A Printed Log Periodic Dipole Array

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Abstract- *An antenna is a basic component of any communication device required for both transmitting as well as receiving of the signal. Starting from Radio or Television transmission to satellite communication, be it Wi-Fi or Bluetooth or mobile phone network; all these technologies would not have been possible without the development of antennas. In Government and Commercial applications like mobile or wireless communication, high performance aircrafts, satellites and missile applications, where size, cost, weight, performance, etc. are the constraints, low profile antennas are used.*

The Printed Log periodic antenna that we have designed can work on a frequency of 1-4Ghz . A LPDA has many attractive features like light weight, small volume and low production cost. Log periodic antenna is basically used for enhancing the narrow bandwidth. Log periodic antenna is important with their ability to show nearly frequency independent characteristics over wide band of frequencies although they have relatively simple geometry. Test results shows that the antenna can operate with voltage standing wave ratio (VSWR) less than 2 and high directional radiation patterns. This antenna can be used for amateur radio broadcasting etc. It can act as an earth receiving station in satellite communication.

I. INTRODUCTION

An antenna, or aerial is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter supplies an electric current oscillating at radio frequency (i.e. a high frequency alternating current (AC)) to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals that is applied to a receiver to be amplified.

Antennas are essential components of all equipment that uses radio. They are used in systems such as radio broadcasting, broadcast television, two-way radio, communications receivers, radar, cell phones, and satellite communications, as well as other devices such as garage door.openers, wireless microphones, Bluetooth-enabled devices, wireless computer networks, baby monitors, and RFID tags on merchandise

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

Miniaturized concepts are often utilized

II. LITERATURE SURVEY

1] J.h.reed:-

Spatial antenna diversity has been important in improving the radio link between wireless users. Historically, microscopic antenna diversity has been used to reduce the fading seen by a radio receiver, whereas macroscopic diversity provides multiple listening posts to ensure that mobile communication links remain intact over a wide geographic area. In later years, the concepts of spatial diversity have been expanded to build foundations for emerging technologies, such as smart (adaptive) antennas and position location systems. Smart antennas hold great promise for increasing the capacity of wireless communications because they radiate and receive energy only in the intended directions, thereby greatly reducing interference. To properly design, analyze, and implement smart antennas and to exploit spatial processing in emerging wireless systems, accurate radio channel models that incorporate spatial characteristics are necessary. In this tutorial, we review the key concepts in spatial channel modeling and present emerging approaches. We also review the research issues in developing and using spatial channel models for adaptive antennas.

2] Rgharpurev& peter kinget:-

This chapter discusses circuit-level issues related to the design of transceivers for ultra wideband systems. Several techniques for achieving broadband gain, and their tradeoffs with respect to power, performance and area are presented. An overview of circuit approaches for front-end and variable gain amplification, frequency translation, filtering, data conversion and frequency syn-thesis is provided. The problem of interference and coexistence in UWB systems is introduced.

3] L. Zhu, S, Sun and R. Li,

A compact microstrip-line ultra-wideband (UWB) bandpass filter (BPF) using the proposed stub-loaded multiple-mode resonator (MMR) is presented. This MMR is formed by loading three open-ended stubs in shunt to a simple stepped-impedance resonator in center and two symmet-rical locations, respectively. By properly adjusting the lengths of these stubs, the first four reso-nant modes of this MMR can be evenly allocated within the 3.1-to-10.6 GHz UWB band while the fifth resonant frequency is raised above 15.0GHz. It results in the formulation of a novel UWB BPF with compact-size and widened upper-stopband by incorporating this MMR with two interdigital parallelcoupled feed lines. Simulated and measured results are found in good agree-ment with each other, showing improved UWB bandpass behaviors with the insertion loss lower than 0.8dB, return loss higher than 14.3dB, and maximum group delay variation less than 0.64ns in the realized UWB passband

