

REF200

DUAL CURRENT SOURCE/CURRENT SINK

FEATURES

- COMPLETELY FLOATING:
No Power Supply or Ground Connections
- HIGH ACCURACY: $100\mu\text{A} \pm 0.5\%$
- LOW TEMPERATURE COEFFICIENT:
 $\pm 25\text{ppm}/^\circ\text{C}$
- WIDE VOLTAGE COMPLIANCE:
2.5V to 40V
- ALSO INCLUDES CURRENT MIRROR

APPLICATIONS

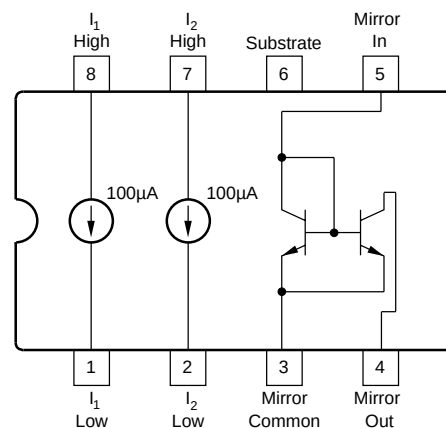
- SENSOR EXCITATION
- BIASING CIRCUITRY
- OFFSETTING CURRENT LOOPS
- LOW VOLTAGE REFERENCES
- CHARGE-PUMP CIRCUITRY
- HYBRID MICROCIRCUITS

DESCRIPTION

The REF200 combines three circuit building-blocks on a single monolithic chip—two $100\mu\text{A}$ 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 $50\mu\text{A}$, $100\mu\text{A}$, $200\mu\text{A}$, $300\mu\text{A}$ or $400\mu\text{A}$. 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.



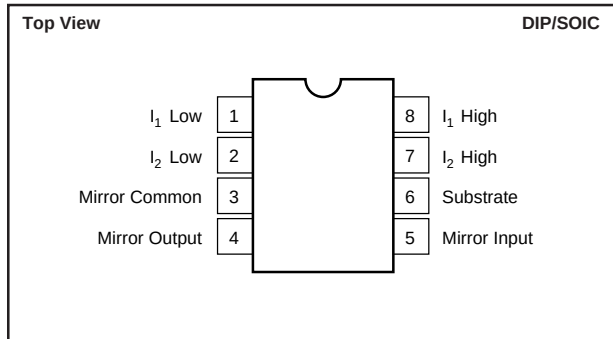
SPECIFICATIONS

ELECTRICAL

At $T_A = +25^\circ\text{C}$, $V_S = 15\text{V}$, 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/ $^\circ\text{C}$
Output Impedance	2.5V to 40V	20	100		M Ω
	3.5V to 30V	200	500		M Ω
Noise	BW = 0.1Hz to 10Hz		1		nAp-p
	f = 10kHz		20		pA/ $\sqrt{\text{Hz}}$
Voltage Compliance (1%)	T_{MIN} to T_{MAX}		See Curves		
Capacitance			10		pF
CURRENT MIRROR					
Gain	I = 100 μA Unless Otherwise Noted	0.995	1	1.005	
Temperature Drift			25		ppm/ $^\circ\text{C}$
Impedance (output)	2V to 40V	40	100		M Ω
Nonlinearity	I = 0 μA to 250 μA		0.05		%
Input Voltage			1.4		V
Output Compliance Voltage			See Curves		
Frequency Response (-3dB)	Transfer		5		MHz
TEMPERATURE RANGE					
Specification		-25		+85	$^\circ\text{C}$
Operating		-40		+85	$^\circ\text{C}$
Storage		-40		+125	$^\circ\text{C}$

PIN CONFIGURATION



ABSOLUTE MAXIMUM RATINGS

Applied Voltage	-6V to +40V
Reverse Current	-350 μA
Voltage Between Any Two Sections	$\pm 80\text{V}$
Operating Temperature	-40 $^\circ\text{C}$ to +85 $^\circ\text{C}$
Storage Temperature	-40 $^\circ\text{C}$ to +125 $^\circ\text{C}$
Lead Temperature (soldering, 10s)	+300 $^\circ\text{C}$
(SOIC 3s)	+260 $^\circ\text{C}$

PACKAGE/ORDERING INFORMATION

PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER ⁽¹⁾	TEMPERATURE RANGE
REF200AP	8-Pin Plastic DIP	006	-25 $^\circ\text{C}$ to +85 $^\circ\text{C}$
REF200AU	8-Pin SOIC	182	-25 $^\circ\text{C}$ to +85 $^\circ\text{C}$

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.

ELECTROSTATIC DISCHARGE SENSITIVITY

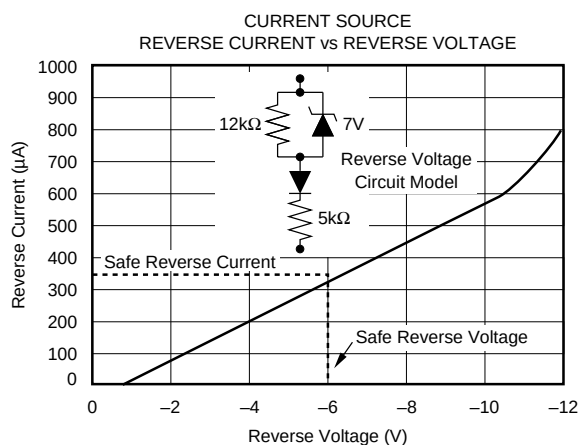
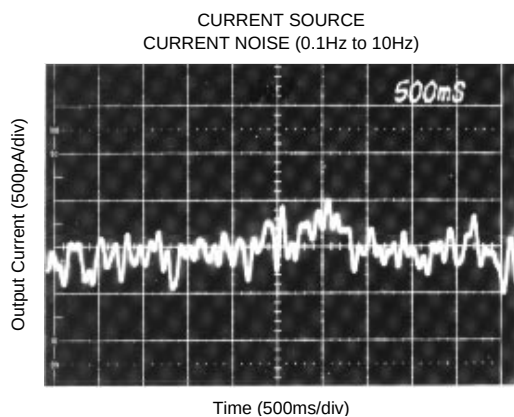
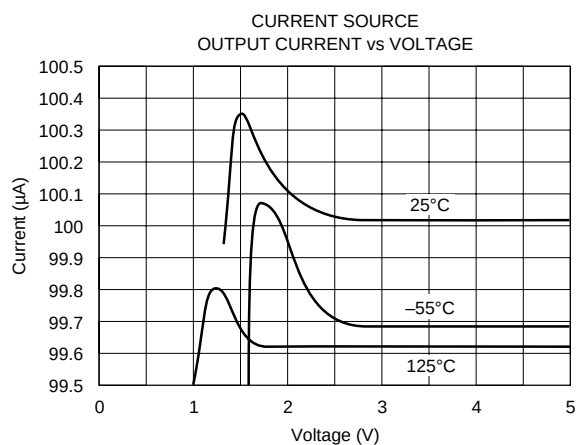
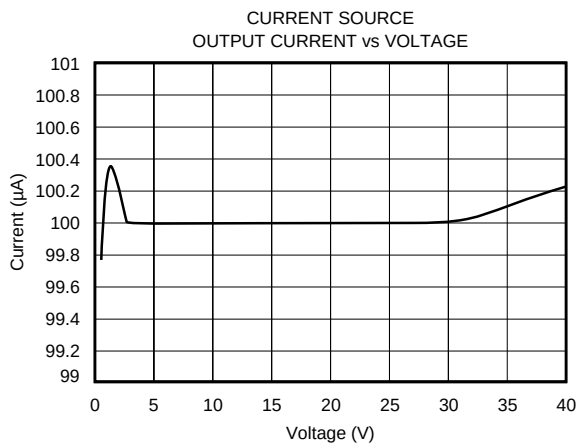
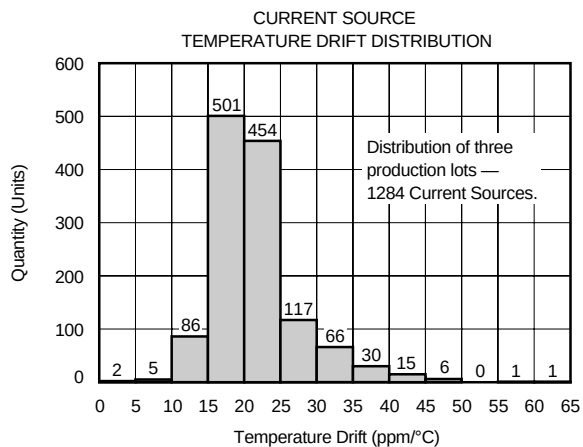
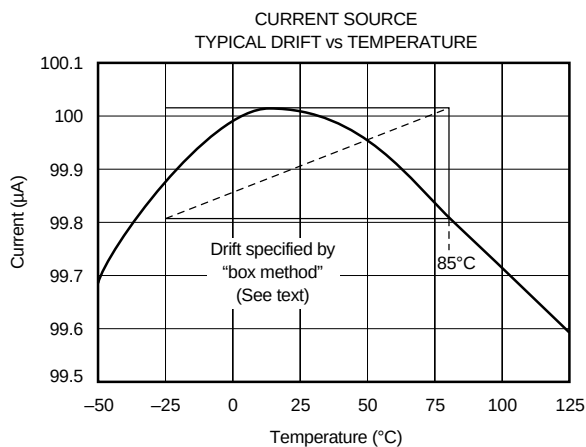
This integrated circuit can be damaged by ESD. Burr-Brown recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

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.

