AJEMA GLOBAL RESEARCH NETWORK

AMERICAN Journal of Engineering, Mechanics and Architecture
Volume 3, Issue 1, 2025 ISSN (E): 2993-2637

Study and Analyses Frequency Spectrum of the Modulated Signal

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Abstract: This article is about simulation of all the type of FM and AM with full control over every aspect of this two modulation including there amplitude modulation index and many more and show the difference between the AM type like double side band transmitted carrier and double sideband suppressed carrier and single side band suppressed carrier and show briefed compression between MATLAB Simulink with LabView and why should choose the LabView in the comminution simulation also studying spectral analyzer which can be used to measure frequency spectrum and the simulation that we done it include in Realtime modulation and FFT (Fast Fourier Transform) that used to show the signal in frequency domain , also we can mention that the simulation in this project contain wide range of excrement which mean it not limited for range of input value.

Keywords: FM signal, AM signal, DSB –SC waveform, spectrum analyzer, LabView.

1. Introduction:

And why analysis is important in first case of the technology filed [1]And the point is to analysis the frequency spectrum of modulation signal before the discussing the importance modulation,.[2]of thesis idea start discuss frequency spectrum of the electromagnetic wave he 'radio waves'. And in the Figure (1) show the range of the frequency [3].

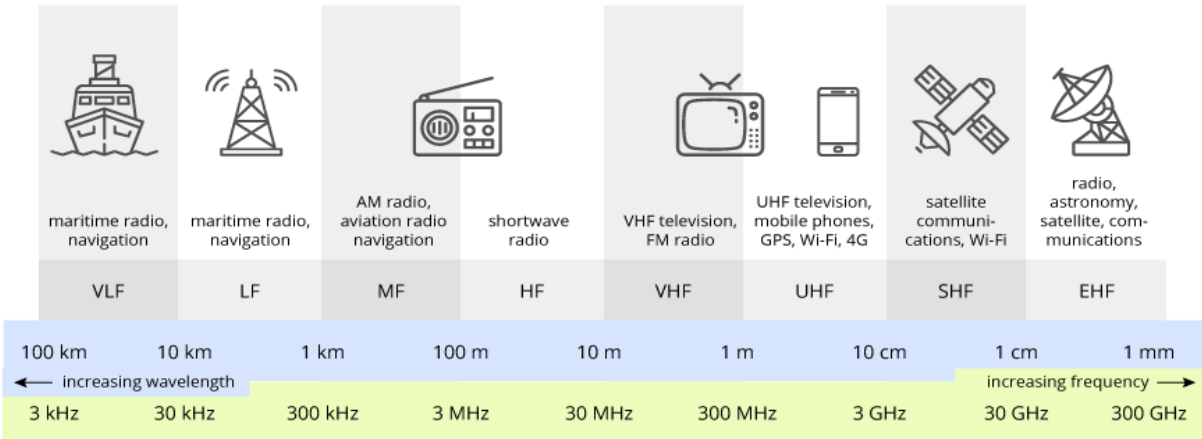


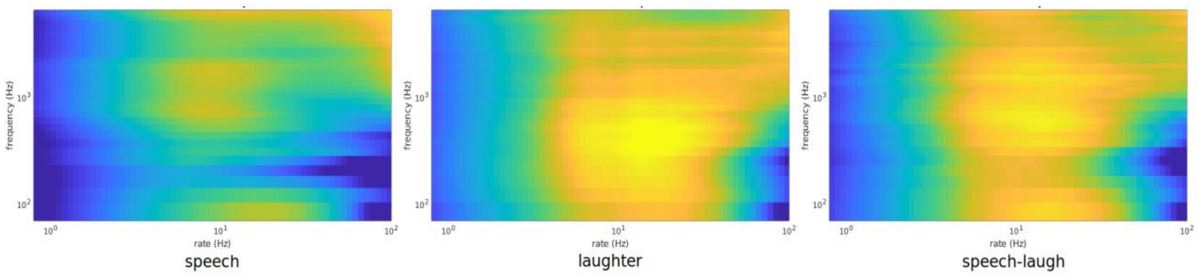
Fig (1.1) spectrum of Radio Frequency

the International Telecommunication Union (ITU). and table(1.1) show the itu band number until (9) .[4] As cyber threats continue to grow, so does the reality that digital satellite communications can be degraded and denied either through digital or

Table (1.1) information about bands

Band name	Abbreviation	ITU band number	Frequency	Wavelength	Example Uses
Extremely low frequency	ELF	1	3–30 Hz	100,000–10,000 km	Communication with submarines
Super low frequency	SLF	2	30–300 Hz	10,000–1,000 km	Communication with submarines
Ultra low frequency	ULF	3	300–3,000 Hz	1,000–100 km	Submarine communication, communication within mines
Very low frequency	VLF	4	3–30 kHz	100–10 km	Navigation, time signals, submarine communication, wireless heart rate monitors, geophysics
Low frequency	LF	5	30–300 kHz	10–1 km	Navigation, time signals, AM longwave broadcasting (Europe and parts of Asia), RFID, amateur radio
Medium frequency	MF	6	300–3,000 kHz	1,000–100 m	AM (medium-wave) broadcasts, amateur radio, avalanche beacons
High frequency	HF	7	3–30 MHz	100–10 m	Shortwave broadcasts, citizens band radio, amateur radio and over-the-horizon aviation communications, RFID, over-the-horizon radar, automatic link establishment (ALE) / near-vertical incidence skywave (NVIS) radio communications, marine and mobile radio telephony
Very high frequency	VHF	8	30–300 MHz	10–1 m	FM, television broadcasts, line-of-sight ground-to-aircraft and aircraft-to-aircraft communications, land mobile and maritime mobile communications, amateur radio, weather radio
Ultra high frequency	UHF	9	300–3,000 MHz	1–0.1 m	Television broadcasts, microwave oven, microwave devices/communications, radio astronomy, mobile phones, wireless LAN, Bluetooth, ZigBee, GPS and two-way radios such as land mobile, FRS and GMRS radios, amateur radio, satellite radio, Remote control Systems, ADSB

electromagnetic means. If these capabilities are compromised, however, high frequency radio provides a means to continue communicating even beyond the line of sight by leveraging the ionosphere to refract radio signals back to earth.and the challenge is to be able to analyse these high frequency range and to able to study it properly and make sure the percentage of error of instrument that capable of spectra these signal are not impacting the accurate result [5].



and to be able to analyse and study also at the same time to be able to experiment these studies to evaluate them accurately and prove it is another struggle as we said before these high range frequencies are difficult to spectra. Is to analyses and study briefly the am and fm spectrum of frequency and the result of study evaluating them by using communication instruments and communication software. and brief comparison between different frequencies from collected data .Spectrum wide range of frequency with frequency analyzer and the FFT technique of oscilloscope . the aim of this paper is: to make overall study of frequency spectrum of modulated signal, improve communication technology, study impact of noise in frequency of modulated signal, show brief comparison AM - FM - PM using MULTISIM, study high frequency modulated signal of wireless communication, study frequency impact of distortion of power.In one of the research papers they worked out vocalizations generalized and in the FIG(2.1) the different frequency analysing of speech so the idea of these research was to know the different of frequency rate.

FIG 2.1 modulation index spectrum obtained for the three considered classes: speech, laughter and speech-laugh. The vertical axis represents the audio frequency, while on the horizontal axis we have the modulation rate.

In the thing thats good about these analysis is can be used for machine learning or AI to detect if these sound made by human when they send it is which type and the problem is like the research have been make model for it is that the accuracy or the difference between these sounds of laughter and speech by general is not that much [6] .

