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Microstrip Planner Five-element Yagi-Uda Antenna for ISM Band Application

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Abstract

This paper describes a design of Microstrip Planar five–element yagi–uda antenna for 2.4 GHz band.The structure has been optimized for a maximum front-to-back ratio by CST Simulation software. Special feature of the antenna are reflector formed by ground plane edge and solution of impedance summarization and matching. Antenna has been realized simulated result.

Keywords: *CST simulator software, Printed yagi-uda antenna, resonant frequency.*

1 Introduction

The planar five-element Yagi-Uda (see fig. 1) has been designed for an ISM(Industrial, Science, Medical) band with a frequency range 2.40 GHz. Similar threeelement provides symmetrization and matching of unbalanced feeding microstrip MS) line to balanced coplanar strip (CPS) line. The third part is the symmetrical CPS line that transforms array impedance Z_{arr} to the impedance Z_{CPS} at the MS-CPS balun output antenna array has been realized in [1]. The structure of the planar antenna consists of three main parts. The first part is an antenna array itself. The second one is a planar microstrip coplanner balun that (see reference planes in Fig1).

2 Antenna Designing

This parameter will used to design Microstrip yagi –uda antenna CST software simulator. Fig. 1 The structure of the planar Yagi-Uda antenna a) layout, b) photograph of the antenna Parameters:
L6=82mm, L7=52.84mm, L8=47.8mm, L9=40.95mm, L10=36.54mm, L11=100mm,
L12=165mm, 5=0.74mm, W6=1mm, W7=2.52mm, W8=4.6mm, W9=6.35mm, S1=15.1mm, S2=13.32mm, S3=32.13mm,
S4=22.6mm,S5=0.61mm.

3 Antenna Array

The analysis and optimization of antenna array has been done by planar simulator CST that uses integral equation/method of moment (IE/MOM) analysis in frequency domain. Simulator CST includes the ability of the analyses with finite substrate dimensions that also has been used in simulation of antenna structure. The genetic algorithm optimization scheme has been chosen to reach maximum directivity and maximum front-to back ratio ($FBR \geq 25$ dB). Optimization requirement for the directivity has been selected with respect to theoretically reachable value presented in [2]. The principle of the planar Yagi-Uda antenna is the same as the wire Yagi-Uda antenna[3]. The reflector of the array is formed by the ground plane edge. Folded dipole as active fed element and three directors with various element width as a result of optimization process are used to provide array input impedance $Z_{arr} = 81.3 – j114.4$.

4 Design Procedure and Simulated Results of Microstrip Yagi-Uda Antenna

The Microstrip Yagi-Uda Antenna is designed at FR-4 (Lossy) substrate. The parameter specifications of microstrip Yagi-Uda antenna are mentioned in Table 1.

Table 1: Microstrip Yagi-Uda Antenna Specifications

	Dimensions	Unit
Dielectric Constant (ϵr)	4.3	-
Loss Tangent (tan∂)	0.02	-
Thickness (h)	1.6	mm
Operating Frequency	2.40	GHz
Length (L)	165	mm
Width (W)	100	mm

Return loss S_{11} of Microstrip Yagi-Uda Antenna at ISM band is shown in Fig. 2.

