Pulse Modulation Systems

Sampling theorem - Types of Sampling. Pulse modulation schemes – generation and detection PAM, PPM and PWM, Conversion of PWM to PPM. Multiplexing Techniques – FDM and TDM

Tips: DA3 - Q3

How to find Bandwidth and number of side bands from Bessel functions

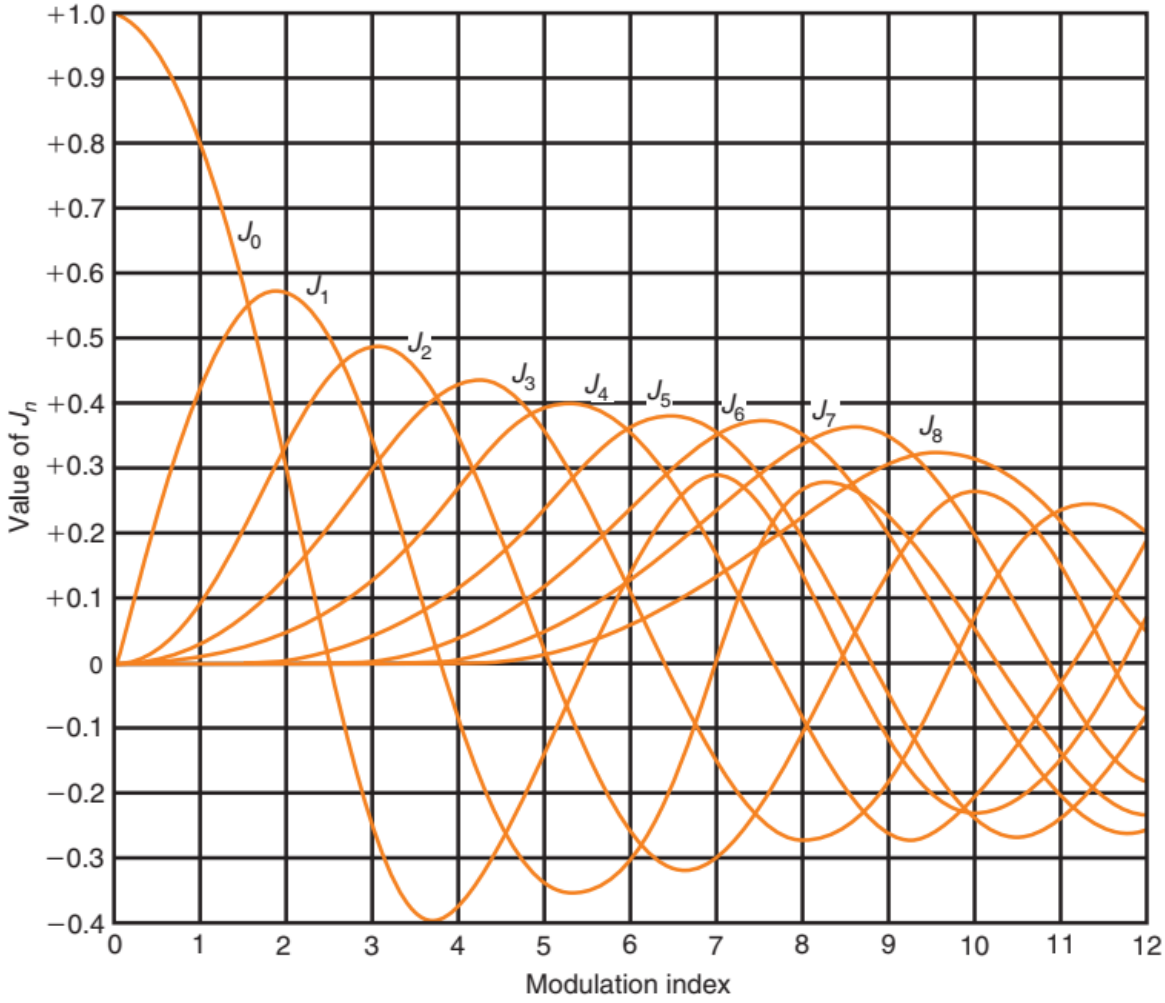
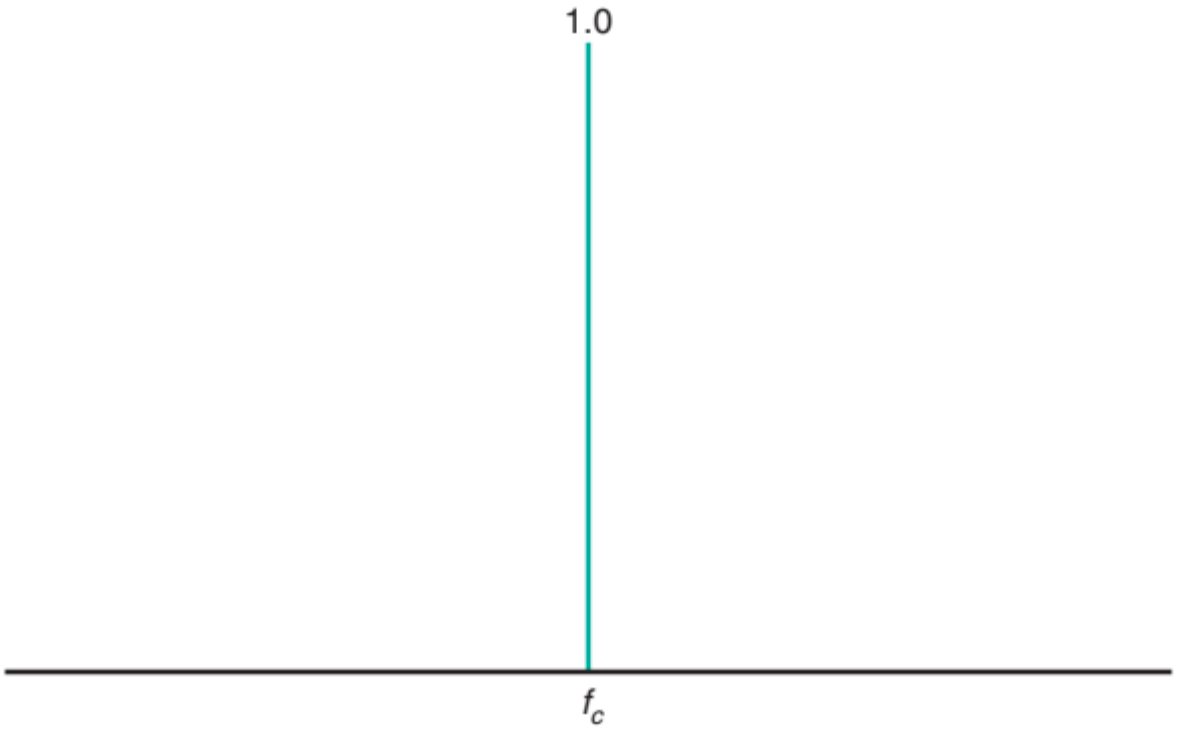