And also in one of the other research that discuss and , which the analysis the modulation index in purpose to see the effect of these modulation index on the noise on the modulated signal and in the FIG(2.2) show the experiment they have been done it in one of their circuit

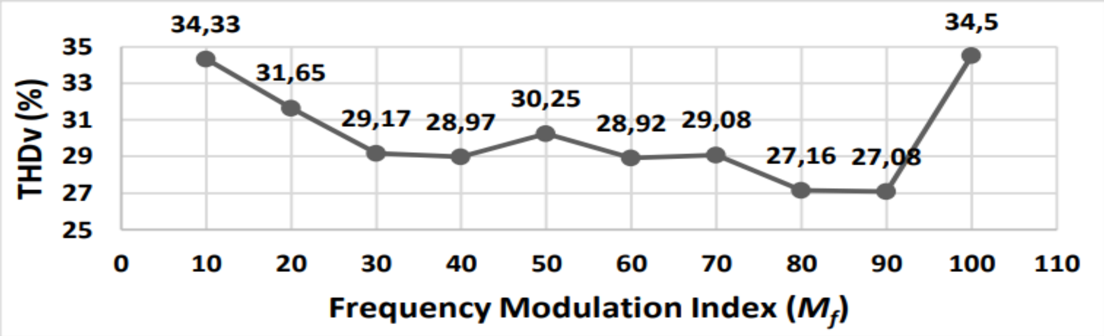


FIG (2.2) Effect on THD vs frequency modulation index

And the advantage of these research its that can be used to improve electronic circuit and improve also the efficiency of the circuit , the quality of message can be improved from using lower THD [7] The aim of another paper is to review and the research focused on IM(Index of modulation) and how it will impact the new technology advantage is new vision of . [8] And the narrowband FM is not explained in these research which count as disadvantage in our opinion [9] QCL The frequency effects with normalized to the current modulation index m, as function of the modulation frequency between 800 kHz and 160 MHz The IM index normalized FM behavior is consistently slightly larger in the ring-devices, advantage is that . [10] In another research purpose, using In order to improve reliability and the main point to lower frequency range of these circuit by modify frequency of carrie in manner of output voltage so in the FIG(2.3) .And the advantage for these research was By changing the carrier frequency, extending the harmonic spectrum, CCFMT to TSMC. The proposed new CCFMT can effectively improve the reliability of commutation, solve the narrow pulse problem, and simplify the commutation process. [11] simulation analyses then determined that AOIM not only affects the calculation of PMD and the frequency range of pmd show that also [12],

3. Mythology:

In this paper we show in depth the Am modulation and Fm modulation Frequency spectrum with LabView

3.1-AM Modulation

In this section we will discuss the AM Double side band and AM Double side band suppressed carrier and Single Side Band suppressed Carrier modulation and the block that have been used to represent each one of them

3.1.1-AM-DSB-LC(Amplitude modulation double side band latch carrier)

so these type of modulation mean there will be double side band in the modulation wave with a carrier so the equation for these modulation will be as follow in the equation (1)

St=Ac[1+1Acm(t)]coswct

The S(t) mean the modulated signal and the Ac mean the carrier amplitude the coswct it's the carrier signal and need to use these equation to make the Simulink with LabView in the Figure(3.1) show the block diagrams of the am modulation.

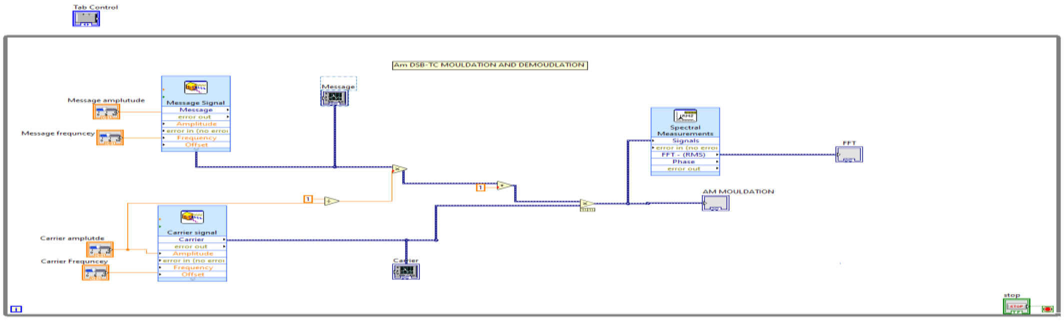


Fig (3.1) Am DSB-Tc or Am DSB-LC modulation block diagram

So in these block diagram the equation that we showed have been used and convert to the block diagram the message signal is sin wave form so the information entered as follow for the signal block in the Figure (3.2)

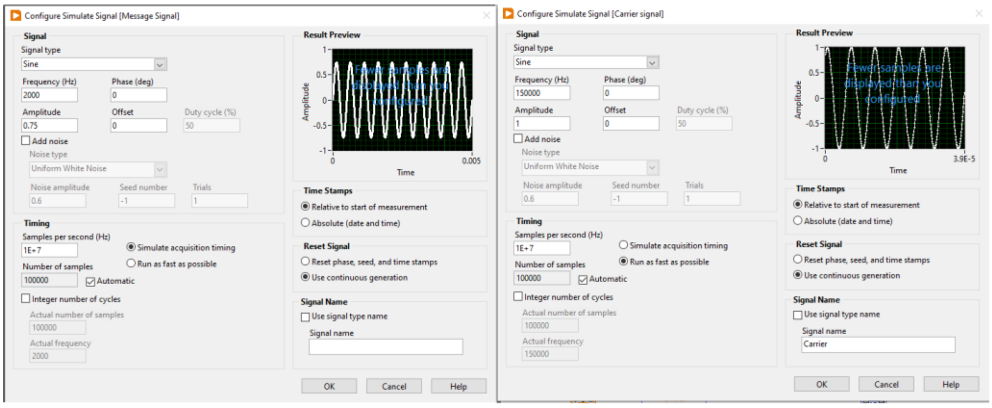


Fig (3.2) information entered for message and carrier signal

And the figure showed the information the have been entered with sample rate higher than the message and carrier frequency and the amplitude and carrier amplitude have been entered and also there frequency but the and the amplitude will varies between

And the varies part done be scroll bar numeric and it shown in the Figure(3.3)

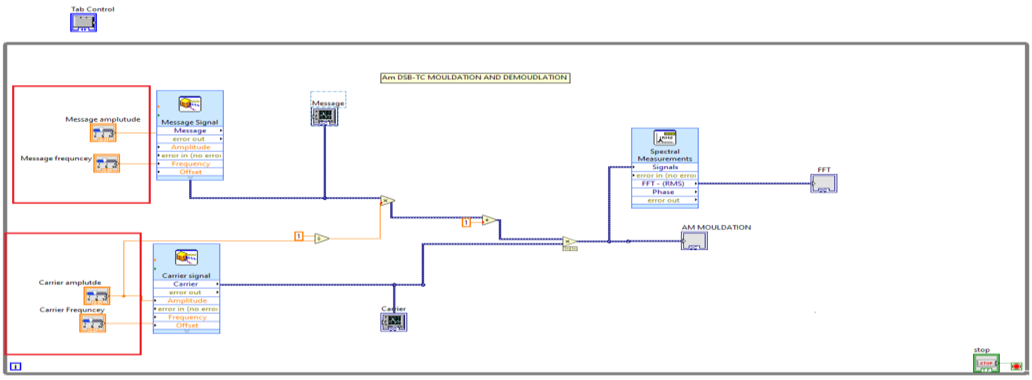


Fig (3.3) it shows the amplitude and frequency slide bard for message and carrier

And after that the carrier signal multiplied by the one plus the one divide by the carrier signal also multiplied by message signal and after the summation with help of numeric in LabView the wave connected to the Spectral analyzer and also the wave form indictor

3.1.2-AM-DSB-SC (Amplitude modulation double side band Suppressed Carrier)

In these type of modulation the carrier frequency will be zero ideally and the equation (2) will be simply

$$S(t) = m(t) \times Accoswct$$

And the block diagram will shown in the Figure (3.3) and the difference between these and the latch carrier or the transmitted carrier that the power loss will eventually will be higher than these suppressed carrier cause from the name it clear that we get same message from both of the modulation but will less power in one of them

