

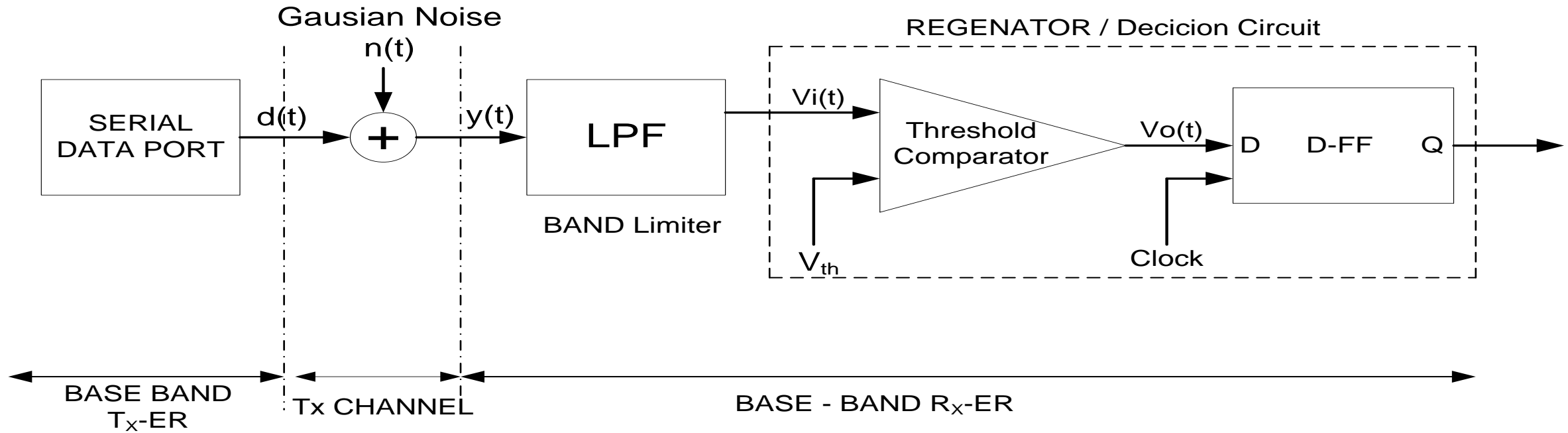
Sistem Komunikasi 1

Bab 11

Pengenalan Transmisi Digital



Baseband Digital Transmission Link



Sinyal Terima + AWGN

