MEASUREMENT OF POLARIZATION CHARACTERISTICS OF A PLANAR LOG-PERIODIC ANTENNA WITH AN INNOVATIVE STEP-LANE REFLECTOR

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(Oct.4-Nov.3, 2005)

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To whomsoever it may concern

I am happy to express that the works carried out by Shri Somak Bhattacharyya, 3rd year B.Tech student(Institute of Radio Physics and Electronics, University of Calcutta) under the project titled "MEASUREMENT OF POLARIZATION CHARACTERISTICS OF A PLANAR LOG-PERIODIC ANTENNA" during the period 04-10-2005 to 03-11-2005 has been satisfactory to me. Due to lack of time only the received power plots were constructed from the measured data using MATLAB script programs. His character and conduct had been good. I wish him a happy and prosperous career.

(Shubhendu Joardar)

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Somak Bhattacharyya

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Date: 03-11-2005
Place: GMRT

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CHAPTER 1

GENERAL DISCUSSIONS ON POLARIZATIONS

Polarization, or the plane of polarization, of an electromagnetic wave indicates the direction in which the electric vector is aligned during its passage through a full cycle. Generally, the magnitude and tip of the electric vector vary during each cycle so that the electric vector traces out an ellipse in a plane perpendicular to direction of propagation of the electric field vector at the point of observation. The ratio of major-to-minor-axis in an ellipse is called the axial ratio, which is of importance. The direction along which the major axis of an ellipse lie is the polarization orientation.

Let us suppose an electromagnetic wave, radiated by an antenna, has an electric field E (a vector) with two components: E_x and E_y.

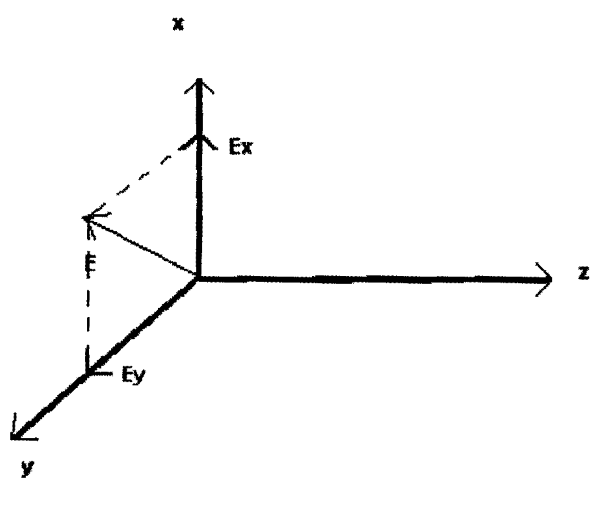


Fig.1.1: Electric field vector at any instant

We are going to explore the figure traced by the tip of vector E at a given position along the z axis as the time changes.

Let us assume that the components E_x and E_y of electric field E are given by

$$E_x = a\cos(\omega t - \beta z) \quad ....(1.1)$$

$$E_y = b\cos(\omega t - \beta z + \phi) \quad ......(1.2)$$

where a is the amplitude of the component E_x and b is the amplitude of component E_y . ϕ is the difference of phase between the two components.

If $\phi = \pm 90°$, the wave is said to be circularly polarized, where '+' corresponds to the sense of polarization in the anti-clockwise direction. Thus the wave is polarized along a circular path in left-hand direction. For '-', the sense of polarization is along clockwise direction .Hence, the wave is clockwisely or right-handed circularly polarized in nature.

For a receiving antenna, the direction of polarization must match with that of an electromagnetic wave passing through so that maximum power can be extracted from the passing wave. In general, there are three conditions should be satisfied in order to receive maximum power from a transmitting antenna, assuming both the transmitting and the receiving antenna are elliptically polarized in nature.

1. The ratios of the electric fields along major to minor axis are same both in transmitting and receiving antenna.
2. The sense of polarizations of the two antennas must be same.
3. The orientations of the ellipse are translated by a negative sign i.e., the phase constant of transmitting antenna and that of receiving antenna must have opposite signs.

THEORY FOR THE MEASUREMENT OF ANTENNA POLARISATION

A transmitting antenna when fed by a source radiates power which is received by a receiving antenna . However, the power transmitted is not received totally by the receiving antenna. The received power can be obtained by Frii's transmission formula

$P_r = P_t G_t G_r (\lambda / 4\pi d)^2$ ....(1.3)

Where P_r = received power

P_t = transmitted power

G_t = gain of transmitting antenna

G_r = gain of received antenna

λ = operating wavelength

d = distance between transmitter and receiver

But, the power received by the receiving antenna is somewhat less than that expected from Frii's formula. This is due to the losses incurred by the adjoining cables where attenuation occurs and due to some atmospheric problems.

Now the adjoining cables are calibrated for different frequencies. This is done by measuring the incoming and outgoing powers of the cables. Thus, the losses of the cables can be calculated easily. So, at different frequencies the power sent to the transmitting antenna should be the power sent together with the losses of the cables. Under these circumstances, the power received by the receiving antenna should be nearly equal to the expected value calculated from Frii's transmission formula provided the signal-to-noise ratio remains same in all practical conditions.

The receiver position can be indicated by a compass situated at the receiver. Thus, at a particular frequency, the powers are obtained for different orientations of the receiver. Now, it is observed that for a particular angle, the power received is maximum and for another particular angle, power received is minimum. So, it can be concluded easily that the angle corresponding to the maximum power is nothing but the direction of the polarization of the antenna. Similarly, the minimum power corresponds to the perpendicular direction of the polarization of the antenna.

CHAPTER 2

A BRIEF INTRODUCTION OF THE ANTENNAS USED

The antenna used is a log-periodic frequency independent one. For this type of antennas, the operating range is over a wide bandwidth with constant impedance, pattern, polarization and gain. Log-periodic antenna is a frequency independent antenna. It was first proposed by Raymond DuHamel & Dwight Isbell at the University of Illionis in 1960. The antenna is used in VHF & UHF range for wideband communication purposes.

Mainly there are two types of designs of log-periodic antenna available viz., planar & dipole. A flat planar design of log-periodic antenna is preferable in radio astronomy so that a common phase-centre is obtained for all frequencies. An ultra wide band planar dual-polarised log-periodic antenna with an innovative reflector was designed and built by Mr. Shubhendu Joardar of GMRT.

TRANSMITTING ANTENNA(LOG-PERIODIC DIPOLE ARRAY)

The first log-periodic antenna was first demonstrated by Isbell in 1960. In such antennas, the electrical properties vary periodically over the logarithm of frequency and if the variation is small of gain and impedance, the antenna is a frequency independent one. For the frequency independent operations, the location of the elements with respect to each other is defined by angles rather than distances. According to DuHamel, the fields fell off sharply with distances from conductors of antennas. The removal of material should not affect pattern and impedance characteristics of the antenna .

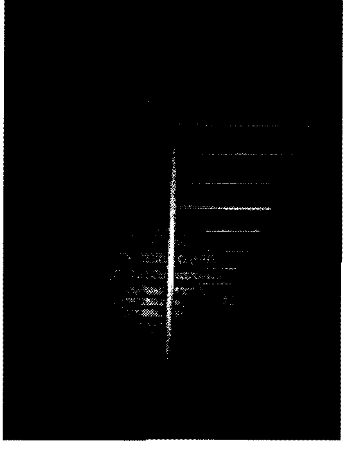


Fig. 2.1: Log-periodic dipole array

The log-periodic antenna is applied by folding two halves so that they lie on a wedge-surface. This leads to the antenna structure like English letter 'V'. This antenna radiates a unidirectional pattern whose main beam points off the antenna tip. Along the log-periodic 'V' linear polarization can be obtained.

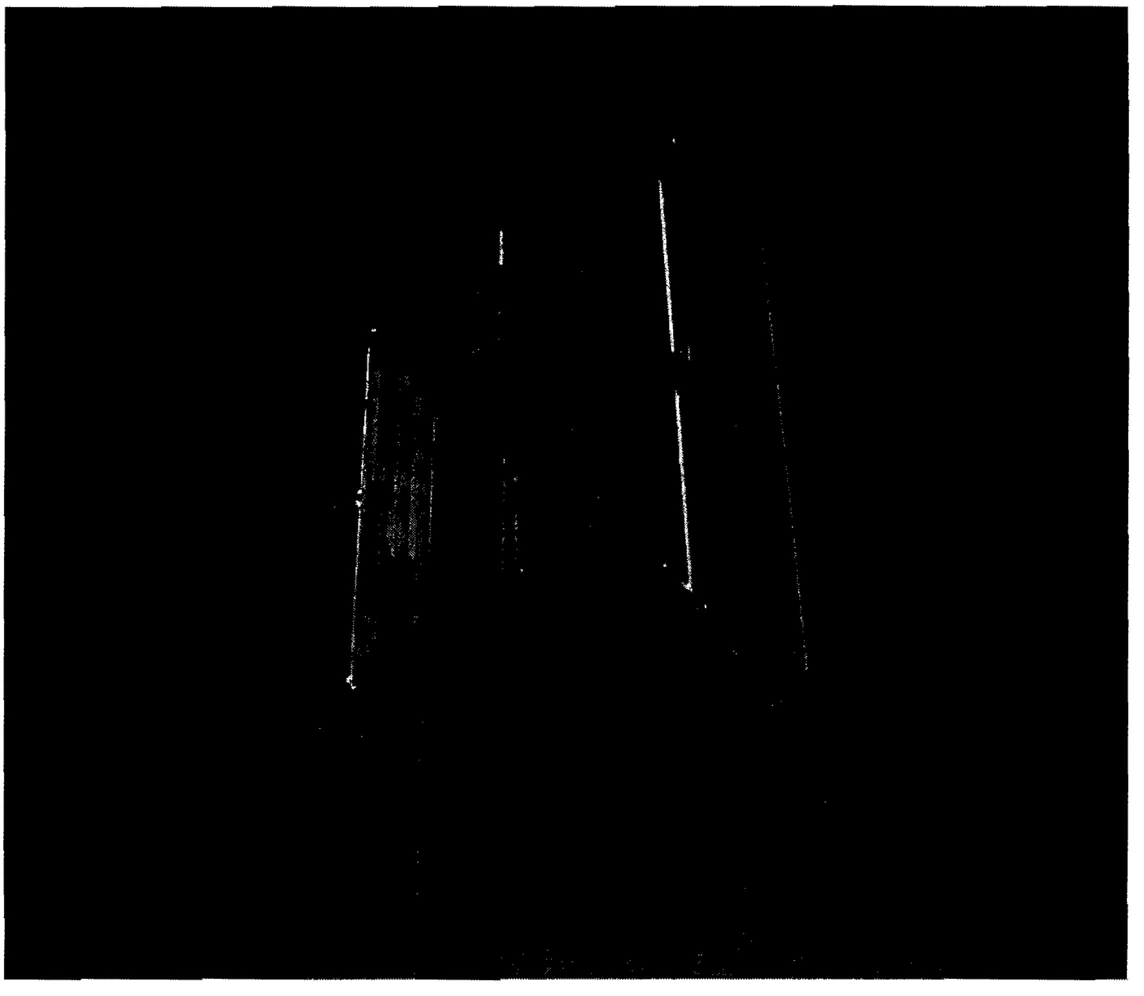
In a log-periodic structure, there is a region of high current excitation called active region encompassing 4 to 5 dipole elements. With the change of frequency, the relative voltage and current pattern remains same, but move toward the direction of active region. A linear increase in current phase occurs from shorter to longer elements which is opposite in direction to that of an unloaded transmission line suggesting propagation of wave traveling toward feed forming a unidirectional end fire radiation pattern toward the vertex ideally. The gradually expanding structure radiates effectively when the dipole elements are near resonance such that with the change in frequency, the active region moves along the array. For lowerer frequencies, the active region shifts to the longer dipoles and for higherer frequencies, the active region shifts towards the region containing the shorter dipoles.The current concentration is strong at or near the edges of the conductors of the antenna structure. The cut-off frequencies of the log-periodic antenna depends upon the electrical lengths of the longest and shortest elements of the structure. The lower cut-off frequency occurs when the longest element is of the order of half of the wavelength and higher cut-off frequency occurs when the shortest element is of the order of half the wavelength only when the active region is very narrow.

RECEIVING ANTENNA (PLANAR DUAL-POLARIZED LOG-PERIODIC ANTENNA WITH AN INNOVATIVE "STEP-LANE" REFLECTOR)

An ultra wide band planar log-periodic antenna feed was designed for the frequency range of 200 MHz to 2 GHz. The relative phase error is minimized which arises due to the frequency sensitive elements of the antenna have at least some orientation along main path of incident electromagnetic wave. The structure posses bidirectional radiation pattern. For this purpose, an innovative "Step-Lane" reflecting surface was developed and introduced at the back of the antenna. Thus the gain increases due to the transformation of bidirectional radiation pattern into a unidirectional one. The leakage portion of incident wave was reflected into the planar structure. In the design of the reflector, behind each active region corresponds to a particular frequency band in the planar structure a half-wavelength plane reflector was placed whose width equals to that of the corresponding antenna elements. The gain of the antenna in both planes of polarization is within 8 to 9 dBi over the entire frequency range.

