High-Voltage AC Plasma Display Drivers

GENERAL DESCRIPTION

The XR-2284 and the XR-2288 are high voltage display driver arrays especially designed for interfacing with ac plasma display systems. The XR-2284 contains four independent driver channels, whereas its dual version, the XR-2288, contains eight driver channels. Each driver array can be used for either the segment or the column (or digit) drive, and several arrays can be "stacked" together to drive a large number of display segments.

All four channels of the XR-2284 are driven by a common ac toggle voltage; however, the XR-2288 has two independent toggle inputs, one for each of the four channels in the IC. The XR-2284 and the XR-2288 are designed for 360 volt ac plasma systems and have minimum stand-off voltages of 90 volts. The XR-2284C and the XR-2288C are designed for 240 volt plasma systems, and have minimum stand-off voltages of 60 volts.

The circuits can operate with ac toggle frequencies up to 200 kHz, and each driver channel can sink or source 100 mA of capacitive load current. For proper operation, the substrate terminals of all drivers must be grounded through an external disconnect diode, D_X, as shown in the schematic diagram.

FEATURES

High Stand-off Voltage
- 90 V minimum for XR-2284/XR-2288
- 60 V minimum for XR-2284C/XR-2288C

Very Low AC Standby Power
- (≈25 mW/channel at 100 kHz)

Zero DC Standby Power
100 mA Output Drive Capability
TTL and CMOS Compatible Inputs
Digital or Segment Drive Capability

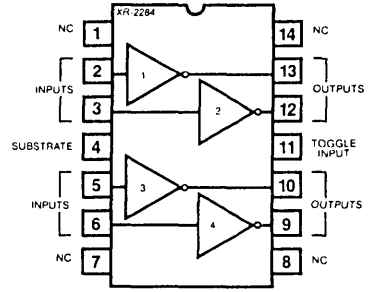
APPLICATIONS

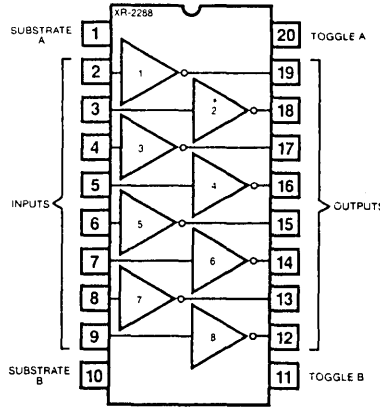
High Voltage AC Plasma Panels
High Voltage Pulsed Displays
Pulsed AC Switching

ABSOLUTE MAXIMUM RATINGS

Toggle Input Voltage	
XR-2284P/XR-2288P	±90V peak
XR-2284CP/XR-2288CP	±60B peak

FUNCTIONAL BLOCK DIAGRAMS





Power Dissipation	
XR-2284P/XR-2284CP	625 mW
XR-2288P/XR-2288CP	900 mW
Derate above +25°C	5 mW/°C
Storage Temperature	−65°C to 150°C

ORDERING INFORMATION

Part Number	Package	Operating Temperature
XR-2284P	Plastic	0°C to 70°C
XR-2284CP	Plastic	0°C to 70°C
XR-2288P	Plastic	0°C to 70°C
XR-2288CP	Plastic	0°C to 70°C

7

XR-2284/2288

ELECTRICAL CHARACTERISTICS

Test Conditions: Test Circuit of Figure 1, with external diode D_X = IN4002 or equivalent, T_A = 25°C, unless otherwise specified. (See operating precautions.)

