PREMIER UNIVERSITY

Department of Computer Science & Engineering

Report

Report No.	: 01
Course Code	: EEE 310
Course Title	: Communication Engineering Laboratory
Experiment Name	: Familiarizing with various instruments of the Communication Engineering Lab.
Date of Experiment	:
Date of Submission	:

Submitted To:

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Lecturer, Department of EEE
Premier University

Submitted By:

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Program	: B.Sc. in CSE
Batch	: 41st
Section	: C

Remarks:

Experiment No:01

Experiment Name: Familiarizing with various instruments of the Communication Engineering Lab.

Objective: To become capable in working and understanding the assorted instruments utilized in the Correspondence Communication Engineering Lab.

Equipment:

(1) Pulse code modulation transmitter trainer (IT-4203)

(2) Signal Sampling & Reconstruction Trainer (IT-4201)

(3) Time Division Multiplexing Transceiver Trainer (IT-4202)

(4) AM DSB/SSB Transmitter Trainer (IT-4101)

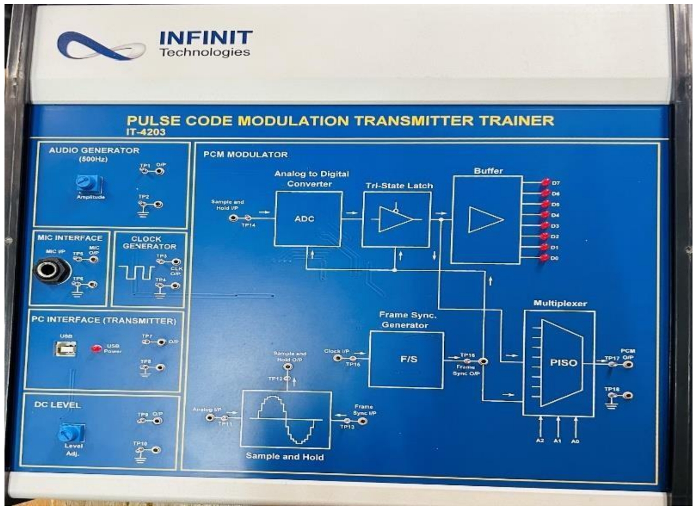
(5) AM DSB/SSB Receiver Trainer (IT 4102)

(6) Pulse Code Modulation Receiver Trainer (IT-4204)

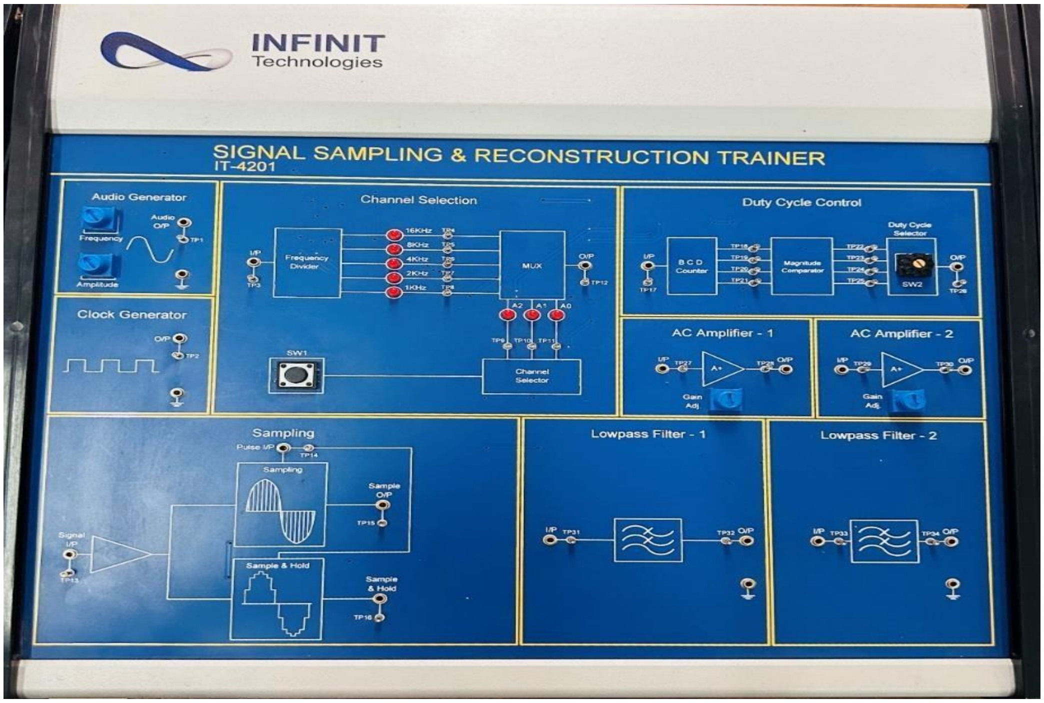
(7) Frequency Modulation/Demodulation Trainer (IT-4103)

PULSE CODE MODULATION TRANSMITTER TRAINER (IT-4203):

Pulse Code Modulation (PCM) Transmitter Coach (IT-4203) is a particular instructive gadget utilized in correspondence designing labs to show the standards of PCM transmission. Its purpose is to show how PCM encoding processes transform analog signals into digital ones. The mentor normally incorporates a mouthpiece contribution to catch simple sound signs, which are then handled through a simple to-computerized converter (ADC) to create PCM yield. This PCM yield addresses discrete examples of the simple sign at ordinary spans. The IT-4203 PCM Transmitter Mentor additionally consolidates parts like an examining clock generator, which decides the rate at which tests are taken, and a quantization circuit to change over each example into a computerized code. The advanced codes are regularly addressed as paired numbers and can be shown or dissected utilizing worked in apparatuses on the coach. Furthermore, the mentor might highlight controls for changing boundaries, for example, testing rate and quantization levels to investigate their effect on signal quality and information rate. This coach is fundamental for understudies and architects to figure out the major ideas of PCM, including examining, quantization, and coding, which are urgent in current computerized correspondence frameworks. By utilizing the PCM Transmitter Mentor, students can acquire viable involvement with working with PCM innovation and extend their appreciation of computerized signal handling in correspondence applications.

