**VISHWAKARMA GOVERNMENT ENGINEERING COLLEGE,CHANDKHEDA**

**ELECTRONICS AND COMMUNICATIONS ENGINEERING DEPARTMENT**

**SATELLITE COMMUNICATION (2171007)**

| SR NO. | TITLE | DATE | PAGE NO. | SIGN |
|---|---|---|---|---|
| 1 | Introduction | | | |
| 2 | Understanding the basic concepts of satellite communication | | | |
| 3 | To setup a communication link between uplink transmitter and downlink receiver using Satellite | | | |
| 4 | To setup an Active satellite communication link and demonstrate link fail operation | | | |
| 5 | To communicate voice & Video signal through satellite link | | | |
| 6 | Observe the effect of Different combinations of uplink and downlink frequencies on satellite link. | | | |
| 7 | To transmit and receive three separate signals (Audio, Video , Tone) simultaneously through satellite link | | | |
| 8 | To transmit and receive function generator signals through satellite link. | | | |
| 9 | To measure the signal parameters in an analog FM/FDM TV satellite link. | | | |
| 10 | To transmit digital waveforms through a satellite communication link. | | | |
| 11 | calculate Bit Error Rate in a satellite communication link. | | | |

# EXPERIMENT- 1

**AIM:** Understanding Basic Concepts in Satellite TV

**THEORY:**

**Sinusoidal electromagnetic waves (e/m waves)**

All radio and television signals consist of electrical and magnetic fields which, in free space, travel at the speed of light (approximately 186,000 miles per second or 3 x 108 meters per second), These waves consist of an electric field (E), measured in volts/meter and a magnetic field (H), measured in amps per meter, The E and H field components are always at right angles to each other and the direction of travel is always at right angles to both fields. The amplitudes vary sinusoidal as they travel through space. In fact, it is impossible to produce a non-sinusoidal e/m wave! (The importance of this statement will be grasped more easily when modulation is discussed).

**The sine wave**

**Cycle:** One complete electrical sequence.

**Peak value (Vp) :** Maximum positive or negative value -also called the amplitude.

**Period (t) :** Time to complete one cycle.

**Frequency (f) :** Number of cycles per second measured in Hertz (Hz).

(One hertz = one cycle per second). It follows that period and frequency are reciprocals of each other :t = 1/f

Commonly used multiples of the Hertz are:

Kilohertz (kHz) =1000 Hz

Megahertz (MHz) = 1000000 Hz

Gigahertz (GHz) = 1000000 000 Hz

**RMS value:**

This is 0.707 of the peak value and, unless otherwise stated, any reference to voltage or current in technical literature is normally taken to mean this value. For example, the supply mains in the UK is a sinusoidal variation, stated to be

'240 volts' so the peak value is 240/ 0.707 = 339 volts.

**Angular velocity (w)**

This is an indirect way of expressing the frequency:

$\omega = 2\pi f$ radians per second.

Instead of considering the number of complete cycles, angular velocity is a measure of how fast the vector angle is changing. The voltage equation of a sine wave, which gives the instantaneous value (v) of a sine wave at any point in the cycle is given by:

$$v = V_p \sin \theta$$

where $V_p$ is the peak voltage and $\theta$ is an angle measured in radians (not degrees). There are $2\pi f$ radians in a circle and, since the sine wave can be visualized as a vector rotating in a circle, the above equation can be written in terms of frequency and angle:

$$v = V_p \sin 2\pi f t$$

For convenience and brevity, the 2 $\pi$f part is often lumped together and given the title of angular velocity (w). Using this notation, the equation of the sine wave can be written as:

$$v = V_p \sin \omega t$$

**Wavelength**

Since e/m waves at a known velocity vary sinusoidally, it is possible to consider how far a wave of given frequency (f) would travel during the execution of one cycle. Denoting the speed of light as ( c), the wavelength ($\lambda$) is given by: $\lambda = c/f$

From this, it is clear that the higher the frequency, the shorter the wavelength. Satellite broadcasting employs waves in the order of 10 GHz frequency so the order of wavelength can be calculated as follows:

$$\lambda = (3 \times 10^8)/(10 \times 10^9)$$

$$\lambda = 3 \times 10^{2} = 3 \text{ cm}$$

In practice, the frequencies used are not necessarily a nice round figure like 10 GHz. Nevertheless, the wavelengths in present use invariably work out in terms of centimetres - they are, in fact known as **'centimetric waves'**. It is pertinent at this stage to question why such enormously high frequencies are used in satellite broadcasting? Before this can be answered, it is necessary to understand some fundamental laws relating to broadcasting of information, whether it be sound or picture information.

**Carrier frequency**

For simplicity, assume that it is required to transmit through space a 1000 Hz audio signal. In theory, an electrical oscillator and amplifier could be rigged up and tuned to 1000 cycles per second and the output fed to a piece of wire acting as a primitive aerial. It is an unfortunate fact of nature that, for reasonably efficient radiation, a wire aerial should have a length somewhere in the order of the 'wavelength' ($\lambda$) of 1000 Hz. Using the equation given above:

$$\lambda = c/f = (3 \times 10^8)/(10^3) = 3 \times 10^5 \text{ metres}$$

$\lambda$ = 300000 metres which is about 188 miles!

Apart from the sheer impracticality of such an aerial, waves at these low frequencies suffer severe attenuation due to ground absorption. Another important reason for using high frequencies is due to the considerations of bandwidth which is treated later.

The solution is to use a high frequency wave to 'carry' the signal but allow the intelligence' (the 1000 Hz in our example) to modify one or more of its characteristic.

The high frequency wave is referred to as the carrier ($f_c$) simply because it 'carries' the information in some way. The method of impressing this low frequency information on the carrier is called modulation. There are two main types, amplitude modulation (AM) and frequency modulation (FM).

**Amplitude modulation**

The low frequency modulating signal is made to alter the amplitude of the carrier at the transmitter before the composite waveform is sent to the aerial system. If the amplitude of the modulating signal causes the carrier amplitude to vary between double its un modulated height and zero, the modulation is said to be 100 per cent. Terrible distortion results if the modulation amplitude is ever allowed to exceed 100 percent.

**Modulation factor (m)**

This is the ratio of modulation amplitude ($V_m$) to carrier amplitude ($V_c$):

$m = V_m/V_c$ When m = 1, the modulation is 100 per cent. Although 100 per cent modulation is an advantage, it is too dangerous in practice because of the possibility of over modulation, **so 80 per cent (m = 0.8) is normally considered the safe limit.**

**Sidebands**

Although the modulating signal is a simple sinusoidal waveform, in practice it will be more complex. Thus the envelope of the waveform will be non-sinusoidal. Bearing in mind that only sinusoidal waveforms can be sent through space, there is clearly something odd to explain. This is where a little school maths comes in handy. The un modulated carrier sine wave has the instantaneous form: $v = V_p \sin \omega ct$ But the amplitude of this wave ($V_p$) is made to vary by the modulating frequency which causes $V_p$ to have the form:

$$V_p = V_m \sin \omega ct$$

Substituting this expression in the first equation gives:

$$v = V_m \sin \omega ct \sin \omega ct$$

$\sin A \sin B = 1/2 \cos (A- B) -1/2 \cos (A + B)$

So it follows that the modulated carrier waveform splits up in space into three pure sinusoidal components:

1. The carrier frequency.
2. A frequency equal to the sum of the carrier and modulating frequencies. This is called the **'upper sideband'**.
3. A frequency equal to the difference between the carrier and modulating frequency. This is called the **'lower sideband'.**

Taking a simple numerical example, if the carrier frequency is 1000000 Hz and the modulating frequency is 1000 Hz, then the upper sideband is a 1001000 Hz sine wave and the lower sideband is a 999000 Hz sine wave. In practice, the modulating frequency will seldom be anything as simple as a 1000 Hz sine wave but, more probably, may consist of speech or picture information which contains a complex mixture of frequencies. This does not invalidate the former reasoning. It just means that instead of single frequency upper and lower sidebands, there will be literally, a band of sinusoidally varying frequencies either side of the carrier. For example, the music frequency spectrum extends from about 20 Hz to about 18 kHz so, to transmit high quality sound, the upper sidebands would have to contain a spread of frequencies extending from 20 Hz to 18 kHz above the carrier, and the lower sidebands, frequencies 20 Hz to 18 kHz below the carrier. Television transmission is more difficult because pictures have a far greater information content than sound.

The sidebands must extend several MHz either side of the carrier. The wider the sidebands of transmission, the greater space it will occupy in the frequency spectrum, so broadcast stations geographically close together must operate on frequencies well away from each other in order to prevent interference from their respective sidebands. Since television stations occupy several MHz in the spectrum, carrier frequencies are forced into ever higher and higher frequencies as the number of stations fight for space. There are several novel solutions to the overcrowding problem. For example, it is not essential to transmit both sidebands since all the required information is contained in one of them, providing of course the carrier is sent with it. Such transmissions are called **SSB (single sideband)**. An even more drastic curtailment is to reduce the carrier amplitude at the transmitter to almost zero and use it to synchronize a. locally generated carrier at the receiving end, a technique known as **'single sideband vestigial carrier'** transmission.

**Frequency modulation (FM)**

Whereas amplitude modulation alters the envelope in the 'vertical plane', frequency modulation takes place in the 'horizontal plane'. The amplitude of the carrier is kept constant but the frequency is caused to deviate proportional to the modulating amplitude.

**Frequency deviation**

The maximum amount by which the carrier frequency is increased or decreased by the modulating amplitude is called the frequency deviation. It is solely dependent on the amplitude (peak value) of the modulating voltage. In the case of satellite broadcasting, the signal beamed down to earth has a typical frequency deviation of about 16 MHz/V and the bandwidth occupied by the picture information is commonly about 27 MHz.

**Modulation index (m)**

This is the ratio of the frequency deviation ($f_d$) to the highest modulating frequency ($f_m$): $m = f_d/f_m$ In contrast with amplitude modulation, the modulation index is not necessarily restricted to a maximum of unity.

**Noise**

Any unwanted random electrical disturbance comes under the definition of noise. Such noise is all-pervading and is the worst enemy of the electronic designer. It begins in conventional circuitry, particularly with the apparently harmless resistor because, at all temperatures above zero kelvin (0 K), a minute, but not always negligible, e.m.f. (called Johnson noise) appears (and can be measured) across the ends. This is due to random vibration of the molecules within the body of the resistor and nothing whatever can be done to stop it. Although the following equation for Johnson noise, is not particularly important in this text it is worth examining if only to grasp the strange connection between noise e.m.f.s and temperature.

RMS value of Johnson noise = (4k tBR)1/2 where t = 0 absolute temperature kelvin (room temperature may be taken as around (290 K)

k = Boltzman' s constant = $1.38 \times 10^{-23}$

R = the resistance in ohms

B = the bandwidth of the instrument used to measure the e.m.f.

