

1. DESCRIPTION

The XLOP27G precision operational amplifier combines the low offset and drift of the XLOP27G with both high speed and low noise. Offsets down to 25 μV and maximum drift of 0.6 $\mu\text{V}/^\circ\text{C}$ make the XLOP27G ideal for precision instrumentation applications. Low noise, $e_n = 3.5 \text{ nV}/\sqrt{\text{Hz}}$, at 10 Hz, a low 1/f noise corner frequency of 2.7 Hz, and high gain (1.8 million), allow accurate high-gain amplification of low-level signals. A gain bandwidth product of 8 MHz and a 2.8 $\text{V}/\mu\text{s}$ slew rate provide excellent dynamic accuracy in high speed, data-acquisition systems.

A low input bias current of $\pm 10 \text{ nA}$ is achieved by use of a bias current cancellation circuit. Over the military temperature range, this circuit typically holds I_B and I_{OS} to $\pm 20 \text{ nA}$ and 15 nA, respectively.

The output stage has good load driving capability. A guaranteed swing of $\pm 10 \text{ V}$ into 600 Ω and low output distortion make the XLOP27G an excellent choice for professional audio applications.

PSRR and CMRR exceed 120 dB. These characteristics, coupled with long-term drift of 0.2 $\mu\text{V}/\text{month}$, allow the circuit designer to achieve performance levels previously attained only by discrete designs.

Low cost, high volume production of XLOP27G is achieved by using an on-chip Zener zap-trimming network. This reliable and stable offset trimming scheme has proven its effectiveness over many years of production history.

The XLOP27G provides excellent performance in low noise, high accuracy amplification of low level signals. Applications include stable integrators, precision summing amplifiers, precision voltage threshold detectors, comparators, and professional audio circuits such as tape heads and microphone preamplifiers.

2. FEATURES

- Low noise: 80 nV p-p (0.1 Hz to 10 Hz), 3 $\text{nV}/\sqrt{\text{Hz}}$
- Low drift: 0.2 $\mu\text{V}/^\circ\text{C}$
- High speed: 2.8 $\text{V}/\mu\text{s}$ slew rate, 8 MHz gain bandwidth
- Low VOS: 10 μV
- CMRR: 126 dB at VCM of $\pm 11 \text{ V}$
- High open-loop gain: 1.8 million
- Available in die form

3. PIN CONFIGURATIONS

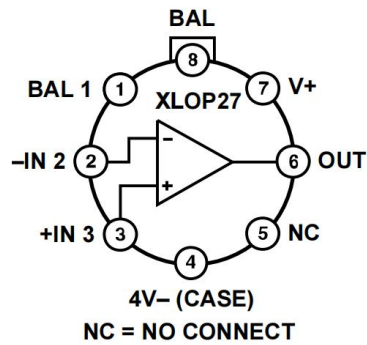


Figure 1. 8-Lead TO-99 (J-Suffix)

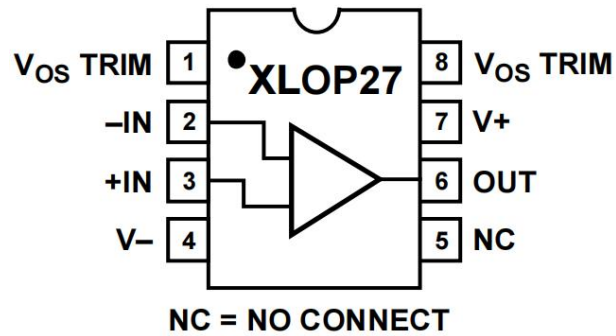


Figure 2. 8-Lead Cerdip – Glass Hermetic Seal (Z-Suffix),
8-Lead PDIP (P-Suffix), and 8-Lead SOIC (S-Suffix)

4. FUNCTIONAL BLOCK DIAGRAM

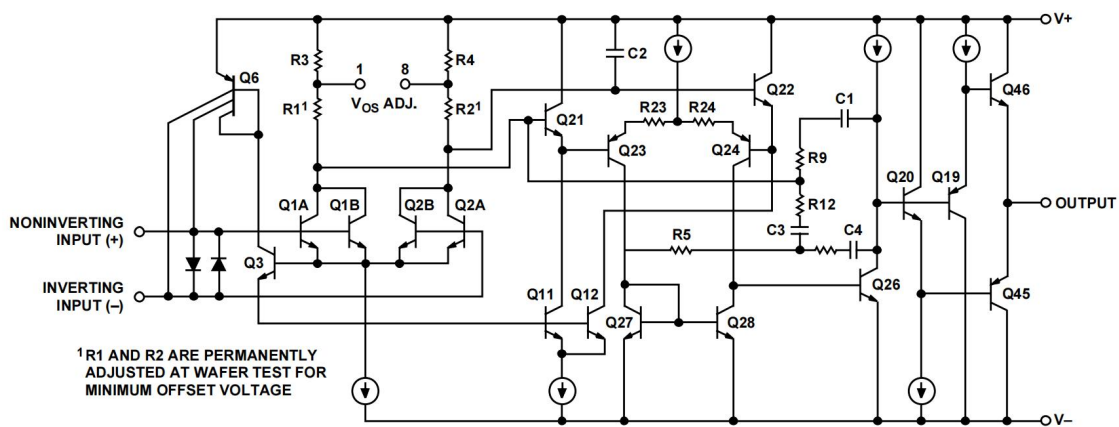


Figure 3.

5. SPECIFICATIONS

ELECTRICAL CHARACTERISTICS

VS = ±15 V, TA = 25°C, unless otherwise noted

Table 1.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
INPUT OFFSET VOLTAGE ¹	V _{OS}			30	100	μV
LONG-TERM VOS STABILITY ^{2, 3}	V _{OS} /Time			0.4	2.0	μV/Mo
INPUT OFFSET CURRENT	I _{OS}			12	75	nA
INPUT BIAS CURRENT	I _B			±15	±80	nA
INPUT NOISE VOLTAGE ^{3, 4}	e _{n p-p}	0.1 Hz to 10 Hz		0.09	0.25	μV p-p
INPUT NOISE Voltage Density ³	e _n	f _o = 10 Hz		3.8	8.0	nV/√Hz
		f _o = 30 Hz		3.3	5.6	nV/√Hz
		f _o = 1000 Hz		3.2	4.5	nV/√Hz
INPUT NOISE Current Density ³	i _n	f _o = 10 Hz		1.7		pA/√Hz
		f _o = 30 Hz		1.0		pA/√Hz
		f _o = 1000 Hz		0.4	0.6	pA/√Hz
INPUT RESISTANCE Differential Mode ⁵ Common Mode	R _{IN}		0.7	4		MΩ
	R _{INCM}			2		GΩ
INPUT VOLTAGE RANGE	IVR		±11.0	±12.3		V
COMMON-MODE REJECTION RATIO	CMRR	V _{CM} = ±11 V	100	120		dB
POWER SUPPLY REJECTION RATIO	PSRR	V _S = ±4 V to ±18 V		2	20	μV/V
LARGE SIGNAL VOLTAGE GAIN	A _{VO}	R _L ≥ 2 kΩ, V _O = ±10 V	700	1500		V/mV
		R _L ≥ 600 Ω, V _O = ±10 V	600	1500		V/mV
OUTPUT VOLTAGE SWING	V _O	R _L ≥ 2 kΩ	±11.5	±13.5		V
		R _L ≥ 600 Ω	±10.0	±11.5		V
SLEW RATE ⁶	SR	R _L ≥ 2 kΩ	1.7	2.8		V/μs
GAIN BANDWIDTH PRODUCT ⁶	GBW		5.0	8.0		MHz
OPEN-LOOP OUTPUT RESISTANCE	R _O	V _O =0, I _O =0		70		Ω
POWER CONSUMPTION	P _d	V _O		100	170	mW
OFFSET ADJUSTMENT RANGE		R _P = 10 kΩ		±4.0		mV

1. Input offset voltage measurements are performed approximately 0.5 seconds after application of power. A/E grades guaranteed fully warmed up.

