Chapter2: Boolean Algebra and Logic Gates

Lecture5- Positive and Negative Logic

Engr. Arshad Nazir, Asst Prof
Dept of Electrical Engineering
SEECS

Objectives

- Study Positive and Negative Logic
- Integrated Circuits
- Digital Logic Families

Positive and Negative Logic

- Binary signals in a circuit can have one of two values.
  - ➢ One signal represents logic-1 and the other logic-0.
- A circuit input or output will hold either a high or low signal.
  - ➢ Choosing the high level, H, to represent logic-1 is called a positive logic system.
  - ➢ Choosing the low level, L, to represent logic-1 is called a negative logic system

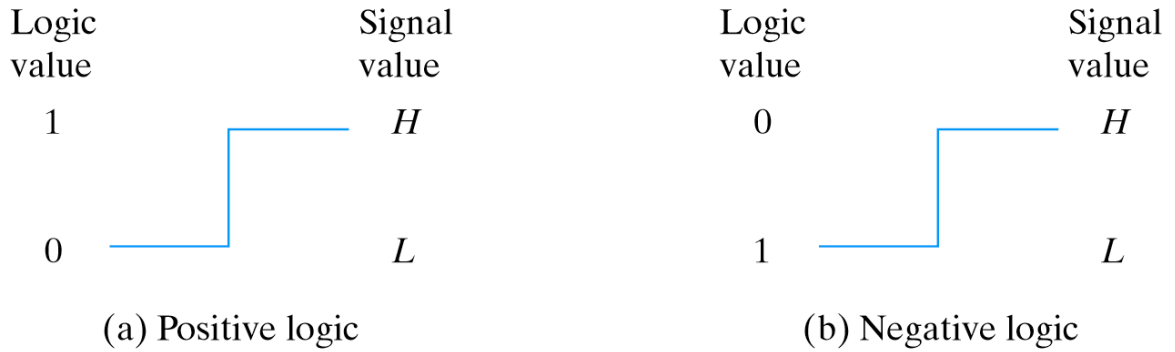
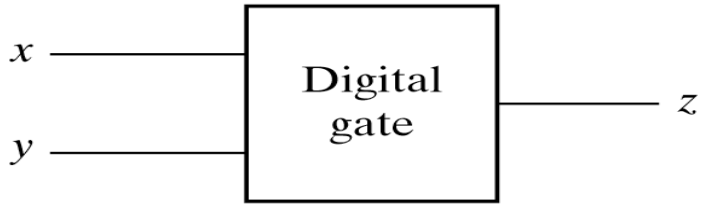


Fig. 2-9 signal assignment and logic polarity

Positive and Negative Logic gates

x	y	F
L	L	L
L	H	L
H	L	L
H	H	H

(a) Truth table with H and L



(b) Gate block diagram

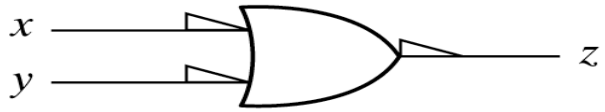
x	y	z
0	0	0
0	1	0
1	0	0
1	1	1

(c) Truth table for positive logic

(d) Positive logic AND gate

x	y	z
1	1	1
1	0	1
0	1	1
0	0	0

(e) Truth table for negative logic



(f) Negative logic OR gate

Fig. 2-10 Demonstration of positive and negative logic

Integrated Circuits

- An integrated circuit (IC) is a silicon semiconductor crystal, called a chip, containing the electronic components for constructing digital gates.
  - Gates are interconnected within the chip to form the required circuit
  - The IC is housed inside a ceramic or plastic container with connections welded to external pins
  - There can be 14 to several thousand pins on a chip
  - Each IC has a numeric designation printed on the surface for identification. The number can be looked up in catalogs (paper and electronic) that contain descriptions and information about the IC

Levels of Integration

- ICs are categorized by the number of gates that they contain in them:
  - Small-scale integration (SSI) devices contain several (usually less than 10) independent gates in a single package. Early 60's
  - Medium-scale integration (MSI) devices include 10 to 1000 gates in a single package, used to perform elementary digital operations. Late 60's
  - Large-scale integration (LSI) devices contain thousands of gates in a single package, used in processors, memory chips, and programmable logic devices. Mid 70's
  - Very Large-scale integration (VLSI) devices contain hundreds of thousands of gates in a single package, used in large memory arrays and complex microcomputer chips. 80's
  - Ultra Large-scale integration (ULSI) devices contain millions of gates in a single package. 90's and 00's
  - Giga-scale integration (GSI) devices contain hundreds of millions of gates in a single package.
  - Tera-scale integration (TSI) devices contain millions of millions of gates in a single package.

Digital Logic Families

- ICs are also classified by the specific circuit technology (digital logic family) that they belong to:
  - Transistor-transistor logic (TTL) is a standard.
  - Emitter-coupled logic (ECL) is used in high-speed operation.
  - Metal-oxide semiconductor (MOS) is used for high component density.
  - Complementary metal-oxide semiconductor (CMOS) is used in low power consumption.
  - Diode-Transistor Logic (DTL) being obsolete not used these days.
  - Resistor-Transistor Logic (RTL) not used these days.

Logic Family Characteristics

- Digital logic families are usually compared by the following characteristics:
  - Fan-out specifies the number of standard loads that the output of a gate can drive without impairing its normal operation or it specifies the amount of current that an output needs to drive many input pins on other gates.
  - Fan-in is the number of inputs available in a gate.
  - Power dissipation is the power consumed by the gate.
  - Propagation delay is the average delay time for the signal to propagate from input to output.
  - Noise margin is the maximum external noise voltage added to an input signal that does not cause an undesirable change in the circuit output.
  - Reliability is the long-term success factor of the IC.

Integrated Circuits Design

- Why is it better to have more gates on a single chip?
  - Easier to build systems
  - Less power consumption
  - Higher clock frequencies
- What are the drawbacks of large circuits?
  - Complex to design
  - Chips have design constraints
  - Need tools to help develop integrated circuits
- Need tools to help develop integrated circuits
  - Computer Aided Design (CAD) tools
  - Automate tedious steps of design process
  - Hardware description language (HDL) describe circuits

The End