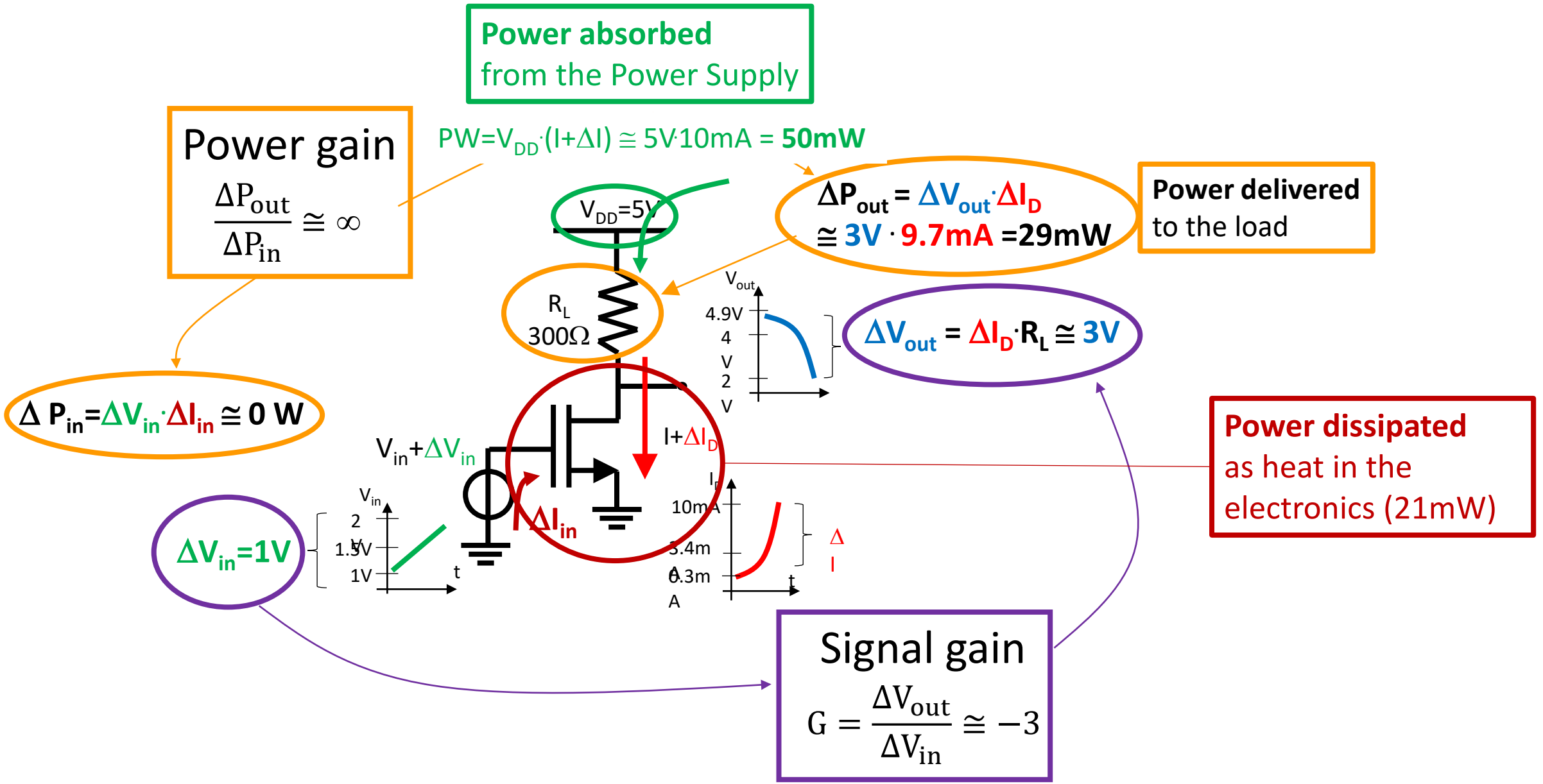
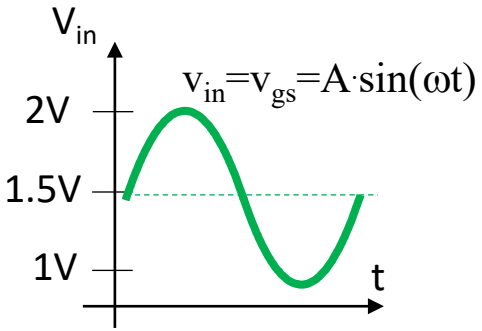
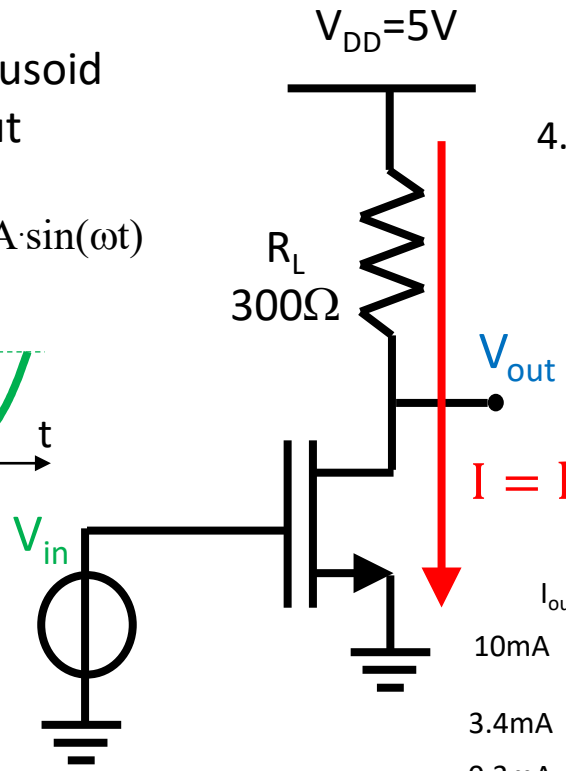
Recap : Signal Gain, Power Gain and Power consumption

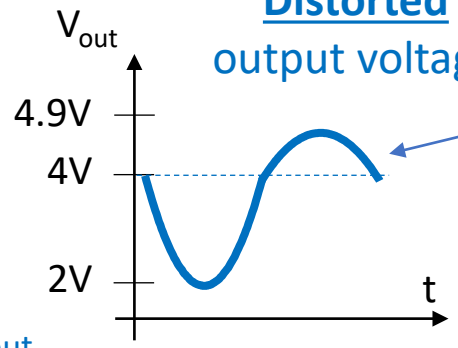


Recap : signal Distortion and Harmonics generation

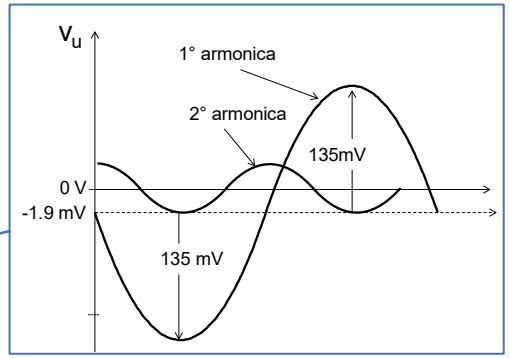
Perfect sinusoid
at the input



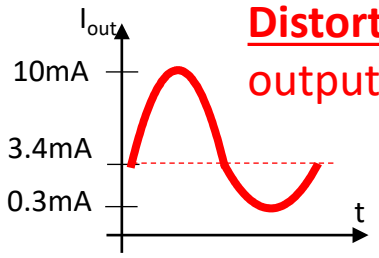




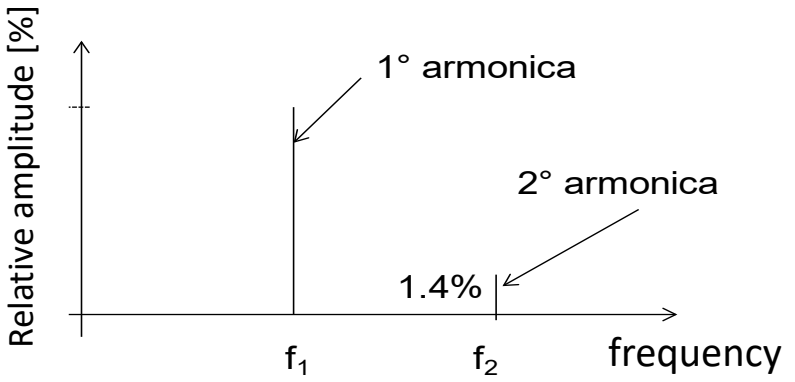
Distorted
output voltage



$$I = k(A\cdot\sin(\omega t) - V_T)^2 = kV_T^2 + \frac{kA^2}{2} - 2kAV_T\sin(\omega t) - \frac{kA^2}{2}\cos(2\omega t)$$



Distorted
output current



Exercise 2

You are the chief designer of the next generation of satellites for earth survey. Your team of mechanical engineers have designed a solar cell panel that is always (24h/day) directed toward the sun. They also defined the maximum area of the solar cell panel, of $20m^2$.

Find how much electric power you will have available for all your electronic instrumentation and the transmission of data to the base station.

