EVALUATING UHF RFID READER ANTENNA ON FORKLIFT TRUCKS USING HIGH FREQUENCY STRUCTURE SIMULATOR

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Abstract

Field strength and field distribution are major factors in obtaining reliable data link between RFID tag and reader. The UHF RFID has become one of the major factors in RFID applications due to its wide range of 10m and high frequency of 2.45 GHz. In Forklift trucks, the geometry and environmental conditions are not static. Due to this the field strength is affected. So it is very much necessary to measure the field strength in such applications. In this paper forklift truck designed and is attached with an UHF (Ultra High Frequency) RFID reader. The variations in field strength are measured through simulation in HFSS (High Frequency Structure Simulator). Initially a rectangular patch antenna of 900MHz is considered as RFID reader antenna. Later the antenna models used in the RFID reader are varied and the results are compared to see which antenna model is least affected by the geometry and environment factors. Thereby a better knowledge is obtained on the type of antenna used in the RFID reader for better performance.

***Keywords**: UHF RFID, HFSS, Antenna models. least affected.*

I. Introduction

The Radio Frequency Identification (RFID) concept has been around for decades. The recent reductions of size and cost related to integrated circuits have greatly expanded the range of feasible applications. Unlike integrated circuits, antenna cost and size has not kept track with Moore's law. Today, antenna and sensor technology is a key to successful deployment. The requirements of reader and tag antennas are not unlike those for many communication systems. They are driven by the applications and the regulations. However, the warehouse environments require designs that cannot be easily damaged. Mounting on Forklifts require yet another degree of toughness. The optimal antenna design is driven by the RFID application and governmental regulations. The distinctive characteristics dictated by all applications for RFID antennas are durability, ease of mounting and small in size [2]. In RFID gate applications the effects on field propagation are simpler than in forklift scenarios because geometry and environmental conditions are almost static. By contrast RFID forklift applications suffer from varying geometry between forklift truck, goods carriers and environment and of course metal near the transceiver (reader) and transponder (tag) [1]. All these influences create multi-path field propagation which cannot be estimated by analytical formula. Field measurement can give results which can be used for component or system design, but they are very time consuming and therefore an expensive task. In order to overcome this drawback, simulation using HFSS (High Frequency Structure Simulator) is done. HFSS gives accurate results when compared to experimental results [3] [1]. In this paper, an UHF (Ultra High Frequency) RFID reader which uses patch antenna is designed. Then the reader is simulated to obtain the various parameters like gain, directivity, etc. Further a forklift truck is designed using the same software and the RFID reader is attached to it. A comparison is made to find the variations in field parameters. Later the antenna models used in the RFID reader is changed and the one which is least affected due to the forklift is determined. In section II, a brief objective of this paper is described. Section III and IV describes the graphical flow of the process and results obtained respectively. Section V describes the future work of this paper.

II. Analysis Using HFSS

Initially, the UHF RFID reader consists of a rectangular patch antenna of size 10cm x 9cm x 3.32cm. The patch and ground of the patch antenna is made up of Rogers RT/duroid 5880 (tm) material having a relative permittivity of 2.2. The antenna consists of a center feed probe made up of Pec material. The patch antenna having the above mentioned dimensions is designed using HFSS. The radiation pattern of the antenna design is measured through simulation. Then a forklift is designed using the same software. Here the fork of the truck has the dimension of 75.5cm x 115cm x 2cm. The patch antenna that was designed already is attached with the forklift truck as shown in the figure 1. Now the radiation pattern is measured and the variation with the previous result is found. Apart from radiation pattern parameters like S parameter, Z parameter, Y parameter, gain, directivity and gamma (reflection coefficient) are measured. Similarly a bowtie antenna having a dimension of 34mm x 64mm x 19mm is designed using HFSS and is attached with the forklift truck which was designed already. The same parameters are measured with and without forklift truck.

