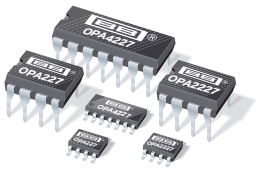
BURR-BROWN®



OPA227
OPA2227
OPA4227

High Precision, Low Noise OPERATIONAL AMPLIFIERS

FEATURES

- LOW NOISE: 3nV/√Hz
- WIDE BANDWIDTH: 8MHz
- HIGH CMRR: 138dB
- HIGH OPEN-LOOP GAIN: 160dB
- LOW BIAS CURRENT: 10nA max
- LOW OFFSET VOLTAGE: 75μV max
- WIDE SUPPLY RANGE: ±2.5V to ±18V
- REPLACES OP-27, LT1007, MAX427
- LOW COST
- SINGLE, DUAL(1), AND QUAD(1) VERSIONS

APPLICATIONS

- PROFESSIONAL AUDIO EQUIPMENT
- PORTABLE TELECOM EQUIPMENT
- DATA ACQUISITION
- GEOPHYSICAL ANALYSIS
- VIBRATION ANALYSIS
- SPECTRAL ANALYSIS
- ACTIVE FILTERS
- POWER SUPPLY CONTROL

DESCRIPTION

The OPA227 series op amps combine low noise and wide bandwidth with high precision to make them the ideal choice for applications requiring excellent ac and dc performance. They are unity-gain stable and free of latch-up and output inversion problems found in other products.

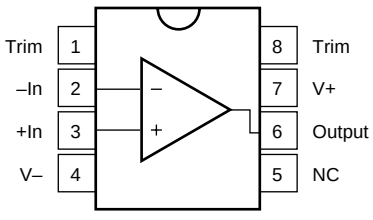
The OPA227 series op amps are perfect for professional audio equipment. In addition, low quiescent current and low cost make them ideal for portable applications requiring high precision.

The OPA227 is a pin-for-pin replacement for the industry standard OP-27 with substantial improvements in open-loop gain, common-mode rejection, and power supply rejection. The dual and quad versions are available for space-savings and per-channel cost reductions.

The OPA227 and OPA2227 are available in 8-pin DIP and SO-8 surface-mount packages. The OPA4227 is available in 14-pin DIP and SO-14 surface-mount packages with standard pin configurations. Operation is specified from –40°C to +85°C.

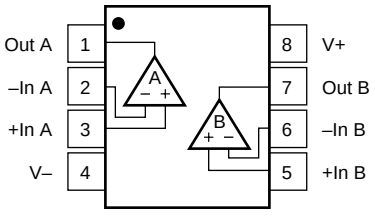
NOTE: (1) Dual and quad versions available 1Q'99.

OPA227



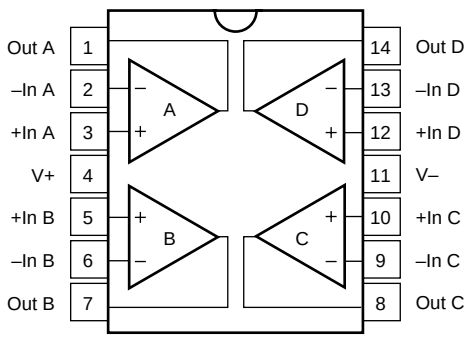
8-Pin DIP, SO-8

OPA2227(1)



8-Pin DIP, SO-8

OPA4227(1)



14-Pin DIP, SO-14

International Airport Industrial Park • Mailing Address: PO Box 11400, Tucson, AZ 85734 • Street Address: 6730 S. Tucson Blvd., Tucson, AZ 85706 • Tel: (520) 746-1111
Twx: 910-952-1111 • Internet: http://www.burr-brown.com/ • Cable: BBRCORP • Telex: 066-6491 • FAX: (520) 889-1510 • Immediate Product Info: (800) 548-6132

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SPECIFICATIONS: V_S = ±5V to ±15V

At T_A = +25°C, and R_L = 10kΩ, unless otherwise noted.
Boldface limits apply over the specified temperature range, T_A = –40°C to +85°C.