2. Long-term input offset voltage stability refers to the average trend line of VOS vs. time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in VOS during the first 30 days are typically 2.5 μV. Refer to the Typical Performance Characteristics section.

3. Sample tested.

4. See voltage noise test circuit (Figure 26).

5. Guaranteed by input bias current

6. Guaranteed by design.

$V_S = \pm 15\text{ V}$, $-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$ for XLOP27G, unless otherwise noted.

Table 2.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
INPUT ONSET VOLTAGE	V_{OS}			55	220	μV
AVERAGE INPUT OFFSET DRIFT	TCV_{OS}^1			04	1.8	$\mu\text{V}/^\circ\text{C}$
	TCV_{OSn}^2			04	1.8	$\mu\text{V}/^\circ\text{C}$
INPUT OFFSET CURRENT	I_{OS}			20	135	nA
INPUT BIAS CURRENT	I_B			± 25	± 150	nA
INPUT VOLTAGE RANGE	IVR		± 10.5	± 11.8		V
COMMON-MODE REJECTION RATIO	CMRR	$V_{CM} = \pm 10\text{ V}$	96	118		dB
POWER SUPPLY REJECTION RATIO	PSRR	$V_S = \pm 4.5\text{ V}$ to $\pm 18\text{ V}$		2	32	$\mu\text{V}/\text{V}$
LARGE SIGNAL VOLTAGE GAIN	A_{VO}	$R_L \geq 2\text{ k}\Omega$, $V_O = \pm 10\text{ V}$	450	1000		V/mV
OUTPUT VOLTAGE SWING	V_O	$R_L \geq 2\text{ k}\Omega$	± 11.0	± 13.3		V

1. The TCV_{OS} performance is within the specifications unnullled or when nulled with $R_P = 8\text{ k}\Omega$ to $20\text{ k}\Omega$. TCV_{OS} is 100% tested for A/E grades, sample tested for C/G grades.

2. Guaranteed by design.

6. TYPICAL ELECTRICAL CHARACTERISTICS

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

Table 3.

Parameter	Symbol	Test Conditions	Typical	Unit
AVERAGE INPUT OFFSET VOLTAGE DRIFT ¹	TCV_{OS} or TCV_{OSn}	Nulled or unnullled, $R_P = 8\text{ k}\Omega$ to $20\text{ k}\Omega$	0.2	$\mu\text{V}/^\circ\text{C}$
AVERAGE INPUT OFFSET CURRENT DRIFT	TCI_{OS}		80	$\text{pA}/^\circ\text{C}$
AVERAGE INPUT BIAS CURRENT DRIFT	TCI_B		100	$\text{pA}/^\circ\text{C}$
INPUT NOISE VOLTAGE DENSITY	e_n	$f_0 = 10\text{ Hz}$	3.5	$\text{nV}/\sqrt{\text{Hz}}$
		$f_0 = 30\text{ Hz}$	3.1	$\text{nV}/\sqrt{\text{Hz}}$
		$f_0 = 1000\text{ Hz}$	3.0	$\text{nV}/\sqrt{\text{Hz}}$
INPUT NOISE CURRENT DENSITY	i_n	$f_0 = 10\text{ Hz}$	1.7	$\text{pA}/\sqrt{\text{Hz}}$
		$f_0 = 30\text{ Hz}$	1.0	$\text{pA}/\sqrt{\text{Hz}}$
		$f_0 = 1000\text{ Hz}$	0.4	$\text{pA}/\sqrt{\text{Hz}}$
INPUT NOISE VOLTAGE SLEW RATE	e_{np-p}	0.1 Hz to 10 Hz	0.08	$\mu\text{V p-p}$
	SR	$R_L \geq 2\text{ k}\Omega$	2.8	$\text{V}/\mu\text{s}$
GAIN BANDWIDTH PRODUCT	GBW		8	MHz

1. Input offset voltage measurements are performed by automated test equipment approximately 0.5 seconds after application of power.

7. ABSOLUTE MAXIMUM RATINGS

Table 4.

Parameter	Rating
Supply Voltage	$\pm 22\text{ V}$
Input Voltage ¹	$\pm 22\text{ V}$
Output Short-Circuit Duration	Indefinite
Differential Input Voltage ²	$\pm 0.7\text{ V}$
Differential Input Current ²	$\pm 25\text{ mA}$
Storage Temperature Range	-65°C to $+150^\circ\text{C}$
Operating Temperature Range XLOP27G	-40°C to $+85^\circ\text{C}$
Lead Temperature Range (Soldering, 60 sec)	300°C
Junction Temperature	-65°C to $+150^\circ\text{C}$

1. For supply voltages less than $\pm 22\text{ V}$, the absolute maximum input voltage is equal to the supply voltage.

2. The inputs of the XLOP27G are protected by back-to-back diodes. Current limiting resistors are not used in order to achieve low noise. If differential input voltage exceeds $\pm 0.7\text{ V}$, the input current should be limited to 25 mA .

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage

to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

8. THERMAL RESISTANCE

θ_{JA} is specified for the worst-case conditions, that is, θ_{JA} is specified for device in socket for TO-99, CERDIP, and PDIP packages; θ_{JA} is specified for device soldered to printed circuit board for SOIC package.

Absolute maximum ratings apply to both dice and packaged parts, unless otherwise noted.

Table 5.

Package Type	θ_{JA}	θ_{JC}	Unit
8-Lead PDIP (P)	103	43	°C/W
8-Lead SOP N (S)	158	43	°C/W

9. ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

10. TYPICAL PERFORMANCE CHARACTERISTICS

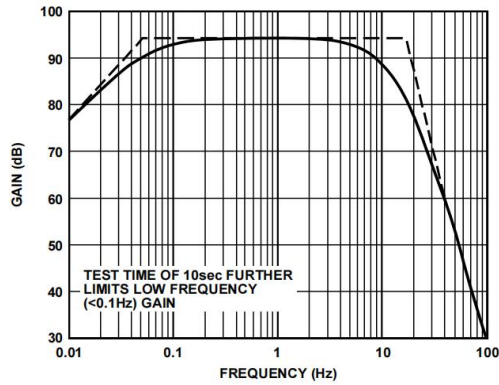


Figure 4. 0.1 Hz to 10 Hz p-p Noise Tester Frequency Response

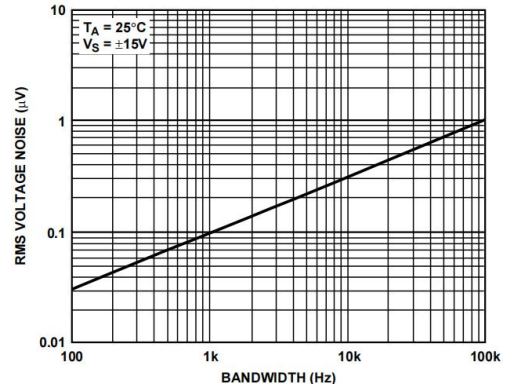


Figure 7. Input Wideband Voltage Noise vs. Bandwidth (0.1 Hz to Frequency Indicated)