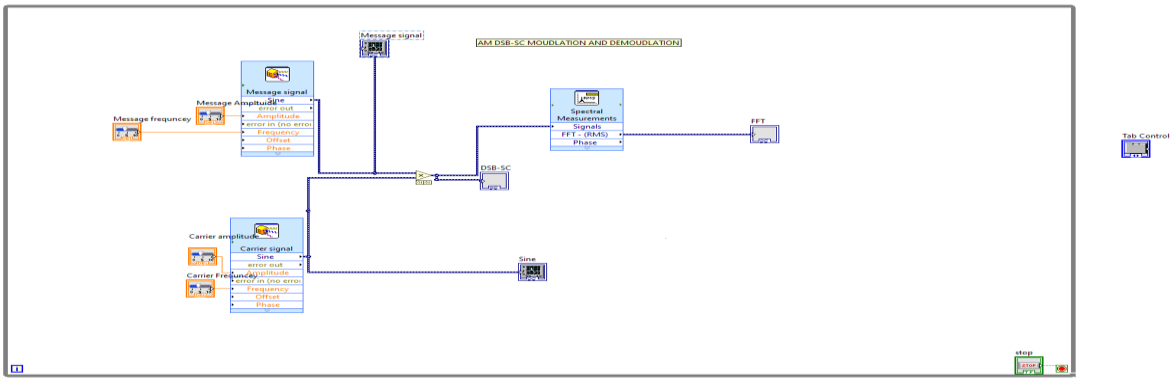


Fig (3.4) the block diagram of am double side band suppress carrier

And as we showed the viable part for the signal and the sample rate and frequency variable is same, we not gone go through that again

3.1.3-AM-SSB-SC (Amplitude modulation single side band Suppressed Carrier)

In this modulation will that count as better modulation in term of power loss but it more complected than the other before so in the equation(3) below

$$C(t) = Accoswct$$

$$S(t) = C(t)m(t) \pm C(t \pm 90)m(t \pm 90)$$

So the equation saying that if the carrier signal has multiplied with the message signal and summed or mins the same multiplication with phase shift it will give us the am modulation with signal side band and the block diagram showed in the Figure(3.5)

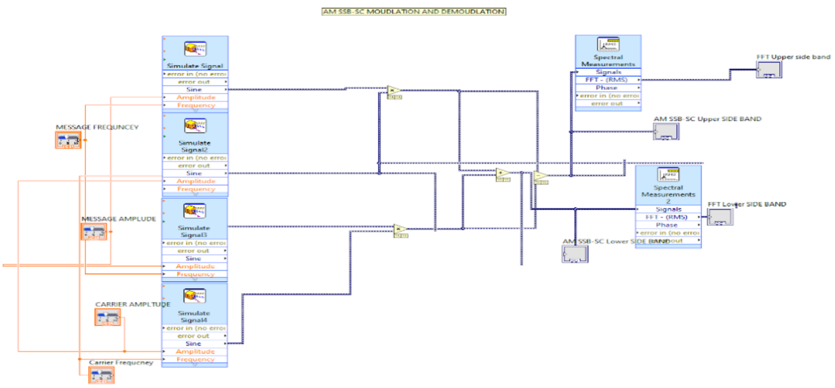


Fig (3.5) the block diagram of am double side band suppress carrier

And the figure 3.5 show the block diagram for both upper and lower side band once in after summation and other after minuses numeric block and the input information shown in the Figure (3.6) for all four signal so the simulate signal is the m(t) and the simulate signal(2) is C(t) and the simulate signal(3) is the m(t+90) and simulate signal(4) is the C(t+90) which is the same information as the equation (3) was shown that the only different between the signal with the original is shifted with 90 positive or minuses 90 degree and after that summation and minuses numeric block it connected to wave inductor and also the spectral analyzer and as we said before the information of the frequency and amplitude is same for C(t) with phase shifted and also for message signal same concept

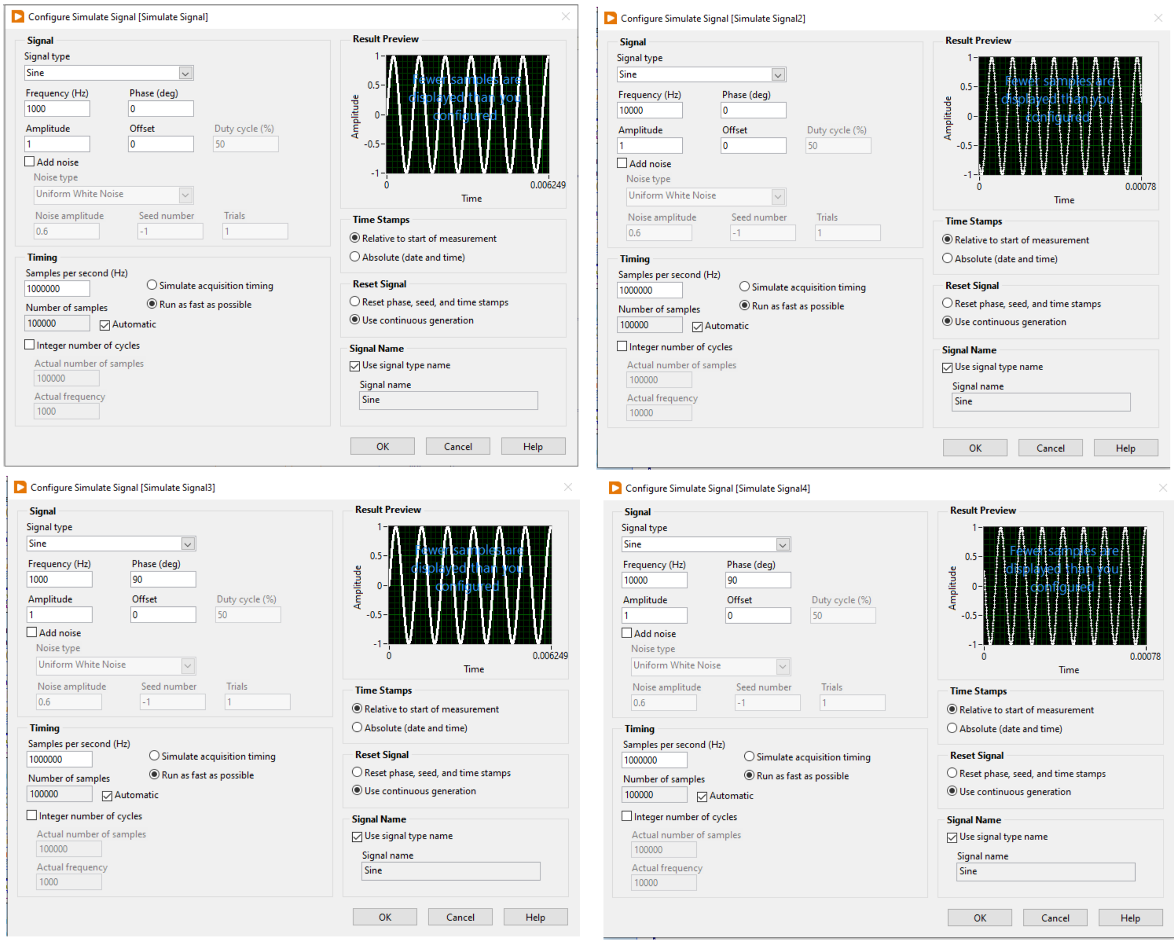


Fig (3.6) data entry for both message signal and carrier signal

3.2-AM Demodulation

In these section we will show the block diagram for demodulation and math behind it

3.2.1-AM Demodulation for DSB-TC

For these part we just need to multiply the carrier signal with modulation and we will get the modulated signal after input it to lowpass filter the cut off frequency will be the message frequency and in the Figure (3.7) showed the whole block diagram contain the modulation and demodulation