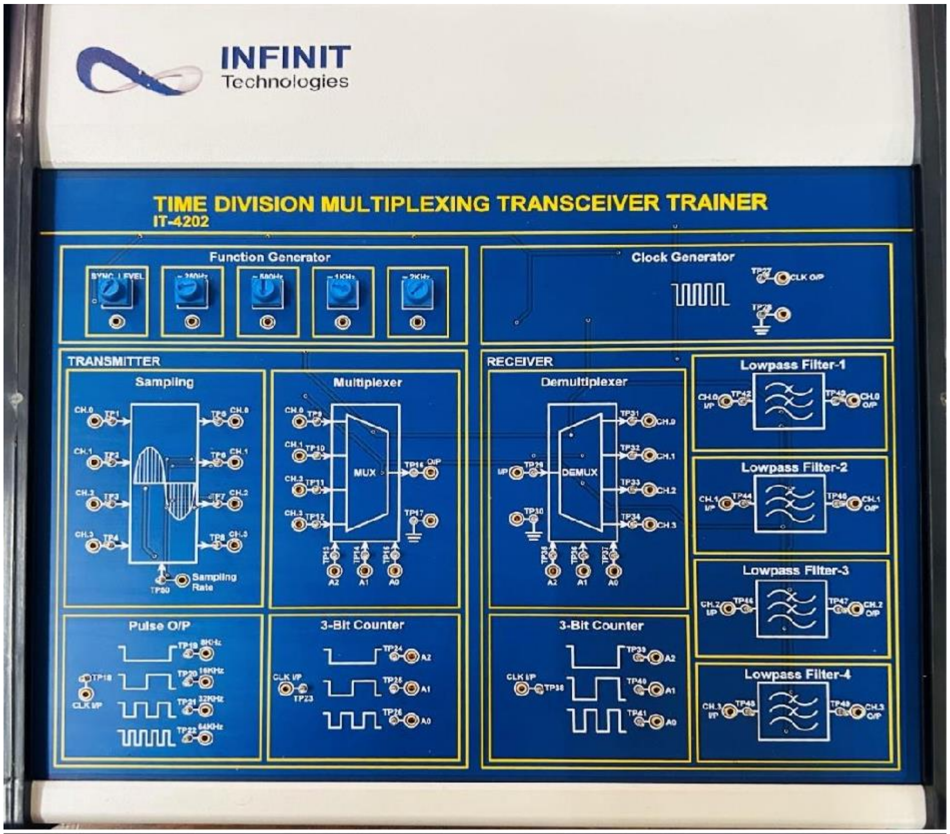


Signal Sampling & Reconstruction Trainer (IT-4201): The Signal Sampling & Reconstruction Trainer (IT-4201) is a valuable educational tool used in communication engineering labs to explore the concepts of signal sampling and reconstruction. This trainer facilitates hands-on learning of how continuous-time signals are converted into discrete-time signals through the process of sampling. It typically includes various input interfaces such as sine wave generators or audio inputs to provide analog signals for sampling. The IT-4201 trainer allows students to adjust sampling parameters such as sampling rate and observe the effects of aliasing when the sampling theorem is violated. It often features built-in analog-to-digital converters (ADCs) to convert sampled signals into digital form, which can be analyzed or processed further. The trainer also demonstrates signal reconstruction techniques using digital-to-analog converters (DACs) to convert discrete-time signals back into continuous-time analog signals. With the Signal Sampling & Reconstruction Trainer, learners can study practical aspects of signal processing, including anti-aliasing filtering, quantization effects, and reconstruction filters. This hands-on experience enables a deeper understanding of how digital signals are generated from analog sources and reconstructed back into their original forms. Overall, the IT-4201 trainer essential for comprehending the principles and applications of signal sampling and reconstruction in modern communication systems.



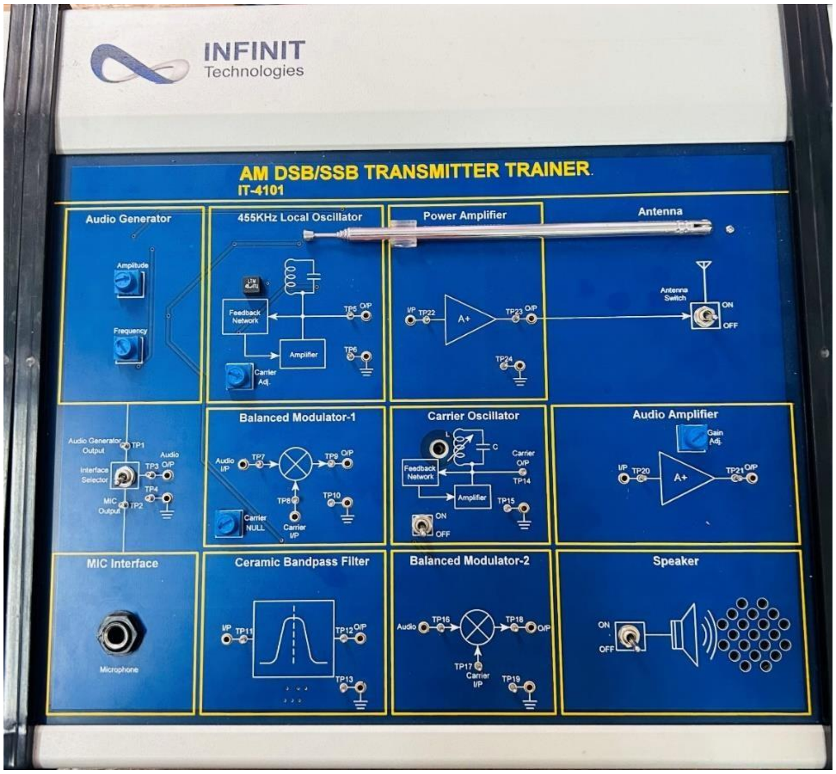
Time Division Multiplexing Transceiver Trainer IT-4202:

The Time Division Multiplexing (TDM) Transceiver Trainer (IT-4202) is a specialized equipment used in communication engineering labs to study and experiment with TDM techniques. This trainer enables hands-on learning of how multiple signals can be combined into a single transmission channel by allocating different time slots for each signal. It typically includes multiple input interfaces to provide signals for multiplexing and demultiplexing. The IT-4202 trainer allows students to configure parameters such as the number of channels, frame structure, and sampling rate to observe the behavior of TDM systems under different conditions. It often incorporates features like signal generators, multiplexers, demultiplexers, and digital displays to visualize and analyze the multiplexed signals. By using the TDM Transceiver Trainer, learners can gain practical experience in setting up and operating TDM systems, which are widely used in telecommunication networks for efficient data transmission. Overall, the IT-4202 trainer is essential for understanding the principles and applications of Time Division Multiplexing in real-world communication systems, providing a comprehensive platform for experimentation and exploration of TDM technology.



AM DSB/SSB Transmitter Trainer IT-4101:

The AM DSB/SSB Transmitter Mentor (IT-4101) is a particular gadget utilized in correspondence designing labs to exhibit the standards of Plentifulness Tweak (AM), Twofold Sideband Smothered Transporter (DSB-SC) balance, and Single-Sideband (SSB) regulation. This coach permits understudies to create and examine AM, DSB-SC, and SSB signals utilizing different information sources, for example, sound signals or sign generators. It typically includes modulators that combine audio signals with carrier waves to produce AM, DSB-SC, and SSB signals. The IT-4101 coach gives active involvement with arranging tweak boundaries, for example, adjustment file, recurrence deviation, and transporter concealment to notice the consequences for signal attributes. In order to alter these parameters and investigate how they affect signal quality and bandwidth efficiency, it frequently incorporates amplitude and frequency modulation controls. By utilizing the AM DSB/SSB Transmitter Mentor, understudies can develop how they might interpret simple regulation strategies usually utilized in radio correspondence frameworks. In general, this mentor is fundamental for viable learning and trial and error in simple regulation standards and applications.



AM DSB/SSB Receiver Trainer IT- 4102:

The IT-4102 is a training system designed to teach students about Amplitude Modulation (AM) signal reception techniques. It specifically focuses on demodulating DSB (Double-Sideband) and SSB (Single-Sideband) signals.

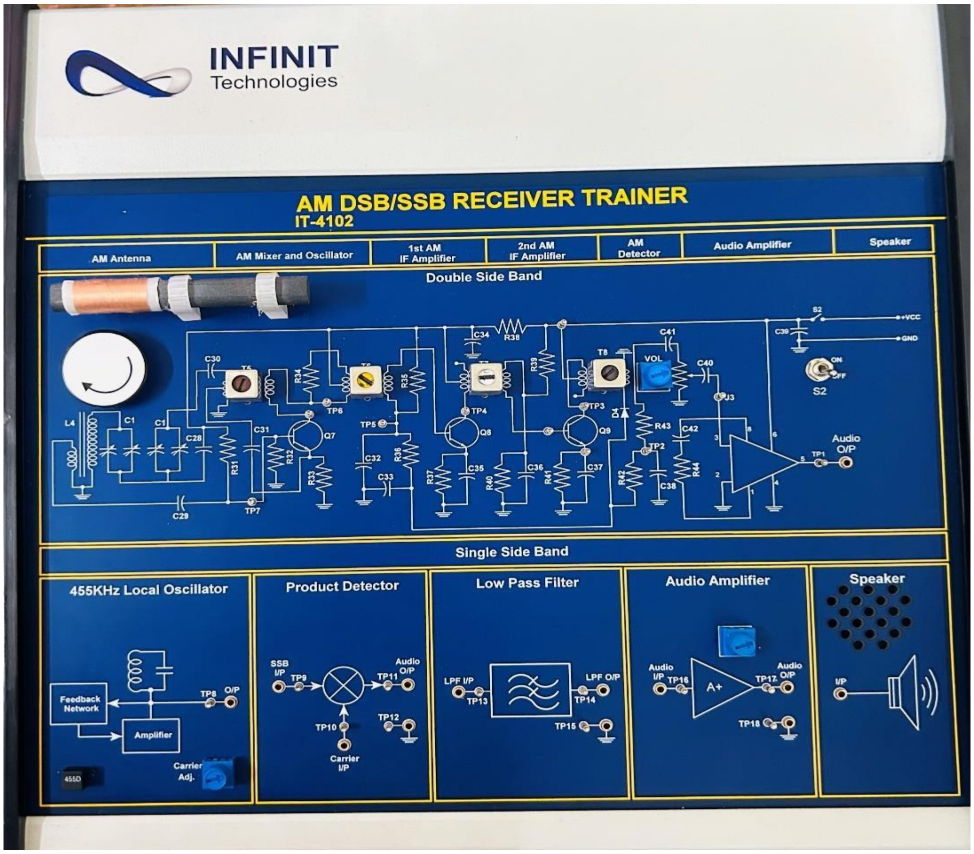
Here's a breakdown of its functionalities:

DSB Reception: It simulates a commercial radio receiver using a superheterodyne architecture with Automatic Gain Control (AGC) to recover DSB signals.

SSB Reception: It employs a product detector to demodulate SSB signals.

Components: It includes a local oscillator (455 kHz), an audio amplifier with volume control and speaker, and a low-pass filter for final audio output.

Overall, the IT-4102 is a valuable tool for anyone looking to understand the principles behind AM radio reception, with a particular emphasis on DSB and SSB demodulation techniques.