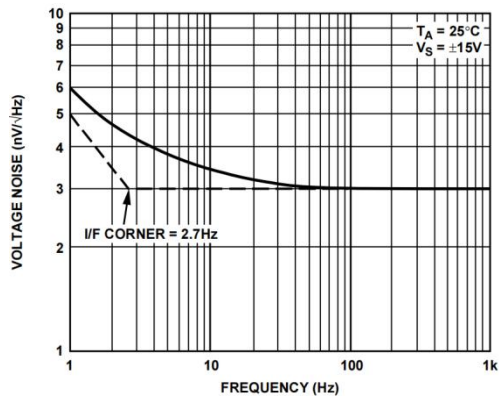


Figure 5. Voltage Noise Density vs. Frequency

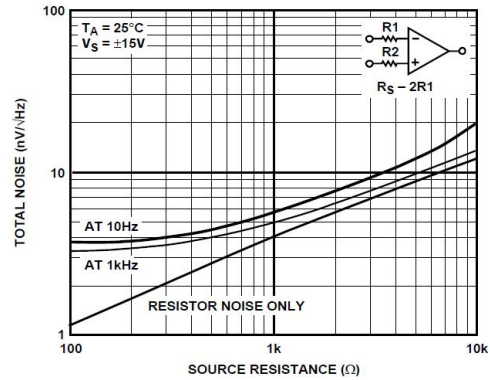


Figure 8. Total Noise vs. Sourced Resistance

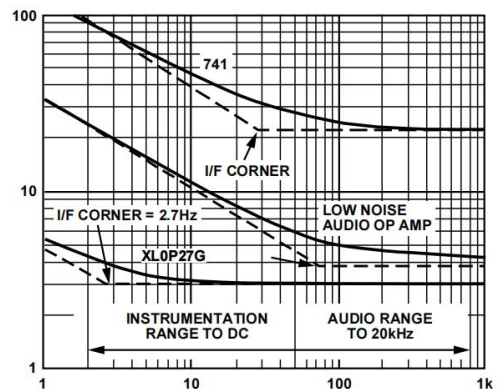


Figure 6. A Comparison of Op Amp Voltage Noise Spectra

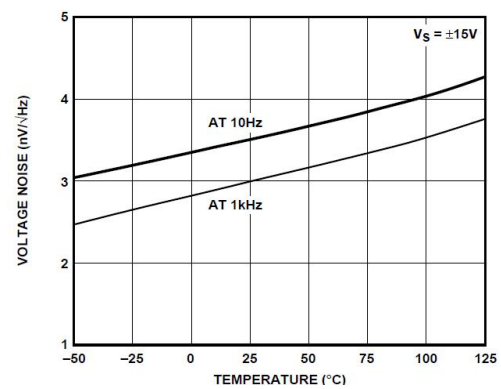


Figure 9. Voltage Noise Density vs. Temperature

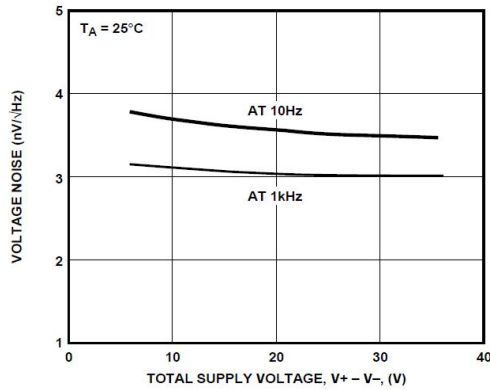


Figure 10. Voltage Noise Density vs. Supply Voltage

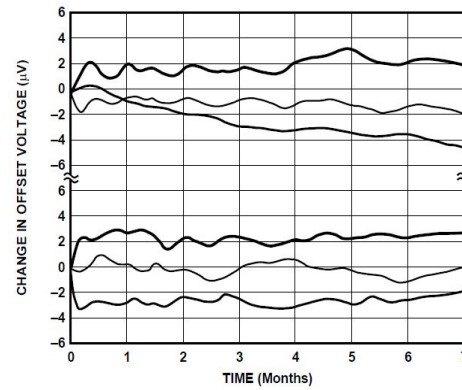


Figure13.Long Term Offset Voltage Drift of Six Representative Units

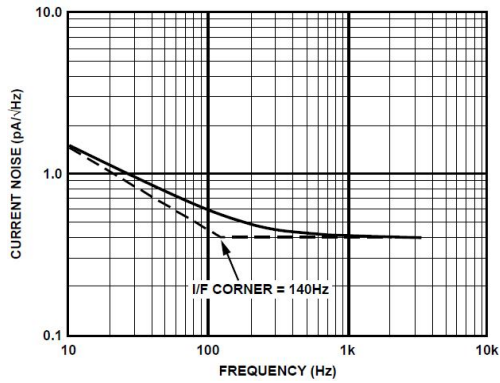


Figure 11. Current Noise Density vs. Frequency

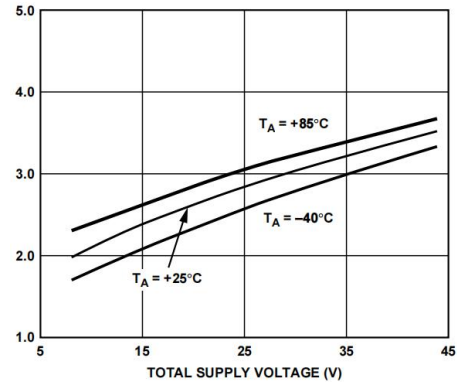


Figure 14. Supply Current vs. Supply Voltage

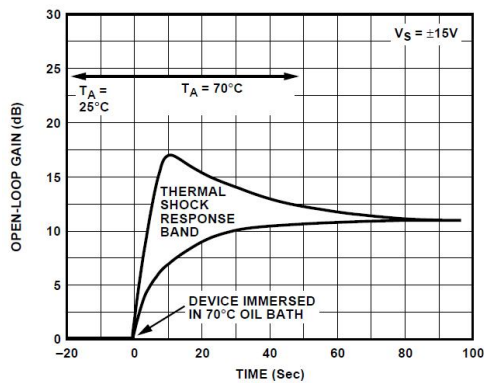


Figure 12. Offset Voltage Change Due to Thermal Shock

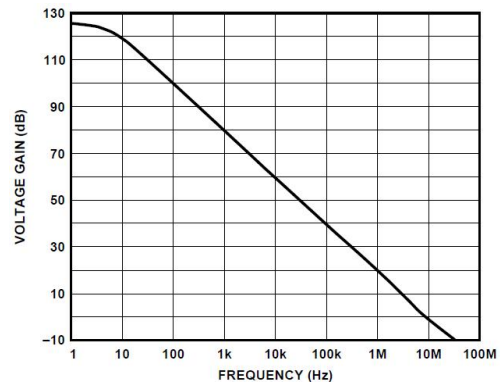


Figure 15. Open-Loop Gain vs. Frequency

