

Elementos de Sistemas

Transistores e CIs

"Tais coisas simples, e nós fazemos delas algo tão complexo que nos derrota, quase."

"Such simple things, and we make of them something so complex it defeats us, almost."

John Ashbery (1927) poeta americano

apud Nisan, N. & Schocken, S. 2005. Elements of Computing Systems

No começo tudo era mecânico



1961 - Voskhod Spacecraft "Globus" IMP navigation instrument

https://thereaderwiki.com/en/Voskhod_Spacecraft_%22Globus%22_IMP_navigation_instrument

Com a válvula passou a ser elétrico

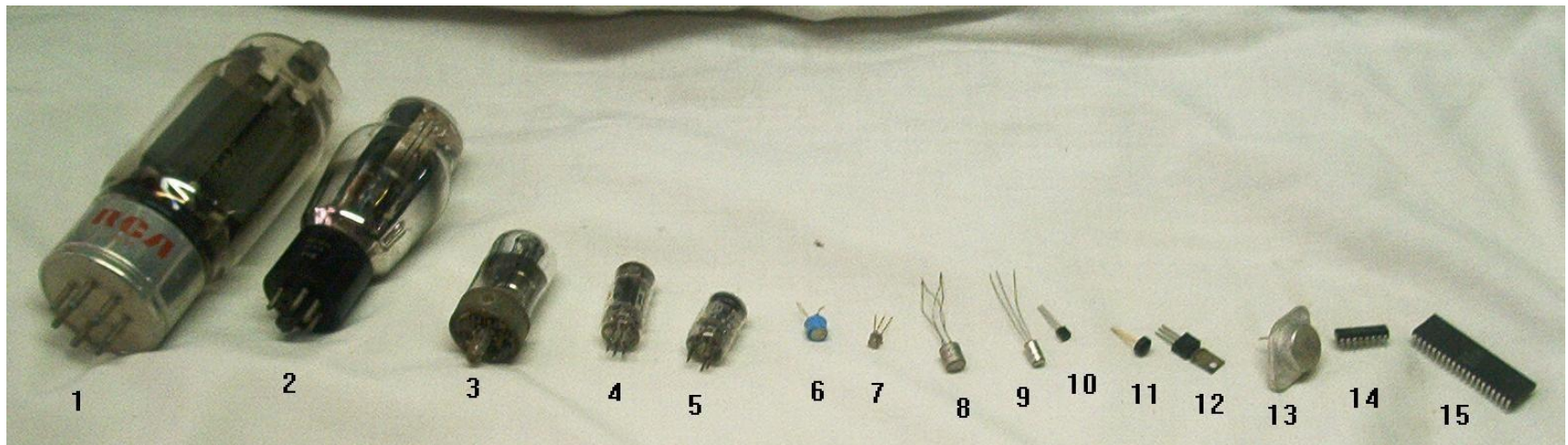


By Stefan Riepl (Quark48) - Self-photographed, CC BY-SA 2.0 de,
<https://commons.wikimedia.org/w/index.php?curid=14682022>



Harwell Dekatron vacuum-tube (valve) computer, 1951-57 - National Museum of Computing, Bletchley Park, England

Que evoluiu para o transistor

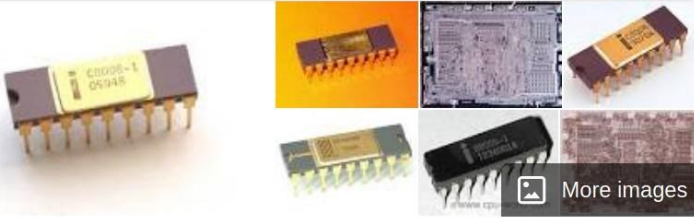


<http://mmnchny.org/exhibits/296-2/>

E evoluiu...



Primeiro transistor funcional
1947



Intel 8008
Microprocessor

The Intel 8008 is an early byte-oriented microprocessor designed and manufactured by Intel and introduced in April 1972. It is an 8-bit CPU with an external 14-bit address bus that could address 16 KB of memory. [Wikipedia](#)

Designed by: [Intel](#)

Successor: [Intel 8080](#)

