Programmable Logic Controllers - PLC

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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.

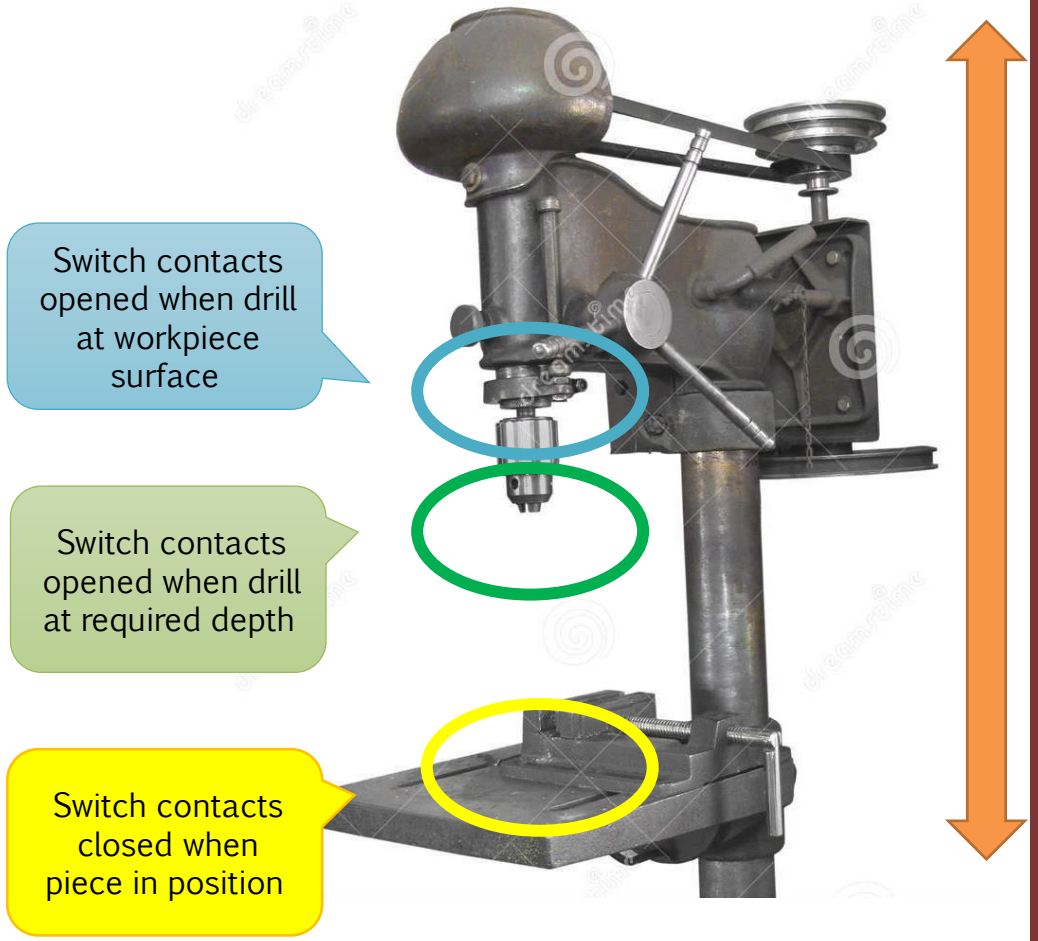
What makes a PLC different to MC/PUs?

