High Precision Operational Amplifiers

Description

The HXx277 series precision operational amplifiers replace the industry standard HX177. They offer improved noise, wider output voltage swing, and are twice as fast with half the quiescent current. Features include ultralow offset voltage and drift, low bias current, high common-mode rejection, and high power supply rejection. Single, dual, and quad versions have identical specifications, for maximum design flexibility.

HXx277 series operational amplifiers operate from ±2-V to ±18-V supplies with excellent performance. Unlike most operational amplifiers which are specified at only one supply voltage, the HXx277 series is specified for real-world applications; a single limit applies over the ±5-V to ±15-V supply range. High performance is maintained as the amplifiers swing to their specified limits. Because the initial offset voltage (±100μV maximum) is so low, user adjustment is usually not required. However, the single version (HX277) provides external trim pins for special applications.

HX277 operational amplifiers are easy to use and free from phase inversion and the overload problems found in some other operational amplifiers. They are stable in unity gain and provide excellent dynamic behavior over a wide range of load conditions. Dual and quad versions feature completely independent circuitry for lowest crosstalk and freedom from interaction, even when overdriven or overloaded.

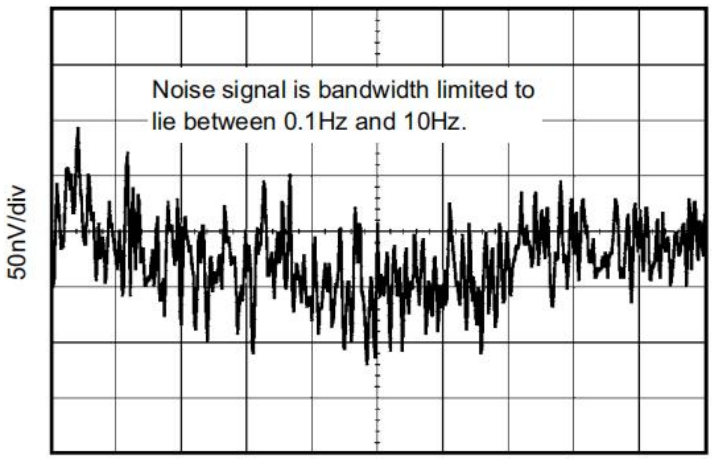
Features

- Ultralow Offset Voltage: 10 μV
- Ultralow Drift: ±0.1 μV/°C
- High Open-Loop Gain: 134 dB
- High Common-Mode Rejection: 140 dB
- High Power Supply Rejection: 130 dB
- Low Bias Current: 1-nA maximum
- Wide Supply Range: ±2 V to ±18 V
- Low Quiescent Current: 800 μA/amplifier
- Single, Dual, and Quad Versions

Applications

- Transducer Amplifiers
- Bridge Amplifiers
- Temperature Measurements
- Strain Gage Amplifiers
- Precision Integrators
- Battery-Powered Instruments
- Test Equipment

0.1 Hz to 10 Hz Noise

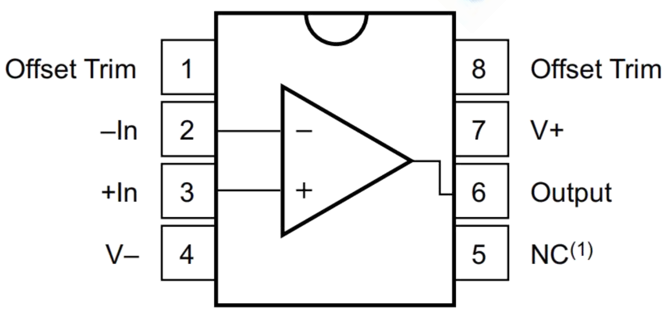


ORDERING INFORMATION

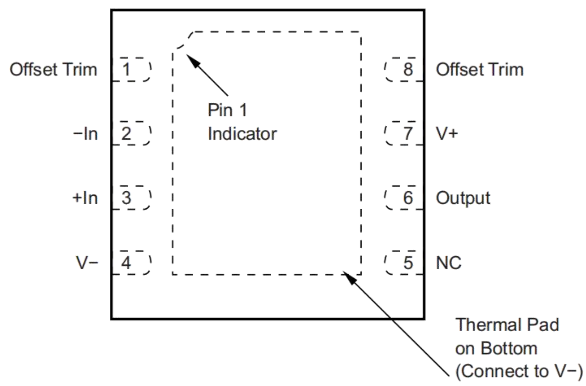
DEVICE	Package Type	MARKING	Packing	Packing Qty
HX277UPG	DIP8L	A277U	TUBE	2000pcs/box
HX277UAPG	DIP8L	A277UA	TUBE	2000pcs/box
HX277PG	DIP8L	A277	TUBE	2000pcs/box
HX277UDRG	SOP-8L	A277U	REEL	2500pcs/reel
HX277UADRG	SOP-8L	A277UA	REEL	2500pcs/reel
HX277DRG	SOP-8L	A277	REEL	2500pcs/reel
HX277UDQRG	DFN-8 4*4	A277U	REEL	3000pcs/reel
HX277UADQRG	DFN-8 4*4	A277UA	REEL	3000pcs/reel
HX277DQRG	DFN-8 4*4	A277	REEL	3000pcs/reel
HX2277UPG	DIP8L	A2277U	TUBE	2000pcs/box
HX2277UAPG	DIP8L	A2277UA	TUBE	2000pcs/box
HX2277PG	DIP8L	A2277	TUBE	2000pcs/box
HX2277UDRG	SOP-8L	A2277U	REEL	2500pcs/reel
HX2277UADRG	SOP-8L	A2277UA	REEL	2500pcs/reel
HX2277DRG	SOP-8L	A2277	REEL	2500pcs/reel
HX2277UDQRG	DFN-8 4*4	A2277U	REEL	3000pcs/reel
HX2277UADQRG	DFN-8 4*4	A2277UA	REEL	3000pcs/reel
HX2277DQRG	DFN-8 4*4	A2277	REEL	3000pcs/reel
HX4277PG	DIP14L	HX4277	TUBE	1000pcs/box
HX4277DRG	SOP14L	HX4277	REEL	2500pcs/reel
HX4277PWRG	TSSOP14L	A4277	REEL	2500pcs/reel

Pin Configuration and Functions

8-Pin DIP and SOP



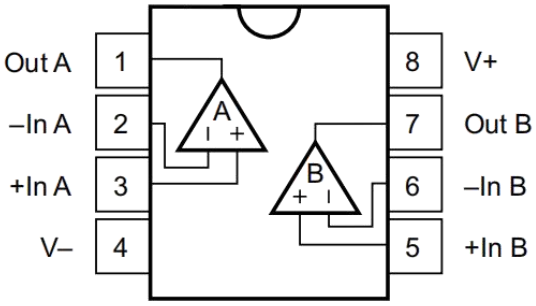
8-Pin DFN



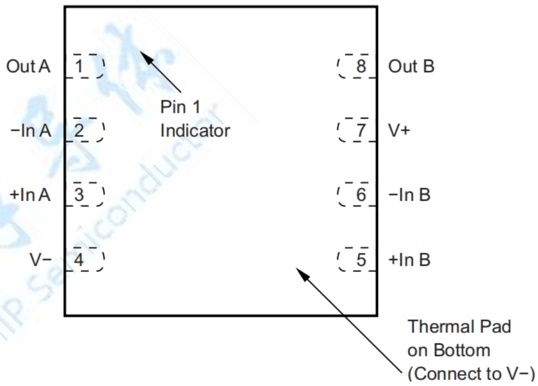
Pin Functions: HX277

PIN			I/O	DESCRIPTION
NAME	DIP, SOP NO.	DFN NO.		
Out A	1	1	O	Output channel A
–In A	2	2	I	Inverting input channel A
+In A	3	3	I	Noninverting input channel A
V–	4	4	—	Negative (lowest) power supply
+In B	5	5	I	Noninverting input channel B
–In B	6	6	I	Inverting input channel B
Out B	7	8	O	Output channel B
V+	8	7	—	Positive (highest) power supply

