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ORIGINAL ARTICLE

Design of Half Circular Disk Printed Monopole Antenna for Ultra Wide Band and Super Wide Band Applications

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ABSTRACT

In this paper, a half circular disc PMA (Printed Monopole Antenna) for SWB (Super Wide Band) applications is presented. The dimensions of the substrate is 40x40x1.7mm. The antenna is printed on Rogers RT5880 dielectric material. The antenna VSWR (Voltage Standing Wave Ratio) has less than 2 between 2.7 and 50 GHz. The antenna S11 has less than -10 between 2.7 and 50GHz. The antenna has maximum gain of 12.4dBi. The BW (Bandwidth) of proposed antenna is about 47.3 GHz. The antenna covered the WiMAX ((Worldwide Interoperability for Microwave Access), WLAN (Wireless Local Area Network), X band, Ka band, Ku band, 4G band and the band of 5G (Fifth Generation) at same time with nice gain and radiation efficiency. The radiator of the proposed antenna is design from half circular disc, rectangle and a triangle. The antenna has partial ground plane. Three solts are etched in ground plane for better impedance matching, two are circular slots and one is rectangular slot. The antenna design is simulated in CST microwave studio 2016. The antenna has good radiation efficiency, other parameter such VSWR S11, gain and radiation pattern are discussed in detail.

Keywords: Printed Monopole Antenna, Super Wide Band, Gain, Voltage Standing Wave Ratio, Radiation Pattern

Author`s Contribution
[1,2,3,3] Manuscript writing, Data Collection Data analysis, interpretation, Conception, synthesis, planning of research, and discussion

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INTRODUCTION

Communication system is the need of modern world and antenna is backbone of such system so the researchers are interested in the designing of antenna. Recently PMA became very popular in communication industry and academia due to low profile, easy in fabrication and installation, low cost, low weight and small size. PMAs have been used in various applications of wireless communication such as radar, CR (Cognitive Radio), and indoor positioning because of their affordability, wider BW, and design flexibility. PMAs have various geometries but the most common shapes of PMAs used by researchers for UWB (Ultra Wide Band) applications are rectangular, circular, square, triangular, elliptical, and hexagonal. UWB

communications achieve very high data rate and need very low transmitting power for its transmission. In past various designs of PMA are proposed for UWB and SWB application [1]-[22].

Chen et. al. [1] presented the antenna with the size of 35×77mm, the BW of antenna is 17.36 GHz with elliptical slot in ground plane. The author proposed a MPA with impedance BW of 40 GHz starting from 10-50 GHz and antenna size is 60×60mm [2]. Liu et. al. [3] a PMA for SWB application is presented with the size of 120×124mm, the BW of antenna is 26.32 GHz starting from 1.08-27.4 GHz. Srifi et. al. [4] a PMA with circular shaped is proposed with the impedance BW of 28.4 GHz, the size of the antenna is 30×35mm. Deng et. al. [5] a CPW fed rectangular shaped PMA is proposed with dimension and impedance BW of 41×30mm and 21.9 GHz respectively. Dong et. al. [6] have proposed the antenna for SWB application with the BW of 0.64-16 GHz and dimension of 150×150mm respectively, the shape of antenna is semicircular and semi elliptical. Singhal, and Singh [7] a CPW (Coplanar Waveguide) fed Phi shaped PMA is presented, the BW of proposed antenna is 33.7 GHz and peak gain is 3.5 dB. A circular polarized SWB antenna is proposed with the size of 36×27 mm, the radiator shape is circular and ground shape is elliptical [8].

The author proposed circular shape PMA for UWB application with the BW of 7.92 GHz; in the range of 2.78-10.7 GHz, the overall dimension of presented design is 32×30mm [9]. Zhang et. al. [10] proposed triangular shaped SWB antenna with impedance BW of 48.58 GHz (1.42-50 GHz) with very large size of 57×34mm. Khan et. al. [11] proposed hexagonal shape PMA for UWB application with dimension of 38x38 mm2, the antenna VSWR is less than 2 in the range of 2.9-10.7 GHz with impedance BW of 7.2 GHz. Khan et. al. [12] proposed UWB antenna with overall dimension of 32×29.3×1.6 mm, the BW of presented antenna is 13.1 GHz ranging from 2.9-16GHz. Khan et. al. [13] proposed hexagonal PMA with overall dimension of 30×28×1.6 mm, the BW of presented antenna is 8 GHz starting from 3-11 GHz.

