Line Code (3C)

Please send corrections (or suggestions) to youngwlim@hotmail.com.

This document was produced by using OpenOffice and Octave.

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9/20/13

PCM Waveform Types

- **Nonreturn-to-zero (NRZ)** NRZ-L, NRZ-M, NRZ-S
- **Return-to-zero (RZ)** Unipolar-RZ, Bipolar-RZ, RZ-AMI
- **Phase encoded** Bi-Phase-Level, Bi-Phase-Mark, Bi-Phase-Space, DM
- **Multilevel binary** Bipolar-RZ, RZ-AMI, Dicode-NRZ, Dicode-RZ

Manchester Coding = Bi-Phase-Level

Miller Coding = Delay Modulation

PCM Waveform Types

- **NRZ-L** — digital logic circuits
- **NRZ-M** — magnetic tape recording
- **NRZ-S**
- **Unipolar RZ**
- **Bipolar RZ**
- **RZ-AMI**

  baseband data transmission
  magnetic tape recording
  → telephone systems

- **Bi-Φ-L**
- **Bi-Φ-M**
- **Bi-Φ-S**
- **Delay Mod**

  magnetic tape recording
  optical communication
  satellite telemetry links

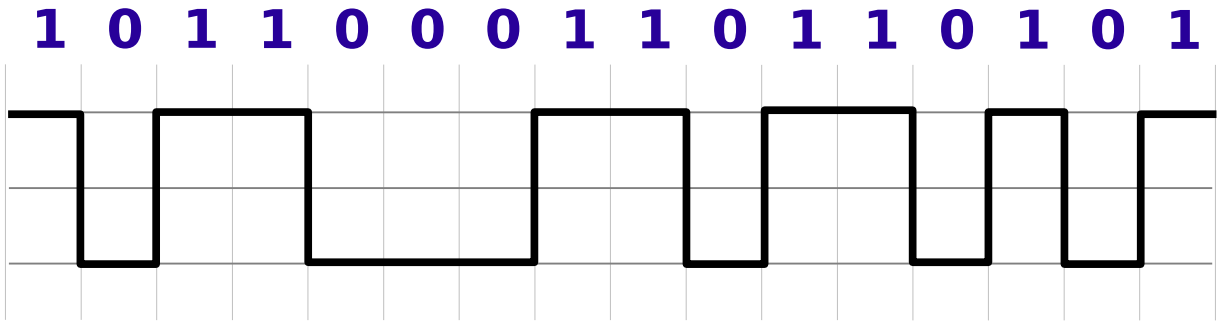
- **Dicode NRZ**
- **Dicode RZ**

Non Return to Zero (NRZ)

NRZ-L (Level)

0 : +V

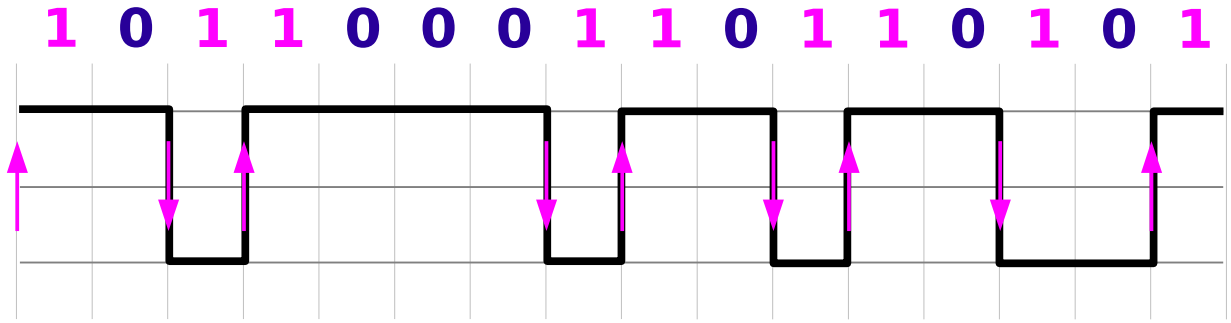
1: – V



NRZ-M (mark)

