Data Transmission and Telemetry

VTU B.E. (EEE) VI Sem Sensors & Transducers
Module 4 Part 1

Data Transmission and Telemetry

Contents

- Data/Signal transmission; Mechanical transmission-Hydraulic transmission- Pneumatic transmission-Magnetic transmission-Electric type of transmitters-Converters;
- Telemetry-Definition-General telemetering system; Types of telemetry systems-Voltage telemetering system-Current telemetering system-Position (Or ratio) telemetering system-RF telemetry system, Introduction to types of signals and transmission paths-Modulation and demodulation-FM telemetry system-PAM telemetry system; Highlights;

DATA/SIGNAL TRANSMISSION

The terms "Data transmission" and "Telemetry“ refer to the process in which the measurand is transferred to a remote location for the purpose of being processed, recorded and displayed.

"transmitters" could be considered as devices which transmit the value of the primary variable at a considerable distance from the primary element. If transmission is to be carried over very long distances, then devices are known as "telemeters".

For transmission purposes, the measured variable is converted into a transmittable signal (either pneumatic or electrical), so that it can be received by a remote indicating, recording, Or controlling device. The selection of transmission device depends upon the nature of the variable and the distance the signal is required to be sent.

DATA/SIGNAL TRANSMISSION

For data transmission various methods have been developed; the choice of a particular method depends upon :

(i) The physical variable;

(ii) The distance involved.

• The hydraulic and pneumatic methods are employed for transmission over a short distance.

— The pneumatic type transmission devices are generally suitable for transmission up to maximum distance of 200 m.

-The electrical/electronic methods are suitable equally for short as long distance transmission. Generally short transmission is carried out on own communication connections between sending and receiving devices.

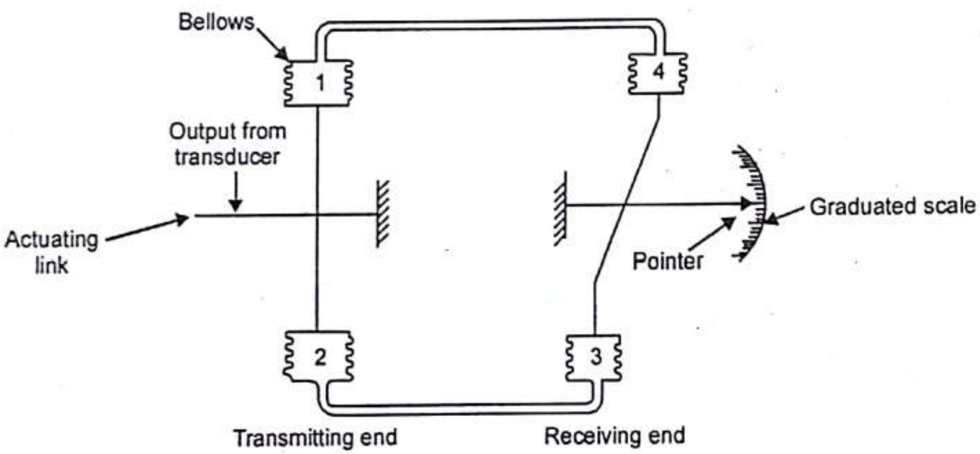
— The telemeters which are designed for long-distance transmission may be designed to transmission over their own wire or over phone wires or by microwave.

DATA/SIGNAL TRANSMISSION

Mechanical Transmission

The "rack and pinion arrangement" and the "gear trains" as used in Bourdon-tube pressure gauge and dial indicator gauge constitute mechanical transmission. They amplify the displacement and also transmit the signal to a pointer which moves across a calibrated

Hydraulic Transmission



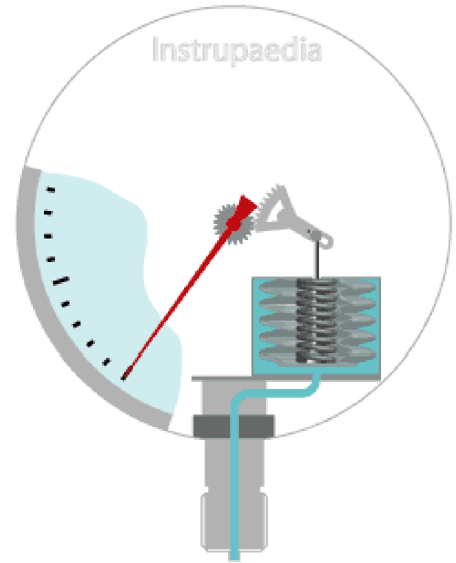
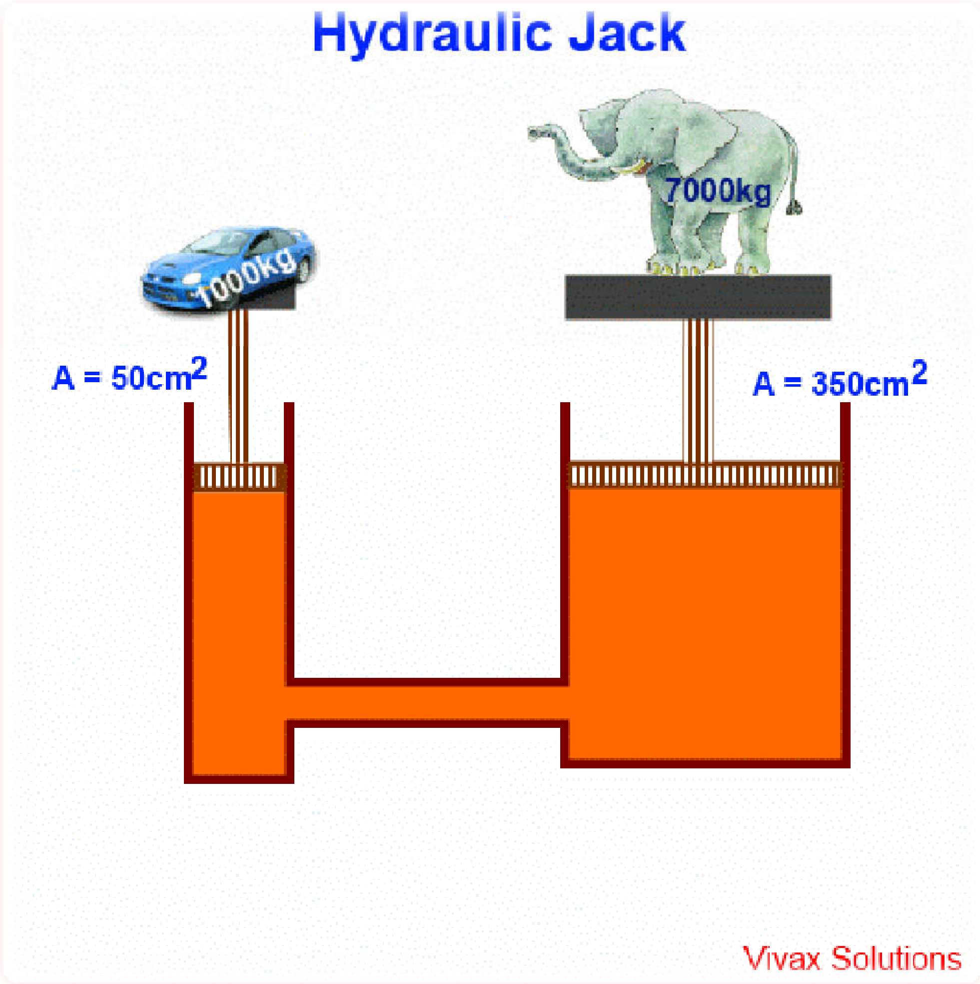