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…

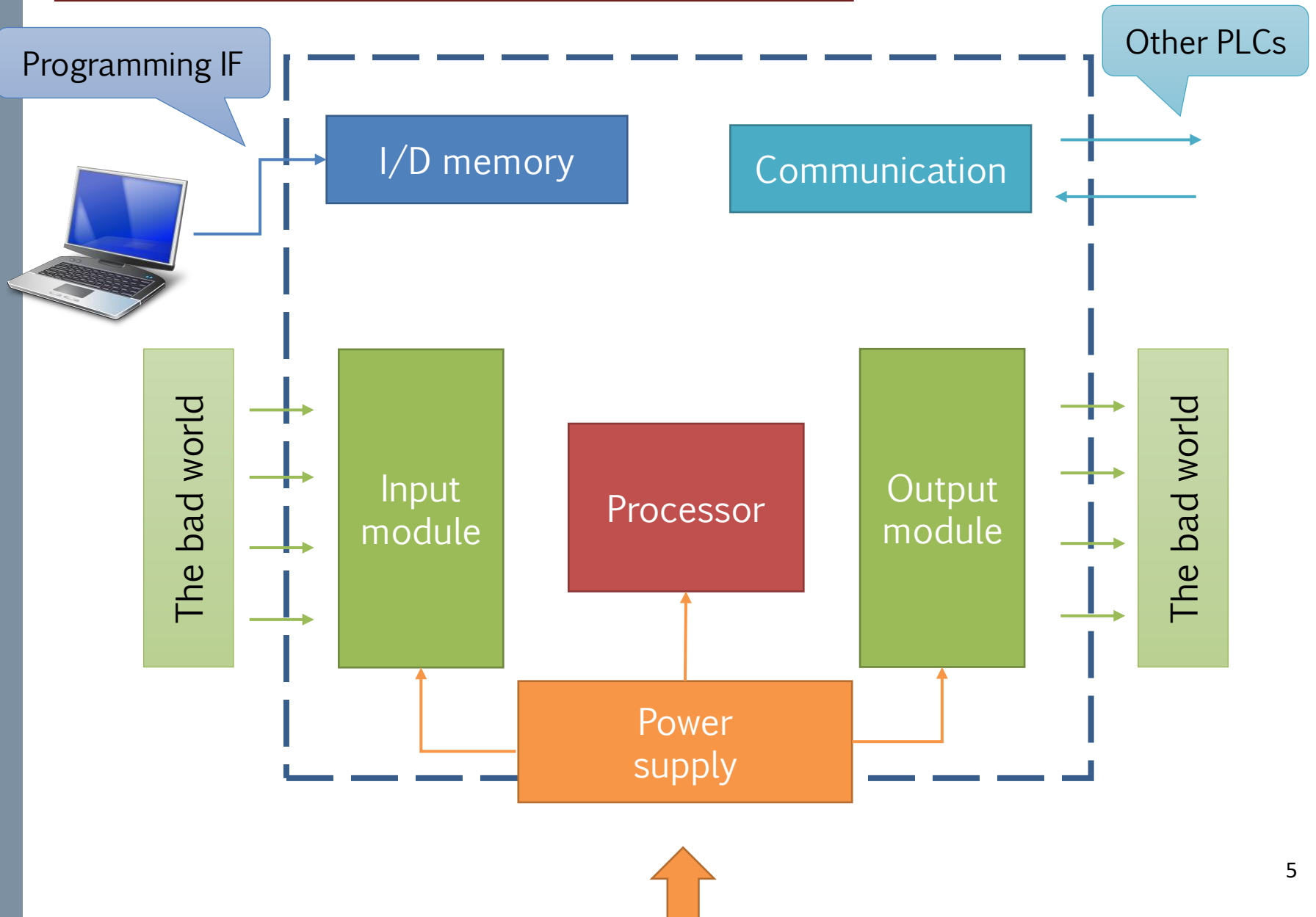
- Robust to vibration, highest/lowest temperature, humidity, noise..
- Rich I/O connectivity (relays)
- More reliable (i.e., less crashes)

