DESIGN OF NORMAL MODE HELICAL ANTENNA FOR UHF RFID APPLICATIONS

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Abstract: In this paper, normal mode helical antenna is designed for UHF RFID Tag. The antenna is linearly polarised with operating frequency of 900MHz. In the design, meandered path is formed in the helix shape, over the Rogers RO3010(tm) substrate with permittivity of 10.2. The proposed antenna is verified using HFSS simulation software. The proposed antenna is having bandwidth of 200MHz with the axial ratio of 36.5dB. The volumetric size of the tag is 200mm3 and simulated read range of the proposed tag is 10cm. The proposed antenna is mainly designed for near field applications.

Keywords: RFID, polarization, Axial Ratio, Return Loss, Impedance Bandwidth, helical antenna, Read Range.

1 INTRODUCTION

Due to the advancement in RFID technology in the recent years, there is an emergence of many applications which works in the UHF band. There are varieties of ways in which RFID can be used. RFID applications help in speeding up the handling of goods and materials. It replaces the earlier used technologies which require the line of sight and have small read range. The large set of IDs which RFID supports, is incorporated with the additional data than barcode such as product type, product manufacturer and even measurement of environmental factors i.e. temperature, humidity etc.

Although RFID is not as cheap as earlier technologies but still adopted at large scale due to its advantages. RFID is mainly used for automatic identification and tracking purpose. Various antenna designs are needed to meet the cost, size, bandwidth and read range requirements. RFID tags are integrated with the temperature sensors and can be placed in liquids, on metals and human body. RFID tags are designed for both far fields and near field applications. According to the requirement of application, both active and passive tags are used. RFID readers are become portable now and small in size so that they can be installed inside the small sized application.

In the recent years, various techniques have been proposed so as to achieve the bandwidth enhancement, polarisation, flexibility and miniaturisation etc., but in this paper, linearly polarised tag antenna is proposed which works in UHF RFID range for near field application. To achieve the flexibility, textile planar antennas are designed on protective foam in [8]. In [3], ceramic and parasitic patch is used to improve the gain, directivity and radiation efficiency. In [20], hex ferrite glass composite is used for the reduction in size of axial mode helical antenna. In [26], highly conductive E fibre is used to achieve elasticity, flexibility and mechanical strength.

II RFID Antenna Design

Fig.1. shows the proposed tag configurations for near field application. Tag is made up by etching the copper layer on Rogers RO3010(tm) substrate with electrical permittivity of 10.2

having thickness of 0.8mm, the narrow rectangular gap 'o' is provided at the feed terminal to accommodate the microchip alien higgs-4, which is integrated with the tag having chip sensitivity of -20dBm and chip impedance of 21.55-j191.45, resonating at 900MHz.

Fig.1. shows the substrate of 10mm length and 25mm width in 'Y' and 'X' direction respectively having height of 0.8 mm. Rectangle 'a' with length 1.2mm and width 19mm is connected with rectangle 'f' with length 2.8mm and width 1mm. Rectangle 'f' is connected with rectangle 'b' of length and width equals to 1.2mm and 19 mm respectively.

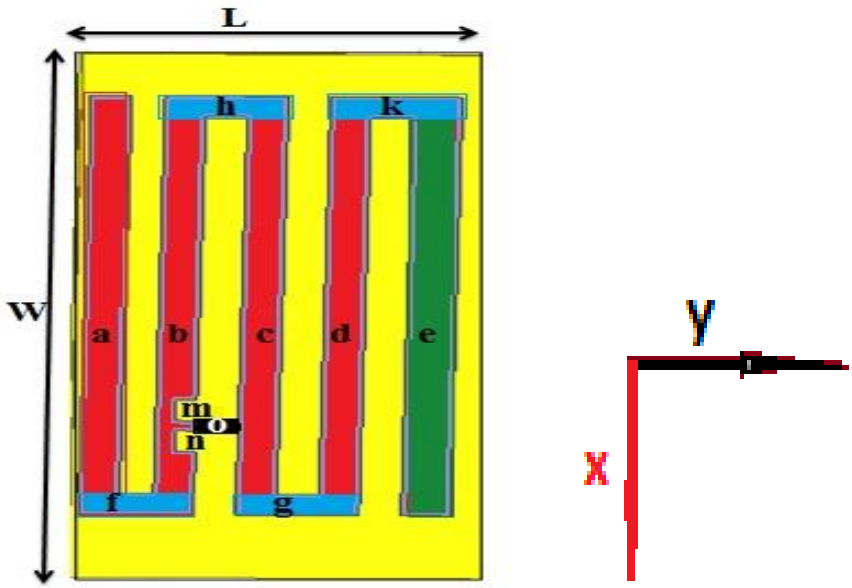

Fig.1. Proposed Antenna Design

Rectangle 'h' , 'g' ,'k' each of length and width equals to 2.8mm and 1mm respectively connects rectangle 'c' ,'d', 'e' each of length and width equals to 2.8mm and 1mm respectively .

