Digital Electronics (SKEE1223)

Logic Gates

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Introduction

- Digital components use only two voltages
  - LOW voltage (0 volts) or OFF or binary 0
  - HIGH voltage (+5 volts) or ON or binary 1
- Manipulation of binary information is done by logic circuits called logic gates.
- A gate is logic circuit with one or more input signals but only one output signal.
- Logic gates are combined to build complete systems.

Logic Gates

- 3 basic gates: AND, OR and NOT
  - Other gates can be derived from them
  - NAND, NOR, XOR, XNOR
- Gates are described using
  - Logic symbols
  - Boolean expressions
  - Truth tables
  - Timing diagrams

AND Gate

- **Output is HIGH when all inputs are HIGH .**

Logic symbol

$F = AB$

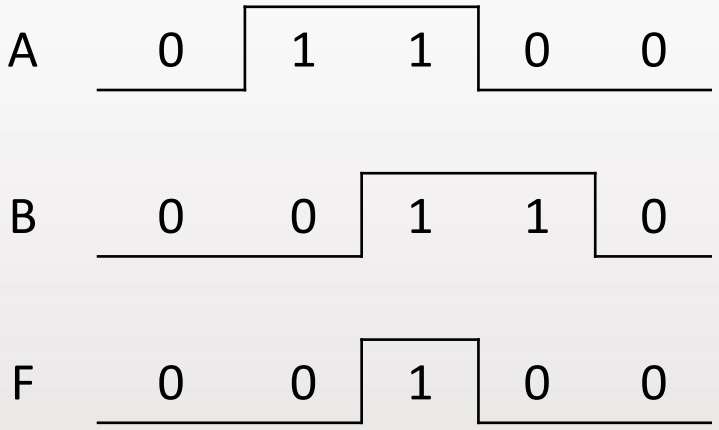
Boolean expression

AND Gate

- **Output is HIGH when all inputs are HIGH .**

A	B	F
0	0	0
0	1	0
1	0	0
1	1	1

Truth table



Timing diagram

OR Gate

- **Output is HIGH when any input is HIGH .**

Logic symbol

$$F = A + B$$

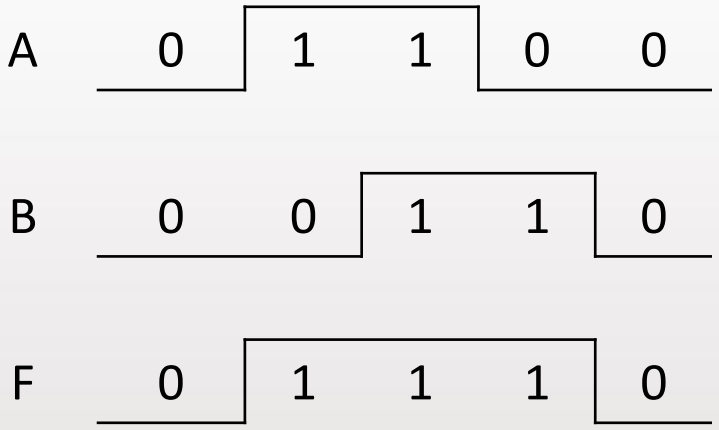
Boolean expression

OR Gate

- **Output is HIGH when any input is HIGH .**

A	B	F
0	0	0
0	1	1
1	0	1
1	1	1

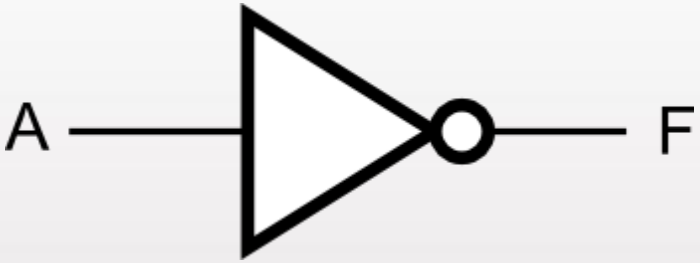
Truth table



Timing diagram

NOT Gate

- Output is opposite its input.
- Has only one input.



