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Design of Irregular M Shape Microstrip Patch Antenna with U Slots For Broadband and C Band Applications

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Abstract: *This paper presents the enhance in bandwidth of a Microstrip patch Antenna using an irregular polygon (M shape)and using U slots technique for enhancing bandwidth for broadband and fed by Microstrip line using coaxial probe. The main aim of proposed work is to obtain a Hues bandwidth and the size of antenna is reduced. The proposed microstrip antenna has a wide bandwidth, the range from3.30-6.85 GHz. The wide bandwidth achieved 71% and the VSWR is less than 2.The other parameters are as our research requirements antenna simulated on the Zeeland IE3D software.*

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I. Introduction

Antennas are a very important device of communication systems [1]. By definition, an antenna is a device used to transform an RF signal, traveling on a conductor, in to an electromagnetic wave in free space the broadband linear polarized MSA, play a important role in wireless system due to its low-profile, small-size and light weight. As well known, a linearly polarized wave can be obtained when spatially orthogonal modes are excited with equal amplitude. Conventional designs [2] of MSA for linearly polarization are usually achieved by truncating patch corners, cutting U slots in the radiating plate for the C Band Application.The C band is a designation by the Institute of Electrical and Electronics Engineers (IEEE) for a portion of the electromagnetic spectrum in the microwave range of frequencies ranging from 4.0 to 8.0 GHz, this definition is the one used by radar manufacturers and users, not necessarily by microwave radio telecommunications users. The C band (4 to 8 GHz) is used for many satellite communications transmissions, some Wi-Fi devices, some cordless telephones as well as some surveillance and weather radar systems.The communications C band was the first frequency band that was allocated for commercial telecommunications via satellites. The same frequencies were already in use for terrestrial microwave radio relay chains. Nearly all C-band communication satellites use the band of frequencies from 3.7 to 4.2 GHz for their downlinks, and the band of frequencies from 5.925 to 6.425 GHz for their uplinks. Note that by using the band from 3.7 to 4.0 GHz, this C band overlaps somewhat into the IEEE S band for radars.The C-band communication satellites typically have 24 radio transponders spaced 20 MHz apart, but with the adjacent transponders on opposite polarizations.Hence, the transponders on the same polarization are always 40 MHz apart of the 40 MHz, each transponder utilizes about 36 MHz[10].

II. Material Used

The first design step is to choose a suitable dielectric substrate with appropriate thickness and appropriate value of loss tangent. A thicker substrate is not only being mechanically strong but also will increases the radiated power, reduce conductor losses and improve impedance bandwidth however it will also increase the weight, dielectric loss, surface wave loss and extraneous radiations from the probe field. The substrate[2] taken for the designing is Glass epoxy which is very cost effective (Rs. 600 for 1 Sq. foot) and possesses nearly all appropriate characteristic for designing an antenna, value of h is 1.6 mm and loss tangent is 0.012. The first design step is to choose a suitable dielectric substrate of appropriate thickness h and losstangent [3]. A thicker substrate, besides being mechanical strong, will increase the radiated power, reduceconductor loss, and improved impedance, bandwidth, however it will also increase the weight, dielectric loss,surface wave loss, and extraneous radiations from the probe field. Substrate dielectric constant ε_r plays a rolesimilar to that of the substrate thickness.

