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Aula 3 – Transistores

"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

Rafael Corsi – rafael.corsi@insper.edu.br

Aula 3

- História do transistor e CIs
- Realizando portas lógicas com BJT
- CI família TTL 74xx

Atividades:

- Lab 3

Conteúdos: transistores; rtl; bjt; 74xx

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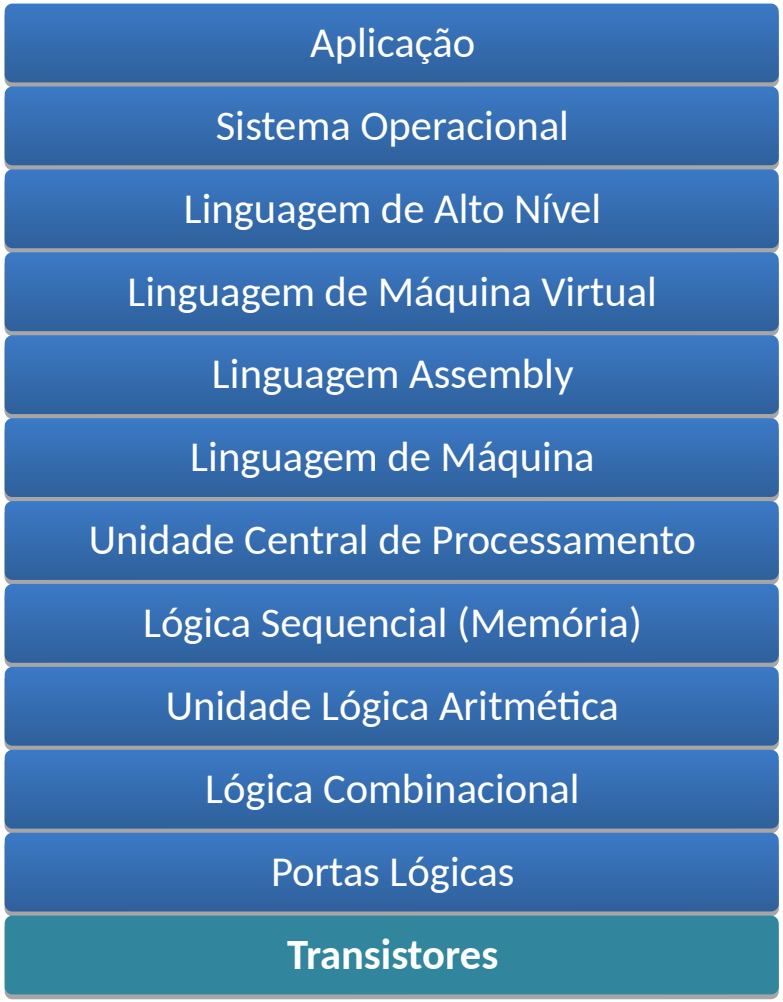
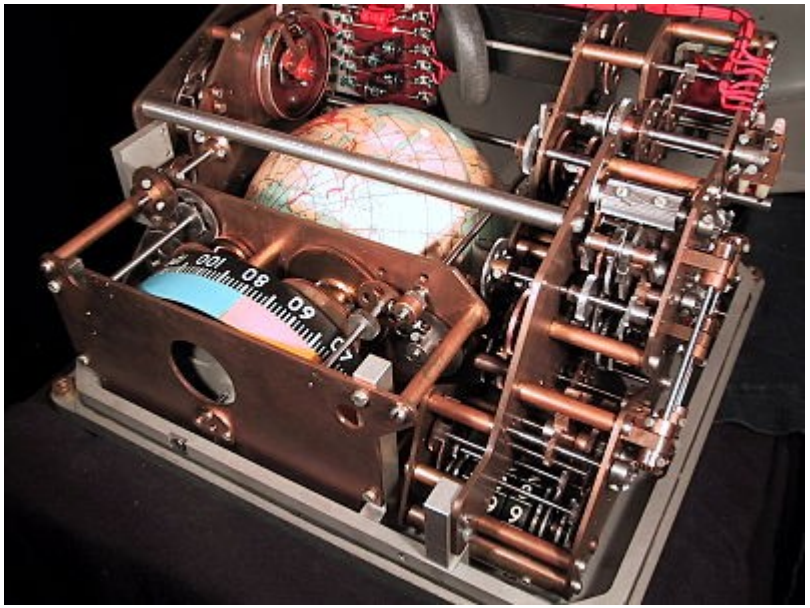
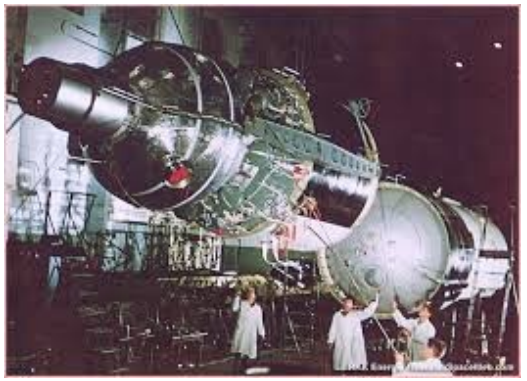
Níveis de Abstração