Pink Floyd, Animals, 1977

Programmable, simple architecture + no OS + connected

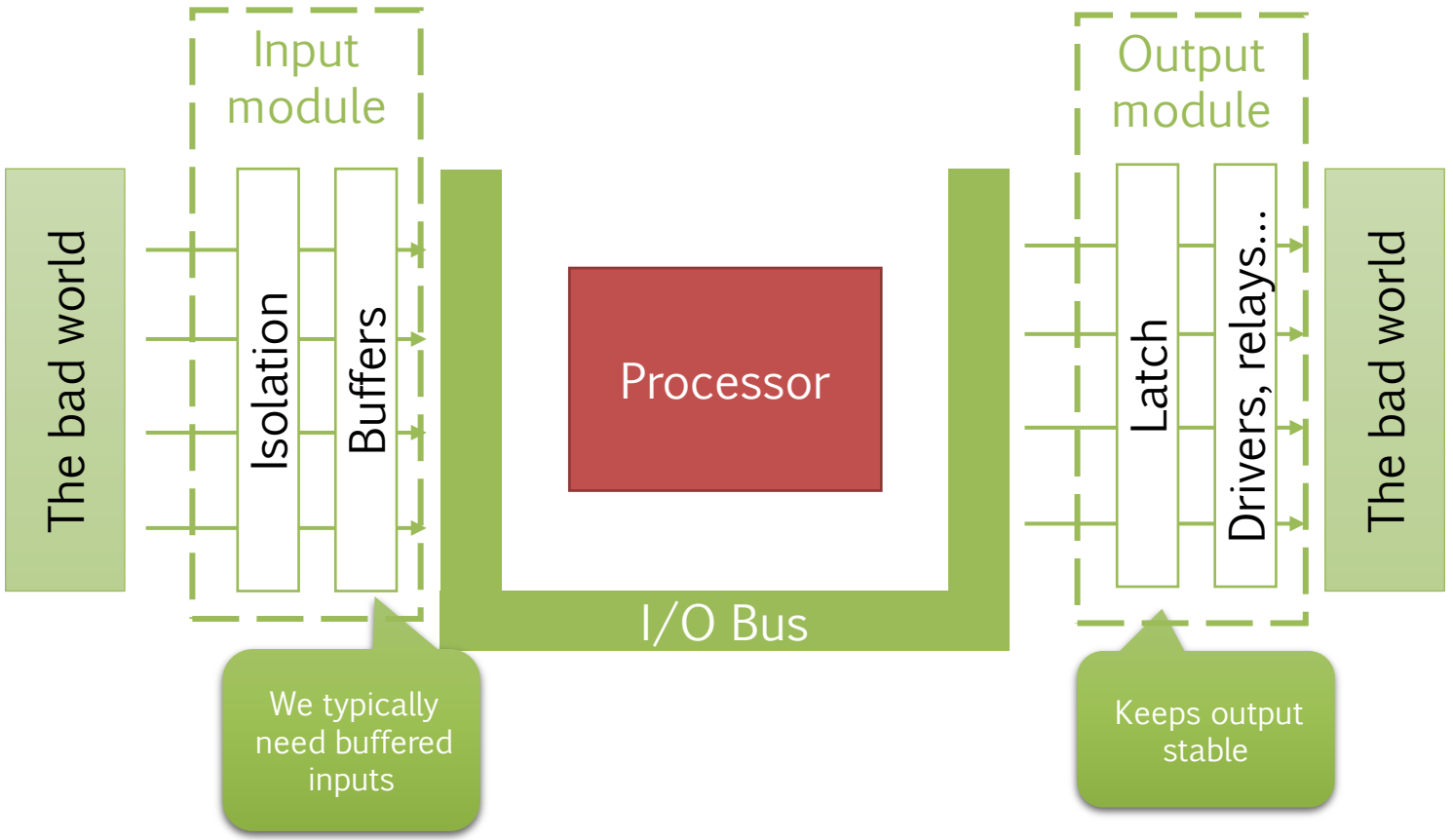
- ***Can easily be hacked!!!***
- (not part of this course…)

