VF DISPLAY FUNDAMENTALS

1. DESCRIPTION

The Vacuum Fluorescent (VF) Display is basically a vacuum tube. Electrons are emitted from a cathode (filament) and are controlled by a grid. The voltage on the grid determines whether the electrons are repelled or allowed to collide with a phosphor coated anode. Electrons striking the anode cause light to be emitted from the phosphor. The resultant light emission produces the specific wavelength light and resultant color associated with VF technology.

2. BASIC STRUCTURE

There are a number of variations in the structure of the VF tube. The basic structure is best explained by taking a triode structure VF Display and showing its architecture. Figure 1 shows the various parts of the basic structure.

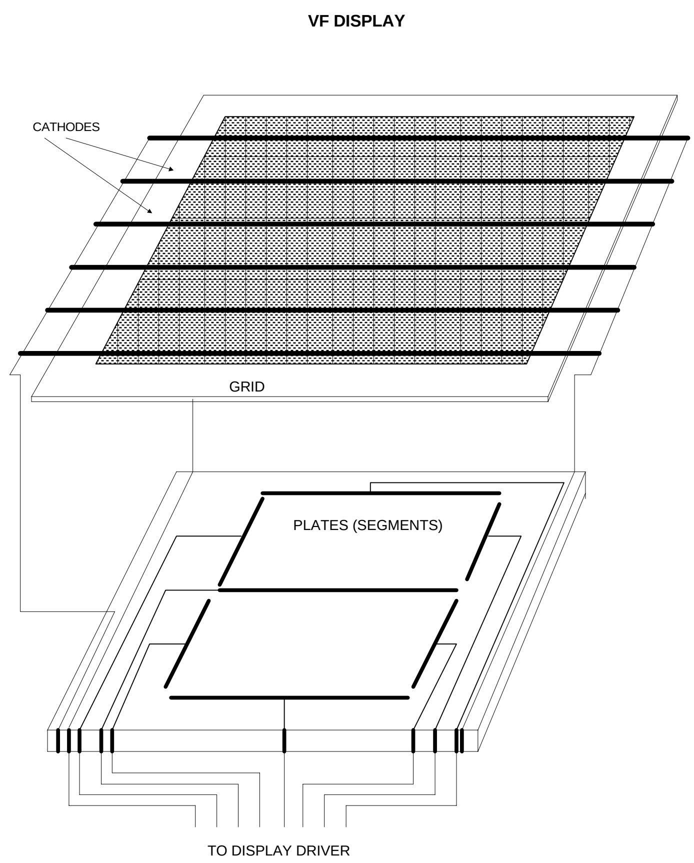

Figure 1 - VF Structure

3. ELECTRODE CONNECTIONS

The internal connection of electrodes is dependent on the type of drive system for which it is intended. The display may be structured for either static or dynamic drive. Figures 2 and 4 show a multiplexed configuration that is the most common. In a multiplexed system, grids are connected separately for each digit while the anodes are connected in common for the segments. This structure allows each digit to be strobed individually by a grid signal, while the anode of the segment signal is common to all the digits. In this configuration, only the digit that receives a grid signal is turned on. (See Figure 3)

In a Static Drive System, the grids are connected in common for all digits and the anodes are connected separately for each digit. The static drive system is not practical for multiple digit displays.

