1. DESCRIPTION

The XLA3240 have dual versions of the integrated circuit operational amplifiers. They combine the advantages of MOS and bipolar transistors on the same monolithic chip. The gate-protected MOSFET (PMOS) input transistors provide high input impedance and a wide common-mode input voltage range (typically to 0.5V below the negative supply rail). The bipolar output transistors allow a wide output voltage swing and provide a high output current capability.
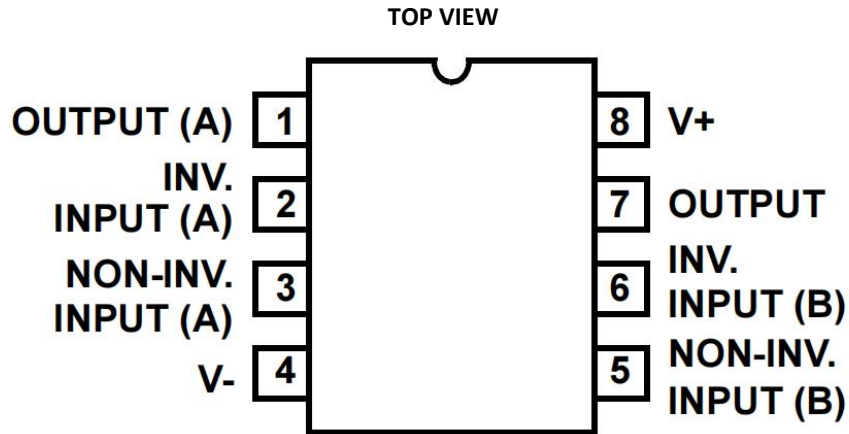
2. FEATURES

- Internally Compensated
- MOSFET Input Stage
  - Very High Input Impedance (Z_{IN}) 1.5TΩ(Typ)
  - Very Low Input Current (I_I) 10pA (Typ) at ± 15V
  - Wide Common-Mode Input Voltage Range (V_{ICR}): Can Be Swung 0.5V Below Negative Supply Voltage Rail
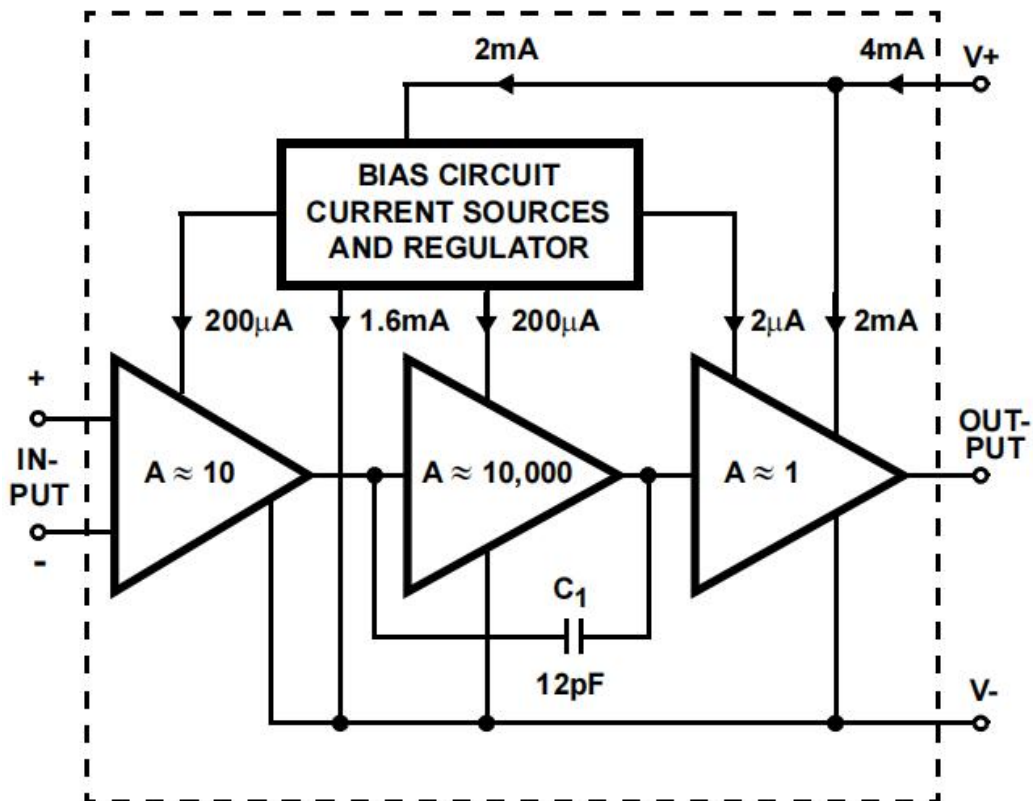
3. APPLICATIONS

- Ground Referenced Single Amplifiers in Automobile and Portable Instrumentation
- Sample and Hold Amplifiers
- Long Duration Timers/Multivibrators (MicrosecondsMinutes-Hours)
- Photocurrent Instrumentation
- Intrusion Alarm System
- Active Filters
- Comparators
- Function Generators
- Instrumentation Amplifiers
- Power Supplies

4. PINOUT

TOP VIEW

OUTPUT (A)	1	8 V+
INV. INPUT (A)	2	7 OUTPUT
NON-INV. INPUT (A)	3	6 INV. INPUT (B)
V-	4	5 NON-INV. INPUT (B)

5. FUNCTIONAL DIAGRAM

BIAS CIRCUIT CURRENT SOURCES AND REGULATOR

2mA   4mA   V+

200µA   1.6mA   200µA   2µA   2mA

+ INPUT −

A ≈ 10   A ≈ 10,000   A ≈ 1   OUTPUT

C_1

12pF

V-

6. ABSOLUTE MAXIMUM RATINS

Supply Voltage (Between V+ and V-). 36V

Differential Input Voltage 8V

Input Voltage . . . . (V+ +8V) to (V- -0.5V)

Input Current 1mA

Output Short Circuit Duration (Note 1). . . . . Indefinite

7. THERAML INFORMATION

Thermal Resistance (Typical, Note 2) . . . . θ_{JA} (°C/W)

   8 Lead PDIP Package* 100

Maximum Junction Temperature (Plastic Package) . . . . 150°C

Maximum Storage Temperature Range. . . . . -65°C to 150°C

Maximum Lead Temperature (Soldering 10s) . . . . 300°C

*Pb-free PDIPs can be used for through hole wave solder processing only. They are not intended for use in Reflow solder processing applications.

8. OPERATING CONDITIONS

Temperature Range . . . . -40°C to 85°C

Voltage Range . . . . 4V to 36V or ±2V to ±18V

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTES:

1. Short circuit may be applied to ground or to either supply. Temperatures and/or supply voltages must be limited to keep dissipation within maximum rating.

2. θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

9. ELECTRICAL SPECIFICATIONS

For Equipment Design, V_{SUPPLY} = ±15V, T_A = 25° C, Unless Otherwise Specified

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Input Offset Voltage	V_{IO}	-	5	15	mV
Input Offset Current	I_{IO}	-	0.5	30	pA
Input Current	I_I	-	10	50	pA
Large-Signal Voltage Gain (See Figures 12, 27) (Note 3)	A_{OL}	20	100	-	kV/V
		86	100	-	dB
Common Mode Rejection Ratio (See Figure 17)	CMRR	-	32	320	μV/V
		70	90	-	dB
Common Mode Input Voltage Range (See Figure24)	VICR	-15	-15.5 to +12.5	11	V
Power Supply Rejection Ratio (See Figure 19)	PSRR ($\Delta V_{IO}/\Delta V\pm$)	-	100	150	μV/V
		76	80	-	dB
Maximum Output Voltage (Note 4) (See Figures 23, 24)	V_{OM}+	12	13	-	V
	V_{OM}-	-14	-14.4	-	V
Maximum Output Voltage (Note 5)	V_{OM}-	0.4	0.13	-	V
Total Supply Current (See Figure 15) For Both Amps	I+	-	8	12	mA
Total Device Dissipation	P_D	-	240	360	mW

NOTES:
3. At V_O = 26$V_{P-P,}$ +12V, -14V and R_L = 2kΩ.
4. At R_L = 2kΩ.
5. At V+ = 5V, V- = GND, I_{SINK} = 200μA.

