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Performance of Z-Monopole Antenna Fed with CPW

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ABSTRACT: In this paper, a monopole antenna for UHF Radio Frequency Identification (RFID) is acquainted. A slotted Z-shaped monopole disposition is selected and fabricated using printing technology on a flexible, cheap paper substrate utilizing a simple, fast, and eco- friendly process. The design characteristics of the antenna are verified and the simulated results are compared with measurements showing good agreement. Here HFSS 13.0 tool is taken as investigating tool.

I. INTRODUCTION

The appeal for pliable, inexpensive, adept, broadband and condensed size antennas for wireless sensors nodes (WSN) and UHF RFID labels has got ample increase during the last couple of years due to the conception of wireless applications especially in fields such as: Biomedical sensing, automotive/logistics tracking, retail management, item level tracking, and security. In addition to, their recent integration with power scavenging circuits (solar, piezoelectric, and wireless) has enabled the recognition of truly autonomous pervasive WSN nodes. Most commonly used antenna design for an RFID label is a dipole. In this paper, a CPW-fed monopole antenna is put- forth, because of its immense characteristics for broadband and the use of a ground plane as an additional shield for various other electronics, sensors, and power supplies in the system. Normally, RFID IC's impedance relays on frequency and the applied power (i.e., input) and is acute to tolerate fabrications, thus reducing the return loss and matching it to the antenna is a big ultimatum. Anyhow, this can be achieved by a wideband monopole antenna which has desirable matching unlike dipole which has differently fed input signal, due to the presence of its ground plane. This ground plane even makes simpler integration of 3D to the antenna with other electronic components (ICs, power sources) of the tag, highlighting the cross-coupling and interference. The proposed antenna was designed and simulated using the 3D EM Simulator Ansoft HFSS and was fabricated on a paper substrate using printing technology. In the beginning antenna design is explained and later printing technology with its measured results.

II. ANTENNA DESIGN:

The geometry of the CPW-fed monopole Z antenna can be shown in Fig. 1. The Z- paper substrate has loss tangent of0.08 , relative permittivity of 3.4 and thickness of 0.254mm and with dimensions of 75mm (width) x 100mm (length), considering the feeding line length. A CPW transmission line consisting of a single metallic layer is selected for feeding the antenna because of its easy integration on the paper substrate due to its planar structure.

