Practical Manual

LAB: WIRELESS AND SATELITE COMMUNICATION

Deptt.of Electronics &Communication Engg. (ECE)

RAO PAHALD SINGH GROUP OF INSTITUTIONS BALANA(MOHINDER GARH)123029

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EXPERIMENT No.1

OBJECTIVE:
To set up a active & passive satellite communication link and study their difference.
EQUIPMENT REQUIRED:
• Satellite uplink transmitter, satellite downlink receiver and satellite link emulator
• Pair of Yagi antennas and RHCP & LHCP axial mode helix antennas
Antenna stands with connecting cables, reflecting sheet
PROCEDURE:
1. Connect the Satellite uplink transmitter to AC mains outlet with the lead provided.
2. Switch ON the transmitter and the frequency display will come on.
3. The frequency display will read 2.400 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 2.400GHz, 2.427GHz, 2.4F GHz, 2.481 GHz and back to 2.400GHz in cyclic manner in Tx, Rx and satellite link emulator. This indicates that each channel is spaced
27 MHz apart.
6. PLL means that when both receiver and transmitter are set at same frequency, they are accurate to less than 10KHz of each ether and no further tunipg1and repeated adjustments are required.
7. Now bring the transmitter to 2.48 1 GHz and connect the RHCP Helix antenna with a BNC lead to R.F. out of Tx,
8. Set the R.F. output level of Tx to maximum by turning the path loss pot fully clockwise (i.e., making path loss low).
9. The RHCP helix antenna of Tx should be rotated with the anteena pointing in the same direction to that of RHCP Helix antenna of UPLINK CHANNEL of Satellite link emulator.
10 Now, switch ON the satellite link emulator and the Frequency Display will come on.
I 1. The Uplink Frequency display will read 2.400 GHz.
12. Now, bring the frequency of uplink Satellite link emulator to 2.481 GHz.
13. Similarly, the Downlink Display will read- 2.400 GHz.
14. Now, bring the frequency of Downlink Satellite.link emulator to 2.400 GHz.
15. Make sure the Thermal Noise an4 Fading pot of satellite link emulator is turned fully anticlockwise.
16. The receiver can be switched on, now, after plugging into AC mains outlet.
17. The frequency display will light up and speaker will start making hissing sound.
18. Set the frequency of Rx to 2.400 GHz using frequency control. Set the R.F. input level of Rx to maximum by turning the path loss pot fully clockwise (i.e., making path loss low) for maximum' sensitivity. The level shown on. display in absence of antenna connected is the internal noise floor of the equipment.
19. Now, connect LHCP Helix antenna with BNC lead to the receiver. The receiver noise will be squelched to silence.
20. Point the LHCP Helix antenna of Rx towards LHCP Helix antenna of Downlink

satellite link emulator.
21. Setup the link in a TRIANGLUR fashion with Tx, Rx and Satellite link emulator at 3 vertices of a triangle. Make sure that RHCP Helix antenna of Tx should point towards RHCP Helix antenna of satellite link emulator and LHCP HeI1x antenna of Rx should point towards LHCP Helix antenna of satellite link emulator. Set the distances between antennas to approx. 5 meters.
22. If switching ON the 1kHz tone on transmitter will make the receiver sound to 1KHz test tone, a successful sat link is said to be established.
23. This is a sat link using active satellite link emulator. In case of a Passive satellites, no frequency translation takes place and no power is increased. Set Tx & Rx at same freq and switch off the satellite. Point the Tx and Rx antennas (both being either RHCP or LHCP) towards the reflector sheet in same triangular fashion as explained above. The only difference being that instead of satellite there is a reflecting sheet. The transmitted signal is reflected back to receiver without the power being increased and frequency remaining the same. Here, the reflecting surface is functioning like a passive satellite.

RESULT:

•A clear test tone at the receiver indicates that a microwave satellite communication link has been set up successfully. In active satellites, the freq 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 translation and power amplification.

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EXPERIMENT NO:-2

AIM:-

Study the communication satellite link design

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EXPERIMENT No. 2

OBJECTIVE:
To study the communication satellite link design : process of transmitting a signal to a satellite (UPLINKING) , reception of same signal via satellite (DOWN LINKING) arid functioning of transponder of a satellite.
EQUIPMENT REQUIRED: . Satellite uplink transmitter, satellite downlink receiver and satellite link emulator
• Pair of Yagi antennas and RHCP & LHCP axial mode helix antennas.
• Antenna stands with connecting cables

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 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 converte 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 fewerchannels 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 relay program material for cable TV operators but, unfortunately, receiving dishes of monstrous proportions are necessary for noise free reception, often in excess of 1 meter. 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 an board Astra 1A. Such satellites are now commonly termed semiDBS (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 satellitesusually 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.

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. European transponder frequencies are in the band 11.70 to 12.50 GHz which ös known as the DBS band. It has been agreed that the transponder bandwidths are 27MHz.

