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PRINTED DIPOLE ANTENNA FOR 2.4 GHZ FREQUENCY BAND

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ПРОЄКТУВАННЯ ТА ОПТИМІЗАЦІЯ ДРУКОВАНОЇ ДИПОЛЬНОЇ АНТЕНИ ДЛЯ ЧАСТОТНОГО ДІАПАЗОНУ 2,4 ГГЦ

Здійснено проєктування та оптимізацію симетричної дипольної антени діапазону 2,4 ГГц, виконаної за мікросмужковою технологією. Живлення антени здійснюється коаксіальним кабелем, що передбачає реалізацію симетрувального пристрою. Проведено моделювання роботи антени методом скінченних елементів в діапазоні робочих частот 2.4…2.483 ГГц. В результаті оптимізації антени збільшено смугу її пропускання та покращено узгодження у смузі робочих частот. В межах робочої смуги частот КСХ розрахованої антени знаходиться в діапазоні 1…1.2.

Printed microstrip antennas are widely used in communication systems due to their small dimensions, low cost and possibility to integrate an antenna with the device at the common printed circuit board (PCB). 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 dipole antenna for 2.4 GHz band is designed and simulated using the finite-element method. The antenna to be designed shall operate in 2400…2483 MHz frequency range, and have uniform directivity pattern in one of the planes. The proposed antenna can be used in mobile ISM (Industrial, Scientific and Medical) band communication systems, such as Wi-Fi, Bluetooth or Zigbee applications. Thus, the operating frequency of the antenna was chosen to be f_0 = 2442 MHz, which is the center frequency of the operating band.

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 $t = 0.020$ 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 microstrip line or coaxial cable using SMA (SubMiniature version A) connector. Since a dipole antenna has balanced input, a balun is needed to convert unbalanced coaxial or microstrip input to balanced input of the antenna. In the presented antenna, tapered balun was used. Linear tapering was implemented due to its simplicity and pertinent transmission characteristics. To provide impedance matching, the dipole arms section, feed section and the balun were designed to have 50 Ω input impedance.

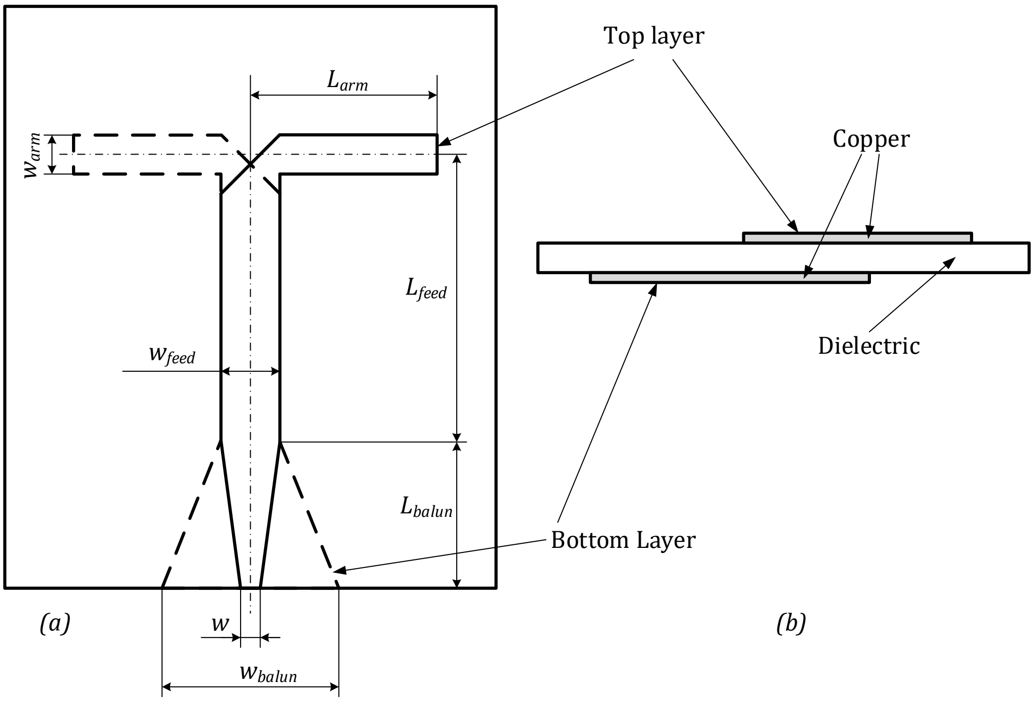


Fig. 1. Dimensions of a microstrip dipole antenna. (a) Antenna dimensions. (b) Side view of the antenna.

