PRACTICAL WORK BOOK

For Academic Session 2009

COMMUNICATION SYSTEMS

(TC-383)

For

TE (CIS)

Name: ____________________

Roll Number: ____________________

Batch: ____________________

Department: ____________________

Year: ____________________

Department of Electronic Engineering
NED University of Engineering & Technology, Karachi

LABORATORY WORK BOOK

For The Course

TC-383 COMMUNICATION SYSTEMS

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INTRODUCTION

Communication Systems Practical Workbook covers those practical that are very knowledgeable and quite beneficial in grasping the core objective of the subject. These practical solidify the theoretical and practical concepts that are very essential for the engineering students.

This work book comprise of practical covering the topics of communication systems that are arranged on modern trainer boards. Above all this workbook contains a relevant theory about the Lab session.

Telecommunications Laboratory

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Telecommunications Laboratory

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LAB SESSION 01

OBJECT:-

To carryout Fourier Synthesis of a square wave.

EQUIPMENTS REQUIRED:-

1 Modules T10H.
1 +/- 12Vdc Supply
1 Oscilloscope.

THEORY:-

A square wave spectrum is made of the sum of all the harmonics being odd of the fundamental with decreasing amplitude according to the law of trigonometric fourier series. In other words the square wave shown in fig 2.1 can be obtained by summing up the infinite sine waves as per the following relation:
S(t) = sin(2ΠFt)/1 + sin(2Π3Ft)/3 + sin(2Π5Ft)/5 + sin(2Π7Ft)/7 + sin(2Π9Ft)/9 + ……..

PROCEDURE AND OBSERVATIONS:-

1- Odd harmonics (1, 3, 5, 7, 9): **two way switches** -/0/+ **on +** and two way switches sin/cos **on sin.**
2- Even harmonics (2, 4, 6, 8): two way switches -/0/+ **on 0.**
3- Connect the oscilloscope with the amplifier output of the fundamental (1st) and adjust the amplitude at 10Vp-p.

4- Connect the oscilloscope with the output of the third harmonic amplifier (3RD) and adjust the amplitude at 10/3 ≈ 303Vp-p.

5- Connect the oscilloscope with the output of the 5TH harmonic amplifier (5TH) and adjust the amplitude at 10/5 = 2Vp-p.

6- Connect the oscilloscope with the output of the seventh harmonic amplifier (7TH) and adjust the amplitude at 10/7 ≈ 1.4Vp-p.

7- Connect the oscilloscope with the output of the 9th harmonic amplifier (9TH) and adjust the amplitude at 10/9 ≈ 1.1Vp-p

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8- Connect the oscilloscope with OUT and check that there is the signal corresponding to the components sum.

9-Remove some harmonics (put the relating two way switch **on 0**) and check the o/p signal.

10- Prove the Fourier series of square & sawtooth wave by using formula

$$f(t) = a_0 + \sum_{n=1}^{\infty} (an \cos nwt + bn \sin nwt)$$

LAB SESSION 02

OBJECT:-

To examine the main parameters of an amplitude modulated signal. Also check the operation of an amplitude modulator.

EQUIPMENTS REQUIRED:-

1 Modules T10A-T10B.
1 +/- 12Vdc Supply
1 Oscilloscope.

THEORY:-

Modulation: -

The modulation is simply a method of combining two different signals and is used in the transmitter section of a communication system. The two signals that are used are the information signal and the carrier signal. The information signal is the signal that is to be transmitted and received and is sometimes referred to as the intelligent signal.The carrier signal allows the information signal to be transmitted efficiently through the transmission media. The carrier signal is normally generated by an oscillator and has a constant frequency and amplitude. The information signals that is fed into the transmitter modifies the carrier signal.

Amplitude Modulation: -

It is the simplest form of signal processing in which the carrier amplitude is simply changed according to the amplitude of the information signal hence the name Amplitude modulation. When the information signals amplitude is increased the carrier signals amplitude is increased and when the information signals amplitude is decreased the carrier signals amplitude is decreased .In other words the ENVELOPE of the carrier signals amplitude contains the information signal.

$$\text{Modulation index "m"} = \frac{V_{max} - V_{min}}{V_{max} + V_{min}}$$

PROCEDURE & OBSERVATIONS:-

1- Carryout the connections between modules T10A and T10B as shown in fig 1.4.
2- Power the modules with the supply and carryout the following presetting:

- Function generator sine wave (J1): *level* about 0.5Vp-p, *Freq*. about 1KHz

- VCO2: *level* about 1Vp-p *Freq.* 450 KHz.
- Balanced modulator: C*arrier null* completely clock wise(to unbalance the modulator & to obtain an AM signal without suppressed carrier across o/p), *Outlevel* in intermediate position.

3- Connect the oscilloscope to the inputs of the modulator (***points 2 and 1***) and detect the modulating signal and carrier signal

----

4- Move the probe to ***point 3 (output of the modulator*)** where a signal modulated in amplitude is detected (fig1.5c). Note that the modulated signal envelope corresponds to the waveform of the modulating signal.

5- Vary the amplitude of the modulating signal and check the 3 following conditions:

- Modulation index lower than the 100%(under modulation) fig1.5c
- Equal to the 100% (exact modulation) fig 1.5d
- Superior to 100% (over modulation) fig 1.5e

6- Vary the frequency and waveform of the modulating signal and check the corresponding variations of the modulated signal.

7- Vary the amplitude of the modulating signal and note that the modulated signal can result saturated or over modulated.

9- Using the oscilloscope measures the max and min amplitude of the modulated signal and calculate the % index of modulation ‘m’ for the three cases.

LAB SESSION 03

OBJECT:-

To Measure the frequency response of a ceramic filter. To Check the operation of the balanced amplitude modulator with suppressed carrier.

EQUIPMENTS REQUIRED:-

1 Modules T10A-T10B.
1 +/- 12Vdc Supply
1 Oscilloscope.

THEORY:-

Double sideband suppressed carrier modulation: -
In AM modulation, two-third of the transmitted power appears in the carrier which itself conveys no information. The real information is contained within the sidebands. One way to overcome this problem is simply to suppress the carrier since the carrier does not provide any useful information there is no reason why it has to be transmitted. By suppressing the carrier the resulting signal is simply the upper and lower sidebands. Such a signal is referred to as a double-sideband suppressed carrier (DSB-SC or DSB) signal. Double sideband suppressed carrier modulation is simply a special case of AM with no carrier. A circuit called a balanced modulator generates double sideband suppressed carrier signals.

Ceramic filter:-
A ceramic filter is a bandpass filter using a piezoelectric ceramic material. Important parameters of ceramic filter are input & output impedance. The central freq of ceramic is 455KHz. The response curve can be obtained by applying a variable freq across i/p & detecting amplitude at o/p. the attenuation measured at different freq is given by:

$$A = V_o / V_i$$
$$A_{dB} = 20 \log(V_o / V_i)$$

PROCEDURE & OBSERVATIONS:-

FREQUENCY RESPONSE OF CERAMIC FILTER:
1- Supply the modules with dc supply. Carryout the following presetting:
- VCO1: switch on 500 kHz, *leve*l about 2Vp-p, *Freq.* 450 kHz.

2- Apply a signal of 455 kHz corresponding to the central frequency of the ceramic filter.
3- If Vo and Vi are the peak-to-peak voltages measured across the output and the input of the filter. The attenuation A of the filter at 455 KHz is given by

A=Vo/Vi and in dB = 20log (Vo/Vi).

4- Repeat the measurement carried out in the last step varying the frequency from 445 to 465 kHz at steps of 1 kHz.

5- Calculate AdB in correspondence to each frequency and report all in the following table.

Frequency (kHz)	**Output voltage(Vo)**	**Input voltage (Vi)**	**AdB =20log(Vo/Vi)**
445			
446			
447			
448			
449			
450			
451			
452			
453			
454			
455			
456			
457			
458			
459			
460			
461			
462			
463			
464			
465			

6- With the data in the table plot a graph setting AdB on the Y axis and frequency on the x-axis, you obtain the frequency response curve of the filter.

