Basis for Comparison	PAM	PWM	PPM
Varying parameter	Amplitude	Width	Position
Immunity towards noise	Low	High	High
Signal to noise ratio	Low	Moderate	Comparitively high
Need of synchronization pulse	Not exist	Not exist	Exist
Bandwidth dependency	On pulse width	On rise time of pulse	On rise time of pulse
Transmission power	Variable	Variable	Constant
Bandwidth requirement	Low	High	High
Similarity of implementation	Similar to AM	Similar to FM	Similar to PM
Synchronization between Transmitter and Receiver	Not needed	Not needed	Needed

Key	TDM	FDM
Definition	TDM stands for Time Division Multiplexing.	FDM stands for Frequency Division Multiplexing.
Signal	TDM works well with both analog as well as digital signals.	FDM works only with analog signal.
Conflict	TDM has low conflict.	FDM has high conflict.
Wiring	Wiring or Chip of TDM is simpler.	Wiring or Chip of FDM is complex.
Efficiency	TDM is efficient	FDM is quiet inefficient.
Sharing	Time is shared in TDM.	Frequency is shared in FDM.
Required Input	Synchronization pulse is mandatory in TDM.	Synchronization pulse is not mandatory.

S.No.	Parameter/Characteristics	Wideband FM	Narrowband FM
1.	Modulation index	Greater than 1	Less than or slightly greater than 1
2.	Maximum deviation	75 kHz	5 kHz
3.	Range of modulating frequency	30 Hz to 15 kHz	30 Hz to 3 kHz
4.	Maximum modulation index	5 to 2500	Slightly greater than 1
5.	Bandwidth	Large about 15 times higher than BW of narrowband FM	Small. Approximately same as that of AM
6.	Applications	Entertainment broad-casting (can be used for high quality music transmission)	FM mobile communication like police wireless, ambulance etc. (This is used for speech trans-mission)
7.	Pre-emphasis and De-emphasis	Needed	Needed

Parameter of Comparison	Pulse Code Modulation (PCM)	Differential Pulse Code Modulation (DPCM)	Delta Modulation (DM)	Adaptive Delta Modulation (ADM)
Number of bits	It can use 4,8, or 16 bits per sample.	Bits can be more than one but are less than PCM.	It uses only one bit for one sample	It uses only one bit for one sample
Levels and step size	The number of levels depends on number of bits. Level size is fixed.	Number of levels is fixed.	Step size is kept fixed and cannot be varied.	According to the signal variation, step size varies.
Quantization error and distortion	Quantization error depends on number of levels used.	Slope overload distortion and quantization noise is present.	Slope overload distortion and granular noise are present.	Quantization noise is present but other errors are absent.
Transmission bandwidth	Highest bandwidth is required since numbers of bits are high.	Bandwidth required is less than PCM.	Lowest bandwidth is required.	Lowest bandwidth is required.
Feedback	There is no feedback in transmitter or receiver.	Feedback exists.	Feedback exists in transmitter.	Feedback exists.
Complexity of Implementation	System is complex.	Simple	Simple	Simple

PCM	ADPCM
Sample rate is 8 bits per sample	Sample rate is 4 bits per sample
Better quality	Comparatively lower quality
Shorter duration	Longer duration
Less efficient	More efficient
Best for audio with quality	Low frequencies will be properly reproduced whereas high frequencies will be produced with distortion
Best for quality	Best for long distance transmission and storing using less space

Ans. :

Sr. No.	Parameter	DSB-FC	DSB-SC	SSB	VSB
1.	Carrier suppression	N.A.	Fully	Fully	N.A.
2.	Sideband suppression	N.A.	N.A.	One S.B. completely	One S.B. suppressed partially
3.	Bandwidth	$2 f_m$	$2 f_m$	f_m	$f_m < BW < 2f_m$
4.	Transmission efficiency	Minimum	Moderate	Maximum	Moderate
5.	No. of modulating inputs	1	1	1	2
6.	Application	Radio broadcasting	Radio broadcasting	Point to point mobile communication	T.V.
7.	Power requirement to cover same area	High	Medium	Very small	Moderate
8.	Complexity	Simple	Simple	Complex	Simpler than SSB

Parameter	ASK	FSK	PSK
Variation	Amplitude	Frequency	Phase
Bandwidth	Less	More	Less to Moderate
Noise Immunity	Poor	Better	Better
Need of Synchronization	Not Needed	Not Needed	Needed
Effect of DC	More	Less	Less
Power Required	More	Moderate	Less-Moderate
Bit Rate Application	Low	Moderate	High
Implementation	Simple	Moderate	Complex

