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A Compact Slots Loaded Disc Patch Antenna for Multiband Application

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***Abstract**: The article consists of a novel compact disc patch antenna with S-shaped slot. It is proposed that it operates on multiband covering the applications in WiMAX, WLAN, X-bands and ITU of frequency. The multiband behavior of proposed antenna with a wide band (6.091-7.27) is achieved, mainly due to the appropriate placing of two shorting pins, S-shaped slots on the circular disc patch and the material of the substrate used. The designed antenna operates at resonating frequencies of 2.63 GHz, 3.12 GHz, 4.52 GHz, 6.68 GHz and 8.32 GHz respectively. It is suitable for WiMAX, WLAN, C-band (4-8 GHz) and ITU. The geometry is then simulated using available IE3D software and the results are measured. It is found that the agreements between the simulated and experimental results are very good.*

***Keywords:** Multiband antenna, WIMAX, WLAN, disc, shorting pin, IE3D, ITU (International Telecommunication Union).*

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I. Introduction

Nowadays, Microstrip patch antenna is very popular due to its merits such as low profile, light weight, inexpensive to manufacture and easy to fabricate. Inspite of these merits, there are demerits like narrow bandwidth, poor power handling capacity in MSA's (microstrip antennas) [1-2]. MSA's generally operates at defined frequency band which leads to space-limiting problem. One way to get rid of this problem is using multiple antennas, but this increases system size and complexity. To overcome this problem, multiband antennas are required where the same antenna resonate at different frequencies. Hence it reduces the system size as well as complexity [3].

In multi-band MSA's it is possible that many standards such as GPS (Global positioning system), WIMAX (Worldwide Interoperability for Microwave Access) and WLAN (wireless local area networks) standards can be integrated into a single wireless device. Microstrip patch antennas can be of any shape such as rectangular, circular, triangular or square etc. Microstrip multiband disc patch is applicable for many wireless applications such as S-band (2-4) GHz, C-band (4-8) GHz and X-band (8-12) GHz [4-6]

The diodes, switches, cutting slots of different geometry, multiple narrow slits, stacking, slot antenna with edge fed is used to obtain multiband applications of the antenna [7]. Wide-band or multiband antennas are required for multiservice system [8-11]. Over the past years, several techniques have been reported for multiband antenna design, one of the widely accepted technique to design multiband antenna is loading the radiating patch with a slot [12] appropriately design not only lower the fundamental resonant frequency of the antenna but also leads to dual or wideband operation. There are many techniques which are reported in literatures that obtain multiband behavior such as employing Microstrip line feeds in orthogonal direction and circular disc antenna excited by Y-shape like Microstrip feed [13-14]. Also cutting two pairs of orthogonal narrow slits on stacked circular disc exhibits multiband application [15]. Although some of these antenna structures involve complex calculation, sophisticated design structure and large size compared to proposed antenna. In this paper, the proposed antenna consists of S-shape slots on circular patch. The proposed antenna resonates at 2.63 GHz, 3.12 GHz, 4.52 GHz, 6.68 GHz, 8.32 GHz frequencies. The designed antenna is applicable for WiMax, WLAN, C- band application and military communication satellite (uplink) range assigned by ITU [9, 16-17]. The shape of geometry is circular with S-shaped slots on radiating patch fed by co-axial feed. IE3D simulator software, based on MOM (Method of Moments) is used to simulate the result and Vector Network Analyzer is used to measure the result. The measured results show that the proposed antenna operates in multiband behavior. The details of antenna design and results are explained in following section.

II. Antenna Configuration

Designed antenna structure is shown in figure 1, which consists of circular radiating patch on fr4 substrate with dielectric constant of 4.4 and loss tangent 0.02. The radius of disc patch is 11 mm. The dimension of substrate chosen [27x27] mm of height 1.6 mm.The diameter of circular radiating patch is 22mm. The co-axial feed of 50 ohm input impedance is used to excite the antenna. The slots and shorting pins are introduced in the antenna to generate new resonating frequencies. The front view, side view and 3-D geometry of the antenna is shown in figure 1(a), 1(b) and 1(c). The current distribution shows the radiation mechanism of antenna as shown in figure 2. This antenna provides multiband behavior due to multiple slots and shorting pins on radiating patch. The experimental set up shown in figure 3(a),(b) and (c).