PARAMETERS	XR-2284/XR-2288 MIN	XR-2284/XR-2288 TYP	XR-2284/XR-2288 MAX	XR-2284C/XR-2288C MIN	XR-2284C/XR-2288C TYP	XR-2284C/XR-2288C MAX	UNIT	SYMBOL	CONDITIONS
Maximum Toggle Voltage	±90			±60			V_{pp}	V_T	Peak-to-peak AC voltage- See Figure 3.
Output Current Capability									
Max Sourcing Current	100	150		100	120		mA	I_{source}	12% Duty Cycle
Max Sinking Current	100	120		100	120		mA	I_{sink}	12% Duty Cycle
Output Voltage									See Figure 4.
High Output) (selected)		(V_T-4)			(V_T-4)		V_{peak}	V_{OHS}	
High Output (non-selected)		4V			4V			V_{OHN}	
Low output		$(-V_T+2)$			$(-V_T+2)$		V_{peak}	V_{OL}	
Maximum Toggle Frequency	200			100	200		kHz	f_T	
High-Level Input	2	1.4		2	1.4		V	V_{IH}	
Low-Level Input		1.2	0.8		1.2	0.8	V	V_{IL}	
Input Current		8	16		8	16	mA	I_{IN}	See Figure 3.
Switching Characteristics									See Figure 4.
Rise Delay		500			500		nsec	t_{rd}	
Fall Delay (selected)		500			500		nsec	t_{fds}	
Fall Delay (non-selected)		500			500		nsec	t_{fdn}	

IMPORTANT OPERATING PRECAUTIONS

1. External diode D_X with reverse breakdown voltage $\geq V_T$ *must* be included in all circuit applications. This diode decouples or "floats" the IC from the circuit ground during the negative excursions of the toggle voltage, V_T.

2. the rise and fall times of toggle voltages, V_T, *must* be held to a value such that output current of each channel does not exceed 100 mA. This can be done by limiting the slewrate of toggle voltage to:

$$\left(\frac{dV_T}{dt}\right)_{max} \leq \frac{100\ mA}{C_L},$$

where C_L is the *total* load capacitance, including the capacitance of the display elements, driven by the particular output.

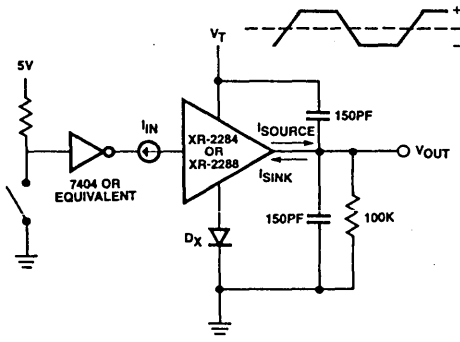


Figure 1. Generalized Test Circuit

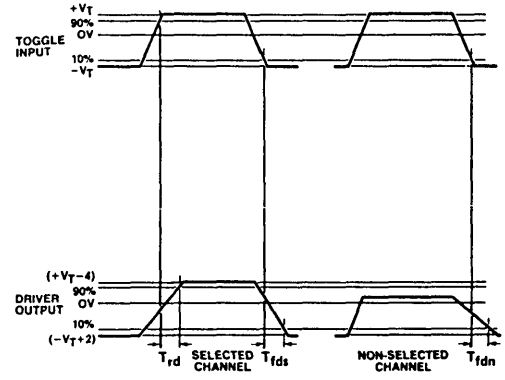


Figure 2. Typical Timing Waveforms

FUNDAMENTALS OF AC PLASMA DISPLAYS

Ac plasma display offer significant advantages over other alpha-numeric displays such as fluorescent or LED type panels. Some of these advantages are the low cost of the display itself, its wide viewing angle, and the ease of formatting in the selection of display segments and digits. Plasma systems typically require high voltage (200V or higher) ac drivers operating at relatively high frequencies (100 kHz and up). Although the plasma display panel is a capacitive load and does not draw dc current, the display driver output is required to provide a high output drive current (typically 50 to 100 mA), during the rising and the falling edges of the toggle voltage, so that the driver output can still follow the ac toggle voltage at high frequencies.

