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Design And Analysis Of Various Patch And Substrate Technology Antenna For Satellite Communication Application

K.Arulmozhi[1], P.Rajeswari[2]
Pg Student[1], Associate proffesor[2]
(Dhanalakshmi Srinivasan Engineering College)[1&2],Perambalur.
Arulmozhinkp94@gmail.com[1],prajeswari2k5@gmail.com[2]

Abstract: *The proposed T shaped resonator structure can be used as the building block of improved design filters with tunable operating frequency. Micro strip antenna is an electrical antenna which consists of a metallic patch on a grounded substrate. To minimize the interference with using tunable notch bands. Micro strip antennas were primarily used for space borne applications which uses frequencies of the microwave range. The main intention of this project is to design and characterize Rectangular Microstrip patch antenna to operate with UHF-band frequency of 240MHz. In this development, a Rectangular Micro strip antenna resonating at 240MHz frequency has been designed and characterized using HFSS(High Frequency Structural Simulator) software. The parameters of the antenna in the element of the bandwidth, radiation pattern, and return loss have been found out using the HFSS software. The specific frequency chosen here is used for space communications, radar applications, amateur radio, other terrestrial communications and networking.*
Keywords: *Circular polarized, Patch antenna, UHF satcom, HFSS,*

I. Introduction

An antenna is an important basic component in the communication system. Basically antennas are the metallic structures designed for radiating and receiving the electromagnetic energy in an effective manner which is used for conveying the information. The antenna provides the links between transmitter to free space and free space to receiver. The characteristics of the communication system are mainly depends upon the characteristics of antenna used in that system. the different antennas are used in different system based on the requirements. For satellite communication, circularly polarized antennas are often used since they have the ability to mitigate the multipath effects and provide additional freedom to the orientation angle of the transmitting and receiving antennas. In modern communication system, circularly polarized antennas with compact size are desired for overall size reduction and mobility improvement of the communication systems, especially at lower frequencies. Circularly polarized antennas such as spiral antennas and cross-dipole antennas support wideband operations, however, they often require a ground plane to provide unidirectional radiation pattern, which increase the overall size of the antenna. On the other hand, patch antennas are desirable for miniature antenna design as they have the advantages of low profile and easy to fabricate.

There are many researches in progress in overcoming these disadvantages in order to make full use of advantages such as ease in design, ease in manufacturing and low cost in manufacturing these compact Micro strip antennas. The performances of these antennas are dependent upon their physical configuration. Various methods to improve the performance of antenna on their physical configuration are suggested by the researchers. Micro strip patch antennas are fed by two methods that are categorized into contacting and non-contacting method. In contacting methods, RF power is fed to the radiating patch directly by using the connecting link which is the Micro strip line. In non-contacting method, electromagnetic field coupling is conducted by transmission of power from Micro strip line to radiating patch.In Micro strip line, different type of feed techniques are used there are coaxial probe (both contacting schemes), aperture coupling and proximity coupling (both non-contacting schemes). In this paper, antenna structure with U-slot is designed by cutting a indentation in a rectangular Micro strip patch antenna. Moreover, in this research, we consider the effect of very high operating frequency in MHz range which increases chances calculation error in the model. In this paper,proposed antennacan be used for broadcasting, remote sensing, aeronautical radio navigation and mobile satellite applications.Antennas are essential components of all equipment that uses radio. Broadcasting, broadcast, two-way radio, communications receivers, radar, cell phones, and satellite communications, as well as other devices such as garage door openers, satellite microphones, Bluetooth-enabled devices, satellite computer networks, baby monitors, and RFID tags on merchandise which are used in the system.

Commercial substrate materials are readily available for use at RF and microwave frequencies, specifically for the design of micro strip antennas and printed circuits. Selection is based on desired material characteristics for optimal performance over specific frequency ranges. Common manufacturer specifications include dielectric constant, dissipation factor (loss tangent), thickness, and Young’s modulus.

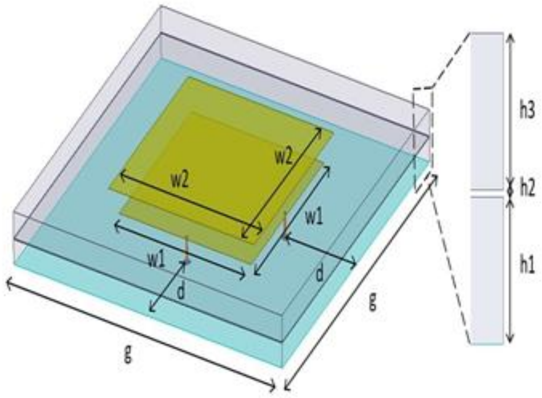

Fig. 1. Initial stacked patch antenna design.

