ANALOG AND DIGITAL COMMUNICATIONS LABORATORY MANUAL

(R22A0484)

B.TECH
(II YEAR–II SEM)
(2024-25)

Preparedby
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Department of Electronics & Communication Engineering

MALLAREDDY COLLEGE OFE NGINEERING &TECHNOLOGY
(AutonomousInstitution–UGC,Govt.ofIndia)
Recognized under2(f)and12(B)ofUGCACT1956
AffiliatedtoJNTUH,Hyderabad,ApprovedbyAICTE -AccreditedbyNBA&NAAC –'A'Grade-ISO9001:2015 Certified)
Maisammaguda, Dhulapally(Post Via. Kompally), Secunderabad – 500100, Telangana State, India

VISION

To evolve into a center of excellence in Engineering Technology through creative and innovative practices in teaching-learning, promoting academic achievement & research excellence to produce internationally accepted competitive and world class professionals.

MISSION

To provide high quality academic programmes, training activities, research facilities and opportunities supported by continuous industry institute interaction aimed at employability, entrepreneurship, leadership and research aptitude among students.

QUALITYPOLICY

- ❖ Impart up-to-date knowledge to the students in Electronics & Communication area to make them quality engineers.
- ❖ Make the students experience the applications on quality equipment and tools.
- ❖ Provide systems, resources and training opportunities to achieve continuous improvement.
- ❖ Maintain global standards in education, training and services.

PROGRAMMEEDUCATIONALOBJECTIVES

PEO1:PROFESSIONALISM&CITIZENSHIP To create and sustain a community of learning in which students acquire knowledge and learn to apply it professionally with due consideration for ethical, ecological and economic issues.
PEO2:TECHNICALACCOMPLISHMENTS To provide knowledge based services to satisfy the needs of society and the industry by providing hands on experience in various technologies in core field.
PEO3:INVENTION,INNOVATIONANDCREATIVITY To make the students to design, experiment, analyze, interpret in the core field with the help of other multi disciplinary concepts wherever applicable.
PEO4:PROFESSIONALDEVELOPMENT Toeducatethestudentstodisseminateresearchfindingswithgood soft skills and become a successful entrepreneur.
PEO5:HUMANRESOURCEDEVELOPMENT To graduate the students in building national capabilities in technology, education and research.

CODEOFCONDUCTFORTHELABORATORIES

1. AllstudentsmustobservetheDressCodewhileinthelaboratory.
2. Sandalsoropen-toedshoesareNOTallowed.
3. Foods,drinksandsmokingareNOTallowed.
4. Allbagsmustbeleft attheindicatedplace.
5. Thelabtimetablemustbestrictlyfollowed.
6. BePUNCTUALforyour laboratorysession.
7. Programmustbeexecutedwithinthegiventime.
8. Noisemustbekeptto aminimum.
9. Workspacemustbekeptcleanandtidyatalltime.
10. Handlethesystemsandinterfacingkitswithcare.
11. Allstudentsare liable for anydamagetothe accessoriesduetotheirown negligence.
12. Allinterfacingkitsconnectingcablesmust beRETURNED ifyoutakenfromthe lab supervisor.
13. StudentsarestrictlyPROHIBITEDfromtakingout anyitems fromthelaboratory.
14. StudentsareNOTallowedtoworkaloneinthelaboratorywithouttheLab Supervisor
15. USBPortshavebeendisabled ifyouwanttouseUSBdriveconsultlabsupervisor.
16. ReportimmediatelytotheLabSupervisorifanymalfunctionoftheaccessories, is there.

Beforeleaving the lab

- Place the chairs properly.
- Turnoffthesystemproperly
- Turn off the monitor.
- Pleasecheck thelaboratorynoticeboardregularlyfor updates.

CONTENTS

Analog CommunicationExperiments

DigitalCommunicationExperiment

S.NO	NAMEOFTHEEXPERIMENT
1.	PulseCodeModulation&Demodulation
2.	TimeDivisionMultiplexing &Demultiplexing
3.	DifferentialPulseCodeModulation&Demodulation
4.	DeltaModulation
5.	AmplitudeShiftKeying
6.	FrequencyShiftKeying
7.	BinaryPhaseShiftKeying
8.	DifferentialPhaseShiftKeying

ANALOGCOMMUNICATION EXPERIMENTS

EXPERIMENTNO-1

DATE:

AMPLITUDEMODULATION&DEMODULATION

AIM:(i) To study the function of Amplitude Modulation & Demodulation (under modulation, perfect modulation & over modulation) and also to calculate the modulation index.

(ii) ToverifythespectrumofAMsignals usingspectrumanalyzer.

APPARATUS:

1. AmplitudeModulation&Demodulationtrainerkit.
2. C.R.O (20MHz)
3. Functiongenerator(1MHz).
4. Connectingcords&probes.
5. PCwith windows(95/98/XP/NT/2000)
6. MATLABSoftwarewithcommunicationtoolbox

THEORY:

Modulation is defined as the process of changing the characteristics (Amplitude, Frequency or Phase) of the carrier signal (high frequency signal) in accordance with the intensity of the message signal (modulating signal).

Amplitudemodulationisdefinedasasystemofmodulationinwhichtheamplitudeof the carrier is varied in accordance with amplitude ofthe message signal (modulating signal).

Themessagesignalisgivenbytheexpression.

Em(t) =Em cosWmt

WhereWmis>Angular frequency

Em --------→Amplitude

CarriervoltageEc(t)=EccosWct E(t)=Ec

+ KaEm cosWmt

KaEmcosWmt------ →change incarrieramplitude

Ka ----→constant

Theamplitudemodulatedvoltageisgivenby E=E(t)

cosWct

Fromabovetwoequations

E=(Ec+KaEmcosWmt)cosWct.

E=(1+KaEm/EccosWmt)EccosWct

E= Ec(1+Ma cosWmt)cosWct

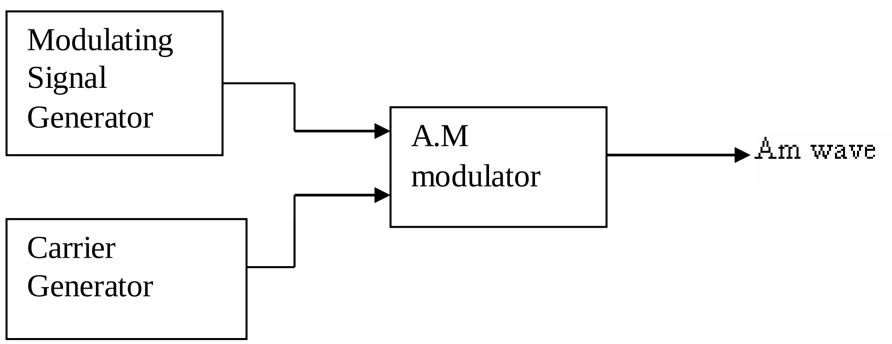
WhereMa -----→depthofmodulation/modulation index/modulationfactor

Ma=KaEm/Ec

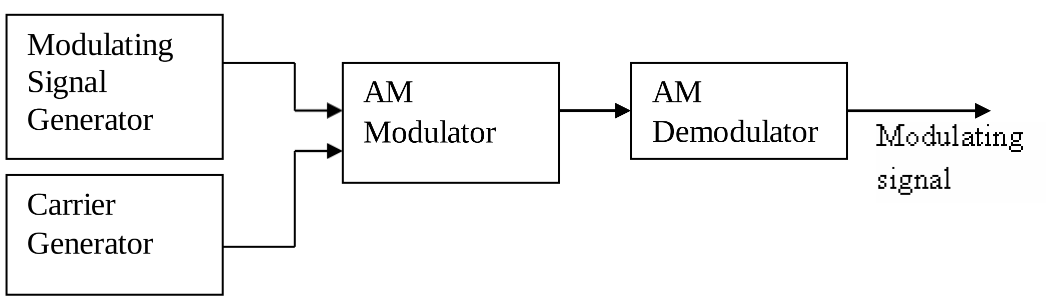
100*Magivesthepercentageofmodulation.

BLOCKDIAGRAM:

Modulation



Demodulation



(i) PROGRAM:

```
%programforAMmodulationanddemodulation
close all
clear all
clc
fs=8000;
```

```
fm=20;
fc=500;
Am=1;
Ac=1;
t=[0:0.1*fs]/fs;
m=Am*cos(2*pi*fm*t);
c=Ac*cos(2*pi*fc*t);
ka=0.5;
u=ka*Am;
s1=Ac*(1+u*cos(2*pi*fm*t)).*cos(2*pi*fc*t);
subplot(4,3,1:3);
plot(t,m);
title('ModulatingorMessagesignal(fm=20Hz)');
subplot(4,3,4:6);
plot(t,c);
title('Carriersignal(fc=500Hz)');
subplot(4,3,7);
plot(t,s1);
title('Under Modulated signal(ka.Am=0.5)');
Am=2;
ka=0.5;
u=ka*Am;
s2=Ac*(1+u*cos(2*pi*fm*t)).*cos(2*pi*fc*t);
subplot(4,3,8);
plot(t,s2);
title('Exact Modulated signal(ka.Am=1)');
Am=5;
ka=0.5;
u=ka*Am;
s3=Ac*(1+u*cos(2*pi*fm*t)).*cos(2*pi*fc*t);
subplot(4,3,9);
plot(t,s3);
```

```
title('Over Modulated signal(ka.Am=2.5)');
r1= s1.*c;
[ba]=butter(1,0.01);
mr1= filter(b,a,r1);
subplot(4,3,10);
plot(t,mr1);
title('deModulated signal for(ka.Am=0.5)');
r2= s2.*c;
[ba]=butter(1,0.01);
mr2= filter(b,a,r2);
subplot(4,3,11);
plot(t,mr2);
title('deModulatedsignalfor(ka.Am=1)');
r3= s3.*c;
[ba]=butter(1,0.01);
mr3= filter(b,a,r3);
subplot(4,3,12);
plot(t,mr3);
title('deModulatedsignalfor(ka.Am=2.5)');
```

(ii) PROGRAM:

```
%programofspectrumanalyzerandanalysisofamsignals close
all
clearall
clc
Fs = 100;          %samplingfrq
t = [0:2*Fs+1]'/Fs;
Fc=10;             %Carrierfrequency
x = sin(2*pi*2*t);     %messagesignal
Ac=1;
% compute spectra of am
xam=ammod(x,Fc,Fs,0,Ac);
zam = fft(xam);
```

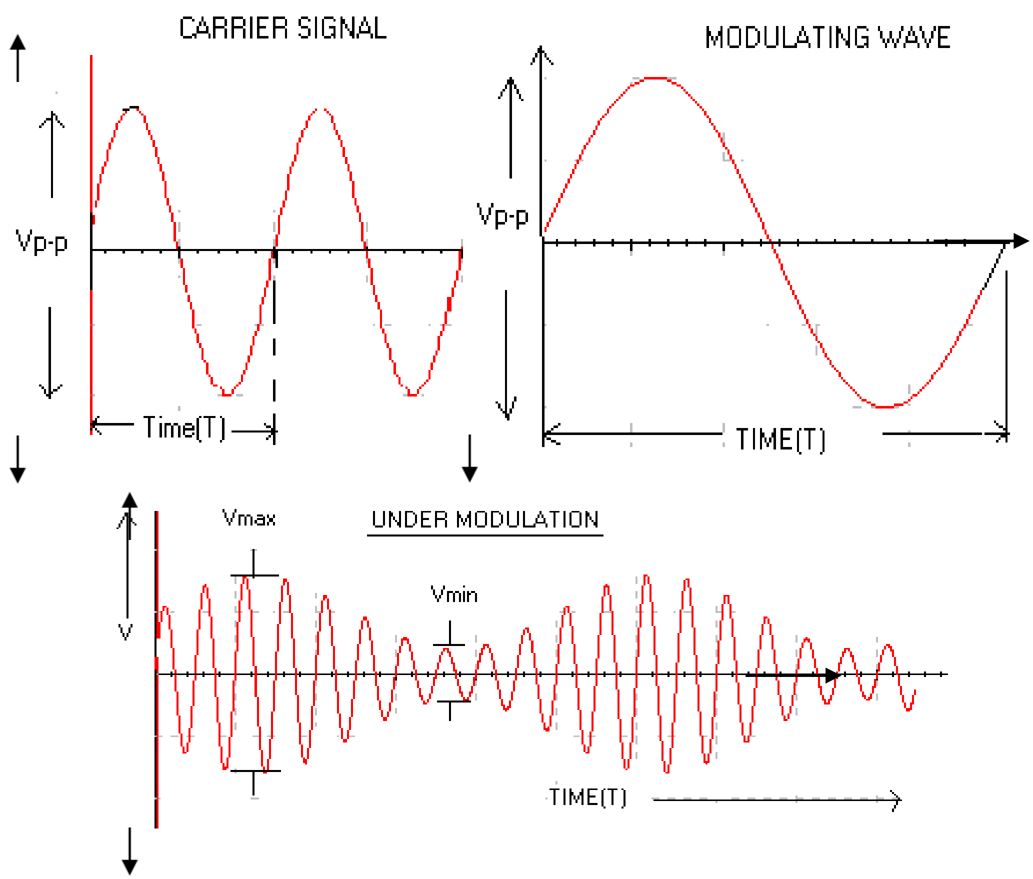
```
zam=abs(zam(1:length(zam)/2+1));
frqam=[0:length(zam)-1]*Fs/length(zam)/2;
% compute spectra of dsbsc
ydouble=ammod(x,Fc,Fs,3.14,0);
zdouble = fft(ydouble);
zdouble = abs(zdouble(1:length(zdouble)/2+1));
frqdouble = [0:length(zdouble)-1]*Fs/length(zdouble)/2;
%computespectraofssb
ysingle= ssbmod(x,Fc,Fs,0,'upper');
zsingle = fft(ysingle);
zsingle = abs(zsingle(1:length(zsingle)/2+1));
frqsingle = [0:length(zsingle)-1]*Fs/length(zsingle)/2;
%Plotspectrumsofamdsbscandssb figure;
subplot(3,1,1); plot(frqam,zam);
title('Spectrum of am signal');
subplot(3,1,2); plot(frqdouble,zdouble);
title('Spectrumofdouble-sidebandsignal');
subplot(3,1,3); plot(frqsingle,zsingle);
title('Spectrum of single-sideband signal');
```

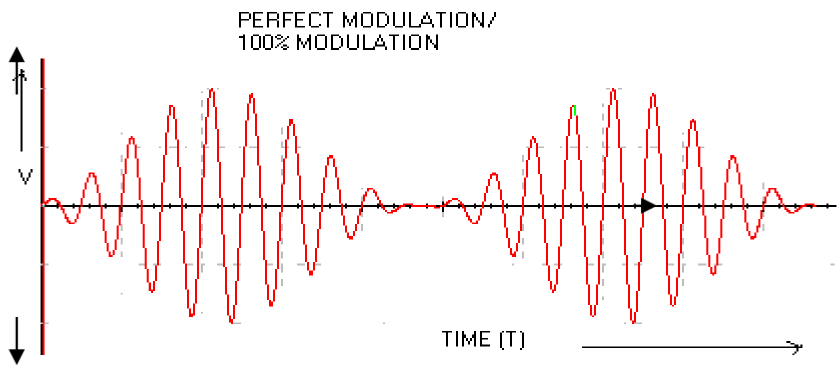
PROCEDURE:-

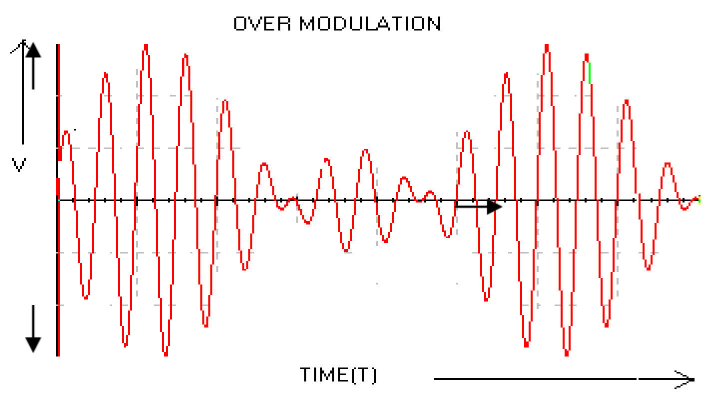
1. Connect the AC Adapter to the mains and the other side to the Experimental Trainer. Switch 'ON' the power.
2. Observe the carrier and modulating waveforms and note their frequencies. (Carrier frequency is around 100 KHz and amplitude is variable from 0 -8Vp-p, modulating signal is 1KHz).
3. Connectthecarrierand modulatingsignalstothemodulatorcircuit.
4. Observetheamplitudemodulated wave.
5. Connect Carrier I/P to ground and apply a 2V peak to peak AF Signal input to (modulating I/P) and adjust P1 in anti-clock wise position to get minimumA.C output.

6. ConnectmodulatingI/Ptogroundandapplya3Vpeaktopeakcarriersignalto carrier I/P and adjust P2 in clock wise direction to get minimum A.C ouyput..
7. Connect modulatinginput&carrierinput togroundandadjustP3forzeroD.Coutput.
8. Makemodulatingi/p2Vppandcarrieri/p3Vpppeak topeakandadjust potentiometer P4 for maximum output.
9. Calculate maximum and minimum points on the modulated envelope on a CRO and calculate the depth of modulation.
10. Observethatbyvaryingthemodulatingvoltage,thedepthofmodulationvaries.
11. Duringdemodulationconnectthis AMoutputtotheinputofthedemodulator.
12. Byadjusting the RC time constant (i.e., cut off frequency) of the filter circuit we get minimum distorted output.
13. Observe that this demodulated output is amplified has some phase delay because ofRC components.
14. Alsoobservetheeffects bychangingthecarrier amplitudes.
15. Inallcases,calculatethe modulationindex.

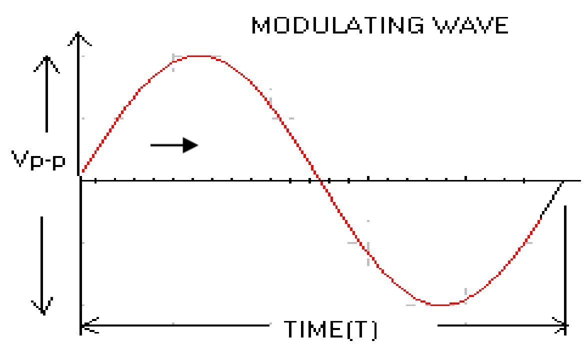
EXPECTEDWAVEFORMS:-

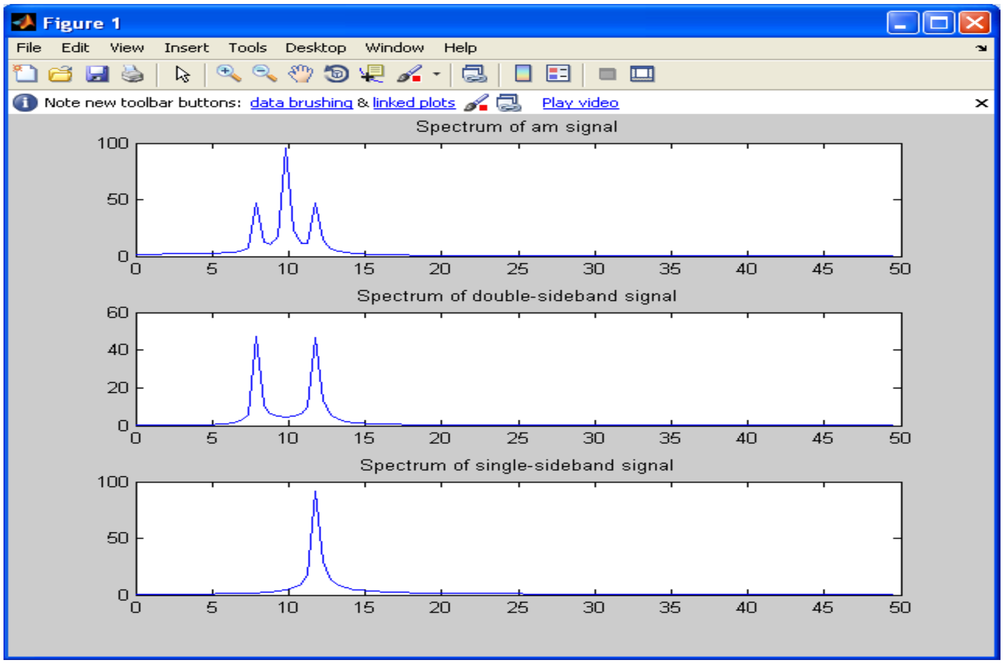






Demodulated signal





OBSERVATIONS:

Modulation

	Vc (V)	Vm (V)	Vmax (V)	Vmin (V)	m=(Vmax-Vmin)/(Vmax+Vmin)	m=Vm/Vc
Under modulation						
Perfect modulation						
Over modulation						

Demodulation

Modulatingsignal Frequency	Demodulatedoutput signalfrequency

RESULT:

QUESTIONS

1. DefineAManddrawitsspectrum?
2. Drawthephase'srepresentationofanamplitudemodulated wave?
3. Givethesignificanceofmodulationindex?
4. Whatarethedifferentdegreesofmodulation?
5. What arethelimitationsofsquare lawmodulator?
6. Comparelinearandnonlinearmodulators?
7. Comparebasemodulationandemittermodulation?
8. ExplainhowAMwaveisdetected?
9. Definedetectionprocess?
10. What arethedifferent typesofdistortionsthat occurinanenvelopdetector?Howcan they be eliminated?
11. What istheconditionofforovermodulation?
12. Definemodulation&demodulation?
13. Whatarethedifferent typesoflinearmodulationtechniques?
14. Explaintheworkingofcarrier wavegenerator.
15. Explaintheworkingofmodulator circuit.

EXPERMENTNO-2 DATE:

FREQUENCYMODULATIONANDDEMODULATION

AIM:(i) To studythe process offrequencymodulation and demodulation and calculate the depth of modulation by varying the modulating voltage.

(ii) ToverifythespectrumofFM signals usingspectrumanalyzer.

APPARATUS:

1. FMmodulationanddemodulationkit
2. DualtraceCRO.
3. CROprobes
4. Patchcards.
5. PCwith windows(95/98/XP/NT/2000)
6. MATLABSoftwarewithcommunicationtoolbox

THEORY:

The modulation system in which the modulator output is of constant amplitude, in whichthesignalinformationissuperimposedonthecarrierthroughvariationsofthecarrier frequency.

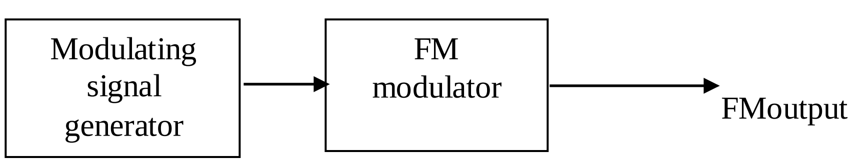
The frequency modulation is a non-linear modulation process. Each spectral component of the base band signal gives rise to one or two spectral components in the modulated signal. These components are separated from the carrier by afrequency difference equal to the frequency of base band component. Most importantly the nature of the modulators is such that the spectral components which produce decently on the carrier frquencyandthebasebandfrequencies.Thespetralcomponentsinthemodulatedwaveform depend on the amplitude.

