Implementation of Hepta-band Antenna Loaded with E-shaped Slot for S/C/X-band Applications

P. SIVA PRASAD SIDDU, S. BINDU, R. VASIM AKRAM

ASSISTANT PROFESSOR [1,2,3]

siddhu9f@gmail.com, somaguttabindu94@gmail.com, vasim487@gmail.com

Department of ECE, Sri Venkateswara Institute of Technology,

N.H 44, Hampapuram, Rapthadu, Anantapuramu, Andhra Pradesh 515722

ABSTRACT: A small slotted MSPA with seven frequency bands and an E-shaped slot is shown in this study. The 2-by-4 rectangular patch antenna may be implemented here. The suggested setup is a strong contender for S-band, C-band, and X-band uses due to its excellent impedance matching, respectable radiation performances, and reasonable gain. When tested against state-of-the-art approaches utilising HFSS software, our design outperforms others.

KEYWORDS- Micro strip Patch antenna, Good impedance matching and High Gain.

INTRODUCTION

It is important to review some fundamental antenna fundamentals before moving on to the Microstrip Patch Antenna (MSPA). Antennas are defined broadly as devices that convert one kind of energy into another. This study presents a comprehensive design and simulation of an E-shaped slotted MSPA, one of many varieties of MSPAs described in the literature. Research on MSP antennas has recently made significant strides. The printed circuit board is the typical medium for their production. The majority of devices that employ frequencies in the giga hertz range rely on these antennas because of their compact size. The ground, patch, substrate, and feeding portion make up a microstrip antenna. The MSP antenna has various benefits, including a compact footprint, low weight, tiny dimensions, ease of fabrication, compatibility with planar configurations, and compliance with almost all non-planar structures. It is also compatible with many MMIC designs. These MSPA's supplementary characteristics have a disproportionate impact on many studies. These might find usage in the C-band for mobile communication (apart from aeronautical mobile), the X-band for satellite applications, aviation, and space research, as well as WiMAX, medical imaging, and radiolocation. The basic dimensions, shape, sustain, and operating frequency are required to build an MSPA. However, guaranteeing the substrate in terms of size, feasibility, and affordability is the most fundamental need. Materials ranging from 2.2 to 12 are used for MSPA.

In comparison to smaller ones, larger antennas with lower f dielectric materials achieve better profitability and higher transmission limits. A phone, tablet, computer, or game console wouldn't be complete without an antenna. In MSPA, the two conductors—the radiator and the ground plane—are encased in a dielectric substrate that has varying relative permeability and permittivity. The concept of the MSPA was first proposed in 1953, long before actual antennas were available.Various methods exist for activating MSPA equipment. Two broad categories emerge from this set of tactics: non-contacting and contacting. Coaxial probe, microstrip line, aperture coupling, and proximity coupling are some of the feeding methods used to create MSPAs. The microstrip line is the most common feeding technology due to its simplicity of manufacture and integration. The ground plane is the most crucial component of MSPA. Radiation in MSPA has developed as a result of the ground-patching effect. Utilising a variety of substrates, each with its own unique thickness, various states of patch, sizes of patch, feeding procedure, and feed position allows the reception equipment to generate radiation through irregular and rapid contact.A need for tiny multiband antennas has arisen recently due to the introduction of new measurements and smaller devices, and this is being met in various ways. Without disturbing the structure's volume, cutting holes and indents of different sizes and shapes in the ground plane or front patch are often used as part of the available data transmission capacity expansion processes. Modifying the patch width and substrate thickness is one possible approach to increasing the MSPA's Transfer speed (TS). All things considered, the problem should be enhanced with authentic upgrades while maintaining the desired emphasis or complete recurrence. Recent work by experts has shown an improved TS by the use of several outlines, such as modificationofshape and patch.Because it is easy to design, requires little effort, and supports both circular and direct polarisations, the MSPA apparatus is in high demand in communication and radar systems, and it finds considerable usage in ultra-wideband (UWB) applications.

