Bit Concept – bit is a contraction of the term binary digit
- a unit of information represented by either a none or zero
- Has two possible state at any time

The Information Code or Character Set:

1. <u>Baudot Code</u>
   -developed by a French postal engineer, Thomas Murray in 1875 and named after Emile Baudot, an early pioneer in telegraph printing
   - 5-bit binary code used primarily for low-speed teletype equipment
   - recommended as CCITT as International Alphabet No.2

2. <u>ASCII Code</u>
   - American Standard Code for Information Interchange
   - 7-bit character set which has 128 codes
   - Recommended as CCIITT as International Alphabet No. 5

3. <u>EBCDIC Code</u>
   - Extended Binary-Coded Decimal Interchange
   - 8-bit character code developed by IBM used extensively in IBM and IBM-compatible equipment
   - Has 256 codes

Binary Transmission Convention:

1. <u>Parallel Transmission</u> – bits are transmitted character at a time and each bit of the set of bits that represent a character has its own wire or line
2. <u>Serial Transmission</u> – bits are transferred over a single cable at a time

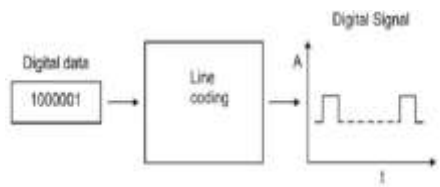
DIGITAL ENCODING

- For digital signalling, the data source can be either analog or digital, which is encoded into digital signal, using different encoding techniques

Data	Signal	Approach
Digital	*Digital*	*Encoding*
Analog	*Digital*	*Encoding*
Analog	*Analog*	*Modulation*
Digital	*Analog*	*Modulation*

LINE ENCODNG

- part of the digital carrier system that involves converting standard logic level (TTL, CMOS, and the like) to a form more suitable to telephone line transmission
- converts digital data to digital signal
- consists of representing the digital signal to be transported by an amplitude- and time-discrete signal that is optimally tuned for the specific properties of the physical channel (and of the receiving equipment



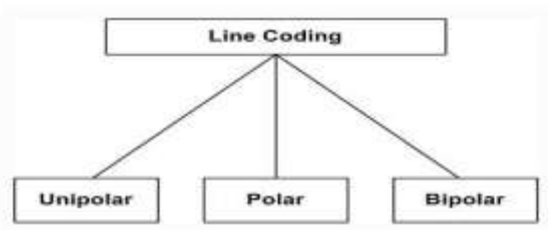
- After line coding, the signal is put through a "physical channel", either a "transmission medium" or "data storage medium"

<u>The most common physical channels are</u>:

a. the line-coded signal can directly be put on a transmission line, in the form of variations of the voltage or current (often using differential signaling).
b. the line-coded signal (the "base-band signal") undergoes further pulse shaping (to reduce its frequency bandwidth) and then modulated (to shift its frequency bandwidth) to create the "RF signal" that can be sent through free space.
c. the line-coded signal can be used to turn on and off a light in Free Space Optics, most commonly infrared remote control.
d. the line-coded signal can be printed on paper to create a bar code.
e. the line-coded signal can be converted to magnetized spots on a hard drive or tape drive.

f. the line-coded signal can be converted to pits on an optical disc

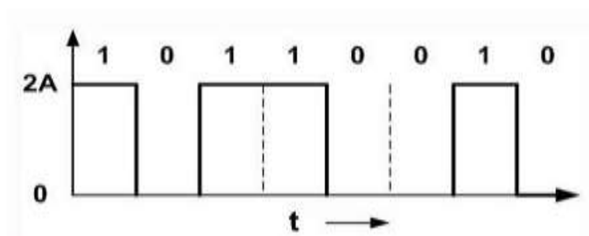
DIFFERENT LINE ENCODING TECHNIQUES



I.UNIPOLAR CODING TECHNIQUE

A. UNIPOLAR NON-RETURN TO ZERO (UPNRZ)

- two voltage levels are used and only one polarity of voltage level
- uses only one polarity of voltage level
- bit rate is same as data rate
- DC component present in the encoded signal and there is loss of synchronization for long sequences of 0's and 1's.

