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Performance Analysis of L-Shaped Microstrip Patch Antenna for Wi-Max Application

S.Kannadhasan[1], M.Rubadevi[2], S.Sushmitha[3], S.Vimala[4]

Assistant Professor, Department of Electronics and Communication Engineering, Cheran College of Engineering, Tamilnadu, India[1]

UG Student, Department of Electronics and Communication Engineering, Cheran College of Engineering, Tamilnadu, India[2,3,4]

ABSTRACT: Wireless infrastructure is one of the most important fields of science in today's field of communication systems, and an analysis of communication systems is incomplete without knowledge of antenna function and architecture. This was the primary motivation for us to pursue a project in this region. The aim of this project is to build an L-Shaped Microstrip Patch Antenna with improved gain and bandwidth, as well as to investigate the impact of antenna measurements Length (L), Width (W), and substrate parameters relative dielectric constant (r), substrate thickness on antenna gain and bandwidth. The conducting patch may be formed into a rectangle. Some configurations are more difficult to interpret and necessitate extensive computational calculations. HFSS simulator is used to simulate the desired patch antenna. Patch antenna is realized according to design specifications. A Microstrip Patch Antenna in the L- Shaped has been designed. The parameters such as VSWR, gain, reflection coefficient, and efficiency are measured, and the proposed antenna's simulated results are promising.

KEYWORDS:- L-Shaped, VSWR, Gain and Radiation Pattern

I. INTRODUCTION

The antenna is a small-printed Bluetooth/LTE/UWB/X-band/Ku-band monopole with a heavy rejection triple band-notch. WiMAX (3.30-3.80 GHz), WLAN IEEE802.11a/h/j/n (5.15-5.35 GHz, 5.25-5.35 GHz, 5.47-5.725 GHz, and 5.725-5.825 GHz), and downlink satellite channel are among the notched bands (7.1-7.9 GHz). With calculated large band rejection (VSWR = 14.59 at 3.69 GHz, VSWR = 39.40 at 5.42 GHz, and VSWR = 6.43 at 7.57 GHz) and a UWB useable fractional bandwidth of 157.75 percent (2.285-19.35 GHz = 17.065 GHz), a triple band-notch feature is achieved by including an offset T-shaped stub and etching two C-shaped slots on the radiating patch [1]-[5]. PIN diodes, which power the individual notched bands, are used to achieve reconfigurable characteristics. The antenna is printed on a Rogers RT/duroid5880 substrate of 20 x 22 mm2 compact measurements. Bluetooth, LTE, UWB, and other various wireless applications for near range radar (8-12 GHz) in the X-band, as well as satellite networking in the Ku-Band with an omnidirectional pattern in the H-plane, are all possible applications for the proposed antenna. For 4G/5G smartphones, a nine-band antenna measuring 70 mm x 7 mm x 5.8 mm is used. A T-shaped coupled line and two field branches make up the antenna. The resonances at about 925 and 2900 MHz are generated using a T-shape coupled line. The lower band (698-960 MHz) is covered by one ground branch and the T-shape coupled line, whereas the 3.6 GHz band is covered by the other ground branch (3400-3800 MHz). The higher band (1710-2690 MHz) is shielded by utilizing the higher order modes of the T-shape coupled line and the field divisions. The proposed antenna has the benefit of being able to achieve a nine-band antenna with just 7 mm of ground clearance with no lumped elements. A prototype is built and then weighed. The S11 are less than 6 dB at the bands of 0.693-0.98 GHz, 1.69-2.94 GHz, and 3.05-4 GHz, according to the calculated data. The suggested antenna's 6 Db impedance operating frequency range covers the LTE700, GSM850, GSM900, DCS, PCS, UMTS, LTE2300, LTE2500, and 3.6 GHz bands. The findings of the radiation efficiency simulations and measurements are also discussed [6]-[10].

