Singapore Polytechnic
School of Electrical and Electronics Engineering
ET1205: Wireless Technology Applications

Experiment 06: Spectrum Analyser and Its Signal Measurements

I Objectives

Students will learn how to:

- Operate the R&S FSV3 Spectrum Analyser to display the frequency spectrum of signals.
- Measure an RF Signal using a spectrum analyser to display at the correct position to provide an accurate reading.
- Describe the RF units as such in dBm, dBµV, dBc, etc.. to measure an RF signal.

II Equipment

R&S FSV3 spectrum analyser

R&S SMB100A RF signal generator

III Introduction

1. The spectrum analyser is used to analyse the characteristics of an RF input signal. It enables direct observation of amplitude, frequency, distortion products, modulation sidebands and frequency conversions. Thus, using a spectrum analyser, frequency and amplitude of an input signal can be viewed in linear and log scales respectively. In comparison to a linear scale, the advantageous increase in the measurement range of a log scale can thus be realised. Additionally, noise being a deterrent to the signal transmission in any communication system, can be measured by a spectrum analyser.

2. However, in this experiment, only the frequency and amplitude of an input signal will be measured.

IV Frequency and amplitude measurement

1. Initial setup

Connect the R&S SMB100A RF signal generator and R&S FSV3 spectrum analyser as shown in Figure 1.

Figure 1: Test setup

Setting up an RF carrier signal from the RF Generator

(i) Set the RF signal generator to generate the following sinusoidal carrier signal:
Frequency: 128 MHz
Output: -30 dBm
Modulation: off
RF output: on

(ii) Set the frequency to 128 MHz by selecting the FREQ hard key and input using the number keys. Select the unit via 

hard key. If you make a mistake while entering a value, select 

to correct it. You may also change the frequency by turning the knob.

(iii) Select LEVEL hard key to set the amplitude to -30 dBm. Select 

to apply the value. You may also change the amplitude by turning knob.

(iv) Select 

to turn **off** the modulation source since **a pure sine wave** is to be generated.

(v) Select 

to turn **on** the RF output.

2. Procedure

(i) To capture and display the spectrum of the RF carrier signal at the spectrum analyzer, set the center frequency of the analyzer by pressing the following keys: **<FREQ>**, 128 **<MHz>**.

(ii) Set the span by pressing the following keys: <**SPAN**>, 2 **<MHz>**.

(iii) Since the default reference level of the display is -10dBm, the signal is 20 dB (two graticule divisions) below the top of the screen using these spectrum analyzer

settings. If desired, adjust the reference level: press **<AMPT>** to activate the reference level, and use the knob or step keys to change the reference level.

(iv) Determine the amplitude and frequency of the signal. You can either press **<PEAK SEARCH>** or press **<MKR>** and move the marker to the signal peak. Read the amplitude and frequency. Record the results in Table 1. See the waveform in Figure 2. Frequency is displayed horizontally, and amplitude is displayed vertically.

(v) Change the units of the spectrum analyzer by pressing **<AMPT>, <Unit>, <dBm>/<dBµV>, etc…**

