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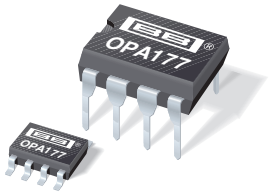


OPA177

Precision OPERATIONAL AMPLIFIER

FEATURES

- LOW OFFSET VOLTAGE: 25μV max
- LOW DRIFT: 0.3μV/°C
- HIGH OPEN-LOOP GAIN: 130dB min
- LOW QUIESCENT CURRENT: 1.5mA typ
- REPLACES INDUSTRY-STANDARD OP AMPS: OP-07, OP-77, OP-177, AD707, ETC.

APPLICATIONS

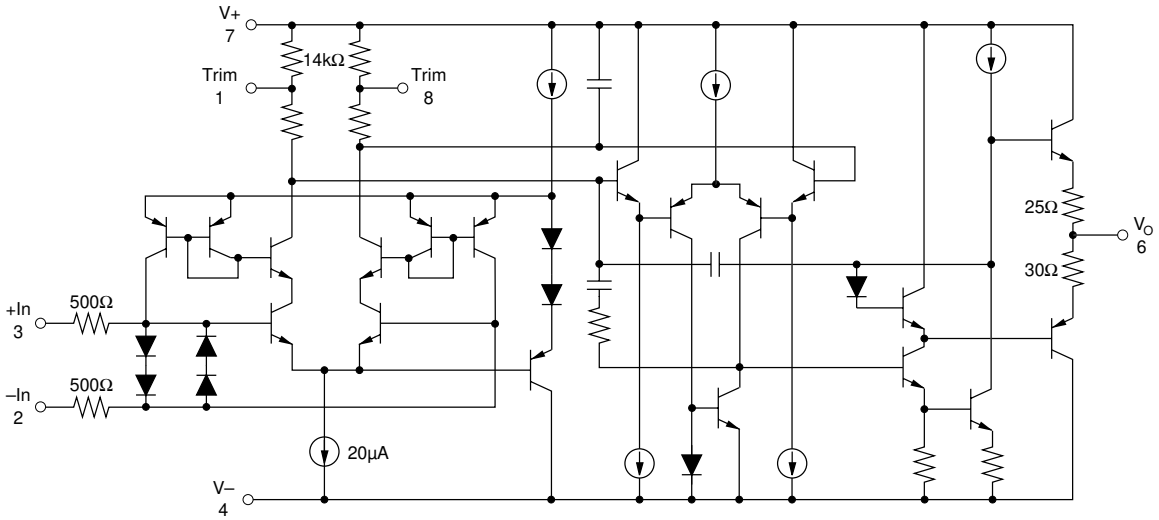
- PRECISION INSTRUMENTATION
- DATA ACQUISITION
- TEST EQUIPMENT
- BRIDGE AMPLIFIER
- THERMOCOUPLE AMPLIFIER

DESCRIPTION

The OPA177 precision bipolar op amp feature very low offset voltage and drift. Laser-trimmed offset, drift and input bias current virtually eliminate the need for costly external trimming. The high performance and low cost make them ideally suited to a wide range of precision instrumentation.

The low quiescent current of the OPA177 dramatically reduce warm-up drift and errors due to thermoelectric effects in input interconnections. It provides an effective alternative to chopper-stabilized amplifiers. The low noise of the OPA177 maintains accuracy.

OPA177 performance gradeouts are available. Packaging options include 8-pin plastic DIP and SO-8 surface-mount packages.



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Internet: http://www.burr-brown.com/ • FAXLine: (800) 548-6133 (US/Canada Only) • Cable: BBRCORP • Telex: 066-6491 • FAX: (520) 889-1510 • Immediate Product Info: (800) 548-6132

