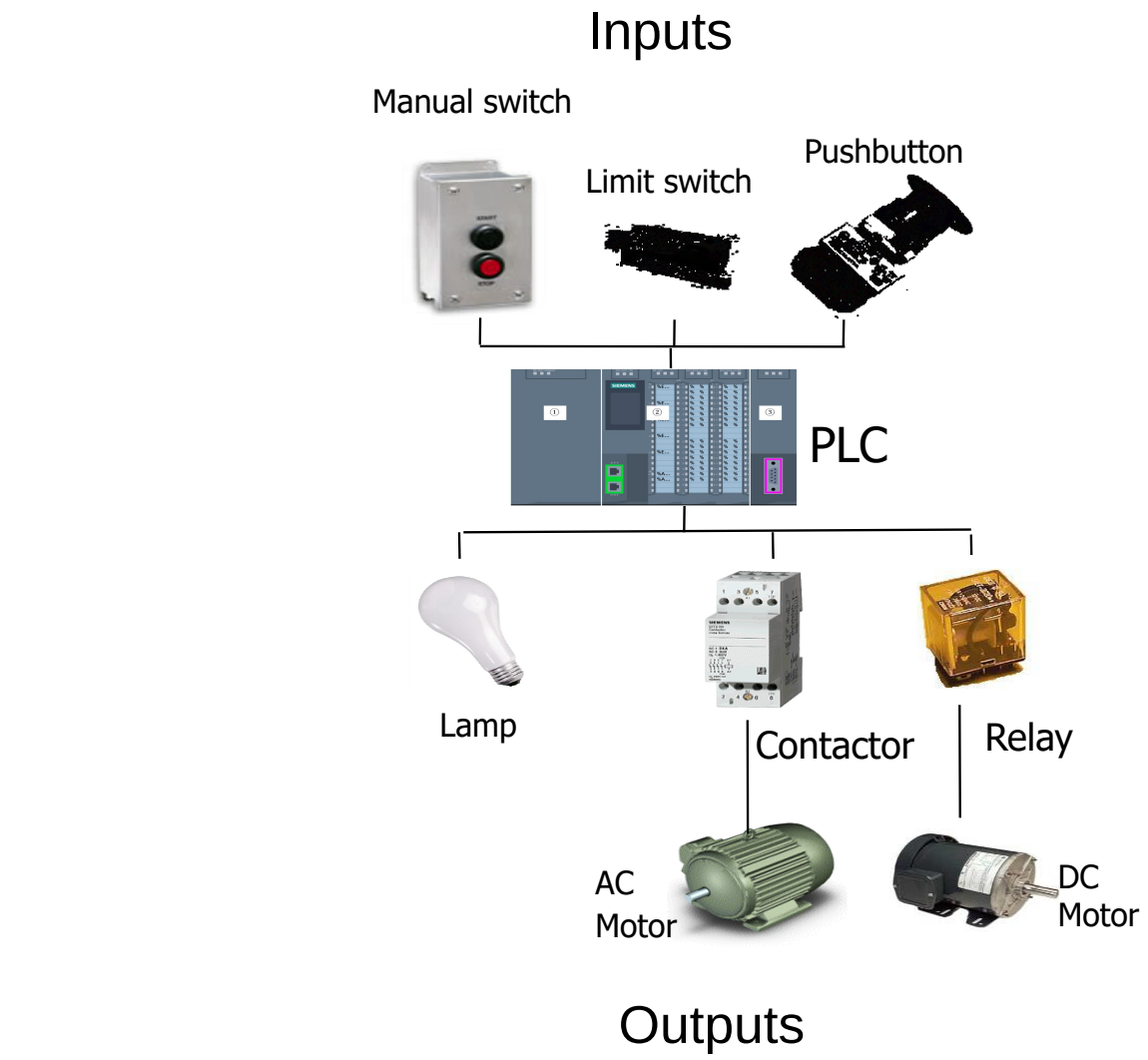
Hardware Components Interfacing to PLC

Digital IO

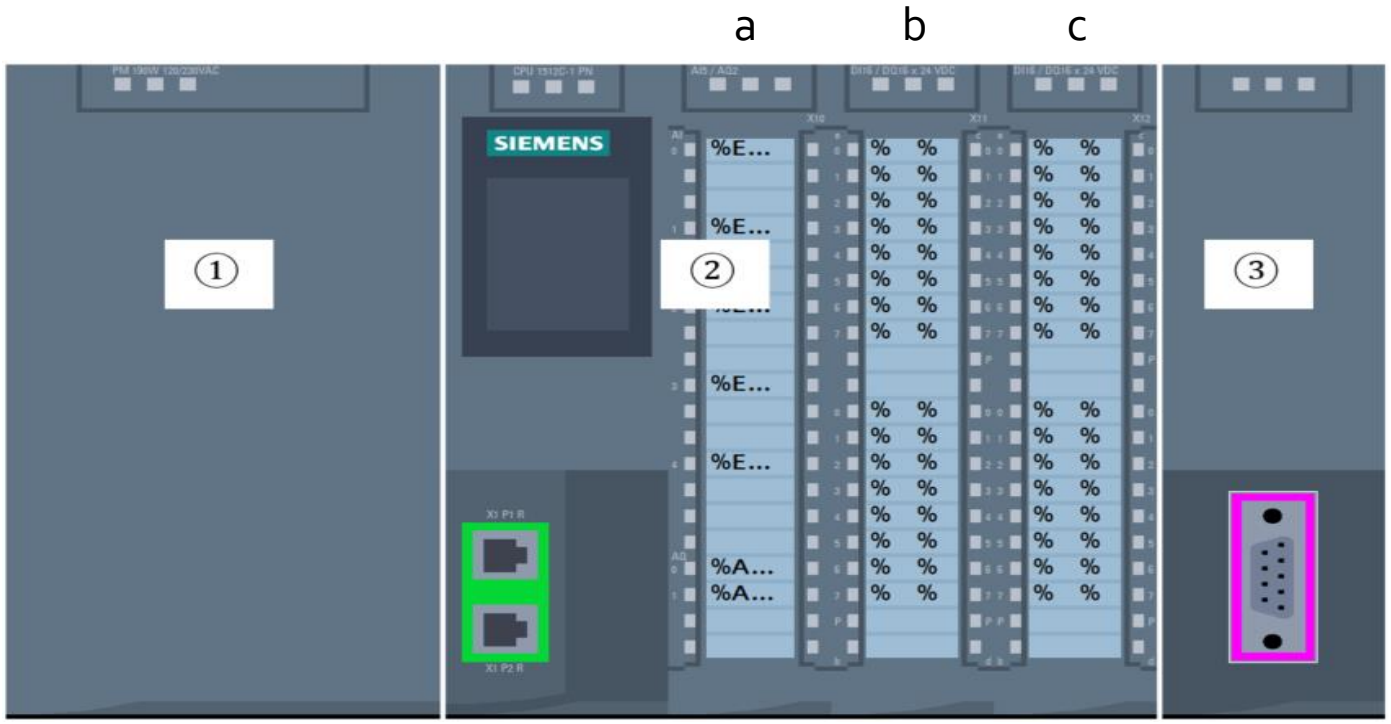
Learning Outcome

- List the hardware components commonly used with PLC systems
- Identify commonly used industrial sensors and describe their characteristic and applications
- Describe basic circuitry and applications for discrete I/O modules

Hardware Components Interfacing to PLC



S7-1500 PLC

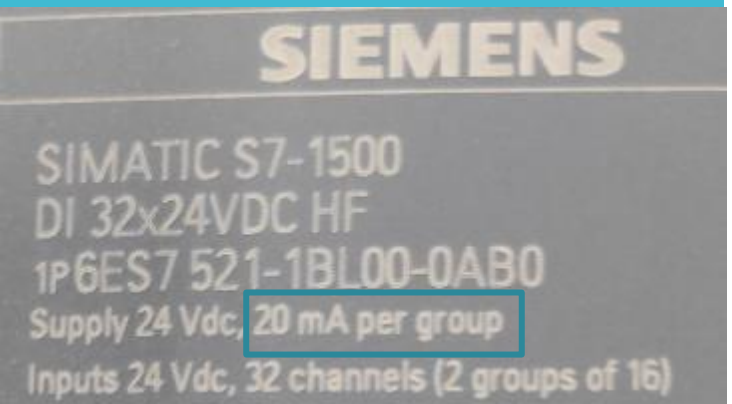


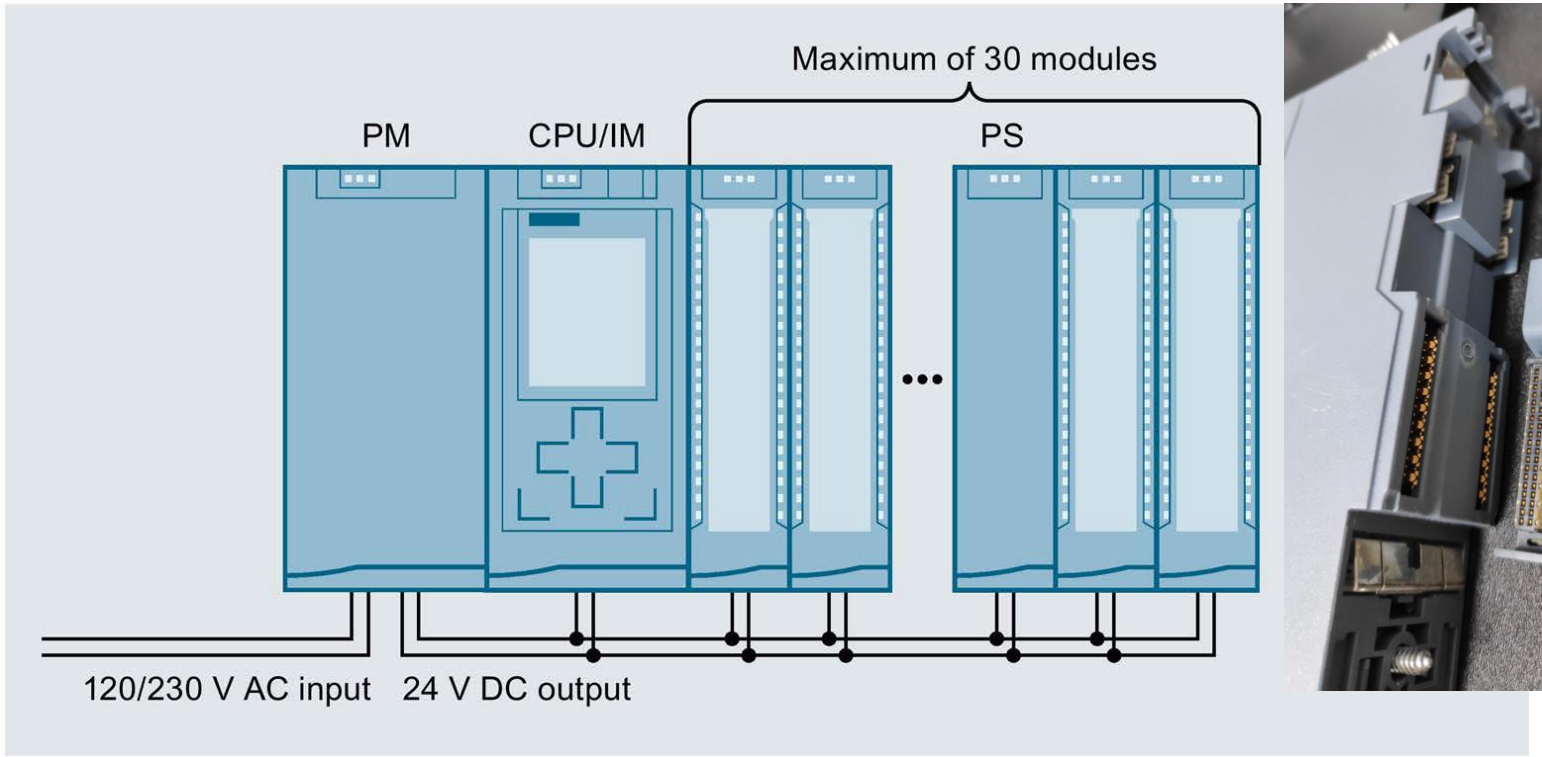
1. Power Supply – 230Vac, 50Hz, 190W. 24VDC/ 8A output

