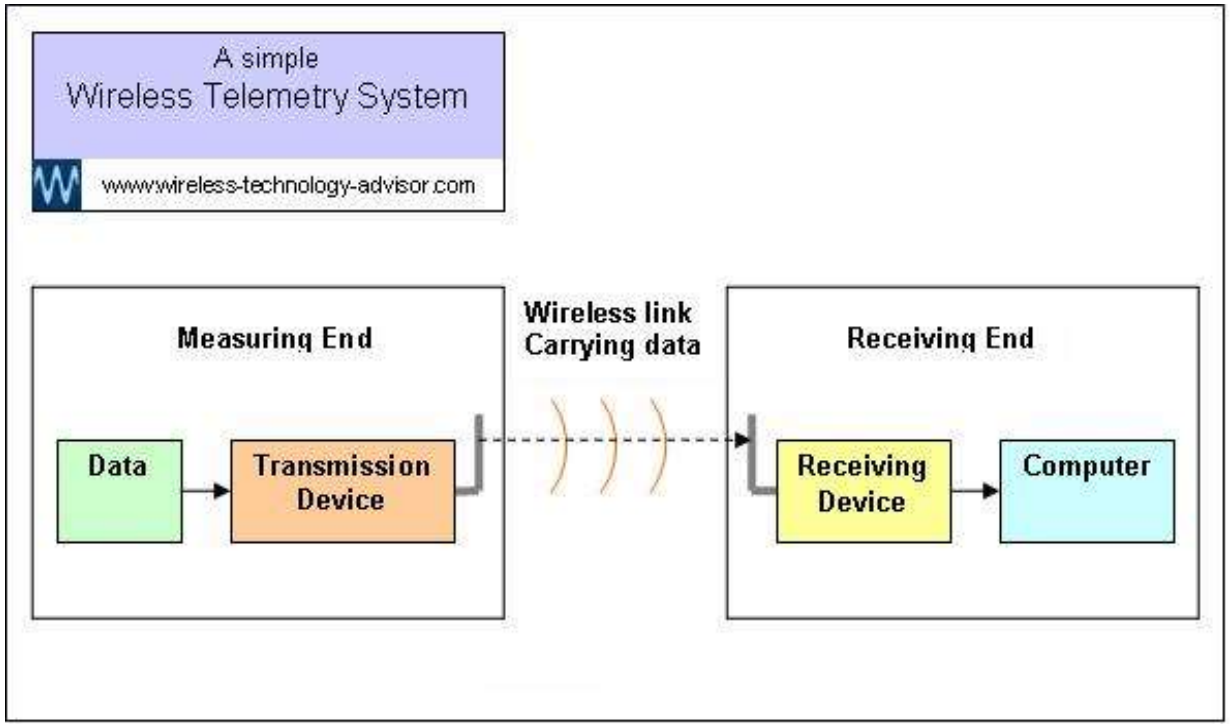
TELEMETRY

- Telemetry is the automatic recording and transmission of data from remote or inaccessible sources to an IT system in a different location for monitoring and analysis. Telemetry data may be relayed using radio, infrared, ultrasonic, GSM, satellite or cable, depending on the application (telemetry is not only used in software development, but also in meteorology, intelligence, medicine, and other fields).
- In the software development world, telemetry can offer insights on which features end users use most, detection of bugs and issues, and offering better visibility into performance without the need to solicit feedback directly from users.

GENERAL TELEMETRY SYSTEM



HOW IT WORKS

- In a general sense, telemetry works through sensors at the remote source which measures physical (such as precipitation, pressure or temperature) or electrical (such as current or voltage) data. This is converted to electrical voltages that are combined with timing data. They form a data stream that is transmitted over a wireless medium, wired or a combination of both.
- At the remote receiver, the stream is disaggregated and the original data displayed or processed based on the user's specifications.

TYPES OF TELEMETRY SYSTEMS

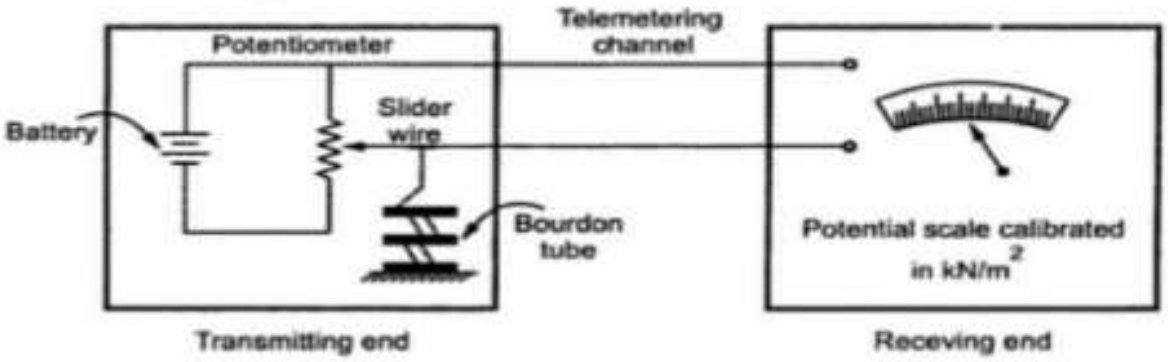
- Landline Telemetry system- Power lines, Telephone Lines, Electrical Wires. Distance Range from 50m to 1 km: example labs, industries

  Types are- voltage, current and position.
- Radio Frequency System- Radio links from 1 km to 50 km at 4MHz. Repeaters are installed after every 30 to 60 km for long transmission.
- Types are- amplitude modulation, Frequency modulation, phase modulation

LANDLINE TELEMETRY SYSTEM

VOLTAGE TELEMETRY SYSTEM

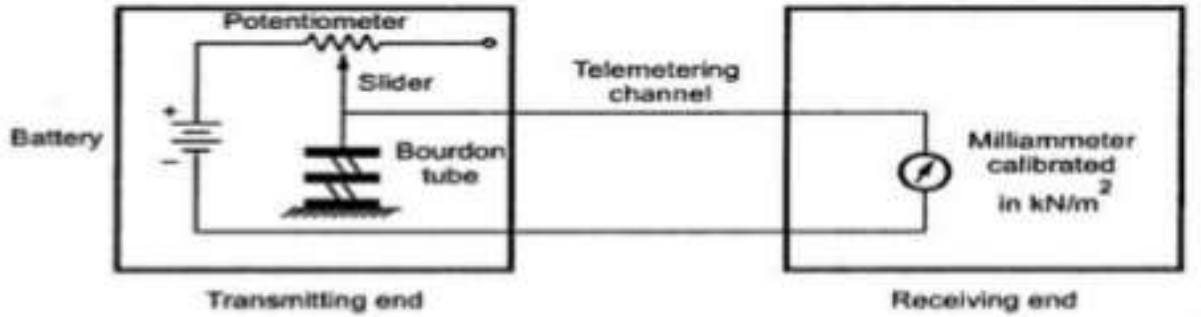
- Measured Variable is transmitted in form of voltage
- At transmitting end, Slide wire is connected in series with battery.
- Slide wire is further connected to Bourdon tube for pressure measurement.
- When pressure changes, slider actuates the slider of potentiometer. Thus , change in Voltage is transmitted to rvr.



Circuit of Voltage Telemetry System

CURRENT TELEMETRY SYSTEM

- Working is almost same as of Voltage telemetry system
- When pressure changes Borden tube moves sliding contact thereby value of current changes
- This current passes through pair of wires and measured by milliammeter.



