

## Basics of EL Panel Drive Techniques

Thin film electroluminescent (EL) panels operate on the principle of successive pulses of opposite polarity. These pulses must exceed a threshold of approximately 200V for the panel to emit light.

A flat panel display is a sandwich of phosphor material with dielectric coating on either side; transparent ITO (Indium Tin Oxide) row electrodes on one side and column electrodes on the opposite side. These layers are built up on a sheet of glass to form a very thin, lightweight display panel.

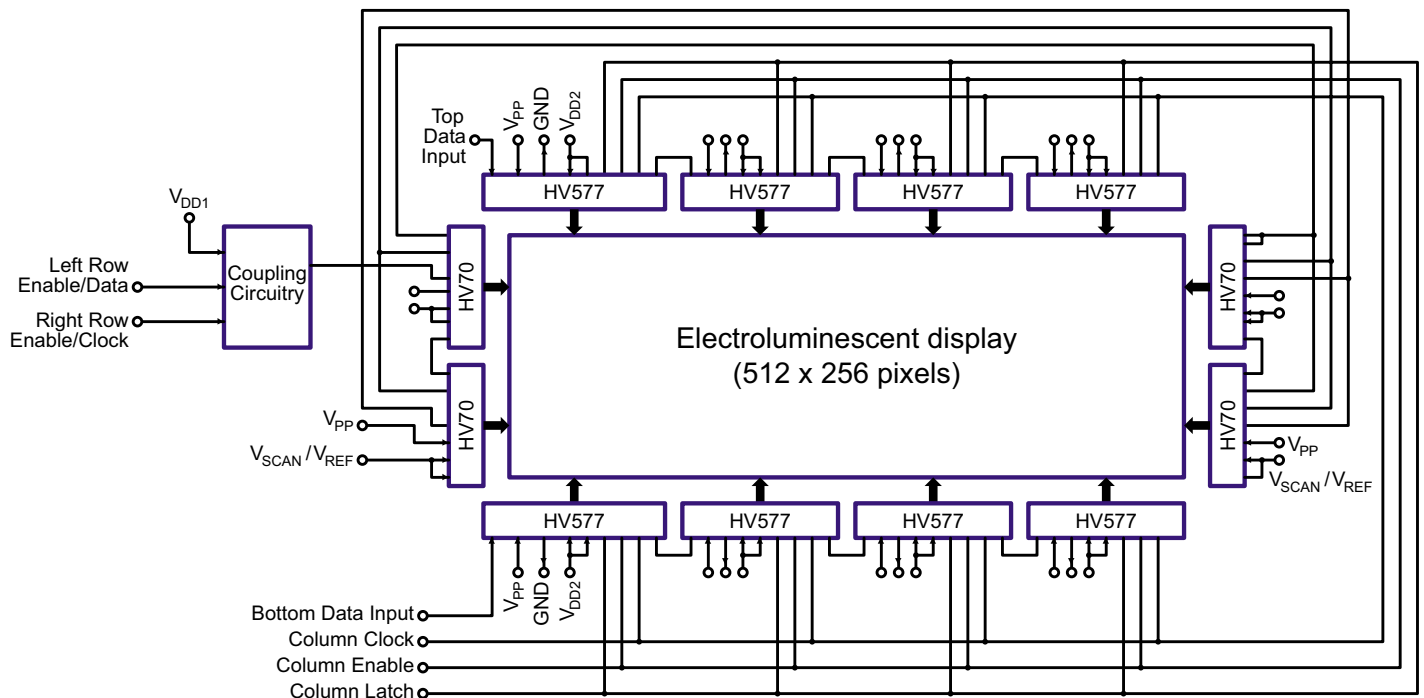
Since the drive electrodes are dielectrically isolated from the phosphor material, and each other, the display panel exhibits a capacitive load to the drive electronics. On larger panels this capacitance can be quite high. Surge currents can be large; therefore, coupling from the row to the column electrodes should be considered.

The drive electronics used to operate the panel are organized in a manner to surround the display panel with contacts as shown in Figure 1.

Generally, the row electrode electronics supply the major portion of the threshold voltage, called the scan pulse, and the opposite polarity “refresh” pulse, which is necessary for the panel to emit light. The refresh pulse is usually applied to all rows at one time while the scan pulse is applied to one row at a time (starting with row #1), similar to a television raster scan.

