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MICROSTRIP RING ANTENNA FOR 2.4 GHZ FREQUENCY BAND

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МІКРОСМУЖКОВА КІЛЬЦЕВА АНТЕНА ДЛЯ ЧАСТОТНОГО ДІАПАЗОНУ 2,4 ГГЦ

Здійснено проєктування та оптимізацію несиметричної вібраторної антени із випромінювачем кільцевого типу для роботи у діапазоні 2,4 ГГц, виконаної за мікросмужковою технологією. Живлення антени здійснюється мікросмужковою лінією. Проведено моделювання роботи антени методом скінченних елементів в діапазоні робочих частот 2.4…2.483 ГГц. За результатами оптимізації антени забезпечено зменшення зворотних втрат, так що пристрій демонструє достатні для експлуатації характеристики у діапазоні частот, що значно перевищує робочу смугу. В межах робочої смуги частот КСХ розрахованої антени знаходиться в діапазоні 1…1.2.

Printed microstrip antennas are widely used in radiocommunication systems due to their small dimensions, low cost and possibility to be integrated at the common PCB with the device. There is a large number of small-size antenna types and design techniques that can be used for their analysis and fabrication [1] – [3]. Among the microstrip radiating structures, patch antennas are often used. However, these antennas are not omnidirectional and typically have gain of 6…9 dB [4 – 7]. To obtain omnidirectional directivity pattern, dipole or monopole antenna structures should be used.

In this paper, a microstrip monopole antenna for 2.4 GHz band is designed and simulated. The antenna is designed to operate in 2400…2483 MHz frequency band. As a radiating element, a ring topology was used. Antennas with such layout manifest ultrawideband operation. Therefore, even being optimized for 2.4 GHz band, the proposed antenna can be used in larger frequency range. The antenna can be used in mobile ISM band communication systems, such as Wi-Fi, Bluetooth or Zigbee applications. As numeric technique for the simulation, finite element method was used.

As a substrate for the antenna, FR4 laminate was used with the following parameters: dielectric constant $\varepsilon_r = 4.4$; thickness $h = 1.5$ mm; thickness of the top and bottom copper layers $t = 0.018$ mm; dissipation is defined by tan $\delta = 0.02$.

The layout of the antenna is shown in Fig. 1. The antenna was designed so as to be fed by 50 Ω microstrip line or coaxial cable using SMA connector. The antenna of the selected type is ultrawideband and has pertinent performance in the frequency range that covers a few gigahertz higher 2 GHz frequency. As soon as it was designed primarily of 2.4 GHz band, its parameters were optimized to have the lowest return loss value in 2400…2483 GHz frequency range.

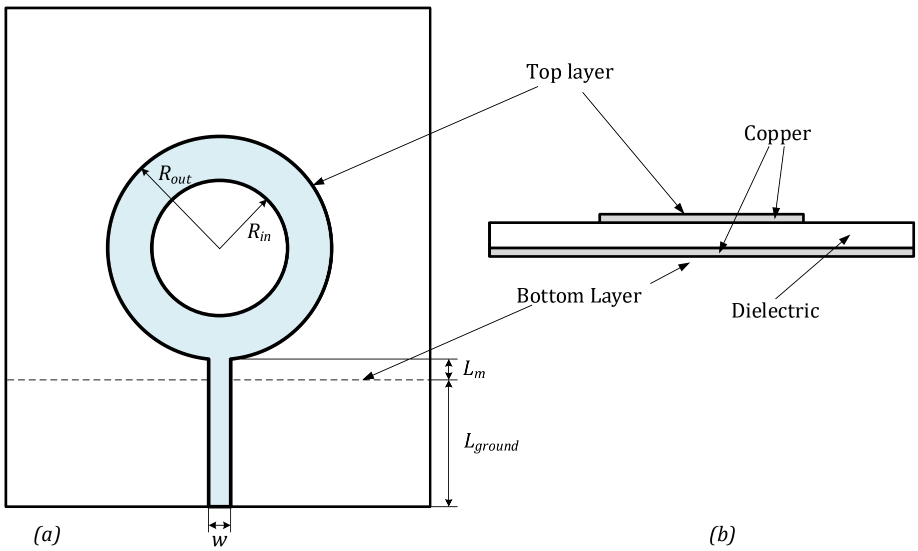
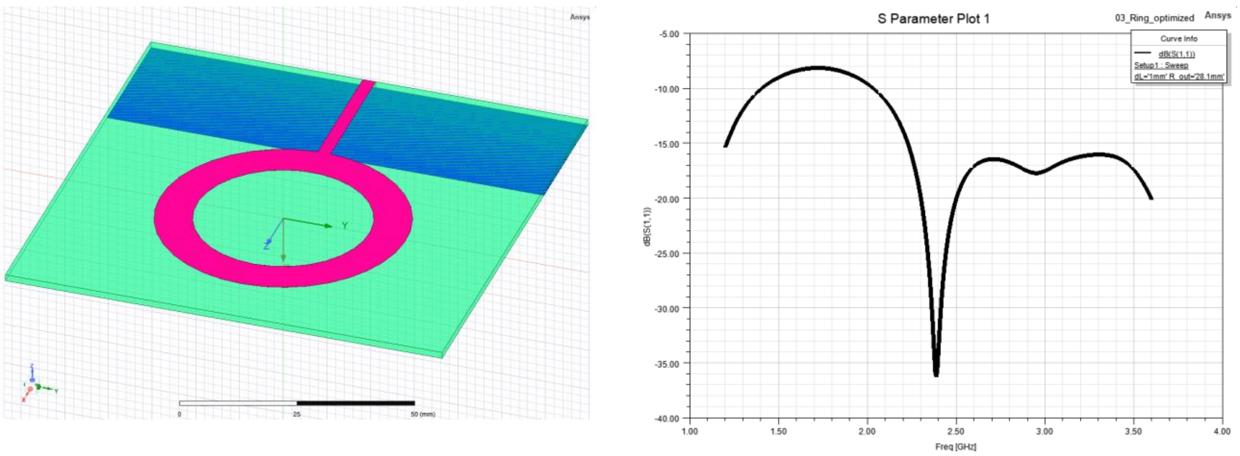