4] Munir, T. Praludi and M.R. Effendi:-

In this paper, the design and realization of microstripbased ultra-wideband (UWB) composite bandpass filter (BPF) with short-circuited stubs is presented. The BPF is compositely constructed from the step impedance lowpass filter (LPF) and the optimum distributed highpass filter (HPF). Prior to the realization, the performances of filter and its physical dimension are investigated numerically to obtain the optimum design. The BPF is deployed on a grounded FR4 Epoxy die-lectric substrate with the thickness of 0.8mm and the dimension of 25mm x 25mm. From the measurement result, it shows that the realized UWB composite BPF has 3dB bandwidth response of 10.03GHz ranges from 1.86GHz to 11.89GHz.

5] C. P. Baliarda:-

Fractal objects have some unique geometrical properties. One of them is the possibility to enclose in a finite area an infinitely long curve. The resulting curve is highly convoluted being nowhere differentiable. One such curve is the Koch curve. In this paper, the behavior the Koch monopole is numerically and experimentally analyzed. The results show that as the number of iterations on the small fractal Koch monopole are increased, the Q of the antenna approaches the fundamental limit for small antennas

6] Munir, D.T. Putranto, and H. Wijanto:- In this paper, characterization of log-periodic fractal Koch antenna in series iteration and equipped with balanceunbalance (balun) unit is investigated numerically and experimentally. The proposed antenna which is deployed an FR-4 Epoxy dielectric substrate using printed-antenna techniques is designed based on Koch fractal geometry in series iteration to minimize its transversal dimension. Since the proposed antenna is a balanced antenna type, then it requires a balun circuit to be available being fed from a coaxial type transmission line. Prior to realization and experimental characterization, some basic antenna parameters including VSWR, impedance characteristic, gain, and radiation pattern are investigated numerically to obtain the optimum ar-chitectural design. Moreover, the number of antenna elements as well as the effect of balun unit is also analyzed numerically. From the result, it shows that the proposed antenna has a dimension of 120mm x 150mm, working bandwidth from 0.7GHz–2.6GHz for VSWR < 2, and overall gain of more than 6dB for frequency range > 1.6GHz.

7] R. G. Hohlfeld and N. Cohen,

Self-similarity and origin symmetry are shown to be the key geometric constraints in the deter-mination of frequency independent properties of antennae. Fractal antennae with origin sym-metry meet these criteria of the extended version of Rumsey's principle. Frequency independence is not achieved by self-similarity alone. Self-complementarity plays no role in frequency inde-pendence, but does aid in smoothing out impedance variations for coarsely iterated frequency independent antennae. New families of practical designs arise from these geometric insights, which need not follow the usual constraints of angle-defined structure of the original Rumsey's principle.

8] S. D. Ahirwar, Y. Purushottam, T. Khumanthem, a traveling wave Koch dipole antenna is proposed. The antenna is an amalgamation of traveling wave antennas that require large elctrical lengths and fractal curves that are known for excellent form factor characteristics. The antenna is analyzed using a Mom code. The antenna exhibits an impedance bandwidth that is more than 10 : 1 for VSWR < 3 : 1. A comparision of simulated and measured results are presented. The traveling wave fractal antenna has many potential appli-cations in communications and electronics warfare.

III. PROPOSED ANTENNA

The most common form of log-periodic antenna is the log-periodic dipole array or LPDA. The log periodic antenna that we have designed id proposed to work on a frequency of 1-4Ghz.the antenna is designed on a FR4-epoxy substrate with thickness of 1.6mm and relative permittivity of 4.4. The log periodic dipole antenna, hereafter referred to as LPDA antenna was invented in 1958 by Isbell of the university of Illinois, United states of America. This antenna is a system of driven elements designed to operate over a wide range of frequencies. The LPDA antenna exhibits constant electrical characteristics i.e. fairly constant gain, pattern and VSWR etc. over the designed frequency range. The LPDA consists of a number of half-wave dipole driven elements of gradually increasing length, each consisting of a pair of metal rods. The dipoles are mounted close together in a line, connected in parallel to the feedline with alternating phase. Electrically, it simulates a series of two or three-element Yagi antennas connected together, each set tuned to a different frequency.

