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Heptagonal Patch Antenna for UWB Applications

[1]*Alejandro Iturri-Hinojosa,* [2]*Cynthia Hernández-Martínez and* [3]*R. Linares Y. Miranda*

[1,2]Instituto Politécnico Nacional, ESIME Zacatenco, CDMX, México, C.P. 07320
[3]Instituto Politécnico Nacional, SEPI Zacatenco, Ciudad De México, México, C.P. 07320

Abstract: A proposal of a heptagonal patch antenna for Ultra-Wide Band applications is presented. The antenna impressed over FR4 Epoxy dielectric substrate with 1.6 mm of thickness and 38x30 mm^2. The antenna has a bandwidth of 8.72 GHz, from 1.64 GHz to 10.36 GHz. The gain of the patch antenna reaches to 2.1 dB.

Key words: UWB systems · Patch antenna · Return loss · Radiation pattern

INTRODUCTION

With the constant development of electronic devices and telecommunication standards for wireless communication systems, the need to increase information capacity is greater. Recently there have been proposals for patch antennas that operates atlarge bandwidths for application inUltra-Wide Band communication systems [1]. Patch antennas are characterized by meeting most current requirements, such as light weight, ease of manufacture, low volume and are mechanically robust. Patch antennas have various applications, such as radars, sensors, wireless, satellite, ultra-broadband networks, radio frequency identification (RFID), reading devices, etc. [1].

With the recent frequency assignment for UWB, a lot of interest in UWB technologies has been generated. There is 7, 500 MHz of spectrum for unlicensed use. The main limitations are provided by the low power in the spectral density and the fact that the transmission signal must occupy at least 500 MHz at all times. IEEE 802.15.3a is being developed for high bit rate PAN applications and UWB is the most promising technology to meet the stringent requirements: 110, 200 and 480 Mbps. Ultra-Wide Band (UWB)also known as radio technology pulse, is defined as any radio transmission that occupies a bandwidth greater than 25% of the center frequency or more than 1.5 GHz [1, 2]. UWB is a radio technology that can use a very low energy level for short bandwidth and high bandwidth communications in a large part of the radio spectrum. The most recent applications focus on sensor data collection, precision tracking and tracing. In UWB communication systems, the transmitted signal is ultra-short pulses (PS) generated by Pulse Position Modulation (PPM) or Pulse Amplitude Modulation (PAM) [3] and stands out for its multi-user access capability and its resistance to effects by multi-path propagation. It is designed to occupy frequency bands assigned to other services without causing great interference because UWB systems emit at a very low power of a few mW / MHz spread over bandwidth [2].

It is important to specify that UWB is useful for applications such as sensor networks with very high battery durability, high precision radars, image generation systems, low frequency detection and interception communications [3]. It also excels in applications to improve the safety of miners, using radar systems installed in vehicles to avoid collisions and remote control for machinery so that it can operate in extreme environment conditions. Wireless sensor monitoring is another crucial application for worker safety in mines. Since UWB has excellent spatial resolution, it can be advantageously applied for location and navigation [4, 5].

There are currently interesting proposals for patch antennas that operate in ultra-wide band (UWB). [6] Presents its proposal of a circular patch that covers the frequency range from 2, 030 GHz to 11.87 GHz, giving 9.84 GHz of bandwidth, with a gain of approximately 2.4 dB, proposed for satellite communication systems, WIMAX, ISM and LTE. Another proposal is a rectangular patch antenna with a defect in the ground plane, for UWB application which operates in a frequency range of 1.65 GHz to 10.68 GHz. It makes use of two rectangular stubs to produce an increase in resonance, reaching a gain of 2.0725 dB [7]. Currently there are also proposals for dual band antennas such as the one presented [8].