0 : no change

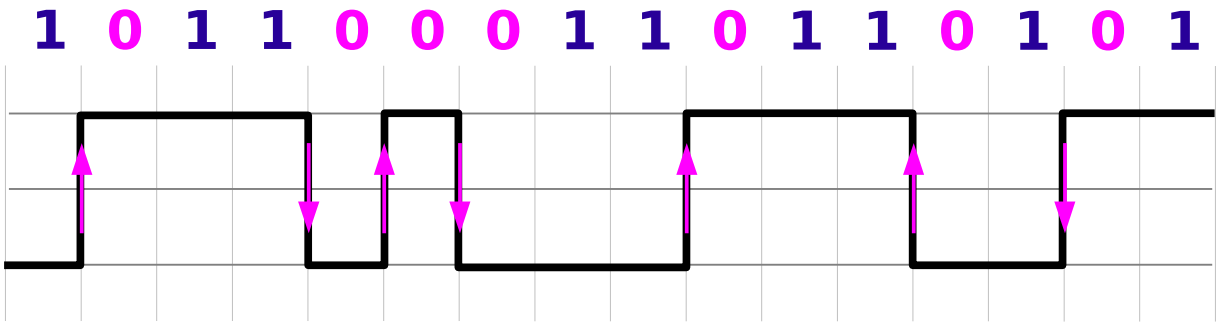
1 : change



NRZ-S (Space)

0 : change

1 : no change



Non Return to Zero (NRZ)

NRZ-L (Level)

0 : +V +V voltage level

1: – V –V voltage level

NRZ-M (mark)

0 : no change no change in level differential encoding

1 : change  change in level

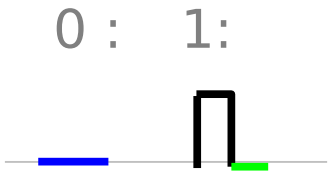
NRZ-S (Space) complement of NRZ-M

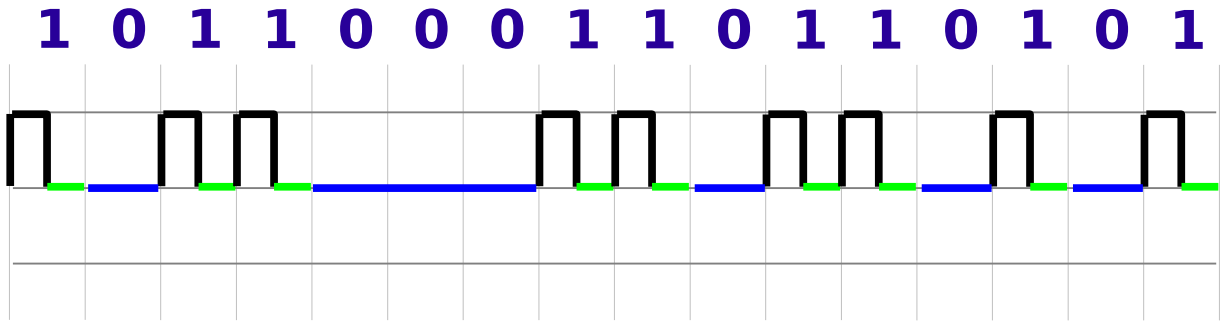
0 : change  change in level

1 : no change no change in level

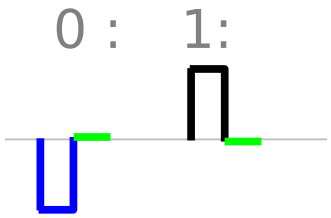
Return to Zero (RZ)

