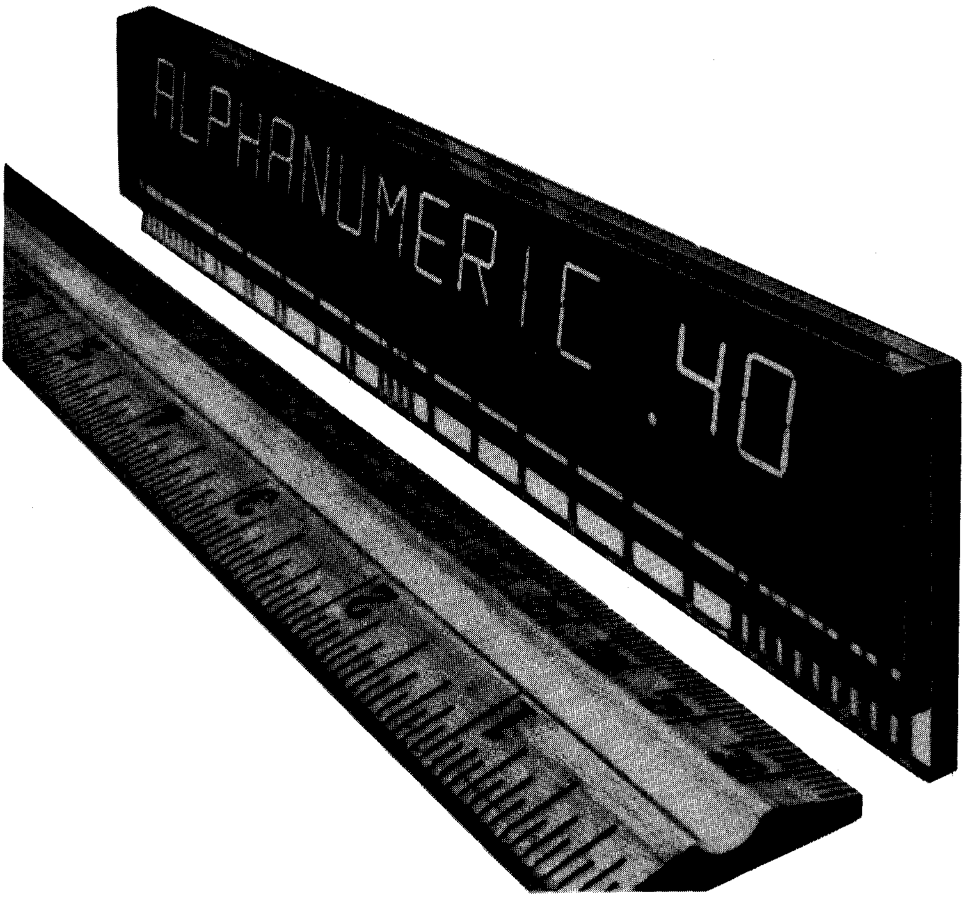
DALE

DRIVE CIRCUITRY DESIGN MANUAL FOR DALE PLASMA DISPLAYS



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INTRODUCTION

D.C. Plasma Displays can be driven by one of two methods, dc (segments on continuously, with each segment requiring its own drive) or multiplexing.

Multiplexing is usually the most cost effective plasma display driving method, and is the preferred method for driving Dale Plasma Displays. In multiplexed operation, all of the display digits are not on simultaneously, but rather, individual digits are switched on in a sequence at a high repetition rate. Therefore, more than one digit can time share a single cathode driver circuit. If the display consists of a large number of digits, a matrix of two or more cathode driver circuits may be used with a corresponding reduction in anode driver circuits.

The recommended method for multiplexing Dale displays connects all like cathode segments, in parallel, to one cathode driver, and scans the display anodes. Either of two anode scanning techniques may be used: sequential — each adjacent anode is successively switched on and off; or interlaced — anodes are scanned so that no two adjacent anodes are successively selected.