Circuit of Current Telemetry System

POSITION TELEMETRY SYSTEM

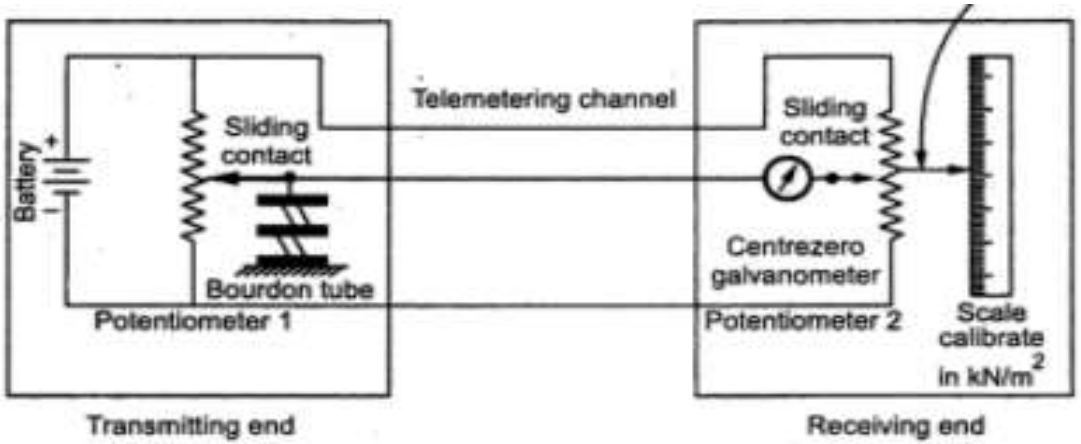


Fig. 8.6 Position telemetering system

Construction and working

A simple position telemetering system consists two potentiometers; one placed at transmitting end and other at receiving end. To have the proportional changes at the transmitter and receiver, both the potentiometers are connected by a common supply as shown in the Fig. 8.6.

The sliding contact at the transmitting end is positioned according to the pressure exerted on the bourdon tube. The sliding contact at the receiving end is positioned with the help of **centre zero galvanometer.** This position is achieved by moving the sliding contact of the potentiometer 2 at the receiving end, till the centre zero galvanometer indicates zero.

When the pressure at the transmitting end changes, the bourdon tube moves the slider of the potentiometer 1. Accordingly the slider at the receiving end moves and it inturn moves the pointer along the scale calibrated interms of the pressure scale (kN/m^2).

FM TELEMETRY SYSTEM

In the R.F. telemetry systems, FM telemetry system is the earliest system which is still used in the telemetry field. A simple FM telemetry system used for mixing of various data channels is as shown in the Fig. 8.8.

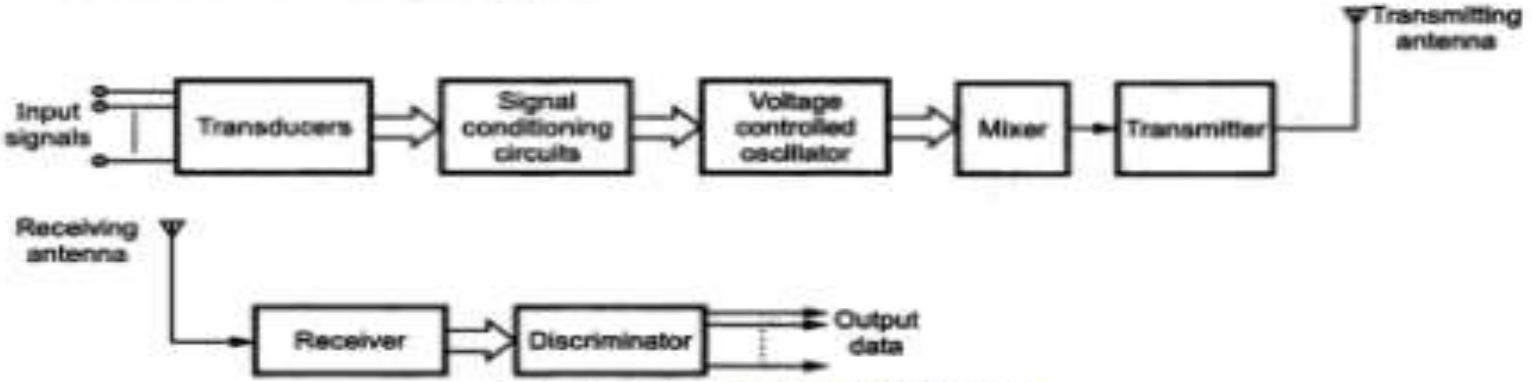
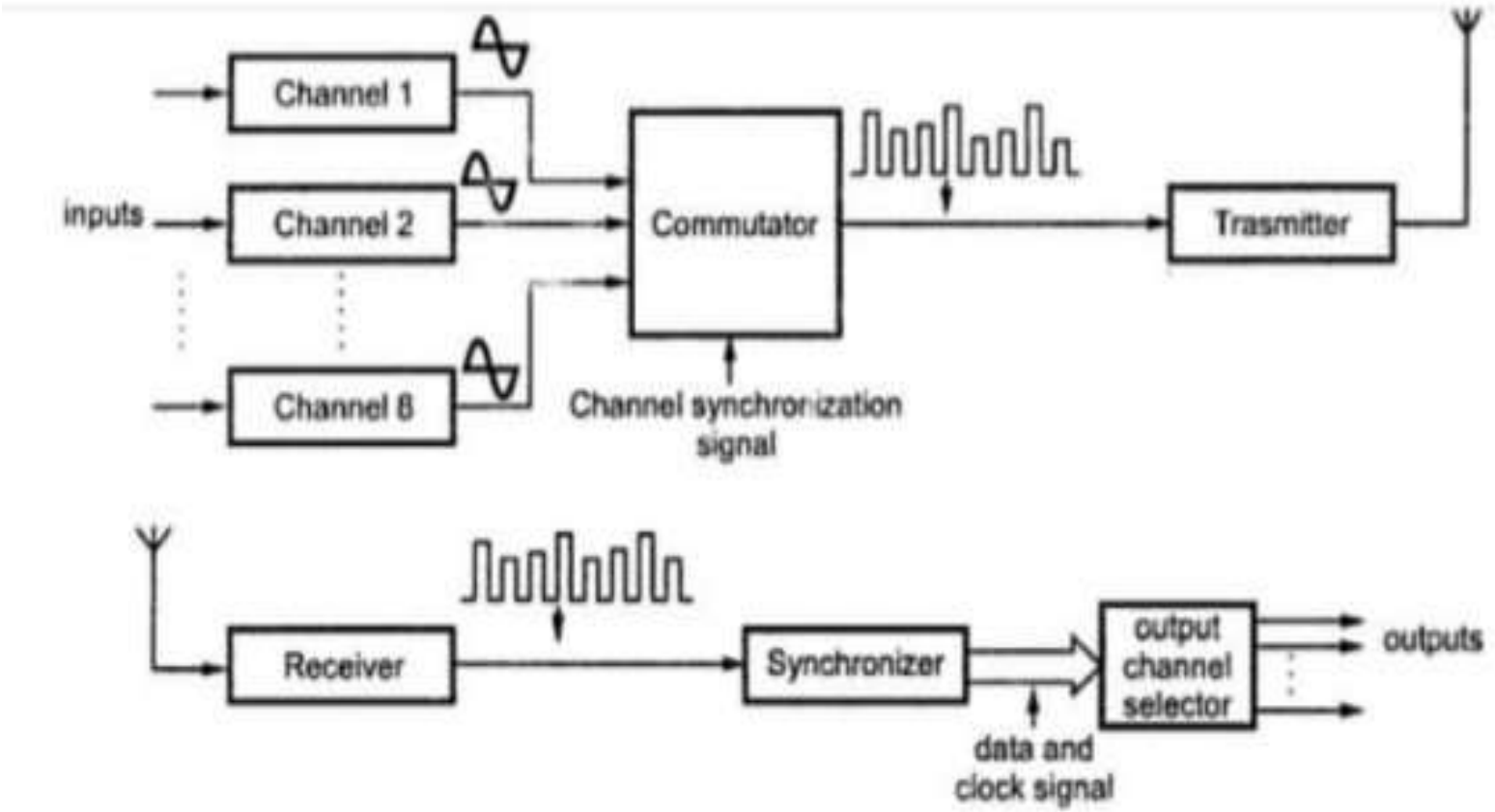


Fig. 8.8 FM telemetry system

Using transducers, different quantities are measured. The output of the transducer is obtained in the representable from by using appropriate signal conditioning circuits. The outputs of the signal conditioning circuits is given to the Voltage Controlled Oscillator (VCO) stage. There are number of VCOs present where each oscillator operates at a dedicated frequency output of each signal conditioner circuit modulates the frequency of the VCO and it is presented for radio transmission. As each VCO is assigned with a separate frequency of the frequency spectrum, so each signal can be modulated without interfering with other signals.

