Telkom University

Diploma of Telecommunication Engineering

DTG2F3

Sistem Komunikasi

BASEBAND TRANSMISSION

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Where We Are?

1. **PENDAHULUAN**
   - Perkenalan dan sosialisasi SAP&syllabus
   - Elemen dasar Sistem Komunikasi
   - Sistem komunikasi Analog Vs Digital
   - Sumber Informasi dalam sistem komunikasi
   - Kanal dalam sistem komunikasi
   - Teorema shanon
   - Modulasi (modulasi analog vs modulasi digital ; CW modulation vs pulse modulation)
2. **MODULASI ANALOG**
   - Modulasi , demodulasi, dan kinerja sistem AM
   - Modulasi, demodulasi, dan kinerja sistem FM
   - Aplikasi sistem AM dan FM (Radio Broadcasting, dan TV analog)
3. **SISKOM DIGITAL → ADC, SOURCE CODING, MULTIPLEXING**
   - Analog to Digital converter (ADC)
   - Source Coding (Shanon faco coding dan huffman coding)
   - Multiplexing (Time Division Multiplexing (TDM) : PCM 30/E1 dan PCM 24/T1)
4. **SISKOM DIGITAL → Baseband Transmission**
   - Binary digit waveform
   - PCM waveform type
5. **SISKOM DIGITAL → Passband Modulation**
   - Modulasi ASK
   - Modulasi FSK
   - Modulasi PSK
   - Modulasi QAM
   - Modulasi GMSK
   - OFDM
6. **NOISE DALAM SISKOM**
   - Sumber Noise (internal dan external)
   - Shot Noise dan Thermal Noise
   - AWGN (Additive White Gaussian Noise)
   - Noise Figure, Noise Temperature, dan Sistem Temperatur
7. **SISKOM DIGITAL → Channel Coding**
   - Linear Block Code
   - Cyclic Code
   - Convolution COde

OUTLINE

SISKOM DIGITAL → ADC, SOURCE CODING, MULTIPLEXING

1. Pendahuluan
2. Line Coding
3. M-ary Pulse Modulation

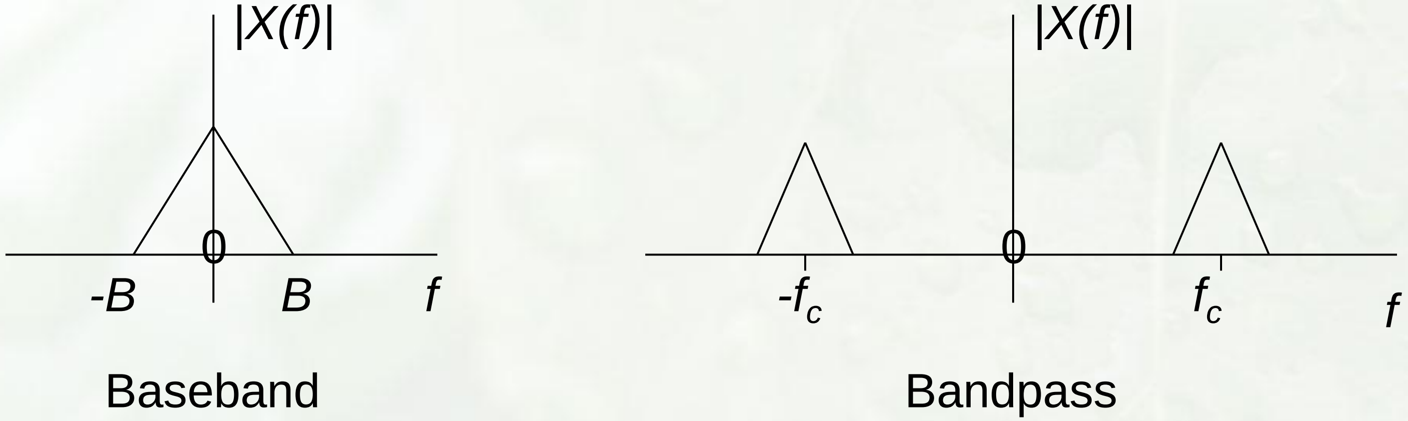
OUTLINE

PENDAHULUAN

BASEBAND TRANSMISSION

Baseband Transmission

- The transmitted signal is limited to a range from *-B* Hz to +*B* Hz.



- Signal is sent without conversion to an analog signal.
- Requires a transmission channel with bandwidth that starts at 0Hz (a *low-pass* channel).

BASEBAND TRANSMISSION

DIGITAL TRANSMISSION

“**Baseband’Transmission**” means that no carrier wave modulation is used for transmission

Transmitted power;
bandpass/baseband signal

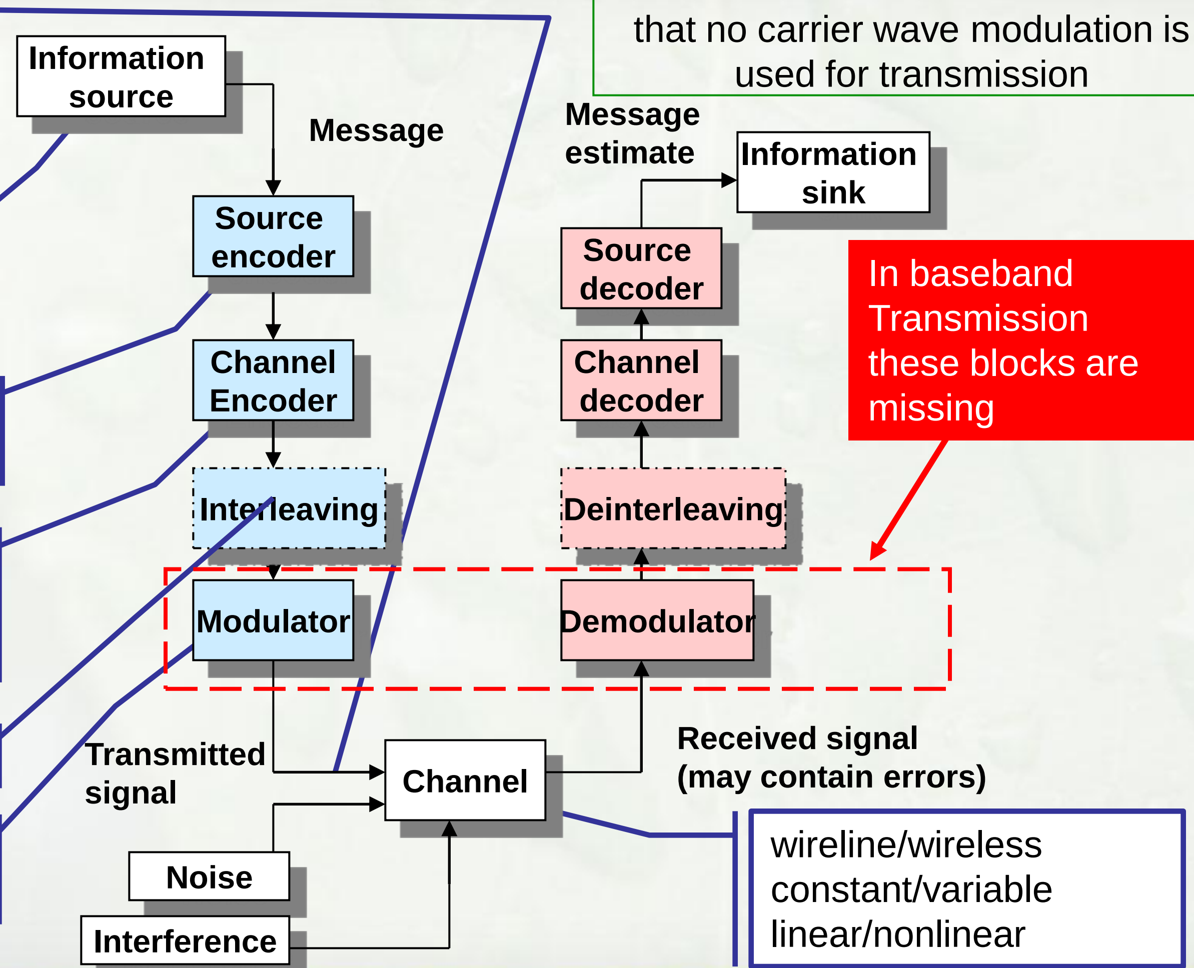
Information:
- analog:BW & dynamic range
- digital:bit rate