Front view of the Ultra wide band dual polarised planar antenna
(mounted on top of a building at GMRT colony while testing)

Fig. 2.2: Front view of the receiver



Back view of the Ultra wide band dual polarised planar antenna (mounted on top of a building at GMRT colony while testing)

Fig. 2.3: Back view of the receiver

CHAPTER 3

ARRANGEMENT FOR THE EXPERIMENT FOR MEASUREMENT OF POLARIZATION

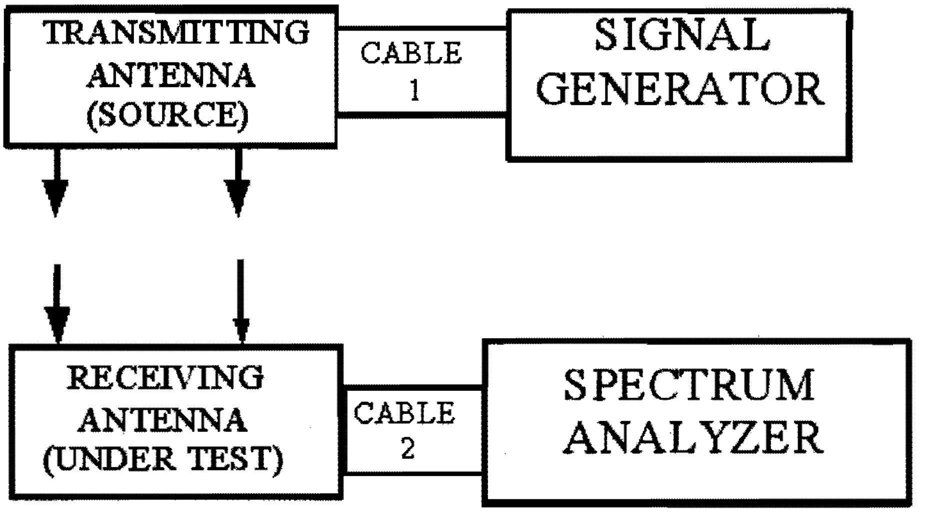


Fig. 3.1: Block diagram of the arrangement made for the measurement of antenna polarization

Fig3.1 shows the arrangement of the instruments used during the measurement of polarization of the antenna under test, planar dual-polarized log-periodic antenna with step-lane reflector. Here the antenna under test(AUT) can be a transmitting antenna as well as a receiving antenna. But, here it is taken as the receiving one so that data processing and antenna manipulation can occur at a time. The distance between the transmitting and receiving antenna is so chosen that the far-field or Fraunhoffer approximation is valid .

TRANSMITTER AND RECEIVER

For accurate measurements of antenna polarization, a powerful transmitter and receiver is required. The power of the source antenna (transmitter) is controlled by the power source which is here a signal generator. The transmitter should have a stable frequency and spectrum allowing use of narrow receiving bandwidth which is required for a sensitive receiver. The receiver is so designed that it is capable to suppress the interfering signals, linear having a large dynamic range. The power meter which is here a spectrum analyzer is used to measure the received power at the transmitted frequency. It should be tuned at different frequencies which is given out by the transmitter while driven by a signal generator of appropriate power.

ANTENNA POSITIONER

The antenna under test (receiving one) has been placed on a position indicator, which indicates the angle made by the receiver with the transmitter . The antenna has been rotated along its azimuth, keeping its elevation fixed.

DATA PROCESSING

The received power is measured by a spectrum analyzer which is acting as a power meter . The magnitude of the received power at different positions and different frequencies are measured . Thus, at a particular frequency, the position of maximum and minimum received power is calculated. This gives rise to the angle of polarization of AUT at different frequencies.

To minimize the losses incurred, the cables are callibrated suitably .If the cable losses are x dB and y dB respectively, for 0 dBm power radiated by the transmitter, the amount of supplied power from the signal generator will be (x + y) dBm .

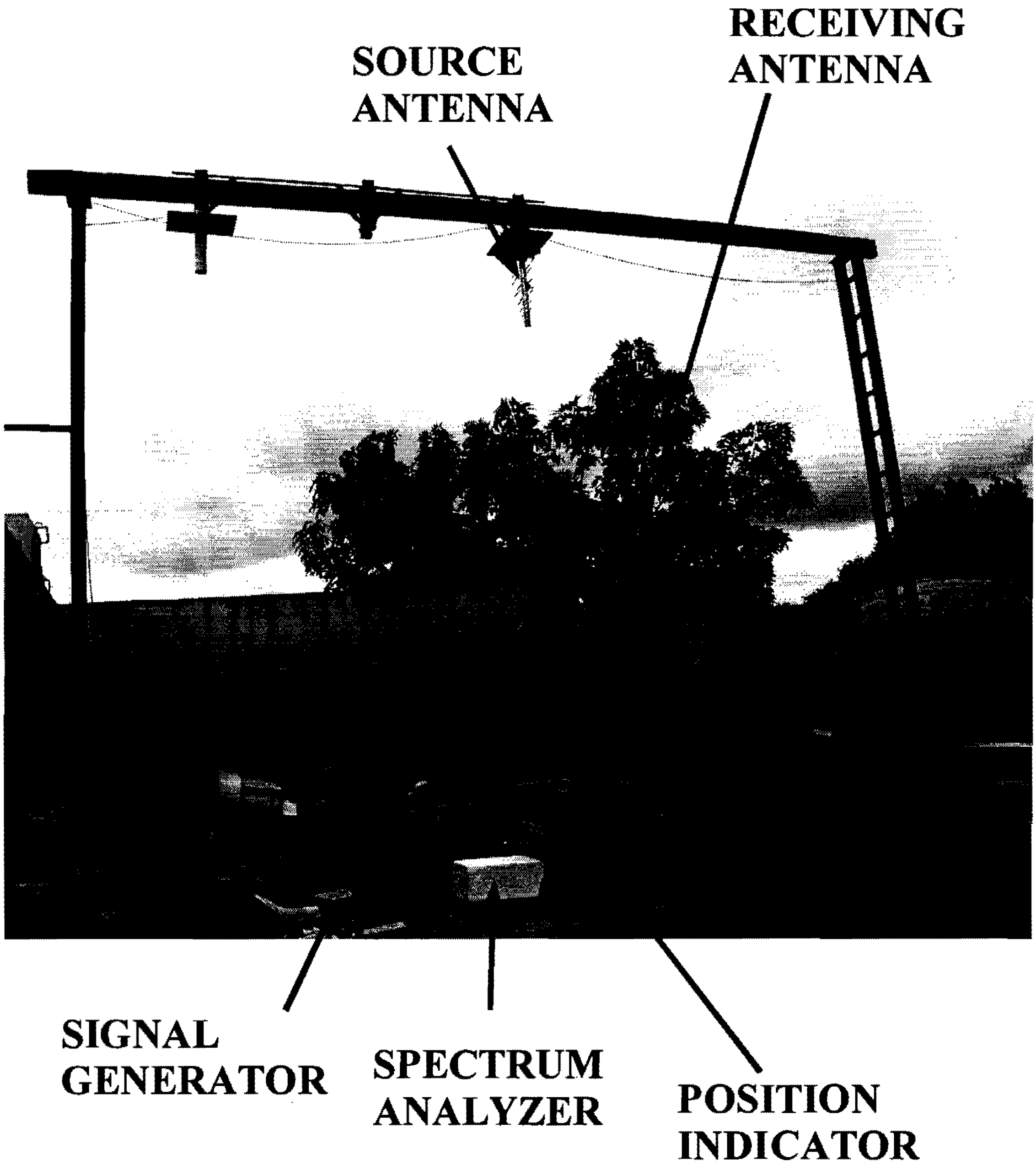


Fig. 4.2: Arrangement made for the measurement of angle of polarization

CHAPTER 4

EXPERIMENTAL DATA

Cable Loss Measurements

Cable Type: Type N (RG 214)
Cable length: 23.71m

Start Frequency = 200 MHz
Stop Frequency = 2000 MHz
Increment step = 50 MHz
Input Power = -30 dBm
Dated: 13/10/2005

Freq (MHz)	Input Pwr (dBm)	Output Pwr (dBm)	Loss (dB)
200	-30	-32.57	- 2.57
250	-30	-32.90	- 2.90
300	-30	-33.26	- 3.26
350	-30	-33.64	- 3.64
400	-30	-33.84	- 3.84
450	-30	-34.12	- 4.12
500	-30	-34.36	- 4.36
550	-30	-34.66	- 4.66
600	-30	-34.94	- 4.94
650	-30	-35.17	- 5.17
700	-30	-35.46	- 5.46
750	-30	-35.76	- 5.76
800	-30	-36.12	- 6.12
850	-30	-36.17	- 6.17
900	-30	-36.40	- 6.40
950	-30	-36.54	- 6.54
1000	-30	-36.75	- 6.75
1050	-30	-37.00	- 7.00
1100	-30	-37.32	- 7.32
1150	-30	-37.50	- 7.50
1200	-30	-37.66	- 7.66
1250	-30	-37.86	- 7.86
1300	-30	-38.16	- 8.16
1350	-30	-38.31	- 8.31
1400	-30	-38.44	- 8.44
1450	-30	-38.63	- 8.63
1500	-30	-38.84	- 8.84
1550	-30	-39.17	- 9.17
1600	-30	-39.92	- 9.92
1650	-30	-39.50	- 9.50
1700	-30	-39.62	- 9.62
1750	-30	-39.79	- 9.79
1800	-30	-39.90	- 9.90
1850	-30	-40.04	-10.04
1900	-30	-40.20	-10.20
1950	-30	-40.44	-10.44
2000	-30	-40.62	-10.62

Cable Type: Type N (RG 223)
Cable length: 3.06 m
Start Frequency = 200 MHz
Stop Frequency = 2000 MHz
Increment step = 50 MHz
Input Power = -30 dBm
Dated: 13/10/2005

Freq (MHz)	**Input Pwr (dBm)**	**Output Pwr (dBm)**	**Loss (dB)**
200	-30	-30.86	-0.86
250	-30	-30.95	-0.95
300	-30	-31.00	-1.00
350	-30	-31.22	-1.22
400	-30	-31.20	-1.20
450	-30	-31.21	-1.21
500	-30	-31.40	-1.40
550	-30	-31.45	-1.45
600	-30	-31.55	-1.55
650	-30	-31.58	-1.58
700	-30	-31.63	-1.63
750	-30	-31.84	-1.84
800	-30	-31.85	-1.85
850	-30	-31.88	-1.88
900	-30	-31.92	-1.92
950	-30	-31.92	-1.92
1000	-30	-32.05	-2.05
1050	-30	-32.17	-2.17
1100	-30	-32.30	-2.30
1150	-30	-32.33	-2.33
1200	-30	-32.41	-2.41
1250	-30	-32.42	-2.42
1300	-30	-32.42	-2.42
1350	-30	-32.44	-2.44
1400	-30	-32.51	-2.51
1450	-30	-32.58	-2.58
1500	-30	-32.62	-2.62
1550	-30	-32.63	-2.63
1600	-30	-32.64	-2.64
1650	-30	-32.74	-2.74
1700	-30	-32.83	-2.83
1750	-30	-32.85	-2.85
1800	-30	-32.85	-2.85
1850	-30	-32.87	-2.87
1900	-30	-32.93	-2.93
1950	-30	-32.97	-2.97
2000	-30	-33.07	-3.07

POLARISATION TEST FOR PLANAR DUAL-POLARISED LOG-PERIODIC ANTENNA WITH STEPLANE REFLECTOR

14/10/2005
15/10/2005

POLARISATION 1(ANTENNA ALLIGNED WITH LOG-PERIODIC DIPOLE ARRAYS)