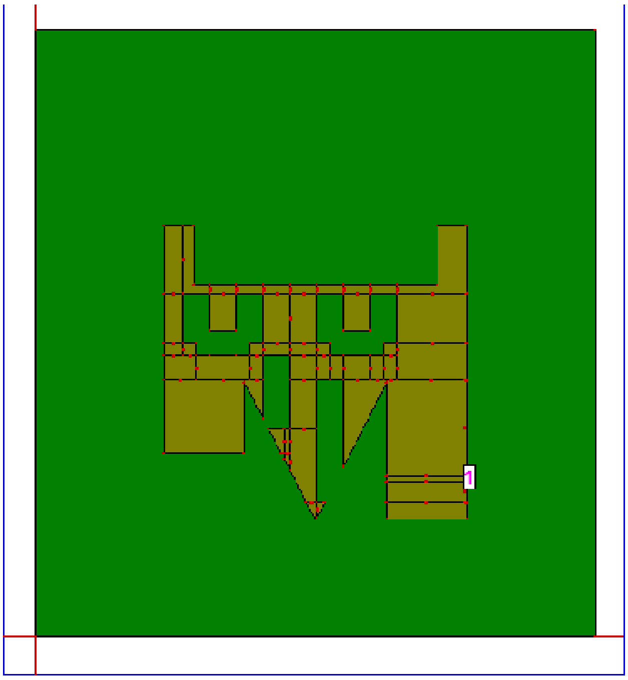


Fig. 1: Proposed Geometry of irregular M shape slotted antenna on IE3D

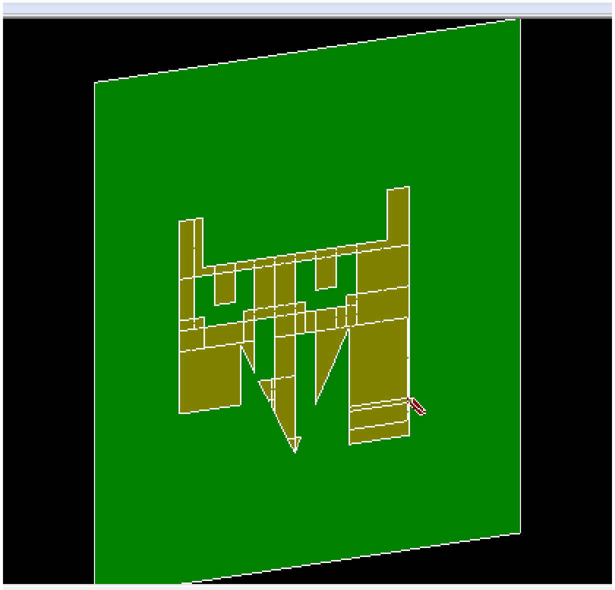


Fig. 2 :3D view of Proposed Geometry of irregular M shape slotted antenna on IE3D

III. Antenna Design

Fig.1 shows the geometry of the proposed ultra band MSA, The radiating rectangular patch,printed on a substrate of thickness h(1.6 mm) and dielectric constant $\varepsilon_r$is 4.4, the dielectric material thickness is 1.6mm thelength of both side, Lp=11.32mm , Wp=15.20mm and ground Lg=20.92mm, Wg=24.80mm . Which are oriented in orthogonal directions and have the feed point of irregular U slot polygon is X_f= 16.12 mm. and Y_f=6.5mm [4] [5].

IV. Experimental Results

To validate whether the design technique is applicable, the antenna has been simulated with IE3D Fig.3,Fig.4 and Fig. 5 shows the Return Loss Vs Frequency, VSWR versus frequency and smith chart respectively, the proposed irregular M shape slotted MSA. Fig.6, Fig.7, and Fig.8 shows the Return Loss Vs frequency of microstrip antenna by Vector analyzer, Gain Vs Elevation angle and 3D radiation Pattern respectively for theproposed slotted antenna.Fig.9, Fig. 11, Fig.12, Fig.13 shows 2D radiation pattern indicate greater main lobe, Directivity Vs Frequency of microstrip antenna, Gain (dBi) Vs Frequency, Efficiency (Antenna and Radiating) Vs Frequency respectively. From the simulation and hardware result we observe that the proposed slotted MSA is able to achieve the Return loss is -32 db,-31db respectively and the VSWR less than 2 for the slotted geometry. The outputresult by the Vector analyzer is shown in Fig.6 return loss (reflection coefficient) versus frequency ofthe proposed antenna. Since the feed point connected with the coaxial probe [6] , have good equal amplitudeand 90° phase shift, broadband LP radiation can be achieved. By using the thick air substrate, muchwider (71%)LP bandwidth obtained. The impedance matching of the antenna can be achieved by adjustment of the feed pointlocation, and the height between the radiator and the ground is (1.6mm) [8],[9].

