
**College of Engineering & Technology**
**University of Sargodha**

**Department of Electrical Engineering Technology**

**Telecommunication Technology (ET-314)**

# 1. Introduction. Communication Systems

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Lecture#1
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## 1. Information, Messages, Signals

**Information:** general intuitive term.

**Message:** a physical manifestation of the information as produced by the source.

Various **sources of messages (**people, machines, measuring instruments, etc.).

**Analog message:** a physical time-variable quantity usually in smooth and continuous form.

**Digital message:** ordered sequence of symbols selected from finite set of elements.

**Signal:** physical embodiment of the information.

$$\text{Signal} \approx \text{Message}$$

**Electrical signal:** voltage or current representing the message

# 2. Elements of a Communication System

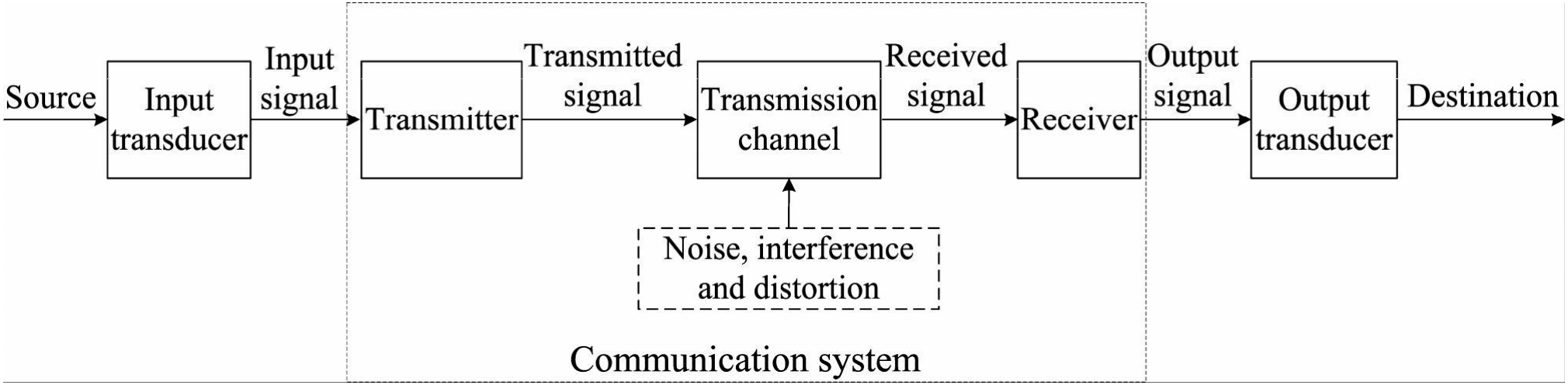


**Figure 1. Block-diagram of a communication system with input and output transducers.**

**Input transducer** converts the message to an electrical signal.

The **transmitter** converts the input signal to transmitted signal suited for the transmission channel.

**Transmission cannel** is the electric medium that bridges the distance from source to destination.

The **receiver** converts the received signal in a form appropriate for the output transducer.

