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Field Optimization using Segmented Patch Antennas at High Frequencies

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Abstract: ***in recent day's communication technology has increased in every field where in antenna propagation transmission of signals to the other end is dependent on antennas. This propagation should be appropriate in both the fields as near and far fields for effectively covering which RFIDs are used which abbreviate as radio frequency identification which are considered as reader antenna developed for operating in near and far fields with high frequency band range. Here in this paper segmented loop designed of patch antenna is developed and the fabrication of antenna is done where the frequency range will be 900 MHz approximately with coefficient of reflection as less than 8dB which covers major UHB frequency range of band. It has linearly polarized pattern of radiation which provides gain of 6dBi and the capacity of reading of antenna is from 12-15m for both the applications of near and far field.***

Keywords: ***Far-field, near-field, radio frequency identification (RFID), reader antenna.***

I. INTRODUCTION

There is a drastic change in technology of antennas where covering all the fields is main for radiation. Frequency range we are discussing is also an ultra high frequency range which needs more concentration. The main objectives occur in near and far field of electromagnetic operations have used to transfer data between reader and tag. Due to its range of reading far field antennas are preferred. Whereas near field is used for metal objects and having liquids in vicinity of that. [1] Due to the performance of normal field tags which are affected due to presence of objects [2]. We conventionally use the inductive coupling for low and high frequency application. Due to item level promising performance which is tagging expensive, small and highly sensitive objects promisingly with different applications such as medical, bio, and many other and different applications of high band frequencies. Whole world is paying attention towards near field antennas [3]. Even huge work is going on in RFIDs also which emerging as reader antennas that reads all radio frequencies which are in its range at UHF we only have few patents on this reader based field operation. Anyhow these antennas which have patents might have different directions or frequencies.

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The segmented antennas are introduced in this paper which is an loop procedure with the patch antenna is used which is considered as RFID sincerity towards reader antenna with near and far field operation in ultra high frequency range of nearly 900MHz.
there are many more research operations going on in this field for further reducing the antenna bandwidth, gain, magnetic distribution of field, polarized operation and many more parameters are considered.

II. ANTENNA DESIGN

For near field systems of RFID we use these Loop antennas commonly for inductive coupling. For making this loop electrically small at both the frequencies such as low and high band where its very minimum to use physical loop. Among the amplitude and phase distribution of current is common with such a loop is uniform. So, near the loop an uniform and strong magnetic field is produced in near region of loop. The size is either very large or comparable electrically with loop antenna optimal size with wavelength band of UHF. It doesn't have the uniform amplitude and phase distribution of current in this case. This reverses at every wavelength about half. This causes at loop center results in magnetic field which is weak and non-uniform [7]. Using large loops ay high frequencies is a major problem which can be overcome by loop segmentation and intruding the capacitors in between every pair segments [8]. Depending on the length and width values each segment provides the inductance equally. Here the value of capacitance between segments of loop is considered that signet introduced phase lag shouls get removed from required frequency.

$$f = \frac{1}{2\pi\sqrt{LC}} \quad \ldots\ldots\ldots\ldots \quad (1)$$

For providing small and unidirectional flow of current the segment should be small electrically and for field distribution also which is uniform in the loop. Using lumped capacitors is not at all necessary in segments. By the implementation of top to bottom coupling near the section supporting which is done for 6GHz frequency range previously for having capacitive effect by segments coupling which we produce. The substrate material thickness is due to an separation and overlapping area in current distribution of each segment of coupled consequence of segments which results in capacitance as given in equation below.

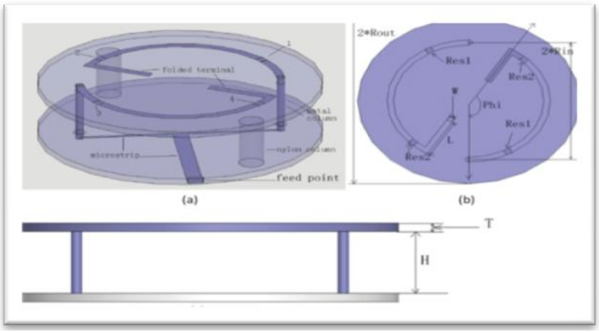

Figure.1: RFID Reader

$$C = \epsilon_0 \epsilon_r \frac{A}{h} \ldots\ldots\ldots\ldots\ldots \quad (2)$$

Here $\epsilon_{0,}\epsilon_r$ are considered as relative permittivity for substrate and relative permittivity for free space. So, by changing the length, width and area overall of overlapping of segments with height and permittivity also of substrate we can tune to desired frequency in the required design.

