Design of Rectangular Patch Antenna with Double-F-Slot for RFID Application

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Abstract–Recently, the need for security system devices using Radio Frequency Identification (RFID) systems tends to increase. RFID is a small, planar-shaped electronic device consisting of a Chip and Antenna. In this paper, the design and simulation of a rectangular patch antenna with double-F-slot in the frequency range of 2.4GHz – 2.48 GHz is presented in accordance with the Regulation of the Minister of Communication and Information of the Republic of Indonesia for SRD (Short Range Device) applications. The proposed antenna is designed on a FR-4 epoxy dielectric substrate with a thickness of 1.6 mm and relative permittivity of 4.4. The antenna has the patch dimensions of 36.9 mm x 27.1 mm and the substrate dimensions of 46.5 x 35.4 mm. The simulation results obtained the parameters such as the S_{11} of −46.83 dB, the bandwidth of 63 MHz (at S_{11} −10 dB), and the gain of 1.201 dBi at the frequency of 2.47 GHz.

Keywords—Double-F-slot; Radio Frequency Identification (RFID); rectangular patch antenna.

I. INTRODUCTION

Radio Frequency Identification (RFID) is currently increasingly widely used in everyday life, RFID is an electronic component consisting of a chip and antenna, RFID tag is used as a marker or labeling attached to an object where data, code, or certain identities are stored. an object.

In the RFID system, the antenna is one of the most important components because the antenna functions to transmit and receive data signals by converting electrical energy into electromagnetic waves which are commonly called transducers. [3]

The RFID works by identifying the object of the RFID tag in which there is a microchip containing a unique code, this tag is read by the RFID interrogator which is then processed as data. It's tag consists of a decoder and a microstrip antenna as a transceiver [4]-[5], the antenna functions to transmit signals to and from the tag so that the RFID tag is active and can be read or written by the data signal sent by an RFID writer or interrogator [6]-[7]

II. DESIGN OF RECTANGULAR PATCH ANTENNA WITH DOUBLE-F-SLOT

Patch antenna or sometime called as microstrip patch antenna is a type of antenna that is in the form of a thin board which is capable of working at very high frequencies [5]. The patch antenna has three layers of structures, namely the patch, substrate, and ground plane. The proposed antenna for RFID application is designed and simulated to obtain the antenna parameter, such as resonant frequency, return loss, VSWR, bandwidth, gain, and radiation pattern.

The first stage of this design is to determine the antenna specification parameters to be designed as shown in Table 1.

Table 1. Antenna Specifications.

Parameters	Specifications
VSWR	≤ 2
Return Loss	$\leq$ -10 dB
Bandwidth	≥ 11 MHz
Resonant Frequency	2.45 GHz
Gain	≥ 0 dBi

Then in the second stage the dielectric substrate specifications of the antenna are determined as shown in Table 2.

Table 2. Dielectric Substrate Specifications.

Parameter	Value
Substrate	FR4 Epoxy
Relative Dielectric Constant (εr)	4.4
Dielectric Thickness	1.6 mm
Tangential Loss (tan δ)	0,02

Furthermore, in the final stage, the dimensions of proposed rectangular patch antenna are defined as tabulated in Table 3.

Table 3. Dimensions of Rectangular Patch Antenna

Components	Dimension (mm)
Dimensional length (lg/ls) *substrate/Groundplane*	35.4
Dimensional width (wg/ws) *substrate/Groundplane*	46.5
Patch width	36.9
Patch length	27.1
Feeder length (lf)	5.64
Feeder width (wf)	2.96

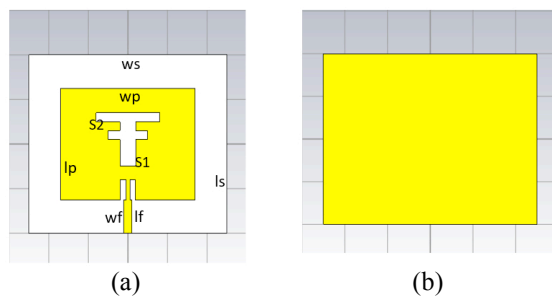The configuration of proposed rectangular patch antenna with double-F-slot is illustrated in Fig. 1.

Fig. 1. Configuration of rectangular patch antenna corporated with double-F-slot (a) Front view. (b) Rear view.

