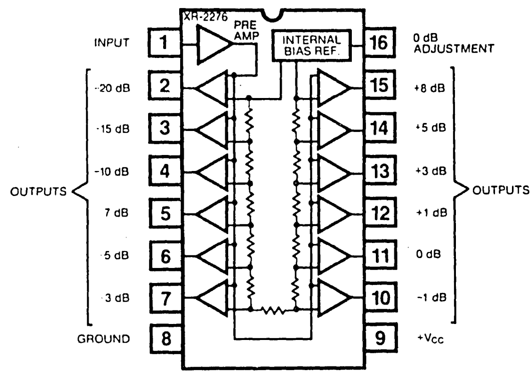
Bar Graph Display Generator

GENERAL DESCRIPTION

The XR-2276 is a 12-point logarithmic bar graph display generator designed for interfacing with fluorescent displays. The device's twelve comparators, internally biased at logarithmic intervals about an adjustable reference, controlling twelve fluorescent drivers. The XR-2276 may also drive LEDs if the maximum device power dissipation is not exceeded.

The XR-2276 is especially suited for generating 12-point bar graphs or other multi-segment fluorescent displays, such as those used for audio level-detector or level-indicator applications.

FUNCTIONAL BLOCK DIAGRAM



FEATURES

High Input Impedance
Internal Pull-Down Resistors
Logarithmic Display Characteristics
External Reference Level Adjustment

ORDERING INFORMATION

Part Number	Package	Operating Temperature
XR-2276CP	Plastic	0°C to +70°C

APPLICATIONS

Bar-Graph Display Generator
12-Point Display Driver
Audio Level Indicator
Channel Separation Indicator
12-Point Digital Controller
Sequential Display Generator

ABSOLUTE MAXIMUM RATINGS

Power Supply	24V
Input Signal Range	−1V to +10V
Output Current	5 mA
Power Dissipation	625 mW
Derate Above +25°C	5 mW/°C
Operating Temperature	0°C to +70°C
Storage Temperature	−65°C to +125°C

SYSTEM DESCRIPTION

The XR-2276 is a logarithimic level detection and fluorescent display driver. The circuit is comprised of an input buffer amplifier, 12 high gain comparators, an internal voltage reference and a bias-setting resistor string. All of the twelve comparator stages have independent buffered outputs.

Each of the comparators have a threshold level higher than the preceeding comparator stage. With no input signal, all of the comparators are "off" and all the outputs are at a low state. As the input level is increased, the outputs successively switch to their high state. The threshold levels are within the range of −20 dB to +8 dB with reference to a 0 dB level setting. The 12 ranges are: −20 dB, −15 dB, −10 dB, −7 dB, −5 dB, −3 dB, −1 dB, 0 dB, 1 dB, 3 dB, 5 dB, and 8 dB.

ELECTRICAL CHARACTERISTICS

Test Conditions: V_{CC} = 18 Volts, T_A = 25°C, unless otherwise specified. (See Test Circuit of Figure 1)