Maximization of information transferred

Message protection & channel adaptation;
convolution, block coding

Fights against burst errors

M-PSK/FSK/ASK..., depends on channel BW & characteristics



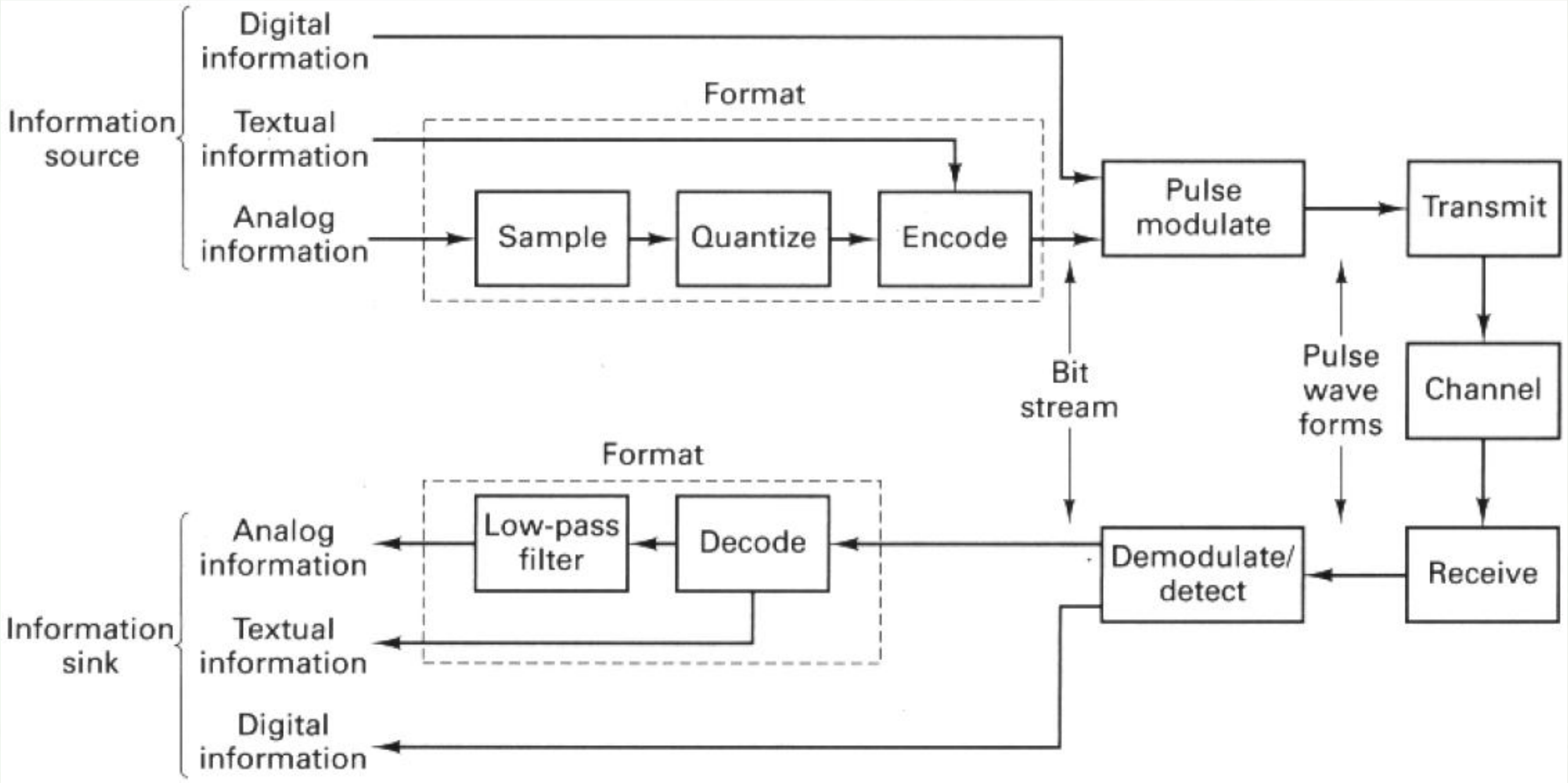
BASEBAND TRANSMISSION

WHY DIGITAL TRANSMISSION

- Digital communication withstands channel noise, interference and distortion better than analog system. For instance in analog systems interference must be below 50 dB whereas in digital system 20 dB is enough. With this respect digital systems can utilize lower quality cabling than analog systems
- Regenerative repeaters are efficient. Note that cleaning of analog-signals by repeaters does not work as well
- Circuits can be easily reconfigured and preprogrammed by DSP techniques (an application: software radio)
- Digital signals can be coded to yield very low error rates
- The cost Consideration

BASEBAND TRANSMISSION

FORMATTING AND BASEBAND TRANSMISSION



BASEBAND TRANSMISSION

BASEBAND TRANSMISSION

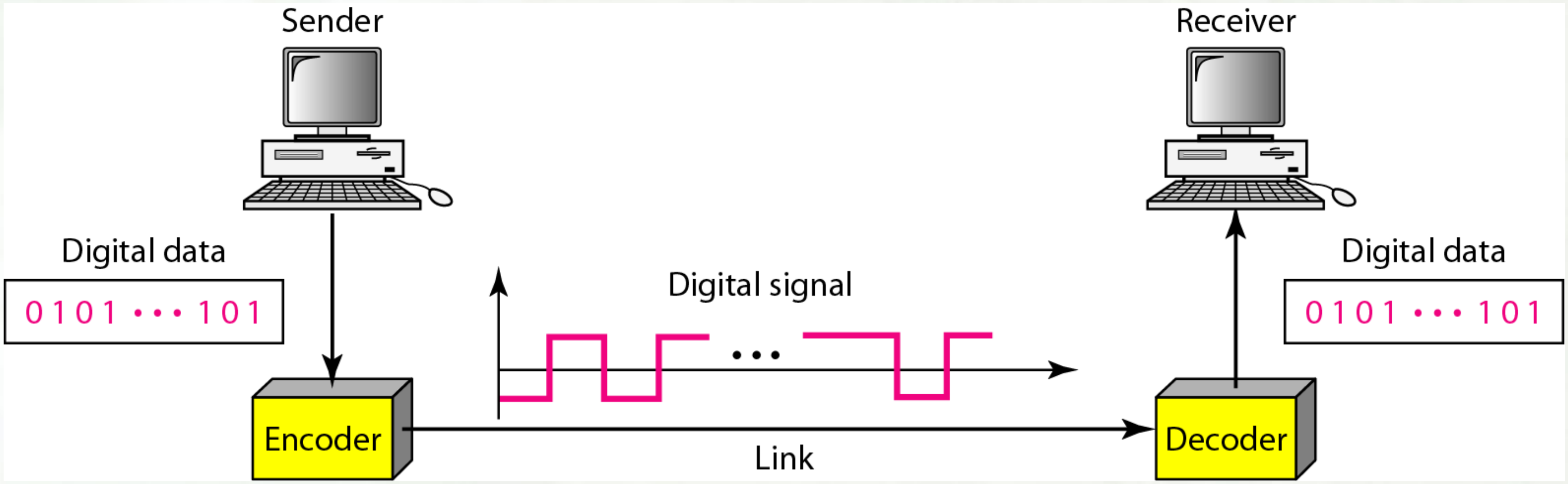
- To transmit information through physical channels, PCM sequences (codewords) are transformed to pulses (waveforms).
  - Each waveform carries a symbol from a set of size M.
  - Each transmit symbol represents $k = \log_2 M$ bits of the PCM words.
  - PCM waveforms (line codes) are used for binary symbols (M=2).
  - M-ary pulse modulation are used for non-binary symbols (M>2).

OUTLINE

LINE CODING

BASEBAND TRANSMISSION

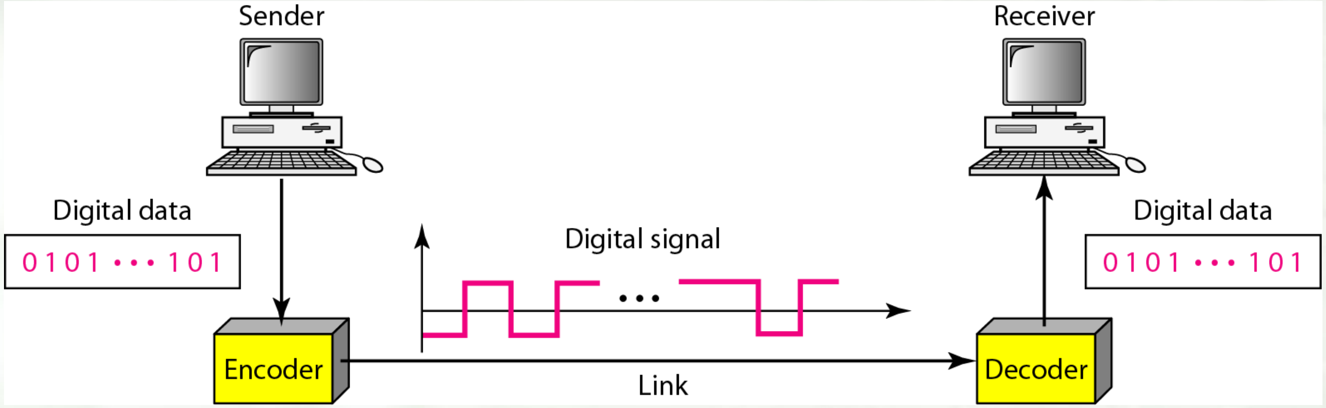
Line Coding and Decoding



Line Coding- Coding of the bit stream to make its spectrum suitable for the channel response. Also to ensure the presence of frequency components to permit bit timing extraction at the receiver.

BASEBAND TRANSMISSION

Line Coding and Decoding



Signal Element Versus Data Element In data communications, our goal is to send data elements. A data element is the smallest entity that can represent a piece of information: this is the bit. In digital data communications, a signal element carries data elements. A signal element is the shortest unit (timewise) of a digital signal. In other words, data elements are what we need to send; signal elements are what we can send. Data elements are being carried; signal elements are the carriers.

BASEBAND TRANSMISSION

Line Coding

- Binary data can be transmitted using a number of different types of pulses.
- The choice of a particular pair of pulses to represent the symbols 1 and 0 is called Line Coding
- The choice is generally made on the grounds of one or more of the following considerations:
  - Presence or absence of a DC level.
  - Bandwidth.
  - BER performance
  - Ease of clock signal recovery for symbol synchronisation.
  - Presence or absence of inherent error detection properties.

