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Circular Patch Antenna for Ultra Wide Band Applications

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Abstract: A circular patch antenna for Ultra WideBand (UWB) applications is proposed. The patch antenna ensures the 90% of signals power with frequency between 0.80 GHz to 10.15 GHz will be radiated, i.e., the antenna has an operation bandwidth of 9.35 GHz. Also, E and H-plane radiation patterns for the operation frequency of 7.5 GHz are presented. The estimated patch antenna´s gain is equal to 4.24 dB.

Key words: Patch antenna · UWB · Return Loss · Radiation patterns and Gain

INTRODUCTION

A microstrip patch antenna is an electromagnetic field radiator element which is made up of a conductive ground plane, a dielectric substrate and the conductive patch. The ground plane and the patch are made of conductive electrical material; the most commonly used is copper, while the dielectric substrate is an insulating material that supports the ground plane and the patch. The most commonly used dielectric substrates are: FR4, Arlon AD 250, RT Druids, Roger r4003 and Teflon. The most commonly used patch geometries for this type of antennas are rectangular, circular and equilateral triangle. The three most popular feed techniques used are coaxial probe, microstrip line and aperture-coupledfeed [1, 2].

Currently applications require high performance of patch antennas such as manufacturing quality, light in weight, low cost, small dimensions and that are feasible for installation [2]. However, these types of antennas have certain limitations such as narrow bandwidth and problems associated with tolerance, smaller gain and excessiveohmic loss in the power supply [3].

UWB radio technologies can use a low level of radiated signal energy for short bandwidth and high bandwidth communications, in a large part of the radio spectrum. The operating range of 3.1 GHz to 10.6 GHz is used for a small group of UWB wireless applications. In Ultra WideBand impulse radio the transmitted signal consists of ultra-short pulses (picoseconds) generated by Pulse Position Modulation (PPM) or Pulse Amplitude Modulation (PAM) [4]. Within the UWB operating frequency range we have the Global Satellite Navigation System or Global Positioning System (GNSS or GPS). UWB radio networks are low-power, low-cost and quickly to set up as a local positioning systems and can be seen as the intermediary sensors between GNSS and Inertial Measurement Units [5]. GNSS occupies a frequency range of 1000 MHz to 2000 MHz. Another application of UWB is the Global Mobile Communications System (GSM), which operates in the frequency range of 380 MHz - 1.8 GHz. In GSM the 900 MHz frequency band is used for mobile communication applications [6]. The Long Term Evolution (LTE) mobile application is used for high-speed data transmission for mobile phones and its operating frequency band is 2.3 GHz to 2.4 GHz [2]. On the other hand, Wireless Local Area Networks (WLAN) with the 802.1 a / b / g / n standards of the Institute of Electrical and Electronic Engineers (IEEE) use the 2.4 GHz (2.412 GHz to 2.4835) and 5 GHz (4.9 to 5.9)of frequency bands [2]. Global Interoperability for Microwave Access (WiMAX) is another wireless communications application designed for high-speed data connectivity. It offers high-speed Internet access and telephone services and operates in the 2.35 GHz (2.300 to 2.400), 2.5 GHz (2.496 to 2.690), 3.5 GHz (3.300 to 3.800) and 5.8 GHz (5.25 to 5.85) frequency bands [7]. The radio, scientific and medical bands (ISM) are reserved internationally for the use of radiofrequency energy, their frequency band is 2.45 GHz [2]. An interesting proposal of UWB antenna is presented in [8], with heptagonal patch, with operating bandwidth equal to 8.72 GHz (1.64 to 10.36 GHz) and 2.1dB of antenna gain at 5.82 GHz of the central frequency. In [9] a wideband wearable patch antenna is proposed for 5.6 GHzwith 1.12 GHz of bandwidth and cotton as the substrate material.

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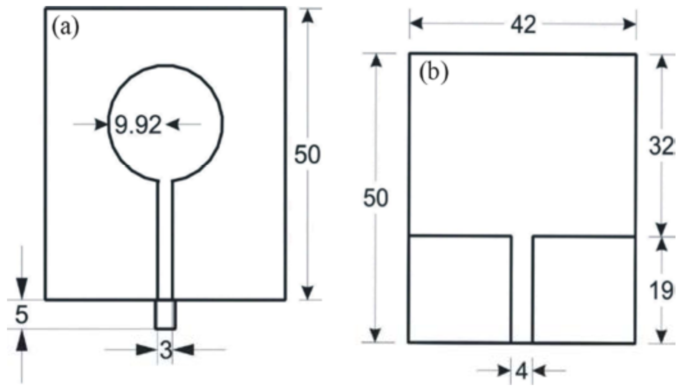

Fig. 1: Patch geometry a) Top view and b) Bottom view. Units in millimeters.