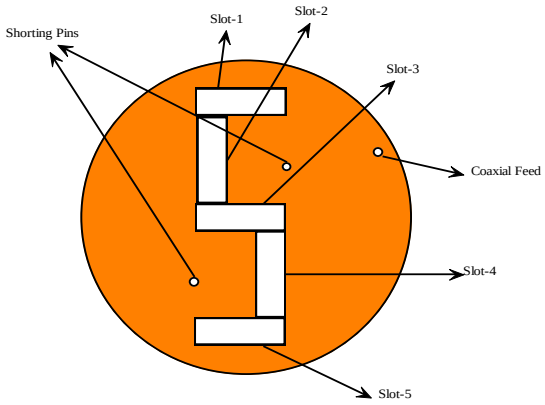

Fig. 1(a)

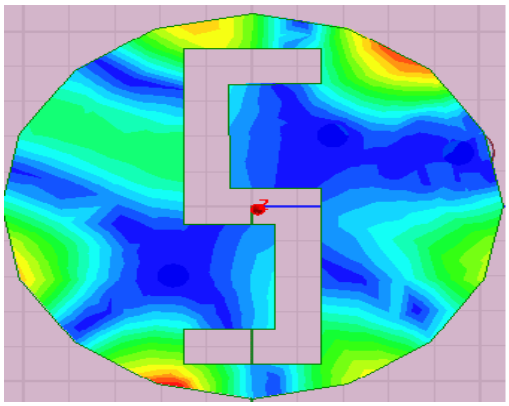

Fig. 1 (b)

Figure1. The geometry (a), and current distribution using HFSS simulation software of proposed S-shaped circular patch antenna (b).

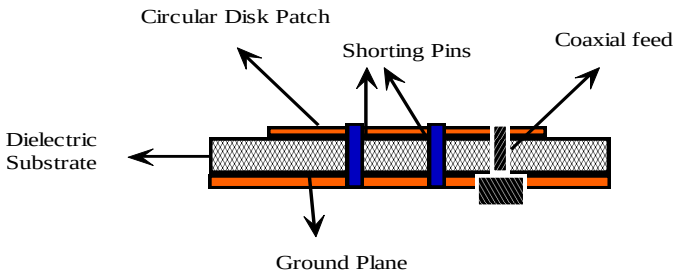

Figure 2: Side view of proposed antenna

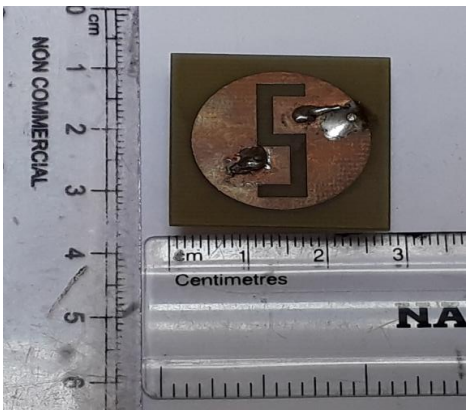

Fig. 3(a)

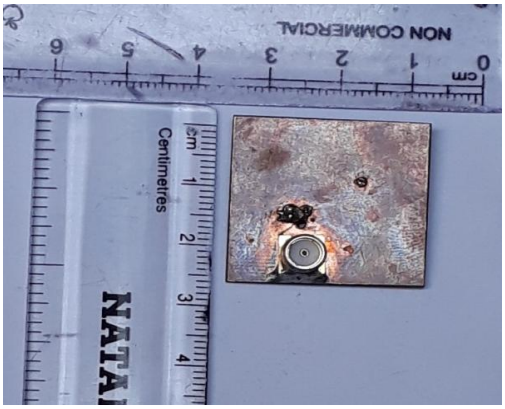

Fig. 3(b)

Figure 3: Fabrication of Proposed antenna having (a) Top view, and (b) Bottom view

Table-1 Design specification of proposed antenna:

Dielectric Material (Substrate) Used	FR-4
Dielectric Constant of Substrate Used	4.4
Height of Substrate	1.6mm
Loss Tangent of Substrate Used	.02
Radius of Circular Disc patch	11 mm

