DESIGN AND ANALYSIS OF SUPER-HETERODYNE RECEIVER FOR AMATEUR RADIO

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ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITI TEKNOLOGI PETRONAS

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by

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18333

Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Engineering (Hons)
(Electrical and Electronic Engineering)

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CERTIFICATION OF APPROVAL

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Approved by,

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(Dr Mohd Azman Bin Zakariya)

UNIVERSITI TEKNOLOGI PETRONAS
BANDAR SERI ISKANDAR, PERAK
January 2017

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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(Muhammad Hanif Bin Zakaria)

ABSTRACT

The super-heterodyne technique was long develop and well-known in the area of communication field study. The uniqueness of this design that focusing on the incoming RF frequency have makes this design universal usage and interesting among the radio frequency designer. Most of the radio communication in today world has develop their own design system but their basis remain on the basis of super-heterodyne. Thus this project is about implementing the basic design study and the project simulation was run using the Agilent Advance Design System Simulation Software (ADS). Other than that, further simulation and analysis on this design will be done to find the ideal result of this design to be implement. This project is about design and analysis consisting the circuit of block component and together with the filter design. The design should be able to optimize giving the best result output throughout the receiver to the speaker.

ACKNOWLEDGEMENTS

Praise to the Almighty Allah S.W.T I manage to finish this report within the time frame that is set by Universiti Teknologi Petronas (UTP) successfully and also giving me the privilege as well as the health to complete the report. I would like to give me deepest thank you notes to my supervisor Dr Mohd Azman Bin Zakariya for guiding me and supervised all of my work and for giving me a deeper appreciation towards the work that I dedicated my time and energy to. Furthermore I would like to express my uttermost gratitude to him for all the inputs, guidance and motivation to make sure that I will finish my final year project within the time frame.

Besides that, I would like to thank Associate Professor Dr. Mohd Noh Karsiti for giving me the insight of the true meaning of Amateur Radio, without the understanding the basic concept of Amateur Radio I would never truly understand the purpose of this project as well as providing the basic reading material that required for me to refer as a guidance in other for the completion of this project.

Lastly, I would like to thanks Electrical and Electronics Engineering Department for giving me the opportunity to work in this project not only to fulfil my requirement as a degree student as well as to deepen my theoretical and practical knowledge in order to complete this project. I would like to express my gratitude to my family and friends who relentlessly giving me the support that I need and to be here with me through my ups and downs in the completion of my final year project.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

After the World War I end, Mejar Edwin Howard Armstrong has patented the 'Super-heterodyne' as his collection in the radio communication world. His creation used the principle of Fessenden's Heterodyne where two frequency signal are mixed and converted into a single and fixed frequency. In his design, Armstrong used this principle with different approach by convert the incoming high RF signal into a single low and fixed frequency known as Intermediate Frequency (IF) instead of focusing on demodulating CW [11].

This design eventually turn out to be the most superior receiver design in communication world. The advantages it have in terms selectivity, sensitivity and frequency stability attract the radio designer enthusiast [6, 7, 10]. Today many radio design used this basic design in their product even with different technology as this design can be easily use and compatible with any other component [10].

1.2 Problem Statement

In radio reception, the incoming signal frequency obtain are very small about microvolts. The amplifier and filter are needed in filtering and bring up the signal into the reasonable level. Suitable antenna have to be chosen in detecting and capturing this frequency. The Local oscillator (LO) that is controlled with the tuning knob will be use in adjusting the reception into a particular station. In this process the tracking of LO will be made by the tuning circuit that are made of variable capacitor. A mixer is a non-linear device made for converting two incoming signal into a single and lower frequency. The output form this mixer is either the sum of both frequency or the different between the two. The two frequencies that are fed into the mixer comes from RF stage, signal frequency (f_o) and the other one is oscillator frequency (f_o) from the local generated frequency.

1.3 Objectives

The main focus of this project is:

1. To study the design of Super-heterodyne receiver design for the RF signal communication.
2. To perform analysis from the output of the mixer that include the RF signal (f_{RF}), LO signal (f_{O}) and both the resultant frequency from the mixer (IF down-conversion product).
3. To analyses the mixer and the IF bandpass in eliminating the unwanted signal and image frequency.

1.4 Scope

The scope for this project:

1) To study the Super-heterodyne technique for receiver for amateur radio.
2) The operation of components signal between 1 MHz to 500 MHz.
3) The components design simulation using the Agilent Advance Design System (ADS) focusing on the main RF amplifier, Mixer, IF Bandpass Filter and IF amplifier unit.

CHAPTER 2

LITERATURE REVIEW

In this chapter, the discussion is about the working principle of the Super-heterodyne technique and the important consideration in designing the receiver are explained. Most of references is based on the book materials and the others research paper and journals.

2.1 THE SUPERHETERODYNE PRINCIPLE OPERATION.

In this technique, the incoming signal or frequency will be captured by the aerial of the receiver and being fed into the RF block. Here contains two part which are 1) RF filter 2) RF Amplifier. The early selectivity begins here where the filter will eliminated the unwanted frequency from the captured signal. All left is the information frequency, f_S. After being amplified the frequency is then mixed up with the Local Oscillator frequency, f_O. The mixer convert the signal into a single and fix frequency, it is either the sum or the different of the two ($f_S - f_O$) or ($f_S + f_O$) [1 - 5]. The resultant frequency from the mixer is what we called the intermediate frequency (IF). The information frequency lies between the IF, thus after being amplified by IF amplifier the frequency fed to the demodulator to extract the information in audio frequency. The final stage is send the audio frequency to the audio amplifier then connected to the speaker [1]-[5]. The diagram of the system can be seen in the Figure 2.1 in next page.

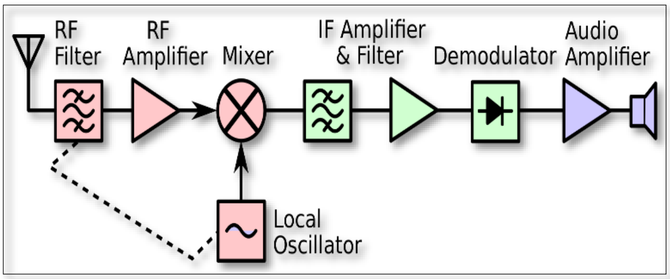


Figure 2.1: The block diagram of super-heterodyne [2].

2.2 Super-heterodyne Components and Considerations

2.2.1 Radio Frequency (RF) Block

This block building made of two component that are the tuning/pre-selector and the RF amplifier [1]. Two general function of tuning or pre-selector part is basically to receive the signal from antenna and eliminate the unwanted signal and to give protection for the component from the high input power signal [12]. The high input power would have cause the receiver to be overload or damaging the active component in the circuit, thus effecting the system output. However the pre-selector only provide the image rejection up to the double of the IF away from the desired signal, the remaining image rejection on the wanted signal or in the same frequency in tuning will be eliminated later, providing earlier image rejection filter for the system.

