

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

Experiment 07: Setup the Analog Wireless Communication System

I Objectives

Students will learn:

- What are the components of a wireless communication system?
- The importance of modulation and demodulation in wireless communication systems.
- The effects of bandwidth, signal power, signal to noise ratio in a wireless communication system.

II Equipment

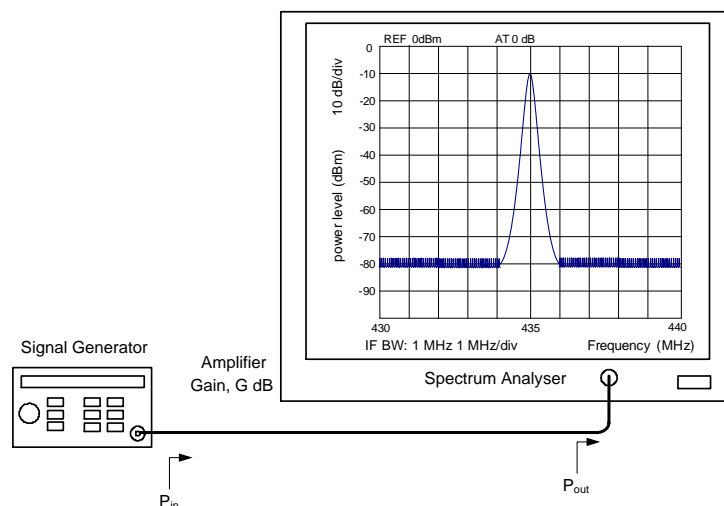
R&S FSV3 spectrum analyser

R&S SMB100A RF signal generator

Antennas

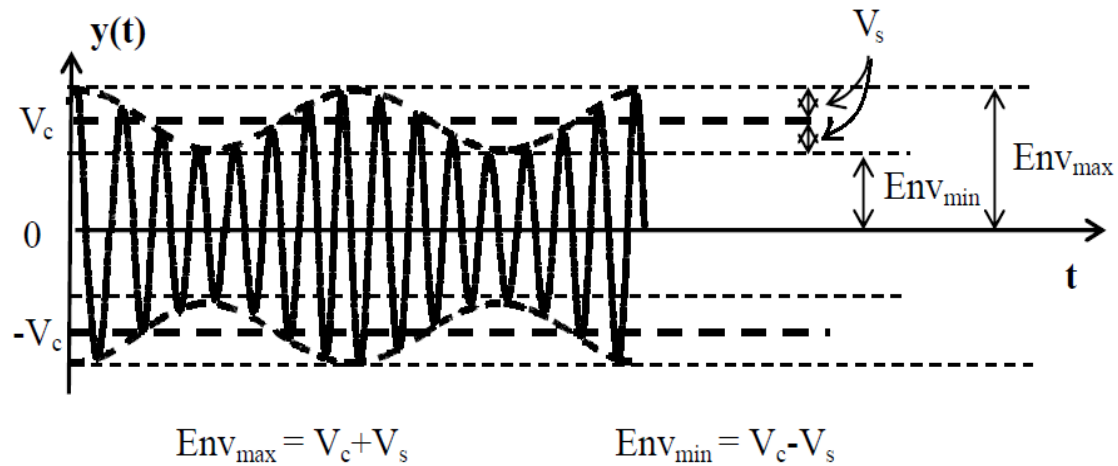
III Introduction

Setup a communication system using a RF signal generator and a spectrum analyser as shown in the following Figure.