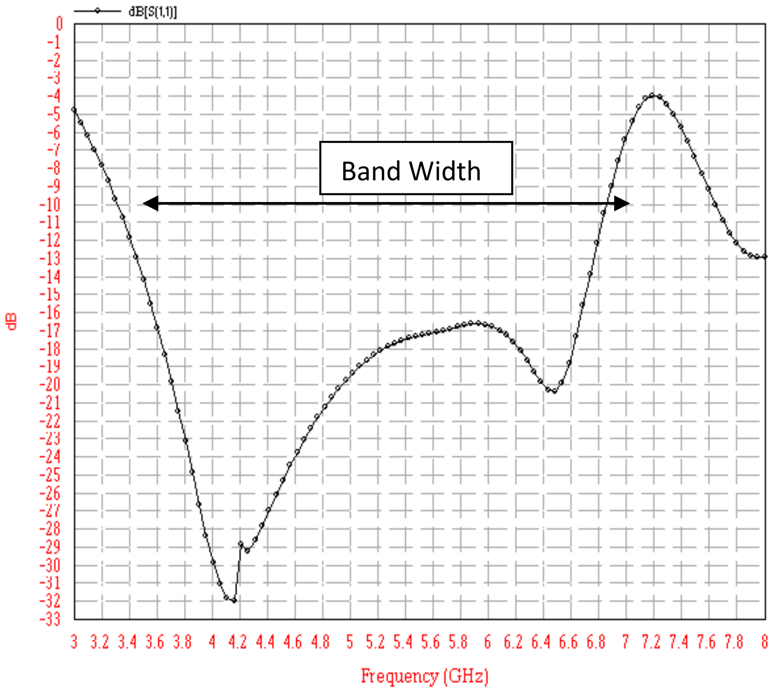


Fig. 3: S_{11} (Return Loss) Vs frequency of microstrip antenna

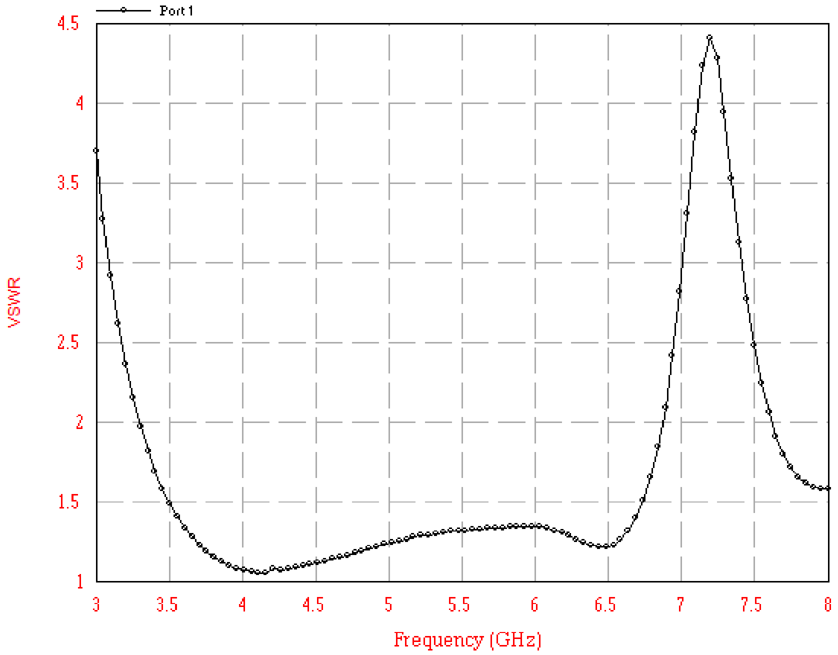


Fig. 4: Voltage standing wave ratio (vswr)Vs frequency