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.

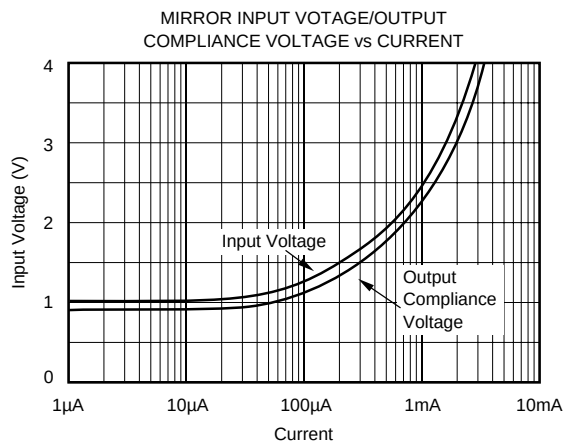
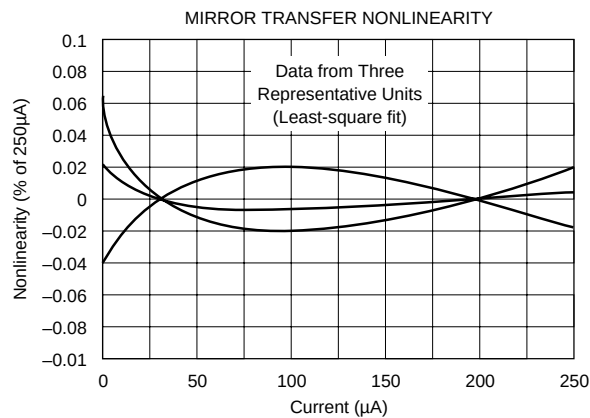
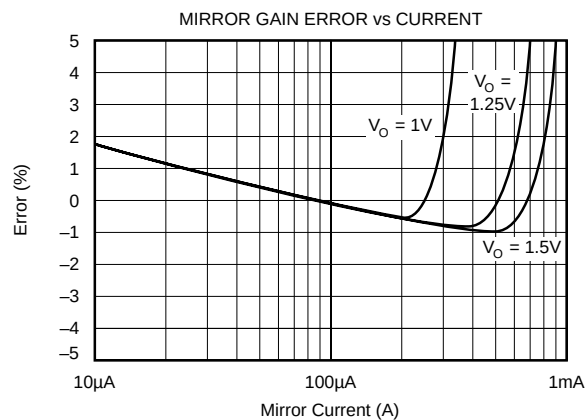
TYPICAL PERFORMANCE CURVES

At $T_A = +25^\circ\text{C}$, $V_S = +15\text{V}$, unless otherwise noted.



TYPICAL PERFORMANCE CURVES (CONT)

At $T_A = +25^\circ\text{C}$, $V_S = +15\text{V}$, unless otherwise noted.



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 $+85^{\circ}\text{C}$.

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 350 μA , 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.

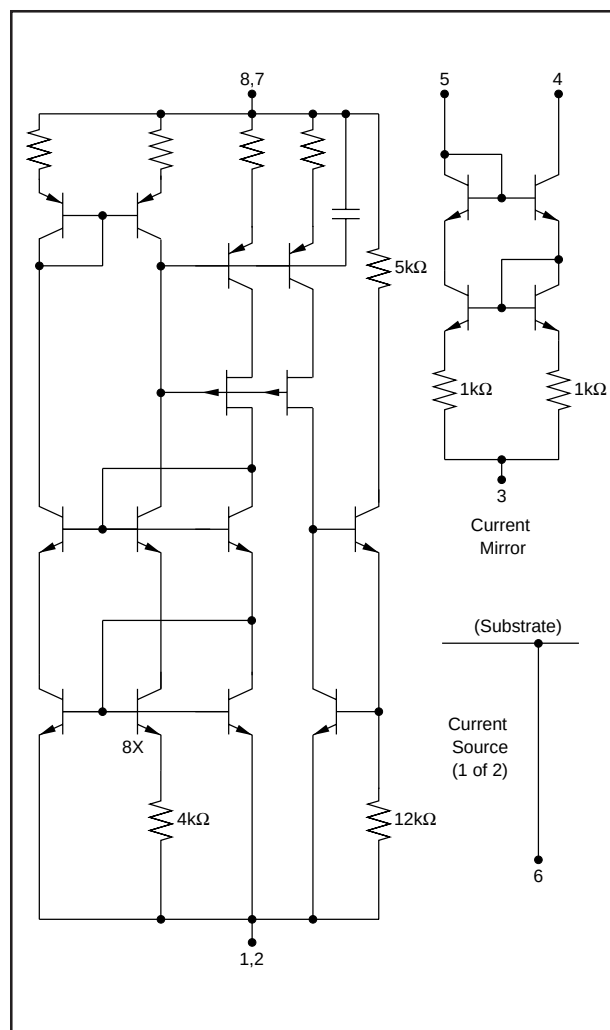


FIGURE 1. Simplified Circuit Diagram.

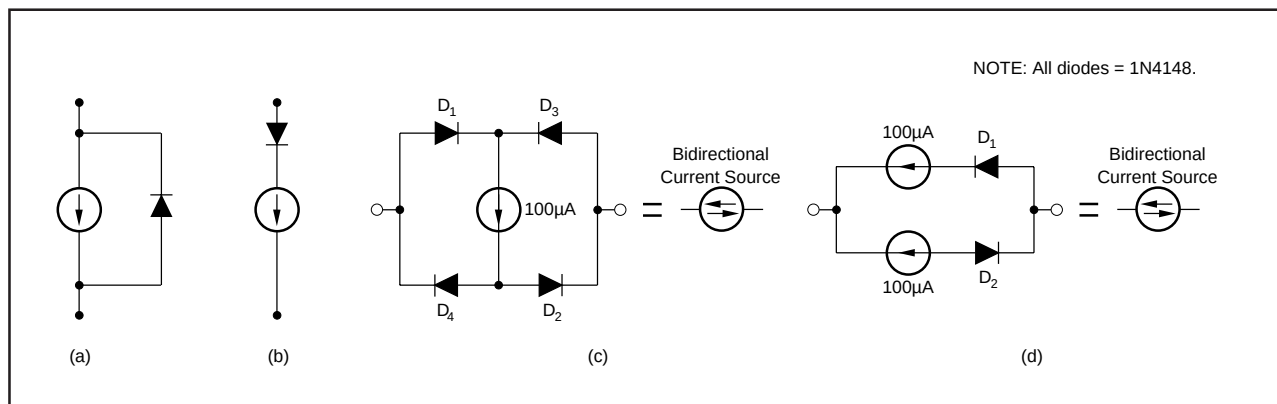


FIGURE 2. Reverse Voltage Protection.

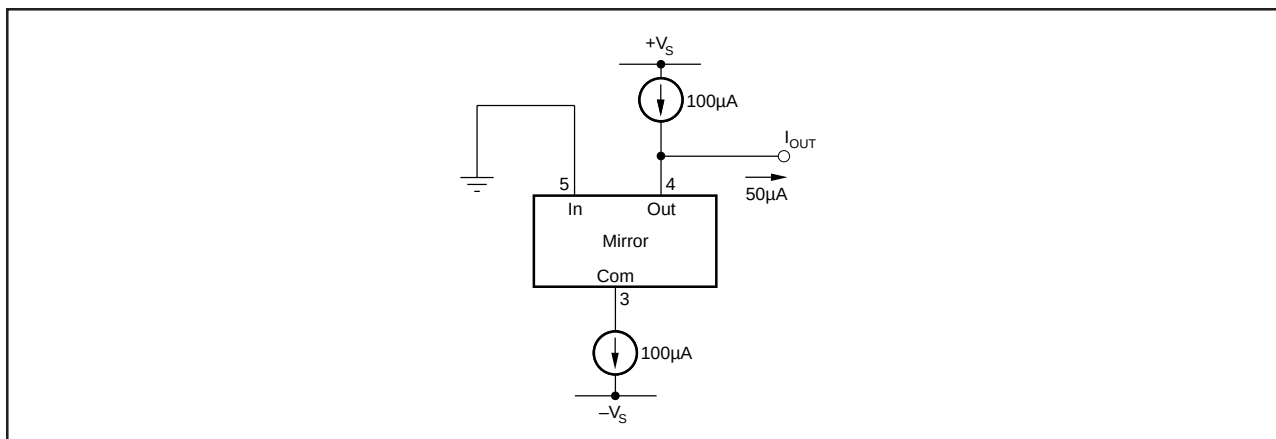


FIGURE 3. 50µA Current Source.

