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Dual Band E-Shape Micro strip Patch Antenna on RT DUROID 5880 Substrate for Pervasive Wireless Communication

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Abstract— **The area of micro strip antennas has seen some inventive work in recent years and is currently one of the most dynamic fields of antenna theory. This designing is very easy and chip in micro strip antenna designing. In this paper SHF band frequencies x-band frequency 10 GHz and Ku- band frequency 13GHz are gives the best result, the antenna has become a necessity for many applications in recent wireless communications, such as Radar, Microwave and space communication. The proposed antenna design on different optimum patch length and analyzed result of all optimum patch length between 1GHz to 15GHz frequency, When the proposed antenna design on a 62 mil RT DUROID 5880 substrate from Rogers-Corp with dielectric constant of 2.2 and loss tangent of 0.0004. At 13GHz the verify and tested result on IE3D SIMULATOR are Return loss = -26.29dB, VSWR = 1.102, Directivity = 12 dBi, Gain = 7dBi, 3 dB beam width = 21.3627 degrees, and the achievable bandwidth of the proposed antenna obtained is 31% (9.6-13.3 GHz) at -10dB return loss. All results shown in Simulation results. The Return losses and VSWR results shown in Table 1, Table2 respectively.**

Keywords— **Micro strip antenna, IE3D SIMULATOR, Dielectric, Patch width, Patch Length, Losses, strip width, strip length**

I. INTRODUCTION

Micro strip Patch antenna has several well known advantages, such as low profile, low cost, light weight, ease of fabrication and conformity Microstrip patch antennas have several well-known advantages, such as low profile, low cost, light weight, ease of fabrication and conformity. However, the microstrip antenna inherently has a low gain and a narrow bandwidth. To overcome its inherent limitation of narrow impedance bandwidth and low gain, many techniques have been suggested e.g., for probe fed stacked antenna, microstrip patch antennas on electrically thick substrate, slotted patch antenna and stacked shorted patches have been proposed and investigated.

M. T. Islam, N. Misram, M. N. Shakib, and M. N. A. Zamri[1] proposed study of Circularly Polarized Micro strip Patch Antenna increase the bandwidth of proposed antenna obtained is 27% (2.14-2.81GHz) at -10 dB Return Loss. A A Deshmukh and G Kumar [2] proposed compact L Shape patch broadband Microstrip antenna experimentally increase bandwidth up to 13.7%. Z M Chen [3] further increase bandwidth of this antenna up to 23.7% - 24.43%. Ahmed H. Reja [4] proposed Study of Micro Strip Feed Line Patch Antenna experimentally increase the Return Loss -33.6dB at 2.5GHz frequency and VSWR is 1.5 by using CAD (Microwave office 2000 version 3.22) for RT DUROID 5880. Santanu Kumar Behera and Y. Choukiker [5] proposed Design and Optimization of Dual Band Micro Strip Antenna using Practical Swarm Optimization maximize the return loss for dual band Frequency at 2.4GHz is -43.95dB and at 3.08GHz is -27.4dB. K F Lee [6] proposed U Shape slot shorting post small size Microstrip Antenna and increase bandwidth up to 42%. S C Gao [7] used uniplanar photonic band gap structure for enhancing band width and gain. M Khodier [8] New wideband stacked microstrip antennas for enhancing band width. The resulting antenna using the proposed structure has an ultra-wide bandwidth of 35%, compared to 21.8% for the conventional stacked antenna structure. Major issue for micro strip antenna is narrow Bandwidth.

II. MATHMATICAL ANALYSIS

Theoretical analysis and calculations From of all dimensions will be obtained,
The width of the patch element (W) is given by.

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

Substituting c = 3x108 m/s, ε r = 2.2, and f o = 5 GHz, then

W =2.3717cm or 933.74 mile.

The effective of the dielectric constant (εreff) depending on the same geometry (W, h) but is surrounded by a homogeneous dielectric of effective permittivity εreff, whose value is determined by evaluating the capacitance of the fringing field.

