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ANALYSIS OF ORTHOGONAL FEED DUAL FREQUENCY RECTANGULAR MICROSTRIP PATCH ANTENNA FOR S-BAND APPLICATIONS

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ABSTRACT

The proposed antenna exhibits dual resonance at 2.524GHz and 3.222GHz due to the multi resonance characteristics of a single patch. Rectangular patch shape of dimensions 30X40mm is etched on the RT-duroid substrate material having dielectric constant ε_r=2.2 with loss tangent tan δ=0.0009. Orthogonal feed is given at (6, 6) position. The resultant characteristics of the proposed antenna is compared with the rectangular MSPA with single feed at (6,0) and single feed at (0,6) positions. The theoretical results are compared with the simulated data using CONCERTO software which are in close agreement. Further returnloss, 2D radiation pattern, 3D radiation pattern, Total E field and H Field, power, axial ratio, probe impedance results for the proposed antenna are calculated and presented.

Keywords: *Patch antenna, Dual Band MSPA, Orthogonal polarization*

1. INTRODUCTION:

Microstrip patch antennas in general have a conducting patch printed on a grounded microwave substrate. The attractive features like low profile, light weight, easy fabrication and conformability to mounting hosts makes patch antenna as a better option in wireless communications[1-4]. Recent advances in wireless applications at S-Band that demands frequency reuse or polarization diversity involves dual band antennas rather than broad band antennas. In this paper a simple design for dual frequency rectangular microstrip patch antenna with orthogonal feed is proposed and the performance is evaluated with the normal single feed rectangular MSPA. Use of circulator or diplexer is avoided by the proposed antenna for dual band operation for wireless communications [5-7].

Various kinds of MSA were proposed for dual band operation such as multilayer stacked patchs,a square patch with a rectangular notch, a rectangular patch loaded with shorting pins and slots, a rectangular patch fed by an inclined coupling slot. The proposed antenna is a regular size dual frequency design which can give good return loss characteristics [8-10].

The results are simulated by CONCERTO software. it is a state of the art system for high frequency field simulation. The main components are modeller, QuickWave simulator, quickwave2D, CLASP, SOPRANO/EV and post processor. This provides a complete tool chain for RF and microwave electromagnetic design for use on 32 or 64 bit windows platform.

2. THEORETICAL CONSIDERATIONS:

Rectangular microstrip patch antenna used to operate at TM_{10} and TM_{01} mode [11-12]. The frequency variation $f_2/f_1$is approximately equal to L/W.where L and W are length and width of the patch respectively. Based on the cavity model approximation, we can express the resonant frequencies for the TMmn mode as

$$f_{mn}=\frac{c}{2\sqrt{\varepsilon_r}}\sqrt{\left(\frac{m}{L}\right)^2+\left(\frac{n}{W}\right)^2}$$

Dual frequency operation f_{01} and f_{10} for the proposed antenna is achieved by orthogonal feed located at (x, y) location.

3. DESIGN SPECIFICATIONS FOR THE PROPOSED ANTENNA:

The geometrical configuration of proposed antenna is shown in Fig (1).Length of the patch is 30mm and width of the patch is 40mm.which is designed on a 50X60 mm RT-duroid substarte.Fig (2) depicts the feed locations for the proposed design indicated as A,B and C. If MSA fed at A it operates at single frequency and if it is fed at B it operates at other single frequency. For single feed dual band operation MSA should fed at C which is called orthogonal feeding so that it resonates at two frequencies.

