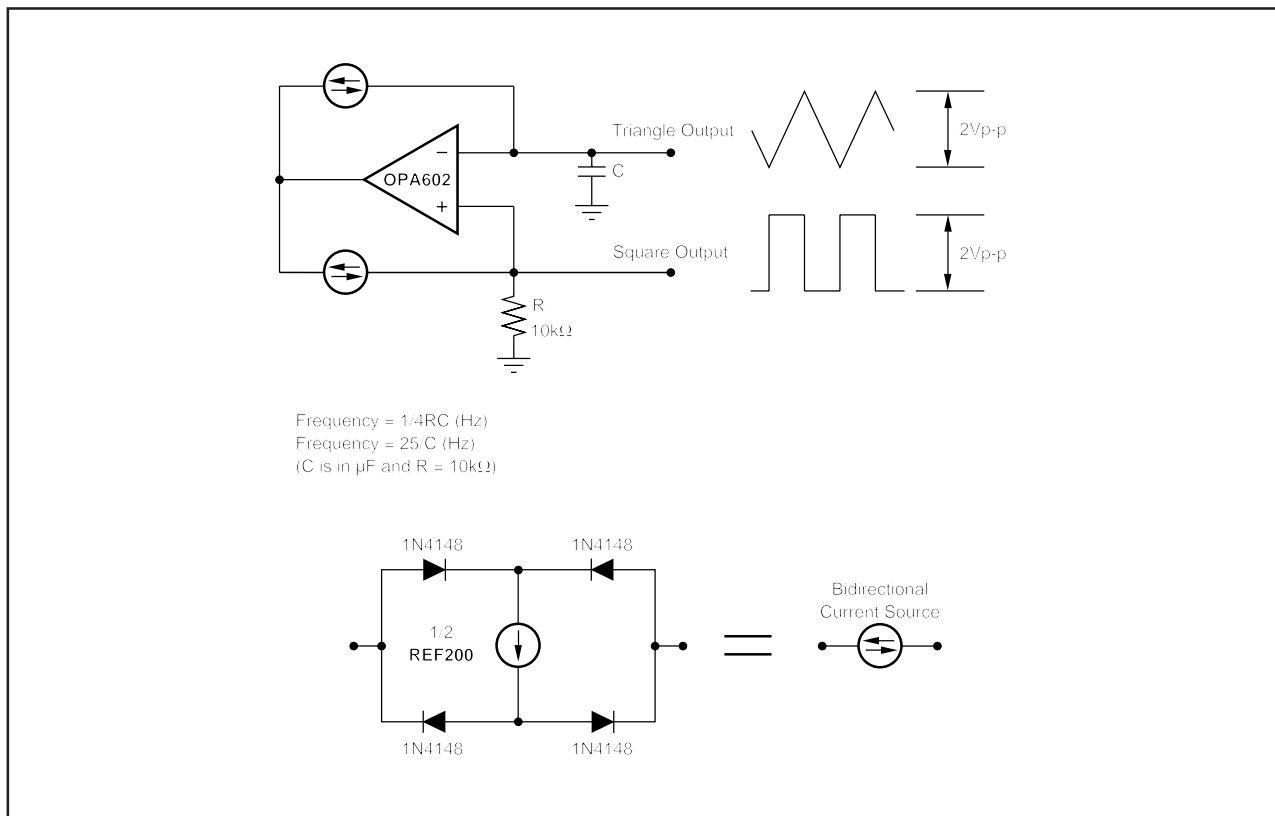
FIGURE 12. Precision Triangle Waveform Generator.
