Control System Basics – Isolation

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In the final installment of this five-part series, Jon Titus explores the basic elements of a control system. In previous installments, Jon has covered relays, sink vs. source control, PNP vs. NPN logic and open collectors.

Q: I don't like the idea of control signals going from a field device into my rack of expensive controllers. A short circuit in a processing plant could cause a lot of damage. How do I protect my investment?

A: I don't like that situation either. You already know relays isolate the coil-control current from the electrical circuits switched by the mechanical contacts. But relays don't solve every isolation problem. The simplest isolation technique involves an optical "link" between a light transmitter and a light receiver. Think of an optical isolator as a short piece of optical fiber between a light-emitting diode and a phototransistor. No electrical path connects these two devices.

When a circuit turns on the LED it's light shines on the transistor, which then starts to conduct current. This transistor connects to electronic circuits that can then control motors, furnaces, heaters, pumps, and so on. **Figure 16** shows how NPN and PNP devices in a sensor can control an optically-coupled input. The SeaI/O-420U module provides 16 optically isolated inputs that offer 300-volt isolation. The input signal may range from 5 to as high as 30 volts.

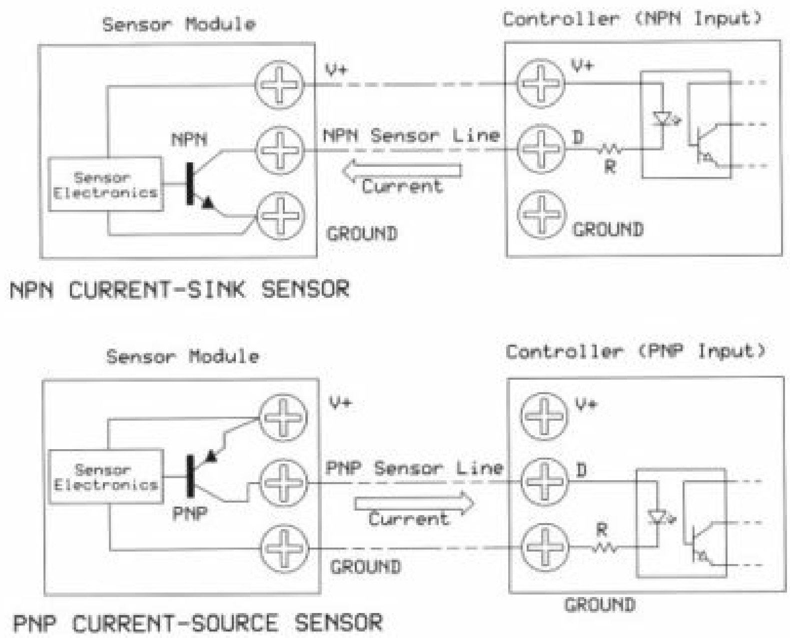

Figure 16. NPN and PNP sensors can power an LED in an optoisolator to provide protection against short circuits to line voltages in field equipment. These optoisolators also protect against transient voltages getting into expensive instruments and measurement

systems. Because the controller's NPN or PNP outputs simply supply a current to the LED, the circuit requires no pull-up or pull-down resistor. An internal resistor limits current through the LED.

The fiber-optic "gap" electrically, or galvanically, isolates the LED circuit from the transistor circuit. That small distance–a millimeter or so–between an LED and photo-transistor can isolate a 1000V signal on one side from the device on the other side. Special optical isolators "separate" 10's of thousands of volts.

Optical couplers in the form of solid-state relays put the isolation, control circuit and high-power control all in one package. The Sealevel Systems Seal/O-462 family of modules has TTL outputs that can source up to 64 mA or sink up to 32 mA. An encapsulated Omron model G3NE-210T-US-DC5 optically coupled solid-state relay, for example, requires only a 20-mA current to control a load with a maximum current of 10A with AC voltages between 100 and 240 volts AC.

Q: OK, I understand how an optoisolator lets me control high-power devices, but can I also isolate analog signals coming into my apparatus from remote sensors and switches?

A: Yes, but equipment rarely requires such isolation. Specialized analog-isolation devices and modules are available. Companies such as Silicon Laboratories, Analog Devices, Avago Technologies, and Maxim Integrated sell different types of isolation devices that use optical, transformer, and capacitive techniques. Application notes from these companies describe how to use their analog-isolation products. **Figure 17** illustrates an analog-isolation circuit that I built and tested. It exhibits excellent linearity across its input range.

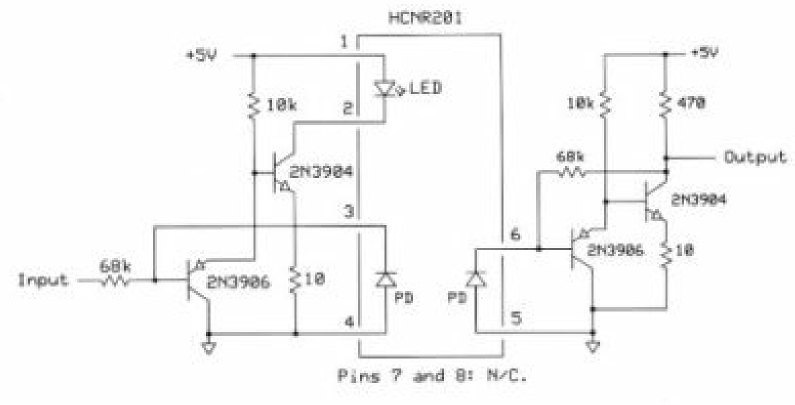

Figure 17. This analog isolation circuit uses a Broadcom HCNR201 optoisolator, for transistors, and seven resistors.

We hope you enjoyed the final installment. Be sure to read the previous installments:

- Relays Explained
- Sink vs. Source Control
- PNP vs. NPN Logic
- Open Collectors