Table of Bessel functions

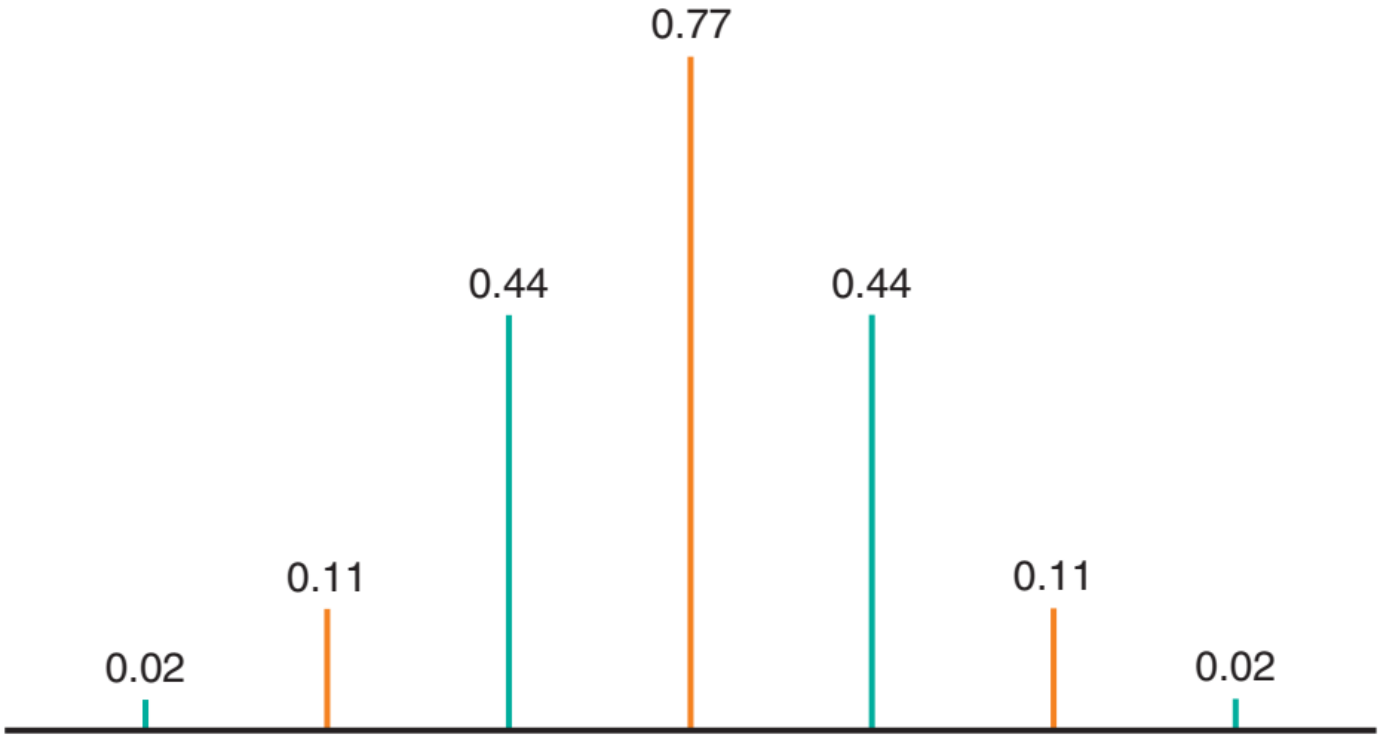
Modulation Index	Carrier	Sidebands (Pairs)								
		1st	2d	3d	4th	5th	6th	7th	8th	9th
0.00	1.00	—	—	—	—	—	—	—	—	—
0.25	0.98	0.12	—	—	—	—	—	—	—	—
0.5	0.94	0.24	0.03	—	—	—	—	—	—	—
1.0	0.77	0.44	0.11	0.02	—	—	—	—	—	—
1.5	0.51	0.56	0.23	0.06	0.01	—	—	—	—	—
2.0	0.22	0.58	0.35	0.13	0.03	—	—	—	—	—
2.5	−0.05	0.50	0.45	0.22	0.07	0.02	—	—	—	—
3.0	−0.26	0.34	0.49	0.31	0.13	0.04	0.01	—	—	—
4.0	−0.40	−0.07	0.36	0.43	0.28	0.13	0.05	0.02	—	—
5.0	−0.18	−0.33	0.05	0.36	0.39	0.26	0.13	0.05	0.02	—

Spectrum of FM signal with Modulation Index 0



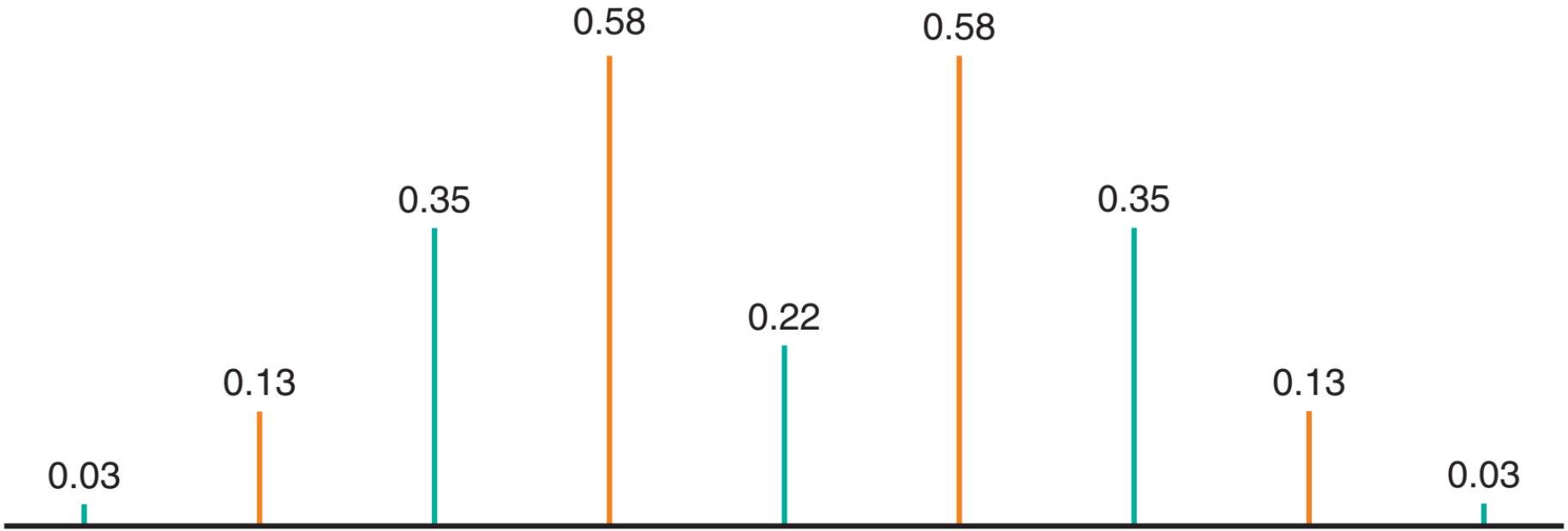
Spectrum of FM signal with Modulation Index 1