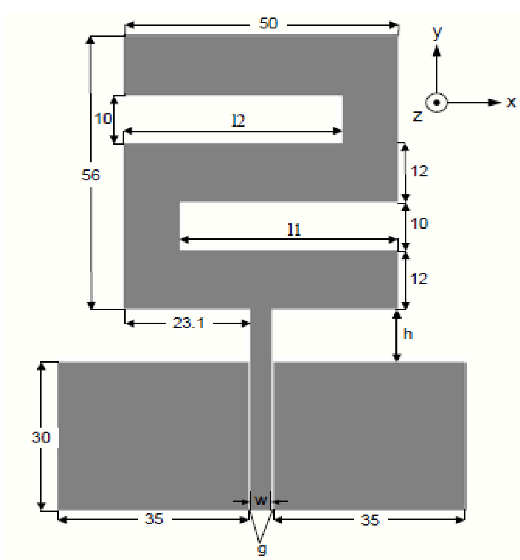

Fig. 1 Z-shaped CPW-fed monopole antenna configuration

The antenna structure consists of a planar Z-shaped rectangular monopole havinglength 56mm, width 50mm and a spacing of height11mm from the ground plane. Two rectangular slots are implanted into the radiating element from both side edges, therefore resulting in a wander-like antenna as seen in Fig. 1. The two slots will have a width 10mmand lengths of (l1=l2=40mm), chosen to modify the antenna matching to the load. RFID antenna design should fulfill several design prerequisites: “universal-operability” Ultra High Frequency (UHF) bandwidth [Europe (865–868 MHz),USA (902–928 MHz)] RFID band, omnidirectional radiation pattern, matching of impedance with RFID circuitry, wide spread range, and compact size. Optimizing the above parameters involves highly imminent tradeoffs between them. As we increase the size of the ground plane, the directivity of the antenna increases, as the ground is acting as radiating element and also provides a shielding to it from the remainingelectronic circuitry; anyhow it increases the profile of the antenna. Impedance matching in RFID tags between the antenna and the load plays a key role for the range maximization. In order to secure maximum power transfer to the load, the input impedance of theantenna must be conjugate to that of the tag’s load chosen to be (37.3 + j65.96Ω) in our design, at the tag’s operating frequency 904.5MHz [2]. The parameters h, g, and w were also optimized to fine tune the desired antenna impedance and increase the directivity. The height (h) of the radiating element from the ground has a major influence on the performance of the antenna, as it modifies the radiation pattern and the impedance of the antenna. Increasing it, guided waves of the antenna are transitioning more efficiently into free-space waves and the impedance becomes more capacitive. Maximizing it however results into thick and difficult to mount RFID tags. The value of the parameters after optimization where found h=11mm, g=0.3mm and w=3.8mm. The proposed antenna was fabricated on a typical flexible photo paper substrate using inkjet printing technology, a direct-write technique for fabricating electronic circuits and RF structures. Here, the benefits of using paper as a substrate along with the inkjet printing process will be discussed.

Paper Substrate Advantages: There are many aspects of paper that make it an excellent candidate for an extremely low cost substrate for RFID and RF applications, such as antenna fabrication. Paper has excellent dielectric characteristics. Its dielectric constant is close to air meaning electromagnetic power can penetrate easily even if the RFID is embedded in the substrate. The high demand and the mass production of paper make it widely available and at the same time the lowest cost material evermade. From a manufacturing point of view paper can underage reel-to-reel processing, thus mass fabricating RFIDsurface profile and with appropriate coating it is suitable for direct write methodologies, such as conductive inkjet printing, instead of the traditional metal etching techniques. Moreover, paper is one of the most environmentally-friendly materials, because of its high biodegradability with respect to other ceramic substrates, such as FR-4, making it the ultimate solution for the first generation of truly “yellow” RF electronics and modules. inlays on paper becomes more feasible

Boundary conditions: Here we use Perfect E, is a perfect electrical conductor, also referred as a perfect conductor. This type of boundary forces the electric field (E-field), perpendicular to the surface.There are also two automatic Perfect E assignments: Any object surface that touches the background is automatically defined to be a Perfect E boundary and given the boundary condition name outer. Any object that is assigned the material pec(Perfect Electric Conductor) is automatically assigned the boundary condition Perfect E to its surface and given the boundary condition name smetal. Perfect H – Perfect H is a perfect magnetic conductor. Forces E-Field tangential to the surface. Natural – for a Perfect H boundary that overlaps with a perfect E boundary, this reverts the selected area to its original material, erasing the Perfect E boundary condition. It does not affect any material assignments. It can be used, for example, to model a cut-out in a ground plane for a coax feed.