In the same band of frequency an antenna is introduced in addition to loop antenna segmented, to work with it that is a patch antenna the length which is required for frequency operation of patch antenna is as given in equation below [13].

$$Len \approx \frac{c}{2f\sqrt{\epsilon_{reff}}} \ldots\ldots\ldots\ldots \quad (3)$$

here light speed is considered as c andrelative permittivity which is effective of substrate is given as ϵ_{reff}. Depending on height, width of the substrate the effect of fringing is depended. For feeding the patch antenna a microstrip line of insect type is used for also making simple the loop feed connection. The patch antennas input resistance can be changed by changing the insect depth.

III. OPERATION OF ANTENNA

As shown in figure.1 above the loop segment has top to bottom coupling which encompasses the design of patch antenna consist by the design of proposed antenna. To have very small antenna structure we introduced the patch antenna inside the loop of segment even though this structure has tradeoff approach in magnetic flux blocking part among the loop. The antenna surface lies on the x-plane in Cartesian coordinates system where as on y= coordinate the we desire a reading performance the total size of antenna is very small in all coordinates which is in few mm, with the loop perimeter is 600 mm, that is same as wave length of free space of which approximately is equal to 1 free-space wavelength. If we use this type of antenna with read unit of hand held for intended reader unit we get straight way of reducing the size of antenna overall structure as straightforward which using more permittivity.

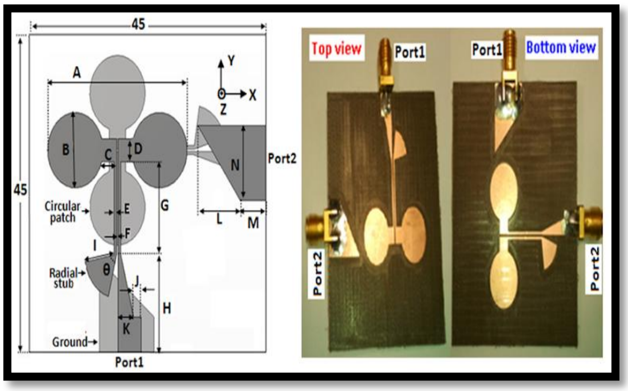

Figure.2: Antenna dimensions

By using the milling machine the main prototype this structural design is made with RF substrates. The exact dimensions of antenna are as shown in figure.2 above. We segment the loop in to 8 major parts where 4 parts will be on top of substrate and 4 will be on bottom of substrate. With some area of coupling each we couple at the end of each consecutive segment, where each segments width is nearly 6mm. for getting required frequency resonance the width, length and area of overlapping are considered by adjusting.

A radiating patch is there on top and ground layers of patch antenna on the fabricating substrate bottom. For getting 900 MHz resonant frequency the patch antenna length is tuned properly. For getting acceptable S11 value we adjust the insect depth for having proper input resistance, which is in required band especially. The plane of ground is only 5mm large because of having loop antenna which is larger than patch antenna. The antenna gain and bandwidth decreases due to a small decrease in ground plane of patch antenna, but due to the structure integration of proposed antenna it became necessary in design having both patch and loop.

IV. RESULTS

We have done simulation on CST tools software that uses the FEM. Where S11 is considered as reflection coefficient and pattern of radiation was measured with VNA which is abbreviated as Vector Network Analysis and star labs are used for comparing the results of simulation. With a slight deviation the S11 we measured will be similar to simulated one but the deviation is 3MHz frequency to right side which is shown in figure.3 below. The bandwidth we measured is having a range of frequency but we approximate it as 900 MHz that covers the high band range frequencies. Overall bandwidth is very narrow relatively of 9MHz and its limited design of structure integrated to the antennas and this antenna have both patch and loops which having smaller size relatively of ground plane of antenna.

As shown in figure below the entire patch antenna we proposed have segmented loop of distribution of current which is in the loop having unidirectional. For having the same size in the conventional loop it is investigated. As in figure the direction of current is changing in each and every corner of simulated graph.

Whereas the figure.5 gives the magnetic field component resulting on a plane above antenna. On the entire region the field distribution is not uniform but there is sufficient field of interrogation on both regions having sufficient field energy for reading the tags of near field.

