SIR C.R.REDDY COLLEGE OF ENGG

ELURU-534007

DEPARTMENT OF
ELECTRONICS AND COMMUINICATION AND ENGINEERING

COMMUNICATION ENGINEERING LAB MANNUAL
M.Tech, Communication systems (ECE)

SIR C.R.REDDY COLLEGE OF ENGINEERING
ELURU-534007

Sir. C.R.R College of Engineering, Eluru
Department of Electronics & communication engineering
M-Tech (communication engineering lab)
List of experiments

1) study of consolation diagram of Quadrature Phase Shift Keying (QPSK) modulation and demodulation

2) study of data scrambling and unscrambling technique

3) Study of Eye Pattern

4) Study of spectrum by using spectral analyzer
   a) Sine wave
   b) Square wave
   c) Triangular wave

5) Time division multiplexing and framing in the TDM

6) Study of Manchester coder – decoder

7) Measurement of various losses in optical fibers

8) Study of micro-strip components (S-band)
   a) Directional coupler
   b) Power divider
   c) Ring resonator

9) Study of micro-strip antenna Radiation patterns
   a) Yagi - uda antenna
   b) Dipole antenna
   c) Patch antenna

10) Measurement of satellite communication

   a) set up an active and passive link

   b) measure the base band analog signal parameters

   c) measure the C/N ratio

11) simulation of digital communication modulator / demodulator using MATLAB simulink

12) simulation of channel coding / decoding using MATLAB simulink

EXPERIMENT NO. 1

STUDY OF QPSK MODULATION AND DEMODULATION

OBJECTIVE:
To study Quadrature Phase Shift Keying modulation and demodulation

EQUIPMENTS:
DCS-02 board and its power supply

THEORY:
QPSK Sometimes known as quaternary or quadriphase PSK, 4-PSK, or 4-QAM, QPSK uses four points on the constellation diagram, equispaced around a circle. With four phases, QPSK can encode two bits per symbol, shown in the diagram with Gray coding to minimize the BER — twice the rate of BPSK. Analysis shows that this may be used either to double the data rate compared to a BPSK system while maintaining the bandwidth of the signal or to maintain the data-rate of BPSK but halve the bandwidth needed. As with BPSK, there are phase ambiguity problems at the receiver and differentially encoded QPSK is used more often in practice Implementation The implementation of QPSK is more general than that of BPSK and also indicates the implementation of higher-order PSK. Writing the symbols in the constellation diagram in terms of the sine and cosine waves used to transmit them

$$s_i(t) = \sqrt{\frac{2E_s}{T}} \cos\left(2\pi f_c t + (2i-1)\frac{\pi}{4}\right), \quad i = 1, 2, 3, 4.$$

This yields the four phases π/4, 3π/4, 5π/4 and 7π/4 as needed. This results in a two-dimensional signal space with unit basis functions

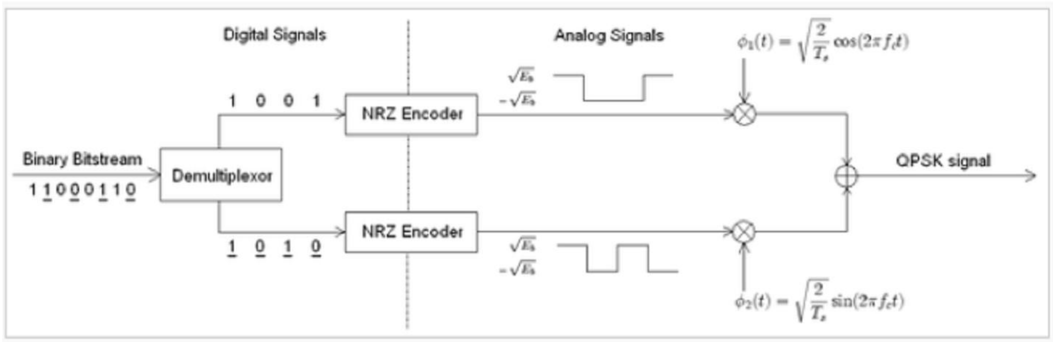
$$\phi_1(t) = \sqrt{\frac{2}{T_s}} \cos(2\pi f_c t)$$

$$\phi_2(t) = \sqrt{\frac{2}{T_s}} \sin(2\pi f_c t)$$

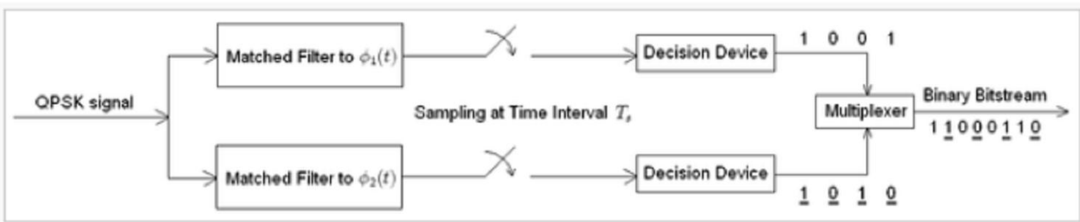
The first basis function is used as the in-phase component of the signal and the second as the quadrature component of the signal. Hence, the signal installation consists of the signal-space 4 points

$$\left(\pm\sqrt{E_s/2}, \pm\sqrt{E_s/2}\right).$$

The factors of 1/2 indicate that the total power is split equally between the two carriers. Comparing this basis function with that for BPSK shows clearly how QPSK can be viewed as two independent BPSK signals. QPSK systems can be implemented in a umber of ways. An illustration of the major components of the transmitter and receiver structure are shown below



Conceptual transmitter structure for QPSK. The binary data stream is split into the in-phase and quadrature-phase components. These are then separately modulated onto two orthogonal basis functions. In this implementation, two sinusoids are used. Afterwards, the two signals are superimposed, and the resulting signal is the QPSK signal. Note the use of polar non-return-to-zero encoding. These encoders can be placed before for binary data source, but have been placed after to illustrate the conceptual difference between digital and analog signals involved with digital modulation.



Receiver structure for QPSK. The matched filters can be replaced with orrelators.Each detection device uses a reference threshold value to determine whether a 1 or 0 is detected.

Bit error rate Although QPSK can be viewed as a quaternary modulation, it is easier to see it as two independently modulated quadrature carriers. With this interpretation, the even (or odd) bits are used to modulate the in-phase component of the carrier, while the odd (or even) bits are used to modulate the quadrature-phase component of the carrier. BPSK is used on both carriers and they can be independently demodulated. As a result, the probability of bit-error for QPSK is the same as for BPSK

PROCEDURE:

1) Do the Connections as per block diagram shown.
2) Connect the power supply to the kit and switch it ON.
3) Select the QPSK Experiment using SW1. Observe the corresponding LED indication.
4) Select 8 bit data pattern for modulation using SW6. Observe the corresponding LED indication.
5) Set the data pattern as shown in block diagram using SW3.Odserve the 8 bit serial data at SERIAL DATA post
6) Observe the carrier used for modulation at SIN 1, SIN 2, SIN3 and SIN4 posts.

7) Connect SERIAL DATA to DATA IN 2 of DIBIT ENCODER section. Observe the Clock at CLK2 post. Compare the dibit encoded data at EVEN and ODD post with. EVEN CLK and ODD CLK respectively
8) Connect EVEN and ODD post to C1 and C2 respectively in CARRIER MODULATOR post.
9) Observe QPSK modulated signal at MOD OUT post of CARRIER MODULATOR. Compare modulated signal with EVEN and ODD of DIBIT ENCODER.
10) To Demodulate the QPSK signal Connect MOD OUT to IN23 in QPSK DEMODULATOR section.
11) Observe the demodulated EVEN and ODD signal at test point provided.
12) Observe the decoded signal at OUT 22 of QPSK DEMODULATOR and Compare it with original signal i.e with signal at SERIAL DATA.
13) To observe the constellation diagram connect X and Y test points from

CONSTELLATION OUTPUT section to X and Y channel OF CRO. Keep CRO in XY mode.

NOTE: observe the intermediate signals during QPSK demodulation at

TP1. Change the jumper position to observe other signal.

OBSERVATION:

1. Input Data at SERIAL DATA.
2. Carrier frequency SIN 1 to SIN 4
3. Dibit Clock EVEN CLK and ODD CLK
4. Dibit generated data I bit & Q bit at DIBIT ENCODER.
5. QPSK modulated signal at MOD OUT.
6. Intermediate signal during demodulation at TP1.
7. Recovered data bits (Even & Odd bits) at EVEN and ODD test points.
8. Recovered data from Even & Odd bits at OUT 22, the output of DATA DECODER.

CONCLUSION:

In BPSK we deal individually with each bit of duration Tb. In QPSK we lump two bits together to form a SYMBOL. The symbol can have any one of four possible values corresponding to two-bit sequence 00, 01, 10, and 11. We therefore arrange to make available for transmission four distinct signals. At the receiver each signal represents one symbol and, correspondingly, two bits. When bits are transmitted, as in BPSK, the signal changes occur at the bit rate. When symbols are transmitted the changes occur at the symbol rate which is one-half the bit rate. Thus the symbol time is Ts = 2Tb.