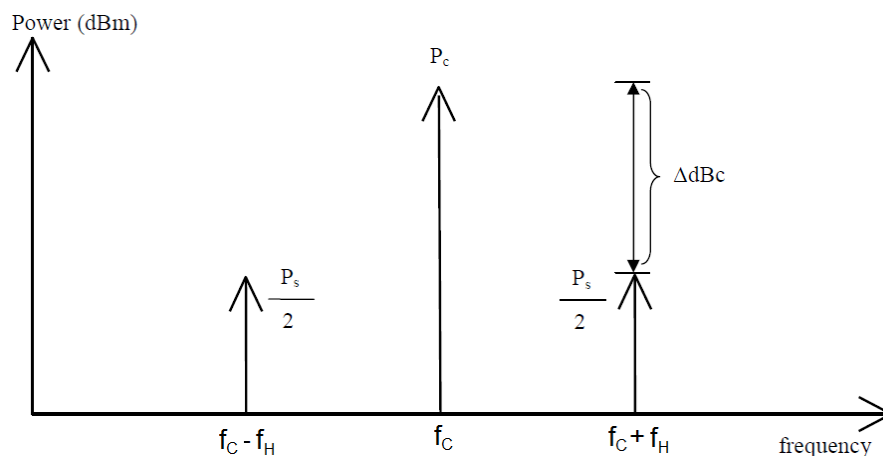
IV AM communication system

In amplitude modulation, the amplitude of the carrier is varied in accordance with the instantaneous amplitude of the modulating (information) signal as shown in the following Figure.



Amplitude Modulated Carrier

The spectrum displayed on the spectrum analyser is power spectrum as shown in the following Figure. The power of the sideband component relative to the carrier component is denoted as ΔdBc .



Power spectrum of AM signal

From power spectrum measurement, it is also possible to calculate the modulation index using the following equation.

$$m = 2 \times 10^{\frac{-|\Delta dBc|}{20}}$$

If the frequency of the baseband signal is f_H , the bandwidth (B_{AM}) of the AM signal will be as follows.

$$B_{AM} = (f_c + f_H) - (f_c - f_H) = 2f_H$$

Follow the steps given below to generate an AM signal with the following parameters:

RF output power: -20 dBm

Carrier frequency (f_c): 435 MHz

Modulating signal (f_s): sine wave of 1.2 kHz

Modulation index (m): 10 %

Modulation: on


RF output: on

Procedure


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

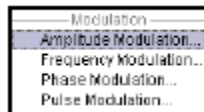
generator Select FREQUENCY hard key → 435 → 

Select LEVEL hard key → -20 → 

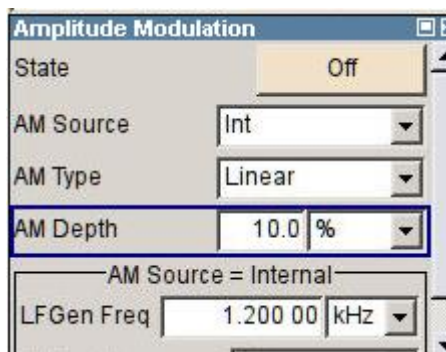
Select  to turn **on** the RF output.


- (ii) Set the AM modulation with modulation index of 10%.


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.



- (iii) Turn the knob to select the AM DEPTH and press the knob to key the modulation index value → 10 → 

- (iv) Set the modulating signal frequency via turning the knob to select the LFGGen FREQ and press the knob to enter the value → 1.2 → 

- (v) Set the State ON

- (vi) Set the spectrum analyser to display the AM signal. Determine the centre frequency and span to display the AM signal:

Centre frequency = _____

Span = _____

FREQ → CENTER FREQ → _____ → SPAN _____

Sketch the frequency spectrum of this AM signal with all the correct labelling.



Question 1: What are the lower side frequency and upper side frequency?

Question 2: What is the carrier frequency?

Question 3: What is the bandwidth of the AM signal?

Question 4: What is the value of the modulating frequency (f_s or f_H)?

- (vii) Keep the centre frequency of the spectrum at 435 MHz and change the SPAN to zero. Turn on the demodulator at the spectrum analyser to demodulate the AM signal as follow:

FREQ → CENTER FREQ → 435 MHz → <Zero SPAN>

Turn on one marker e.g Marker 1 and Press <MKR FUNC> → <Marker Demod> , <Mkr Demod ON/ OFF> (so that ON is underlined), and click <AM>. Using the



AF output control to increase the Speaker's volume.

- (viii) Change the modulation index to 20%, 50%, 80% and 100%. Investigate the amplitude spectrum of the AM signal at the spectrum analyser and listen the audio output from the speaker.

