

Programmable Logic Controllers - PLC

Paolo Burgio
paolo.burgio@unimore.it



UNIMORE
UNIVERSITÀ DEGLI STUDI DI
MODENA E REGGIO EMILIA

High Performance
Real Time **Lab**



NOVITÀ

Perché odiamo tanto i bug? Non siamo noi i loro creatori? Eliminandoli, non eliminiamo anche una parte di noi stessi? No, non è stata una debolezza o un fallimento a farli venire al mondo. È stata la luce dell'innovazione che gettiamo negli angoli bui che questi bug chiamano casa. Sono state le nostre torce a farli sgattaiolare nel mondo. In questo aggiornamento troviamo loro una nuova casa.

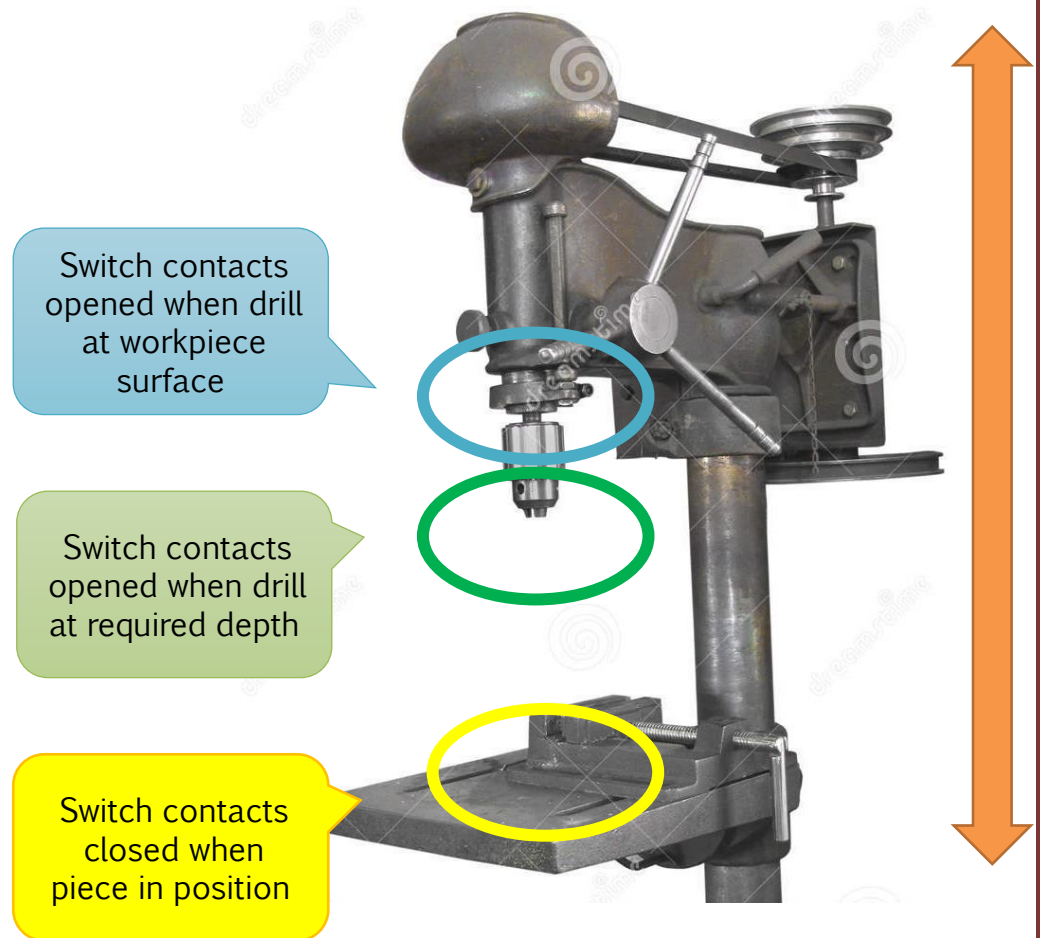
What makes a PLC different to MC/PUs?