ThemodulationindexforFMisdefined as

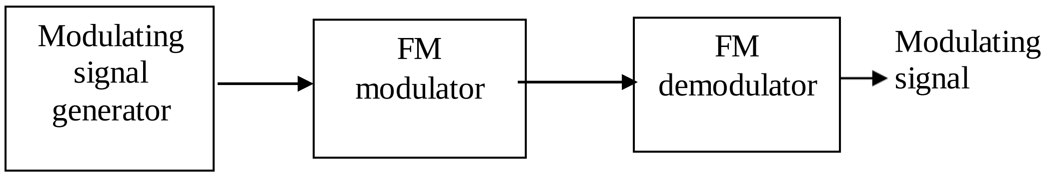
Mf=maxfrequencydeviation/modulatingfrequency.

BLOCKDIAGRAM:

Modulation



Demodulation



(i) PROGRAM:-

```
%programforfmmodulationanddemodulation
close all
clearall
clc
%fm=35HZ,fc=500HZ,Am=1V,Ac=1V,B=10
fs=10000;
Ac=1;
Am=1;
fm=35;
fc=500;
B=10;
t=(0:.1*fs)/fs;
wc=2*pi*fc;
wm=2*pi*fm;
m_t=Am*cos(wm*t);
subplot(4,1,1);
plot(t,m_t);
title('ModulatingorMessagesignal(fm=35Hz)');
c_t=Ac*cos(wc*t);
subplot(4,1,2);
plot(t,c_t);
title('Carrier signal(fm=500Hz)');
s_t=Ac*cos((wc*t)+B*sin(wm*t));
subplot(4,1,3);
plot(t,s_t);
```

```
title('Modulatedsignal');
d=demod(s_t,fc,fs,'fm');
subplot(4,1,4);
plot(t,d);
title('demodulatedsignal');
```

(ii) PROGRAM:

```
%programofspectrumanalyzerandanalysisoffmsignals close all
clearall
clc
Fs = 100;          %samplingfrq
t = [0:2*Fs+1]'/Fs;
Fc=10;             %Carrierfrequency
x = sin(2*pi*2*t);      %messagesignal
Ac=1;
% spectrum of fm
xfm=fmmod(x,Fc,Fs,10);
zfm = fft(xfm);
zfm=abs(zfm(1:length(zfm)/2+1));
frqfm=[0:length(zfm)-1]*Fs/length(zfm)/2;
figure;
plot(frqfm,zfm);
title('Spectrumoffmsignal');
```

PROCEDURE:

1. Switchontheexperimental board.
2. Observe the FM modulator output without any modulator input which is the carrier signal and note down its frequency and amplitude.
3. Connect modulatingsignaltoFMmodulatorinputandobservemodulatingsignalandFMoutput on two channels of the CRO simultaneously.
4. AdjusttheamplitudeofthemodulatingsignaluntilwegetlessdistortedFMoutput.
5. ApplytheFM output toFM demodulator andadjust thepotentiometer indemodulationuntil we get demodulated output.

OBSERVATIONS:

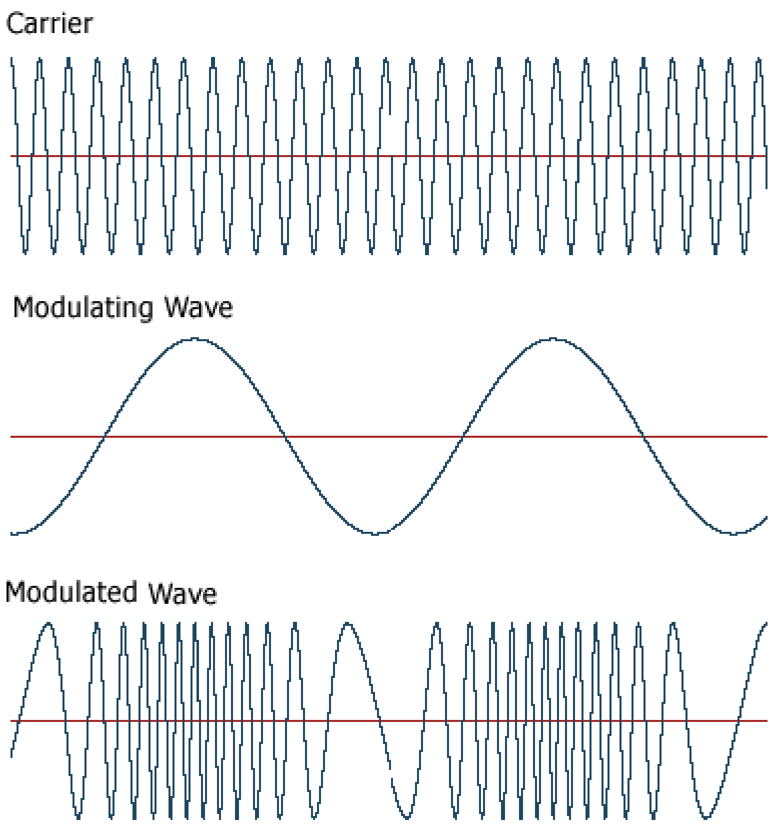
Modulation

Vm	F1	F2	Frequency deviationFd (f1-f2)	Modulating index (f1-f2)/Fm	Bandwidth= 2(Fd+Fm)

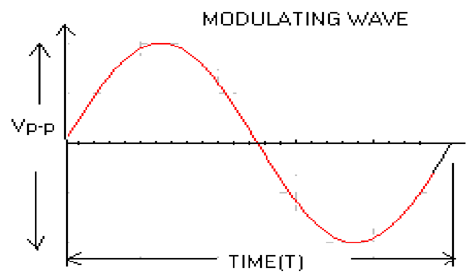
Demodulation

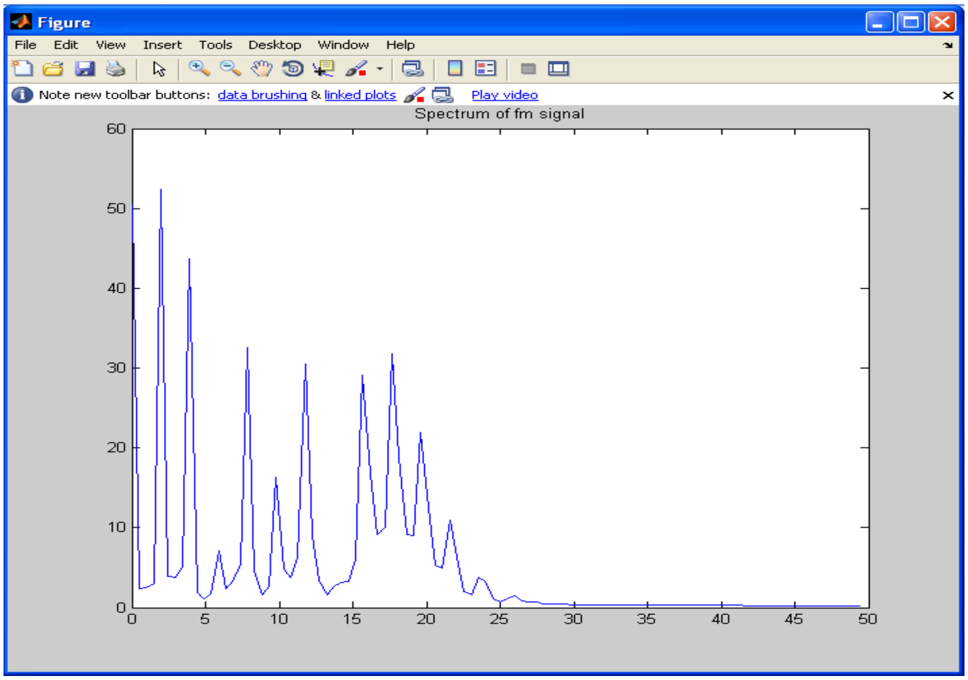
Modulatingsignal frequency	Demodulatingsignal frequency

<u>EXPECTEDWAVEFORMS</u>:-



Demodulated signal





RESULT:

QUESTIONS

1. DefineFM&PM.
2. WhataretheadvantagesofAnglemodulationoveramplitudemodulation?
3. WhatistherelationshipbetweenPMandFM?
4. WithaneatblockdiagramexplainhowPMisgeneratedusingFM.

EXPERIMENTNO-3 DATE:

DSB-SCMODULATOR&DETECTOR

AIM: To studythe working ofthe BalancedModulatorand demodulator.

APPARATUS:

1. Balancedmodulatortrainerkit
2. C.R.O (20MHz)
3. Connectingcordsandprobes
4. Functiongenerator(1MHz)
5. PCwithwindows(95/98/XP/NT/2000)
6. MATLABSoftwarewithcommunicationtoolbox

THEORY:

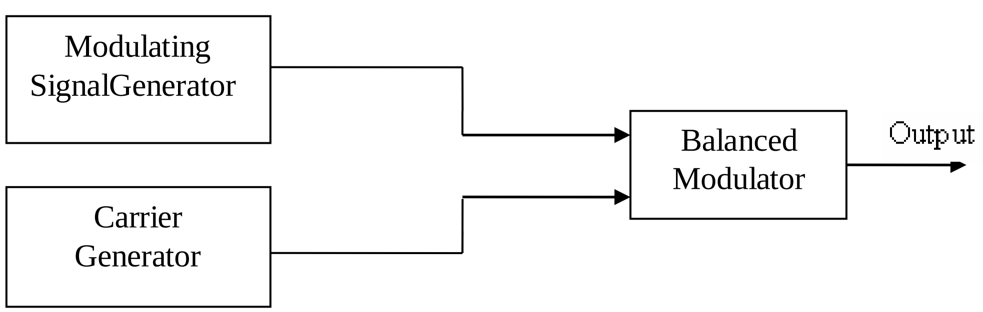
Balanced modulator circuit is used to generate only the two side bands DSB-SC. The balanced modulation system is a system is a system of adding message to carrier wave frequency there by only the side bands are produced. It consists of two AM modulators arranged in a balanced configuration. The AM modulator is assumed to be identical. The carrier input to the two modulators is same.

If we eliminate or suppress the carrier then the system becomes suppressed carrier DSB-SC.Inthisweneedreinsertthecarrier iscomplicatedandcostly. Hencethesuppressed carrier DSB system may be used in point to point communication system.

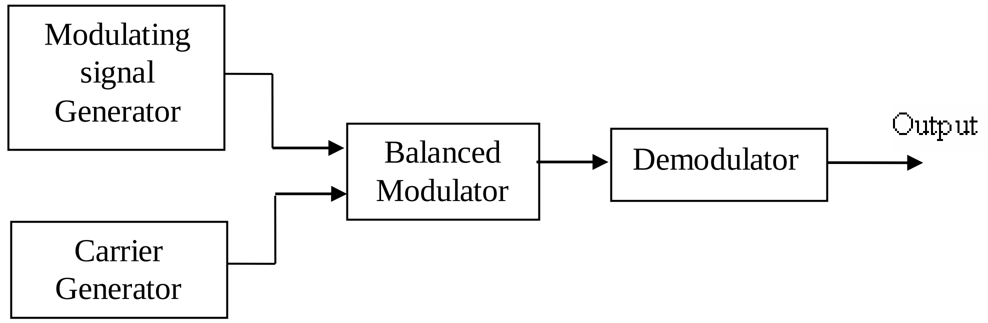
Generation ofsuppressed carrier amplitude modulated volt balanced modulator maybe of the following types.

1. UsingtransistorsorFET.
2. UsingDiodes

BLOCK DIAGRAM: **Modulation**



Demodulation



PROGRAM:

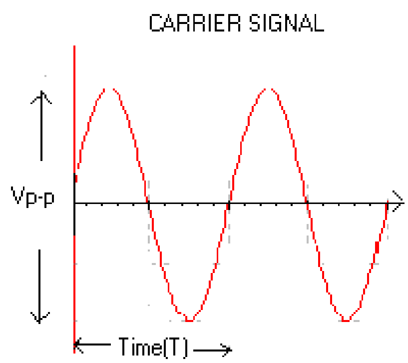
```
%programfordsbscmodulationanddemodulation close
all
clearall
clc
t =0:0.000001:.001;
Vm=1;
Vc=1;
fm=2000;
fc=50000;
m_t=Vm*sin(2*pi*fm*t);
subplot(4,1,1);
plot(t,m_t);
c_t=Vc*sin(2*pi*fc*t);
subplot(4,1,2);
plot(t,c_t);
subplot(4,1,3);
s_t=m_t.*c_t;
hold on;
plot(t,s_t);
plot(t,m_t,'r:');
plot(t,-m_t,'r:');
hold off;
r=s_t.*c_t;
[ba]=butter(1,0.01);
```

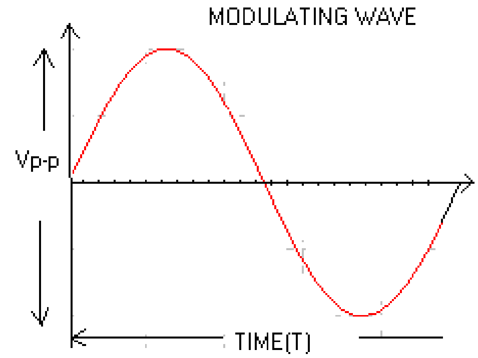
```
mr=filter(b,a,r);
subplot(4,1,4);
plot(t,mr);
```

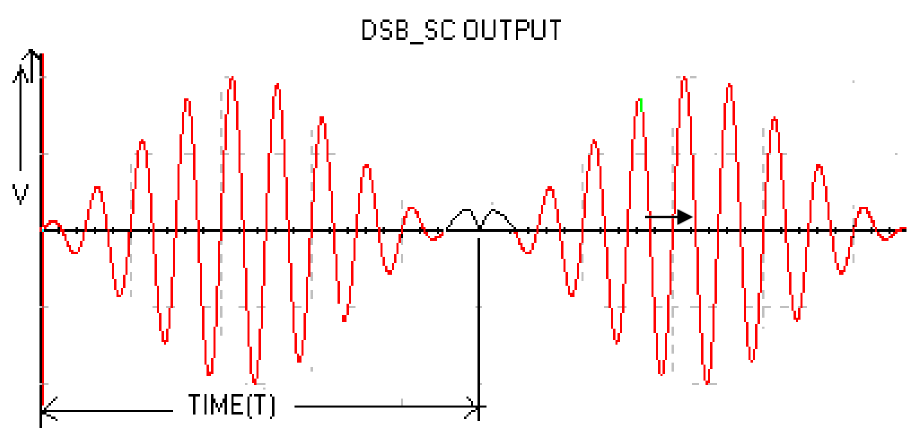
PROCEDURE:-

1. Connectthecircuitasperthegivencircuitdiagram.
2. Switchonthe powertothetrainerkit.
3. Applya100KHz,0.1peaksinusoidaltothecarrierinputanda5KHz,0.1peak sinusoidal to the modulation input.
4. Measuretheoutputsignalfrequencyandamplitudebyconnectingthe outputto CRO.
5. Andnotedowntheoutputsignals.

EXPECTEDWAVEFORMS:-







OBSERVATIONS:

CarrierSignal		Messagesignal		Modulatedsignal output		DemodulatedSignal output	
Fc(Hz)	Vc(volts)	Fm(Hz)	Vm(v)	Fo(Hz)	Vo(v)	F(Hz)	V(v)

RESULT:

QUESTIONS

1. Whatarethetwowaysofgenerating DSB_SC?
2. Whataretheapplicationsofbalancedmodulator?
3. Whataretheadvantagesofsuppressingthecarrier?
4. Whataretheadvantagesofbalancedmodulator?
5. Whataretheadvantages ofRingmodulator?
6. Writetheexpressionfortheoutput voltageofabalancedmodulator?
7. ExplaintheworkingofbalancedmodulatorandRingModulatorusing diodes.

EXPERIMENT.NO-4

DATE:

SSB-SCMODULATOR&DETECTOR(PHASE SHIFT METHOD)

AIM:- To generate SSB using phase method and detection of SSB signal using Synchronous detector.

APPARATUS:-

1. SSBtrainerkit
2. C.R.O (20MHz)
3. Patchcards
4. CROprobes

THEORY:

AM and DSBSC modulation are wasteful of band width because they both require a transmission bandwidth which is equal to twice the message bandwidth In SSB onlyone side band and the carrier is used. The other side band is suppressed at the transmitter, but no information is lost. Thus the communication channel needs to provide the same band width, when only one side band is transmitted. So the modulation system is referred to as SSB system.

The base band signal may not be recovered from a SSB signal by the Use of a diode modulator. The bae band signal can be recovered if the spectral component of the output i.e either the LSB or USB is multiplied by the carrier signal.

Considerthemodulating signal

$$M(t)=A_m \cos W_{mt}$$

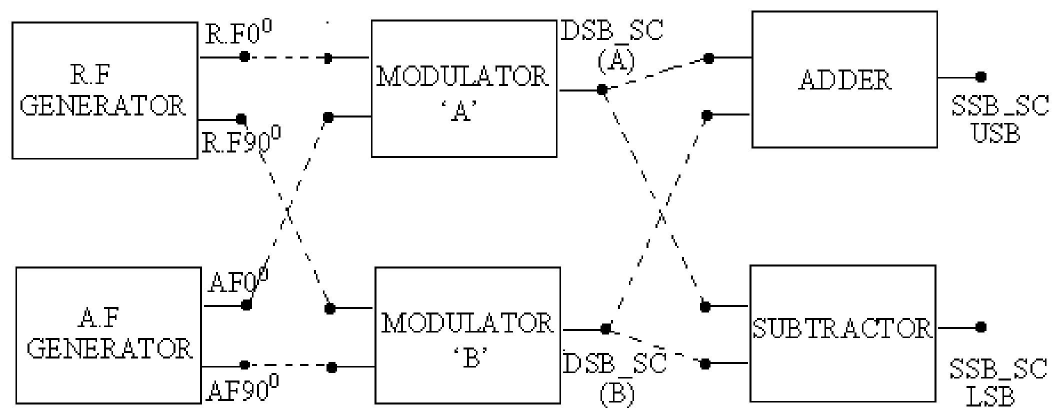
$$C(t)=A_c \cos W_{ct}$$

$$M(t)c(t)=A_c A_m \cos W_{mt} \cos W_{ct}$$

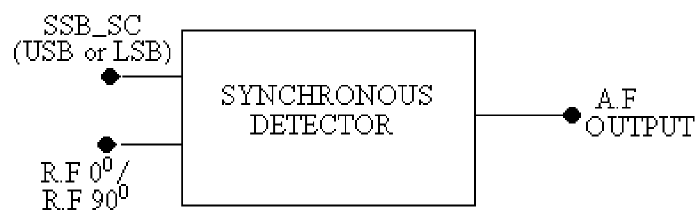
The above signal when passed through a filter, only one of the above component is obtained which lays the SSB signal.

BLOCKDIAGRAM:-

SSB MODULATION



SSB DEMODULATION/SYNCHRONOUS DETECTOR



PROGRAM:-

```
%programforssbmodulationanddemodulation
close all
clear all
clc
fs=8000;
fm=20;
fc=50;
Am=1;
Ac=1;
t=[0:0.1*fs]/fs;
subplot(5,1,1);
m1=Am*cos(2*pi*fm*t);
plot(t,m1);
title('Message Signal');
m2=Am*sin(2*pi*fm*t);
```

```
subplot(5,1,2)
c1=Ac*cos(2*pi*fc*t);
plot(t,c1)
title('Carrier Signal');
c2=Ac*sin(2*pi*fc*t);
subplot(5,1,3)
% Susb=0.5* Am*cos(2*pi*fm*t).* Ac*cos(2*pi*fc*t) -- 0.5* Am*sin(2*pi*fm*t).*
Ac*sin(2*pi*fc*t);
Susb=0.5*m1.*c1-0.5*m2.*c2;
plot(t,Susb);
title('SSB-SCSignalwithUSB');
subplot(5,1,4);
Slsb=0.5*m1.*c1+0.5*m2.*c2;
plot(t,Slsb);
title('SSB-SCSignalwithLSB'); r
= Susb.*c1;
subplot(5,1,5);
[b a] = butter(1,0.0001);
mr=filter(b,a,r); plot(t,mr);
title('demodulatedoutput');
```

PROCEDURE:-

SSBMODULATION

1. Connect the Adaptor to the mains and the other side to the Experimental Trainer Switch'ON' the power.
2. (a)Connectcarrierf_c90^{0}toA_{in} ofBalancedModulator–Aandadjustitsamplitudeto 0.1Vpp.
(b).Connectmodulatingsignalf_m0^{0}5VpptoB$_{in}$oftheBalancedModulator-A.
3. ObservetheDSB-Aoutput onCRO.
4. Connect fc 0^0 at 0.1 Vppat C$_{in}$ofBalanced Modulator B. Connectfm90^0 at 5 Vpp at D$_{in}$of Balanced Modulator B.

5. Connect the DSB-A output and DSB-B output to the summing amplifier. Observe the output (SSBoutput)on thespectrumanalyzer. This gives single sideband (upper) onlywhile the lower side band is cancelled in the summing Amplifier.

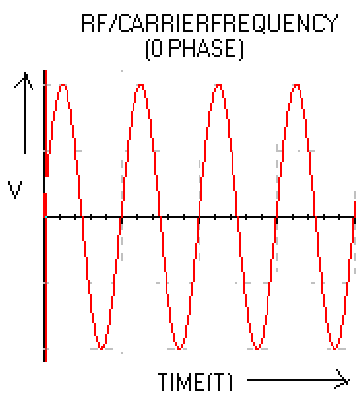
SSBDEMODULATION

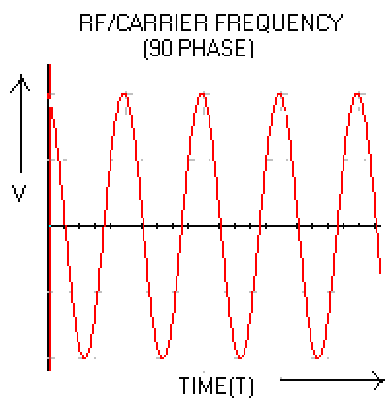
1. Connectthecarrierfc0^0 andSSBoutputtothesynchronousdetector.
2. Connectthedemodulatoroutputontheoscilloscopewhichistherecovered modulating signal.