Max. CPU clock rate: 200 kHz to 800 kHz

Min. feature size: 10 μm

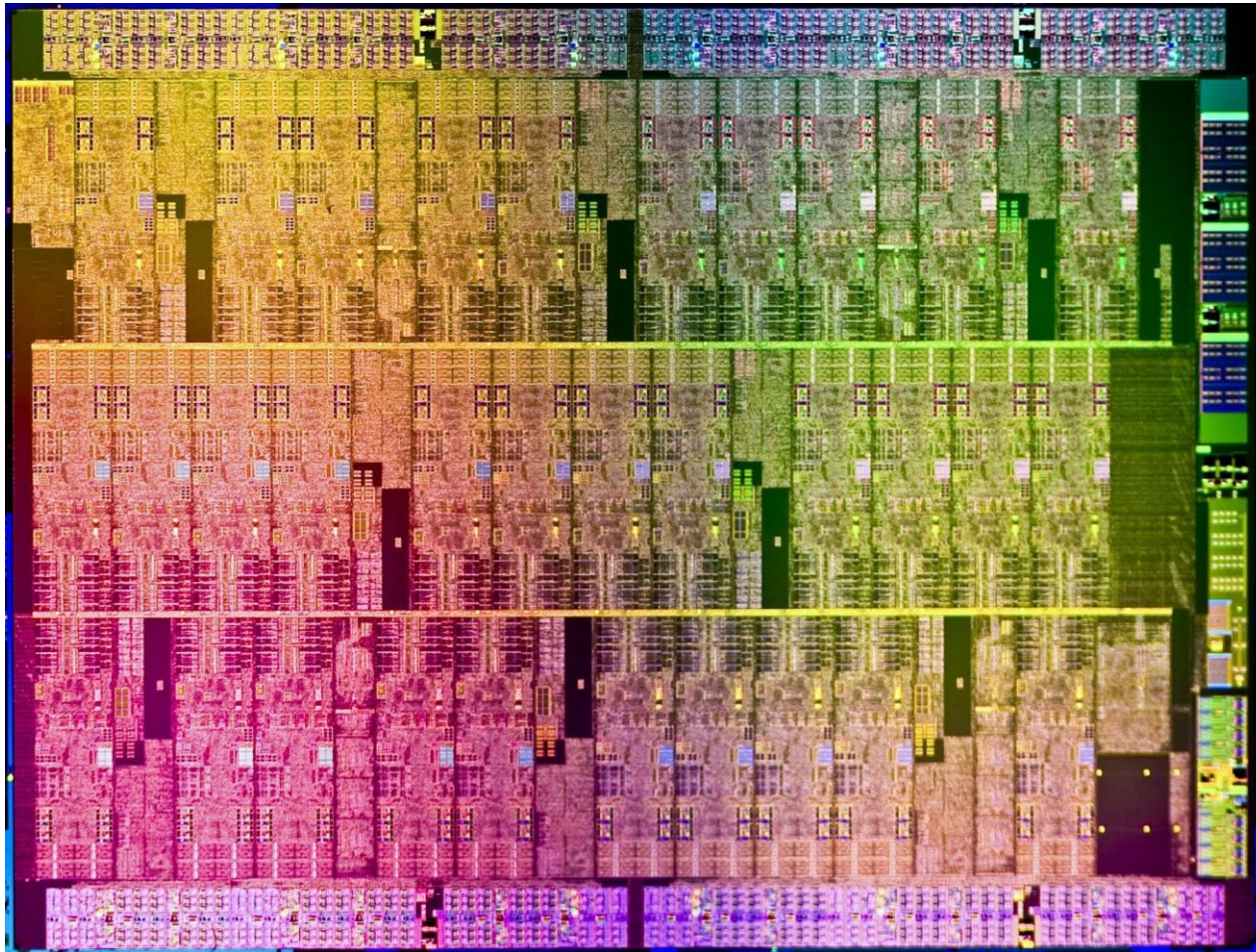
Transistors: 3,500

Address width: 14 Bit

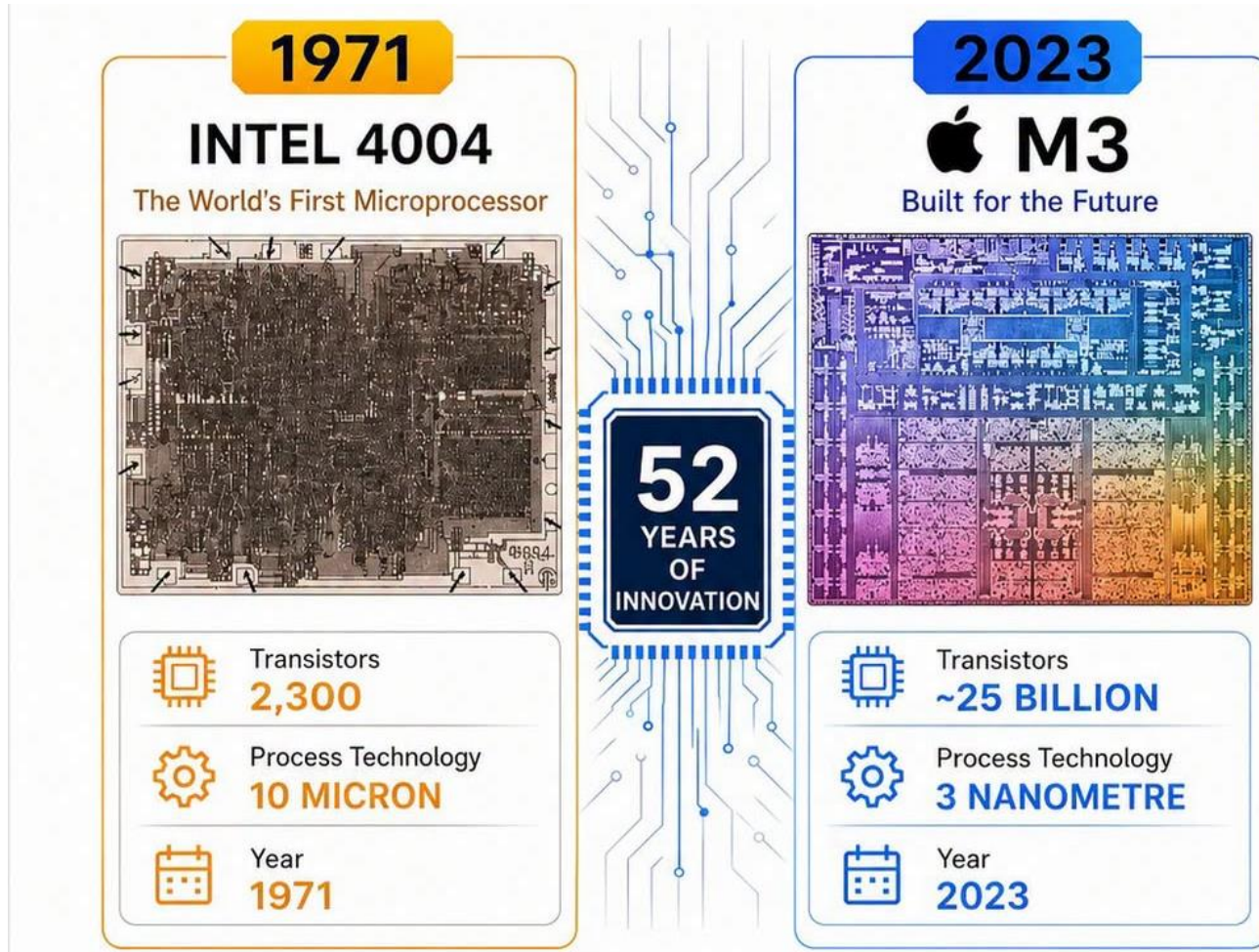
People also search for [View 15+ more](#)

 Intel 4004	 Intel 8088	 Intel 80386	 Intel 8080	 DEC Alpha
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E continua evoluir...



E continua evoluir...



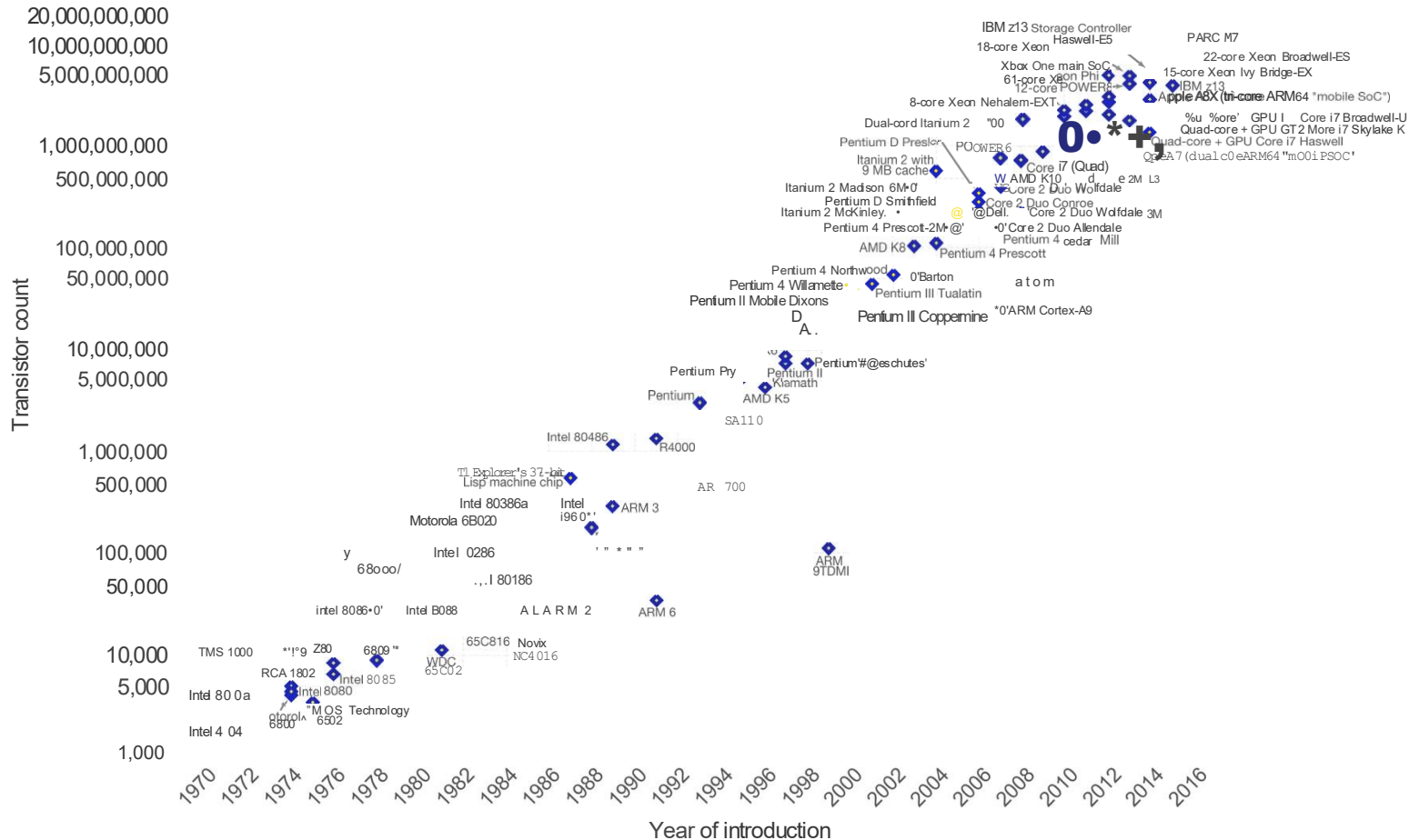
E continua a evoluir ????