A radiating patch, dielectric layer, feed, and ground plane make up a Microstrip Antenna. Material such as copper or gold is used for the patch and the ground plane. Patches come in a variety of shapes and sizes to fit a variety of applications. Rectangular, Round, Circular Ring, Dipole, Elliptical, or Triangular Microstrip Patches are examples. Microstrip Patch Antennas are used for narrowband devices in general. It has a large beam that is created by etching a design pattern on a metallic surface on a dielectric insulating foundation. The ground plane is formed by a continuous metal sheet on the strip's opposite side. Microstrip Patch Antennas come in a variety of sizes, as seen in the diagram.

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Standard forms, such as rectangle, rectangular, circle, triangular, and so on, are common, although every unusual but continuous form is possible. Regular shapes are commonly preferred because they are simple to analyze, fabricate, have appealing radiation characteristics, and have low cross radiation properties [11]-[15]. Instead of a dielectric layer, dielectric spacers are used, resulting in a less rugged construction with a wider bandwidth.

II. RELATED WORK

A compact Microstrip Patch Antenna with a partial ground plane with symmetrical parasitical components, an expanded Microstrip thread, and an L-Shaped Patch with a rectangular slot is modeled in this article. The suggested antenna is 15201.6 mm in diameter and has a FR4 substrate with a relative permittivity of 4.3 and a failure tangent of 0.025. In an L-Shaped Patch, the cumulative impact of an expanded Microstrip line and a rectangular slot results in bandwidth enhancement. The suggested antenna's impedance bandwidths (S11 -10 dB) are 2.34-2.46 GHz, 4.61-5.92 GHz, and 9-9.9 GHz, according to simulation data. The suggested antenna's peak gain is 3.0209 dB, which is in the high frequency range. Although the antenna's gain is very low in the low frequency band due to its limited scale, it has a gain of 2.7 dB in the middle frequency band. Wi-Fi, Wi-MAX, and X-band are the best bands with this antenna. The work's measured effects are in close alignment with the proposed antenna's simulated result. A commercial electromagnetic simulator built on the Finite Integration Technique (FIT) is used to build and model the proposed antenna (CST Microwave studio). In the lab, the proposed antenna is fabricated on a FR4 substrate utilizing the chemical etching process (Phoenix) and measured with an Agilent Vector Network Analyzer (VNA) using a SMA connector.

III. DEVELOPMENT STAGES OF L-SHAPED ANTENNA

The small bandwidth of the basic element, which is normally about a few percent, is probably one of the most serious weaknesses of the Microstrip Antenna. Many techniques for increasing its bandwidth have been suggested in recent years, including introducing an impedance matching network, using stacked patches, using edge-coupled parasitic patches, and using lossy materials. The input impedance bandwidth of the conventional L-slot patch antenna is 38.80%, and its impedance properties are further increased with electromagnetic coupling utilizing the L-probe and stacked rectangular patch, which has a bandwidth of 44.4 percent.

Figure 1 depicts an L-Shaped Microstrip Antenna for 4G/5G cell phones, with dimensions of 60 mm x 8 mm x 4.8 mm. The antenna operates in the frequency ranges of 3.5GHz to 5.5GHz. The L-Shaped frame is made of a dielectric FR4 epoxy substratum with a dielectric constant of £r = 4.4 and a height of dielectric substrate of 1.6 mm, and it comes with a 50 matching impedance coaxial cable with a bandwidth of 1750 MHz and 2680 MHz. The suggested antenna configuration parameters were tested and simulated using the HFSS Simulator. The experiment employs a coaxial feed or probe feed method. The bandwidth, gain, return loss, VSWR, and radiation pattern of the built antenna were all evaluated. The concept was tweaked to achieve the best possible outcome. For 1750 MHz bandwidth of frequencies 3.5 GHz to 3.9 GHz, the estimated reflection coefficient is -18.5 dB, and for 2680 MHz bandwidth of frequencies 4.5 GHz to 4.8 GHz, it is -16.5 dB. The measured efficiencies are 65.8% to 80.4 percent in the lower band and 75.1 percent to 90.5 percent in the upper band.