Table I: Dimensions Of The Initial Patch Antenna Design On Different Substrates (In Millimeters).

	w1	w2	d	h1	h2	h3	g
FR4	215	254	96.5	22	0.8	15.2	400
TC600	190	217	109	18	0.8	19.2	400
TMM10i	148	172	130	18	0.8	19.2	400

when designing micro strip antennasthickness of the substrate is considerableimportance. The most desirable substrates for antenna performance are the ones that are thick with a low dielectric constant. This tends to result in an antenna with a large bandwidth and high efficiency due to the loosely bound fringing fields that emanate from the patch and propagate into the substrate. However, this comes at the expense of a large volume antenna and an increased probability of surface wave formation. On the other hand, thin substrates with high dielectric constants reduce the overall size of the antenna and are compatible with MMIC devices, since the fringing fields are tightly bound to the substrate. With thin substrates, coupling and electromagnetic interference (EMI) issues are less probable. However, because of the relatively higher loss tangents (dissipation factors), they are less efficient and have relatively smaller bandwidths. Therefore, there is a fundamental trade off that must be evaluated in the initial stages of the Micro strip antenna design – to obtain loosely bound fields to radiate into free space while keeping the fields tightly bound for the feeding circuitry and to avoid EMI.

II. Existing System

A slot loaded rectangular micro-strip patch antenna and a sub-wavelength compact, resonant patch antenna loaded with meta material. In this patch the slot is taken as capacitive reactance. It is found that the resonance frequency decreases by increasing slot width for a given slot length the decrease in the resonance frequency in the lighter side for longer slot length, where as it is in the min. side for the lower slot length, in case of resonant patch antenna loaded with metamaterial the matching and radiation properties have analyzed. These configurations may reveal in principle an arbitrarily low resonant frequency for a fixed dimension, when their size is electrically smallthey may necessarily radiate efficiently. Demand for compact radiators with sufficiently high gain is rapidly increasing in many application areas, as modern satellite telecommunication systems and space communications require compact antennas with high gain, which become even more relevant requirements when the radiating elements have to be combined in large antenna arrays for satellites, space vehicles, airplanes, and so on. Micro strip patch antennas, due to their inherent capabilities (mainly low cost, low weight and low profile) are widely used in those setups. Even though such antennas are very thin compared to the operating wavelength (0.05-0.01 λ) in their cross section, however, still their transverse dimensions cannot be made arbitrarily short, since a regular patch antenna resonates at a given frequency when its linear transverse dimension is of the order of half wavelength. The interest in overcoming this limitation represents one of the main challenges for antenna designers. In this context of novel artificial materials an important role may be played by metamaterials, which, due to their interesting anomalous electromagnetic features, have attracted a great deal of attention in recent years for several electromagnetic applications.

In the present paper, we have comparatively analyzed the rectangular antenna loaded with metamaterial and fed with Micro strip line by thoroughly revisit the theory of patch antennas in terms of resonance frequency and VSWR with respect to slot length and slot width with the help of equivalent circuit diagram to show how suitable pairing of metamaterials and standard dielectrics may indeed allow a sub-wavelength resonance in such structures. Determined to get such quasi-static resonances for patch antenna setups necessary and sufficient condition are required. Then, the radiation properties of such sub-wavelength patches are studied theoretically, showing which configurations may be designed to properly radiate in free space. Finally, some optimized designs are verified through full-wave numerical simulations, taking into account dispersion,losses and feeding networks for these devices.

III. Proposed System

In antenna design, the important factor is that antenna must be capable of working for different bands must have small in size. In this mpaper presents design and simulation of multiple u slot antenna by using HFSS simulation software for wireless applications. In this demonstration, slots have been cut on side of patch so as to obtain better characteristics; initially 30 mm patch length is taken and analyzed using coaxial feed at (1, 13, 0).U slots cut in patch is having 6 mm length and 2 mm wide. Two straight arms are surrounding it with dimensions of 1x 8 mm^2. This u slot is repeated for four sides.. By cutting four u slots, antenna resonated at 4.6 GHz, 5.2 GHz and 7.4 GHz with return loss of -19.81 dB, -11.10 dBand-18.1 dB with bandwidth of 200 MHz, 100 MHz and 800MHz. This antenna had good gain with maximum power in major lobe direction. This antenna can be most widely used for defence and secure communication application, WLAN application, satellite, RADAR and different C band applications. Parametric analysis had been applied by varying substrate thickness, feed point, substrate, changing dimensions of patch. It is found that best results obtained using patch of dimensions30mmusingFR-4assubstrate.