Those with sufficient zeal to work out the noise from a one MΩ resistor at room temperature would come up with a value of about 0.4 millivolts! This may seem small but it is relative, rather than absolute values that are important. If the wanted signal is of the same order as this (in practical cases it could be much smaller) then the noise will swamp it out. Note from the equation, which incidentally is not restricted to manmade materials, the noise depends on the temperature, and the bandwidth of the 'instrument used to measure it'. Such an 'instrument' includes a broadcast receiving station! A high quality transmission has wide sidebands so the receiving installation must also have a wide bandwidth in order to handle the information in the sidebands. The occurrence of this form of noise entering the chain can seriously limit the quality of reception. Although Johnson noise has been used as an example, there are many other forms of noise (including ground and the man-made variety).

**Comparison of FM and AM**

There are two features of AM which, in the past, have been responsible for its popularity:

1. The demodulation circuitry in the receiver, called 'rectification', is simple, requiring only a diode to chop off one half of the composite waveform and a low pass filter to remove the carrier remnants.
2. The sidebands are relatively narrow so the transmission does not occupy too much space in the available frequency spectrum.

**The most serious criticism of AM is that noise**, at least most of it, consists of an amplitude variation. That is to say, any noise e.m.f.s present ride on the top of the envelope. So, apart from meticulous design techniques based on increasing the S/N ratio, nothing much can be done about reducing noise without degrading signal quality by crude methods such as bandwidth reduction. FM, on the other hand, is often stated to be 'noise free'. This is not true! A FM transmission is as vulnerable to noise pollution as AM but, due to the manner in which the information is impressed on the carrier, much of the noise can be removed by the receiver circuitry. Since noise rides on the outside of an FM waveform, it is possible to slice off the top and bottom of the received waveform without destroying the information (remember that the information is inside the waveform rather than riding on the top and bottom). The slicing-off process is known as 'amplitude limit ing' . A disadvantage of FM is the wide bandwidth required. FM is only possible if the carrier frequencies are relatively high. Fortunately, satellite broadcasting is well above 1 GHz so this is a trivial disadvantage. It cannot be denied that the circuitry required to extract the information from an FM carrier is, to say the least, awkward! The circuitry which performs this function is called an 'FM demodulator' which often takes bizarre forms. Among the various circuits that have been developed for FM demodulation are discriminators, ratio detectors and phased locked loops. This latter type is the most often used method.

**Decibels (dB)**

Decibels provide an alternative, and often more convenient, way of expressing a ratio between two powers. Instead of the actual ratio, the logarithm to base 10 of the ratio is used as shown below:

$dB = 10 \log P_1/P_2$

The sign of the result is positive if $P_1$ is greater than $P_2$ and negative if $P_1$ is less than $P_2$. To avoid the trouble of evaluating negative logarithms, it is a good plan always to put the larger of the two powers on top and adjust the sign afterwards in accordance with the above rule.

Examples:

If $P_1 = 1000$ and $P_2 = 10$ then, $dB = 10 \log 1000/10 = 10 \log 100 = +20$ dB.

(If $P_1$ was 10 and $P_2$ was 1000, the absolute value in decibels would be the same but it would be written as -20 dB). There are several advantages of using dBs instead of actual ratios:

1. Because the human ear behaves logarithmically to changes in sound intensity, decibels are more natural than simple ratios. For example, if the power output of an audio amplifier is increased from 10 watts to 100 watts, the effect on the ear is not 10 times as great.
2. Decibels are very useful for cutting large numbers down to size. For example, a gain of 10000000 is only 70 dB.
3. The passage of a signal from the aerial through the various stages of a receiving installation is subject to various gains and losses. By expressing each gain in terms of positive dBs and each loss in negative dBs, the total gain can be easily calculated by taking the algebraic sum.
   Example: (+5) + ( -2) + ( +3) + ( -0.5) = 5.5 dB.

**Voltage dB**

Although dBs are normally used in conjunction with power ratios, it is sometimes convenient to express voltage ratio in dB terms. The equation in these cases is: dB= 20 log $V_1/V_2$ The use of 20 instead of 10 is because power is proportional to the square of the voltage so the constant is 20 instead of 10.Ku-band satellite TV The European nations have almost exclusively adopted **Ku-band (10.95 to 14.5 GHz)** for the transmission of satellite TV signals.

**The Clarke belt**

Back in 1945, Arthur C. Clarke, the famous scientist and science fiction novelist, predicted that an artificial satellite placed at a height of 35803 km directly above the equator would orbit the globe at the same speed with which the earth was rotating. As a result, the satellite would remain stationary with respect to any point on the earth's surface. This equatorial belt, rather like one of Saturn's rings, is affectionately known as the Clarke belt. Any satellite within this belt is termed **geostationary**, and is placed in a subdivision known as an **orbital slot**. Signals are sent up to a satellite via an uplink, electronically processed and then re-transmitted via a downlink to earth receiving stations.

**The antenna**

The antenna or 'dish' is concerned with the collection of extremely weak microwave signals and bringing them to a focus. The surface must be highly reflective to microwaves and is based on a three-dimensional geometric shape called a paraboloid which has the unique property of bringing all incident radiation, parallel to its axis, to a focus. There are two main types of antenna, one is called prime focus and the other offset focus. Briefly, a prime focus antenna has the head unit mounted in the central axis of the paraboloid whereas the offset focus configuration, has the head unit mounted at the focal point of a much larger paraboloid of which the observable dish is a portion. Antennas are normally made from steel, aluminium or fibreglass with embedded reflective foil.

**Feedhorn**

The feed horn, positioned at the focal point of an antenna, is a device which collects reflected signals from the antenna surface whilst rejecting any unwanted signals or noise coming from directions other than that parallel to the antenna axis. These are carefully designed and precision engineered to capture and guide the incoming microwaves to a resonant probe located at the front of the LNB.A feed horn is really a waveguide. They normally consist of rectangular or circular cross-section tubes and exhibit two important properties, dictated by waveguide theory. First, signals having wavelengths longer than half the internal dimensions are severely attenuated as the signal progresses down its length. Secondly, wavelengths shorter than the waveguides designed dominant mode become rapidly attenuated; thus the feed horn behaves, in effect, like a band pass filter. The reason for the fluted horn is to match the free space impedance of the air with that of the waveguide.

**The low noise block (LNB)**

The function of a LNB is to detect the weak incoming microwave signals via an internal tuned resonant probe, provide low noise amplification, and finally down convert the whole block of frequencies to one suitable for cable transmission. It is common nowadays for the combination of feed horn, polarizer and LNB to be manufactured as a single sealed unit. The entire assembly is often referred to as an LNB, for convenience, but it should be remembered that this is not strictly the case. **Satellite receivers** The purpose of a satellite receiver is the selection of a channel for listening, viewing, or both, and transforming the signals into a form suitable for input to domestic TV and stereo equipment. Down-converted signals of about 1 GHz are fed by coaxial cable from the LNB to the input of the receiver. The various subsections of a receiver are listed below:

1. Power supply.
2. Second down-conversion and tuner unit.
3. Final IF stage.
4. FM video demodulator.
5. Video processing stages.
6. Audio processing stages.
7. Modulator.

It will be increasingly common to find TV sets with built-in satellite receivers designed to cover both the FSS and DBS band.

**Effective isotropic radiated power (EIRP) and footprint maps**

An isotropic radiator is defined as one which radiates uniformly in all directions. For purposes of illustration it is perhaps better to use a lightbulb analogy. Imagine a 40 W Light bulb suspended from a ceiling so as to be in line with a keyhole. An observer looking through the keyhole would see just a 40 W isotropic radiator. If a parabolic reflector from an old car headlamp is placed directly behind it, then the energy from the bulb will be reflected and magnified in one general direction, toward the keyhole, similar to a car's headlamp on main beam. To an observer, with a restricted field of view, the light source will appear as an isotropic radiator of much higher power. In other words, the effective power appears much higher than the actual power. This effect is somewhat similar to that which occurs with a parabolic transmitting antenna of a satellite. To a distant observer, which in this case is the receiving site antenna, the radiated power

appears much higher than that of an isotropic radiator because the transponder antenna has a parabolic reflector and the receiving site antenna
('eye at the keyhole') has a restricted view of the transmitted beam. We know that the EIRP of the Astra 1A satellite is 52 dBW in the central service area, and that the transponder power is 45 W, therefore we can calculate the effective isotropic radiated power in watts as seen by the antenna.
EIRP = 10 log (effective power)
effective power = 10(EIRP/10) =10(52/10) = 158489 W or 158.5 kW
From this we can calculate the magnification factor of the transponder's transmitting antenna:
magnification = 158489/45 = 3522 times
Repeating the calculation for a typical DBS satellite with a transponder power output of 110 W and an EIRP value of 61 dBW in the central service area we get: effective power = 10(EIRP/10) = 1258925 W or 1.25 MW magnification = 1258925/110 = 11445 times As with the lamp analogy the intensity of the beam will fall off as the distance from the main axis increases, since the beam will naturally diverge, in a conic fashion, with distance. A satellite EIRP footprint map is constructed by linking contours or lines through points of equal EIRP in the service area. The values will decrease away from the center which shows footprint maps for the four beams generated by the Astra 1A satellite. The above calculations show that large and unwieldly numbers start to emerge when we talk in effective power terms; this is why **EIRP is measured in logarithmic decibel units relative to 1 watt**. Remember that a 3 dB increase corresponds to a doubling of power. Therefore the apparent small increases in the values seen on footprint maps correspond to large changes in power levels. In this way relatively small numbers can be used to describe large power changes. Most footprint maps have this characteristic circular shape with EIRP levels falling off linearly away from the main service area.
An isotropic radiator is defined as one which radiates uniformly in all directions. This is not obtainable in reality but is easy to visualize. By using a reflector an isotropic radiator can concentrate all its energy into a narrow beam which appears to some distant observer, at the other end of the beam, as an isotropic source of several magnitudes greater power output. Thus the term equivalent isotropic radiated power is used as a measure of signal strength that a satellite transmits to earth. EIRP is measured in dB relative to one watt (dBW) and is highest at the beam centre. This value decreases logarithmically at distances away from the beam centre. The EIRP of any satellite can be obtained from the appropriate footprint map, as contours of equal magnitude. Modern satellites can shape their EIRP contours to a certain extent to fit the desired service area although the methods used need not concern us here.A typical value of EIRP for medium power semi-DBS satellites such as Astra is 52 dBW. High power DBS satellites have EIRP values in excess of 60 dBW **Downlink frequency allocations** The ITU has split the world up into three regions. The approximate frequency allocations above 10 GHz are as follows.
Region 1: Europe, CIS, Africa and Middle East

Fixed satellite service (FSS) band: 10.70-11.70 GHz
12.50-12.75 GHz
17.70-21.20 GHz

Direct broadcast service (DBS): 11.70-12.50GHz

Broadcast satellite service (BSS): 21.40-22.00 GHz (from 2007) Region 2: The Americas and Greenland

Fixed satellite service (FSS) band: 11.70-12.20 GHz
17.70-21.20 GHz

Direct broadcast service (DBS): 12.20-12.70 GHz

Broadcast satellite service (BSS): 17.30-17.80 GHz (from 2007) Region 3: India, Asia, Australasia and the Pacific

Fixed satellite service (FSS) band: 11.70-12.75 GHz
17.70-21.20 GHz

Direct broadcast service (DBS): 11.70-12.75GHz

Broadcast satellite service (BSS): 21.40-22.00 GHz(from 2007) **Pre-emphasis (de- emphasis) improvement** Since the noise power density of a receiver demodulator output increases with frequency. High frequencies are boosted or pre-emphasized prior to transmission. When the signal is subsequently demodulated in the receiver the signal and its acquuired noise is de- emphasized or reduced by an equal amount. The overall effect is to reduce the noise component and leads to a typical improvement in S/N of 2 dB for PAL I signals or 2.5 dB for NTSC M signals.