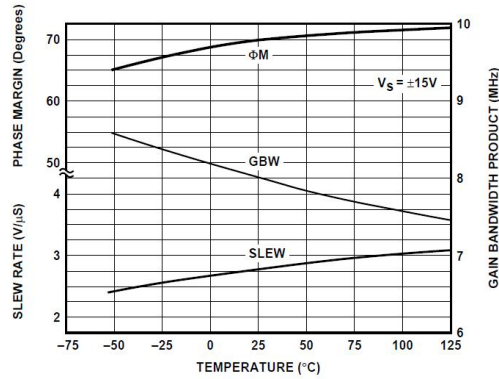


Figure 16. Slew Rate, Gain Bandwidth Product, Phase Margin vs. Temperature

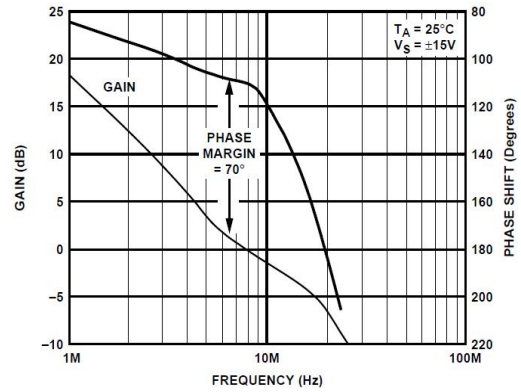


Figure 19. Gain, Phase Shift vs. Frequency

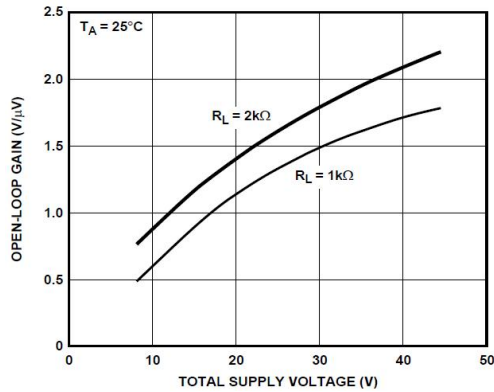


Figure 17. Open-Loop Voltage Gain vs. Supply Voltage

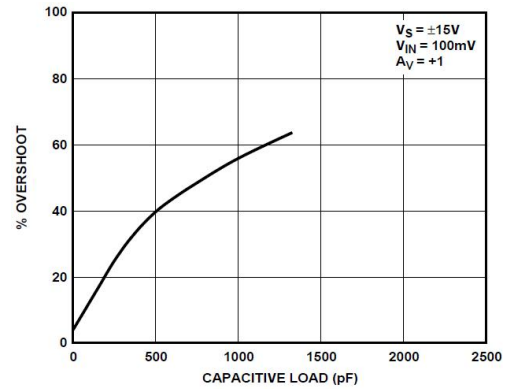


Figure 20. Small-Signal Overshoot vs. Capacitive Load

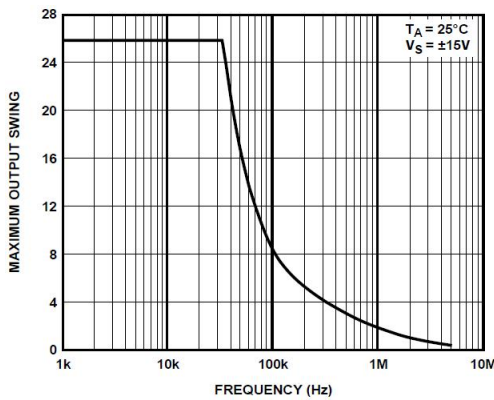


Figure 18. Maximum Output Swing vs. Frequency

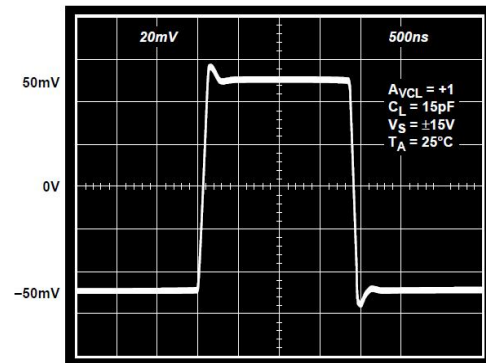


Figure 21. Small-Signal Transient Response

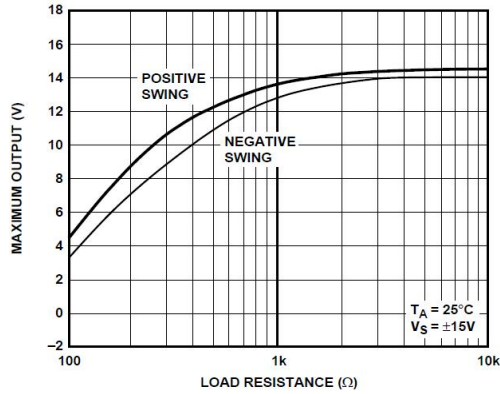


Figure 22. Maximum Output Voltage vs. Load Resistance

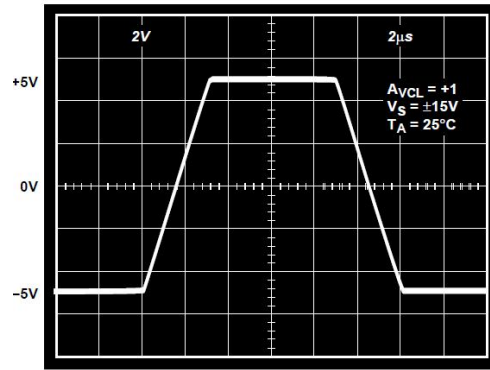


Figure 25. Large Signal Transient Response

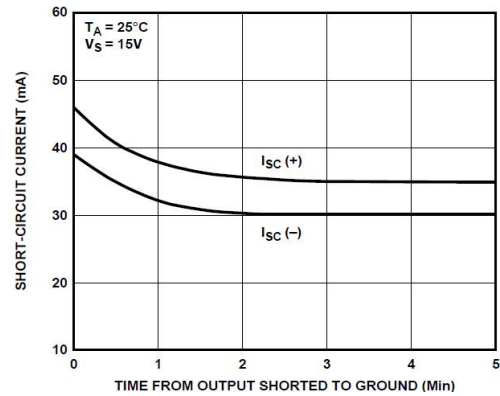


Figure 23. Short-Circuit Current vs. Time

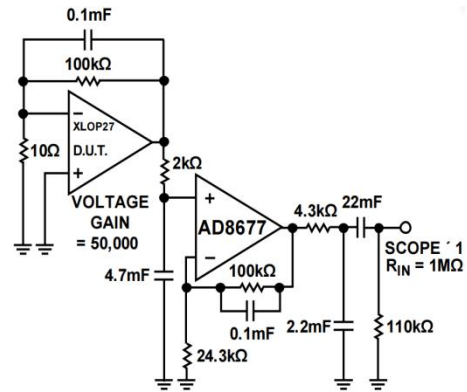


Figure 26. Voltage Noise Test Circuit (0.1 Hz to 10 Hz)

