AND8110/D

Improving the Versatility of the NLSF595 by Multiplexing

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APPLICATION NOTE

The NLSF595 is basically a shift-register with serial inputs and parallel outputs, along with an RCK (pos. edge) and an OE (low) pin. The standard mode of operation involves loading in an 8 bit word by shifting in data followed by clock, either in software or through an SPI port. After the 8 bit word is loaded in, a positive rising edge is asserted on the RCK pin, and data is latched and held until this sequence is performed again. It is assumed that the $\overline{OE}$ pin is low. The output is now free to drive up to 8 LED segments, each segment must be ≤25 mA (sink only). The output is Over-Voltage Tolerant (OVT) and can accept any voltage level ≤7.0 volts. Since LEDs drop at least 1.5 V, the safe open circuit voltage to drive the diodes is 8.0 V. A series limiting resistor is then placed in each leg.

Multiplexing can achieve superior brightness with the same average current. J. Lepkowski et al[1] showed this in an application note. Other reasons for using multiplexing is to achieve more colors, or more levels of brightness of the LEDs. In the first scenario, the brightness is fixed by the supply voltage and the value of the limiting resistor used (along with the LED itself). By multiplexing, the designer can increase the brightness for a given level of current consumption, or similarly reduce the current to achieve the same brightness. This design note will outline two approaches to multiplexing.

Method 1: All LEDs are affected the same.

In this method, the designer uses the $\overline{OE}$ pin to control the brightness. He sets the brightness to the maximum level and then uses an effective PWM technique to control the brightness. In both methods, the author will assume a 70 Hz refresh rate. This rate was chosen empirically to be high enough not to see the flicker, and not interfere with either 50 or 60 Hz lighting. The method is simple. The software designer creates a 14 ms routine and breaks it up into N sub-periods. The author will assume 4 sub-periods for convenience. This paper will show 5 conditions: OFF, 1/4 Brightness, 1/2 Brightness, 3/4 Brightness, Full Brightness. The $\overline{OE}$ pin is held HIGH for all four periods and that creates an OFF condition. Similarly, if the $\overline{OE}$ is held HIGH for 2 of the 4 periods, and LOW for 2 periods, the output is at 1/2 brightness. If the software engineer were trying to go from full brightness to OFF in graceful steps, he could use 10 periods, and go from full ON to full OFF in 140 ms. Similarly, he could chose 280, 560, or 1120 ms.

1. AND8067/D http://www.onsemi.com/pub/Collateral/AND8067-D.PDF

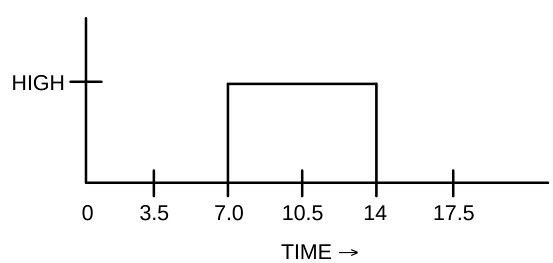

Figure 1. Output $\overline{EN}$ Pin for 1/2 Brightness

Method 2: Leave the $\overline{OE}$ pin fixed and create 3.5 ms periods that the software designer uses to update the data every time.

Case A: Output is to remain constant.

1. Either skip the shift routine or;
2. Shift the same data out and latch it in as above.

Case B: Output is to change either intensity or color.

Using the 3.5 ms period, pick one of 5 possible levels:

1. Full Brightness: Shift a ZERO to each line that is desired ON.

Keep the data the same for each of the 4 periods.

2. 3/4 Brightness: Shift a ZERO for 3 periods and a ONE for 1 period.
3. 1/2 Brightness: Shift a ZERO for two periods and a ONE for 2 Periods.
4. 1/4 Brightness: Shift a ZERO for 1 period and a ONE for 3 periods.
5. OFF: Shift a ONE for 4 periods.

Conclusion

Multiplexing can add to the versatility of the NLSF595 at no additional cost and very little software overhead, just a few bytes every 3.5 ms. Either the efficiency can improve or the number of colors may be enhanced or the ability to go from full on to full off gracefully can be achieved. It is also possible to create more colors by using different levels of brightness which will create more colors in a tri-color LED. All this is achieved at no extra hardware or system cost.

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