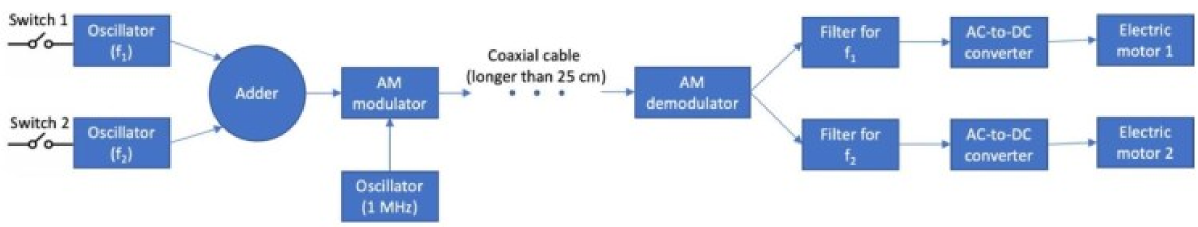
OBJECTIVE

Designing a system that controls two electric motors through a switch. The system to be designed will consist of the following subsystems.



DESIGN AND TEST PROCEDURES

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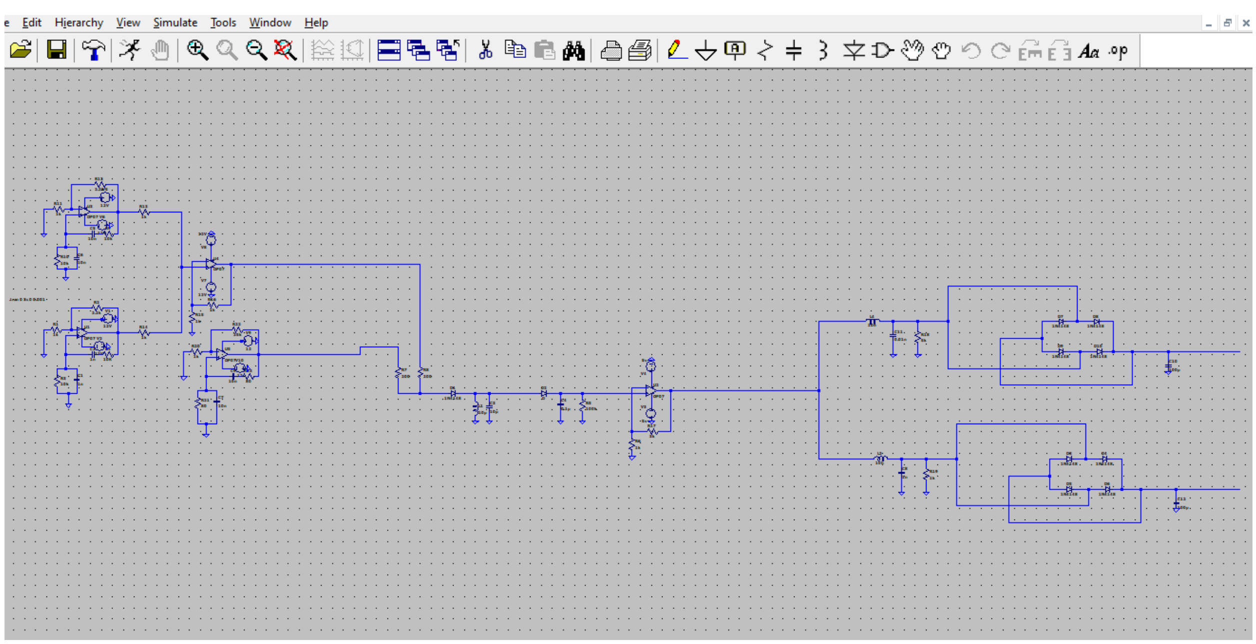
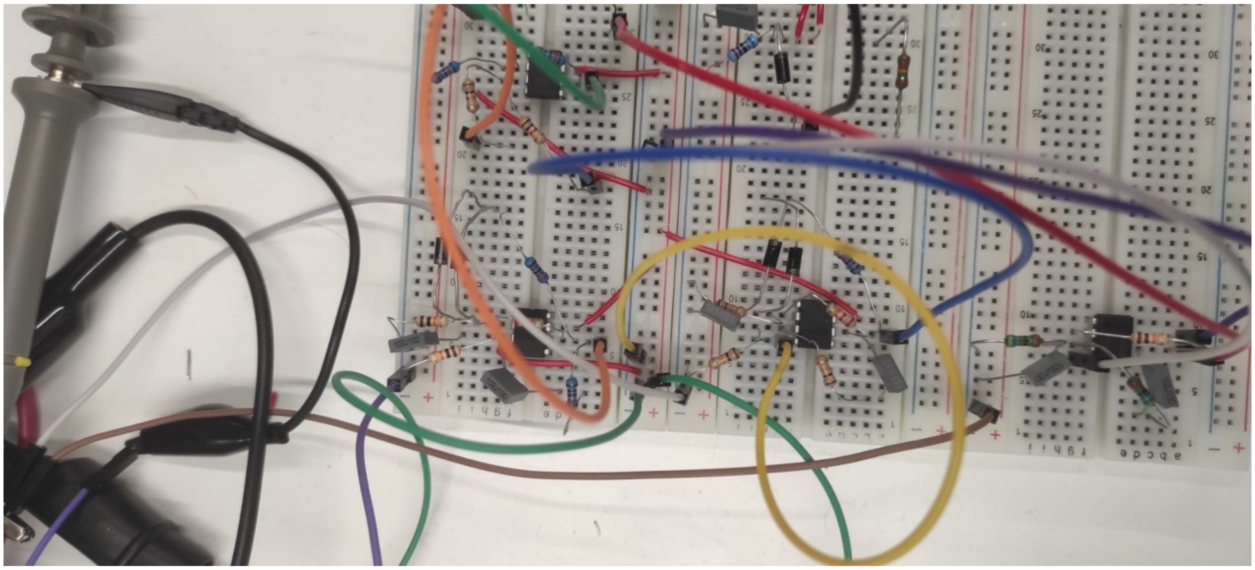
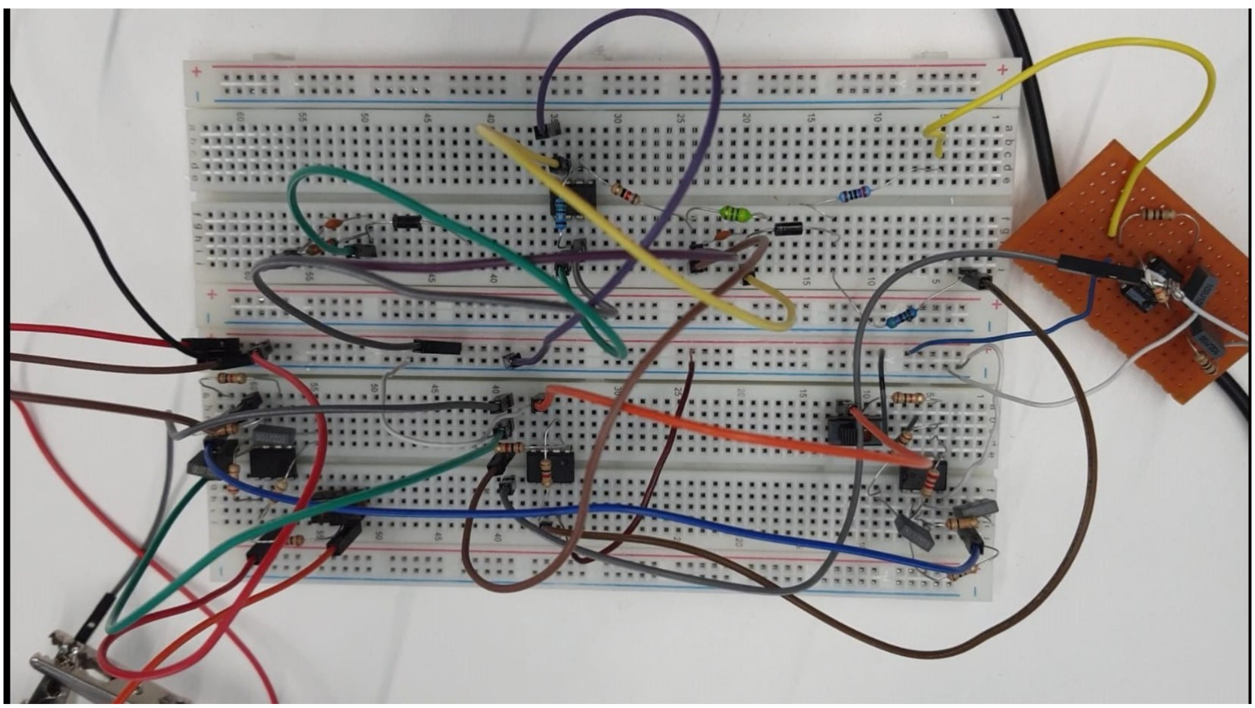
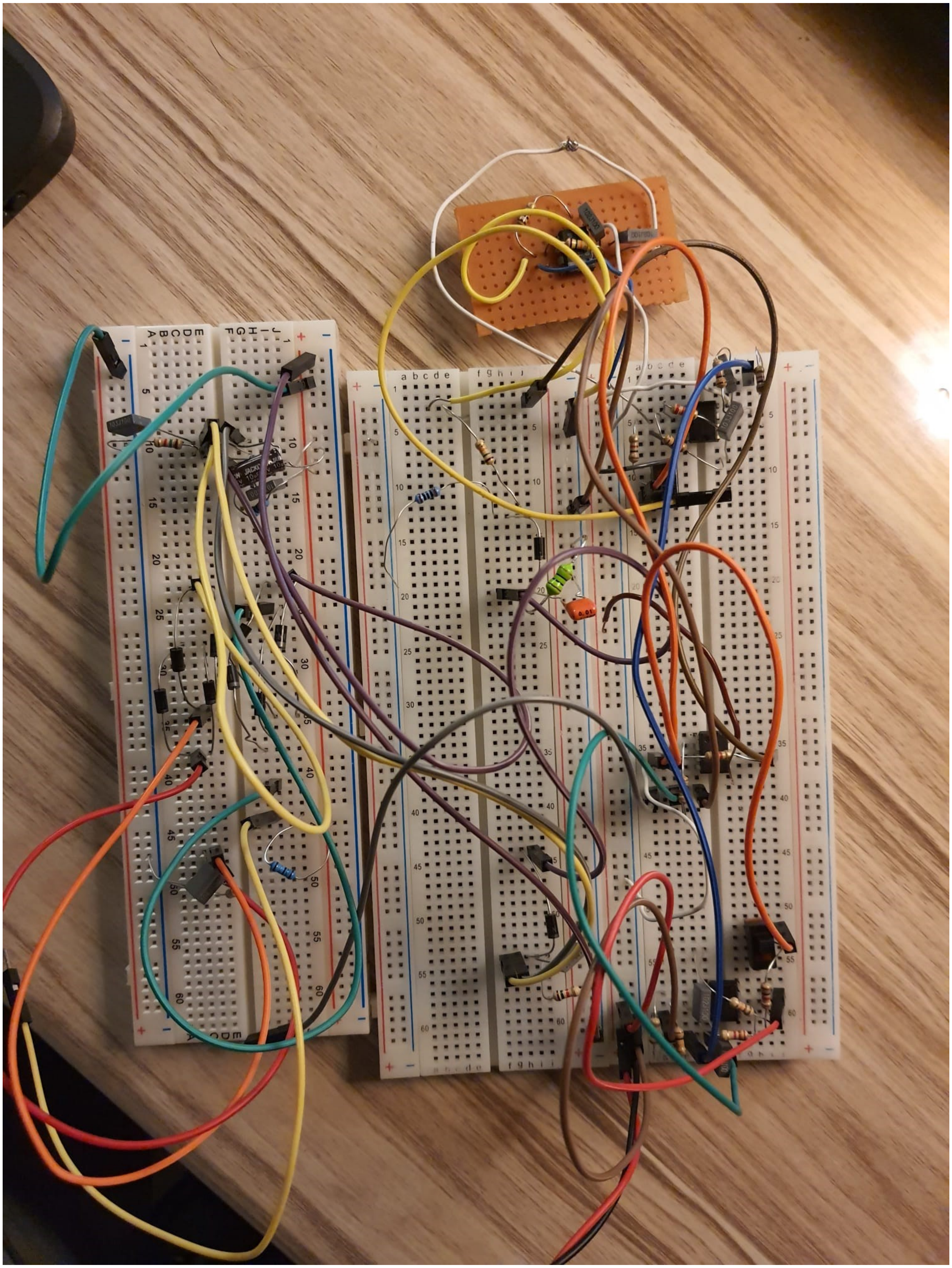