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 VHFIUHF bands. Microwaves still exhibit a wave-like nature but inherit a tendency to severe attenuation by wa.ter 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 lo 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 2.481 GHz and connect the RHCP Helix antenna with BNC lead to R.F. out of Tx.
2. Set the path loss of Txto HIGH by turning the pot fully anticlockwise.
3. The RHCP Helix antenna of Tx should be rotated with the antenna axis pointing in the same direction to that of RHCP Helix antenna of UPLINK Satellite link emulator.
4. Bring the uplink Satellite link emulator to 2.481 GHz.
5. Uplinking-to a satellite is normally carried out at a higher frequency because of narrow beàmwidth at higher frequency. There are two uplinking frequency çhännel5 2.48 1 GHz & 2.454 GHz.•
6. The satellite link emulator consists of transponder (transmit-receive pair). it receives frequency in 2.4-2.5 GHz band and has the capability to retrasmit after amplification in 2.4-2.5 (5Hz band. It can be set t receive at one particular frequency and transmit. At some different frequency
7. Bring the DOVVNLINK Satellite link emulator to 2.400 GHz.
8. Make sure the Thermal Noise and Fading pot is turned fully anticlockwise.
9. Set the frequency of Down link Rx to 2.400 .GHz using frequency control. Set the path loss of Rx to HIGH by turning the, pot fully anticlockwise for minimum sensitivity.
10. NoW connect LHCP Helix antenna with BNC lead to the receiver.
11. Point the LHCP Helix antenna to LHCP Helix antenna of Downiink sat emulator.
12. Downiinking from a satellite is carried out at lower frequencies because wider beamwidth gives more footprint coverage. There are two downlinking frequency channels 2.400 GHz & 2.427 GHz.
13. Setup the link in a TRIANGLUR fashion with Tx, Rx and Sat-emulator at. 3 vertices

of a triangle. Make sure that RHCP Helix antenna of Tx should point towards RHCP Helix antenna of satellite link emulator and LHCP Helix antenna of Rx should point towards LI-ICP Helix antenna of satellite link emulator. Set the distance between antennas to approx. 5 meters.
14.. Check the link with the help of 1KHz test tone.
15. Repeat the experiment by selecting a different uplinking & downlinking channel frequencies.
16. Connect the spectrum out of Rx to spectrum analyzer for signal analysis.
17. Also, two C.R.C. can be connected at Tx and Rx end for signal analysis.
18. Normally, approx. 200 dB of path loss occurs during uplinking and downlinking that is why power amplification is mandatory at satellite.

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 GRz and
Downlinking in commercial Ku band is at 11.700 — 12.200 GHz
In our case, uplinking is carried out at 2.481 & 2.454 GHz whereas Downlinking is carried out at 2.400 & 2.427 GHz.
In our case the uplink and downlink frequencies are 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.
ISM (INDUSTRIAL., SCIENTIFIC & MEDICAL) band for satellite communication simulation as it is a license free band for institutional use. This band is from 2400 MHz to 2500 MHz.

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EXPERIMENT NO:-3

AIM:-

Measure the baseband analog (voice) signal

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EXPERIMENT No 3

OBJECTIVE:
To measure the baseband analog (voice) signal parameters in a satellite link.
EQUIPMENT REQUIRED:
• Satellite uplink transmitter, satellite downlink receiver and satellite link emulator
• Pair of Yagi antennas and RHCP & LHCP axial mode helix antennas
. Antenna stands with connecting cables, Mic, Function Generator, CRO X 2
PROCEDURE:
1. Bring the transmitter to 2.481 Or 2.454 GHz and connect the RHCP Helix
. antenna with BNC lead to R.F. out of Tx.
2. Set the path loss of Tx to LOW by turning the pot fully clockwise.
3. Connect a microphone to mic in of Tx. Also connect a 400 Hz sine wave with a connector to AUDIO IN of Tx so.that the same audio signal can be observed on one channel of CR0..
4. The RHCP Helix antenna of Tx should be rotated with the antenna pointing in the same direction to that of RHCP Helix antenna of uplink Satellite link emulator.
5. Bring the uplink Satellite link emulator to 2.481 or 2.454 GHz.
6. Bring the Downlink Satellite link emulator to 2.40.0 or 2.427 GHz.
7. Make sure the Thermal Noise & fading pot is turned off.
8. Set the frequency of Rx to 2.400 or 2.427 GHz using frequency control. Set path loss of Rx to LOW for maximu.m sensitivity.
9. Connect the Audio out of Rx to other channel of CRC for comparing the transparency of signal received via satcom link.
10. Now connect LHCP Helix antenna with BNC lead to the receiver.
11. Point the LHCP Helix antenna to LHCP Helix antenna of Downlink satellite link emulator.