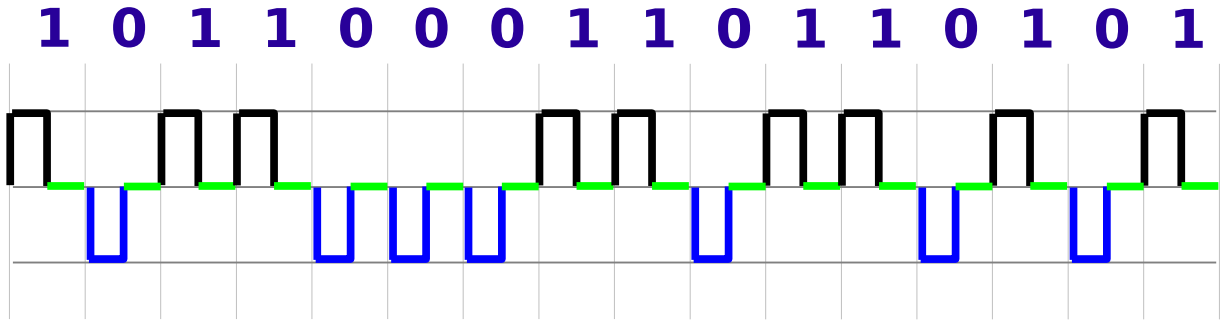
Unipolar-**RZ**



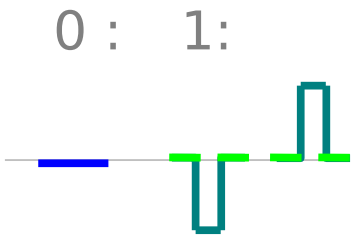


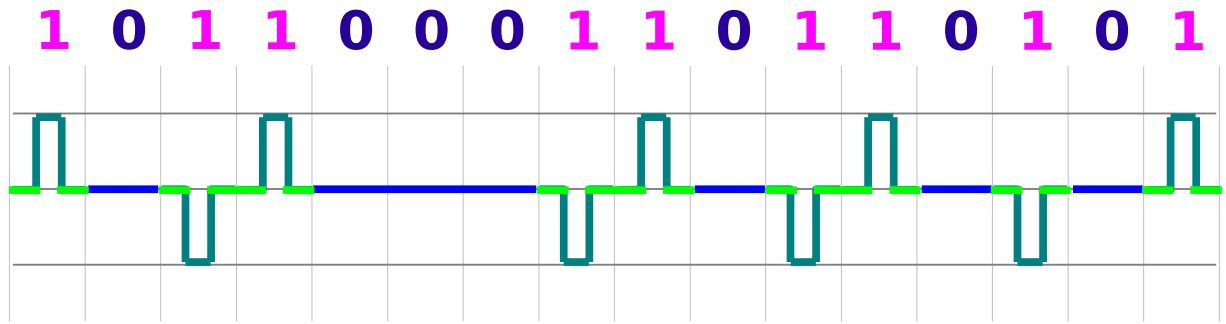
Bipolar-**RZ**





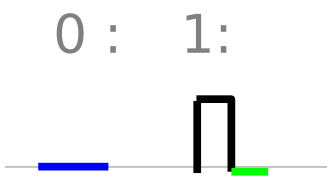
RZ-AMI





Return to Zero (RZ)