OPERATION OF BALANCED MODULATOR WITH SUPPRESSED CARRIER:-

7- Carryout the connection between T10A and T10B. Power the modules and carryout the following presetting:

- Function generator sine wave (J1): *Freq*. about 1KHz, *amplitude* about 1Vp-p
- VCO1 switch on 500 kHz: *leve*l about 2Vp-p *Freq*. 450 kHz.
- Balanced modulator: C*arrier null* completely clock wise(to unbalance the modulator & to obtain an AM signal without suppressed carrier across o/p), *Outlevel* in intermediate position.

8- Connect the oscilloscope to the inputs of the modulator (points 2 and 1) and detect the modulating signal and the carrier signal.

9- Move the probe to point 3 (modulator output) where the modulated signal is detected

----

10- Reset the level of the modulating signal and adjust the carrier null to obtain the min of the output carrier of the modulator. Take to about 0.5Vp-p the amplitude of the modulating signal. Note that the waveform of the modulating signal doesn't correspond to the envelope of the modulated signal as it occurs instead in case of signal AM.

11- Vary the amplitude of the modulating signal and check the corresponding variation of the modulated signal amplitude. Note that differently from the AM modulation where the modulated signal annuls when the modulating signal is null.

12- Vary frequency and waveform of the modulating signal and check the corresponding variations of the modulated signal.

LAB SESSION 04

OBJECT:-

To examine the main parameters of the single sideband modulation. To Check the use of filters to generate the SSB.

EQUIPMENTS REQUIRED:-

1 Modules T10A-T10B.
1 +/- 12Vdc Supply
1 Oscilloscope.

THEORY:-

Single sideband modulation: -
A modulation technique in which only one sideband out of the two is transmitted is known as single sideband transmission. In double sideband transmission the basic information is transmitted twice once in each sideband. Therefore transmitting both signals is redundant. The information can be transmitted through one sideband by further suppressing the one sideband. The generated signal is termed as single sideband suppressed carrier.

Single sideband demodulation: -
SSB demodulation requires the presence of carrier which must be locally generated in the receiver. To obtain modulating signal from modulated signal, multiply modulating signal with locally generated carrier & filter extracts the modulating signal. The circuit carrying out multiplication of two signals can be same used to generate the modulation with suppressed carrier in transmission. When used as demodulator the circuit commonly called *Product detector. I*f the carrier inserted in reception doesnot have same freq of carrier suppressed in transmission the freq of demodulated signal is translated by the difference b/w two carriers altering this way the reception.

PROCEDURE & OBSERVATIONS:-

SSB generation:
1- Carryout the connection between T10A and T10B. Power the modules and carryout the following presetting:

- Function generator sine wave (J1): Freq. about 3KHz amplitude about 1Vp-p
- VCO1 switch on 500 kHz: level about 2Vp-p Freq. 452 kHz.

- Balanced modulator: carrier null in central position, Outlevel in clockwise position.

2- Connect the output of the balanced modulator (test point 3) to the input of 455 kHz ceramic filter (test point 10). With the oscilloscope examine the output signal of the filter (point 11) and check that it is a sine wave(filter extracts only one of two components generated by balanced modulator).

3- Measure the frequency fc of the carrier (point 1), fm of the modulating signal (point 2) and fssb of the SSB signal across the output of the filter (point 11).

Fssb = fc + fm. This means that the band extracted by the filter corresponds to the upper sideband.

4- repeat last measurements by setting freq of carrier to 458KHz.

Fssb = fc - fm. This means that the band extracted by the filter corresponds to the lower sideband

5- Increase the frequency of the modulating signal and check that the SSB signal attenuates and tends to annul. Explain the reason.

Demodulation of SSB signal:

6- Connect the output of the SSB modulator (point 11) output of the ceramic filter) to the input signal (point 16) of the balanced modulator 2. In this case the balanced modulator is used as product detector.

7- Across the input carrier of the balanced modulator 2, apply the same carrier supplies to the modulator (VCO1).

8- Connect the output of the balanced modulator 2 to the low pass filter at 3400Hz (point 18).

9- Examine the signals across the following points:

- Point 11 (output of the SSB modulator) it is a sine wave which corresponds to the upper sideband at the base of the frequency set for the carrier.

- Point 17 (output of the product detector) there is a sine wave with frequency equal to the one of the modulating signal (point 2) to which a component with much higher frequency is laid over.

- Point 19 (output of the low pass filter) the high frequency component has been removed and the demodulated signal remains equal to the transmission modulating one.

10- Increase the frequency of the modulating signal and check that the detected signal attenuates and tends to annul. Explain the reason.

11- Disconnect VCO1 from the balanced modulator 2 (point 15) and connect VCO2. In this way you supply the product detector with a different carrier from the one used in the modulator.

12- Vary the frequency of VCO2 to find out a frequency, which is more equal possible to the one used by the modulator (generated by VCO1). Check that it is really difficult to obtain the starting modulating signal across the output of the filter. This is due to the fact that it is very difficult to set the two VCOs to the same frequency.

LAB SESSION 05

OBJECT:-

To examine the operation of RF(Radio Frequency) transmitter.

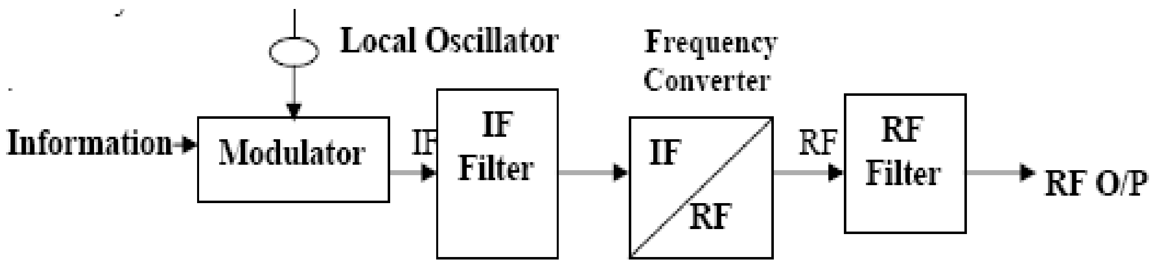
EQUIPMENTS REQUIRED:-

1 Power supply mod. PSI-PSU/ EV
1 Experiment Mod MCM24/EV
1 Dual-trace Oscilloscope
1 Function generator

THEORY:-

The purpose of the transmitter is to convert the information that is to be transmitted into modulated radio frequency signal. Through a transmission line, this signal is applied to the antenna that radiates the information is space as electromagnetic waves. Transmission can be obtained not only via radio but also from copper & optical fiber.

In the past direct modulation was used which guarantee a circuit simplicity to the detriment of the quality in the communication. Today modulation is achieved on a fixed and well stabilized frequency(intermediate frequency) signal that translates at frequency of channel to be used & makes circuit complexity balanced & easily controlled.



Basic block diagram for transmitter

Functions of the blocks of transmitter:

Above diagram shows a typical modern transmitter.

The *local oscillator* provides the modulator with a signal which frequency is stabilized through a PLL circuit. The *modulator* changes the frequency spectrum of the signal provided by the local oscillator, according to the kind of modulation used and the provided information and generates the IF signal. The *IF frequency* is always equal and does not depend on the frequency of the RF channel that is to be used. This enables the optimization of the modulation and filtering circuits. The *IF filter* cleans the useful signal from any intermodulation products or noise. As the IF is always the same the filter does not need any regulation or calibration. The *frequency converter* has the purpose to translate the frequency from IF to RF and so to the frequency of the channel that is to be used .The *RF filter or output filter*, cleans the useful signal from the intermodulation products that was added during frequency conversion. As the RF can be changed the filter must be calibrated again.