It is common practice to use a sequential stage feed for antennas in order to increase operating transfer speed and gain. In numerous seminal publications it was shown that the directivity of a conventional rectangular patch antenna is just a function of its electrical width and length. The only practical way to increase the patch's directivity, according to the proportionality of a two-opening show, is to increase its electrical size.

LITERATUREREVIEW

JagadishM.Rathod[3]ComparativeStudyofMicrostrippatchantennaforwireless communication but Bandwidth is Low.

A.Kashinathan,Dr.V.Jayaraj[6]"EShapeMicrostripPatchAntennaDesignforwirelessApplications" Gain is Very Low.

P.Ramaya,S.Gopalkrishnan[1]"ModifiedE-shapedMicrostripPatchAntennaForWimax Applications"ReturnLossesareMore.

Y. Rahmai[8] Wide Band E Shaped Patch Antennas for Wireless Communication Directivity is Less.

EXISTINGMETHOD

TheproposedantennastructureismodeledonFR4substrate(height=1.6mm,r=4.4andð =0.02)with compact sizeof32 ×32 mm2, as detailed in Fig. 1. Theproposed design consists of the ground plane and radiating patch loaded with λ 4 E-shaped slot which are jointly used as a singleantennaasshowninFig.1.TheE-shapedslotisengravedonthefrontpatch(basicallya radiator)oftheantenna.TheE-shapedstructureistheelementarystructure.Theoutline procedure of the proposed E-shaped structure is very simple for implementation in different handheld gadgets. The detailed E-shaped slot antenna dimensions are illustrated in Table I. The presentation of this E-shaped slot adjusts the electrical current length path because of which antennaworksinmultibandmodewiththefrequenciesof3.1/4.7/6.4/7.6/8.9/10.4/11.8GHz. The designed patch antenna is excited by microstrip feed line to achieve good impedance match atthe operating bands.

1) AntennaDesignEquationsThewidthandthelengthoftheproposed antennacanbe calculated by the following design equations

$$W = \frac{\lambda_o}{f_o\sqrt{(\varepsilon_r+1)/2}}$$

$$\varepsilon_{reff} = \frac{(\varepsilon_r+1)}{2} + \frac{(\varepsilon_r-1)}{2}[1+12\frac{h}{w}]^{-1/2}$$

$$L = \frac{\lambda_o}{f_o\sqrt{\varepsilon_{reff}}} - 2\Delta L$$

$$\frac{\Delta L}{h} = 0.412\,\frac{(\varepsilon_{reff}+0.3)(\frac{W}{h}+0.264)}{(\varepsilon_{reff}-0.258)(\frac{W}{h}+0.8)}$$

2) Design Methodology the proposed antenna design and its detailed dimensional layoutsare illustrated in Fig. 1 and Table I respectively. The antenna consists of a rectangular patch ($L1 \times$ W1) in which anλ 4 E-shaped slot ($L3 \times$ W3 × W7 × L5) is etched out.The overall impedance match is provided by microstrip feed line ($L6 \times$ W10) using lumped port excitation. The design and the structure of the proposed antenna are intended to be used for S band (3.1 GHz), C-band (4.7/6.4/7.6 GHz) and X-band (8.9/10.4/11.8 GHz) applications.