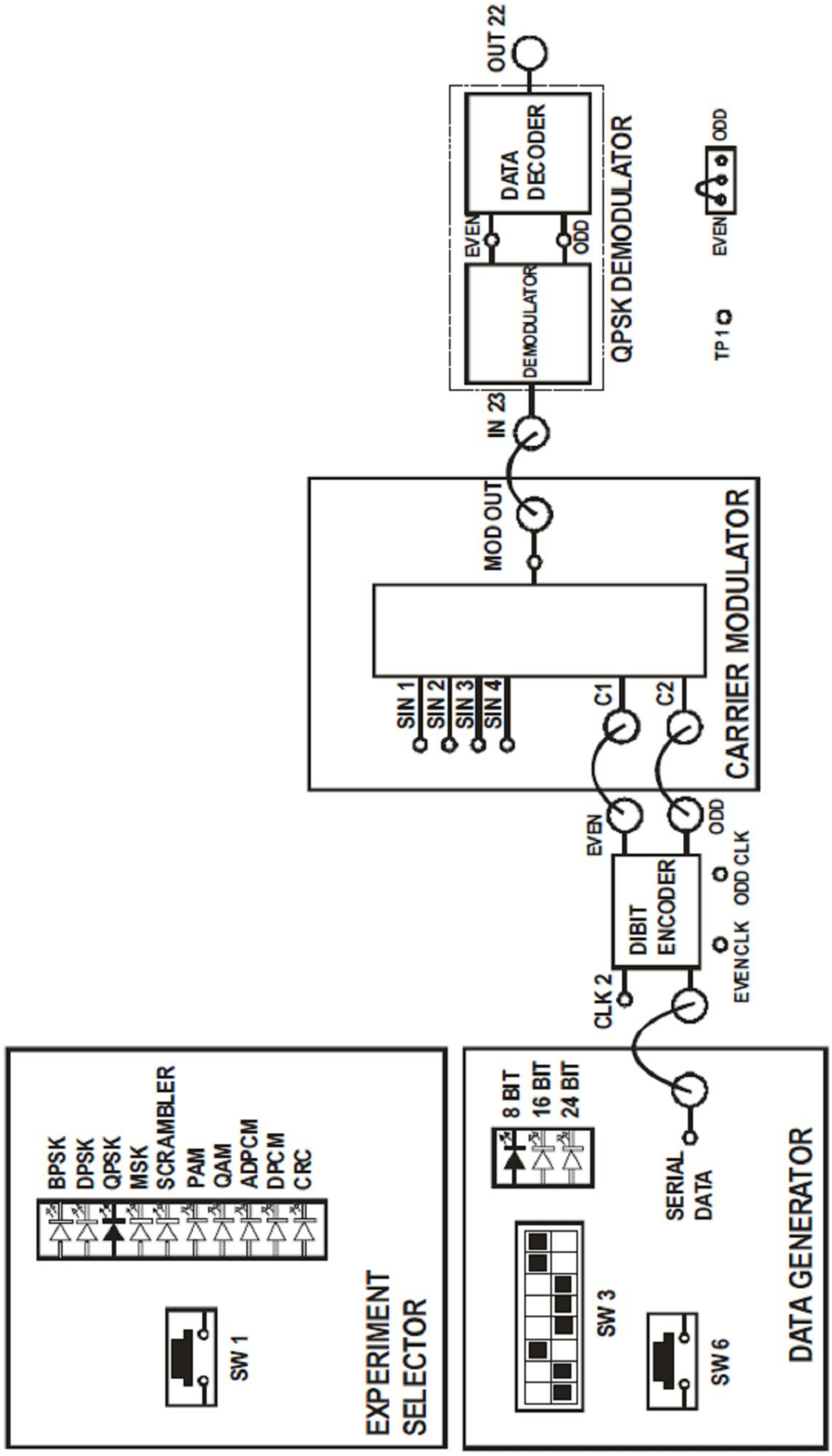
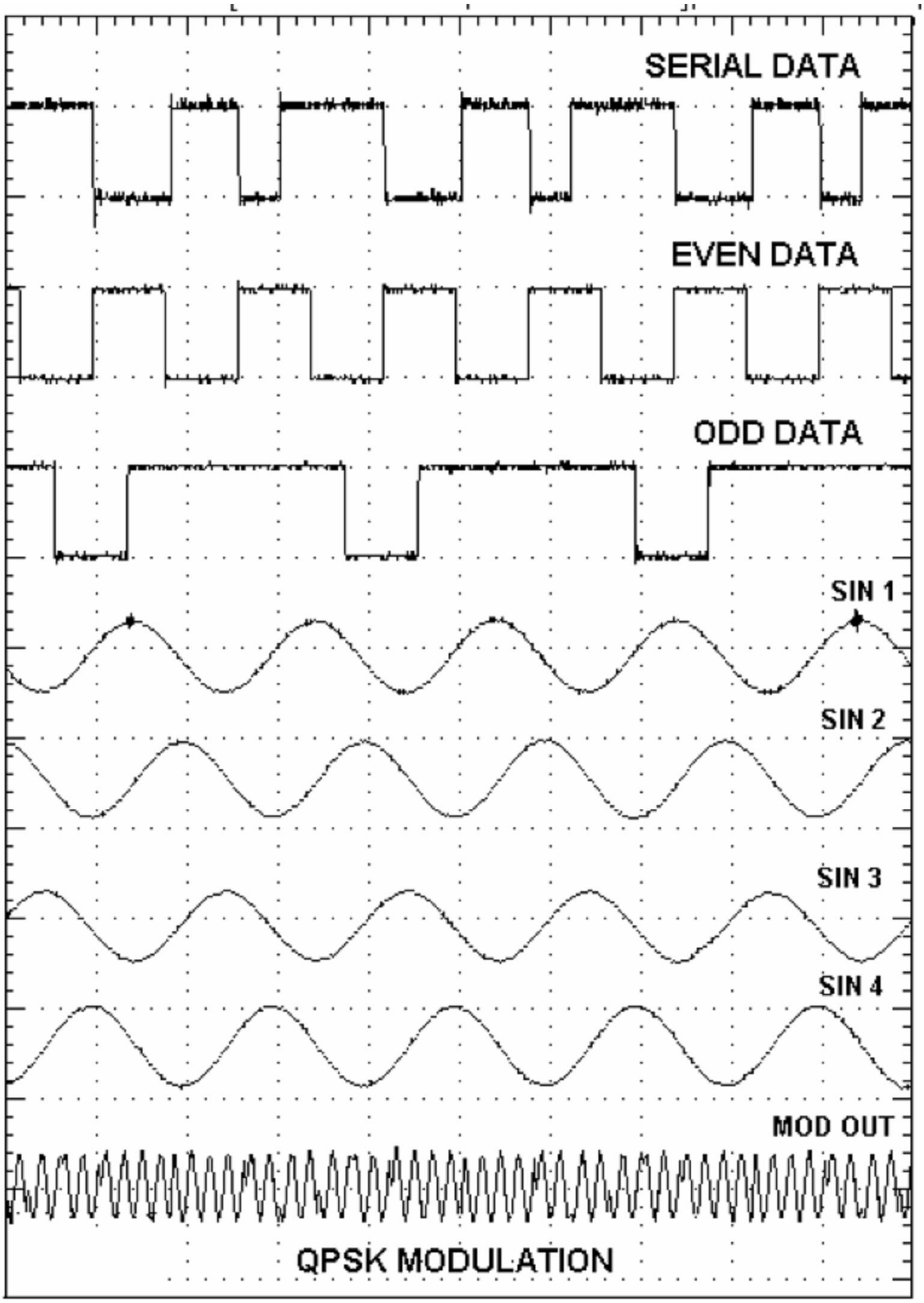
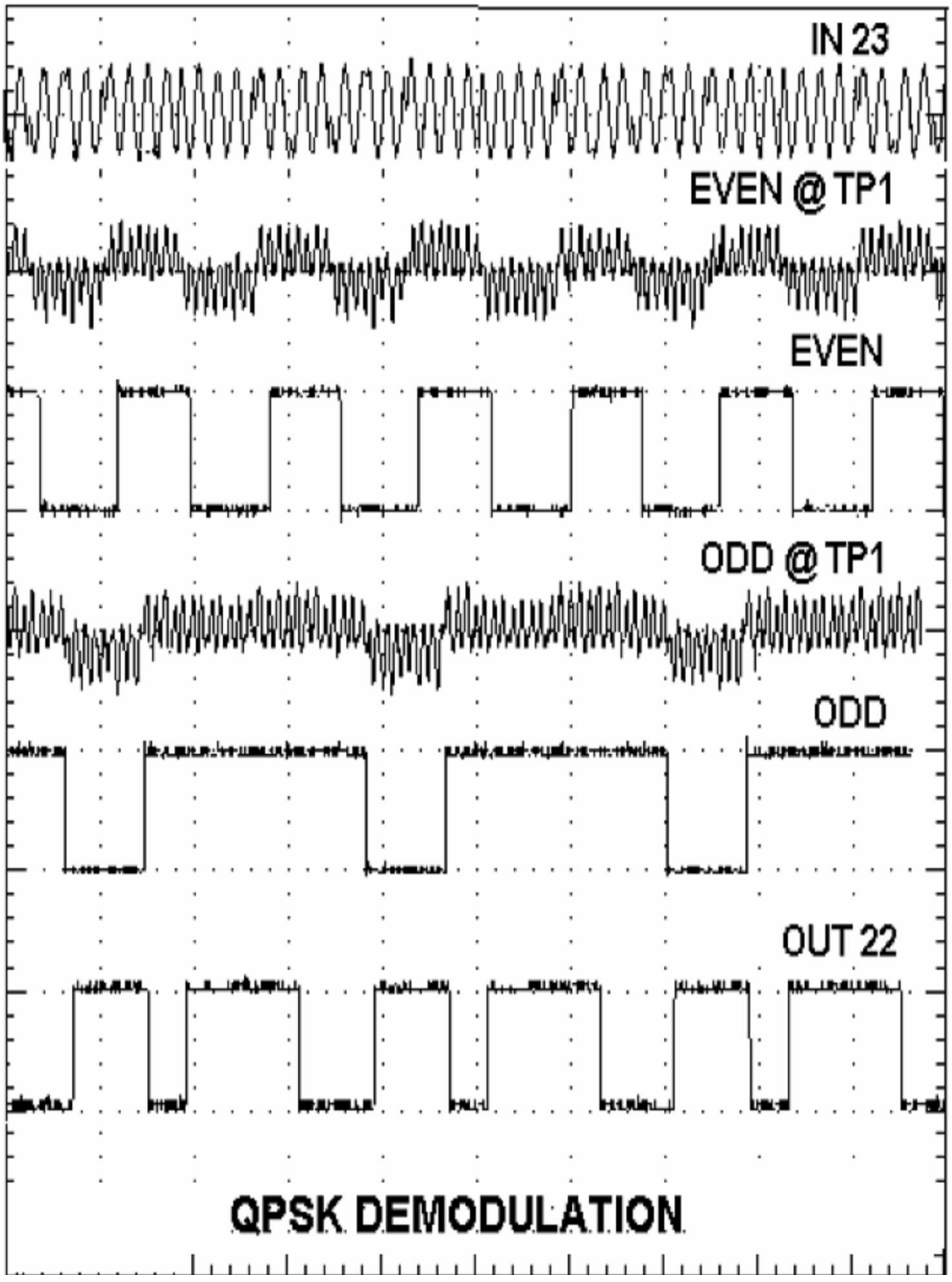


FIG 3.BLOCK DIAGRAM FOR QPSK MODULATION AND DEMODULATION

Modal graphs:
<u>QPSK MODULATION</u>



QPSK DEMODLATION



EXPERIMENT NO. 2

DATA SCRAMBLER
STUDY OF SCRAMBLER AND UNSCRAMBLER

OBJECTIVE:
To study data scrambling and unscrambling technique

EQUIPMENTS:
DCS-02 board and its power supply

THEORY:
Scrambling is a coding operation applied to the message at the transmitter that "randomizes" the bit stream, eliminating long strings of like bits that might impair receiver synchronization. Scrambling also eliminates most periodic bit patterns that could produce undesirable discrete frequency components in the power spectrum. Needless to say, the scrambled sequence must be unscrambled at the receiver so as to preserve all bit sequence transparency. Simple but effective scramblers and unscrambles are built from shift registers.

MESSAGE SCRAMBLING AND UNSCRAMBLING

The binary message sequence mk at the input to the scrambler is mod-2 added to The register output m"k to form the scrambled message m'k which is also fed back to the register input. Thus,

$$m''_k = m'_{k-3} \oplus m'_{k-4}$$

$$m'_k = m_k \oplus m''_k \qquad (a)$$

The unscramble has essentially the reverse structure of the scrambler and Reproduces the original message sequence, since

$$\begin{aligned} m'_k \oplus m''_k &= (m_k \oplus m''_k) \oplus m''_k \\ &= m_k \oplus (m''_k \oplus m''_k) \\ &= m_k \oplus (0) \\ &= m_k \qquad (b) \end{aligned}$$

Equation (a) and (b) hold for any shift register configuration as long as the Scrambler and unscramble have identical registers

PROCEDURE:
1) Do the Connections as per block diagram shown.
2) Connect the power supply to the kit and switch it ON.
3) Select the SCRAMBLER Experiment using SW1. Observe the corresponding LED indication.

4) Set the switch SW7 in PRBS GENERATOR section as per block diagram to generate the PRBS. Observe the 16 bit PRBS data at PRBS DATA post.
5) Set the Clock to 16 KHz using SW2 in CLOCK GENERATION section. the clock at CLOCK OUT post.
6) Connect PRBS DATA to IN 6 and CLOCK OUT to CLK4 post of SCRAMBLER.
7) Observe the scrambled data at OUT 6 post of SCRAMBLER.
8) To decode the scrambled data connect OUT 6 posts to IN 7 and CLK4 to CLK5 post of UNSCRAMBLER.
9) Observe the decoded data at OUT 7 posts and compare it with PRBS DATA.
10) Change the clock using SW2 and observe the effect on Scrambled and unscrambled data.

OBSERVATION:

1. PRBS at PRBS DATA post of PRBS generator.
2. Clock for scrambler and unscramble at CLOCK OUT post
3. Scrambled data at OUT 6 post of scrambler
4. Unscrambled data at OUT 7 post of unscramble.

CONCLUSION

There is no loss or delay of data in the process of scrambling and unscrambling the binary data’s.

