Instrumentation

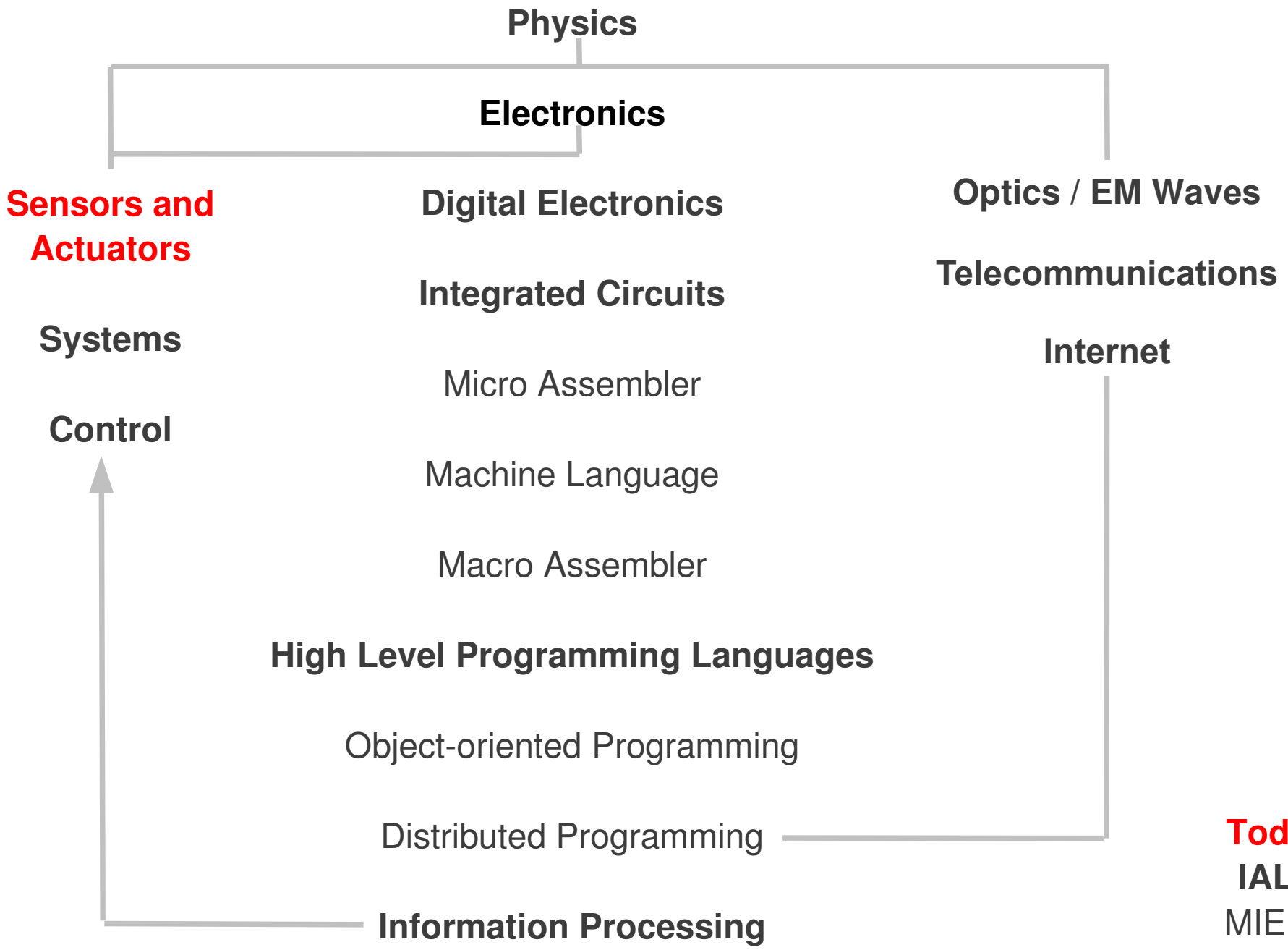
MIEET 1º ano

UAlg
UNIVERSIDADE DO ALGARVE

30 anos
1979 | 2009

Peter Stallinga, UAlg 2011

MIEET. The levels of knowledge



Instrumentation

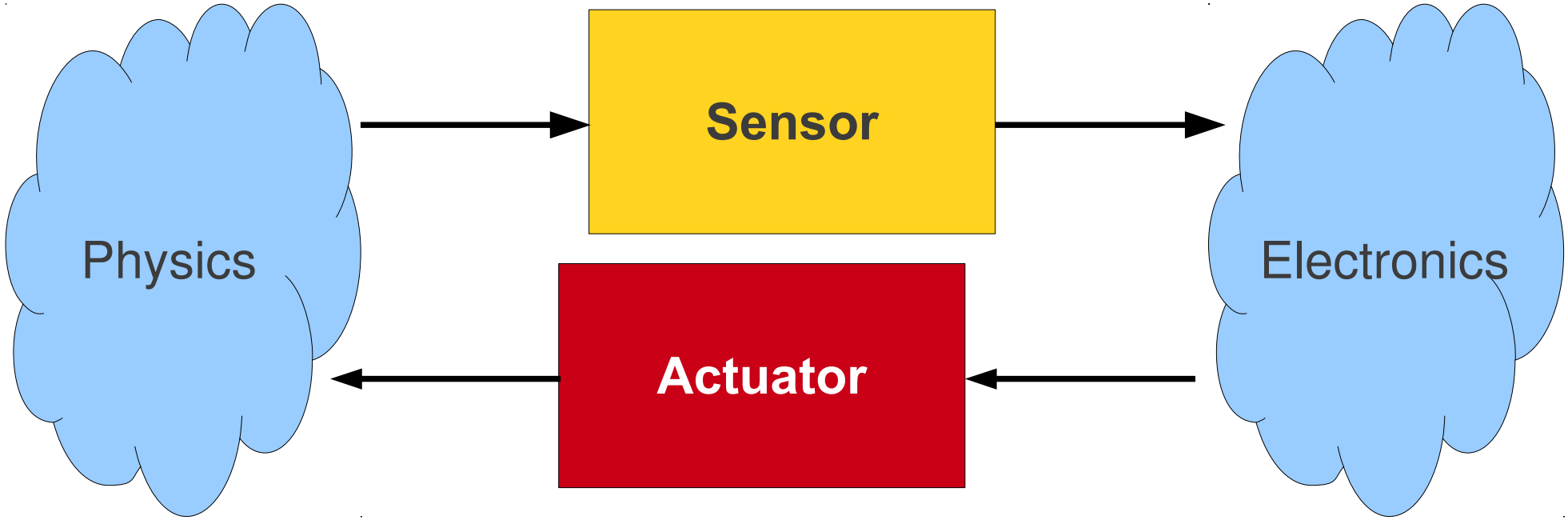
Signal Acquisition. Sensors. Actuators

ADC-DAC

Instrumentation

Transducers: **Sensors** & **Actuators**

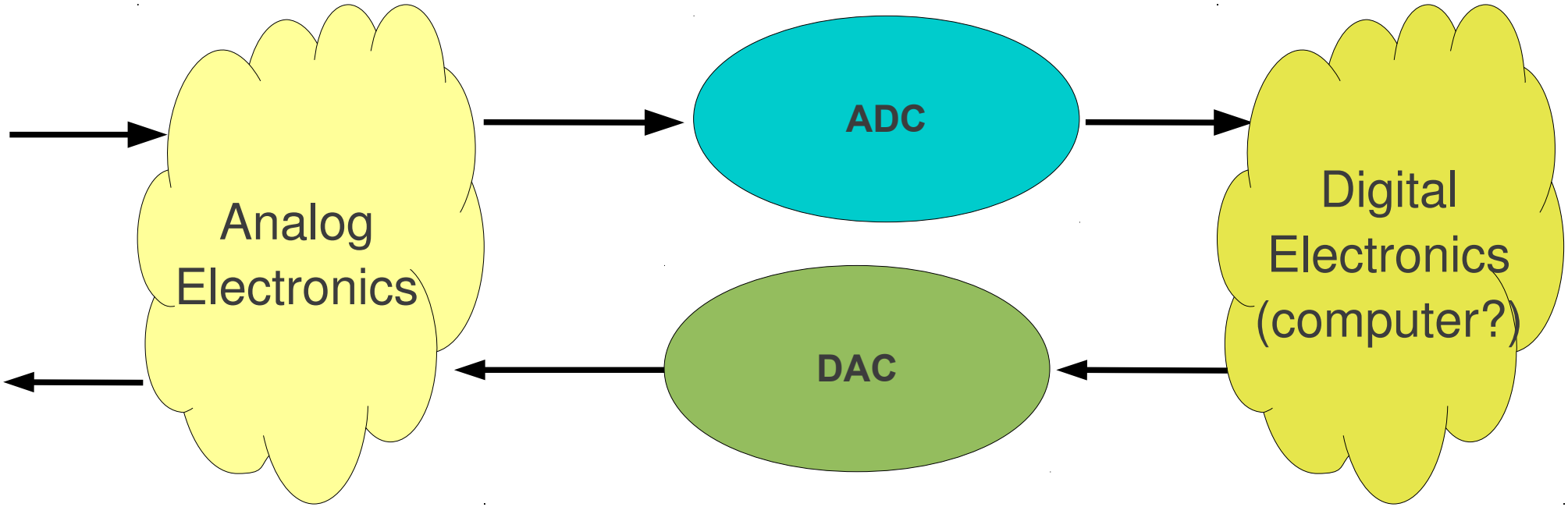
Translation of information ('signal') from a physical domain to an electronic domain



Transducers ADC-DAC

