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Application Note FAN1201

Driving Multiplexed Segment LCDs

Driving a segment LCD using multiplexing reduces the number of pins required to turn on or off the segments of a display. This application note discusses what a segment display is and the driving method in detail. The SDAF102NCRN01, a 3V, 7-segment custom LCD is used as an example.

1. Segment Liquid Crystal Displays

Segment LCDs are constructed using two pieces of Indium Tin Oxide (ITO) glass with a twisted nematic fluid sandwiched in between. The majority of these displays are custom-made. Typical applications include measuring acidity levels in swimming pools, gases, or temperature. There are two types: static and multiplexed. A static display is a segment display with one pin for every one segment, whereas a multiplexed LCD has grouped segments, reducing the number of pins.

Advantages of Segment LCDs

- Lowest unit cost
- Lowest tooling cost
- Low power consumption

So, what is a segment? A segment is any line, dot or symbol that can be turned on and off independently. The figure below shows an example of a custom display developed by Focus LCDs.

Figure 1: A custom segment display module.

The number of segments is dependent on what will be displayed. The most popular are seven-segment displays. In Figure 1, the digits: “0”, “8”, “4”, “7” are all seven segments. Each segment can be independently turn on or off to show a letters or number. However, the range of letters are limited. While fourteen segments have the ability to display any number and more letters.

Icons such as symbols for battery, signal strength, plus/minus and bar graphs are also considered segments. Finally, segments can also be “permanent”. This means it is always on even with no power. This is accomplished by burning the segment onto the glass. The text: “FOCUSLCDS.COM” in Figure 1 is an example.

2. Multiplexed Drive or Displays

The multiplexing technique aims to reduce the number of pins that are necessary for driving the segments of the display. This results in a simplified LCD module. In this setup, each segment control line can be connected to as many segments as there are backplanes, provided that each of the connected segments are tied to separate backplanes. This method "multiplexes" each of the segment control lines and minimizes the number of pins. The advantage of this is increased display density and reliability at the expense of complicated drive circuitry.

The basic principle is to group segments and backplanes. In datasheets, backplanes are designated by the word “COM” e.g. COM1, COM2, and so on. A group is associated to a unique backplane. Therefore, to switch on a segment, one needs to select the group then select the element in that group which corresponds to that segment.

Consider the SDAF102NCRN01 multiplexed segment display in Figure 2. Main features:

- 3V operating voltage
- Top-view, no backlight
- Normal temperature (0-50ºC)
- Reflective (Positive)
- Gray-white background, TN[1]
- Transmissive front polarizer