The other part of the RF block is the amplifier. The amplifier in RF plays important role in early signals receiving. It must have the capability in handling the signal in terms that the signal amplified just sufficient in giving a good Signal and Noise Ratio [12]. This aspect are very important as we don't want the signal distorted [1]. Hence better sensitivity product will be driven into the mixer for the heterodyning process.

2.2.2 Mixer/ Converter Block

The function of this block is to convert the two signal into a single lower frequency also familiar with the name first detector [2]. The signals are fed from two source that are from the RF and the other is from the Local Oscillator. This process are the heterodyne and the signal output from this are called the Intermediate Frequency (f_{IF}) [1]. Figure 2.2 below showing the heterodyning process in the mixer.

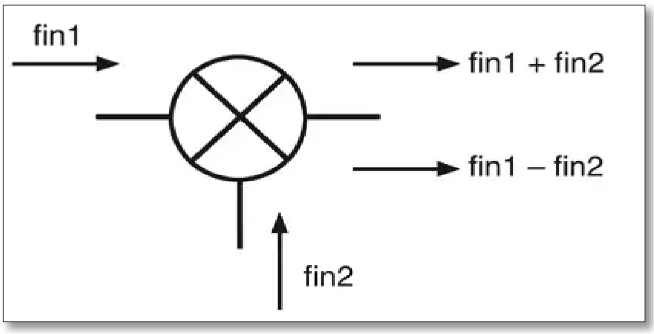


Figure 2.2: The operation of Mixer [13].

Together in this block is the local oscillator. The range of the RF are varied depending on the desired frequency. The LO also should be capable in tuning thus making the fLo always higher than the signal frequency in order to low the ratio of $f_{01(max)}/f_{01(min)}$. The type of oscillator chosen depends on the stability and accuracy desired, and all the type can be seen in the chapter2.

There are two type of conversion in the mixer: one is down-conversion and the other is up-conversion. Each one of these conversion depend on the frequency selected from the Local Oscillator (LO) and designer consideration. Given the signal comes from RF block, f_s and the signal from LO (f_o). If the fo is less than the fs, the resultant is down-conversion frequency signal of IF ($f_{IF} = f_s - f_o$) and the other side for the f_o is greater than f_s [4], [2]. The process as in Figure 2.3 in next page.

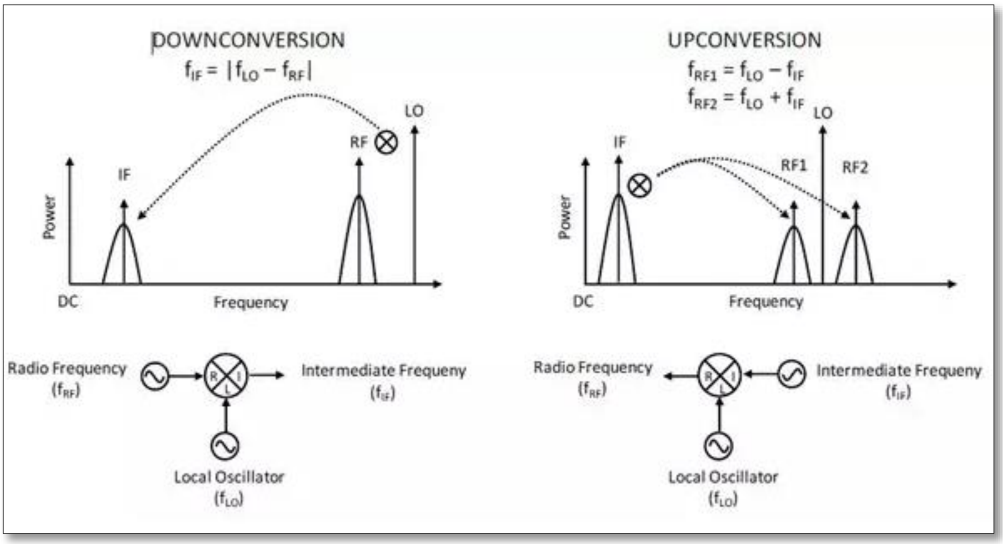


Figure 2.3: The operation of down and up conversion [13].

2.2.3 Intermediate Frequency (IF) Block

The product output from the mixer is known as Intermediate Frequency (f_{IF}).The frequency of (f_{IF}) is single and lower than the (f_{RF}) but have remain have the same shape of envelope from the (f_{RF}). Information signal are stored in within this envelope. This block mainly have series of IF amplifier and bandpass filter [1]. In this block the system will amplified the (f_{IF}) and filtering the signal. All the unwanted signal near the wanted signal being rejected [4].

This technique is known for its powerful in terms of selectivity, sensitivity and frequency stabilization. The specialty in selectivity of this design comes from the IF part [10]. The IF signal gives more advantages in the passband hence easier in extracting information. Since the RF block already made the elimination for the interference signal the IF signal is much more selective with full of information signal only. The complex IF amplifier with the filter make this design more advance where only single signal, IF are being amplified and filtered [1]-[5].

One of the important consideration in receiver is the image frequency as shown in Figure 2.3 below. It is a frequency that comes with the desired signal frequency, (f_S) into the RF receiver part. The image frequency can't be happened to pass through the converter since it will also heterodyning with LO and producing the second unwanted IF. If the image is send through into the mixer, the heterodyning product is in the form of cross product where in up-conversion the image produce is ($f_{image} = f_{lo} + f_{IF}$) [2]. But the desired frequency is given by ($f_{image} = f_{lo} - f_{IF}$) hence the image frequency during down-conversion is ($f_{image} = f_{RF} + 2f_{IF}$) It is possible here to say that the greater IF will be easier in extracting the information. Once converted it is impossible to suppress the image frequency, so the filter in the RF block must be well designed in order to reject the image-frequency from entering the mixer [4], [2], [7].

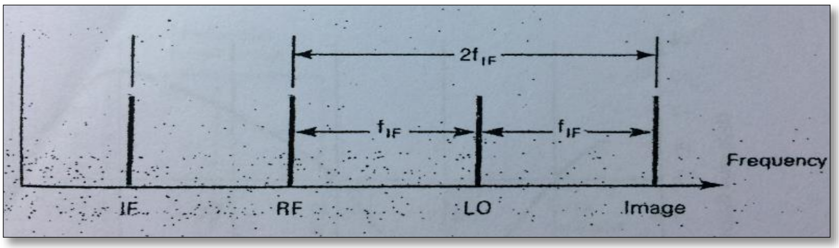


Figure 2.4: The Frequency Spectrum of the (f_{image}) [1].