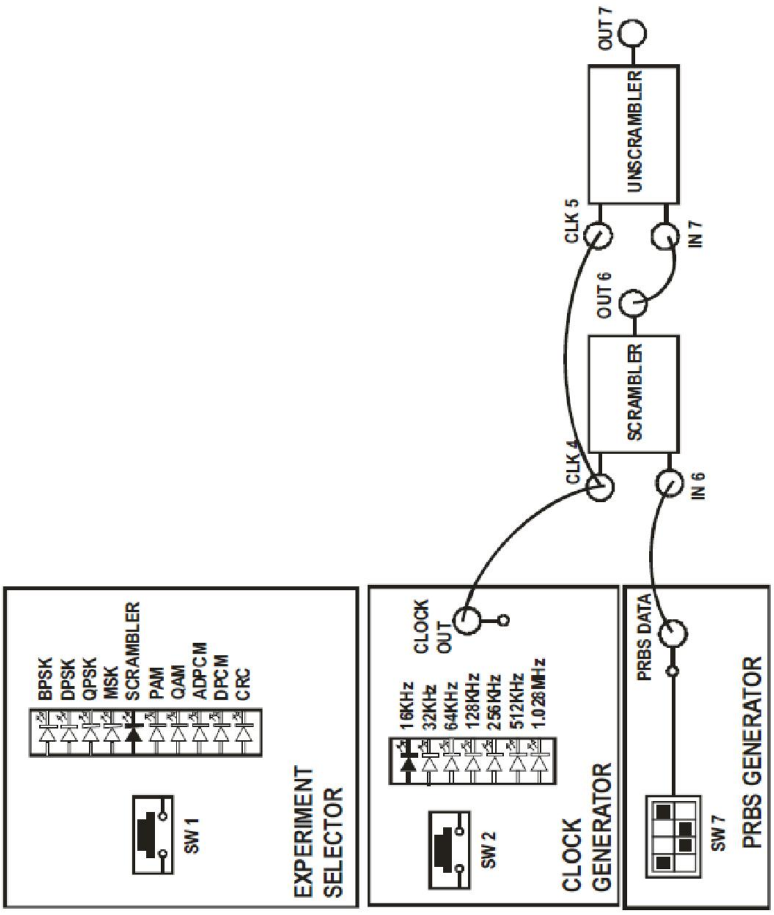
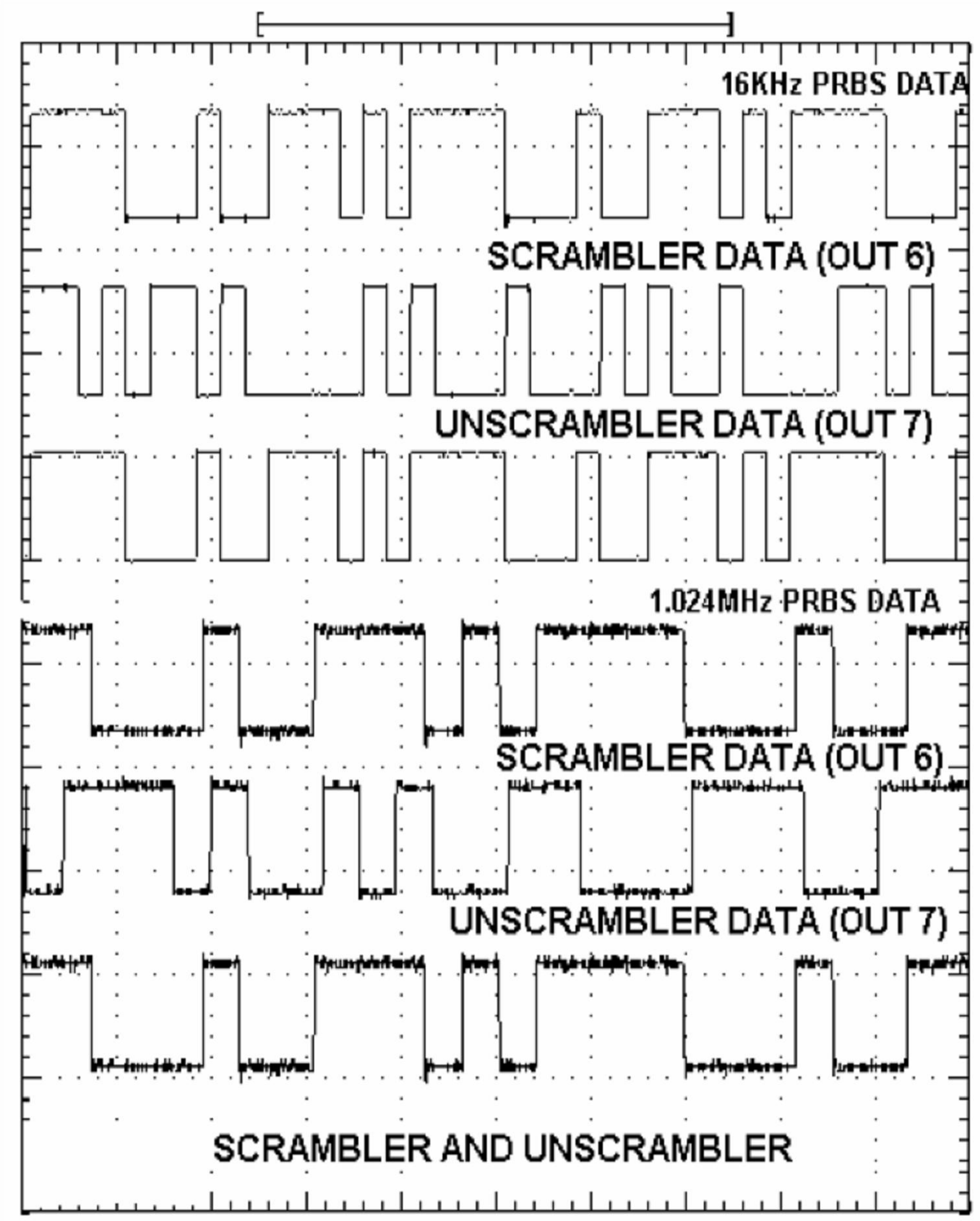


FIG 5.BLOCK DIAGRAM FOR SCRAMBLER AND UNSCRAMBLER

MODAL GRAPHES



EXPERIMENT NO.3

BASEBAND COMMUNICATION
STUDY OF DIGITAL BASE BAND TRANSMISSION

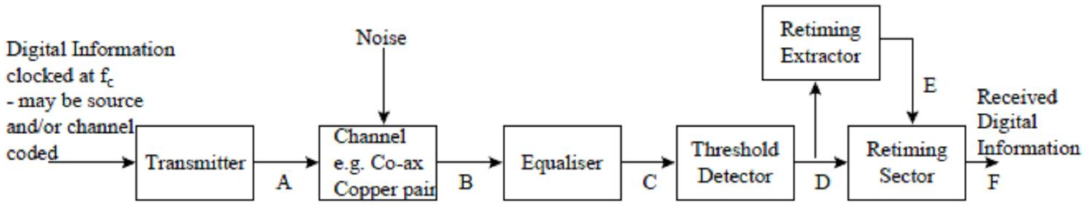
OBJECTIVE:
Study of Eye Pattern.

EQUIPMENT:
DCS-02 board and its power supply

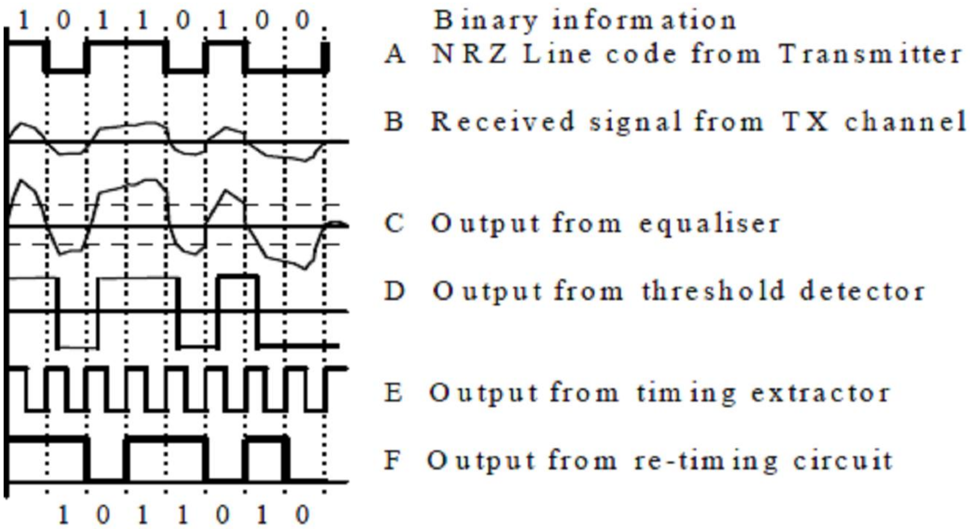
THEORY:
Base band Requirements
In the case of base band the data bits are transmitted directly as pulses. These pulses may have to be shaped so as

- To minimize the effect of noise on the received pulses,
- To minimize the distortions introduced by the transmission medium,
- To minimize the bandwidth required for transmission of the signals and hence to maximize the throughput of data across the medium,
- To prevent Inter Symbol Interference (ISI),
- To reduce crosstalk with other channels using the same medium, etc., etc. In addition various line coding systems may be used
- To ensure that there is at least one voltage transition per pulse to assist in clock synchronization and data recovery at the receive end
- To eliminate long term DC voltages on the medium
- To minimize the bandwidth requirements, and maximize throughput.

In general the pulse shape, and coding system is optimized for the particular application and medium, but it may not be possible to optimize all requirements simultaneously. If one bit of data is transmitted per pulse then the pulse is defined as binary (the pulse has only two levels, or only two shapes, corresponding to “1” and “0”). It may be possible to combine a number of data bits into a single multi-level, (or multiple shaped) pulse prior to transmission to give, for example, 3 levels (ternary), 4 levels (quaternary), 5 levels (quinary), or in general, M levels (M-ary) coding prior to transmission. This permits more than 1 bit of data to be transmitted per pulse, so that a higher bit rate is achieved. However because there are more voltage levels they are inevitably closer together than in the case of binary so that a lower level of noise/distortion picked up on the transmission medium can cause a level to be misidentified on reception, leading to errors on the received signal. Therefore, if the transmission medium is sufficiently quiet, M-ary coding can be used to increase throughput, where the value of m depends on the noise on the medium. Problems are encountered when a digital signal is sent through a channel. This shows the basic stages in a digital signal transmission. Non-return-to-zero (NRZ) is assumed. The transmission medium might be a coaxial cable or a copper twisted pair used in local area networks or digital telephone systems. The principles apply to systems using other media and/or codes.



Typical waveforms at the points labeled A to F in the system are shown. The original waveform A is attenuated and a noise component is added. Because of finite system response time and propagation delays, the transition between voltage levels becomes indistinct



To counteract the distortion the system includes an equalizer. which reshapes the received waveform, so that the relationship of the equalizer output C to the original binary symbols is much clearer, e.g. if a copper cable to picks up 50 Hz noise from the mains or other electromagnetic interference the equalizer must remove it. Or in the case of pulse spreading leading to ISI, or reflections in the case of radio signals leading to multiple receptions, the equalizer eliminates these also. The input to the equalizer must be protected from over-voltages such as induced lightning and other transients. Passing the equalized waveform through a threshold detector (e.g. a Schmitt trigger) generates a binary signal very similar to the transmitted one. If the threshold settings are too small then noise will trigger the detector. If the settings are too large then the data may not trigger the detector. It is important that the slew rate of the comparator used in the detector is fast enough for the data rate. If the noise levels are sufficiently low, and the equalizer and threshold detector are set correctly, the only difference between waveforms A and D is that the transitions are not perfectly in step.

CONCLUSION:

It is observed that as the clock frequency increases the eye opening becomes smaller. With the increase of clock frequencies and the noise the noise margin percentage decreases which means that it becomes less immune to noise.

PROCEDURE:

1) Do the Connections as per block diagram shown.
2) Connect the power supply to the kit and switch it ON.
3) Select the PAM Experiment using SW1. Observe the corresponding LED indication.
4) Set the switch SW7 in PRBS GENERATOR section as per block diagram to generate the PRBS. Observe the 16 bit PRBS data at PRBS DATA post.
5) Set the Clock to 16 KHz using SW2 in CLOCK GENERATION section. Observe the clock at CLOCK OUT post.
6) Connect PRBS DATA to IN 1 of PAM GENERATOR. Observe the PAM data at OUT 1 post of PAM GENERATOR.
7) Connect OUT1 post to IN5 of TRANSMISSION CHANNEL. Set SW8 to position 5 Observe the output of transmission channel at OUT 5 post.
8) Connect OUT 5 to IN 8 of ADDER. Connect NOISE from NOISE GENERATOR section to NOISE IN post of ADDER. Initially keep noise to minimum level by rotating P3 fully anticlockwise direction.
9) Observe the ADDER output at OUT 9 post. Observe the adder output by increasing the noise by pot P3.
10) To observe eye pattern connect OUT 8 post of ADDER to Y channel and CLOCK OUT post to EXT. Triggering of CRO.
11) Observe effect on eye pattern by changing the clock frequency.

OBSERVATION:

1. PRBS at PRBS DATA post of PRBS generator.
2. PAM data at OUT 1 post of PAM generator.
3. NOISE at noise generator post.
4. Signal through transmitter channel at OUT 5
5. Adder output at OUT 8 post.