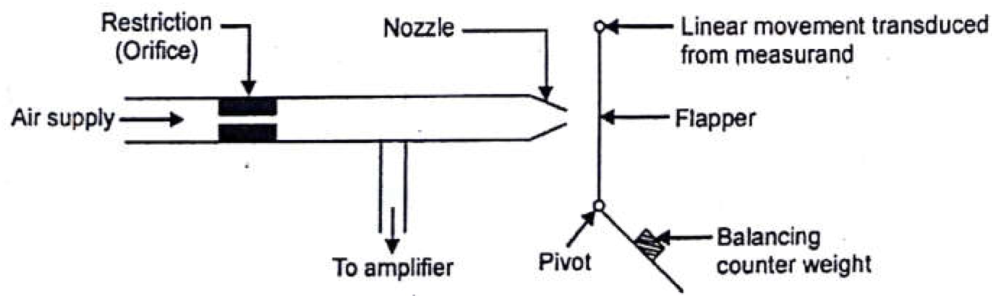
Fig. shows the hydraulic method of transmission, which is commonly used.

Here four bellows are employed, two at the transmission end and two at the receiving end. The four bellows are connected by an impulse pipeline and the whole system is filled with liquid. When the actuating link, on the transmission end, is operated by the measurand, then One bellow is expanded and Other is contracted. This expansion and contraction is communicated to receiving end, which moves the receiving pointer an equal amount. The purpose of using two bellows on either side is to compensate for changes in ambient temperature.


Hydraulic Jack
7000kg
1000kg
A = 50cm2
A = 350cm2
Vivax Solutions

DATA/SIGNAL TRANSMISSION

- Pneumatic Transmission



- Fig., shows the one of the pneumatic methods of transmission (Flapper nozzle mechanism).
- It consists of an open nozzle which is supplied with air through a restriction/orifice (its diameter being smaller than nozzle diameter for proper functioning). In front of the
- nozzle there is a flapper which is positioned by the measuring element. The force on the flapper is produced by a transducer which Converts the measurand into linear displacement. The flapper is pivoted about a point and the other end, it contains some balancing counter weight.

TELEMETRY

- Telemetry is defined as a technology Which allows users to collect information from inaccessible and inconvenient locations and transmit it to the accessible places to process, record and display the information in presentable form.

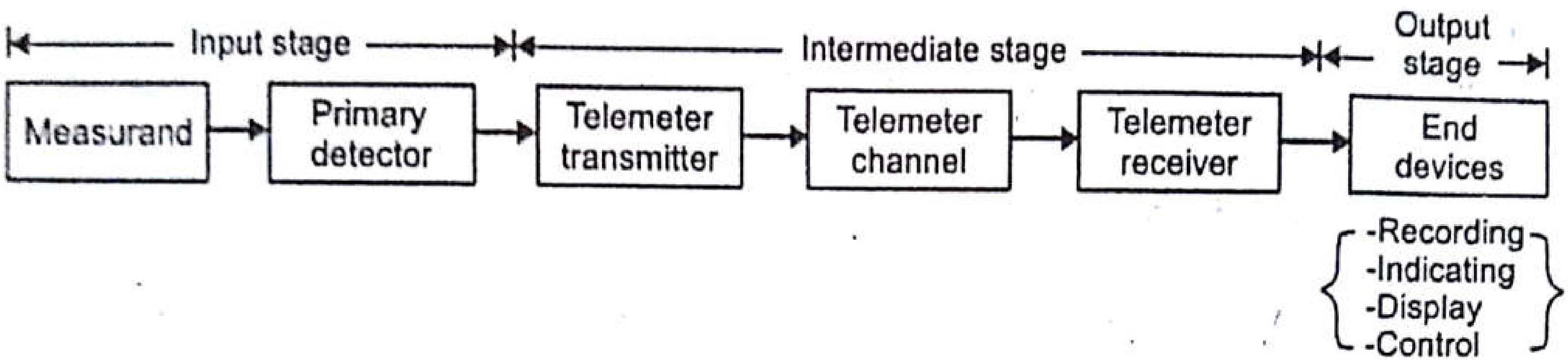
or

- Telemetry (as the name implies) means measuring at a distance.

Draw the general block diagram of telemetry system and explain briefly.

Block diagram of a general telemetering

- Fig. shows the block diagram of a general telemetering.



Block diagram of a general telemetering

In the primary stage', the "measurand" is detected by the "primary detector" and sent to the channel transmitter.

The 'intermediate stage' consists of the following three elements

(i) Telemeter transmitter;

(ii) Telemeter charnel;

(iii) Telemeter receiver.

The "telemeter transmitter" converts the Output of the primary detector into an electrical signal and transmits it to the "telemetering channel". This signal (in electrical form) is received by a "telemeter receiver" placed at a remote location. This receiver converts the signal into a usable form and is indicated or recorded Or displayed by the "end device“ (output stage) which is calibrated in terms of the measurand. The control device is provided to take corrective action on measurand through feed back loop to control the output.

For telemetry, some basic instruments are required for :

— translating the measurand into a suitable electrical signal;

— processing and transmission of signal over the channel;

— receiving the signal and converting it into a readily comprehensible reading.

Types of Telemetry Systems

The telemetry systems Can be classified as follows :

I. According to the link between the telemeter transmitter and the telemeter receiver :

l. land line (D.C.) telemetry system :

(i) Voltage telemetering system.

(ii) Current telemetering system.

(iii) Position (or ratio) telemetering system.

2. Radio frequency (RF) telemetry system :

— Frequency telemetering system

— Pulse telemetering system.

- A.C. telemetering system is employed both for land line and radio-frequency airborne telemetry techniques. A.C. telemetry is employed for sensors, which provide an A.C. Output or voltage to frequency converters. The data is available in the form of current or voltage, which is usually very weak for such transmission. Hence it is modulated by an A.C. carrier wave generated by an oscillator.

Types of Telemetry Systems

According to the form in which the information is transmitted :

1. Analog telemetry system. Here information is transmitted in the form of current voltage, position and frequency.
2. Digital telemetry system. In this system the information is transmitted in the form of "pulses".

o The "land line telemetry system" comes under a category of a system with direct physical link. This physical link between the transmitter and receiver is nothing but a 'telemeter channel'. This link can be a cable used for telephony or telegraphy or a power carrier line. — This system is most suitable for short distance telemetry.

- In "radio frequency (RF) telemetry system" there is no physical link between the telemeter transmitter and the telemeter receiver. The link between the transmitting end and the receiving end is established through the radio links.

Advantages and disadvantages of land line telemetry system :

Advantages :

(i) Very effective system for short-distance transmission (as the telemeter or communication Channel can be established with the help of a Simple cable or transmission line).

(ii) Very simple circuitry is required for the measurement set-up.

(iii) The information can be transmitted (in the form of voltage current and position) easily by the use of modem electronic circuitry available now-a-days.

(iv) A wide variety of detectors (or the primary sensing elements) are available which produce electrical signal (voltage or current) in relation with the variable being measured at the system's input Stage.

Disadvantages :

(i) Limited frequency response.

(ii) Signal multiplexing is very difficult.

(ii) distortions in the transmission links are directly incorporated in the main system.