PARAMETER	CONDITION	OPA227P, U OPA2227P, U[1]			OPA227PA, UA OPA2227PA, UA[1] OPA4227PA, UA[1]			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
OFFSET VOLTAGE								
Input Offset Voltage V_{OS}			±5	±75		±10	±200	µV
T_A = –40°C to +85°C				**±100**			**±200**	µV
vs Temperature dV_{OS}/dT			**±0.1**	**±0.6**		**±0.3**	**±2**	µV/°C
vs Power Supply PSRR	V_S = ±2.5V to ±18V		±0.5	±2		*	*	µV/V
T_A = –40°C to +85°C				**±2**			*	µV/V
vs Time			0.2			*		µV/mo
INPUT BIAS CURRENT								
Input Bias Current I_B			±2.5	±10		*	*	nA
T_A = –40°C to +85°C				**±10**			*	nA
Input Offset Current I_{OS}			±2.5	±10		*	*	nA
T_A = –40°C to +85°C				**±10**			*	nA
NOISE								
Input Voltage Noise Density, f = 10Hz e_n			3.5			*		nV/√Hz
f = 100Hz			3			*		nV/√Hz
f = 1kHz			3			*		nV/√Hz
Current Noise Density, f = 1kHz i_n			0.4			*		pA/√Hz
INPUT VOLTAGE RANGE								
Common-Mode Voltage Range V_{CM}		(V–) +2		(V+) –2	*		*	V
Common-Mode Rejection CMRR	V_{CM} = (V–) +2V to (V+) –2V	120	138		*	*		dB
T_A = –40°C to +85°C		**120**			*			dB
INPUT IMPEDANCE								
Differential			10^7 || 12			*		Ω || pF
Common-Mode	V_{CM} = (V–) +2V to (V+) –2V		10^9 || 3			*		Ω || pF
OPEN-LOOP GAIN								
Open-Loop Voltage Gain A_{OL}	V_O = (V–) +2V to (V+) –2V, R_L = 10kΩ	132	160		*	*		dB
T_A = –40°C to +85°C		**132**			*			dB
	V_O = (V–) +3.5V to (V+) –3.5V, R_L = 600kΩ	132	160		*	*		dB
T_A = –40°C to +85°C		**132**			*			dB
FREQUENCY RESPONSE								
Gain Bandwidth Product GBW			8			*		MHz
Slew Rate SR			2.3			*		V/µs
Settling Time, 0.1%	G = 1, 10V Step, C_L = 100pF		5			*		µs
0.01%	G = 1, 10V Step, C_L = 100pF		5.6			*		µs
Overload Recovery Time	V_{IN} • G = V_S		1.3			*		µs
Total Harmonic Distortion + Noise THD+N	f = 1kHz, G = 1, V_O = 3.5Vrms		0.00005			*		%
OUTPUT								
Voltage Output	R_L = 10kΩ	(V–) +2		(V+) –2	*		*	V
T_A = –40°C to +85°C	R_L = 10kΩ	**(V–) +2**		**(V+) –2**	*		*	V
	R_L = 600Ω	(V–) +3.5		(V+) –3.5	*		*	V
T_A = –40°C to +85°C	R_L = 600Ω	**(V–) +3.5**		**(V+) –3.5**	*		*	V
Short-Circuit Current I_{SC}			±45			*		mA
Capacitive Load Drive C_{LOAD}			See Typical Curve			*		
POWER SUPPLY								
Specified Voltage Range V_S		±5		±15	*		*	V
Operating Voltage Range		±2.5		±1.8	*		*	V
Quiescent Current (per amplifier) I_Q	I_O = 0		±3.7	±3.8		*	*	mA
T_A = –40°C to +85°C	I_O = 0			**±3.8**			*	mA
TEMPERATURE RANGE								
Specified Range		–40		+85	*		*	°C
Operating Range		–55		+125	*		*	°C
Storage Range		–55		+125	*		*	°C
Thermal Resistance θ_{JA}								
SO-8 Surface Mount			150			*		°C/W
8-Pin DIP			100			*		°C/W
14-Pin DIP			80			*		°C/W
SO-14 Surface Mount			100			*		°C/W

* Specifications same as OPA227P, U.

NOTE: (1) Dual (OPA2227) and quad (OPA4227) versions available 1Q'99.

ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage	±18V
Signal Input Terminals, Voltage	(V–) –0.7V to (V+) +0.7V
Current	20mA
Output Short-Circuit[2]	Continuous
Operating Temperature	–40°C to +125°C
Storage Temperature	–55°C to +125°C
Junction Temperature	150°C
Lead Temperature (soldering, 10s)	300°C

NOTE: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. (2) Short-circuit to ground, one amplifier per package.

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.

PACKAGE/ORDERING INFORMATION

PRODUCT	OFFSET VOLTAGE max, µV	OFFSET VOLTAGE DRIFT max, µV/°C	PACKAGE	PACKAGE DRAWING NUMBER[1]	TEMPERATURE RANGE	ORDERING NUMBER(2)	TRANSPORT MEDIA
Single							
OPA227PA	±200	±2	8-Pin DIP	006	–40°C to +85°C	OPA227PA	Rails
OPA227P	±75	±0.6	8-Pin DIP	006	–40°C to +85°C	OPA227P	Rails
OPA227UA	±200	±2	SO-8 Surface Mount	182	–40°C to +85°C	OPA227UA	Rails
"	"	"	"	"	"	OPA227UA/2K5	Tape and Reel
OPA227U	±75	±0.6	SO-8 Surface Mount	182	–40°C to +85°C	OPA227U	Rails
"	"	"	"	"	"	OPA227U/2K5	Tape and Reel
Dual✻							
OPA2227PA	±200	±0.2	8-Pin DIP	006	–40°C to +85°C	OPA2227PA	Rails
OPA2227P	±75	±0.6	8-Pin DIP	006	–40°C to +85°C	OPA2227P	Rails
OPA2227UA	±200	±0.2	SO-8 Surface Mount	182	–40°C to +85°C	OPA2227UA	Rails
"	"	"	"	"	"	OPA2227UA/2K5	Tape and Reel
OPA2227U	±75	±0.6	SO-8 Surface Mount	182	–40°C to +85°C	OPA2227U	Rails
"	"	"	"	"	"	OPA2227U/2K5	Tape and Reel
Quad✻							
OPA4227PA	±200	±2	14-Pin DIP	010	–40°C to +85°C	OPA4227PA	Rails
OPA4227UA	±200	±2	SO-14 Surface Mount	235	–40°C to +85°C	OPA4227UA	Rails
"	"	"	"	"	"	OPA4227UA/2K5	Tape and Reel

NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix C of Burr-Brown IC Data Book. (2) Products followed by a slash (/) are only available in Tape and Reel in the quantities indicated (e.g. /2K5 indicates 2500 devices per reel). Ordering 2500 pieces of "OPA227UA/2K5" will get a single 2500 piece Tape and Reel. For detailed Tape and Reel mechanical information, refer to Appendix B of Burr-Brown IC Data Book.