1965 – Lei de Moore

“Moore's law is the observation that the number of transistors in a dense integrated circuit doubles approximately every two years.”

Moore's Law —The number of transistors on integrated circuit chips (1970-2016)

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important as other aspects of technological progress —such as processing speed or the price of electronic products —are strongly linked to Moore's law.

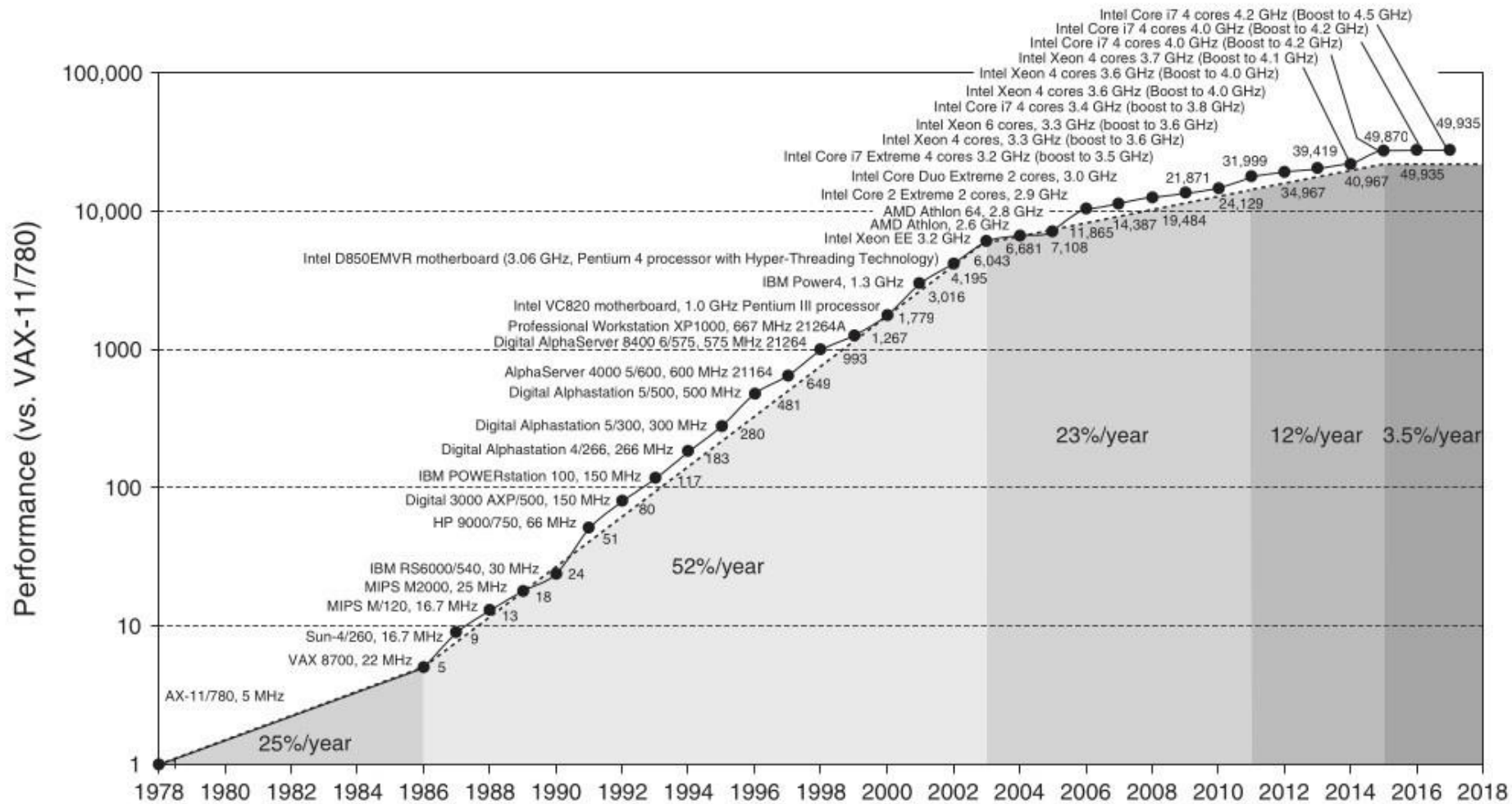


Data source: Wikipedia (https://en.wikipedia.org/wiki/Transistor_count)

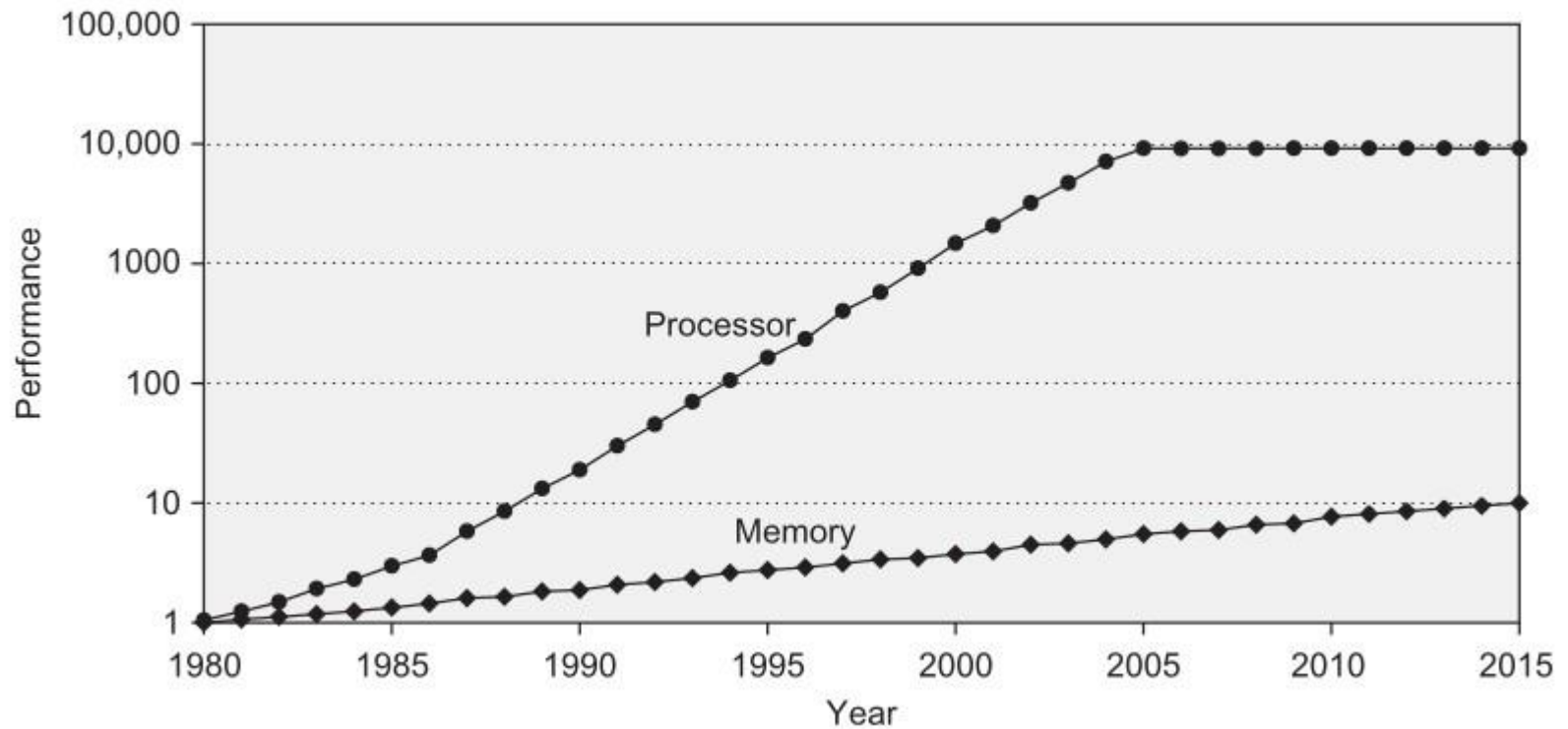
The data visualization is available at OurWorldInData.org. There you find more visualizations and research on this topic.

