EEP3010: Laboratory Report (Experiment#1)

On

"To study amplitude modulation (AM) and demodulation"

By

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ABSTRACT:

Amplitude modulation: The amplitude of the carrier signal varies in accordance with the instantaneous amplitude of the modulating signal. Amplitude modulation is most commonly used in the form of electronic communication. This is commonly used to transmit information over a radio carrier and

- $\mu > 1$ it is Over Modulation, when $\mu < 1$ it is Under Modulation and if $\mu \sim 1$ we can say it is Critical Modulation where μ is modulating index

OBJECTIVE:

The objective of this experiment is to study the amplitude modulation (AM) and demodulation and to learn and observe the spectrum of under-modulation, critical modulation and over modulation.

Equipment Required:

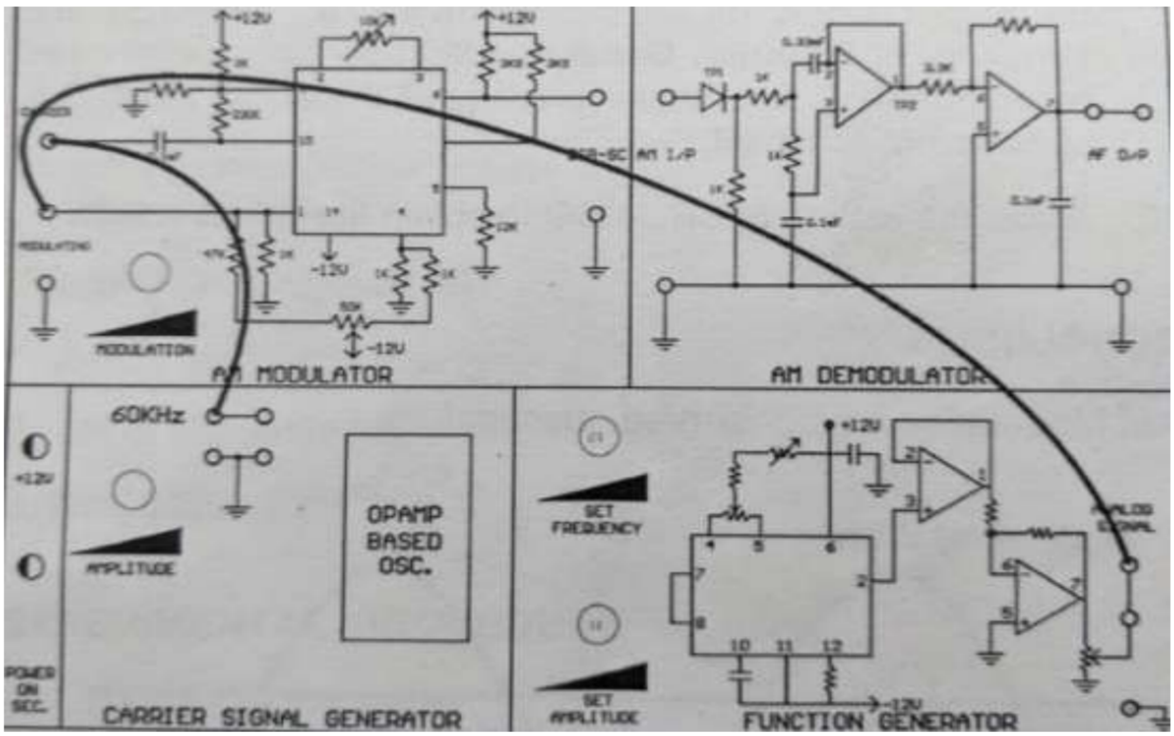
- N9010A Signal Analyzer/89601
- AFG3021B Function Generator (2 sets)
- DPO2024 Oscilloscope, 200 MHz
- AM trainer kit (Vinytics CT AM)

Accessories Required:

- BNC(m)-to-BNC(m) coaxial cable
- SMA(m)-to-BNC(m) coaxial cable
- SMA(m)-to-SMA(m) coaxial cable
- Connecting Chords