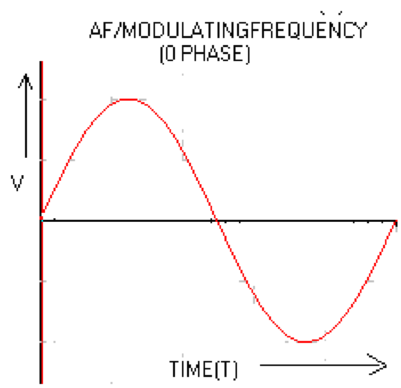
OBSERVATIONS:

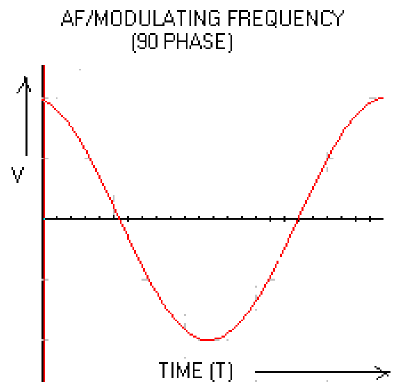
Carrier signal		Modulating signal		Balanced modulator-A		Balanced modulator-B		Adder/ Subtractor Output		Synchronous detector	
Fc	Vc	Fm	Vm	Vmax	Vmin	Vmax	Vmin	Vmax	Vmin	Fd	Vd

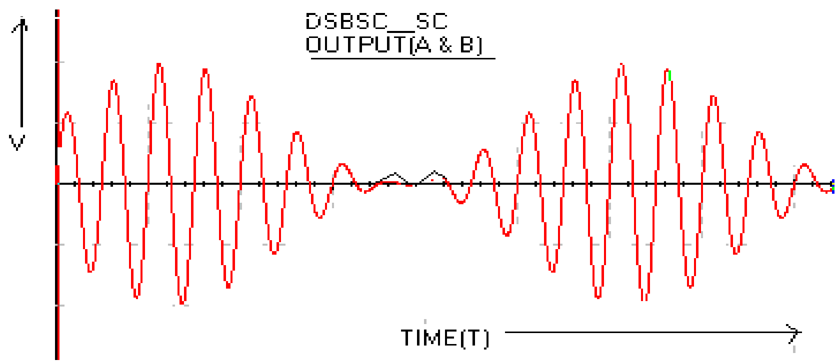
EXPECTEDWAVEFORMS:-

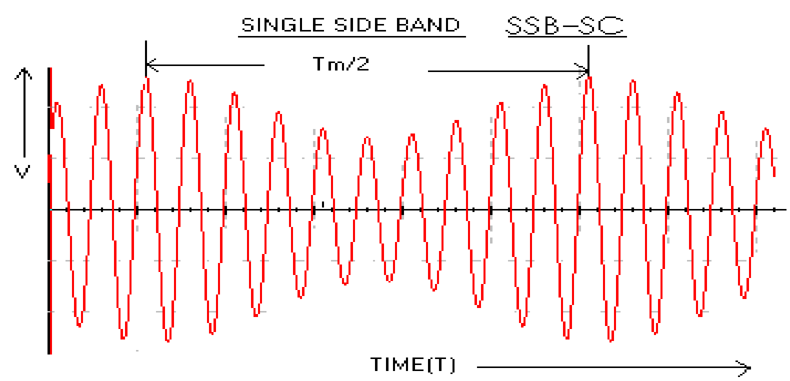




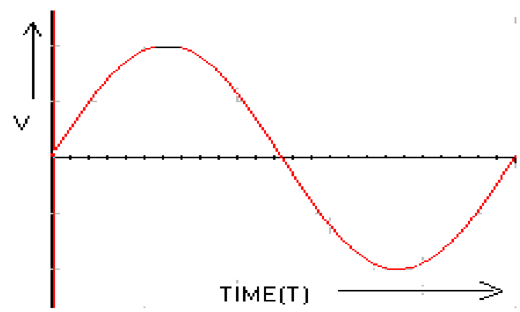








SSB DEMODULATED OUTPUT



RESULT:

QUESTIONS

1. WhatistheadvantageofSSB-SCoverDSB-SC?
2. WhatarethedifferentmethodstogenerateSSB-SCsignal?
3. ExplainPhaseShiftmethodforSSBgeneration.
4. WhySSB isnotusedforbroadcasting?

SSBDETECTION

5. Givethecircuitforsynchronousdetector?
6. Whataretheusesofsynchronousorcoherentdetector?
7. Givetheblockdiagramofsynchronousdetector?
8. Whythe name synchronousdetector?

EXPERIMENTNO-5 DATE:

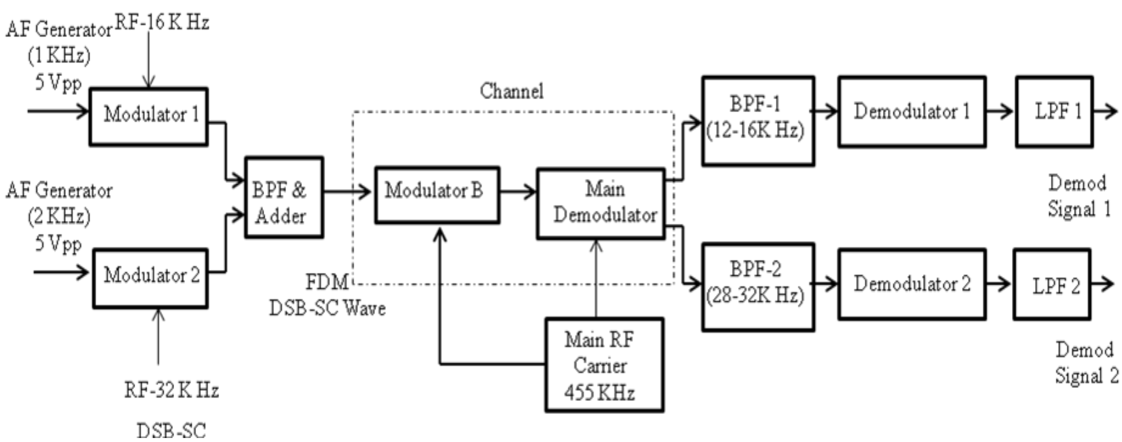
FREQUENCYDIVISIONMULTIPLEXING& DE MULTIPLEXING

AIM: Tostudythefrequencydivisionmultiplexingand DemultiplexingTechniques.

APPARATUS/SOFTWAREREQUIRED:

1. FREQUENCYDIVISIONMULTIPLEXING&DEMULTIPLEXINGTrainerKit.
2. C.R.O(30MHz)
3. Patchchords.
4. PCwithwindows(95/98/XP/NT/2000)
5. MATLABSoftware

BLOCKDIAGRAM:



PROGRAM:

```
%programforfrequencydivisionmultiplexinganddemultiplexing close
all
clearall
clc
Fs = 100;          %samplingfreq
t = [0:2*Fs+1]'/Fs;
x1=sin(2*pi*2*t);%signal1signal z1
= fft(x1);
z1=abs(z1);
```

```
x2=sin(2*pi*10*t);%signal2signal z2
= fft(x2);
z2=abs(z2);
figure;
subplot(4,1,1);plot(x1);
title('signal 1');xlabel('time');ylabel('amplitude');
subplot(4,1,2); plot(x2);
title('signal 2');xlabel('time');ylabel('amplitude');
subplot(4,1,3); plot(z1);
title('Spectrum of signal 1');xlabel('freqency');ylabel('magnitude');
subplot(4,1,4); plot(z2);
title('Spectrumofsignal2');xlabel('freqency');ylabel('magnitude');
%freqencymultiplexing
z=z1+z2;
figure;
plot(z);
title('frequencymultiplexedsignals');
figure;
%freqencydemultiplexing
f1=[ones(10,1);zeros(182,1);ones(10,1)];%applyingfilterforsignal1 dz1=z.*f1;
d1=ifft(dz1); subplot(2,1,1)
plot(t*100,d1);
f2=[zeros(10,1);ones(182,1);zeros(10,1)];%applyingfilterforsignal2 dz2=z.*f2;
d2=ifft(dz2);
title('recovered signal 1');xlabel('time');ylabel('amplitude');
subplot(2,1,2)
plot(t*100,d2);
title('recoveredsignal2');xlabel('time');ylabel('amplitude');
```

PROCEDURE:

FDMMultiplexing:

1. Connectthecircuitasshowninthefigure.

2. SwitchONthepowersupply.

3. Set the amplitude of each modulating signal as 5Vp-p and frequencyof each AF signal to 1kHz and 2kHz respectively.

4. MonitortheoutputsatTp1(signal-1),Tp2(signal-2),Tp10(RF-16kHz),Tp12(RF-32KHz),Tpq(modulation-1),Tp11(Modulator-2),Tp17(BPF & adder)

5. Setoutput frequencyofRFoscillatorto455kHz and amplitudeto10Vp-p.

6. MonitortheoutputatTp18theFDMDSB-SCwavewill beobserved.

FDMDeMultiplexing&LPF:

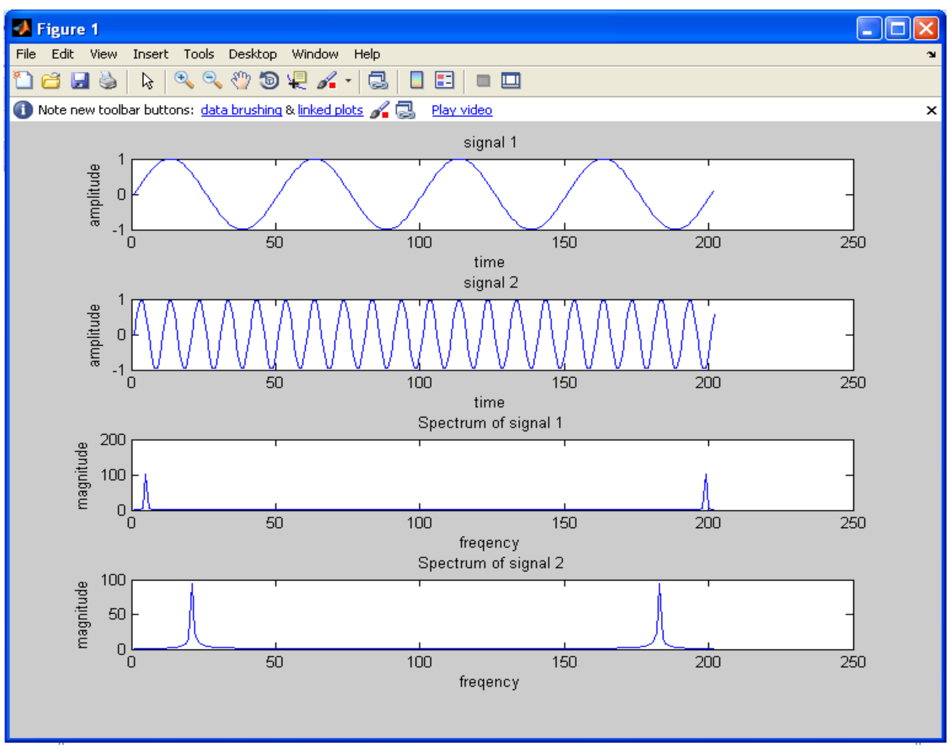
1. ConnecttheTp18toTp22 andobserve theoutputofmain demodulatorat Tp23.

2. ConnectthemaindemodulatoroutputtotheBPF1(28-32kHz)andBPF1(12-16 kHz).

3. ConnecttheoutputofBPF,stotherespectivedemodulator andthentoLPF,s.

4. MonitorthedemodulatedsignaI1andatTP32anddemodulatedsignal2atTP39.

EXPECTEDWAVEFORMS:



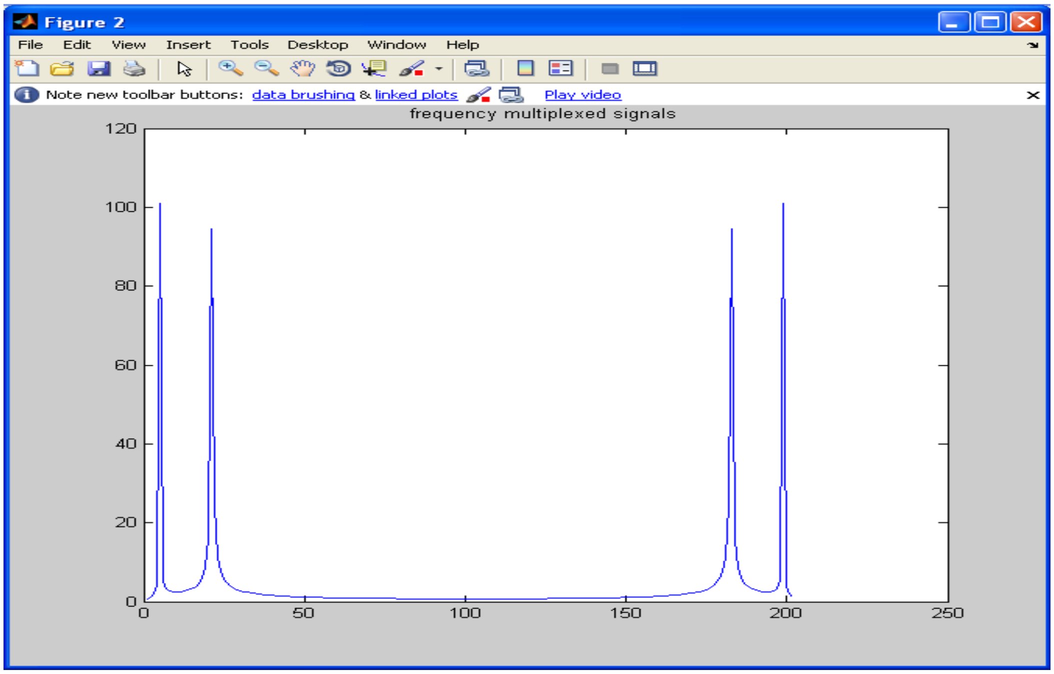


Figure 2
File Edit View Insert Tools Desktop Window Help
Note new toolbar buttons: data brushing & linked plots Play video
frequency multiplexed signals
120
100
80
60
40
20
0
0
50
100
150
200
250

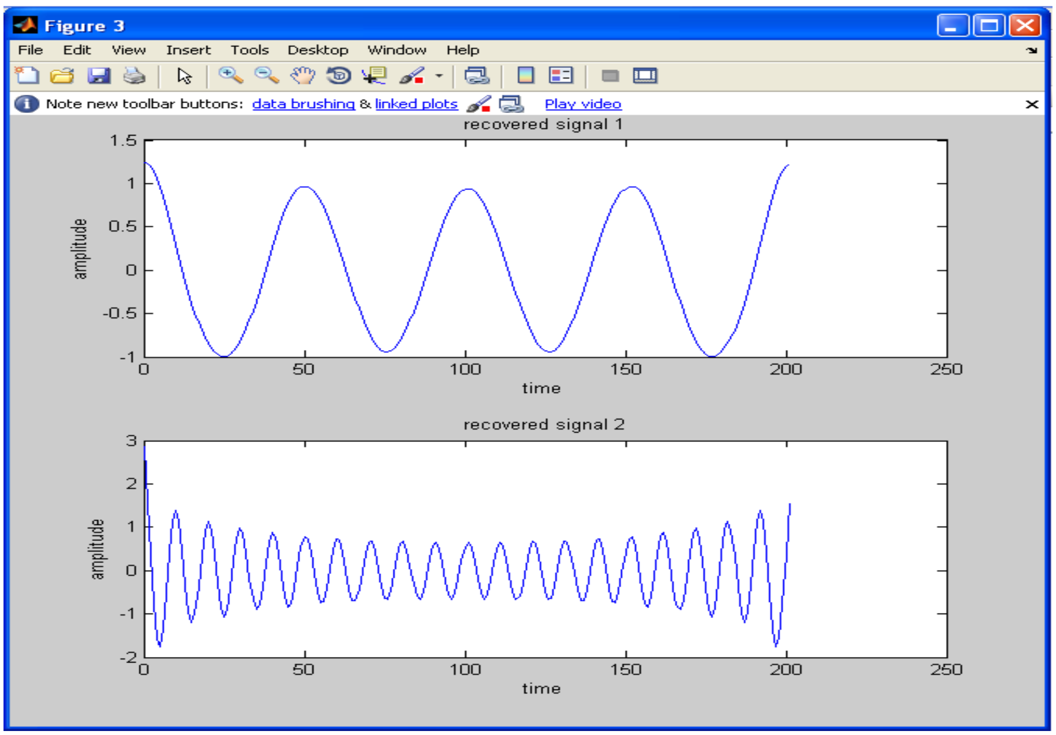


Figure 3
File Edit View Insert Tools Desktop Window Help
Note new toolbar buttons: data brushing & linked plots Play video
recovered signal 1
amplitude
time
recovered signal 2
amplitude
time

RESULT:

EXPERIMENTNO-6 DATE:

PULSEAMPLITUDEMODULATION

AIM:- 1.TostudythePulseamplitudemodulation&demodulationTechniques.

2. To studythe effect of amplitude and frequency variation of modulating signal on the output.

APPARATUS:-

1. Pulseamplitudemodulation&demodulationTrainerKit.
2. Dualtrace CRO.
3. Patchchords.
4. PCwith windows(95/98/XP/NT/2000)
5. MATLABSoftwarewithcommunicationtoolbox

THEORY:-

Pulse modulation is used to transmit analog information. In this system continuous wave forms are sampled at regular intervals. Information regarding the signal is transmitted only at the sampling times together with syncing signals.

At the receiving end, the original waveforms may be reconstituted from the information regarding the samples.

Thepulseamplitudemodulation is thesimplest form ofthepulsemodulation. PAMis a pulse modulation system is which the signal is sampled at regularintervals, and each sample is made proportional to the amplitude of the signal at the instant of sampling. The pulses are then sent byeither wire or cables are used to modulated carrier.

The two types of PAM are i) Double polarity PAM, andii) the single polarity PAM, in which a fixed dc level is added to the signal to ensure that the pulses are always positive. Instantaneous PAM sampling occurs if the pulses used in the modulator are infinitely short.

NaturalPAMsamplingoccurswhenfinite-widthpulsesareusedinthemodulator,but the tops of the pulses are forced to follow the modulating waveform.

Flat-topped sampling is a system quite often used because of the ease ofgenerating the modulated wave.

PAM signals are very rarely used for transmission purposes directly. The reason for this lies inthe fact that the modulatinginformation is contained in the amplitude factor of the pulses, which can be easilydistorted during transmission by noise, crosstalk,other forms of distortion. Theyare used frequently as an intermediate step in other pulse-modulating methods, especially where time-division multiplexing is used.

Circuitdescription:-

PulseandModulationSignalGenerator:-

A 4.096 MHz clock is used to derive the modulating signal, which is generated by an oscillator circuit comprising a 4.096MHz crystal and three 74HC04(U9) inverter gates. This 4.096MHz clock is then divided down in frequency by a factor of 4096, by binary counter 74HC4040(U10), to produce 50% duty cycle, 1 KHz square wave on pin no.1 of U10, and 2KHz square wave on pin no.15. the frequency is selectable by means of SW1. this goes to input of fourth order low pass filter U11(TL072) is used to produce sine wavefrom the square wave. The amplitude of this sine wave can be varied.

The square wave which is generated by the oscillator is buffered by inverter 74HC04(U9), to produce 32KHz square wave at pin no.4 of the 74HC4040(U10). This pulse is given to the monostable multi to obtain the 16 KHz and 32 KHz square wave at the output which are selected by the frequency pot.

Modulation:-

The ICDG211 (U3) is used as a pulse amplitude modulation in this circuit. The modulation signal & pulse signals are given to TL074 (U2) & 7400(U1) IC's respectively. These outputs are fed to the inputs the D4211 (U3).

The sampled output is available at the pin no 2 of DG211 and it is buffered by using TL074 (U2) and then output is available at TP5.

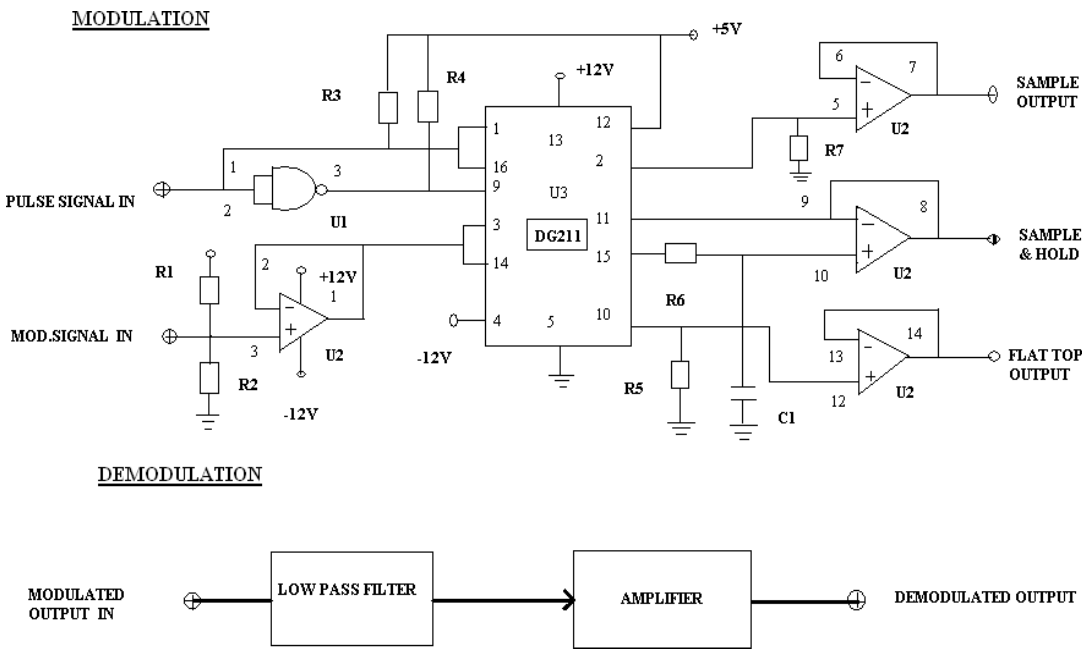
Similarly the sample & hold output and the flat top output are available at pin no.15 &10 of DG211 respectively. These are buffered by TL074 (U2) and then outputis available at TP6&TP7 respectively.

Demodulation:-

The demodulation section comprises of fourth order low pass filter and an AC amplifier. The TL074 (U5) is used as a low pass filter and AC amplifier. The output of the modulator is given as the input to the low pass filter.

The low pass filter output is obviously less and it is fed to the AC amplifier which comprises of a single op amp and whose output is amplified.

CIRCUITDIAGRAM:



PROGRAM:-

```
%pulseamplitudemodulation
close all
clearall
clc
t = 0 : 1/1e3 : 10;        %1kHzsamplefreqfor1sec d =
0 : 1/5 : 10;
x = 5+sin(2*pi/4*2*t);       %messagesignal
figure;
subplot(3,1,1)
plot(x);
title('message');
xlabel('time');ylabel('amplitude');
y=pulstran(t,d,'rectpuls',0.1);%generationofpulseinput
subplot(3,1,2)
plot(y);
```

```
title('Pulse Input ');
xlabel('time');ylabel('amplitude');
z=x.*y;                %PAMoutput
subplot(3,1,3)
plot(z);
title('PAM modulation ');
xlabel('time');ylabel('amplitude');
```

PROCEDURE:

DoublePolarity:-

Modulation:-

1. Connectthecircuitasshownindiagram1.
   a. The output of the modulating signal generator is connected to the modulating signal input TP2 keeping the frequency switch in 1KHz position, and amplitude knob to max position
   b. 16KHz pulse output to pulse input TP1.(Keep the frequencyin minimum position in pulse generator block).
2. SwitchONthepowersupply.
3. Monitortheoutputs at TP5, TP6&TP7.And observe the outputs also by varying amplitude pot (Which is in modulation signal generator block).
4. Now varythe frequency selectionwhichposition in modulating signal generator block to 2 KHz, amplitude pot to max position.
5. Observetheoutput at TP5, TP6&TP7 andobservethe outputsalso byvarying amplitude pot (Which is in modulation signal generator block).
6. Repeat allthe above steps forthe pulse frequency 32KHz (Byvarying the frequencypot in the pulse generator block).
7. SwitchOFFthepower supply.