2. CPU 1512C-1 PN with integrated PROFINET interfaces
   a) AI5/AQ2 (5 x Analog inputs, 2 x analog outputs
   b) DI16/DQ16-24vdc (16 Digital inputs and 16 outputs)
   c) DI16/DQ16-24vdc(16 Digital inputs and 16 outputs)

3. Communications processor CP 1542-5 Profibus DP

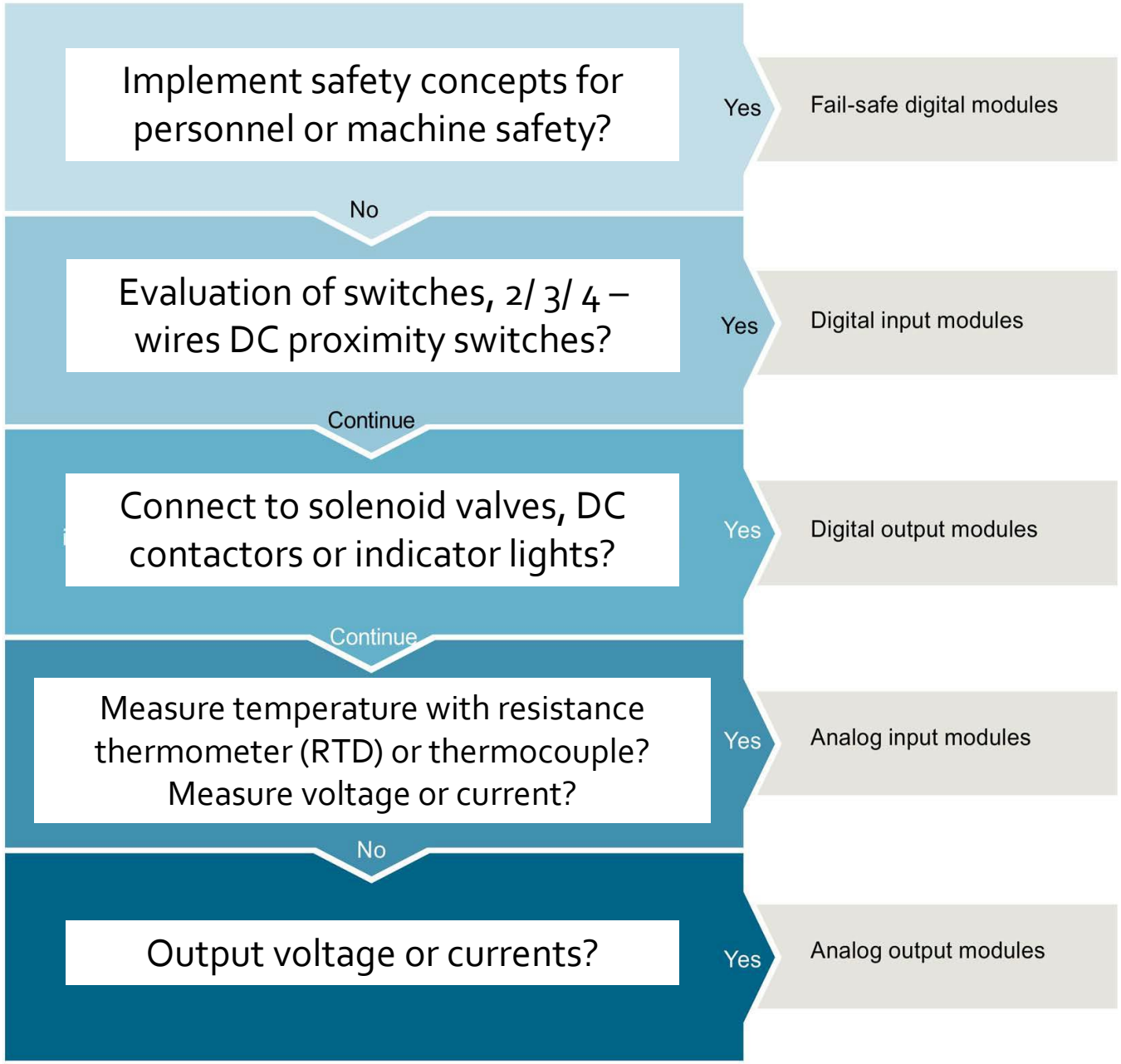
S7-1500 PLC Scalable System





1. Most PLC are scalable, S7-1500 could easily add modules for expansion
2. Power supply shall be rated sufficient for the modules
3. Modules are interconnected with the bus at the base

Selection Guide for I/O Module



Common Hardware Components

INPUT DEVICES	Types of Inputs
Push Buttons	Digital Input
Mechanical limit switches	Digital Input
Photoelectric sensors	Digital Input
Proximity Sensors Inductive/Capacitive	Mainly Digital Input – Some vendors provide Analog Signals
Light Curtains	Digital (Safety System)
Level switch	Digital Input
Level sensor	Analog Input
Pressure switch, Flow switch	Digital Input
Pressure sensor, Flow sensor	Analog Input

Common Hardware Components

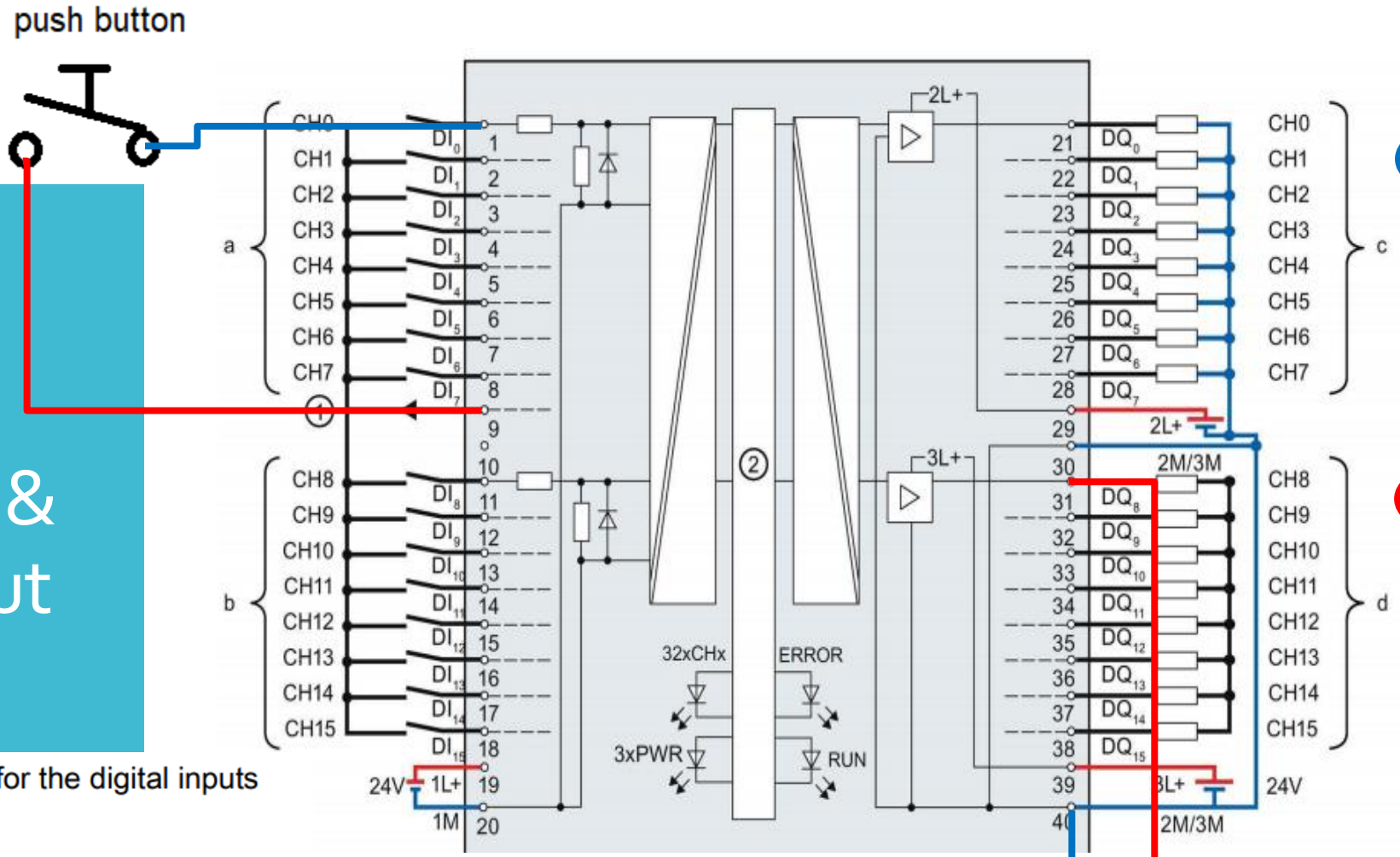
OUTPUT DEVICES	Types of Outputs
Indicating Lamp / LED	Digital Output
Relays / Contactors	Digital Output
Solenoids	Digital Output
Buzzer	Digital Output
On/Off Valves (Open or Close)	Digital Output
Control Valve	Analog Output
Motors (through drivers)	Digital Output
Variable Speed Drives	Digital and Analog Output

Digital Inputs and Outputs

- ON / OFF
- Discrete Type
- Bit Oriented I/O
- Depending on the type of I/O, some would require external power to the devices rather than using the same power to the I/O module

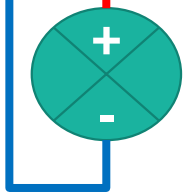
S7-1500 Digital Input & Digital Output Terminals

How will you wire the push button to DI_0?