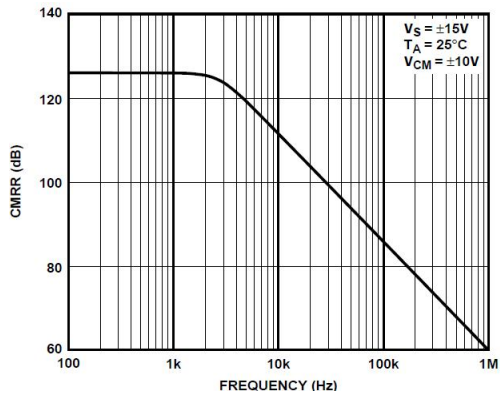


Figure 24. CMRR vs. Frequency

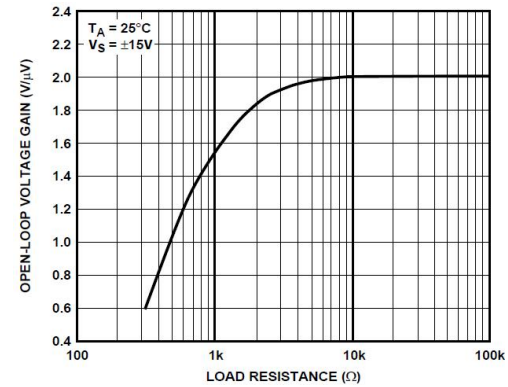


Figure 27. Open-Loop Voltage Gain vs. Load Resistance

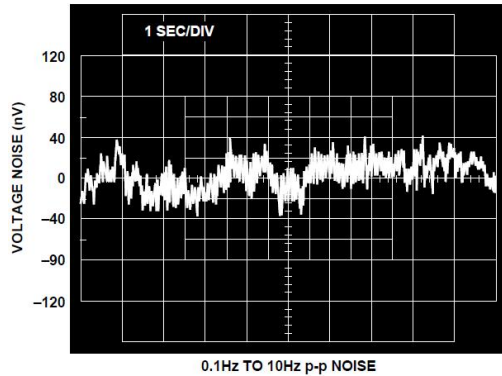


Figure 28. Low Frequency Noise

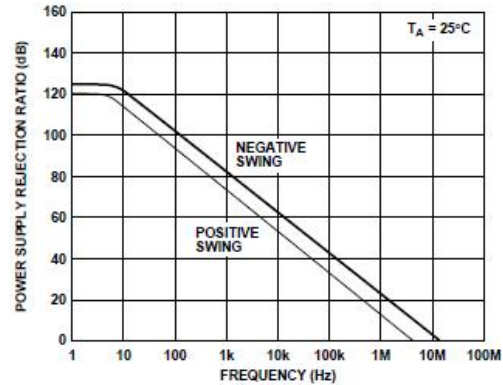


Figure 29. PSRR vs. Frequency

11. APPLICATIONS INFORMATION

XLOP27G series units can be inserted directly into XLOP27G sockets with or without removal of external compensation or nulling components. XLOP27G offset voltage can be nulled to 0 (or another desired setting) using a potentiometer (see Figure 35).

The XLOP27G provides stable operation with load capacitances of up to 2000 pF and ± 10 V swings; larger capacitances should be decoupled with a 50 Ω resistor inside the feedback loop. The XLOP27G is unity-gain stable.

Thermoelectric voltages generated by dissimilar metals at the input terminal contacts can degrade the drift performance. Best operation is obtained when both input contacts are maintained at the same temperature.

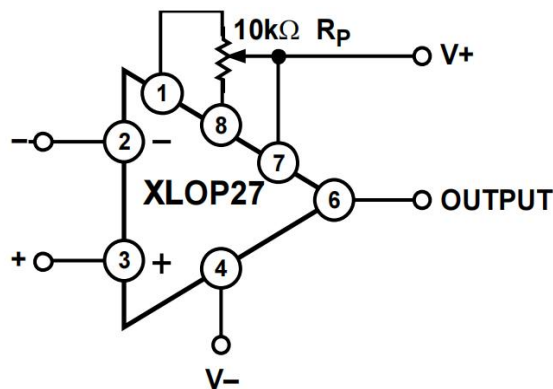


Figure 35. Offset Nulling Circuit

12. OFFSET VOLTAGE ADJUSTMENT

The input offset voltage of the XLOP27G is trimmed at wafer level. However, if further adjustment of VOS is necessary, a 10 k Ω trim potentiometer can be used. TCVOS is not degraded (see Figure 35). Other potentiometer values from 1 k Ω to 1 M Ω can be used with a slight degradation (0.1 μ V/ $^{\circ}$ C to 0.2 μ V/ $^{\circ}$ C) of TCVOS. Trimming to a value other than zero creates a drift of approximately (VOS/300) μ V/ $^{\circ}$ C. For example, the change in TCVOS is 0.33 μ V/ $^{\circ}$ C if VOS is adjusted to 100 μ V. The offset voltage adjustment range with a 10 k Ω potentiometer is $\pm$ 4 mV. If smaller adjustment range is required, the nulling sensitivity can be reduced by using a smaller potentiometer in conjunction with fixed resistors. For example, Figure 36 shows a network that has a $\pm$ 280 μ V adjustment range.

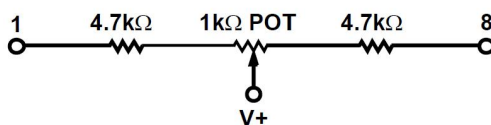


Figure 36. Offset Voltage Adjustment

13. NOISE MEASUREMENTS

To measure the 80 nV p-p noise specification of the XLOP27G in the 0.1 Hz to 10 Hz range, the following precautions must be observed:

The device must be warmed up for at least five minutes. As shown in the warm-up drift curve, the offset voltage typically changes 4 μ V due to increasing chip temperature after power-up. In the 10-second measurement interval, these temperature-induced effects can exceed tens-of-nanovolts.

For similar reasons, the device has to be well-shielded from air currents. Shielding minimizes thermocouple effects.

Sudden motion in the vicinity of the device can also feedthrough to increase the observed noise.

The test time to measure 0.1 Hz to 10 Hz noise should not exceed 10 seconds. As shown in the noise-tester frequency response curve, the 0.1 Hz corner is defined by only one zero. The test time of 10 seconds acts as an additional zero to eliminate noise contributions from the frequency band below 0.1 Hz.

A noise voltage density test is recommended when measuring noise on a large number of units. A 10 Hz noise voltage density measurement correlates well with a 0.1 Hz to 10 Hz p-p noise reading, since both results are determined by the white noise and the location of the 1/f corner frequency.

14. UNITY-GAIN BUFFER APPLICATIONS

When $R_f \leq 100 \Omega$ and the input is driven with a fast, large signal pulse ($>1 \text{ V}$), the output waveform looks as shown in the pulsed operation diagram (see Figure 37).

During the fast feedthrough-like portion of the output, the input protection diodes effectively short the output to the input, and a current, limited only by the output short-circuit protection, is drawn by the signal generator. With $R_f \geq 500 \Omega$, the output is capable of handling the current requirements ($I_L \leq 20 \text{ mA}$ at 10 V); the amplifier stays in its active mode and a smooth transition occurs.

When $R_f > 2 \text{ k}\Omega$, a pole is created with R_f and the amplifier's input capacitance (8 pF) that creates additional phase shift and reduces phase margin. A small capacitor (20 pF to 50 pF) in parallel with R_f eliminates this problem.

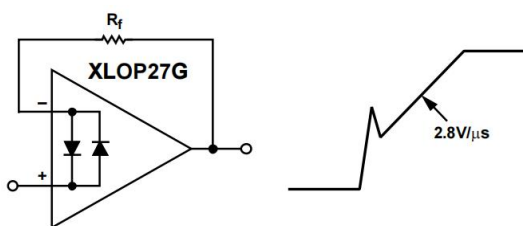


Figure 37. Pulsed Operation

15. COMMENTS ON NOISE

The XLOP27G is a very low noise, monolithic op amp. The out-standing input voltage noise characteristics of the XLOP27G are achieved mainly by operating the input stage at a high quiescent current. The input bias and offset currents, which would normally increase, are held to reasonable values by the input bias current cancellation circuit.

Voltage noise is inversely proportional to the square root of bias current, but current noise is proportional to the square root of bias current. The noise advantage of the XLOP27G disappears when high source resistors are used. Figure 38, Figure 39, Figure 40 compare the observed total noise of the XLOP27G with the noise performance of other devices in different circuit applications.

$$Total\ Noise = \left[\begin{aligned} &(Voltage\ Noise)^2 + \\ &(Current\ Noise \times R_s)^2 + \\ &(Resistor\ Noise)^2 \end{aligned} \right]^{1/2}$$

Figure 38 shows noise vs. source resistance at 1000 Hz. The same plot applies to wideband noise. To use this plot, multiply the vertical scale by the square root of the bandwidth.