Licensed under CC-BY-SA by the author Max Roser.

Performance



Performance



Clock

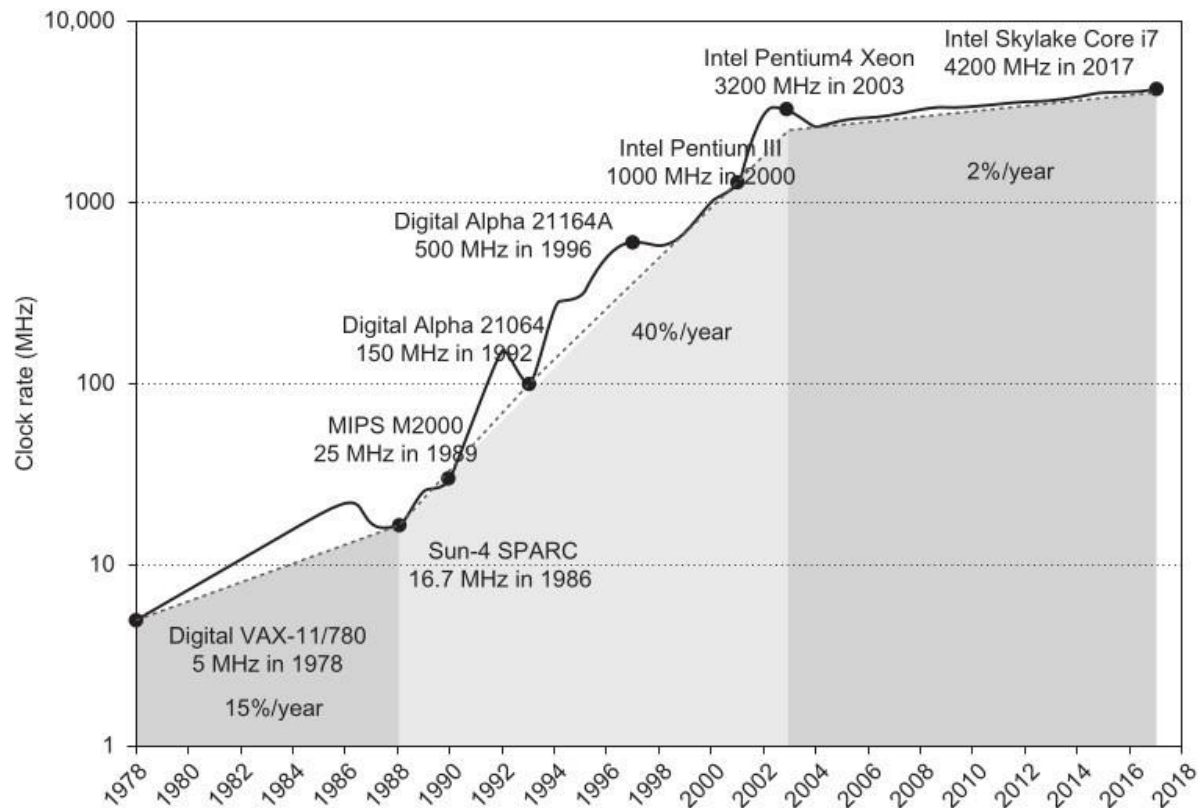


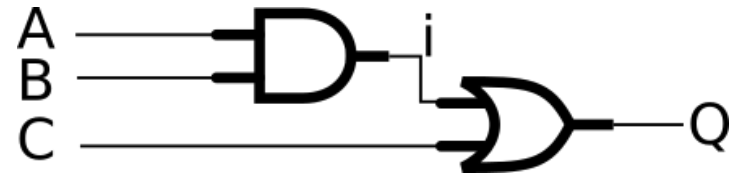
Figure 1.11 Growth in clock rate of microprocessors in Figure 1.1. Between 1978 and 1986, the clock rate improved less than 15% per year while performance improved by 22% per year. During the “renaissance period” of 52% performance improvement per year between 1986 and 2003, clock rates shot up almost 40% per year. Since then, the clock rate has been nearly flat, growing at less than 2% per year, while single processor performance improved recently at just 3.5% per year.



Como tudo isso é
possível?

Da equação para implementação

- Partindo da equação :
 - $Q = (A \cdot B) + C$
- Podemos escrever como :
 - $Q = (A \text{ and } B) \text{ or } C$
- Que por sua vez pode ser :
 - $I = (A \text{ and } B)$
 - $Q = I \text{ or } C$





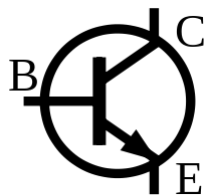
Mas do que é feito uma porta lógica ?

Transistores

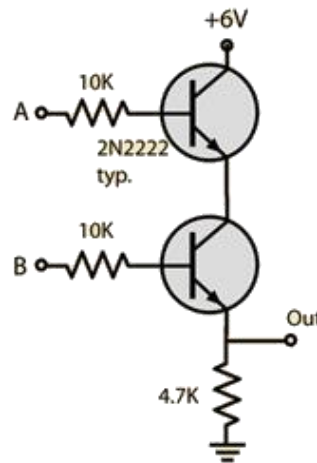
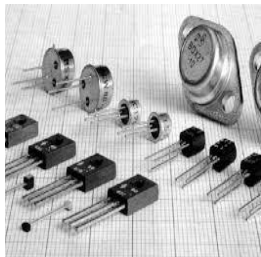
- Vários tipos de transistores
 - BJT
 - MOSFET
 -
- Várias formas de realizar
 - RTL
 - DTL
 - TTL
 - CMOS (mais utilizada hoje em dia)

RTL

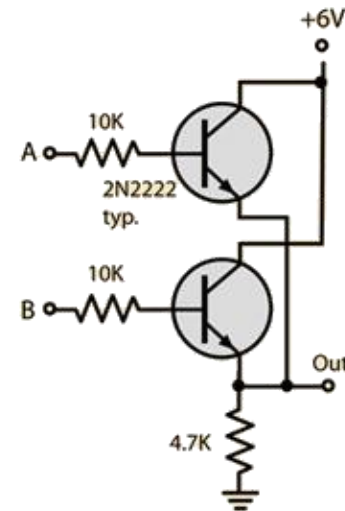
A implementação de portas lógicas por RTL faz uso de transistores BJT do tipo N e resistores:



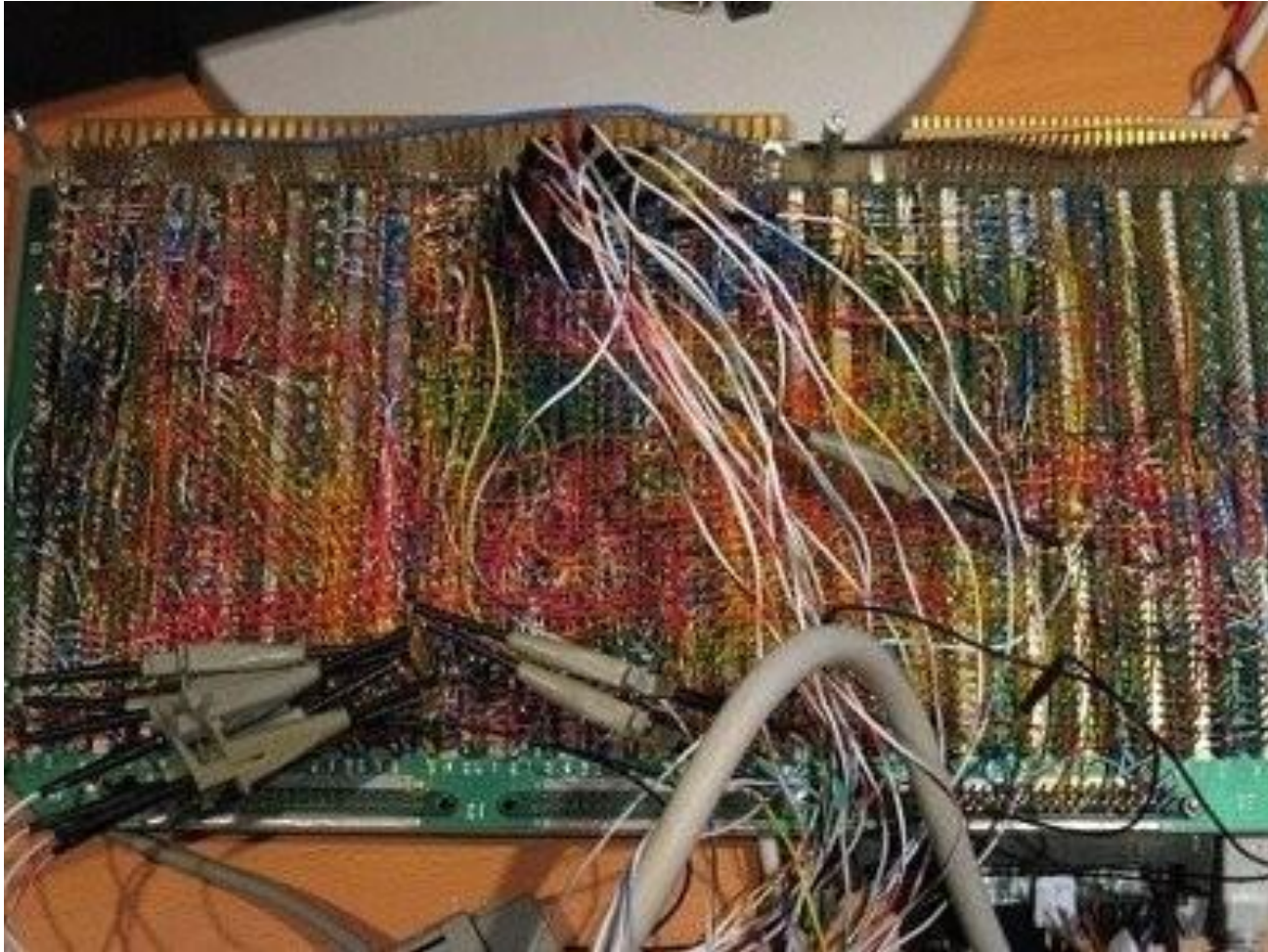
BJT



AND



OR



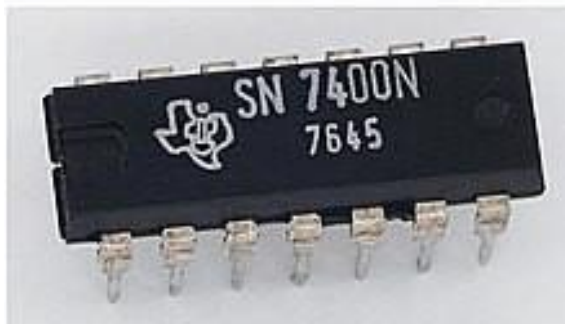
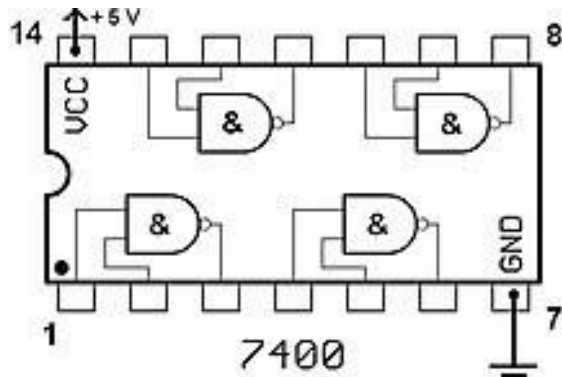
<https://3.14.by/en/read/homemade-cpus>



CIs

TTL 74xx

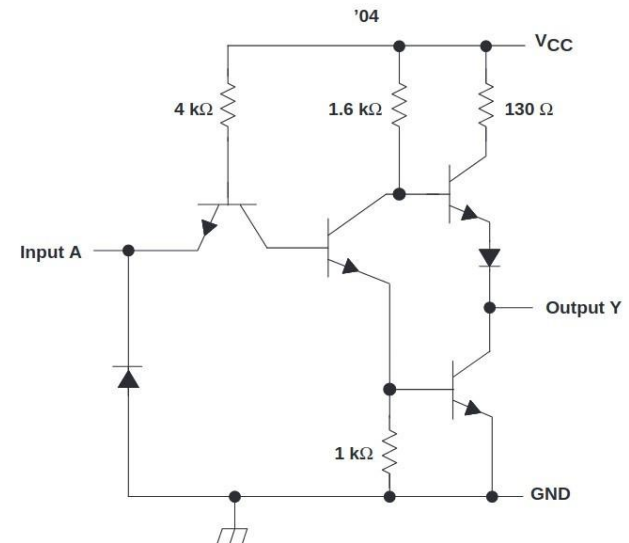
Integra em um único Chip vários transistores a fim de implementar um componente



SN5404, SN54LS04, SN54S04,
SN7404, SN74LS04, SN74S04
HEX INVERTERS

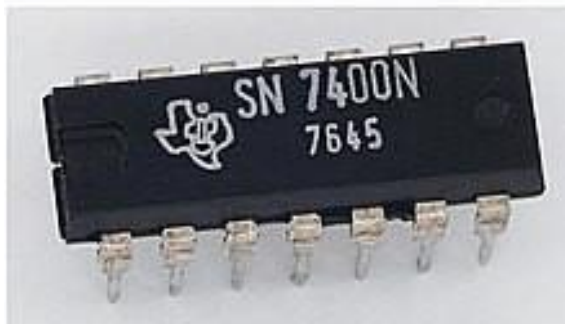
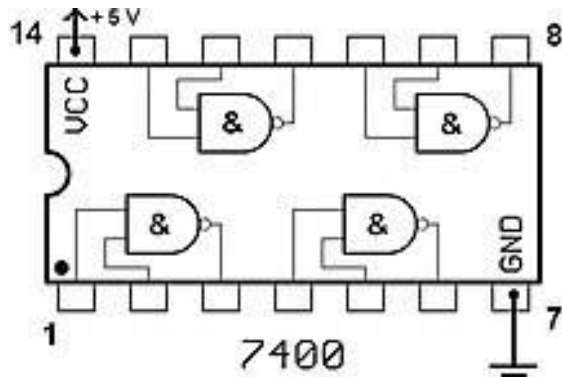
SDLS029C – DECEMBER 1983 – REVISED JANUARY 2004

schematics (each gate)



