Ex. No: 1 **AMPLITUDE MODULATION AND DEMODULATION**

AIM:

To determine the performance of Amplitude Modulation and Demodulation and analyses the input and output waveforms.

APPARATUS REQUIRED:

1. Amplitude Modulation / Demodulation kit
2. Patch chards.
3. Cathode ray oscilloscope (CRO).

THEORY:

Amplitude modulation is the process by which amplitude of the carrier signal is varied in according with instantaneous value of the modulated signal. But frequency and phase of the carrier wave is remains constant.

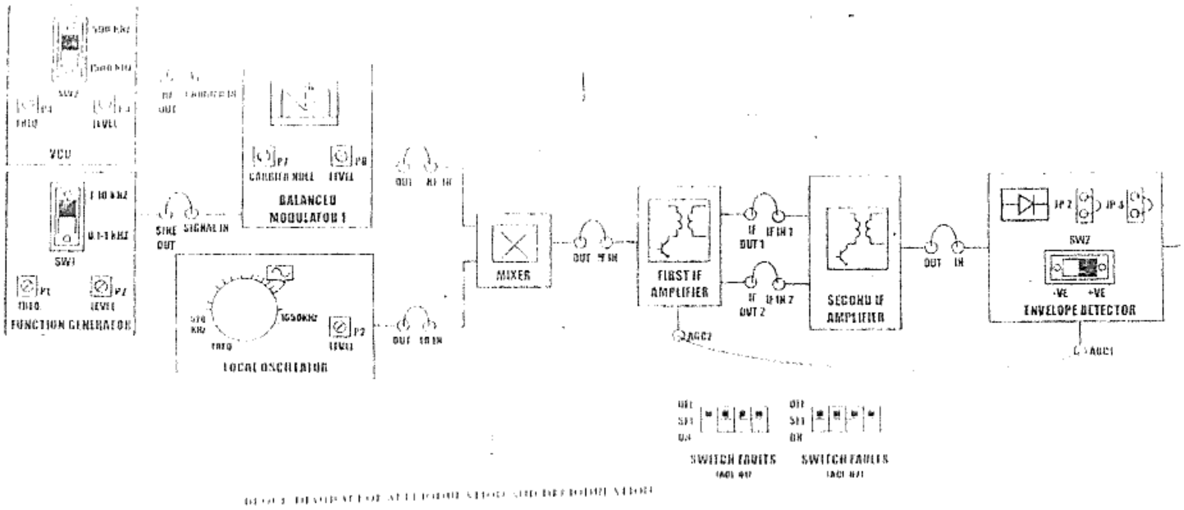
Modulation process in which the characteristics of carrier wave is varied (or) altered in accordance with the instantaneous amplitude of the modulating signal usually low frequency signal or audio frequency signal.

Let the sinusoidal carrier wave is usually Modulation,

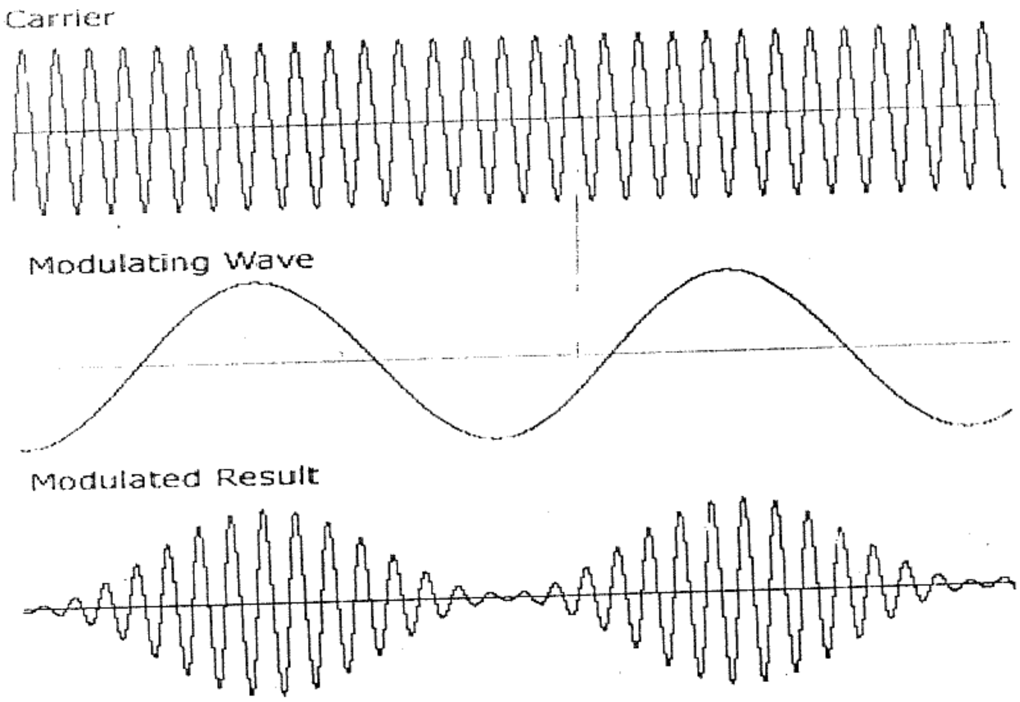
$$V(t) = V_c \sin(W_c + C)$$

Amplitude modulation signal is greater than the carrier signal. Therefore test portion of envelop of the modulating signal across the axis. So both Positive and Negative extension of Modulation signal as concealed or clipped signal.

BLOCK DIAGRAM:



WAVEFORM:



Tabular column

SIGNAL	AMPLITUDE (V)	FREQUENCY (Hz)
Message Signal		
Modulated output		
Demodulated output		

OUTPUT WAVEFORMS:

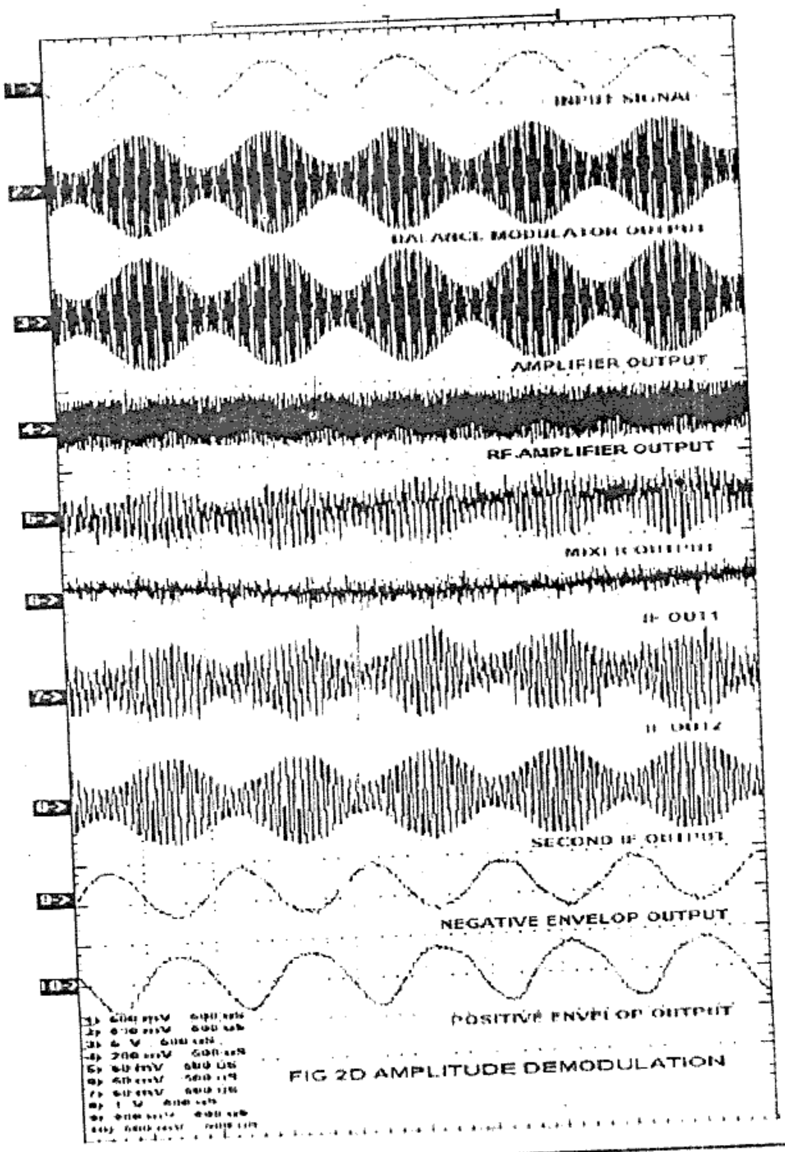


FIG 2D AMPLITUDE DEMODULATION

PROCEDURE:

1. Refer to the FIG. & Carry out the following connections.
2. Connect o/p of **FUNCTION GENERATOR** section (ACL-01) **OUT** post to the i/p of Balance Modulator1 (ACL-01) **SIGNAL IN** post.
3. Connect o/p of VCO (ACL-01) **OUT** post to the input of Balance modulator 1(ACL-01) **CARRIER IN** post.
4. Connect the power supply with proper polarity to the kit ACL-01 & ACL -02,While connecting this, ensure that the power supply is OFF.
5. Switch on the power supply and Carry out the following presetting:

- **FUNCTION GENERATOR:** Sine LEVEL about 0.5 Vpp; FREQ. about 1KHz.
- **VCO:** LEVEL about 2Vpp; FREQ. about 850 KHz, Switch on 1500KHz.
- **BALANCED MODULATOR1:** CARRIER NULL completely rotates Clockwise or counter clockwise, so that the modulator is "unbalanced" and an AM signal with not suppressed carrier is obtained across the output· adjust OUTLEVEL to obtain an AM signal across the output whose amplitude is about 100mVpp.
- **LOCAL OSCILLATOR (ACL-02):** 1300KHz, 2V.

6. Connect local oscillator **OUT** post to **LO IN** of the mixer section.
7. Connect balance modulator1 out to **RF IN** of mixer section in ACL-02.
8. Connect mixer **OUT** to **IF IN** of 1st IF AMPLIFIER in ACL-02.
9. Connect **IF OUT1** of 1st IF to **IF IN 1** and **IF OUT2** of 1st IF to **IFIN 2** of 2ND IF AMPLIFIER.
10. Connect **OUT** post of 2nd IF amplifier to **IN** post of envelope detector.
11. Connect post **AGC1** to post **AGC2** and jumper position as per diagram.
12. Observe the modulated signal envelope, which corresponds to the waveform of the modulating signal at **OUT** post of the balanced modulator1 of ACL-01.Connect the oscilloscope to the **IN** and **OUT** post of envelope detector and detect the AM signal and the detected one . If the central frequency of the amplifier and the carrier frequency of the AM signal and local oscillator frequency coincides, you obtain two signals
13. Check that the detected signal follows the behavior of the AM signal envelope. Vary the frequency and amplitude of the modulating signal, and check the corresponding variations of the demodulated signal.