Corresponding Author: Alejandro Iturri-Hinojosa, Instituto Politécnico Nacional, ESIME Zacatenco, CDMX, México, C.P.07320

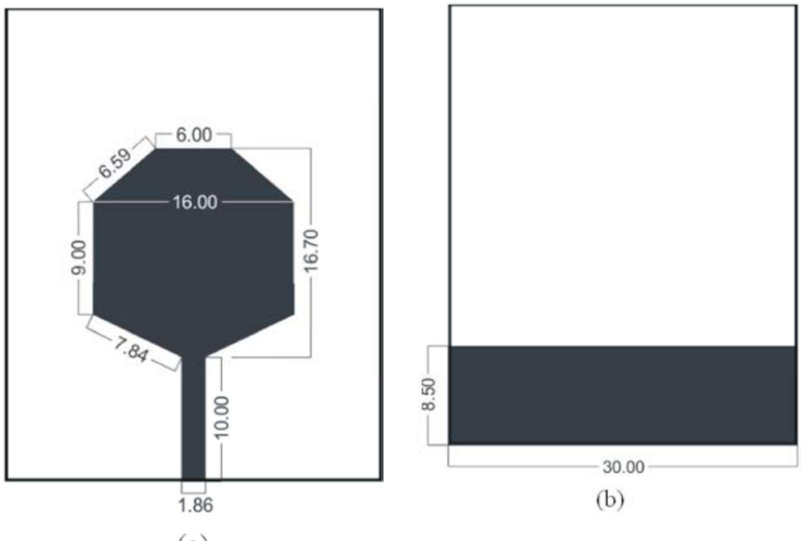

Fig. 1: Patch antenna geometry(a) top view and (b) back view.Units in millimeters

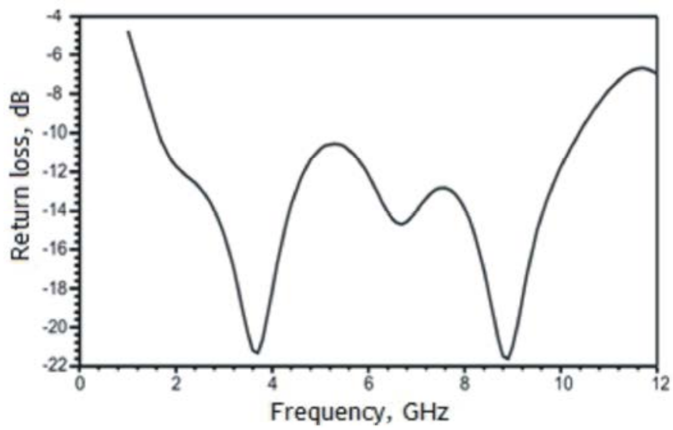

Fig. 3: Return loss, dB.