The ac plasma displays normally require a net voltage in excess of 200 volts across the display to turn it on. In practice, this is achieved by "pulsing" the display with two out-of-phase toggle voltages (V_T), such that a net peak-to-peak voltage of $2V_T$ appears across the selected display portion to make it turn on. Thus, in controlling the plasma display, one must control the amplitude of two peak-to-peak toggle swings, one on the "segment-side" and the other on the "digit-side" of the display, where each toggle swing is equal to only one-half of the total voltage swing needed to light up the display. For example, for 240 volt ac plasma display systems, the toggle voltage used (V_T) would be 120 volts; and for 360 volt display systems, 180 volt toggle voltage will be needed.

PRINCIPLES OF OPERATION

The XR-2284 and the XR-2288 ac plasma display driver circuits control the drive voltage applied to the segment or the digit section of an ac plasma panel.

Figure 3 shows the timing waveforms associated with the ac plasma driver circuit, for the case of a 360 volt display system (i.e., $V_T = \pm 90V = 180V$ pp). In normal operation, all of the driver channels are driven by a common ac toggle voltage (V_T) shown in Figure 3(a). When the control input to a driver channel, V_{in}, is at "high" state, as shown in Figure 3(b), its output would be clamped nearly to ground and would follow the negative excursions of the toggle voltage, V_T. This produces only 1/2 of the required peak-to-peak voltage across the particular display segment, which is *not* enough to light it. However, if V_{in} is at a "low" state, the driver output, V_{out}, would be enabled and follow closely the peak-to-peak excursions of the toggle voltage. This would then cause the nearly full peak-to-peak swing of the ac drive to appear across the selected display segment.

It should be noted that due to the external blocking diode D_X of Figure 1, the monolithic IC substrate is completely decoupled from ground during the negative excursion of the toggle voltage and the internal diode, D_2, of the schematic diagram causes the output to follow the toggle voltage within one diode drop. In this manner, the IC has to withstand only *one-half* of the total ac signal swing, or the *one-fourth* of the total voltage appearing across the entire plasma panel.

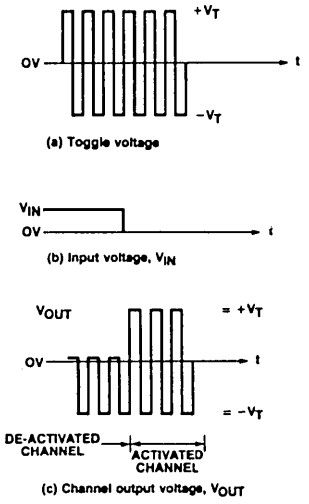


Figure 3. Timing Diagram of Circuit Waveforms

CIRCUIT DESCRIPTION

Both the XR-2284 and the XR-2288 are multichannel driver circuits, packaged in 14 and 20-pin dual-in-line IC packages respectively. The XR-2284 is a four-channel display driver, whereas the XR-2288 is an eight-channel circuit, made up of *two* four-channel driver chips in the same dual-in-line package. Thus, the XR-2288 has two toggle voltage and substrate inputs; one for each of the two four-channel IC chips sharing the same package.

The equivalent circuit diagram for a typical driver channel is shown in the schematic. All the channels have their own independent inputs and outputs, but share a common toggle or clock input and a common substrate or ground connection. The circuit is designed as a series connection of two controlled-switches, or SCR's. The transistors, Q_3 and Q_2, form one of the controlled-switches, and Q_1 and Q_4, form the second controlled-switch. The internal junction capacitance, C_j, causes

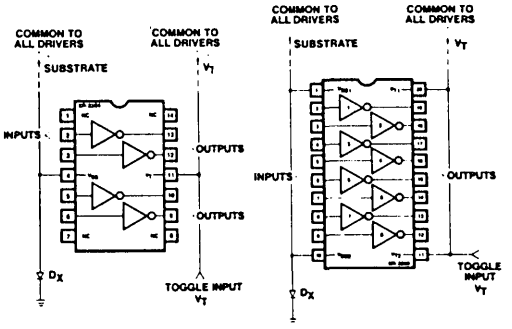


Figure 4. Generalized Connection Diagram XR-2284 and XR-2288.

the respective controlled-switches to be turned on during the positive and negative edges of the toggle input, V_T.