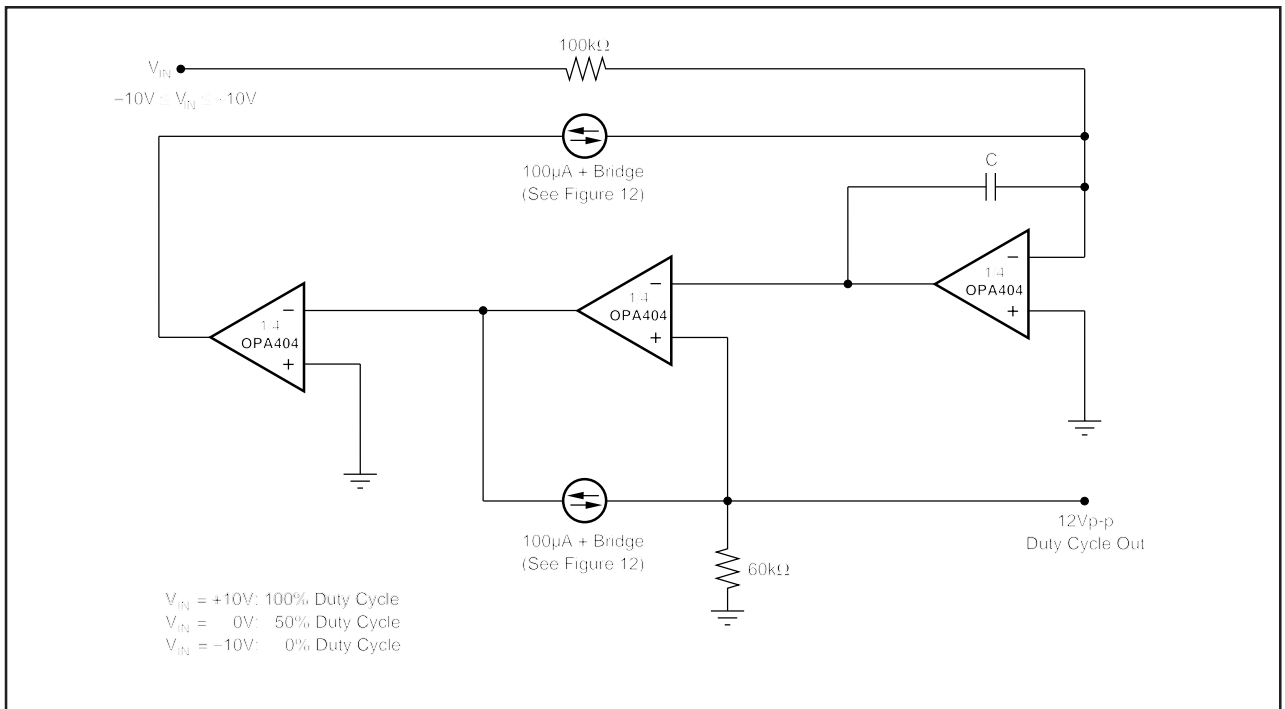
FIGURE 13. Precision Duty-Cycle Modulator.
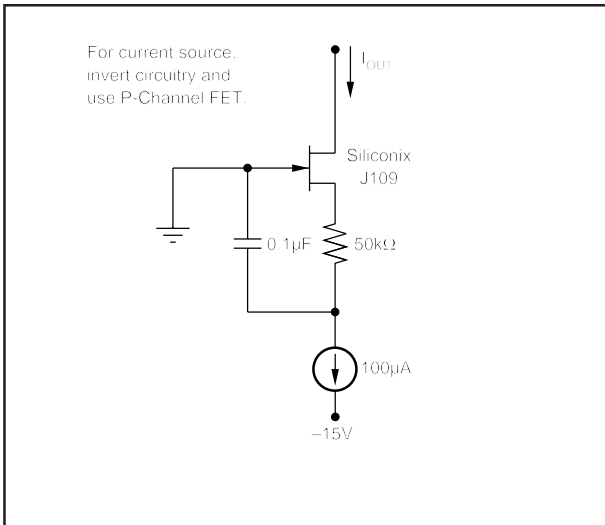
FIGURE 14. Low Noise Current Sink.
