VCO (Voltage Controlled Oscillator) of Exciter Design For Electronic Jammer Using IC MC 1648

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Abstract - **Jamming is a way for disabling electronic communications by cover up a signal from a transmitter with another signal. Jamming signal emitter consists of Frequency monitor, Jammer control, Noise source (Sawtooth generator and or Noise generator), Tx (HF, VHF, or UHF), combiner and HPA (high power amplifier). In this paper, exciter in Jammer is designed using integrated circuit MC 1648 type. Its working frequencies are 30 MHz to 80 MHz. They are divided into 20 bands, each band of 2.5 MHz width. The Exciter design result with VCO for only two band, ie VCO1 with output frequency 30 MHz - 32.5 MHz and VCO2 with output frequency 32.5 MHz - 35 MHz.**

Key words : Jamming, Exciter, VCO

I. INTRODUCTION

"Jamming" is a method for disabling electronic communications by means overwriting or covering up a signal from transmitter with another Signal (called a jamming Signal) having the same frequency but much higher power (energy), so that the intended receiver will only detect the jamming Signal which has the greater power. This would result in communication impairment or even failed at all.

Emitter in Jamming Signal device (also called Radio Jammer) as shown Figure 1, consists of: Frequency monitor, Jammer control, Noise source (Sawtooth generator and or noise generator), Group Tx (HF, VHF, or UHF) consists of exciter a VCO (Voltage controlled oscillator) or frequency synthesizer and Amplifier, combiner and HPA (high power amplifier).

Exciter is the most important part in jamming signal generation, since the entire signal generation process including sweeper signal, noise signal and the oscillator signal are derived from this part. In this paper, it will be presented an exciter designed using integrated circuit (IC) type MC 1648 a design.

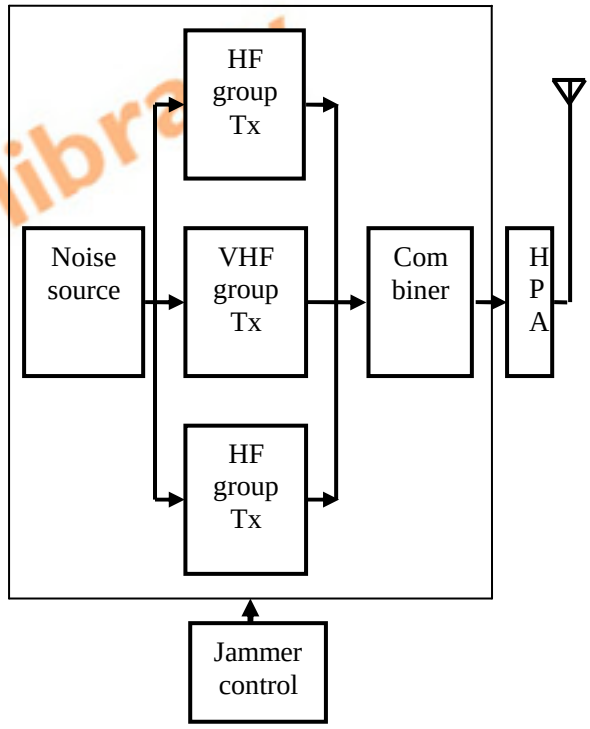

Figure 1. Jamming signal Emitter Block Diagram

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II. EXITER WITH VCO (VOLTAGE CONTROLLED OSCILLATOR).

Exciter design is planned to work in the output frequency area of 30 MHz to 80 MHz, which is divided into 20 bands, each band width is 2.5 MHz as shown in figure 2.

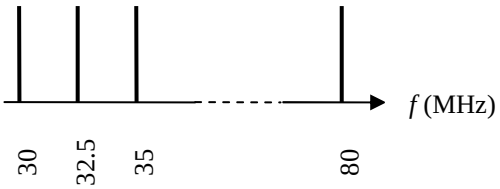

Figure 2. Band 30 s/d 80 MHz

VCO (voltage controlled oscillator) is a form of LC oscillator, as described at figure 3, where the magnitude of output frequency is generated from the control value of capacitance resonant circuit (tank circuit) by an external voltage. Varactor diode, with reverse bias voltage, will result in changes on the capacitance value.

