CS311: Data Communication

Trasmission of Digital Signal - I

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Outline of the Lecture

- Introduction
- Important characterstics of Line Coding
- Popular line coding techniques:
  - Unipolar
  - Polar
  - Bipolar
- Modulation rate of various code
- Comparison of line coding techniques

Comparison of the Transmission Media

Medium	Cost	Bandwidth, Data rate	Attenuation	EMI	Security
UTP	Low	3MHz, 4Mbps	High, 2-10Km	High	Low
Coaxial	Moderate	356MHz, 500Mbps	Moderate, 1-10Km	Moderate	Low
Optical Fiber	High	2GHz, 2Gbps	Low, 10-100Km	Low	High
Radio	Moderate	1-10Mbps	Low-High	High	Low
Microwave	High	1 Mbps-10 Gbps	Variable	High	Moderate
Satelite	High	1 Mbps - 10 Gbps	Variable	High	Moderate
Infrared	Low	2400 bps - 4 Mbps	Low	Low	High

Introduction

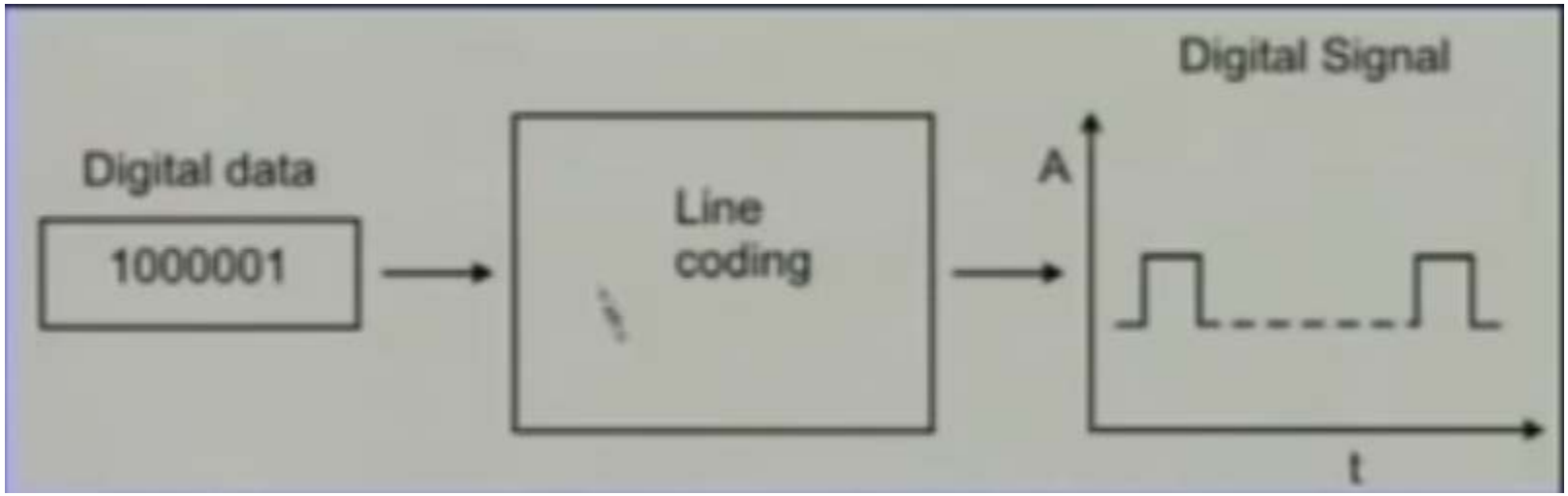
- Various conversion technique used

Data	Singal	Approach
Digital	Digital	Encoding
Analog	Digital	Encoding
Analog	Analog	Modulation
Digital	Analog	Modulatio

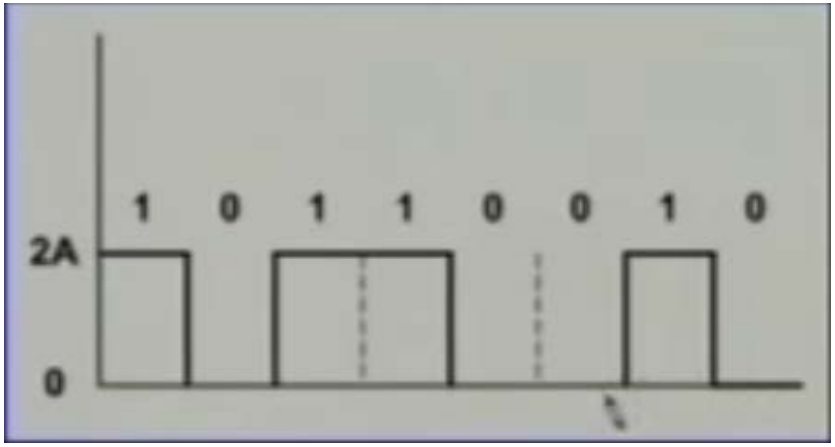
- What type of signal should we use?
- It depends on the situation and available bandwidth

Digital Data- Digital Signal

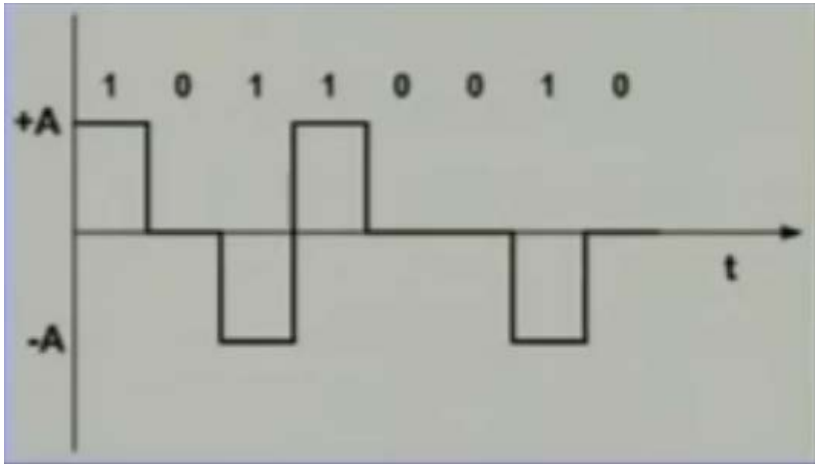
- Digital or Analog data is converted to digital signal for tansmission
- Line Coding : Technique for converting digital signal into digital signal