PROCEDURE & OBSERVATIONS:-

OPERATION OF 1ST CONVERTER:-

1. Following section used for converter1: VCO1, modulator, IF filter.
2. Set the sw1 on the **modulation selectors** section to AM/DSB/FM.
3. Turn the trimmer Level completely Clockwise to obtain the maximum amplitude on the signal VCO1 out provided by the local Oscillator VCO1.
4. Set switch **SW6 to DC** to obtain the manual control of the local Oscillator frequency.
5. Adjust trimmer DC source of VCO1 out to obtain a frequency of about **10750 kHz**.

   ----
6. Connect the input AM/DSB/MOD into a sine signal with amplitude of 1Vpp and frequency of 50 kHz using an external generator.

   ----
7. Set switch **SW4 to Mix out** so that the signal of the local oscillator reaches the input CARRIER IN of the mixer.
8. Set switch **SW3 to DSB**: in this condition the mixer is perfectly balanced and does not show the signal with higher frequency (carrier) across the output.
9. Connect and set the oscilloscope as follows:
   Channel 1 to the input AM/DSB/MOD IN
   Channel 2 to the output of the mixer (TP2)

   ----
10. Check that the signal across TP2 which is the product of the carrier and modulating signal is of DSB shape

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11. With the current setting of SW4, the signal produced by the mixer reaches the section IF filter.
12. Set switch **SW5 to QUARTZ** so that the signal crosses the quartz band pass filter.
13. Turn the trimmer LEVEL completely clockwise to obtain the maximum amplitude of the signal across TP3 at the output of the section IF FILTER.
14. Connect the oscilloscope to TP3 & check there is a sine signal. Adjust modulating signal to display max amplitude.

    ----

15. Connect the oscilloscope to **TP3** and measure the frequency of the present signal which is equal to **10.7MHz**.
16. Set switch **SW5 to CERAMIC** so that the signal crosses the ceramic band pass filter
17. Connect one probe of the Oscilloscope to TP3 of IF filter.

    ----

18. Set switch **SW5 to QUARTZ** again. Keep generator setting unchanged i.e 50kHz.

OPERATION OF 2ND CONVERTER:-

19. Following section used for converter2: VCO1&2, modulator, IF filter, RF mixer, RF filter, RF power amplifier
20. remove external generator
21. Set the sw1 on the **modulation selectors** section to AM/DSB/FM.
22. Turn the trimmer Level completely Clockwise to obtain the maximum amplitude on the signal VCO1 out provided by the local Oscillator VCO1
23. Set switch **SW6 to PLL** to obtain automatic control of the fixed local Oscillator frequency
24. Set switch **SW4 to VCO1 out** so that the signal of the local oscillator reaches the IF filter
25. Set switch **SW5 to QUARTZ**
26. Turn the trimmer LEVEL completely clockwise to obtain the maximum amplitude of the signal across TP3

----

27. Connect the oscilloscope to TP3 and measure the frequency of the present signal which is equal to 10.7MHz.

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28. Set switch **SW7 to PLL** to obtain automatic control of the fixed local Oscillator frequency. With these setting choice of ceramic or quartz filter does not change received signal substantially.

----
29. Connect the oscilloscope to **VCO2 OUT** and measure the frequency which is equal to **11.7MHz**

----
30. Set switch SW10 to LPF that corresponds to the low pass filter with cut-off frequency of 1.5MHz.
31. Set switch SW11 to OFF in order to turn off antenna amplifier
32. Connect one probe of the oscilloscope to the out put **CABLE OUT** and check there is the signal of frequency equal to **1MHz.**

----
33. Adjust the LEVEL of the section RF FILTER for the best display.
34. Now Set switch **SW7 to DC** to obtain the manual control of the local Oscillator frequency
35. connect oscilloscope to VCO2 out & adjust DC source to get freq of 12MHz. check frequency of output signal.

LAB SESSION 06

OBJECT:-

To examine the operation of AM-RF (Radio Frequency) transmitter.

EQUIPMENTS REQUIRED:-

1 Power supply mod. PSI-PSU/ EV
1 Experiment Mod MCM24/EV
1 Dual-trace Oscilloscope
1 Function generator

THEORY:-

Amplitude Modulation: -

It is the simplest form of signal processing in which the carrier amplitude is simply changed according to the amplitude of the information signal hence the name amplitude modulation. When the information signals amplitude is increased the carrier signals amplitude is increased and when the information signals amplitude is decreased the carrier signals amplitude is decreased .In other words the ENVELOPE of the carrier signals amplitude contains the information signal.

Generation of Amplitude Modulation in RF TX: -

In our module *BALUN* (impedance match transformer) converts balanced signal at o/p into unbalance signal or vice versa to match mixer operation. Mixer is calliberated to operate in balance mode. *DSB/AM* enables to balance or unbalance the circuit. *IF filter* is used in particular as ceramic BPF is centered on IF freq equal to 10.7MHz. Here we use transmission channel with 1MHz freq via PLL or variable tuning. SW7 enables 2modes: *fixed tuning* at RF channel at 1MHz using VCO, *variable tuning* using DC Source. To filter o/p signal we use LPF of 1.5MHz. Amplifiers present in signal path (*buffer*) are used to match o/p or i/p impedance of filters. RF power amplifier consist of 2 stages : *antenna amplifier* tuned on freq of 1MHz to operate with ferrite antenna, *cable amplifier* gives o/p via coaxial cable.

PROCEDURE & OBSERVATIONS:-

MODULATOR OPERATION:-

1. Following section are used: VCO1, Low freq, modulator.
2. Set the sw1 on the **modulation selectors** section to AM/DSB/FM.

3. Turn the trimmer Level completely Clockwise to obtain the maximum amplitude on the signal VCO1 out provided by the local Oscillator VCO1.
4. Set switch **SW6 to PLL** to obtain automatic control of the fixed local Oscillator frequency
5. connect o/p **OUT2** to i/p AM/DSB MOD IN
6. Set switch **SW3 to AM** to carryout AM modulator with unbalance mixer
7. Set switch **SW4 to Mix out** to take signal of the mixer & not the one of VCO.1
8. Set switch **SW5 to CERAMIC** so that the signal crosses the ceramic band pass filter
9. Connect and set the oscilloscope as follows:
    1. Channel 1 to the input AM/DSB/MOD IN
    2. Channel 2 to the output of the mixer (TP2)

    ----
10. Adjust the trimmer LEVEL of modulating signal for the best display
11. Vary the amplitude of the modulating signal and check the 3 following conditions:

    Modulation percentage
    lower than the 100% under modulation
    Equal to the 100% exact modulation
    Superior to 100% overmodulation

    ----
12. Remove modulating signal & check presence of carrier signal. Remove carrier signal & check complete absence of signal across o/p

FREQUENCY RESPONSE OF CERAMIC IF FILTER:

13. Provide a signal of 1kHz-1vpp to modulating i/p.
14. Move probe from TP2 to TP3& see no change are visible. This is because filter removes all unnecessary components & displayed signal represent single IF component.

    ----
15. Remove modulator & measure amplitude of IF signal

    ----
16. Connect modulator again & increase its frequency.

17. See that w/f displayed is of 400kHz. This is maximum useful bandlimit of ceramic filter.

AM RADIO TRANSMITTER:

18. Set switch SW10 to LPF to use o/p LPF
19. Set switch SW11 to TX ON to enable antenna power amplifier
20. Adjust the trimmer LEVEL of the section RF MIXER to maximum amplitude & check signal after conversion made by RF MIXER at TP6.

    ----
21. Observe signals at o/p via cable & antenna.
22. At TP7 observe signal higher than power supply voltage due to effect of tuned ckts.

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23. With sine signal of 1kHz if o/p is distorted then reduce level of IF signal to reduce saturation of mixer

LAB SESSION 07

OBJECT:-

To examine the operation of SSB-RF (Radio Frequency) transmitter.