original message
 $d(t)$

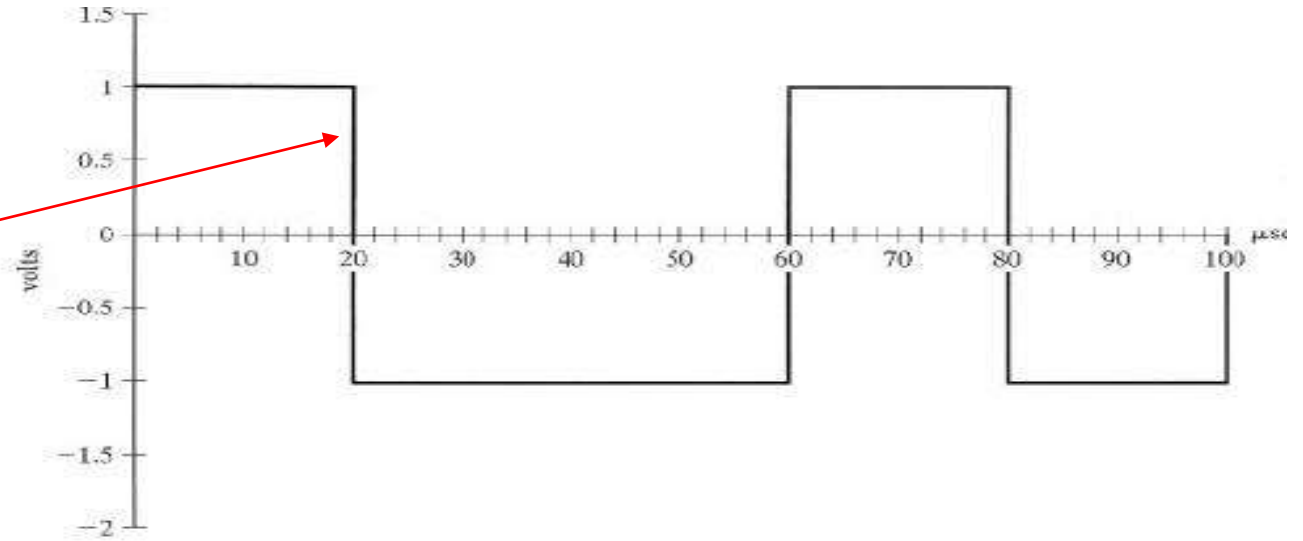
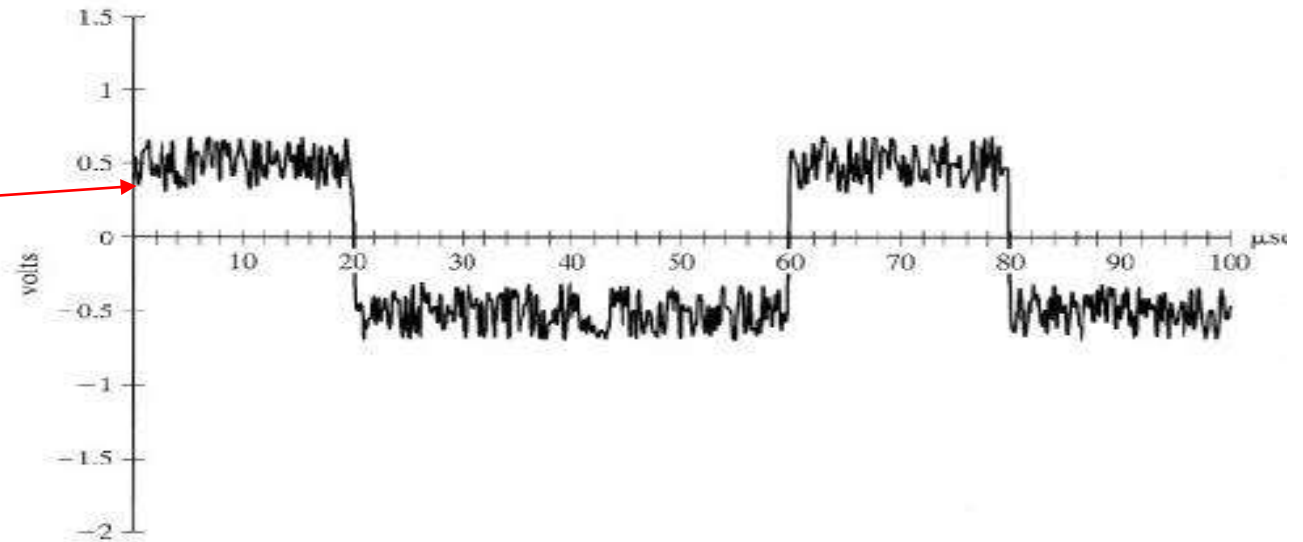


Figure 3-23a Transmitted signal for "10010" using rectangular pulses.