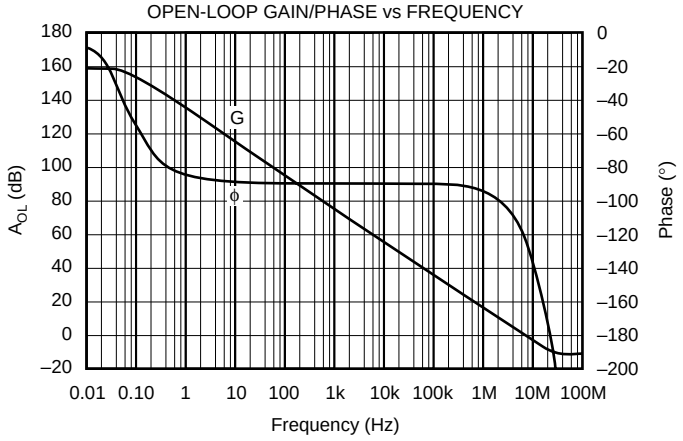
✻ Dual and quad versions available 1Q'99.

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.

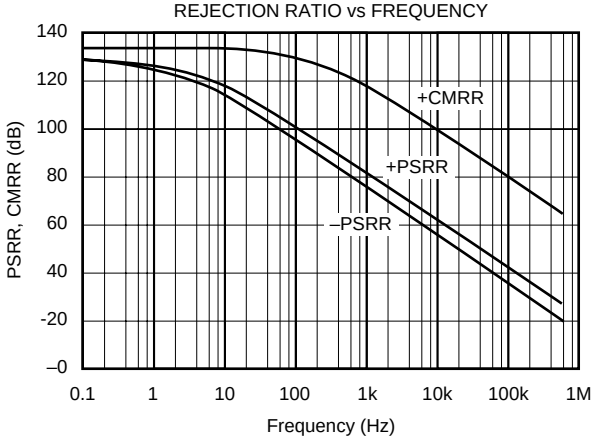
TYPICAL PERFORMANCE CURVES

At T_A = +25°C, R_L = 10kΩ, and V_S = ±15V, unless otherwise noted.

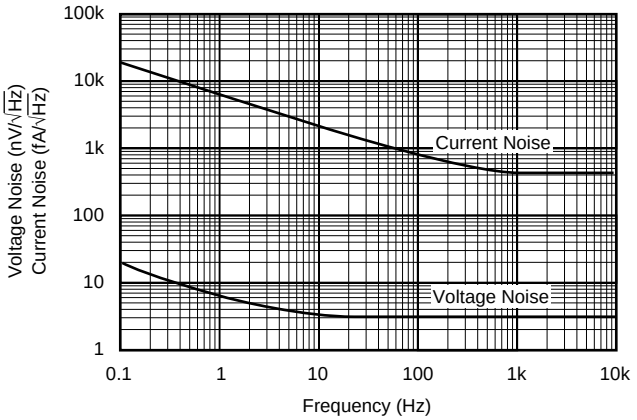
OPEN-LOOP GAIN/PHASE vs FREQUENCY



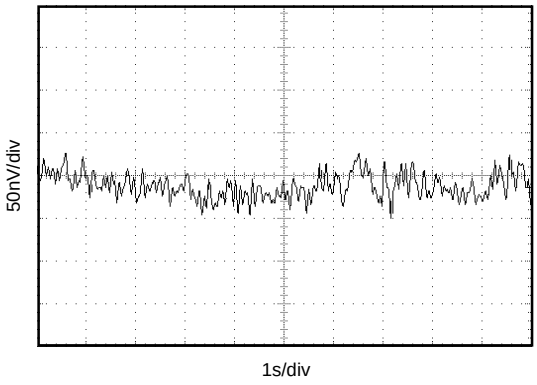
POWER SUPPLY and COMMON-MODE REJECTION RATIO vs FREQUENCY



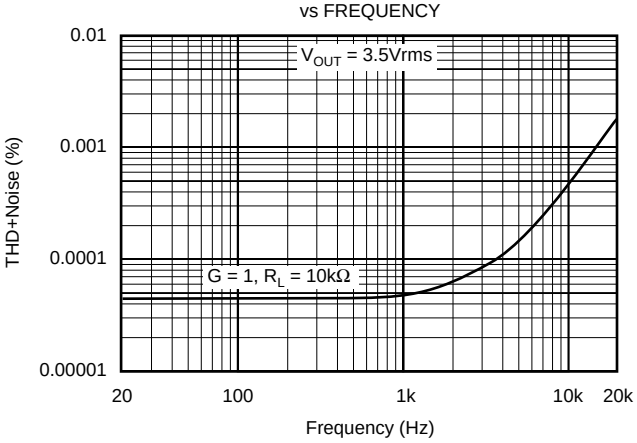
INPUT VOLTAGE and CURRENT NOISE SPECTRAL DENSITY vs FREQUENCY