Logic symbol

$$F = \overline{A}$$

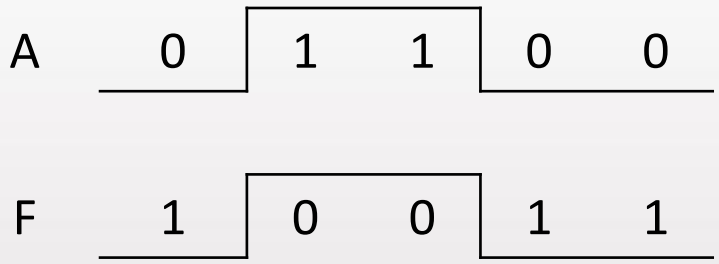
Boolean expression

NOT Gate

- **Output is opposite its input.**

A	F
0	1
1	0

Truth table



Timing diagram

NAND Gate

- **Output is LOW when all inputs are HIGH.**

Logic symbol

$$F = \overline{AB}$$

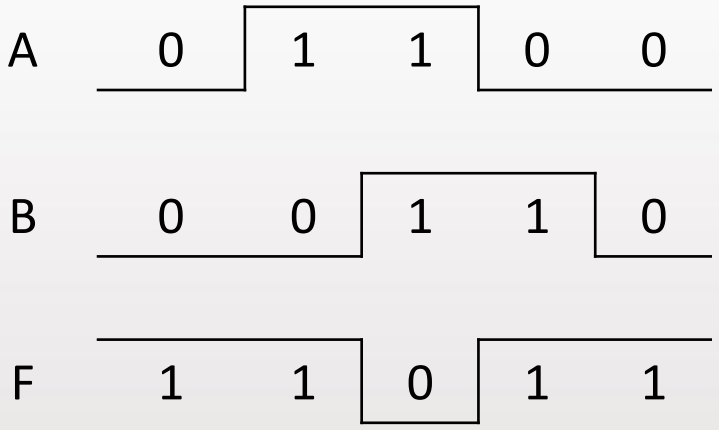
Boolean expression

NAND Gate

- **Output is LOW when all inputs are HIGH.**

A	B	F
0	0	1
0	1	1
1	0	1
1	1	0

Truth table



Timing diagram

NOR Gate

- **Output is LOW when any input is HIGH.**

Logic symbol

$$F = \overline{A + B}$$

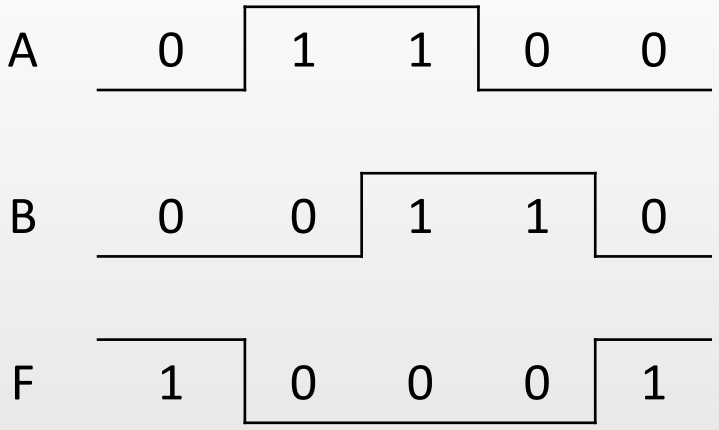
Boolean expression

NOR Gate

- **Output is LOW when any input is HIGH.**

A	B	F
0	0	1
0	1	0
1	0	0
1	1	0

Truth table



Timing diagram

XOR Gate

- Output is HIGH when inputs are different.
- Has exactly two inputs.

