EXPERIMENT – 9

DIFFERENTIAL PHASE SHIFT KEYING (DPSK)

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Aim:

To implement Binary Differential Phase Shift Keying (B-DPSK) on a randomly generated binary message sequence, demodulate the noisy modulated signal, and compare it with the original message. Additionally, generate plots for various stages of the modulation and demodulation process.

Theory:

PHASE SHIFT KEYING (PSK):

PSK is a digital modulation technique where the phase of the carrier signal is varied in accordance with the message signal.

DIFFERENTIAL PHASE SHIFT KEYING (DPSK):

In DPSK, instead of transmitting the absolute phase of the carrier, the information is conveyed by the phase difference between consecutive bits.

- **No reference signal** is required for demodulation.
- Reduces the complexity of the receiver design.
- However, **error propagation** may occur during demodulation.

BINARY DPSK (B-DPSK):

- Consecutive bits with the same value → No phase change.
- Opposite bits → Phase shift of π (180°).
- The first bit is treated as a reference.

Modulation and Demodulation Logic:

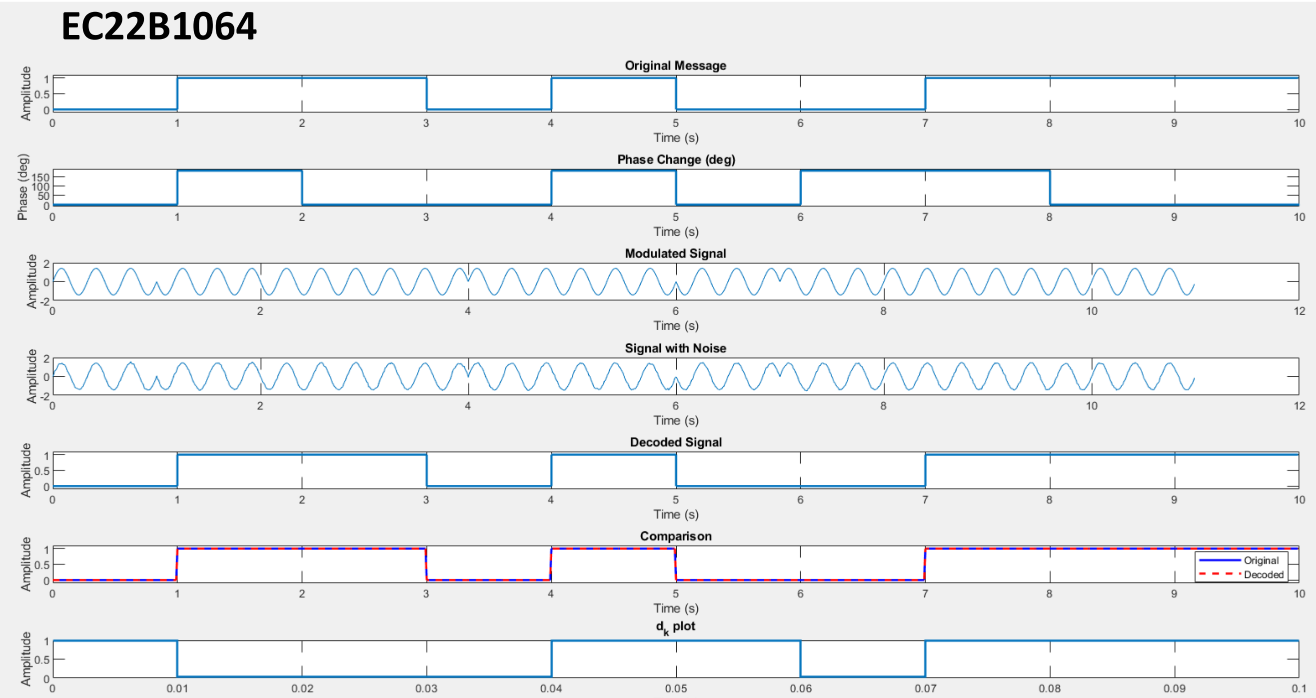
- A differential encoder encodes the input message sequence.
- At the receiver, the decoder compares the current phase with the previous phase to decode the original message.