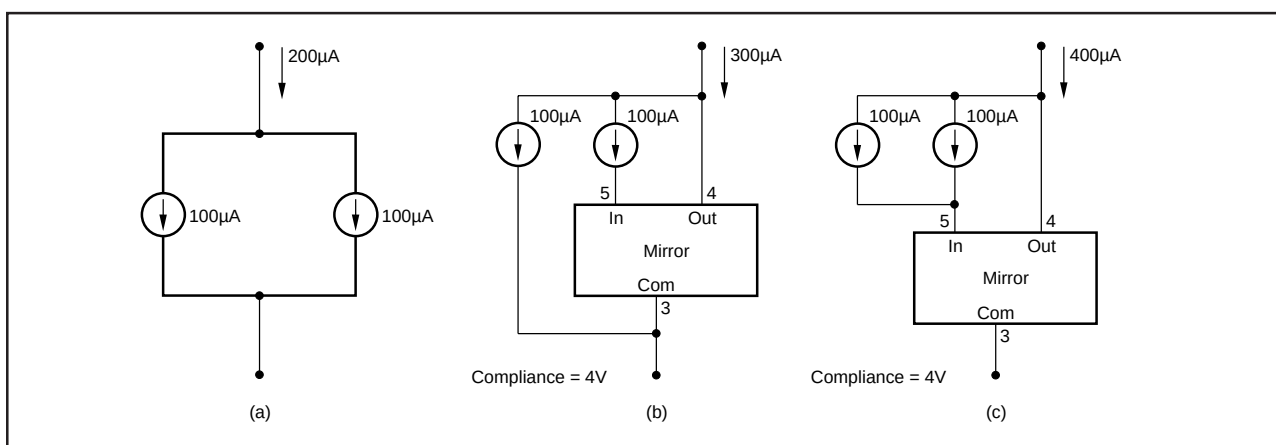


FIGURE 4. 200µA, 300µA, and 400µA Floating Current Sources.

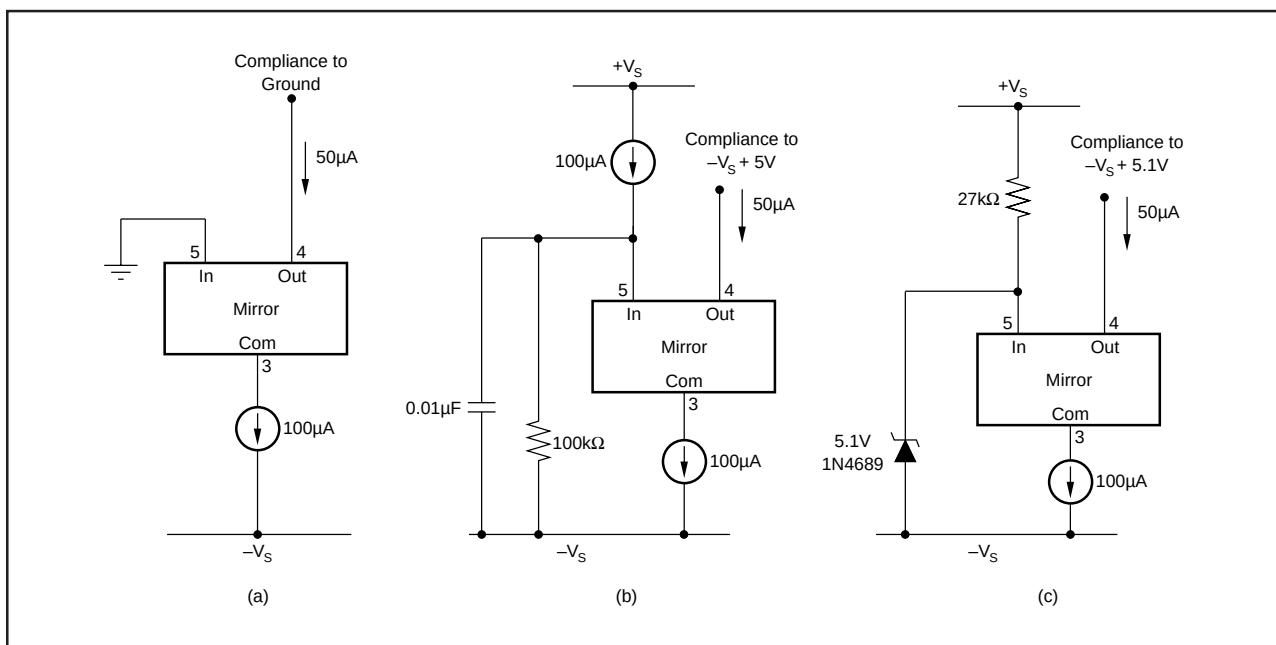


FIGURE 5. 50µA Current Sinks.

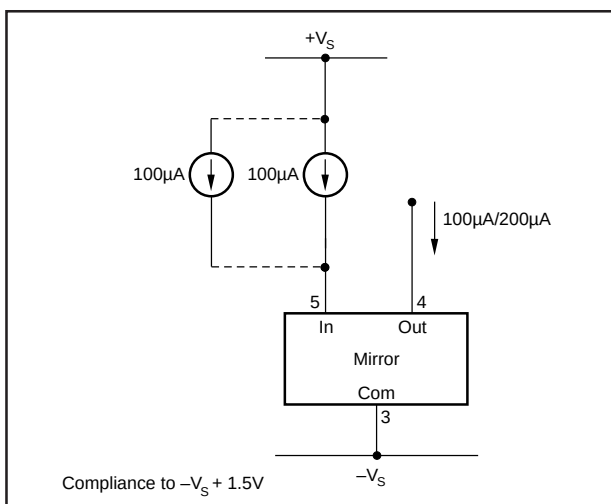


FIGURE 6. Improved Low-Voltage Compliance.

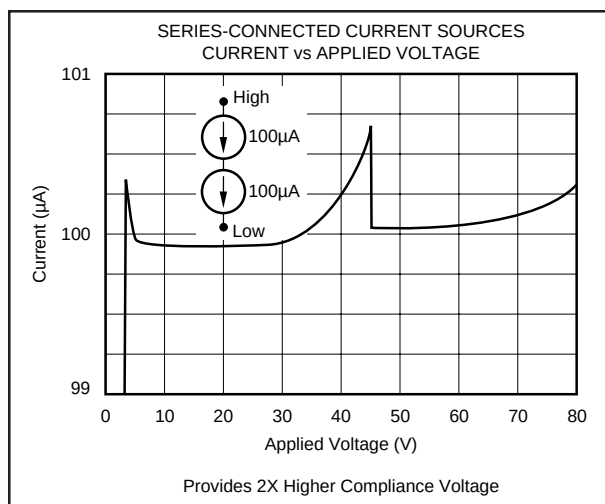


FIGURE 7. 100µA Current Source—80V Compliance.