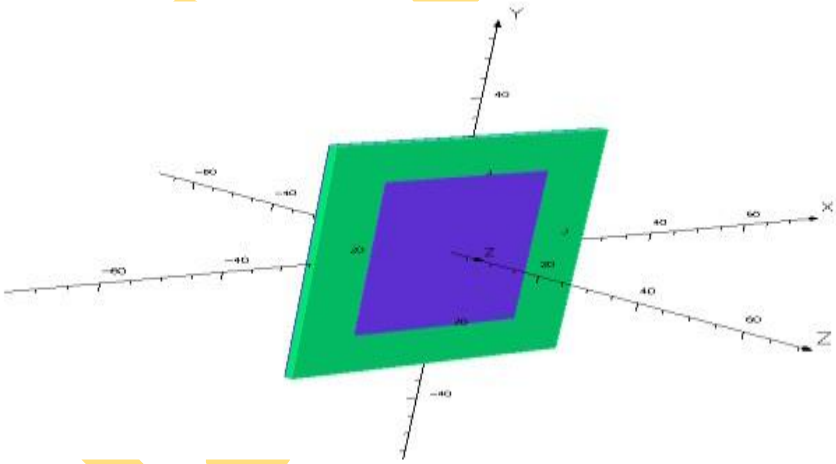

Fig (1) Geometrical configuration of RMSA

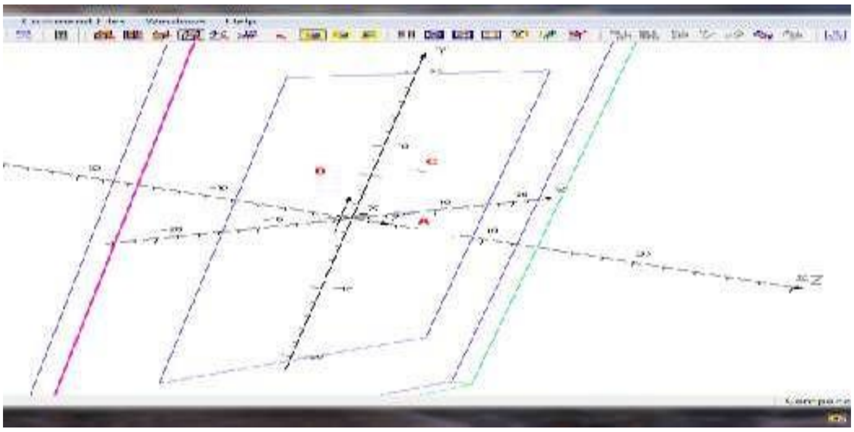

Fig (2) Feed locations for RMSA

Fig (3) depicts clear view of wire edge feeding at point C.It indicates that feed start at 0 and extends up to the backend of the patch.

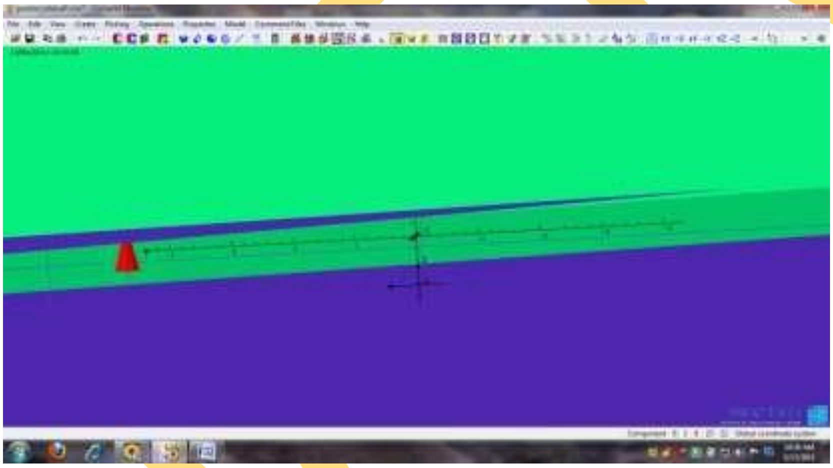

Fig (3) Wire edge feed for RMSA

4. EVALUATION OF PROPOSED ANTENNA DESIGN:

Variation of return loss as a function of frequency for different feed locations A (6, 0), B (0, 6), A along with B and only at C (6, 6) are analyzed mainly.

The variation of return loss as a function of frequency for RMSA fed at point A (6,0) is shown in Fig (4) It indicates that the return loss is -12.7 dB at 2.7 GHz.