ELECTRONIC SYSTEMS and TECHNOLOGIES

Master in Management Engineering

Prof. Marco Sampietro

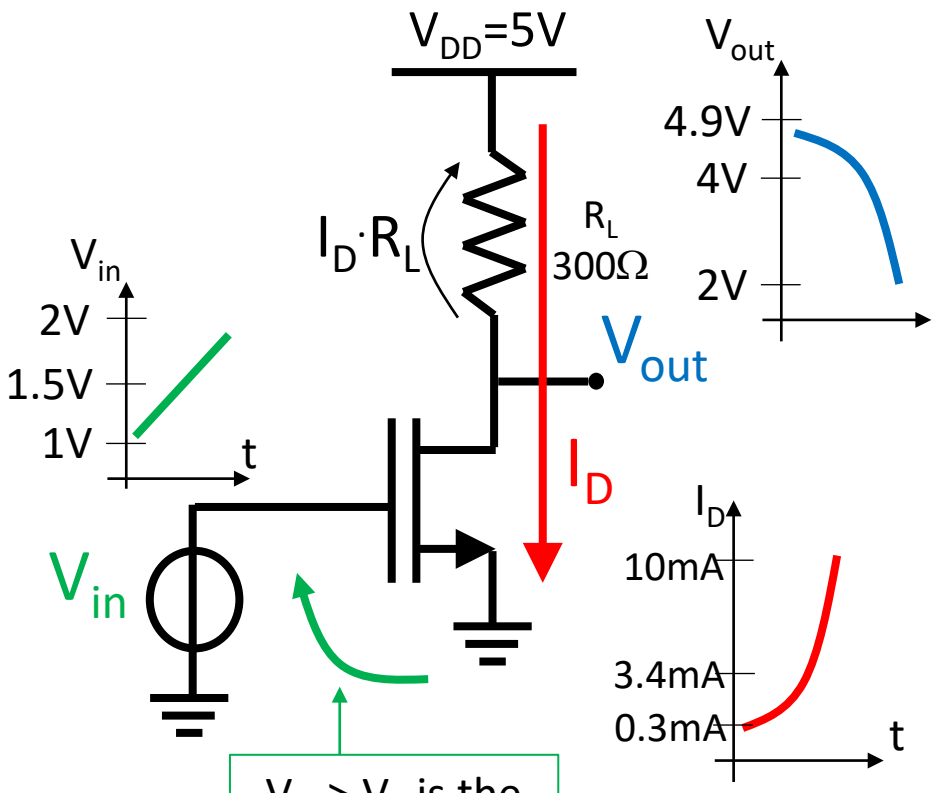
GROUND CONCEPTS ON ELECTRONICS

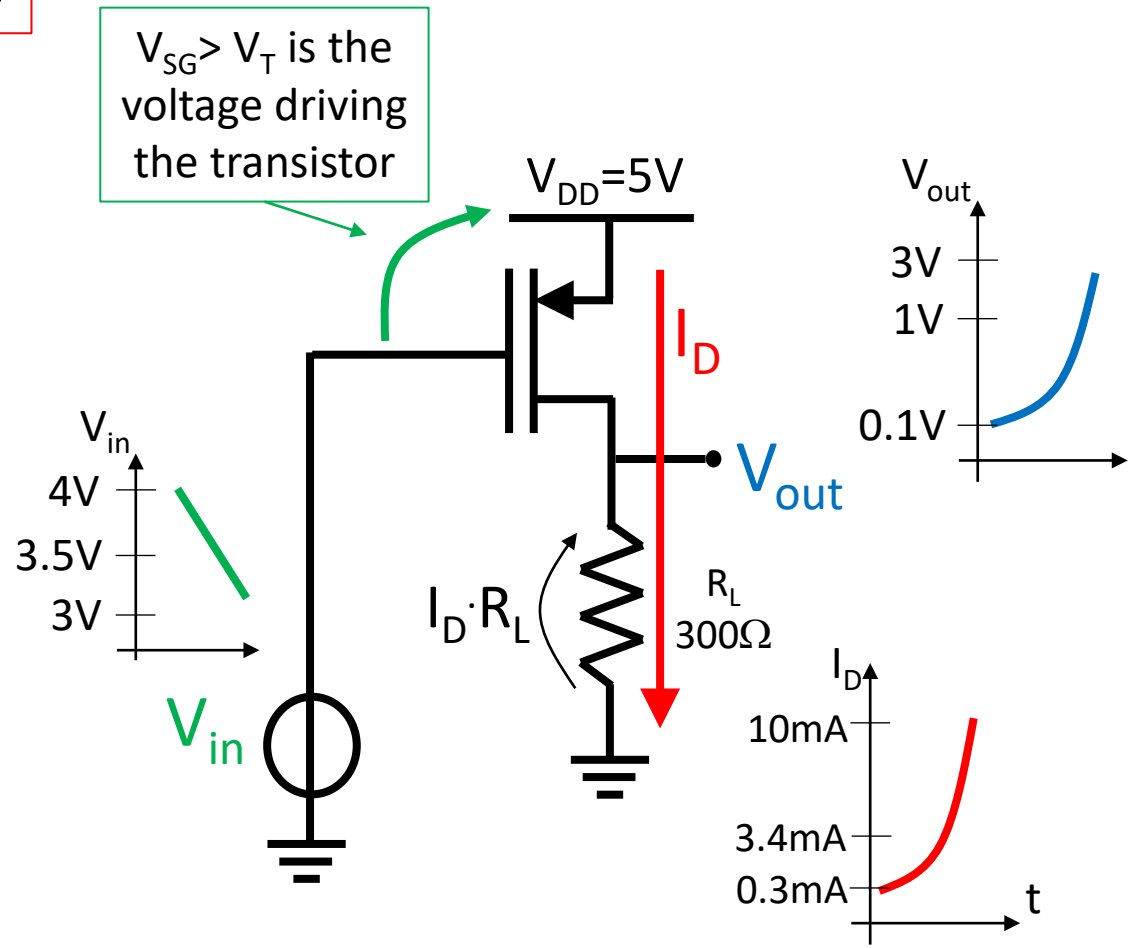
CMOS and the Digital world

nMOSFET and pMOSFET circuits

Electrons travels from S to D

Holes travels from S to D





In this example V_T=0.8V and K=7mA/V^2 for both type of transistors

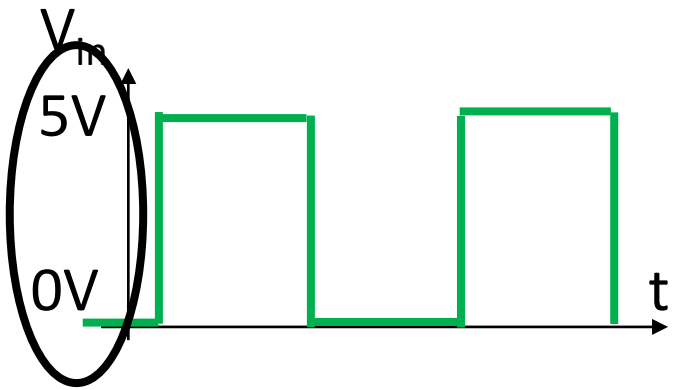