ADC (Analog-Digital Converter)
DAC (Digital-Analog Converter)

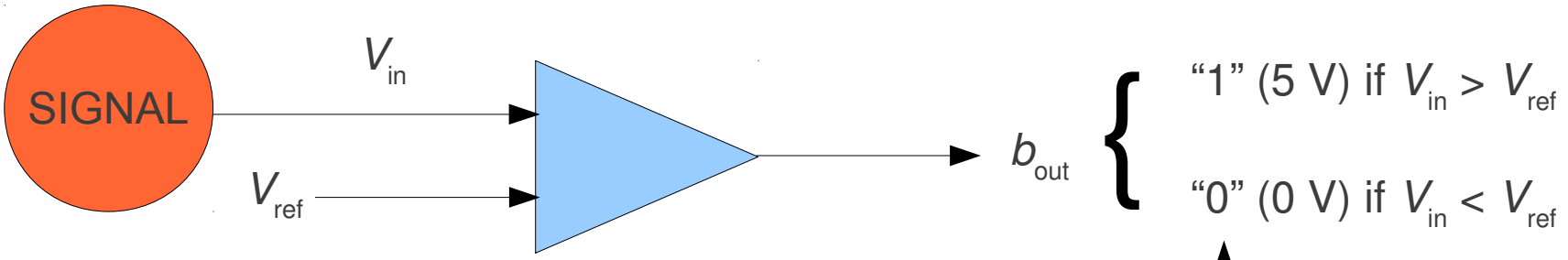
Translate signal from **analog** (electronics) to **digital** (electronics) domain and back



ADC/DAC

ADC (Analog-Digital Converter)
DAC (Digital-Analog Converter)

Translate signal from **analog** (electronics) to **digital** (electronics) domain and back

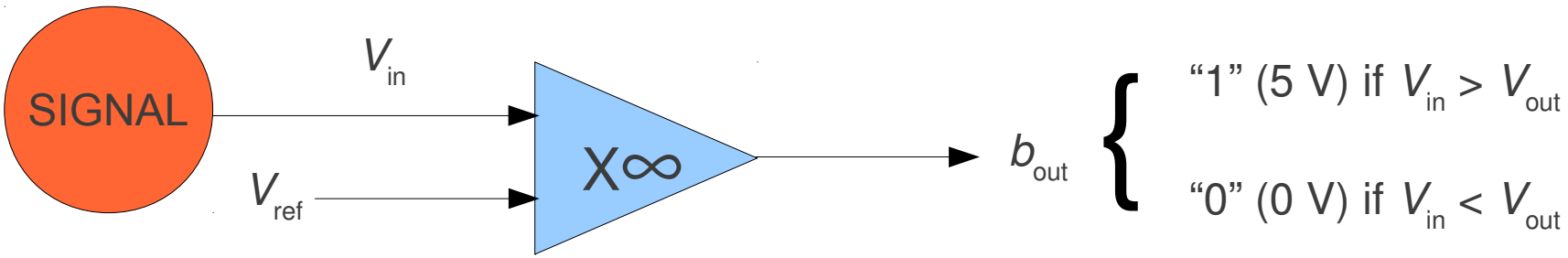


Simple 1-bit ADC: comparator

"0" and "1" are only **our** (human) interpretation

1-bit ADC (comparator)