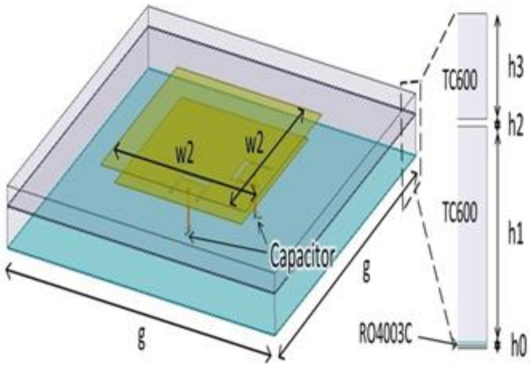

Fig.2. Schematic of the proposed antenna design with U-slots Isometric view.

In the current state developments in wireless communication industries continue to derive requirement of small, compatible and affordable micro strip patch antennas. A patch antenna is a narrowband antenna with large beam width. It is fabricated by engraving the antenna element pattern in metal trace which is bonded to an insulating dielectric substrate such as a printed circuit board with a continuous metal layer bonded to the opposite side of the substrate known as a ground plane. Micro strip antenna can have different shapes which are square, rectangular, circular and elliptical, but antenna can have any continuous shape. Instead of using a dielectric substrate, some antennas can be made of a metal patch mounted above a ground plane using dielectric spacers. They are often mounted on the exterior of aircraft and spacecraft or are incorporated into mobile radio communications devices. Micro strip antennas are best choice for wireless devices because of characteristics like low profile, low weight, ease of fabrication and low cost. Since it is common practice to combine several radios into one wireless and use single antenna. Microstrip antenna can have less bandwidth and gain sometimes it will be suffered.

Different techniques have been used like cutting slot in patch, fractal geometry and DGS to obtain multiband and wideband characteristics. In order to DGS has been used to increase the bandwidth. When cutting shape from ground planeDGS may be realized. This Shape can be simple or complex. It is to be observedthat within particular area of ground.Different resonant frequencies and differentbandwidth can be produced by using different DGS. A 90° hybrid coupler feeding network was designed on the Rogers RO4350B substrate layer of the antenna to

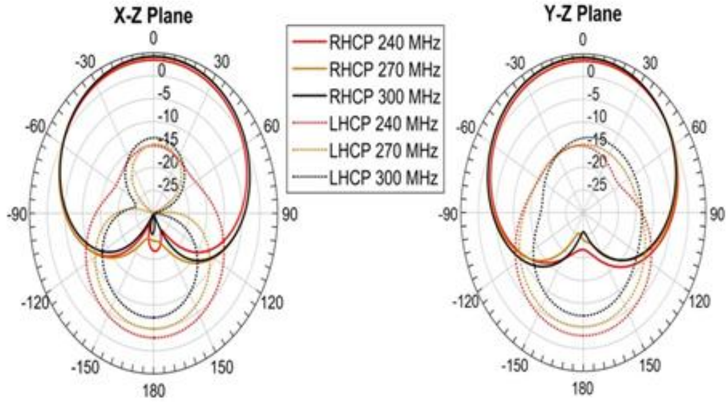

Fig. 3. Simulated radiation patterns in X-Z plane and Y-Z plane at different frequencies.

feed the feeding probes with phase offset of 90°. Other feeding networks such as T-junction microstrip or Wilkinson power divider can also be used to feed the antenna. However, due to the high *S*11 value of this antenna, the unique feature of the 90° hybrid coupler, which reflected energy from the output ports is transmitted to the isolation port [16], is used to improve the *S*11 of the antenna.

Various applications like defense, airplane and military applications are used in microstrip antenna. But these antennas suffer from inconvenienciesof small bandwidth, gain and return loss. In order to improve antenna characteristics, different techniques have been used like use of fractal geometry, defected ground structure and cutting slot. In this dissertation, slots have been cut on side of patch so as to obtain better characteristics; initially patch of length 30 mm is taken and analyzed using coaxial feed at (1, 13, 0). FR-4 has been used as substrate with dielectric constant of 4.4 and loss tangent of 0.02. Design is modified by making a u slot so as to make similar to that of reference antenna. Details of antenna dimensions are made in table 1. These dimensions had been used to design antenna. Various applications like defense, airplane and military applications are used in microstrip antenna. But these antennas suffer from inconvenienciesof small bandwidth, gain and return loss. In order to improve antenna characteristics, different techniques have been used like use of fractal geometry, defected ground structure and cutting slot. In this dissertation, slots have been cut on side of patch so as to obtain better characteristics; initially patch of length 30 mm is taken and analyzed using coaxial feed at (1, 13, 0). FR-4 has been used as substrate with dielectric constant of 4.4 and loss tangent of 0.02. Design is modified by making a u slot so as to make similar to that of reference antenna. Details of antenna dimensions are made in table 1. These dimensions had been used to design antenna.