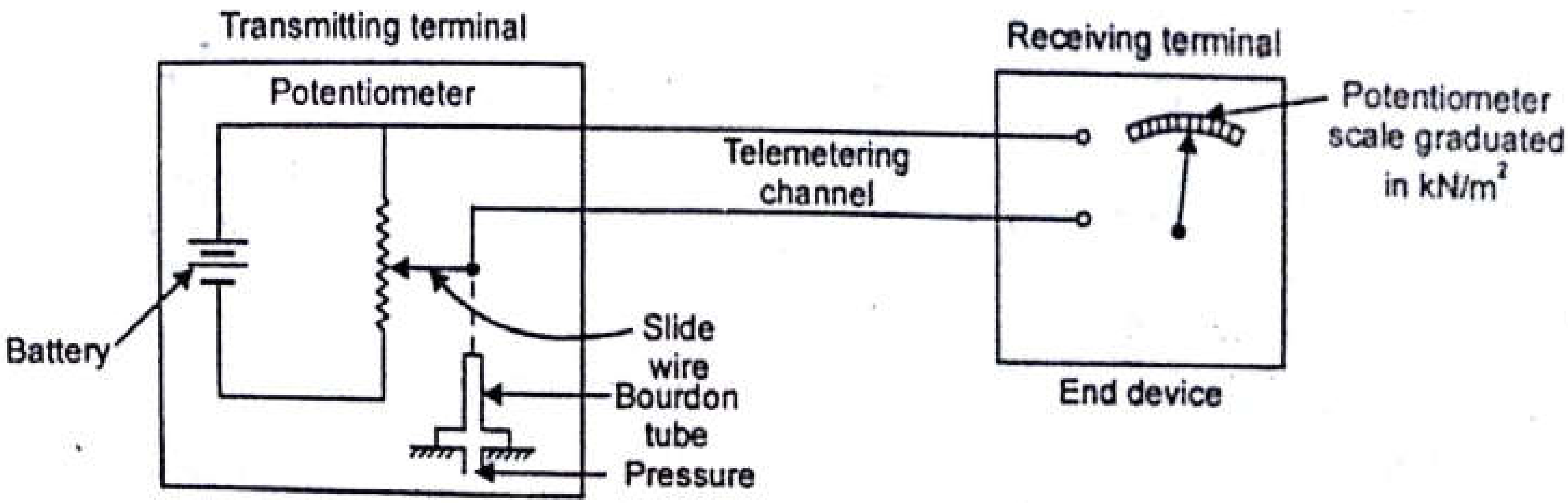
(iv) The information transmitted through the link is affected by the EMI effects of main frequency from nearby cable.

(v) The effects of thermoelectric emfs are significant in Case of telemetry systems transmitting D.C. signals.

Explain the working of landline voltage telemetry system.

Voltage telemetering system

In these systems' the measurand is converted to A.C Or D.C voltage. For such systems, the self-balancing potentiometers are the usual receivers.



Voltage telemetering system

Construction :

— It consists of a slide wire potentiometer connected in series with a battery at the transmitting terminal. The sliding contact is connected to the bourdon tube used for pressure measurement. — At the receiving terminal a null balance D.C. potentiometer or a recorder is used.

— In between the transmitting terminal and the receiving terminal, a pair of wires form a telemeter channel.

Working :

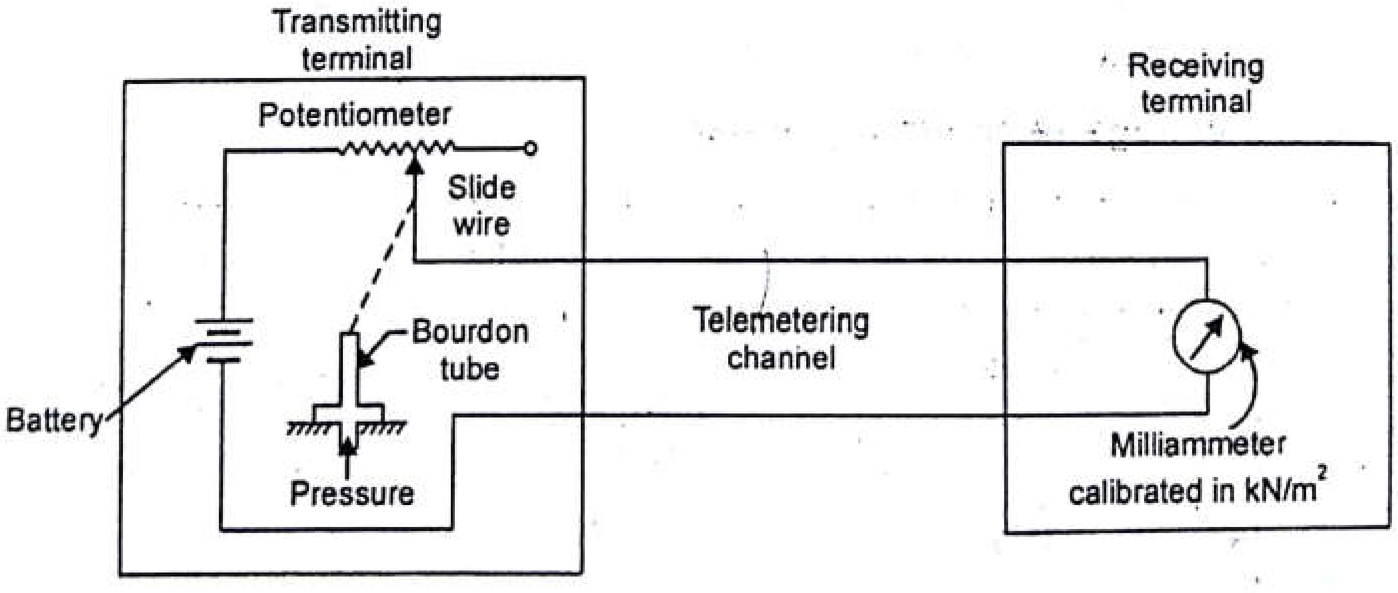
— With the change of pressure in the system, the bourdon tube actuates the slider of the potentiometer. Consequently, the voltage changes at the transmitting end. — This voltage is carried by the telemetering channel to the receiving terminal, where it is measured with the help of null balanced D.C. potentiometer indicator calibrated in terms of pressure scale (kN /m^2) or recorded if required. Some systems make use of the deflection type indicators to measure voltage; these indicators are calibrated -for the line resistance. Basically, a null balance D.C. potentiometer reduces the current carried by the telemetering channel with negligible resistance. Such systems use primary sensing elements (detectors) such as microphones, tachometers, bourdon tubes Or differential transformers as all produce voltage signal.

Disadvantage : These systems are affected by line resistance, leakage, interfering Sources nearly, noise and require higher-quality circuits than current systems, especially for low voltages.

- The voltage telemetering system is limited for transmission up to 300 metres distances.
- A voltage telemetering system is very much suited for adding several input voltages in series provided the measurement is linear However, this system needs a relatively more expensive receiving terminal. This system is normally not suitable to the use of many receivers at the same time.

Explain the working of landline current telemetry system.

Current telemetering system



Current telemetering system

Construction :

— It consists of a slide-wire potentiometer in series with a battery. The slider is connected to the bourdon tube which measures pressure. At the receiving terminal, a multimeter is connected in series, which is calibrated in terms of pressure scale (kN/m2).

Working/Operation :

— When the pressure in the system changes, the bourdon tube moves the sliding contact thereby changing the current at the transmitting terminal.

— This current passes to the receiving terminal through the pairs of wires (telemetering Channel) and at the receiving terminal it is 'measured by the milliammeter.