Rectangle 'a', 'b', 'c','d' 'e', 'f', 'g', 'h' , 'k' joined to form the helix shaped patch over the substrate. Slots 'm' and 'n' of length and width equals to 0.5mm and 1mm respectively has been cut from rectangle 'b' near the chip 'o'.

Table 1 Proposed Antenna Dimensions

rectangle	Length(mm)×width(mm)	rectangle	length(mm)×width(mm)
a	19×1.2	k	1×2.8
b	19×1.2	o	1×0.5
c	19×1.2	h	1×2.8
d	19×1.2	g	1×2.8
e	19×1.2	Slot(n)	1×0.5
f	1×2.8		
Slot(m)	1×0.5		
W(width of substrate)	25	L(length of substrate)	10

III Working Principle

The antenna works on the principle of meandering. An normal mode helical antenna(NMHA) is achieved when the largest dimension is small as compared to its working wavelength. It can be approximated by the combination of n small loops and n short dipoles connected in series. It can be understood as n equivalent magnetic current over the ground plane and the polarisation becomes essentially linear. The idea behind this technique is to make compact sized antenna.

IV Results and Simulations

The simulated S11 of proposed antenna is shown in fig.3.below. The S11 of proposed antenna is -18.78 dB having impedance of 151.82+ j25.66 which is impedance matched with the alien higgs 4 chip of impedance 21.55-j191.45. as shown in fig.4.