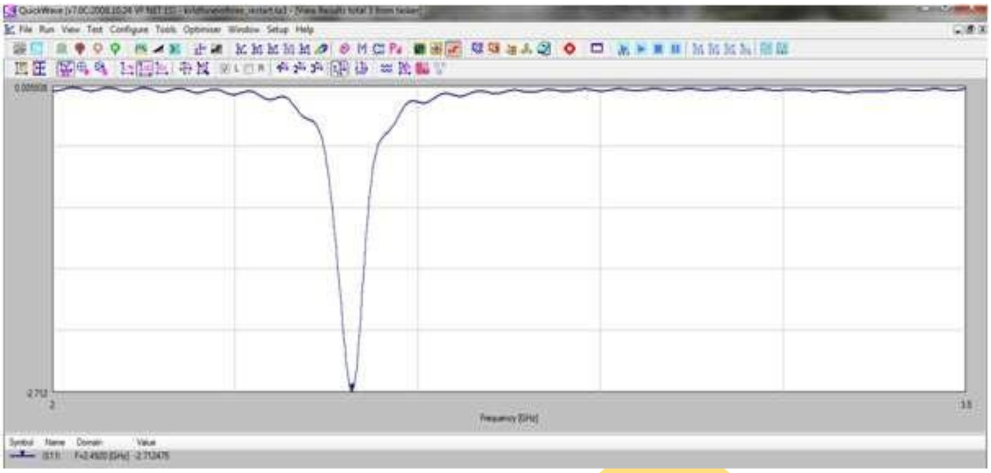

Fig (4) Return loss Vs Frequency for feed point at A(6,0)

The variation of return loss as a function of frequency for RMSA fed at point B (0,6) is shown in Fig (5) It indicates that the return loss is –10.7 dB at 3.24 GHz

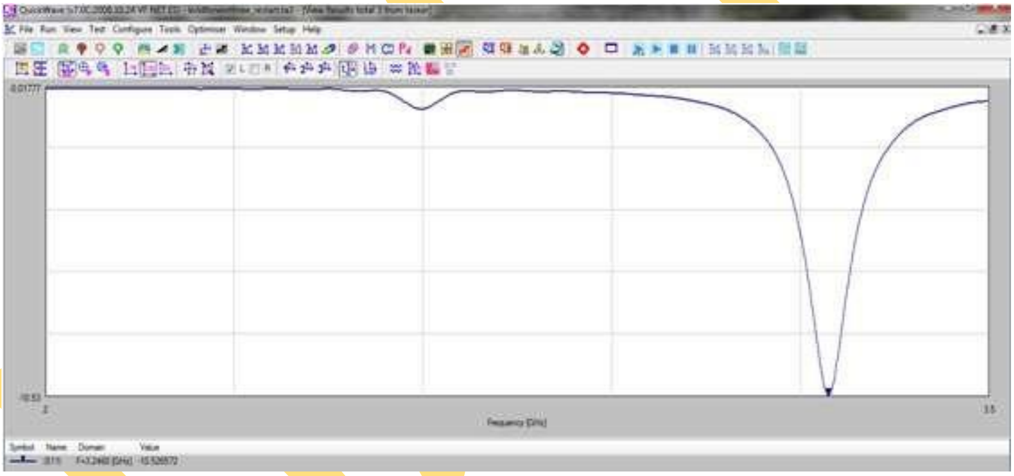

Fig (5) Return loss Vs Frequency for feed point at B (0, 6)

The variation of return loss as a function of frequency for RMSA fed at two points A & B i.e. (6, 0) and (0, 6) respectively is shown in Fig (6). It indicates that the return loss is –12.01 dB at 2.7 GHz and return loss is -11.06 dB at 3.24 GHz. Fig (6) depicts that dual frequency operation can achieved for the designed patch but it requires two feeds. Compact design can achieved by the proposed feed location.

