ELECTRONICS AND COMMUNICATION TECHNOLOGIES: ELECTRONICS SYSTEMS

LM Cyber Security – Fall 2024

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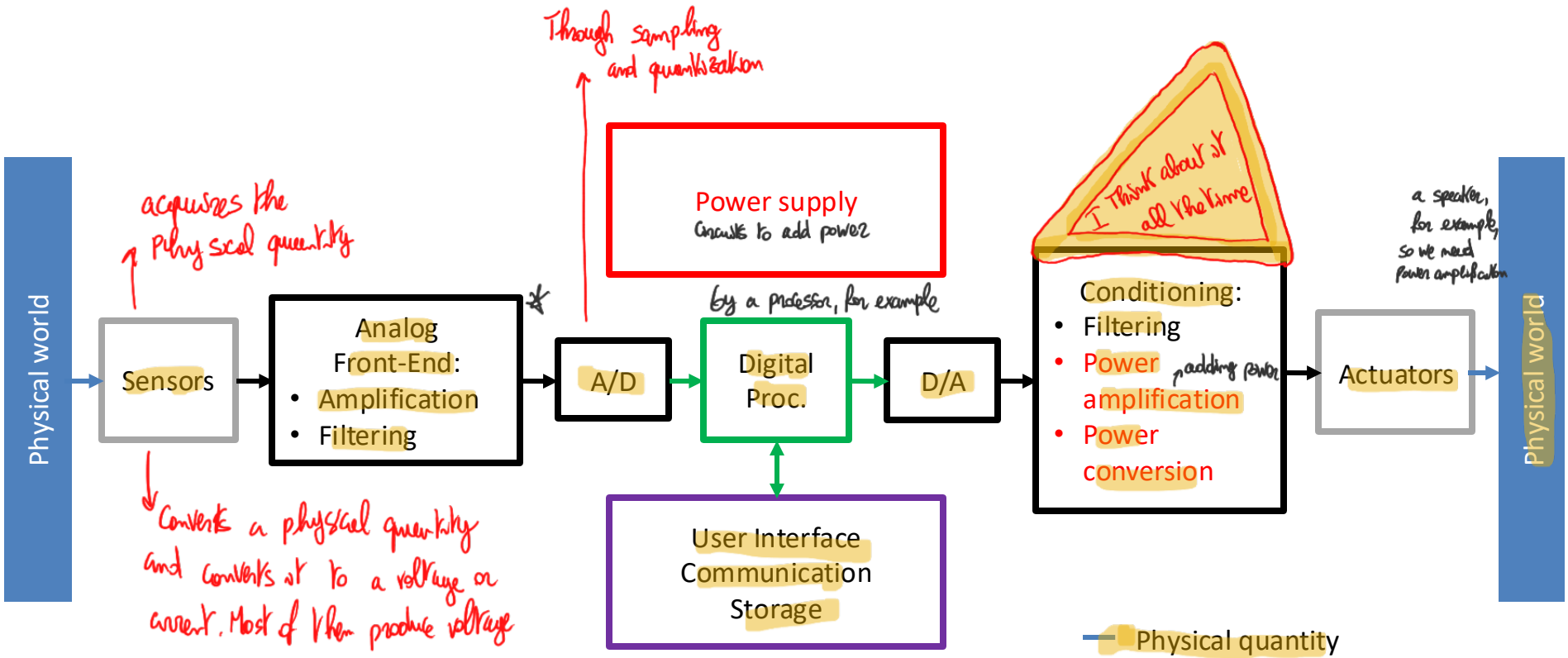
Office hours:

Friday 14-16. Please, contact me in advance before showing up. We can also arrange an appointment remotely on Microsoft Teams.

Electronic Processing System



A/D: Analog to Digital converter
D/A: Digital to Analog converter

* It's possible that the output of a sensor is small and has to be amplified. Keep in mind that the circuits are analog.

Physical quantity
Analog signal
Digital signal

It is represented by a continuous function of time. Varies continuously inside a range and continuously through time. But can't be processed by digital systems.

NOTE: every circuit has its own specifications for power supply needed.

Lithium cell provides ≈ 4.2 V when fully charged, ≈ 3 V when out of charge.