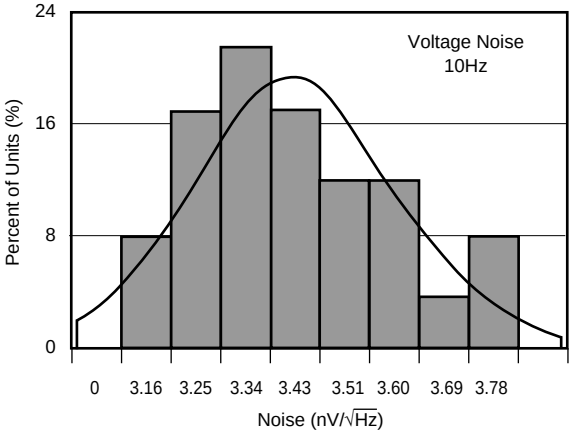
INPUT NOISE VOLTAGE vs TIME



TOTAL HARMONIC DISTORTION + NOISE vs FREQUENCY



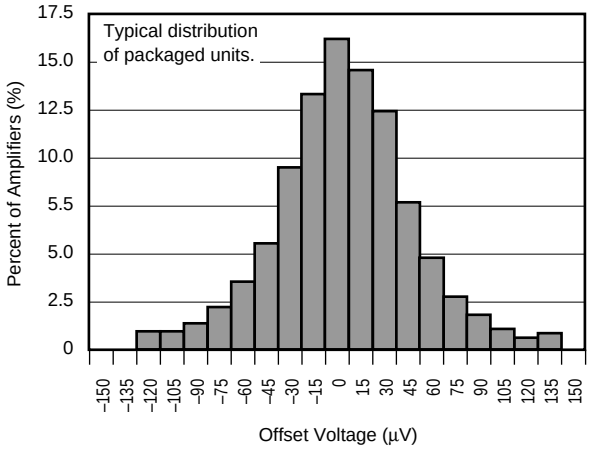
VOLTAGE NOISE DISTRIBUTION



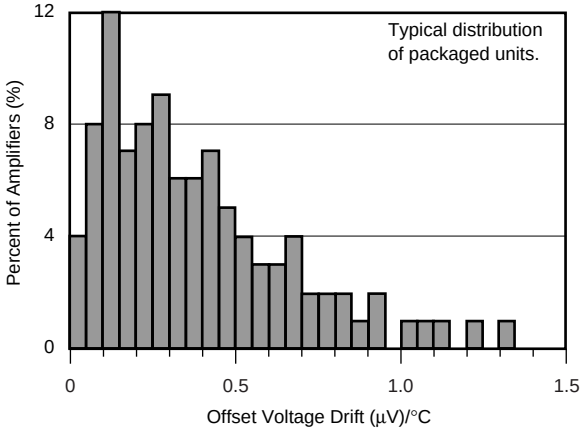
TYPICAL PERFORMANCE CURVES (CONT)

At T_A = +25°C, R_L =10kΩ, and V_S = ±15V, unless otherwise noted.

