SHORTING WALL PLANAR INVERTED FOLDED ANTENNA ON LC SUBSTRATE FOR BLUETOOTH APPLICATION

[1]S.S.Mohan Reddy, [2*]B.T.P.Madhav, [3]S. Siva Kumar, [3]S. Raviteja Raju, [3]V. Siva Kiran, [3]V. Prudhvi

[1]Associate Professor, Department of ECE, SRKR Engg. College, Bhimavaram, AP, India
[2]Associate Professor, Department of ECE, K L University, AP, India
[3]Project Students, Department of ECE, SRKR Engg. College, Bhimavaram, AP, India

Abstract: Number of investigations done to reduce the size of the microstrip patch antennas at a fixed operating frequency. In general microstrip antennas are half wavelength structures and are operated at the fundamental resonant mode TM01 or TM10. To reduce the size without disturbing the substrate material permittivity value we are having some special techniques like shorting pin, shorting plate, shorting wall and some other slot models. This paper describes the design and simulation of planar inverted folded antenna with shorting wall model on the liquid crystal substrate material. The present study includes verification of radiation patterns, return loss and field distributions. The operating frequency is chosen 2.4GHz for Bluetooth applications. All the output parameters are simulated using commercial Ansoft-HFSS Software.

References: Shorting wall, Planar Inverted Folded Antenna (PIFA), Liquid Crystal Substrate, Bluetooth.

1. Introduction: Planar Inverted folded antenna is one of the mostly used antenna in the mobile phones for various applications like, transmission and reception of signals, Bluetooth, Internet etc. The Inverted F Antenna (IFA) typically consists of a rectangular planar element located above a ground plane, a short circuiting plate or pin, and a feeding mechanism for the planar element. The Inverted F antenna is a variant of the monopole where the top section has been folded down so as to be parallel with the ground plane. This is done to reduce the height of the antenna, while maintaining a resonant trace length. This parallel section introduces capacitance to the input impedance of the antenna, which is compensated by implementing a short-circuit stub [1-3].

The ground plane of the antenna plays a significant role in its operation. Excitation of currents in the printed IFA causes excitation of currents in the ground plane. The resulting electromagnetic field is formed by the interaction of the IFA and an image of itself below the ground plane. Its behavior as a perfect energy reflector is consistent only when the ground plane is infinite or very much larger in its dimensions than the monopole itself. In practice the metallic layers are of comparable dimensions to the monopole and act as the other part of the dipole [4-6].

PIFA can be considered as a kind of linear Inverted F antenna (IFA) with the wire radiator element replaced by a plate to expand the bandwidth.

· One advantage of PIFA is that can be hiding into the housing of the mobile when comparable to
whip/rod/helix antennas.

· Second advantage of PIFA is having reduced backward radiation toward the user's head, minimizing the electromagnetic wave power absorption (SAR) and enhances antenna performance.

· Third advantage is that PIFA it exhibits moderate to high gain in both vertical and horizontal states of polarization. This feature is very useful in certain wireless communications where the antenna orientation is not fixed and the reflections are present from the different corners of the environment. In those cases, the important parameter to be considered is the total field that is the

vector sum of horizontal and vertical states of polarization [7-9].

Narrow bandwidth characteristic of PIFA is one of the limitations for its commercial application for wireless mobile. The shorting post near the feed probe point of usual PIFA types is good method for reducing the antenna size, but this result into the narrow impedance bandwidth [10].

2. Techniques to increase the Bandwidth for PIFA:

Bandwidth is affected very much by the size of the ground plane. By varying the size of the ground plane, the bandwidth of a PIFA can be adjusted. For example, reducing the ground plane can effectively broaden the bandwidth of the antenna system. To reduce the quality factor of the structure (and to increase the bandwidth), can be inserted several slits at the ground plane edges. Use of thick air substrate to lower the Q and increase the bandwidth [11-13]. Using parasitic resonators with resonant lengths close to main resonant frequency. Adjusting the location and the spacing between two shorting posts. Excitation of multiple modes designed to be close together or far apart depending on requirements. Using stacked elements it will increase the Bandwidth [14-15].