CHAPTER 3

METHODOLOGY

In this chapter, the focus is the method on how the project will be done. The details of the steps taken in approaching the objectives, solving any issue is discussed. The project begins with gaining the knowledge in understanding the problem to get the idea then continue with simulations and analysis. The data collected from this process important for better understanding is this super-heterodyne technique deign. Figure 3.1 showing the project flow-chart towards the objectives of this project.

3.1 PROJECT FLOW-CHART

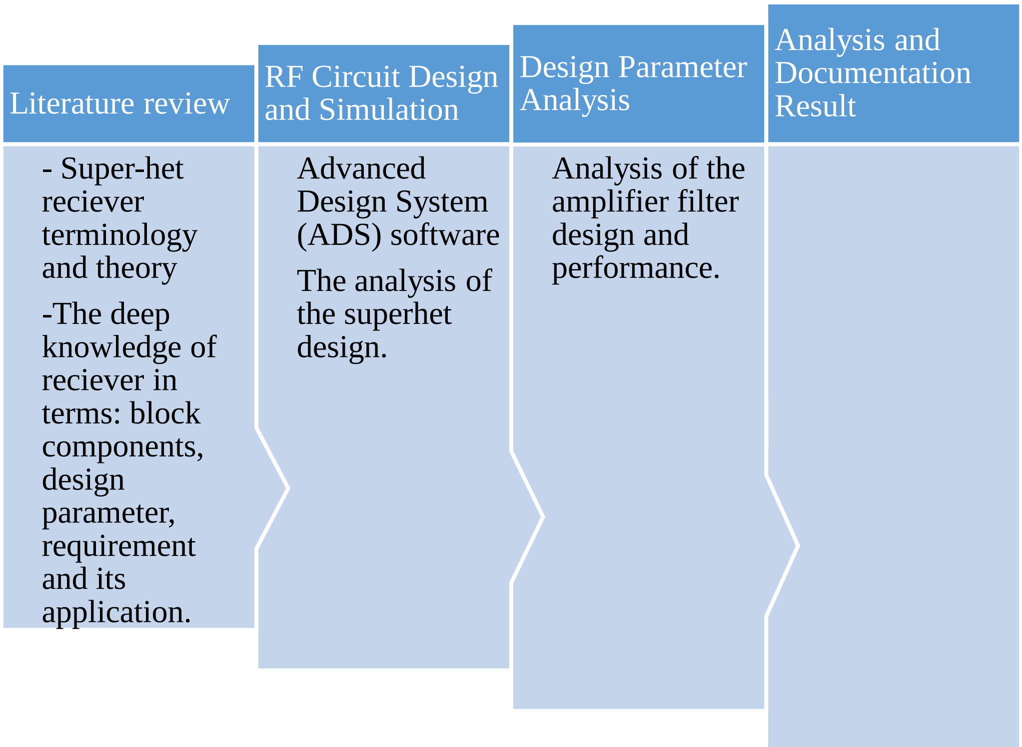


Figure 3.1: The Project Flow-Chart.

3.2 Literature Review

Fundamental is the most important thing in doing something or work. Books and some other research papers and journals will be reviewed and collecting data for the topic. Some important and improvement may have been made by others that could more benefits in doing this project. This technique consisting of several type of block that each block have different function. The parameter of each block requirement in terms gain, quality factor, noise figure and signal analysis need to be precise in order this project to successful reliable. With the review from the journals, research paper and books, the desired signal or the output frequency will much understand.

In each block also are made up with many type electrical and electronic components which either active or passive components. So the type of components used in the design are also play important role in this project. This components gives effect to the system parameter so the best analysis of the component used should be given attention. Overall this process would probably takes time and it is important for this project flow that the data collected in the test or simulations are all correct and reliable for further improvement.

3.3 RF Circuit Design and Simulation

For this project the software that will be using is the Advanced Design System (ADS) from the Agilent. This software is use for the designer in designing and stimulating their design. The basic circuit design obtain from book review can be used and will be analyze for any other improvement can be made. The ADS such a powerful software that gives the designer ability to optimize their design in one of the tools function.

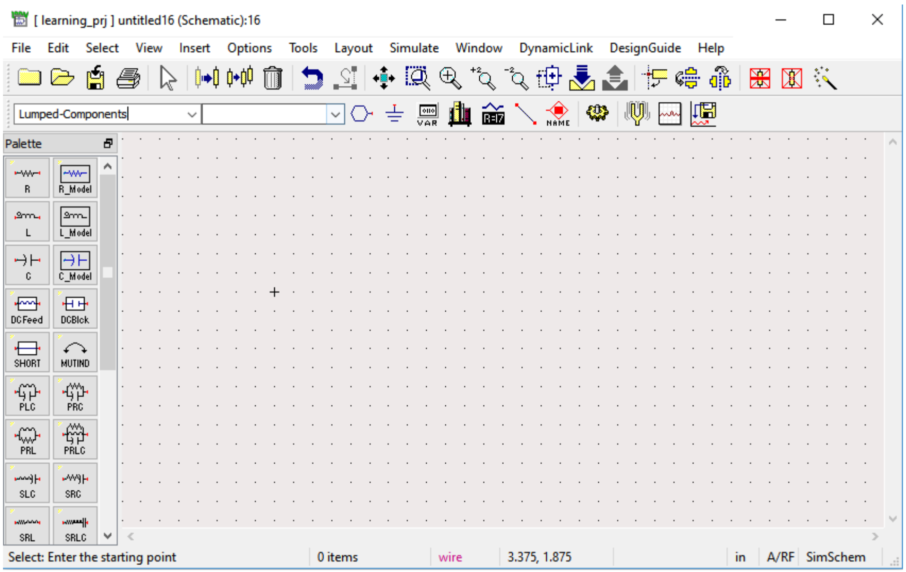


Figure 3.2: The ADS simulator environment.

3.4 Design Parameter Analysis

With the simulation going on using the ADS software, the next thing is to design a receiver that meet all the specifications. This is prior to make a functional 'superhet' receiver that can translate an incoming signal from the transmitter. Based on the review and the theory gained, circuit for the receiver design will be design and get the simulation result from ADS. The aim is to develop a circuit that can have the output from the receiver same as the output from broadcast radio.

What will be focusing on the simulation is the parameter result of the system. There are many parameter that can be focusing on but the major like the gain, the amplitude power from the input and output and the signal over noise ratio in the system. The simulation result would be analyze and compare with the theory result and then discussion with other superior person would be made to make sure the data collected are correct.