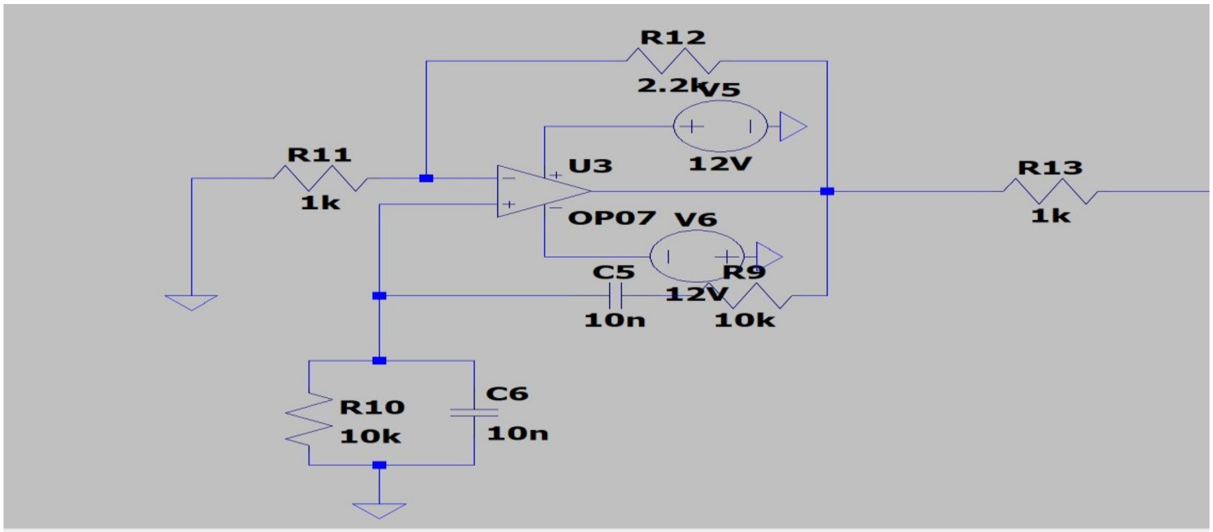
a clear diagram for the whole circuit together

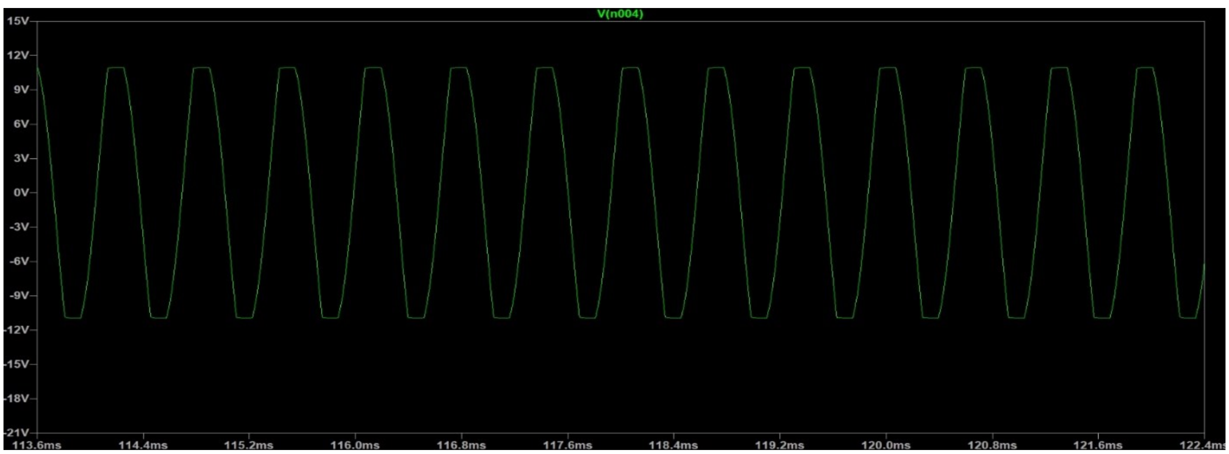


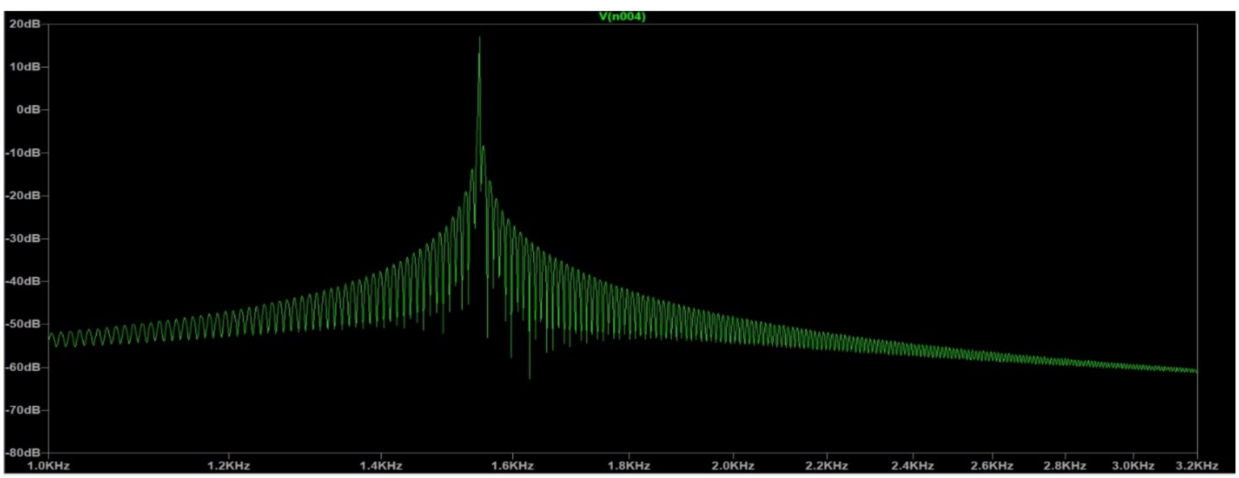




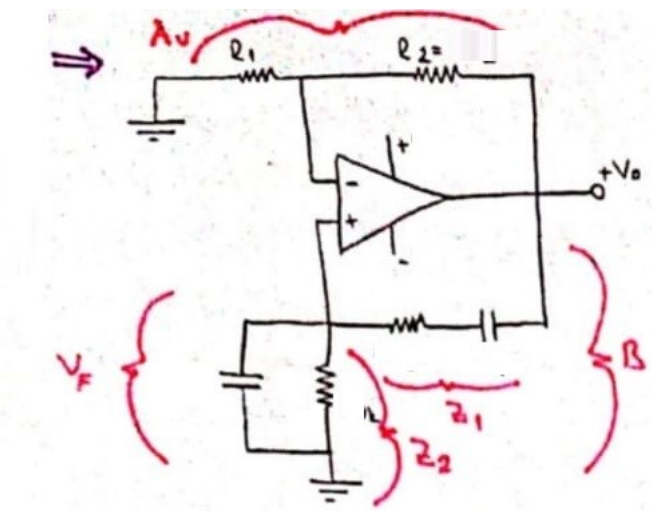
The first oscillator design and the output







The calculation of oscillator 1



$\boldsymbol{A_v}$ **= (1+$\boldsymbol{R_1}$/ $\boldsymbol{R_2}$)** ➡ B = $\boldsymbol{V_F}$/ $\boldsymbol{V_0}$ ➡ $\frac{z_2}{z_1+z_2}$

$$z_1 = R + \frac{1}{Jwc} = \frac{1+jwlc}{jwc}$$

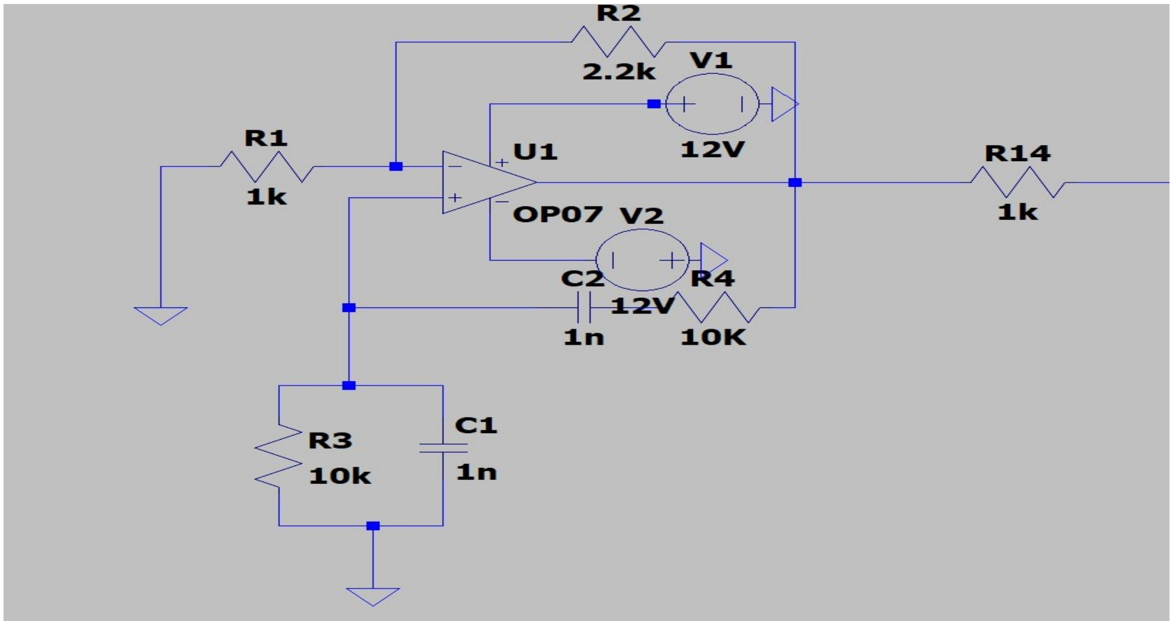
$$z_2 = \frac{1}{Jwc + \ (1/R)} = \frac{R}{1+jwcR}$$

