



DIGITAL COMMUNICATION

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BASEBAND SHAPING

Pulse Shaping Line Coding

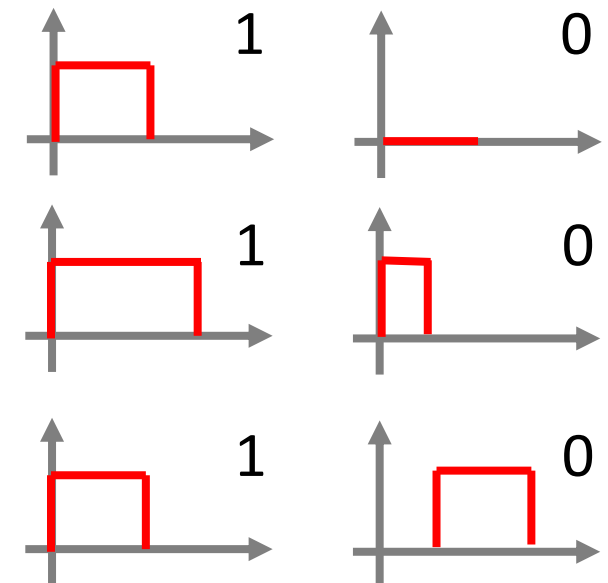
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BASEBAND SHAPING FOR DATA TRANSMISSION

Pulse Modulation Schemes

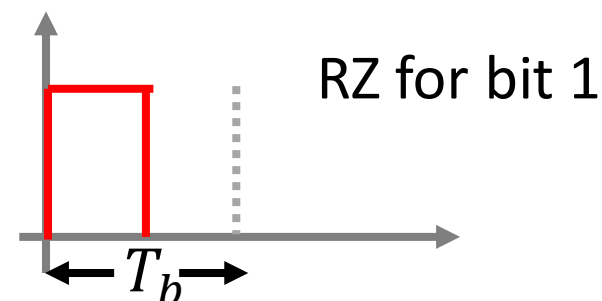
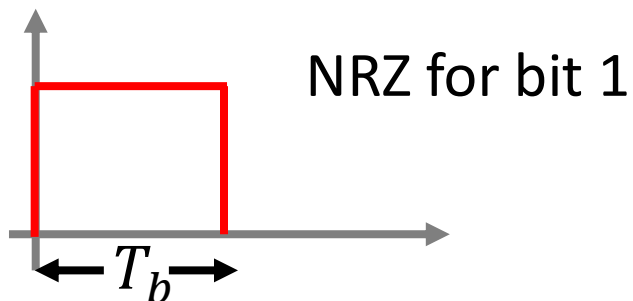
- At the end of quantization, we now have a bit sequence to transmit
- Pulse shaping is required, which is a process of representing a bit stream in terms of an electrical (analog) waveform
- In discrete pulse modulation, the amplitude, duration or position of the transmitted pulses are varied according to the binary data to be transmitted
- This is called **baseband shaping** or **pulse modulation**
- The pulse modulation schemes are:
 - Pulse Amplitude Modulation (PAM)
 - Pulse Duration Modulation (PDM)
 - Pulse Position Modulation (PPM)



BASEBAND SHAPING FOR DATA TRANSMISSION

Pulse Amplitude Modulation (PAM) and Types

- Among these techniques, PAM is preferred since it is the most efficient among all in terms of bandwidth and power
- In baseband transmission, we assume that the digital pulses are rectangular, and the transmission lines to be distortionless
- We consider the rectangular pulse as a basic shape. Let T_b denote the bit duration
- PAM signals are of two types
 - **Non-return to zero (NRZ)**: Pulse occupies entire duration of T_b
 - **Return to zero (RZ)**: Pulse occupies a fraction of duration T_b



PULSE AMPLITUDE MODULATION

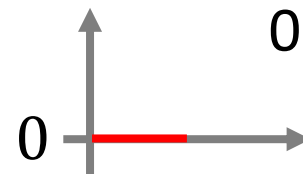
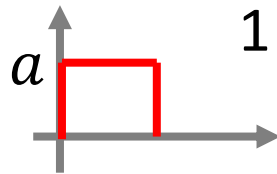
Non-Return to Zero (NRZ) and Sub-Types

- NRZ PAM is also called as Type I coding
- NRZ in PAM can be further classified into the following categories
 - Unipolar NRZ technique
 - Polar NRZ technique
 - Bipolar NRZ technique
 - Manchester coding
 - ~~• M-ary format coding~~

