Open Collector Output

Many +GF+ SIGNET instruments and sensors feature "Open Collector Outputs" for purposes of signal transmission, alarming, control signal output, etc. Although such outputs allow for a lot of wiring flexibility, care must be taken not to destroy the circuits via incorrect polarity, over-voltage, transients or current overload. Below is an explanation of proper wiring and dimensioning of related circuit components. Please note that the following recommendations may or may not apply to other manufacturer's equipment.

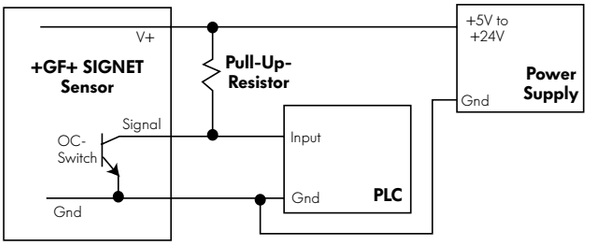
1. Function

Open Collector ("OC") outputs are low powered, solid state switches. Although the term "Open Collector" stipulates the use of bipolar transistors (NPN-type or PNP-type) as a switch, nowadays Field Effect Transistors (FET or MOSFET) are used. Unlike electromechnical switches (e.g. pushbuttons or dry contact relays) these OC switches are very fast, use little power, are inexpensive, do not bounce and do not wear. However, OC's are also more limited in terms of voltage and current rating as well as being polarized (i.e. they have a "plus" and "minus" terminal and thus DC only switching capability). They are less tolerant to overload abuse than electromechanical devices. Usually these switches have higher resistance and voltage drop.

2. Sensor Wiring

A typical example of the need for high speed switching capability is the OC frequency output of +GF+ SIGNET flow sensors like 3-2536 or 3-2540. Signal frequencies can reach several hundred pulses per second while voltage and current requirements are small enough, allowing the use of a transistor switch. For each output pulse this switch connects the signal output to the negative supply or ground terminal of the sensor and is therefore an "NPN" style output. +GF+ SIGNET does not produce sensors with PNP style outputs (which connect the signal output internally to the positive supply terminal).

Most indicating instruments or control system inputs require a signal voltage of 0 to 5V (TTL or CMOS logic levels) or 0 to 24V. Therefore, Open Collector output circuits must be complemented with a "Pull-Up-Resistor" to function properly. Please see the following example diagram for wiring with a PLC input:



Do not exceed the absolute maximum voltage rating of the OC output as listed in the sensor specifications, normally 27 or 30 Volt, DC only. This includes changes to power line fluctuations, transients or power supply instability, otherwise damage to the OC will occur.

Please note that the voltage connected to the positive sensor supply (V+) must correspond to the required high-level PLC input voltage (i.e. if the high-input voltage of the PLC is 24V, then the pull-up must be supplied with 24V). If the input is "TTL-Level" or "CMOS-Level", that means 5V for high level, then the pull-up should not be connected with a supply higher than 5V.

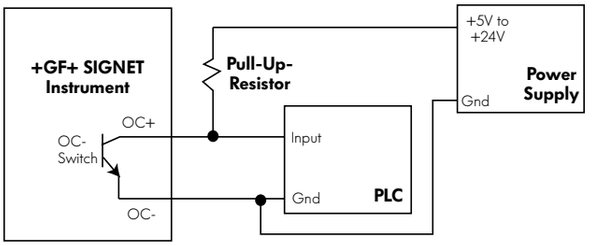
+GF+ SIGNET instruments already have the pull-up-resistor and the sensor power supply built into the instrument. No external pull-up-resistors are required.

Open Collector Output (continued)

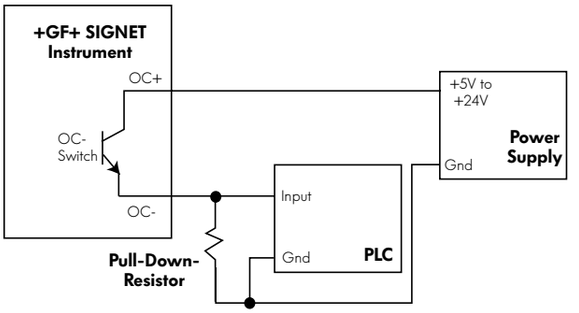
3. Instrument Output Wiring

Open collector control and alarm outputs on +GF+ SIGNET instruments (i.e. ProcessPro® or ProPoint™ series) are electrically isolated from the instrument's power supply. That means these can be used in the above mentioned NPN configuration as well as in PNP configuration, if required. Below are a few sample circuits:

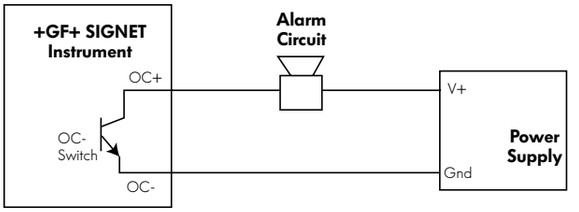
- PLC Wiring "NPN" style



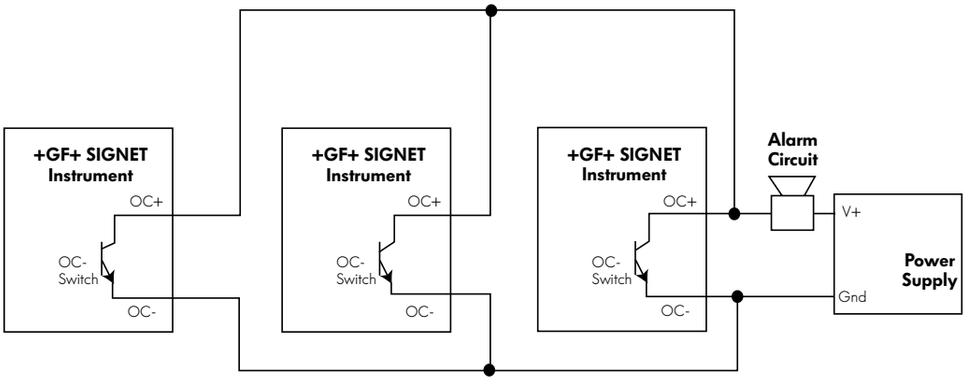
- PLC Wiring "PNP" style



- Alarm circuit or alarm lamp wiring to a single +GF+ SIGNET instrument



- Alarm circuit or alarm lamp wiring to serve multiple +GF+ SIGNET instruments



Open Collector Output (continued)

4. Voltage and Current Limitation

As mentioned before, the supply voltage in the OC output circuit MUST be limited to the specified maximum OC voltage (see operating manual for specific instrument). The use of a quality regulated 5V, 12V or 24V (depending on the application) power supply is recommended. Depending on the stability of the main power line and the location, it may be necessary to use additional over-voltage protection components or lightning arrestors.

Similarly, the current through the Open Collector switch must be limited. Typical OC outputs allow only for 10 to 50mA switch current (please consult manual). Exceeding this current limit can burn out the OC output components immediately. Please see the following section on how to dimension the loads.

5. Load and Pull-Up/Down Resistor Considerations

By utilizing basic arithmetic and Ohm's law, one can determine the safe limits of load resistance. When the OC switch is closed, almost the entire supply voltage is applied to the load, (i.e. the pull-up or pull-down resistor, the alarm horn input, a potential power relay coil or annunciator lamp). The resulting current through the load and through the OC switch, as well, can be calculated as:

(Current) = (Supply Voltage)/(Load Resistance)

- Example 1:
  The supply voltage is 24V and a pull-up-resistor of 10kΩ is used.
  Current is 24/10,000 = 2.4mA

(If the OC current rating is 10mA, then in this example, it would be considered safe.)

- Example 2:
  The supply voltage is 12V and a horn with a resistance of 100Ω is used
  Current is 12/100 = 120mA

(Even if the OC current rating is 50mA, this load will damage the instrument)

6. Transient Protection

There are several "difficult" load cases that must be considered:

- Inductive loads
  These can be power relay or other solenoids, motors, alarm horn coils, etc. Such loads generate very high voltage spikes when the OC switch is turned off. If such a load is unavoidable, the use of transient suppression components or RC-Filters (or snubbers) wired parallel to the load is required. This is critical, as a single transient pulse may destroy the output.
- Capacitive loads
  This type of load should be rare but can occur if the load contains an internal power supply/regulator that is fed from the OC output circuit. In such a case, it must be assured that the in-rush current does not exceed the OC current rating.
- Incandescent lamps
  Such lamps have a very high start-up current until the filament glows and the current settles to the specified value. The use of incandescent lamps on an OC output is not recommended. An LED type annunciator should be used instead.

Open Collector Output (continued)

7. "Active High" and "Active Low" Setting

Depending on the desired function of the circuit attached to the OC output, it may be necessary to have the OC output switch turned "on" or "off" when the criteria for the activation of this output are met.

By default, +GF+ SIGNET instruments are set to operate in "active low" mode. This means when the user-defined condition for the activation is met (e.g. exceeding of an alarm limit) the OC switch is turned "on". If wired as standard "NPN-style" output (see previous page) the logic level of the attached control system or PLC input consequently becomes "low" logic level.

If a high input logic level is required for activation, it can be accomplished in two ways:

- to wire the OC output "PNP" style as described in the previous page
- to change the OC output function to "active high" in the menu system of the instrument. Most +GF+ SIGNET instruments allow for this option.

8. Fail-Safe Behavior

No matter what the setting, all OC outputs of +GF+ SIGNET instruments turn off when the instrument loses power. This must be taken into account when evaluating system failure consequences. If the system layout requires a "closed" or "on" condition for the output in case of power loss, a mechanical dry contact relay (NC contacts) must be used instead of the OC output.