Design of Log Periodic Dipole Array Antenna Using Two Sides with Comparision of Two Dielectric Material Result

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ABSTRACT : **In this paper, design log periodic dipole array antenna using two side with two dielectric material is proposed. The proposed antenna has the capability of operating between 3 GHz to 13 GHz .This antenna is design using two dielectric material such as duroid and FR4_epoxy and compare result of two dielectric material antenna and select best antenna result. The antenna is printed on dielectric substrate of dimensions 400 mm X 100 mm X 1.5 mm. The log periodic dipole array shape is made in two side on dielectric material. This log periodic dipole array antenna is design using scale factor τ = 0.850 and spacing factor S_k = 0.150 and apex angle α =14^0 .This antenna is simulated using n dielectric material ANSOFT HFSS13.0 software and compare the simulation result. The measure antenna parameter such as return loss , gain and far field radiation pattern of this antenna for two dielectric material and given the antenna application for best result.**

KEYWORDS: **Log periodic dipole array antenna, duroid dielectric material , FR4_epoxy dielectric material, HFSS, Broadband application**

I. INTRODUCTION

Design of the modern microwave communication systems and off board equipment for air craft and ship EW/ECM needs for proper technical solutions of small-size broadband antennas. Microwave front often contain in small cylindrical volumes, so the main goals in antenna design are low profile , small weight and high reliability of parameter in desired frequency band. This paper represents the results of log periodic dipole array antenna for frequency band 3-13GHz[1].

LOG-periodic dipole array (LPDA) antennas used in broadband applications can achieve high directivity and low cross-polarization ratio over a very large frequency range. Such *wideband* antennas have typically been constructed using radiating element. In application space and weight is restricted, antennas need to be light-weight and to have small physical size and increase frequency.

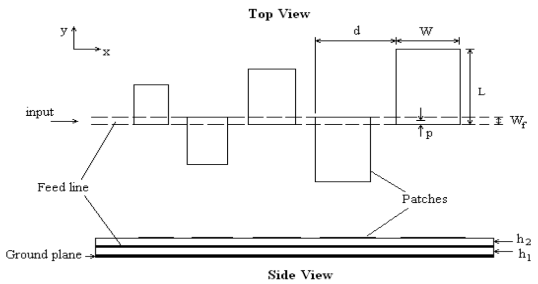

Fig.1Microstrip log periodic dipole Antenna

Microstrip antennas that operate as a single element usually have a relatively large half power beamwidth, low gain and low radiation efficiency[2]. In order to improve on these parameters, microstrip antennas are used in array configurations to improve the gain and range of the radiating structure. There are many effects such as mutual coupling between elements which must be taken into consideration when analyzing array structure. As a result full wave analyses are usually used to model arrays. The log periodic antenna structure consists is similar to a proximity coupled antenna, however the elements are designed such that they are a log size and spacing apart. These structures have relatively broad bandwidth. The above figure is show the top view of the log periodic dipole array a antenna. This LPDA antenna design using one side with two dielectric material result is compared.

II. ANTENNA DESIGN

Design of log periodic dipole array antenna is capability of operating frequency range 3 – 13 GHz.

STEP 1: The Scale Factor τ = 0.850 and Spacing Factor S_k = 0.150

STEP 2: The apex angle can be obtained as,

$$\tan(\alpha) = (1-\tau) / 4 S_k$$

$$\alpha = 14^0$$

STEP 3: The number of element in array is given by,

$\mathrm{Log}(f_U) - \mathrm{Log}(f_L) = (n-1)\,\mathrm{Log}(1/\tau)$

$f_U = 13$ GHz , $f_L = 3$ GHz , $\tau = 0.850$

Number of elements n = 10

STEP 4: Calculation of lengths of dipole ,

The length of last dipole ,

$L_{10} = c/(2 * f_L) = 33.3$ mm

Where , $c = 3\text{x}10^8$

$L_n / L_{n+1} = \tau = 0.850$[4]