For Equipment Design, VSUPPLY =±15V, T_A = 25°C, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	TYPICAL VALUES	UNITS
Input Resistance	R_I		1.5	TΩ
Input Capacitance	C_I		4	pF
Output Resistance	R_O		60	Ω
Equivalent Wideband Input Noise Voltage (See Figure 2)	e_N	BW = 140kHz, R_S = 1MΩ	48	μV

For Equipment Design, V_{SUPPLY} = ±15V, T_A = 25°C, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS		TYPICAL VALUES	UNITS
Equivalent Input Noise Voltage (See Figure 18)	e_N	f = 1kHz, RS = 100		40	nV/√Hz
		f = 10kHz, RS = 100		12	nV/√Hz
Short-Circuit Current to Opposite Supply	I_{OM}+	Source		40	mA
	I_{OM}-	Sink		11	mA
Gain Bandwidth Product (See Figures 13, 27)	f_T			4.5	MHz
Slew Rate (See Figure 14)	SR			9	V/μs
Transient Response (See Figure 1)	t_r	R_L = 2kΩ, C_L = 100pF	Rise Time	0.08	μs
	OS	R_L = 2kΩ, C_L = 100pF	Overshoot	10	%
Settling Time at 10VP-P (See Figure 25)	t_S	A_V = +1, R_L = 2kΩ, C_L = 100pF, Voltage Follower	To 1mV	4.5	μs
			To 10mV	1.4	μs
Crosstalk (See Figure 22)		f = 1kHz		120	dB

For Equipment Design, at V_{SUPPLY} = ±15V, T_A = -40 to 85°C, Unless Otherwise Specified

PARAMETER	SYMBOL	TYPICAL VALUES	UNITS
Input Offset Voltage	$\|V_{IO}\|$	10	mV
Input Offset Current (Note 8)	$\|I_{IO}\|$	32	pA
Input Current (Note 8)	I_I	640	pA
Large Signal Voltage Gain (See Figures 12, 27), (Note 6)	A_{OL}	63	kV/V
		96	dB
Common Mode Rejection Ratio (See Figure 17)	CMRR	32	µV/V
		90	dB
Common Mode Input Voltage Range (See Figure 24)	V_{ICR}	-15 to +12.3	V
Power Supply Rejection Ratio (See Figure 19)	PSRR	150	µV/V
	$(\Delta V_{IO}/\Delta V\pm)$	76	dB
Maximum Output Voltage (Note 7) (See Figures 23, 24)	$V_{OM}+$	12.4	V
	$V_{OM}-$	-14.2	V
Supply Current (See Figure 15) Total For Both Amps	I+	8.4	mA
Total Device Dissipation	P_D	252	mW
Temperature Coefficient of Input Offset Voltage	$\Delta V_{IO}/\Delta T$	15	µV/°C

NOTES:

6. At V_O = 26V_{P-P}, +12V, -14V and R_L = 2kΩ.

7. At R_L = 2kΩ.

8. At T_A = 85°C.

For Equipment Design, at V+ = 5V, V- = 0V, TA = 25°C, Unless Otherwise Specified

PARAMETER		SYMBOL	TYPICAL VALUES	UNITS
Input Offset Voltage		$\|V_{IO}\|$	5	mV
Input Offset Current		$\|I_{IO}\|$	0.1	pA
Input Current		I_I	2	pa
Input Resistance		R_{IN}	1	TΩ
Large Signal Voltage Gain (See Figures 12, 27)		A_{OL}	100	kV/V
			100	dB
Common Mode Rejection Ratio		CMRR	32	µV/V
			90	dB
Common Mode Input Voltage Range (See Figure 24)		V_{ICR}	-0.5	V
			2.6	V
Power Supply Rejection Ratio		PSRR	31.6	µV/V
			90	dB
Maximum Output Voltage (See Figures 23, 24)		$V_{OM}+$	3	V
		$V_{OM}-$	0.3	V
Maximum Output Current	Source	$I_{OM}+$	20	mA
	Sink	$I_{OM}-$	1	mA
Slew Rate (See Figure14)		SR	7	V/µs
Gain Bandwidth Product (See Figure 13)		f_T	4.5	MHz
Supply Current (See Figure 15)		I+	4	mA
Device Dissipation		P_D	20	mW

10. TEST CIRCUITS AND WAVEFORMS
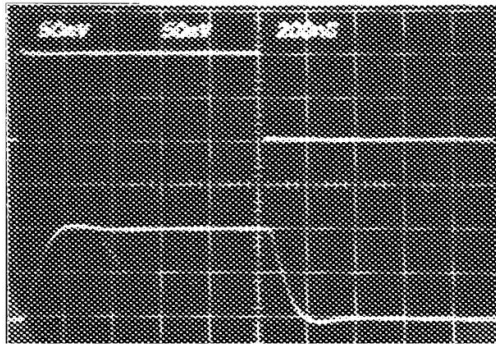
50mV/Div., 200ns/Div.
Top Trace: Input, Bottom Trace: Output

FIGURE 1A. SMALL SIGNAL RESPONSE
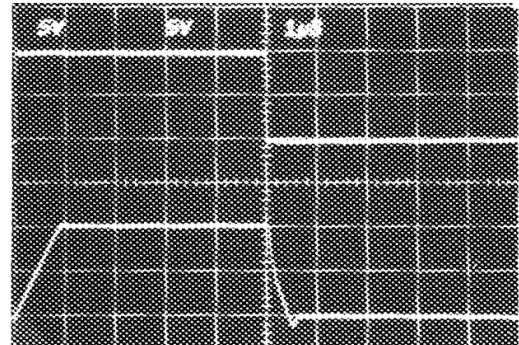
5V/Div., 1μs/Div.
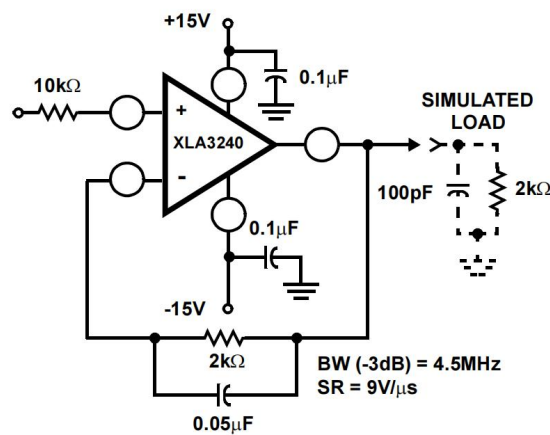Top Trace: Input, Bottom Trace: Output