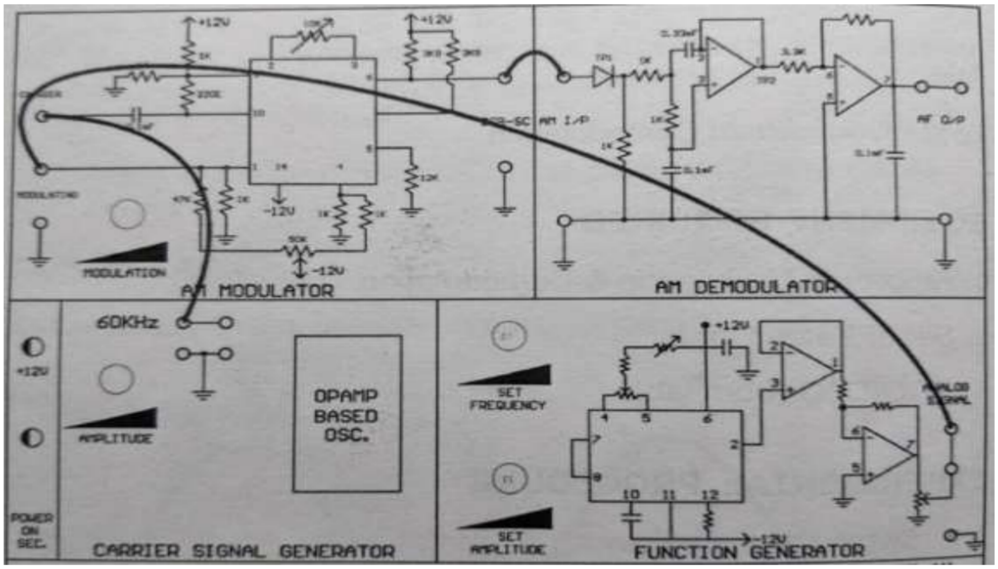
Experimental Procedure:

AM MODULATION:



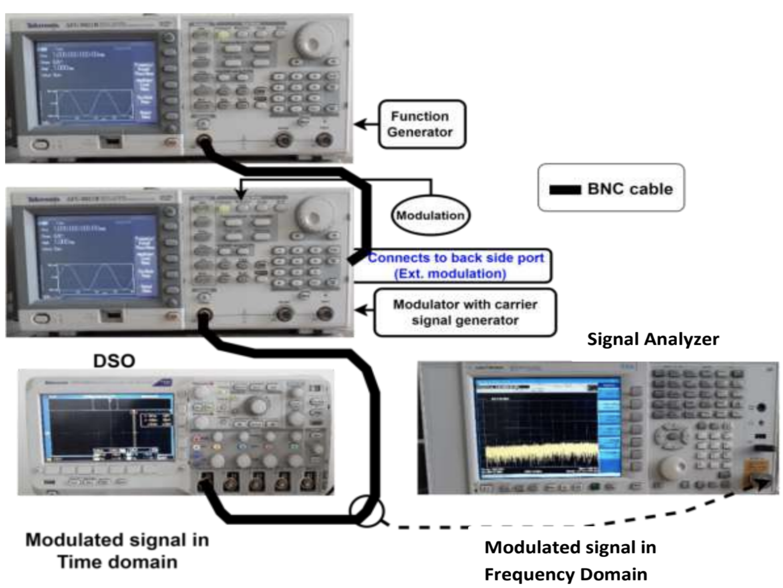
- Make connections as shown in the above diagram and Switch on the Am trainer kit
- Create a sinusoidal message signal with a peak-to-peak amplitude of 10 volts and a frequency of 3.5 kHz using the Function Generator's output
- Create a sinusoidal carrier signal with a high frequency and a peak-to-peak amplitude of 2.5 volts, then check it using the Function Generator's output
- We can experiment with the amplitude of the Sine wave function generator component to observe how it affects the modulated signal on DSO
- Experiment with different settings of the potentiometer labeled "Modulation" in the "AM modulator Section" to observe how the depth/percentage influences AM modulation. **Modulation index = Ka Am** is the formula and Try different combinations of Am, Ac, and Ka to get critical modulation

AM DEMODULATION:



- Make connections as shown in above diagram and Switch on the Am trainer kit.
- Examine the AM demodulated signal at the Demodulator Section's AM O/P
- Change the amplitude of the Sine wave in the Function Generator Section
- Get a picture/screenshot of the DSO display

Frequency Domain Analysis:



- In the Function Generator shown in the above diagram, select the continuous button
- Take the output (OUT) of the Function Generator acting as the modulating signal (Sine, Ramp, Rectangular, etc.)
- Connect the "Modulator with Carrier Signal" Generator's output (OUT) to the DSO for time-domain monitoring. Change the modulation depth of the "Modulator with Carrier Signal" Generator to investigate the modulation type
- Connect the output of the “Modulator with Carrier Signal” Generator to the Signal Analyzer block
- Take a picture/screenshot of the signal analyzer's screen.