These days, the following improved versions of this system are used

1. Motion balance system;

2. Force balance system

1. Motion balance current telemetering system :

In this system slide-wire potentiometer is replaced by a position detector like inductor transducer or capacitor transducer.

Current telemetering system

Advantages of current telemetering system :

(i) The current systems can develop higher voltages than most voltage systems and, consequently, it can be made more immune to the effect of thermal and inductance voltages in the interconnecting leads as well as line resistance,

(ii) Simple D.C. milliammeters can be used with special calibration for line resistance.

(iii) Several receivers can be operated simultaneously.

(iv) The received signals can be added or subtracted directly.

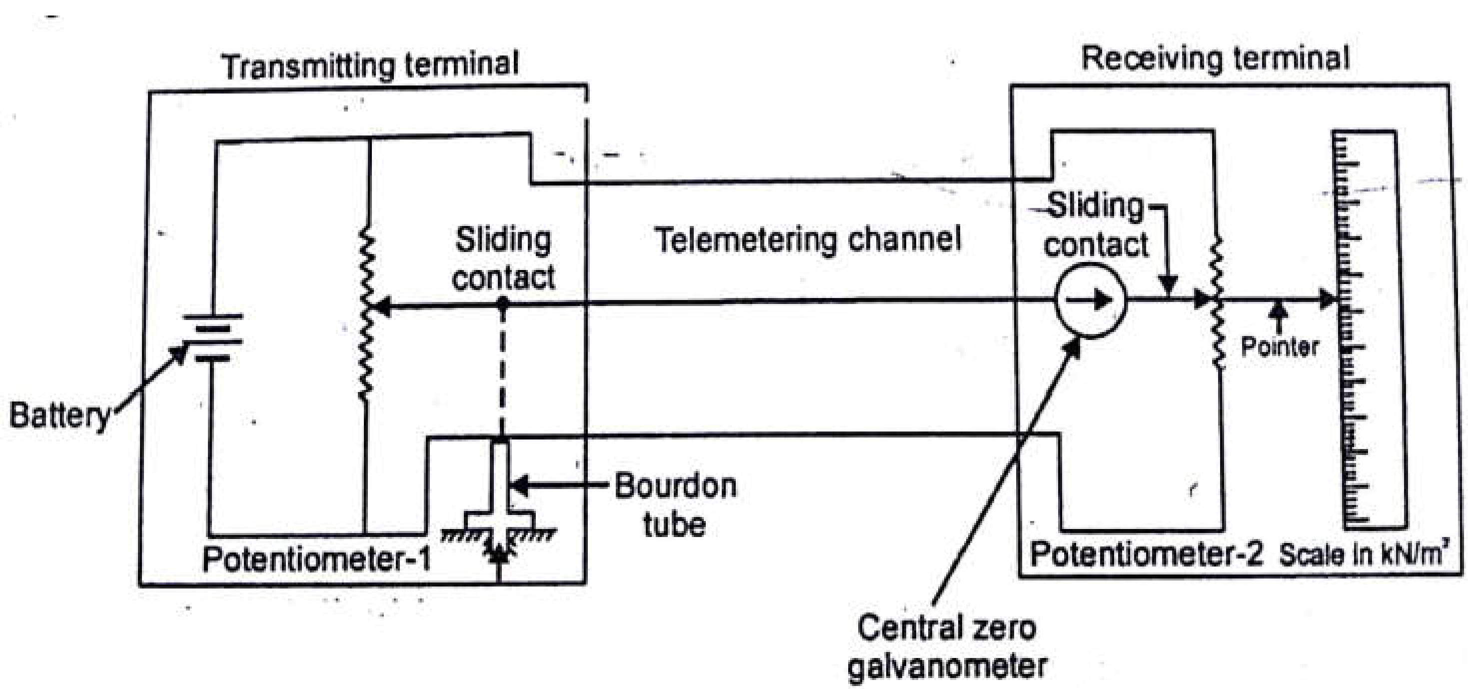
(v) Changes in line resistance are compensated by basic feedback method.

(vi) The response of the system to an input change is almost instantaneous.

(vii) The energy level is adequately high to minimise the effects of extraneous voltages.

- o This system is also not suitable for long distance since the current output is varied by means of an adjustable resistance in the line.

Position (Ratio) Telemetering



Position (Ratio) Telemetering

This system transmits and reproduces the measured variable by positioning variable resistors or other electrical components in a bridge circuit form so as to produce proportional changes at both the transmitter and the receiver ends.

Construction and working :

— It consists of two potentiometers 1 and 2, 1 at the transmitting end and 2 at the

receiving end. These potentiometers are operated by a common power supply. — When the pressure is applied the bourdon tube positions the sliding contact at the receiving end. If the sliding contact at the receiving end is positioned until the centre zero galvanometer shows zero, then the position of the contact will assume the same position as the contact at the transmitter.

— The receiving contact moves the pointer which indicates on the scale the pressure which is being measured.

The principle involved is the same as that of a Wheatstone bridge.

o The "synchromotor (selsyn) telemetering System (purely an A.C. system)" is the most common example of position or ratio telemetering. Another example being "inductance bridge

— In this system angular input displacement is converted into relative magnitude of three phase A.C. voltages.

Position (Ratio) Telemetering

Advantages :

(i) Requires no intermediate amplifiers or conversions.

(ii) Relatively inexpensive.

(iii) Minimum moving parts, so the maintenance is low.

(iv) Instantaneous response.

(v) Power taken for their-operation directly from the line.

Limitation : These systems are affected by excessive line resistance.

Radio Frequency (RF) Telemetry System

In this telemetry system the link between the transmitting end and the receiving end is established through the "radio links" (there being no physical link).

Example : The controlling of aircraft on test flights, rockets and spacecrafts.

The RF telemetry systems are more suitable for transmission of data Over distances more than I km.

In this system, along with certain band of the radio frequency spectrum, a

microwave link above 4 MHZ is also allocated. This is because the radio-waves.at these frequencies travel in straight lines with some repeaters, located every 30 km to 60 km, on high buildings Or towers.

Types of Signals and Transmission Paths

Introduction to Types of Signals and Transmission Paths
Types of Signals
Encoders produce the following two types of electrical signals :
1. Analog signals :
— A telephone, radio broadcast or TV signals are very common types of signals for use of general public.
— These are represented by voltage waveforms that have different amplitudes at different instants of time.
2. Digital signals :
These signals comprise of pulses occurring at discrete intervals of time.
— The pulse may occur singly at a definite period of time or as group.
— These signals play a very important role in the transmission and reception of coded messages.

Line communications :

- The most common form of line communication is telephone and telex networks,

These are carried out using overhead lines on poles and also by use of buried cables,

- In VHF range and above, line communications are carried out the use of wave guides. The following points worth noting :

(i) In the signal propagation takes place by means of radio provided the cross-sectional dimensions of the proper wave guide rectangular hollow pipe maintain a proper relation with a wavelength of the wave.

(ii)Wave guides are employed as transmission lines for microwave communication in the frequency range 2 GHz to 11 GHZ.

(iii) Wave guides do not transmit signals IV10tv cut-off frequency and can have band-width in excess of 20% of their operating frequencies.

(iv) Optical Wave guides have been developed in the form of glass fibres to carry light modulated signals at frequencies of' the order of 100 THz (l Tera hertz =10^{12} hertz) from lasers. This will have a very vast capacity to carry signals.

Radio communications :

- In this type of communication propagation of signals through atmosphere is used.