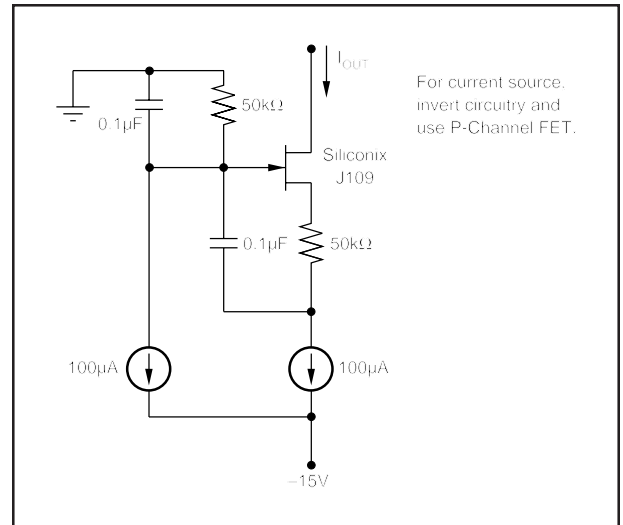
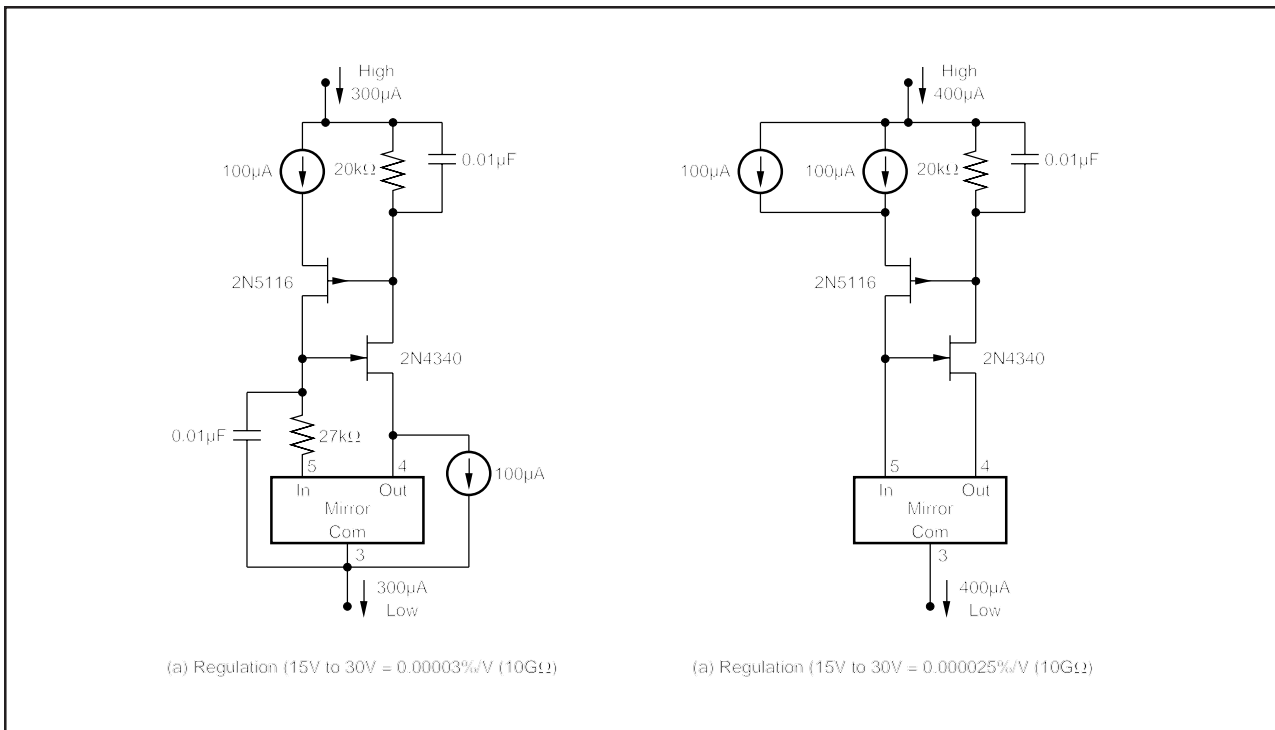FIGURE 15. Low Noise Current Sink with Compliance Below Ground.

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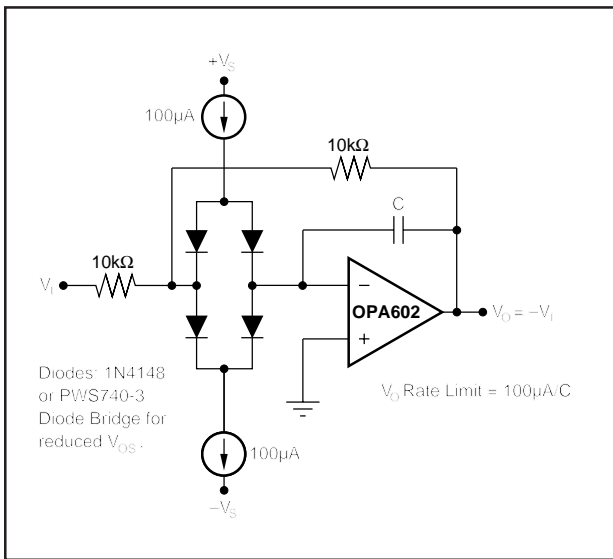FIGURE 16. Floating 300μA and 400μA Cascoded Current Sources.
