

RF_SL

by Sam Lloyd

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Introduction

In this write up there will be a description of 3 tasks that all are to create a form of modulation and demodulation of either a sound wave or a sine wave, then examine the outputs and complete a comparison. For task 1 this required a basic AM Modulation and demodulation using the maths shows in Equation 1. Task 2 is to build a DSB SC modulator using Balanced Modulator and demodulate it to get the original signal both in frequency and time domain. Finally task 3 is to Implement a FM modulator using any FM Modulation technique and demodulate it to get the original signal in frequency and time domain.

Background research

Task 1

For task 1 this required research into Amplitude modulation and how to create the bellow Equation 1 and Equation 2 using the values in Equation 3 as the set values.

$$c(t) = A_c \sin \omega_c t;$$

Equation 1: AM carrier wave [1]

$$m(t) = A_m \sin \omega_m t$$

Equation 2: AM message wave [1]

$$\omega_c = 2\pi(10000); \text{ or } f_c = 10\text{KHz}$$

$$\omega_m = 2\pi(1000); \text{ or } f_m = 1\text{KHz}$$

Equation 3: values for carrier and message frequency

A = amplitude

$\omega_c t$ = frequency in rad/s or f = frequency

It is also important to set the modulation index for the wave, this is done using the Equation 4, so for creating a modulation index = 0.6 you would want $A_m = 0.6$ and $A_c = 1$.

$$m = \frac{A_m}{A_c}$$

Equation 4: Modulation Index [2]

Once the modulation was completed the next thing to do would be to demodulate the wave and get a wave the same as the starting message, $m(t)$.

Task 2

For this it was important to research how to create a DSB SC modulator using a balance modulator. Once created then transmit a real sound message using the multimedia block and once this is done add noise to the channel recording the sound output for these. The equation for this can be seen in Equation 5.

$$v_{out} = mV_c [\cos(\omega_c - \omega_m)t - \cos(\omega_c + \omega_m)]$$

Task 3

The Final task is to create a FM modulator and demodulator that transmits a sine wave. Once completed then transmit a real sound message using the multimedia block and once this is done add noise to the channel recording the sound output for these.

To start it's important to understand the formula to create the modulation, this can be seen in Equation 6.

$$x_{FM}(t) = A_c \cos[2\pi f_c t + 2\pi K_{VCO} \int_0^t m(t) dt]$$

Equation 6: FM Modulation [4]

From this equation you can draw the logic required to create the modulation for FM. Looking into demodulation techniques there was 2, Frequency Discrimination Method which uses an envelope detector and Phase Discrimination Method which uses a VCO [5]. In this Frequency Discrimination Method will be used, this was decided as it was a simpler setup and had all working p Simulink, the block diagram can be seen in Figure 13, and formula in Equation 7.

$$\frac{ds(t)}{dt} = A_c(2\pi f_c)[1 + (\frac{k_f}{k_c})m(t)]\sin(2\pi f_c t + 2\pi k_c \int m(t) dt - 180^\circ)$$

Equation 7: Frequency Discrimination Method Formula [5]

