Dual Feed Dual Polarized Printed Antenna

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***Abstract*—A dual feed dual polarized printed antenna for operation of dual polarization is proposed. The proposed antenna comprises of two ports connected to the square shape path. By using IE3D software simulation and measurement shows horizontal polarization and vertical polarization simultaneously with a gain of around 2dB covering a frequency range from 900 kHz to 6GHz which include ISM band, Bluetooth, WiFi, and GPRS. Return loss of -10dB is achieved within the above mentioned Bandwidth for proposed antenna. The overall dimensions of antenna small in size with patch (15mm X 15mm) and dielectric substrate (50mm X 50mm).**

***Index Terms*— Dual Feed, Dual Polarization, Printed Monopole Antenna, polarization techniques, radiation pattern**

I. INTRODUCTION

In telecommunication, a printed antenna is normally fabricated over the dielectric substance like FR4 with partial ground plane [1-3]. The printed monopole antenna is fed through microstrip line feed to perfectly match the source/destination. IEEE standards definition for antenna is a way of radiating or receiving radio waves. There is another way of considering antenna as coupler between the transmitter/ receiver and the free space for transferring the electromagnetic energy [4]. There are many geometries available for printed monopole antenna (PMA) such as hexagonal, pentagonal, circular, square. For an efficient communication system, one needs guided medium. In the modern day wireless communication systems have been reduced in their size and so PMA became an important component of communication system. The different shapes of antenna include rectangular and other regular shapes to have larger bandwidth and hence improves the capacity, speed, reliability and reduces the interference, cost, size etc. Secondly, to enhance the capacity of communication, one may use dual polarization techniques for PMA [5-8]. This also helps to reduce the side effects of multipath fading. There are many applications for dual polarization operation for wireless communication which covers S-band and C-band frequency applications [9-10].

Presently, wireless communication technology is increasing exponentially with requirement of multiband and broad band antennas. For an efficient high channel capacity communication system, one may need to have a broad bandwidth, light weight, low profile, high gain, capacity, speed, simple structure antenna to ensure reliability, mobility, interference, cost, size etc. The reduced size of PMA plays a very important role for small systems. To fulfill all requirements of antenna the geometry and simulation must be accurate otherwise the transmission and reception of signal can be affected. To enhance the capacity and efficiency of the antenna single polarization can be replaced by using dual polarization. To achieve vertical and horizontal polarization single polarization requires two antennas but this problem can be overcome using dual polarization which requires only single antenna [11-12]. The rapid growth of communication system need dual polarized antenna to handle the large capacity. To improve multimedia application larger data rates for mobile users are required. To increase data rate and gain various wireless standards are used for example MIMO system. The majority of the current applications such as, Wi-Fi, Bluetooth operates on s-band frequency [13].

To increase the capacity of communication, one prefers to use dual polarization. Earlier research shows that the dual polarization works with single feed [14-15]. The major drawbacks of microstrip antenna is their narrow bandwidth due to surface wave losses and large size of patch and for better performance PMA has been used.

This paper presents the design of the printed PMA where return loss, gain, directivity have been discussed. The size of the radiating patch is determined by the lower edge frequency rather than the central resonance frequency. The performance parameters of antenna were measured by VNA (Vector Network Analyser) in the laboratory. PMA is, actually, planar antenna and having radiation patterns as omni-directional on one plane and figure of eight on another plane behaving like a dipole antenna. The fluctuation of input impedance between the higher order modes is reduced by proper coupling of two feed lines of the PMA. In the presented paper numerical analysis is performed using IE3D software.

In duplex communication, single antenna can be used for both transmission and reception. A single polarized antenna is one that provides only one polarization either horizontal polarization or vertical polarization. The presented PMA may respond to both horizontally and vertically polarized signals.
Polarization diversity is possible using dual polarized antenna.

- Why dual feed antenna?

A novel dual feed PMA is presented with good matching for radiating patch and considerable isolation among the ports. The radiated fields are omnidirectional with horizontal and vertical polarization. The implemented antenna has partial ground plane with microstrip line feed.

- Why dual polarizations?

A dual polarized antenna radiated the vertically and horizontally simultaneously so it can cover the larger coverage area in both directions. Single feed single polarization antenna radiated either vertically or horizontally and given the radiation pattern look like a figure of eight at one direction. The concept is validated with simulation and measurement results including resonance frequency and radiation pattern [8-9],[11-13].

