Quick Guide to Sensor Interfacing

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While a given sensing technology may be used across a number of varying applications, each application often has unique electrical interface requirements. Although there are literally hundreds of ways to interface a sensor to a larger system, for simple binary (on/off) devices, a dual state voltage or current signal is often the most economical interface method. Some of the more common interface structures are:

- Open Collector (Sinking) output
- Sourcing output
- Two-wire current-signalling interface

Open Collector, or *Sinking* output stages are by far the most commonly used in binary sensors. When the sensor is in a quiescent or OFF state, the output can be viewed as an open switch. When the sensor detects its target and turns ON, the switch closes, connecting the output to the sensor's ground return lead. One source of confusion when applying sinking output devices comes from not realizing that the output does not provide a voltage output signal. In order to get an output one can read on a voltmeter or oscilloscope one must add a pull-up resistor between the output and a positive voltage supply (Vp). With a pull-up resistor as part of the circuit, one will read Vp on the output when the sensor is OFF, and will read about '0' volts out when the sensor is activated.

Despite requiring an external pull-up resistor, and having inverse (0V=ON) logic, open collector outputs are popular because they provide a lot of interfacing flexibility, allowing one to easily connect a sensor to the most common digital logic families, such as TTL, CMOS microcontrollers and microprocessors. Open collector outputs are also easily interfaced with data acquisition systems and industrial PLC's (Programmable Logic Controllers).

Open collector outputs have two principal limitations, however, in the amount of current they can conduct in the ON state (Iout (max)) and the amount of voltage they can withstand in the OFF state (Vout (max)). Subjecting a sensor to voltages or currents exceeding its maximum ratings, even for a short time, can cause permanent and irreversible damage to the device. By using external transistors, however, it is possible to control devices that require more current or voltage than can be handled by the sensor itself, such as relays or incandescent lamps.

Sensors with *sourcing* output configurations are less frequently encountered than the devices with sinking outputs. A sourcing output works much the same as a sinking one, except that the output is switched to the positive voltage supply, and is intended to drive a load returned to ground. Although this type of output is not as useful for interfacing with logic devices, it can be used with many types of PLC devices, and sometimes even be used to directly drive small relays.

Like sourcing devices, two-wire current signalling devices are also relatively rare in general use. The primary advantage they offer over sinking or sourcing devices is that they only require two wires for operation, which can offer a significant savings in the cost of cabling and connectors in high-volume applications, particularly automotive.

Like a sinking or sourcing sensor, a two-wire device requires a power supply to operate. Instead of switching the output lead to either V- or V+, however, it switches an current source to the V+ lead when activated. This causes the amount of current drawn by the sensor to vary in response to the sensor state. Specialized interface electronics are then required to read the sensor state from its current draw.

One major advantage a two-wire device offers over sinking and sourcing devices is the ability for the interfaced system to detect wiring faults. By the use of suitable circuitry it is possible to detect many types of open and short-circuit conditions. For applications where there is much cabling, or where the system must fail safe, this can be an important feature.