EQUIPMENTS REQUIRED:-

1 Power supply mod. PSI-PSU/ EV
1 Experiment Mod MCM24/EV
1 Dual-trace Oscilloscope
1 Function generator

THEORY:-

DSB to SSB (Double side Band to Single side band):

The carrier doesnot carry any information as it has constant amplitude & frequency independently from modulating signal. The signal is called suppressed carrier modulation or DSB modulation. The two side bands are exactly same. It follows that information can be transmitted using single side band: carrier is superfluous & the other sideband redundant. We can generate SSB by using filters. First amplitude modulation with suppressed carrier DSB is generated using balanced modulator then a BPF extracts one of two side bands.

Transmit SSB signal it is necessary to convert SSB signal with IF on RF channel. suppression is made through quartz filter. This becomes IF signal that must be converted into RF using conversion stage. To filter o/p signal from RF mixer & take single component use RF BPF with center frequency 3.5MHz. Amplifiers present in signal path (*buffer*) are used to match o/p or i/p impedance of filters. RF power amplifier consist of 2 stages : *antenna amplifier* tuned on freq of 1MHz to operate with ferrite antenna, *cable amplifier* gives o/p via coaxial cable. Here o/p via cable is used as it is wide band.

PROCEDURE & OBSERVATIONS:-

OPERATION OF SUPPRESSED CARRIER AMPLITUDE MODULATOR (DSB):

1. Following section are used: VCO1, Low freq, modulator.
2. Set the sw1 on the **modulation selectors** section to AM/DSB/FM.
3. Turn the trimmer Level completely Clockwise to obtain the maximum amplitude on the signal VCO1 out provided by the local Oscillator VCO1.

4. Set switch **SW6 to PLL** to obtain automatic control of the fixed local Oscillator frequency
5. connect o/p **OUT2** to i/p AM/DSB MOD IN
6. Set switch **SW3 to DSB** to carryout AM modulator with unbalance mixer
7. Set switch **SW4 to Mix out** to take signal of the mixer & not the one of VCO.1
8. Connect and set the oscilloscope as follows:
   - Channel 1 to the input AM/DSB/MOD IN
   - Channel 2 to the output of the mixer (TP2)

   ----
9. See w/f of signals. Adjust the trimmer LEVEL of modulating signal for the best display.

SINGLE SIDE BAND GENERATION (SSB):-

10. Set switch SW1 to SSB & SW2 to LSB
11. Set switch **SW5 to QUARTZ** so that the signal crosses the band pass filter
12. Connect o/p **OUT3** to i/p AM/DSB MOD IN
13. Connect and set the oscilloscope as follows:
    - Channel 1 to the input of modulating signal AM/DSB/MOD IN
    - Channel 2 to the output of the mixer (TP2)

    ----
14. Move probe from TP2 to TP3 & check the presence of sine signal : we can state filter extracts only one of two components generated by balanced modulator so there is a SSB signal across this TP.

    ----
15. Measure the following IF frequencies
    - frequency of carrier (VCO1 OUT)
    - freq of modulating signal (OUT3)
    - freq of SSB signal across filter o/p (TP3)

SINGLE SIDE BAND RADIO TRANSMITTER (SSB):-

16. Analyze signal during path from IF freq upto RF freq o/p on CABLE OUT

17. Set switch SW1 to SSB & SW2 to USB
18. Check freq relation b/w RF, IF, modulating signal & carrier.

    ----

19. Check signal transmitted via CABLE

    ----

20. Compare operation of TX via cable b/w SSB & AM.

FREQUENCY RESPONSE OF QUARTZ IF FILTER:-

21. Set switch SW1 to SSB & SW2 to LSB
22. Set switch **SW5 to QUARTZ** to use quartz band pass filter
23. Provide a signal of 2khz-1Vpp to modulating i/p.

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24. The freq of IF signal in these condition is equal to center band freq of quartz filter i.e. 10.7 MHz

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LAB SESSION 08

OBJECT:-

To examine the operation of RF (Radio Frequency) receiver.

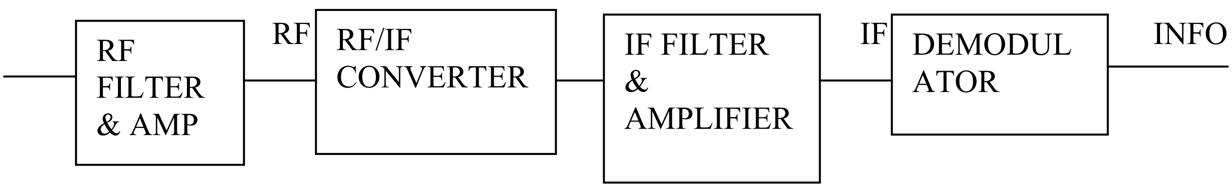
EQUIPMENTS REQUIRED:-

1 Power supply mod. PSI-PSU/ EV
1 Experiment Mod MCM25/EV
1 Dual-trace Oscilloscope
1 Function generator

THEORY:-

The purpose of receiver is to convert the modulated radio frequency signal into information that is to be received. Using an antenna RF signal is picked up by the space in which it traveled electromagnetic wave and sent through a transmission line to the electronic circuit of the receiver in order to be de-modulated. The reception cannot be only radio but also from other supports like copper & optical fiber.

In the past direct modulation was used which guarantee a circuit simplicity to the detriment of the quality in the communication. Today demodulation is achieved on a fixed and well stabilized frequency(intermediate frequency) signal that translates at frequency of channel to be used & makes circuit complexity balanced & easily controlled.



Operation of block of receiver (Superheterodyne receiver):

The *filter and RF amplifier* remove the channel we donot want to receive from the useful signal and increases its amplitude level. As the RF signal can be different, the input filter must change its characteristics. Typically this occurs automatically without the user intervention, by means of D.C control circuits. The *frequency converter* translates the frequency from RF channel frequency that is to be received to IF. It employs a frequency stabilized oscillator with a PLL circuit. The *filter and IF amplifier* cleans the useful signal from any inter-modulation products or noise and increases its amplitude level. As the IF is always the same the filter does not need regulation or calibration and can be a commercial component optimized for this purpose. The *demodulator* must receive or extract the information contained into the IF signal. The frequency spectrum of the IF signal depends on the kind of used modulation and on the same information. The IF frequency is always equal and dose not depend on the frequency of the RF channel that is to be used. This optimizes the modulation and filtering circuits.

PROCEDURE & OBSERVATIONS:-

OPERATION OF CONVERTER:

1. Following section used for converter: Antenna/cable, RF filter, voltage control amplifier, Automatic gain control(AGC), RF mixer, VCO1/2, 10.7MHz IF filter.
2. Set the switch **SW1** of the antenna / Cable section to cable.
3. Set switch **SW2** of the RF filter section to BYPASS
4. In the AGC/LEVEL METER section:
   - Turn switch SW6 off.
   - Turn the D.C source trimmer completely clockwise to obtain the maximum gain of the voltage controlled amplifier .
5. In the LOCAL Oscillator 1/2 section (Local Oscillator 1)
   - Set switch **SW8** to FM
   - Set switch **SW10** to PLL to obtain the automatic control of the frequency of the local oscillator (in these condition the frequency is fixed)
6. Set switch **SW4** of the 10.7MHz if filter section of CERAMIC.
7. Set switch **SW7** of the IF amplifier / FM demodulator section to FM/SSB (to enable the operation of the local oscillator 1)
8. Insert a sine signal to the input CABLE IN with amplitude of 1Vpp and frequency of 1 MHz using an external generator .
9. Connect the Oscilloscope and check the presence and amplitude of the signal in the following test point.
   - **TP2 (**input signal): it is about half the value set on the generator as the input has an impedance of 50 ohm equal to the one of the generator so the voltage reduce to half

----

   - **TP3(** signal after the RF switch) : equal to the one in **TP2,**

   - **TP4 (**signal after the RF filter) :it is about one across its input, using or not (by pass setting) the same filter

----

- **TP5 (**output signal across the variable attenuator): changing the DC source control, the signal amplitude change from some tens of **mV** (in maximum position) up to negligible values

----

- **TP6 (**output signal of the amplifier): changing the DC source control the signal amplitude increases until saturation with evident signal distortion

----

----

10. Adjust the DC source command of **AGC** /Level Meter section to obtain about 1Vpp in **TP6** .
11. check that the signals in the last test points are all at the same frequency.
12. Use oscilloscope to check that the frequency of the local oscillator 1(test point local oscillator 1 **of VCO out)** is equal to **11.7MHz**. Measure the amplitude of the same signal.

