Dot and Bar Graph Display Generators

GENERAL DESCRIPTION

The XR-2277 and XR-2278 are 12 point level detector circuits designed for direct interfacing to light emitting diode (LED) moving-dot or bar-graph displays. Each of the circuits is comprised of an input buffer amplifier and 12 comparators, biased from a resistor string at logarithmic intervals. Accuracy is enhanced by an internal reference. Each comparator provides a high impedance current source output which are all very closely matched and simultaneously adjustable with a single external resistor. A control signal applied to the mode select pin determines whether the display is driven in a moving-dot or bar-graph format.

FEATURES

High Impedance Buffered Input
Direct LED Interface
Constant Current Outputs
External Dot/Bar Mode Select

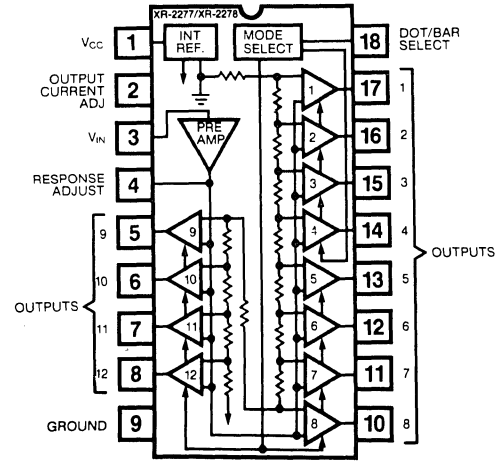
APPLICATIONS

Bar-Graph Display Generator/Driver
Moving-dot Display Driver
Sequential Display Indicator
Audio Level Indicator

ABSOLUTE MAXIMUM RATINGS

Power Supply	15V
Power Dissipation	625 mW
Derate Above 25°C	5 mW/°C
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C

FUNCTIONAL BLOCK DIAGRAM



ORDERING INFORMATION

Part Number	Package	Operating Temperature
XR-2277P	Plastic	0°C to +70°C
XR-2278P	Plastic	0°C to +70°C

SYSTEM DESCRIPTION

The XR-2277 and XR-2278 are 12 point logarithmic level detectors and LED drivers. LED driving current is provided by on board adjustable current sinks; no series limiting resistors are required. All LEDs receive matched currents, ensuring equal brightness. The drivers can be programmed to source up to 22 mA.

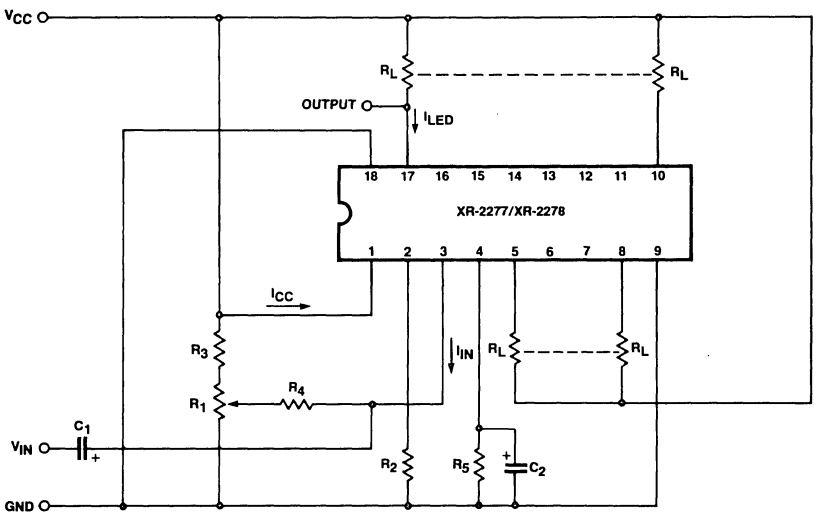
The LED current is set by a resistor from Pin 2 to Ground. The zero dB reference is set by varying the bias on Pin 3. The output may be either moving dot (one segment only) or bar mode (all segments up to the measured value illuminated). This is determined by Pin 18.

The XR-2277 provides 12 discrete outputs for an input level range of −30 dB to +6 dB, referenced to an internally set zero dB level which is typically 0.2 V_{RMS}. The XR-2278 has similar electrical charcteristics, providing a −20 dB to +8 dB input dynamic range referenced to 0.13 V_{RMS}. Both parts operate from a nominal 12V supply.

ELECTRICAL CHARACTERISTICS V_{CC} = 12 Volts, T_A = 25°C, unless otherwise specified. (See Test Circuit of Figure 2.)