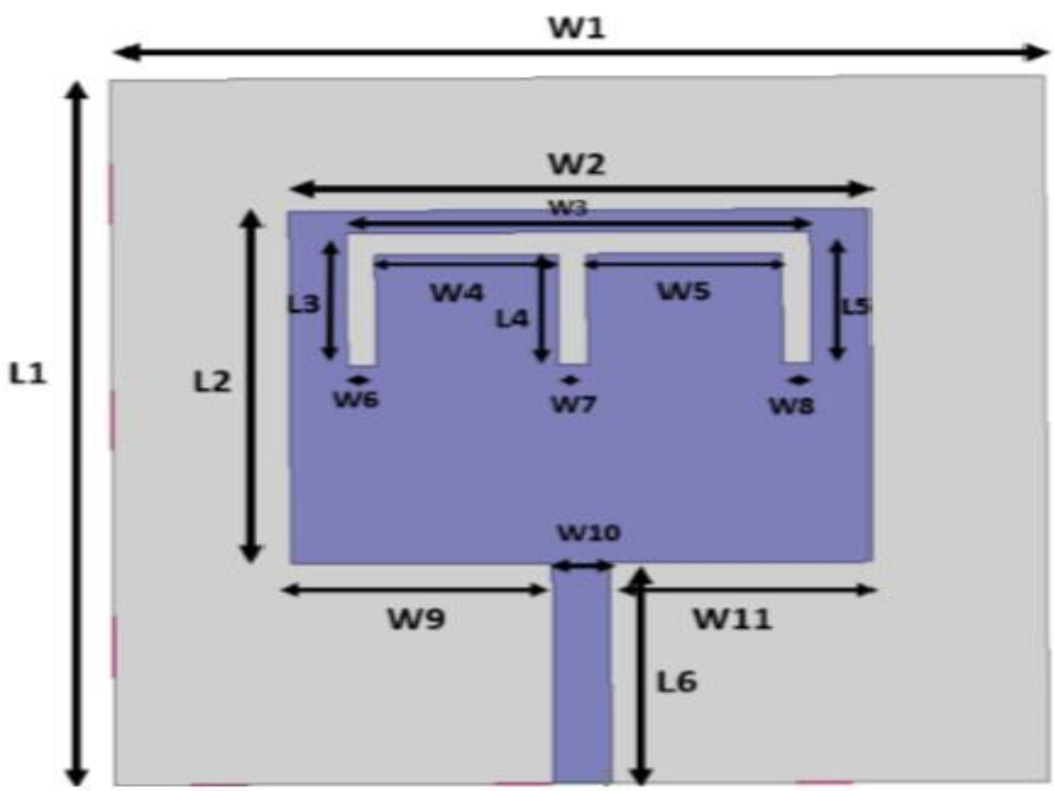


Fig.1.Physicallayoutoftheproposedantenna

Operate at 3.8/6.6/9.0 GHz (Fig. 3). Further modification of this slot in to L-shaped slot (i.e. “Design 2”, Fig. 2) makes the antenna to operate at 3/6.4/7.3/8.5 GHz (Fig. 3). Modification of L-shapedslotinto F-shapedslot (“Design3”, Fig.2) disturbs the current path of the radiatoras a result of which antennain “Design3”operatesat 3.6/6.5GHz(Fig.3).Finally,toobtainmoreno multiple bands we lastly optimize the F-shaped slot to E-shaped slot (i.e. proposed “Design 4”, Fig. 2). This modification further affects the surface electrical current path and thus making the antenna to finally operate at 3.1/4.7/6.4/7.6/8.9/10.4/11.8 GHz.

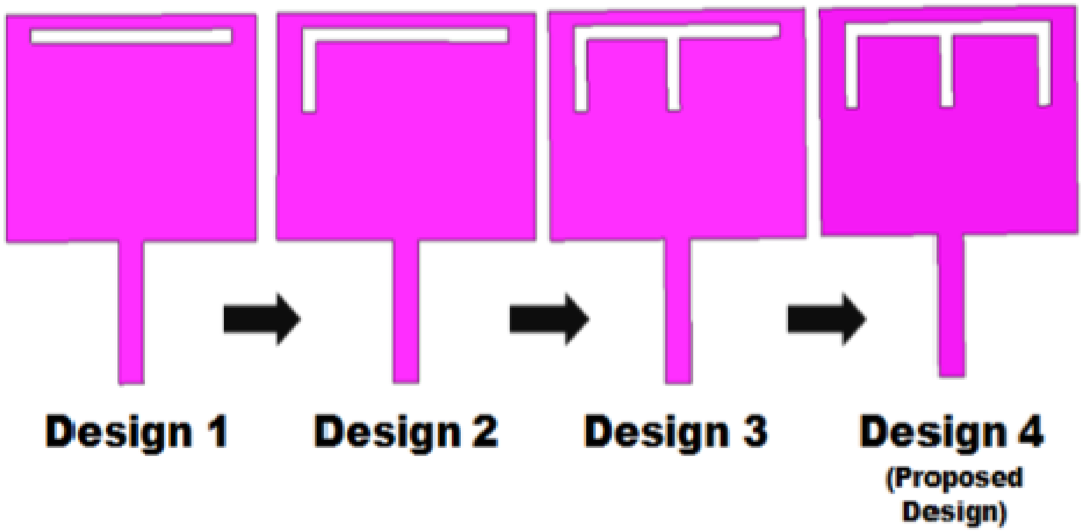


Fig.2.Evolutionstepsoftheproposedantennastructure.