Circuit Diagram

Task 1

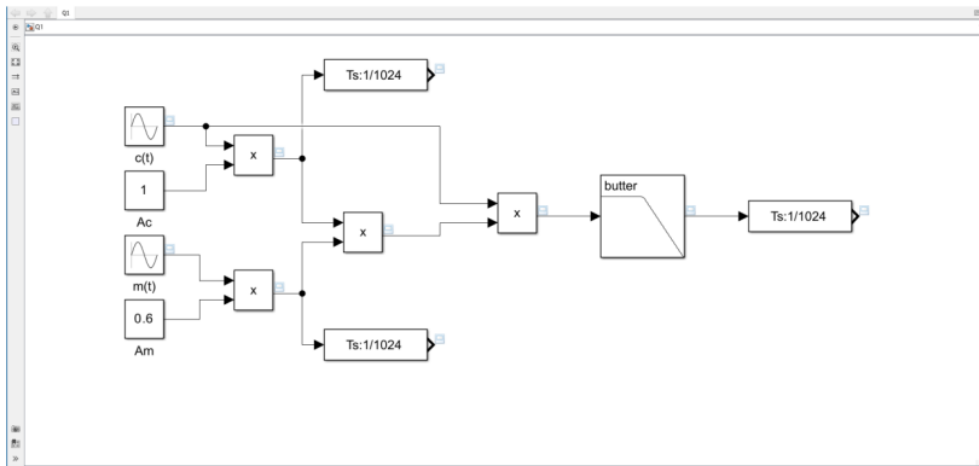


Figure 1: Task 1

Task 2

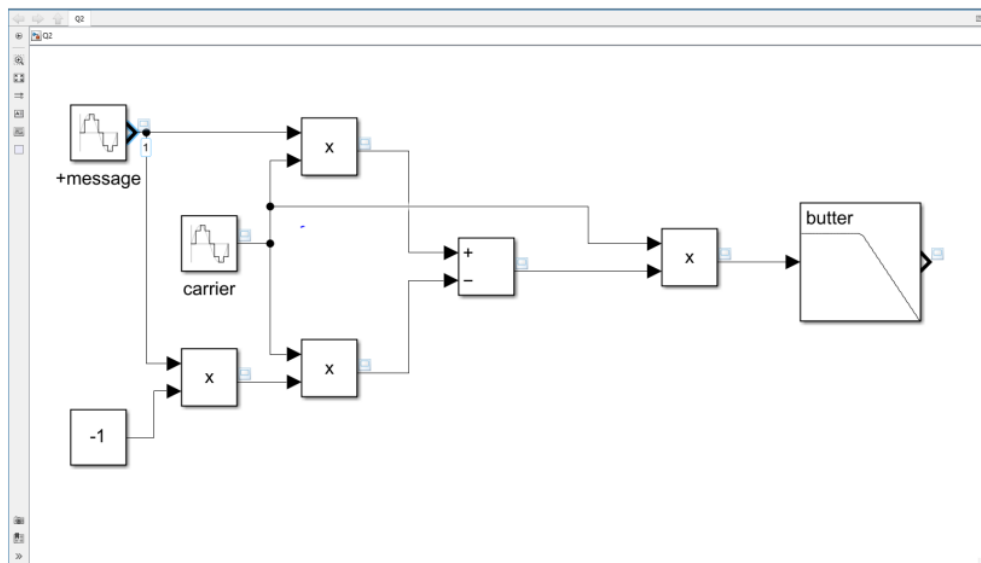


Figure 2: Task 2.a

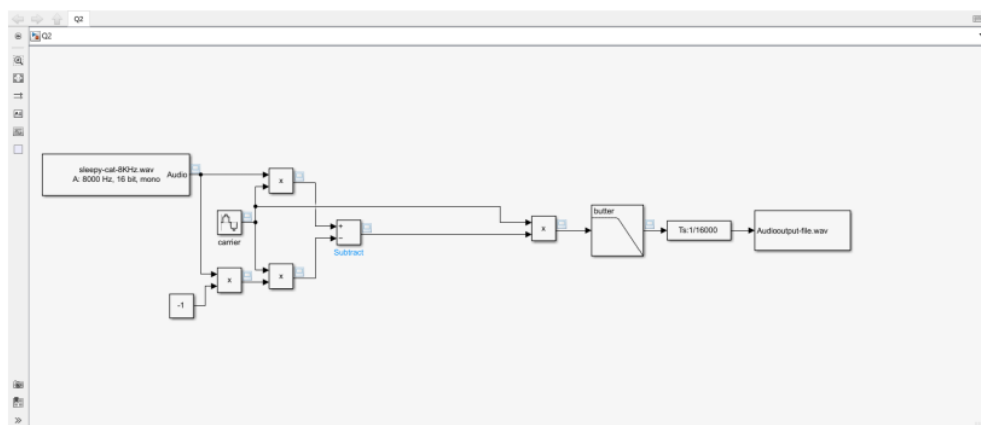


Figure 3: Task 2.b

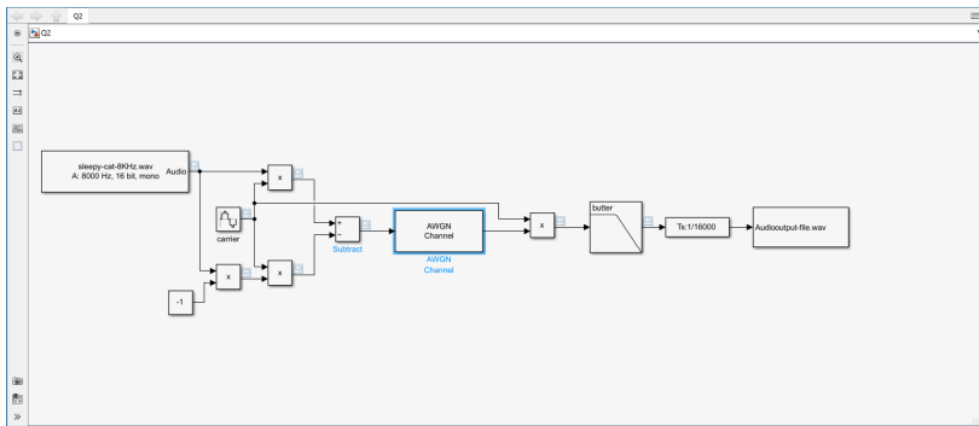


Figure 4: Task 2.c

Task 3

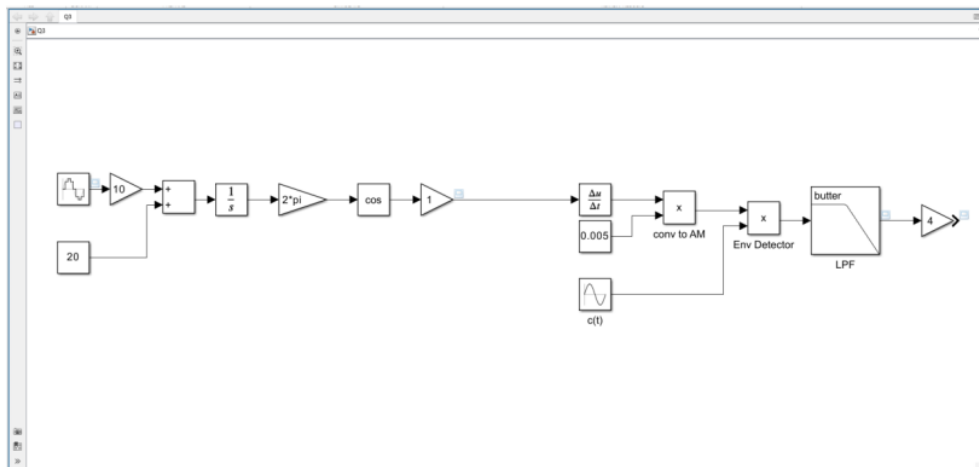


Figure 5: Task 3.a

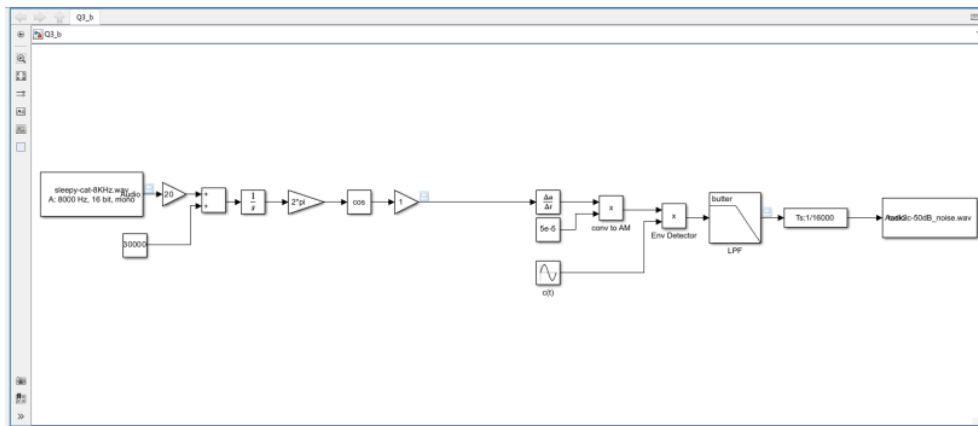


Figure 6: Task 3.b

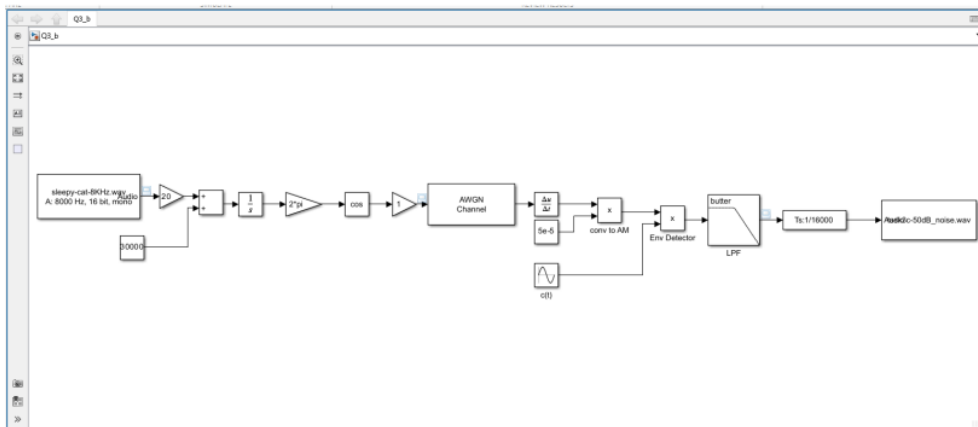


Figure 7: Task 3.c

2

Block design

Task 1

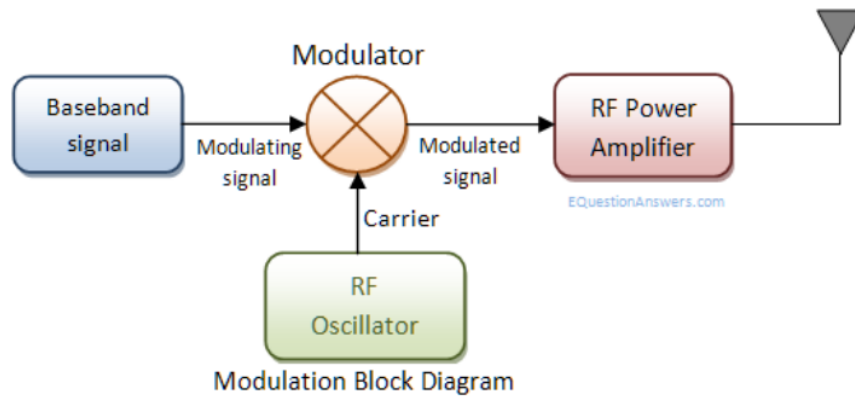


Figure 8: AM Modulation [6]

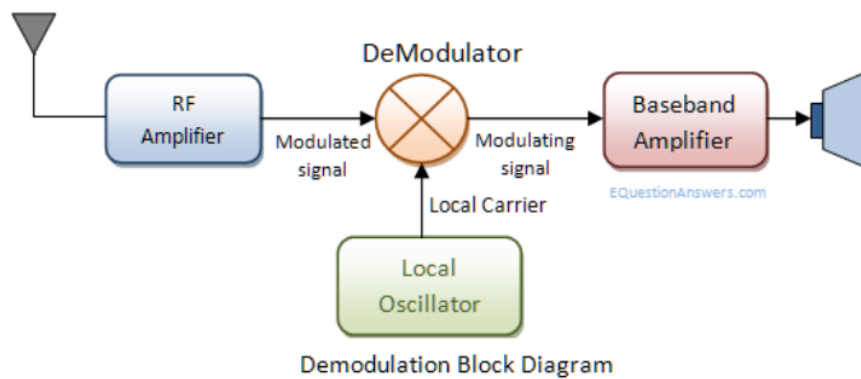


Figure 9: AM Demodulator [7]



Task 2

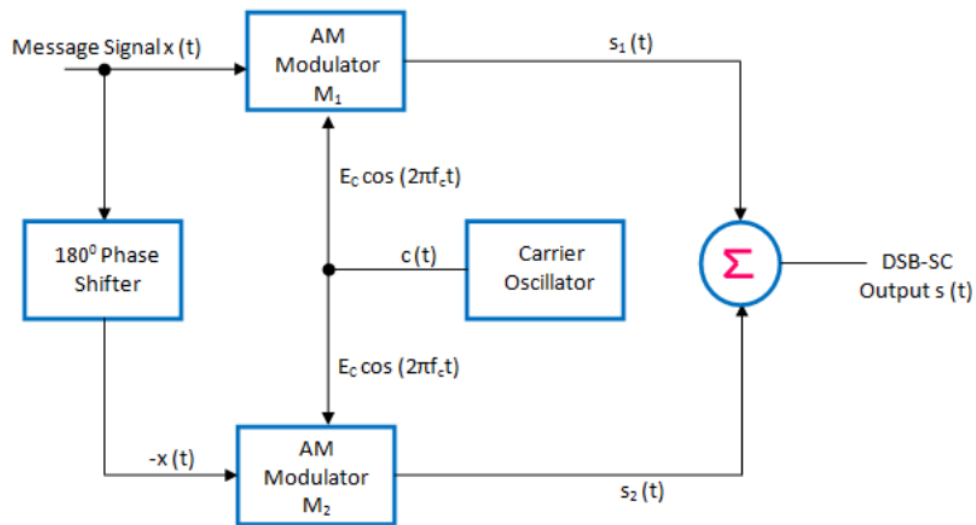


Figure 10: DSB-SC modulation [8]

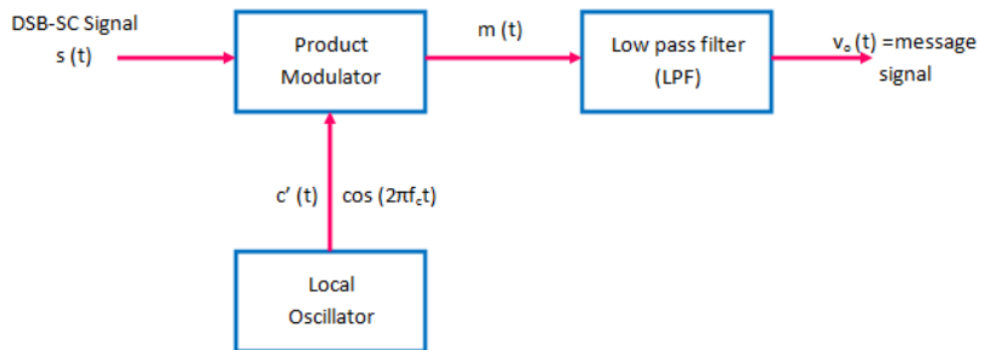


Figure 11: DSB-SC demodulation [9]