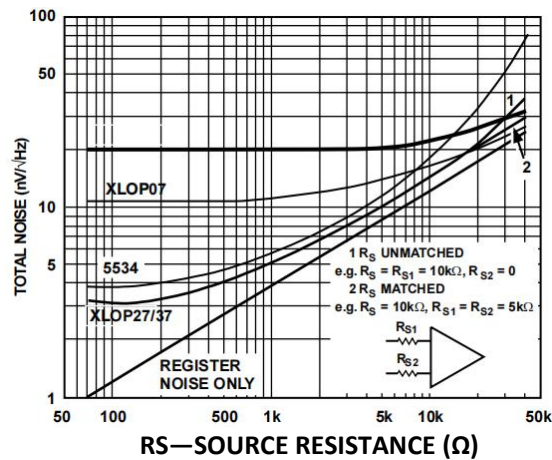
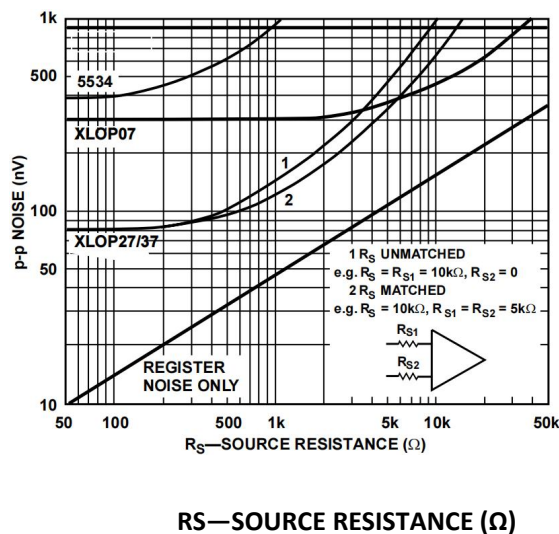


Figure 38. Noise vs. Source Resistance (Including Resistor Noise) at 1000 Hz

At $R_S < 1\text{ k}\Omega$, the low voltage noise of the XLOP27G is maintained. With $R_S < 1\text{ k}\Omega$, total noise increases but is dominated by the resistor noise rather than current or voltage noise. It is only beyond R_S of 20 $\text{k}\Omega$ that current noise starts to dominate. The argument can be made that current noise is not important for applications with low-to-moderate source resistances. The crossover between the XLOP27G and XLOP07 noise occurs in the 15 $\text{k}\Omega$ to 40 $\text{k}\Omega$ region.

Figure 39 shows the 0.1 Hz to 10 Hz p-p noise. Here the picture is less favorable; resistor noise is negligible and current noise becomes important because it is inversely proportional to the square root of frequency. The crossover with the XL07 occurs in the 3 $\text{k}\Omega$ to 5 $\text{k}\Omega$ range depending on whether balanced or unbalanced source resistors are used (at 3 $\text{k}\Omega$ the IB and IOS error also can be 3× the VOS spec).



**Figure 39. Peak-to-Peak Noise
(0.1 Hz to 10 Hz) as Source Resistance (Includes Resistor Noise)**

For low frequency applications, the XL07 is better than the XLOP27G/XLOP37 when $R_S > 3\text{ k}\Omega$. The only exception is when gain error is important.

Figure 40 illustrates the 10 Hz noise. As expected, the results are between the previous two figures.

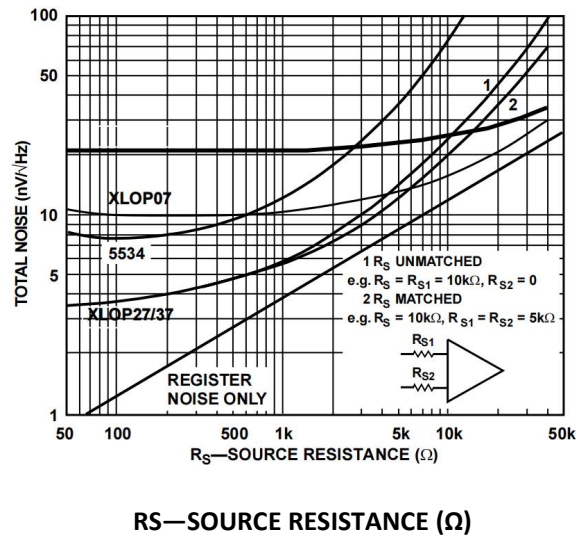


Figure 40. 10 Hz Noise vs. Source Resistance (Includes Resistor Noise) Audio Applications

For reference, typical source resistances of some signal sources are listed in Table 6.

Table 6.

Device	Source Impedance	Comments
Strain Gauge	$<500\ \Omega$	Typically used in low frequency applications.
Magnetic Tape Head	$<1500\ \Omega$	Low is very important to reduce self-magnetization problems when direct coupling is used. XLOP27G IB can be neglected.
Magnetic Phonograph Cart ridges	$<1500\ \Omega$	Similar need for low IB in direct coupled applications. XLOP27G does not introduce any self-magnetization problems.
Linear Variable Differential Transformer	$<1500\ \Omega$	Used in rugged servo-feedback applications. Bandwidth of interest is 400 Hz to 5 kHz.

Table 7. Open-Loop Gain

Frequency	XLOP07	XLOP27G	XLOP37
At 3 Hz	100 dB	124 dB	125 dB
At 10 Hz	100 dB	120 dB	125 dB
At 30 Hz	90 dB	110 dB	124 dB

16. AUDIO APPLICATIONS

Figure 41 is an example of a phono pre-amplifier circuit using the XLOP27G for A1; R1-R2-C1-C2 form a very accurate RIAA network with standard component values. The popular method to accomplish RIAA phono equalization is to employ frequency dependent feedback around a high quality gain block. Properly chosen, an RC network can provide the three necessary time constants of 3180 μ s, 318 μ s, and 75 μ s.

For initial equalization accuracy and stability, precision metal film resistors and film capacitors of polystyrene or polypropylene are recommended because they have low voltage coefficients, dissipation factors, and dielectric absorption. (High-k ceramic capacitors should be avoided here, though low-k ceramics, such as NPO types that have excellent dissipation factors and somewhat lower dielectric absorption, can be considered for small values.)

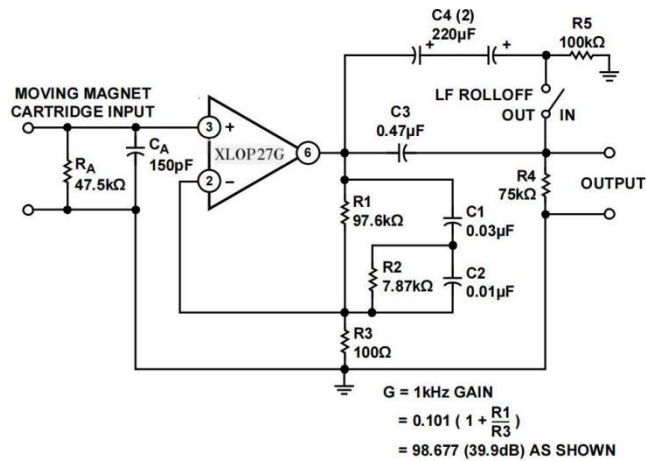


Figure 41. Phono Preamplifier Circuit

The XLOP27G brings a 3.2 nV/VHz voltage noise and 0.45 pA/VHz current noise to this circuit. To minimize noise from other sources, R₃ is set to a value of 100 Ω , generating a voltage noise of 1.3 nV/VHz. The noise increases the 3.2 nV/VHz of the amplifier by only 0.7 dB. With a 1 k Ω source, the circuit noise measures 63 dB below a 1 mV reference level, unweighted, in a 20 kHz noise bandwidth.