Sl NO.	Angle (DEG)	FREQUENCY(MHz) 200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950
1	0	-20.67	-21.35	-22.20	-28.67	-29.10	-28.50	-30.73	-29.31	-29.63	-32.22	-38.00	-36.02	-35.50	-35.75	-37.30	-35.80
2	10	-20.59	-22.26	-23.12	-27.17	-28.92	-28.87	-30.13	-29.50	-29.24	-33.10	-38.12	-37.11	-37.40	-35.68	-37.97	-36.60
3	20	-20.48	-23.45	-23.92	-26.87	-28.81	-29.40	-30.66	-30.73	-29.28	-34.32	-38.30	-38.03	-38.28	-35.51	-38.39	-37.32
4	30	-20.57	-25.37	-25.20	-27.30	-29.31	-30.47	-30.72	-33.85	-29.95	-35.48	-39.40	-39.41	-38.32	-36.19	-39.60	-37.71
5	40	-20.65	-28.00	-26.60	-28.00	-30.25	-31.60	-30.86	-34.41	-30.94	-37.29	-42.43	-41.51	-38.88	-36.73	-41.30	-38.82
6	50	-21.14	-31.75	-28.50	-29.30	-31.62	-33.25	-30.92	-34.65	-32.03	-39.00	-45.00	-45.20	-38.94	-38.17	-45.17	-41.46
7	60	-22.18	-36.67	-31.62	-31.05	-33.00	-35.50	-31.50	-34.75	-32.64	-40.62	-50.40	-50.30	-41.34	-39.35	-51.15	-44.83
8	70	-24.50	-37.78	-36.30	-33.15	-34.50	-38.80	-32.00	-35.63	-32.47	-41.45	-57.80	-53.12	-45.65	-41.86	-54.00	-50.00
9	80	-25.50	-33.40	-39.74	-36.70	-36.87	-46.50	-33.62	-36.96	-33.15	-38.04	-51.72	-49.24	-47.20	-44.50	-50.68	-48.50
10	90	-27.41	-29.47	-34.29	-42.38	-43.90	-39.72	-36.74	-39.41	-33.73	-36.50	-46.37	-43.32	-49.00	-47.18	-46.75	-46.41
11	100	-29.50	-26.80	-29.31	-55.00	-64.10	-34.65	-46.00	-41.63	-33.51	-34.91	-43.76	-41.00	-48.00	-49.56	-43.10	-42.96
12	110	-31.59	-24.80	-26.36	-42.61	-43.40	-31.31	-47.30	-38.51	-33.66	-33.50	-40.93	-39.55	-46.00	-47.06	-40.33	-41.75
13	120	-31.65	-22.93	-24.33	-36.40	-37.50	-29.56	-43.30	-34.60	-34.01	-32.41	-39.33	-37.94	-43.00	-43.81	-38.50	-40.00
14	130	-28.54	-21.62	-23.30	-34.84	-34.30	-29.12	-40.20	-32.87	-33.85	-31.92	-38.00	-36.50	-40.10	-42.40	-37.33	-38.73
15	140	-26.63	-20.94	-22.46	-33.37	-32.22	-27.43	-34.40	-32.67	-32.53	-31.69	-37.35	-35.50	-37.30	-39.60	-37.12	-37.07
16	150	-24.22	-20.62	-21.84	-31.90	-30.70	-27.21	-33.45	-31.22	-31.47	-31.41	-36.22	-35.32	-36.34	-37.64	-37.01	-35.65
17	160	-23.20	-20.51	-21.60	-31.02	-29.75	-27.05	-33.97	-32.00	-30.51	-31.89	-35.82	-35.19	-35.74	-37.53	-36.70	-35.41
18	170	-22.23	-21.35	-21.51	-30.10	-29.09	-26.98	-31.70	-31.84	-30.33	-32.00	-35.93	-35.69	-35.24	-36.26	-36.32	-35.55
19	180	-21.86	-21.65	-21.81	-29.71	-28.91	-26.77	-31.31	-31.63	-31.07	-32.10	-36.06	-36.16	-35.02	-35.80	-37.00	-35.67
20	190	-20.45	-22.03	-22.44	-29.14	-28.87	-27.17	-30.89	-31.42	-31.27	-32.75	-36.63	-37.32	-35.09	-35.00	-38.31	-35.88
21	200	-20.24	-23.25	-23.18	-29.00	-28.85	-28.10	-29.34	-31.68	-31.70	-34.06	-37.56	-38.60	-35.89	-35.30	-38.55	-36.83
22	210	-20.18	-24.92	-24.50	-29.40	-29.05	-29.30	-28.98	-31.92	-31.81	-35.60	-38.40	-40.42	-37.66	-36.85	-39.62	-38.50
23	220	-20.53	-26.06	-25.50	-30.00	-30.00	-30.70	-29.36	-32.21	-31.61	-38.00	-40.51	-43.20	-39.81	-37.73	-41.30	-40.15
24	230	-21.27	-28.78	-28.10	-30.13	-30.91	-33.43	-29.78	-33.50	-32.47	-40.20	-43.31	-47.31	-41.58	-39.00	-48.34	-42.65
25	240	-22.32	-33.65	-31.58	-31.46	-32.78	-39.48	-31.30	-36.00	-32.02	-41.61	-48.00	-51.02	-44.60	-41.12	-47.63	-47.65
26	250	-23.44	-38.50	-36.80	-33.00	-34.97	-42.47	-31.74	-39.50	-33.28	-42.29	-54.21	-52.61	-46.31	-42.67	-52.41	-49.90
27	260	-24.75	-35.20	-38.76	-35.50	-38.87	-43.61	-33.28	-43.10	-33.08	-40.16	-52.00	-45.00	-49.32	-45.67	-50.79	-48.04
28	270	-26.30	-39.67	-33.54	-39.80	-45.00	-40.21	-35.96	-45.02	-33.16	-38.07	-45.22	-42.40	-51.21	-43.23	-47.71	-47.61
29	280	-28.00	-26.15	-29.23	-47.12	-58.12	-35.11	-39.00	-42.00	-33.69	-35.61	-41.50	-39.83	-42.10	-50.23	-44.40	-44.00
30	290	-30.27	-24.10	-26.30	-55.30	-41.50	-31.00	-42.53	-39.31	-32.97	-33.80	-39.57	-38.36	-41.04	-50.11	-41.53	-42.24
31	300	-31.80	-22.76	-24.30	-43.61	-37.00	-29.22	-40.32	-36.42	-33.90	-32.12	-39.11	-37.51	-39.60	-45.00	-40.05	-40.28
32	310	-30.25	-21.88	-22.84	-39.81	-34.70	-28.20	-37.26	-32.86	-33.05	-31.57	-38.22	-36.30	-37.32	-41.63	-38.87	-38.50
33	320	-27.43	-21.59	-21.71	-37.07	-32.94	-27.77	-36.14	-31.09	-32.89	-31.30	-37.67	-35.35	-36.42	-39.32	-37.70	-36.97
34	330	-24.69	-21.19	-21.30	-33.40	-31.59	-27.65	-33.15	-30.51	-32.13	-31.37	-37.00	-35.00	-36.23	-38.20	-37.30	-36.52
35	340	-23.30	-20.85	-21.19	-31.91	-30.63	-27.38	-33.02	-30.15	-31.34	-31.67	-36.82	-35.17	-35.81	-36.81	-37.00	-36.00
36	350	-21.94	-21.11	-21.15	-30.80	-29.78	-27.16	-32.21	-30.05	-31.21	-31.72	-36.72	-35.65	-35.56	-35.76	-36.30	-36.17
37	360	-20.83	-21.51	-21.67	-28.97	-29.18	-26.97	-31.15	-30.37	-30.13	-32.21	-37.61	-36.24	-35.43	-35.47	-37.30	-36.31

CONTD..

POLARISATION TEST FOR PLANAR DUAL-POLARISED LOG-PERIODIC ANTENNA WITH STEPLANE REFLECTOR

15/10/2005

POLARISATION 1(ANTENNA ALLIGNED WITH LOG-PERIODIC DIPOLE ARRAYS)

Sl.	Angle	Frequency(MHz)														
No	(DEG)	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700
1	0	-38.10	-40.50	-40.65	-40.40	-46.80	-44.96	-45.06	-44.70	-50.60	-51.64	-49.00	-50.10	-48.47	-57.18	-45.31
2	10	-38.77	-41.05	-41.51	-40.54	-46.93	-44.90	-45.71	-44.52	-49.00	-52.51	-48.00	-49.73	-48.22	-54.52	-44.97
3	20	-40.20	-42.15	-41.85	-42.03	-47.30	-45.22	-47.31	-44.38	-48.21	-54.18	-47.87	-49.15	-48.41	-52.61	-44.69
4	30	-42.54	-43.97	-43.53	-43.10	-45.54	-46.52	-49.35	-44.22	-47.41	-55.92	-46.83	-48.23	-48.61	-52.31	-44.52
5	40	-45.65	-45.56	-45.60	-43.38	-45.74	-49.10	-50.75	-44.15	-46.92	-58.86	-46.77	-47.50	-47.51	-50.57	-44.34
6	50	-49.80	-46.31	-46.81	-45.10	-46.90	-49.95	-53.22	-44.50	-45.95	-61.00	-46.52	-47.00	-48.88	-48.61	-45.29
7	60	-55.15	-45.64	-47.22	-48.40	-46.92	-55.00	-53.80	-45.20	-46.10	-63.67	-46.90	-47.72	-48.76	-48.85	-45.39
8	70	-58.90	-44.65	-47.02	-48.76	-47.35	-60.61	-53.10	-45.40	-46.50	-62.66	-46.82	-47.89	-48.49	-49.39	-46.17
9	80	-50.77	-44.07	-45.50	-52.12	-49.15	-61.00	-49.50	-45.67	-47.62	-61.37	-46.75	-48.00	-47.11	-49.52	-47.42
10	90	-47.03	-43.30	-43.93	-54.81	-50.33	-58.80	-48.26	-47.62	-48.93	-60.69	-47.70	-49.25	-48.55	-49.86	-50.25
11	100	-43.87	-41.09	-42.02	-51.67	-52.90	-56.56	-45.53	-48.00	-50.20	-59.70	-47.81	-50.62	-48.75	-51.74	-54.18
12	110	-41.77	-40.61	-41.11	-46.22	-55.00	-52.37	-45.00	-47.70	-51.10	-56.10	-47.60	-52.66	-49.75	-53.00	-56.50
13	120	-40.31	-40.24	-39.42	-44.65	-56.10	-47.94	-44.92	-47.24	-51.95	-55.32	-47.80	-52.92	-49.65	-55.00	-66.00
14	130	-39.05	-39.30	-39.12	-42.46	-54.80	-46.00	-44.81	-47.05	-55.36	-53.50	-47.90	-53.09	-50.70	-56.00	-58.68
15	140	-38.26	-38.79	-39.04	-41.24	-40.90	-45.16	-44.00	-46.90	-66.00	-52.80	-49.42	-52.48	-51.03	-60.52	-52.61
16	150	-37.96	-38.70	-38.93	-40.69	-50.80	-45.03	-43.60	-46.85	-64.00	-52.75	-49.63	-52.29	-49.70	-62.41	-50.00
17	160	-37.34	-39.17	-39.00	-40.33	-48.27	-44.91	-43.52	-46.65	-59.05	-52.13	-50.12	-51.21	-49.00	-60.00	-48.00
18	170	-37.38	-39.33	-39.82	-39.62	-47.15	-44.00	-44.45	-46.00	-53.25	-51.88	-50.24	-50.11	-49.25	-59.63	-45.70
19	180	-37.95	-40.15	-40.69	-39.31	-46.95	-44.45	-45.61	-45.50	-51.33	-53.00	-50.52	-48.59	-48.95	-56.66	-44.11
20	190	-39.04	-40.72	-41.62	-38.94	-44.72	-44.78	-46.00	-45.04	-49.75	-53.22	-50.24	-48.50	-48.18	-54.19	-43.80
21	200	-40.51	-41.86	-43.05	-39.28	-44.64	-45.21	-47.00	-44.62	-49.20	-54.20	-47.77	-47.90	-47.50	-52.64	-43.44
22	210	-42.62	-42.56	-44.83	-40.70	-45.65	-46.28	-49.40	-44.40	-48.95	-54.30	-47.65	-46.60	-46.92	-55.67	-43.58
23	220	-46.00	-43.80	-45.89	-42.76	-45.79	-47.80	-52.72	-44.60	-48.88	-55.80	-47.22	-46.52	-47.54	-50.10	-44.00
24	230	-49.50	-46.95	-47.57	-44.55	-45.90	-50.45	-55.35	-45.10	-48.40	-58.00	-47.30	-46.23	-47.73	-49.00	-44.29
25	240	-55.56	-46.90	-47.72	-45.13	-47.15	-52.30	-56.25	-45.35	-48.52	-59.70	-48.21	-46.52	-47.82	-49.24	-44.37
26	250	-59.30	-46.71	-45.72	-46.41	-48.81	-55.92	-52.35	-46.68	-48.63	-61.50	-46.92	-46.63	-47.92	-49.63	-44.52
27	260	-50.86	-46.42	-43.37	-49.53	-49.22	-62.65	-49.75	-46.75	-50.00	-61.00	-46.70	-48.00	-48.22	-50.14	-45.87
28	270	-47.49	-43.15	-41.73	-53.67	-50.84	-60.87	-47.63	-47.30	-50.78	-59.00	-46.44	-48.50	-49.50	-50.21	-47.31
29	280	-43.08	-41.92	-41.10	-52.00	-52.56	-56.16	-46.13	-48.60	-52.75	-57.20	-47.00	-50.30	-49.90	-51.69	-49.42
30	290	-41.12	-41.00	-40.00	-48.00	-53.43	-50.85	-44.93	-48.00	-56.22	-53.47	-47.27	-51.75	-50.47	-53.22	-52.05
31	300	-40.45	-39.80	-38.76	-46.00	-52.71	-48.67	-44.89	-47.60	-58.41	-51.75	-47.35	-52.10	-51.00	-55.93	-55.37
32	310	-38.89	-38.70	-38.32	-44.04	-52.62	-46.89	-44.38	-47.49	-59.39	-50.56	-48.06	-52.82	-50.87	-56.54	-66.20
33	320	-37.69	-38.12	-38.27	-42.44	-51.75	-45.58	-44.21	-47.21	-67.32	-49.38	-50.02	-53.12	-50.74	-62.55	-61.40
34	330	-37.41	-38.60	-38.33	-41.22	-49.40	-44.61	-44.00	-46.77	-62.40	-49.90	-50.48	-52.22	-49.51	-61.21	-51.76
35	340	-37.21	-38.70	-38.81	-40.75	-48.35	-44.07	-44.10	-45.95	-55.60	-50.25	-49.46	-51.63	-48.62	-60.82	-48.44
36	350	-37.54	-38.91	-39.15	-40.21	-47.45	-44.00	-44.75	-46.00	-52.46	-50.61	-49.31	-50.00	-48.41	-59.44	-46.60
37	360	-37.80	-40.26	-40.21	-39.92	-46.56	-44.79	-45.33	-45.10	-49.90	-51.32	-49.12	-49.59	-48.48	-56.84	-45.09

CONTD..