SinglePolarity PAM:-

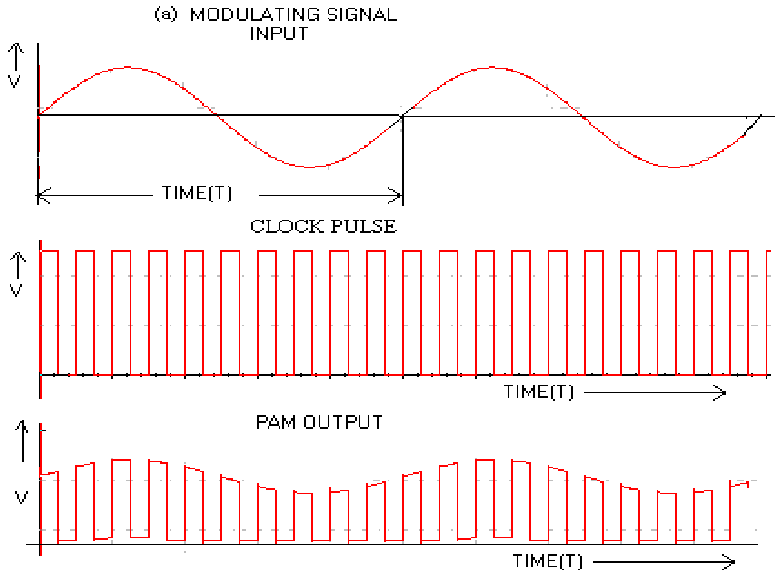
8. Connectthecircuitasshownindiagram2.
   a. The output of the modulating signal generator is connected to the modulating signal input TP2 keeping the frequency switch in 1KHz position, and amplitude knob to max position
   b. 16KHzpulseoutputtopulseinputTP1.

9. SwitchONthepowersupply.
10. Repeatabovestep 3to6andobservetheoutputs.
11. VaryDCoutput pot untilyougetsingle polarityPAMatTP5,TP6,TP7.
12. SwitchOFFthepower supply.

Demodulation:-

1. Connectthecircuitasshownindiagram3.
   a. The output of the modulating signal generator is connected to the modulating signal input TP2 keeping the frequency switch in 1KHz position, and amplitude knob to max position
   b. 16KHzpulseoutputtopulseinputTP1.
   c. Sampleoutput,sampleandholdoutputandflattopoutputs Respectively to the input of low pass filter(TP9) and LPF output (TP10)to AC amplifier input(TP11).
2. Observe the output of LPF and AC amplifier at TP10,TP12 respectively, corresponding to inputs from TP5,TP6 &TP7. The outputs will be the true replica of the input.
3. Now, set the switch position in modulating signal generator to 2KHz and observe the outputs at TP10&TP12 respectively, corresponding toinputs from TP5,TP6&TP7.
4. Vary the frequency of pulse to 32KHz (By varying the frequency pot(Put in maxposition) in pulse generator block) and repeat the above steps 2&3.
5. SwitchOFFthepowersupply.

EXPECTEDWAVEFORMS



RESULT:

QUESTIONS

1. TDMispossibleforsampledsignals. Whatkindofmultiplexingcanbeusedin continuous modulation systems?
2. Whatistheminimumrateatwhichaspeechsignalcanbesampledforthepurposeof PAM?
3. What iscrosstalkinthecontext oftimedivisionmultiplexing?
4. Whichisbetter,naturalsamplingorflattoppedsamplingand why?
5. Why a dc offsethasbeen added tothemodulatingsignal in thisboard?Wasitessential for the working of the modulator? Explain?
6. If the emitterfollowerinthemodulatorsection saturatesfor somelevel of inputsignal, then what effect it will have on the output?
7. DerivethemathematicalexpressionforfrequencyspectrumofPAMsignal.
8. Explainthemodulationcircuitoperation?
9. Explainthedemodulationcircuitoperation?
10. IsPAM&DemodulationissensitivetoNoise?

EXPERIMENTNO-7

DATE:

PULSEWIDTHMODULATION&DEMODULATION

AIM:

1. TostudythePulse WidthModulation(PWM)and Demodulation Techniques.
2. Tostudytheeffect ofAmplitudeand FrequencyofModulatingSignalon PWM output.

APPARATUS:

1. PWMtrainerkit
2. C.R.O(30MHz)
3. PatchChords.
4. PCwith windows(95/98/XP/NT/2000)
5. MATLABSoftwarewithcommunicationtoolbox

THEORY:-

Pulse modulation is used to transmit analog information. In this system continuous wave forms are sampled at regular intervals. Information regarding the signal is transmitted only at the sampling times together with synchronizing signals.

At the receiving end, the original waveforms may be reconstituted from the information regarding the samples.

The pulse Width Modulation of the PTM is also called as the Pulse Duration Modulation (PDM) & less often Pulse length Modulation (PLM).

InpulseWidthModulationmethod,wehavefixedandstartingtimeofeachpulse,but the width of each pulse is made proportional to the amplitude of the signal at that instant.

This method converts amplitude varying message signal into a square wave with constant amplitude and frequency, but which changes duty cycle to correspondtothe strength of the message signal.

Pulse-Width modulationhas the disadvantage, that its pulses areof varying width and therefore of varying power content. This means that the transmitter must be powerful enough to handle the maximum-width pulses. But PWM still works if synchronization between transmitter and receiver fails, whereas pulse-position modulation does not.

Pulse-Width modulation may be generated by applying trigger pulses to control the starting time of pulses from a mono stable multivibrator, and feeding in the signal to be sampled to control the duration of these pulses.

When the PWM signals arrive at its destination, the recovery circuit used to decode the original signal is a sample integrator (LPF).

CIRCUITDESCRIPTION:-

Pulse&ModulatingSignalGenerator:-

A 4.096MHz clock is used to derive the modulating signal, which is generated by an oscillator circuit comprising a 4.096MHz crystal and three 74HC04(U9) inverter gates. This 4.096MHz clock is then divided down in frequency by a factor of 4096, by binary counter 74HC4040(U2),toproduce50%dutycycle,1KHzsquarewaveon pinno.1ofU4, and2KHz squarewave onpin no.15.thefrequencyisselectablebymeansofSW1.Thisgoestoinputof fourth order low pass filter U3 is used to produce sine wave from the square wave. The amplitude of this sine wave can be varied.

The square wave which is generated bythe oscillator is buffered byinverter 74HC04, to produce 32KHz square wave at pin no.4 of the 74HC4040(U2). This pulse is given to the monostable multi to obtain the 16KHz and 32KHz square wave at the output which are selected by the frequency pot.

Modulation:-

The PWM circuit uses the 555 IC (U1) in monostable mode. The Modulating signal input is applied to pin no.5 of 555IC, and there Pulse input is applied to pin no.2.

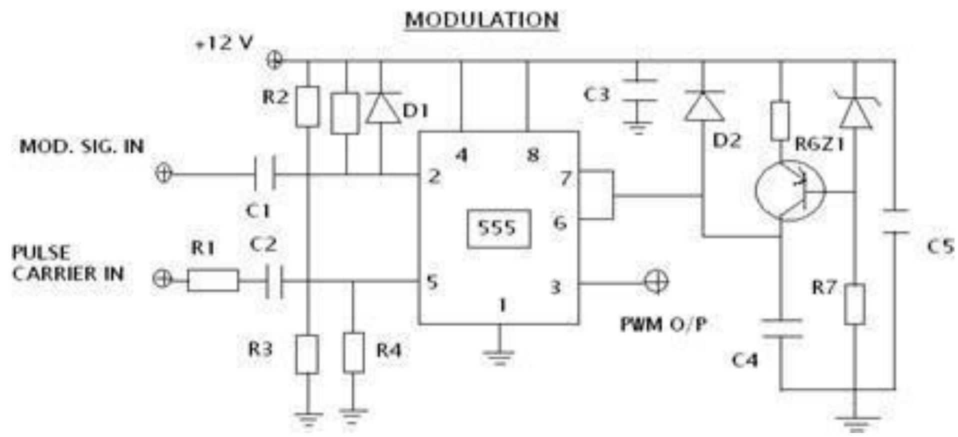
TheoutputofPWMis takenatthe pinno.3of555IC i.e.,TP3.

Demodulation:-

The demodulation section comprises of a fourth order low pass filter and an AC amplifier. The TL074(U5) is used as a low pass filter and an AC amplifier. The output of the modulator is given as the input to the low pass filter.

The low pass filter output is obviously less and it is feed to the AC amplifier which comprises of a single op amp and whose output is amplified.

CIRCUITDIAGRAM:



PROGRAM:-

```
%pulsewidthmodulation&demodulation
close all
clear all
clc
fc=1000;
fs=10000;
f1=200;
t=0:1/fs:((2/f1)-(1/fs));
x1=0.4*cos(2*pi*f1*t)+0.5;
%modulation
y1=modulate(x1,fc,fs,'pwm');
subplot(311);
plot(x1);axis([0
5001]);
title('originalsignaltakenmesage,f1=500,fs=10000')
subplot(312);
plot(y1);
axis([0 500 -0.21.2]);
title('PWM')
 %demodulation
```

```
x1_recov=demod(y1,fc,fs,'pwm');
subplot(313);
plot(x1_recov);
title('timedomainrecovered,singletone,f1=200')
axis([0 50 0 1]);
```

PROCEDURE:

Modulation:-

1. Connectthecircuitasshowninthediagram1.
   a. The output of the modulating signal generator is connected to the modulating signal input TP2 keeping the frequency switch in 1KHz position, and amplitude knob to max position
   b. 16KHz pulse output (by varying the frequency pot (put it min position) in pulse generator block) from pulse generator to pulse input(TP1).
2. SwitchONthepowersupply.
3. ObservetheoutputofpulsewidthmodulationblockatTP3.(Byvaryingtheamplitude pot).
4. Vary the modulating signal generator frequency by switching the frequency selector switch to 2 KHz.
5. Now,againobservethe PWMoutputat TP3.(Byvaryingtheamplitude pot).
6. Repeat the above steps (3 to 5) for the pulse frequency of 32KHz(by varying the frequency pot(put it in max position) in pulse generator block).
7. SwitchOFFthepowersupply.

Demodulation:-

8. Connectthecircuitasshownindiagram2.
   a. Theoutputofthemodulatingsignal generatorisconnectedtothemodulatingsignal input TP2 keeping the frequency switch in 1KHz position, and amplitude knob to max position.
   b. 16KHz pulse output (put frequency pot minimum) from pulse generator block to pulse input TP1.
   c. PWMoutputtoLPFinput.
   d. LPFoutputtoACamplifierinput.
9. SwitchONthepowersupply.

10. Observe the outputof low pass filter andAC amplifierrespectively atTP6 & TP8. The output will be the true replica of the input.
11. Nowvarythepositionoftheswitchinmodulatingsignalgeneratorto2KHzand observe the outputs at TP6 & TP8.
12. Repeat the steps 10& 11 for pulse frequency 32 KHz (By varying the frequencypot (put in max). in pulse generator block). Observe the output waveforms.
13. SwitchOFFthepower supply.

EXPECTEDWAVEFORMS

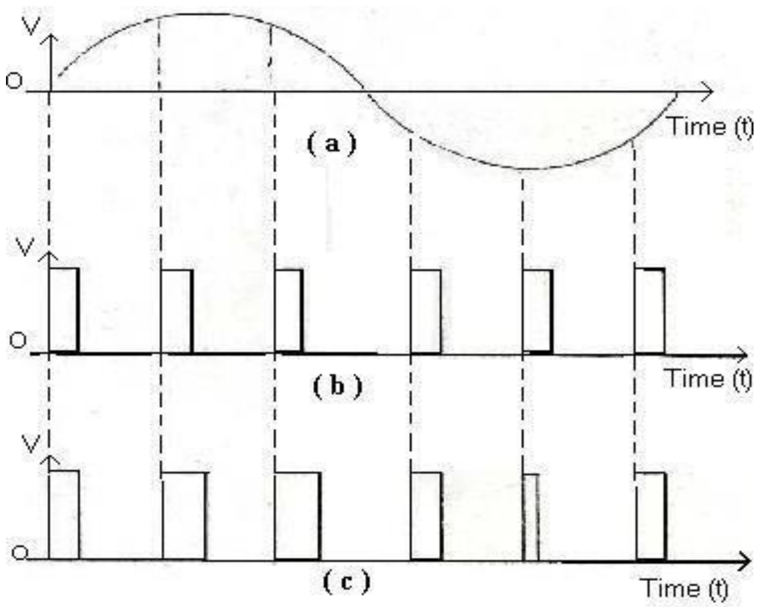


Fig (2) PULSE WIDTH MODULATION
(a) Signal
(b) Unmodulated pulses
(c) PWM

RESULT:

QUESTIONS

1. An audio signal consists of frequencies in the range of 100Hz to 5.5KHz.What is the minimum frequency at which it should be sampled in order to transmit it through pulse modulation?
2. DrawaTDMsignalwhichishandlingthreedifferentsignalsusingPWM?
3. What doyouinferfromthefrequencyspectrumofaPWM signal?
4. Clock frequency in a PWM system is 2.5 kHz and modulating signal frequency is 500Hzhowmanypulses per cycle of signal occur in PWM output? Draw the PWM signal?
5. WhyshouldthecurveforpulsewidthVsmodulatingvoltagebelinear?
6. Whatistheothername forPWM?
7. WhatisthedisadvantageofPWM?
8. WillPWMworkifthesynchronizationbetweenTxandRxfails?
9. WhyintegratorisrequiredindemodulationofPWM?
10. Whatkind ofconversion is doneinPWM generation?

EXPERIMENTNO-8 DATE:

PULSEPOSITIONMODULATIONANDDEMODULATION

AIM:

1. TostudythegenerationPulsePositionModulation(PPM) andDemodulation.
2. Tostudy theeffectof Amplitudeandthefrequency of modulatingsignalonits output and observe the wave forms.

APPARATUS:

1. PulsePositionModulation(PPM)anddemodulationTrainerKit.
2. C.R.O(30MHz)
3. Patchchords.
4. PCwith windows(95/98/XP/NT/2000)
5. MATLABSoftwarewithcommunicationtoolbox

THEORY:-

Pulse Modulation is used to transmit analog information in this system continuous wave forms are sampled at regular intervals. Information regarding the signal is transmitted only at the sampling times together with synchronizing signals.

At the receiving end, the original waveforms may be reconstituted from the information regarding the samples. Pulse modulation may be subdivided in to two types analog and digital. In analog the indication of sample amplitude is the nearest variable. In digital the information is a code.

The pulse position modulation is one of the methods of the pulse time modulation.PPM is generated bychanging the position of a fixed time slot.

The amplitude&width of the pulses iskept constant, while the positionofeach pulse, in relation to the position of the recurrent reference pulse is valid by each instances sampled value of the modulating wave. Pulse position modulation into the category of analog communication. Pulse-Position modulation has the advantage of requiring constant transmitter power output, but the disadvantage of depending on transmitter receiver synchronization.

Pulse-position modulation may be obtained very simply from PWM. However, in PWMthelocationsoftheleadingedgesarefixed,whereasthoseofthetrailingedges arenot. Theirpositiondependsonpulsewidth,whichisdeterminedbythesignalamplitudeatthat instant. Thus, it may be said that the trailing edges of PWM pulses are, in fact, position-modulated. This has positive-going narrow pulses corresponding to leading edges and negative-going pulses corresponding to trailing edges. If the position corresponding to the trailingedgeofan un modulated pulseis counted as zerodisplacement, then theothertrailing edges will arrive earlier or later. They willtherefore have a time displacement other than zero; this time displacement is proportional to the instantaneous value of the signal voltage. The differentiated pulses corresponding to theleading edges are removed with adiode clipper or rectifier, and the remaining pulses, is position-modulated.

CircuitDescription:-

ModulatingSignalGenerator:-

A 4.096 MHz clock is used to derive the modulating signal, which is generated by an oscillator circuitcomparing a 4.096MHz crystal and three 74HC04(U9) inverter gates. This 4.096 MHz clock is then divided down in frequency by a factor of 4096, by binary counter 74HC4040(U4), to produce 50% duty cycle, 1 KHz square wave on pin no.1 of U4, and 2 KHz square wave on pin no.15. The frequency is selectable by means of SW1. This goes to inputoffourthorderlow passfilterU3(TL072)is usedtoproducesinewavefrom thesquare wave. The amplitude of this sine wave can be varied.

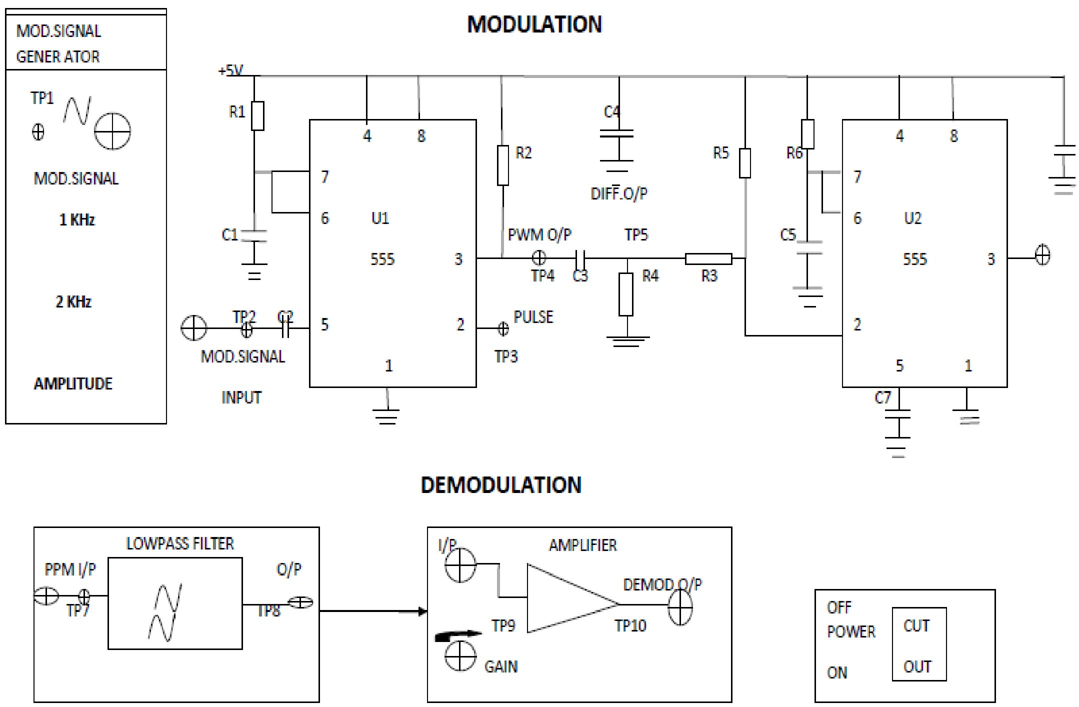
Modulation:-

The circuit uses the IC 555(U1) a Mono stable Multivibrator to perform the pulse position Modulation action.

The Modulating signal is given to Pin No. 5 at Pin No.2 the pulse is 32 KHz which is connected internally.

The PWM is available at TP2; this PWM output is differentiated by using differentiated circuit. This differentiated output is available at TP8. This differentiated output is fed tothe 555 IC(U2) (Mono stable Mode)Pin No.2. The PPMoutput isavailable at TP3.

CIRCUITDIAGRAM:



PROGRAM:-

```
%pulsepositionmodulation
close all
clear all
clc
fc=100;
fs=1000;
f1=80;
t=0:1/fs:((2/f1)-(1/fs));
x1=0.4*cos(2*pi*f1*t)+0.5;
%modulation
y1=modulate(x1,fc,fs,'ppm');
subplot(311);
plot(x1);axis([0
1501]);
```

```
title('original signal taken mesage,f1=80,fs=1000')
subplot(312);
plot(y1);
axis([0250-0.21.2]);
title('PPM')
 %demodulation
x1_recov=demod(y1,fc,fs,'ppm');
subplot(313);
plot(x1_recov);
title('timedomainrecovered,singletone,f1=80')
axis([0 15 0 1]);
```

PROCEDURE:

Modulation:

1. Connectthecircuitasshownindiagram1.
   a. Connectthemodulatingsignalgeneratoroutputtomodulatingsignalinput (TP1) in PPM block.
   b. Keeptheswitch in1KHzpositionand amplitudepotinmaxposition.
2. SwitchONthepowersupply
3. ObservethePWMoutputatTP2, andthedifferentiatedoutputsignalatTP8.
4. Now,monitorthePPMoutputat TP3.
5. Tryvaryingtheamplitudeandfrequencyofsinewavebyvarying amplitude pot.
6. RepeatStep5forfrequencyof2KHzand observethe PPMoutput.
7. SwitchOFFthepowersupply.

Demodulation:-

8. Connectthecircuitasshownindiagram2.
   a. Connectthemodulatingsignalgeneratoroutputtomodulatingsignalinput (TP1) in PPM block.
   b. Keeptheswitchin1KHzpositionandamplitudepotinmaxposition.
   c. Connectthe PPMoutput(TP3)toinput ofLPF(TP4).
9. SwitchONthepowersupply
10. Observethedemodulated signalattheoutputofLPFatTP5.
11. Thustherecoveredsignalistruereplicaoftheinputsignal

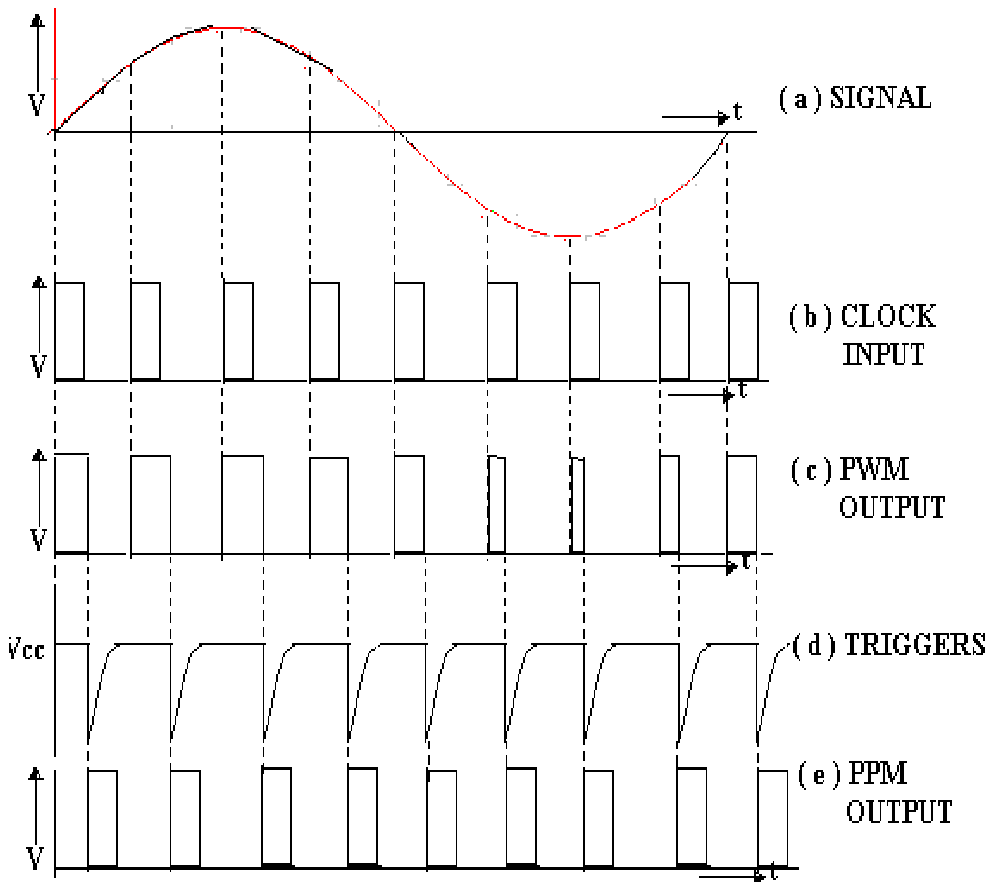
12. a. As the output ofLPF has less amplitude, connect the output ofLPFto the input of an AC amplifier (TP5 to TP6).

b.Observethedemodulatedoutputontheoscilloscopeat TP7 and also observetheamplitudeofdemodulatedsignalbyvaryinggainpot.Thisisamplitude demodulated output.