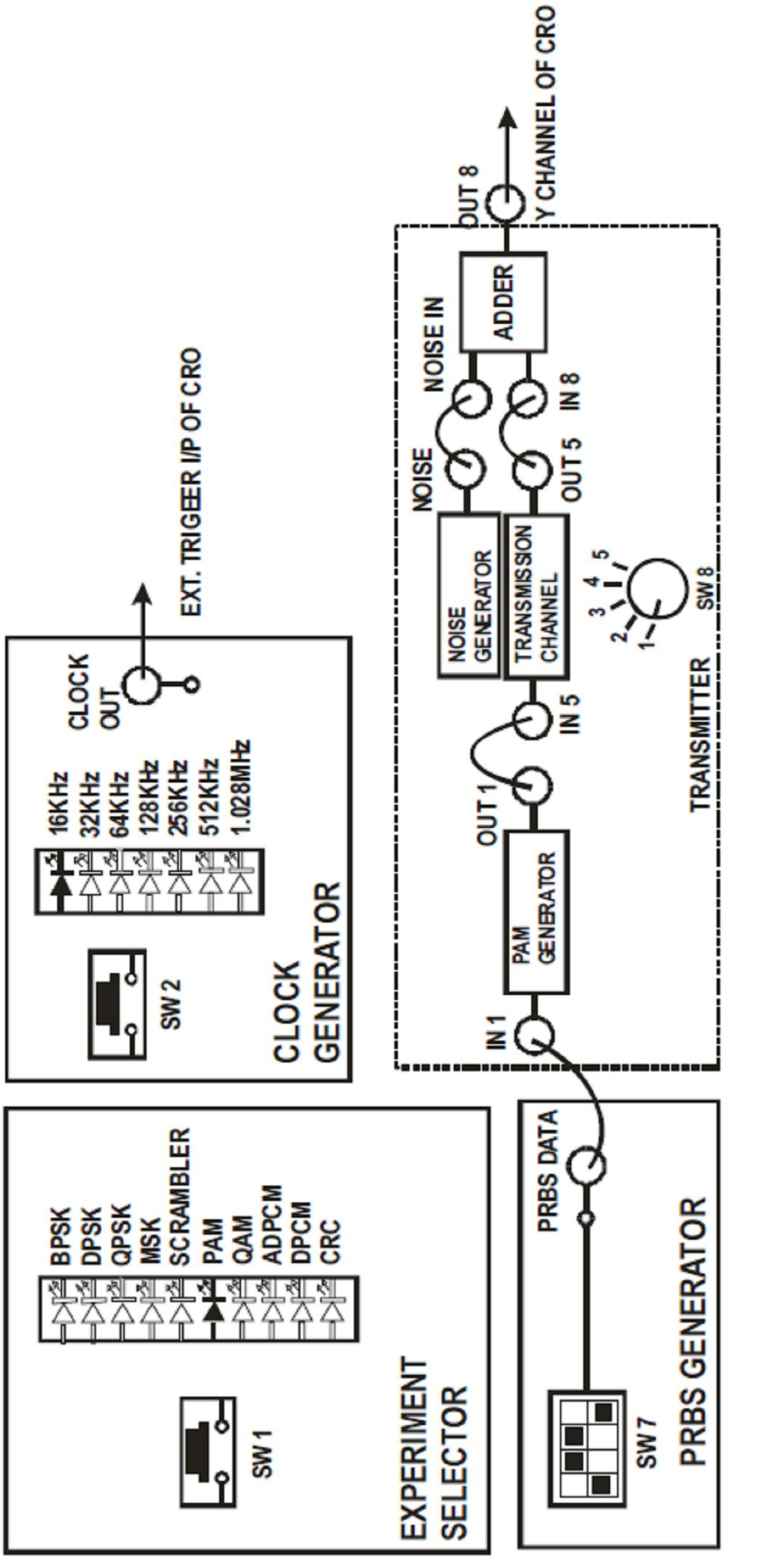
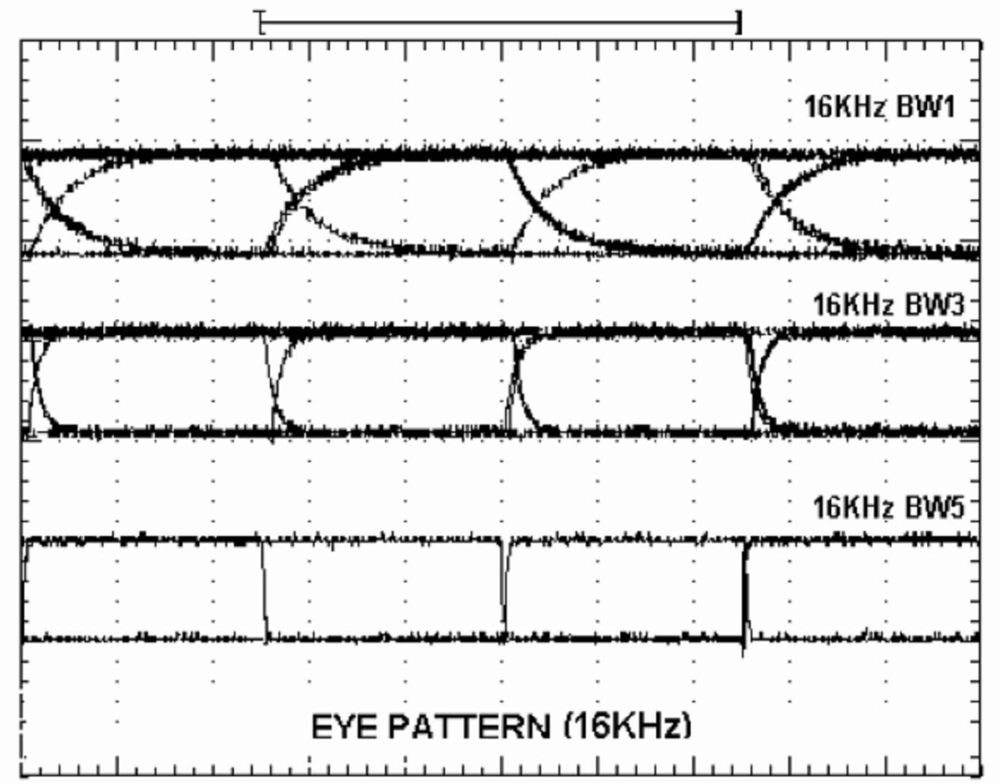
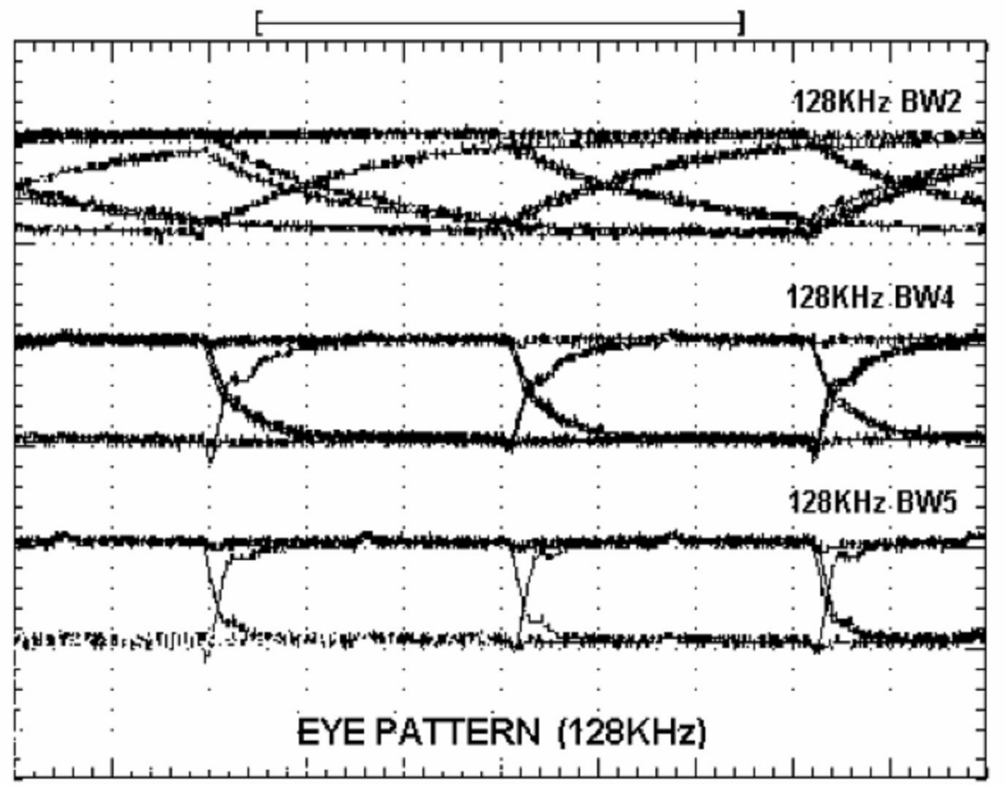


FIG 6B.BLOCK DIAGRAM FOR EYE PATTERN


16KHz BW1
16KHz BW3
16KHz BW5
EYE PATTERN (16KHz)


128KHz BW2
128KHz BW4
128KHz BW5
EYE PATTERN (128KHz)

EXPERIMENT NO.4

Spectrum analyzer

OBJECTIVE: To measure Harmonics of SINE wave

EQUIPMENT USED:

1) Spectrum Analyzer
2) Signal source
3) BNC – BNC cable

THEORY:

A **spectrum analyzer** or **spectral analyzer** is a device used to examine the spectral composition of some electrical, acoustic, or optical waveform. It may also measure the power spectrum.

There are analog and digital spectrum analyzers: An *analog* spectrum analyzer uses either a variable band-pass filter whose mid-frequency is automatically tuned (shifted, swept) through the range of frequencies of which the spectrum is to be measured or a super heterodyne receiver where the local oscillator is swept through a range of frequencies.

- A *digital* spectrum analyzer computes the discrete Fourier transform (DFT), a mathematical process that transforms a waveform into the components of its frequency spectrum.

Some spectrum analyzers (such as "real-time spectrum analyzers") use a hybrid technique where the incoming signal is first down-converted to a lower frequency using superheterodyne techniques and then analyzed using fast fourier transformation (FFT) techniques

Typical functionality

Frequency range

Two key parameter for spectrum analysis are frequency and span. The frequency specifies the center of the display. Span specifies the range between the start and stop frequencies, the bandwidth of the analysis. Sometimes it is possible to specify the start and stop frequency rather than center and range.

Marker/peak search

Controls the position and function of markers and indicates the value of power. Several spectrum analyzers have a "Marker Delta" function that can be used to measure Signal to Noise Ratio or Bandwidth.

Bandwidth/average

Is a filter of resolution. The spectrum analyzer captures the measure on having displaced a filter of small bandwidth along the window of frequencies.

Amplitude

The maximum value of a signal at a point is called amplitude. A spectrum analyzer that implements amplitude analysis is called a Pulse height analyzer.

View/trace

Manages parameters of measurement. It stores the maximum values in each frequency and a solved measurement to compare it.**uses** Spectrum analyzers are widely used to measure the **frequency response**, **noise** and **distortion** characteristics of all kinds of RF circuitry, by comparing the input and output spectra. In **telecommunications**, spectrum analyzers are used to determine occupied bandwidth and track interference sources. Cell planners use this equipment to determine interference sources in the GSM/TETRA and UMTS technology. In **EMC testing**, spectrum analyzers may be used to characterize test signals and to measure the response of the equipment under test.

PROCUDUDE :

1) Switch on the Spectrum Analyzer and check if the instrument is meeting the Calibrated requirements else refer to the manual supplied along with the Instrument
2) Switch on the signal source and set as given below

FUNCTION KNOBE :	SINE WAVE
FREQUENCY KNOBE:	1 M HZ
FREQ. VARIABLE KNOB:	MAX
LEVEL KNOB:	MIN
ATTENUATION P.B SWITCHES:	BOTH PRESSED

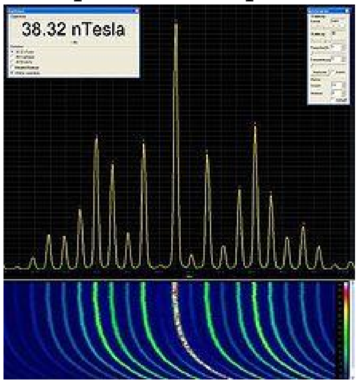
3) Set the Spectrum Analyzer as given bellow

CENTER FREQUENCY:	000.0
ATTENUATION:	ALL DEPRESSED
SCAN WIDTH	2MHZ / div

4) Connect Spectrum Analyzer and signal generator via, BNC – BNC cable as shown in the fig 1.1

A spectrum analyzer Fig 1.1

Typical spectrum analyzer display, showing power vs. frequency/wavelength A **spectrum analyzer** or **spectral analyzer** is a device used to examine the spectral components



5) On connecting both the instruments you shall observe a spectral lines other than the zero frequency line as shown in fig 1.2

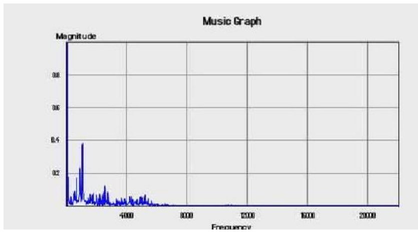


Fig 1.2

6) Now switch on the MARKEB PUSH button. MK is lit and the display shows the Marker frequency. The marker is shown on the screen as a vertical needle. now adjust the marker knob so as to align the needle with the highest spectral line. The Reading as obtained on the display in the fundamental frequency.
7) Now move on the marker to the adjacent spectral lines on RHS and note down the Display readings. These readings correspond to the harmonic frequencies.
8) Also note down the levels of each spectral line on the CRT display.
9) Repeat (7) and (8) till you can observe spectral lines and note down the readings

OBSERVATIONS:

SL . NO	Frequency on display	Level in db

PRECAUTIONS:

Never exceed the input to the Spectrum Analyzer beyond 10 mV rms with no attenuation and 1 Vrms with all attenuation switches pressed

Spectrum analyzer

OBJECTIVE: To measure Harmonics of SQUARE wave

EQUIPMENT USED:

4) Spectrum Analyzer
5) Signal source
6) BNC – BNC cable

THEORY:

A **spectrum analyzer** or **spectral analyzer** is a device used to examine the pectral composition of some electrical, acoustic, or optical waveform. It may also measure the power spectrum.