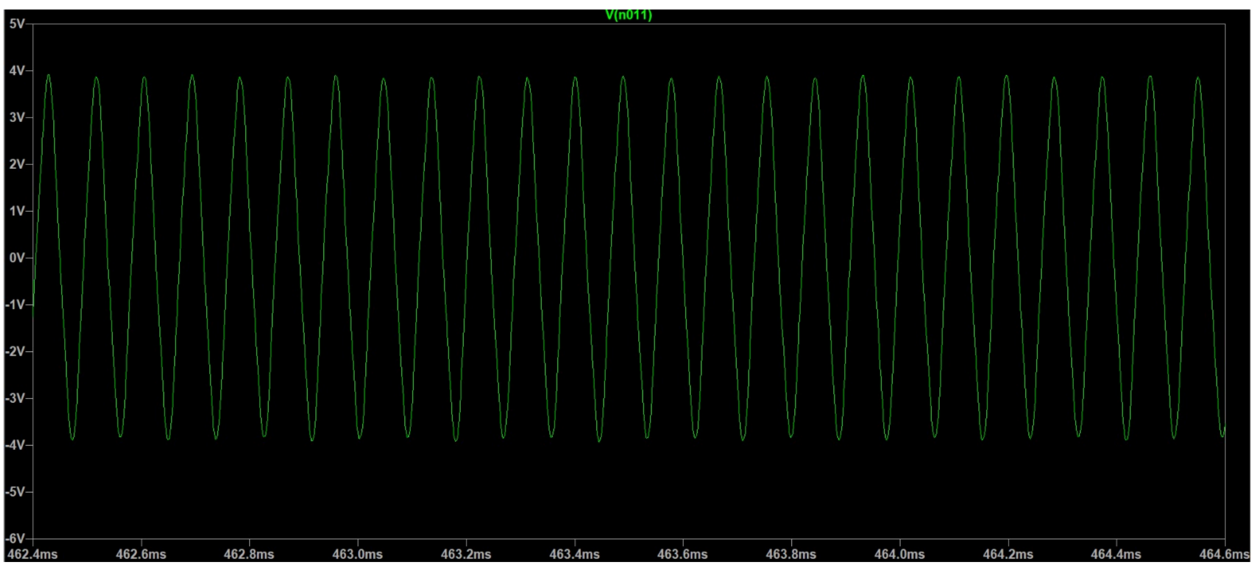
α = jwR ⟶ $z_2 = (\frac{1+j\alpha}{j\alpha}).$ R z = R / (1+ $j\alpha$)

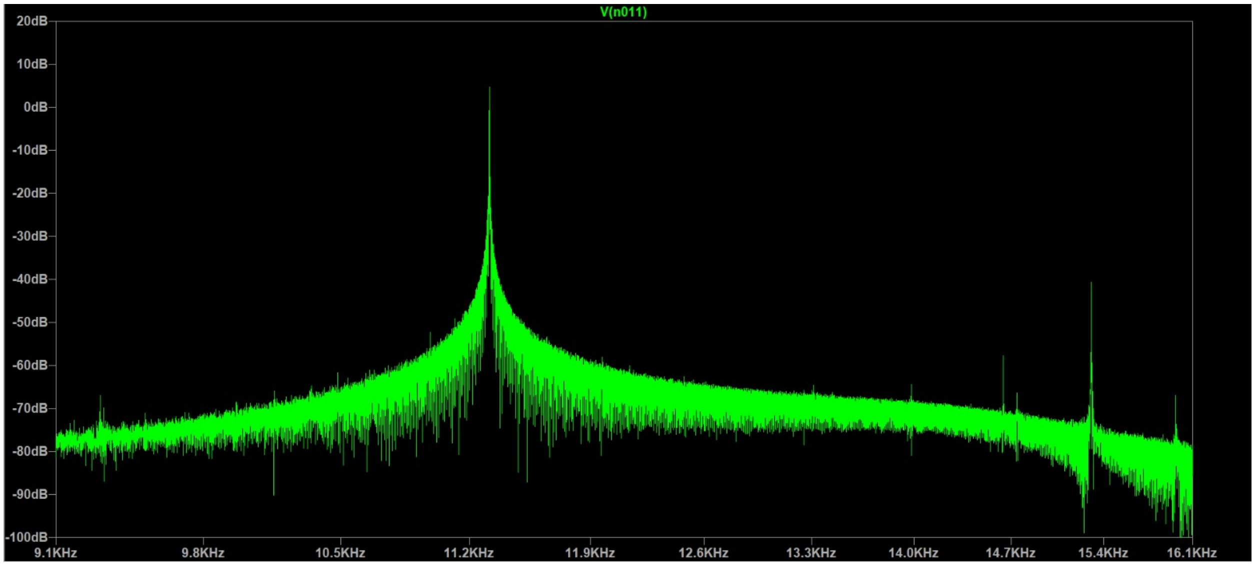
$$z_1+z_2 = \frac{R+JR\alpha}{j\alpha} + \frac{R}{1+j\alpha} = \frac{R+3jR\alpha-(R\,\alpha^2)}{j\alpha-\alpha^2}$$

B = $\frac{R}{1+(j\alpha)} * \frac{\alpha(J-\alpha)}{R(1+3j\alpha-\alpha^2)}$ ➡ $\alpha = 1$ ➡ $F_0 = \frac{1}{2\pi\sqrt{R_1C_1R_2C_2}}$ = 1.6 khz

The second oscillator design and the output:

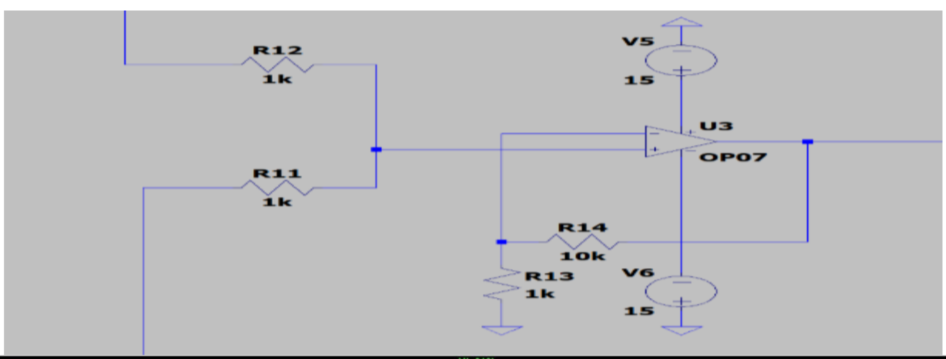


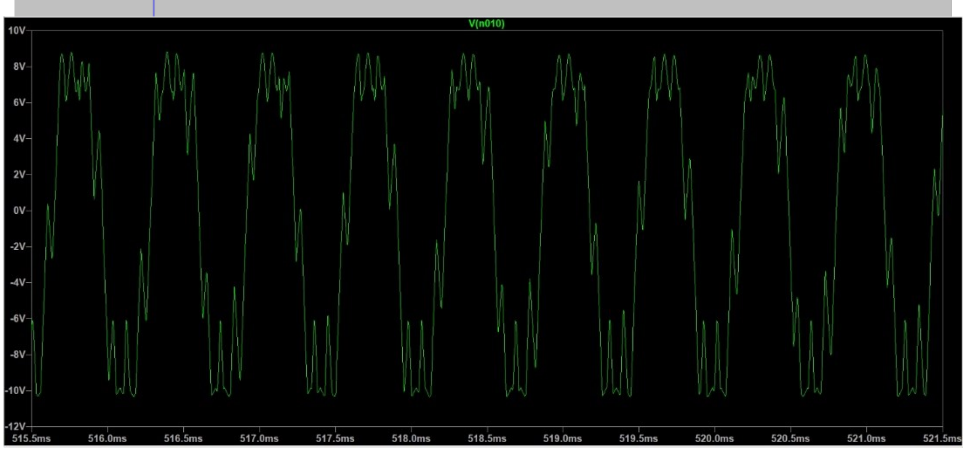


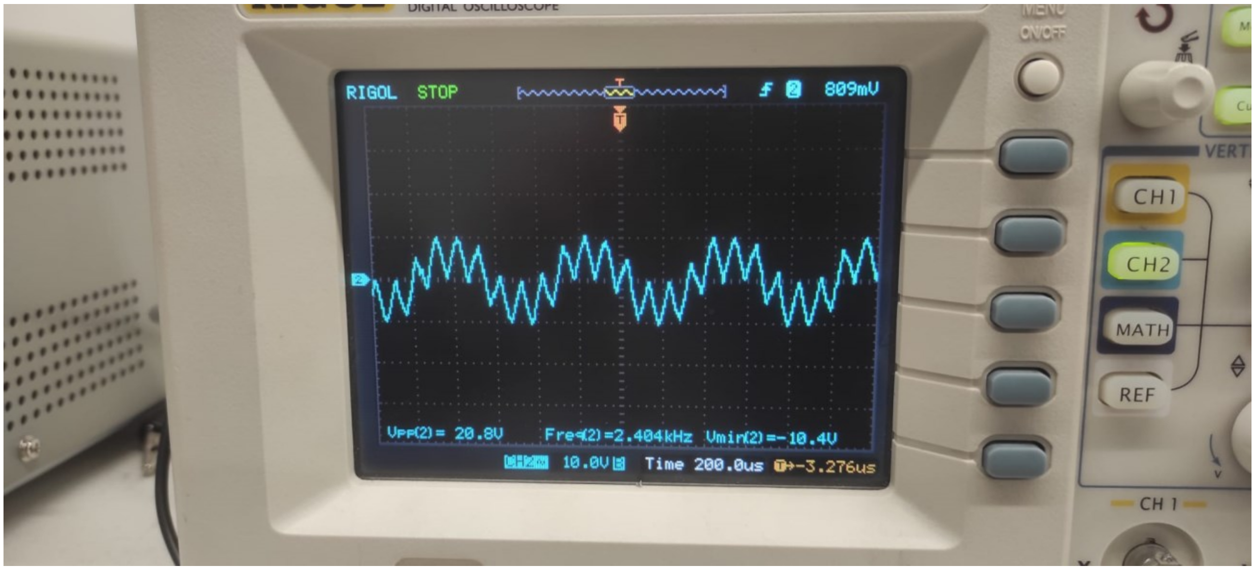


$$F_0 = \frac{1}{2\pi\sqrt{R_1C_1R_2C_2}} = 16 \text{ khz}$$

After the two oscillators are done, we have adder to collect the sinusoidal wave together to feed AM with the signal

