Application Note AN-3002

Low Current Input Circuit Ideas 6N138/139 Series

Introduction

Advancements in opto-coupling and LED technology have given us the 6N139. This unique optocoupler, having an input LED current specification at 500 microamperes, has opened some interesting design doors. Besides the obvious and much written about ability to be directly driven by CMOS circuits, the 6N139 can be considered for signal detection, transient detection, matrices and non-loading line receiving. Following are but a few circuit ideas to stimulate the designer's interest.

Signal Detection

The detection of noise, spikes or oscillations can easily and directly be detected by the input of the 6N139 as shown in the circuit of Figure 1.

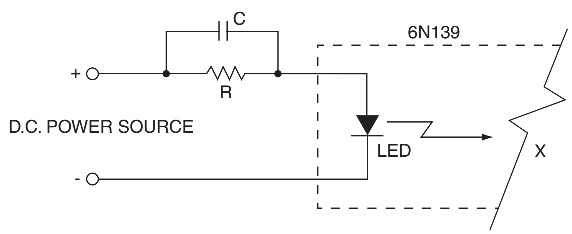

Figure 1. 6N139 Input Circuit For Signal Detection

For the detection of undesirable signals on a D.C. power source use:

$$R = \frac{\text{Power supply voltage} - 1.5 \text{ volts}}{50 \text{ microamperes}}$$

C=To inject 500 microamperes into LED

X=Latching or non-latching output circuitry to follow

LED=Input diode of 6N139

The LED is provided with a 50 microampere forward current to charge the LED capacity to the VF level. In this way, the LED is not causing conduction in its output circuitry but is prepared to conduct very quickly. Any noise or oscillation on the "D.C. power source" is coupled through "C" which develops a signal across the LED. Even small unwanted signals can cause a large change in the LED forward current. Once the LED's forward current equals or exceeds 500 microamperes, the output circuitry will conduct indicating the presence of the unwanted signal.

Transient Detection

The detection of the presence or absence of waveforms can easily be detected by the circuit in Figure 2.

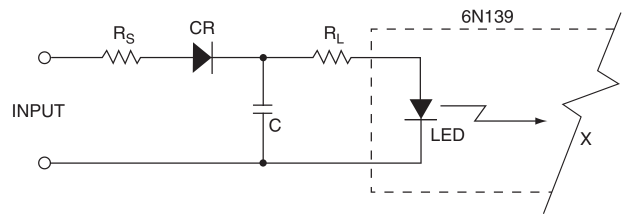

Figure 2. Pulse or Waveform Detection Circuit

For the detection of the presence of a desired signal, pulse or waveform use:

CR=Silicon diode

$$R_L = \frac{(\text{Positive Vpk. of input}) - 2.5 \text{ volts}}{1 \text{ milliampere}}$$

$$C_{min} = \frac{\text{Pulse interval of } 1/f}{R_L}$$

$$R_S max = \frac{\text{Pulse width or } 1/4f}{5C}$$

X=Non-Latching output circuitry to follow

LED=Input diode of 6N139

f=frequency

Examples:
A desired pulse train to be present is shown in Figure 3.

The resulting LED forward current that will keep the output circuitry conducting is shown as the result of proper design.

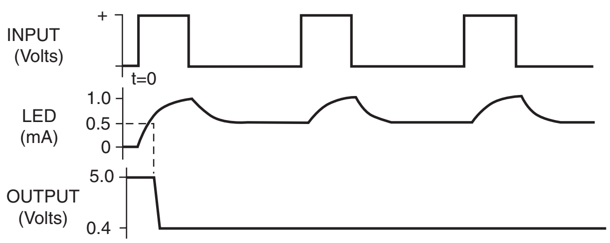

Figure 3. Pulse Train Waveforms

A desired sine wave to be present is shown in Figure 4.
The resulting LED forward current that will keep the output circuitry conducting is shown as the result of proper design.

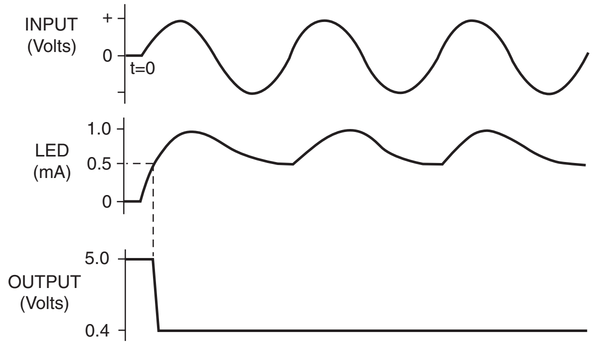

Figure 4. Sine Wave Waveforms

Matrices Opto-Coupling

With the low input LED current advantage of the 6N139, the ability to drive matrices with but one TTL output is now possible as shown in Figure 5.