Tight interaction with other electrical devices

- › Sensors, actuators
- › *Via* switches, relays, ...
- › E.g, drill

Designed for non-informatics

- › Programs are made of simple operations
- › Easily programmable w/o high level prog. languages





PLCs (late sixties)



Designed for implementing simple software operations

- › Arithmetics, logics, timers, counters...
- › That could also be implemented with dedicated circuitry
- › Can be re-programmed

Physically speaking...

- › Robust to vibration, highest/lowest temperature, humidity, noise..
- › Rich I/O connectivity (relays)
- › More reliable (i.e., less crashes)

Programmable, simple architecture + no OS + connected

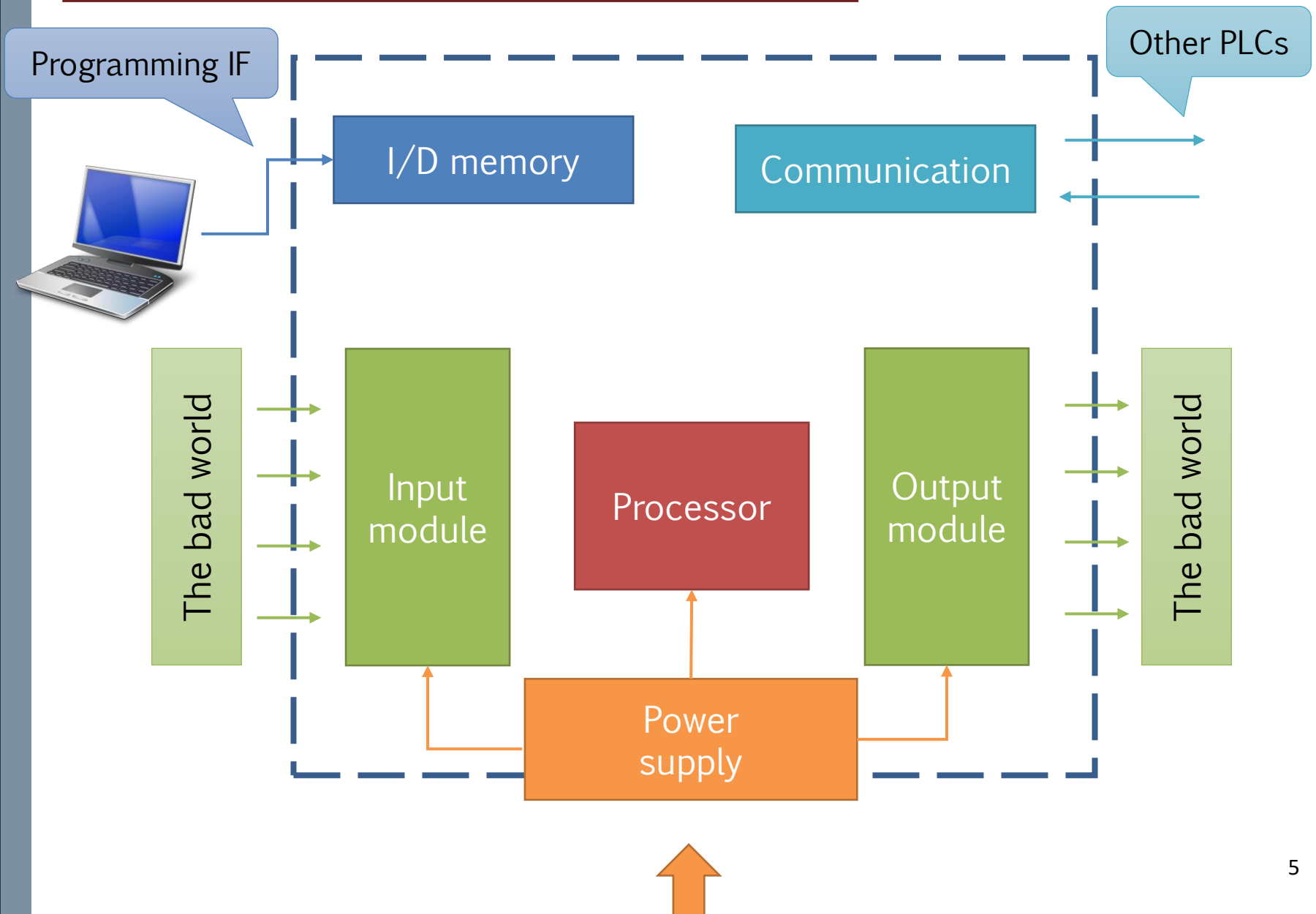
- › *Can easily be hacked!!!*
- › (not part of this course...)