Table 1. Comparison of various shapes of microstrip antenna

Sr.No.	Shape of antenna	Return Loss	Gain(dB)	Bandwidth(GHz)
1	Circle	-16.5	8.1756	0.63
2	Ellipse	-25	7.2326	1.06
3	Hexagon	-22	7.4406	1.24
4	Square	-21	8.2799	1.22

II. ANTENNA THEORY

A. Antenna Design

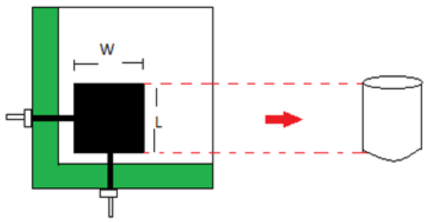

Fig.1 Basic structure of antenna

Assuming the same height for rectangular and cylindrical structure as L, hence their resonance frequency would be same for monopole antenna.

$$2\pi r\ L = W\ L \quad (1)$$

Gives,

$$r = W/(2\pi) \quad (2)$$

In the given equation, r is the radius corresponding to cylindrical monopole antenna and the resonant length is given as

$$L = 0.24\ \lambda\ F \quad (3)$$

whereas,

$$F = (L/r)/(1 + L/r) = L/(L + r) \quad (4)$$

By clubbing equation (3) and (4) the wavelength λ is obtained as:

$$\lambda = (L + r)/0.24 \quad (5)$$

Hence, fL, the lower band edge frequency is calculated by using:

$$fL = c/\lambda = 0.24\{c/L\}\ \{L/(L+r)\}$$

Assuming all the dimensions in centimetres:

$$fL = 7.2/\{L + (W/2\pi)\}\ \text{GHz} \quad (6)$$

But the monopole is fabricated on a substrate, thus

$$fL = 14.4\ \pi/(2\pi\ L + W)\ k\ \text{GHz} \quad (7)$$

where,

k is the correction factor,

k=1.15 for FR4 substrate with $\varepsilon r = 4.3$ and h = 0.159 cm [14-15]. If one includes the effect of feed gap p then the equation (7) can be re-written as

$$fL = 7.2/\{(L + p) + 0.159W\}\ k\ \text{GHz} \quad (8)$$

III. RESULTS AND DISCUSSION

In the proposed design two SMA connector are connected to antenna for feeding. The advantage of connecting two port is one can connect two applications to single antenna such as Bluetooth on port one and Wi-Fi on port two. Since it is polarized in both horizontal and vertical direction, the two applications can carry out their tasks successfully.

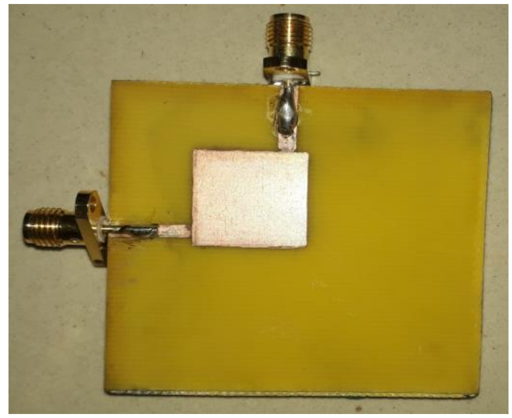

Fig.2. Hardware implementation of antenna

The designed antenna's radiation pattern was simulated for entire bandwidth which was observed as shown in Fig 3 and Fig 4. The radiation pattern is figure of eight on elevation plane and omnidirectional on azimuthal plane with two planes of polarization exactly perpendicular to each other. The corresponding measured radiation patterns for 3 GHz are shown in figure 5 and 6 on both the planes to validate the radiation with dual polarization.