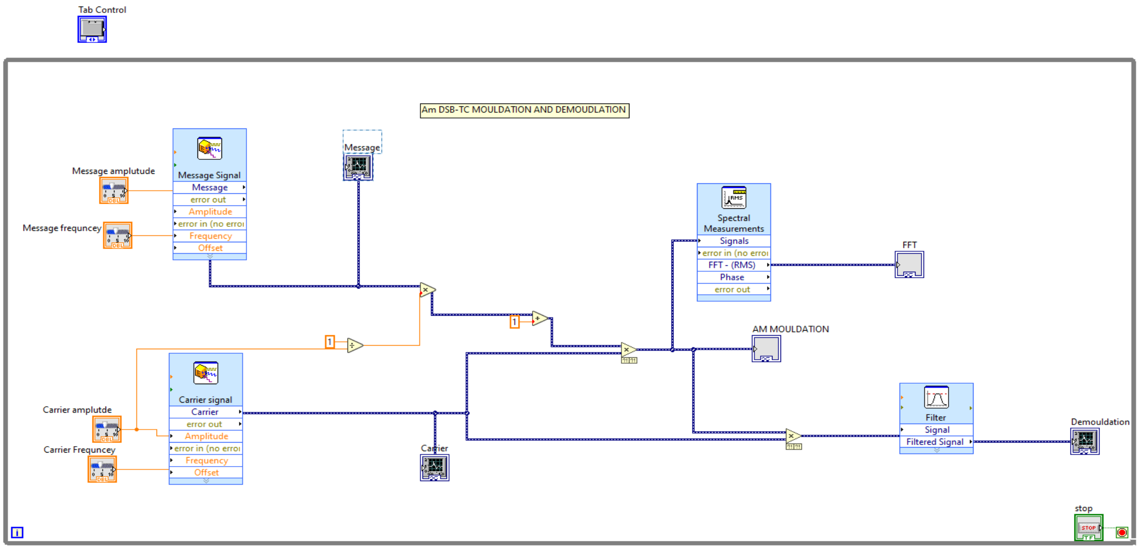


Fig (3.7) am modulation latch carrier modulation and demodulation

3.2.1-Am Demodulation for DSB-SC

For this part we will show same as latch carrier the demodulating of the DSB-SC is by the multiplying the carrier signal with modulation signal and it shown in the Figure (3.8)

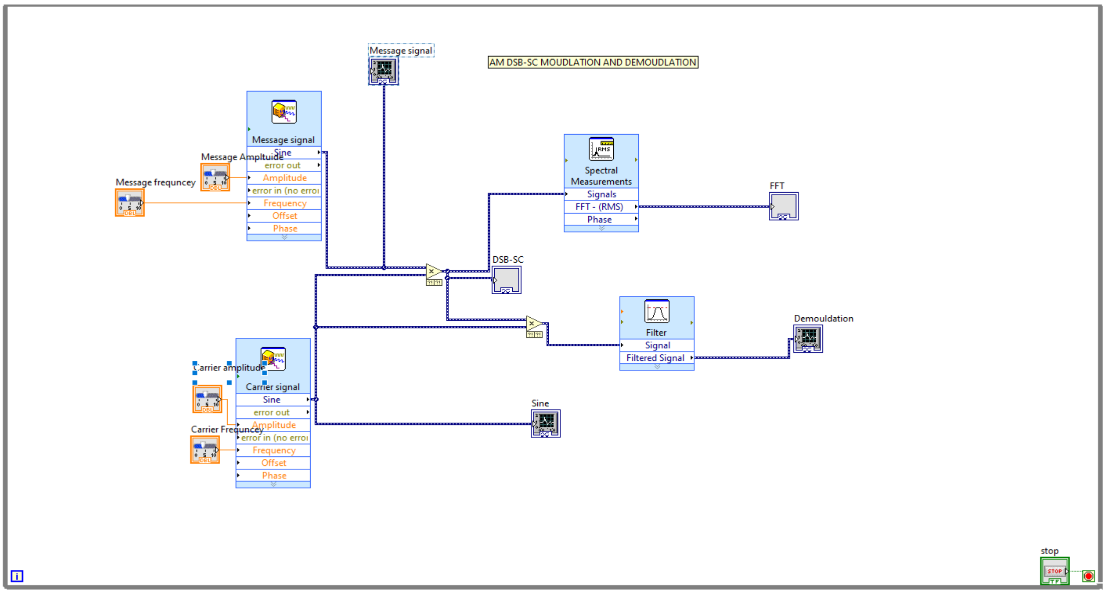


Fig (3.8) am modulation suppressed carrier modulation and demodulation

3.2.1-AM Demodulation for SSB-SC

in these part we will show the demodulation of the Single side band suppressed carrier which is done by multiply the modulation signal if lower side band signal or the upper side band just need to multiply with the carrier signal that not shifted and the block diagram shown in the Figure(3.9)

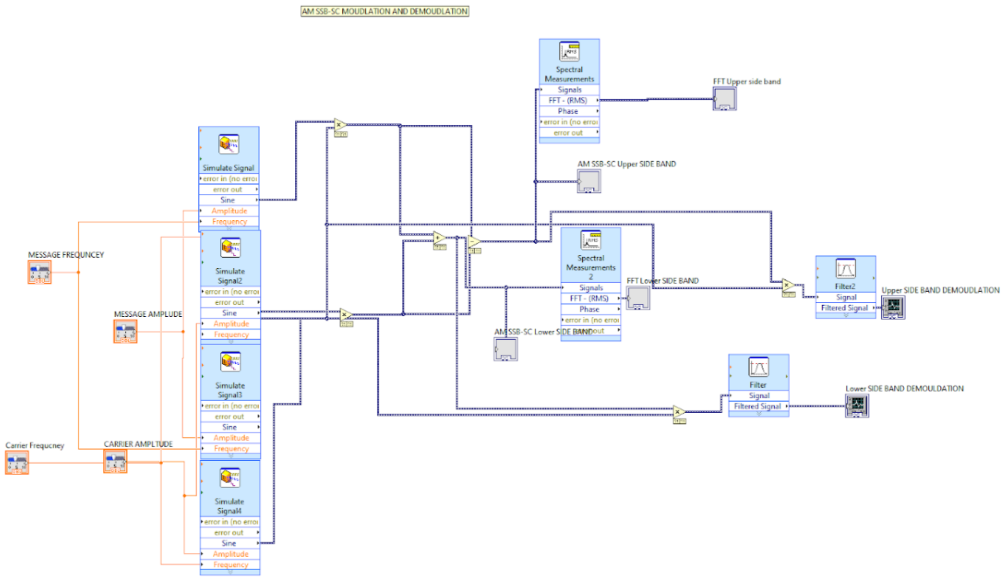


Fig (3.9) Signal side band suppressed carrier demodulation and modulation block diagram

3.3-FM modulation and demodulation

in these section we show the mathematical equation and the block diagram and the equation for the will be as show in Equation(4) which one that below

$$S(t) = Ac \times \cos(2\pi fct + 2\pi f_{\Delta} \int_0^t m(t)\, dt)$$

And the block diagram will be shown in the figure 3.10 the block diagram for FM modulation and demodulation

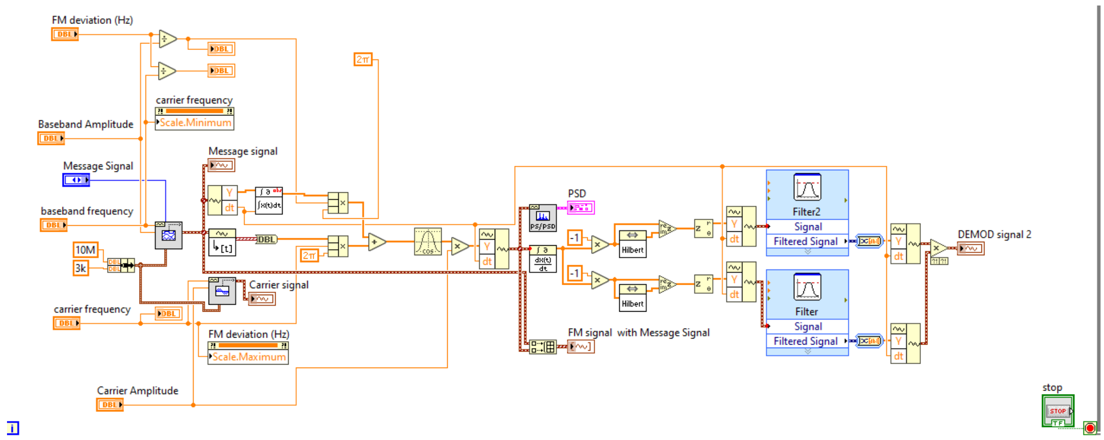


Fig (3.10) Fm modulation and demodulation

So block diagram the DBL mean slide bar the we talked before in FM signal and the block diagram goes like these the we multiplied the carrier ampliated with the cousin trigonometric function in LabView the include the message signal that converted to data array using Get wave form component in LabView so that will convert or in other word we can get the value of the signal to use it for the integration part so that done by using the function get wave form component and after that the message signal will enter the integral for the time of the message signal and after that will multiplied by the 2 and pi and after that summed with the carrier signal using function generator that after that converted or we need to get value for that function same we use get wave form data array and also the will multiplied by the same idea of 2 and pi and after that it will summed with the other message signal the been integrated and all that will enter the cousin trigonometric function that will be multiplied with the carrier amplitude so after that the signal will be modulated but we need to convert it signal information so that we use get waveform component and from that we will connect that to wave form inductor and PSD that will show the FFT for the modulated signal which these block will show spectral analyzer and also the power spectrum density which in other word or the shortens for it will be PSD and after to get the original message we use to times the Fast Hilbert transform and connect that to low pass filter which the connected signal or the modulated signal should multiplied by minuses one and after that connect that to the Fast Hilbert transform