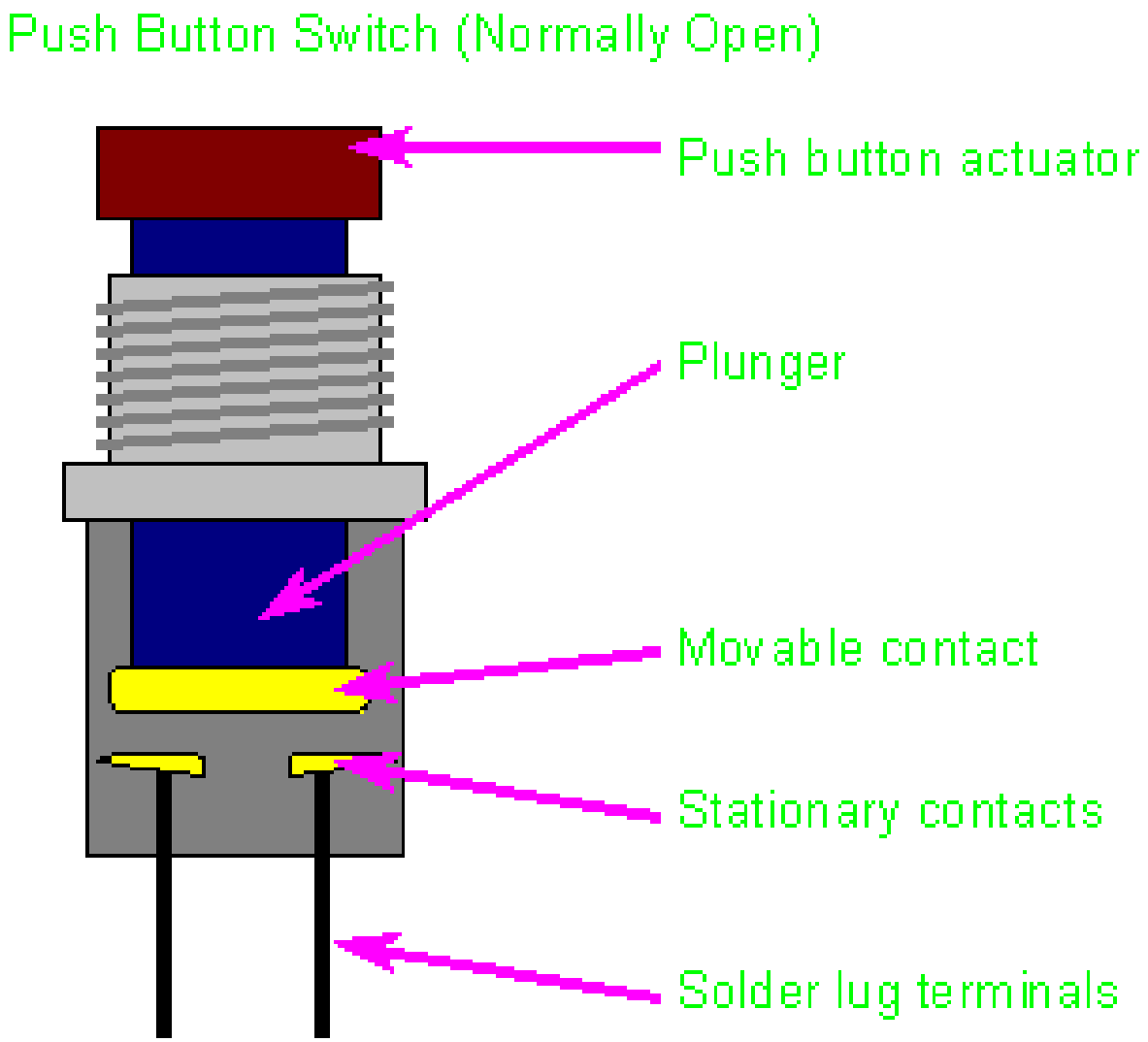


①	Encoder supply for the digital inputs
②	CPU interface
xL+	Connection for 24 V DC supply voltage
xM	Connection for ground
CHx	Channel or channel status LED (green)
RUN	Status display LED (green)
ERROR	Error display LED (red)
PWR	POWER supply voltage LED (green)

How will you wire 24Vdc LED to DO_8?



Push Button (Digital Input)

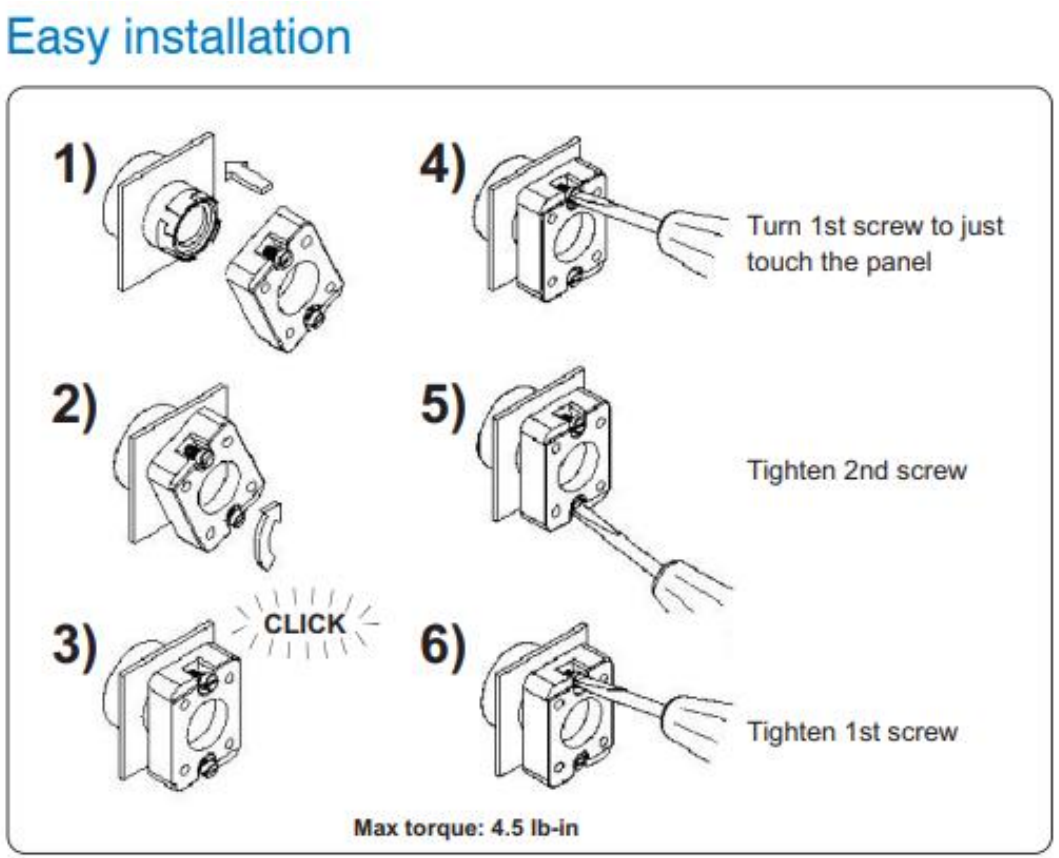


Industrial Push Buttons

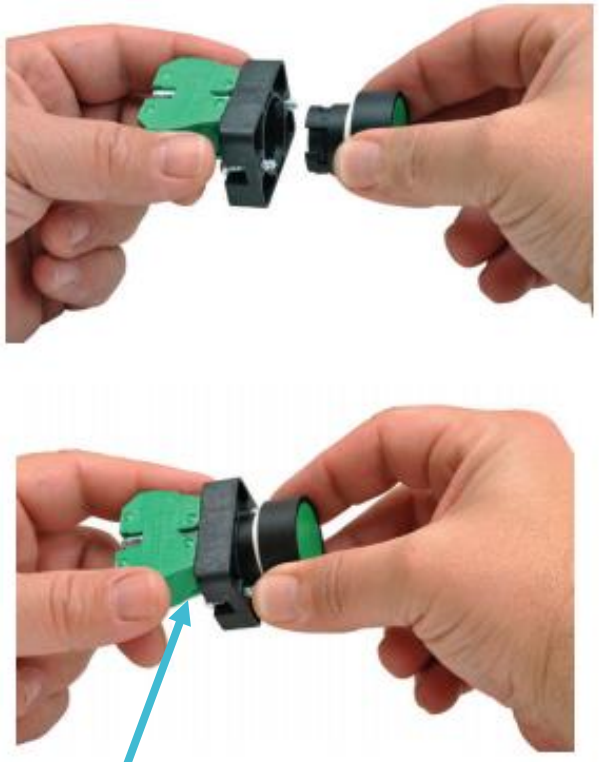
https://new.siemens.com/global/en/products/automation/industrial-controls/sirius/sirius-command/sirius-act.html

https://www.alibaba.com/product-detail/400-300-160mm-Electric-Large-Panel_60513885390.html

Industrial Push Buttons

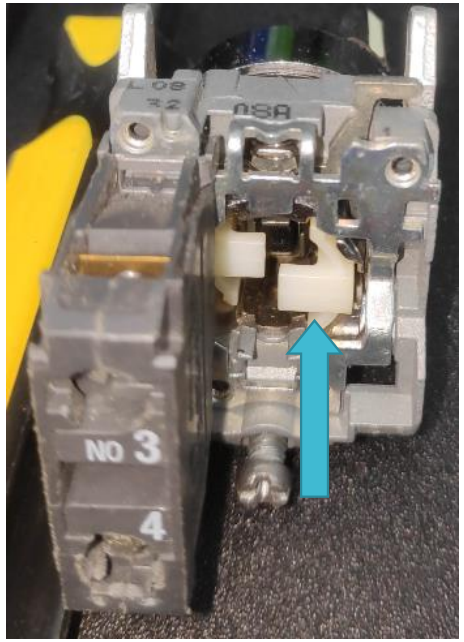


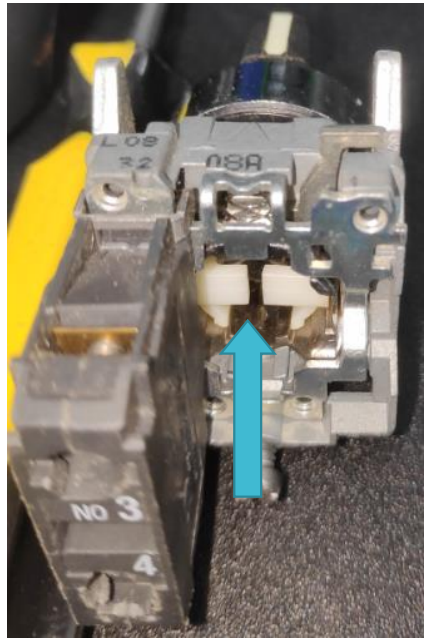
http://res.abtronics.ru/pdf/730/AutomationDirect/abtronics_GCX3141.pdf

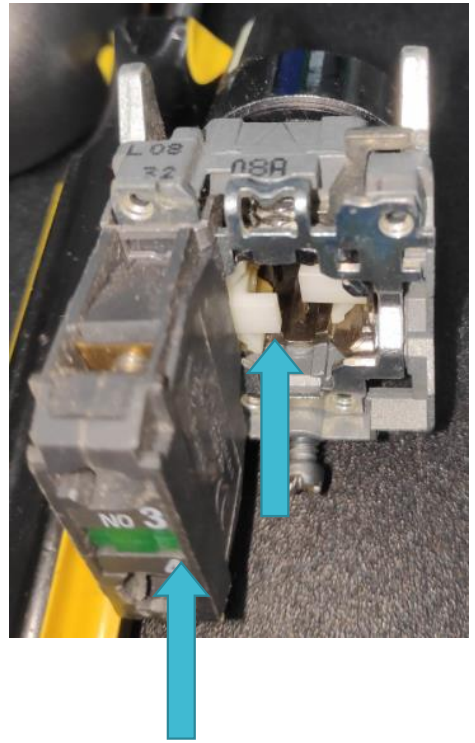


Contacts – Could be NO or NC
NO – Typically Green
NC – Typically Red

3-way Selector Switch







Limit Switches

Typically activates the switch when reaches the limit and used to cut off signal or as presence detection


Honeywell Limit Switch Roller Plunger ...
sg.rs-online.com · In stock


Safety Limit switch D4B- ...
monotaro.sg


Snap Action Limit Switch Roller Lev...
sg.rs-online.com · In stock

Types Of Omron Safety L...
alibaba.com


Limit Switches | Schneider E...
se.com


ZCT25P16 - TELEMEC...
sg.element14.com · In st...