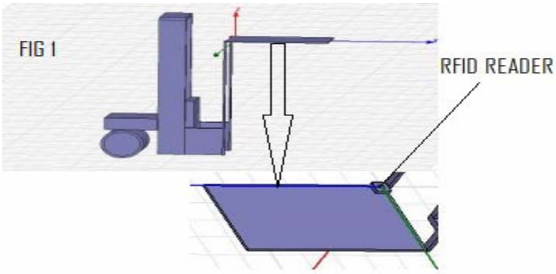
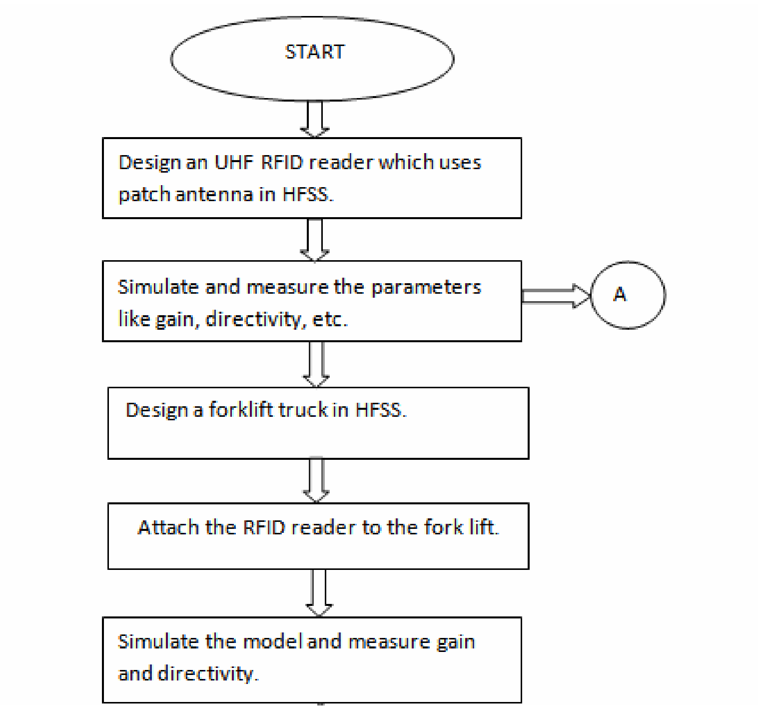
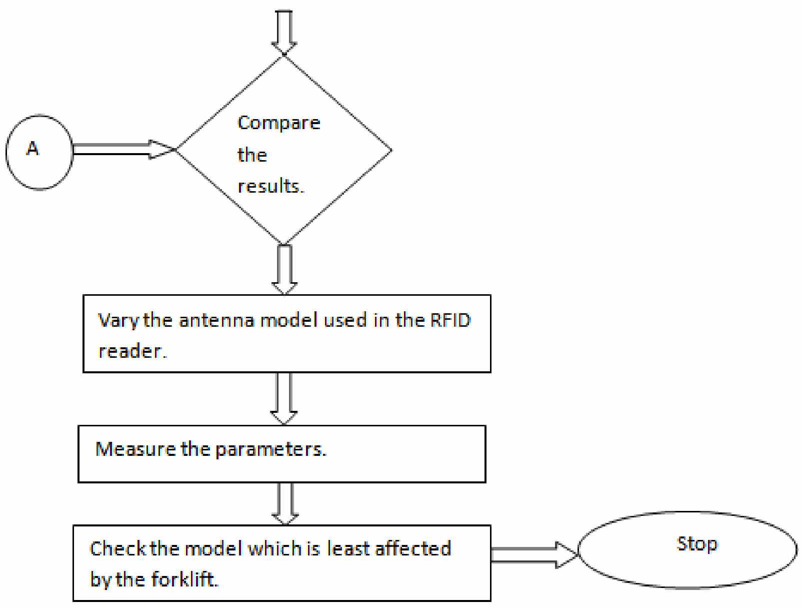


Fig.1 Forklift truck attached with an RFID reader

III. Process flow





IV. Results and discussion

The variations obtained in the field parameters are displayed in the figures shown below.

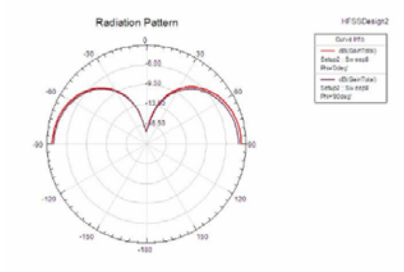


Fig 2. Radiation pattern of patch antenna attached with forklift truck.

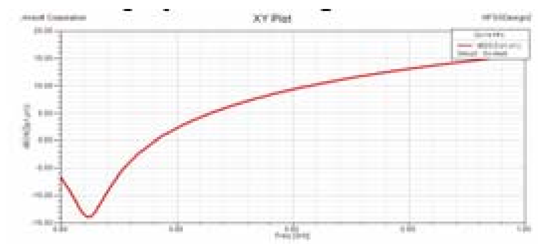


Fig 3. Z parameter of patch antenna attached with forklift truck.

