

E-Shaped Wide Band Microstrip Array Antenna for Wireless Communication Systems

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ABSTRACT: A novel idea for improvement of bandwidth in microstrip antenna is explained in this paper. The initiation of E-shaped microstrip patch antenna enhances the bandwidth by 13% in comparison to rectangular antenna of 3.6% at 8-9GHz frequency. The recommended antenna offers a significant amount of return loss i.e. S_{11} characteristics and impedance performance. The design constant of antenna comprises single layer thickness of 2mm along with functioning frequency of 2.5 GHz. The design was optimized to attain the excellent probable outcome. The positive features of choosing E-shape antenna from other antennas is because of its low volume, low profile planar configuration, easiness in mounting, light weight and less fabrication cost. The main functions of this antenna incorporate remote sensing, biomedical application, mobile radio satellite and wireless communication. To conclude, the functioning of the designed antenna was examined in term of gain, return loss, VSWR, and radiation pattern.

KEYWORDS: E-shaped Antenna, Wireless Communication, IE3D.

I. INTRODUCTION

Microstrip patch antenna is very important for wireless communication ever since it was first shown in the year of 1886 by Heinrich Hertz and its practical appliance by Guglielmo Marconi in 1901. Microstrip patch antenna have been famous for its benefits like light weight, low fabrication cost, mechanically tough when mounted on firm surfaces and ability of dual and triple frequency performances. Nevertheless, narrow bandwidth is one of the main drawbacks for this kind of antenna. Various methods have been implemented to conquer this problem such as enhancing the substrate thickness, establishing parasitic elements i.e. co-planar or stack configuration, or by adjusting the patch's shape itself. Amending patch's shape occupies designing an E-shaped patch antenna by cutting two slots from a rectangular shape. This occurrence effects in improvement of bandwidth, gain and return loss of the antenna [3]. In comparison to the U-slot microstrip patch antenna, the E-shaped patch antenna is easy to construct.

The E-shaped patch is climbed on the top of the dielectric sheet and the dielectric sheet is positioned on a ground plane. Wireless Sensor Network (WSN) consists of spatially disseminated independent sensors to observe physical or environmental situations, for example temperature, sound, vibration, pressure, motion or pollutants and to considerably pass their data throughout the network to a major location. Nowadays such networks are utilized in several industrial and consumer applications, for example industrial process monitoring and control, machine health monitoring, environment and habitat monitoring, healthcare applications, and home automation [1]. Because of the increasing requirements in wireless communication system applications, microstrip patch antennas fascinates a lot of importance because of their low profile, light weight, contented to planar and nonplanar surfaces, simple and inexpensive to construct by means of modern printed circuit technology, mechanically robust when mounted on rigid surfaces, similar with MMIC designs. When specific shape and mode are chosen, they give versatility in terms of its frequency, polarization, pattern and impedance [6].

II. ANTENNA CONFIGURATION

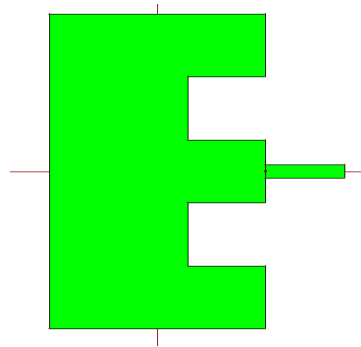


Fig.1(a) Geometry of E-shape Antenna

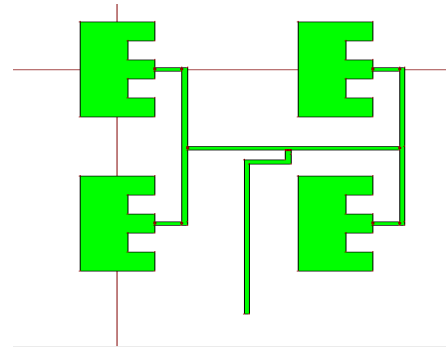


Fig.1(b) E-shape Antenna Array

The antenna geometry demonstrated in Fig.1(a) has only one patch, which is easier than conventional broad-band microstrip antennas. The antenna is devised with the help of edge feed to resonate at frequency of 2.4 GHz. The patch is accumulated on a glass substrate with comparative permittivity, $\epsilon_r = 2.2$. Here length of patch and height of patch are 27.4mm and 2mm respectively. The antenna shown above in Fig.1(b) includes the sub - array designing of E- Shaped antenna where four same ingredients are built to construct a 2x2 sub array. The feeding strip is tied with another vertical strip that goes through an air layer associating a 50 Ohm microstrip feed line on a ground substrate.