12. Setup the link in a TRIANGLUR fashion with Tx, Rx and Satellite link emulator at 3 vertices of a triangle. Make sure that RHCP Helix antenna of Tx should point towards RHCP Helix antenna of satellite link emulator and LHCP Helix antenna of Rx should point towards LHCP Helix antenna of satellite link emulator.
13. Listen to the quality of voice spoken into the mic at the speaker of the receiver.
14. The spoken signal at Tx can be displayed on CR0 at Tx end. The received spoken signal via satcom link can also be displayed atRx end by connecting a CR0 as well at Rx end. See and listen if the signal is same.
15. Measure how much noise is being added to signal after it has passed through
. various circuitry of Tx, Rx and transponder.
16. Also see how much noise increases or decreases if path loss at Tx and Rx end is varied.
17. Find at what level of path loss does audio or sinewave vanishes at Rx end.
18. Now, connect a sine wave input at audio in of Tx end and vary the frequency

of sine wave source from 20 Hz to 20 kHZ and measure its level, frequency, distortion on CRC. Now, measure the level, frequency, distortion, noise added of sinewave at Rx end on. each channel.

19. Also find the bandwidth of sinewave which can be supported on each audio channel.

20. Observe if increasing or decreasing the audio bandwidth from pot at Tx end has any effect on parameters of received sinewave.

21. Observe on CR0, how does audio/sinewave behaves on fading the carrier by introducing the Fading from satellite link emulator.

22. Observe on CRC, how does audio/sinewave behaves on introducing the thermal noise onto carrier by introducing the noise.from satellite link emulator. See if noise introduced can completely shadow the audio.

RESULT:

The speech spoken into mic is converted into electrical signal and FM modulated onto a carrier of 2.4854 or 2.481 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 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..

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EXPERIMENT NO:-4

AIM:-

To measure the C/N ratio

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EXPERIMENT No 4

OBJECTIVE: To measure the C/N ratio.
EQUIPMENT REQUIRED:

• Satellite uplink transmitter, satellite downlink receiver and satellite link emulator
• Pair of Yagi antennas and RHCP **&** LHCP axial mode helix antennas
• Antenna stands with connecting cables, mic, video monitor, ccd camera,
• Function generator, CRC X 2, spectrum analyser

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 Lfr + G/T usable -10 log (kB) -Arain -Aatm (d)
where : EIRP = the equivalent isotropic radiated power from the satellite at the site location (dBW)
Lfr = free space path loss on the earth to satel!ite path (dB)
.GIT usable = minimum degraded value of the system figureof merit (dB/K)
k = Boltzmann's constant (1.38 x 10^{-23} J/p)
B = receiver's pre-detection intermediate frequency (IF) bandwidth (Hz)
Aatm = gaseous attenuation due to atmospheric absorption (dB)
Arain = rain attenuation for a given percentage of the time (dB).
Note: (a) Arain & Aatm can be Qmitted for operation frequencies of <8 0Hz; and
(b) for a 'clear-sky' calculation omit the Arain term and substitute the nominal figure of merit, GIT(nominal), for GIT(usable).

PROCEDURE:

1. Bring the transmitter to 2.481 or 2.454 GHz and connect the RHCP Helix anteena.with BNC lead to R.F. out of Tx.
2. Set the output level of Tx to minimum by turning the path loss high.
3. Do not connect any video camera or mic to Tx.
4. The RHCP Helix antenna of Tx should be rotated with the antenna pointing in the same direction to that of RHCP, Helix antenna of uplink Satellite link emulator.
5. Bring the uplink Satellite link emulator to 2.481 or 2.454 GHz..
6. Bring the Downlink Satellite link emulator to2.400 or 2.427 GHz.
7. Make sure the Thermal Noise **&** Fading pot is turned fully anticlockwise.
8. Set the frequency of Rx to 2.400 or 2.427 GHz using frequency control. Keep the path .loss to high for minimum sensitivity.
9. Now connect LHCP Helix antenna with BNC lead to the receiver.
10. Point the LHCP Helix antenna to LHCP Helix antenna of Downlink satellite link
11'. Setup the link in same fashion with Tx, Rx and Satellite link emulator at 3 vertices of a triangle. Make sure that RHCP Helix antenna of Tx should, point towards RHCP Helix antenna of satellite link emulator and LHCP Helix anteena of Rx should point towards LHCP Helix antenna of satellite link emulator. Set the distance between antennas to approx. 5 meters.

12. Measure the noise floor of Demodulator of Rxby turning off Tx and satellite link emulator with the help of spectrum analyzer. Connect the spectrum out of Rx to spectrum analyzer and tune the spectrum at 479.5 MHz which is IF of Rx. This noise floor will be read in dB.

13. Now, turn on Tx and satellite link emulator. You will start receiving carrier whose level can be read from spectrum analyzer. Thus except for conversion gain of RF to IF, behavior of RF is same as If i.e., IF follow RF. Same FM deviation can be read at IF instead of at RF. This technique of down conversion is widely used for very high frequency measurements.

14. As both noise and carrier signal detected are measured in dB, C/N can be calculated by taking the difference of two readings.

15. 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 taking Rx farther away from satellite. Further, by using different handedness or different polarisation antennas at Rx & .downlink channel of satellite. This can still further be increased by turning the face of two antennas away from each other so that they don't point each other. If you stand between antennas you will attenuate the signal further. Check the link with the help of I KHz test tone.