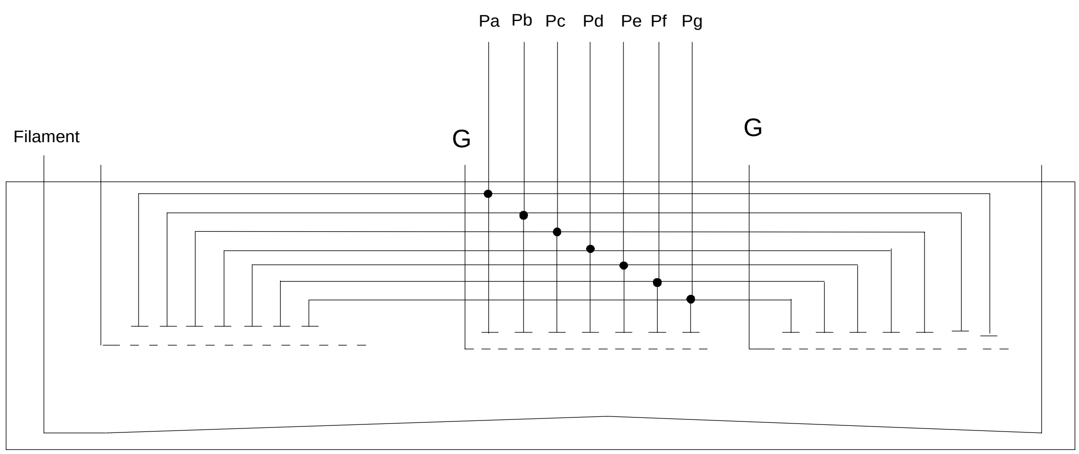

Figure 2 - Electrode Interconnections, 3 Segments of a Multi Segment Element

3.1 Electrode Drive Requirements

The VF drive requirements involve the proper biasing and signal driving of each of the three electrodes. In addition, certain special concerns must be addressed (for example: cut-off bias) in order to allow the system to operate properly.

3.1.1 Filament Drive

The filament or cathode is typically driven with an AC voltage, although certain displays allow the use of DC supplies. Figure 4 shows the basic DC filament biasing technique. With the DC drive method, a resultant filament potential exists across the width of the filament. This results in a non-uniform luminance in the display due to the variance in potential between the grid and the filament. In some displays made specifically for DC bias, the filament may be hung at different heights with respect to the substrate to compensate for this potential difference. Obviously this type of construction would produce a polarity concern which must be observed.