No começo tudo era mecânico





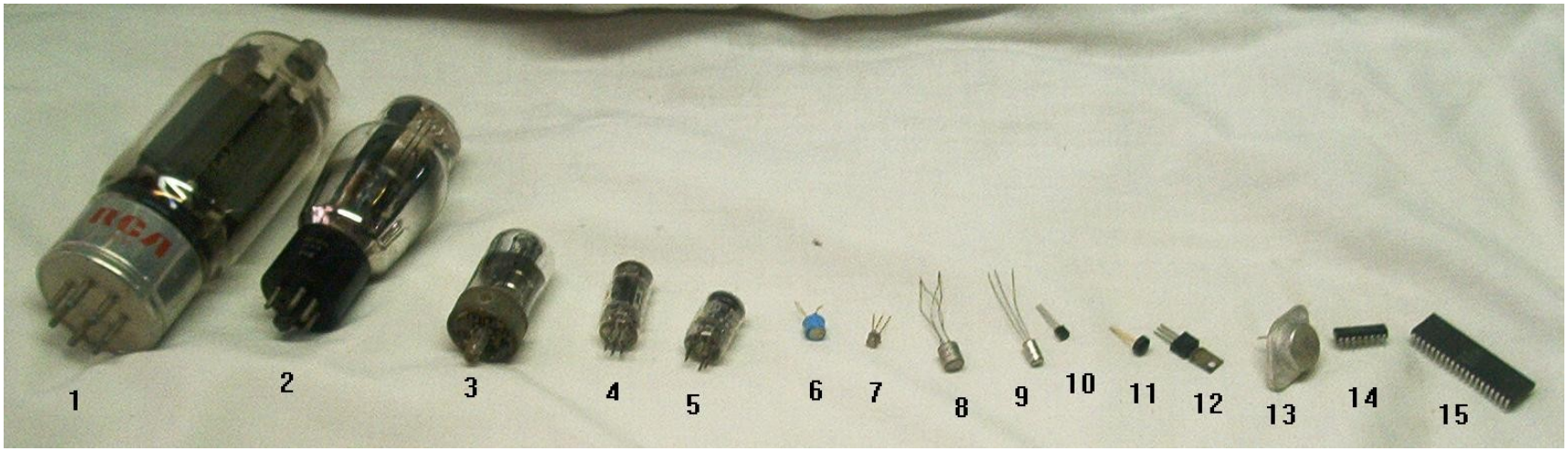
1961 - Voskhod Spacecraft "Globus" IMP navigation instrument

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

Com a válvula passou a ser elétrico

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

Que evoluiu para o transistor



http://mmncny.org/exhibits/296-2/

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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

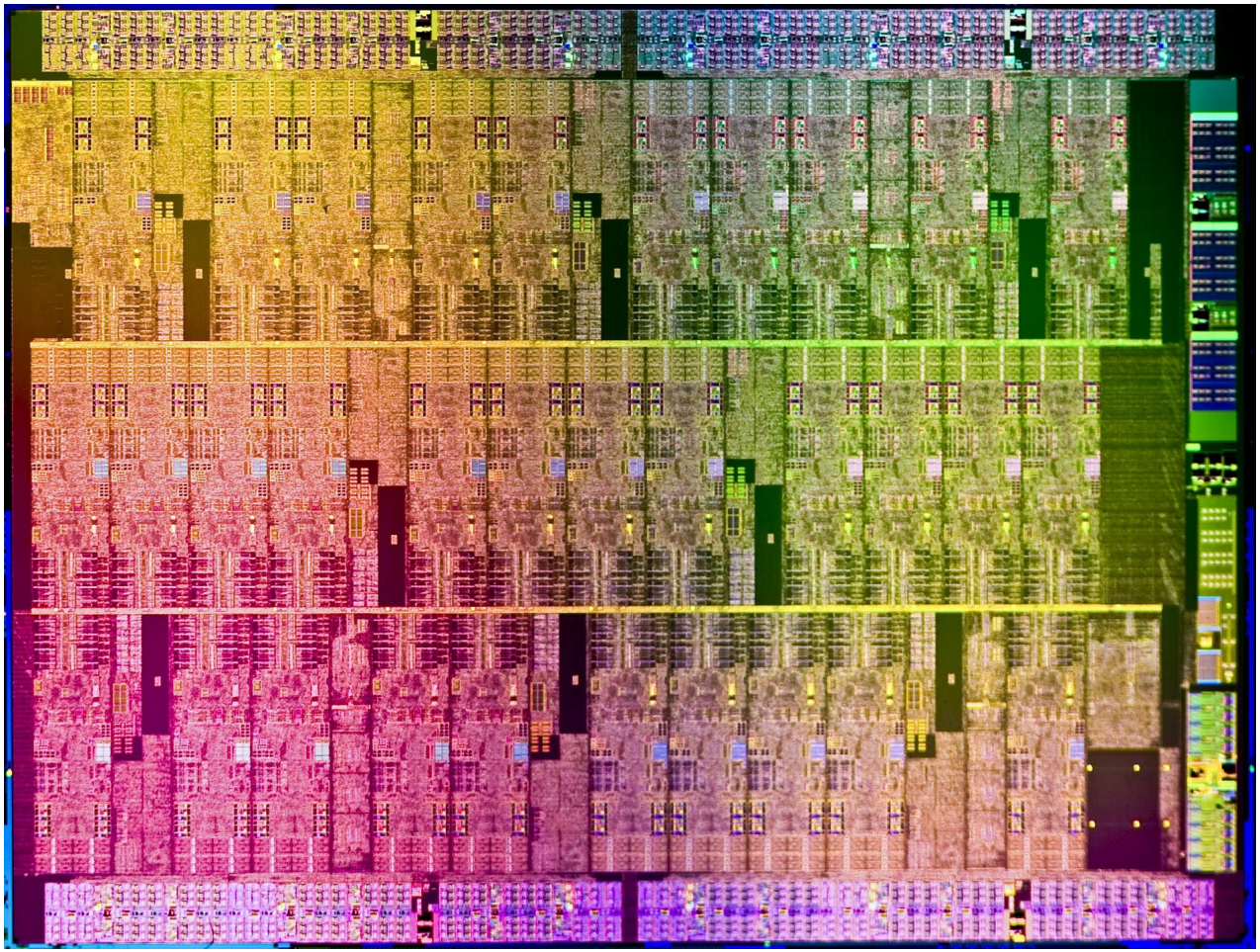
Transistors: 3,500

Address width: 14 Bit

People also search for View 15+ more

Intel 4004 Intel 8088 Intel 80386 Intel 8080 DEC Alpha

E continua evoluir...