3.4- LabView over MATLAB Simulink

As we know MATLAB is great app for math work which include one of the famous app for that manner but in term of Simulink is package which add it to the MATLAB so the reason why we used LabView over MATLAB Simulink its first that LabView can be worked with live which I mean by that we can use LabView with Realtime and see what happened to the signal and in same time we can use viable value which I mean by that we monitor our signal live and also change the component value without need to stop the simulation and turn on again so that's advantage for our circuit or project to compare value and give more information about signal with different circumstances and for the MATLAB Simulink will use a lot of memory of the Hardwar that Simulink will work on it if we go to high frequency about 1 M Hz which is these count a normal frequency for FM which work more than these frequency so with any doubt the LabView will have more feature and advantage over the MATLAB Simulink for the communication

3.4- Spectral analyzer

A spectrum analyzer is a device that measures and displays signal amplitude (strength) as it varies by frequency within its frequency range (spectrum). The frequency appears on the horizontal (X) axis, and the amplitude is displayed on the vertical (Y) axis. It looks like an oscilloscope, and in fact, some devices can function as either oscilloscopes or spectrum analyzers. Importance of spectrum analyzers Radio frequency (RF) signals and wireless communications are ubiquitous today thanks to Wi-Fi, mobile networking and communications, wireless internet of things device sensors, traditional radio, RADAR and more.

4. Simulation Software:

In this section we will show the simulation result that contain frequency spectrum and in real time signal and also the frequency analyzer also the difference in LabVIEW and MATLAB

4.1 – AM DOUBLE SIDE BAND TRANSMITTED CARRIER

So first we will start by showing off the section of the scopes or wave form indictor for the Am modulation double side band transmitted carrier so that will be in the Figure(4.1)

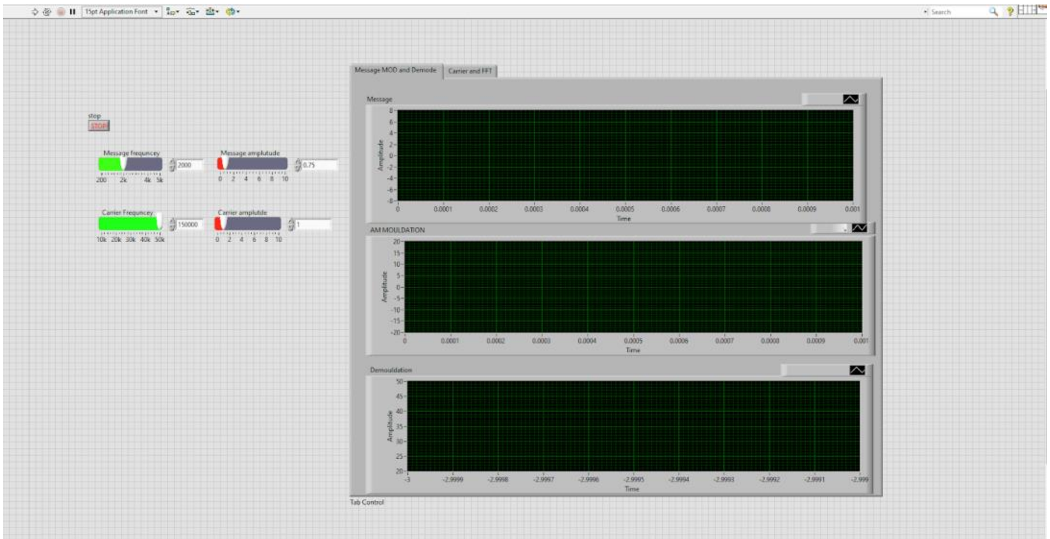


Fig (4.1) AM DSB-TC wave form indictor section

So as we can see there's no signal the simulation has not been runed so in the Figure(4.2) that will show the simulation ruined but before that let's look at the part that we have show shown in the Figure(4.1) in the left there's the slide bar the in the red will bar these a value from 0 to 10 for the message and carrier and in the green slide bar for the message the maximum frequency that will our signal will reach 200 for 5k in acutely there's no problem to go higher for example use the whole voice spectrum for that will be from (20 to 20k)Hz but we use these amount number which will indicate the all of the spectrum in same time the reason why we not choose it is when the frequency get higher the visibility or in another manner the signal will not be easy to track or to see what will happen so it will no give a much piece full information about the whole processed so by that we choose theses value also for the green slide bar we use frequency bar from (10 to 50) k and the right side that there's 3 wave indictor or in another word a scope respectively we will go through and in the top of them there's a another page can be opened is named by FFT and carrier signal which there's also there are a two wave form indictor so in the Figure(4.2) we will try to run the simulation at the different number frequency so for that reason

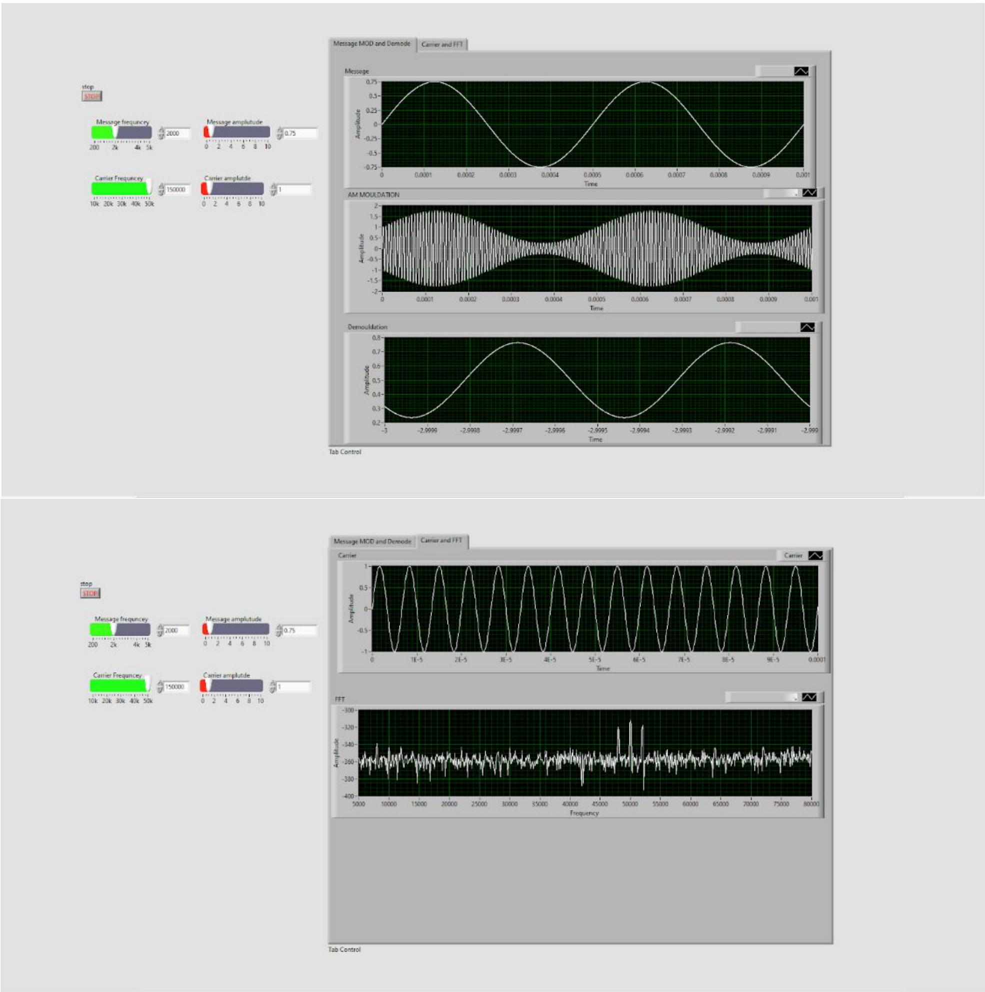


Fig (4.2) Simulation result for the AM-DSB-TC

4. 2 – AM DOUBLE SIDE BAND SUPPRESED CARRIER:

and also these part will be about Am DSB-Suppressed Carrier and we will try to enter a same value from the Am double side band transmitted carrier so in the LabView the user can designed the way that they want to put wave form the shapes and pages so for that manner we used same designed for all our simulation to be easy to understand and be able to intricate with easily so in the Figure(4.3) it shown the information that we got from the simulation and we will not go though the explanation of the component of these section because we already explained in section before and also the modulation