GENERAL DESIGN CONSIDERATIONS

WAVEFORMS AND TERMINOLOGY — Figure 1 shows the typical waveforms required for plasma display multiplexing and lists the terms used to describe the circuit operation. The timing requirements are important but not critical. For example, the scan period (refresh rate) is limited only by visual flicker at the low end, and the digit turn on delay at the high end. Digit on-time can vary from 80μs to 2 msec.

TYPICAL ANODE AND CATHODE WAVEFORMS FOR MULTIPLEXED DISPLAY

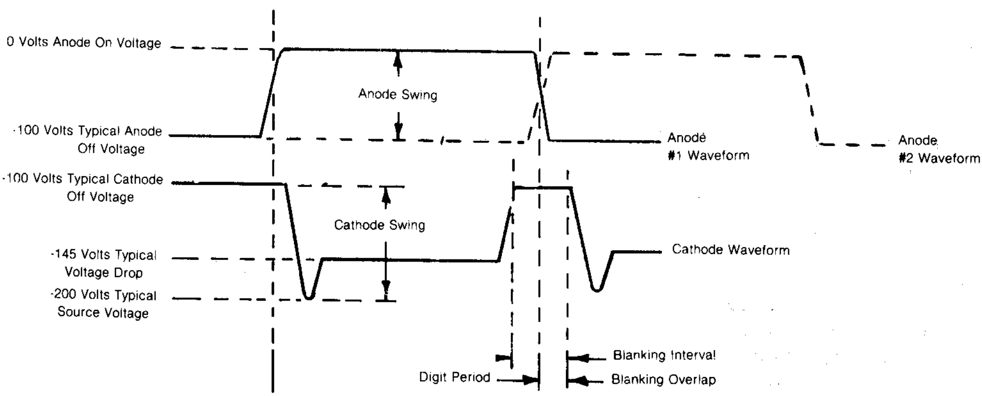

Figure 1

Flicker — The refresh rate must be fast enough so that the display appears flicker free. A 65hz rate is generally adequate, however an apparent flicker may be seen if the display and viewer are moving with respect to each other. A minimum refresh rate of 100hz will prevent this.

Random flicker can occur when slow refresh rates are used (generally greater than 3 msec) due to reionization delay uncertainty. This can be avoided by proper use of a keep alive cathode (described later) and by providing a digit period of 80 μsec minimum.

Streamers — If sufficient potential difference exists between the anodes of adjacent digits, the lower potential anode will act as a cathode for the pair and spurious ionization will cause a blue glow called a streamer to appear between the two digits. The same condition can exist between two cathodes.

The maximum potential difference between adjacent anodes is 110 volts. However, we recommend 90 volts, since a lesser voltage swing will produce less stress on the anode drivers and still provide proper display operation.

Blanking — Streamers may also occur when the anode of one digit position acts as an anode for an adjacent digit position. This condition can occur in multi-digit, multiplexed displays when insufficient deionization time is allowed between adjacent digit strobes.

To prevent streamers caused by residual ionization, the removal of turn-on voltage from, and the application of turn-on voltage to adjacent digits must be separated in time by electrode blanking, or successively energized digits must be physically separated by the use of interlaced scan, or both.

Electrode blanking creates a "dead time" between the on times of adjacent digits so that high level ionization from a previously energized digit can sufficiently decay before the next digit is energized. Interlaced scan simply increases the distance between successively energized digit position thereby eliminating the need for electrode blanking.

Blanking may be applied to the anodes, cathodes, or both (for best results, both) using either the leading or trailing edge of the addressing waveform. If both anode and cathode blanking is not feasible, cathode blanking has been found to the most effective.

The blanking time required for each display is called out in the display specifications and averages 30-40 μsec.

Keep Alive — A keep alive is another cathode-anode pair which is energized with a continuous current of approximately 50 microamperes. The function of the keep alive (available in all Dale displays) is to provide a continuous source of low level ionization within the display. Depending on the size of the display and mode of operation, more than one keep alive may be used. In most displays the keep alive is a separate set of electrodes, that is, the anode and cathode are not connected to any other electrode. A separate resistor in series with both anode and cathode, of the proper value to allow 50 microamperes current flow, should be used. These separate resistors will lower the potential difference between adjacent anodes and cathodes reducing the possibility of streamers.

