OPTIMIZATION ANALYSIS FOR UHF RFID TAG ANTENNA USING CST MICROWAVE STUDIO

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Abstract

A planar meander line tag antenna for the radio frequency identification application at the ultra-high frequency (UHF) band covering the Malaysia band (919–923 MHz) is designed by using Computer Simulation Technology Microwave. The simulation result and some of the features of CST MWS will be shown in this paper.

Keywords : Radio Frequency identification (RFID), UHF band, CST MW

1. Introduction

Radio frequency identification (RFID) is a wireless communication technology that enables users to uniquely identify tagged objects or people, which includes virtually everything on earth. Thus, RFID is an example of automatic ID (auto-ID) technology, in which physical objects can be identified automatically [1]. RFID systems recently had tremendous growth due to their wide application in many fields, such as retail, transportation, manufacturing, and supply chain. RFID systems transmit the data between the tag and the reader in a contactless manner through radio waves, unlike the barcode system, which requires line of sight. RFID systems also have longer reading distances.

RFID systems are generally distinguished through four common bands; low-frequency (LF) (125–134 kHz), high-frequency (HF) (13.56 MHz), ultra-high frequency (UHF) (860–960 MHz), and microwave (MW) (2.45 GHz or 5.8 GHz) [2]. However, there are different operating frequencies for UHF band used in the different regions for RFID systems such as 840.5–844.5 MHz and 920.5–924.5 MHz in China, 866–869 MHz in Europe, 902–928 MHz in the US, 866–869 MHz and 920–925 MHz in Singapore, 920–928 MHz in Hong Kong, and 952–955 MHz in Japan [3]. For Malaysia, based on the Malaysia Communications and Multimedia Commission, the UHF band used is 919–923 MHz [4]. Each operating frequency has its own characteristics. LF bands have low data-transfer rates but are good for operating environments with metals and liquids, while HF bands have more reasonable data-transfer rates compared with LF bands and penetrates water but not metal. However, compared with other RFID frequency bands, UHF bands are more popular in many application areas because it provides a broad readable range, fast reading speed, and large information storage capability [5–6].

In this paper, a UHF tag antenna with the operating frequency used in Malaysia is designed and simulated by using computer simulation technology MW studio (CST MWS). CST MWS is a three-dimensional (3D) electromagnetic (EM) field simulator useful in designing the antenna. It provides features such as optimization, sweeping, and some calculations that are helpful during the simulation. Some features of this simulation tool will be shown in this paper.

2. Structure and Design

The geometry of a compact meander line antenna at the UHF band is shown in Figure 1. The antenna consists of a small rectangular feed ring, a meander line antenna, and the shorting pin.

Shorting pins are used to enhance impedance matching for the proposed antenna design, while the feed ring is used to improve the gain of the proposed antenna. Table 1 presents the parameters used to define the value of the meander line antenna for further optimization and sweeping. The radiating patch is constructed on a Roger 4003C substrate with thickness of 0.813 mm and a relative of permittivity 3.38. The radiating patch is constructed by the copper, with a thickness of 0.035 mm. By using CST MW, even in the simulation, the proposed antenna can be modeled like an actual antenna by constructing the SubMiniature version A (SMA) connector to the waveguide port of the proposed antenna. This can help provide good agreement between the simulation and the measurement result. The inner and outer diameters of the SMA connector can also be calculated by using the impedance calculation tool of the CST MW to match the antenna to the impedance required. In this paper, the proposed antenna is matched to 50 Ω.