**Output transducer** converts the output electrical signal the desired message form.

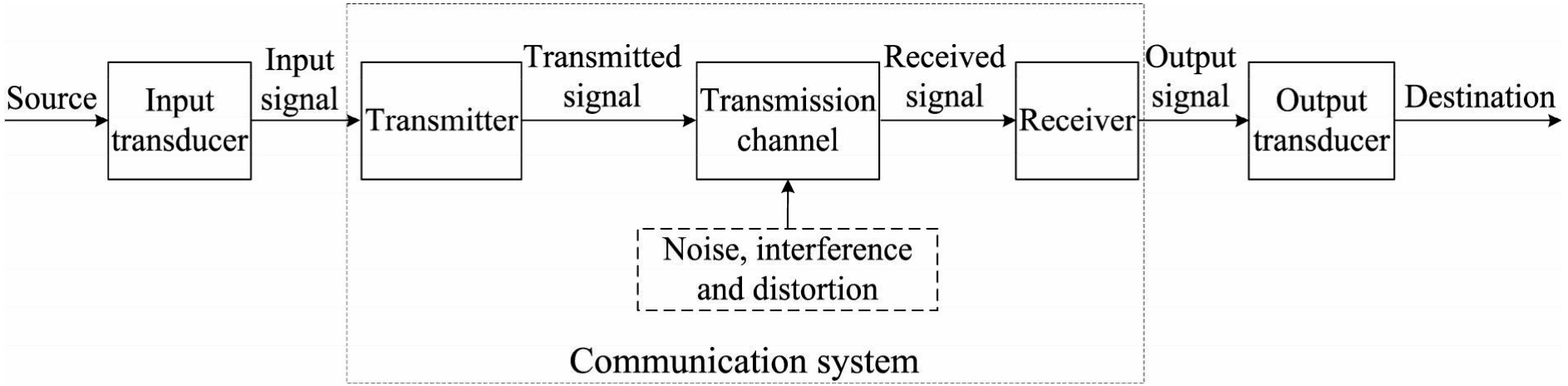


**Figure 1 (repeated). Block-diagram of a communication system with input and output transducers.**

## Basic operations in the transmitter

- *Modulation*
- *Coding*

## Basic operations in the receiver

- *Amplification*
- *Filtering*
- *Demodulation*
- *Decoding*

## Effects of the channel on the transmitted signal

- *Attenuation:* decreasing the signal strength;
- *Distortion of the signal waveform:* caused by channel characteristics (linearity, frequency response, etc.)
- *Noise:* contamination of random natural signals added to the transmitted signal
- *Interference:* contaminations of extraneous signal of human sources – machinery, power lines, digital switching circuits, etc.

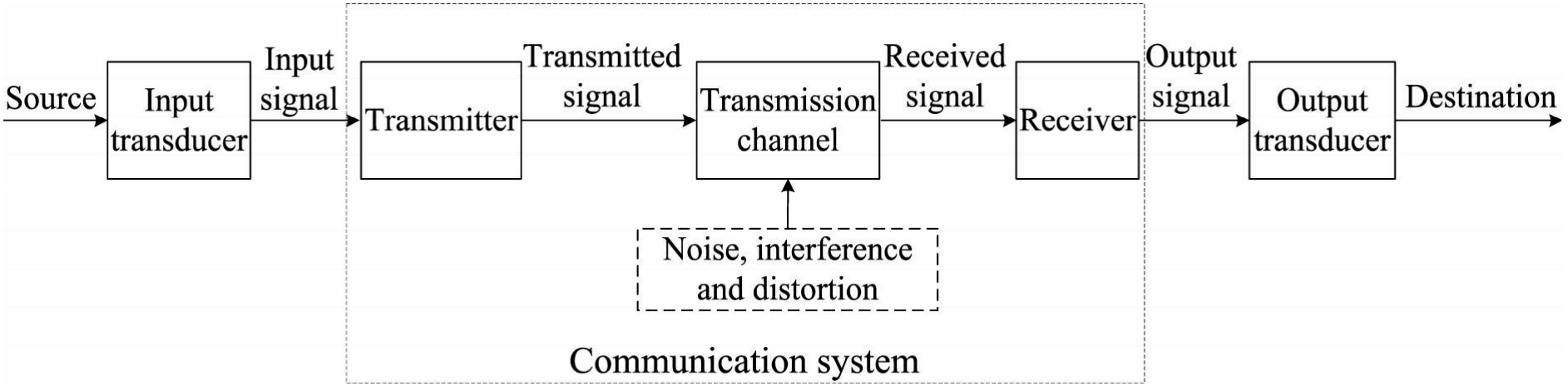


**Figure 1 (repeated). Block-diagram of a communication system with input and output transducers.**

**One-way** or **simplex** (**SX**) transmission. Transmission in one direction only. Example - Figure 1.

**Full-duplex** (**FDX**) system – a system, which channel allows transmission in both directions.

**Full-duplex** (**HDX**) system – a system, which channel allows transmission in both directions but not simultaneously.

# 3. Fundamental Limitations in Communications

## 3.1. Limitations Due to Technological Problems

- Hardware availability
- Economic factors
- International and national regulating norms

## 3.2. Fundamental Physical Limitations

*3.2.1. Transmission Bandwidth B.*

• Limits the spectrum of the transmitted signal, i.e. the maximum speed of variation of the transmitted signal.

• The time required for transmission of a given amount of information is inversely proportional to the transmission bandwidth *B*.

*3.2.2. Noise*

• Noise is generated in all conductors and in electronic devices as well.

• Thermal noise due to random motion of the charged particles like electrons.

• Noises generated in electronic devices: shot, flicker, popcorn, avalanche.

• The noise degrades the fidelity in analog communication systems and produces errors in digital communications.

• Noise generation limits the weakest transmitted signal. Significant in long-distance communications when the signal attenuation is large.

• Signal-to-noise ratio *S/N*

$$S/N = \frac{\text{power of the signal}}{\text{power of the noise}}$$

*3.2.3. Hartley-Shannon low*

The rate of information transmission cannot exceed the **channel capacity C**

$$C = B \log(1 + S/N)$$

# 4. Modulation

## 4.1. Modulation Methods

• **Modulating signal** – represents the message.

• **Carrier wave** – suits the application.