There are analog and digital spectrum analyzers: An *analog* spectrum analyzer uses either a variable band-pass filter whose mid-frequency is automatically tuned (shifted, swept) through the range of frequencies of which the spectrum is to be measured or a super heterodyne receiver where the local oscillator is swept through a range of frequencies.

- A *digital* spectrum analyzer computes the discrete Fourier transform (DFT), a mathematical process that transforms a waveform into the components of its frequency spectrum.

Some spectrum analyzers (such as "real-time spectrum analyzers") use a hybrid technique where the incoming signal is first down-converted to a lower frequency using superheterodyne techniques and then analyzed using fast fourier transformation (FFT) techniques

Typical functionality

Frequency range: Two key parameter for spectrum analysis are frequency and span. The frequency specifies the center of the display. Span specifies the range between the start and stop frequencies, the bandwidth of the analysis. Sometimes it is possible to specify the start and stop frequency rather than center and range.

Marker/peak search: Controls the position and function of markers and indicates the value of power. Several spectrum analyzers have a "Marker Delta" function that can be used to measure Signal to Noise Ratio or Bandwidth.

Bandwidth/average: Is a filter of resolution. The spectrum analyzer captures the erasure on having displaced a filter of small bandwidth along the window of frequencies.

Amplitude: The maximum value of a signal at a point is called amplitude. A spectrum analyzer that implements amplitude analysis is called a Pulse height analyzer.

View/trace: Manages parameters of measurement. It stores the maximum values in ach frequency and a solved measurement to compare it.

PROCUDUDE :

1) Switch on the Spectrum Analyzer and check if the instrument is meeting the Calibrated requirements else refer to the manual supplied along with the Instrument
2) Switch on the signal source and set as given below

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FREQUENCY KNOBE:	1 M HZ
FREQ. VARIABLE KNOB:	MAX
LEVEL KNOB:	MIN
ATTENUATION P.B SWITCHES:	BOTH PRESSED

3) Set the Spectrum Analyzer as given bellow

CENTER FREQUENCY:	000.0
ATTENUATION:	ALL DEPRESSED
SCAN WIDTH	2MHZ / div

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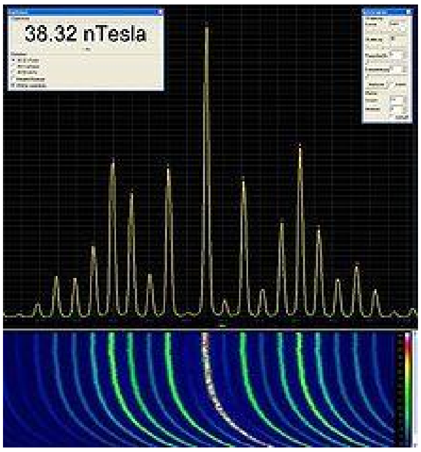

5)On connecting both the instruments you shall observe a spectral lines other than the
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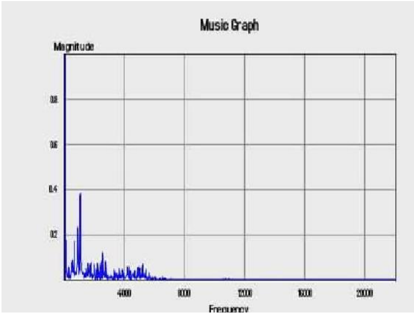

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OBSERVATIONS:

SL . NO	Frequency on display	Level in db

PRECAUTIONS:
Never exceed the input to the Spectrum Analyzer beyond 10 mV rms with no attenuation and 1 Vrms with all attenuation switches pressed

Spectrum analyzer

OBJECTIVE: To measure Harmonics of TRAINGULAR wave

EQUIPMENT USED:

7) Spectrum Analyzer
8) Signal source
9) BNC – BNC cable

THEORY:

A **spectrum analyzer** or **spectral analyzer** is a device used to examine the spectral composition of some electrical, acoustic, or optical waveform. It may also measure the power spectrum.

There are analog and digital spectrum analyzers: An *analog* spectrum analyzer uses either a variable band-pass filter whose mid-frequency is automatically tuned (shifted, swept) through the range of frequencies of which the spectrum is to be measured or a super heterodyne receiver where the local oscillator is swept through a range of frequencies.

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Two key parameter for spectrum analysis are frequency and span. The frequency pecifies the center of the display. Span specifies the range between the start and stop

frequencies, the bandwidth of the analysis. Sometimes it is possible to specify the start and stop frequency rather than center and range.

Marker/peak search Controls the position and function of markers and indicates the value of power. Several spectrum analyzers have a "Marker Delta" function that can be sed to measure Signal to Noise Ratio or Bandwidth.

Bandwidth/average

Is a filter of resolution. The spectrum analyzer captures the measure on having displaced a filter of small bandwidth along the window of frequencies.

Amplitude

The maximum value of a signal at a point is called amplitude. A spectrum analyzer that implements amplitude analysis is called a Pulse height analyzer.

PROCUDURE :

1) Switch on the Spectrum Analyzer and check if the instrument is meeting the Calibrated requirements else refer to the manual supplied along with the Instrument
2) Switch on the signal source and set as given below

FUNCTION KNOBE :	SINE WAVE
FREQUENCY KNOBE:	1 M HZ
FREQ. VARIABLE KNOB:	MAX
LEVEL KNOB:	MIN
ATTENUATION P.B SWITCHES:	BOTH PRESSED

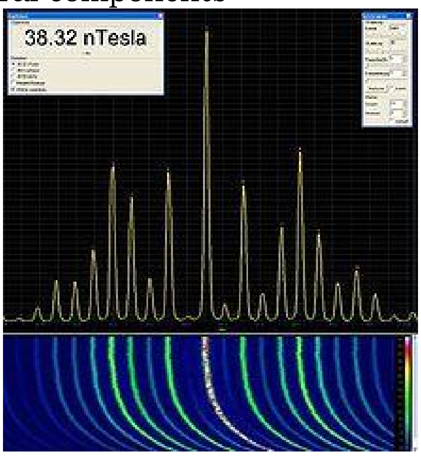
3) Set the Spectrum Analyzer as given bellow

CENTER FREQUENCY:	000.0
ATTENUATION:	ALL DEPRESSED
SCAN WIDTH	2MHZ / div

4) Connect Spectrum Analyzer and signal generator via, BNC – BNC cable as shown in the fig 1.1

A spectrum analyzer
Fig 1.1

Typical spectrum analyzer display, showing power vs. frequency/ wavelength A **spectrum analyzer** or **spectral analyzer** is a device used to examine the spectral components



5) On connecting both the instruments you shall observe a spectral lines other than the zero frequency line as shown in fig 1.2

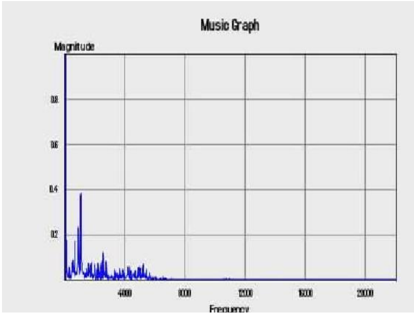


Fig 1.2

6) Now switch on the MARKEB PUSH button . MK is lit and the display shows the Marker frequency. The marker is shown on the screen as a vertical needle. now adjust the marker knob so as to align the needle with the highest spectral line. the Reading as obtained on the display in the fundamental frequency.

7) Now move on the marker to the adjacent spectral lines on RHS and note down the Display readings. These readings correspond to the harmonic frequencies.

8) Also note down the levels of each spectral line on the CRT display.

9) Repeat (7) and (8) till you can observe spectral lines and note down the readings

OBSERVATIONS:

SL . NO	Frequency on display	Level in db

PRECAUTIONS:

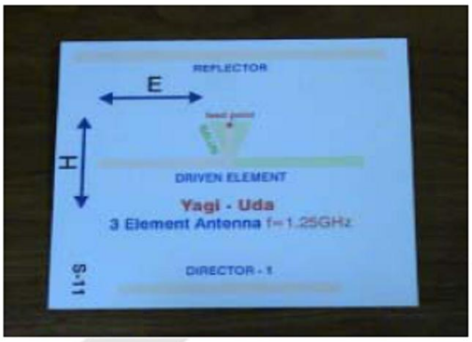
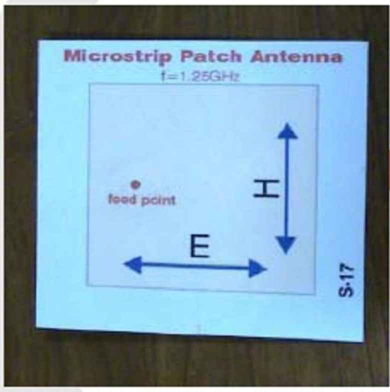
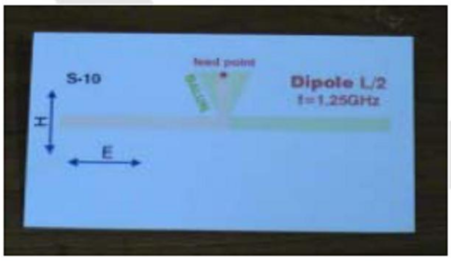
Never exceed the input to the Spectrum Analyzer beyond 10 mV rms with no attenuation and 1 Vrms with all attenuation switches pressed

EXPERIMENT NO.9

Micro strip Antenna Trainer

OBJECTIVE:
Setup and Procedure for obtaining a Polar Plot Readings of the following Antennas

EQUIPMENT:
S-9990 Transmitter

	**S-11** **3 Element Yagi-Uda Antenna** Printed Microstrip FREQ 1250 MHz
	S-17 **Microstrip Patch Antenna** FREQ 1250 MHz
	**S-10** **2 PCS.** **DIPOLE L/2** Printed Microstrip FREQ 1250 MHz

THEORY:
Antenna Fundamentals:

Antenna is a device which belongs to a class called *transducers*. The term transducer is derived from two Latin words, meaning literally “to lead across” or “to transfer”. Thus, any device that transfers , or converts energy from one form to another, is called a transducer. The purpose of an antenna is to convert radio-frequency electric current to *electromagnetic waves* Electromagnetic waves cannot be heard, seen, tasted or touched, so it is not surprising that the process by which these waves are launched in space by our antennas can be mystifying, especially to a newcomer, a student. Daily, we come across different types of transducers; a *loudspeaker,* for instance. A loudspeaker converts audio-frequency electric current from the output of your radio or stereo into acoustic pressure waves, also known as sound waves. The sound waves travel through air to your ears, where they are converted in what we call sound. Generally we think of loudspeaker as that which converts electrical energy to sound energy, however we could reverse the process. We could apply sound energy to a loudspeaker which it will convert to electrical energy. When used thus, the loudspeaker becomes a microphone. The loudspeaker /microphone are said to exhibit the principle of reciprocity, derived from Latin word to move back and forth. Now, we take a closer look at the special transducer called an antenna. When the transmitter feeds RF current to an antenna, it launches electromagnetic waves, which are propagated through free space. This is similar to the way sound waves are propagated through air by a loudspeaker. In the next city or perhaps a far away continent a similar transducer (a receiving antenna) intercepts some of these electromagnetic waves and converts them to electrical current which is then amplified and detected by the receiver.

Types of Antennas

Antennas can be broadly classified by the directions in which they radiate or receive electromagnetic radiation. They can be isotropic, omni directional or directional. An isotropic antenna is a hypothetical antenna that radiates uniformly in all directions so that the electric field at any point on a sphere (with the antenna at its center) has the same magnitude. Such radiation cannot be realized in practice since in order to radiate uniformly in all directions an isotropic antenna would have to be a point source .The nearest equivalent to an isotropic antenna is a Hertzian dipole. The Hertzian dipole is the name given to a dipole which is very small compared to its wavelength, that is about one-hundredths of the wavelength at its operating frequency; even in this case its pattern is not truly isotropic. An omnidirectional antenna radiates uniformly in one plane. Examples of omnidirectional antennas are Monopoles, Dipoles and Slotted-Cylinder .The radiation of a vertical dipole is uniform in the horizontal plane and a figure of 8 in the vertical plane. A directional antenna radiates most of its power in one particular direction. Examples of directional antennas are Yagis, Log-Periodics, Reflector systems and Helicals. For a circularly symmetrical reflector the radiation pattern is the same in all planes.