3.5 Gantt Chart and Milestone Planning

This section will discuss about the project development plan and progress. The project milestone showing the target towards the completion. This is the project planning that play important role in systemize the project flow in order to complete all the requirement within the ample time given. The new software of ADS need some attention to get familiarization. From the Gantt chart given, it show the scheduling planning in this two period of FYP project. The first period is FYP 1 that took about 14 weeks. This is where the research for the project begin and take place as well as the ADS software understanding. As for the assessment in this period of FYP 1, UTP has set that will three assessment that should comply for the regulation. The submission are Extended proposal where the beginning of the research development, Proposal Defence where the preliminary findings and expected outcome for the project and last the Interim report which is the details of the project progress for this period of FYP 1.

FYP 2 is the continuation period from previous work. There are 4 assessment involved in this period which are the Progress report about the project development continuation submitted by week 8, Pre-Sedex presentation basically the poster presentation of the project, Final report is the report submitted regarding all the finding and discussion of the project and the final assessment is Viva. Viva is done with the external examiner judging the project presentation.

Table 3.1: Project Gantt chart FYP 1 and FYP 2 period.

Activities	Week														
FYP 1 Progress and Milestone (September	1	2	3	4	5	6	7	8	9	1	11	12	1	14	15
Title Selection	■														
Preliminary Research & Literature Review	■	■	■	■	■										
Familiarize with ADS software				■	■	■	■	■							
Superheterodyne components design				■	■	■	■	■	■	■	■	■	■	■	
FYP 1 Assessment															
Extended Proposal					■	■									
Proposal Defence							■	■	■						
FYP 1 Report (Draft										■	■	■	■		
FYP 1 Report (Final														■	
FYP 2 Progress and															
Simulation of the Superheterodyne Designed	■	■													
Result and Analysis			■												
Examine the findings				■	■	■	■	■	■						
FYP 2 Assessment															
Submission of progress report								■							
Pre-Sedex presentation												■			
Submission of Draft													■		
Submission of Final Report														■	
Final Viva															■

CHAPTER 4

RESULTS AND DISCUSSION

This section we are discussing about the simulation in designing the receiver system. The system made up of many block components hence the fundamental result or information is important in designing the system. The ADS software library simulator provides most components list for the components block or the circuit components to perform work. The tools simplified the process and development of the design and analysis.

4.1 Amplifier Component Simulation

Figure 4.0 is the simulation block for the amplifier of the Super-heterodyne receiver. The purpose here is to simulate and analyse the amplifier output for the block component before being simulate in the system. Before looking to the result, the parameter set up for this simulation is used single toned frequency at 1 MHz as the input to the amplifier. This 1 MHz is the input that will be used for the rest of the simulation. This is the RF carrier being fed into the amplifier. The amplifier with the parameter named *S21*, *S11*, *S22* and *S12* are explained as the forward transmission coefficient, forward reflection coefficient, reverse reflection coefficient and reverse transmission coefficient. The setting was set so that the Voltage gain in the output will be 10. The Harmonic Balance simulator was picked to simulate the components and set at fundamental frequency at 1 MHz as the input with order 4.

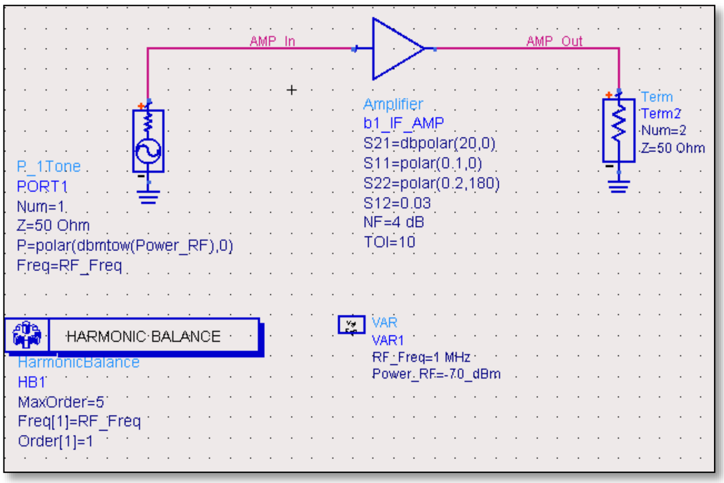


Figure 4.1: The amplifier block ADS simulation components

Referring to the Figure 4.2 is the result for the amplifier component mention in Figure 4.1. Base on before explanation, the parameter use have shown the above result. The measure node is name AMP_In for the input value and AMP_Out for the output measurement of the amplifier. From the figure, the result obtain showing that 110 microvolt of input was fed into the amplifier and the output is at 1000 microvolt. The voltage gain (Av) for this simulation is 10.

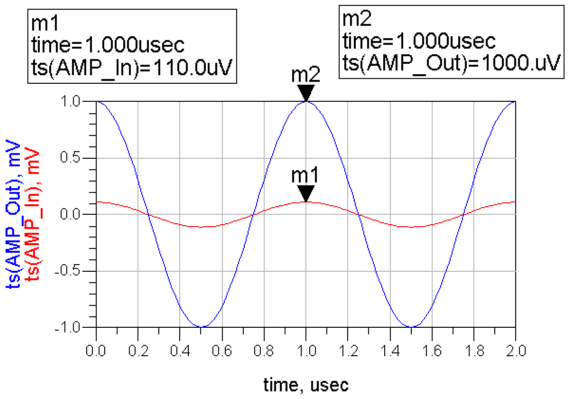


Figure 4.2: The result of Amplifier ADS components

4.2 Mixer Component Simulation

Figure 4.3 is about the Mixer components in ADS software. The structure component parameter use in above simulation is using the 2-Tone simulation, one for the RF input and the other for the LO input in port 2. The RF use was 1 MHz and LO was 1455 kHz in with the Mixer setting was set-up for LOWER which means Low sideband simulation. For this simulation, using the Harmonic Balance simulator the output that we want to see is the difference between this two frequencies which is 455 kHz in the IF. The result from this simulation can be seen in Figure 4.4 next.

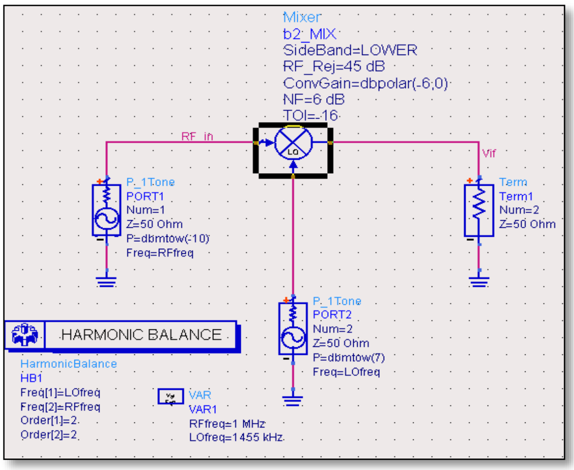


Figure 4.3: ADS Mixer Components simulation.