In some cases the keep alive anode may not be separate, but connected to an anode that also serves other cathodes. In these cases the keep alive cathode should be kept 20 to 30 volts lower than the other cathodes to insure that the keep alive remains on continuously.

In either case a minimum source voltage of 180 volts is required to insure continuous keep alive operation.

To summarize, keep alive use expands the performance range of a display by permitting shorter digit periods, lower refresh rates, faster initial ionization, and lessened need for power supply filtering.

Power Consumption — The display's power requirements can be determined by several methods as follows.

(1) $P_{a\,(max)} = \dfrac{P_{pd} N t_d}{T_{scan}}$

where:

$P_{a\,(max)}$ = maximum average power per display

P_{pd} = peak power per digit with all segments ON

N = number of digits

t_d = digit period

T_{scan} = display scan period

however, it is readily apparent that $\dfrac{N}{T_{scan}} = \dfrac{1}{t_d}$

Therefore (1) becomes:

(2) $P_{a\,(max)} = P_{pd}$

If blanking is used, then (1) becomes:

(3) $P_{a\,(max)} = \dfrac{P_{pd} N (t_d - t_b)}{T_{scan}}$ or (4) $P_{a\,(max)} = P_{pd}\left(1 - \dfrac{t_b}{t_d}\right)$

where: t_b = blanking interval

When the digit period approaches 80μ secs, reionization time should be considered. Reionization time is the time required for a segment to turn on after the "ON" voltage has been applied. This time depends on the applied voltage, rise time, available ionization and the display temperature, but usually is 10-15 μ sec. (See Figure 2.) Thus equation (4) becomes:

(5) $P_{a\,(max)} = P_{pd}\left(1 - \dfrac{t_b - t_i}{t_d}\right)$

where t_i = reionization time

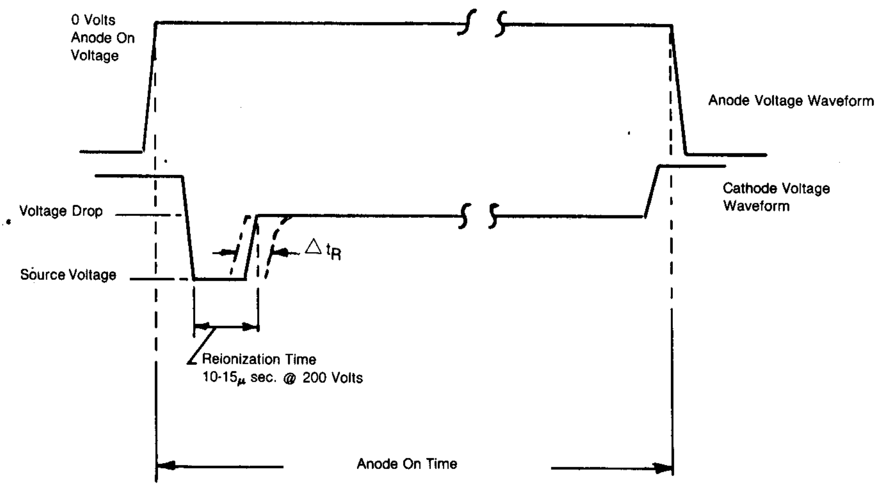

Figure 2

Voltage Requirements — Figure 3 shows the voltage/current characteristics of a typical display. For proper operation it is important to select a high enough supply voltage to support the required segment current but not so high that excessive power is wasted in the current limiting devices. Values of current limiting resistors for displays driven by transistor switches may be derived from the V-I curves. However, constant current IC drivers are suggested to constant brightness and consistent circuit performance.

