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Efficiency in Bandwidth by using Meander Line Antennas Simulation

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ABSTRACT- In communication technology antennas plays a major role and now a days it has tremendous demand we do have different types of antennas for efficient transmissions discuss about a monopole antenna which is printed of meander line that is used for very low frequency operations of about 900 MHz With partially defected ground plane is backed with E-shaped meander line antennas of double structure is obtained by numerous slots evaluation which is the novelty of this design. By using this monopole antennas fabrication we can reduce the size of antenna and can have less operating frequency which is drastically reduced by these slots and meander lines. By this proposed design we can achieve 70% of reduction in size of antenna as conventional antennas compared. The size is of 42.2mm× 70 mm or $0.12\lambda_0 \times 0.2\lambda_0$ is obtained to antenna which is very reduced by this model. For having simulation performance valid we use FR4 substrate material for fabrication of antenna and is low cost. After simulation we can observe that the radiation pattern for this antenna is omni-directional measured with bandwidth impedance of 40 MHz with the -1dB gain which is maximum. We use CST Tool for simulation and fabrication technology is as simple even with this FR4 material.

Keywords: *omni- direction, E- shape, CST, FR4 material, Meander Line.*

I. INTRODUCTION

As we use MIMO antennas even in near and far field operations which occupies larger area and power consumption even bandwidth is very less as compared to our proposed antennas these are slotted meander line antennas. In number of countless applications we use these Ultra High Frequency (UHF) bands including in LTE700/GSM850/900 band [1], wireless M-Bus [2], and wireless body area network [3]. As we use the UHF frequencies there is more size of antenna is required due to its larger wavelength. So, particularly for low frequency band signals there should be minimized because the size of antenna for this operating band is very large. Before meander line for low frequency bands we use to have wired antennas for even UHF range frequency also. But there are difficulties in integration with circuit boards of microwave integrated and have manufacturing in complex and clumped manner.

Nevertheless, we have a solution for this that is using planar antennas which can overcome those issues but bulk size does matters.

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So, based on slotted meander line a monopole printed antenna of miniaturized size patch at 900MHz is simulated in this paper based on CST tools for Ultra High Band frequencies. For antennas impedance matching we develop a ground of small square defected structure. As we see the miniaturized evolution techniques by using slotted meander line reduce the power consumption required the size of this meander line miniaturized antenna is 46 × 72 mm^2 or about $0.12\lambda_0 \times 0.2\lambda_0$.

II. MEANDER LINE ANTENNA

This antenna has lots of advantages and disadvantages which we discuss further and as for now the antenna design model is evaluated in this section. Figure.1 is a meander line antenna structure which is a fabrication model on FR-4 material of substrate and ε_r = 4.2 which is for constant dielectric, and height of substrate is denoted by h=1.4mm and which is tangent of loss 0.01 our antenna structure is having microstrip line which is 50 Ω feed that is backed partially. For improving the impedance we add the small rectangular slot on antennas back side with parameters of length and width of 3.5 mm is realized on the back side of the antenna to improve the impedance matching of the design.

