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Design of Broadband Printed Dipole Microstrip Patch Array Antenna

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ABSTRACT

In addition with rapid development of mobile communication. The bandwidth required to cover the communication band is more than 45.5%. This paper presents a broadband printed dipole microstrip patch antenna and its array in order to generate a horizontally polarized omnidirectional antenna to that three planar dipoles are placed on the substrate and acts as single unit with inverter L-shaped microstrip feeding line which is employed for each dipole element. In such a way four antenna units are placed to generate the omnidirectional radiation pattern and produce the bandwidth of 59.1% operating in range of 1.52 GHz to 2.75 GHz. In the proposed antenna array each unit produce the gain of 3dB. Hence by combining the four antenna units they can produce the gain of 9.5dB which is used for the base station applications and WLAN applications.

Keywords: *Dipole element; Omnidirectional antenna pattern; Micro strip patch antenna; Polarization; Antenna array.*

1.0 Introduction

Omnidirectional antennas are capable of functioning over a wideband are required in many applications including electronic counter measures or as calibration antenna for electromagnetic compatibility testing and particularly in wireless telecommunication systems are vertical polarized, the polarization of the propagating electromagnetic wave may change significantly after complicated multiple reflections or scattering. Hence horizontally polarized antenna with an omnidirectional pattern preferred to the harvest the polarization resource and maximize system capacity[2]. Horizontally polarized omnidirectional antenna are commonly used for indoor and base station wireless communications since they can transmit or receive HP wireless signal equally in all directions of the azimuthal plane to ensure full coverage of surrounding environment[3]. As reported in although many current wireless system are vertically polarized, it have been predicated that using horizontally polarized antenna at both transmitter and receiver will result in 10dB more power, a compared to the power received by using vertically antenna at both end of the link [4].

Hence it seems that a horizontally polarized antenna with an omnidirectional pattern may be most suitable for WLAN card application. Due to the particular charactertics of omnidirectional antenna such as 360 full coverage and supporting free alignment between the receiving and transmitting antenna[5-6] are especially suitable for wireless communication system covering a large service area.

Another advantage is the horizontally polarized antenna are generate the high gain. Usually the gain of the vertical polarized field about 11dB less than that of the horizontal polarization field[7]. However to cover large area, the antenna with omnidirectional pattern in the azimuthal plane are required in base station.In modern wireless communication system dual polarized antenna are widely adapted to increase spectrum efficiency but mitigate polarization mismatch between transmitter and receiver [8].

In particular, such system dual polarized antenna are usually employed to substitute two specially separated single polarized antenna, saving the space between them for the good performance increasing the channel capacity and gain of antenna[9].

Omnidirectional radiation in the horizontal plane is highly required for base station antenna used in

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mobile wireless communication, such as GSM and WLAN. Though the position of mobile users are not priori known exactly the wireless access of mobile users anywhere can be realized easily with omnidirectional base station antennas[10]. Moreover, wide or multiband miziaturized omnidirectional antennas have attracted much attention in application, where one single antenna operate at multiple frequency band simultaneously .Therefore, multiple antennas for multiple bands not for necessary and the volume of the antenna systems can be reduced significantly with broadband omnidirectional antenna.

In recent years, a rapid growth of mobile communication industry has fortuned the development of antenna. Different mobile communication system have been designed with different frequency bands[11]. Numerous frequency ranges are currently in use of mobile communication systems.For example, the GSM/PCS/DCS/UMTS/ LTE system operated at 2GHZ band need to cover the frequency range from 1.7GHZ to 2.17GHZ is GSM1800(1719-1880MHZ), GSM1900(1850-1990 MHZ), PCS(1900-1920MHZ) and UMTS(1920-2170MHZ). Therefore, a bandwidth of atleast 45.5% is required for GSM/PCS/UMTS/LTE base station application [12].