FIGURE 1B. LARGE SIGNAL RESPONSE

FIGURE 1C. TEST CIRCUIT

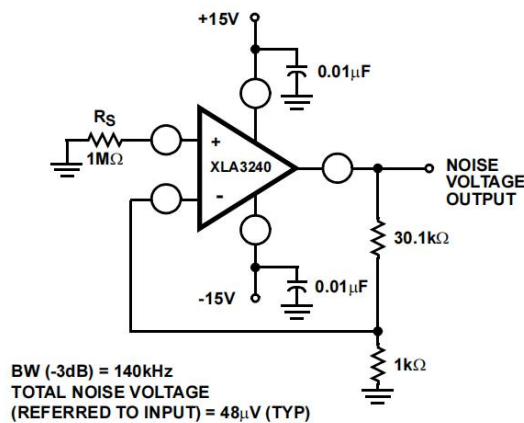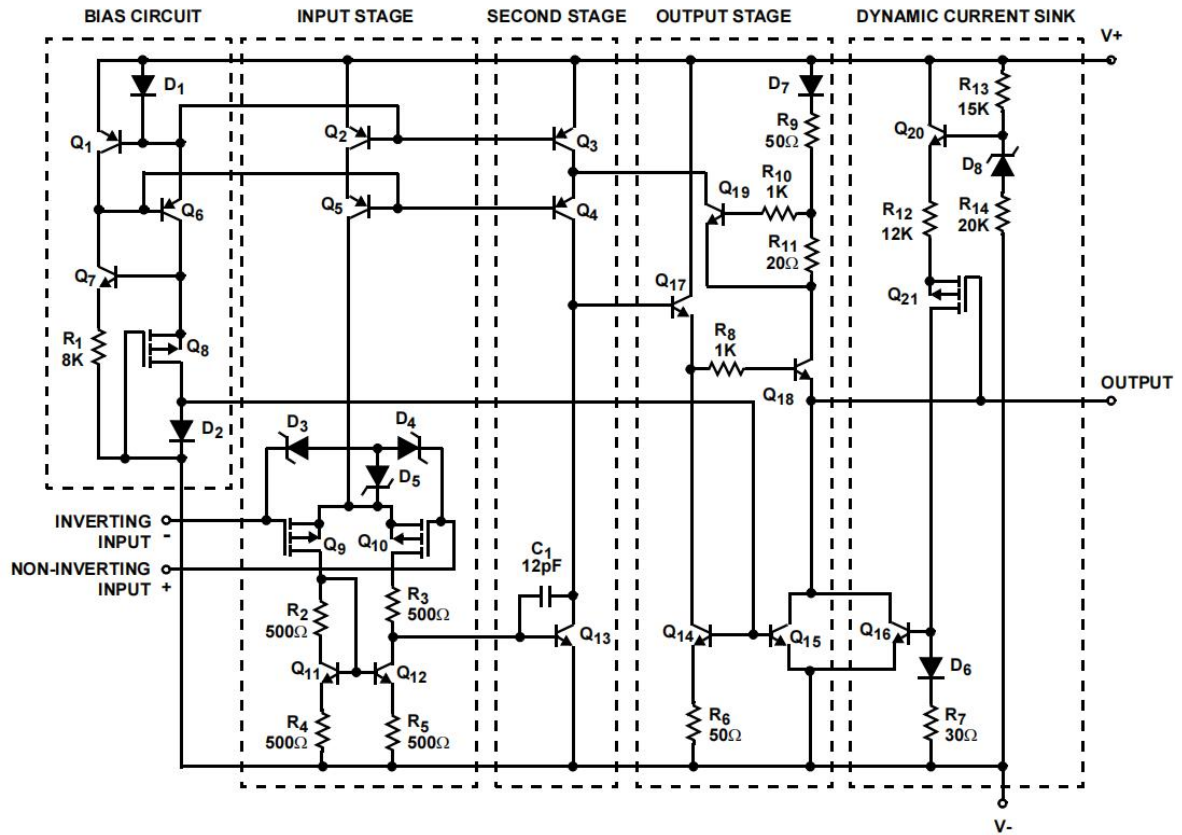**FIGURE 1. SPLIT-SUPPLY VOLTAGE FOLLOWER TEST CIRCUIT AND ASSOCIATED WAVEFORMS**

BW (-3dB) = 140kHz
TOTAL NOISE VOLTAGE
(REFERRED TO INPUT) = 48μV (TYP)

FIGURE 2. TEST CIRCUIT AMPLIFIER (30dB GAIN) USED FOR WIDEBAND NOISE MEASUREMENT

11. SCHEMATIC DIAGRAM(One Amplifier of Two)

NOTES:
9. All resistance values are in ohms.

12. APPLICATION INFORMATION

12.1. Circuit Description

The schematic diagram details one amplifier section of the XLA3240. It consists of a differential amplifier stage using PMOS transistors (Q_9 and Q_{10}) with gate-to-source protection against static discharge damage provided by zener diodes D_3, D_4, and D_5. Constant current bias is applied to the differential amplifier from transistors Q_2 and Q5 connected as a constant current source. This assures a high common-mode rejection ratio. Theoutput of the differential amplifier is coupled to the base of gain stage transistor Q_{13} by means of an NPN current mirror that supplies the required differential-to-single-ended conversion.

The gain stage transistor Q_{13} has a high impedance active load (Q_3 and Q_4) to provide maximum open-loop gain. The collector of Q13 directly drives the base of the compound emitter-follower output stage. Pulldown for the output stage is provided by two independent circuits: (1) constant-currentconnected transistors $Q1_4$ and $Q1_5$ and (2) dynamic currentsink transistor Q_{16} and its associated circuitry. The level of pulldown current is constant at about 1mA for Q_{15} and varies from 0 to 18mA for Q16 depending on the magnitude of the voltage between the output terminal and V+. The dynamic current sink becomes active whenever the output terminal is more negative than V+ by about 15V. When this condition exists, transistors Q_{21} and Q_{16} are turned on causing Q_{16} to sink current from the output terminal to V-. This current always flows when the output is in the linear region, either from the load resistor or from the emitter of Q_{18} if no load resistor is present. The purpose of this dynamic sink is to permit the output to go within 0.2V (V_{CE} (sat)) of V- with a 2kΩ load to ground. When the load is returned to V+, it may be necessary to supplement the 1mA of current from Q_{15} in order to turn on the dynamic current sink (Q_{16}). This may be accomplished by placing a resistor (Approx. 2kΩ) between the output and V-.

12.2. Output Circuit Considerations

Figure 23 shows output current-sinking capabilities of the XLA3240 at various supply voltages. Output voltage swing to the negative supply rail permits this device to operate both power transistors and thyristors directly without the need for level-shifting circuitry usually associated with the 741 series of operational amplifiers.

Figure 3 shows some typical configurations. Note that a series resistor, RL, is used in both cases to limit the drive available to the driven device. Moreover, it is recommended that a series diode and shunt diode be used at the thyristor input to prevent large negative transient surges that can appear at the gate of thyristors, from damaging the integrated circuit.

12.3. Input Circuit Considerations

As indicated by the typical VICR, this device will accept inputs as low as 0.5V below V-. However, a series currentlimiting resistor is recommended to limit the maximum input terminal current to less than 1mA to prevent damage to the input protection circuitry.

Moreover, some current-limiting resistance should be provided between the inverting input and the output when the XLA3240 is used as a unity-gain voltage follower. This resistance prevents the possibility of extremely large inputsignal transients from forcing a signal through the inputprotection network and directly driving the internal constantcurrent source which could result in positive feedback via the output terminal. A 3.9kΩ resistor is sufficient.

The typical input current is on the order of 10pA when the inputs are centered at nominal device dissipation. As the output supplies load current, device dissipation will increase, raising the chip temperature and resulting in increased input current. Figure 4 shows typical input-terminal current versus ambient temperature for the XLA3240.
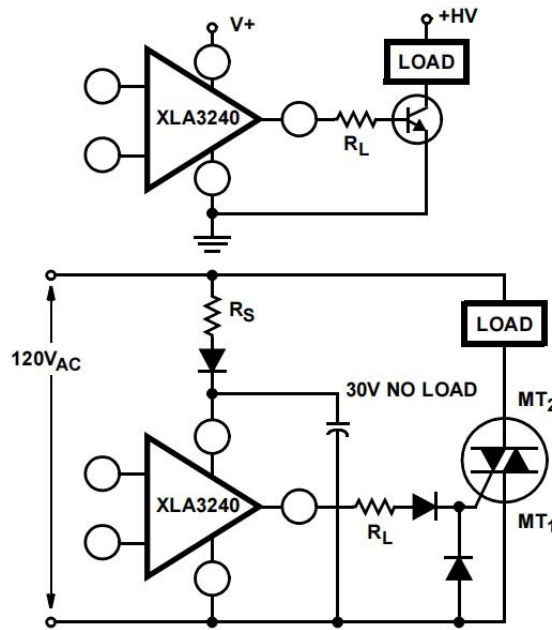
FIGURE 3. METHODS OF UTILIZING THE $V_{CE (SAT)}$ SINKING CURRENT CAPABILITY OF THE XLA3240 SERIES
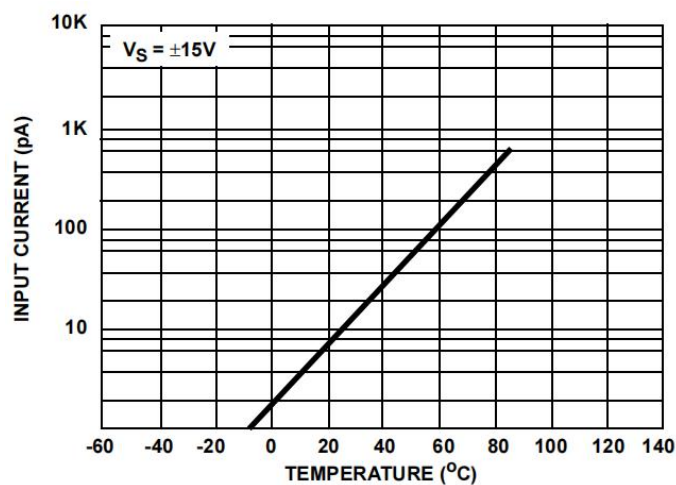
FIGURE 4. INPUT CURRENT vs TEMPERATURE

