COMPARISON BETWEEN E-SHAPE ANTENNA FOR SINGLE AND DUAL BAND ANTENNA

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***Abstract*—-** The modern microwave communication system demands good antenna performance with variety of application. One antenna should serve the purpose of many antennas to reduce the resource cost and installation cost. For this reason the concept of dual band antenna arises. In this paper the attention has been given towards the design of a dual band antenna. In this paper a modified E-shaped compact size probe-feed micro-strip antenna is proposed for dual band operation in C-band and X-band with increased bandwidth. the return loss value at the resonant frequency fr = 5.40 GHz is -46.92 dB. A dual band E-shaped Micro-strip patch antenna has been designed for high-speed wireless local area networks (IEEE 802.11a standard) and other wireless communication systems covering 4.97GHz to 5.37GHz and 5.72GHz–5.86 GHz frequency bands.

Keywords: E-Shape Antenna, Return Loss,

I. INTRODUCTION:

Micro-strip patch antennas have been used for many applications, such as Direct Broadcasting Satellite (DBS) systems, mobile communications, Global Positioning System (GPS) and various radar systems [1]. Their advantages include low profile, light weight, low cost, ease of fabrication and integration with RF devices, etc.

They can also be made conformal to mounting structures [2]. However, when they are applied in the frequency range below 2GHz, the sizes of conventional rectangular micro-strip patches seem to be too large, which makes it difficult for them to be installed on televisions, notebook computers or other hand-held terminals, etc.

S. Sharma reported that connected E and U shaped micro-strip antenna structure is designed for dual frequency wideband is proposed at a height of 3.5mm from the ground plane. Rectangular micro-strip patch antenna along with the proposed structure is designed to resonate at two frequencies 12.48GHz and 10.40GHz, which exhibits -13.10dB and -10.93dB return loss at operating frequency and has impedance bandwidth from 1.933 to 1.958GHz

Several techniques have thus been proposed to reduce the sizes of conventional half-wavelength micro-strip patch antennas. Material of high dielectric constant has been used. However, this will lead to high cost and high loss. Also, poor efficiency due to surface wave excitation is another drawback of this method.

A dual band E-shaped micro-strip patch antenna has been designed for high-speed wireless local area networks (IEEE 802.11a standard) and other wireless communication systems covering 4.97GHz to 5.37GHz and 5.72GHz–5.86 GHz frequency bands. Two parallel slots are incorporated to perturb the surface current path, introducing local inductive effect that is responsible for the excitation of the second resonant mode.

The length of the centre arm can be trimmed to tune the frequency of the second resonant mode without affecting the fundamental resonant mode.

A comprehensive parametric study has been carried out to understand the effects of various dimensional parameters and to optimize the performance of the antenna.

A substrate of low dielectric constant is selected to obtain a compact radiating structure that meets the demanding bandwidth specification. The reflection coefficient at the input of the optimized E-shaped Microstrip patch antenna is below −10 dB over the entire frequency band.

For the E-shaped patch antenna, two parallel slots are incorporated to introduce a second resonant mode, resulting in a dual band antenna. If the feed point is located at the tip of the centre arm as in [3–6], the second resonant mode will be introduced at a lower frequency than the fundamental resonant mode.

If the feed point is moved to the base of the center arm [7], the second resonant mode will be introduced at a higher frequency than the fundamental resonant mode.

Dual band antenna (MIMO) can be used for LTE band (0.746 – 0.787 GHz) and the M-Wi MAX (2.5 – 2.69 GHz). It consists of two identical elements, each of which is 15 × 13.25 mm^2.

The minimum separation between two elements is 0.5 mm [14]. Novel coplanar waveguide fed planar monopole antenna with dual-band operation for Wi-Fi and 4G LTE. It's operating bands consists of 2.3 – 3.0 GHZ, 4.7 to 5.9 GHz are achieved by carefully optimizing the position and size of a smiling slot.