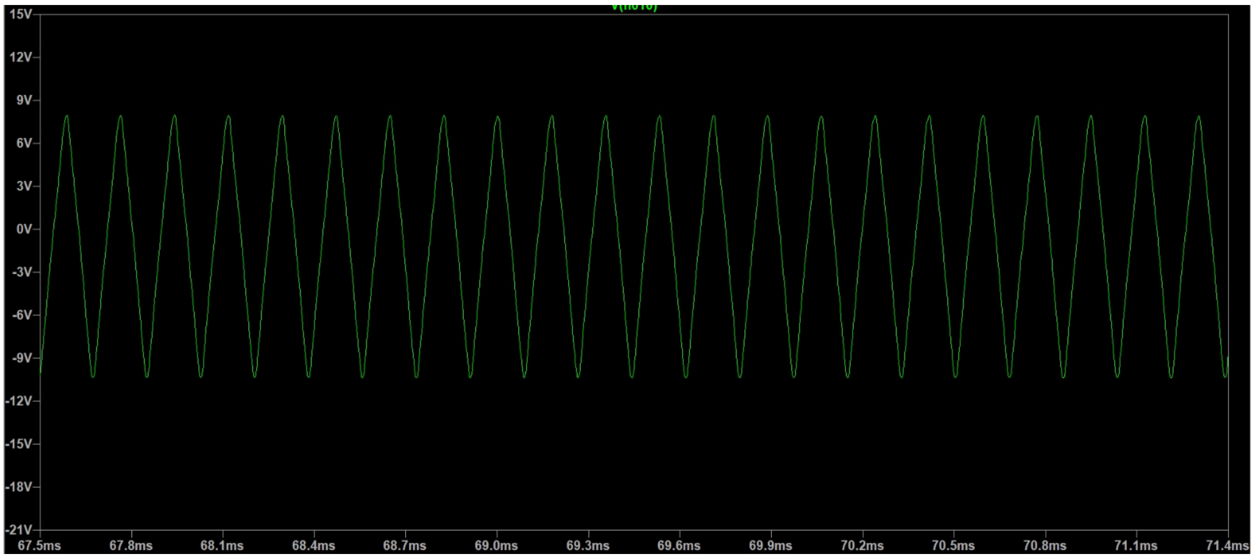


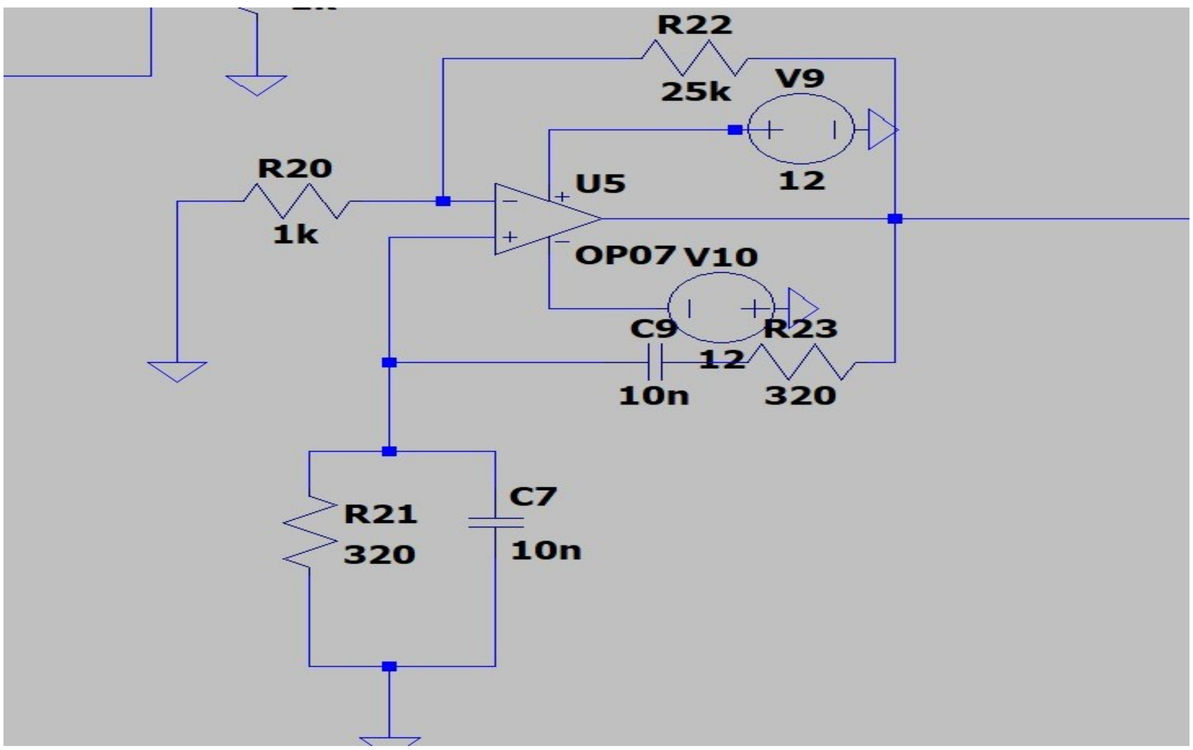


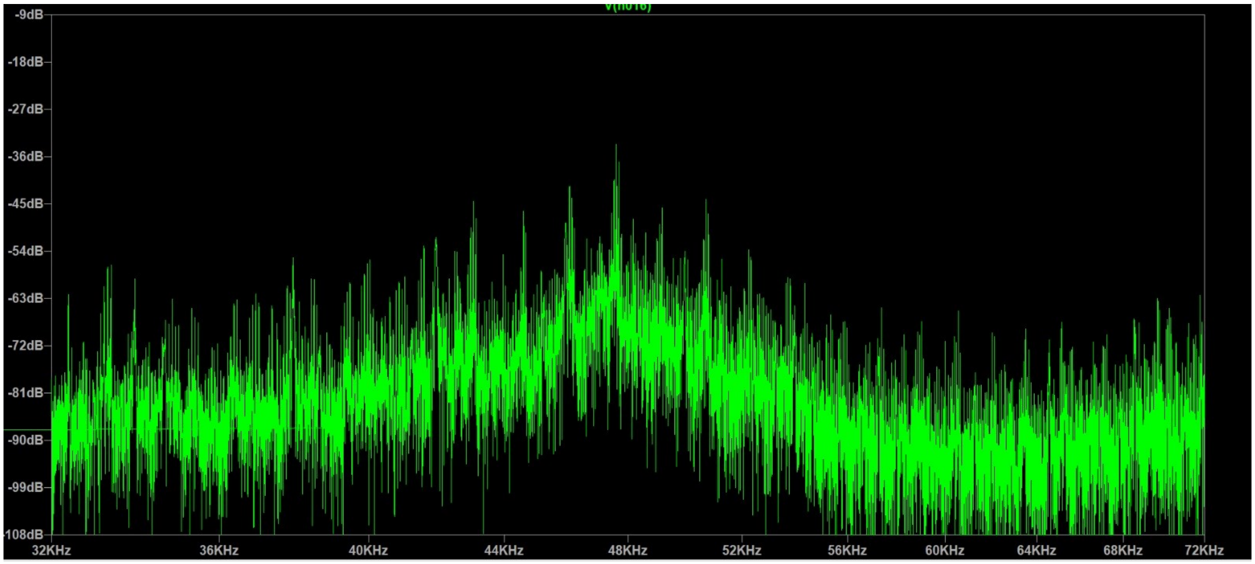


The adder parts

The modulator is also fed by 3rd oscillator


15V
12V
9V
6V
3V
0V
-3V
-6V
-9V
-12V
-15V
-18V
-21V
67.5ms
67.8ms
68.1ms
68.4ms
68.7ms
69.0ms
69.3ms
69.6ms
69.9ms
70.2ms
70.5ms
70.8ms
71.1ms
71.4ms

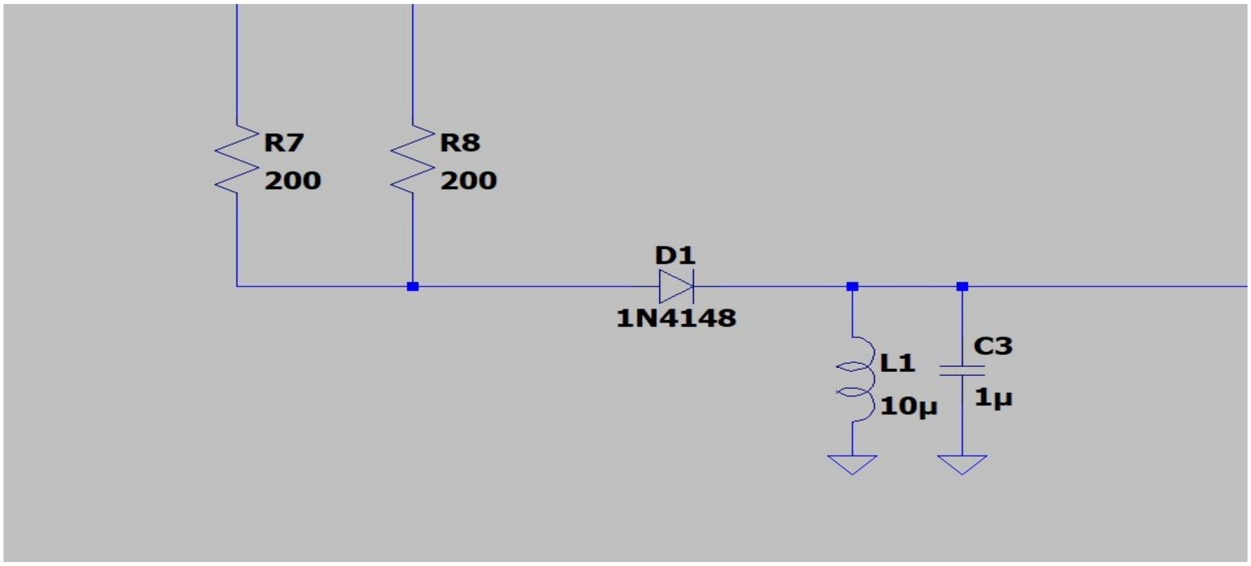

R22
25k
V9
12
R20
1k
U5
OP07
V10
C9
12
R23
10n
320
R21
320
C7
10n

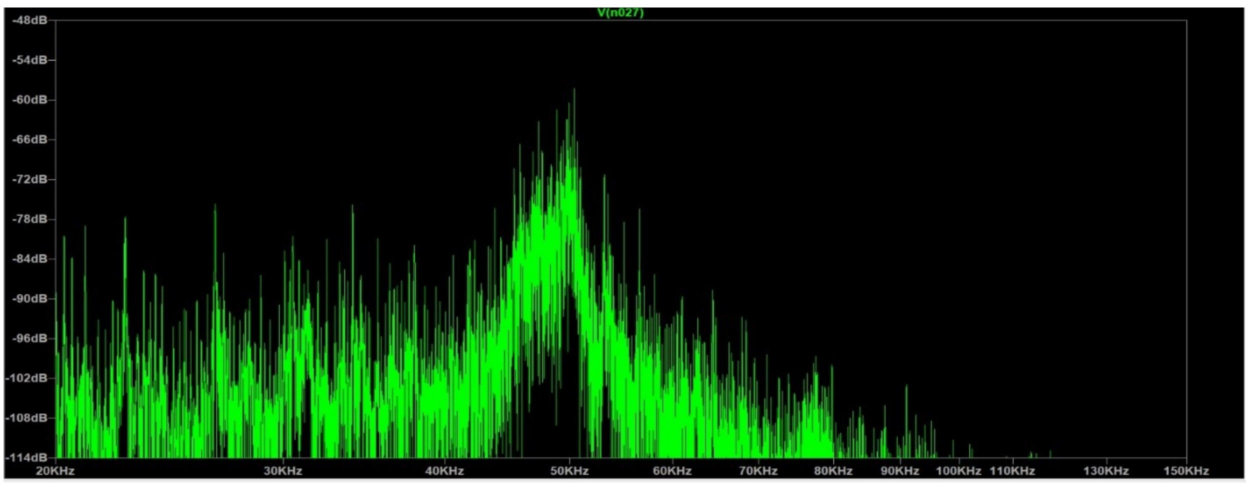


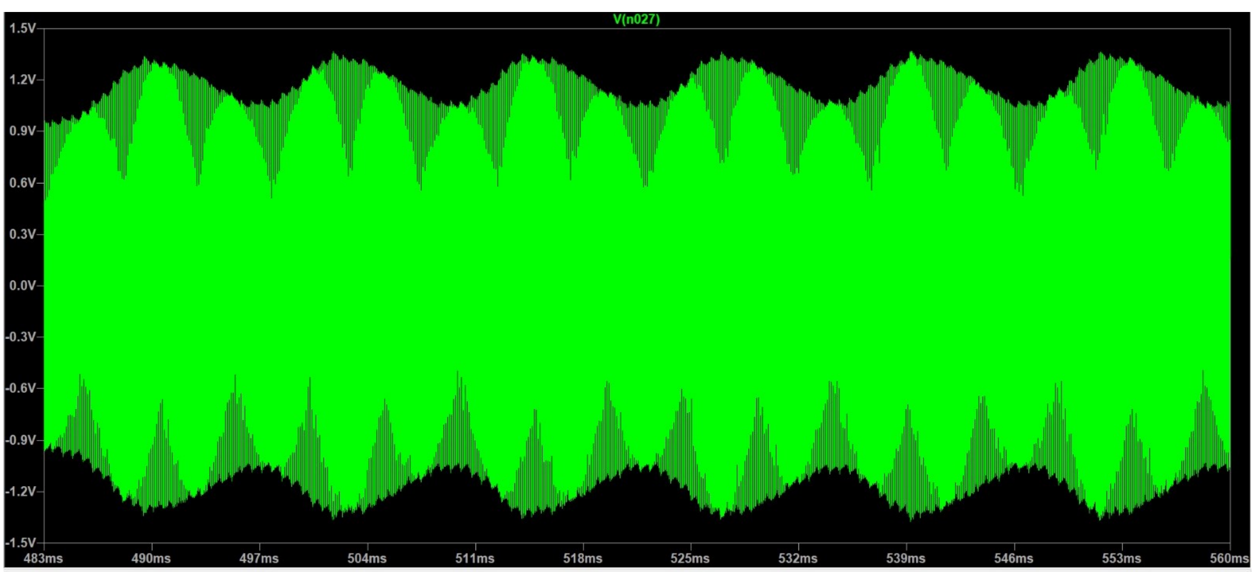
$$F_0 = \frac{1}{2\pi\sqrt{R_1 C_1 R_2 C_2}} = 50\text{khz}$$