Structure of a PLC



I/O system bus and peripherals

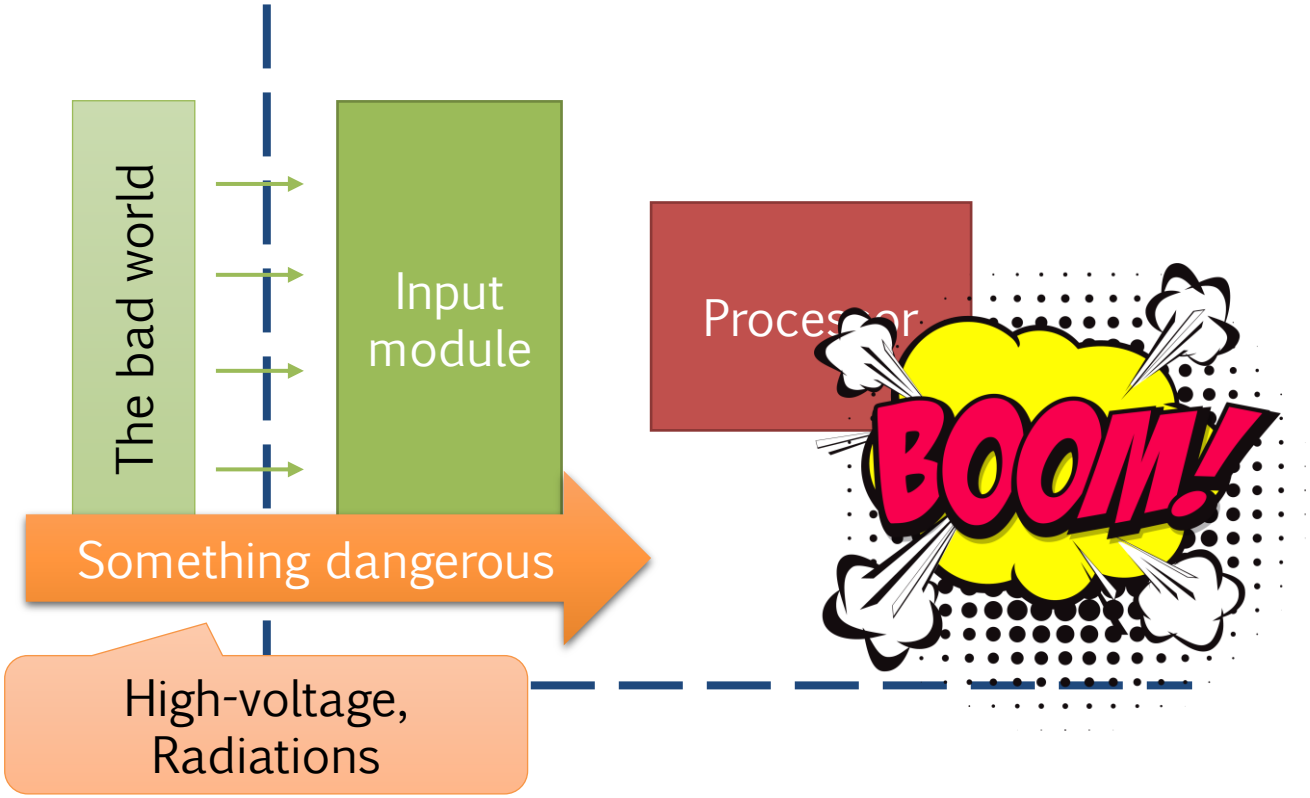
- Inputs: isolate, and buffer them
- Outputs: latch, and implement drivers for, e.g., relays



Input isolation: electrical decoupling

Some physical signals might be dangerous for the internal circuitry

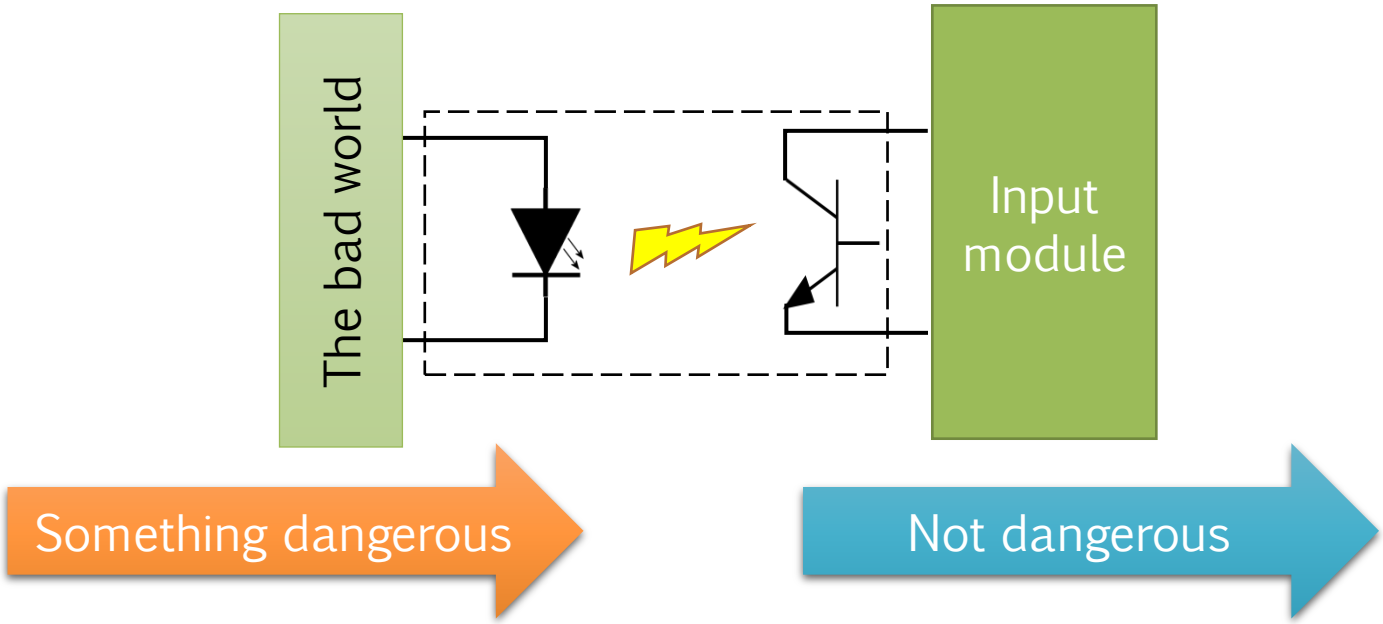
- Need to find a way to capture their value…without damaging the HW
- E.g., Optoisolation/optocoupling
- PLCs support a variety of input Voltages, from 5V to 240V…



