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CIRCULARLY POLARIZED MICRO STRIP PATCH ANTENNA WITH SHORTING PIN FOR WIMAX APPLICATIONS

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ABSTRACT: The primary focus is on the development of planar circularly polarized antenna, which is fabricated using PCB techniques and thus are lightweight and cost-efficient. Unlike in classical micro strip patch antenna designs, it is used the simple probe feed techniques, which substantially reduce the complexity and fabrication cost of antennas. This helps to achieve wide AR bandwidth and miniaturize the antenna.

Here Circularly Polarized Micro strip Patch Antenna with Shorting Pin for WiMAX Applications is proposed. The proposed antenna, consist of a multiple resonators which can be connected with thin micro strip lines to increase the coupling. Cylindrical shorting pins probes are used to enhanced the bandwidth of antenna. Diagonal feed network excites two orthogonal signals of equal magnitude which generated CP radiation. The protocol of proposed antenna is simulated by using IE3D.From that experimental results shown 10 dB impedance bandwidth of 13.3%, 3 dB axial ratio bandwidth is of 6.79% and measured gain over 3 dB Axial Ratio (AR) is 8.5 dBi

KEYWORDS: Circular polarization, axial ratio, broadband antenna, simple probe feed technique, square patch.

INTRODUCTION

Around 1892, concept of Poincare sphere was introduced, allowing easy viewing and analysis of all possible polarizations. On the sphere surface, azimuth angle is double the tilt of the major axis of the polarization ellipse and polar angle corresponds to the phase shift between the two orthogonal components. From a practical point of view, polarization can be classified into three categories. linear at the equator of the Poincare sphere (with horizontal and vertical polarization being in antipodes), two circular polarizations at the poles and elliptical polarization elsewhere. The elliptical polarization is a very general term and radio systems are rarely designed to use explicitly this type, although both linear and circular polarizations can be considered as special cases of elliptical polarization. Linear polarization is very simple to generate and is used for radio broadcasting, mobile phones and in many classical radio applications. However circular polarization (CP) exhibits unique properties, which are employed in high performance radio systems.

Circular polarization is immune to Earth atmospheric effects, as both orthogonal components are equal in magnitude and rotated by the same angle. This is the main reason for using CP in almost all Earth's Satellite Communication Systems. A circularly polarized wave, after reflection from a conducting surface or at surface, becomes counter polarized (that is right hand CP wave becomes left-hand CP and vice versa). This allows the antenna to filter out reflected signal and is of huge benefits for navigation systems, especially in satellite based. It also offers benefits for high data rate communication in indoor environments, as it decreases interference between direct and reflected signals.

For linearly polarized communication systems the receiving and transmitting antenna must be aligned to avoid polarization mismatch. For CP this is not required. It is worth mentioning that if ideal CP signal is received by a linearly polarized antenna, loss is 3 dB, regardless of orientation of the receiving antenna. This property is especially useful for RFID systems, as it ensures detection of portable tag regardless of its orientation. Due to several advantages as stated there is large demand for Circular Polarized Antennas.

The oldest and most simple linearly polarized antenna (i.e. dipoles and monopoles) produces omnidirectional radiation pattern, achieving similar performance with circularly polarized antenna is much more difficult. This is mainly due to the fact, that CP generation requires two orthogonal components of the electric field, each with equal magnitude and 90^0 phase shift. However, for wider angles it is difficult to maintain orthogonal ability of these components. For micro strip patch antennas, which are very convenient due to easy manufacturability? Ground plane attenuates electric component parallel to it, degrading the axial ratio. So far proposed unidirectional CP antennas usually either use multiple radiators or complex polarisers.

I. SCOPE

Increasing growth of wireless communication technologies, many satellite system and GPS applications demands the design of high gain, broadband CP antenna. Circularly polarized antenna allows more adjustable adaptation between transmitter as well as receiver antenna. CP can be retrieved when asymmetry is introduced in patch geometry or exciting two orthogonal modes in radiating patch of equal amplitude and 90^0 phase difference. The coplanar waveguide feed, has also been used to excite the MSA, the main disadvantage of this method is the high radiation from longer slot, leading to the poor front-to back ratio. The front-to-back ratio is improved by reducing the slot dimension and modifying its shape in the form of a loop. A suspended near square patch with single feed and loaded the parasitic patch with shorting pin configuration is used to achieve wide AR BW and large gain. The wideband CP radiation is achieved by the excitation of the orthogonal modes in the antenna.