TTL 74xx

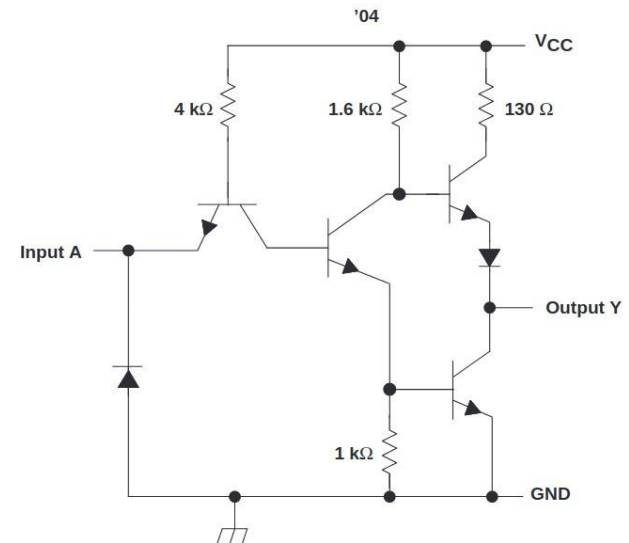
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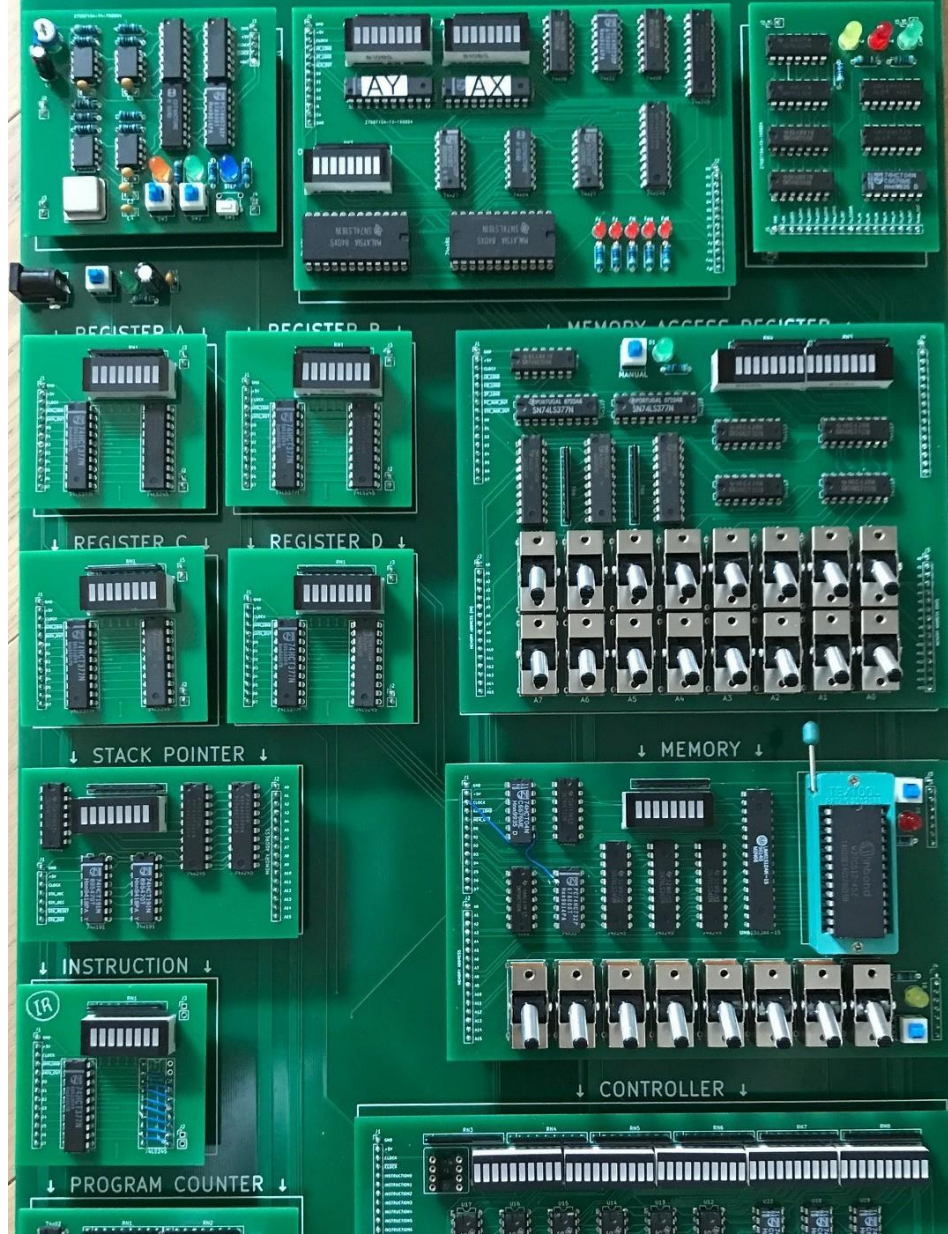
SDLS029C – DECEMBER 1983 – REVISED JANUARY 2004

schematics (each gate)



74xx COMPUTER

DESIGNED BY RUUD VAN FALIER



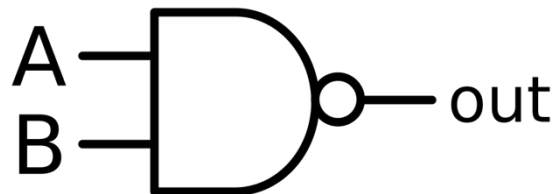
<https://github.com/DutchMaker/TTL-computer>

NAND

As portas lógicas NAND e NOR podem ser ditas como portas universais, pois delas podem ser criadas quaisquer outras portas. Essa propriedade é conhecida como **completude funcional**.

Porém, porque a NAND é preferida a NOR?

- NAND acaba sendo mais rápida (menos latência).
- NAND ocupa menos área em silício.
- NAND usa transistores de tamanhos similares