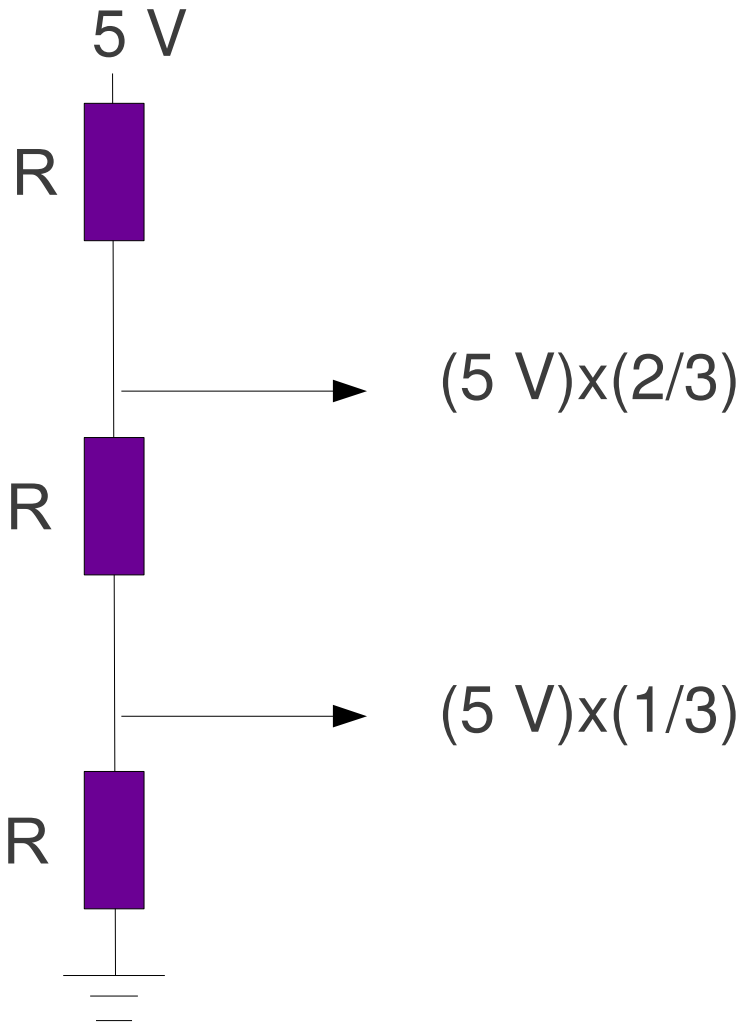
Simple 1-bit ADC:
comparator



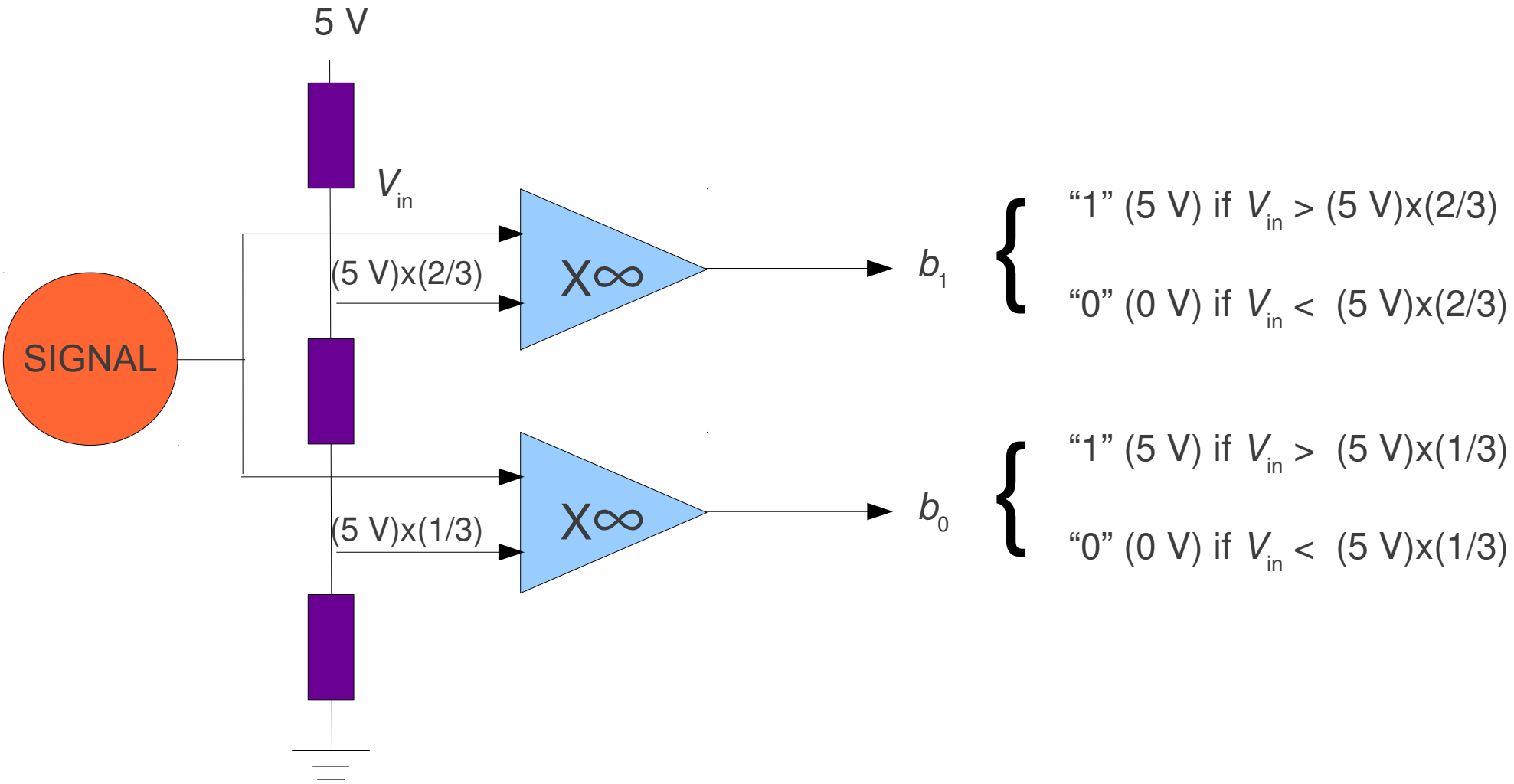
A comparator is an infinite-gain differential amplifier

$$V_{out} = \infty(V_{in} - V_{ref}) = \pm V_{CC}$$

ADC voltage divider



2-bit ADC?

