

Low Pass Filtering for Checker with Input Noise from Mechanical Relays

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1 Preconditions

- Checker is connected to a PLC via discrete I/O to perform job change, retrain or trigger.
- The PLC outputs are mechanical relays.
- The Checker inputs are configured for current sink operation (InputCommon = Ground)

2 Symptoms

- Job change does not appear to work or the selected job isn't the job that was requested. Typically this is an intermittent problem, sometimes it works but often it doesn't. Typically the selected job is a job in a higher numbered slot.
- The Checker retrain or trigger doesn't occur as expected. Sometimes extra retrain or trigger events occur.

3 Description of the issue

If the PLC employs mechanical relays, the output will not make a clean, monotonic change from the OFF (0 volt) state to the on (12-24 volt) state. Rather the contacts will bounce for some period of time before settling to the closed (i.e. ON) position. During this settling time the Checker can view the input as having switched more than once. A normal input signal is shown below in Figure 1. In this case the Trigger input rises cleanly to 24 volts, remains there for 200ms, and returns to the off state.

If a Checker receives a clean signal of this type on any of the job change, retrain, or trigger inputs the behavior will be as expected.

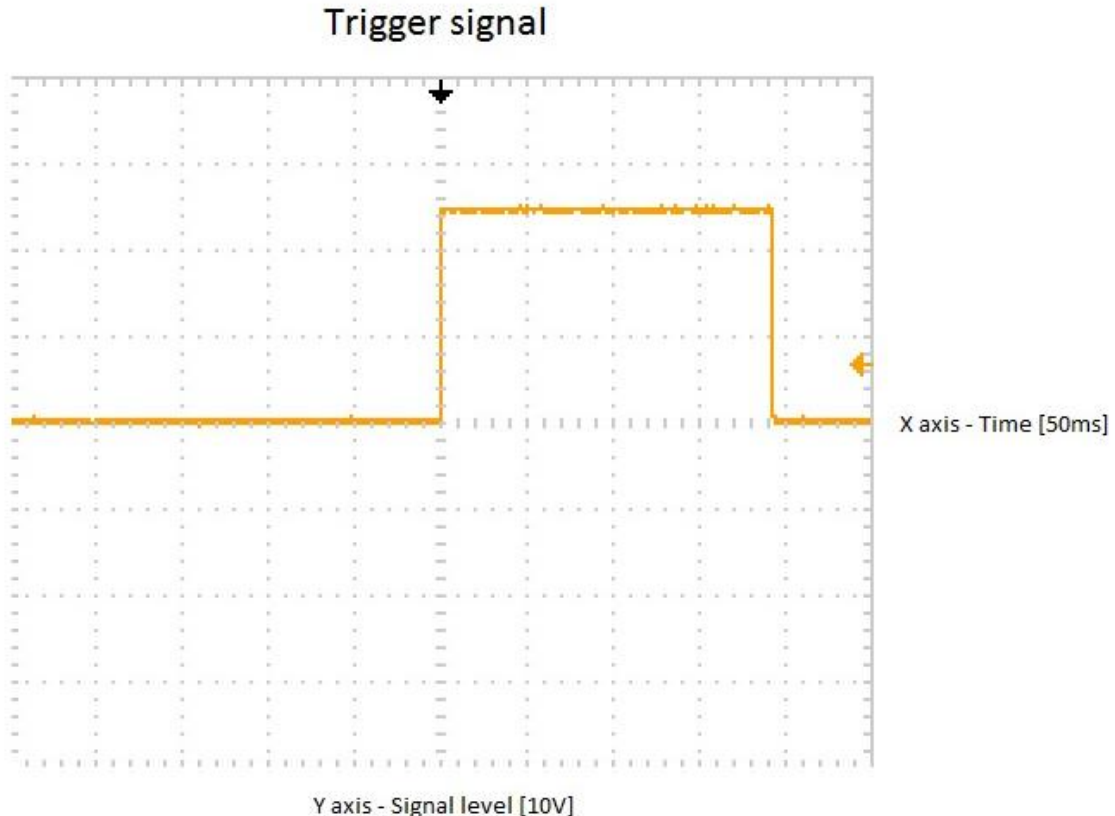


Figure 1: Normal input signal behavior to the Checker

Two cases are known to result in incorrect behavior.

- Noisy or non-monotonic edges
- Cross talk

When using mechanical relays, the input signal could look like the one shown in figure 2. In this case the signal requires a long time to settle to the final ON state and contains two intermediate states where the signal plateaus. Checker could interpret this signal as multiple events rather than single pulse. During the relay settling time the signal could also exhibit full scale swings at frequencies higher than the signal contains under normal operation. For example a signal developed using a mechanical relay with a nominal on time of 500ms could contain pulses that last hundreds of micro-seconds while the contacts settle to the closed (i.e. ON) state. This could also result in multiple events being detected.