13. Repeatthesteps(7to9)forthemodulating signal forfrequency2KHz.

14. SwitchOFFthepowersupply.

EXPECTEDWAVEFORMS:



RESULT:

QUESTIONS:

1. WhatistheadvantageofPPMoverPWM?
2. Isthesynchronization ismustbetweenTxandRx
3. ShiftinthepositionofeachpulseofPPMdependsonwhat?
4. CanwegeneratePWM fromPPM?
5. Whydowe need 555timers?
6. DoesPPMcontainderivativeofmodulatingsignalcomparedto PWM?
7. Forabovescheme,dowehavetouseLPFandintegrator inthat order?
8. IfweconvertPPMtoPWM&thendetectthemessagesignal,willtheo/phasless distortion?
9. IssynchronizationcriticalinPPM?
10. HowrobustisthePPMtonoise?

DIGITALCOMMUNICATION EXPERIMENTS

EXPERIMENTNO-1

PULSECODEMODULATION&DEMODULATION

Aim: Toconvertananalogsignalintoapulsedigitalsignalusing PCMsystemandto convert the digital signal into analog signal using PCM demodulation system.

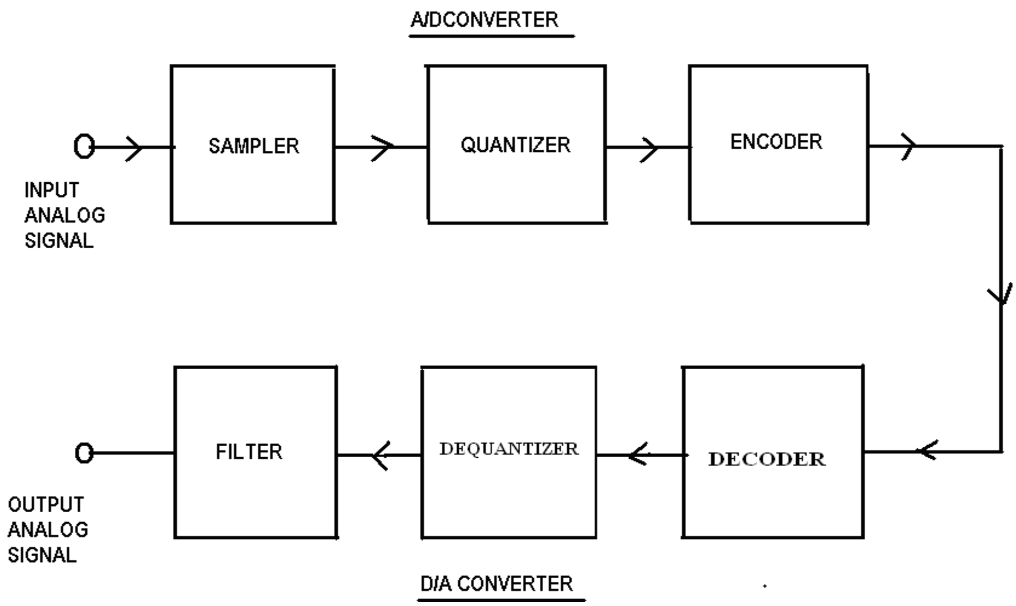
Apparatu:
1. PCMtransmittertrainer.
2. PCMreceivertrainer.
3. CROandconnecting wires.

Theory:

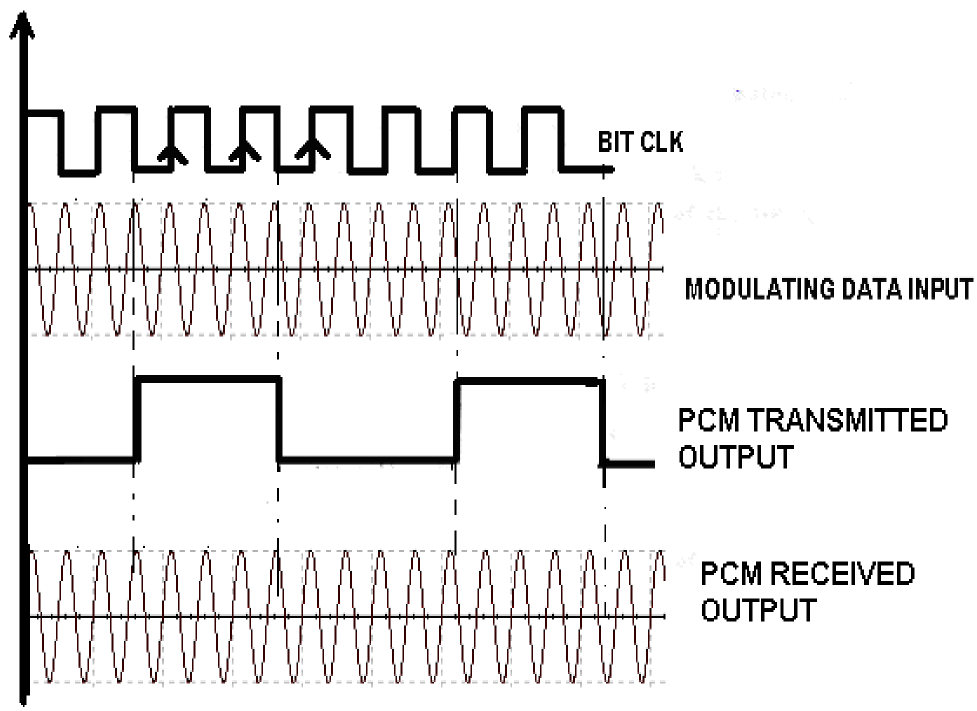
In the PCM communication system, the input analog signal is sampled and these samplesaresubjectedtotheoperationofquantization.Thequantizedsamplesareapplied to an encoder. The encoder responds to each such a sample by generation unique and identifiable binary pulse. The combination of quantize and encoder is called analog to digital converter. It accepts analog signal and replaces it with a successive code symbol, each symbol consists of a train of pulses in which the each pulse represents a digit in arithmetic system.

When this digitallyencoded signal arrives at the receiver, the first operation to be performed is separation of noise which has been added during transmission along the channel. It is possible because of quantization of the signal for each pulse interval; it has to determine which of many possible values has been received.

BlockDiagram:



OutputWaveform:



Procedure:

1. The two inputs of function generator are connected to channel -0 and channel-1 simultaneouslythat is DC_1 output to channel -0 and DC_2 to channel-1.
2. WiththehelpofoscillatorDC$_1$outputisadjustedto0volts.
3. Transmitter and receiver are connected by the synchronization of clock pulses and by connecting ground transmitter to groundreceiver.
4. The transmitter is connected to the input of receiver to go the original signal at the receiver output.
5. After connection is made the inputs channel 1 and channel 0 are noted. The sampled output of bit channels are taken by connecting DC_1output to channel 0 and DC_2 output to channel-1.
6. The phase shift of a channel can be obtained by comparing the input and output of channels at the transmitter block.
7. Thustheoutputoftransmittercanbenoteddownandinputofreceiverissimilarto that.
8. The receiver output signals are noted down at channel 0 and channel 1 of the receiver block.

Result:

Questions:

1. WhatistheexpressionfortransmissionbandwidthinaPCMsystem?
2. What istheexpressionforquantizationnoise/errorinPCMsystem?
3. Whataretheapplications ofPCM?
4. WhataretheadvantagesofthePCM?
5. WhatarethedisadvantagesofPCM?

EXPERIMENTNO-2

TIMEDIVISIONMULTIPLEXING&DEMULTIPLEXING

Aim:

Studyof4 ChannelAnalogMultiplexingandDemultiplexing Techniques.

Apparatus:

1. Timedivisionmultiplexing&demultiplexingtrainerkit.
2. CRO(30mhz)
3. Patchchords.

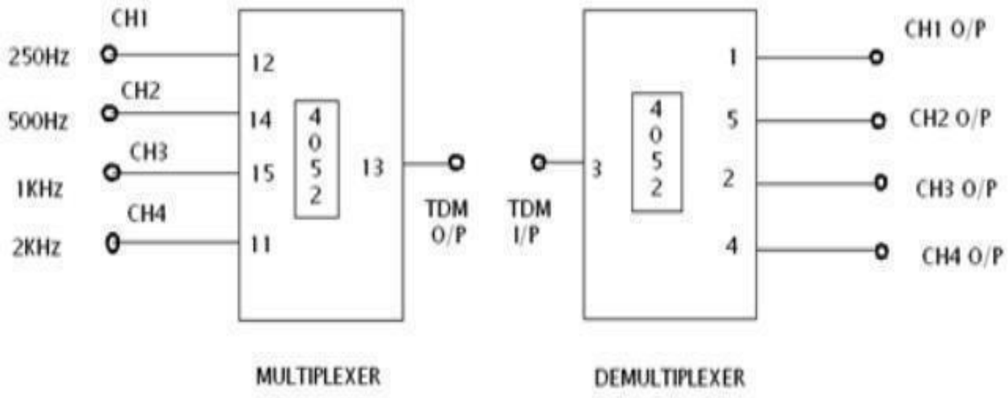
Theory:

The TDM is used for transmitting several analog message signals over a Communication channel by dividing the time frame into slots, one slot for each message signal. The four input signals, all band limited by the input filters are sequentially sampled, the output of which is a PAM waveform containing samples of the input signals periodically interlaced in time. The samples from adjacent input message channels are separated byTs/M, where M is the number of input channels. A set of M pulses consisting of one sample from each of the input M-input channels is called a frame.

At thereceiverthesamples from individual channels areseparatedbycarefully synchronizing and are critical part TDM. The samplesfrom each channel are filtered to reproduce the original message signal. There are two levels of synchronization. Frame synchronization is necessary to establish when each group of samples begins and word synchronization is necessary to properly separate the samples within each frame.

Besides the space diversity & frequency diversity there is a method of sending multiple analog signals on a channel using “TIME DIVISION MULTIPLEXING & DEMULTIPLEXING” Technique.

CIRCUIT DIAGRAM:



Procedure:

Multiplexing:

1. Connectthecircuitasshownindiagram.
2. SwitchONthepowersupply.
3. Settheamplitudeofeachmodulatingsignalas5vpeak-peak.
4. Monitortheoutputsattestpoints5,6,7,8.thesearenaturalsamplingPAMoutputs.
5. Observe the outputs varying the duty cycle pot(P5). The PAM outputs will varying with 10% to 50% dutycycle.
6. Tryvaryingtheamplitudeofmodulatingsignalcorrespondingeachchannelby using amplitude pots P1,P2,P3,P4. Observe the effect on all outputs.
7. Observe the TDM output at pin no.13 (at TP9) OF 4052. all the multiplexer channel are observed during the full period of the clock(1/32 KHz).

Demultiplexing&LowPassFilter:

1. Connectthecircuit asshownindiagram2.
2. Observethedemultiplexedoutputsattestpoints13,14,15,16respectively.
3. ObservebyvaryingthedutycyclepotP5andseetheeffectontheoutputs.
4. Observe the low pass filter outputs for each channel at test points 17,18,19,20 and at sockets channels CH1,CH2,CH3,CH4. These signals are true replica of the inputs. These signals have loweramplitude.

Expected Waveforms:

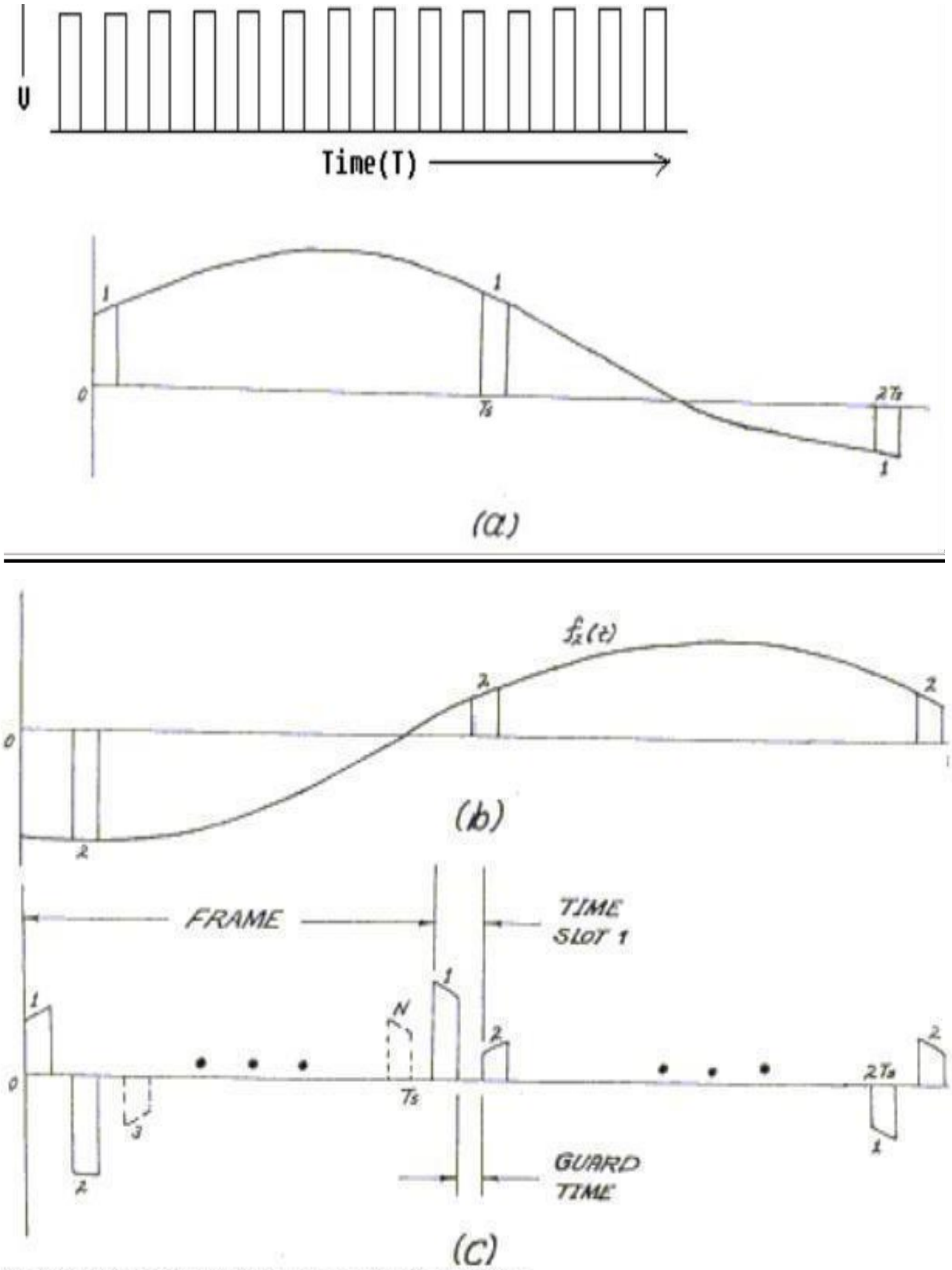


fig (2) TDM output should be natural sampling

Fig (a) message1 (b) message 2 and

Result:

Questions:

1. DrawtheTDMsignalwith2signalsbeing multiplexedoverthechannel?
2. Defineguardtime&frame time?
3. ExplainblockschematicofTDM?
4. HowTDMdifferfromFDM?
5. WhattypeoffilterisusedatreceiverendinTDMsystem?
6. WhataretheapplicationsofTDM?
7. If2signalband limitedto 3kHz,5KHz&areto betimedivisionmultiplexed. What is the maximum permissible interval between 2 successive samples.?
8. IsthebandwidthrequirementforTDM&FDMwillbesame?
9. IsTDMsystemisrelativelyimmunetointerferencewithinchannels(interchannel cross talk) as compared toFDM?
10. IstheFDMsusceptibletoharmonicdistortioncomparedtoTDM?
11. Inwhataspects,TDMissuperiortoFDM?

EXPERIMENTNO-3

DIFFERENTIALPULSECODEMODULATION

Aim:

Tostudythedifferentialpulsecodemodulationand demodulationbysending variablefrequencysinewaveandvariableDCsignaloutputs.

Apparatus:

1. DPCMTrainerkit
2. Patchcards
3. CRO-(0-20MHz)
4. ACAdapter(±8V)
5. CROProbes.

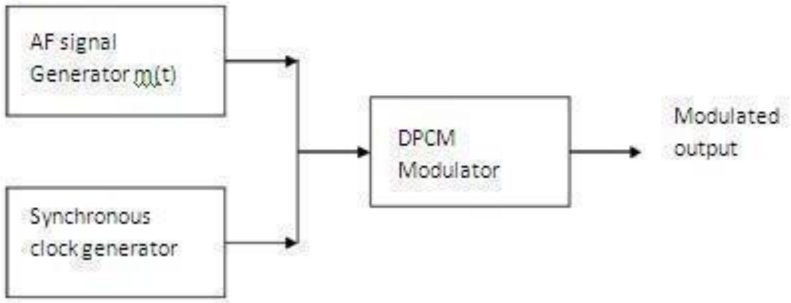
Theory:

In Differential Pulse Code Modulation (DPCM), instead of quantizing each sample, the difference between the two successive samples is quantized, encode, and transmitted as in the PCM. This particularly useful in the Voice communication, because in this case two successive samples do not differ much in amplitude.

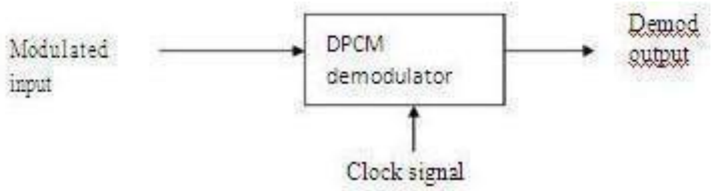
Thus, the difference signal is much less in amplitude than the actual sample and, hence, less number of quantization levels is needed. Therefore, the number ofbits per code is reduced, resulting in a reduced bit rate. Thus, the band width required in this case is less than the one required in PCM.

The disadvantage of DPCM is that the modulator and demodulator circuits are more complicated than those in PCM.