POLARISATION 1(ANTENNA ALLIGNED WITH LOG-PERIODIC DIPOLE ARRAYS)

SL NO.	THETA (DEG)	FREQUENCY(MHz) 1750	1800	185	190 0	1950	2000
1	0	-48.37	-59.00	-46.00	-52.10	-56.75	-52.00
2	10	-47.32	-58.60	-46.15	-50.58	-55.64	-54.30
3	20	-47.63	-57.20	-46.67	-50.05	-53.47	-55.42
4	30	-48.65	-56.50	-46.77	-49.24	-51.00	-58.34
5	40	-48.81	-55.00	-47.24	-47.49	-49.62	-56.85
6	50	-48.92	-54.00	-47.92	-48.48	-49.15	-56.61
7	60	-49.00	-54.14	-49.20	-49.19	-49.00	-56.00
8	70	-50.38	-54.37	-51.82	-49.63	-47.87	-55.00
9	80	-50.61	-54.66	-53.61	-49.82	-47.73	-52.31
10	90	-53.82	-54.84	-58.12	-50.78	-47.61	-51.61
11	100	-56.30	-55.37	-60.51	-52.00	-48.42	-51.48
12	110	-64.51	-55.61	-56.82	-53.00	-48.85	-51.00
13	120	-66.00	-55.85	-53.09	-53.10	-49.81	-50.22
14	130	-65.72	-56.21	-50.76	-54.21	-52.03	-50.81
15	140	-61.23	-56.29	-49.16	-55.64	-53.33	-51.31
16	150	-56.61	-58.81	-48.15	-57.37	-54.75	-51.62
17	160	-52.48	-60.66	-46.52	-52.42	-62.12	-51.73
18	170	-50.13	-58.67	-46.63	-50.92	-68.12	-51.89
19	180	-49.36	-58.22	-45.85	-50.00	-72.34	-52.65
20	190	-48.26	-59.81	-45.69	-49.50	-55.71	-54.00
21	200	-48.44	-59.50	-46.66	-49.00	-53.37	-55.72
22	210	-48.59	-59.10	-46.86	-48.20	-50.33	-57.23
23	220	-48.67	-56.00	-46.92	-48.06	-49.10	-56.85
24	230	-49.52	-53.81	-47.22	-49.00	-48.33	-56.69
25	240	-49.73	-53.00	-49.21	-49.53	-48.22	-55.57
26	250	-49.90	-53.35	-51.83	-49.81	-47.85	-53.32
27	260	-51.61	-53.90	-54.23	-50.00	-48.00	-51.45
28	270	-53.17	-54.84	-60.90	-50.65	-48.25	-51.32
29	280	-57.86	-55.17	-61.65	-50.93	-48.87	-50.42
30	290	-62.40	-55.62	-56.72	-51.32	-49.21	-50.29
31	300	-65.00	-55.69	-52.25	-53.22	-50.09	-49.46
32	310	-60.78	-55.91	-50.19	-53.36	-51.21	-49.27
33	320	-57.00	-56.15	-48.43	-57.00	-53.40	-50.00
34	330	-55.30	-59.69	-47.70	-56.62	-57.21	-49.23
35	340	-51.47	-59.93	-47.43	-54.52	-60.93	-49.00
36	350	-49.67	-58.23	-46.88	-52.58	-71.21	-49.10
37	360	-48.48	-59.13	-45.95	-52.31	-56.06	-51.65

POLARISATION TEST FOR PLANAR DUAL-POLARISED LOG-PERIODIC ANTENNA WITH STEPLANE REFLECTOR 15/10/2005
16/10/2005

POLARISATION 2(ANTENNA RIGHT-ANGLED WITH LOG-PERIODIC DIPOLE ARRAYS)

SL NO.	Angle (DEG)	FREQUENCY(MHz) 200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950
1	0	-29.50	-30.27	-30.33	-36.50	-42.20	-35.03	-46.00	-41.60	-48.21	-38.00	-54.34	-51.72	-43.03	-42.02	-50.73	-46.71
2	10	-32.83	-29.67	-26.85	-35.32	-44.00	-31.82	-39.90	-37.00	-39.12	-36.67	-48.00	-46.34	-43.44	-44.68	-55.30	-44.52
3	20	-34.34	-24.50	-24.53	-32.70	-49.00	-29.90	-35.30	-33.90	-36.47	-35.00	-42.85	-41.90	-43.53	-47.85	-57.42	-42.20
4	30	-32.13	-23.00	-23.02	-29.73	-42.16	-28.63	-32.75	-32.54	-35.05	-34.00	-41.55	-40.00	-41.34	-50.80	-57.80	-40.55
5	40	-28.89	-21.79	-21.92	-28.24	-36.00	-27.44	-32.32	-31.68	-33.32	-33.25	-39.20	-38.65	-39.53	-46.15	-44.27	-39.10
6	50	-26.28	-21.00	-21.31	-27.44	-32.22	-26.80	-32.18	-31.00	-31.90	-32.20	-37.40	-37.55	-39.08	-42.71	-40.95	-37.76
7	60	-24.25	-20.55	-21.00	-27.07	-31.32	-26.58	-31.87	-30.66	-30.62	-31.71	-36.15	-36.53	-39.17	-39.98	-39.75	-38.11
8	70	-22.83	-20.42	-20.88	-27.13	-30.50	-26.42	-31.57	-30.82	-29.77	-31.05	-35.78	-36.22	-39.02	-38.62	-38.62	-38.66
9	80	-21.51	-20.70	-21.19	-27.51	-30.10	-27.50	-31.50	-31.34	-29.12	-30.78	-35.10	-36.34	-38.92	-37.32	-37.78	-38.77
10	90	-20.63	-21.27	-21.67	-29.27	-29.72	-28.32	-31.57	-31.45	-28.93	-31.16	-34.78	-36.42	-38.56	-36.02	-37.92	-39.71
11	100	-20.07	-21.94	-22.51	-29.87	-29.28	-28.46	-31.67	-32.10	-29.18	-31.30	-34.32	-36.77	-38.08	-35.46	-38.83	-39.82
12	110	-19.84	-22.89	-23.41	-31.45	-29.12	-29.80	-32.05	-33.80	-29.34	-32.12	-34.70	-37.10	-38.75	-34.68	-38.82	-39.97
13	120	-19.90	-24.31	-24.54	-33.58	-29.45	-31.53	-32.55	-35.58	-30.00	-34.10	-35.00	-37.69	-38.82	-34.22	-39.17	-40.38
14	130	-20.32	-26.08	-26.38	-36.14	-29.61	-34.20	-33.21	-38.00	-30.85	-36.10	-35.50	-38.73	-39.33	-34.34	-39.92	-41.00
15	140	-21.12	-28.65	-28.90	-37.65	-30.50	-36.56	-34.10	-40.65	-31.77	-39.57	-37.00	-40.42	-40.44	-34.96	-40.75	-41.57
16	150	-22.52	-32.65	-33.40	-41.50	-31.65	-41.83	-36.75	-43.75	-34.64	-42.13	-38.10	-42.95	-43.24	-35.46	-42.62	-44.22
17	160	-24.09	-36.86	-42.73	-48.92	-33.42	-52.00	-43.53	-50.80	-38.15	-46.00	-41.45	-45.45	-47.05	-37.15	-44.65	-48.83
18	170	-27.27	-34.00	-37.00	-43.83	-36.25	-39.90	-55.21	-44.47	-43.83	-43.36	-46.37	-48.13	-51.13	-38.21	-47.97	-53.33
19	180	-29.81	-29.54	-30.39	-37.71	-42.23	-35.11	-46.42	-39.08	-48.50	-39.50	-53.57	-50.62	-52.15	-39.32	-52.83	-51.13
20	190	-32.49	-26.62	-26.82	-36.11	-44.59	-33.54	-44.67	-36.23	-43.12	-36.82	-54.00	-49.82	-48.68	-41.00	-59.20	-44.33
21	200	-33.46	-24.40	-24.60	-32.42	-49.33	-31.51	-38.45	-34.00	-37.83	-35.00	-48.87	-44.47	-43.95	-43.28	-55.50	-41.85
22	210	-31.87	-23.00	-23.30	-30.65	-40.27	-30.50	-36.69	-33.52	-34.71	-33.18	-43.68	-40.69	-42.06	-46.90	-47.80	-41.47
23	220	-28.36	-21.70	-22.19	-29.56	-36.00	-29.54	-34.90	-32.44	-32.69	-32.70	-39.11	-39.33	-40.05	-49.10	-45.50	-40.63
24	230	-26.10	-21.00	-21.48	-29.29	-33.67	-28.48	-33.58	-31.84	-30.95	-31.60	-36.83	-38.36	-38.42	-47.50	-43.20	-40.23
25	240	-23.81	-20.60	-21.11	-28.00	-31.67	-27.50	-32.22	-30.93	-30.19	-30.69	-35.10	-37.94	-38.08	-44.68	-41.74	-39.00
26	250	-22.24	-20.42	-20.92	-28.17	-30.00	-27.00	-31.64	-30.53	-29.63	-30.63	-34.12	-37.14	-38.15	-40.23	-40.12	-38.32
27	260	-21.47	-20.55	-21.02	-28.43	-29.20	-27.08	-31.10	-30.72	-29.00	-30.79	-33.89	-36.71	-37.32	-40.44	-39.51	-38.13
28	270	-20.50	-20.89	-21.48	-28.53	-28.34	-27.76	-31.23	-31.41	-28.79	-31.21	-34.31	-36.43	-37.24	-36.39	-39.28	-38.00
29	280	-19.95	-21.61	-22.22	-28.76	-28.21	-28.26	-31.39	-32.20	-29.20	-31.61	-34.75	-36.06	-37.25	-35.60	-39.34	-38.97
30	290	-19.83	-22.67	-23.27	-29.91	-28.61	-29.28	-32.00	-33.00	-29.80	-32.83	-34.93	-36.53	-37.82	-35.72	-39.66	-39.60
31	300	-20.08	-24.17	-24.80	-30.94	-29.35	-30.80	-33.05	-34.65	-30.74	-33.88	-35.00	-37.44	-38.68	-35.55	-39.06	-40.00
32	310	-20.68	-26.22	-26.85	-33.10	-30.00	-33.33	-33.45	-37.12	-32.00	-35.17	-35.67	-39.15	-39.12	-34.80	-39.34	-41.76
33	320	-21.69	-28.86	-30.32	-36.14	-31.06	-36.42	-34.92	-40.91	-34.15	-36.72	-37.26	-40.65	-40.02	-35.04	-39.92	-43.64
34	330	-23.03	-33.70	-35.24	-40.61	-32.52	-44.42	-36.81	-49.22	-37.00	-39.81	-39.67	-42.13	-41.20	-36.01	-41.18	-44.97
35	340	-24.83	-39.46	-43.16	-49.52	-34.82	-49.53	-41.05	-57.33	-40.69	-42.00	-42.21	-45.00	-42.21	-37.30	-42.72	-48.49
36	350	-27.35	-35.60	-37.11	-48.31	-38.34	-39.11	-47.12	-45.42	-44.65	-41.51	-46.42	-51.24	-43.38	-37.51	-44.50	-51.11
37	360	-30.10	-30.29	-30.52	-37.23	-41.96	-34.74	-46.38	-41.23	-48.00	-37.82	-53.00	-55.18	-44.85	-39.19	-47.23	-49.27

CONTD..

POLARISATION 2(ANTENNA RIGHT-ANGLED WITH LOG-PERIODIC DIPOLE ARRAYS)

