Slotted Microsrip Patch Antenna at 60GHz for Point- to- Point Communication

(IJCSNT) International Journal of Communication Systems and Network Technologies
ISSN Number: 2053-6283
Volume 13, Issue No. 2, 77–83
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https://journals.mirlabs.in/index.php/ijcsnt
DOI-10.18486/ijcsnt/13.2.178
IJCSNT

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Abstract

A compact slotted planar square ring-shaped micro strip antenna simultaneously suitable for point to point communication at 60 GHz is presented. The antenna is simulated by the software CST. CST, computer simulated technology simulator is employed to analyze the proposed antenna and simulated results on return loss, the radiation pattern and polar plot gain is presented. The simulation and measurement result met the IEEE 802.1lad standard operate in 60 GHz band for point to point communication. The measured results shows a return loss of -26.69 db, gain of antenna is 7.566 dB and the voltage standing wave ratio VSWR $<$ 2 at 60 GHz indicating that the antenna is a good candidate for very high speed WLAN applications.

Keywords

Slotted Patch Antenna, Probe Feed Micro Strip Antenna, Point To Point Communication, WLAN

Received: 25 April 2024; **Revised:** 29 July 2024; **Accepted:** 25 August 2024;
Published: 31 August 2024;

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Introduction

Microstrip antennas are currently one of the fastest growing segments in the telecommunications industry and promise to become the preferred medium of telecommunications in the future. Microstrip antenna technology began its rapid development in the late 1970s. In the last decades printed antennas have been largely studied due to their advantages over other radiating systems, such as light weight, reduced size, low cost, conformability and possibility of integration with active devices [6].

In high-performance point to point application where size, weight, cost, performance, ease of installation are constraints, low profile antenna is very much required. To meet these requirements, microstrip antenna is preferred. Although microstrip antenna has several advantages like low profile, light weight and simple to manufacture, it also has several disadvantages such as low gain, narrow bandwidth with low efficiency [6]. These disadvantages can however be overcome with intelligent designs incorporated in whole antenna structures [4]. One of the ways to overcome these problems is by constructing patch antennas in slotted square ring configuration. WLAN point to point application is based on IEEE 802.1la standard operates in the upper Unlicensed National Information Infrastructure (UNII) band (5.725 to 5.875 GHz) [7].In 1995, the FCC assigned the 59 -64 GHz band (millimetre-wave band) as an unlicensed band. The report states that" The Commission noted that the spectrum would be suitable for short-range, high data rate, broadband applications, such as wireless computer-to-computer communications, and determined that licensing was not needed because of the limited potential for interference, due to shorter propagation distances of these frequencies. Interference potential would also be limited by the narrow beam width of point-to-point antennas, which are likely to be operating in this range" [8]. In December 2000, Industry Canada (IC) released a consultation document to introduce the license exempt wireless devices in the band 57- 64 GHz. In Japan The 59-66 GHz band is allocated for unlicensed use with a maximum transmitter power output of 10 mW and a maximum antenna gain of 47 dBi [9]. There is also an ongoing effort to migrate indoor WLAN network toward less congested higher frequency unlicensed spectrum band such as 60-GHz band in other countries. The Institute of Electrical and Electronics Engineers Standards Association (IEEE SA) developed the IEEE standard 802.11ad to promote and harmonies Wireless Local Area Network (WLAN) technologies operate in 60 GHz band in the world. 60-GHz Point to point communication has the potential for dramatically increasing radio link speed from current megabit per second to gigabit per second, while also improving radio system capacity and spectrum efficiency significantly [1]. Antennas for communication systems at 60 GHz are expected to be broadband to achieve high data rate [12] and should have a high gain due to the high path loss at these frequencies [11].

Designed antenna could provide the infrastructure for future applications which is envisioned to need a faster data rate. Furthermore, millimeter wave bands could relieve congestion and reduce demand for spectrum in frequency bands below 20 GHz.

Literature Review

In the time of fast-moving wireless technology and specifically in the area of microwave and millimeter wave range, which has proved to be carrying high range of data with improved bandwidth and carrier. There have been several conceptual designs of the antenna with different methods and frequency bands and have proved to be critical in the air interface and the data transmission. Some of these antennas still have shortcomings in terms of superior directivity and gain. In the literature, several practitioners have contributed to the field of antenna layout and interpretation. For instance, Ali et al.[2,3] proposed the draft and inspection of an MPA with a DGS for WLAN application. Alam et al. In[5] authors presented a compressed dual-band MPA with a DGS for 2.4 GHz and 5.8 GHz WLAN implications.[6,7] Chia et al. (conceptualized a DGS for an MPA to improve RP and diminish back radiation. Kumar and Sarin[12] assured to have developed a compressed square MPA with a DHS for Wi-Fi, WLAN implications. In[8,9] authors have conceptualized dual-band MPA with a DGS for WC implications at 2.4 GHz and 5.2 GHz. In[7] authors have studies have established the effectiveness of using DGS to improve the proficiency of PA in abundant WC practices.