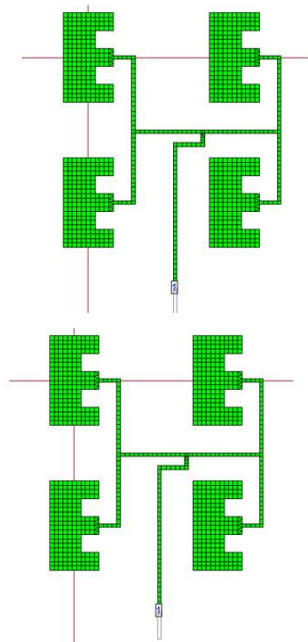


Fig.1 (c) Meshed Patch of E-shape Antenna Array

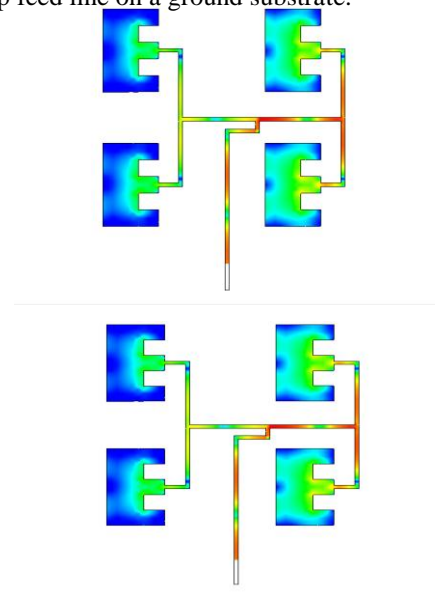


Fig.1 (d) Current Density of E-shape Array

Fig. 1 (c) shows the star shaped antenna at 2.4 GHz frequency with 40 cells per wavelength which looks like a meshed structure. It is done in order to progress the bandwidth and decrease the cross polarization of the antenna measurements of gain. The figure presented in Fig.1 (d) depicts the current distribution performance of E-Shape patch at 2.4 GHz excitation. The important alterations in radiation pattern of arrays can be obtained by altering current distribution array

of the antenna, including phase delay among elements, variation in the radiation features of distinctive radiating structure in an array, modification in the geometry of the array and by altering the inter-element spacing.

III. DESIGN SPECIFICATIONS

A. 1. Calculation of patch width (w) of determined by the formula

$$w = \frac{v_0}{2f_r} \sqrt{\frac{2}{\epsilon_r + 1}} \quad (1)$$

Where, v_0 = speed of light in free space, ϵ_r =dielectric constant of patch.

2. Calculation of effective dielectric constant ϵ_{reff} computed by the formula

$$\epsilon_{reff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[1 + 12 \frac{h}{w} \right]^{-\frac{1}{2}} \quad (2)$$

Here, h and w denote the height of the patch, width of the patch respectively.

3. Determination of increment of patch length (Δl) computed by the formula

$$\Delta l = 0.412 \frac{(\epsilon_{reff} + 0.3) \left(\frac{w}{h} + 0.264 \right)}{(\epsilon_{reff} - 0.258) \left(\frac{w}{h} + 0.8 \right)} \quad (3)$$

4. Calculation of patch length (l) computed by the formula

$$l = \frac{1}{2f_r \sqrt{\epsilon_{reff}} \sqrt{\mu_0 \epsilon_0}} - 2\Delta l \quad (4)$$

Here, f_r , ϵ_{reff} , μ_0 , ϵ_0 signify the resonant frequency of antenna, effective dielectric constant The essential parameters for the design of E-Shape Microstrip Patch Antenna Array are as follows $f=2.4$ GHz, $\epsilon_r = 2.2$, $h=2$ mm.

Calculating the design parameters we get $w=4.94$ cm, $\epsilon_{reff} = 1.84$, $\Delta l= 0.931$ cm, $l=2.74$ cm.