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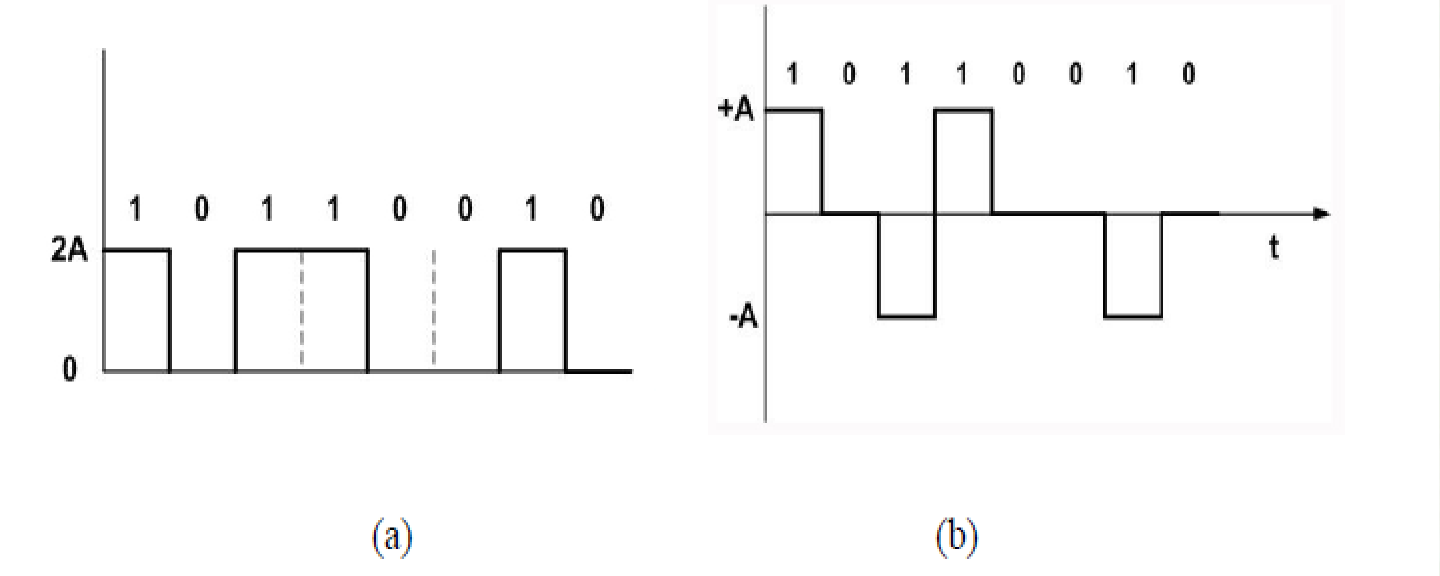
Importance Characteristic of Line Coding

- No. Of Levels

This refers to the number values allowed in a signal, known as s**ignal levels**, to represent data.



(a) Signal with two voltage levels, (b) Signal with three voltage levels

BASEBAND TRANSMISSION

Importance Characteristic of Line Coding

- Bit rate Versus Baud rate
  - The **bit rate** represents the number of bits sent per second,
  - whereas the **baud rate** defines the number of signal elements per second in the signal.
  - Depending on the encoding technique used, baud rate may be more than or less than the data rate.
- DC components
  - After line coding, the signal may have zero frequency component in the spectrum of the signal, which is known as the direct-current **(DC) component**.
  - Not Desirable. e.g. Transformer, Capacitive Coupling
  - Unwanted Energy Loss

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Importance Characteristic of Line Coding

- Signal Spectrum
  - Different encoding of data leads to different spectrum of the signal.
  - It is necessary to use suitable encoding technique to match with the medium so that the signal suffers minimum attenuation and distortion as it is transmitted through a medium.

- Cost of Implementation
  - It is desirable to keep the encoding technique simple enough such that it does not incur high cost of implementation.

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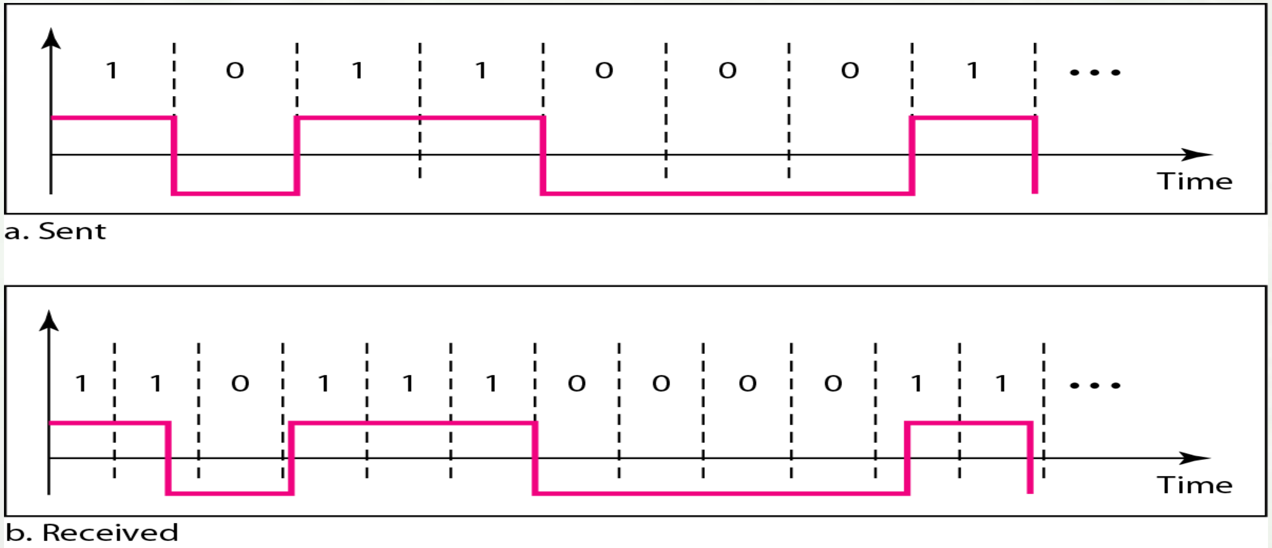
Importance Characteristic of Line Coding

- Synchronization
  - To interpret the received signal correctly, the bit interval of the receiver should be exactly same or within certain limit of that of the transmitter.
  - Any mismatch between the two may lead wrong interpretation of the received signal.



Effect of lack of synchronization

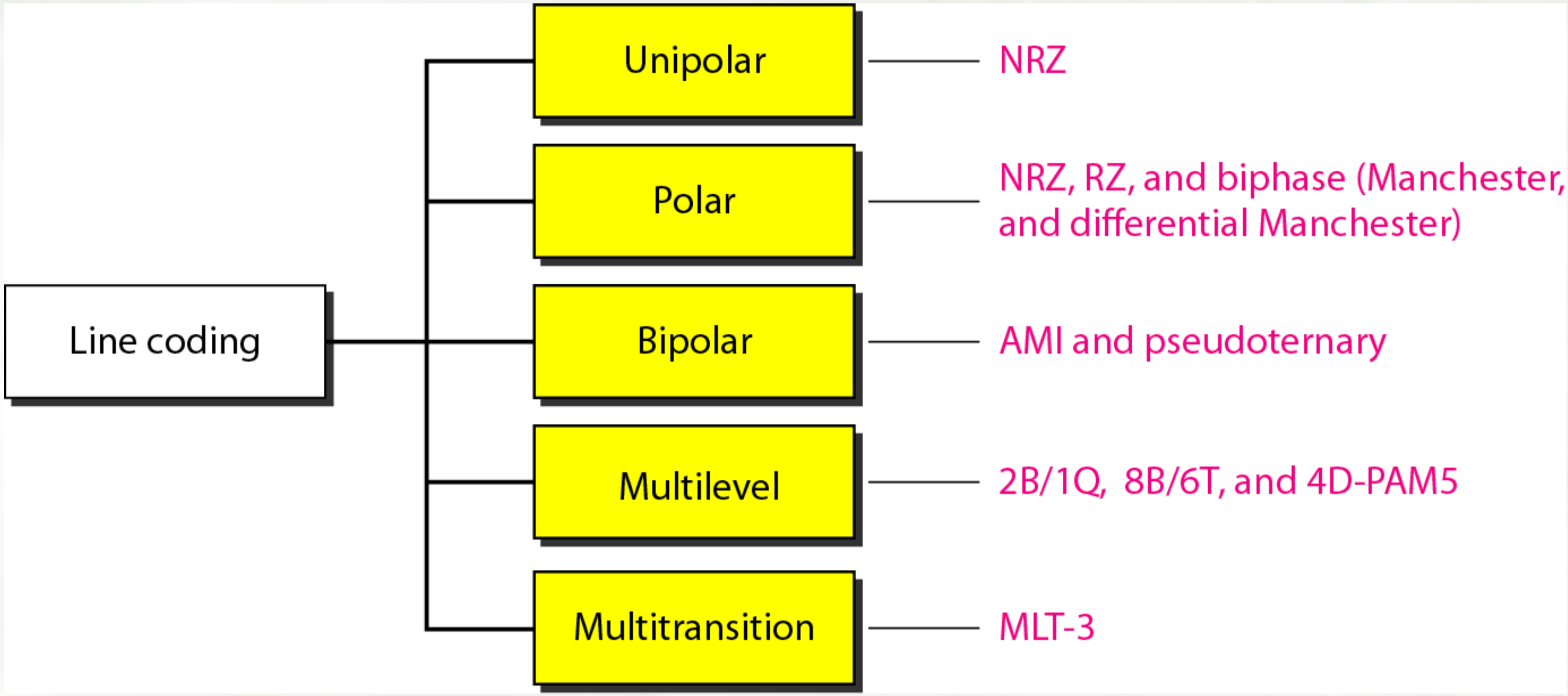
BASEBAND TRANSMISSION

Importance Characteristic of Line Coding

- SELF SYNCHRONIZATION
  - To correctly interpret the signals received from the sender, the receiver’s bit intervals must correspond exactly to the sender’s bit interval.
  - A self-synchronizing digital signal includes timing information in the data being transmitted.
  - This can be achieved if there are transitions in the signal that alert the receiver to the beginning, middle, or end of the pulse.
  - If the receiver’s clock is out of synchronization, these alerting points can reset the clock.