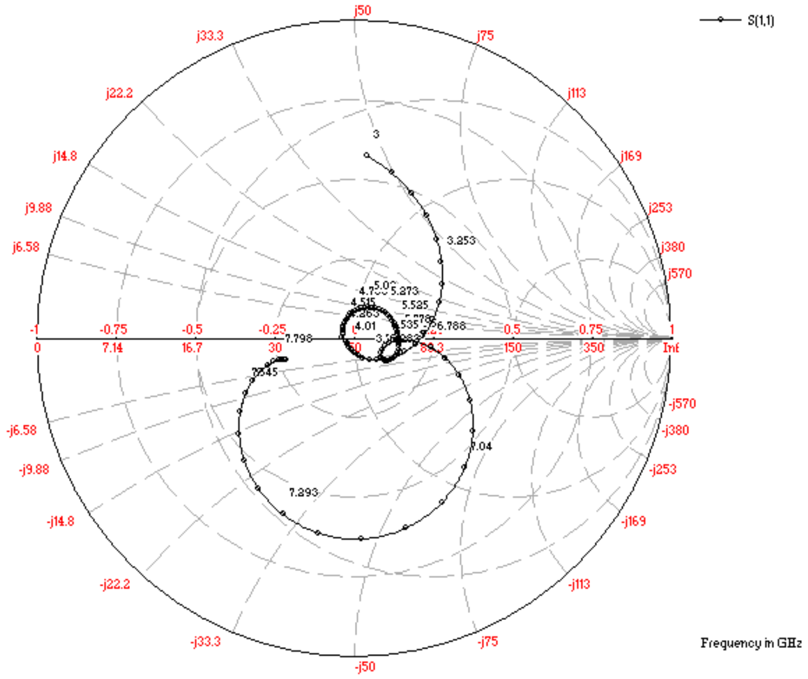


Fig. 5: Smith chart of proposed microstrip antenna

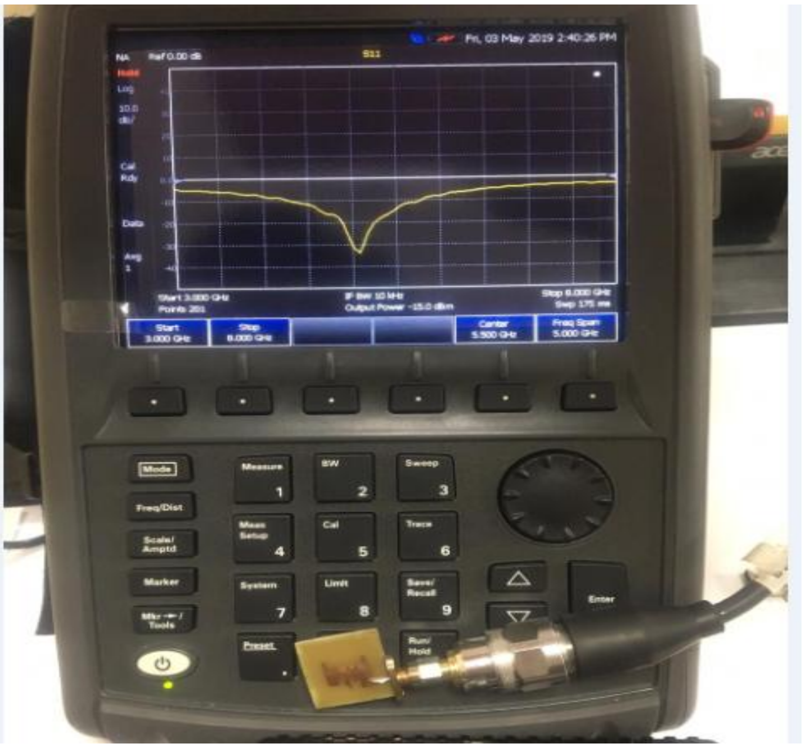


Fig. 6: S_{11} (Return Loss) Vs frequency of microstrip antenna by Vector analyzer