The theory and design approach for the selected antenna type are considered in [1] – [3]. The design procedure contained the following stages: analysis of the printed dipole section in order to match the resonant frequency and provide 50 Ω input with minimum value of reactance; design of the feeding section so as to provide impedance matching; design and optimization of the balun section; final simulation and optimization of the antenna.

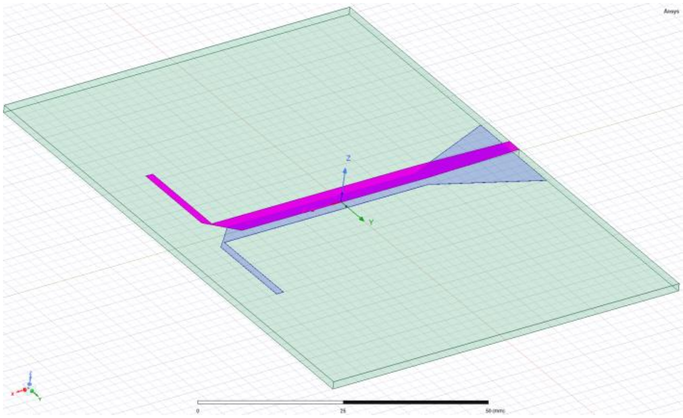
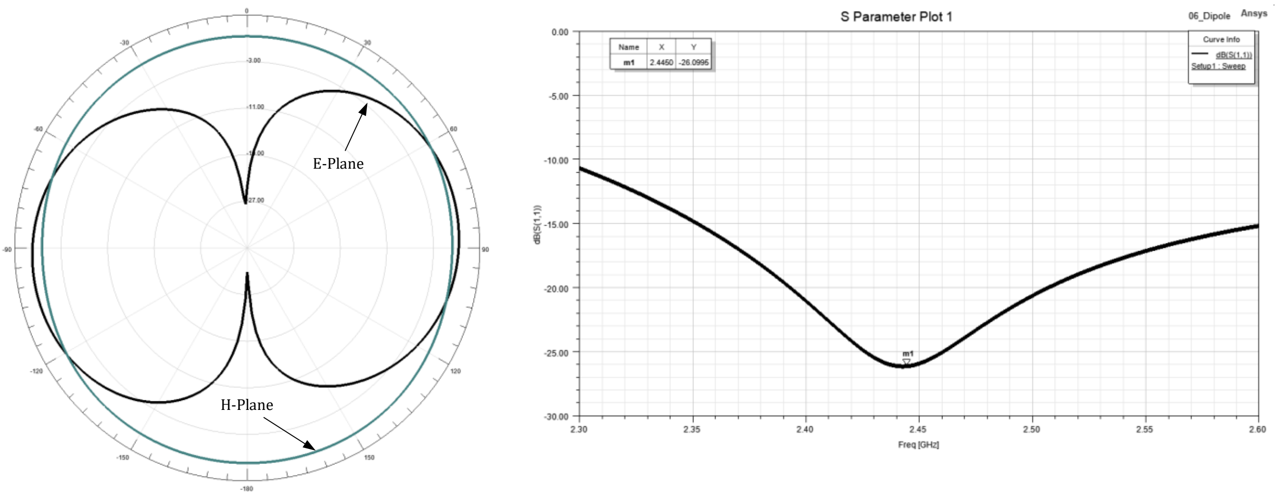


Fig. 2. Model of the antenna.

As a result of the optimization process, the following values were obtained for the antenna geometry L_{arm} = 20 mm; L_{feed} = 45 mm; L_{balun} = 20 mm; w_{arm} = 1.5 mm; w_{feed} = 4.1 mm; w_{balun} = 20 mm; w = 2.9 mm.

In Fig.3, the simulated results for the directivity diagram and the frequency responses of the antenna are shown. As it could be seen, the return loss is $RL = |S_{11}| \approx$ -21 dB at the operating band's left bound (f_L = 2.4 GHz), and $RL = |S_{11}| \approx$ -21.9 dB at the band's right bound (f_R = 2.483 GHz), and $RL = |S_{11}| \approx$ -

26.1 dB at the center frequency $f_0 = 2.442$ GHz. The gain of the antenna is $G \approx 2$ dBi. The polarization of the antenna is linear.



(a) (b)

Fig.3. Characteristics of the antenna. (a) Directivity. (b) Return loss.

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 band 2.4…2.483 GHz. It can be noticed that the directivity pattern has some distortion relative to the pattern of an ideal dipole antenna. This is caused by the impact of the dielectric plate and feeding elements in the proximity of the radiating section of the antenna.

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