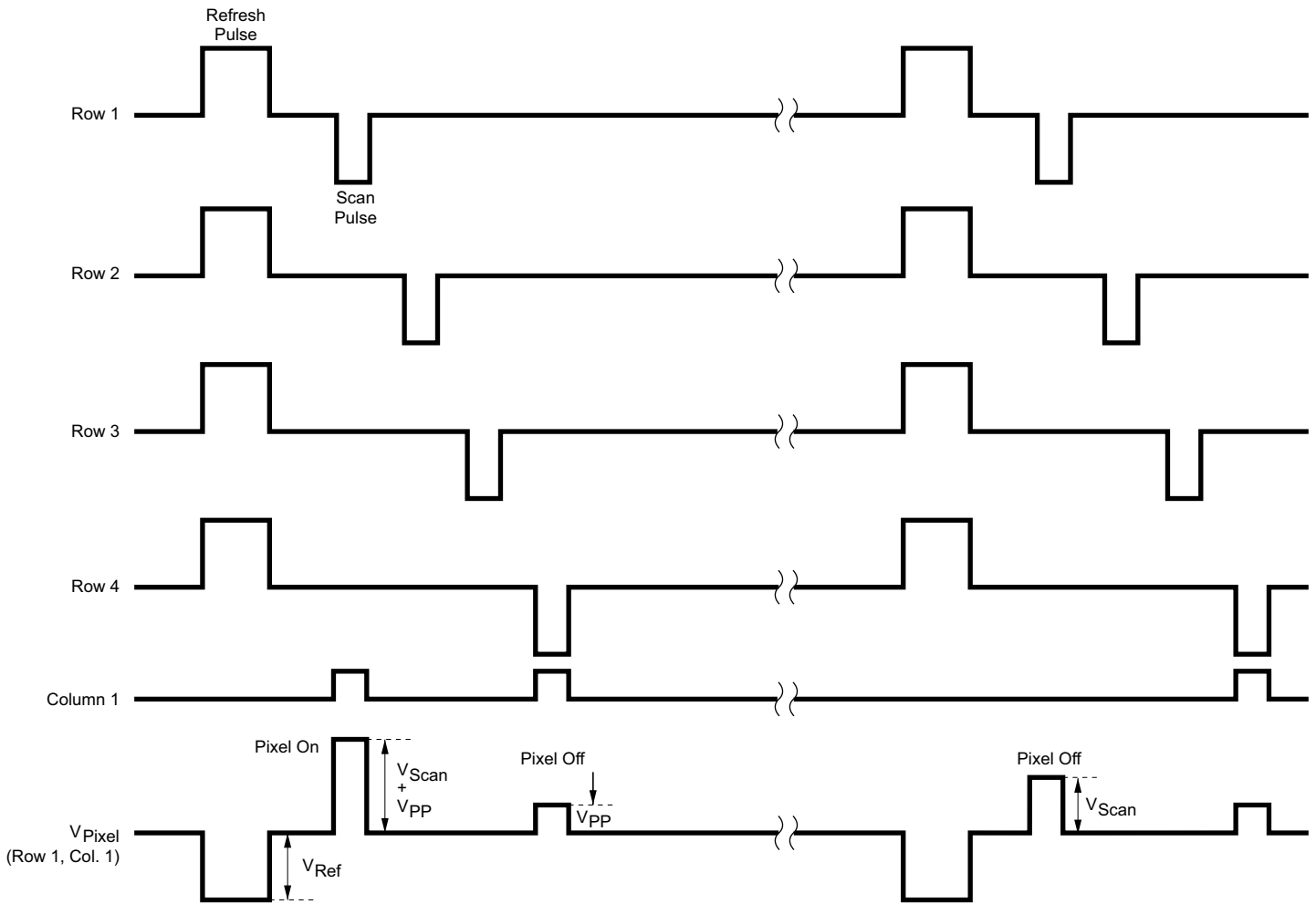
Depending on the data to be displayed in each column, the column electrode electronics supply a voltage of opposite polarity to the row scan pulse. This combination of row and column voltage across the phosphor will exceed the threshold and cause the phosphor in areas between the energized row electrodes and the energized column electrodes to glow. This sequence, applied to successive rows, causes certain portions of the display to be illuminated.