Non-directional antennas are employed for broadcast transmission and reception while directional antennas are employed in radio telephony and Other point-to-point links.

- Radio waves are commonly termed as unbounded waves but generally they are bounded by the surface of earth and various ionospheric conducting layers that lie between height of 50 km and 400 km above ground.

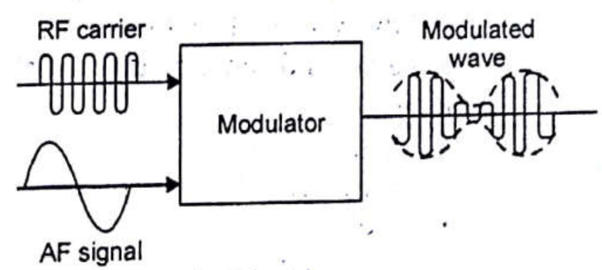
Major Radio Frequency Bands

Major Radio Frequency Bands

	Name	*Frequencies*		
1.	Very low frequency (VLF)	Below 30 kHz	...	Radio location equipment
2.	Low frequency (LF)	30 kHz to 300 kHz	...	Wartime radio navigation
3.	Medium frequency (MF)	300 kHz to 3 MHz	...	Includes AM radio broadcast band
4.	High frequency (HF)	3 MHz to 30 MHz	...	Radio
5.	Very high frequency (VHF)	30 MHz to 300 MHz	...	Includes FM broadcast band and television VHF channels

Modulation and Demodulation

Several signals out of different types of signals that are generally encountered in communication systems have frequency spectra that is not suitable for direct transmission especially when atmosphere is used as the transmission channel. In such a case, the frequency spectra of the signal may be. trans).ted by modulating high frequency carrier wave with signal. In order to transmit and receive the intelligence (code, voice, music etc.) successfully, the following two processes are essential :



(i) Modulation;

(ii) Demodulation.

Modulation :

Definition :

Modulation may be defined as follows

- Modulation is the process of combining the low:-frequency signal-with a very high- frequency radio wave called 'carrier wave (CW). The resultant wave is called modulated carrier wave. This job is done at the transmitting station.

Or

Modulation is a process in electronic circuits by which the characteristics of one wave form (carrier) is modified by the variations in another wave (audio signal).

Or

Modulation is' process of combining an audio-frequency (AF) signal with a radio frequency (RF) carrier. wave. (Fig.).

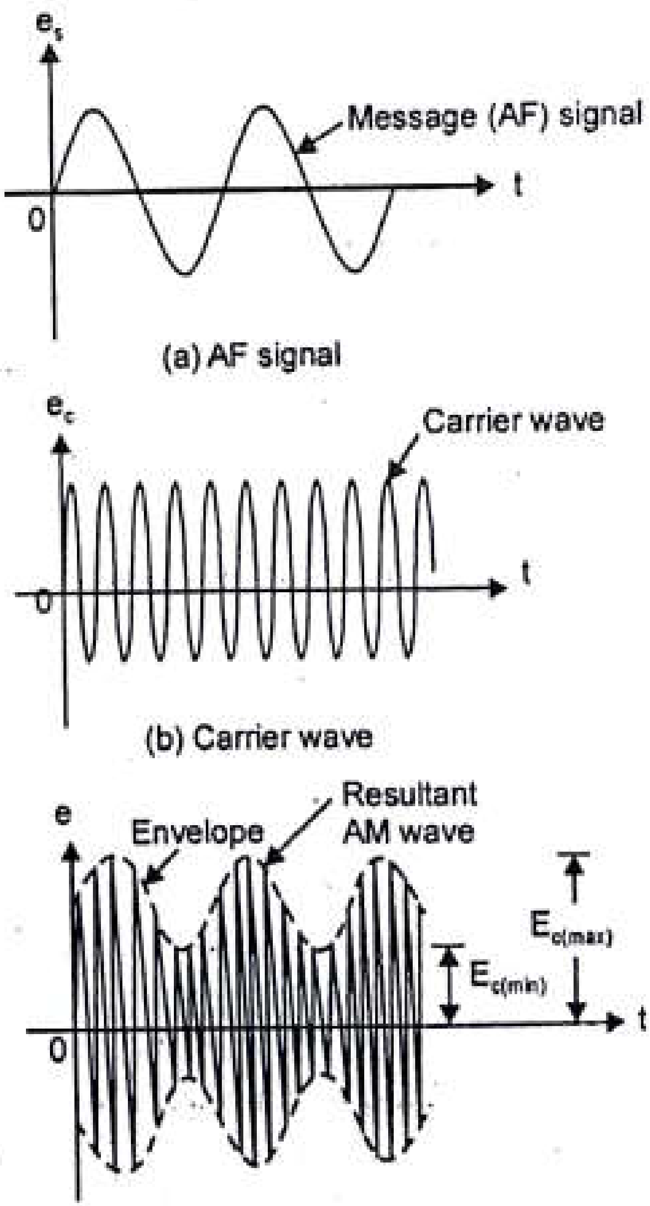
Explain the need for Modulation

Need of modulation

In electronic communication, the modulation is necessary for the following reasons :

1. Modulation increases operating range.
2. It reduces the size of transmitting and receiving antennas.
3. It permits transmission without wire.
4. It is extremely difficult to radiate low frequency signals through earth's atmosphere in the form of electromagnetic energy.

- Methods of modulation
- For a sinusoidal carrier wave, the mathematical expression is given as
- $e = Ec \sin(\boldsymbol{\omega} t + \Phi) = Ec \sin(2\boldsymbol{\pi} fct + \Phi)$
- Thus, the waveform can be varied by any of its following three factors or parameters :
- (i) Ec — The amplitude ;
- (ii] fc — The frequency ;
- (iii) — The phase.
- Accordingly, there are three types of sine-wave modulations known as :
- 1. Amplitude Modulation (AM)
- 2. Frequency Modulation (FM)
- 3. Phase Modulation (FM).



(a) AF signal

(b) Carrier wave

(c) Modulated wave

Explain briefly amplitude modulation.

Amplitude modulation (AM) :

The process by which the amplitude of a carrier wave is varied in accordance with the modulating signal is called amplitude modulation.

The process of amplitude modulation is shown graphically in Fig.— For the sake of simplicity, the AF/message signal has been assumed sinusoidal [Fig. (a)].

— The carrier wave by which it is desired to transmit the AF signal is shown in (Fig, (b)).

— The resultant wave called modulated wave is shown in [Fig. (c)]. The function of the modulation is to mix these two waves in such a way that (a) is transmitted along with (b).

— The fluctuations in the amplitude of the carrier wave depend on the signal amplitude and the rate at which these fluctuations take place depends on the frequency of the audio signal

— All stations is broadcasting on the standard broadcast band (550 — 1550 kHz) use AM modulation.

— Percent modulation indicates the degree to which the AF signal modulates the carrier wave,

Limitations of amplitude modulation :

Following are the limitations of amplitude modulation :

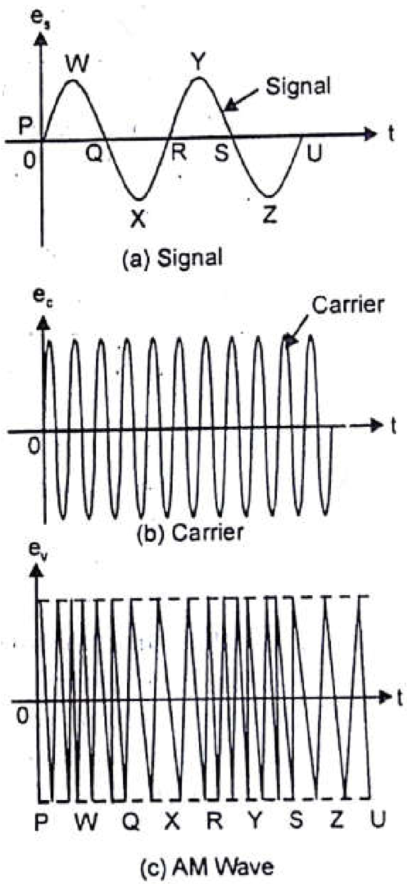
i. Smaller operating range.