SL NO.	Angle (DEG)	FREQUENCY(MHz) 1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700
1	0	-48.7	-47.47	-58.62	-48.50	-46.70	-53.43	-60.60	-60.52	-54.13	-52.75	-45.92	-45.20	-49.00	-50.65	-49.37
2	10	-44.74	-47.00	-55.34	-47.80	-47.60	-53.92	-60.4 0	-60.32	-57.62	-52.80	-45.85	-46.10	-49.00	-53.34	-52.10
3	20	-43.53	-45.63	-51.29	-47.75	-48.28	-54.00	-56.11	-59.90	-60.00	-50.70	-45.65	-47.50	-48.65	-53.86	-55.78
4	30	-41.44	-44.72	-47.65	-47.42	-47.42	-52.50	-54.07	-58.00	-66.36	-49.00	-44.82	-48.00	-48.52	-55.40	-60.75
5	40	-39.83	-42.90	-44.32	-47.30	-45.79	-51.65	-52.58	-56.70	-68.22	-48.92	-46.46	-47.87	-50.11	-56.05	-56.30
6	50	-38.75	-42.00	-43.18	-46.35	-45.61	-49.53	-50.42	-52.00	-71.00	-48.65	-46.85	-47.40	-51.62	-59.50	-52.00
7	60	-38.41	-42.16	-41.82	-45.51	-44.76	-48.45	-48.48	-48.70	-62.00	-48.22	-48.90	-47.32	-50.32	-62.41	-49.53
8	70	-38.23	-42.26	-41.72	-44.72	-43.56	-47.20	-47.15	-49.00	-57.74	-48.51	-48.83	-47.25	-49.39	-64.80	-46.62
9	80	-37.83	-42.89	-41.65	-44.33	-42.71	-45.61	-46.77	-50.10	-54.65	-48.81	-47.58	-47.00	-49.19	-63.70	-45.18
10	90	-37.71	-44.15	-40.97	-44.12	-42.51	-45.08	-46.50	-50.76	-53.92	-49.00	-47.32	-46.42	-50.24	-60.00	-44.13
11	100	-38.31	-44.32	-40.87	-43.81	-41.80	-44.83	-46.84	-50.86	-53.32	-49.18	-45.75	-46.65	-50.30	-56.83	-43.47
12	110	-38.65	-44.58	-41.43	-44.50	-41.65	-44.70	-46.92	-50.95	-52.18	-49.50	-44.79	-46.52	-50.76	-55.23	-43.50
13	120	-40.31	-45.34	-42.42	-46.16	-41.26	-45.12	-47.72	-51.20	-51.72	-49.71	-44.52	-45.45	-49.92	-52.64	-43.33
14	130	-42.95	-46.53	-42.72	- 46.61	-41.39	-45.75	-48.42	-51.40	-51.37	-49.82	-44.37	-44.44	-47.72	-50.68	-43.27
15	140	-44.15	-49.58	-43.93	-47.55	-41.95	-46.24	-48.82	-51.70	-51.10	-50.00	-44.10	-44.84	-47.50	-50.42	-43.82
16	150	-47.02	-51.78	-45.43	-48.17	-42.05	-47.02	-50.31	-53.77	-51.40	-51.82	-44.41	-44.92	-48.50	-50.22	-44.80
17	160	-55.55	-49.57	-46.93	-49.69	-42.37	-49.00	-53.92	-54.00	-51.80	-52.02	-44.53	-45.00	-49.67	-50.08	-45.95
18	170	-59.15	-49.00	-50.60	-48.47	-42.57	-50.71	-57.00	-56.89	-52.52	-52.10	-44.35	-45.02	-50.64	-50.12	-46.71
19	180	-53.62	-48.23	-56.65	-48.10	-43.53	-54.92	-60.42	-62.18	-53.87	-53.42	-43.73	-45.55	-51.50	-50.50	-48.70
20	190	- 47.65	-48.19	-54.85	-47.57	-45.43	-56.90	-60.32	-61.17	-57.07	-55.56	-44.50	-46.55	-51.75	-52.20	-50.92
21	200	-43.18	-47.78	-48.28	-46.61	-46.32	-59.62	-55.50	-57.00	-60.27	-52.10	-44.60	-47.40	-50.25	-52.82	-56.00
22	210	-40.86	-46.67	-44.82	-46.17	-45.69	-55.42	-52.37	-52.83	-63.56	-51.21	-44.84	-47.50	-50.19	-53.42	-61.37
23	220	-39.75	-45.78	-44.00	-46.12	-45.43	-51.58	-49.90	-51.65	-65.70	-50.72	-47.00	-47.68	-50.10	-54.50	-58.52
24	230	-38.92	-45.47	-43.72	-44.74	-45.00	-48.67	-49.82	-51.39	-67.30	-50.45	-48.38	-47.75	-51.45	-59.00	-52.90
25	240	-38.60	-44.54	-43.00	-44.63	-44.47	-47.72	-48.27	-51.00	-59.92	-48.85	-48.72	-47.60	-49.70	-63.65	-49.62
26	250	-36.82	-43.85	-42.82	-44.60	-43.00	-45.92	-47.70	-50.82	-55.81	-48.00	-48.80	-47.20	-49.30	-63.45	-47.13
27	260	-36.30	-39.67	-42.63	-43.80	-42.10	-44.44	-46.57	-50.63	-54.69	-47.15	-49.21	-47.00	-49.75	-61.00	-46.09
28	270	-36.83	-44.00	-41.84	-43.55	-41.54	-44.39	-46.330.52		-53.74	-48.30	-49.32	-46.92	-50.25	-58.76	-44.16
29	280	-39.00	-44.22	-41.95	-44.33	-41.33	-44.72	-47.20	-50.12	-53.51	-48.45	-48.10	-46.80	-49.14	-55.73	-43.96
30	290	-40.00	-44.35	-42.00	-45.40	-40.82	-45.44	-47.45	-50.52	-52.30	-48.76	-47.32	-46.72	-48.44	-54.56	-43.82
31	300	-41.15	-44.50	-42.19	-45.74	-41.27	-45.53	-47.69	-50.69	-52.25	-50.52	-47.72	-45.58	-48.55	-53.37	-43.26
32	310	-42.69	-44.62	-42.95	-46.30	-41.33	-46.07	-48.80	-51.60	-52.00	-51.61	-45.77	-44.76	-48.60	-50.68	-43.44
33	320	-45.65	-44.70	-44.00	-47.00	-41.41	-46.72	-49.35	-51.75	-51.32	-52.20	-45.62	-44.52	-48.72	-50.22	-43.71
34	330	-49.28	-44.75	-45.21	-47.68	-42.43	-47.62	-52.35	-53.27	-51.62	-52.61	-45.50	-44.58	-48.80	-50.04	-44.82
35	340	-57.74	-45.72	-47.25	-48.50	-42.92	-48.52	-54.55	-55.25	-51.90	-52.72	-45.43	-44.70	-48.85	-50.16	-46.31
36	350	-54.42	-47.17	-51.20	-48.82	-44.50	-50.57	-55.67	-57.67	-52.20	-53.63	-45.22	-44.90	-48.47	-50.37	-48.00
37	360	-50.37	-48.00	-59.36	-47.92	-45.75	-52.46	-59.29	-59.13	-53.30	-52.33	-44.64	-45.10	-49.42	-50.55	-49.67

CONTD...

POLARISATION 2(ANTENNA RIGHT-ANGLED WITH LOG-PERIODIC DIPOLE ARRAYS)

16/10/2005

Sl No.	Angle (DEG)	Frequency(MHz) 1750	1800	1850	1900	1950	2000
1	0	-56.45	-55.40	-55.72	-53.53	-47.22	-50.28
2	10	-62.45	-56.42	-59.45	-54.08	-47.20	-49.96
3	20	-65.00	-56.92	-61.21	-55.61	-47.61	-49.15
4	30	-61.00	-57.68	-57.90	-54.55	-48.87	-49.01
5	40	-56.65	-58.39	-54.03	-51.08	-51.32	-49.21
6	50	-54.15	-59.00	-51.21	-53.25	-54.32	-49.07
7	60	-51.80	-59.81	-49.12	-55.43	-59.25	-48.72
8	70	-49.45	-60.85	-49.02	-52.76	-65.78	-48.52
9	80	-48.00	-61.80	-47.46	-50.48	-67.70	-49.44
10	90	-47.63	-63.11	-47.13	-50.40	-57.53	-50.91
11	100	-47.40	-61.22	-46.92	-48.51	-54.19	-52.01
12	110	-46.89	-60.39	-47.01	-50.04	-52.54	-54.50
13	120	-46.72	-59.59	-46.21	-51.94	-49.69	-56.65
14	130	-47.37	-56.67	-46.45	-51.59	-48.29	-54.57
15	140	-48.27	-54.92	-47.63	-51.65	-47.91	-55.62
16	150	-48.61	-54.54	-48.28	-52.24	-47.65	-55.10
17	160	-51.32	-53.58	-50.65	-51.75	-46.66	-52.82
18	170	-53.00	-53.20	-52.27	-51.86	-46.95	-51.01
19	180	-56.42	-54.26	-55.82	-52.78	-47.01	-50.40
20	190	-61.76	-55.24	-59.62	-53.57	-47.53	-49.84
21	200	-67.21	-55.32	-61.73	-54.81	-48.48	-49.33
22	210	-63.58	-55.35	-57.46	-53.25	-49.45	-48.60
23	220	-54.94	-56.80	-53.28	-51.53	-51.61	-49.30
24	230	-54.14	-58.25	-50.92	-54.12	-55.06	-49.41
25	240	-52.35	-63.12	-49.52	-55.55	-62.01	-48.90
26	250	-50.40	-70.61	-48.84	-52.44	-64.40	-48.62
27	260	-48.52	-80.00	-47.72	-50.28	-62.65	-50.16
28	270	-47.16	-79.22	-46.85	-50.65	-56.10	-51.46
29	280	-46.86	-65.85	-46.84	-48.25	-52.10	-52.92
30	290	-46.75	-62.10	-46.18	-49.20	-50.85	-55.82
31	300	-47.85	-60.00	-46.24	-51.08	-49.22	-57.50
32	310	-47.93	-56.70	-46.50	-49.94	-48.08	-56.06
33	320	-48.05	-54.83	-47.31	-51.45	-47.61	-57.86
34	330	-48.58	-53.64	-48.19	-53.02	-47.45	-55.57
35	340	-49.76	-53.35	-50.58	-52.71	-47.65	-52.92
36	350	-52.75	-54.00	-51.67	-53.47	-47.60	-50.81
37	360	-55.00	-55.40	-55.01	-53.72	-47.25	-49.72

CHAPTER 5
PROGRAMS AND GRAPHS

****Program to find the variation of power with different angles at different frequencies for first antenna:**

```
clear;
close;
clc;
 % Polarization alligned with the radiator (freq = 200:50:950)
rawData1 = [ ...
1   0  -20.67 -21.35  -22.20 -28.67 -29.10 -28.50 -30.73 -29.31 -29.63 -32.22 -38.00 -36.02 -
35.50 -35.75 -37.30 -35.80;
2   10  -20.59 -22.26  -23.12 -27.17 -28.92 -28.87 -30.13 -29.50 -29.24 -33.10 -38.12 -37.11 -
37.40 -35.68 -37.97 -36.60;
3   20  -20.48 -23.45  -23.92 -26.87 -28.81 -29.40 -30.66 -30.73 -29.28 -34.32 -38.30 -38.03 -
38.28 -35.51 -38.39 -37.32;
4   30  -20.57 -25.37  -25.20 -27.30 -29.31 -30.47 -30.72 -33.85 -29.95 -35.48 -39.40 -39.41 -
38.32 -36.19 -39.60 -37.71;
5   40  -20.65 -28.00  -26.60 -28.00 -30.25 -31.60 -30.86 -34.41 -30.94 -37.29 -42.43 -41.51 -
38.88 -36.73 -41.30 -38.82;
6   50  -21.14 -31.75  -28.50 -29.30 -31.62 -33.25 -30.92 -34.65 -32.03 -39.00 -45.00 -45.20 -
38.94 -38.17 -45.17 -41.46;
7   60  -22.18 -36.67  -31.62 -31.05 -33.00 -35.50 -31.50 -34.75 -32.64 -40.62 -50.40 -50.30 -
41.34 -39.35 -51.15 -44.83;
8   70  -24.50 -37.78  -36.30 -33.15 -34.50 -38.80 -32.00 -35.63 -32.47 -41.45 -57.80 -53.12 -
45.65 -41.86 -54.00 -50.00;
9   80  -25.50 -33.40  -39.74 -36.70 -36.87 -46.50 -33.62 -36.96 -33.15 -38.04 -51.72 -49.24 -
47.20 -44.50 -50.68 -48.50;
10  90  -27.41 -29.47  -34.29 -42.38 -43.90 -39.72 -36.74 -39.41 -33.73 -36.50 -46.37 -43.32 -
49.00 -47.18 -46.75 -46.41;
11  100  -29.50 -26.80  -29.31 -55.00 -64.10 -34.65 -46.00 -41.63 -33.51 -34.91 -43.76 -41.00 -
48.00 -49.56 -43.10 -42.96;
12  110  -31.59 -24.80  -26.36 -42.61 -43.40 -31.31 -47.30 -38.51 -33.66 -33.50 -40.93 -39.55 -
46.00 -47.06 -40.33 -41.75;
13  120  -31.65 -22.93  -24.33 -36.40 -37.50 -29.56 -43.30 -34.60 -34.01 -32.41 -39.33 -37.94 -
43.00 -43.81 -38.50 -40.00;
14  130  -28.54 -21.62  -23.30 -34.84 -34.30 -29.12 -40.20 -32.87 -33.85 -31.92 -38.00 -36.50 -
40.10 -42.40 -37.33 -38.73;
15  140  -26.63 -20.94  -22.46 -33.37 -32.22 -27.43 -34.40 -32.67 -32.53 -31.69 -37.35 -35.50 -
37.30 -39.60 -37.12 -37.07;
16  150  -24.22 -20.62  -21.84 -31.90 -30.70 -27.21 -33.45 -31.22 -31.47 -31.41 -36.22 -35.32 -
36.34 -37.64 -37.01 -35.65;
17  160  -23.20 -20.51  -21.60 -31.02 -29.75 -27.05 -33.97 -32.00 -30.51 -31.89 -35.82 -35.19 -
35.74 -37.53 -36.70 -35.41;
18  170  -22.23 -21.35  -21.51 -30.10 -29.09 -26.98 -31.70 -31.84 -30.33 -32.00 -35.93 -35.69 -
35.24 -36.26 -36.32 -35.55;
19  180  -21.86 -21.65  -21.81 -29.71 -28.91 -26.77 -31.31 -31.63 -31.07 -32.10 -36.06 -36.16 -
35.02 -35.80 -37.00 -35.67;
20  190  -20.45 -22.03  -22.44 -29.14 -28.87 -27.17 -30.89 -31.42 -31.27 -32.75 -36.63 -37.32 -
35.09 -35.00 -38.31 -35.88;
21  200  -20.24 -23.25  -23.18 -29.00 -28.85 -28.10 -29.34 -31.68 -31.70 -34.06 -37.56 -38.60 -
35.89 -35.30 -38.55 -36.83;
```

