Driving TN Shutters

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Driving TN displays or shutters is very straightforward from an electronics perspective. Segmented or matrix displays are typically driven with integrated circuits specifically designed for this purpose. Therefore, this applications note will focus on driving TN shutters.

All LC displays require an AC waveform, usually a square wave, to drive them into the “on” state. Depending on the TN shutter design (fluid, cell gap, contrast and response time requirements, etc.), the drive voltage will typically be 3 Volts to 15 Volts. The “off” state voltage will typically be zero Volts. TN shutters are sensitive to the RMS voltage, not the peak voltage. With a square wave, the RMS and peak are identical. With any other waveform, they will not be equal. The duty cycle (high time/low time) should be as close as possible to 50%, if the shutter will be driven on for long periods.

The square wave frequency will also be dependent on design requirements. Frequencies below about 30 Hertz may result in visible flicker in the shutter. Current draw from the driver will increase in proportion to the frequency. Therefore, battery operated devices must operate at relatively low frequencies. Special techniques that are beyond the scope of this note may be used in low power applications at low frequencies.

A typical function generator may be used to operate most shutters, by setting the waveform to square wave, the frequency to 60 Hertz and the voltage to 5 to 10 Volts peak. The function generator will also allow checking for flicker and viewing the effects of various drive voltages

A simple oscillator circuit is shown in Figure 1. This circuit will drive a TN shutter of up to several square inches in area. It will operate from 3 to 15 Volts. A 9 Volt battery is ideal for general experimentation. It will operate with any variation of the CD4049, such as the HCF4049 or MC14049U. R1 can be fixed or variable from about 39K to 150K to set the operating frequency. This circuit will drive a shutter into the “on” state by connecting the output leads to the shutter. The limitation is that it does not allow external circuitry to control the state of the shutter.

Note that the two output pins are driven to opposite polarity from each other. This gives a true AC waveform with the RMS voltage equal to the supply voltage. Neither output pin can be connected to ground.

Figure 2 adds the ability to control the state of the shutter by setting the control signal input to a high or low state. This can be done with a simple switch or an external logic signal. This circuit will also work from 3 Volts to 15 Volts, but the voltage must be compatible with any external circuitry used to control it. Therefore, if a TTL level signal is used, the operating voltage must be approx. 5 Volts.

The operation of the circuit in Figure 2 is typical of the method used inside many display driver circuits. The “trick” is to use a logic device called an Exclusive-Or (XOR) gate. It is related to the OR gate, but different in that the output will be high only when the inputs are in opposite states. Therefore the output state can be flipped by changing the logic state of one of the inputs. This means that the relative polarity of the lower output pin is controlled by the signal input pin.

This is shown visually in Graph 1.

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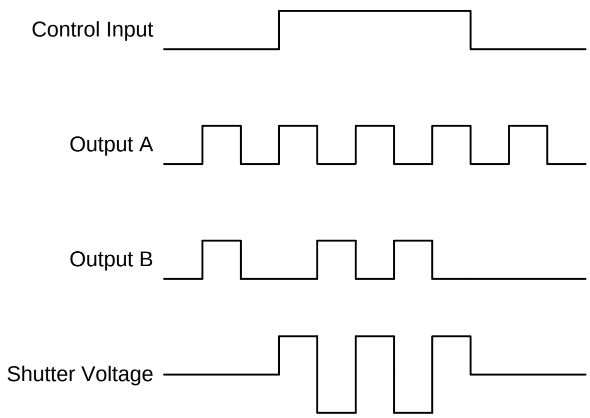

Graph 1

Note that Circuit 2, as in Circuit 1, has outputs that cannot be grounded, and has the same benefit of a true AC output equal to the supply voltage.

There are many variations of these circuits, many more complex possibilities. These are basic enough for most people, yet versatile enough for many practical applications. Be careful about ESD damage to the CMOS components. Never apply voltage above the manufacturer’s absolute maximum rating (it’s at least 15 Volts for most of these parts) and never reverse the supply voltage.