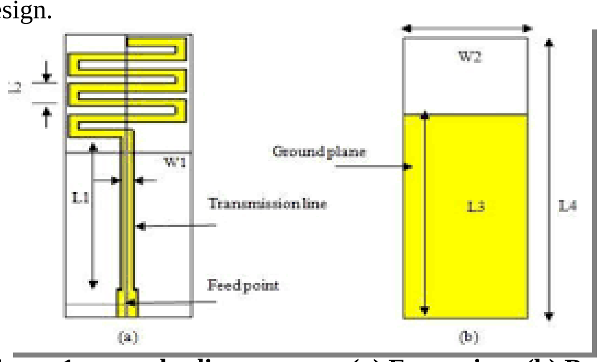

Figure.1: meander line antenna. (a) Front view. (b) Back view

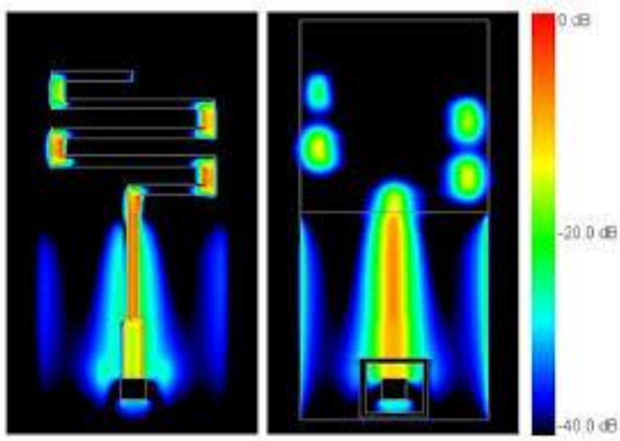

Figure.2: radiation in meander line antenna

Major cause of going to meander line antenna is its size which is very small of about 45mm × 72 mm ($0.12\lambda_0 \times 0.2\lambda_0$) here λ_0 denotes a wavelength of free space in 900 MHz. whole antenna uses particular substrate and feed dimensions in same fabrication. These antennas are simulated in Computer Simulation Technology (CST) Microwave Studio (MWS) software.

For reducing the size these meander lines and slots are used for current path in effective way in antenna. So, the design inductance and capacitance are increased as the current path increases in design which tends to reduce the resonant frequency as derived in equation (1) below for the antenna.

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

All the antenna design dimensions such as meander line, slots, patch, and ground plane are shown in above figure.1 which is organized in below Table 1.

Table.1: parameters.

Parameters	W_p	W_s	L_s	W_f	L_f	W_1	W_2
Unit (mm)	37	45.3	72	2.6	30	5	8.3
Parameters	W_3	W_4	L_1	L_2	L_g	W_d	L_d
Unit (mm)	10	6	9	4	31	3	3.2

We can see from the figure.2 that radiation pattern in antenna is very sevior when we use this meander line and slotted section because the main use of meander line is to have miniaturized size that leads to thin feed wired for current flow this thin wires radiates a lot so this is major cause that exactly illustrated with front view of antenna in 3D image form for understanding. Based on the equations given below the width and length of this radiation pattern are measured.

$$a = \frac{L_p}{2} - 0.5 \quad (2)$$

$$W_1 = 0.139 L_p \quad (3)$$

$$L_a = \frac{a-5}{6} \quad (4)$$

$$W_a = \frac{a}{4.72} + 1 \quad (5)$$

$$W_b = \frac{a}{2.28} + 1 \quad (6)$$

$$W_d = W_e = 0.069 L_p \quad (7)$$

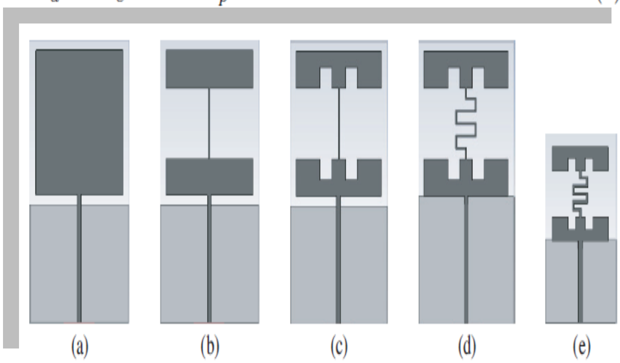

Figure.3: Antenna evaluate at different stages

Our antenna as shown in figure.3 gone for evaluation in different stages which indicates that for getting miniaturized size different steps are followed. Where fig. a represents the initially printed antenna of monopole that covers 900 MHz frequency of wideband. In fig. b a slot is introduced on both the sides of patch with having the current carrying path very thin which increase the path of current and decreases the resonating frequency. Further etching is done to remove the excess part of slots in both the sides for having resonant frequency reduction in fig. c. A thin current line is made to meander line which is very thin at the center of radiation path as shown in fig. d. A ground structure is given at the back which is a square slot that increases the antennas matching impedance. All 4 figures have same antenna size of 82 mm ×142 mm but having resonant frequency difference. So, in these all 4 processes the resonant frequency is less due to their large size for that sake we reduce the size of antenna to increase the resonant frequency as shown in fig. e. its totally 80 % reduction in size to bring back the same resonance so, that to have 900MHz. The size reduced to 44 mm × 72 mm or $0.13\lambda_0 \times 0.2\lambda_0$.