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SBOS008

OPA177 SPECIFICATIONS

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

PARAMETER	CONDITION	OPA177F MIN	OPA177F TYP	OPA177F MAX	OPA177G MIN	OPA177G TYP	OPA177G MAX	UNITS
OFFSET VOLTAGE								
Input Offset Voltage			10	25		20	60	µV
Long-Term Input Offset[1]			0.3			0.4		µV/Mo
Voltage Stability								
Offset Adjustment Range	R_P = 20kΩ		±3			*		mV
Power Supply Rejection Ratio	V_S = ±3V to ±18V	115	125		110	120		dB
INPUT BIAS CURRENT								
Input Offset Current			0.3	1.5		*	2.8	nA
Input Bias Current			0.5	±2		*	±2.8	nA
NOISE								
Input Noise Voltage	1Hz to 100Hz[2]		85	150		*	*	nVrms
Input Noise Current	1Hz to 100Hz		4.5			*		pArms
INPUT IMPEDANCE								
Input Resistance	Differential Mode[3]	26	45		18.5	*		MΩ
	Common-Mode		200			*		GΩ
INPUT VOLTAGE RANGE								
Common-Mode Input Range[4]		±13	±14		*	*		V
Common-Mode Rejection	V_{CM} = ±13V	130	140		115	*		dB
OPEN-LOOP GAIN	R_L ≥ 2kΩ							
Large Signal Voltage Gain	V_O = ±10V[5]	5110	12,000		2000	6000		V/mV
OUTPUT								
Output Voltage Swing	R_L ≥ 10kΩ	±13.5	±14		*	*		V
	R_L ≥ 2kΩ	±12.5	±13		*	*		V
	R_L ≥ 1kΩ	±12	±12.5		*	*		V
Open-Loop Output Resistance			60			*		Ω
FREQUENCY RESPONSE								
Slew Rate	R_L ≥ 2kΩ	0.1	0.3		*	*		V/µs
Closed-Loop Bandwidth	G = +1	0.4	0.6		*	*		MHz
POWER SUPPLY								
Power Consumption	V_S = ±15V, No Load		40	60		*	*	mW
	V_S = ±3V, No Load		3.5	4.5		*	*	mW
Supply Current	V_S = ±15V, No Load		1.3	2		*	*	mA

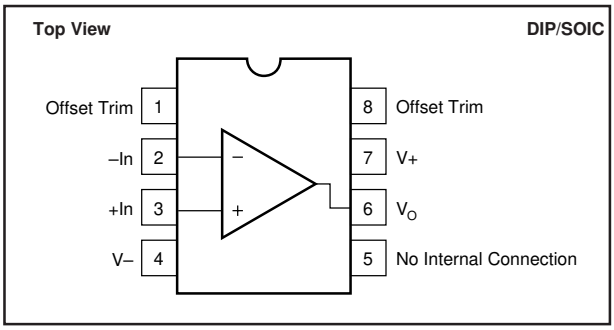
At V_S = ±15V, –40°C ≤ T_A ≤ +85°C, unless otherwise noted.

OFFSET VOLTAGE								
Input Offset Voltage			15	40		20	100	µV
Average Input Offset			0.1	0.3		0.7	1.2	µV/°C
Voltage Drift								
Power Supply Rejection Ratio	V_S = ±3V to ±18V	110	120		106	115		dB
INPUT BIAS CURRENT								
Input Offset Current			0.5	2.2		*	4.5	nA
Average Input Offset Current			1.5	40		*	85	pA/°C
Drift[6]								
Input Bias Current			0.5	±4		*	±6	nA
Average Input Bias Current			8	40		15	60	pA/°C
Drift[6]								
INPUT VOLTAGE RANGE								
Common-Mode Input Range		±13	±13.5		*	*		V
Common-Mode Rejection	V_{CM} = ±13V	120	140		110	*		dB
OPEN-LOOP GAIN								
Large Signal Voltage Gain	R_L ≥ 2kΩ, V_O = ±10V	2000	6000		1000	4000		V/mV
OUTPUT								
Output Voltage Swing	R_L ≥ 2kΩ	±12	±13		*	*		V
POWER SUPPLY								
Power Consumption	V_S = ±15V, No Load		60	75		*	*	mW
Supply Current	V_S = ±15V, No Load		2	25		*	*	mA

* Same as specification for product to left.

NOTES: (1) Long-Term Input Offset Voltage Stability refers to the averaged trend line of V_{OS} vs time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in V_{OS} during the first 30 operating days are typically less than 2µV. (2) Sample tested. (3) Guaranteed by design. (4) Guaranteed by CMRR test condition. (5) To insure high open-loop gain throughout the ±10V output range, A_{OL} is tested at –10V ≤ V_O ≤ 0V, 0V ≤ V_O ≤ +10V, and –10V ≤ V_O ≤ +10V. (6) Guaranteed by end-point limits.