RESULT:

Thus the Amplitude Modulation and Demodulation has been performed and its output waveforms are obtained.

Ex. No: 2 FREQUENCY MODULATION AND DEMODULATION

AIM:

To determine the performance of Frequency Modulation and Demodulation and analyses the input and output waveforms.

APPARATUS REQUIRED:

1. Frequency Modulation / Demodulation kit
2. Patch chards.
3. Cathode ray oscilloscope (CRO).

THEORY:

Frequency modulation is the process by which amplitude of the carrier signal is varied in accordance with instantaneous value of the modulated signal. But frequency and phase of the carrier wave is remains constant.

Modulation process in which the characteristics of carrier wave is varied (or) altered in accordance with the instantaneous amplitude of the modulating signal usually low frequency signal or audio frequency signal.

Frequency modulation signal is greater than the carrier signal. Therefore test portion of envelop of the modulating signal across the axis. So both Positive and Negative extension of Modulation signal as concealed or clipped signal.

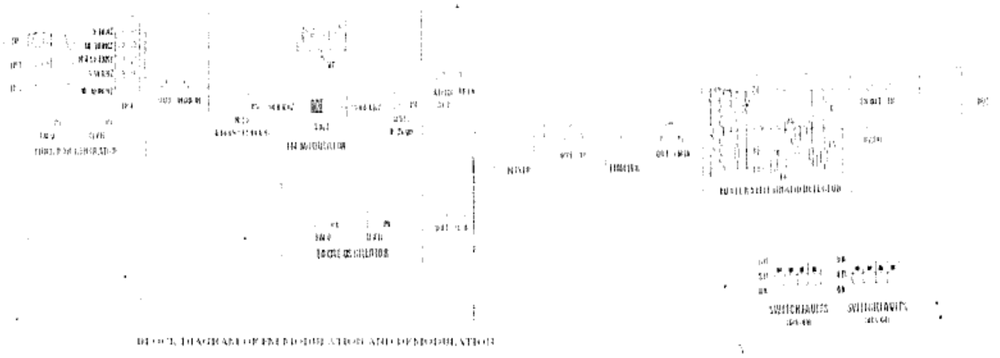
F (K) = Ac

B → Modulated signal index

Depend on the 'B' the FM signal is Classified as

1. Narrow Band FM (B < 1)
2. Wide Band FM (B > 1)

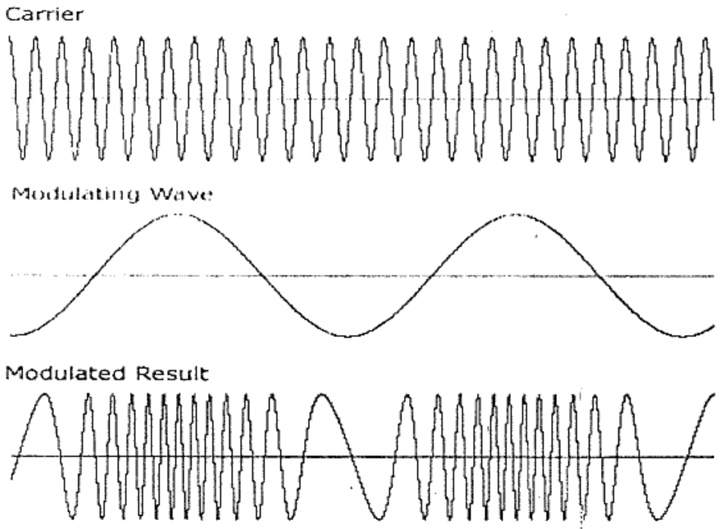
BLOCK DIAGRAM:

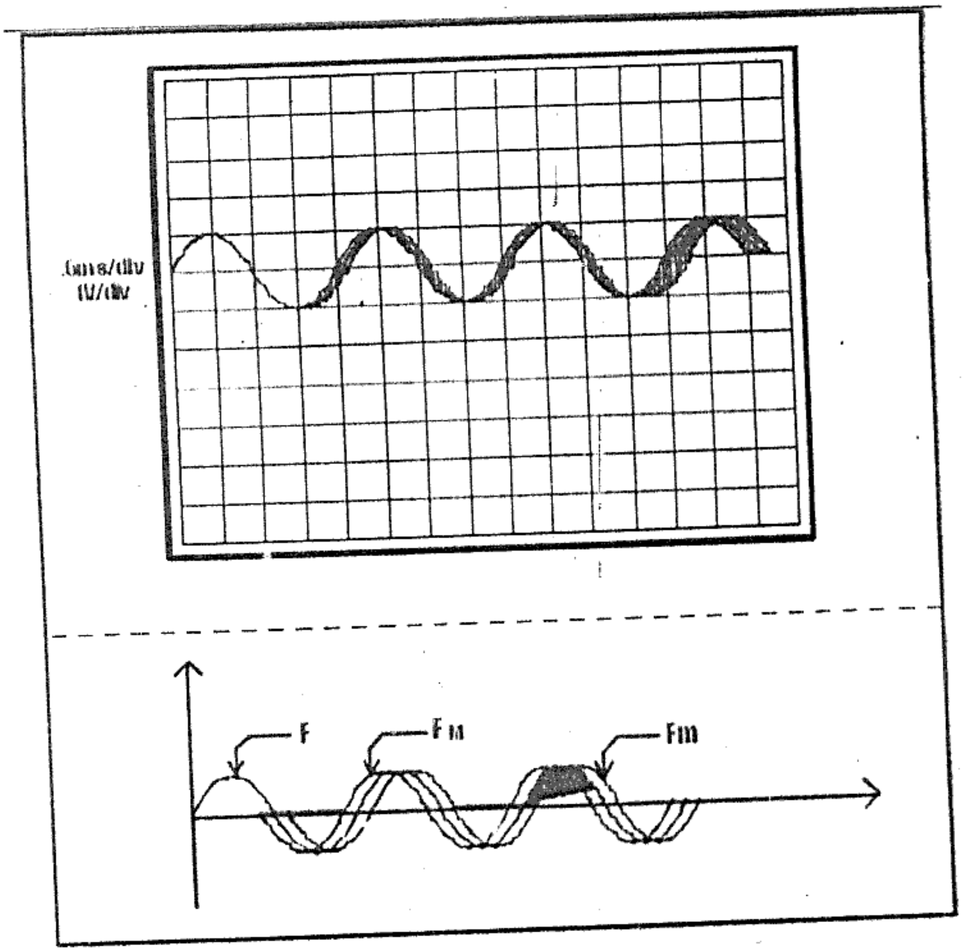


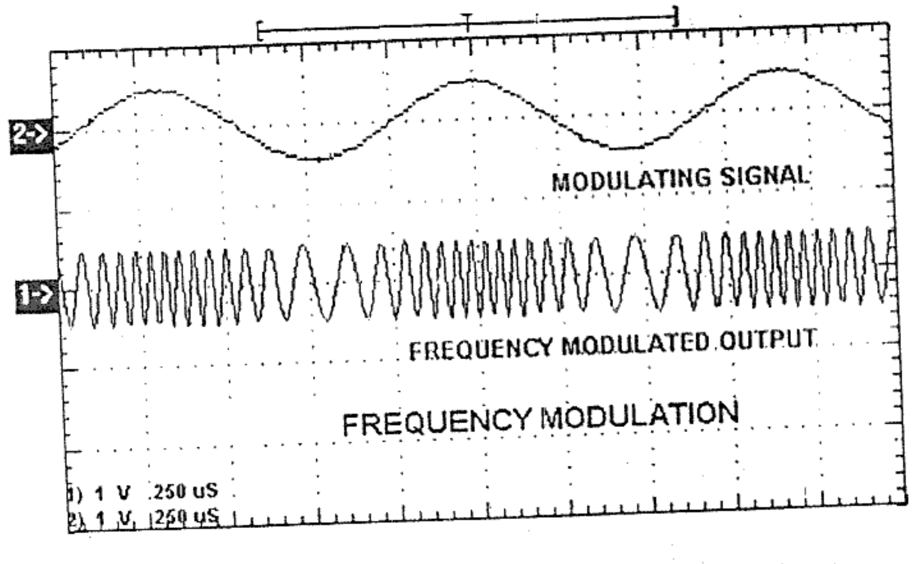
Tabular column

SIGNAL	AMPLITUDE (V)	FREQUENCY (Hz)
Message Signal		
Modulated output		
Demodulated output		

WAVEFORM:




F
Fm


2->
MODULATING SIGNAL
1->
FREQUENCY MODULATED OUTPUT
FREQUENCY MODULATION
1) 1 V .250 uS
2) 1 V .250 uS

PROCEDURE:

1) Connect the output of function generator (ACL-03) OUT post to the MOD IN (ACL-03)post.
2) Connect the output of frequency modulator FM/RF OUT post to the input of RF IIN of mixer in ACL-03.
3) Connect the power supply with proper polarity to the kit ACL-03 & ACL-04, while connecting this; ensure that the power supply is OFF.
4) Switch ON the power supply and carry out the following presetting:
   Frequency Modulator: Switch on 500khz; level about 1 Vpp; freq.about 450khz.
   Frequency demodulator in foster-seeley mode (Jumpers in FS position).
   Function generator: Sine wave (JP1); Level about 100mVpp;Freq.about 500hz.
   Local oscillator : Level about 1Vpp; freq. about 1000khz on(center).
5) Connect the local oscillator OUT to the LO IN of the mixer and mixer OUT to the Limiter IN post with the help of shorting links.
6) Then connect the limiter OUT post to the FM IN of Fooster–seeley detector and Fs OUT to the IN of Low pass filter.
7) Then observe the frequency modulated signal at FM/RF OUT post of frequency modulator and achieve the same signal by setting frequency of local oscillator at OUT post of Mixer,then observe Limiter OUT post where output is clear from moise and stabilize around a value of about 1.5Vpp.
8) Connect the oscilloscope across post FS OUT of ALC-04(detected signal) and Function generator OUT post(modulating signal) of ACL-04. If the central frequency of the discriminator and the carrier frequency of the FM signal and the local oscillator frequency coincide,you obtain two signals.The fact that there is still some high frequency ripple at the output of the FOSTER-SEELEY detector block indicates that the passive low pass filter circuit at the blocks output is not sufficient to remove this unwanted high frequency components.
9) The demodulated signal has null continuous component. Vary the amplitude of FM Signal and check that the amplitude of the detected signal varies, too.
10) Increase the carrier frequency and note that positive voltages added to the detected signal.
11) Reduce the carrier frequency towards the proper value (450 Khz). Increase the amplitude of modulating signal to generate FM Signal with frequency deviation over the linear zone of the discriminator.