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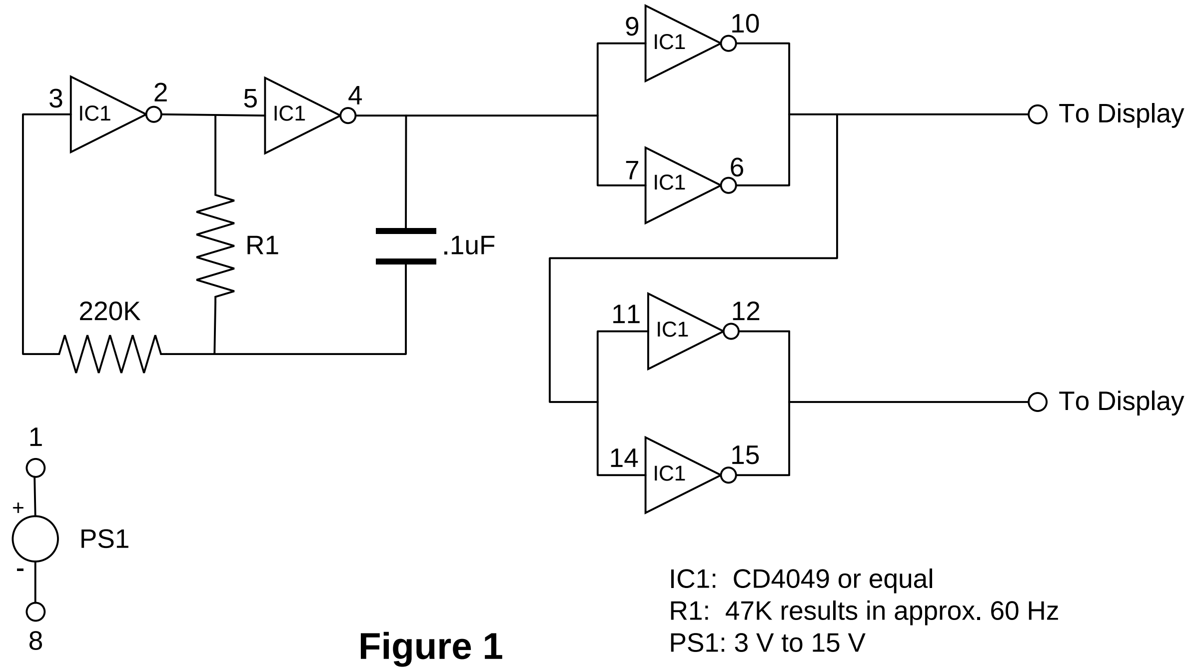

Figure 1

IC1: CD4049 or equal
R1: 47K results in approx. 60 Hz
PS1: 3 V to 15 V

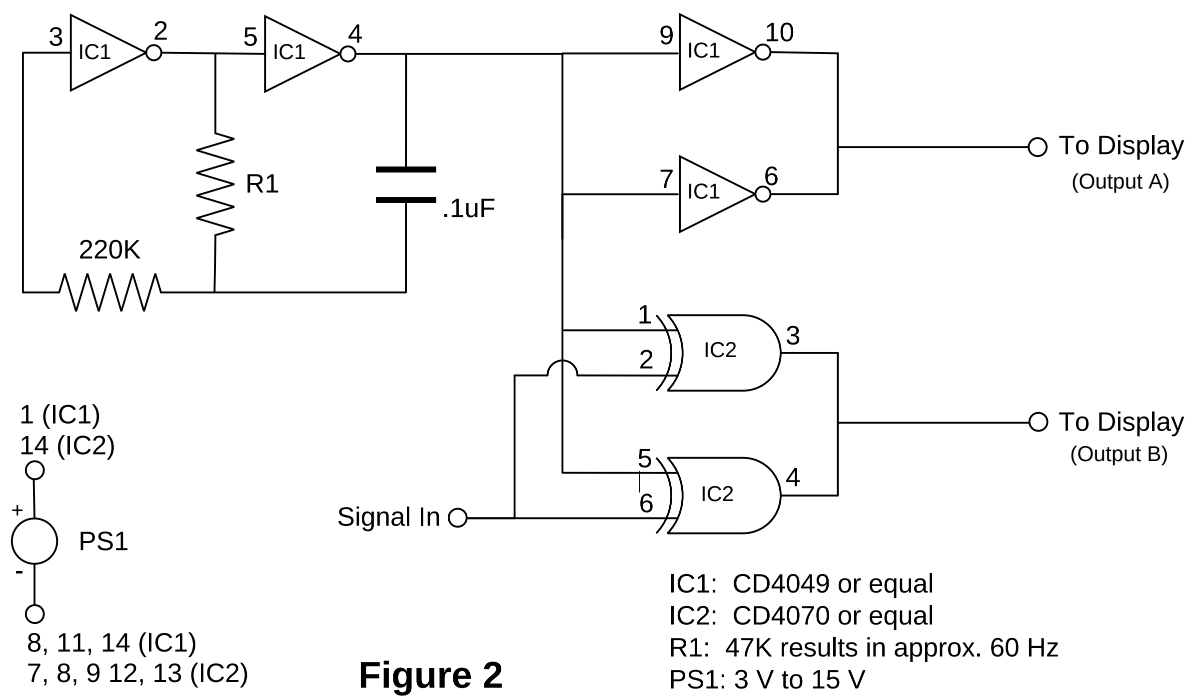

Figure 2

IC1: CD4049 or equal
IC2: CD4070 or equal
R1: 47K results in approx. 60 Hz
PS1: 3 V to 15 V