No of Sideband: 6



Spectrum of FM signal with Modulation Index 2

No of Sideband: 8

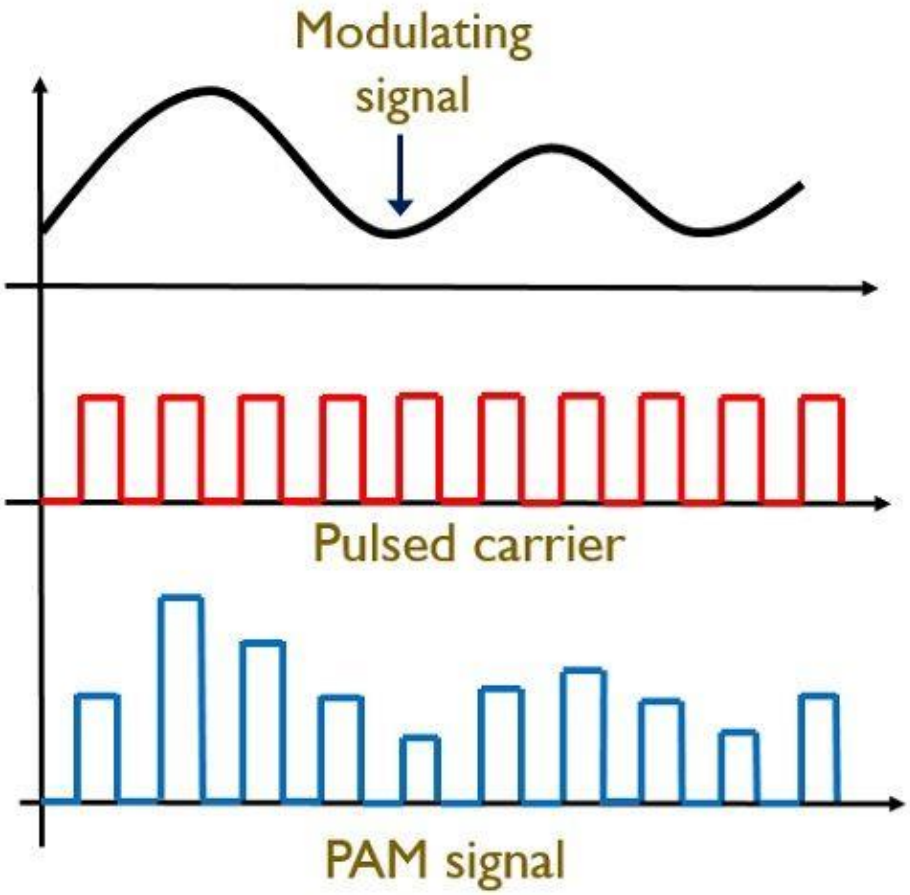


Bandwidth from Bessel functions

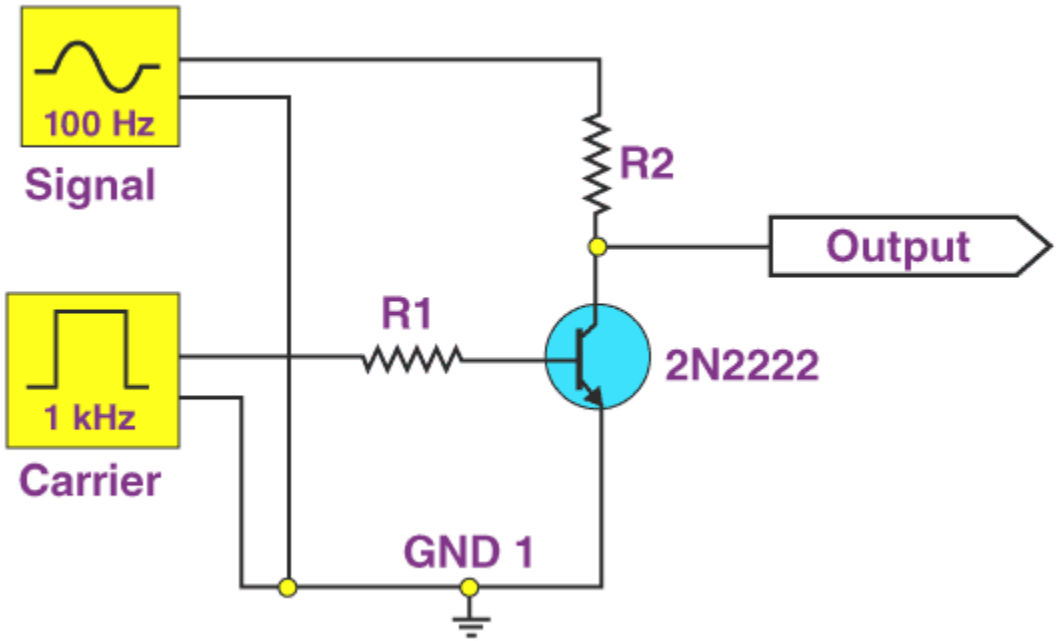
$$BW = 2fm\ N$$

fm – message signal frequency
N – number of sideband pairs