Because the phosphor requires successive pulses of opposite polarity to operate, an opposite polarity refresh pulse is applied to all row electrodes simultaneously while the column drivers are kept at ground. The sequence then begins



**Figure 1: Block diagram of the driver system for a TFEL (Thin Film Electroluminescent) panel.**

*Note that the column drivers have two data lines with interleaved pixel data.*



**Figure 2: Simplified diagram illustrating row and column timing to operate an EL Panel.**

$V_{REF}$  only lights pixels that were turned on by  $V_{SCAN}$  and  $V_{PP}$  pulses in the previous frame of information.

again at row #1 with the next frame of data. Figure 2 is a representative timing diagram of the signals applied to a TFEL panel showing the first four rows and the first column.

Due to the fact that the phosphor illumination threshold has a slope of illumination versus applied voltage within a short range, the column drive electronics can be made to vary the applied voltage within this range, dictated by the intensity of light desired for a particular element on the display. By this means, a gray shade image can be created using the EL display.

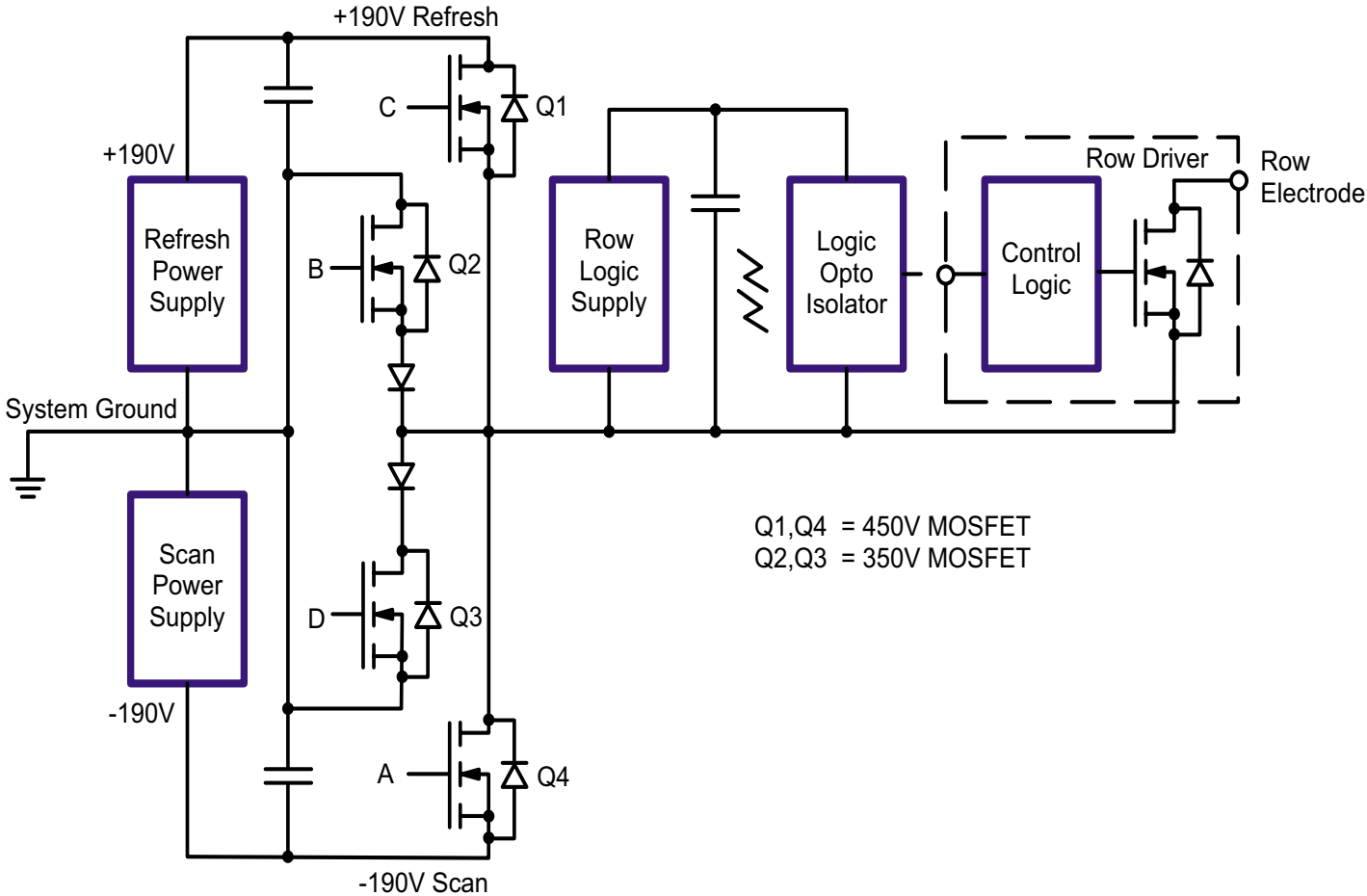
### Row Drivers (HV51, HV52, HV70)