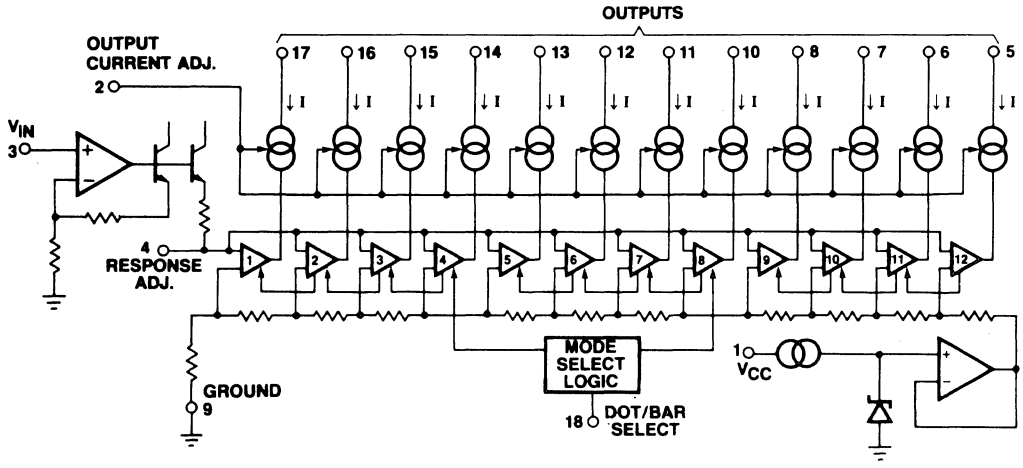
PARAMETERS	XR-2277 MIN	XR-2277 TYP	XR-2277 MAX	XR-2278 MIN	XR-2278 TYP	XR-2278 MAX	UNITS	CONDITIONS
Supply Voltage	10	12	14	10	12	14	V_{DC}	$V_{F(LED)}$ = 2 V
Supply Current		5	10		5	10	mA	V_{IN} = 0 V
LED Current			22			22	mA	R_2 Varied See Figure 4
LED Current	12	15	18	12	15	18	mA	R_2 = 27 KΩ
I_{LED} Matching between Outputs	−1.5		+1.5	−1.5		+1.5	mA	R_2 = 27 KΩ
Input Voltage for 0 dB Output	0.10	0.20	0.25	0.09	0.13	0.18	V_{RMS}	0 dB Output Threshold
Input Current		50			50		nA	
Outputs								
Output 1 (pin 17)	−31.5	−30.0	−28.5		20.0		dB	See Note 1
Output 2 (pin 16)		−27.0		−16.5	−15.0	−13.5	dB	See Note 2
Output 3 (pin 15)	−25.0	−24.0	−23.0	−11.5	−10.0	−8.5	dB	
Output 4 (pin 14)	−21.5	−20.0	−18.5	−8.0	−7.0	−6.0	dB	
Output 5 (pin 13)	−18.5	−17.0	−15.5	−6.0	−5.0	−4.0	dB	
Output 6 (pin 12)	−15.5	−14.0	−12.5	−4.0	−3.0	−2.0	dB	
Output 7 (pin 11)	−11.0	−10.0	−9.0	−1.5	−1.0	−0.5	dB	
Output 8 (pin 10)	−8.0	−7.0	−6.0		0		dB	
Output 9 (pin 8)	−5.0	−4.0	−3.0	+0.5	+1.0	+1.5	dB	
Output 10 (pin 7)		0		+2.0	+3.0	+4.0	dB	
Output 11 (pin 6)	+2.0	+3.0	+4.0	+4.0	+5.0	+6.0	dB	
Output 12 (pin 5)	+4.5	+6.0	+7.5	+6.5	+8.0	+9.5	dB	

NOTES:
1. Calibration adjustment for XR-2277: An input voltage, V_{IN}, is applied at −27 dB level, referenced to zero dB setting, and R_1 is adjusted until Output 2 (Pin 16) turns on.
2. Calibration adjustment for XR-2278: An input voltage, V_{IN}, is applied at −20 dB level, referenced to zero dB setting, and R_1 is adjusted until Output 1 (Pin 17) turns on.