Small Safety Limit Switches, P...
monotaro.sg

IP65 Waterproof Elevator Sp...
chnanma.en.made-in-china.co...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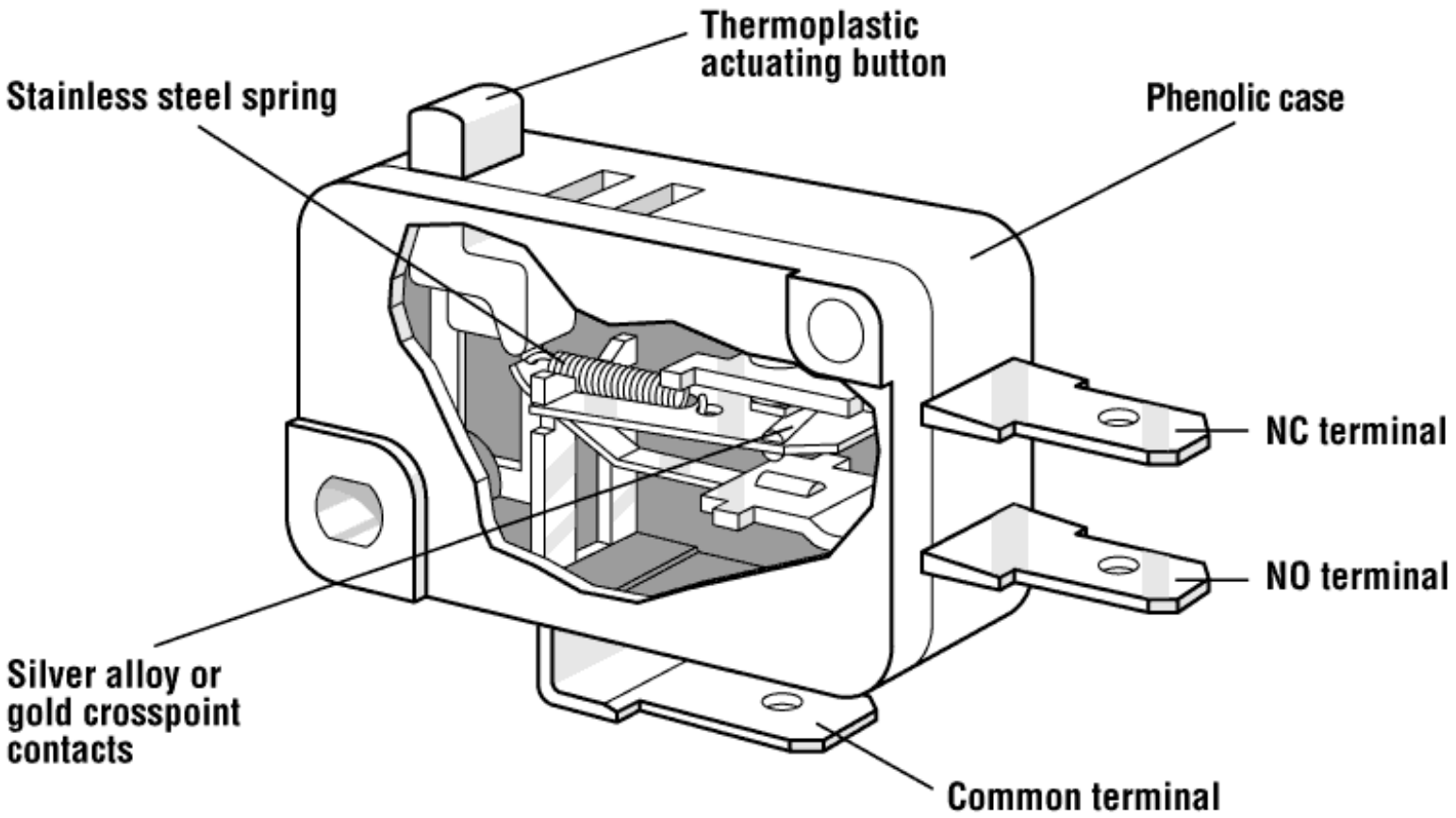
Limit Switches



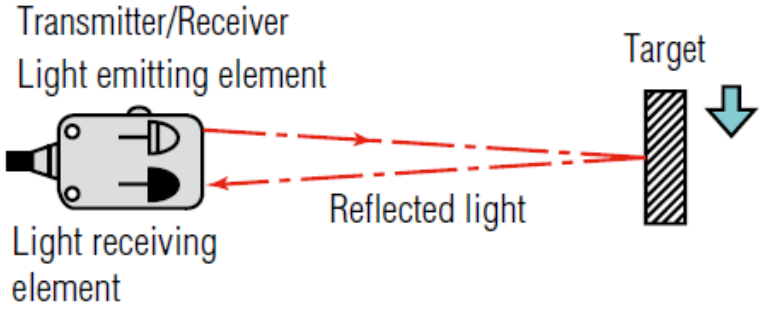
Photoelectric Sensors

https://cdn.sick.com/media/docs/4/64/564/Product_catalog_Photoelectric_sensors_en_IM0061564.PDF