To allow the open drain outputs to provide the opposite polarity pulses to the panel, the sources of the output MOSFETs must be switched between the different voltages required for the panel.

Since these MOSFET source connections are connected to chip ground, the entire device needs to be isolated or “floated” from the system ground. The control signals to the row driver chips therefore must be opto-isolated from the system ground. Figure 3 shows a simplified way to accomplish this.

The two high voltage supplies are switched to the row substrate (driver chip ground) using MOSFET switches. Application of the voltages to the panel is as follows:

*The refresh pulse is applied to the entire panel at the same time by pulsing on “C,” forward biasing the body-drain diodes on all row outputs. The panel is returned to ground by pulsing “D” while having all the row driver outputs on. The scan pulse is applied, one row at a time, by pulsing on “A” while the selected row output is on. The selected row is returned*



**Figure 2: Simplified diagram illustrating row and column timing to operate an EL Panel.**

*V<sub>REF</sub> only lights pixels that were turned on by V<sub>SCAN</sub> and V<sub>VPP</sub> pulses in the previous frame of information.*

to ground by turning on “B.” The next row to be scanned is then selected, and the scan is repeated; first “A,” then “B.” When the entire panel has been scanned, the refresh sequence is executed; first “C,” then “D.” The scan cycle then begins again. In this way the proper voltages and sequences are applied to the panel for operation.

**Monolevel Column Driver (HV577)**

The column drivers are used to apply the data to be displayed onto the panel. The data for each row of picture elements (pixels) is loaded into all the column drivers serially and latched into the output latches. The outputs are thus turned to their desired state, and then the high voltage (V<sub>pp</sub>) is applied. Columns selected for data display are connected to V<sub>pp</sub> through the CMOS output and are pulled up to V<sub>pp</sub>. The combination of the column V<sub>pp</sub> and the selected row voltage will cause selected pixels to light in that particular row.

During the time that the data for one row is being displayed, the data for the next row is being loaded into the shift registers, awaiting the display of the next row. When a row is completed, the column driver V<sub>pp</sub> is brought low and the data waiting in the shift register is loaded into the output latches. The cycle then begins again for each successive row. The column drivers are designed with a serial shift register output for use in cascading the column drivers together. This allows the data for one row to be loaded serially, using one serial input at the first column driver device.

**Gray Scale Column Driver (HV623)**

This device is designed to take seven data inputs in parallel into seven shift registers. The data is then taken from equivalent stages of each shift register and converted to an analog level, 1 of 128 between ground and V<sub>pp</sub>. This is done by a digital counter using seven bits of input data. The counter starts with zero and increments up to turn on an output. This transistor allows the output to ramp at the same rate as

the ramp voltage ( $V_R$ ) using a holding capacitor ( $C_H$ ) for coupling. At the end of the gray scale cycle, the outputs will be at their respective levels based on the seven bit input value. The output voltage is applied to the column of the panel and is combined with the row scan voltage to vary the light output from each pixel in the selected row.

### Panel Brightness

The varying brightness of an EL panel by voltage variation can only achieve a limited range. Dramatically increased panel output such as required by panels to be operated in direct sunlight, requires another method of increasing output. This is done by increasing the panel frame rate, or refresh rate. Normal CRT based systems work on a 60Hz frame rate. Most applications of EL panels replacing CRTs, then, also

operate at this rate. This is fine for office and home use but does not provide enough brightness to accommodate most military applications. By increasing the refresh rate up to ten-fold, a dramatic increase in brightness can be achieved.

This increase in refresh rate requires some changes in the column driver configuration. Instead of cascading all the column drivers together, each column driver shift register input is driven in parallel by the controlling system at the same time. This increases the number of data lines required but allows the data to be loaded much faster, enabling the faster frame rates desired. The row drivers are used at a much slower rate, so no changes are required to achieve faster operation.

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