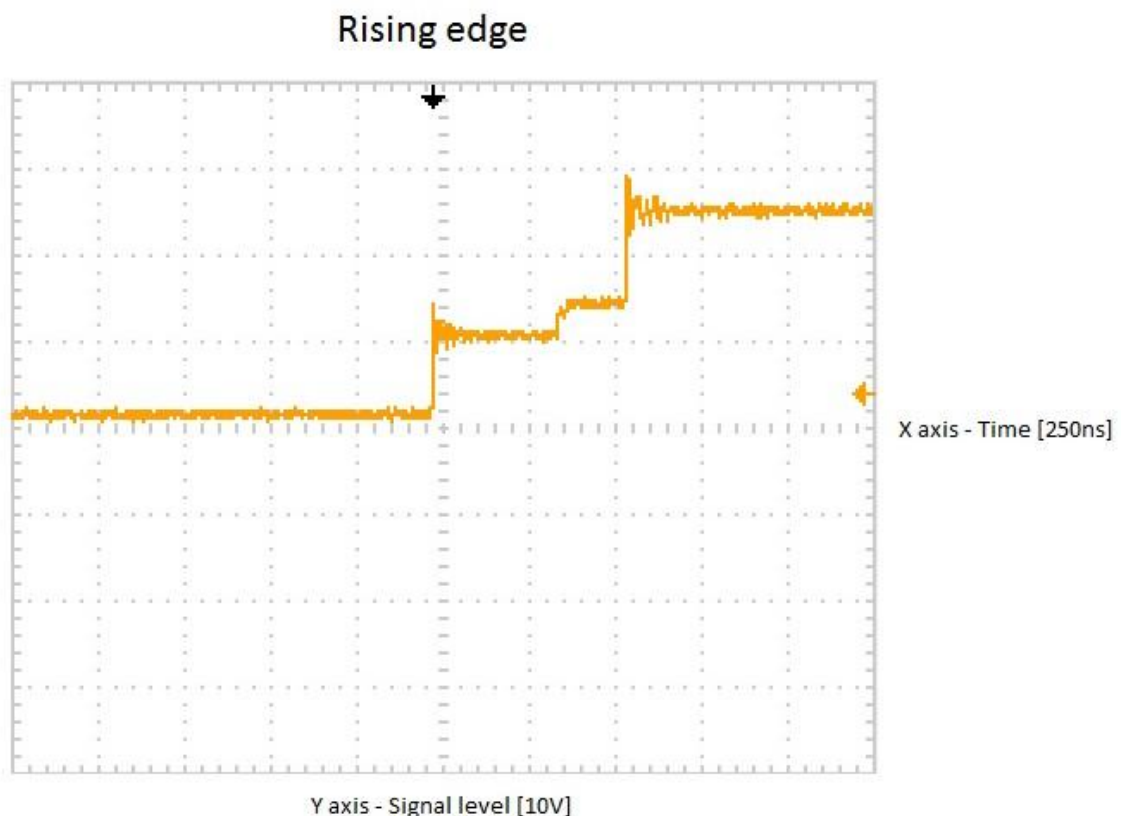


Figure 2: Noisy input signal to the Checker

The other issue is cross talk. During the relay settling interval high-frequency pulses of significant amplitude could be generated. The energy from these signals could couple onto other conductors within the cable. This scenario is also more of an issue as the length of the I/O cable increases. An example of such as signal is shown in Figure 3.