Figure 4.4 in the next page is showing the result from the mixer component simulation. There are marker were located to analyse the result. To explain, marker 1 *(m1)* is the fundamental frequency of the RF input from port 1 of the mixer at 1 MHz with -55 dBm. Marker 3 *(m3)* is the frequency for LO that fed in through the port 3 in the mixer component before at 1455 kHz with -48 dBm. Marker 2 *(m2)* is the difference product from both frequencies called as Intermediate frequency (IF) at 455 kHz with -24.455 dBm. This show the mixer component works resulting the desired frequency. Meanwhile marker 4 *(m4)* and the rest of the unmentioned spectrum observed indicating the sum product from of both which we don't want to consider in the analysis. This is the image frequency that need to be filter out.

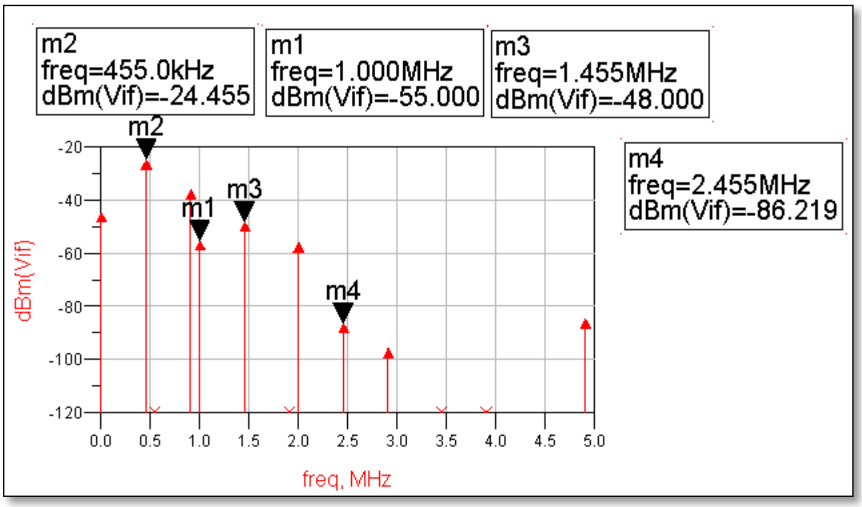


Figure 4.4: Result of ADS Mixer Components simulation

4.3 Super-heterodyne System Component Simulation

The above figure 4.5 showing the simulation of the Super-heterodyne system with Amplifier, Mixer, Bandpass filter and amplifier block components. The mixer and amplifier that was explained before were combined in this system with the same exact parameter as before. The functionality of this system adding with the bandpass filter in the IF side. The frequency use was maintained as before 1MHz for *RF frequency* in Port 1 and 1455 kHz for *LO frequency* but this time the source used changed to the sine wave. Meanwhile the BPF filter block setting was set with *Fcenter* of 455 kHz which is the *IF frequency* that we want. The bandwidth pass was set at 10 kHz and the bandwidth stop at 20 kHz. We will observe and the output result of each block.

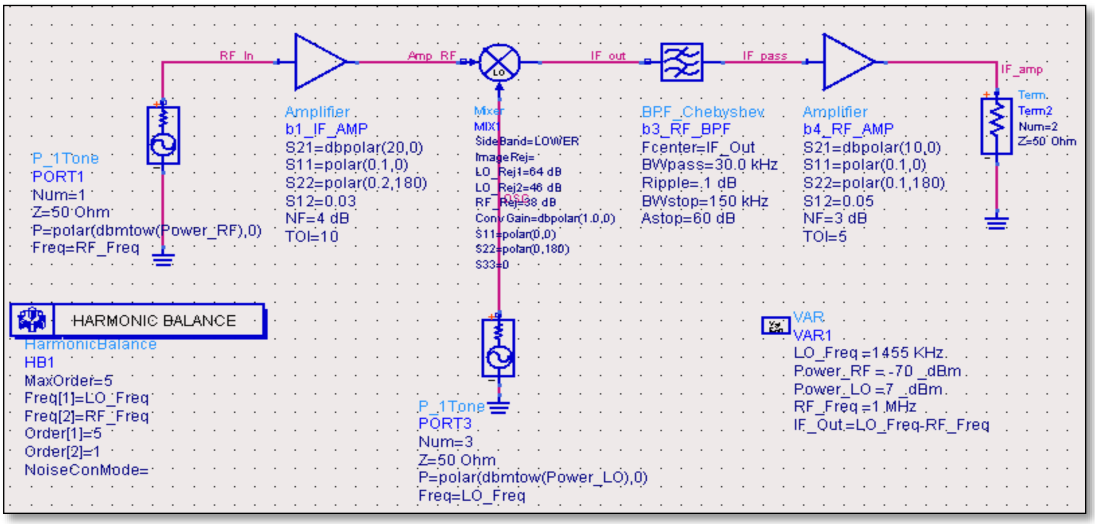


Figure 4.5: The ADS Super-heterodyne Block System

Figure 4.6 is the value that observe in the node of *RF_In* which is the frequency that we fed into the system. The marker (*m1*) is the RF frequency at 1 MHz and *m2* is the LO frequency at 1455 kHz. This value is then supply into the RF Amplifier block with the voltage gain of 10, we can refer this in figure 4.7.

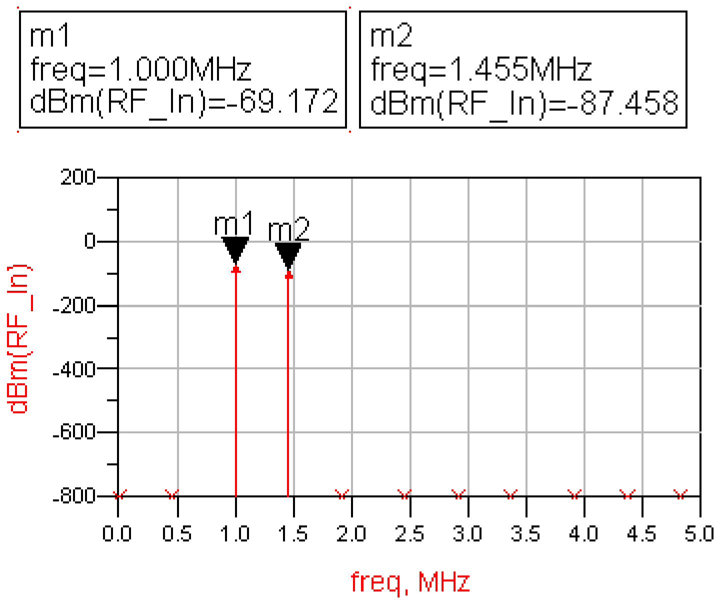
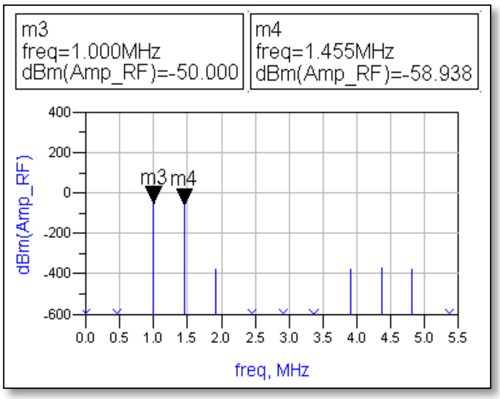