Parameters	AM	FM	PM
Definition	Amplitude of carrier varies according to amplitude of modulating signal	Frequency of carrier varies according to amplitude of modulating signal	Phase of carrier varies according to amplitude of modulating signal
Noise immunity	AM receivers are susceptible to noise	Better than AM and PM	Better than AM but not FM
Function	Amplitude of carrier wave diverges as per amplitude of modulating signal	Frequency of carrier wave diverges as per amplitude of modulating signal	Phase of carrier wave diverges as per amplitude of modulating signal
Constant Parameter	Frequency	Amplitude	Amplitude
Types	DSB-FC, DSB-SC, SSB, VSB	FSK, GFSK, etc	QPSK, QAM, etc

Parameter	**Analog Communication**	**Digital Communication**
Signal	Analog	Digital
Range of Amplitude	0 to 100.	0 or 1
Noise Immunity	Low	High
Number of Channel	Low	High
Error Probability	High	Low
Coding	Not possible.	Possible
Noise Separation	Not Possible	Possible
Hardware	Complex	Simple
Multiplexing	FDM is used.	TDM is used.
Cost	Low	High
Bandwidth Requirement	Low	High
Power Consumption	High	Low
Portability	Low	High
Privacy	Low	High
Accuracy	Low	High
Synchronization Problem	Hard	Easy

Sampling	Quantization
Digitization of co-ordinate values.	Digitization of amplitude values.
x-axis(time) – discretized.	x-axis(time) – continuous.
y-axis(amplitude) – continuous.	y-axis(amplitude) – discretized.
Sampling is done prior to the quantization process.	Quantization is done after the sampling process.
It determines the spatial resolution of the digitized images.	It determines the number of grey levels in the digitized images.
It reduces c.c. to a series of tent poles over a time.	It reduces c.c. to a continuous series of stair steps.
A single amplitude value is selected from different values of the time interval to represent it.	Values representing the time intervals are rounded off to create a defined set of possible amplitude values.

Parameter	Synchronous Detection	Envelope Detection
Types of Error	Phase and Frequency Error	Diagonal Clipping and Negative Clipping
Complexity	High	Low
Synchronization with Transmitter	Needed	Not Needed
Application	DSB-SC, SSB, VSB	DSB-FC
Modulation Index	Greater than 1	Between and 0 and 1