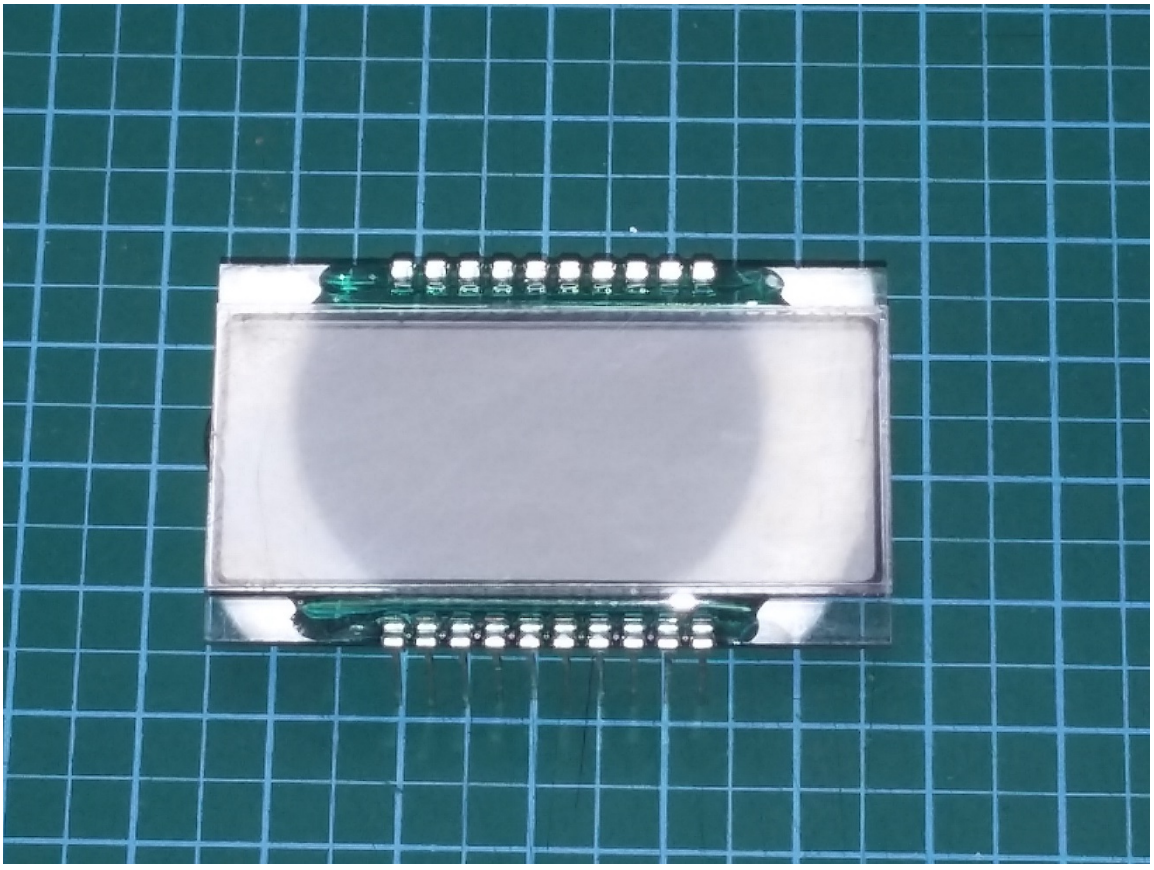

Figure 2: SDAF102NCRN01 segment display.

[1]TN (Twisted Nematic) is a popular LCD technology that does not require current flow for TN cells to work and uses lower operating voltages, making them suitable for portable applications.

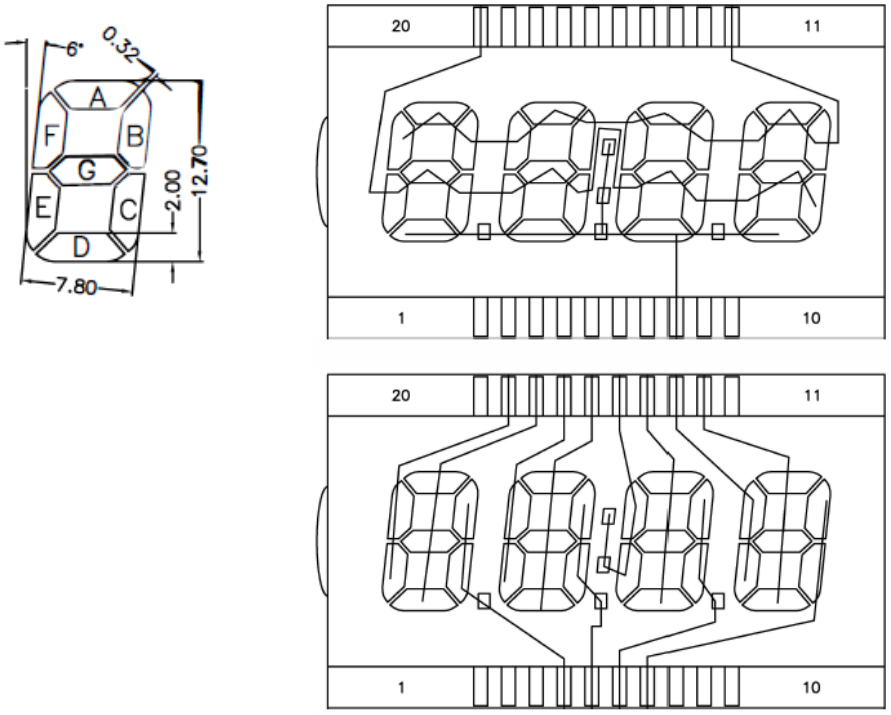

Figure 3: SDAF102NCRN01 segments and COM groupings.