8-Pin DIP and SOP



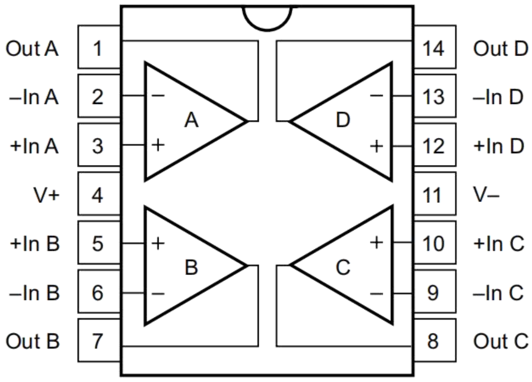
8-Pin QF



Pin Functions: HX2277

PIN			I/O	DESCRIPTION
NAME	DIP, SOP NO.	DFN NO.		
Out A	1	1	O	Output channel A
–In A	2	2	I	Inverting input channel A
+In A	3	3	I	Noninverting input channel A
V–	4	4	—	Negative (lowest) power supply
+In B	5	5	I	Noninverting input channel B
–In B	6	6	I	Inverting input channel B
Out B	7	8	O	Output channel B
V+	8	7	—	Positive (highest) power supply

14 Pins DIP, and TSSOP



Pin Functions: HX4277

PIN		I/O	DESCRIPTION
NO.	NAME		
1	Out A	O	Output channel A
2	–In A	I	Inverting input channel A
3	+In A	I	Noninverting input channel A
4	V+	—	Positive (highest) power supply
5	+In B	I	Noninverting input channel B
6	–In B	I	Inverting input channel B
7	Out B	O	Output channel B
8	Out C	O	Output channel C
9	–In C	I	Inverting input channel C
10	+In C	I	Noninverting input channel C
11	V–	—	Negative (lowest) power supply
12	+In D	I	Noninverting input channel D
13	–In D	I	Inverting input channel D
14	Out D	O	Output channel D

Specifications

Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)

	MIN	MAX	UNIT
Supply voltage, Vs = (V+) – (V–)		36	V
Input voltage	(V–) –0.7	(V+) +0.7	V
Output short-circuit(2)	Continuous		
Operating temperature	–20	85	°C
Junction temperature		150	°C
Lead temperature		300	°C
Storage temperature, T_{stg}	–20	125	°C

1. Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
2. Short-circuit to ground, one amplifier per package.

ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±2000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101(2)	±500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

	MIN	NOM	MAX	UNIT
Supply voltage, Vs = (V+) – (V–)	4(±2)	30(±15)	36(±18)	V
Specified temperature	–20		+85	°C

Thermal Information for HX277

THERMAL METRIC(1)		HX277			UNIT
		N (DIP)	M (SOP)	DQ(DFN)	
		8 PINS			
RθJA	Junction-to-ambient thermal resistance	49.2	110.1	40.7	°C/W
RθJC(top)	Junction-to-case (top) thermal resistance	39.4	52.2	41.3	°C/W
RθJB	Junction-to-board thermal resistance	26.4	52.3	16.7	°C/W
ΨJT	Junction-to-top characterization parameter	15.4	10.4	0.6	°C/W
ΨJB	Junction-to-board characterization parameter	26.3	51.5	16.9	°C/W
RθJC(bot)	Junction-to-case (bottom) thermal resistance	—	—	3.3	°C/W

1. For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application report, SPRA953.

Thermal Information for HX2277

THERMAL METRIC[1]		HX2277 N (DIP)	HX2277 M (SOP)	HX2277 MT (TSSOP)	UNIT
		8 PINS			
$R_{\theta JA}$	Junction-to-ambient thermal resistance	47.2	107.4	39.3	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	36.0	45.8	36.9	°C/W

1. For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application report, SPRA953.

Thermal Information for HX2277(continued)

THERMAL METRIC[1]		HX2277 N (DIP)	HX2277 M (SOP)	HX2277 DQ (DFN)	UNIT
		8 PINS			
$R_{\theta JB}$	Junction-to-board thermal resistance	24.4	47.9	15.4	°C/W
ψ_{JT}	Junction-to-top characterization parameter	13.4	5.7	0.4	°C/W
ψ_{JB}	Junction-to-board characterization parameter	24.3	47.3	15.6	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	—	—	2.2	°C/W

Thermal Information for HX4277

THERMAL METRIC[1]		HX4277 N (DIP)	HX4277 M (SOP)	UNIT
		14 PINS		
RθJA	Junction-to-ambient thermal resistance	67.0	66.3	°C/W
RθJC(top)	Junction-to-case (top) thermal resistance	24.1	20.5	°C/W
RθJB	Junction-to-board thermal resistance	22.5	26.8	°C/W
ΨJT	Junction-to-top characterization parameter	2.2	2.1	°C/W
ΨJB	Junction-to-board characterization parameter	22.1	26.2	°C/W
RθJC(bot)	Junction-to-case (bottom) thermal resistance	—	—	°C/W

1. For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application report, SPRA953.

Electrical Characteristics

At TA = 25°C, and RL = 2 kΩ, unless otherwise noted

PARAMETER		TEST CONDITIONS	HX277U,UA HX2277U,UA			HX277 HX2277 HX4277			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
OFFSET VOLTAGE									
V_{OS} Input Offset Voltage				±10	±50		±100	±250	μV
Input Offset Voltage Over Temperature	HX277U HX2277U	T_A = –20°C to 85°C			±20				μV
	HX277UA HX2277UA		±20		±50				
	All Versions							±250	
dV_{OS}/dT Input Offset Voltage Drift	HX277U (high-grade, single)	T_A = –20°C to 85°C		±0.1	±0.15				μV/°C
	HX2277U (high-grade, dual)			±0.1	±0.25				
	All AIDRM Versions						±0.15	±1	
Input Offset Voltage: (all models)	vs Time			0.2			See(1)		μV/mo
	vs Power Supply (PSRR)	V_S = ±2 V to ±18V		±0.3	±0.5		See(1)	±1	μV/V
		T_A = –20°C to 85°C			±0.5			±1	
Channel Separation (dual, quad)		DC		0.1			See(1)		μV/V

(1) VS = ±15 V

(2) Specifications are the same as HX277U

Electrical Characteristics (continued)