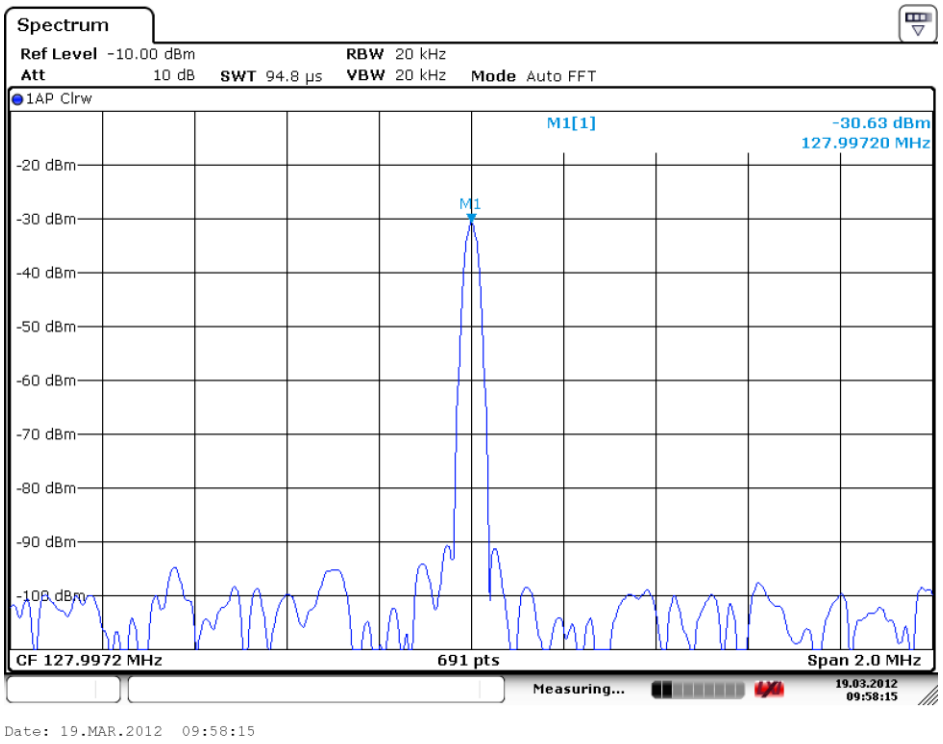


Figure 2: Reading the amplitude and frequency

Frequency, MHz	Amplitude, dBm	Amplitude,dBµV

Table 1: Frequency and Amplitude

(vi) Change the span by pressing the following keys: **<SPAN>, 100 <kHz)** to zoom in the signal as shown in Figure 3.

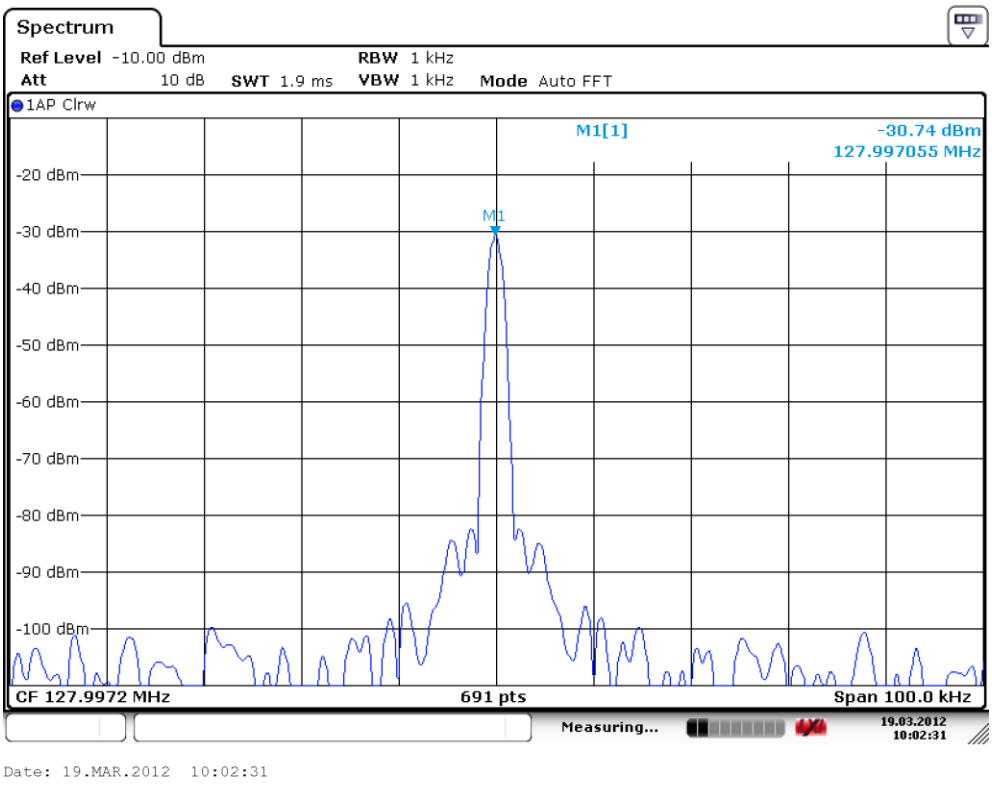


Figure 3: After zooming in on the signal with Span 100kHz

V Comparing different frequency components of an AM modulated RF signal from RF Generator using delta markers

Using the spectrum analyzer, you can easily compare frequency and amplitude differences between signals, such as radio or television signal spectra. The spectrum analyzer delta marker function lets you compare two or more signals when both appear on the screen simultaneously or when only one appears on the screen.

Required setup

(i) Press <**PRESET**> button at the Spectrum analyser.