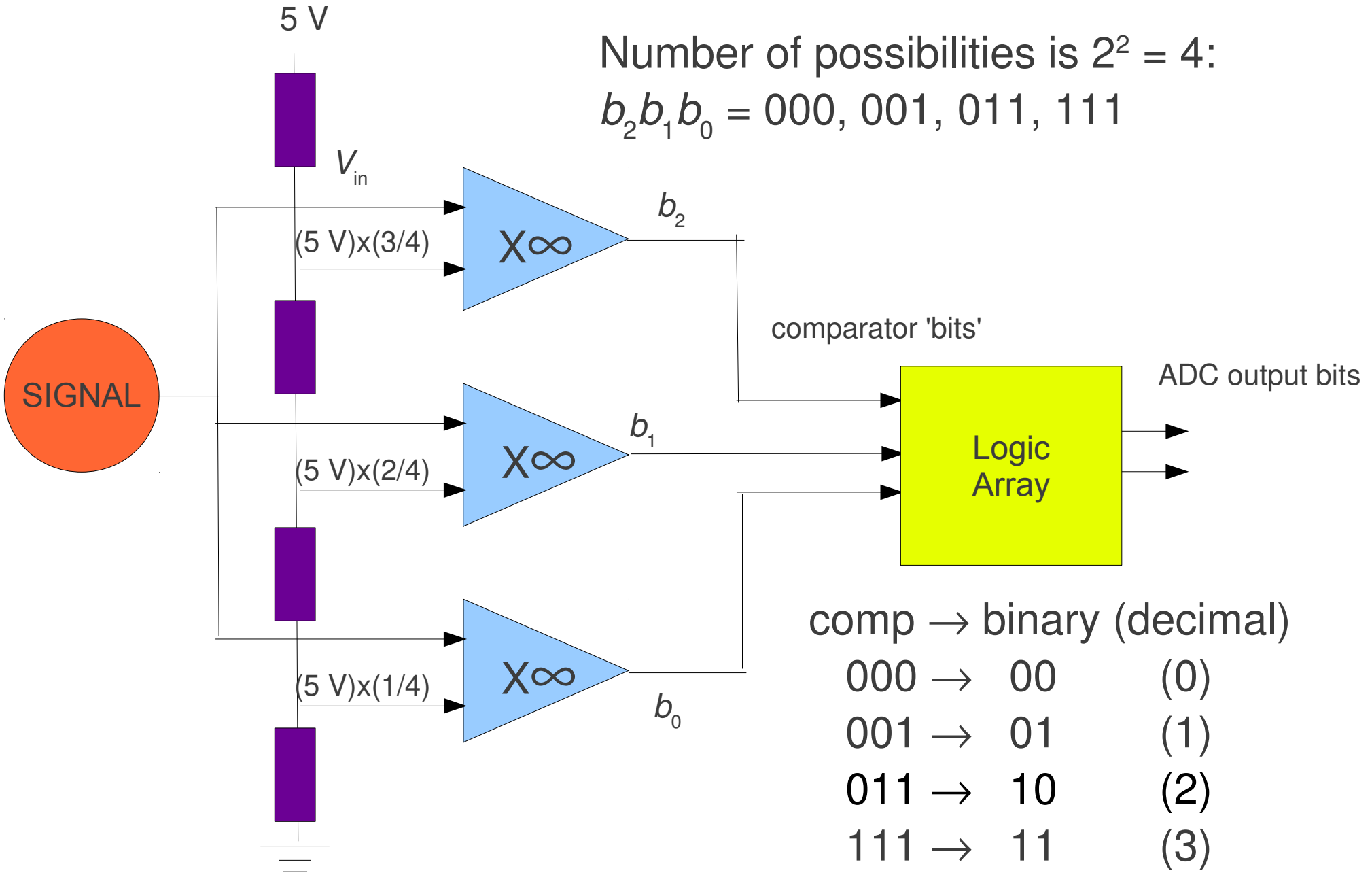


This is **not a 2-bit ADC**: Number of possibilities is not $2^2 = 4$:

$b_1 b_0$ = 00, 01, 10, 11 (3 possibilities)

Not possible!!!

2-bit ADC



Number of possibilities is $2^2 = 4$:

$b_2 b_1 b_0$ = 000, 001, 011, 111

comp →	binary	(decimal)
000 →	00	(0)
001 →	01	(1)
011 →	10	(2)
111 →	11	(3)

Sensors & Actuators

Translation of information ('signal') from a physical domain to an electronic domain

For example: a resistor
The resistance value of a resistor depends on the temperature
If we know the resistance value we know the temperature!