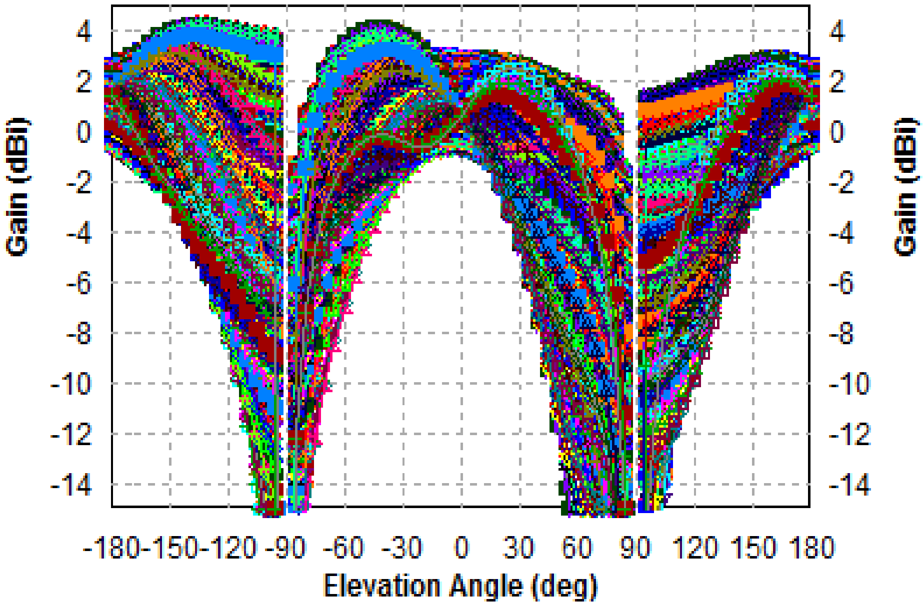


Fig. 7: Gain Vs Elevation angle of microstrip antenna by IE3D

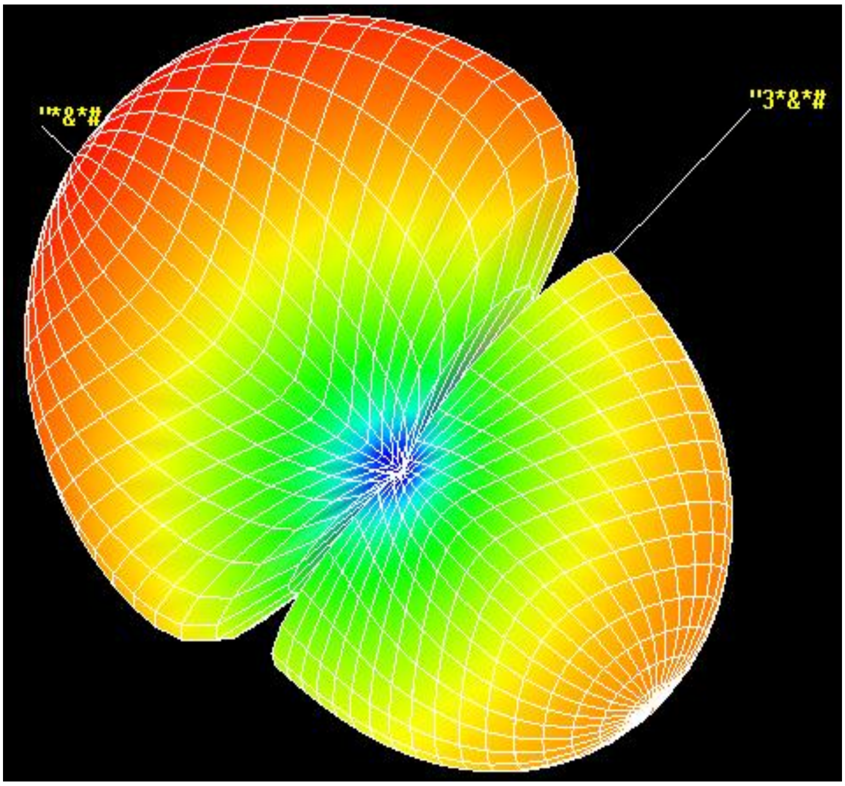


Fig. 8:3D radiation Pattern containing main lobe and back lobe of antenna

