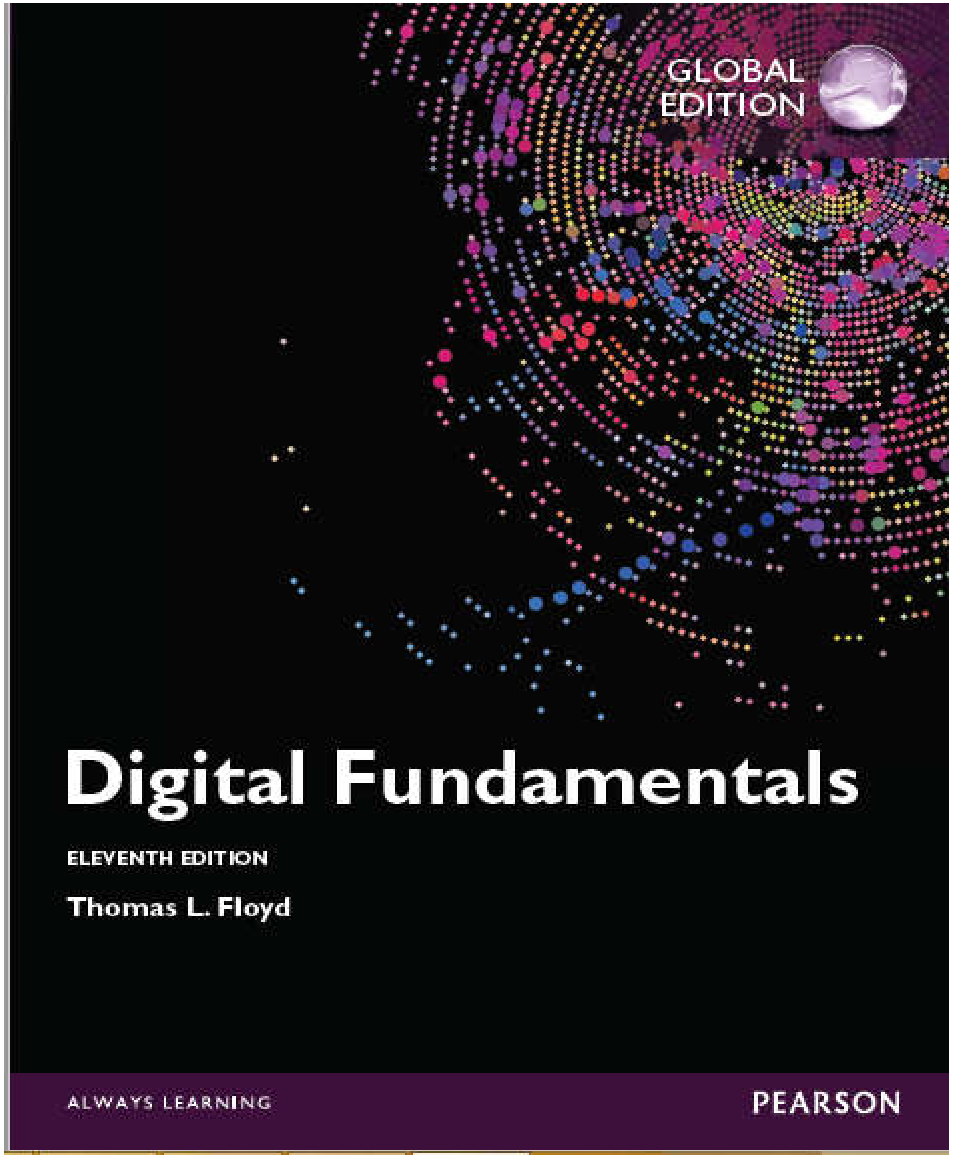
- Digital Logic Design (EE227)