3. Antenna Dimensions:

The resonant frequency is 2.4GHz and patch dimension along x-axis is 12 mm, patch dimension along y-axis is 14 mm. Substrate material of liquid crystal is chosen in this present work and its relative permittivity is 2.55 and loss tangent is 0.03. Substrate dimension along x-axis is 42 mm and y-axis is 65 mm. feed location along y-axis is -16.5 mm, coaxial inner radius of 1.6mm and outer radius of 5.5mm and feed length of 16.3mm. Figure (1) shows the shorting plate PIF Antenna on LC Substrate.
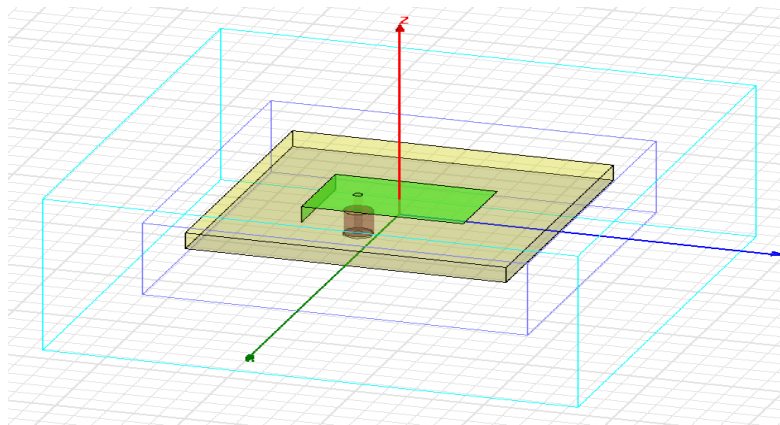
Figure (1) Shorting Wall PIF Antenna

4. Results and Analysis:
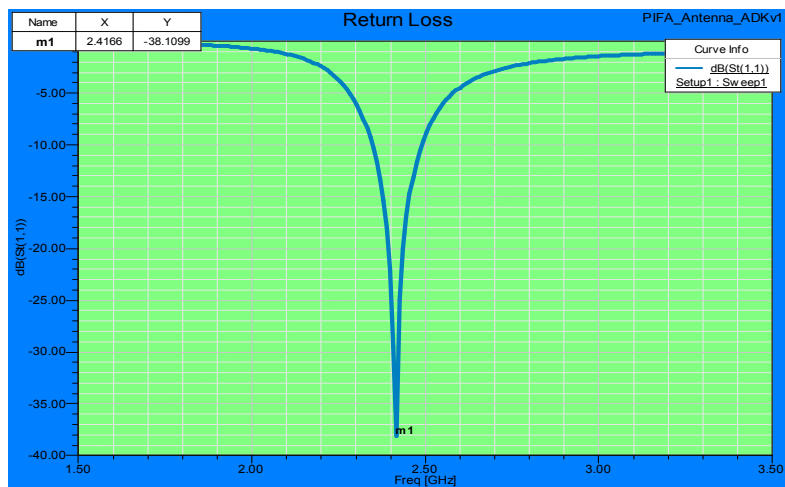
Figure (2) Return loss Vs Frequency

The simulation results are giving good agreement for the applicability of the proposed antenna. The return loss for the proposed antenna is shown in figure (2). The return loss obtained at 2.4GHz is about -38.10dB.
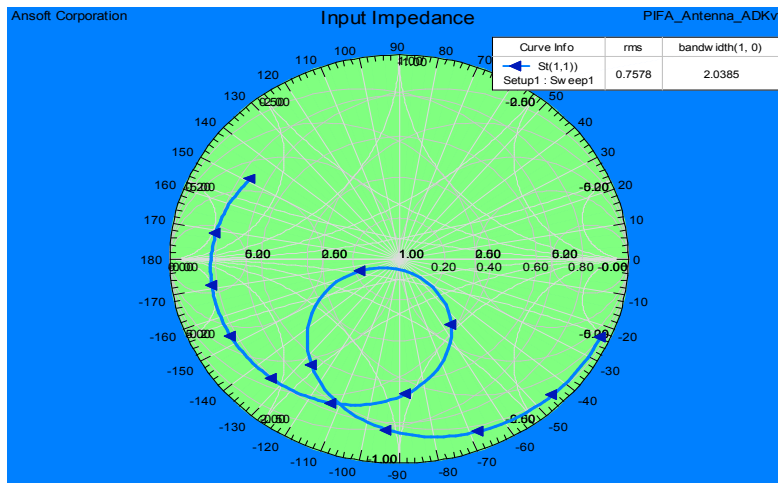
Figure (3) Input Impedance smith chart