At T_A = 25°C, and R_L = 2 kΩ, unless otherwise noted

<table>
<tr><th rowspan="2">PARAMETER</th><th rowspan="2"></th><th rowspan="2">TEST CONDITIONS</th><th colspan="3">HX277U,UA HX2277U,UA</th><th colspan="3">HX277 HX2277 HX4277</th><th rowspan="2">UNIT</th></tr>
<tr><th>MIN</th><th>TYP</th><th>MAX</th><th>MIN</th><th>TYP</th><th>MAX</th></tr>
<tr><td colspan="10">INPUT BIAS CURRENT</td></tr>
<tr><td rowspan="2">I_B Input Bias Current</td><td rowspan="2"></td><td rowspan="2">T_A = –20°C to85°C</td><td></td><td>±0.5</td><td>±1</td><td></td><td>See (2)</td><td>±2.8</td><td rowspan="2">nA</td></tr>
<tr><td></td><td></td><td>±2</td><td></td><td></td><td>±4</td></tr>
<tr><td rowspan="2">I_{OS} Input Offset Current</td><td rowspan="2"></td><td rowspan="2">T_A = –20°C to85°C</td><td></td><td>±0.5</td><td>±1</td><td></td><td>See (2)</td><td>±2.8</td><td rowspan="2">nA</td></tr>
<tr><td></td><td></td><td>±2</td><td></td><td></td><td>±4</td></tr>
<tr><td colspan="10">NOISE</td></tr>
<tr><td colspan="2">Input Voltage Noise, f = 0.1 to 10 Hz</td><td></td><td></td><td>0.22</td><td></td><td></td><td>See (2)</td><td></td><td>μVPP</td></tr>
<tr><td rowspan="4">Input Voltage Noise Density</td><td>f = 10 Hz</td><td rowspan="4"></td><td></td><td>12</td><td></td><td></td><td>See (2)</td><td></td><td rowspan="4">nV/√Hz</td></tr>
<tr><td>f = 100 Hz</td><td></td><td>8</td><td></td><td></td><td>See (2)</td><td></td></tr>
<tr><td>f = 1 kHz</td><td></td><td>8</td><td></td><td></td><td>See (2)</td><td></td></tr>
<tr><td>f = 10 kHz</td><td></td><td>8</td><td></td><td></td><td>See (2)</td><td></td></tr>
<tr><td colspan="2">I_n Current Noise Density, f = 1 kHz</td><td></td><td></td><td>0.2</td><td></td><td></td><td>See (2)</td><td></td><td>pA/√Hz</td></tr>
<tr><td colspan="10">INPUT VOLTAGE RANGE</td></tr>
<tr><td colspan="2">V_{CM} Common-Mode Voltage Range</td><td></td><td>(V–)+2</td><td></td><td>(V+)–2</td><td>See (2)</td><td></td><td>See (2)</td><td>V</td></tr>
<tr><td rowspan="2">CMRR Common-Mode Rejection</td><td rowspan="2"></td><td>V_{CM} = (V–) +2 Vto (V+) –2 V</td><td>130</td><td>140</td><td></td><td>115</td><td>See (2)</td><td></td><td rowspan="2">dB</td></tr>
<tr><td>T_A = –20°C to85°C</td><td>128</td><td></td><td></td><td>115</td><td></td><td></td></tr>
<tr><td colspan="10">INPUT IMPEDANCE</td></tr>
<tr><td colspan="2">Differential</td><td></td><td></td><td>100 || 3</td><td></td><td></td><td>See (2)</td><td></td><td>MΩ || pF</td></tr>
<tr><td colspan="2">Common-Mode</td><td>V_{CM} = (V–) +2 Vto (V+) –2 V</td><td></td><td>250 || 3</td><td></td><td></td><td>See (2)</td><td></td><td>GΩ || pF</td></tr>
<tr><td colspan="10">OPEN-LOOP GAIN</td></tr>
<tr><td rowspan="2">A_{OL} Open-Loop Voltage Gain</td><td rowspan="2"></td><td>V_O = (V–)+0.5 V to (V+)–1.2 V,R_L = 10 kΩ</td><td></td><td>140</td><td></td><td></td><td>See (2)</td><td></td><td rowspan="2">dB</td></tr>
<tr><td>V_O = (V–)+1.5 Vto (V+)–1.5 V,R_L = 2 kΩ</td><td>126</td><td>134</td><td></td><td>See (2)</td><td>See (2)</td><td></td></tr>
<tr><td rowspan="2"></td><td rowspan="2"></td><td>V_O = (V–)+1.5 V to (V+)–1.5 V,R_L = 2 kΩ</td><td rowspan="2">126</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">See (2)</td><td rowspan="2"></td><td rowspan="2">dB</td></tr>
<tr><td>T_A = –20°C to85°C</td></tr>
<tr><td colspan="10">FREQUENCY RESPONSE</td></tr>
<tr><td colspan="2">GBW Gain-Bandwidth Product</td><td></td><td></td><td>1</td><td></td><td></td><td>See (2)</td><td></td><td>MHz</td></tr>
<tr><td colspan="2">SR Slew Rate</td><td></td><td></td><td>0.8</td><td></td><td></td><td>See (2)</td><td></td><td>V/μs</td></tr>
<tr><td rowspan="2">Settling Time</td><td>0.1%</td><td rowspan="2">V_S = ±15 V,G = 1, 10-V Step</td><td></td><td>14</td><td></td><td></td><td>See (2)</td><td></td><td rowspan="2">μs</td></tr>
<tr><td>0.01%</td><td></td><td>16</td><td></td><td></td><td>See (2)</td><td></td></tr>
<tr><td colspan="2">Overload Recovery Time</td><td>V_{IN} × G = V_S</td><td></td><td>3</td><td></td><td></td><td>See (2)</td><td></td><td>μs</td></tr>
<tr><td colspan="2">THD+N Total Harmonic Distortion+Noise</td><td>1 kHz, G = 1, V_O = 3.5 Vrms</td><td></td><td>0.002%</td><td></td><td></td><td>See (2)</td><td></td><td></td></tr>
</table>

Electrical Characteristics (continued)

At TA = 25°C, and RL = 2 kΩ, unless otherwise noted

PARAMETER	TEST CONDITIONS	HX277U,UA HX2277U,UA			HX277 HX2277 HX4277			UNIT
		MIN	TYP(1)	MAX	MIN	TYP	MAX	
OUTPUT								
V_O Voltage Output	R_L = 10 kΩ	(V–)+0.5		(V+)–1.2	See(2)		See(2)	V
	T_A = –20°C to +85°C	(V–)+0.5		(V+)–1.2	See(2)		See(2)	V
	R_L = 2 kΩ	(V–)+1.5		(V+)–1.5	See(2)		See(2)	V
	T_A = –20°C to +85°C	(V–)+1.5		(V+)–1.5	See(2)		See(2)	V
I_{SC} Short-Circuit Current		±35			See (2)			mA
C_{LOAD} Capacitive Load Drive		See (3)						
Z_O Open-loop output impedance	f = 1 MHz	40			See (2)			Ω
POWER SUPPLY								
V_S Specified Voltage Range		±5		±15	See(2)		See(2)	V
Operating Voltage Range		±2		±18	See(2)		See(2)	V
I_Q Quiescent Current (per amplifier)	I_O = 0		±790	±825		See(2	See(2)	μA
	T_A = –20°C to 85°C	±900					See(2)	μA
TEMPERATURE RANGE								
Specified Range		–20		85	See(2)		See(2)	°C
Operating Range		–20		125	See(2)		See(2)	°C

(3) See Typical Characteristics

Typical Characteristics

At TA = 25°C, VS = ±15 V, and RL = 2 kΩ, unless otherwise noted.

