MICROSTRIP LOG PERIODIC ANTENNA ARRAY

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***Abstract** - In this paper, a microstrip log-periodic dipole array (MLPDA) antenna is presented. The operating frequency is 500 MHz to 3 GHz with VSWR<2, return loss >-10dB and impedance is 50 Ω. This is the design of eight element microstrip log periodic antenna. This antenna is combination of both log periodic and microstrip antenna. The disadvantages of log periodic antenna are eliminated by using microstrip antenna to achieve high gain, wide bandwidth and high directivity. It is suitable for wideband and military applications .This antenna is design using dielectric material FR4 _epoxy having dielectric constant 4.4 and thickness of 1.6mm. This microstrip log periodic antenna is design using scale factor =0.802 and spacing factor =0.133.The Microstrip log periodic antenna is simulated using ANSOFT HFSS software having average gain of 7 dB. The array of eight Microstrip log periodic antenna are tested using vector network analyzer (VNA) ANTRITSU MS2024B.The measure antenna parameter such as return loss, gain, VSWR and impedance.*

Keywords-Microstrip antenna, Log periodic antenna, Microstrip log periodic antenna (MLPA), Gain, VSWR.

1. Introduction

Wireless communication is one of the rapidly growing fields of technology. For the successful implementation of any wireless communication network, the design of the antenna plays the most crucial role. Log periodic antenna is important with their ability to show nearly frequency independent characteristics over wide band of frequencies. Log periodic antenna is having a high gain. The major drawback of this antenna is as frequency increases the number of elements are also increases and it becomes large. The Microstrip Antenna (MSA) can work on an ultra-wide band. A MSA has many attractive features like low profile, lightweight, small volume and low production cost. Microstrip antennas are compact and planar and can be easily integrated to RF circuits. The inherent narrow bandwidth and moderate gain are the major drawback for this antenna. The advantage of the Microstrip antenna is as frequency increases the size reduces, by combining the both the antenna the new antenna is formed called as Microstrip log periodic antenna (MLPA).The drawback of the both antennas can be eliminated by combining them.

2. Background

Log periodic dipole array (LPDA) antenna achieves high directivity in a very wide frequency range. Therefore, it is indispensable, and it has never lost its importance since its first introduction. It is widely used in many applications both in industry and military. In today's space and weight limited applications, antennas need to be wideband, compact, lightweight, relatively small and planar for easy fabrication and integration [1].

The log-periodic antenna (LPA) is one of the frequency independent antennas with linearly polarized radiation characteristic. Compared to the traditional handmade metal
Log-periodic dipole antenna (LPA) printed on a PCB has many advantages, including the low manufacturing cost, the high yield rate, and the lightweight. The characteristic of this antenna changes with the logarithm of frequency, and expand the characteristic in one cycle to a wide channel [2].

Microstrip antenna has gain popularity of their small size and light weight, however: a limitation of Microstrip antenna is the narrow bandwidth of the basic element. The bandwidth of basic patch element is usually 1-3%. The bandwidth of antenna is defined as the range of frequencies over which the performance of the antenna with respect to some characteristics confirms to a specified standard. The bandwidth of the antenna depends on patch shape, resonant frequency, dielectric constant and the thickness of the substrate. The bandwidth of an antenna can be increased by reducing the substrate permittivity (εr) or increasing its thickness (h). However there are some problems associated with increasing the substrate thickness. [3].

There are many techniques to enhance the bandwidth of Microstrip antenna. Most of the work done for bandwidth enhancement has been directed towards improving the impedance bandwidth of the antenna element. The bandwidth can be increased using multilayer structure antenna, parasitic element, non-contact feeding technique, different shape slot or log periodic technique [4].

3. Designing of microstrip log periodic antenna

While designing microstrip log periodic antenna we have to consider some parameters like spacing factor and scaling factor. Both plays vital role in designing the antennas. Gain is depends on scale factor while distance between two strips depends on spacing factor.

Step1: Consider some parameters:

1) Frequency range: 500 MHz to 3GHz
2) Scale factor: 0.802
3) Spacing factor: 0.133

STEP 2: The apex angle can be obtained as,

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

$\alpha = 15$

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

$\log(F_u) - \log(F_l) = (n-1)\log(1/\tau)$

Where, Fu = 500 MHz, Fl= 3 GHz, $\tau = 0.802$

$\log(3*10^9) - \log(500*10^6) = (n-1)\log(1/0.802)$

So, n=8

Number of elements n = 8

STEP 4: Calculation of lengths of dipole,

The length of last dipole,

$L_n = c/(2 * F_l) = 50$ mm

Where, $c = 3x10^8$

$L_n / L_{n+1} = \tau = 0.802$

1. Ln =50mm
2. $L_{n+1} = \tau \times (L_n) = 40.1$ mm
3. $L_{n+2} = \tau \times (L_{n+1}) = 32.16$ mm
4. $L_{n+3} = \tau \times (L_{n+2}) = 25.79$ mm
5. $L_{n+4} = \tau \times (L_{n+3}) = 20.68$ mm
6. $L_{n+5} = \tau \times (L_{n+4}) = 16.58$ mm
7. $L_{n+6} = \tau \times (L_{n+5}) = 13.30$ mm
8. $L_{n+7} = \tau \times (L_{n+6}) = 10.67$ mm

