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3D DESIGN AND COMPARISON OF DUAL BAND FREQUENCY MICROSTRIP PATCH ANTENNA

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Abstract:

This paper presents design of Z shape, E shape, H shape dual band frequency antennas. The aim of this paper is to improve the bandwidth, gain and return loss. The main features of these antennas are compact dimensions and operating frequency is 0.6GHZ to 2 GHZ. The impedance increased with the combined design on RT-Duroid 5880 and ground plan. The properties of antenna such as band width, return loss, VSWR, gain has been obtained and compared between these dual band frequency antennas using HFSS.

Key Words: Z Shape Antenna, E Shape Antenna, H Shape Antenna, HFSS, VSWR & Return Loss.

1. Introduction:

Microstrip antennas are designed to have many geometrical shapes and dimensions but rectangular and circular microstrip patches have been used in many application. The microstrip patch is preferred antenna structures for low cost, low profile, light weight, conformal shaping, high efficiency and compact design for the wireless system. These antennas are popular for low profile applications at frequency above 100 MHz [8]. A microstrip patch antenna in its simplest form consists of a radiating patch on one side of a dielectric substrate and a ground plane on the other side [1]. It consists of a flat rectangular sheet or "patch" of metal, mounted over a larger sheet of metal called a ground plane [7].The rectangular microstrip patch antenna is made of a rectangular patch with dimensions width (W) and length (L) over a ground plane with a substrate thickness (h).

The purpose of new design antenna presents to enhance the bandwidth of double slotted H shape MSP antenna for many broadband applications such as military, wireless communication, satellite communication, global positioning system (GPS), RF devices, WLAN/WI -MAX application [8]. The major drawbacks of MSP antennas in basic form are narrow bandwidth and low gain [7] and many techniques are used to enhance bandwidth and gain of MSP patch antennas. By using thick substrate with low dialectic constant and compact slotted patch can enhance the bandwidth and gain of antennas. The MSP antenna have good features such as low cost, low profile, light weight, high efficiency, simply manufacture and easy to implement with circuits [8].The design structure components of antenna become small in size and have low processing cost [11]. In this paper transmission line method are used to analysis the rectangular MSP antenna. The design resonant frequency of rectangular MSP antenna is 2.5GHz with 50Ω microstrip line feed. MSP antenna is characterized by using thickness (h), dialectic constant (εr), and length (Lg, L), width (Wg, W) of ground plane and patch. The performances of design MSP antenna such as radiation pattern, return loss, directivity, VSWR and gain are simulated by using HFSS software.

2. Related Work:

In this paper a compact size Z shaped antenna has been designed having good impedance matching as well as high antenna; efficiency of about 95% is achieved. The proposed antenna has larger impedance bandwidth of 43.578% covering the frequency range from 1.696 GHz to 2.646 GHz which is suitable for PCS-1900, GSM and WLAN (802.11b) applications. Obviously there are some limitations of Z shape antenna some of them are listed below:

- Its effective dielectric constant is lower.
- Layout is very compact.
- Shunt element is quite low.

The antenna's resonant properties were predicted and optimized using High Structure simulation software Ansoft version 11. The design procedure begins with determining the length, width and the type of dielectric substance for the given operating frequency. Then using the measurements obtained above simulation has been setup for the basic rectangular micro strip antenna and the parameters are optimized for the best impedance matching. Furthermore two parallel slots are incorporated and optimized such that it closely resembles E shape; this increases the gain of the antenna. After that two more parallel slots and one perpendicular slot are incorporated and optimized such that it closely resembles U shape. Then dielectric substrate of dielectric constant of 1.0006 introduces to decrease the size of the antenna and to further enhance the bandwidth. At last the probe feeding is introduced for attaining a required bandwidth, resonating frequency and gain value.

The antenna is made of a single patch on top, one layers of dielectric (air) and a vertical probe connected from ground to the upper patch. The main E shaped patch has Wa x La dimension while the outer patch has Wb x Lb dimension. The antenna is fed by a SMA connector positioned at the center arm. The center of probe is positioned at (Wc/2,Lf). The H-shaped microstrip antenna [8] consists of an H shaped patch; supported on a grounded dielectric sheet of thickness h and dielectric constant εr. An H-shaped microstrip patch antenna, shown in figure 6 is obtained by cutting equal rectangular slots along both the non radiating edges of the rectangular MSA. The H-shaped patch antenna [8] reported here has a size about half that of the rectangular patch, with larger bandwidth. The H-shaped microstrip patch antenna, because of its considerably smaller size, could replace the rectangular patch at UHF frequencies. When they are applied in the frequency range below 2 GHz, the sizes of conventional rectangular microstrip patches seem to be too large.

3. Simulation Results:

3.1 Return Loss:

The radiation field of the micro strip antenna may be determined using either an electric current model or a magnetic current model. In the electric current model, the current is used directly to find the far-field radiation pattern. The electric current for the (1,0) patch mode. If the substrate is neglected (replaced by air) for the calculation of the radiation pattern, the pattern may be found directly from image theory. If the substrate is accounted for, and is assumed infinite, the reciprocity method may be used to determine the far-field pattern. In the magnetic current model, the equivalence principle is used to replace the patch by a magnetic surface current that flows on the perimeter of the patch.