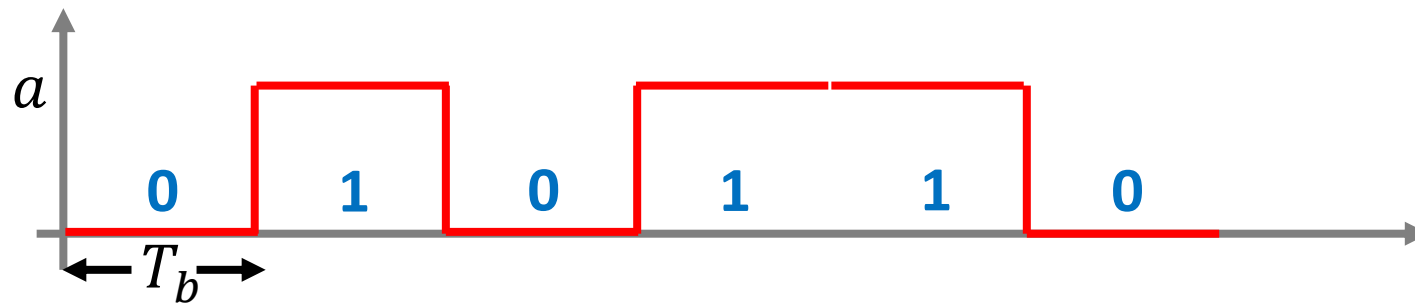
NON-RETURN TO ZERO (NRZ)

Unipolar NRZ

- In unipolar NRZ, the bits 1 and 0 have amplitudes a and 0, respectively



- Example of unipolar NRZ: Consider the bit sequence – 010110

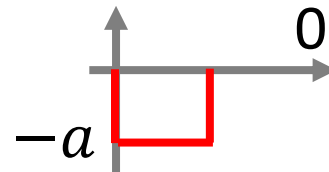
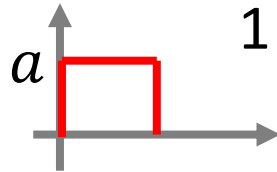


- Major issue:** Presence of a non-zero DC value
- This DC component contains no information, and only drains the power
- Repeaters in the channel typically use transformers, which block DC
- Creates problems in magnetic storage (due to hysteresis)

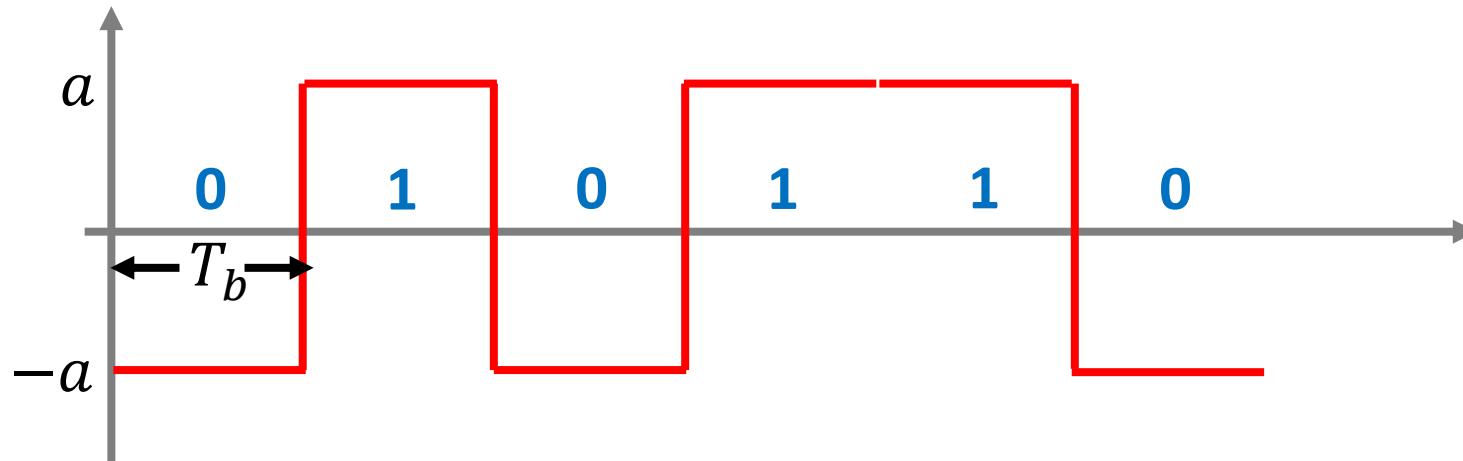
NON-RETURN TO ZERO (NRZ)