# EXPERIMENT-2

**AIM :** To set up a communication link between uplink transmitter and downlink receiver using Satellite.

**EQUIPMENT REQUIRED**:Satellite uplink transmitter and Satellite downlink receiver,connecting cables, Pair of Dish antennas with mounts.

**PROCEDURE**:

1. Connect the transmitter to AC mains outlet with the lead provided.
2. Switch ON the transmitter and the frequency LED will come on.
3. The LED will read – 5.74 GHz.
4. The transmitting frequency can be selected by means of a select switch provided on the front panel.
5. Pressing the select switch will increase the frequency from 5.74, 5.76, 5.78, 5.80, 5.82, 5.84 and 5.86 GHz and back to 5.74 GHz in cyclic manner. This indicates that each channel is allocated a bandwidth of 20 MHz.
6. The best part is that it holds good for receiver also and PLL means that when both receiver and transmitter show same frequency, they are accurate to less than 10 KHz of each other and no tuning and repeated adjustments are required.
7. Now bring the transmitter to 5.74 GHz and connect the Dish antenna with SMA lead to R.F. out of Tx.
8. Set the output level of Tx to maximum by turning the RF level fully clockwise.
9. Switch on the satellite link Emulator and set the frequency of uplink Rx as 5.74 Ghz and Downlink Tx as 2.414 GHz.
10. The Dish of Tx should be rotated with the antenna pointing in the same direction to that of Patch of satellite uplink Rx. Also, the Patch of satellite Downlink Tx should be rotated with the antenna pointing in the same direction to that of Dish of Rx.
11. The receiver could be switched on now after plugging into AC mains outlet.
12. The LED will read – 2.414 GHz.
13. The receiving frequency can be selected by means of a select switch provided on the front panel.
14. Pressing the select switch will increase the frequency from 2.414GHz, 2.432GHz, 2.450 GHz, 2.468 GHz and back to 2.414GHz in cyclic manner.
15. Set the frequency to 2.414 GHz using frequency control.
16. Now connect Dish with SMA lead to the receiver. The receiver noise will be squelched to silence.
17. Point the Rx Dish to Dish of satellite Downlink Transmitter.
18. Keep the switch audio 1 audio 2 to audio1 and also mic 1 KHz switch to 1 KHz. Similarly, the switch audio 1 audio 2 to audio1 at Rx end also. This will make the receiver sound to 1KHz test tone.

## CONCLUSION:

# EXPERIMENT-3

**AIM**: To setup an Active satellite communication link and demonstrate link fail operation.

**EQUIPMENT REQUIRED**: Satellite uplink transmitter and Satellite downlink receiver, Satellite link emulator, connecting cables, Pair of Dish antennas with mounts.

**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 downlink**

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 then 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:

1. **Low power** - These have transponder powers around the 20 W mark and are primarily general telecommunication satellites. Due to the low transmission power of each transponder they can support many channels with the available collected solar energy. Many of these transponders link emulator programme material for cable TV operators across Europe. Small numbers of enthusiasts eavesdrop on these broadcasts but, unfortunately, receiving dishes of monstrous proportions are necessary for noise free reception, often in excess of 1 meter. This state of affairs is clearly not too popular with the general public who consider them, quite understandably, as dinosaurs of a past age. Even so, domestic TV reception is not the primary reason for the existence of such high channel capacity satellites. Transponder bandwidths can vary.

2 **Medium power** - These satellites have typical transponder powers of around 45 W, such as those on board Astra 1A. Such satellites are now commonly termed semi- DBS (direct broadcast service) and represent the first serious attempt to gain public approval by offering the prospect of dustbin-Lid-sized dishes of 60 cm diameter. About sixteen transponders are average for this class at the present time. Medium power European satellites usually operate in the frequency band 10.95 GHz to 11.70 GHz and form the fixed satellite service (FSS). The transponder bandwidths are commonly 27 MHz or 36 MHz. Some medium power satellites, such as the Eutelsat II series, also have a number of transponders that can be active in the 12.5 GHz to 12.75 GHz band, originally termed the business band service (BBS) by the International Telecommunication Union (ITU).

3 **High power** - These pure DBS satellites have transponder powers exceeding 100 W and have a correspondingly reduced channel capacity of around four perhaps five channels. The specified dish size is minimal, about 30 to 45 cm in the central service area. These are perhaps the ideal size as far as the public are concerned and interest in satellite TV is expected to blossom as these come on stream. European transponder frequencies are in the band 11.70 to 12.50 GHz which is known as the DBS band. It has been agreed that the transponder bandwidths are 27 MHz.

**Microwaves and the receiving site**

The medium used to transmit signals from satellite to earth is micro-wave electromagnetic radiation which is much higher in frequency than normal broadcast TV signals in the VHF/UHF bands. **Microwaves still exhibit a wave-like nature but inherit a tendency to severe attenuation by water vapour or any obstruction in the line of sight of the antenna**. 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; A television receive only **(TVRO)** site consists of an antenna designed to collect and concentrate the signal to its focus where a feedhorn is precisely located. This channels microwaves 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.

**PROCEDURE**:

1. Bring the transmitter to 5.74 GHz and connect the Dish antenna with SMA lead to R.F. out of Tx.
2. Set the output level of Tx to maximum by turning the RF level fully clockwise.
3. The Dish of Tx should be rotated with the antenna pointing in the same direction to that of Patch of Satellite Uplink Receiver.
4. Switch on the satellite link Emulator and set the frequency of uplink Rx as 5.74 Ghz and Downlink Tx as 2.414 GHz.

5. The Dish of Tx should be rotated with the antenna pointing in the same direction to that of Patch of satellite uplink Rx. Also, the Patch of satellite Downlink Tx should be rotated with the antenna pointing in the same direction to that of Dish of Rx.
6. The receiving frequency can be selected by means of a select switch provided on the front panel.
7. Pressing the select switch will increase the frequency from 2.414GHz, 2.432GHz, 2.450 GHz, 2.468 GHz and back to 2.414GHz in cyclic manner.
8. Set the frequency to 2.414 GHz using frequency control.
9. Now connect Dish with SMA lead to the receiver. The receiver noise will be squelched to silence.
10. Point the Rx Dish to Patch of Satellite Uplink Transmitter.
11. Keep the switch audio 1 audio 2 to audio1 and also mic 1 KHz switch to 1 KHz . Similarly, the switch audio 1 audio 2 to audio1 at Rx end also. This will make the receiver sound to 1KHz test tone.
12. Bring the transmitter to 5.86 GHz and connect the Dish antenna with SMA lead to R.F. out of Tx.
13. Set the output level of Tx to maximum by turning the RF level fully clockwise.
14. The Dish of Tx should be rotated with the antenna pointing in the same direction to that of Patch of uplink Satellite link emulator.
15. Bring the uplink Satellite link emulator to 5.76 GHz.
16. Uplinking to a satellite is normally carried out at a higher frequency. There are 7 uplinking frequency channels 5.74, 5.76, 5.78, 5.80, 5.82, 5.84 and 5.86 GHz having a bandwidth of 20 MHz each. .
17. Bring the Downlink Satellite link emulator to 2.468 GHz.
18. Set the frequency of Down link Rx to 2.468 GHz using frequency control.
19. Now connect Dish with SMA lead to the receiver.
20. Point the Dish to Patch of Downlink sat-link emulator.
21. Downlinking from a satellite is carried out at lower frequencies. There are 4 downlinking frequency channels 2.414, 2.432, 2.45, 2.468 GHz having a bandwidth of 18 MHz each.
22. Setup the link in a TRIANGLUR fashion with Tx, Rx and Sat-link emulator at 3 vertices of a triangle. Make sure that Dish of Tx should point towards Patch of sat-link emulator and Dish of Rx should point towards Patch of sat-link emulator. Set the distance between antennas to approx. 5 meters center to center.
23. Check the link with the help of 1KHz test tone.
24. Repeat the experiment by selecting a different uplinking & downlinking channel frequencies.
25. Selecting different frequencies at Uplinking end say, Transmitter(5.86) and uplink channel of satellite(5.76) and also different frequency at Receiver(2.468) and Downlink channel of satellite(2.414) will result in link fail.

**RESULT :**

Uplinking in commercial C band is at 5.925 – 6.425 GHz and uplinking in commercial Ku band is at 14.000 – 14.500 GHz.

Downlinking in commercial C band is at 3.700 – 4.200 GHz and Downlinking in commercial Ku band is at 11.700 – 12.200 GHz

In our case, uplinking is carried out at 5.74, 5.76, 5.78, 5.80, 5.82, 5.84 and 5.86 GHz whereas Downlinking is carried out at 2.414, 2.432, 2.45, 2.468 GHz.

In our case the uplink and downlink frequencies are not so closer as compared to a commercial setup to conserve bandwidth and limit channel usage. The bandpass filters inside the receiver and transmitter are real good with steep curves and accurate frequencies for optimum performance which can be tested by watching the receiver noise floor with transmitter at different frequency.

We use ISM band for satellite communication simulation as it is a license free band for institutional use. This band is from 2400 MHz to 2500 MHz & 5.8 Ghz.

**CONCLUSION:**

# EXPERIMENT 4

**AIM**: To communicate voice and Video signal through satellite link.

**EQUIPMENT REQUIRED**: Satellite uplink transmitter and Satellite downlink receiver, Satellite link emulator, connecting cables, Pair of Dish antennas with mounts, microphone.