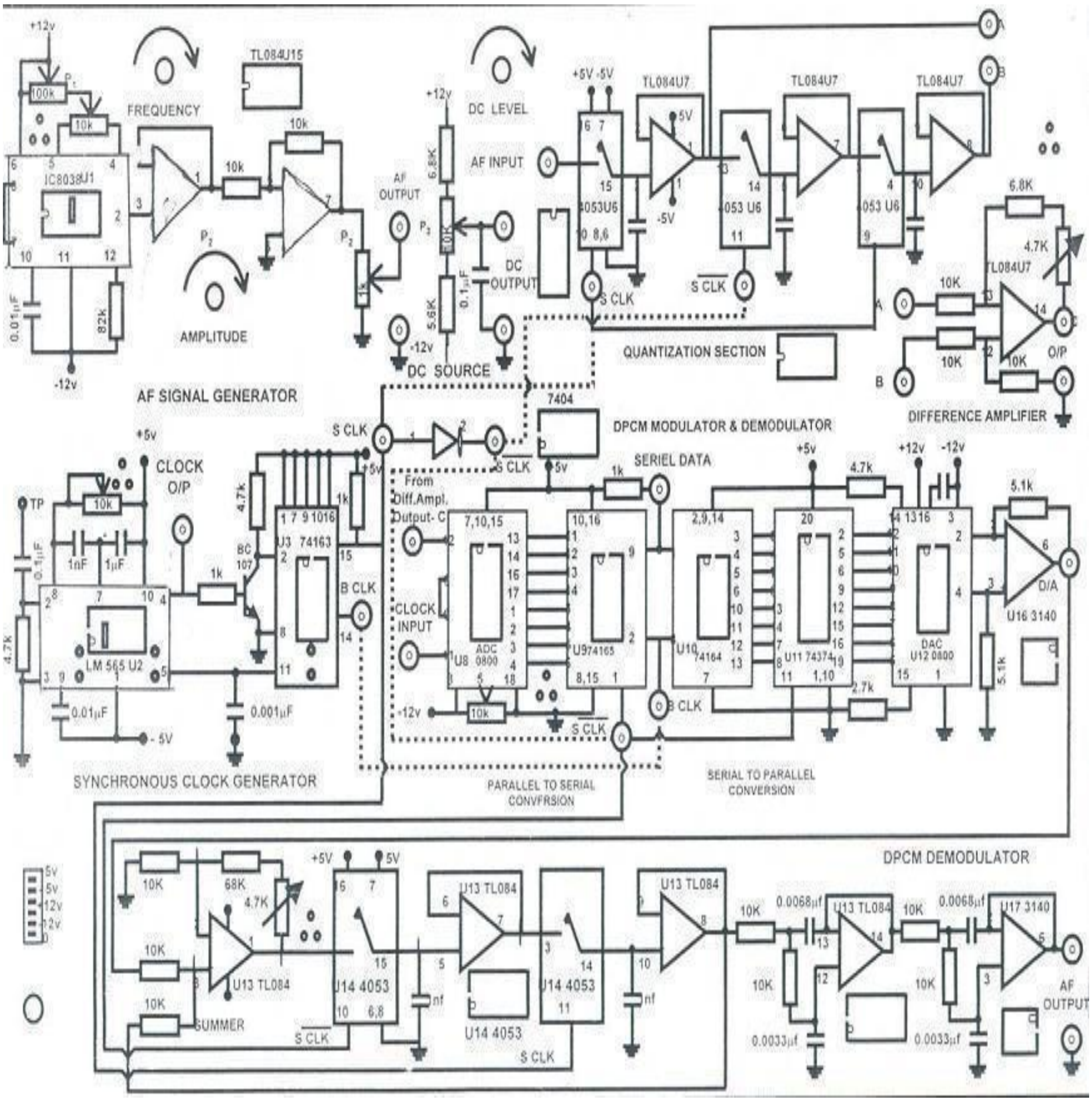
DPCMMODULATOR



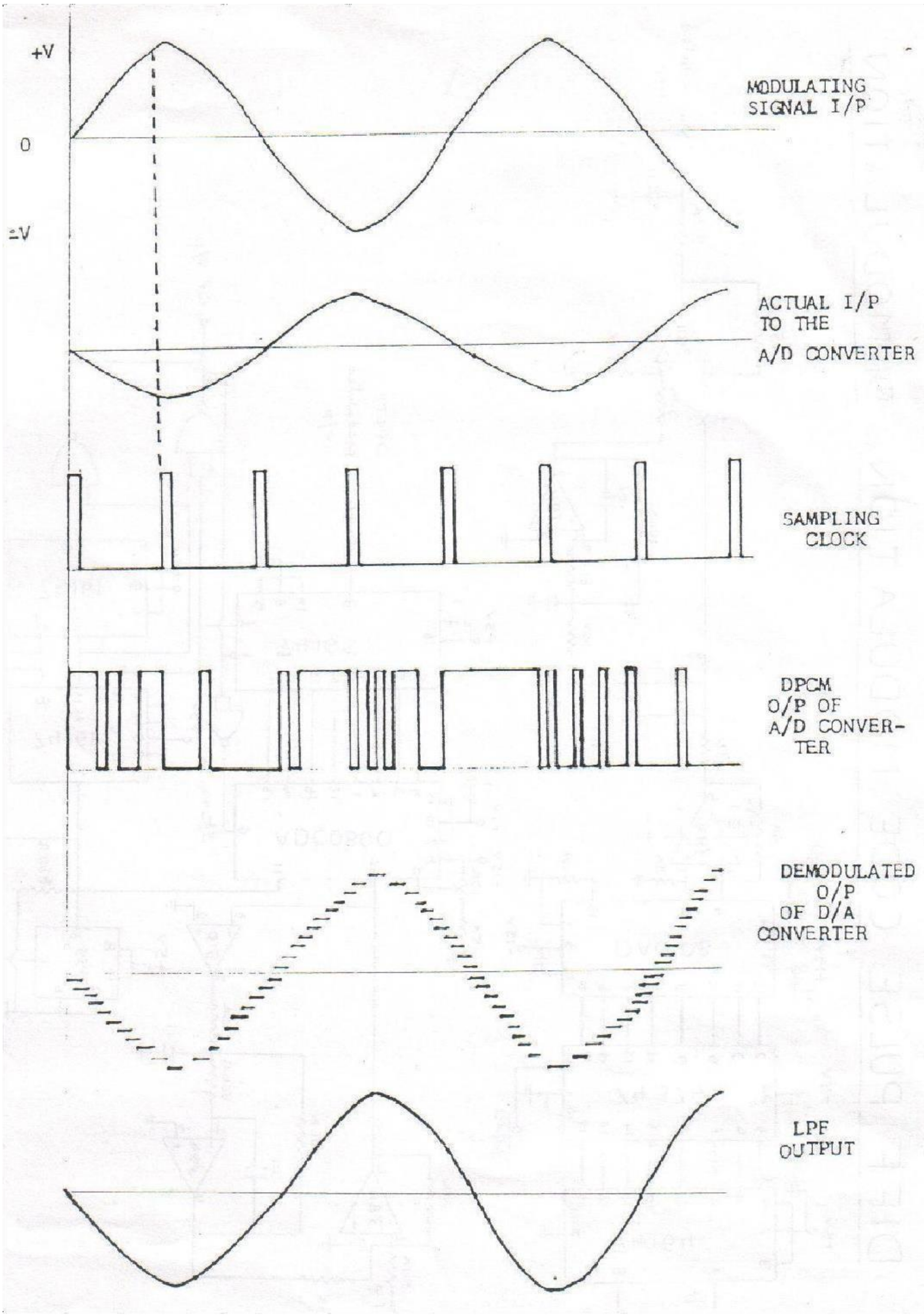
DPCMDEMODULATOR



CircuitDiagram:



ModelWaveforms:



Procedure:

1. SwitchontheKit.

2. ApplythevariableDCsignaltotheinputterminalsofDPCMmodulator.

3. ObservethesamplingsignaloutputonCRO

4. ObservetheoutputofDPCMonthesecondchannelofCRO.
h
5. Byadjusting theDCvoltagepotentiometerwecangettheDPCMoutputfrom 0000 0000to1111 1111.

6. Now,disconnecttheDCvoltageandapplyAFoscillatoroutputtothe inputofthe DPCM modulator

7. Observetheoutputofconditioningamplifier(differentialoutput)andDPCM outputs in synchronization with the sampling signal.

8. Duringdemodulation, connectDPCMoutputtotheInputofdemodulationand observe the output ofDemodulator

Observations:

1. mplitudeofAFsignal=----------------
2. FrequencyofAFsignal =---------------
3. AmplitudeofSynchronousclocksignal=---------------
4. FrequencyofSynchronousclocksignal=---------------
5. AmplitudeofDPCMModulatedsignal =---------------
6. FrequencyofDPCMModulatedsignal =---------------
7. Amplitudeofdemodulatedoutput =---------------
8. Frequencyofdemodulatedoutput =----------------

Result:

EXPERIMENTNO-4

DELTAMODULATION&DEMODULATION

Aim:

To study the Deltamodulation process by comparing the presentsignal withtheprevious signal of the given modulating signal.

Apparatus:

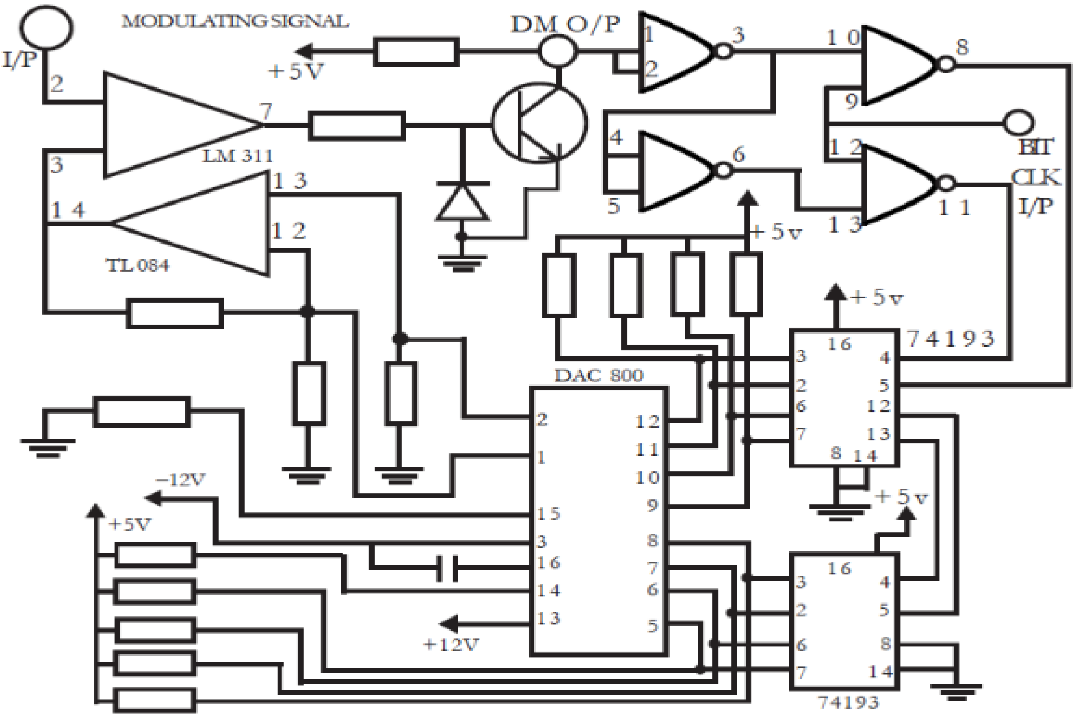
1. DeltaModulationtrainer
2. CRO
3. Connectingwires.

Theory:

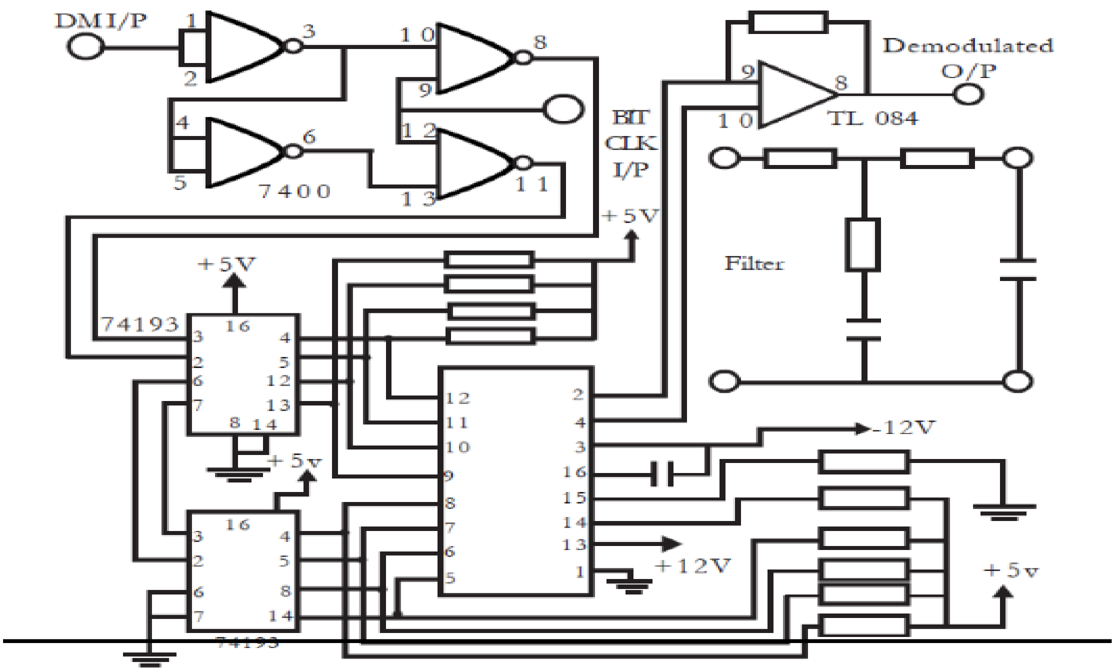
DM uses a single bit PCM code to achieve to achieve digital transmission of analog signal. With conventional PCM each code is binaryrepresentation of both sign and magnitude of a particular sample. With DM, rather than transmitting a coded representation of a sample a single bit is transmitted, which indicates whether the sample is smaller or larger than the previous sample.The algorithm for a delta modulation system is a simple one. If the current sample is smaller than the previous sample then logic 0 is transmitted or logic 1 is transmitted if the current sample is larger than the previous sample.The input analog is sampled and converted to a PAM signal followed bycomparing it with the output of the DAC.The output of the DAC is equal to the regenerated magnitude of the previous sample which was stored in the up/down counter as a binary number. The up/down counter is incremented or decremented whether the previous sample is larger or smaller than the current sample.The up/down counter is clocked at a rate equal to the sample rate. So, the up/down counter is updated after each comparison.

Circuit Diagram:-

<u>Modulator</u>:-



<u>Demodulator</u>:-



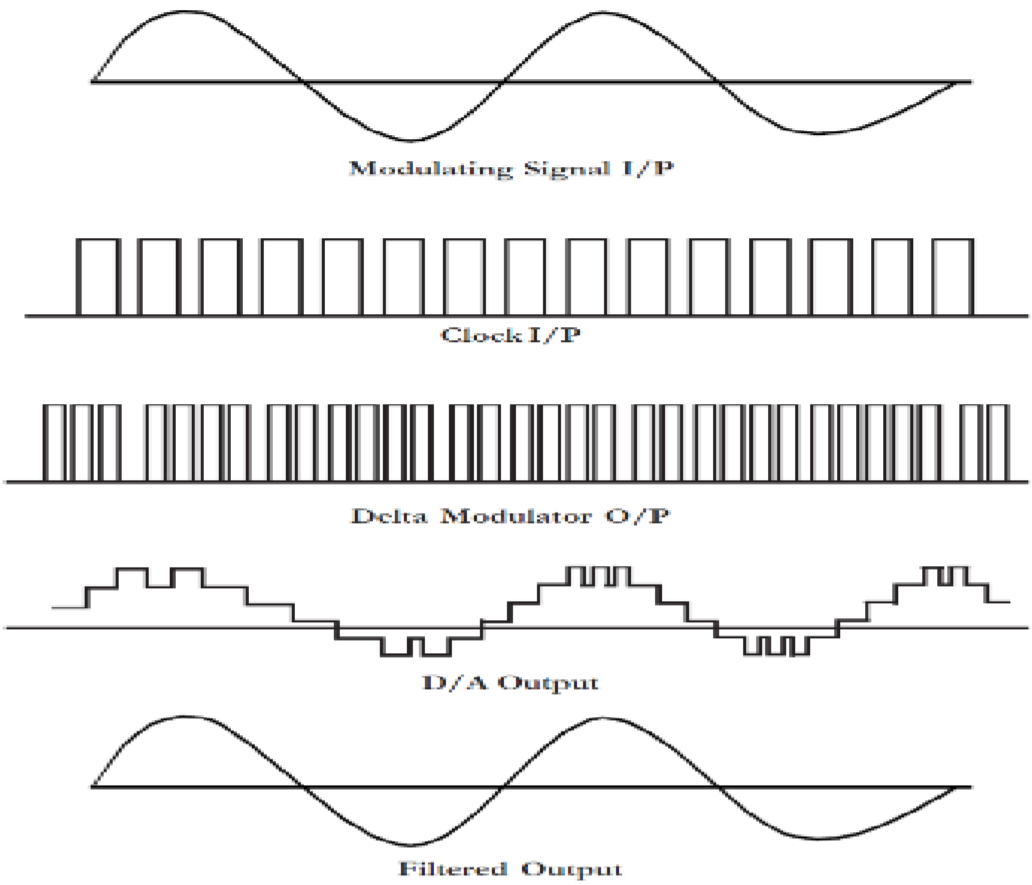
Procedure:

1. Switchontheexperimentalboard
2. ConnecttheclocksignalofBitclockgeneratortothebitclockinputof Deltamodulator circuit.
3. Connectmodulatingsignalofthemodulatingsignalgeneratortothe modulatingsignal input of the Delta modulator.
4. ObservethemodulatingsignalonChannel1ofCRO
5. Observethe Delta modulatoroutputonchannel2ofCRO
6. ConnecttheDMo/pofmodulatortothe DM I/PofDemodulatorcircuit.
7. ConnecttheclocksignaltotheBitclockI/PofDemodulatorcircuit.
8. Observethe demodulatedo/ponchannel2 ofCRO.

Connectthedemodulatedo/ptothefilterinputofdemodulatorcircuit.

9. Observethedemodulatedo/pwith filteronCRO.

ExpectedWaveforms:



Result:

Questions:

1. Whatis Delta

Modulation?

2. DifferentiateDMand

ADM.

3. What arethedrawbacksofDMandwhat is

theremedy?4.How DM differ from PCM?

5. Whatisslopeoverloaddistortion?

EXPERIMENTNO-5

ASKMODULATIONANDDEMODULATION

Tostudythe processofASKmodulation&demodulationandstudyvarious

Aim:

dataformatting modulationanddemodulationtechniques.

Apparatus:

1. ASKMODULATION&DEMODULATIONTrainerkit.
2. CRO30MHzDualChannel.
3. PatchChords.

Theory:

Modulation also allows different data streams to be transmitted over the same channel. This process is called as 'Multiplexing' & result in a considerable saving in bandwidth no of channels to be used. Also it increases the channel efficiency.

The variation of particular parameter variation of the carrier wave give rise to various modulation techniques. Some of the basic modulation techniquesaredescribed as under.

ASK:-

In this modulation involves the variation of the amplitude of the carrier waves in accordance with the data stream. The simplest method of modulating a carrier with a data stream is to change the amplitude of the carrier wave every time the data changes. This modulation technique is known as amplitude shiftkeying.

The simplest way of achieving amplitude shift keying is 'ON' the carrier whenever the data bit is 'HIGH' & switching 'OFF' when the data bit is low i.e. the transmitter outputs the carrier for HIGH & totally suppresses the carrier for low. This technique is known as ON-OFF keying Fig. illustrates the amplitude shift keying for the given data stream.

Thus,

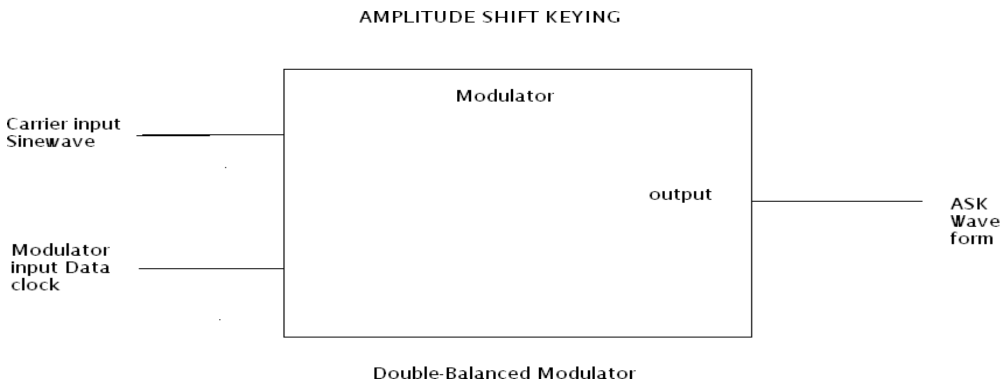
DATA =HIGH CARRIERTRANSMITTED

DATA = LOW CARRIER SUPPRESSED

The ASK waveform is generated by a balancedmodulator circuit,also known as a linear multiplier, As the name suggests, the device multiplies the instantaneous signal at its two inputs, the output voltage being product of the two input voltages at any instance of time. One of the input is a/c coupled 'carrier' wave of high frequency. Generallythecarrierwaveisasinewavesinceanyotherwaveformwouldincreasethe bandwidthimparting anyadvantagesrequirementwithoutimprovingorto it.The otheri/pwhichistheinformationsignaltobetransmitted,isD.C.coupled.Itis known as modulating signal.

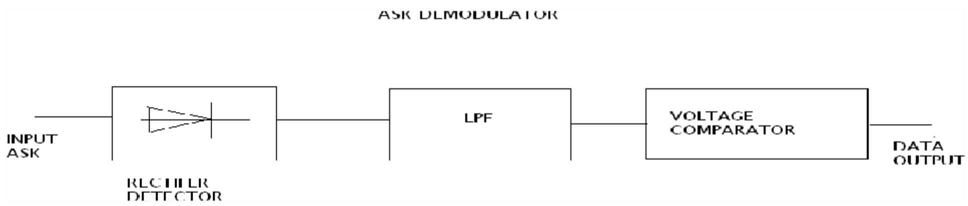
In order to generate ASK waveform it is necessary to apply a sine wave at carrier input & the digital stream at modulation input. The double balanced modulator is shown in fig.

BlockDiagram:



The data stream applied is uniploar i.e. 0Volt at logic LOW & +4.5Volts at logic HIGH. The output of balanced modulator is a sinewave, unchanged in phase when a data bit ‘HIGH’ is applied to it. In this case the carrier is multiplied with a positive constant voltage when the data bit LOWis applied, the carrier is multiplied by0 Volts, giving rise to 0Volt signal at modulator’so/p.

The ASK modulation results in a great simplicity at the receiver.The method to demodulate the ASK waveform is to rectify it, passit through the filter &’square up’ the resulting waveform. The o/p is the original digital data stream. Fig. shows the functional blocks required inorder to demodulatethe ASK waveform atreceiver.



CircuitDescription:-

The function of the carrier is to generate a stable sine wave signal at the rest frequency, when no modulation is applied. It must be able to linearly change frequencywhen fully modulated, with no measurable change in amplitude.

Sine wave is generated by using the colpitts Oscillator. 500KHz and 1MHz frequencies are selected.

ModulationGeneration:-

The square wave generated by 555 and is given to 74121. the o/p of this multivibrator is used as a clock i/p to a decade counter 7490. Which generators the modulating data outputs D1,D2, D3,D4.

Modulator:-

The ASK215 Modulator is based on U2(LM 1496). It is configured as a linear multiplier. At any movement of time the o/p of this U2(PIN 12) is proportional to the instantaneous product of the CARRIER INPUT and MODULATION INPUT saignals which serves as two inputs to this U2. The CARRIER INPUT canbe monitored at TP7 & The MODULATION INPUT can be monitored at TP8.

The o/p voltage from U2 can be adjusted in amplitude by potentiometer P3(5K). it is now fed to the OP-AMP U3, LF 356 at its non-inverting terminal(pin 3). The op-amp configured as a simple non inverting amplifier with the gain of 2.47. the o/p(pin 6 is a/c coupled by capacitor C18 to appear at the o/p of OUTPUT socket.to signal multiplication. The DC bias from both the signals can be removed by careful setting of the two potentiometers.

Demodulation:-

TheASKdemodulatorcomprisesof

1) op-ampICU6Aconfiguredasaunitygain,non invertingbuffer,and
2) AsimplehalfwaverectifiercircuitconsistingdiodeD1andresistorR72.

The incoming ASK signal can be monitored at TP12. the signal at TP12is then buffered by ICU6A & then rectified by half wave rectified CKT comprising of Diode D5 & resistor R72. This removes the negative half cycle of the wave form. The output of rectifier is available at OUTPUT socket of the demodulator & can be monitoredat TP13. example waveforms are asshownin the timing diagram in Fig.

LowPassFilters:-

The low pass filter block consists of two fourth-order butter worth low pass filter circuit. The filter is identical & i.e. is described in the section to follow.

The input signal to this block is first buffered by the op-amp ICU6B. The op-amp is simply configured as a noninvert in, unity-gain buffer.Thebuffer output(TP15) is then fed into data squaring circuit. The final o/p's of the filter can be monitored at TP15.

DataSquaringCircuits:-

The data squaring circuit 'square up' the inputsignal. Itdoes this with the help of voltage comparator. The function of comparator circuit is identical & hence onlyone is described. The input is connected to the non-inverting(+ve) input(pin 5) of the voltage comparator ICU4A whose inverting (-ve) input(pin 4) is connected to a voltage divider network of resistors R61, R60 & variable Resistor P4 through resistor R59. the input impedance of the comparator circuit is set to 100k by resistor R58. A hystersis of 0.3V is set by resistor R59& R57. the slider voltage of can be adjusted from 2.2V to +2.2V.

The output of the comparator is 0V when the input at inverting terminal is more positive then the input at non invertingterminal.

