EE 257 – Signals & Systems

Basic Operation of a Spectrum Analyzer and Time – Frequency Domain Conversion of Signals

- **In This laboratory task you will need to use the knowledge that you should have gathered in the pre – lab preparation and in the discussion section of this lab experiment. Individual assessment will be done and active participation during the lab experiment will carry marks.**

OBJECTIVES :

1. **To gain an understanding about the basic functioning of a swept frequency spectrum analyzer.**
2. **To understand how time- frequency domain conversion is performed.**
3. **To observe the frequency contents of different types of time domain signals.**

TIME ALLOCATED : **Three hours**

EQUIPMENT : **Tektronix MDO3014 Mixed Domain Oscilloscope - 1**

Function Generator – 1

DISCUSSION :

You should be able to clearly explain the below points at the end of this discussion.

1. **Basic architecture of a swept – tuned spectrum analyzer.**
2. **Purpose of the individual components of the mixed domain oscilloscope shown in Figure 1.**
3. **Describe the possible adjustments that can be performed using the components of the spectrum analyzer depicted Figure 1.**
4. **Describe the overall operation of the spectrum analyzer using an example.**

PROCEDURE

1. Laboratory Task 1 – Basic Operation of a Spectrum Analyzer

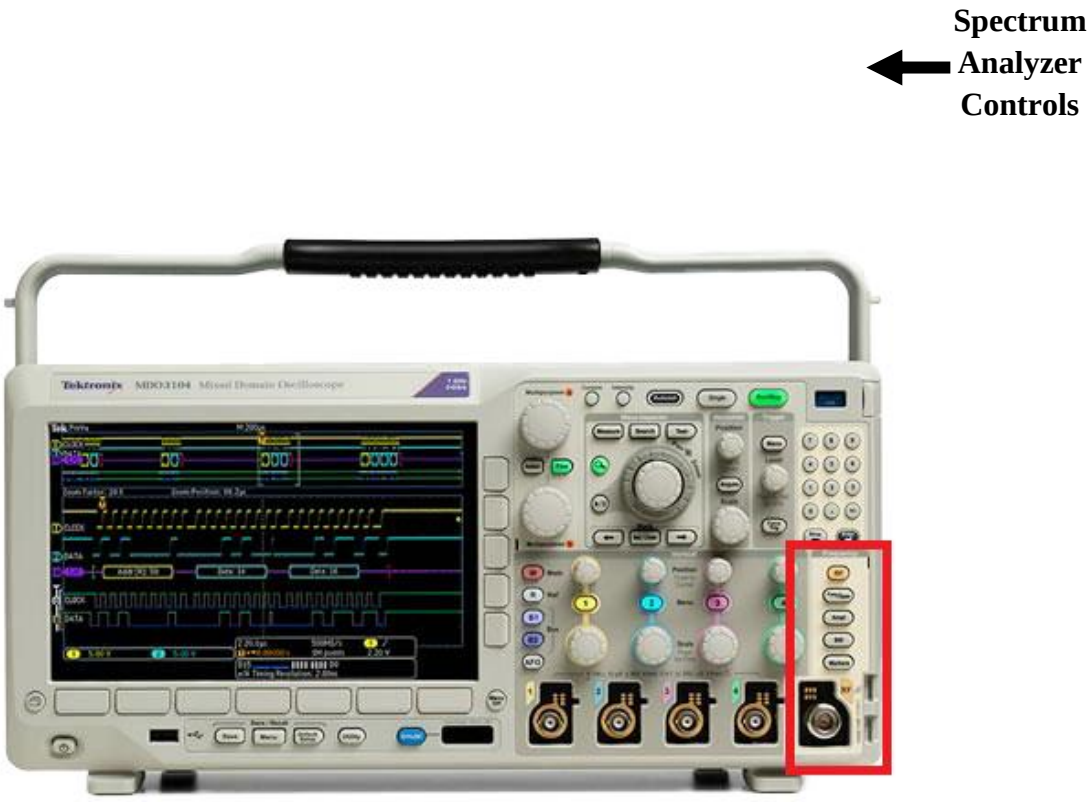

Figure 10: Front Panel of the Tektronix MDO3014 mixed domain oscilloscope

I. Reading Amplitude and Frequency
(Basic spectrum analyzer measurement of a signal)

- Turn on the spectrum analyzer by pressing the power **ON** button. Wait for the power up process to complete.
- Feed a sinusoidal signal of 1 V peak-to-peak amplitude and 1 MHz frequency to the spectrum analyzer using the function generator.

- Press the **FREQ/SPAN** key on the spectrum analyzer controls to open the Frequency & Span window.
- Set the **Center Frequency** to 1 MHz and **Span** to 0.1 MHz using the keys on the front panel.
- Press the **AMPL** key on the spectrum analyzer controls to open the Amplitude window.
- Set the **Ref Level** to 0.00 dBm, the **Vertical** to 0.00 div and 10.0 dB/div, and **Scale** to dBm.
- Use the **MARKERS** key to open the markers window.
- Identify the operation of **Peak Values** and **Manual Marker** controls.
- Using above options measure the frequency and the amplitude of the peak.

Discussion Question 1 – Discuss the operation of the **FREQ/SPAN** and **AMPL** functions using your knowledge about the spectrum analyzer.

II. Use of the **Resolution band width (RBW)** setting.
(Resolving two signals of approximately equal amplitude and small frequency separation)

In this task, AM modulation function of the function generator is initially used to generate signals that have a small frequency separation and approximately equal amplitudes. .

- Set the carrier signal to be 100 kHz sinusoidal signal with a peak to peak voltage of 2 V using the first function generator.
- Set the modulating signal frequency to 5 kHz.
- Observe the spectrum of the resulting signal using the spectrum analyzer (It should have three peaks of equal height).
- Press **BW** key on the spectrum analyzer controls to open the Bandwidth window.
- Now, change the **RBW Mode** to **Manual**.
- Then observe the spectrum of the signal with different resolution band widths (Note that you cannot observe the accurate shape of the spectrum with three spikes in some cases).
- Adjust the resolution bandwidth using the **RBW** control located in the front panel until the correct (with the expected shape) form of the spectrum can be observed.

Discussion Question 2 –

I. Discuss the reason for the difference in the spectrums that you observed for different resolution bandwidth settings.

II. Explain the internal functioning of the **RBW** settings from the knowledge that you have gained in the discussion.

III. Explain the advantages and disadvantages of using a small and large resolution bandwidth using your knowledge about the spectrum analyzer.

2. Laboratory Task 2 – Time - Frequency Conversion and Frequency Content of Signals.

Use the knowledge that you have gathered from previous section of the laboratory session and use that knowledge effectively in this section.

I. Fourier series of a **square wave** and effect of duty ratio.

- Generate a square wave (symmetric) of T = 10 µs and 1V peak to peak using the given function generator.
- Connect that signal to the spectrum analyzer and observe the output after making the necessary adjustments.
- Then change the duty ratio of the square wave and observe the spectrums for duty ratio values of 0.5, 0.1 and infinity.
- Then set the duty ratio back to the standard value 0.5) and observe the spectrums for T = 10 µs, 5 µs and 2 µs.

Discussion Question 1 –

I. Explain reason for your observation when changing duty ratio.
II. Explain the reason for your observations when changing the frequency of the square wave.

II. Fourier series of a **Triangular wave**.

- Generate a triangular wave of a 500 Hz signal using the given function generator.
- Observe the spectrum of the signal using the spectrum analyzer (Make the necessary configuration changes).