The modulator usage and design:

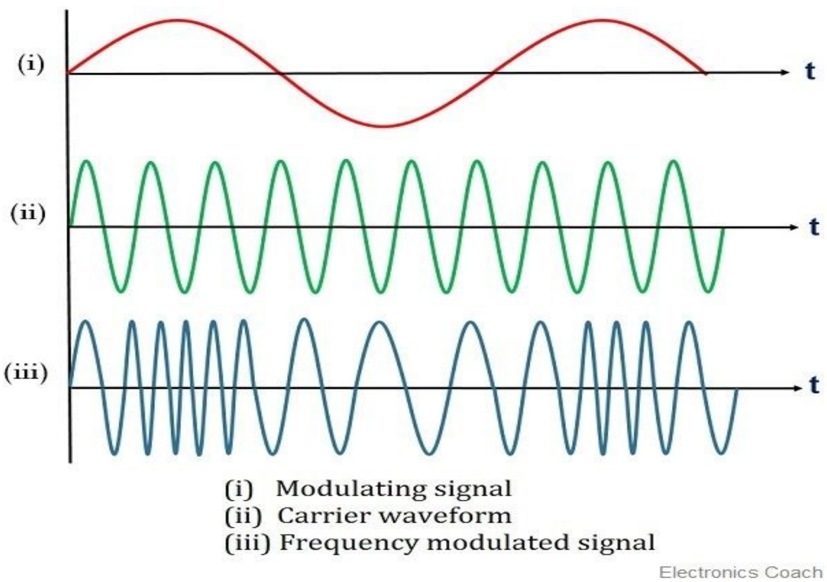
In this step, the process of altering some component of our sinusoidal wave carrier signal with an information-bearing modulation waveform, such as sound. In this sense, the information is carried by the carrier wave, which has a significantly higher frequency than the message signal.


R7
200
R8
200
D1
1N4148
L1
10µ
C3
1µ


V(n027)
-48dB
-54dB
-60dB
-66dB
-72dB
-78dB
-84dB
-90dB
-96dB
-102dB
-108dB
-114dB
20KHz
30KHz
40KHz
50KHz
60KHz
70KHz
80KHz
90KHz
100KHz
110KHz
130KHz
150KHz


V(n027)
1.5V
1.2V
0.9V
0.6V
0.3V
0.0V
-0.3V
-0.6V
-0.9V
-1.2V
-1.5V
483ms
490ms
497ms
504ms
511ms
518ms
525ms
532ms
539ms
546ms
553ms
560ms

The output above representing the following:



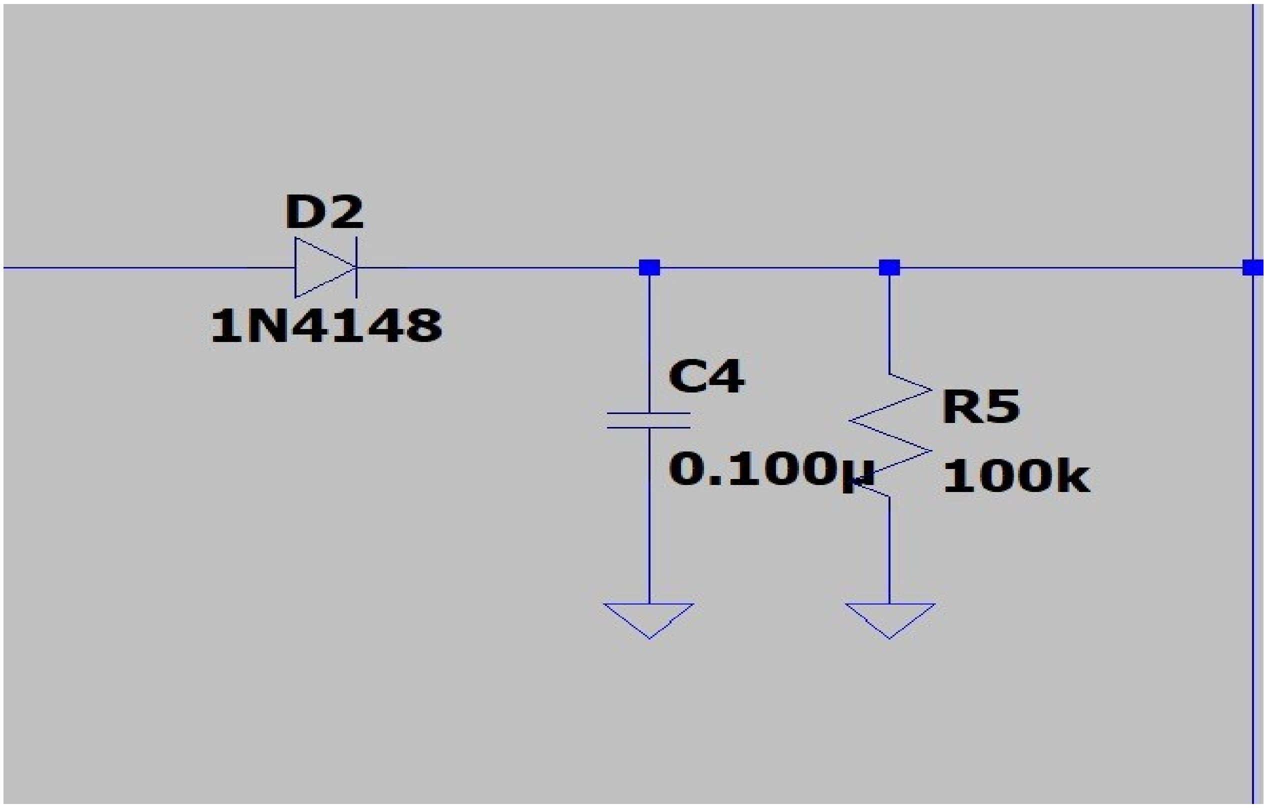
Frequency Modulation Equation

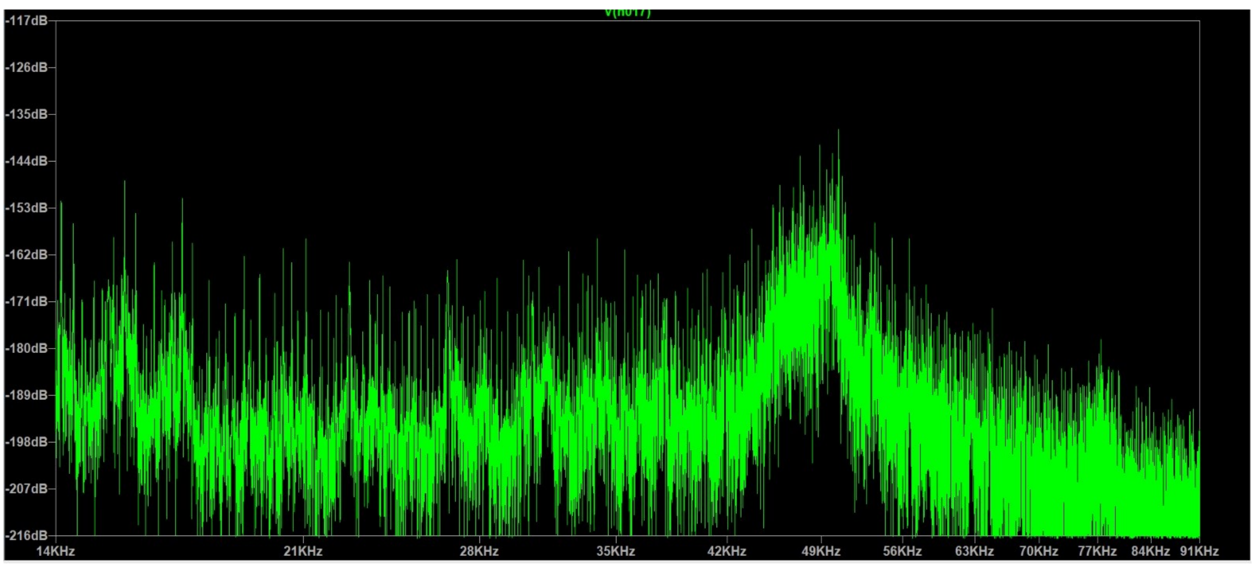
$F = \frac{1}{2\pi\sqrt{Lc}}$

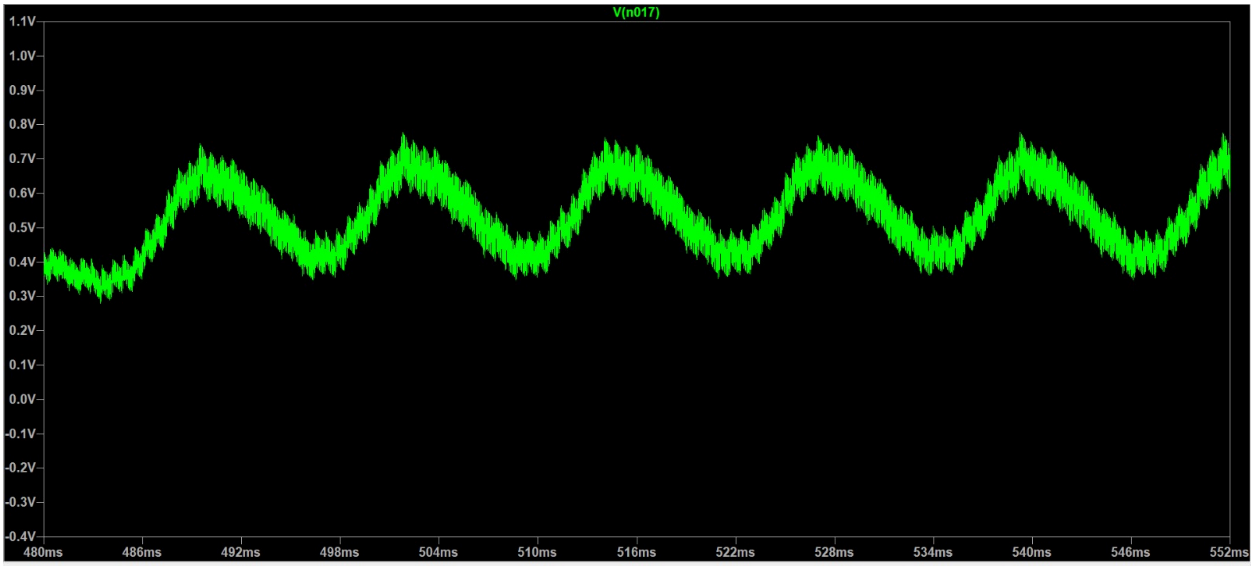
The signal out from modulation is going through long cable It enables us to send a signal over a specific frequency range known as the channel bandwidth. The modulated signals are not mutually exclusive. because, the lower the frequency of that signal the bigger the antenna required to transmit a signal.