**PROCEDURE**:

1. Setup the link in a TRIANGLUR fashion with Tx, Rx and Sat-link emulator at 3 vertices of a triangle. Make sure that Dish of Tx should point towards Patch of sat-link emulator and Dish of Rx should point towards Patch of sat-link emulator. Set the distance between antennas to approx. 5 meters center to center.
2. Listen to the voice spoken into the mic at the speaker of the receiver. Also observe that the audio signal that was sent and received are exactly same.
3. Connect the video camera output to Video in of Tx and connect the power supply of camera. Set the input select switch to video.
4. Connect the video Monitor to video out of Rx and connect the power supply of Monitor.
5. See if you are able to receive both the audio & video sent at different channels clearly.
6. Now, connect a T connector at video in of Tx so that the video signal from CCD camera can be simultaneously viewed on CRO. Similarly, connect another CRO at Rx end using T connector for visualizing the received video signal via satcom link. Also view the audio channel on the other channel of CRO at both Tx and Rx end using T connectors.
7. Find the sync. level of video signal fed using CRO. If you put a black sheet of paper or your hand in front of CCD camera so that no light can enter into lens of camera then negligible signal is present to modulate the video carrier. Therefore, what you see on LED of CRO is the internal sync. level of camera. Measure how much mV is it.
8. If you vary intensity of light in front of camera, meaning that you remove black sheet in front of lens. Then varying light from object etc. will modulate the video signal and you will see a continuously varying complex video signal on CRO. See if same varying signal can be retrieved at Rx end. Bringing your hand in front of camera and taking it away will vary the FM deviation of signal. See if it happens at Rx end also.

**RESULT :**

The speech spoken into mic is converted into electrical signal and FM modulated onto a carrier of 5.8 GHz. The same holds true for any other audio signal also. The modulated carrier is then radiated from the antenna and received by the satellite transponder. The satellite then transverts this carrier to another frequency and retransmits to receiving base station at different frequency. This frequency is then received by the earth station and demodulated to give the audio output. Base-band analog (Voice) Signal could be received only because the Tx., Uplink sat-link emulator, Downlink sat-link emulator and Rx all are PLL locked to accuracy of less than 10KHz. This is an analog FM/FDM system where audio and video both are FM modulated on carrier at transmitter and transmitted to the receiving station. The system uses achannel allocation of 20 / 18 MHz as specified for satellite video link. Within this band there are audio sub carriers of 6 & 6.5 MHz, which can carry different audio channels simultaneously for different languages or stereo. The video amplifier has a bandwidth of 5 MHz. The fm deviation is 4MHz for a video signal of 1V p/p.

The process of modulation and demodulation is analog FM with wide bandwidth for video signal and narrow bandwidth for audio signal. The FM demodulation is carried out using PLL demodulators for wide band response and good linearity.

**CONCLUSION:**

# EXPERIMENT -5

**AIM**: Observe the effect of different combinations of uplink and downlink frequencies on satellite link.

**EQUIPMENT REQUIRED**: Satellite uplink transmitter and Satellite downlink receiver, Satellite link emulator, connecting cables, Pair of Dish antennas with mounts, microphone, video camera, video Monitor

**PROCEDURE**:

1. Bring the transmitter to 5.8 or 5.86 GHz and connect the Dish antenna with SMA lead to R.F. out of Tx.
2. Connect the video camera output to Video in of Tx and connect the power supply to camera.
3. The Dish of Tx should be rotated with the antenna pointing in the same direction to that of Patch of uplink Rx Satellite link emulator.
4. Bring the uplink Rx Satellite link emulator to 5.8 or 5.86 GHz.
5. Bring the Downlink Tx Satellite link emulator to 2.45 or 2.468 GHz.
6. Set the frequency of Rx to 2.45 or 2.468 GHz using frequency control.
7. Connect the video Monitor to video out of Rx and connect the power supply to Monitor.
8. Setup the link in a TRIANGLUR fashion with Tx, Rx and Sat-link emulator at 3 vertices of a triangle. Make sure that Dish of Tx should point towards Patch of sat-link emulator and Dish of Rx should point towards Patch of sat-link emulator. Set the distance between antennas to approx. 5 meters center to center.
9. See if you are able to receive audio & video sent at different-different channels clearly.
10. Transponder in a satellite is a receive transmit pair. Change the up-linking frequency of sat-link emulator keeping down-linking sat-link emulator freq. constant. Then change the down-linking frequency of sat-link emulator keeping up-linking satlink emulator freq constant. This forms different transponder pairs.
11. Press the frequency select switch of satellite emulator down link channel several times so as to set the frequency display from 2.414, 2.432, 2.450, 2.468 and then back to 2.414. This is done to ensure the emulator downlink PLL is locked and displayed frequency is generated correctly**.** Up-linking to a satellite is normally carried out at a higher frequency because of narrow beam-width, for pinpointing distant satellites, at higher frequency. There are 7 up-linking frequency channels 5.74, 5.76, 5.78, 5.80, 5.82, 5.84 and 5.86 GHz.
12. The satellite link emulator consists of transponder (transmit-receive pair). It receives frequency in 5.8 GHz band and has the capability to retrasmit after amplification in 2.4-2.5 GHz band. It can be set to receive at one particular frequency and transmit at some different frequency. Down-linking from a satellite is carried out at lower frequencies because wider beam width gives more footprint coverage. There are 4 down-

linking frequency channels 2.414, 2.432, 2.45, 2.468 GHz.

13. Repeat the experiment by selecting a different uplinking & downlinking channel frequencies.
14. Also, two C.R.O. can be connected at Tx and Rx end for signal analysis. 15. Normally, approx. 180 dB of path loss occurs during actual uplinking anddownlinking that is why power amplification is mandatory at satellite.

**RESULT :**

This is an analog FM/FDM system where audio and video both are FM modulated on carrier at transmitter and relayed to satellite which then transverts the signal and sends it back to the receiving station. The system uses a channel allocation of 20/18 MHz as specified for satellite video link. Within this band there are audio sub carriers which can carry different audio channels simultaneously for different languages or stereo. The process of modulation and demodulation is analog FM with wide bandwidth for video signal and narrow bandwidth for audio signal. The FM demodulation is carried out using PLL demodulators for wide band response and good linearity.

# EXPERIMENT -6

**AIM**: To transmit and receive three separate signals (Audio, Video, Tone) simultaneously through satellite link.

**EQUIPMENT REQUIRED**:Satellite uplink transmitter and Satellite downlink receiver,Satellite link emulator, connecting cables, Pair of Dish antennas with mounts, microphone, video camera, video Monitor

**PROCEDURE**:

1.Set up the link as before. Press the frequency select switch of satellite emulator down link channel several times so as to set the frequency LED from 2.414, 2.432, 2.450, 2.468 and then back to 2.414. This is done to ensure the emulator downlink PLL is locked and LED frequency is generated correctly. If switching ON the 1kHz tone on transmitter will make the receiver sound to 1KHz test tone via satellite, PLL of complete link are O.K. and a successful sat link is said to be established.

2. Connect the video camera output to Video in of Tx and connect the power supply of camera. Set the input select switch to video.

3. Select the 1KHz tone at audio1 channel and feed a 2 KHz sine wave externally at audio2 channel.

4. Connect the video Monitor to video out of Rx and connect the power supply of Monitor.

5. See if you are able to receive both the audio & video sent at different channels clearly. This would perform the functionality of a satellite MODEM: Modulating the baseband on a carrier at Tx end and Demodulating the received carrier at Rx end after being passed through satellite.

6. Now, connect a T connector at video in of Tx so that the video signal from CCD camera can be simultaneously viewed on CRO. Similarly, connect another CRO at Rx end using T connector for visualizing the received video signal via satcom link. Also view both the the audio channels one by one on the other channel of CRO at both Tx and Rx end using T connectors. Use a function generator to feed sine waves at Tx end.

7. See if you can receive video as well as both audio frequencies simultaneously.
This is a complete **Analog FM/FDM** TV satcom link. In commercial broadcast the two audio channel are the left & right stereo channels and the video is the motion picture, which together comprise the signal content.

8. Now increase the path loss at both ends by increasing the distance between antennas and see if you can receive both audio as well as video simultaneously. Why does video signal remain hardly disturbed whereas audio reception is highly susceptible to path loss and multipath effect?

9. Find the sync. level of video signal fed using CRO. If you put a black sheet of paper or your hand in front of CCD camera so that no light can enter into lens of

camera then negligible signal is present to modulate the video carrier. Therefore, what you see on LED of CRO is the internal sync. level of camera. Measure how much mV is it.

10. If you vary intensity of light in front of camera, meaning that you remove black sheet in front of lens. Then varying light from object etc. will modulate the video signal and you will see a continuously varying complex video signal on CRO. See if same Satellite Trainer 25 varying signal can be retrieved at Rx end. Bringing your hand in front of camera and taking it away will vary the FM deviation of signal. See if it happens at Rx end also.
11. Now, connect a sine wave input at video in of Tx end and vary the frequency of sine wave source from 20 Hz to 7 MHz and measure its level, frequency, and distortion on CRO. Now, measure the level, frequency, distortion, noise added to sine wave at Rx end on each channel.
12. Measure the noise level at output of audio2 channel of receiver when no signal is being fed to the transmitter. Measure the noise level when a 1KHz sine wave is being fed to the video input of Tx. Now measure the noise on increasing the FM deviation of video channel or feeding a signal of higher amplitude into video input. Does the noise increase in audio2? Does the 1KHz signal of video breaks into audio. If it does then at what level at video input.
13. Feed a sine wave signal of 5 MHz into video input. Gradually increase the frequency to 7MHz and monitor the audio2 channel. Does a frequency of 6.5 MHz of video input result in noise at the audio2 channel. Similarly does a frequency of 6 MHz result in noise at audio1 channel. See that the video input frequency crosses the audio sub carriers resulting in noise in audio channels.
14. Observe the demodulated frequencies of 100Hz, 1KHz, 100 KHz, 1MHz and 10 MHz at video output of the receiver on the CRO. Does the video output gets distorted at 1MHz and 10MHz. Does reducing the deviation at Tx end help reduce the **distortion** at Rx end.

**RESULT:**

This is an analog FM/FDM system where audio and video both are FM modulated on carrier at transmitter and link relayed to satellite which then transponds the signal and sends it back to the receiving station. The system uses a channel allocation of 20 / 18 MHz as specified for satellite video link. Within this band there are audio sub carriers of 6 & 6.5 MHz, which can carry different audio channels simultaneously for different languages or stereo. FDM is implemented because three different frequencies are used for transmission of three separate signals. The video amplifier has a bandwidth of 5 MHz. The fm deviation is 4MHz for a video signal of 1V p/p. The process of modulation and demodulation is analog FM with wide bandwidth for video signal and narrow bandwidth for audio signal. The FM demodulation is carried out using PLL demodulators for wide band response and good linearity

# EXPERIMENT 7

**AIM :** To transmit & receive the Function Generator waveforms through a satellite communication link.

**EQUIPMENT REQUIRED**: Satellite uplink transmitter and Satellite downlink receiver, Satellite link emulator, connecting cables, Pair of Dish antennas with mounts.