----

13. Observe the signal at the mixer **(TP7**) output after the conversion b/w the RF input signal and the signal provided by the local oscillator 1 (**LO1)**

----

14. see the o/p signal from IF filter (TP8) generated by freq conversion.

----

15. with amplitude of involved signals: RF(TP6), IF(TP8) & LO1, we define mixer conversion gain'K', produced by relation b/w signal amplitudes

$$A_{IF} = K (A_{RF} . Alo1)$$

16. Set switch **SW10** to DC: in these condition freq regulation depend on DC Source trimmer level of LO1
17. Adjust VCO1 freq to get 11.8 MHz.
18. Connect oscilloscope at TP8 measure freq & check that it is 10.8mhz.

----

19. Set switch **SW10** to PLL again
20. Increase freq of external generator to 100khz taking RF signal to 1.1 mhz

21. Measure freq at TP8 & check it is 10.6 mhz

CHARACTERISTIC OF RF FILTER (1.5MHZ):

22. Let's analyze operation of LP RF filter
23. Set switches SW2 to FILTER & SW3 to 1.5mhz
24. Set external generator to provide a sine signal with amplitude 1Vpp & freq 1 mhz
25. Connect oscilloscope at TP4 & measure amplitude of present signal

----

----

26. Increase freq of generator & check that cutoff freq is 1.5MHz

CHARACTERISTIC OF RF FILTER(3.5MHZ):

27. Set SW3 to 3.5mhz
28. Set external generator to provide a sine signal with amplitude 1Vpp & freq 1 mhz
29. Connect oscilloscope at TP4 & measure amplitude of present signal

----

----

30. Increase freq of generator & check that cutoff freq is 3.5mhz

CHARACTERISTIC OF IF FILTER(10.7MHZ CERAMIC):

31. Set switches SW2 to BYPASS
32. Set external generator to provide a sine signal with amplitude 1Vpp & freq 1 mhz
33 Set VCO1 to variable freq control i.e DC
34. Connect oscilloscope at TP8 & measure amplitude of present signal

----

----

35. Increase freq of VCO1 & check that cutoff freq is 10.7mhz

CHARACTERISTIC OF IF FILTER (10.7MHZ QUARTZ):

36. Set switches SW2 to BYPASS
37. Set external generator to provide a sine signal with amplitude 1Vpp & freq 1 mhz
33 set VCO1 to fixed freq (11.7mhz) i.e PLL
34. Connect oscilloscope at TP8 & measure amplitude of present signal

----

----

35. Increase freq of generator & check that cutoff freq is 10.7MHz

OPERATION OF 2ND CONVERTER:

36. Following section used for converter2:RF mixer2, VCO1/2, 455kHz IF filter.
37. Set switch **SW2** of the RF filter section to BYPASS
38. In the AGC/LEVEL METER section:
    - Turn switch SW6 off.
    - Turn the D.C source trimmer completely clockwise to obtain the maximum gain of the voltage controlled amplifier.
39. In the LOCAL Oscillator 1/2 section (Local Oscillator 2)
    - Set switch **SW8** to AM/DSB
    - Set switch **SW13** to PLL to obtain the automatic control of the frequency of the local oscillator (in these condition the frequency is fixed)
40. Set switch **SW7** of the IF amplifier / FM demodulator section to AM/DSB(local oscillator 1 Is not used)
41. set switch SW5 of RFMixer2 section to RF to provide mixer with signal coming from VCA & not IF1 i.e provided by 10.7Hz IF filter
42. Insert a sine signal to the input CABLE IN with amplitude of 1 Vpp and frequency of 1 MHz using an external generator .
43. Adjust the DC source command of **AGC** /Level Meter section to obtain about 1Vpp in **TP6** .
44. check that the signals present upto this test points are all at the same frequency.
45. Use oscilloscope to check that the frequency of the local oscillator1**(test point local oscillator2 of VCO out)** is equal to 455 k**Hz**.

----

46. Adjust the DC source command of **AGC** /Level Meter section to obtain about 1Vpp in **TP6** .
47. see the o/p signal at the mixer **(TP9**) after the conversation between the RF input signal and the signal provided by the local oscillator2 (**LO2)**

----

48. see o/p signal of IF filter (**TP10)** generated by freq conversion cleaned from unnecessary components

----

----

49. check that extracted component is 455KHz.
50. check relation b/w signal Fif2 = Flo2 – Frf. check that pass band of ceramic filter is about 10KHz.

LAB SESSION 09

OBJECT:-

To observe the normal operation of Pulse amplitude modulator and demodulator.

EQUIPMENTS REQUIRED:-

1- PAM modulator module 736061
1- PAM demodulator module 736071.
1- Function generator module 72695
1- Power supply module 72686.
1- Digital oscilloscope.
1- Multimeter.
Bridging plugs
Cable pairs.

THEORY:-

PULSE AMPLITUDE MODULATION: It is a modulation technique in which analog signal is sampled and sampled values are used to modify certain parameters of a periodic pulse train to convert information into form for transferring pulses from a source to a destination.There are two categories of pulse modulation
Digital pulse modulation
Analog pulse modulation

PAM is analog pulse modulation in which amplitude of a constant width and constant position pulse train is varied according to the amplitude of the analog signal this process is termed as sampling of the analog signal. PAM signal is time discrete and value continuous. PAM signal is neither digital nor analog and it is not suitable for transmission. To avoid aliasing sampling theorem must be followed. PAM is used as an intermediate stage of the Pulse code modulation PCM.

PROCEDURE:-

1- Set up the experiment as specified in the diagram.
2- Set the pulse generator (G) to t/Tp = max and fp = 15 kHz
3- Feed into the input filter CH1 a sinusoidal signal with fm = 500Hz & Am= 5V.
4- Observe the output of the filter by using oscilloscope with Vp-p unchanged and change frequency of i/p signal fm.
5- Measure the amplitude of the output of the low pass CH-1 and calculate the gain of the low pass filter from Am and Ao.

$$A\,dB = 20 \log Ao/ Am$$

6- connect the oscilloscope at o/p of modulator & see the waveform of PAM1.

7- Connect CH2 of the oscilloscope at the output of the demodulator repeat the experiment at different t/Tp with pulse frequency fp unchanged observe the effect on the output signal at CH-1.

8- Set the pulse duty factor t/Tp to max and lower the sampling frequency and take readings at different fp values, observe the effect on the output signal of the demodulator at CH-1 using oscilloscope.

OBSERVATIONS & RESULT:-

a- Filter Response

INPUT SIGNAL TYPE------------ Vpp	INPUT SIGNAL frequency	OUTPUT SIGNAL TYPE---------------- Vpp	OUTPUT SIGNAL frequency

b- Influence of Pulse duty factor on PAM signal.

PULSE DUTY CYCLE t/ Tp(variable)	FREQUENCY OF PULSE Fp(fixed) MAX	INPUT SIGNAL TYPE---------------- Vpp, frequencyfi	OUTPUT SIGNAL TYPE-------------- Vpp,frequency fo

c- Influence of sampling frequency on PAM signal.

PULSE DUTY CYCLE t/ Tp(fixed) MAX	FREQUENCY OF PULSE Fp(variable)	INPUT SIGNAL TYPE---------------- Vpp, frequency fi	OUTPUT SIGNAL TYPE-------------- Vpp,frequency fo

- What did you analyze about the influence of pulse duty factor & frequency of pulse on the output of Modulated & demodulated signal

----

LAB SESSION 10

OBJECT:-

To observe the normal operation of a 2- Channel PAM time-division multiplex system (PAM – TDM) system.