16. Turn the deviation pot to zero until no tone is heard. See the signal strength on spectrum. This is the level of carrier. Observe that the C/N ratio will improve due to a number of factors.

RESULT:

The difference between two readings of receiver noise level and carrier level is the C/N ratio in dB. The noise level for a typical case is around 20dB. The signal level for a nominal case is around 40dB. So C/N ratio would be 20dB for a typical case. Actual reading will depend on a number of factors and will differ from to case to case.

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EXPERIMENT NO:-5

AIM:-

To measure the *SIN* ratio

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EXPERIMENT No.5

OBJECTIVE:
To measure the *SIN* ratio.
EQUIPMENT REQUIRED:
• Satellite uplink transmitter, satellite downlink receiver and satellite link emulator
• Pair of Yagi antennas and RHCP & LHCP axial mode helix antennas
• Antenna stands with connecting cables, mic, video monitor, ccd camera, Function generator, CR0 X 2, spectrum analyser

Theory:
Signal to noise ratio *(SIN* ratio)
This is the ratio of the desired signal e.m.f to any noise e.m.f. present It should be as high as possible. If this ratio falls to unity or below, the signal is rendered virtually useles (It is possible, but expensive, to use computer generated 'signal enhancement' techniques in some cases, but for domestic satellite broadcasting this
is out of the question).
Providing the individual deviations of a small number of audio channels are small in relation to the video deviation, it is assumed for practical purposes that the overall peak-to-peak deviation of a base band signal (including the multiple sound carriers) that of the video signal alone.
For frequency modulated (FM) television signals, the signal-to-noise (SIN) ratio on demodulation can be calculated as:
$S/N = C/N + 10 \log [3\{f(p-p) / fv \}^2] + 10 \log(b/2fv) + Kw$ (dB)
where: S/N = the peak-to-peak luminance amplitude to weighted r.m.s. noise ratio (dB)
C/N = carrier-to-noise ratio (dB)
f(p-p) = peak-to-peak deviation by the video signal including the sync pulses (Hz)
= highest video frequency present (Hz)
b = radio frequency bandwidth (usually taken as f(p- p) + 2fv (Hz)
kw = combined de-emphasis and weighting improvement factor in FM systems (dB).
• Note: (a) above Equation is only valid for systems operating above the demodulator threshold. (b) The effect of the additional deviation for multiple sound sub-carriers located above the video base band tends to improve the video *SIN* ratio slightly (by a fraction of a decibel) over that calculated using above Equation. For practical purposes the overall peak- to-peak deviation may be taken as the overall peak-to pea deviation by the video signal, provided the individual deviations of the audio channels is small in comparison; (c} The combination of the second and third terms of Equation is sometimes called the 'FM modulation gain' or 'FM improvement.

Signal availability and operational margins

An attenuation figure for rain .has to be predicted from long-term rainfall statistics for the receive site of interest. Rather than allow a massive operational margin over threshold for the worst ever rain storm likely, we are normally content with specifying a signal availability figure for .an average year, which potential customers find acceptable. In other words for a percentage of time the signal will not fall below some. predetermined C/N (or S/N) ratio. For example, when we say a **CCIR grade** *4* **(good)** signal is available for 99.7% of an average year we mean that the SIN ratio is not expected to fall **below** 42.3 dB for 99.7% of the time (or 99% of the worst month). However, it will be expected to occasionally fall[below this for 0.3% of the time during severe storms. The higher the signal availability designed into a system, the better will be the protection against the effects of rain attenuation. The dish size needed also grows alarmingly as the designed signal availability increases. Rain attenuation, or more specifically the downlink degradation, is the major component of the overall loss margin for Ku and Ka band systems. For typical direct-to-home (DTH) systems, a figure of 99.5% availability is normally considered acceptable. In fact most packaged fixed dish systems for popular satellites are designed around this figure. For satellite master antenna TV (SMATV) you may require .a higher figure of 99.9%, and for cable head even higher. The law of diminishing returns eventually intervenes since 100% availability is impractical.

1. Bring the transmitter to 2481 or 2.454 GHz and connect the RHCP' Helix antenna with BNC lead to R.F. out of Tx.
2. Set the output Level of Tx to minimum by turning the path loss high. '
3. Do not connect any video camera or mic toTx._
4. The RHCP Helix antenna of -Tx should be rotated with the antenna p9inting in the same direction to that of RHCP Helix antenna of uplink Satllite link emulator.
5. Bring the uplink Satellite link emulator to 2.481 or 2.454 GHz..
6. Bring the Downlink Satellite link emulator to 2.400 or 2.427 GHz.
7. Make sure the Thermal Noise & Fading pot is turned fully anticlockwise.

Set the frequency of Rx to 2.400 or 2.427 GHz using frequency control. Keep the path Loss to high for minimum sensitivity.