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

Substituting ε r = 2.2, W =2.3717cm, and h =0.1575cm, then ε reff = 2.0475cm or 806.14mile.

The effective length (L eff) is given

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{reff}}}$$

Substituting c = 3x108 m/s, ε reff = 2.0475cm, and f o = 5 GHz, then L_{eff}=2.0965cm or 825.42 mile.

The length extension (ΔL) is given by:

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

Substituting reff = 2.0745cm,W =2.3717cm, and h =0.1575cm, then ΔL= 0.08224cm or 32.380mile.

The actual length (L) of patch is obtained by:

$$L = L_{eff} - 2\Delta L$$

Substituting ΔL= 0.08224cm, and L_{eff} = 2.0965cm, then L=1.932cm or 760.63mile.

II. ANTENNA DESCRIPTION

The results of proposed E-Shaped Multiband microstrip patch antenna verified in IE3D Simulator

A. Proposed Antenna at13GHz on 62 mil RT DUROID 5880 substrate:

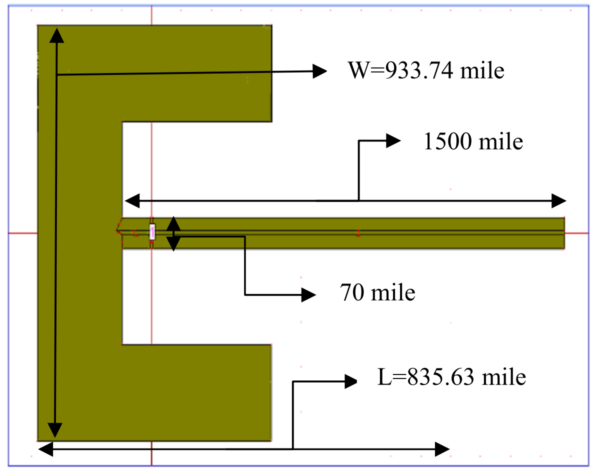

Fig. 1 Antenna Overview

The Proposed antenna has:-
Proposed Patch length = 75+760.63
Proposed Patch Width = W
Strip Path Length= 1500miles
Strip Path Width= 70miles
Cut width =300miles
Cut depth = 300 miles

III. RESULT AND DISCUSSIONS

A. Comparison of Different Micro strip Patch Antenna in Different Patch Length in IE3D Simulator for 62 mil RT DUROID 5880 Substrate

(1)Patch length when L=610.63

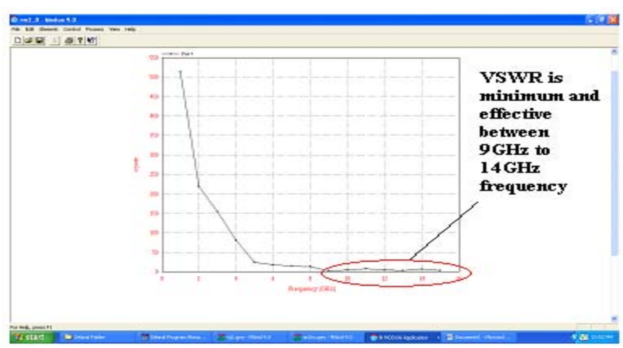

Fig. 2 VSWR Vs Frequency (in GHz)

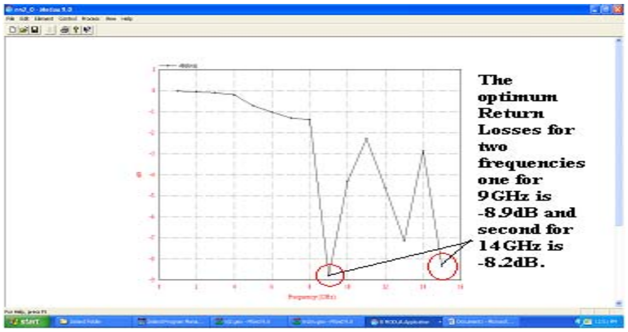

Fig. 3 Return Loss Vs Frequency (in GHz)