II. RELATED WORK

Although use of more than two feeds may seem redundant, it was demonstrated by [4] that such antennas have significantly wider axial ratio bandwidth than dual feed antennas. Also by using four feeds, one can also excite higher modes in the patch as demonstrated in [5]. For this configuration, feed points are located at various angles in a circular patch. Three configuration discussed in [5] employ feeds located in 45^0 (for TM21 mode), 30^0 (for TM31) and 67.5^0 (for TM41). The phase shift is not proportional to the angle and is either 0^0, 90^0, 180^0 or 270^0 for odd order modes (TM11 and TM31), or two 0^0 and two 90^0 shifted inputs for even order modes (TM21 and TM41). Motivation for this arrangement is to achieve a CP conical beam, where angle of the beam can be designed in the range of 35^0 to 70^0. Antenna with single fed, it can be observed in thickness of the substrate affect the axial ratio bandwidth [6]. Horizontal micro strip feed line technique is used to achieve good impedance bandwidth in [7]. In dual feed and four feed antenna structure, modifications in patch are not required. By using 90^0 hybrid or power divider circuit, wide axial ratio bandwidth can be achieved as in [8]. Drawback of such technique is complicated structure and large antenna size. In [9], it has been shown that the VSWR bandwidth of micro strip patch antennas enhanced by adding two additional resonators, which are directly coupled to the radiating edges of a RMSA. Reference [10][11] describes the design of circularly polarized planar antennas for a cross array of given patches and a square array of nine elements which are fed by two probes. The cross-array gives axial ratios over a 3.3% bandwidth, and wide angular range, but square array of nine elements gives lesser axial ratio bandwidth. In [12], to obtain wide AR BW, circularly polarized antenna with L-shaped strip feeding and shorting-pin is proposed and AR BW of 17.9% is achieved. By using chip resistor techniques in place of shorting posts, AR bandwidth is broadened at the expense of gain.CP is achieved by placing shorting post on the radiating patch near the edges of diagonal-fed patch.

III. SYSTEM MODEL

The project implementation is divided into following Three Phases:

Step 1. Antenna Design:

In the first phase, antenna is designed that will operate in Wi-MAX bands. This is a single feed antenna that provides excellent frequency response and good circular polarization. It will be implemented using IE3D software.

Structures for Antenna

The design equations of a patch are as given below. The width W of the patch in (mm)

$$W = \frac{c}{2fo\sqrt{\frac{(\varepsilon r+1)}{2}}}$$

The effective dielectric constant ε reff, is given by

$$\varepsilon reff = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\left[1+12h/w\right]^{-1/2}$$

Where, ε r = relative permittivity of the substrate used. h= height of the substrate, w=width of the patch,
The effective length Leff of the patch is given by,

$$L_{eff} = \frac{c}{2fo\sqrt{\varepsilon reff}}$$

Where f0=operating frequency of the patch, $\varepsilon reff$ =effective dielectric constant of the substrate
The differential increase in length ΔL is,

$$\Delta L = 0.421h\frac{(\varepsilon reff+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon reff-0.258)\left(\frac{w}{h}+0.8\right)}$$

The actual length of the patch is given as:
L= L_{eff} -2 ΔL

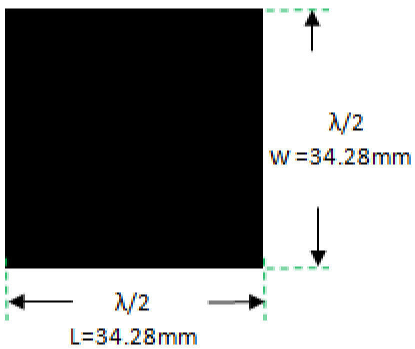

Fig.1 A Square Patch Antenna Working In ISM Band

Step 2. Directly coupled RMSAs Design:

Three directly coupled rectangular patches, only the central patch is fed and the adjoining two rectangular patches along its radiating edges are connected by thin micro strip lines. The side view and top view of actual micro strip patch antenna as shown in fig 2 and fig 3 respectively. The strips are generally located at the midpoint of the width of the patches so that antenna is symmetrical with the feed point axis. The length of these connecting strips are greater than twice the substrate thickness to minimize coupling through the gaps between the patches .When the length is less than this ,hybrid (gap and direct)coupling occurs as now the coupling between the patches is through the gap as well as due to the connecting strip.