Transistores MOSFET

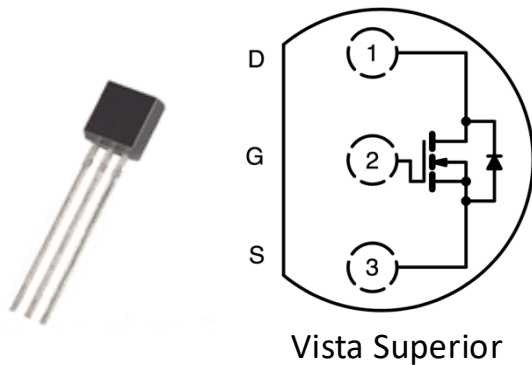
BS170

MOSFET N-Channel

Enhancement-mode

Empacotamento: TO-92

Material do Transistor: Si



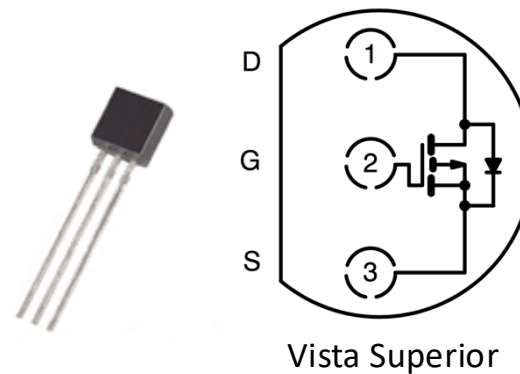
BS250

MOSFET P-Channel

Enhancement-mode

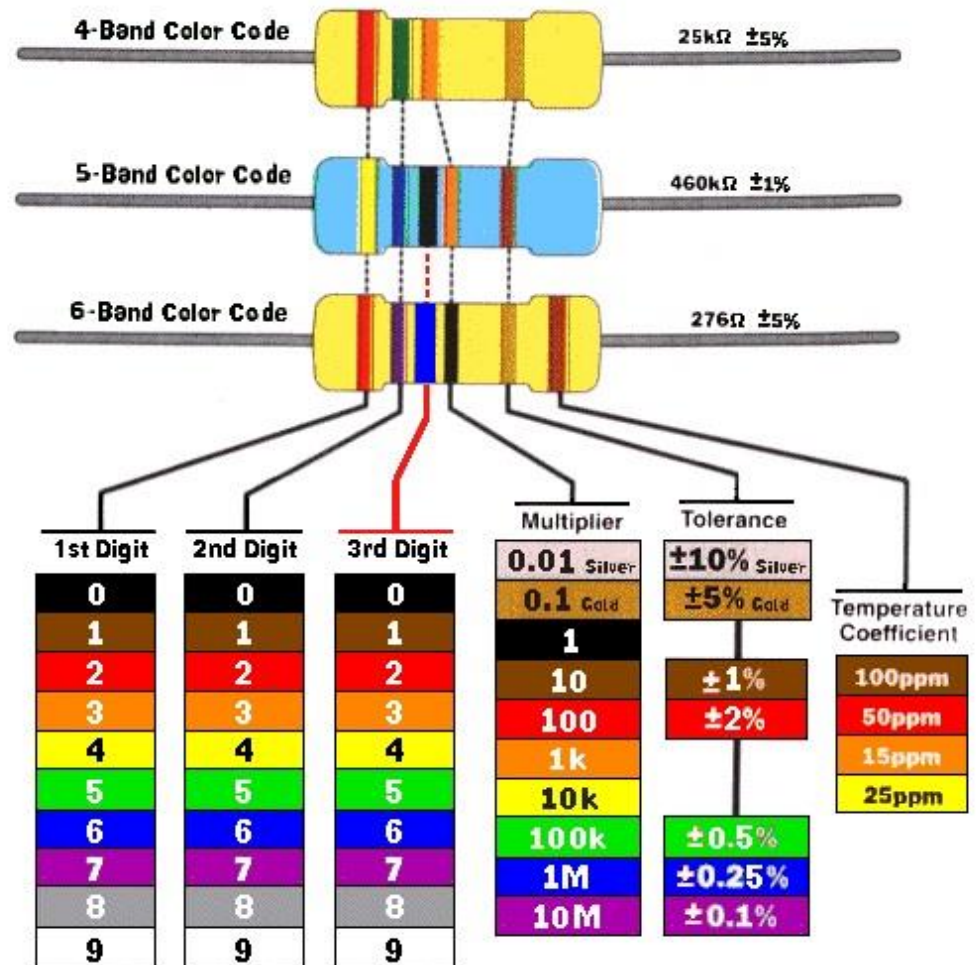
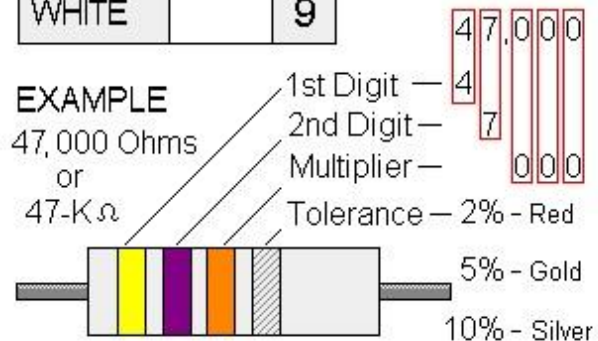
Empacotamento: TO-92

Material do Transistor: Si



Revisão de Resistências e LEDs

			Multiplier
BLACK		0	_____
BROWN		1	____0
RED		2	____00
ORANGE		3	____000
YELLOW		4	__0,000
GREEN		5	_00,000
BLUE		6	000,000
VIOLET		7	
GRAY		8	
WHITE		9	