It is well known that MOSFET devices can exhibit slight changes in characteristics (for example, small changes in input offset voltage) due to the application of large differential input voltages that are sustained over long periods at elevated temperatures.

Both applied voltage and temperature accelerate these changes. The process is reversible and offset voltage shifts of the opposite polarity reverse the offset. In typical linear applications, where the differential voltage is small and symmetrical, these incremental changes are of about the same magnitude as those encountered in an operational amplifier employing a bipolar transistor input stage.

13. TYPICAL APPLICATIONS

13.1. On/Off Touch Switch

The on/off touch switch shown in Figure 5 uses the XLA3240 to sense small currents flowing between two contact points on a touch plate consisting of a PC board metallization "grid". When the "on" plate is touched, current flows between the two halves of the grid causing a positive shift in the output voltage (Terminal 7) of the XLA3240. These positive transitions are fed into the U1, which is used as a latching circuit and zero-crossing TRIAC driver. When a positive pulse occurs at Terminal 7 of the XLA3240, the TRIAC is turned on and held on by the U1 and its associated positive feedback circuitry (51kΩ resistor and 36kΩ/42kΩ voltage divider). When the positive pulse occurs at Terminal 1 (XLA3240), the TRIAC is turned off and held off in a similar manner. Note that power for the XLA3240 is supplied by the U1 internal power supply.

The advantage of using the XLA3240 in this circuit is that it can sense the small currents associated with skin conduction while allowing sufficiently high circuit impedance to provide protection against electrical shock.

13.2. Dual Level Detector (Window Comparator)

Figure 6 illustrates a simple dual liquid level detector using the XLA3240 as the sensing amplifier. This circuit operates on the principle that most liquids contain enough ions in solution to sustain a small amount of current flow between two electrodes submersed in the liquid. The current, induced by an 0.5V potential applied between two halves of a PC board grid, is converted to a voltage level by the XLA3240 in a circuit similar to that of the on/off touch switch shown in Figure 5. The changes in voltage for both the upper and lower level sensors are processed by the OPA to activate an LED whenever the liquid level is above the upper sensor or below the lower sensor

13.3. Constant-Voltage/Constant-Current Power Supply

The constant-voltage/constant-current power supply shown in Figure 7 uses the XLA3240 as a voltage-error and current-sensing amplifier. The XLA3240 is ideal for this application because its input common-mode voltage range includes ground, allowing the supply to adjust from 20mV to 25V without requiring a negative supply voltage. Also, the ground reference capability of the XLA3240 allows it to sense the voltage across the 1μ current-sensing resistor in the negative output lead of the power supply. The transistor array functions as a reference for both constantvoltage and constant-current limiting. The power Darlington is used as the pass element and may be required to dissipate as much as 40W. Figure 8 shows the transient response of the supply during a 100mA to 1A load transition.

13.4. Precision Differential Amplifier

Figure 9 shows the XLA3240 in the classical precision differential amplifier circuit. The XLA3240 is ideally suited for biomedical applications because of its extremely high input impedance. To insure patient safety, an extremely high electrode series resistance is required to limit any current that might result in patient discomfort in the event of a fault condition. In this case, 10MΩ resistors have been used to limit the current to less than 2μA without affecting the performance of the circuit. Figure 10 shows a typical electrocardiogram waveform obtained with this circuit.
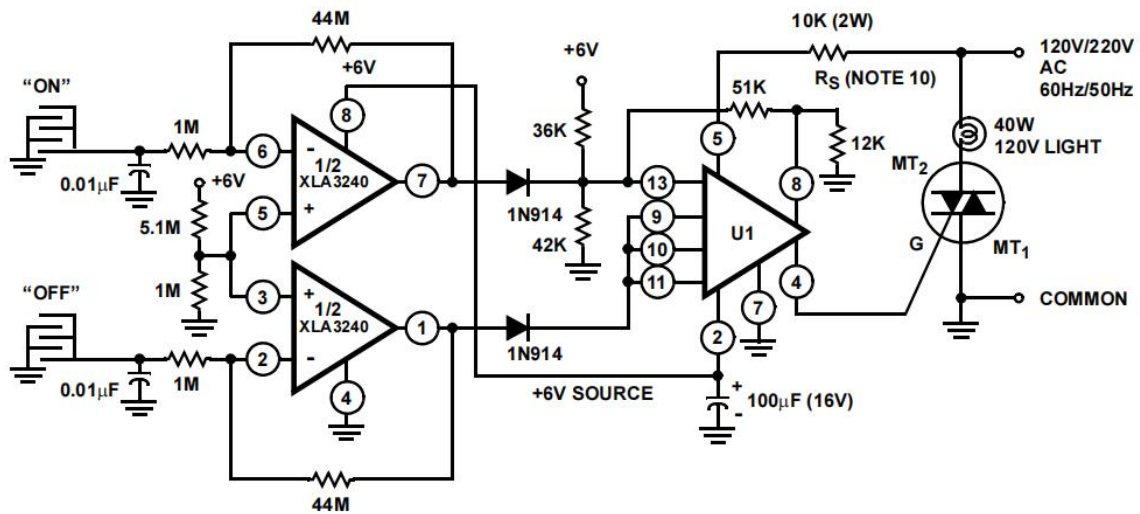
NOTE:
10. At 220V operation, TRIAC should be T2300D, Rs = 18K, 5W.
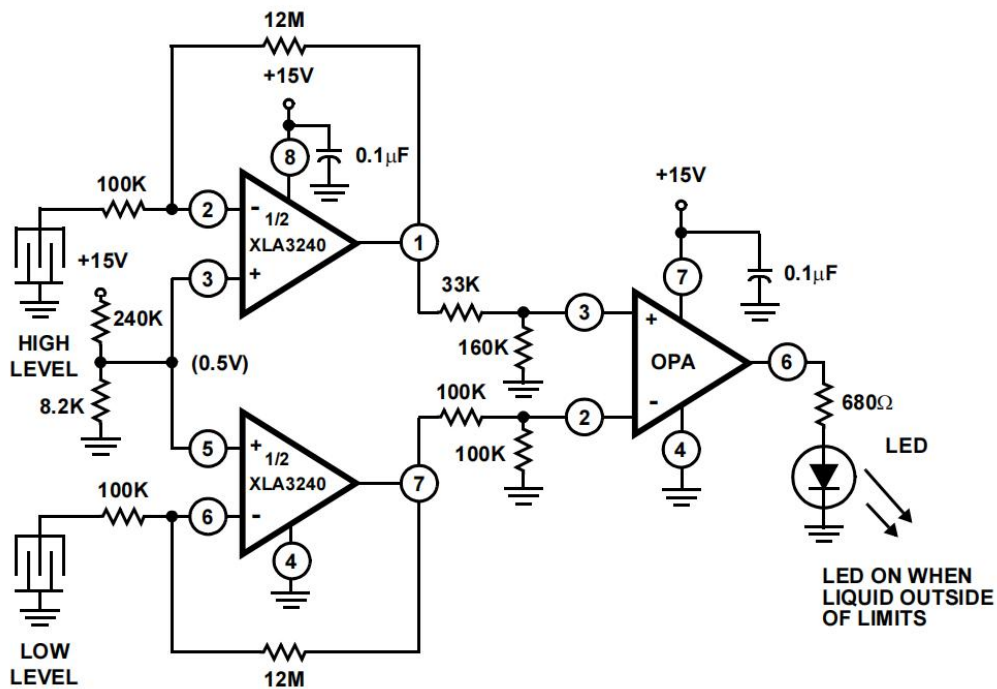11. U1 is a Zero Voltage Switch.