EQUIPMENTS REQUIRED:-

1 PAM modulator module 736061
1 PAM demodulator module 736071
2 Function generator module 72695
1 Power supply module 72686
1 Frequency counter module 72699
1 Digital storage oscilloscope
1 Multimeter
Bridging plugs
Cable pairs

THEORY:-

Multiplexing
Multiplexing is the process of simultaneously transmitting more than one individual signals over a single communication link. Multiplexing has the effect of increasing the number of communication channels so that more information can be transmitted. There are two basic types of multiplexing
1- FDM (Frequency division multiplexing)
2- TDM (Time division multiplexing)

In TDM each signal can occupy the entire bandwidth of the channel however each channel is transmitted for a brief period of time.

PROCEDURE:-

1. Set up the experiment as specified in the figure.
2. Feed in a triangular signal with fm1=200Hz and Am1=2V in channel1 (CH1)
3. Feed in a sinusoidal signal with fm2 = 300Hz and Am2=3V into channel 2 (CH2).
4. Set the sampling frequency to maximum fp = 20 KHz.
5. Set the Pulse duty factor to maximum t/Tp = 48%.
6. Display the input signals simultaneously on the oscilloscope and sketch it.

   ----

7. Display the PAM-TDM signal and sketch it.

   ----
8. Display the respective input and output signal of the demodulator low pass filter of CH1 and CH2.

   ----
9. Display the CLOCK signal and the demux trigger signal on the oscilloscope and set delta t so that the trigger signal is delayed by 90 degree w.r.t the CLOCK signal.
10. Display the respective input and output signal of the demodulator low pass filter of CH1 and CH2.

    ----
11. Adjust delta t with 180 degree phase difference you will observe that the demodulated signals from CH1 and CH2 are interchanged completely.
12. Display the respective input and output signal of the demodulator low pass filter of CH1 and CH2.
13. Now vary the pulse-duty factor from min to max and see the effect at the output signals of the CH1 and CH2 low pass filters. Alternate from PAM1 to PAM2 by changing the bridging plug at the PAM modulator.

OBSERVATION AND RESULT:

CH1 Input signal Vp-p, f1	**CH2 Input signal Vp-p, f2**	**Pulse duty factor t/Tp Variable**	**Sampling frequency fp Fixed (max)**	**Output signal CH1 Without S&H Vp-p, f1**	**Output signal CH2 With S&H Vp-p, f2**
		10%			
		20%			
		30%			
		40%			
		50%			

- What did you analyze about the influence of pulse duty factor on the output of Modulated & demodulated signal

LAB SESSION 11

OBJECT:-

To observe the effect of Linear and Non linear quantization in PCM (Pulse code modulation) System.

EQUIPMENTS REQUIRED:-

1 PAM modulator 736061
1 PAM demodulator 736071
1 PCM modulator 736101
1 PCM demodulator 736111
1 Function generator 0-200kHz 72695
1 Frequency counter 72699
1 Power supply 15V
1 Digital storage oscilloscope
Bridging plugs
Cable pairs

THEORY:-

Quantization means narrowing down of all possible signal values to a finite number. The quantization process takes an infinite number of all possible continuous signals. The quantization interval can be either equidistant discrete or logarithmic steps. In the case of equidistant quantization intervals this is referred to as *linear quantization*. In the case of logarithmic steps this is called *non linear quantization*. The quantization becomes more precise with an increasing number of steps and there is a decrease in the quantization noise.

PROCEDURE:-

1. Use the experiment setup according to figure.
2. By pressing the MODE button several times switch to the operating mode: PCM linear quantization (recognizable when the appropriate LED lights up).
3. Enable all of the bits. For this press the push button SELECT until all (red) LEDs on the PCM modulator indicate ACTIVE.
4. Connect the DC voltage source of the PCM modulator as the input U1.
5. The quantified voltage is U2 and can be tapped at the D/A converter of the PCM demodulator.
6. Set to -9.5V on the 10 stage potentiometer.
7. Alternately measure U1 and U2 using the multimeter and note down the voltages together with the binary coded bit sequence of the PCM bit modulator in Table7.1
8. The bit sequence is displayed by LEDs whereby the LSB is at the top.

9. Now increase the input voltage U1 in steps of approx. 1V and repeat the recording of the measurement value until the upper modulation limit of the PCM modulator is reached.
10. Display the curve of U2 versus U1 as a quantization characteristic in graph.
11. By pressing the MODE push button on the PCM modulator several times switches to the operating mode: PCM non linear quantization. The PCM demodulator remains in linear operation.
12. Record the compressor characteristic. Proceed in the same manner as for the recording of the linear quantization characteristic in Table 7.2.
13. Plot the curve of U2 versus U1 as a compressor characteristic in graph.
14. For expander characterstic set the PCM modulator to linear quantization & PCM demodulator to non linear quantization.
15. Plot the curve of U2 versus U1 as an expander characteristic in graph.
16. In order to record the Non linear transmission characteristic switch the PCM modulator and demodulator to non linear mode. Record the transmission characteristic in Table 7.4 & Plot the curve of U2 versus U1 in graph.

OBSERVATION AND RESULT:-

Table 7.1 linear Quantization Characteristic

U1 Volts, Bit pattern	U2 Volts, Bit pattern	U1 Volts, Bit pattern	U2 Volts, Bit pattern
-9,			
-8,		1,	
-7,		2,	
-6,		3,	
-5,		4,	
-4,		5,	
-3,		6,	
-2,		7,	
-1,		8,	
0,		9,	

Table 7.2 Non-linear quantization Compressor characteristic

U1 Volts, Bit pattern	U2 Volts, Bit pattern	U1 Volts, Bit pattern	U2 Volts, Bit pattern
-9,			
-8,		1,	
-7,		2,	
-6,		3,	
-5,		4,	
-4,		5,	
-3,		6,	

-2,		7,	
-1,		8,	
0,		9,	

Table 7.3 Non-linear quantization Expander characteristic

U1 Volts, Bit pattern	U2 Volts, Bit pattern	U1 Volts, Bit pattern	U2 Volts, Bit pattern
-9,			
-8,		1,	
-7,		2,	
-6,		3,	
-5,		4,	
-4,		5,	
-3,		6,	
-2,		7,	
-1,		8,	
0,		9,	

Table 7.4 Non-linear Transmission Characteristic

U1 Volts, Bit pattern	U2 Volts, Bit pattern	U1 Volts, Bit pattern	U2 Volts, Bit pattern
-9,			
-8,		1,	
-7,		2,	
-6,		3,	
-5,		4,	
-4,		5,	
-3,		6,	
-2,		7,	
-1,		8,	
0,		9,	

LAB SESSION 12

OBJECT:-

To construct a series of binary coded words, using the set of 8keys switches on data source and observe its output on receiver.

EQUIPMENTS REQUIRED:-

1 DCS 297A Data source
1 DCS 297H Data receiver
1 DCS 297M Power supply module
1 Oscilloscope

THEORY:-

Binary coded numbers are manually formulated and transmitted as eight bit words to the receiver where they are reconstructed and displayed. In a binary coded data each digit is represented by using one signaling state to represent the digit '0' and other to represent digit '1'

Each character in a message is represented by a group of digits called 'word'

To send each of 8 bits in a coded data word on a separate wire or channel would be costly Therefore they are usually transmitted serially. Each code word contains an equal number of bits and each bit is of equal duration. Very often 8 bits transmission is used, with 7bits carrying the code and extra bit used for special purposes.

PROCEDURE:-

1. Connect the power supply module DCS 297M to the electric supply but do not switch on.
2. Connect the leads which come out of the rear face of data source and data receiver into sockets of the power supply.
3. Connect the modules and the oscilloscope as shown in fig.
4. On the data source module, set the format switch to 8 data bits and the data source switch to mid position.
5. The group of 8key switches is used to construct the bit pattern for any 8bit word Each switch has a lamp that is ON for digit 1 and OFF for digit 0.
6. On the data receiver set the data bit right hand switch and the data correction left hand switch to their top position.