The width of the micro strip patch antenna was computed with t he following equation:

$$W = \frac{c}{2f_o\sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

where c is the speed of light (3x108 m/s), fr is the operating frequency of 3.6 GHz and Er is the dielectric permittivity of 4.28.
The length of micro strip patch antenna is given by the following equations:

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

where E_{reff} is the effective dielectric constant and h is the thickness of the dielectric substrate.

$$L_{eff} = \frac{c}{2 f_o \sqrt{\varepsilon_{reff}}}$$

$$\Delta L = 0.412h \frac{\left(\varepsilon_{reff} + 0.3\right)\left(\frac{W}{h} + 0.264\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{W}{h} + 0.8\right)}$$

In the equation above ΔL stands for length extension.
Therefore, the actual length of the micro strip patch antenna is given by:

$$L_{eff} = L + 2\Delta L$$

Hence, For the Resonance frequency f=3.6 GHz the patch dimension are **W= 25.4 and L= 18.3.**

Calculation of the Length Extension (ΔL)

The extended length of the patch is given by, as expressed in [7]
$\Delta L = 0.412h(\varepsilon_{reff} + 0.3)(W/h + 0.264)/((\varepsilon_{reff} - 0.258)(W/h + 0.8))$ ………..(3)

The extended length of patch was calculated by using (3) ΔL=.5 mm.

Calculation of the Effective length (Leff)

The effective length of patch is given by, as expressed in [7]

$L_{eff} = c/(2f_o\sqrt{(\varepsilon_{reff})})$ ……………..(4)
The effective length of patch was calculated by using (4)
L_{eff} =12.6 mm.

Calculation of the resonant length of patch (L)

The actual length of the patch is given by, as expressed in [7]

L = Leff – 2 ΔL …………(5)
This comes out to be 12.0mm.

Now, for **MULTIBAND** Application we use parasitic element with the width = 2mm and gap b/w patch and resonators is 0.1mm and the length is respectively 17, 19mm.

The antenna geometry is shown in Figure 2 & 3. First, a rectangular micro-strip patch antenna is designed based on the standard design procedure to determine the length (L) and width (W) for resonant frequency at 5.25 GHz.

It is fed by a coaxial probe at position (x_o, y_o). Two parallel slots are incorporated to perturb the surface current path, introducing local inductive effect that is responsible for the excitation of a second resonant mode. The slot length (Ls), slot width (Ws), and the center arm dimensions (Wt and Lt) of the E-shaped patch control the frequency of the second resonant mode and the achievable bandwidth.

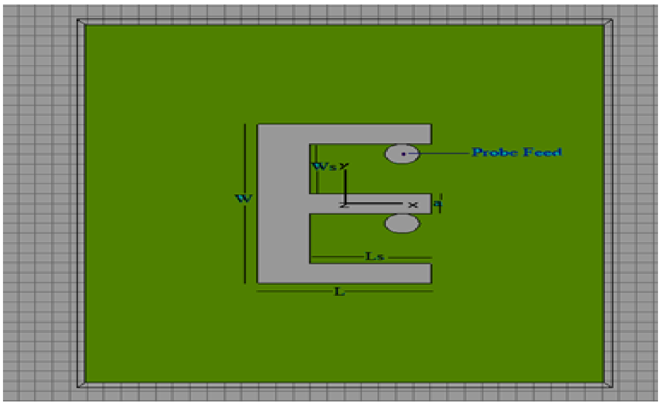

Figure 1. Geometry of E-Shaped Patch Antenna

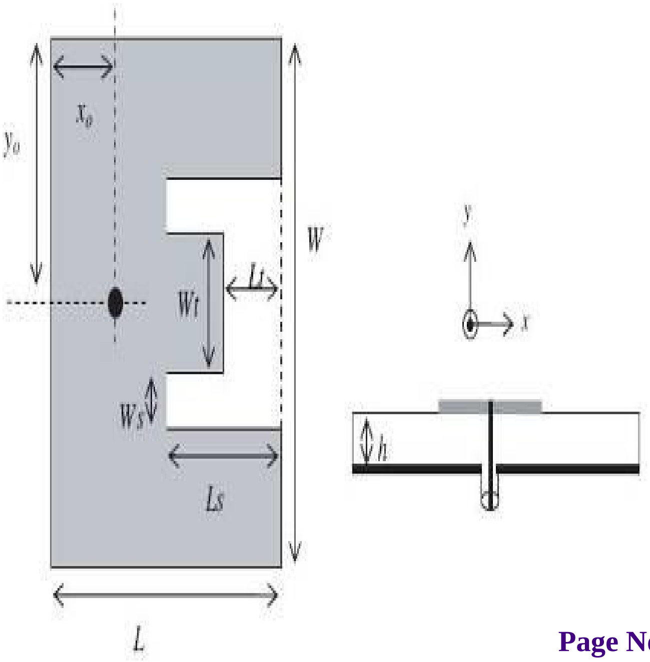

Figure 2: Geometry of E-Shaped Micrpstrip Patch Antenna.