After the signal went to the wire it will feed the demodulator:

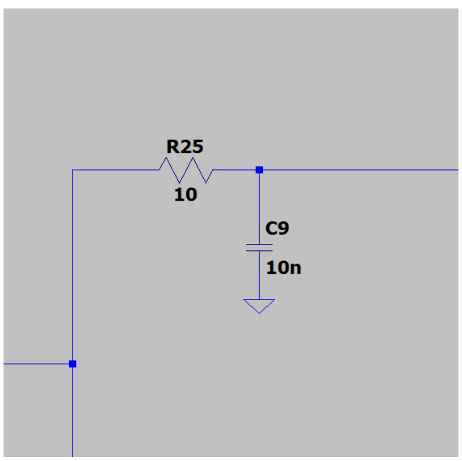
The buffer used before the demodulator to increase the very low frequency signal which came out from modulator


D2
1N4148
C4
0.100µ
R5
100k

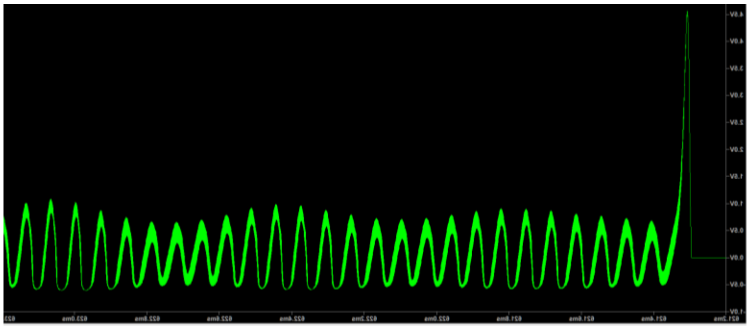

-117dB
-126dB
-135dB
-144dB
-153dB
-162dB
-171dB
-180dB
-189dB
-198dB
-207dB
-216dB
14KHz
21KHz
28KHz
35KHz
42KHz
49KHz
56KHz
63KHz
70KHz
77KHz
84KHz
91KHz



A simple technique to demodulate a signal with a carrier and two equidistant sideband components is to connect two filters, with the first device demodulating at the carrier frequency and the second at the sideband frequency.

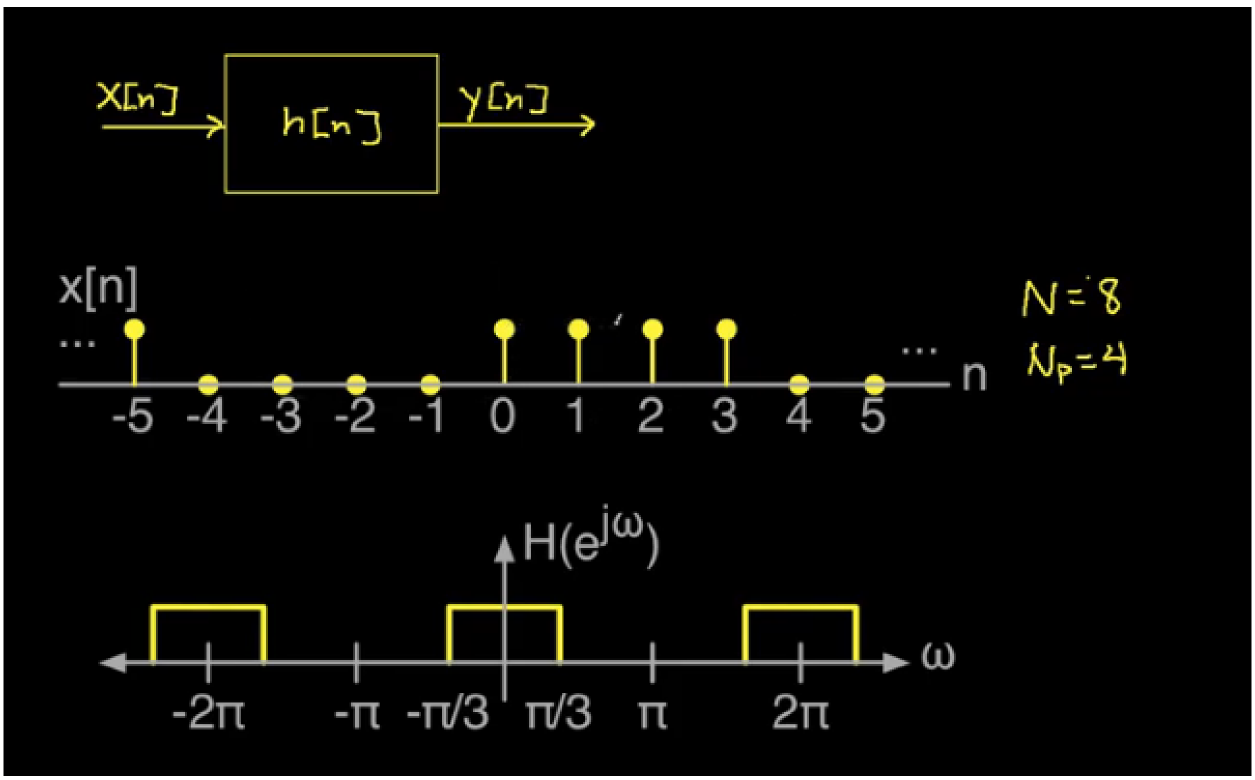


This low pass filter will allow the signal from first oscillator to be separated



This high pass filter will allow the signal from first oscillator to be separated

We use the frequency response of the filter to compute the transform of the signal input which as the Fourier transform of the out equal to frequency response times the Fourier transform of the input



Where X[n] is the system input and periodic square wave so it has a value of one for four samples and value of zero for four samples and H[n] is representing an ideal low pass filter with cut off frequency $\pi/3$ & Y[n] is the output transform

X [n] = $x\left(e^{jw}\right) = \sum_{-\infty}^{\infty} 2\pi \ * c_k * \eth \ (w - kw_0)$

$w_0 \ = \ 2\pi/n$ the fundamental frequency of the wave

$\eth = \ delta\ function \ \ / \ c_k \ = \ the\ coofecients\ of\ the\ series$

Where $c_k \ = \ e^{-j3\pi k/8} \quad \frac{sin(k\frac{\pi}{2})}{sin(k\frac{\pi}{4})}$

So, Fourier transform Y[n] = $\frac{1}{2\pi}\int_{-\pi}^{\pi} H_L(e^{jw}) \ dw$

$= \frac{1}{2\pi}\int_{-w0}^{wc} (e^{jwn}) \ dw$

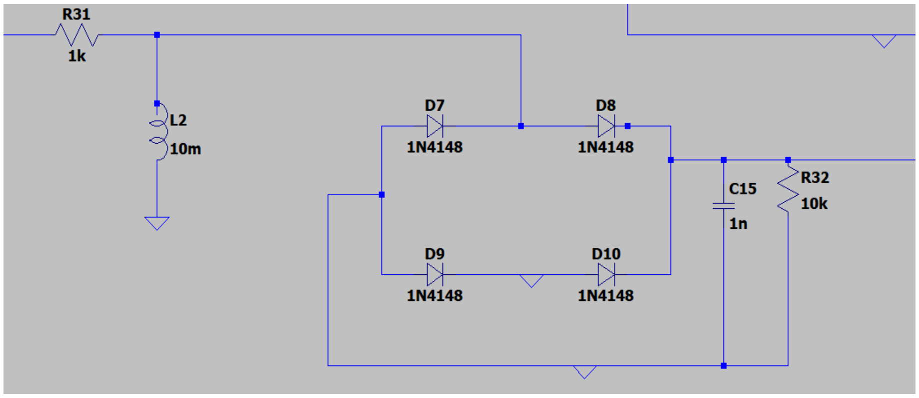
$= \frac{1}{2\pi} \ * \frac{1}{jn}(e^{jwn} - e^{-jwn})$

$= \frac{1}{\pi n} \ sin\ wcn$

But we suppose the filters were ideals

After the signal were filtered high and low will use a rectifier to get dc current to feed the motor

The amplified AC signal coming from demodulator undergoes rectification. For the first positive cycle, only the diodes D8 and D9 are in forwarding bias while for the second half, only diodes D7 and D8 are in forwarding bias. This special circuit arrangement is known as the Wheatstone bridge and the process is known as full-wave rectification. Finally, the sinusoidal AC signal is converted to DC signal



The out put signal will power the motor as

Electromotor construction and calculations

First of all, we determined the materials to be used in the construction of the electromotor. These materials are copper and coil wire, play dough to fix the copper wire and a magnet. We fixed the copper wire to the electromotor construction as two opposite poles and bent it to pass between the coil wire. We wound the coil wire by looping it to create a field for the magnetic flux. After wrapping the coil wire in a circle, we sanded it to reveal the conductive wire inside, since the ends are insulating. We passed the resulting coil wire ends through the middle of the copper wire we bent. We brought our magnet close enough by giving current to the ends of the copper wires. Here we have created an electromagnetic magnet. Thus, we made a simple electromotor.

Magnetic flux calculation

$$\Phi_B = \iint_{\Sigma(t)} \bar{B}(t).dA$$

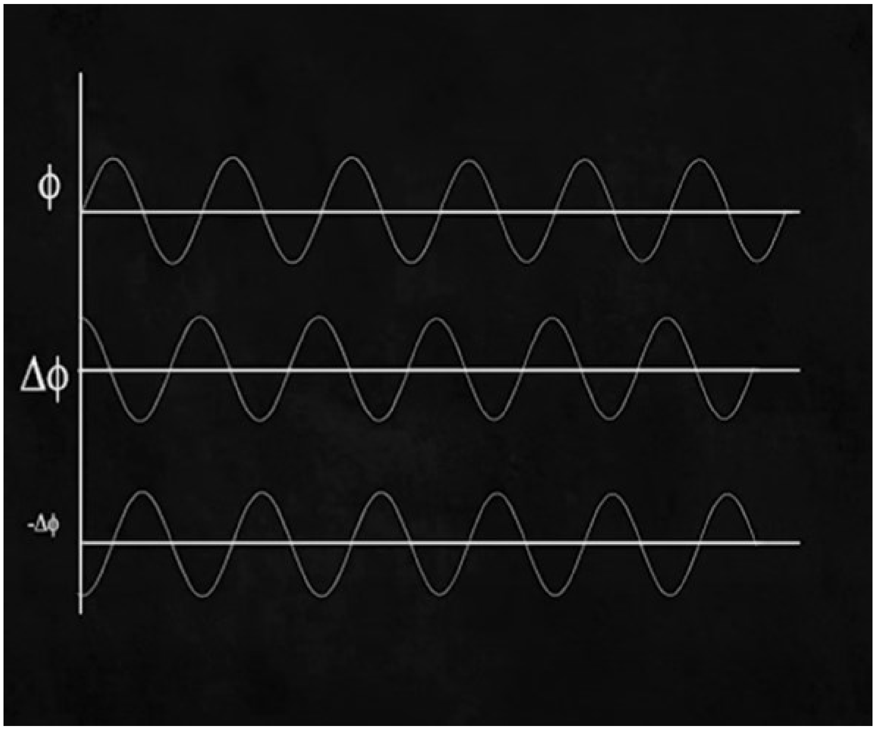
Where dA is an element of surface area of the moving surface Σ(t), B is the magnetic field, and B · dA is a vector dot product representing the element of flux through dA. In more visual terms, the magnetic flux through the wire loop is proportional to the number of magnetic field lines that pass through the loop.

Faraday's law states that the emf is also given by the rate of change of the magnetic flux

$$\varepsilon = -\frac{\mathrm{d}\Phi_B}{dt}$$

where ε is the electromotive force (emf) and Φ_B is the magnetic flux

The electromotive force around a closed path is equal to the negative of the time change rate of the magnetic flux surrounded by the path.



Magnetic torque calculation

The wire we wrapped is a circle with a radius of 4 cm and we wrapped it 7 times. In addition, the length of the coil wire was 30 cm. We gave a current of 2 amperes from both ends of the copper. According to this formula, we get a higher torque by increasing the area, the number of turns, and amps. By bringing our magnetic field closer to a stronger magnet or magnet, we increase the magnetic field, thus increasing our torque value. If everything was the same and we used a lighter wire, the wire would still be faster.

Magnetic torque has a formula that changes depending on some values.