Polar NRZ

- In polar NRZ, the bits 1 and 0 have amplitudes a and $-a$, respectively



- Example of polar NRZ: Consider the bit sequence – 010110

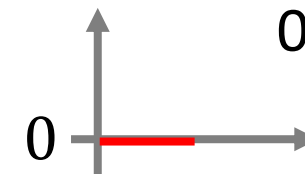
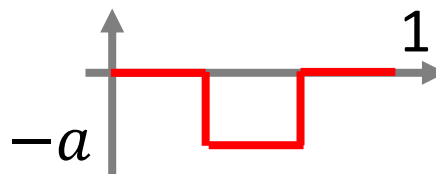
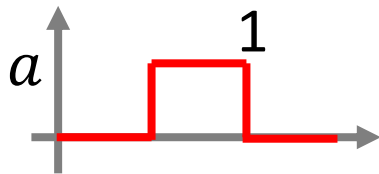


- If 1 and 0 occur with equal probabilities, then this scheme has zero DC value
- Major issue:** Polarity inversion (switched telephone networks) is problematic
- Efficient scheme, since it consumes least power among all other techniques

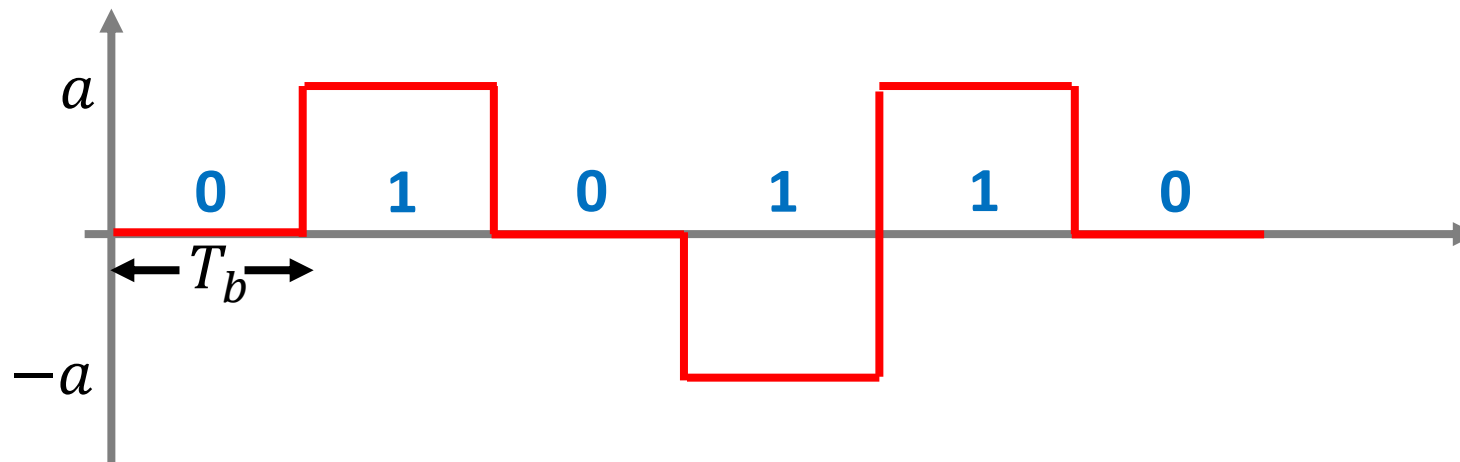
NON-RETURN TO ZERO (NRZ)

Bipolar NRZ

- In bipolar NRZ, the bit 1 has amplitudes a , and $-a$ alternatively, and bit 0 has an amplitude of 0. This is also called as **pseudo-ternary coding** technique