Various Multiple-Input Multiple-Output (MIMO) antennas are also proposed for UWB and SWB application [23]-[33].The author proposed circular shape MIMO antenna, the antenna is resonating from 3-40GHz with impedance BW of 37GHz, the overall size of antenna is 18×36×1.6mm [23]. The author presented stepped shape MIMO-UWB antenna, the size of antenna is 33×48×1.6mm, the impedance BW is 11.7GHz resonating from 2-13.7GHz [24]. The author proposed circular shape MIMO antenna with decoupling stub, the impedance BW of proposed antenna is 8GHz resonating from 3-11GHz and size of antenna is 18×3×1.6mm [25]. The author proposed flexible fractal antenna with impedance BW of 15.48GHz starting from 3.6-19.08GHz [26]. The author proposed rectangular shape PMA with overall size of 24×24×1.6mm, the impedance bandwidth is 9.1GHz starting from 2.9-12GHz [27].

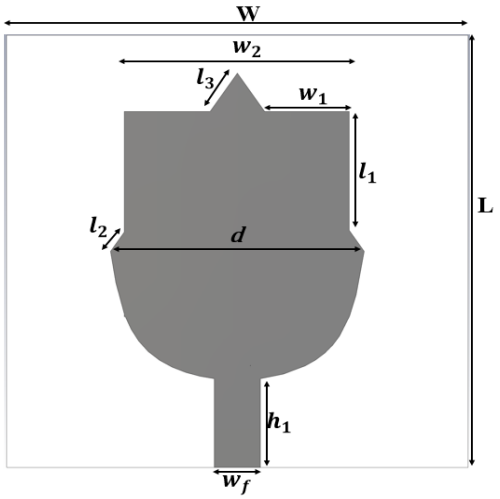
Various types of PDA (Printed Dipole Antenna) is also used for SWB application. PDA is simple in structure and easy in installation [34]. Jin et. al. [35] SWB antenna with Dipole structure is proposed with impedance BW of 16.5 GHz and size of 40×5mm. The narrow band is the main problem of PDA. There are several techniques to overcome narrow BW problem such as bi-cone dipole antenna and disk dipole antenna, disk dipole antenna is used to wider the BW about 110% but their size is increased as compared to simple Dipole antennas [36]-[42].

This paper presents a simple structure PMA with compact size of 40x40x1.7mm. The peak gain is about 12.4dBi. The impedance BW of proposed antenna is about 47.3 GHz which is much wider than above discussed designs. The proposed antenna has partial ground plane. The antenna design is simulated in CST microwave studio 2016. The antenna has good radiation efficiency and gain; other parameters such as VSWR, S11 and gain are also mentioned and discussed

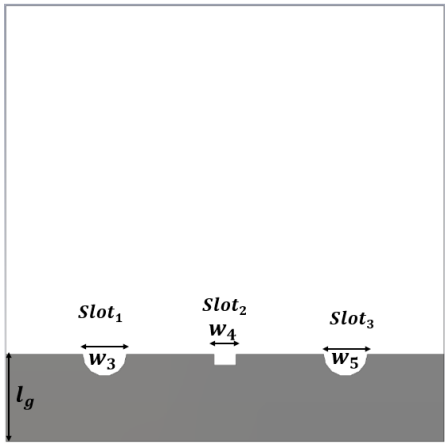
ANTENNA DESIGN AND CHARACTERIZATION

The design of half circular disc PMA for SWB applications is depicted in Fig. 1(a-b). The dimensions of the substrate is 40x40x1.7mm. The antenna consist of radiator, partial ground and substrate. The antenna is designed on Rogers RT5880 dielectric material. The radiator consist of rectangle, triangle and half circular

disc. The size of ground plane is 8x40mm. The ground plane have two half circular slots with the diameter of 4mm and one small rectangular slotof 2mm. The each side of the triangle on the top of rectangle in radiator is 4.3 mm. The length of the rectangle is 11.2mm and width is19.5mm respectively. The diameter of the half circular disc is 22mm. The dimension of the feed line is 8.2mm and 4mm respectively. Various other parameters are given in Table 1. The VSWR and S11 are also depicted in Figs. 2-3.



(a) Top view



(b) Bottom view

Fig. 1. Proposed half circular disc PMA

TABLE 1. PARAMETERS OF THE HALF CIRCULAR DISC PMA FOR SWB APPLICATIONS

Parameter	Value (mm)
L	40.0
W	40.0
l_1	11.2
l_2	2.3
l_3	4.3
w_1	2.0
l_g	8.0
h_1	8.2
w_1	7.6
w_2	19.5
w_3	4.0
w_f	4.0
w_5	4.0
d	22