R_1 = 500Ω
R_2 = 27KΩ
R_3 = 330KΩ
R_4 = 10KΩ
R_5 = 10KΩ
C_1 = 2.2μF
C_2 = 10μF
R_L = 200Ω

Figure 2. Generalized Test Circuit



EQUIVALENT SCHEMATIC DIAGRAM

PRINCIPLES OF OPERATION

As shown in the equivalent circuit schematic of Figure 1, each circuit is comprised of 12 voltage comparators with current source outputs. One input in each of the comparators is connected to a common voltage line. The input voltage, V_{IN}, is applied to this signal line through a buffer amplifier. The remaining input of each of the comparators is biased from an internal resistor ladder connected to a voltage reference on the IC chip. Thus, each of the 12 ladder taps corresponds to the particular output thresholds, listed as outputs one through twelve, in the electrical characteristics.

As the input voltage applied to the device is increased, each of the 12 comparators in the chip changes state sequentially at the time the input signal levels reach their respective threshold levels. The current source outputs of these comparators can directly drive LED displays. The circuit can operate both in moving-dot or bar-graph display format.

Figure 3 shows the typical output current waveforms for operating in either the moving-dot or the bar-graph modes. The mode of operation is selected by the logic state at Pin 18. If this pin is grounded, the output display is in the moving-dot format where only one of the current outputs is active at any one time, depending on the input signal level.

If Pin 18 is left an open circuit, then the IC operates as a bar-graph display generator. In this mode of operation, the external LEDs are connected in series, in groups of four to minimize power dissipation.

The outputs of the comparators (4), (8), and (12), continue conducting in this manner as long as the voltage level is above in respective threshold points.

EXTERNAL ADJUSTMENTS

Output Brightness Adjustment

The output current level for each of the 12 outputs is controlled by an external current setting resistor, R_2, ($R_2 \geq 20$ kΩ) connected from Pin 2 to Ground, Figure 4 shows the available output drive current, I_{LED}, as a function of R_2.

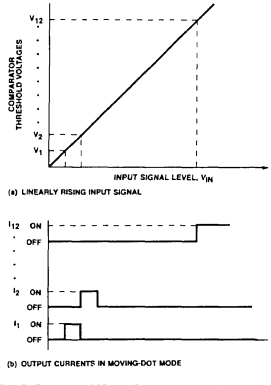


Figure 3. Typical Output Waveforms in Moving-Dot Display Mode

Response Adjustment

Transient response of the circuit is adjusted by an external resistor, R_5, and capacitor, C_2, connected from Pin 4 to ground. Typical component values for audio frequency applications, from 20 Hz to 20 kHz, are: R_5 = 10 kΩ and C_2 = 10 μF. The internal impedance at Pin 4 is approximately 100 ohms. C_2 functions as a holding capacitor of the internal peak rectifier circuit, with R_5 controlling its decay time.

Scale Adjustment

The output thresholds for the XR-2277 or the XR-2278 are measured relative to an internal zero dB reference level. Thus, for a given input signal dynamic range, each circuit must be calibrated with respect to the zero dB reference level setting. This calibration is performed by adjusting the potentiometer, R_1, shown in Figure 2. The scale adjustment is performed with an audio frequency ac signal applied to the circuit.

XR-2277

Step 1: Determine exact value of input voltage to produce zero dB output. This is done by increasing the ac input signal amplitude until Output 10 (Pin 7) begins conduction.

Step 2: Reduce input voltage level to −27 dB referenced to the input level of Step 1. Adjust R_1 until Output 1 (Pin 16) begins conduction.

XR-2278

Step 1: Determine exact value of input voltage to produce zero dB output. Do this by increasing ac input signal level until Output 8 (Pin 10) begins conduction.

Step 2: Reduce input voltage level by −20dB referenced to its zero dB level. Adjust R_1 until Output 1 (Pin 17) beings conduction.

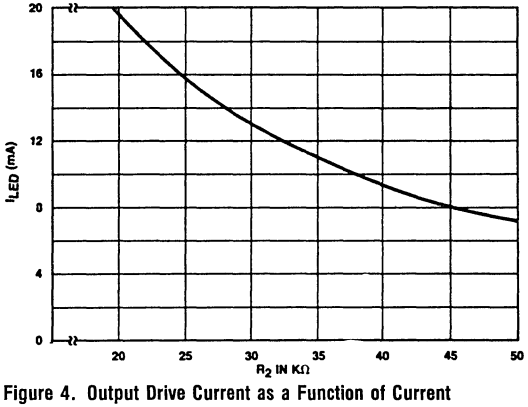


Figure 4. Output Drive Current as a Function of Current Setting Resistor, R_2

APPLICATIONS

MOVING-DOT DISPLAY

Figure 5 shows the basic connection of the XR-2277, or the XR-2278, as a moving-dot display generator and driver. In this mode of operation Pin 18 is connected to ground. Increasing the voltage at the input will cause each one of the 12 LEDs to turn on, one at a time, at the appropriate input level, and thus generate a moving dot of light. Output waveforms for this mode are shown in Figure 3(b).