Location of First Shorting Pin From the centre of circular disc patch	(3.325,3.6)
Location Of Second Shorting Pin	(-3.7,-4.05)
Location of Coaxial feed	(8.6,3.35)
Length and Width of Slot-1	6mm x 2mm
Length and Width of Slot-2	2mm x 6mm
Length and Width of Slot-3	6mm x 2mm
Length and Width of Slot-4	2mm x 6mm
Length and Width of Slot-5	6mm x 2mm

III. Result And Discussion

IE3D simulation software is used to simulate the proposed antenna configuration. The return loss of the designed antenna is shown in figure 4(a). The antenna resonates at resonating frequencies of 2.63 GHz, 3.12 GHz, 4.52 GHz, 6.68 GHz, 8.32 GHz with fractional BW of 4.94%, 1.15%, 4.38%, 17.64% and 4.1 %. The designed antenna has multiband behavior with a wideband operation. The range of wideband for this antenna is from 6.091 GHz to 7.27 GHz as shown in figure 4. The gain vs frequency of proposed antenna is shown in figure 5, which concludes that antenna has good gain. The simulated and experimental results are shown figure 5 , and they are in close agreement with each other.

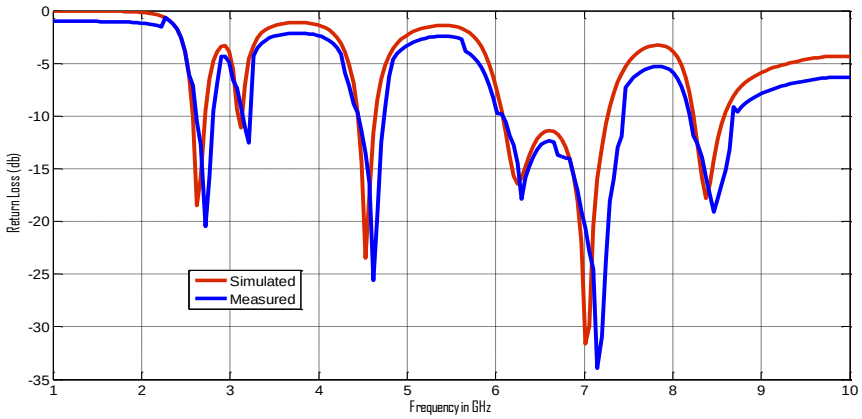

Fig. 4

Figure - 4 shows the Frequency vs. Return Loss graph and from the above figure its clear that Simulated result and measured result are in close agreement.

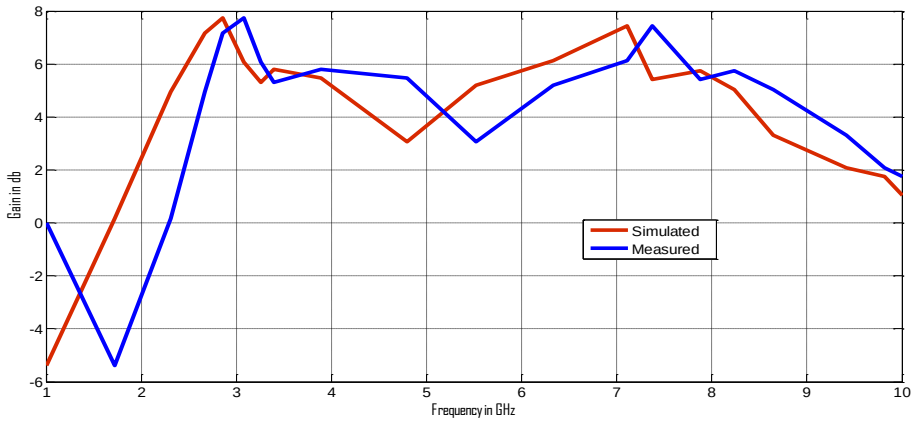

Fig. 5

Figure -5 Shows the gain vs. frequency graph. And from the graph its observe that simulated and experimental are in close agreement