Procedure:

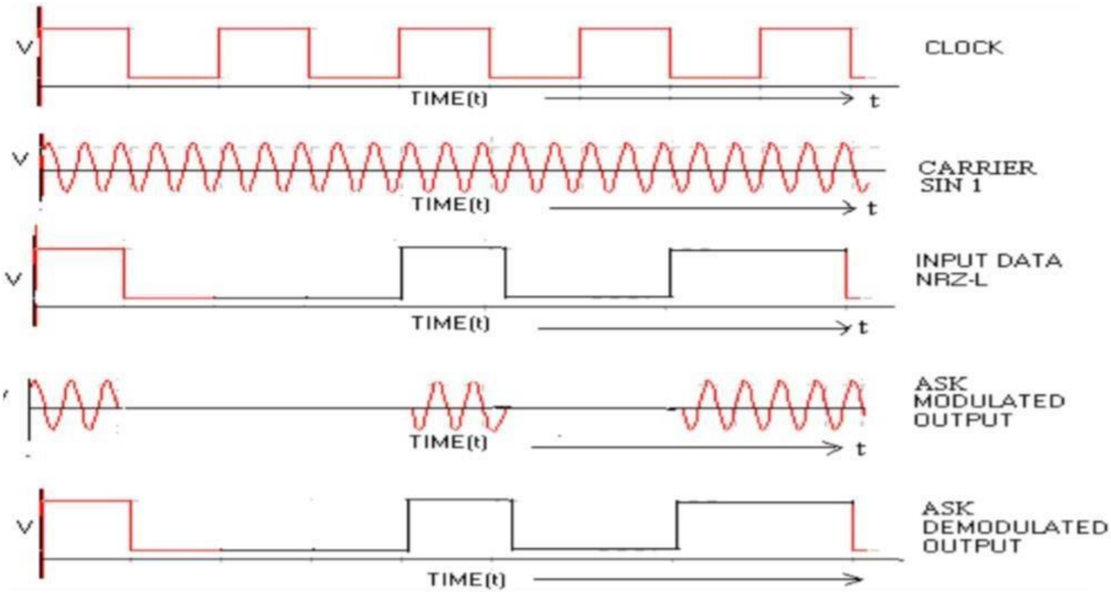
Modulation:

1. Connectthesinewave500KHz fromthecarriergeneratorTP1tothecarrierinput of the modulator TP7.
2. AndalsoconnectdataclockD1i.e.,modulationsignalTP3tothemodulationinput TP8.
3. SwitchONthepowersupply.
4. Observetheoutput atTP9.
5. ByvaryingthegainpotP3observetheASKoutputatTP10.
6. AdjustingthecarrieroffsetandmodulationoffsetwecanobservetheASKoutput.
7. Bychangingthecarrier signal1MHzanddifferentdataclocksD2,D3,D4observe the output.

Demodulation:

1. ConnectASKoutputTP10totherectifierinputTP12andobservethewaveform.
2. Nowconnect rectifieroutputTP13tothelowpassfilterinput TP14andobservethe output at TP15.
3. CONNECTLPFoutputTP15tothedatasquaringcircuitinput TP16andobserve the demodulation output waveform at TP17.
4. Bychangingthedifferentdataclocksandobservethedemodulationoutput.

ExpectedWaveforms:



Result:

Questions:

1. IfthebitrateofanASK signalis1200bps,whatisthebaud rate?

2. IsASKhighlysusceptible?

3. Whatarethecharacteristicsoftransmissionmediumwhicheffectspeedof transmission in ASK?

4. Findtheminimum bandwidth foranASKsignaltransmittingat2000bps.The transmission made is halfduplex?

5. IfB.Wis5000Hzfor anASKsignal,whatarethebaudrate?

6. WhatistheadvantageofON-OFFkeying( )inASK?

7. Giventhebandwidthof10KHz(1Hzto1KHz),Findthebandwidthforupperside & lower side band of carrier in full duplexASK?

8. Fortheaboveproblem,whatarethecarrierfrequenciesinupper&lowerside bands?

EXPERIMENTNO-6

FREQUENCYSHIFTKEYING

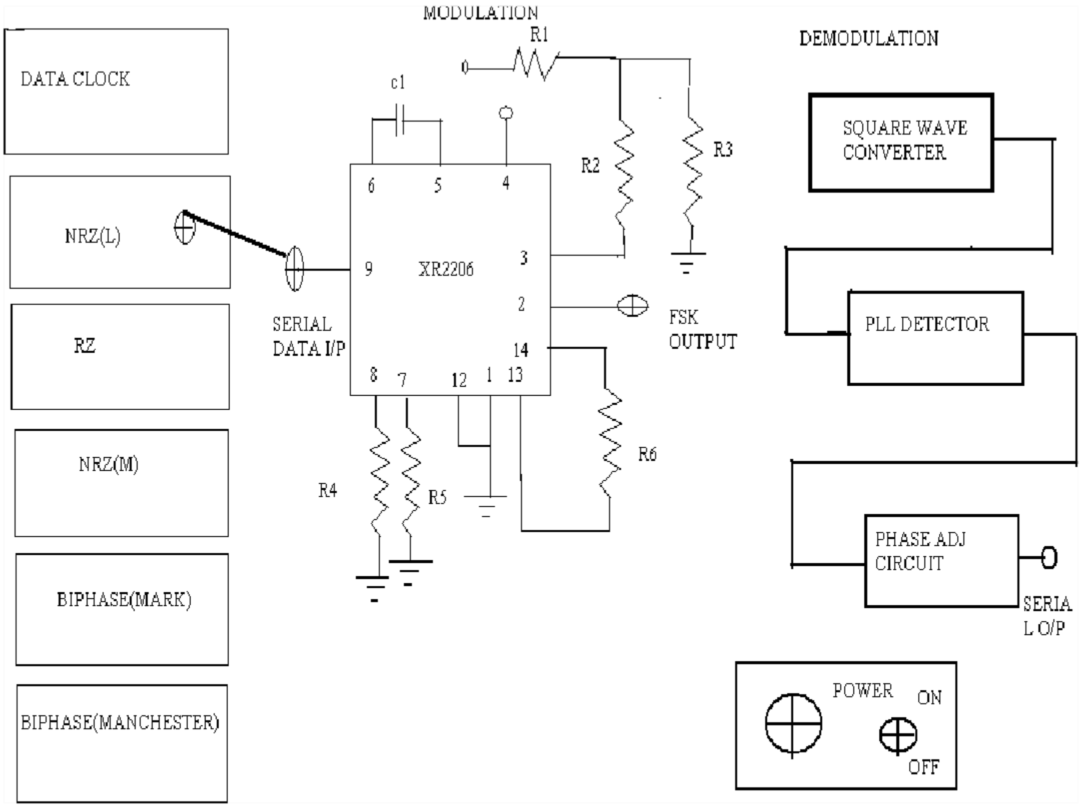
Aim:

1. TogenerateFSKModulation
2. ToDemodulatetheFSKsignals
3. To generate NRZ(L),RZ,NRZ(M),BIPHASE(MARK),BIPHASE(MANCHESTER).

Apparatus:

1. FrequencyShiftKeyingkit
2. C.R.O(30MHz)
3. Patchcords

CircuitDiagram:



Theory:

Binary FSK is a form of constant-amplitude angle modulation and the modulating signal is a binary pulse stream that varies between two discreate voltage levels but not continuous changing analog signal. In FSK, the carrier amplitude(Vc) remains constant with modulation and the carrier radian frequency(wc) shifts by an amount equal to +w/2. The frequency shift is proportional to the amplitudeand polarity of the input binary signal. For example, a binary 1 could be +1 volt and a binaryzero could be -1 volt producingfrequencyshifts of +delta(w)/2 and –delta(w)/2 respectively. The rate at which the carrier frequency shifts is equal to the rate of change of the binary input signal vm(t). thus the output carrier frequency deviates(shifts) between wc+delta(w)/2 and wc-delta(w)/2 at the rate equal to fm.

DataFormating:-

A modulation code is defined as a rule by which a serial train of binary data is converted to a signal suitable for transmission. Some of the commonlyused codes are listedforstudyinthis experiment.Therearefewotherswhich areoutsidethescopeof this experiment.

In serial data transmission, a 'symbol' is a signal level that is held for a length of time. The capacity ofa channel is the symbol rate. This is the symbols per second or baud. Channel capacity has the units of symbols per second or baud. Some modulation codes require several symbols per bit of data. For example self clocking codes require two symbols per bit of data. The various codes are described below. Relative features of the codes are given in the table. The waveform diagram the patterns for the serial train 11001100.

Non-returntozero(NRZ):-

Thisis leveltypecodeandisonethatiswidelusedinserialdatatransmission. A'0'islowlevelanda'1' isahighlevel.

ReturntoZero(RZ):-

This is an impulse type code where a '1' is represented by a high level that returns to zero. Its advantage is power conservation as transmission takes place only for '1'.

NRZ(M):-

If the logic '0' is to be transmitted the new level is inverse ofthe previous level i.e., change in level occurs. If '1' is transmitted the level remainsunchanged.

Biphase(Mark):-

This is an edge type invertible self-clocking code in which each bit cell starts with an edge and for a '0' an additional edge occurs during the middle ofthe bit cell.

Biphase(Manchester):-

This is a level type of code in which a '1' bit cell is initially high and then hasa high to low transition in the middle of the bit cell. A '0' bit cell is initially low and has a low to high transition in the middle of the bit cell.

CircuitDescription:-

Data clock

Generator:-

The bit clock generator is design around the tim IC 555(U1)operatedin astable mode. The 100Kohm preset P1 in conjunction with .0047microfarad capacitor in the timing circuit facilitates the frequency to be set and at any chosen value from 300Hz to 1KHz. This output is available atTP1.

DataSelection:-

The 8 bit parallel load serial shift IC 74165(U2) is used to generatethe required word pattern. A dip switch is used toset ONE&ZERO pattern. The bitpattern set bythe switch is parallelyloaded by controlling the logic level at pin 1. The last stage output Q7 is coupled to the first stage input D0 in the shiftregister. The serial shift clock is given at pin 2. The 8 bit data set bythe switch and loaded with the register parallely is now shifted serially right and circulated respectively.Thus the 8 bit word pattern is generated cyclically which is used as modulating signal in the FSK modulator. It is available atTP12.

FskModulation:-

The XR-2206 can be operated with two separate timing resistors,R24 andR25, connected to the timing pin 7 and 8, respectively. Depending on the polarity of the logic signal at pin 9, either one or the other of these timing resistors is activated. If pin 9 is open-circuited or connected to a bias voltage>2V, only R24 is activated. Similarly, if the voltage level at pin 9 is<1v, only R25 is activated. Thus, the output frequency can be keyed between two levels. F1 andF2.

F1=1/R24C9 and f2=1/R25C9. In our circuit R24=3.9Kohm, R25=6.8Kohm, C9= 100nf.For split-supply operation, the keying voltage at pin 9 is referenced to V. the FSK output can be monitored at TP8Demodulation:-

SquareWaveConverter:-

The incoming FSK modulated signal can be monitored at TP9.This signal is then attenuated by resistor network R43,R44 then AC coupled via capacitor C12 to remove anydc component in the signal. The signal is connected to SIGIN input of the U12. The signal is first squared up by an inbuiltcomparator and isconnected to one of the input of on chip2 input EX-OR gate. The other 5 input of the gate is connected to the COMPIN input of IC U12. The output is monitored atTP10.

PLLDetector:-

A very useful application of the 565 PLL is as a FSK demodulator. In the 565 PLL the frequency shift is usually accomplished by driving a VCO with thebinary data signal so that the two resulting frequencies correspond to the logic 0 and logic 1 states of the binary data signal. The frequencies corresponding to logic 1 and logic 0 states are commonly called the mark and space frequencies. Capacitive coupling is used at the input to remove a dclevel. As the signal appears at the inputof the 565,the loop to the input frequency and tracks it between the two frequencies with a corresponding dc shift at the output. Preset p2 and capacitor C15 determine the free- running frequency of the VCO. A three-stage RC ladder filter is used to remove the carrier component from the output. The high cutoff frequency of the ladder filter is chosen to be approximately halfway between the max keying rate and twice the input frequency.This output signal can be made logic compatible by connecting voltage comparator(u11) between the output of ladder filter and pin 6 ofPLL.

PhaseAdjustmentCircuit:-

U17,U18 used as phase adjustmentcircuit.The output of voltage comparatoris fed yto pin 2 of U17 which is connected as monostable mode. And the outputof U17 is again fed to U18. The output is available at pin 3 of U18 can be monitored at TP11. This is serial date ofoutput.

Procedure:

Modulation:

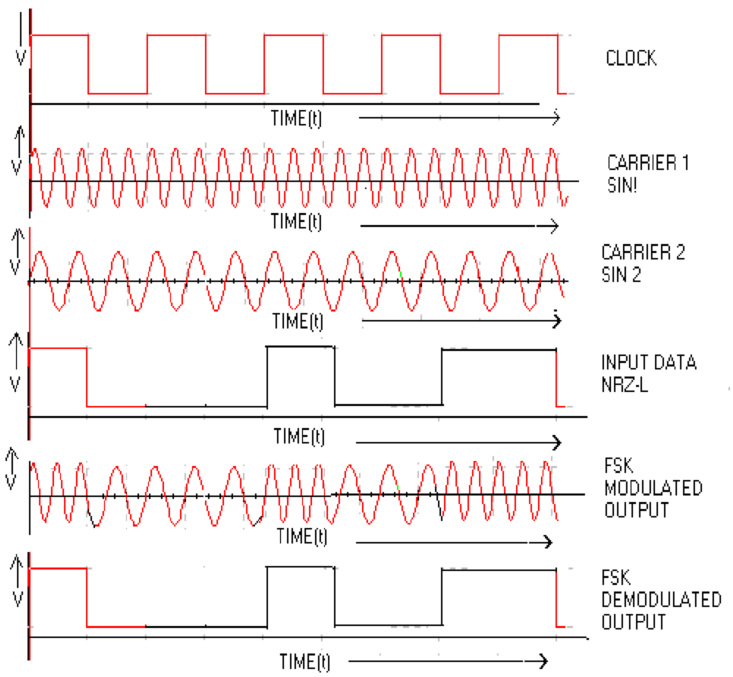
1. SwitchONthepowersupply.
2. Setthedataselectionswitch('DATASELECTION')tothedesired code(say11001100).
3. Settheswitch(DATAON-OFF)ONposition.Observethe8bitWord pattern at TP12.

4. Observe the data clock at TP1 and also observe the NRZ(L) at TP2,RZ atTP3,NRZ(M) at TP4, BIPHASE(MARK) at TP5,BIPHASE(MANCHESTER) atTP6.
5. Connect the patch cord as shown in diagram 1.Observe the corresponding FSK output at(when datais logic '1', thefrequency is high and data is logic '0' the frequency islow)TP8.
6. Repeat the step 5 for other inputs.(like NRZ(M),RZ,BIPHASE) observe the corresponding FSK outputs.
7. Nowchangethedataselectionandrepeattheabovesteps3to6 andobserve the corresponding FSK outputs.

Demodulation:

1. Connectthepatchcordsasshownindiagram.
2. TheincomingFSKinputisobservedatTP9.
3. The output of 'square wave converter' is available at TP10. The serial data output is available atTP11.
4. Repeat the above steps 1,2,3 for other serial data inputs and observe the corresponding serial data outputs. These outputs are true replica of the orginal inputs.

ExpectedWaveforms*:*



Result:

Questions:

1. ExplaintheconceptofFSK?

2. CompareASK,FSK&PSK?

3. DrawthewaveformsofFSK?

4. WhatisM-raysignaling?Whatisitsadvantagesover 2-arysignaling?

5. Whatarethedifferentdatacoding formats&drawthewaveformswhat is advantages of Manchaster coding over other formats?

6. ExplainthedemodulationschemeofFSK?

7. Whatistheformula forBandWidthrequiredinFSK?

8. Whatisthe minimumB.WforanFSKsignaltransmittingat2000bps(haif duplex),if carriers are separated by3KHz?

9. IstheFSKspectrum, acombinationoftwo ASKspectracenteredaroundtwo frequencies?

10. IstheFSKband widthismorethanASKbandwidthforagivenbandrate?

11. IsitmoresusceptibletonoisethanASK?

12. WhatarethelimitingfactorsofFSK?

13. Isthebandrate&bitratearesameforFSK?

EXPERIMENT NO-7

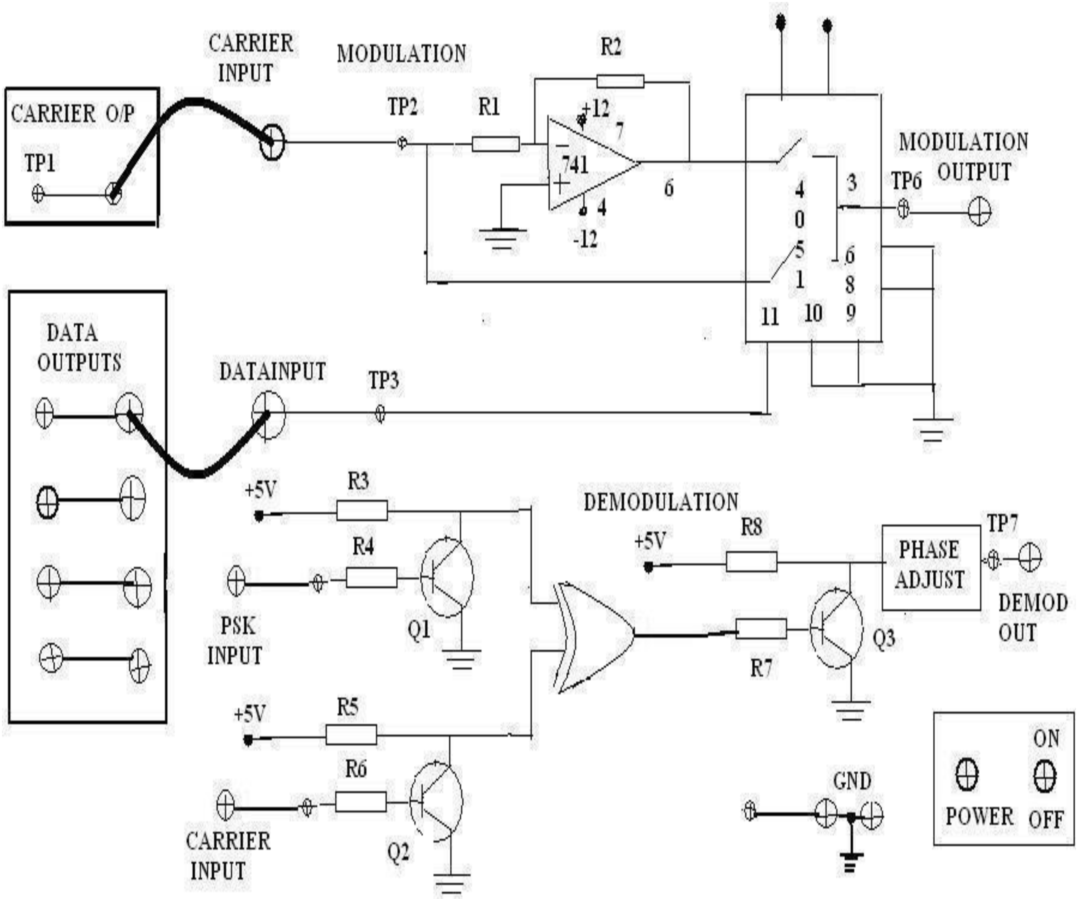
BINARYPHASESHIFTKEYING

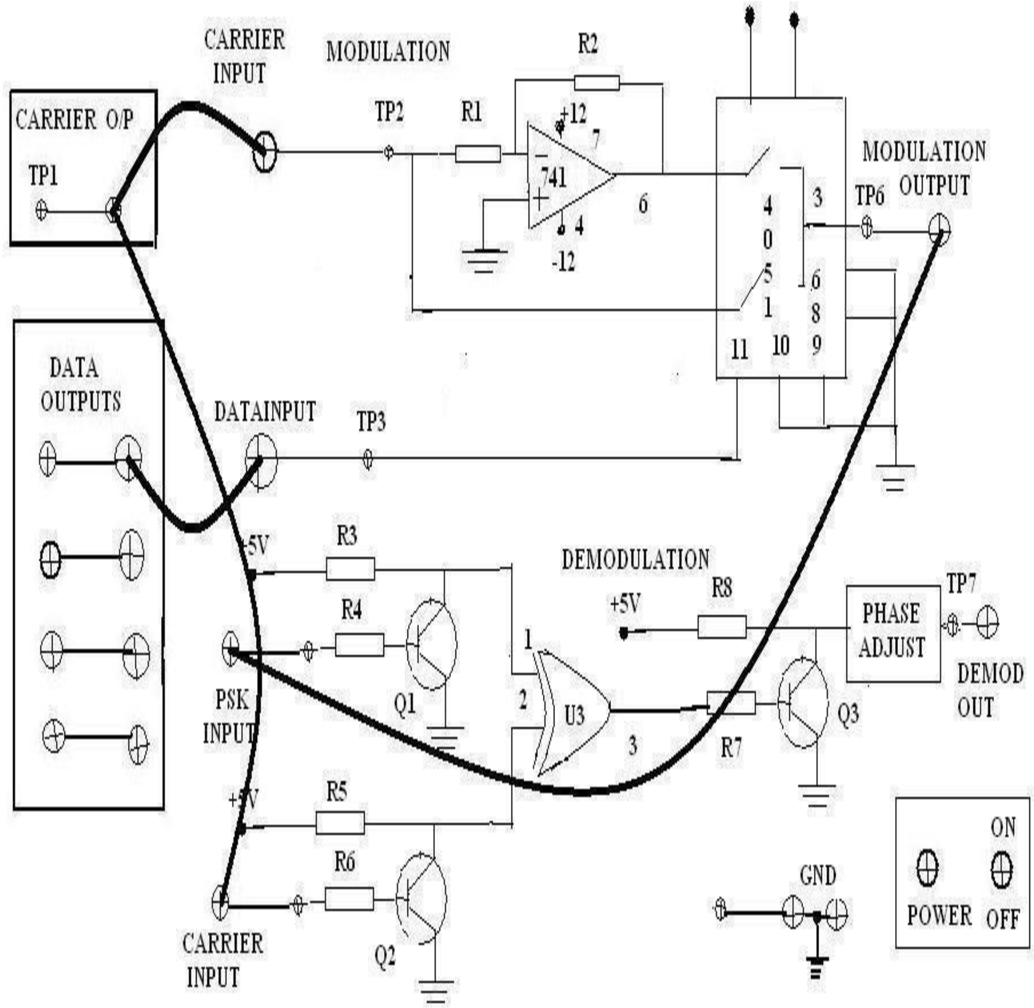
Aim: StudyofcarrierModulationtechniquesbyphaseshiftkeyingmethod.

Apparatus:

1. PskModulationAndDemodulationTrainer.
2. 30MHzDualTraceOscilloscope.
3. Patchchords

CircuitDiagram:





Theory:

To transmit the digital data from one place to another, we have to choose the transmission medium. The simplest possible method to connect the transmitter to the receiver with a piece of wire. This works satisfactorily for short distances in some cases. But for long distance communication & in situations like communication with the aircraft, ship, vehicle this is not feasible. Here we have to opt for the radio transmission.

It is not possible to send the digital data directly over the antenna because the antenna of practiced size works on very high frequencies, much higher than our data transmission rate.

To able to transmit the data over antenna, we have to 'module' the signal i.e., phase, frequency or amplitude etc. is varied in accordance with the digital data. At receiver we separate the signal from digital information by the process of demodulation. After this process we are left with high frequency signal which we discard & the digital information, which we utilize.