Number of Signal Levels



Two data levels
and two signal levels



Two data levels
and three signal levels

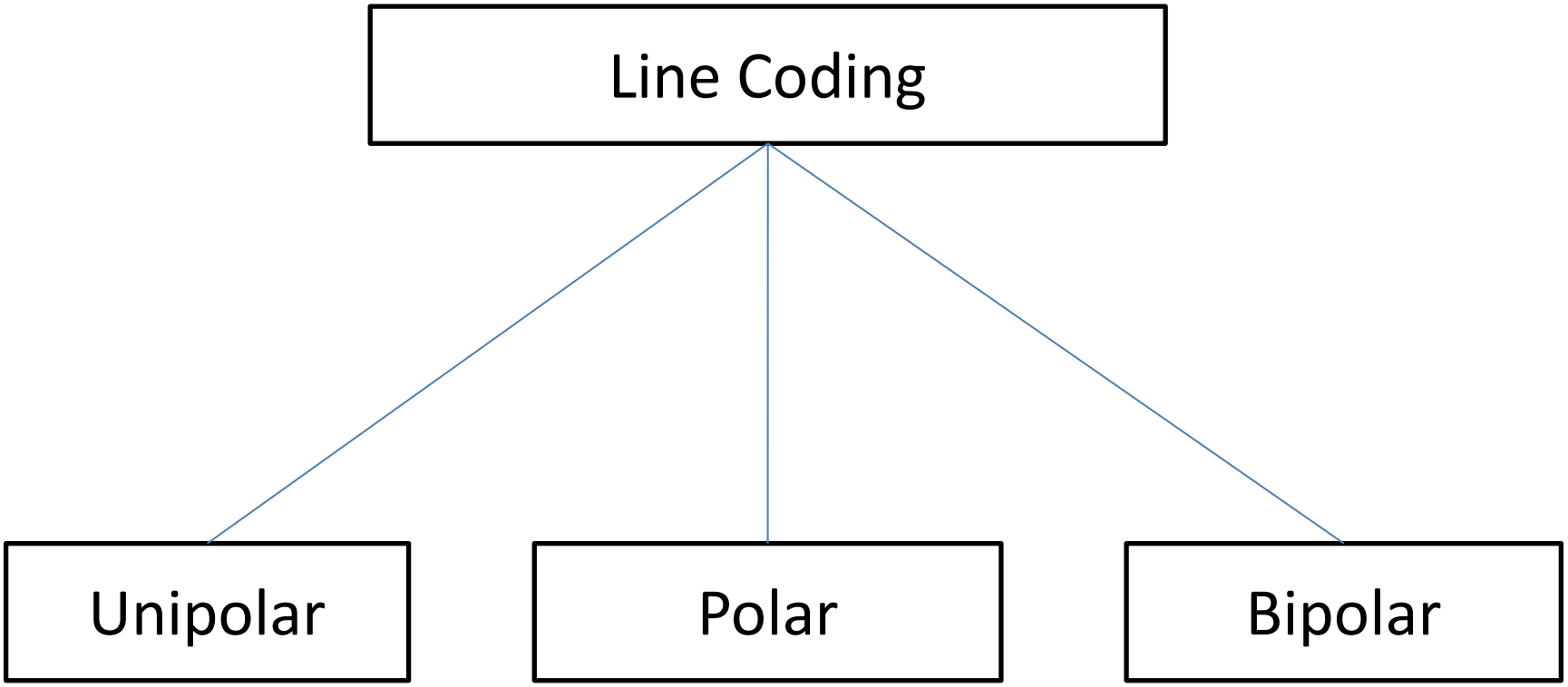
Digital Data - Digital Signal

Important Characterstics

- No of signal levels
- Bit rate versus Baud rate
- DC components
- Signal Spectrum
- Noise Immunity
- Error Detection
- Synchronization
- Cost of Implentation