FIGURE 5. ON/OFF TOUCH SWITCH
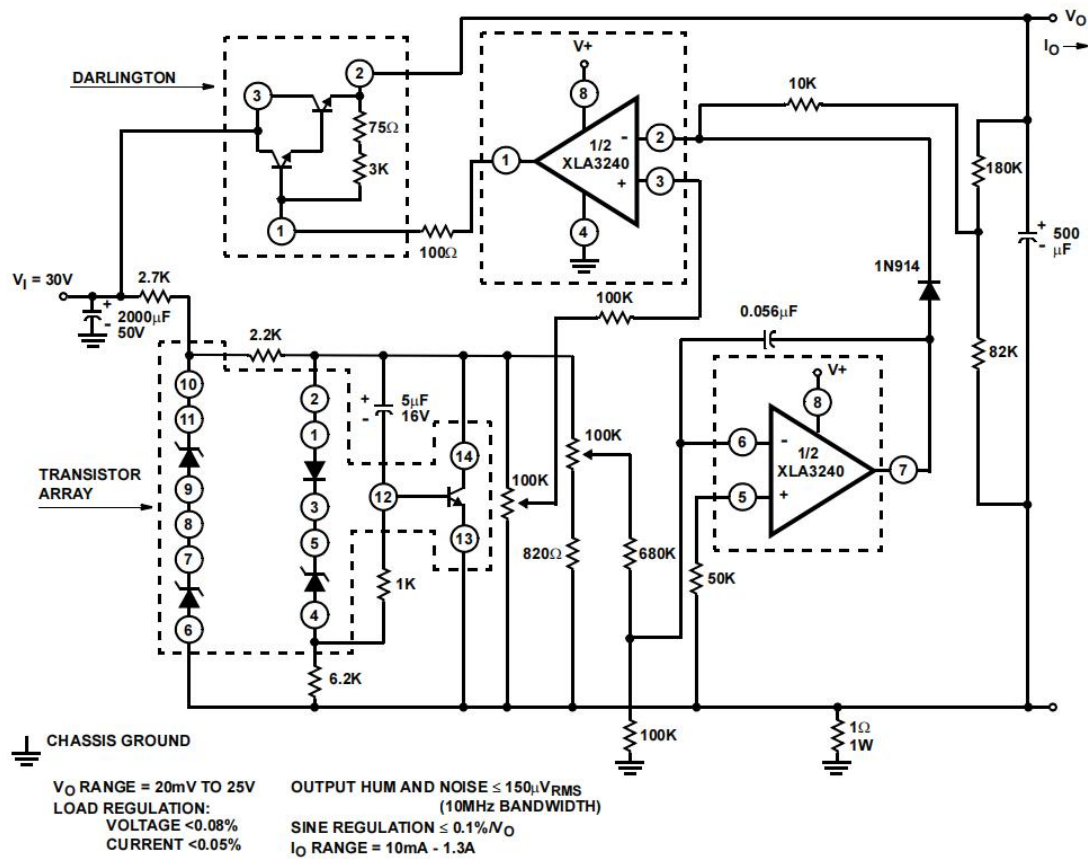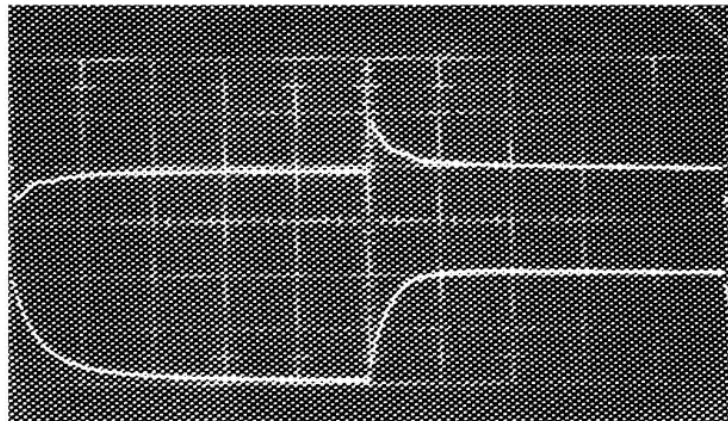

FIGURE 6. DUAL LEVEL DETECTER

V_O RANGE = 20mV TO 25V
LOAD REGULATION:
    VOLTAGE <0.08%
    CURRENT <0.05%

OUTPUT HUM AND NOISE ≤ 150μV_RMS
    (10MHz BANDWIDTH)
SINE REGULATION ≤ 0.1%/V_O
I_O RANGE = 10mA - 1.3A

FIGURE 7. CONSTANT-VOLTAGE/CONSTANT-CURRENT POWER SUPPLY

Top Trace: Output Voltage;
              500mV/Div., 5μs/Div.

Bottom Trace: Collector Of Load Switching Transistor
              Load = 100mA to 1A; 5V/Div., 5μs/Div.