Modulation also allows different data streams to be transmitted over the same channel.

This process is called as ‘multiplexing’ & result in a considerable saving in bandwidth no of channels to be used. Also it increases the channel efficiency.

The variation of particular parameter variation of the carrier wave give rise to various modulation techniques. Some of the basic modulation techniques ASK,FSK, PSK,DPSK,QPSK.

PhaseShiftKeying(PSK):

The PSK is a form of angle modulated, constant amplitude digital modulation. Digitalcommunications because importantwith the expansion oftheuseof computers and data processing, and have continued to develop into a major industry providing the interconnection of computer peripherals and transmission of data between distant sites. Phase shift keying is a relatively new system, in whichthe carrier may be phase shifted by +90 degree for a mark, and by-90 degrees for a space. PSK has a number of similarities to FSK in may aspects, as in FSK, frequency of the carrier is shifted according to the modulating squarewave.

CircuitDescription:

In this IC 8038 is a basic wave form generator which generates sine, square, triangle waveforms. The sine wave generated by this 8038 IC is used as carrier signal to the system. This square wave is used as a clock input to a decade counter which generates the modulating data outputs.

The digital signal applied to the modulation input for PSK generationisbipolar i.e. have equal positive and negative voltagelevels. When the modulating input is negative the output of modulatoris a sine wave in phase withthe carrierinput. Where as for the positive voltage levels, the output of modulator is a sine wave which is shifted out of phase by 180 degree from the carrier input compared to the differential data stream. This happens because the carrier input is now multiplied by the negative constantlevel.

Thus the output changes in phase when a change in polarity of the modulating signalresults. Fig shows the functional blocks of the PSK modulator & demodulator.

Modulation:-

IC CD 4051 is an analog multiplexer to which carrier is applied with and without 180 degree phase shift to the two multiplex inputs of the IC. Modulating data input is applied to its control input. Depending upon the levelof the control signal

carrier signal applied with or without phase shift is steered to the output. the 180 degreephase shift tothecarrier signalcreated byanoperational amplifier using 741C.

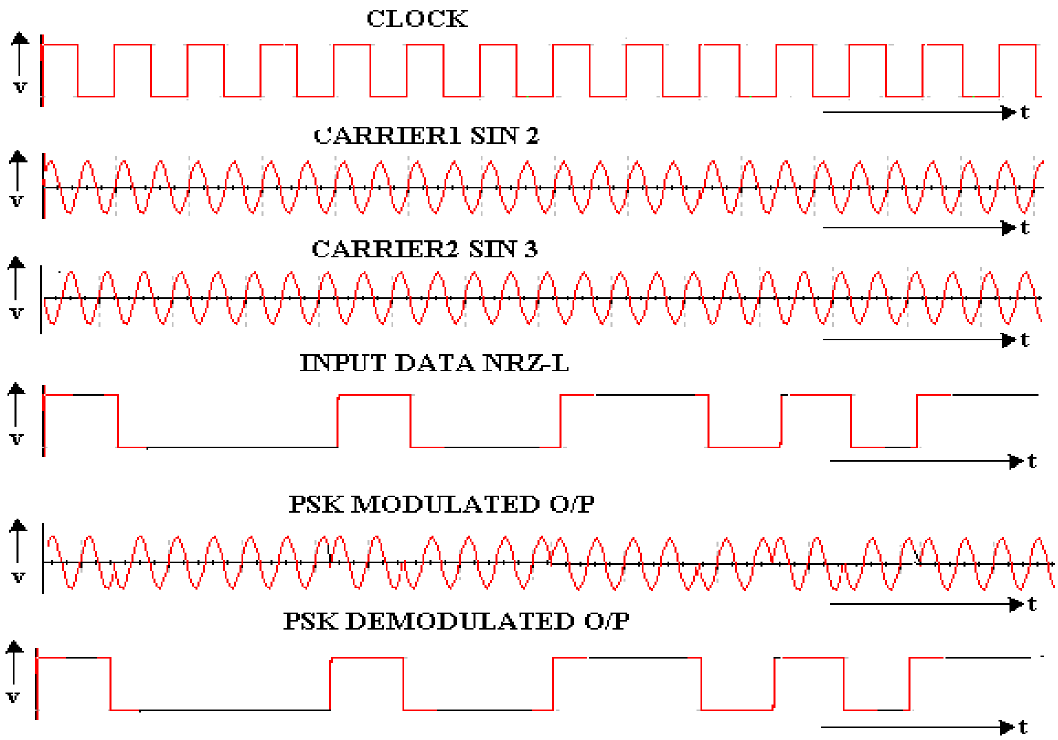
Demodulation:-

During the demodulation the PSK signal is converted into a +5volts square wave signal using a transistor and is applied to one input of an EX-OR gate. To the second input of the gate carriersignal is applied after conversion into a +5volts signal. So the EX-OR gate output is equivalent to the modulating data signal.

Procedure:

1. NowswitchONthetrainerand seethatthesupply LEDglows.
2. ObservethecarrieroutputatTP1.
3. Observethe dataoutputs(D1,D2,D3,D4).
4. NowtheconnectthecarrieroutputTP1tothecarrierinputofPSKmodulator TP2 using patch chord(as shown in dig 1).
5. Connectthed1todatainputofPSKmodulatorTP3(Asshown.indig1).
6. ObservethephaseshiftedPSKoutputwaveformonCROonchannel1and corresponding data output on channel2.
7. Repeatthesteps4,5,6fordataoutputsD2,D3,D4andobservethePSKoutputs.
8. connectthePSKmodulationoutputTP6tothePSKinput ofdemodulation TP4(as shown in dig 2).
9. connectthecarrieroutputTP1tothecarrierinputofPSKdemodulationTP5.(As shown in dig 2).
10. Now,observethePSKdemodulatedoutput atTP7onCROat channel1and corresponding data output on channel2.
11. thedemodulatedoutputistruereplicaofdataoutput.
12. Repeat thesteps 8to10forotherdataoutputsD2,D3,D4.

ExpectedWaveforms:



Result:

Questions:

1. Explaintheconcept ofPSK?
2. CompareASK,FSK,PSK?
3. DrawthewaveformsofPSK?
4. WhatisM-arysignaling?Whatareitsadvantagesover2-arysignaling?
5. ExplainthedemodulationschemeofPSK?.
6. WhatistheadvantageofPSKoverASK,FSK?
7. Willthesmallervariationsinthesignalcanbedetectedreliably byPSK?
8. Canwetransmitdatatwiceasforusing4-PSKaswecanusing2-PSK?
9. WhatistheminimumB.WrequiredinPSK?
10. IstheB.WinPSKissameasinASK?
11. IsthemaximumbitrateinPSKisgreaterthanASK?

EXPERIMENTNO-8

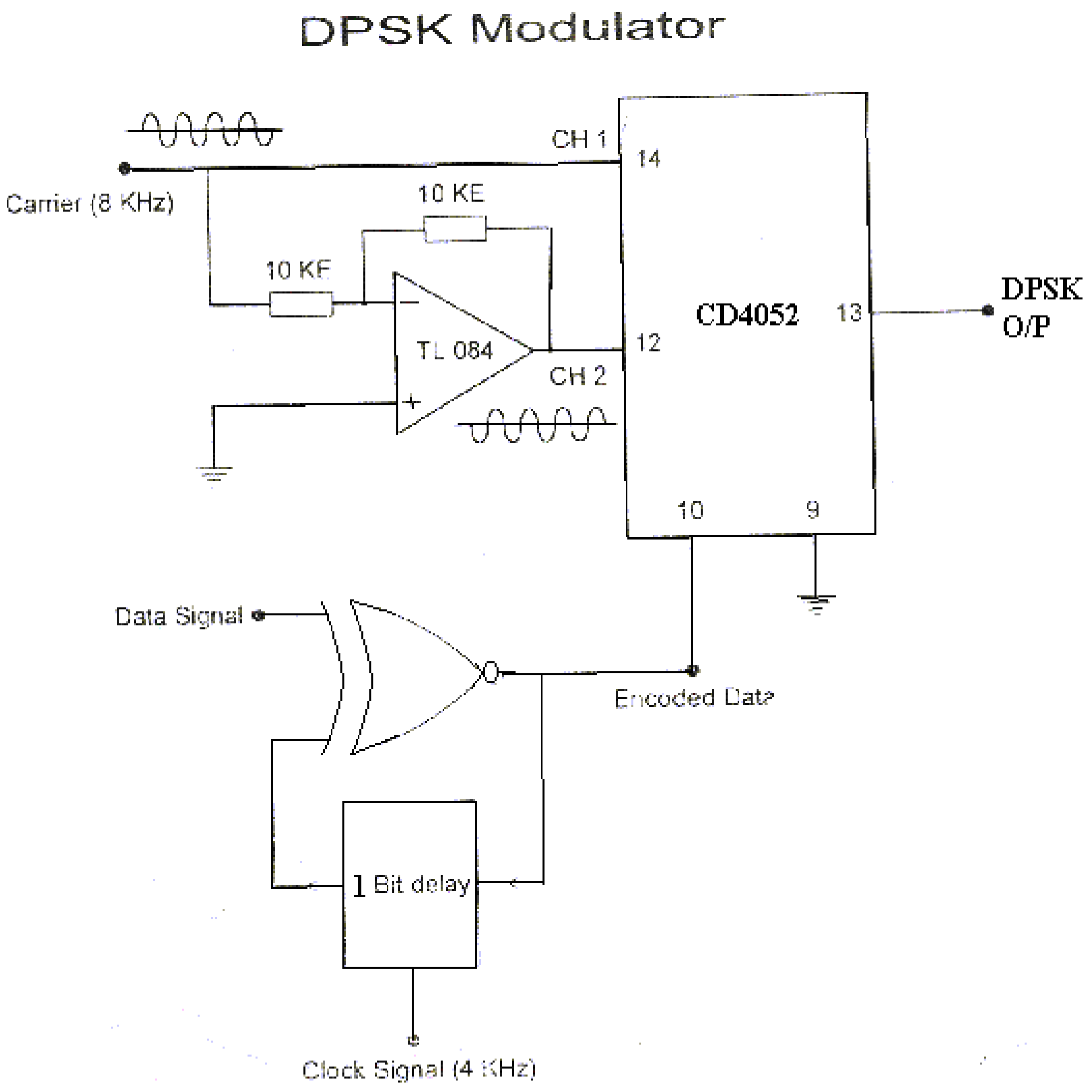
DIFFERENTIALPHASESHIFTKEYING

Aim: To studyoperation Differential PhaseshiftKeyingmodulation &demodulation Techniques.

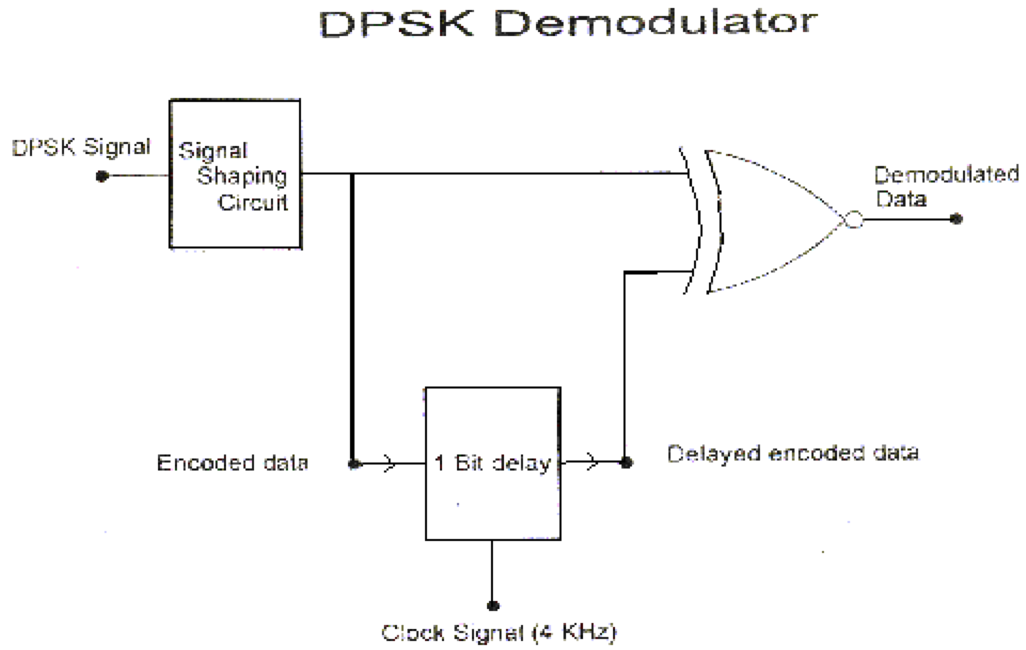
Apparatus:

1. DPSKMODULATION &DEMODULATIONTrainer.
2. Oscilloscope30MHz,DualChannel
3. Pathchords.

BlockDiagram:



fig(1.1)



Theory:

To transmit the digital data from one place to another, we have to choose the transmission medium. The simplest possible method to connect the transmitter to the receiver with a piece of wire. This works satisfactorily for short distances in some cases. But forlong distance communication & institutions like communication with the aircraft, ship, vehicle this is not feasible. Here we have to opt for the radio transmission.

It is not possible to send the digital data directly over the antenna because the antenna of practiced size works on very high frequencies, much higher than our data transmission rate.

Tobeabletotransmitthe dataoverantenna, wehaveto'module'thesignal
i.e. phase, frequency or amplitude etc. is varied in accordance with the digital data. At receiver we separate the signal from digital information by the process of demodulation. After this process we are left with high frequency signal(called as carrier signal) which we discard & the digital information, which we utilize.

Modulation also allows different data streams to be transmitted over the same channel(transmission medium).

This process is called as 'Multeplexing' & result in a considerable saving in bandwidth no of channels to be used. Also it increases the channel efficiency.

The variation of particular parameter variation of the carrier wave give rise to various modulation techniques. Some of the basic modulation techniques are ASK,FSK,PSK,DPSK & QPSK.

DifferentialPhase-ShiftKeying(DPSK):-

The DPSK is a non-coherent version of PSK. In coherent detection, the carrier wave's phase reference should be known for obtaining optimum error performance.(However it is impractical to have knowledge of the carrier phase at the receiver).

The DPSK eliminates the need for a coherent reference signal at the receiver by combining two basic operations at the transmitter:

1.DifferentialEncodingoftheinputbinary wave2.Phase-shift keying

And hence the name differential phase shift keying. Thus to send symbol 0,we phase advance the current signal waveform by180 degrees and to send 1, we have the phase of the current signal waveform unchanged. The receiver is equipped with a storage capability so that it can measure the relative phase difference between the wave forms received during two successive bit intervals. Provided that the unknown phase θ contained in the received wave varies slowly (slow enough and considered essentially constant over two bit intervals), the phase difference between waveforms received in two successive bit intervals will be independent of θ.

CircuitDescription:-

In this IC 8038 is a basic wave form generator which generates since,square,triangle waveforms. The sine wave generated by this 8038 IC is used as carrier signal to the system. This square wave is used as a clock input to a decade counterwhich generates the modulating data outputs.

The digital signal applied to the modulation input for DPSK generation is bipolar have equal positive and negative voltage levels. When the modulating input is negative the output of modulator is a sinewave in phase with the carrier input. Where as for the positive voltage levels,the output of modulator is a sinewave which is shifted out of phase by 180 degrees from the carrier input compared to the differential data stream. This happens becausethe carrier input is now multiplied bythe negative constant level.

Thus the output changes in phase when a change in polarityof the modulating signalresults. Figshowsthefunctionalblocks oftheDPSKmodulator&demodulator.

Modulation:-

The differential signal to the modulating signal is generated using an X-OR gate and1-bit delaycircuit(itisshown infig).CD 4051 isan analog multiplexer to which carrierisappliedwithandwithout180degreesphaseshift(createdbyusingan operationalamplifierconnectedininvertingamplifiermode)tothetwoinputsofthe ICTL084.Differential signal generated by X-OR gate is given to the multiplexer's control signal input. depending upon the level of the control signal,carrier signal applied with or without phase shift is steered to the output. 1-bit delay generation of differential signal to the input is created by using aD-flip-flop(IC7474).

Demodulation:-

During the demodulation, the DPSK signal is converted into a +5V square wave signal using a transistor and is applied to one input of an X-OR gate. to the second input of the gate, carrier signal is applied after conversion into a +5V signal. So the X-OR gate output is equivalent to the differential signal of the modulatingdata. This differential data is applied to oneinput ofan X-OR gate and to the second input, after1-bit delaythesame signal is given. So the output of this X-OR gate is modulating signal.

OutputWaveforms:-

ToseetheDPSKdemodulationprocess,examinetheinputofDPSKdemodulator with the demodulation output.

Checkthevarioustestpointsprovidedattheoutputofthefunctionalblocksofthe DPSK demodulator. This will help you fully grasp the DPSK demodulation technique.

Figure1.4:

b'(t)		0	1	1	0	0
b(t)	1	0	0	0	1	0
Phase	0^0	180^0	180^0	180^0	0^0	180^0
B(t)	0	1	1	1	0	1
Phase	180^0	0^0	0^0	0^0	180^0	0^0

Figure1.5ExampleforCompleteDPSKoperation (witharbitarybitas 0):

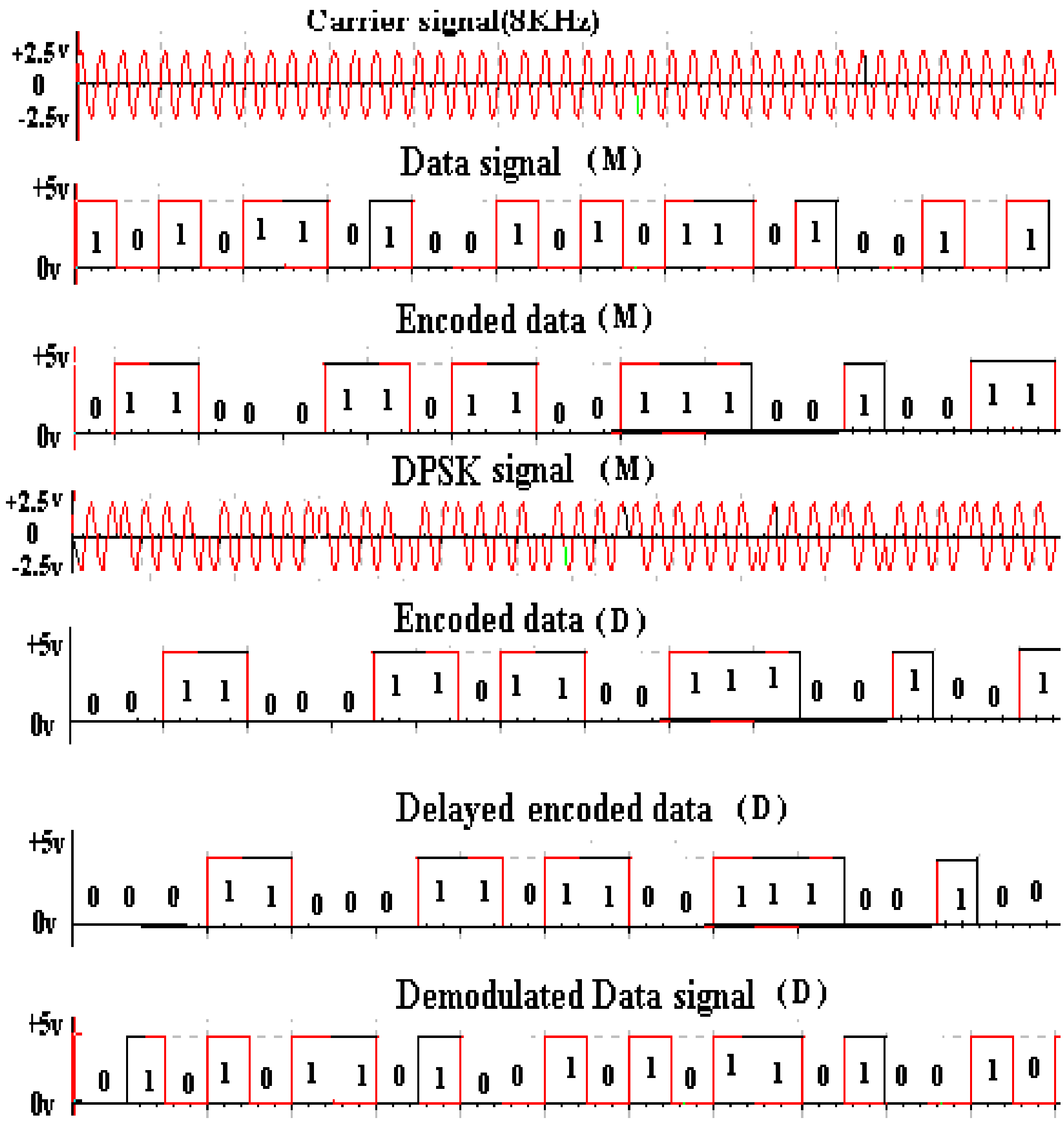
Messagesignal(tobetransmitted)	0	1	1	0	0	
Encodeddata(differentialdata)	0	1	1	1	0	1
Trasnmittedsignalphase:	180^0	0^0	0^0	0^0	180^0	0^0
Receivedsignalphase:	180^0	0^0	0^0	0^0	180^0	0^0
Encodeddata(differentialdata)		0	1	1	1	0
Messagesignal(Demodulation)		0	1	1	0	0

Procedure:

1. NowswitchONthetrainerand seethat thesupply LEDglows.
2. Connect dataoutput from4(D1,D2,D3,D4)dataoutputstothedatainputof the DPSK modulator TP7.
3. Connectclock outputTP1totheclockinputoftheDPSK modulatorTP8.
4. NowconnectcarrieroutputTP2tothecarrierinputoftheDPSKmodulator TP10.
5. ObservethedifferentialdataoutputontheCROatTP9testpointasshown on the frontpanel.
6. ObservethephaseshiftedDPSKoutput waveformontheCROcorresponding to the differential data output.
7. Connect DPSKMODULATOR outputTP11totheDPSKinput ofthe DEMODULATOR TP12.
8. ConnectcarrieroutputTP2tothecarrierinputoftheDPSKDemodulator TP13.
9. Alsoconnect clockoutputTP1totheclockinputoftheDPSKdemodulator TP14.
10. Nowobservethe DPSKdemodulatedoutputwaveformTP15ontheCRO.

ExpectedWaveforms:

Fig 1:3 DPSK Wave forms



RESULT:

Questions:

1. HowdoesDPSKdifferfromPSK?

2. Explaintheoreticalmodulation&demodulationofDPSKusing arbitrarybit sequence and assuming initial bit 0 and1?

3. WhatistheadvantageofDPSKoverPSK?

4. Whydoweneed 1bitdelayinDPSKmodulator&demodulator?

5. Whatdoesasynchronousdetector(multiplier)doinDPSKdemodulator?

6. whatistherelationbetweencarrierfrequency&thebitinterval'T'?

7. WhatisthedisadvantagesofDPSK.?

8. IstheerrorrateofDPSKisgreaterthanPSK?

9. WhatistheexpressionforDPSKerror?

10. Whatarethe applicationsofDPSK?