1. DESCRIPTION

The XLRC4580 device is a dual operational amplifier that has been designed optimally for audio applications,such as improving tone control. It offers low noise,high gain bandwidth, low harmonic distortion, and high output current, all of which make the device ideally suited for audio electronics,such as preamplifiers, active filters, and industrial measurement equipment. When high output current is required, the XLRC4580 device can be used as a headphone amplifier. Due to its wide operating supply voltage, the XLRC4580 device can also be used in low- voltage applications.

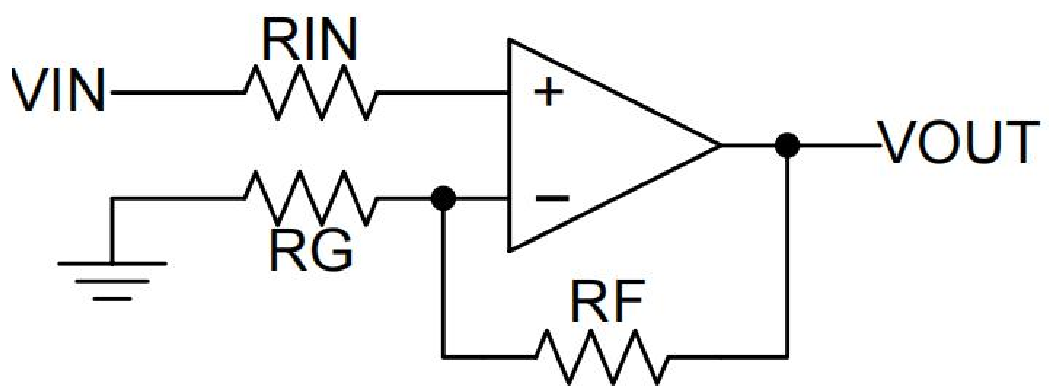
2. FEATURES

- ±2-V to ±18-V Operating Voltage
- 0.8-µVrms Low Noise Voltage
- 12-MHz Gain Bandwidth Product
- 0.0005% Total Harmonic Distortion
- 5-V/µs Slew Rate

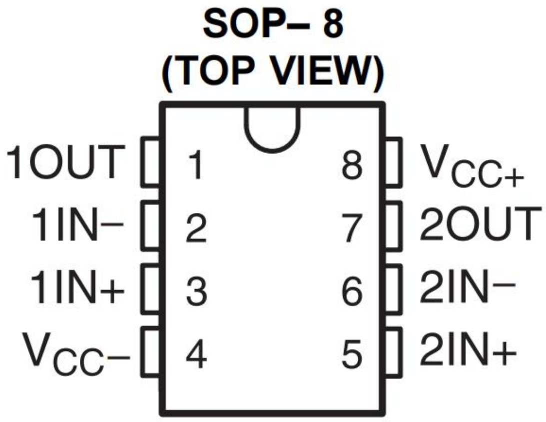
3. APPLICATIONS

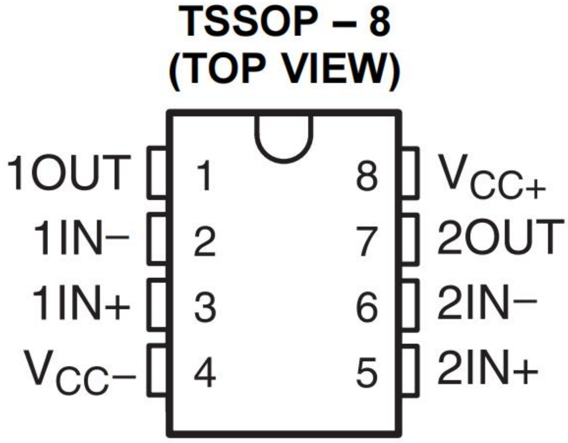
- Audio Preamplifiers
- Active Filters
- Headphone Amplifiers
- Industrial Measurement Equipment
- Noninverting Amplifier Schematic

Noninverting Amplifier Schematic



4. PIN CONFIGURATION AND FUNCTIONS





Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
1IN+	3	I	Noninverting input
1IN-	2	I	Inverting Input
1OUT	1	O	Output
2IN+	5	I	Noninverting input
2IN-	6	I	Inverting Input
2OUT	7	O	Output
V_{CC+}	8	—	Positive Supply
V_{CC-}	4	—	Negative Supply

5. SPECIFICAIONS

5.1. Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) (1)

		MIN	MAX	UNIT
V_{CC}	Supply voltage		±18	V
V_I	Input voltage (any input)		±15	V
V_{ID}	Differential input voltage		±30	V
I_O	Output current		±50	mA
T_A	Ambient temperature range	-40	85	°C
T_{stg}	Storage temperature range	-60	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.

5.2. Handling Ratings

			MIN	MAX	UNIT
Tstg	Storage temperature range		-60	125	°C
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins(1)	0	1000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins(2)	0	1000	

(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.