22 210 -20.18 -24.92 -24.50 -29.40 -29.05 -29.30 -28.98 -31.92 -31.81 -35.60 -38.40 -40.42 -37.66 -36.85 -39.62 -38.50;
23 220 -20.53 -26.06 -25.50 -30.00 -30.00 -30.70 -29.36 -32.21 -31.61 -38.00 -40.51 -43.20 -39.81 -37.73 -41.30 -40.15;
24 230 -21.27 -28.78 -28.10 -30.13 -30.91 -33.43 -29.78 -33.50 -32.47 -40.20 -43.31 -47.31 -41.58 -39.00 -48.34 -42.65;
25 240 -22.32 -33.65 -31.58 -31.46 -32.78 -39.48 -31.30 -36.00 -32.02 -41.61 -48.00 -51.02 -44.60 -41.12 -47.63 -47.65;
26 250 -23.44 -38.50 -36.80 -33.00 -34.97 -42.47 -31.74 -39.50 -33.28 -42.29 -54.21 -52.61 -46.31 -42.67 -52.41 -49.90;
27 260 -24.75 -35.20 -38.76 -35.50 -38.87 -43.61 -33.28 -43.10 -33.08 -40.16 -52.00 -45.00 -49.32 -45.67 -50.79 -48.04;
28 270 -26.30 -39.67 -33.54 -39.80 -45.00 -40.21 -35.96 -45.02 -33.16 -38.07 -45.22 -42.40 -51.21 -43.23 -47.71 -47.61;
29 280 -28.00 -26.15 -29.23 -47.12 -58.12 -35.11 -39.00 -42.00 -33.69 -35.61 -41.50 -39.83 -42.10 -50.23 -44.40 -44.00;
30 290 -30.27 -24.10 -26.30 -55.30 -41.50 -31.00 -42.53 -39.31 -32.97 -33.80 -39.57 -38.36 -41.04 -50.11 -41.53 -42.24;
31 300 -31.80 -22.76 -24.30 -43.61 -37.00 -29.22 -40.32 -36.42 -33.90 -32.12 -39.11 -37.51 -39.60 -45.00 -40.05 -40.28;
32 310 -30.25 -21.88 -22.84 -39.81 -34.70 -28.20 -37.26 -32.86 -33.05 -31.57 -38.22 -36.30 -37.32 -41.63 -38.87 -38.50;
33 320 -27.43 -21.59 -21.71 -37.07 -32.94 -27.77 -36.14 -31.09 -32.89 -31.30 -37.67 -35.35 -36.42 -39.32 -37.70 -36.97;
34 330 -24.69 -21.19 -21.30 -33.40 -31.59 -27.65 -33.15 -30.51 -32.13 -31.37 -37.00 -35.00 -36.23 -38.20 -37.30 -36.52;
35 340 -23.30 -20.85 -21.19 -31.91 -30.63 -27.38 -33.02 -30.15 -31.34 -31.67 -36.82 -35.17 -35.81 -36.81 -37.00 -36.00;
36 350 -21.94 -21.11 -21.15 -30.80 -29.78 -27.16 -32.21 -30.05 -31.21 -31.72 -36.72 -35.65 -35.56 -35.76 -36.30 -36.17;
37 360 -20.83 -21.51 -21.67 -28.97 -29.18 -26.97 -31.15 -30.37 -30.13 -32.21 -37.61 -36.24 -35.43 -35.47 -37.30 -36.31];
% Polarization alligned with the radiator (freq = 1000:50:1700)
rawData2 = [...
1 0 -38.10 -40.50 -40.65 -40.40 -46.80 -44.96 -45.06 -44.70 -50.60 -51.64 -49.00 -50.10 -48.47 -57.18 -45.31;
2 10 -38.77 -41.05 -41.51 -40.54 -46.93 -44.90 -45.71 -44.52 -49.00 -52.51 -48.00 -49.73 -48.22 -54.52 -44.97;
3 20 -40.20 -42.15 -41.85 -42.03 -47.30 -45.22 -47.31 -44.38 -48.21 -54.18 -47.87 -49.15 -48.41 -52.61 -44.69;
4 30 -42.54 -43.97 -43.53 -43.10 -45.54 -46.52 -49.35 -44.22 -47.41 -55.92 -46.83 -48.23 -48.61 -52.31 -44.52;
5 40 -45.65 -45.56 -45.60 -43.38 -45.74 -49.10 -50.75 -44.15 -46.92 -58.86 -46.77 -47.50 -47.51 -50.57 -44.34;
6 50 -49.80 -46.31 -46.81 -45.10 -46.90 -49.95 -53.22 -44.50 -45.95 -61.00 -46.52 -47.00 -48.88 -48.61 -45.29;
7 60 -55.15 -45.64 -47.22 -48.40 -46.92 -55.00 -53.80 -45.20 -46.10 -63.67 -46.90 -47.72 -48.76 -48.85 -45.39;
8 70 -58.90 -44.65 -47.02 -48.76 -47.35 -60.61 -53.10 -45.40 -46.50 -62.66 -46.82 -47.89 -48.49 -49.39 -46.17;
9 80 -50.77 -44.07 -45.50 -52.12 -49.15 -61.00 -49.50 -45.67 -47.62 -61.37 -46.75 -48.00 -47.11 -49.52 -47.42;
10 90 -47.03 -43.30 -43.93 -54.81 -50.33 -58.80 -48.26 -47.62 -48.93 -60.69 -47.70 -49.25 -48.55 -49.86 -50.25;

```
11      100  -43.87 -41.09  -42.02 -51.67 -52.90 -56.56 -45.53 -48.00 -50.20 -59.70 -47.81 -50.62
-48.75 -51.74 -54.18;
12      110  -41.77 -40.61  -41.11 -46.22 -55.00 -52.37 -45.00 -47.70 -51.10 -56.10 -47.60 -52.66
-49.75 -53.00 -56.50;
13      120  -40.31 -40.24  -39.42 -44.65 -56.10 -47.94 -44.92 -47.24 -51.95 -55.32 -47.80 -52.92
-49.65 -55.00 -66.00;
14      130  -39.05 -39.30  -39.12 -42.46 -54.80 -46.00 -44.81 -47.05 -55.36 -53.50 -47.90 -53.09
-50.70 -56.00 -58.68;
15      140  -38.26 -38.79  -39.04 -41.24 -40.90 -45.16 -44.00 -46.90 -66.00 -52.80 -49.42 -52.48
-51.03 -60.52 -52.61;
16      150  -37.96 -38.70  -38.93 -40.69 -50.80 -45.03 -43.60 -46.85 -64.00 -52.75 -49.63 -52.29
-49.70 -62.41 -50.00;
17      160  -37.34 -39.17  -39.00 -40.33 -48.27 -44.91 -43.52 -46.65 -59.05 -52.13 -50.12 -51.21
-49.00 -60.00 -48.00;
18      170  -37.38 -39.33  -39.82 -39.62 -47.15 -44.00 -44.45 -46.00 -53.25 -51.88 -50.24 -50.11
-49.25 -59.63 -45.70;
19      180  -37.95 -40.15  -40.69 -39.31 -46.95 -44.45 -45.61 -45.50 -51.33 -53.00 -50.52 -48.59
-48.95 -56.66 -44.11;
20      190  -39.04 -40.72  -41.62 -38.94 -44.72 -44.78 -46.00 -45.04 -49.75 -53.22 -50.24 -48.50
-48.18 -54.19 -43.80;
21      200  -40.51 -41.86  -43.05 -39.28 -44.64 -45.21 -47.00 -44.62 -49.20 -54.20 -47.77 -47.90
-47.50 -52.64 -43.44;
22      210  -42.62 -42.56  -44.83 -40.70 -45.65 -46.28 -49.40 -44.40 -48.95 -54.30 -47.65 -46.60
-46.92 -55.67 -43.58;
23      220  -46.00 -43.80  -45.89 -42.76 -45.79 -47.80 -52.72 -44.60 -48.88 -55.80 -47.22 -46.52
-47.54 -50.10 -44.00;
24      230  -49.50 -46.95  -47.57 -44.55 -45.90 -50.45 -55.35 -45.10 -48.40 -58.00 -47.30 -46.23
-47.73 -49.00 -44.29;
25      240  -55.56 -46.90  -47.72 -45.13 -47.15 -52.30 -56.25 -45.35 -48.52 -59.70 -48.21 -46.52
-47.82 -49.24 -44.37;
26      250  -59.30 -46.71  -45.72 -46.41 -48.81 -55.92 -52.35 -46.68 -48.63 -61.50 -46.92 -46.63
-47.92 -49.63 -44.52;
27      260  -50.86 -46.42  -43.37 -49.53 -49.22 -62.65 -49.75 -46.75 -50.00 -61.00 -46.70 -48.00
-48.22 -50.14 -45.87;
28      270  -47.49 -43.15  -41.73 -53.67 -50.84 -60.87 -47.63 -47.30 -50.78 -59.00 -46.44 -48.50
-49.50 -50.21 -47.31;
29      280  -43.08 -41.92  -41.10 -52.00 -52.56 -56.16 -46.13 -48.60 -52.75 -57.20 -47.00 -50.30
-49.90 -51.69 -49.42;
30      290  -41.12 -41.00  -40.00 -48.00 -53.43 -50.85 -44.93 -48.00 -56.22 -53.47 -47.27 -51.75
-50.47 -53.22 -52.05;
31      300  -40.45 -39.80  -38.76 -46.00 -52.71 -48.67 -44.89 -47.60 -58.41 -51.75 -47.35 -52.10
-51.00 -55.93 -55.37;
32      310  -38.89 -38.70  -38.32 -44.04 -52.62 -46.89 -44.38 -47.49 -59.39 -50.56 -48.06 -52.82
-50.87 -56.54 -66.20;
33      320  -37.69 -38.12  -38.27 -42.44 -51.75 -45.58 -44.21 -47.21 -67.32 -49.38 -50.02 -53.12
-50.74 -62.55 -61.40;
34      330  -37.41 -38.60  -38.33 -41.22 -49.40 -44.61 -44.00 -46.77 -62.40 -49.90 -50.48 -52.22
-49.51 -61.21 -51.76;
35      340  -37.21 -38.70  -38.81 -40.75 -48.35 -44.07 -44.10 -45.95 -55.60 -50.25 -49.46 -51.63
-48.62 -60.82 -48.44;
36      350  -37.54 -38.91  -39.15 -40.21 -47.45 -44.00 -44.75 -46.00 -52.46 -50.61 -49.31 -50.00
-48.41 -59.44 -46.60;
37      360  -37.80 -40.26  -40.21 -39.92 -46.56 -44.79 -45.33 -45.10 -49.90 -51.32 -49.12 -49.59
-48.48 -56.84 -45.09  ];
```

```
% Polarization alligned with the radiator (freq = 1750:50:2000)

rawData3 = [ ...
1    0   -48.37 -59.00 -46.00 -52.10 -56.75 -52.00;
2    10  -47.32 -58.60 -46.15 -50.58 -55.64 -54.30;
3    20  -47.63 -57.20 -46.67 -50.05 -53.47 -55.42;
4    30  -48.65 -56.50 -46.77 -49.24 -51.00 -58.34;
5    40  -48.81 -55.00 -47.24 -47.49 -49.62 -56.85;
6    50  -48.92 -54.00 -47.92 -48.48 -49.15 -56.61;
7    60  -49.00 -54.14 -49.20 -49.19 -49.00 -56.00;
8    70  -50.38 -54.37 -51.82 -49.63 -47.87 -55.00;
9    80  -50.61 -54.66 -53.61 -49.82 -47.73 -52.31;
10   90  -53.82 -54.84 -58.12 -50.78 -47.61 -51.61;
11   100 -56.30 -55.37 -60.51 -52.00 -48.42 -51.48;
12   110 -64.51 -55.61 -56.82 -53.00 -48.85 -51.00;
13   120 -66.00 -55.85 -53.09 -53.10 -49.81 -50.22;
14   130 -65.72 -56.21 -50.76 -54.21 -52.03 -50.81;
15   140 -61.23 -56.29 -49.16 -55.64 -53.33 -51.31;
16   150 -56.61 -58.81 -48.15 -57.37 -54.75 -51.62;
17   160 -52.48 -60.66 -46.52 -52.42 -62.12 -51.73;
18   170 -50.13 -58.67 -46.63 -50.92 -68.12 -51.89;
19   180 -49.36 -58.22 -45.85 -50.00 -72.34 -52.65;
20   190 -48.26 -59.81 -45.69 -49.50 -55.71 -54.00;
21   200 -48.44 -59.50 -46.66 -49.00 -53.37 -55.72;
22   210 -48.59 -59.10 -46.86 -48.20 -50.33 -57.23;
23   220 -48.67 -56.00 -46.92 -48.06 -49.10 -56.85;
24   230 -49.52 -53.81 -47.22 -49.00 -48.33 -56.69;
25   240 -49.73 -53.00 -49.21 -49.53 -48.22 -55.57;
26   250 -49.90 -53.35 -51.83 -49.81 -47.85 -53.32;
27   260 -51.61 -53.90 -54.23 -50.00 -48.00 -51.45;
28   270 -53.17 -54.84 -60.90 -50.65 -48.25 -51.32;
29   280 -57.86 -55.17 -61.65 -50.93 -48.87 -50.42;
30   290 -62.40 -55.62 -56.72 -51.32 -49.21 -50.29;
31   300 -65.00 -55.69 -52.25 -53.22 -50.09 -49.46;
32   310 -60.78 -55.91 -50.19 -53.36 -51.21 -49.27;
33   320 -57.00 -56.15 -48.43 -57.00 -53.40 -50.00;
34   330 -55.30 -59.69 -47.70 -56.62 -57.21 -49.23;
35   340 -51.47 -59.93 -47.43 -54.52 -60.93 -49.00;
36   350 -49.67 -58.23 -46.88 -52.58 -71.21 -49.10;
37   360 -48.48 -59.13 -45.95 -52.31 -56.06 -51.65 ];
%separating the powers for individual frequencies
theta = rawData1(:,2); %preserving the theta
tmp1 = rawData1;
tmp1(:,1) = []; %removing the first column containing serial no.
tmp1(:,1) = []; %removing the next column containing theta
tmp2 = rawData2;
tmp2(:,1) = []; %removing the first column containing serial no.
tmp2(:,1) = []; %removing the next column containing theta
tmp3 = rawData3;
tmp3(:,1) = []; %removing the first column containing serial no.
tmp3(:,1) = []; %removing the next column containing theta
PMat = [tmp1, tmp2, tmp3]; %A single matrix containing only power values for all freqs.
tmp1 = [];
tmp2 = [];
tmp3 = [];
rawData1 = [];
```

```
rawData2 = [];
rawData3 = [];
PMat(37,:) = []; %removing the last row since it should be same as first row
theta(37,:) = [];
fMHz = 200:50:2000; %frequency range
%The above operations gives us: (1)Theta, (2)Power-Matrix & (3) Frequency
figure(1); %angle vs. pwr. for every frequency
plot(theta,PMat(:,1),'b',theta,PMat(:,2),'r',theta,PMat(:,3),'g',theta,PMat(:,4),'m',...
   theta,PMat(:,5),'c',theta,PMat(:,6),'y',theta,PMat(:,7),'k',theta,PMat(:,8),'--r*',theta,PMat(:,9),'--
g*');
grid on;
grid minor;
legend('200 MHz','250 MHz','300 MHz','350 MHz','400 MHz','450 MHz','500 MHz','550 MHz','600
MHz',-1);
xlabel('Angle(degree)-->');
ylabel('Power(dBm)-->');
title('Variation of Power with Angle for different frequencies');

figure(2);
plot(theta,PMat(:,10),'b',theta,PMat(:,11),'r',theta,PMat(:,12),'g',theta,PMat(:,13),'m',...
   theta,PMat(:,14),'c',theta,PMat(:,15),'y',theta,PMat(:,16),'k',theta,PMat(:,17),'--
r*',theta,PMat(:,18),'--g*');
grid on;
grid minor;
legend('650 MHz','700 MHz','750 MHz','800 MHz','850 MHz','900 MHz','950 MHz','1000
MHz','1050 MHz',-1);
xlabel('Angle(degree)-->');
ylabel('Power(dBm)-->');
title('Variation of Power with Angle for different frequencies');

figure(3);
plot(theta,PMat(:,19),'b',theta,PMat(:,20),'r',theta,PMat(:,21),'g',theta,PMat(:,22),'m',...
   theta,PMat(:,23),'c',theta,PMat(:,24),'y',theta,PMat(:,25),'k',theta,PMat(:,26),'--
r*',theta,PMat(:,27),'--g*');
grid on;
grid minor;
legend('1100 MHz','1150 MHz','1200 MHz','1250 MHz','1300 MHz','1350 MHz','1400 MHz','1450
MHz','1500 MHz',-1);
xlabel('Angle(degree)-->');
ylabel('Power(dBm)-->');
title('Variation of Power with Angle for different frequencies');

figure(4);
plot(theta,PMat(:,28),'b',theta,PMat(:,29),'r',theta,PMat(:,30),'g',theta,PMat(:,31),'m',...
   theta,PMat(:,32),'c',theta,PMat(:,33),'y',theta,PMat(:,34),'k',theta,PMat(:,35),'--
r*',theta,PMat(:,36),'--g*',theta,PMat(:,37),'--b*');

grid on;
grid minor;
legend('1550 MHz','1600 MHz','1650 MHz','1700 MHz','1750 MHz','1800 MHz','1850 MHz','1900
MHz','1950 MHz','2000 MHz',-1);
xlabel('Angle(degree)-->');
ylabel('Power(dBm)-->');
  title('Variation of Power with Angle for different frequencies');
```