Main Characteristics of an Antenna

An antenna is chosen for a particular application according to its main physical and electrical characteristics. Further, an antenna must perform in a desired manner for the particular application. An antenna can be characterized by the following key factors, not all are applicable to all types of antenna. Most of the characteristics mentioned below can be studied using this trainer and software.

1. Its radiation resistance.
2. Its radiation pattern.
3. The beam width and gain of its main lobe.
4. The position and magnitude of its side lobes.
5. The front to back ratio.
6. Its bandwidth.
7. Its aperture.
8. The polarization of the electric field that it transmits

There are two principal planes in which the antenna characteristics are measured. These are known as the azimuth and elevation planes and can be considered as the horizontal and vertical planes, respectively, for land-based antennas. Some characteristics such as beam width and side lobes are the same in both planes for symmetrical antennas such as helical and reflectors. Other characteristics such as gain on bore sight (ie: where the azimuth and the elevation planes intersect) can only have a single value. In general, for unsymmetrical antennas the characteristics are different in the two principal planes, with a gradual transition in the intervening region between these two planes.

SPECIFICATIONS

1. RECEIVER

The Receiver is used for the measurement of RF signal level with a high accuracy and repeatibility. Facility is provided for obtaining the Polar Diagram of the Antennas.Frequency fr om 850 MHz to 1300 MHz can be measured. For obtaining the Polar Diagram, the Receiving Antenna is rotated by 5 degrees and the readings are stored in the memory of the unit.

Frequency Range	:	850 MHz to 1300MHz freq range
Input Impedance	:	50ohms nominal
Level Resolution	:	.1dB resolution
Level Range	:	>65 dB measurement range.
Level Accuracy	:	+-3dB typ accy at 50ohms
Level Array	:	Array of 72 points is provided for storing Polar dBuV readings.
Display	:	LCD Display 16 Character x 2 Line
Power	:	230V AC rms + 10%, 50Hz

2. TRANSMITTER GENERATOR

Transmitting source to drive the transmitting antenna. 850 MHz to 1300 MHz variable source with a nominal output of >105 dBuV at 50ohms, to obtain the Polar Plot of the antenna under test. 5 digit LED display of Frequency counter displays Frequency of Output. Acc. 100 PPM.

3. ANTENNAS FOR TRAINING - 4 NOS

Antennas have been provided which can be used around 1250MHz. Each antenna with its type no and name has been illustrated below on the next pages. In the descriptions below, “L” refers to Wavelength Lambda. Additional antennas which are also available have been shown and marked as Optional.

Setup and Procedure for obtaining a Polar Plot Readings

Overall setup, with receiving antenna mounted for making **E-Plane** measurements.

Overall setup, with receiving antenna mounted for making **H-Plane** measurements.

Procedure

1) Mount the Transmitting Antenna on the stand connect it to the S-9990 Transmitter Output as shown.

2) Mount the Receiving Antenna on the Positioner and connect it to the S-9990 Receiver to the input as shown. Connect the mains cable and connect to the mains and Switch ON

3) A manual rotater capable of rotating the antenna by 5 deg is used to obtain the Polar Plot. At every 5 degrees position of the antenna the dBuV reading is stored in the 72 point memory array of the S-9990 Receiver. On completion, the data can be displayed; Recalled from memory. With these readings the Polar Plot can be obtained by using suitable software or plotting it on paper manually.

4) Put the equipment ON. Press Data Array sw (6), and adjust the antenna positioned as shown below, to measure the Reading No. 1.Align the positioned such that the indicator is pointing to Reading No.1 (0 deg) on the disk.

5) Press Data Array sw (6) again, the LCD indicates the level reading of 73dBuV at 0deg (reading no.1) Press Data Array sw (6) again, the LCD indicates that the Reading No.1 has been stored in memory location no.1 and the student must now rotate the positioner to measure reading no.2 Align the positioner such that the indicator is pointing to Reading No.2 (5 deg) on the disk.

6) Press Data Array sw (6) again, the LCD indicates the level reading of 73dBuV at 5deg (reading no.2) Continue in this sequence untill the reading no.72 (at 355 deg) is measured and stored in the memory. This completes the measurement of the Polar Plot. In order to EXIT the SAVE MODE at any time while measurement is in progress PRESS the Recall Button. This will take it to the Normal Display.

7) Press the Arrow Keys sw(7). The LCD displays the stored value of 73dBuV at 0deg which is the reading no.1 Pressing the down arrow key displays the next value af 73dBuV at 5degs, which is the reading no.2 In this manner all the 72 readings of the array can be recalled and written down on paper. These readings will remain in memory until a new Save is initiated. Using the Polar Graph paper provided, the student can obtain a Polar Plot.

8) In order to EXIT the Memory Mode press the SAVE button. It will revert to normal Display.

EXPERIMENT NO.8

Micro strip Component Trainer

OBJECTIVE:

a) Experiment Setup for determination of coupling characteristics of a Micro strip Directional Coupler.
b) 2 Way 3 dB Power Divider/Combiner Used for splitting and combining RF & Microwave signals
c) Ring Resonator Micro strip Resonators are widely utilized to measure effective dielectric constant, dispersion, and discontinuity parameters of the dielectric layer.

EQUIPMENT:
S-9990 Transmitter

1. RECEIVER

The Receiver is used for the measurement of RF signal level with a high accuracy
and repeatability. Facility is provided for obtaining the dBuV Levels of the Micro strip Components. Frequencies from 850 MHz to 1300 MHz can be measured.

SPECIFICATIONS

Frequency Range	:	850 MHz to 1300MHz freq range
Input Impedance	:	50ohms nominal
Level Resolution	:	.1dB resolution
Level Range	:	>65 dB measurement range.
Level Accuracy	:	+-3dB typ accy at 50ohms
Data Array	:	Array of 99 points is provided for storing dBuV readings for various frequencies.
Display	:	LCD Display 16 Character x 2 Line
Power	:	230V AC rms + 10%, 50Hz

2. TRANSMITTER GENERATOR

Transmitting source to drive the transmitting antenna.850 MHz to 1300 MHz variable source with a nominal output of >105 dBuV at 50ohms, to obtain the various characteristics of the micro strip components. 5 digit LED display of Frequency displays Frequency of Output. Acc. 100 PPM. S-3663

3. ACCESSORIES FOR TRAINING - 4 NOS

a] 5 dB wideband Attenuator with a characteristic impedance of 50 ohms. Used for terminating the receiver input.
b] 50 ohms SMA terminations 2 pcs. used to terminate the unused ports of the micro strip component under test.
c] Adapter - SMA (F) - SMA (F) used for normalizing the Transmitter/ Receiver.

4. CABLES

Two, BNC to SMA 0.5 metre cables 50 ohms provided to connect to the micro strip component under test.

THEORY

a) 2 Way 3 dB Power Divider/Combiner Used for splitting and combining RF & Microwave signals. Exacting in terms of low loss, high isolation, excellent VSWR and precise phase & amplitude balance.

	**2 Way 3 dB Power Divider/Combiner** Used for splitting and combining RF & Microwave signals. Exacting in terms of low loss, high isolation, excellent VSWR and precise phase & amplitude balance.

b)Directional Coupler The microstrip transmission lines here posses an appropriate plane of symmetry

c) Ring Resonator Microstrip Resonators are widely utilized to measure effective dielectric constant, dispersion, and discontinuity parameters of the dielectric layer. Microstrip ring resonator is one of the popular planar resonators and has also ben dlters, oscillators, mixers and antennas.

Directional Coupler

The microstrip transmission lines here posses an appropriate plane of symmetry.

i) Port 4 which is named also as Isolated port, always has a zero output, without being dependent of the electrical length of the coupling region. Major cause of poor isolation in practical circuits are unequal phase velocities of even and odd mode.

ii) The input at each port is matched to the feed line characteristic impedance, Z0, irrespective of the electrical length.

iii) The total output power equals the input power.

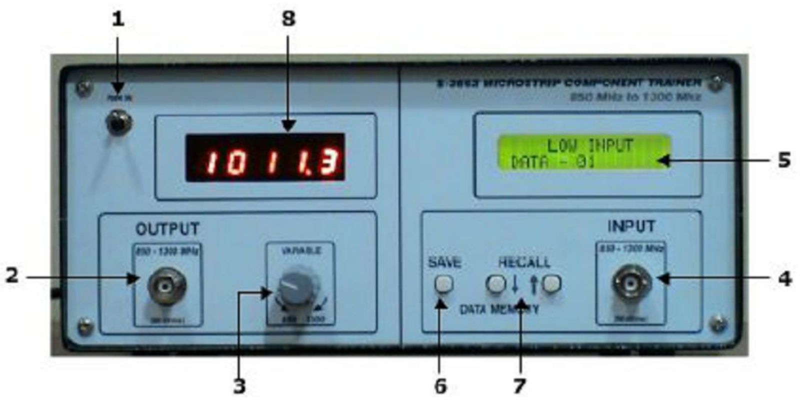
iv) The maximum coupling to port 2 occurs at the frequency that gives a quarter wave coupling length which is l/4. This is the mid-band frequency and due to this property, this couplers are also known as quarter-wave couplers.

v) At the maximum coupling frequency, there is a 90° phase difference between the voltages at port 2 and port 3. Such a coupler can also be described as quadrature coupler.

Ring Resonator

Microstrip Resonators are widely utilized to measure effective dielectric constant, dispersion, and discontinuity parameters of the dielectric layer. Microstrip ring resonator is one of the popular planar resonators and has also been used in filters, oscillators, mixers and antennas.

S-3663 Micro strip Component Trainer Front Panel – Description



1) PWR ON: Switch to put equipment ON

2) OUTPUT: Output BNC Transmits signal between 850 MHz to 1300 MHz and used to feed to the Micro strip component which is to be characterized. Impedance is 50 ohms.

3) FREQUENCY VARIABLE: Control used to vary the transmitting signal frequency from 850 MHz to 1300 MHz. Frequency is read out directly on the Frequency Counter Display.

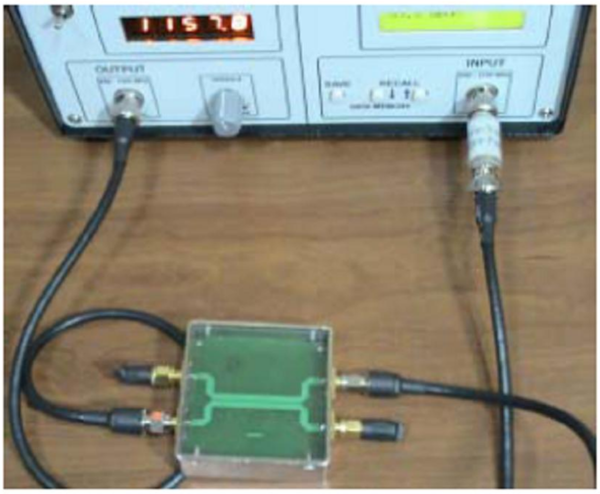
4) INPUT: Input BNC. Measures the signal connected to this input from 850 MHz to 1300 MHz. Connect the output of the micro strip component via the cable provided and the 5 dB Attenuator to this input.

5) LCD DISPLAY: 16 character by 2 Line LCD displays RF signal level in dBuV, as well as other instructions when saving and recall modes are activated.

6) SAVE DATA ARRAY: This key allows the user to measure and store the readings of the various frequencies for obtaining the Frequency versus dB graph. The array has 99 memory locations for storing data readings.

7) RECALL MEMORY Up/Dn Arrows: These keys allow the user to read the dBuV levels stored in 99 memory locations of the data array (ref 6 above)

8) FREQUENCY COUNTER DISPLAY: Display the Frequency selected by the Variable Frequency Control. Frequency is displayed in MHz. Resolution is 0.1 MHz



Procedure

1) First determine the frequencies you are going to use for measurement in your experiments.

2) Connect the S3663 as shown in the photo. Connect one cable to the output and the other is to be connected via the Attenuator pad to the input. Directly connect the input and output via the SMA adapter provided.

4) Say you take readings from 900 MHz to 1200 MHz every 10 MHz. ie. 31 readings. Save them in the first 31 Data memory Array.

5)These readings are used for normalizing the readings obtained from setup of the micros tip component under test.