BASEBAND TRANSMISSION

JENIS LINE CODING



BASEBAND TRANSMISSION

Line Coding

	Two wire BW kecil (misal kabel telepon)	Two wire BW sedang (misal kabel 2 Mbps)	Coaxial
Output Line coding	Rate kecil : bipolar , AMI , HDB-3 , B6ZS	Rate kecil / sedang : bipolar , AMI , HDB-3 , B6ZS	bilpolar , AMI , HDB-3 , B6ZS
	Rate sedang / besar : Sinyal multi level	Rate besar : sinyal multi level	

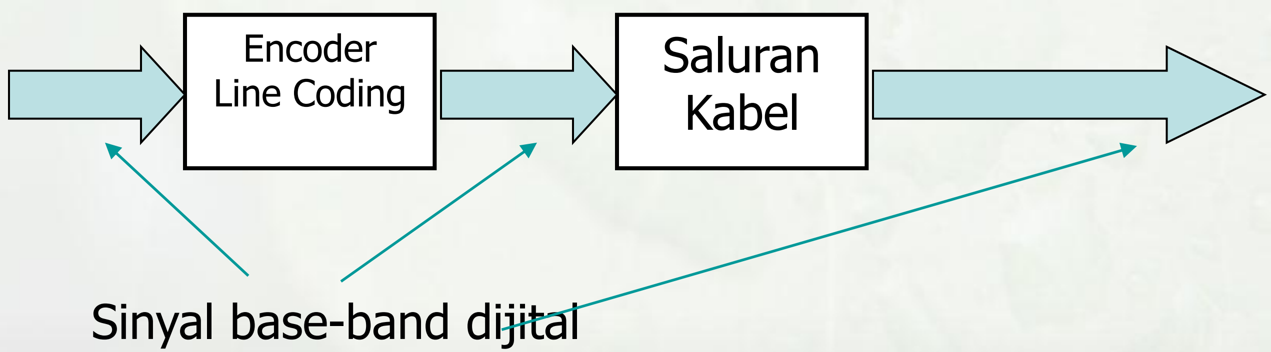
-output ADC

- sinyal TDM

-Sinyal data text

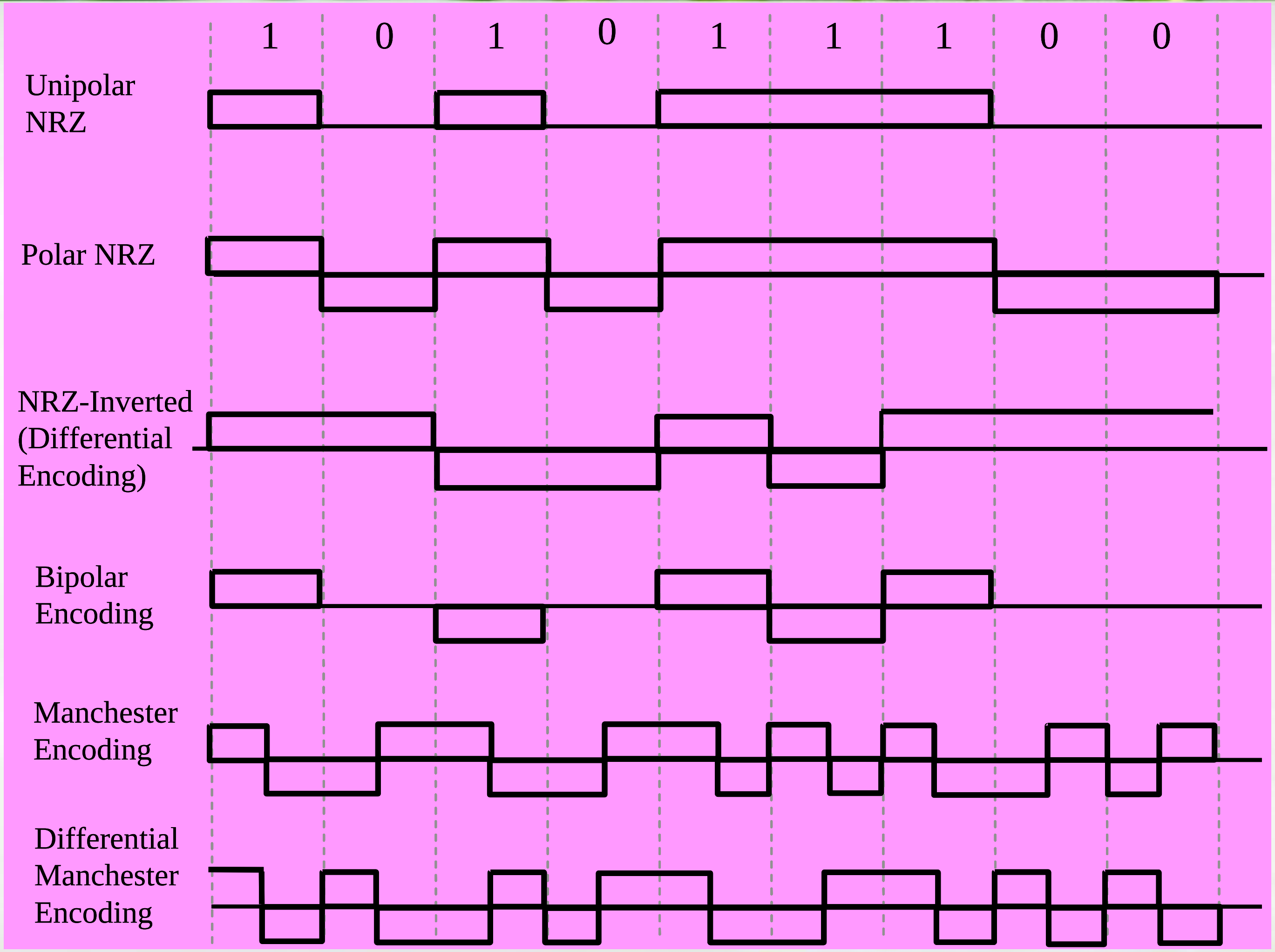
-Output scrambler

-Output FEC



BASEBAND TRANSMISSION

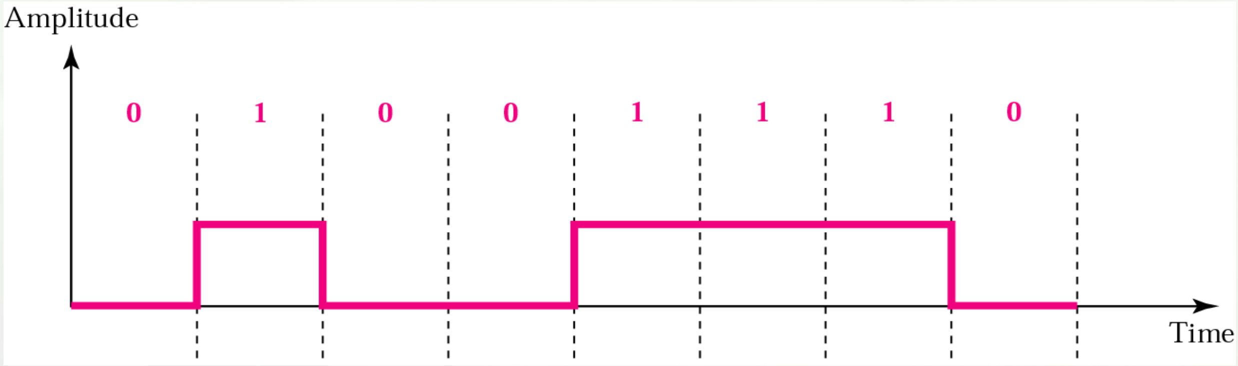
Line Coding



BASEBAND TRANSMISSION

UNIPOLAR ENCODING

- Digital transmission systems work by sending voltage pulses along a cable.
- In unipolar encoding, the polarity is assigned to ‘1’ bit, while the ‘0’ bit is represented by zero voltage.
- Unipolar encoding has two problems: dc component and lack of synchronization
- The average amplitude of a unipolar encoded signal is nonzero, which creates a dc component.
- If data contains a long sequence of 1s or 0s, synchronization is lost.



Unipolar Encoding

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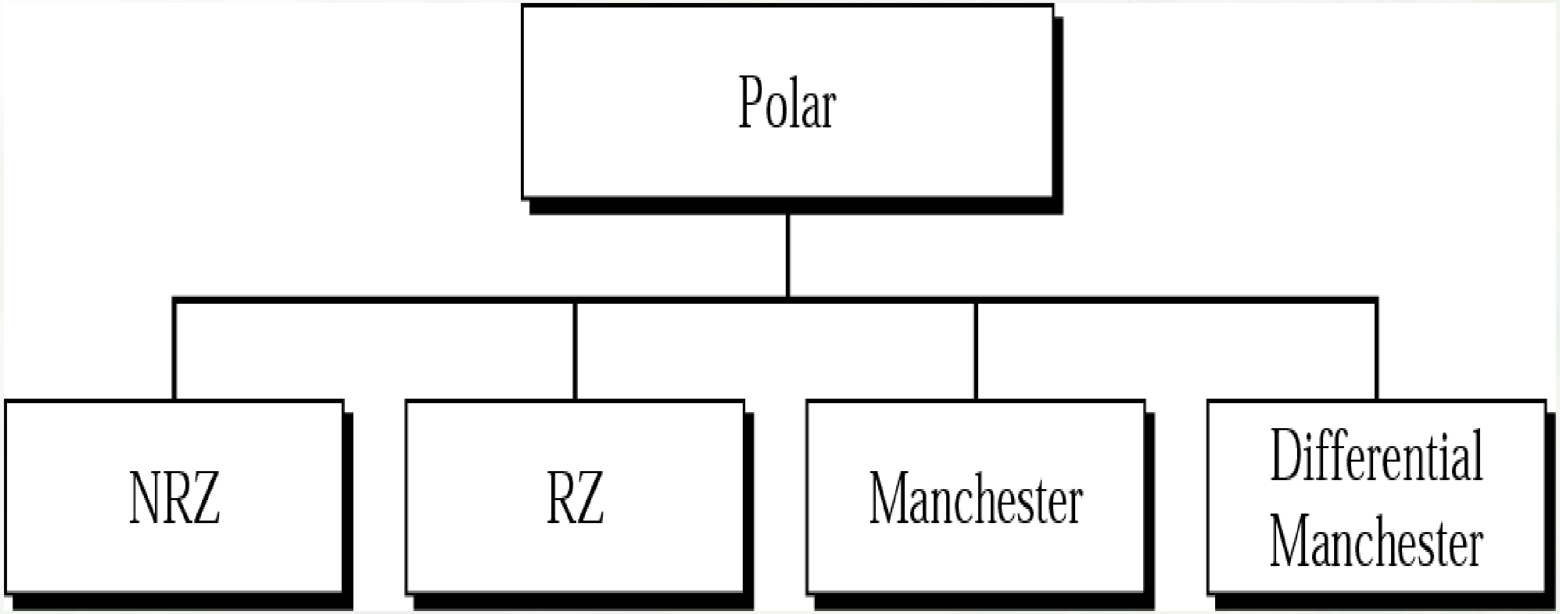
POLAR ENCODING

- Polar encoding uses two voltage levels (positive and negative).