Test Results:

Modulation Type	Am(PP) (V)	Ac(PP) (V)	Fm (kHz)	Fc (kHz)	(Amax-Amin) /(Amax+Amin)=μ
Under Modulation	10	2.5	3.5	71	0.58
Critical Modulation	10	2.5	3.5	71	0.932
Over Modulation	10	2.5	3.45	71	1.11

<u>Undermodulation</u>:

Amax = 2.4V
Amin = 640 mV = 0.64V

μ = (Amax - Amin)/(Amax + Amin)
μ = (2.4-0.64)/(2.4+0.64) = 0.58 < 1

<u>Critical modulation:</u>

Amax = 2.28 V
Amin = 80 mV
= 0.08V

μ = (Amax - Amin)/(Amax + Amin)
μ = (2.28-0.08)/(2.28+0.08) =
0.932 ~ 1

<u>Overmodulation:</u>

Amax = 2.28 V
Amin = -120 mV = -0.12 V

μ = (Amax - Amin)/(Amax + Amin)
μ = (2.28+-0.12)/(2.28-0.12) = 1.1 > 1

Discussion:

Amplitude modulation is a method of transmitting a wave signal by altering its amplitude, such that Amplitude A (t) varies linearly with m. (t). During the demodulation process, the modulation of the original information-carrying signal is removed from the incoming overall received signal. The phase is determined by (kx + wt); changes in x might affect the phase of both signals. The frequency domain analysis of the experiment clearly shows the phase shift of the message signal and the demodulated signal. This phase shift might be caused by varying durations covered by separate signals.

Conclusion:

Amplitude modulation and demodulation were completed successfully and We were able to demonstrate that signal reception in a communication system is affected by a variety of elements, including carrier amplitude, carrier frequency, and sensitivity factor. An excessively modulated signal, as we've seen, cannot be demodulated. The frequency domain study revealed three distinct frequency bands.

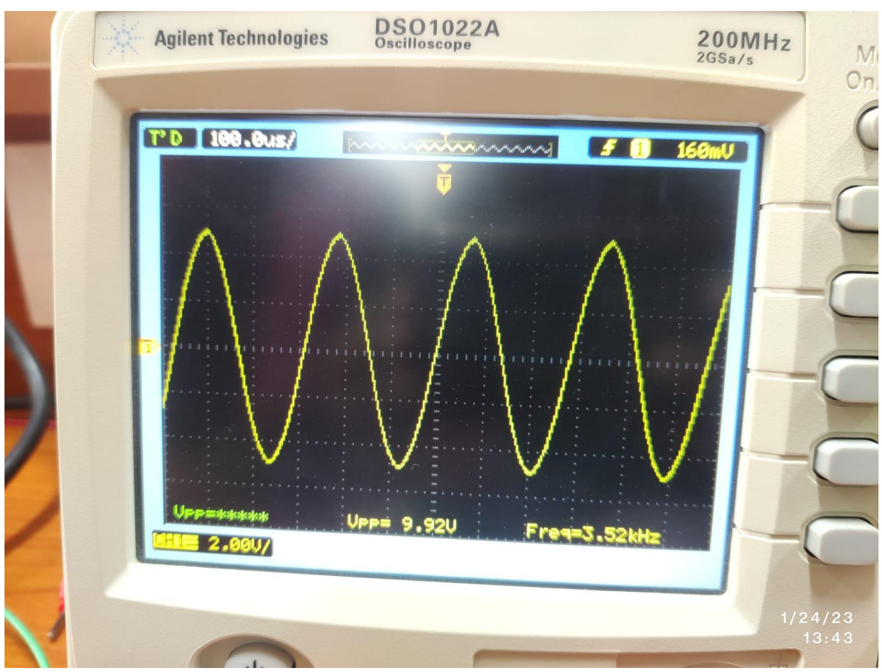
References:

- Lab Manual
- https://www.electronics-notes.com/articles/radio/modulation/amplitude-modulation-am-demodulation-detection.php#:~:text=Demodulation%20is%20a%20key%20process,the%20incoming%20overall%20received%20signal.
- https://www.tutorialspoint.com/analog_communication/analog_communication_amplitude_modulation.htm