In[12] Aperture-Coupled Microstrip Open-Loop Resonators is proposed with their applications to the design of Novel Microstrip Bandpass Filters. A new filter configuration consists of two arrays of microstrip open-loop resonators, which can be coupled through the apertures on the common ground plane, which can also be used for antenna design. Two types of slot patches are loaded in each corner to split the degenerate modes easily. In[13] stepped-impedance coupled resonators (SICR) for implementation of parallel coupled microstrip filters or antennas are proposed with spurious band suppression. The SICR relies upon the incorporation of different stepped impedances for even and odd propagation modes of the coupled microstrip lines.

Use of discontinuities in ground planes or in micro strip lines is currently employed to improve the performance of different passive circuits and has helped in the design process. It includes size reduction of amplifiers, enhancement of filter characteristics and applications to suppress harmonics in patch antennas. This paper presents an improved method of size reduction of a micro strip antenna using Defected Micro strip Structure.

Analysis and Design

The geometry of the proposed slotted microstrip patch antenna designed at 60GHz is shown in Fig. 1. A rectangular patch is employed as the antennas main radiating element. The patch is fed by a 50Ω coaxial cable. The antenna has overall dimensions of only 6 mm x 6mm with the electrical length of $0.297\lambda_0$ x $0.297\lambda_0$ at 60 GHz. The antenna is fabricated on a RogerRT5880 substrate of relative permittivity of 2.2, loss tangent 0f 0.0009, and thickness of 1.6 mm. Electromagnetic simulation software, CST Microwave Studio is used for simulation purpose.

A copper plate with dimensions of 6mm * 6mm and thickness of 0.1 mm is used as the ground plane. Length of outer ring patch is 4 mm and width is 4 mm. Dimension of middle ring patch is 2mm *2.4mm and Dimension of inner ring patch is 0.5 mm *0.6mm. . This antenna has been designed to work at 60 GHz frequency. The complete structure of antenna has shown in Figure 1.

Figures shown above specifically shows the simulated design by which it is clear that shape and size is also compatible and design evaluation has been done with the analysis of the parameters and its value for the proposed frequency rnage.

Simulation and Results

Figure 2 is clear where x-axis and y-axis are plotted with parameters frequency in G Hz and S-parameters thereof. It is clear that loss and gain graph is very encouraging.

The simulated reflection coefficient (S11) of the antenna is shown in Figure 2.1. The antenna resonates at 60 GHz with the impedance bandwidth of 2.6 GHz and return loss of -26.69dB. The simulated radiation

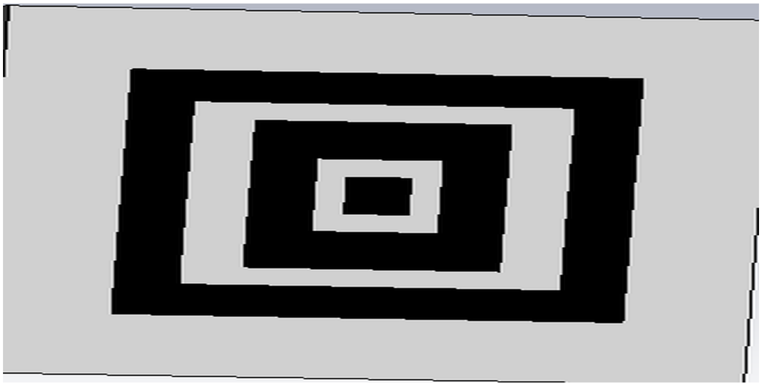

Figure 1. Fig. (1.1) Top view of designed antenna

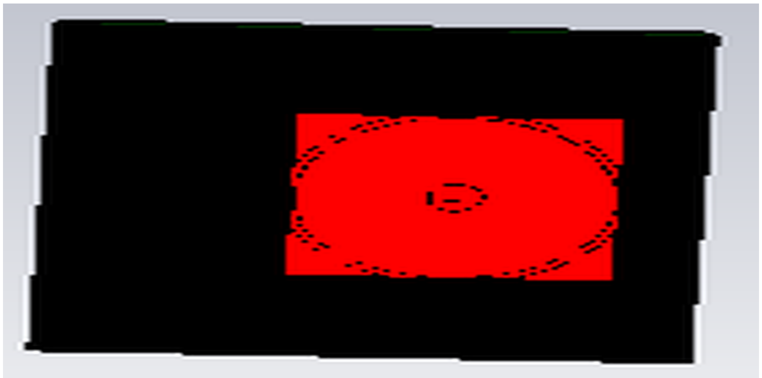

Figure 2. Fig.(1.2) bottom view of designed antenna

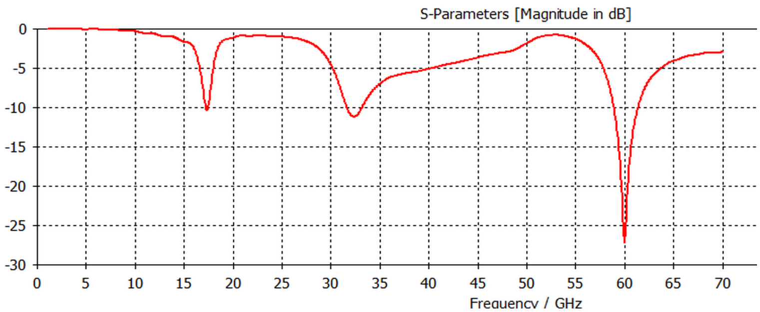

Figure 3. Fig.(2.1) Simulated Return Loss plot[magnitude in dB]

