Heaven's Light is Our Guide
Rajshahi University of Engineering and Technology

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Lab Report 4:
Study of Time Division Multiplexing (TDM) & De-multiplexing

Submitted to	**Submitted by**
Dr. Md. Kamal Hosain	Md. Tajim An Noor
Professor	Roll: 2010025
Dept of ETE, RUET	

Contents

Study of Time Division Multiplexing (TDM) & De-multiplexing

Theory

Time Division Multiplexing (TDM) allows multiple message signals to share a common communication channel by dividing time into slots, each allocated to a different signal [1]. This technique maximizes bandwidth utilization by ensuring each signal gets a dedicated time slot for transmission. Initially, each message signal is filtered to limit its bandwidth, preventing interference with other signals. The signals are then sampled at a rate slightly higher than the Nyquist rate to avoid aliasing and ensure accurate reconstruction at the receiver [2].

The sampled signals are interleaved in time by a commutator, assigning each sample to a specific time slot. This interleaving allows simultaneous transmission of multiple signals over a single channel without interference. At the receiver, a decommutator separates the interleaved samples, assigning them back to their respective message signals [3].

Reconstructing the original message signals from the separated samples is achieved using low-pass filters that smooth out the samples and recreate the continuous-time signals. Synchronization between the commutator and decommutator is essential for proper TDM functioning. Any misalignment can lead to errors in the reconstructed signals, making synchronization mechanisms critical [4]. Overall, TDM is a powerful technique enabling efficient and reliable communication in various applications, including telecommunications and data networks.

Required Apparatus

- TDM Pulse Amplitude Modulation/Demodulation Kit
- Oscilloscope
- Connecting Wires
- Power Supply

Diagrams

Block Diagram of TDM System

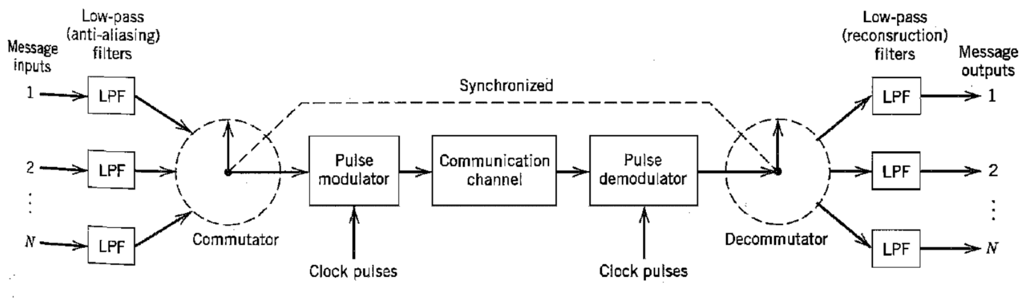

Figure 1: Block Diagram of TDM System [3]

Circuit Connection of the Kit

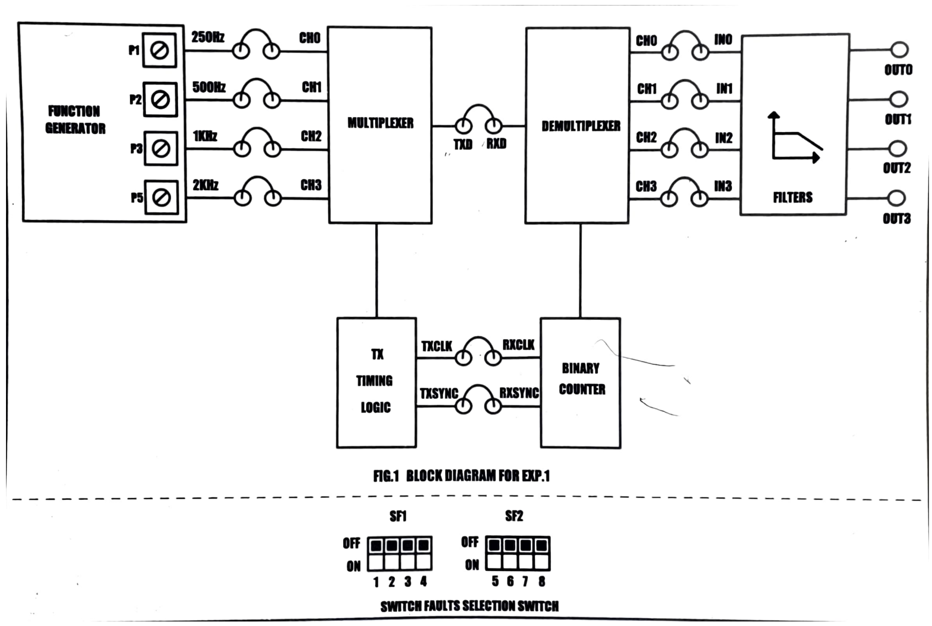

Figure 2: Circuit Connection of the TDM Kit

Procedure

1. The TDM pulse amplitude modulation/demodulation kit was set up and connected to the power supply.

2. The oscilloscope was connected to the output ports of the kit to visualize the signals.

3. The kit was configured to use 5 sources for the TDM process.
4. 4 different signals were selected from the available sources.
5. The selected signals were passed through the multiplexer on the kit.
6. Observe the output message at different ports using the oscilloscope.
7. Record the observations and ensure the signals are correctly multiplexed and de-multiplexed.