7. Set the sample word 01011000 by pressing appropriate keys on data source module.
8. The received data lamp on data receiver module should show the same bit pattern as that sent out by data source module.
9. Adjust oscilloscope to produce display.
10. with the help of switches sent a word **: *COMMUNICATION*** from transmitter to reciever.

OBSERVATION AND RESULT:-

LAB SESSION 13

OBJECT:-

To examine RZ (Return to zero) & NRZ (Not Return to zero) digital data formats.

EQUIPMENTS REQUIRED:-

1	DCS297A	Data source
1	DCS297B	Data format
1	DCS297M	Power supply
1	Oscilloscope	

THEORY:-

A binary coded waveform can be represented by a number of different data formats using either unipolar or bipolar signals. Different data formats can be distinguished by the bandwidth required and the characterstics available for channel.

Message:A message can be transmitted either as a continuously varying analog waveform or as a coded sequence of pulses.

Data:Data is a content of message expressed as sequence of alphabetical or numerical symbols which may be digitally encoded.

Binary data formats: Binary data formats are classified into:

1. value of *unipolar* signal is either zero or +A
2. value of *bipolar* signal is either zero, +A,-A
3. *NRZ* (non return to zero) pulse doesnot fall to zero during time interval T
4. *RZ* (return to zero) pulse does fall to zero during time interval T
5. *Ternary AMI*(alternate mark invert) digit zero is represented by zero value & digit 1 has values of +A, -A alternately.
6. *Biphase (Manchester)*

PROCEDURE:-

1. Connect data source, format modules with power supply and oscilloscope as shown in fig.
2. Connect word clock with external trigger on oscilloscope.
3. On data source module set the format switch to '8data bits' and data source switch to 'mid position'.

4. Data format is synchronized with data source by repetitive bit clock and word clock pulses.
5. Generate and display 8bit word using push buttons on data source and observe the difference between all data formats.
6. Sketch all formats in observation & compare them.

OBSERVATION AND RESULT:- SAMPLE WORD 1110110

LAB SESSION 14

OBJECT:-

- To describe the ASK (amplitude shift keying) modulation and demodulation
- To examine the effect of noise and attenuation.

EQUIPMENT REQUIRED:-

- Power unit PSU
- Module holder base
- Experiment module MCM3 1
- Oscilloscope.

THEORY:-

Amplitude shift keying -ASK

In this form of modulation the sine carrier takes 2 amplitude values, determined by the binary data signal. Usually the modulator transmits the carrier when the data bit is “1”. It completely removes when the bit is”0”. There are also ASK shapes called multi-level where the amplitude of the modulated signal takes more then 2 values.
The demodulation can be coherent or non coherent. In the first case, more complex as concern the circuit but more effective as against the noise effect, a product demodulator multiplies the ASK signal by the locally generated carrier. In the second case the envelope of the ASK signal is detected via diode. In both cases the detector is followed by a low pass filter which removes the residual carrier component and a threshold circuit which squares the data signal.

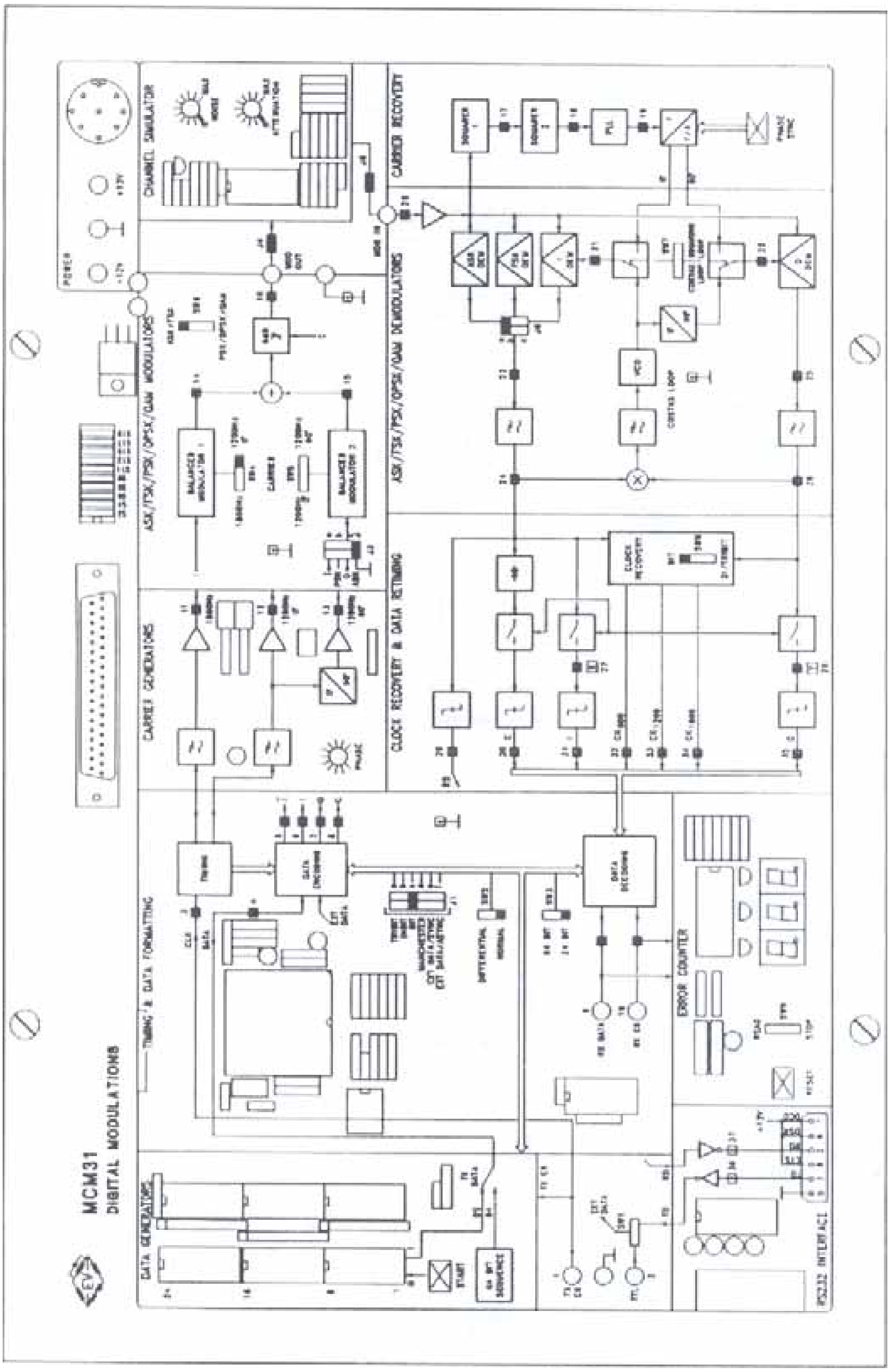
Bit Error rate- B.E.R

The B.E.R is the ratio of the error bits to the total received bits. Practically it tells the user how accurate the received data is.
BER = (No. of error Bits) / (Total No of received bits)

PROCEDURE:-

Modulation

1. Power on module
2. Set the circuit in ASK mode, with 24-data bit source and without data coding (connect J1c-J3d-J4-J5-J6a ; set SW2=normal, SW3=24 bit, SW4=1200 ,SW6=ASK, SW8=BIT and ATT=min, NOISE=min


MCM31
DIGITAL MODULATIONS
DATA GENERATORS
TIMING & DATA FORMATTING
CARRIER GENERATORS
CLOCK RECOVERY & DATA RETIMING
ASK/FSK/PSK/QPSK/QAM MODULATORS
ASK/FSK/PSK/QPSK/QAM DEMODULATORS
CHANNEL SIMULATOR
CARRIER RECOVERY
ERROR COUNTER
RS232 INTERFACE
POWER

3. Set an alternate data sequence 00/11 and push START
4. Connect the oscilloscope to TP6 and TP16 so to display the data signal and ASK signal wave form.
5. Adjust the phase of the carrier to make the zero of sine wave correspond to the starting of the bit intervals.