E continua a evoluir ????

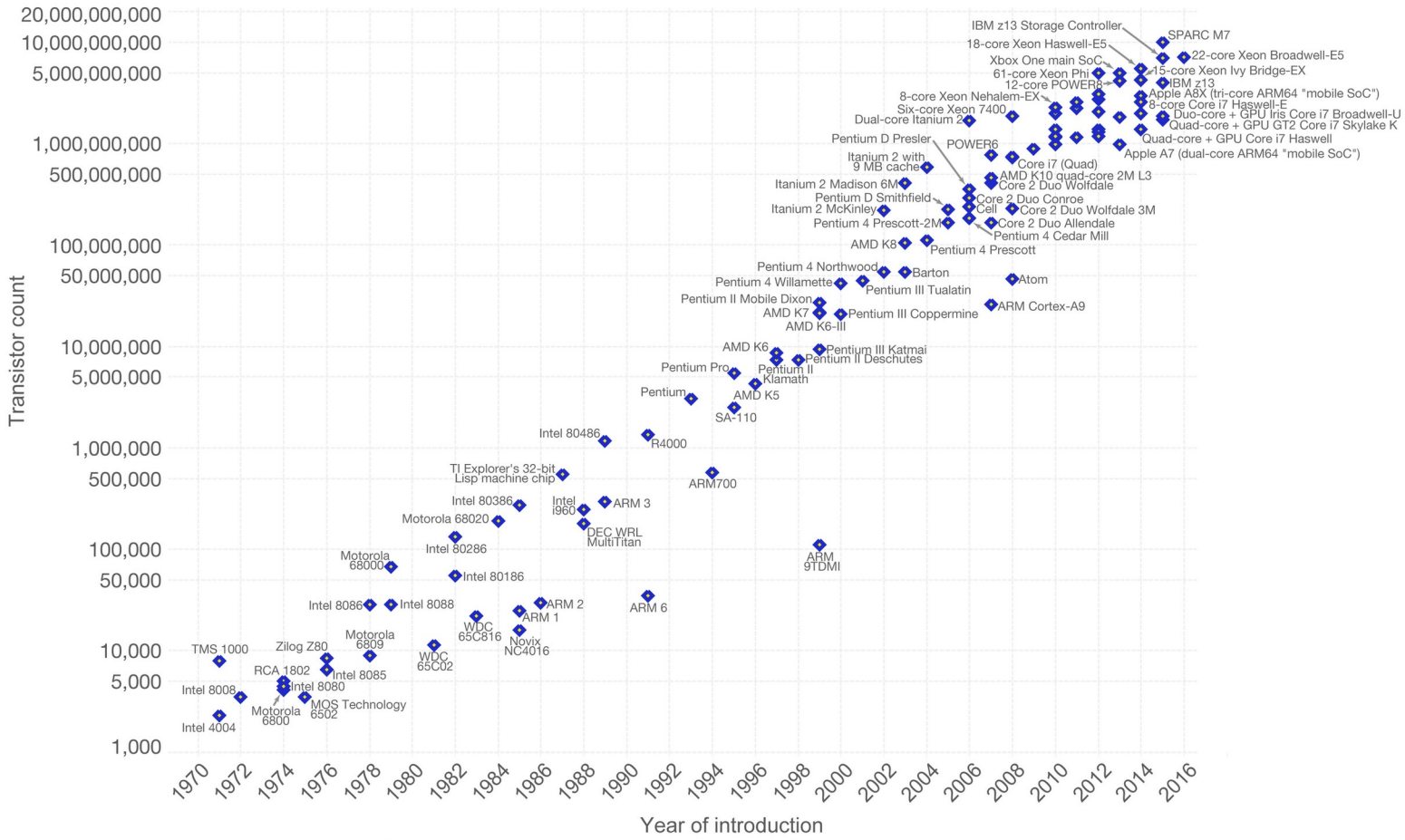
1965 – Lei de Moore

“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 (1971-2016)

Our World in Data

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.