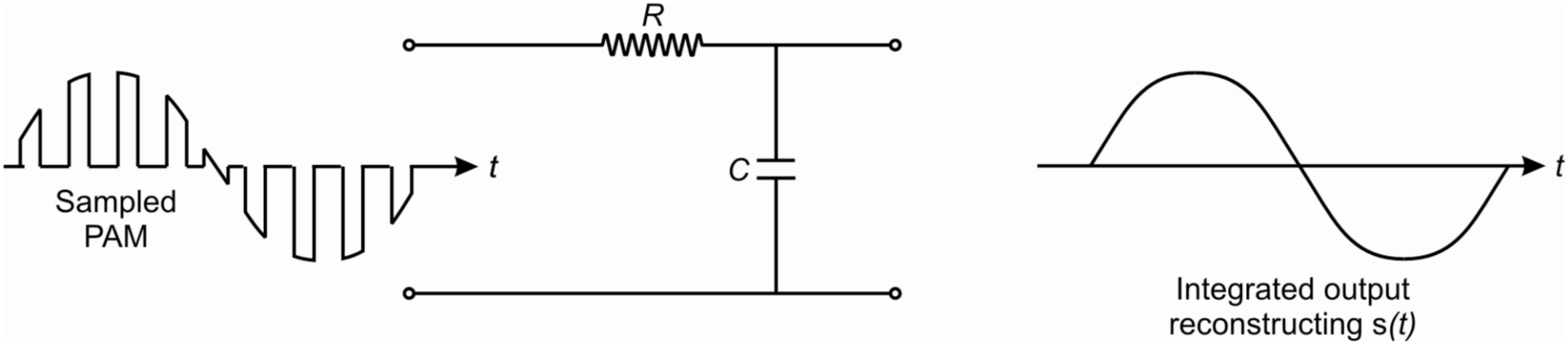
Pulse Amplitude Modulation



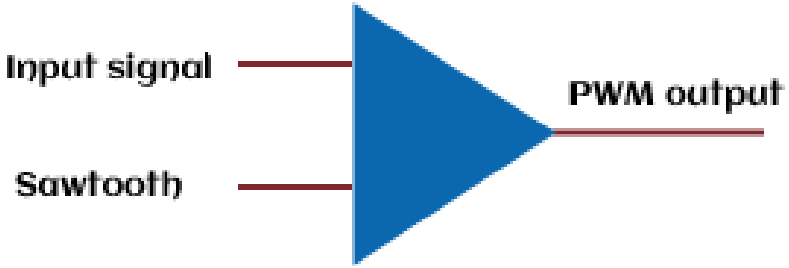
PAM– Modulator

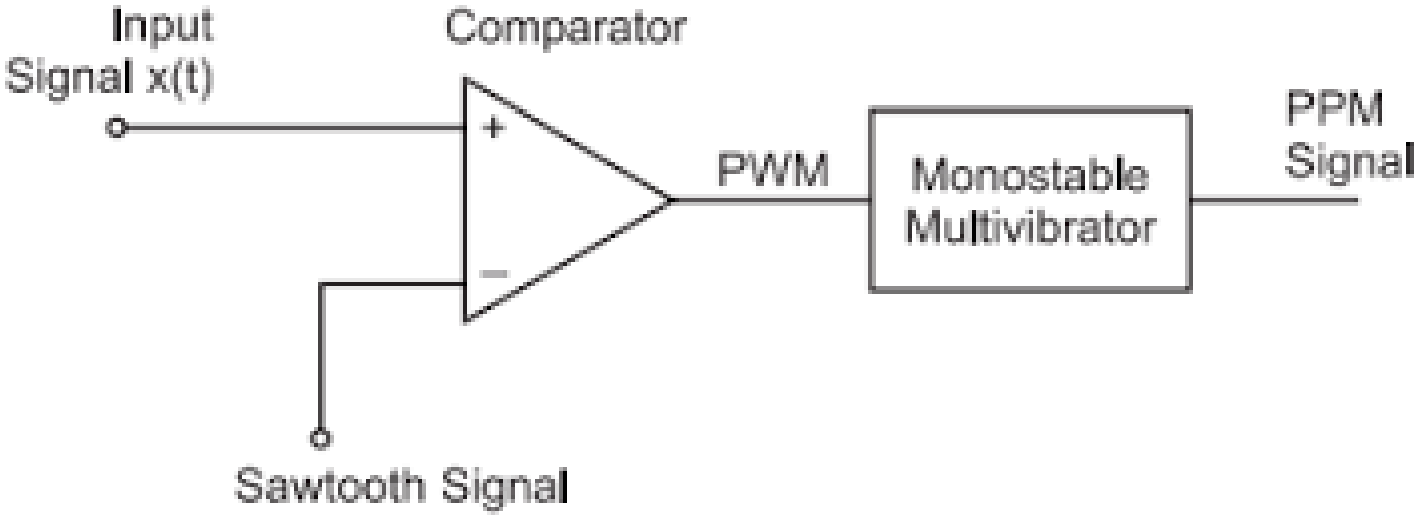


•PAM Detector

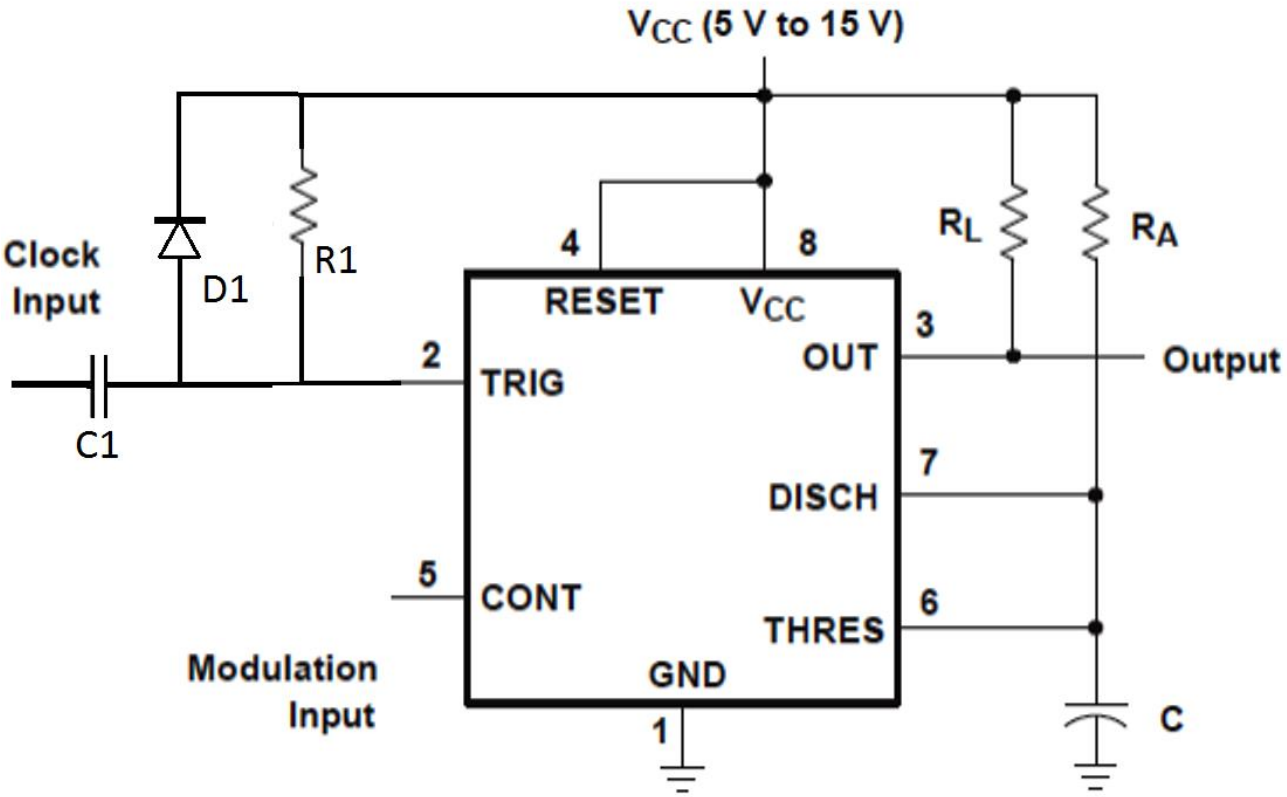


PWM & PPM Generator

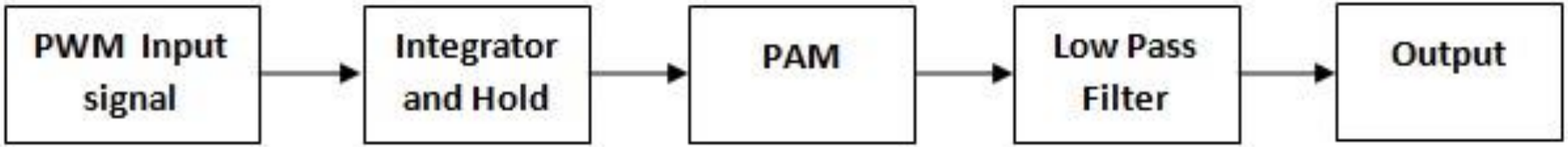


