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University of Dhaka

Department of Computer Science and Engineering

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Lab Report: 01
Report Name:
Implementation of Different Encoding and Decoding Scheme

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Submitted to:

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1. Introduction

Encoding schemes are essential for converting digital binary data into signal forms suitable for physical transmission media. These methods help address synchronization, bandwidth efficiency, and error detection issues. This lab report investigates the implementation of six common line encoding schemes:

- NRZ-L (Non-Return to Zero-Level)
- NRZ-I (Non-Return to Zero-Inverted)
- Manchester
- AMI (Alternate Mark Inversion)
- Pseudo-Ternary
- MLT-3 (Multi-Level Transmit-3)

2. Objectives

- To understand and implement different line encoding and decoding schemes.
- To observe the waveform representation of encoded signals.
- To verify correctness of decoding logic for each scheme.

3. Algorithms / Pseudocode

NRZ-L

- For each bit:
  - 1 → High voltage level.
  - 0 → Low voltage level.

NRZ-I

- Initialize with a starting level.
- For each bit:
  - 1 → Invert signal.
  - 0 → Maintain previous level.

Manchester

- For each bit:
  - 1 → Low-to-High transition.
  - 0 → High-to-Low transition.

AMI

- Alternate polarity for 1s: $+V$, $-V$, $+V$, etc.
- 0 $\rightarrow$ Zero level.

Pseudo-Ternary

- Alternate polarity for 0s.
- 1 $\rightarrow$ Zero level.

MLT-3

- Use three voltage levels: $+V$, 0, $-V$.
- For 1s: change level in sequence.
- For 0s: maintain current level.

4. Sample Input and Output

Input Stream:
`1 0 1 1 0 0 1 0`

Encoding Results:

Scheme	Encoded Signal (Conceptual)	Decoded Output
NRZ-L	1 0 1 1 0 0 1 0	1 0 1 1 0 0 1 0
NRZ-I	1 1 0 1 1 1 0 0	1 0 1 1 0 0 1 0
Manchester	10 01 10 10 01 01 10 01	1 0 1 1 0 0 1 0
AMI	1 0 -1 1 0 0 -1 0	1 0 1 1 0 0 1 0
Pseudo-Ternary	0 -1 0 0 1 -1 0 1	1 0 1 1 0 0 1 0
MLT-3	1 1 0 -1 -1 -1 0 0	1 0 1 1 0 0 1 0

Table 1: Encoded Signals and Decoded Output

Waveform Plots

NRZ-L Encoding Scheme:

Input: 1 0 1 1 0 0 1 0

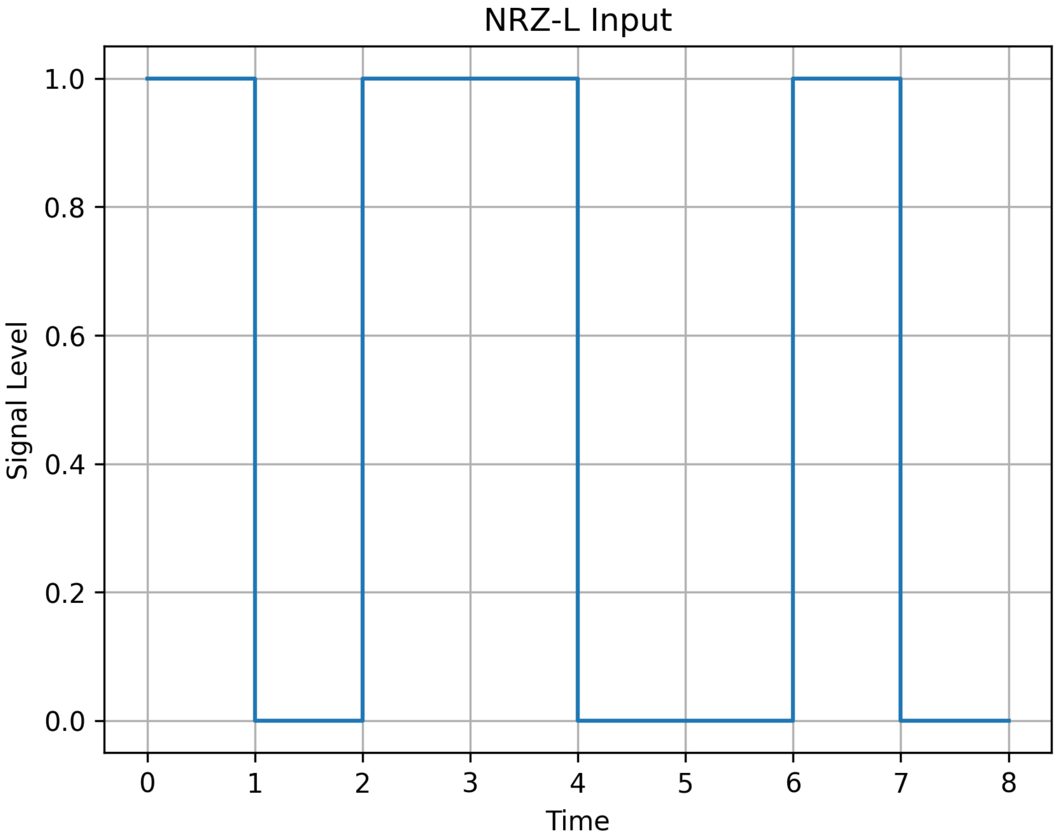

Figure 1: Waveform for NRZ-L Input

Encoding: 1 0 1 1 0 0 1 0

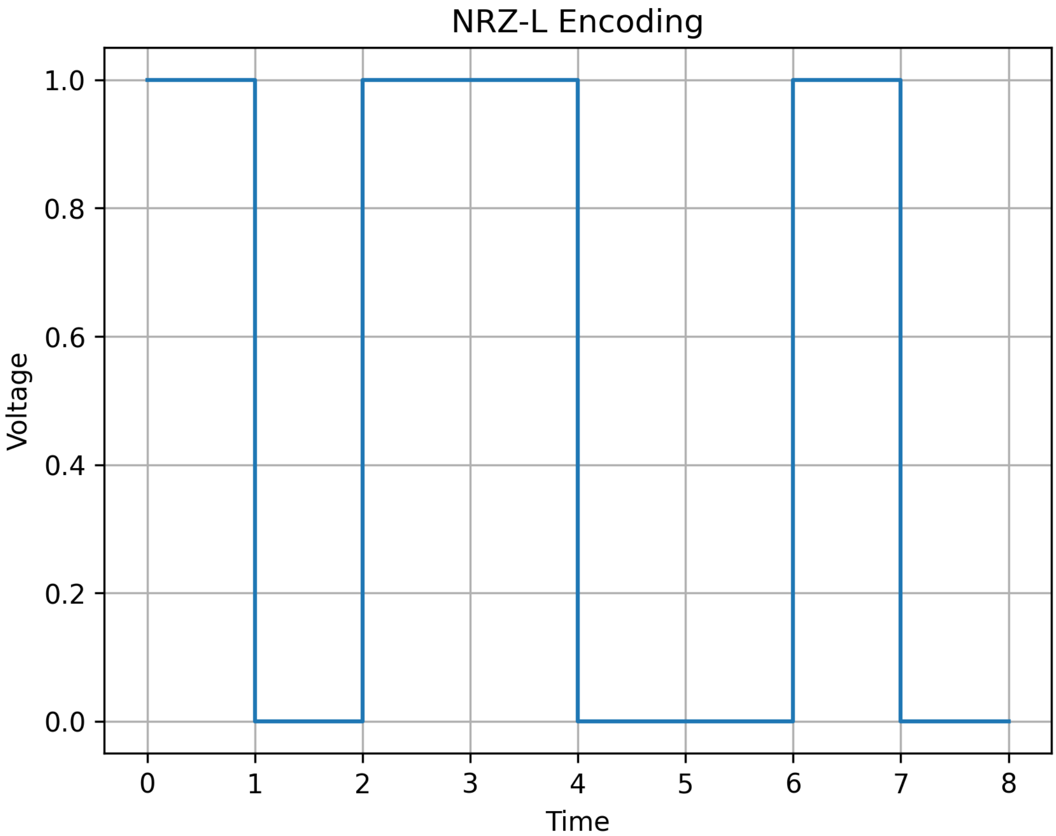

Figure 2: Waveform for NRZ-L Encoding

Output: 1 0 1 1 0 0 1 0

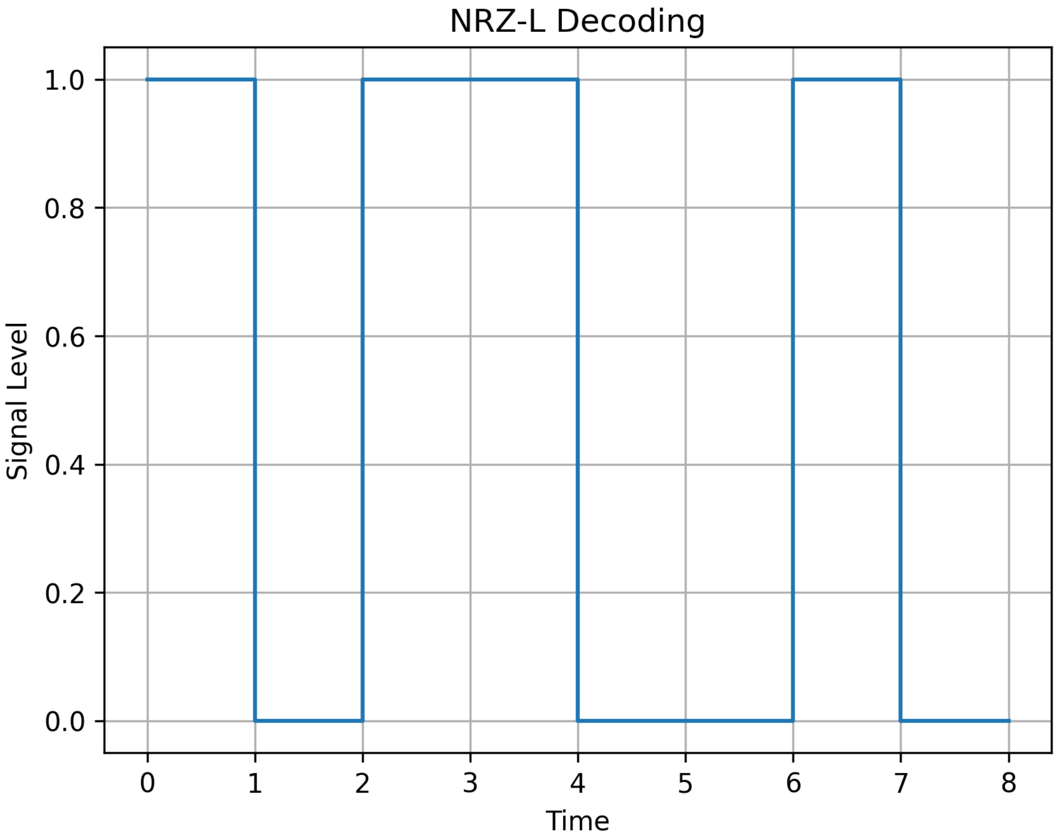

Figure 3: Waveform for NRZ-L Decoding

NRZ-I Encoding Scheme:

Input: 1 0 1 1 0 0 1 0

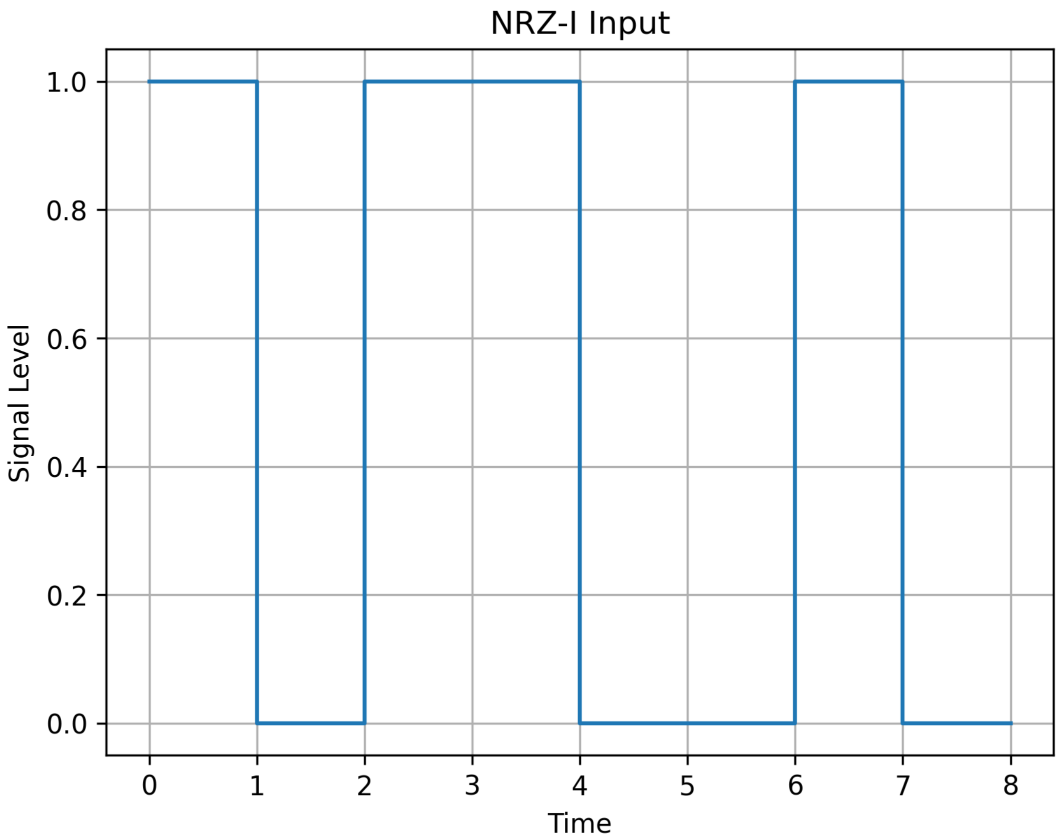

Figure 4: Waveform for NRZ-I Input

Encoding: 1 1 0 1 1 1 0 0

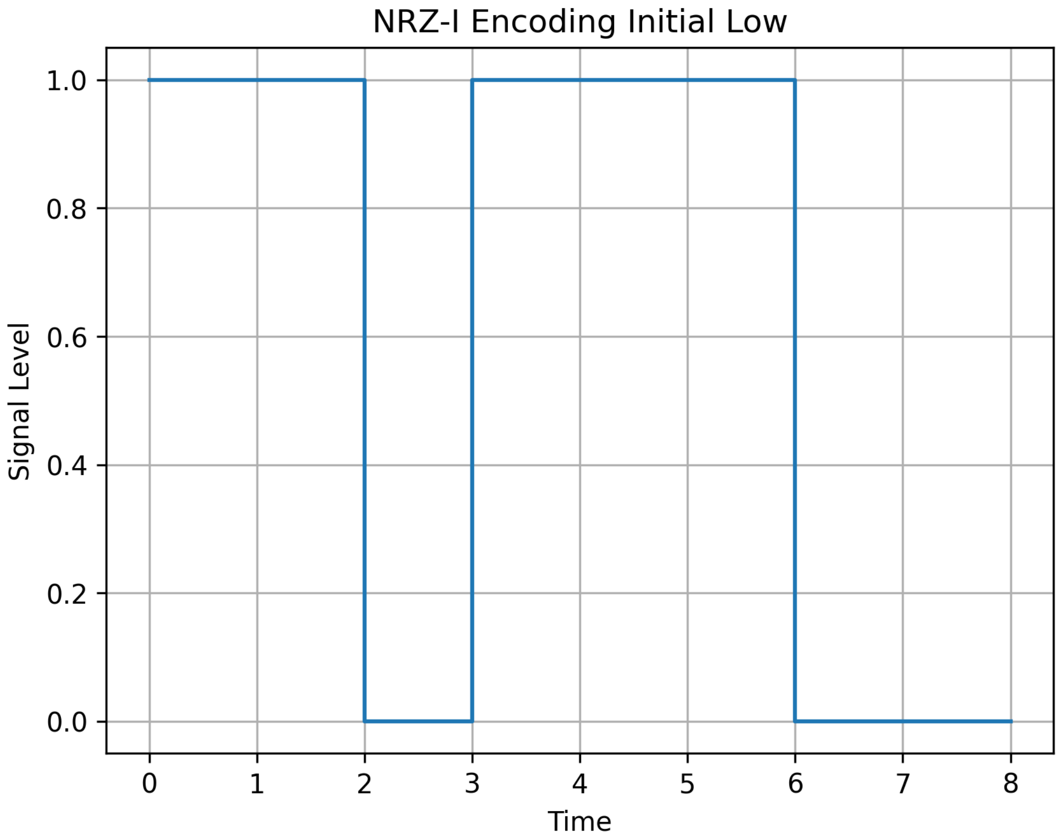

Figure 5: Waveform for NRZ-I Encoding

Output: 1 0 1 1 0 0 1 0

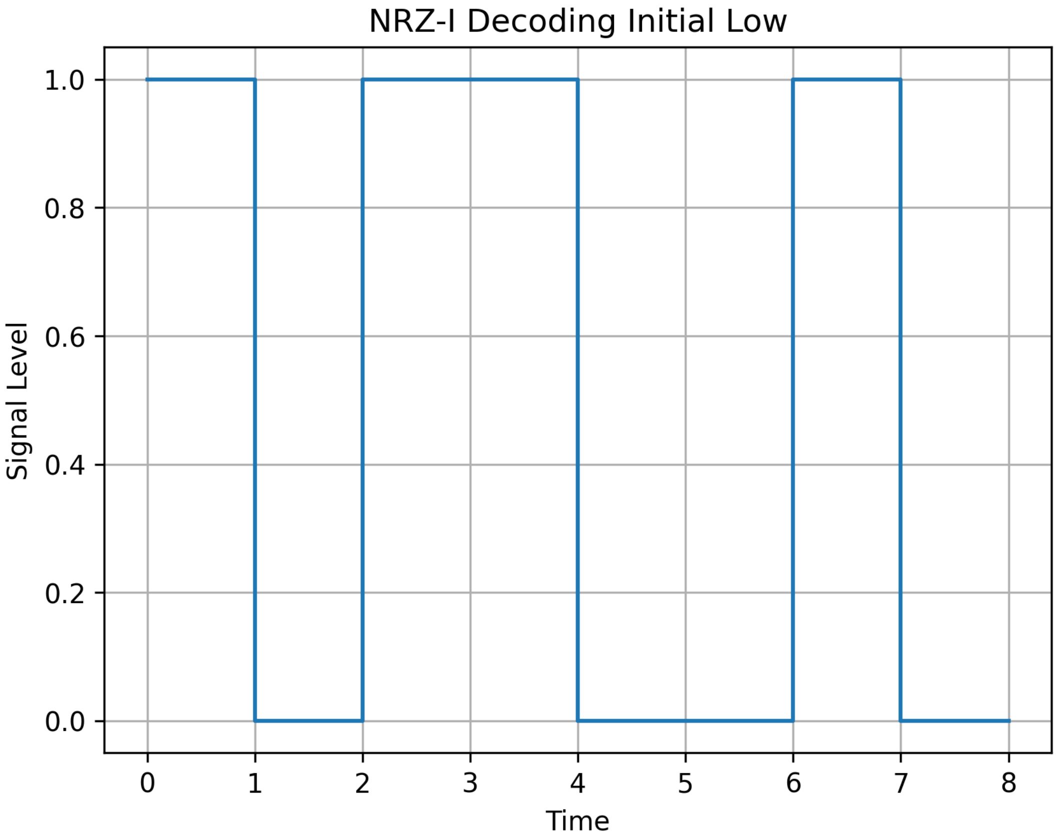

Figure 6: Waveform for NRZ-I Decoding

Manchester Encoding Scheme:

Input: 1 0 1 1 0 0 1 0

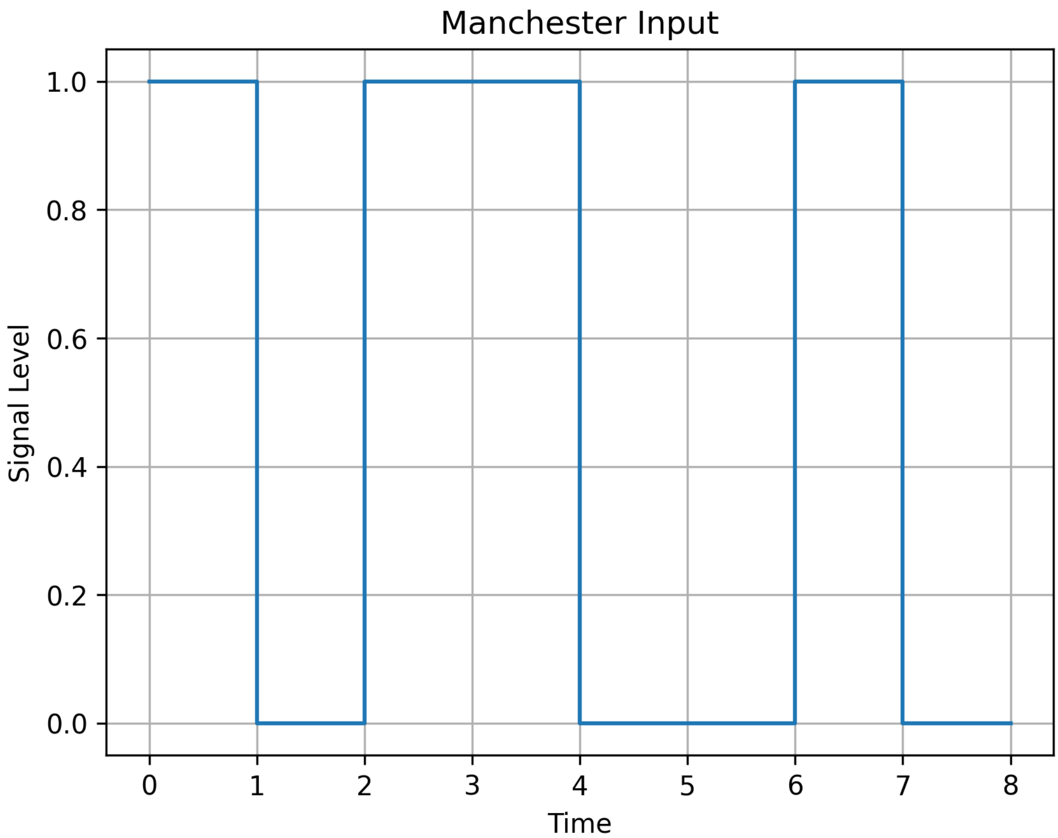

Figure 7: Waveform for Manchester Input

Encoding: 10 01 10 10 01 01 10 01

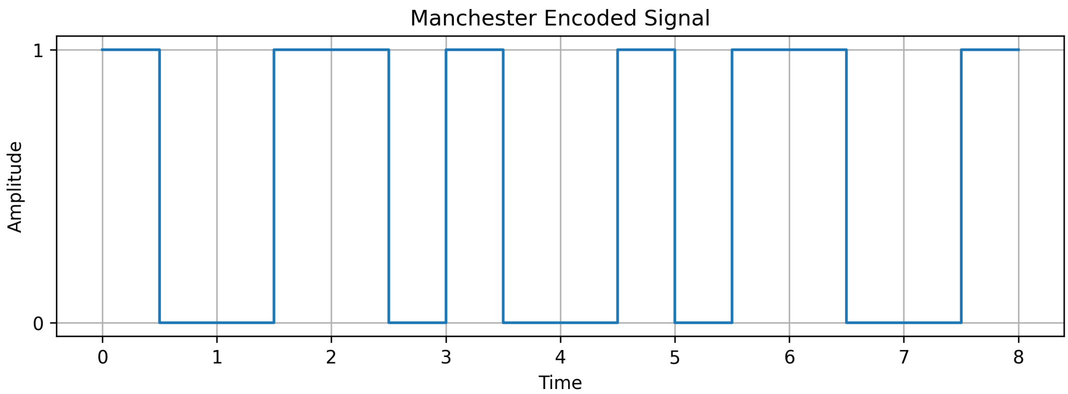

Figure 8: Waveform for Manchester Encoding

Output: 1 0 1 1 0 0 1 0

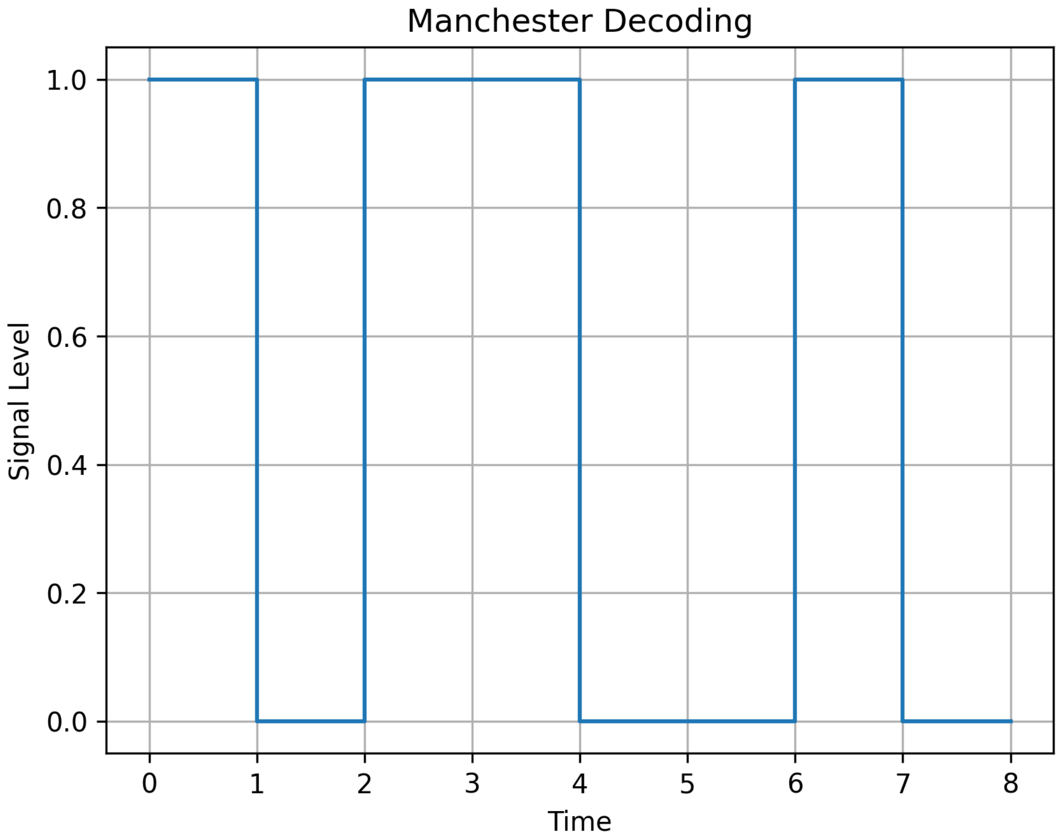

Figure 9: Waveform for Manchester Decoding

AMI Encoding Scheme:

Input: 1 0 1 1 0 0 1 0

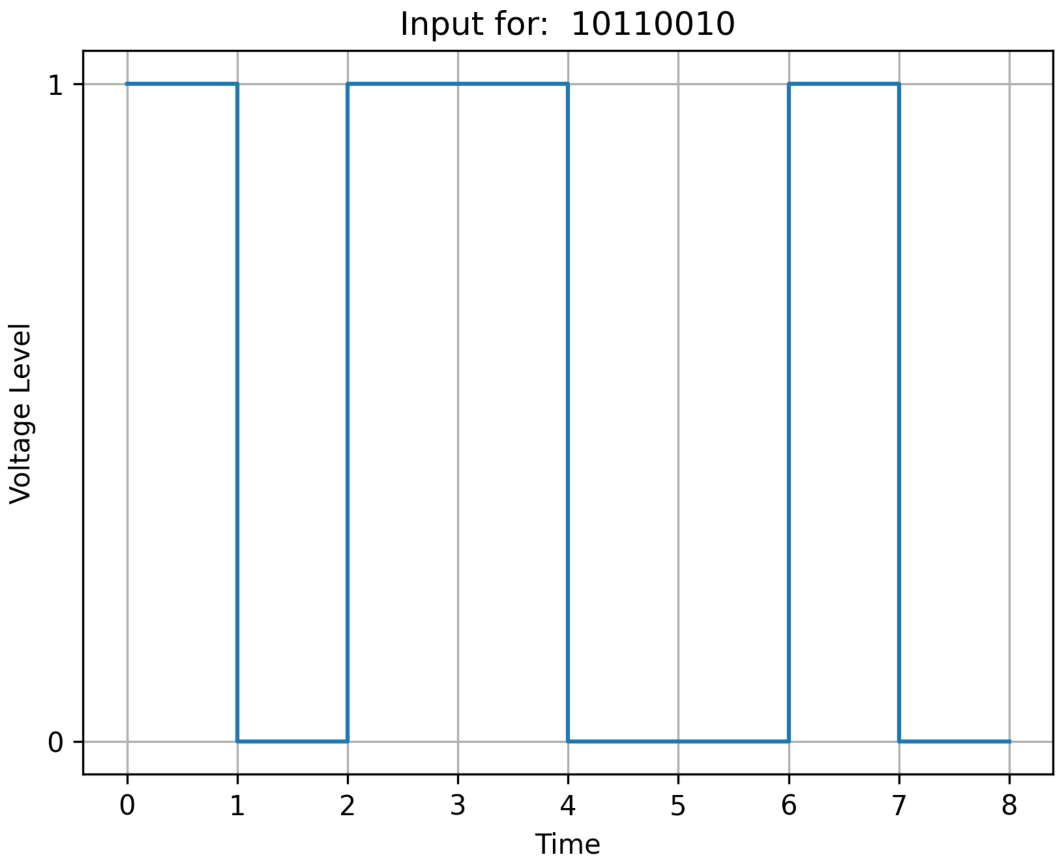

Figure 10: Waveform for AMI Input

Encoding: 1 0 -1 1 0 0 -1

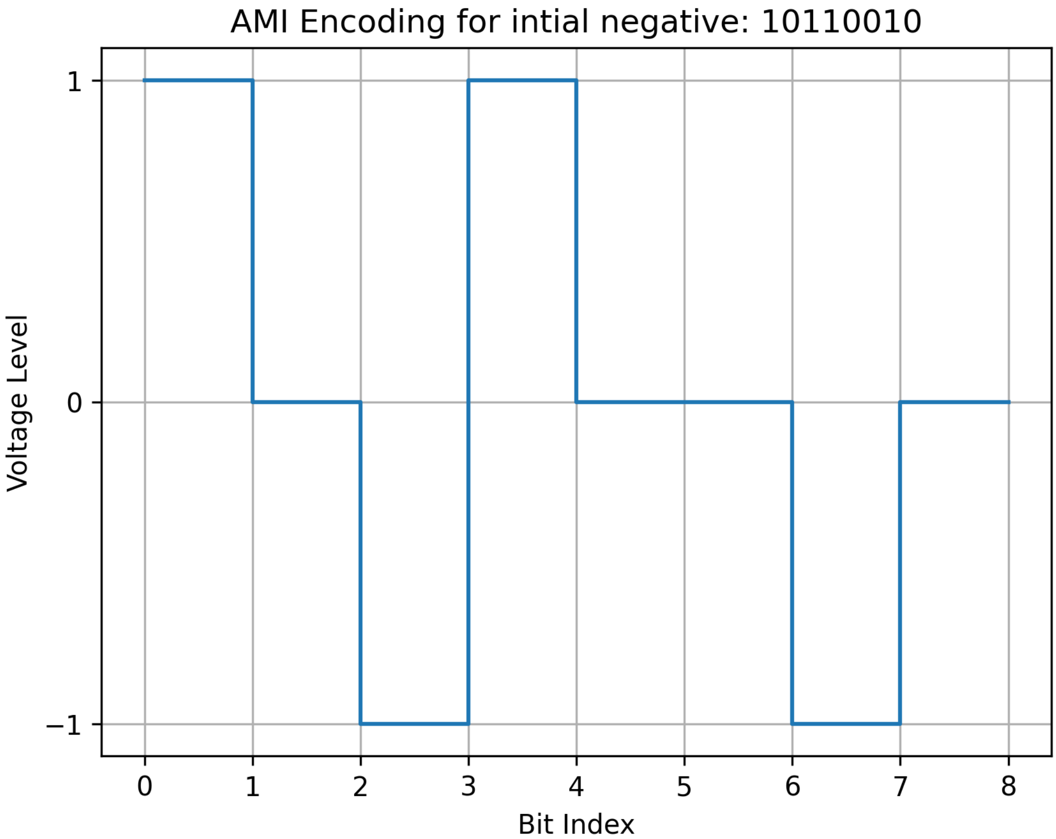

Figure 11: Waveform for AMI Encoding

Output: 1 0 1 1 0 0 1 0

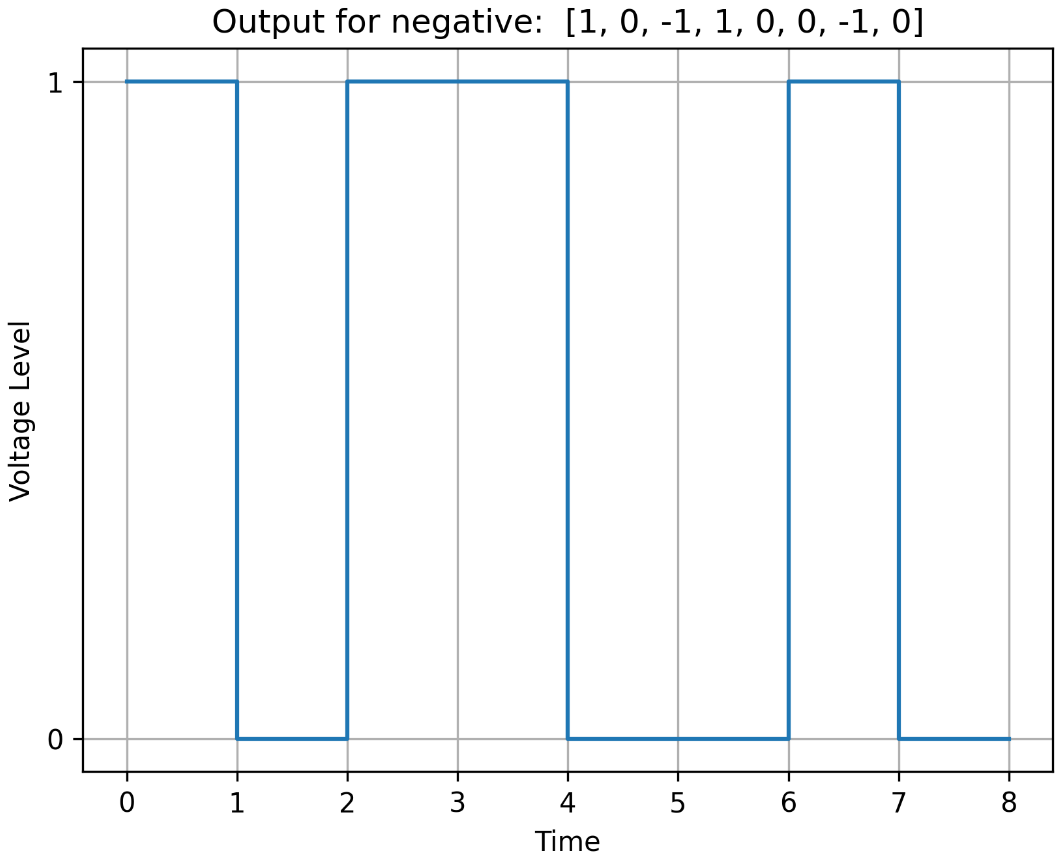

Figure 12: Waveform for AMI Decoding

Pseudo-Ternary Encoding Scheme:

Input: 1 0 1 1 0 0 1 0

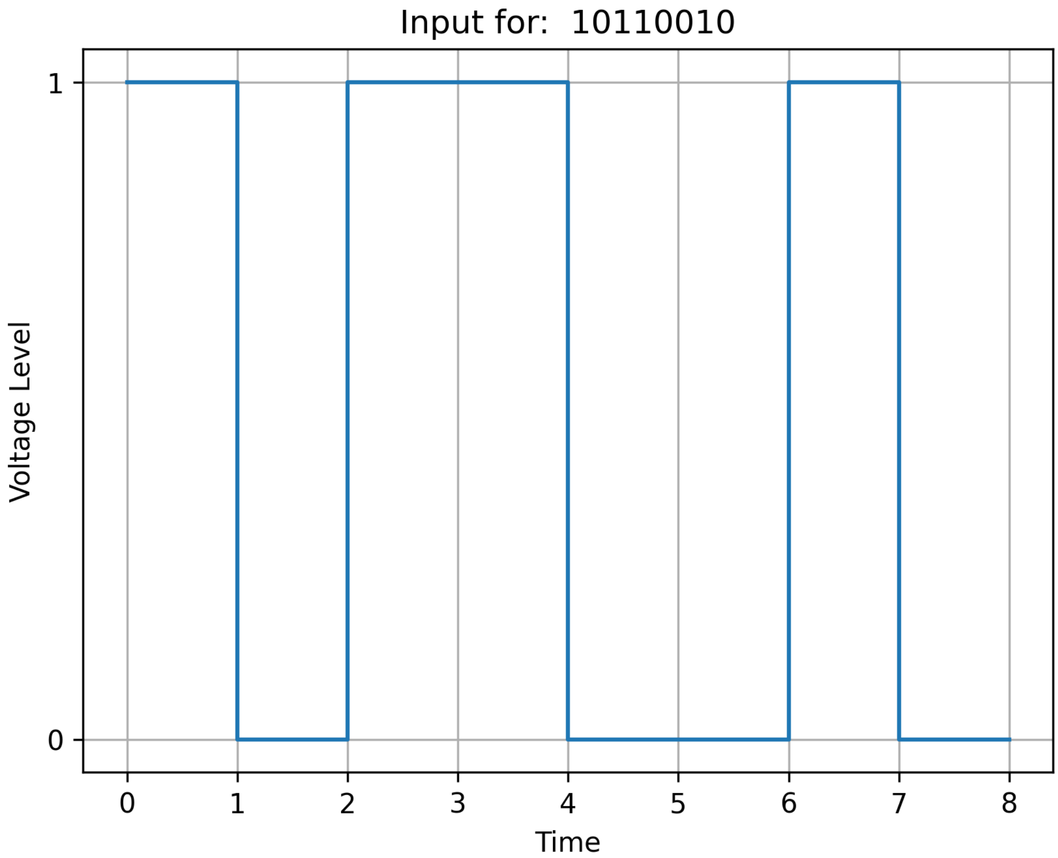

Figure 13: Waveform for Pseudo-Ternary Input

Encoding: 0 -1 0 0 1 -1 0 1

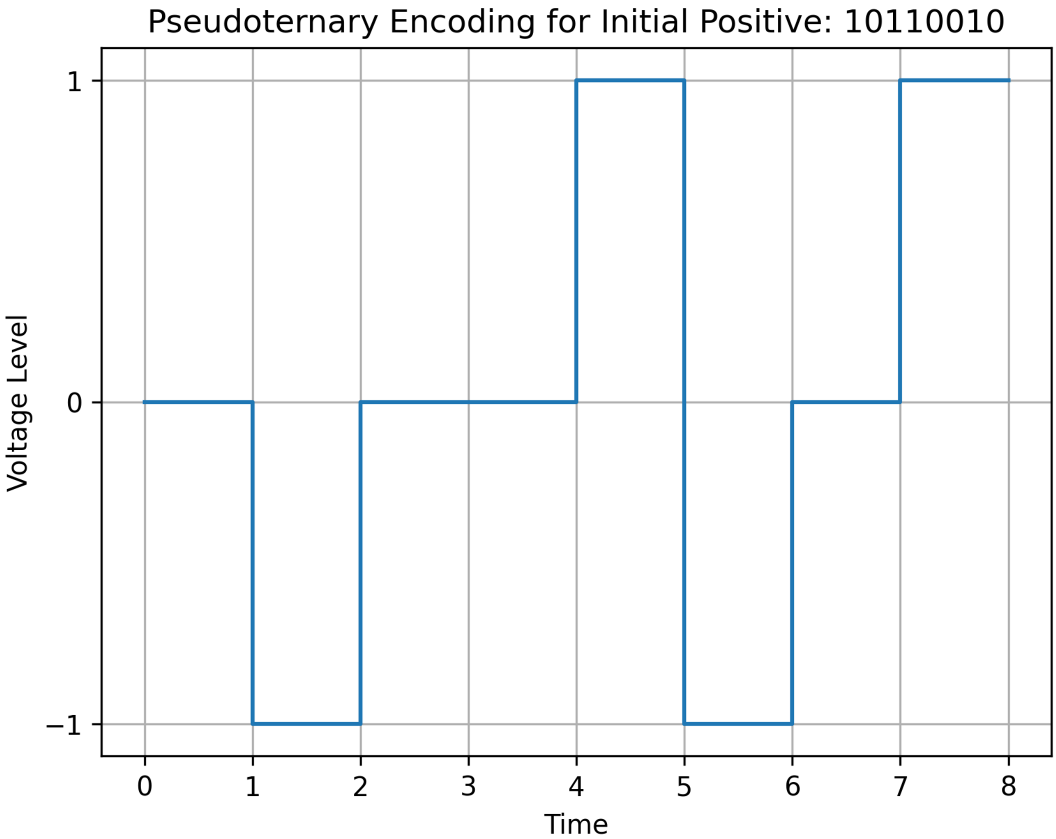

Figure 14: Waveform for Pseudo-Ternary Encoding

Output: 1 0 1 1 0 0 1 0

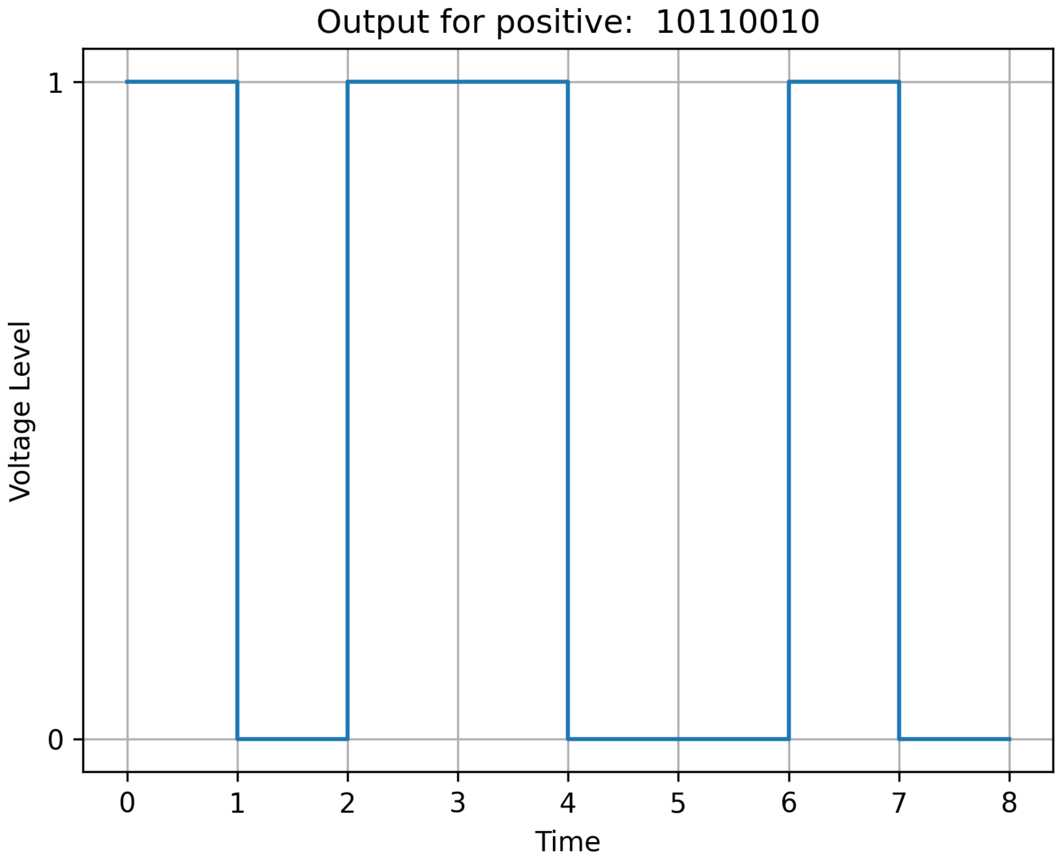

Figure 15: Waveform for Pseudo-Ternary Decoding

MLT-3 Encoding Scheme:

Input: 1 0 1 1 0 0 1 0

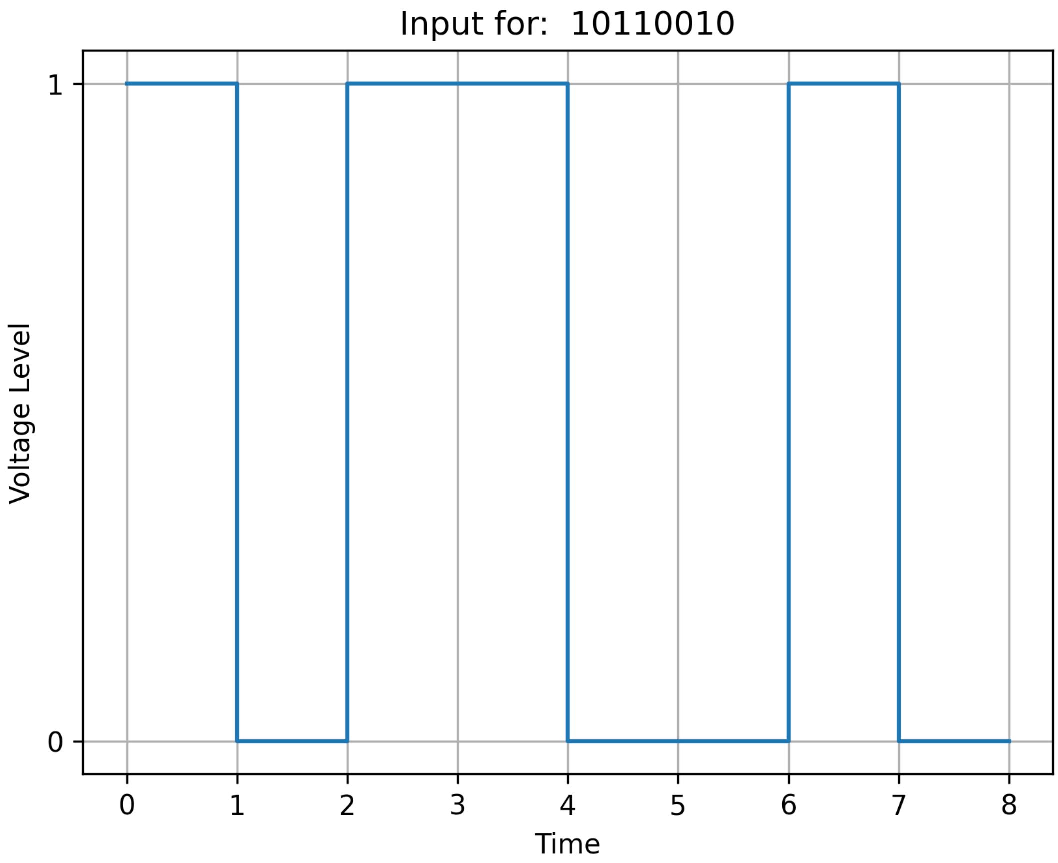

Figure 16: Waveform for MLT-3 Input

Encoding: 1 1 0 -1 -1 -1 0 0

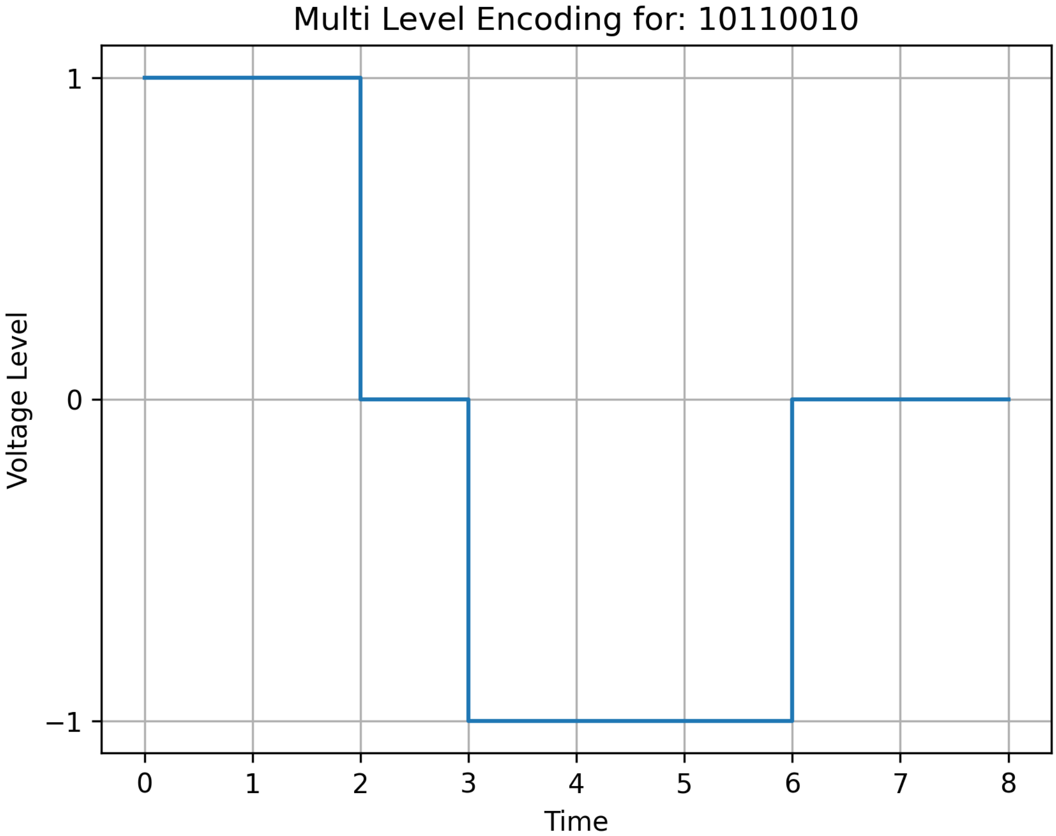

Figure 17: Waveform for MLT-3 Encoding

Output: 1 0 1 1 0 0 1 0

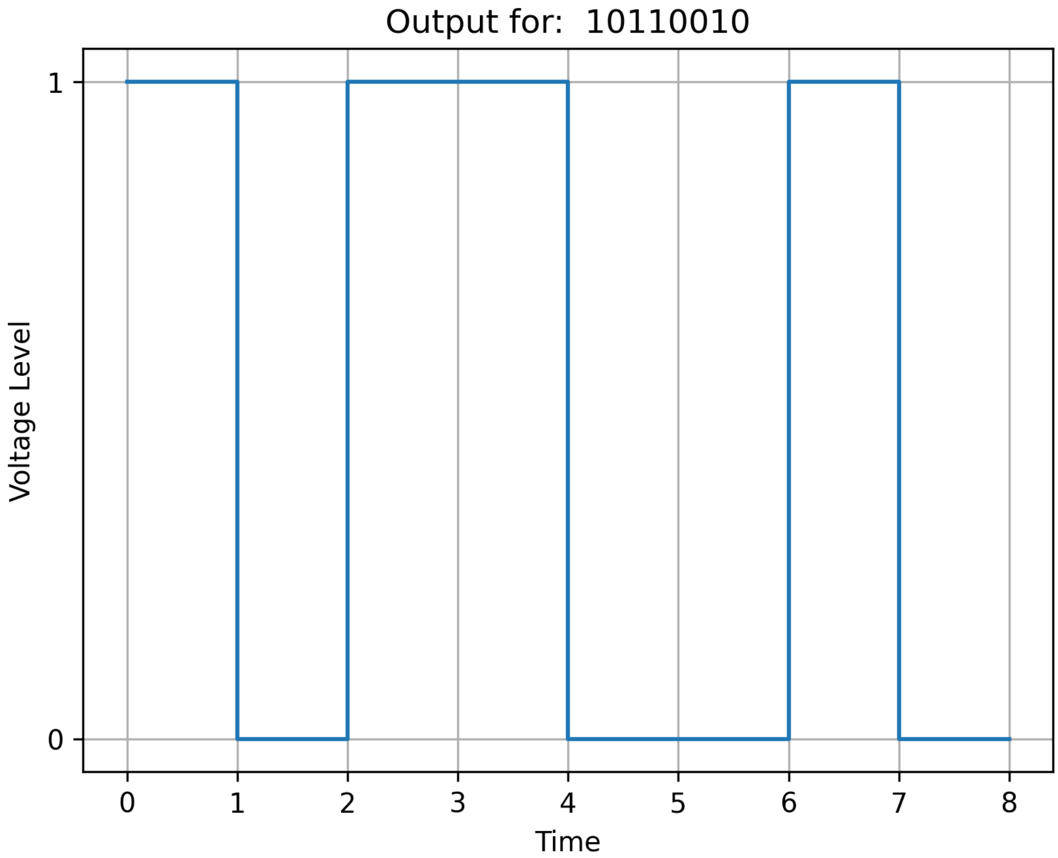

Figure 18: Waveform for MLT-3 Decoding

5. Learning and Difficulties

- Implementing polarity switching schemes (AMI, Pseudo-Ternary) required careful logic to maintain alternation.
- Manchester encoding was challenging due to mid-bit transitions.
- MLT-3 had the most complex level sequencing but was effective in reducing bandwidth.

6. Conclusion

In this lab, we successfully implemented and analyzed six encoding schemes. Each scheme offers a different trade-off between complexity, bandwidth efficiency, and signal synchronization. Understanding these encoding methods is fundamental in the design of digital communication systems.