$L_9 = \tau \text{ x } (L_{10}) = 28.305$ mm

$L_8 = \tau \text{ x } (L_9) = 24.05$ mm

$L_7 = \tau \text{ x } (L_8) = 20.44$ mm

$L_6 = \tau \text{ x } (L_7) = 17.374$ mm

$L_5 = \tau \text{ x } (L_6) = 14.76$ mm

$L_4 = \tau \text{ x } (L_5) = 12.55$ mm

$L_3 = \tau \text{ x } (L_4) = 10.66$ mm

$L_2 = \tau \text{ x } (L_3) = 9.061$ mm

$L_1 = \tau \text{ x } (L_2) = 7.70$ mm

STEP 5: The distance between dipole is given by ,

$S_n = L_n / 2 \tan(\alpha)$

$S_1 = L_1 / 2 \tan(\alpha) = 15.44$mm

$S_2 = L_2 / 2 \tan(\alpha) = 18.16$mm

$S_3 = L_3 / 2 \tan(\alpha) = 21.377$mm

$S_4 = L_4 / 2 \tan(\alpha) = 25.16$mm

$S_5 = L_5 / 2 \tan(\alpha) = 29.59$mm

$S_6 = L_6 / 2 \tan(\alpha) = 34.84$mm

$S_7 = L_7 / 2 \tan(\alpha) = 40.99$mm

$S_8 = L_8 / 2 \tan(\alpha) = 48.22$mm

$S_9 = L_9 / 2 \tan(\alpha) = 58.76$mm

$S_{10} = L_{10} / 2 \tan(\alpha) = 66.77$mm

- Width of all strips is 2.91mm
- Height of dielectric material is 1.59mm
- Height of patch material is 0.035mm

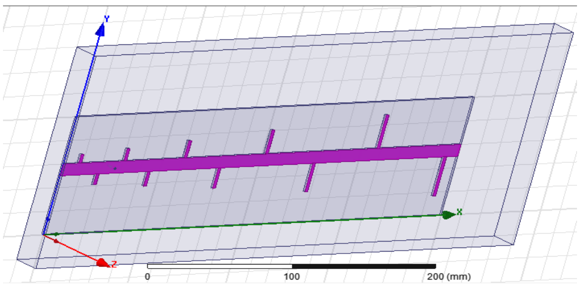

FIG.2.1 3-D Model of log-periodic dipole array antenna using duroid dielectric material (one side)

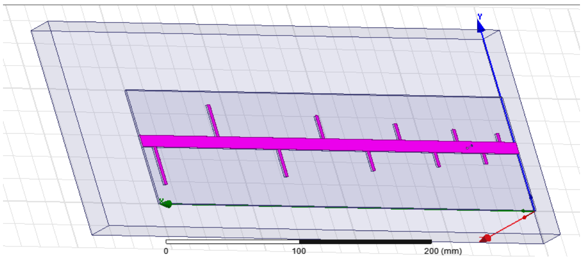

FIG.2.2 3-D Model of log-periodic dipole array antenna using duroid dielectric material.(second side)

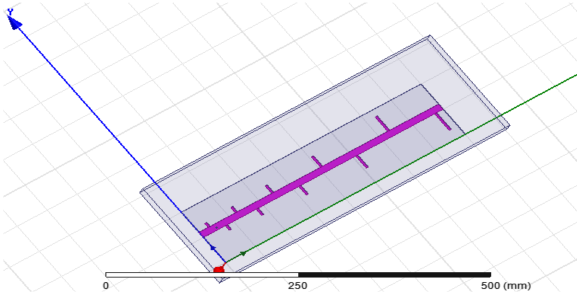

FIG.2.3 3-D Model of log-periodic dipole array antenna using FR4_epoxy dielectric material.(one side)

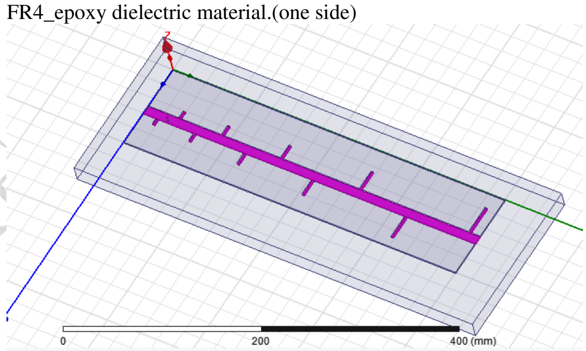

FIG.2.4 3-D Model of log-periodic dipole array antenna using FR4_epoxy dielectric material.(second side)

TABLE .1
Length , space and width of antenna element

ELEMENTS	LENGTH L(mm)	SPACE R(mm)	WIDTH W(mm)
1	7.70	15.44	2.91
2	9.06	18.66	2.91
3	10.66	21.37	2.91
4	12.55	25.16	2.91
5	14.76	29.59	2.91
6	17.374	34.84	2.91
7	20.44	40.99	2.91
8	24.05	48.22	2.91
9	28.305	58.76	2.91
10	33.3	66.77	2.91

- CO-AXIAL FEED

The Coaxial feed or probe feed is a very common technique used for feeding Microstrip patch antennas but this feed is applied to the log periodic dipole array antenna . As seen from Figure 3.1, the inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane[1].