The measured gains are 7.2 dBi in the lower band and 7.5 dBi in the upper band. The estimated VSWR at the lower and higher bands is 1.6 and 1.8, respectively. The simulated results of the proposed antenna are strong in terms of VSWR, radiation pattern, gain, reflection coefficient, and performance. The suggested antenna configuration is used for LTE700, GSM850, GSM900, DCS, PCS, UMTS, LTE2300, LTE2500, UWB, and other numerous X-band, Ku band, C-band, and satellite communications wireless applications (table 1).

Table.1 Parameters of L-Shaped Antenna Structure

S.No	Parameters	Range
1	Dielectric Substrate	FR4
2	Dielectric Constant	4.4
3	Input Impedance	50Ohm

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4	Height of dielectric Substrate	1.6mm
5	Operating Frequencies	3.5-5.5GHz
6	Antenna Size	60 mm x 8 mm x 4.8 mm

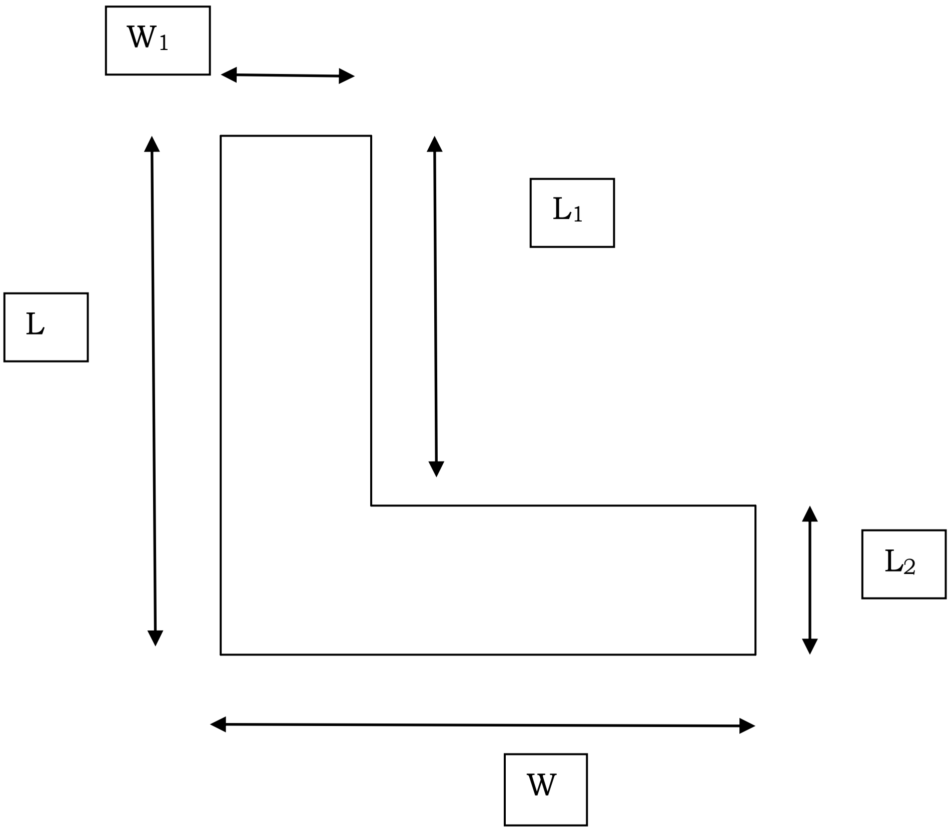

Figure.1. Proposed Model of L-Shaped Microstrip Antenna

Table. 2. Numerical Analysis of L-Shaped Microstrip Antenna

Parameters	L	W	L1	L2	W1
Value (mm)	12.43	16.59	8.54	3.89	4.25

Thus the L-Shaped Microstrip Patch Antenna designed and is Parameters are analyzed with the above proposed system values is table 2.