DISPLAY CURRENT VS. DISPLAY VOLTAGE

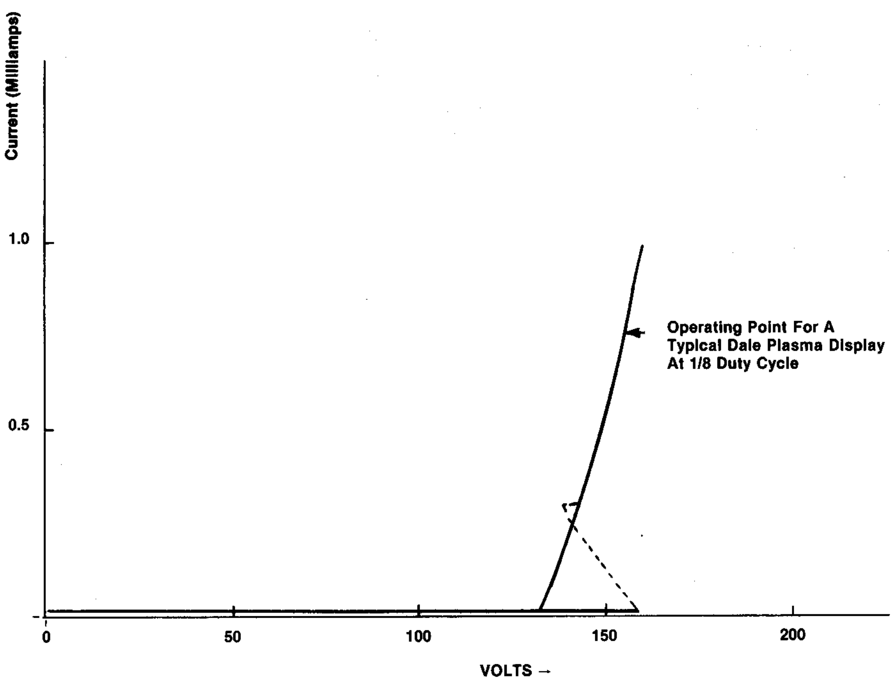

Figure 3

Brightness and Life — Both brightness and life of a display are a function of cathode current and duty cycle. Brightness may also be expressed in terms of average power, since average power is a function of current, voltage, and duty cycle. Display lifetime, unlike brightness, is approximately a non-linear inverse function of cathode current. That is, the lifetime of the display is reduced with increasing cathode current. Therefore, in order to obtain the best lifetime, the current should be kept at the lowest level possible to obtain brightness just necessary to be easily read in the maximum ambient light encountered.

Figure 4 shows light output versus current for a display with a 1/8 duty cycle. Light output for other designs and duty cycles can be extrapolated from the graph in Figure 4.