Lecture 1


GLOBAL EDITION
Digital Fundamentals
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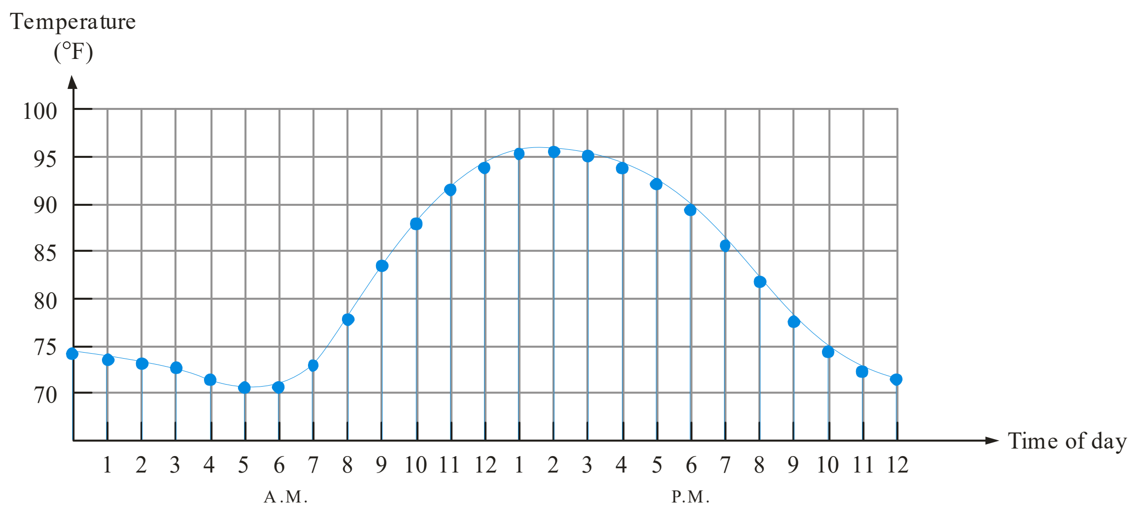
Summary

Analog Quantities

Most natural quantities that we see are **analog** and vary continuously. Analog systems can generally handle higher power than digital systems.

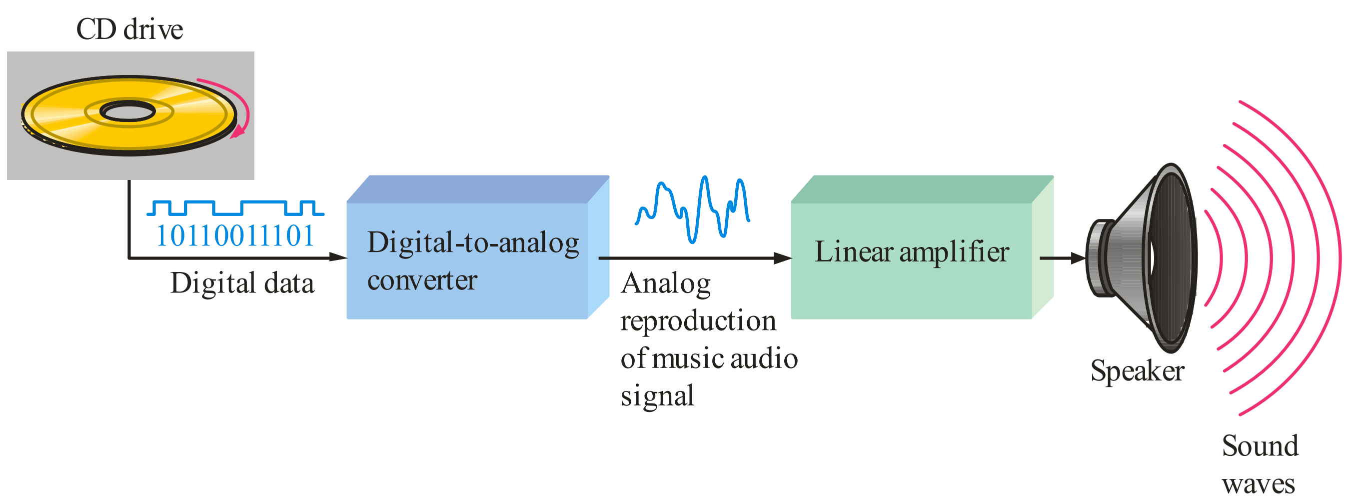


Digital systems can process, store, and transmit data more efficiently but can only assign discrete values to each point.

Summary

Analog and Digital Systems

Many systems use a mix of analog and digital electronics to take advantage of each technology. A typical CD player accepts digital data from the CD drive and converts it to an analog signal for amplification.