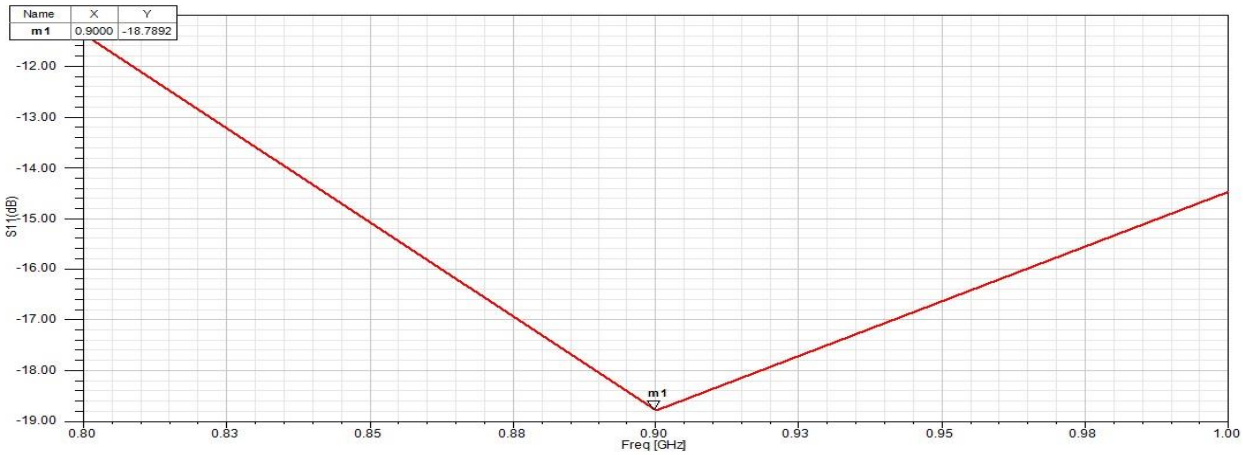

Fig.3. S11 of Proposed Antenna

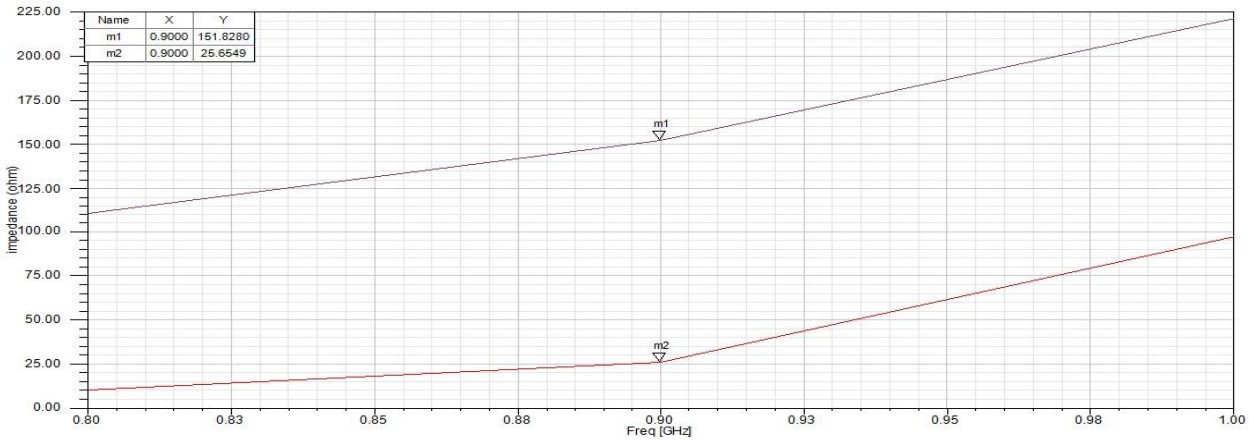

Fig.4. Input Impedance of Proposed Antenna

The proposed antenna has axial ratio of 36.5dB at 900 MHz which shows that antenna is nearly linearly polarised as shown in fig.5. Axial ratio is one of the parameter which helps in recognizing the mode of helical antenna.as the proposed antenna is linearly polarised which concludes that proposed helical tag antenn aworks in normal mode.

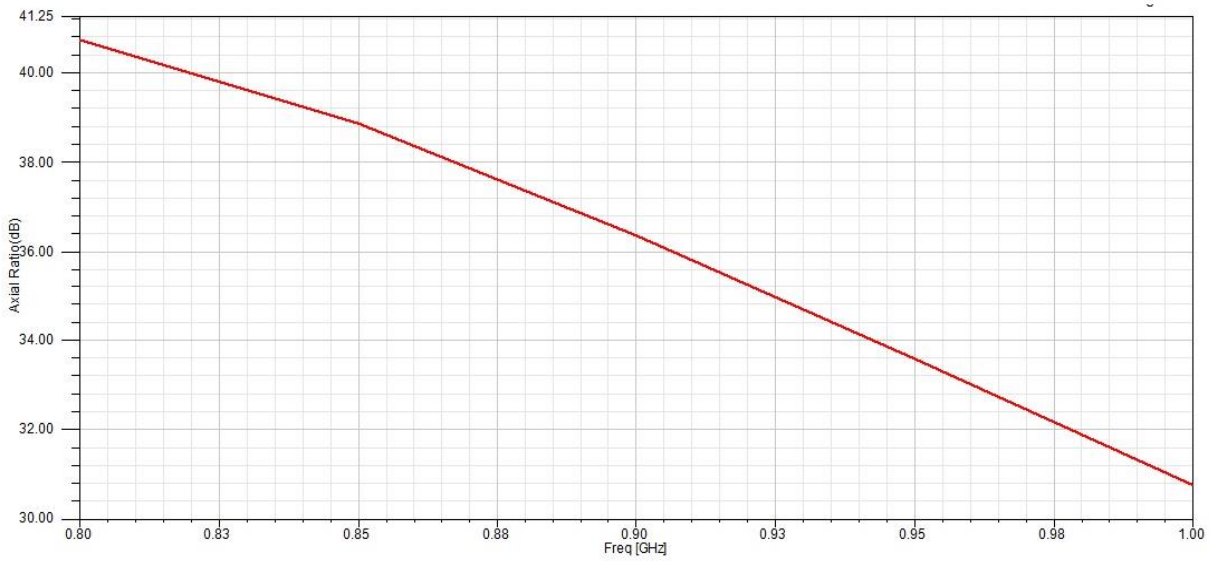

Fig.5. Axial Ratio of Proposed Antenna

The radiation pattern of proposed design is shown in fig.6. The radiation pattern is in the shape of 'figure of eight' pattern,when viewed in 2D radiation pattern. The E field radiation pattern of NMHA achieve its max radiation intensity at theta equals to 90 degree which shows that maximum radiation intensity is normal to main axis of antenna.