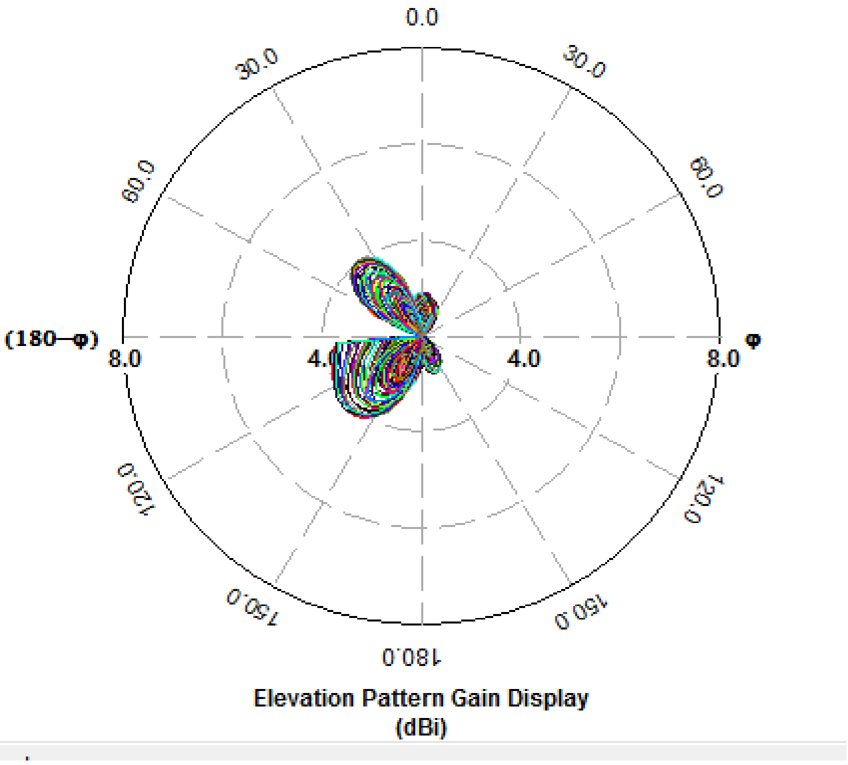


Fig. 9: 2D radiation pattern indicate greater main lobe in z direction

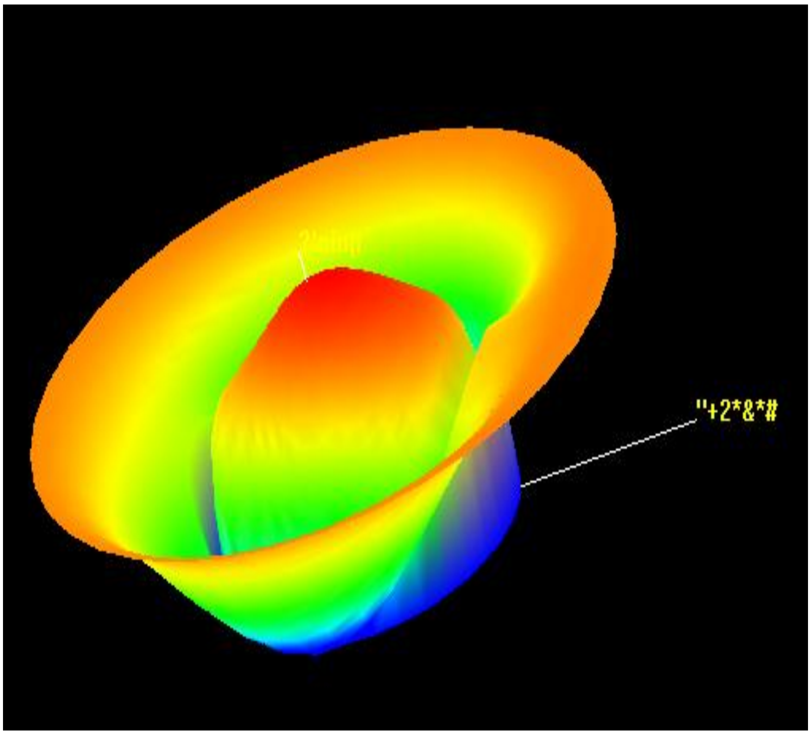


Fig. 10:3D radiation pattern of microstrip patchradiator

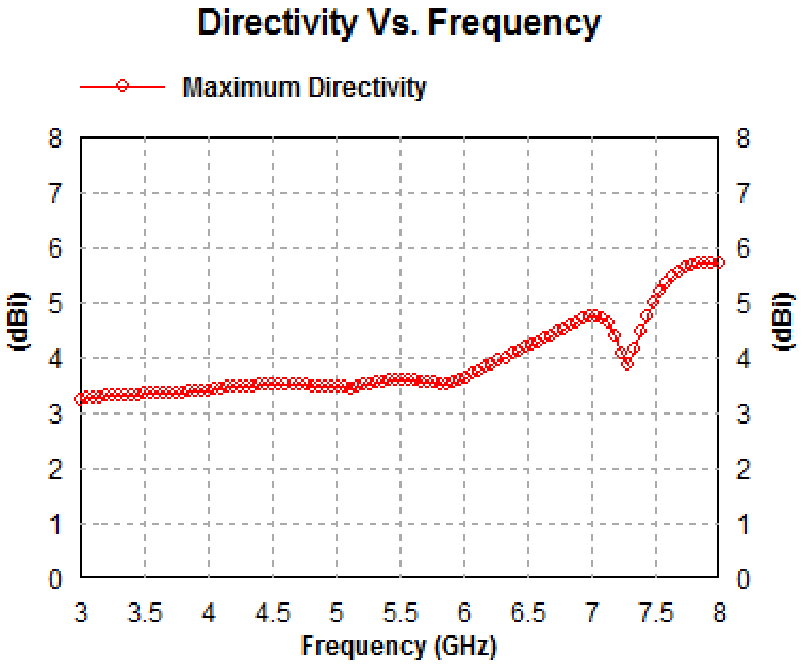