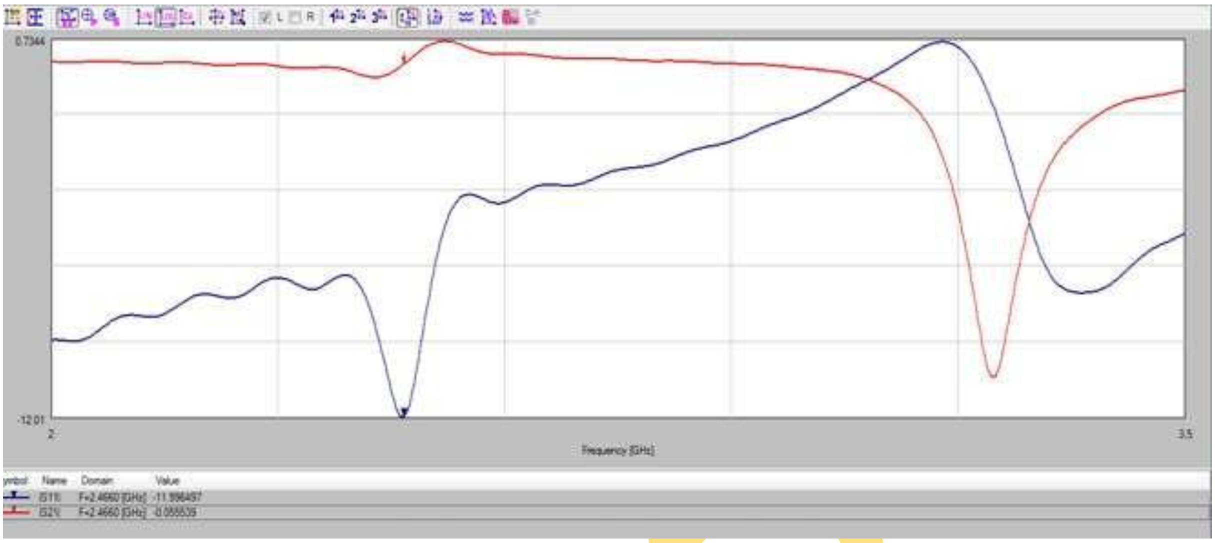

Fig (6) Return loss Vs Frequency for feed point at A and B

5. DISCUSSION OF RESULTS:

5.1 Return Loss: Variation of return loss as a function of frequency for the proposed antenna design is shown in Fig (7).

It shows that a RMSA fed at a single point C (6, 6) can generates dual resonance at 2.524GHz and 3.222GHz with the return loss value of -33.3dB and -12.8 dB respectively.

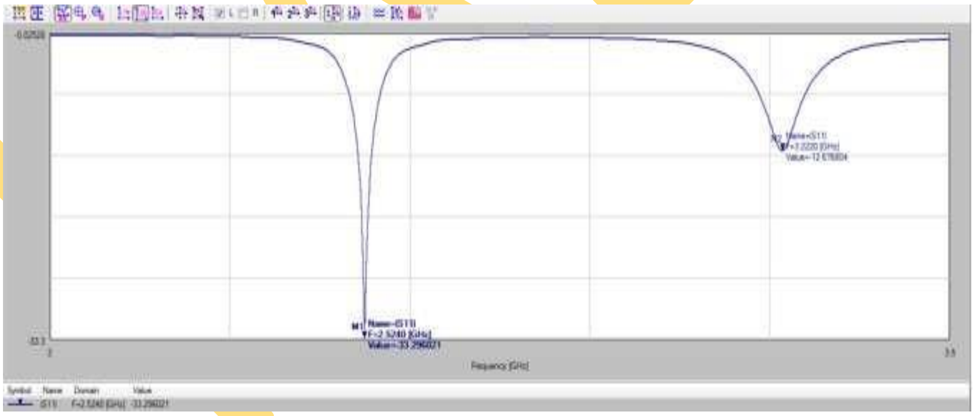

Fig (7) Return loss Vs Frequency for feed point at C (6,6)

It is interesting to note that the ratio of two resonances depend on the dimensions of the slot. It is found that the ratio of two frequencies (2.524 GHz/3.222GHz) approximately equal to patch length to width ratio (30mm/40mm).The dependence of ratio of two frequencies allows flexibility in the design of dual band antennas.

5.2 Radiation pattern in 3D view:

Fig (8) shows the radiation pattern at f_1 (2.524 GHz) in 3D view. The gain value is found to be 6.9dB.

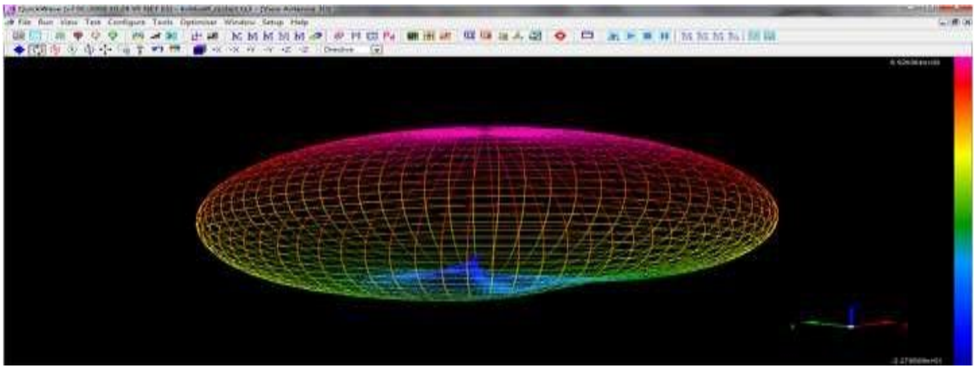

Fig (8) 3D radiation pattern at 2.524GHz

Fig (9) shows the radiation pattern at f_2 (3.222 GHz) in 3D view. The gain value is found to be 7.89dB.