(ii) Set the RF signal generator to generate the following sinusoidal carrier signal:
Frequency: 128 MHz
Output: -30 dBm
Modulation: on
RF output: on
Modulating signal (f_S): sine wave of 10 kHz
Modulation index (m): 30%

Procedure

(i) Select the carrier frequency and output amplitude (power) of RF signal generator :

Select FREQUENCY hard key➔ 128 ➔ 

Select LEVEL hard key ➔ -30 ➔ 

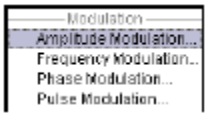
Select 

to turn **on** the RF output.

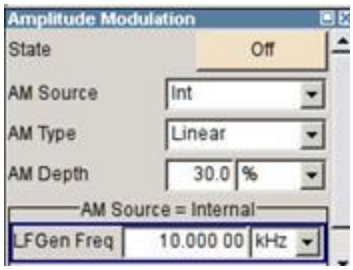
(ii) Set the AM modulation with modulation index of 30%.

Select 

and turn the knob to select the Modulation block. Press the knob and a drop down dialog appeared. Select Amplitude Modulation … to choose AM modulation type



The Amplitude Modulation dialog appeared.



Turn the knob to select the AM DEPTH and press the knob to key the modulation index value ➔ 30 ➔ 

(iii) Set the modulating signal frequency via turning the knob to select the LFGEN FREQ and press the knob to enter the value ➔ 10 ➔ 

(iv) Set the State ON

(v) To display the AM signal at the spectrum analyser, set the centre frequency by pressing the following keys: <**FREQ**>, 128 <**MHz**> and set the span by pressing the following keys: <**SPAN**>, 40 <**kHz**>.
Note: If the signal is not right at the centre of the display screen, then it can be brought to the centre by using the <**FREQ**> button and the knob.

(vi) Press **<PEAK SEARCH>** to place a marker at the highest peak on the display. Read the amplitude and record it in Table 2.

(vii) See the frequency spectrum shown in Figure 4.

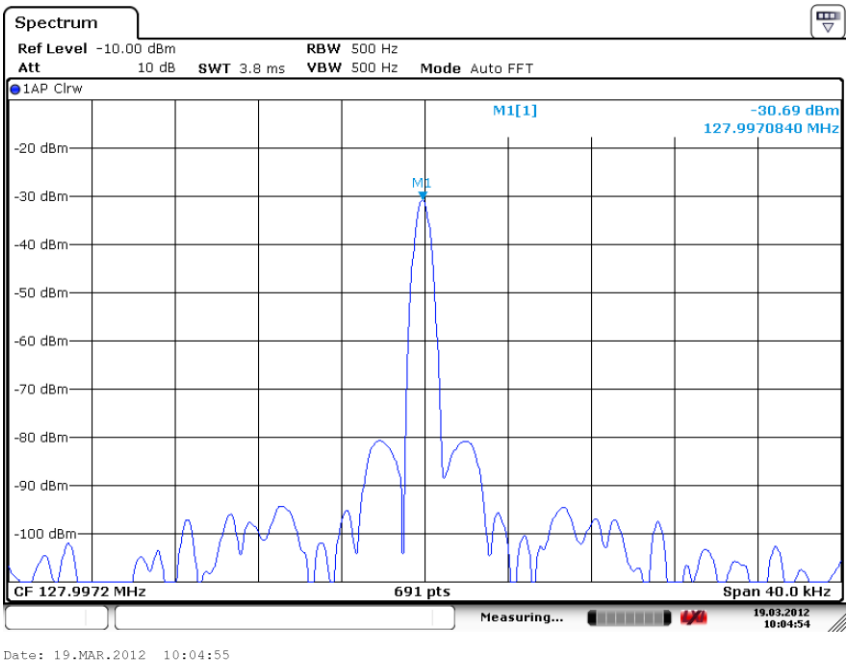


Figure 4: Placing a marker on the AM RF signal

(viii) Press **<MKR>** and activate a Delta marker press <**Marker Norm/Delta**> soft key until the **"Delta" highlight**. Delta maker, D1, will be placed at the one of the sideband components.

(ix) Press <**MKR➔**> and move the marker to another signal peak using the **<Next Peak>** soft keys or the knob.

(x) The amplitude and frequency difference between the markers are displayed in the upper-right corner of the screen. Record the amplitude and frequency of ΔMarker value of the upper and lower sidebands of the AM signal in Table 2.

(xi) See the waveform in Figure 5 & 6.