PIN CONFIGURATION



ABSOLUTE MAXIMUM RATINGS

Power Supply Voltage	±22V
Differential Input Voltage	±30V
Input Voltage	$\pm V_S$
Output Short Circuit	Continuous
Operating Temperature:	
Plastic DIP (P), SO-8 (S)	–40°C to +85°C
θ_{JA} (PDIP)	100°C/W
θ_{JA} (SOIC)	160°C/W
Storage Temperature:	
Plastic DIP (P), SO-8 (S)	–65°C to +125°C
Junction Temperature	+150°C
Lead Temperature (soldering, 10s) P packages	+300°C
(soldering, 3s) S package	+260°C

PACKAGE/ORDERING INFORMATION

PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER(1)	TEMPERATURE RANGE
OPA177FP	8-Pin Plastic DIP	006	–40°C to +85°C
OPA177GP	8-Pin Plastic DIP	006	–40°C to +85°C
OPA177GS	SO-8 Surface-Mount	182	–40°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.

ELECTROSTATIC DISCHARGE SENSITIVITY

Any integrated circuit can be damaged by ESD. Burr-Brown recommends that all integrated circuits be handled with appropriate precautions. ESD can cause damage ranging 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 published specifications.

Burr-Brown's standard ESD test method consists of five 1000V positive and negative discharges (100pF in series with 1.5kΩ) applied to each pin.

Failure to observe proper handling procedures could result in small changes to the OPA177's input bias current.

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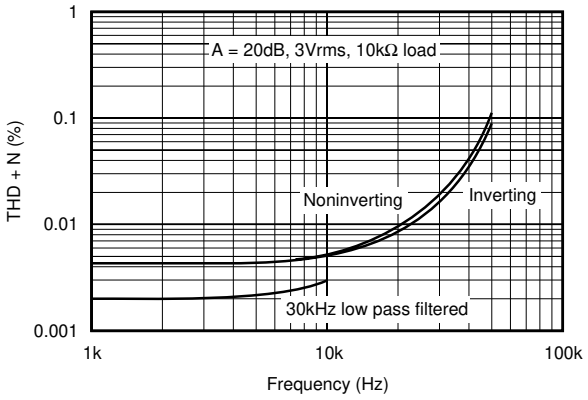
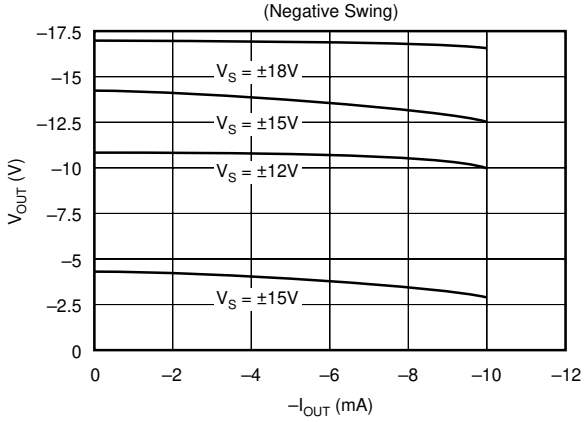
TYPICAL PERFORMANCE CURVES

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

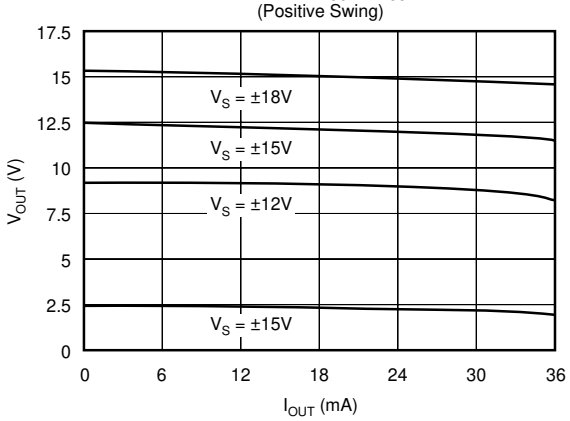
TOTAL HARMONIC DISTORTION AND NOISE vs FREQUENCY