IV. RESULT AND DISCUSSION

Figure 2 represents output reflection co-efficient of L-Shaped Microstrip Antenna. Figure 3 represents output gain of L-Shaped Microstrip Antenna. Figure 4 represents output VSWR of L-Shaped Microstrip Antenna. Figure 5

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represents the output radiation pattern (H-Field and E-Field) of L-Shaped Microstrip Antenna. The result analysis of L-Shaped Microstrip Antenna at different operating Frequencies are shown in table 3.

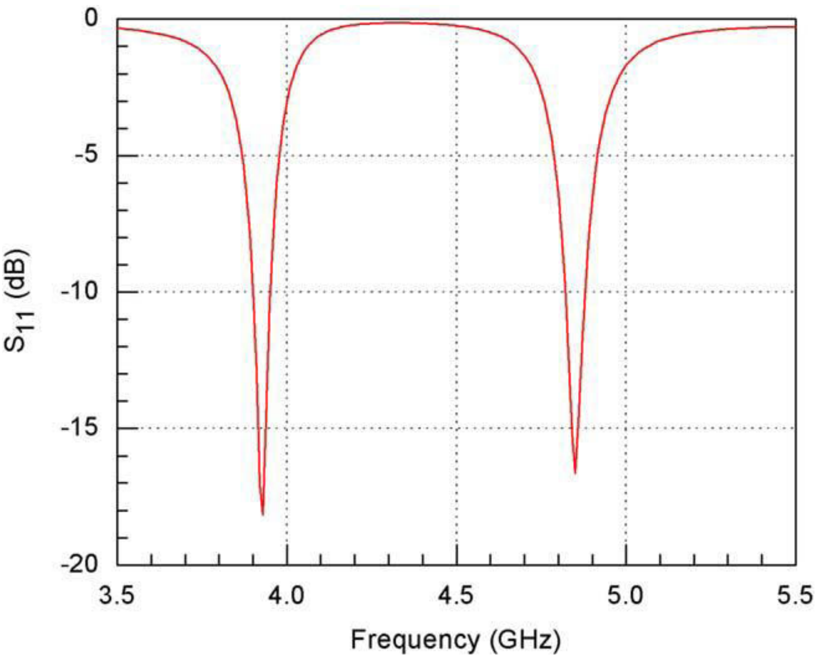

Figure.2. Reflection Coefficient of L-Shaped Microstrip Antenna

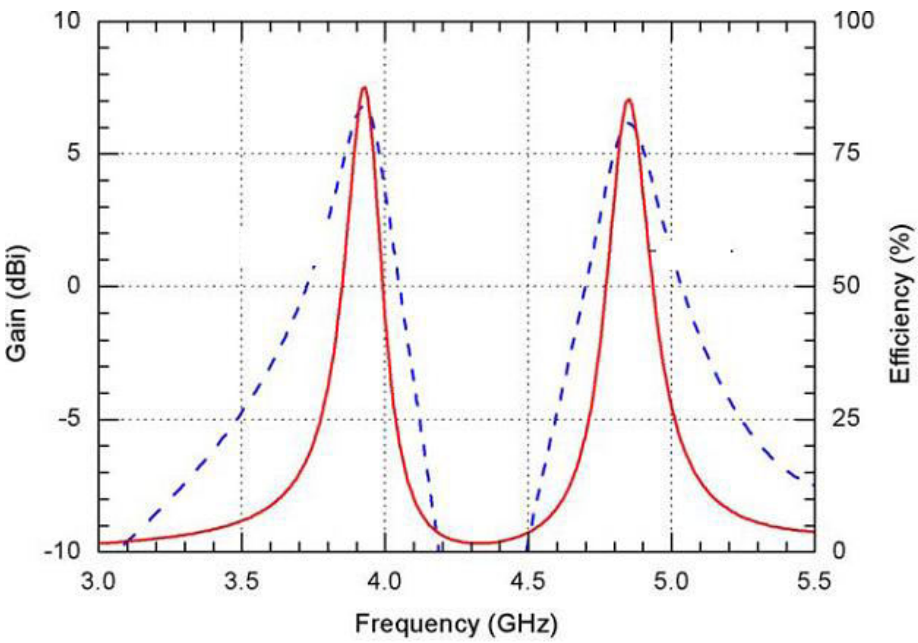

Figure.3. Gain of L-Shaped Microstrip Antenna

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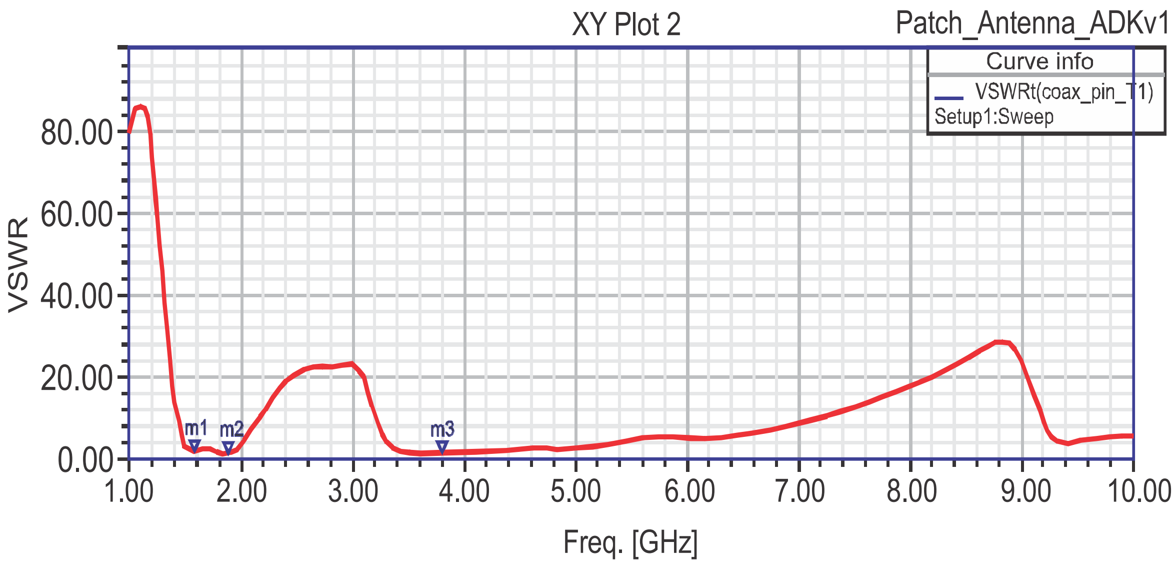