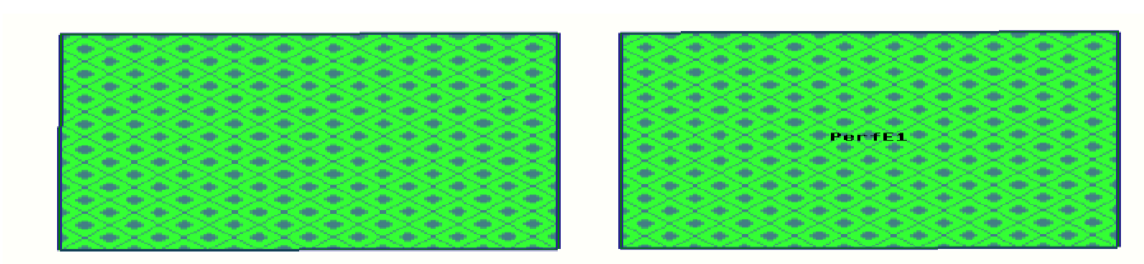

Fig: Perfect E-field distribution for rectangular slots

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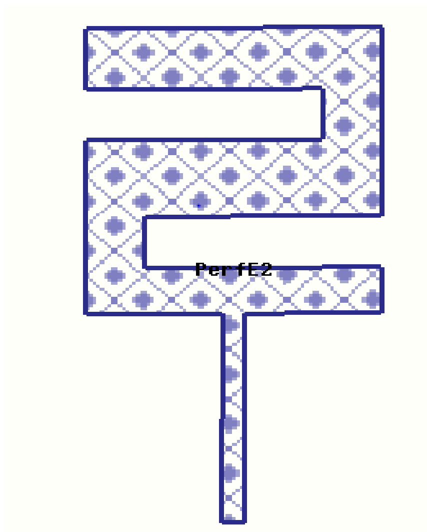
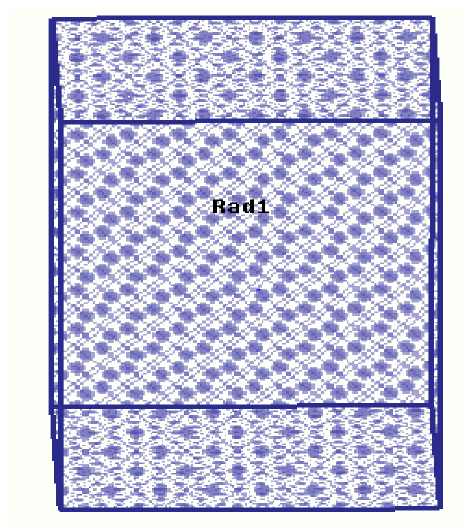
Radiations: Radiation boundaries, also referred as absorbing boundaries, enables to model a surface as electrically open: waves can then radiate out of the structure and toward the radiation boundary. The system absorbs the wave at the radiation boundary, essentially ballooning the boundary infinitely far away from the structure and into space. Radiation boundaries may also be placed relatively close to a structure and can be arbitrarily shaped. This condition eliminates the need for a spherical boundary. For structures that include radiation boundaries, calculated S- parameters include the effects of radiation loss. When a radiation boundary is included in a structure, far-field calculations are performed as part of the simulation.





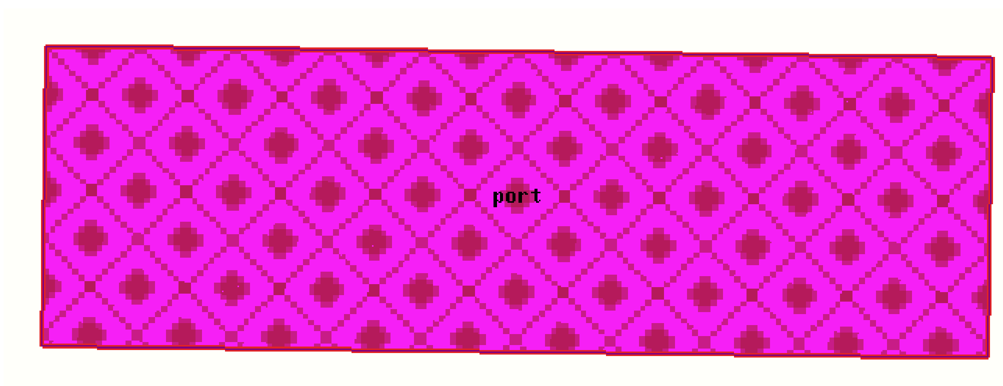


Fig: Exitation of port

Wave Port: The port solver assumes that the Wave Port you define is connected to a semi infinitely long waveguide that has the same cross-section and material properties as the port. Each Wave Port is excited individually and each mode incident on a port contains one watt of time-averaged power. Wave Ports calculate Characteristic impedance, complex propagation constant, and generalized Parameters. The edge of a wave port has the following boundary conditions:

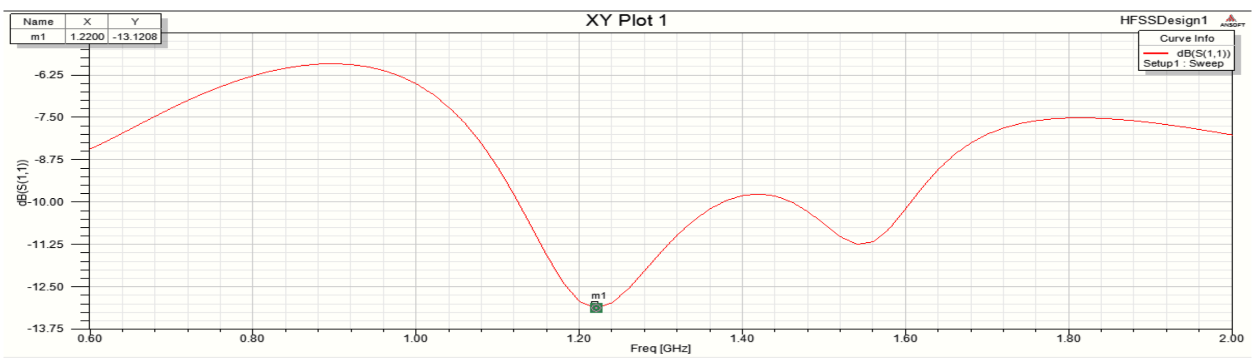
- Perfect E – by default the outer edge has a perfect E boundary.
- Symmetry-the port solver understands perfect E and perfect H symmetry planes.
- Impedance-the port solver recognizes an impedance boundary at the edges of the port.
- Radiation-the default setting for the interface between wave port and radiation boundary is to apply a perfect E boundary to the edges of the ports.

III. SIMULATION AND MEASUREMENT RESULTs

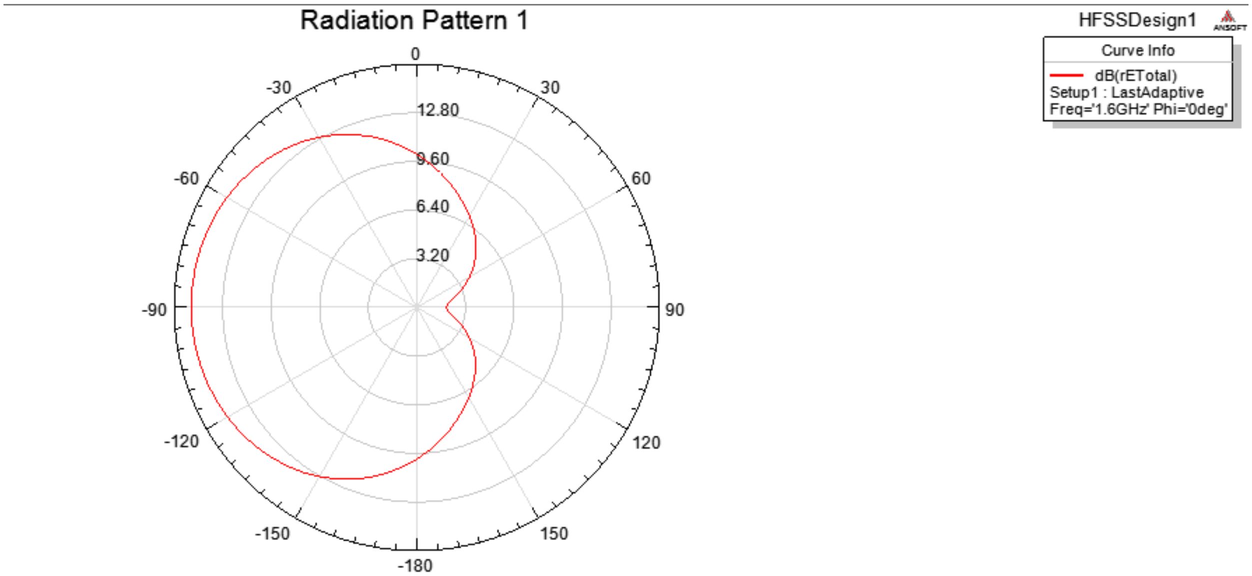
The performance of the prototype is experimented and results are discussed here. Return loss has been observed at two different frequencies which act as a dual band but the one which has more return loss has been chosen to get better performance. Return loss generally expresses how much signal is sent to receiver side.