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

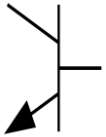


Output channel

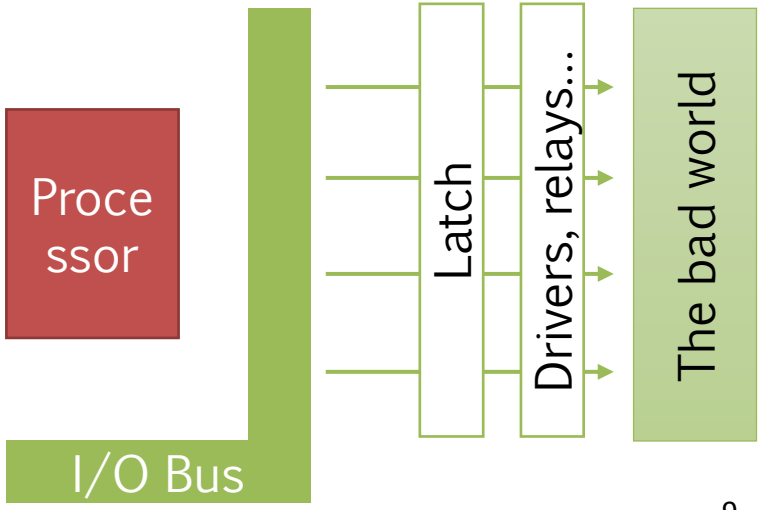
Has a **latch** to keep analog output stable