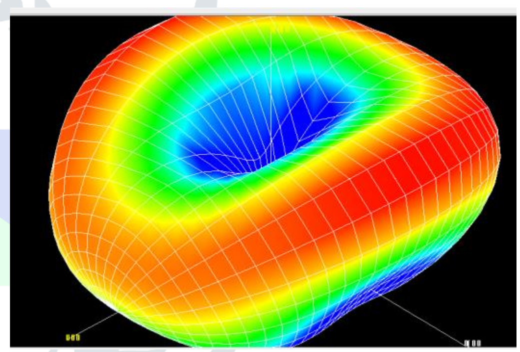

Fig 3. 3-dimensional radiation pattern

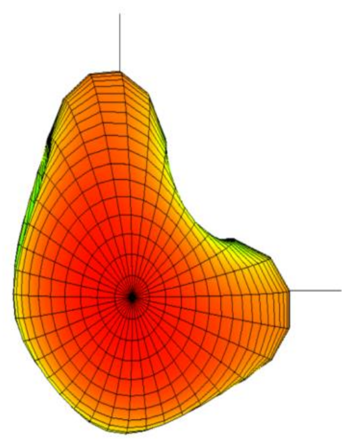

Fig 4. Radiation Pattern of Dual Polarization

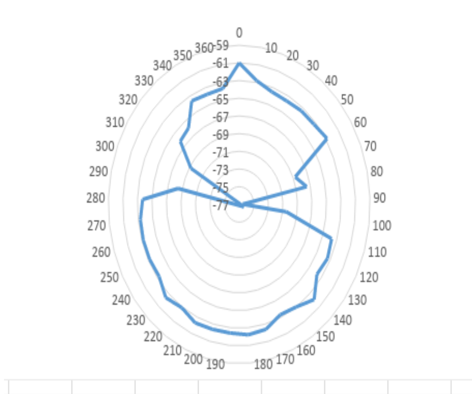

Fig.5. Monopole antenna's radiation pattern

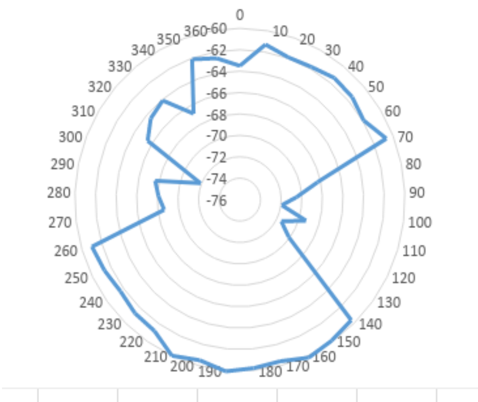

Fig.6. Monopole antenna's radiation pattern

The proposed prototype antenna is tested for various S parameters using Vector Network Analyser and the results observed are as shown in Fig. 7 and Fig.8.

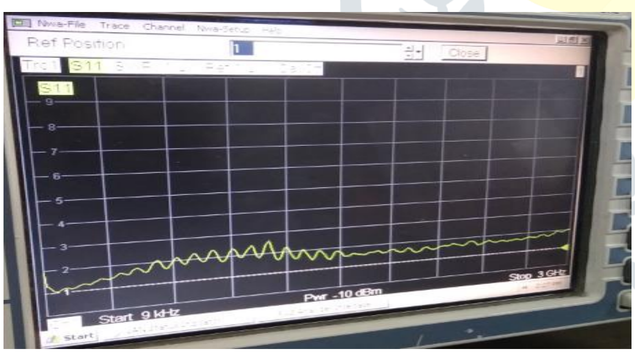

Fig 7. VNA Screenshot of VSWR at port one

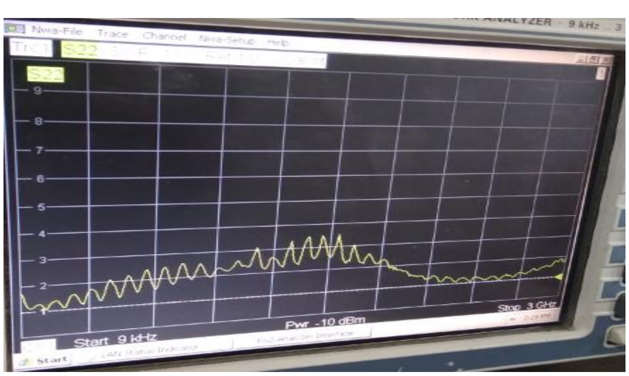

Fig 8. VNA Screenshot of VSWR at port two

Corresponding to the figure 7 and 8, the simulated VSWR is shown in figure 9, they are in agreement.