DrawbacksofExistingMethod:

- Returnlossesaremore.
- Directivityisless.

1. PROPOSEDMETHOD

Intheproposedmethod thearrayoftherectangularantennaisdesignedinorderto increasethedirectivityandreducetheradiationoftheantenna.Thedesignarchitectureofthe proposed method is given by

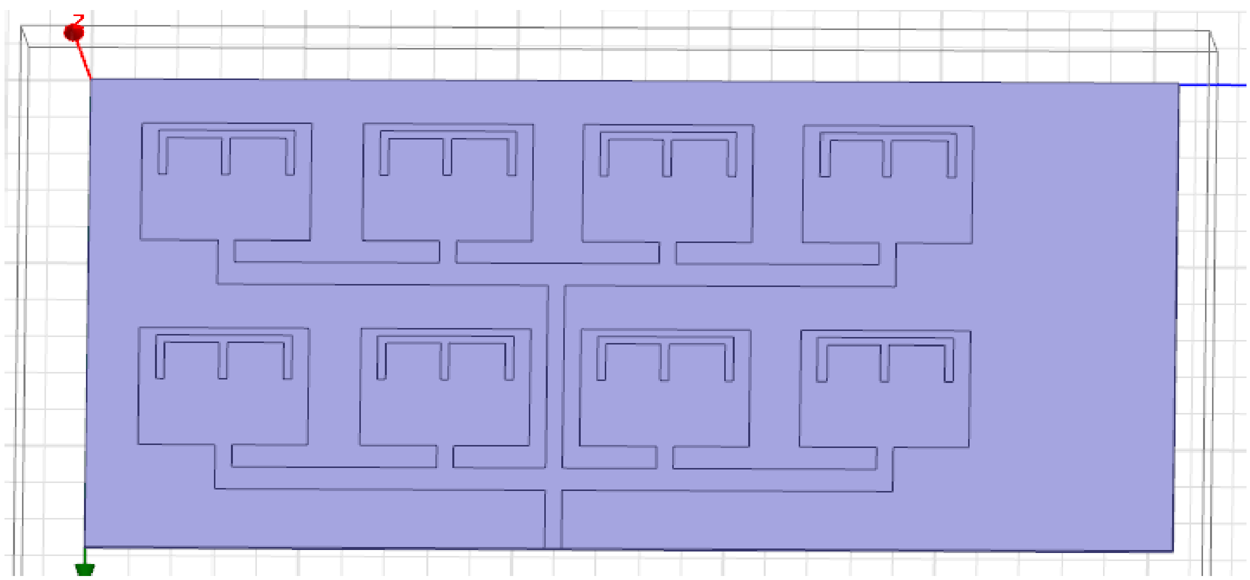


Fig.3.2*4Eshapedpatchantenna

Inthisdesignthespecificationsare:

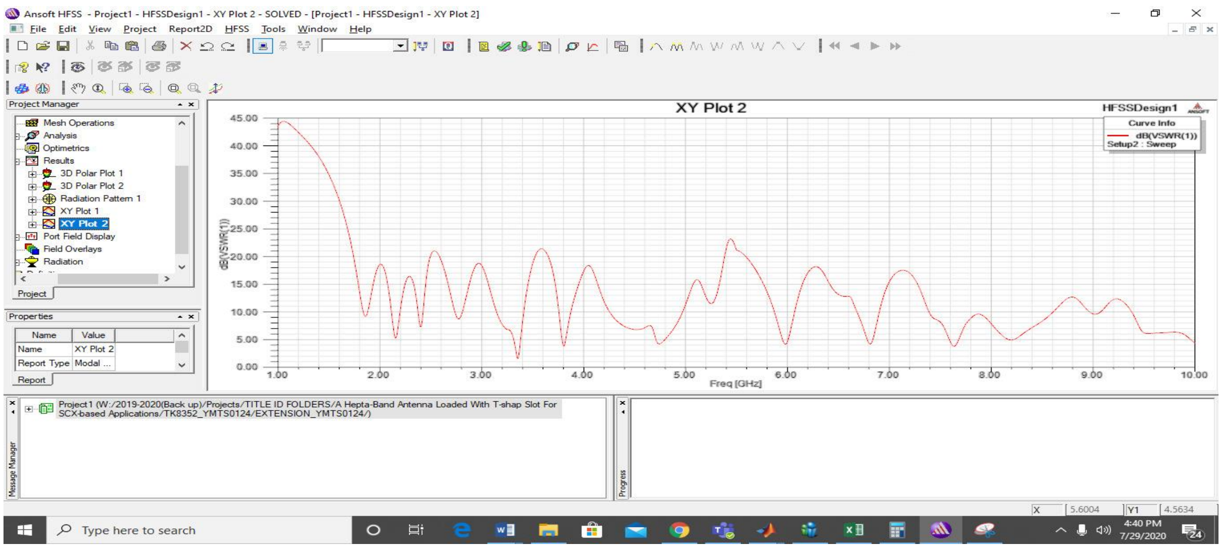
Forground:

- Thepositionis0,0,0
- XSizeis364 Sizeis128. For substrate:
- Thepositionis64,54 ,1.6
- YSizeis-2 Sizeis1.6 Patch size is
- Thepositionis34,6 ,1.6
- XSizeis16
- YSizeis20

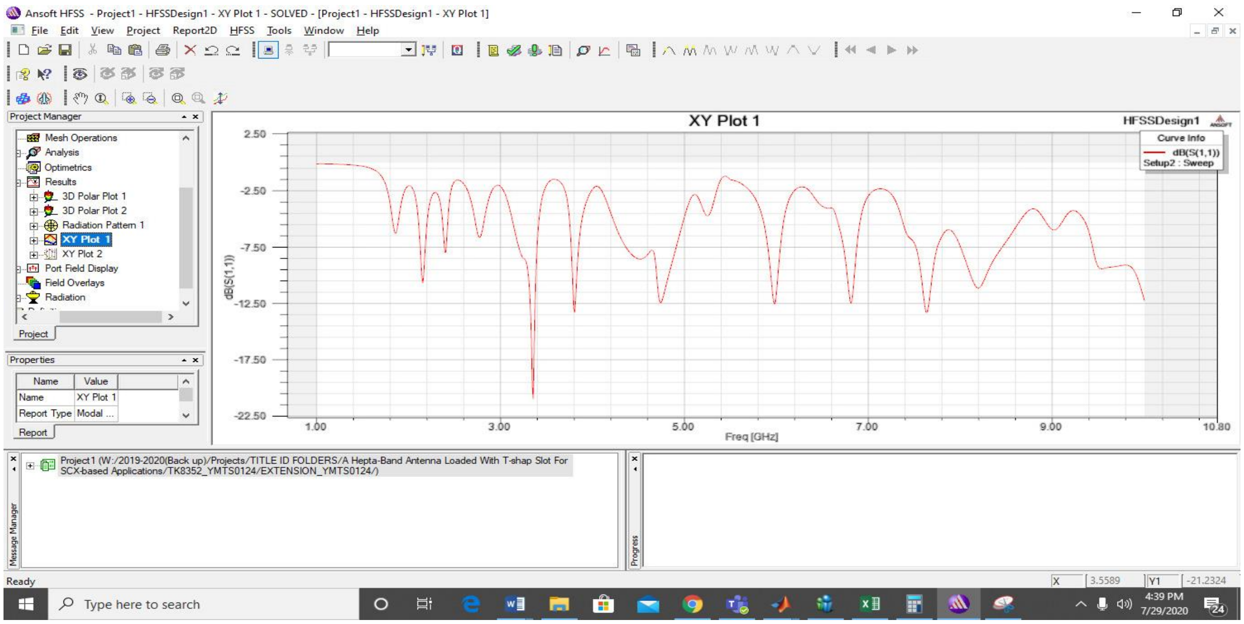
Based on the above dimensionalities the patches and rectangles are created as shown in theabove figure. The substrates are filled with the FR4-Epoxy material and the radiation box ismade up of vacuum. The feed is given using the lumped port.