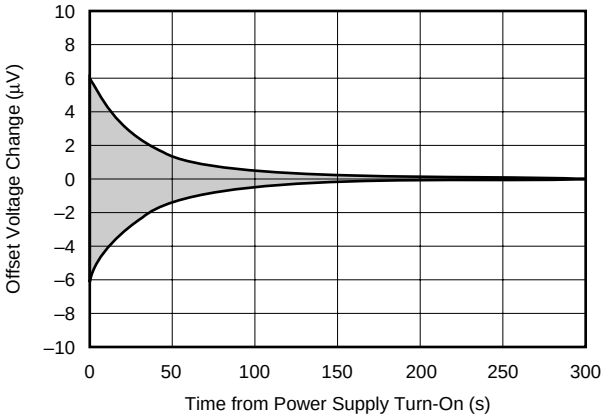
OFFSET VOLTAGE PRODUCTION DISTRIBUTION



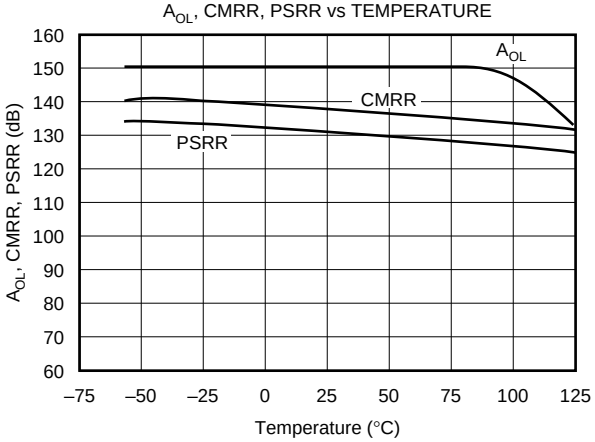
OFFSET VOLTAGE DRIFT PRODUCTION DISTRIBUTION



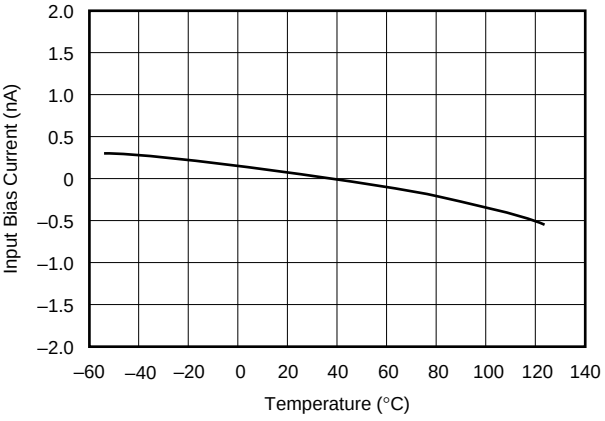
WARM-UP OFFSET VOLTAGE DRIFT



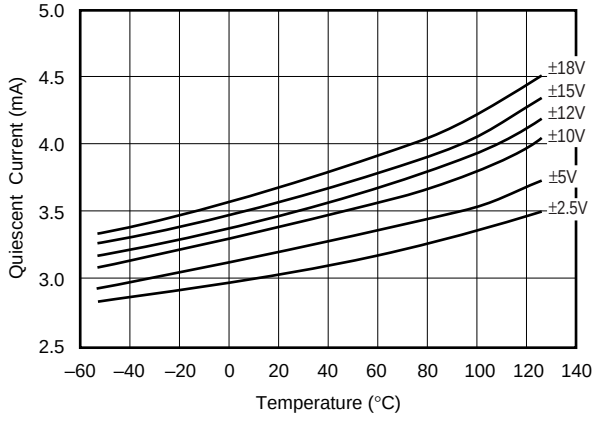
A_{OL}, CMRR, PSRR vs TEMPERATURE



INPUT BIAS CURRENT vs TEMPERATURE



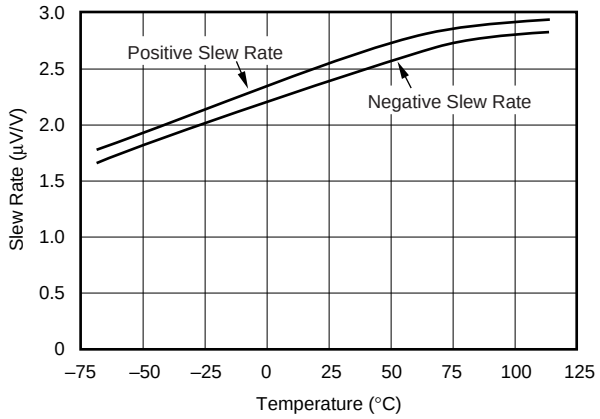
QUIESCENT CURRENT vs TEMPERATURE



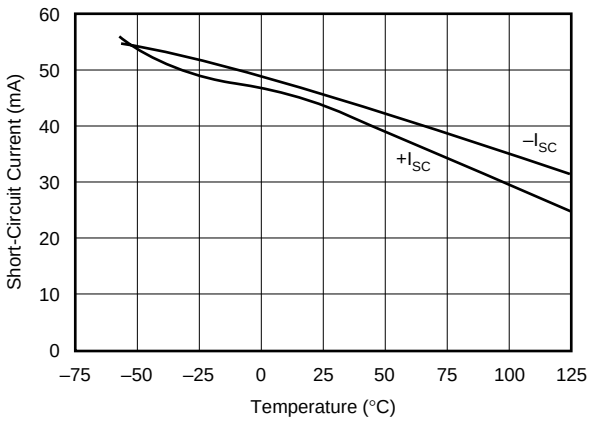
TYPICAL PERFORMANCE CURVES (CONT)

At T_A = +25°C, R_L = 10kΩ, and V_S = ±15V, unless otherwise noted.