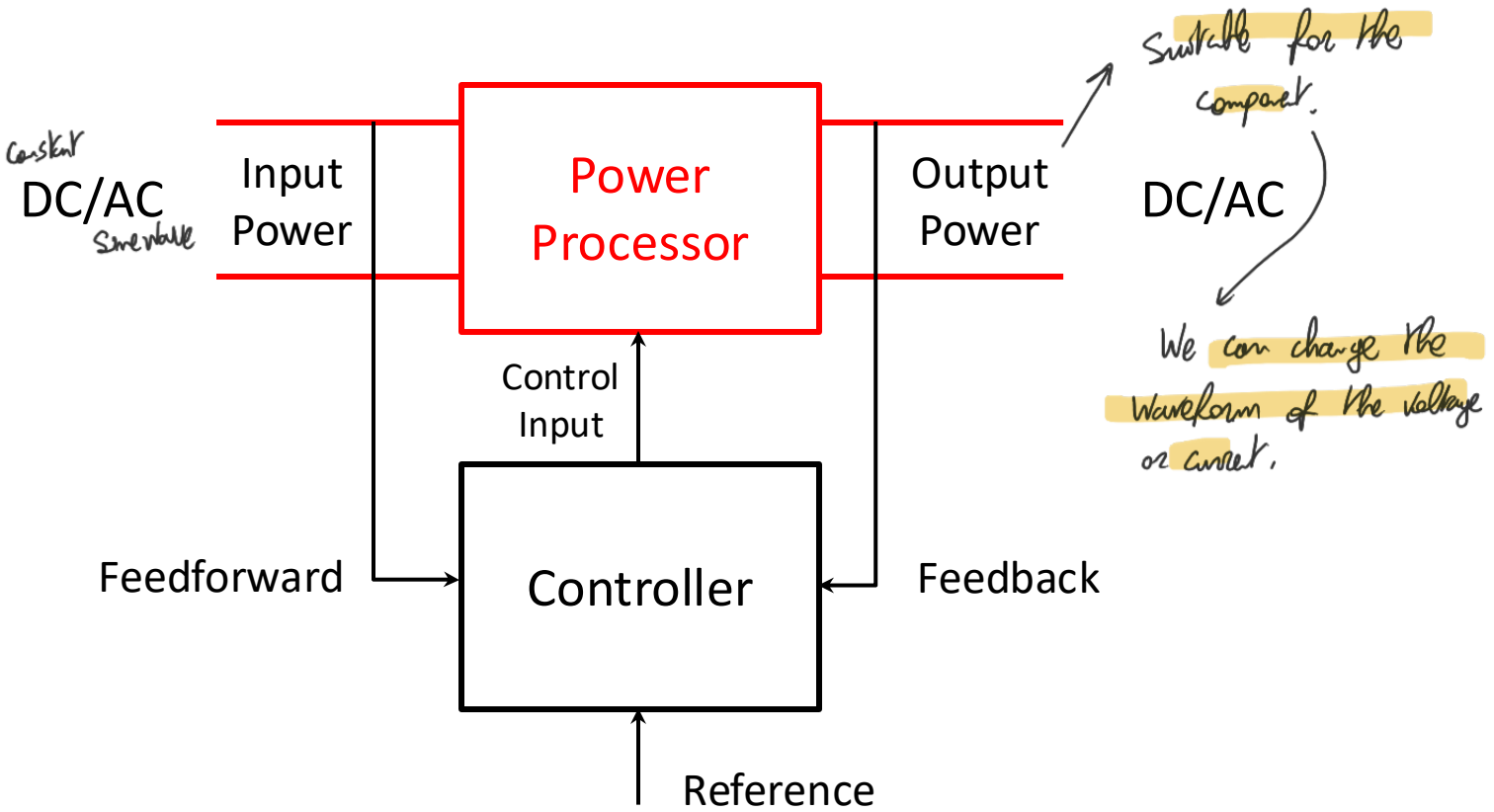
In general, for our pieces we need a stable supply voltage and each needs their own supply voltage.

Power conversion is important: example, a PC charger in Europe takes 130 V, 50 Hz voltage as input and converts that to the right power supply needed for the PC.

Power Converter

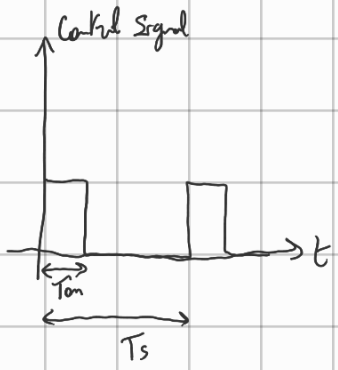
brat

brat



The power processor treats power and needs to be controlled. It is usually done with switches
The control input is a rectangular wave with a duty cycle. Controller measures the output, knows what we want (Reference) and operate its control (Feedback). Sometimes we can also do the opposite. Feedback offer better performance.