ANALOG vs DIGITAL signals

Signals assume any value in a continous time

Digital Input Signal

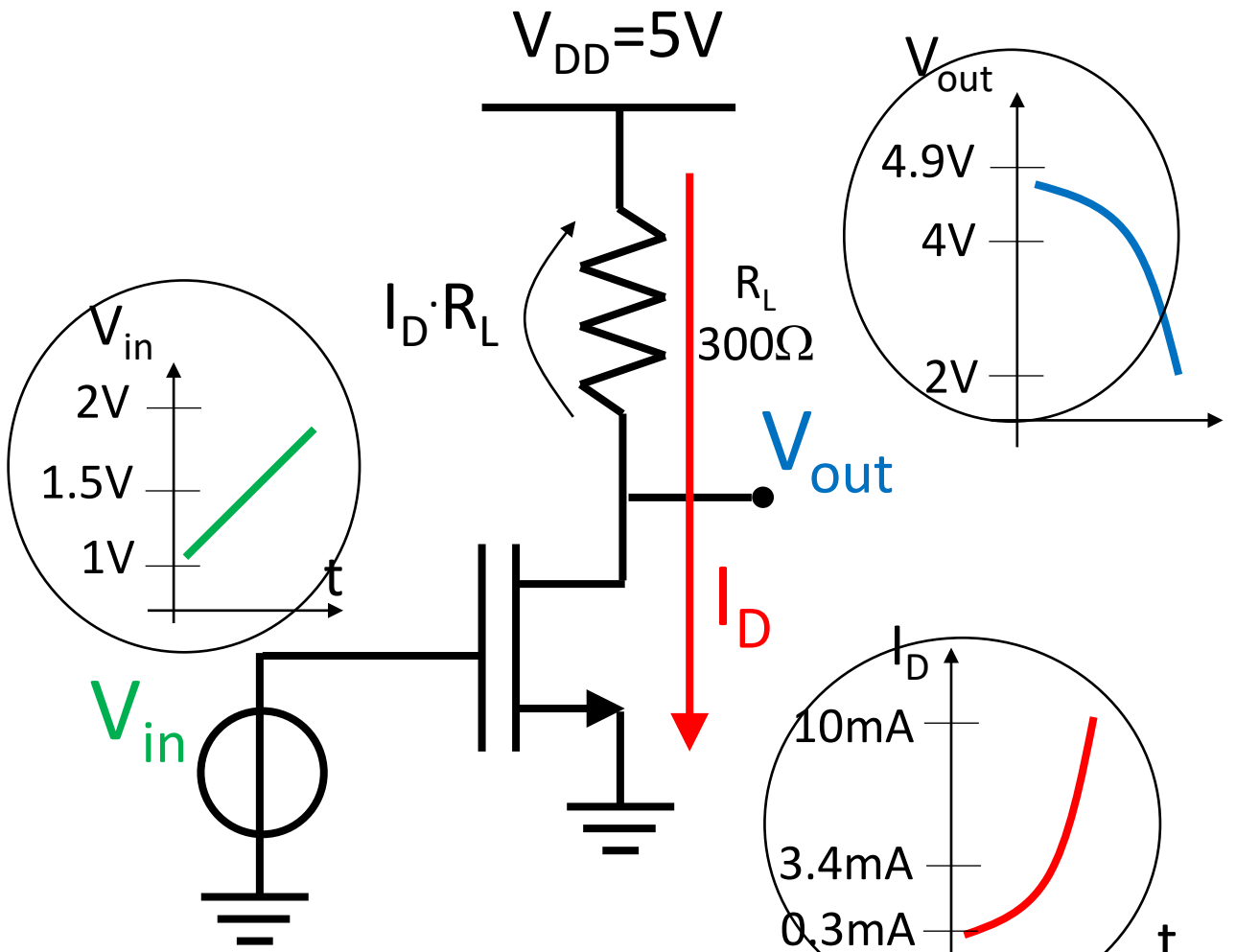
Logic «0» -> 0V

Logic «1» -> 5V



Rail-to-rail

(from the voltage supply to ground)



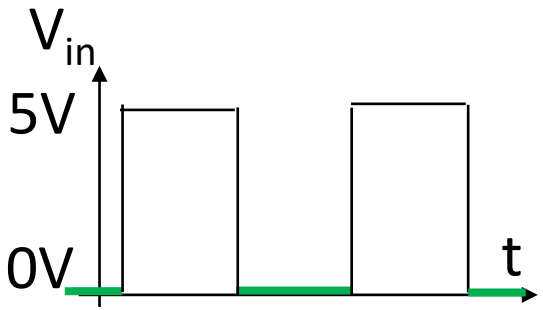
?

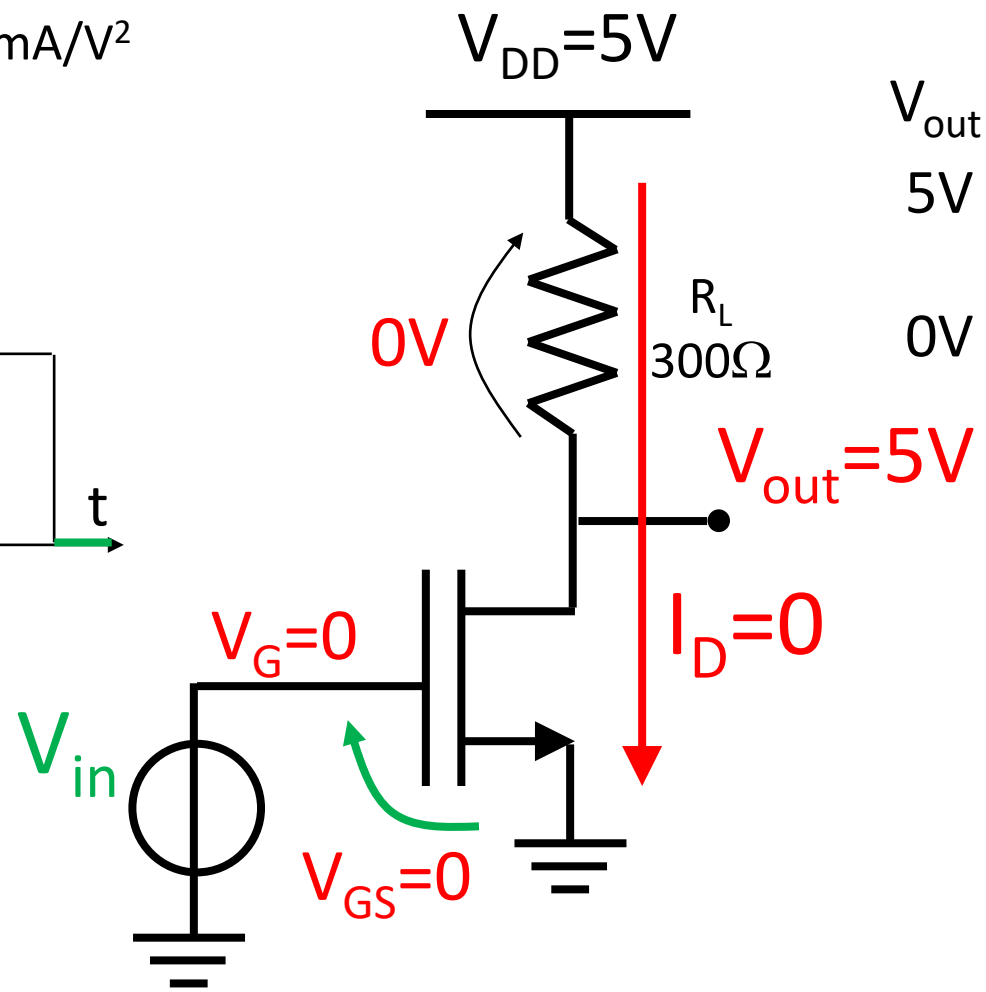
?

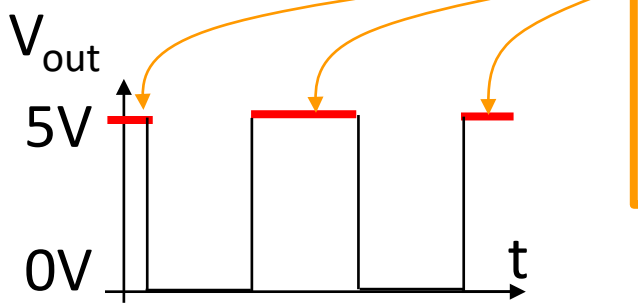
V_T=0.8V and K=7mA/V²

Response to a digital input signal low (0V)