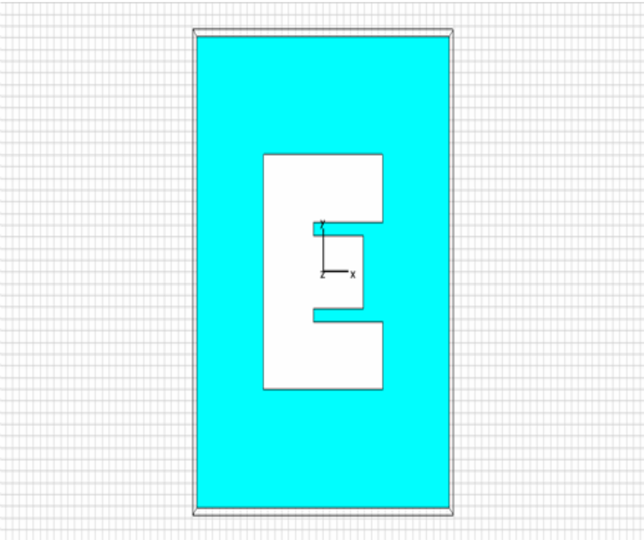

Figure 3: Front View of Designed Antenna on CST Microwave Studio

Table 1. Dimensions of E-Shaped Patch Antenna

L(in mm)	W(in mm)	Ls(in mm)	Ws(in mm)	a(in mm)	h(in mm)
10	16	7	5	2	6

Table 2. Dual Band Antenna Dimensions

L(mm)	W(mm)	h(mm)	ε_r	W_t(mm)	L_t(mm)	W_s(mm)	L_s(mm)
17.2	20	3.2	2.2	6.2	2.8	1.12	10

Figure 4: Design of E-Shape Antenna

Figure 5: Calculation Parameter of E-Shape Antenna

Results

The return loss of slot loaded patch antenna is shown in figure 3. It resonates at 5.40 GHz frequency. The resonant frequency gives the measures of impedance bandwidth characteristics of the patch antenna. The impedance bandwidth for the proposed antenna is 3.06GHz (from 3.68GHz to 6.74GHz). From the figure 3 the return loss value at the resonant frequency fr = 5.40 GHz is -46.92 dB. The achieved value of return loss is small enough.

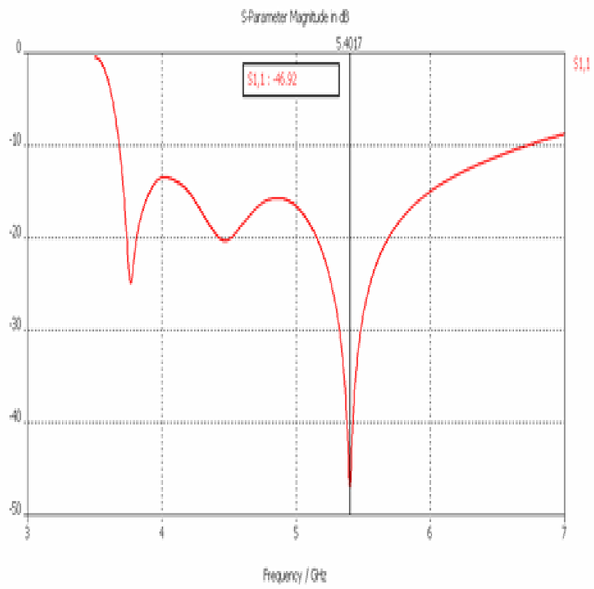

Figure 6. Simulated Return Loss for E Shaped Patch Antenna

The bandwidth of antenna can be said to those range of frequency over which RL is greater than -9.5dB. The three frequency are 3.6, 4.9, 6.4 GHz.

