ECE 351

EXPERIMENT EM4
THE SPECTRUM ANALYZER AND SPECTRAL CONTENT

OBJECTIVE: The purpose of this experiment is to introduce the student to the spectrum analyzer and to demonstrate the activity in the radio spectrum that can be observed with the spectrum analyzer.

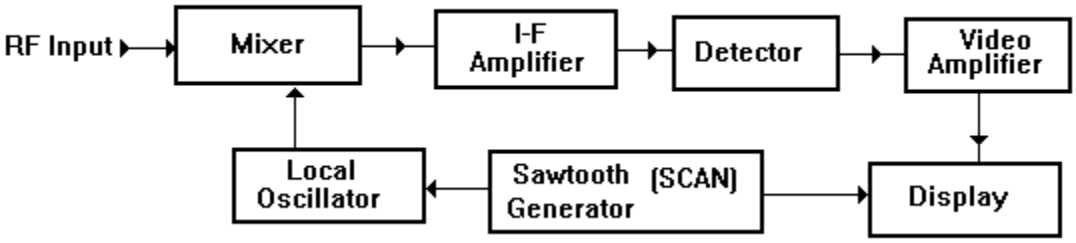
EQUIPMENT: Agilent E4402B Spectrum Analyzer
Connectors and Clip Leads
EMCO 6512 Passive Loop Antenna

I. INTRODUCTION TO THE SPECTRUM ANALYZER:

The Agilent E4402B Spectrum Analyzer is capable of effectively displaying frequencies from 9 kHz to 3000 MHz. This section briefly describes the operation of the spectrum analyzer.

A. OVERVIEW OF OPERATION OF SPECTRUM ANALYZER

A conventional spectrum analyzer is a superheterodyne receiver which has a local oscillator that mixes with the incoming RF signal. When the result of this frequency mixing falls within the bandwidth of the I-F (intermediate frequency) amplifier, the signal is passed on to the detector, video amplifier and display. The frequency of the LO (local oscillator) is varied by some sort of sawtooth voltage. An approximate block diagram is shown below:



B. FREQUENCY SELECTION:

At the top-left corner of the spectrum analyzer is the ‘FREQUENCY’ button. This button controls what frequency is CENTERED on the display.

C. SCAN WIDTH PER DIVISION:

The ‘SPAN’ button below the ‘Frequency’ button controls how much of the radio spectrum appears on the display. For example, if the ‘SPAN’ is set to 100 MHz,

the display will show 50 MHz to the left and 50 MHz to the right of whatever frequency is set as the center frequency.

D. BANDWIDTH:

The ‘BW/Avg’ (BW) button controls the pass band inside the spectrum analyzer, (i.e. the bandwidth of the intermediate frequency amplifier), and how much of a signal appears on the display.

E SCAN TIME PER DIVISION:

The ‘Sweep’ button controls how fast the spectrum analyzer sweeps the spectrum and determines how fast the trace sweeps across the display. AVOID scanning at fast speeds.

II. OBSERVING SPECTRAL CONTENT:

Turn on the spectrum analyzer, while following the cautions previously stated. The table below will help you to understand the requirements that follow.

Requirements	Step	Prominent Stations	Center Freq	Span	Res BW	Video BW	Name/ Type of the Live stations
DC Marker			25 MHz	100 MHz			
Frequency Modulation (FM)	Step 1		100 MHz	200 MHz			
	Step 2		100 MHz	6 MHz			
	Step 3	F1		136 kHz			
		F2		136 kHz			
		F3		136 kHz			
Amplitude Modulation (AM)	Step 1		1 MHz	2 MHz			
	Step 2	A1		136 kHz			
		A2		136 kHz			

A. DC Marker:

Find the DC Marker using the following settings:

CENTER FREQUENCY(FREQUENCY button): 25 MHz
SPAN (SPAN button): 100 MHz

Notes:

- There is a marker to indicate the zero Hertz reference (DC) which will appear if the trace sweep is set to include 0 Hz. Any spectrum appearing to left of the DC marker is essentially a mirror image of the spectrum to the right of the marker.