STEP 5: Calculation of distance of dipole,

$D_n / D_{n+1} = \tau = 0.802$

1. Dn =17 mm
2. $D_{n+1} = \tau \times (D_n) = 13.63$ mm
3. $D_{n+2} = \tau \times (D_{n+1}) = 10.93$ mm
4. $D_{n+3} = \tau \times (D_{n+2}) = 8.76$ mm
5. $D_{n+4} = \tau \times (D_{n+3}) = 7.033$ mm
6. $D_{n+5} = \tau \times (D_{n+4}) = 5.64$ mm
7. $D_{n+6} = \tau \times (D_{n+5}) = 4.52$ mm
8. $D_{n+7} = \tau \times (D_{n+6}) = 3.62$ mm

Table 1. Length, Space and Width of Antenna Element

ELEMENTS	LENGTH(mm)	SPACE(mm)	WIDTH(mm)
1	50	17	3
2	40.1	13.63	3
3	32.16	10.93	3
4	25.79	8.76	3
5	20.68	7.033	3
6	16.58	5.64	3
7	13.30	4.52	3
8	10.67	3.62	3

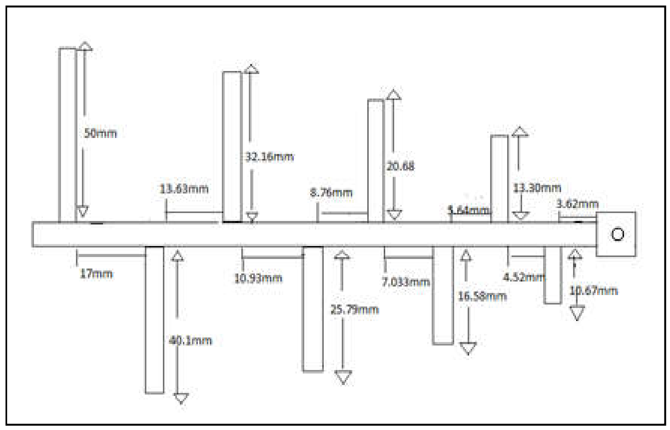

Figure 1. Design of Microstip Log Periodic Antenna (front view)

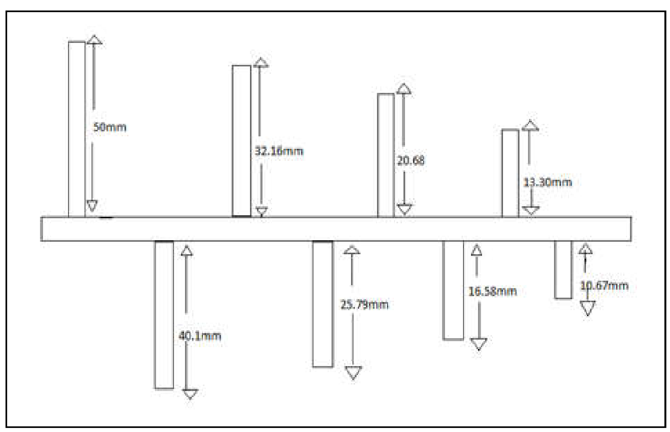

Figure 2. Design of Microstip Log Periodic Antenna (back view)

4. Simulation of Microstip log periodic antenna

The simulation of Microsrtip log periodic antenna is done by using ANSOFT HFSS software.

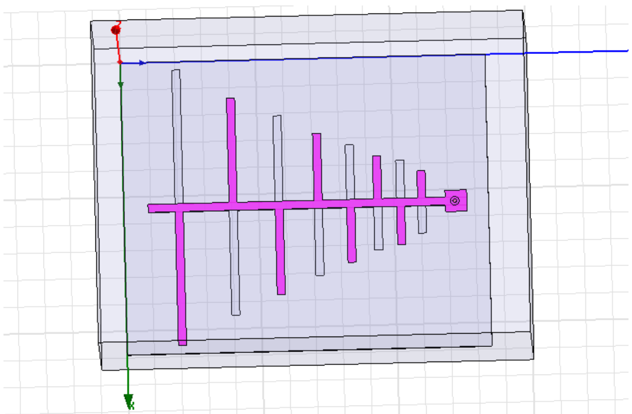

Figure 3. 3-D model of log periodic antenna using FR_4 epoxy dielectric material (front view)