LPDAs look somewhat similar to multi-element Yagi designs, but work in very different ways. Adding elements to a Yagi increases its directionality, or gain, while adding elements to a LPDA increases its frequency response, or bandwidth. Because both designs are linear, a widely used design for television reception combined a Yagi for UHF reception in front of a larger LDPA for VHF. These can be identified by the much smaller elements at the front, and often a V-shaped reflector between the two sections.

LPDA/Yagi combo antennas were very popular from the 1960s through the 1980s when television broadcasting moved largely to cable. The digital transition in the 2000s led to the retirement of the VHF frequencies for television use in most countries. Modern terrestrial television antennas are more often dedicated to UHF, and the bowtie array is more common today. In the United States, however, some stations remained on the VHF spectrum.

The antennas can be designed in many of the following categories as:

1. broadband antennas
2. frequency independent antenna
3. frequency independent planar log spiral antenna
4. frequency independent planar conical antenna

The log periodic antenna that we have designed is basically a frequency independent structure.

IV. LOG PERIODIC ANTENNA & MEASUREMENT

Feeding Methods

The method of feeding the antenna is rather simple. A balanced feeder is required for each element, and all adjacent elements are fed with a 180° phase shift by alternating element connections. In this section the term antenna feeder is defined as that line which connects each adjacent element. The feed line is that line between antenna and transmitter.

The input resistance of the LPDA, R0, varies with frequency, exhibiting a periodic characteristic.

The range of the feed-point resistance depends primarily on Z0, the characteristic impedance of the antenna feeder. R0 may therefore be selected to some degree by choosing Z0, that is, by choosing the conductor size and the spacing of the antenna feeder conductors. Other factors that affect R0 are the average characteristic impedance of a dipole, Zav and the mean spacing factor, s¢. As an approximation (to within about 10%), the relationship is as follows:

Where

$$R_0 = \frac{Z_0}{\sqrt{1 + \frac{Z_0}{4\sigma' Z_{av}}}}$$

R0 = mean radiation resistance level of the LPDA input impedance
Z0 = characteristic impedance of antenna feeder
Zav = average characteristic impedance of a dipole

$$= 120\left[\ln\left(\frac{\ell_n}{d_n}\right) - 2.25\right]$$

ln/diamn = length to diameter ratio of nth element

$$\sigma' = \text{mean spacing factor} = \frac{\sigma}{\sqrt{\tau}}$$

If all element diameters are identical, then the element l/diam ratios will increase along the array.

Ideally the ratios should remain constant, but from a practical standpoint the SWR performance of a single band LPDA will not be noticeably degraded if all elements are of the same diameter. But to minimize SWR variations for multiband designs, the LPDA may be constructed with progressively increasing element diameters from the front to the back of the array. This approach also offers structural advantages for self supporting elements, as larger conductors will be in place for the longer elements. The standing-wave ratio varies periodically with frequency. The mean value of SWR, with respect to R0, has a minimum of about 1.1:1 ,and rises to a value of 1.8:1 at sigma = 0.05. In other words, the periodic SWR variation (with frequency changes) swings over a wider range of SWR values with lower values of sigma. These SWR ranges are acceptable when using standard 52 and 72-W coax for the feed line. However, a 1:1 SWR match can be obtained at the transmitter end by using a coax-to-coax Transmatch. A Transmatch enables the transmitter low-pass filter to see a 52-W load on each frequency within the array passband. The Transmatch also eliminates possible harmonic radiation caused by the frequency-independent nature of the array.

R0 should be chosen for the intended balun and feed-line characteristics. For HF arrays, a value of 208 W for R0 usually works well with a 4:1 balun and 52-W coax. Direct 52-W feed is usually not possible. (Attempts may result in smaller conductor spacing for the antenna feeder than the conductor diameter, a physical impossibility.)