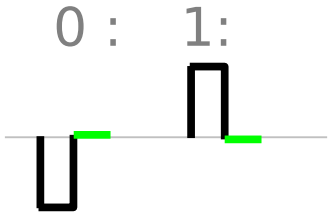
Unipolar-**RZ**



0: absence of a pulse

1: a half bit wide pulse

Bipolar-**RZ**

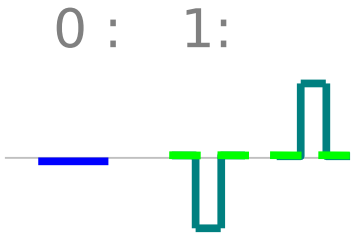


0: a negative half bit wide pulse

1: a positive half bit wide pulse

RZ-AMI

Alternate **M**ark **I**nversion



0: absence of a pulse

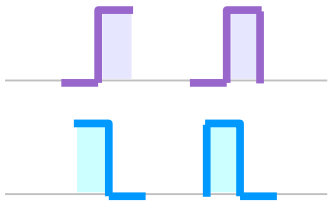
1: alternating pulses

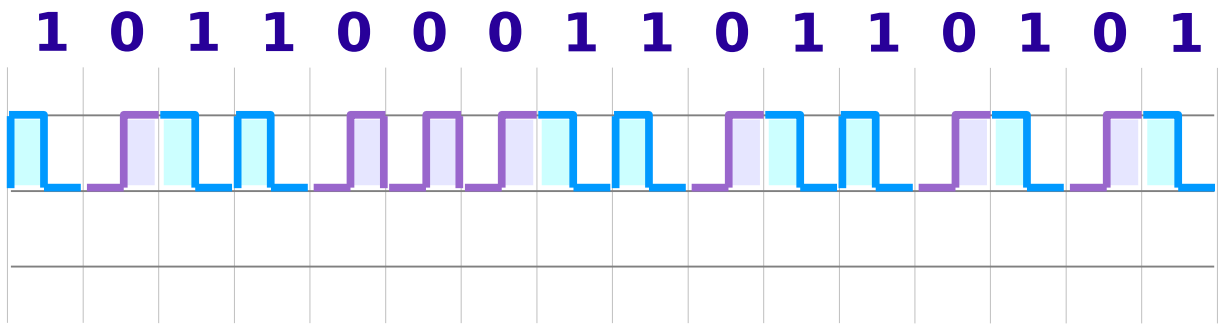
Phase Encoded (Bi-Φ)

Bi-Φ-L (Level)

0 :

1 :

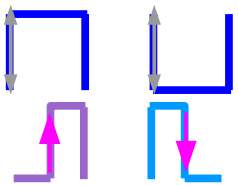


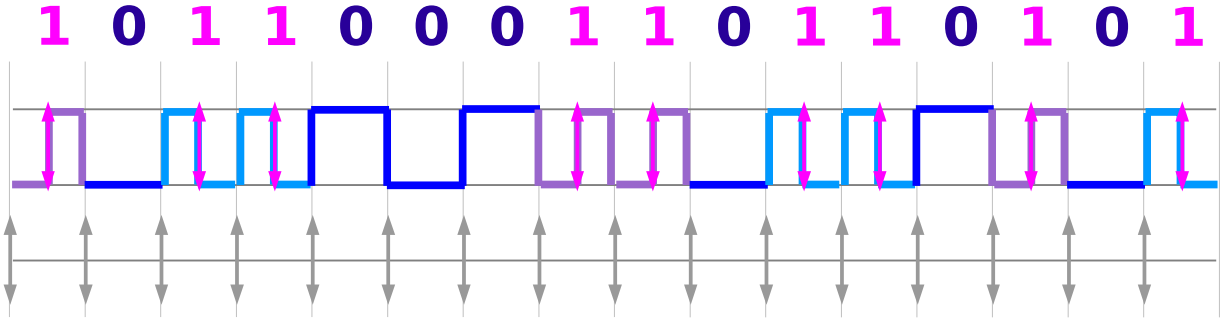


Bi-Φ-M (mark)