At receiver end, the FM demodulator called as **discriminator** is used. This discriminator is tuned to the frequency of each subcarrier and the bandwidth is equal to that of the modulated subcarrier. So when the value of the measured quantity changes, accordingly the output signal of the discriminator changes.

PULSE TELEMETRY SYSTEM



MODULATION

- **modulation** is the process of varying one or more properties of a periodic waveform, called the *carrier signal*, with a modulating signal that typically contains information to be transmitted.

  There are three types of modulation:

- Amplitude modulation
- frequency modulation
- Phase modulation

AMPLITUDE MODULATION

- Amplitude Modulation may be defined as a system in which the maximum amplitude of the carrier wave is proportional to the instantaneous value (amplitude) of the modulating or base band signal.
- Let us consider a sinusoidal carrier wave c(t) given as :
- $C(t) = A \cos \omega_c t$ .....(1)

  Here A is the maximum amplitude of the carrier wave and ω_c is the carrier frequency. For simplicity here we have assumed that the phase of the carrier wave is zero in equation (1).

  Let x(t) denote the modulating or base band signal.

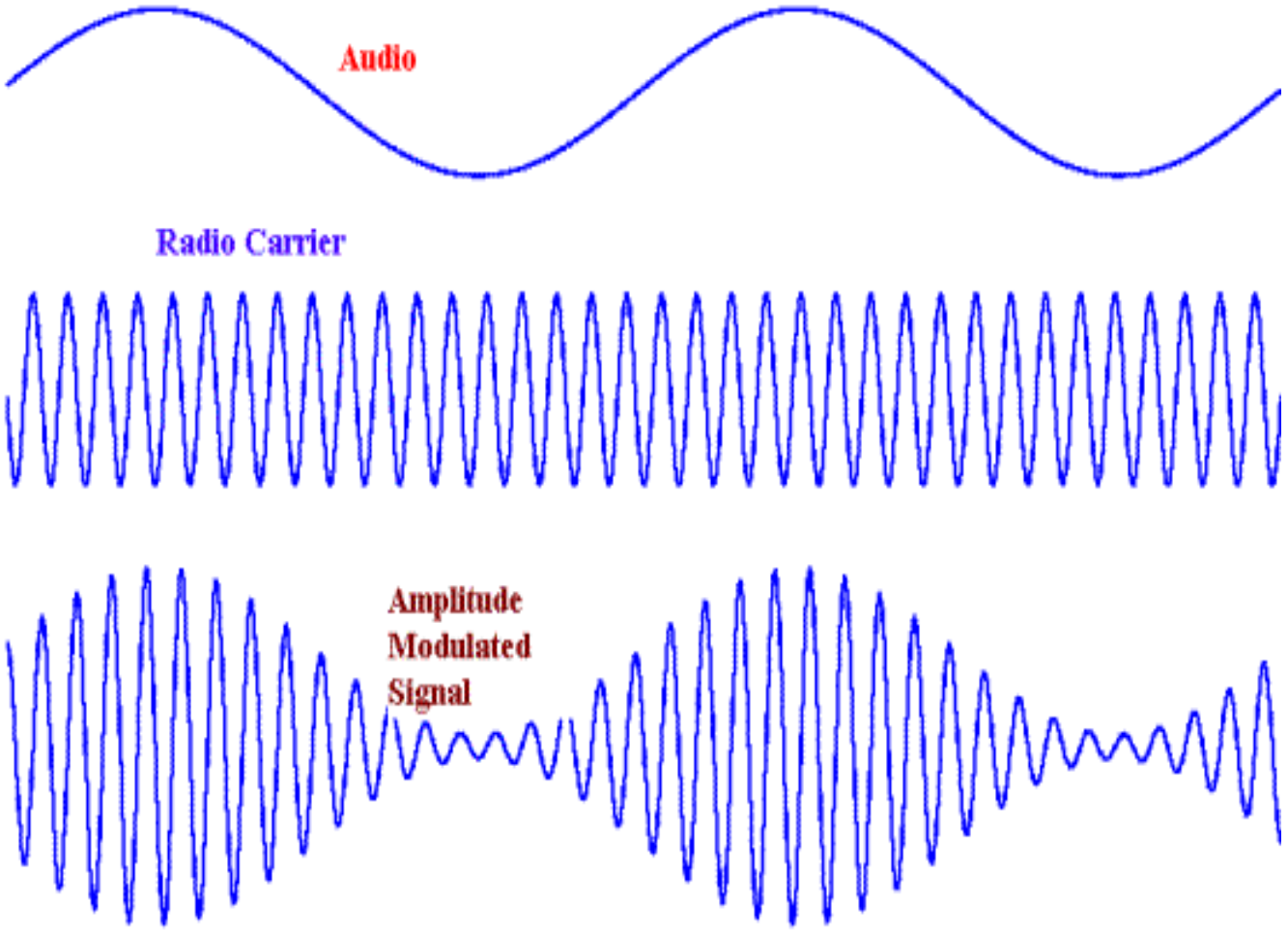
  Then according to amplitude modulation, the maximum amplitude A of the carrier will have to be made proportional to the instantaneous amplitude of the modulating signal x(t).

  The standard equation for amplitude modulated (AM) wave may be expressed as :
- $s(t) = x(t) \cos \omega_c t + A \cos \omega_c t$ .....(2)

Or,

- $s(t) = [A + x(t)] \cos \omega_c t$ .....(3)

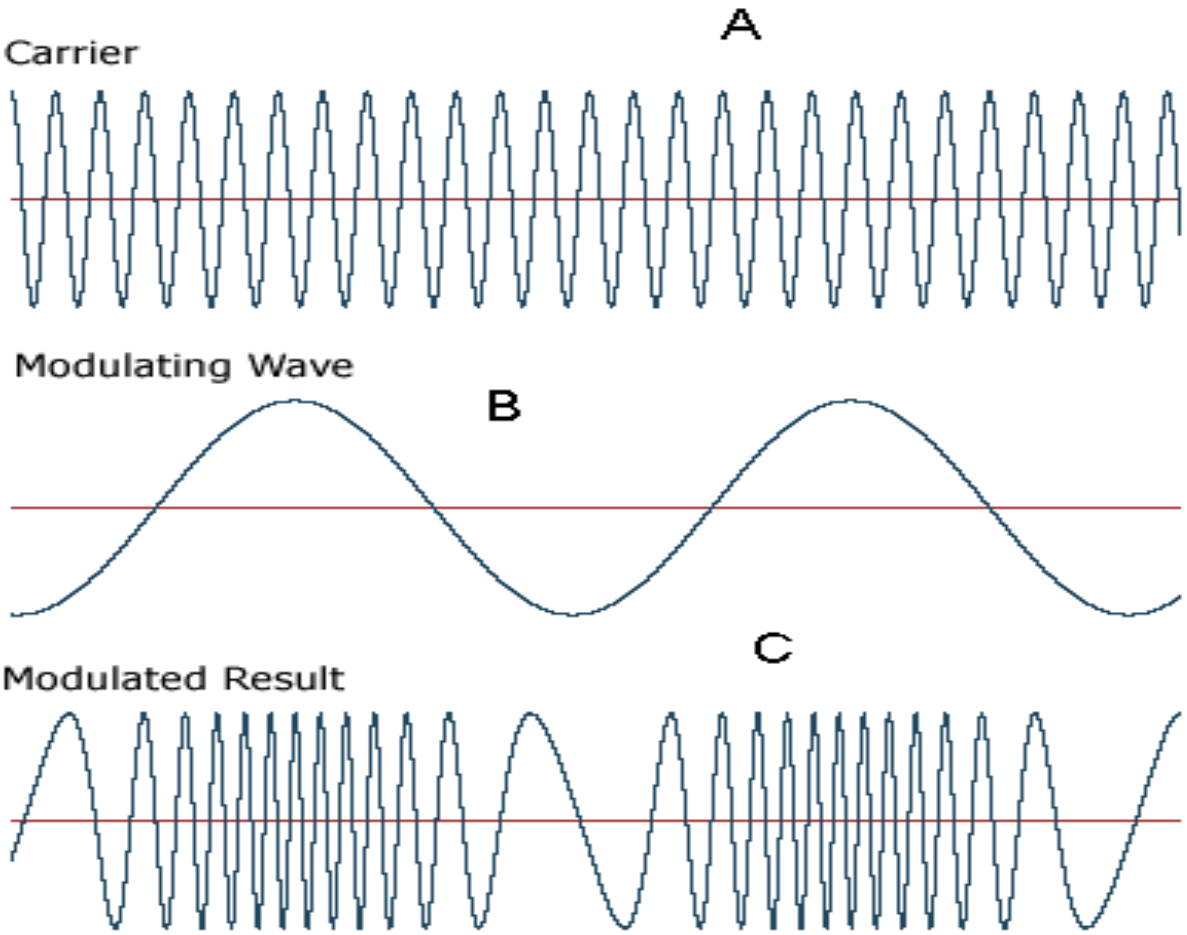
AMPLITUDE MODULATION WAVEFORM



FREQUENCY MODULATION

- In telecommunications and signal processing, **frequency modulation** (**FM**) is the encoding of information in a carrier wave by varying the instantaneous frequency of the wave.