III. RESULTS

To our proposed antenna as in fig.2 and 3 for all parameters the simulation results are as shown below with resonance at same frequency but at different sizes. By seeing the simulation results we can say that better reflection coefficients are obtained in proposed antenna with efficient matching of impedance. Anyhow proposed antenna has narrow bandwidth which doesn't effects any other applications so for UHF narrowband frequency we can use our antenna effectively.

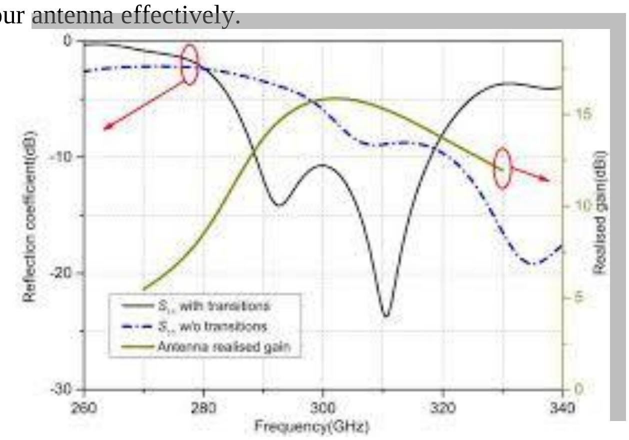

Figure.4: reflection coefficient

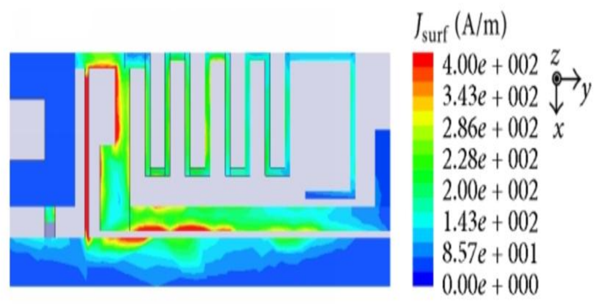

Figure.5: surface current distribution

From fig. 'b' and 'a' we get low resonant frequency in 'b' than in 'a' similarly in fig. 'c' and 'b' where 'b' has high resonance than 'c' and this is due to the presence of slots and meander line which reduces the resonant frequency maximum from 550 MHz to 450MHz from fig. 'd' to 'c' so for this reason the size of fig. 'd' is reduced to match the desired frequency.

The simulation for current distribution in our proposed antennas is shown in Figure.5. Form this we can observe that current is majorly concentrated on center of antenna where feed line meander line are present there radiation is very high. How the length of electrical current path is increased can also be observed by noticing the maximum current at the slots edges which portraits all its efficiencies and defects.

Due to the presence of defected ground structure the impedance is increased of input antenna as we discussed earlier. We can see the input impedance in fig.6 as Z_{in} = 52 + j0.2 Ω at 900MHz. to validate the structure of antenna we fabricated and validate to measure the results of simulation. By using LPKF machine for milling our fabrication is done where the measurement is done using chamber of anechoic by vector network analysis. As shown in figure.6 below is the fabrication photograph of antenna.

We do comparison for results which we simulated and measured that is shown in figure.7, where blue dashed lines represents the coefficient of reflection in simulation where as the measured coefficients results is represented in solid red line. Now the measured and simulated frequency resonance is approximating 900MHz range.