0 : no trans

1 : trans

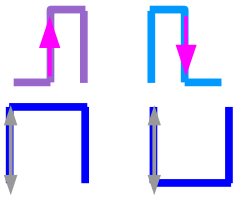


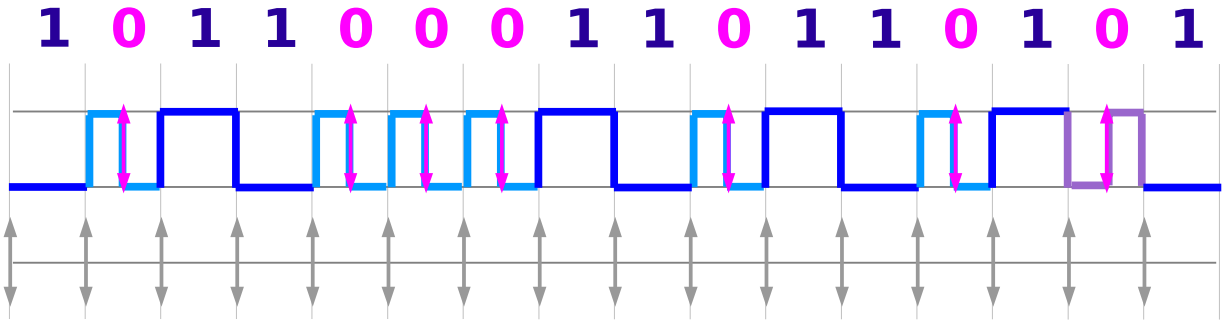


Bi-Φ-S (Space)

0 : trans

1 : no trans





Phase Encoded (Bi-Φ)

Bi-Φ-L (Level) Manchester Encoding

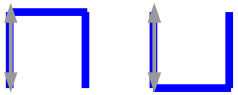
0 : 

0: a half bit wide pulse at the 2nd half

1 : 

1: a half bit wide pulse at the 1st half

Bi-Φ-M (mark)

0 : no trans 

0: 1st transition at the beginning, no 2nd transition

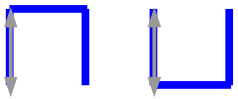
1 : trans 

1: 1st transition at the beginning, 2nd transition in the middle

Bi-Φ-S (Space)

0 : trans 

0: 1st transition at the beginning, 2nd transition in the middle

1 : no trans 

1: 1st transition at the beginning, no 2nd transition

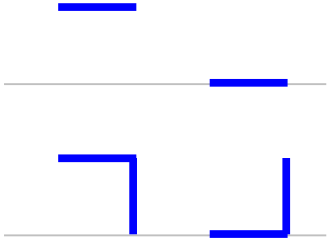
Delay Modulation

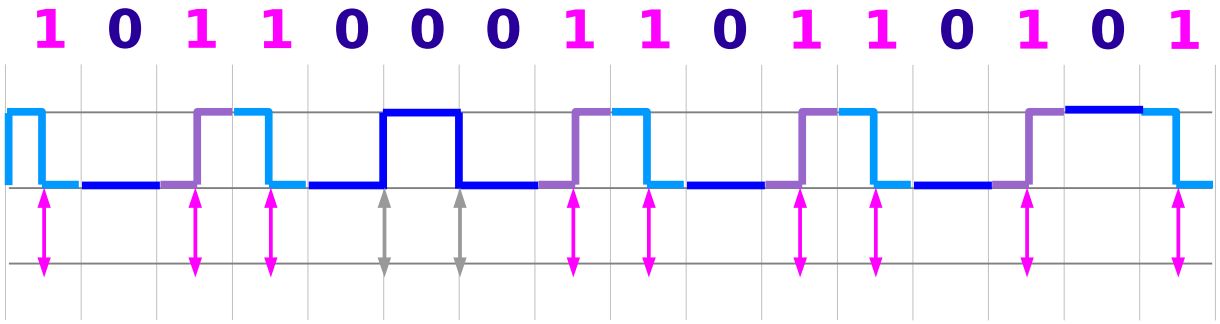
DM

0 :

1 :

0 :





1: a transition in the mid point

0: no transition in the mid point

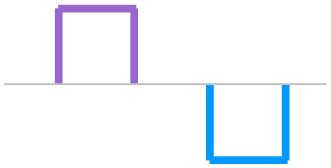
a transition when a zero is followed by another zero