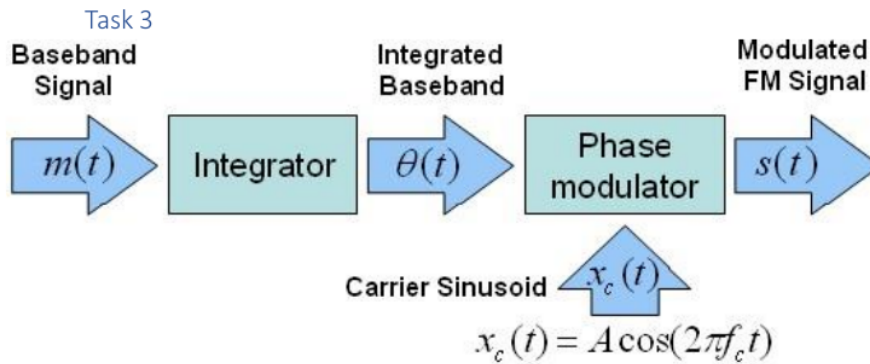


Figure 12: FM Modulation 4

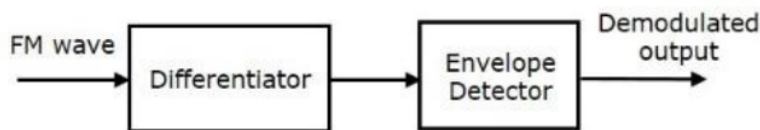


Figure 13: Frequency Discrimination Method [5]

Transmitter and Receiver Architectures

Task 1

The architecture for the AM transmitter can be seen in the block diagram on Figure 8. Inside the modulator the input signal is multiplied with the carrier wave and then output through the antenna, sometimes passing through an amplifier to affect the distance the output can be seen at.

For the AM demodulator shown in the block diagram, Figure 9, this then multiplies the wave with the carrier and then outputs the noise. This is sometimes amplified before and after the demodulation, this is to improve the output quality after traveling for long distance and removing.

Task 2

DSB-SC block diagram can be seen in Figure 10, this shows how the circuit takes an input signal, on one side multiplies this with the carrier signal. On the other, creates a negative of the input and then multiplies this with the carrier and then adds these together and outputs this.

For the demodulation seen in Figure 11 this is the same as for AM modulation in task 1.

Task 3

For Frequency modulation the block diagram can be seen in Figure 12, this is done slightly differently in practice as you need to multiply the input wave and add the desired frequency before then this is integrated, multiplied by 2 and pi, then cos and finally, an amplifier if required, this can all be seen in Figure 5. this is then completed Frequency modulation.

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To demodulate Frequency modulation, it is required to make this into an AM wave and then decipher the information, this can be seen in Figure 13. This method is called Frequency Discrimination and is done by differentiating the FM wave, which outputs an AM wave which is then multiplied with a carrier wave which is of the frequency of the FM wave, this is then passed through a filter to get the desired output, this can be seen in Figure 5. The additional step made here is to get the wave in the correct amplitude.

Simulated Outputs and results

For creating simulations MATLAB Simulink was used to create the results [11], this was done by building the block diagrams seen above in Figure 1 to Figure 7 and the simulating these to get the following results and the sound outputs attached in the .zip file attached to this document.