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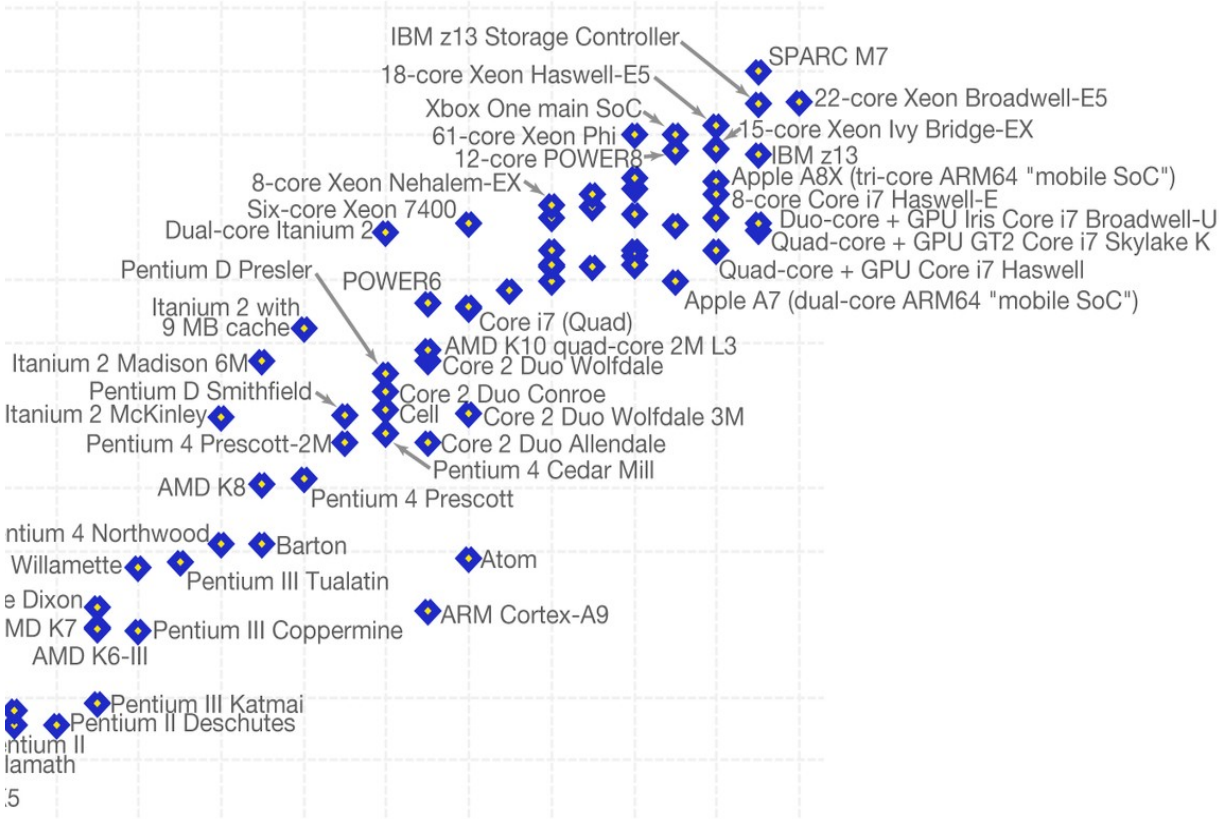
egrated circuit chips (1971-2016)

Our World in Data

egrated circuits doubles approximately every two years.
processing speed or the price of electronic products – are



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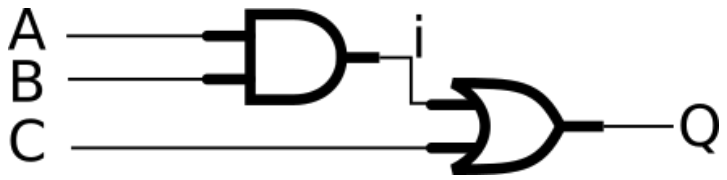
Como tudo isso é possível?

Da equação para implementação

- Partindo da equação :
  - `Q = (A.B) + C`
- Podemos escrever como :
  - `Q =(A and B) or C`
- Que por sua vez pode ser :
  - `I = (A and B)`
  - `Q = I or C`



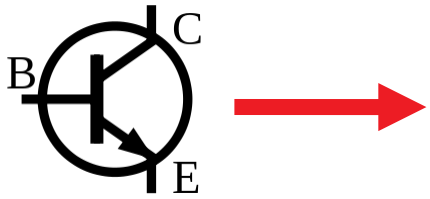
Mas do que é feito uma porta lógica ?

Transistores

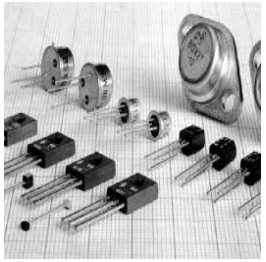
- Vários tipos de transistores
  - BJT
  - MOSFET
  - ….
- Várias formas de realizar
  - RTL
  - DTL
  - TTL
  - CMOS (mais utilizada hoje em dia)