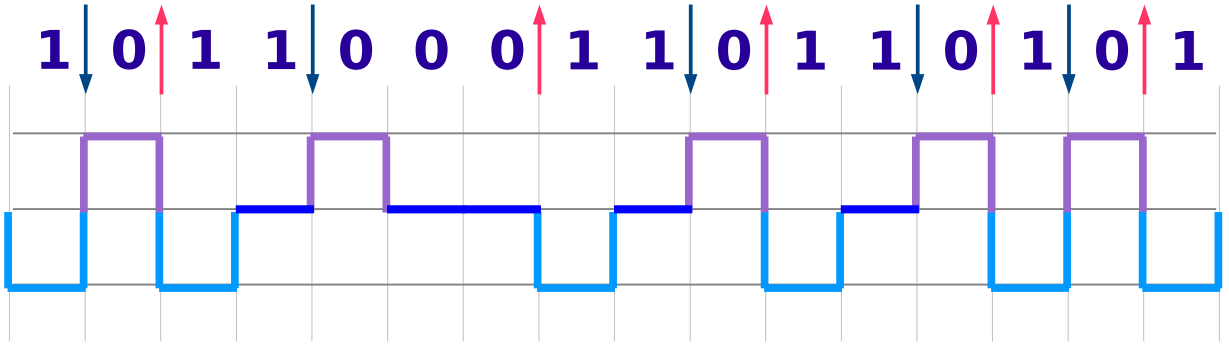
Multilevel Binary

Dicode **NRZ**

0→0, 1→1 : no pulse

0→1, 1→0 : alt pulse



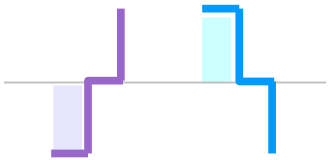


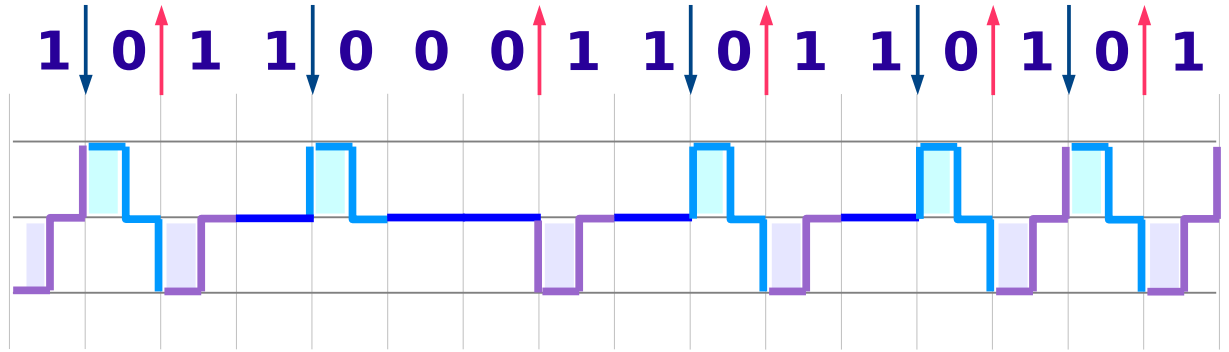
0→1, 1→0: alternating pulses

Dicode **RZ**

0→0, 1→1 : no pulse

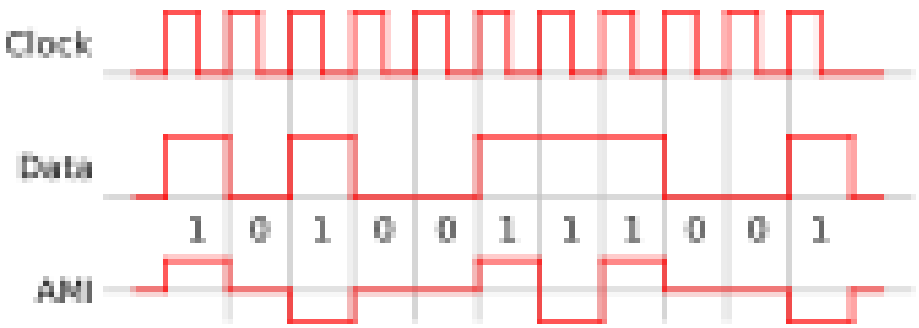
0→1, 1→0 : alt pulse



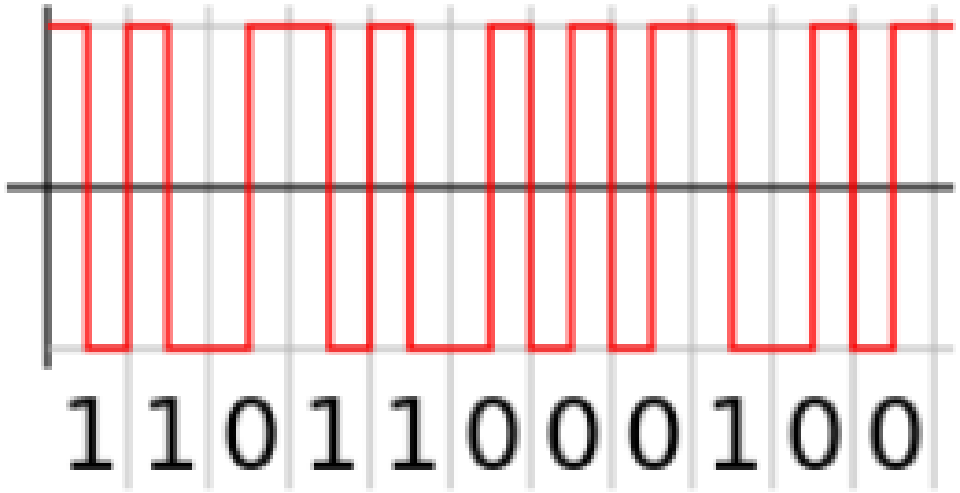


0→1, 1→0: alternating half pulses