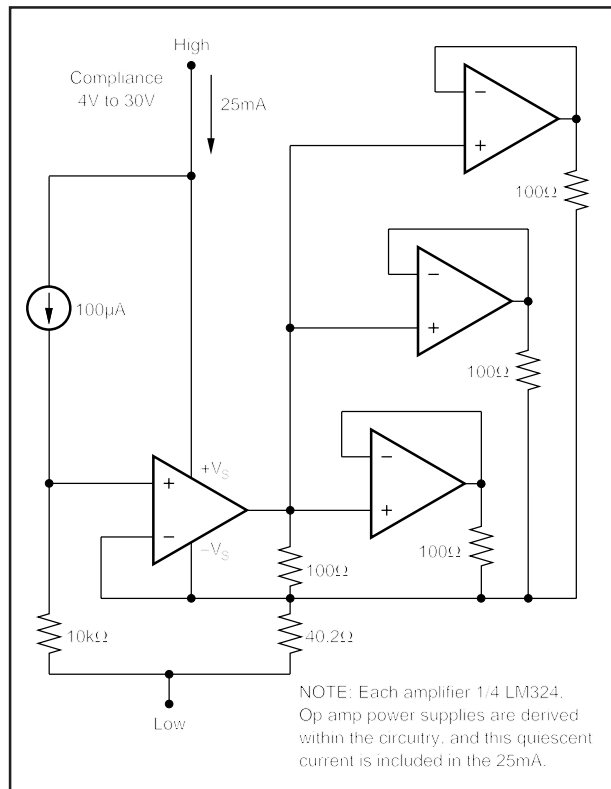

FIGURE 17. Rate Limiter.

FIGURE 18. 25mA Floating Current Source.
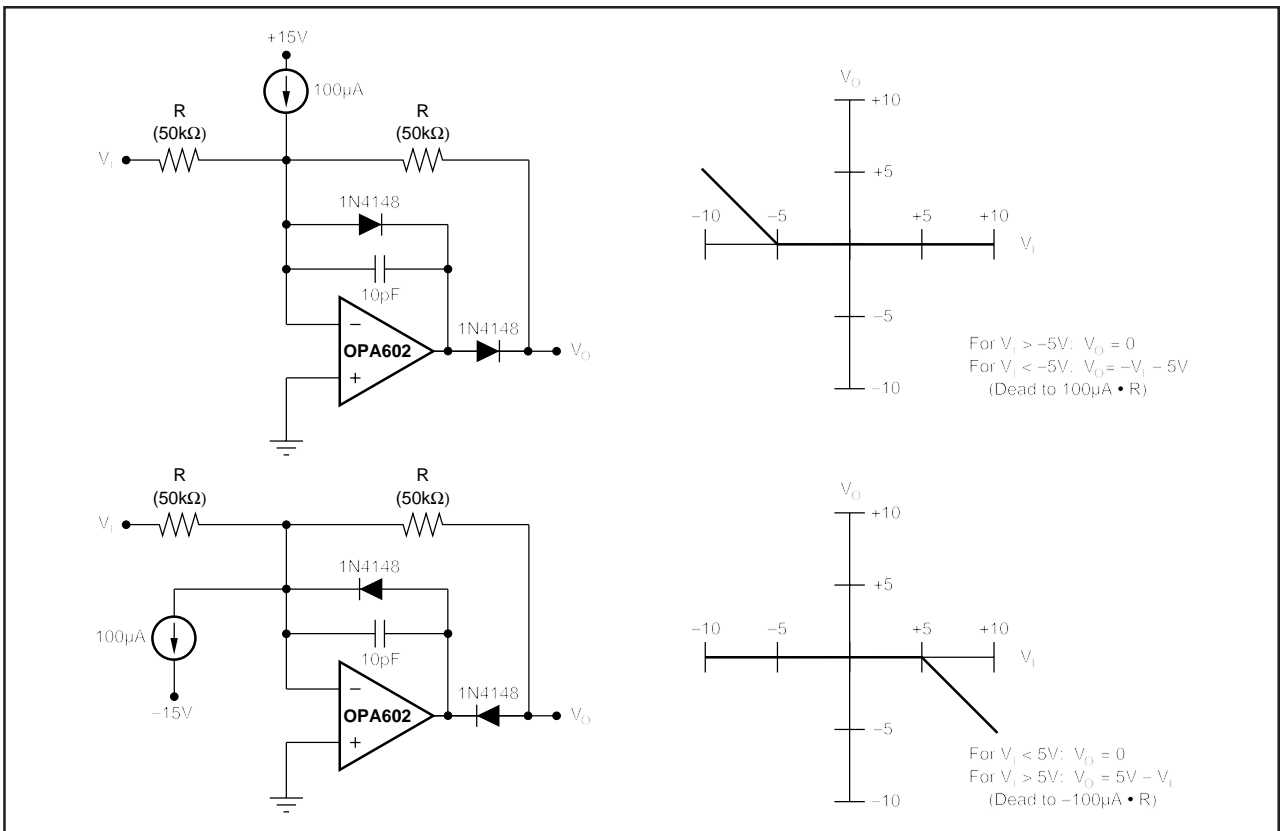
FIGURE 19. Dead-Band Circuit.