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

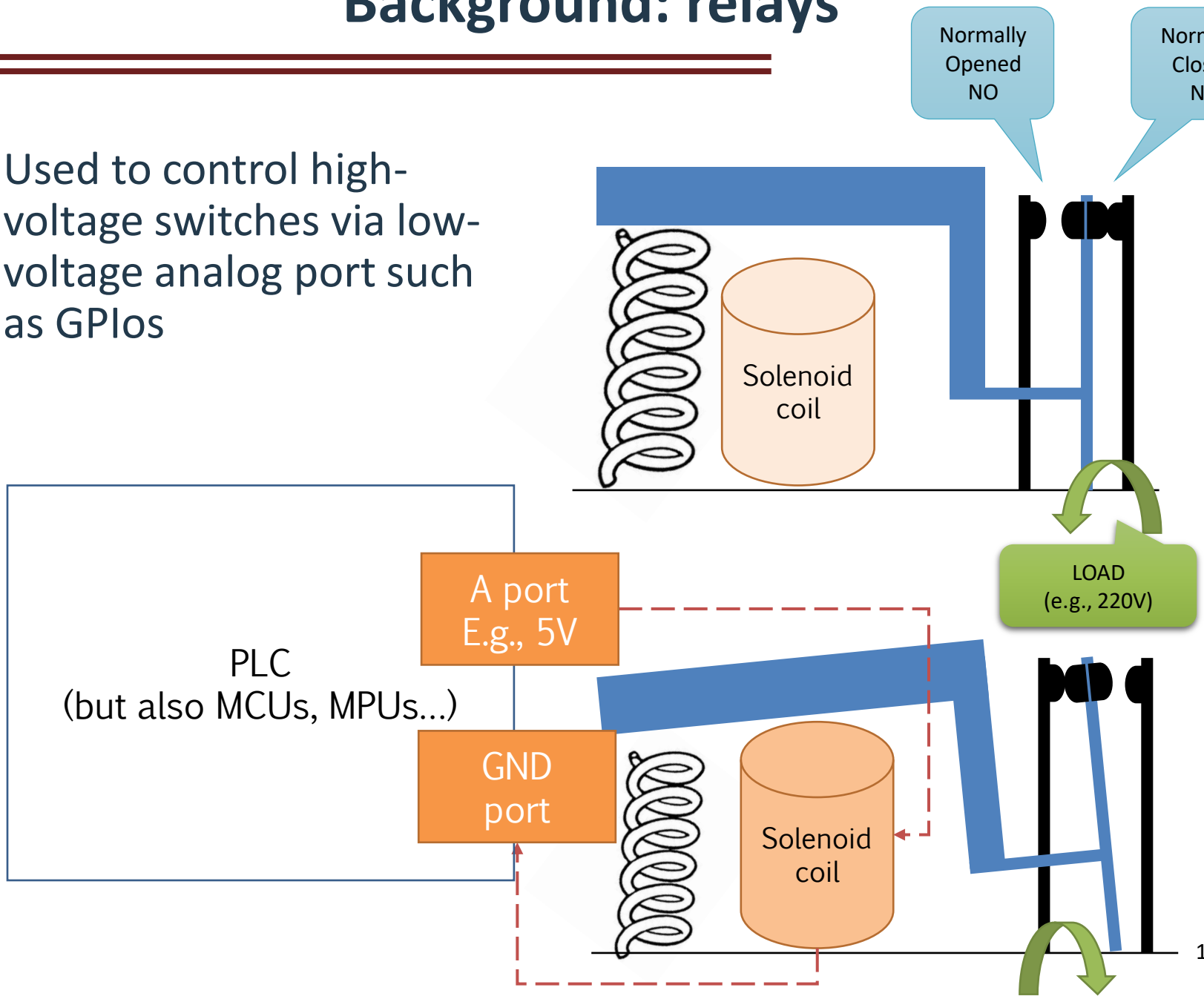


3. **Triac** with optoisolators
   - For AC current
   - Sensitive to overcurrent