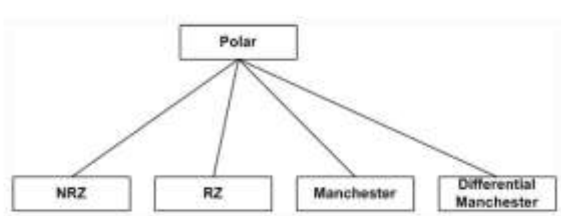


B. UNIPOLAR RETURN-TO-ZERO (UPRZ)

- uses only one polarity of voltage level
- there is a signal transition in each bit.

II. POLAR CODING TECHNIQUES

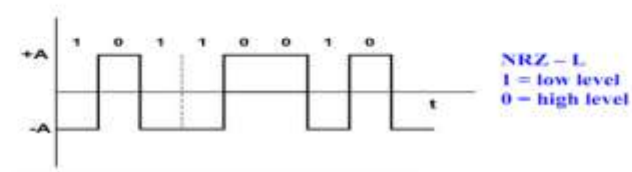
-uses two voltage levels (one positive and the other negative)

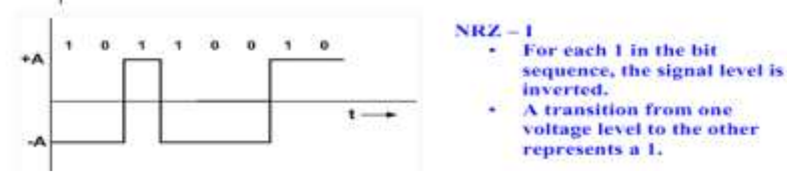


A. Non Return to zero (NRZ):

-The most common and easiest way to transmit digital signals is to use two different voltage levels for the two binary digits

-data is encoded as the presence or absence of a signal transition at the beginning of the bit time





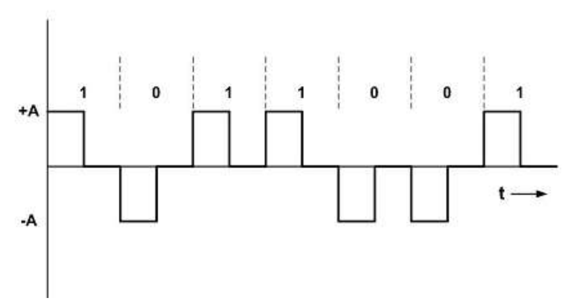
The advantages of NRZ coding are:

- 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.
- Main limitations are: the presence of a dc component lack of synchronization capability.

B. Return to Zero RZ

To ensure synchronization, there must be a signal transition in each bit. Key characteristics of the RZ coding are:

- Three levels
- Bit rate is double than that of data rate
- No dc component
- Good synchronization
- Main limitation is the increase in bandwidth



BIPHASE (MANCHESTER and DIFFERENTIAL MANCHESTER CODING)

- To overcome the limitations of NRZ encoding mid-bit transition serves as a clocking mechanism and also as data
- There is a transition at the middle of each bit period.
- A binary 1 corresponds to a low-to-high transition and a binary 0 to a high-to-low transition in the middle

  For DIFFERENTIAL MANCHESTER;

  *encoding of a 0 -transition both at the beginning and at the middle

  *encoding of 1 - transition only in the middle of the bit period.