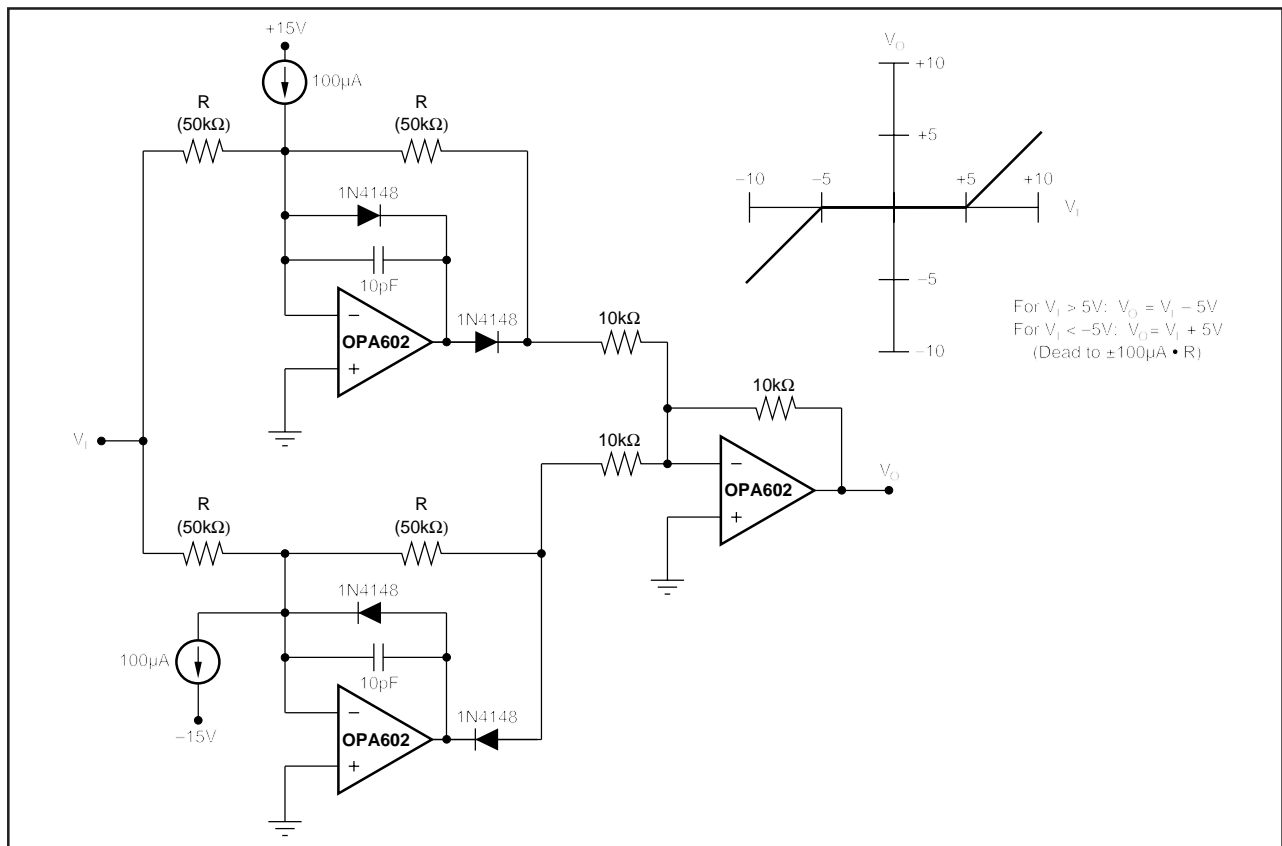
FIGURE 20. Double Dead-Band Circuit.

