World Journal of Environmental Biosciences

Available Online at: **www.environmentaljournals.org**

Volume 6, Supplementary: 21-23

ISSN 2277- 8047

Design, Simulation and Fabrication of Exemplary Log-Periodic Antenna Which Receives Two Orthogonal Polarizations Simultaneously in 1-4ghz Frequency Band

Mehran Atamanesh[1], Mohsen Abdollahi[2*]

[1]*Professor of Electronic&Tele Communi Cations, Faculty Higher Educathon Institute of Ghythadin Jamshid Kashani Abyek. Iran.*
[2]*Phd of Electronic& Tele Communi Cations, Faculty ofHigher Educathon Institute of Ghythadin Jamshid Kashani Abyek. Iran.*

ABSTRACT

In this study, computer simulation, fabrication and finally measuring the properties of a Log-Periodic Antenna in 1-4GHz frequency band have been done. For choosing final design, first we reviewed studies focused on Log-Periodic Antennas with ability to receive two orthogonal polarizations; then, we studied the function of antenna and design connections. Antenna designed considering our researches and its performance simulated in CST-Microwave environment. In the following, antenna was fabricated and its different parameters such as pattern and VSWR were measured. Measurement and simulation results showed good agreement and had admissible values for input VSWR and radiation pattern of antenna.

Key words: *frequency independent antenna, log-periodic dipole antenna, orthogonal polarizations, antenna pattern, voltage standing wave ratio*.

Corresponding author: Mohsen Abdollahi

INTRODUCTION

Telecommunication systems gained more attention in recent decades and we could definitely declare that have developed more than other scientific fields. Beside, as we mentioned previously, using wideband technology in telecommunication systems is essential because of sending information with high rate or sending small-width pulses quickly in military industries. Reaching these goals needs designing ultra wideband devices obviously. Antenna is one of these devices that plays essential role in sending and receiving signal accurately and if it be designed improperly, it could have harmful effect. Antennas are crucial part of a telecommunication system. We need wideband antenna with high Directivity in radar systems, Short range system with Line of Sight (LoS) and for high rate sending data. Log-Periodic Antenna is one of conventional wideband antennas with acceptable gain. In the other hand, it's better for system to have ability of receiving orthogonal polarizations simultaneously in military and nonmilitary applications. Design, simulation, fabrication and finally measuring and comparing a Log-Periodic Antenna in 1-4 GHz frequency band is objective of our study. This antenna should cover at least 2 octaves of bandwidth and its pattern should be relatively frequency independent in this range; also it should result in values less than 2.6 for input VSWR. Antenna fabrication is challenging because the part which sends and receives signal in higher frequencies, must be small. In this study, design and feasibility of a simpler model (with ability to send & receive in lower bandwidth) will be investigated. Design and fabricating a 1-18 GHz antenna is our final objective. This model could be an effective pace toward design and fabrication of a wideband antenna .

Log-Periodic Array Antenna

Log-Periodic Array Antenna is one of frequency independent antennas which its special structure causes impedance and radiation's characteristics repeat periodically proportional to logarithm of frequency. Its characteristic's change is low in working frequency band and hence, Log-Periodic Antennas generally considered as a frequency independent antennas (Warrant and et al , 2001). Parameter's analysis and evaluation in both time and frequency domain (pertinent to antenna type and performance) is essential in antenna design. For instance, impedance frequency bandwidth (and in practical words, frequency bandwidth calculation) is first parameter that should be studied in wideband antenna design, in which VSWR should be less than 2. Antenna characteristics such as 3dB-radiation pattern, Side Lobe Level and other parameters should be investigated. Log-Periodic Antennas have variety of applications. Planar antennas used from lower frequencies (about 1 GHz) (Mirzapour and etal ,2014) to upper frequencies (like millimeter waves) (Zhou and et al, 2012). Modern Telemetry Systems receiving signals sent from space crafts, could work simultaneously in multiple Sub-bands including wavelengths in order of meter and decimeter. In this reference, supply of 12m reflector antenna was Log-Periodic Array Antenna which worked in 120-225 MHz and 625-650 MHz frequency bands (N. Plastikov, V. A. Vasiliev and S. E. Chadov, 2013). Log-Periodic Antenna could yield high bandwidth (more than a decade!) with intermediate gain (larger than 6dB) which is appropriate in antenna measurements and EMC fields. Since phase center changes sharply with frequency in these antennas, they rarely used as supply for reflector antennas (Dybdal, 1985). Generally, Log-Periodic Array Antenna must be designed in a way that three regions (Transmission-Line Region, active region and stop region) were created on it in every frequency so that antenna had correct performance in a given frequency range (Yang and et al, 2012). Transmission-Line Region in a frequency is called to a section of antenna in that frequency in which elements not radiating. This is because the size of the elements is smaller than the wavelength at that frequency. Active region is a region in which elements are radiating. Stop region is a region that despite the largeness of elements' length to wavelength ratio, no radiation occurs. This is because the current approaches zero in it. The current is zero since the current passed through previous element (smaller element) and the current generated by Mutual coupling of active region's elements (and inducted through free space) have almost equal amplitude but have 180° phase difference. Hence, resultant current approaches zero. As to have these three regions in every frequency of bandwidth, largest dipole' length should be larger than half-wavelength of lowest frequency and similarly, smallest dipole' length should be smaller than half-wavelength of upmost frequency.