Pulse Code Modulation Receiever Trainer IT-4204:

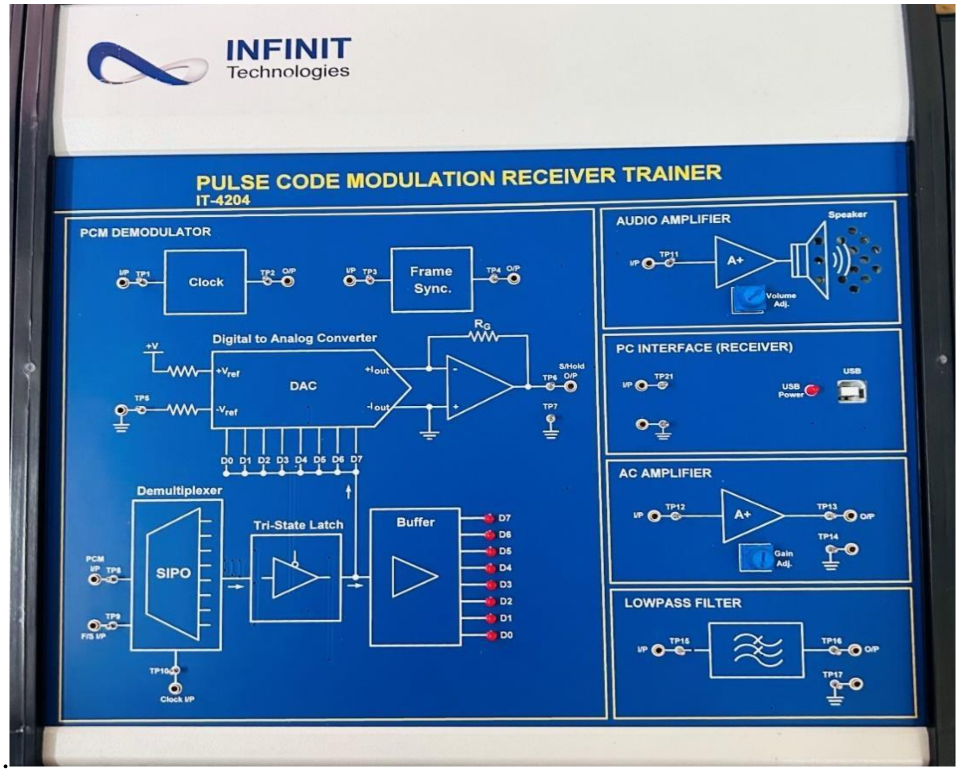
The IT-4204 trainer focuses on the receiver side of Pulse Code Modulation (PCM) systems. It's designed to familiarize users with the process of demodulating a PCM signal back into its original form.

Here are some key aspects of the IT-4204:

PCM Demodulation: It provides hands-on experience in decoding PCM signals, likely including converting the digital signal back into an analog representation.

Voice Link Experiments: It might include functionalities for practicing PCM demodulation with voice signals, allowing users to understand how voice data is transmitted using PCM.

Experiments: The trainer likely comes with pre-designed experiments or guides users through setting up their own experiments to explore different aspects of PCM reception.



Frequency Modulation/Demodulation Trainer IT-4103:

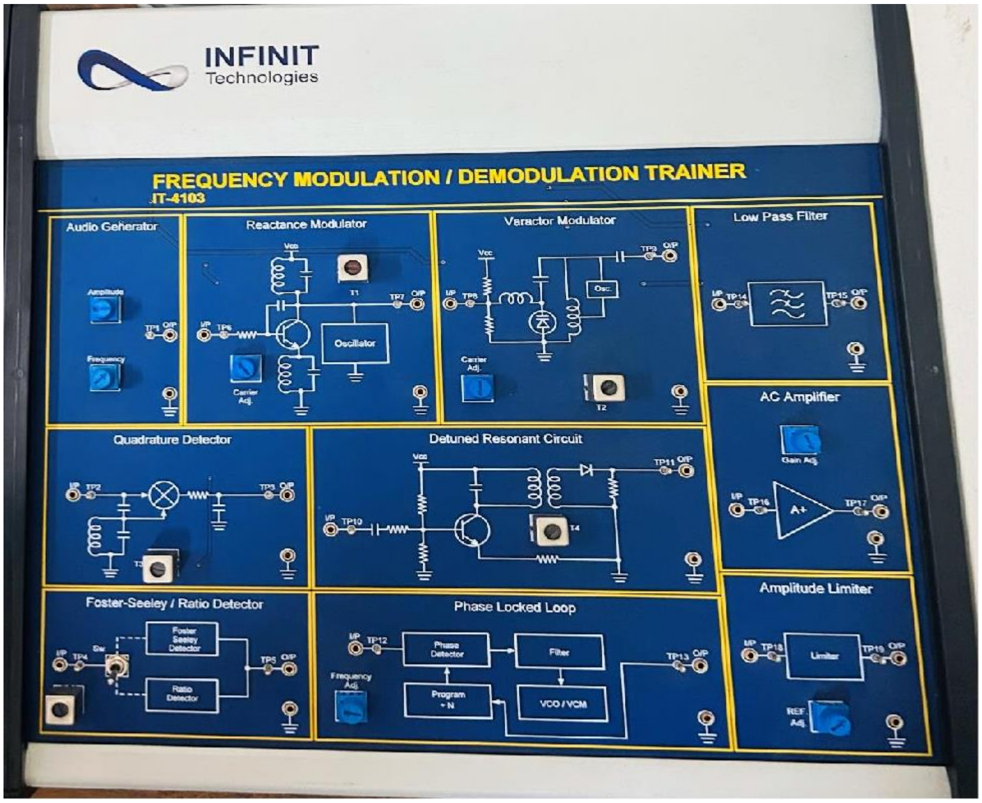
The IT-4103 trainer delves into the world of Frequency Modulation (FM) and Demodulation, providing a hands-on learning experience for analog communication systems. Here's a quick rundown of its capabilities:

FM Modulation Techniques: It equips users with the ability to explore different FM modulation methods, likely including varactor and reactance modulators.