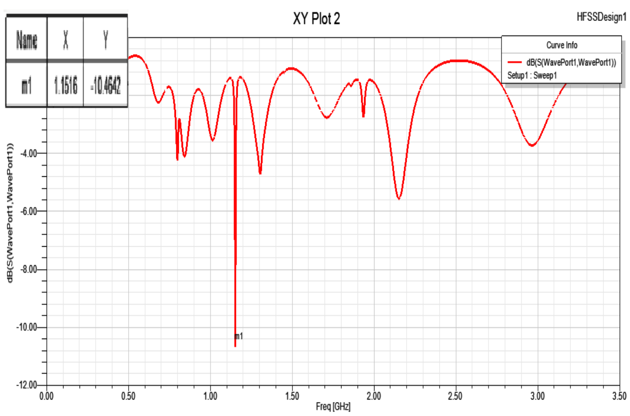

Figure 5. Return Loss

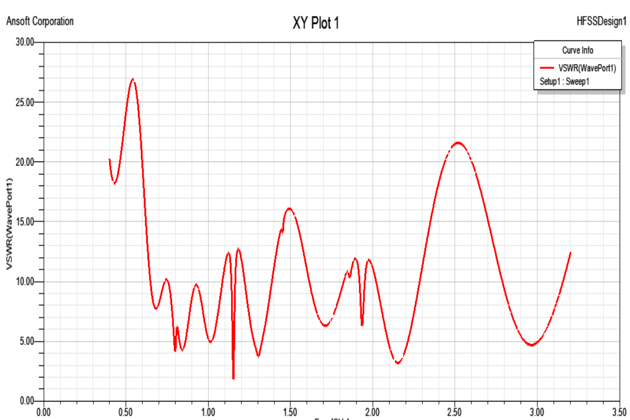

Figure 6. VSWR

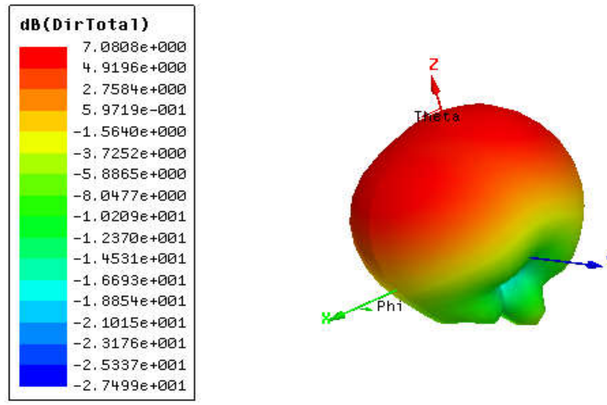

Figure 7. Gain

5. MLPA Array

The array of Microstrip log periodic array by using eight elements as shown in figure 8.