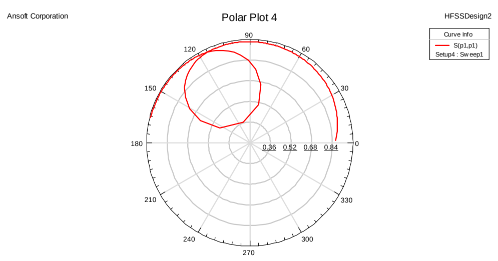


Fig 4. S parameter of patch antenna attached with forklift truck

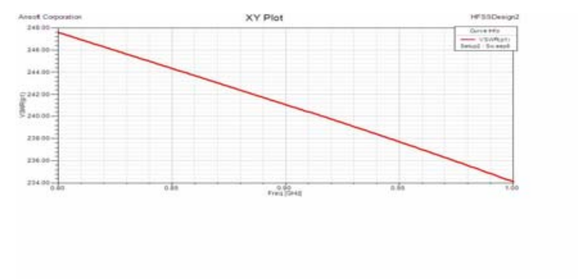


Fig 5. VSWR of patch antenna attached with forklift truck

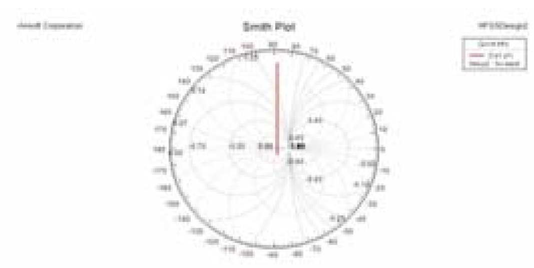


Fig 6. Z parameter of patch antenna attached with forklift truck

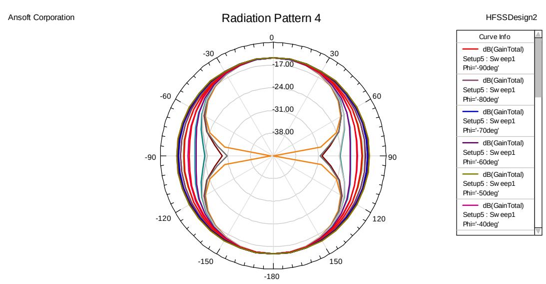


Fig 7. Radiation pattern of bow-tie antenna.

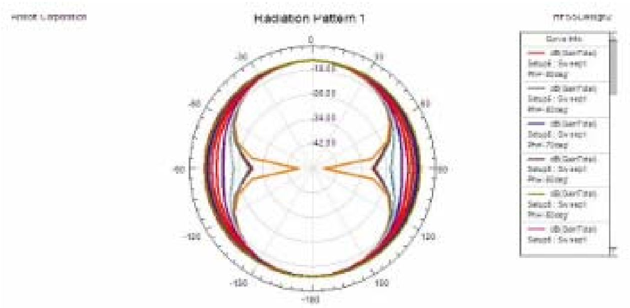


Fig 8. Radiation pattern of bow-tie antenna attached with forklift truck

The results obtained are simulated results obtained using HFSS. All the parameters are obtained by simulation the antenna with a setup frequency of 900MHz and start and stop frequency of 700MHz and 2GHz respectively. The step value is 1MHz. The figures shown represent only few of the obtained results. Similarly many results like data table, smith chart and polar charts of other parameters, etc can be obtained. From the results obtained it is clear that bow-tie antenna is least affected when attached with the forklift truck.

V. Conclusion

The UHF RFID reader which consists of a patch antenna was attached to a forklift truck and was simulated using HFSS. Various antenna parameters were obtained. Then the patch antenna used in the RFID reader was replaced with a bow-tie antenna. This new bow-tie design provides wider bandwidth, smaller size, higher gain, and smaller cross polarization than the rectangular patch antenna at 900MHz. The design of UHF RFID reader with bow-tie antenna is more efficient when compared to reader made of rectangular patch antenna.

The UHF RFID reader is affected by the environmental conditions and geometry of the forklift trucks. This paper analysed the antenna models used in the RFID reader and had found the antenna model that is least affected. In the future work the bow-tie antenna model is to be replaced with a circular patch antenna and further compared with the previous results.

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