Logic symbol

$$F = A \oplus B$$

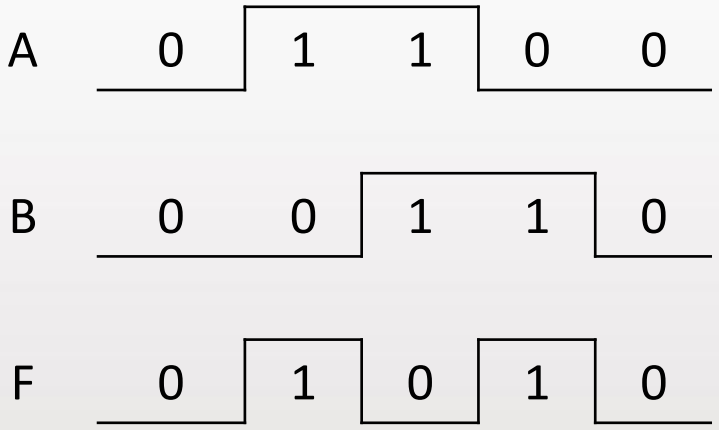
Boolean expression

XOR Gate

- **Output is HIGH when inputs are different.**

A	B	F
0	0	0
0	1	1
1	0	1
1	1	0

Truth table



Timing diagram

XNOR Gate

- Output is HIGH when inputs are the same.
- Has exactly two inputs.