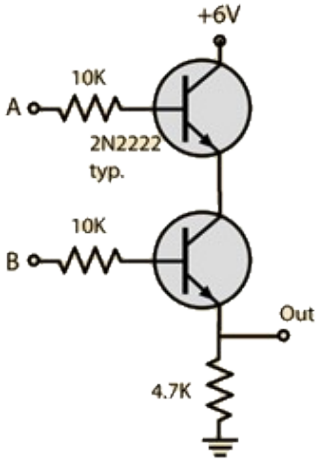
RTL

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

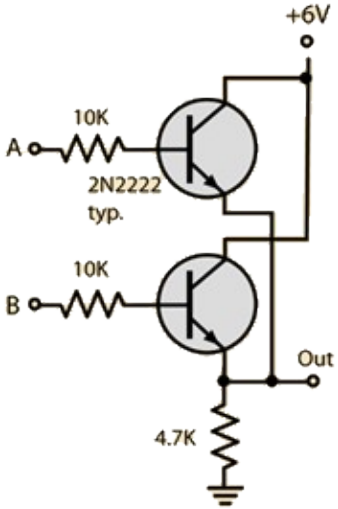


BJT

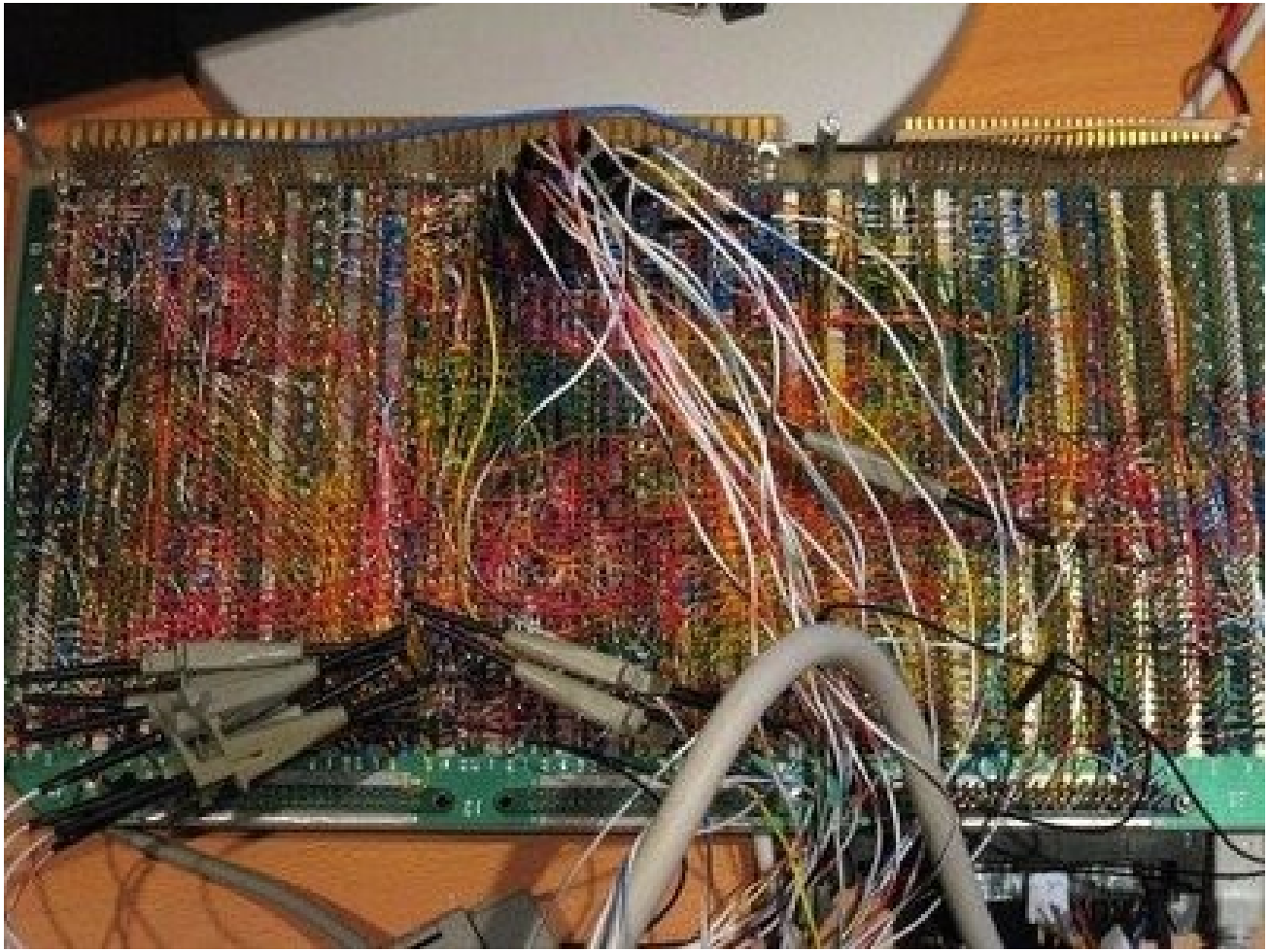




AND



OR

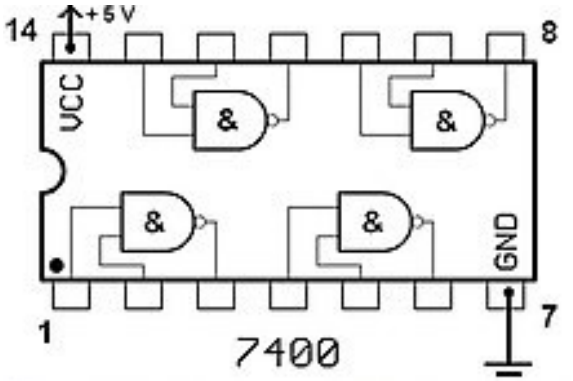


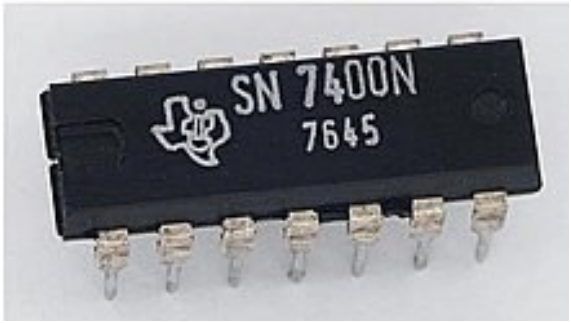
https://3.14.by/en/read/homemade-cpus

CIs

TTL 74xx

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

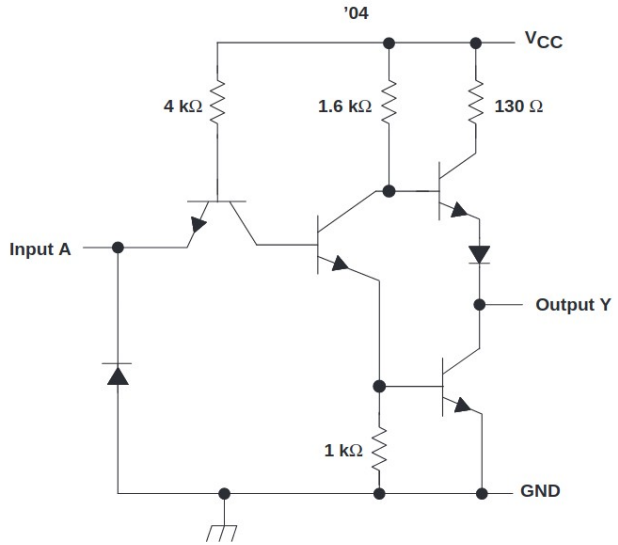




SN5404, SN54LS04, SN54S04,
SN7404, SN74LS04, SN74S04
HEX INVERTERS

SDLS029C – DECEMBER 1983 – REVISED JANUARY 2004

schematics (each gate)