(2) Patch length when L=685.63

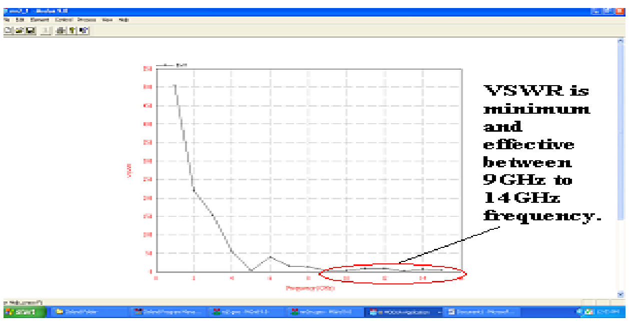

Fig. 4 VSWR Vs Frequency (in GHz)

Fig. 5 Return Loss Vs Frequency (in GHz)

(3) Patch length when L=760.63

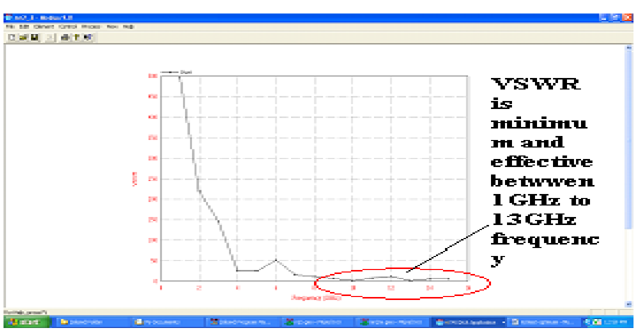

Fig. 6 VSWR Vs Frequency (in GHz)

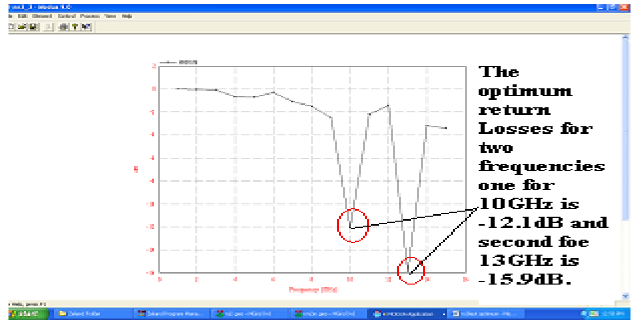

Fig. 7 Return Loss Vs Frequency (in GHz)

(4) Patch length when L=835.63

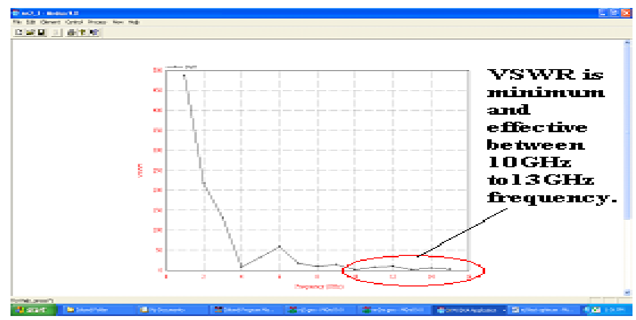

Fig. 8 VSWR Vs Frequency (in GHz)

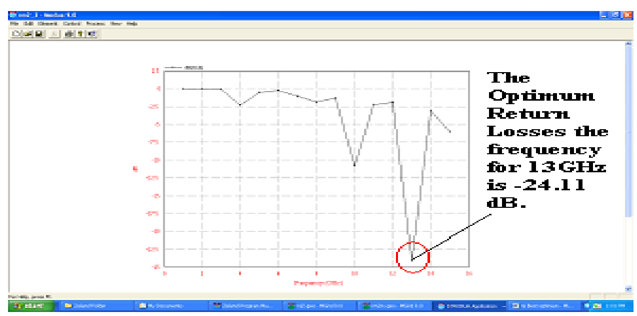

Fig. 9 Return Loss Vs Frequency (in GHz)

