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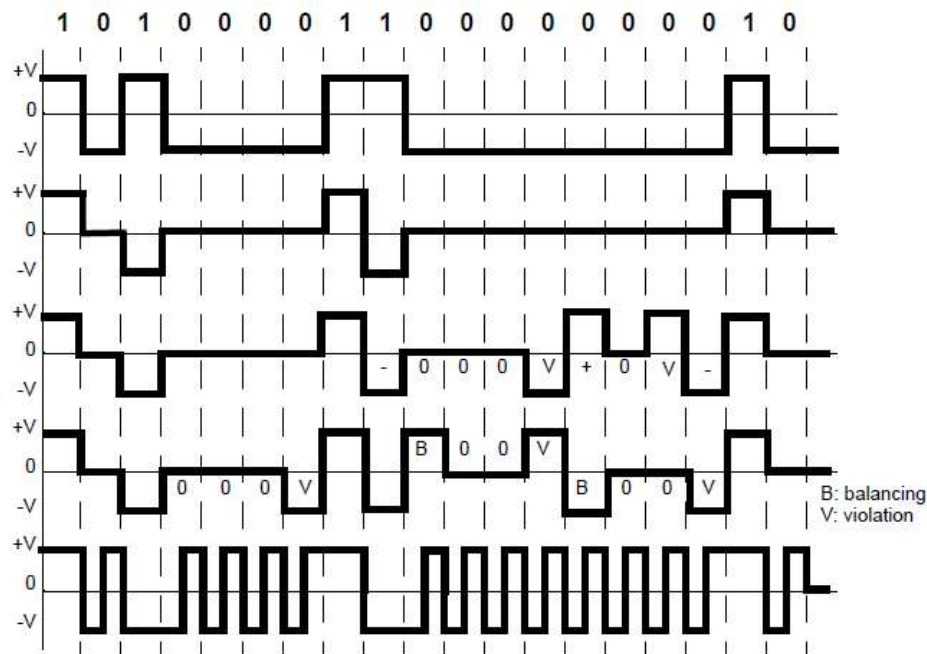
General

Line Coding

By [Avon ampo](#) | Friday, January 30, 2015

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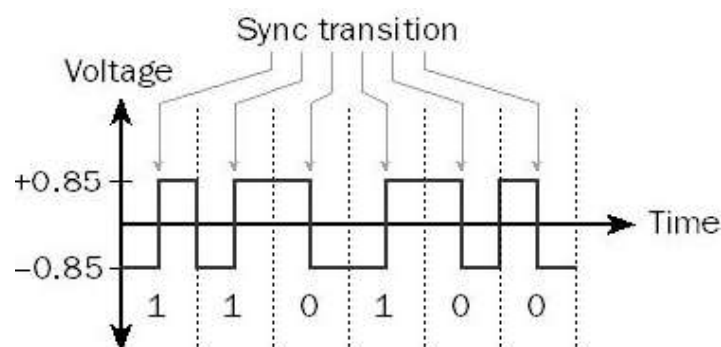




Digital to digital conversion involves three techniques that include line coding, block coding and scrambling. However, among the techniques mentioned, line coding is the most essential.

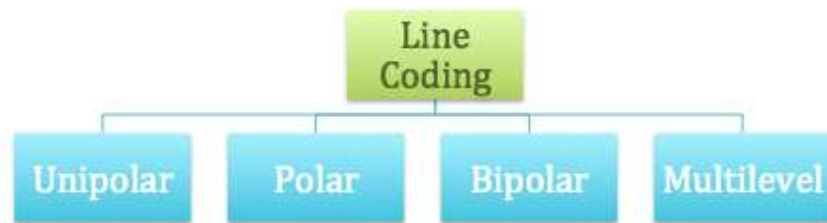
What is line coding?

Line coding is the process of converting binary data to a digital signal. It is represented (stored) internally as series of 1s and 0s as shown in Figure 1. Data, in the form of text, numbers, graphical images, audio, or video, are stored in computer memory as sequences of bits. At the sender, digital data are encoded into a digital signal while at the receiver, digital data are recreated by decoding the digital signal.



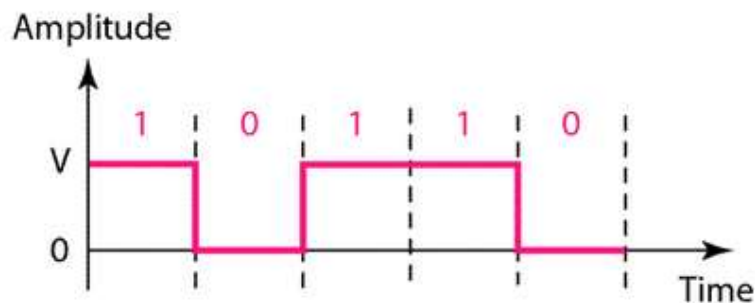
This coding technique is often used for digital data transport. In telecommunication, a line code also known as digital baseband modulation or digital baseband transmission method is chosen for use within a communications system for baseband transmission purposes.