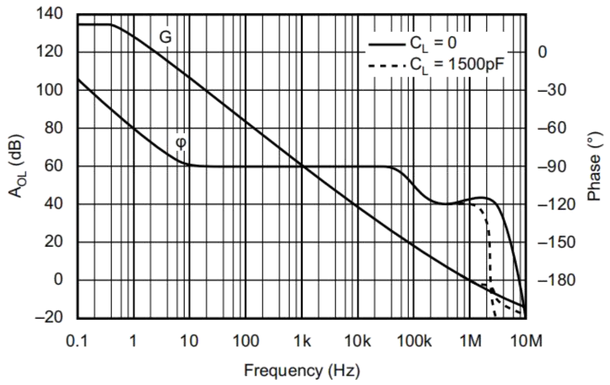


Figure 1. Open-Loop Gain and Phase vs Frequency

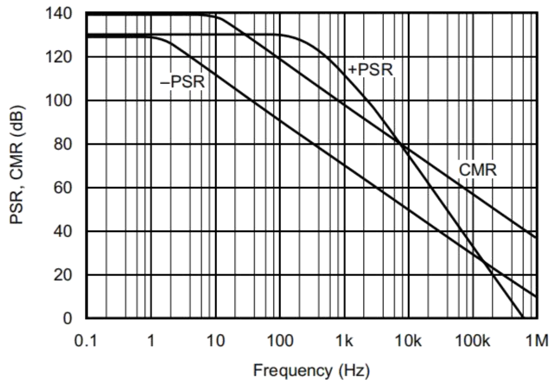


Figure 2. Power Supply and Common-Mod Rejection vs Frequency

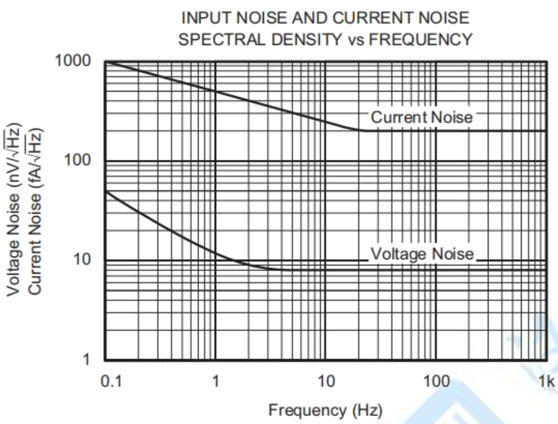


Figure 3. Input Noise and Current Noise Spectral Densityvs Frequency

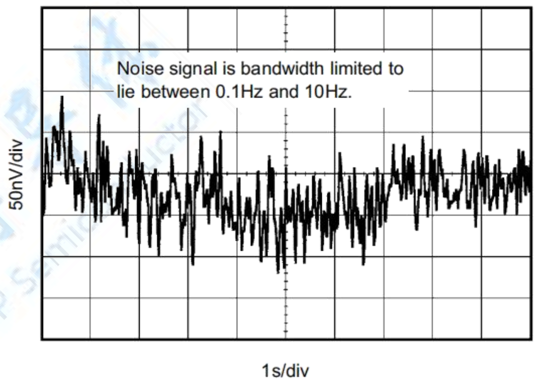


Figure 4. Input Noise Voltage vs Time

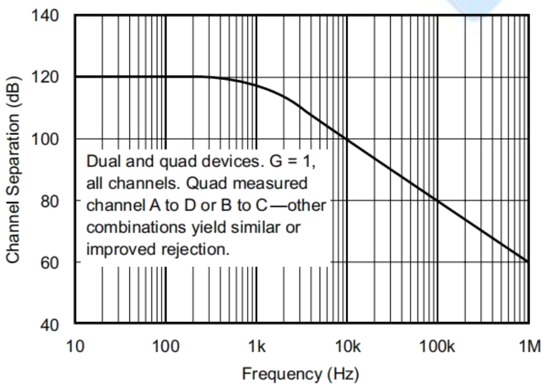


Figure 5. Channel Separation vs Frequency

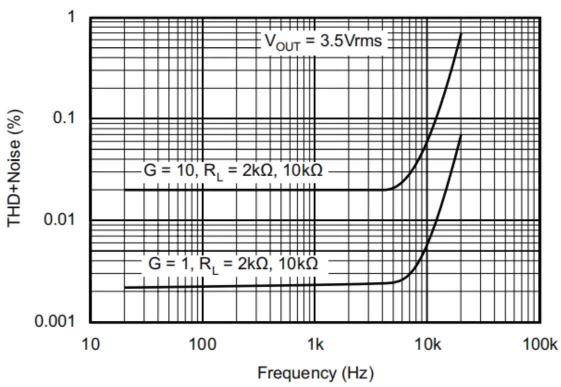


Figure 6. Total Harmonic Distortion + Noise vs Frequency

Typical Characteristics (continued)

At TA = 25°C, VS = ±15 V, and RL = 2 kΩ, unless otherwise noted.

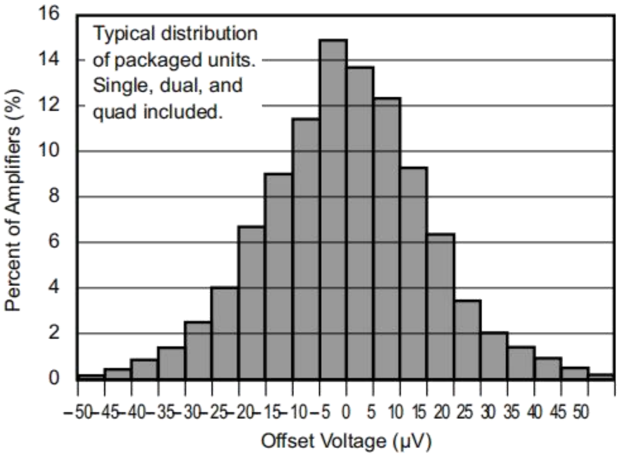


Figure 7. Offset Voltage Production Distribution

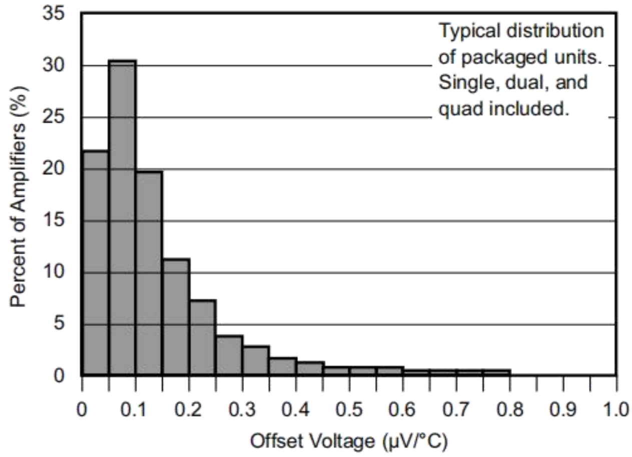


Figure 8. Offset Voltage Drift Production Distribution

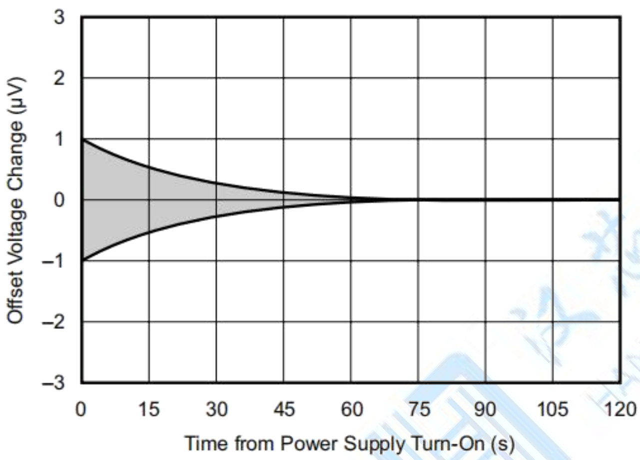


Figure 9. Warm-Up Offset Voltage Drift

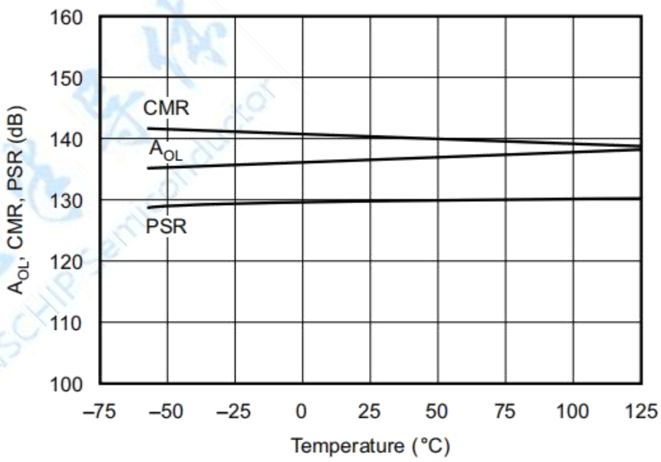


Figure 10. AOL, CMR, PSR vs Temperature

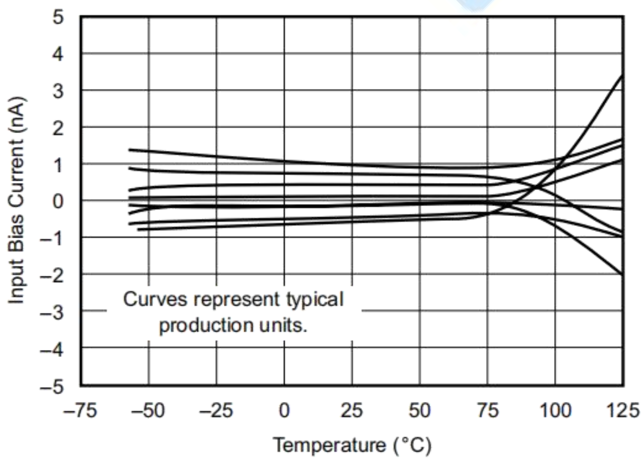


Figure 11. Input Bias Current vs Temperature

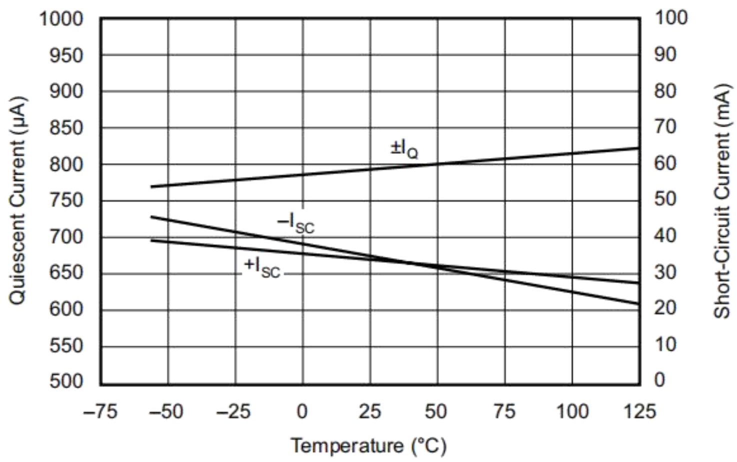


Figure 12. Quiescent Current and Short-Circuit Current vs Temperature

Typical Characteristics (continued)

At TA = 25°C, VS = ±15 V, and RL = 2 kΩ, unless otherwise noted.