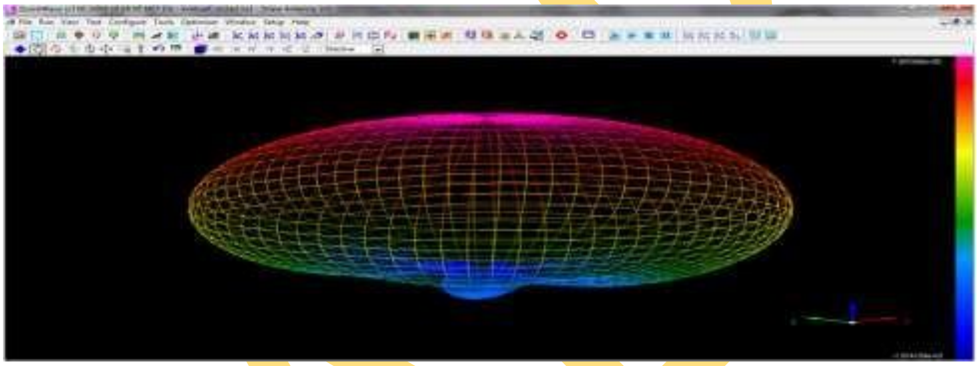

Fig (9) 3D radiation pattern at 3.222GHz

5.3. 2D Radiation pattern:

Fig (10) and Fig (11) depicts antenna results in polar coordinates when $\Phi=0^0$ and 90^0 respectively. Where θ varies from -90^0 to 90^0

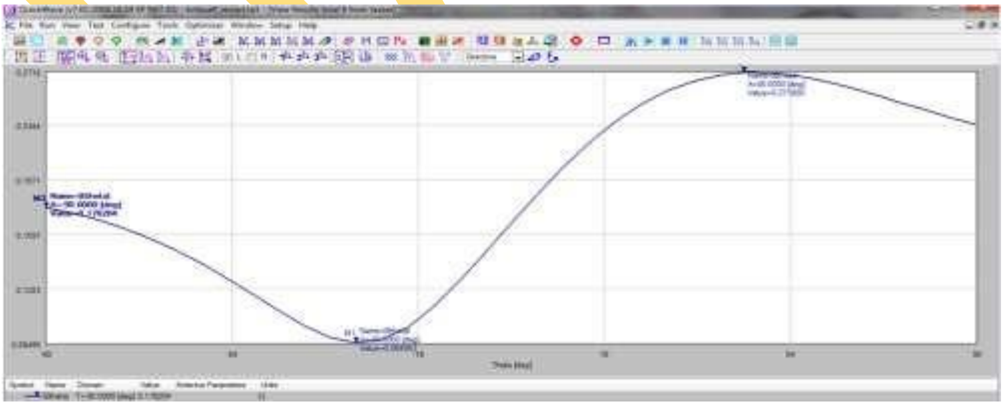

Fig (10) 2D radiation pattern for $\Phi=0^0$

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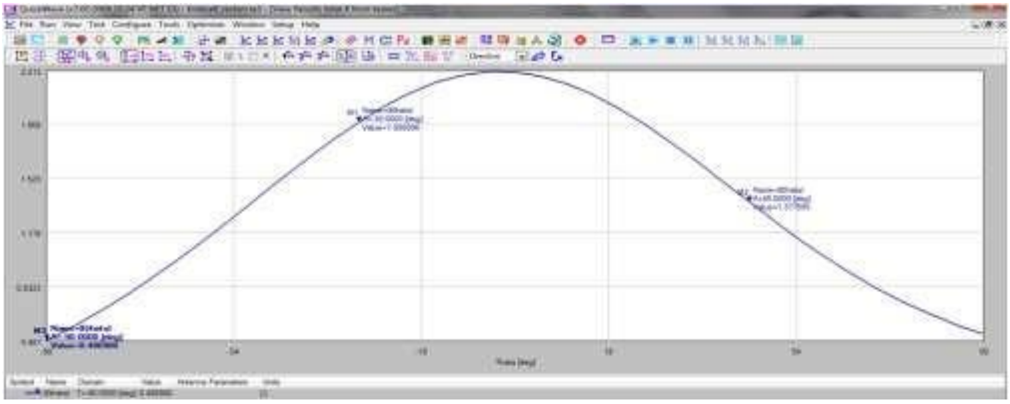