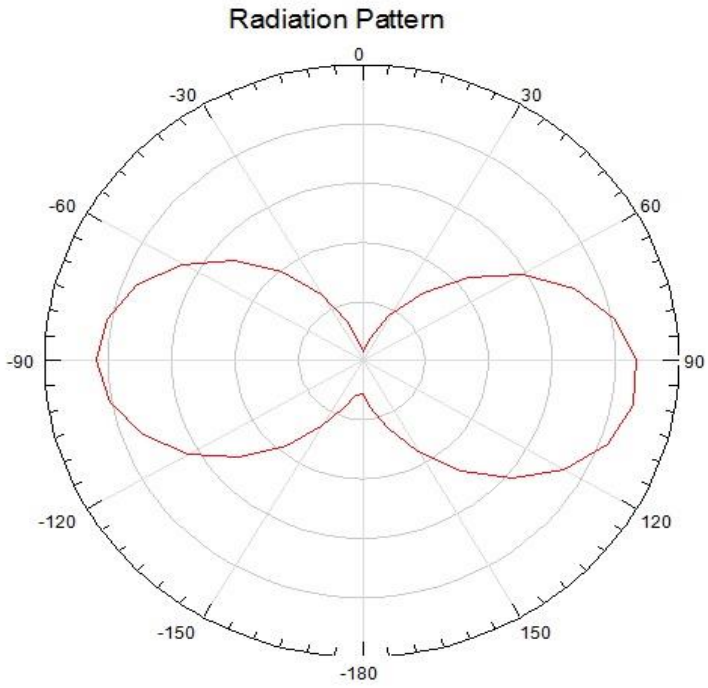

Fig.6(a) 2D Radiation Pattern

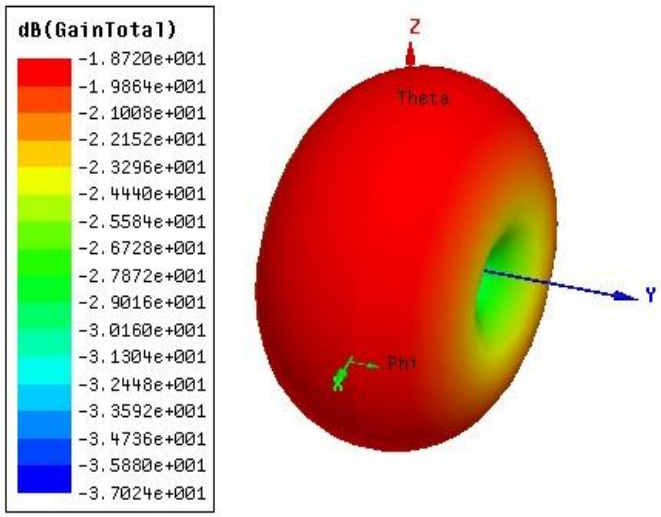

Fig.6(b) 3D Plot

The simulated gain of proposed antenna is -18.8dB at 900MHz as shown in fig. 7 and the corresponding simulated read range of proposed tag antena calculated by using friss equation which comes out to be 10cm.

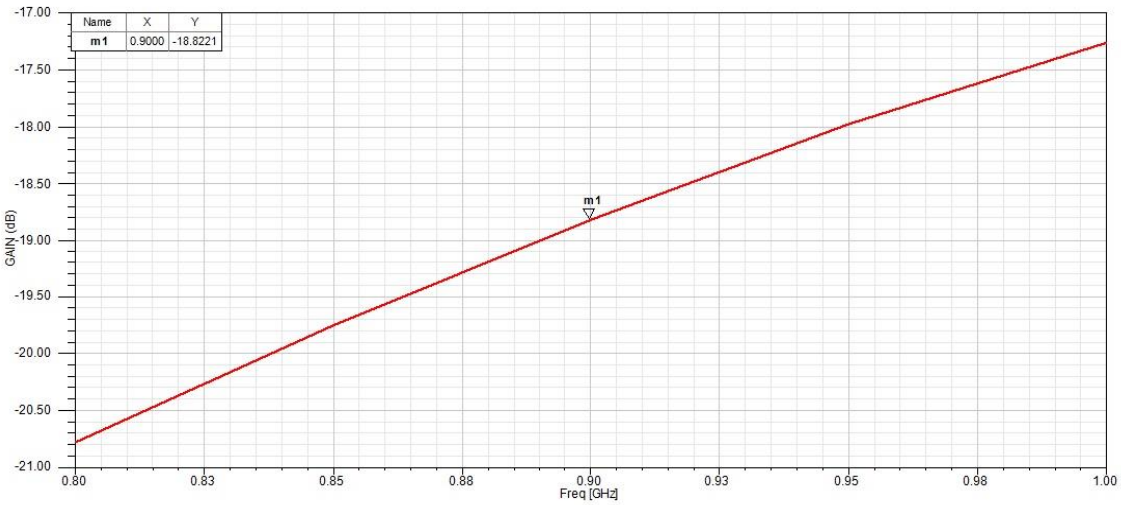

Fig.7. Simulated Gain of Proposed Antenna

V Conclusion

The impedance bandwidth can be increased to desired level. The antennas designed so far either have larger dimension with circular polarization or small dimension with linear polarization for the near field applications. Best techniques and procedures are reviewed for the designing of antenna, so as to reduce the antenna dimension. Linear polarization is achieved to design the normal mode helical antenna. Proposed antenna tag is impedance matched with the chip. In the future, size of antenna can be further reduced. Substrate of different material can be used to increase the flexibility and decrease the size of antenna. The substrate with less permittivity can enhance the gain. Further, proposed antenna can be used to study the characteristics of antenna while using over metal and in other environments.

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