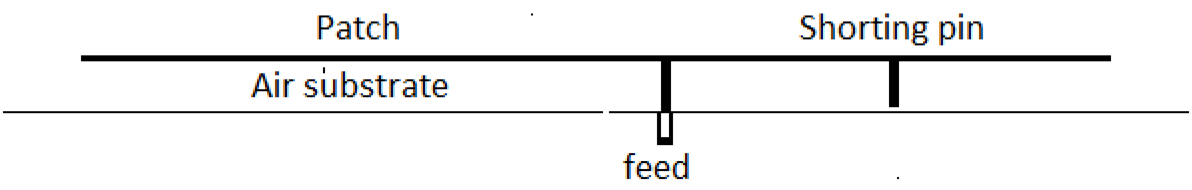

Fig.2 Side View of Micro Strip Patch Antenna

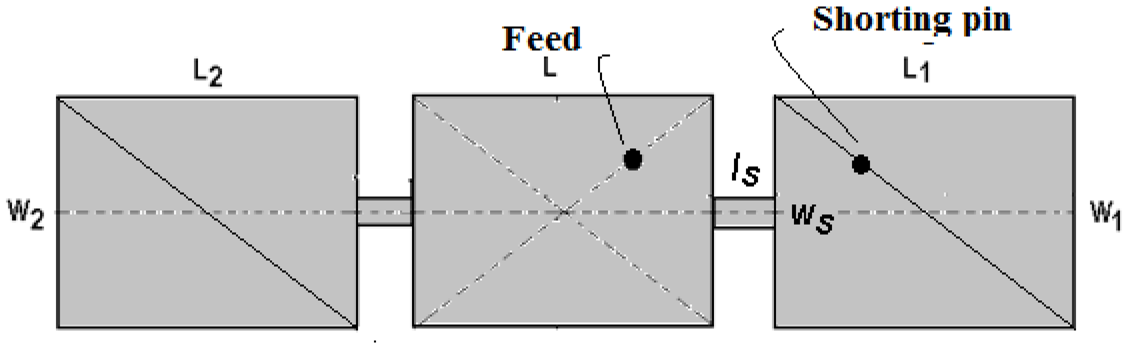

Fig.3 Top View of Micro Strip Antenna

Step 3. System Integration:

Third phase consist of co-simulation to mitigate any integration issue of first and second phase .Designed Antenna, L-strip patch and dual feed structure will be implemented on different board using FR-4 substrate.

Results for AR bandwidth and impedance bandwidth as shown in fig 4 and fig 5 as 3dB axial ratio (AR) is 6.79% and -10dB impedance bandwidth of 13.3% respectively.

