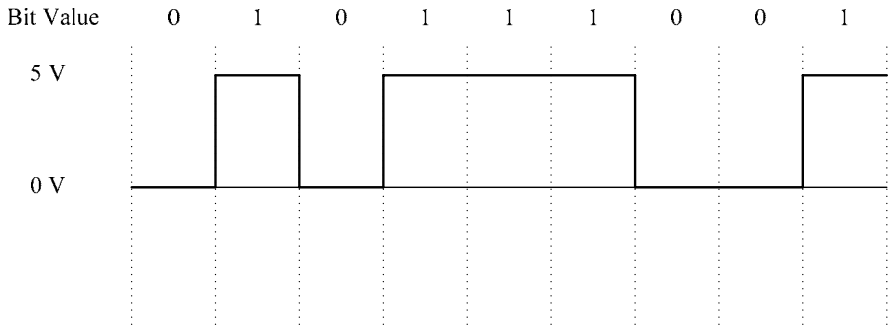
Sources of Digital Communication Systems

In digital communication systems, the information is always assumed to be generated in the form of binary data of with values 0 or 1. The origin of the digital binary information to be transmitted over digital communication systems may be an analog signal such as an audio signal or an analog picture that have been sampled and quantized and then converted to a PCM signal. The origin of the digital binary information may also be digital data in the form of text. In any case, the purpose of this chapter is to study the transmission of the information in the form of a digital binary signal.

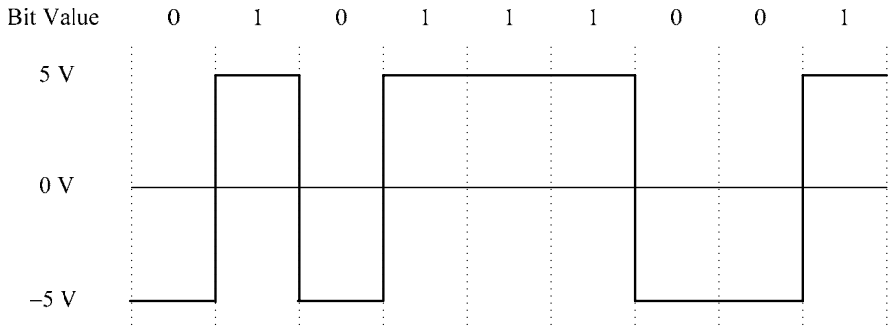
Line Coding

Given some binary information, the binary bits are not transmit through the channel as 1's and 0's but is used to generate a voltage signal that represents the information we would like to transmit. There are different forms of signals (called Line Codes) that can be used to represent the information. The terms Return to Zero (RZ) and Non–Return to Zero (NRZ) will be used in describing these signal.

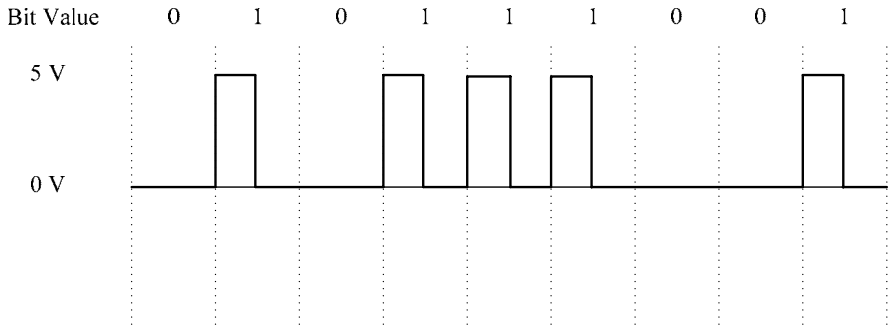
1. **On–Off (NRZ):** In this form of line codes, a bit of 1 is represented by some positive voltage (+5 volts for example) and a bit of 0 by 0 volts (justifying calling this signal On–Off). The pulses corresponding to binary 1 remain at the positive voltage for the whole duration of the bit period (it does not return to zero at any time during the bit period justifying calling this line code NRZ).



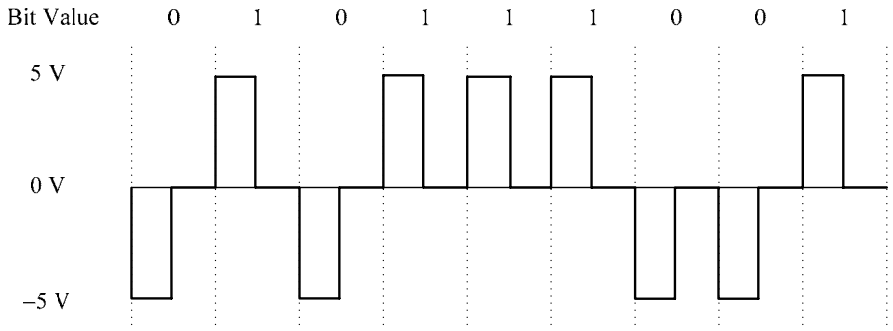
2. **Polar (NRZ):** In this line codes, a bit of 1 is represented by some positive voltage (+5 volts for example) and a bit of 0 is represented by negative of that voltage (so it would be –5 volts). The pulses corresponding to binary 1 and binary 0 remain at the positive and negative voltages, respectively, for the whole duration of the bit period (they do not return to zero). The advantage of this line code over the On–Off (NRZ) is that it has zero–DC value when the number of binary 1's is equal to the number of binary 0's. A line code with zero–DC is desired in some applications that require that the transmitted signal to have no DC.