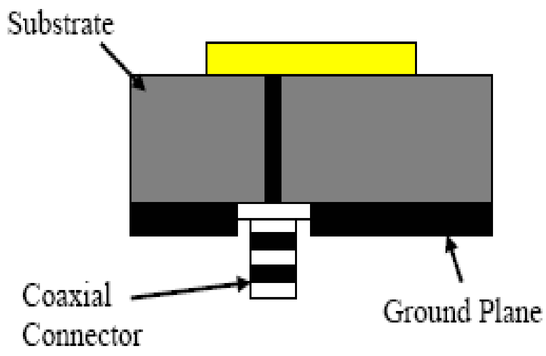

FIG. 2.3 Co-axial feed

III. 3-D MODEL ANTENNA USING DUROID MATERIAL AND SIMULATION RESULT

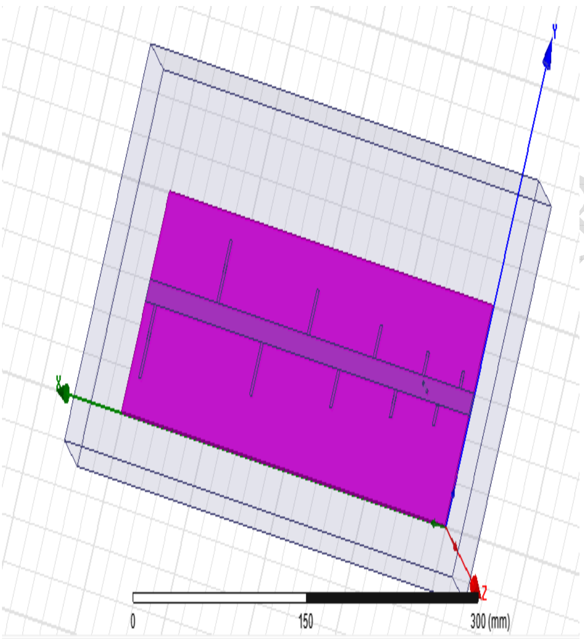

FIG.3.1 3-D Model of log-periodic dipole array antenna using two sides with duroid dielectric material

In our paper we taken the dielectric Substrate material is Duriod (tm) with relative permittivity = 2.2, relative permeability = 1, Dielectric Loss Tangent = 0.009 and magnetic loss tangent = 0.

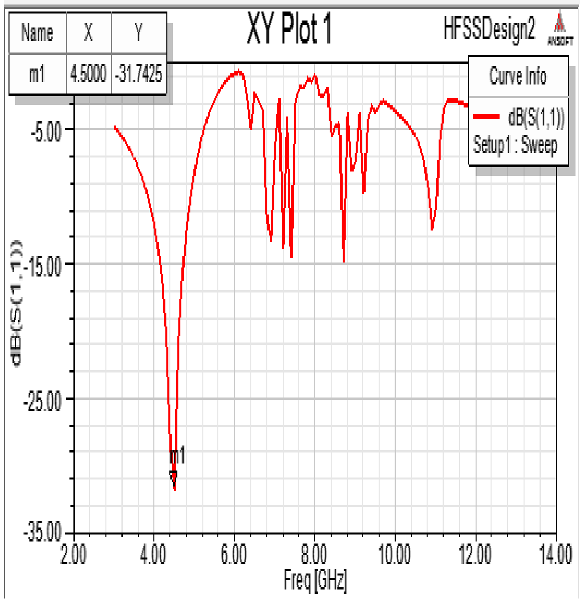

FIG.3.2 Return loss of the log periodic dipole array antenna using two sides with duroid material

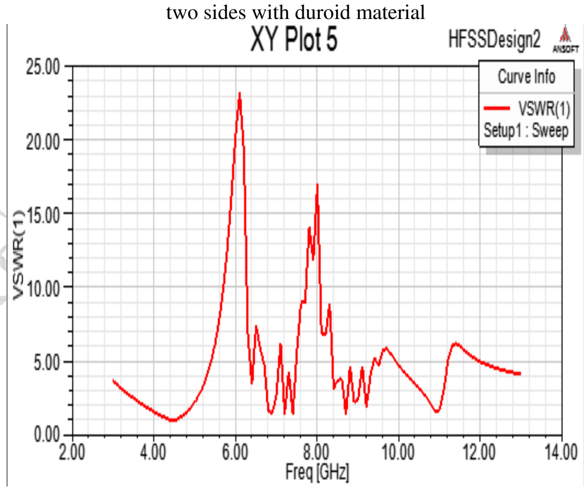

FIG.3.3 VSWR of the log periodic dipole array antenna using two sides with duroid material