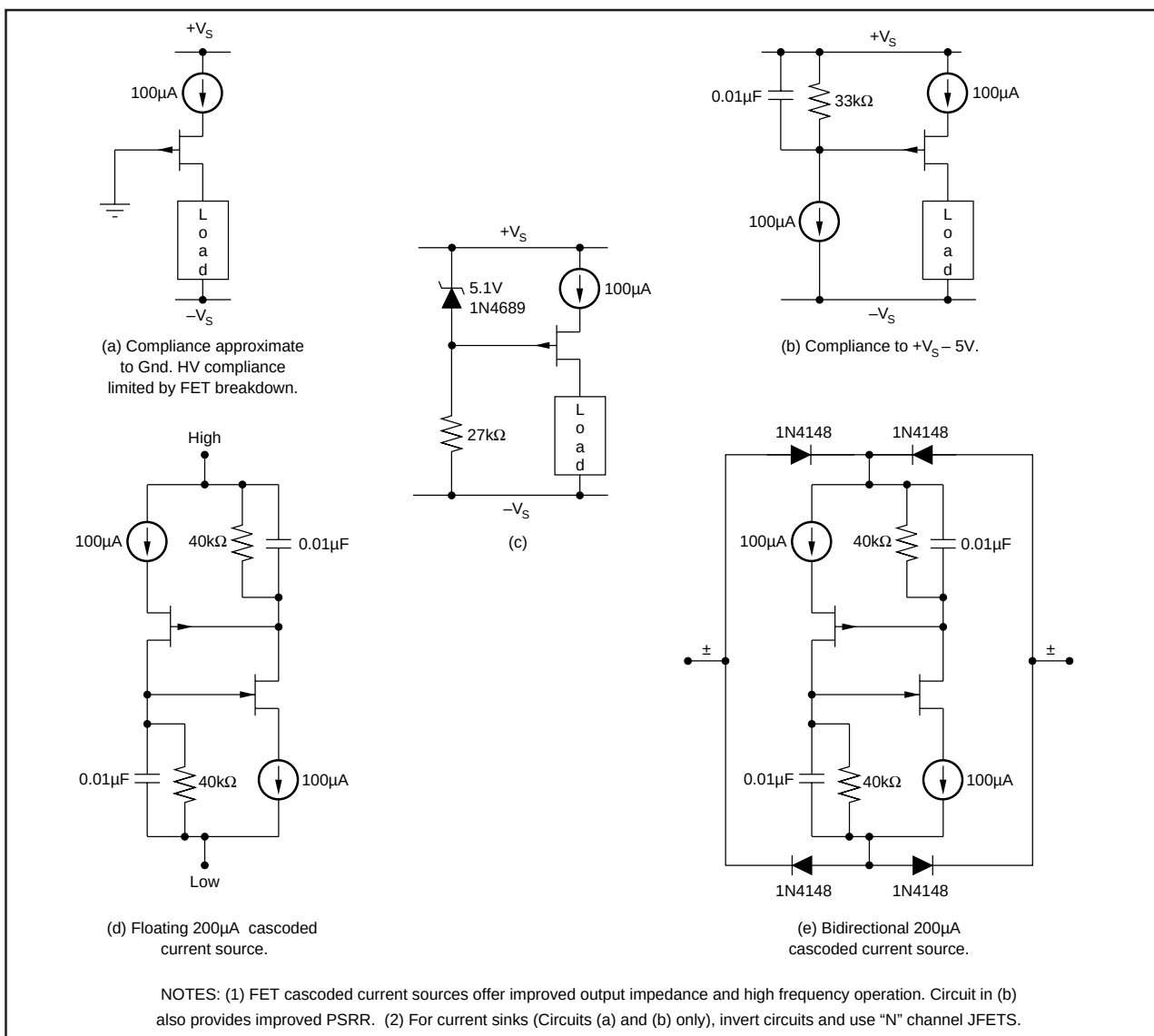


FIGURE 8. FET Cascode Circuits.

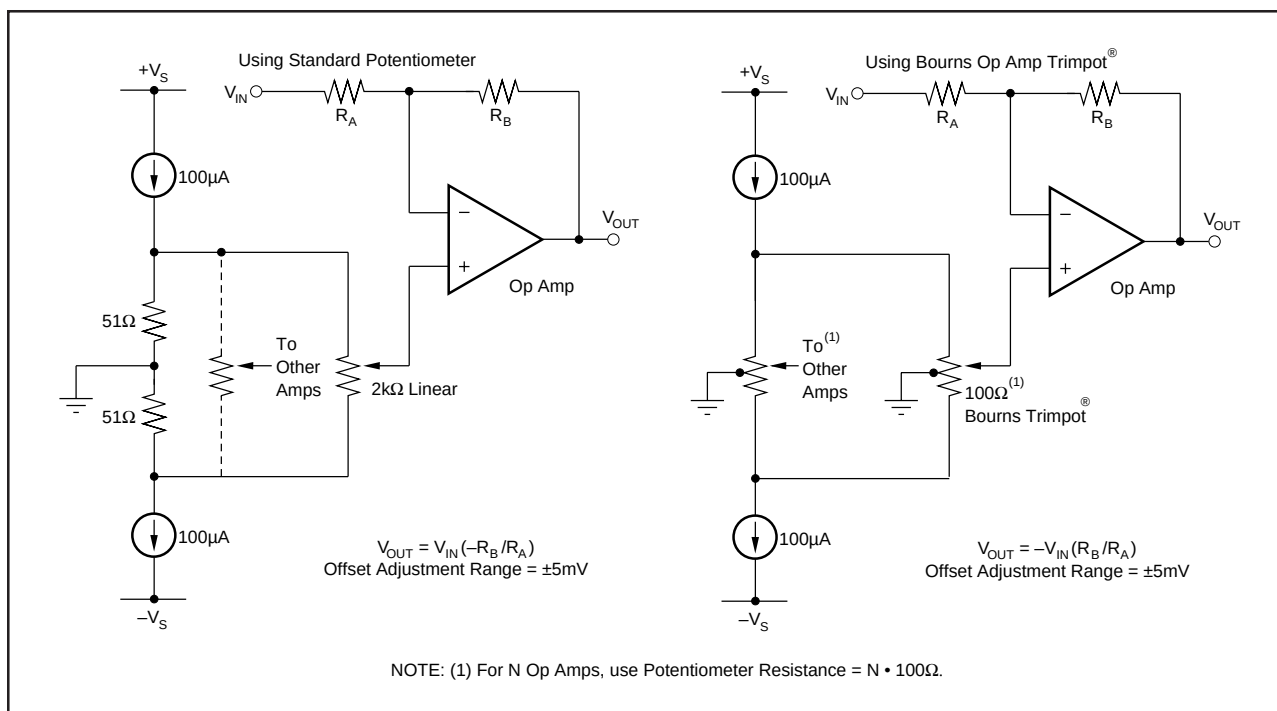
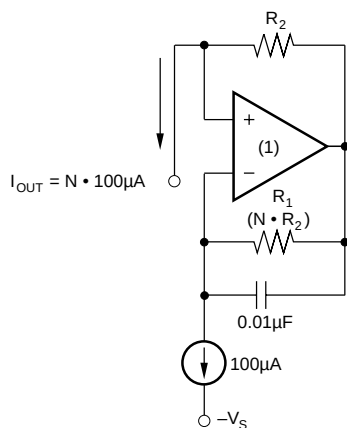


FIGURE 9. Op Amp Offset Adjustment Circuits.



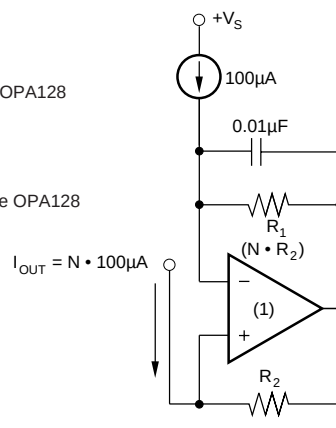
(a)

NOTE: (1) Burr Brown® OPA602 or OPA128

EXAMPLES

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

→ Use OPA128



(b)

FEATURES:

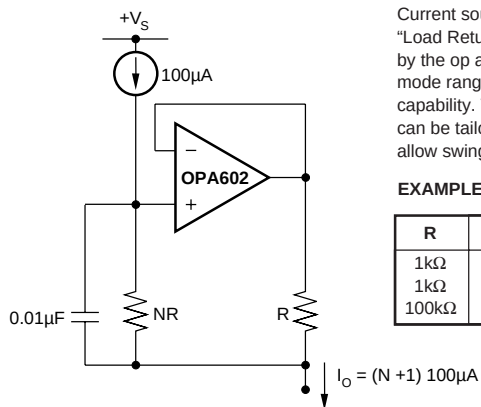
- (1) Zero volts shunt compliance.
- (2) Adjustable only to values above reference value.

NOTE:

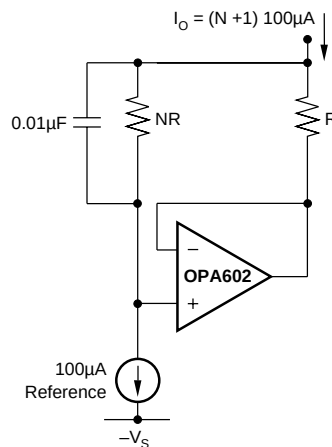
Current source/sink swing to the "Load Return" rail is limited only by the op amp's input common mode range and output swing capability. Voltage drop across "R" can be tailored for any amplifier to allow swing to zero volts from rail.

EXAMPLES

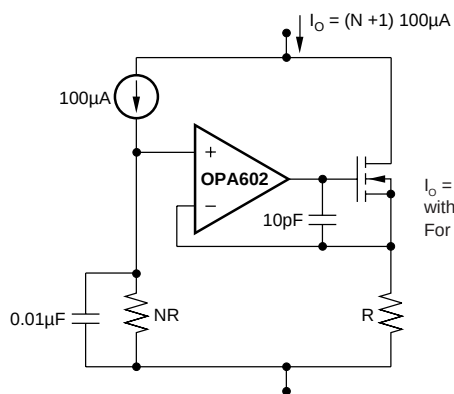
R	NR	I_{OUT}
1kΩ	4kΩ	500µA
1kΩ	9kΩ	1mA
100kΩ	9.9kΩ	10mA



(c)



(d)



(e)

$I_O = 100\mu A (N + 1)$. Compliance $\approx 3.5V$ with 0.1V across R. Max I_O limited by FET. For $I_O = 1A$, $R = 0.1\Omega$, $NR = 1k\Omega$.

FIGURE 10. Adjustable Current Sources.