**PROCEDURE**:

1. Bring the transmitter to 5.8 GHz and connect the Dish antenna with SMA lead to R.F. out of Tx.
2. Bring the uplink Satellite link emulator to 5.8 GHz.
3. Bring the Downlink Satellite link emulator to 2.45 GHz.
4. Set the frequency of Rx to 2.45 GHz using frequency control.
5. Now connect Dish with SMA lead to the receiver.
6. Point the Rx Dish towards Patch of Downlink sat-link emulator.
7. Setup the link in a TRIANGLUR fashion with Tx, Rx and Sat-link emulator at 3 vertices of a triangle. Make sure that Dish of Tx should point towards Patch of sat-link emulator and Dish of Rx should point towards Patch of sat-link emulator. Set the distance between antennas to approx. 5 meters center to center.
8. Set the Function Generator O/P to 0.5V p/p and don't exceed this level else clipping will occur.
9. Connect the Function Generator O/P to video In of Tx and video Out of Rx to CRO.
10. Now vary the frequency of Function Generator and see the same O/P on CRO.

**RESULT :** The Function Generator O/P waveforms can be transmitted over a distance via a satcom link.

**CONCLUSION:**

# EXPERIMENT 8

**AIM**: To measure signal parameters in an analog FM /FDM TV satellite link.

**EQUIPMENT REQUIRED**: Satellite uplink transmitter and Satellite downlink receiver, Satellite link emulator, connecting cables, Pair of Dish antennas with mounts, video camera

**PROCEDURE**:

1. Set up the link as before.
2. The spoken signal at Tx can be displayed on CRO at Tx end at Audio 2. The received spoken signal via satcom link can also be displayed at Rx end by connecting a CRO at audio output at Rx end. Analyse the similarity in signals at both ends.
3. Now connect a 1 KHz sine wave with a BNC-T connector to AUDIO 2 of Tx so that the same sine wave signal can also be observed on one channel of CRO. Ensure that the level of sine wave fed is less than 1V p/p.
4. Connect the Audio 2 out of Rx to the other channel of CRO for comparing the transparency of signal received via satcom link. The transmitted & received waveforms are being monitored simultaneously on the same CRO on dual channel chopped mode.
5. Measure the level of signal being transmitted and the level of signal being received.
6. Find the levels of signals received on transmitting signal level of 10 mV to 2V in steps of 50mV. Draw a graph between transmitted and received signal levels. If the graph shows straight line then there is no companding being used in the system. **Companding** is used to increase the level of low level signals from microphones and reduce the level of high level signals in telephony.
7. From the graph measure the level of signal for which the graph deviates from a straight line by 1dB. 1dB would mean that the signal level is lower than the expected level by 11%. This level will be the **1dB compression level** of the system for audio2 channel.
8. Find the minimum level of audio signal that can be received over the noise floor of the equipment.
9. Find the ratio of the maximum level unclipped sine waveform to minimum signal. This would give the **dynamic range** of audio signal the link can handle.
10. Now set the frequency of input sine wave signal to 10Hz and measure the level of signal being received. Vary the frequency of input signal to 100 KHz in steps and measure the level of received signals at different frequencies.
11. Draw a graph between frequency of the signal and level of input sine wave signal. This would show the frequency response of the signal source. Also draw a graph between frequency of the signal and level of the received signal. This would

show the **frequency response of the communication link** for audio2 channel.

12. Measure the **–3dB bandwidth** of the audio2 channel. –3dB would be the level for which the measured signal is 30% lower than its level at a reference frequency of say 1KHz.
13. Repeat the same experiment for audio1 channel. Find the difference from audio2 channel.
14. Now feed a signal in audio1 channel and measure the received signal in audio2 channel for different levels of FM deviation. Find the ratio of received signal in audio1 channel to the signal in audio2 channel. This would be a measure of **cross-talk** or channel separation.
15. Now repeat the same measurements of frequency response etc for video channel.
16. Find the level of the highest unclipped sine wave that can be received at video out of Rx.
17. Find the difference in frequency response from audio channels. Does the video channel show a better frequency response at higher frequencies? Does it correlate to difference in frequencies of audio and video signals?
18. Now remove the sine wave source at TX end. Measure the noise at audio2 input at Tx end on CRO. It will be in the vicinity of few millivolts.
19. Measure the noise at audio2 output at Rx end on CRO. It will be in the vicinity of few tens of millivolts.
20. Measure how much noise is being added to signal after it has passed through various circuitry of Tx, Rx and transponder.
21. Also measure the noise when the satellite is removed and Tx and Rx are kept at same frequency with antennas pointing to each other. See if the increase in noise is less than if it were passed through satellite. The difference, if any is due to **noise addition in satellite transponder.**
22. Also see how much noise increases or decreases if path loss (path loss can be increased by keeping the Tx and Rx antennas apart) at Tx, Rx and satellite end is varied.
23. Now, connect a sine wave input at video in of Tx end and vary the frequency of sine wave source from 20 Hz to 7 MHz and measure its level, frequency, and distortion on CRO. Now, measure the level, frequency, distortion, noise added to sine wave at Rx end on each channel.
24. Measure the noise level at output of audio2 channel of receiver when no signal is being fed to the transmitter. Measure the noise level when a 1KHz sine wave is being fed to the video input of Tx. Does the noise increase in audio2? Does the 1KHz signal of video breaks into audio. If it does then at what level at video input.
25. Feed a sine wave signal of 5 MHz into video input. Gradually increase the frequency to 7MHz and monitor the audio2 channel. Does a frequency of 6.5 MHz of video input result in noise at the audio2 channel. Similarly does a frequency of 6 MHz result in noise at audio1 channel. See that the video input frequency crosses the audio sub carriers resulting in noise in audio channels.

26. Observe the demodulated frequencies of 100Hz, 1KHz, 100 KHz, 1MHz and 10 MHz at video output of the receiver on the CRO. Does the video output gets distorted at 1MHz and 10MHz. Does reducing the deviation at Tx end help reduce the **distortion** at Rx end.

**RESULT:**

This is an analog FM/FDM system where audio and video both are FM modulated on carrier at transmitter and link relayed to satellite which then transponds the signal and sends it back to the receiving station. The system uses a channel allocation of 20/18 MHz as specified for satellite video link. Within this band there are audio sub carriers of 6 & 6.5 MHz, which can carry different audio channels simultaneously for different languages or stereo. FDM is implemented because three different frequencies are Satellite Trainer 29 used for transmission of three separate signals. The video amplifier has a bandwidth of 5 MHz. The fm deviation is 4MHz for a video signal of 1V p/p. The process of modulation and demodulation is analog FM with wide bandwidth for video signal and narrow bandwidth for audio signal. The FM demodulation is carried out using PLL demodulators for wide band response and good linearity.

The speech spoken into mic is converted into electrical signal and FM modulated onto a sub-carrier of 6 or 6.5 MHz. The sub-carrier is then mixed with main carrier at 5.8 GHz. The main carrier is carrying the video signal on FM modulation. The same holds true for any other audio signal also. The mixing of sub carrier generates signals of say 5.806 and 5.8065 and also at 5.794 and 5.7935 GHz with main carrier at 5.8 GHz. The sub-carriers are at a level of around 20-25dB lower than the main carrier. For this reason audio channels are more prone to fading. The modulated carrier is then radiated from the antenna and received by the satellite transponder. The satellite then transverts this carrier to another frequency and retransmits the amplified signal to receiving base station at different frequency. This frequency is then received by the earth station and demodulated to give the audio output. Baseband analog (Voice) Signal could be received only because the Tx, Uplink satellite link emulator, Downlink satellite link emulator and Rx all are PLL locked to accuracy of less than 10KHz.

# EXPERIMENT- 8

**AIM**: To measure signal parameters in an analog FM /FDM TV satellite link.

**EQUIPMENT REQUIRED**: Satellite uplink transmitter and Satellite downlink receiver, Satellite link emulator, connecting cables, Pair of Dish antennas with mounts, video camera

**PROCEDURE**:

1. Set up the link as before.
2. The spoken signal at Tx can be displayed on CRO at Tx end at Audio 2. The received spoken signal via satcom link can also be displayed at Rx end by connecting a CRO at audio 2 output at Rx end. Analyse the similarity in signals at both ends.
3. Now connect a 1 KHz sine wave with a BNC-T connector to AUDIO 2 of Tx so that the same sine wave signal can also be observed on one channel of CRO. Ensure that the level of sine wave fed is less than 1V p/p.
4. Connect the Audio 2 out of Rx to the other channel of CRO for comparing the transparency of signal received via satcom link. The transmitted & received waveforms are being monitored simultaneously on the same CRO on dual channel chopped mode.
5. Measure the level of signal being transmitted and the level of signal being received.
6. Find the levels of signals received on transmitting signal level of 10 mV to 2V in steps of 50mV. Draw a graph between transmitted and received signal levels. If the graph shows straight line then there is no companding being used in the system. Companding is used to increase the level of low level signals from microphones and reduce the level of high level signals in telephony.
7. From the graph measure the level of signal for which the graph deviates from a straight line by 1dB. 1dB would mean that the signal level is lower than the expected level by 11%. This level will be the 1dB compression level of the system for audio2 channel.
8. Find the minimum level of audio signal that can be received over the noise floor of the equipment.
9. Find the ratio of the maximum level unclipped sine waveform to minimum signal. This would give the dynamic range of audio signal the link can handle.
10. Now set the frequency of input sine wave signal to 10Hz and measure the level of signal being received. Vary the frequency of input signal to 100 KHz in steps and measure the level of received signals at different frequencies.
11. Draw a graph between frequency of the signal and level of input sine wave signal. This would show the frequency response of the signal source. Also draw a graph between frequency of the signal and level of the received signal. This would show the frequency response of the communication link for audio2 channel.
12. Measure the –3dB bandwidth of the audio2 channel. –3dB would be the level for which the measured signal is 30% lower than its level at a reference frequency of say 1KHz.
13. Repeat the same experiment for audio1 channel. Find the difference from audio2 channel.
14. Now feed a signal in audio1 channel and measure the received signal in audio2 channel for different levels of FM deviation. Find the ratio of received signal in audio1 channel to the signal in audio2 channel. This would be a measure of cross-talk or channel separation.
15. Now repeat the same measurements of frequency response etc for video channel.

