ANALYSIS OF A COMPACT WIDEBAND CIRCULAR SLOTTED MICROSTRIP PATCH ANTENNA

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Abstract- ***In this research work, from the designing of a circular slotted rectangular shaped antenna for full filling the requirements of S-Band and C-Band applications at 3.29- 7.98 GHz frequency. It is observed that the value of wideband in proposed antenna is 4.687 GHz (4687 MHz) which is very wide with respect to wideband of reference antenna which has 4.28 GHz (4280 MHz) bandwidth. So the difference between proposed antenna and reference antenna is 4.687 – 4.280 = 0.407 GHz= 407 MHz. So the value of wideband is very large than the reference antenna. The parametric study of the designed antenna has been attempted in this thesis. The physical parameters examined in this study include the dimensions and locations of the substrates and their dielectric constants, feed line, ground plane coupling slot and patch.***

Keywords- Circular slots, Wideband antenna, Microstrip line feed, C-Band, S-Band, Return Loss, Smith Chart, VSWR, resonant frequency and HFSS.

I. INTRODUCTION

Presently rapid growing of wireless communication and is the fastest growing segment of the communication field. Wireless communication systems have been growing as the application of mobile phones and systems are booming in use. Antenna is not active device; they are passive that only guides the signal energy in a peculiar direction in connection with isotropic antenna. Some of the alluring characteristics of antenna include low profile, radiation emitted from the antenna should be less, less bulkier, high gain, fabrication should be done in an uncomplicated manner. Microstrip patch antenna is the most suitable and prevalent type of antenna in use today, their effective frequency range is in between 1GHz to 6 GHz. Since 1970s this antenna has been flourishing, where its size and performance were very effective as conversation entity was required at these frequencies. The architecture of the microstrip patch antenna consists of the substrate of which below is the ground plane and above is the patch. [1].

The advancements in microstrip antenna technology ensued its start in the late 1970s. Basic microstrip antenna elements and arrays in term of design and modeling had been utilized at fair level by the early 1980s. In the last decades printed antennas have been largely analyzed owing to their merits such as light weight property, miniaturized size, lesser cost, conformability and the easy integration with active device over other radiating systems. The conducting materials such as copper and gold due to their better conductivity and adhesive property to substrate are generally used on the outer surfaces of the substrate for the purpose of patch and ground. Electromagnetic wave radiation from microstrip patch antennas occurs primarily by the reason of the fringing fields between the patch edge and the ground plane [2].

Microstrip Patch Antennas has quite a lot of advantages over other antennas due to their light weight, low profile, low cost of production, and are easily well-suited with optoelectronic integrated circuits (OBICs) and microwave monolithic integrated circuits (MMICs). Due to these striking features, the researchers are having noteworthy attention towards microstrip antennas. Microstrip patch antennas are used in extensive range of applications such as in wireless communication and biomedical diagnosis.[3]

In recent years, the widespread proliferation of wireless communication has augmented the demand for compact broadband antennas for handheld devices, satellite systems, etc. To overcome the inherent limitation, many techniques such as probe fed antenna, stacked shorted patches, patch antenna with thick substrate electrically and slotted patch antenna have been planned and investigated. In general, there are different shapes for Microstrip Patch Antenna is available, such as Disc sector, Square, Rectangular, Elliptical, Dipole, Circular, Triangular, Circular ring and Ring sector. Each design has its own merits and demerits. In this paper, a fan shaped microstrip patch antenna for the above said application is presented. The fan shaped antenna resonates at two frequency with DGS provided to progress the antenna characteristics. This defect provided disturbs the current distribution of the patch antenna, which in turn is due to the change in characteristics of the effective capacitance and inductance of the microstrip patch antenna. These microstrip patch antennas have caused a tremendous revolution in the field of space technology owing to their promising [4].