Figure.4. VSWR of L-Shaped Microstrip Antenna

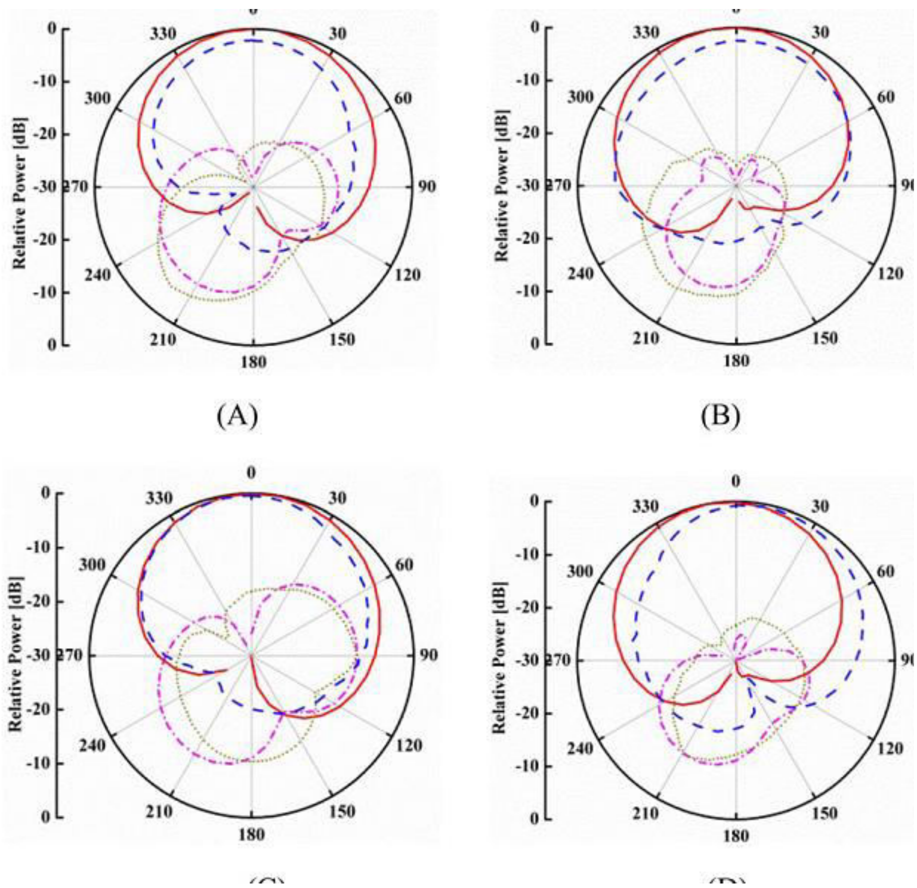

Figure.5. Radiation Pattern (H-field and E-field) of L-Shaped Microstrip Antenna

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Table.3. Result Analysis of L-Shaped Microstrip Antenna

Operating Frequencies (GHz)	Reflection Coefficient (dB)	Gain (dB)	VSWR	Efficiency (%)
3.9	-18.5	7.2	1.6	80
4.2	-17.8	7.3	1.6	85
4.5	-17.2	7.4	1.7	88
4.8	-16.5	7.5	1.8	90

Parameters of antenna such as gain, efficiency, VSWR, reflection coefficient values obtained from the designed antenna are
Gain : 7.2 dBi at lower band and 7.5 dBi in higher band.
VSWR : 1.6 at lower band and 1.8 at higher band.
Efficiency : 65.8% to 80.4% at lower band and 75.1% to 90.5% at higher band.
Reflection coefficient : -18.5 dB at 3.5 to 3.9 GHz and -16.5 dB at 4.5 to 4.8 GHz.
The above results show that the proposed antenna is suitable for Wi-MAX communication system and for 4G/5G mobile phones. The efficiency obtained is greater than 90% which is a desirable one. VSWR is 1.6 and 1.8 which is less than 2 shows that the antenna designed is efficient.

V. CONCLUSION

The analysis of methods that aid in antenna design optimization was the main objective of this project. In this article, an L-shaped Microstrip Patch Antenna is modeled and its output parameters are examined. The comparison of the traditional and proposed antennas was thoroughly investigated. The comparisons were thorough, including the examination of antenna structures at similar frequencies and with varying measurements. HFSS (High Frequency Structure Simulator) software was used to run all of the simulations. The simulation and study provide effects that are very similar to the real circumstances, allowing the antenna to be programmed thus saving resources and time. 1750MHZ bandwidth of frequencies 3.5GHZ to 3.9GHZ and -16.5dB of 2680MHZ bandwidth of frequencies 4.5GHZ to 4.8GHZ, respectively, provide a calculated value of reflection coefficient of -18.5 dB. The measured efficiencies range from 65.8% to 80.4 percent in the lower band and 75.1 percent to 90.5 percent in the upper band. The measured increases are 7.2dBi in the lower band and 7.5dBi in the upper band. The estimated VSWR at the lower and higher bands is 1.6 and 1.8, respectively. The proposed antenna performs well in terms of VSWR, radiation pattern, gain, reflection coefficient, and performance. LTE700, GSM850, GSM900, DCS, PCS, UMTS, LTE 2500, UWB, and other X-band, Ku band, C band, and satellite connectivity utilize the suggested antenna system. It is also well-suited to Wi-MAX applications.

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