Fig. 11: Directivity Vs Frequency of microstrip antenna

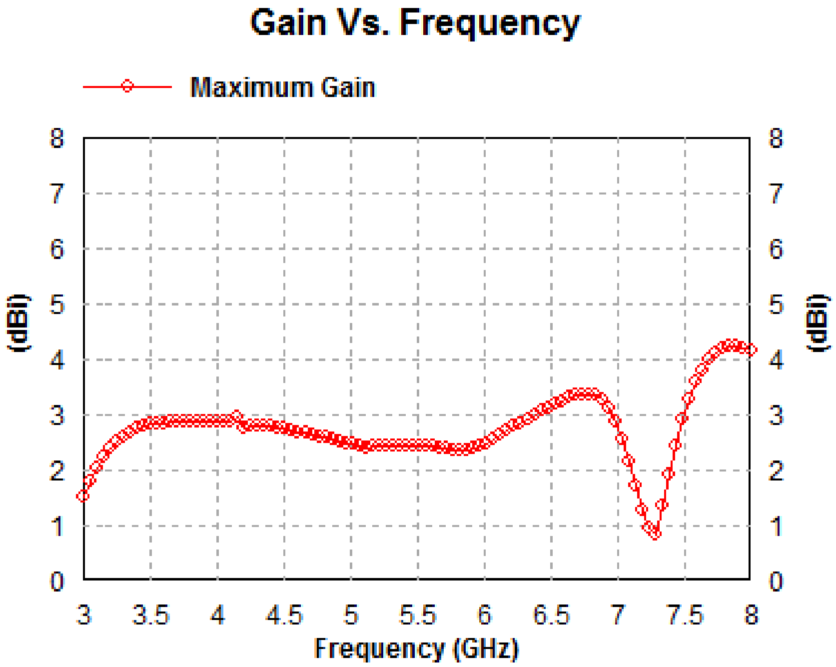


Fig. 12: Gain (dBi) Vs Frequency of microstrip patch radiator

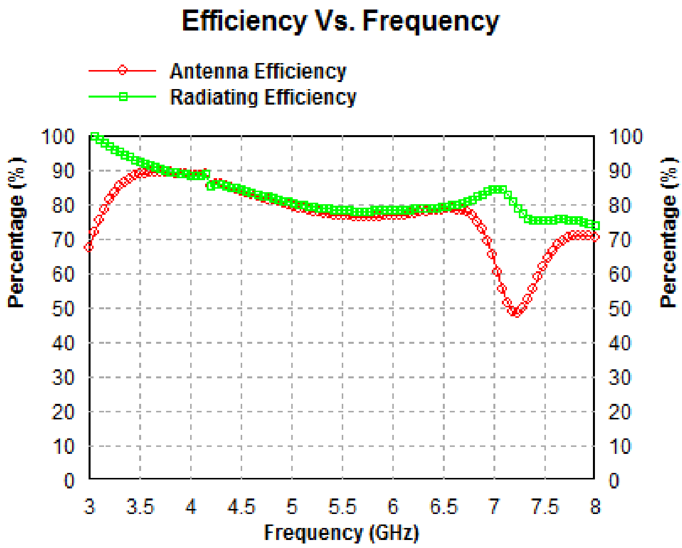
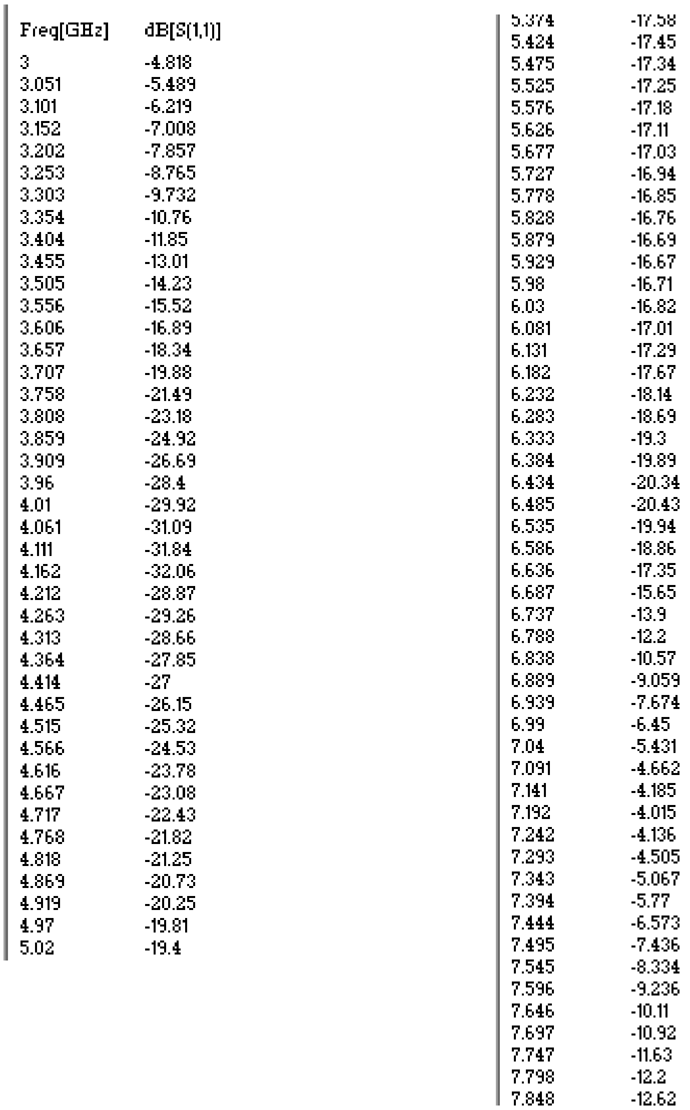