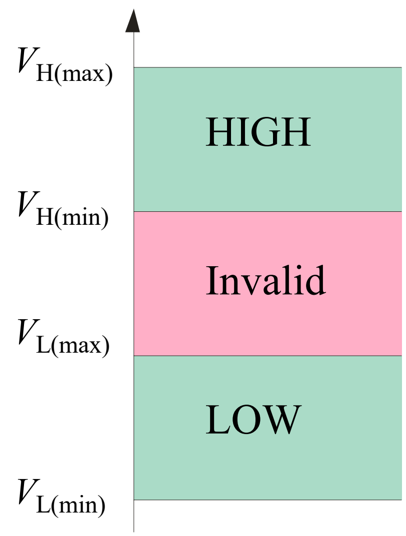


Summary

Binary Digits and Logic Levels

Digital electronics uses circuits that have two states, which are represented by two different voltage levels called HIGH and LOW. The voltages represent numbers in the binary system.

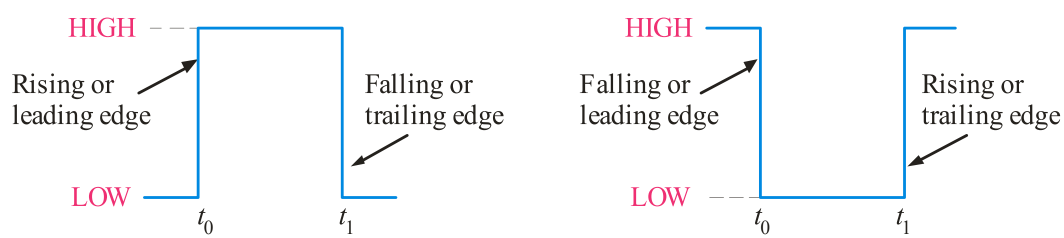
In binary, a single number is called a *bit* (for *b*inary dig*it*). A bit can have the value of either a 0 or a 1, depending on if the voltage is HIGH or LOW.



Summary

Digital Waveforms

Digital waveforms change between the LOW and HIGH levels. A positive going pulse is one that goes from a normally LOW logic level to a HIGH level and then back again. Digital waveforms are made up of a series of pulses.

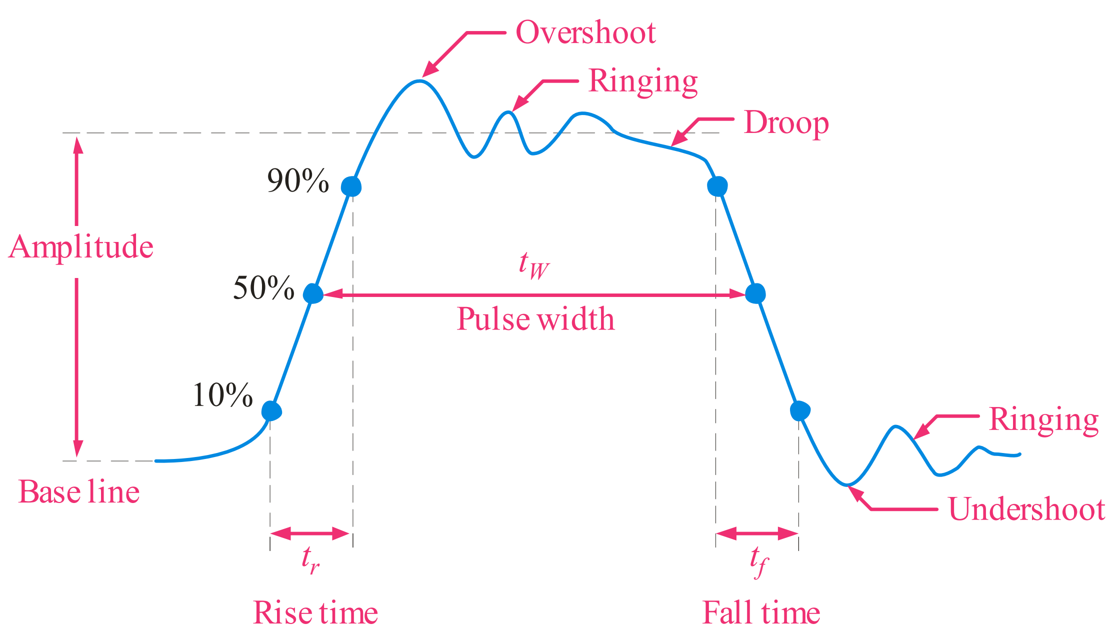


(a) Positive–going pulse (b) Negative–going pulse

Summary

Pulse Definitions

Actual pulses are not ideal but are described by the rise time, fall time, amplitude, and other characteristics.