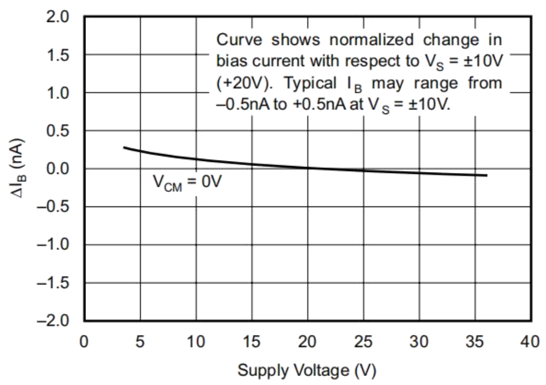


Figure 13. Change in Input Bias Current vs Power Supply Voltage

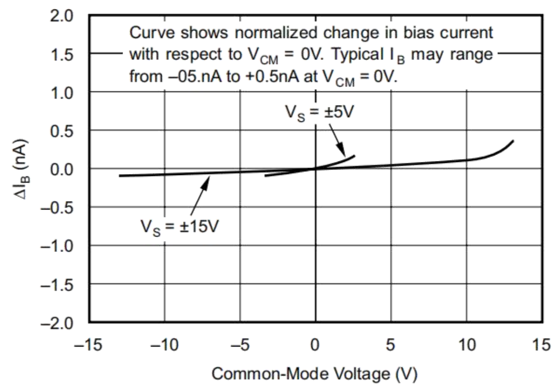


Figure 14. Change in Input Bias Current vs Common-Mode Voltage

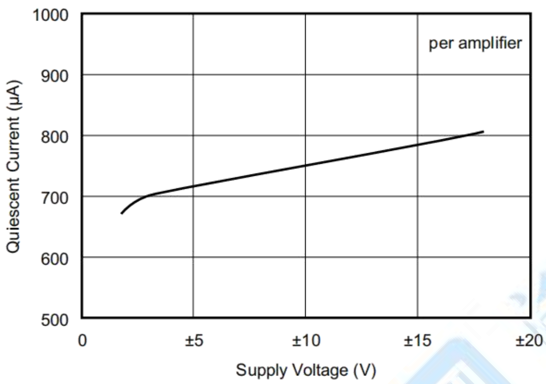


Figure 15. Quiescent Current vs Supply Voltage

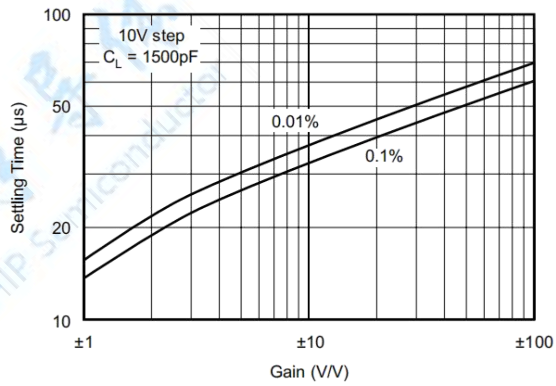


Figure 16. Settling Time vs Closed-Loop Gain

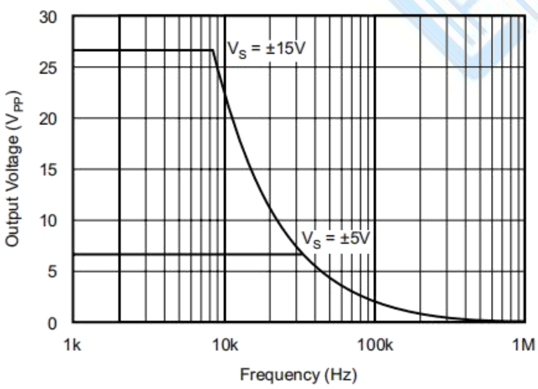


Figure 17. Maximum Output Voltage vs Frequency

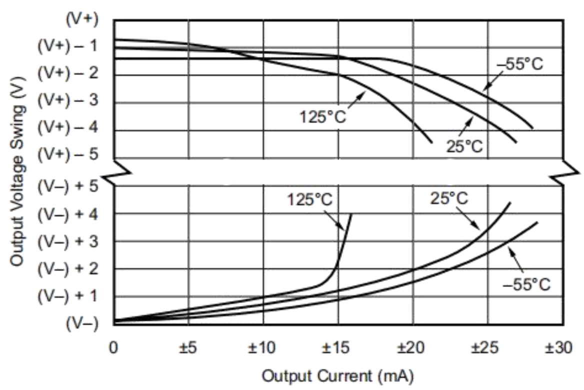


Figure 18. Output Voltage Swing vs Output Current

Typical Characteristics (continued)

At TA = 25°C, VS = ±15 V, and RL = 2 kΩ, unless otherwise noted.

