Radar and Satellite

Lab Record

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EXPERIMENT-01

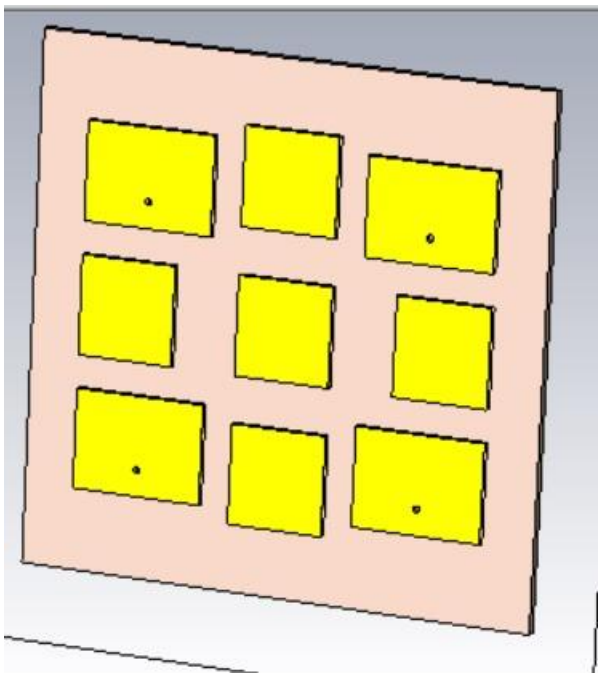
RCS Reduction of a Patch Array Antenna Based on Microstrip Resonators

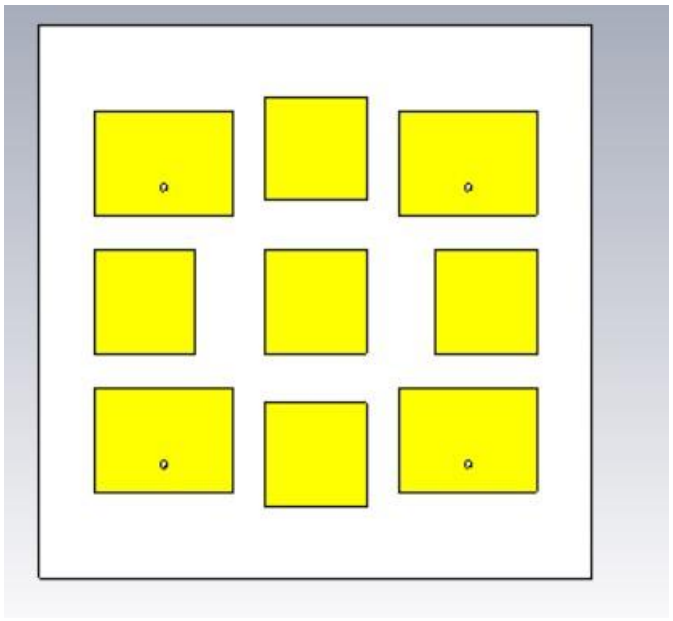
Theory: Total RCS=

$$\sigma = \left| \sqrt{\sigma_s} - (1 - \Gamma_a) \sqrt{\sigma_a} e^{j\varphi} \right|^2$$

Design:

Front View:





Parameters:

Parameter List

Name	Expression
h	1.5
p	4
d3	7.15
d4	10
a1	14.7
a2	15
b	15
a	20
d1	24
d2	25
L	80

Simulation: S-parameters:

EXPERIMENT-05

Objective:

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

Equipment:

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

Procedure:

1. the Satellite uplink transmitter is connected to AC mains outlet with the lead provided.
2. turned ON the transmitter and the Welcome Message will be displayed for 5Seconds.
3. After the welcome message, another message for Menu will be displayed.
4. Press MENU key on the front panel of the Satellite uplink transmitter. The message for selection from the menu options will be displayed. 4. Press MENU key on the front panel of the Satellite uplink transmitter. The message for selection from the menu options will be displayed.
5. pressing A key to select the Uplink Frequency Band. The message for available frequencies to be selected will be displayed.
6. The transmitting frequency from 2.400GHz, 2.427GHz, 2.454 GHz, 2.481 GHz can be selected by means of pressing a corresponding key (i.e. A, B, C, D) provided on the front panel. This indicates that each channel is spaced 27 MHz apart.
7. All frequencies are PLL locked. PLL means that when both receiver and transmitter are set at same frequency, they are accurate to less than 10 KHz of each other and no further tuning and repeated adjustments are required.
8. Now bring the transmitter to 2.481 GHz by pressing key D. The message for selected 2.481 GHz frequency band will be displayed for 5 seconds.
9. Now press ECS key to go to the main menu.
10. Press key B on the front panel of the transmitter. The message for the Input Channels will be displayed.
11. See that the cursor is in front of the AUDIO CH1: Use ▲ UP arrow or ▼ DOWN arrow keys to do that. Use forward arrow ► or down arrow key ◄ to select AUDIO CH1 at MIC1 and Video CH 3 at VIDEO.

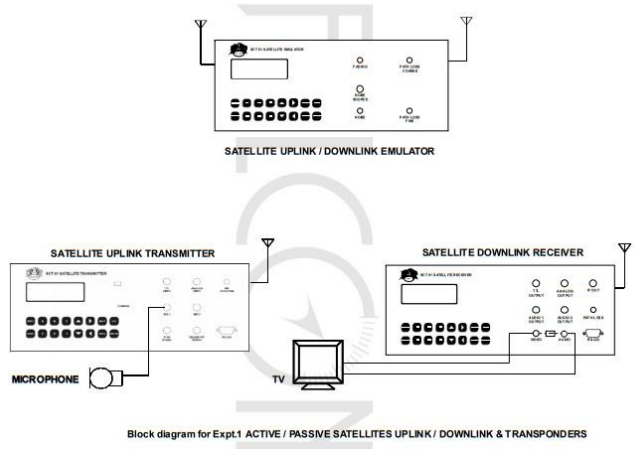
Press ENTER to set it for MIC1 and CH3 to VIDEO.

Press ECS key twice to come out from RSSI menu to main menu.

12. Connect the microphone to the MIC 1 post of the UPLINK TRANSMITTER. Make sure that the FM DEVIATION potentiometer is at the fully anticlockwise position.
13. Connect the RHCP Helix antenna with a SMA lead to R.F. out of Transmitter.
14. Connect the Satellite EMULATOR to AC mains outlet with the lead provided. 15. Switch ON the Satellite EMULATOR and the Welcome Message will be displayed for 5Seconds.

17. Pressing Menu key to go to the menu options.
18. Pressing key A to go to the menu for uplink/downlink frequency selection for the Emulator.
19. Pressing key A to go to uplink Frequency Band Selection.
20. Selecting uplink frequency of 2.481 GHz by pressing key D.
21. This message will be flashed for 5 seconds, Press ESC key to go to previous Menu. Press B key to Downlink Frequency Band selection.
22. Pressing key A to select the downlink frequency of 2.400 GHz. The message for selected downlink frequency of 2.400GHz will be displayed for 5 seconds. Press ECS key two times to go to main MENU.
23. Pressing B key from main Menu for Input Channels selection for the Emulator, following window will be displayed. Press A Key for Audio, Video, Analog, TTL and RS-232 selection.
24. Connecting the Satellite downlink receiver to AC mains outlet with the lead provided.
25. Pressing Menu key on the front panel of the Satellite downlink Receiver. The message for selection from the menu options will be displayed.
26. Pressing A key to select the downlink Frequency Band. the Receiver to 2.400 GHz by pressing key A. The message for selected 2.400 GHz frequency band will be displayed for 5 seconds.
27. Pressing ECS Key to go to previous menu. Pressing key B on the front panel of the Receiver.
28. See that the cursor is in front of the AUDIO CH1: Use ▲ UP arrow or ▼ DOWN arrow keys to do that. Use ► forward arrow or ◄ downward arrow key to select AUDIO CH1 at MIC1 and VIDEO CH3 to VIDEO.
29. Press key ENTER to set it for MIC1 & VIDEO
30. User can view the settings done using ‘VIEW SETTING ‘menu. Press key ‘C ‘to go to the view setting menu.
31. Pressing A’ key to see settings done or Pressing ‘B ‘key to see the strength of received signal.
32. Connecting LHCP Helix antenna with SMA lead to the receiver. Point the LHCP Helix antenna of Receiver towards LHCP Helix antenna of Downlink satellite link emulator.
33. Setting up the link in a TRIANGLUR fashion with Transmitter, Receiver and Satellite link emulator at 3 vertices of a triangle.
34. Connecting the Speaker to the AUDIO post of the DOWNLINK RECEIVER. Speak out on the microphone on