Pink Floyd, Animals, 1977

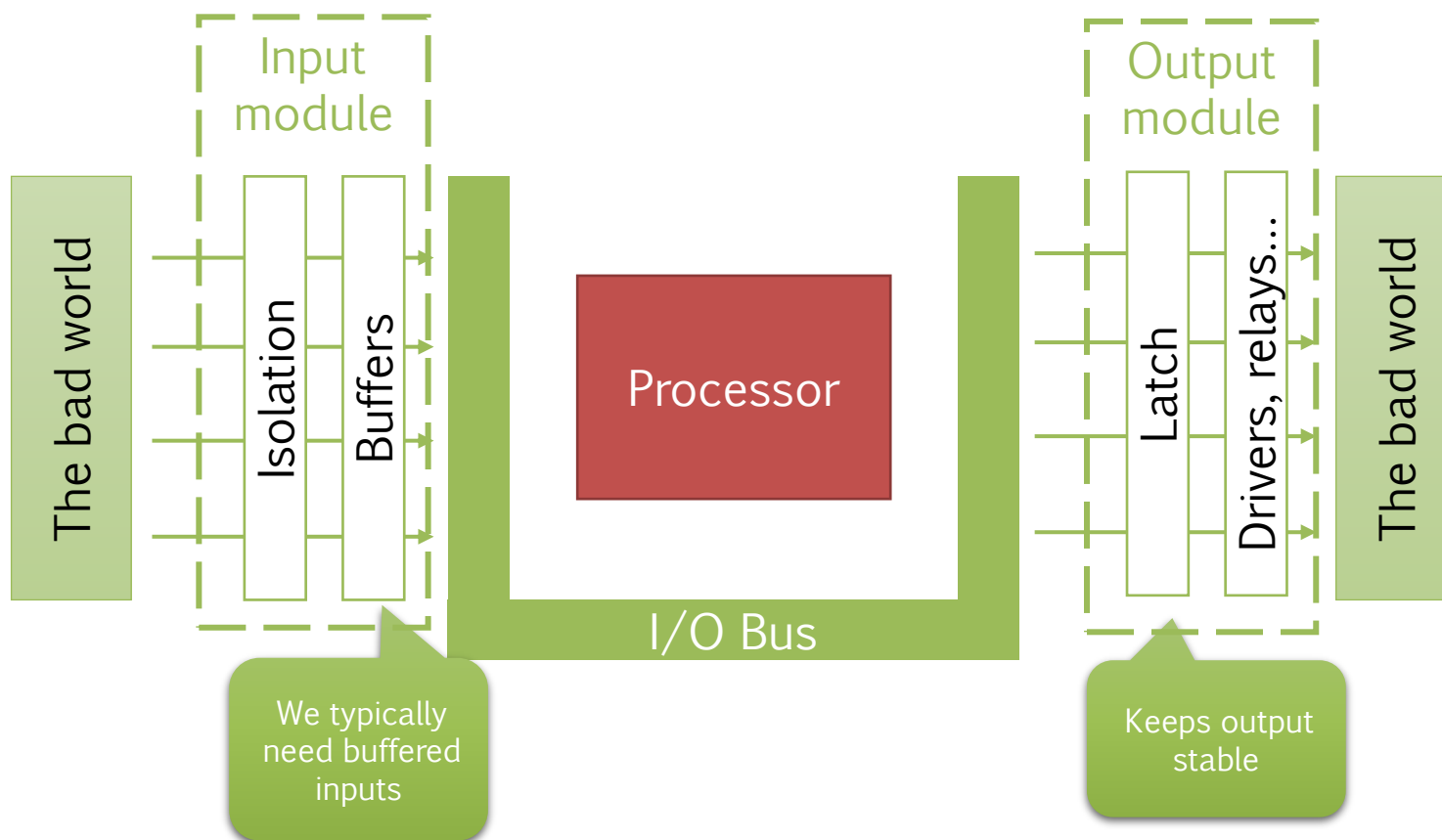


Structure of a PLC



I/O system bus and peripherals