PARAMETERS	LIMITS			UNITS	SYMBOL	CONDITIONS
	MIN	TYP	MAX			
Input Current		30	300	nA	I_{IN}	V_{IN} = 7.5 Volts
Output Low Voltage		0	0.5	V	V_{OL}	R_L = 220 KΩ Measured at each output
Output High Voltage	14.0	15.5		V	V_{OH}	R_L = 15 KΩ Measured at each output
Input Bias Voltage	0.9	1.25	1.6	V	V_{OS}	
Comparator Threshold Voltages					V_C	Input level above V_{OS} necessary to change comparator state.
0 dB Output	—	2.10	—	V		Measured at pin 11 after 0 dB adjustment
−20 dB Output		0.3		V		Measured at pin 2
−15 dB Output	0.40	0.46	0.52	V		Measured at pin 3
−10 dB Output	0.65	0.73	0.83	V		Measured at pin 4
−7 dB Output	0.92	0.99	1.07	V		Measured at pin 5
−5 dB Output	1.15	1.23	1.30	V		Measured at pin 6
−3 dB Output	1.43	1.52	1.61	V		Measured at pin 7
−1 dB Output	1.77	1.88	2.00	V		Measured at pin 10
+1 dB Output	2.21	2.34	2.49	V		Measured at pin 12
+3 dB Output	2.76	2.93	3.10	V		Measured at pin 13
+5 dB Output	3.37	3.66	3.97	V		Measured at pin 14
+8 dB Output	4.72	5.12	5.56	V		Measured at pin 15
ODB Adjust Range		+1 −2		Segments		10 K Trim Pot from pin 16 to GND V_{IN} = 3.35V
Comparator Threshold Change with Supply	−0.6		+0.6	dB	ΔV_C	ΔV_{CC} = 6V R_L = 15 KΩ
Supply Current		13	20	mA	I_{CC}	V_{IN} = 7.5V R_L = 220 KΩ, V_{CC} = 18V

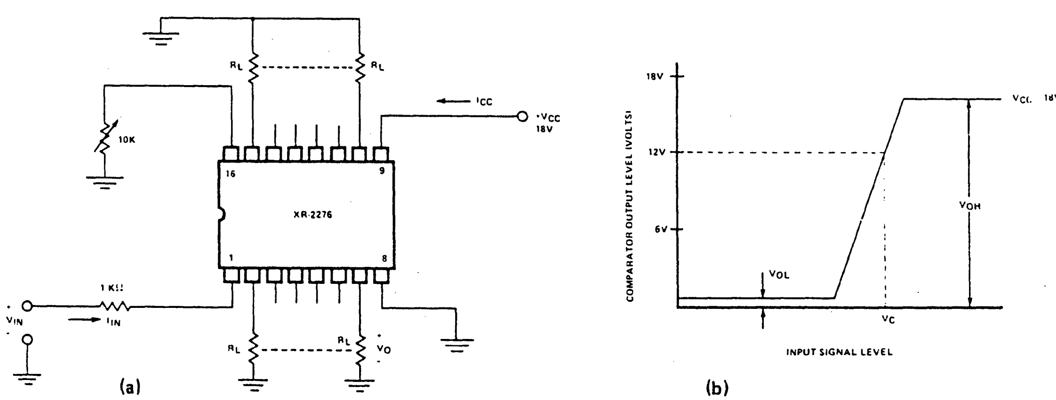
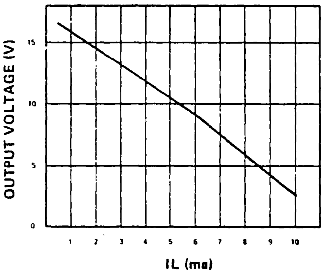


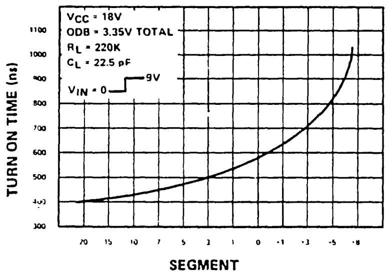
Figure 1. Basic Test Circuit: (a) Circuit Connection, (b) Output Waveform.