III. RESULTS AND DISCUSSION

After the simulation is run, the results of the specification parameters are obtained as shown in Figs. 2-5 for return loss, VSWR, gain, and radiation pattern.
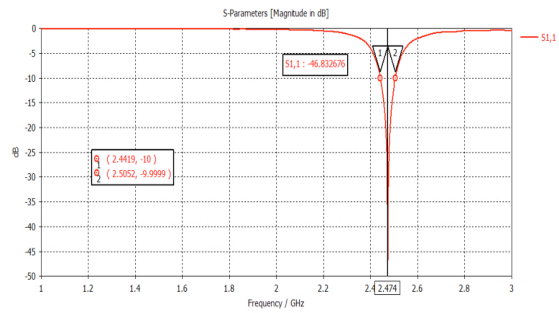

Fig. 2. Graph of S11 (return loss) for rectangular patch antenna with double-F-slot.

From Fig. 2, it can be seen that the return loss value is –46.83 dB with a working frequency of 2.47 GHz, with a frequency of 2.442 GHz to 2.505 GHz and a bandwidth of 63 MHz. The return loss value obtained has met the specification parameter value ≤ -10dB.
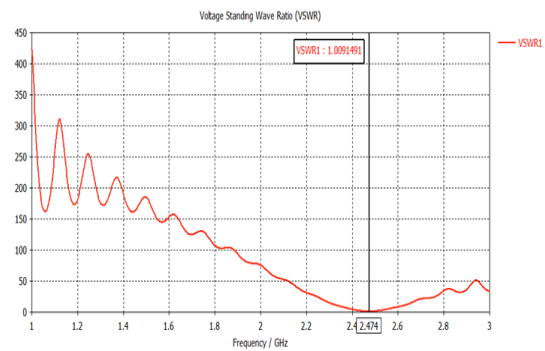

Fig. 3. VSWR graph for rectangular patch antenna with double-F-slot.

From Fig. 3, it can be seen that the VSWR value is 1.01, this value has met the VSWR specification parameter value ≤ 2.
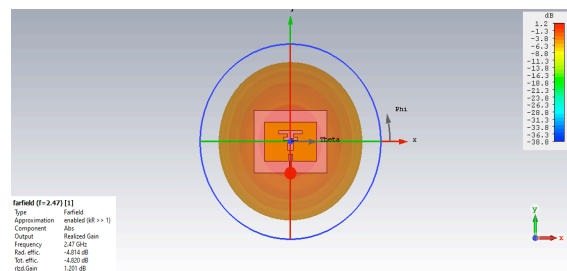

Fig. 4. Gain for rectangular patch antenna with double-F-slot

While from Fig. 4, it can be seen that the gain value of the antenna is 1.201 dBi, this value has met the parameter value of the gain specification ≥ 0 dBi. Fig. 5 shows the radiation and beamwidth of proposed antenna.
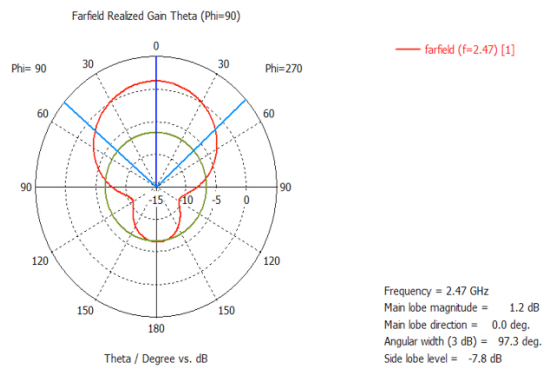
Fig. 5. Radiation pattern and beamwidth for rectangular patch antenna with double-F-slot.

IV. CONCLUSION

The design of rectangular patch antenna with double-F-slot for microwave RFID application has been presented. The simulation results of antenna parameters are the resonance frequency of 2.47 GHz, S_{11} of –46.83 dB with a VSWR of 1.01, the impedance bandwidth of 63 MHz at S_{11} of –10 dB and the antenna gain of 1.201 dB. These results are in accordance with RFID system specifications.

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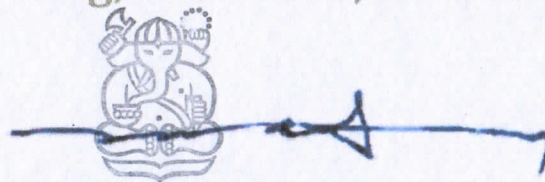
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