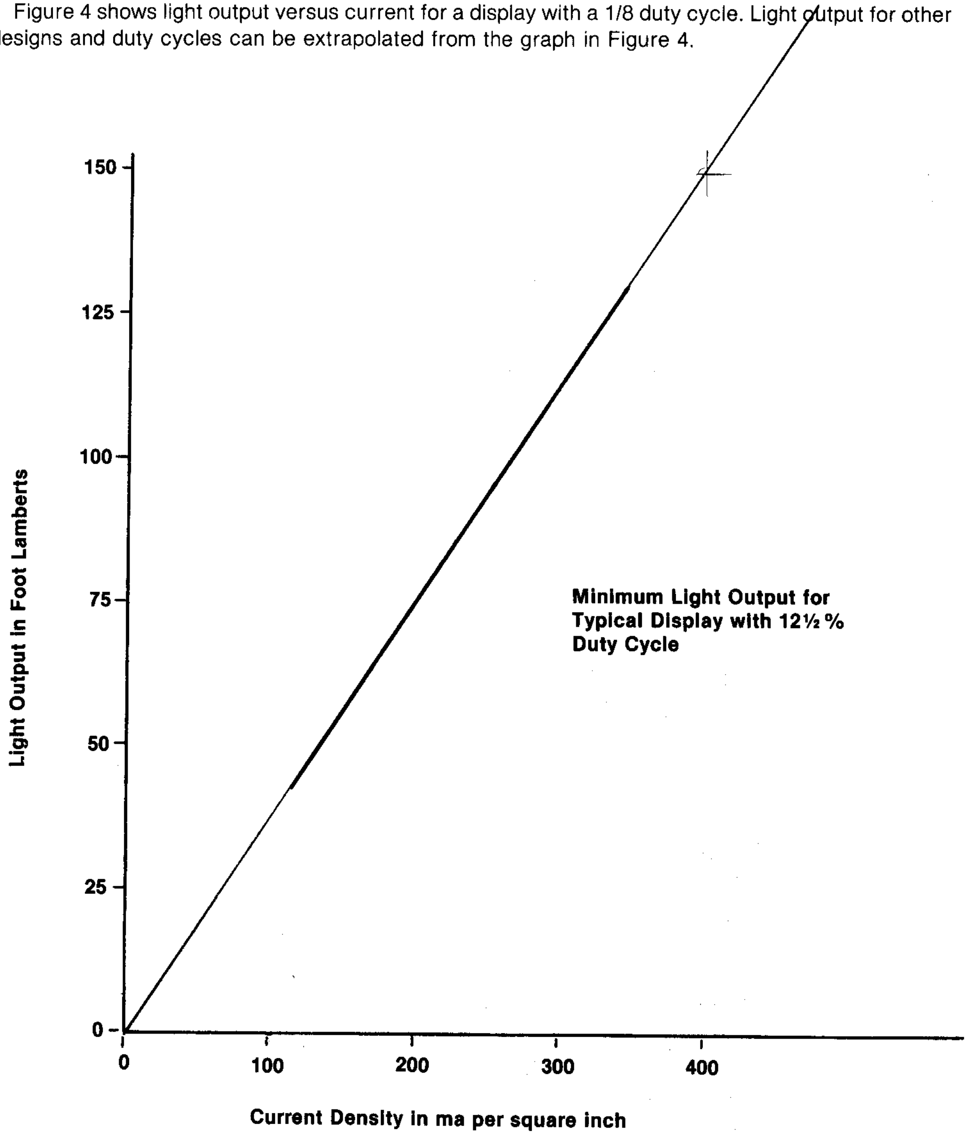

Figure 4

Integrated Circuit Drivers — Integrated circuits to directly drive plasma displays are manufactured by many semiconductor companies. They are made with level shifting capabilities of 70, 110, and as high as 200 volts. Cathode drivers may be of the constant current variety, or may use internal or external current limiting resistors. Some units have internal pull up or pull down resistors whereas others require external resistors.

Figures 5 and 6 show circuits using Dionics drivers. Their anode drivers are capable of being level shifted 200 volts, and the cathode drivers are programmable constant current sources (to adjust display current/brightness).