Gain (G) of the circuit at 1 kHz can be calculated by the expression:

$$G = 0.101 \left(1 + \frac{R1}{R3} \right)$$

For the values shown, the gain is just under 100 (or 40 dB). Lower gains can be accommodated by increasing R3, but gains higher than 40 dB show more equalization errors because of the 8 MHz gain bandwidth of the XLOP27G.

This circuit is capable of very low distortion over its entire range, generally below 0.01% at levels up to 7 V rms. At 3 V output levels, it produces less than 0.03% total harmonic distortion at frequencies up to 20 kHz.

Capacitor C3 and Resistor R4 form a simple –6 dB per octave rumble filter, with a corner at 22 Hz. As an option, the switch selected Shunt Capacitor C4, a nonpolarized electrolytic, bypasses the low frequency roll-off. Placing the rumble filter's high-pass action after the preamplifier has the desirable result of discriminating against the RIAA-amplified low frequency noise components and pickup produced low frequency disturbances.

A preamplifier for NAB tape playback is similar to an RIAA phono preamplifier, though more gain is typically demanded, along with equalization requiring a heavy low frequency boost. The circuit in Figure 41 can be readily modified for tape use, as shown by Figure 42.

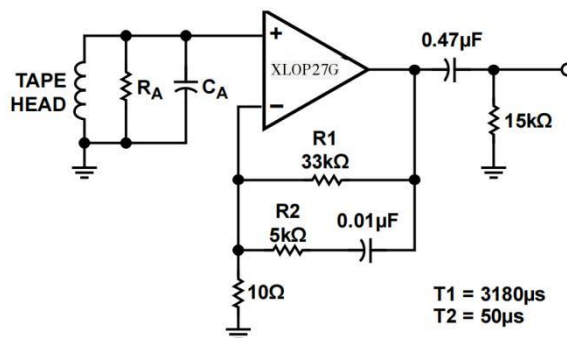


Figure 42. Tape Head Preamplifier

While the tape equalization requirement has a flat high frequency gain above 3 kHz ($T_2 = 50 \mu s$), the amplifier need not be stabilized for unity gain. The decompensated XLOP37 provides a greater bandwidth and slew rate. For many applications, the idealized time constants shown can require trimming of R1 and R2 to optimize frequency response for nonideal tape head performance and other factors (see the References section).

The network values of the configuration yield a 50 dB gain at 1 kHz, and the dc gain is greater than 70 dB. Thus, the worst-case output offset is just over 500 mV. A single 0.47 μ F output capacitor can block this level without affecting the dynamic range.

The tape head can be coupled directly to the amplifier input, because the worst-case bias current of 80 nA with a 400 mH, 100 μ inch head (such as the PRB2H7K) is not troublesome.

Amplifier bias-current transients that can magnetize a head present one potential tape head problem. The XLOP27G and XLOP37 are free of bias current transients upon power-up or power-down. It is always advantageous to control the speed of power supply rise and fall to eliminate transients.

In addition, the dc resistance of the head should be carefully controlled and preferably below 1 k Ω . For this configuration, the bias current induced offset voltage can be greater than the 100 pV maximum offset if the head resistance is not sufficiently controlled.

A simple, but effective, fixed gain transformerless microphone preamp (Figure 43) amplifies differential signals from low impedance microphones by 50 dB and has an input impedance of 2 k Ω . Because of the high working gain of the circuit, an XLOP37 helps to preserve bandwidth, which is 110 kHz. As the XLOP37 is a decompensated device (minimum stable gain of 5), a dummy resistor, R_p , may be necessary if the microphone is to be unplugged. Otherwise, the 100% feedback from the open input can cause the amplifier to oscillate.

Common-mode input noise rejection will depend upon the match of the bridge-resistor ratios. Either close tolerance (0.1%) types should be used, or R_4 should be trimmed for best CMRR. All resistors should be metal film types for best stability and low noise.

Noise performance of this circuit is limited more by the Input Resistors R_1 and R_2 than by the op amp, as R_1 and R_2 each generate a 4 nV/VHz noise, while the op amp generates a 3.2 nV/VHz noise. The rms sum of these predominant noise sources is about 6 nV/VHz, equivalent to 0.9 μ V in a 20 kHz noise bandwidth, or nearly 61 dB below a 1 mV input signal. Measurements confirm this predicted performance.

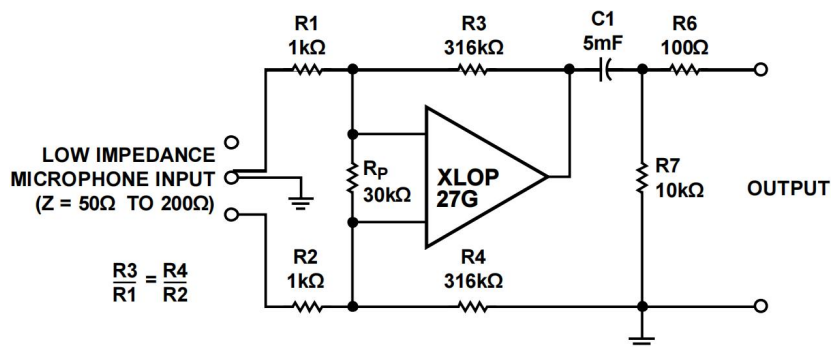


Figure 43. Fixed Gain Transformerless Microphone Preamplifier

For applications demanding appreciably lower noise, a high quality microphone transformer coupled preamplifier (Figure 44) incorporates the internally compensated XLOP27G. T1 is a JE-115K-E 150 Ω /15 k Ω transformer that provides an optimum source resistance for the XLOP27G device. The circuit has an overall gain of 40 dB, the product of the transformer's voltage setup and the op amp's voltage gain.

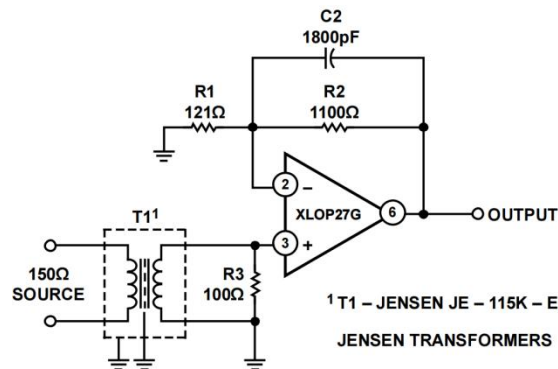


Figure 44. High Quality Microphone Transformer Coupled Preamplifier

Gain can be trimmed to other levels, if desired, by adjusting R2 or R1. Because of the low offset voltage of the XLOP27G, the output offset of this circuit is very low, 1.7 mV or less, for a 40 dB gain. The typical output blocking capacitor can be eliminated in such cases, but it is desirable for higher gains to eliminate switching transients.

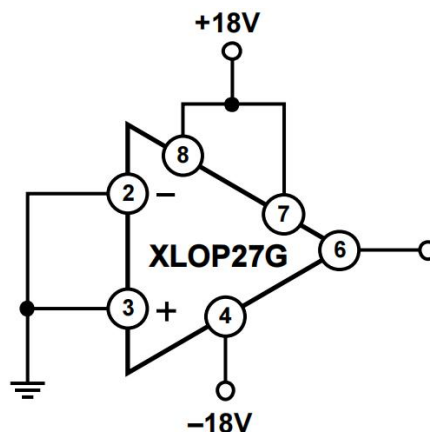


Figure 45. Burn-In Circuit

Capacitor C2 and Resistor R2 form a 2 μ s time constant in this circuit, as recommended for optimum transient response by the transformer manufacturer. With C2 in use, A1 must have unity-gain stability. For situations where the 2 μ s time constant is not necessary, C2 can be deleted, allowing the faster XLOP37 to be employed.