• Usually the modulation signal is much slower than the carrier wave.

• **Modulation** – altering one or more of the parameters (amplitude, frequency, phase, pulse width) of the carrier in correspondence with the modulating signal.

• **Demodulation** – extraction of modulating signal from modulated signal; reverse operation to modulation.

• **Continuous wave modulation** – when the carrier is sinusoidal.

• **Pulse modulation** – the carrier is pulse train.

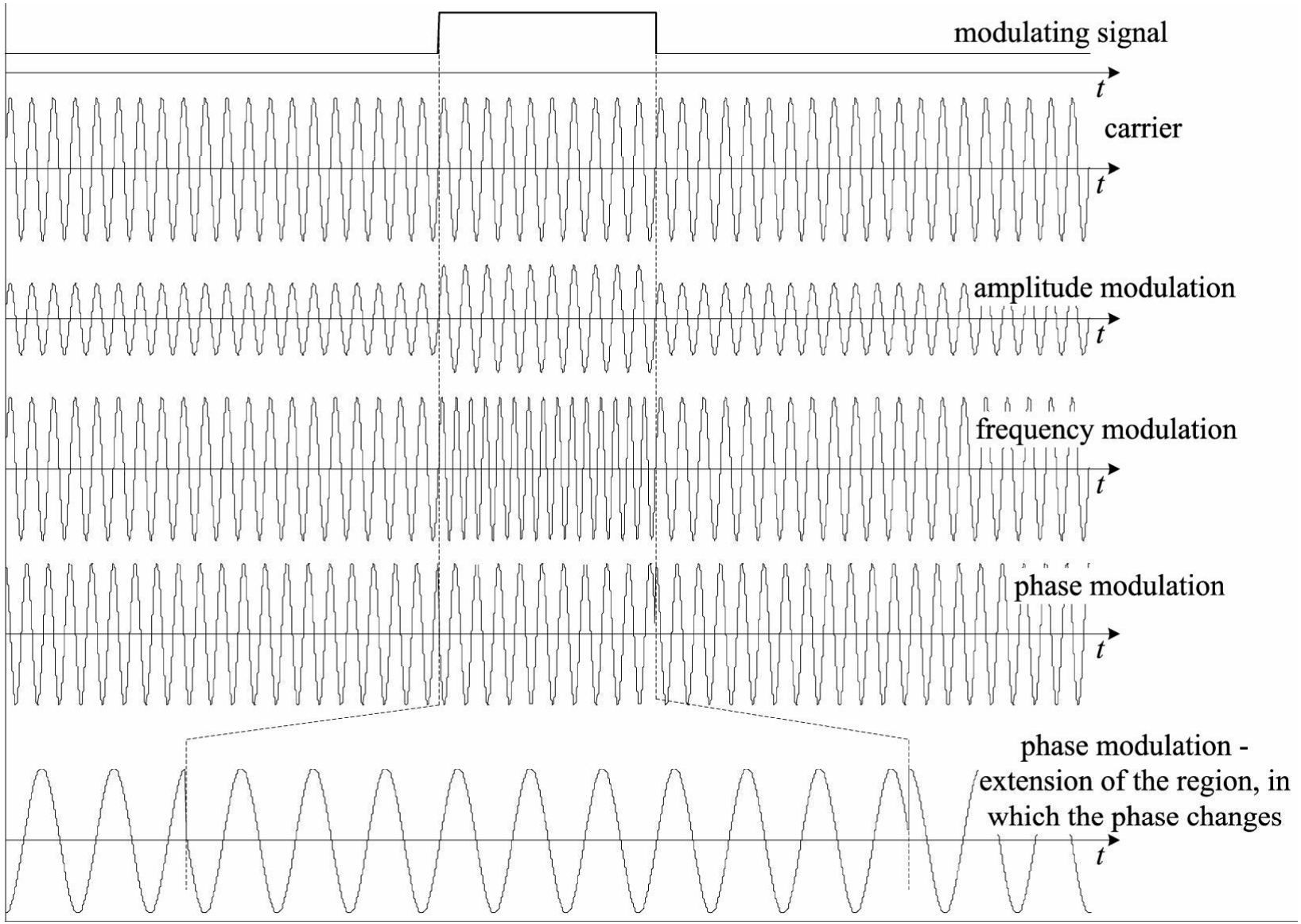


**Figure 2. Examples of the basic continuous modulations.**

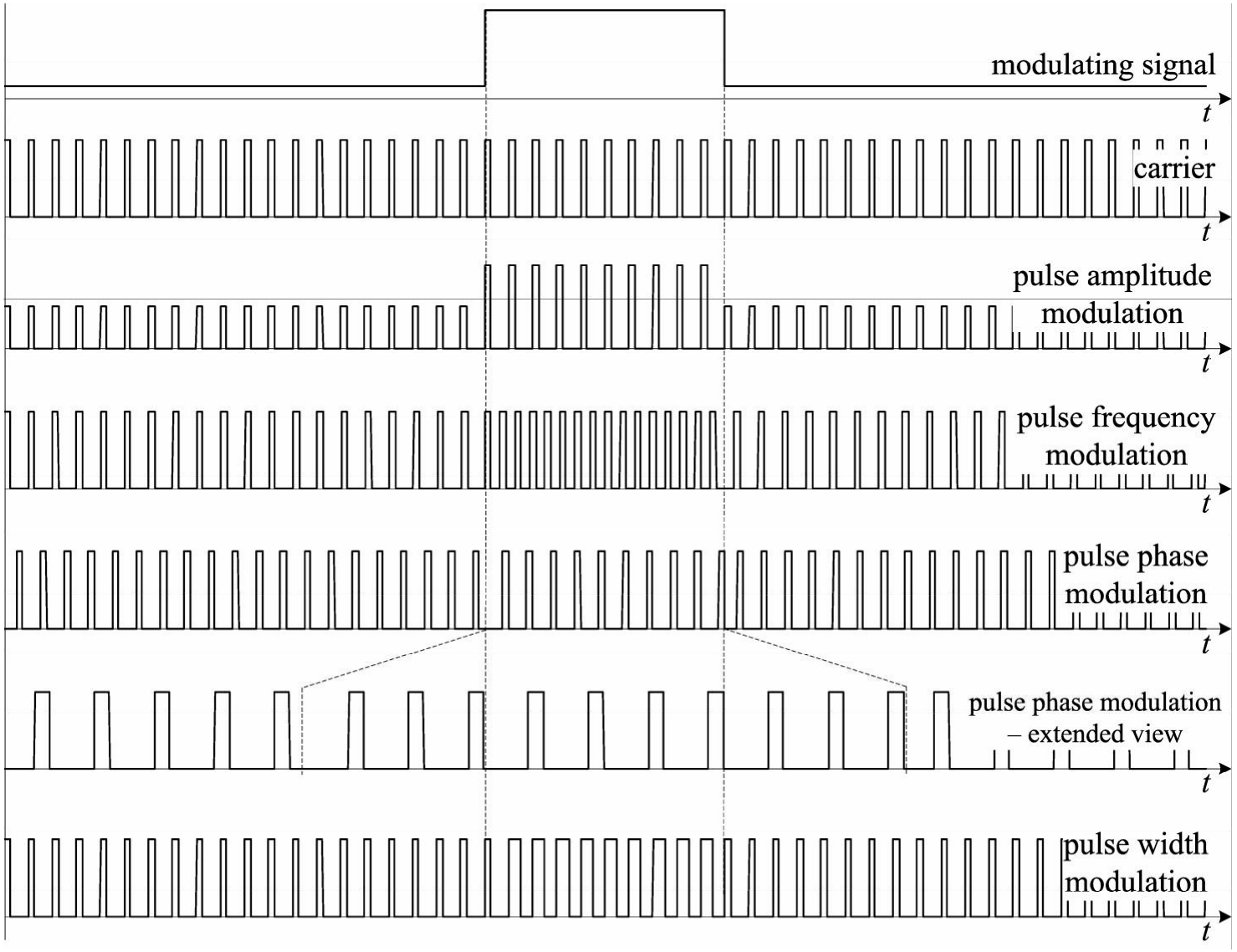


**Figure 3. Examples of the basic pulse modulations.**

## 4.2. Modulation Benefits and Applications

- Modulation for efficient transmission;
- Modulation to overcome hardware limitation;
- Modulation to overcome noise and interference;
- Modulation for frequency assignment
- Modulation for multiplexing: frequency division; time division, multiple access
- Coding methods and benefits

## 4.3. Analog and Digital Communications

- **Analog communication systems:** the informative signal is transmitted in continuous form.
- **Digital communication system:** the informative signal is represented as a sequence of limited set of symbols (digits) and these symbols are transmitted via the channel by applying of and appropriate modulation. The input signal must be **sampled** if it enters in analog form.
- Basic advantages of the digital communication systems:
  ¾better resistivity against the noise;
  ¾allows the use of effective coding methods;
  ¾more flexible signal handling suggested by digital signal processing methods
- However the front end of radiofrequency (RF) communication systems are always analog since signals are existing only in analog form.

## References:

1. [1] A. Bruce Carlson, P. B. Crilly, J. C. Rutledge, Communication Systems, 4th ed., McGraw-Hill, 2002, ISBN 0-07-011127-8.