REF200
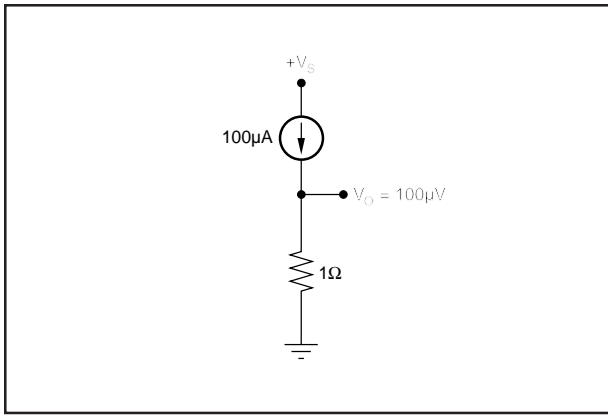
FIGURE 21. Low-Voltage Reference.
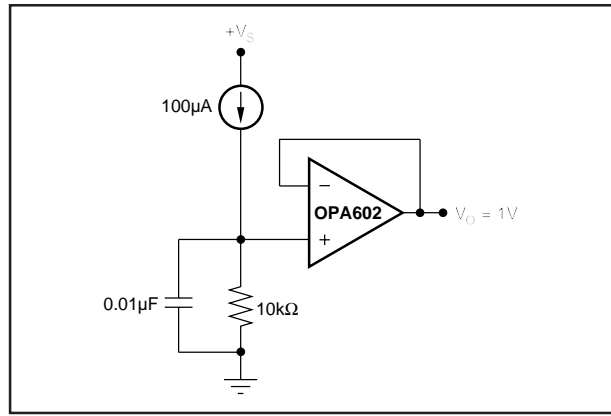
FIGURE 22. Voltage Reference.

$V_O = V_I \ (-5V < V_I < 5V)$
$V_O = 5V \ (V_I > 5V)$
$V_O = -5V \ (V_I < -5V)$
$(\text{Bound} = 100\mu A \cdot R)$
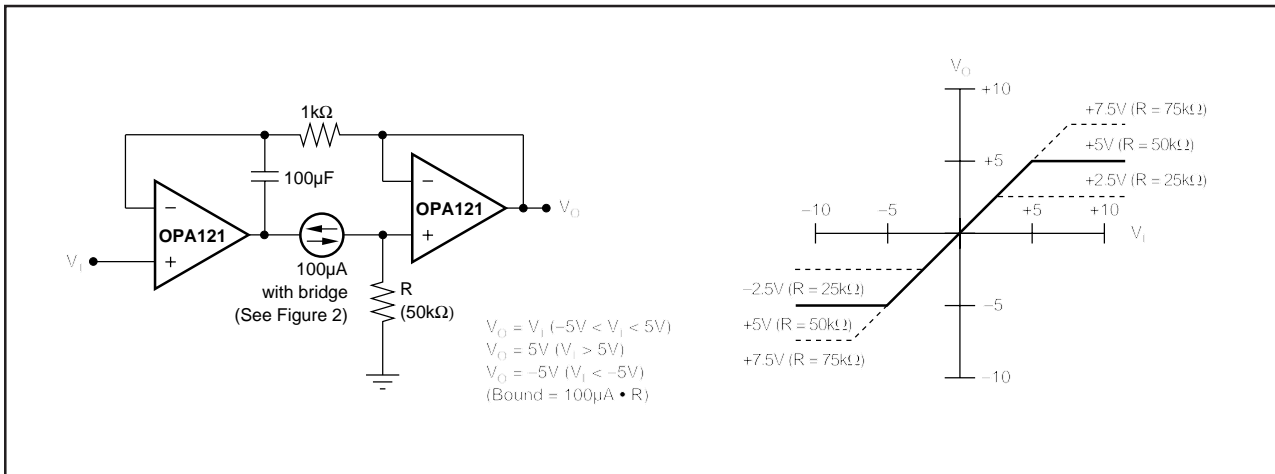
FIGURE 23. Bipolar Limiting Circuit.