For VHF and UHF designs, the antenna feeder may also serve as the boom. With this technique, element halves are supported by feeder conductors of tubing that are closely spaced. If R0 is selected as 72 W, direct feed with 72-W cable is possible. An effective balun exists if the coax is passed through one of the feeder conductors from the rear of the array to the feed point. Fig 5 shows such a feed-point arrangement.
If the design bandwidth of the array is fairly small (single band), another possible approach is to design the array for a 100-W R0 and use a 1/4-wave matching section of 72-W coax between the feed point and 52-W feed line. In any case, select the element feeder diameters based on mechanical considerations. The required feeder spacing may then be calculated.

The antenna feeder termination, Zt, is a short circuit at a distance of lmax/8 or less behind element no. 1,the longest element. In his 1961 paper on LPDAs, Dr Robert L. Carrel reported satisfactory results in some cases by using a short circuit at the terminals of element no. 1. If this is done, the shorted element acts as a passive reflector at the lowest frequencies.

Some constructors indicate that Zt may be eliminated altogether without significant effect on the results. The terminating stub impedance tends to increase the front-to-back ratio for the lowest frequencies. If used, its length may be adjusted for the best results, but in any case it should be no longer than lmax/8. For HF-band operation a 6-inch shorting jumper wire may be used for Zt.

It might also be noted that one could increase the front-to-back ratio on the lowest frequency by moving the passive reflector (element no. 1) a distance of 0.15 to 0.25 l

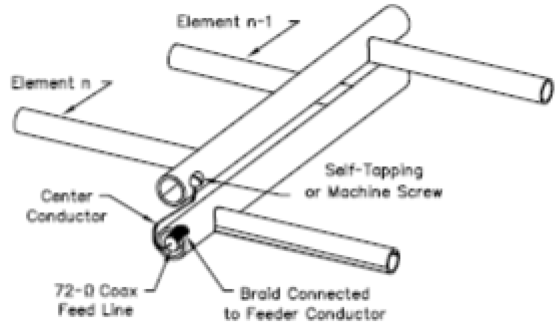
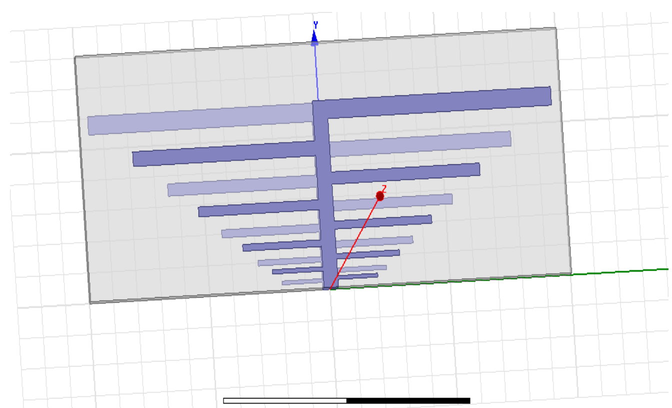


Fig 1: A method of feeding the LPDA for VHF & UHF

behind element no. 2, as would be done in the case of an ordinary Yagi parasitic reflector. This of course would necessitate lengthening the boom. The front-to-back ratio increases somewhat as the frequency increases. This is because more of the shorter inside elements form the active region, and the longer elements become additional reflectors.