- Please DO NOT apply a DC signal to the spectrum analyzer because of the low input impedance. Also, please DO NOT apply an AC signal with more than 0.22 Vrms (0.3 V-pk) without padding the input.

Observation:

- Observe the DC marker appearing as a spike in the spectrum. The settings given above are initial settings only. Save the spectrum for your report by taking a snapshot using your smartphone or camera.

- Record your settings: Center frequency, Span, Resolution bandwidth (under the BW/Avg button) and Video bandwidth (under the BW/Avg button).

B. Frequency Modulation (FM):

Notes:

- Connect a flexible wire antenna with the BNC connector to the 'RF INPUT' terminal of the Spectrum analyzer. You should see several signals displayed.

- The BANDWIDTH and SCAN TIME are automatically selected by the spectrum analyzer.

Step 1:

Find the radio spectrum from 0 to 200 MHz:
CENTER FREQUENCY MHz: 100 MHz
SPAN: 200 MHz

Observation:

- Observe the radio spectrum from 0 to 200 MHz. Save the spectrum for your report by taking a snapshot using your smartphone or camera.

- Record your settings: Center frequency, Span, Resolution bandwidth (under the BW/Avg button) and Video bandwidth (under the BW/Avg button).

Step 2:

Find the radio spectrum from 97 to 103 MHz:
CENTER FREQUENCY: 100 MHz
SPAN: 6 MHz

Observation:

- Observe the radio spectrum from 97 to 103 MHz. Use the marker button to note the frequency of the three most prominent signals (F1, F2, and F3)

- Record your settings: Center frequency, Span, Resolution bandwidth (under the BW/Avg button) and Video bandwidth (under the BW/Avg button).

Step 3:

Find the three most prominent signals (F1, F2, and F3)
CENTER FREQUENCY: F1, F2, or F3 MHz
SPAN: 136 kHz

Notes:

- Set the center frequency of the spectrum analyzer to one of the prominent signals recorded in step 2. Then set the span to approximately 136 kHz. Next, press the Det/Demod button and select the Demod option from the screen. Then select FM demodulation and make sure the speaker in the same menu is on. Increase the volume knob on the bottom right-had side of the spectrum analyzer until you hear the radio station. Audio should be heard on the speaker.
- You might have to increase the **demod** time in order to get continuous audio.

Observation:

- Record your settings: Center frequency, Span, Resolution bandwidth (under the BW/Avg button), Video bandwidth (under the BW/Avg button), and the name of the live FM radio stations (F1, F2, and F3). If the stations are not familiar to you, please write the type of the station (Music/ News/ Sports/Others).

C. Amplitude Modulation (AM):

Notes:

- The loop antenna is most commonly used for the frequency range of 10 kHz - 30 MHz. Place the loop antenna on its stand, with the height at a convenient level. Connect the cable from the loop antenna to the 'RF INPUT' terminal of the spectrum analyzer.

- The BANDWIDTH and SCAN TIME are automatically selected by the spectrum analyzer.

Step 1:

Find the radio spectrum from 0 to 2 MHz:
CENTER FREQUENCY: 1 MHz
SPAN: 2 MHz

Observation:

- Observe the radio spectrum from 0 to 2 MHz. Use the marker button to note the frequency of the two most prominent signals (A1 and A2)

- Record your settings: Center frequency, Span, Resolution bandwidth (under the BW/Avg button) and Video bandwidth (under the BW/Avg button).

Step 2:

Find the three most prominent signals (A1 and A2)
CENTER FREQUENCY : A1 or A2 MHz
SPAN: 136 kHz

Notes:

- Set the center frequency of the spectrum analyzer to one of the prominent signals recorded in step 1. Then set the span to approximately 136 Hz. Next, press the Det/Demod button and select the Demod option from the screen. Then select AM demodulation and make sure the speaker in the same menu is on. Increase the volume knob on the bottom right-had side of the spectrum analyzer until you hear the radio station. Audio should be heard on the speaker.

Observation:

- Record your settings: Center frequency, Span, Resolution bandwidth (under the BW/Avg button), Video bandwidth (under the BW/Avg button), and the name of the live AM radio stations (A1 and A2). If the stations are not familiar with you, please write the type of the station (Music/ News/ Sports/Others).