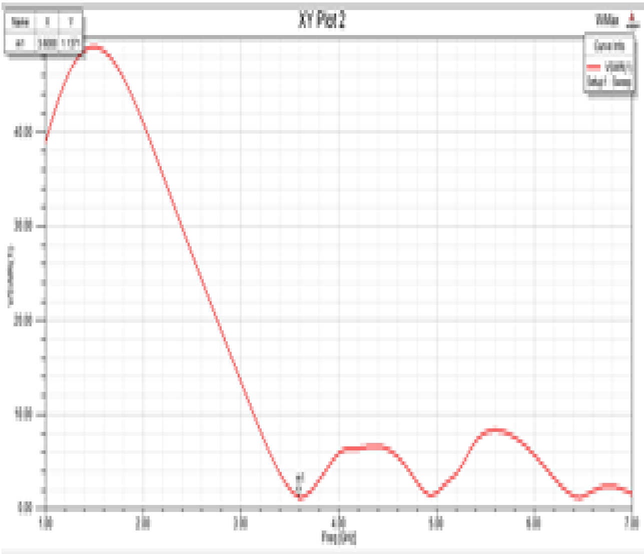

Figure 7 VSWR curve

Effects of Variation in L_s

The slot length L_s is varied from 9.6mm to 10.4mm. On increasing the slot length, return loss parameter improves but does not affect on resonating frequency significantly. While the second resonating mode decreases.

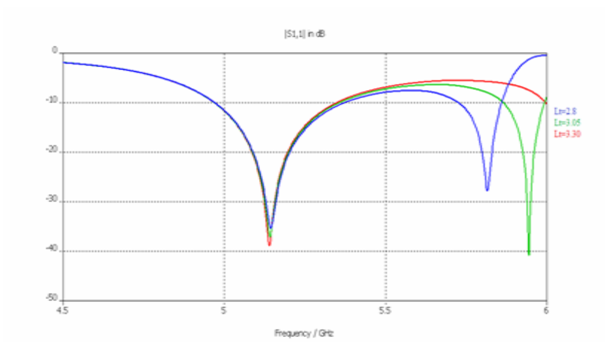

Figure 8. Simulated Return Loss for Various Ls

Figure 8. Simulated Return Loss for Various Ls.

Effects of Variation in Ws

The slot width W_s is varied from 0.5mm to 1.12mm. The wider is slot, the resonant frequency of second order resonating frequency decreases with wider slot. The fundamental resonating frequency is also affected. As we increase the slot width, the return loss parameter improves.

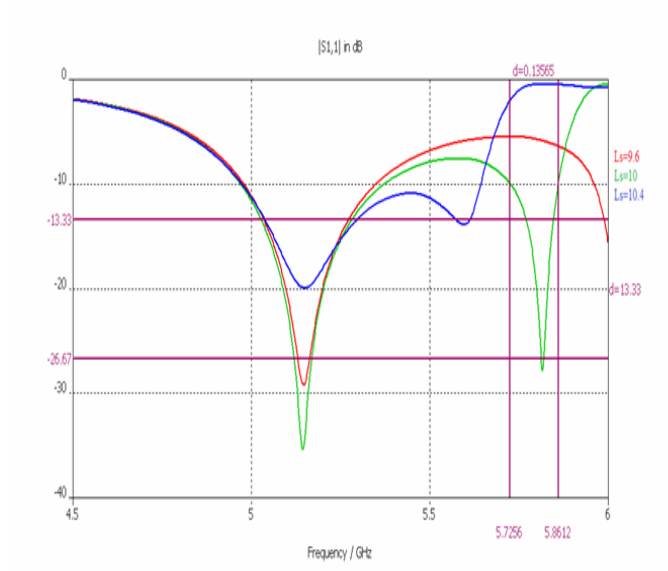

Figure 9 Simulated Return Loss for Various Ws

Effect of Variation in L_t

As the centre arm length (Lt) increases, frequency of the second resonant mode increases as shown in figure . The center arm slot length Lt does not affect significantly on fundamental resonating mode frequency.