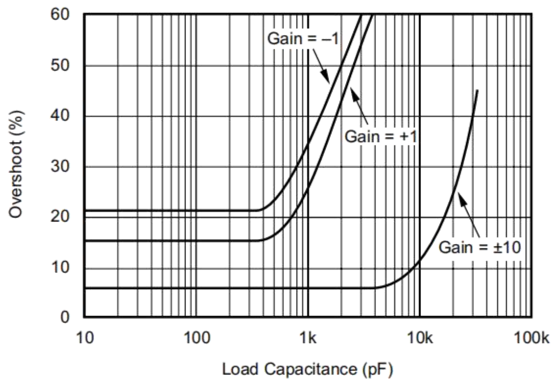


Figure 19. Small-Signal Overshoot vs Load Capacitance

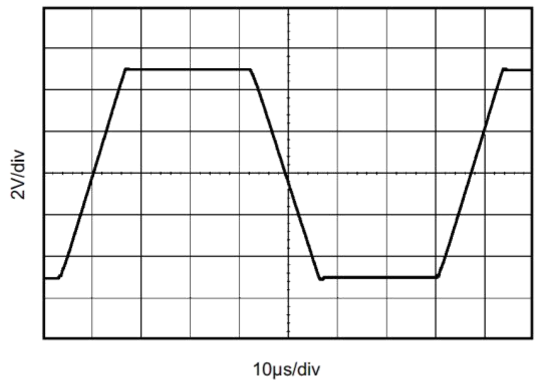


Figure 20. Large-Signal Step Response
G = 1, CL = 1500 pF, VS = ±15 V

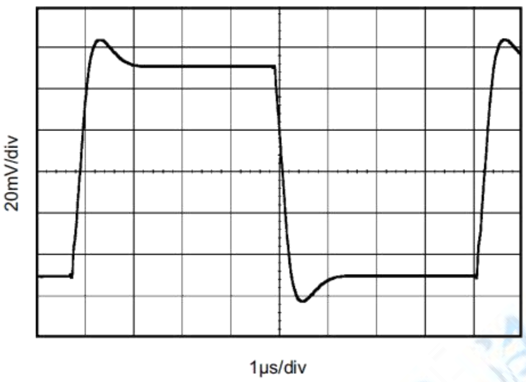


Figure 21. Small-Signal Step Response
G= +1, CL = 0, VS = ±15 V

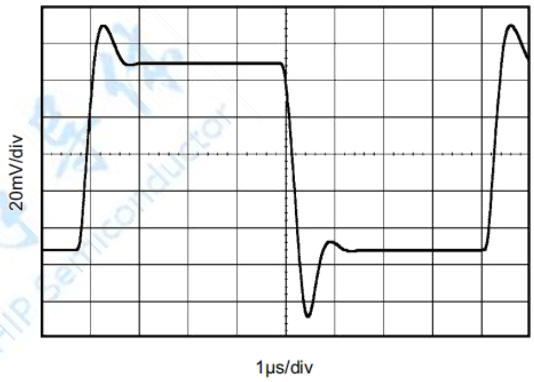


Figure 22. Small-Signal Step Response
G= 1, CL = 1500 pF, VS = ±15 V

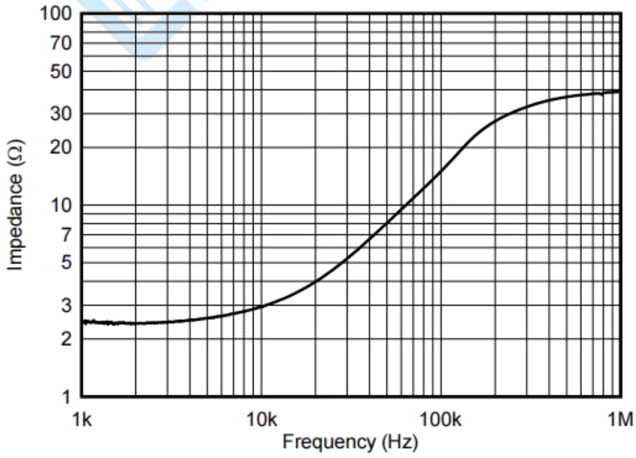


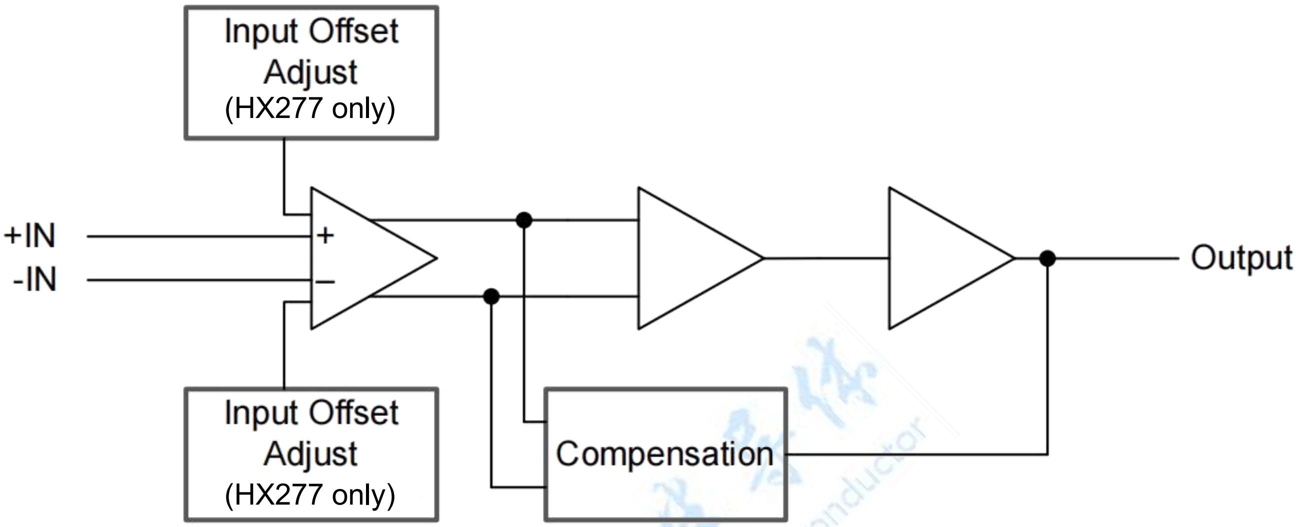
Figure 23. Open-Loop Output Impedance VS = ±15 V

Detailed Description

Overview

The HXx277series precision operational amplifiers replace the industry standard HX177.They offer improved noise, wider output voltage swing, and are twice as fast with half the quiescent current. Features include ultralow offset voltage and drift, low bias current, high common-mode rejection, and high power supply rejection. Single, dual, and quad versions have identical specifications, for maximum design flexibility.

Functional Block Diagram



Feature Description

The HXx277series is 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 0.1-μF capacitors are adequate.

The HXx277series has low offset voltage and drift. To achieve highest performance, the circuit layout and mechanical conditions should be optimized. Offset voltage and drift can be degraded by small thermoelectric potentials at the operational amplifier inputs. Connections of dissimilar metals generate thermal potential, which can degrade the ultimate performance of theHXx277series. These thermal potentials can be made to cancel by assuring that they are equal in both input terminals.

- Keep the thermal mass of the connections to the two input terminals similar
- Locate heat sources as far as possible from the critical input circuitry
- Shield operational amplifier and input circuitry from air currents, such as cooling fans

Operating Voltage

HXx277series operational amplifiers operate from ±2-V to ±18-V supplies with excellent performance. Unlike most operational amplifiers, which are specified at only one supply voltage, the HX277series is specified for real-world applications; a single limit applies over the ±5-V to ±15-V supply range. This allows a customer operating at VS = ±10 V to have the same assured performance as a customer using ±15-V supplies. In addition, key parameters are assured over the specified temperature range, –20°C to 85°C. Most behavior remains unchanged through the full operating voltage range (±2 V to ±18 V). Parameters which vary significantly with operating voltage or temperature are shown in Typical Characteristics.

Offset Voltage Adjustment

The HXx277series is laser-trimmed for low offset voltage and drift, so most circuits do not require external adjustment. However, offset voltage trim connections are provided on pins 1 and 8. Offset voltage can be adjusted by connecting a potentiometer, as shown in Figure 24. Only use this adjustment to null the offset of the operational amplifier. This adjustment should not be used to compensate for offsets created elsewhere in a system, because this can introduce additional temperature drift.

Feature Description (continued)

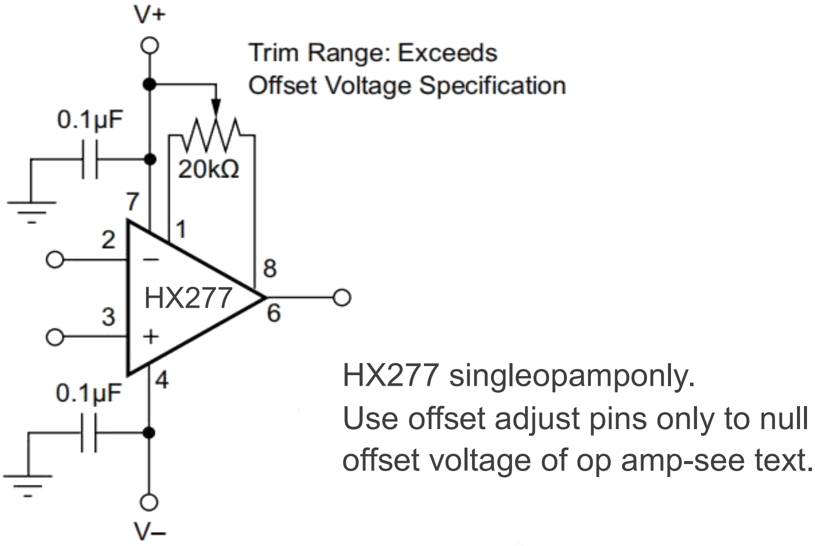


Figure 24. HX277 Offset Voltage Trim Circuit

Input Protection

The inputs of the HXx277series are protected with 1-kΩ series input resistors and diode clamps. The inputs can withstand ±30-V differential inputs without damage. The protection diodes conduct current when the inputs are over-driven. This may disturb the slewing behavior of unity-gain follower applications, but will not damage the operational amplifier.

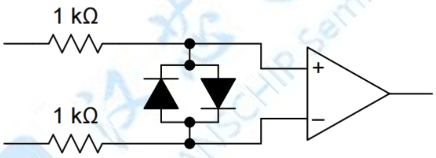


Figure 25. HXx277Input Protection

Input Bias Current Cancellation

The input stage base current of the HXx277series is internally compensated with an equal and opposite cancellation circuit. 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 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 often done with other operational amplifiers (see Figure 26). A resistor added to cancel input bias current errors may actually increase offset voltage and noise.

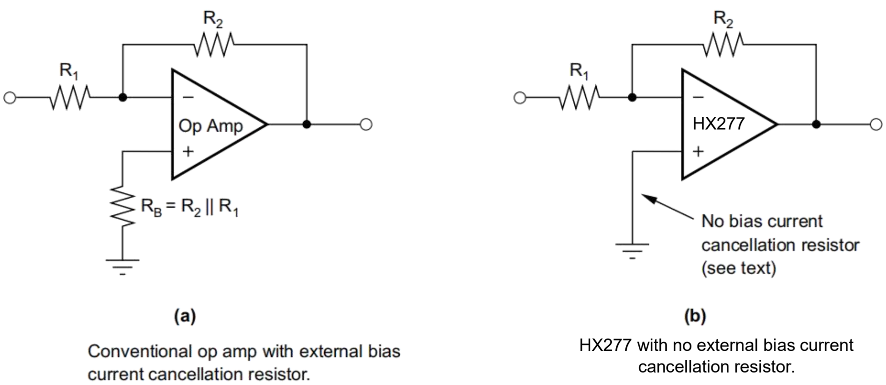


Figure 26. Input Bias Current Cancellation

EMI Rejection Ratio (EMIRR)

The electromagnetic interference (EMI) rejection ratio, or EMIRR, describes the EMI immunity of operational amplifiers. An adverse effect that is common to many operational amplifiers is a change in the offset voltage as a result of RF signal rectification. An operational amplifier that is more efficient at rejecting this change in offset as a result of EMI has a higher EMIRR and is quantified by a decibel value. Measuring EMIRR can be performed in many ways, but this report provides the EMIRR IN+, which specifically describes the EMIRR performance when the RF signal is applied to the noninverting input pin of the operational amplifier. In general, only the noninverting input is tested for EMIRR for the following three reasons:

1. Operational amplifier input pins are known to be the most sensitive to EMI, and typically rectify RF signals better than the supply or output pins.
2. The noninverting and inverting operational amplifier inputs have symmetrical physical layouts and exhibit nearly matching EMIRR performance.
3. EMIRR is easier to measure on noninverting pins than on other pins because the noninverting input terminal can be isolated on a printed circuit board (PCB). This isolation allows the RF signal to be applied directly to the noninverting input terminal with no complex interactions from other components or connecting PCB traces.