MIC 1 post at the Transmitter side and try to listen it on the TV Speaker at the AUDIO post on the Receiver



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

Observation:

A clear sound at the receiver indicates that a microwave satellite communication link has been set up successfully. In active satellites, the frequency is translated by transponders in satellite and then sent back to receiver after amplifying the signal at different frequency

Result:

Up linking in commercial C band is at 5.925 – 6.425 GHz and Up linking in commercial Ku band is at 14.000 – 14.500 GHz. Down linking in commercial C band is at 3.700 – 4.200 GHz and Down linking in commercial Ku band is at 11.700 – 12.200 GHz

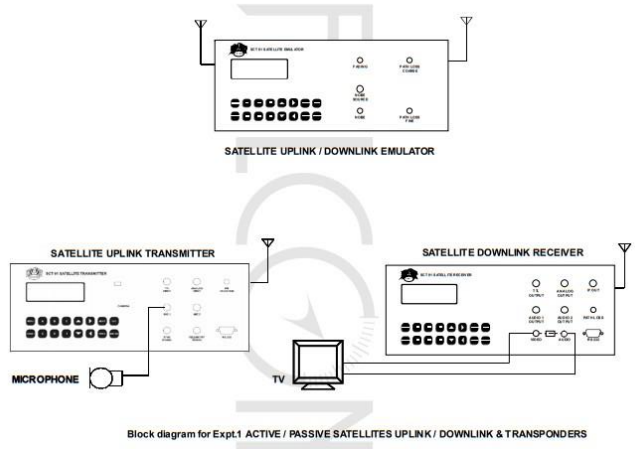
EXPERIMENT-06

Objective:

To measure the signal parameters in an analog FM/FDM TV Satellite link and to study the functionality of a satellite MODEM

Equipment:

- Satellite uplink transmitter, satellite downlink receiver and satellite link emulator.
- RHCP & LHCP axial mode helix antennas
- Antenna stands with connecting cables, Microphone, 10MHz Function Generator, Digital oscilloscope.



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

Procedure:

1. Setting up the communication link, Satellite Emulator Downlink frequency for 2.400 GHz, the PATH LOSS and NOISE potentiometer is in fully anticlockwise position
2. Connecting a microphone to MIC 2 in socket of Transmitter. Set the input channel for AUDIO CH2 for MIC 2
3. Selecting Input channel for AUDIO CH2 to MIC 2 at Receiver end. Listening to the quality of voice spoken into the microphone at the TV speaker of the receiver in the AUDIO post. This establishes a voice communication satellite link <u>For Companding:</u>
4. connecting 1 KHz sine wave with a BNC-T connector to ANALOG INPUT of Transmitter so that the same sine wave signal can also be observed on one channel of DSO. checking that the level of sine wave fed is less than 1V p/p. Setting the Input Channel in the Transmitter for AUDIO CH2 to ANALOG
5. Pressing A key from INPUT DATA menu for analog transmission through Emulator.
6. Setting the Input Channel in the Receiver for AUDIO CH2 to ANALOG.
7. Connectting the ANALOG OUTPUT of Receiver to the other channel of CRO for comparing the transparency of signal received via satellite communication link
8. Measuring the level of signal being transmitted and the level of signal being received <u>For observing Frequency Response of Audio CH2 Channels:</u>
9. Apply 1 KHz, 1 Vp-p sine wave from function generator to ANALOG post of transmitter. Select CH2 to Analog in transmitter, Select VIDEO in Emulator and Select CH2 to Analog in receiver.
10. Now measuring the level of signal being received. Varying the frequency of input signal to 20 KHz in steps of 1 KHz and measuring the level of received signals at different frequencies.
11. Measure the –3dB bandwidth of the audio channel. –3dB would be the level for which the measured signal is 30% lower than its level at a reference frequency of say 1 KHz.
12. For AUDIO CH 1 channel analog frequency response is limited to 3.5KHz, because of the internal CODEC in Emulator