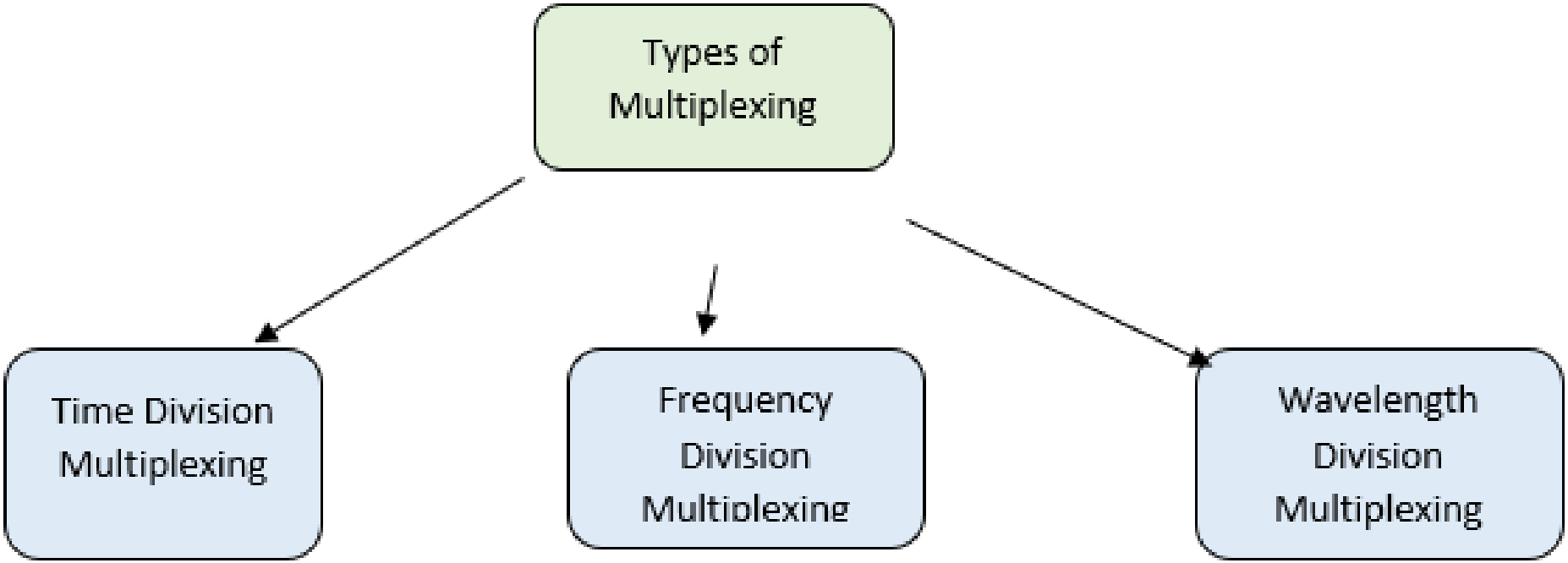


PWM Generator

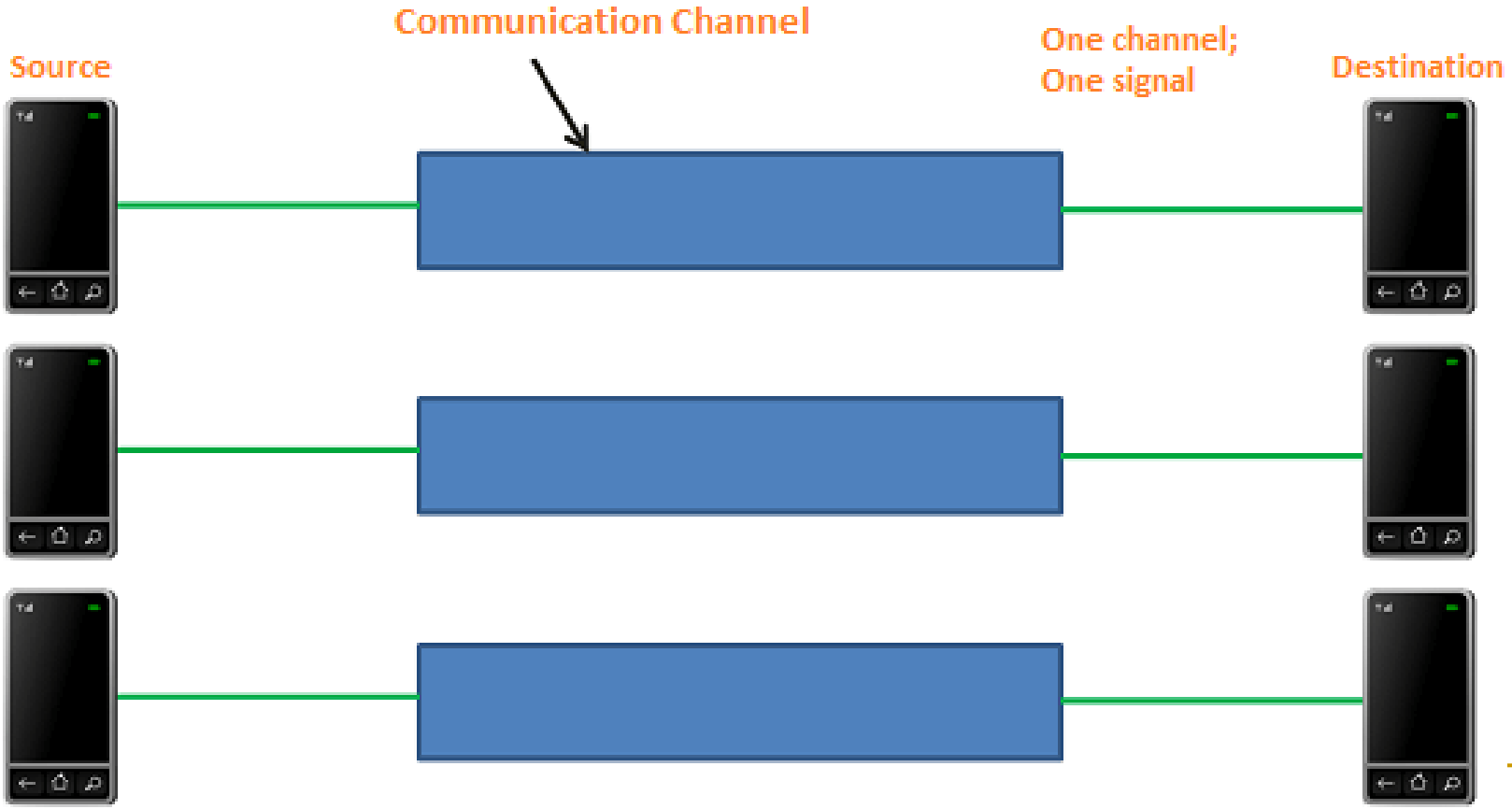


PWM & PPM Detector



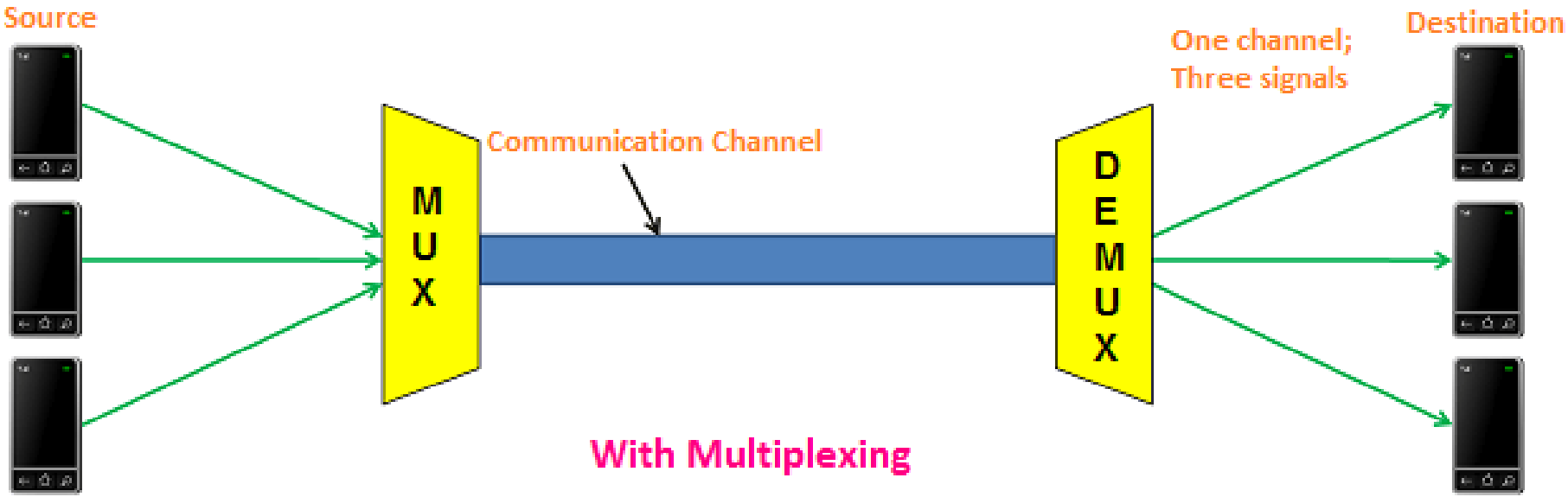

Types of Multiplexing
Time Division Multiplexing
Frequency Division Multiplexing
Wavelength Division Multiplexing