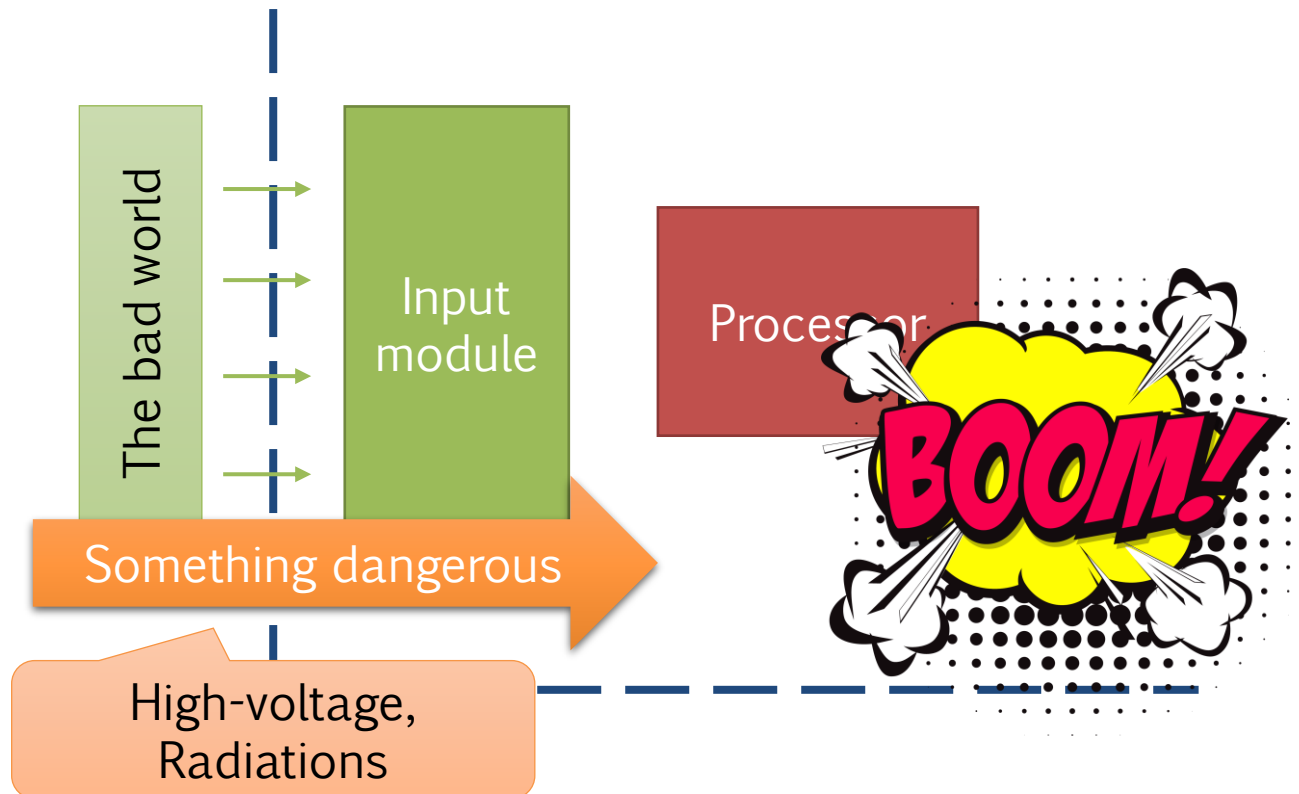
- › Inputs: isolate, and buffer them
- › Outputs: latch, and implement drivers for, e.g., relays