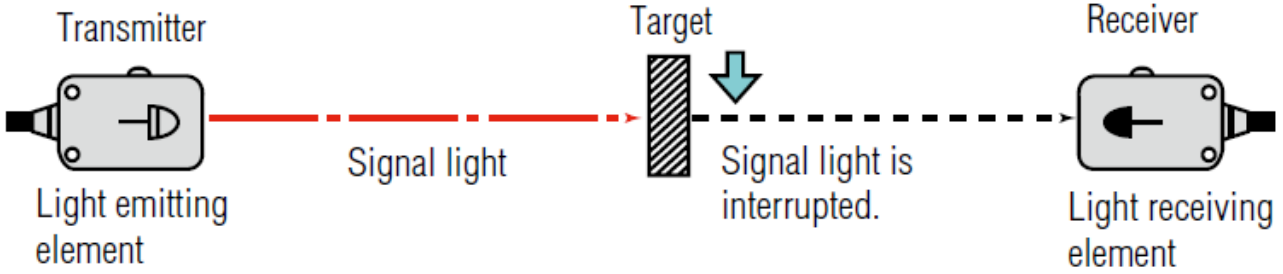
Types of Photoelectric Sensors

Diffuse

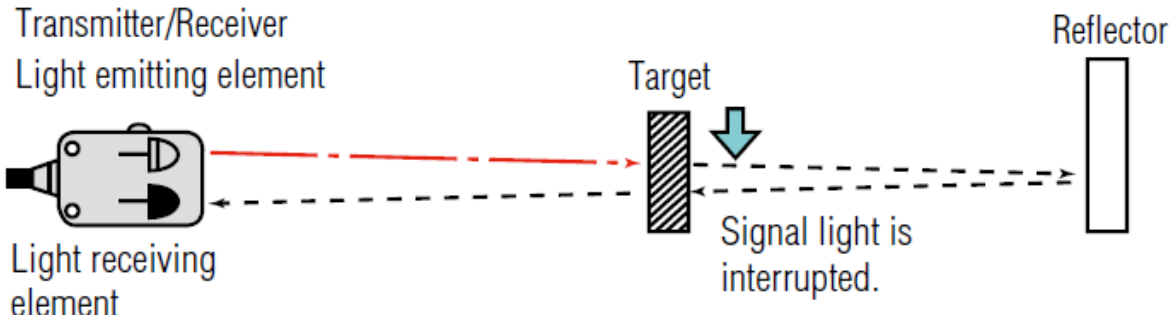
Reflective model



Thrubeam model

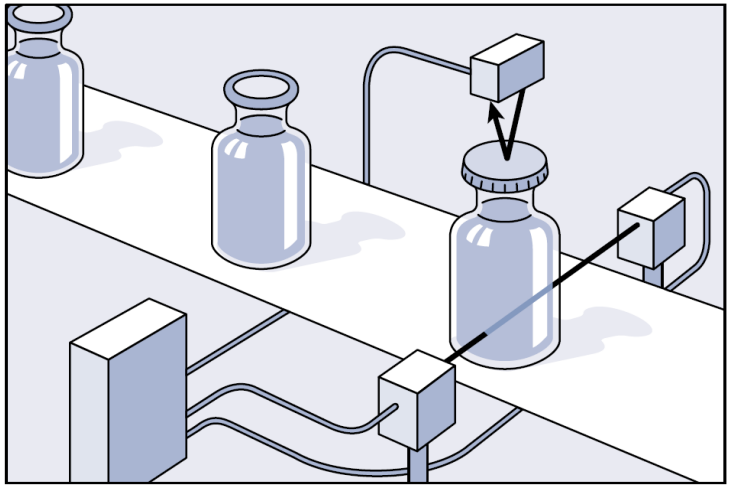


Retro-reflective model

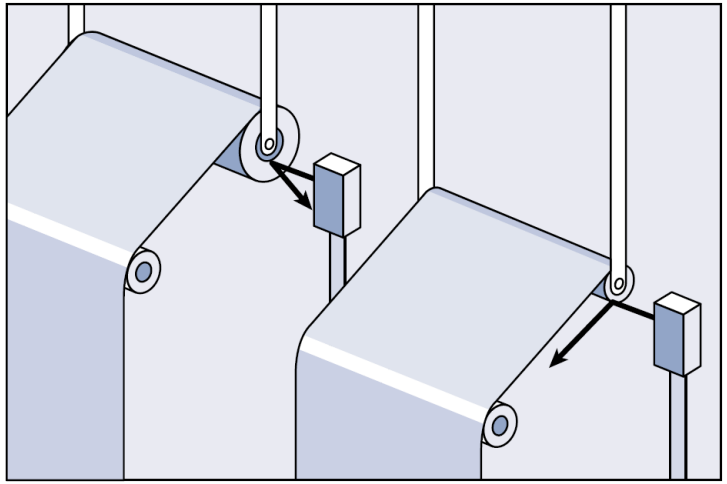


Photoelectric Sensors – Diffuse Application

Detect bottle cap presence

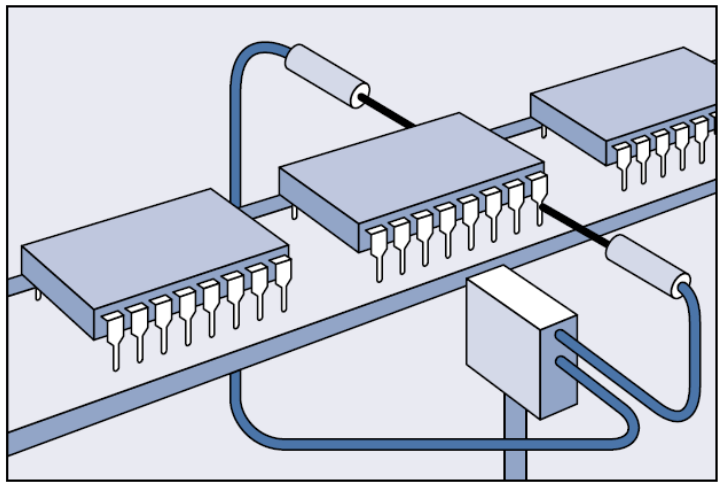


Detect End of Roll

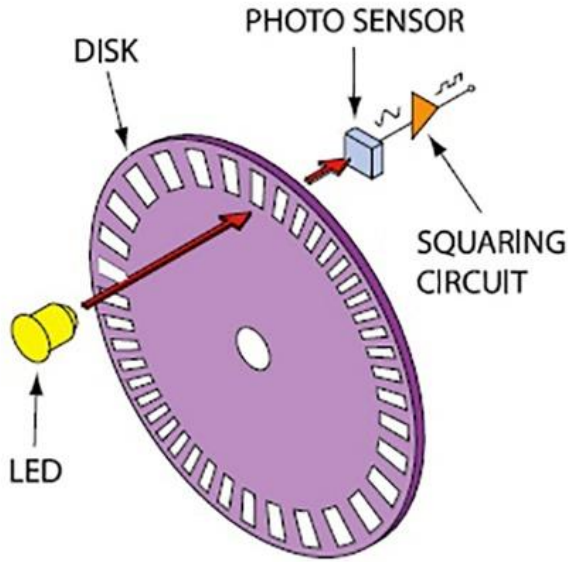


Photoelectric Sensors – Thru Beam Application

Counting IC chip pins

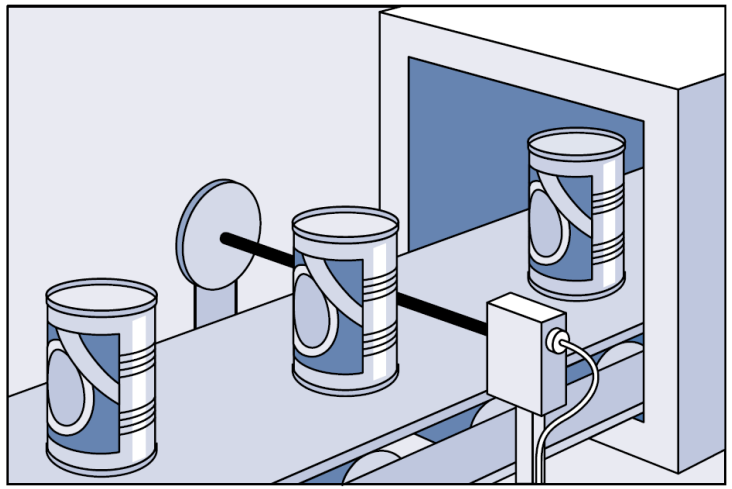


Encoder Counting

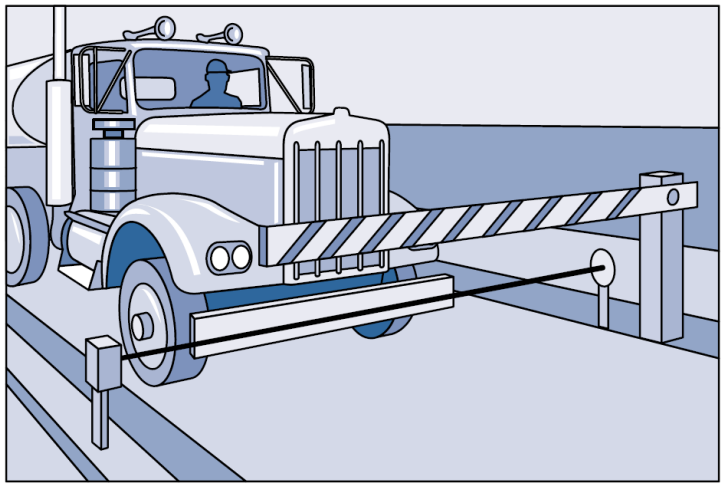


Photoelectric Sensors – Retro Reflective Application

Counting cans

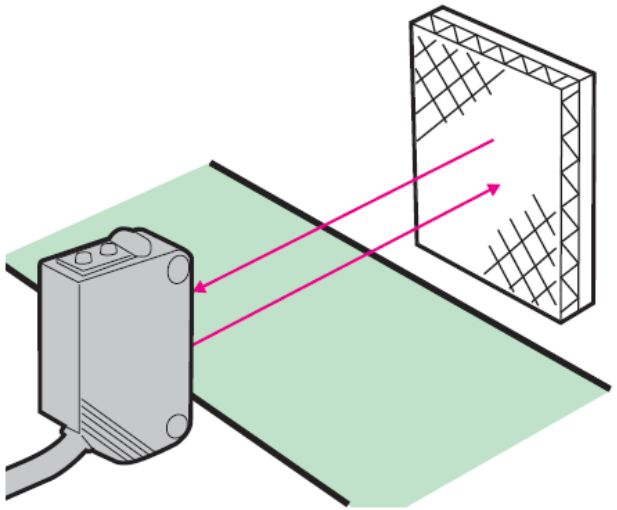


Car Park Gantry

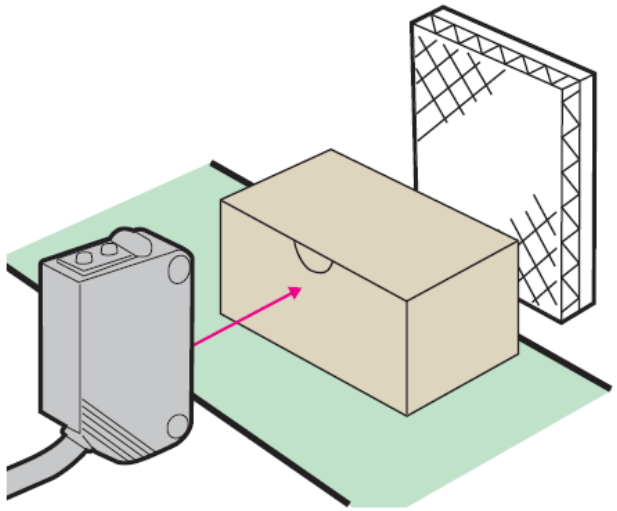


Photoelectric Sensors – Retro Reflective Application

(1) No Object
The light from the Emitter hits the Reflector and returns to the Receiver.



(2) Non-glossy Object
Light from the Emitter is intercepted by the object, does not reach the Reflector, and thus does not return to the Receiver.



Proximity Sensors

PROXIMITY SENSORS

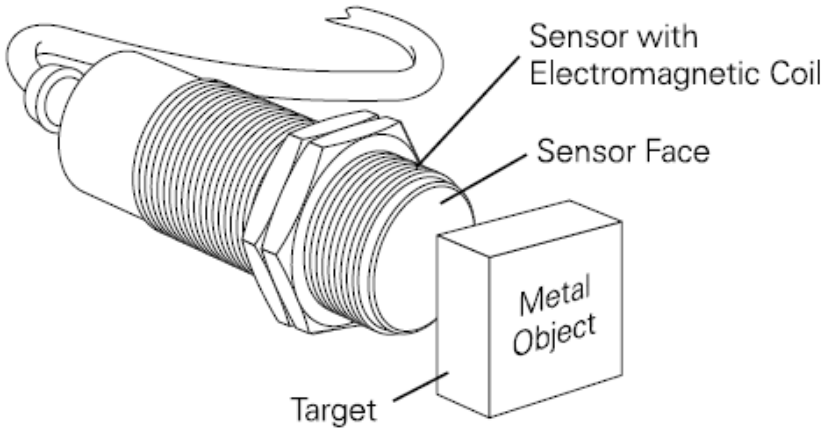
Inductive proximity sensors, inductive safety switches,
capacitive proximity sensors, magnetic proximity sensors

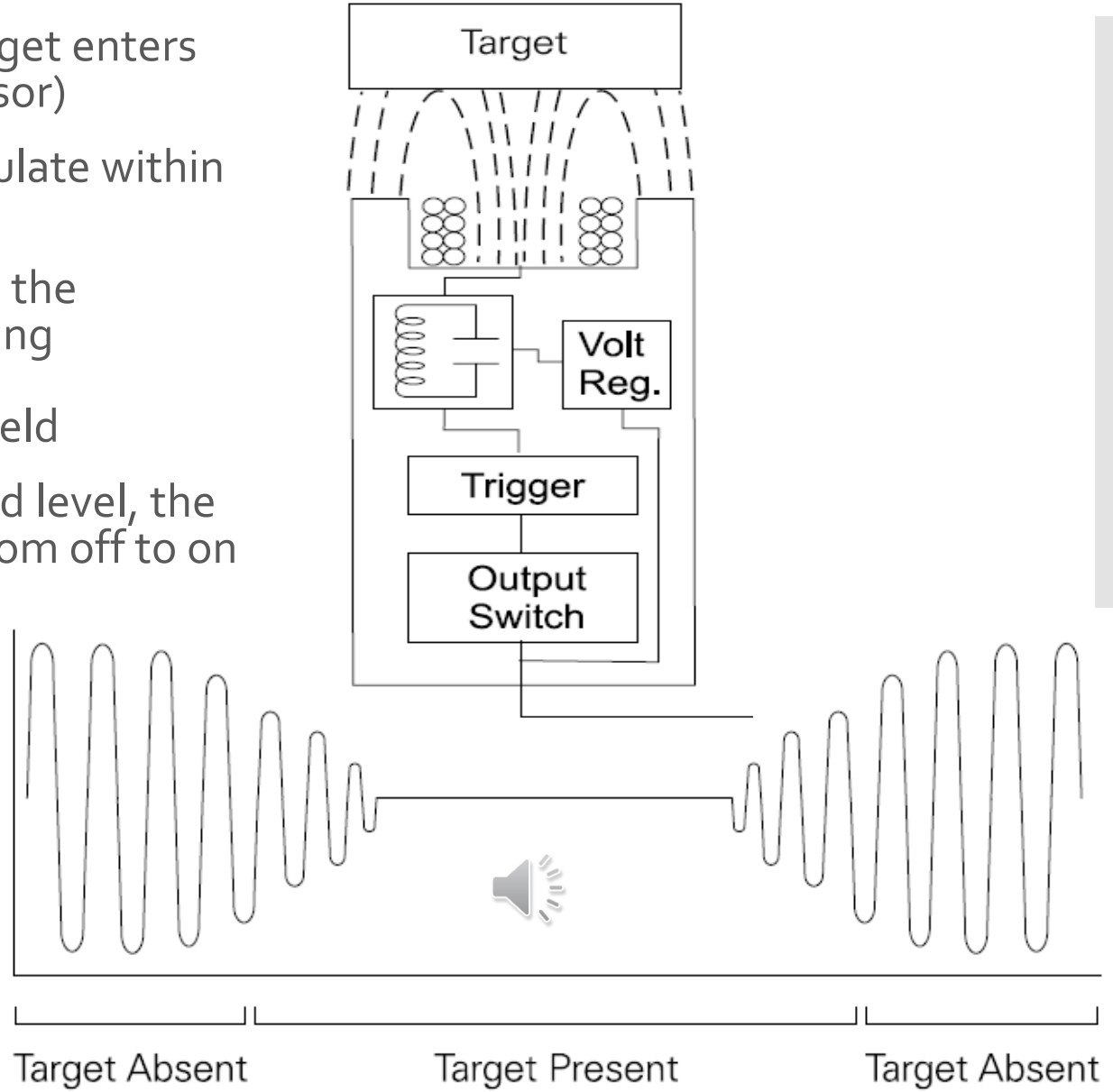
SICK
Sensor Intelligence.

https://cdn.sick.com/media/docs/8/18/618/Product_catalog_Proximity_Sensors_en_IM0048618.PDF