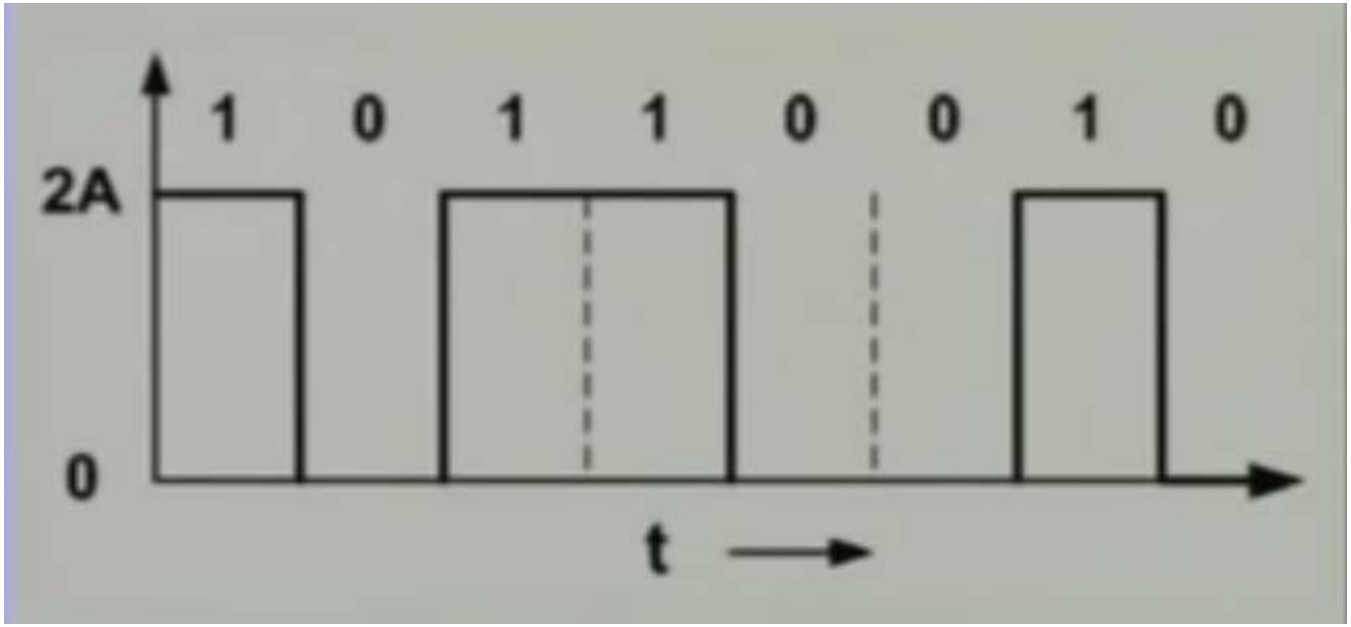
Line Coding Schemes

Three basic categories of line coding



Unipolar

Only two voltage levels are used



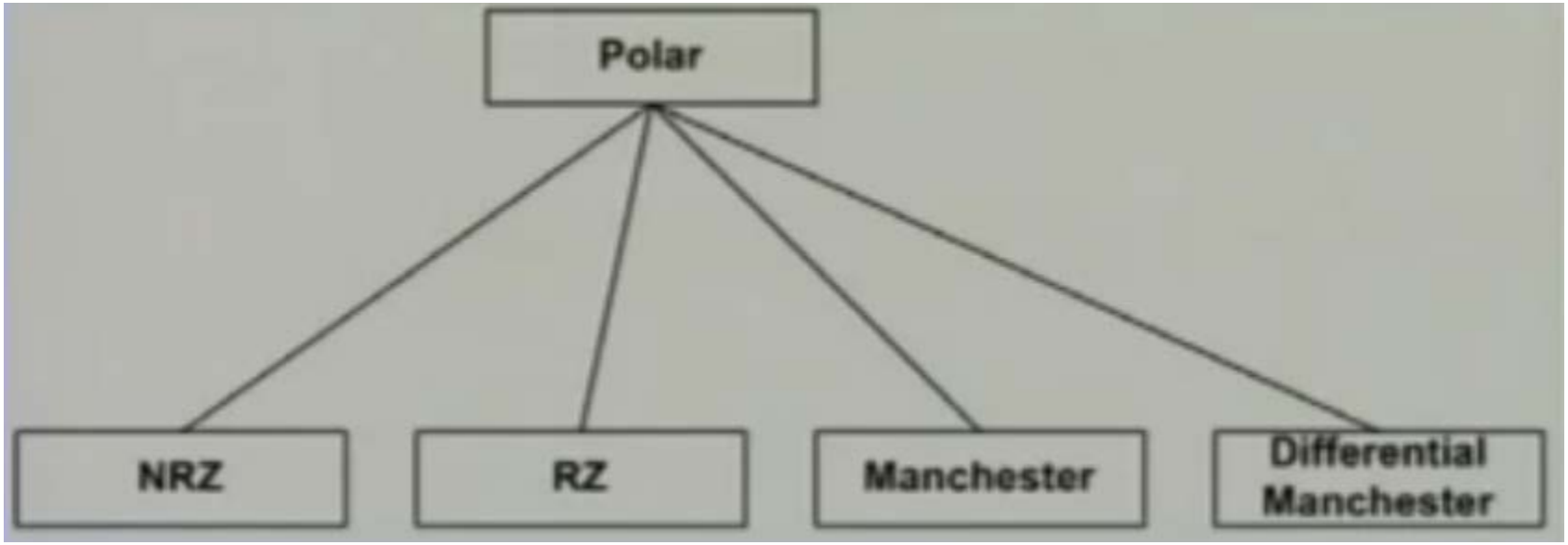
Unipolar

Characterstics of Unipolar Signal:

- It uses only one polarity of voltage level
- Bit rate same as data rate
- DC components present
- Loss of synchronization for long sequences of 0's and 1's
- Simple but obslete

Polar

- Uses Two voltage levels - one positive and the other one negative

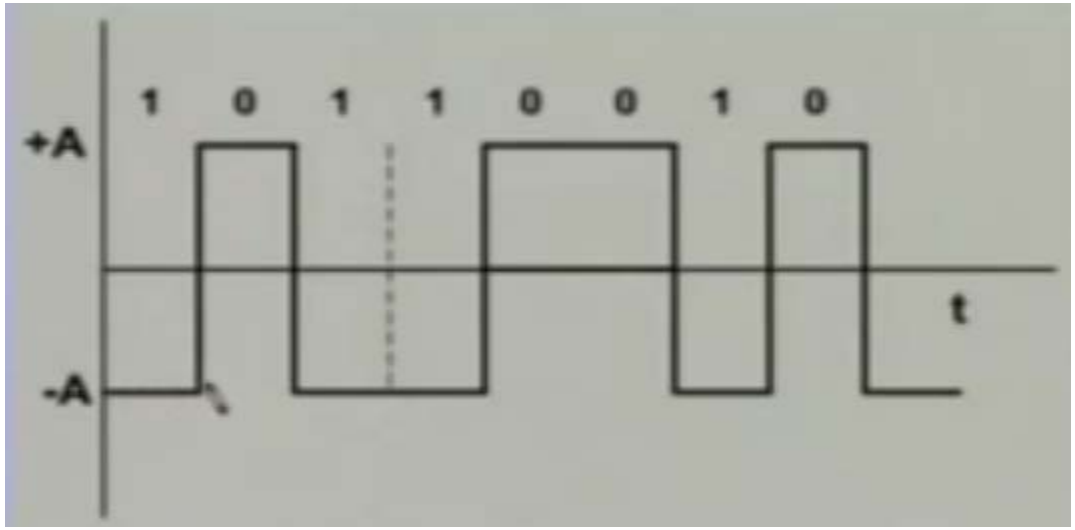


Polar Encoding Schemes

NRZ

➢ Non-Returning-to-Zero

- Voltage level is constant during a bit interval
- There are two NRZ schemes
  - NRZ-L
  - NRZ- I