Design and simulation of antenna

In this section, we design and simulate the antenna. We want that antenna gain exceeds 8dB, so we start the design for 8.5dB gain and obtain 0.91 for scale factor. This antenna should cover 1-4 GHz frequency band. Antenna pattern is almost frequency independent and its polarization could be set horizontally or vertically. Simulations performed with CST software. Results showed that antenna gain would be about 8dBi and VSWR would be less than 2.6. The final design is derivation from reference (Plastikov and et al ,2013) except that we used strip dipoles (planar dipoles) instead of tubular dipoles as following: Dipoles structure catted on aluminum plate; This plate then bent 90° from the middle .

The software solves Maxwell's equations in drawn structure using FDTD method which is a time domain solution (www.cst.com). Central conductor of a coaxial cable is connected to a dipole plane in tip of it and outer conductor of cable is connected to plane faced to it, so as to supply antenna. Table 1 shows radiation characteristics for different frequencies .

Table 1. Radiation characteristics for 1-4GHz frequency

Freq (MHz)	Gain (dBi)	Back lobe (dBi)	Beam width theta=90 deg	Beam width Phi=90 deg
1	8.3	14	67.2	92.7
2	8.6	14	58.6	92.6
4	7.9	10	49.5	87.2

Fabrication and measurement

In this section, Fabrication and results of antenna measurement have been studied. Mechanical diagram of simulated antenna prepared in Solidworks software for fabrication (www.solidworks.com). Antenna and its base made from. Since coaxial supply line shall be soldered in antenna tip, so dipoles section should be bonderized. We choose absorbent from Eccosorb Company (www.eccosorb.com). In the following, antenna height and radius supposed to be 270mm and 105mm respectively. Considering simulation results, antenna gain should be more than 8dBi and VSWR must be less than 2.5 in almost all of the bandwidth. Figure 1 shows fabricated antenna. Antenna blades including dipoles, were incised by Wire cut and then were bent manually. Antenna base also were cut by CNC machine. For allocating these 4 blades in appropriate distances, we used two plastic fragment in the middle and tip (upper) of antenna

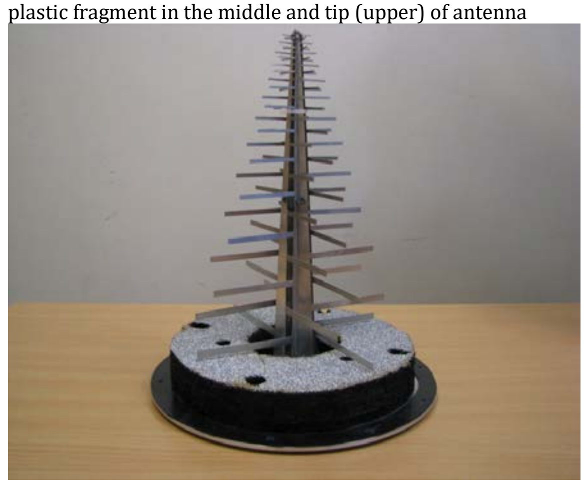

Fig 1. Schematic of fabricated antenna

Figures bellow show antenna pattern in different frequencies on the same graph for better comparison. As you can see, antenna acted as a frequency independent model in 1-4GHz frequency band and yielded excellent results in this frequency band .

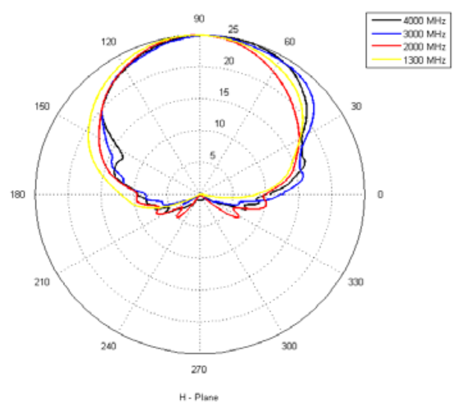

Fig 2. Measured pattern for different frequencies (H-plane)

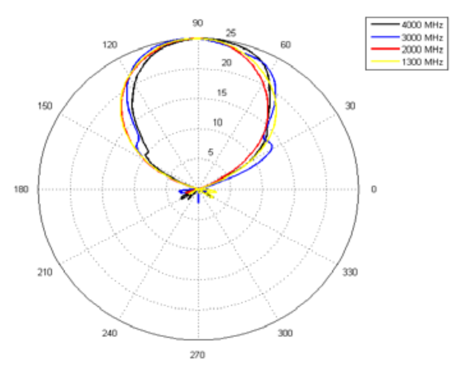

Fig 3. Measured pattern for different frequencies (E-plane)

Figure 4 also shows VSWR measured by Network Analyzer.