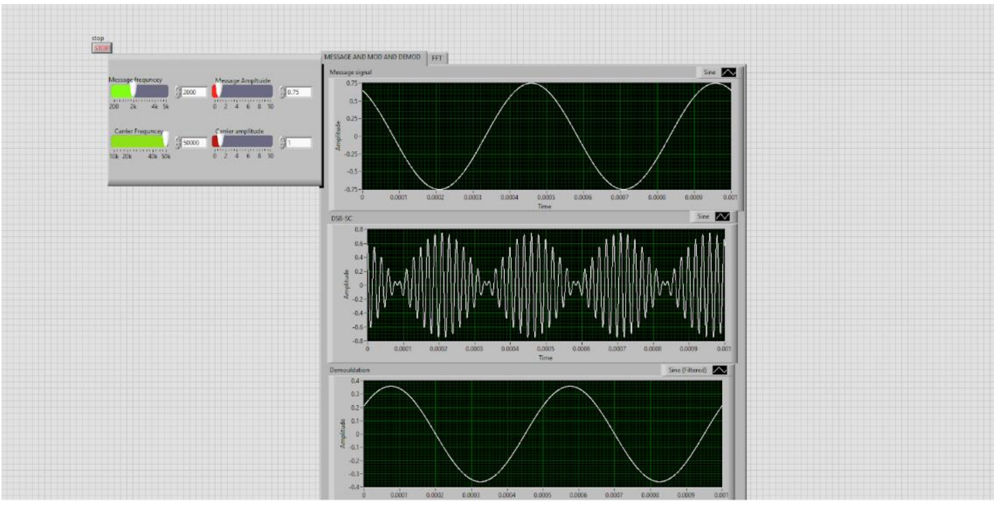
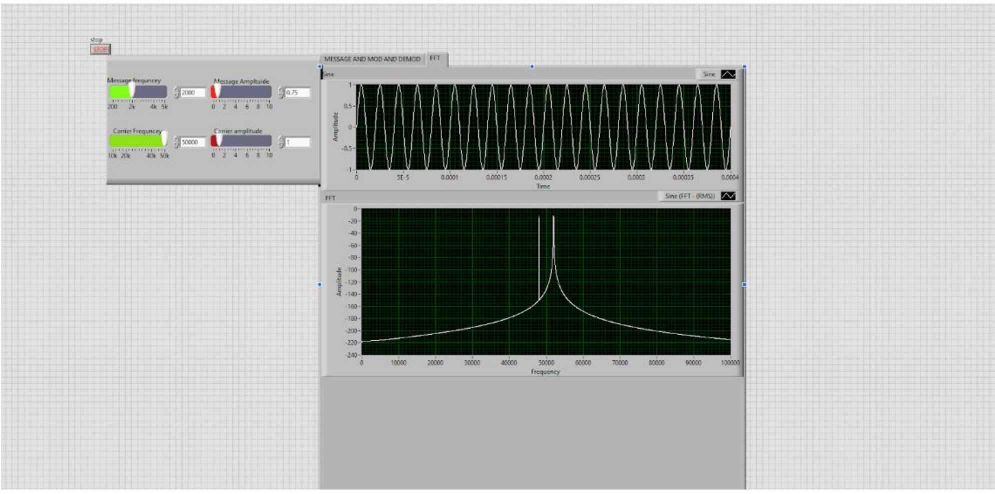


Fig (4.3) Simulation result for the AM-DSB-SC



For the wave form are shown in all simulation result

AM SINGLE SIDE BAND SUPPRESED CARRIER – 4.3

for these simulation as we saw in the chapter 3 the modulation and demodulation of the type was more complicated compare to the two other before and in the real life its same as well to build the circuit will cost more money and the reason its more complicated but in term wasted power and all of that its more efficient so as we saw in modulation of Am-SSB-SC we done both modulation upper and lower so in the Figure(4.4) will show the FFT for both Upper side band and Lower side band with same input as Am Double side band suppressed carrier in section before and also same for Am double side band transmitted carrier so the Figure will focus on the result of the FFT or in another word it will be zoom in only for the scope to be number more clear and visible

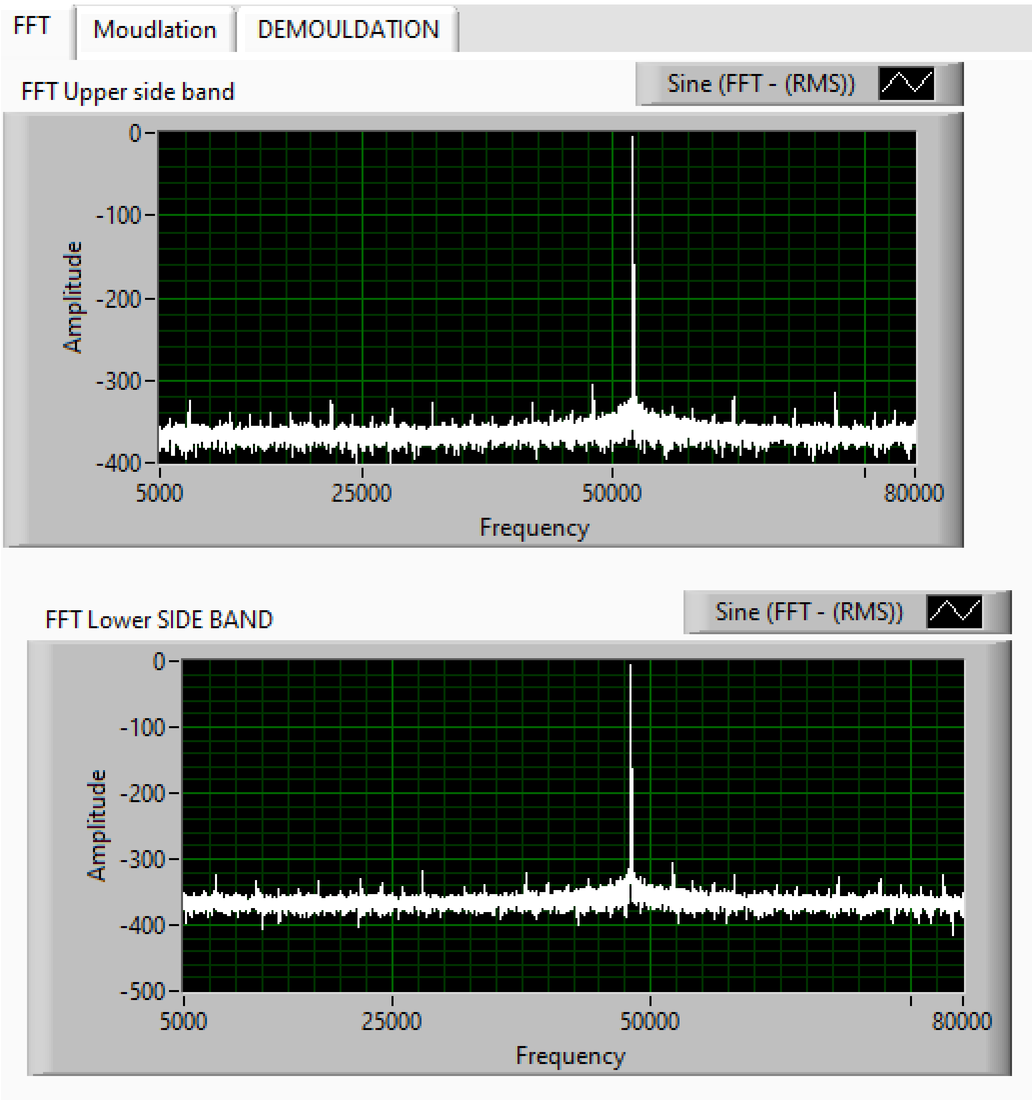


Fig (4.4) Simulation result for the AM-SSB-SC FFT

The result of simulation will show clearly the one of side band and the carrier has been suppressed out and also the modulation and demodulation will shown the Figure(4.5) which the modulation which we can explained it is that