received wave
 $y(t)=d(t)+n(t)$

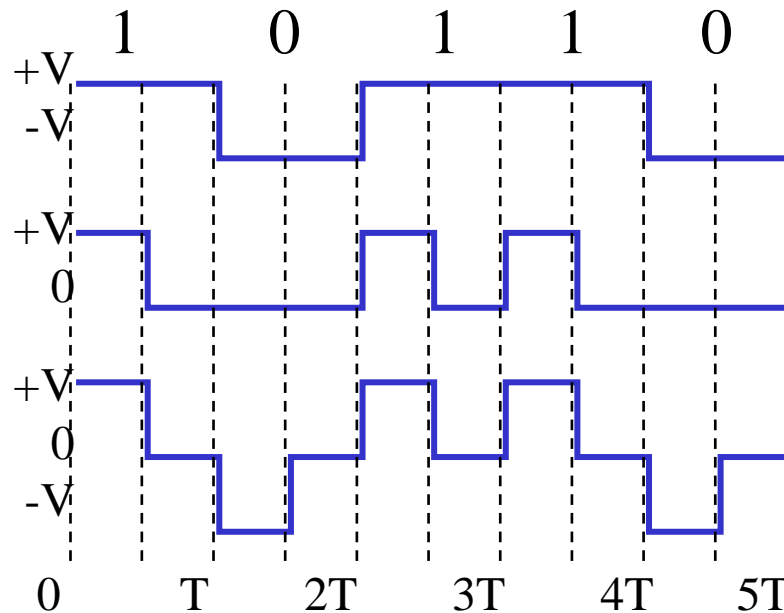


Bentuk gelombang/sinyal PCM

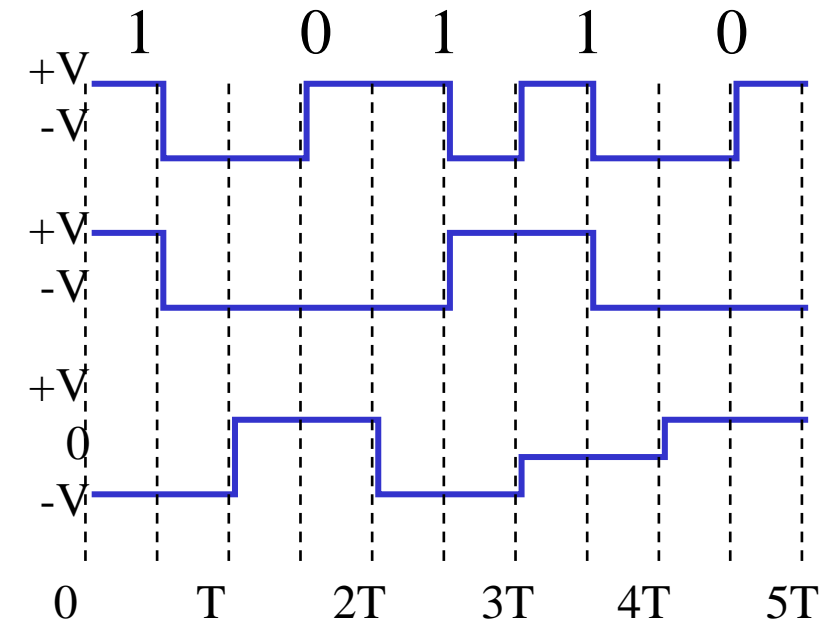
- NonReturn-to-Zero (NRZ)
- Return-to-Zero (RZ)