16. Find the level of the highest unclipped sine wave that can be received at video out of Rx.
17. Find the difference in frequency response from audio channels. Does the video channel show a better frequency response at higher frequencies? Does it correlate to difference in frequencies of audio and video signals?
18. Now remove the sine wave source at TX end. Measure the noise at audio2 input at Tx end on CRO. It will be in the vicinity of few millivolts.
19. Measure the noise at audio2 output at Rx end on CRO. It will be in the vicinity of few tens of millivolts.
20. Measure how much noise is being added to signal after it has passed through various circuitry of Tx, Rx and transponder.
21. Also measure the noise when the satellite is removed and Tx and Rx are kept at same frequency with antennas pointing to each other. See if the increase in noise is less than if it were passed through satellite. The difference, if any is due to noise addition in satellite transponder.
22. Also see how much noise increases or decreases if path loss (path loss can be increased by keeping the Tx and Rx antennas apart) at Tx, Rx and satellite end is varied.
23. Now, connect a sine wave input at video in of Tx end and vary the frequency of sine wave source from 20 Hz to 7 MHz and measure its level, frequency, and distortion on CRO. Now, measure the level, frequency, distortion, noise added to sine wave at Rx end on each channel.
24. Measure the noise level at output of audio2 channel of receiver when no signal is being fed to the transmitter. Measure the noise level when a 1KHz sine wave is being fed to the video input of Tx. Does the noise increase in audio2? Does the 1KHz signal of video breaks into audio. If it does then at what level at video input.
25. Feed a sine wave signal of 5 MHz into video input. Gradually increase the frequency to 7MHz and monitor the audio2 channel. Does a frequency of 6.5 MHz of video input result in noise at the audio2 channel. Similarly does a frequency of 6 MHz result in noise at audio1 channel. See that the video input frequency crosses the audio sub carriers resulting in noise in audio channels.
26. Observe the demodulated frequencies of 100Hz, 1KHz, 100 KHz, 1MHz and 10 MHz at video output of the receiver on the CRO. Does the video output gets distorted at 1MHz and 10MHz. Does reducing the deviation at Tx end help reduce the distortion at Rx end.

**RESULT:**

This is an analog FM/FDM system where audio and video both are FM modulated on carrier at transmitter and link relayed to satellite which then transponds the signal and sends it back to the receiving station. The system uses a channel allocation of 20/18 MHz as specified for satellite video link. Within this band there are audio sub carriers of 6 & 6.5 MHz, which can carry different audio channels simultaneously for different languages or stereo. FDM is implemented because three different frequencies areSatellite used for transmission of three separate signals. The video amplifier has a bandwidth of 5 MHz. The fm deviation is 4MHz for a video signal of 1V p/p. The process of modulation and demodulation is analog FM with wide bandwidth for video signal and narrow bandwidth for audio signal. The FM demodulation is carried out using PLL demodulators for wide band response and good linearity.

The speech spoken into mic is converted into electrical signal and FM modulated onto a sub-carrier of 6 or 6.5 MHz. The sub-carrier is then mixed with main carrier at 5.8 GHz. The main carrier is carrying the video signal on FM modulation. The same holds true for any other audio signal also. The mixing of sub carrier generates signals of say 5.806 and 5.8065 and also at 5.794 and 5.7935 GHz with main carrier at 5.8 GHz. The sub-carriers are at a level of around 20-25dB lower than the main carrier.

For this reason audio channels are more prone to fading. The modulated carrier is then radiated from the antenna and received by the satellite transponder. The satellite then transverts this carrier to another frequency and retransmits the amplified signal to receiving base station at different frequency. This frequency is then received by the earth station and demodulated to give the audio output. Baseband analog (Voice) Signal could be received only because the Tx, Uplink satellite link emulator, Downlink satellite link emulator and Rx all are PLL locked to accuracy of less than 10KHz.

# EXPERIMENT- 9

**AIM:** To estimate the C/N ratio.

**EQUIPMENT REQUIRED**: Satellite uplink transmitter and Satellite downlink receiver, Satellite link emulator, connecting cables, Pair of Dish antennas with mounts,

**THEORY:**

**Carrier-to-noise ratio**

For the Ku and Ka bands the system carrier-to-noise (C/N) ratio is given by:

$$C/N = EIRP - L_{fs} + G/T\ usable - 10 \log (kB) - A_{rain} - A_{atm}\ (dB)$$

Where: EIRP = the equivalent isotropic radiated power from the satellite at the site location (dBW)

$L_{fs}$ = 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 ($1.38 \times 10^{-23}$ J/K)

B = receiver's pre-detection intermediate frequency (IF) bandwidth (Hz)

$A_{atm}$ = gaseous attenuation due to atmospheric absorption (dB)

$A_{rain}$ = rain attenuation for a given percentage of the time (dB).

Note: (a) $A_{atm}$ and $A_{rain}$ can be omitted for operation frequencies of <8 GHz; and

(b) for a 'clear-sky' calculation omit the Arain term and substitute the nominal figure of merit, G/T(nominal), for G/T(usable).

**Antenna noise**

Any signal received is combined with an element of noise, which degrades the overall performance:

Signal = wanted signal + noise

Obviously, the noise component must be kept as small as possible, taking into account cost and available technology. Noise can come from many sources and is produced by the thermal agitation of atoms and molecules above absolute zero (-273°C or 0 K; note that the degree sign is not used on the kelvin scale). This is why noise is said to have an equivalent noise temperature. The noise temperature of the earth is normally standardized at 290 K (17°C). There are three main sources of noise in the environment:

**1.Extraterrestrial noise sources**- This is wide bandwidth radiation caused by the energy conversion in stars and the residual back-ground radiation of the 'big bang'. This tends to taper off at 1 GHz and settles to that of the residual background noise alone which is taken as 2.7 K. Above 2 GHz, there are only a few isolated points of very strong non-thermal noise, principally from Cygnus A, Cygnus X, Cassiopeia A and the Crab nebula. There is also a narrow band of increased noise from the Milky Way. The Sun is an enormous source of noise at around 10,000 K at 12GHz and the Moon at about 200 K. **This noise enters the antenna mainly via the main lobe.** Satellite Trainer

**2. Man-made noise-** This noise emanates from microwave pollution due to man's electrical activities and principally **enters the antenna via the side lobes.**

**3. Ground noise-** In the long term, this is the major component of noise incident on the antenna aperture, and depends mainly on the antenna diameter, antenna depth,
and elevation setting. The smaller the diameter of the dish the wider and more spread out will be the side lobes, so more noise will enter from the warm earth. The noise temperature also increases as the elevation angle decreases, since lower elevation settings will pick up more ground noise due to side lobes intercepting the ground (diffraction effects at the antenna rim). This may be reduced by various methods of feed illumination. The design of the antenna itself also plays a part. A deep dish picks up less ground noise at lower elevations than do shallow ones, also prime focus mounted head units will add to noise since it is 'seen' at the same temperature as the Earth. Inclining the head unit away from the earth and towards the cool sky as happens in the case of an offset focus design can also improve things. This practice tends to counteract the negative effects of increased beamwidth for small antennas set at low elevation angles.

**Noise and its effects**

Any body, above the temperature of 0 K or -273°C has an inherent noise temperature. Only at absolute zero temperature does all molecular movement or agitation cease. At higher temperatures molecular activity causes the release of wave packets at a wide range of frequencies some of which will be within the required bandwidth for satellite reception. The warmer the body the higher the equivalent noise temperature it will have, resulting in an increase in noise density over the entire spectrum of frequencies. The warm earth has quite a high noise temperature of about 290 K and consequently rain, originated from earth, has a similar value. **The characteristic appearance of noise on FM video pictures can be either black or bright white tear drop or comet shaped blobs (sparklies) that appear at random on the screen.** It is subjectively far more annoying than the corresponding snowy appearance of noise on terrestrial AM TV pictures. Video cassette recorder pictures, also frequency modulated, LED annoying sparklies as a result of worn/dirty heads or faulty head amplifiers. Only relatively small amounts of FM noise can be tolerated.

**Free space path loss**

As the radiated signal of a transponder travels towards earth it loses power by spreading over an increasingly wide area thus diluting the signal strength. This effect is known as the free space path loss and the greater the distance the receiving site from the satellite the more it increases. Contributory factors include absorption of microwaves by gases and moisture in the atmosphere. The power density of signals, measured in watts per square meter, finally arriving at earth are extremely weak.

### Rain attenuation

One of the major problems with satellite reception is rain, and to a lesser extent snow and hail. The weak incoming microwave signals are absorbed by rain and moisture, and severe rainstorms occurring in thunder conditions can reduce signals by as much as 10 dB (reduction by a factor of 10). Not many installations can cope with this order of signal reduction and the picture may be momentarily lost. Even quite moderate rainfall can reduce signals by 2 to 3 dB which is enough to give noisy reception on Satellite Trainer some receivers. Another problem associated with rain is an increase in noise due to its inherent noise temperature, which is similar to that of the earth. **In heavy rain depolarization of the signal can also occur resulting in interference from signals of the opposite polarization but same frequency.** This effect is more noticeable with circular polarization.

### Factors affecting satellite reception

The performance of a satellite TV receive only (TVRO) system is affected by a number of physical factors. Some of these are outlined below:

1. The equivalent isotropic radiated power (EIRP) of the satellite..
2. The effective antenna diameter.
3. The low noise block (LNB) noise figure or noise temperature.
4. Coupling losses by waveguides and polarizers.
5. Antenna pointing losses: initial pointing error (degrees).
6. Antenna stability in wind or other environmental conditions (degrees).
7. Satellite station keeping accuracy.
8. Polarization losses.
9. Transponder ageing.
10. Rain attenuation for a signal availability (typically 99.5% of average year).
11. For Ku and Ka band, noise increase due to precipitation (rain, snow or hail).
12. Atmospheric absorption by oxygen and water vapour (depends on humidity).
13. Temperature variations.
14. The receiver (demodulator threshold) figure.
15. The signal modulation characteristics.
16. Scattering of signals due to blockages such as trees, buildings, birds and aircraft.
17. Spreading loss through the atmosphere. Transient effects such as passing birds and aircraft are largely unpredictable so can be neglected from the calculation. The others can all have a significant long-term effect, although factors 8, 9 and 10 can be neglected for S and C band reception.

### Downlink path distance

The path distance, sometimes called the 'slant range', is the distance between the ground station and the satellite of interest. Clearly the further away from the equator this is, the longer the path distance. An equation used to calculate this is: Path distance (D) = 6378.16 (m2 + 1 -2m[cos(A) cos(B)] )sq.root (km) **Wavelength**

In many equations, including those that follow, a wavelength (O) value rather than frequency is required for simplif ication. Conversion from frequency to wavelength can be done using:$\lambda = c/f$

Where: c = the speed of light ($2.998 \times 10^8$ m/s)

f = frequency (Hz). Satellite Trainer

**Free space loss**

The free space loss (LFS), or path loss, expresses the attenuation of microwave signals on their Earth-bound journey and occurs due to the spreading out of the beam. A good analogy is visualized by the intensity fall-off of a car headlight beam with distance. The path loss increases with frequency and is greatest for low antenna elevation angles. A suitable equation for calculating its value is: LFS = 20 log[(4000piD)/O O] (dB)

Where: pi = 3.14159

D = path distance (km)

OO= wavelength (m).

**Antenna gain**

The antenna gain (Ga) increases with the effective antenna size which takes into account the efficiency (p) of the antenna. The gain can be expressed as:

Antenna gain (Ga) = 10 log {(pi.d) 2p/100 OO2}dB Where d = the antenna diameter (m)

p = the percentage antenna efficiency (60-80% typically)

OO= wavelength (m)

Note: the antenna efficiency may be specified as a normalized value less than 1 (e.g. 0.67 or 0.80) rather than as a percentage. In such cases delete the term 100 in the denominator and substitute the normalized factor for p.