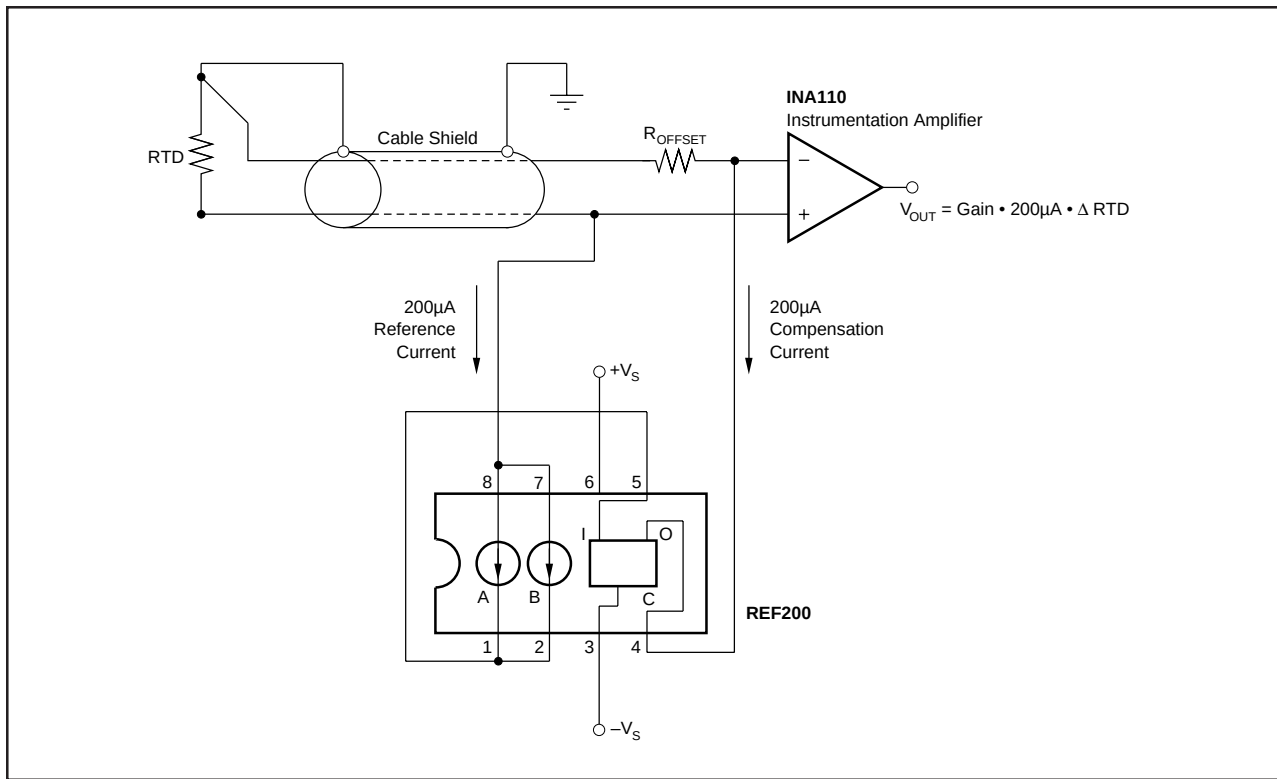


FIGURE 11. RTD Excitation With Three Wire Lead Resistance Compensation.

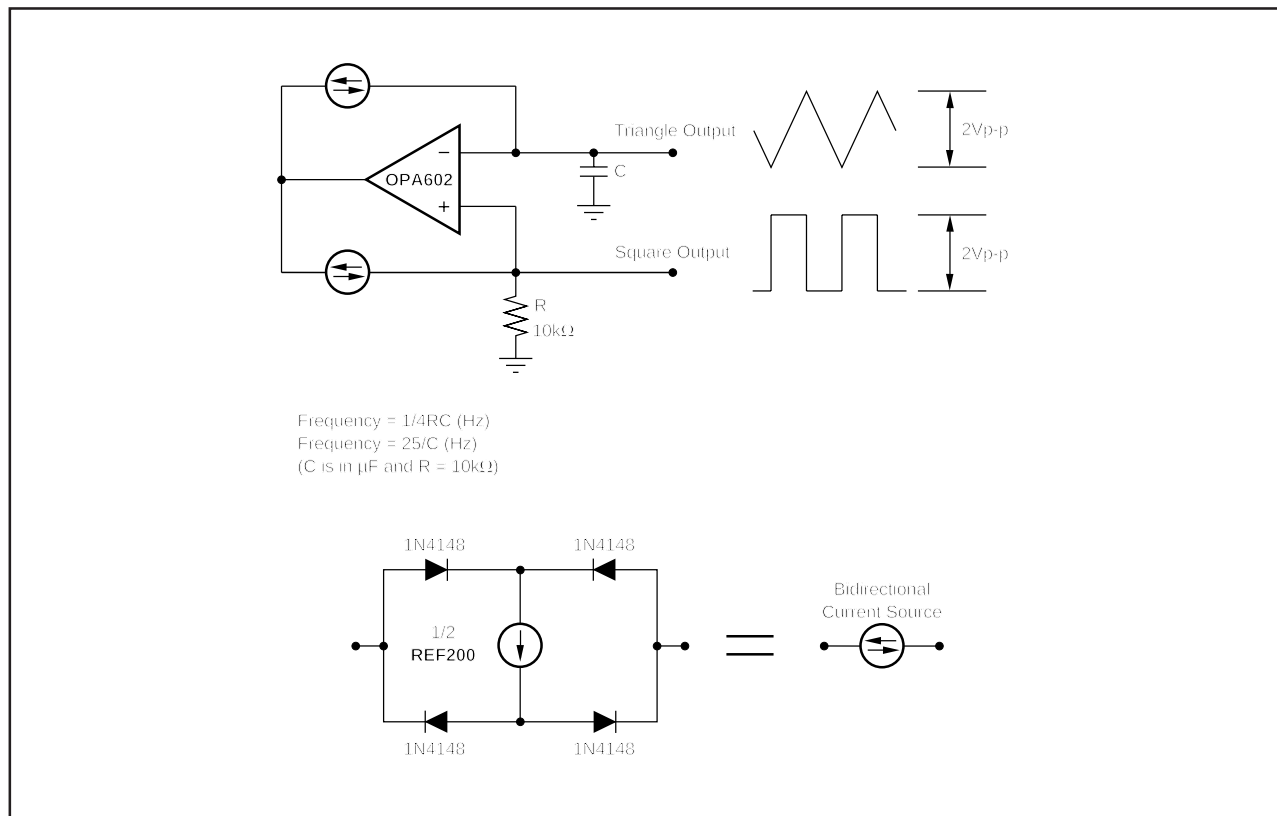


FIGURE 12. Precision Triangle Waveform Generator.

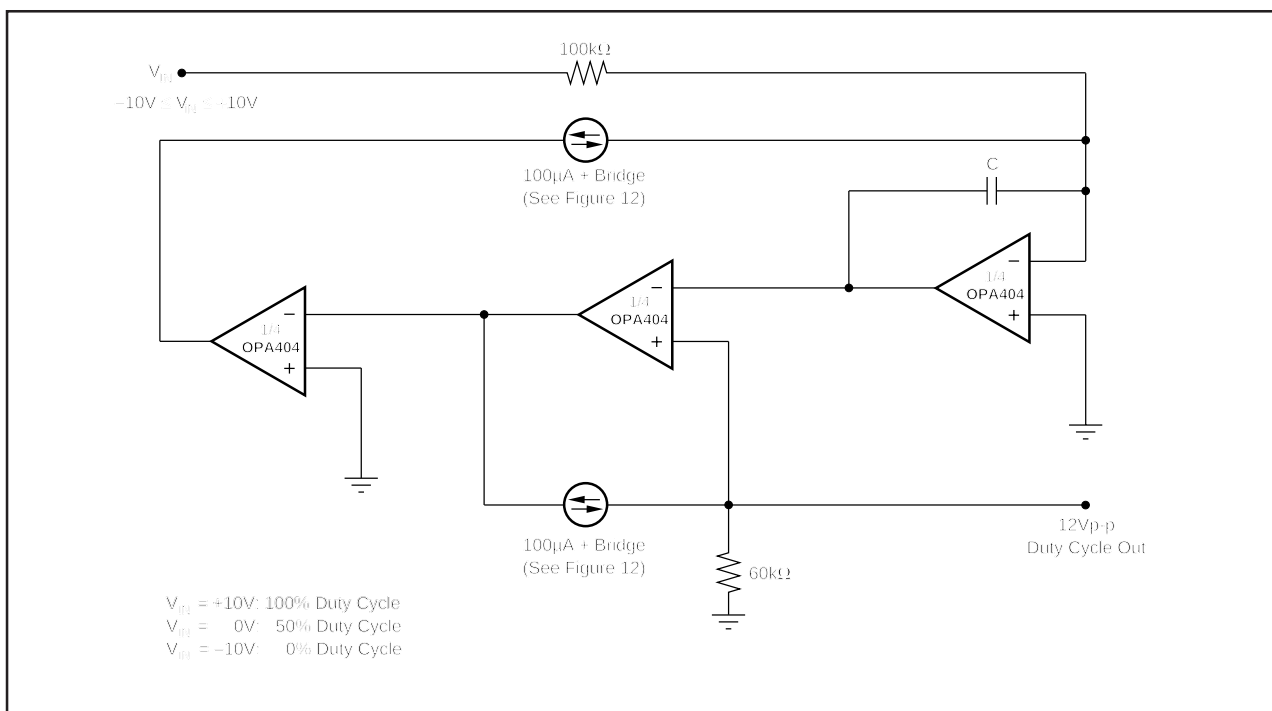


FIGURE 13. Precision Duty-Cycle Modulator.