At some frequencies a given antenna will not be matched to the transmission line, and will not accept or radiate power, while at those frequencies where the antenna is designed to operate, the impedance of the antenna will allow the electromagnetic energy to pass into the structure and radiate into the surrounding space. These frequencies would be deemed to be inside the antenna's impedance bandwidth. Figure (3) shows the input impedance smith chart. The rms of 0.75 and impedance bandwidth of 0.85% is attained from the current design.
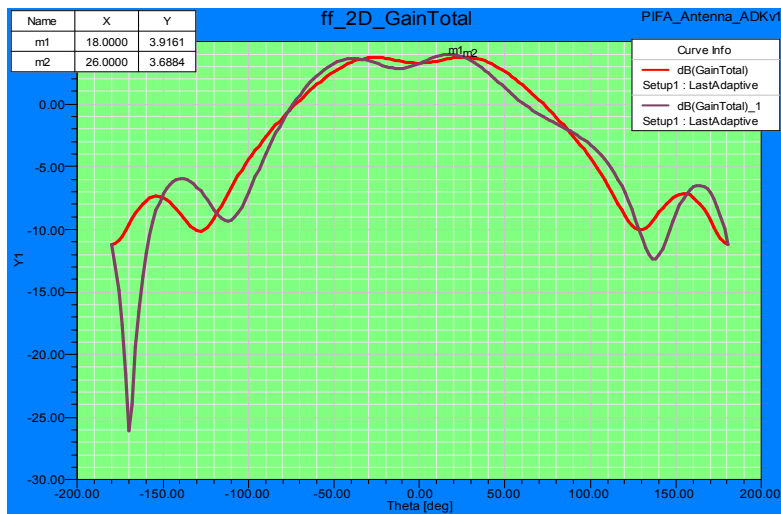
Figure (4) Two Dimensional Gain

Figure (4) shows the two dimensional gain curve for the antenna. Maximum gain of 3.91dB can be attained from the current model and it shown in the figure (4).
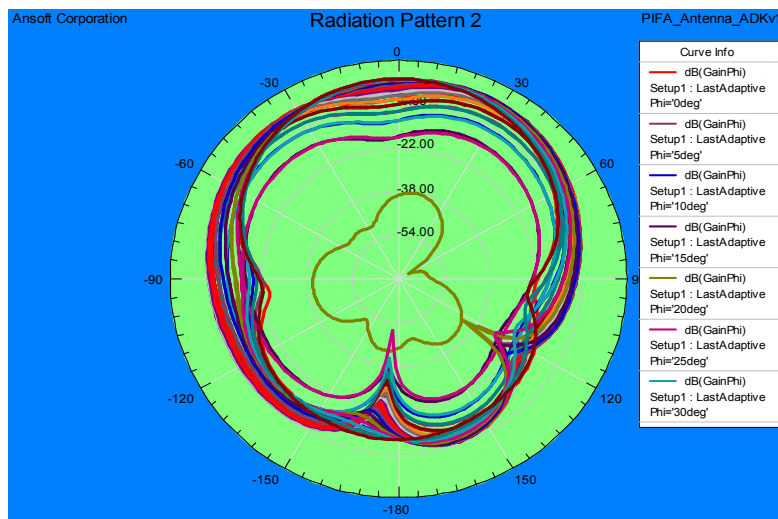
Figure (5) Polar Plot for radiation pattern in phi direction