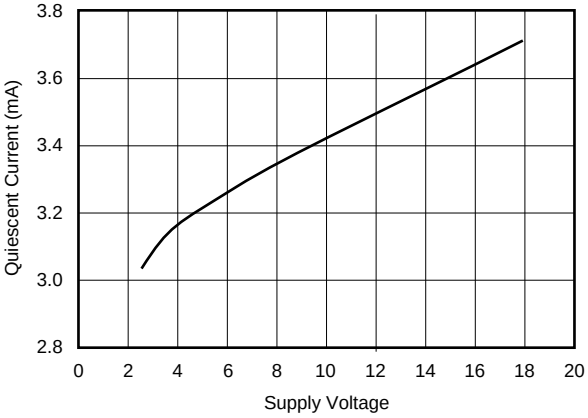
SLEW RATE vs TEMPERATURE



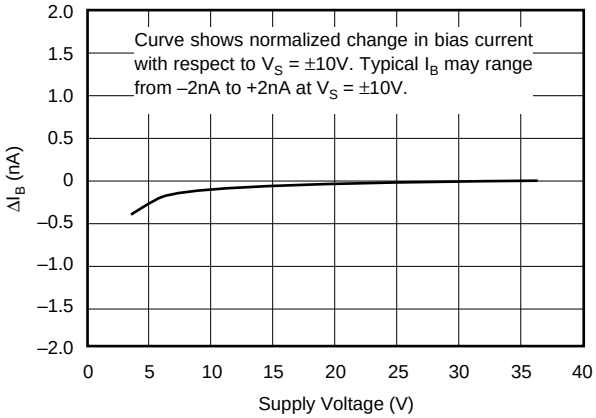
SHORT-CIRCUIT CURRENT vs TEMPERATURE



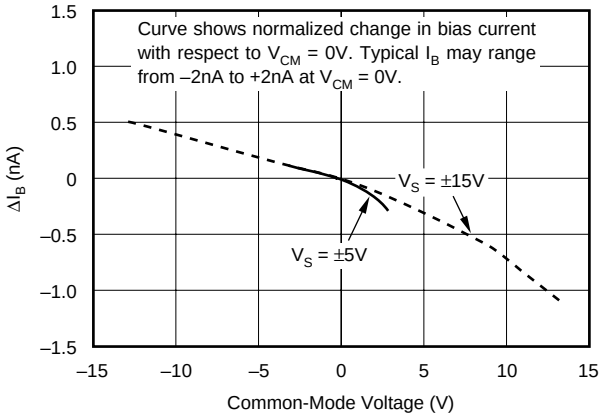
QUIESCENT CURRENT vs SUPPLY VOLTAGE



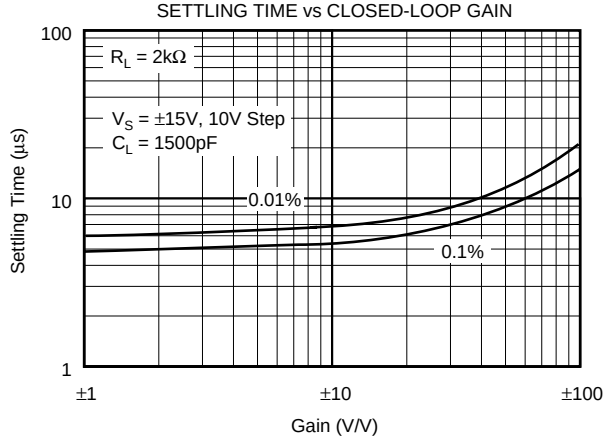
CHANGE IN INPUT BIAS CURRENT vs POWER SUPPLY VOLTAGE



CHANGE IN INPUT BIAS CURRENT vs COMMON-MODE VOLTAGE



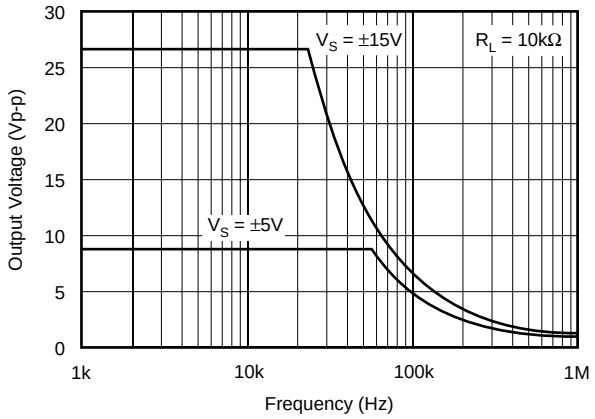
SETTLING TIME vs CLOSED-LOOP GAIN



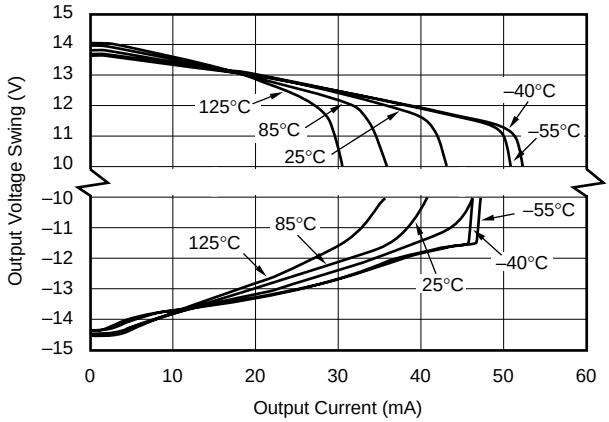
TYPICAL PERFORMANCE CURVES (CONT)

At T_A = +25°C, R_L = 10kΩ, and V_S = ±15V, unless otherwise noted.

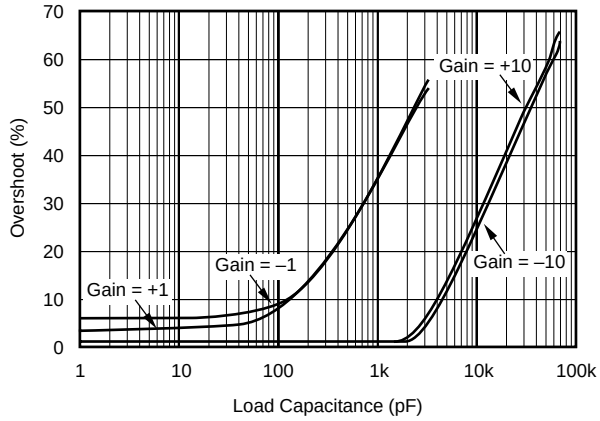
MAXIMUM OUTPUT VOLTAGE
vs FREQUENCY



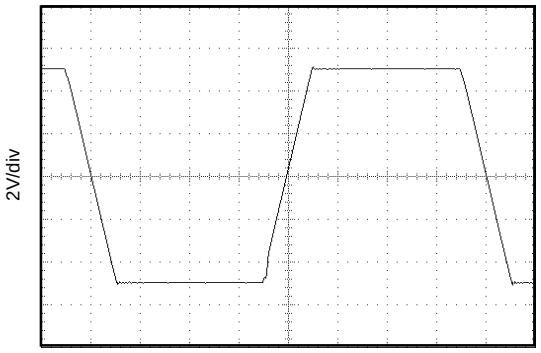
OUTPUT VOLTAGE SWING vs OUTPUT CURRENT



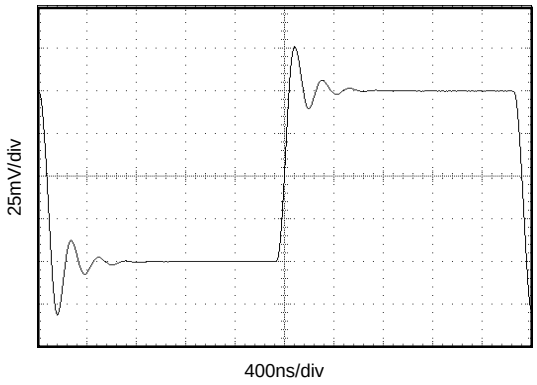
SMALL-SIGNAL OVERSHOOT
vs LOAD CAPACITANCE



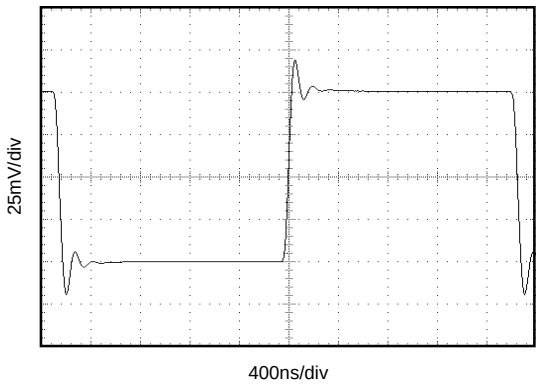
LARGE-SIGNAL STEP RESPONSE
G = +1, C_L = 1500pF, V_S = ±15V



SMALL-SIGNAL STEP RESPONSE
G = +1, C_L = 1000pF, V_S = ±15V



SMALL-SIGNAL STEP RESPONSE
G = +1, C_L = 0pF, V_S = ±15V



APPLICATIONS INFORMATION

The OPA227 series are precision op amps with very low noise. They are unity-gain stable and free from unexpected output phase reversal, making it easy to use in a wide range of applications. Applications with noisy or high impedance power supplies may require decoupling capacitors close to the device pins. In most cases, 0.1µF capacitors are adequate.