<u>For Observing Frequency Response of Video Channel:</u>

13. Applying 10 KHz, 1 Vp-p sine wave from function generator to ANALOG post of transmitter. Selecting CH3 to Analog in transmitter, Select VIDEO in Emulator and Selecting CH3 to Analog in receiver.

14. Adjusting the received signal level to 1Vp-p by FM deviation pot at transmitter & Fading pot at
    Emulator. Measure the level of signal being received. Varying the frequency of input signal to 10 MHz in steps of 100 KHz and measuring the level of received signals at different frequencies.
15. Measuring the –3dB bandwidth of the video channel. –3dB would be the level for which the measured signal is 30% lower than its level at a reference frequency of say 10 KHz. Finding the difference in frequency response from audio channels. Comparing the signal bandwidth at Receiver through wireless and through satellite link.

For Observing Cross Talk:

16. Applying 1 KHz, 1 Vp-p sine wave from function generator to ANALOG post of transmitter. Select CH1 to Analog in transmitter, Select VIDEO in Emulator and Select CH1 to Analog in receiver.
17. Measuring the received signal in audio2 channel for different levels of FM deviation and mark this as V2. Observe the received signal at Audio1 post of receiver and mark this as V1. Find the ratio of received signal in audio1 channel to the signal in audio2 channel. Crosstalk = V1 / V2 = [20 Log10 (V1 / V2)] dB That would be a measure of cross-talk or channel separation.

For observing Unclipped Sine wave:

18. Applying 1 KHz, 1 Vp-p sine wave from function generator to ANALOG post of transmitter. Selecting CH2 to Analog in transmitter, Select VIDEO in Emulator and Selecting CH2 to Analog in receiver.
19. Observing the demodulated signal at the AUDIO2 OUTPUT post of the Receiver. Increase the Amplitude of the Sine Wave above 1Vpp. Observing the effect on the Amplitude level of the received signal at the Receiver. Finding the maximum Amplitude of the Sine Wave above which the received signal starts getting clipped.

For observing effect of Noise:

20. Applying 1 KHz, 1 Vp-p sine wave from function generator to ANALOG post of transmitter. Selecting CH2 to Analog in transmitter, Selecting VIDEO in Emulator and Select CH2 to Analog in receiver. Setting up uplink and downlink as per expt.1. Note down the Noise Level at ANALOG OUTPUT of receiver in absence of input signal at transmitter. Apply 1 KHz, 1Vpp sine wave to ANALOG INPUT post of transmitter. Set the Input Channel in the Transmitter for VIDEO CH3 to ANALOG.
21. Observing the demodulated signal with noise at the ANALOG OUT post of receiver. Switch off the emulator and tune Satellite Transmitter and Receiver for the same frequency (2.400GHz, 2.427GHz, 2.454GHz or 2.481GHz). Note down the noise level at ANALOG OUTPUT post of receiver in absence of input signal at transmitter.
22. Applying 1 KHz 1Vpp sine wave to Analog input post of transmitter. Set the Input Channel in the Transmitter for VIDEO CH3 to ANALOG.
23. Observing the demodulated signal with noise at ANALOG OUTPUT post of receiver. Set up uplink and downlink as per expt.1. Setting the Input Channel in the Transmitter for VIDEO CH3 to VIDEO.
24. Observing the demodulated signal on the screen of the DSO at receiver. Introduce noise by rotating NOISE potentiometer clockwise and observe the effect on picture as noise goes on increasing.