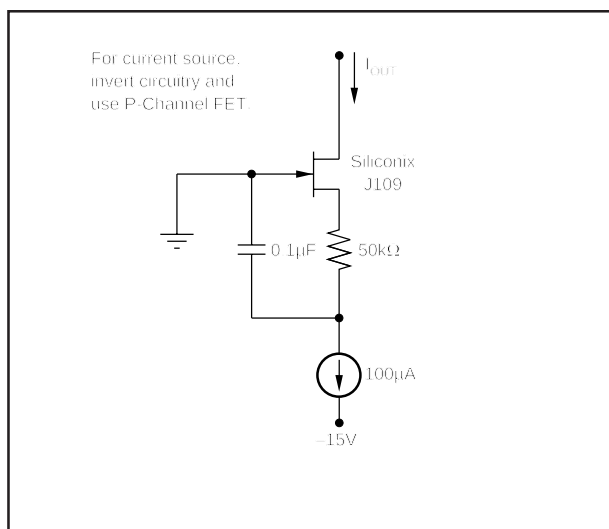


FIGURE 14. Low Noise Current Sink.

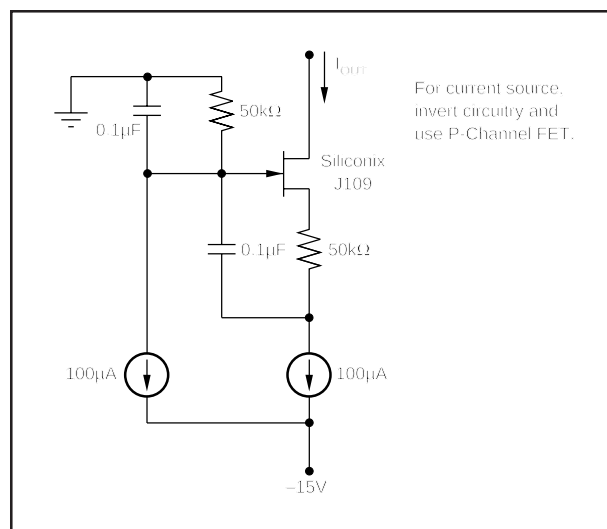


FIGURE 15. Low Noise Current Sink with Compliance Below Ground.

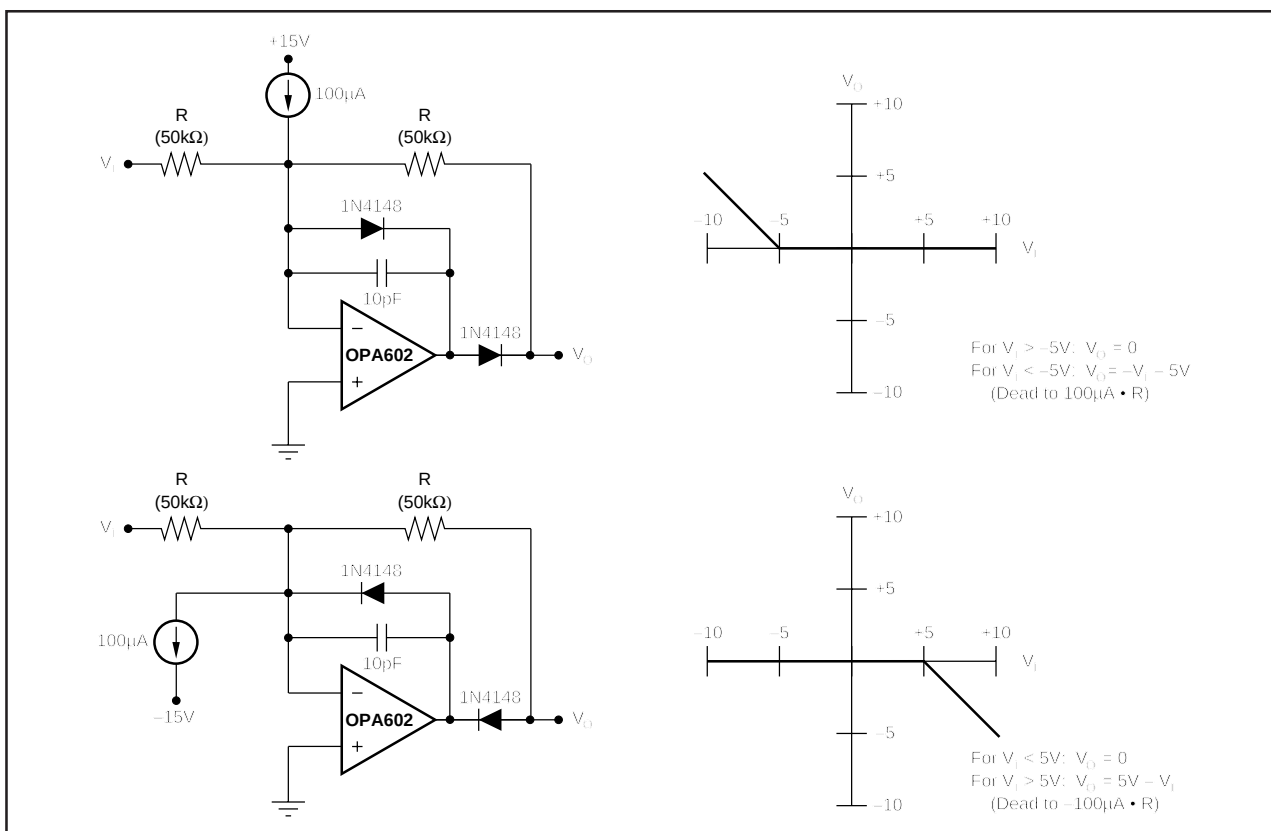


FIGURE 19. Dead-Band Circuit.

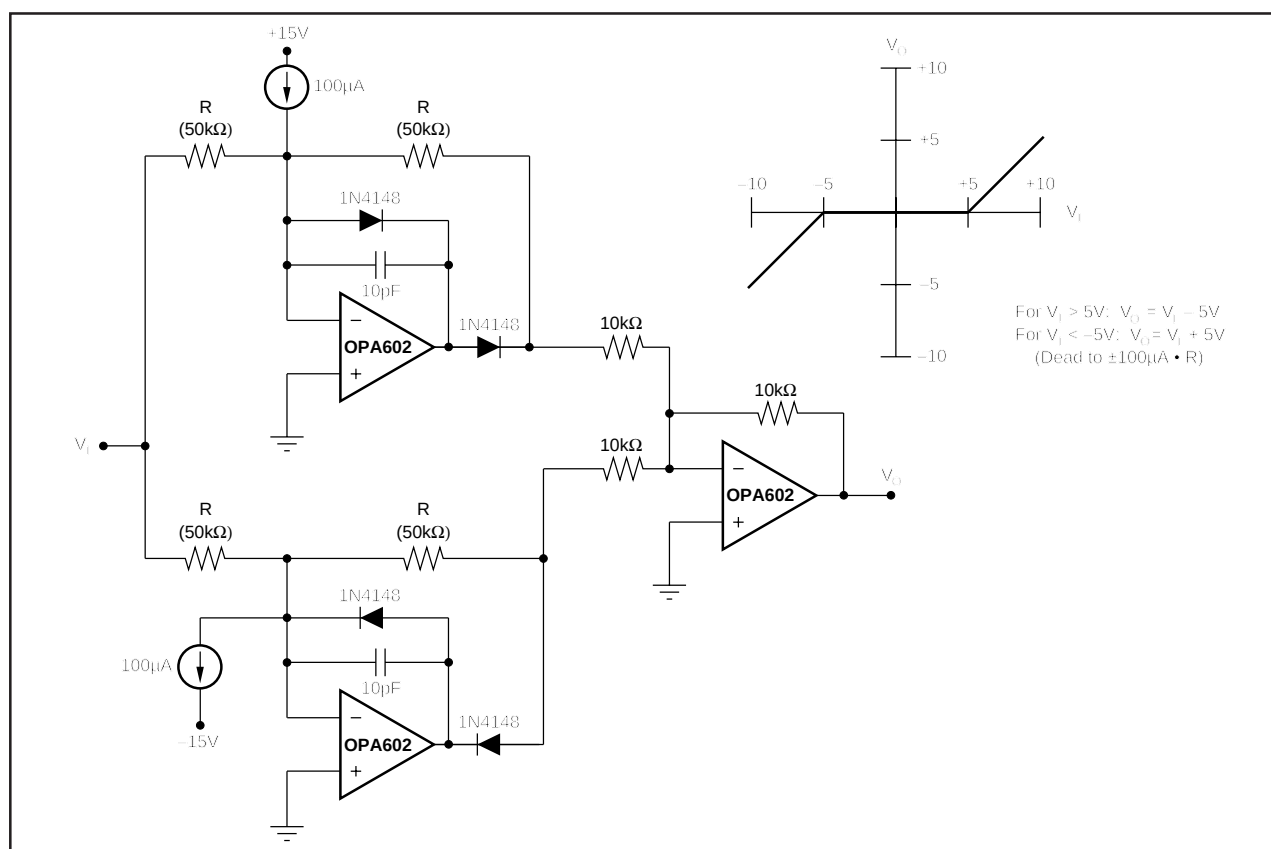


FIGURE 20. Double Dead-Band Circuit.