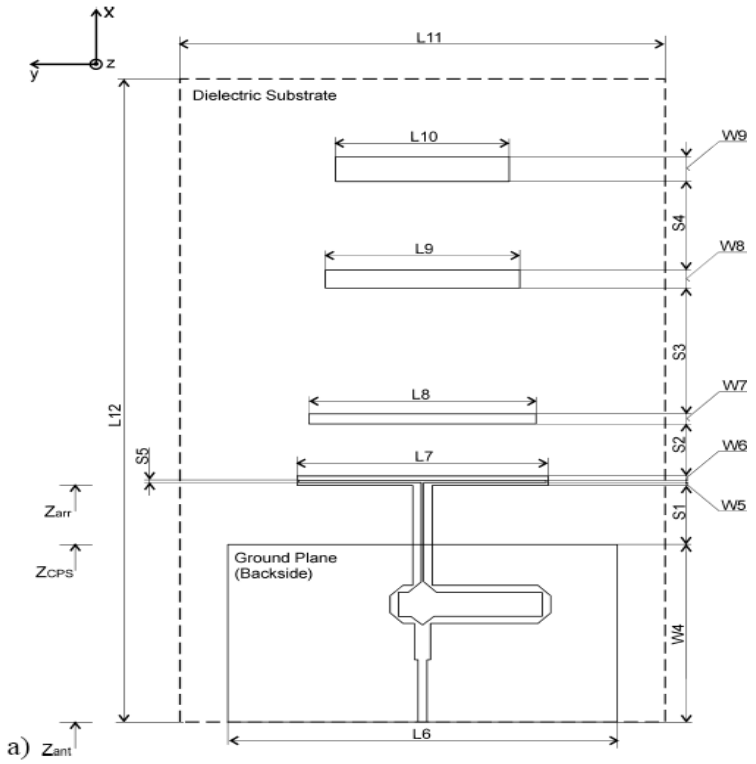

Fig 1.a: Layout of Microstrip planner five element yagi- uda antenna

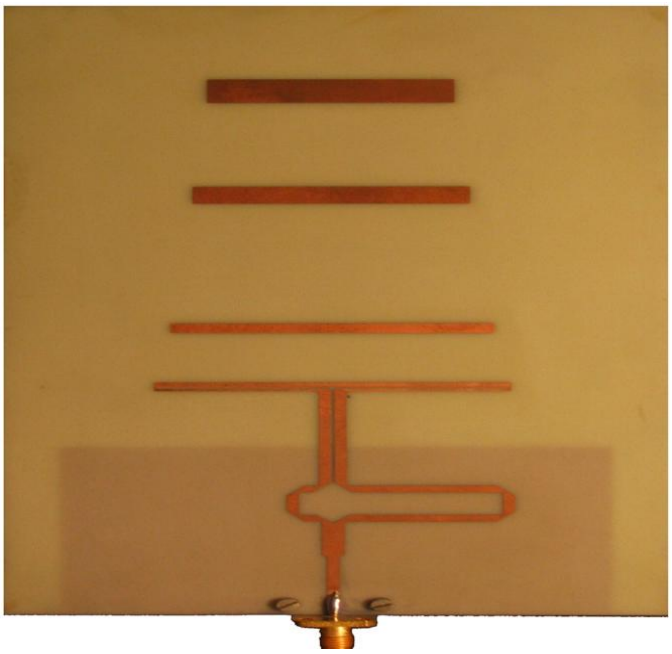

Figure 1b: Photograph of Microstrip yagi uda antenna

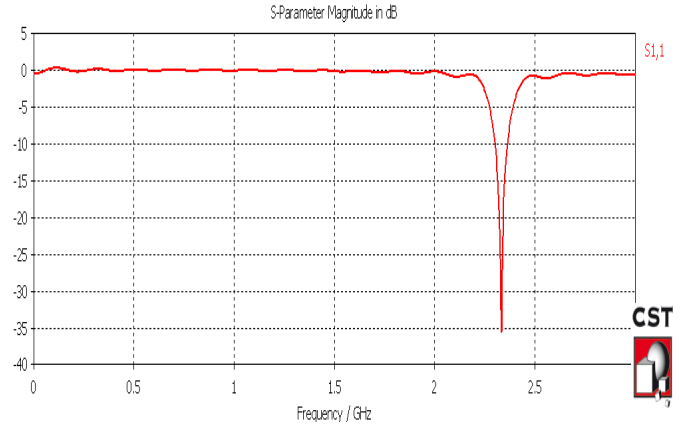

Figure 2**:** Simulated Return loss of microstrip yagi-uda antenna shown in graph 35 dB, at 2.4GHz