Fig (11) 2D radiation pattern for $\Phi=90^0$

5.4 Polar plots of 2D radiation pattern: Radiation pattern of the proposed antenna in polar coordinates is observed for $\Phi=0^0$ and 90^0 where Φ varies between -90^0 to 90^0 .Fig (12) and Fig (13) shows the radiation patterns in polar coordinates as line form for the two cases $\Phi=0^0$ and 90^0 respectively.

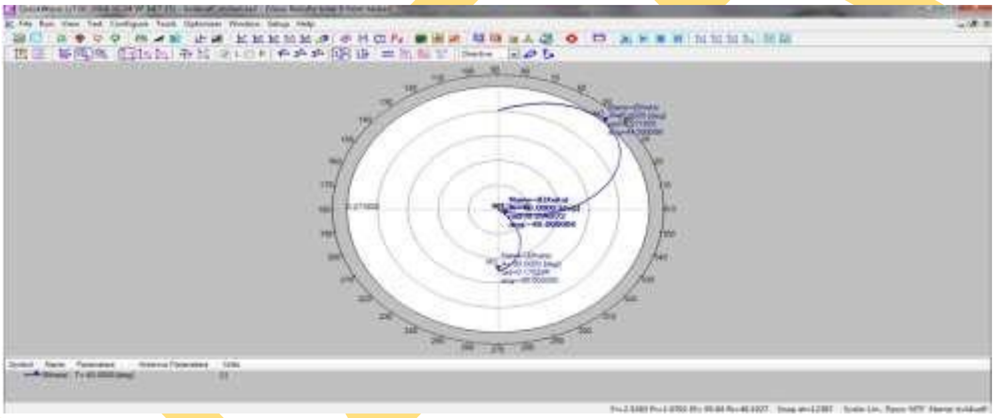

Fig (12) Polar results (at $\Phi=0^0$) line form

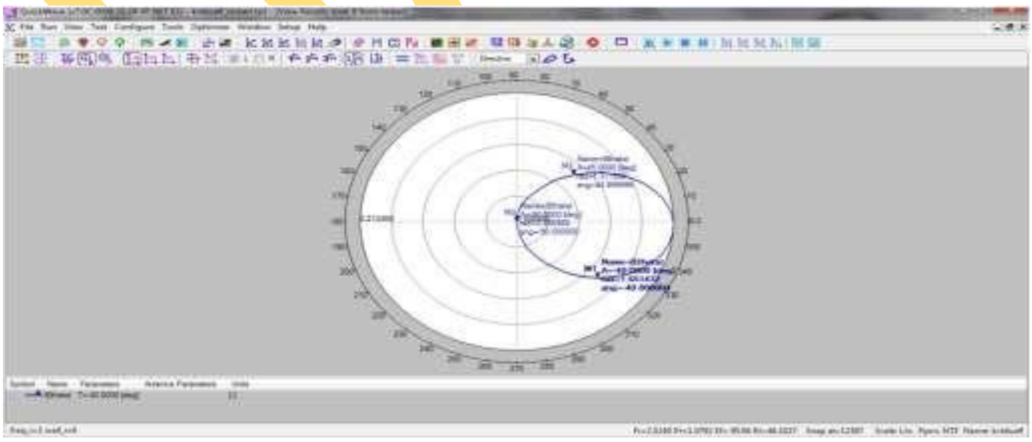

Fig (13) Polar results (at $\Phi=90^0$) line form

5.5 Field distributions:

Electric and magnetic field distributions in X, Y, Z axis has been shown in Fig (14) and Fig (15). E-field distribution is found to be $3.346613e^{-03}$and H-field distribution is found to be $3.064786e^{-02}$