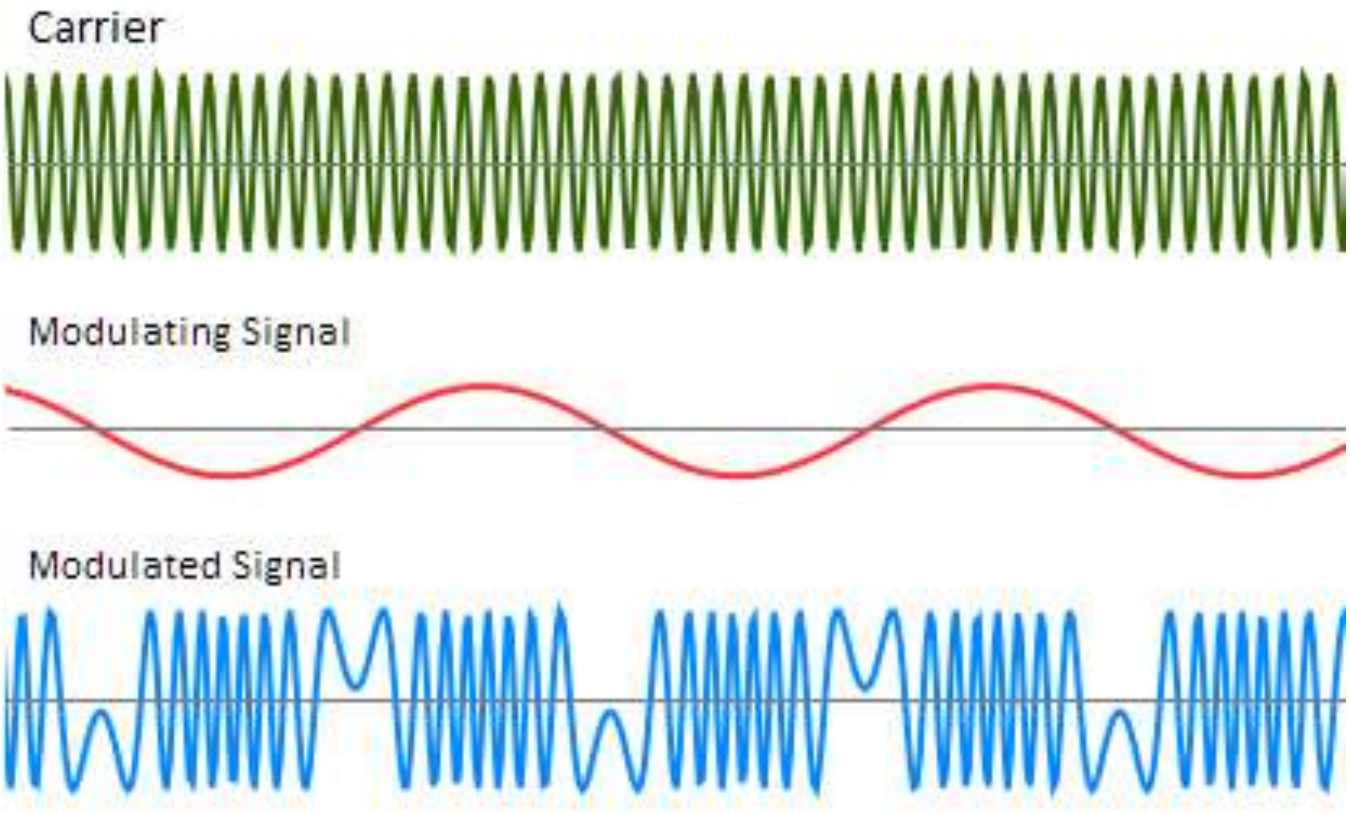
FREQUENCY MODULATION WAVEFORM



PHASE MODULATION

- Phase modulation (PM) is a method of impressing data onto an alternating-current (AC) waveform by varying the instantaneous phase of the wave. This scheme can be used with analog or digital data.
- In analog PM, the phase of the AC signal wave, also called the *carrier*, varies in a continuous manner. Thus, there are infinitely many possible carrier phase states. When the instantaneous data input waveform has positive polarity, the carrier phase shifts in one direction; when the instantaneous data input waveform has negative polarity, the carrier phase shifts in the opposite direction. At every instant in time, the extent of carrier-phase shift(the *phase angle*) is directly proportional to the extent to which the signal amplitude is positive or negative.