(5) Patch length when L=910.63

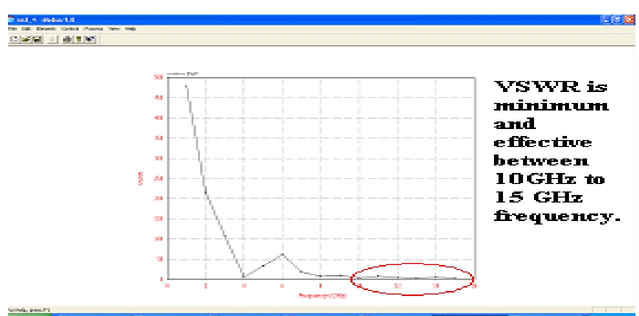

Fig. 10 VSWR Vs Frequency (in GHz)

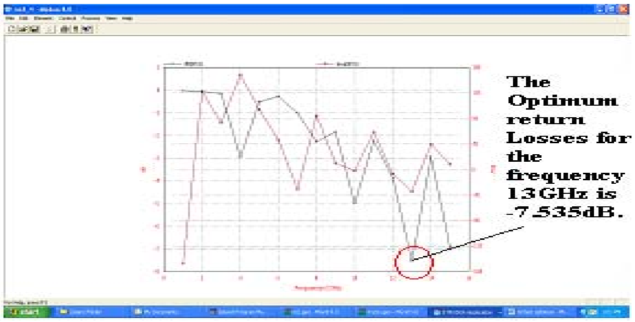

Fig. 11 Return Loss Vs Frequency (in GHz)

C. Best Result Simulated Micro strip Patch Antenna in IE3D Simulator for 62 mil RT DUROID 5880 Substrate

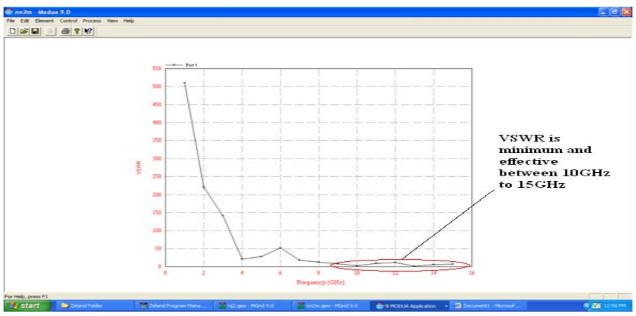

Fig. 12 VSWR Vs Frequency (in GHz)

For proposed design the value of VSWR is effective between 10GHz to 15GHz, for this value return loss is minimum. At 13GHz return loss is -26.29dB and VSWR is 1.102, At 7GHz VSWR is 7.617, 10GHz VSWR is 1.299, At 11GHz VSWR is 7.724, at 14GHz VSWR is 5.52.

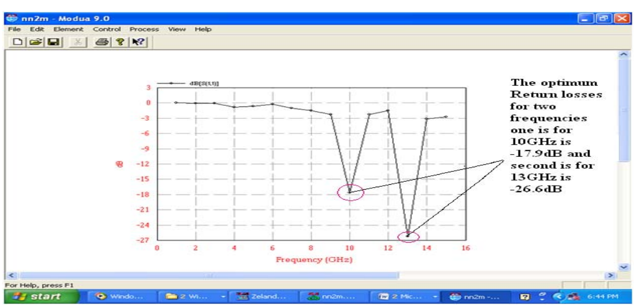

Fig. 13 Return Loss Vs Frequency (in GHz)

The frequency at 10GHz return losses is -17.71, at 11GHz return losses is -2.262, and at 13GHz return losses reduce very significantly -26.29.