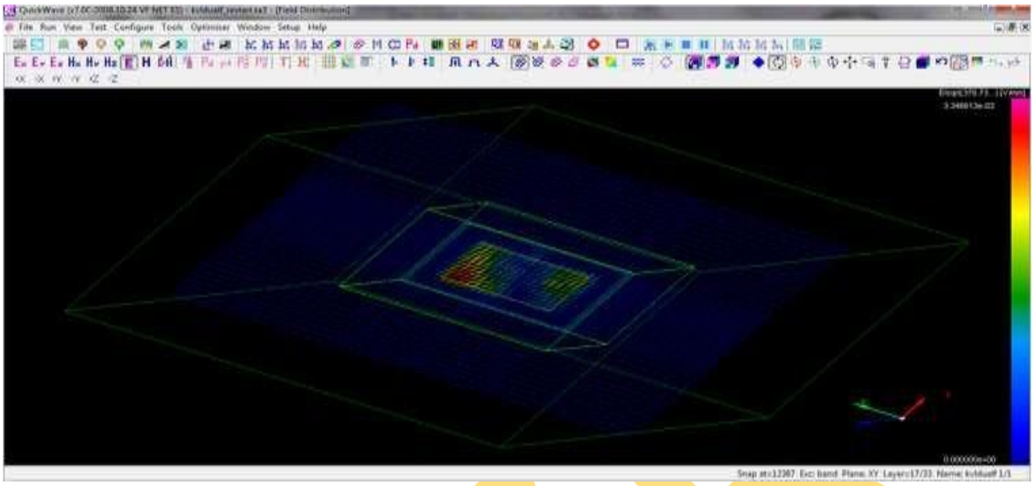

Fig (14) Total E-Field distribution

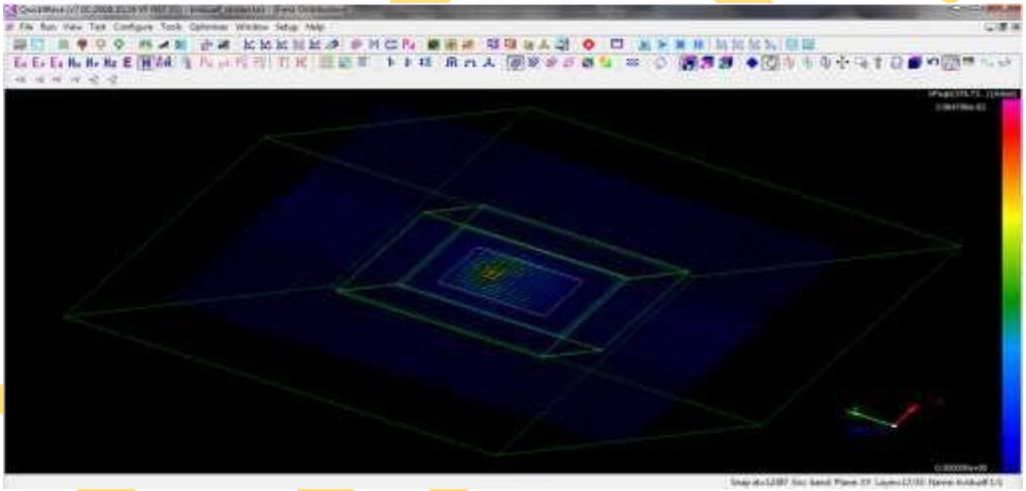

Fig (15) Total H-Field distribution

5.6 current distributions in linear and log form:

Fig (16) and Fig (17) shows the current distribution over 2 to 3.5 GHZ range in linear form and log form respectively.