5.3. Recommended Operating Conditions

		MIN	MAX	UNIT
V_{CC+}	Supply voltage	2	16	V
V_{CC-}		-2	-16	
V_{ICR}	Input common-mode voltage range	-13.5	13.5	V
T_A	Operating free-air temperature	-40	85	°C

5.4. Thermal Information

THERMAL METRIC		XLRC4580		UNIT
		SOP	TSSOP	
		8 PINS	8 PINS	
$R_{θJA}$	Junction-to-ambient thermal resistance	109	163	°C/W
$R_{θJC(top)}$	Junction-to-case (top) thermal resistance	55.7	38	
$R_{θJB}$	Junction-to-board thermal resistance	49	90.6	
$ψ_{JT}$	Junction-to-top characterization parameter	10.6	1.3	
$ψ_{JB}$	Junction-to-board characterization parameter	48.6	88.9	
$R_{θJC(bot)}$	Junction-to-case (bottom) thermal resistance	—	—	

5.5. Electrical Characteristics

$V_{CC\pm}$ = ±15 V, T_A = –40°C to 85°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	R_S = < 10 kΩ		0.5	3	mV
I_{IO}	Input offset current			5	200	nA
I_{IB}	Input bias current			100	500	nA
A_{VD}	Large-signal differential voltage amplification	R_L ≥ 2 kΩ, V_O = ±10 V	90	110		dB
V_{CM}	Output voltage swing	R_L ≥ 2 kΩ	±12	±13.5		V
V_{ICR}	Common-mode input voltage		±12	±13.5		V
CMRR	Common-mode rejection ratio	R_S ≤ 10 kΩ	80	110		dB
k_{SVR}	Supply-voltage rejection ratio(1)	R_S ≤ 10 kΩ	80	110		dB
I_{CC}	Total supply current (all amplifiers)			6	9	mA

(1) Measured with VCC± varied simultaneously

5.6. Operating Characteristics

$V_{CC\pm}$ = ±15 V, T_A = –40°C to 85°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	TYP	UNIT
SR	Slew rate at unity gain	R_L ≥ 2 kΩ	5	V/µs
GBW	Gain-bandwidth product	f = 10 kHz	12	MHz
THD	Total harmonic distortion	V_O = 5 V, R_L = 2 kΩ, f = 1 kHz, A_{VD} = 20 dB	0.0005%	
V_n	Equivalent input noise voltage	RIAA, R_S ≤ 2.2 kΩ, 30-kHz LPF	0.8	µVrms