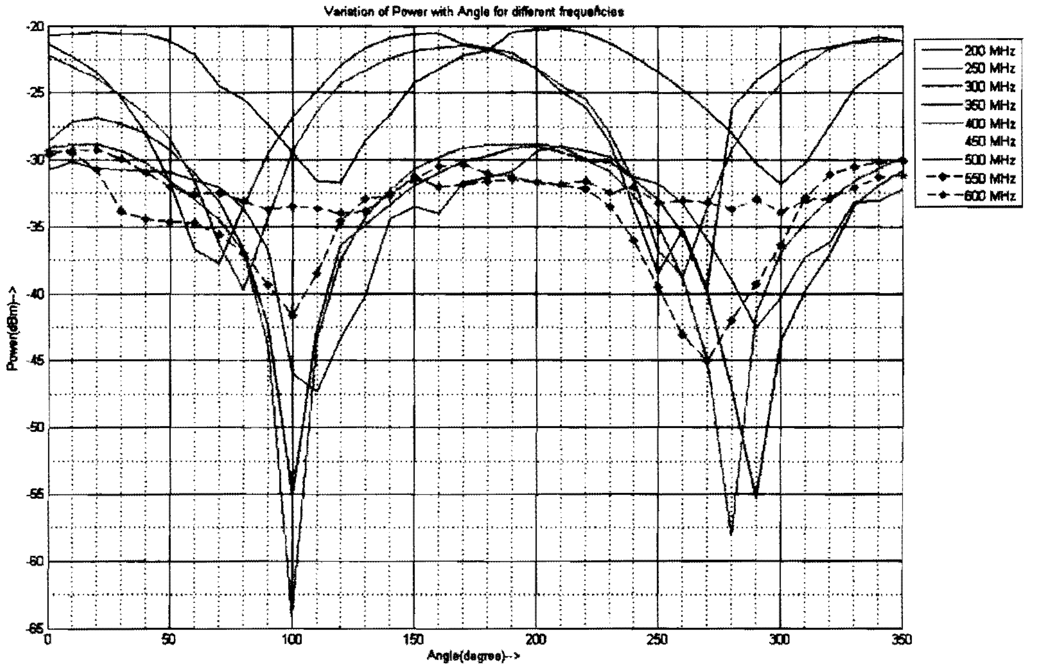


Fig. 5.1:Plot of power with angle for frequency range 200-600 MHz

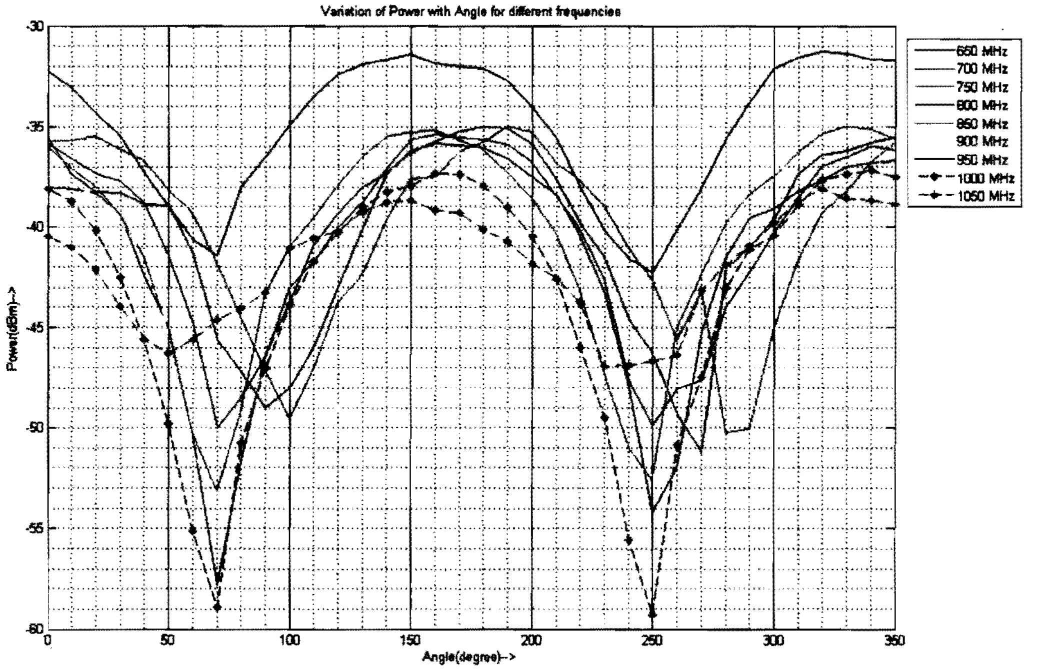


Fig.5.2: Plot of power with angle for frequency range 650-1050 MHz

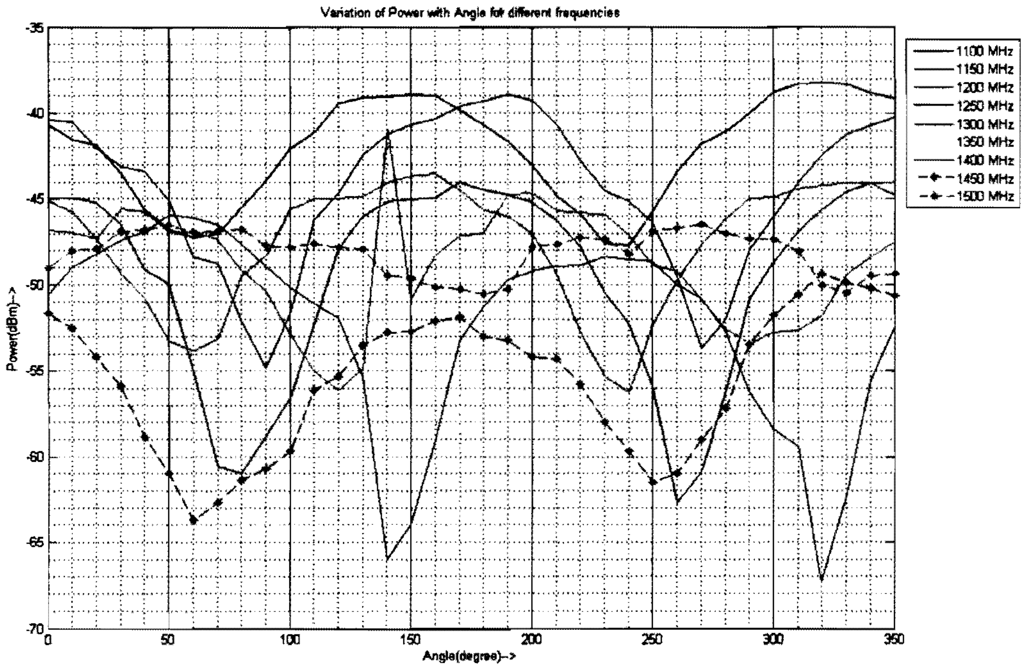


Fig. 5.3: Plot of power with angle for frequency range 1100-1500 MHZ

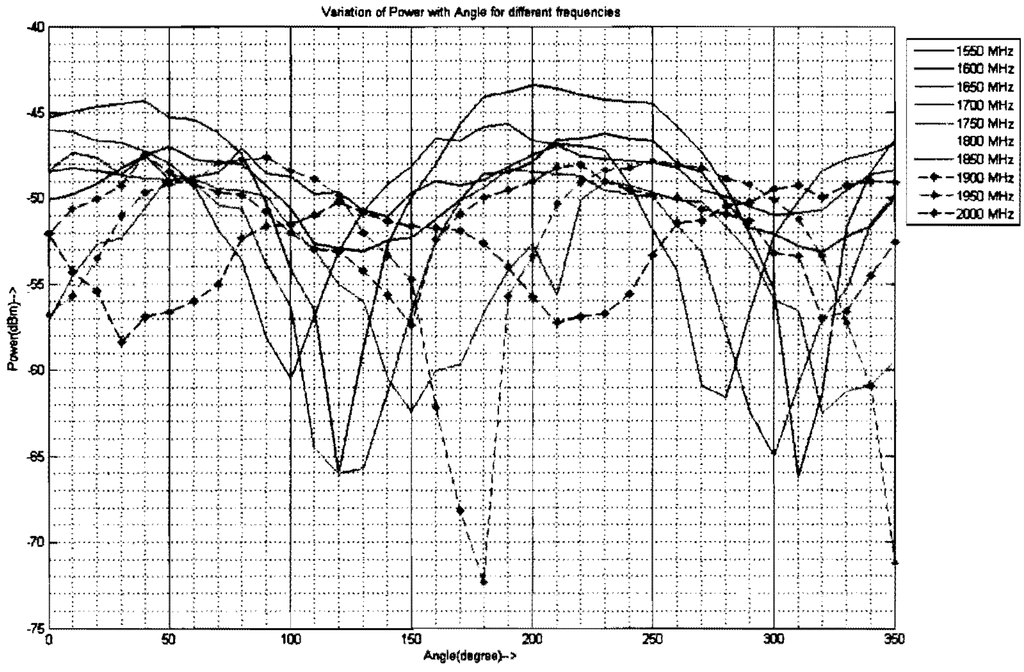


Fig. 5.4: Plot of power with angle for frequency range 1550-2000 MHz

****Power variation for different angles for the seçond antenna**

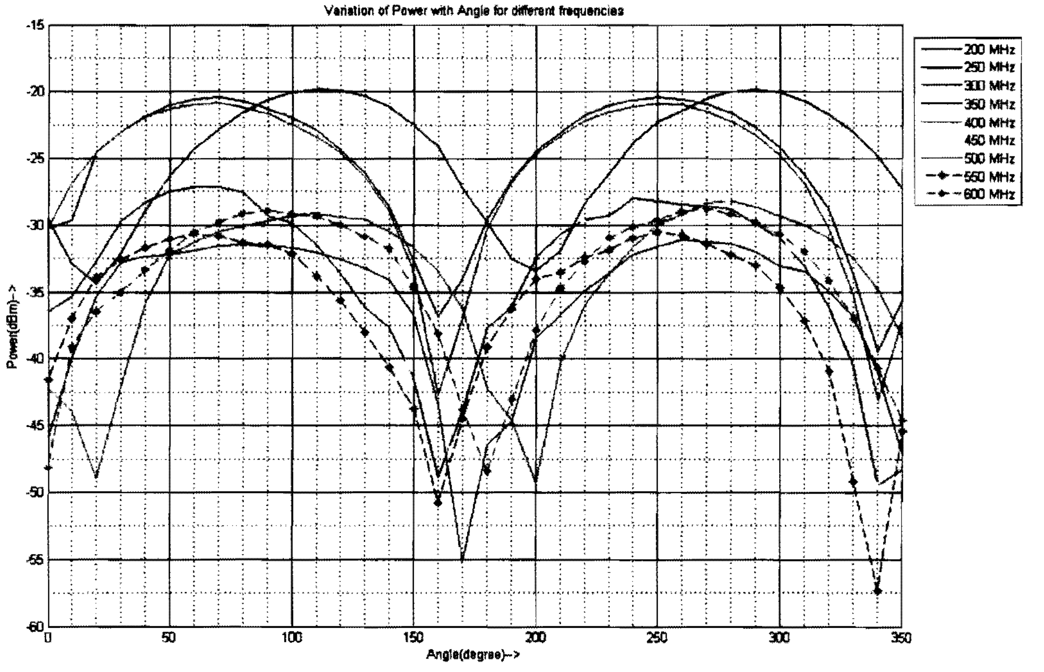


Fig. 5.5:Plot of power with angle for frequency range 200-600 MHz

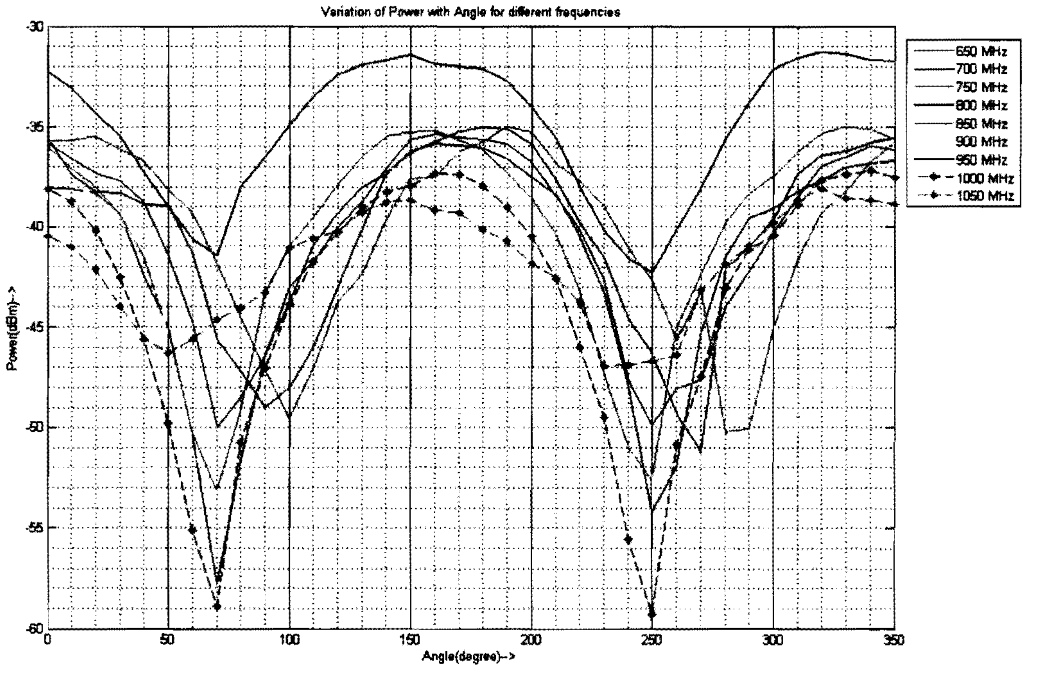


Fig. 5.6:Plot of power with angle for frequency range 650-1050 MHz

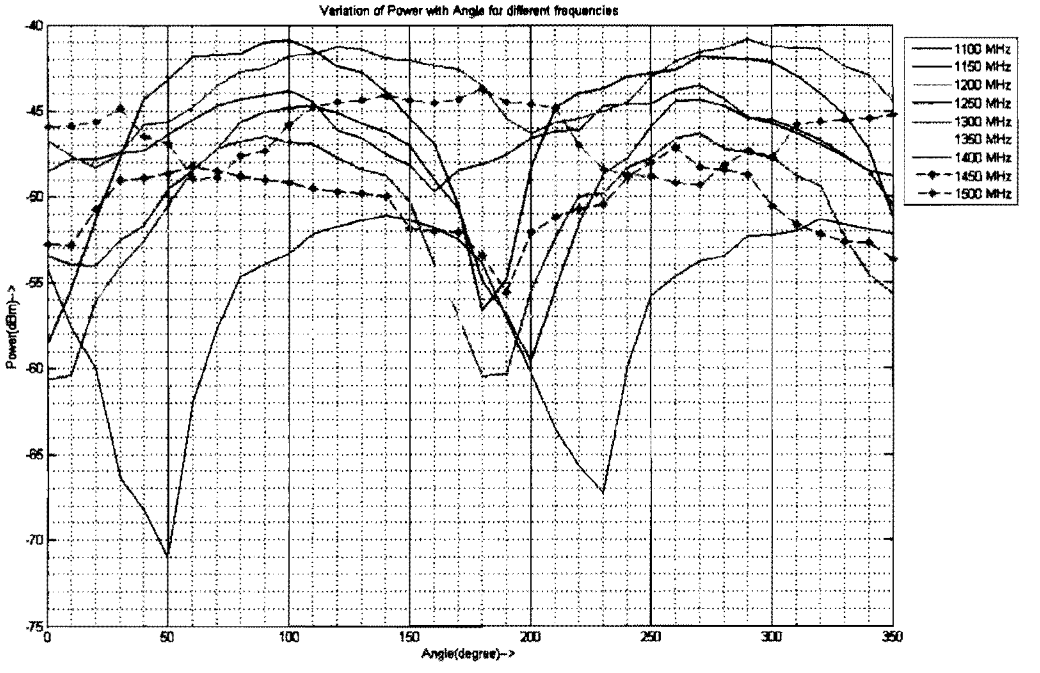


Fig.5.7: Plot of power with different angles for frequency range 1100-1500MHz

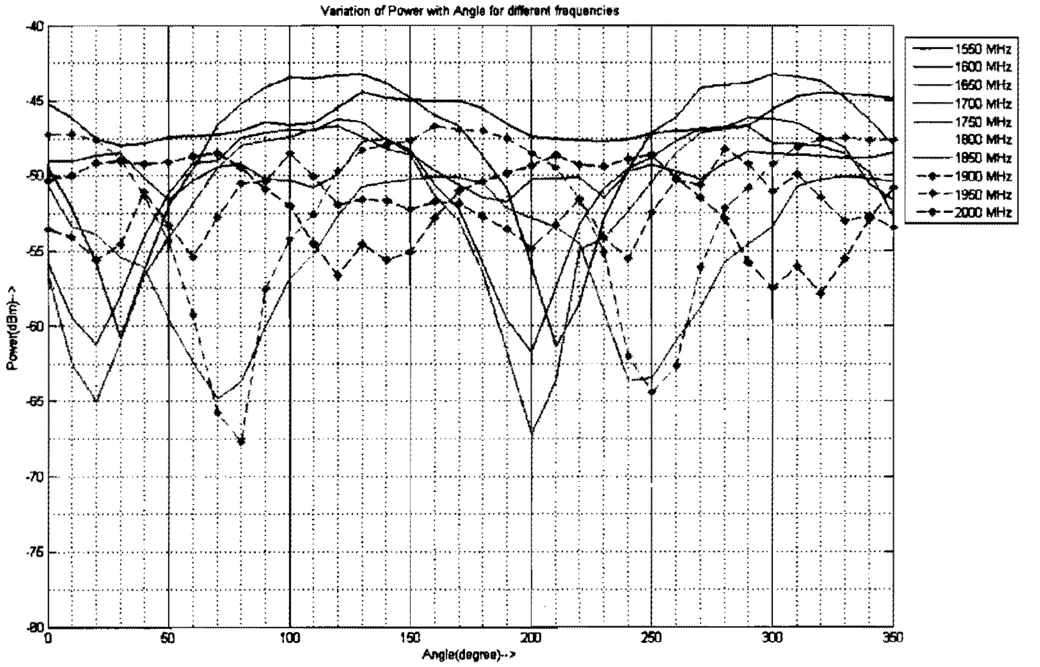


Fig.5.8: Plot of power with different angles for frequency range 1550-2000 MHz

Program to find the losses of cables with frequency

```
rawData7 = [...
200     -30     -32.57    -2.57;
250     -30     -32.90    -2.90;
300     -30     -33.26    -3.26;
350     -30     -33.64    -3.64;
400     -30     -33.84    -3.84;
450     -30     -34.12    -4.12;
500     -30     -34.36    -4.36;
550     -30     -34.66    -4.66;
600     -30     -34.94    -4.94;
650     -30     -35.17    -5.17;
700     -30     -35.46    -5.46;
750     -30     -35.76    -5.76;
800     -30     -36.12    -6.12;
850     -30     -36.17    -6.17;
900     -30     -36.40    -6.40;
950     -30     -36.54    -6.54;
1000    -30     -36.75    -6.75;
1050    -30     -37.00    -7.00;
1100    -30     -37.32    -7.32;
1150    -30     -37.50    -7.50;
1200    -30     -37.66    -7.66;
1250    -30     -37.86    -7.86;
1300    -30     -38.16    -8.16;
1350    -30     -38.31    -8.31;
1400    -30     -38.44    -8.44;
1450    -30     -38.63    -8.63;
1500    -30     -38.84    -8.84;
