STACKED PLANAR ANTENNA FOR IMPROVING RFID COVERAGE

1Sakthivel P, Asst. Professor, ECE Dept, mw_sakthi@yahoo.co.in
2Pooranakumari C, Asst. Professor, ECE Dept, pooranakumari@engineer.com
3Franklin Telfer, M.E Student, PGSE Dept, franklin_telfer@yahoo.co.in
1,3SA Engineering College, Chennai-77, 2Panimalar Engineering College, Chennai-123, India

ABSTRACT

This paper presents design, simulation, fabrication and testing of stacked planar antenna for improving RFID coverage. It was designed to the center frequency of 915 MHz with the bandwidth of 26 MHz unlicensed ISM band. The planar εr = 4.3 Glass epoxy was selected and designed for ISM band specifications. It was simulated using ADS 2002C which is a widely used RF and Microwave component and system design tool. The fabricated antenna was tested using J6800 which is Agilent’s vector network analyzer used to measure up to 20GHz. The results of simulated and tested antenna parameters were compared and concluded the performance of given antenna.

Keywords: Stacked planar antenna, band, ADS 2002C, Network Analyzer

I. INTRODUCTION

The widespread adoption of RFID applications are entirely new communication infrastructure which uses unlicensed spectrum has begun to new season and increasing number of applications. The frequencies at 900 MHz, 2.4GHz and 5.6 GHz are very widely used and updated regularly. The stacked planar antenna for improving RFID coverage and perform satisfactorily. The microstrip antenna is one of the optimum antenna solutions for UHF and SHF frequency range transceiver systems. This paper describes the top to bottom antenna making of stacked planar antenna.

II. DESIGN AND SIMULATION

The microstrip Patch Antenna was designed for 915 MHz. The following design parameters are synthesized using ADS Line calc and simulated using ADS momentum. The layout diagram is as shown in figure (1) which is an antenna diagram
on ADS 2002C window with \( \varepsilon_r = 4.3 \) and the substrate thickness is 1.6 mm. Based on the \( f_c \), \( \varepsilon_r \) and the values will define the physical parameters of antenna. In this case, Antenna length \( L = 162.6 \) mm width \( W = 100.7 \) mm and the Feed type is coaxial. The formulas for physical parameters which is used to design the planar microstrip antenna are given in equation (1) to (5), the guide wavelength \( \lambda_g = \frac{\lambda_0}{\varepsilon_{eff}} \) where \( c \) is speed of light and \( f_c \) is center frequency of operation.

\[
W = \frac{C}{2 f_c} \times \sqrt{\left[ \left( \frac{\varepsilon_r + 1}{2} \right) + \left( \frac{\varepsilon_r - 1}{2} \right) \right]} \ldots (1)
\]

\[
\varepsilon_{eff} = \left[ \left( \frac{\varepsilon_r + 1}{2} \right) + \left( \frac{\varepsilon_r - 1}{2} \right) \right] \left[ \left( 1 + \frac{12h}{W} \right)^{0.5} \right] \ldots (2)
\]

\[
L_{eff} = \frac{c}{2 f_c} \times \sqrt{\varepsilon_{eff}} \ldots (3)
\]

\[
\Delta L = 0.412h \times \frac{\left[ \left( \varepsilon_{eff} + 0.3 \right) / \left( \varepsilon_{eff} - 0.258 \right) \right]}{\left( W/h + 0.264 \right) / \left( W/h + 0.8 \right)} \ldots (4)
\]

\[
L = L_{eff} - 2 \Delta L \ldots (5)
\]

III. DESIGN PARAMETERS

**Substrate Parameters:** Frequency: 915 MHz
- \( \varepsilon_r : 4.3 \) (dielectric 1 and 3)
- \( \varepsilon_r : 1 \) (dielectric 2, air)
- Substrate height: 1.6 mm (Plate 1 and 3)
- Substrate height: 1 cm (Plate 2)

**Physical Parameters:**
- Patch width : 100.7 mm
- Patch length : 162.6 mm
- Location of Feed point:
  - Width : 1/3 of Total Width
  - Length : 1/3 of Total Length
IV. PROCEDURE FOR SIMULATION

There are few steps to follow to complete the simulation of an antenna are, Step 1: From the given specification, obtain the center frequency $f_c$, dielectric constant $\varepsilon_r$, substrate thickness $h$. Step 2: Synthesize the physical parameters of microstrip using ADS2002c Linecalc. Step 3: Find out the guide wavelength $\lambda_g$. Step 4: Calculate the patch width and length using analytical equations are given in equation no (1) to (5). Step 5: Draw the Patch Antenna in ADS2002c. Step 9: Simulate the single layer microstrip patch antenna using ADS Momentum. Step 10: Repeat the steps until the optimized results are obtained. The optimization is very important to get right results.

IV. FLOW CHART

The flowchart gives the steps of making an antenna from the design to the simulation results but it is not noted about the fabrication and testing in its flow.
V. FABRICATION

The fabrication method of planar antenna is a physical workout. The $\varepsilon_r$ and $h$ value should be selected as similar to what have selected for design and simulation. The complete preparation and fabrication of planar antenna needs to go around 5 to 10 steps, which are as follows. 1. Layout design 2. +ve and –ve preparation 3. Sizing the layout 4. Edging the unwanted areas 5. Cleaning and Trilling 6. Masking to remove unwanted portions of the layout 6. Connecting Leads. After completion of all the above steps will attain and gives antenna which is ready to test. As per parameters of simulated antenna have been fabricated and its photocopy is shown in the figure(2).

![Fabricated Microstrip Patch Antenna at 915 MHz](image)

Figure (2) The fabricated microstrip patch antenna at 915 MHz

VI. TESTING

The network analyzer J8600 was used to test antenna. The return loss $S_{11}$ and other related results have been seen by this network analyzer. This network analyzer system consists source, oscilloscope and inbuilt computer system for saving the data and results. The model in figure (3) is the testing setup ready to test.

![Testing of Microstrip Patch Antenna at 915 MHz](image)

Figure (3) Testing of microstrip patch antenna at 915 MHz
VII. SIMULATED AND TESTED RESULT

The simulated and tested results are mostly similar and both are matched in case of $S_{11}$, radiated power, beam width etc, and are shown in the figure (4) to figure (8).

![Figure (4) Return loss $S_{11}$ –SIMULATED](image1)

![Figure (5) XY plot of Radiation plot](image2)

The input port is matched and hence $S_{11} = -28\, \text{dB}$ and $-25\, \text{dB}$ in the simulation and testing respectively as shown in the figure (4) and figure (8). The radiated signal is $-40\, \text{dB}$ as shown in the figure (5) and figure (6). The maximum radiated power is 3.5watt; effective angle $177^\circ$ and the directivity 6.11 dB are as shown in the figure (7). This result satisfies more than the basic requirements for RFID-Reader in ISM band regulations.
Figure (6) 3D view of radiation plot

Figure (7) Power and gain display

Figure (8) Return loss (S11) – TESTED
VIII. CONCLUSION

As per the results obtained in the simulation and testing of the stacked planar microstrip antenna is matched for RFID and it satisfies the transmission power level, input match, beam width and directivity. So that it could improve the coverage of RFID-Reader. Also the cost of making is very low and fabrication is not having any very big process because of the selection of $\varepsilon_r = 4.3$ (glass epoxy). Here it is concluded that the stacked planar antenna is opt for RFID-Reader systems.

REFERENCES


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