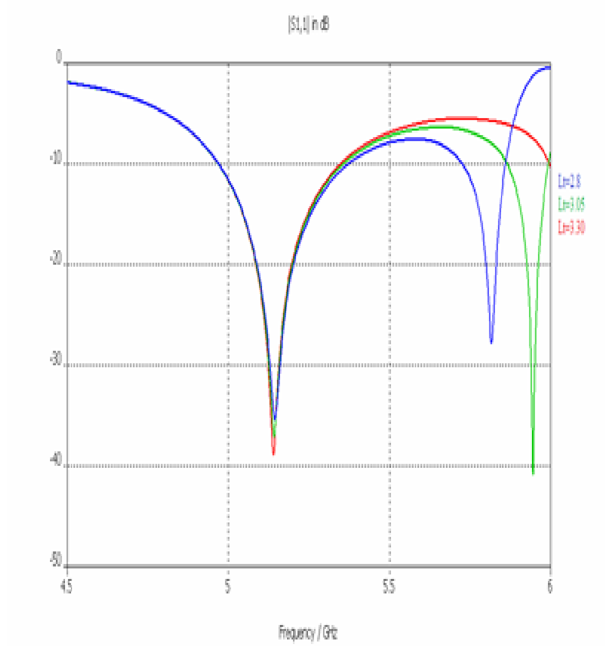

Figure 10. Simulation Return Loss for Various Lt

Effect of Centre Arm Slot Width W_t

Wi ... nd
reson ... urn
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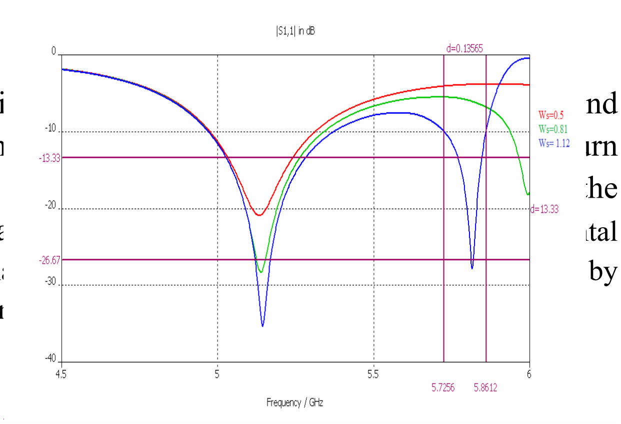