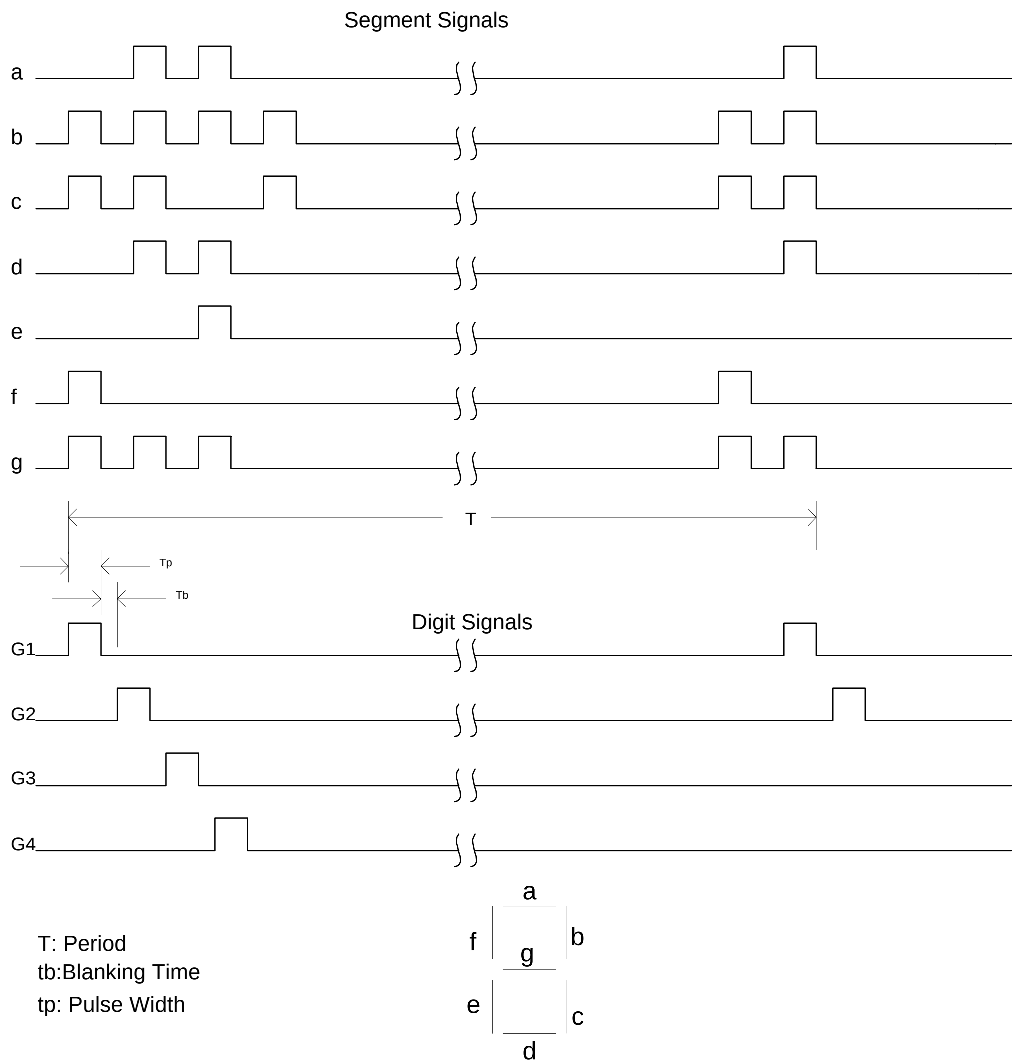

Figure 3 - Timing Relationship for a 4 Segment, Dynamic Drive

3.1.2 Grid and Anode Drive

The grid is a control electrode and either prevents or allows the flow of electrons to the anode. The grid is usually comprised of a screen mesh, which allows a majority of the electrons to pass through the grid area and impact the anode causing light emission**.** ***Typically the light emissions will occur when a positive voltage is applied to both the grid and the anode.***

3.1.3 Voltage Drive Requirements

The voltage required to properly drive a VF Display is dependent on the required luminance, the type of display, ambient light levels, and whether the display will be driven static or dynamic. Since constant voltage is applied in the case of static drive, considerable luminance can be obtained with relatively low voltage, while the dynamic drive may require considerably higher voltages due to the duty cycle.

3.1.4 Voltage Cutoff

It was mentioned earlier that voltage cutoff is an important characteristic for proper VF drive. This characteristic is a concern for both anode and grid, but the grid requirements are most important. In essence, cutoff is the voltage required to assure that the luminance of the display is totally off when required. Since phosphor has a luminance threshold, the cutoff voltage for the anode with respect to filament is not a major concern. The grid, being a control electrode, must be typically placed several volts lower than the filament when cutoff is desired.

4. DRIVE CIRCUIT REQUIREMENTS

VF applications typically require considerable effort relative to drive circuit design. Dynamic applications, in particular, require attention to duty cycle, pulse width, and segment timing.

4.1 Dynamic Drive

The upper circuit in Figure 6 depicts a typical dynamic drive circuit application. The cutoff voltage is supplied via the Zener Diode in order to reduce luminosity leakage. The active pull-down of the 6800 series serves to reduce the shut-off time of grid and anode. Since the anode and grid essentially represent high impedance capacitive loads, the fall time of the waveform would otherwise be prohibitive and limit the duty cycle of the display.