**Effective antenna noise temperature**

The effective antenna noise temperature (Ta) defined above is now discussed in a little more detail. The effective antenna noise temperature is determined by many factors, such as antenna size, elevation angle, external noise sources and atmospheric propagation effects During clear-sky conditions, the principal noise component of the effective antenna noise temperature is ground noise pick-up This is easy to see since, neglecting atmospheric propagation effects (rain, etc), this is virtually all the noise entering the antenna This is the 'antenna noise' parameter that manufacturers often tabulate for a range of elevation angles; it may also include a relatively small contribution by galactic background noise There are three main contributions to the overall antenna noise :

1. **Antenna noise temperature due to ground noise (Tant)** -The smaller the antenna, the wider and more spread out are the side lobes intersecting the warm earth, and, consequently, the more ground noise is picked up by the antenna. It can also be seen that these side lobes, principally the first side lobe, would intersect the ground at a higher elevation angle than that of a larger antenna and so would be a noisier device when set at a given elevation. Ground noise pick-up may be reduced, at the expense of gain, by under-illuminating the dish; thus, this factor essentially determines the efficiency of the dish. Size being equal, a prime focus antenna would detect increased ground noise over an offset design since the head unit, directly mounted in the signal path, would be 'seen' at the same temperature as the Earth. Since the antenna noise temperature has so many variable factors, it is apparent that in the absence of a manufacturer-supplied figure, an estimate is perhaps the best we Satellite Trainer can hope for. Equation takes into account the elevation and the diameter, may be used to calculate a reasonable approximation for the antenna noise under clear-sky conditions.

$T_{ant} = 15 + 30/D + 180/EL(K)$ where: D = antenna diameter (m) EL = dish elevation angle (degrees)

2. **Cosmic or galactic noise component**- This is background cosmic noise, principally the residual noise of the 'big bang'. It has a small noise temperature of about 2.7 K. This component is relatively small in relation to the error in estimating the ground noise component, and may be omitted from practical calculations. In any case, depending on how 'antenna noise' is defined in manufacturers' specifications, this may be incorporated.

3. **Atmospheric propagation components** -There are two main propagation effects experienced on the downlink. Firstly, atmospheric gaseous absorption by water vapour and oxygen; this is basically a clear-sky effect. Its value depends on the absolute humidity or vapour density measured in grams per square metre, the antenna elevation and the frequency involved. It is a relatively minor contributor below about 7.5 GHz. The second propagation effect is attenuation due to precipitation. Considering the uplink situation, a receiver on board a satellite will 'see' a fairly constant but high noise temperature emitted from the warm Earth of around 290 K, so further thermal energy emission by rain will have a negligible effect. In the downlink situation, the receiver is directed toward a relatively cool sky so, in a relative sense, the additional thermal noise contribution by rain is by no means a negligible component of the total system noise, especially if the receiver (LNB) is a low noise device operating in the Ku or Ka band. The effects of rain and atmospheric absorption are negligible in the S and C bands. Precipitation will not only directly attenuate the signal (known as a 'rain fade'), but the system noise temperature will also increase since the temperature of the intervening

medium approaches that of the Earth. It is important that the increase in system noise is taken into account and not just the attenuation experienced by a rain fade. The combination of the two is known as the "**downlink degradation (DND)**"

The effects of precipitation become significant above about 8 GHz. Rain, or to a lesser extent snow, fog, or cloud, attenuate and scatter microwave signals. The magnitude depends more on the size of the water droplets (in cubic wavelengths) rather than the precipitation rate itself. Heavier rain tends to comprise larger droplets so the two are normally related. As a general rule, the physical-medium temperature, of all forms of precipitation, is taken as 260 K. For clouds and clear-sky use 280 K.

**PROCEDURE**:

1. Setup the link as before. Press the frequency select switch of satellite emulator down link channel several times so as to set the frequency LED from 2.414, 2.432, 2.450, 2.468 and then back to 2.414. This is done to ensure the emulator downlink PLL is locked and LED frequency is generated correctly. If switching ON the 1kHz Satellite Trainer tone on transmitter will make the receiver sound to 1KHz test tone via satellite, PLL of complete link are O.K. and a successful sat link is said to be established.
2. Now, switch off the carrier by switching of both Transmitter (Tx) and satellite.
3. Receiver(Rx) will read only it's noise floor at RSSI output which has a DC voltage output in proportion to the received signal strength.
4. The chart at the back of the manual can be used to convert DC voltage to corresponding RF signal level in dBm or dBuV.
5. Say, in absence of any carrier Rx reads 0.92 V which is equal to -96 dBm (refer to chart).
6. Thus, -96 dBm is noise floor of Rx that means if carrier received by Rx is less than -96 dBm it will be unable to measure it.
7. Now, switch on Tx and satellite and say, the Rx reads 1.93 V which equals to -59 dBm of carrier level being received.
8. 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).
9. Hence, C/N = -59-(-96)=37 dB.
10. Make sure the Rx is not saturated with carrier otherwise incorrect C/N will be read. This can be done by increasing path loss at Rx and satellite and or taking Rx farther away from satellite.
11. Measure the C/N readings for different levels of path-loss. (path loss can be increased by keeping the Tx and Rx antennas apart)
12. 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.
13. 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 received signal strength to a considerable level. This can be achieved by increasing the path loss.

14. 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 Rx.

**RESULT:**

The difference between two readings of receiver noise level and carrier level is the C/N ratio in dB. Actual reading will depend on a number of factors and will differ from to case to case. Increasing the path loss and distance between antennas shall result in lower C/N ratios due to lower levels of received carrier. Amount of noise received/generated remains constant.

More power at transmitter shall result in better picture quality and more C/N ratio.

Lower noise at receiver is essential for better picture. Higher gain antenna could be used to capture more signal. Hence a Dish antenna could result in higher C/N. Sparklies start appearing on black or white portions of picture when noise is increased. Further increasing the noise will make the picture lose it's sync resulting in complete loss of information.

# EXPERIMENT- 10

**AIM:** To transmit digital waveforms through a satellite communication link.

**Equipment required**: Satellite uplink transmitter and Satellite downlink receiver, Satellite link emulator, connecting cables, Pair of Dish antennas with mounts.

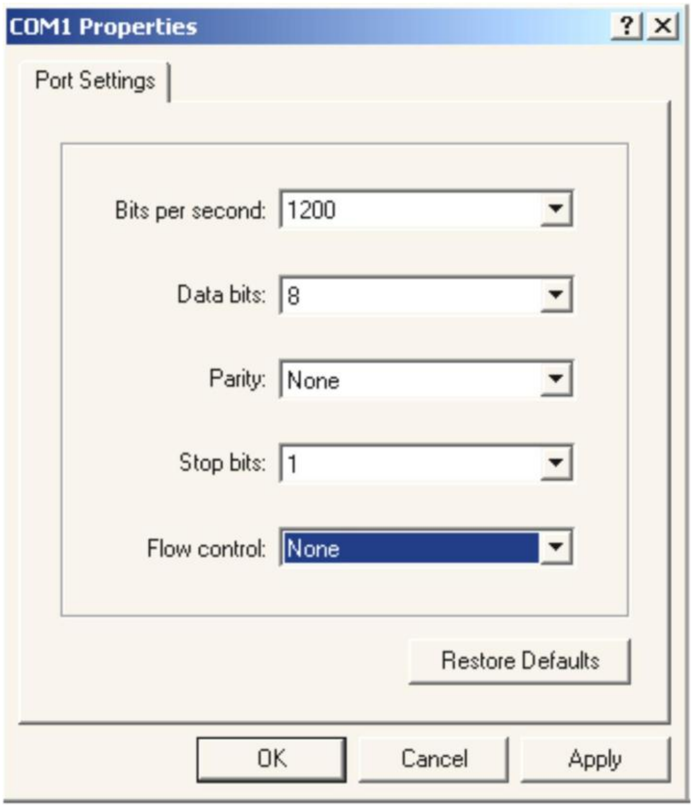
**Procedure**:

1. Bring the transmitter to 5.8 GHz and connect the Dish antenna with SMA lead to R.F. out of Tx.
2. Set the output level of Tx to maximum.
3. The Dish of Tx should be rotated with the antenna pointing in the same direction to that of Patch of uplink Satellite link emulator.
4. Bring the uplink Satellite link emulator to 5.8 GHz.
5. Bring the Downlink Satellite link emulator to 2.414 GHz.
6. Set the frequency of Rx to 2.414 GHz using frequency control.
7. Now connect Dish with SMA lead to the receiver.
8. Point the Rx Dish to Patch of Downlink sat-link emulator.
9. Setup the link in a TRIANGLUR fashion with Tx, Rx and Sat-link emulator at 3 vertices of a triangle. Make sure that Dish of Tx should point towards Patch of sat-link emulator and Dish of Rx should point towards Patch of sat-link emulator. Set the distance between antennas to approx. 5 meters center to center.
10. Connect the Function Generator TTL O/P to Digital In of Tx and the Digital Out of Rx to CRO. Turn the data/video switch to data on both Tx and Rx.
11. Now vary the frequency of Function Generator and see the same O/P on CRO.