PHASE MODULATION WAVEFORM

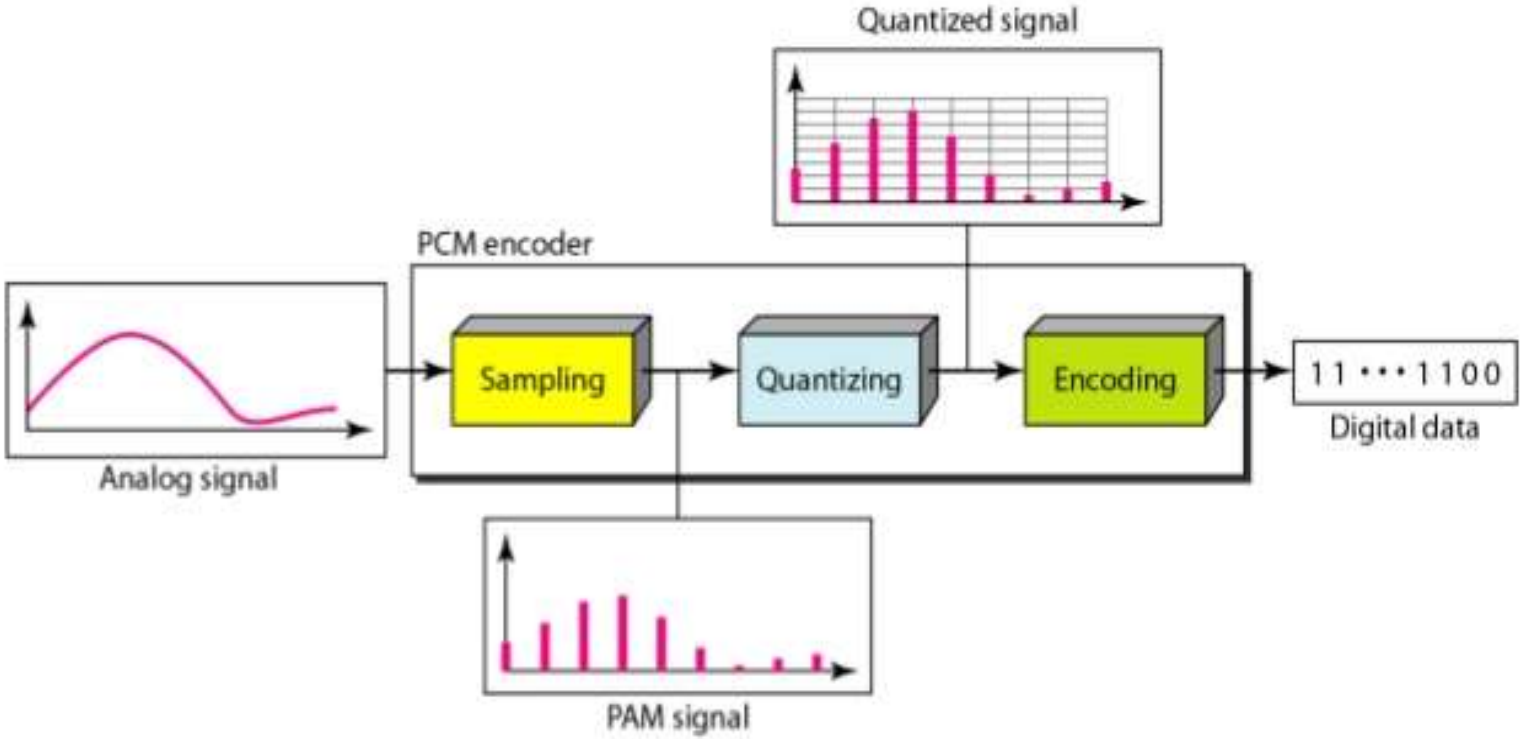


Phase Modulation

PULSE CODE MODULATION

- **Pulse-code modulation** (**PCM**) is a method used to digitally represent sampled analog signals. It is the standard form of digital audio in computers, compact discs, digital telephony and other digital audio applications. In a PCM stream, the amplitude of the analog signal is sampled regularly at uniform intervals, and each sample is quantized to the nearest value within a range of digital steps.

BLOCK DIAGRAM OF PCM



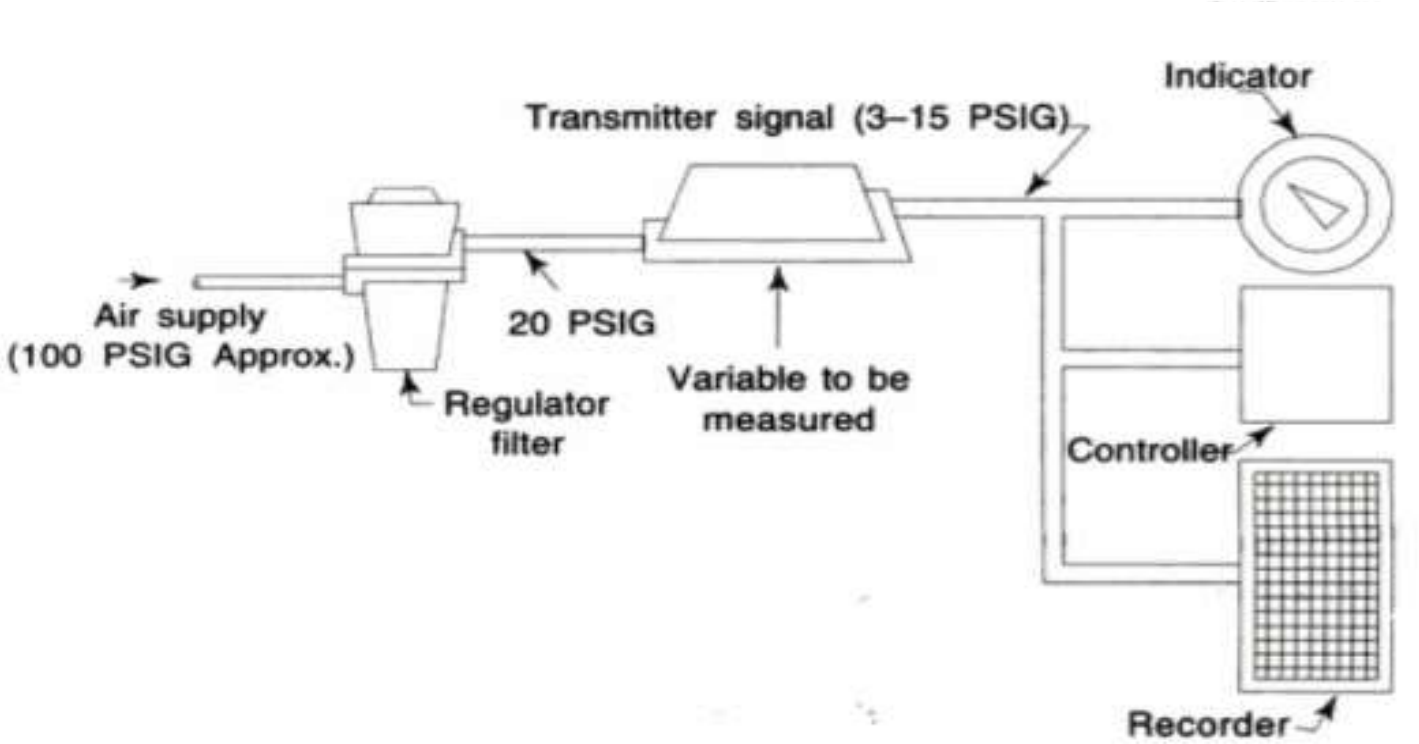
To obtain PCM from an analog waveform at the source (transmitter end) of a communications circuit, the analog signal amplitude is sampled (measured) at regular time intervals. The sampling rate, or number of samples per second, is several times the maximum frequency of the analog waveform in cycles per second or hertz. The instantaneous amplitude of the analog signal at each sampling is rounded off to the nearest of several specific, predetermined levels. This process is called **quantization**. The number of levels is always a power of 2 -- for example, 8, 16, 32, or 64. These numbers can be represented by three, four, five, or six binary digits (bits) respectively. The output of a pulse code modulator is thus a series of binary numbers, each represented by some power of 2 bits.

At the destination (receiver end) of the communications circuit, a pulse code demodulator converts the binary numbers back into pulses having the same quantum levels as those in the modulator. These pulses are further processed to restore the original analog waveform.

PNEUMATIC SYSTEM

In a pneumatic telemetry system, compressed air is used to communicate the values of measured quantity from one location to the other location. A block diagram of a pneumatic telemetry system is shown in Fig. 16.14. It consists of a source of compressed air, a transmitter which modulates the air supply, output tubing or piping to carry the modulated air signal to the receiving point, and one or more receivers, connected in parallel. A receiver may be a simple pressure gauge or other indicators, a recorder, an automatic controller, or some other suitable device. The air supply must be clean, dry air at constant pressure, which is achieved by the regulator filter. A clean and dry air supply increases the reliability of the system.

PNEUMATIC SYSTEM



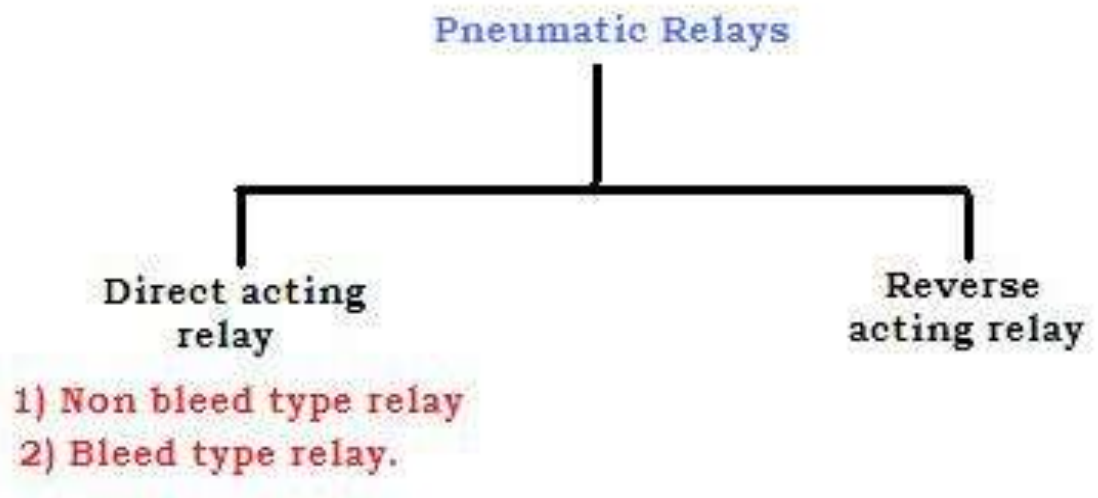
The air output pressure of the transmitter is proportional to the value of the variable being measured. An output-pressure range of 3 to 15 psi is most common, and usually requires use of a 20 psig air supply pressure. The transmitter is adjusted so that its output is 3 psi when the variable is at the lowest value to be measured. As the variable increases, the transmitter output increases on the proportion, linearly, to be 15 psi when the variable has increased to its maximum value.