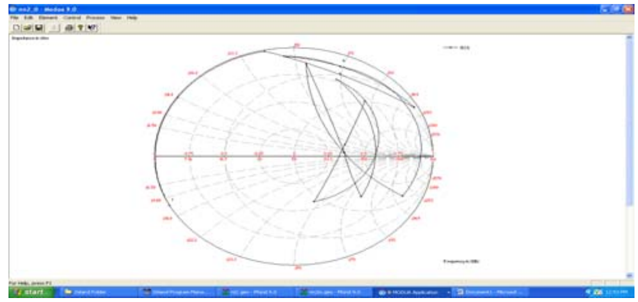

Fig. 14 Smith Chart for Different Measurement

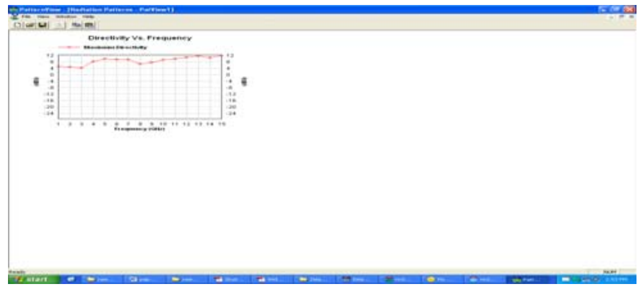

Fig. 15 Directivity Vs Frequency (in GHz)

At 10GHz frequency Directivity is 9dBi, at 12GHz Directivity is 11dBi, at 13GHz Directivity is 12dBi, at 14GHz Directivity is 10dBi.

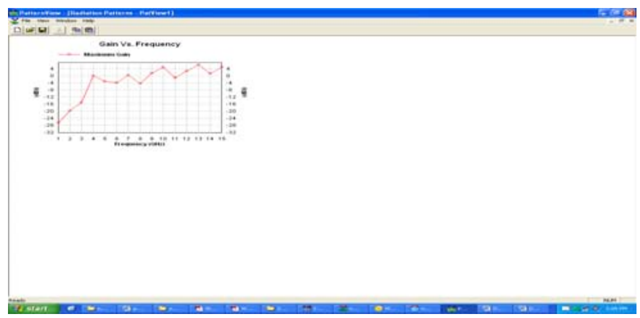

Fig. 16 Gain Vs Frequency (in GHz)

At 10GHz Frequency Gain is 5dBi, at 12GHz Gain is 3dBi, at 13GHz Gain is 7dBi, at 15GHz Gain is 5dBi.

D. Radiation Pattern for 13GHz Frequency:

(1) Study of different Azimuth pattern and Elevation pattern in IE3D. Analysed radiation characteristic of antenna at 13 GHz shown in figure.

(A). Elevation Pattern

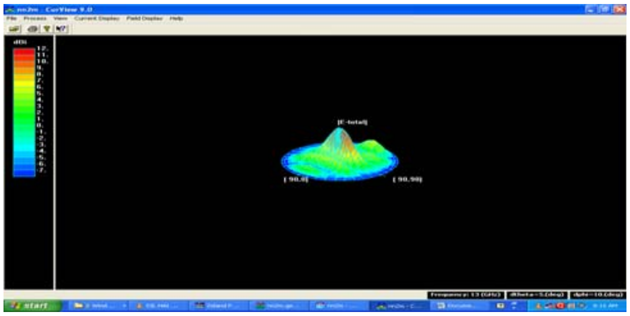

Fig. 17 Elevation Pattern of E Maximum

Fig. 18 Elevation Pattern of E Total, E Right, E Left, E Theta, E Phi at Phi=90 (deg)

(B). Azimuth Pattern

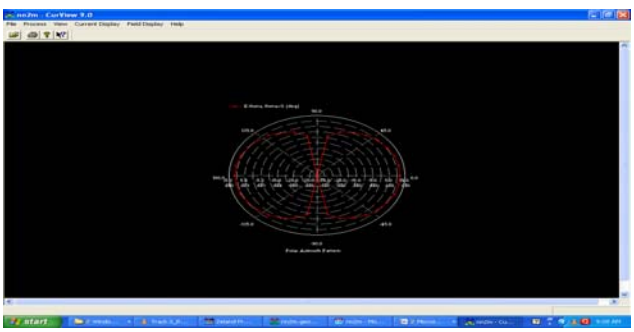

Fig. 19 Azimuth Pattern of E Theta=0(deg)