Fig: Perfect E-field Distribution for Z-antennaFig: Radiation distribution in Radbox

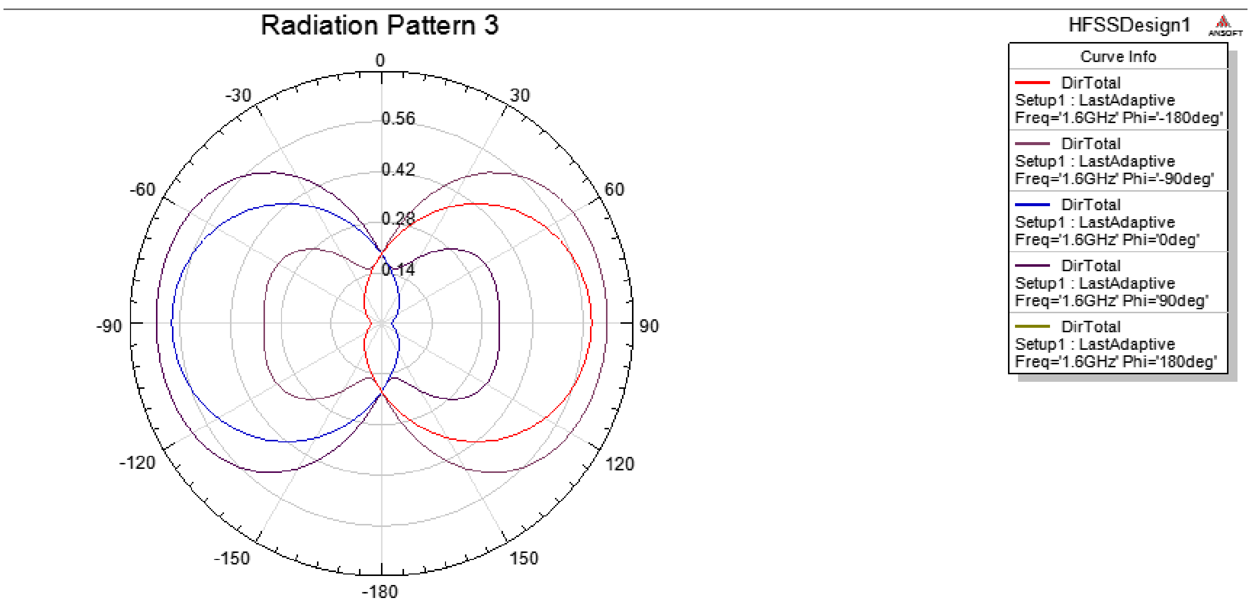
Fig: Return loss at operating frequency 1.6GHz



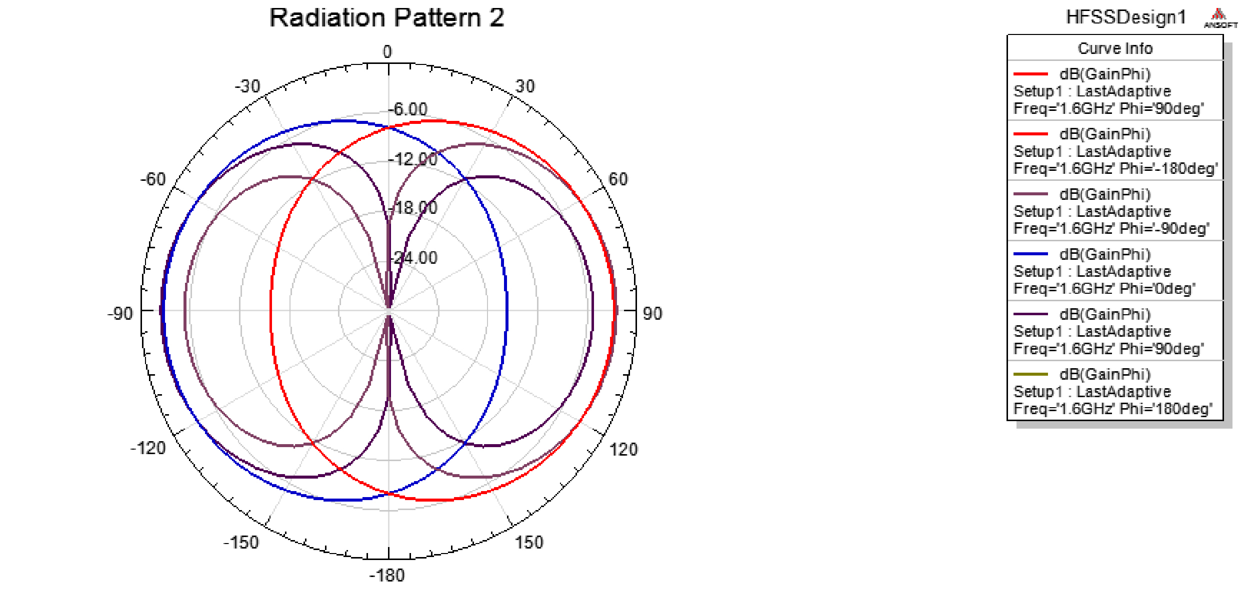
Here we calculated frequency sweeps using fast because uses an Adaptive Lanczos-Pade Sweep(ALPS) based solver to extrapolate an entire bandwidth of solution information from the center frequency. Very good for high-Q devices but it cannot be used to solve for devices that pass through cut-off. Once the band has been extrapolated, a high number of frequency points can be calculated without a penalty. In addition, the Fields can be displayed at any frequency within the sweep range. The time and memory required to solve a fast frequency sweep may be much larger than the single frequency solve.