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TTL 74xx

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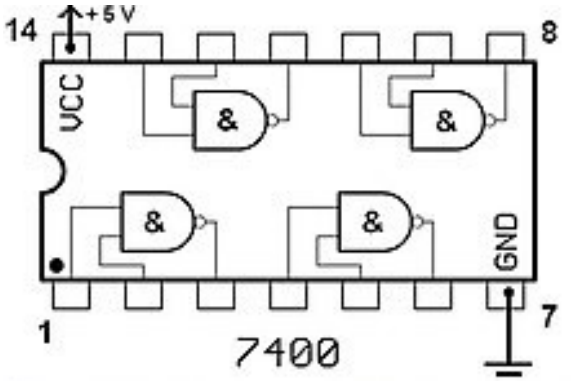

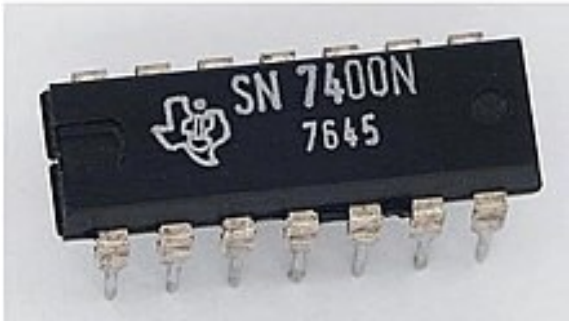

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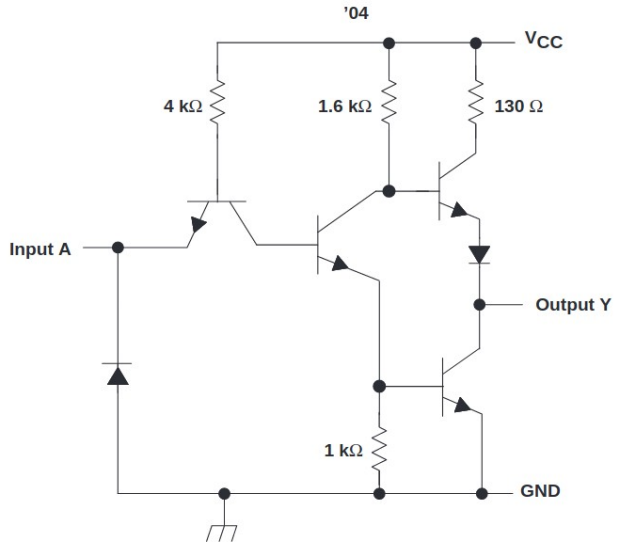

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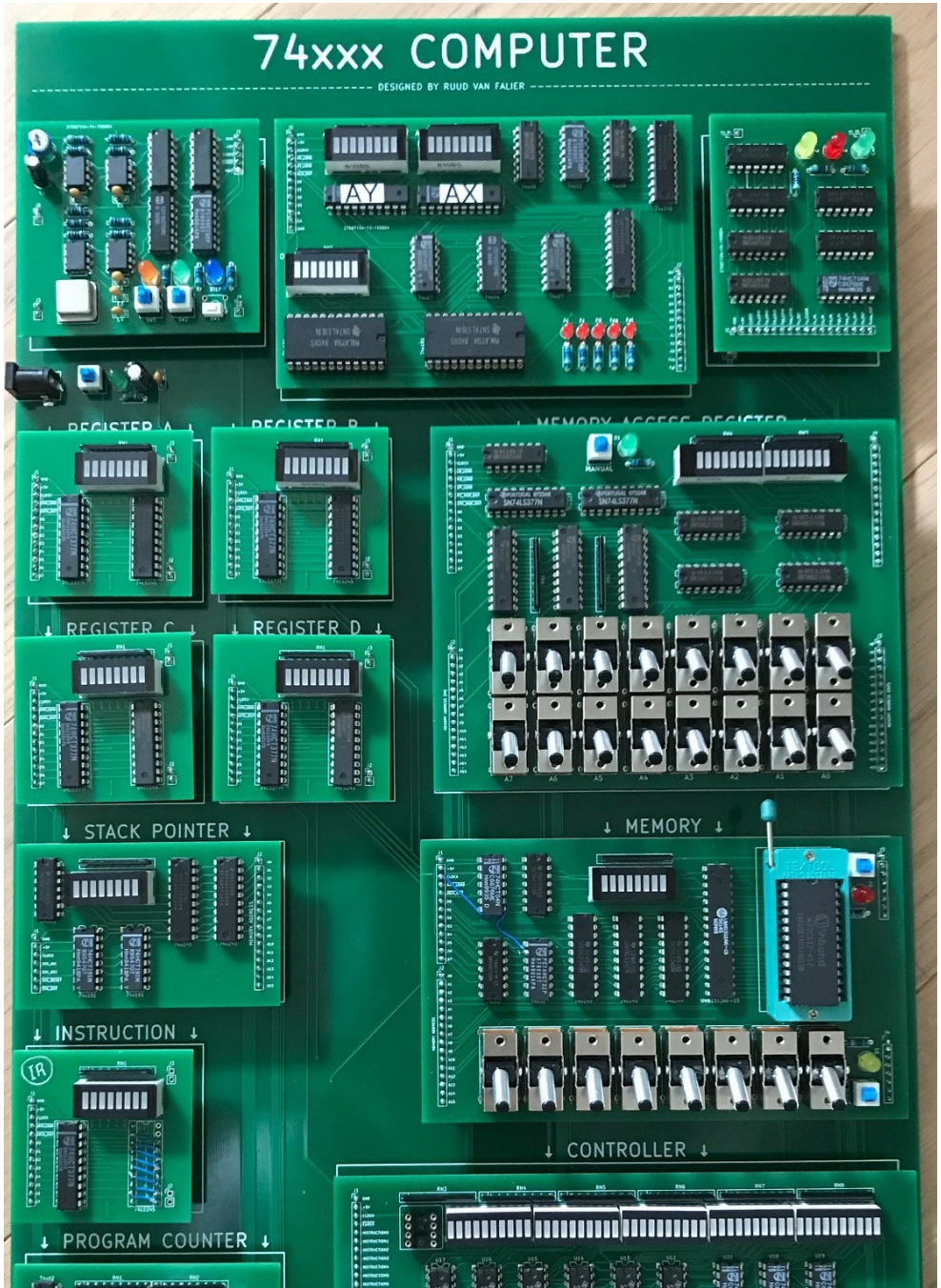