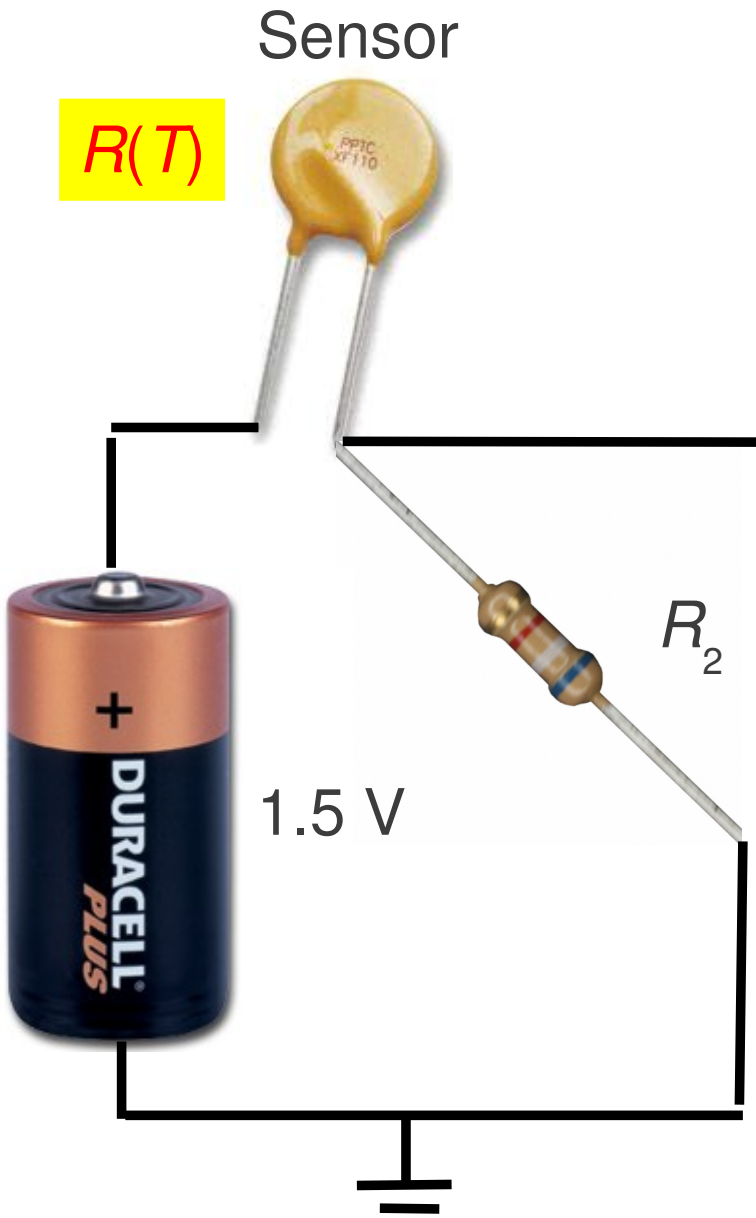
PTC: (positive temperature coefficient) resistor, “thermistor”

An electronic thermometer

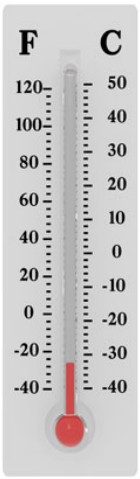
Sensor

$R(T)$

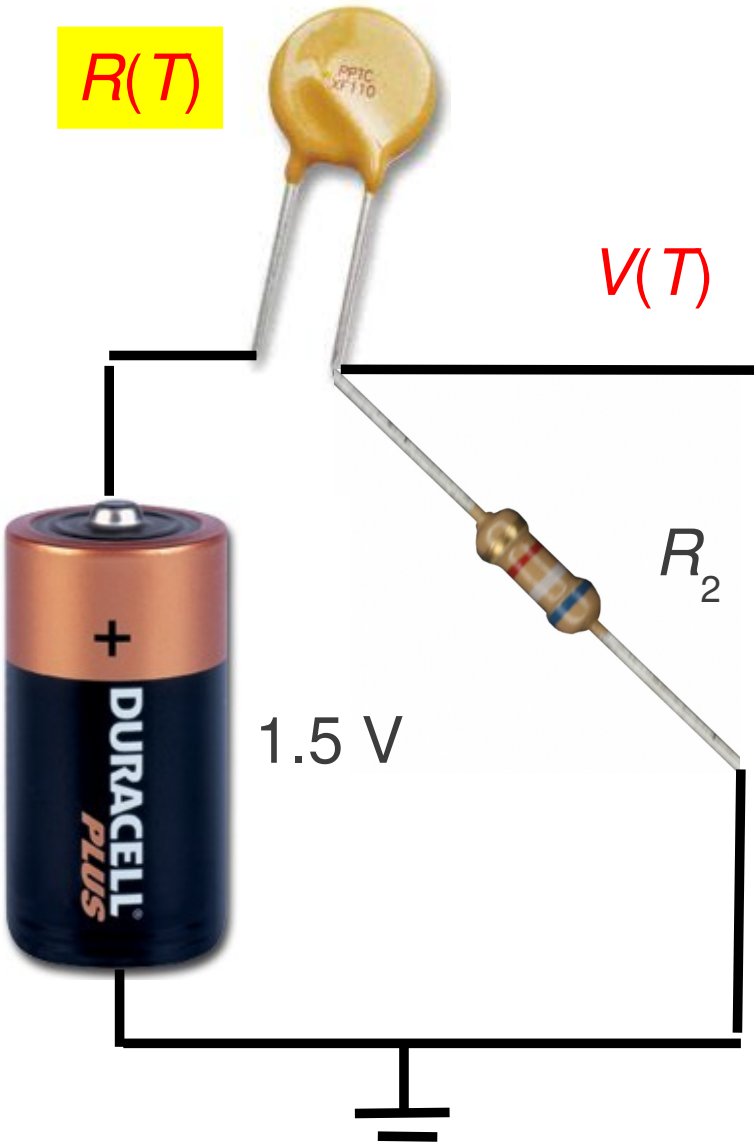
An electronic thermometer



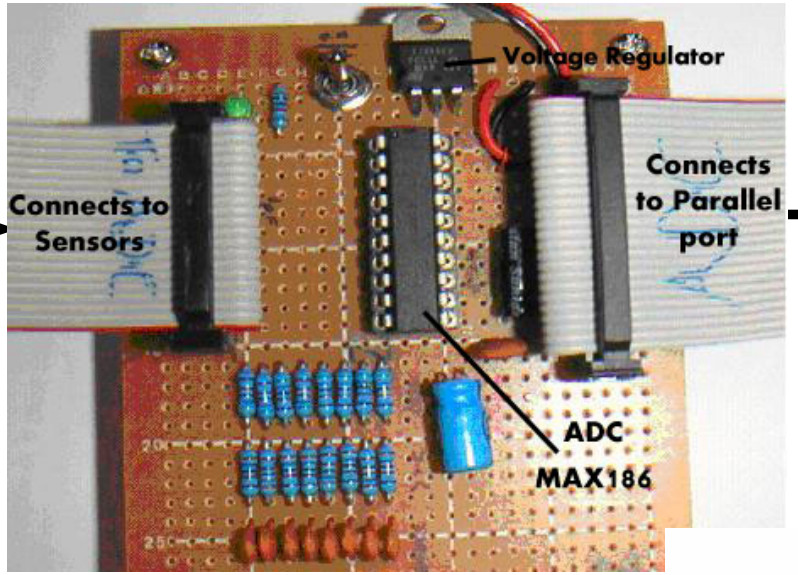
$$V(T) = (1.5\ \text{V}) \times \frac{R_2}{R(T) + R_2}$$