Without Multiplexing vs With Multiplexing



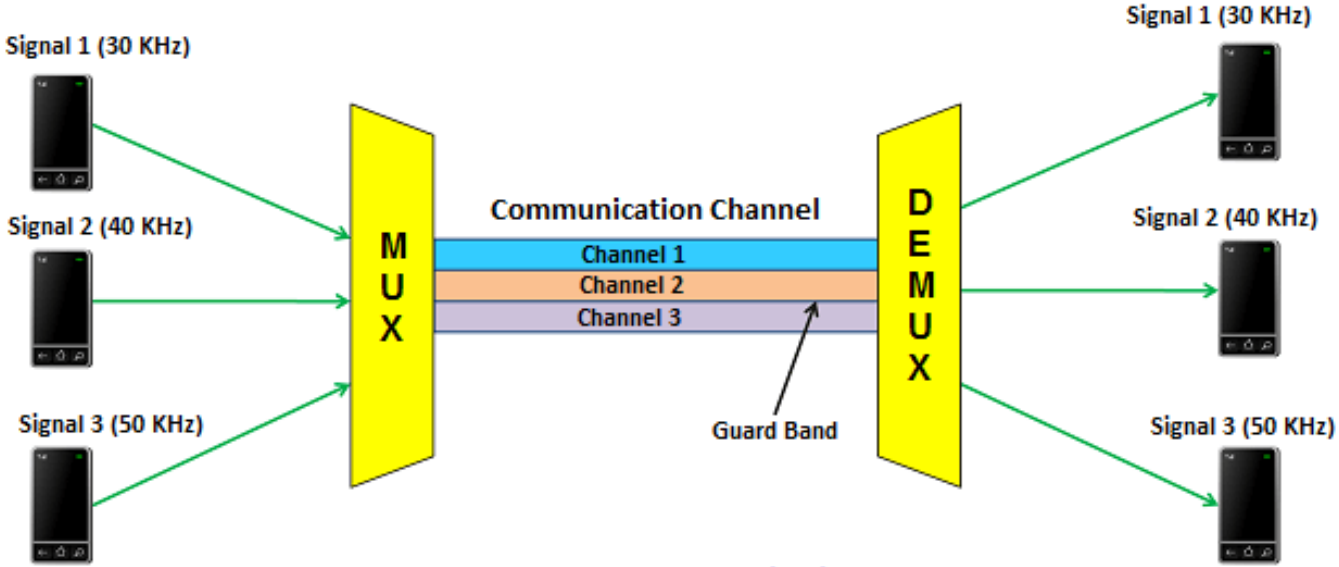
Without Multiplexing

Without Multiplexing vs With Multiplexing



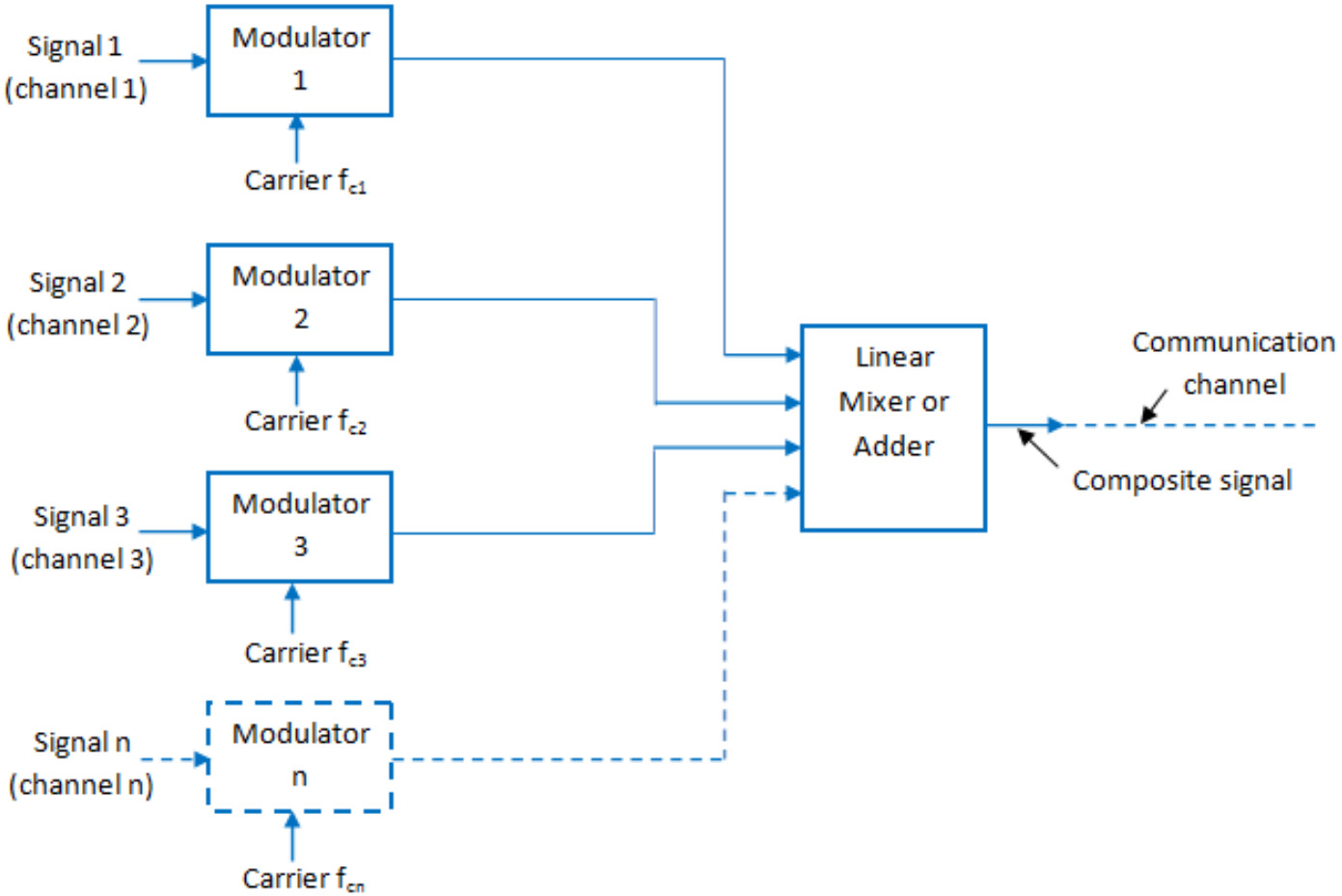
FDM

In this, a number of signals are transmitted at the same time, and each source transfers its signals in the allotted frequency range. There is a suitable frequency gap (Guard Band) between the 2 adjacent signals to avoid over-lapping.

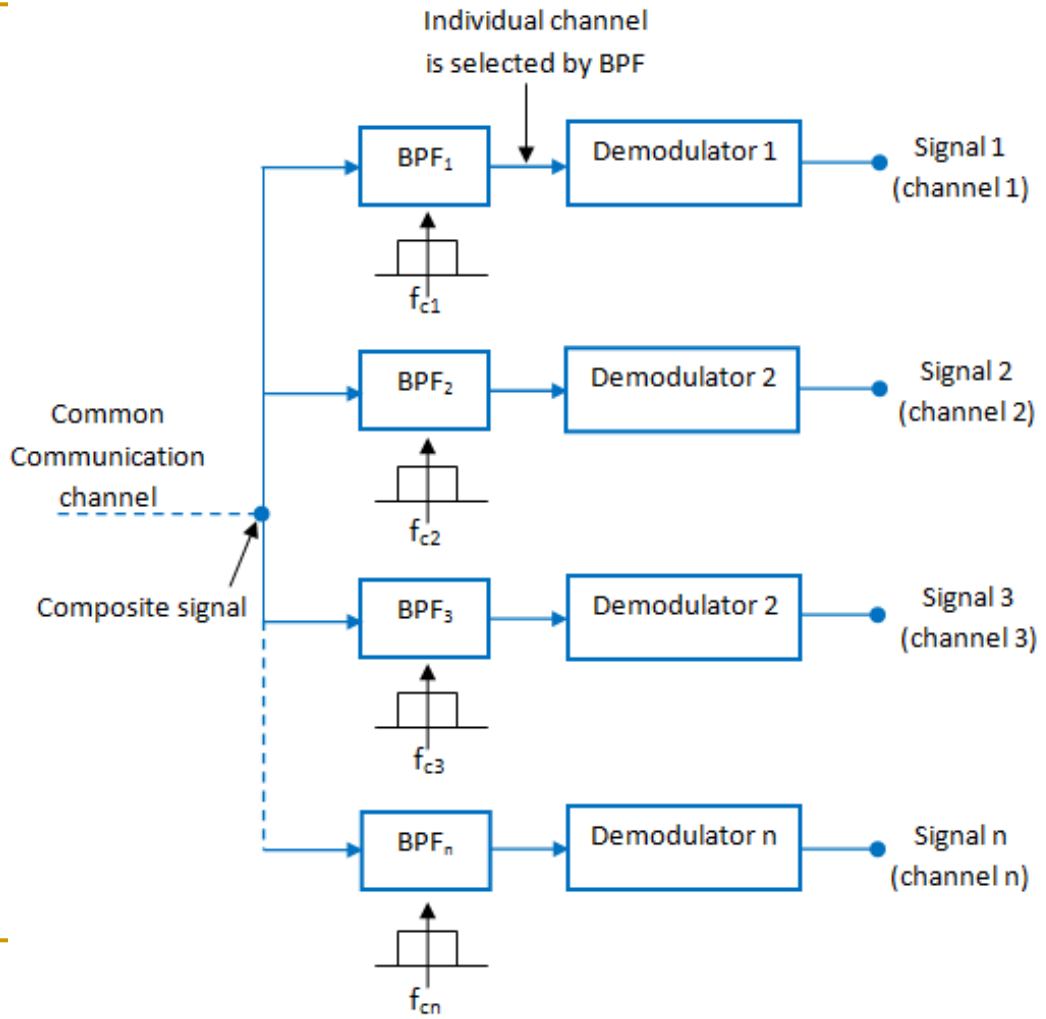


Frequency Division Multiplexing

FDM Transmitter



FDM Receiver



FDM

PROS:

- It uses analogue signals
- Multiple signals can be transmitted simultaneously
- Demodulation is easier
- It does not require synchronization between sender and receiver

CONS:

- Low speed channels supported
- Problem of crosstalk
- Large number of modulators required
- High bandwidth channel requirement to operate

Applications of FDM (Frequency division multiplexing)