Task 1

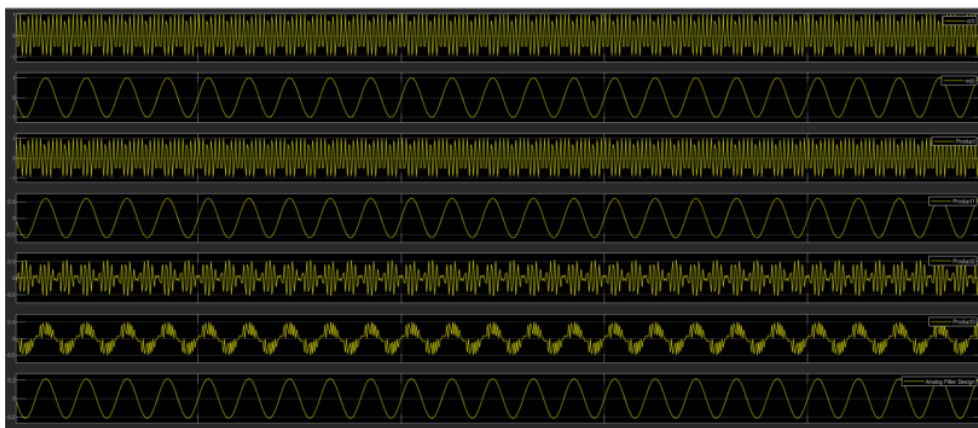


Figure 14: Task 1 - 0.6 Modulation Index

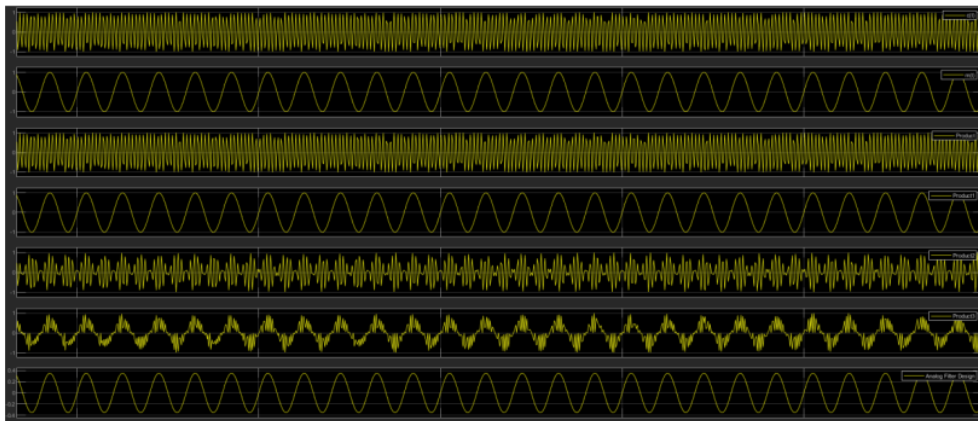


Figure 15: Task 1 - 1 Modulation Index

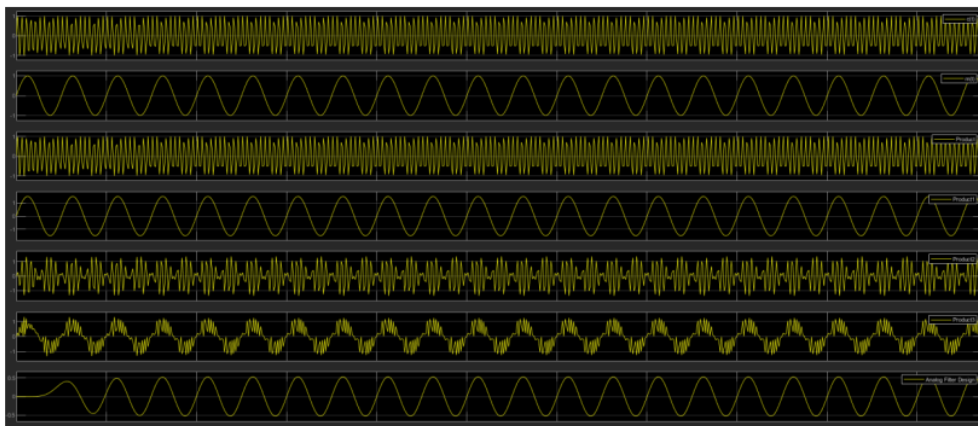


Figure 16: Task 1 - 1.5 Modulation Index

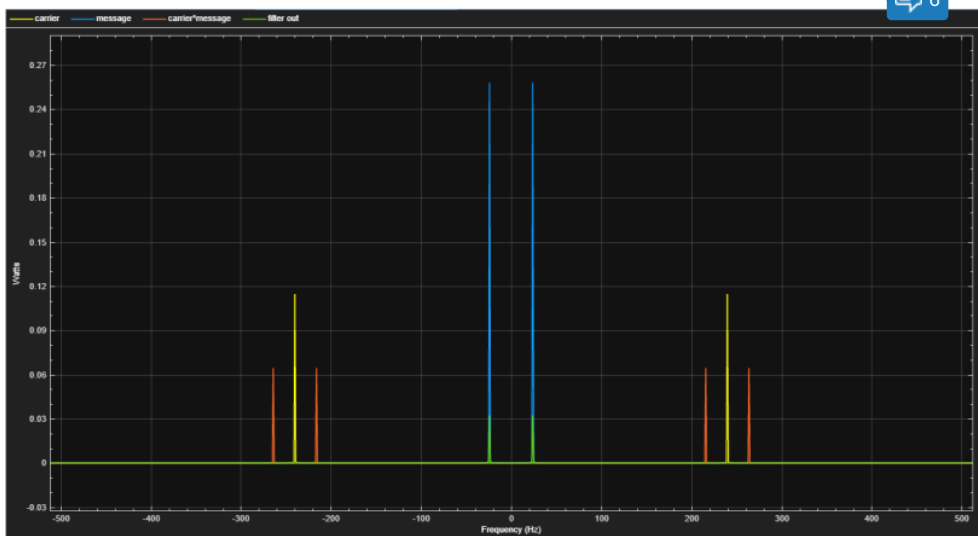


Figure 17: Task 1 - Spectrum output



Task 2

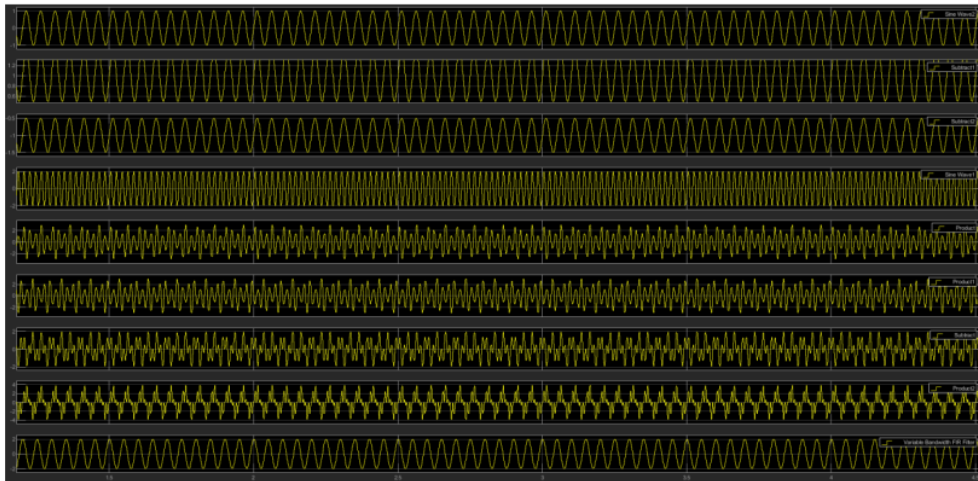


Figure 18: Task 2.a - Scope - 0.5 Modulation Index

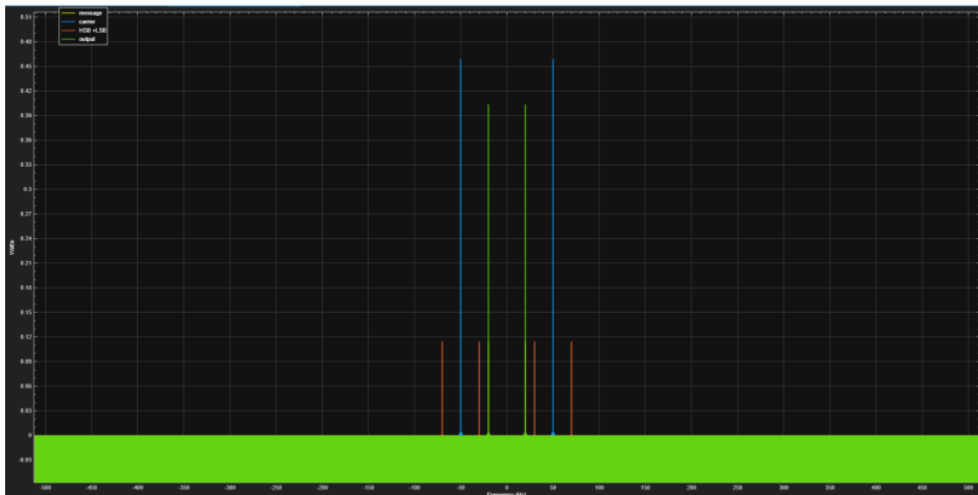


Figure 19: Task 2.a- Spectrum - 0.5 Modulation index

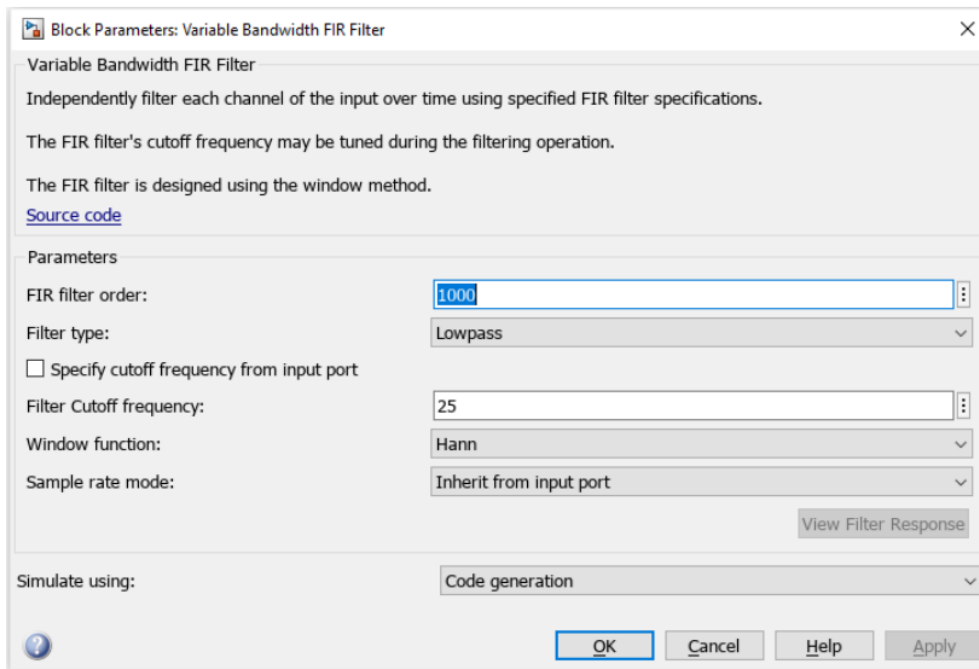


Figure 20: Task 2.a - Filter

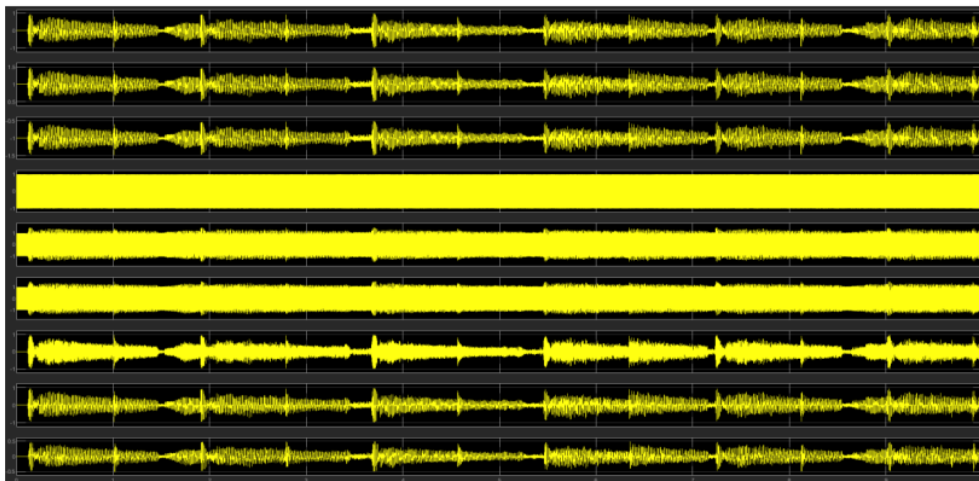


Figure 21: Task 2.b - Scope output

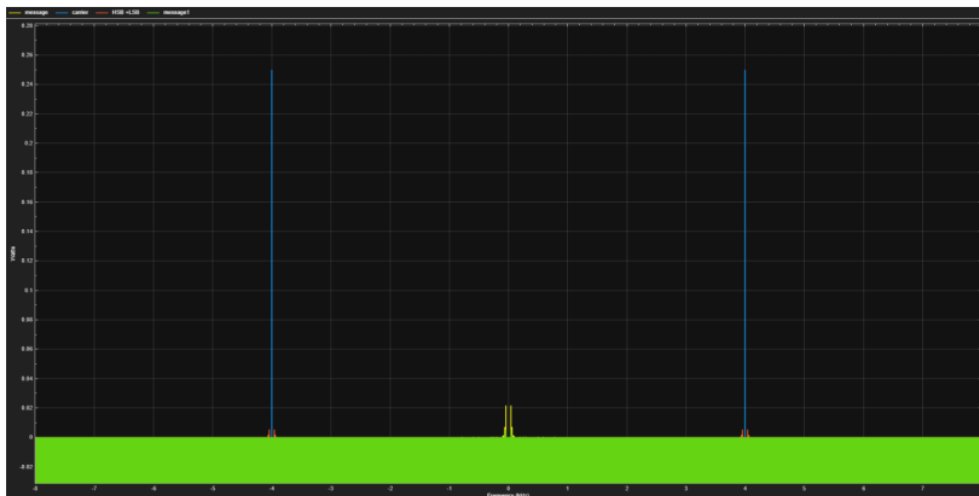


Figure 22: Task 2.b - spectrum analyser output

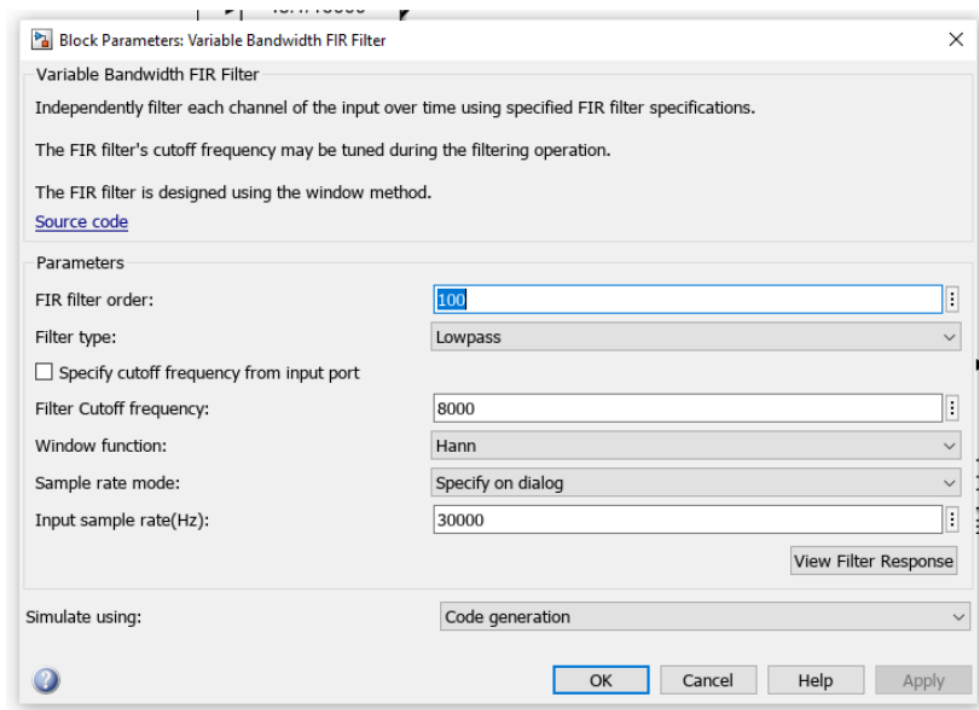


Figure 23: Task 2.b - Filter

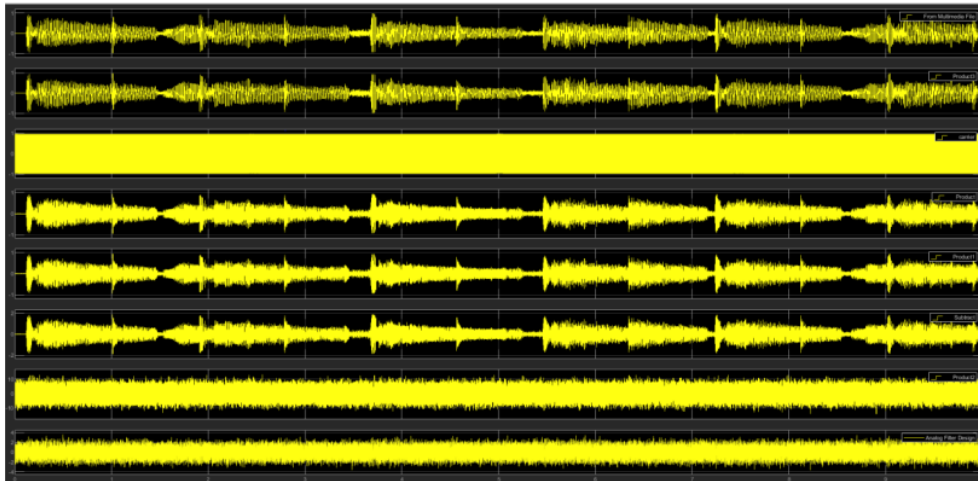


Figure 24: Task 2.c with -10dB Noise

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Task 3

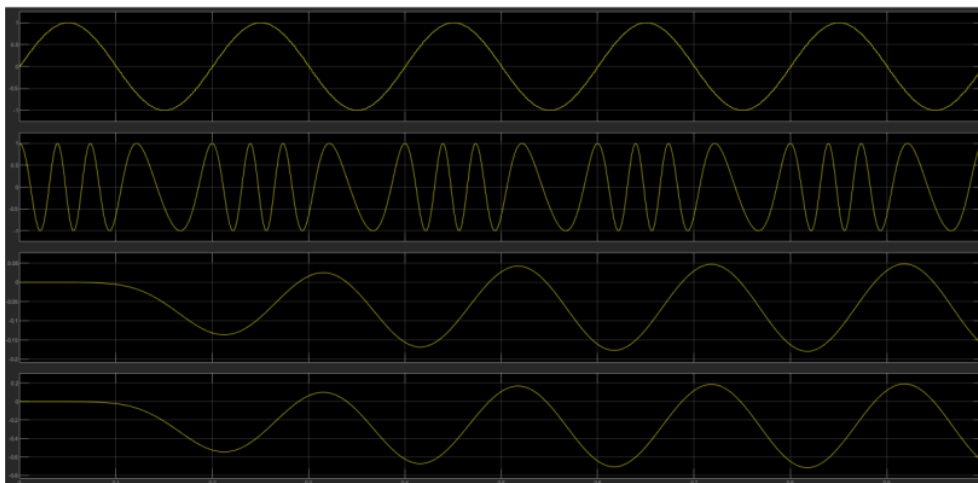


Figure 25: Task 3.a

11

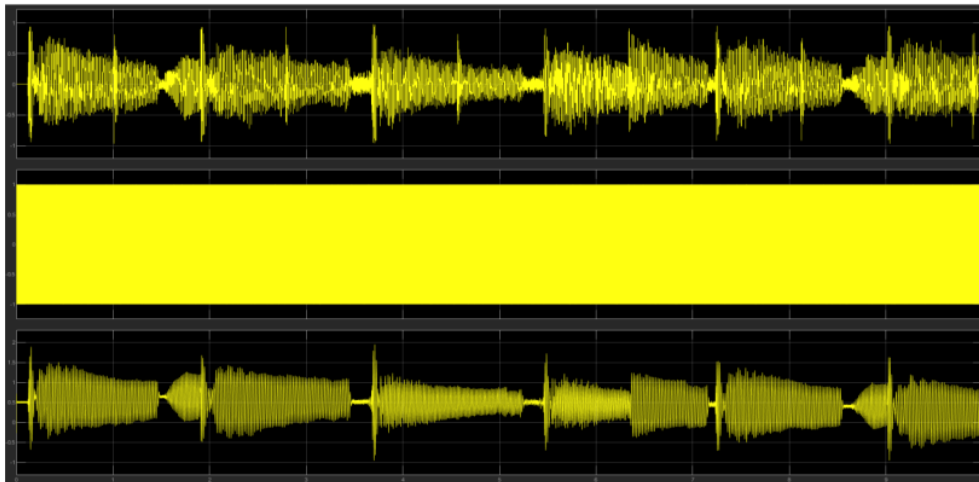


Figure 26: Task 3.b – Scope output

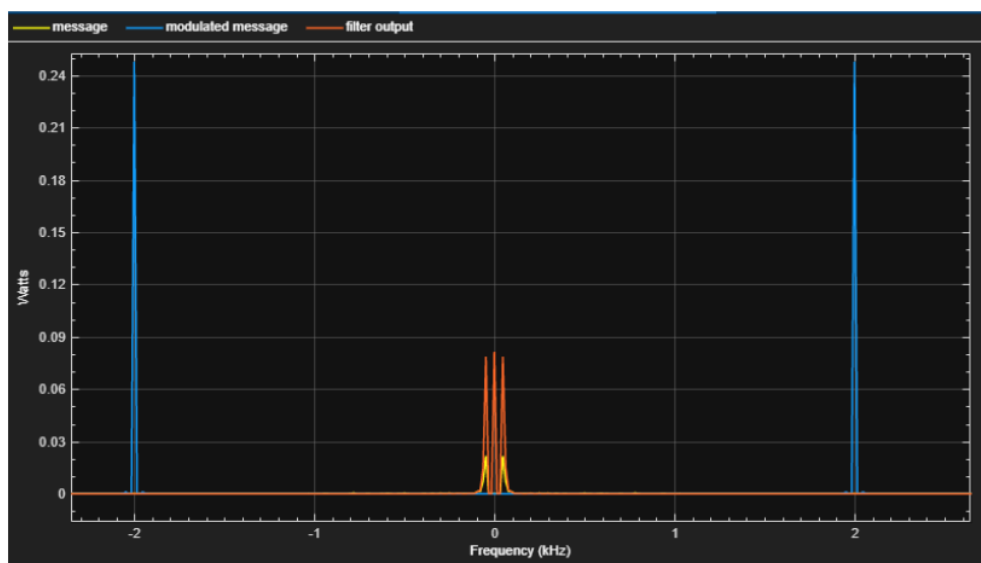


Figure 27: Task 3.b – Spectrum output

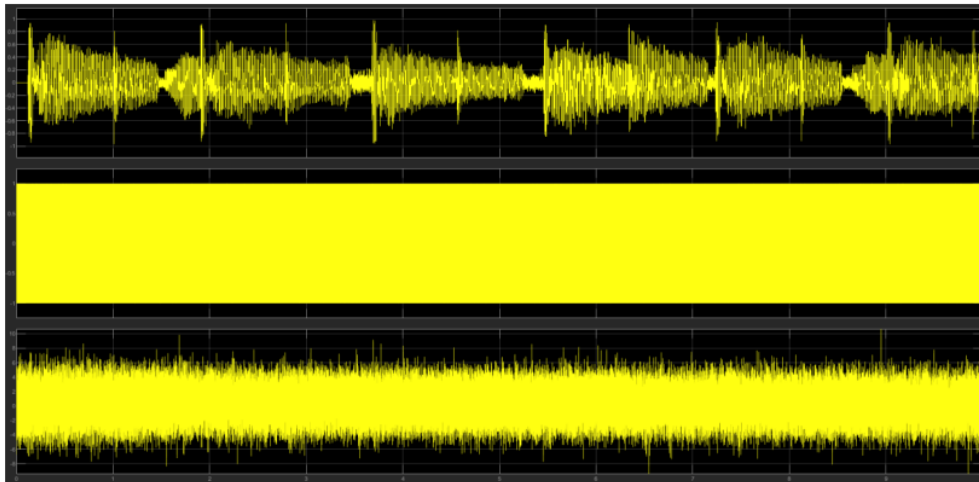


Figure 28: Task 3.c - 20dB noise - Scope output

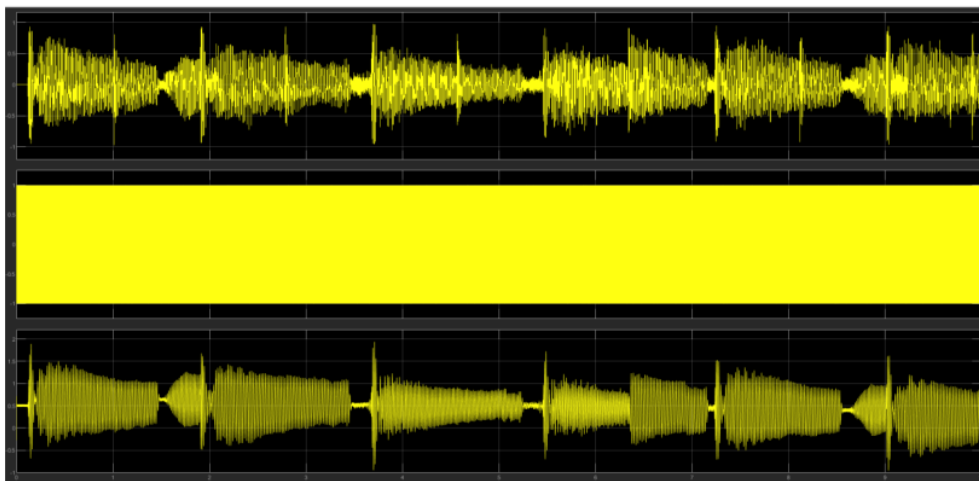


Figure 29: Task 3.c - 100dB noise - Scope output

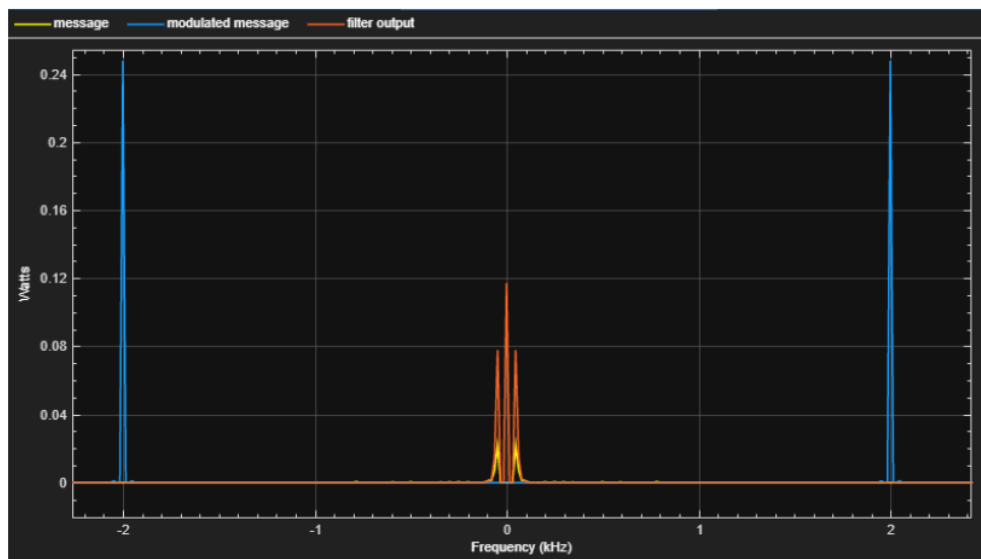


Figure 30: Task 3.c - 100db noise - Spectrum output

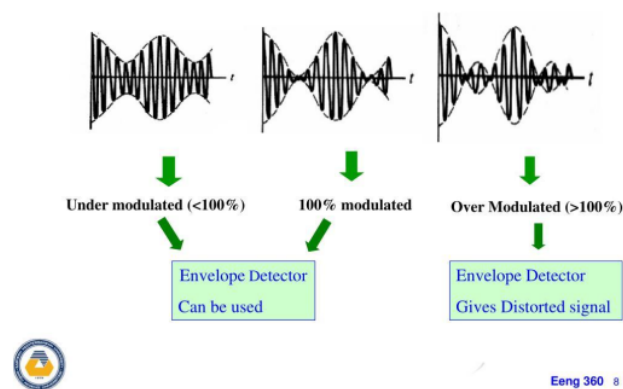