Proximity - Inductive Sensor Basic Working Principle

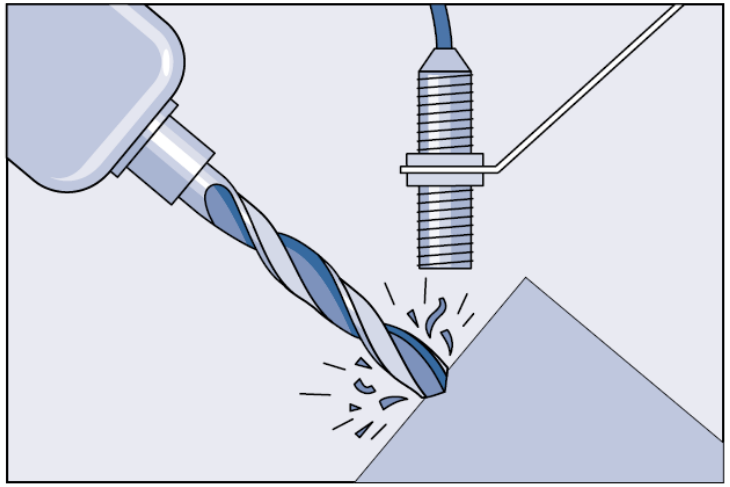
- When **metallic** target enters the field (near sensor)
- Eddy currents circulate within the target.
- Resulting a loss on the oscillator, decreasing amplitude of the electromagnetic field
- At a predetermined level, the output switches from off to on state



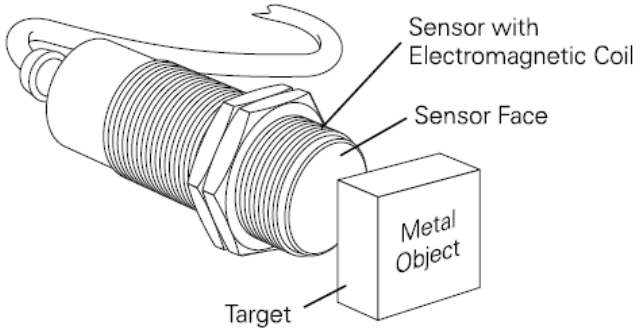


Inductive Sensors Application

Detect broken drill bit

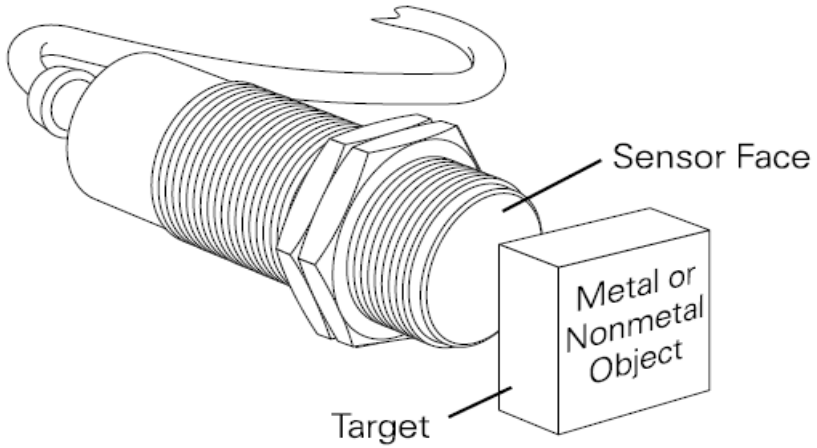


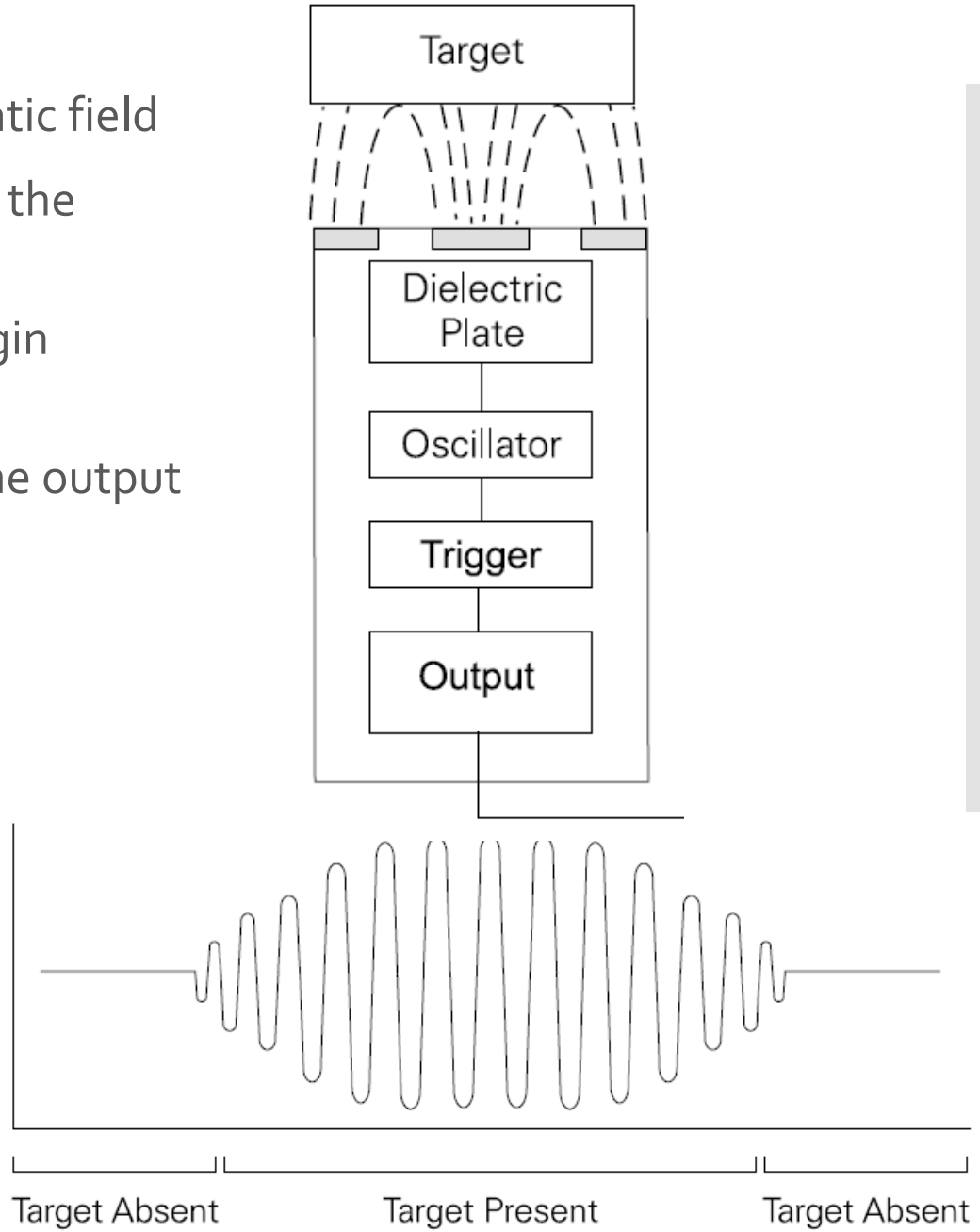
Senses metallic object only



Proximity - Capacitive Sensor Basic Working Principle

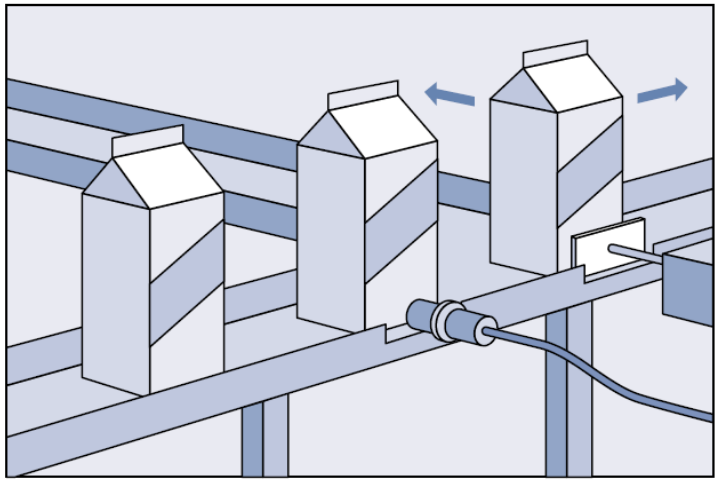
- Target enters the electrostatic field
- Changes the capacitance in the oscillator circuit.
- This causes oscillator to begin oscillating
- at a predetermined level, the output switches from off to on



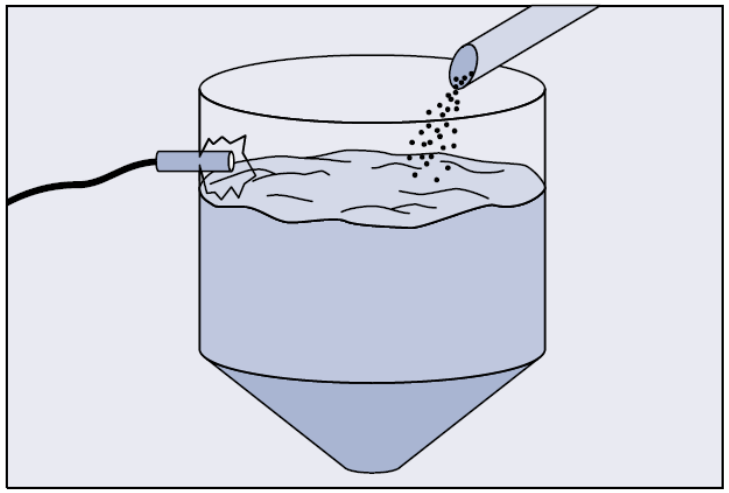


Capacitive Sensors Application

Detecting milk carton

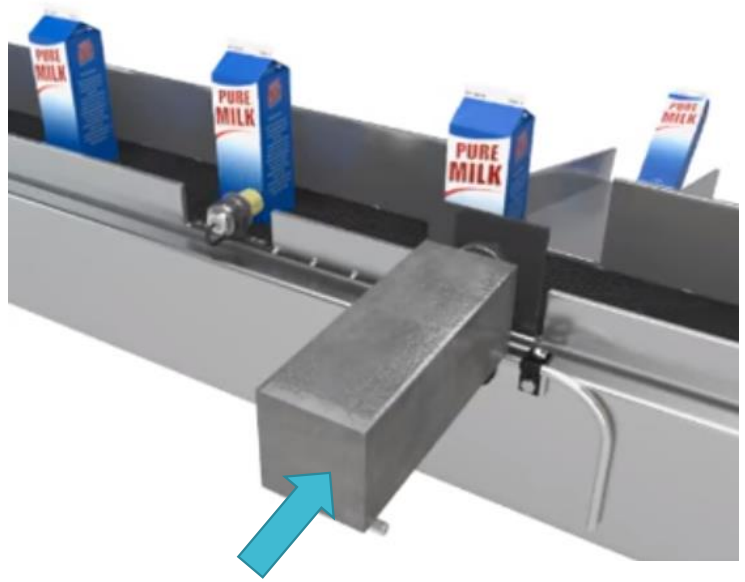


Controlling fill level



Application example

- Capacitive sensor sense milk level within the carton
- If detected without milk, solenoid after the sensor actuates and push product down
- With milk detected would continue to transport on the conveyor