(3). Axial Ratio Pattern

(A). Elevation Pattern

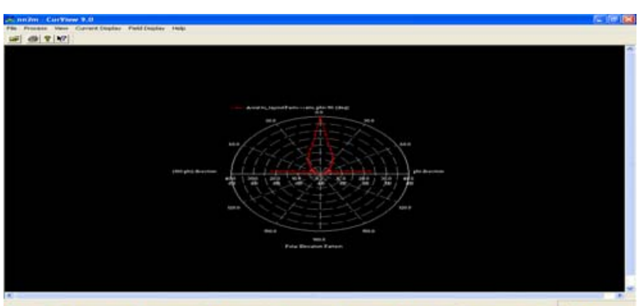

Fig. 20 Axial Pattern of Phi= 90(deg)

(B). Azimuth Pattern

Fig. 21 Axial Pattern of theta = 0(deg)

(C). 3D Pattern

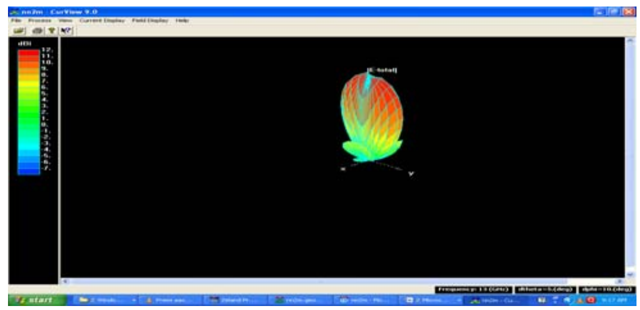

Fig. 22 Elevation Pattern at E-total

(4) 2D Radiation Pattern

(A). Elevation Pattern

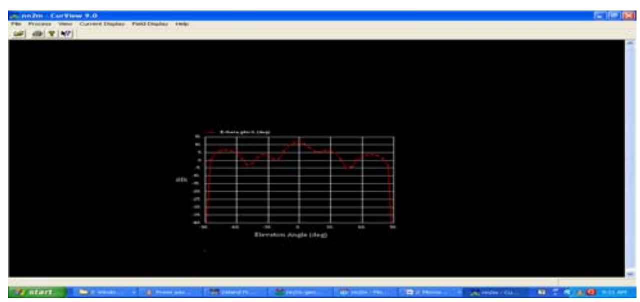

Fig. 23 Elevation Pattern at E-theta at phi=0(deg)

(B). Azimuth Pattern

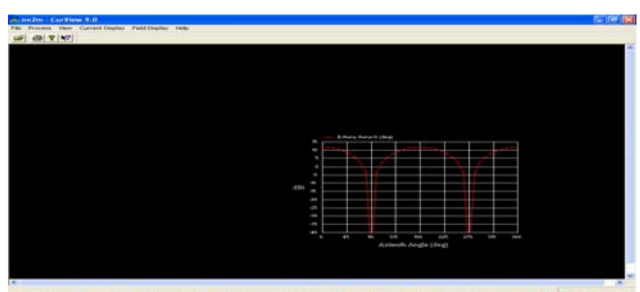

Fig. 24 Azimuth Pattern at E-total at theta=0(deg)