1550    -30     -39.17    -9.17;
1600    -30     -39.92    -9.92;
1650    -30     -39.50    -9.50;
1700    -30     -39.62    -9.62;
1750    -30     -39.79    -9.79;
1800    -30     -39.90    -9.90;
1850    -30     -40.04    -10.04;
1900    -30     -40.20    -10.20;
1950    -30     -40.44    -10.44;
2000    -30     -40.62    -10.62 ];

Freq=rawData7(:,1);
Loss1=rawData7(:,4);

rawData8 = [ ...
200     -30     -30.86    -0.86;
250     -30     -30.95    -0.95;
300     -30     -31.00    -1.00;
350     -30     -31.22    -1.22;
400     -30     -31.20    -1.20;
450     -30     -31.21    -1.21;
500     -30     -31.40    -1.40;
550     -30     -31.45    -1.45;
600     -30     -31.55    -1.55;
650     -30     -31.58    -1.58;
```

```
700     -30     -31.63     -1.63;
750     -30     -31.84     -1.84;
800     -30     -31.85     -1.85;
850     -30     -31.88     -1.88;
900     -30     -31.92     -1.92;
950     -30     -31.92     -1.92;
1000    -30     -32.05     -2.05;
1050    -30     -32.17     -2.17;
1100    -30     -32.30     -2.30;
1150    -30     -32.33     -2.33;
1200    -30     -32.41     -2.41;
1250    -30     -32.42     -2.42;
1300    -30     -32.42     -2.42;
1350    -30     -32.44     -2.44;
1400    -30     -32.51     -2.51;
1450    -30     -32.58     -2.58;
1500    -30     -32.62     -2.62;
1550    -30     -32.63     -2.63;
1600    -30     -32.64     -2.64;
1650    -30     -32.74     -2.74;
1700    -30     -32.83     -2.83;
1750    -30     -32.85     -2.85;
1800    -30     -32.85     -2.85;
1850    -30     -32.87     -2.87;
1900    -30     -32.93     -2.93;
1950    -30     -32.97     -2.97;
2000    -30     -33.07     -3.07  ];

Loss2=rawData8(:,4);

Loss=Loss1+Loss2;

figure(11);
plot(Freq,Loss,'b');
grid on;
grid minor;
xlabel('Frequency(MHz)-->');
ylabel('Loss(dB)-->');
title('Variation of losses of the cables with frequency');
```

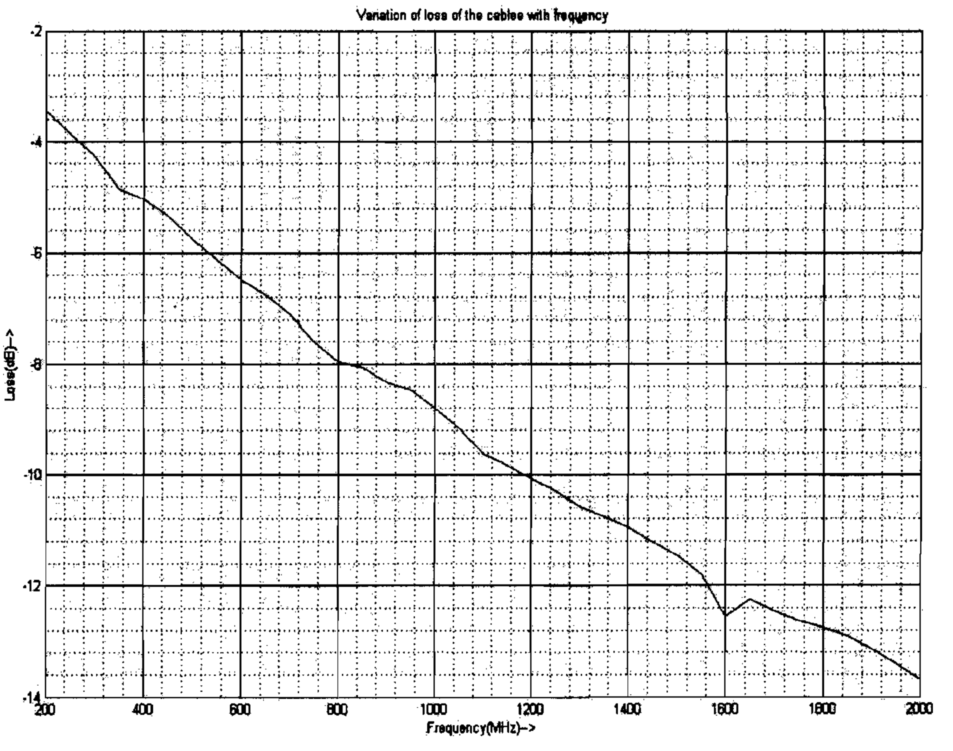


Fig. 5.9:Variation of cable loss with frequency