II. WIRELESS NETWORKS

Wireless Communication is the process of transmitting radio waves or micro waves over a distance between the two points without any physical wire attachment. It encompasses various types of devices such as Bluetooth, remote control, Hand-held walkie-talkies, personal digital assistant, wireless computer mice and so on.[5]

Worldwide Interoperability for Microwave Access is a wireless communications standard designed to provide a high speed data rates. Its capability to deliver high-speed Internet access and telephone services to subscribers enables new operators to compete in a number of different markets. In urban areas already covered by DSL (Digital Subscriber Line) and high-speed wireless Internet access, WiMAX allows new entrants in the telecommunication sector to compete with established fixed-line and wireless operators. The increased competition can result in cheaper broadband Internet access and telephony services for subscribers. In rural areas with limited access to DSL or cable Internet, WiMAX networks can offer cost-effective Internet access and may also encourage the UMTS/HSDPA (Universal Mobile Telecommunications System/ High Speed Downlink Packet Access) operators to extend their networks into these areas. WLAN is designed to operate in the frequencies bands 2.4-2.5GHz (802.11b/g/n), 3.6 GHz (802.11y),4.9-5.9In various wireless communication applications, microstrip patch antennas are highly preferred due to their light weightiness, small size, low cost, conformability and the ease of integration with active device. It is known that one of the major microstrip antennas limitations is their low gain. Regular substrate geometry is no longer able to provide solutions to more critical and demanding future applications. Satellite-communication applications require structures of low profile, good radiation pattern and high gain. Much research has gone into further increasing the gain; these include using phased array antennas, inevitably, as the number of array elements is increased more antenna volume is required. Another way is to use a thick lower permittivity substrate. Knowing that the patch size is inversely dependent to the substrate permittivity, thus, substrate with higher permittivity is needed to ensure the patch compactness. Fiber Reinforced (FR4) is good in this regard; also its low cost is another benefit. Nevertheless, more permittivity is increased; more the patch suffers from losses inherent the substrate due to the surface waves that propagate along the substrate. These waves, will also lead to increased coupling between adjacent elements and can cause ripples in the radiation pattern [6].

Many applications including aviation (aeronautical radio navigation and radio navigation satellite), satellite communication and maritime aviation (space operation, mobile satellite and earth exploration satellite), wireless communication (mobile except aeronautical mobile and broadcasting satellite), private land mobile (space research), fixed microwave devices, ISM equipment, personal land mobile, personal radio and amateur radio utilize the microstrip patch antennas that have a radiating patch mounted on a dielectric layer (substrate) supported by a ground plane. These microstrip patch antennas provide significant performance with an appreciable bandwidth. Several recent microstrip patch antennas have been studied in this literature review. In yet another work, maximum attained gain is 3.4 dBi. Also both of and slotted rectangular patches in offer a peak gain less than the proposed antenna. Even the triangular slot microstrip patch antenna for wireless communication as in offers a much less gain [7].

III. BASIC PATCH ANTENNA GEOMETRIES

In its most basic form, a microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate, which has a ground plane on the other side as shown in Figure1.

The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate

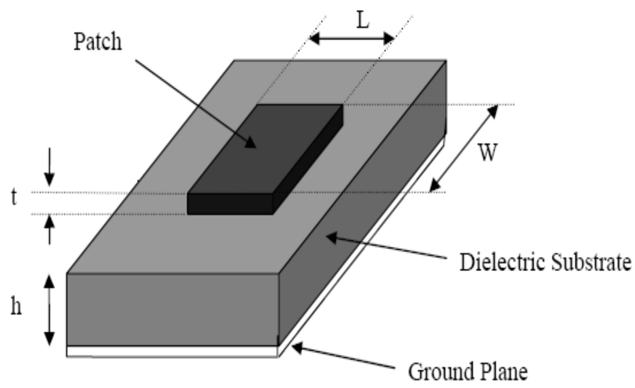

Figure 1: Basic Microstrip patch antenna

The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate. In order to simplify analysis and performance prediction, the patch is generally square, rectangular, circular, triangular, and elliptical or some other common shapes. Rectangular patches are probably the most utilized patch geometry.
It has the largest impedance bandwidth compared to other types of geometries, and is the main research interest in this project. Circular and elliptical shapes are slightly smaller than of rectangular patches. Thus it will have smaller bandwidth and gain. This circular geometry patches were difficult to analyze due to its inherent geometry.