V_T=0.8V and K=7mA/V²

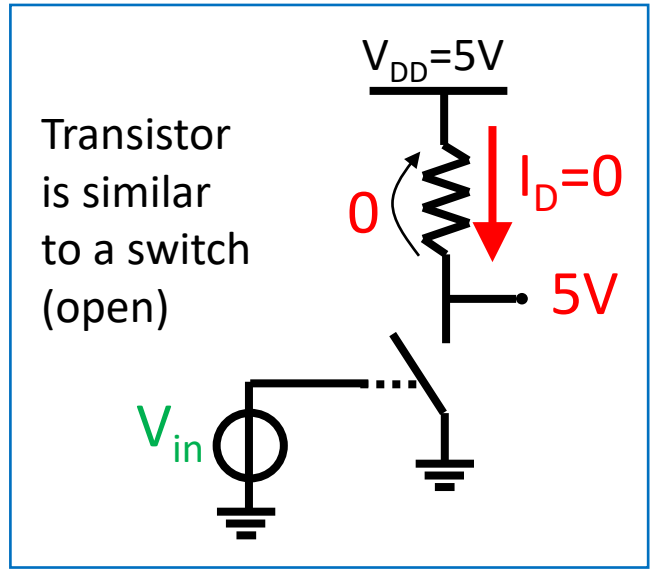






NO power consumption

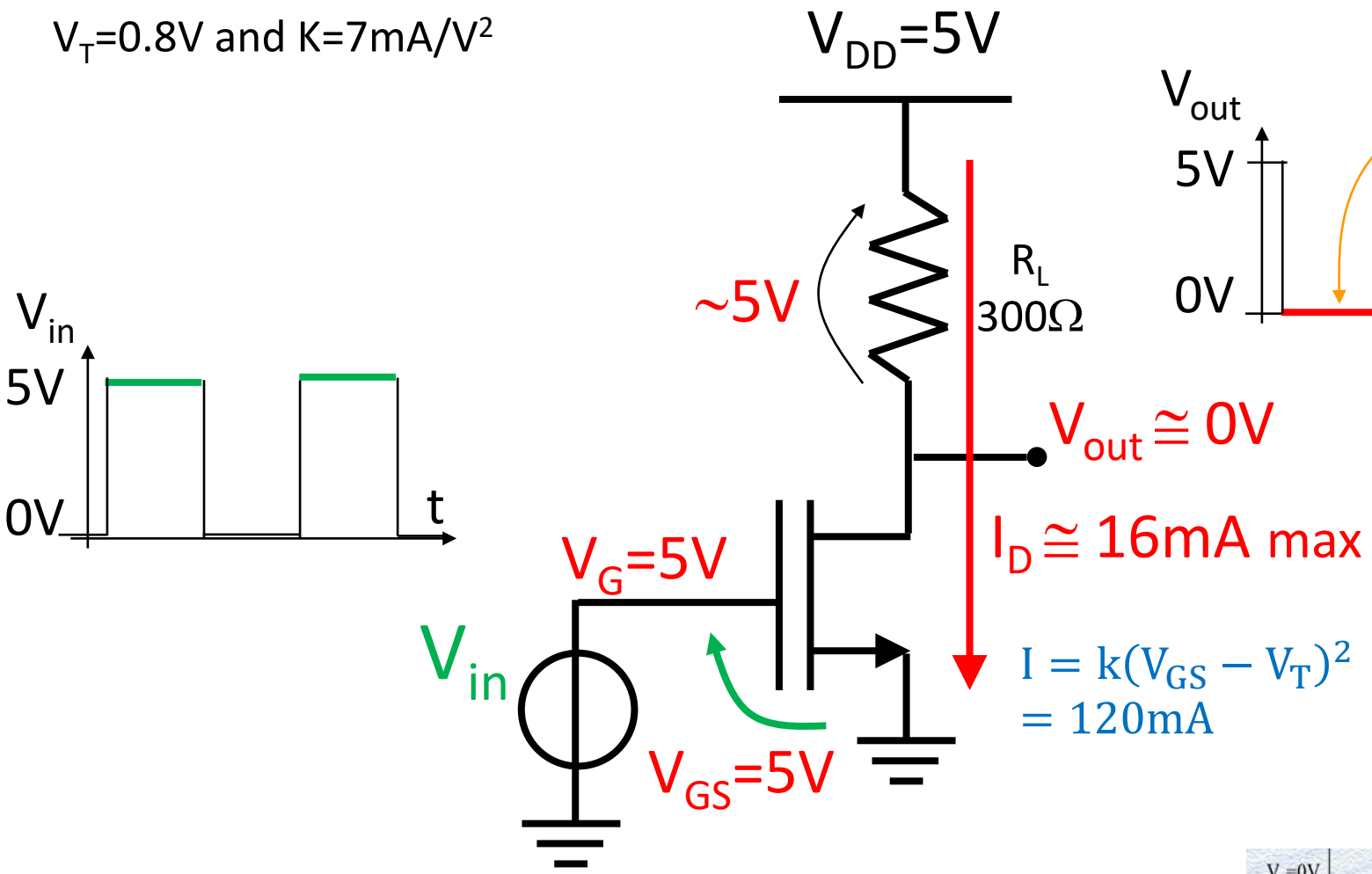
$P=V_{DD}\cdot I_D=\mathbf{0}$

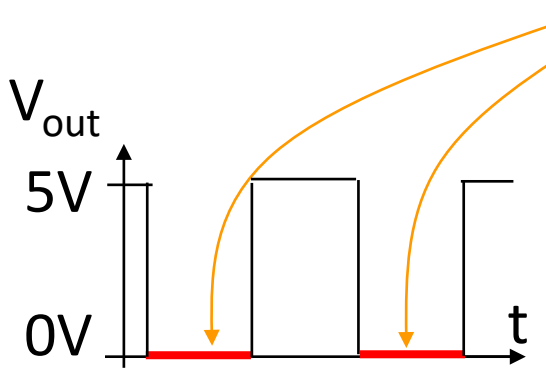


MOSFET operates below threshold : $V_{GS} < V_T$ → $I_D=0$ → V_u=+5V

Response to a digital input signal high (5V)

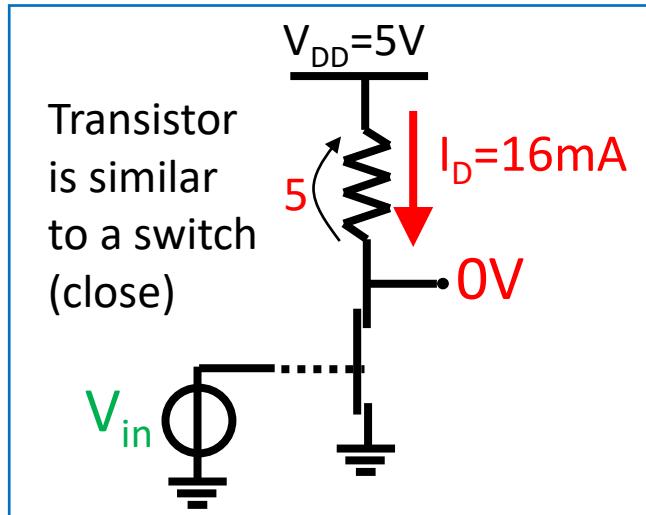
V_T=0.8V and K=7mA/V²



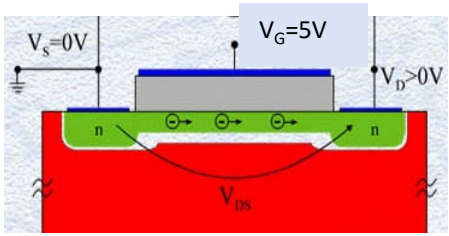


HIGH power consumption

$P=V_{DD}\cdot I_D$=**80mW**



MOSFET operates as a resistor (of low value) :



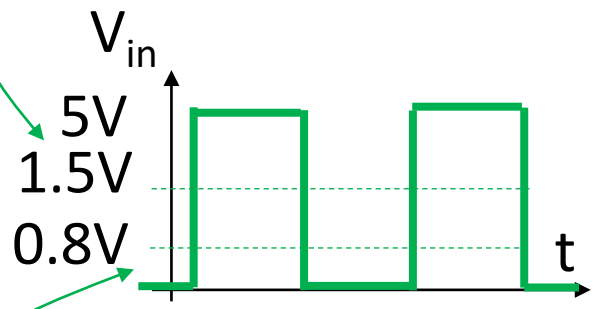
The Digital Inverter

V_T=0.8V and K=7mA/V²

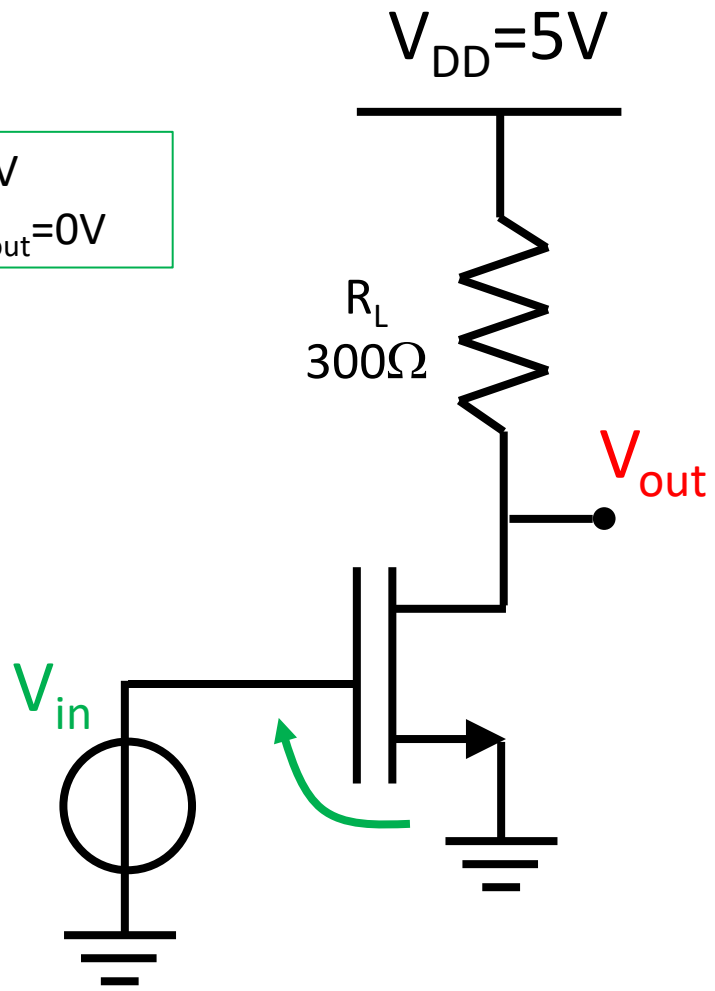
$V_{in} = 0V(0) \rightarrow V_U = 5V(1)$

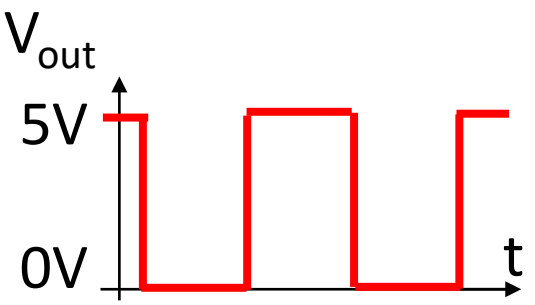
$V_{in} = 5V(1) \rightarrow V_U = 0V(0)$