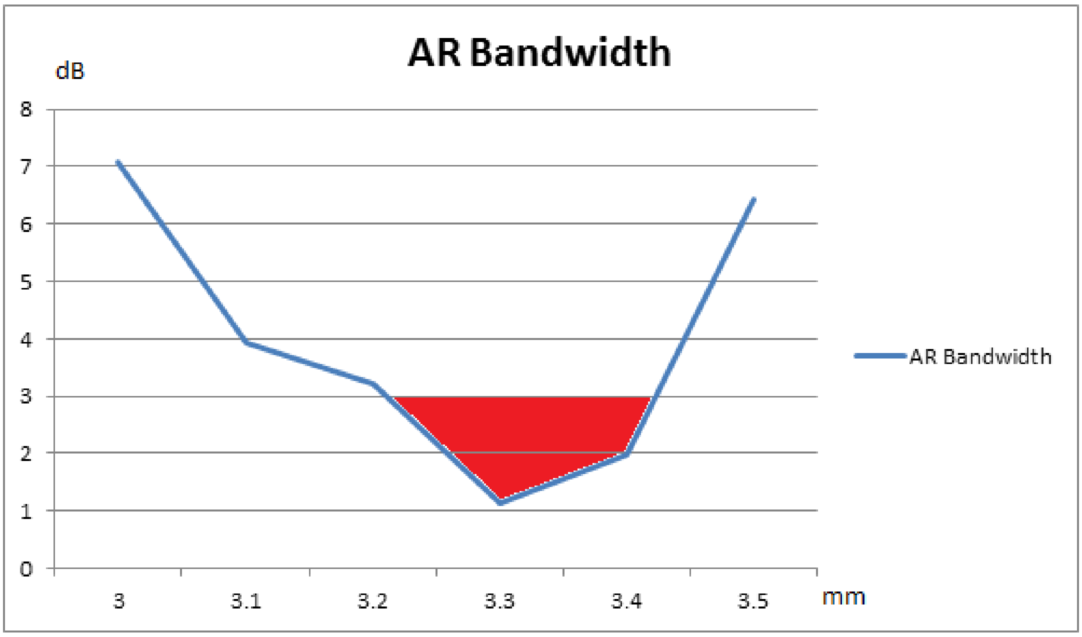

Fig.4 Axial Ratio of Micro Strip Patch Antenna below 3db

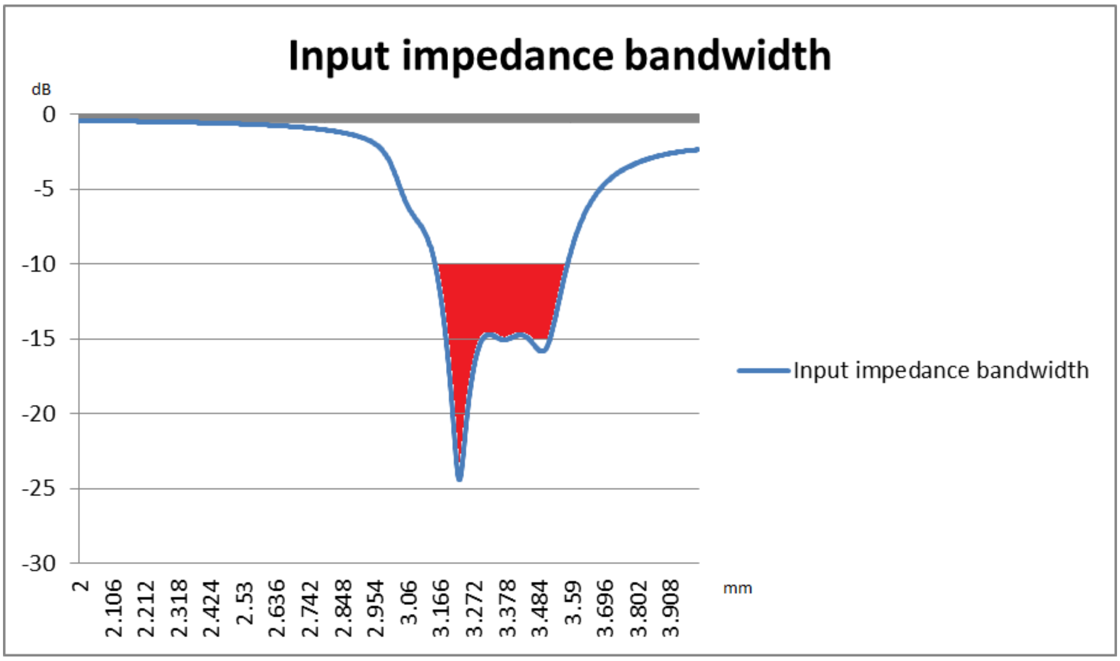

Fig.5 Input Impedance -10db

IV. CONTRIBUTIONS

This is compact and Omni directional CP antenna could provide all benefits of circular polarization in system, where a centrally located node broadcast radio messages to surrounding units. The Omni directional pattern would minimize the risk of not detecting a tag due to nulls in radiation pattern; the circular polarization would ensure a tag is detected regardless of its orientation. This is most significant requirement in security system .Currently all satellite navigation signals are right handed circularly polarized therefore omnidirectional CP antenna could overcome this problem.

V. CONCLUSION

The wideband CP radiation is achieved by the excitation of the orthogonal modes in the antenna, with the shunt inductive effect of the pin, the resonant frequency of an MPA operating in its dominant mode is substantially tuned up, which enlarges the overall radiation gain and electrical radiating area of the proposed CP antenna, as a positive outcome. A suspended near square patch with single feed and loaded the parasitic patch antenna with shorting pin configuration to achieve wide AR BW and large gain. Finally, CP MPA with shorting pin is designed. The simulated result of proposed antenna shows that the AR BW of the proposed CP MPA has 6.79% and the gain 8.5 dBic. Indoor wireless communications may use the above proposed configuration where usually large AR BW is required.

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