PLANAR INVERTED MULTIBAND SLOTTED PATCH ANTENNA FOR RFID APPLICATION

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Abstract-In this paper the inverted-H-shape slotted Microstrip patch antenna with high efficiency suitable for x-band to ku-band range has been design. The proposed Antenna is specifically designed for RFID applications. To design an antenna with high efficiency and to have good impedance matching with wide operating bandwidth for obtaining better radiation performance is a taxing task. The motive of this design is to obtain multiple resonances with effective bandwidth of 3.25GHz, from 9.75 to 13.0GHz, with 8.5dBi of peak gain. Electromagnetic band-gap (EBG) structure is incorporated in this design to enhance the gain. Overall size of the antenna is reduced to more than 50% on an average compared to other multiband antennas. The proposed work simulated using Ansoft HFSS 14.0.

Keywords:UWB, Electron Band Gap, Patch antenna, line-fed, RFID.

I. INTRODUCTION

Automatic identification technology facilitates to identify and track the assets and goods. It can be executetogether with barcodes, LASERS, voice recognition, and, biometrics but these process have the limitations such as it require LOS and for human involvement. The radio-frequency identification (RFID) is a non contact wireless communications for target recognition. Now-a-days the RFID systems are growing to be more popular in all kinds of fields because it needsno manual labor[1]. Using RFID can read each second More than a thousand tags with high rapidity and immense accuracyso that only despite the fact thatbarcodes are less expansive then RFID, it isnot preferable.The Microstrip patch antennas are smart in RFID systems since of their low expenditure,small in size and it can be incorporated with any other components. In order to miniaturization of Microstrippatch antenna some key factors are used such as high dielectric constant substrates, probes length is smaller and make slotted line [2–4]. The RFID antennas can be designed in various frequency ranges that is given bellow (see Table I).

Commercially UHF bands are used and that is designed as dipole antennas, but it suffers from performance degradation when it is placed nearer to the conductors, e.g. high dielectric materials(water).Thus during conduction, the use RFID tags near such materials, are limited and this problem is termed as 'metal-water'[10]. In this proposed design that issue is addressed by the RFID designed in UWB (includes X and Ku-band).

TABLE I. FREQUENCY RANGE FREQUENCIES PASSIVE READ DISTANCE [5]

Designation	**Frequency**	**Wavelength**
Low Frequency (LF)	120-140 KHz	10-20 cm
High Frequency (HF)	13.56 MHz	10-20 cm
Ultra-High Frequency (UHF)	868-928 MHz	3 meters
Microwave	2.45 & 5.8 GHz	3 meters
Ultra-Wide Band (UWB)	3.1-10.6 GHz	10 meters

The lower frequency range (<3GHz) is extremelyused in many wireless communication for example mobile communication, satellite and all licensed & unlicensed ISM bands so over which the spectrum is more congested and also has interference, EMI noise immunity hazards. More over the RFID is mostly used only at indoor application so larger wavelength can accommodate because rain and other moisture harms are not creating any fading or attenuation issues.

In this paper, a different technique is proposed to obtain the miniaturization of microstrip antenna by inserting a special shaped slotted structure. The RFID are expansive then barcode but more advantage, so reduce the cost of RFID by properly chooses the substrate material. Here low cost Reinforced Fiber-Glass Polymer Resin Material used it comprised of epoxy resin 40% and fiberglass 60% with specifications (see Table II).

II. ANTENNA CONFIGURATIONS

The proposed design is evolved from rectangular patch by trenching the radiated patch with dimension of about L_gxW_g. which is much smaller then conventional RFID antenna.A Dual-Band Diamond-Shaped Antenna for RFID Application with overall dimensions of 190 × 190 mm^2 in [6]. Miniaturized Circularly Polarized Microstrip RFID Antenna Using Fractal Metamaterials with overall dimensions of 122 × 135mm^2 in [7].Compact and Circular Polarized RFID Antenna for Portable Terminal Applications with overall dimensions of 120 × 60 mm^2 in[8].

The specified characteristics of this substrate are 1.6mm in thickness and 4.6 in relative permittivity (ε_r) with dielectric tangent loss of 0.023 respectively. As seen in the Fig.1, at lower two center of the patch dual rectangular notches were cut with dimensions of L_nxW_n in order to improve the matching condition and to extend the impedance bandwidth with triple resonance property in a limited space for radar application. For further bandwidth enhancement, three different straight slots with length of L_1, L_2&L_3 is embedded into the notched patch with equal width is 1mm.