Line Coding Schemes



A. Unipolar Scheme

In a unipolar scheme, all the signal levels are on one side of the time axis, either above or below. NRZ (Non Return to Zero) scheme is an example of this code where the signal level does not return to zero during a symbol transmission. This scheme is prone to baseline wandering and DC components. It has no synchronization or any error detection and it is costly in power consumption. Thus, this scheme is now obsolete.

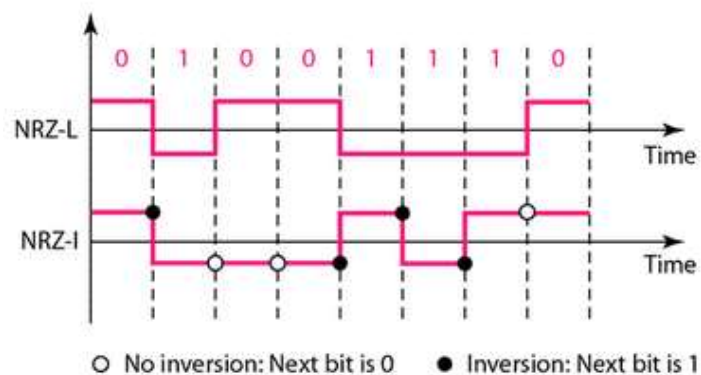


B. Polar Scheme

In polar schemes, the voltages are on the both sides of the time axis where the voltage level for 0 can be positive and the voltage level for 1 can be negative.

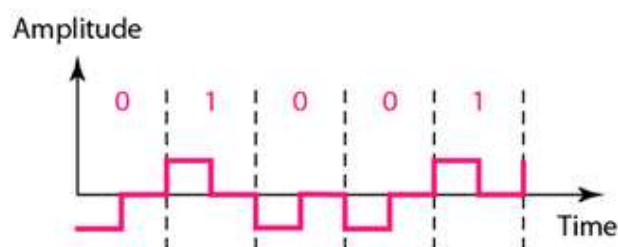
1. Polar – NRZ

The voltages are on both sides of the time axis. It can be implemented with two voltages like $+V$ for 1 and $-V$ for 0. There are actually two versions of Polar-NRZ namely NRZ – Level (NRZ-L) that has positive voltage for one symbol and negative for the other and the other one is NRZ – Inversion (NRZ-I) where the change or lack of change in polarity determines the value of a symbol.



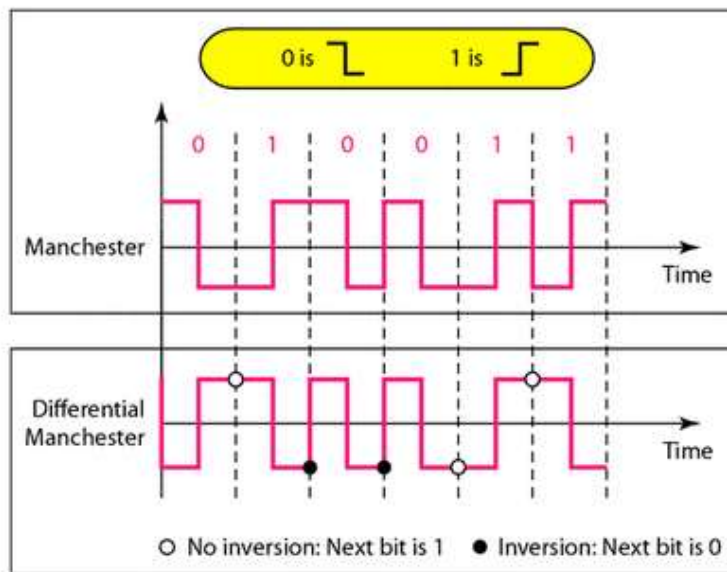
2. Polar RZ

The Return to Zero (RZ) scheme uses three voltage values: +, 0, -. Each symbol has a transition in the middle either from high to zero or from low to zero. This scheme has more signal transitions (two per symbol) and therefore requires a wider bandwidth. In addition, it has no DC components or baseline wandering and has also no error detection capability.



3. Polar Bi-phase: Manchester and Differential Manchester

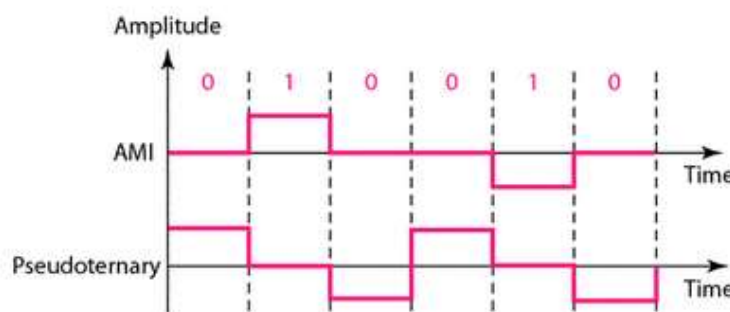
- Manchester coding consists of combining the NRZ-L and RZ schemes. Every symbol has a level transition in the middle: from high to low or low to high. Uses only two voltage levels.
- Differential Manchester coding consists of combining the NRZ-I and RZ schemes. Every symbol has a level transition in the middle. But the level at the beginning of the symbol is determined by the symbol value. One symbol causes a level change the other does not.