Summary

Periodic Pulse Waveforms

Periodic pulse waveforms are composed of pulses that repeats in a fixed interval called the **period**. The **frequency** is the rate it repeats and is measured in hertz.

$$f = \frac{1}{T} \qquad T = \frac{1}{f}$$

The **clock** is a basic timing signal that is an example of a periodic wave.

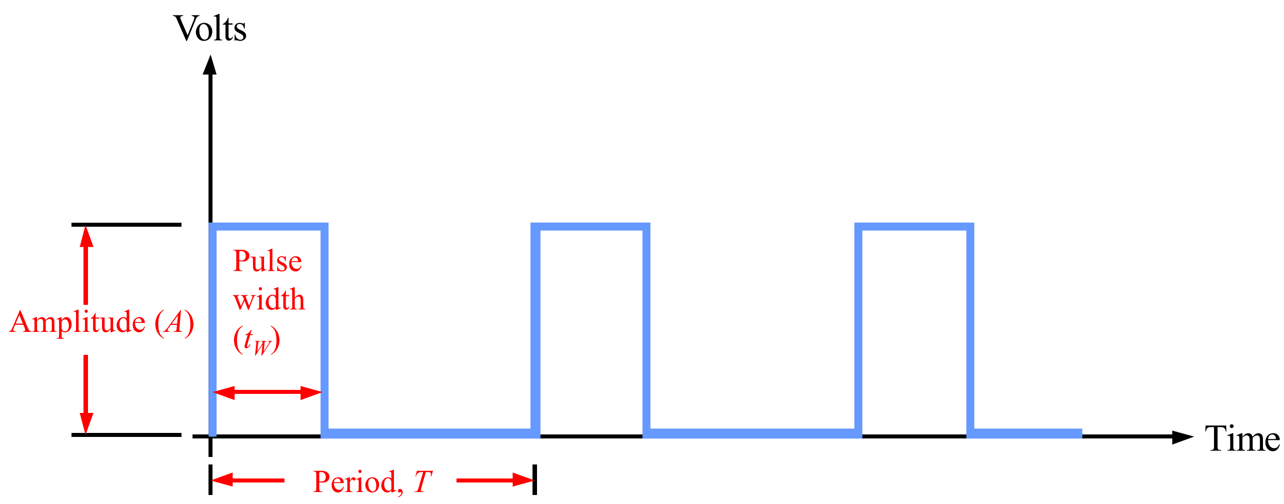
Example What is the period of a repetitive wave if f = 3.2 GHz?

Solution $T = \frac{1}{f} = \frac{1}{3.2\,\text{GHz}} =$ 313 ps

Summary

Pulse Definitions

In addition to frequency and period, repetitive pulse waveforms are described by the amplitude (A), pulse width (t_W) and duty cycle. Duty cycle is the ratio of t_W to T.



A portion of a periodic digital waveform is shown in Figure 1–10. The measurements are in milliseconds. Determine the following:

(a) period (b) frequency (c) duty cycle

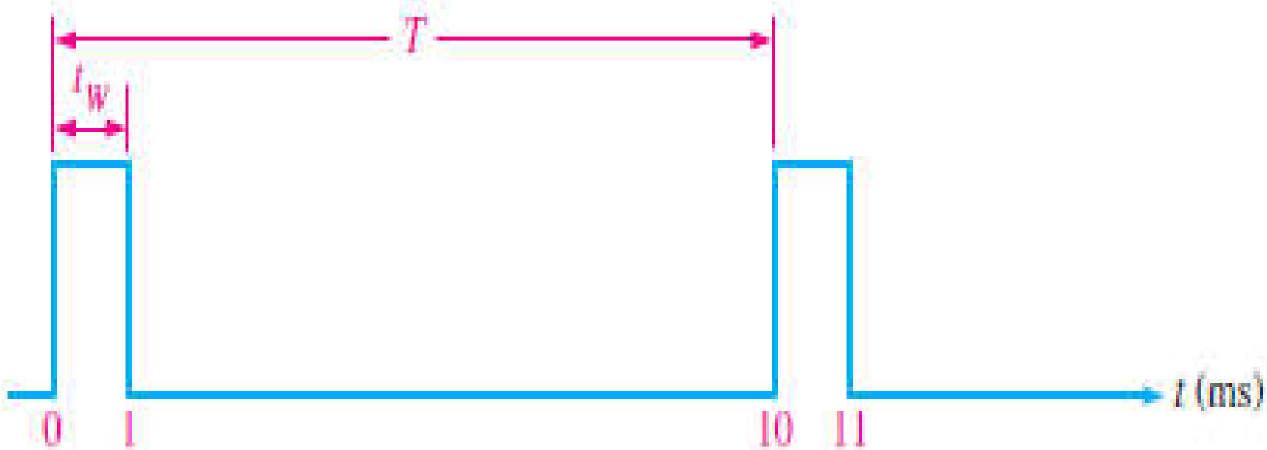


FIGURE 1–10

Example Continued….

Solution

(a) The period (T) is measured from the edge of one pulse to the corresponding edge of the next pulse. In this case T is measured from leading edge to leading edge, as indicated. T equals **10 ms.**

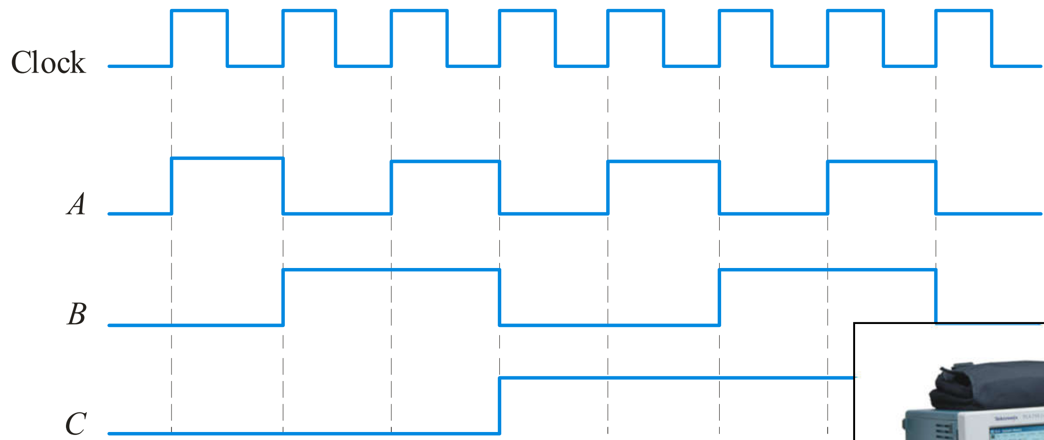
(b) $f = \dfrac{1}{T} = \dfrac{1}{10\text{ ms}} = \mathbf{100\ Hz}$

(c) Duty cycle $= \left(\dfrac{t_W}{T}\right)100\% = \left(\dfrac{1\text{ ms}}{10\text{ ms}}\right)100\% = \mathbf{10\%}$

Summary

Timing Diagrams

A timing diagram is used to show the relationship between two or more digital waveforms,