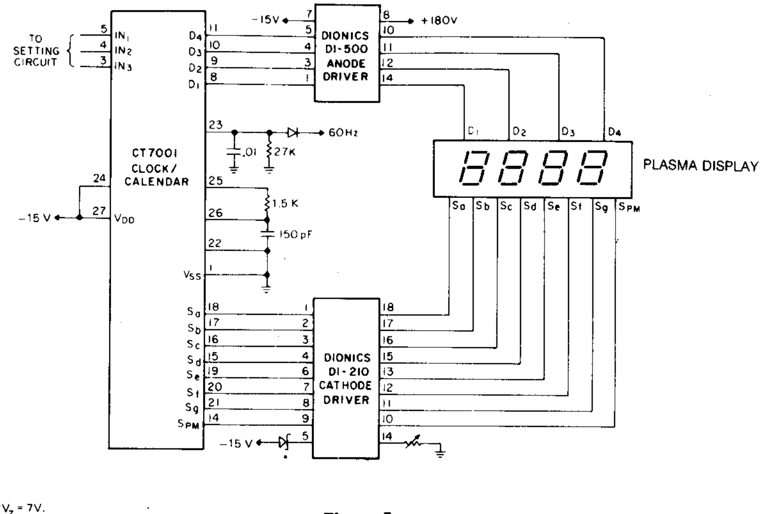

Figure 5

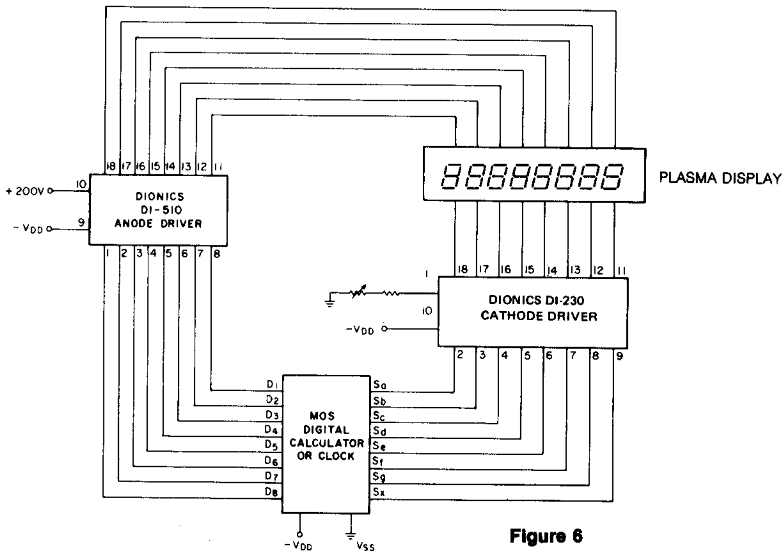

Figure 6

Figures 7 and 8 are examples of Sprague drivers that have internal pull up, and pull down resistors, and series resistors. They are capable of level shifting 100 volts or more. By using a split power supply of +100 and −100 volts, no other level shifting is required.

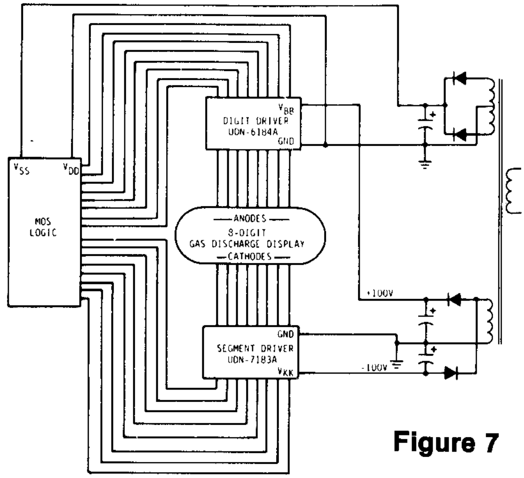

Figure 7

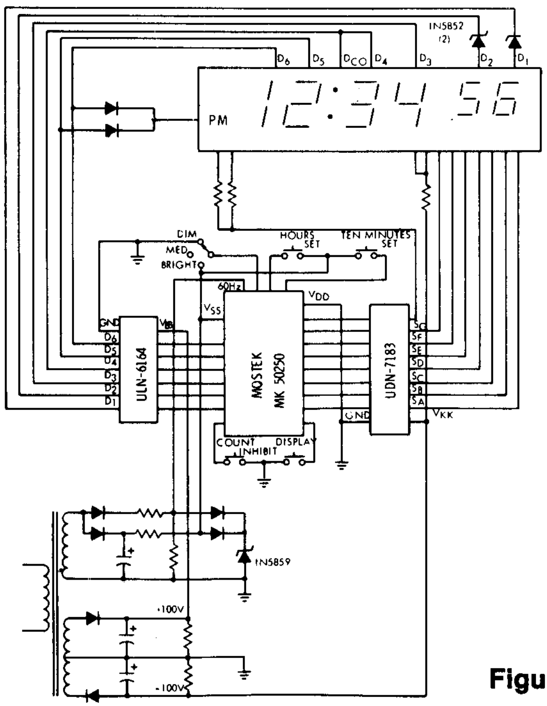

Figure 8

Not all of the IC's are only high voltage switches. For example, Texas Instruments has a cathode driver shown in Figure 9 that also has a latch and a seven segment decoder for use with BCD logic input.