https://github.com/DutchMaker/TTL-computer

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Problema com o BJT

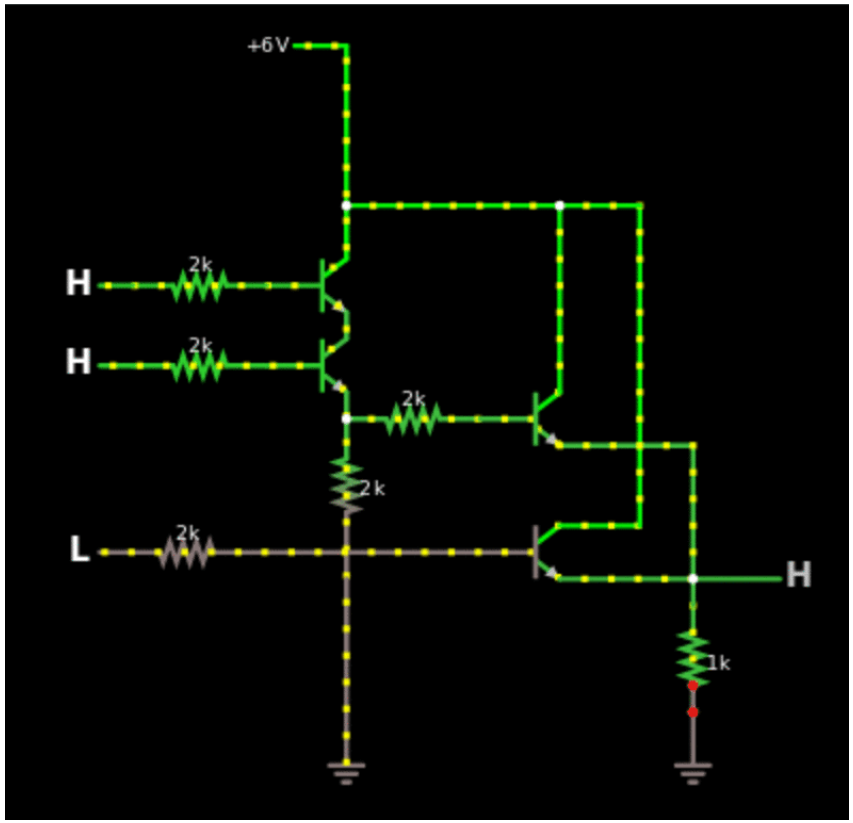
- Necessita de resistores
- Maior gasto energético durante condução
- Opera por corrente

Solução? MOSFET...