RESULT:

Thus the Frequency modulation and demodulation has been performed and its output waveforms are obtained.

Ex.No:3a) PULSE WIDTH MODULATION AND DEMODULATION

AIM:

To perform the pulse width modulation and its demodulation using DCS kit.

APPARATUS REQUIRED:

Sl.No.	EQUIPMENTS	SPECIFICATION	QTY.
1.	DCS kit		1
2.	Connecting chords		As required
3.	Power supply		1
4.	Dual Trace Oscilloscope	20 MHZ	1
3.	Power connection cables	-	1

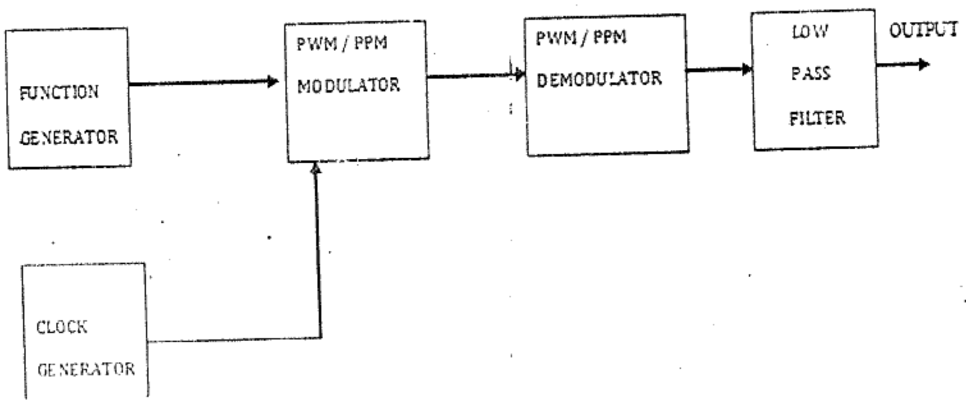
THEORY:

Pulse Width Modulation refers to a method of carrying information on a train of pulses, the information being encoded in the width of the pulses. In applications to motion control, it is not exactly information we are encoding, but a method of controlling power in motors without (significant) loss. There are several schemes to accomplish this technique. One is to switch voltage ON and OFF, and let the current recirculation through diodes when the transistors have switched OFF. Another technique is to switch voltage polarity back and forth with a full-bridge switch arrangement, with four transistors. This technique may have better linearity, since it can go right down to an effective zero percentage duty cycle by having the positive and negative voltage periods precisely equal. ON/OFF techniques may have trouble going down extremely close to 0% duty cycles and may Jitter between minimum duty cycles of positive and negative polarity.In battery system, PWM is the most effective way to achieve a constant voltage for battery charging by switching the system controllers power devices ON and OFF.

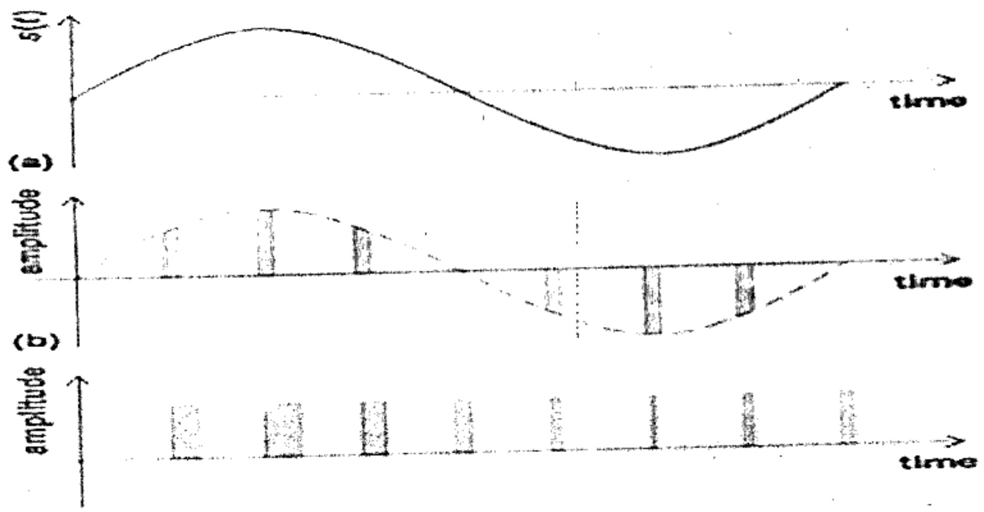
The generation of exact working PWM circuitry is complicated, but it is extremely conceptually important since there is good reason to believe that neurons transmit information using PWM spike trains.

BLOCK DIAGRAM:

PULSE WIDTH MODULATION / PULSE POSITION MODULATION



OUTPUT WAVEFORM:



Tabular column (PWM):

Slno.	Signal	Amplitude (v)	Time period(ms)	Frequency(Hz)
1.	Message signal			
2.	Modulated output			
3.	Demodulated output			

PROCEDURE:

1. Connect a low frequency sine wave from SINE OUT post having amplitude of 1Vpp,using port P2 from function generator section to the IN18 post of the PWM section.
2. Keep jumper JP2 on the position of 2nd.
3. Observe the variation in the width of the carrier at the OUT12 post of the PWM section. Change the frequency of input sine wave from 1 to 30 Hz, Using port P1 and observe the variation.
4. Now connect 1 KHz sine wave having amplitude of 1Vpp, using pot P5 to the IN18 post of the PWM section. Also, observe the counter outputs at there corresponding test points.
5. Observe the pulse width modulated output at OUT12 post of the PWM section.
6. Connect OUT12 post of PWM to the IN20 post of the PWM demodulation section.
7. Keep switch S7 to PWM position.
8. Observe the pulse width demodulation output at OUT15 post of the PWM demodulator section.
9. Connect OUT15 post of the PWM demodulator section to the IN33 post of the 2nd order LPF.
10. Connect OUT30 post of the 2nd order LPF to the IN34 of the 4th order LPF.
11. Observe the recovered signal at the OUT31 post of the 4th order LPF.
12. Repeat the experiment for different input signal and sampling clock by changing the position of the jumper JP2.

RESULT:

Thus the Pulse width Modulation and demodulation signal has been performed.

Ex.No:3b) PULSE POSITION MODULATION AND DEMODULATION

AIM:

To perform the pulse position modulation and its demodulation using DCS kit

APPARATUS REQUIRED:

Sl.No.	EQUIPMENTS	SPECIFICATION	QTY.
1.	DCS kit		1
2.	Connecting chords		As required
3.	Power supply		1
4.	Dual Trace Oscilloscope	20 MHZ	1
3.	Power connection cables	-	1

THEORY:

In this technique of modulation, the position of TTL pulse is changed on time scale, according to the variation of input, modulating signal amplitude. The pulse positions are directly proportional to the instantaneous values of the modulating signal.

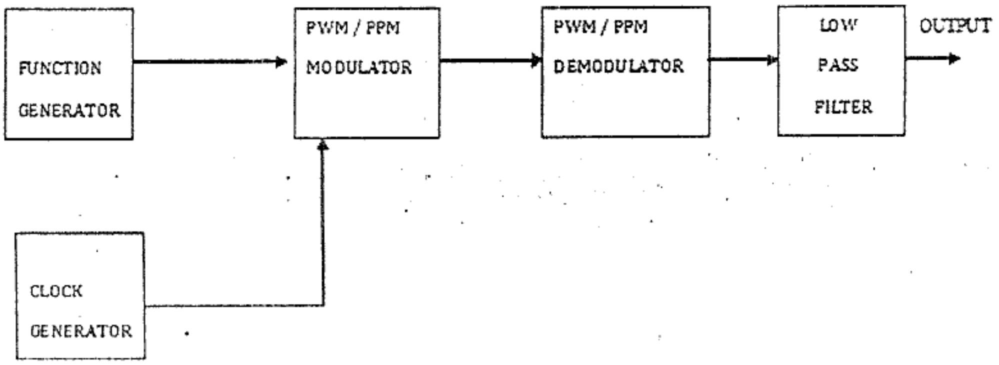
The amplitude and width of the pulse is kept constant in the system.

The position of each pulse, in relation to the position of a recurrent reference pulse, is varied by each instantaneous sampled value of the modulating wave.PPM has the advantage of requiring constant transmitter power since the pulses are of constant amplitude and duration.

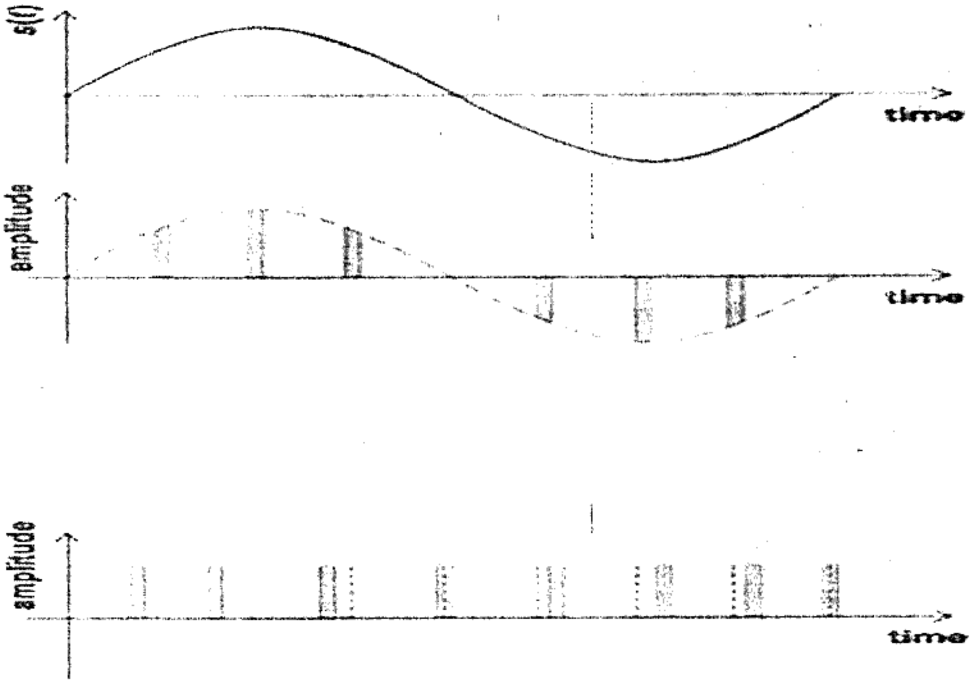
It is widely used but has a big disadvantage that it needs synchronization between the transmitter and the receiver. For generating a PPM pulse modulator can be made to trigger a monostable multivibrator. From the negative going edge of the PWM pulses. Thereby, producing a pulse of fixed height and width at the negative going edge of the PWM pulse.