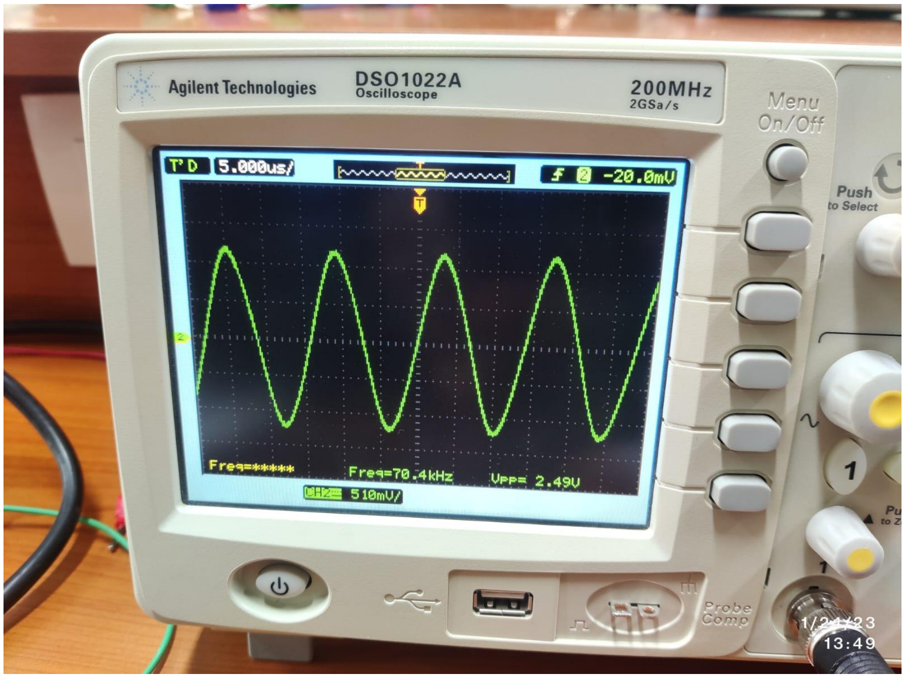
Appendices:

Time domain Analysis

1. Message signal

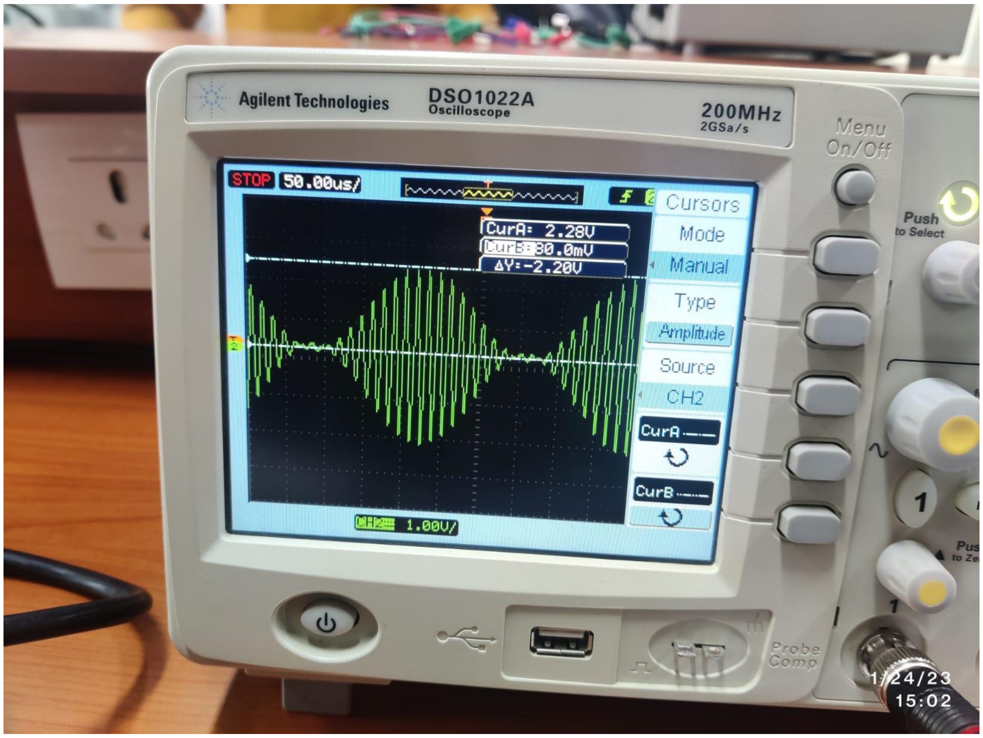


2. Carrier signal

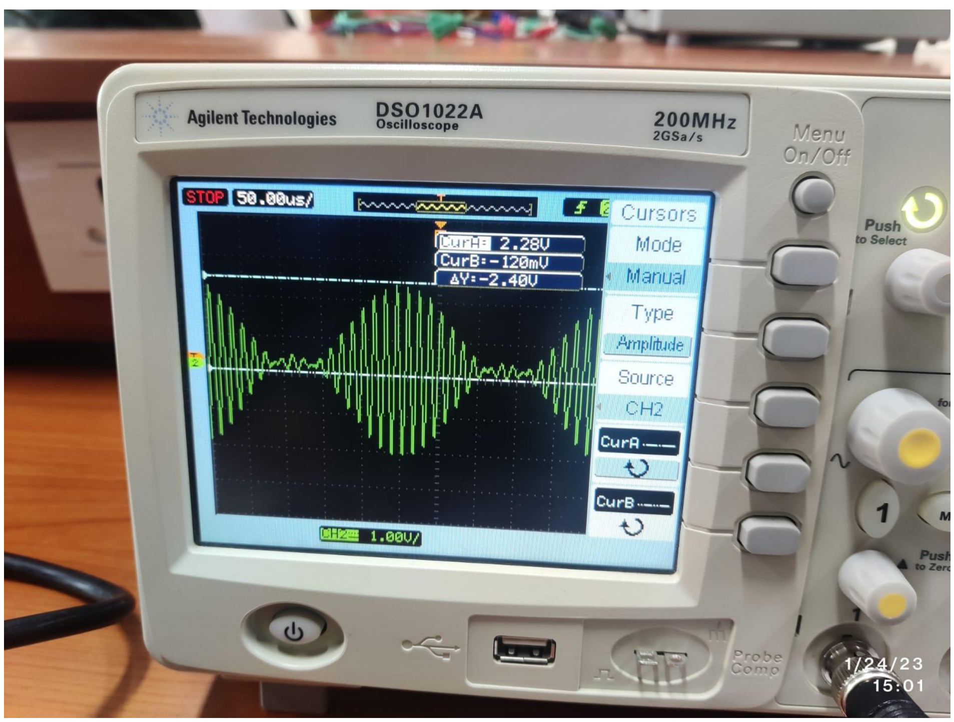


3. Under modulated signal

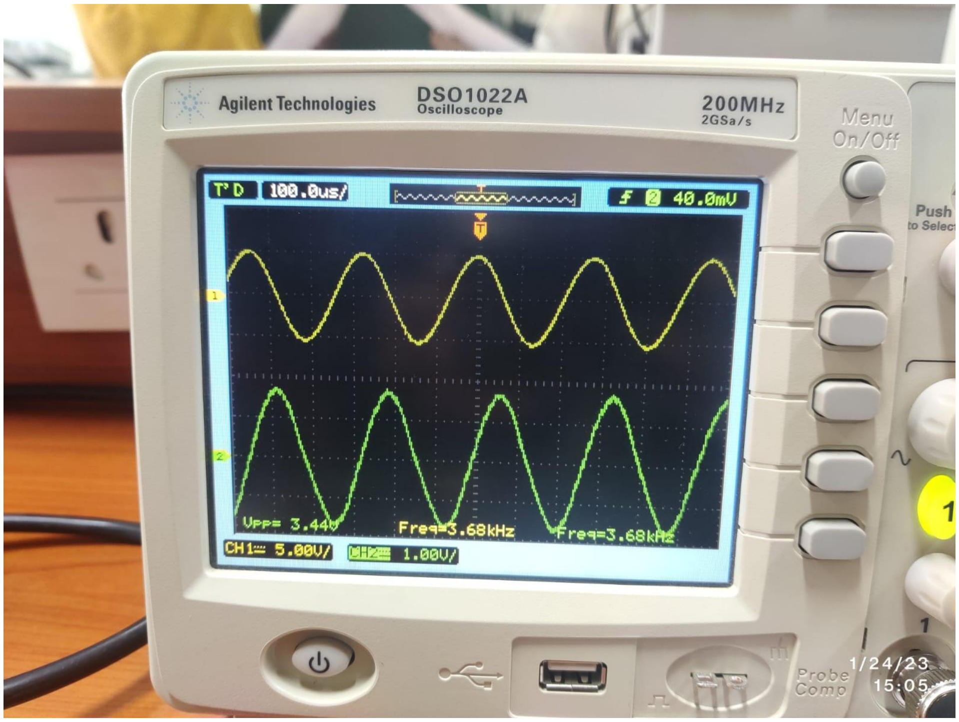
4. Critically modulated signal



5. Over modulated signal

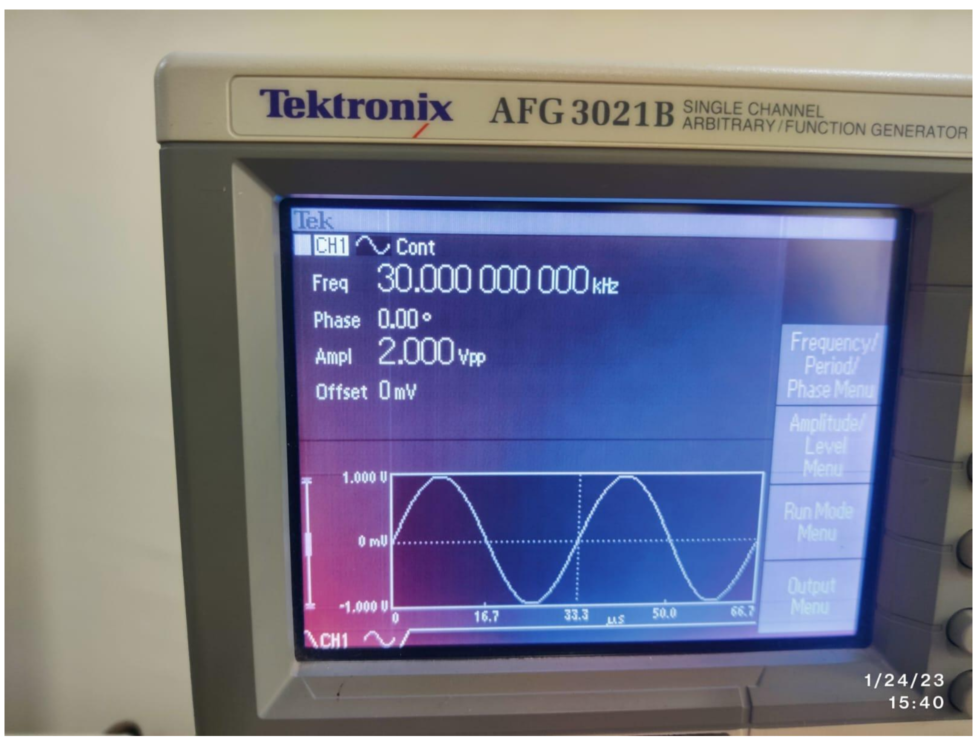


6. Demodulated signal

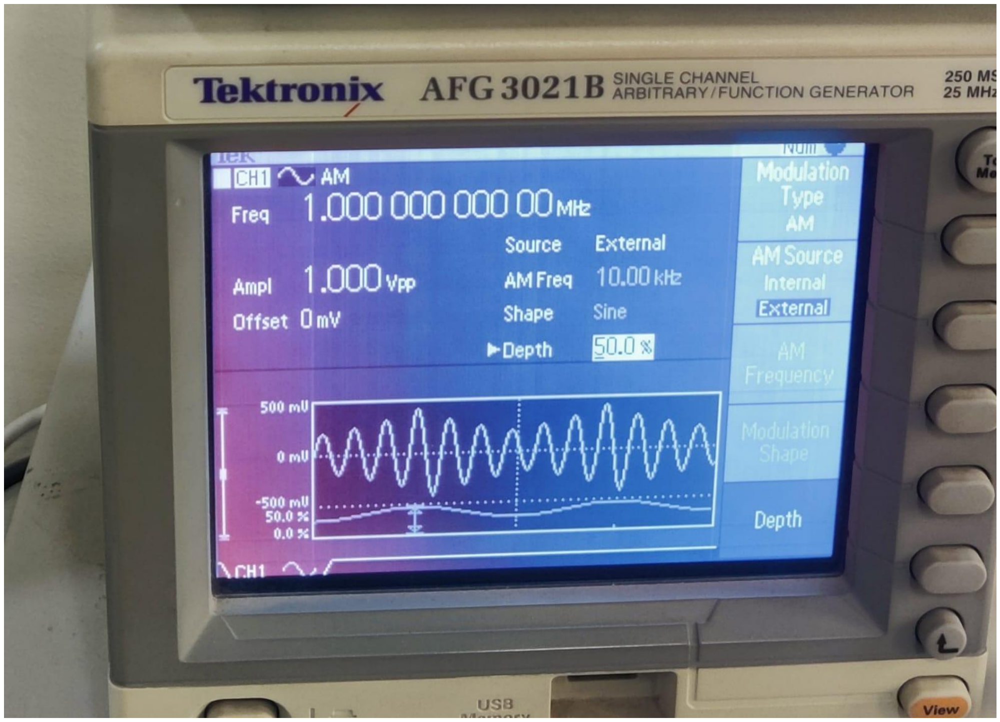


Frequency Domain Analysis