9. Now connect LHCP Helix antenna with BNC lead to the receiver..
10. Point the LHCP Helix antenna to LHCP Helix antenna of Downlink satellite link emulator.
11. Setup the link in same fashion with Tx, Rx and Satellite link emulator at 3 vertices of a triangle. Make sure that RHCP Helix antenna of Tx should point towards RHCP Helix antenna. of satellite link emulator and LHCP Helix antenna of Rx should point towards LHCP Helix antenna of satellite link emulator. Set the distance between antennas to approx. 5 meters.
12. Measure the noise floor of all the base band outputs of Demodulator of Rx by turning off Tx and satellite link emulator with the help of CR0. The DPM of Rx measure the noise floor of video signal only, in mV. The CRO can. measure the noise floors of each base band outputs in mV.
13., Now turn on Tx and satellite link emulator. You will, start receiving carrier. Now put the video or audio signal into Base band in of Tx so that you will start receiving the modulated carrier. The baseband out, of Rx. will demodulate the received. signal and extract the send modulating'signal. Both audio as well as video signal can be measured using CRO. For convenience, video signal can be approximately read on display of Rx also. This reading will again be in mV
14. As both noise and modulating signal are measured in mV, actual signal (S)can be

calculated by taking the difference of. the two readings. Say, noise floor is *50m v&* video signàl.at Rx as read on CR0 or DPM is say,1050 mV. Now, S is equal to l000mV. Now, *SIN* is 20 (in numerals) and S/N in dB = 10 log S/N (in numerals). That is 10 log2O = 13dB.

15. Measure S/N by varying path loss Rx and taking Rx farther away from Measure by using different handedness or different polarisation anteena at Rx & downlink channel of satellite. Measure SIN by turning the fabe of two antennas away from each other so that they.don't point each other.If you stand ,between antennas you will attenuate the signal further.

RESULT ,

The signal to . noise ratio is difference in dB of measured signal level with full' modulation . *and* noise floor of the instument. The actual S/N ratio will depend on a number ,.of .parameters at actual link. ,

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EXPERIMENT NO:-6

AIM:-
To transmit & receive the Function Generator waveforms through a satcom link

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EXPERIMENT No. 6

OBJECTIVE:
To transmit & receive the Function Generator waveforms through a satcom link.

EQUIPMENT REQUIRED:
. Satellite uplink transmitter, satellite downlink receiver and satellite link emulator
• Pair of Yagi antennas and RHCP & LHCP axial mode helix antennas
• Antenna stands with connecting cables, mic, video monitor, ccd camera, Function generator, CRC X 2, spectrum analyse

PROCEDURE:
1. Bring the transmitter to 2.481 GHz and connect the RHCP Helix antenna with BNC lead to R.F. Qut of Tx.
2. Set the output level of Tx to maximum.
3. The RHCP Helix antenna of Tx should be rotated with the antenna pointing in the same direction to that of RHCP Helix antenna of uplink Satellite link emulator.
4. Bring the uplink Satellite link emulator to 2.481 GHz.
5. Bring the Downlink Satellite link emulator to 2.400 GHz.
6. Make sure the Thermal Noise & Fading pot is turned fully anticlockwise.
7. Set the frequency of Rx to 2.400 GHz using frequency control. Now connect LHCP Helix antenna with BNC lead to the receiver.
8. Point the LHCP Helix antenna to LHCP Helix antenna of Downlink satellite link emulator.
9. Setup the link in same fashion with Tx, Rx and Satellite link emulator at 3 vertices of a triangle.
10. Set the Function Generator 0/P to 0.5V p/p and don’t exceed this level else clipping will occur. .
11. Connect the Function Generator 0/P to video In (which is a high frequency Analog input also) of Tx and connect video Out of Rx to CRC.
12. Now, connect a sine, triangle or Ramp waveform input at video in of Tx end and vary the frequency of waveforms from 20 Hz to 7 MI-lz and measure its level, frequency, distortion on CR0. Now, measure the level, frequency, distortion, noise added to waveform at Rx end on each channel. Measure how much noise/distortion has been added to signal after it has passed through various circuitry of Tx, Rx and transponder.
13. Also see how much noise is added to Waveforms if path loss at Tx and Rx end is varied.
14. Find at what level of path loss does waveforms vanishes at Rx end.
15. Also find the bandwidth of all the waveforms which can be supported on video /analog channel.
16. Observe if increasing or decreasing the video/analog bandwidth from pot at Tx end has any effect on parameters of received waveforms.
17. Observe on CRC, how does waveforms behaves on fading the carrier by introducing the Fading from satellite link emulator.

18. Observe on CR0, how does waveforms behaves on introducing the thermal noise onto carrier by introducing the noise from satellite link emulator. See if. noise introduced can completely shadow the waveforms.