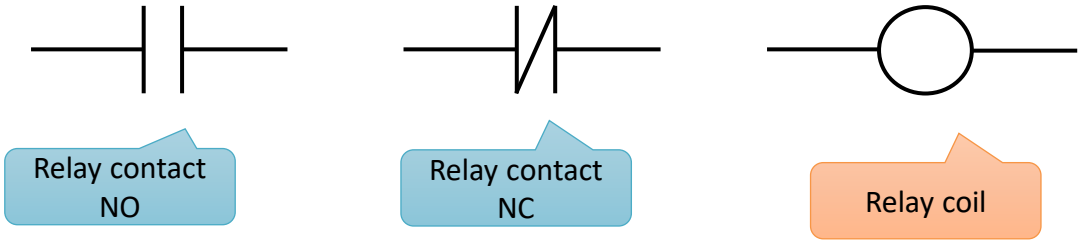


Background: relays

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

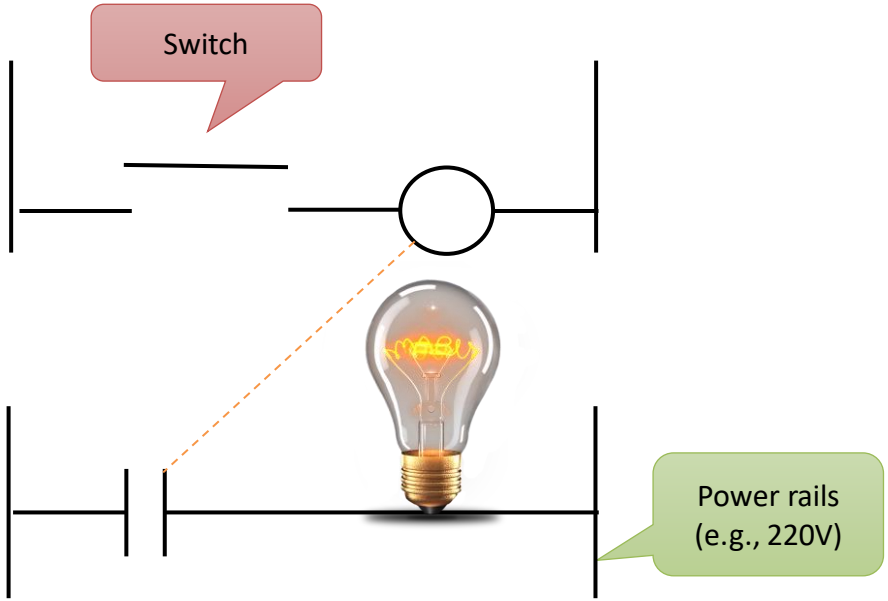


Symbols



Possible circuit to turn on a light

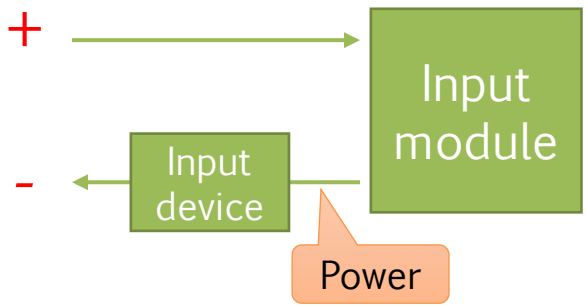
› Switch can either be manual or driven by PLC/MCU..



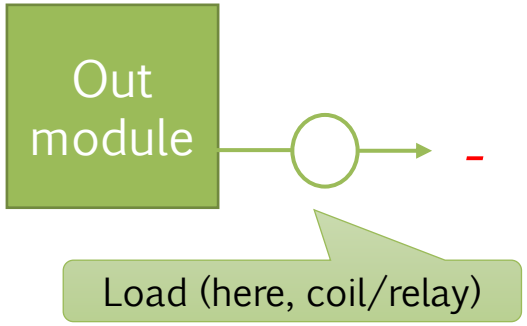
Who powers the in/output?

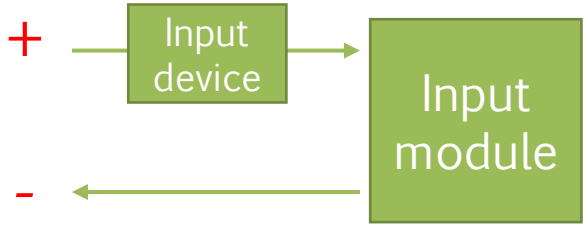
Both input and output DC devices models can be connected to PLC input module

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

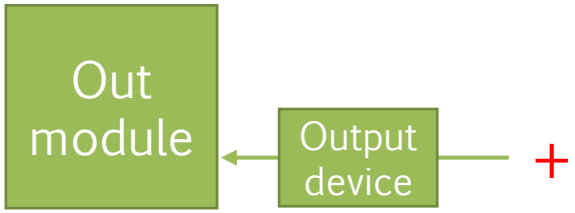


Sourcing





Sinking



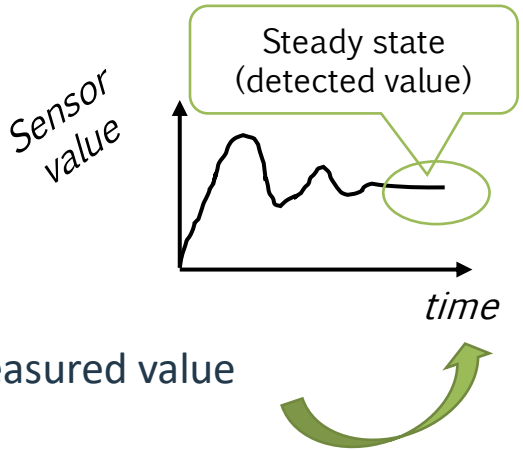
Input devices

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 ± 0.1˚C error
- **Range** of the measurable value
  - e.g., -10˚C to +20˚C



- **Response time** to get to **steady state** upon variation of the measured value
- **Sensitivity**
  - e.g., thermocouple might vary 10µV 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*
- …

References

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