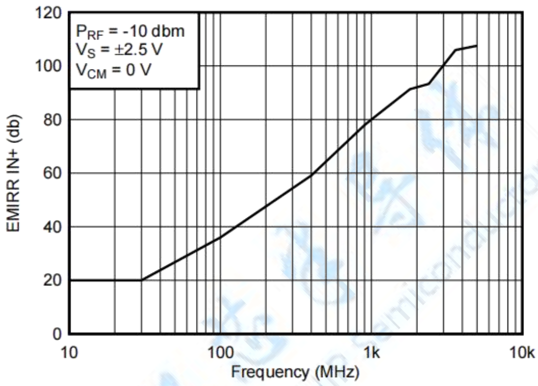


Figure 27. HX277 EMIRR IN+ vs Frequency

If available, any dual and quad operational amplifier device versions have nearly similar EMIRR IN+ performance. The HX277unity-gain bandwidth is 1 MHz. EMIRR performance below this frequency denotes interfering signals that fall within the operational amplifier bandwidth.

Feature Description (continued)

Table 1 shows the EMIRR IN+ values for theHX277at particular frequencies commonly encountered in real world applications. Applications listed in Table 1 may be centered on or operated near the particular frequency shown. This information may be of special interest to designers working with these types of applications, or working in other fields likely to encounter RF interference from broad sources, such as the industrial, scientific, and medical (ISM) radio band.

Table 1. HX277EMIRR IN+ for Frequencies of Interest

FREQUENCY	APPLICATION/ALLOCATION	EMIRR IN+
400 MHz	Mobile radio, mobile satellite/space operation, weather, radar, UHF	59.1 dB
900 MHz	GSM, radio com/nav./GPS (to 1.6 GHz), ISM, aeronautical mobile,UHF	77.9 dB
1.8 GHz	GSM, mobile personal comm. broadband, satellite, L-band	91.3 dB
2.4 GHz	802.11b/g/n, Bluetooth™, mobile personal comm., ISM, amateurradio/satellite, S-band	93.3 dB
3.6 GHz	Radiolocation, aero comm./nav., satellite, mobile, S-band	105.9 dB
5.0 GHz	802.11a/n, aero comm./nav., mobile comm., space/satelliteoperation, C-band	107.5 dB

EMIRR IN+ Test Configuration

Figure 28 shows the circuit configuration for testing the EMIRR IN+. An RF source is connected to the operational amplifier noninverting input terminal using a transmission line. The operational amplifier is configured in a unity gain buffer topology with the output connected to a low-pass filter (LPF) and a digital multimeter (DMM). Note that a large impedance mismatch at the operational amplifier input causes a voltage reflection; however, this effect is characterized and accounted for when determining the EMIRR IN+. The resulting dc offset voltage is sampled and measured by the multimeter. The LPF isolates the multimeter from residual RF signals that may interfere with multimeter accuracy. Refer to SBOA128 for more details.

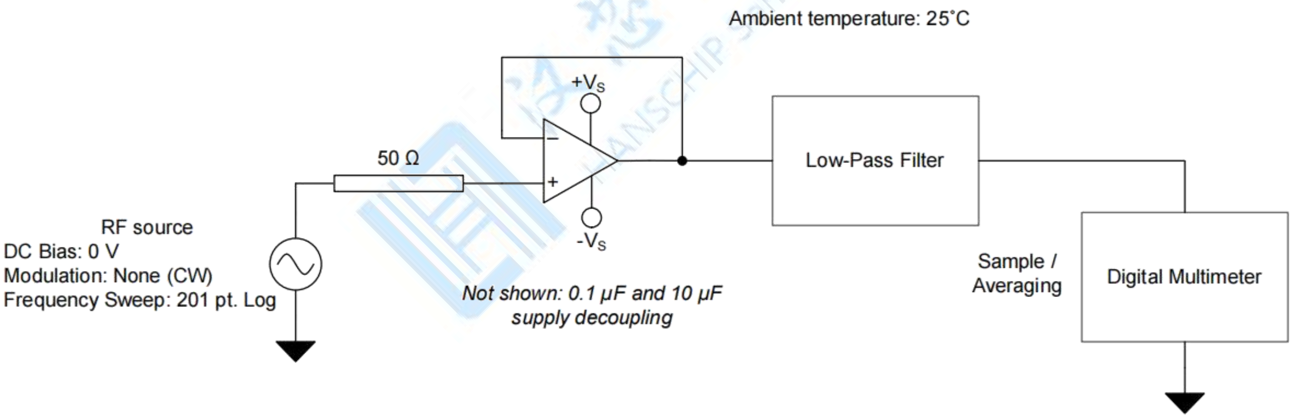


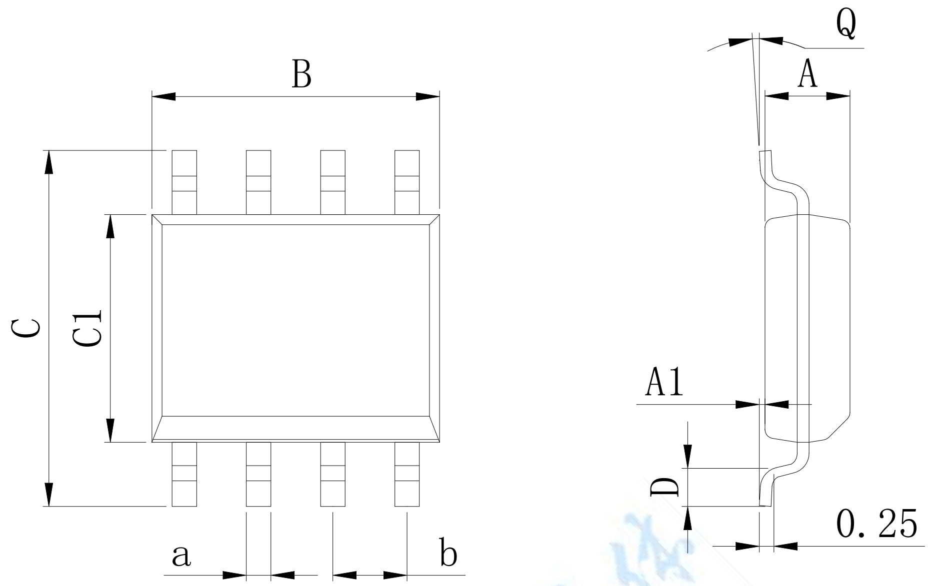
Figure 28. EMIRR IN+ Test Configuration Schematic

Device Functional Modes

TheHXx277has a single functional mode and is operational when the power-supply voltage is greater than 4V (±2 V). The maximum power supply voltage for the HXx277is 36 V (±18 V).

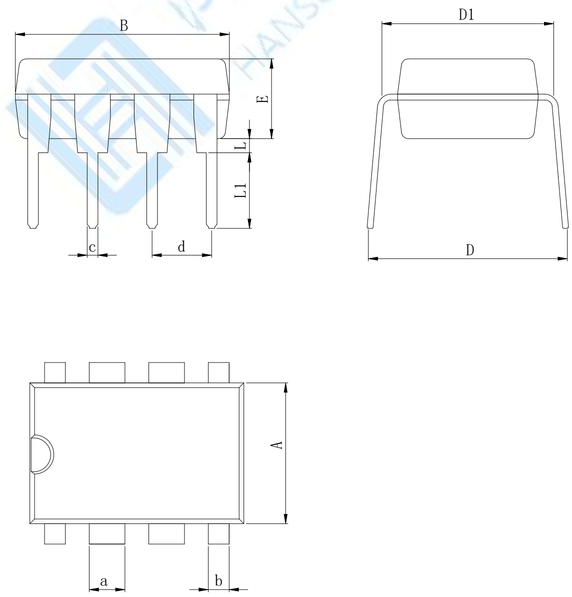
Physical Dimensions

SOP-8L 150mil



Dimensions In Millimeters(SOP8L)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	1.35	0.05	4.90	5.80	3.80	0.40	0°	0.35	1.27 BSC
Max:	1.55	0.20	5.10	6.20	4.00	0.80	8°	0.45	