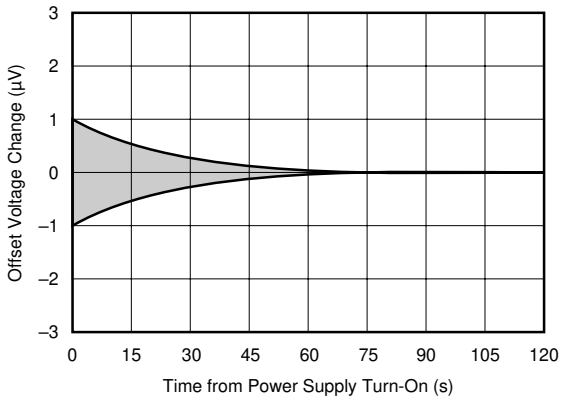
MAXIMUM V_{OUT} vs I_{OUT} (Negative Swing)



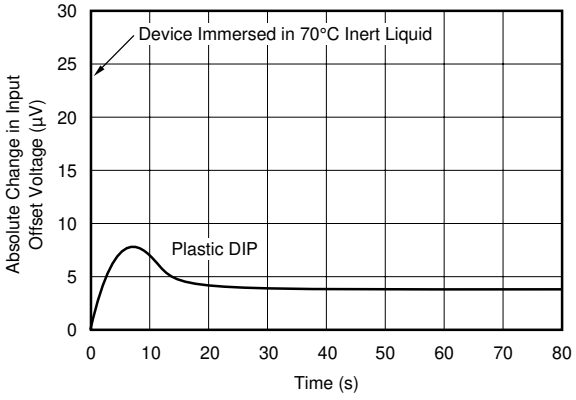
MAXIMUM V_{OUT} vs I_{OUT} (Positive Swing)



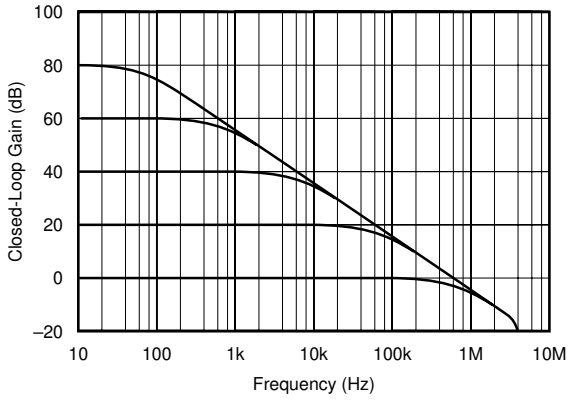
WARM-UP OFFSET VOLTAGE DRIFT



OFFSET VOLTAGE CHANGE DUE TO THERMAL SHOCK



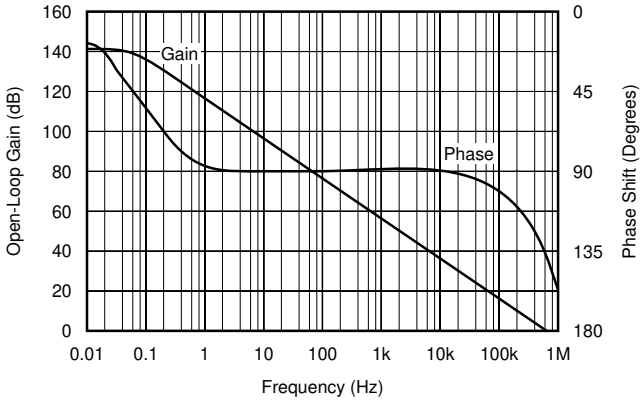
CLOSED-LOOP RESPONSE vs FREQUENCY



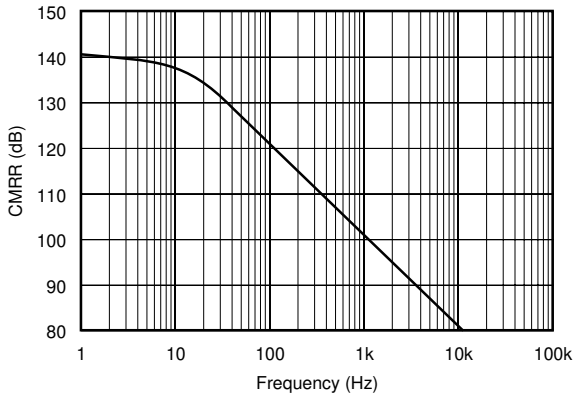
TYPICAL PERFORMANCE CURVES (CONT)