Pneumatic telemetry systems have one serious disadvantage that the time lag in a pneumatic system increases with the distance between transmitter and the receiver and thus, this system becomes impracticable for larger distances.

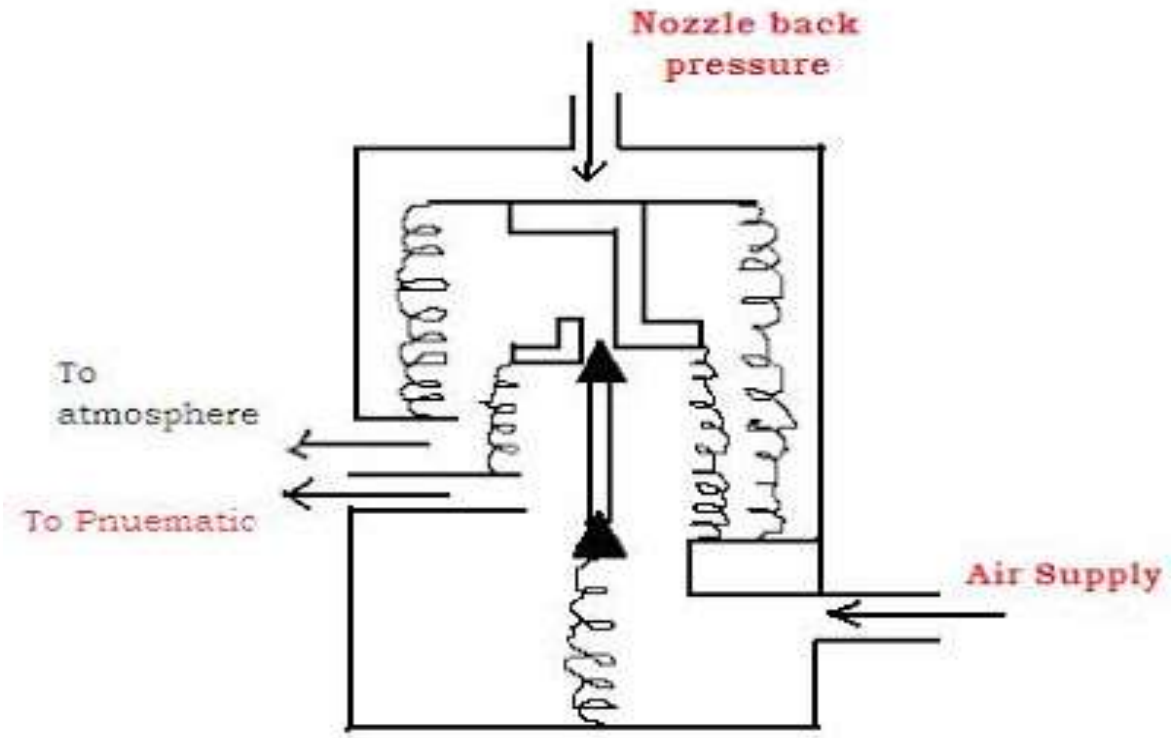
PNEUMATIC RELAY

one of the main elements of pneumatic automatic control; a contr ol element in which the sensing member is a diaphragm(usually el astic) or bellows, and the mechanopneumatic converter of the me chanical displacement into a change in pressure

of air or a gas is a nozzle and baffle.



NON BLEED TYPE RELAY



CONSTRUCTION

1) The non-bleed relay is a type of direct acting relay, it consists of two bellows connected to the force beam

2)It also consists of a rod, and plugs are connected to the both ends of the rod.

3)The spring is connected to plug at the downward side.

4)The air supply is given from the bottom side of the non bleed type of relay.

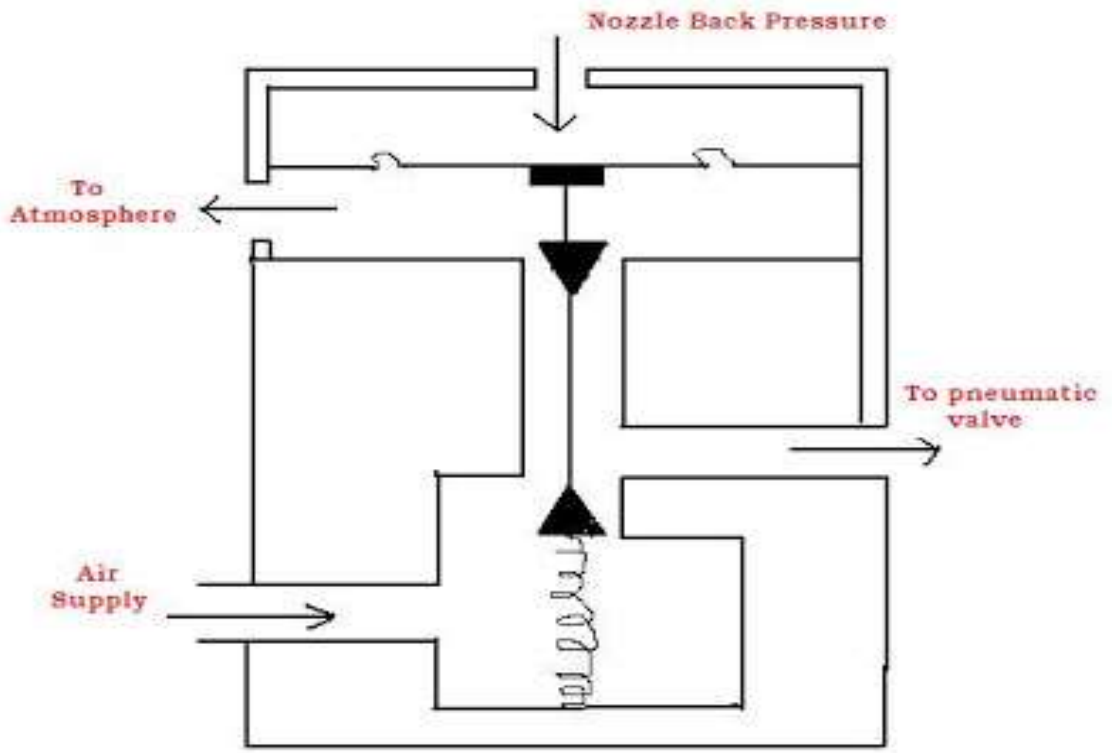
WORKING

In direct acting relays, the input is directly proportional to the output. So when the input increases the output also increases. And when the input decreases, the output also decreases.

When the nozzle back pressure increases, there is a movement of bellows. The bellows move towards the downward direction. Then the air supply is from the bottom side of relay, so there is a restriction to the air supply, because the nozzle back pressure increases. Hence the output also increases. The air bleed stops when equilibrium condition is obtained, no loss of pressurized air at steady state position.

When the nozzle back pressure decreases , the bellows starts moving to upward direction. The air supply is given to the spring from the downward direction, hence the spring moves in upward direction. There is no restriction to the air, because the nozzle back pressure decreases. Hence the output also decreases. The air bleed stops when equilibrium condition is obtained, no loss of pressurized air at steady state position.

BLEED TYPE RELAY



CONSTRUCTION

1) The bleed type of relay is consists of a main diaphragm on which the nozzle back pressure acts.
2)The diaphragm is connected to the metal rod.
3)At the both ends of metal rods the plugs are connected.
4) The plugs are connected to the spring.
5) The air supply is given to the spring from the bottom side of the relay.

WORKING

The bleed type of relay is a type of direct acting relay. In this relay, the output is directly proportional to the input. Means if the input increases, the output also increases. And if the input decreases, the output also decreases.

When the nozzle back pressure increases, this back pressure acts on the metal diaphragm. The metal diaphragm moves in downward direction because of increase in pressure. As the diaphragm is connected to the rod, the metal rod and plugs are also moves in downward direction. Then the air supply is given to the spring from the bottom side of the relay. But the air is restricted by the nozzle back pressure, therefore spring also moves in downward direction. so the output also increases.