Figure 4.6 Result RF input spectrum

Figure 4.7 is the output from the amplifier in the system in frequency domain while Figure 4.8 the output in time domain. Referring to Figure 4.7 the result show that the power have been amplified, where marker *(m3)* reading is from -69 dBm to -50 dBm and from the Figure 4.8, the amplification is at voltage gain of 10. Next, the frequency will be heterodyne with the LO frequency in the mixer.



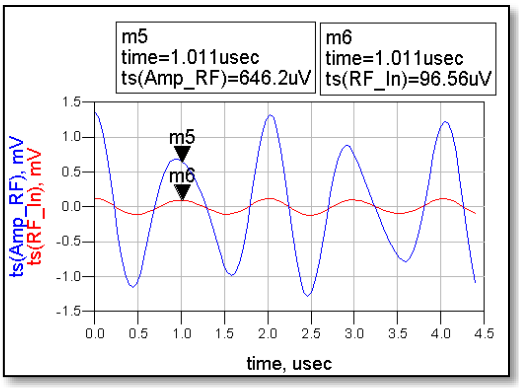


Figure 4.7: Amplifier output spectrum   Figure 4.8: Amplifier output in time-domain

Figure 4.9 is the output that observe from the node *IF_out* in the system. This result showing that the IF frequency exist through this simulation but it is also produce out the image frequency in this simulation and the marker *(m7)* is the IF frequency at 455k kHz from the difference. The other spectrum that can be observe as in the picture depicted the image frequency that should be the unwanted frequency.

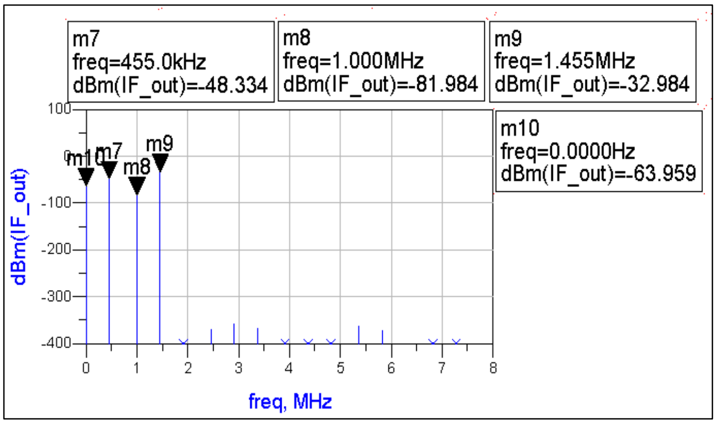


Figure 4.9: Output Spectrum of IF

The output as in previous explanation are having the spectrum of the image frequency. To eliminate the image frequency is by applying the bandpass filter after mixer. As the result from the filter, the Figure 4.10 shows the signal after the filter. Comparing to previous result, the other signal being rejected while the fundamental frequency for RF and LO are being attenuated. Marker (*m1)* is the IF frequency that maintain in terms of signal power as compare to RF frequency (*m2*) and LO frequency (*m3*) and the other frequency spectrum as in the figure are eliminated. Since the (m2) and (m3) are too low in signal level which is at -240 dBm and -213 dBm, it is to be considered eliminated.

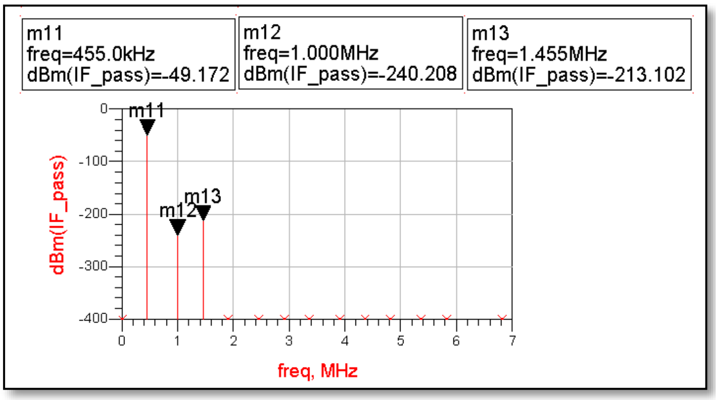


Figure 4.10: The signal after applying filter

Figure 4.11 showing the result of the IF Amplifier block from the system. The same parameter setting was used with previous amplifier and the signal input was fed using the signal from the IF output. The *IF_Pass* is the frequency input to the amplifier and the *IF_amp* as the output signal from the amplifier. It can be seen above that the signal is amplified from about 1.0 millivolt to 3 millivolt output. This difference from the RF amplifier is that, it is lower because the IF signal is low in power after heterodyne compare to the RF signal. That is why enough amplification is needed in this stage so that the correct signal can be decode to audio frequency.

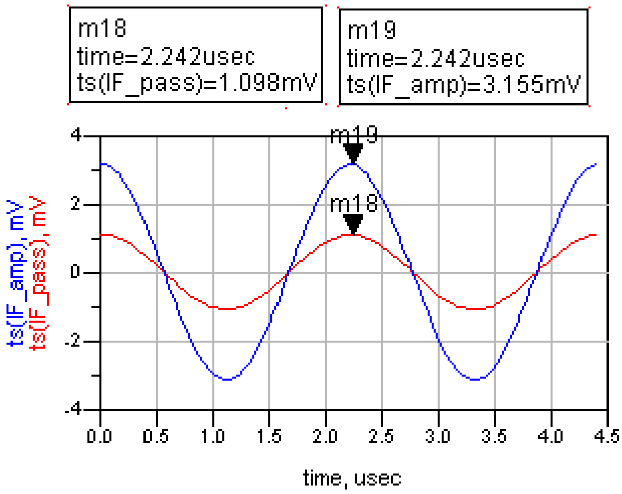


Figure 4.11: Amplifier system signal analysis

4.4 Harmonic Balance Noise Performance Simulation

This section the figure is about the noise figure analysis in the system. The simulation is using the noise controller in the ADS function. The block system used consisting the main part which are the *RF Amplifier*, *Mixer*, *BPF Filter* and *IF Amplifier*. The system parameter design is set with the same configuration as in before in the Super-heterodyne receiver system simulation. Figure 4.12 and Figure 4.14 are the figure of the system simulation configuration with all the parameter set up. The signal for the incoming RF *(RF frequency)* is given through the Port 1 signal generator with node named *RF Input* and the local oscillator signal *(LO frequency)* is from the Port 3 with the node named *LO input*. The *RF_Freq* input is made with 1 MHz with *RF power* of -70 dBm and the *LO_Freq* is 1455 KHz input with the *LO power* of 7 dBm. These variable can be refer as in Figure 4.13.