FIGURE 8. TRANSIENT RESPONSE
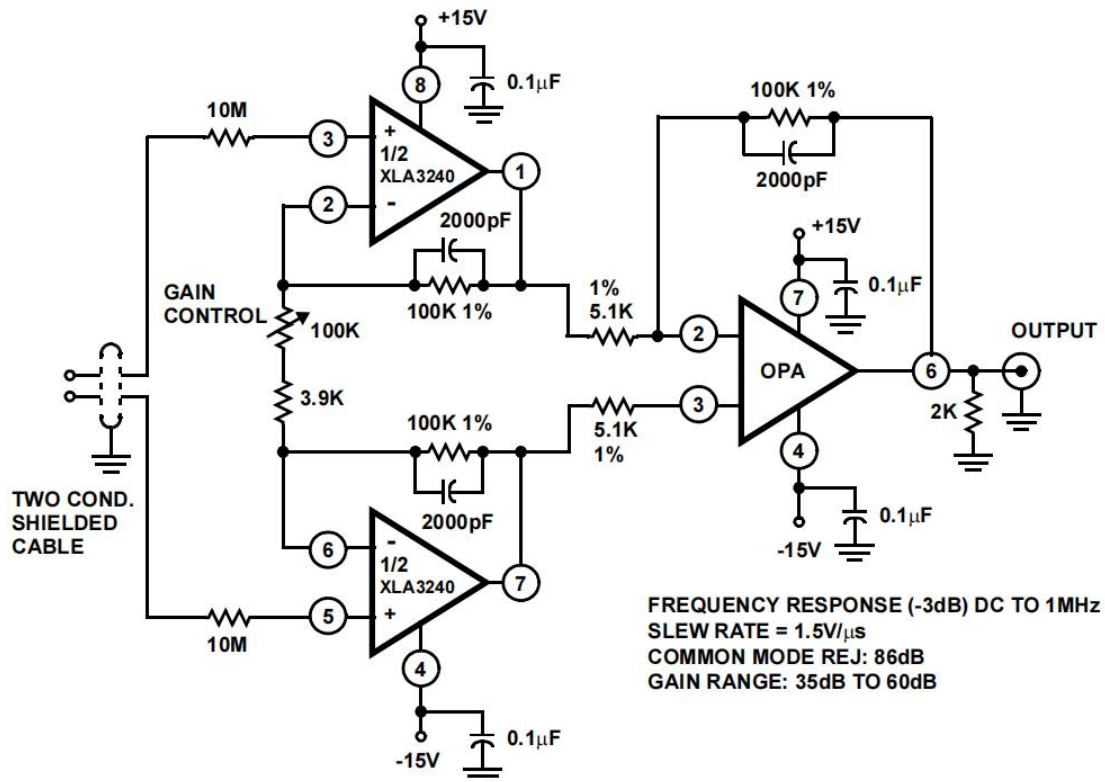
FIGURE 9. PRECISION DIFFERENTIAL AMPLIFIER

FREQUENCY RESPONSE (-3dB) DC TO 1MHz
SLEW RATE = 1.5V/μs
COMMON MODE REJ: 86dB
GAIN RANGE: 35dB TO 60dB
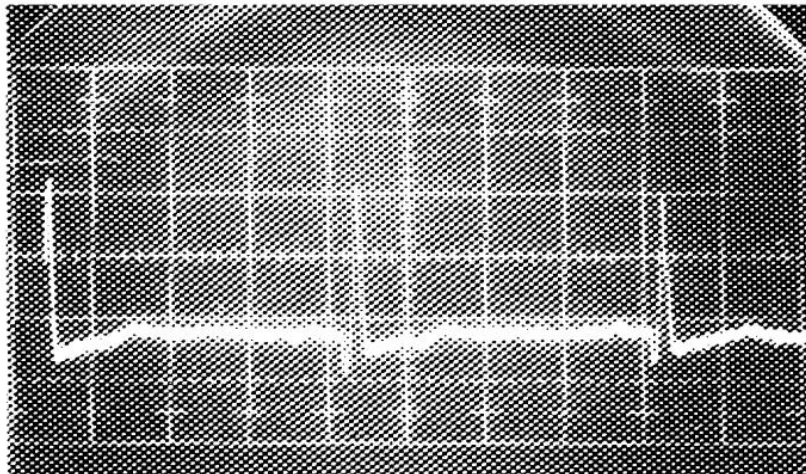
Vertical: 1.0mV/Div.
Amplifier Gain = 100X
Scope Sensitivity = 0.1V/Div.

Horizontal: >0.2s/Div. (Uncal)

FIGURE 10. TYPICAL ELECTROCARDIOGRAM WAVEFORM
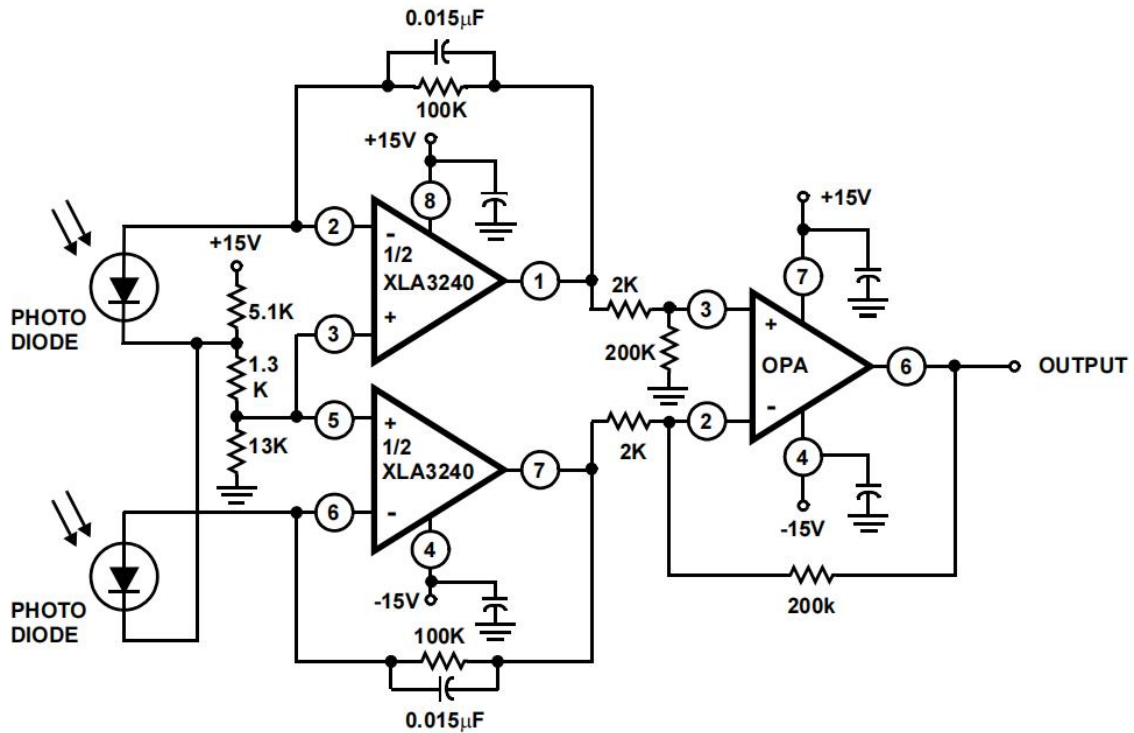
FIGURE 11. DIFFERENTIAL LIGHT DETECTOR

Differential Light Detector

In the circuit shown in Figure 11, the XLA3240 converts the current from two photo diodes to voltage, and applies 1V of reverse bias to the diodes. The voltages from the XLA3240 outputs are subtracted in the second stage (OPA) so that only the difference is amplified. In this manner, the circuit can be used over a wide range of ambient light conditions without circuit component adjustment. Also, when used with a light source, the circuit will not be sensitive to changes in light level as the source ages.