When the nozzle back pressure is decreases, that back pressure acts on the metal diaphragm. The metal diaphragm moves in up direction because the pressure is decreases. The air supply is given to the spring from the bottom side of the relay. Because of decrease in pressure, the spring moves in up direction. Therefore the plugs and rods are also moves in up direction. so the output gets decreases.

In all position of valve excepts the position of shut off the air supply, air continues to bleed in atmosphere even after equilibrium condition is obtained between nozzle back pressure & control pressure.

TRANSMISSION CHANNELS

- Transmission of the data is very much important in the services related to the data communication and the information technology as this technique makes use of the data processed in the order to forward the same to the end user.
  The communication of the data mainly involves the processing of the data as well as the transmission of the data and for the communication of the data, following devices play a very critical role and these devices should work in a very efficient manner.

Transmission Channels

Transmission channels are generally referred to as the communication channels and these act as the links, which help in the transmission of the data from one device in a particular network to the other. A transmission channel has the ability to make use of the various types of the media like the following –

1. Physical connection lines –

a. Twisted pair of the copper wires.
b. Coaxial cables.
c. Optical fiber.

2. Micro – wave lines –

a. 'Line of sight' earth micro wave (from tower to the tower)
b. Radio/wire – less transmission waves (AM/FM)
c. Satellite

WIRE LINE CHANNEL

1-Wireline channels:

-Telephone network makes extensive use of wire lines for voice signal transmission as well as data and video transmission.

- *Twisted pair wire lines*
- *coaxial cables*

Feature	Twisted pair	Coaxial cable
Bandwidth	1khz-100khz	1MHz-100Mhz
Noise	Signal transmitted through it are distorted in both Amplitude and phase and further corrupted by additive noise. Prone to cross talk interference from physical adjacent channels	Signal transmitted through it are distorted in both Amplitude and phase and further corrupted by additive noise.

Wireline Channel

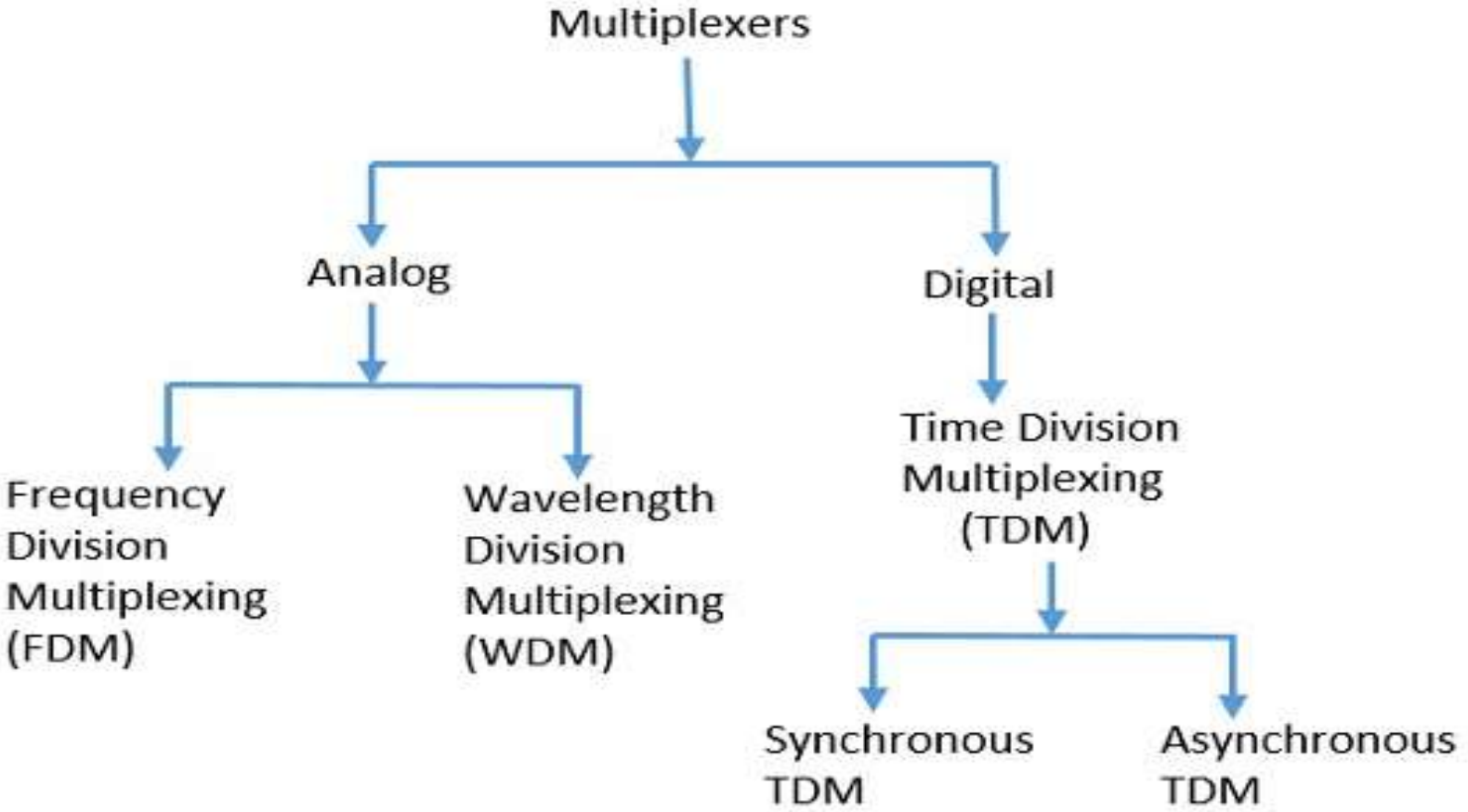
Too many noises?	Shielded against electromagnetic noise
Large signal attenuation?	Use repeaters
Data speed too low?	Upgrade to coaxial cable
Data speed still too low?	Upgrade to optical fiber

- The telephone network makes extensive use of wire lines for voice signals as well as data and vide transmission.
- Twisted pair wire lines and coaxial cable provided relatively modest bandwidth of kHz and for coaxial cable it has MHz range.
- Signal transmitted through this channel distorted both through amplitude, phase and further corrupted by additive noise.

MULTIPLEXING

- **Multiplexing** is the process of combining multiple signals into one signal, over a shared medium.
- The process is called as **analog multiplexing** if these signals are analog in nature.
- If digital signals are multiplexed, it is called as **digital multiplexing**.
- Multiplexing was first developed in telephony. A number of signals were combined to send through a single cable. The process of multiplexing divides a communication channel into several number of logical channels, allotting each one for a different message signal or a data stream to be transferred. The device that does multiplexing, can be called as a **MUX**.