5.7. Typical Characteristics

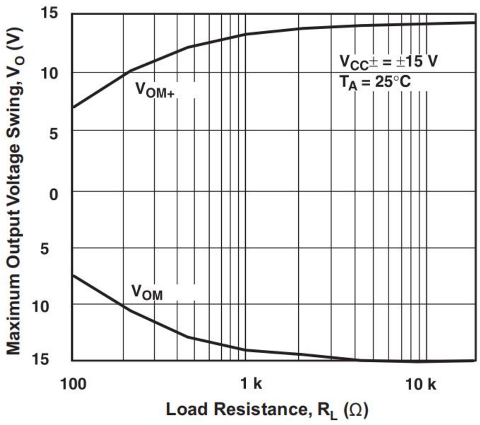


Figure 1. Maximum Output Voltage Swing vs Load Resistance

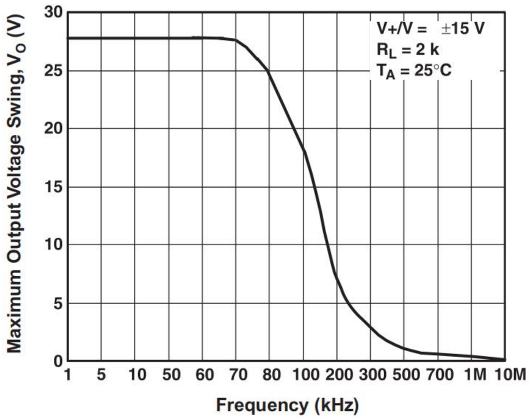


Figure 2. Maximum Ouput Voltage Swing vs Frequency

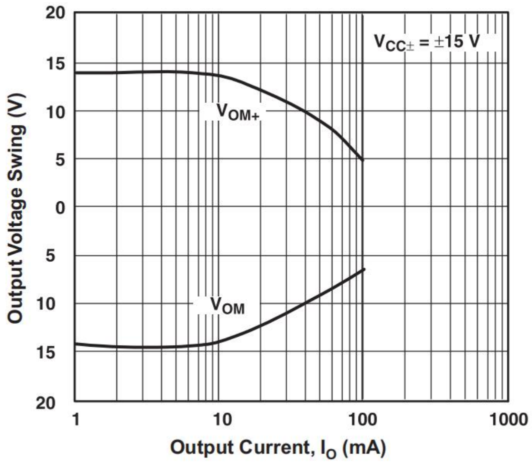


Figure 3. Output Voltage Swing vs Output Current

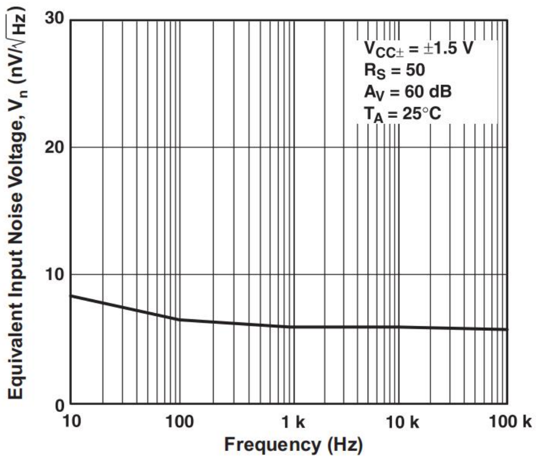


Figure 4. Equivalent Input Noise Voltage vs Frequency

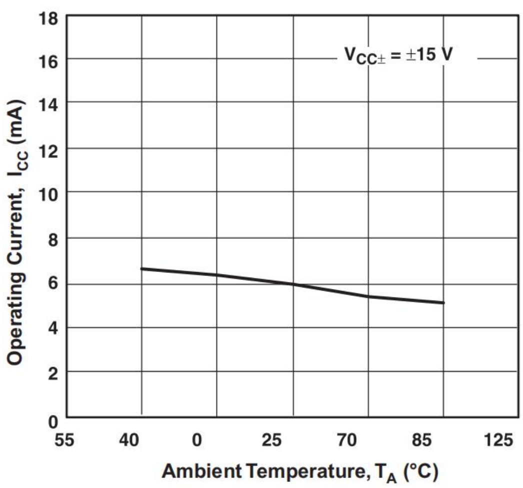


Figure 5. Operating Current vs Temperature

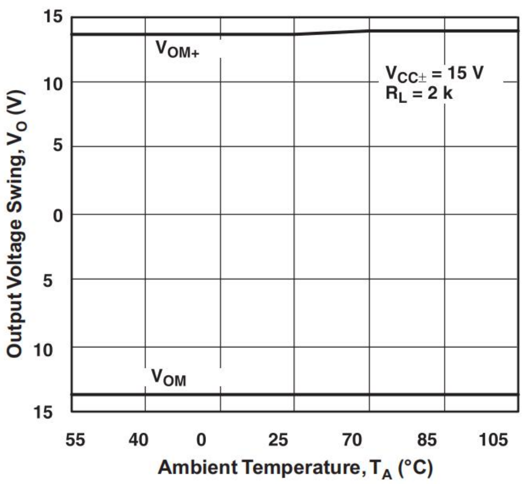


Figure 6. Output Voltage Swing vs Temperature