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

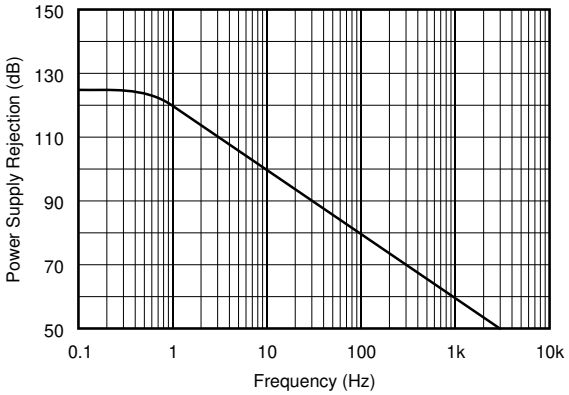
OPEN-LOOP GAIN/PHASE vs FREQUENCY



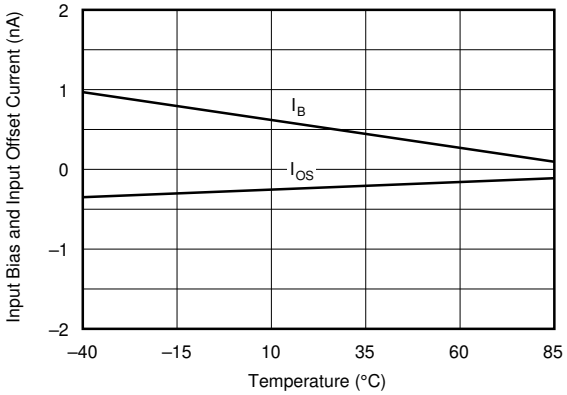
CMRR vs FREQUENCY



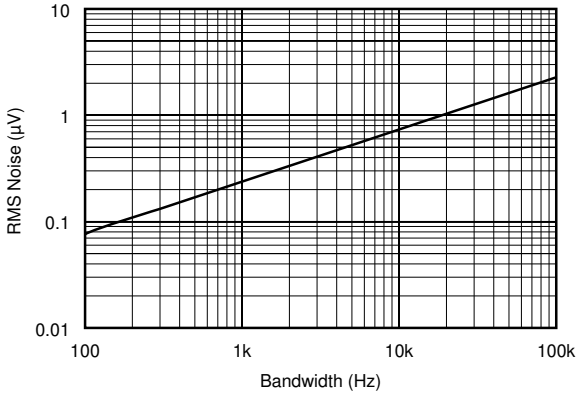
POWER SUPPLY REJECTION vs FREQUENCY



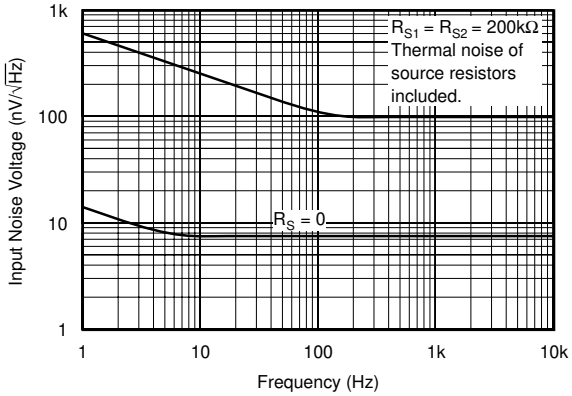
INPUT BIAS AND INPUT OFFSET CURRENT vs TEMPERATURE



TOTAL NOISE vs BANDWIDTH (0.1Hz to Frequency Indicated)