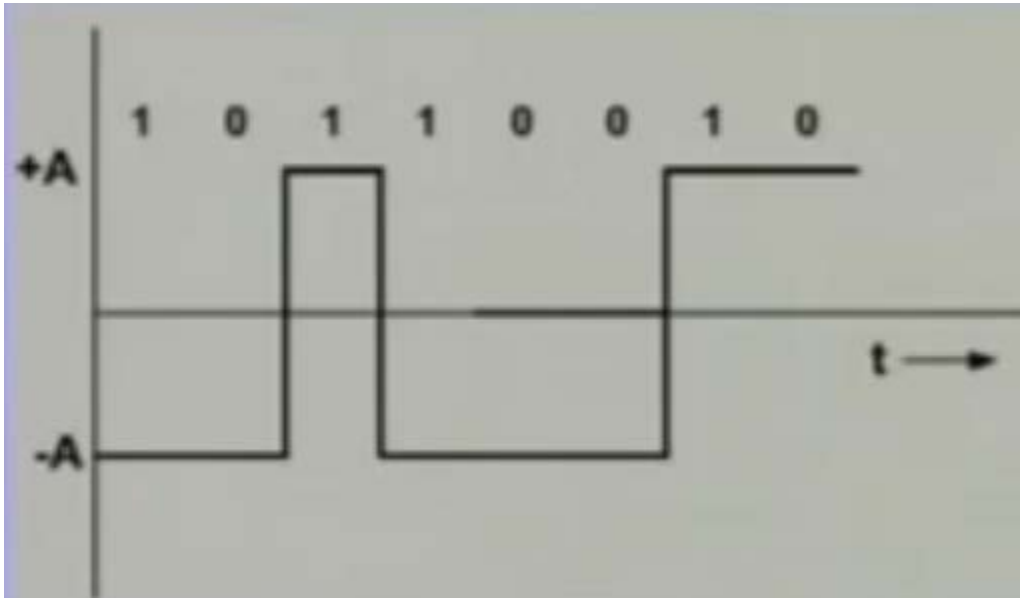


1 = low level

0 = high level

NRZ-I

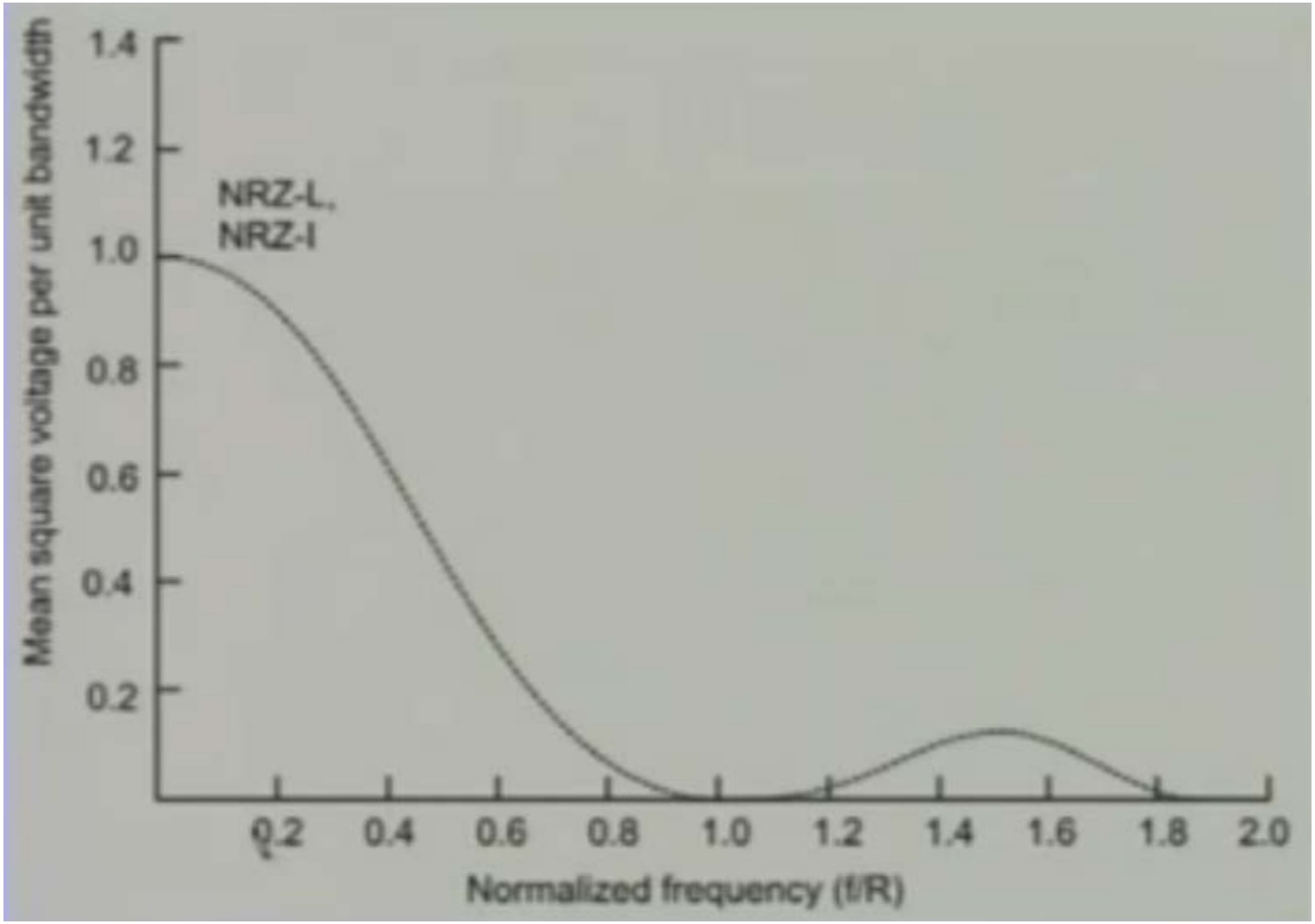
- For each 1 in the bit sequence, the signal level is inverted.
- A transition from on voltage level to the other represents a 1.