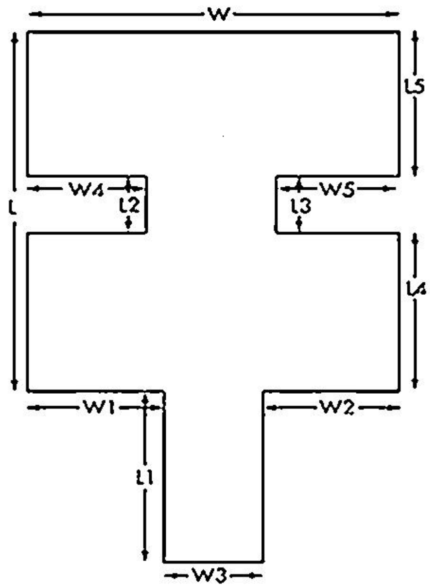

Figure 1. Configuration of slotted patch antenna

As seen in the Fig.1, at lower two centre of the patch dual rectangular notches were cut with dimensions of $L_n x W_n$ in order to improve the matching condition and to extend the impedance bandwidth.

TABLE II. DESIGN SPECIFICATIONS FOR A PROPOSED ANTENNA

Parameters	**Specifications**
Material used	Reinforced Fiber-Glass Polymer Resin Material
Nature of material	Low cost and easy to fabricate, loss tangent = 0.019 , ε_r = 4.6, copper thickness = 0.02 mm
Radiation Pattern	Omni-Directional
Operating frequency	X- through Ku-band

The Table II shows the materials used and other design specification of proposed antenna design.

TABLE III.OPTIMAL GEOMETRICAL PARAMETERS OF AN ANTENNA

Parameters	L	L1	L2	L3	L4	L5
Value(mm)	15	5	2	2	6.5	6.5
Parameters	W	W1	W2	W3	W4	W5
Value(mm)	12	4.5	4.5	3	4	4

Table III contains the designed values which are obtained by using equations [9]. Here the L is length and W is width of the antenna. In order to examine the performance of this antenna configuration to enhance ultra wide bandwidth, commercially available software HFSS was used for required numerical analysis.

III. RESULTS AND DISCUSSION

Constructed prototype is shown in Fig.1 and band range from 9.75-13.0GHz respectively. This antenna resonates at various frequencies which covers I/J band (from 8 to 13 GHz mainly used for long distance radio communication), suitable for RFID standard applications.

Fig.2 has shown the return loss (S_{11}) of proposed antenna, ideally the return loss need to more then -10dB at which the antenna is resonating. Here the antenna is resonating at more then two frequency called multiband antenna. The significant effect of the embedded slots to resonate at different frequencies of the proposed antenna.Simulated and measured results for the antenna design agree closely and indicate that the bandwidth can be greatly increased through the use of the metamaterials, reaching a bandwidth of 10.3 GHz with high gain Ultra wide bandwidth of about 3.25 GHz.

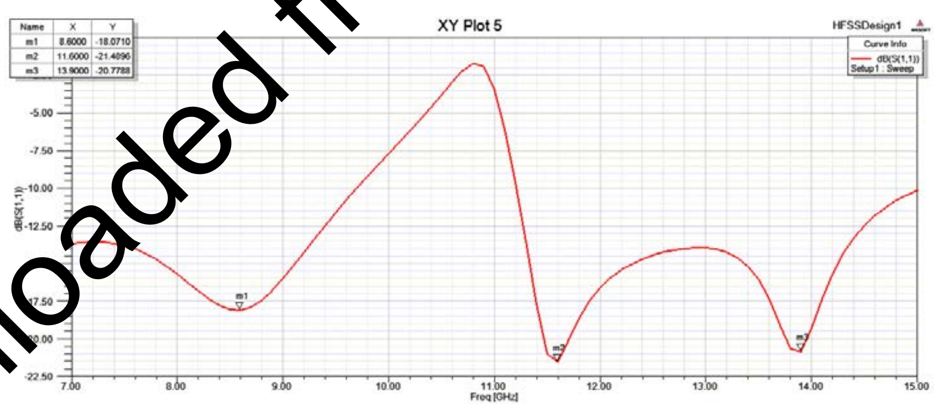

Figure 2: Frequency vs Return Loss (S_{11})

Fig.3 shows the radiation pattern of proposed antenna. Even to the three bands with a worse matching condition, the overall VSWR is still better than 2.5 (i.e. VSWR < 2.5) and this makes the whole available bandwidth, if defined for VSWR < 2.5, reach 10.28 GHz (3.1–13.38 GHz), fully covering the requirement of a UWB operation.