Trabalhando

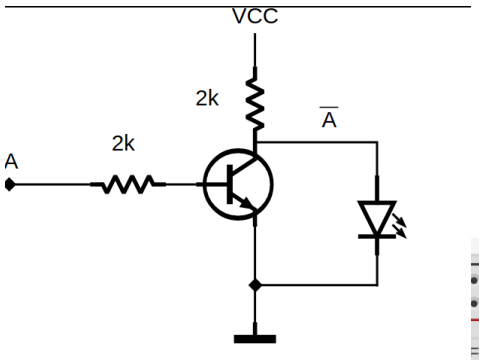
LAB 3

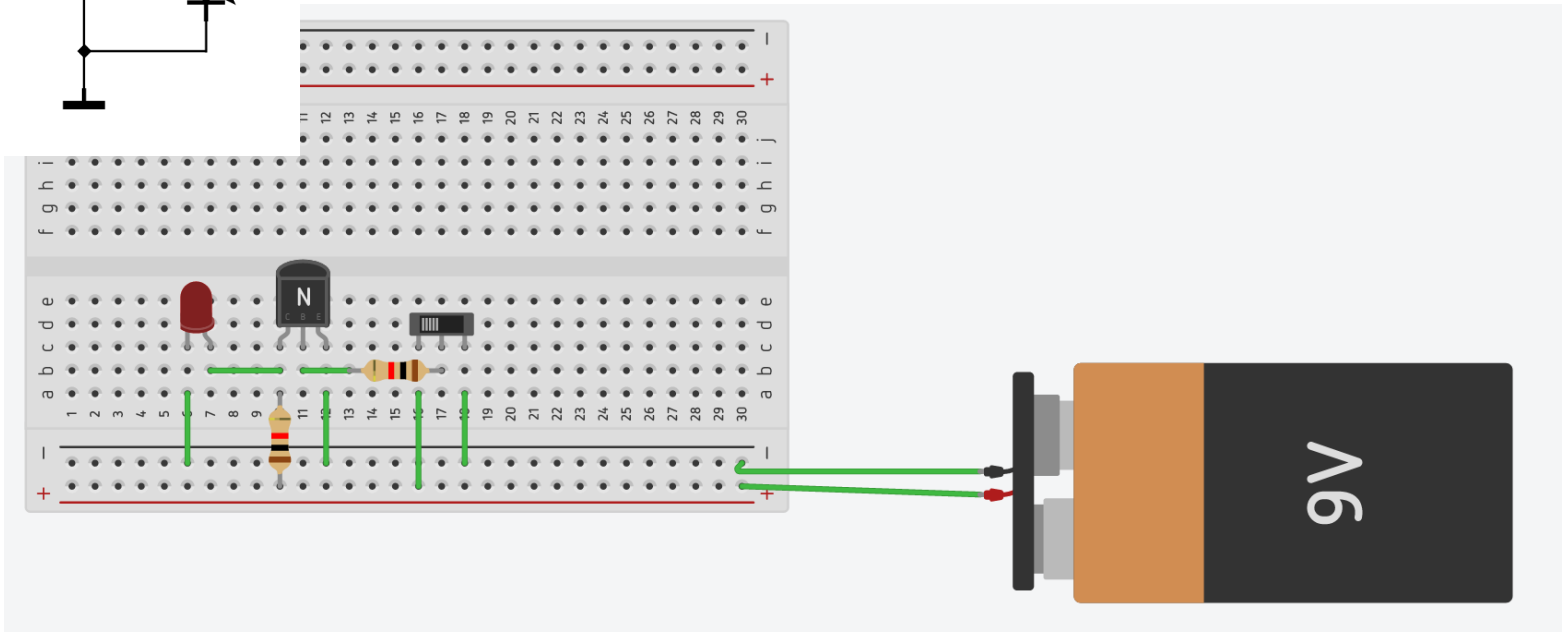
Lab 3 - Parte 1



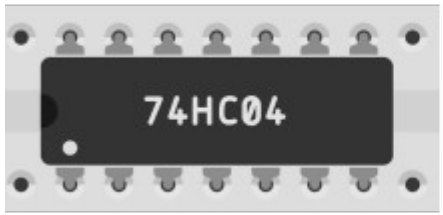
- Tabela Verdade
- Equação
- Diagrama

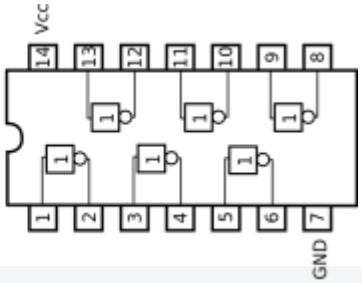
Lab 3 - Parte 2 - BJT

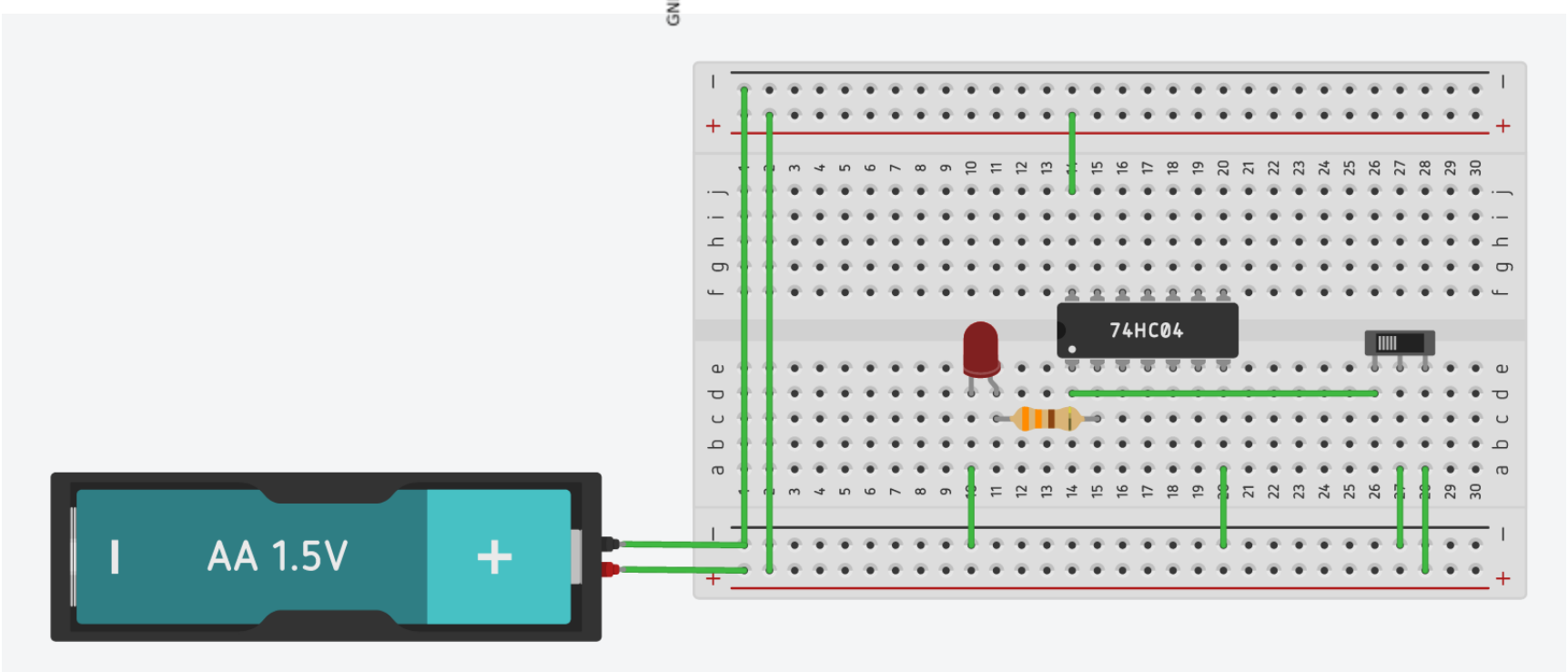




Lab 3 - Parte 3 - CI







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