RESULTS AND DISCUSSION

The proposed half circular disc PMA is operating in SWB which is seen in Figs. 2-3. From Fig. 2 it is justified that the antenna VSWR has less than 2 between 2.7 and 50 GHz and similarly the antenna S11 has less than -10dB between 2.7 and 50GHz, justified from Fig. 3. From results it is justified that the proposed antennacovered the WiMAX, WLAN, X band, Ka band, Ku band, 4G band and the band of 5G at same time with nice gain and radiation efficiency. The gain is depicted in Fig. 4 which show that the gain is low at lower frequencies and increased at upper frequencies. The maximum gain of proposed design is 12.4 dBi. The E-plane and H-Plane are depicted in Fig. 5, the radiation pattern in E-Plane is nearly quasi omni radiation patternand similarly nearly Omni-directional in H-plane at both 6 and 12GHz. The radiation pattern is nearly Omni-directional in both E-Plane and H-plane at 29 45GHz. The 3D (Three-Dimensional) radiation pattern at various frequencies is also depicted in Fig. 6.

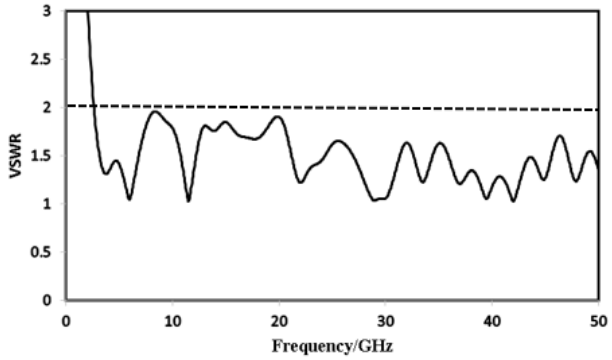


Fig. 2. Simulated VSWR of half circular disc PMA

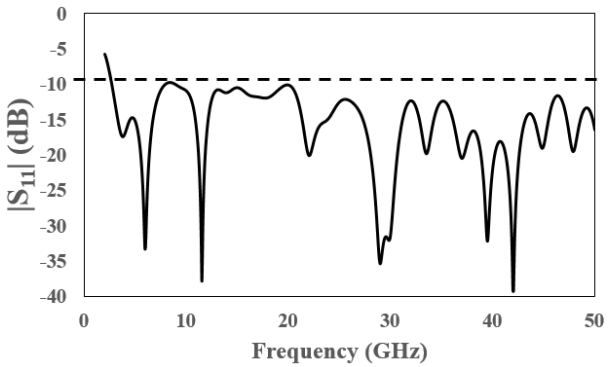


Fig. 3. Simulated S11 (dB) of half circular PMA

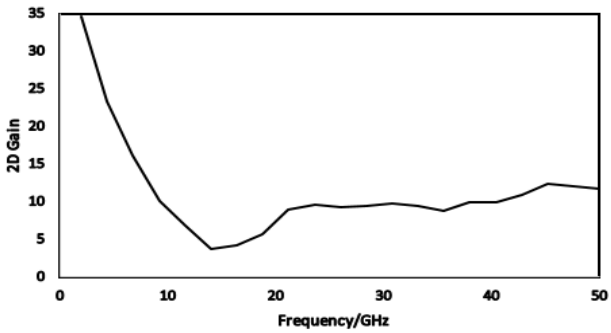
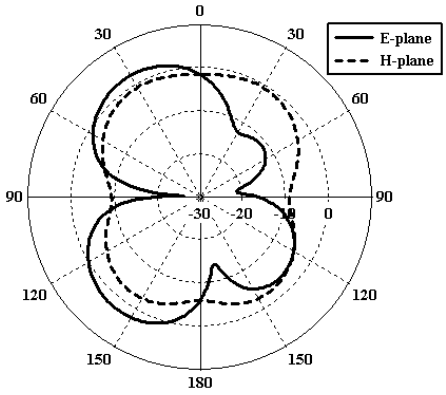
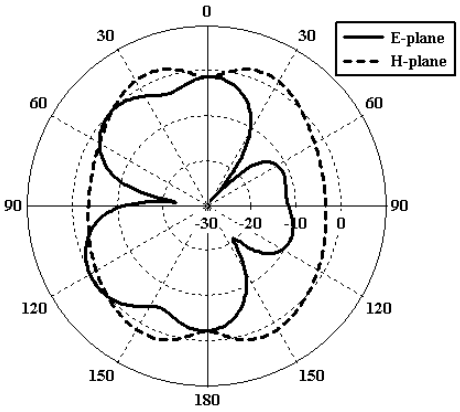


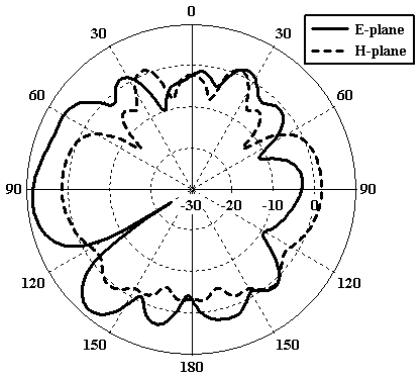
Fig. 4. Simulated 2D-Gain of half circular disc PMA