TYPICAL PERFORMANCE CHARACTERISTICS

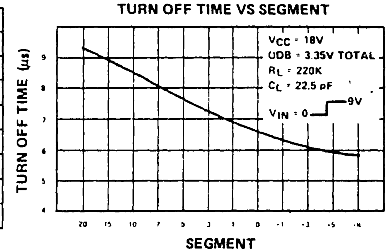
OUTPUT VOLTAGE VS LOAD CURRENT



TURN ON TIME VS SEGMENT



TURN OFF TIME VS SEGMENT



APPLICATION INFORMATION

Vacuum Fluorescent Displays: Vacuum fluorescent displays operate like vacuum tubes. The display consists of a filament, a grid and several plates. Each segment on the bar graph and the other symbols, reference numbers, etc., are plates coated with fluorescent material. As with a vacuum tube, when the plate is at a potential lower than that of the grid, no plate current flows and the segment associated with that plate is cut off. When the plate is at the same potential as the grid, electrons flow from the filament to the plate, striking the fluorescent material, thus, causing it to glow. Most of the new low voltage vacuum fluorescent displays operate with a plate voltage of about 16V–18V, a filament voltage of 3V rms and a filament current of about 100 ma.

XR-2276 Detailed Description: The XR-2276 contains an input buffer amplifier, a bias network and 12 comparators. The input buffer amplifier, pin 1, must be biased at approximately +1.25V under quiescent conditions. The signal is then applied in addition to this bias voltage. The full scale calibration of the XR-2276 can be fine tuned by varying the bias voltage slightly.

The buffer amplifier is a high input impedance unity gain amplifier that applies the input voltage to one input of each of the twelve comparators.

The bias network consists of a voltage reference and a string of weighted resistors which provide the threshold voltages for the twelve comparators. The reference voltage is adjustable by connecting a 10K trimpot from pin 16 to ground. This feature allows a precise setting of the 0 db point.

Since decibels are ratios with respect to a reference value, the threshold voltages determined by the resistor string may not correspond to the desired reference. In this case it will be necessary to scale the input signal with either gain or attenuation to obtain the desired correspondence (see the design examples below).

The comparators have a high open loop gain, NPN output transistors with 220K resistors connected from the emitters to the ground terminal, pin 8, and a 1.5K resistor in series with the output.

Applications Circuits: Figure 2 shows a typical connection for a two channel display. Note that the grid and any plate segments that are to remain constantly on are tied to the V+ line. All other plate connections are switched by either the XR-2276 or some other means (i.e., a selective switch for a Dolby symbol, etc.). The 0 db point is adjusted for each device by the 10K pot from pin 16 to ground.

Design Example: Design a gain scaling and peak detector circuit to drive the circuit in Figure 2, to yield an audio level indicator with 0 db referenced to 1 mw into 600Ω. The circuit should have an input impedance of 100 kΩ, respond to frequencies from 50 Hz to 15 kHz, have an output dc offset of 1.25V to bias the input of the XR-2276 and operate from a single 16V supply. This circuit is shown in Figure 3.

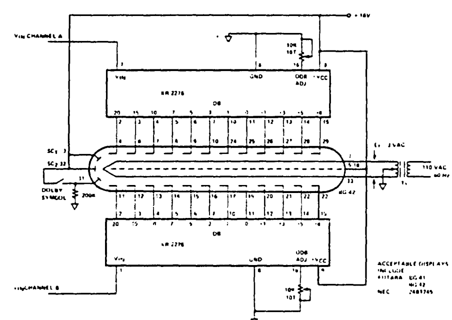


Figure 2. 2 Channel Display

Calculate the component values for the gain scaling stage.

The rms voltage that corresponds to 1 mw in 600Ω is:

$$\sqrt{PR} = \sqrt{(1\text{ mw})(600\Omega)} = .774\ V_{rms}$$

Therefore

$$V_{peak} = (1.414)(.774)V_{rms} = 1.095V$$

The dc input voltage to the XR-2276 that gives a 0 db indication is 2.10V.