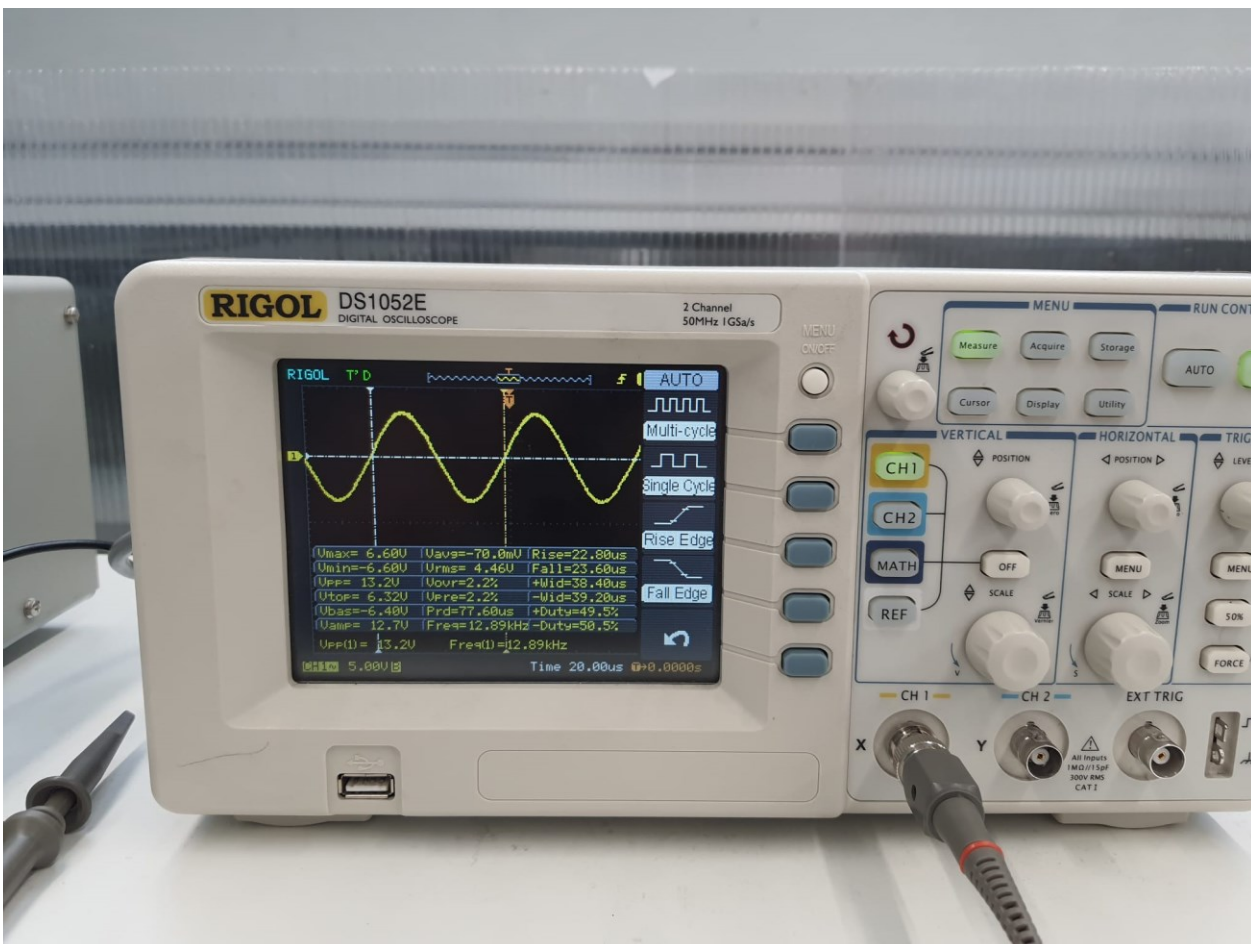
$$B_B = \frac{\mu \times n \times I}{L}$$

$$0{,}0000293207\ \mathbf{T} = (4 \times \pi \times 10^{-7} \times 7)/0.3$$

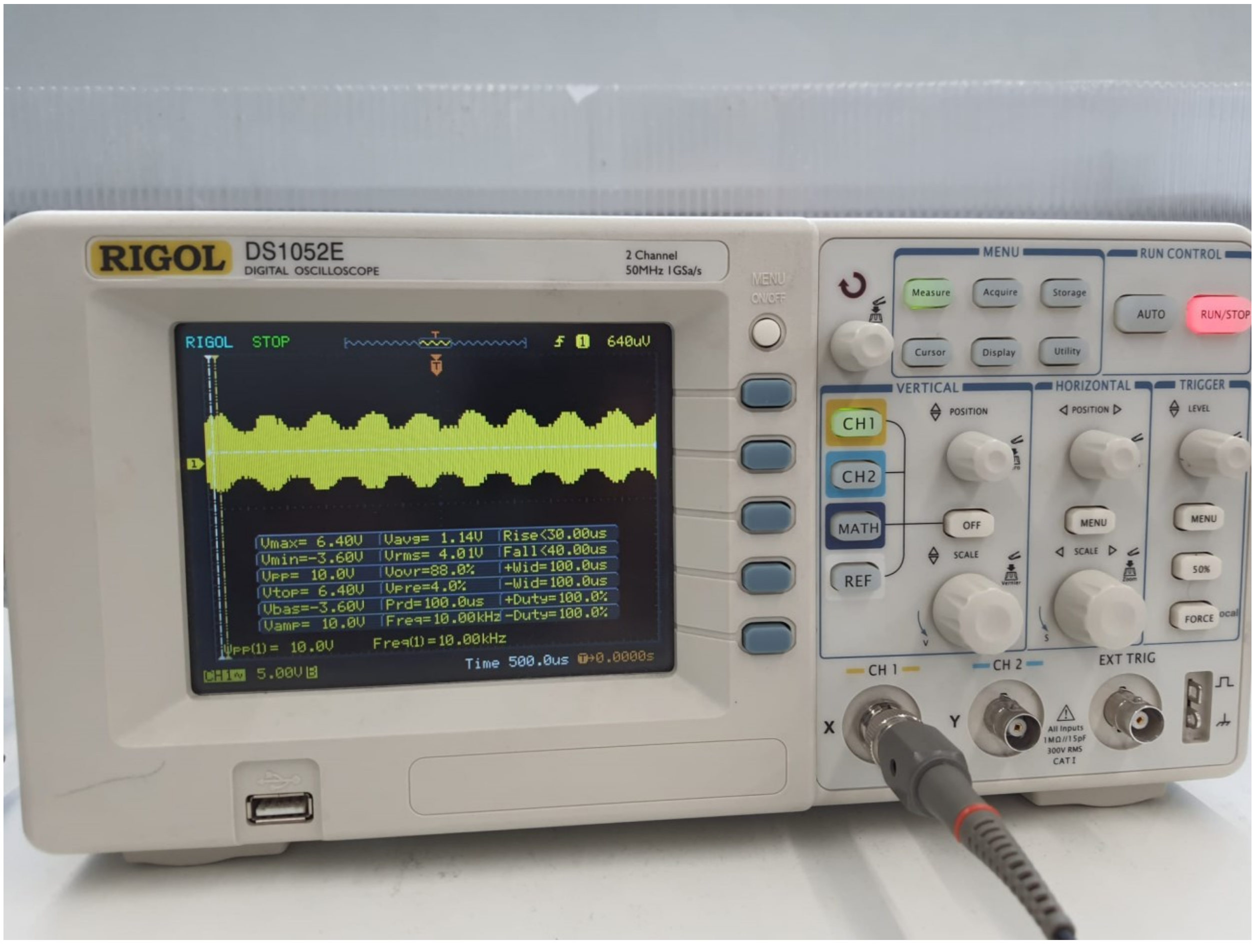
$$\tau = B \times I \, x \, \pi r^2$$

$$\mathbf{2,94763826} \times \mathbf{10^{-7}}[\boldsymbol{N.m}] = 2 \times \pi \, x \, 0.0016 \; \times \; 0,0000293207$$