Referring to Figure 3, the SDAF102NCRN01 has 3 backplanes (COM): pins 8, 11, 20. Also known as: 3:1 mux which means there is one pin for every 3 segments. The advantage of this configuration is that it reduces the number of pins by 66%. Add up all the segments, divide by three and you arrive at the number of pins necessary, plus supporting pins (Power, Ground and COM).

The segments of a given digit for backplanes are grouped as follows:

- COM1 (Pin 11) = A, B, F
- COM2 (Pin 20) = C, E, G
- COM3 (Pin 8) = D, COLON, DECIMAL POINTS 1, 2, 3

On the front-plane:

- Group1 = A, D, G
- Group2 = B, C, DECIMAL POINT
- Group3 = E, F, COLON

Therefore, to switch on a segment, select drive the correct group and backplane.

Segments are turned on or off using an AC voltage with no DC component (Figure 4). This means that the average voltage of the AC waveform should be equal to zero. Having a DC bias will reduce the life of the display. Also, there must be always an AC voltage on all the segments of the LCD. A sign that the LCD is degrading is when there is a loss of alignment on the edge of the characters, resulting in a distorted visual appearance.

For the SDAF102NCRN01, the drive frequency (frame frequency) is 32-128Hz or typically 64Hz. Higher drive frequencies will increase power consumption. Operating voltage is 3.0V, Duty cycle = 1/4, Bias = 1/2 or 1.5V. Figure 4 shows the waveform to select or deselect a particular segment with respect to a COM (backplane) pin. Note that the average voltage over the entire period is zero (no DC component).

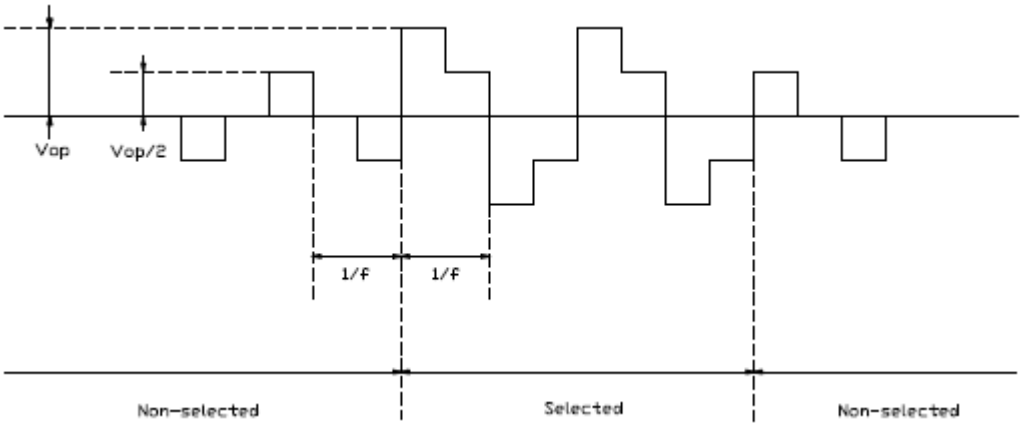

Figure 4: Drive waveform for the SDAF102NCRN01.

Crosstalk, or “ghosting”, occurs when an LCD is overdriven by a combination of frequency and voltage. This appears as a partial turning on or off of a segment. To prevent inadvertent turning on or off of the segments, unused segments must be connected to its backplane (COM) pins.

One major disadvantage of multiplexed drivers is reduced contrast due to a lower duty cycle. In this case, a segment is on 25% of the time, while in static-driven displays have sharper contrast from being on 100% of the time. However, to the human eye this decrease in contrast is not noticeable.

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