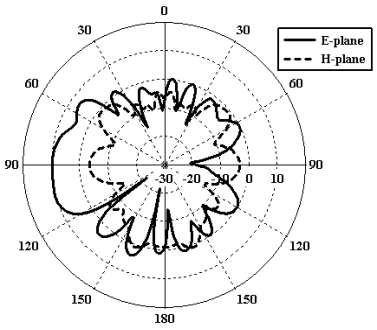
6 GHz



(b) 12 GHz

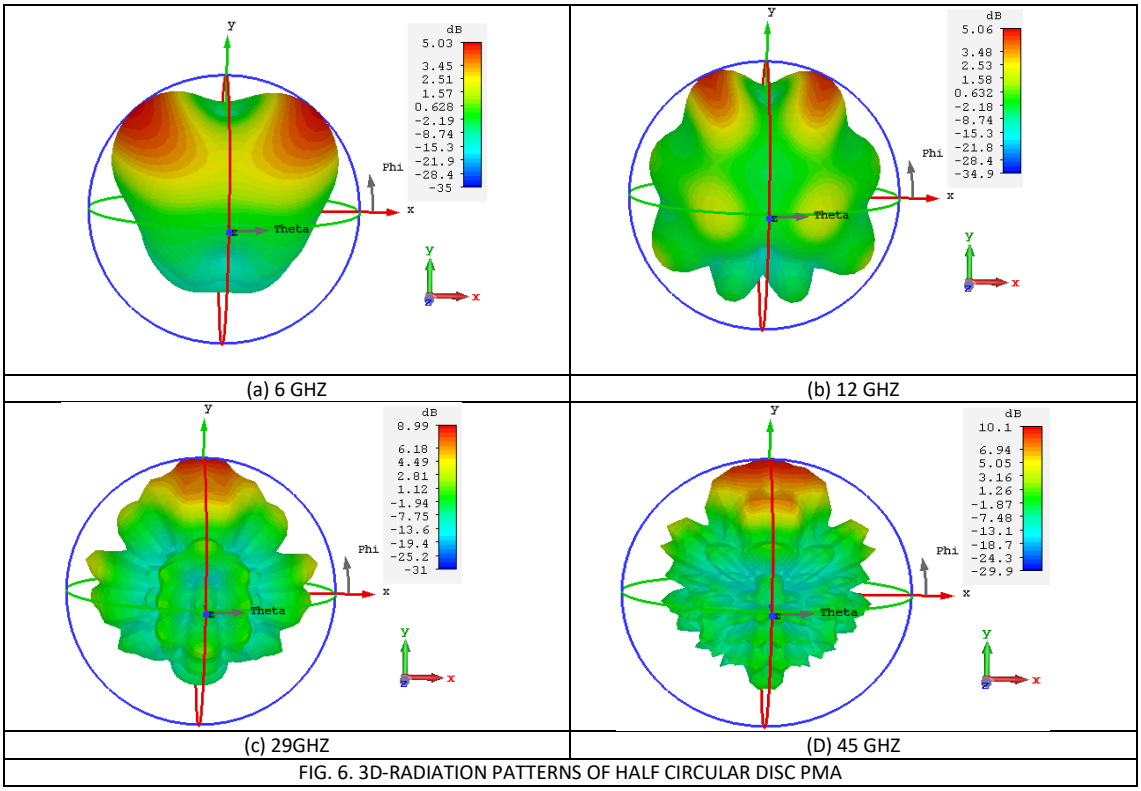


(c) 29 GHz



(d) 45 GHz

FIG. 5. 2D-RADIATION PATTERNS OF HALF CIRCULAR DISC PMA



(a) 6 GHZ | (b) 12 GHZ

(c) 29GHZ | (D) 45 GHZ

FIG. 6. 3D-RADIATION PATTERNS OF HALF CIRCULAR DISC PMA

CONCLUSION

In this article, a half circular disc PMA for SWB applications is presented. The antenna VSWR has less than 2 between 2.7 and 50GHz. The antenna S11 has less than -10 between 2.7 and 50GHz and can be used SWB application. The antenna covered the WiMAX, WLAN, X band, Ka band, Ku band, 4G band andthe band of 5G at same time with nice gain and radiation efficiency. The antenna has maximum gain of 12.4dBi. The antenna design is simulated in CST microwave studio 2016. The antenna have compact size and simple structure which can easily fabricate. The antenna has good radiation efficiency, VSWR and Gain that can used for various wireless communication systems.

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