Return loss versus frequency plot of Z shape, E shape & H shape Rectangular Microstrip Patch Antennas are shown in figure 1, figure 2 & figure3 respectively.

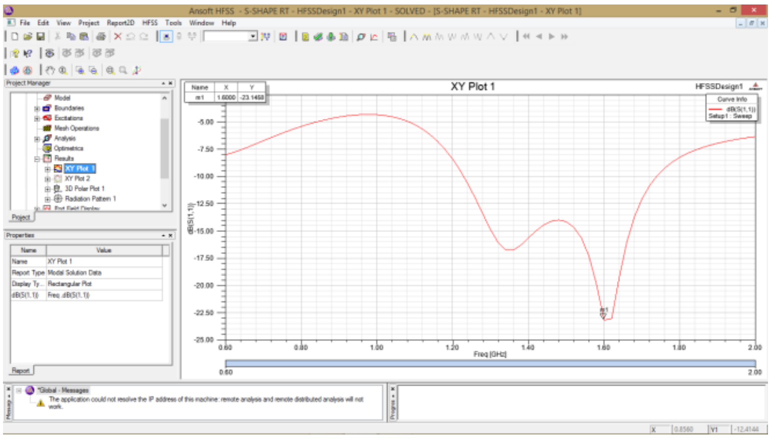

Figure 1: Return loss of Z shape dual band frequency antenna

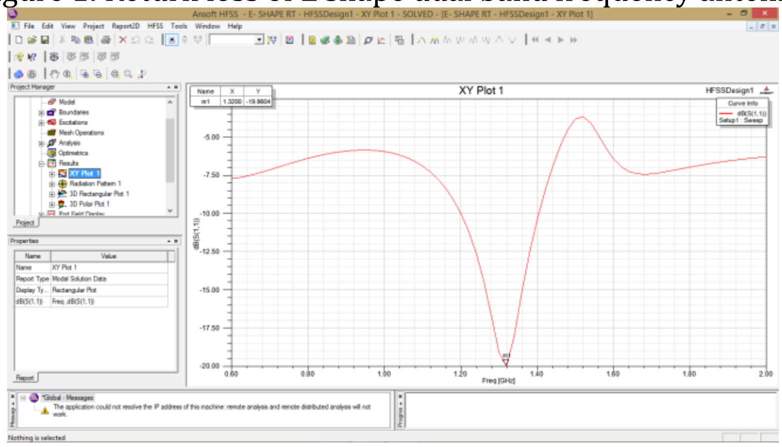

Figure 2: Return loss of E shape dual band frequency antenna

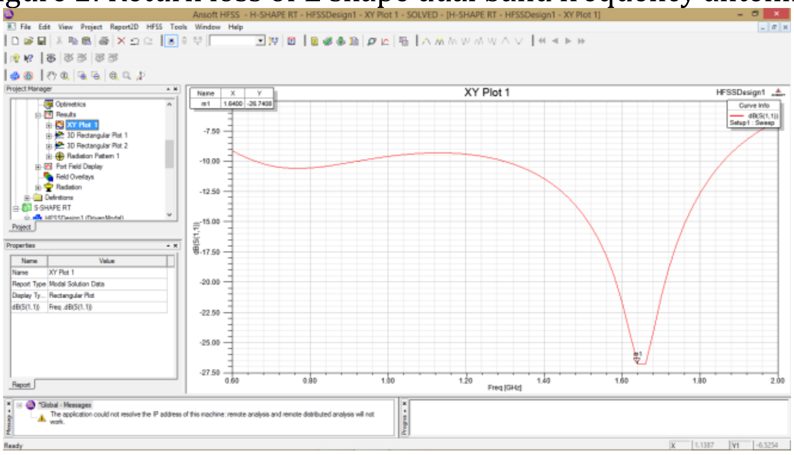

Figure 3: Return loss of H shape dual band frequency antenna

3.2 Gain:

Another useful measure describing the performance of an antenna is the gain. Although the gain of the antenna is closely related to the directivity, it is a measure that takes into account the efficiency of the antenna as well as its directional capabilities. Remember that directivity is a measure that describes only the directional properties of the antenna, and it is therefore controlled only by the pattern. Gain of an antenna (in a given direction) is defined as "the ratio of the intensity, in a given direction, to the radiation intensity that would be obtained if the power accepted by the antenna were radiated isotropically. The radiation intensity corresponding to the isotropically radiated power is equal to the power accepted (input) by the antenna divided by 4π."Three dimension radiation pattern of H shape, E shape & Z shape slotted dual band frequency Microstrip Patch Antennas at 2.4GHz are shown in figure 6, 7 & 8 respectively. From Figure 6 it is clear that H- slot Rectangular Microstrip Patch Antenna has a gain of 9.6dB, figure 7 is E shape antenna has a gain9.58dB, on the other hand Z slot Rectangular Microstrip Patch Antenna has a gain of 7.46dB.