To cover the band various types of antenna are developed such as Alfred loop antenna [13], loop antenna [14], annular slot antenna [15] but these are having bandwidth of 10% for maximum bandwidth array antenna are introduced such as four dipole array has the bandwidth of 30% to achieve higher bandwidth employed by combining two four dipole array produce the bandwidth 52% but VSWR<2. These are not suitable for mobile communication. Then HP omnidirectional antenna array is designed which has three dipole elements on each unit.It consist of four antenna unit with individual microstrip feeding line to produce omnidirectional radiation pattern and having the bandwidth of 59.1% and VSWR<1.7

2.0 Existing System

In existing system of broadband Horizontally Polarized Omnidirectional Antenna Array for Base-Station Applications is antenna array consists of six antenna units.On the each antenna unit consists of wibeband three planar dipole elements are employed with three power divider of equal magnitude and phase. For lesser gain variations are provided by dividing six antenna unit into three antenna unit pair which are connected in complementary radiation. The antenna array operated in range of 1.67-2.73GHZ and having the bandwidth of 48.2% it produces the high gain of the antenna[1].

3.0 A Basic Dipole Element Design

Figure 1 shows the top and bottom views of the proposed dipole element. The geometry of the dipole element having the substrate, ground and patch. In fig(b) a ground of the dimensions with LgxWg is printed on top side of the substrate while in the bottom side having two patch with U-shaped microstrip line are connected together and inverter L-shaped microstrip feeding line acts as feeding element.

Figure 1 (a): Bottom View of Dipole Element

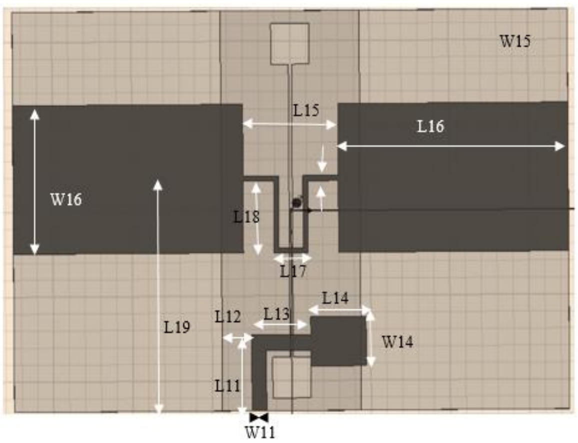
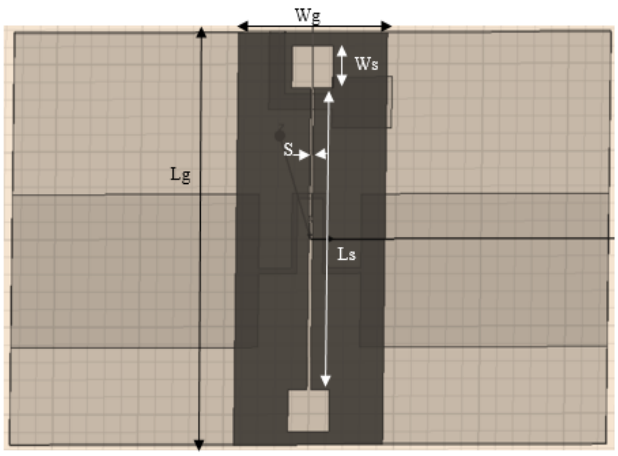
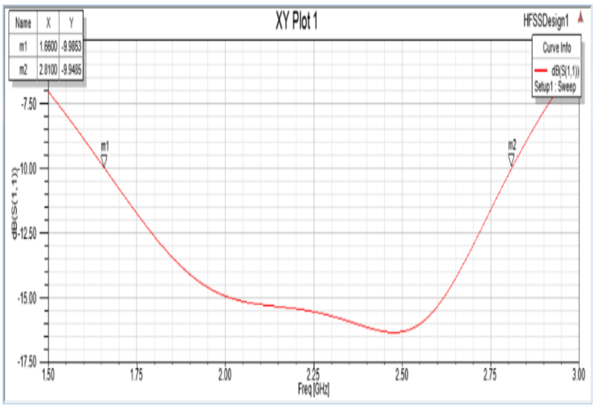


Figure 1 (b): Top View of Dipole Element



In this antenna has combination of microstrip line and proximity coupled element properties it leads antenna has advantage of minimum spurious feed radiation and produce wide bandwidth. The substrate material used in antenna is roger4003 which has dielectric constant 3.38 and thickness of 0.81mm. As top side having the H-shaped slot etched on the ground plane and it is used to guide the signals from feeding element to radiating patch.