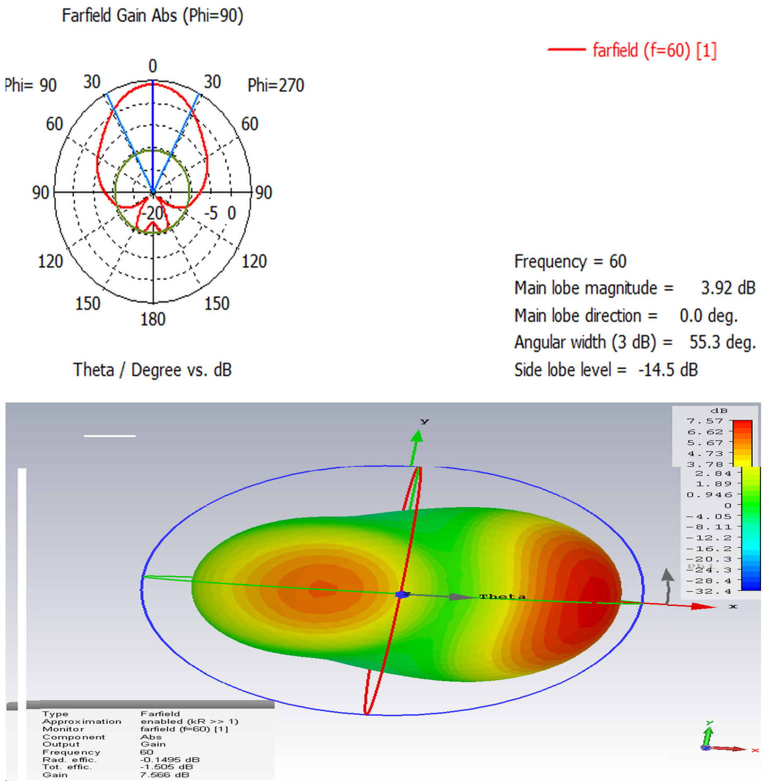

Figure 4. Fig.(2.2) Simulated radiation pattern plot

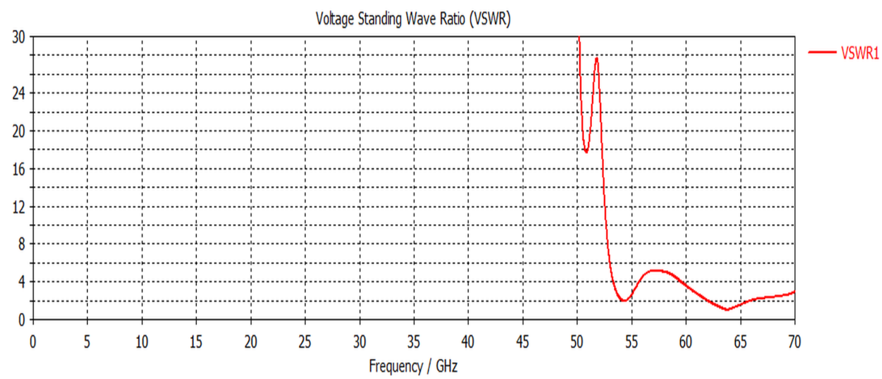

Figure 5. Fig. (2.3) Simulated VSWR pattern for antenna

patterns for E- and H- planes are shown in Fig. 2.2 and Fig. (2.3) respectively. It can be seen that the proposed antenna provides nearly stable directional pattern in E–plane and H-plane typical of patch antenna.

Conclution

A compact square ring-shaped microstrip patch antenna has been designed for high-speed wireless communication systems. The refection coefficient is below −10dB from 58.80 GHz to 61.58GHz. The gain of antenna is 7.566 dB. At the same time, the antenna is thin and compact with the use of low dielectric constant substrate material. the 60 GHz frequency band has the potential to support very high data rate wireless communication applications. Considering the limited data rates offered by current wireless LAN systems (802.11a, 11b, etc), it is anticipated that future higher data rate wireless LAN technology could occur in the 60 GHz band. The 60 GHz technology will be used for short range communication links typically up to 1 km. The propagation characteristics of 60 GHz systems and the narrow beamwidths of antennas are such that there will be a low likelihood of interference between systems operating in the band. These features are very useful for worldwide portability of wireless communication equipment. By locating the feed point at the base rather than the center arm, the resonant frequency of the second resonant mode can be tuned without affecting the resonant frequency of the fundamental resonant mode. The bandwidth can be easily enhanced by increasing the height of substrate.

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