Demodulation Techniques: The trainer offers the opportunity to experiment with various demodulation techniques like detuned resonant circuits, quadrature detectors, phase-locked loop detectors, Foster-Seeley detectors, and ratio detectors.

Independent Sections: For a structured learning approach, the trainer might have separate sections for modulation and demodulation, allowing users to focus on each stage individually.

Built-in Components: It likely includes an audio generator, amplifier, and low-pass filter as essential components for generating audio signals, amplifying them, and filtering the final recovered audio after demodulation.



Discussion: Finally, We summarizes the key findings of the lab experiment and discusses their significance. It may reflect on the effectiveness of the experimental setup, highlight any challenges encountered during the experiment, and suggest areas for further exploration or improvement. The conclusion ties the experiment back to the objectives outlined in the equipment and provides closure to the lab report.

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Department of Computer Science & Engineering

Report

Report No.	: 02
Course Code	: EEE 310
Course Title	: Communication Engineering Laboratory
Experiment Name	: Double Sideband Suppressed Carrier AM Generation
Date of Experiment	:
Date of Submission	:

Submitted To:

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Batch	: 41st
Section	: C

Remarks:

Experiment No: 02
Experiment Name: Double Sideband Suppressed Carrier AM Generation

Objective: AM DSB modulation of audio signal using 455 kHz oscillator

Equipment:

1. IT-4101 Trainer Board
2. 2 mm Patch Cords
3. Oscilloscope

Theory:
In Double Sideband Suppressed Carrier (DSB-SC) AM generation, we aim to modulate a carrier signal with a message signal while eliminating the carrier itself. Here's a simplified explanation:

Start with Signals: We have two signals - a high-frequency carrier (f_c) and a lower-frequency message signal (m(t)).
Amplitude Modulation: In conventional AM, the carrier's amplitude varies in proportion to the message signal's amplitude, creating two sidebands:
Upper Sideband (f_c + f_m)
Lower Sideband (f_c - f_m) - This carries the same information as the upper sideband.
Carrier Suppression: The key step in DSB-SC is to suppress (ideally remove completely) the carrier signal itself. This leaves only the two sidebands carrying the message information.
Benefits of DSB-SC:

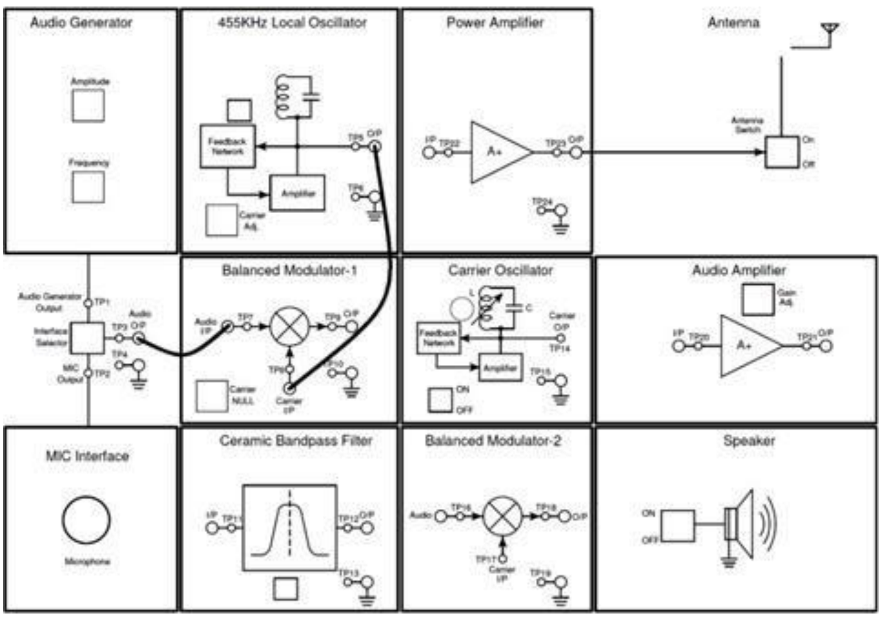
Increased Efficiency: By eliminating the carrier (which doesn't carry information), DSB-SC offers better power efficiency compared to conventional AM (where carrier takes up 2/3rds of the power).
Spectral Efficiency: The bandwidth required for transmission is just twice the message signal bandwidth (f_m to f_c + f_m), making it more bandwidth-efficient than conventional AM.
Challenges of DSB-SC:

Demodulation Complexity: Recovering the original message from a DSB-SC signal requires more complex demodulation techniques compared to conventional AM.
Carrier Synchronization: Perfect synchronization with the original carrier is necessary for proper demodulation, which can be challenging in real-world scenarios.
In conclusion, DSB-SC offers advantages in power and spectral efficiency but comes

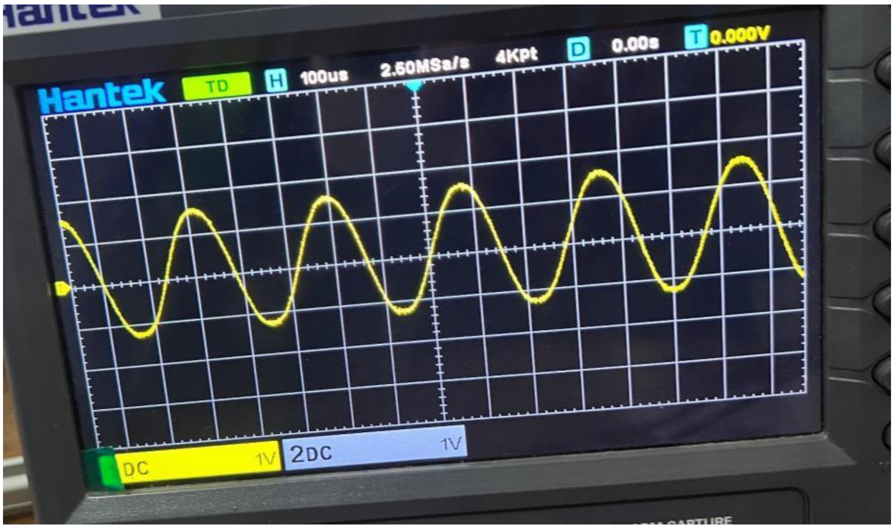
with complexities in demodulation and carrier synchronization.