Observation:

The sound into the microphone 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 2.454 or 2.481 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 2.4475, 2.448, 2.454, 2.460 & 2.4605 GHz with main carrier at 2.454 GHz. The sub-carriers are at a level of around 20-25dB lower than the main carrier.

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.

Result:

The system can transmit and receive two audio signals and a video signal simultaneously. The nominal level it can support is 1V for audio & video channels. It can support an audio signal well up to 20 KHz and a video signal well up to 5MHz. Both the audio channels are almost identical. Signal quality degrades slightly when passing though satellite. Cross-talk in audio channels is around 30dB.

EXPERIMENT-07

Objective:

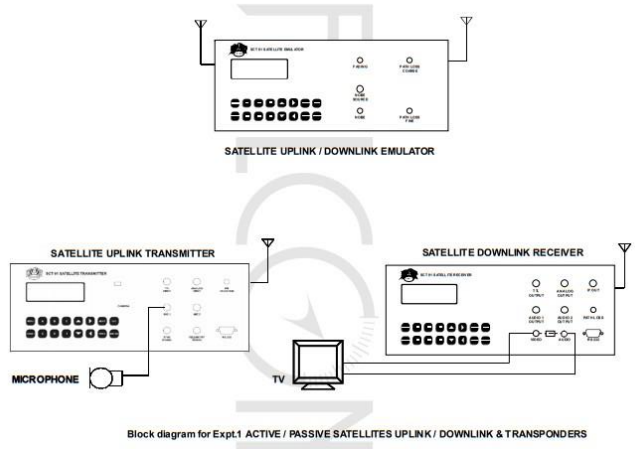
To measure the signal parameters in an analog FM/FDM TV Satellite link and to study the functionality of a satellite MODEM

Equipments Required:

Satellite uplink transmitter, satellite downlink receiver and satellite link emulator

• RHCP & LHCP axial mode helix antennas

• Antenna stands with connecting cables, microphone, video monitor, video camera, Function generator, Digital oscilloscope X 2, spectrum analyzer



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

Procedure:

1. To setting the Video Link, setting the Transmitter & Emulator Uplink Frequency to 2481 MHz, and Receiver & Emulator Downlink frequency to 2400 MHz. This is done to ensure the emulator downlink PLL is locked and displayed frequency is generated correctly.

2. If you get the picture on the TV screen at the receiver via satellite, PLL of complete link are O.K. and a successful satellite link is said to be established. Setting up the input channel for VIDEO CH3 of the Transmitter to video.
3. Feeding a 2 KHz 1Vp-p sine wave externally at ANALOG INPUT of the Transmitter, set AUDIO CH2 to ANALOG and set the input channel for AUDIO CH1 to MIC 1.
4. Connecting the video Monitor to video out of Receiver and connect the power supply of Monitor. Checking if you are able to receive both the audio & video sent at different channels clearly.
5. Connecting DSO to SYNC SIGNAL of transmitter and finding the sync. Level of video signal fed. 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 display of DSO is the internal sync. Level of camera. Measure how much mV is it.
6. Observing if increasing or decreasing the video FM deviation from pot at Transmitter end any effect on parameters of has received sine wave
7. Observing on CRO, how video, audio/sine wave behaves on fading the carrier by introducing the Fading from satellite link emulator.

Observation: The system uses a channel allocation of 27 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

Result: 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.

An analog FM/FDM system where audio and video both are FM modulated on carrier at transmitter and relayed to satellite which then transponds the signal and sends it back to the receiving station.