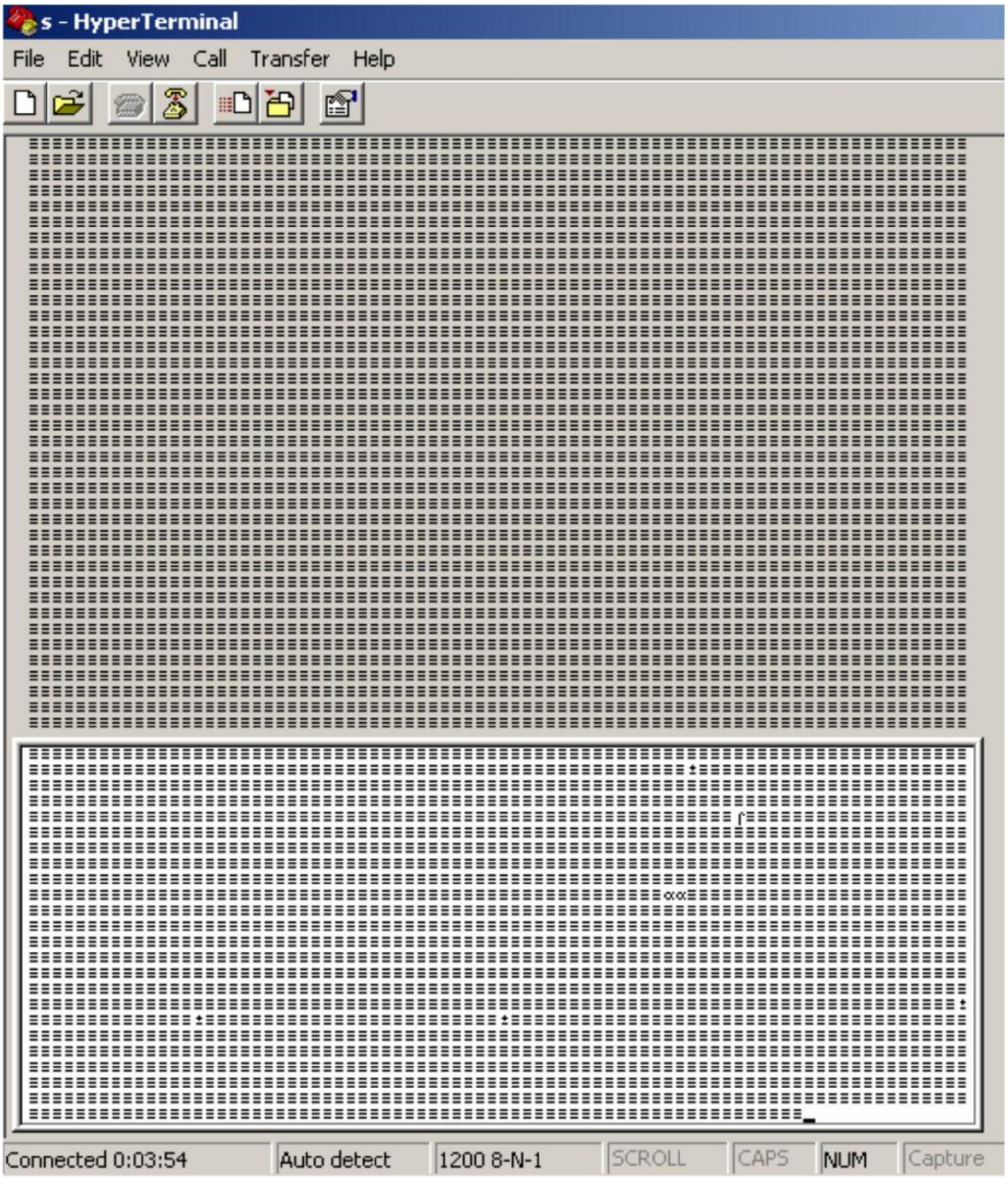
**RESULT :**

The Function Generator TTL O/P waveforms can be transmitted over a distance via a satcom link and same TTL O/P waveform can be received at Rx input. Function Generator digital waveform to be transmitted could vary between 1000bps to 10,000Kbps or better.


Select comport to which TTL data out of Rx is to be connected.




Select com port baud rate and TTL output frequency of Function Generator same. Here it is 1200bps and 1200Hz.




Data received at Hyperterminal window - 7 characters have been received incorrect out of a collection of 1000 characters. Hence BER = 0.007

# EXPERIMENT NO-11

**AIM:** calculate Bit Error Rate in a satellite communication link.

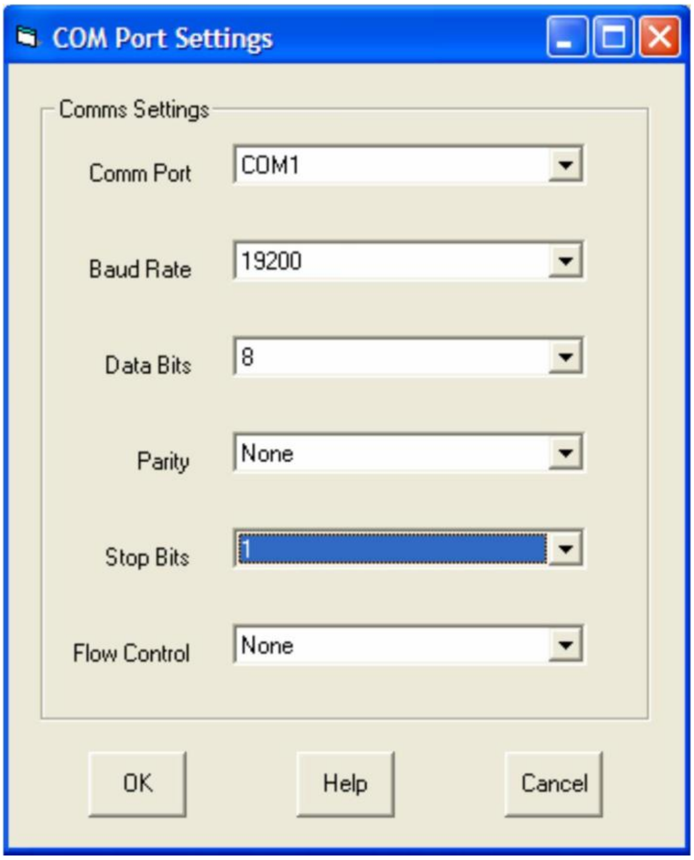
**EQUIPMENT REQUIRED**: Satellite uplink transmitter and Satellite downlink receiver, Satellite link emulator, connecting cables, Pair of Dish antennas with mounts, PC

**PROCEDURE :**

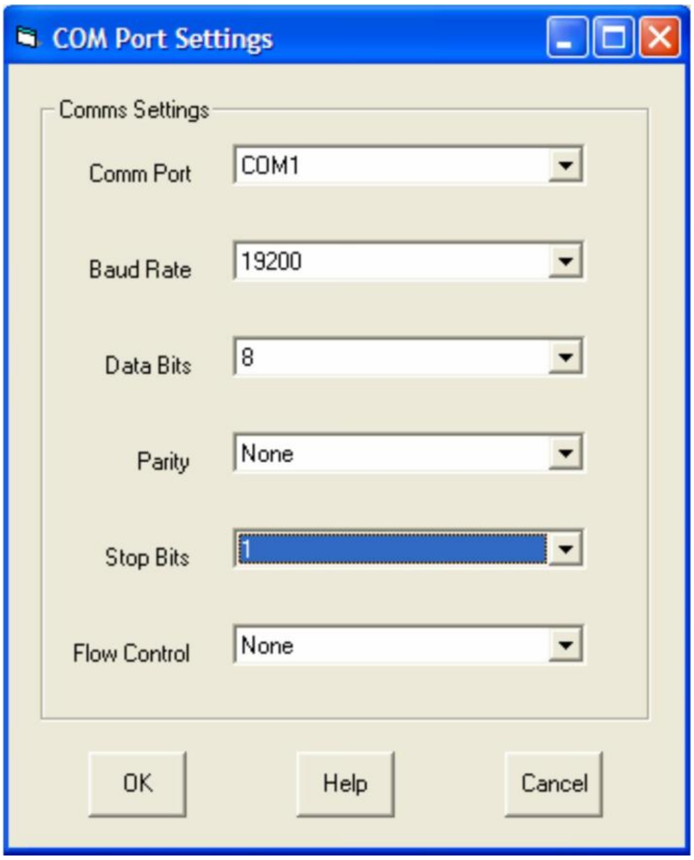
1. Setup the link in same fashion with Tx, Rx and Satellite link emulator at 3 vertices of a triangle. Press the frequency select switch of satellite emulator down link channel several times so as to set the frequency display from 2.414, 2.432, 2.45, 2.468 and then back to 2.414. This is done to ensure the emulator downlink PLL is locked and displayed frequency is generated correctly. If switching ON the 1kHz tone on transmitter will make the receiver sound to 1KHz test tone via satellite, PLL of complete link are O.K. and a successful sat link is said to be established. Make sure that video/data select switch at Tx, Rx and satellite should be at data**.**
2. Open the Hyper Terminal on your PC at Rx end. Set the baud rate to say 1200 bps and open any com port available and connect Rx cable to Rx's Data out and comport in order to receive.
3. Connect the BNC-BNC cable at TTL in of Tx and TTL output of a function generator.
4. Adjust the output frequency of TTL of function generator approximate to baud rate of com port of PC at Rx end. Now, see if you are able to receive some characters on hyper terminal window.
5. Adjust the frequency so that you receive only one character continuously. Allow the function generator frequency to stabilize.
6. Now, receive the transmitted waveforms at Hyper Terminal window at Rx end.
7. Adjust the frequency of function generator in order to receive the same character.
8. The horizontal line on hyper terminal window contains 80 characters. Count the erroneous characters in a set of 1000 or 10,000 characters being received.
9. BER can be introduced by maximizing path loss and interrupting carrier signal.
10. Now change the RF level and measure the BER.
11. Measure the BER for different levels of baudrates. Do higher baudrate result in higher BER.

**RESULT :**

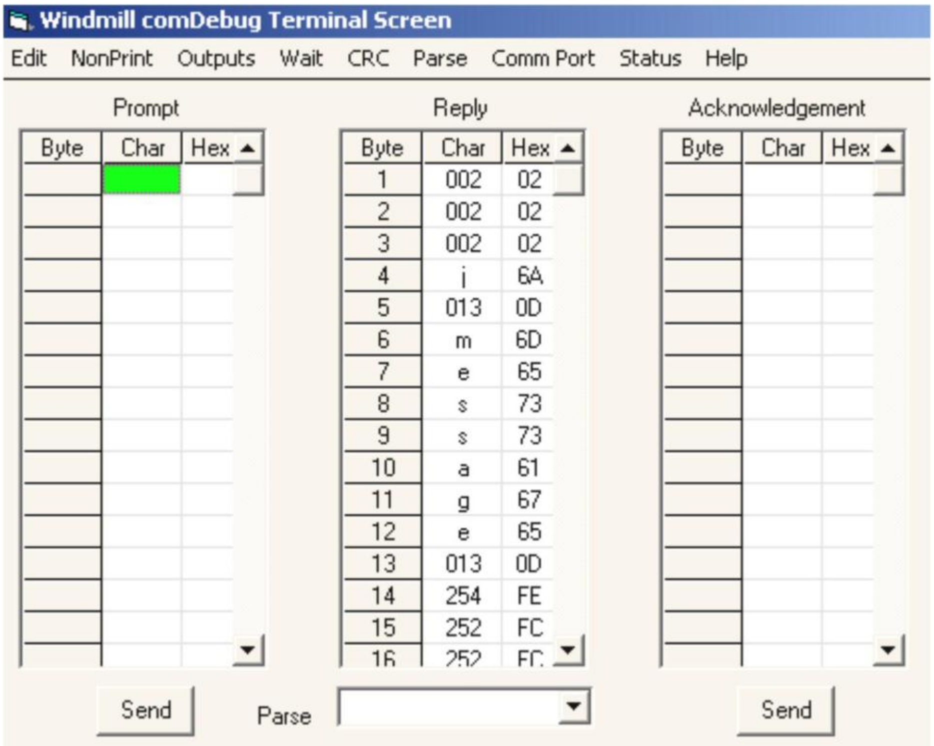
Bit Error Rate is equal to erroneous character divided by total number of received characters.




Select protocol – 19,200, 8, N, 1 at Tx end.




Select protocol – 19,200, 8, N, 1 at Rx end.




Rx PC window

Actual Data sent is “message”. The data received has actual transmitted data plus some garbage data. Correct is between first 013 and second 013.