A system: temperature measurement



ADC:



N(T)

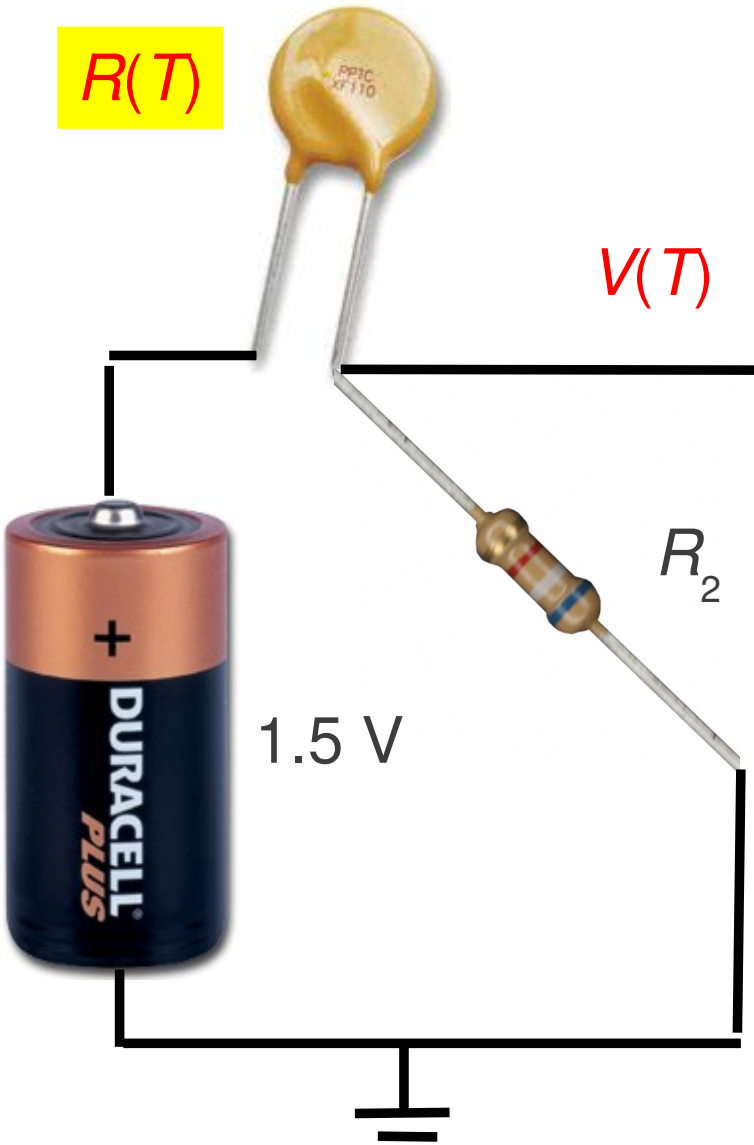
N is a function of *T*
T is a function of *N*
Computer can calculate *T*

A system: temperature measurement

Sensor Volt. divider ADC

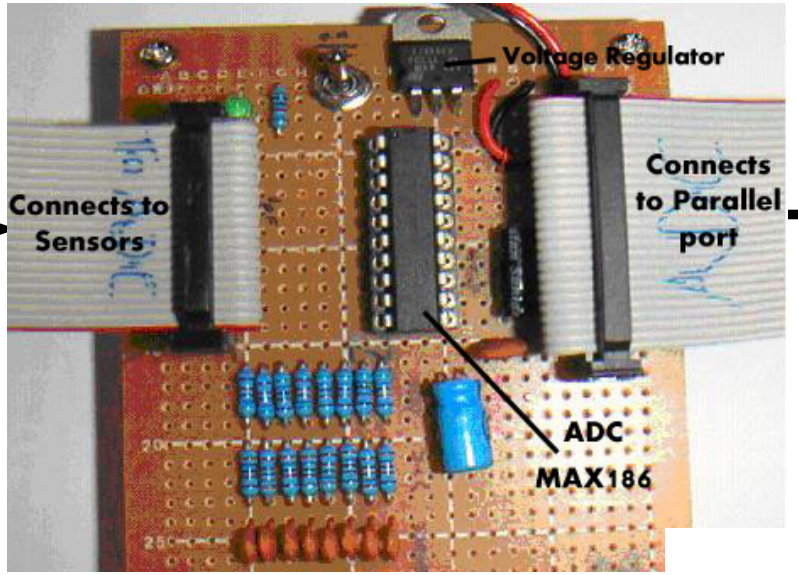
Temperature → Resistance → Volt → Number

$R(T)$



$V(T)$

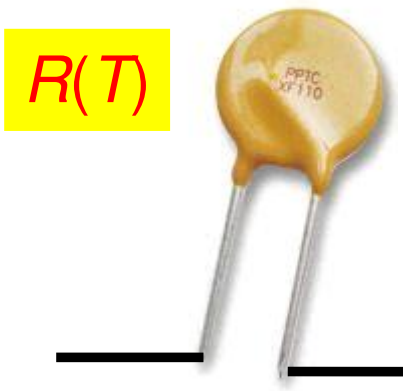
ADC:



$N(T)$

N is a function of T
T is a function of N
Computer can calculate T

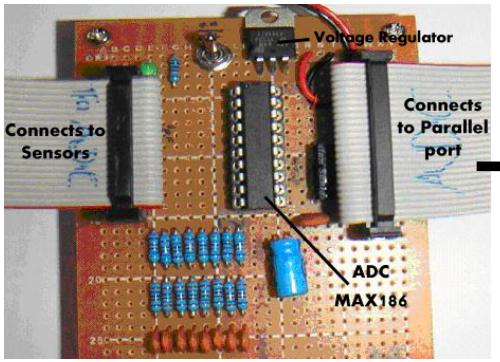
A system: PID control of temperature



$R(T)$

$V(T)$

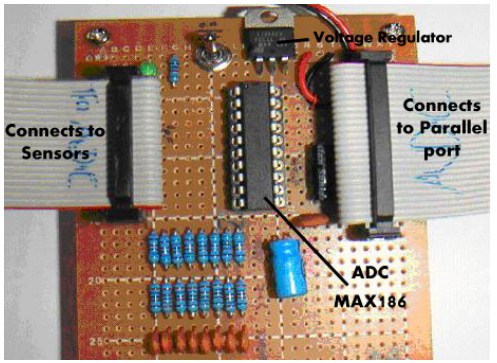
ADC:



$N(T)$

$P(P,I,D,T(t))$

DAC:

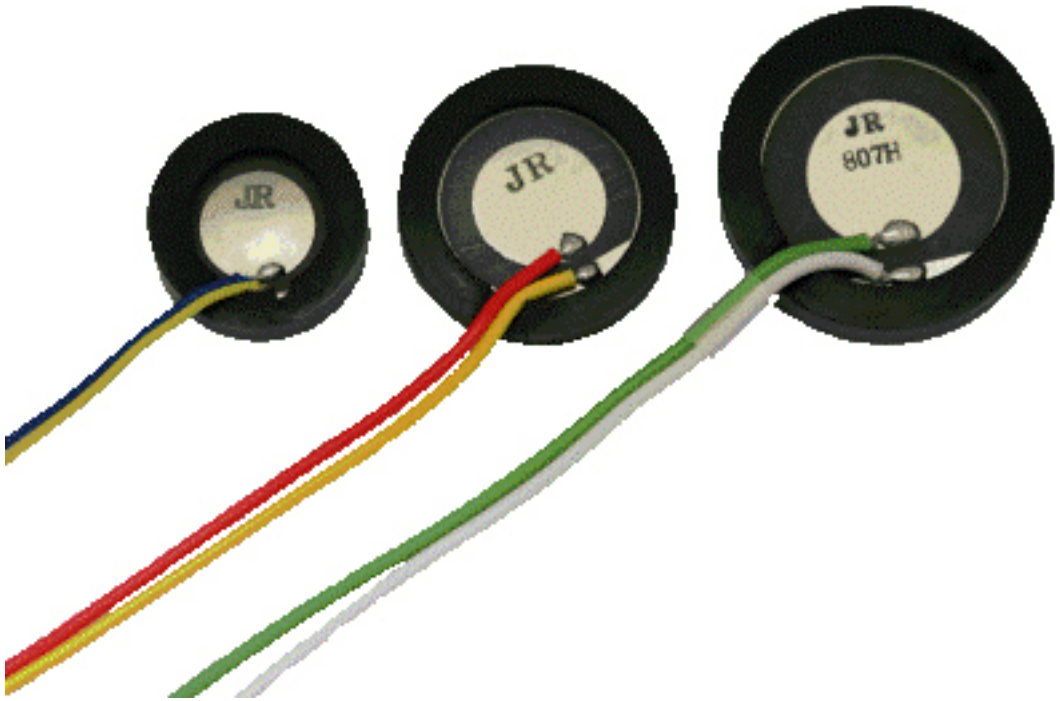


$N(P,I,D,T(t))$

$V(P,I,D,T(t))$

Parameters of transducers

What are important parameters of transducers?