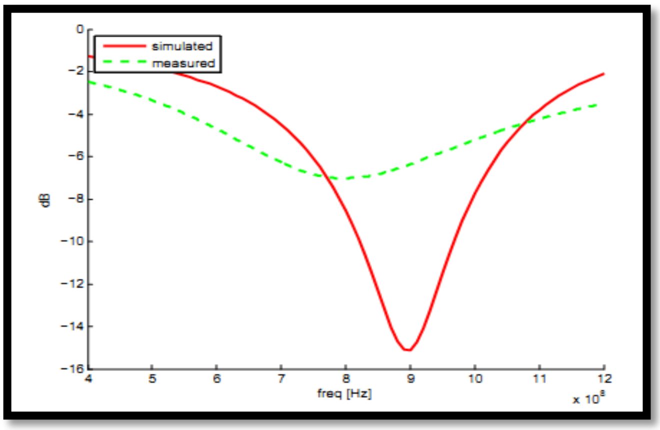

Figure.3: S11 of Antenna

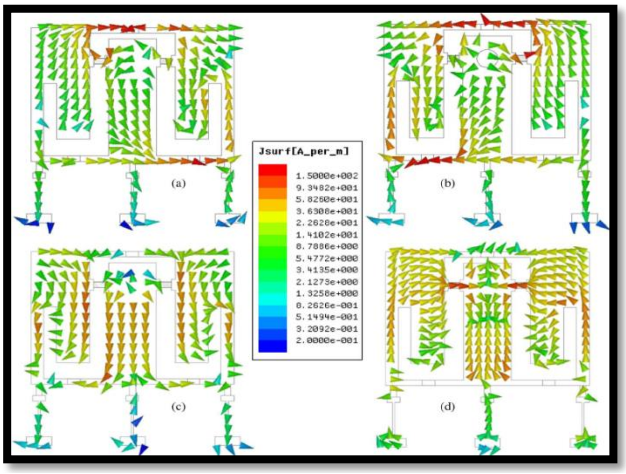

Figure.4: Distribution of current

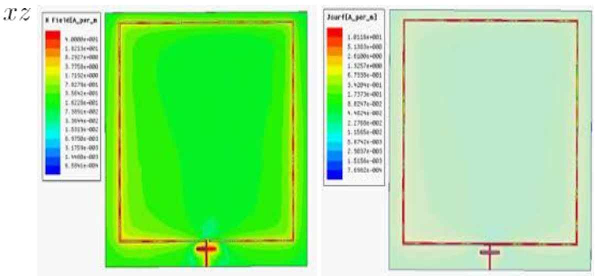

Figure.5: Magnetic field distribution

Here the distribution of field is is having high amplitude which is relative to the loop conventionally having at least 8dB in every exposed area which is as shown in figure.5 above. The presence of path reduces or weakens the magnetic field at the center point and also due to current distribution. But we can't avoid totally the center region due to applying this approach. So, for detecting the area in near field region of read we use the miniaturized techniques which are applied to patch antenna for isolating the antenna from each other which enhances the performance. If the gain and bandwidth reduces then only our patch antenna size reduces. If it is the only way we have for near field approach then it is intended to improve.

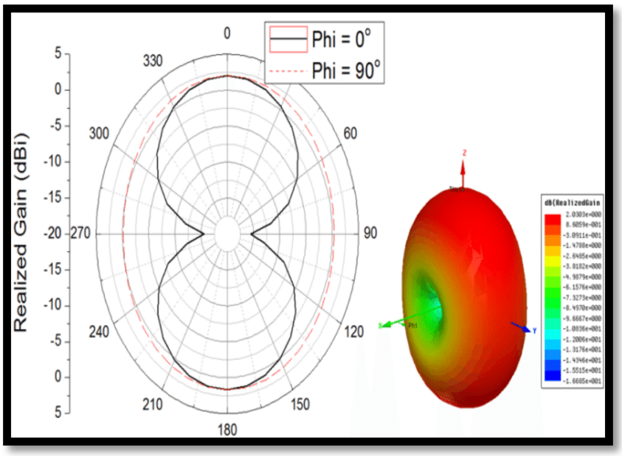

Figure.6: Pattern of Radiation.

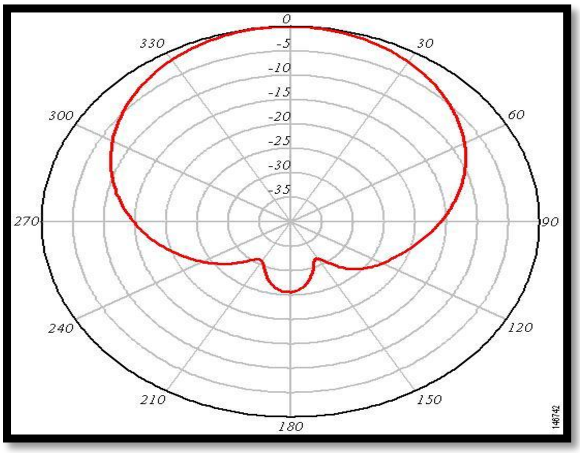

Figure.7: xy- plane Radiation

A. READ-RANGE MEASUREMENTS

As shown in figure 6 and 7 which gives the radiation pattern of far field antenna characteristics in both the planes x- plane and y-plane. Here the main beam have positive x-axis of targeted direction.