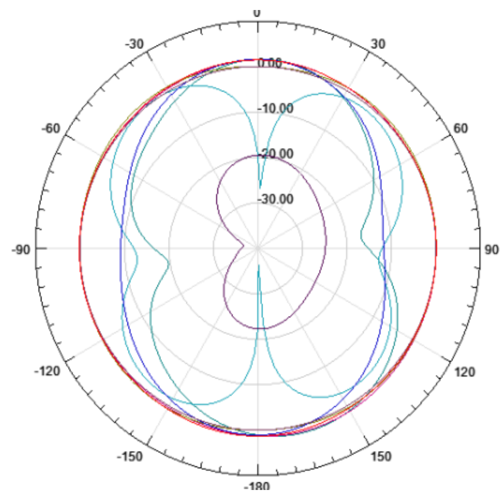

Figure 3: Radiation pattern

Fig.4 shows the gain for the proposed antenna design with respect to the frequency 9-14GHz. From the plot it is inferred that if frequency increased then gain also increased accordingly. The maximum gain is attained at 13GHz respectively.

Fig.5 shows the frequency vs VSWR, in order to achieve maximum energy transfer between sources to the antenna is only attained if impedance is matched. If the impedance is not matched properly then the energy is not transferred. It will return back to the source. This makes unnecessary standing waves and in order to avoid such case here the proposed antenna is engineered. Ideally the VSWR need to be low (between the range of 1-2) from Fig.5, it is clearly show that the proposed antenna attains it.

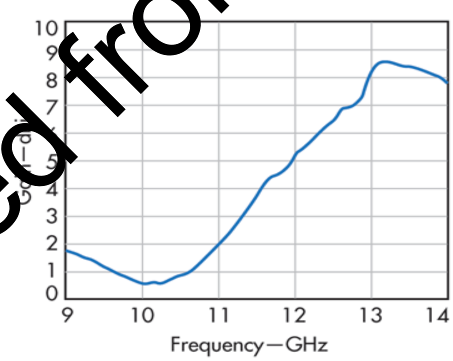

Figure 4: Frequency vs Gain

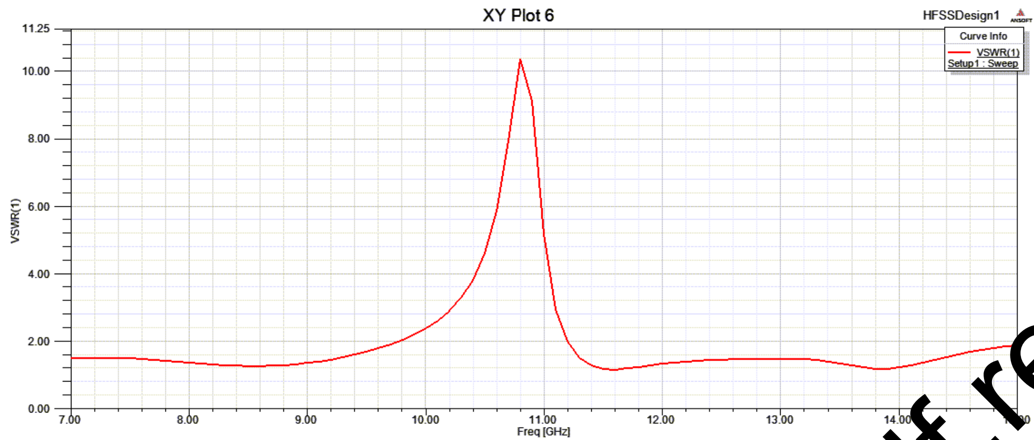

Figure 5: Frequency vs VSWR

CONCLUSION AND FUTURE WORK

A novel compact Microstrip-line-fed planar slotted patch antenna is designed by making inverted H-shape slot in the patch for RFID operations. The RFID antenna is designed in such a frequency range where the range of frequency is not used much. The antenna size has been reduced to 12x15x1.6mm , which is much smaller than other conventional multi-resonance antenna. The SRA also measured by using simulation result is about 0.98W/kg.The simulated results shows the performance better with ultra wide bandwidth and improved radiation pattern with increase in gain.In future the designed antenna is to be implemented in wearable model.

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