Geometry of log periodic Antenna



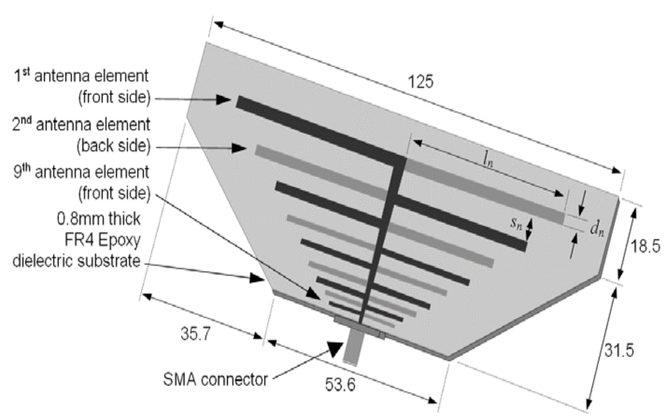


Fig. 2: Geometry of Rectangular Patch Antenna

dielectric constant of the uniform dielectric material so that the line of figure:7 has identical electrical characteristics, particularly propagation constant, as the actual line of figure:5.For a line with air above the substrate, the effective dielectric constant has values in the range of 1<Єreff<Єr. For most applications where the dielectric constant of the substrate is much greater than unity (Єr>> 1), the value of Єreff will be closer to the value of the actual dielectric constant Єr of the substrate.

The effective dielectric constant is also a function of frequency. As the frequency of operation increases, most of the electric field lines concentrate in the substrate. Therefore the microstrip line behaves more like a homogeneous line of one dielectric (only the substrate), and the effective dielectric constant approaches the value of the dielectric constant of the substrate. Typical variations, as a function of frequency, of the effective dielectric constant for a Microstrip line with three different substrates are shown in figure.

V. RESULT

RADIATION PATTERN

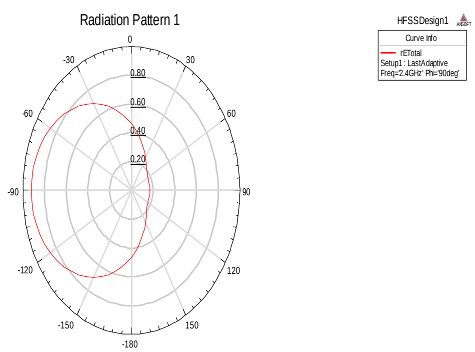


Fig 3: radiation pattern

X-Y PLOT 1

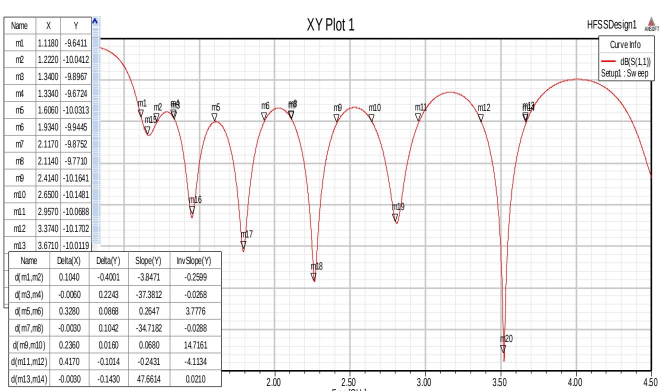


Fig.4: Graph of Reflection Coefficient vsFrequency

GAIN

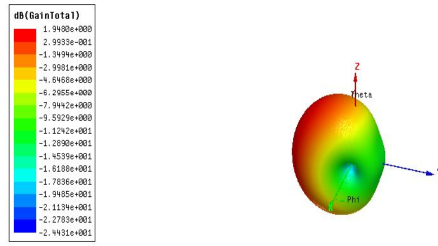


Fig 5 : gain

DIRECTIVITY

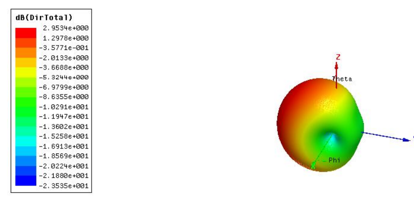


Fig 6: directivity

VI. CONCLUSION

Here, the conventional antenna is printed considering the factors of space, weight, cost .along with the conventional antenna. Here, the printed antenna performance is comparable to a traditional LPDA and covers the desired frequency range with similar and directive pattern of constant gain, which occupies an area which is drastically reduced compared to the conventional LPDA . The structure of printed LPDA is planar and relatively simple to fabricate using standard PCB fabrication technique

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