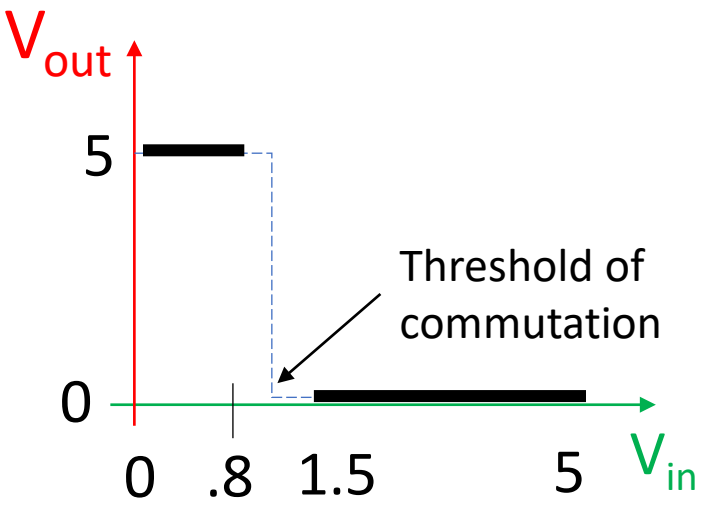
Input values above 1.5V (I>16mA) surely give V_{out}=0V



Input values below 0.8V surely give V_{out}=5V



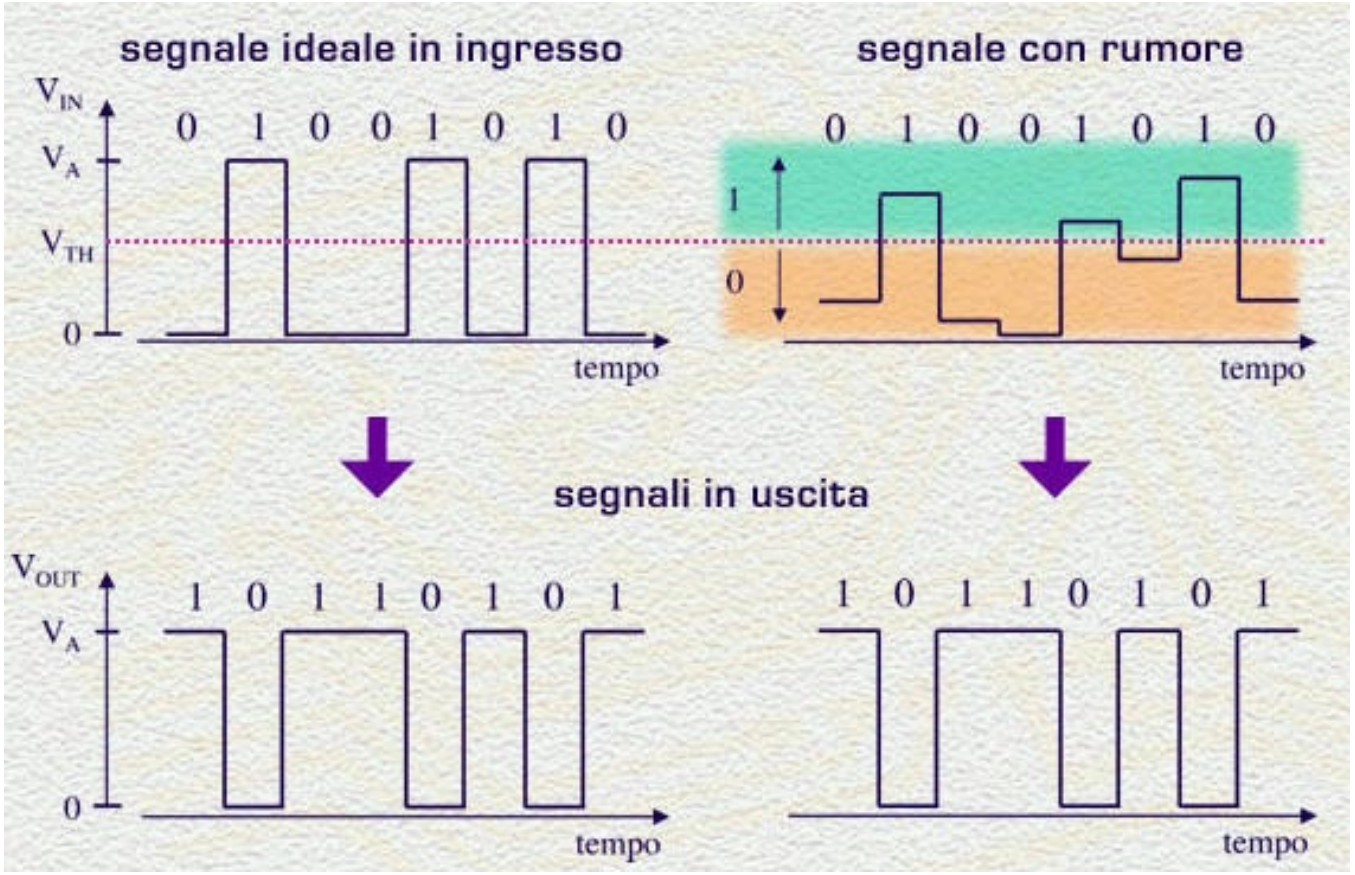




Immunity to disturbances of a digital circuit

The threshold characteristic of the inverter allows, in many cases, a correct interpretation of the sequence even in the presence of a significant noise level.

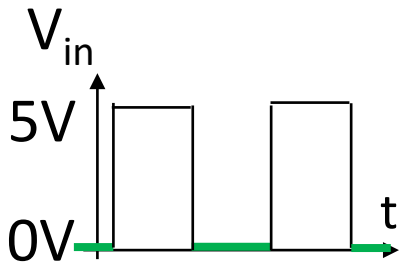
Note also that the inverter has reset the logic levels to 0 volts and 5 volts !

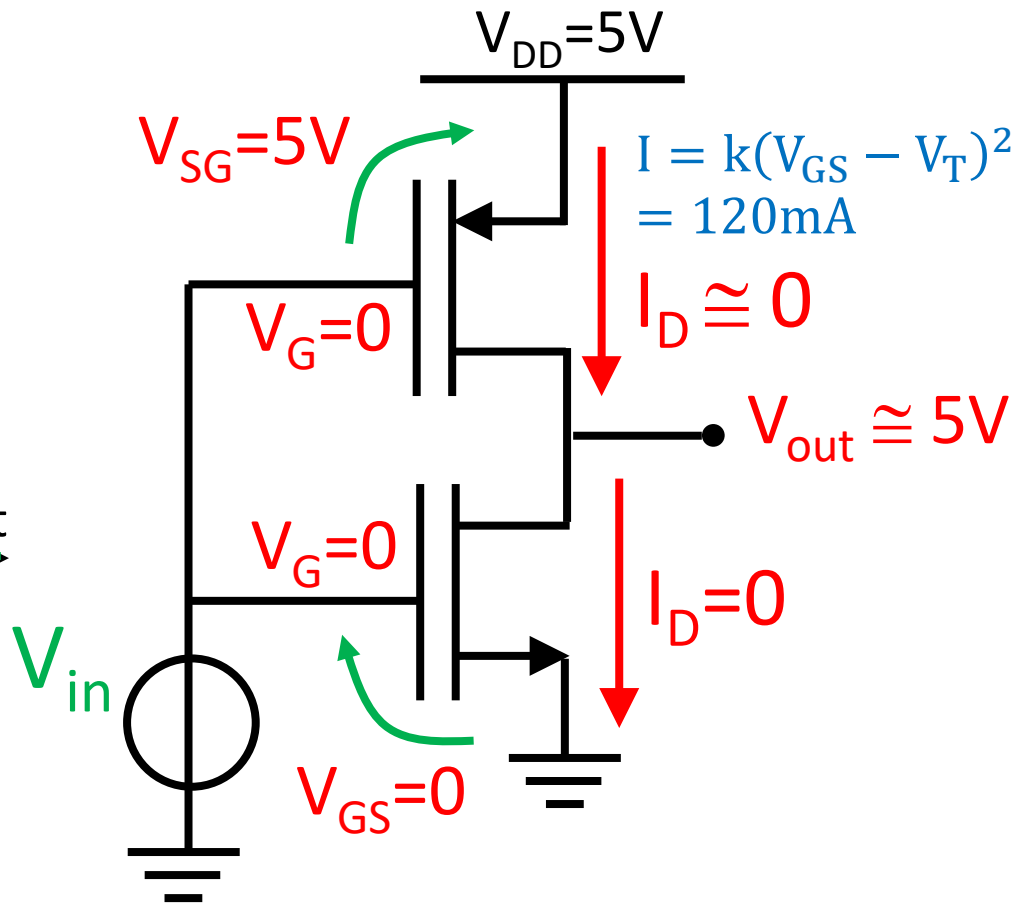


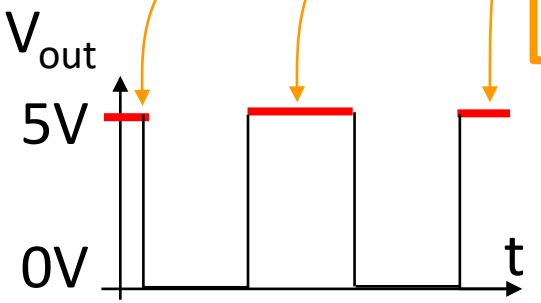
This feature is fundamental of digital systems and it provides «high degree of immunity to disturbances».