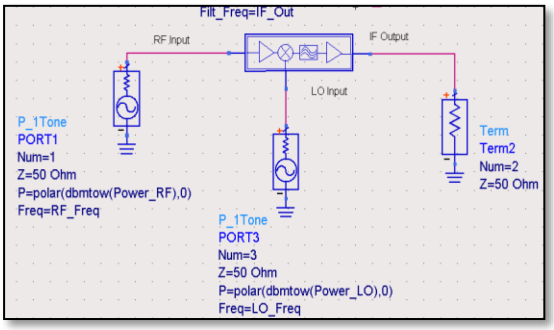


Figure 4.12: The system simulation block.

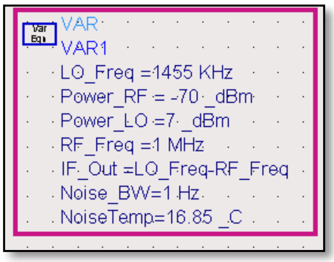


Figure 4.13: The variable parameter set up

Look inside into the centre box in Figure 4.11 are the RF amplifier, Mixer, BPF and the IF amplifier components. The connections node for all the components were named before the components block which are *V_RF_In*, *V_Mix_In*, *V_Mix_Out*, *V_Filt_Out and V_IF_Out.* The *'V'* in front of every nodes name were reference for the Voltage. This is for the voltage measurement for the simulation. As for current measurement, there are five current probe tool installed along with each nodes to measure the current in each nodes for the simulation purpose.

For this noise figure performance simulation, the configuration for and setting for the system are the same as previous simulation. The difference in this simulation are the noise insertion for each of the components block. The noise is set with noise figure *(NF)* in each component. RF amplifier with 4 dB of NF, Mixer with 6 dB of NF and IF amplifier with 3 dB of NF. The setting for these can be refer to the Figure 4.12.

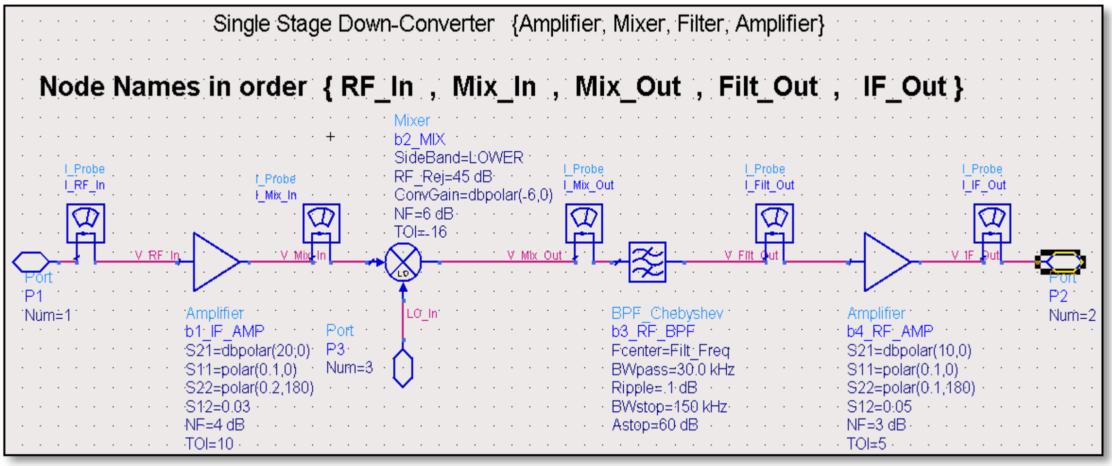


Figure 4.14: The system Block components.

Results of Harmonic Balance Noise Performance:

Table 4.1 is the result for the performance for this simulation. There are three measurement were measured in this process of result. The first are the power performance for each of the nodes in the system. Next is measurement for the gain in dBm in each of the nodes and the last is the noise figure measurement for each of the nodes in the system. Before go through each of the result measurement, the nodes that the measurement taken are Mixer input, Mixer output, Filter output and the IF output where the nodes are as follow in the Figure 4.15.

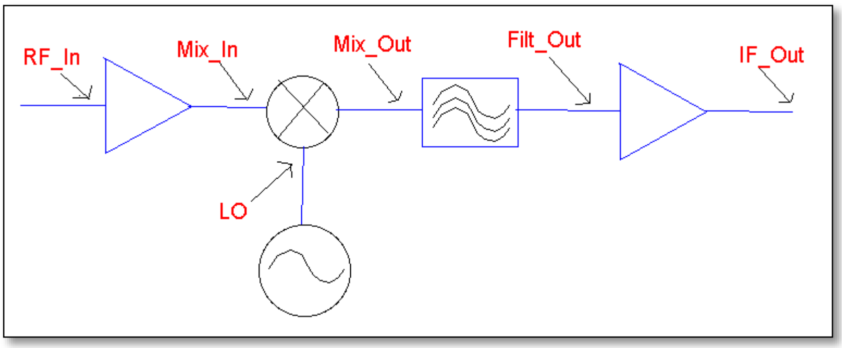


Figure 4.15: Node name for the system.

To continue, as in Table 4.1 the result for the simulation are about the power, gain and the noise in the system configuration design and to note that this result is in cascaded measurement. For power at nodes measurement, the table show power performance for this system. It start with -50 dBm at Mixer in where the signal comes from the RF amplifier. Then after the mixing or heterodyne process the power degraded to -56.919 dBm depicted that the Mixer devices causing the power losses to the system by -6 dBm. The output from the filter is measure at node *Filt out* is at -57.935 dBm, this shows the filter also causing the signal loss but at small limited value about -1.0 dBm. Then the output from the IF output value with value of -47.892 dBm. This value shows that the signal being power up by the IF amplifier back to reasonable level back with the initial signal power.

For the cascaded power gain at nodes, the measurement taken is in dB. It is observed that the gain from before the mixer device is 19.784 dB and after the mixing process the resultant gain is 13.081 dB. The gain at filter output node is 12.065 dB. As for analysis purpose, as show the power gain at each after the components of mixer has degraded the power gain. But the IF amplifier turn up back the power gain to reasonable as can be seen the overall gain system is up to 22.108 dB.