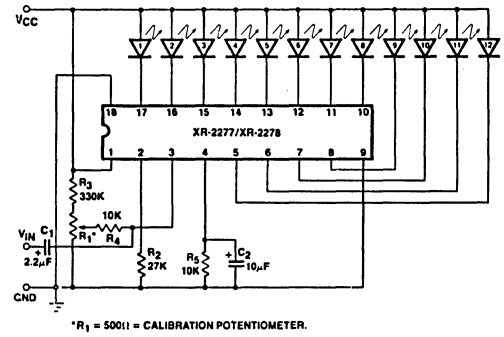


Figure 5. Circuit Connection for Moving-Dot Display Generation

BAR-GRAPH DISPLAY

Figure 6 shows the basic circuit connection for the XR-2277, or the XR-2278, as a bar-graph display generator and driver. Note that in this mode of operation the 12 LEDs are connected in series in three groups of four LEDs, and the mode-select terminal (Pin 18) is left an open circuit. Each LED will turn on and stay on as the input signal amplitude is increased as long as the input voltage stays above the threshold level corresponding to that particular output.

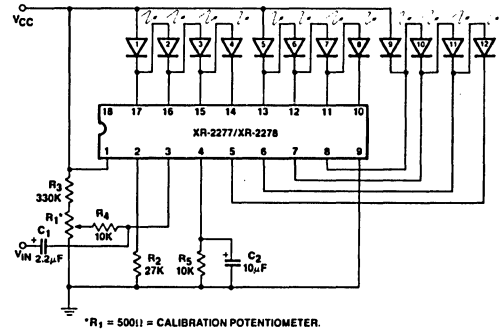
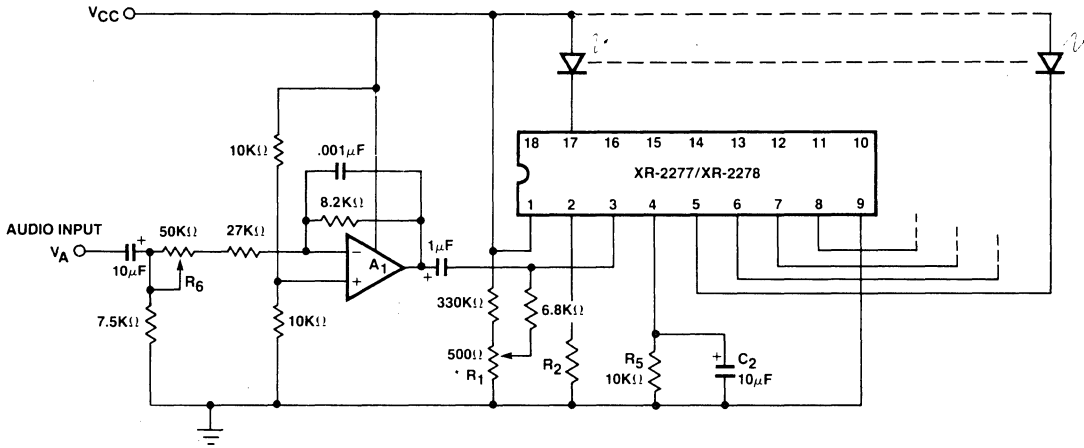


Figure 6. Circuit Connection for Bar-Graph Display Generation

AUDIO LEVEL INDICATOR

Figure 7 shows a complete audio level indicator system made up of either the XR-2277 or the XR-2278 Display Generator and an adjustable gain amplifier. For a given dynamic range of the input audio voltage, V_A, the potentiometer R_6 is used to set the gain of the input amplifier which is adjusted to give the desired zero dB output level from the display generator IC. The potentiometer R_1 is then adjusted to set the lowest output level; i.e., the −27 dB level for the XR-2277 or the −20 dB level for the XR-2278. The display output format can be either the moving-dot or the bar-graph type, by choosing the LED interconnections and the logic signal applied to Pin 18.



A_1 = ½ OF XR-082

* R_1 = CALIBRATION POTENTIOMETER.

Figure 7. Typical Audio Level Indicator System Using the XR-2277/XR-2278.