Digital input signal low (0V) - *adding a pMOSFET*

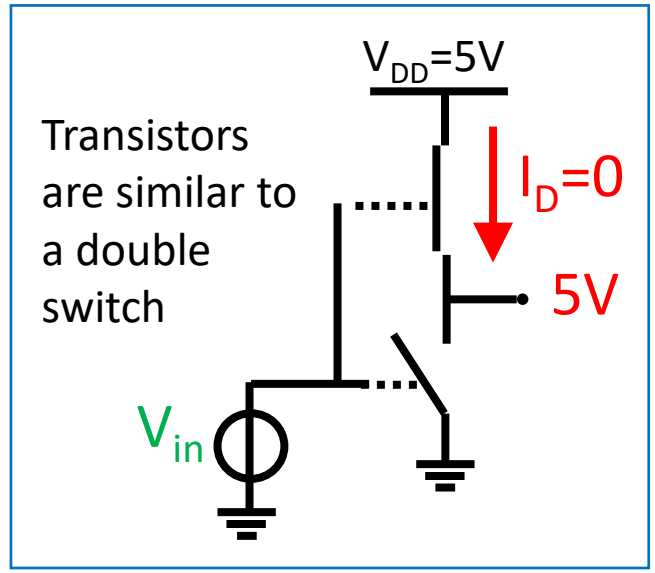
V_T=0.8V and K=7mA/V²





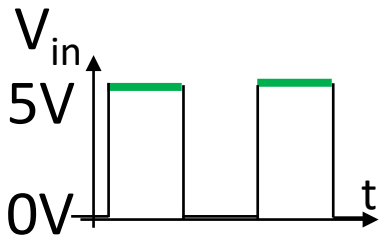


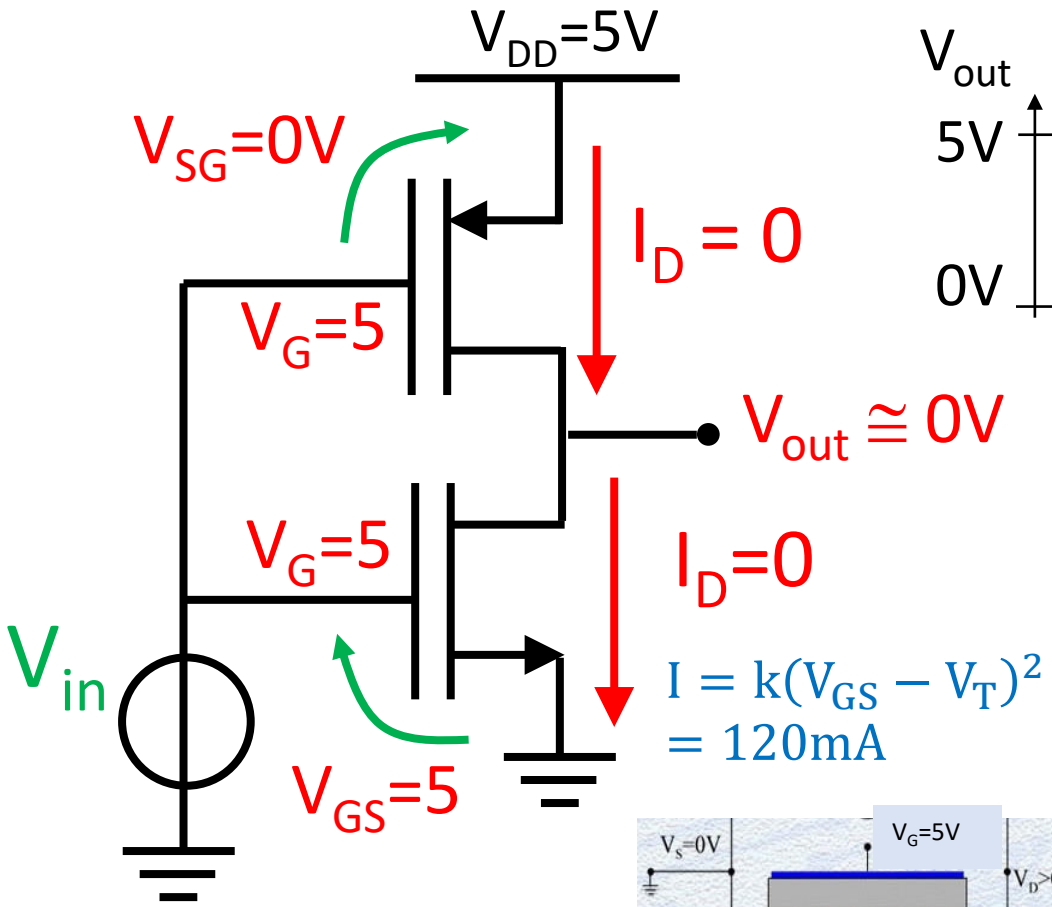
NO power consumption
$P=V_{DD} \cdot I_D = \mathbf{0}$

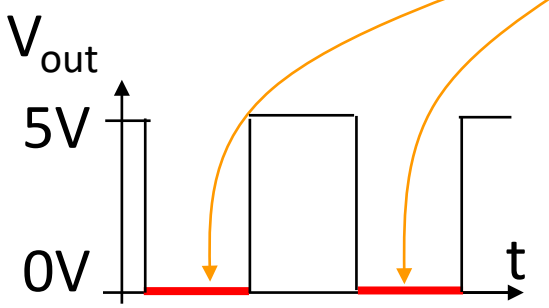


Digital input signal high (5V) - *adding a pMOSFET*

V_T=0.8V and K=7mA/V²

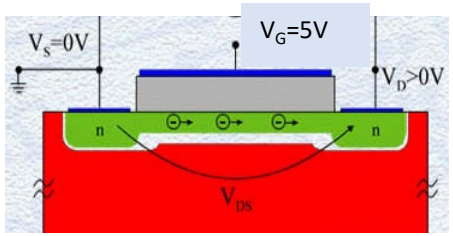




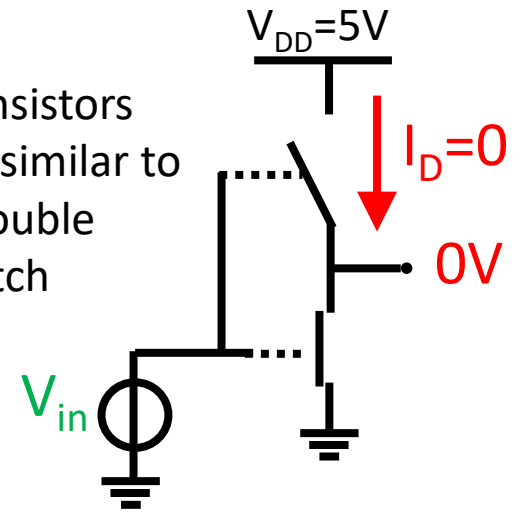


NO static power consumption

$P=V_{DD}\cdot I_D=\mathbf{0}$



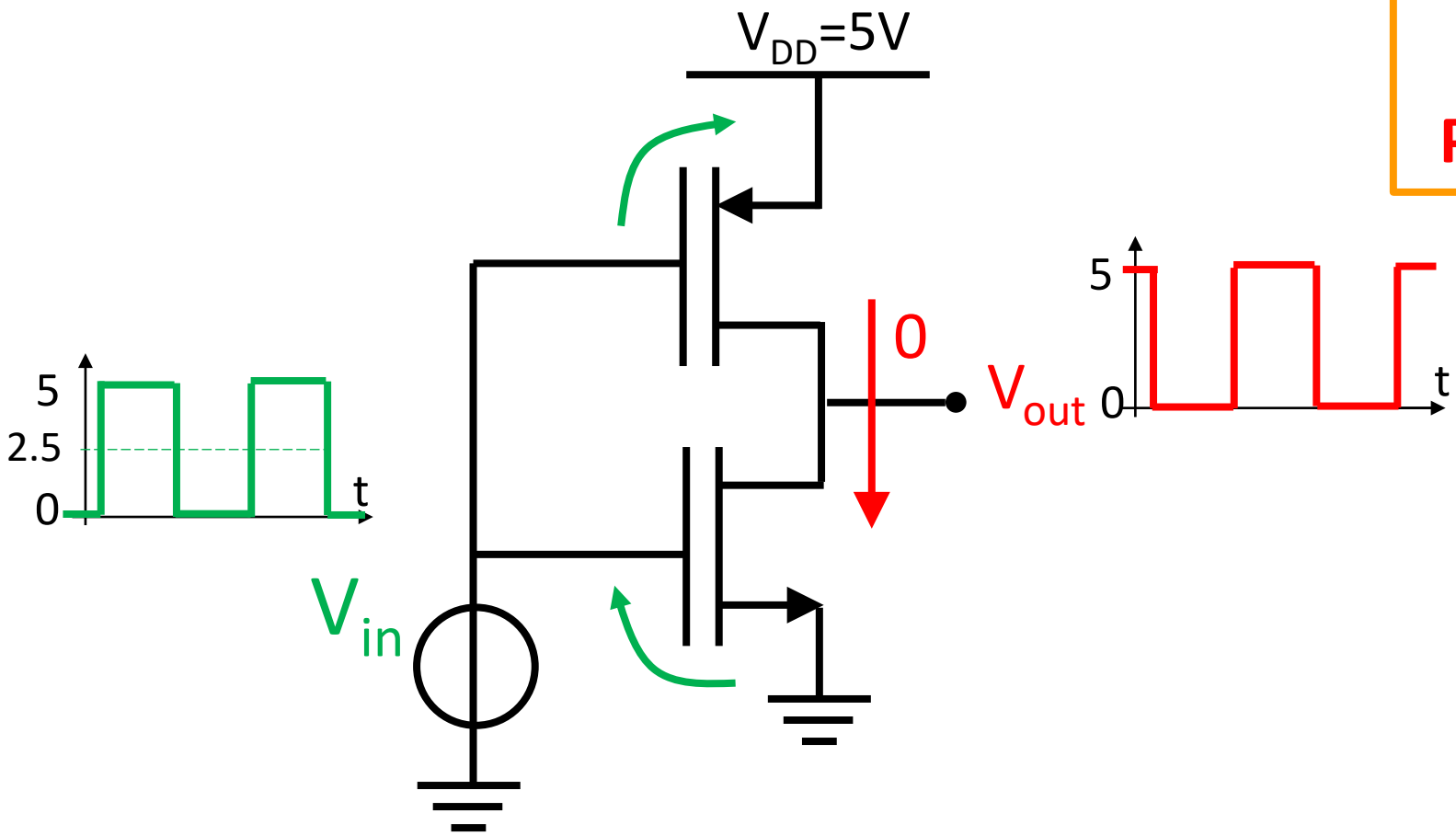
Transistors are similar to a double switch