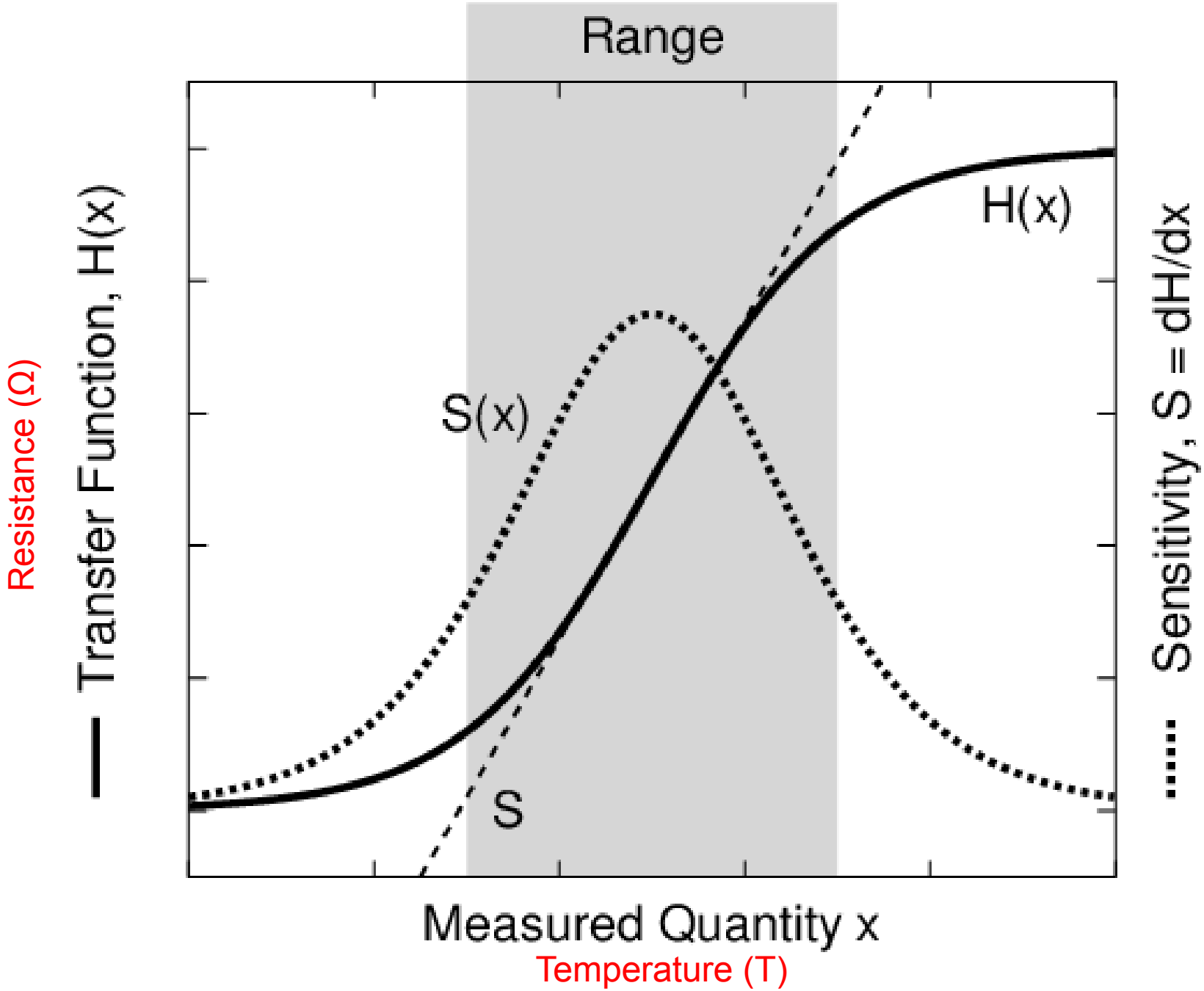


Piezoelectric acoustic sensors

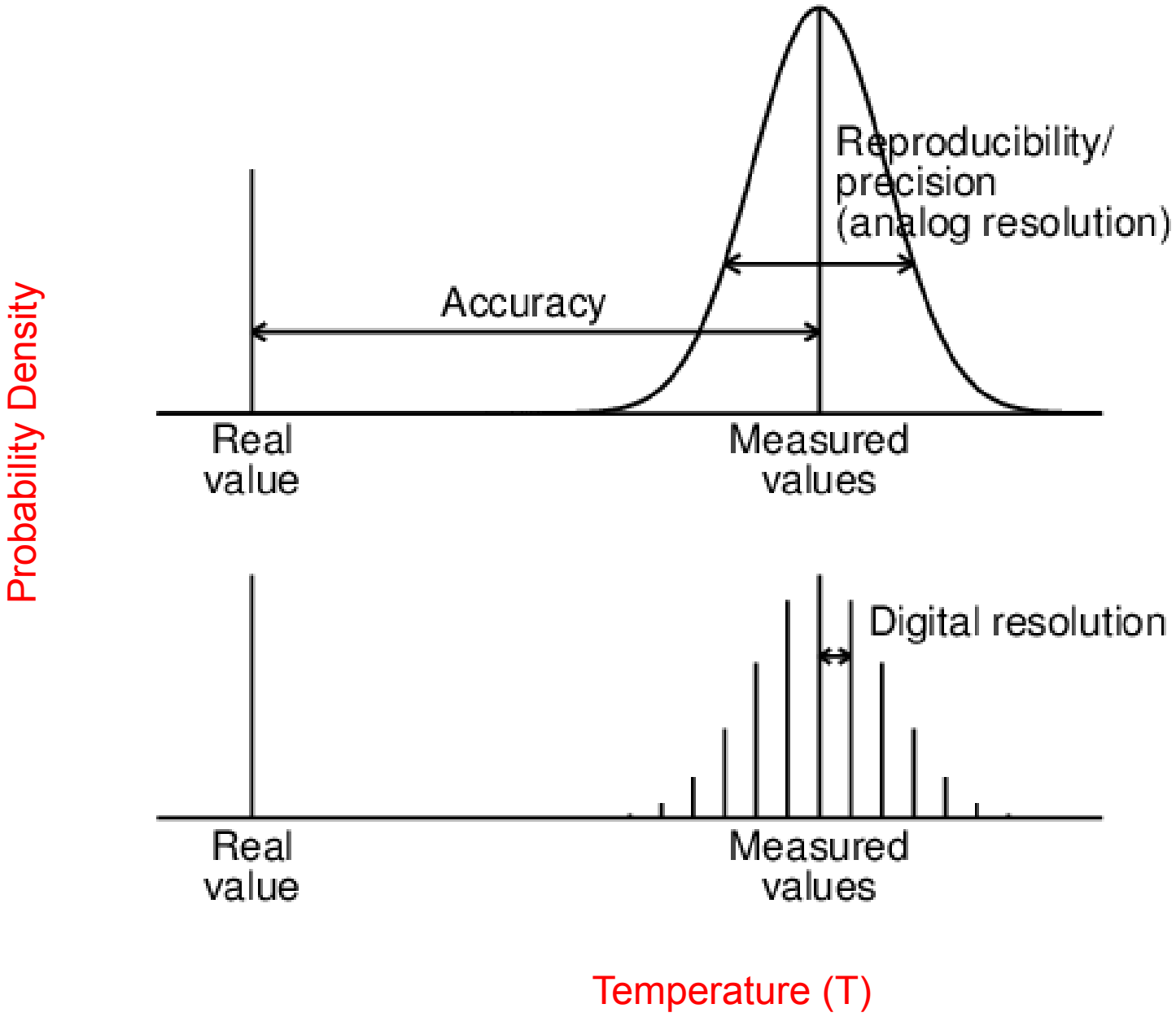
Parameters of transducers

- Price
- Transfer function (ex. $V(T)$)
- Sensitivity (ex. $\mathrm{d}V/\mathrm{d}T$)
- Offset
- Selectivity
- Linearity
- Range
- Accuracy
- Reproducibility/precision, (analog) resolution
- (Digital) resolution
- Shelf life & operational life
- Speed
- Durability
- Interference
- S/N Noise
- Ease of operation /maintenance

Transfer function, sensitivity, linearity & range



Resolution, Accuracy & Precision



Examples: Pissing sensor

2 transducers:

IR light source (LED)
IR light detector (photo-transistor)

$L(I)$

$R(L)$

(Actuator) LED emits light. Person modulates light. Photo-transistor sensor's current depends on light intensity.

Examples: Parking sensors

Processor

Speakers / microphones

Speakers emit (ultra)sound. Objects reflect sound. Sensor microphones detect sound. Processor calculates time difference and (thus) distance