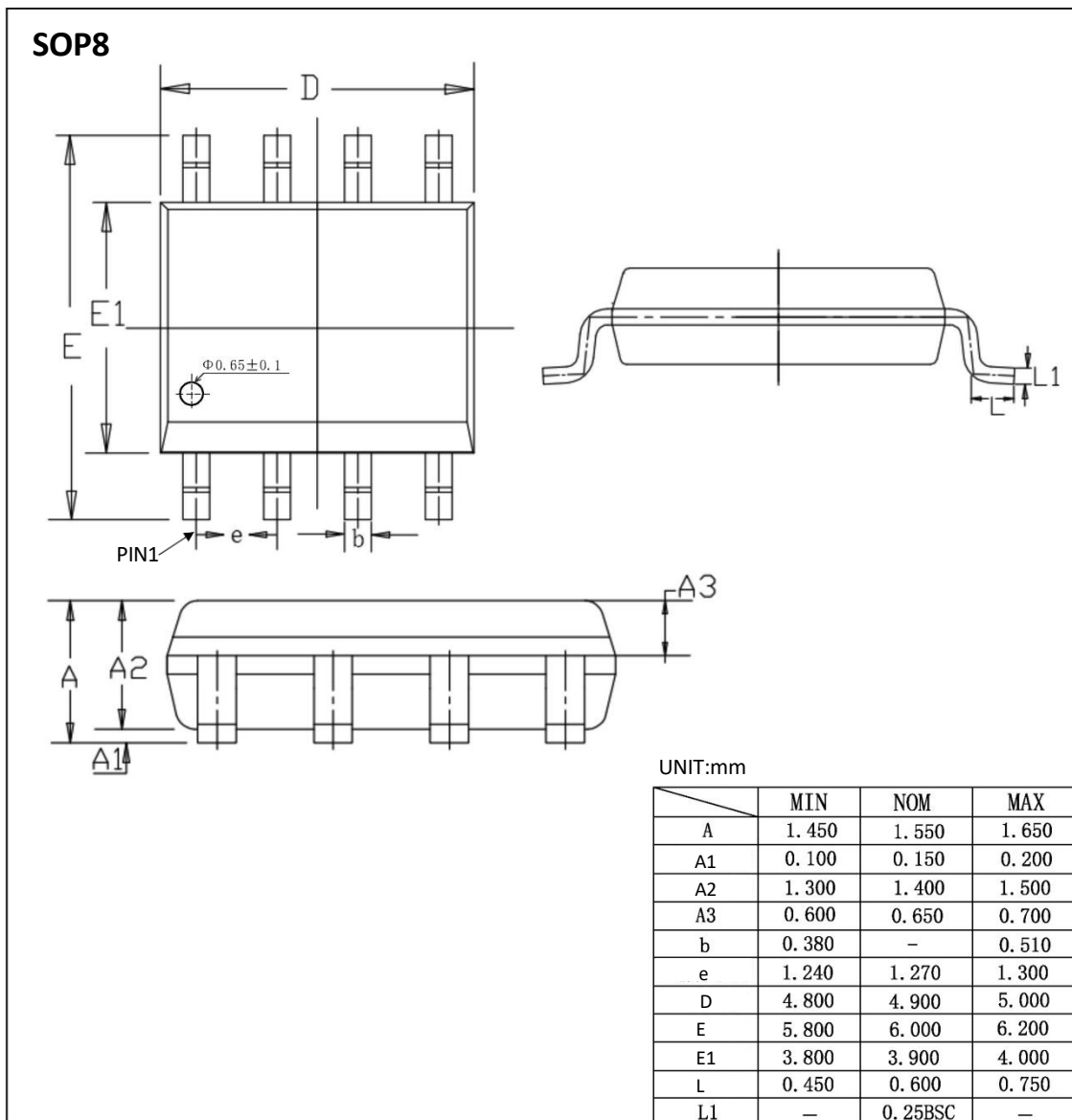
A 150 Ω resistor and R1 and R2 gain resistors connected to a noiseless amplifier generate 220 nV of noise in a 20 kHz bandwidth, or 73 dB below a 1 mV reference level. Any practical amplifier can only approach this noise level; it can never exceed it. With the XLOP27G and T1 specified, the additional noise degradation is close to 3.6 dB (or -9.5 referenced to 1 mV).

17. ORDERING INFORMATION

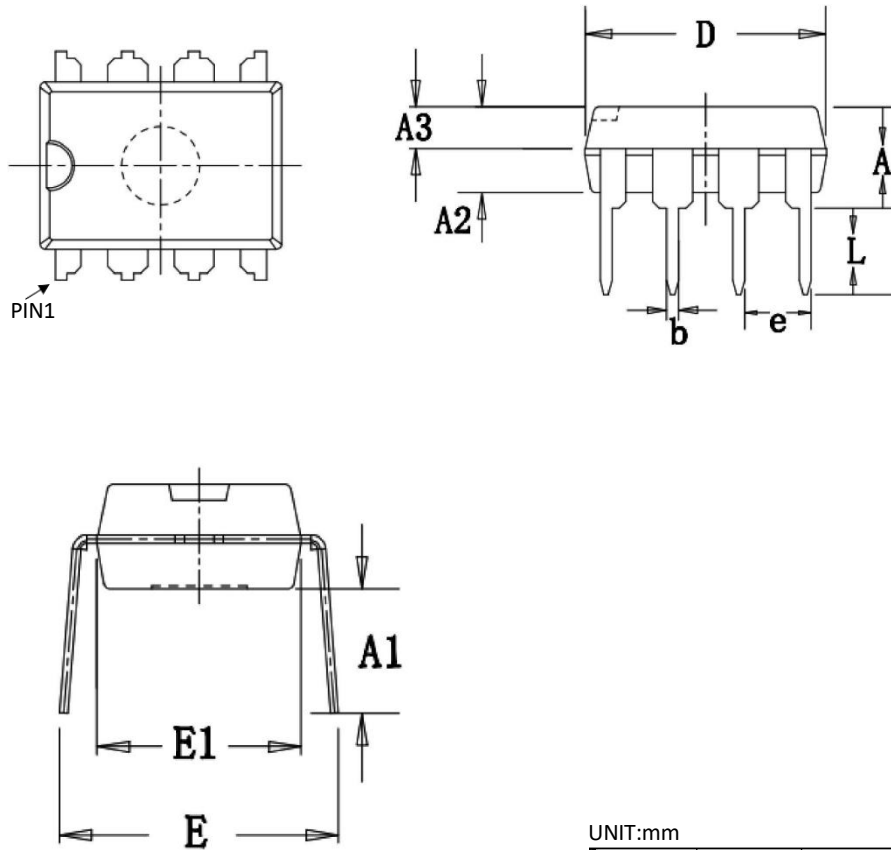
Ordering Information

PartNumber	Device Making	Package type	Body size (mm)	Temperate (°C)	MSL	Transpo Media	Package Quantit
XLOP27GSZ-REEL	XL27GS	SOP-8	4.90*3.90	-40 to +85	MSL3	T&R	2500
XLOP27GPZ	XL27GP	DIP-8	9.25*6.38	-40 to +85	MSL3	Tube 50	2000

18. DIMENSIONAL DRAWINGS



DIP8



UNIT:mm

	MIN	NOM	MAX
A	3.600	3.800	4.000
A1	3.786	3.886	3.986
A2	3.200	3.300	3.400
A3	1.550	1.600	1.650
b	0.440	—	0.490
e	2.510	2.540	2.570
D	9.150	9.250	9.350
E	7.800	8.500	9.200
E1	6.280	6.380	6.480
L	3.000	—	—