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NRZ Encoding

- In Nonreturn to Zero (NRZ) encoding, the value of the signal is always either positive or negative.
- There are two popular forms of NRZ: NRZ-L and NRZ-I
- In NRZ-Level (NRZ-L), a positive voltage means ‘0’ bit, while a negative voltage means ‘1’ bit.
- The advantages of NRZ coding are:
    - Detecting a transition in presence of noise is more reliable than to compare a value to a threshold.
    - NRZ codes are easy to engineer and it makes efficient use of bandwidth.
- Disadvantage
    - A problem can arise when the data contains a long stream of 0s or 1s that can cause synchronization lost.

BASEBAND TRANSMISSION

NRZ Encoding

- In NRZ-Invert (NRZ-I), it is the transition between positive and negative voltage, not the voltage itself, that represents a ‘1’ bit. A ‘0’ bit is represented by no change.

- NRZ-I is better than NRZ-L due to the synchronization provided by the signal change each time a 1 bit is encountered.

- Both NRZ-L and NRZ-I have synchronization problem.

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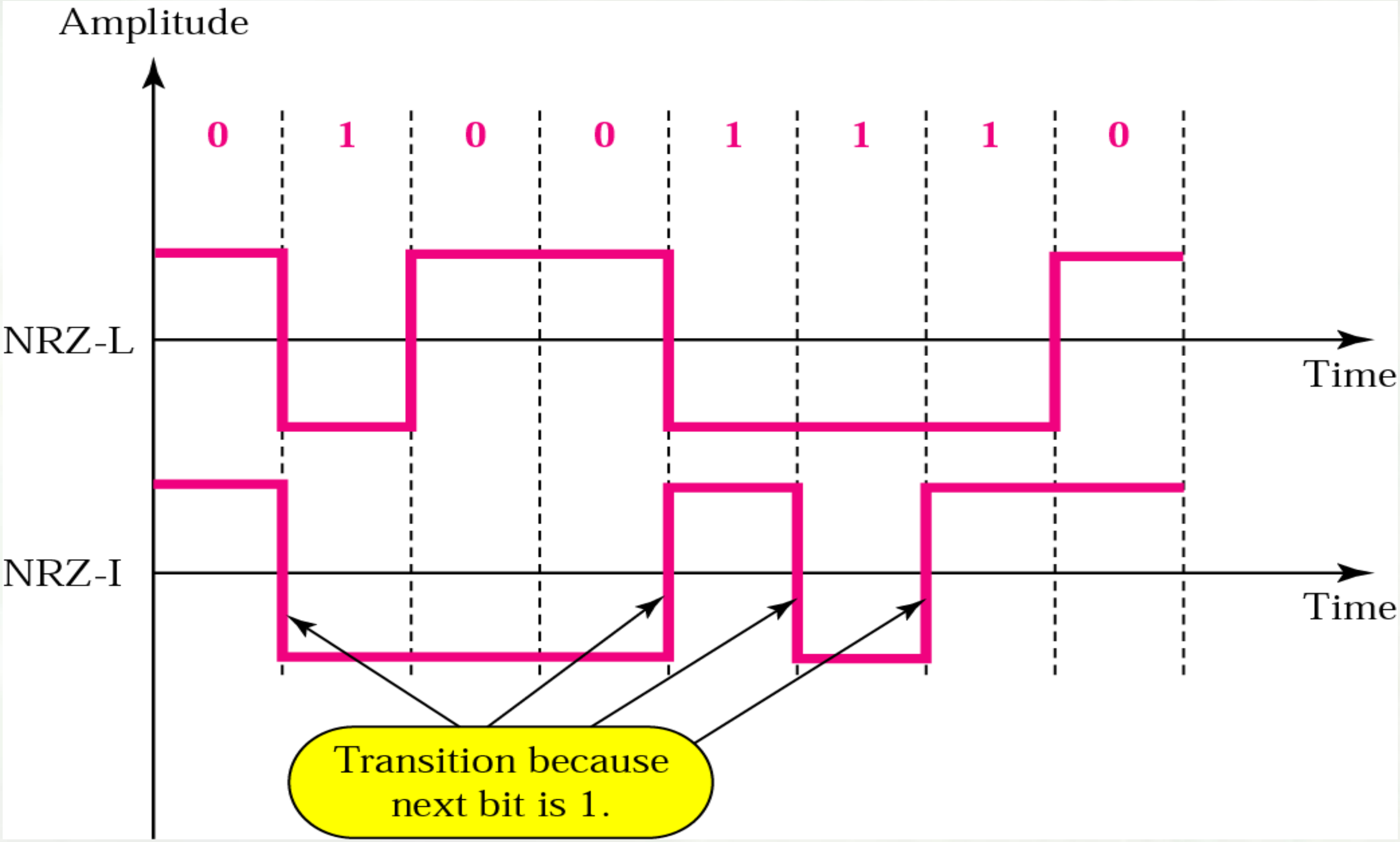
NRZ Encoding



BASEBAND TRANSMISSION

RZ Encoding

- To ensure synchronization, there must be a signal change for each bit. The receiver can use these changes to build up, update and synchronize its clock.
- Return to Zero (RZ) uses three values: positive, negative and zero. In RZ, the signal changes not between bits but during (middle of) each bit.
- A 1 bit is represented by positive-to-zero and a 0 bit by negative-to-zero.
- The main disadvantage of RZ is that it requires two signal changes to encode one bit and therefore occupies more bandwidth.

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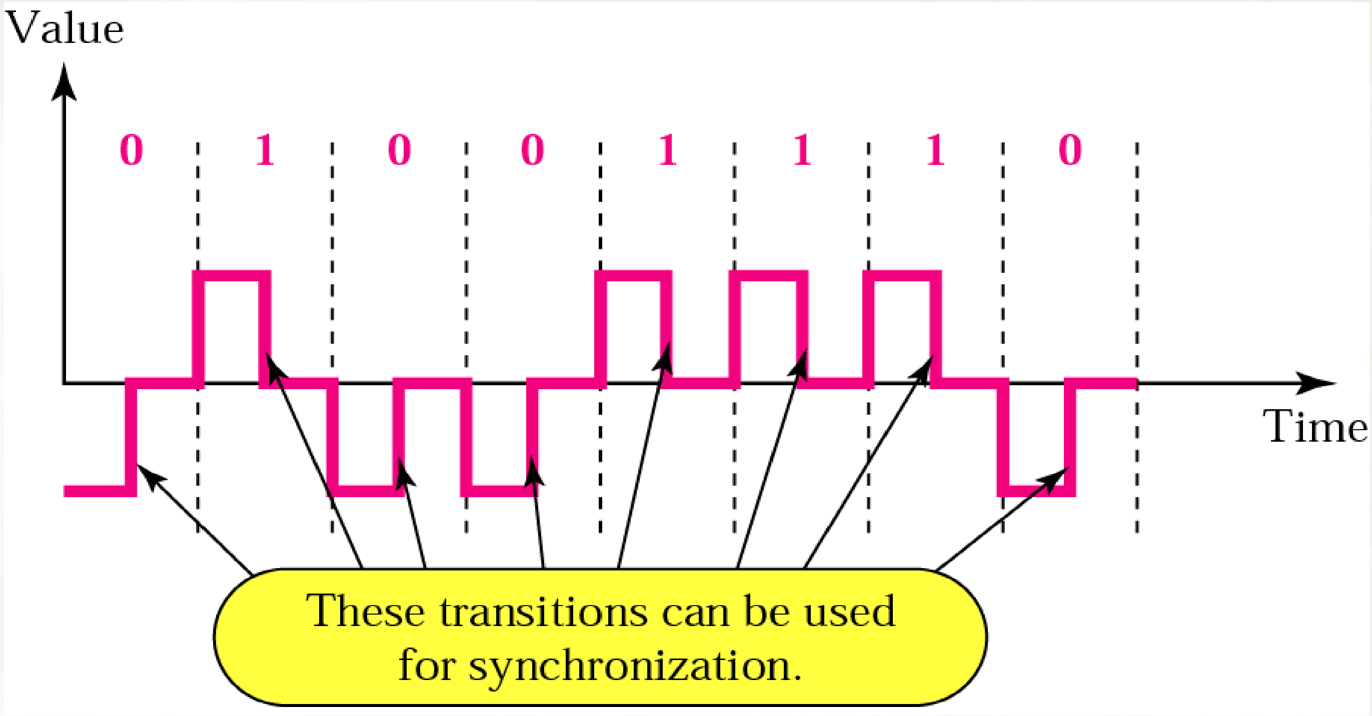
RZ Encoding



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Biphase Encoding

- To overcome the limitations of NRZ encoding, biphase encoding techniques can be adopted.
- *Manchester* and *differential Manchester Coding* are the two common Biphase techniques
- Bit changes at the Middle (mid bit Transition) serves as a clocking mechanism and also as data.