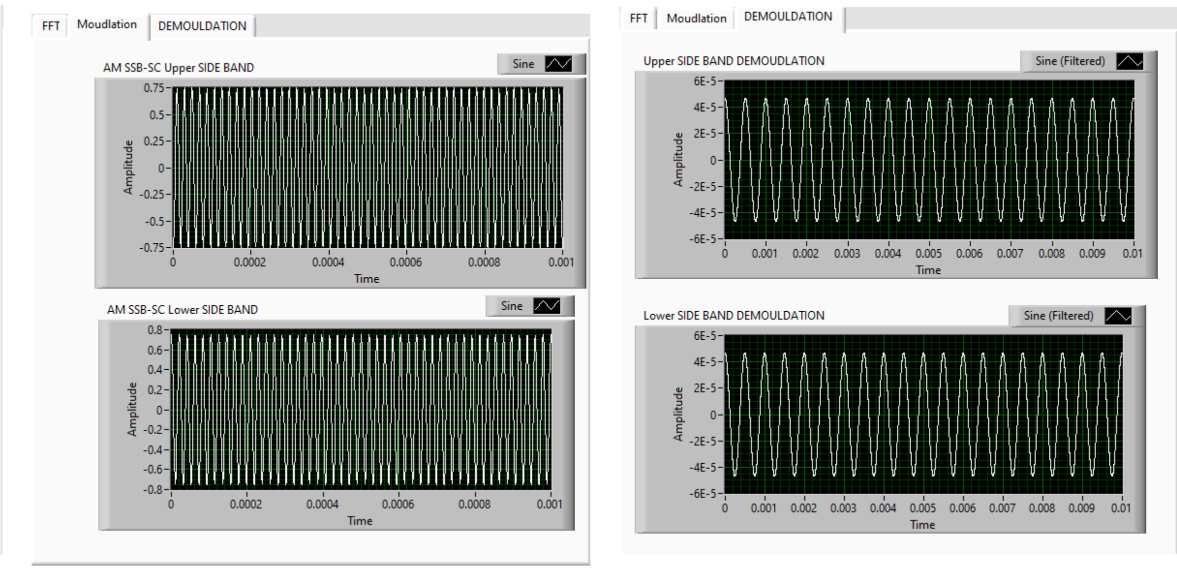


Fig (4.5) Simulation result for the AM-SSB-SC Modulation and demodulation

4.4 – Frequency Modulation

In these part we will show the Fm modulation with varies modulation index and different frequency deviation so we will see as we when we showed block diagram we explained the work principle so in the Figure(4.6) the result have been showed

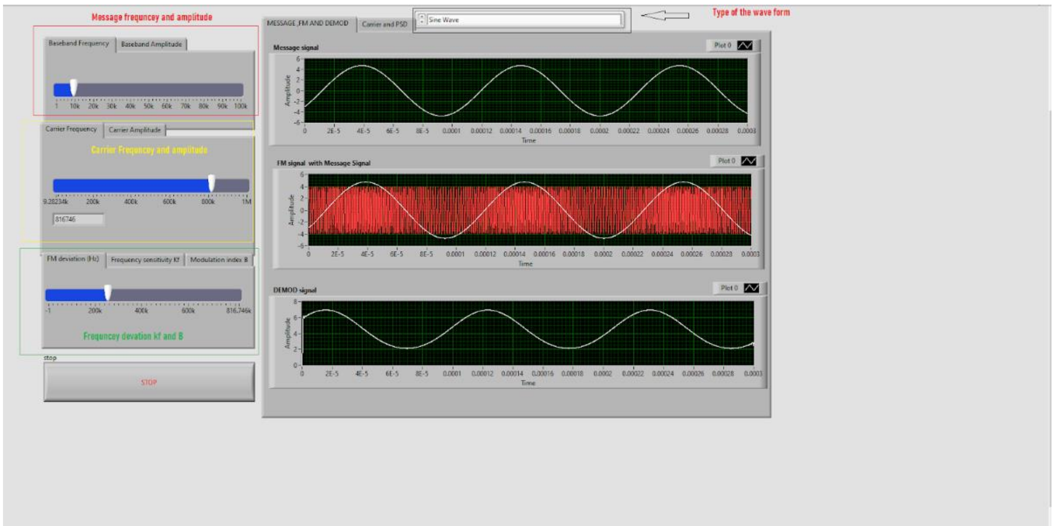


Fig (4.6) Fm simulation and some demonstration

and the message frequency and amplitude can varies and is mentioned in Figure(4.6) that is able to done that it's two page which one of them is the amplitude and other page is the frequency also in the yellow part we marked the carrier frequency and the amplitude varies also in the last section in the left side that in green showed three important part of the FM modulations which modulation index of the modulation and frequency deviation in less important is sensitivity so we can see the signal modulation index and their sensitivity and also change frequency deviations by slide bar in the green area as shown which these explanation of two important parameters in the frequency modulation

In the Figure(4.7) it showed the FFT of the FM signal and before that in Figure(4.6) in the top there's different wave form that we can change during or before the simulation is runnel it contain other four common signal which triangle and sawtooth and square wave

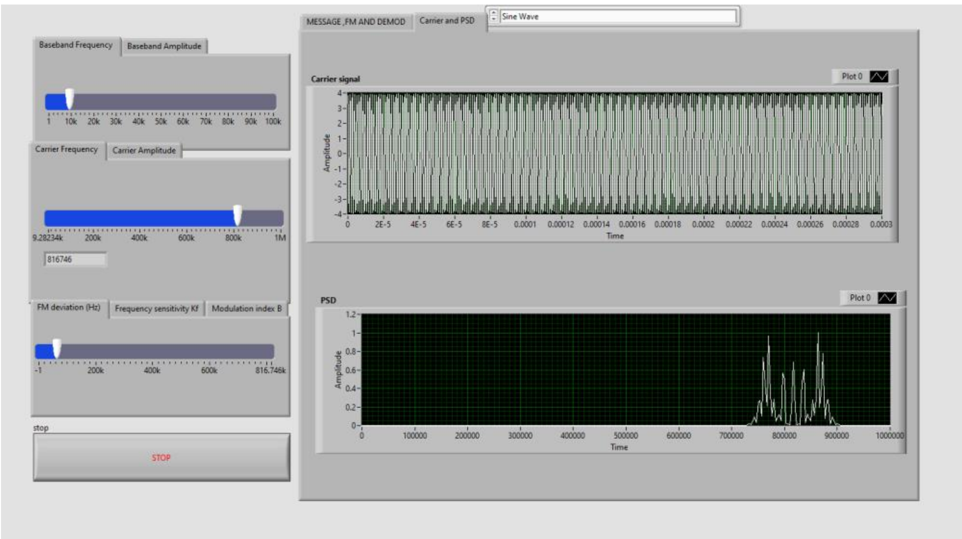


Fig (4.7) FFT of the Fm

And in the wave form of FFT we can there's more than one frequency that what make the modulation signal with these different frequency and in the Figure(4.8) it shown other parameters like modulation index for these modulation and the sensitivity as well but these

Figure(4.7) is the same information with Figure(4.6) but the frequency deviation become less because in high frequency deviations the FFT will not be that clear is purpose to show it but when simulation runed its easy to notice or track