By using the read range measurement we can verify the practical performance of reader antenna which is proposed of RFID. Depending on reader range magnetic intensity of field the near field operation is dependent on tag loops size and orientation. The operation of reader and tag antennas gain, polarization with orientation are considered for far field radiation antenna operation, with considering the sensitivity of antennas decides the range. So, by commonly used tag type we measure the performance of reading of reader antenna which is very important as configured the setup of measurement is as shown in figure.8 below. The UPM is the one who gives both near field tag which is like button type and far field tag which is of short dipole type tag gets manufactured and are used in measurement in our antennas.

By increasing gradually the power of reader transmission up to 3 dBm we characterize the zones of emerging near field reader which is additional for measurements of reader range and this power range from 3 to 20 dBm which is shown in figure.9 below where the least range of power levels we can see is 0.5 cms for specific transmissions.

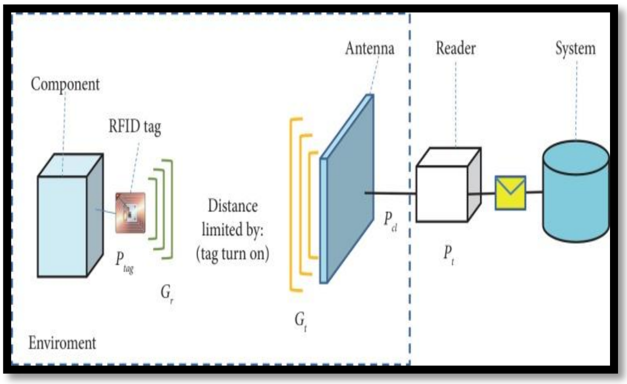

Figure.8: read range setup

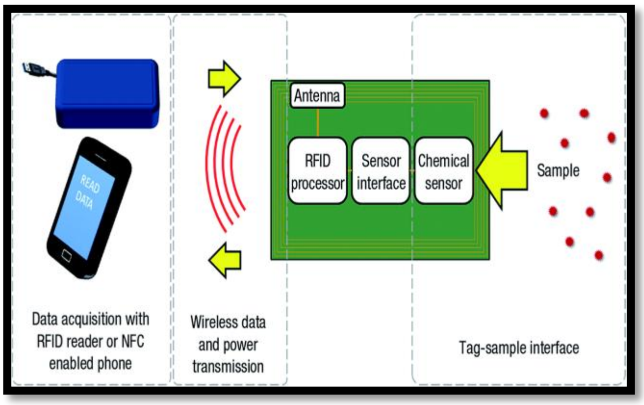

Figure.9: Reading zone

as shown in figure.5 the intensity of magnetic field is highest where the reader has maximum range is obtained that is about 10cm this is by the button type tag which is placed in parallel to the antenna according to the intensity of field we have different near field reading ranges due to having different regions of antenna. Where the small and gray color region can't read the tag in the near field. Or else there is change in range which is from some meters to 10 cm. tag is measured with its read range by fixing this tag on different objects which are solid, liquid, gaseous etc. the reading performance is not affected by this liquid objects which considered as advantage majorly in near field operations. In the way of x- axis positive the short dipole reader range of UPM tag of about 8 meters long. We achieve the far field performance much better by several meters by having this tag on objects.

As shown in figure.9 the proposed antennas performance results are shown where this design needs low power of transmission is required. As we see the simulation result the maximum power of transmission we get is 20dBm and expected regulations will provide nearly 35dBm of transmission power. We can say that in near field regions we can use regions close to loop of segmentation with very low levels of power.

V. CONCLUSION

An RFID reader antenna is developed in this paper for near and far field reading efficiency. Simulation is done by using CST Micro Wave platform tool itself which is for high frequency range operations to provide a uniform magnetic field aperture of high frequency distribution we implemented an segmented loop system in which a patch antenna is placed for far field operation. The RFID of high frequency range have used button type tag by which we obtained high arrange of 9cm. if we place the tag in liquid the near-field reading performance never degrades. For detecting this high frequency range passive frequency approximately we use RFID reader antenna approximation successfully.

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