Input isolation: electrical decoupling

Some physical signals might be dangerous for the internal circuitry

- › Need to find a way to capture their value...without damaging the HW
- › E.g., Optoisolation/optocoupling
- › PLCs support a variety of input Voltages, from 5V to 240V...

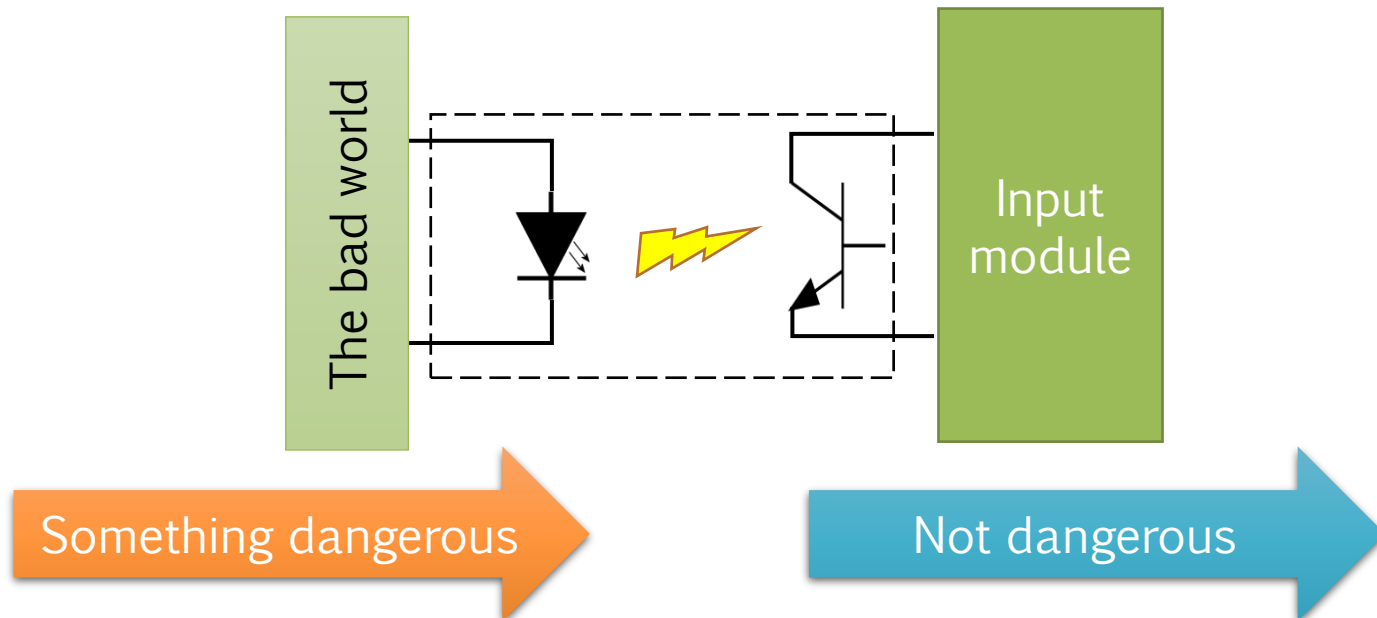




Optoisolation (principle)

A photo-transistor is triggered by a (digital) LED which is driven by the physical signal

- › Transistors also work as an amplifier, so its output is proportional to LED input
- › No electrical coupling