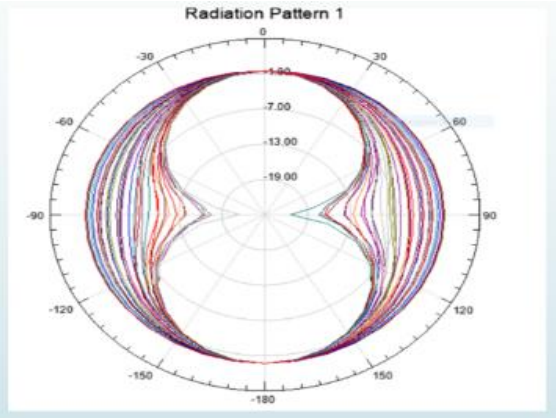
Figure 2 (a): Reflection Coefficient Graph



3.1 Measured result of dipole element

The design parameter of dipole element are w11=1.84 mm, L11=8.915 mm, L12=3.71 mm, L13=7.44 mm, L14=7.0 mm, w14=5.8 mm, L15=12.50 mm, w15=0.62 mm, L16=29.0 mm, w16=17.5 mm, L17=4.3 mm, L18=8.5 mm, L19=28.5mm, wg=17.5 mm, Lg=47.1 mm, ws=4.8 mm, Ls=34.5 mm, s=0.4 mm.

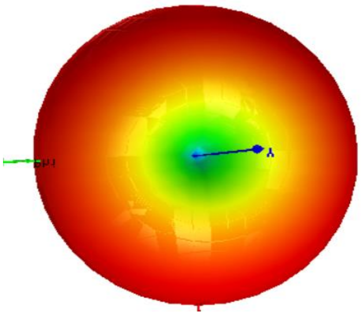
Figure 2 (b): Radiation Pattern



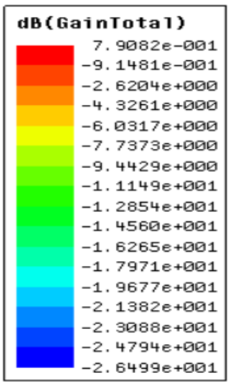
After simulation of the dipole element the reflection coefficient is measured and shown in the fig 1.1. The dipole element has reflection coefficient less than 10dB in the range of 1.65-2.8GHZ. As result the antenna is having the bandwidth of 51.68% and radiation pattern given in below in figure 2. The measured antenna gain is 7.8dB and it shown in figure 3.

Figure 3: 3D Polar Plot, b) Gain Readings

(a)

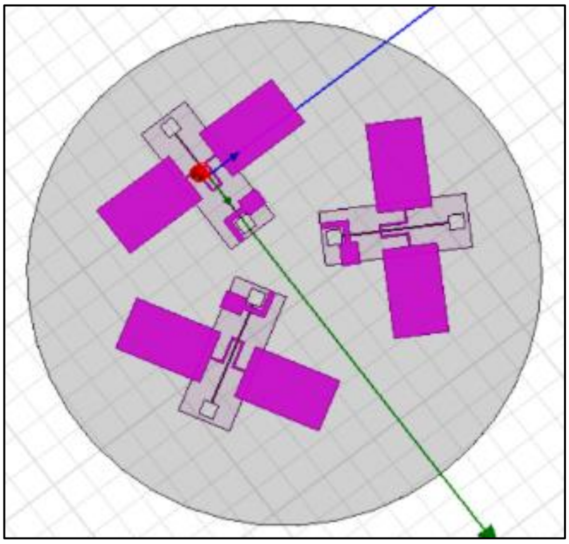


(b)



4.0 Antenna Unit Design

Figure 4: Antenna Unit

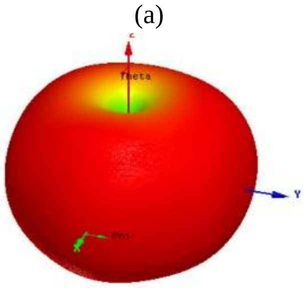


The geometry of antenna unit design as shown in figure 4. To produce HP omnidirectional radiation pattern three dipole elements are printed on substrate. Here the roger4003 substrate in the circular shape for covering the large area. The dipole elements are arranged with angle of 60,120 and 300 in the horizontal plane.