RESULT:

The Function Generator 0/P waveforms can be transmitted over a distance via a satcom link:

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EXPERIMENT NO:-7

AIM:-

To send telecommand and receive the telemetry Data

Deptt.of Electronics &Communication Engg. (ECE)

RAO PAHALD SINGH GROUP OF INSTITUTIONS BALANA(MOHINDER GARH)123029

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Mr.SANDEEP KUMAR	Mr.SANDEEP YADAV

EXPERIMENT No. 7

OBJECTIVE:
To send telecommand and receive the telemetry Data.
EQUIPMENT REQUIRED:
- Satellite uplink transmitter, satellite downlink receiver and satellite link emulator
- Pair of Yagi antennas and RHCP & LHCP axial mode helix antennas
- Antenna stands with connecting cables, mic, video monitor, ccd camera, Function generator, CRC X 2, spectrum analyzer

PROCEDURE:
1. Setup the link in same fashion with Tx, Rx and Satellite link emulator at 3 vertices of a triangle.
2. To send the telecommand signal from Tx to Satellite link emulator, set addresses of both Tx & Satellite link emulator same.
3. Now, switch ON the ENABLE function at Tx and see if VALID LED glows at Satellite link emulator. If it blinks intermittently or doesn't glow at all, vary the digital bandwidth at Tx till LED glows permanently. Always make sure that Video bandwidth pot is turned fully clockwise whenever you operate digital bandwidth pot. Also, ensure the select switch at Tx is turned towards Digital side during Digital transmission.
4. Now, select the data switches at Tx side and see if corresponding LED's glow or not. If during data selection LED again starts blinking set the digital bandwidth again. Set till all the data can be send transparently. To visualize as to what is happening by digital bandwidth connect a CRC at Tx at Data in and see the address and data pulses selection and their framing.
5. Now, once data has been send from Tx to uplink channel of Satellite link emulator and same can be send to Rx end. Ensure not to switch ON ENABLE at Downlink channel of Satellite link emulator. Hence telecommand data at 2.481 GHz gets received by Rx at 2.400GHz.
6. In order to send telemetry data. to Rx from Downlink channel of Satellite link emulator, switch OFF the ENABLE of Tx and then set the addresses of both Rx and Satellite link emulator same. Now, send the data from downlink channel of Satellite link emulator to Rx.
7. If LED at Rx (VALID) blinks intermittently or doesn't glow at all, vary the digital/analog selection pot at Rx till LED glows permanently. Now, select the data switches at downlink channel of Satellite link emulator side and see if corresponding LED's at Rx glows or not. If during data selection LED again starts blinking set the digital/analog selection pot again. Set till all the data can be send transparently. To visualize as to what is happening by digital/analog selection pot connect a CR0 at Rx at Data out and see the address and data pulses selection and their framing.
8. Measure the level, distortion, noise added to waveform at Rx end on each channel. Measure how much noise/distortion has been added to signal after it has passed through.
9. Also see how much noise is added to waveforms if path toss at Tx and Rx end is varied. Find at what level of path loss does waveforms vanishes at Rx end.
10. Observe on CR0, how does waveforms behaves on fading the carrier by introducing

the Fading from satellite sink emulator.

11. Observe on CR0, how does waveforms behaves on introducing the thermal noise onto carrier by introducing the noise from satellite link emulator. See if noise introduced ca.n completely shadow the data and addresses.

12. Thus, the Telecommand and Telemetry signals can also be viewed at CR0. But make sure not send any video or data signal at Tx. Though audio channels can be used simultaneously.

RESULT:

The Telecommand and Telemetry signals can be transmitted over a distance via a satcom link and same signals can be received at Rx input.

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EXPERIMENT NO:-8

AIM:-

To study the phenomenon of Linear and Circular polarization of antennas

Deptt.of Electronics &Communication Engg. (ECE)

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EXPERIMENT No 8

OBJECTIVE: •
To study the phenomenon of Linear and Circular polarization of antennas.
EQUIPMENT REQUIRED:
Satellite transmitter, receiver and satellite link emulator
• Pair of Yagi antennas and RHCP & LHCP axial mode helix antennas
• Antenna stands with connecting cables, mic, video monitor, ccd camera, Function generator, CRC X 2, spectrum analyser
THEORY:
Polarization
Current polarization techniques are classified as either linear or circular and are utilized for the following main reasons:
Linear polarization -A method to extend the number of channels that can occupy a given bandwidth, by using either horizontal polarization (E field horizontal to the ground) or vertical polarization (E field vertical to ground). This effectively doubles the number of channels that can be provided by a satellite since two channels can share the same frequency, providing they have opposite polarizations. In reality, these channels are staggered to minimize crosstalk (interference) between the two. Two jargon phrases which may cause confusion with regard to polarization, are co polarized channels, meaning channels of the same polarization and cross-polarized channels meaning they are of opposite polarization.
Circular polarization -This method involves spinning the E field of the microwave signal into a spiral or corkscrew. The two opposite polarizations are:
(a) Clockwise or right hand circular polarization (RHCP)
(b) Anticlockwise or left hand circular polarization (LHCP).
Although circular polarization can be used in much the same way as linear polarization, to extend the number of channels, it is more frequently used in high power DBS satellites for a different reason. DBS satellites usually have all their channels fixed at a single polarization either LHCP or RHCP. There is no need to extend the channel capability because this is limited more by power considerations than the numbers of channels. Adjacent DBS satellites in the geo-arc, due to their high power output, usually have opposite polarizations to reduce interference between signals on their earthward journey. Cross-polarization leads to an equivalent suppression in interference in excess of 20 dB and is not noticeable to the viewer.
Polarizers
Polarizers are fitted either between the feedhorn and the LNB or inside the feedhorn itself and fall into three main categories.
1.The V/H switch type- These are simply a pair of probes positioned 90 degrees apart. A solid state switch can select the output from one or the other depending on the selected polarization sense. This type is restricted to single satellite systems.
2. Mechanical polarizer- This type mechanically rotates a lightweight metal polarizer probe to lie in the plane of the required incoming electric field, that is to say the polarizer probe is vertical for receiving vertical polarized signals and horizontal for receiving horizontally polarized signals. The servo motor automatically positions the polarized probe according to the channel polarity selection stored in the receiver's