Fig. 13: Efficiency(Antenna and Radiating) Vs Frequency of microstrip patch radiator



Freq[GHz]	dB[S(1,1)]
3	-4.818
3.051	-5.489
3.101	-6.219
3.152	-7.008
3.202	-7.857
3.253	-8.765
3.303	-9.732
3.354	-10.76
3.404	-11.85
3.455	-13.01
3.505	-14.23
3.556	-15.52
3.606	-16.89
3.657	-18.34
3.707	-19.88
3.758	-21.49
3.808	-23.18
3.859	-24.92
3.909	-26.69
3.96	-28.4
4.01	-29.92
4.061	-31.09
4.111	-31.84
4.162	-32.06
4.212	-28.87
4.263	-29.26
4.313	-28.66
4.364	-27.85
4.414	-27
4.465	-26.15
4.515	-25.32
4.566	-24.53
4.616	-23.78
4.667	-23.08
4.717	-22.43
4.768	-21.82
4.818	-21.25
4.869	-20.73
4.919	-20.25
4.97	-19.81
5.02	-19.4
5.374	-17.58
5.424	-17.45
5.475	-17.34
5.525	-17.25
5.576	-17.18
5.626	-17.11
5.677	-17.03
5.727	-16.94
5.778	-16.85
5.828	-16.76
5.879	-16.69
5.929	-16.67
5.98	-16.71
6.03	-16.82
6.081	-17.01
6.131	-17.29
6.182	-17.67
6.232	-18.14
6.283	-18.69
6.333	-19.3
6.384	-19.89
6.434	-20.34
6.485	-20.43
6.535	-19.94
6.586	-18.86
6.636	-17.35
6.687	-15.65
6.737	-13.9
6.788	-12.2
6.838	-10.57
6.889	-9.059
6.939	-7.674
6.99	-6.45
7.04	-5.431
7.091	-4.662
7.141	-4.185
7.192	-4.015
7.242	-4.136
7.293	-4.505
7.343	-5.067
7.394	-5.77
7.444	-6.573
7.495	-7.436
7.545	-8.334
7.596	-9.236
7.646	-10.11
7.697	-10.92
7.747	-11.63
7.798	-12.2
7.848	-12.62

Fig. 14: Data chart of S_{11} (Return Loss) Vs Frequency by simulation software

Table no 1: Proposed antenna Design parameters for software and hardware

Design of Micro strip patch antenna	**Design on Software base antenna**	**Design on Hardware base antenna**
Name of Pattern	Irregular M shape	Irregular M shape
Frequency of Operation (GHz)	6.0	6.0
Dielectric constant of substrate	4.4	4.4
Loss tangent	.0012	.0012
Height of the dielectric substrate (mm)	Z =1.6mm	Z=1.6mm
Feeding method (Probe feed) mm	Point (x=16.12,y=6.5)	Point (x=16.12,y=6.5)
Width of the ground (W_g)	24.8mm	24.8mm
Length of the ground (L_g)	20.92mm	20.92mm
Width of the patch (W_p)	15.20mm	15.20mm
Length of the patch (L_p)	15.20mm	15.20mm

Table no 2: Measured result by IE3D software and hardware by network analyzer

Antenna Design	**Bandwidth (%)**	**Return Loss (dB)**
Software Based Design	71%	-32
Hardware Based Design	58%	-31

V. Conclusion

In this paper, a new design ofbroadband irregular slotted MSA with operating frequency6.0 GHz. The antenna has an output by using IE3D and compared with the experimental value. A thick air substrate is used in the present proposed design, and impedance matching is obtained through the irregular M shape radiating patch. The software result shows the bandwidth is achieve 71% and 58% which is usable for the C Band applications, resultsshows that the proposed antenna is able to achieve VSWR less than 2 and the return loss is -32.db.

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