BASEBAND TRANSMISSION

Manchester Encoding

- Manchester encoding uses an inversion at the middle of each bit interval for both synchronization and bit representation.
- A negative-to-positive transition represents 1 and a positive-to-negative transition represents 0.
- Manchester encoding achieves the same level of synchronization as RZ but with only two levels of amplitude.

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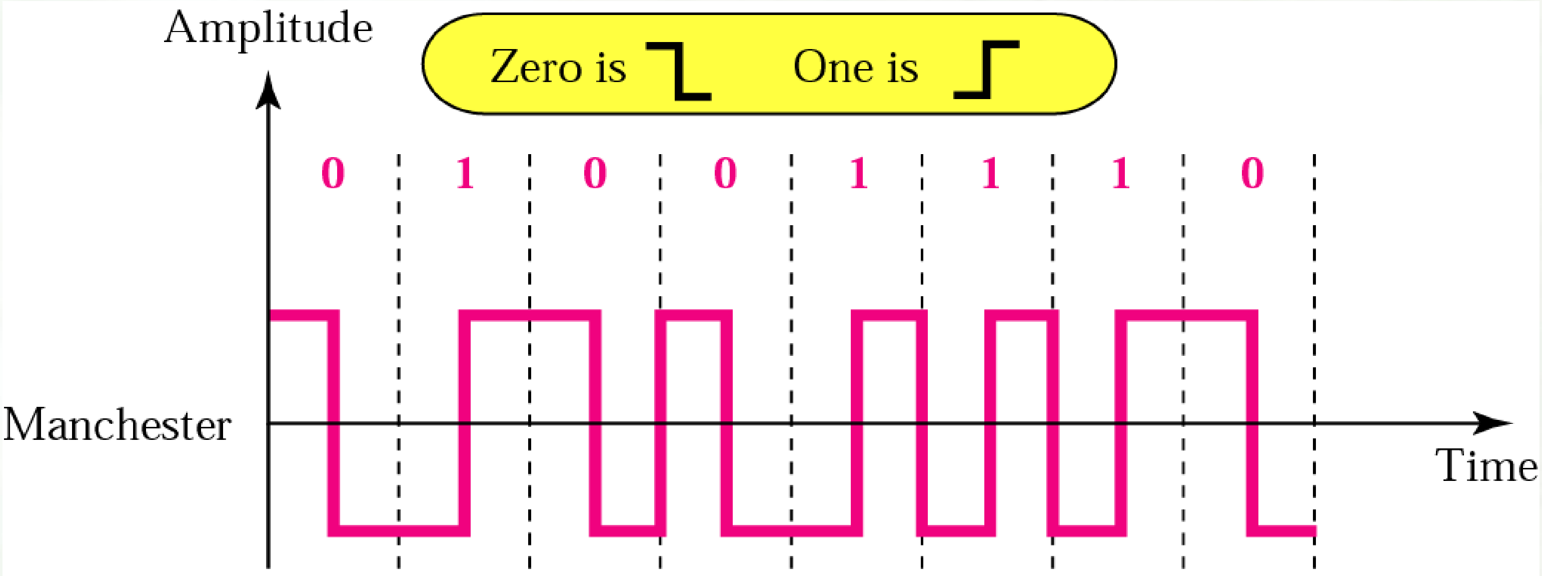
Manchester Encoding



BASEBAND TRANSMISSION

Manchester Encoding

Note:

In Manchester encoding, the transition at the middle of the bit is used for both synchronization and bit representation.

BASEBAND TRANSMISSION

Differential Manchester Encoding

- In differential Manchester encoding, the inversion at the middle of the bit interval is used for synchronization, but the presence (0) or absence (1) of an additional transition at the beginning of the interval is used to identify the bit.

- Differential Manchester encoding requires two signal changes to represent binary 0 but only one to represent binary 1.

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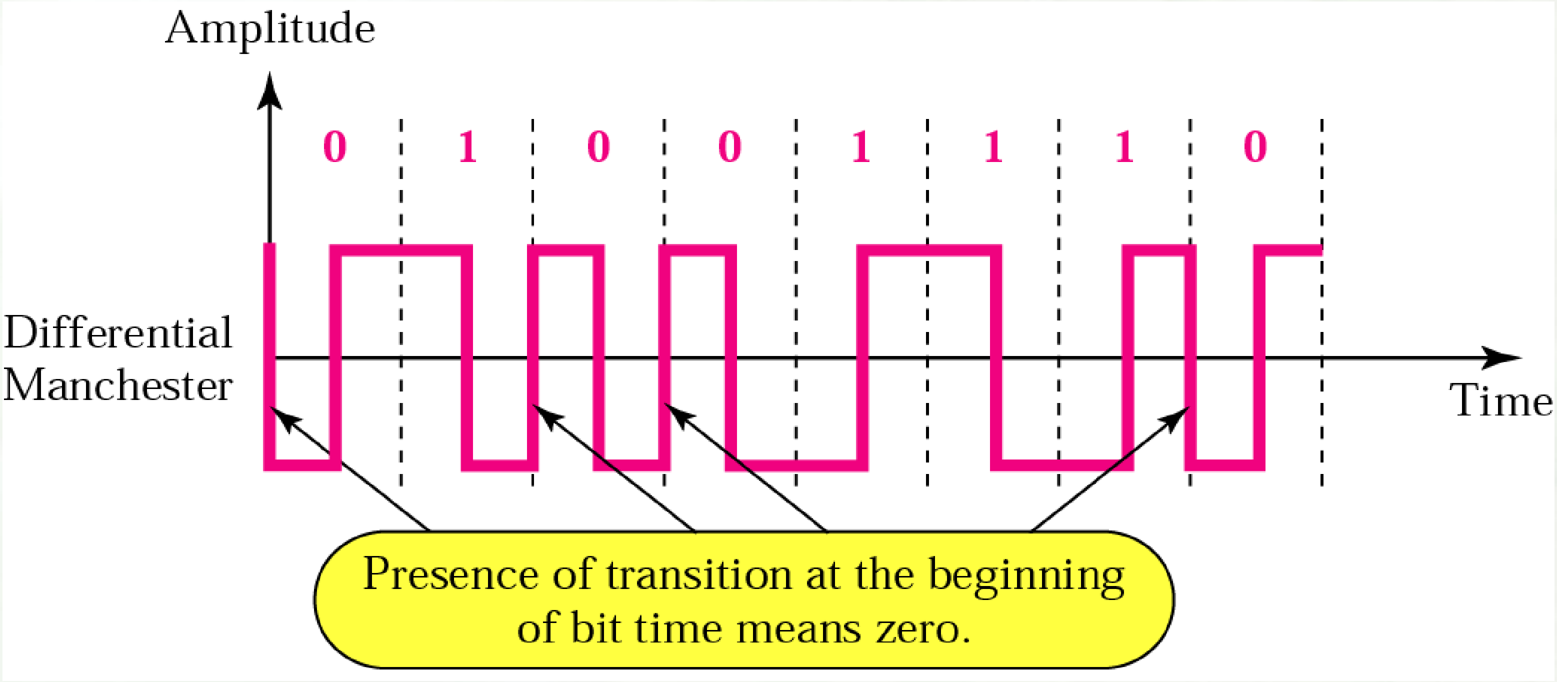
Differential Manchester Encoding



BASEBAND TRANSMISSION

Differential Manchester Encoding

Note:

In differential Manchester encoding, the transition at the middle of the bit is used only for synchronization.
The bit representation is defined by the inversion or noninversion at the beginning of the bit.

BASEBAND TRANSMISSION

Bipolar Encoding

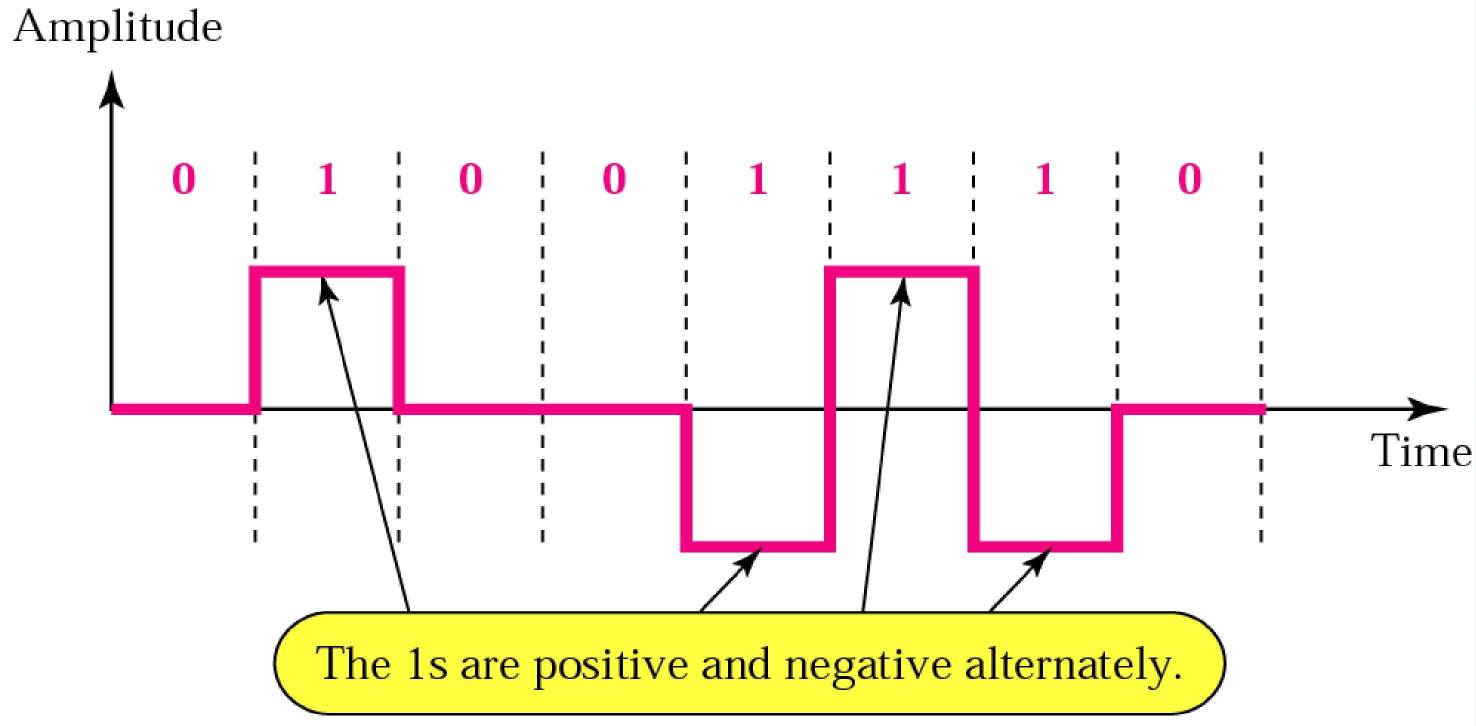
- In bipolar encoding, we use three levels: positive, zero, and negative.