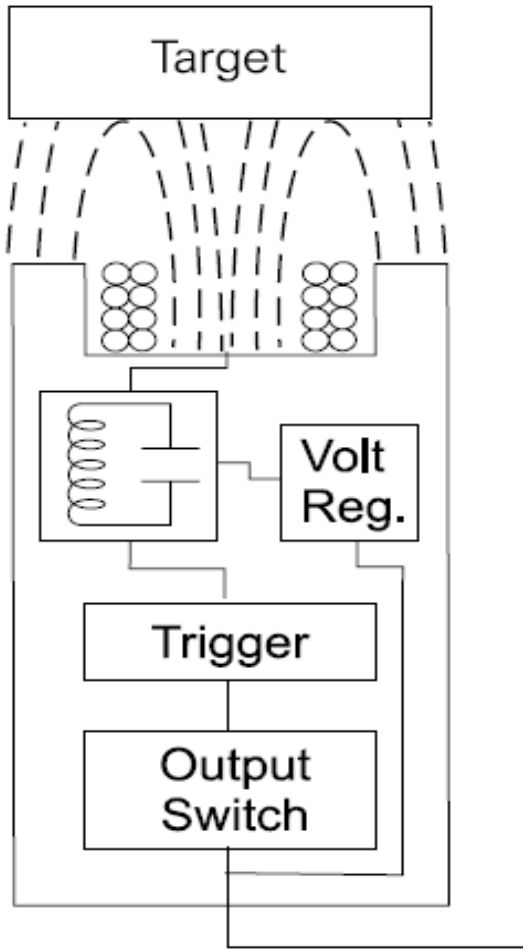


Solenoid plunger

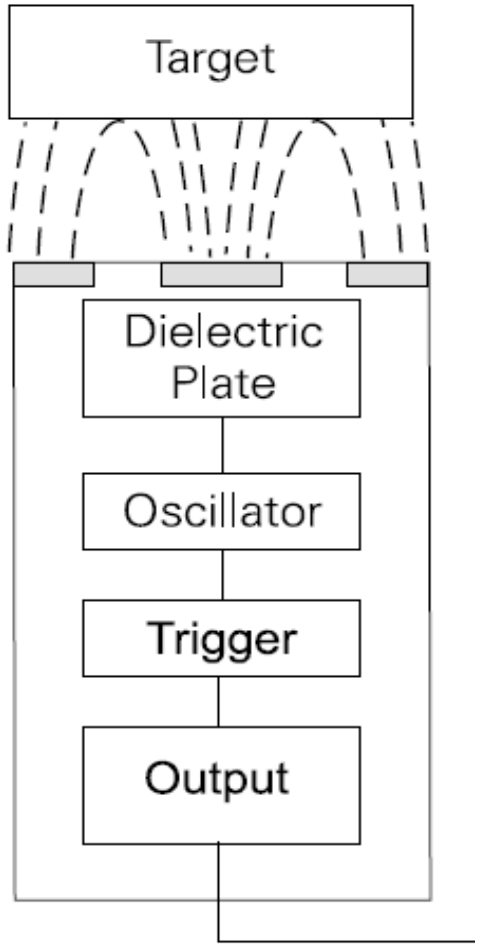
Inductive and Capacitive Sensors Wiring

These sensors requires power to the circuitry.
Output signal is typically via transistors.
Hence these are 3-Wires Digital Inputs

Inductive Sensor

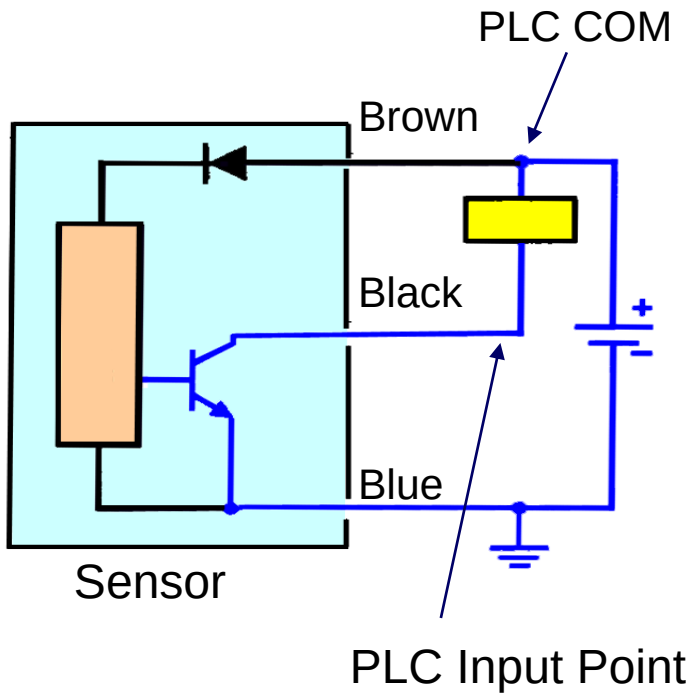


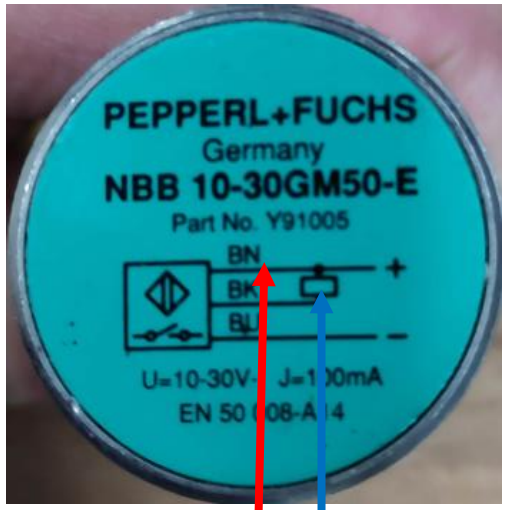
Capacitive Sensor



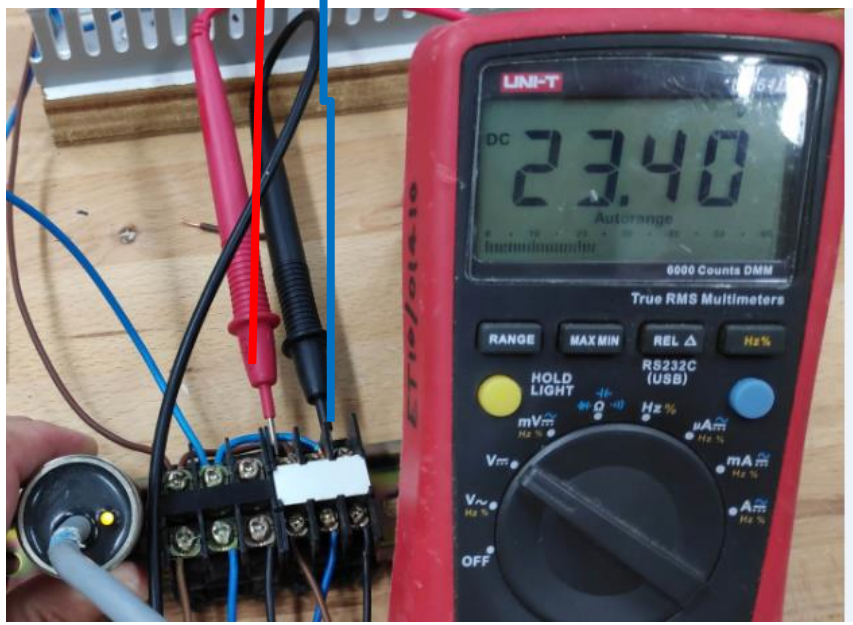
3-Wire NPN Sensor

Note that each sensor draws 100mA, This adds up to the power consumption requirements. Ensure PSU can support!





10mm distance
Inductive sensor
Operates 10 – 30V
Current: 100mA



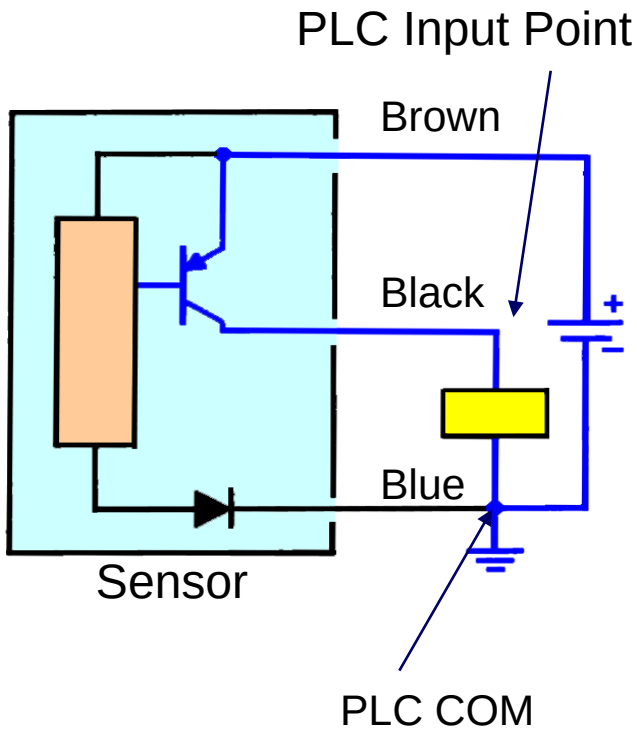
Common colour code of sensor:

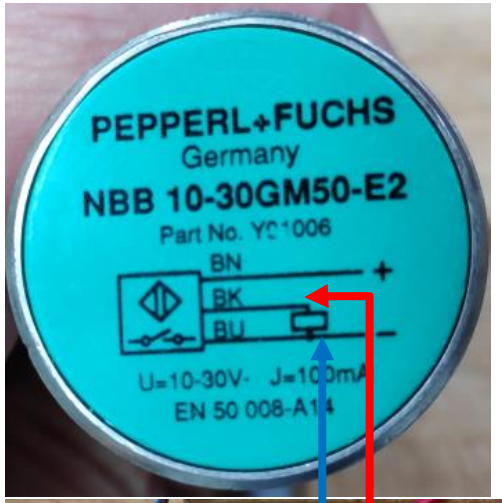
Black : Signal (to input terminal)

Brown : + of power supply

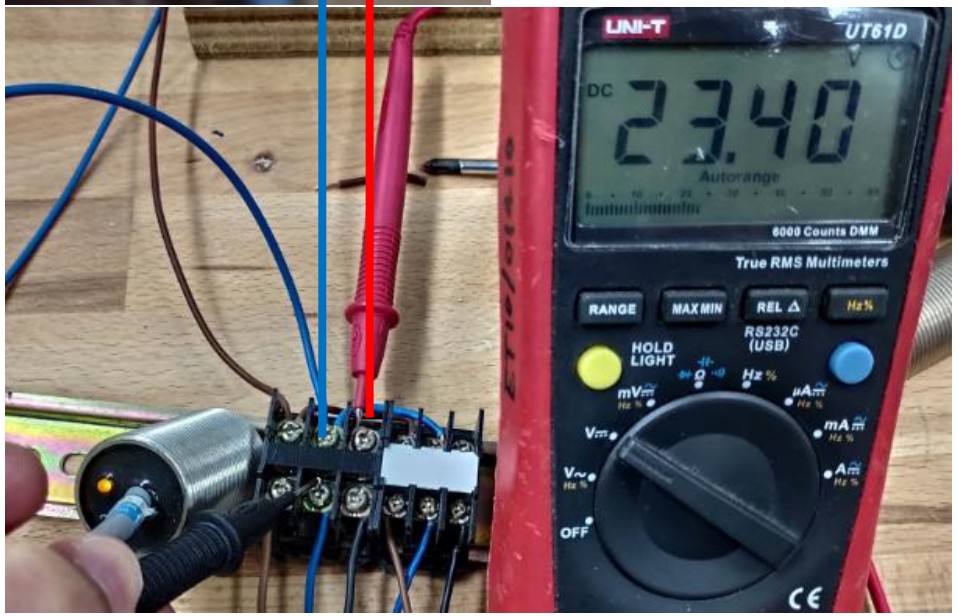
Blue : - of power supply

3-Wire PNP Sensor





10mm distance
Inductive sensor
Operates 10 – 30V
Current: 100mA



Common colour code of sensor:

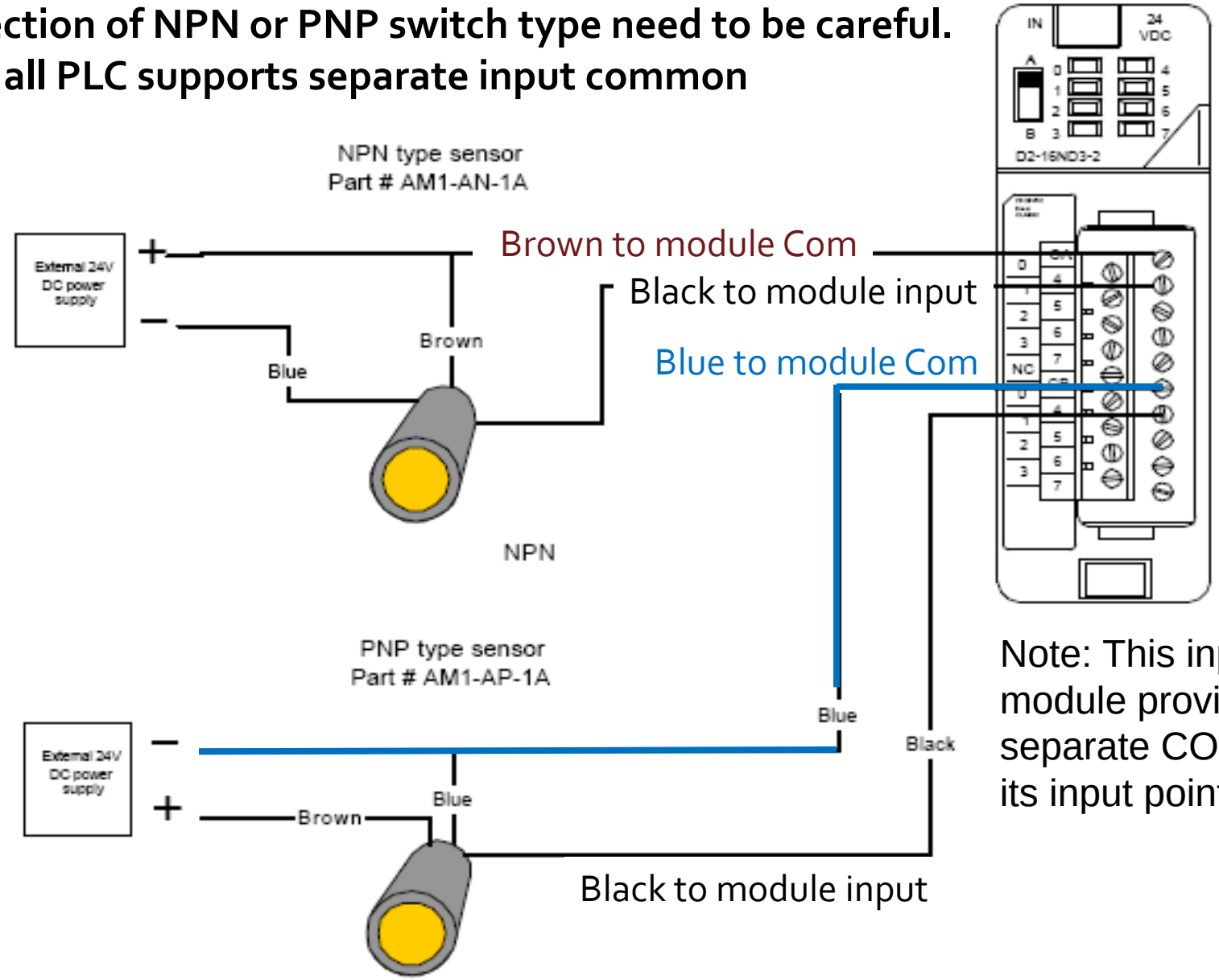
Black : Signal (to input terminal)

Brown : + of power supply

Blue : - of power supply

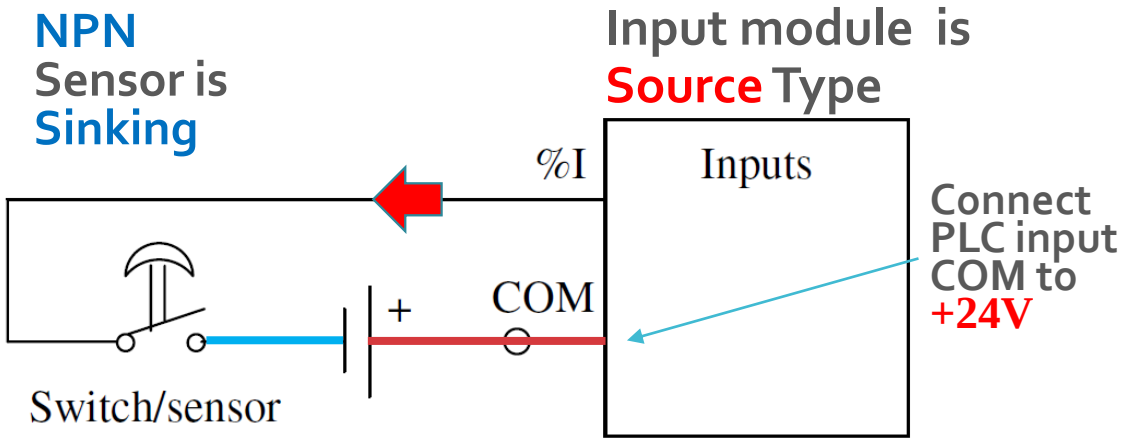
Wiring of NPN & PNP to PLC requires separate COM

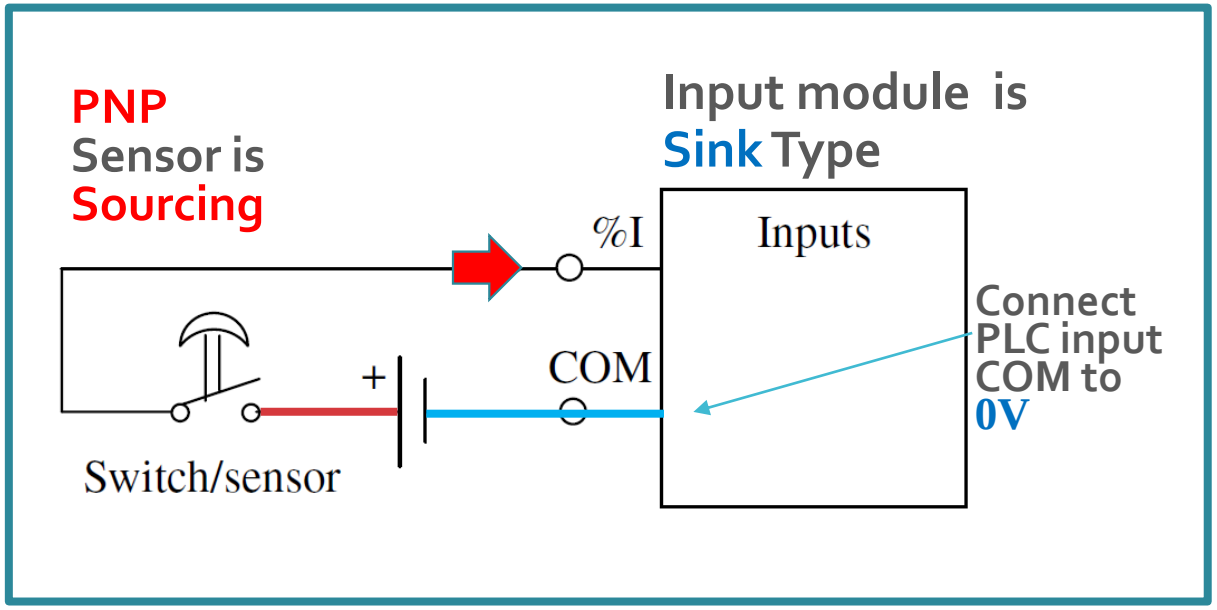
Selection of NPN or PNP switch type need to be careful. Not all PLC supports separate input common



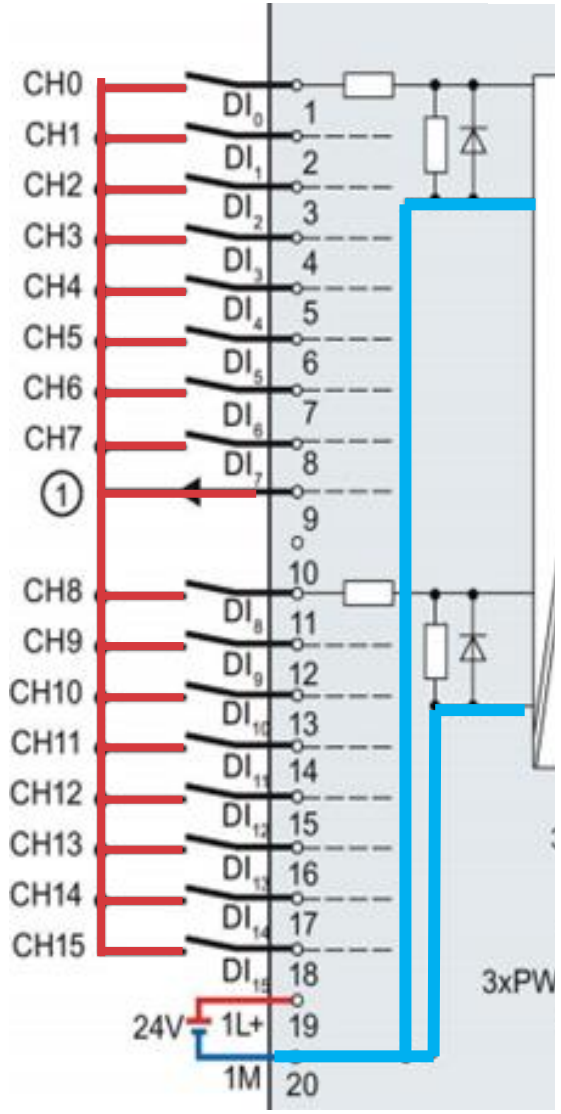
Note: This input module provides separate COM for its input points.

Sink or Source Input Module





The S7-1500 module Illustrated below is suitable for Npn or Pnp sensor??



What have you learnt

- PLC takes in digital and analog signals to evaluate the environment and processes
- PLC program would execute the logic programmed by user
- PLC output to perform tasks via digital and analog signals
- Typical DI are buttons, variety of switches & proximity sensors
- Typical AI are sensors such as flow, level, pressure sensors certain kind of proximity sensors
- Typical DO are lamps, relays, contactors, solenoid, on/off valves
- Typical AO are control valves, speed control of VSD
- VSD are special, it requires Digital IO **and** Analog IO to operate
- Wiring considerations for DI, DO and 3-wire sensors