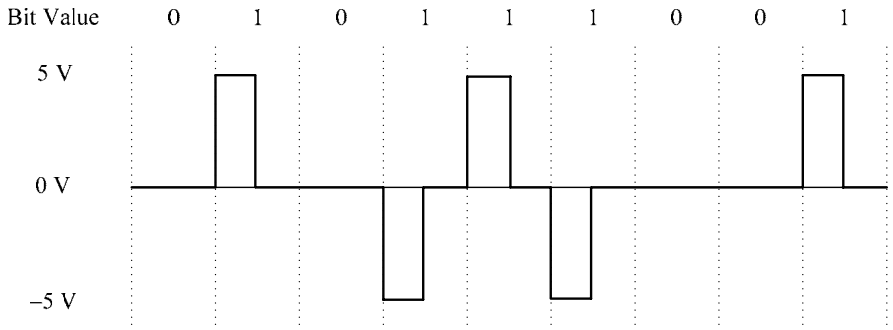
3. **On–Off (RZ):** In this line codes, a bit of 1 is represented by some positive voltage (+5 volts for example) for half of the bit period and zero in the other half of the bit period and a bit of 0 is represented by zero for the whole bit period. This is why this line code is a return–to–zero line code (because any pulse corresponding to binary 1 always returns back to zero). The advantage of this line code over the previous line codes is that a long sequence of ones always has transitions at the center of each bit and therefore bit synchronization becomes easy for long sequences of ones. Long sequence of zeros is still difficult to be synchronized.



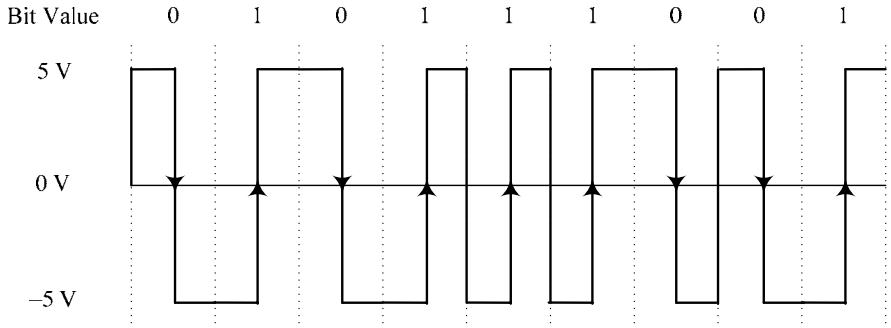
4. **Polar (RZ):** In this line code, a bit of 1 is represented by some positive voltage (+5 volts for example) for half of the bit period and zero in the other half of the bit period and a bit of 0 is represented by the negative of that voltage for half of the period and zero for the other half. The advantage of this line code over the previous ones is that long sequences of ones or zeros have transitions at the center of each bit and therefore bit synchronization becomes easy for long sequences of ones or zeros. Also, this line code has zero DC when the number of ones and zeros is the same.



5. **Bipolar (RZ):** In this line code, a bit of 0 is represented by zero volts for the whole bit period. A bit of 1 is represented by some positive voltage (+5 volts for example) for half of the bit period and zero in the other half of the bit period. However, the next bit of one (wither it is the next bit or 1000 bits later is represented by the negative of the voltage for half of the bit period and zero for the second half. So, the bits of 1's are represented by alternating positive and negative pulses. This insures that the DC value of the signal is always zero even if we have non–equal number of ones and zeros.



6. **Manchester (also called bi-phase):** In this line code, a bit of 0 is represented by +5 volts for the first half of the bit period and -5 volts for the second half while a bit of 1 is represented by a -5 volts for the first half of the bit and +5 for the second half of the bit. Therefore, the data is not transmitted in the signal level but in the transmission at the middle of a bit. Note that there are transmissions that may occur at the beginning or end of a bit when two consecutive bits have the same bit value (a 1 followed by a 1 or a 0 followed by a 0). These transitions however do not carry any information. So, we can say that a up transition in the middle of the bit represents a bit of 1 and a down transition in the middle of the bit represents a bit of 0.


Bit Value
0
1
0
1
1
1
0
0
1
5 V
0 V
–5 V