OFFSET VOLTAGE AND DRIFT

The OPA227 series has very low offset voltage and drift. To achieve highest performance, circuit layout and mechanical conditions should be optimized. Connections of dissimilar metals will generate thermal potentials at the op amp inputs which can degrade the offset voltage and drift. These thermocouple effects can exceed the inherent drift of the amplifier and ultimately degrade its performance. The thermal potentials can be made to cancel by assuring that they are equal in both input terminals. In addition:

- Keep thermal mass of the connections made to the two input terminals similar.
- Locate heat sources as far as possible from the critical input circuitry.
- Shield op amp and input circuitry from air currents such as those created by cooling fans.

OPERATING VOLTAGE

OPA227 series op amps operate from ±2.5V to ±18V supplies with excellent performance. Unlike most op amps which are specified at only one supply voltage, the OPA227 series is specified for real-world applications; a single set of specifications applies over the ±5V to ±15V supply range. Applications can be operated from any supplies between ±5V and ±15V and be assured to be in specification. In addition, key parameters are guaranteed over the specified temperature range, –40°C to +85°C. Parameters which vary with operating voltage or temperature are shown in the Typical Performance Curves.

OFFSET VOLTAGE ADJUSTMENT

The OPA227 series is laser-trimmed for very low offset and drift so most circuits will not require external adjustment. However, the OPA227 (single version) offset voltage trim connections are provided on pins 1 and 8. Offset voltage can be adjusted by connecting a potentiometer as shown in Figure 1. This adjustment should be used only to null the offset of the op amp. This adjustment should not be used to compensate for offsets created elsewhere in a system since this can introduce additional temperature drift.

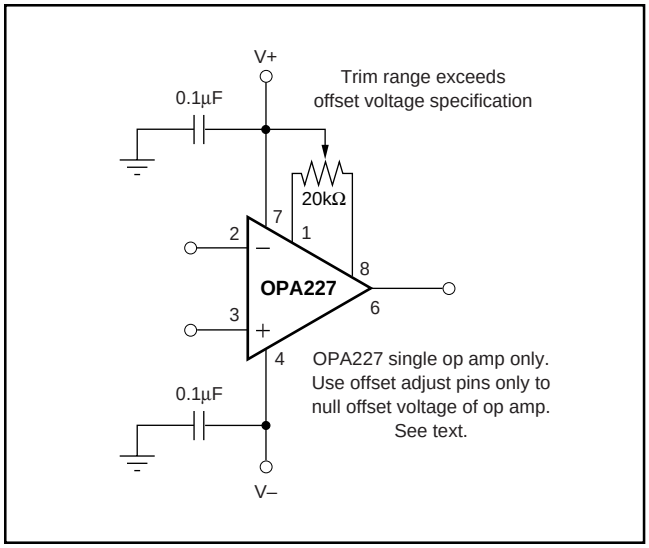


FIGURE 1. OPA227 Offset Voltage Trim Circuit.

INPUT PROTECTION

Back-to-back diode pairs (see Figure 2) are used for input protection on the OPA227. Exceeding the differential threshold of these diodes will cause current to flow and without external current-limiting resistors, the input will be destroyed. The size of any external resistors must be carefully chosen since they will increase the noise.

Accidental static discharge, as well as high current, can damage the amplifier's input circuit. Although the unit may still be functional, important parameters such as input offset voltage, drift, and noise may shift, as will any precision operational amplifier subjected to abuse.

Transient conditions can cause feedthrough due to the amplifier's finite slew rate. When using OPA227 as a unity gain buffer (follower), a feedback resistor of 1kΩ is recommended (see Figure 2).

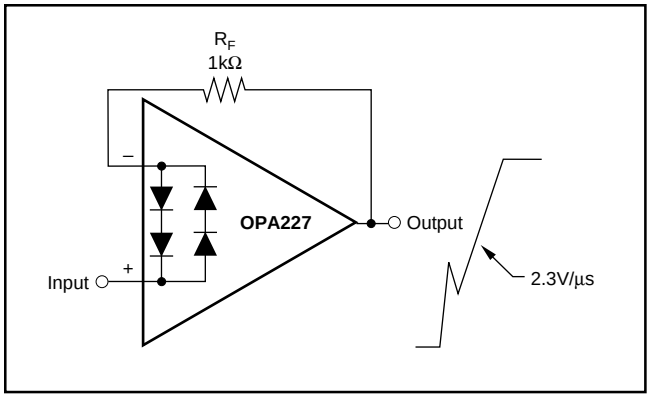


FIGURE 2. Pulsed Operation.

INPUT BIAS CURRENT CANCELLATION

The input stage base current of the OPA227 series is internally compensated with nearly equal and opposite cancellation circuit. This residual input bias current can be positive or negative.

When the bias current is canceled in this manner, the input bias current and input offset current are approximately the same magnitude. As a result, it is not necessary to use a bias current-cancellation resistor as is common practice with other op amps (Figure 3). A resistor added to cancel input bias current errors may actually increase offset voltage and noise.

NOISE PERFORMANCE

The noise performance of the OPA227 is optimized for source impedances less than 5kΩ. Total noise in an applications is a combination of the op amp's input voltage noise and input bias current noise reacting with source impedances. For applications with higher source impedance (up to 20kΩ), the OPA277 will generally provide lower noise.