Performance of that antenna,Gain is perhaps the most widely used descriptor. Most commonly used more than one designationor interpretation. Most antennas are passive devices which do not have power gain in the sense that an amplifier may paradepower gain. A particular antenna may radiate much more power in a given direction than an isotropic antenna in the sense of viewed from the standpoint of a generalizedreceiver. Therefore, the ratio of the intensity is called gain, in a given direction, if the power accepted by the antenna were radiated isotropicthat time radiation intensity would be obtained.Note that the total power radiated from an antenna is related to the total input power by a coefficient called antenna radiation efficiency. The greater the radiation efficiency, the greater the energy transmitted or received. According to the IEEE standard, gain doesn't include losses arising from impedance mismatches (reflection losses) and polarization mismatch (losses). This means, therefore, that the gain takes into account only the loss of the dielectric and conduction system of the same antenna. The reflection losses and the polarization mismatch are very important losses and they need to be included in the link calculation of a communication system to determine the received or radiated power.

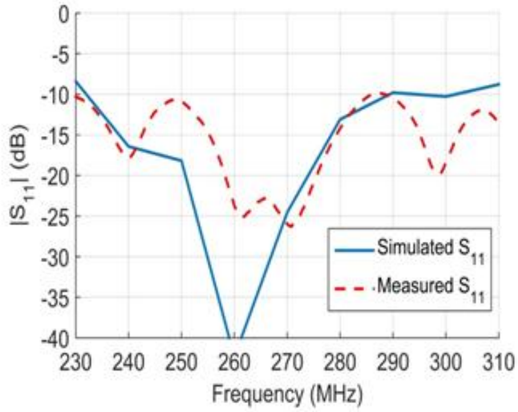

Fig.3. Measured S_{11} of the fabricated antenna.

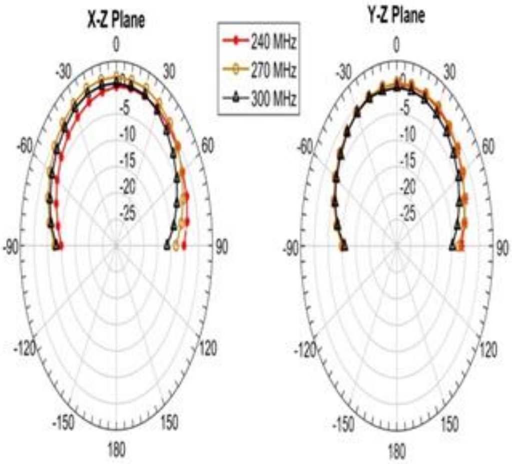

Fig.4. Measured Radiation patterns of the fabricated antenna.

Micro strip antennas have numerous advantages such a slight weight, low profile, easy fabrication and simple modeling. They can be designed to operate over a large range of frequencies (14- 18 MHz) and easily combine to form linear or planar arrays. The substrate dielectric constant used for micro strip antenna generally low (typically ~ 2.5) to reduced fringing field.The proposed antenna is designed for 2.45 MHz frequency with E shaped patch. Coaxial feed is the simplest feed for micro strip antennas. In this, an inner conductor of coaxial line is attached to the radiating patch while outer conductor is connected to ground plane. It has spurious radiation because the radiating and feeding systems are disposed on two sides of ground plane and shielded from each other

IV. Conclusion

It may be concluded that loading of patch with narrow slot. Affects significantly resonance frequency.input impedance and bandwidth increase with slot with for a given slot length. we have analyzed the possibility of designing sub wavelength resonant patch antennas using met material blocks. Realistic numerical simulations, considering material dispersion, losses and the presence of the feeding network have been also presented, providing a validation of the theoretical results and showing how a practical realization is foreseeable. While as with the equilateral triangular Micro strip antenna with Micro strip feed it is found that 35.5% of space can be save is constructing ETMP structure. This may indeed open interesting venues for the design of small-scaled antennas with enhanced performance.

A small-size Micro strip antenna for UHF band Application using probe feed and aperture feed is proposed and successfully implemented. It is concluded that unequal slot in patch provides a bandwidth of 16.4 % with 4 dB gain and near about 1.06 VSWR. This proposed Micro strip antenna enhanced the impedance bandwidth and provides good matching. This antenna simulated by HFSS'11.The bandwidth of Micro strip antenna can be further increased by changing the configuration of the patch to different shapes such as Patch antenna or U-slot Patch antenna. The simulation will be done using HFSS.

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