De-modulation

6. Keep the last condition (J1c-J3d-J4-J5-J6a; SW2=normal, SW3=24 bit SW4=1200, SW6=ASK, SW8=BIT and ATT=min, NOISE=min
7. Set an alternate data sequence 00/11 and push START
8. Connect the oscilloscope to TP16 and TP20 to examine the ASK signal before and after the communication channel. Note the readings at TP23, TP24, TP29
9. Note the effect of the communication channel on the ASK signal.

Bit Error Rate

10. Set the jumpers as follows: J1d-J3d-J4-J5-J6a.
11. Set Switches as per the following SW2=Normal, SW3=64 bit, SW4=1200Hz, SW6=ASK, SW8=BIT, **SW9=STOP.**
12. Set NOISE at 50 % of maximum value. Set SW9=READ and Push RESET (to initialize counter to zero). Let the counter progress for 60 seconds after which set SW9=STOP and note counter reading.
13. Repeat steps and note error reading for NOISE at 100 %.
14. The received bits are 18000 per minute. (300 bits/s times 60 seconds).

OBSERVATION:-

TP6 ______________________________

TP14/16 ______________________________

TP23 ______________________________

TP24 ______________________________

TP29 ______________________________

CONCLUSION:-

- Effect of Attenuation

- Effect of Noise

- Bit Error Rate readings
    - At 50 % of maximum Noise
    - At 100 % Noise

LAB SESSION 15

OBJECT:-

- To observe the FSK modulation and demodulation (frequency shift keying)
- To examine the noise effect and effect of attenuation on the connection.

EQUIPMENT REQUIRED:-

- Power unit PSU
- Module holder base
- Experiment module MCM3 1
- Oscilloscope

THEORY:-

Frequency shift keying -FSK

In this modulation the sine carrier takes 2 frequency values, determined by the binary data signal. The modulator can be carried out in different ways among the most used we can mention.

- A voltage controlled oscillator (VCO)
- A system transmitting one of the 2 frequencies as function of the data signal.
- A frequency divider controlled by the data signal.

The most used demodulation techniques are the one using a PLL circuit. The FSK signal across the PLL input takes two frequency values. The error voltages supplied by the phase comparator follows such variations, and so, it constitutes the NRZ binary representation (high and low level) of the FSK input signal. The PLL demodulator is followed by a low pass filter, which removes the residual carrier components and a squarer circuit which forms the proper data signal.

Bit Error rate- B.E.R

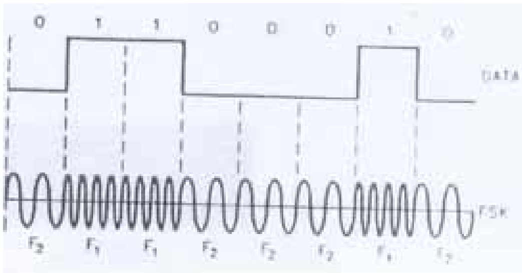
The B.E.R is the ratio of the error bits to the total received bits. Practically it tells the user how accurate the received data is.

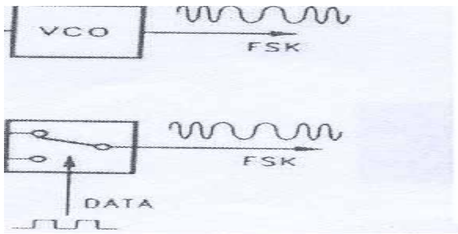
BER = (No. of error Bits) / (Total No of received bits)

PROCEDURE:-

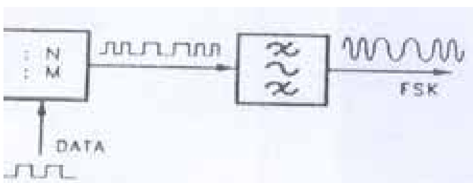
Modulation

1. Power the module
2. Set the circuit in FSK mode, with 24-bit data source and with out data coding (connect J1c-J3a-J5-J6b; set SW2=normal, SW3=24bit, SW4=1 800, SW5=1200/0^o, SW6=FSK, SW8=BIT , ATT=min, NOISE=min)
3. Set an alternate data sequence 00/11 and push START

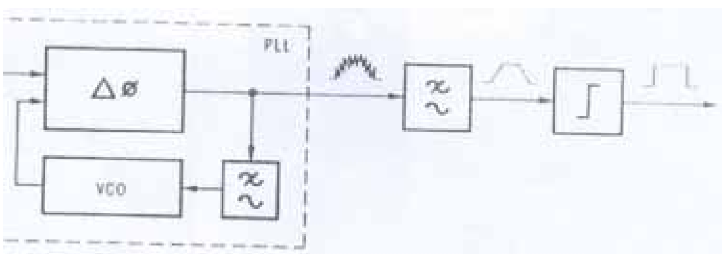




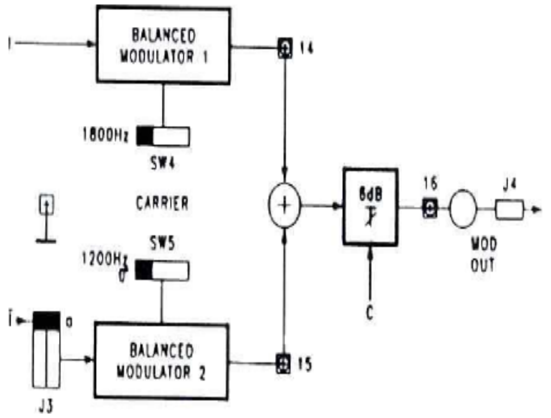
FSK Modulation

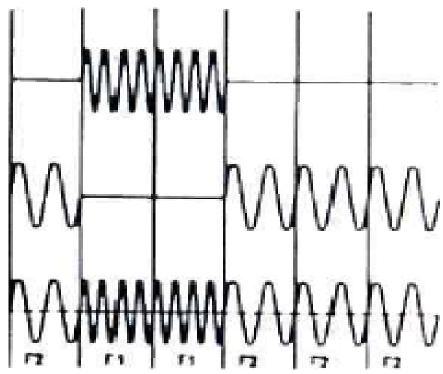


FSK Modulation



FSK Demodulation





FSK modulator

4. Connect the oscilloscope to TP6, TP 14, TP 15, TP16 and examine the data signal and FSK signal, adjust the phase (PHASE) of the 1200-Hz carrier to get continuity of FSK signal in the passage between the two frequencies (this kind of modulation is known as minimum frequency shift keying)

Demodulation

5. Keep the last condition (J1c –J3a-J4-J5-J6b; SW2=Normal ,SW3= 24bit, SW4=1 800, SW=5=1200/0^0 , SW6=FSK, SW8=BIT , ATT=Min, NOISE =Min
6. Set a alternated data sequence 00/11 and push START
7. Connect the oscilloscope to TP16 and TP20, to examine the FSK signal before and after the communication channel. Connect oscilloscope to TP23, TP24 and TP29. Note down observations.
8. Increase noise & note result then increase attenuation and note result.

Bit Error Rate

9. Set the jumpers as follows: J1d-J3d-J4-J5-J6a.
10. Set Switches as per the following SW2=Normal, SW3=64 bit, SW4=1200Hz, SW6=ASK, SW8=BIT, SW9=STOP**.**
11. Set NOISE at 50 % of maximum value. Set SW9=READ and Push RESET (to initialize counter to zero). Let the counter progress for 60 seconds after which set SW9=STOP and note counter reading.
12. Repeat steps and note error reading for NOISE at 100 %.
13. The received bits are 18000 per minute. (300 bits/s times 60 seconds).

OBSERVATION:-

TP6 ____

TP14____

TP15____

TP16____

TP20 ____

TP23 ____

TP24 ____

TP29 ____

CONCLUSION:-

- Effect of Attenuation

- Effect of Noise

- Bit Error Rate readings
    - At 50 % of maximum Noise
    - At 100 % Noise