Q)Performing Binary Differential Phase Shift Keying(B-DPSK) on random message singal, demodulating the signal, performing the same operations on a noisy signal and showing the plots

```
N_bits = 10;
Fs = 100;
T = 1;

t_mod = 0:1/Fs:(N_bits+1)*T-1/Fs;
t_msg = 0:1/Fs:N_bits*T-1/Fs;

mk = [0 1 1 0 1 0 0 1 1 1];
d = zeros(1, N_bits+1);
d(1) = 1;

for k = 1:N_bits
    if mk(k) == 0
        d(k+1) = ~d(k);
    else
        d(k+1) = d(k);
    end
end

signal = ones(size(d));
signal(d==0) = -1;


phase = zeros(size(d));
phase(1) = 0;
for k = 2:length(d)
    if d(k) ~= d(k-1)
        phase(k) = 180;    % 180° change when bit flips
    else
        phase(k) = 0;      % No change when bit stays same
    end
end


fc = 3;
norm = sqrt(2/T);
carrier = norm * sin(2*pi*fc*t_mod);
mod_signal = repelem(signal, Fs*T) .* carrier;


snr = 25;
noisy_signal = awgn(mod_signal,snr, 'measured');

demod = noisy_signal .* carrier;
integrated = sum(reshape(demod, Fs*T, []))/(Fs*T);
received = ones(size(integrated));
received(integrated < 0) = 0;
```

```
decoded = zeros(1, length(received)-1);
for k = 1:length(decoded)
    if received(k+1) == received(k)
        decoded(k) = 1;
    else
        decoded(k) = 0;
    end
end

msg_plot = repelem(mk, Fs*T);
dec_plot = repelem(decoded, Fs*T);
phase_plot = repelem(phase, Fs*T);

figure
subplot(7,1,1)
stairs(t_msg, msg_plot,'LineWidth', 1.5)
title('Original Message')
xlabel('Time (s)')
ylabel('Amplitude')
ylim([-0.1 1.1])

subplot(7,1,2)
stairs(t_mod, phase_plot,'LineWidth', 1.5)
title('Phase Change (deg)')
xlabel('Time (s)')
ylabel('Phase (deg)')
ylim([-10 190])
xlim([0 10])

subplot(7,1,3)
plot(t_mod, mod_signal)
title('Modulated Signal')
xlabel('Time (s)')
ylabel('Amplitude')

subplot(7,1,4)
plot(t_mod, noisy_signal)
title('Signal with Noise')
xlabel('Time (s)')
ylabel('Amplitude')

subplot(7,1,5)
stairs(t_msg, dec_plot(1:N_bits*Fs*T), 'LineWidth', 1.5)
title('Decoded Signal')
xlabel('Time (s)')
ylabel('Amplitude')
ylim([-0.1 1.1])

subplot(7,1,6)
plot(t_msg, msg_plot, 'b', t_msg, dec_plot(1:N_bits*Fs*T), 'r--', 'LineWidth', 1.5)
legend('Original', 'Decoded')
title('Comparison')
xlabel('Time (s)')
ylabel('Amplitude')
ylim([-0.1 1.1])
```

```
subplot(7,1,7)
stairs(t_msg(1:length(d)),d, 'LineWidth',1.5);
xlabel("Time (s)")
ylabel("Amplitude")
title("d_k plot")

disp(d);
```



Inference:

Differential encoding in B-DPSK allows demodulation without a reference phase, which simplifies receiver circuitry. Noise can still impact phase differences between bits, potentially causing bit errors due to error propagation, especially at very low SNRs. However, it provides a robust alternative to conventional PSK for systems where carrier phase synchronization is difficult.

Conclusion:

The experiment successfully demonstrates B-DPSK modulation and demodulation. The decoded output matches the original message with slight variations in the presence of noise. B-DPSK is particularly useful in scenarios where coherent detection is not feasible, offering simplified receiver design at the cost of occasional error propagation.

References:

[1] Simon Haykins, Communication systems, 2nd ed. (New York John Wiley and Sons, 2005).