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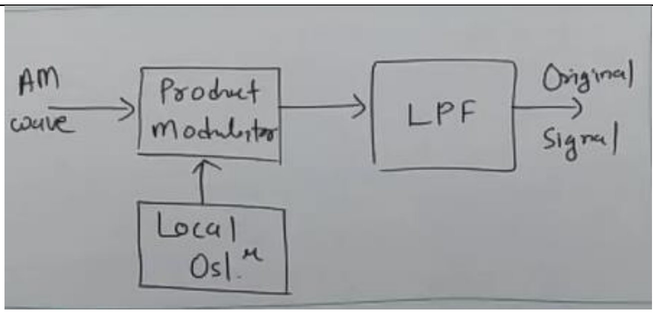
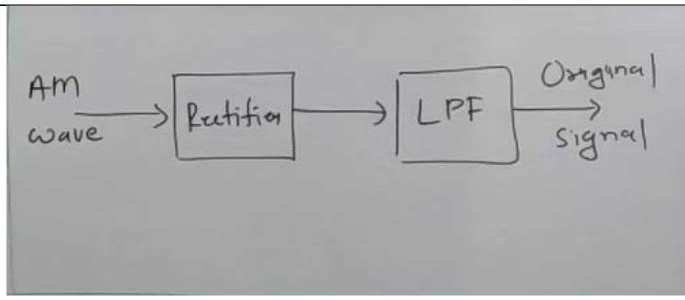
<tr><td>Block Diagram</td><td>
</td><td>
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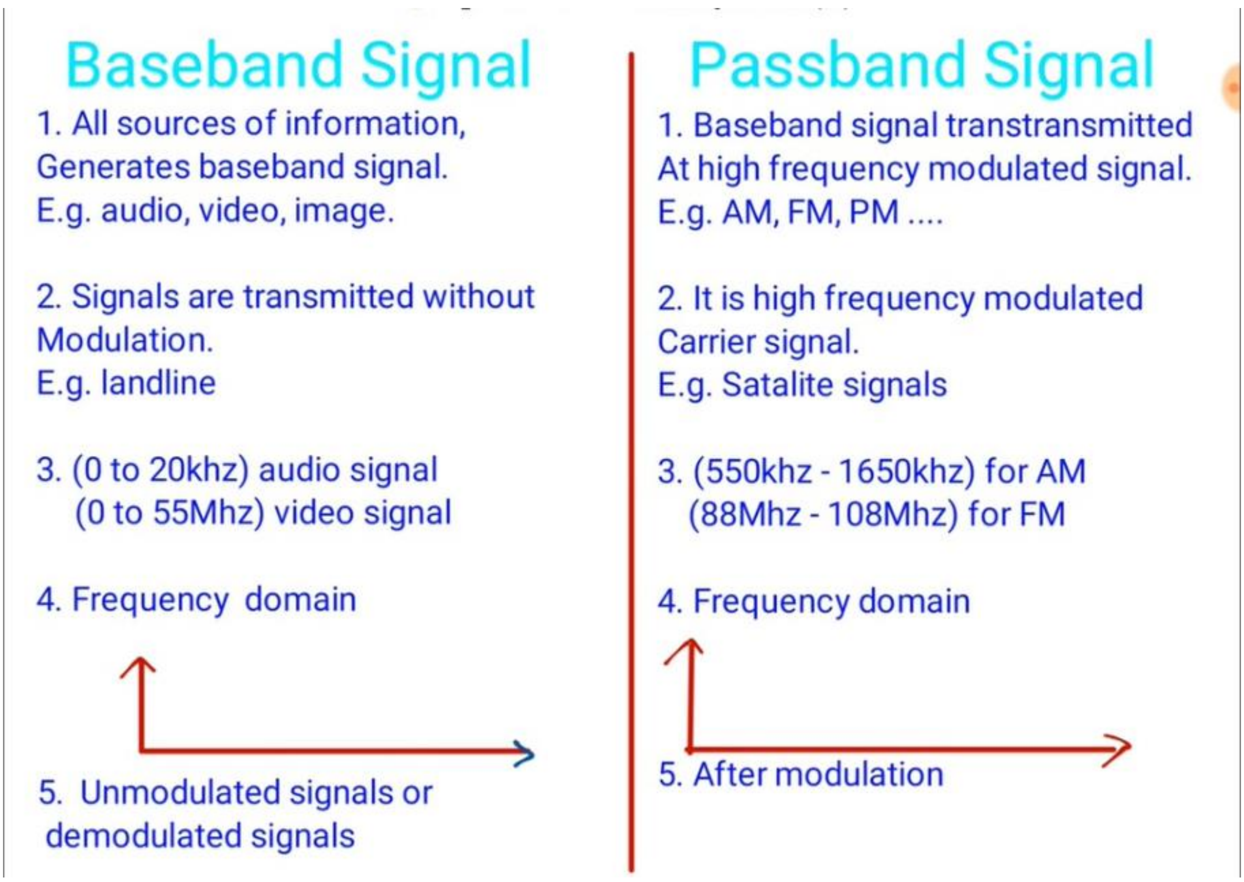
Parameter	**Coherent Reception**	**Incoherent Reception**
Complexity	High	Low
Performance	High	Low
Phase Locking of Carriers	Needed	Not Needed
Error Probability	Low	High

Parameter	**Filter Method of SSB Generation**	**Phase Shift Method of SSB Generation**
Sideband Cancellation	By using Filter	By using Phase Shifter of 90 degree
SSB Frequency Range	High	No range
Up Conversion	Needed	Not Needed
System Designing	Filter Designing	Phase Shifter of 90 degree Product Modulator Symmetry

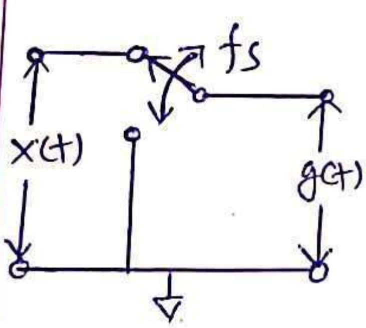
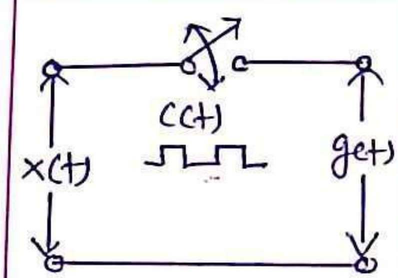
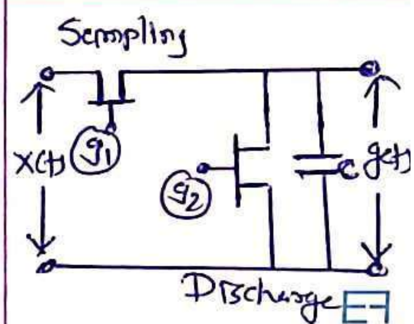
Category	Frequency Modulation (FM)	Phase Modulation (PM)
Definition	When the frequency of the carrier wave varies with the amplitude of the message signal, the modulation process is known as frequency modulation.	When the phase of the carrier wave varies with the amplitude of the message signal, the modulation process is known as phase modulation.
Signal's quality	High	Low
SNR	Signal to noise ratio is better in FM than PM.	Signal to noise ratio is worse than FM.
Modulation and demodulation	Complex than PM	Easier than FM
Noise Immunity	Good	Less than FM
Varying element	Frequency	Phase
Conversion	FM can be converted to PM.	PM can be converted to FM.
Applications	Telemetry, radio broadcasting, magnetic tape recording, etc.	Telephone communication, radio communication, digital synthesizers, etc.