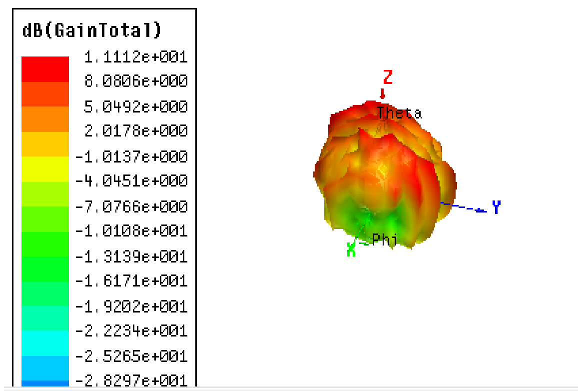

FIG.3.4 GainTotal of the log periodic dipole array antenna using two sides with duroid material

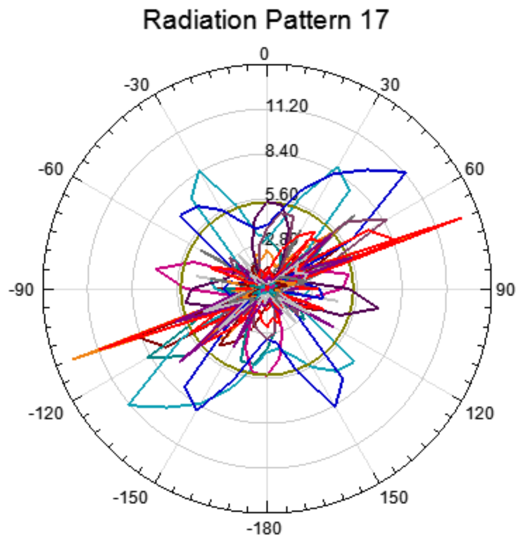

FIG.3.5 Far field radiation pattern of the log periodic dipole array antenna using two sides with duroid material

IV. 3-D MODEL ANTENNA USING FR4_epoxy MATERIAL AND SIMULATION RESULT

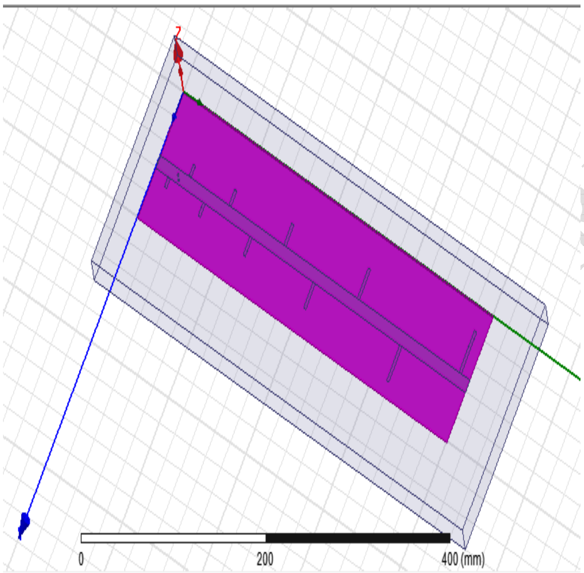

FIG.4.1 3-D Model of log-periodic dipole array antenna using two sides with FR4_epoxy dielectric material

In our paper we taken the dielectric Substrate material is FR4_epoxy with relative permittivity = 2.2, relative permeability = 1, Dielectric Loss Tangent = 0.02 and magnetic loss tangent = 0.