Triangular patch is even smaller than both rectangular and circular geometries. However, this will produce even lower gain and smaller bandwidth. It will also produce higher cross-polarization due to its unsymmetrical geometry. Dual polarized patch could be generated from these geometries.

Circular ring patches has relatively the smallest conductor size, but at the expense of bandwidth and gain. Furthermore, for this geometry, it will not be easy to excite lower order modes and obtain a good impedance match for resonance. Non-contacting forms of excitation are normally turned to for this shape.

For a rectangular patch, the length L of the patch is 0.3333 λo< L< 0.5λo, where λo<< is the free-space wavelength. The patch is selected to be very thin such that t<<λo (where t is the patch thickness). The height h of the dielectric substrate is 03333.0≤ h ≤ 0.5λo. The dielectric constant of the substrate is typically in the range 2.2< ε_r <12

Microstrip patch antennas radiate primarily because of the fringing fields between the patch edge and the ground plane. For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation. However, such a configuration leads to a larger antenna size[1,2].

IV. DESIGN & RESULT ANALYSIS

Design of Proposed Wideband Antenna with five circular Slots: In which the antenna parameter are same as above but there is a change in positions of four extra small circles which are cut from the patch to find more wider band, uses normal ground plane while other dimensions are same.

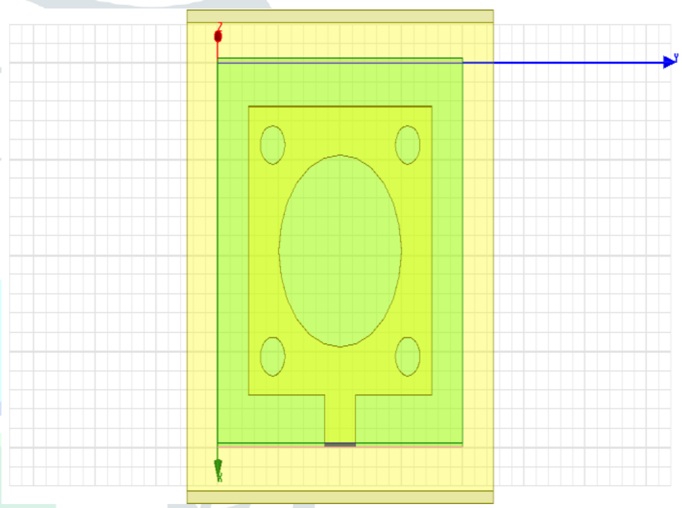

Figure 2 Proposed wideband antenna design with changed slots position

The Return loss plot: The return loss plot for the designed antenna at -10 dB bandwidth with microstrip line feed is shown in figure as below.
Resonant frequency = 3.80 GHz at -32.74 dB
Band width= f2-f1= 7.9809 – 3.2963= **4.6846 GHz**= which is good **(4.68- 4.28) GHz = 0.4 GHz = 400 MHz** more than base paper return loss result.

Figure 3 Simulated return loss

VSWR plot: The VSWR plot for the proposed antenna is 1.0472 which is very close to ideal value one.

Sr.No	RETURN LOSS (dB)	BANDWIDTH (GHz)	VSWR	IMPEDANCE MATCHING
1. Reference Antenna	-25.5	6.19-1.91= **4.28**	1.11	About 55 ohm
2. Proposed Antenna	-32.74	7.980 – 3.293= **4.687**	1.04	50.47 ohm