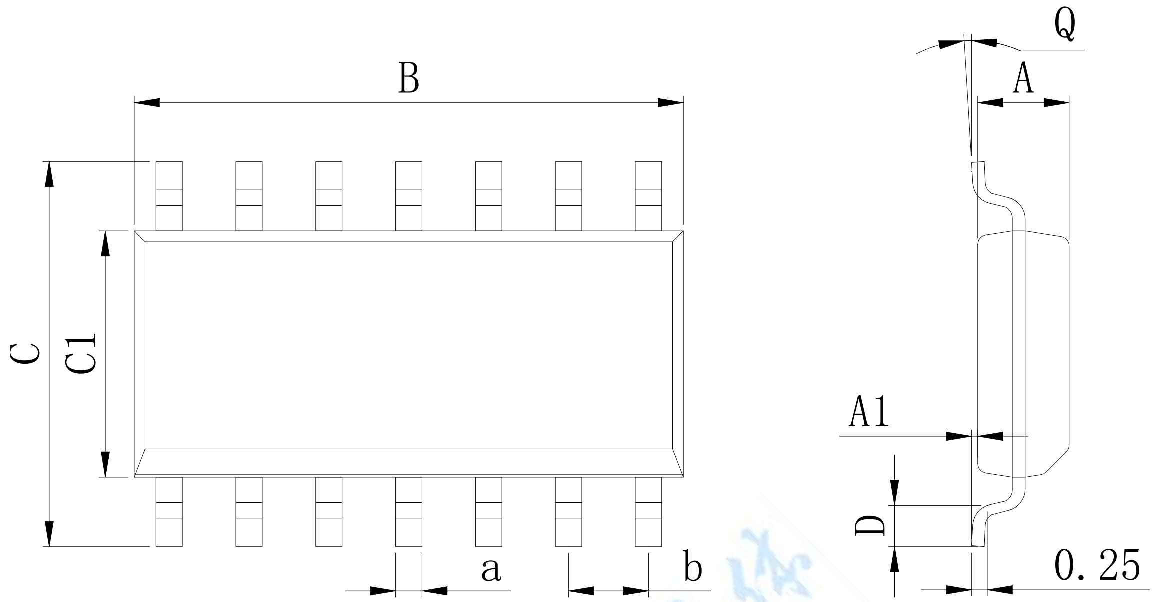
DIP-8L



Dimensions In Millimeters(DIP8L)											
Symbol:	A	B	D	D1	E	L	L1	a	b	c	d
Min:	6.10	9.00	8.40	7.42	3.10	0.50	3.00	1.50	0.85	0.40	2.54 BSC
Max:	6.68	9.50	9.00	7.82	3.55	0.70	3.60	1.55	0.90	0.50	

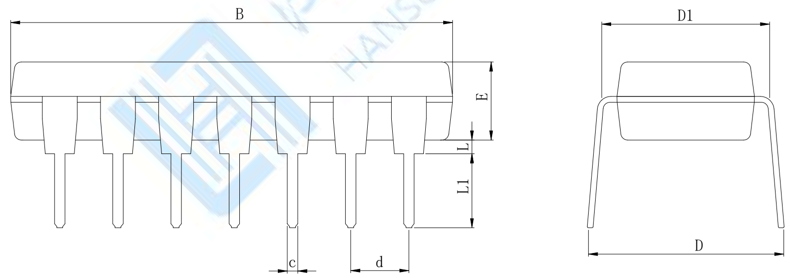
Physical Dimensions

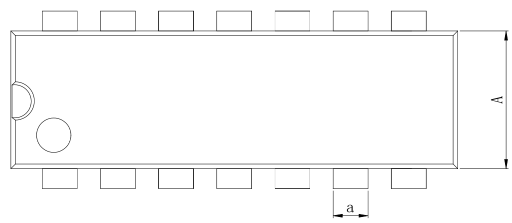
SOP14L



Dimensions In Millimeters(SOP14L)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	1.35	0.05	8.55	5.80	3.80	0.40	0°	0.35	1.27 BSC
Max:	1.55	0.20	8.75	6.20	4.00	0.80	8°	0.45	

DIP-14L

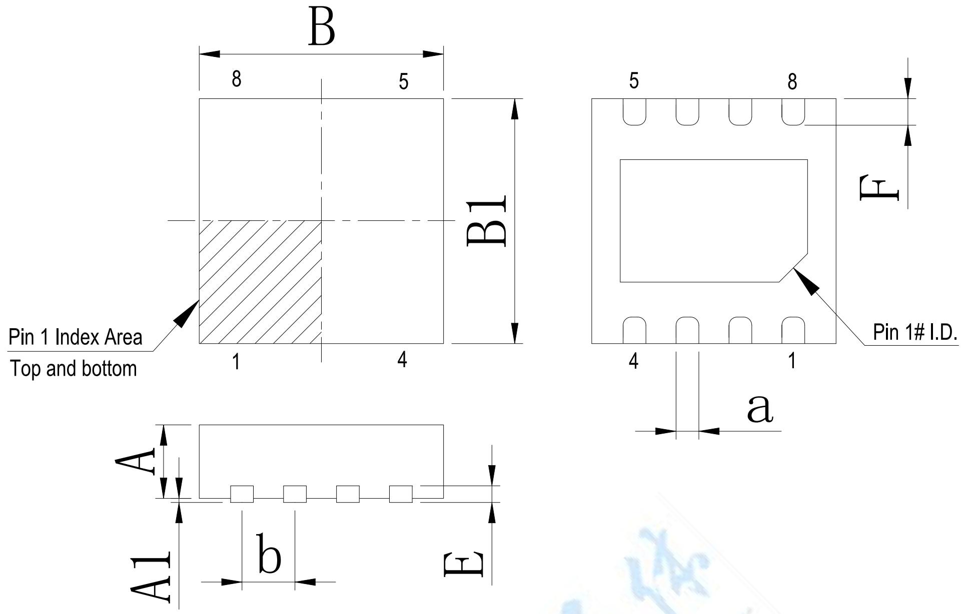




Dimensions In Millimeters(DIP14L)									
Symbol:	A	B	D	D1	E	L	L1	a	c	d
Min:	6.10	18.94	8.40	7.42	3.10	0.50	3.00	1.50	0.40	2.54 BSC
Max:	6.68	19.56	9.00	7.82	3.55	0.70	3.60	1.55	0.50	

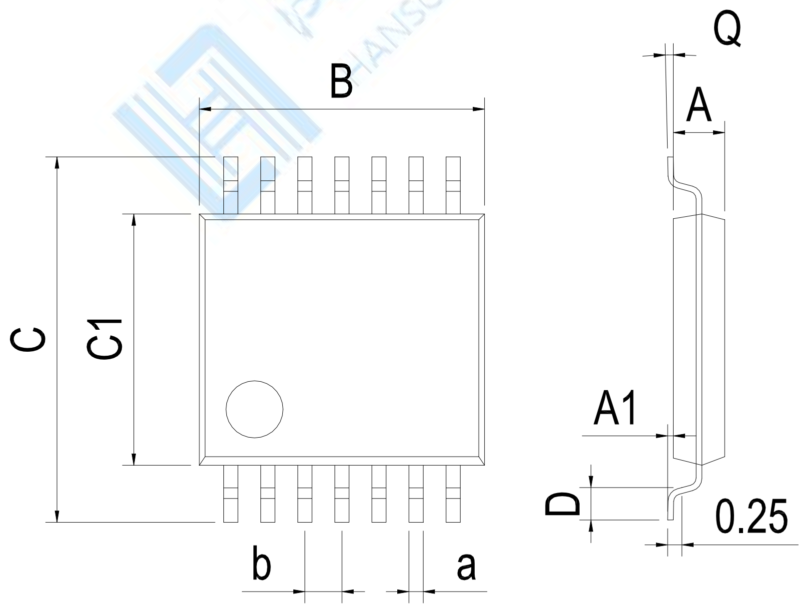
Physical Dimensions

DFN-8 4*4



Dimensions In Millimeters(DFN-8L 4*4)								
Symbol:	A	A1	B	D	E	F	a	a
Min:	3.9	3.9	0.80	0.0	0.23	0.30	0.20	0.80TYP
Max:	4.1	4.1	1.0	0.05	0.30	0.50	0.34	

TSSOP-14L



Dimensions In Millimeters(TSSOP14L)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	0.85	0.05	4.90	6.20	4.30	0.40	0°	0.20	0.65 BSC
Max:	0.95	0.20	5.10	6.60	4.50	0.80	8°	0.25	

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