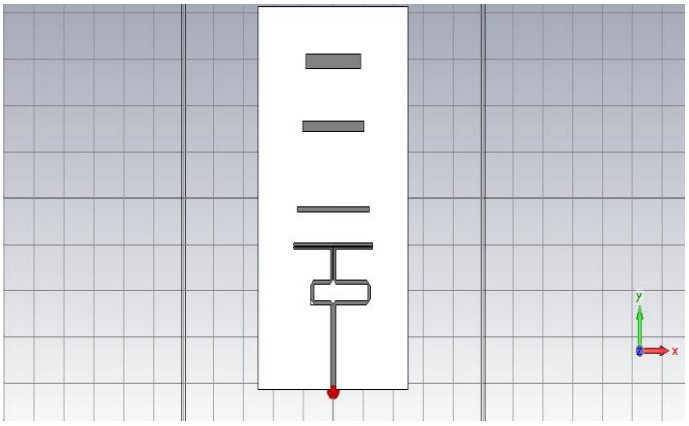

Figure3:Simulated result Microstrip yagi-uda antenna at ISM band

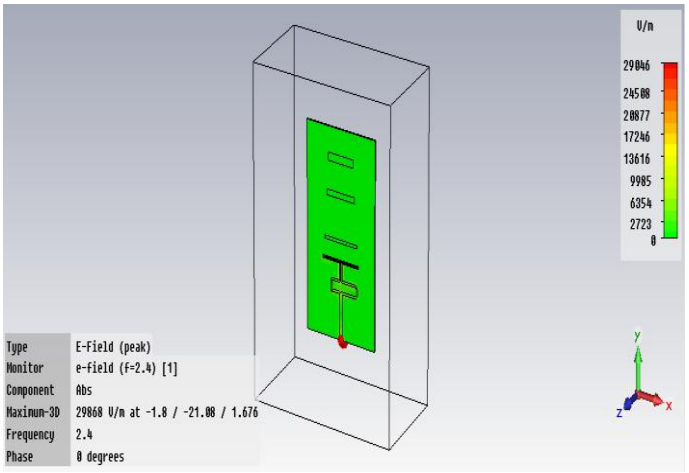

Fig4: E-field simulator Microstrip yagi –uda antenna

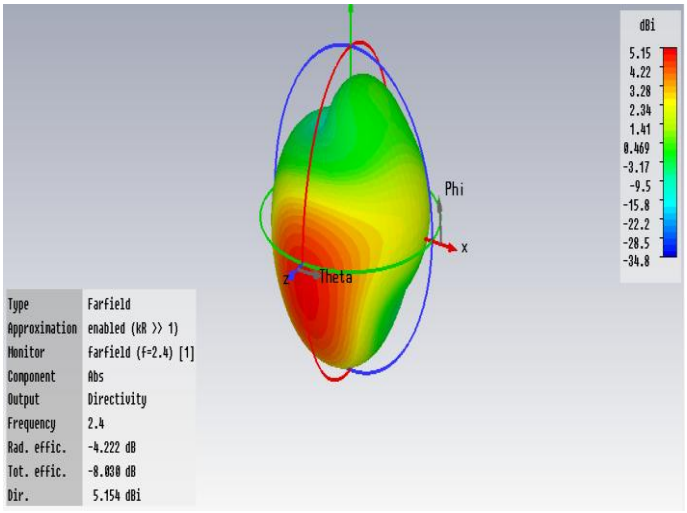

Fig5: Radiation pattern of Microstrip yagi –uda antenna showing 16% efficiency & 5.154dbi directivity

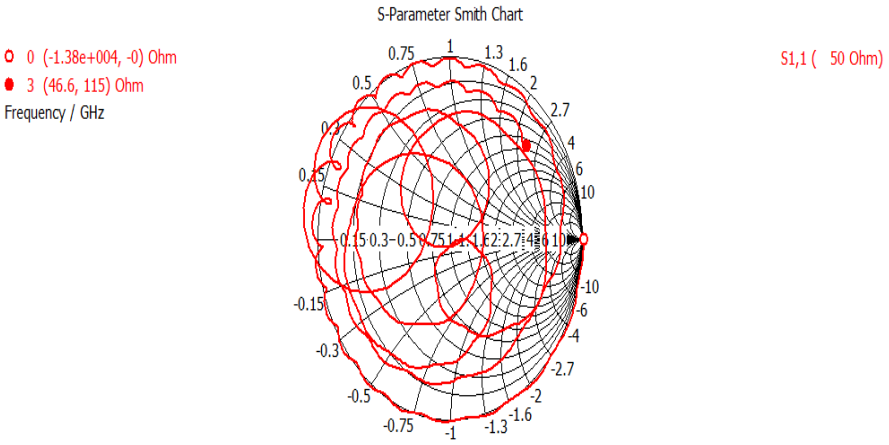

Fig6: Smith–Chart of Microstrip yagi-uda antenna at 2.4 GHz

5 Results

In this section, the simulated results are presented. When the microstrip Yagi-Uda antenna structure is simulated using CST-MWS software. This antenna operated at 2.4 GHz as it provides single band operation,at 2.4 GHz the values of Return loss -35dB. Radiation Pattern show in fig.5 having 16% efficiency 5.154dbi directivity and Smith Chart in Fig.6 shows the impedance variation within the simulated frequency range.

6 Conclusion

Planar five element Yagi-Uda array has been designed with the help of planar simulator CST. MS-CPS balun and transformation CPS line has been used to provide symmetrization and impedance matching between input SMA connector and active folded dipole of the array. Antenna has been realized and measured, agreement of simulated radiation pattern is quite good.this antenna has been designed for an ISM (Industrial, Science, Medical) band with a frequency range 2.40 GHz.

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