IV. CONCLUSION

Micro strip antennas have become a rapidly growing area of research. Their potential applications are limitless, because of their light weight, compact size, and ease of manufacturing. One limitation is their inherently narrow bandwidth. However, recent studies and experiments have found ways of overcoming this obstacle. A variety of approaches have been taken, including modification of the patch shape, experimentation with substrate parameters, Most notably mobile communication systems where many frequency ranges could be accommodated by a single antenna. We here design simple and low costlier patch antenna for pervasive wireless communication by using different patch length. When the proposed antenna design on a 62mil RT DUROID 5880 substrate from Rogers-Corp with dielectric constant of 2.2 and loss tangent of 0.0004. The proposed antenna has addition of extra 75mile (L= 855.63) patch length and some little changes of patch width and more feed line length. The proposed frequency range 13GHz (Ku Band) and Analysis Radiation Characteristics of micro strip Antenna by IE3D Simulator. The results of proposed designing are effective between 1GHz-15GHz. proposed antenna simulated in IE3D Simulator. The optimum results of proposed antenna verify and tested in IE3D SIMULATOR. The achievable bandwidth of the proposed antenna is 31% (9.6-13.3 GHz). The simulated results of IE3D at 13GHz is Return loss = -26.29dB, VSWR = 1.102, Directivity = 12 dBi, Gain = 7dBi, 3 dB beam width = 21.3627 degrees, Mismatch loss= -0.0102249dB is very low, Efficiency= 28.844%, Total Radiated Power= 0.00287768W, Average Radiated Power= 0.000228999W/s and Input Radiated Power at ports= 0.00997648.The proposed 62mil RT DUROID 5880 substrate E-Shaped multiband micro strip antenna effective work on 10GHz(x band), and 13GHz (Ku Band) the proposed antenna work very effectively for pervasive wireless communication.

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TABLE 1: Return Losses for Different Length Values vs. Frequency

Freq GHz	[S(1,1)] for L=610.63	[S(1,1)] for L=685.63	[S(1,1)] for L=760.63	[S(1,1)] for L=835.63	[S(1,1)] for L=910.63	Optimum dB [S(1,1)]
1	-3.387e-002	-3.443e-002	-3.504e-002	-3.569e-002	-3.639e-002	-3.411e-002
2	-7.952e-002	-7.91e-002	-7.928e-002	-8.e-002	-8.127e-002	-7.908e-002
3	-0.1127	-0.1139	-0.1192	-0.1325	-0.1632	-0.124
4	-0.2182	-0.3211	-0.6951	-2.339	-2.954	-0.837
5	-0.7274	-8.423	-0.7113	-0.5555	-0.5299	-0.6435
6	-1.024	-0.4398	-0.3357	-0.2977	-0.2807	-0.3404
7	-1.313	-1.19	-1.124	-1.068	-1.007	-1.049
8	-1.397	-1.434	-1.519	-1.87	-2.276	-1.511
9	-8.802	-7.201	-2.535	-1.312	-1.837	-2.294
10	-4.322	-5.829	-12.1	-10.83	-5.	-17.71
11	-2.289	-2.13	-2.236	-2.265	-2.24	-2.262
12	-4.637	-2.029	-1.46	-1.929	-3.886	-1.584
13	-7.14	-10.08	-15.89	-24.11	-7.535	-26.29
14	-2.881	-2.938	-3.224	-3.089	-2.939	-3.188
15	-8.369	-5.061	-3.419	-6.048	-6.954	-2.733

TABLE 2: VSWR for Different Length Values vs. Frequency

Freq GHz	[S(1,1)] for L=610.63	[S(1,1)] for L=685.63	[S(1,1)] for L=760.63	[S(1,1)] for L=835.63	[S(1,1)] for L=910.63	Optimum dB [S(1,1)]
1	513.0	504.5	495.8	486.7	477.3	509.2
2	218.5	219.6	219.1	217.1	213.8	219.7
3	154.1	152.5	145.8	131.2	106.5	140.1
4	79.61	54.1	25.01	7.472	5.937	20.77
5	23.9	2.222	24.43	31.29	32.79	27.01
6	16.98	39.51	51.76	58.36	61.9	51.04
7	13.25	14.62	15.48	16.28	17.27	16.58
8	12.46	12.14	11.47	9.327	7.676	11.53
9	2.14	2.549	6.901	13.26	9.493	7.617
10	4.102	3.091	1.661	1.806	3.57	1.299
11	7.632	8.197	7.812	7.713	7.799	7.724
12	3.835	8.603	11.93	9.044	4.545	11.0
13	2.568	1.913	1.382	1.133	2.448	1.102
14	6.084	5.968	5.451	5.683	5.967	5.51
15	2.234	3.529	5.146	2.987	2.63	6.408