The dipole element printed on the substrate with varied by the distance and uniform or non-uniform arranged of the dipole elements. For example The antenna unit has three dipole elements produce high gain and lesser gain variations. By proper selection of the distance between elements is d the antenna has better gain variations.For example for single, two dipole arrangement in uniform and non-uniform lead to higher gain variations in order to reduce three elements is fixed. The size of the substrate phenomenon also depends on the parameter d. After analysis the value for the distance between the elements is 12mm. After arranging three element in the substrate. The design is simulated and measured the result and the antenna unit is produce horizontal omnidirectional radiation pattern at 1.76GHZ, 2.25GHZ, 2.76GHZ as shown in fig2.3 then bandwidth limited to unit is % in the range of 1.50–2.78GHZ and it has 10dB less reflection coefficient in particular range is obtained in figure 5. And the gain of the antenna unit is 2.65dB and it shown in figure 6.

Figure 5: a) 3D Polar Plot, b) Gain Readings

(a)



(b)

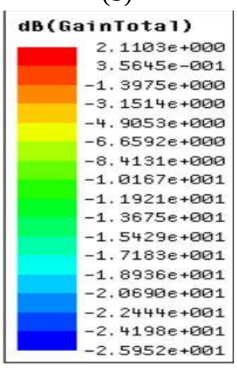


Figure 6: Reflection Coefficient

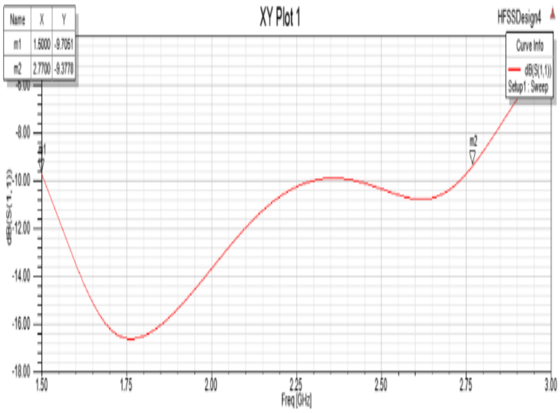
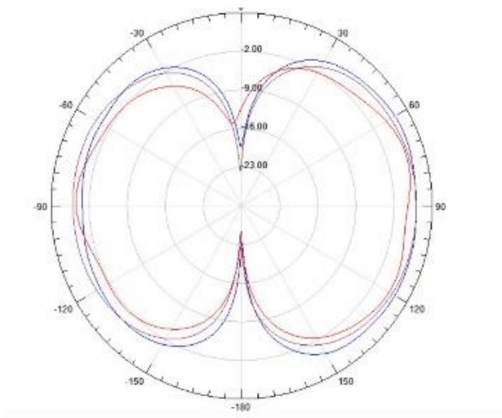


Figure 7: Radiation Pattern



5.0 Antenna Array

After designing the antenna unit by employing three dipole elements on each unit. On achieve maximum gain, the four antenna unit are placed in vertical direction. The separation between antenna unit will effect radiation pattern and gain of the antenna. The distance between the units are 75mm. Each antenna is feed with an L-shaped inverted microstrip line and proximity coupled.

The broadband printed microstrip patch antenna array was simulated and measured Figure 8 shows a prototype of the horizontally polarized omnidirectional antenna. The bandwidth obtained is 59.1% which will advantage of providing higher data transfer and faster application performance. Hence its supports multiple concurrent sessions.The reflection coefficient is measured in figure 9. Maximum gain obtained by antenna array is 9.75dB which is used for mobile communication.