Characterstics of NRZ Encoding

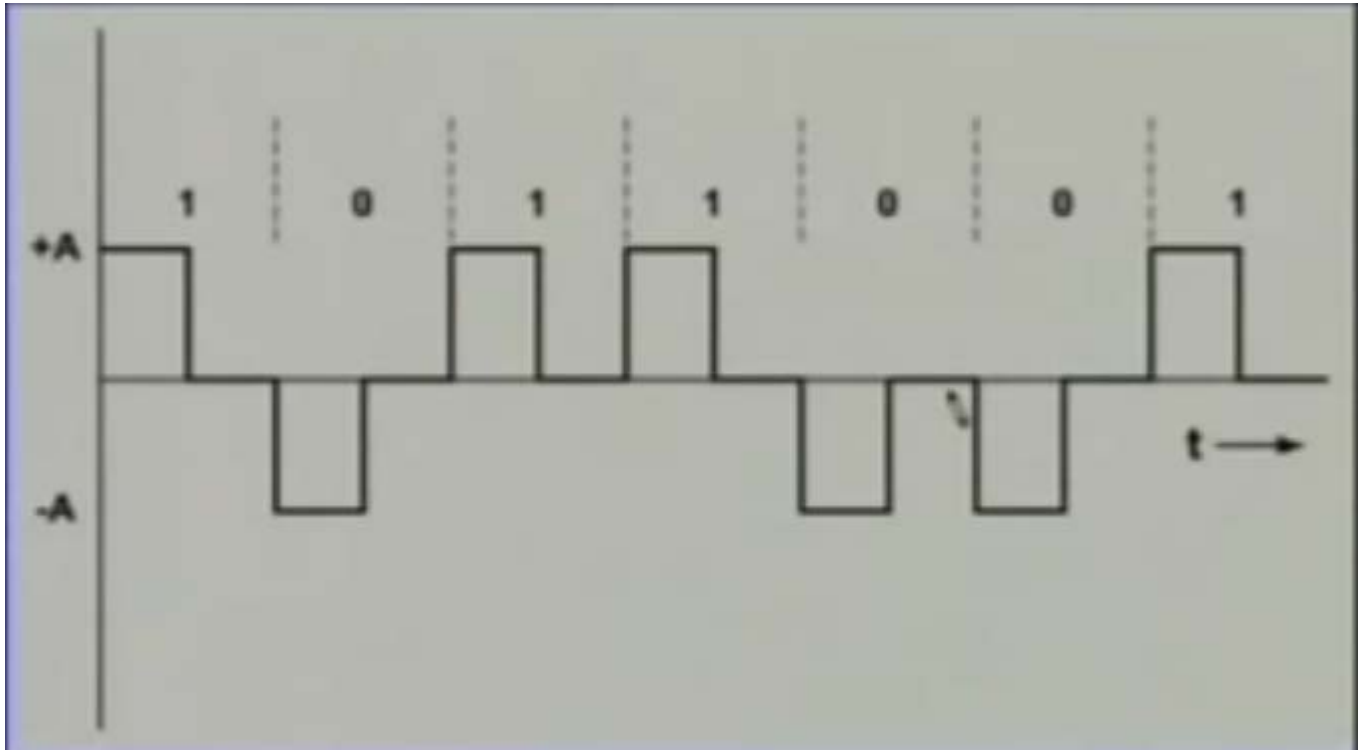
- Two levels
- Bit rate same as data rate
- Loss of sunchronization for long sequences of 0's and 1's.
- Most of the energy is concentrated between 0 and half the bit rate

Signal Spectrum



RZ

- **Return to Zero :** To ensure synchronization there must be a signal transition in each bit

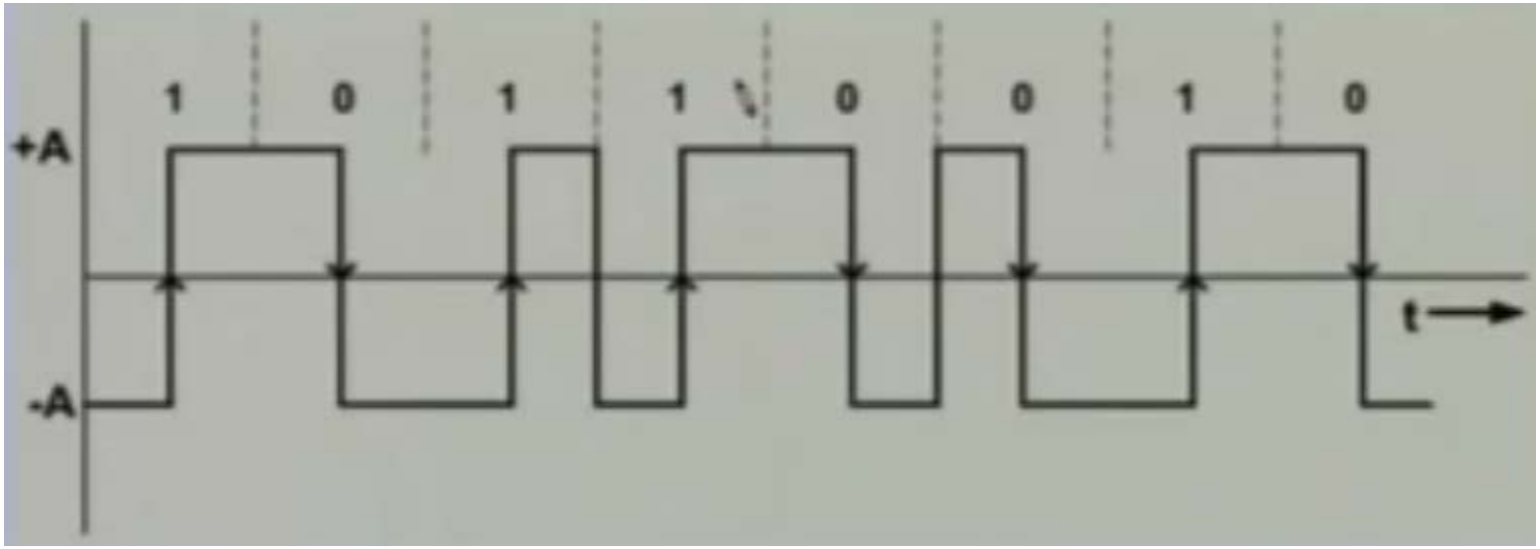


Characterstics of RZ Encoding

- Three levels
- Bit rate is double that of data rate
- No dc component
- Good synchronization
- Increase in bandwidth is the main limitation