- Unlike RZ, the zero level in bipolar encoding is used to represent binary 0. The 1s are represented by alternating positive and negative voltages (even if the 1 bits are not consecutive).

- A common bipolar encoding scheme is called Alternate Mark Inversion (AMI). The word mark comes from telegraphy and it means 1.

BASEBAND TRANSMISSION

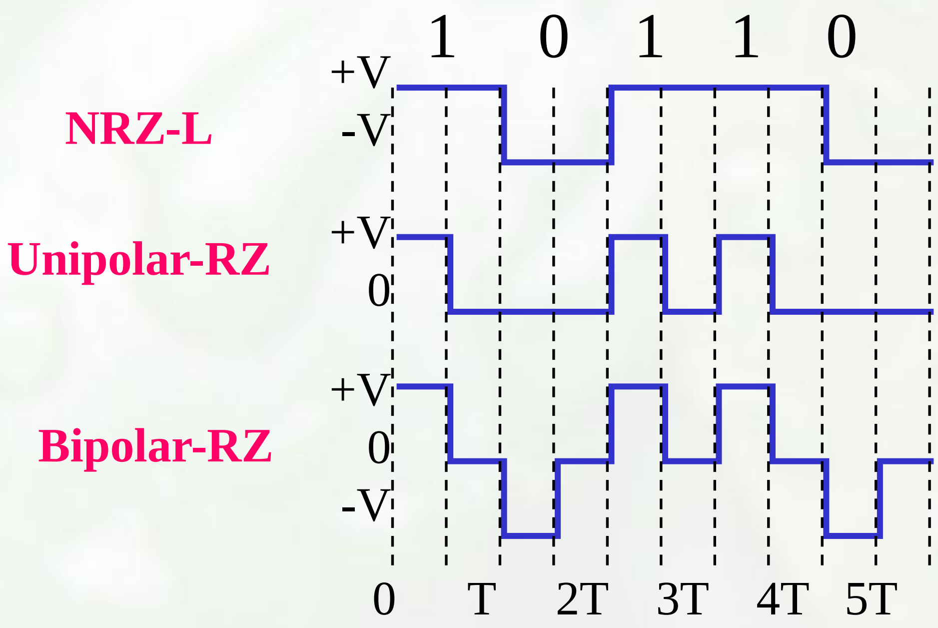
Bipolar AMI Encoding

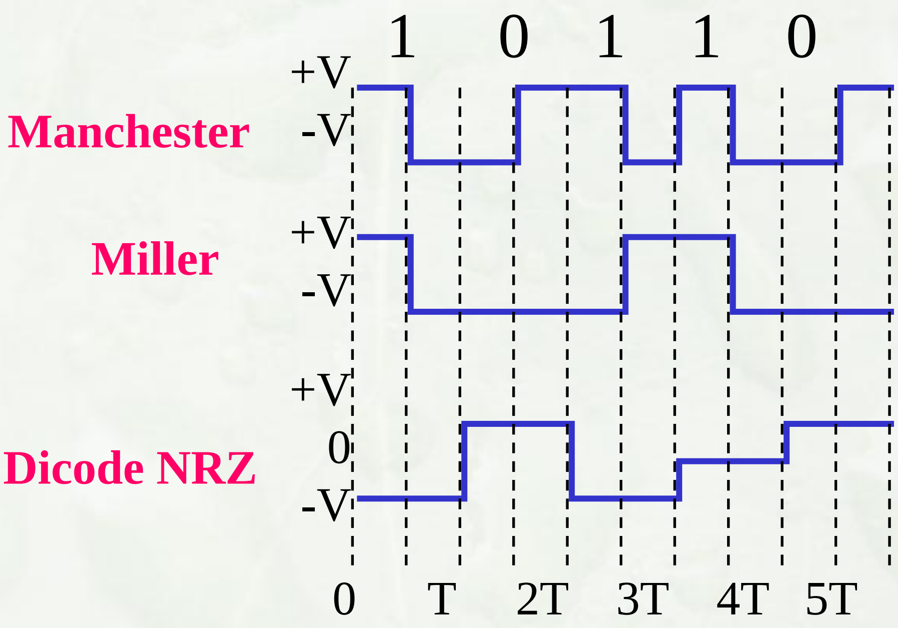


BASEBAND TRANSMISSION

Line Coding

- NonReturn-to-Zero (NRZ)
- Return-to-Zero (RZ)
- Phase encoded
- Multilevel binary





BASEBAND TRANSMISSION

Criteria For Comparing And Selecting PCM Waveforms

1. *Dc component.* Eliminating the dc energy from the signal's power spectrum enables the system to be ac coupled. Magnetic recording systems, or systems using transformer coupling, have little sensitivity to very low frequency signal components. Thus low-frequency information could be lost.

2. *Self-Clocking.* Symbol or bit synchronization is required for any digital communication system. Some PCM coding schemes have inherent synchronizing or clocking features that aid in the recovery of the clock signal. For example, the Manchester code has a transition in the middle of every bit interval whether a one or a zero is being sent. This guaranteed transition provides a clocking signal.

3. *Error detection.* Some schemes, such as duobinary, provide the means of detecting data errors without introducing additional error-detection bits into the data sequence.

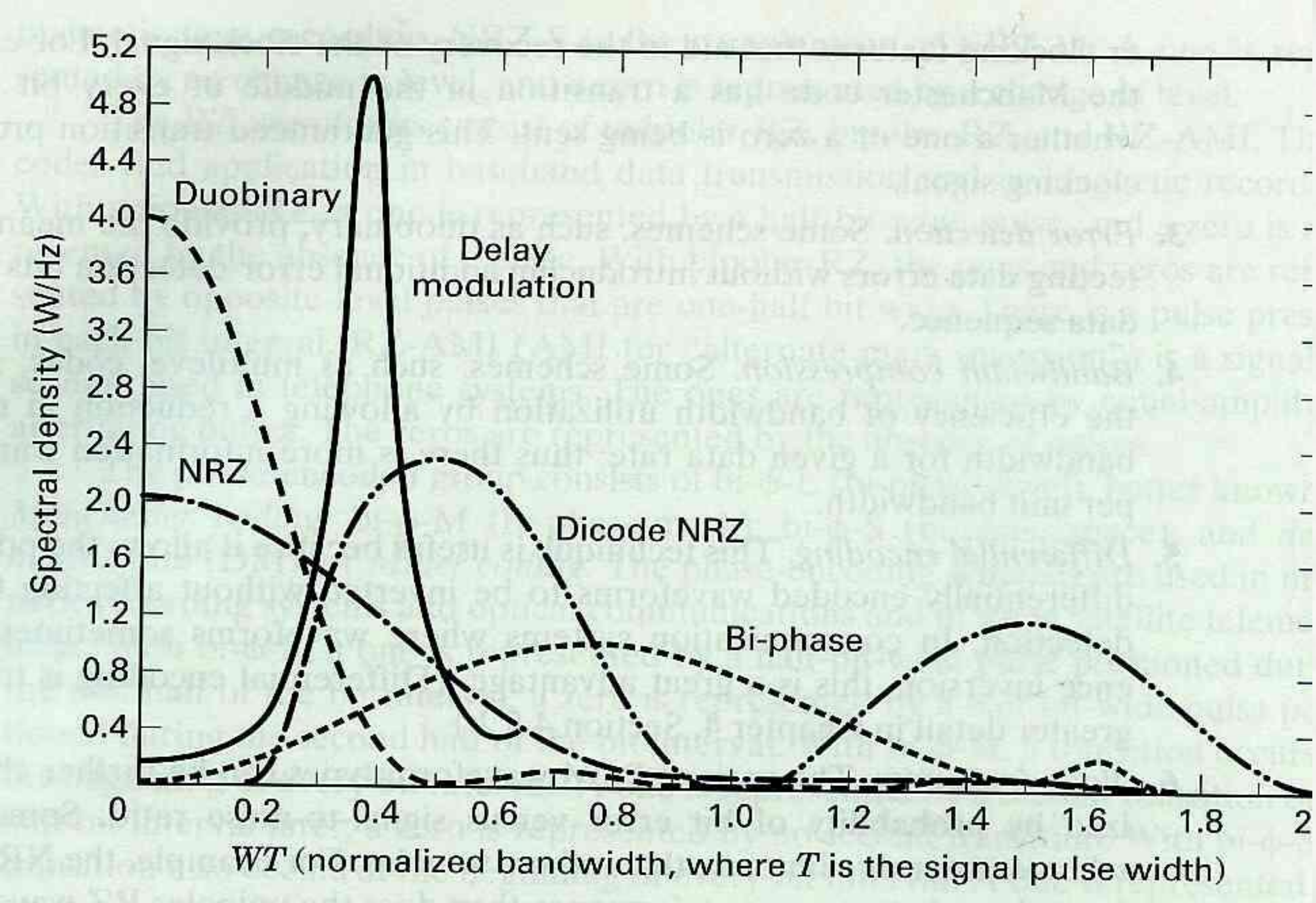
BASEBAND TRANSMISSION

Criteria For Comparing And Selecting PCM Waveforms

4. *Bandwidth compression.* Some schemes, such as multilevel codes, increase the efficiency of bandwidth utilization by allowing a reduction in required bandwidth for a given data rate; thus there is more information transmitted per unit bandwidth.
5. *Differential encoding.* This technique is useful because it allows the polarity of differentially encoded waveforms to be inverted without affecting the data detection. In communication systems where waveforms sometimes experience inversion, this is a great advantage. (Differential encoding is treated in greater detail in Chapter 4, Section 4.5.2.)
6. *Noise immunity.* The various PCM waveform types can be further characterized by probability of bit error versus signal-to-noise ratio. Some of the schemes are more immune than others to noise. For example, the NRZ waveforms have better error performance than does the unipolar RZ waveform.