Output channel

Has a **latch** to keep analog output stable

Can be of three types

1. Relays to drive current to an external circuit

- Small circuit can drive high current (voltage)
- Ensures isolation
- Slow



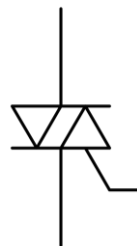
2. Transistor type

- Faster than relays
- Only for DC
- Sensitive to overcurrent (might break)
requires optoisolators

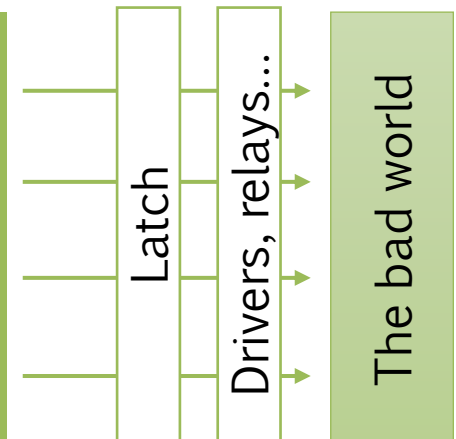


3. Triac with optoisolators

- For AC current
- Sensitive to overcurrent



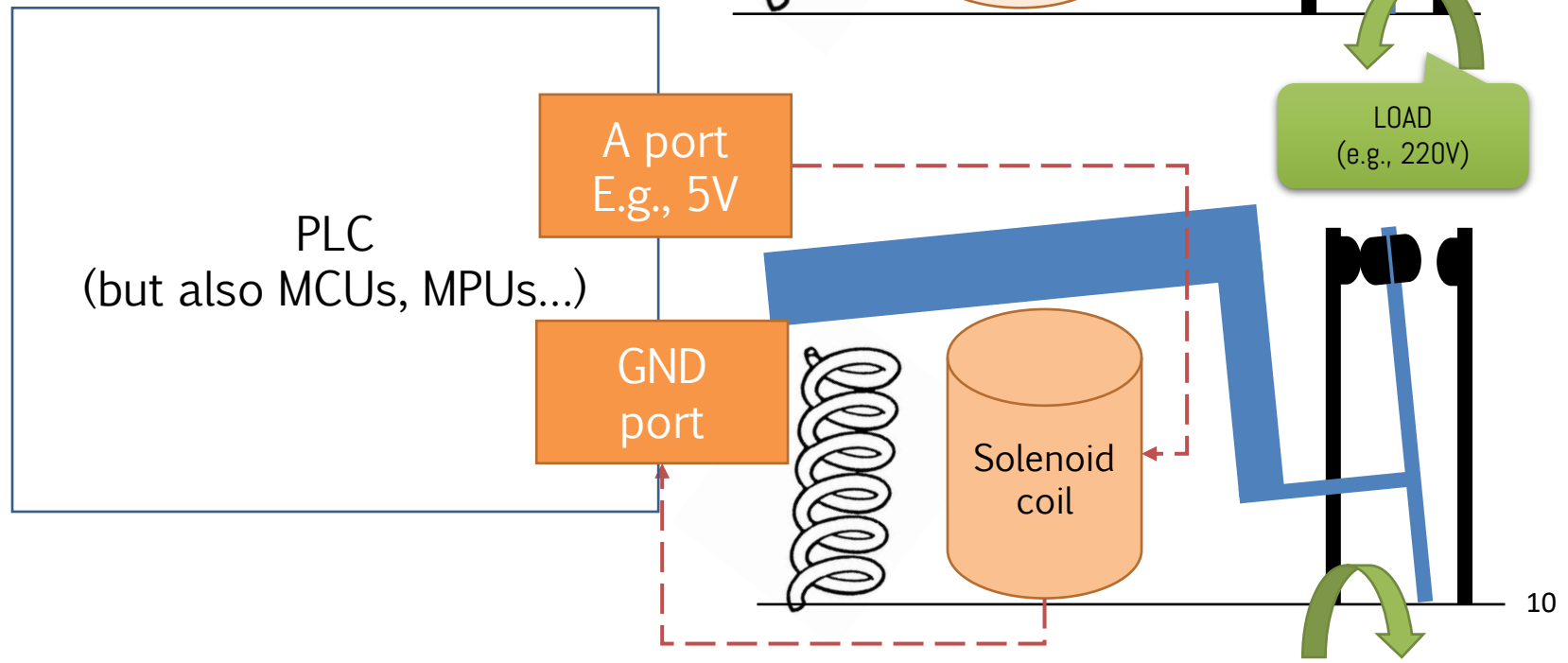
I/O Bus