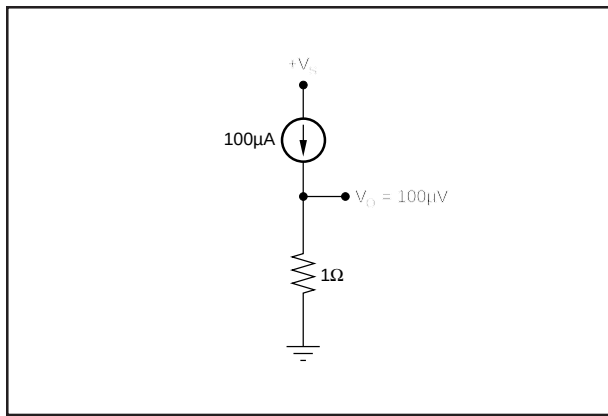


FIGURE 21. Low-Voltage Reference.

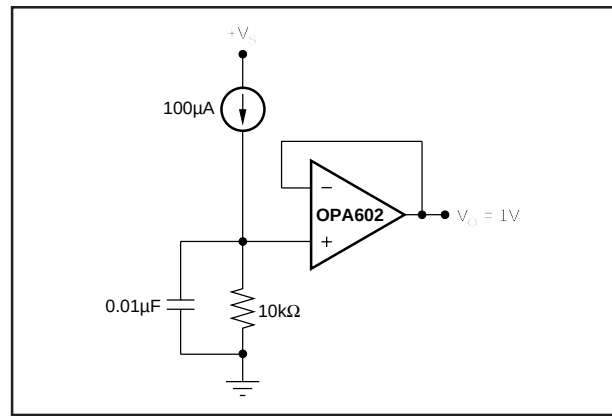


FIGURE 22. Voltage Reference.

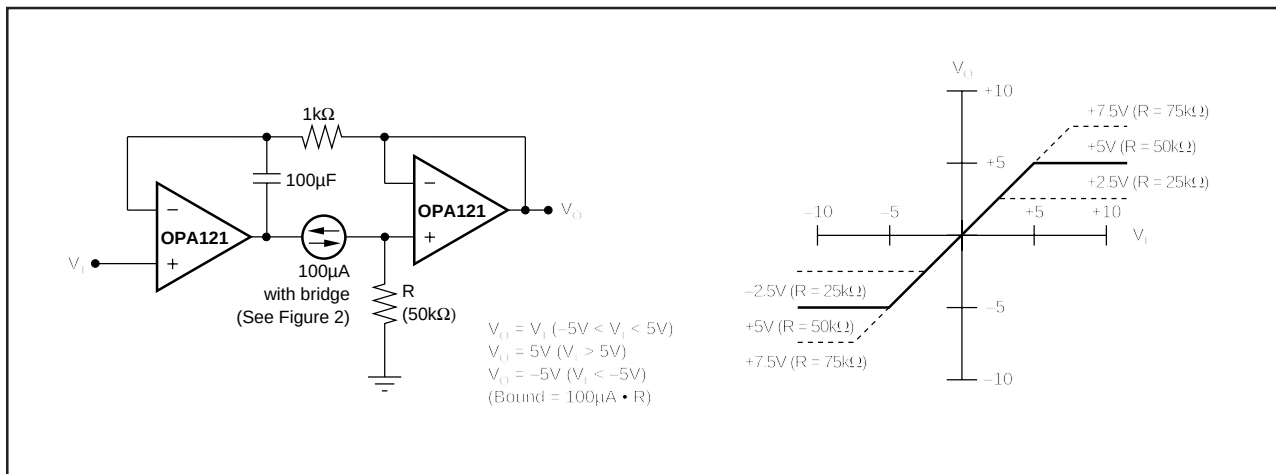


FIGURE 23. Bipolar Limiting Circuit.

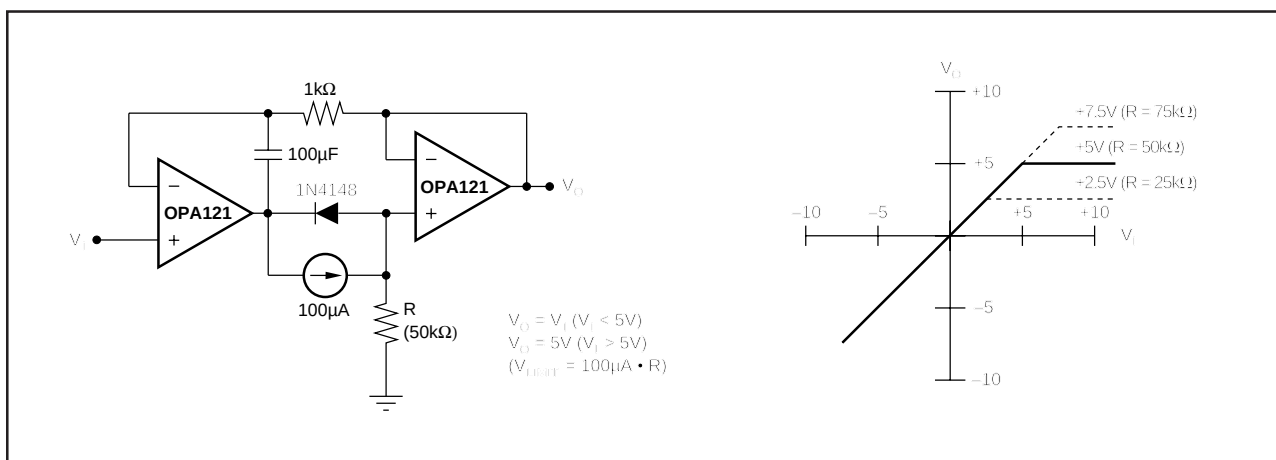


FIGURE 24. Limiting Circuit.

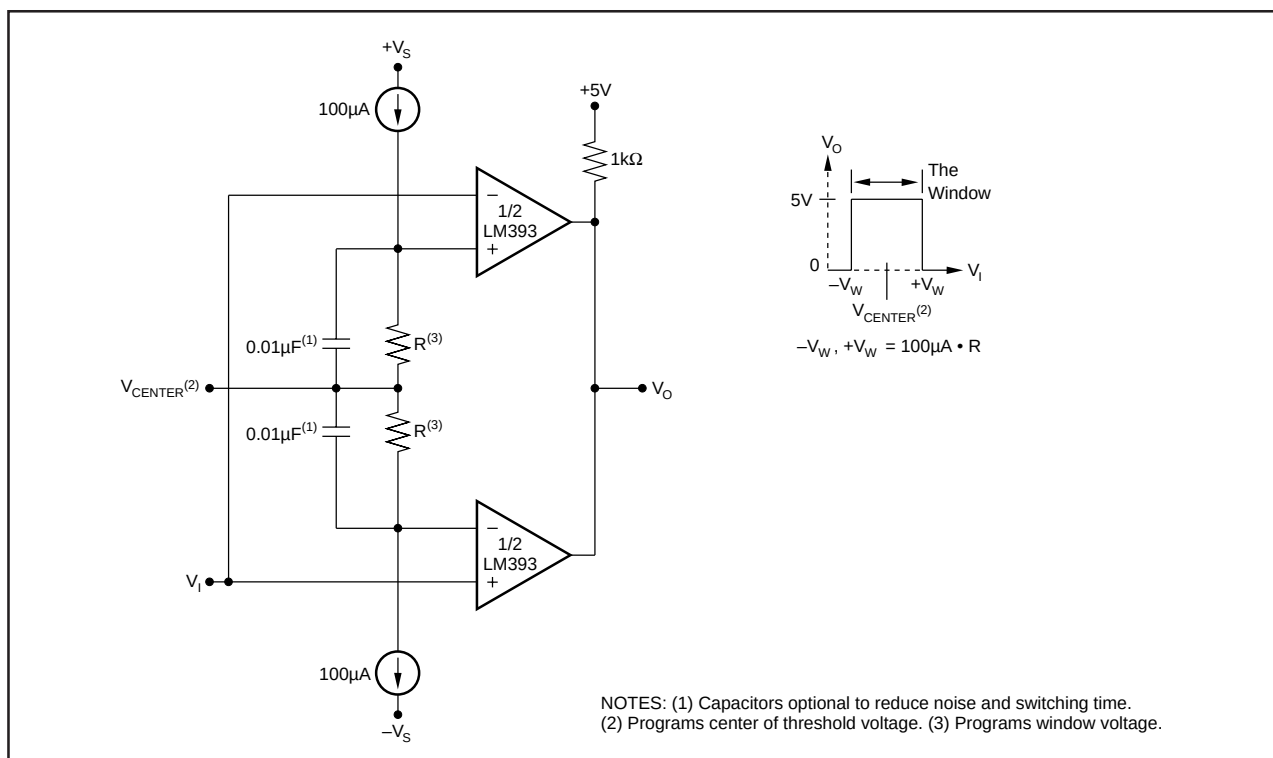


FIGURE 25. Window Comparator.