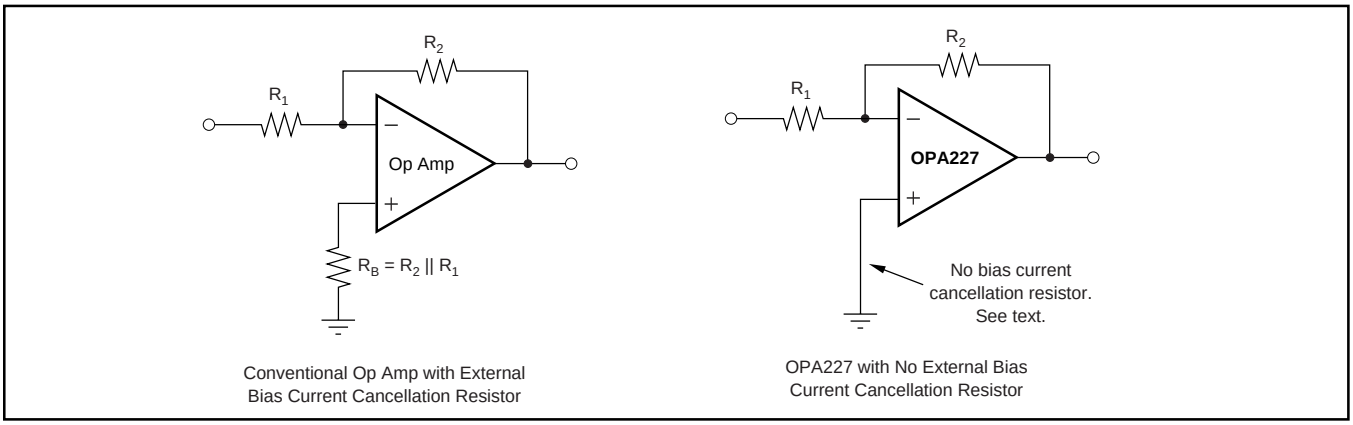


FIGURE 3. Input Bias Current Cancellation.

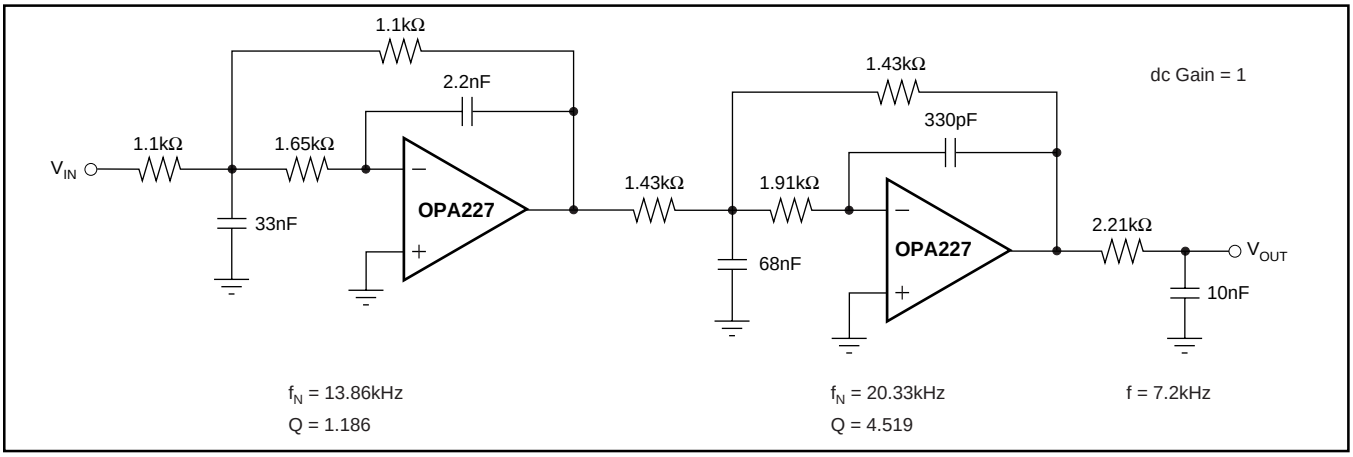


FIGURE 4. Three-Pole, 20kHz Low Pass, 0.5dB Chebyshev Filter.

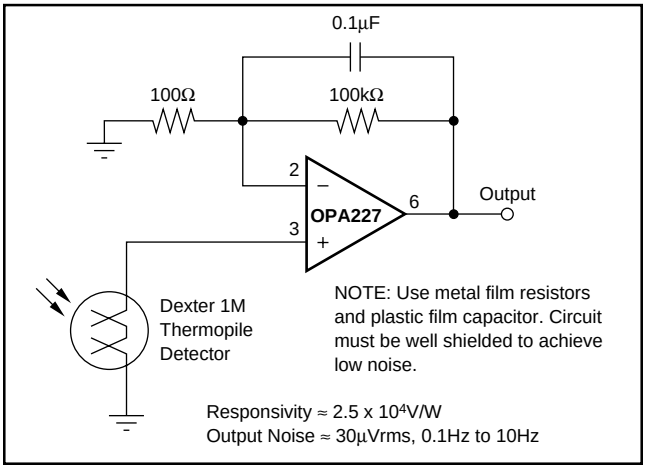


FIGURE 5. Long-Wavelength Infrared Detector Amplifier.

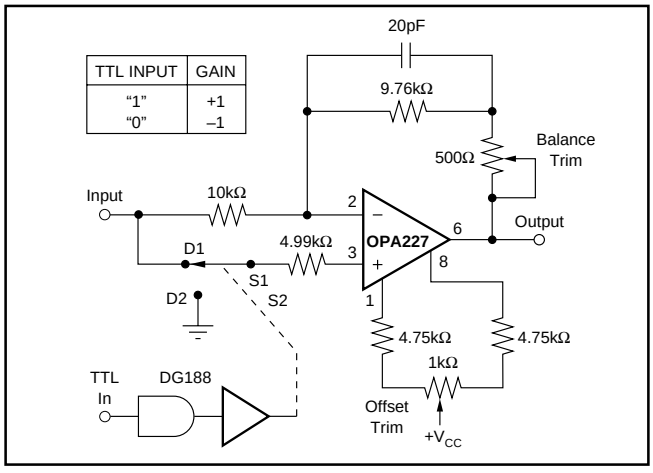


FIGURE 6. High Performance Synchronous Demodulator.