Line codes

- There are several line codes can be used for the electrical representation of binary data stream
- Many codes are available
- Only five codes will be considered in these slides
- A more detailed line codes can be found in reference books

Basic line codes

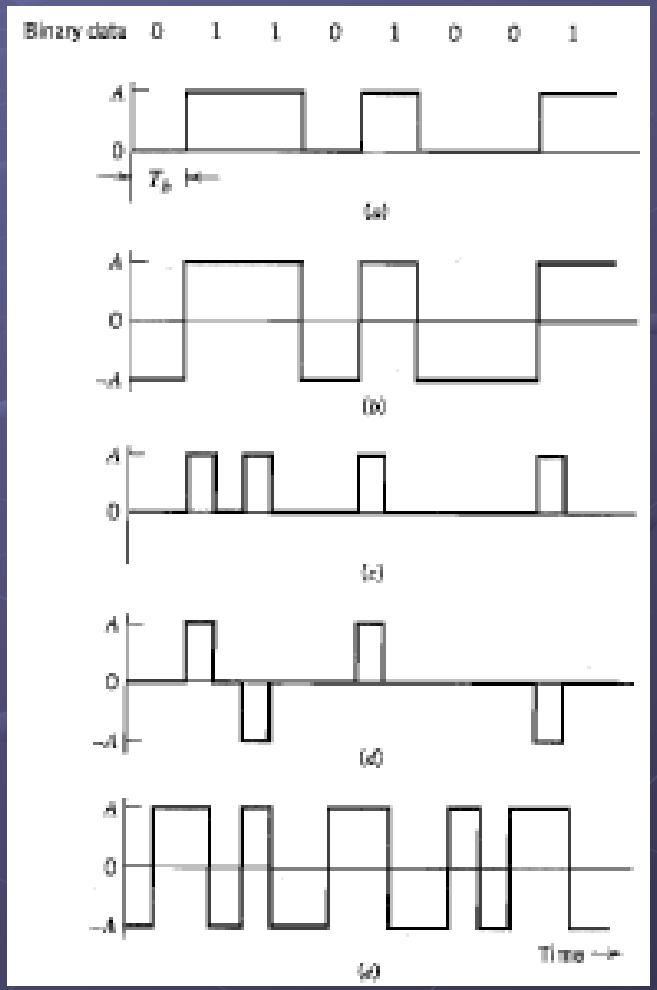
Unipolar NRZ

Polar NRZ

Unipolar RZ

Bipolar RZ

Split phase or Manchester code



Unipolar non return to zero (NRZ)

- In this code symbol 1 is represented by transmitting a pulse of amplitude A for the duration of the symbol
- Symbol 0 is represented by switching off the pulse
- This line code is referred to *on-off* signaling
- Disadvantage of this line code is the waste of power due to the transmission of DC level

Polar non return to zero

- In this line code, symbols 1, 0 are represented by transmitting a pulse of $+A$ and $-A$, respectively
- The disadvantage of this line code is the large power spectrum of the signal near to zero frequency (waste of power transmission)
- Advantage: easy to generate

Unipolar return to zero

- In this line code, symbols 1 is represented by a rectangular pulse of amplitude A for half of the bit width
- 0 is represented by transmitting no pulse
- The disadvantage of this line code is that it requires 3 dB more power than polar-return to zero

Unipolar return to zero

- Advantage: this line code contains a delta function at $f = 0, \pm\frac{1}{T_b}$ in the power spectrum of the transmitted signal
- This can be used for timing recovery at the receiver

