# LAB 3 DIGITAL COMMUNICATION

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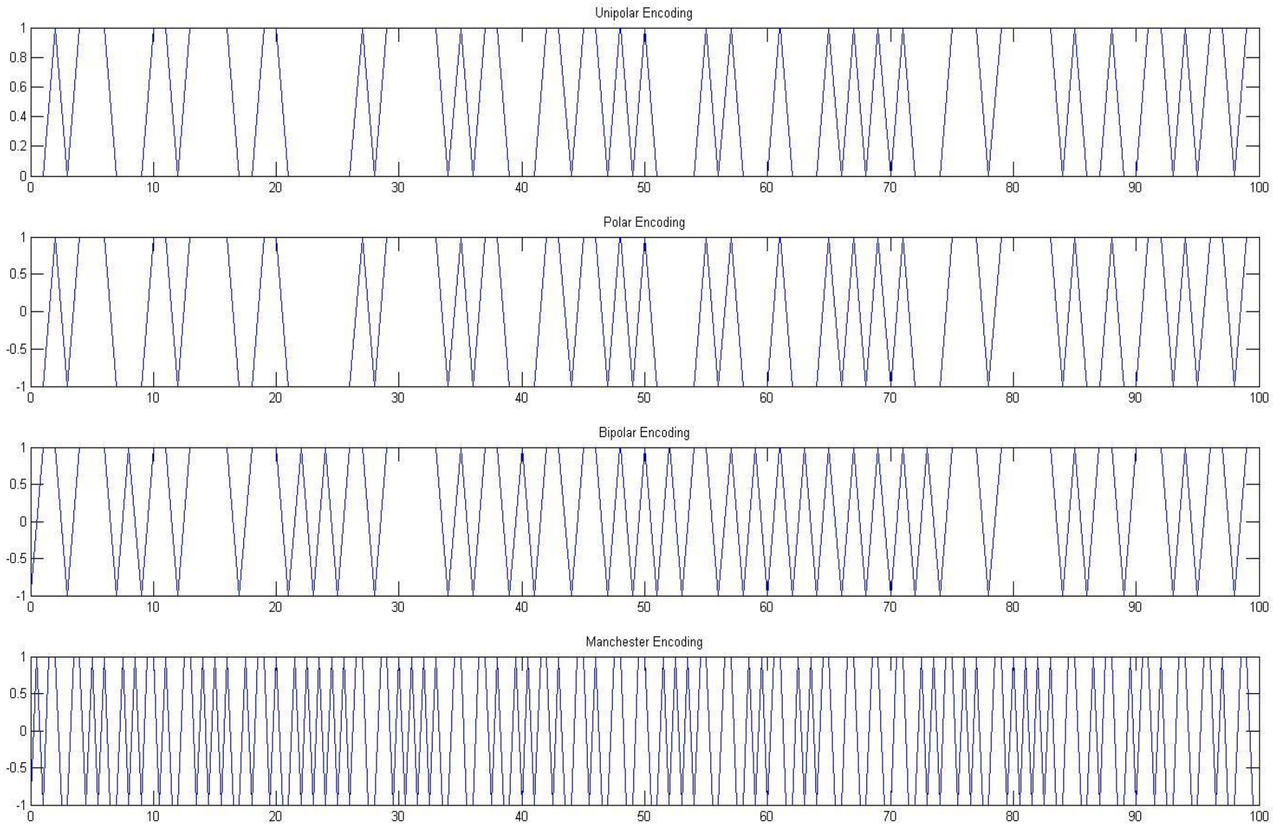
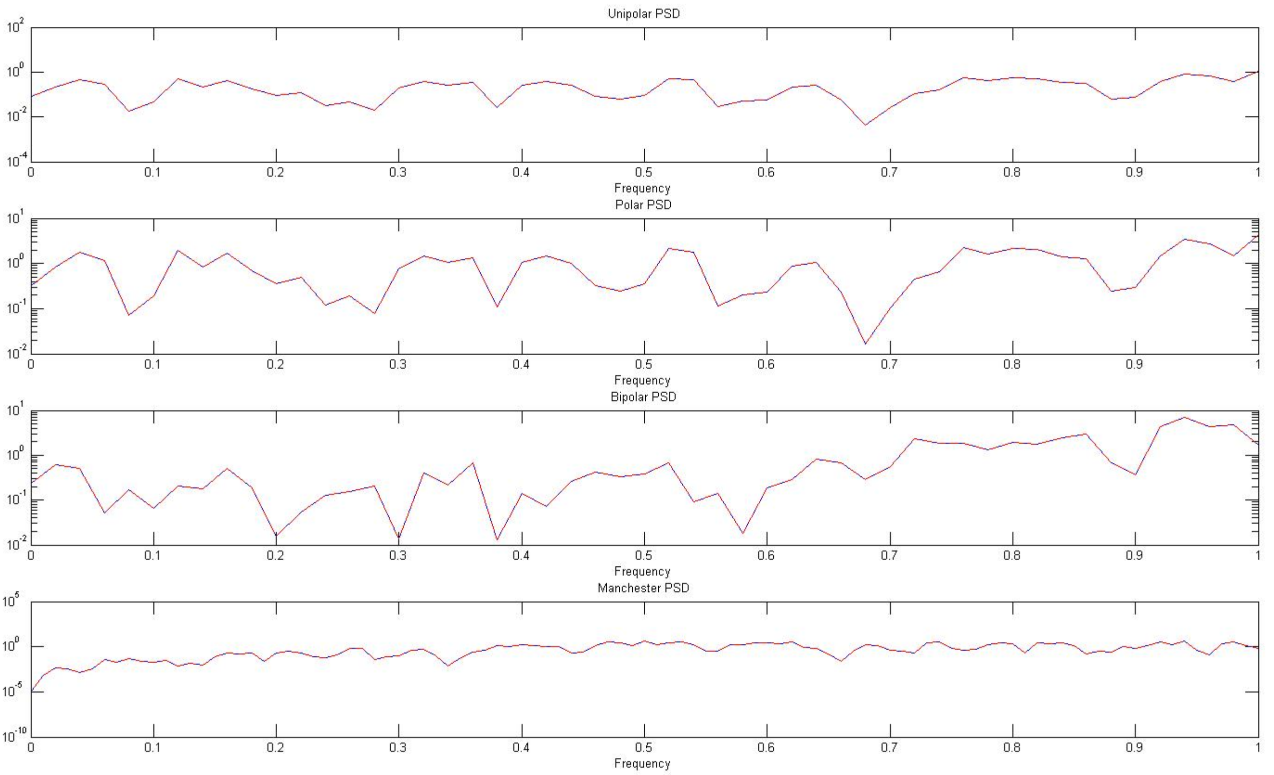
## MatLab Code:

```
% Generate random bits
N = 100; % number of bits
bits = randi([0 1], N, 1);

% Define time vector with Ts = 1
t = 0:N-1;
halfT = 0:0.5:N-0.5;

% Unipolar encoding
unipolar = bits;

% Polar encoding
polar = bits;
polar(polar==0) = -1;

% Bipolar encoding
bipolar = bits;
for i = 1:N
    if bipolar(i) == 0
        bipolar(i) = -1;
        if i > 1 && bipolar(i-1) == -1
            bipolar(i) = 1;
        end
    end
end

% Manchester encoding
manchester = [];
for i = 1:N
    if bits(i) == 0
        manchester = [manchester -1 1];
    else
        manchester = [manchester 1 -1];
    end
end

% Plotting the modulation signals
figure;
subplot(4,1,1);
plot(t, unipolar);
title('Unipolar Encoding');
subplot(4,1,2);
plot(t, polar);
title('Polar Encoding');
subplot(4,1,3);
plot(t, bipolar);
title('Bipolar Encoding');
subplot(4,1,4);
plot(halfT, manchester);
title('Manchester Encoding');

% Calculating the power spectrum density
figure;
subplot(4,1,1);
spectrum(unipolar);
title('Unipolar PSD');
subplot(4,1,2);
spectrum(polar);
title('Polar PSD');
subplot(4,1,3);
spectrum(bipolar);
title('Bipolar PSD');
subplot(4,1,4);
spectrum(manchester);
title('Manchester PSD');
```