C. **Manchester (Bi-phase L)**

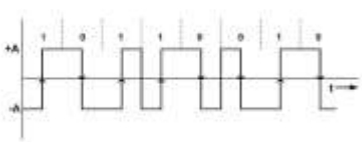
- logic 1 (hi) – transition from high to low in the middle of the clock interval

- logic 0 (low) – transition from low to high in the middle of the clock interval

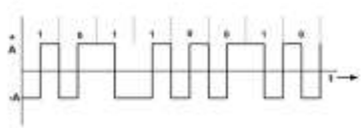
D. Differential Manchester

- logic 1 (hi) – transition in the middle of the clock interval

- logic 0 (low) – transition in the beginning and middle of the clock interval



Manchester Encoding



Differential Manchester Encoding

Digital Bi-phase

- a line encoding that produces a strong timing component for clock recovery and does not cause dc wandering
- transition occurs in the center of every signalling element regardless of its logic condition
- disadvantage is that it contains no means of error correction

E. Biphase M (Biphase Mark)

- logic 1 (hi) – transition in the middle of the clock interval

- logic 0 (low) – no transition in middle of the clock interval

NOTE: there is always a transition at the beginning of the clock interval

F. Biphase S (Biphase Space)

- logic 1 (hi) – no transition in the middle of the clock interval

- logic 0 (low) –transition in middle of the clock interval

NOTE: there is always a transition at the beginning of the clock interval

G. Miller / Delay Modulation

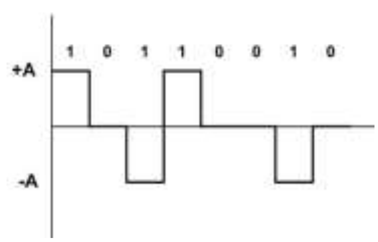
- logic 1 (hi) –transition in the middle of the clock interval

- logic 0 (low) –no transition at the end of the clock interval unless followed by a zero

III. POLAR CODING TECHNIQUES

A. Alternate Mark Inversion (AMI)

- AMI uses three voltage levels. The zero level used to represent a 0 binary 1's are represented by alternating positive and negative voltages
- multi-level binary cose



B. Dicode NRZ

- In every One-to-zero and zero-to-one data transition there is a change in polarity of the signal
- If the data remains constant, then use the zero voltage level

C. Dicode RZ

- In every One-to-zero and zero-to-one data transition there is a change in polarity to half-step voltage increment of the signal
- If the data remains constant, then use the zero voltage level

SIX PRIMARY FACTORS TO CONSIDER WHEN SELECTING A LINE-CODING FORMAT

1. **Transmission voltages and DC component**;
   - Can either be unipolar (UP) or bipolar (BP)
   - It is more power efficient to encode binary data with voltages that are equal in magnitude but opposite in polarity and symmetrically balanced about 0V
   - By using a bipolar symmetrical voltages, the average power is reduced by a factor of 50%.
2. **Duty Cycle**
   - Can be use to categorized the type of transmission
   - *Nonreturn to zero* – binary pulse is maintained for the entire bit time
   - *Return to zero*- the active time of the binary pulse is less than 100% of the bit time
   - *Bipolar-return –to zero alternate mark inversion (BRZ-AMI)* – successive logic 1s are inverted in polarity from the previous logic1 with an average of DC Voltages of OV in its waveform regardless of the bit sequence and this technique is considered to have the best quality or performance especially with error detection
   - *DC Wandering* – lose of amplitude reference for optimum discrimination between 1s and 0s because of its long strings of 1s and 0s
3. **Bandwidth Requirement**
   - Can be determined by considering the highest fundamental frequency associated with the signal
   - UPNRZ and BPNRZ worst-case condition is alternating 1/0 where the fundamental frequency is equal to one half of the bit rate
   - UPRZ and BPRZ worst-case condition is when two successive logic 1s or successive logic 0s occurs and the minimum bandwidth is equal to the bit rate
   - BPRZ-AMI worst case condition occurs when there is two or more consecutive logic 1s and the minimum bandwidth equal to ½ the bit rate
4. **Clock Recovery/Framing Bit Recovery**
   - To maintain synchronization from received data, there must be sufficient transition in the date waveform
   - BPRZ is the best encoding scheme for clock recovery
   - BPRZ-AMI – provides sufficient transition ensure clock synchronization
5. **Error detection**
   - BPRZ-AMI has a built-in error-detection mechanism