Figure 8: Four Antenna Unit Array

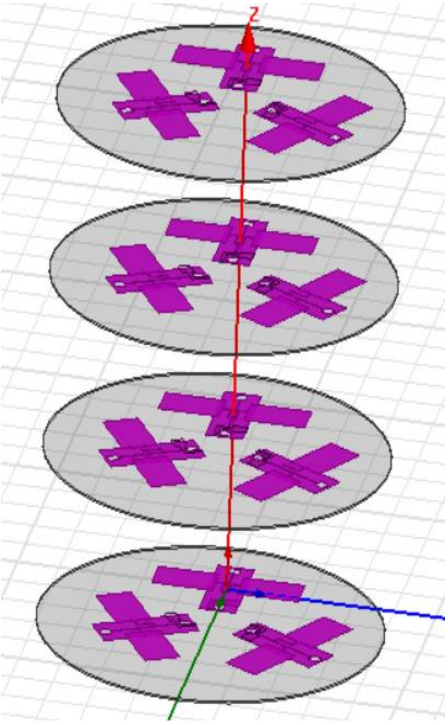


Figure 9: Reflection Coefficient

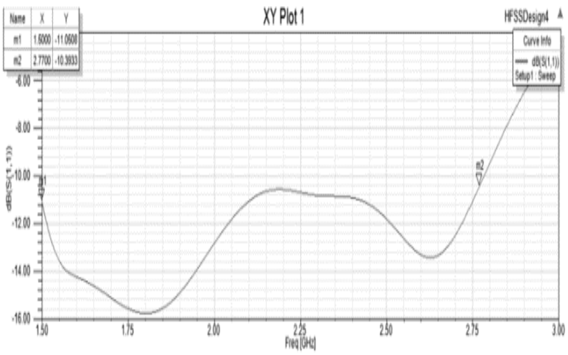
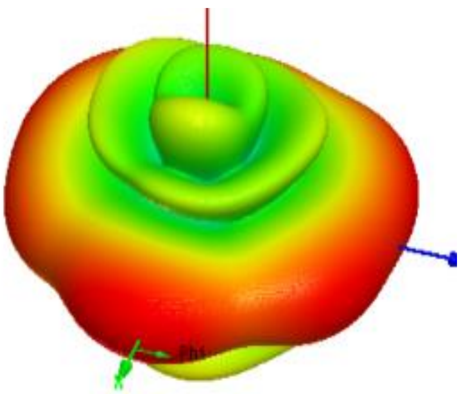


Figure 10: 3D Polar Plot with Readings



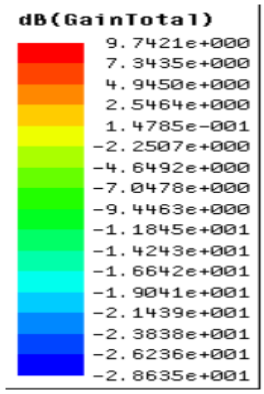
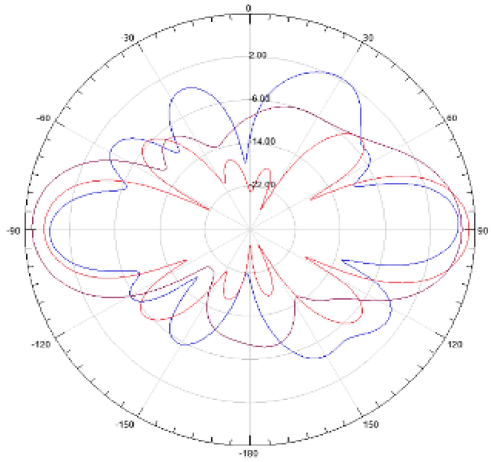


Figure 11: Radiation Pattern



6.0 Conclusions

A novel broadband horizontal polarized omnidirectional antenna array is presented. The antenna array comprising of four antenna units where three dipole elements are employed on each unit. As result of antenna array produce the wide bandwidth of 59.1% (1.50-2.8 GHZ) which is applicable for mobile communication. It has a simple structure based on stripline. It exhibits encouraging radiation features, including a very good omnidirectional pattern in the horizontal plane with small gain variations less than 0.5dB, a high gain up to 9.755dB and good side lobe suppression.

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