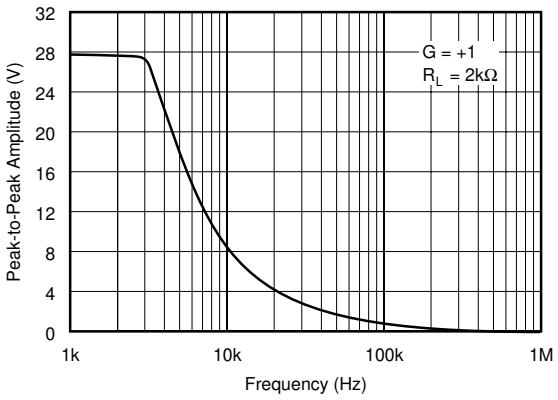
INPUT NOISE VOLTAGE DENSITY vs FREQUENCY



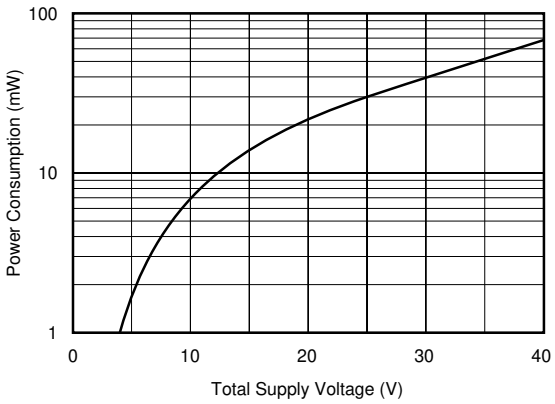
TYPICAL PERFORMANCE CURVES (CONT)

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

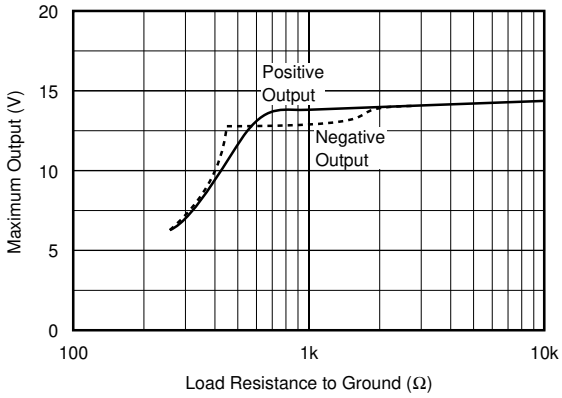
MAXIMUM OUTPUT SWING vs FREQUENCY



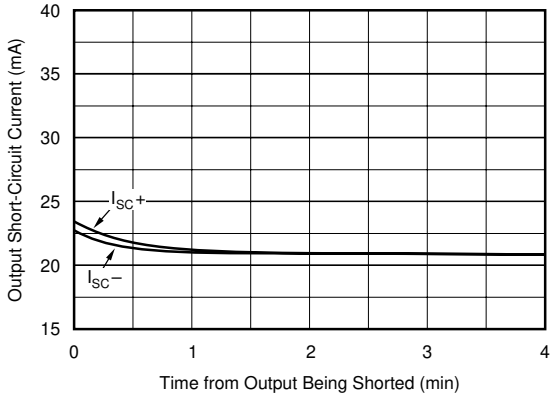
POWER CONSUMPTION vs POWER SUPPLY



MAXIMUM OUTPUT VOLTAGE vs LOAD RESISTANCE



OUTPUT SHORT-CIRCUIT CURRENT vs TIME



APPLICATIONS INFORMATION

The OPA177 is unity-gain stable, making it easy to use and free from oscillations in the widest range of circuitry. Applications with noisy or high impedance power supply lines may require decoupling capacitors close to the device pins. In most cases 0.1µF ceramic capacitors are adequate.

The OPA177 has very low offset voltage and drift. To achieve highest performance, circuit layout and mechanical conditions must be optimized. Offset voltage and drift can be degraded by small thermoelectric potentials at the op amp inputs. Connections of dissimilar metals will generate thermal potential which can mask the ultimate performance of the OPA177. These thermal potentials can be made to cancel by assuring that they are equal in both input terminals.

1. Keep connections made to the two input terminals close together.
2. Locate heat sources as far as possible from the critical input circuitry.
3. Shield the op amp and input circuitry from air currents such as cooling fans.

OFFSET VOLTAGE ADJUSTMENT

The OPA177 has been laser-trimmed for low offset voltage and drift so most circuits will not require external adjustment. Figure 1 shows the optional connection of an external potentiometer to adjust offset voltage. This adjustment should not be used to compensate for offsets created elsewhere in a system since this can introduce excessive temperature drift.