BLOCK DIAGRAM:

PULSE WIDTH MODULATION / PULSE POSITION MODULATION



OUTPUT WAVE FORM



Tabular column (PPM):

Slno.	Signal	Amplitude (v)	Time period(ms)
1.	Message signal		
2.	Modulated output		
3.	Demodulated output		

PROCEDURE:

1. Connect a low frequency sine wave from SINE OUT post having amplitude of 1Vpp,using port P2 from function generator section to the IN18 post of the PPM section.
2. Keep jumper JP2 on the position of 2nd .
3. Observe the variation in the position of the carrier at the OUT13 post of the PPM section. Change the frequency of input sine wave from 1 to 30 Hz, Using port P1 and observe the variation.
4. Now connect 1KHz sine wave having amplitude of 1Vpp, using pot P5 to the IN18 post of the PWM/PPM section.
5. Observe the pulse position modulated output at OUT13 post of the PWM/PPM section. Also,observe the carrier output at their corresponding test points (Tp9 to Tp16).
6. Connect OUT13 post of PWM/PPM to the IN20 post of the PWM/PPM section.
7. Keep switch S7 to PPM position.
8. Observe the pulse width demodulation output at OUT15 post of the PWM/PPM demodulator section.
9. Connect OUT15 post of the PWM/PPM demodulator section to the IN33 post of the 2nd order LPF.
10. Connect OUT30 post of the 2nd order LPF to the IN34 of the 4th order LPF.
11. Observe the recovered signal at the OUT31 post of the 4th order LPF.
12. Repeat the experiment for different input signal and sampling clock by changing the position of the jumper JP2.

RESULT:

Thus the Pulse position Modulation and demodulation signal has been performed

LINE CODING AND DECODING

AIM:

(a) To generate the Bi-phase Manchester code and its detection.

(b) To generate the AMI code and its detection.

APPARATUS REQUIRED:

Sl.No.	EQUIPMENTS	SPECIFICATION	QTY.
1.	DCS kit		1
2.	Connecting chords		As required
3.	Power supply		1
4.	Dual Trace Oscilloscope	20 MHZ	1
3.	Power connection cables	-	1

THEORY:

Bi-phase Manchester:

The encoding rules for bi-phase Manchester code are as follows.

A data '0'is encoded as a low level during first half of the bit time and a high level during the second half. A data '1'is encoded as high level during first half of the bit time and a low level during the second half.

Thus string of 1's or 0's as well as any mixture of them will not pass any synchronization problem in receiver.

Bandwidth:

The Bi-phase Manchester code always contains atleast one transition per bit time, irrespective of the data being transmitted. Hence the maximum frequency of the Bi-phase Manchester code is equal to the data clock rate when a stream of consecutive data '1' & '0' is transmitted. Therefore the required bandwidth is same as that of the RZ code & double as that of the NRZ (L) code.

DC Level:

Since the bi-phase Manchester Code has a **high level for half of each data bit time & low** level for second half irrespective of the data, the effective DC level of the coded waveform is zero. This allows it to be used in AC coupled communication systems.

Problem in Decoding:

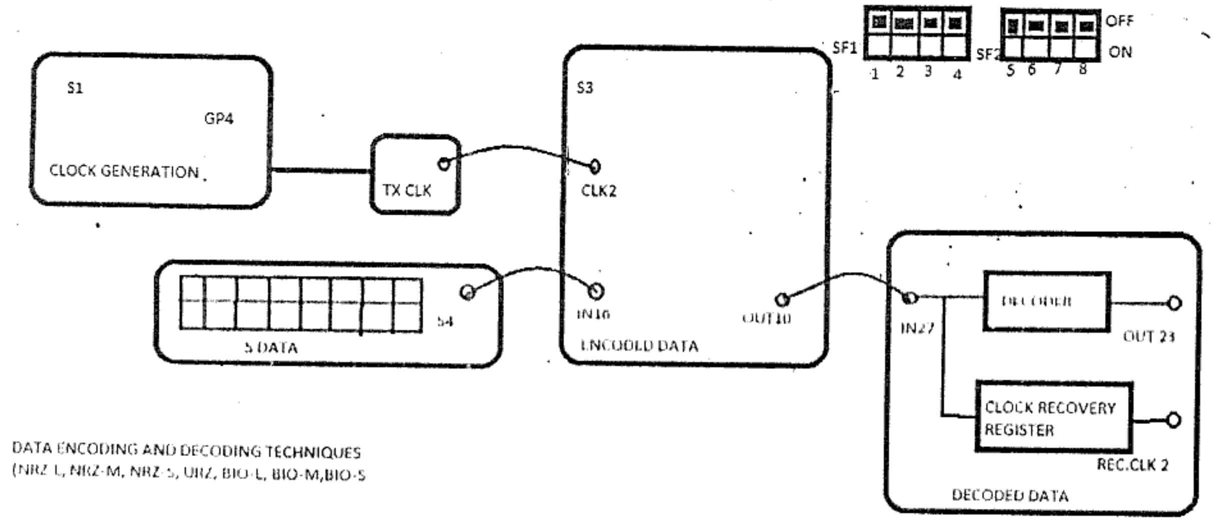
This form of coding provides plenty of rising edges for clock synchronization but they do not all occur at the same time. To overcome this, we employ a special bi-phase clock recovery circuit which can be synchronized by the rising edge occurring at either time.

Alternate - Mark Inversion (AMI):

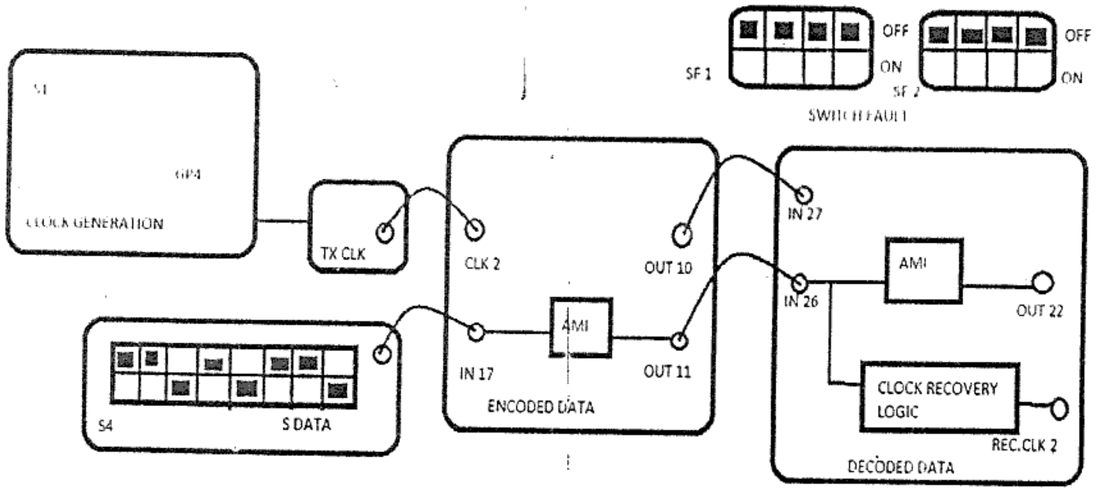
AMI being a three level code uses three levels namely, a positive voltage level, a negative voltage level and a bias level of 0 volts. AMI always returns to the bias level during second half of the bit time interval, during the first half the transmitted level can be a positive level or a negative level or a bias level , according to following coding rules.A data '0' is always represented by the bias level.

A data '1' may be represented by either a positive level or negative level, the level being chose opposite to what it was used to represent the previous data '1'. Thus we have alternating positive level and negative level. The bandwidth required is twice that required for the NRZ codes & equal to the other codes mentioned earlier. The average DC level is always zero volts for any combination of 1's and 0's.

BLOCK DIAGRAM:

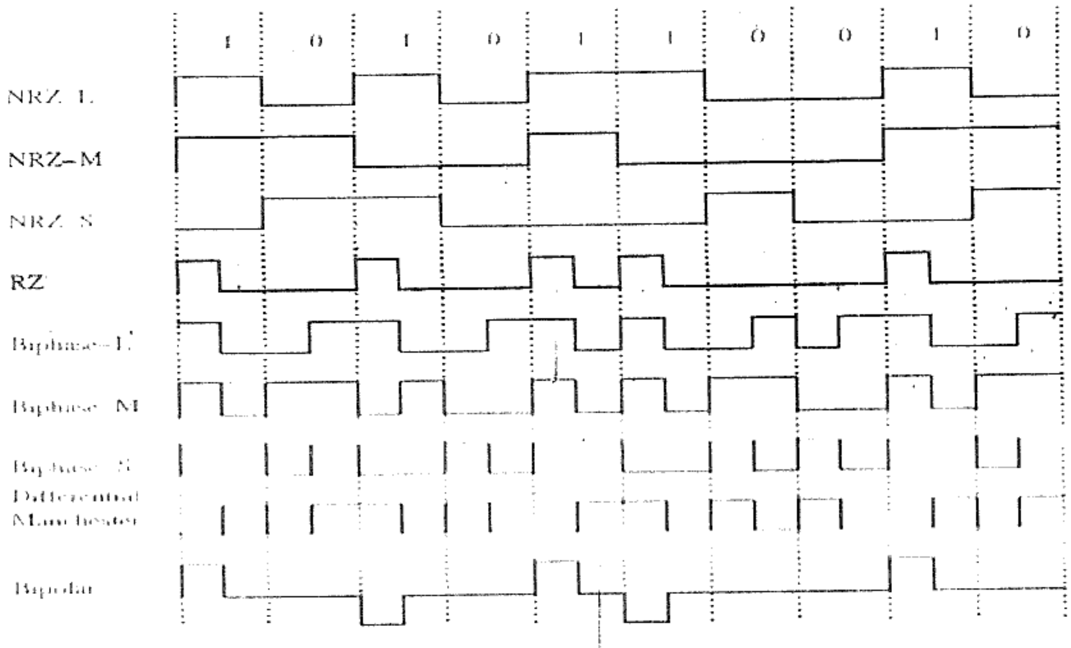


DATA ENCODING AND DECODING TECHNIQUES
(NRZ-L, NRZ-M, NRZ-S, URZ, BIO-L, BIO-M,BIO-S



AMI DATA ENCODING AND DECODING TECHNIQUES

OUTPUT WAVEFORMS:



Tabular column (Coding & Decoding):

Slno.	Signal	Amplitude (v)	Time period(ms)	Frequency(Hz)
1.	Message signal			
2.	NRZ-L Data NRZ-M Data NRZ-S Data BIO/L/SM/S Data			
3.	Modulated output			
4.	Demodulated output			

PROCEDURE:

Bi-phase Manchester code

1. Ensure the group 4 (GP4) clock is selected in the clock generation section. Selection is done with the help of switch S1. Observe the corresponding LED indication.
2. Ovserve the transmitter clock of frequency 250khz at TXCLK post.
3. Set the data pattern using switch S4 as shown in the block diagram.
4. Observe the 8-bit data pattern at S DATA post.
5. Connect S DATA to IN16 post and TXCLK to CLK2 post of the encoded data section.
6. Observe the encoded data at the OUT10 post of the encoded data section. Selection of the different encoded data's are done using switch S3. The selected encoded data is indicated on the corresponding LED indication in the encoded data section.
7. Connect OUT10 to IN27 post of the decoded data section.
8. Observe the recovered clock at REC.CLK 2 test point of the decoded data section.
9. Observe the decoded data at OUT23 post of the decoded data section.
10. We can observe the decoded data as per the selected encoded data.