2. Poor efficiency.

3. Poor audio quality.

4. Noisy reception.

Frequency modulation (FM)



The process by which the frequency of a carrier wave is varied in accordance with the modulating signal is called frequency modulation.

The process of frequency modulation is shown graphically in Fig.

The three waves shown in the figure are : (a) Signal; (b) Carrier; (c) The resultant frequency modulated wave.

When a signal of frequency fs is modulated With carrier wave of frequency f c, a resultant modulated wave is produced.

The following points are worth noting

(i) The amplitude of the modulated wave is the same as that of the carrier wave.

(it) The frequency of the modulated wave varies in accordance with the message signal.

Advantages :

l. Better audio quality

2. High transmission efficiency.

3. Noiseless reception.

Limitations :

1. Smaller area of reception.

2. Wider channel is needed.

3. Equipment used is more complex and costly.

Pulse modulation

:

Pulse modulation is a technique of modulating the analog signal and converting it into corresponding values. In this process the instantaneous voltage of the analog signal is Sampled

Pulse Amplitude Modulation (PAM) :

— PAM Can. be generated by using an AND gate.

— PAM can be demodulated by passing through low pass filter with cut-off frequency as the highest signal frequency.

— Generally FM is used to modulate the pulses so that it can be transmitted;

such a system is called PAM-FM.

o Pulse Width Modulation (PWM) :

— It is also called Pulse Duration Modulation (PDM) or Pulse Length Modulation

— It can be generated using-a monostable multivibrator.

— It can be demodulated by feeding the PWM signal to an integrating circuit.

— In PWM the width of the pulse is changed in accordance with the instantaneous value of the modulating signal with amplitude remaining constant.

— The most often used integrating circuit is the loudspeaker itself.

o Pulse Position Modulation (PPM) :

— It can be generated in the similar way as PWM but the pulse width is kept constant from the Starting point of occurrence of pulse.

— It can be demodulated by converting into PWM using a flip-flop.

— In PPM the position of the pulse Or the time of occurrence of the pulses is changed in accordance With the instantaneous magnitude of the modulating

o pulse code Modulation (PCM) :

— In this type of modulation, digital equivalents of the instantaneous voltage levels of the signals are transmitted in the form of pulses.

— The total amplitude range which the signal may occupy is divided into a number of standard levels; this process is called Quantizing. The level actually set is the nearest standard level. The quantization levels depend upon number of bits per sample. — PCM encoder functions similar to A/D converter; PCM decoder functions similar to D/A converter.

Digital modulation techniques

In digital communications, the modulating signal consists of binary data. This data is used to modulate a carrier wave (usually sinusoidal) with fixed frequency. In fact the input data may represent the digital computer outputs or PCM waves, generated by digitizing voice or video signals. The channel may be a telephone channel, microwave radio link, satellite. channel or an optical fiber. In digital communication, the modulation process involves switching or keying the amplitude, frequency or phase of the carrier in accordance with the input data. Thus, there are three basic modulation techniques for the transmission of digital data; they are known as :

(i) Amplitude-shift. keying (ASK).

(ii) Frequency-shift keying (FSK).

(iii) Phase-shift keying (PSK).

The above techniques can be viewed as special cases of amplitude odulation, frequency modulation and phase modulation respectively.

Types of digital modulation techniques

Various types of digital modulation techniques are :

I. Coherent digital modulation techniques :

1. Coherent binary modulation techniques.
2. Coherent binary amplitude shift keying or on-off keying.
3. Coherent demodulation of binary ASK.

4, Binary phase shift keying (BPSK).

5. Coherent binary frequency shift keying (BFSK).

II. Non-coherent binary modulation techniques :

1. Non-coherent binary ASK.
2. Non-coherent detection of FSK.
3. Differential phase shift keying (DPSK).
4. Quadrature phase shift keying (QPSK).

Demodulation or detection

The process of extracting the low frequency modulating signal from the-modulated is known as demodulation or detection.

- The demodulation of an 'AM wave' involves two operations :

(i) Rectification of the modulated wave ;

(ii) Elimination of the RF component of the modulated wave.

- The demodulation of an 'FM wave' involves three operations :

(i) Conversion of frequency changes pr0duced by modulating signal into corresponding amplitude changes ;

(ii) Rectification of the modulating signal ;

(iii) Elimination of RF component of the modulated wave.

Noise

Noise may be defined, in an electrical sense, as any extraneous form of energy tending to interfere with the proper and easy reception' and reproduction of those Signals which it is desirable to receive.

Noise Power :

— Noise power,

(i) is directly proportional to temperature ;

(ii) is directly proportional to the bandwidth of system ;

(iii) is independent of resistance value.

— Unit of noise power is watts.

— Units of noise power density are watts/hertz.

The average thermal noise power is constant as long as the bandwidth is fixed.

-noise voltage is proportional to temperature, bandwidth and resistance.

Noise figure : It is the ratio of SIN ratio at input to S/N ratio at output. Ideal noise figures is 'l' or 0 dB. Noise figure is always greater than l. Higher the noise figure of the amplifier, nosier the amplifier.

Modems

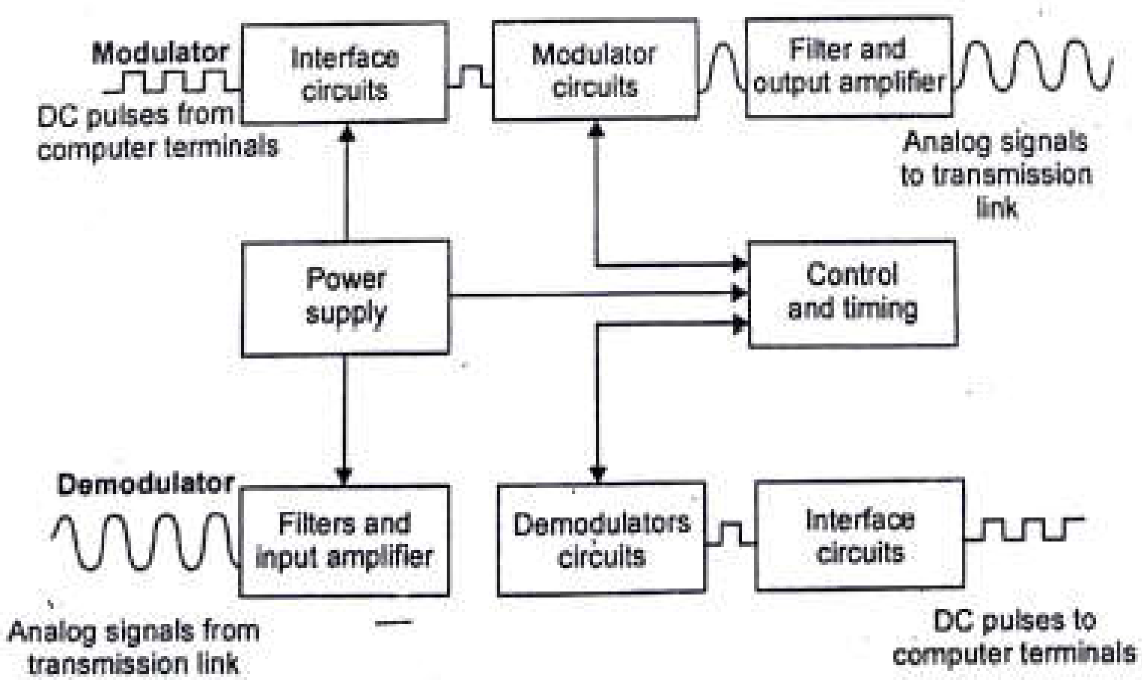
- Modem is an acronym for MODulator DEModulator.