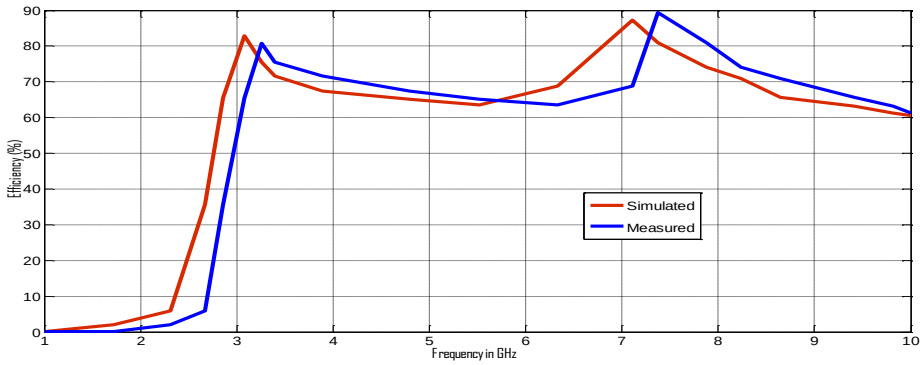

Fig. 6

Figure -6 shows the Efficiency vs. frequency graph. And from the graph its observe that simulated and experimental are in close agreement