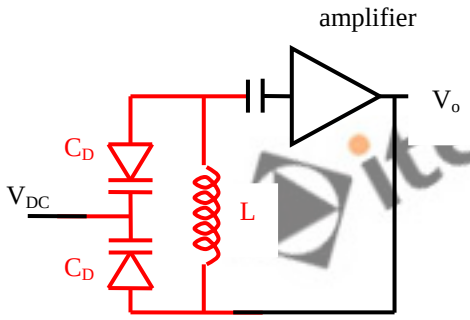

Figure 3. *Voltage controlled oscillator*

IC MC1648 requires an external parallel tank circuit consisting of inductor (L) and capacitor (C). In addition to inductors and capacitors, MC 1648 requires varaktor diodes. Value of the inductor (L) obtained from the calculation in accordance with the desired frequency. MC1648 IC can be operated at 5.0 Vdc.

The varactor diode receives bias voltage V_{DC} which causing changes in the capacitance value by C_D. When the resonance is obtained:

$$X_1 + X_2 + X_3 = 0 \rightarrow \omega L + -\frac{1}{\omega C_D} - \frac{1}{\omega C_D} = 0$$

$$\text{resonance frequency } f_o = \frac{1}{2\pi\sqrt{L.C_T}} \text{ Hz}$$

The VCO circuit design was realized using IC type MC1648. As Figure 4.

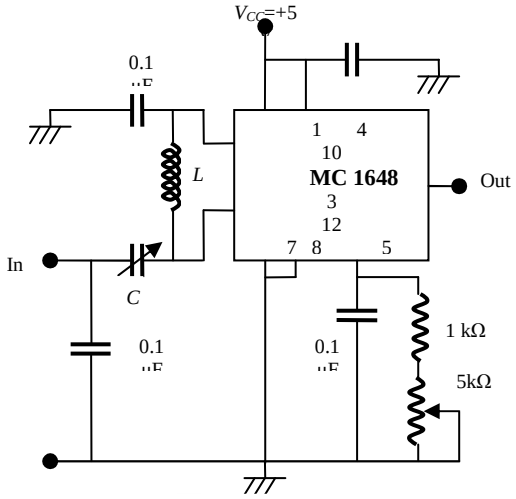

Figure 4 . VCO circuit using the MC 1648

Output frequency of the VCO (Voltage Controlled Oscillator) to be designed is obtained from the following calculation:

$$f_{out}\ (\text{min}) = \frac{1}{2\pi\sqrt{L(C_{D\ maks} + C_S)}}$$

$$f_{out}\ (\text{max}) = \frac{1}{2\pi\sqrt{L(C_{D\ min} + C_S)}}$$

Where :

f_{out} = output frequency (MHz)

L = Inductor (H)

C_D = Capacitance of dioda varactor (F)

C_s = Capacitance of MC 1648 IC (F)

In this paper, exciter design with VCO only for two bands, ie VCO1 with output frequency 30 MHz - 32.5 MHz and VCO2 with output frequency 32.5-35 MHz.

The selection of inductor value is determined based on the magnitude of the following calculation:

C_{Dmaks} = 16,5.10^{-12} F (*datasheet varactor* diode MV2105)

C_{Dmin} = 13,5.10^{-12} F (*datasheet varactor* diode MV2105)

C_S = 6.10^{-12} F (*datasheet* IC MC1648)

III. FREQUENCY OUTPUT CALCULATION.

Prior to the realization of the circuit, we did the calculation in order to obtain the desired output frequency.
For output Frequency 30 MHz – 32,5 MHz
- Minimum frequency 30 MHz

$$f_{out}\,(\min) = \frac{1}{2\pi\sqrt{L(C_{D\,max} + C_S)}}$$

$$30 \times 10^6 = \frac{1}{2\pi\sqrt{L(16.5 \times 10^{-12} + 6 \times 10^{-12})}}$$

$$L = 1.25\ \mu\text{H}$$

- Maximum frequency 32,5 MHz

$$f_{out}\,(\max) = \frac{1}{2\pi\sqrt{L(C_{D\,min} + C_S)}}$$

$$32.5 \times 10^6 = \frac{1}{2\pi\sqrt{L(13.5 \times 10^{-12} + 6 \times 10^{-12})}}$$

$$L = 1.22\ \mu\text{H}$$

- Maximum frequency 35 MHz

$$f_{out}\,(\max) = \frac{1}{2\pi\sqrt{L(C_{D\,min} + C_S)}}$$

$$35 \times 10^6 = \frac{1}{2\pi\sqrt{L(13.5 \times 10^{-12} + 6 \times 10^{-12})}}$$

$$L = 1.06\ \mu\text{H}$$

IV. TESTING AND ANALYSIS

Testing was performed aiming to determine the characteristics of the circuit's output signal. Block diagram of the testing performed is shown in figure 5:

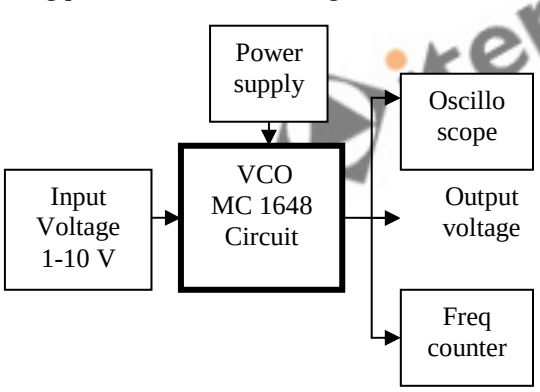

Figure 5. VCO Testing Block Diagram

Circuit Testing Result VCO 1 (30 MHz – 32.5 MHz) :
Image signal waveform of a VCO test results (30 MHz - 32.5 MHz) as shown in 6a and 6b.

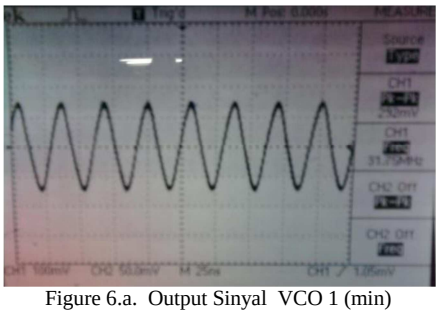

Figure 6.a. Output Sinyal VCO 1 (min)

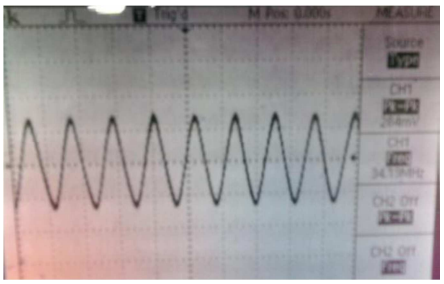

Figure 6.b. Output Sinyal VCO 1 (max)

Whereas the graph of the VCO 1 testing results as shown in 7a and b.

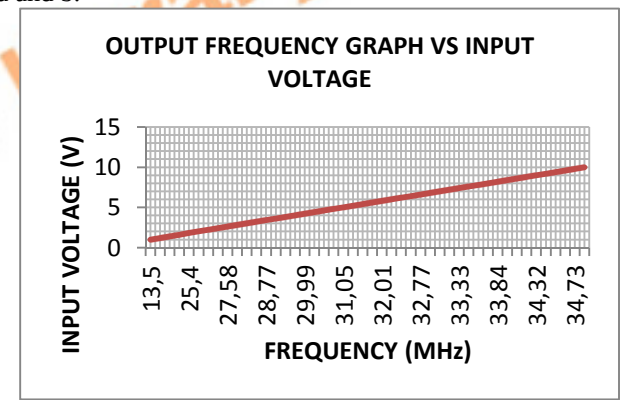

Figure 7a. The output frequency characteristics graph vs input voltage VCO 1

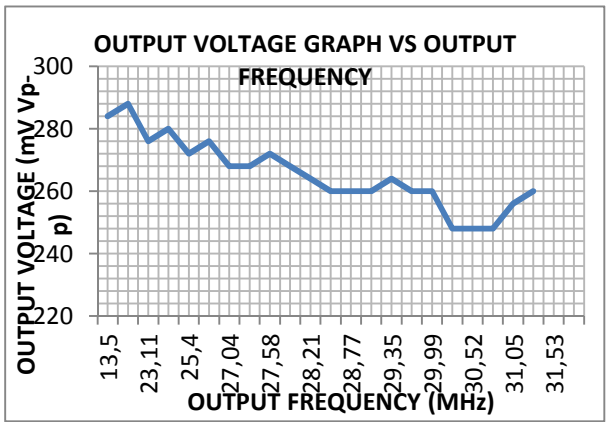

Figure 7.b. The output voltage characteristics graph vs output frequency VCO 1

Circuit Testing Result VCO 2 (32,5 MHz – 35 MHz) : Image signal waveform of a VCO 2 test results (32.5 MHz - 35 MHz) as shown in 8a and 8b.