Readings

Coupling coefficient

Sl No	**Freq in MHz**	**P1 db micro volts**	**P1----P3 in db micro volts**	**IN DB**

Isolated Co-Efficient

Sl No	**Freq in MHz**	**P1 db micro volts**	**P1----P4 in db micro volts**	**IN DB**

Transmission Co efficient

Sl No	Freq in MHz	P1 db micro volts	P1----P2 in db micro volts	IN DB

Power divider

Coupling Characteristics

Sl No	Freq in MHz	P1 db micro volts	P1----P2 in db micro volts	P2 In Db	P1----P3 in db micro volts	P3 In Db

Isolated Characteristics

Sl No	Freq in MHz	P1 db micro volts	P2----P3 in db micro volts	P3 In Db	P3----P2 in db micro volts	P2 In Db

Directional coupler

Coupling Characteristics

Sl No	Freq in MHz	P1 db micro volts	P1----P2 in db micro volts	P2 In Db	P1----P3 in db micro volts	P3 In Db

Isolated Characteristics

Sl No	Freq in MHz	P1 db micro volts	P2----P3 in db micro volts	P3 In Db	P3----P2 in db micro volts	P2 In Db

Experiment NO. 10:

ACTIVE / PASSIVE SATELLITES, UPLINK/DOWNLINK & TRANSPONDERS

Objective**:**

a) To set up an active & passive satellite communication link and study their difference. To study the advantages of satellite communication. To study the communication satellite link design: process of transmitting a signal to a satellite (UPLINKING), reception of same signal via satellite (DOWN LINKING) and functioning of transponder of a satellite.

b) To measure the base band analog signal parameters like Commanding frequency Response of Audio and Video Channel, Cross Talk, Noise and Unclipped Sine wave in a satellite link.

c) To measure the C/N ratio

Equipments required:

- Satellite uplink transmitter, satellite downlink receiver and satellite link emulator
- RHCP & LHCP axial mode helix antennas
- Antenna stands with connecting cables, reflecting sheet

Theory:

The UPLINK:-

In uplink station, the signals have to be sent at a differing frequency, usually in the higher 14 GHz band, to avoid interference with downlink signals. Another function performed by the uplink station is to control tightly the internal functions of the satellite itself (such as station keeping accuracy). Uplinks are controlled so that the transmitted microwave power beam is extremely narrow, in order not to interfere with adjacent satellites in the geo-arc. The powers involved are several hundred watts. The transmitter power for earth station is provided by high power amplifiers. The large power can be supplied to these amplifiers. The transmitting antenna and amplifier units are placed on the ground therefore there is no limitation on size, weight etc. parameters. Therefore high effective isotropic radiated power (EIRP) levels are possible for satellite uplinks. The power levels of 40-60 dB W are possible even at high frequency bands like K-bands and V-bands. The beam pattern of the satellite decides the power actually sent to the satellite and interference to the neighboring satellite.

The TRANSPONDERS**:-**

Each satellite has a number of transponders with access to a pair of receive/transmit antennas and associated electronics for each channel. For example, in Europe, the uplink sends signals at a frequency of about 14 GHz; these are received, down-converted in frequency to about 11/12 GHz and boosted by high power amplifiers for re-transmission to earth.

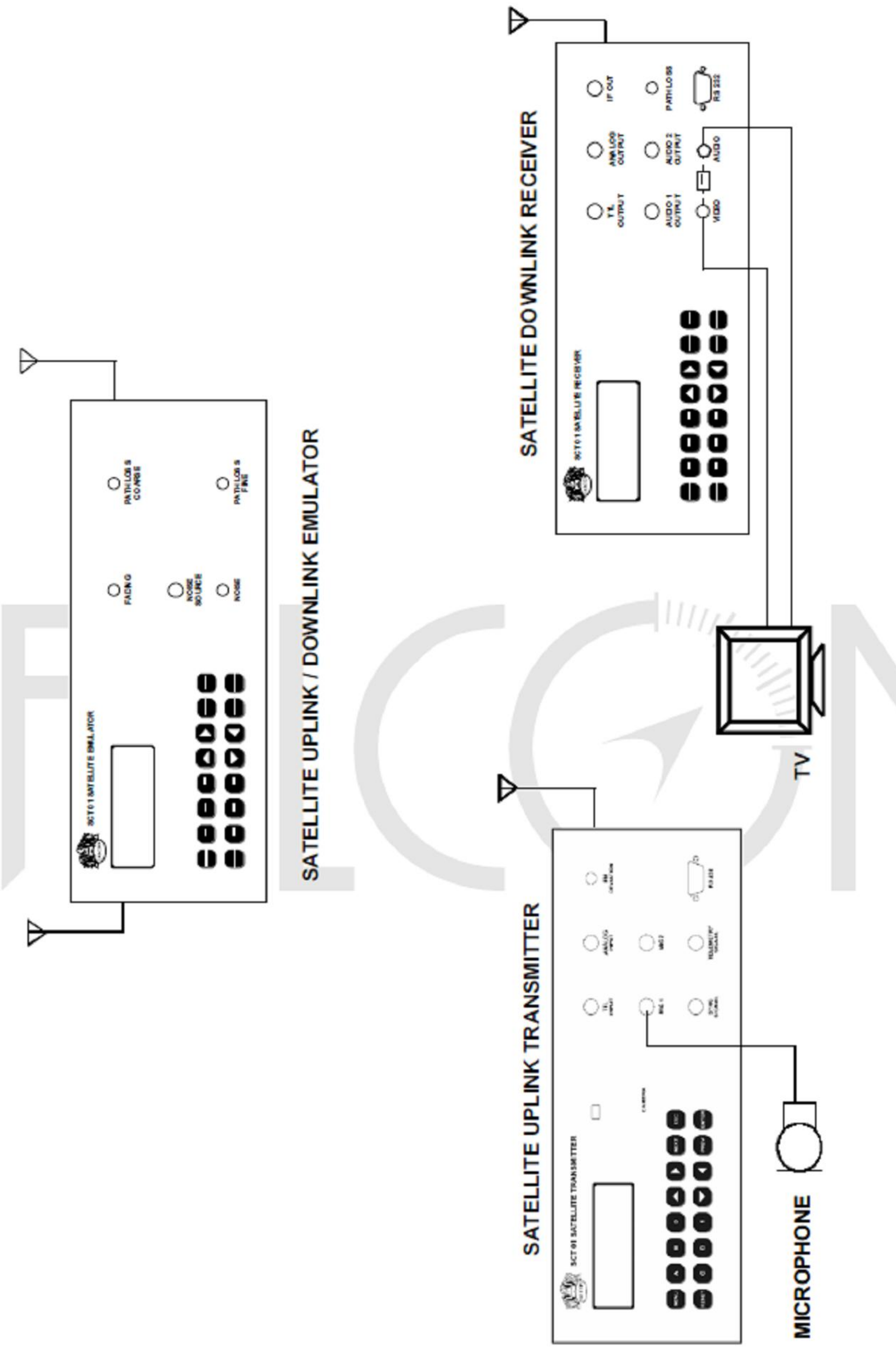
Separate transponders are used for each channel and are powered by solar panels with back up batteries for eclipse protection. The higher the power of each transponder, the fewer channels will be possible with a given number of solar panels, which in turn, is restricted by the maximum payload of launch vehicles as well as cost. Typical power consumption for a satellite such as ASTRA 1A is 2.31 kW with an expected lifetime of 12.4 years. Satellites are conveniently categorized into the following three power ranges:

The DOWNLINK**:-**

The medium used to transmit signals from satellite to earth is microwave electromagnetic radiation which is much higher in frequency than normal broadcast TV signals in the VHF/UHF bands. Microwaves still exhibit a wavelike nature but inherit a tendency to severe attenuation by water vapors or any obstruction in the line of sight of the antenn**a**. The transmitted microwave power is extremely weak by the time it reaches earth and unless well designed equipment is used, and certain installation precautions are taken, the background noise can ruin the signal. Televisions receive only **(TVRO)** site consists of an antenna designed to collect and concentrate the signal to its focus where a feed horn is precisely located. This channels microwave to an electronic component called a low noise block **(LNB)**, which amplifies and down-converts the signal to a more manageable frequency for onward transmission, by cable, to the receiver
located inside the dwelling.

Carrier-to-noise ratio:-

For the Ku and Ka bands the system carrier-to-noise (C/N) ratio is given by:
C/N = EIRP - Lfr+ G/T usable -10 log (kB) -Arain -Aatm (dB)
where : EIRP = the equivalent isotropic radiated power from the satellite at the site
location (dBW)
Lfr = free space path loss on the earth to satellite path (dB)
G/T usable = minimum degraded value of the system figure of merit (dB/K)
k = Boltzmann's constant (1.38 x 10-23 J/K)
B = receiver's pre-detection intermediate frequency (IF) bandwidth (Hz)
Aatm = gaseous attenuation due to atmospheric absorption (dB)
Arian = rain attenuation for a given percentage of the time (dB).
Note: (a) Arain & Aatm can be omitted for operation frequencies of <8 GHz; and
(b) for a 'clear-sky' calculation omit the Arian term and substitute the nominal
figure of merit, G/T(nominal), for G/T(usable).



Block diagram for Expt.1 ACTIVE / PASSIVE SATELLITES UPLINK / DOWNLINK & TRANSPONDERS

Procedure:

1) Connect the Satellite uplink transmitter to AC mains outlet with the lead provided.
2) Switch ON the transmitter and the Welcome Message will be displayed for 5Seconds.
3) After the welcome message, another message for Menu will be displayed
4) Press MENU key on the front panel of the Satellite uplink transmitter. The message for selection from the menu options will be displayed
5.) Press **A** key to select the Uplink Frequency Band. The message for available frequencies to be selected will be displayed.
6). The transmitting frequency from 2.400GHz, 2.427GHz, 2.454 GHz, 2.481 GHz can be selected by means of pressing a corresponding key (i.e. A, B, C, D) provided on the front panel. This indicates that each channel is spaced 27 MHz apart
7). All frequencies are PLL locked. PLL means that when both receiver and transmitter are set at same frequency, they are accurate to less than 10 KHz of each other and no further tuning and repeated adjustments are required.
8). Now bring the transmitter to 2.481 GHz by pressing key D. The message forselected 2.481 GHz frequency band will be displayed for 5 seconds.
9) Now press ECS key to go to the main menu.
10) Press key **B** on the front panel of the transmitter. The message for the Input Channels will be displayed.
11).See that the cursor is in front of the AUDIO CH1: Use ▲ UP arrow or DOWN arrow keys to do that. Use forward arrow ► or down arrow key ◄ to select AUDIO CH1 at MIC1 and Video CH 3 at VIDEO. Press ENTER to set it for MIC1 and CH3 to VIDEO
12). Connect the microphone to the MIC 1 post of the UPLINK TRANSMITTER Make sure that the FM DEVIATION potentiometer is at the fully anticlockwise position.
13). Connect the RHCP Helix antenna with a SMA lead to R.F. out of Transmitter The RHCP Helix antenna of Transmitter should be rotated with the antenna pointing in the same direction to that of RHCP Helix antenna of UPLINK CHANNEL of Satellite link emulator. (Yagi antenna pair with similar type of polarization i.e. either vertical or horizontal can also be used in place of RHCP Helix antenna).
14). Connect the Satellite EMULATOR to AC mains outlet with the lead provided.
15). Switch ON the Satellite EMULATOR and the Welcome Message will be displayed for 5Seconds.

To measure the C/N ratio

1) To set the Video Link, set the Transmitter & Emulator Uplink Frequency to 2481 MHz, and Receiver & Emulator Downlink frequency to 2400 MHz. This is done to ensure the emulator downlink PLL is locked and displayed frequency is generated correctly. If you get the picture on the TV screen at the receiver via satellite, PLL of complete link are O.K. and a successful satellite link is said to be established.

2) Now, switch off the carrier by switching off both Transmitter and satellite Emulator. Receiver will read only its noise floor on RSSI menu. To view the RSSI menu, press 'C' Key from main menu then press 'B' key in Receiver. Say, in absence of any carrier, Receiver reads 0.92 V which correspondence to -96 dBm. Thus, -96 dBm is noise floor of Receiver that means if carrier received by Receiver is less than -96 dBm it will be unable to measure it.

3) Now, switch ON Transmitter and satellite Emulator and say, the Receiver reads -59 dBm (1.93 V) of carrier level being received. Thus, C/N = carrier level / noise level. As both noise and carrier signal detected are measured in dB, C/N can be calculated by taking the difference of two readings or C/N = carrier level (in dB) - noise level (in dB). Hence, C/N = -59-(-96) =37 dB

.

4) Make sure the Receiver is not saturated with carrier otherwise incorrect C/N will be read. This can be done by increasing path loss at satellite Emulator and or taking Receiver farther away from satellite Emulator.

5) Measure the C/N readings for different levels of path loss.

6) Monitor the audio and video transmissions and correlate them to various levels of C/N. Does higher level of C/N result in better picture and sound quality?

if you are able to receive audio & video sent, clearly it means you are well above threshold level of signal. Now, the effect of noise can be seen if you decrease the eceived signal strength to a considerable level. This can be achieved by increasing the path loss. This means the received signal is just above the noise floor of receiver. Although we are using FM demodulator but because the received signal is barely above the noise floor you can hardly receive any intelligent information. Thus, signal cannot be received below noise floor of Receiver.