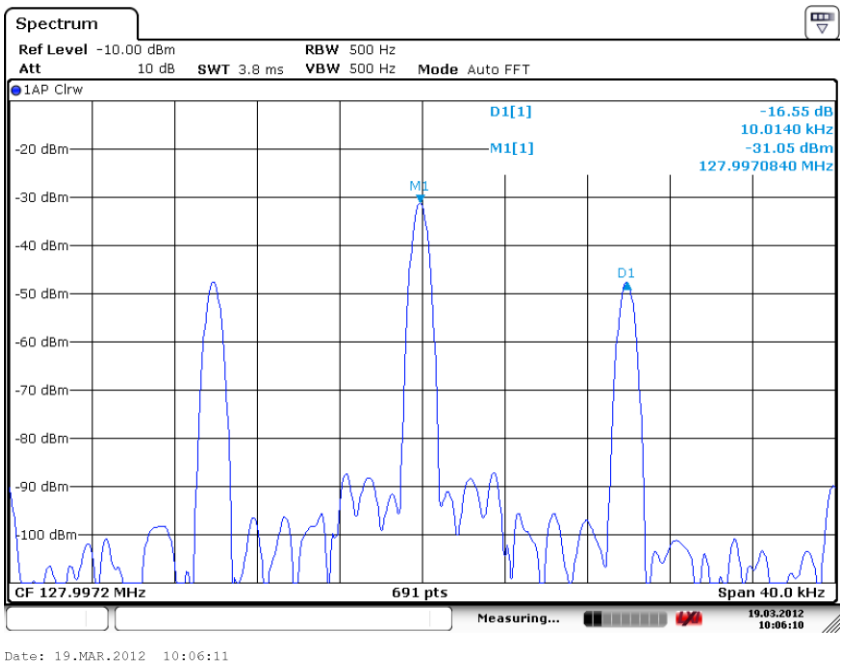


Figure 5: Delta maker at the upper sideband component using the marker delta function

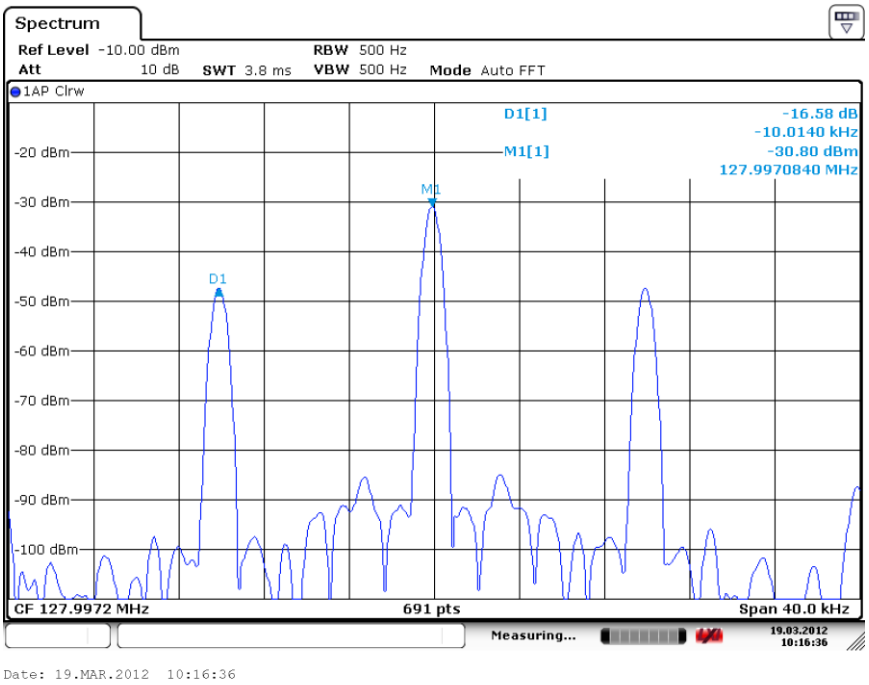


Figure 6: Delta maker at the lower sideband component using the marker delta function

AM RF Signal Measurement	**Amplitude**		**Frequency**	
RF carrier Signal using Marker		dBm		MHz
Lower Sideband Signal, using Δ Marker		dBc		ΔkHz
Upper Sideband Signal, using Δ Marker		dBc		ΔkHz

Table 2: Marker reading

Question 1: Why the unit in Δ Marker is named dBc? Give reason(s) to support your answer.

Question 2: If we want to calculate the amplitude of sideband signals from Table 2, what could the formulae be? Give an example with your answer.

Question 3: How many frequency components in a pure RF carrier sinusoidal signal is/are?

Question 4: How many frequency components are in the AM RF with a sinusoidal modulating signal? What are these components?