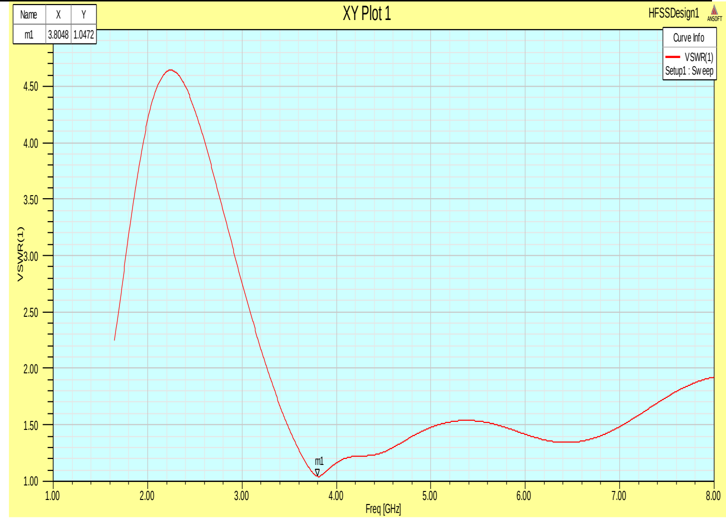

Figure 4 VSWR plot

The Smith Chart Plot: The Smith Chart of Proposed Antenna: Smith Chart of this antenna shows a very good impedance matching of about value 1.0094 ×50 = 50.47 ohm which is practically very good as close to characteristic impedance 50 ohm.

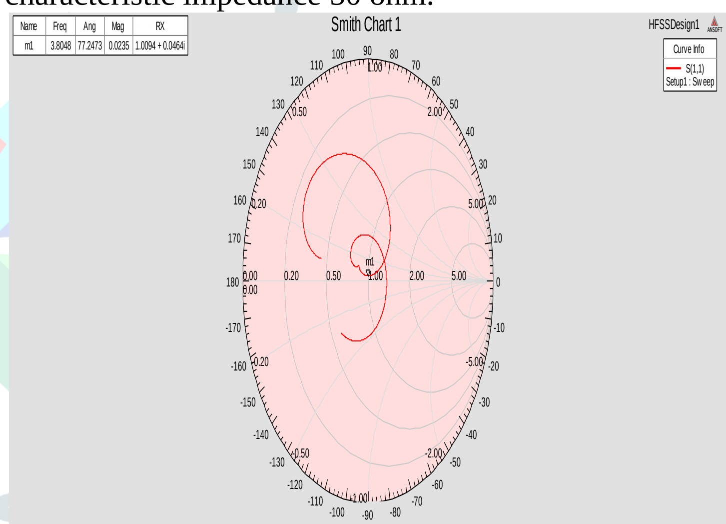

Figure 5 Smith Chart Plot.

V. Observation with difference between results of reference and proposed antenna of wide band:

Hence from the designing of circular shaped antenna for full filling the requirements wide band wireless applications at 3.29 - 7.98 GHz frequency. It is observed that the value of wideband in proposed antenna is 4.687 GHz (4687 MHz) which is very wide with respect to wideband of reference antenna which has 4.28 GHz (4280 MHz) bandwidth. So the difference between proposed antenna and reference antenna is 4.687 – 4.280 = 0.407 GHz= 407 MHz. So the proposed wideband is wider than the reference antenna.

Table 1 Difference result of reference and proposed antenna of wide band

VI. CONCLUSION

In this research work, a typical wideband microstrip patch antenna with circular shape patch forming a simple and efficient technique of design has been introduced for the betterment of bandwidth and impedance matching, also, giving the same performance at the desired resonant frequency. In this the ultra wide band microstrip patch antenna is proposed for the various wireless applications. A novel compact wide band microstrip antenna was designed. This antenna bands is designed for different wireless bands.

Hence, it has been shown that microstrip antenna can be analyzed both theoretically and experimentally through simulations and fed by microstrip line feeding technique. The wideband microstrip patch antenna can have single resonant frequency but can design a single microstrip patch antenna that covers multiple bands.

Ultra wide band microstrip patch antenna has been successfully designed at the frequency of 3.8 GHz.

VII. REFERENCES

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