Experimental Data

Signal Number	Frequency (Hz)
1	250
2	500
3	1000
4	2000

Table 1: Message Signal Frequencies

Observation

1. The message signal was observed using the oscilloscope.
2. The multiplexed signal was visualized on the oscilloscope.
3. The de-multiplexed signal was also observed using the oscilloscope.
4. Finally, the output message signal was checked using the oscilloscope.
5. Some faults in the kit were noted, so the outputs were not accurate.

Matlab Simulation

Code:

```
% Parameters
fs = 10000;           % Sampling frequency
t = 0:1/fs:0.01;      % Time vector for 10 ms
frequencies = [250, 500, 1000, 2000]; % Frequencies of input signals
num_signals = length(frequencies);     % Number of input signals

% Generate input signals
input_signals = zeros(num_signals, length(t));
```

```
for i = 1:num_signals
    input_signals(i, :) = sin(2 * pi * frequencies(i) * t);
end

% TDM Multiplexing
multiplexed_signal = reshape(input_signals, 1, []);

% TDM Demultiplexing
demultiplexed_signals = reshape(multiplexed_signal, num_signals, []);

% Plotting
figure;

% Plot input signals
subplot(3,1,1);
hold on;
for i = 1:num_signals
    plot(t, input_signals(i, :));
end
title('Input Signals');
xlabel('Time (s)');
ylabel('Amplitude');
legend('250 Hz', '500 Hz', '1 kHz', '2 kHz');
hold off;

% Plot multiplexed signal
subplot(3,1,2);
plot(0:1/fs:(length(multiplexed_signal)-1)/fs, multiplexed_signal);
title('Multiplexed Signal');
xlabel('Time (s)');
ylabel('Amplitude');

% Plot demultiplexed signals
subplot(3,1,3);
hold on;
for i = 1:num_signals
    plot(t, demultiplexed_signals(i, :));
end
title('Demultiplexed Signals');
xlabel('Time (s)');
ylabel('Amplitude');
legend('250 Hz', '500 Hz', '1 kHz', '2 kHz');
hold off;
```

Output

Experimental Output

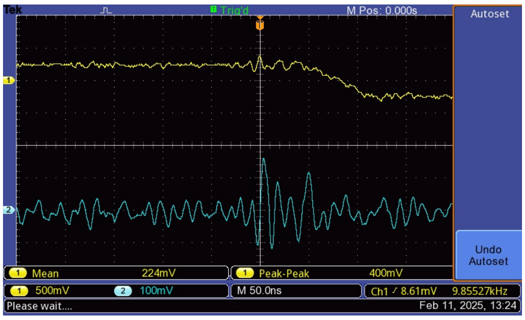

Figure 3: Message (Yellow) and Faulty Output Message (Blue)

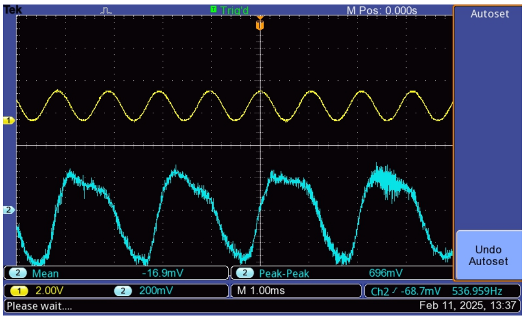

Figure 4: Message (Yellow) and Output Message (Blue)

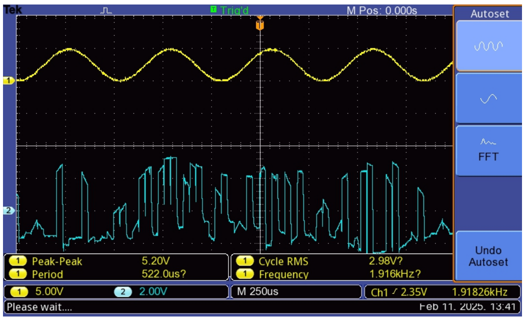

Figure 5: Message (Yellow) and Multiplexed Signal (Blue)