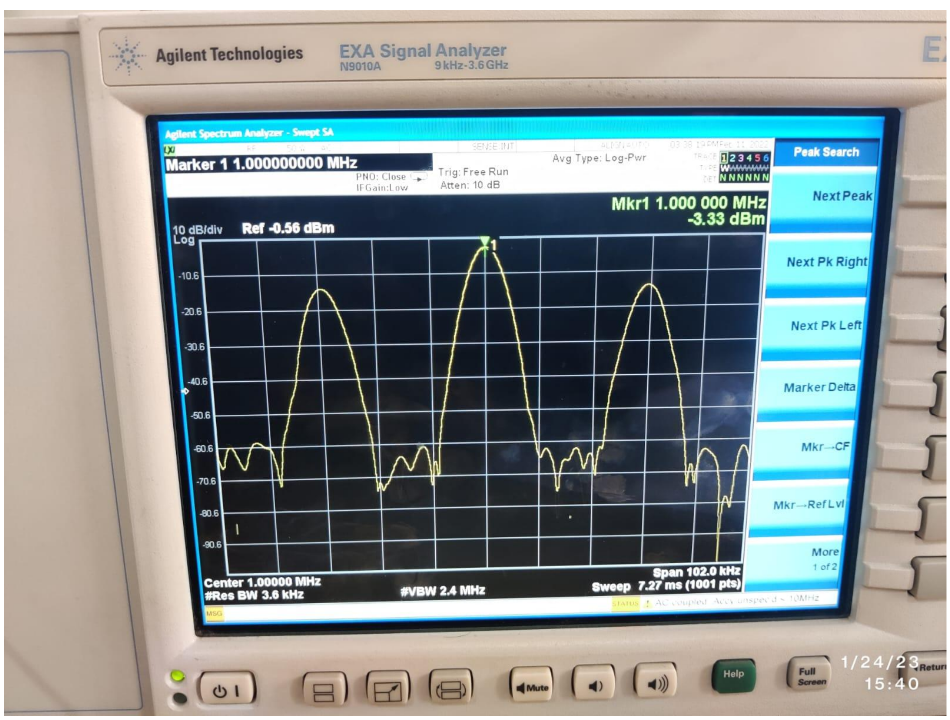
1. Message signal

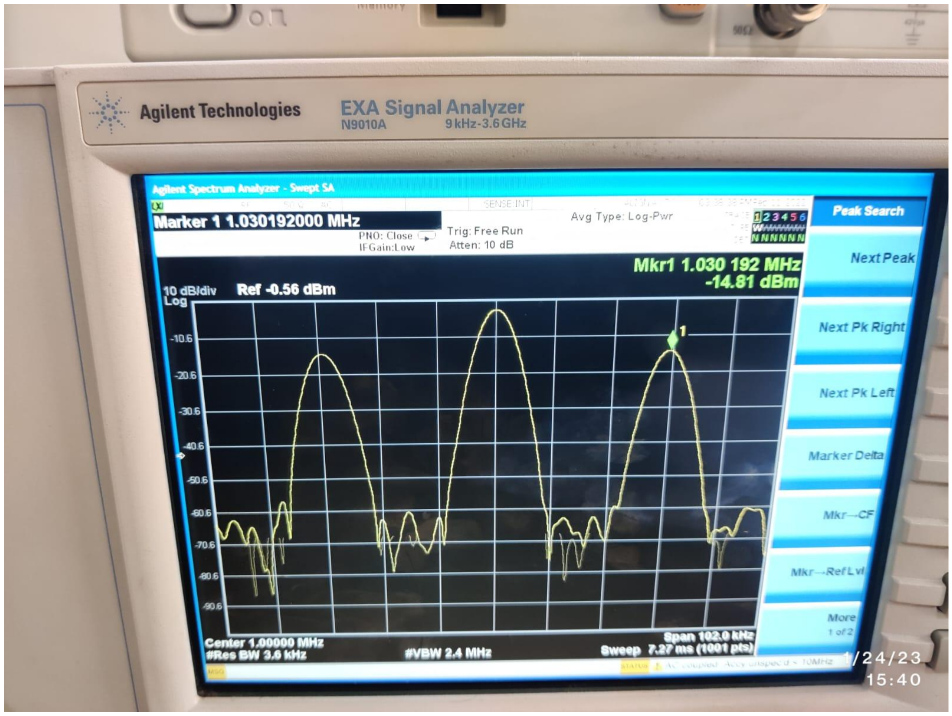


2. Carrier signal



3. Frequency spectrum




Agilent Technologies
EXA Signal Analyzer
N9010A
9 kHz-3.6 GHz
Agilent Spectrum Analyzer - Swept SA
Marker 1 1.030192000 MHz
PNO: Close
IFGain:Low
Trig: Free Run
Atten: 10 dB
Avg Type: Log-Pwr
Mkr1 1.030 192 MHz
-14.81 dBm
10 dB/div
Log