Bipolar return to zero

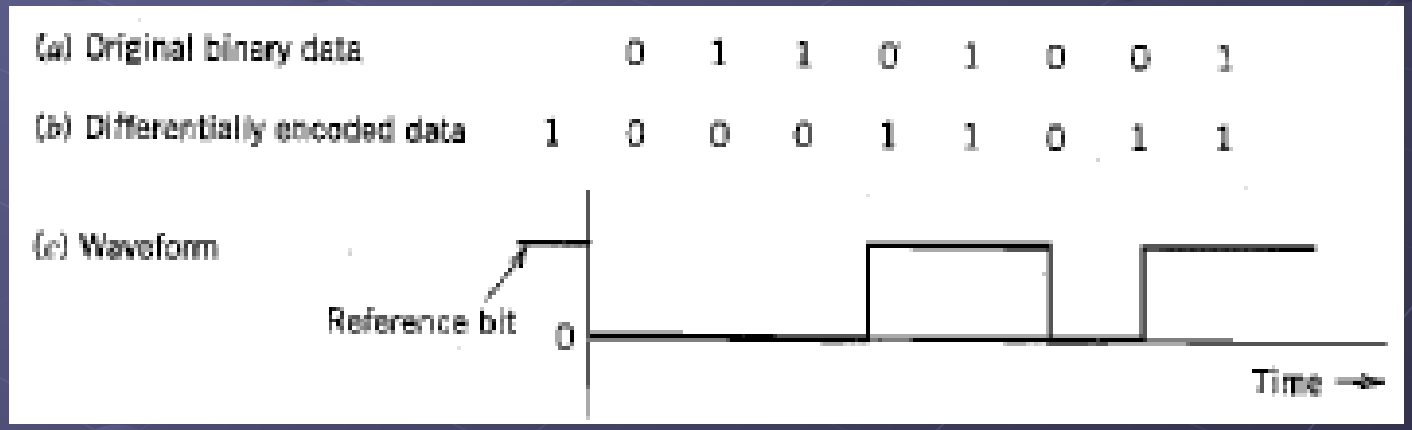
- In this line code symbol *1* is represented by $+A$ and $-A$ for half symbol width
- Symbol *0* is represented by the transmission of no pulse
- Advantage of this line code is that the power spectrum of the transmitted signal has no DC component
- This code is sometimes called alternate mark inversion

Split phase (Manchester code)

- Advantage of this line code is that the power spectrum of the transmitted signal has no DC component
- Also this line code is self clocking

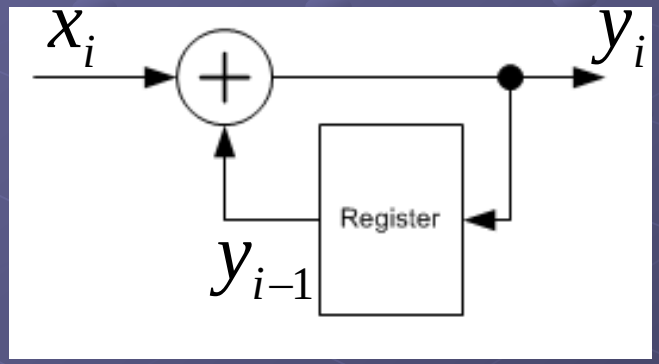
Differential encoding

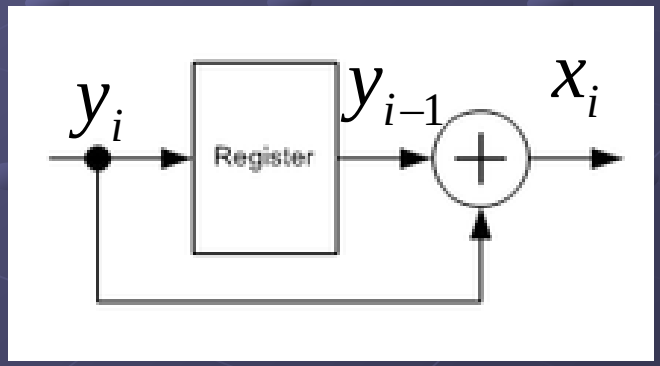
- This method is used to encode information in terms of the signal transition
- A transition is used to present logic zero while no transition is used to present logic one



Differential encoder and decoder

- Differential encoding process equivalent XOR operation between the original bits to passing the original





$$y_i = y_{i-1} \oplus x_i$$

$$x_i = y_i \oplus y_{i-1}$$

Purpose of differential encoding

- In the demodulation of BPSK, the carrier in the demodulator must have the same phase as the carrier in the modulator
- If a phase error is presented in the carrier demodulator, the received data bits are inverted
- Differential encoding ensures that the correct data bits are received whether the data bit stream inverted or not

Application of differential encoding

- This type of modulation is used in satellite and radio relay communications with pass band modulation schemes PSK and QAM

Disadvantageous of differential encoding

- The disadvantage of differential encoding is the error multiplication
- If an error occurs to one bit during transmission, then two bits would be interpreted incorrectly in the receiver