memory. These polarizers, because mechanical movement is involved, have become less popular recently due to their inherent wear and subsequent unreliability. They are also liable to seizure in very cold weather and are often relatively slow in operation.

3. Magnetic polarizers- This is the favoured replacement for the mechanical type of • polarizer; it consists of a ferrite former wound with copper wire, into which a remotely controlled current is passed. The flow of this current generates a magnetic field which twists the incoming waves, depending on the polarization sense selected, to the orientation required for reception. This type of polarizer causes a slight attenuation of the incoming signal in the region of 0.3 dB. Because magnetic polarizers have no moving parts they are, in the main, reliable. The polarization reference plane is sometimes marked on the casing.

PROCEDURE:

1. Bring the transmitter to 2.481 or 2.454 GHz and connect the RHCP Helix antenna with BNC lead to R.F. out of Tx.
2. Set the output level of Tx to minimum.
3. Connect the video camera output to Video in of Tx. Also connect a microphone to Mic in of Tx.
4. The RHCP Helix antenna of Tx should be rotated with the antenna pointing in the same direction to that of RHCP Helix antenna of uplink Satellite link emulator.
5. Bring the uplink Satellite link emulator to 2.481 or 2.454 GHz.
6. Bring the Downlink Satellite link emulator to 2.400 or 2.427 GHz.
7. Make sure the Thermal Noise & Fading pot is turned off.
8. Set the frequency of Rx to 2.400 or 2.427 GHz using frequency control. Keep the path loss maximum for minimum sensitivity.
9. Connect the video Monitor to video out of Rx and torn on the speaker.
10. Now connect LHCP Helix antenna with BNC lead to the receiver.
11. Point the LHCP Helix antenna to LHCP Helix antenna of Downlink satellite link emulator.
12. Setup the link in a TRIANGLUR fashion with Tx, Rx and Satellite link at 3 vertices of a triangle. Make sure that RHCP Helix antenna of Tx should point towards RHCP Helix antenna of satellite link emulator and Helix antenna of Rx should point towards LHCP Helix antenna of satellite link emulator. Set the distance between antennas as far as possible in order to increase the path loss such that the video signal is at threshold.
13. Connect a spectrum analyzer at spectrum out of Rx and measure the same on spectrum output.
14. The effect is more pronounced with audio reception because the level of audio sub carrier is 20 dB down from video sub carrier. That is why audio vanishes with small increase in distance between Downlink and Rx whereas video vanishes with very large increase in distance. Plus video bandwidth is 18MHz whereas audio bandwidth is only ± 75kHz because of which for very small value of C/N of video signal video is still being able to get received. This is because large bandwidth is being sacrificed to achieve good S/N. Same principle is incorporated in satcom reception.
15. At this threshold level of reception antenna gain plays an important role in increasing C/N and the effect of co-polarisation and cross-polarisation can be appreciated and is much more visible.

16. Now, connect a RHCP Helix antenna at Rx and LHCP Helix antenna at Downlink satellite emulator end.
17. See the effect of cross-polarisation discrimination of antennas on spectrum analyzer. Do you find a decrease in C/N at spectrum after connecting a opposite handedness antenna in a link.
18. Besides the change in signal strength also notice the change in audio & video reception quality on monitor as well as on CRC. Is it much more pronounced for audio reception.
19. Similarly, measure the same effect by connecting a horizontally polarized yagi antenna at Rx end and a vertically polarized yagi antenna at Downlink satellite emulator end.

RESULT:

Antenna Polarisation direction is important in satellite communication. Antenna for any receive transmit pairs should be matched for efficient signal transfer. A polarization mismatch result in signal loss and consequent degradation of S/N ratio hence picture or sound quality. A linear transmission should be received by a linear antenna with correct vertical or horizontal polarity and circular transmission could be received by circularly polarized antennas with correct handedness.

Antenna Polarization for linear antennas is in direction of its elements so if the dipole is mounted in horizontal plane it is horizontally polarized. If it is made vertical then it is vertically polarized. Linear polarization of an antenna is measured with reference to a dipole antenna. So if maximum signal is received from a given antenna with test dipole horizontal, then the given antenna is horizontally polarized. As the plane of either of the antenna is changed the received signal strength reduces. A vertical antenna radiates vertically polarized wave as a vertical whip/ vertical dipole/ monopole/ discone/ endfire/ broadside. A horizontal antenna radiates horizontally polarized waves as a horizontal dipole/ biconical/ square loop/ quad/ Vee/ Yagi/ Logperiodic.