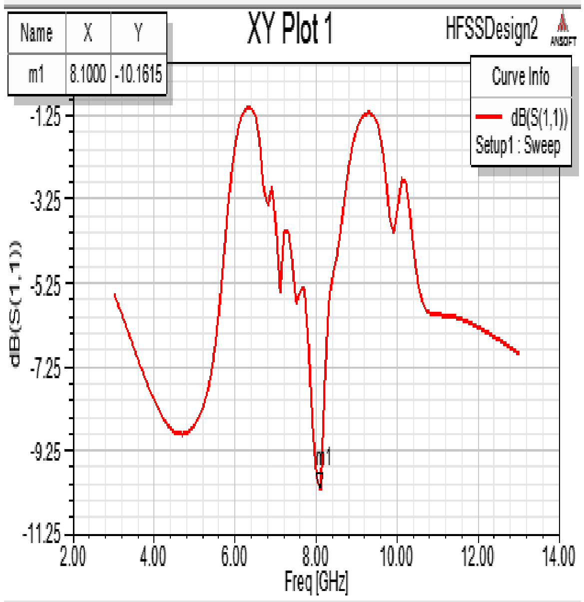

FIG.4.2 Return loss of the log periodic dipole array antenna using two sides with FR4_epoxy dielectric material

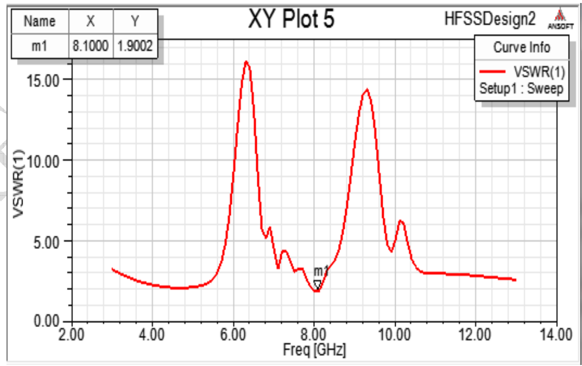

FIG.4.3 VSWR of the log periodic dipole array antenna using two sides with FR4_epoxy dielectric material

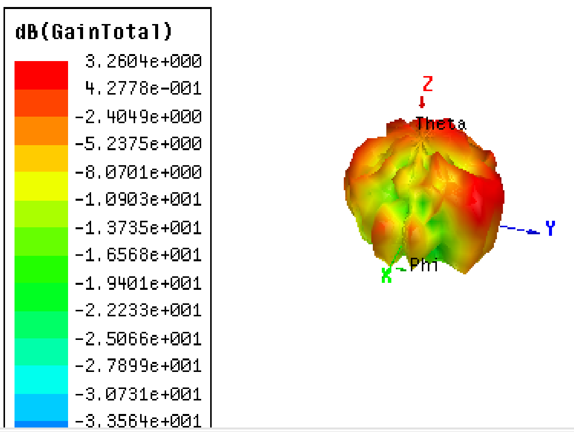

FIG.4.4 GainTotal of the log periodic dipole array antenna using two sides with FR4_epoxy dielectric material

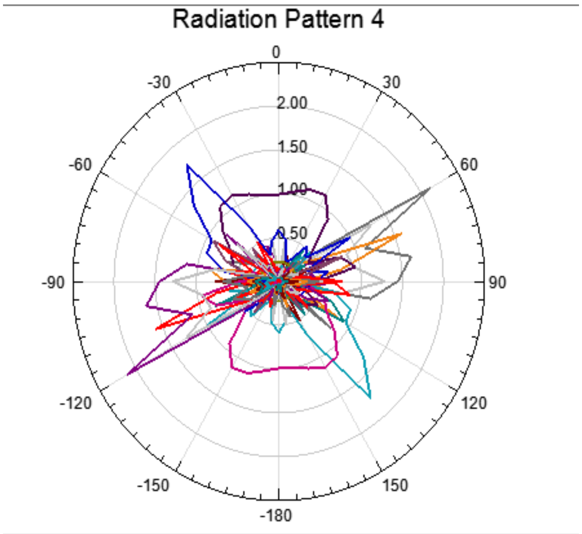

FIG.3.5 Far field radiation pattern of the log periodic dipole array antenna using two sides with FR4_epoxy dielectric material

COMPARE SIMULATION RESULT OF ANTENNA

Log periodic dipole array antenna	Duroid Material	FR4_epoxy Material
Resonant Frequency(GHz)	4.5	8.1
Return Loss (dB)	-31.74	-10.16
High Gain(dB)	8.0	3.26
Radiation Pattern	Directional Radiation Pattern	Directional Radiation Pattern

V. CONCLUSION

The design of log periodic dipole array antenna using two sides with compare two dielectric material result is simulated using ANSOFT HFSS13.0. The compare simulation result of duroid and FR4_epoxy dielectric material and the selected best result is duroid material. This antenna had got return loss S_{11}= -31.74 dB at resonant frequency f_0 = 4.5GHz and higher gain of this antenna is 8.0 dB with directional radiation pattern. The use of this antenna for broadband application.

VI. REFERENCES

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