- Phase encoded
- Multilevel binary

NRZ-L



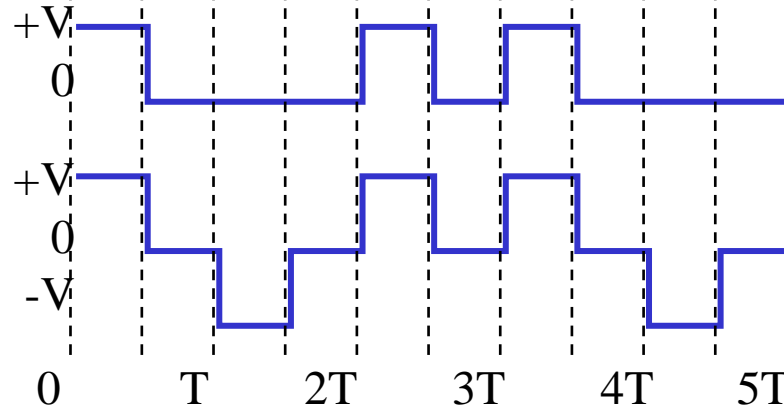
Manchester



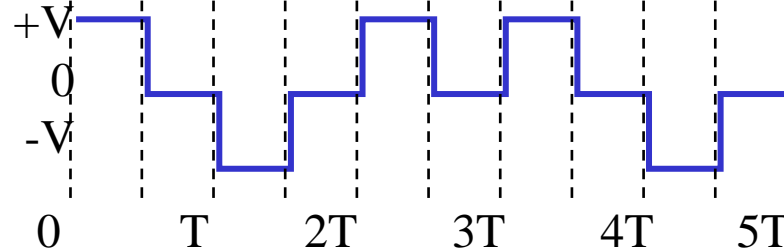
Miller

Dicode NRZ

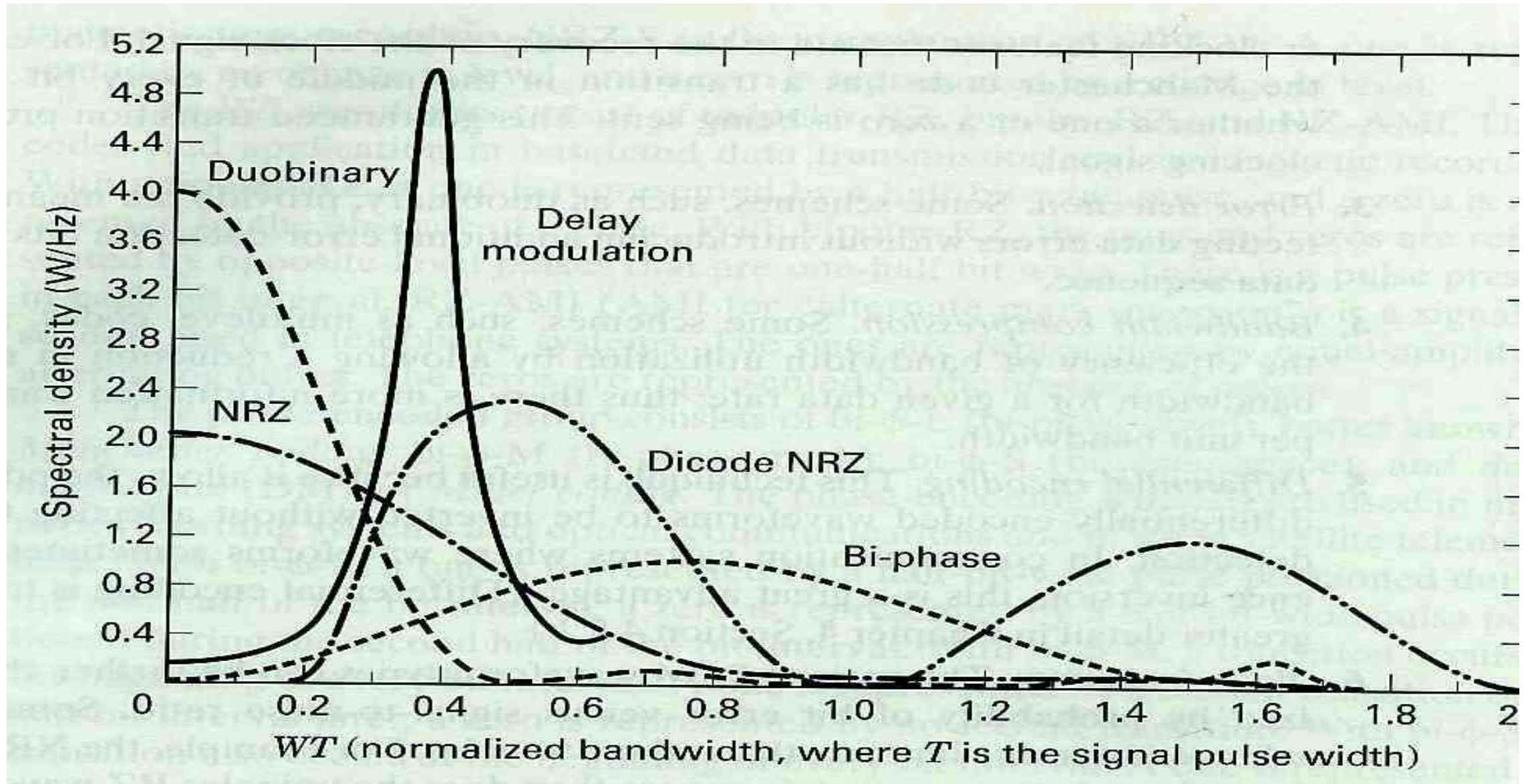
Unipolar-RZ



Bipolar-RZ



Spectrum sinyal PCM



Introduction :

Analog modulation and digital modulation

- **Both** analog and digital modulation systems **use analog carriers** to transport the information signal.
- In **analog modulation**, the **information is also analog**, whereas with **digital modulation**, the **information is digital** which could be computer generated data or digitally encoded analog signals.

Introduction to Digital Modulation

Offer **several outstanding advantages over traditional analog** system.

- Ease of processing
- Ease of multiplexing
- Noise immunity

Applications:

Low speed voice band data comm. modems

High speed data transmission systems

Digital microwave & satellite comm. systems

Mobile *communication systems*

Important Criteria

1. **High spectral efficiency**
2. **High power efficiency**
3. **Robust to multipath**
4. **Low cost and ease of implementation**
5. **Low carrier-to-co channel interference ratio**
6. **Low out-of-band radiation**

Cont'd...