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EXPERIMENT NO:-9

AIM:-

To set a PC-PC satellite communication link using RS 232 ports

Deptt.of Electronics &Communication Engg. (ECE)

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EXPERIMENT No. 9

OBJECTIVE:
To set a PC-PC satellite communication link using RS 232 ports.
EQUIPMENT REQUIRED:
- Satellite uplink transmitter, satellite downlink receiver and satellite link emulator
- Pair of Yagi antennas and RHCP & LHCP axial mode helix antennas
- Pmkerma stands with conrecting cab\es, mc, video monitor, ccd camera, uncton generator, CR0 X 2, spectrum analyzer

PROCEDURE:
1. Setup the link in same fashion with Tx, Rx and Satellite link emulator at 3 vertices of a triangle.
2. **Connect the** Function Generator 0/P to RS232 In of Tx and connect RS232 Out of Rx to CR0. Preferably connect a CRC at Tx end also for viewing transparency of signals using T connectors
3. Now, connect a Pulse waveforms at RS232 in of Tx end and vary the frequency of waveforms from 1 kHz to 100 kHz and see the transparency of signal at Rx end. Now, preferably using a Function generator with variable Duty cycle vary the duty cycle of pulse waveforms from 10 to 90% and see till what bandwidth or at what data rate this transparency is maintained. Because ensuring the transparency of such pulse will ensure noise free data transfer.
4. Open two terminal utility programs of comdebug software in your computer having two comports outputs. Select com 1 at one terminal **&** com2 at another. Connect **Tx** lead at either of the ports say, com land Rx lead at com2. Now, connect both leads using BNC-BNC jointer and send data from com 1 and see if you receive at com2 (at terminal window). This is loop back testing using same computer. Troubleshoot yourself if you are not being able to send data using wires.
5. Now, first set up **Tx** and Rx at same frequency and connect **Tx** lead from com 1 to RS232 in of **Tx &** connect Rx lead from com2 to RS232 out of Rx. See if you are able to send data in a simple wireless link at various baud rates say 1200,2400,4800,9.6kpbs,19.2kpbs and 38.4kpbs. Turn the digital /analog selection pot at Rx fully clockwise and vary the digital bandwidth pot at **Tx** and see what particular setting supports maximum and best data transfer. Also see the effects of parity, data bits and stop bits settings.
6. Now, once the wireless link has been checked, set up a satcom link as usual and send the data via satcom link. Make sure the fading and Noise are OFF.Ordinary CR0 will not be able to capture the fine pulses of Asynchronous data transmission from PC, but it wilt definitely give the idea of noise being introduced in the link. One can always check the link using test tone as if is afr *diffxa'2* 9,9A
7. Find *what* baud rates are supported by the system in satcom link. Are they less as compared to what were supported by wireless link.
8. Fd at swaveT0rms vanishes at Rx end.
9. Observe on CR0, how does waveforms behaves on fading the carrier by introducing the Fading from satellite link emulator.
10. Observe on CR0, how does waveforms behaves on introducing the thermal noise onto carrier by introducing the noise from satellite link emulator. See if noise introduced can

completely stop the link. Do not send Telecommand and Telemetry signals simultaneously. Though audio channels can be used simultaneously.

RESULT:

PC—PC link can be established at variable baud rates from bps to ______Kbps.

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EXPERIMENT NO:-10

AIM:-

To measure the Propagation Delay of signal in a satcom link

Deptt.of Electronics &Communication Engg. (ECE)

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EXPERIMENT No. 10

OBJECTIVE:
To measure the Propagation Delay of signal in a satcom link.
EQUIPMENT REQUIRED:
- Satellite uplink transmitter, satellite downlink receiver and satellite link emulator
- Pair of Yagi antennas and RHCP & LHCP axial mode helix antennas
- Antenna stands with connecting cables, mic, video monitor, ccd camera, Function generator, CRC X 2, spectrum analyzer

PROCEDURE:
1. Setup the link in same fashion with Tx, Rx and Satellite link emulator at 3 vertices of a triangle.
2. Set the Function Generator 0/P to O.5V p/p and don't exceed this level else clipping will occur. Connect the Function Generator 0/P to AUDIO1 In of Tx and a CRC and connect AUDIO 1 Out of Rx to CRC using T connectors.
3. Connect another Function Generator 0/P to AUDIO2 In of Tx and a CR0 and connect AUDIO2 Out of Rx to CRC using T connectors.
4. Now, send two 1kHz Pulse waveforms at both AUDIO1 & AUDIO2 at Tx end. Vary the propagation delay at satellite link emulator. Now, measure the time by which one pulse is delayed from another by viewing both pulse on CR0 and triggering the CRC to any one of the pulses.
5. This effect can be seen by sending audio using Mic. Send voice on each AUDICI & AUDIO2 and hear it on respective channel at Rx and find on which channel the voice signal has been delayed.