Radiation of Total E-field at Phi=00

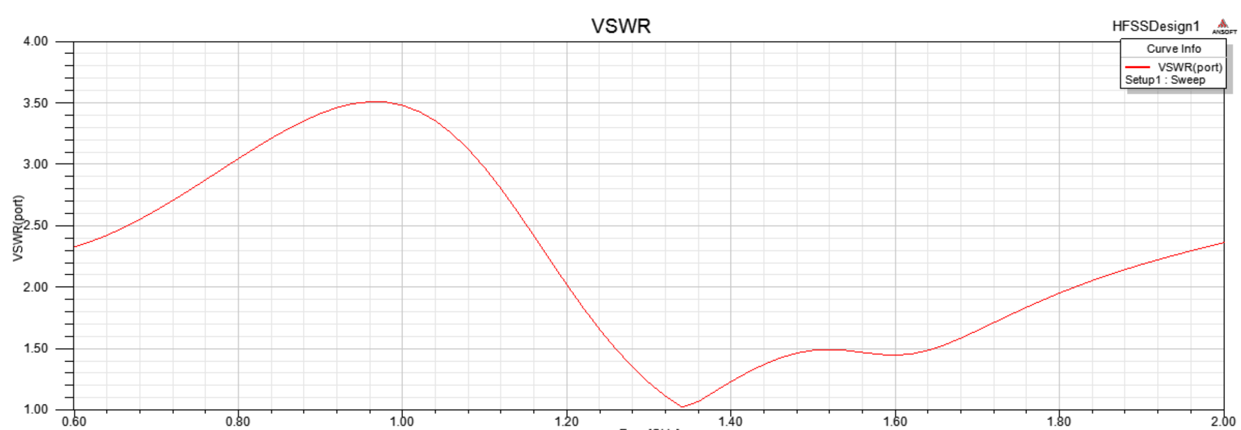


Directivity of the antenna at various phases operating at 1.6GHz Directivity has been increased as angle increases for -1800 to 1800.



Gain of the antenna at various phases at its operating frequency 1.6GHz

Radiations of Total E-field in 3D configurations Radiations of total E-field have been observed in both 2D and 3D configurations.



VSWR port excitation at operating frequency 1.6GHz

CONCLUSIONS

We have undergone the performance of CPW fed monopole antenna as a pliable single device. The performance of this is examined under various parameters like Directivity, Boundary distributions, E-filed distributions at various theta and phi in 2D and 3D and gain also examined at various phi at its operating frequency, in order to inspect the gap between theoretical and practical cases of communication system. It is observed that as angles varies its gain and directivity increases as they increase. The simulation results clearly showed that as phi value increases directivity of covering the area also increased. We have observed that gain at 00 and -1800 didn't meet at the center where as other angles met at the center which are useful to us because of its gain improvement on both sides. We have seen return loss dips at two frequencies where we can have dual band but the one which is at 1.56GHz is just -11.6dB where we cannot get desired radiations at our frequency ranges. The results given in this paper will be useful in validating the results of simulation studies. This type of CPW fed antennas would force communication system to produce more wonders in the RFID tags.

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