14. TYPOCAL PERFORMANCE CURVES
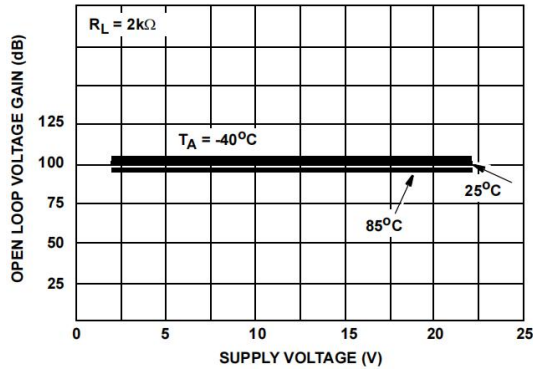
FIGURE 12. OPEN LOOP VOLTAGE GAIN
vs SUPPLY VOLTAGE
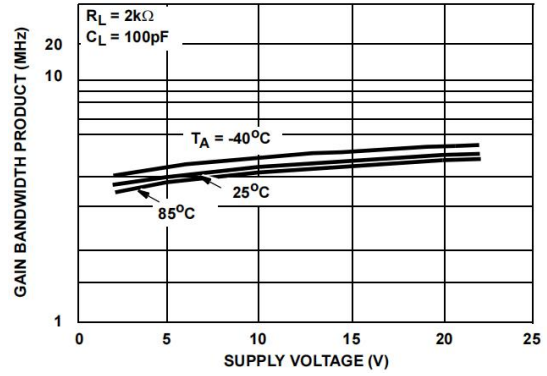
FIGURE 13. GAIN BANDWIDTH
PRODUCT vs SUPPLY VOLT-AGE
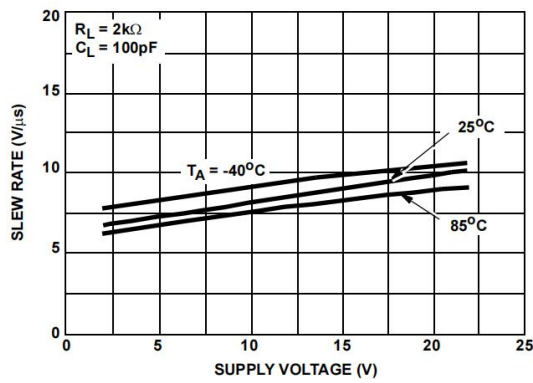
FIGURE 14. SLEW RATE vs SUPPLY
VOLTAGE
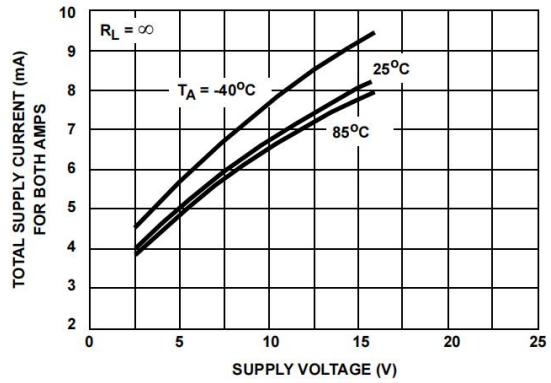
FIGURE 15. QUIESCENT SUPPLY
CURRENT vs SUPPLY VOLT-AGE
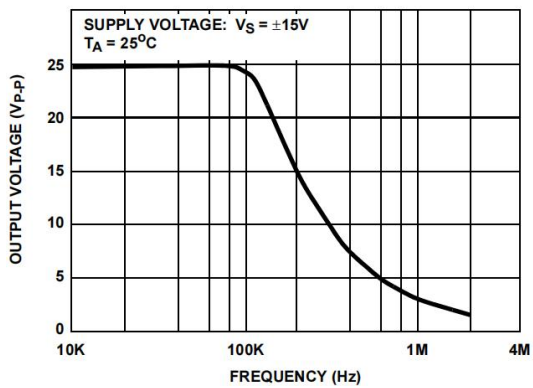
FIGURE 16. MAXIMUM OUTPUT
VOLTAGE SWING vs FREQUENCY
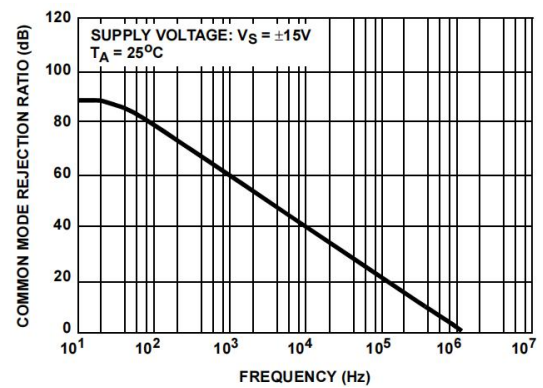
FIGURE 17. COMMON MODE
REJECTION RATIO vs FREQUENCY
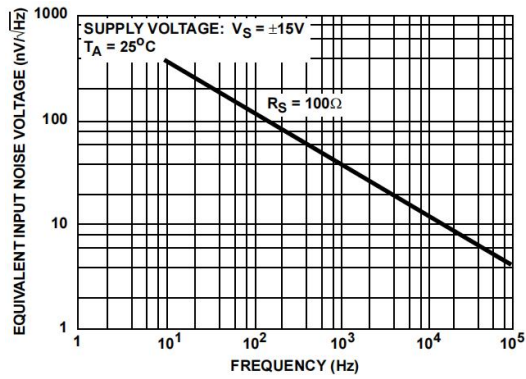
FIGURE 18. EQUIVALENT INPUT NOISE VOLTAGE vsFREQUENCY
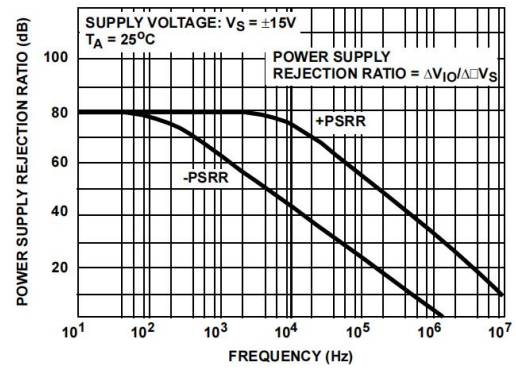
FIGURE 19. POWER SUPPLY REJECTION RATIO vs FREQUENCY
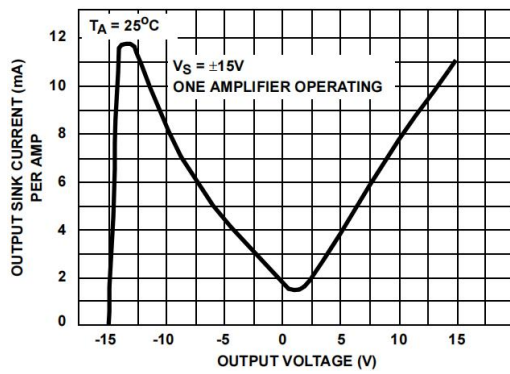
FIGURE 20. OUTPUT SINK CURRENT vs OUTPUT VOLTAGE
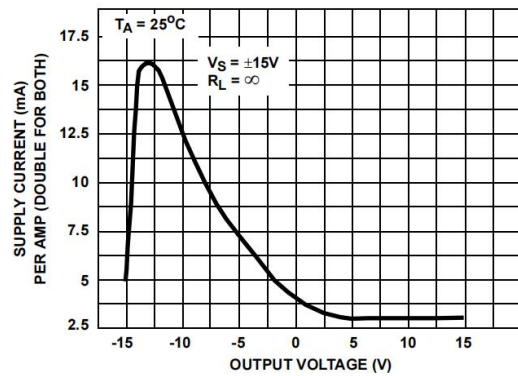
FIGURE 21. SUPPLY CURRENT vs OUTPUT VOLTAGE
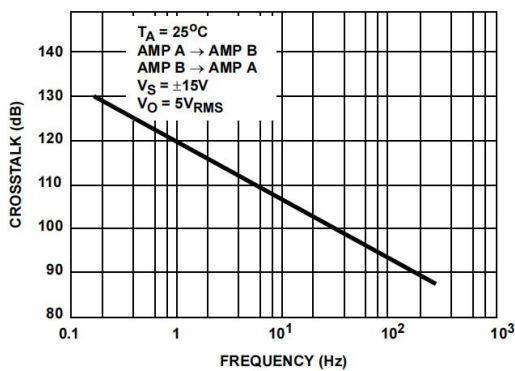
FIGURE 22. CROSSTALK vs FREQUENCY
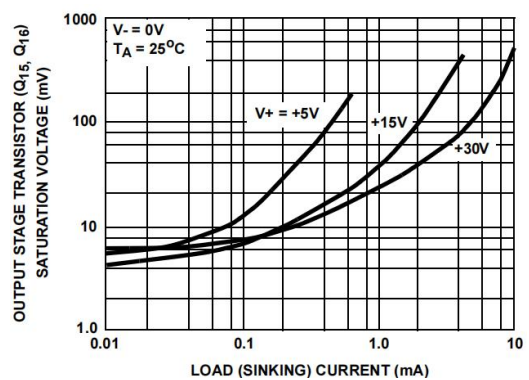
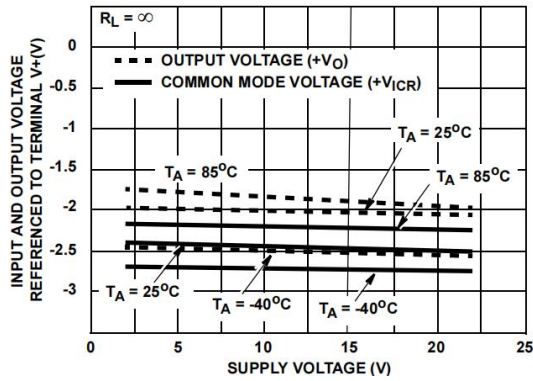**FIGURE 23. VOL TAGE ACROSS OUTPUT TRANSISTORS Q_{15} AND Q_{16} vs LOAD CURRENT**

FIGURE 24A.
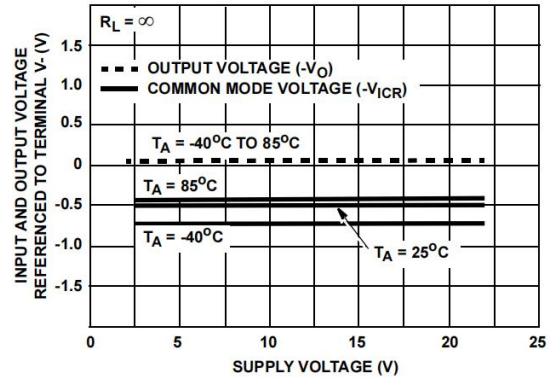
FIGURE 24B.

