DESIGN, FABRICATION AND CHARACTERISTICS STUDY OF YAGI-UDA ANTENNA

[1]KIRTI R. NASHIKKAR, [2]VRUSHALI A. WAKDE, [3]C.S. ADGAONKAR

Ashoka Centre for Business & Computer Studies, Ashoka Nagar, Ashoka Marg, Wadala, Nashik.
Email: knashikkar@yahoo.com, vrushali.wakde@gmail.com, csadgaonkar@rediffmail.co.in

Abstract: For studying various parameters of Yagi-Uda antenna, a transmitter of frequency 110MHz is designed. The signal is transmitted by a properly designed Yagi-Uda Antenna. It is then received by a receiving section consisting of a similar type of Yagi antenna and a peak detector circuit. Radiation pattern of the antenna is studied and reported. By using this set-up, the various parameters of Yagi-Uda antenna can be studied. This low cost experiment can be set up in any UG or PG laboratory.

Keywords: Antenna, Receiver, Transmitter.

I.   INTRODUCTION

An antenna is basically used to radiate electro-magnetic waves into free space or receiving them from free space. Thus antenna is a system of conductors used to convert electrical energy into an electromagnetic energy at a transmitting station and vice-versa at a receiver. Yagi-Uda antenna is one of the most commonly seen VHF antenna used around the world. It is most often used as a TV receiving antenna. Basically the performance of any type of antenna depends mainly on some directional parameters or characteristics and therefore it is necessary to study these characteristics such as radiation pattern for horizontal and vertical polarization, radiation with distance, polarization test, reciprocity property etc. of the antenna.

II.   THEORY

A Yagi-Uda array is an array consisting of a driven element and one or more parasitic elements. The array consists of one passive. One of the passive dipole place back of the active element acts as a 'reflector' and the remaining dipoles place in front of the active dipole operate as 'directors'. They are arranged collinearly and close together. The reflector length is somewhat greater than a half wave length and the director length is somewhat less than a half-wave length. Number of directors may be used because the antenna radiates towards the directors and they are therefore excited consecutively. The dipoles of a Yagi-Uda array can be secured at their midpoints to a longitudinal metal rod. This rod is not excited because the electric lines of force E, cut at right angles. A tuned Yagi-Uda array is highly sensitive to changes in frequency[1]. That is why it is a narrowband system. Yagi-Uda antenna is used as a high frequency transmitting antenna. An antenna is chosen for a particular application according to its main physical and electrical characteristics. Further

an antenna must perform in a desired manner for the particular application.

Experimental Work

For studying the characteristics of an antenna we need two sections- 1) Transmitting Section 2) Receiving Section

Fig.1.1 Experimental Block Diagram

Transmitting Section:-   The transmitter consisting of Colpitts oscillator, Buffer amplifier and Class-C power amplifier is designed which produces a carrier frequency of 110 MHz as shown in fig.1.2
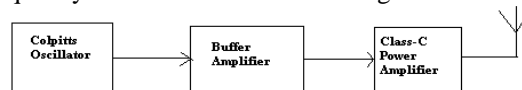

Fig.1.2 Block Diagram of Transmitter

Colpitts Oscillator : Generates 110MHz Carrier Frequency.
Buffer Amplifier : Provides Isolation & Increases strength of the signal.
Class-C Power Amplifier : Decides amount of power delivered to the antenna for transmission.
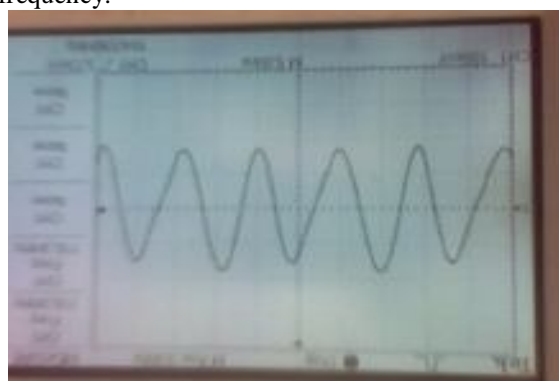This transmitting section produces 110MHz frequency.

Fig 1.3 Observed Waves of transmitter

For fabrication of Yagi-Uda antenna, aluminum hollow pipe of diameter 10mm was used. When designing an antenna depends on the requirements of the situation in which the antenna will be used. Optimization is achieved by simulating the radiation pattern of the antenna while varying the lengths and separations of the elements.

As C = f.λ

So, λ= c/f = 3×10^{10} cm/s/110×10^{6} Hz=272.73cm

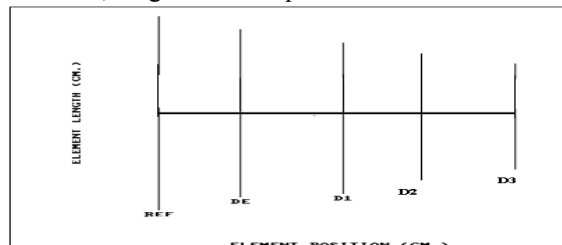Therefore, length of λ/4 dipole= 68.18cm

Fig. 1.4 Diagram of Antenna

The length of reflector is 0.55λ, first director length is 0.45λ, second director length is 0.4λ and third director lengh is 0.35λ. The optimum distance between reflector and dipole is 0.15λ and that of director and dipole is 0.1λ. The optimum distance between each director is 0.1λ.[1] Receiving Section:- A similar type of antenna was fabricated for receiving the signals transmitted by Yagi transmitter antenna, because of the Maximum Power Transfer Theorem. A peak detector circuit is used to detect the electromagnetic wave energy received by the receiving antenna as shown in fig.1.5
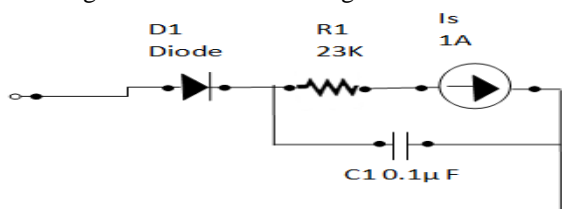