Fig.1. Dimensions of a microstrip dipole antenna. (a) Antenna dimensions. (b) Side view of the antenna.

The theory and design approach for the selected antenna type are considered in [1] – [3]. The design procedure contained the following stages: rough estimation of the geometry parameters according to general principles of the design of monopole antennas; analysis of the impact of L_m parameter on the antenna characteristics; optimization procedure over the two parameters: R_{in}, R_{out}.

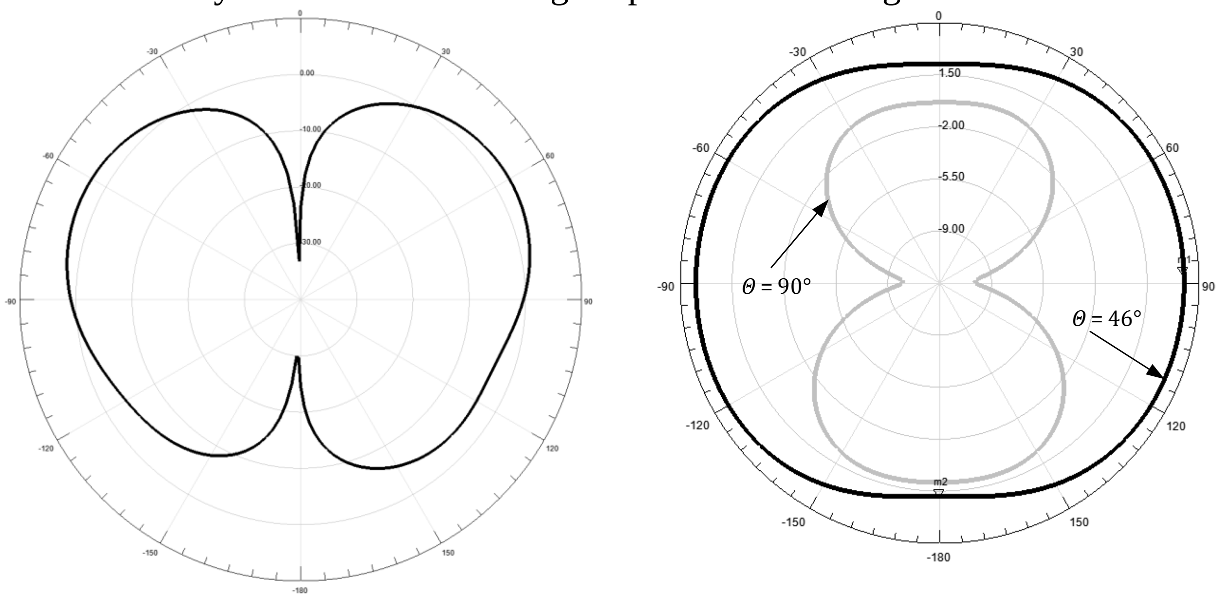
As a result of the optimization process, the following values were obtained for the antenna geometry L_{ground} = 30 mm; L_m = 1 mm; w = 2.9 mm; R_{in} = 19.7 mm; R_{out} = 28.1 mm. The model of the antenna is shown in Fig. 2 (a), and Fig. 2 (b) shows the return loss of the antenna. It can be seen that the return loss is smaller than -20 dB in the operating band.



(a) (b)

Fig.2. (a) Model of the antenna. (b) Return loss of the antenna.

The antenna with a ring shape of monopole has semi-omnidirectional directivity pattern. The maximum radiation is observed not in the azimuthal plane, but is inclined for about 45 degrees. In Fig. 3, the radiation pattern of the antenna is presented. The observed gain is 2…4 dBi within the cone of the highest directivity, which is observed for $\Theta = 46°$. The distortion of the radiation pattern is caused by the dielectric layer of PCB and the ring shape of the radiating element.



(a) (b)

Fig.3. Directivity pattern of the antenna. (a) E-plane. (b) H-plane.

The antenna designed in the course of the present research is small-sized and easily fabricated. VSWR value is less than 1.2 within the operating bandwidth 2.4…2.483 GHz. The antenna gain in the maximum of the main lobe is 2…4 dBi. The main lobe is inclined for about 45° relative to the azimuthal plane, which makes this solution well-suited for being mounted at considerable height for providing wide coverage area.

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