Alternate - Mark Inversion (AMI):

1. Ensure the group4 (GP4) clock is selected in the clock generation section. Selection is done with the help of switch S1.
2. Observe the transmitter clock of frequency 250 KHz at TXCLK post.
3. Set the data pattern using switch S4 as shown in the block diagram.
4. Observe the 8-bit data pattern at S DATA post.
5. Connect S DATA to IN17 post and TXCLK to clk2 post of the encoded data section.
6. Observe the AMI encoded data at the OUT11 post of the encoded data section.
7. Connect OUT11 to IN26 post of the decoded data section.
8. For clock recovery connect OUT10 post of encoded data section to IN 27 post of data decoder section.
9. Select BIO-M data using switch S3 and observe the corresponding LED indication.
10. Observe the decoded AMI data at the OUT22 post of the decoded data section.

RESULT:

Thus the Bi-phase Manchester code and the AMI code have been generated and decoded.

ALert

TIME DIVISION MULTIPLEXING

Aim:

To study the time division multiplexing and demultiplexing of analog signals.

Equipments:

DCS kit

Connecting chords

20 MHz Dual Trace Oscilloscope

Theory:

TDM is a method of getting multiple data streams in a single signal by separating the signal into many segments, each having a very short duration. Each individual data stream is reassembled at the receiving end based on the timing. To maintain proper positions of sample pulses in the multiplexer, it is necessary to synchronise the sampling process. Since the sampling operations are electronic, there is a typically a clock pulse train, that serves as a reference for all samples. At the receiving end, similar clock synchronization can be derived from the received waveforms by observing the pulse sequence over many pulses and averaging the pulses. Clock synchronization does not guarantee that the proper sequence of samples is synchronized. Proper alignment of the time slot sequence requires frame synchronization. Hence one or more time slots per frame may be used to send synchronization information. Different synchronization techniques can be used. In *direct synchronization technique*, the transmitter clock and the channel identification clock are directly linked to the receiver section. Hence the transmitter and the receiver are synchronized and proper reconstruction of the signal is achieved. In *clock recovery through PLL* we recover the clock and sync from the PLL, instead of transmitting it physically from the transmitter to the receiver. In *recovery through threshold detector,* the clock and sync are recovered using the threshold detector instead of transmitting it physically from the transmitter to the receiver.

Procedure:

1) Group 2 clock, clock of frequency 32 KHz and 80 % duty cycle are selected using the corresponding switches S1, S2 and S10.

2) Four sine waves of frequency 250 Hz, 500 Hz, 1 KHz and 2 KHz having amplitude around 2Vpp from the function generator are fed as inputs to the IN7, IN8, IN9 and IN10 posts of the analog multiplexer.

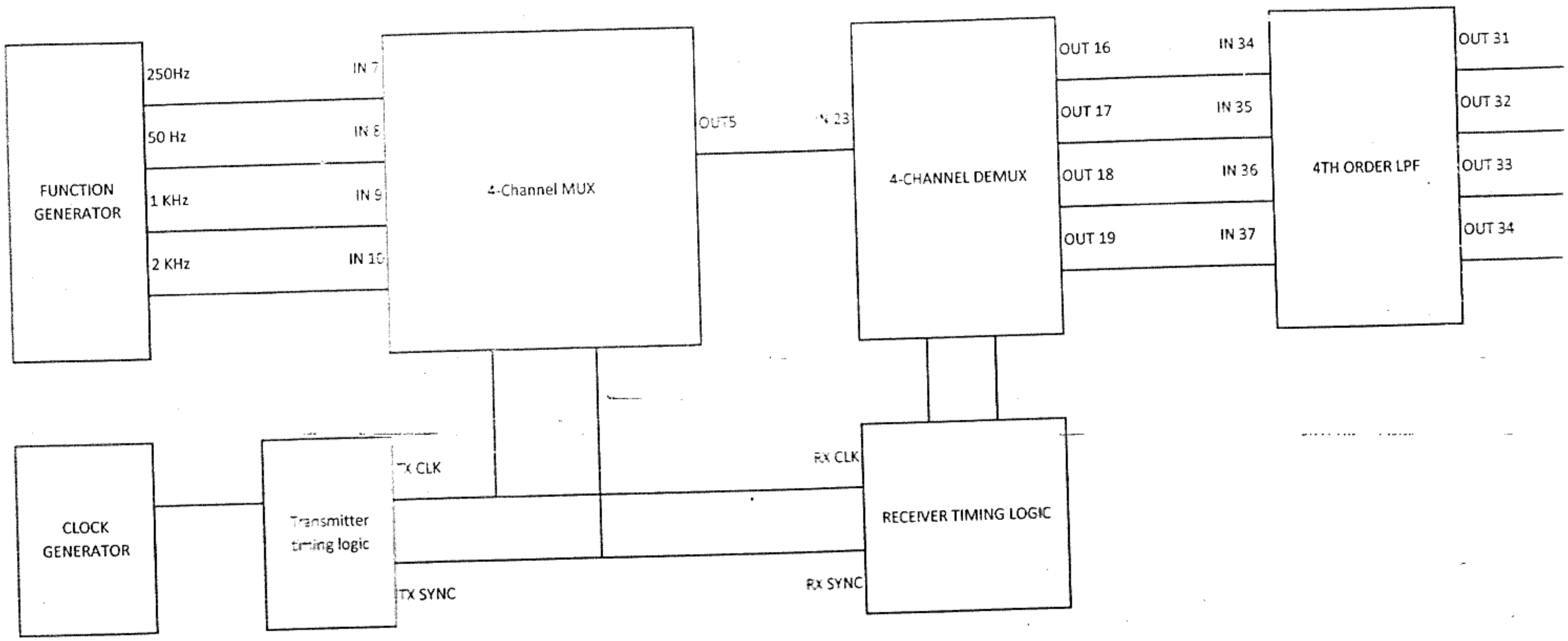
3) The TDM output is observed at the output post OUT 5 of the 4-channel multiplexer section.

4) The TDM output is connected to the IN 23 input of the 4-channel demultiplexer.

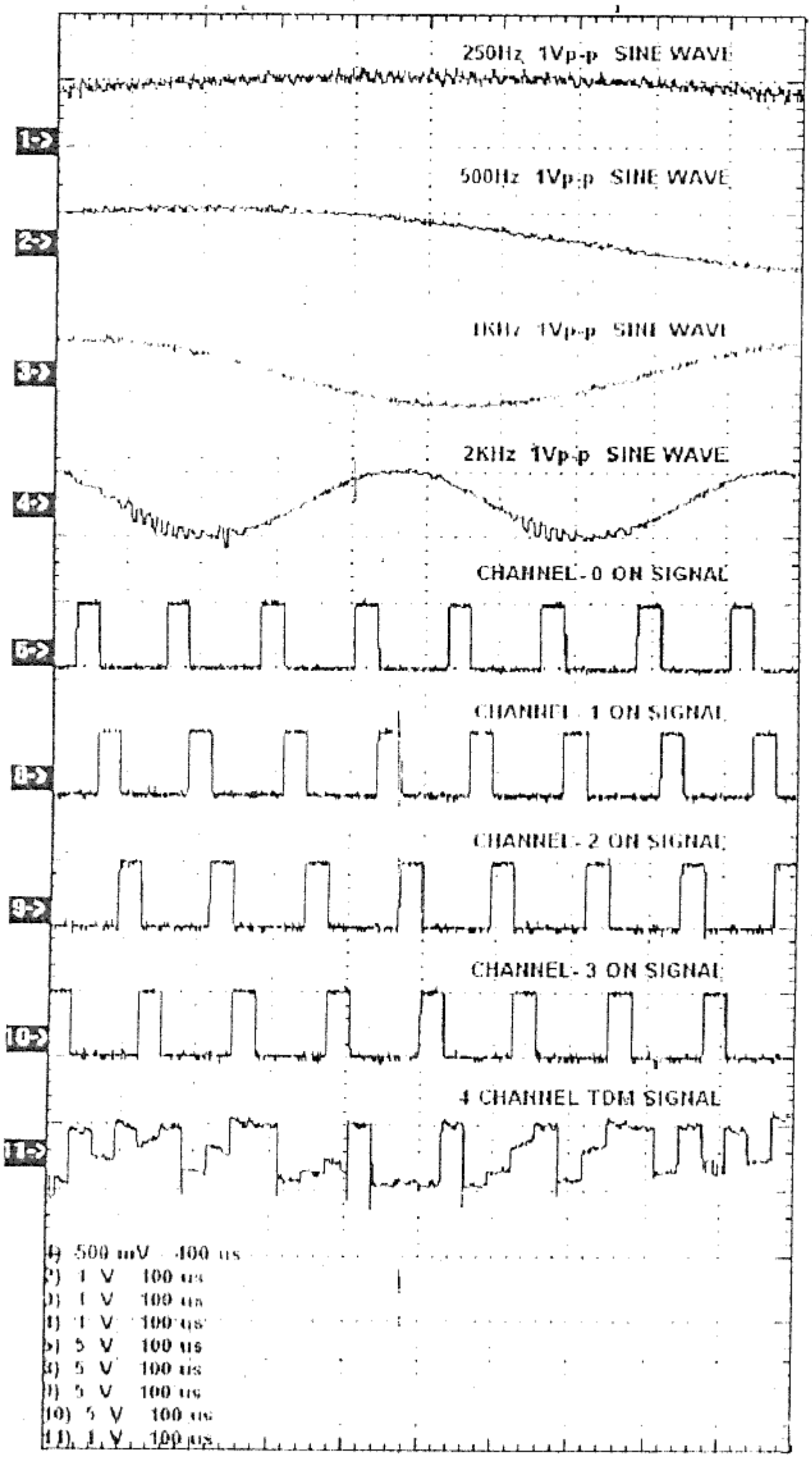
5)To provide the timing and synchronization information to the receiver section, the transmitter clock and sync are connected physically to the receiver clock and sync. This is done by connecting the TXCLK to RXCLK and TXSYNC to RXSYNC. The four demultiplexed signals can be observed from the output posts OUT 31, OUT 21, OUT 33 and OUT 34 of the 4-channel demux section.