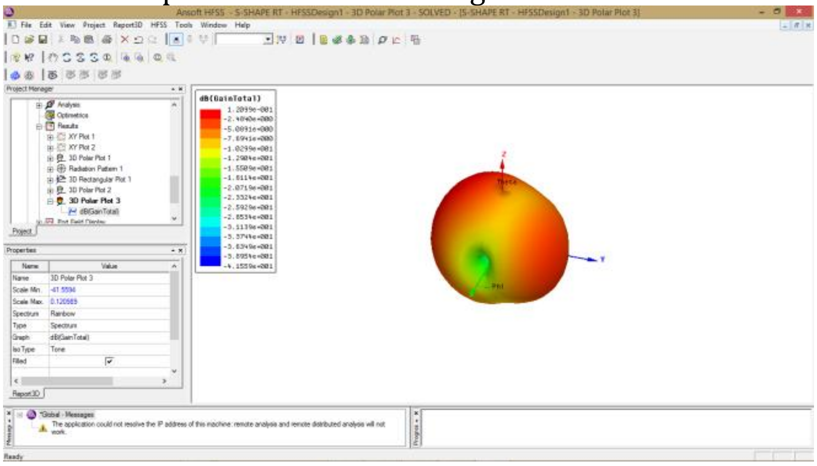

Figure 4: 3D gain of Z shape dual band frequency antenna

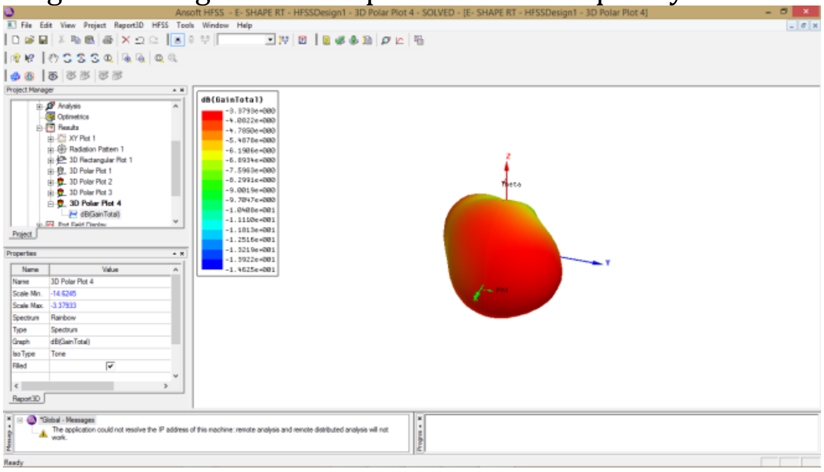

Figure 5: 3D gain of E shape dual band frequency antenna

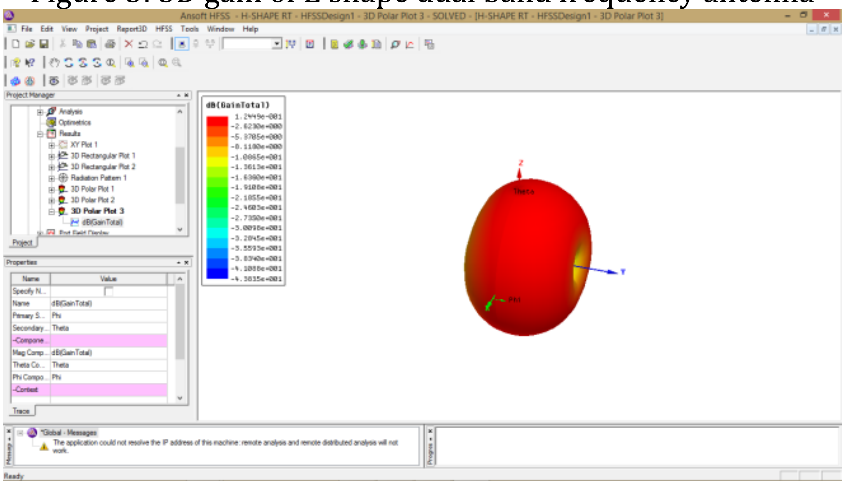

Figure 6: 3D gain of H shape dual band frequency antenna

Table 1: Performance parameters of H shape, E shape & Z shape dual band frequency Rectangular Microstrip Patch Antennas at 2.4 GHz.

PARAMETR	Z- MPA	E- MPA	H- MPA
Length	100mm	100mm	100mm
Width(mm)	75mm	75mm	75mm

Substrate	RT-Duroid 5880	RT-Duroid 5880	RT-Duroid 5880
Gain(dB)	7.46dB	9.58dB	9.6dB
Return loss(dB)	-23.5dB	-19.5dB	-26.7dB

4. Conclusion:

In this paper, the dual band frequency antennas such as Z shape, E shape, H shape antennas are designed. The properties of antennas such as band width, gain, and return loss are obtained and compared. The obtain good performance results of design antenna can be used as various broadband applications such as missile, wireless, satellite, mobile communication, and military purpose.

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