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Analysing the Results.

Task 1

For this task the aim was to create a working Amplitude modulator and demodulator which was successful in completing, this can be seen in Figure 1 and the results of this in Figure 14. The next step was to show Critical, over and under Modulation and display the effects, an example of this can be seen in Figure 31.

AM - Percentage Modulation



Eeng 360 8

Figure 31: Under, Critical and Over modulation [12]

Testing on Simulink did not show these results as expected. Figure 14 and Figure 15, which show under and critical respectively, showed the results as expected of no data loss occurring. But with an

expected data loss in doing Over modulation in Figure 16 this did not occur. It is possible that this is an error in the program that cannot be explained as it was set up appropriately and this can be seen in the figure with the amplitude of the message being higher than that of the carrier. Where data loss should have occurred, it did not in this case. All outputs of all tests can be seen in the relevant figures on the last line.

Task 2

In Figure 2 this shows the working DSB SC modulator built with a 0.5 modulation index, the scope output for the modulation and demodulation of the wave can be seen in Figure 18.

Figure 3 shows how the circuit is built to have a "real message" transmitted. The original message can be seen in the file, this is labelled "sleepy-cat-8KHz". The outputs of the DSB SC output with no noise is labelled "Task_2b_NoNoise". This shows a slight distortion to the output compared to the input, but it is clearly still the same message. The output of this can also be seen in Figure 21 which shows the signal at the start and at the end with minimal difference in the wave shape.