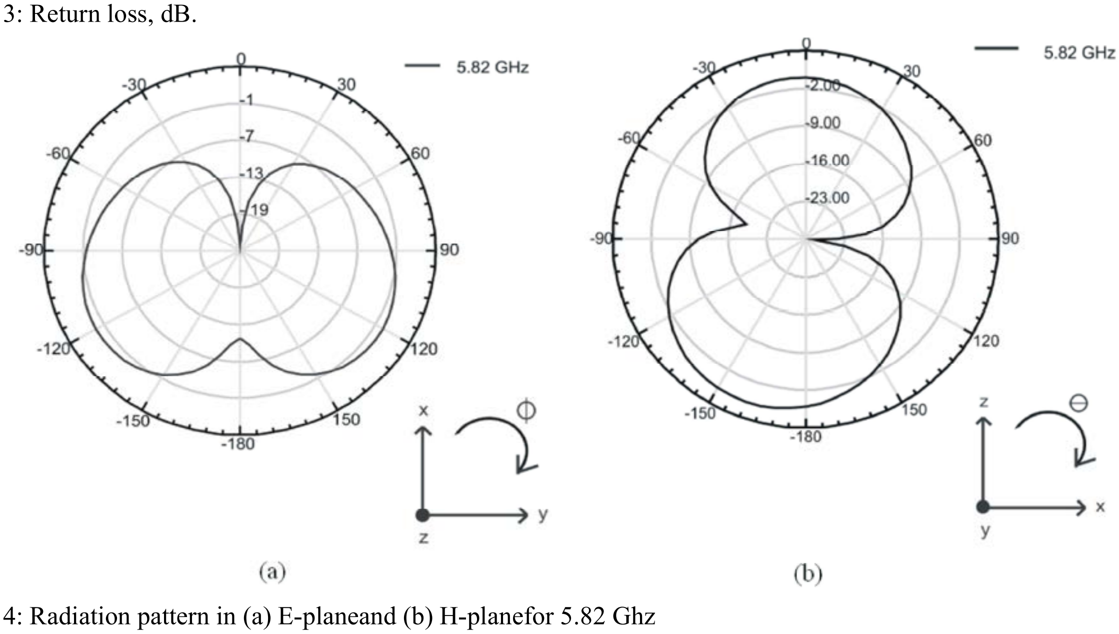

Fig. 4: Radiation pattern in (a) E-planeand (b) H-planefor 5.82 Ghz

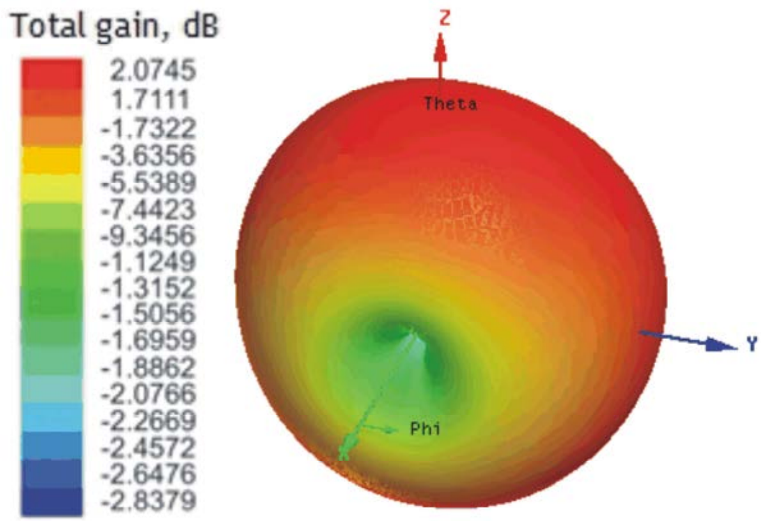

Fig. 5: Total gain of the heptagonal patch antenna

The antenna consists of two patches and operates in the frequency range of 2.89 GHz to 12.43 GHz that covers the frequency bands of 5.2 / 5.8 GHz of WLAN, 3.5 to 5.5 GHz of Wi MAX and 4 GHz of C band.

This paper presents the proposal of a heptagonal patch antenna for application in Ultra-Wide Band systems covering the frequency range of 1.64 GHz to 10.36 GHz, reaching 2.1 dB of gain.

Heptagonal Patch Antenna Geometry: The patch antenna is printed on FR4 epoxy dielectric substrate with relative permittivity ( ) equal to 4.4, with 1.6 mm thickness and dimension equal to 16 × 16.7 mm^2. The patch geometry is presented in Figure 1.

The ground plain is impressed at the other side of the dielectric substrate and its size is 8.5x30 mm^2.

Performance Parameters: HFSS simulation software of ANSYS was used to find the performance responses of the heptagonal patch antenna. The estimated return loss response ensures that 90% of the power delivered to the antenna will be radiated for power signals that have a frequency between 1.64 GHz and 10.36 GHz. Ensuring a bandwidth of 8.72 GHz for the UWB application.

Figure 4 presents the radiation pattern in E and H plane, for the operation frequency of 5.82 GHz.

Figure 5 shows que radiation pattern in 3D of the heptagonal patch antenna. The gain reached by the antenna is 2.1 dB.

La Figura 5 presenta al patrón de radiación en 3 dimensiones de la antena de parche heptagonal. La ganancia que alcanza la antena es igual a 2.1 dB.

CONCLUSIONS

The proposal for a heptagonal patch antenna for ultra-wideband (UWB) applications is presented. The patch has heptagonal geometry and is printed on FR4 Epoxy dielectric substrate. The geometry of the heptagonal patch antenna is presented. The operating bandwidth of the patch antenna is equal to 8.72 GHz, from 1.64 GHz to 10.36 GHz. The antenna achieves a gain of 2.1 dB. The radiation patterns are presented in planes E and H.

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