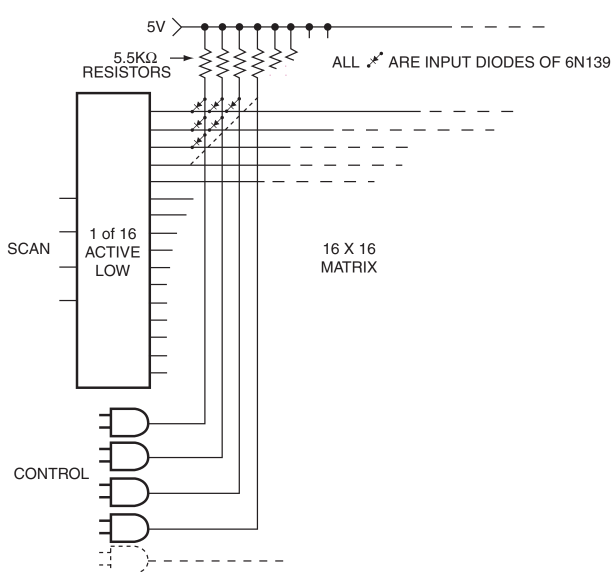

Figure 5. Opto-Coupling out of Matrices

Non-Loading Line Receiver

For virtual non-loading, the 6N139 is compatible with the differential amplifier circuit of Figure 6.

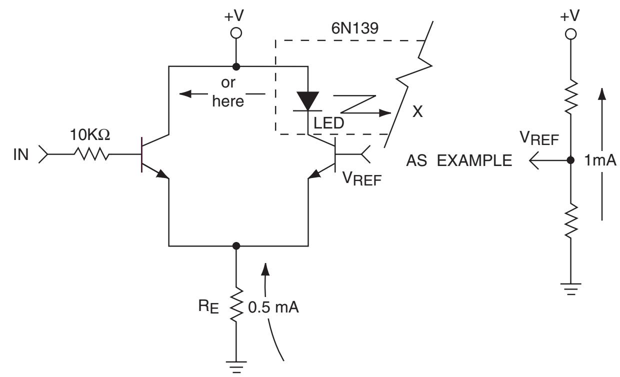

Figure 6. Differential Amplifier Drive

For a virtual no-load optoisolator circuit use:

X=Non-latching output circuitry to follow
LED=Input diode of 6N139

Current requirement at "in" will be less than 20 micro Amperes.

Example:

If "V_{REF}" is made to be +1.4 Volts and the R_E is 1.2 KΩ, the circuit will respond nicely to TTL "0" and "1" levels. That is, a "0" at "In" will cause LED current resulting in the conduction of the output circuitry. Conversely, a "1" at "In" will result in no LED current. Notice that depending upon which collector the LED is in series with it will give the option of LED current flowing with a "0" or a "1" at "In".

6N139 Output Circuitries

The following are two examples of 6N139 output circuitry. One latching (Figure 7); the other non-latching (Figure 8), but both capable of driving a TTL gate directly.

Referring to Figure 7 and assuming that the "RESET" has been actuated by a momentary ground and no input signal is being received, all transistors shown are non-conducting (Output high, "1"). The arrival of an input signal will cause all transistors to turn on. (Output low, "0"). The PNP transistor, being turned on by the output transistor, will in turn latch that same output transistor or until the "RESET" is again initiated.

In Figure 8, where no signal is being received, the input transistor is not conducting. The output transistor is very slightly conducting. The 4.7MΩ resistor causing this slight conduction will not bring the "Output" to a "0" level.
The purpose of this slight conduction is to reduce the turn-on delay time. When a signal is received, both input

and output transistors are turned on causing the "Output" to a logic "0" state. The 4.7 MΩ resistor will now tend to reduce the output transistor's turn-off time.

If you have not looked over the 6N139 specification sheet, you may not be totally aware of the current capabilities of Fairchild Semiconductor optocouplers.

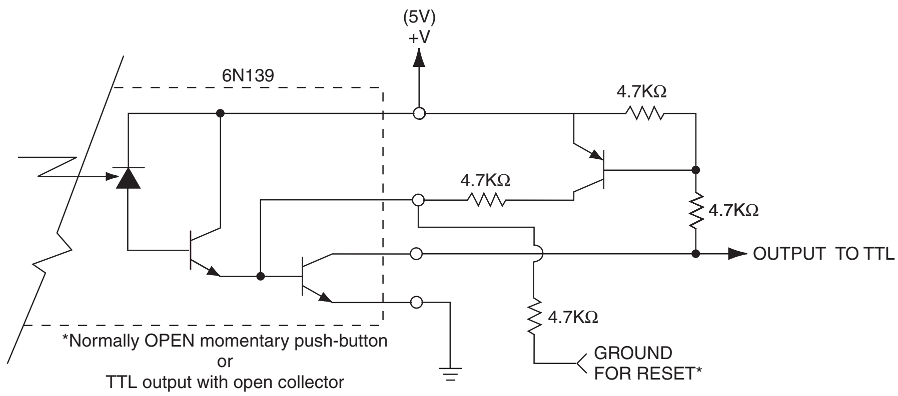

Figure 7. Latching Output Circuit for 6N139

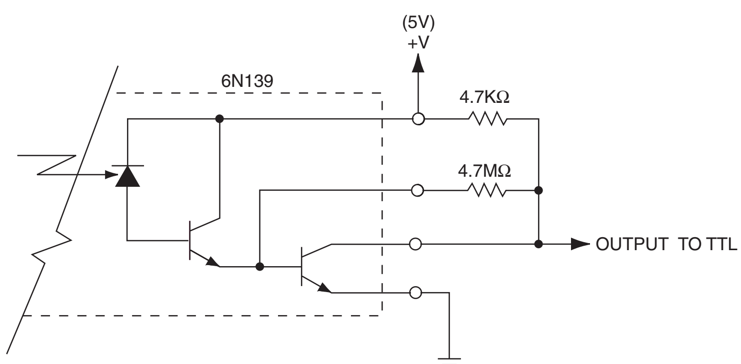

Figure 8. NON-Latching Output Circuit for 6N139

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