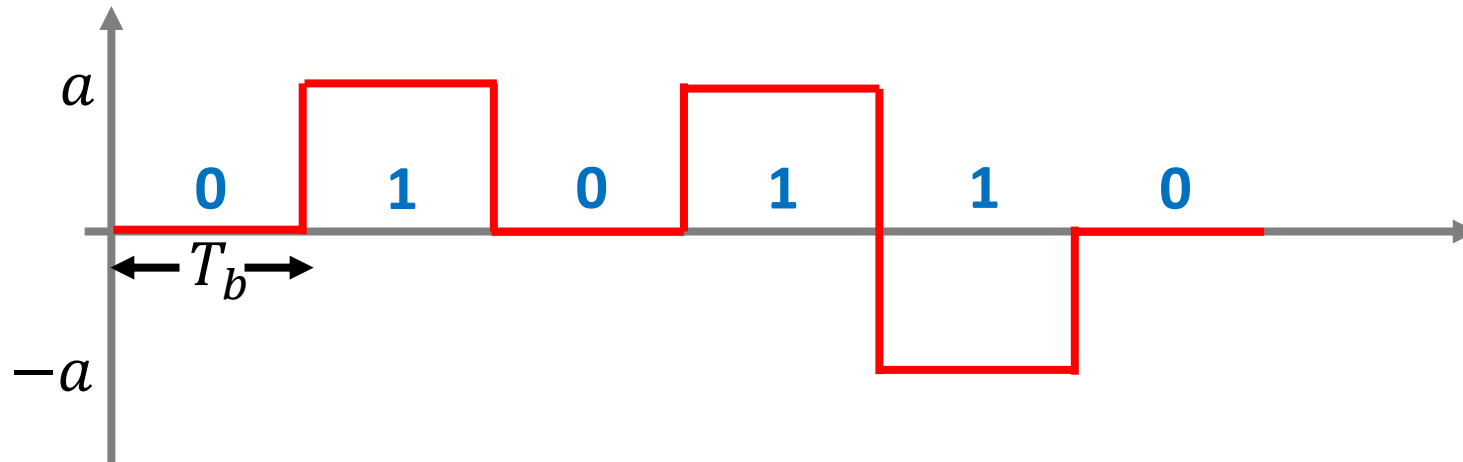
- Example of bipolar NRZ: **Consider the bit sequence – 010110**



NON-RETURN TO ZERO (NRZ)

Bipolar NRZ

- Similar to polar NRZ, the DC value is zero. Polarity inversion is not a problem
- Some bit errors can be recovered, but cannot be corrected

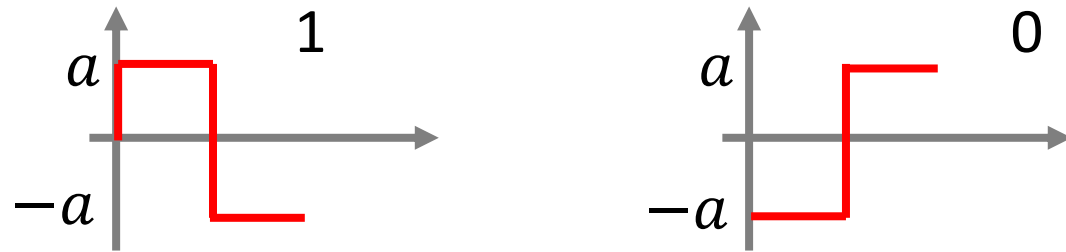


- In case of bipolar NRZ, a long string of 0s can result in a loss of synchronization between the clocks at the transmitter and receiver
- A similar problem exists in unipolar and polar NRZ schemes as well, where a long string of 0s or 1s cause a loss of clock synchronization
- To overcome this, **Manchester coding** is used

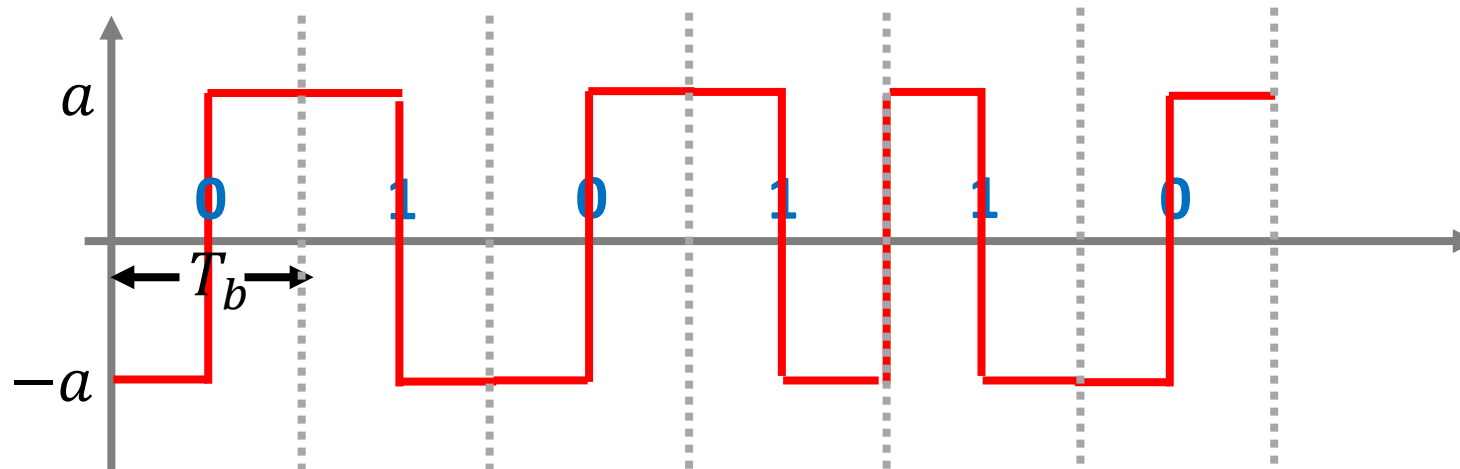
NON-RETURN TO ZERO (NRZ)