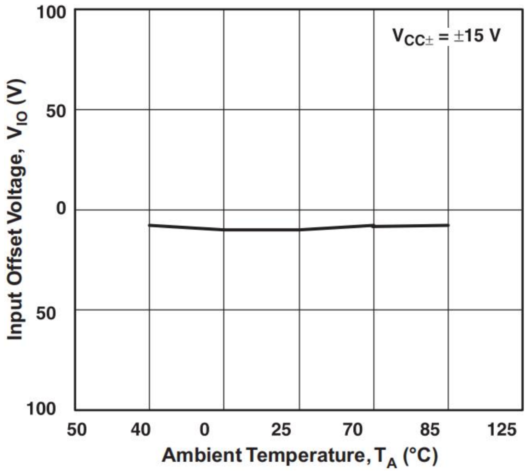


Figure 7. Input Offset Voltage vs Temperature

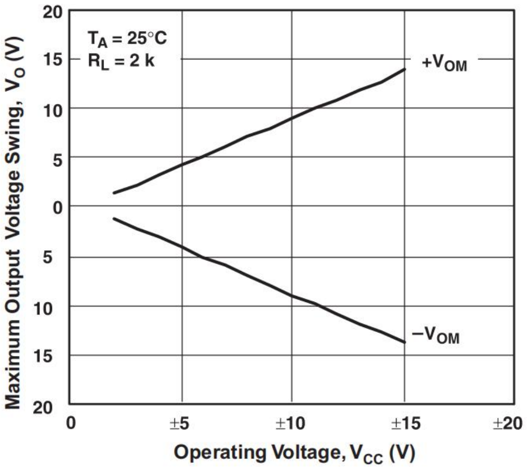


Figure 8. Input Bias Current vs Temperature

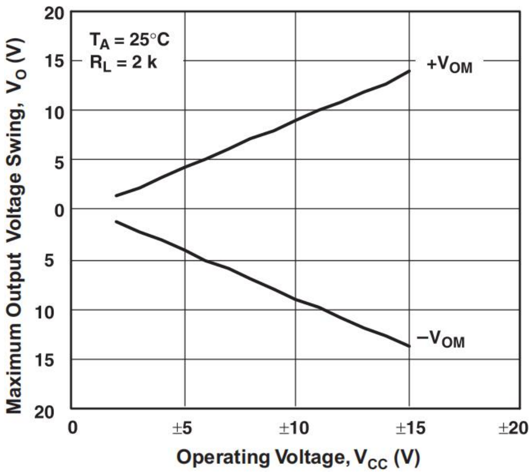


Figure 9. Maximum Output Voltage Swing vs Operating Voltage

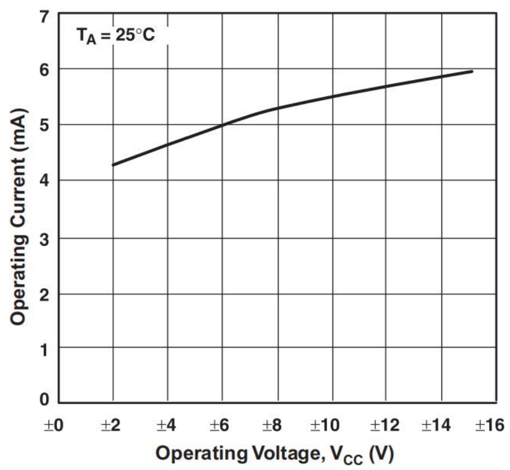


Figure 10. Operating Current vs Operating Voltage

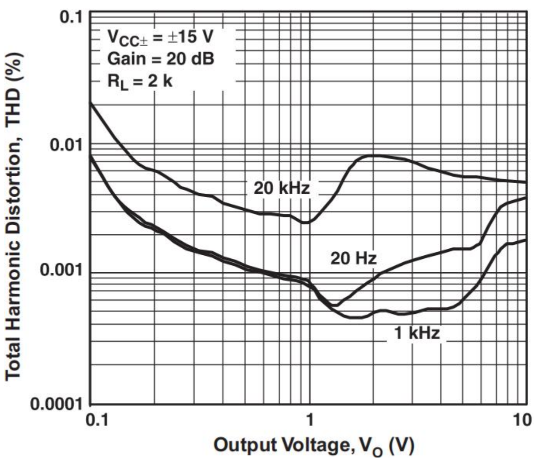


Figure 11. Total Harmonic Distortion vs Output Voltage

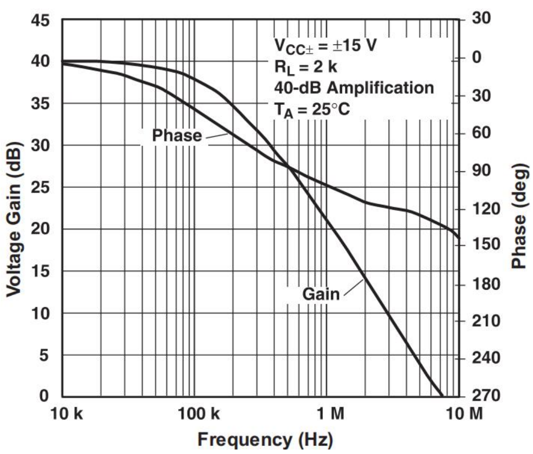


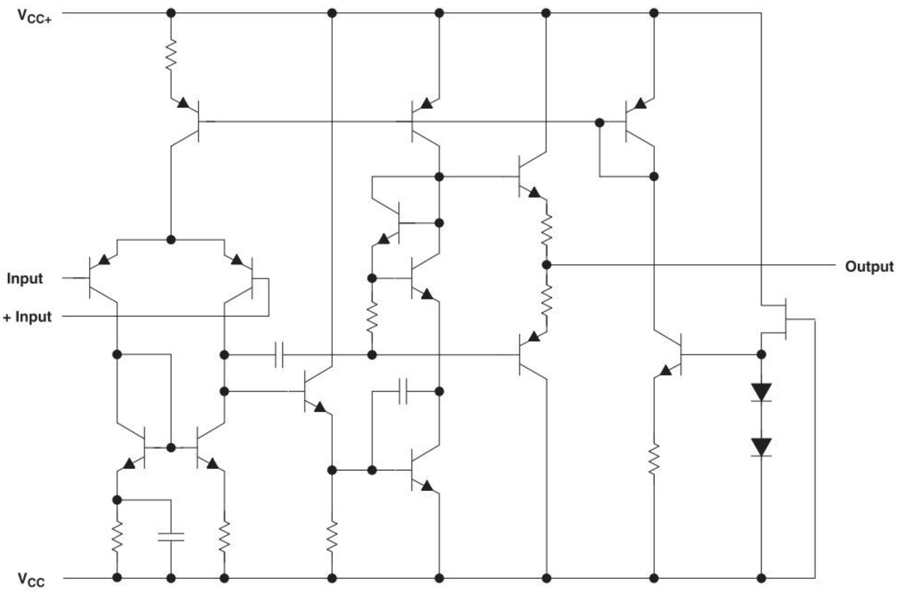
Figure 12. Voltage Gain, Phase vs Frequency