Result:

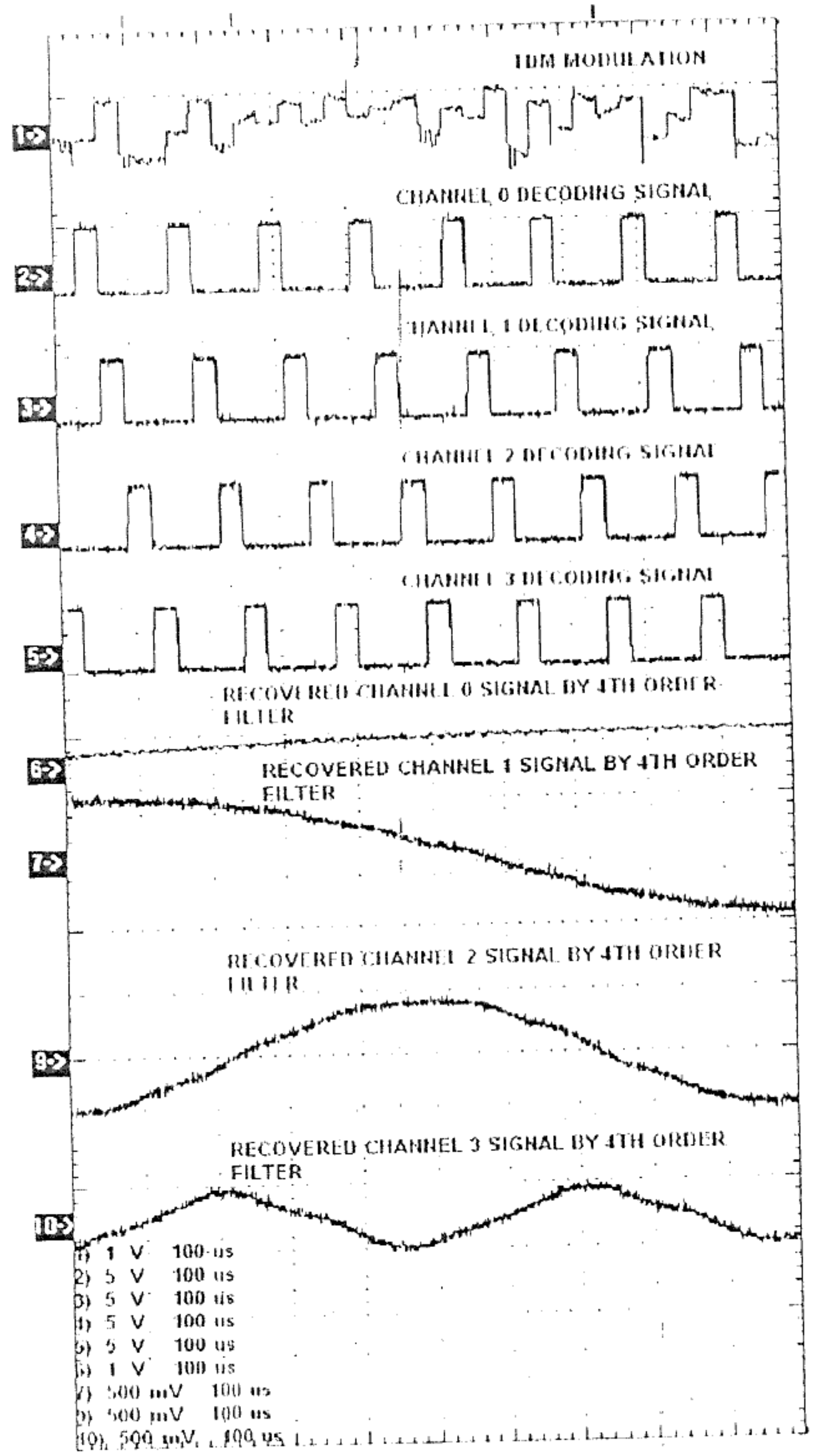
Thus the time division multiplexing and de multiplexing of analog signals have been observed.



FUNCTION GENERATOR
250Hz
50 Hz
1 KHz
2 KHz
IN 7
IN 8
IN 9
IN 10
4-Channel MUX
OUT5
IN 23
4-CHANNEL DEMUX
OUT 16
OUT 17
OUT 18
OUT 19
IN 34
IN 35
IN 36
IN 37
4TH ORDER LPF
OUT 31
OUT 32
OUT 33
OUT 34
CLOCK GENERATOR
Transmitter timing logic
TX CLK
TX SYNC
RX CLK
RX SYNC
RECEIVER TIMING LOGIC



250Hz 1Vp-p SINE WAVE
500Hz 1Vp-p SINE WAVE
1KHz 1Vp-p SINE WAVE
2KHz 1Vp-p SINE WAVE
CHANNEL- 0 ON SIGNAL
CHANNEL- 1 ON SIGNAL
CHANNEL- 2 ON SIGNAL
CHANNEL- 3 ON SIGNAL
4 CHANNEL TDM SIGNAL



TDM MODULATION
CHANNEL 0 DECODING SIGNAL
CHANNEL 1 DECODING SIGNAL
CHANNEL 2 DECODING SIGNAL
CHANNEL 3 DECODING SIGNAL
RECOVERED CHANNEL 0 SIGNAL BY 4TH ORDER FILTER
RECOVERED CHANNEL 1 SIGNAL BY 4TH ORDER FILTER
RECOVERED CHANNEL 2 SIGNAL BY 4TH ORDER FILTER
RECOVERED CHANNEL 3 SIGNAL BY 4TH ORDER FILTER
1) 1 V 100 us
2) 5 V 100 us
3) 5 V 100 us
4) 5 V 100 us
5) 5 V 100 us
6) 1 V 100 us
7) 500 mV 100 us
9) 500 mV 100 us
10) 500 mV 100 us

Altaf

(1)

SAMPLING AND RECONSTRUCTION

Aim:

a) To study different types of signal samplings and their reconstruction.

b) To study the effect of changing sampling frequencies and duty cycles on the sampling and reconstructed signal.

Equipments:

DCS kit

Connecting chords

20 MHz Dual Trace Oscilloscope

Theory:

Types of Sampling

Natural Sampling

In the analogue-to-digital conversion process an analogue waveform is sampled to form a series of pulses whose amplitude is the amplitude of the sampled waveform at the time the sample was taken. In natural sampling the pulse amplitude takes the shape of the analogue waveform for the period of the sampling pulse. With natural sampling, a signal sampled at the nyquist rate may be reconstructed exactly by passing the samples through an ideal low pass filter with cut off frequency fm, where fm is the highest frequency component of the signal.

Flat top sampling

In flat top sampling, the continuous analogue waveform is converted into a series of pulses whose amplitude is equal to the amplitude of the analogue signal at the start of the sampling process. Since the sampled pulses have uniform amplitude, the process is called flat top sampling. Flat top sampling simplifies the design of the electronic circuitry used to perform the sampling information. In flat top sampling the signal is arbitrarily sampled at the beginning of the pulse. In sampling of this type, the original analog signal cannot be recovered exactly by simply passing the samples through an ideal low pass filter. However the distortion need not be large.

Sample and Hold:

Sample and hold circuit is used to interface real world, changing analogue signals to a subsequent system such as an ADC. The purpose is to hold the analogue value steady for a short time while the converter or other following system performs some operation that takes a little time. In most circuits a capacitor is used to store the analog voltage and an electronic gate is used to alternatively connect and disconnect the capacitor from the analog input. The rate at which this switch is operated is the sampling rate of the system. Compared with natural sampling and flat top sampling, the output of the sample and hold is the best.

Effect of changing sampling frequencies:

The sampling theorem states that a signal can be exactly reproduced if it is sampled at a frequency which is greater than the maximum frequency in the signal. If the signal is sampled at a lower rate and is converted back into a continuous time signal, it will exhibit a phenomenon called aliasing. Aliasing is the presence of unwanted components in the reconstructed signal. In addition, some of the frequencies in the original signal may be lost in the reconstructed signal. Aliasing occurs because signal frequencies can overlap if the sampling frequency is too low. If the sampling frequency is increased the reconstructed output is less distorted and almost original signal is reconstructed.

Effect of changing duty cycle:

Duty cycle represents the time period over which the signal information is obtained. Hence as the duty cycle increases the sampling time is more. Hence the reconstructed signal amplitude approaches that of the original signal.

Procedure:

Types of Sampling

1) Group 1 clock is selected in the clock generation section, with the help of the corresponding switch S1.

2) Sampling clock of frequency (2/4/8/16/32/64/128 KHz) is selected using the corresponding switch S2.

3) Adjust the duty cycle of the sampling clock to 50% using the corresponding dipswitch S10.

4) Select the signal to be sampled from the function generator section and connect to input pin IN1 of the sampling section.

5) Observe the input signal and the sampling clock.

6) Connect TX CLK post from the clock generation section to CLK 1 post of the sampling section.

7) Short the jumper JP1 to NS position for selecting ***natural sampling*** and observe the natural sampling output. Observe the reconstructed output by feeding this sampled output to a fourth order low pass filter.

8) Short the jumper JP1 to FT position for selecting ***flat top sampling*** and observe the flat top sampling output. Observe the reconstructed output by feeding this sampled output to a fourth order low pass filter.

9) Short the jumper JP1 to SH position for selecting ***sample & hold*** and observe the sample and hold output. Observe the reconstructed output by feeding this sampled output to a fourth order low pass filter.

Effect of sampling frequencies:

Select a sampling clock of frequency (2/4/8/16/32/64/128 KHz) and observe the sampled and reconstructed outputs.

Select a higher sampling frequency and observe the sampled and reconstructed outputs.

Effect of duty cycle:

Select a sampling clock of frequency (2/4/8/16/32/64/128 KHz).

