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A Novel Wide Band and High Gain Rectangular Microstrip Antenna Utilizing 2x1 Array

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ABSTRACT: The paper shows a new active designing of microstrip patch antenna intended for improvement of gain performance and radiation pattern of antenna. Here the design and analysis of 2x1 array microstrip patch antenna is initiated with center frequency of 3.5 GHz and dielectric constant of 2.2 mm relating to IEEE 802.11 utilized for wireless communication. With the recommended antenna, the antenna radiation pattern with its gain increases approximately about 1.5 times that of an antenna without reactive loading. This suggested antenna fundamentally enhances the gain, high directional beam and also to counteract the consequences of fading when signal propagates through several corrupted environments. Details of the simulation effects are discussed and accordingly optimized in accordance with array elements so that we can achieve a suitable amount of gain.

KEYWORDS: Microstrip patch antenna, Wireless Communication ,2x1 Array, IE3D

I. INTRODUCTION

The requirement for compact and multifunctional wireless communication has urged the increase of miniaturized broadband antennas with enhanced gain. Latest progress in high speed W-LAN and analogous applications require the antenna of wider bandwidth, decrease in size and increase in bandwidth. Microstrip Patch Antenna is useful as it includes beneficiary features like compactness, light weight and high efficiency [2]. Microstrip antenna comprises of a dielectric substrate sandwiched in between a ground plane and a patch. The concept of Micro strip antenna was first suggested in 1953, twenty years before the practical antennas were created. As the first practical antennas were expanded in early 1970s, concern in this type of antennas was held in New Mexico [3]. These are very much helpful for low profile purposes at frequency above 100 MHz. These benefits of Micro strip antennas make them widely accepted in numerous wireless communication purposes like satellite communication, radar, and medical purposes. Selection of the designed parameters (dielectric material, height and frequency, etc.) is of great significance as performance of the antenna relatively depends upon these factors and by utilizing high permittivity substrates , effects in miniaturization of Micro strip antenna dimension. Thick substrates possessing low range of dielectric offers enhanced efficiency and wider bandwidth. Fundamentally it depends on the feeding technique like coaxial feed, microstrip line feed, aperture couple feed etc. and the important parameters like VSWR return loss, and bandwidth [4].

II. ANTENNA CONFIGURATION

The antenna geometry is demonstrated in Figure 1(a) containing only one patch, which is simpler than conventional wide-band microstrip antennas. Antenna is designed with the help of line feed to resonate at frequency of 3.5 GHz. The patch is mounted on a glass substrate by means of relative permittivity, $\varepsilon_r = 2.2$ where length of patch and height of patch are equal to 27.22 mm and 3 mm respectively. The antenna represented in Figure 1(b) includes the subarray designing of Microstrip Patch antenna where four similar elements are built to construct a 2x1 sub array. The feeding strip is linked with another strip that passes through an air layer connecting a 50 Ohm microstrip feed line on a ground substrate. Figure 1(c) shows the star shaped antenna at 3.5 GHz frequency with 40 cells per wavelength which looks like a meshed structure. It is done essentially to develop the bandwidth and diminish the cross polarization of the antenna dimensions of gain while Figure 1(d) demonstrates the current distribution performance of E-Shape patch at 3.5 GHz excitation. The important alterations in radiation pattern of arrays can be achieved by changing current distribution array of the antenna, including phase delay among elements, alteration in the radiation characteristics of individual radiating arrangement in an array, variation in the geometry of the array and by varying the inter-element spacing.

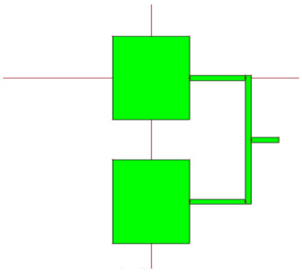

Fig.1 (a) Geometry of 2x1 Array

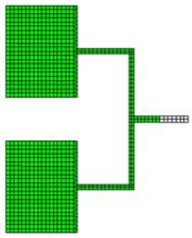

Fig. 1 (b) Antenna Structure view of 2x1 Array

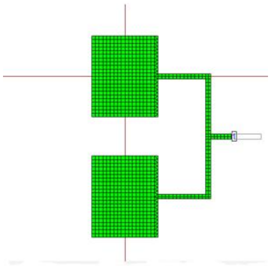

Fig. 1(c) Meshed Patch of 2X1 Array

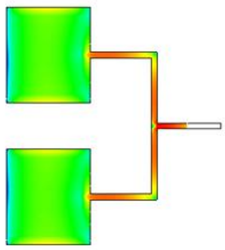

Fig. 1(d) Current Density of 2x1 Array

III. DESIGN SPECIFICATIONS

A. DESIGN EQUATIONS

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

$$w = \frac{v_0}{2 f_r}\sqrt{\frac{2}{\varepsilon_r + 1}} \qquad (1)$$

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

2. Determination of effective dielectric constant ε_{reff} calculated by the formula

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

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

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

$$\Delta l = 0.412\frac{(\varepsilon_{reff} + 0.3)(\frac{w}{h} + 0.264)}{(\varepsilon_{reff} - 0.258)(\frac{w}{h} + 0.8)} \qquad (3)$$

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

$$l = \frac{1}{2 f_r \sqrt{\varepsilon_{reff}} \sqrt{\mu_0 \varepsilon_0}} - 2\Delta l \qquad (4)$$

Here, $f_r, \varepsilon_{reff}, \mu_0, \varepsilon_0$ denote the resonant frequency of antenna, effective dielectric constant of antenna, permeability of the substrate, permittivity of the substrate respectively.