Procedure:

1. Turn on the power of the IT-4101 module.
2. Make the *Interface Selector* Switch in the *Audio Generator Output* position.
3. Connect the oscilloscope probe to *Audio O/P (TP3)* and examine the low-frequency audio waveform. This audio frequency is a sine wave, which will be used as the modulating signal. The modulating frequency and amplitude can be varied by adjusting the *Audio Generator*'s *Amplitude* and *Frequency* preset. Set the amplitude and frequency to anyconvenient value. You can also listen to the audio signal by connecting the *Audio O/P (TP3)* with the *Audio Amplifier I/P (TP20)* and turning the *Speaker* ON. You can vary the volume by adjusting the Audio Amplifier Gain Adj.
4. Connect *455 kHz Local Oscillator O/P (TP5)* with the *Balanced Modulator-1 Carrier I/P (TP8)*. The local oscillator block generates the high-frequency carrier for the modulation process. The frequency is fixedat 455 kHz.
5. Now connect the *Audio O/P (TP3)* with the *Balanced Modulator-1 AudioI/P (TP7)*. The setup of the experiment should look like below:



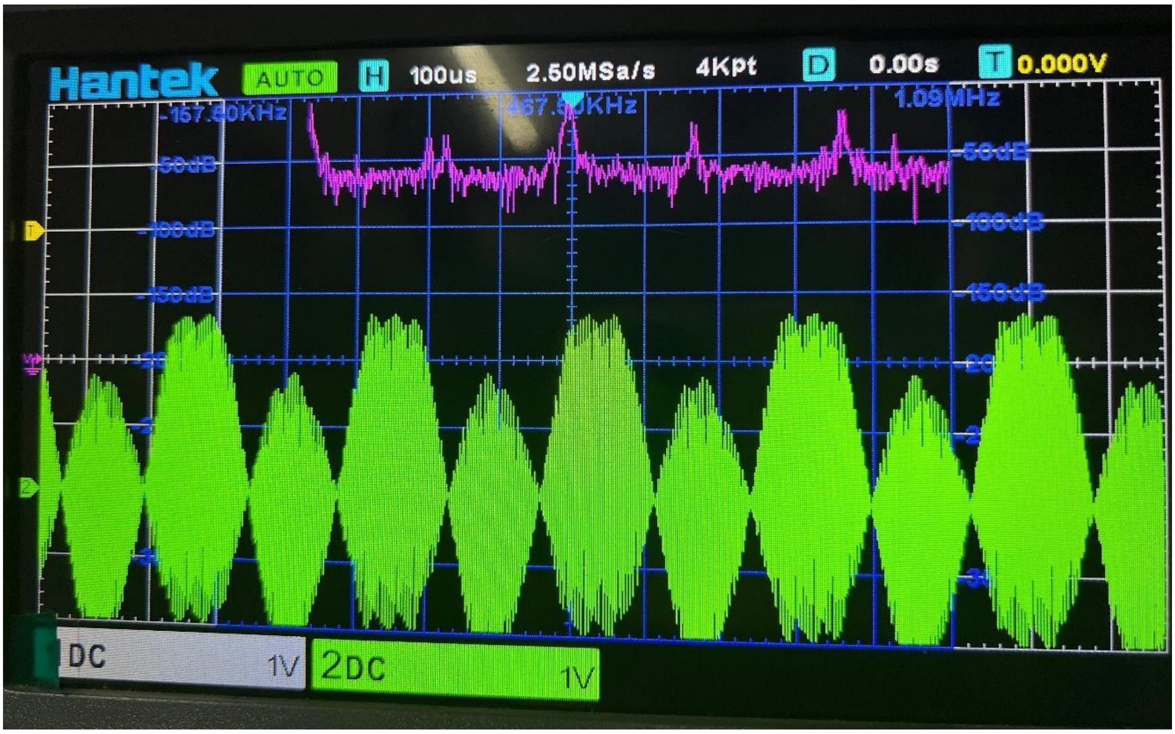
6. Connect the oscilloscope probe with *Balanced Modulator-1 O/P (TP9)* to observe the amplitude modulation. Adjust the *Carrier NULL* potentiometer to the center position until the waveform looks like this:



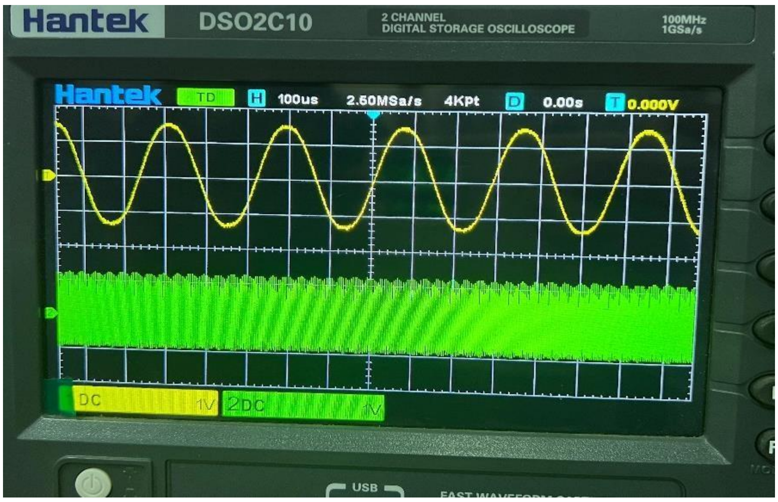
The output is a double sideband suppressed carrier AM waveform, which has been formed by amplitude modulating the 455 kHz carrier sine wave with the audio-frequency sine wave from the *Audio Oscillator*. Ideally, the frequency spectrum of this DSB-SC waveform should look like this:

As we can see from Fig, the carrier component is absent in the DSB-SC modulated signal.