Manchester Coding

- In Manchester coding, the bits 1 and 0 have a transition in the middle of every bit duration, and hence clock recovery becomes easier



- Example of Manchester NRZ: Consider the bit sequence – 010110



PULSE AMPLITUDE MODULATION

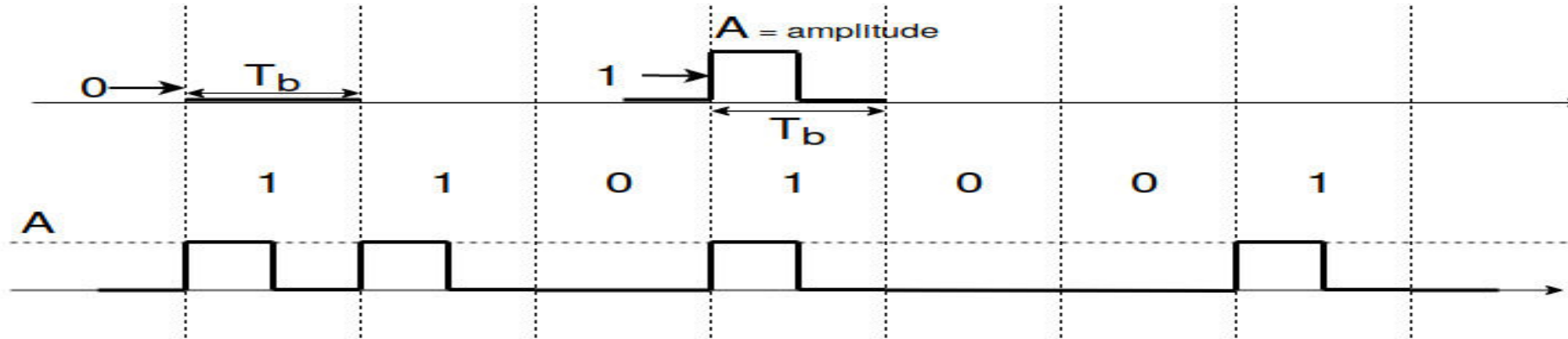
Return to Zero (RZ) and Sub-Types

- RZ PAM is also called as Type II coding
- RZ in PAM can be further classified into the following categories
 - Unipolar NRZ technique
 - Polar NRZ technique
 - Bipolar NRZ technique

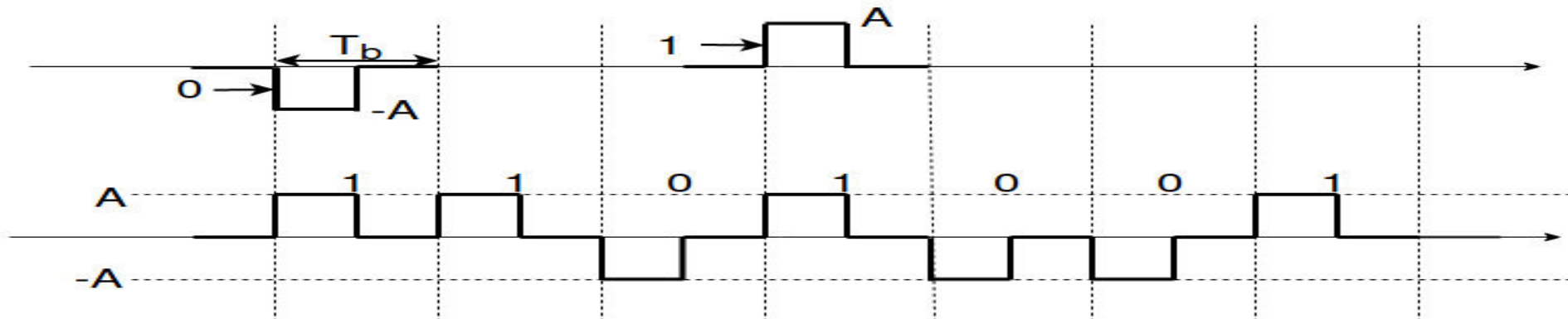
RETURN TO ZERO (RZ)