7. Constant or near constant envelop

8. Bandwidth Efficiency

- Ability to accommodate data within a limited bandwidth
- Tradeoff between data rate and pulse width

9. Power Efficiency

- To preserve the fidelity of the digital message at low power levels.
- Can increase noise immunity by increasing signal power

Forms of Digital Modulation

$$v(t) = V \sin(2\pi f t + \theta)$$

ASK

FSK

PSK

QAM

Forms of Digital Modulation

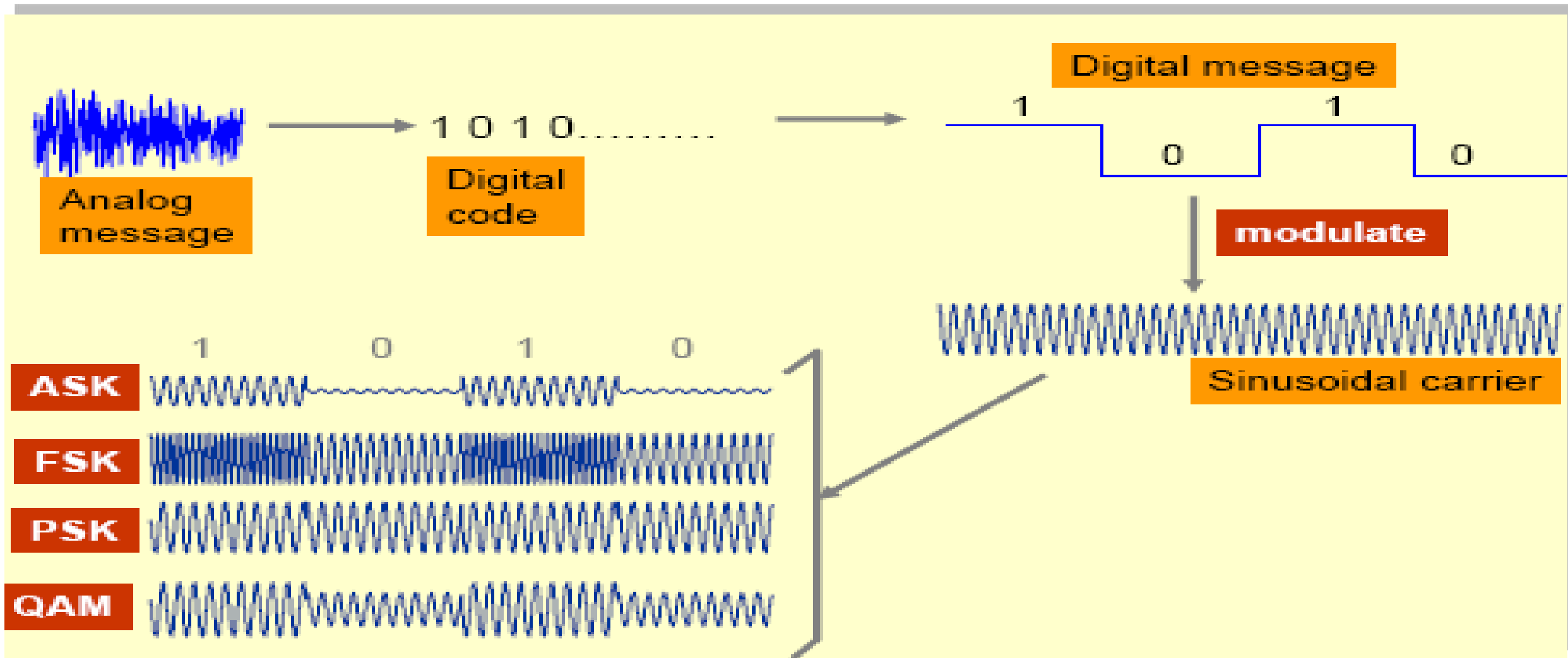
$$v(t) = V \sin(2\pi ft + \theta)$$

- If the *amplitude, V* of the carrier is varied proportional to the information signal, a digital modulated signal is called **Amplitude Shift Keying (ASK)**
- If the *frequency, f* of the carrier is varied proportional to the information signal, a digital modulated signal is called **Frequency Shift Keying (FSK)**

Cont'd...

- If the **phase, θ** of the carrier is varied proportional to the information signal, a digital modulated signal is called **Phase Shift Keying (PSK)**
- If both the **amplitude and the phase, θ** of the carrier are varied proportional to the information signal, a digital modulated signal is called **Quadrature Amplitude Modulation (QAM)**

Cont'd...