B. DESIGN PARAMETERS

The significant parameters for the design of 2x1 Microstrip Patch Antenna Array are as follows: ε_r =2.2, h=3mm, f_r=3.5GHz. We have considered the feed point at 13.23mm from centre. Computing the design parameters in the above equations we obtain w=33.8mm, ε_{reff} = 2.014, Δl= 0.155cm,l=2.72cm.

IV. PERFORMANCE EVALUATION

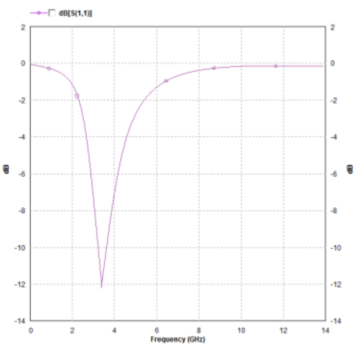

Fig. 2 (a) Return Loss characteristics of 2x1 Antenna Array

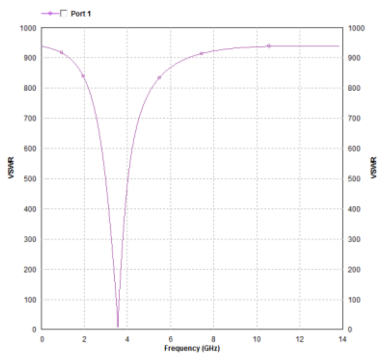

Fig. 2 (b) VSWR of 2x1 Array

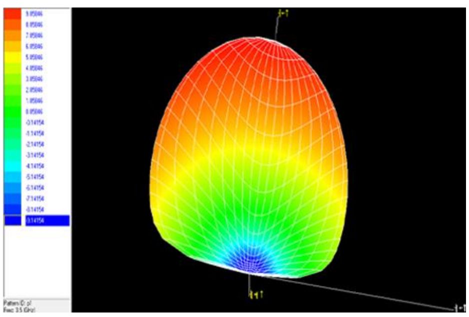

Fig.2 (c) 3-D Directivity Pattern of 2x1 Array

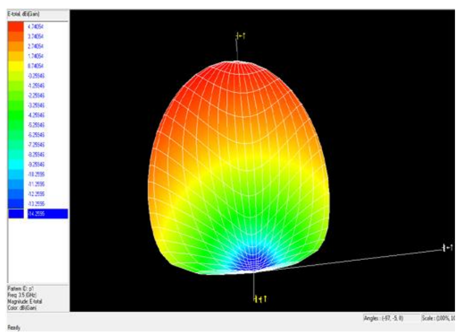

Fig.2 (d) 3-D Gain Polar Pattern of 2x1 Array

The graph in Figure 2 (a) illustrates the Return loss at 3.5 GHz frequency bandwidth is approximately about -12.25 dB. Return loss is associated to both standing wave ratio (SWR) and reflection coefficient (Γ). It is a determination of how fine devices or lines are matched. The above graph in Figure 2 (b) portrays the VSWR (Voltage Standing Wave Ratio) of the antenna acquired at 3.5 GHz around 1.3 dB. VSWR is a measure of how much power is distributed to an antenna. VSWR is also a measure of how nearly the source and load impedance are matched. Figure 2 (c) characterizes the 3- D directive outline of the antenna. Antenna directivity is the ratio of maximum radiation intensity (power per unit surface) emitted by the antenna in the maximum direction and the intensity radiated by a hypothetical

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isotropic radiating similar total power as that antenna. Figure 2 (d) illustrates the 3D pattern of gain in dB scale for the antenna. Gain as a significant parameter of antenna measures the directionality of a provided antenna. An antenna with a low gain emits radiation in all directions uniformly, while a high-gain antenna will radiate better in specific directions.

V. DISCUSSION

By the simulation of the designed antenna it can be easily observed that the designed 2x1 Array microstrip antenna has suited the VSWR i.e. 1.3 dB at 3.5 GHz frequency and optimized return loss less than -10 dB(-12.25 dB) properly. The best results of suggested antenna confirmed and tested with the help of IE3D SIMULATOR. Thus the constructed antenna effects in low cost, improved gain, low weight based station and enhanced the matching level of the antenna. At last this antenna generates a strong radiation in the horizontal direction for a few definite applications inside the complete band. In several applications mostly in radar and satellite communications, it is essential to design antennas with enhanced directive characteristics to come across the requirement of long distance communication.

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BIOGRAPHY

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