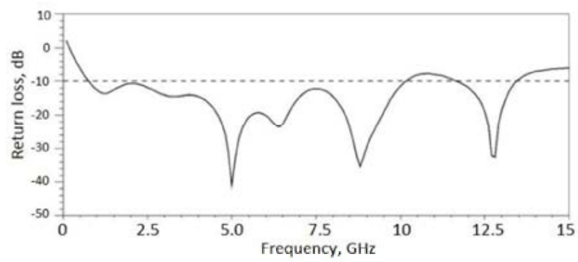

Fig. 2: Return loss in dB

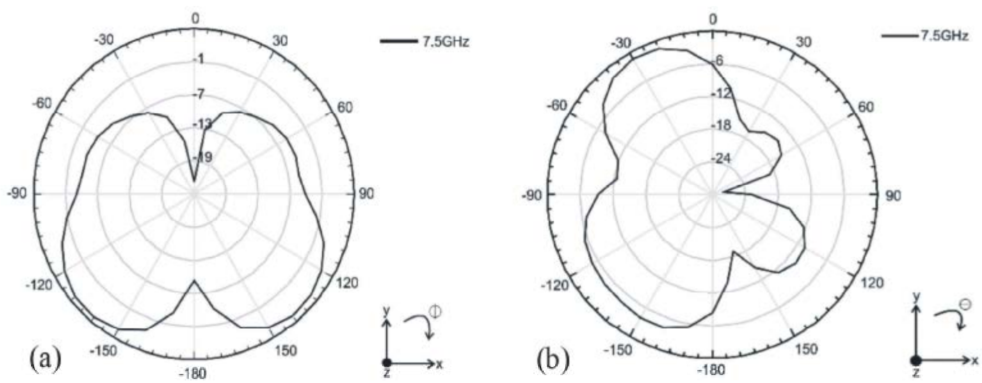

Fig. 3: Radiation pattern in a) E plane and b) H plane for the frequency of 7.5 GHz

This paper proposes a circular patch antenna with 9.35 GHz of bandwidth (0.80 to 10.15 GHz) and 4.24 dB of gain at the central frequency of 7.5 GHz.

Circular Patch Antenna Geometry: The circular patch antenna is composed by an FR4 EPOXY dielectric substrate with thickness of 1.6 mm. The patch antenna occupies a surface equal to 50 x 42 mm^2. The patch antenna geometry is presented in the Figure 1.

Performance Parameters: With a 3D electromagnetic simulation software, like HFSS by ANSYS, the circular patch antenna performance was estimated. The estimated return loss of the circular patch antenna ensures that 90% of the power delivered to the antenna will be radiated for signals with a frequency between 0.80 GHz and 10.15 GHz. This frequency range is used by applications of the UWB technology.

Figure 3 shows the radiation pattern in E and H-planesfor the operating frequency of 7.5 GHz. It can be seen that the directions of maximum radiation are -135° and -30° in E and H-planes, respectively.

Figure 4 shows the 3D radiation pattern of the circular patch antenna. The gain reached is equal to 4.24 dB.

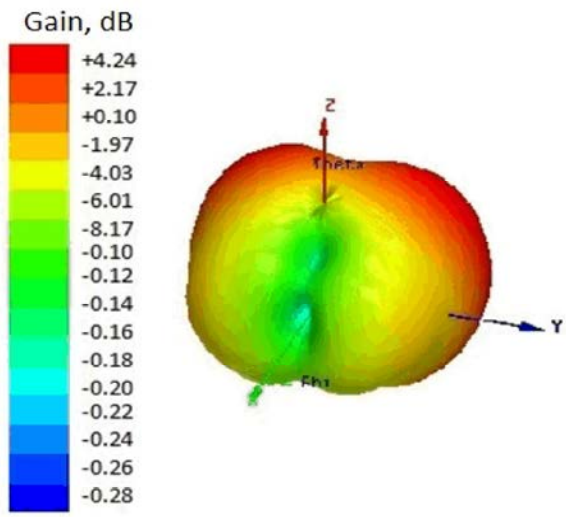

Fig. 4: Total gain and 3D radiation pattern

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CONCLUSIONS

The proposal for a circular patch antenna for UWB applications is presented. The geometry of the patch antenna and the estimated performance parameters such as insert loss, radiation patterns in E and H-planes and antenna gain for the operating frequency 7.5 GHz are presented. The return loss ensures a frequency band between 0.80 GHz to 10.15 GHz, i.e., an operating band of 9.35 GHz. The estimated circular patch antenna gain is equal to 4.24 dB.

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