An external diode, D_X with a brekdown voltage $\geq V_T$, is used to "float" the substrate or decouple it from ground during the negative excursions of the toggle voltage. This external decoupling diode is common to all channels, and can serve more than one IC package, as shown in Figure 4. In this manner, many driver IC's, either of the four-channel (XR-2284) or the eight-channel (XR-2288) type, can be "stacked" to drive a large number of display segments or columns, with only one common blocking diode and a common toggle input, as shown in the Figure 4.

Under dc conditions, i.e., with no ac toggle drive, the driver IC's do not dissipate any appreciable standby power. However, when the ac toggle voltage, V_T, is applied and a particular channel is enabled, then the corresponding output can follow the peak-to-peak toggle voltage and sink or source up to 100 mA of capacitive load current to the plasma panel.

APPLICATIONS

Driving Seven-Segment Displays

Figure 5 illustrates a four digit, seven-segment plasma display panel with decimal point. The entire display can be driven by one XR-2288 driver for the segment side and one XR-2284 driver for the digit side. The segment and the digit drivers each must have their external disconnect diode, D_X, as shown in the figure. The segment and the digit sides of the display are driven by out-of-phase toggle signals, V_T and $\overline{V_T}$, which cause a total firing voltage of four V_T to appear across the enabled display segment. Segments not enabled will have a net voltage of three V_T across them. The peak-to-peak

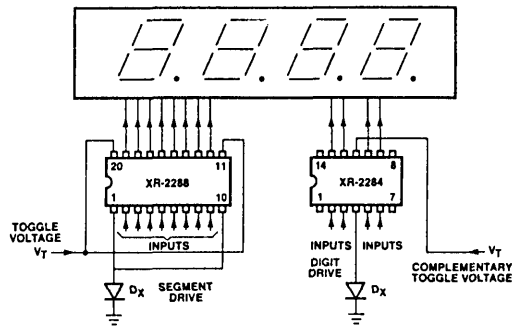


Figure 5. Typical Circuit Connection for Driving 7-Segment 4-Digit Display with Decimal Point

swing of the toggle voltage, V_T, is chosen so that the firing voltage, V_f, necessary for the display to light up, falls into the range of:

$$3\,V_T < V_f < 4\,V_T.$$

In this manner, only the selected and enabled display cells will have an energizing voltage $\geq V_f$.

Driving Alpha-Numeric Displays

Figure 6 shows the circuit connection for driving an eight digit, 16-segment alpha-numeric display. The number of digits can be increased by connecting additional XR-2284 or XR-2288 driver arrays into the digit side. These additional arrays can be directly "stacked" using the same external disconnect diode, D_X, and the same toggle voltage drive lines already present on the digit side.

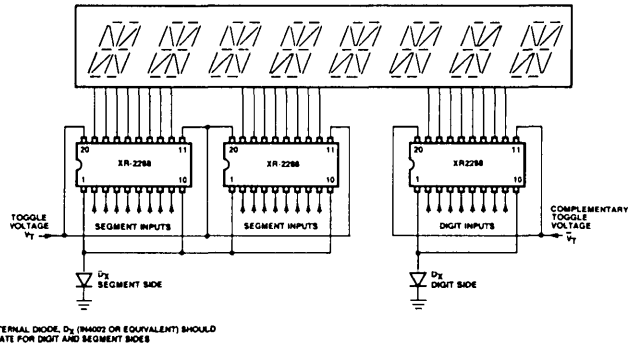


Figure 6. Circuit Configuration for Driving 16-Segment Alpha-Numeric Display Panel

EQUIVALENT SCHEMATIC DIAGRAM