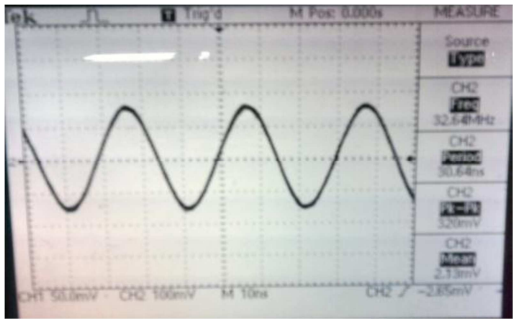

Figure 8.a. Output Sinyal VCO 1 (min)

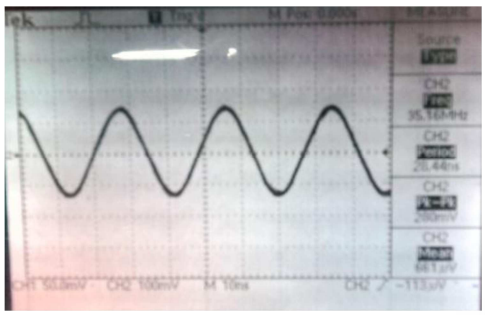

Figure 8.b. Output Sinyal VCO 1 (max)

Whereas the graph of the VCO 2 testing results as shown in 9a and 9b.

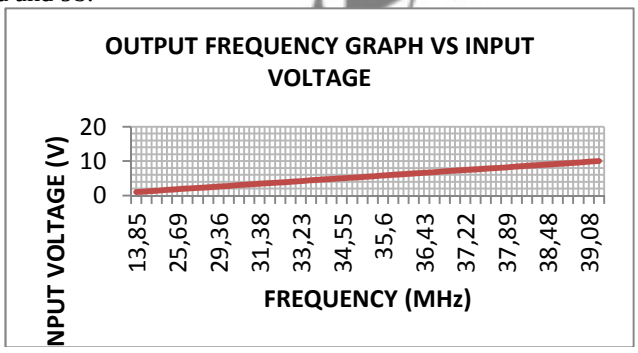

Figure 9a. The output frequency characteristics graph vs input voltage VCO 2

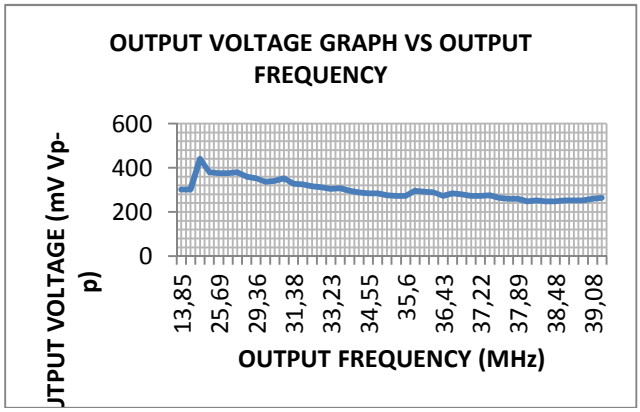

Figure 9.b. The output voltage characteristics graph vs output frequency VCO 2

OUTPUT SIGNAL VCO 1 WITH INPUT SINYAL SWEEP.

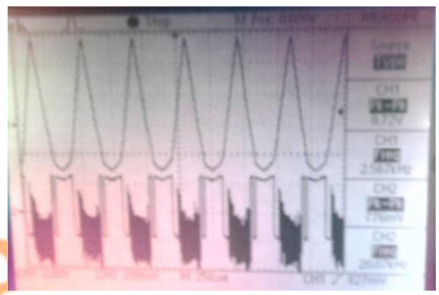

Figure 10. Output Sinyal VCO 1

From testing, the desired results were obtained. VCO output frequency will vary according to the installed input voltage. In testing with sweep input signal, its wave signal output will move closed-stretched (output frequency up and down) according to changes in sweep voltage signal

Output frequency VCO 1, will swing from frequency 30 MHz to 32,5 MHz, as shown in Figure 10.

V. CONCLUSION

From the results of design, testing and analysis, some of the conclusions are obtained:

- Based on testing, the output signal waveform of the VCO (Voltage Controlled Oscillator) is sinusoidal waveform signal.
- Based on test data, input voltage is directly proportional to the frequency output. The greater of its value the greater the input voltage frequency value of output will be produced.
- Based on observation and testing, the VCO 1 output can work at frequency from 30 MHz to 32.5 MHz, with input voltage of 4.4 V - 6.4 V

- Based on observation and testing, the VCO 2 output can work at a frequency of 32.5 MHz -35 MHz, the input voltage of 4 V - 5.4 V.

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