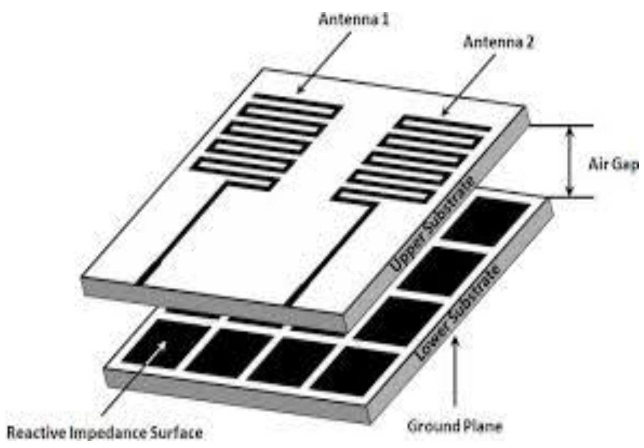

Figure.6: fabricated antennas

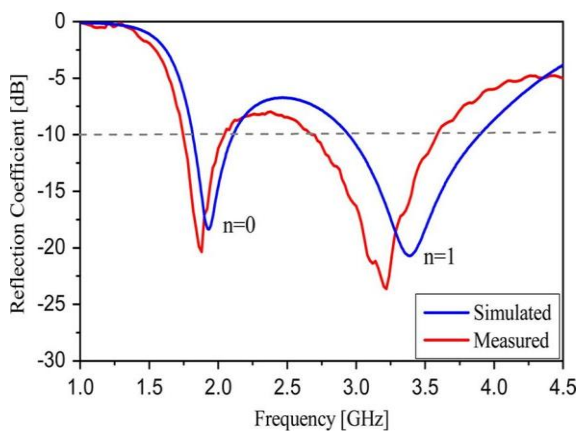

Figure.7: reflection coefficient

As shown in figure.8 above the both simulated and measured graphs are having the similar characteristics of VSWR voltage standing wave ratio these two lines seems agreed to one other as similar with 1.5 dB rate of VSWR which can be further less. It is discovered that the impedance bandwidth and gain of the proposed antenna are higher compared to others. The proposed work consists of a simple structure of smaller size approaching electrically small antenna and easier to fabricate. The size of the antenna can be further decreased but with degradation in antenna gain and efficiency. When the size is more important factor then no need for going to wide bandwidth range of antennas.

The characteristics of radiation in our proposed antennas above where there is an good understanding between both the results where (a and b) are polar plots of simulated antenna of miniaturized size in both the electro-magnetic planes as E-plane and H-plane. These measured and simulated performances are given in table.2 as below where there is discrepancies in both performances occurred because of tolerance in fabrication. Whereas the discrepancies due to small antennas electrically in gain and by effects of ground plane. But the obtained gain is still acceptable for our application.

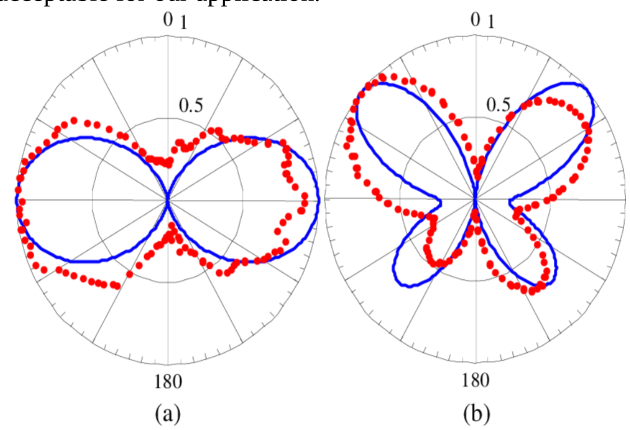

Figure.8: Polar plot (a) E-plane (b) H -plane

Table.2: Parameters of both antennas

Performances/ Parameters	Frequency (MHz)	S_{11} (dB)	Efficiency (%)	Gain (dBi)	VSWR	Bandwidth (%)
Simulated Proposed Antenna	889	−40	78.21	1.95	0.92	6.80
Measured Proposed Antenna	897	−21.96	44.02	−0.97	1.23	7.50

The gain and bandwidth of antenna we proposed are comparatively effective and it has simple structure with small size acceptable power consumption operation, productive fabrication technology high gain and efficiency if size increases if we don't compromise in size then gain and efficiency decreases.

IV. CONCLUSION AND FUTURESCOPE

For the applications of UHB band frequency range our proposed antenna of monopole printed miniaturized meander line antenna with slots for high power consumption and radiation constant operation with frequency resonance range of 900 MHz gives the better gain than other direct antennas where size is nearly 80 percent reduced with offering Omni-directional pattern of radiation. Resonance frequency is also a major consideration with bandwidth of much higher than any other antennas. But the bandwidth is dependent with the size of our antenna as size increases gain and efficiency reduces so, this may be considered in future that obtaining high gain and efficiency for increasing size of antenna.

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