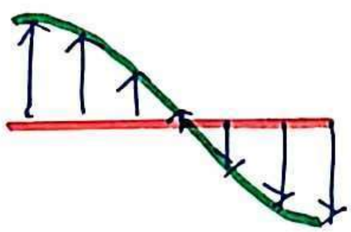
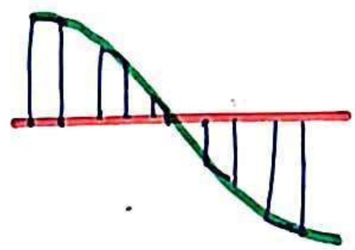
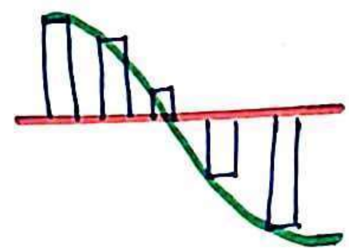


Synchronous TDM	Asynchronous TDM
In this, multiplexer allocates same time slots to each device without considering fact that device contains data or not.	In this, multiplexer does not allocate same time slots to each device without considering fact that device contains data or not.
Number of slots per frame are equal to number of input lines i.e., If it contains n input lines, then it must have n slots in one frame.	Number of slots per frame are less than number of input lines i.e., If there are n input lines, then there are m slots in one frame (m<n).
There is no guarantee that full capacity link is used.	There is guarantee that full capacity link is used.
Total speed of input lines cannot be greater than capacity of path.	Total speed of input lines can be greater than capacity of path.
Usage of devices is less.	Usage of devices is more.
Number of time slots in a frame as always based on number of input lines.	Number of time slots in a frame as always based on statistical analysis of number of input lines that are likely to be transmitting at any given time.
Time slots are fixed and pre-defined.	Time-slots are not pre-defined.

Parameter	Analog Signal	Digital Signal
Definition	It is continuous function of time	It is discrete function of time
Representation	Sine Wave	Square Wave
Signal values	Continuous	Discrete
Bandwidth	Low	High
Suitability	Audio, video	Data storage
Effect of noise	High	Low
Accuracy	Low	High
Power consumption	High	Low
Circuit components	Resistors, capacitors, inductors	Transistors, logic gates
Observational errors	Present	Absent
Examples	Temperature, current, voltage, etc.	Data store in a computer memory.
Applications	Land line phones, thermometer, electric fan, etc.	Computers, keyboards, digital watches, smartphones, etc.

Performance Comparison of Sampling techiques.

Performance Parameter	Ideal Sampling	Natural Sampling	Flat top Sampling
Sampling Principle	Multiplication	Chopping	Sample & Hold Circuit
Generation Circuit			

Waveforms			
Feasibility	Practically not possible	used Practically	used Practically.
Noise Interference.	Very high	Less	high

Feasibility	Practically not possible	used practically	used practically.
Noise Interference.	Very high	Less	high
Time domain Representation	$g(t) = \sum_{n=-\infty}^{\infty} x(t)\,\delta(t-nT_s)$	$g(t) = \frac{\tau A}{T_s} \sum_{n=-\infty}^{\infty} x(t)\,\mathrm{Sinc}(nf_s\tau)\,e^{j2\pi nf_s t}$	$g(t) = \sum_{n=-\infty}^{\infty} x(t)\,h(t-nT_s)$
Freq. domain Representation	$G(f) = f_s \sum_{n=-\infty}^{\infty} X(f-nf_s)$	$G(f) = \frac{\tau A}{T_s} \sum_{n=-\infty}^{\infty} \mathrm{Sinc}(nf_s\tau)\,X(f-nf_s)$	$G(f) = f_s \sum_{n=-\infty}^{\infty} X(f-nf_s)\,H(f)$