Control input is a network of switches (not so many). The control input decides if the switch is open or closed, and the input is a rectangular wave. The control is encoded in the duty cycle, which is the ratio between the time a signal is high and the overall signal period.



$$\text{DUTY CYCLE } \delta = \frac{T_{ON}}{T_S}$$

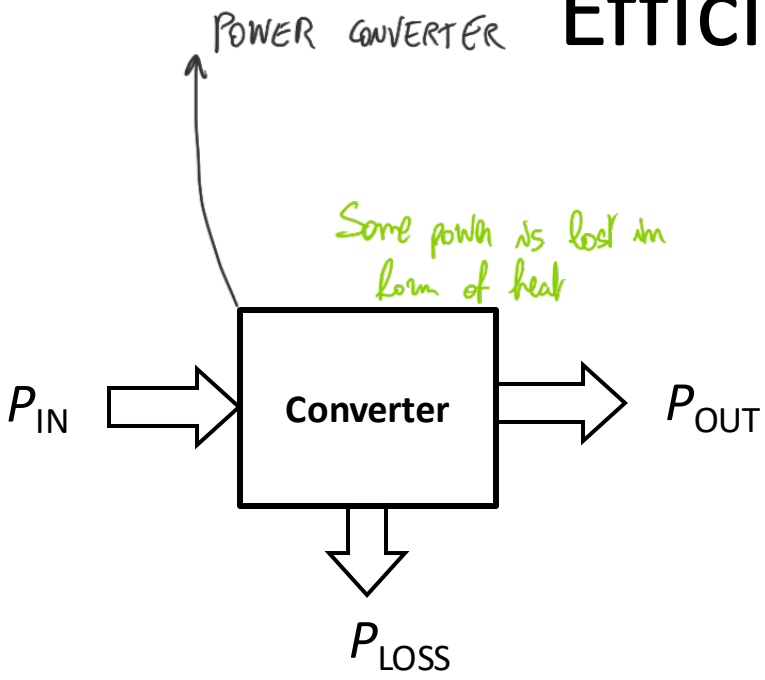
Classificazione convertitori di potenza

Typology	Input	Output	Characteristics
DC-DC	DC	DC	• Different voltage • Regulation • Galvanic insulation => No electrical connection between input and output.
Inverter Solar power	DC	AC	
Rectifier (a diode can be one)	AC	DC	
Cycloconverter	AC	AC	• Different frequency and amplitude

Wind power

because frequency depends on the wind

Efficiency



$$\eta = \frac{P_{OUT}}{P_{IN}}$$

$$P_{LOSS} = P_{IN} - P_{OUT} = P_{OUT}\left(\frac{1}{\eta} - 1\right)$$

- Why we aim at having efficiency as close as possible to 1?
  1. Semplification of the cooling system in terms of size and weight and costs
  2. Higher reliability
  3. Energy saving

↓ Our devices heats up and have a more operating temperature. We need to remove the heat.

Let's say we have $0.98=\eta$ and imagine we could improve to 0.99. How much we are losing?

$P_{Loss} = P_{IN} - P_{OUT} = P_{out}\left(\frac{1}{\eta} - 1\right)$, imagine $P_{out} = 100W$

$P_{loss} = P_{out}\left(\frac{1-\eta}{\eta}\right) \approx P_{out}(1-\eta) = 2W$ if 0.98
$\eta \approx 1$ 1W if 0.99

Reducing to almost a half the loss = reducing the area of the heat sink (of a computer for example).
↓ But if we keep the same size of our component we have lower temperatures ⇒ device works at colder temperatures, better.

INFORMATION CODING RECAP

Info is stored in bits. With N bits, the array is: $(a_{N-1}\, a_{N-2} \cdots a_1 a_0)_2 = \sum_{i=0}^{N-1} a_i \cdot 2^i = A \in [0, 2^N - 1]$

We can say info is encoded in natural numbers (ex. ASCII)

- How to represent integers? 2's Complement.

$b \in [-2^{N-1}, 2^{N-1} - 1]$ is the range of integer numbers we have with N bits.

$$B = \begin{cases} b, & b \geq 0 \\ b + 2^N, & b < 0 \end{cases}$$ if number is positive, we just need to represetate how we would do normally

↳ Also written as $|b|_{2^N}$

- If we have the strings of bits and want b is easy: if $b \geq 0$, the most significant bit is 0, otherwise 1. The rule is:

$$b = -2^{N-1} b_{N-1} + 2^{N-2} b_{N-2} + \dots + 2^0 b_0 \qquad (\text{if } b_{N-1} = 1,\ b = B - 2^N = -2^{N-1} b_{N-1} + \dots)$$

$$S = |a+b|_{2^N} = \left| |a|_{2^N} + |b|_{2^N} \right|_{2^N} = |A+B|_{2^N}$$

↑ Rappresentazione

There is overflow if the carry is different to the most sig. bit.