INPUT PROTECTION

The inputs of the OPA177 are protected with 500Ω series input resistors and diode clamps as shown in the simplified circuit diagram. The inputs can withstand ±30V differential inputs without damage. The protection diodes will, of course, conduct current when the inputs are overdriven. This may disturb the slewing behavior of unity-gain follower applications, but will not damage the op amp.

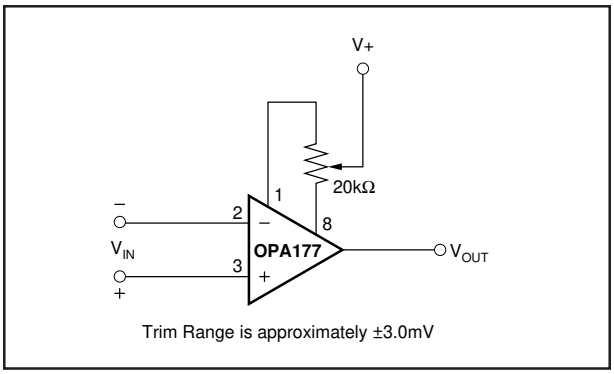


FIGURE 1. Optional Offset Nulling Circuit.

NOISE PERFORMANCE

The noise performance of the OPA177 is optimized for circuit impedances in the range of 2kΩ to 50kΩ. Total noise in an application is a combination of the op amp's input voltage noise and input bias current noise reacting with circuit impedances. For applications with higher source impedance, the OPA627 FET-input op amp will generally provide lower noise. For very low impedance applications, the OPA27 will provide lower noise.

INPUT BIAS CURRENT CANCELLATION

The input stage base current of the OPA177 is internally compensated with an equal and opposite cancellation current. The resulting input bias current is the difference between the input stage base current and the cancellation current. This residual input bias current can be positive or negative.

When the bias current is cancelled in this manner, the input bias current and input offset current are approximately the same magnitude. As a result, it is not necessary to balance the DC resistance seen at the two input terminals (Figure 2). A resistor added to balance the input resistances may actually increase offset and noise.

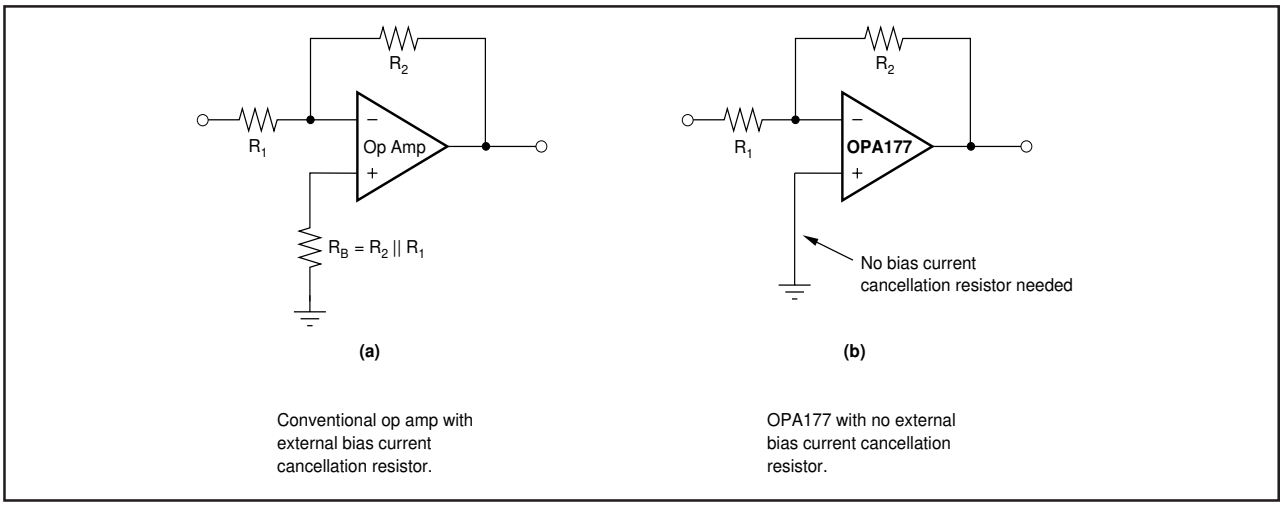


FIGURE 2. Input Bias Current Cancellation.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
OPA177FP	ACTIVE	PDIP	P	8	50	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
OPA177FPG4	ACTIVE	PDIP	P	8	50	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
OPA177GP	ACTIVE	PDIP	P	8	50	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
OPA177GPG4	ACTIVE	PDIP	P	8	50	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
OPA177GS	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA177GS/2K5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA177GS/2K5E4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA177GS/2K5G4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA177GSE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA177GSG4	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.