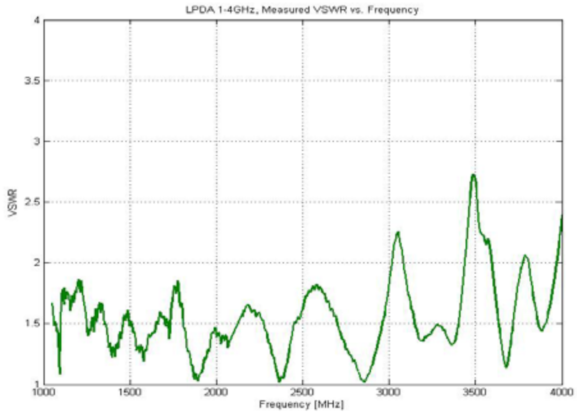

Fig 4. Measured VSWR value at input port

Antenna gain has been shown in figure 5 in terms of frequeny .

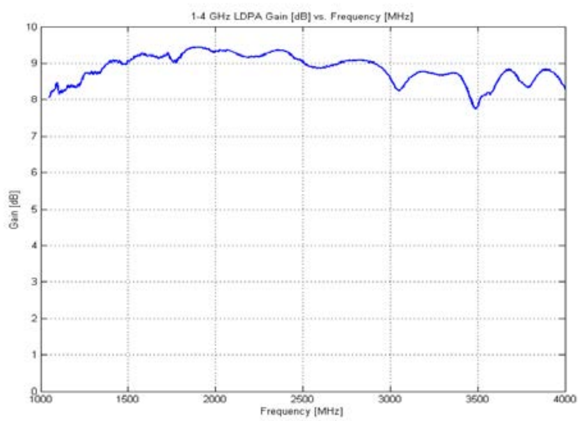

Fig 5. Antenna gain in terms of frequency

As Inferred from figures above, Antenna gain value and input VSWR has good correlation with simulation results (as we expect).

CONCLUSION

In this article, first we introduced and studied Log-Periodic Antennas as a frequency independent antenna; Its structure explained and respective relations investigated. Then we started to design antenna with considering requirements of this project; structure simulated by CST-Microwave software. Antenna must have appropriate input matching in 1-4GHz bandwidth. Antenna pattern and its gain also should be admissible in this frequency range. Antenna is capable of receiving two different polarizations. After design and simulation steps and gain confidence from the results, Mechanical diagram prepared in Solid works and then we were ready for fabrication. Eventually, antenna's VSWR value (or S11 analogously) tested by Network Analyzer and its pattern measured in frequency room for different frequencies. Measurement and simulation results showed good agreement. Since electronic systems are improving increasingly, especially in electronic war, so this improvement must be seen in electronic defense. Systems are increasing speed of process and using effective modulations endlessly so as to make detestation hard with increasing bandwidth and decreasing amplitude of signal. Thus, systems must be wide band in electronic defense too. Antenna is the first element in these systems. We could take first step toward this objective using wideband antennas which detect orthogonal polarizations; so we can use this structure in future and increase its bandwidth. 1-18 GHz bandwidth could be investigated further as a good and efficient choice

REFERENCES

1. Dybdal, R.; "Defocusing loss for a log periodic-fed reflector", in IEEE Transactions on Antennas and Propagation, Vol. 33, No. 7, pp. 809 - 812, July 1985
2. H. Zhou, Y. Wang, Y. C. Lee and D. S. Filipovic, "Dual-polarized K/Ka-band planar log-periodic antenna," 2012 6th European Conference on Antennas and Propagation (EUCAP), Prague, 2012, pp. 1-4.
3. http://www.eccosorb.com/products-overview.htm
4. http://www.solidworks.com/
5. https://www.cst.com/products/cstmws
6. J. Yang, M. Pantaleev, P. S. Kildal and L. Helldner, "Design of Compact Dual-Polarized 1.2–10 GHz Eleven Feed for Decade Bandwidth Radio Telescopes," in IEEE Transactions on Antennas and Propagation, vol. 60, no. 5, pp. 2210-2218, May 2012.
7. M. I. Mirzapour, S. M. J. Razavi and S. H. M. Armaki, "Ultra-wideband planar LPDA antenna with mode converter balun," in Electronics Letters, vol. 50, no. 12, pp. 848-850, June 5 2014.
8. N. Plastikov, V. A. Vasiliev and S. E. Chadov, "Dual-band dual-polarized log-periodic feed for reflector antenna," Antenna Theory and Techniques (ICATT), 2013 IX International Conference on, Odessa, 2013, pp. 455-457.
9. Warrent L Stutzman, Gary A. Thiele; translated & compiled by Dr. Homayoon Arizi; Design and analysis of Antenna; publication center of Iran University of Science & Technology, Tehran, 2001.