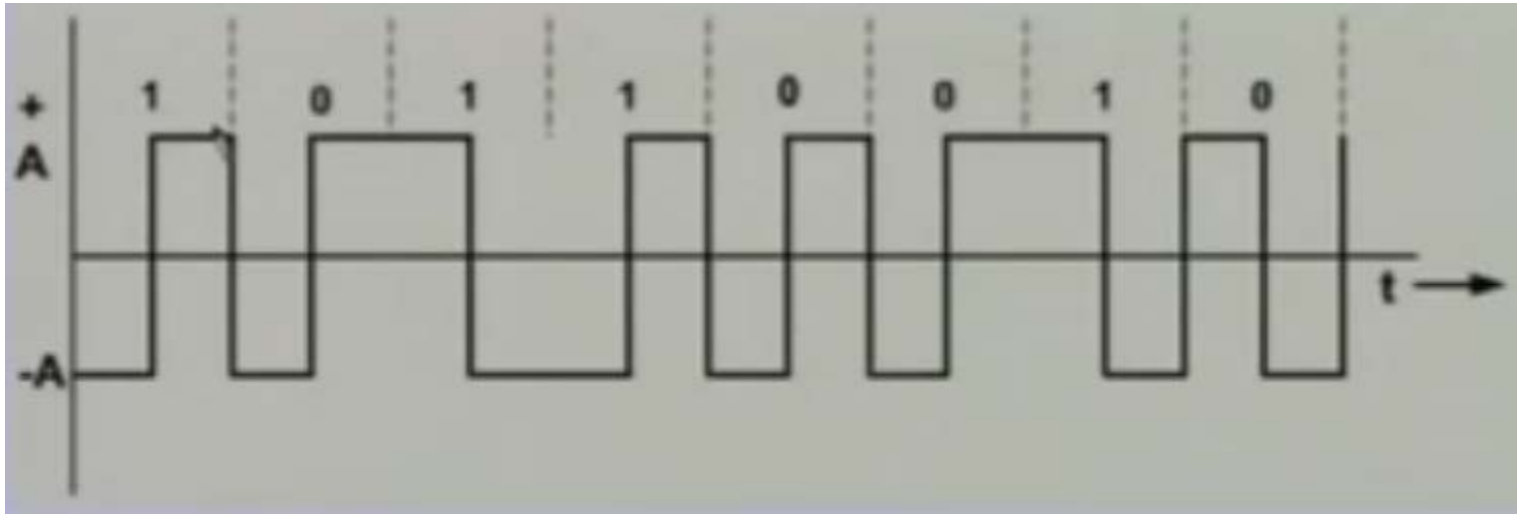
Manchester (Biphase) Encoding

- In Manchester code the mid-bit transition serves as a clocking mechanism and also as data
- Low-to-high represents a 1 and high-to-low represents a 0



Differential Manchester (Biphase)

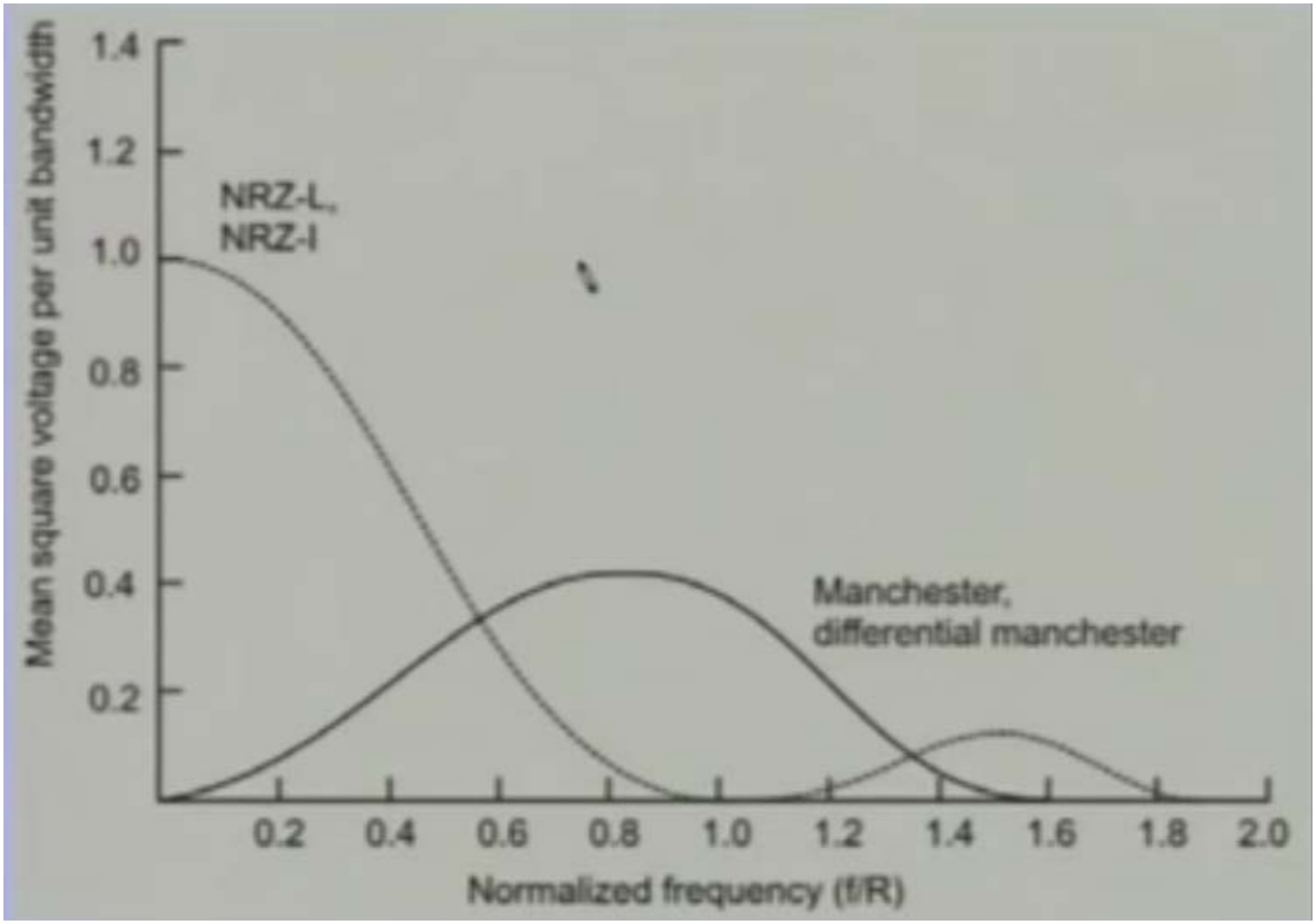
- Presence of transition in the beginning of a bit represents a 0
- Uses inversion in the middle of each bit for synchronization