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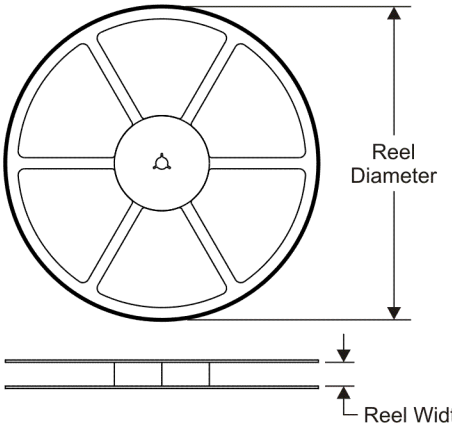
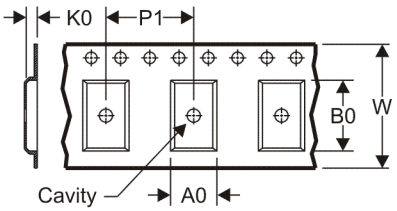
TAPE AND REEL INFORMATION

REEL DIMENSIONS

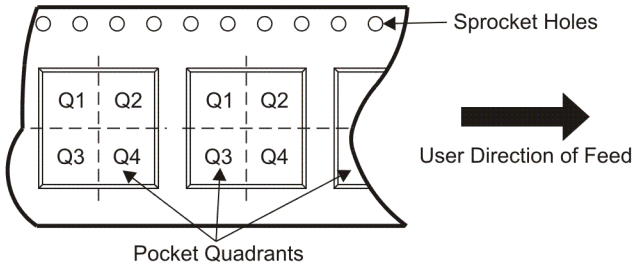


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

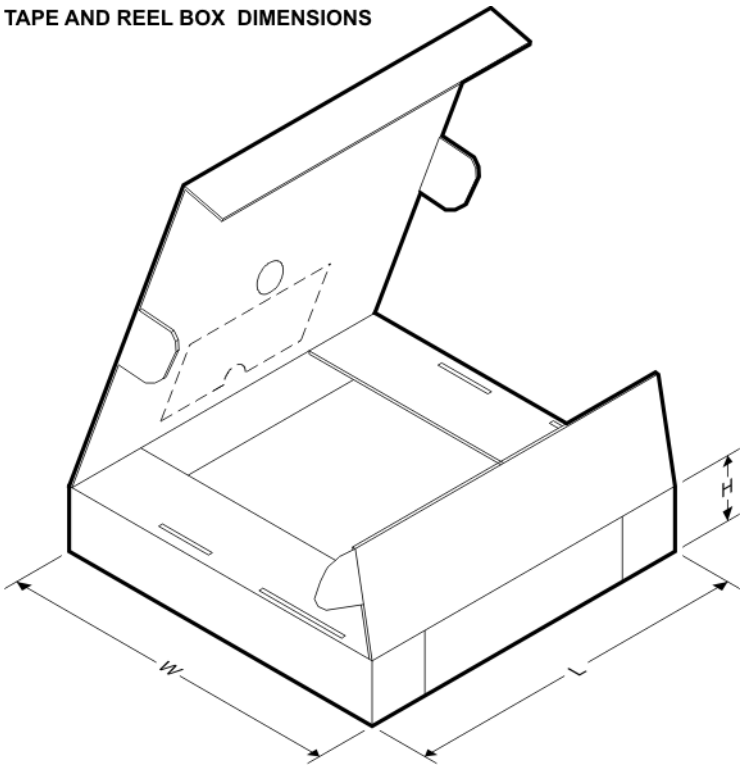
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
OPA177GS/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)
OPA177GS/2K5	SOIC	D	8	2500	346.0	346.0	29.0

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