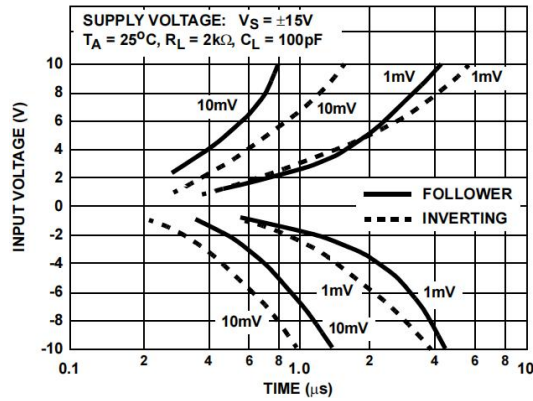**FIGURE 24. OUTPUT VOLTAGE SWING CAPABILITY AND COMMON MODE INPUT VOLTAGE RANGE vs SUPPLY VOLTAGE**
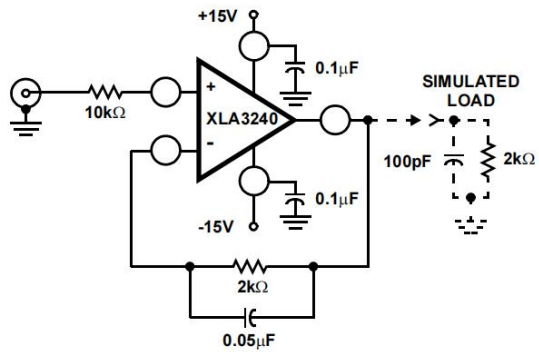

FIGURE 25A. SETTLING TIME vs INPUT VOLTAGE FIGURE
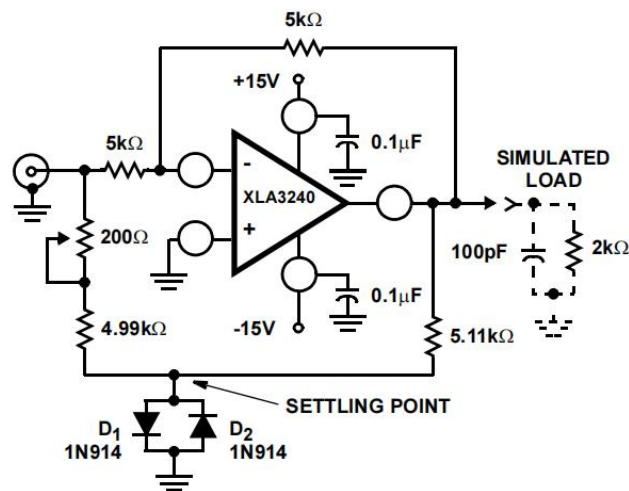

25B. TEST CIRCUIT (FOLLOWER)

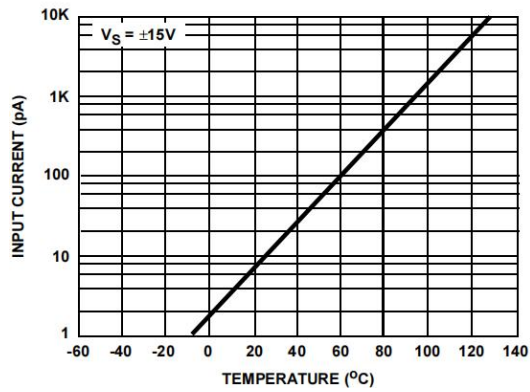FIGURE 25C. TEST CIRCUIT (INVERTING)

FIGURE 25. INPUT VOLTAGE vs SETTLING TIME
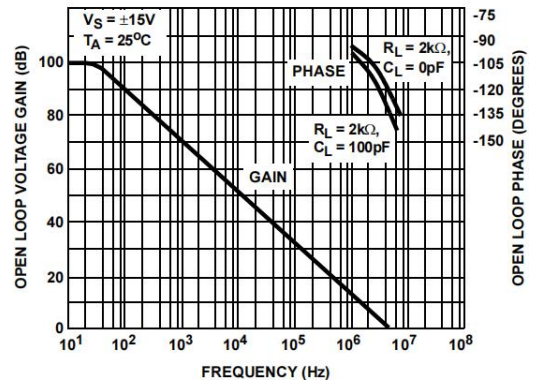
FIGURE 26. INPUT CURRENT vs TEMPERATURE
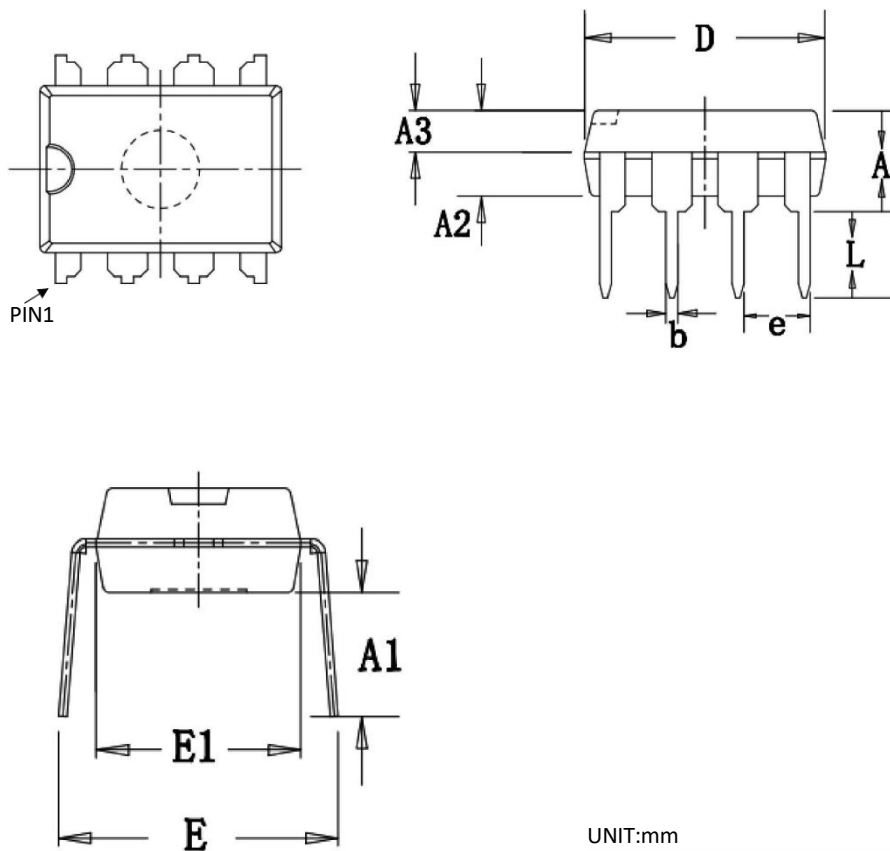

FIGURE 27. OPEN LOOP VOLTAGE GAIN AND PHASE vs FREQUENCY

15. ORDERING INFORMATION

Ordering Information

Part Number	Device Making	Package type	Body size (mm)	Temperate (°C)	MSL	Transpo Rt	Package Quantit
XLA3240AE	XL3240AE	DIP-8	9.25*6.38	-40 to +85	MSL3	Tube 50	2000

16. 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	—	—

[if you need help contact us. Xinluda reserves the right to change the above information without prior notice]