The last column for in the Table 4.1 is the Noise Figure (NF) measurement for the system. The mixer input nodes reading is 4.00 dB where the noise start to effect the signal and the 4 dB of NF is from the RF amplifier. Then the mixer output showing the noise figure of 7.082 dB. The mixer output measure depicted that the noise figure increase by 3 dB. Next the output from the filter node gives the result of 7.084 dB and not much different. As overall noise figure in the system measure at IF output with 7.140 dB. This simulation depicted that this system has causing the SNR level degraded by 7dB.

Table 4.1: The performance simulation results.

Power at Nodes (dBm)			
Mix_In_dBm	Mix_Out_dBm	Filt_Out_dBm	IF_Out_dBm
-50.216	-56.919	-57.935	-47.892
Cascaded Power Gain at Nodes (dB)			
Gain_Mix_In	Gain_Mix_Out	Gain_Filt_Out	Gain_Sys
19.784	13.081	12.065	22.108
Cascaded Noise Figure at Nodes (dB)			
NF_Mix_In	NF_Mix_Out	NF_Filt_Out	NF_Sys
4.000	7.082	7.084	7.140

4.5 Design of amplifier Circuit

After using the ADS component simulation, the amplifier circuit was design to simulate and compare with the components simulation result. Figure 4.16 is the configuration set up after calculation made. The circuit use NPN type of BJT configuration for this amplifier. The base is input supply that connected to the Sine source and the output of this amplifier is at the collector side where the result in Figure 4.17. For this simulation, the simulator selected was transient to see the signal flow through amplifier design.

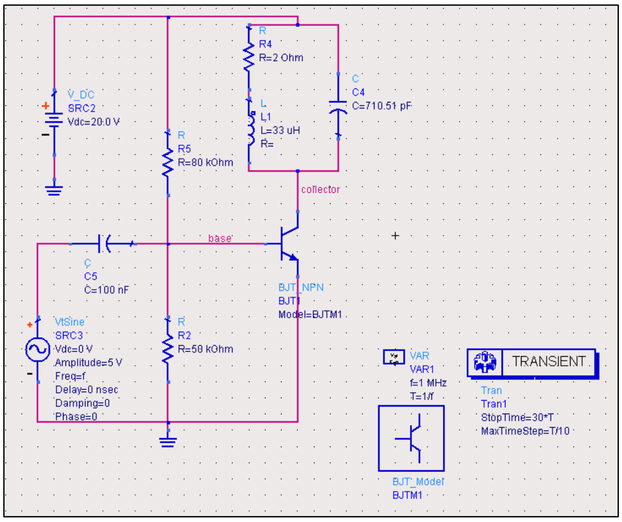


Figure 4.16: The Amplifier Circuit Design.

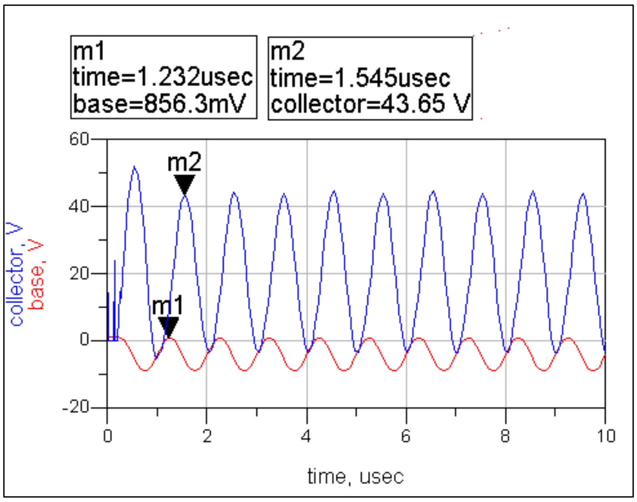


Figure 4.17: The Amplifier design result.

The result was set at base and collector, as mention before base is the input signal and the output signal at collector. The input peak at 856.3 millivolt in average while the output is at 43.65 Volt peak average. Figure 4.18 below shows the result of amplifier response in dB scale resonating at 1 MHz this is set with the circuit design to. The design is yet to be looked for further improvement

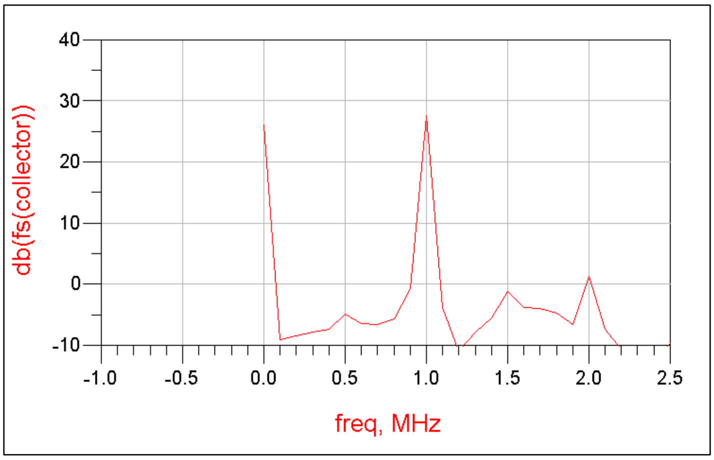


Figure 4.18: Amplifier response.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

As the conclusion super-heterodyne is a technique that have many advantage in designing a good radio communication. It is unique that from the basic theory design to be implemented and developed on the receiver that suit to required design. This project is expected to provide analysis data about the receiver design that can provide improvement to this super-heterodyne receiver performance. This project also expected to be provide better understanding of Amateur radio receiver design. Useful knowledge is gained and can applied consequently for further development.

Throughout this period of final year project 2, the author are able to gain much knowledge and basic regarding the project. During in this period, the author are exposed to the design software that is used communication field (Advanced Design System). The author had took initiative and effort to learn and gain as much knowledge of the software through the superior people.

The difficulties that face by the author is to learn the software usage and in the same time to integrate all the system by using the software to get the result of from the simulation. However the author manage to face the difficulties from the help of lecturers and peer member.

5.2 Recommendation

There are plenty much work need to be done by the author in the next phase of this project. This period the author are expected to get better understanding on the software usage and the system background. On the next phase, next candidate can continue with circuit designing simulation process for further investigation and continued with the model fabrication.

One of the recommendation of future work in the next phase is that the result obtain earlier in system simulation is to be considered in designing the circuit simulation result. Furthermore, the value of the components used need to be calculated and determined carefully comply with the parameter required in the design. Further review needed for the better design implementation considering all the factors.

In the designing process, the design should meet all the parameter stated. The design also need to be make sure it is the desired design and correct. View from the more knowledge person would be prefer like supervisor, lecturer or the industry person. The better the design is when the design is being optimize fully during the design process through the simulation process before the fabricating the model

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