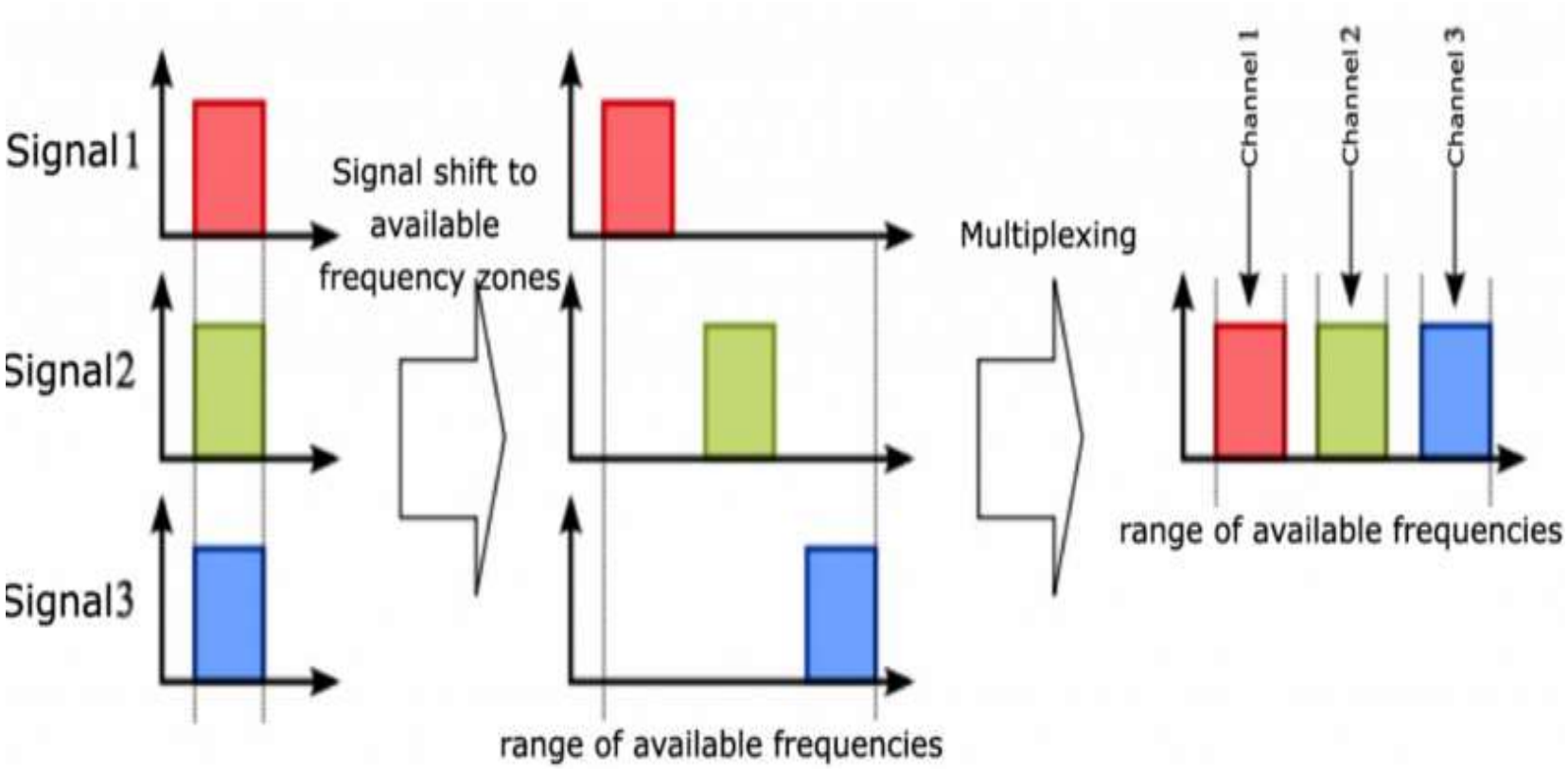
TYPES OF MULTIPLEXING



FREQUENCY DIVISION MULTIPLEXING

- In telecommunications, **frequency-division multiplexing** (**FDM**) is a technique by which the total bandwidth available in a communication medium is divided into a series of non-overlapping frequency bands, each of which is used to carry a separate signal.
- The multiple separate information (modulation) signals that are sent over an FDM system, such as the video signals of the television channels that are sent over a cable TV system, are called baseband signals. At the source end, for each frequency channel, an electronic oscillator generates a *carrier* signal, a steady oscillating waveform at a single frequency that serves to "carry" information. The carrier is much higher in frequency than the baseband signal. The carrier signal and the baseband signal are combined in a modulator circuit. The modulator alters some aspect of the carrier signal, such as its amplitude, frequency, or phase, with the baseband signal, "piggybacking" the data onto the carrier.

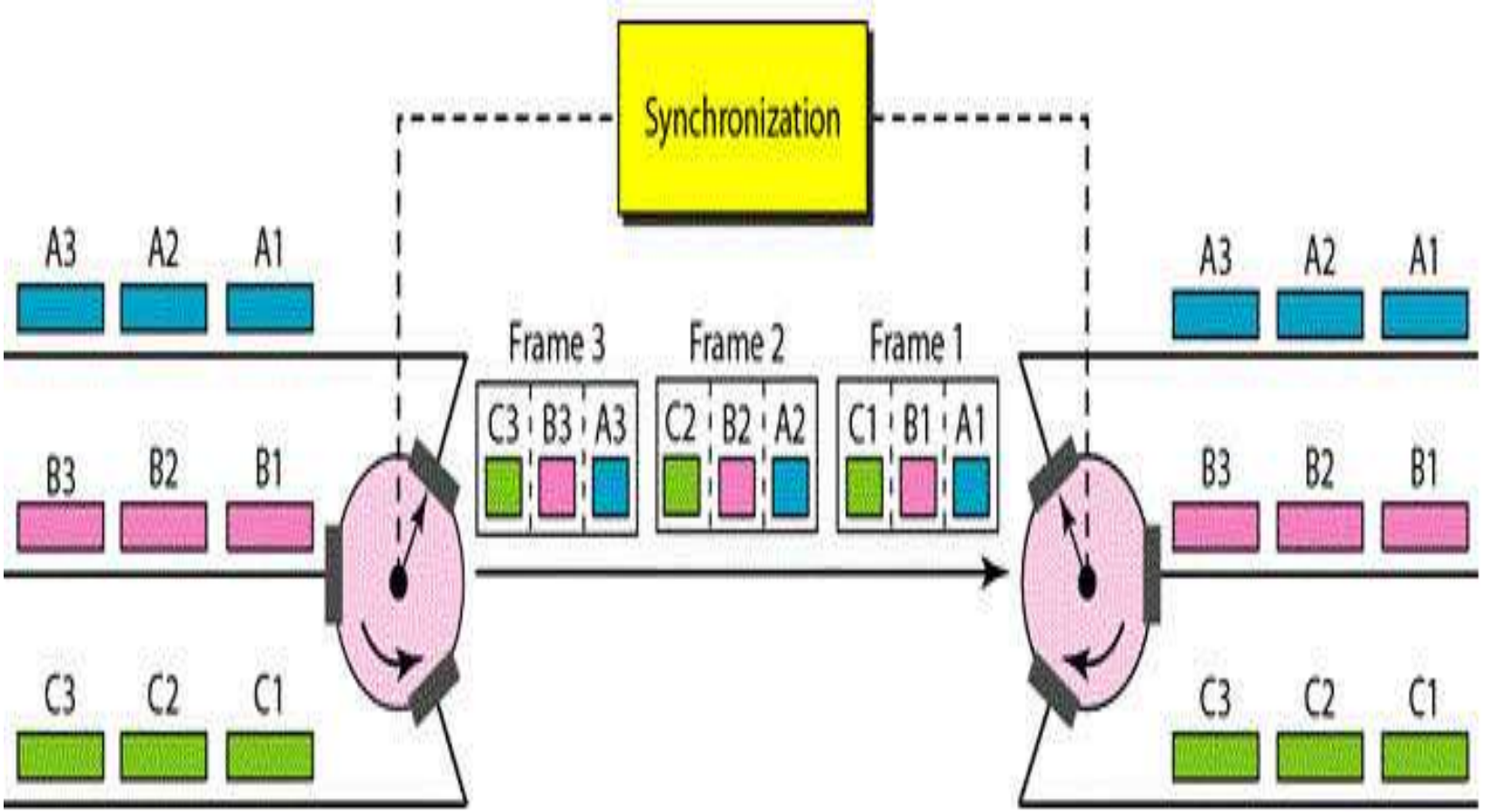
FDM


Signal 1
Signal2
Signal3
Signal shift to
available
frequency zones
range of available frequencies
Multiplexing
Channel 1
Channel 2
Channel 3
range of available frequencies

TIME DIVISION MULTIPLEXING

- Time-division multiplexing (TDM) is a method of putting multiple data streams in a single signal by separating the signal into many segments, each having a very short duration. Each individual data stream is reassembled at the receiving end based on the timing.
- The circuit that combines signals at the source (transmitting) end of a communications link is known as a multiplexer. It accepts the input from each individual end user, breaks each signal into segments, and assigns the segments to the composite signal in a rotating, repeating sequence. The composite signal thus contains data from multiple senders. At the other end of the long-distance cable, the individual signals are separated out by means of a circuit called a demultiplexer, and routed to the proper end users.

TDM


Synchronization
A3
A2
A1
B3
B2
B1
C3
C2
C1
Frame 3
Frame 2
Frame 1
C3 B3 A3
C2 B2 A2
C1 B1 A1
A3
A2
A1
B3
B2
B1
C3
C2
C1