Fig.1.5 Peak Detector Circuit

Circuit Actions:- Of the various RF voltages induced in the receiver antenna, only the resonant frequency voltage is selected because of proper impedance matching at both sides. This input signal is then rectified by the diode and passed on to the low-pass filter RC.

III.   RESULTS AND DISCUSSION

Fig. 1.6 Arrangement for measuring the   Radiation Pattern

a)   Measurement of Radiation With Distance : We have studied the variation in the radiation strength at a given distance from the antenna. The detector showed a higher strength when it is nearer to the transmitting antenna and shall reduce gradually with increasing distance as shown in following fig.1.7

Sr. No.	Distance in Cm.	Radiation in μA
1.	0.5 m	0.60 μA
2.	1.0 m	0.50 μA
3.	1.5 m	0.40 μA
4.	2.0 m	0.30 μA
5.	2.5 m	0.20 μA
6.	3.0 m	0.10 μA

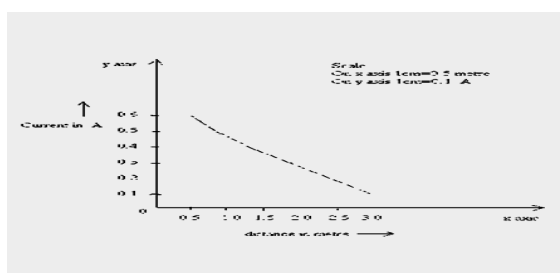**Fig.1.7 Observation Table for   measurement of radiation with distance**

Fig.1.8 representation measurement of radiation with distance of radiation with distance

b) Polarization Test and Measurement of Radiation Pattern : The polarization of the antenna is decided by turning the receiving antenna 90^{0}. Here the plane of receiving antenna is changed to vertical keeping transmitting antenna still in the horizontal plane. The graph of horizontal and vertical polarization is shown in fig. 2.0 and 2.1.
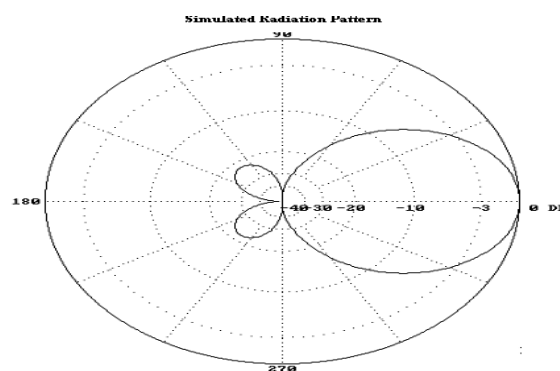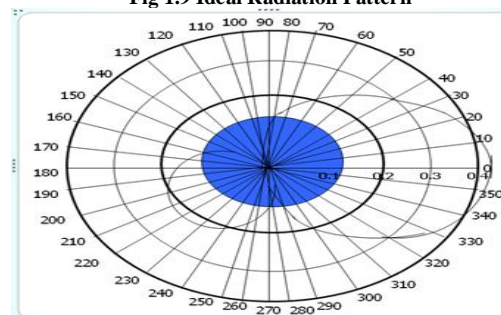

Fig 1.9 Ideal Radiation Pattern

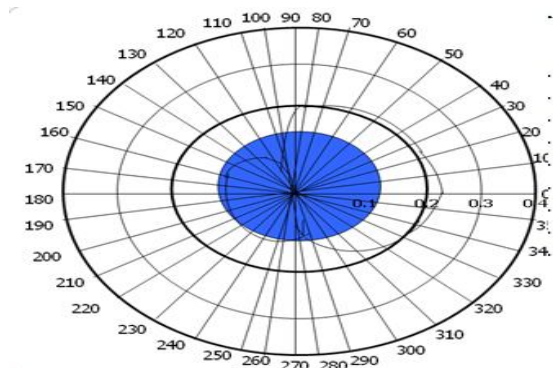**Fig. 2.0 Observed Radiation pattern for Horizontal polarization**

Fig. 2.1 Observed Radiation pattern for Vertical polarization

C) Reciprocity Theorem : is also verified and hence it is observed that both the transmitting and the receiving antenna are alterable.

IV. DISCUSSION :

It is therefore, felt that this experiment on study of Yagi-Uda antenna can easily be set up in any undergraduate or postgraduate communication electronics laboratory in order to make students conversant with its directional characteristics. Yagi antenna is used in UHF or VHF communication, mobile communication system, point to point fixed frequency transmission.

V. FUTURE SCOPE:

This project can be set as a regular experiment in any communication laboratory.
Yagi antenna is used in UHF or VHF TV communication, mobile communication system, point to point fixed frequency transmission.

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