C. Bipolar Scheme

In bipolar encoding (sometimes called multilevel binary), the code uses three voltage levels such as +, - and 0. The voltage level for one data element is at zero, while the voltage level for the other element alternates between positive and negative. In, bipolar Alternate Mark Inversion (AMI), the “0” symbol is represented by zero voltage and the “1” symbol alternates between +V and -V while Pseudoternary is the reverse of AMI. Moreover, bipolar is a better alternative to NRZ. It has no DC component or error detection and no self-synchronization since long runs of “0”s results in no signal transitions.

The following figure shows two variations of bipolar encoding: AMI and pseudoternary.

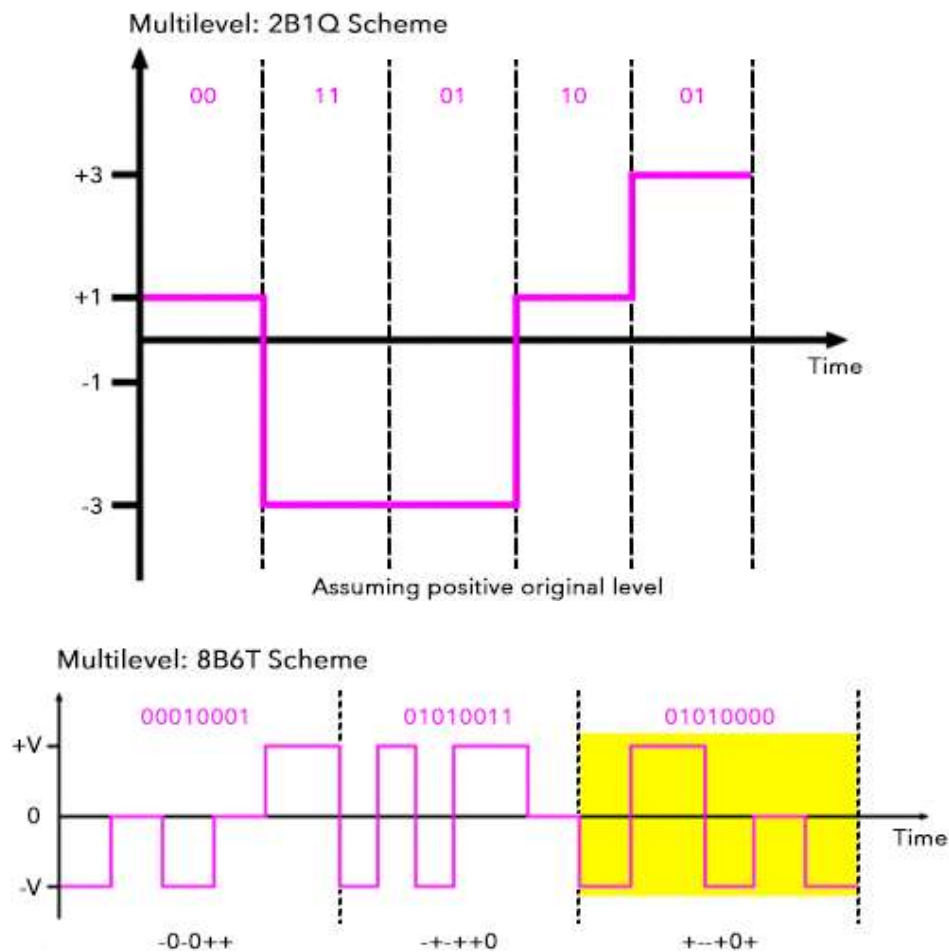


D. Multilevel Scheme

In multilevel schemes, the goal is to increase the number of data bits per symbol thereby increasing the bit rate. It uses only 2 types of data elements a 1 or 0. This scheme can combine 2 data elements such as $2m$ and L_n with the following conditions:

- If $2m > L_n$, not enough signals.
- If $2m = L_n$, an exact mapping of one symbol on one signal.
- If $2m < L_n$, more signals than symbols and more distinct signals can be chosen to represent the symbols. Thus, it has better noise immunity and error detection, as some signals are not valid.

Examples of multilevel schemes are 2B1Q and 8B6T.



Source: Forouzan, B. (2007). Data Communications and Networking (4th ed.). McGraw-Hill Companies, Inc. New York: Digital to Digital Conversion, pp. 101–115.

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