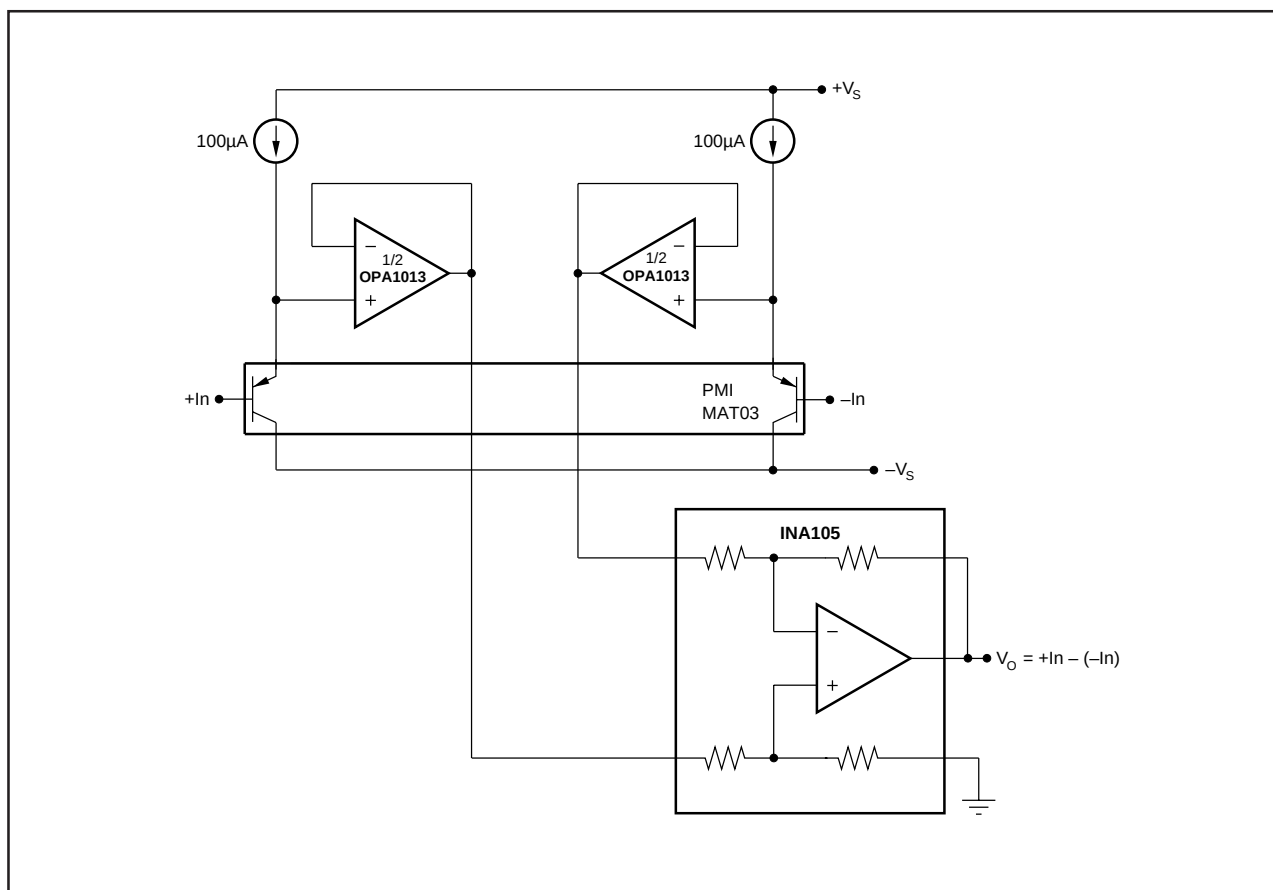


FIGURE 26. Instrumentation Amplifier with Compliance to $-V_S$.

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
REF200AP	OBSOLETE	PDIP	P	8		TBD	Call TI	Call TI
REF200AU	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
REF200AU/2K5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
REF200AU/2K5E4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
REF200AUE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
REF200AUG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

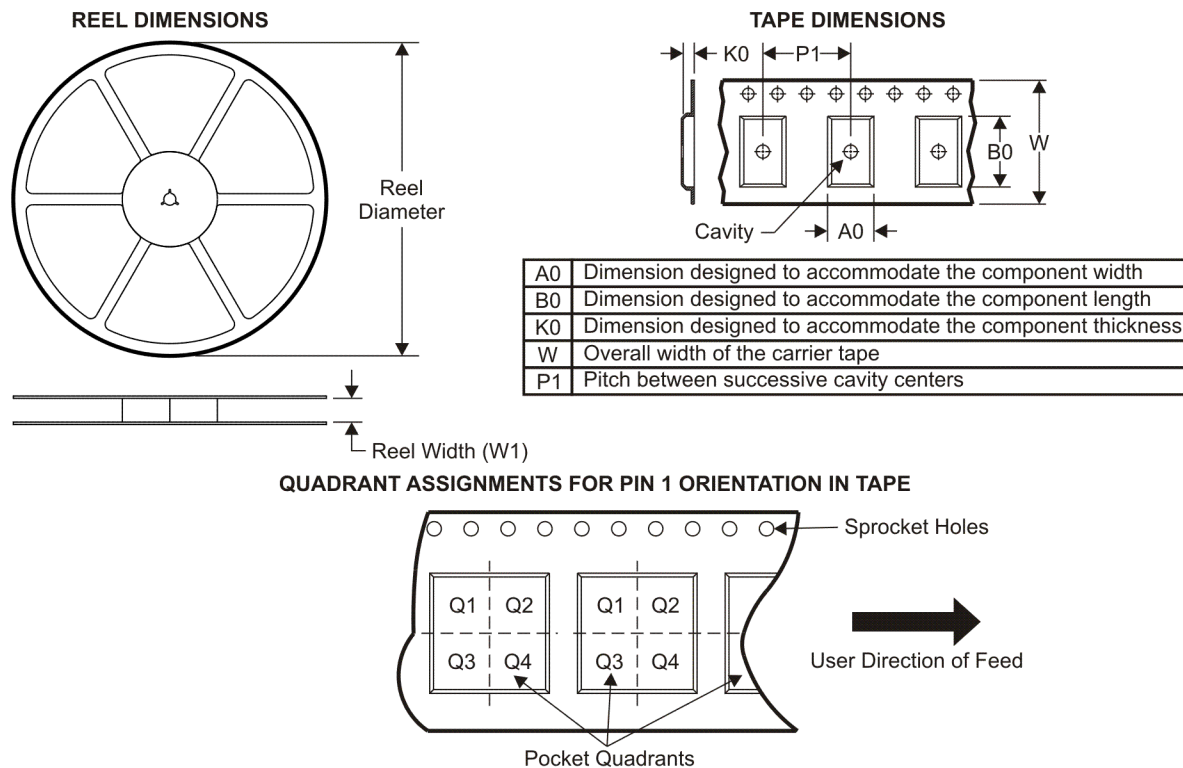
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

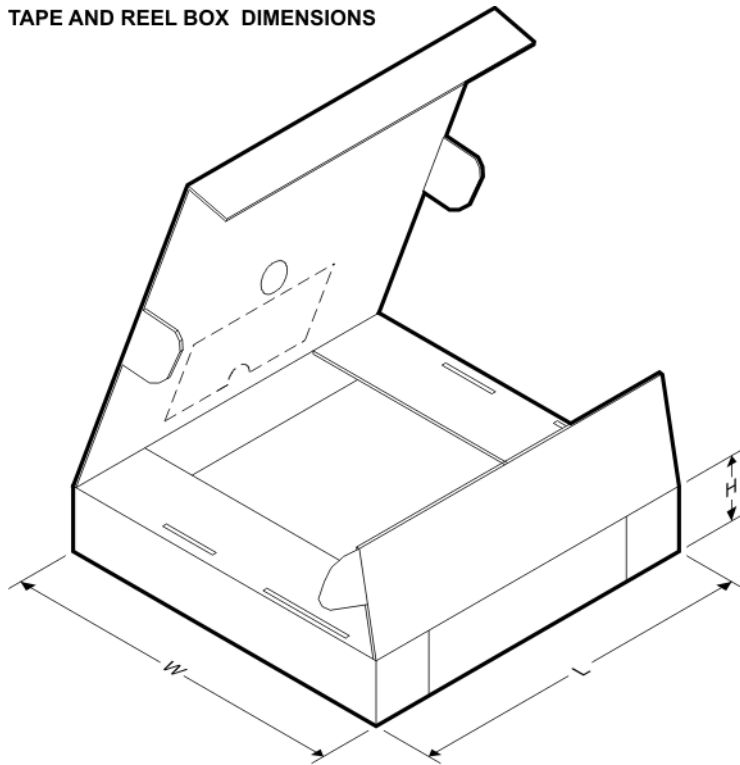
TAPE AND REEL INFORMATION



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
REF200AU/2K5	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
REF200AU/2K5	SOIC	D	8	2500	346.0	346.0	29.0

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI 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. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI 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 and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Audio	www.ti.com/audio
Automotive	www.ti.com/automotive
Broadband	www.ti.com/broadband
Digital Control	www.ti.com/digitalcontrol
Medical	www.ti.com/medical
Military	www.ti.com/military
Optical Networking	www.ti.com/opticalnetwork
Security	www.ti.com/security
Telephony	www.ti.com/telephony
Video & Imaging	www.ti.com/video
Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2009, Texas Instruments Incorporated