6. DETAILED DESCRIPTION

6.1. Overview

The XLRC4580 device is a dual operational amplifier that has been designed optimally for audio applications, such as improving tone control. It offers low noise, high gain bandwidth, low harmonic distortion, and high output current, all of which make the device ideally suited for audio electronics, such as preamplifiers, active filters, and industrial measurement equipment. When high output current is required, the XLRC4580 device can be used as a headphone amplifier. Due to its wide operating supply voltage, the XLRC4580 device can also be used in lowvoltage applications.

6.2. Functional Block Diagram



6.3. Feature Description

6.3.1. Unity-Gain Bandwidth

The unity-gain bandwidth is the frequency up to which an amplifier with a unity gain may be operated without greatly distorting the signal. The XLRC4580 device has a 12-MHz unity-gain bandwidth.

6.3.2. Common-Mode Rejection Ratio

The common-mode rejection ratio (CMRR) of an amplifier is a measure of how well the device rejects unwanted input signals common to both input leads. It is found by taking the ratio of the change in input offset voltage to the change in the input voltage, then converting to decibels. Ideally the CMRR is infinite, but in practice, amplifiers are designed to have it as high as possible. The CMRR of the XLRC4580 device is 110 dB.

6.3.3. Slew Rate

The slew rate is the rate at which an operational amplifier can change its output when there is a change on the input. The XLRC4580 device has a 5-V/ms slew rate.

6.3.4. Device Functional Mode

The XLRC4580 device is powered on when the supply is connected. Each device can be operated as a singlesupply operational amplifier or dual-supply amplifier depending on the application.

7. APPLICATION ADN LMPLEMENTATION

NOTE

Information in the following applications sections is not part of the XLD component specification, and XLD does not warrant its accuracy or completeness. XLD's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

7.1. Typical Application

Some applications require differential signals. Figure 13 shows a simple circuit to convert a single-ended input of 2 V to 10 V into differential output of ±8 V on a single 15-V supply. The output range is intentionally limited to maximize linearity. The circuit is composed of two amplifiers. One amplifier acts as a buffer and creates a voltage, V_{OUT+}. The second amplifier inverts the input and adds a reference voltage to generate V_{OUT-} . Both VOUT+ and VOUT– range from 2 V to 10 V. The difference, VDIFF, is the difference between V_{OUT+} and V_{OUT-} .

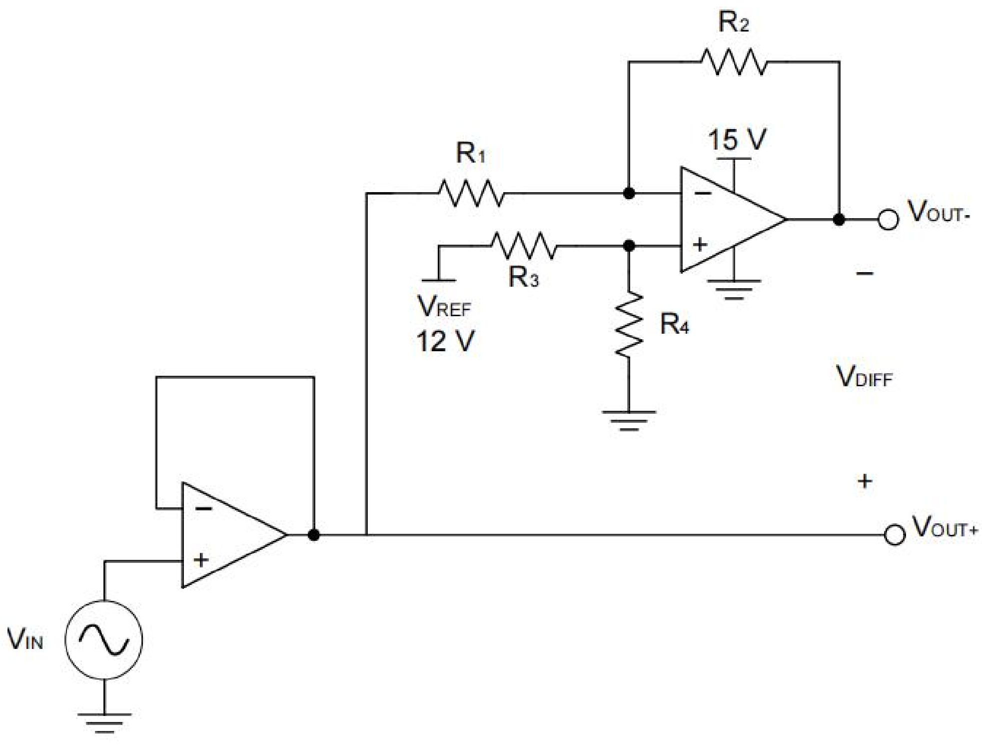


Figure 13. Schematic for Single-Ended Input to Differential Output Conversion

7.1.1. Design Requirements

The design requirements are as follows:

- Supply voltage: 15 V
- Reference voltage: 12V
- Input: 2 V to 10 V
- Output differential: ±8 V

7.1.2. Detailed Design Procedure

The circuit in Figure 13 takes a single-ended input signal, V_{IN}, and generates two output signals, V_{OUT+} and V_{OUT-} using two amplifiers and a reference voltage, VREF. V_{OUT+} is the output of the first amplifier and is a buffered version of the input signal, V_{IN} (see Equation 1). V_{OUT-} is the output of the second amplifier which uses VREF to add an offset voltage to V_{IN} and feedback to add inverting gain. The transfer function for V_{OUT-} is Equation 2.

$$V_{OUT+} = V_{IN} \tag{1}$$

$$V_{OUT-} = V_{REF} \times \left(\frac{R_4}{R_3 + R_4}\right) \times \left(1 + \frac{R_2}{R_1}\right) - V_{IN} \times \frac{R_2}{R_1} \tag{2}$$

The differential output signal, V_{DIFF}, is the difference between the two single-ended output signals, V_{OUT+} and V_{OUT-} . Equation 3 shows the transfer function for V_{DIFF}. By applying the conditions that $R_1 = R_2$ and $R_3 = R_4$, the transfer function is simplified into Equation 6. Using this configuration, the maximum input signal is equal to the reference voltage and the maximum output of each amplifier is equal to the V_{REF}. The differential output range is $2 \times V_{REF}$. Furthermore, the common mode voltage will be one half of VREF (see Equation 7)

$$V_{DIFF} = V_{OUT+} - V_{OUT-} = V_{IN} \times \left(1 + \frac{R_2}{R_1}\right) - V_{REF} \times \left(\frac{R_4}{R_3 + R_4}\right)\left(1 + \frac{R_2}{R_1}\right) \tag{3}$$

$$V_{OUT+} = V_{IN} \tag{4}$$

$$V_{OUT-} = V_{REF} - V_{IN} \tag{5}$$

$$V_{DIFF} = 2 \times V_{IN} - V_{REF} \tag{6}$$

$$V_{cm} = \left(\frac{V_{OUT+} + V_{OUT-}}{2}\right) = \frac{1}{2} V_{REF} \tag{7}$$

7.1.2.1. Amplifier Selection

Linearity over the input range is key for good dc accuracy. The common mode input range and the output swing limitations determine the linearity. In general, an amplifier with rail-to-rail input and output swing is required. Bandwidth is a key concern for this design. Because the XLRC4580 device has a bandwidth of 12 MHz, this circuit will only be able to process signals with frequencies of less than 12 MHz.

7.1.2.2. Passive Component Selection

Because the transfer function of VOUT– is heavily reliant on resistors (R_1 , R_2 , R_3 , and R_4), use resistors with low tolerances to maximize performance and minimize error. This design used resistors with resistance values of 36 kΩ with tolerances measured to be within 2%. But, if the noise of the system is a key parameter, the user can select smaller resistance values (6 kΩ or lower) to keep the overall system noise low. This ensures that the noise from the resistors is lower than the amplifier noise.

7.1.3. Application Curves

The measured transfer functions in Figure 14, Figure 15, and Figure 16 were generated by sweeping the input voltage from 0 V to 12 V. However, this design should only be used between 2 V and 10 V for optimum linearity

