REVIEW OF MICROSTRIP PATCH ANTENNA FOR S-BAND APPLICATIONS

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Abstract: ***The Microstrip patch antenna is probably the most simplest and popular planar antenna. From the appearance of the satellite communication we need to improve two key aspects in the communication systems: The quality of the service as well as the costs. One of the ways to achieve these two aspects is the high gain of communication components. The capabilities require Nano-satellite to be equipped with an efficient, high gain, wideband and small antenna to facilitate communication links with each other and with ground stations. However, the limited real estate, power and communication opportunities of Satellite pose real challenges to any antenna designs. Specifically, designs are required to meet the size and weight restrictions of Satellites while yielding high gain and wide bandwidth This research is about design of planar antenna for satellite communication applications using various performance improvement techniques. This paper explores the capability of the Microstrip antenna at S-band for the Nano-satellite communication.***

IndexTerms - ***Microstrip Antenna, high gain, S-band, Circular Polarization, and Axial Ratio.***

I. INTRODUCTION

Nowadays miniaturization technologies make it feasible to develop smaller satellites than those built a decade ago without degrading the performances. The number of planned missions based on small, mini, micro and even Pico-satellites, referred to henceforth as small satellites, is continuously increasing. Small satellites are attractive because they require lower investments, low cost mass production while offering greater reliability, lower launch costs and greater launch flexibility.

An antenna is one of the most important elements in the RF system for receiving or transmitting signals from and into the air as medium. The Microstrip antennas have been object of study for researchers around the world with the purpose to use them in the telecommunications with the objective of reducing size, cost and improving the quality in the communications.

The Microstrip antennas are designed in such a way that its structure dissipates the power in the particular direction in form of radiation when applied with electrical signal as shown in Fig.1. The important advantages of these planar antennas includes low profile, adaptability to the form of the structure, simple and cheap manufacturing and can work on different frequencies and different polarizations. However, common Microstrip antennas are suffering from limitations like narrow bandwidth, limited power capacity and tolerance problems.

In this paper, To design a rectangular micro-strip patch antenna in which asymmetric v slots are cut in micro-strip patch to enhance its axial ratio bandwidth and gain response.. It is expected that the design may reduce the drawback effects of the Microstrip antenna like low gain, narrow bandwidth and poor directivity.

II. LITERATURE SURVEY REVIEW

Several studies have been conducted on Circular polarized antenna technique in order to proposed new Circular polarized high gain antenna design with improvement in overall system performance in term of its good return loss, voltage standing wave ratio (VSWR), radiation pattern, directivity and gain. HORYU-IV is a 30 cm cubic nano -satellite for a total mass of about 8 kg which is presently under development stage at Kyushu institute of technology (kyutech). HORYU-IV's main mission is to measure discharge current waveform and capture image of the discharges occurring in solar cells, namely discharge mission (DIS). A high gain antenna will be utilized to realize the high data-rate downlink channel for necessary payload data transmission from HORYU-IV to the ground station.

A compact square-shaped circularly polarized antenna is presented for Pico-satellite application. Four dipole antennas are integrated with a phase delay line on a Rogers RO4003C to operate at 2.4 GHz with a dimension of 0.724λg (55mm) × 0.724λg (55mm) × 0.0112λg (0.85mm) based on the lowest guided wavelength. Reflection and radiation performance exhibited are acceptable, with an impedance bandwidth and axial ratio bandwidth of 34 % and 11 % respectively. The proposed antenna operates in circular polarization with a maximum gain of 3.49 dB at 2.45GHz [1].

The power divider can be used in order to change the input values (current input) for each port of the butler matrix. So we didn't need many signal generator to supply input of butler matrix (example for 4x4 butler matrix we just put 1 to 4 Power Divider on input port of butler matrix). A power divider has been designed in this research to support the smart antenna system for satellite tracking, telemetry, and command (TT&C). This research designed the modified Wilkinson Power Divider 3 port to be 5 ports with 4 output ports which can work at a frequency of 2.3 –2.45 GHz with the insertion of each port is < -8 dB, the maximum value theoretically. Amounted to -6dB. This is because the power divider works by dividing power into 1:4 ratio [2].

A novel S band dual circularly polarized antenna array with 12 elements is presented for airborne satellite communication applications. The antenna array is composed of Microstrip patches, 3dB hybrids and dividers. The simulated and measured results show that an impedance bandwidth of 14% (VSWR<2) is achieved. Radiation patterns with low cross polarization are achieved. The overall size of the array is 2.4λ×1.7λ×0.09λ, which makes the antenna array suitable for airborne satellite communication applications. This antenna has a gain of 13.0dBi at freq 2.28GHz [3].