Logic symbol

$$F = \overline{A \oplus B}$$

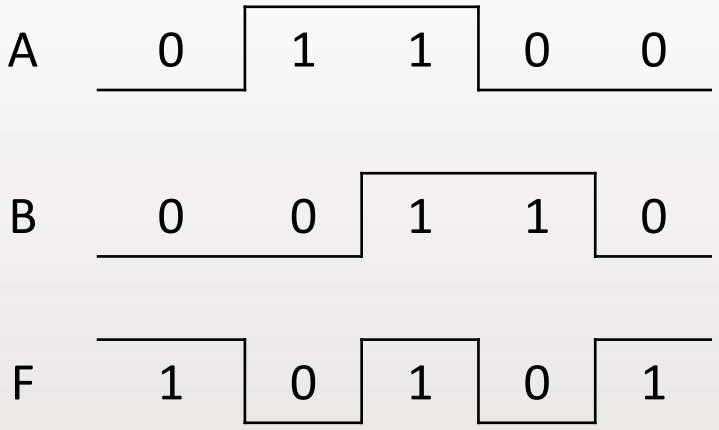
Boolean expression

XNOR Gate

- **Output is HIGH when inputs are the same.**

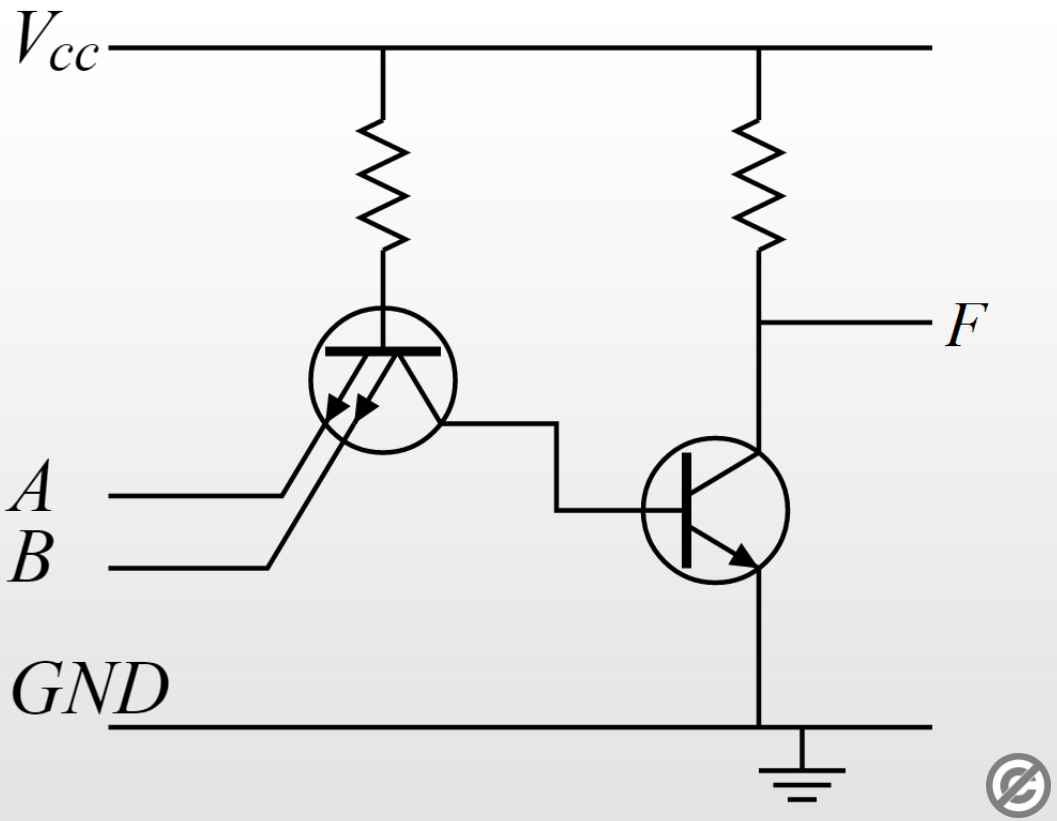
A	B	F
0	0	1
0	1	0
1	0	0
1	1	1

Truth table

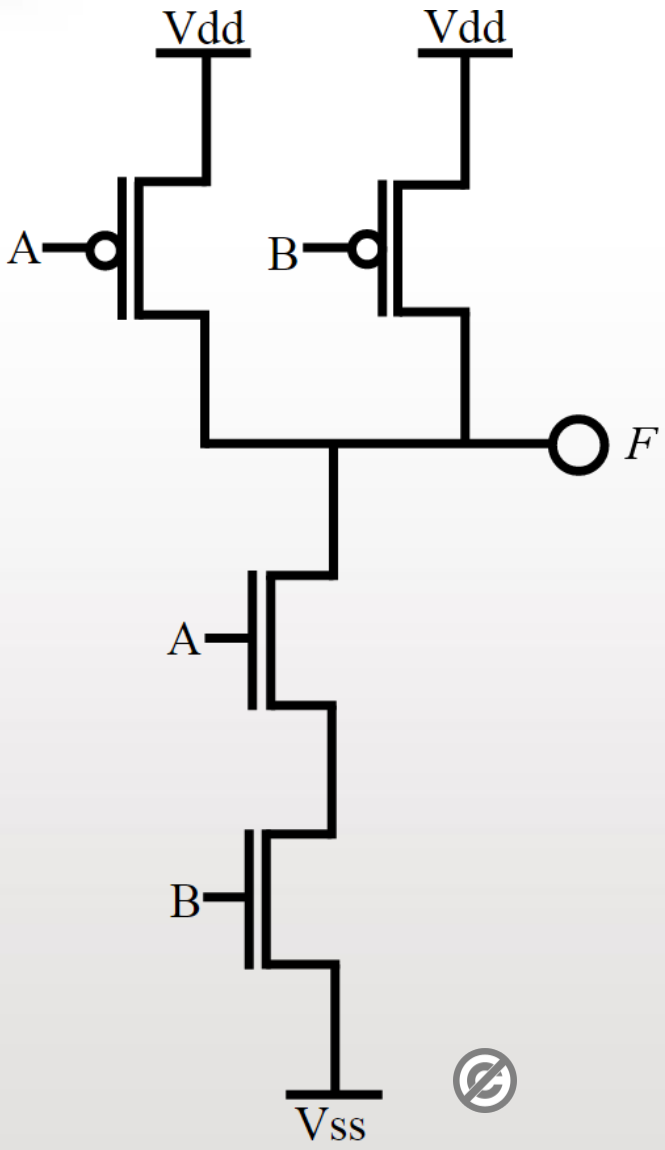


Timing diagram