Result:

A clear sound at the receiver indicates that a microwave satellite communication link has been set up successfully. In active satellites, the frequency is translated by transponders in satellite and then sent back to receiver after amplifying the signal at different frequency. Whereas in Passive satellite, signal is only reflected back to the receiver and no freq. translation and power amplification takes place. Active satellite uses up external energy (solar or battery) and active circuits to perform the frequency

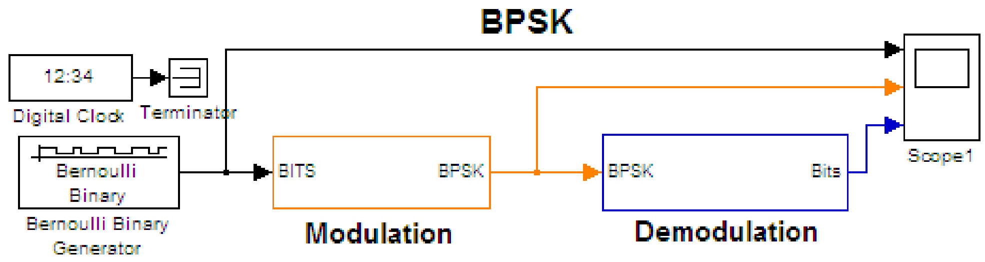
EXPERIMENTNO. 11
SIMULINK OF DIGITAL COMMUNICATION MODULATOR AND DEMODULATOR BY USING MATLAB

OBJECTIVE:

SIMULINK OF DIGITAL COMMUNICATION MODULATOR AND DEMODULATOR BY USING MATLAB

EQUIPMENTS: MAT LAB 7.0.4

BLOCK DIAGRAM:



PROGRAM:

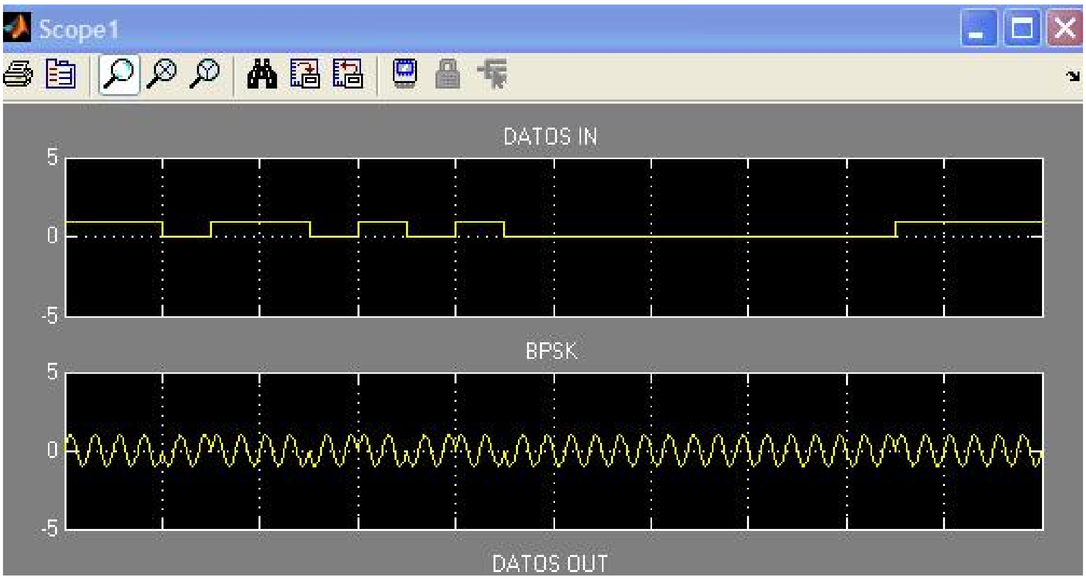
```
m=20;%TIEMPO DE SIMULACIÓN EN SIMULINK
Ts=100;%TIEMPO DE MUESTREO (ES EL MISMO DE LOS SIN Y COS DE LOS TX)

% TIEMPO
tiempo=(0:1/Ts:m)';
% RECORTAR EL RUIDO INICIAL
imp=impares(100*1:end);
par=pares(100*1:end);

% ALINEAR LA TRAMA DESDE EL PRIMER 1
par=par(34:end);
imp=imp(34:end);

% AJUSTAR EL TIEMPO A LA LONGITUD DE LA TRAMA
tiempo=tiempo(1:length(imp));

% PLOTEO DE LAS SEÑALES
% BITS IMPARES
subplot(3,1,2)
plot(tiempo,imp);
ylim([-.5 1.5])
title('IMPARES')
grid on
% BITS PARES
subplot(3,1,1)
plot(tiempo,par);
ylim([-.5 1.5])
title('PARES')
grid on

% UNIR BITS PARES E IMPARES
% MATRIZ NULA PARA ALMACENAR DATOS
D=[];
% CANTIDAD DE BITS DE TAMAÑO 100
lb=floor(length(imp)/100)-1;
% CICLO DE RECONSTRUCCIÓN DE LA TRAMA
```

```
for n=0:lb
   D=[D;par(n*100+1:100*(n+1));imp(n*100+1:100*(n+1))];
end
% TIEMPO DE RECONSTRUCCIÓN DE LA TRAMA PARA AJUSTARLO AL ANCHO DE BIR
% ORIGINAL
tiempo=(1:1/180:50)';
subplot(3,1,3)
plot(tiempo(1:length(D)),D);
ylim([-5 5])
xlim([1 21])
title('SEÑAL ORIGINAL')
grid on
```

PROCEDURE:

1) Start the MAT LAB 7.0.4 soft ware and create new 'M.file'
2) Write down the digital communication modulator and demodulator program and save
3) Simulate the above MATLAB program.
4) The final out put and wave forms are verified

WAVE FORM :



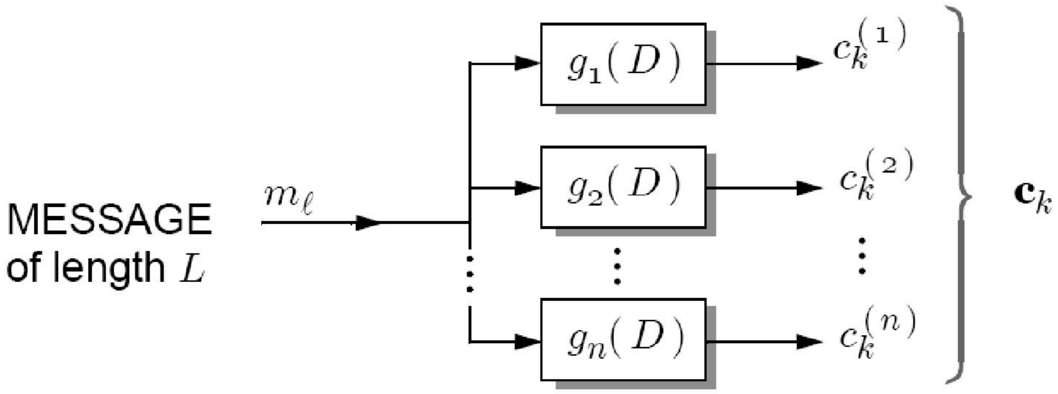
EXPERIMENTNO. 12

SIMULINK OF CHANNEL CODING AND DECODING BY USING MATLAB

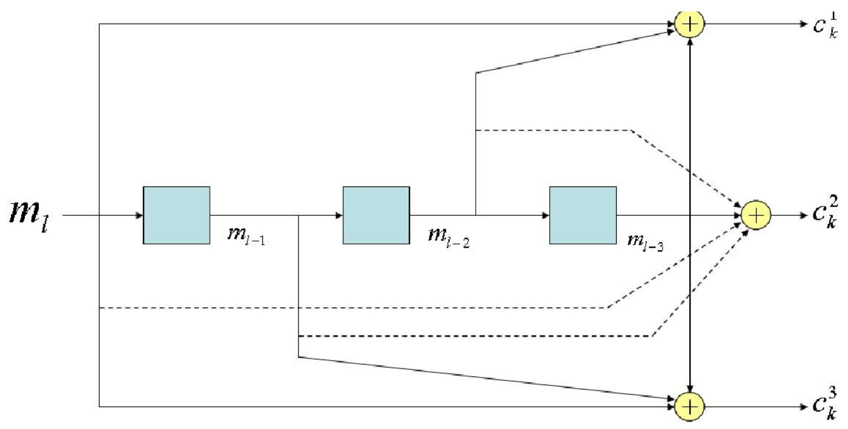
OBJECTIVE: SIMULINK OF channel channel and decoding BY USING MATLAB

EQUIPMENTS: MAT LAB 7.0.4

BLOCK DIAGRAM:



The general form a 1/n convolution encoder



The Optimal Rate 1/3 Convolution Encoder for K = 4.

Sir. CRRCOE .DEPT of ECE

PROGRAM:

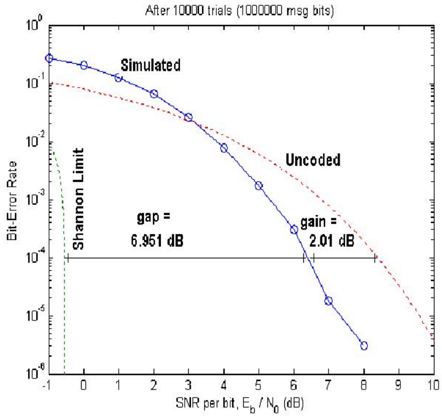
```matlab
% Main code for ECE6606 project, Spring 2009, Georgia Tech
% Skeleton Written by:  Professor Barry
% Convolution Code by:  Romeil Sandhu

%Initialize Simulation Parameters
L = 100;                % message length
R = 1/3;                % code rate
dbs = -1:10;            % SNR per bit, in dB
trials = 1e4;           % number of trials to perform
%------------

%Define Impulse response for the n generators for a 1/n code - here n=3
g(1) = [1 0 1 1 0 0];                % Impulse Responses _ 1
g(2) = [1 1 0 1 0 0];                % Impulse Responses _ 2
g(3) = [1 1 1 1 0 0];                % Implpuse Responses _ 3
n = length(g);                       % Convolution Code (1/n) parameter
memory_els = 3;
%---

%Initialize and compute Shannon Limit/Uncoded Efficiency
errs   = 0*dbs;
EbN0 = 10.^(dbs/10);
sigs = 1./sqrt(2*R*EbN0);
ber0 = logspace(-6,-2.1,81);
ber1 = logspace(-6,-0.99,81);
db0  = 10*log10((2.^(2*R*(1+log2((ber0.^ber0).*(1-ber0).^(1-ber0))))-1)/(2*R));
db1  = 20*log10(erfinv(1-2*ber1));
for trial = 1:trials,

    m = round(rand(1,L));            % message vector

    %--------- ENCODER: 1/3 Convolution Encoder -------%
    c = encode_1_3(m,g,n);
    %--------------------------------------------------%

    %verify code rate!
    if trial==1,disp(['Measured R = ',num2str(length(m)/length(c))]);end;
    noise = randn(1,length(c));
    for i=1:length(dbs),
        r = 2*c - 1 + sigs(i)*noise;

    %--- DECODER:  Convolution Decoder via Trellis Map, ML estimate ---%
    %--- flag = 1 ==> Hard Decoding
    %--- flag = 0 ==> Soft Decoding
    [mhat,node] = decode_1_3(r,n,memory_els,L,1);
    %---------------------------------------------%
    errs(i) = errs(i) + sum(mhat~= m);
    end

    %Plot Simulated Result
    ber = errs/(L*trial);
    semilogy(dbs, ber,'o-', db0, ber0,':', db1, ber1,':');
    hold off;
    xlabel('SNR per bit, E_b / N_0 (dB)');
    ylabel('Bit-Error Rate');
    axis([-1 10 1e-6 1])
    title(['After ',num2str(trial),' trials (',num2str(L*trial),' msg bits)', ...
           ' with Mem = ',num2str(memory_els)]);
```

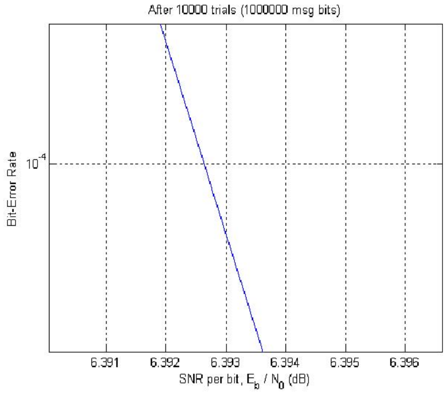
PROCEDURE:

1) Start the MAT LAB 7.0.4 soft ware and create new ‘M.file’
2) Write down the digital communication modulator and demodulator program and save

3) Simulate the above MATLAB program.
4) The final out put and wave forms are verified

WAVE FORMS:





Rate 1/3 Convolution Encoder Simulated Results using a Hard Decoder. (a)-(b) Encoder (Hard Decoding) for K = 4.