Below are the modulated wave (yellow) and its frequency spectrum (purple) seen on the digital oscilloscope. Here, we can see two sideband frequency peaks around the carrier frequency of 455 kHz.



7. Examine the *Audio Output (TP3) (green)* together with the modulated waveform *(yellow)* on the oscilloscope.



Discussion: The discussion section interprets the results obtained from the experiment. It may discuss the observed characteristics of the modulated signal, such as the absence of the carrier and the presence of both sidebands. The analysis might also compare the measured parameters with theoretical expectations or specifications, and discuss any discrepancies or sources of error encountered during the experiment.

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Department of Computer Science & Engineering

Report

Report No.	: 03
Course Code	: EEE 310
Course Title	: Communication Engineering Laboratory
Experiment Name	: Double Sideband Suppressed Carrier AM Detection.
Date of Experiment	:
Date of Submission	:

Submitted To:

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Submitted By:

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Section	: C

Remarks:

Experiment No: 03

Experiment Name : Double Sideband Suppressed Carrier AM Detection

Objective : To investigate the detection of double sideband amplitude modulated (AM) waveforms

Required Instruments :

1. IT-4101 Trainer Board
2. 2 mm Patch Cords
3. Oscilloscope

Theory :

Demodulation is a crucial process in the reception of any amplitude-modulated signal. In DSB-WC modulation, the carrier wave is sent along with the sidebands. Owing to this, information pertaining to the message signal resides solely in the envelope of the modulated signal. We can harness this characteristic and employ a simple envelope detection technique for the demodulation of a DSB-WC-modulated signal. In DSB-SC modulation, only the sidebands are present. The transmitted power is saved through the suppression of the carrier wave. But, the envelope of a DSB-SC modulated wave is different from the message signal, which means that simple demodulation using envelope detection is not a viable option for DSB-SC modulation. The message signal m(t) can be recovered by multiplying the modulated signal s(t) with a locally generated sinusoidal wave and then low-pass filtering the product. It is assumed that the local oscillator signal is exactly coherent or synchronized, in both frequency and phase, with the carrier wave c(t) used in the product modulator used to generate the modulated wave s(t). This method of modulation is known as coherent detection or synchronous detection.

Procedure :

1. Position the IT-4101 and IT-4102 modules, with the IT-4101 module on the left and a small gap between them.

2. Make the necessary connections for DSB modulation as given in experiment no. 1. Turn the IT-4101 module ON and check the modulated waveform on the oscilloscope before proceeding.

3. Connect the Balanced Modulator-1 O/P (TP9) of the IT-4101 module with the Product Detector SSB I/P (TP9) of the IT-4102 module.

4. Connect the 455 kHz Local Oscillator O/P (TP5) of IT-4101 with the Product Detector Carrier I/P (TP10) of IT-4102 module.

5. Connect the Product Detector Audio O/P (TP11) of the IT-4102 module with the Low Pass Filter LPF I/P (TP13) of the IT-4102 module.

6. Connect the Low Pass Filter LPF O/P (TP14) with the Audio Amplifier Audio I/P (TP16) of the IT-4102 module.

7. Connect any two grounds of the IT-4101 and IT-4102 modules.

8. Observe the modulating audio signal and the detected audio signal (Audio Amplifier Audio O/P TP17) in two channels of the oscilloscope and check whether the two signals match. Change the amplitude and frequency of the modulating signal and observe the change in the detected signal. Below are the modulating signal (yellow) and the demodulated signal (green) as seen on the oscilloscope.

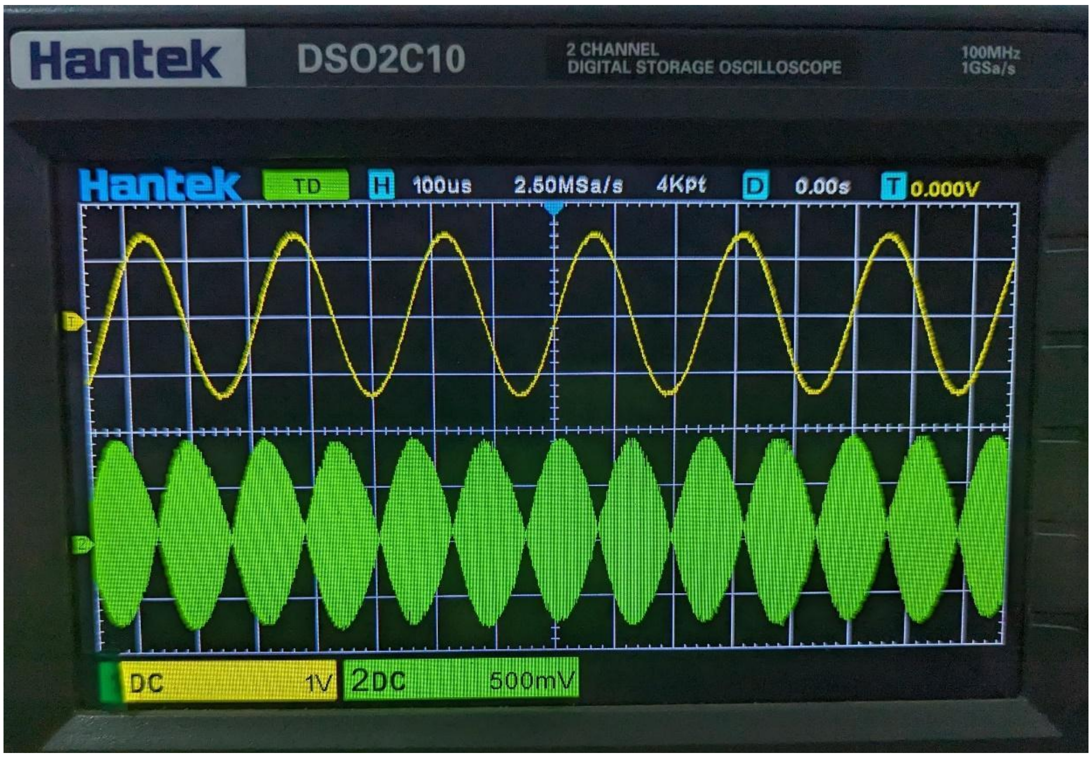

Fig 01 : Modulated signal (yellow) and Demodulated signal (green)