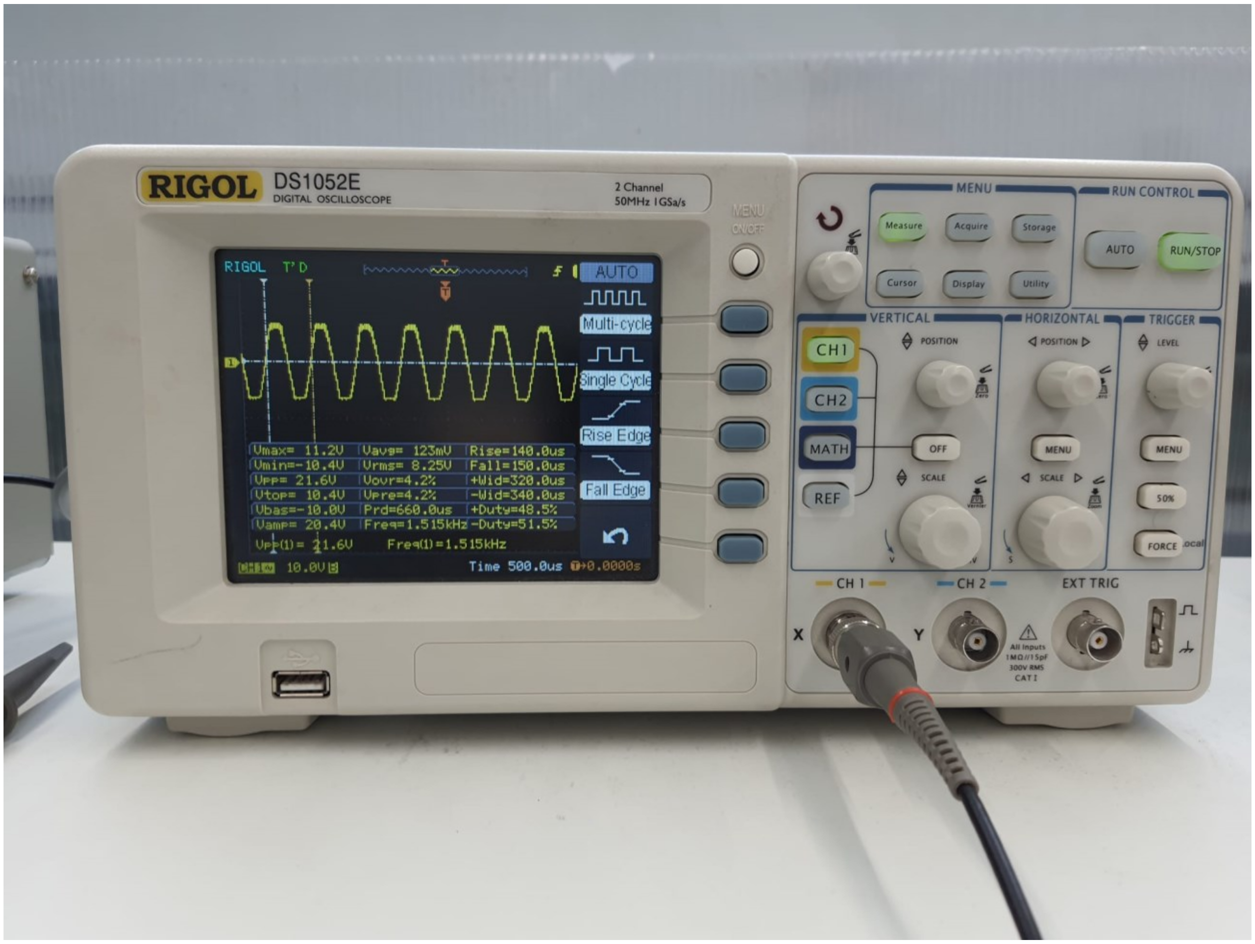
EXPERIMENT PHOTOS

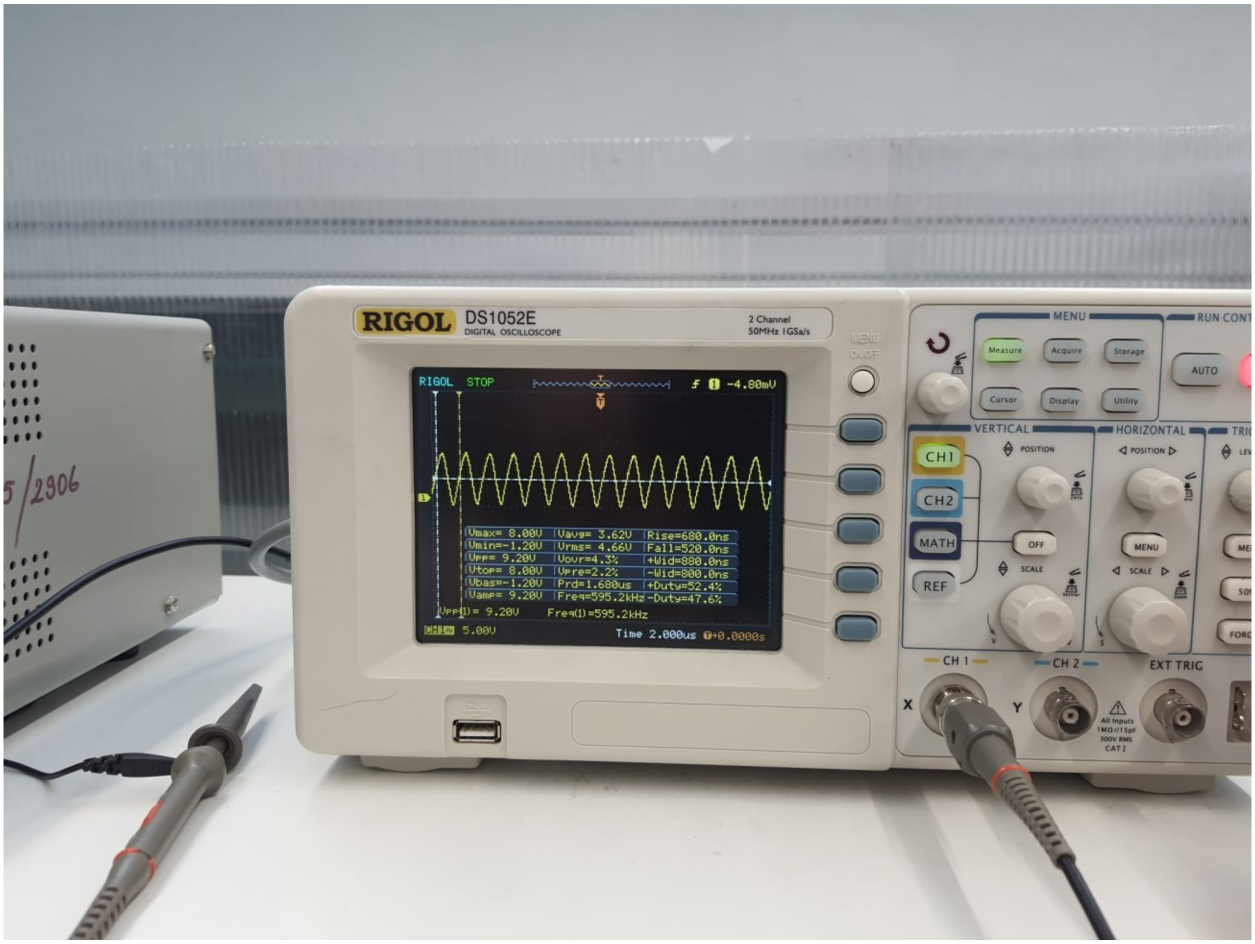


After the modulation

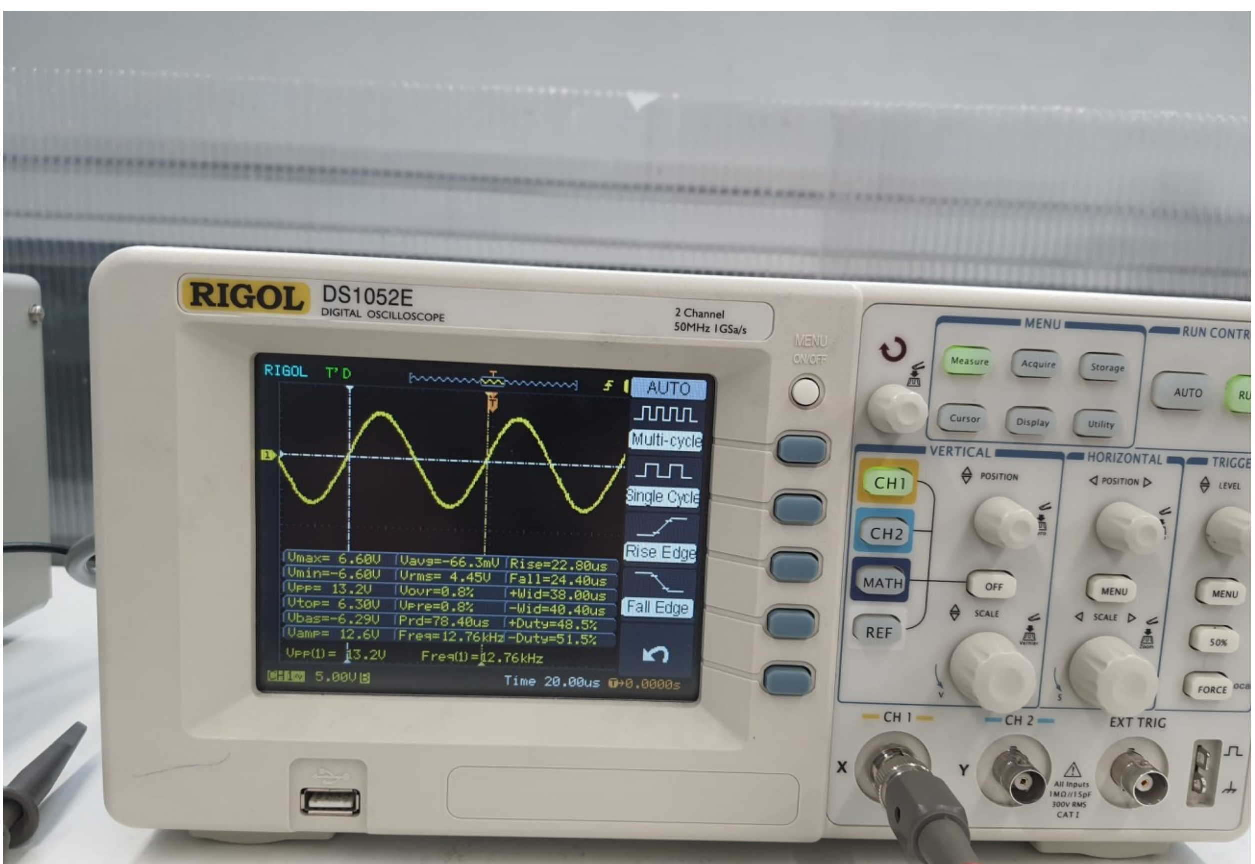


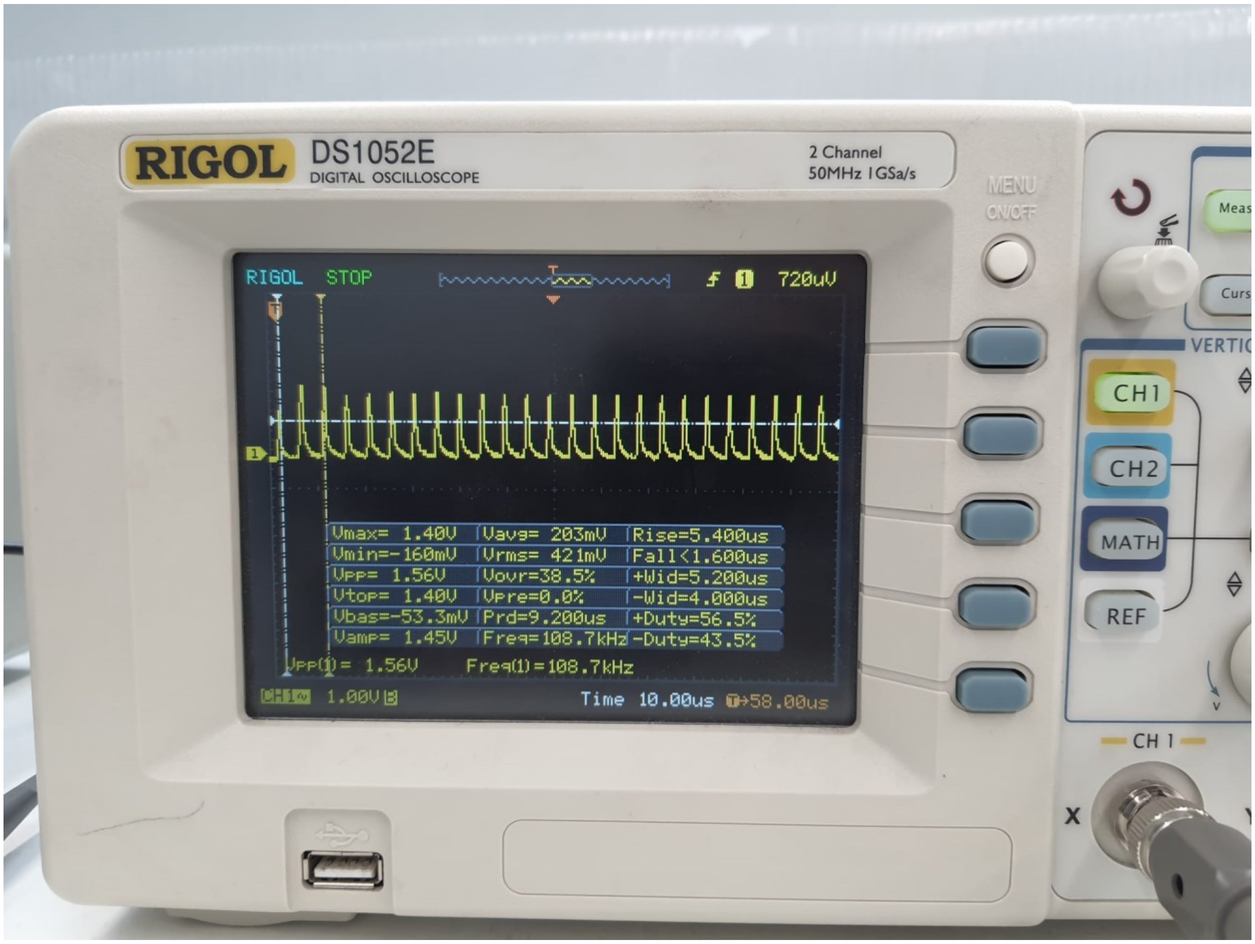
1.6 KHz wien bridge oscillator exit





15 KHz wien bridge oscillator exit




RIGOL DS1052E
DIGITAL OSCILLOSCOPE
2 Channel
50MHz 1GSa/s
RIGOL STOP
720uV
Vmax= 1.40V Vavg= 203mV Rise=5.400us
Vmin=-160mV Vrms= 421mV Fall<1.600us
Vpp= 1.56V Vovr=38.5% +Wid=5.200us
Vtop= 1.40V Vpre=0.0% -Wid=4.000us
Vbas=-53.3mV Prd=9.200us +Duty=56.5%
Vamp= 1.45V Freq=108.7kHz -Duty=43.5%
Vpp(1)= 1.56V Freq(1)=108.7kHz
CH1 1.00V
Time 10.00us T→58.00us
MENU ON/OFF
CH1
CH2
MATH
REF
VERTIC