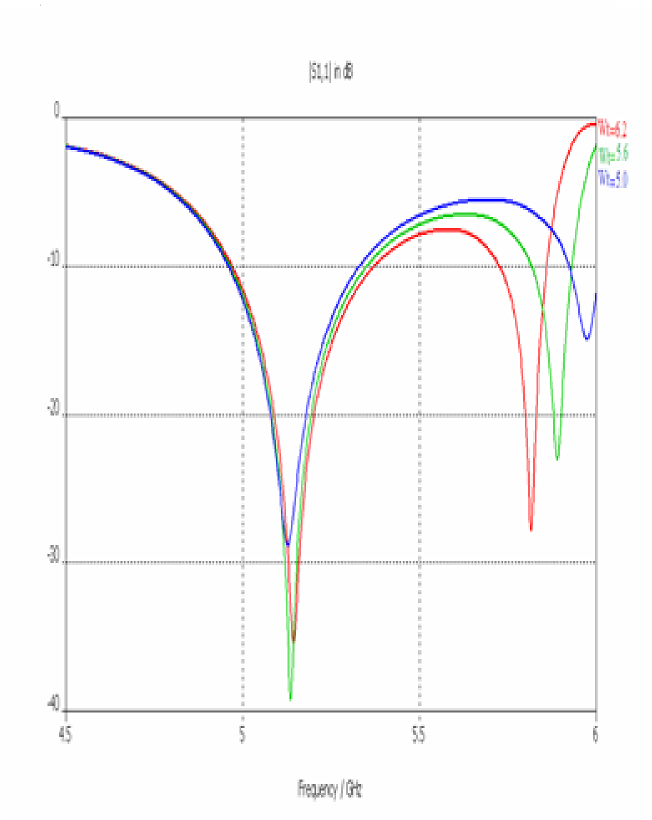


Figure 11. Simulated Return Loss for Various Wt

Figure 11 shows the impedance loci of the proposed patch antenna

Z Parameter Plot

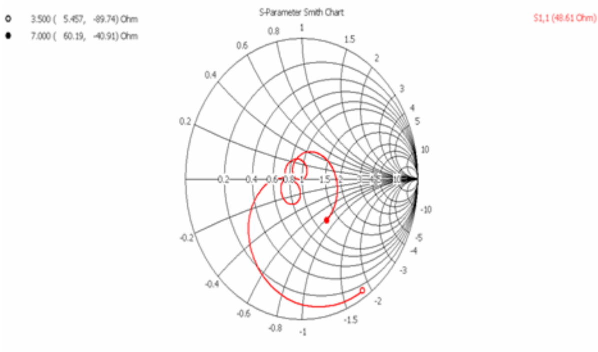


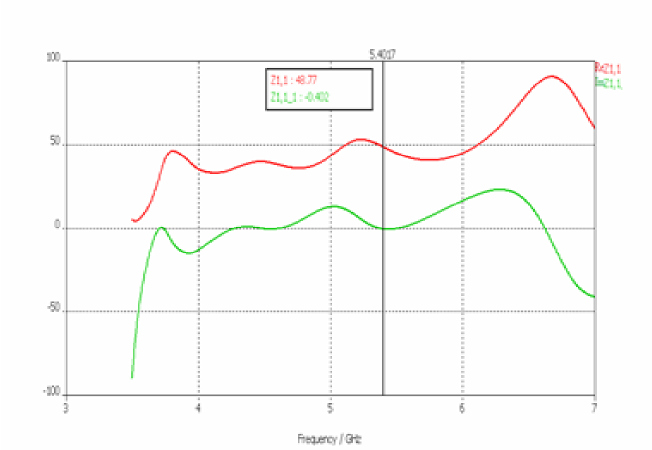
Figure 12. Shows the impedance loci of the proposed patch antenna

Based upon the above parametric study, the optimum value is selected for various parameters as mentioned in Table 2. The simulation results of E slotted patch antenna are shown in figure 12.

Figure 13. shows that the proposed patch antenna is resonating on two frequencies: 5.14GHz and 5.81GHz with return loss of -35dB and -27dB respectively.

This slotted antenna is operating in two bands viz band 1 (4.97GHz to 5.37GHz) and band 2 (5.72GHz–5.86GHz). These bands are suitable for WLAN applications.

Figure 11 shows the input impedance plot of patch antenna. This plot indicates that the antenna impedance is almost real at the resonating frequency.



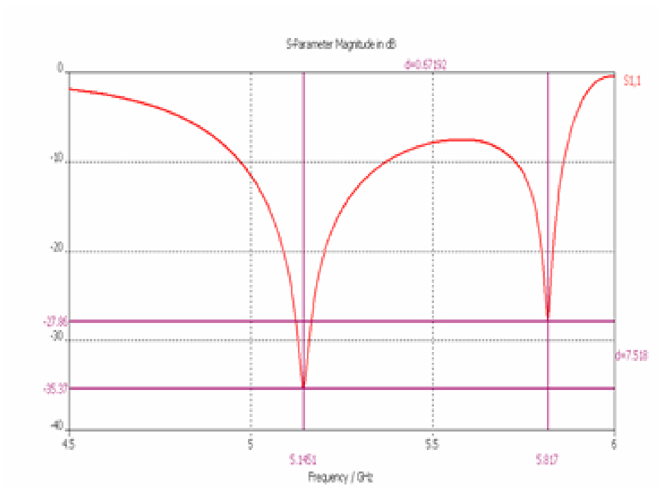


Figure 13 Simulated Return Loss

The smith chart is shown in figure 13 & 14. This chart indicates the be-haviour of antenna impedance with frequency. The antenna impedance is almost real at both resonating frequencies.

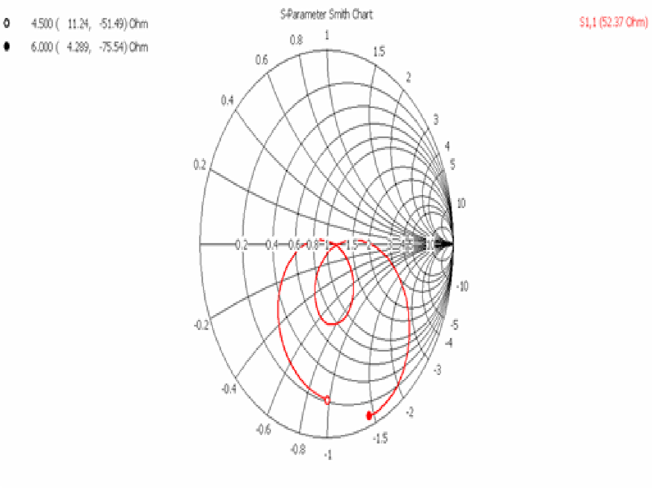


Figure 14. Smith Chart Results of E-Shape Antenna

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