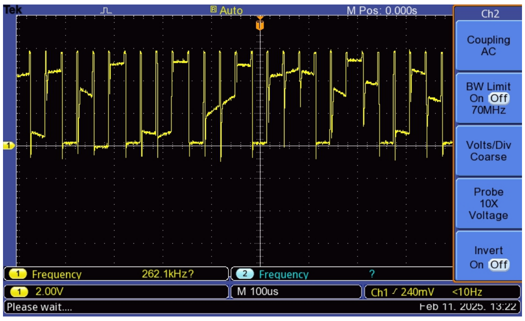

Figure 6: Only Multiplexed Signal (Blue)

Matlab Simulation Output

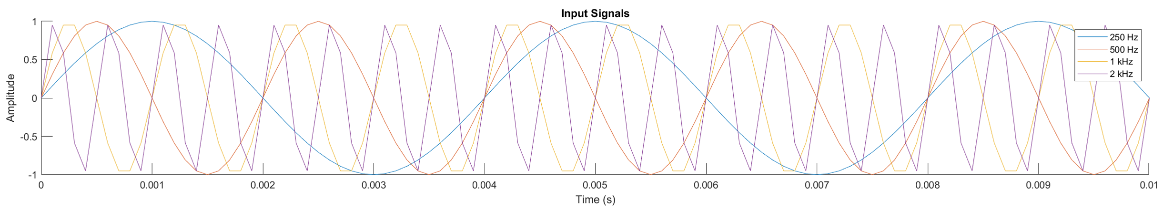

Figure 7: Message Signal

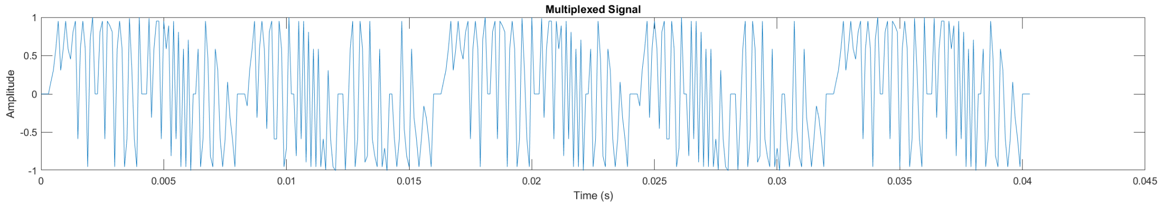

Figure 8: TDM Multiplexed Signal

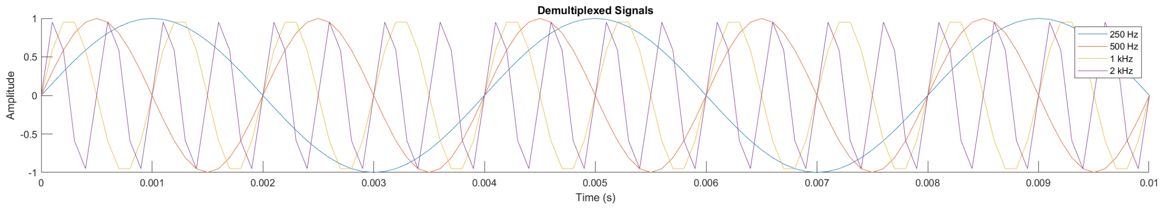

Figure 9: Output Message Signal

Discussion and Conclusion

In this experiment, we explored the principles and practical implementation of Time Division Multiplexing (TDM) and De-multiplexing. Using a TDM Pulse Amplitude Modulation/Demodulation Kit and an oscilloscope, we observed the multiplexing and de-multiplexing processes. The oscilloscope visualized the signals at various stages, and despite some inaccuracies due to faults in the kit, the experiment effectively demonstrated the fundamental concepts of TDM. The Matlab simulation provided additional insights, with the simulation output aligning with theoretical expectations.

In conclusion, this experiment offered valuable insights into TDM and its practical applications. The combination of theoretical study, hands-on experimentation, and Matlab simulation provided a comprehensive understanding of the topic. Future experiments could focus on addressing the kit's faults for more accurate results and exploring advanced TDM techniques for complex communication systems.

References

[1] J. G. Proakis and M. Salehi, *Digital Communications*, 5th ed. McGraw-Hill, 2008.

[2] A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, *Signals and Systems*, 2nd ed. Prentice Hall, 1996.

[3] S. Haykin and M. Moher, *Communication Systems*, 5th ed. Wiley, 2009.

[4] B. Sklar and F. Harris, *Digital Communications: Fundamentals and Applications*, 2nd ed. Prentice Hall, 2001.