A modem is a device that converts data from digital computer signals to analog signals that can be sent over a phone line. This is called "modulation". The analog signals are then converted back into digital by the receiving modem. This is called demodulation".

A modem is fed with digital information in the form of ones and zeros from the CPU (central processing unit). The modem then analyzes this information and converts it into analog signals, that can be sent over a telephone line.

— Another modem then receives these signals, converts them back into digital data, and sends the data to the receiving CPU.

Modems


Modulator
DC pulses from computer terminals
Interface circuits
Modulator circuits
Filter and output amplifier
Analog signals to transmission link
Power supply
Control and timing
Demodulator
Filters and input amplifier
Demodulators circuits
Interface circuits
Analog signals from transmission link
DC pulses to computer terminals

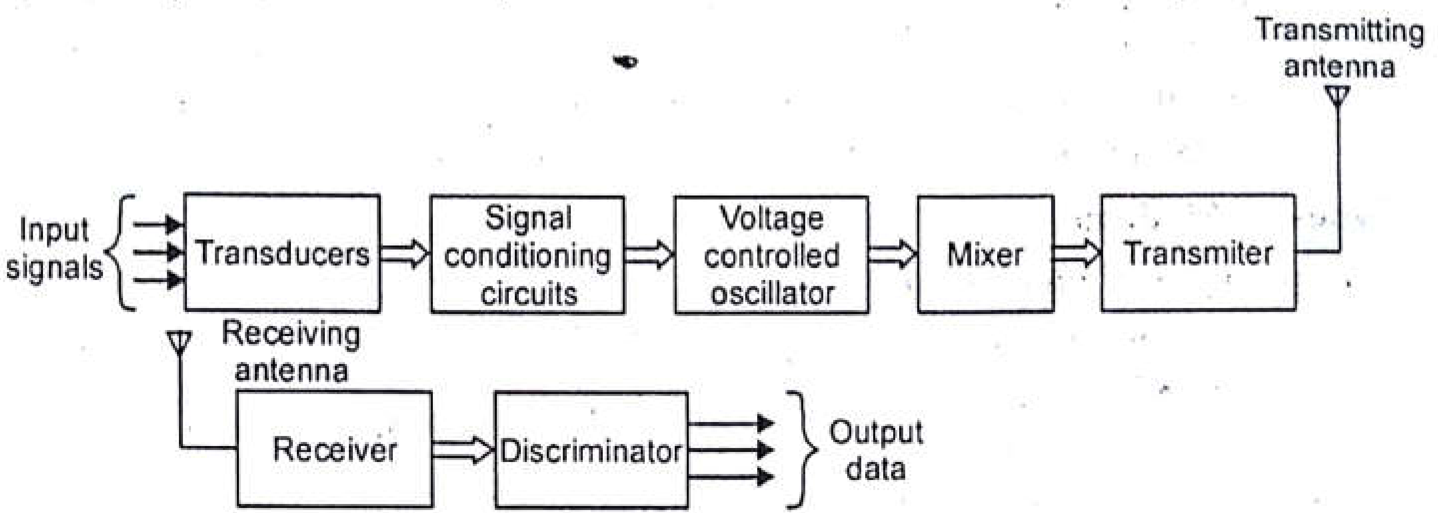
Frequency Modulation (FM) Telemetry System

Frequency Modulation (FM) Telemetry System

The frequency modulation is one of the earliest techniques for mixing (multiplexing)

data channels in a telemetry system, and is still in use to some extent in the telemetry

Fig. shows a basic frequency modulation (FM) telemetry system :



Frequency Modulation (FM) Telemetry System

— The output of each transducer/signal conditioner modulates the frequency of a voltage controlled subcarrier oscillator. Many oscillators, each operating in a dedicated part of the frequency spectrum, are mixed for radio transmission. As each voltage controlled oscillator is assigned with a separate frequency of the frequency spectrum, so each signal can be modulated without interfering with Other signals.

— At the receiving station, a FM demodulator (usually called discriminator) is tuned to the frequency of each subcarrier. Thus, when the measurement value changes at the source, the Output voltages of the discriminator. change accordingly.

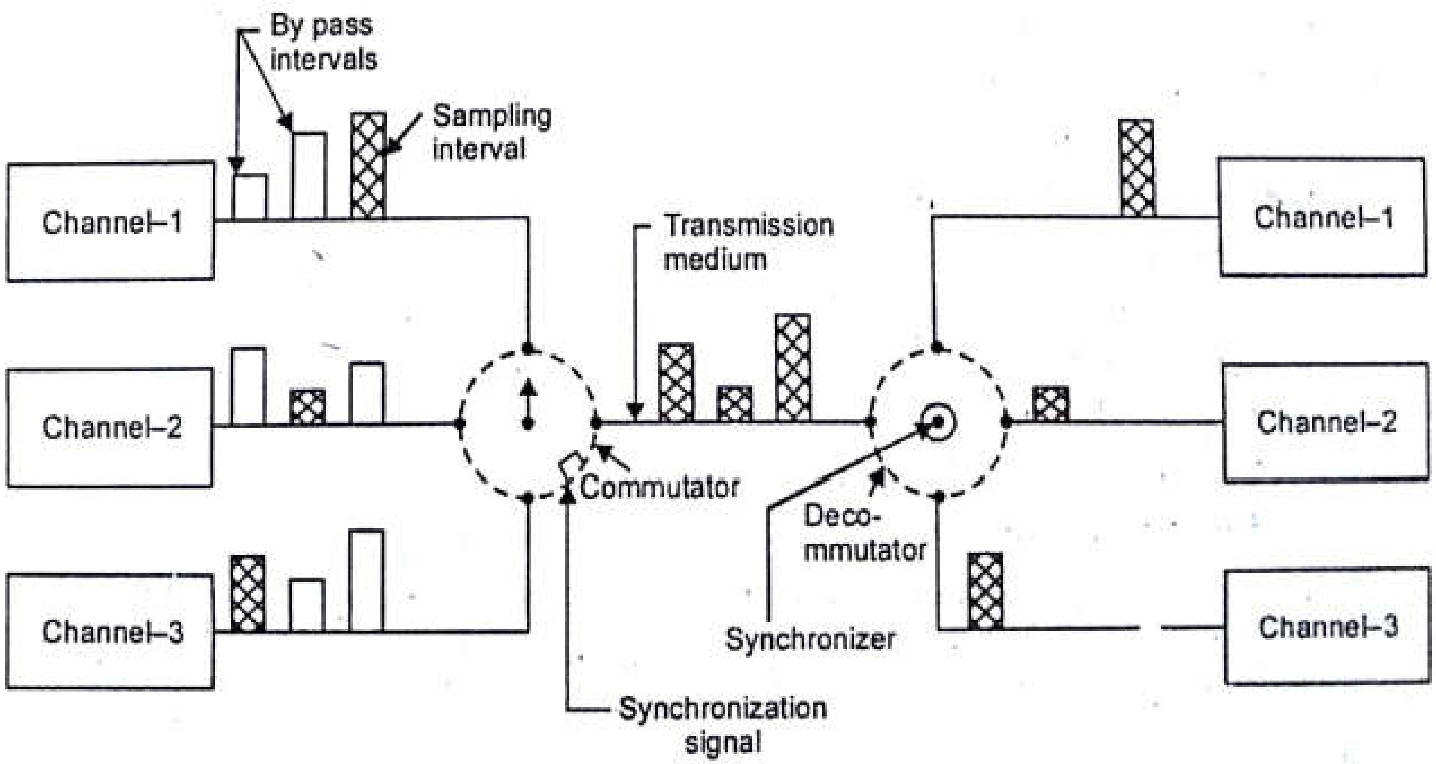
Pulse Amplitude Modulation (PAM) Telemetry System