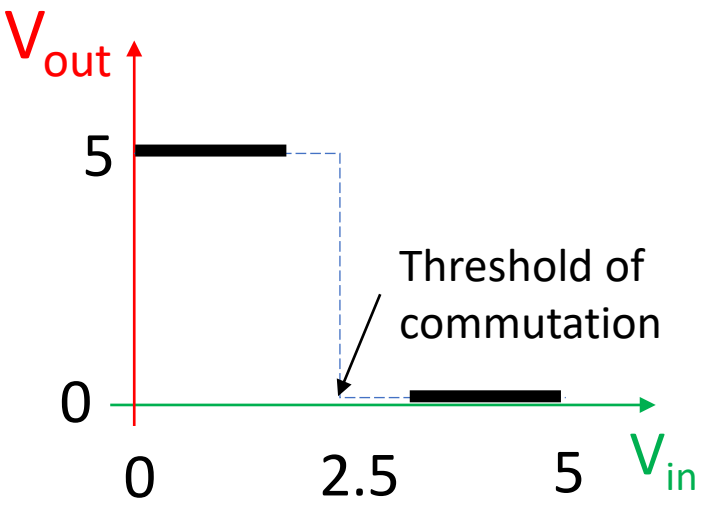


The Complementary MOSFETs architecture : CMOS

ZERO static power consumption

P $= V_{DD} \cdot I_D =$ **0** always

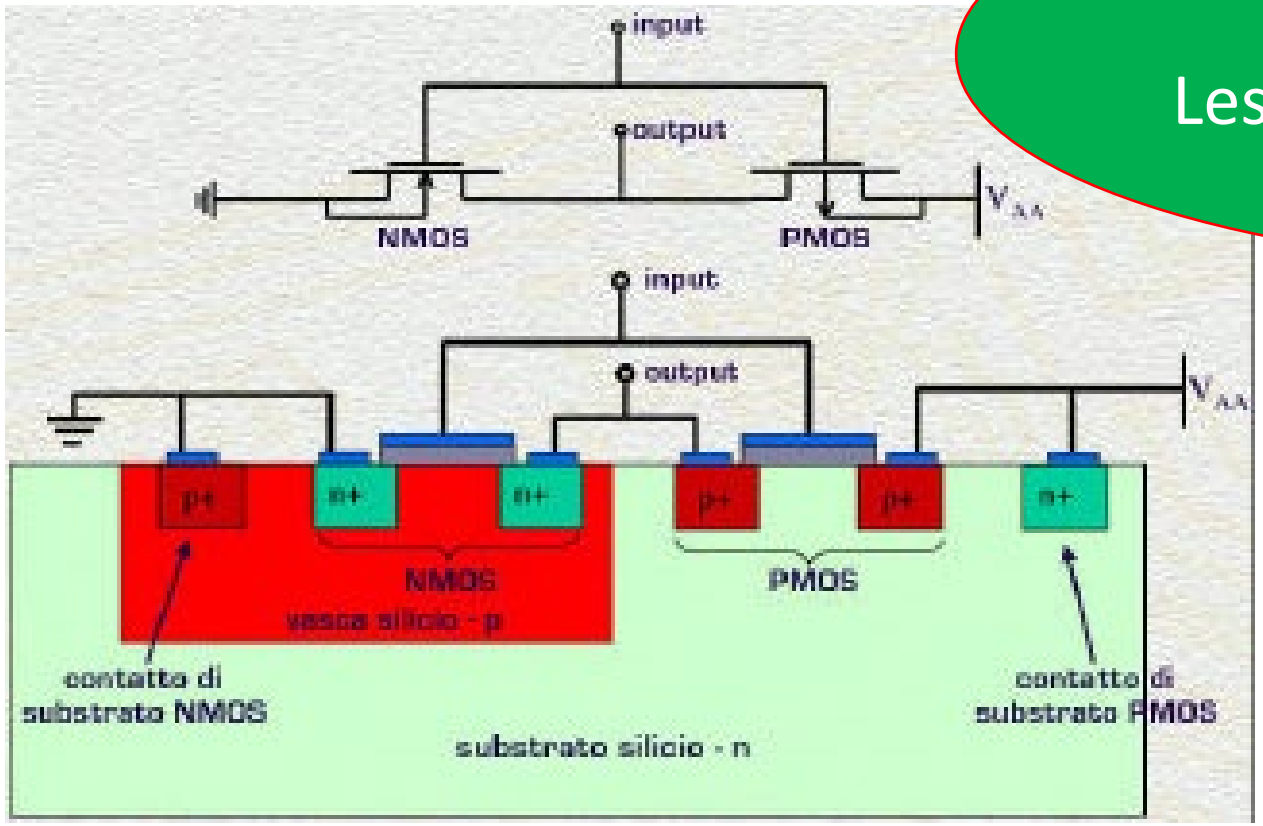


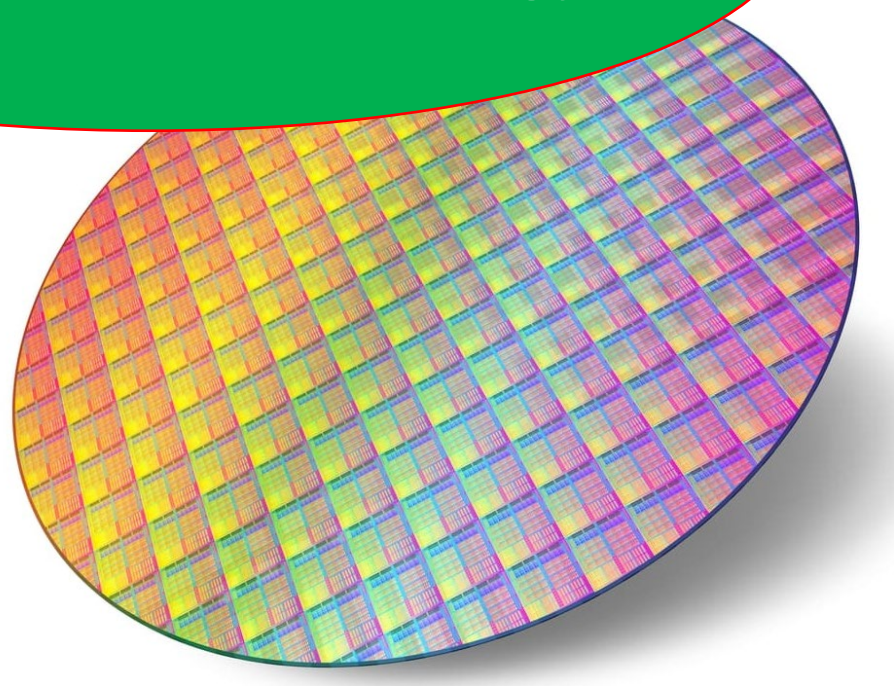


Threshold of commutation at $V_{DD}/2$=2.5V (pMOS = 3 x nMOS)