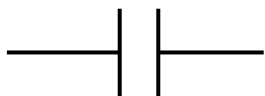


Background: relays

- › Used to control high-voltage switches via low-voltage analog port such as GPIOs



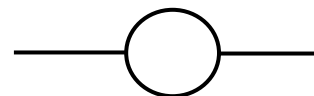
Symbols



Relay contact
NO



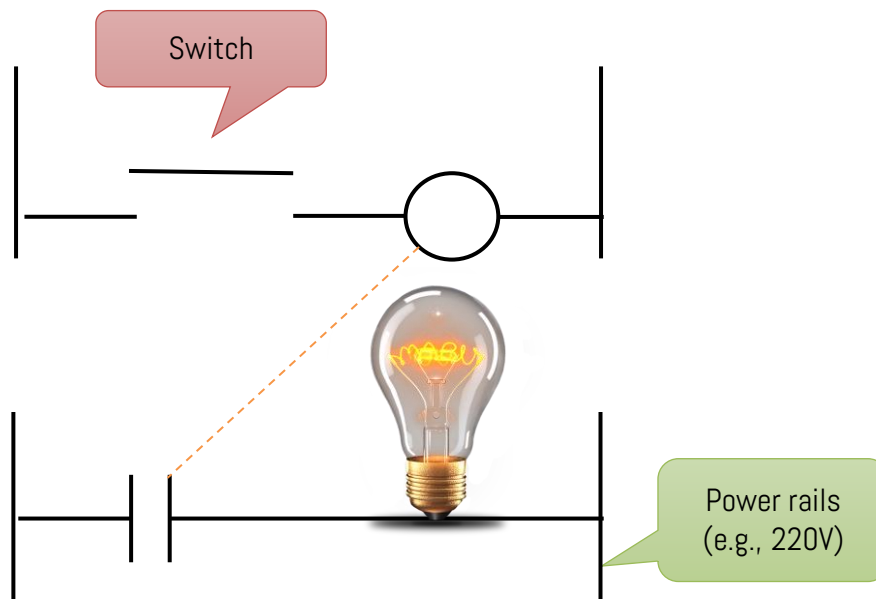
Relay contact
NC



Relay coil

Possible circuit to turn on a light

- › Switch can either be manual or driven by PLC/MCU..

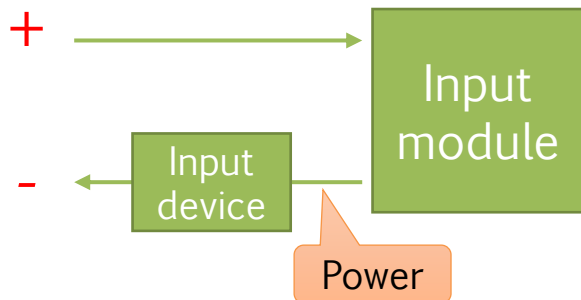




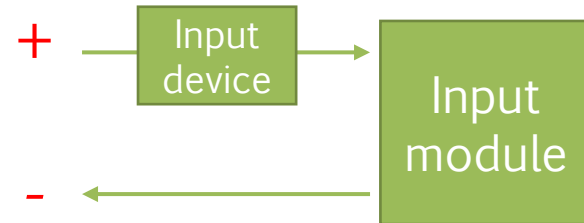
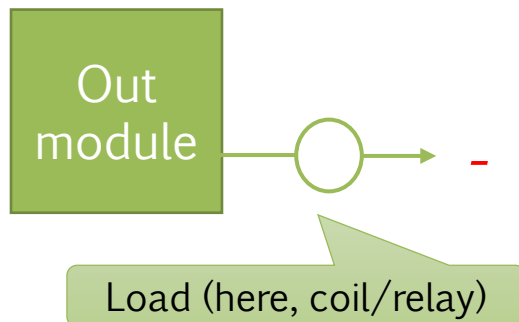
Who powers the in/output?