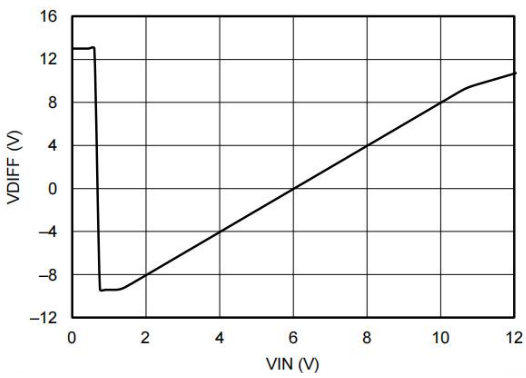


Figure 14. Differential Output Voltage vs Input Voltage

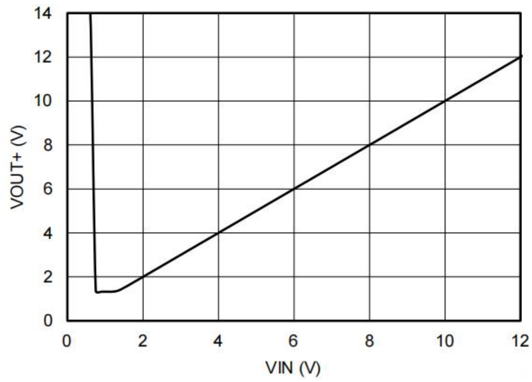


Figure 15. Positive Output Voltage vs Input Voltage

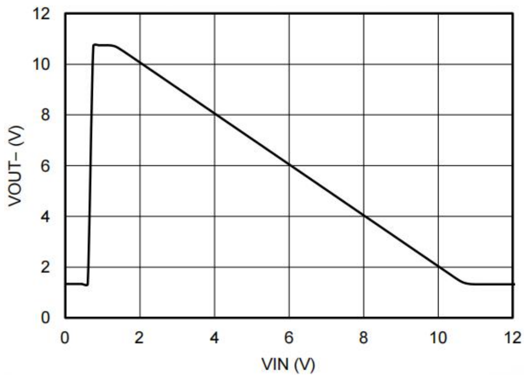


Figure 16. Positive Output Voltage vs Input Voltage

8. POWER SUPPLY RECOMMENDATIONS

The XLRC4580 device is specified for operation over the range of ±2 to ±16 V; many specifications apply from - 40°C to 85°C. The Typical Characteristics section presents parameters that can exhibit significant variance with regard to operating voltage or temperature.

Place 0.1-µF bypass capacitors close to the power-supply pins to reduce errors coupling in from noisy or high impedance power supplies. For more detailed information on bypass capacitor placement, refer to the Layout Guidelines.

CAUTION： Supply voltages outside of the ±18 V range can permanently damage the device (see the Absolute Maximum Ratings)

9. LAYOUT

9.1. Layout Guidelines

For best operational performance of the device, use good PCB layout practices, including:

- Noise can propagate into analog circuitry through the power pins of the circuit as a whole and the operational amplifier. Bypass capacitors are used to reduce the coupled noise by providing low impedance power sources local to the analog circuitry.
  - Connect low-ESR, 0.1-µF ceramic bypass capacitors between each supply pin and ground, placed as close to the device as possible. A single bypass capacitor from V+ to ground is applicable for single supply applications.
- Separate grounding for analog and digital portions of circuitry is one of the simplest and most-effective methods of noise suppression. One or more layers on multilayer PCBs are usually devoted to ground planes. A ground plane helps distribute heat and reduces EMI noise pickup. Make sure to physically separate digital and analog grounds, paying attention to the flow of the ground current.
- To reduce parasitic coupling, run the input traces as far away from the supply or output traces as possible. If it is not possible to keep them separate, it is much better to cross the sensitive trace perpendicular as opposed to in parallel with the noisy trace.
- Place the external components as close to the device as possible. Keeping RF and RG close to the inverting input minimizes parasitic capacitance, as shown in Layout Example.
- Keep the length of input traces as short as possible. Always remember that the input traces are the most sensitive part of the circuit.
- Consider a driven, low-impedance guard ring around the critical traces. A guard ring can significantly reduce leakage currents from nearby traces that are at different potentials.