BASEBAND TRANSMISSION

PCM Waveform Spectrum



OUTLINE

M-Ary Pulse Modulation

BASEBAND TRANSMISSION

M-ary Pulse Midulations

- M-ary pulse modulations category:
  - M-ary pulse-amplitude modulation (PAM)
  - M-ary pulse-position modulation (PPM)
  - M-ary pulse-duration modulation (PDM)
- M-ary PAM is a multi-level signaling where each symbol takes one of the M allowable amplitude levels, each representing $k = \log_2 M$ bits of PCM words.
- For a given data rate, M-ary PAM ($M>2$) requires less bandwidth than binary PCM.
- For a given average pulse power, binary PCM is easier to detect than M-ary PAM ($M>2$).

BASEBAND TRANSMISSION

M-ary Pulse Midulations

- In binary coding:
  - Data bit ‘1’ has waveform 1
  - Data bit ‘0’ has waveform 2
  - Data rate = bit rate = symbol rate
- In M-ary coding, take *k* bits at a time $(M = 2^k)$ and create a waveform (or symbol).
  - ‘00’ → waveform (symbol) 1
  - ‘01’ → waveform (symbol) 2
  - ‘10’ → waveform (symbol) 3
  - ‘11’ → waveform (symbol) 2
  - Symbol rate = bit rate/k

BASEBAND TRANSMISSION

M-ary Pulse Midulations

- Advantages:
  - Required transmission rate is low (symbol rate)
  - Low bandwidth
- Disadvantages:
  - Low signal to noise ratio (due to multiple amplitude pulses)

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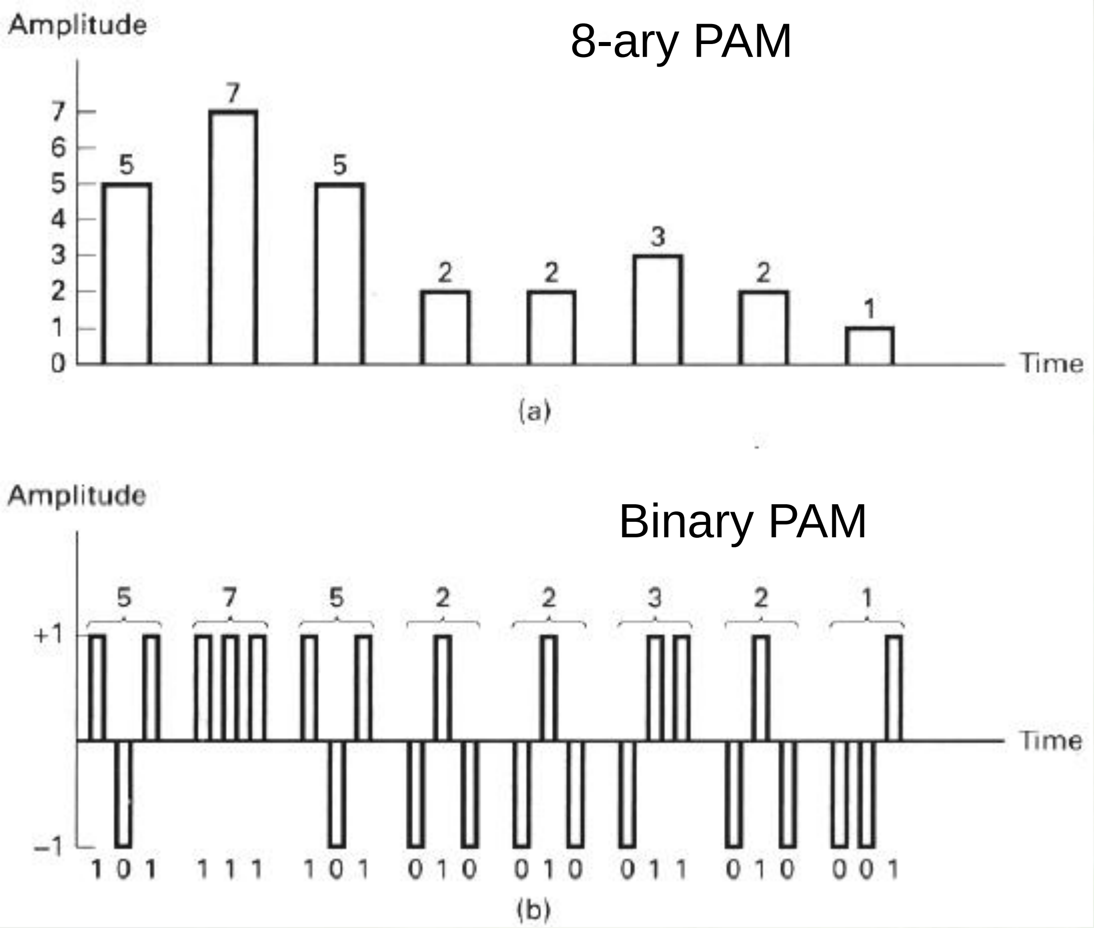
M-ary Pulse Midulations

Contoh PAM



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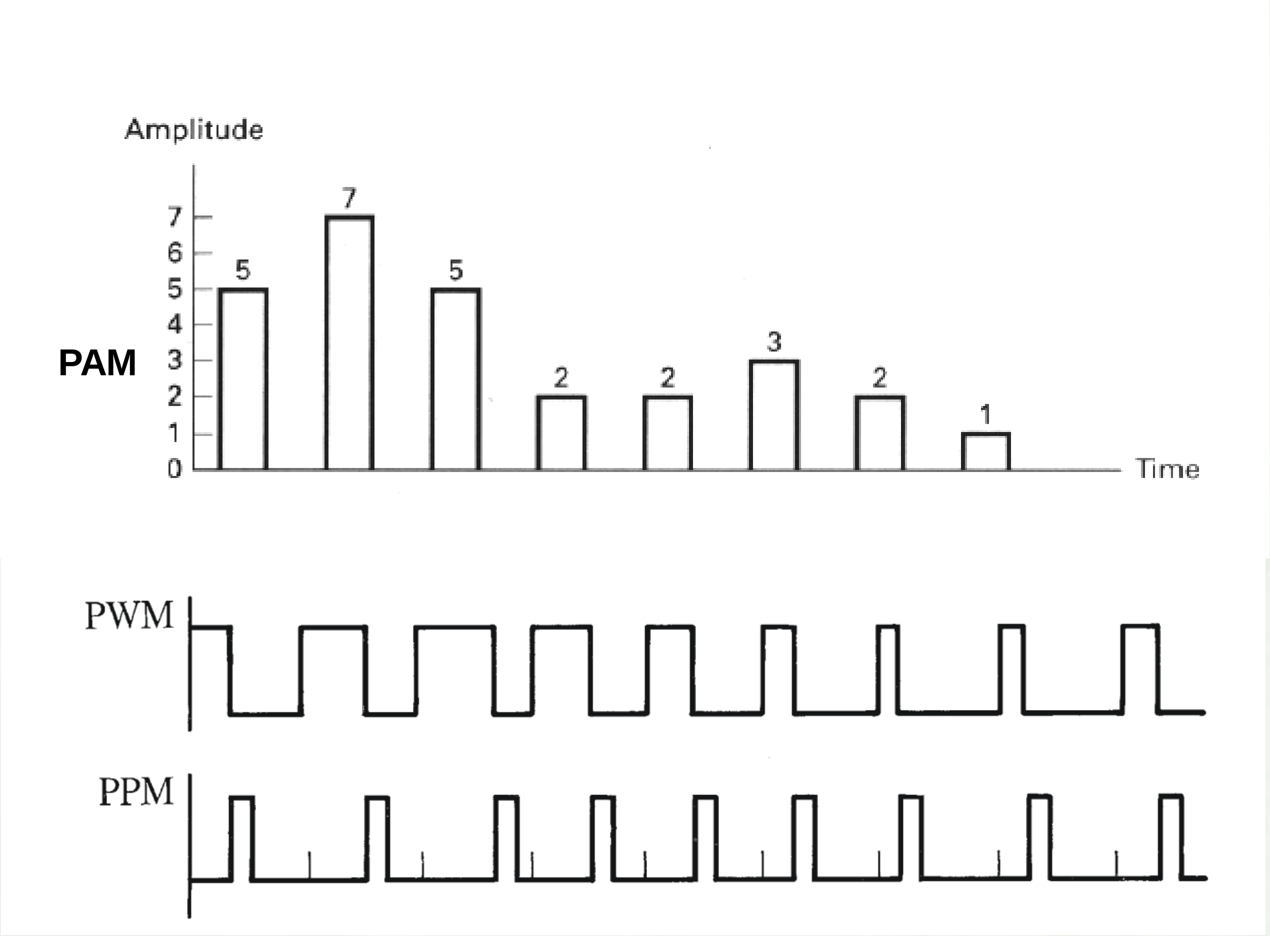
M-ary Pulse Midulations

PAM, PPM, PWM

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