The gain required is 2.10/1.095 = 1.92. For a non-inverting amplifier gain = 1 + R_F/R_S. If we choose,

$$R_F = 22K \text{ Then } R_S = 22K/.92 = 24K$$

$R_1 = R_2 = 200K$ to bias the input at V+/2 and yield an input impedance of 100K.

$$C_1 = 1/2\pi(50\ Hz)(100K) \approx .033\ \mu F$$

$$C_2 = 1/2\pi(50\ Hz)(24K) \approx .15\ \mu F$$

The input impedance to the peak detector is:

$$47K \,/\!/\, 100K \approx 32K$$

$$C_3 = 1/2\pi(50\ Hz)(32K) \cong 0.1\ \mu F$$

The peak detector circuit provides full wave rectification of the incoming audio signal. A_1 serves an inverting unity gain peak detector giving a positive output for the negative half cycle of the incoming signal. A_2 serves as a unity gain non-inverting peak detector giving a positive output for the positive half cycle of the incoming signal. D_3 and D_4 serve as rectifier diodes and D_1 and D_2 keep the feedback loops on A_1 and A_2, respectively, closed during the amplifiers non-rectifying half cycle. R_5 and R_7 set the closed loop gain of A_1 at unity. R_8 and R_7 together with C_5 provide a filter for the peak detector output. C_5 can be adjusted to provide the desired damping. R_4, R_6, C_4, D_5 and D_6 prevent the input of A_2 from being pulled below ground by the large negative transients. R_9, R_{10} and C_6 establish the 1.25 volt (adjustable by R_{10}) dc bias for the XR2276 input. The operational amplifier chosen to be used in this circuit is the XR-3403. It has adequate ac performance and is ideally suited to single supply operation, since its common mode input voltage range includes ground.

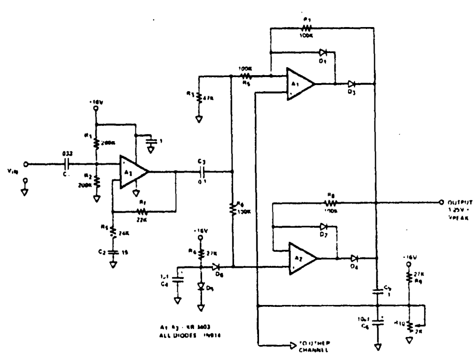


Figure 3. Peak Detector

Design Example: Design a vu indicator. The circuit above could be used to make a vu indicator with a slight adjustment in the circuit gain. Since 0 vu is 4 dB above 1 mw into 600Ω:

$$4\ dB = 20 \log(0\ vu)/1.095$$

$$(10)^{1/5}(1.095)V = 0\ vu$$

$$0\ vu = 1.735V_{peak}$$

The gain for the input amplifier would have to be

$$Gain = (2.10)/1.735 = 1.21$$

$$R_S/R_f = .21 \text{ for non inverting amplifier}$$

if

$$R_f = 24K$$
$$R_S = (24K)(.21) \approx 5.1K$$

Driving LED's with the XR-2276: LED's can be driven by the XR-2276 provided care is taken not to exceed the maximum power dissipation of the device. This can be accomplished in two ways. First, the cathodes of the display device can be multiplexed such that the total current sourced by the XR-2276 at any one time, does not cause excessive power to be dissipated. An alternate method is to drive an external pass device, such as an XR-2203, which in turn drives the LED's. In this way the power dissipation is moved off of the XR-2276.

Design Example: How many LED's can be driven simultaneously without exceeding the maximum power dissipation of 625 mw? $V_{CC} = +18V$, $T_A = 25°C$.

The 1.5K resistor in series with the output can be as high as 3K and the no load output high voltage of the XR-2276 should be $\approx V_{CC} - 1V$. If the forward voltage on an LED is ≈1.7V, the current typically available to drive the LED would be:

$$(18V - 1V - 1.7V)/1.5K = 10.2\ ma$$

(5.1 ma if the series resistor = 3K)

The total voltage across each output would be 16.3V. The total power dissipated per segment is:

$$P_D = (16.3V)(10.2\ ma) = 166\ mw$$

The quiescent dissipation of the device

$$P_{Dq} = (I_{supply\ max})(V_{supply})$$

or

$$(20ma)(18V) = 360\ mw$$

The total number of segments that can be on at once is:

$$625\ mw - 360\ mw/166\ mw/_{segment} \approx 1 \text{ Segment}$$

The circuit in Figure 4 shows an acceptable method for using the XR-2276 in conjunction with LED's.