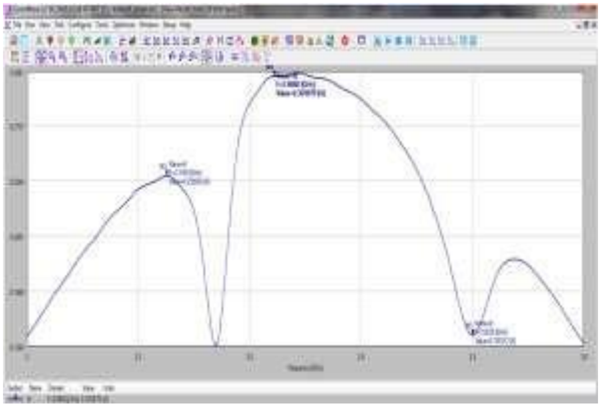

Fig (16) current distribution in line form

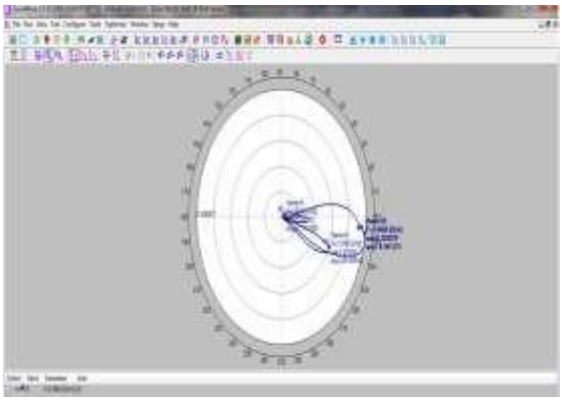

Fig (17) current distribution in log form

5.7 Quality factor and energy:

Electric field energy, magnetic field energy and total filed energy from the proposed antenna are calculated by CONCERTO and same is presented in Fig (18).The quality factor is the additional parameter that can observed in Fig (18) which can able to specify the quality of the designed antenna.

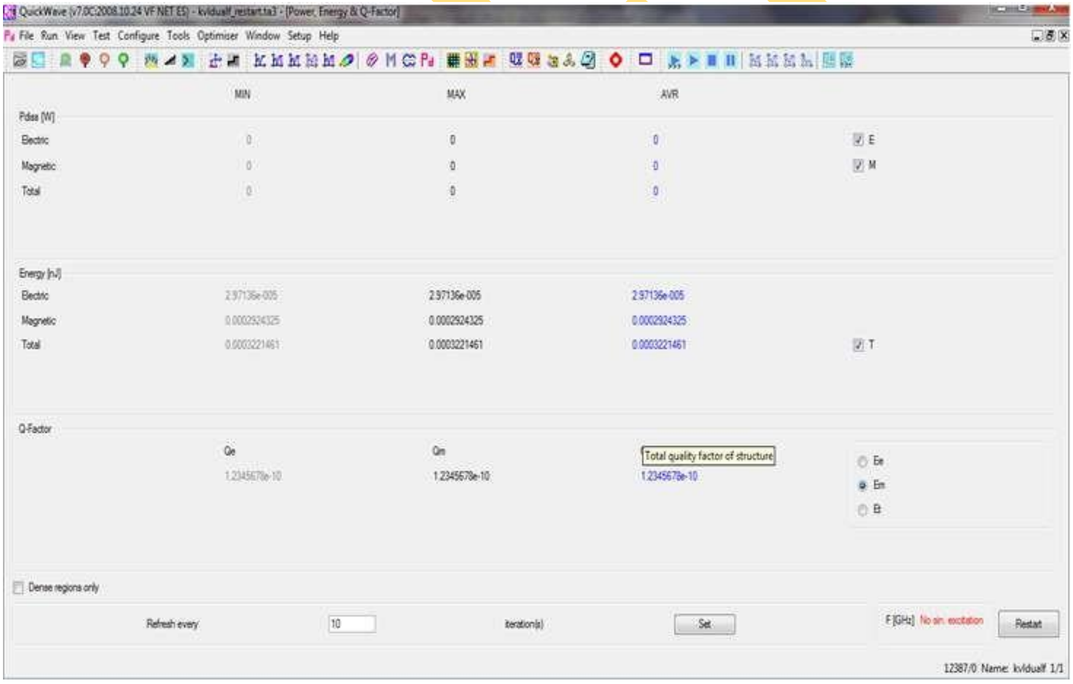

Fig (18) Quality factor and energy: Electric filed energy 2.97e^{-005} magnetic field power 0.0002924325, total 0.0003221461, Q-factor-1.23456e^{-10}

6. CONCLUSIONS:

Single frequency operation of rectangular patch antenna with single feed at different feed locations has been investigated. The Rectangular microstrip patch antenna(RMSA) with RT-duroid as a substrate with orthogonal feed resonates at 2.524GHz and 3.222GHz .The antenna has gain 6.9 dB and 7.89dB at two frequencies respectively and the measured return loss is -33.3dB at 2.524GHz and -12.8dB at 3.222GHz.

7. ACKNOWLEDGEMENT:

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