Unipolar Encoding
Polar Encoding
Bipolar Encoding
Manchester Encoding


Unipolar PSD
Frequency
Polar PSD
Frequency
Bipolar PSD
Frequency
Manchester PSD
Frequency

| LINE CODE | TRANSMITTED BANDWIDTH |
|---|---|
| **Unipolar NRZ** | $R_b$ |
| **Polar NRZ** | $R_b$ |
| **Bipolar RZ** | $R_b$ |
| **Manchester** | $2R_b$ |

## 1. Unipolar NRZ:

**Advantages:**

- Simple to implement.
- Efficient use of bandwidth since there are no signal transitions for consecutive 1s or 0s.

**Disadvantages:**

- Suffers from baseline shift, where long runs of 0s or 1s can cause DC offset in the signal.
- Not suitable for long-distance transmission due to signal attenuation and distortion.

## 2. Polar NRZ:

**Advantages:**

- No baseline shift as the signal alternates between positive and negative values.
- Efficient use of bandwidth like UNIPOLAR NRZ.

**Disadvantages:**

- Like UNIPOLAR NRZ, it is not suitable for long-distance transmission.

## 3. BIPOLAR RZ:

**Advantages:**

- Has no DC component, which eliminates the problem of baseline shift.
- Better suited for long-distance transmission compared to NRZ encoding since there are more signal transitions, which help to recover the clock and maintain synchronization.

**Disadvantages:**

- Uses twice the bandwidth of NRZ encoding, which can be a limitation in high-speed applications.
- Can suffer from intersymbol interference (ISI) due to overlapping pulses.

## 4. MANCHESTER:

**Advantages:**

- Has a guaranteed transition in the middle of each bit, which helps maintain synchronization and improves error detection.

- Efficient use of bandwidth compared to some other encoding techniques.

**Disadvantages:**

- Uses twice the bandwidth of NRZ encoding since each bit is represented by two signal transitions.
- Can be sensitive to clock synchronization errors.

## Two other commonly used line codes are:

5. AMI (Alternate Mark Inversion): In this encoding technique, the signal alternates between positive and negative values for consecutive 1s, and a 0 is represented by no signal. The advantage of this technique is that it has no DC component and uses bandwidth efficiently. However, it suffers from the problem of baseline shift for long runs of 0s or 1s.
6. B8ZS (Bipolar with 8 Zero Substitution): This technique is like BIPOLAR RZ but includes a special substitution rule to replace long runs of 0s with a specific pattern to maintain synchronization. The advantage of this technique is that it provides a DC-balanced signal, which eliminates the problem of baseline shift. However, it is more complex to implement and requires additional overhead to handle the special substitution rule.