Design Example: How can 12 LED's be driven simultaneously at 20 ma without causing excessive power dissipation in the XR-2276:

This can be done easily using two XR-2203's to drive the LED's as shown in Figure 7. The current through the LED's is limited by the series resistors.

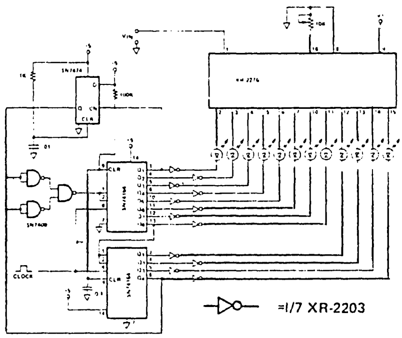


Figure 4. Multiplexed Display

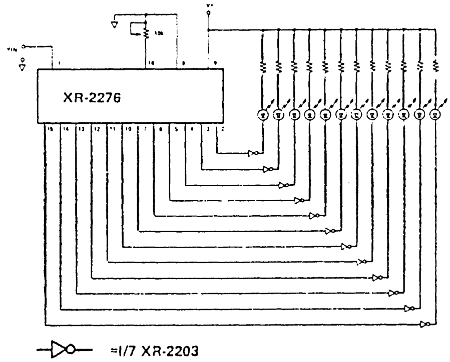
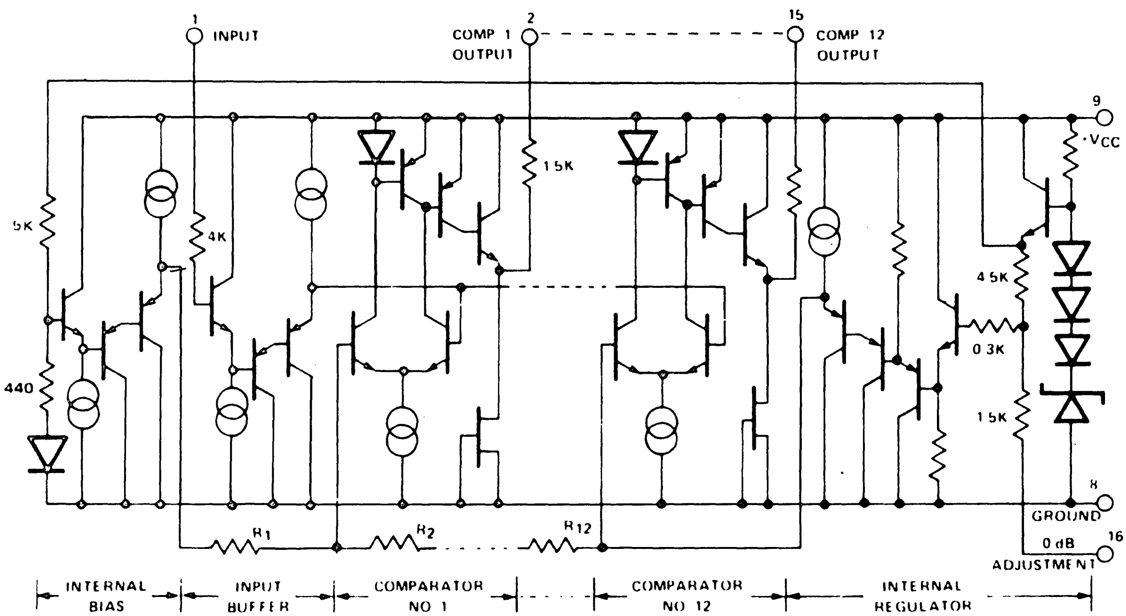


Figure 5. Continuous Display



EQUIVALENT SCHEMATIC DIAGRAM