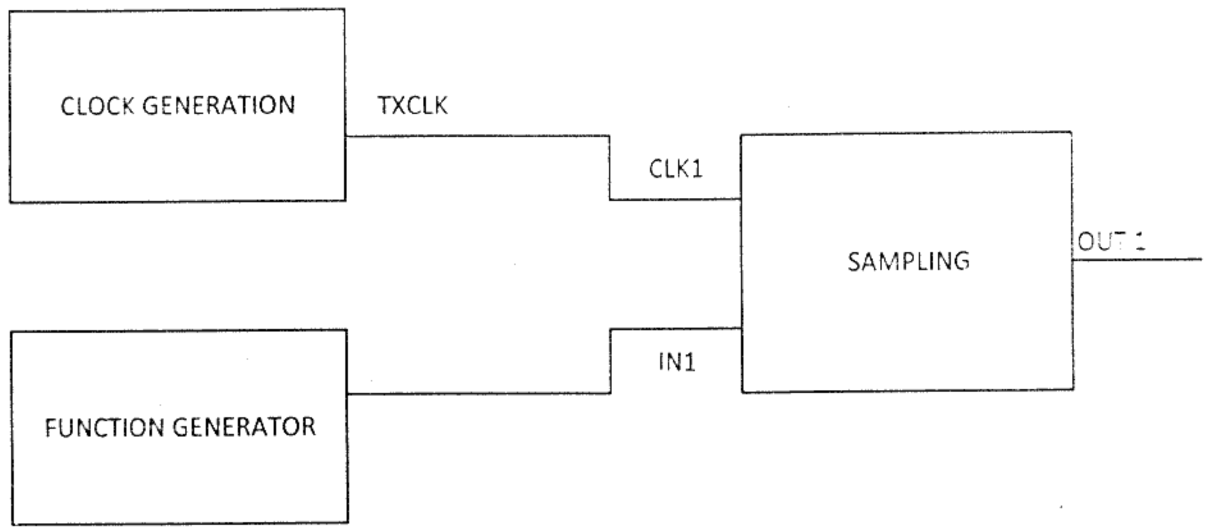
Select sample & hold sampling.

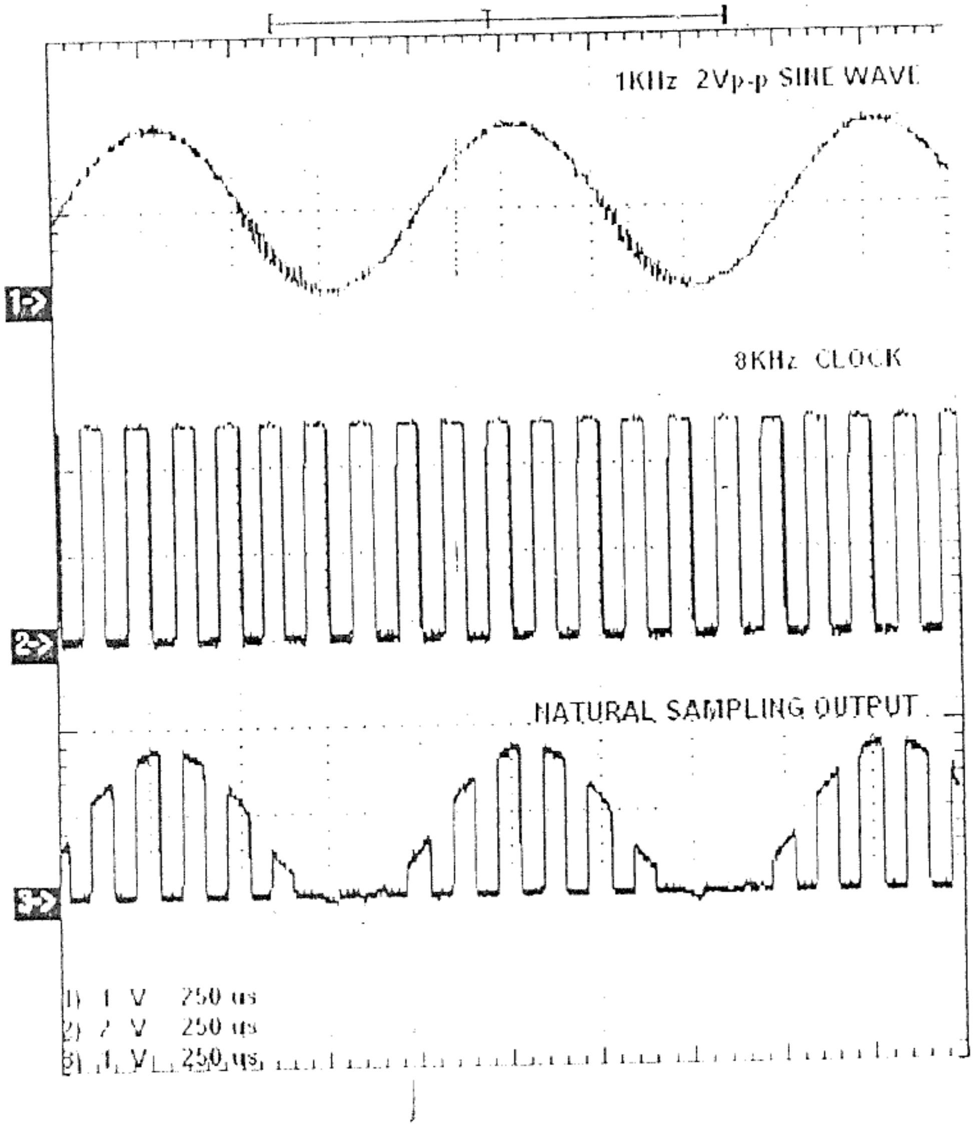
Select a duty cycle of 10%. Observe the sampled output and the reconstructed outputs.

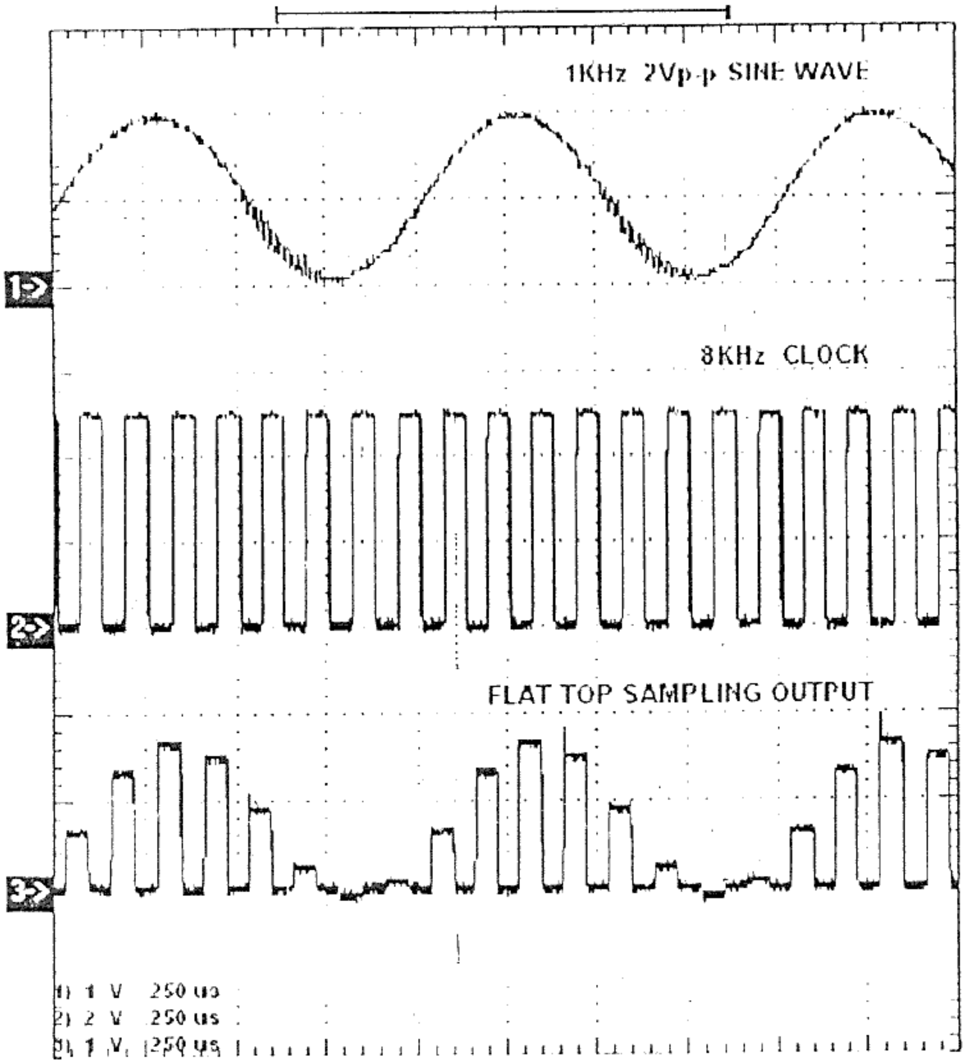
Increase the duty cycle to 90% and observe the difference.

Result:

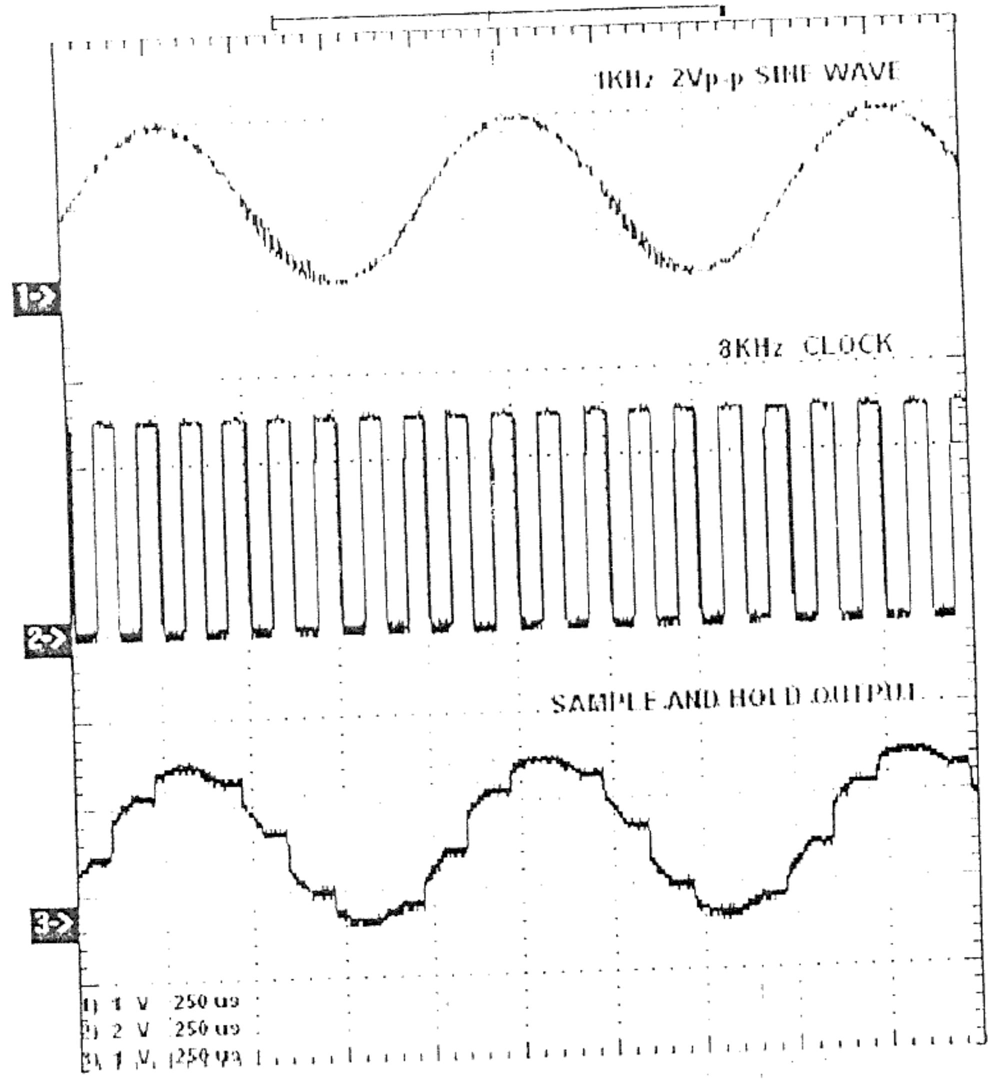
Thus the different types of sampling and effects of changing sampling frequency and duty cycle were observed.