For the final part of this task noise was added to the system using the AWGN block in Simulink in the channel, seen in Figure 4. I attempted this with 100dB of noise and 10dB, with 100dB there was very minimal changes, this can be heard in the file titled "Task_2c_100dbNoise", this is like the no noise as there is a minimal effect but there is some. Whereas with 10 dB noise this was a very distorted noise with little to no resemblance of the original sound, this can be heard in "Task_2c_10dbNoise" and seen on the scope in Figure 24 where this clearly shows the original wave shape cannot be seen at all.

Calculating the theoretical SNR and theoretical Figure of merit.

$$FoM = \frac{SNR_c}{SNR_o}$$

$$SNR_c = \frac{Ac^2 Ka^2 P}{2N_0 BW}$$

$$SNR_o = \frac{Ac^2 (1 + Ka^2) P}{2N_0 BW}$$

Equation 8: DSB-SC FOM & SNR [13]

Using the values

$Ac = 2$ $Ka = 0.5$ $P = 0.5$ $N_0 = 1$ $BW = 16000$

This then returns these values.

$SNR_c = 0.000078125$ converted to dB => 1.000018

$SNR_o = 0.000015625$ converted to dB => 1.000004

Theoretical FoM = 1.000014

This value can then be compared to values created using the simulations.

Calculating SNR and figure of merit in DBW with the noise value set to 50dB.
Using the spectrum analyser to gather the data using the channel measurements tab.

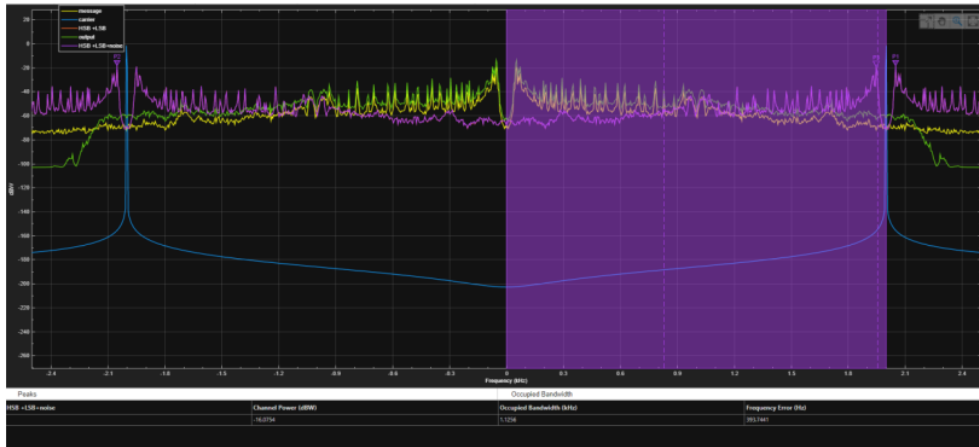


Figure 32: How to find power values.