IV. PERFORMANCE EVALUATION

The graph in Fig. 2 (a) demonstrates the Return loss acquired at 2.5 GHz frequency which is less than -10dB approximately -11 dB. Return loss is associated to both standing wave ratio (SWR) and reflection coefficient (Γ). It is a measure of how fine devices or lines are matched. Fig. 2 (b) shows the VSWR (Voltage Standing Wave Ratio) of the antenna acquired at 2.5 GHz about 1.2. VSWR is a measure of how much power is conveyed to an antenna. The VSWR is also a calculation of how nearly the source and load impedance are corresponded.

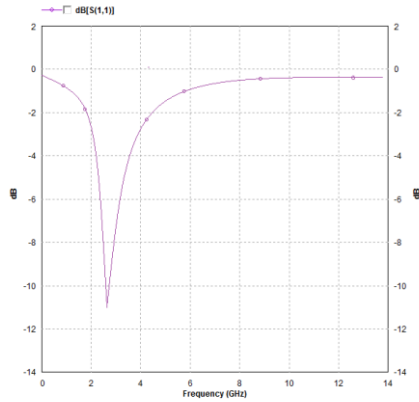


Fig. 2 (a) Return Loss characteristics of E-shape Antenna Array

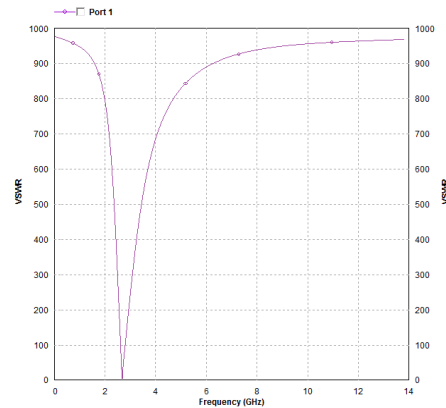


Fig. 2 (b) VSWR characteristics of E-shape Antenna

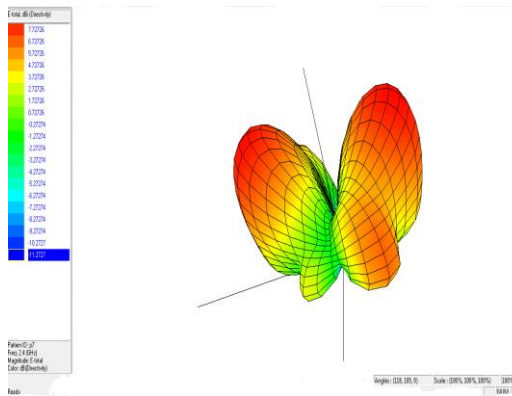


Fig.2(c) 3-D Directivity Pattern for E-shape Antenna Array

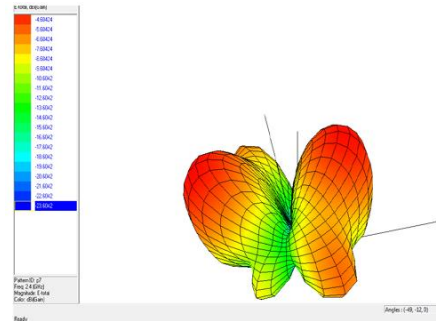


Fig.2 (d) 3-D Gain Pattern for E-shape Antenna Array

The above diagram in Fig. 2 (c) presents the three dimensional directive pattern of the antenna. Antenna directivity is the ratio of maximum radiation intensity (power per unit surface) emitted by the antenna in the maximum direction divided by the intensity radiated by a hypothetical isotropic emitting similar total power as that antenna. The above Fig. 2 (d) illustrates the three dimensional pattern of gain in dB scale for the antenna. Gain as a parameter computes the directionality of a specified antenna. An antenna with a low gain produces radiation in all directions uniformly, while a high-gain antenna will specially radiate in specific directions.

V. DISCUSSION

From the simulation study of the designed antenna it can be simply noticed that the designed E-shaped microstrip antenna has fine VSWR i.e. 1.2 at 2.5 GHz frequency and optimized return loss less than -10 dB. i.e. -11. The optimum consequences of recommended antenna demonstrated and tested using IE3D SIMULATOR. The transmission line model appears to be mainly instructive in showing the bandwidth results by altering the different parameters. Resultant bandwidth can be simply tuned by edging the length of the center arm. It is remarkable that the radiation features of the recommended microstrip antenna are better to those of the usual microstrip antenna because of good cross polarization level in both planes obtainable over the impedance bandwidth. The recommended antenna is productive for antenna engineers so as to design and optimize the antennas for indoor wireless purposes.

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