Characterstics of Biphase Encoding

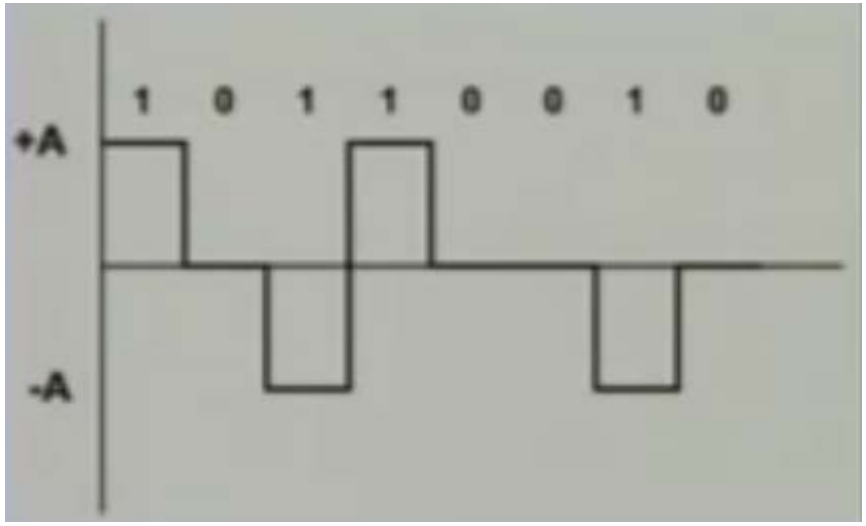
- Two levels
- No DC component
- Good Synchronization
- Higher bandwidth due to doubling of bit rate with respect to data rate

Bandwidth Comparison



Bipolar AMI

- Bipolar AMI uses three voltage levels
- Unlike RZ, the zero level is use to represent a 0
- Binary 1s are represented by alternating positive and negative voltages.



Characterstics of Bipolar AMI

- **Pseudoternary :** Same as AMI, but alternating positive and negative pulse occur for binary 0 instead of binary 1

- Three levels
- No DC component
- Loss of synchronization for long sequences of 0's
- Lesser bandwith

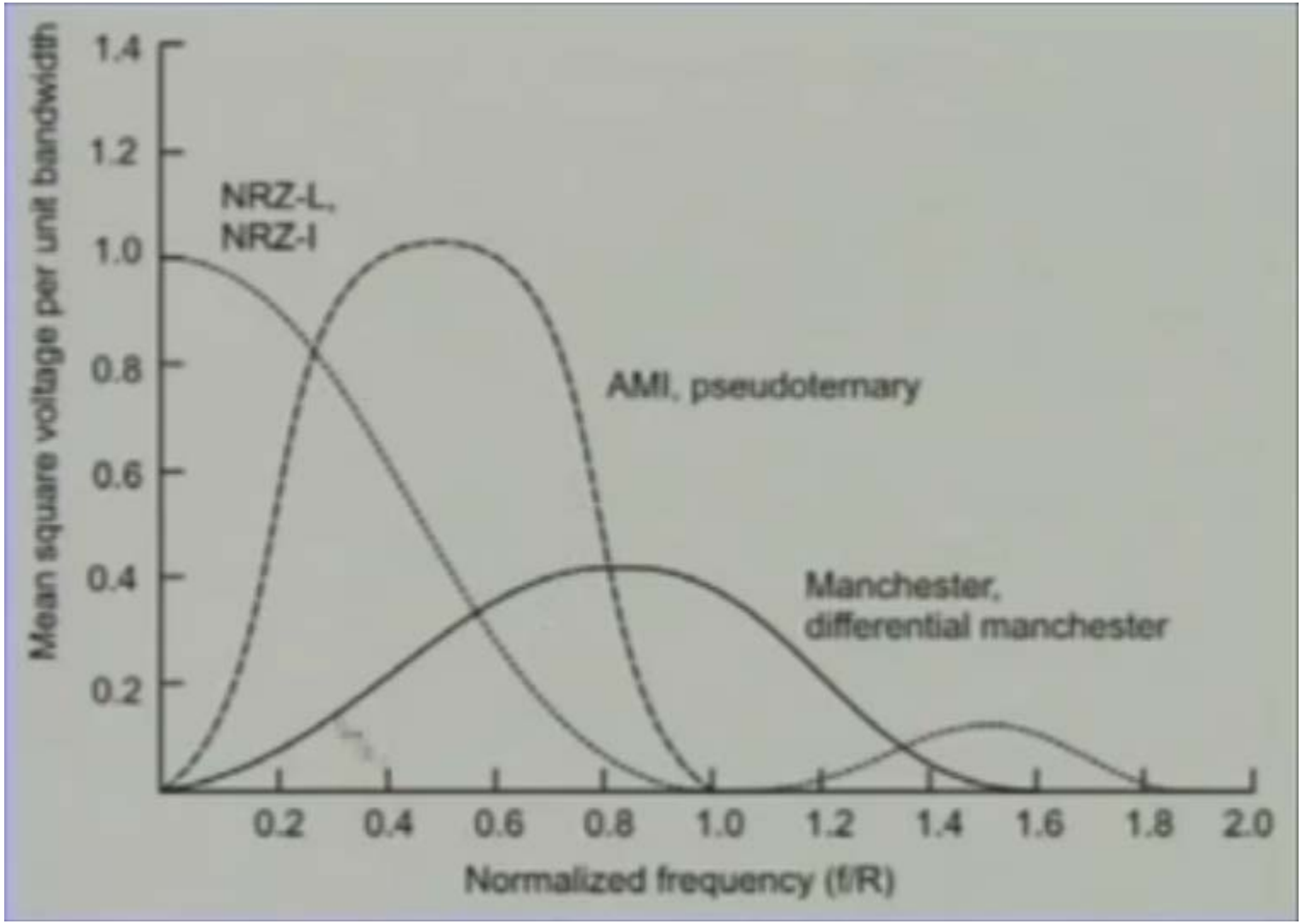
Modulation (Baud) Rate

- Data rate is expressed in bits per second.
- Modulation rate is expressed in bauds.
- General relationship :
  - $D = R/b = R / \log_2 L$
    - D is the modulation rate in bauds
    - R is the data rate in bps
    - L is the number of different signal levels
    - b is the number of bits per signal element