2. RESULTS

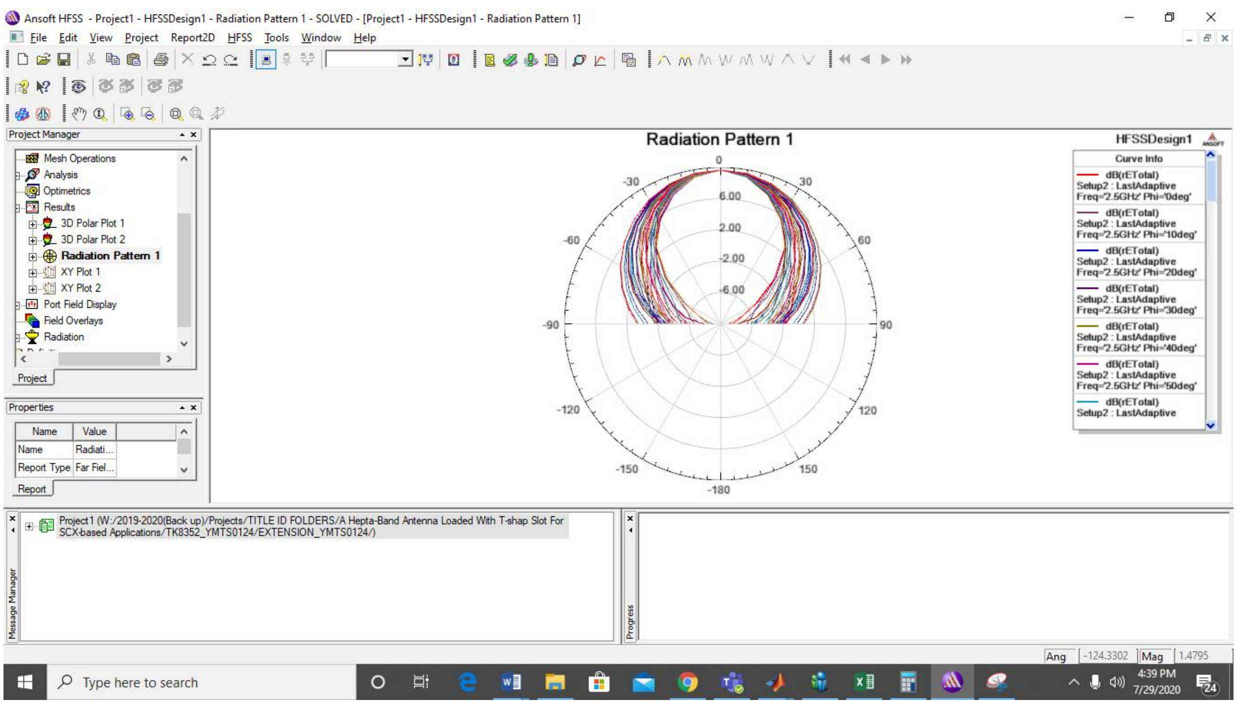
VSWR:



RETURNLOSS:



RADIATIONPATTERN



3. COMPARISIONOFRESULTS

Parameters	Eshapedpatchantenna	2*4Eshapedpatchantenna
Resonantfrequency	3.1GHz	3.1GHz
Returnloss(dB)	-33.91	-20.5
VSWR	4.1	2.4
Gain(dB)	4.5	5.52

CONCLUSION

This research presents a compact slotted MSPA loaded with E-shaped slot with seven frequency bands. Here we implemented the rectangular patch antenna of order 2 by 4.Good impedance matching, acceptable radiation performances and good gain makes the proposed configuration an attractive candidate for S-band, C-band and X-band applications. This design gets better results when compared to state of art methods.

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