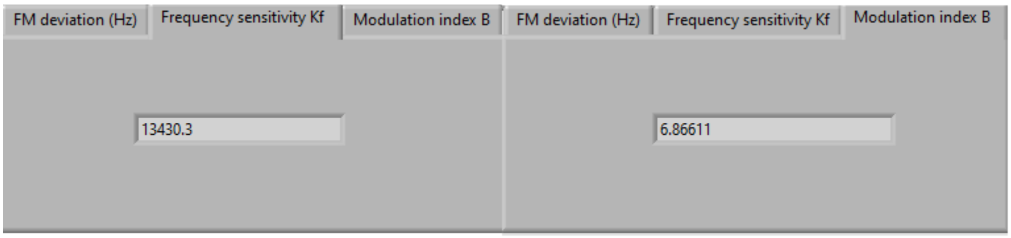


Fig (4.8) Modulation index and the KF

3.1-MATLAB Why we used LabView over an MATLAB and we suggest for any communication has to go with the LabView and the reason that will show an simple am modulation which I mean only the modulation with the latch carrier that shown in figure(4.9) it show the block diagram with entered carrier wave frequency about 25 Hz the complaining time for that It take about 20 second an as we said it no continues compline it just for time frame about 10 second and the other problem with it is that no easy to interact with the MATLAB Simulink at all

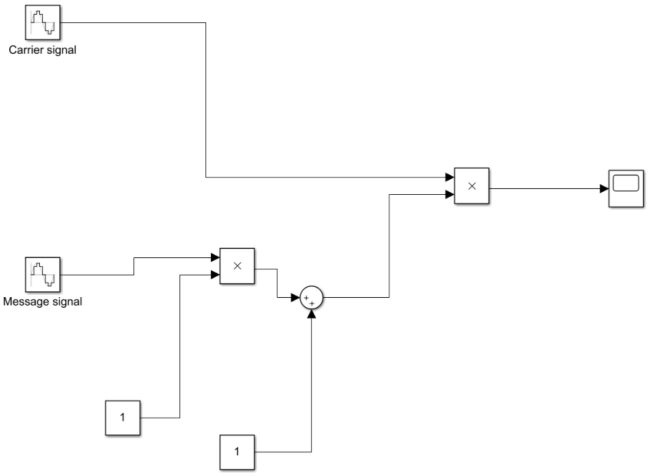


Fig (4.9) MATLAB block diagram for AM

And in the in Figure(4.10) show the information that have been entered with sin wave and that's another part and another issues the problem

Not exactly tell the problem with simulation if not completed or correct

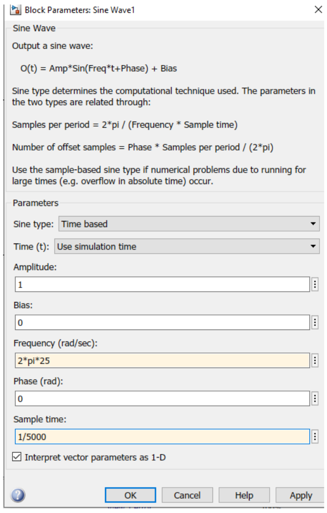


Fig (4.10) data entered for one of the sin wave

And lets go to more important part which is what about high frequency and in same time we will use the value that have been used in the LabView simulation and see the time of compiling and we use the number of frequency for the carrier about 50k and for the message about 2k and the waiting time which was about 3 minute for only these simulation for the that shown in the figure (4.11) and one of the other problem with that is as we can see in that figure the signal is not shown clearly which mean the time is more than to show that and what we done we should lower the time frame which is by changing stop time for different value so

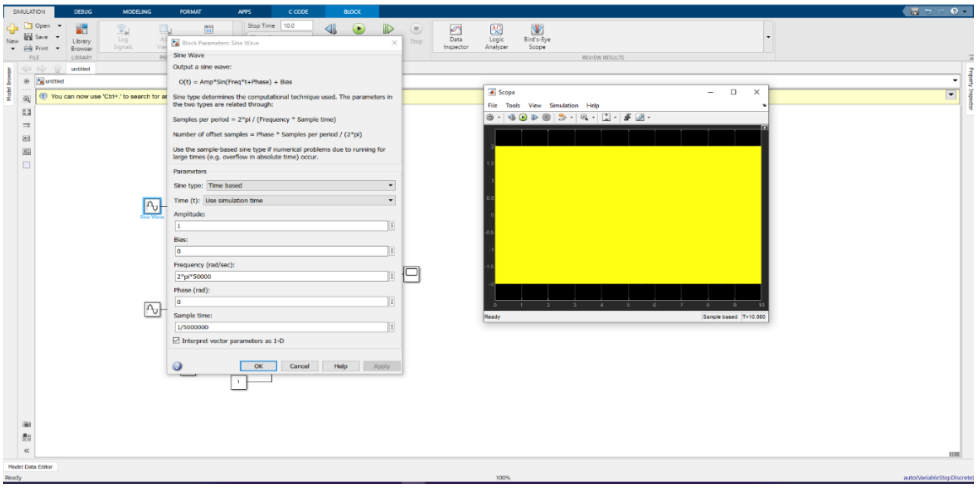


Fig (4.11) data entered for one of the sin wave

after adjusting we get better result in the figure(4.12) showed that but our point is that these for Amo modulation which take all times different value of component what we mean different frequency and like that we get at higher frequency about 2 min every time waiting and for Fm the waiting time will be more and why even we make high frequency for simulation like cause Fm we need high frequency deviation to see the different result but it need to change the resolution of the simulation which it can be done and another thing that if we have different scope like one for FFT one For demodulation one modulation all of them will get same time stop time which I mean by that so every simulation the user need to change the scop x and y for the purpose to see the waveform clear and also before we forget another part the FFT for the wave that block will also take time for compiling so what we want to point out in our research why we used the LabView and why its highly suggest by us for these type of subject should be used

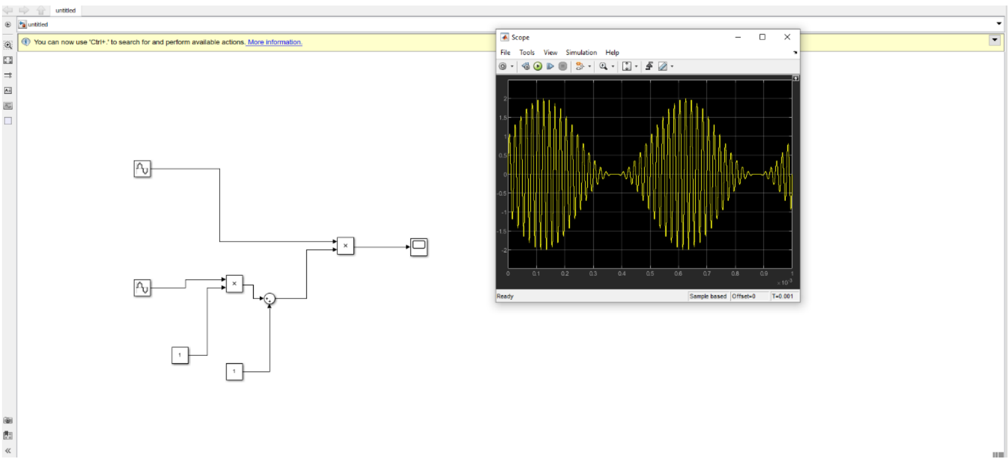


Fig (4.12) MATLAB simulation output after adjusting for Am

5. Conclusion:

in our research we conclude that important of the frequency spectrum and using LabView to show that but to be more precise in this type of area we should in the future make the real circuit for these and this need using a simulation application for that case not only making a circuit that can produce this modulation by all type but able to showcase all possibility with in another word showing that how frequency of the modulation will impact the circuit so studying that and make and overall overview and analysis that any engineer will be able to use it in area of communication , and also making a big data of result of the different circumstance for this circuits and try to cover also PM which one of the important type of modulation in the simulation and in the circuit part also VSB which is one of amplitude modulation that we will cover in the future work and making circuit in real life with testing also this circuit with different circumstance like harmonic distortion of the signal that modulated also the distance that can these modulation reach and all that will be in our future with new methodology to analysis and make one place that any common modulation type available in it and one another important as we know that any type of modulation have different type of circuit so that also our target in the future like for only AM-TC there is more than one circuit to build this circuit so what want Is to build those circuit with analysis part for every circuit that using in the modern technology as well of FM an PM .

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