Experimental Data :

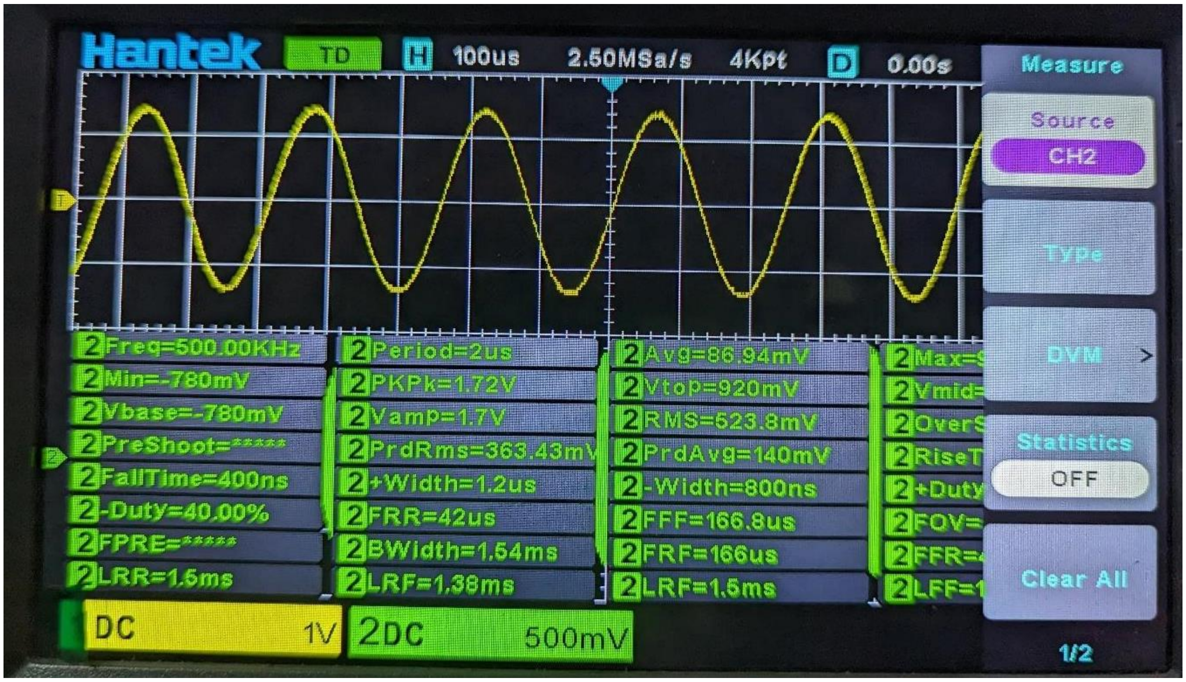

Fig 02: amplitude and frequency of the demodulated signal

Questions & Answers :

1. **Show mathematically how we can retrieve the message signal $m(t)m(t)$ from the modulated signal $s(t)s(t)$.**

To retrieve the message signal $m(t)m(t)$ from the modulated signal $s(t)s(t)$, we can use a product detector or demodulator. In the case of DSB-SC modulation, the product detector works by multiplying the modulated signal by the carrier signal and then passing it through a low-pass filter to remove the high-frequency components, leaving only the baseband signal.

Mathematically, the demodulation process can be represented as follows:

Given the DSB-SC modulated signal: $s(t)=Acm(t)\cos(2\pi fct)s(t)=Acm(t)\cos(2\pi fct)$

Multiplying $s(t)s(t)$ by the carrier signal $\cos(2\pi fct)\cos(2\pi fct)$: $s(t)\cdot\cos(2\pi fct)=Acm(t)\cos 2(2\pi fct)s(t)\cdot\cos(2\pi fct)=Acm(t)\cos 2(2\pi fct)$

Using the trigonometric identity $\cos 2(x)=12(1+\cos(2x))\cos 2(x)=21(1+\cos(2x))$: $s(t)\cdot\cos(2\pi fct)=Acm(t)2(1+\cos(2\cdot 2\pi fct))s(t)\cdot\cos(2\pi fct)=2Acm(t)(1+\cos(2\cdot 2\pi fct))$

Passing the product through a low-pass filter to remove the high-frequency component, leaving only the baseband signal: $m(t)=\text{LPF}(s(t)\cdot\cos(2\pi fct))m(t)=\text{LPF}(s(t)\cdot\cos(2\pi fct))$

Here, LPFLPF represents the low-pass filter operation.

2. **Draw the frequency spectrum of the Product Detector output.**

The frequency spectrum of the Product Detector output after demodulating a DSB-SC modulated signal consists of the original baseband signal centered around zero frequency.

Assuming the baseband signal has frequency components within a certain bandwidth BB, the frequency spectrum of the demodulated signal will have two copies of the original baseband spectrum shifted to positive and negative frequencies, each with a bandwidth of BB. This is because the demodulation process effectively translates the original baseband signal to higher and lower frequencies centered around the carrier frequency.

Therefore, the frequency spectrum of the demodulated signal will have two sidebands centered around the carrier frequency $fcfc$, each containing the frequency components of the original message signal, and separated by $2fc2fc$.

Discussion:

Explain any deviations from the expected results. Discuss potential sources of error, such as imperfect filtering or non-ideal component behavior. Compare the achieved performance with the theoretical aspects of DSB-SC demodulation. Mention any limitations of the chosen demodulation technique.