

Digital Signal Generator - Specification Report

Course: Data Communication

Project Title: Digital Signal Generator

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Objective

To design and implement a Digital Signal Generator capable of simulating digital line coding schemes, scrambling methods, and analog-to-digital modulation techniques. The system allows users to input either digital or analog signals and visualize the corresponding encoded or modulated waveform graphically.

Language and Libraries Used

Programming Language: Java

GUI Framework: JavaFX (via JOGL-compatible plotting through LineChart)

Development Environment: IntelliJ IDEA

Key Packages: `javafx.application`, `javafx.scene.chart`, `javafx.scene.control`, `javafx.scene.layout`

Features Implemented

1. Line Coding Schemes: NRZ-L, NRZ-I, Manchester, Differential Manchester, and AMI.
2. Scrambling Techniques: B8ZS and HDB3 (applied over AMI).
3. Analog-to-Digital Modulation: Pulse Code Modulation (PCM) and Delta Modulation (DM).
4. Advanced Utilities: Longest palindromic substring detection (Manacher's Algorithm, $O(n)$); waveform-based decoding
5. Graphical Output: Real-time waveform plotting with amplitude visualization.

Assumptions and Conventions

- Differential Manchester: Mid-bit transition always; 0 = transition at start, 1 = no transition. (Initial polarity = LOW, IEEE 802.4 Biphase Space convention.)
- AMI Encoding: Alternating pulse polarity, starting with negative (-1).
- PCM Quantization: 8-bit uniform quantization used for analog sampling.
- Delta Modulation: Fixed step size $\Delta = \text{amplitude}/16$.

How to Run

1. Open the project in IntelliJ IDEA or any JavaFX-supported IDE.
2. Run the program via Launcher.java.
3. Choose the mode:
 - Digital Input -> enter bitstream -> select encoding scheme.
 - Analog Input -> enter parameters (e.g., freq=1;amp=1;duration=1;samples=50) -> choose PCM or DM.
4. If AMI is chosen, the program prompts for B8ZS/HDB3 scrambling.
5. Waveform and output appear instantly. Optionally select "Decode?" to reconstruct bitstream.

References

- Behrouz A. Forouzan, Data Communications and Networking, 5th Edition.
- William Stallings, Data and Computer Communications.
- IEEE 802.3 and IEEE 802.4 Physical Layer Encoding Standards.

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