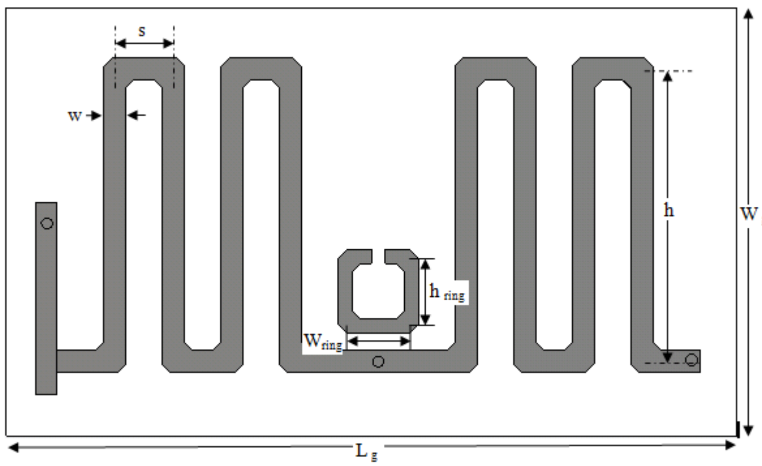


Figure 1. Geometry of the meander line antenna

Table 1. Parameters and values for the meander line antenna

Parameters	Values (mm)
L_g (length of ground)	53.00
W_g (width of ground)	31.00
s (spacing between pitches)	4.25
w (width of meander line)	1.59
h (height of meander line)	21.20
W_{ring} (width of ring)	4.80
h_{ring} (height of ring)	5.00

3. Simulation Result and Discussion

Figure 2 shows the return loss characteristic of the proposed antenna. The bandwidth at -3 dB is measured to be about 13 MHz (913–926 MHz), which includes the UHF band (919–923 MHz) used in Malaysia for the RFID system. The resonant frequency can be controlled by adjusting the spacing between the pitch of the meander line antenna. Figure 3 shows the effect of the different spacing between pitches to the resonant frequency by using the sweeping function of the CST MW. Figure 4 shows that the wider the pitch, the lower the resonant frequency becomes. Therefore, by controlling the spacing of the meander line, the operating frequency for different regions can be obtained. This sweeping function can easily show the effect of the parameter on the variation of the value.

Radiation patterns of the proposed tag antenna were also investigated. The radiation patterns in the H-plane and E-plane at 919.5 MHz were studied, and the corresponding polar forms are presented in Figure 4. The radiation pattern for the H-plane is omni-directional, while the radiation pattern for the E-plane is bi-directional. The directivity value for the proposed antenna at 919.5 MHz is 1.832 dBi.

CST MWS is a specialist tool for the 3D structure electromagnetic simulation, which is a kind of numberical calculation software based on Finite Integration Time Domain method. It provides a powerful solid modeling and adaptive mesh generation function. After completing the design, the software will automatically applied the meshing procedure before the simulation solver is started. Besides that, the CST MWS provided a built-in parametric optimizer that can help to appropriate dimensions in the design, this is the most efficient way to design and can help save a lot of time.