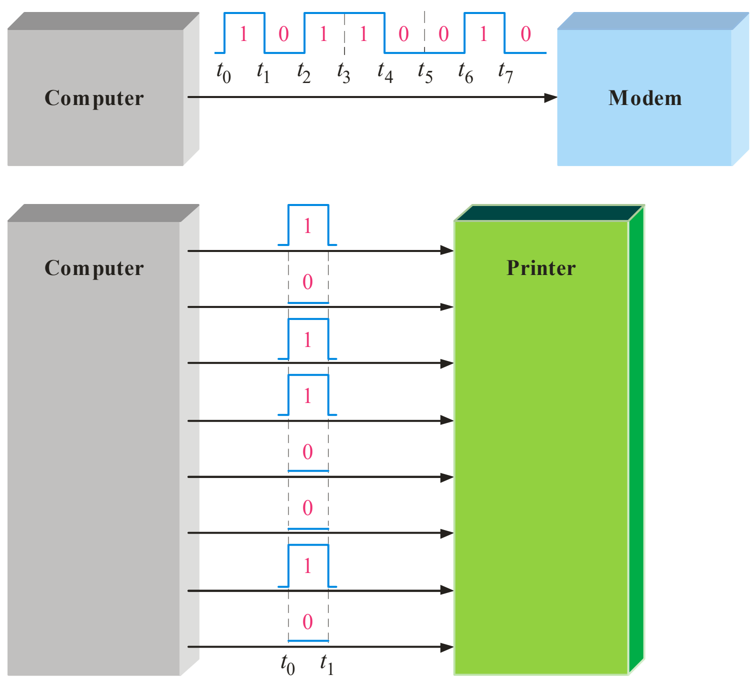


A diagram like this can be observed directly on a logic analyzer.

Summary

Serial and Parallel Data

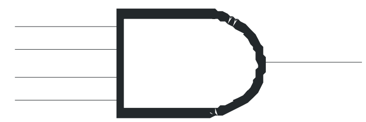
Data can be transmitted by either serial transfer or parallel transfer.



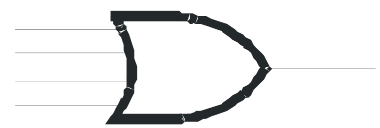
Summary

Basic Logic Functions

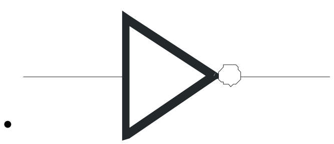
AND True only if *all* input conditions are true.

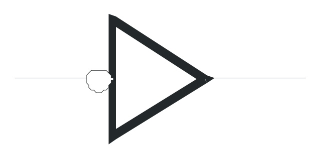


OR True only if *one or more* input conditions are true.



NOT Indicates the *opposite* condition.



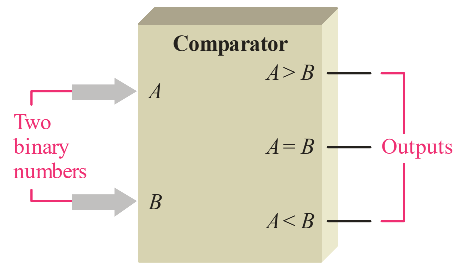


Summary

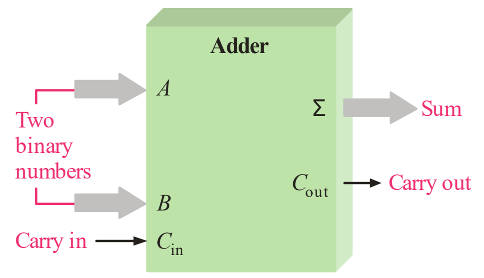
Basic System Functions

And, **or**, and **not** elements can be combined to form various logic functions. A few examples are:

The comparison function



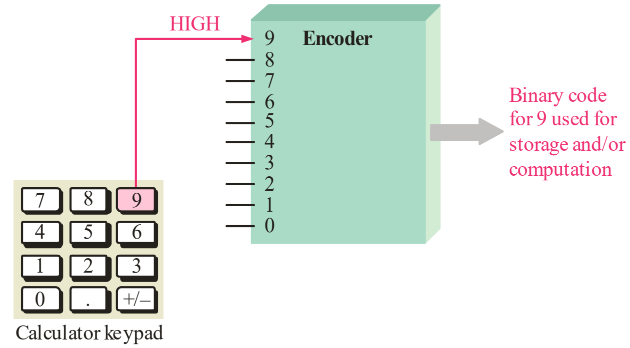
Basic arithmetic functions



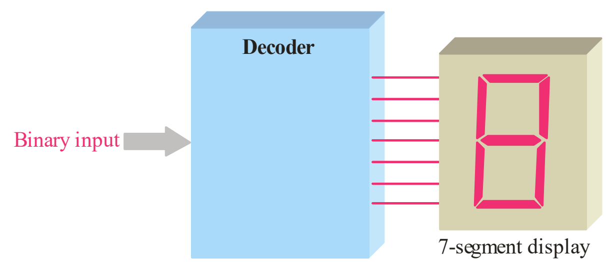
Summary

Basic System Functions

The encoding function



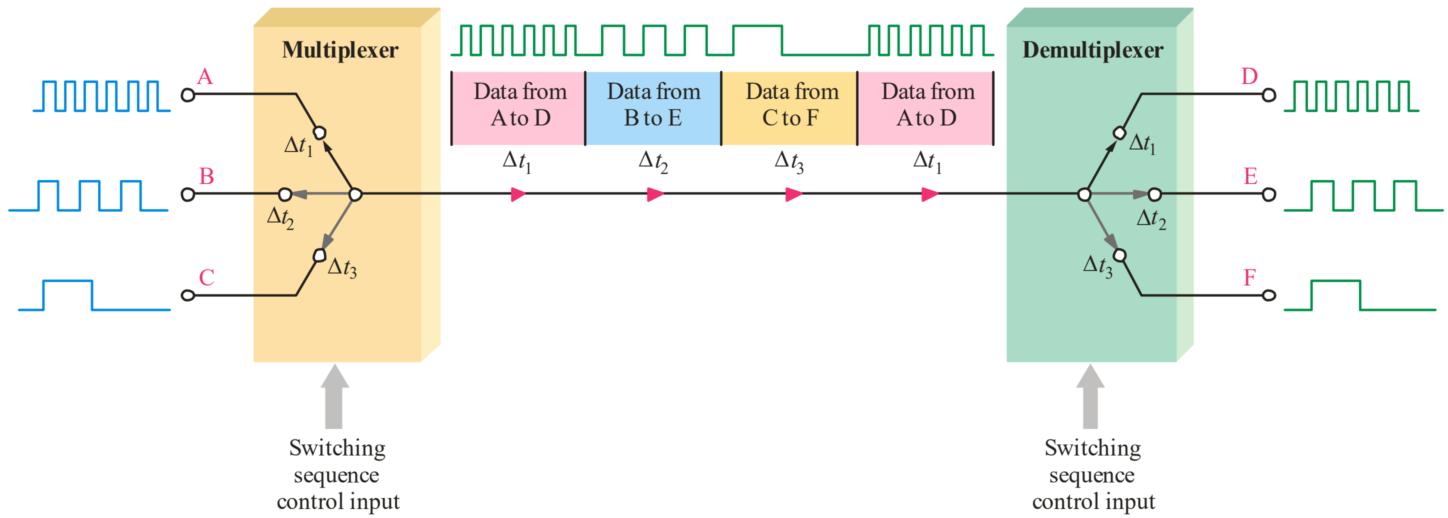
The decoding function



Summary

Basic System Functions

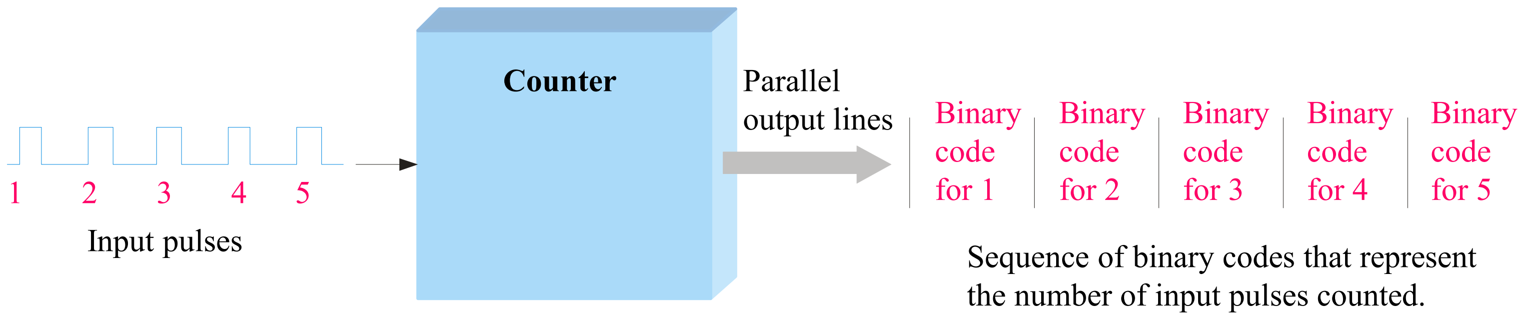
The data selection function



Summary

Basic System Functions

The counting function

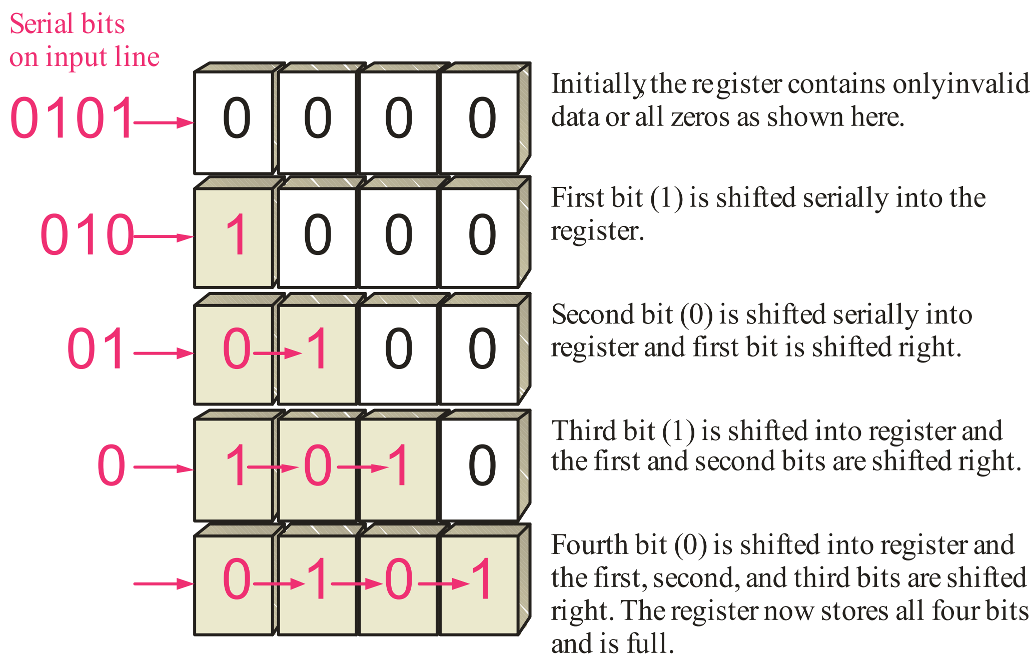


…and other functions such as code conversion and storage.

Summary

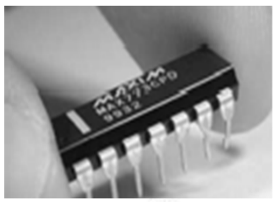
Basic System Functions

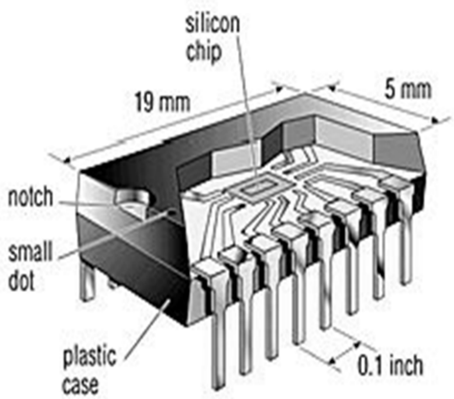
One type of storage function is the shift register, that moves and stores data each time it is clocked.



Summary

Fixed-Function IC and its Classification





- Small-scale integration (SSI) up to 10 gate circuits
- Medium-scale integration (MSI) 10-100 gate circuits
- Large-scale integration (LSI) 100-10,000 gates
- Very large-scale integration (VLSI) 10,000-100,000 gates
- Ultra large-scale integration (ULSI) More than 100,000 gates

Selected Key Terms

Analog Being continuous or having continuous values.

Digital Related to digits or discrete quantities; having a set of discrete values.

Binary Having two values or states; describes a number system that has a base of two and utilizes 1 and 0 as its digits.

Bit A binary digit, which can be a 1 or a 0.

Pulse A sudden change from one level to another, followed after a time, called the pulse width, by a sudden change back to the original level.

Selected Key Terms

Clock A basic timing signal in a digital system; a periodic waveform used to synchronize actions.

Gate A logic circuit that performs a basic logic operations such as AND or OR.

NOT A basic logic function that performs inversion.

AND A basic logic operation in which a true (HIGH) output occurs only when all input conditions are true (HIGH).

OR A basic logic operation in which a true (HIGH) output occurs when when one or more of the input conditions are true (HIGH).