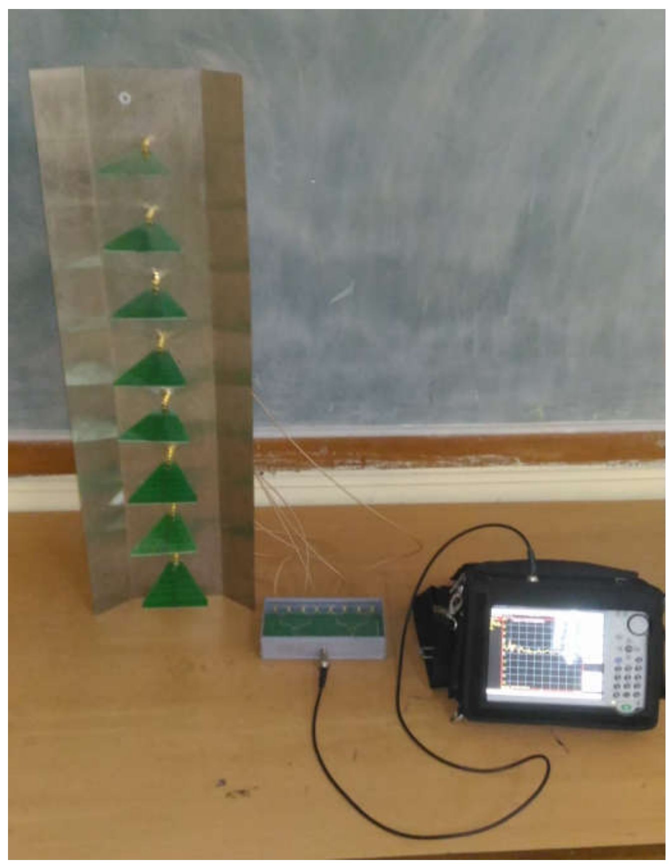

Figure 8. Experimental Setup for MLPA Array

6. Testing of MLPA Array using VNA Result

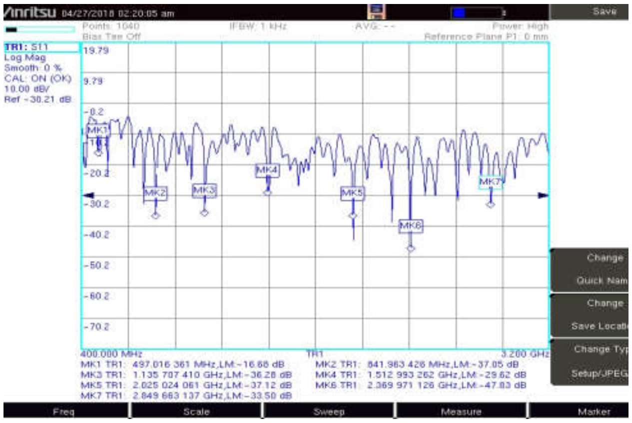

Figure 9. Return Loss

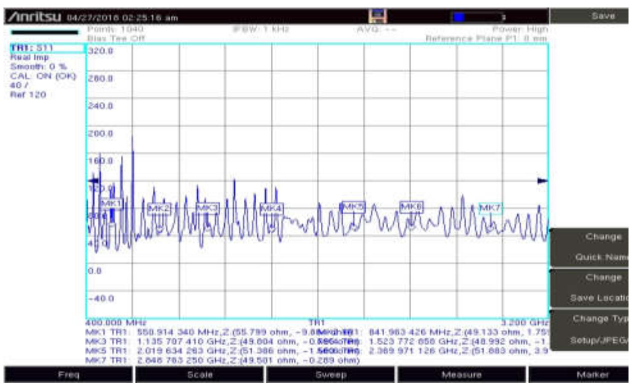

Figure 10. Impedance

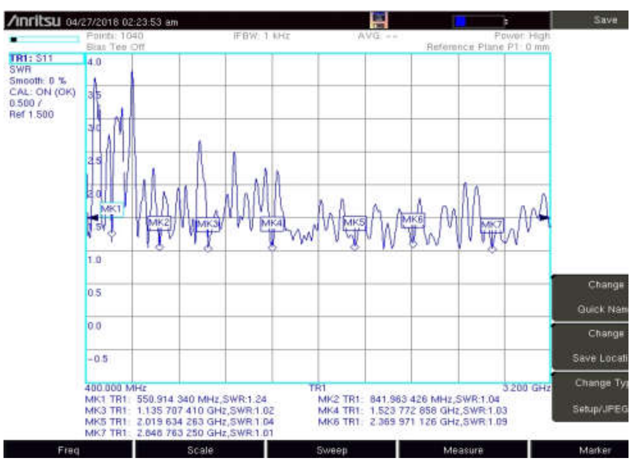

Figure 11. VSWR

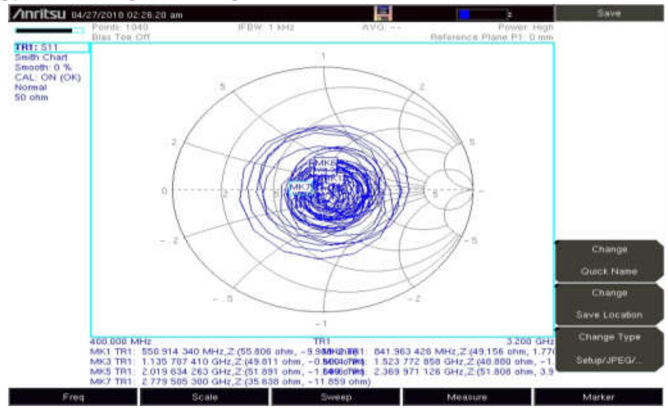

Figure 12. Smith Chart

6. Conclusion

The performance of Microstrip log periodic antenna has been simulated on HFSS software and we got the gain 7dB. The array of eight Microstrip log periodic antenna is tested using vector network analyzer. (VNA) ANTRITSU MS2024B.By using VNA we tested some parameters like return loss, VSWR, impedance and smith chart. VSWR of antenna should be in less than 2, so as we can see that VSWR parameter is less than 2 .The return loss should be less than -10dB and the antenna gives return loss less than -10 and also impedance is nearly equal to 50Ω from the initial frequency we designed (500MHz) to the final frequency (3GHz). So it is clear that result of our microstrip log periodic antenna is obtained with expected result.

8. References

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