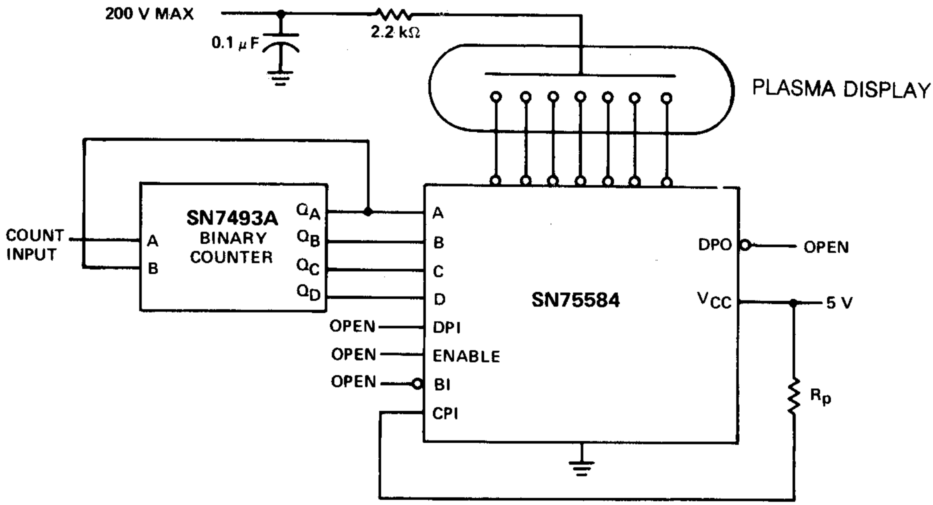

Figure 9

(Note: The 200v input must be adjusted to ensure that the "ON" state and "OFF" state voltages do not exceed 100 volts at the segment outputs of the SN 75584. The peak transient segment current must be limited to 50 mA ($t_w < 10\mu s$, duty cycle < 1%). This may be accomplished by connecting a 2.2K ohm resistor in series with the anode drivers, or otherwise limiting the current.)

Motorola's anode and cathode driver circuit shown in Figure 10 uses a capacitive level shift. The cathode drivers use constant current generators.

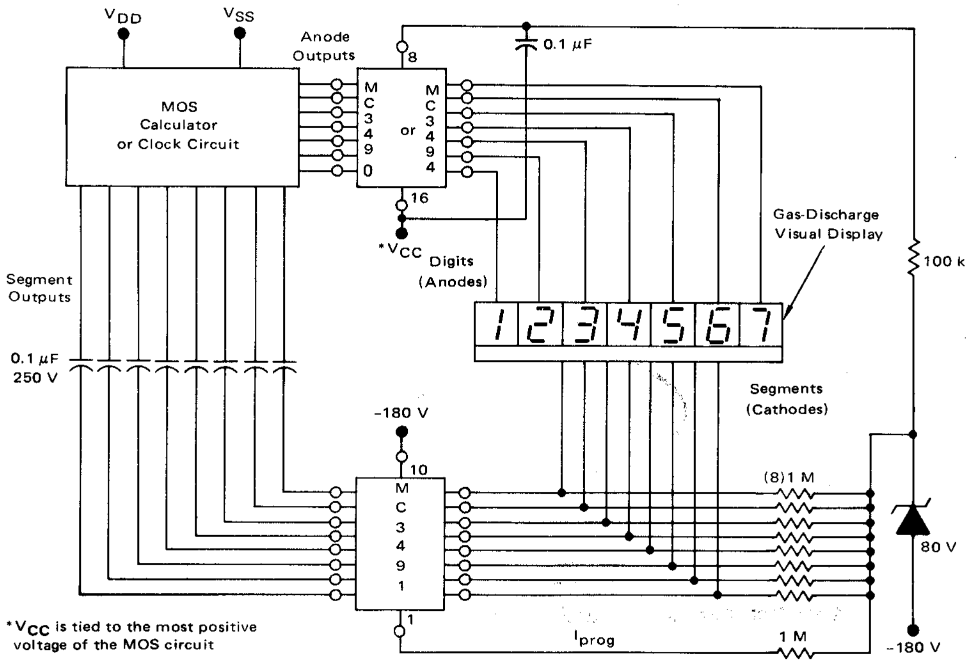

Figure 10

There are, of course, other manufacturers that build good drivers and high voltage switches that will drive plasma displays. The manufacturers listed here also have other types of drivers. The devices shown can be also used in combination to obtain the most desirable circuit for your logic input and power supply consideration.