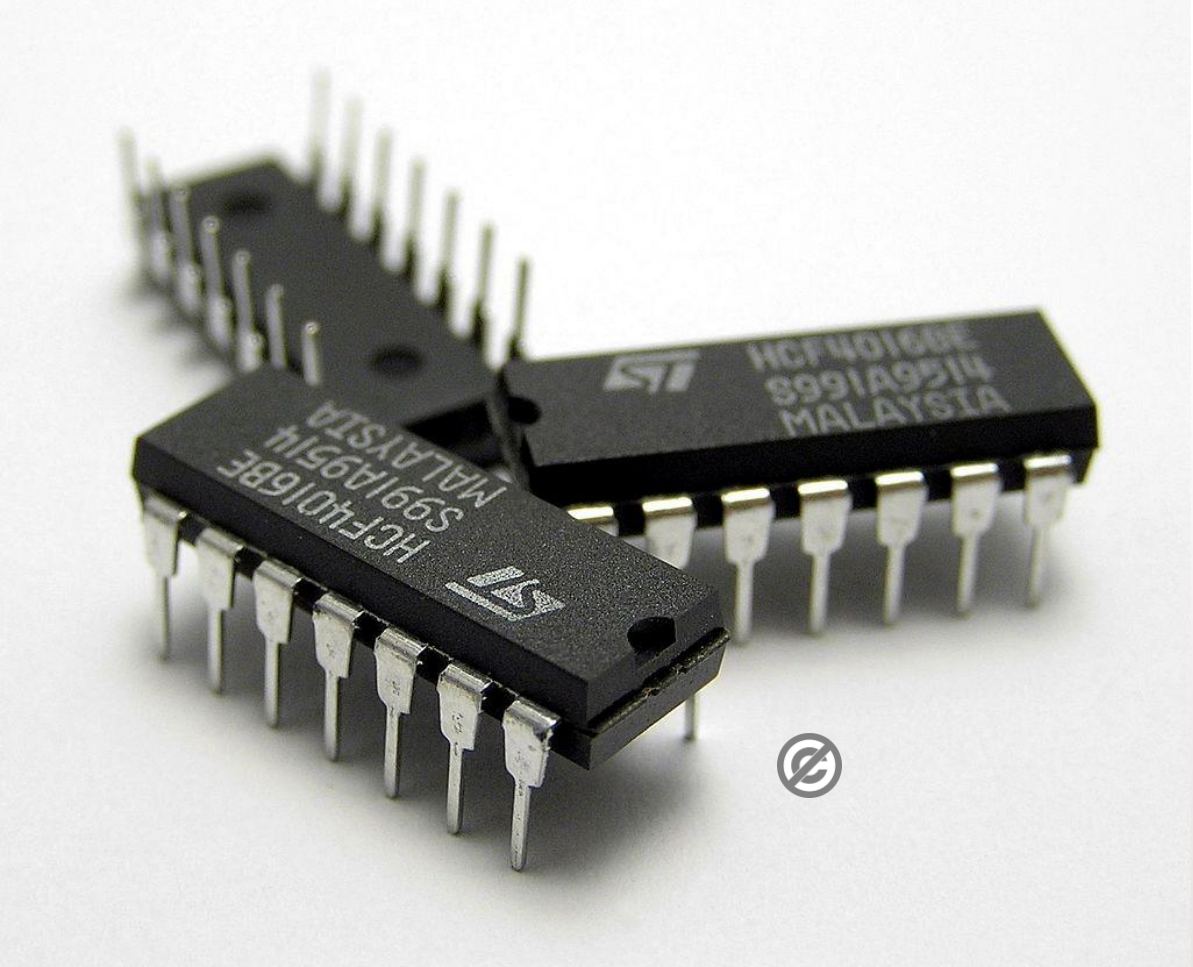
TTL NAND Gate



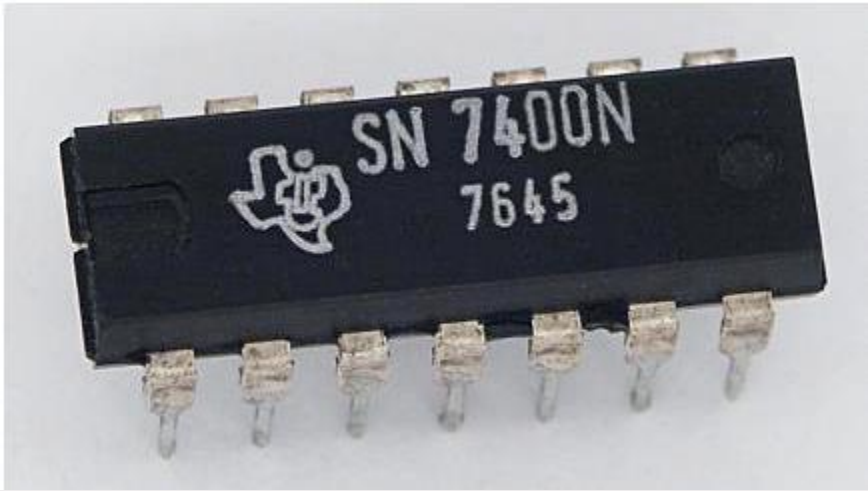
CMOS NAND Gate



Integrated Circuits (Chips)

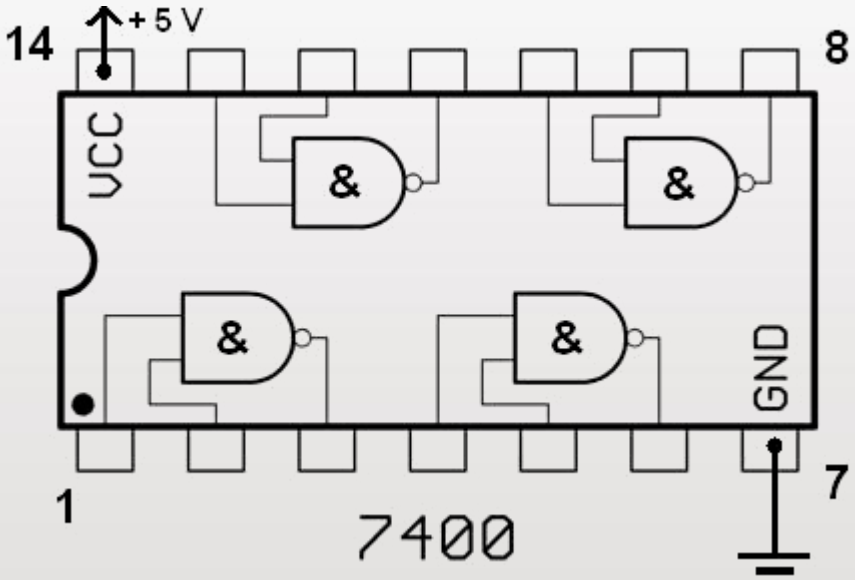


7400 Chip



DIP (Dual Inline Package)

Pin assignments (“Pinout”)



74 Series chips

Chip Number	Type of Logic Circuit
7400	Quad 2-input NAND gates (4 units)
7402	Quad 2-input NOR gates (4 units)
7404	Hex NOT gates (6 units)
7408	Quad 2-input AND gates (4 units)
7410	Triple 3-input NAND gates (3 units)
7420	Dual 4-input NAND gates (2 units)
7430	8-input NAND gate (1 unit)
7432	Quad 2-input NOR gates (4 units)
7486	Quad 2-input XOR gates (4 units)