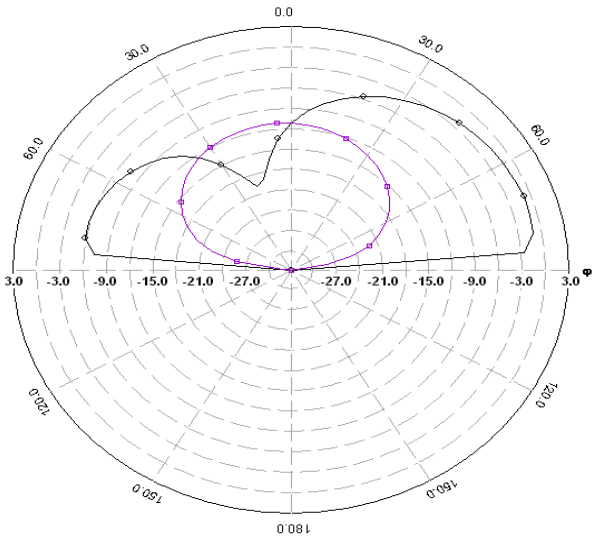

Fig. 7 (a) Radiation Pattern at 2.63 GHZ

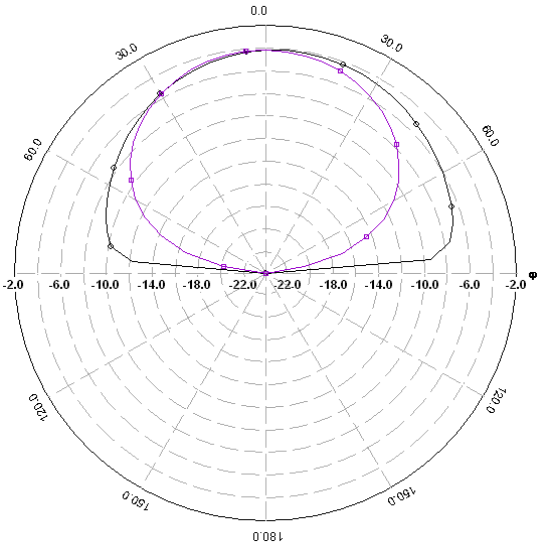

Fig. 7 (b) Radiation Pattern at 3.12 GHz

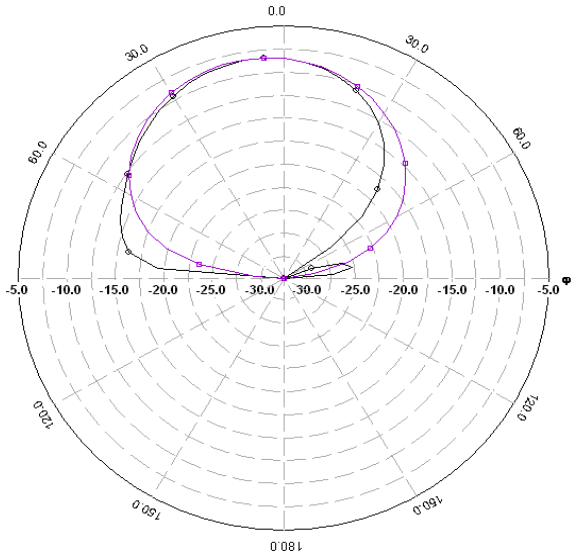

Fig. 7(c) Radiation Pattern at 4.79 Ghz

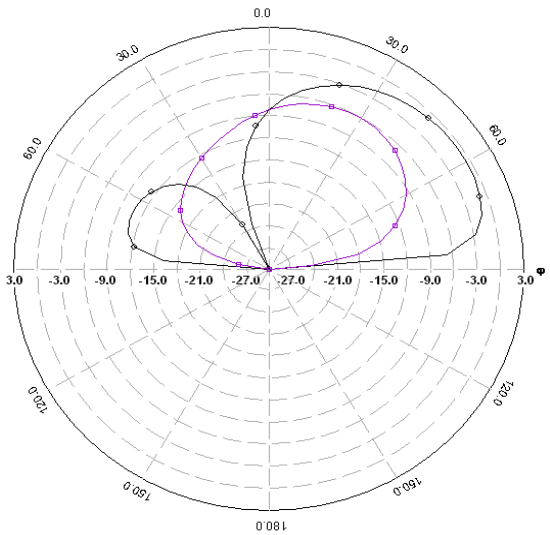

Fig. 7(d) Radiation Pattern at 6.3 GHz

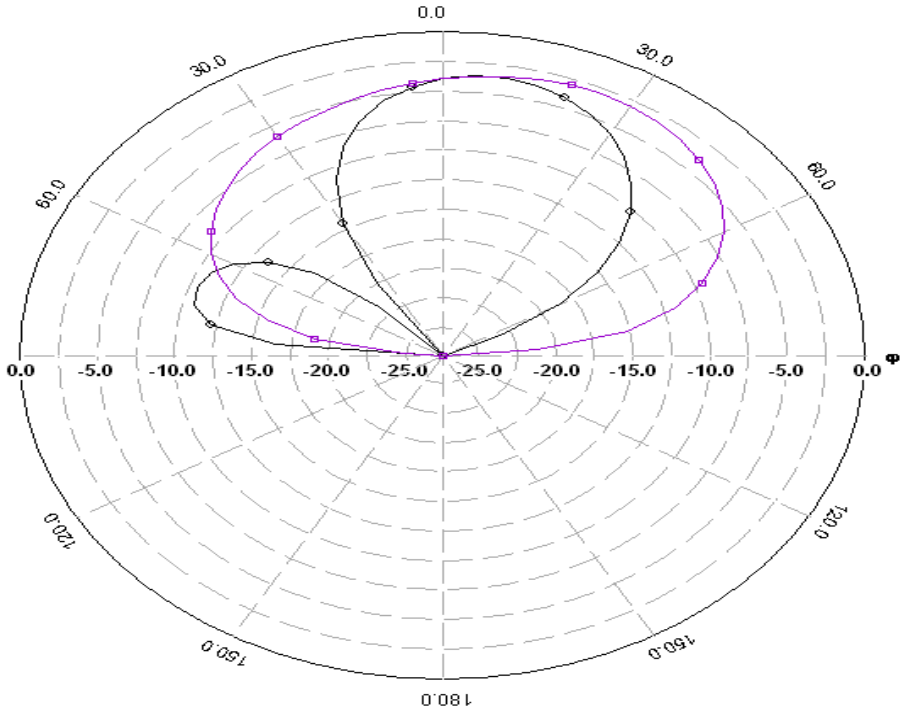

Fig. 7(e) Radiation Pattern at 8.23 Ghz

Figure 7: Radiation pattern of proposed antenna at resonating frequencies such as (a) 2.63 Ghz (b) 3.12 GHz (c) 4.79 GHz (d) 6.3 GHz and (e) 8.23 GHz having E-and H-plane

IV. Conclusion

In this article a novel compact slots loaded circular patch antenna has been designed and on introducing the shorting pins and loading the slots on disc patch antenna, the multiband is achieved. It is found that antenna resonates at 2.63 GHz, 3.12 GHz, 4.52 GHz, 6.68 GHz, 8.32 GHz frequencies with fractional bandwidth of 4.94%, 1.15%, 4.38%, 17.64% and 4.1 %. The proposed antenna is capable of satisfying the requirements of WiMAX, WLAN, C-band (4-8) GHz and military communication satellite (uplink) range assigned by ITU respectively.

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