Using the measurements feature on the spectrum analyser gather results for the channel power for the output, modulated and modulated after noise. The values below are rounded to 3dp but were not during the calculations.

$$\text{Output} = -8.2246\text{dBw} \Rightarrow 10^{\text{dBw}/10} = 0.108...$$

$$\text{Modulated} = -13.3653\text{dBw} \Rightarrow 10^{\text{dBw}/10} = 0.024...$$

$$\text{Modulated + Noise} = -16.0758\text{dBw} \Rightarrow 10^{\text{dBw}/10} = 0.024...$$

$$\begin{aligned} \text{Noise power} &= (\text{Modulated + noise}) - \text{Modulated} \\ &= 2.273... \times 10^{-6} \end{aligned}$$

$$\begin{aligned} \text{SNRo} &= 10\log_{10}(\text{output} / \text{Noise power}) \\ &= 46.801... \text{dBW} \end{aligned}$$

$$\begin{aligned} \text{SNRc} &= 10\log_{10}(\text{output} / \text{Noise power}) \\ &= 40.357... \text{dBW} \end{aligned}$$

$$\text{FOM} = 0.8622$$

Calculating SNR and figure of merit in DBW with the noise value set to 10dB.

$$\text{Output} = -9.6312\text{dBw} \Rightarrow 10^{\text{dBw}/10} = 0.150...$$

$$\text{Modulated} = -16.0754\text{dBw} \Rightarrow 10^{\text{dBw}/10} = 0.046...$$

$$\text{Modulated + Noise} = -16.0761\text{dBw} \Rightarrow 10^{\text{dBw}/10} = 0.024...$$

$$\begin{aligned} \text{Noise power} &= (\text{Modulated + noise}) - \text{Modulated} \\ &= 0.021... \end{aligned}$$

$$SNR_o = 10\log_{10}(\text{output} / \text{Noise power})$$

$$= 8.472...dBW$$

$$SNR_c = 10\log_{10}(\text{output} / \text{Noise power})$$

$$= 3.331...dBW$$

$$FOM = 2.5428$$

Looking at the values above you can see the theoretical FoM value is very close to that of the 50dB test, this is because the output of this is the best, its very similar to the input. Whereas for the 10dB test the noise has much more of an effect on the output which alters the value away from the theoretical.



Task 3

Figure 5 shows a working FM modulator and demodulator using a Frequency Discrimination Method, the output for this can be seen in Figure 25 when you can see the input then the Frequency modulation and then the demodulated output which is the same as the input showing that the system works.

In Figure 6 you can see the setup for FM using a real message input and then on Figure 26 and Figure 27 you can see the outputs of the scope and spectrum analyser accordingly. You can also hear the sound which is affected by a minimal amount on the file titled "task3b-no_noise".

Figure 7 shows the FM circuit using a real message including noise. Figure 28 is with 20dB and Figure 29 is with 100dB and Figure 30 is the spectrum of 100dB noise, both the 20db noise and 100db noise also have an audio file attached, "task3c-20dB_noise" and "task3c-100dB_noise". In these the 100dB message can be clearly heard and seen in the figure, but this clearly losses some of the peaks in places, whereas 20dB is not recognisable on the audio or scope. This is likely because I have not optimised the circuit enough and could be improved but clearly shows the drop of on the circuit.

Calculating the theoretical SNR and theoretical Figure of merit.

$$FoM = \frac{SNR_c}{SNR_o}$$

$$SNR_c = \frac{Ac^2 Ka^2 P}{2N_0 BW}$$

$$SNR_o = \frac{Ac^2(1 + Ka^2)P}{2N_0 BW}$$

Equation 9: FM SNR & FoM [14]

Using the values:

$$Ac = 1 \quad Kf = 20 \quad P = 0.5 \quad N_0 = 1 \quad BW = 2*(Kf + Mf) = 16040$$

these values create the bellow results:

$$SNR_o = 3.117... \times 10^{-5} \quad \Rightarrow \quad 10\log_{10} \quad = -45.062dBW$$

$$\text{SNRc} = 2.423 \times 10^{-11} \Rightarrow 10 \log_{10} = -106.156 \text{ dBW}$$

$$\text{FoM} = 0.4344$$

Calculating SNR and figure of merit in DBW with the noise value set to 50dB.

Using the spectrum analyser to gather the data using the channel measurements tab.

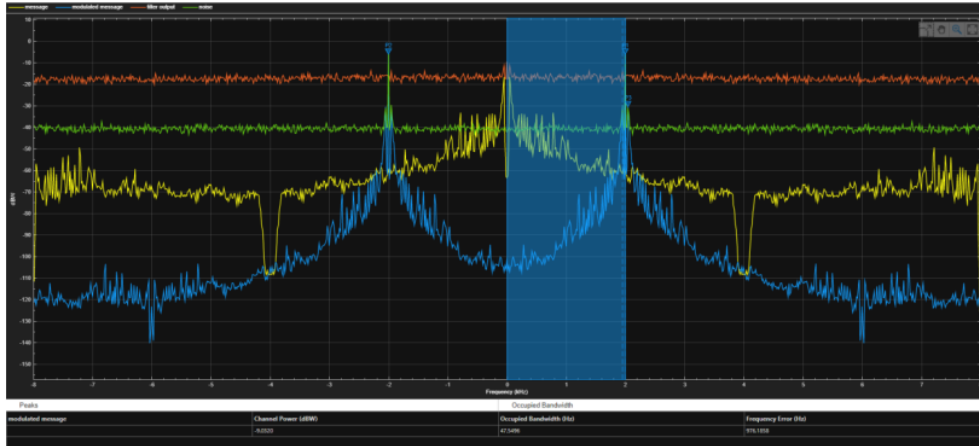


Figure 33: Finding power values.

Using the measurements feature on the spectrum analyser gather results for the channel power for the output, modulated and modulated after noise. The values below are rounded to 3dp but were not during the calculations.

$$\text{Output} = -8.7378 \text{ dBW} \Rightarrow 10^{\text{dBW}/10} = 0.133...$$

$$\text{Modulated} = -9.0317 \text{ dBW} \Rightarrow 10^{\text{dBW}/10} = 0.124...$$

$$\text{Modulated + Noise} = -9.032 \text{ dBW} \Rightarrow 10^{\text{dBW}/10} = 0.124...$$

$$\begin{aligned} \text{Noise power} &= (\text{Modulated + noise}) - \text{Modulated} \\ &= 8.832 \times 10^{-6} \end{aligned}$$

$$\begin{aligned} \text{SNRo} &= 10 \log_{10}(\text{output} / \text{Noise power}) \\ &= 41.900... \text{ dBW} \end{aligned}$$

$$\begin{aligned} \text{SNRc} &= 10 \log_{10}(\text{output} / \text{Noise power}) \\ &= 41.606... \text{ dBW} \end{aligned}$$

$$\text{FOM} = 1.007$$

Calculating SNR and figure of merit in DBW with the noise value set to 10dB.

$$\text{Output} = -4.5354 \text{ dBW} \Rightarrow 10^{\text{dBW}/10} = 2.841...$$

$$\text{Modulated} = -8.6456 \text{ dBW} \Rightarrow 10^{\text{dBW}/10} = 0.136...$$

$$\text{Modulated + Noise} = -9.032 \text{ dBW} \Rightarrow 10^{\text{dBW}/10} = 0.124...$$

$$\text{Noise power} = (\text{Modulated + noise}) - \text{Modulated}$$

$$=1.162... \times 10^{-2}$$

$$\text{SNR}_o = 10 \log_{10}(\text{output} / \text{Noise power})$$

$$= 23.880... \text{dBW}$$

$$\text{SNR}_c = 10 \log_{10}(\text{output} / \text{Noise power})$$

$$= 10.699... \text{dBW}$$

$$\text{FOM} = 2.2319 \text{ dB}$$



These results show in a similar way to the same calculation on the AM testing that the higher the noise level in the channel the greater the effect on the results here due to a higher level of noise being included on the received signal making the data harder hear if listening or see on a scope/ spectrum analyser.

Conclusion

In this task a Working Amplitude modulator was made and was shown how it works using a scope in different locations and a spectrum analyser. After this it clearly showed under and critical modulations using the scope but failed to demonstrate over modulation as the program didn't work correctly when doing this even though the inputs was set up correctly. But in general, when looking at the demodulated signal, this is an effective system but is never tested with noise so this cannot be really said.

For task 2 the DSB SC system works well under no and little noise, this can be seen in Figure 18 and Figure 21 but when under higher noise such as in Figure 24 this clearly shows when the errors occur, this can also be heard in the audio files attached. In general, this system performs well with the multimedia file.