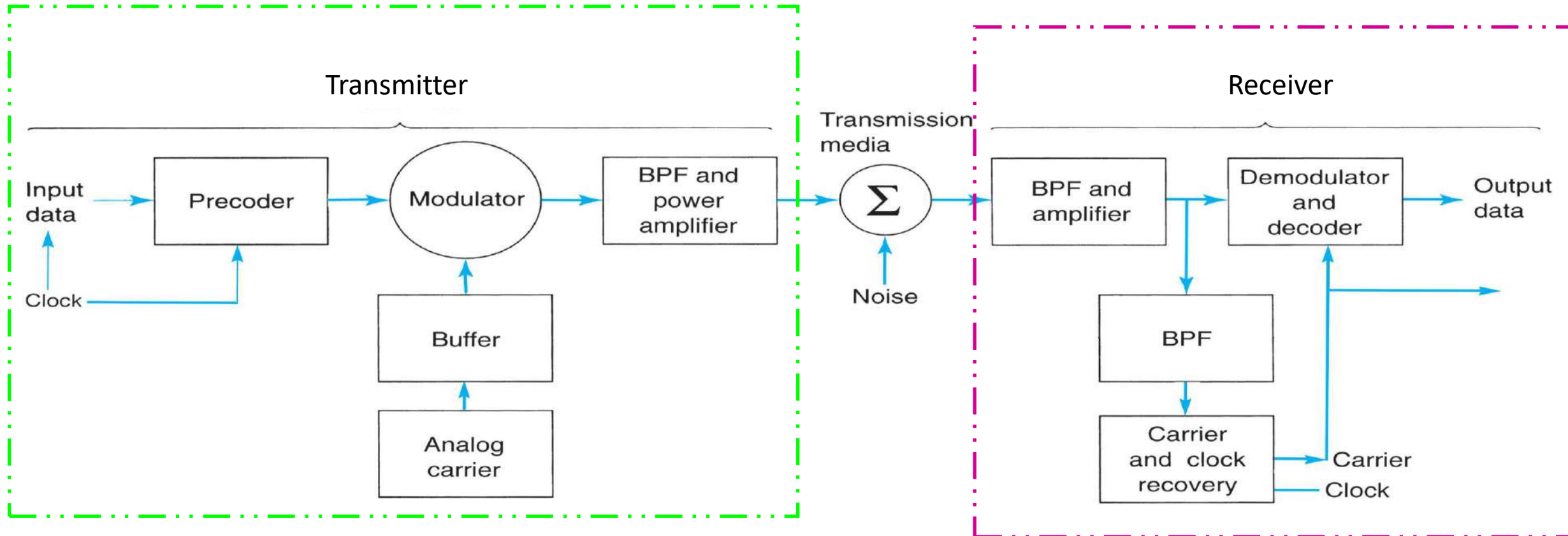
Example 1

For the digital message 1101 1100 1010, sketch the waveform for the following:

- a. ASK
- b. FSK
- c. PSK
- d. QAM

Block Diagram

Simplified block diagram of a digital modulation system



Cont'd...

- Precoder performs **level conversion & encodes incoming data** into group of bits that modulate an analog carrier.
- Modulated carrier **filtered, amplified & transmitted** through **transmission medium** to **Rx**.
- In Rx, the incoming signals **filtered, amplified** & applied to the **demodulator and decoder** circuits which extracts the original source information from modulated carrier.

M-ary Encoding

- It is often advantageous to encode at a level **higher than binary** where there are more than two conditions possible.
- The **number of bits necessary to produce a given number of conditions** is expressed mathematically as

$$N = \log_2 M \quad \text{OR}$$

$$M = 2^N$$

Where **N** = number of bits necessary

M = number of conditions, level or combinations
bits.

possible with **N**

Cont'd...

- Each symbol represents n bits, and has M signal states, where $M = 2^N$.
- Example;
A digital signal with four possible conditions (voltage levels, frequencies, etc) is an M -ary system with number of possible conditions, $M=4$.

Example 2

Find the number of voltage levels which can represent an analog signal with

- a. 3 Bits
- b. 8 bits
- c. 12 bits

Ans: $M=8,256,4096$

Digital Modulation Techniques

- Amplitude Shift Keying (ASK)
- Frequency Shift Keying (FSK)
- Phase Shift Keying (PSK)
- Quadrature Amplitude Modulation (QAM)