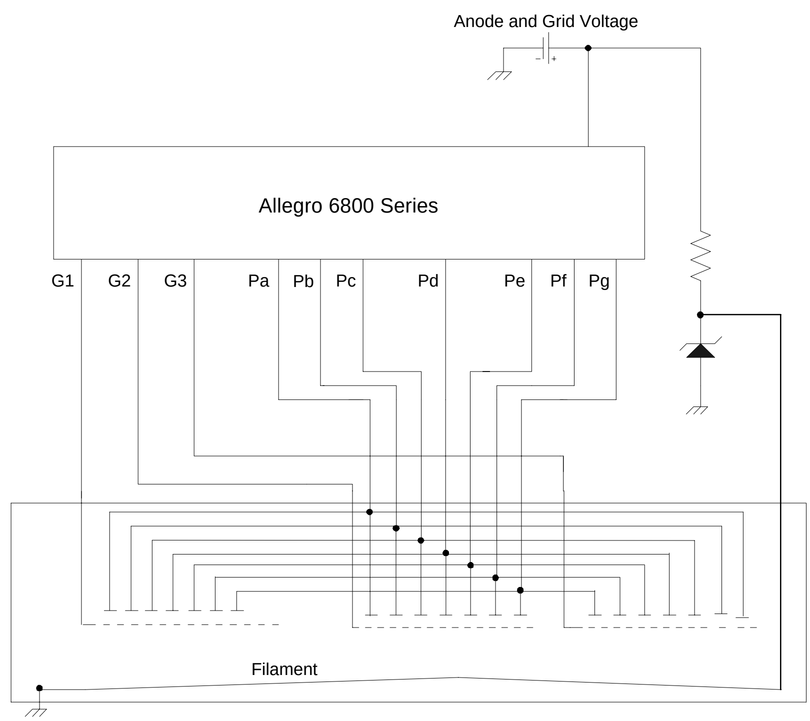

Figure 4 - Dynamic Drive (Multiplexed) Configuration

Figure 3 shows the timing relationships of an N Grid System and the relationship of the segment or anode data. The pulse width (T_P) is determined by the response time of the phosphor used in the display. This number can vary from 50 to several hundred microseconds depending on material. A typical value is 100 microseconds.

The blanking time (tb) is required to allow for the fall time of the pulsed waveforms. This number is dependent on phosphor material and the pull-down resistors.

The display recycle time (t) is dependent on pulse width (tp), blanking time (tb),and the number of digits multiplexed in the display. A point worth noting is that this recycle time must be in the range of 10 to 20µs maximum in order to avoid visual flicker. This is particularly true if the application has movement or vibration associated with it, since this tends to accentuate the flicker problem.

The duty cycle (D_u) of the display drive is the pulse width divided by the recycle time ($T_{P/t}$). The total design concerns of the display are a trade-off between anode/grid voltage, duty cycle, and luminance required.

4.2 Static Drive

The typical usage of static drive displays is in low voltage, high-luminance type applications. Since each anode (or segment) must be brought out separately, static applications typically have a very high pin requirement for drivers. The lower circuit in figure 6 shows a static drive application. The grid can be used to erase the entire display. The segment data must be loaded into the anode driver and latched for display. Note that if the filament voltage is fairly high, cutoff bias voltage may have to be applied to the filament. The static type display drive requirements are very straightforward in design, but costly in terms of driver pin-out requirements.

5. OUTPUT DRIVER CONFIGURATION, Allegro 6800 Series

Figure 5 shows the output stage of Allegro's 6800 series VF display driver. The circuit includes bipolar sourcing outputs and PNP active pull-downs. The schematic shows that the outputs are NPN Darlingtons and are capable of sourcing up to 40 mA, suitable for driving grids and anodes. The PNP active pull-downs are capable of sinking up to 2.5 mA and allow for fast discharge of capacitive loads.

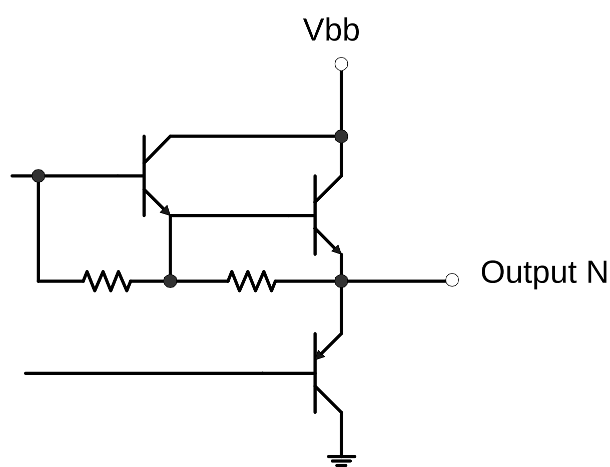

Figure 5 - Output Driver Configurations

In addition, the 6800 series features output slew rate limiting. The controlled output slew rate reduces electromagnetic noise, an important consideration in systems that include telecommunications and/or microprocessors and to meet government emissions regulations.