$V_O = V_I \ (V_I < 5V)$
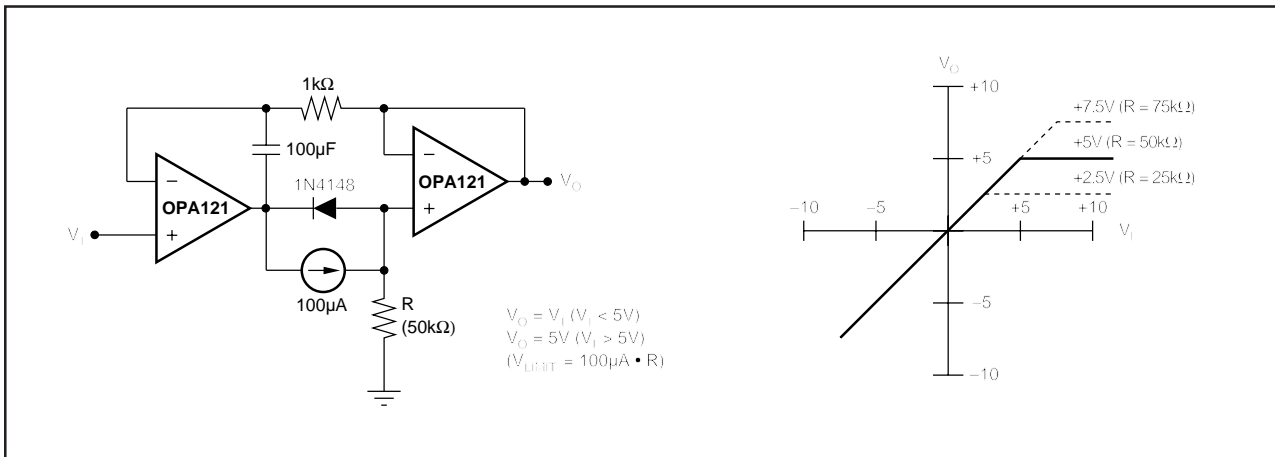$V_O = 5V \ (V_I > 5V)$
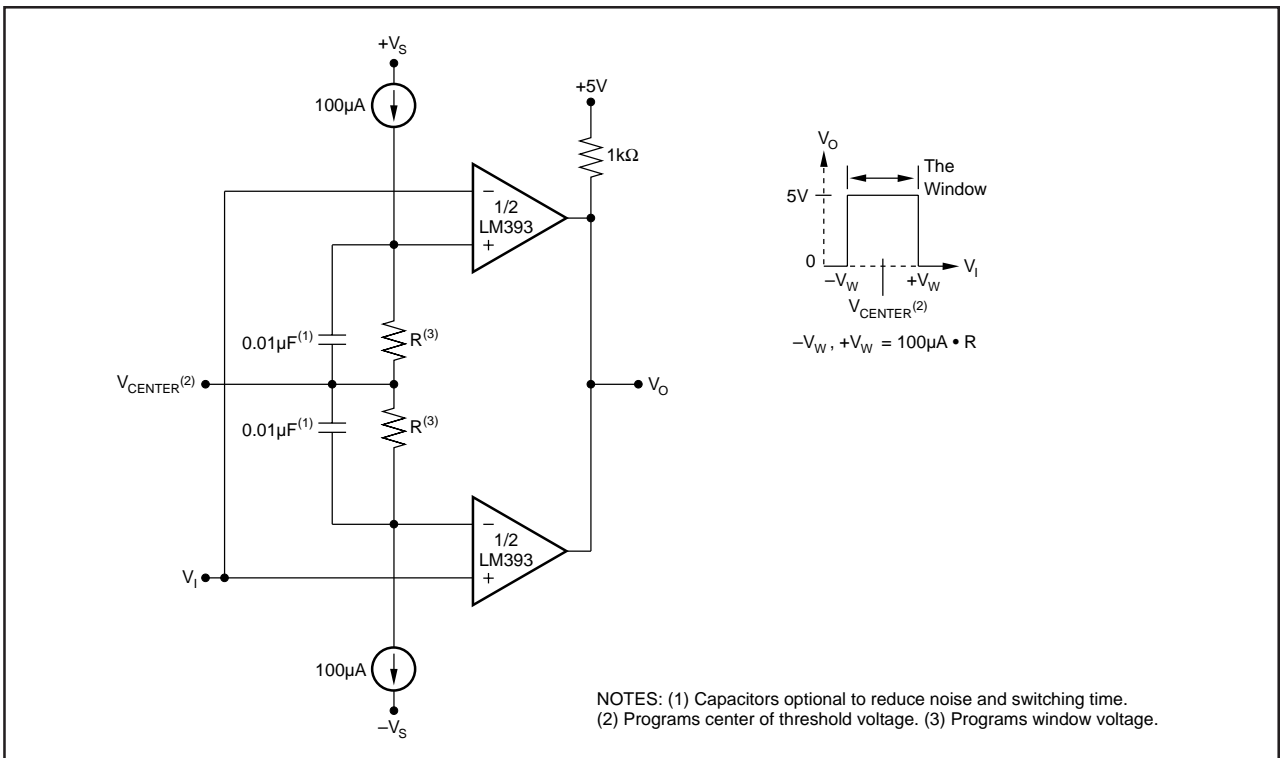$(V_{LIMIT} = 100\mu A \cdot R)$