Both input and output DC devices models can be connected to PLC input module

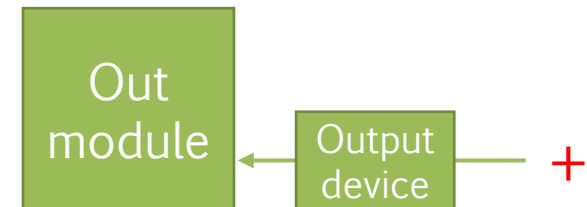
- › ...but who gives the power to whom?
- › **Sourcing** (PLC's input module gives power) vs. **sinking** (input device gives power)



Sourcing



Sinking





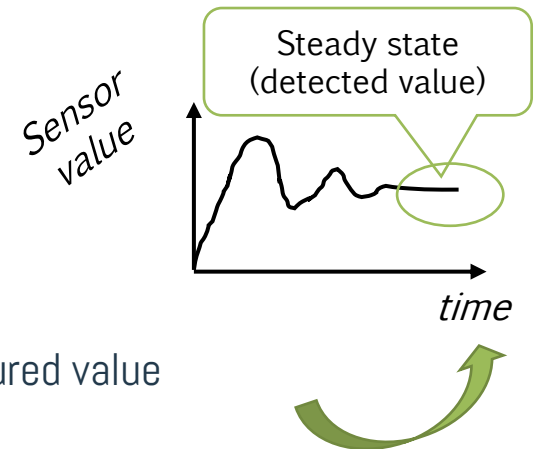
Input devices

Sensors, that convert a signal from one physical form to another form

- › Aka transducer
- › Can be digital/discrete (easy to handle) or analog (requires A/D conversion)

Typically measured/assessed in:

- › **Accuracy** of the measured value wrt the real one
 - e.g., thermometer can have $\pm 0.1^\circ\text{C}$ error
- › **Range** of the measurable value
 - e.g., -10°C to $+20^\circ\text{C}$
- › **Response time** to get to **steady state** upon variation of the measured value
- › **Sensitivity**
 - e.g., thermocouple might vary $10\mu\text{V}$ for every 1°C
- › **Stability** if input signal stays constant
- › **Repeatability**, aka sensitiveness to variation in the environment/sensor
- › **Reliability**, that is, how often does it break?





Common sensor types

- › Mechanical/proximity switches
- › Other proximity sensors (e.g., via ultrasounds)
- › Photoelectric sensors
- › Encoders (for lateral physical displacement)
- › Temperature
- › Position (distance) sensor
- › Strain (*it: tensione*)
- › Pressure
- › Liquid level / fluid flow

Smart sensors already have buffering/isolation circuitry onboard, and already produce safe and digital value

- › Can also have a processor and small EEPROM!
- › Standard interface, e.g., IEEE 1451.4



Output devices

Recap: output ports are relays or transistor/triac w/optoisolators

- › Relays to drive a current switch (on/off)
- › Solenoid operated valves (open/close)
- › DC motors or AC motors with current conversion
- › Rotating motor, aka *stepper*
- › ...



Course website

- › http://hipert.unimore.it/people/paolob/pub/Industrial_Informatics/index.html

My contacts

- › paolo.burgio@unimore.it
- › <http://hipert.mat.unimore.it/people/paolob/>

Resources

- › Alessandro Fantechi, «Informatica Industriale», Città Studi Edizioni
- › W. Bolton, "Programmable Logic Controllers", 6th edition, Newnes
- › A "small blog"
 - <http://www.google.com>