Ref -0.56 dBm
-10.6
-20.6
-30.6
-40.6
-50.6
-60.6
-70.6
-80.6
-90.6
Center 1.00000 MHz
#Res BW 3.6 kHz
#VBW 2.4 MHz
Span 102.0 kHz
Sweep 7.27 ms (1001 pts)
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→RefLvl
More
1 of 2
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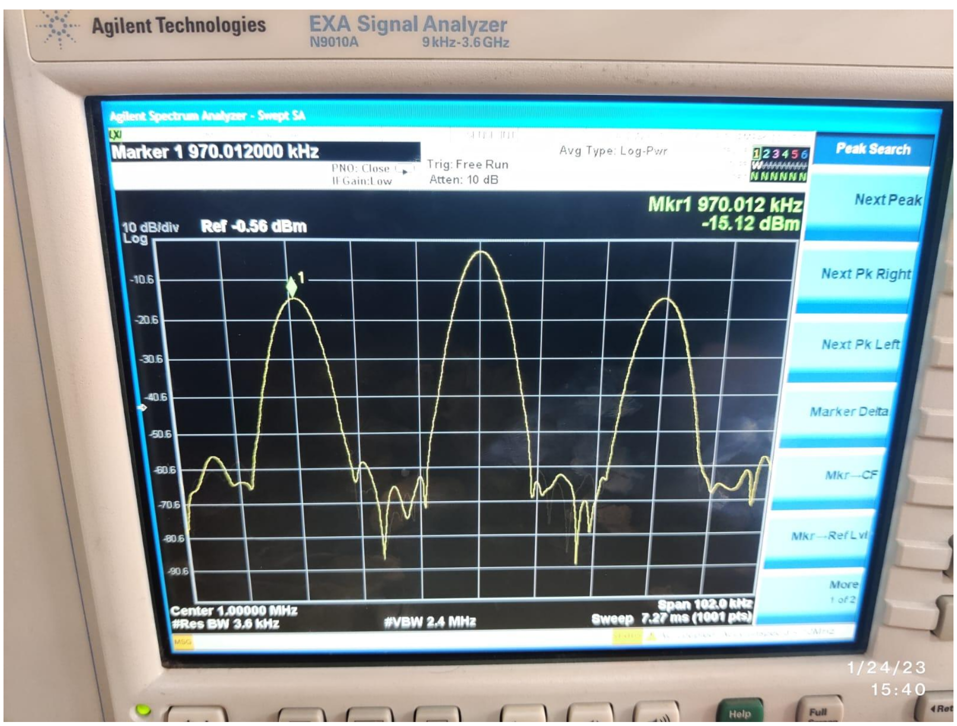
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9 kHz-3.6 GHz
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Marker 1 970.012000 kHz
PNO: Close
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Atten: 10 dB
Avg Type: Log-Pwr
Mkr1 970.012 kHz
-15.12 dBm
10 dB/div
Log
Ref -0.56 dBm
-10.6
-20.6
-30.6
-40.6
-50.6
-60.6
-70.6
-80.6
-90.6
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Help
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1/24/23
15:40