The radiation of the antenna is expressed in terms of the field strength E (in V/m), and then the graphical representation is called field strength pattern or field radiation pattern. Similarly if the radiation of the antenna is expressed in terms of the power per unit solid angle, then the graphical representation is called power radiation pattern. Figure (5), (6), (7) and (8) shows the radiation pattern of the antenna. The far-zone electric field lies in the E-plane and far-zone magnetic field lies in the H-plane. The patterns in these planes are referred to as the E and H plane patterns respectively. Figure (5) and (6) shows the radiation pattern of E-plane(y-z plane) in Polar coordinates and 3-Dimensional view. Figure (7) and (8) shows the radiation pattern of H-plane(x-z plane) in Polar coordinates and 3-Dimensional view.
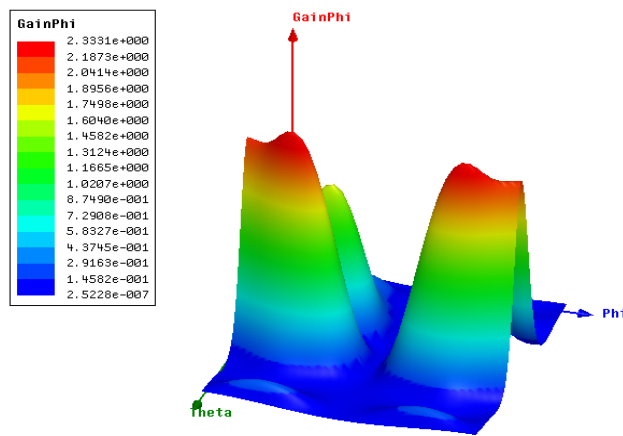
Figure (6) 3D-Radiation Pattern in Phi direction
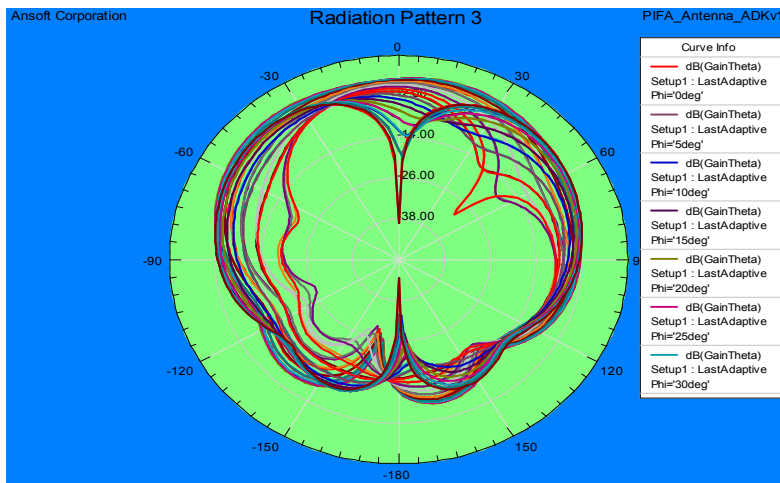
Figure (7) Polar Plot for radiation pattern in theta direction
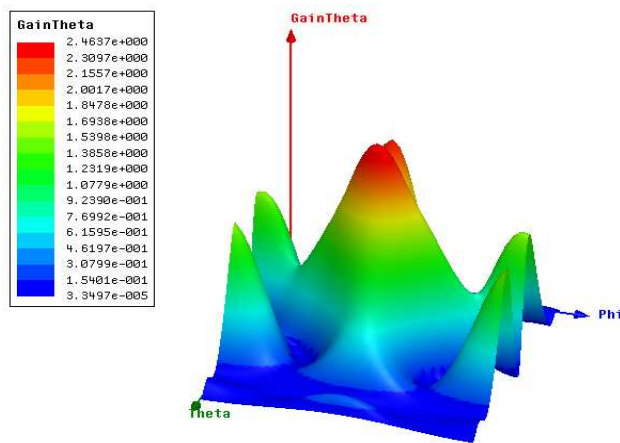
Figure (8) 3D-Radiation Pattern in Theta direction
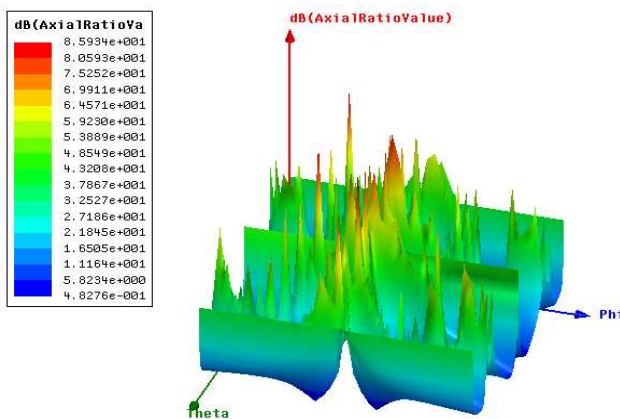
Figure (9) 3D-Axial Ratio

The axial ratio is a parameter which measures the purity of the circularly polarized wave. The axial ratio will be larger than unity when the frequency deviates from f0. Figure (9) shows the axial ratio for the current model in 3-Dimensional view.
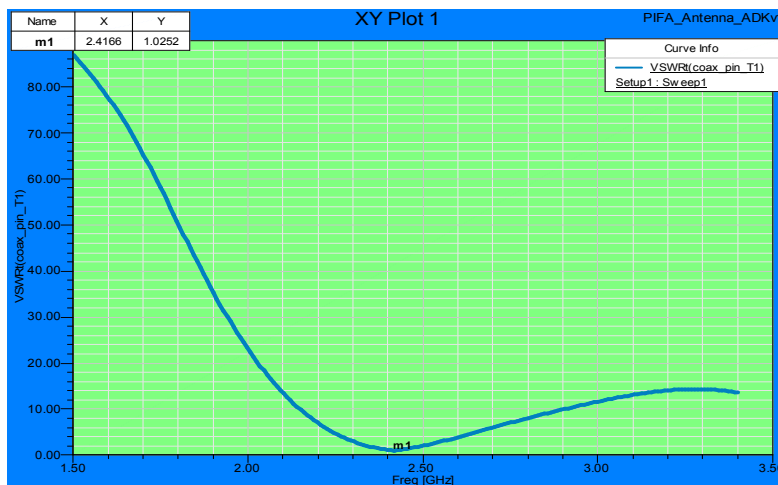

Figure (10) VSWR Vs Frequency

Figure (10) shows the VSWR Vs frequency curve and it is showing the VSWR of 1.02 at desired frequency. The current result maintains the 2:1 ratio of VSWR as per the standards. These results showing the applicability of this antenna for the proposed operation.

Conclusion: The Simulational investigations showing good results for the applicability of this proposed antenna at microwave frequencies. The results are in very good agreement with the industry and standard published antenna requirements with respect to ease of fabrication, compactness and volume miniaturization compared to other antennas so far designed for similar applications. Input impedance bandwidth of 0.85% enhancement can be achieved from

the current antenna. The results are showing the applicability of the Liquid crystal based antennas in various applications of the communication systems.

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