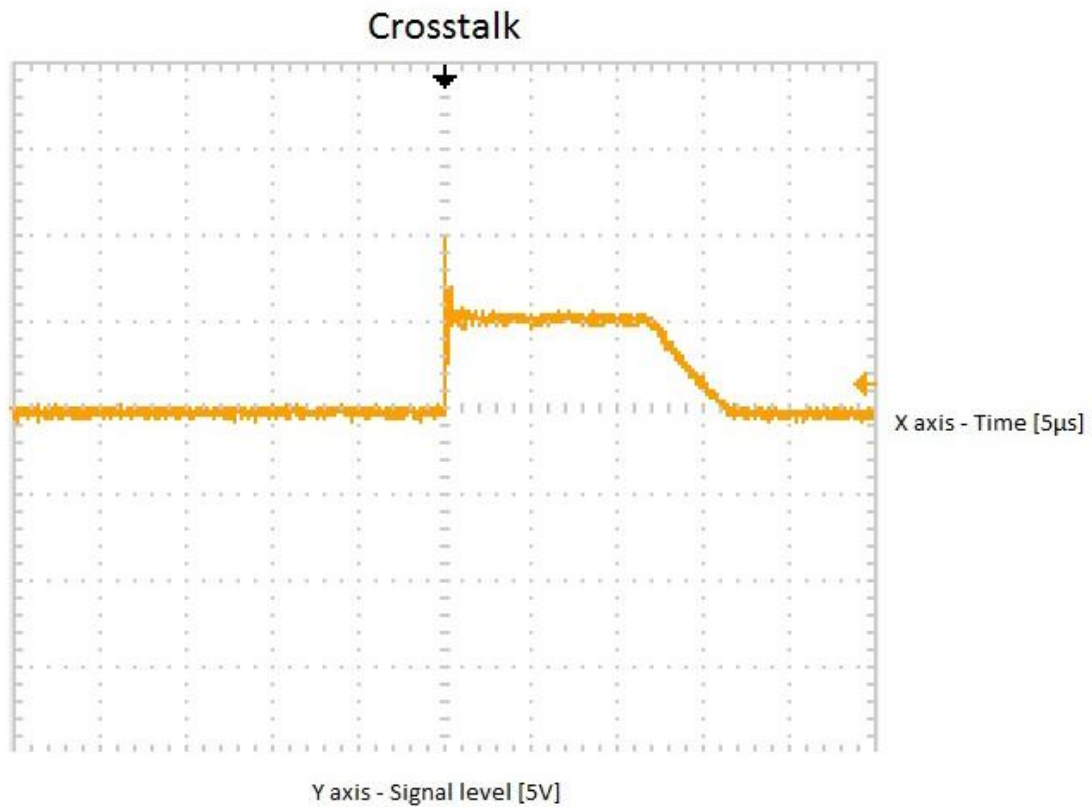


Figure 3: Crosstalk on the Checker input signal

4 Low Pass Filter Solution

To avoid the unwanted, short length signals, a low pass filter is recommended. This filter can also eliminate the signals which have a high frequency. The low-pass filter circuit can also be used to suppress high-frequency transients which could couple into adjacent wires resulting in extra pulses or triggers being detected by Checker.

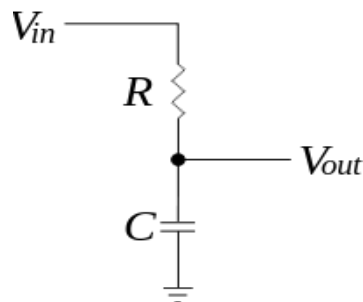


Figure 4: Low Pass Filter Circuit Diagram

The filter contains a resistor and capacitor. The resistor should be connected in series with the load and the capacitor in parallel with the load. *This technique only works with the input configured to operate in current sink mode.*

To determine the recommended resistor and capacitor, the following formula is used:

$$f_c = \frac{1}{2\pi RC}$$

where f_c is the cutoff frequency, R is the filter series resistance. C is the parallel filter capacitance. The value of R should be kept low so as not to significantly alter the switching characteristics of the input. Values of 200 ohms or less is recommended.

For most applications selecting f_c to match the fundamental frequency of the signal should suffice. For example if the expected job change signal contains 25ms pulses at a 50ms interval than setting f_c to 20Hz ($1/0.050 = 20\text{Hz}$) should work. This will filter out sporadic noise pulses whose width is on the order fo 2.5ms or less. If we set R = 169 ohms the required value of C is 47uf.

The final wiring diagram for the filter, PLC and Checker will be:

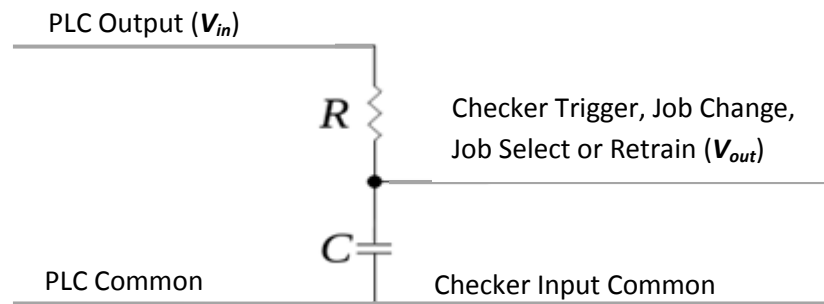


Figure 5: Low Pass Filter Wiring Diagram for Checker

Please note that using this filter on the trigger input could add significant latency to the trigger time depending upon the actual RC time constant of the filter. The trigger response will be slower when compared to a direct connection to the trigger line.

5 Questions and Feedback

For any questions or feedback on this document, please contact Cognex Technical Support.