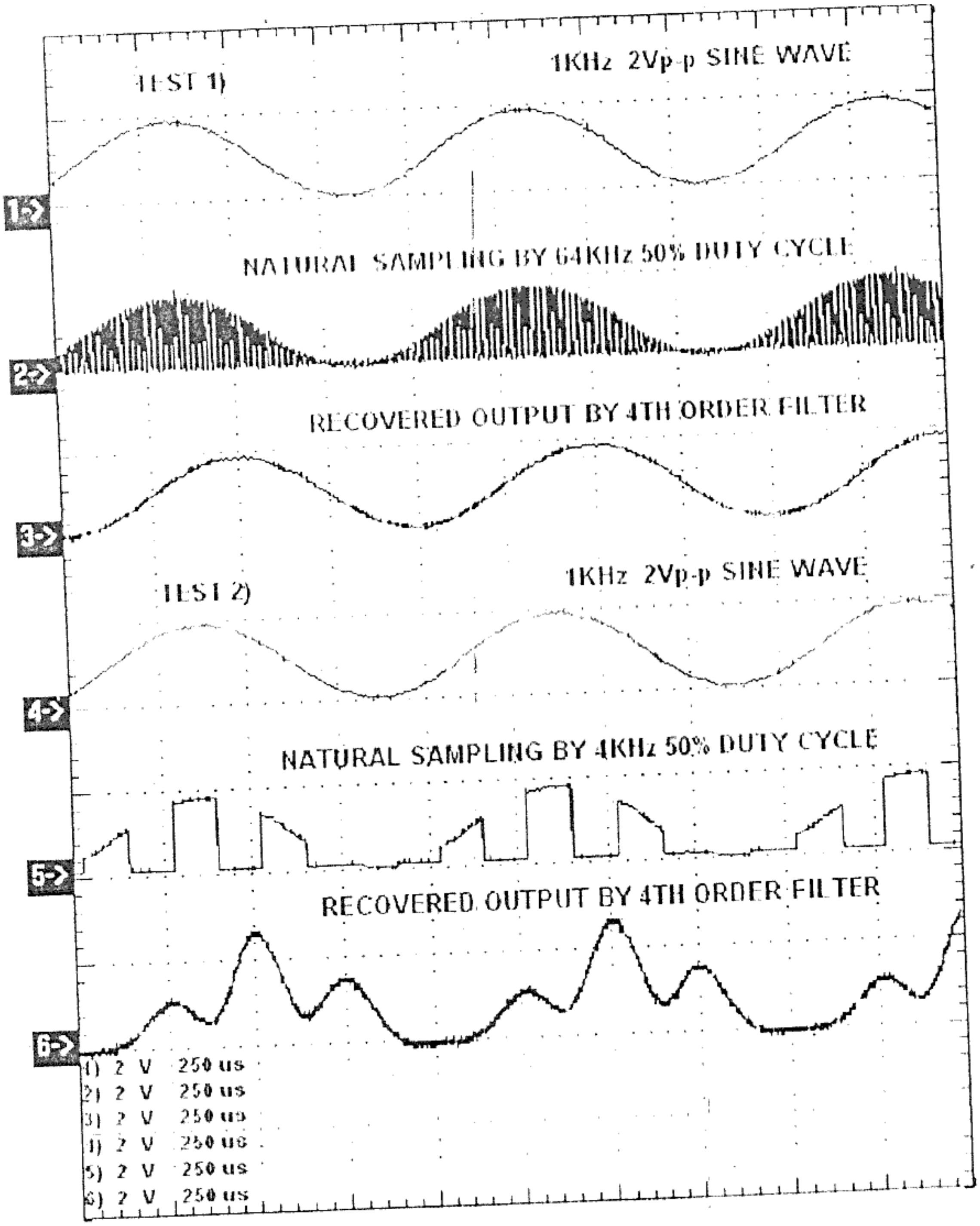

CLOCK GENERATION
TXCLK
CLK1
SAMPLING
OUT 1
IN1
FUNCTION GENERATOR

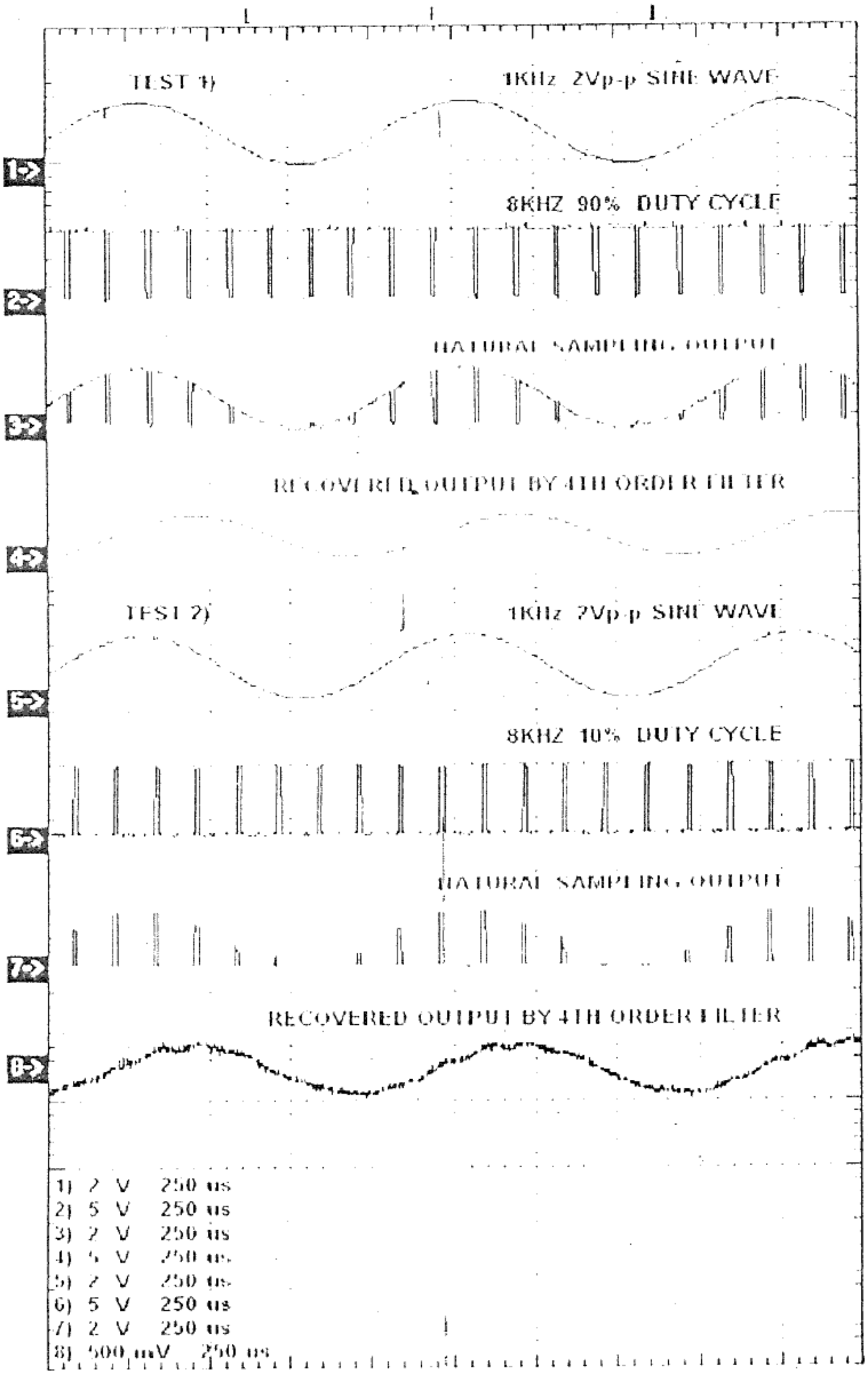

1KHz 2Vp-p SINE WAVE
8KHz CLOCK
NATURAL SAMPLING OUTPUT
1) 1 V 250 us
2) 2 V 250 us
3) 1 V 250 us



1KHz 2Vp-p SINE WAVE
8KHz CLOCK
FLAT TOP SAMPLING OUTPUT
1) 1 V 250 us
2) 2 V 250 us
3) 1 V 250 us


1KHz 2Vp-p SINE WAVE
8KHz CLOCK
SAMPLE AND HOLD OUTPUT
1) 1 V 250 us
2) 2 V 250 us
3) 1 V 250 us


TEST 1)
1KHz 2Vp-p SINE WAVE
NATURAL SAMPLING BY 64KHz 50% DUTY CYCLE
RECOVERED OUTPUT BY 4TH ORDER FILTER
TEST 2)
1KHz 2Vp-p SINE WAVE
NATURAL SAMPLING BY 4KHz 50% DUTY CYCLE
RECOVERED OUTPUT BY 4TH ORDER FILTER
1) 2 V 250 us
2) 2 V 250 us
3) 2 V 250 us
4) 2 V 250 us
5) 2 V 250 us
6) 2 V 250 us



TEST 1)
1KHz 2Vp-p SINE WAVE
8KHZ 90% DUTY CYCLE
NATURAL SAMPLING OUTPUT
RECOVERED OUTPUT BY 4TH ORDER FILTER
TEST 2)
1KHz 2Vp-p SINE WAVE
8KHZ 10% DUTY CYCLE
NATURAL SAMPLING OUTPUT
RECOVERED OUTPUT BY 4TH ORDER FILTER
1) 2 V 250 us
2) 5 V 250 us
3) 2 V 250 us
4) 5 V 250 us
5) 2 V 250 us
6) 5 V 250 us
7) 2 V 250 us
8) 500 mV 250 us