- FM and AM radio broadcasting
- Television broadcasting

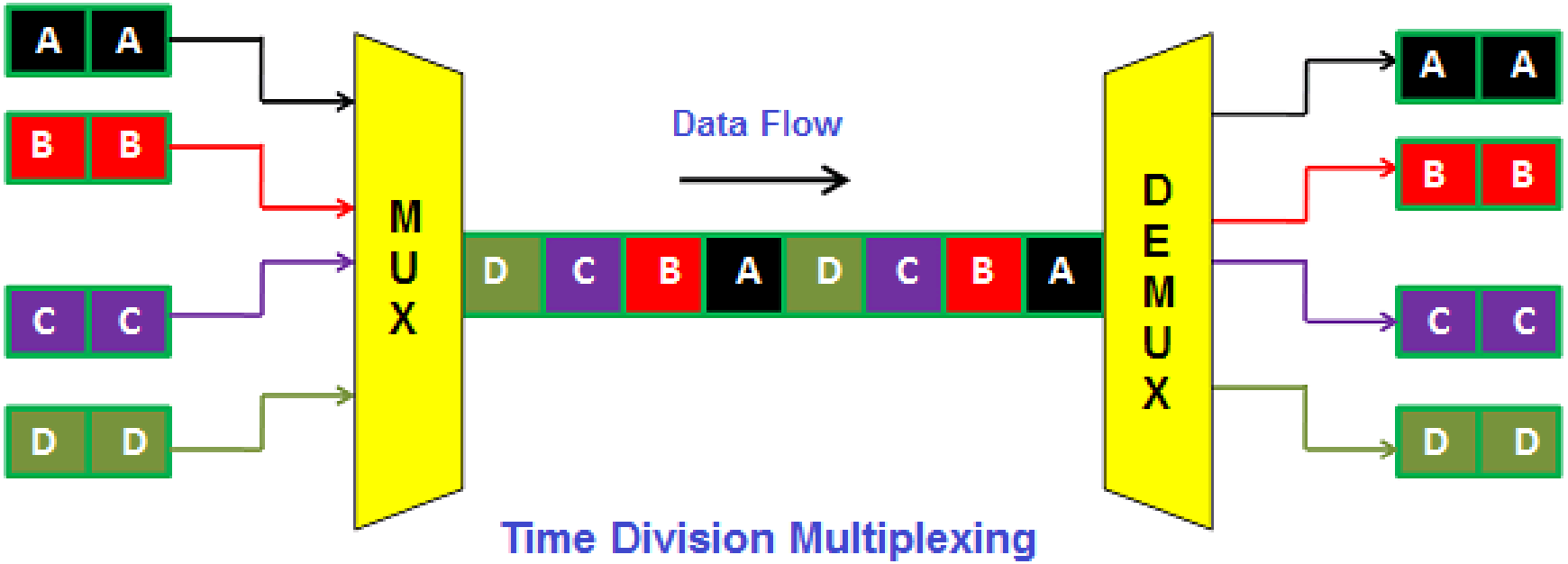
TDM

Time Division Multiplexing is a technique in which multiple signals are combined and transmitted one after another on the same communication channel.

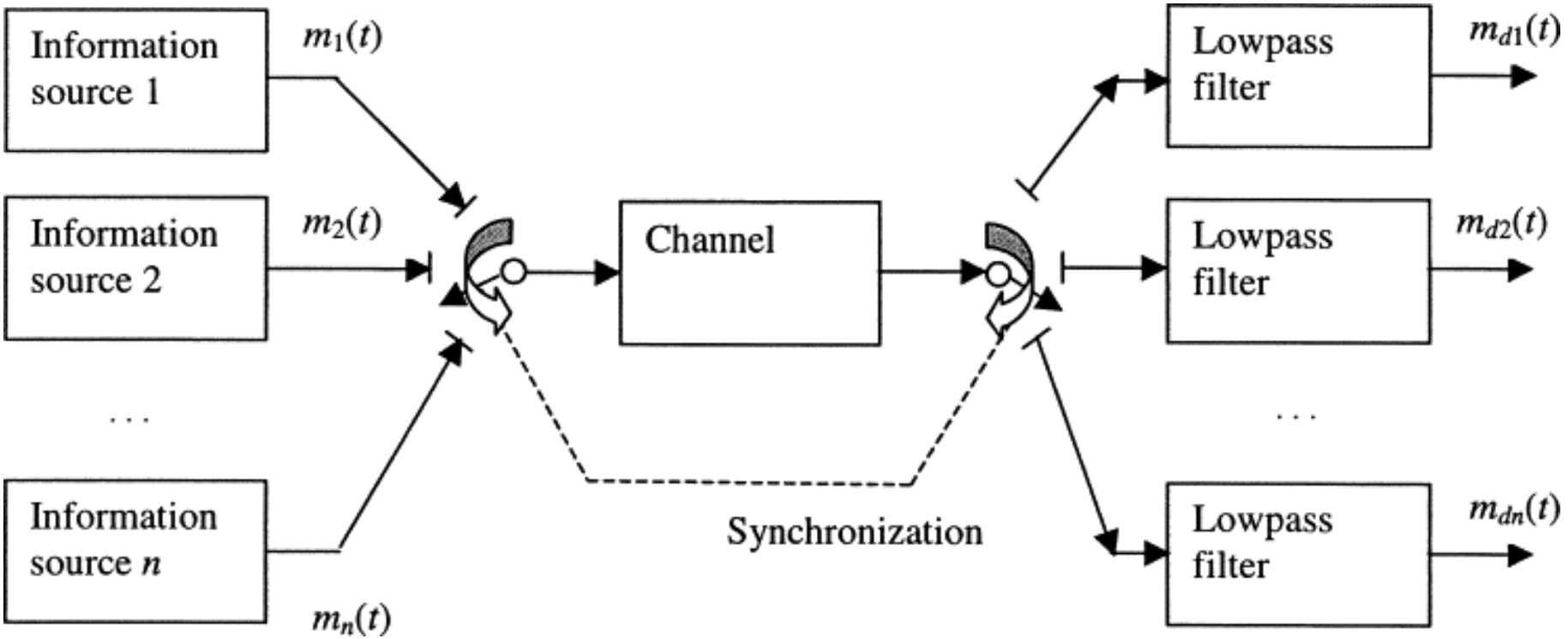
In frequency division multiplexing all the signals operate at the same time with different frequencies, but in time-division multiplexing, all the signals operate with the same frequency at different times.

In time division multiplexing, each user is allotted a particular time interval called time slot during which data is transmitted.

Time Division Multiplexing



Time Division Multiplexing



Time Division Multiplexing

PROS:

- Full bandwidth utilized by user
- More flexible in usage
- Problem of crosstalk is negligible
- Demodulation is easier
- Better protection from tapping

CONS:

- Require synchronization
- Wastage of bandwidth in case of uneven distribution of traffic or reservation of slot for a station it may not have any data to transmit
- Complex to implement

Applications of TDM

- ISDN telephone lines
- Used in PSTN networks