The CMOS in the planar technology

Tuesday, March 15
Lesson on Planar Technology





Boolean variables and logic operations

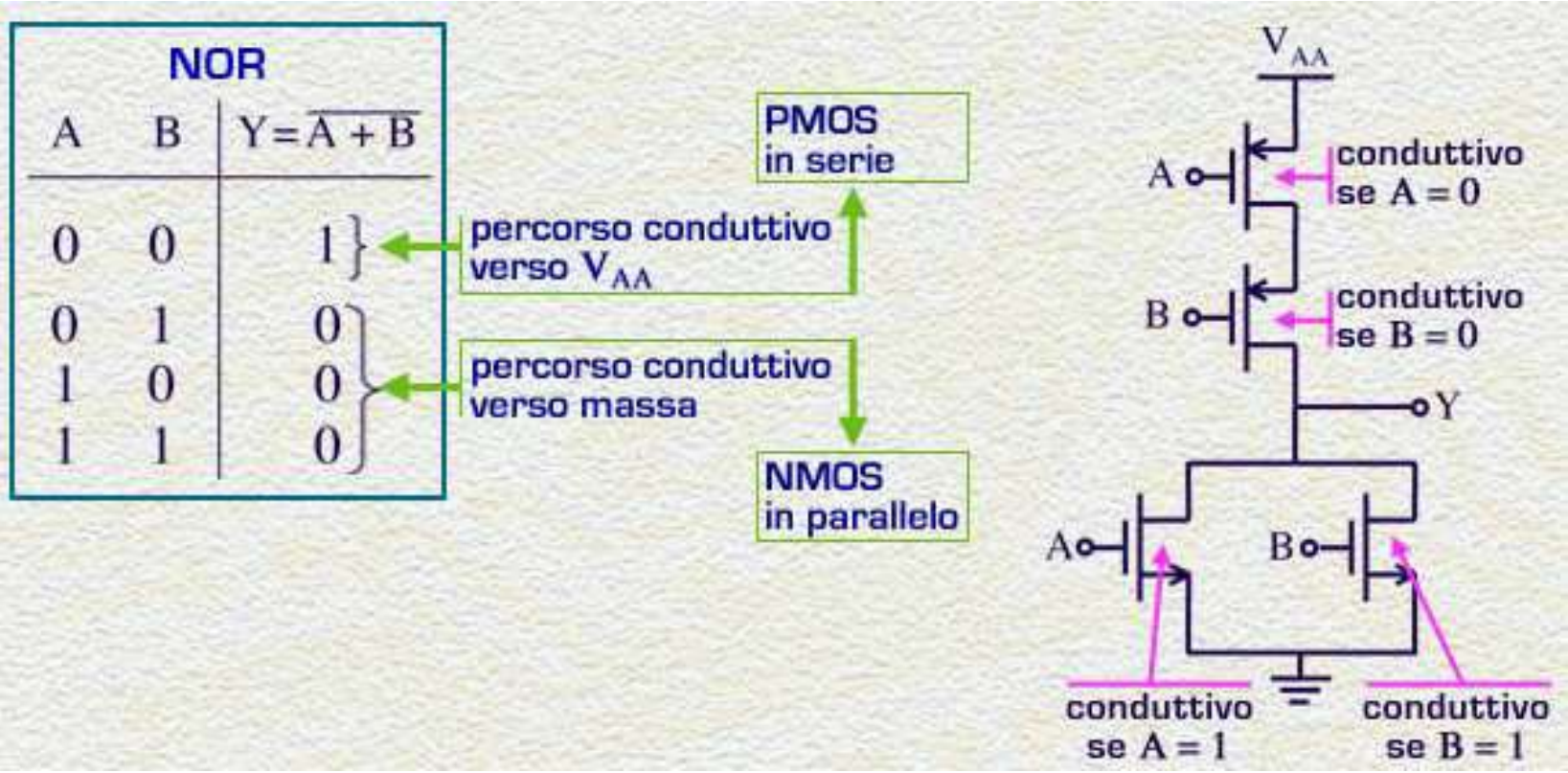
Boolean variables
(a two values variable)

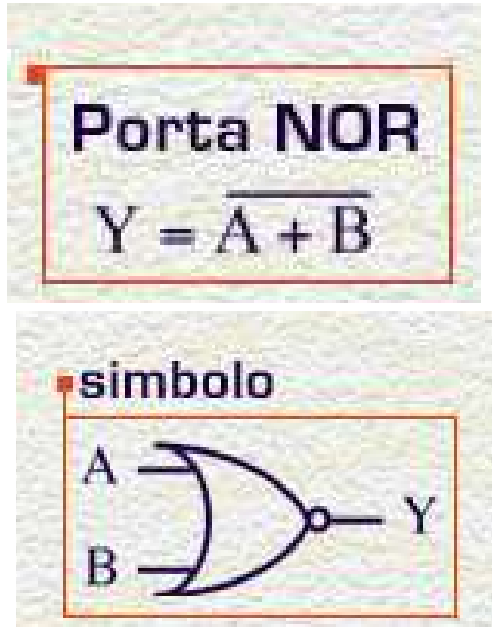
- True or False
- 1 or 0
- High or Low

Boolean Operations

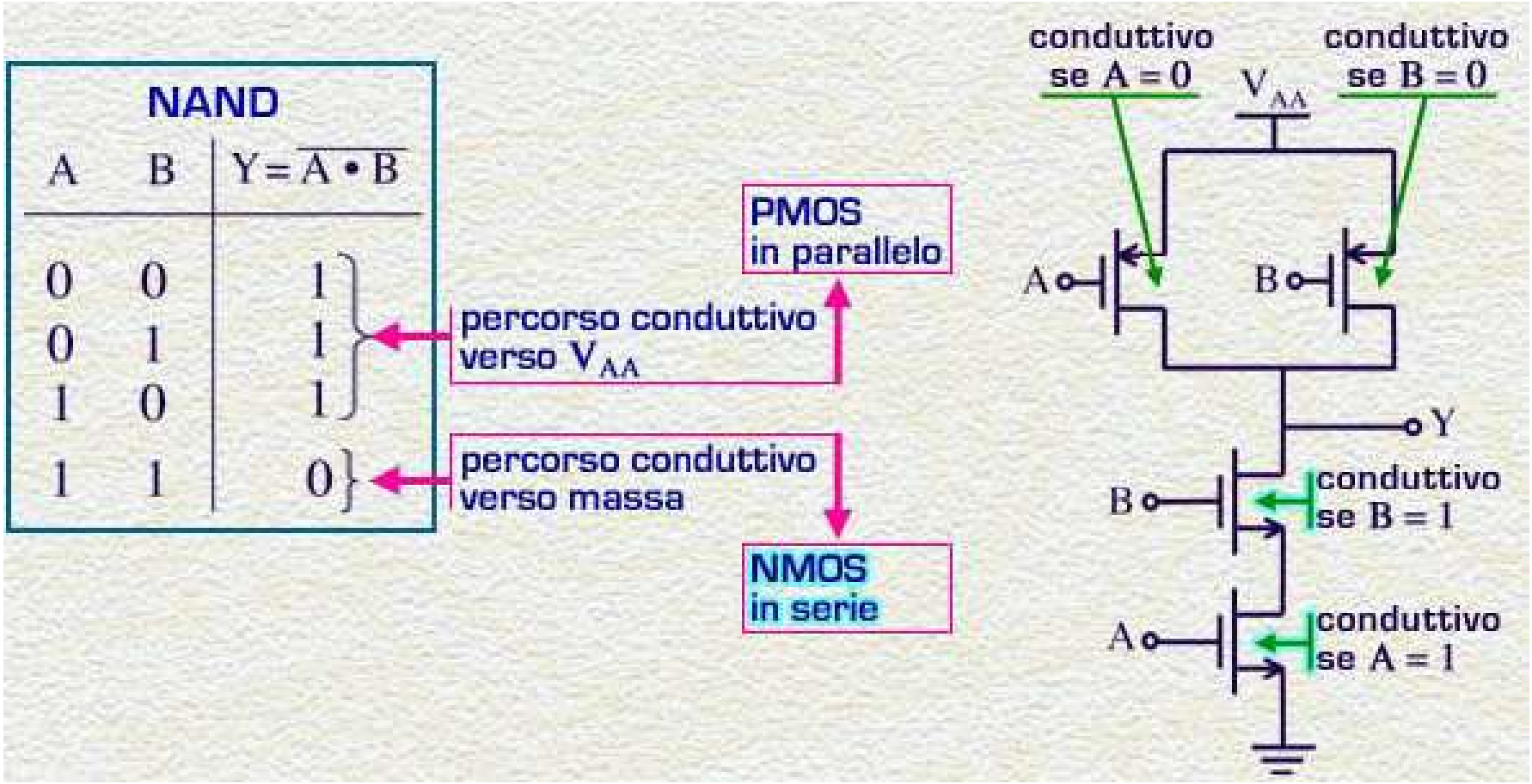
- negation operation (NOT)
- logical product (AND) of two or more variables.
- logical sum (OR) of two or more variables.

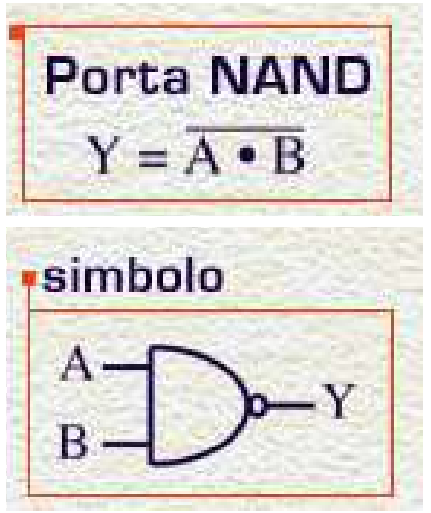
Multiple inputs Logic Gates : the NOR operation





Multiple inputs Logic Gates : the NAND operation





Digital Signal Processing

Possible subjects for Oral Presentations

European Chips Act

Chips shortage

The Silicon Valley : a case study

Comparison btwn European (STm) and Korean (Samsung) company

The evolution of electronics in a car

The technology of electronic boards

Examples of flexible electronics

End of the lesson