Finally for task 3 this demoed how a Frequency modulator worked, how it created and demodulated an FM wave with the input of a sine wave and a multimedia file, this then worked with the added noise and showed the effects this has on the modulated wave.



Recommendations on future work.

In the future it would be beneficial to make these systems more comparable and gather more data on the effect of the noise on the system and create a method of comparing the quality of the outputs if this is a listen in test of something more formal.

Another option for more future work is looking into other techniques of modulations to also compare, for example with FM there are 2 modulation techniques, it is possible to compare these and see if one works better under the effects of noise.

References

- [M. J. P. Devaraj, RF_lecture1, UWTSD.
1
]
- [M. J. P. Devaraj, RF_lecture2, UWTSD.
2
]
- [EEEGuide, "Generation of DSBSC Signal using Balanced and Ring Modulator,"
3 <https://www.eeeguide.com/generation-of-dsbsc-signal-using-balanced-and-ring-modulator/>.
]
- [P. Lawrence Der, "Frequency Modulation (FM) Tutorial,"
4 <https://www.wqa.silabs.com/documents/public/white-papers/FMTutorial.pdf>.
]
- ["Analog Communication - FM Demodulators,"
5 https://www.tutorialspoint.com/analog_communication/analog_communication_fm_demodulators.htm.
]
- [U. PATHRABE, "The Beginners Guide to Communication," <https://analog-modulation.blogspot.com/2020/04/modulation.html>, 2020.
]
- ["Analog and Digital Modulation in the field of communications,"
7 <https://www.equestionanswers.com/notes/modulation-analog-digital.php>.
]
- [Sasmita, "Introduction to Double Sideband Suppressed Carrier (DSB-SC) System . Explain The
8 Generation of DSB-SC Signal," <https://electronicspost.com/introduction-to-double-sideband-suppressed-carrier-dsb-sc-system-explain-the-generation-of-dsb-sc-signal/>, 2015.
]
- [Sasmita, "Coherent Detection of DSB-SC Waves,"
9 <https://www.bing.com/images/search?view=detailV2&ccid=wD7vRuNH&id=F42EBA47026F6CAF98ECE563AEB9D96F989D9A87&thid=OIP.wD7vRuNHdHqZjv7C901YsgHaC3&mediaurl=https%3a%2f%2felectronicspost.com%2fwp-content%2fuploads%2f2015%2f12%2fcoherent-detection-of-DSB-SC-mod>, 2015.
]
- ["Ch 2. Frequency Modulation (FM);," <http://www.rfdh.com/invite/ni/02/02.htm>.
1
0
]
- [C. Devendra K, Modeling and simulation of systems using matlab and simulink,
1 <https://books.google.co.uk/books?hl=en&lr=&id=7WfMBQAAQBAJ&oi=fnd&pg=PP1&dq=using+s>

1 imulink+matlab&ots=WIIIRIR_Uj&sig=-n085PZIRCOTptVvfYNdNOiUxP0#v=onepage&q&f=false,
] 2010.

["Chapter 5 AM, FM, and Digital Modulated Systems Amplitude Modulation (AM)," 1
1 <https://www.slideserve.com/psyche/chapter-5-am-fm-and-digital-modulated-systems-amplitude-2>
2 modulation-am, 2014.
]

["Analog Communication - Introduction,"
1 [https://www.tutorialspoint.com/analog_communication/analog_communication_quick_guide.ht](https://www.tutorialspoint.com/analog_communication/analog_communication_quick_guide.htm)
3 m.
]

[M. M. Simon Haykin, "Introduction to Analog and Digital Communications second edition," 2007.
1
4
]

[M. J. P. Devaraj, "Noise in Analog Communication Systems," UWTSD.
1
5
]

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 **Comment 1** |  Engagement with literature(10)
The literature review covers the topic of AM and FM concepts

PAGE 6

PAGE 7

PAGE 8

 **Comment 2** |  Transferable Skills (20)
An outstanding approach of designing and presenting the blocks for all Modem and adding noise is seen which is appreciable.

PAGE 9

 **Comment 3** |  Knowledge & Understanding(20)
It's Good to see the diagrams illustrating the modulation blocks.

PAGE 10



Comment 4 | Knowledge & Understanding(20)

Good



Comment 5 | Cognitive & Intellectual (20)

It is evident that you have a solid understanding of the tasks.



Comment 6 | Practical Skills (30)

All the variations of AM is captured wrt to the variations in the modulation index.



Comment 7 | Practical Skills (30)

Excellent! The spectrum outputs of AM is well captured.



Comment 8 | Practical Skills (30)

Its Good to see all the outputs of DSBSC signal.



Comment 9 | Cognitive & Intellectual (20)

Well Done



Comment 10 | Practical Skills (30)

The outputs of the audio files are verified. They are clearly captured. Well Done!



Comment 11 | Cognitive & Intellectual (20)

The graphs are up to the required expectations of the tasks. This indeed proves that you have obtained good practical skills from this module.



Comment 12 | **Practical Skills (30)**

Its good to see that you have analysed the scope with different noise values which is appreciable.



Comment 13 | **Cognitive & Intellectual (20)**

Prefect



Comment 14 | **Knowledge & Understanding(20)**

Great job! This truly demonstrates your proficiency in calculating power and skill in comparing the expected and obtained calculations.



Comment 15 | **Transferable Skills (20)**

Your investigations covers more depth which is appreciable.

GRADING FORM: RF

SAM LLOYD

90

ENGAGEMENT WITH LITERATURE(10)

Effectively engage with RF literature by conducting thorough reviews using databases like critically analyzing sources, and ensuring proper citation. Stay updated on RF technology, collaborate with peers, and consider ethical aspects for comprehensive literature engagement. Adapt to evolving technology and integrate information to enhance understanding.



Good engagement with literature. Solid review of AM literature with sound critical analysis. Citations are mostly accurate.

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KNOWLEDGE & UNDERSTANDING(20)

Develop expertise in RF communications by mastering core theories, electromagnetic waves, antennas, and modulation techniques. Acquire a comprehensive understanding of RF propagation, collaborating with peers, engaging in research, and seeking mentorship for knowledge enhancement.



Task 1:

(a)(i) Clear grasp of AM principles, accurate definitions of signals, and recognition of modulation index's.

(a)(ii):Exceptional understanding. Clearly explains critical, over, and under modulation.

(b)Exceptional understanding. Clearly explains the process of demodulating the AM signal.

Task 2 :

(a)Clearly explains the principles of DSB SC modulation and demodulation, highlighting the role and significance of the modulation index (set to 0.5).

(b)Clearly explains the process of generating a modulated signal using a real message signal and provides a comprehensive explanation of the

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frequency domain consistency between DSB SC modulator and demodulator.

(c) Demonstrates an in-depth understanding of signal processing in the presence of noise.

Task 3

(a) Demonstrates an in-depth understanding of FM modulation and demodulation.

(b) Clearly explains the process of generating a modulated signal using FM Modem.

(c) Clearly explains the process of adding different random noises.

COGNITIVE & INTELLECTUAL (20)

Refine cognitive and problem-solving skills in RF communications, emphasizing creativity. Acquire practical proficiency in utilizing simulation tools to optimize the design of RF systems. Foster collaborative abilities to excel in interdisciplinary RF projects.



Task 1

(a): Exceptional application of analysis, clear presentation, and identification of key components.

(b) Clearly articulates the demodulation process and provides insightful observations in the comparison, showcasing a profound understanding.

Task 2 :

(a) & (b) Exceptional application of analysis. Clearly articulates the DSB SC modulation and demodulation processes.

(c) Exceptional application of analysis. Clearly articulates the process of adding random noise, demonstrates distortion, and provides insightful observations on the impact on the original signal,

showcasing a profound understanding. Applies critical thinking to draw connections between theory and practical results.

Task 3

(a) & (b) provides observations on the frequency and time domain analysis, showcasing a profound understanding. Applies critical thinking to draw connections between theory and practical results.
(c) Provides observations on how noise affects the original signal in the frequency domain.

PRACTICAL SKILLS (30)

Gain hands-on experience in noise modelling and analysis to effectively address noise-related challenges. Utilize software tools to simulate real-world scenarios, ensuring optimal RF system performance while adeptly managing noise issues.



Task 1

(a)(i) :Exceptional use of tools, clear demonstration of signals, and understanding of their behaviour.
(a) (ii):Successfully varies modulation indices, demonstrating a clear understanding of their impact on the modulated carrier.
(b)Successfully observes and demonstrates the demodulated AM signal, providing clear comparisons with the modulating signal. .

Task 2 & Task 3

(a) & (b) Exceptional application of analysis. Clearly presents both the DSB SC and FM modulation and demodulation processes.
(c) Exceptional application of analysis. Clearly articulates the process of adding random noise, demonstrates distortion, and provides meaningful observations on the impact on the original signal,

showcasing a excellent understanding of both DSBSC and FM techniques.
Applies critical thinking to draw connections between theory and practical results.

TRANSFERABLE SKILLS (20)

Demonstrating proficiency in organization and time management is crucial for efficient project planning. Uphold ethical principles, showcasing responsible research conduct and adherence to industry standards.



Strong transferable skills are evident with effective communication, good organization, and evident time management. The report is well-structured.

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