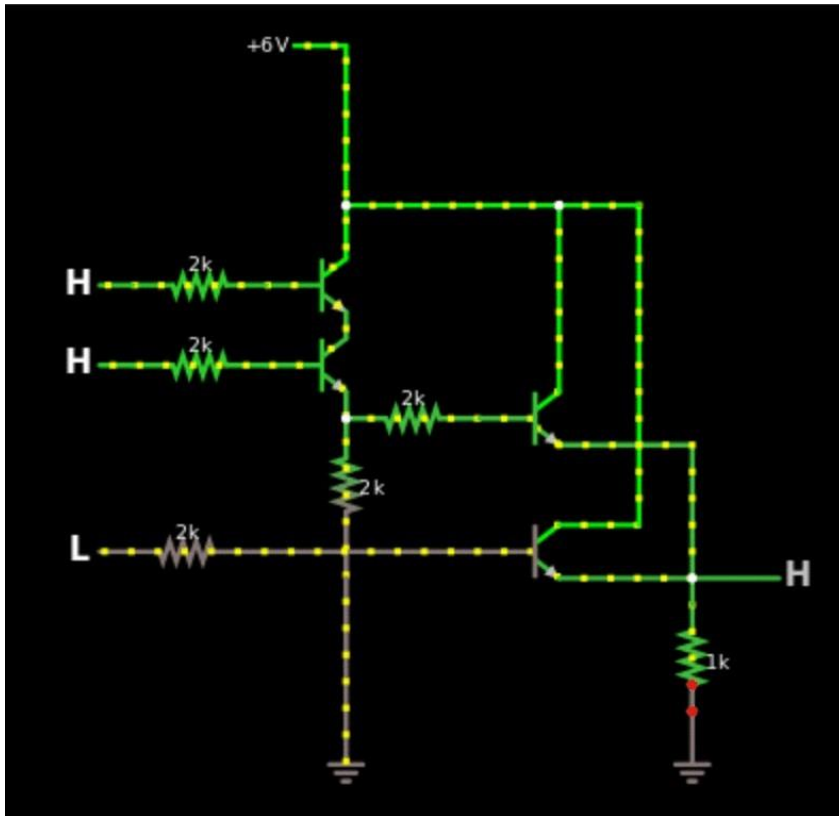




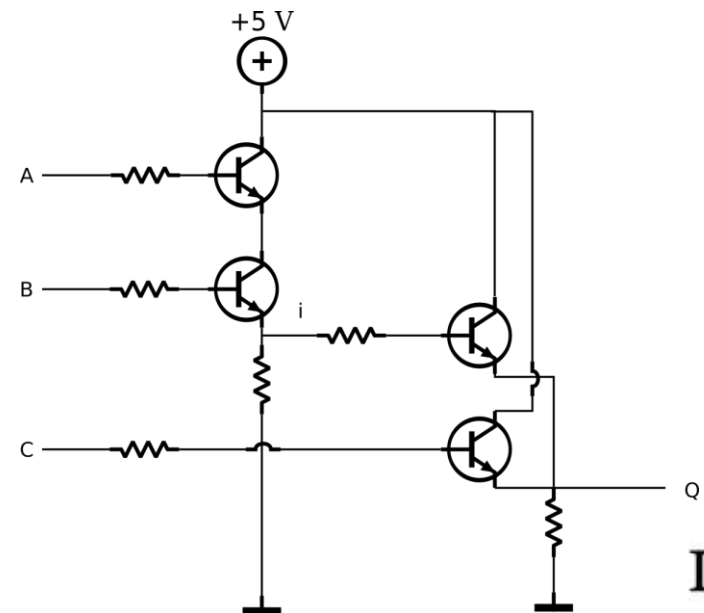
Trabalhando

LAB 3

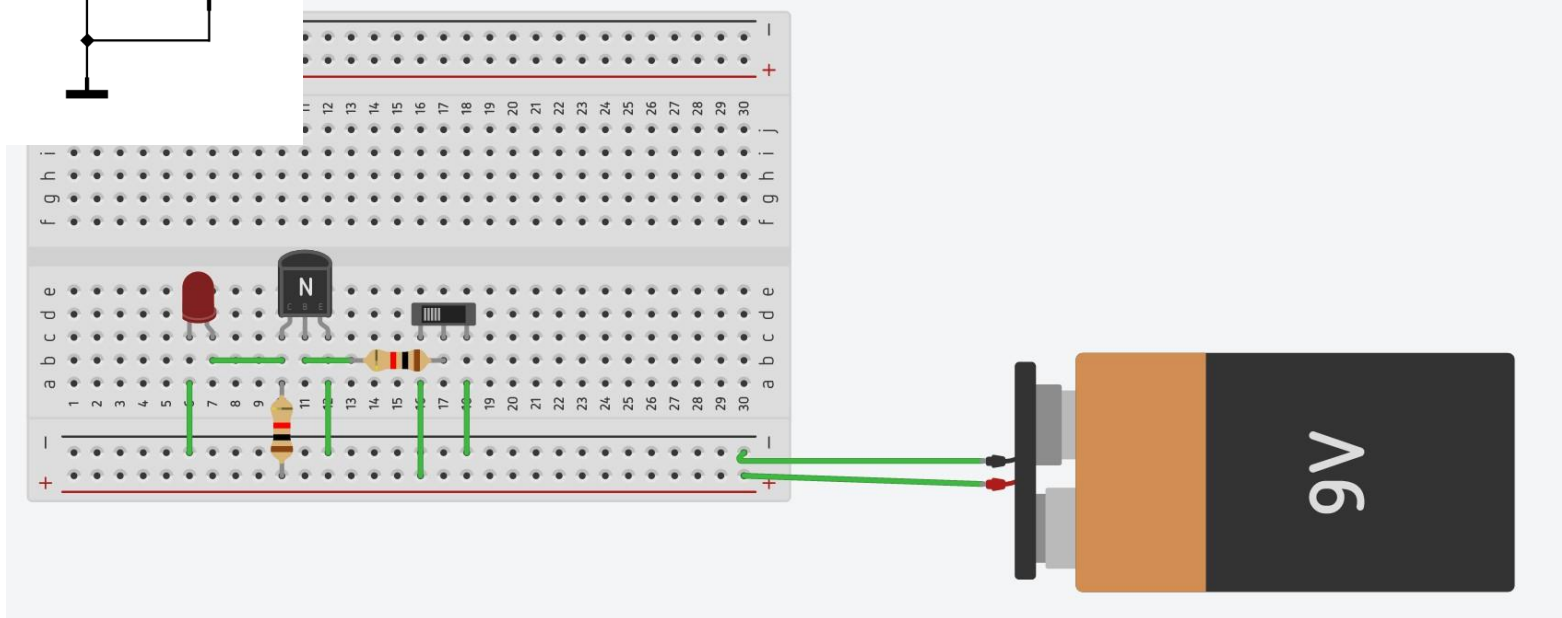
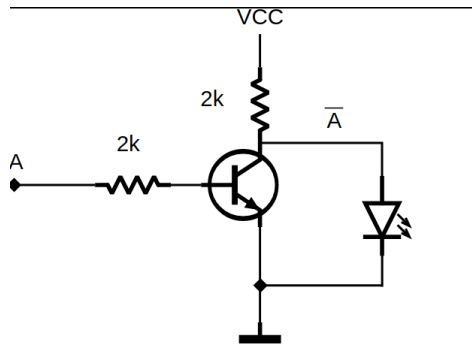
Lab 3 - Parte 1



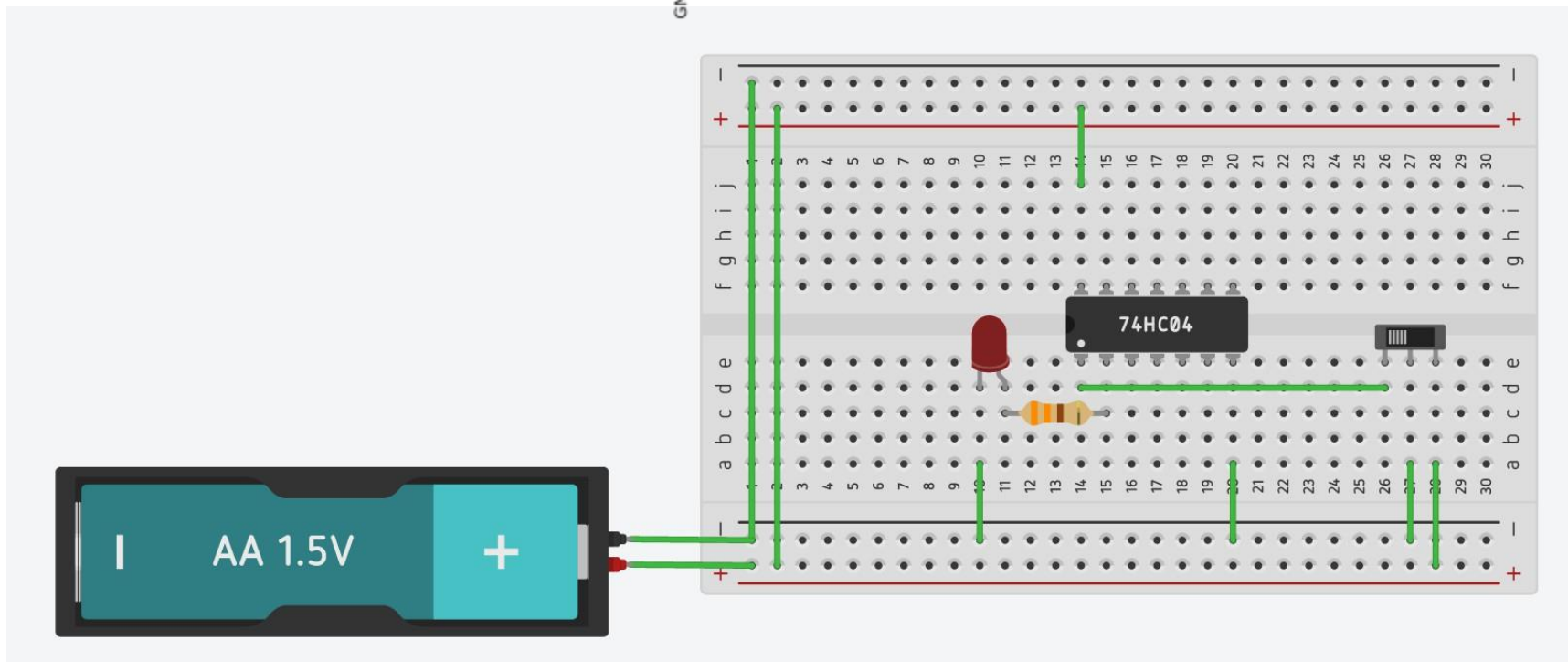
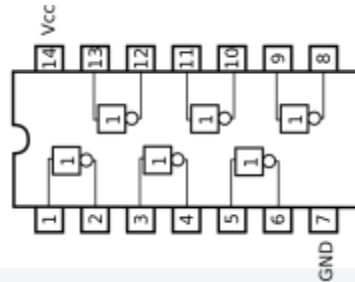
- Tabela Verdade
- Equação
- Diagrama



Lab 3 - Parte 2 - BJT



Lab 3 - Parte 3 - CI



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