Question 5: When the modulation index is increase, what happens to the signal to noise signal of the AM signal, higher or lower? Give reason(s) to support your answer.

V FM communication system

Set the RF signal generator to obtain the following FM signal with the parameters given and display its spectrum:

RF output power: - 30 dBm

Carrier frequency (f_c): 88 MHz

Modulating signal (f_s): sine wave of 20 kHz

Frequency deviation (Δf): 20 kHz

Note: The modulation index (m_f) of FM signal is:

$$m_f = \frac{\Delta f}{f_s}$$

If $m_f < 0.5 \rightarrow$ narrowband FM (NBFM)

If $m_f \geq 0.5 \rightarrow$ wideband FM (WBFM)

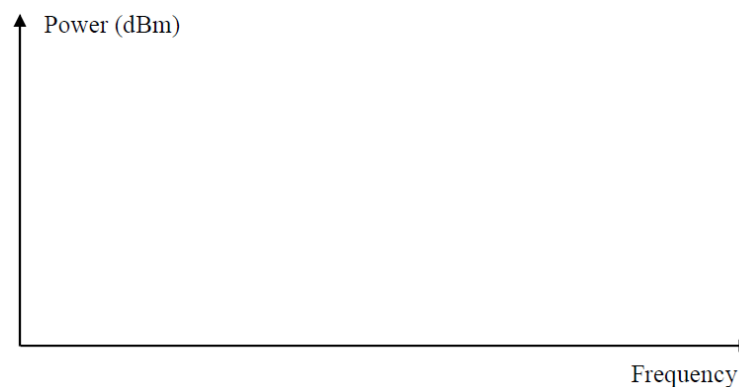
Bandwidth of the narrowband FM,

$$BW = 2 f_H \text{ same as AM}$$

Bandwidth of the wideband FM,

$$BW = 2(1 + m_f)f_H$$

- (i) Sketch the frequency spectrum of this FM signal with all the correct labelling.



- (ii) Keep the centre frequency of the spectrum at 88 MHz and change the SPAN to zero. Turn on the demodulator at the spectrum analyser to demodulate the FM signal as follow.
FREQ → CENTER FREQ → 88 MHz → SPAN 0 Hz
- (iii) Turn on one marker e.g Marker 1 and Press <MKR FUNC> → <Marker Demod> , <Mkr Demod ON/ OFF> (so that ON is underlined), and click <FM>. Using the



AF output control to increase the Speaker's volume.

- (iv) Change the frequency deviation to 10 kHz, 30 kHz and 40 kHz. Investigate the amplitude spectrum of the FM signal at the spectrum analyser and listen the audio output from the speaker.

Question 6: When the frequency deviation is increased, what happens to the signal to noise signal of the FM signal, higher or lower? Give reason(s) to support your answer.

Question 7: When the modulation index is increase, what happens to the bandwidth of the FM signal, higher or lower? Give reason(s) to support your answer.

V Demodulating a commercial AM or FM Signal

- (i) Connect an antenna to the spectrum analyzer input.
- (ii) Select a frequency range on the spectrum analyzer, such as the range AM/FM radio broadcasts. For example, the frequency range for commercial FM broadcasts is 88 MHz for 108 MHz. Press <PRESET>, <FREQ>, START FREQ, 88 <MHz>, STOP FREQ, 108 <MHz>.
- (iii) Place a marker on the signal of interest by using <PEAK SEARCH> to place a marker on the highest amplitude signal, or by pressing <MKR>, NORMAL and moving the marker to a signal of interest.
- (iv) Press <MKR FUNC> → <Marker Demod> , <Mkr Demod ON/ OFF> (so that ON is



underlined), and click <FM>. Using the AF output control to increase the Speaker's volume.

AF output control to

Question 8: What is the frequency range for commercial AM broadcast?

Question 9: State the AM/FM broadcasting system whether it is a simplex or a duplex wireless communication system.

Question 10: Draw the block diagram of the above wireless communication systems?