9.2. Layout Example

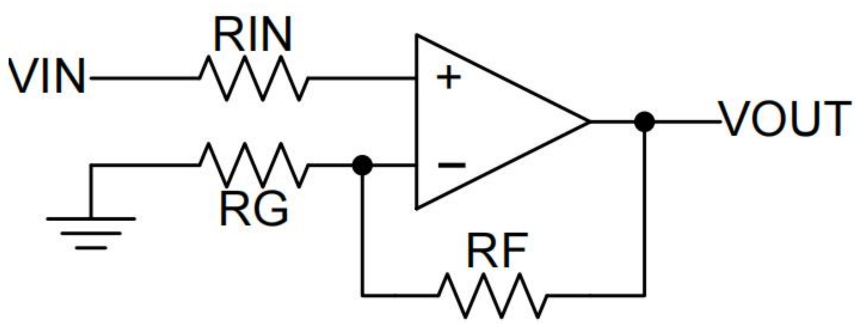


Figure 17. Operational Amplifier Schematic for Noninverting Configuration

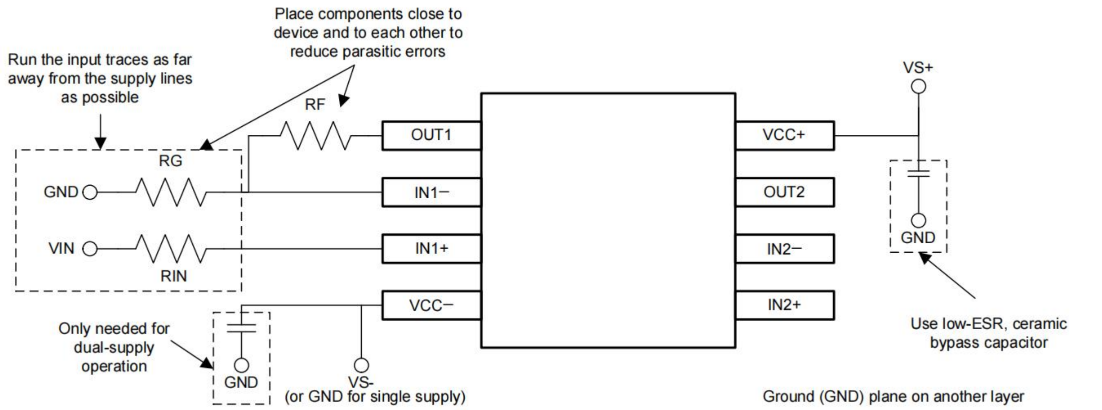


Figure 18. Operational Amplifier Board Layout for Noninverting Configuration

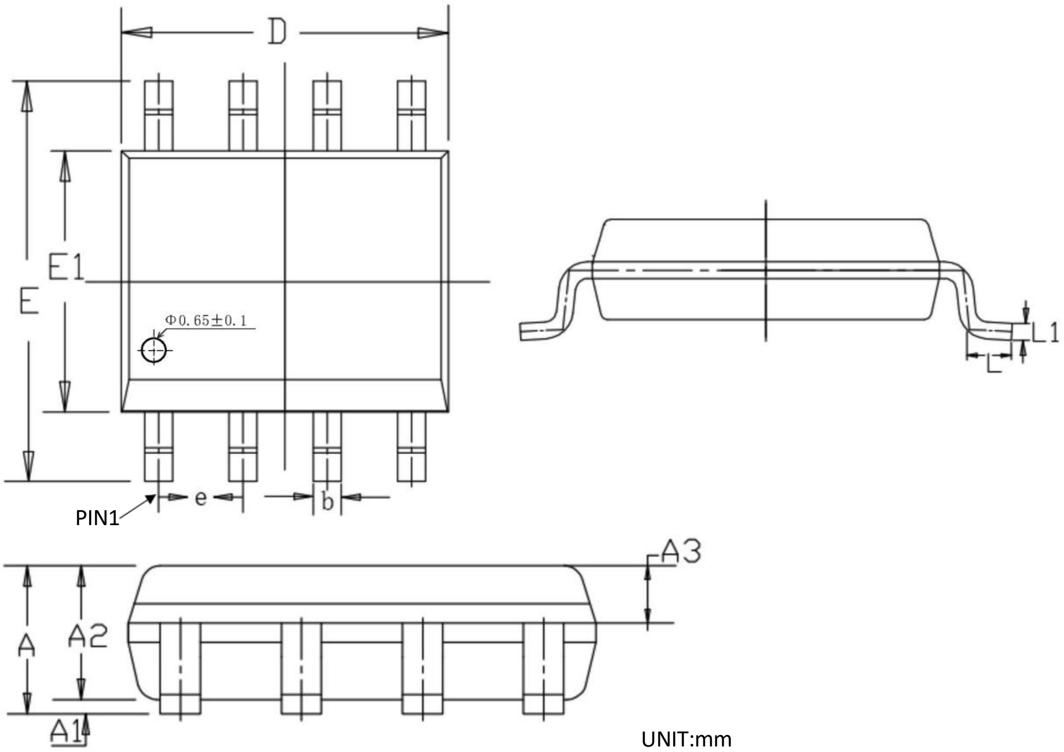
10. ORDERING INFORMATION

Ordering Information

Part Number	Device Making	Package type	Body size (mm)	Temperate (°C)	MSL	Transpo Rt	Package Quantit
XLRC4580IDR	XL4580	SOP-8	4.90*3.90	-40 to +85	MSL3	T&R	2500
XLRC4580IPW	L4580	TSSOP8	3.00*4.40	-40 to +85	MSL3	T&R	2500

11. DIMENSIONAL DRAWINGS

SOP8



UNIT:mm

	MIN	NOM	MAX
A	1.450	1.550	1.650
A1	0.100	0.150	0.200
A2	1.300	1.400	1.500
A3	0.600	0.650	0.700
b	0.380	–	0.510
e	1.240	1.270	1.300
D	4.800	4.900	5.000
E	5.800	6.000	6.200
E1	3.800	3.900	4.000
L	0.450	0.600	0.750
L1	—	0.25BSC	—

TSSOP8

尺寸 标注	最小值（mm)	平均值（mm)	最大值（mm)	尺寸 标注	最小值（mm)	平均值（mm)	最大值（mm)
A	2.95	3.00	3.05	B4	0.50	0.60	0.70
A1		0.22		C	0.95	1.00	1.05
A2	0.63	0.65	0.68	C1	0.39	0.44	0.49
B	4.35	4.40	4.45	C2		0.127	
B1	6.30	6.40	6.50	C3	0.05	0.10	0.15
B2	0.90	1.00	1.10	R		12°	
B3			0.12