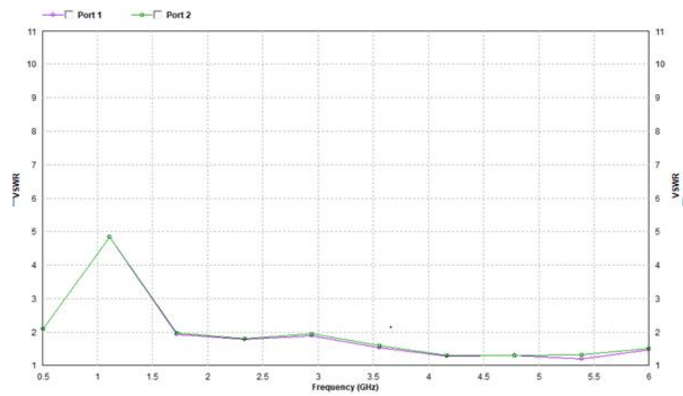

Fig 9. Simulation Graph Of VSWR v/s Frequency for port one and two

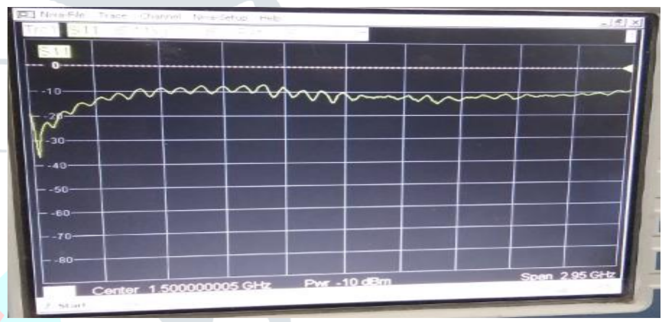

Fig 10. VNA Screenshot of S_{11}

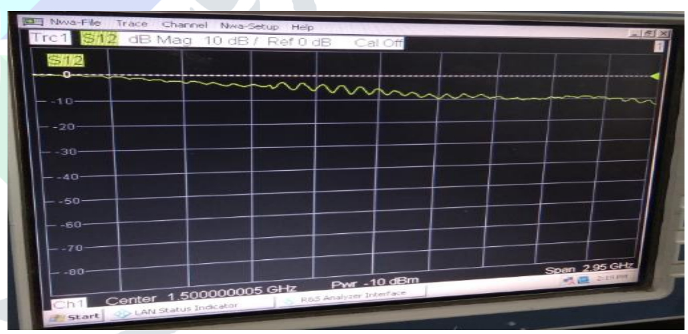

Fig 11. VNA Screenshot of S_{12}

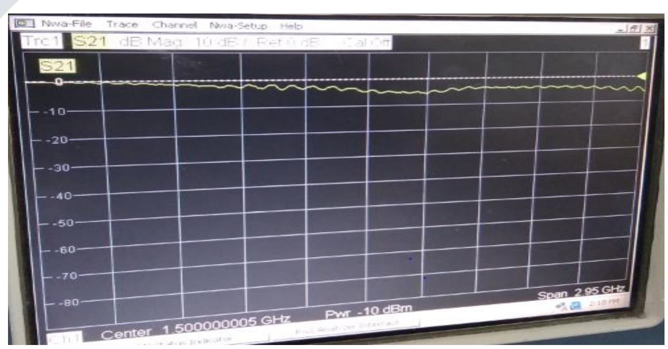

Fig 12. VNA Screenshot of S_{21}

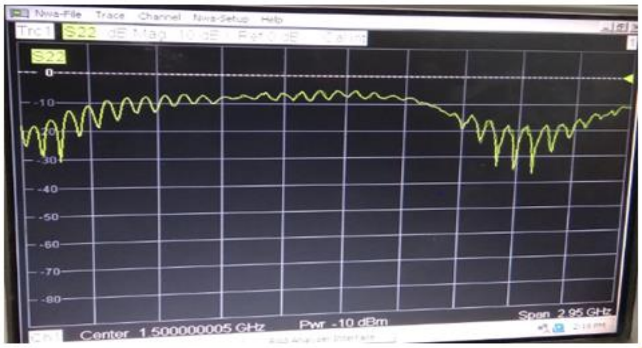

Fig 13. VNA Screenshot of S_{22}

From the figure 10 and 13 it can be seen that the values observed on S_{11} and S_{22} are similar, impedance bandwidth is having good matching. From the figure 11 and 12 it can be seen that the values observed on S_{12} and S_{21} are similar and showing good isolation between the two ports.

IV. Conclusion

The proposed antenna was to implement a Dual Polarized Monopole Printed Antenna. For this studied reference and observed different antenna and their parameter. After the survey of antenna, the rectangular shape of the antenna is implemented with dual feed for dual polarization. To overcome the limitations of the single polarization the antenna with dual feed has been implemented. Hence the resulting parameter, got the impedance matching at both port and due to this the dual polarization which is radiating in both directions in horizontal direction as well as in vertical direction simultaneously successfully. The return loss is also at permissible level and got the Gain around 2db which assure the maximum efficiency and increases the capability of the antenna.

It is beneficial to MIMO technology where we can connect multiple applications to the single antenna. It also covers the maximum number of applications including ISM band, Wi-Fi, Bluetooth etc."

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