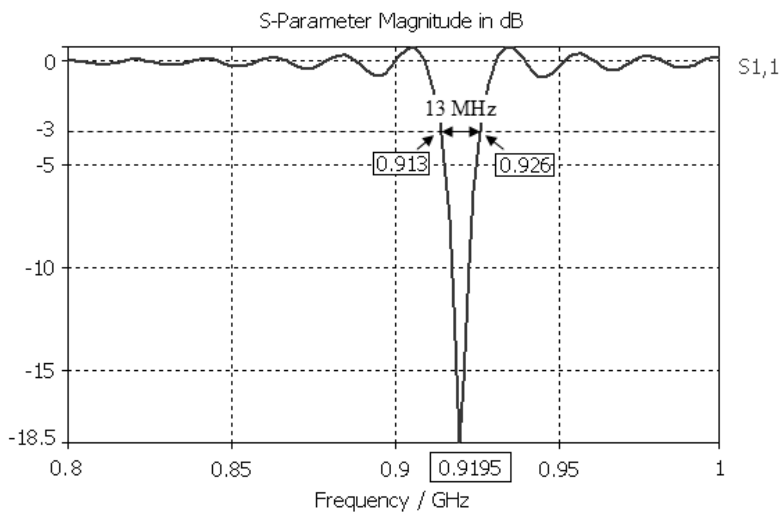


Figure 2. Return loss of the meander line antenna

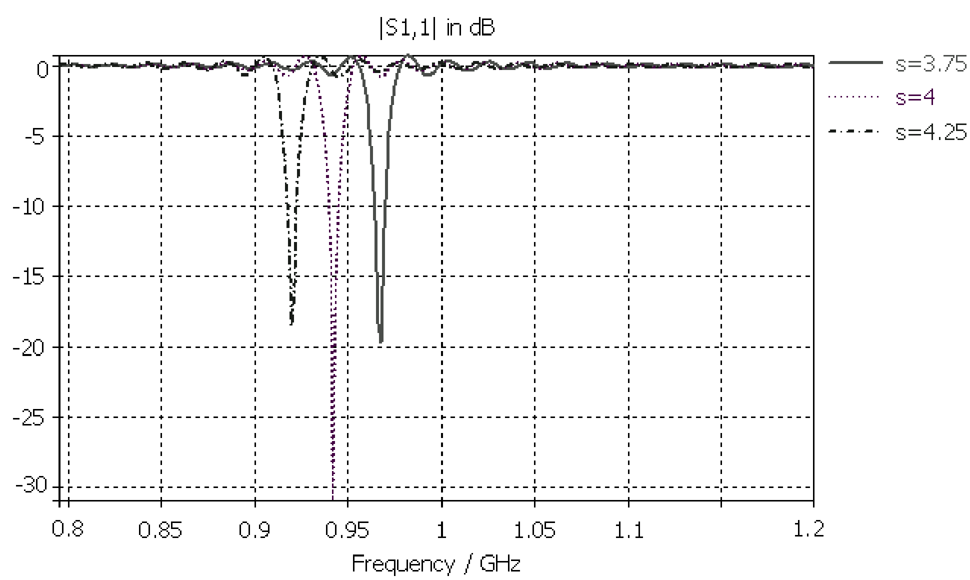
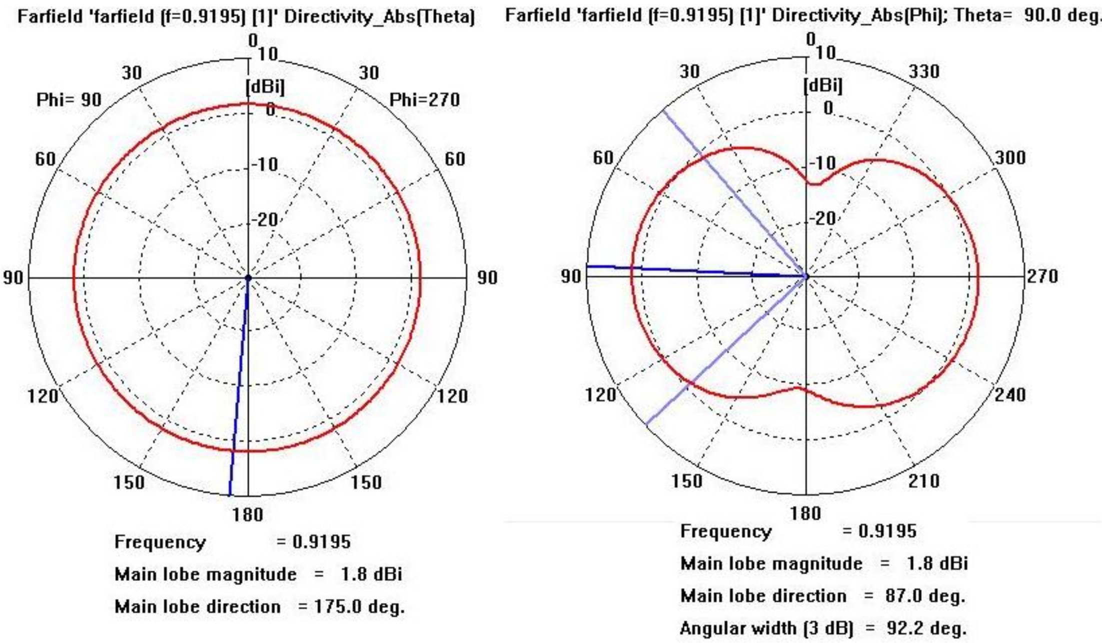


Figure 3. Resonant frequencies for the variation of the spacing between the pitch



(a) (b)

Figure 4. Radiation pattern for (a) H-plane (b) E-plane

4. Conclusion

A UHF band RFID tag antenna covering the Malaysia RFID band (919–923 MHz) was designed using CST MW. The proposed antenna is suitable for general use because of its simple structural design, small size, and the low cost of the materials used. The effects of the spacing between the pitch of the meander line antenna were also investigated in this paper.

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