Modulation Rate Comparison

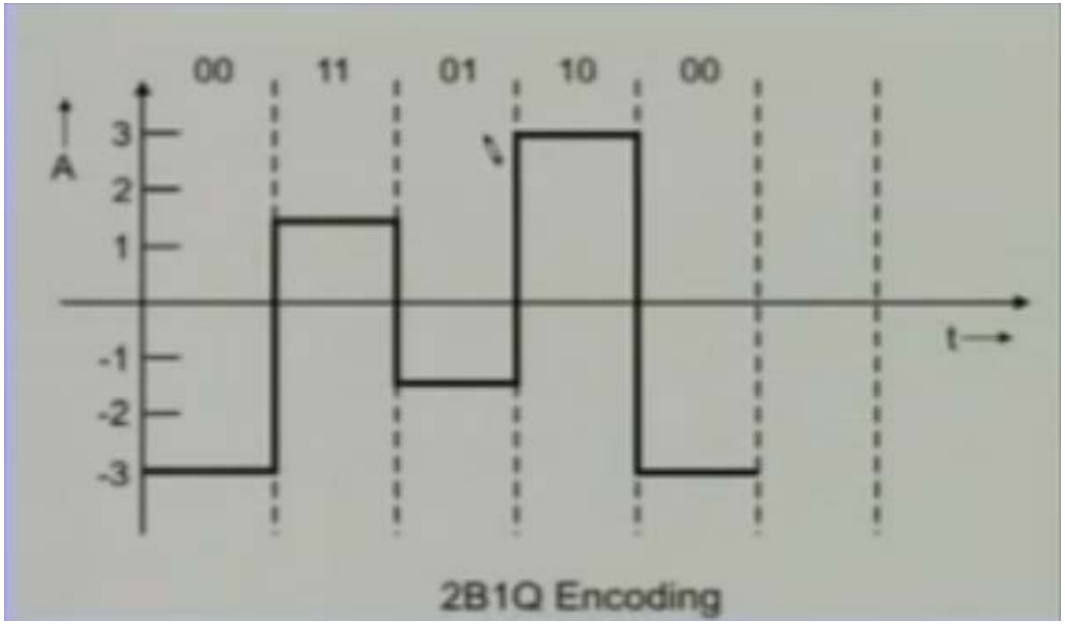
Encoding Technique	Minimum	101010...	Maximum
NRZ-L	0	1.0	1.0
NRZ-I	0	0.5	1.0
BIPOLAR-AMI	0	1.0	1.0
Manchester	1.0	1.0	2.0
Differential Manchester	1.0	1.5	2.0

Bandwidth Comparison



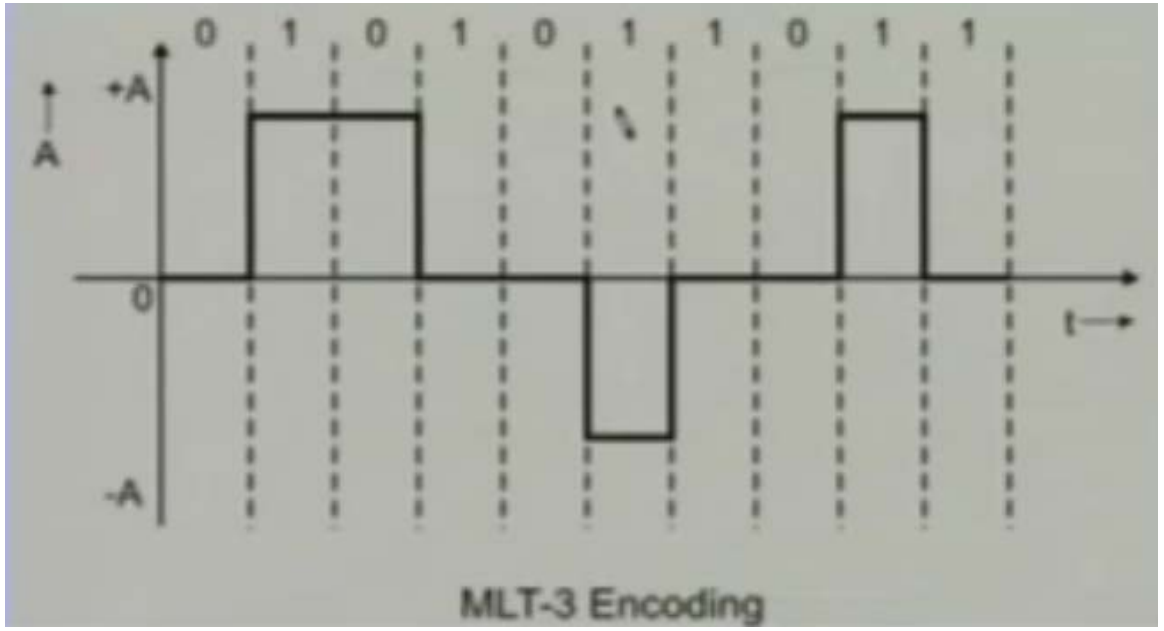
Other Special Purpose Codes

- **2B1Q - Two Binary one Quaternary**
  - Uses four voltage levels
  - More efficient (Allows higher data rate)



Other Special Purpose Codes

- **MLT-3 : Multiline tranmission, three levels**
  - Very similar to NRZ-I, but uses three levels
  - Signal transition occurs at the beginning of each 1 bit



Other Special Purpose Codes

- **Scrambiling Schemes**
  - Extensions of Bipolar AMI
  - Used in case of long distance applications
  - Goals:
    - No dc component
    - No long sequences of 0-level line signal
    - Increase in bandwidth
    - Error detection capability
- Examples : B8ZS, HBD3

Thanks!