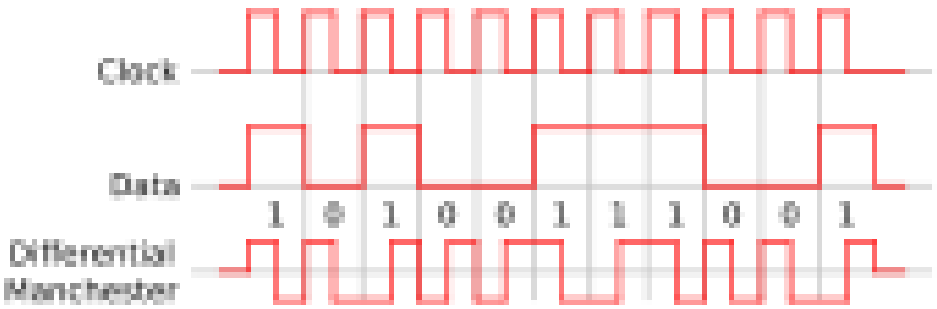
Bipolar AMI



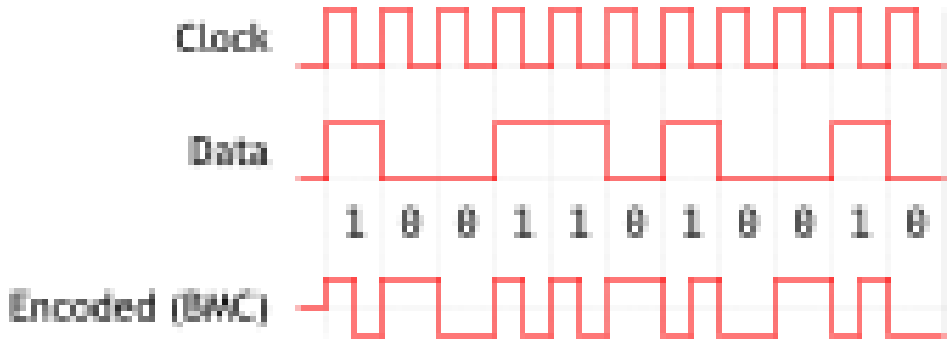
Manchester Encoding



Differential Manchester



Biphase - Mark



Time Averaging and Ergodicity

References

[1] http://en.wikipedia.org/
[2] http://planetmath.org/
[3] B. Sklar, “Digital Communications: Fundamentals and Applications”
[4] S. Haykin, M Moher, “Introduction to Analog and Digital Communications”, 2ed