Pulse Amplitude Modulation (PAM) Telemetry System

The primary limitation of the FM telemetry system is that the capacity of channels offered is less. Thus, to have still higher capacity of channel within a linked bandwidth, the PAM telemetry system is widely used which makes use of the "time division multiplexing"

Fig. shows a basic time division multiplexing system : — All channels use same frequency band of the allotted frequency spectrum but not at the same time.

Pulse Amplitude Modulation (PAM) Telemetry System



Pulse Amplitude Modulation (PAM) Telemetry System

— The commutator samples the signal in each channel in sequence, and the amplitude of each is an indication of the instantaneous data value at that point.

— After the sampling of all channels, the sequence starts over the first channel. Thus, samples from a particular channel are interleaved in time with samples from all the other channels and the amplitude of each is modulated by the input data.

— Because in time-division system no channel is monitored continuously, the sampling must be rapid enough that the signal amplitude in any channel does not change too much between sampling intervals (and the information in the original signal is preserved). In typical telemetry system, the sampling rate is about five times the highest frequency component in the sampled signal.

— A decommutator at the receiving end of the system operates at exactly the same frequency as the Commutator and distributes the parts of the multiplexed signal to the proper output channel'.

Because a time-division system is Used on precise timing, it is of significant importance that the demodulator be synchronized exactly with the commutator.

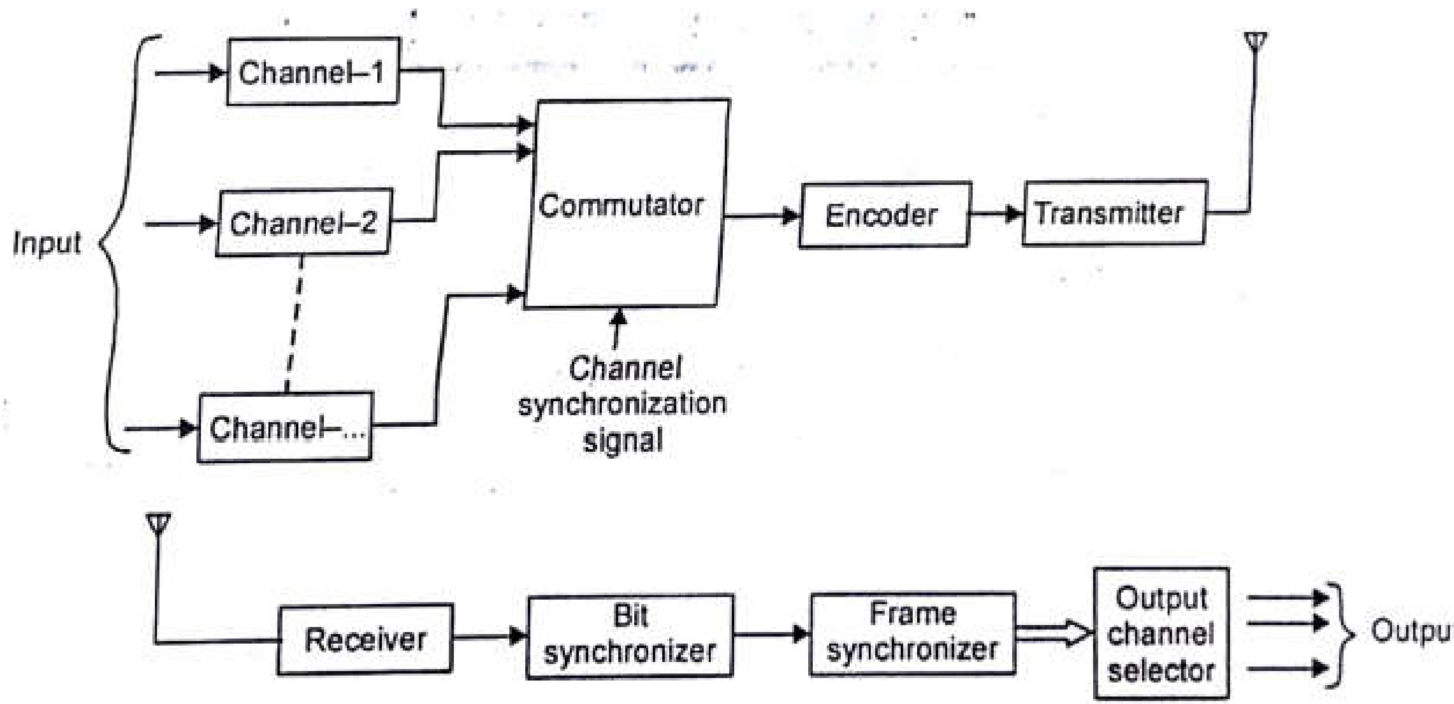
Pulse Code Modulation (PCM) Telemetry System

This system is so named, since the measured data is represented in the form of binary weighted codes.

This system also makes use of time division multiplexing system (as used in PAM); however, in this system an encoder is used after the commutator stage.

Fig. shows the block diagram of the PCM telemetry system •

Pulse Code Modulation (PCM) Telemetry System



Pulse Code Modulation (PCM) Telemetry System

— The function of the "encoder" is to accept each PAM sample and convert it into a binary number and shift the bits of each number serially. The encounter converts zero amplitude pulse to the binary number “0", while the full scale pulse into binary number say "1022". Each number is exactly proportional to the instantaneous amplitude of the signal at the measuring point.

— The receiver section is synchronized on the serial data system

— The "bit Synchronizer" and the "frame synchronizer" identify each sequence of bits and convert it into useful outputs.

Comparison of FM, PAM and PCM

Comparison of FM, PAM and PCM

S. No.	Aspects	FM	PAM	PCM
1.	*Accuracy*	Poor	Poor	Excellent
2.	*Efficiency in use*	Medium	Best	Worst
3.	*Percentage of use in practical systems*	20%	15%	65%

Summary

1. Telemetry is defined as a technology which allows users to collect information from inaccessible and inconvenient locations and to transmit it to the accessible places to process, record and display the information in presentable form.
2. The RF telemetry systems are more suitable for transmission of data over distances more than 1 km.
3. In pulse code modulation (PCM), digital equivalents of the instantaneous voltage levels of the signals are transmitted in the form of pulses.
4. A 'modem' is a device that converts data from digital computer signals to analog that can be sent over a phone line. This is called modulation. The signals are then converted back into digital one by receiving modem. This is called demodulation.

Reference

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Thank you