In this design, a circularly polarized antenna is proposed for satellite communication system. Commercially available Finite Integration Technique (FIT) based software Computer Simulation Technology (CST) microwave studio and finite element method solver based High Frequency Structural Simulator (HFSS) have been used in this analysis. The proposed antenna achieved 3dB axial ratio of 30 MHz with -10dB reflection coefficient. This antenna has a gain of 5.3dBi at freq 2.35GHz [4].

The S-band patch circular polarized antenna for cube satellite application is presented. The antenna has a compact size and its geometry and characteristics are compatible with any cube sat standard structure. The proposed designed antenna has been gain of 8.3 dB experimental measurements shows that antenna achieves good performance match at the desired frequency of 2450 MHz, a directivity of 8.3 dB [5].

A single layer coaxial feed rectangular Microstrip patch antenna designed by introducing different slits on the patch so that it can resonate at different frequencies in Ku-band 15GHz satellite applications is proposed. The Proposed antenna having gain is around 8.0 dB [6].

The purpose of this work is to present and discuss insights of such technology potentially relevant for the automotive market and oriented toward such industry. The product-technology road mapping presented here makes it apparent that today a set of new services in the S band is available, but the target market has not yet positively considered its introduction. To illustrate this situation, this paper describes the example of satellite bi-directional automotive antennas dedicated to the mentioned S-band system. This antenna has a gain of 2.0dBi at freq 2.17GHz [7].

The present of improved shorted patch antenna for inter Pico-satellite communications, and suitable for use in inter Pico-satellite communications in terms of gain, bandwidth and size. We have simulated both antennas in the High Frequency Structure Simulator (HFSS). The antenna has been improved shorted patch antenna has a resonance frequency of 2.45 GHz, and operates with a bandwidth from 2.05 to 5.7 GHz at VSWR ≤ 2 and provides a gain of 3.51 dB. In addition, the Quasi Newton method is used to shift the shorted patch antenna's operating frequency to S-band 2.45 GHz [8].

A circularly polarized, high gain, patch antenna with low axial ratio dedicated for S band nano-satellite communications is presented. Four slotted slits in the diagonal directions on the square patches and a parasitic element are introduced to create circularly polarized (CP) radiation with a large axial ratio beam width. Simulation and measurement results are given, indicating that this S band antenna realizes the required HORYU-IV nano-satellite specifications in terms of frequency bandwidth, gain, circular polarization bandwidth, and axial ratio (AR) beam width. This antenna has a gain of 6.0dBi at freq 2.28GHz [9].

The design of maximum gain of S-band antenna for interactive services with electronic beam steering capabilities. The antenna used to simultaneous reception and transmission of S-band signals and can track the position of a geostationary satellite by electronically switching among a finite set of beams. The tracking system is based on combination of position and attitude sensors embedded in the antenna. The antenna has a low-profile design that allows an easy installation on vehicles without altering their aerodynamics. This antenna has a gain of 9.4dBi at freq 2.01GHz [10].

A single layer coaxial feed rectangular Microstrip patch antenna designed by introducing different slits on the patch so that it can resonate at different frequencies in Ku-band 15GHz. This antenna has a gain of 8.0dBi [11].

This design presents unidirectional antennas for mobile satellite communication systems. The antennas integrate the functionalities for the new S-band mobile satellite systems, the GPS and the GSM/UMTS bands. The achieved structures are low-profile and can be easily installed in any car while maintaining its aesthetics or integrated in plastic structures of the vehicles. The main aspects of the antenna implementation are described together with the main results of the antenna. This antenna has a gain of 2.0dBi at freq 2.17GHz [12].

This design presents the design of an intermediate gain S-band antenna with electronic beam steering capabilities. The tracking system is based on combination of position and attitude sensors embedded in the antenna. The antenna has a low-profile design that allows an easy installation on vehicles without altering their aerodynamics. The main aspects of the antenna implementation are described together with the results obtained with the first prototypes of the antenna .This antenna has a gain of 1.8dBi at freq 2.0GHz [13].