Unipolar RZ and Polar RZ Illustrations

- Unipolar RZ

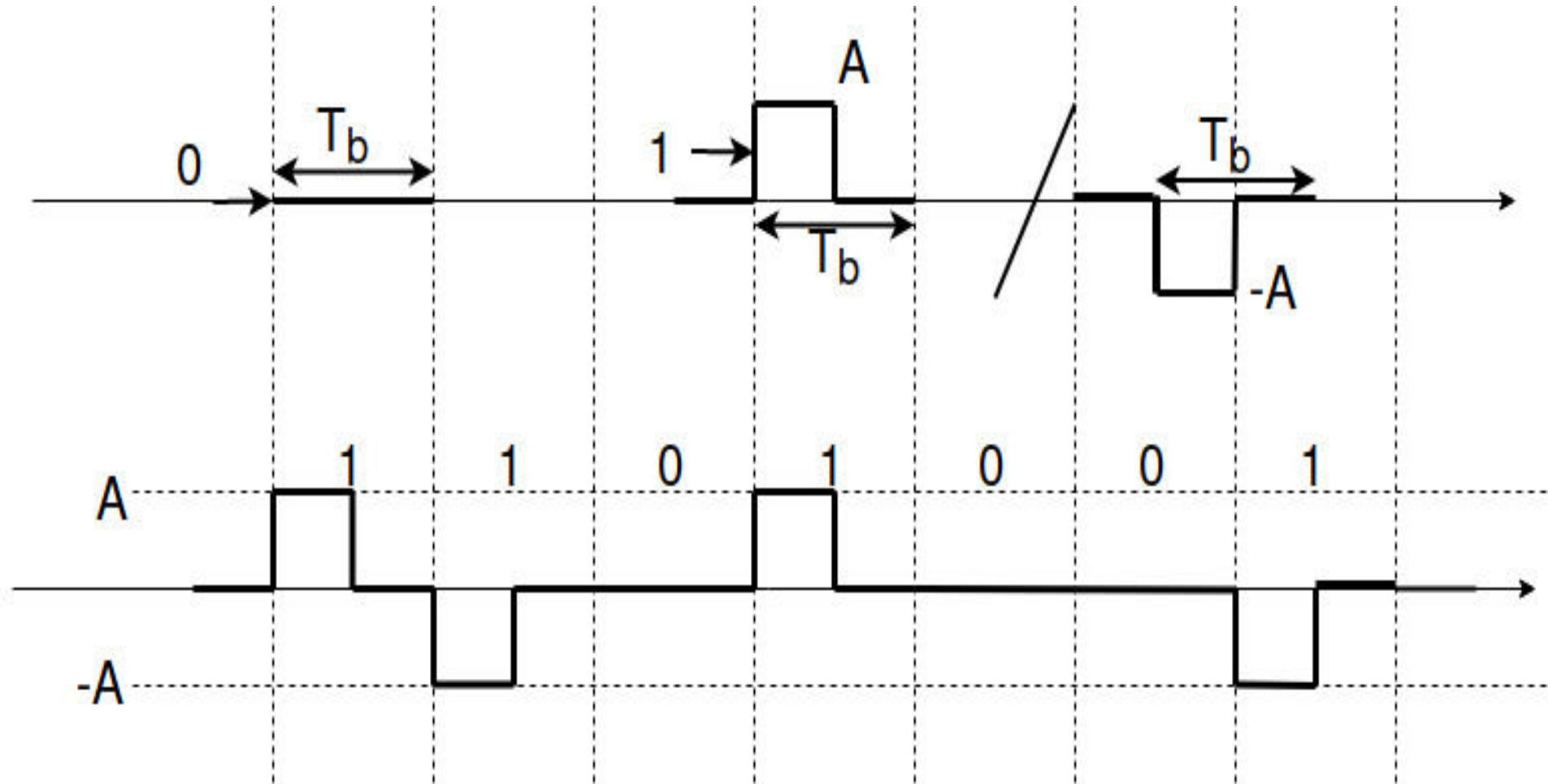


- Polar RZ



RETURN TO ZERO (RZ)

Bipolar RZ Illustration





THANK YOU

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