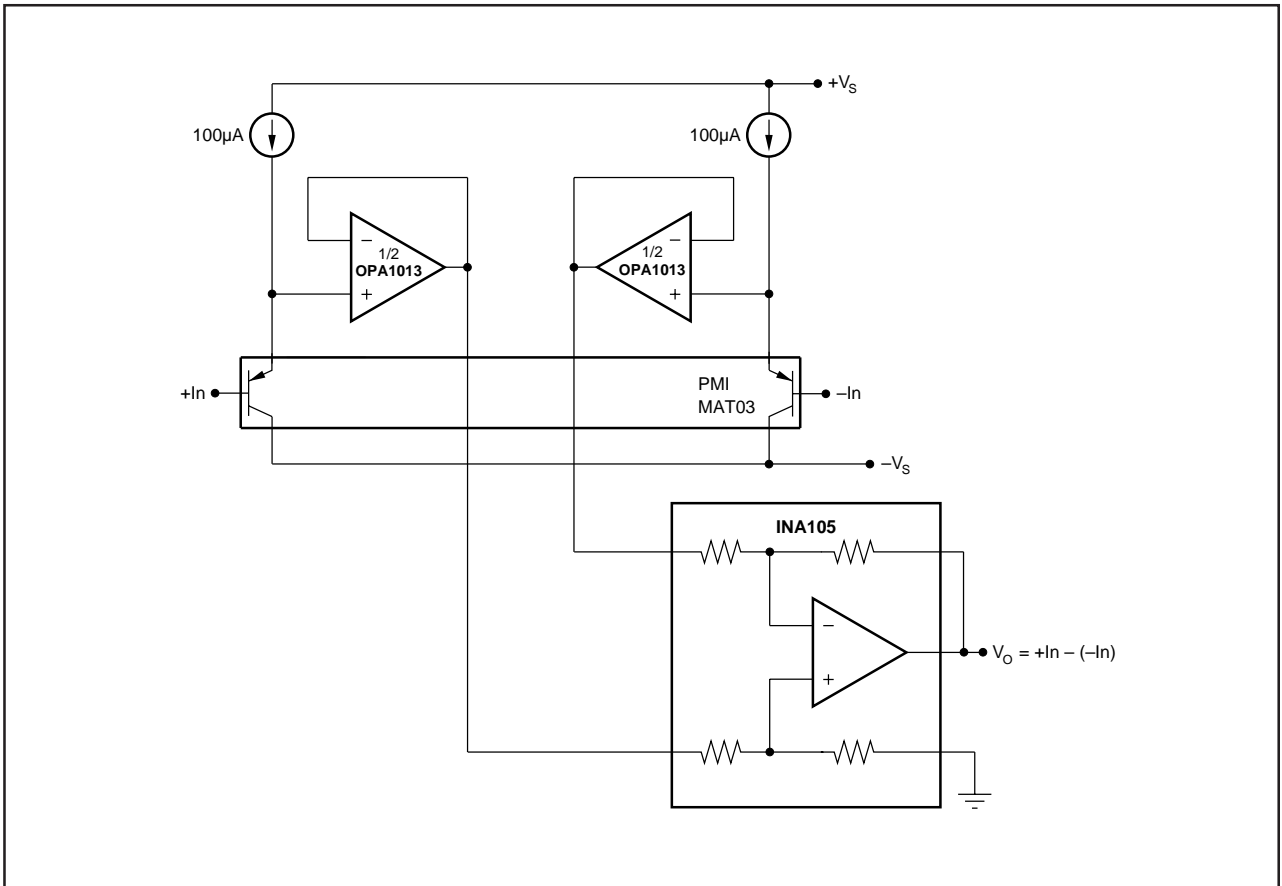FIGURE 24. Limiting Circuit.

FIGURE 25. Window Comparator.

FIGURE 26. Instrumentation Amplifier with Compliance to $-V_S$.

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