In this rectangular patch antenna for nano-satellite applications is presented. The proposed S-Band Patch antenna has been designed and simulated using ADS software. Optimizations the bandwidth efficiency by choosing suitable size without affecting any other parameters of the antenna is the challenge taken over in this work. The low cost, less weight patch antenna has 2 antenna elements of physical dimension 37mm*27mm*1.25mm separated by 10mm. The substrate material being used is Alumina with dielectric constant 9.6. The proposed antenna is designed to be used for TTC and downlink payload purposes. The proposed patch array antenna suitable all the parametric needs for a Polar orbiting satellite at Low Earth Orbit (LEO) region. This antenna has a gain of 6.4dBi at freq 2.45GHz [14].

A low cost all-PEC mechanically robust CP Microstrip patch antenna at S-band frequencies 2.4GHz is presented. The single coaxial feed circularly polarized antenna was optimized for a 3-unit Cube-Sat structure. The measured antenna has a maximum gain of 8.9 dB, and the -10 dB reflection coefficient bandwidth is 5.4%. [15].

The truncated Microstrip square patch antenna has been proposed and designed. Such device is used for UHF Wireless Uplink by cube sat nano-satellite. The antenna is composed of one truncated square patch, a "L" shaped $\lambda/4$ transformer and a extended ground plane [16].

The design of the LISA Antenna is mainly driven by the requirements to achieve maximum gain In bore sight direction with an antenna of limited size and minimum height. LISA is a circularly polarized, planar array antenna providing an inter-satellite link between an LEO and GEO satellite. Within this paper the basic design concept of the antenna, results of a two element breadboard model and performance tests of the full 16 element antenna are presented. The radiation patterns predicted with an electrical field simulation program are in close agreement with co- and cross-polar radiation pattern measured in a Compensated Compact Antenna Test Range. This antenna has a gain of 16dBi at freq 2.2 GHz [17].

In this study, S-Band patch antenna design procedure is examined in order to meet the TCR functional requirements in nano satellites. The proposed patch antenna can be used for transmission which includes the amateur radio applications and earth monitoring. This antenna has a gain of 5.6dBi at freq 2.1GHz [18].

The design of spacecraft, modern numerical electromagnetism can effectively deal with studies into optimization of antenna placement. Such studies are of great importance to reduce risks of disruption communication between spacecraft and Ground Stations. These efforts were concentrated on determination of a combined radiation pattern for several antennas mounted on mini-spacecraft. The Proposed antenna having gain is around 3.0dBi at 2.2 GHz [19].

In this study, antenna was excited through an aperture-coupled feed, resulting in circular polarization at 2.425 GHz with an 8% fractional bandwidth. Similarly, the S-band is utilized for communication by satellites like the SSTL micro-satellite developed by Surrey Satellite Technology Ltd. This antenna has a gain of 11.0dBi at freq 2.42GHz [20].

L.Hadj Abderrahmane and etal.has describe an S band antenna system used on microsatellite constituted by three different RF antennas: S-Band Patch antenna (for command uplink), S-Band Monopole antenna (for telemetry downlink), and S-Band Quadrafilar Helix antenna for payload downlink. The Proposed antenna having gain is around 3.0dBi at 2.2GHz [21].

In this study, Asymmetric cross slot provides the requisite perturbation to excite two orthogonal modes with 90 phase shift for CP radiation. By inserting four symmetrical slits along the diagonals of the corners truncated patch, CP is realized, and a considerable amount of size reduction is also reported. This antenna has a gain of 2.0dBi at freq 2.1GHz [22].
In this study a novel planar antenna is proposed in this paper that obviates the need for deployment and meets most of the communication requirements for a Cube sat. Key characteristics of the proposed antenna are a gain of 3.72 dB with a bandwidth of 2.82 MHz [23].
J.Xia and et al has design approach, choices of substrate material for application in small satellite is presented. Critical issues such as the effect of vibrations and Microstrip antenna's RF power handling capability is also discussed [24].

III. CONCLUSION

All the study of literature survey it is concluded that the 2.4GHz high gain S- band antenna for high speed nano-satellite applications. Several studies have been conducted on Circular polarized antenna technique in order to proposed new Circular polarized high gain antenna design with improvement in overall system performance in term of its good return loss, voltage standing wave ratio (VSWR), radiation pattern, directivity and gain.
Finally, regardless of the frequency of operation of the Nano satellite antenna, there is great interest in studying applicable techniques for broadband Microstrip antennas. One such technique is the etching of slots on the surface of the patch that are shaped after the letters U and E. Again, such broad banding techniques destroy the double orthogonal symmetry of the patch, and hence do not provide for clean circular polarization.

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