DIGITAL LOGIC AND GATES
RELAYS

Control

Magnet

Output

Power Source
RELAYS

Control — Magnet — Output

Power Source
AND GATE

p = 0
q = 0

p AND q = 0

Schematic Symbol

p
q

p AND q
AND GATE

\[ p \text{ AND } q = 0 \]

Schematic Symbol

\[ p \text{ AND } q \]

\[ p = 1 \]

\[ q = 0 \]

\[ p \text{ AND } q = 0 \]
AND GATE

\[
p \land q = 1
\]
OR GATE

\[ p = 0 \]

\[ q = 0 \]

\[ p \text{ OR } q = 0 \]
OR GATE

\[ p = 1 \]
\[ q = 0 \]
\[ p \lor q = 1 \]
OR GATE

p = 0
q = 1

p OR q = 1

Schematic Symbol

p
q

p OR q
MORE GATES

Not \( \neg A \)

NAND \( \neg (A \wedge B) \)

NOR \( \neg (A \vee B) \)

XOR \( A \oplus B \)
DO STUFF ON BOARD
ALL YOU COMPUTER DOES IS LOGIC!

4-Bit Binary Adder

16-Bit Binary Adder
ALL YOUR COMPUTER DOES IS LOGIC!

Reset-set (RS) latch memory cell
WHAT YOU NEED TO BUILD A COMPUTER
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- Wire (magnets)
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- Dowels (wrapping)
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- Wire (magnets)
- Dowels (wrapping)
- Masking tape (insulation)
WHAT YOU NEED TO BUILD A COMPUTER

- Wire (magnets)
- Dowels (wrapping)
- Masking tape (insulation)
- Tin foil (switches)
WHAT YOU NEED TO BUILD A COMPUTER

- Wire (magnets)
- Dowels (wrapping)
- Masking tape (insulation)
- Tin foil (switches)
- Lots of Lemons (power)
WHAT YOU NEED TO BUILD A COMPUTER

- Wire (magnets)
- Dowels (wrapping)
- Masking tape (insulation)
- Tin foil (switches)
- Lots of Lemons (power)
- CMSE 250H
WHAT YOU NEED TO BUILD A COMPUTER

- Wire (magnets)
- Dowels (wrapping)
- Masking tape (insulation)
- Tin foil (switches)
- Lots of Lemons (power)
- CMSE 250H
- Nothing better to do
FIRST DIGITAL COMPUTER

This guy actually did that

Konrad Zuse

Z2, 1939
First electronic digital computer
ENIAC

First “turning complete” machine

• 18K tubes
• 15K relays
• 10K Capacitors
• 5M hand-soldered joints
TRANSISTORS

Transfer-resistor
Semiconductor acts as relay
TRANSISTORS ARE SMALL

WWII Radio

1950'S Radio

Transistor invented in 1947 (Bell Labs)
INTEGRATED CIRCUITS

Logic gates printed on wafer
- Printed on silicon wafer
- Germanium “ink”
- CMOS: Complementary metal–oxide–semiconductor (CMOS)
LOGIC IS BIG BUSINESS

[Image of a webpage from Texas Instruments, showing a product search for logic gates with a table of specifications.]
INTEL XEON

Logic gates printed into chip
MOTOROLA POWER PC