RESEARCH PAPER

New Configuration of Microstrip Patch Antenna Arrays

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ABSTRACT:
A new configuration of a Microstrip patch antenna array is presented in this paper. The array is arranged in such a way that only one patch placed in the E-plane and four patches are placed in the H-plane. This is to make the antenna provide a dual band performance and increase the gain. The feeding network utilized in the array is based on the step-loaded matching structure in order to maintain good matching impedance between the input port and the radiation (out) ports. The antenna array is simulated using the Computer Simulation Technology (CST) Microwave Studio. The gain of the first frequency band, which has the center frequency 4.35 GHz, is 8 dBi, while the second band is 5.8 dBi at the center frequency 9.8 GHz. Due to simplicity and high gain, the antenna array is of interest of many high gain and long distance applications such as point-to-point communication systems.

KEY WORDS: Array antenna, Dual band, High gain.
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1. INTRODUCTION:
One of the essential and the key element of any wireless communication system is the antenna which radiates and receives an electromagnetic wave. Continuous developments in the field of wireless communication require a high performance antenna to fulfill the demand of such wireless systems (Eibert & Volakis, 2007; Najeeb et al., 2016). In recent years, Microstrip antenna draws much attention and have been developed by researchers, to meet the requirements, due to their advantages like low profile, small size, low cost (Yang et al., 2008), patch shape modification (Razali et al., 2015). However, conventional microstrip antennas suffers from some limitations such as narrow bandwidth and low gain.

et al, 2015). Planar monopol (Ho & Chen, 2007). Slot antenna (Kaur & Singh, 2015). Printed dipole (Suh & Chang, 2000). Using a microstrip antenna as an array is another technique widely used to enhance the antenna gain (DeJean & Tentzeris, 2007). In this paper a new configuration of microstrip antenna array design is presented. In the design, only one patch placed in the E-plane and four patches are placed in the H-plane in order to obtain dual band performance and enhance the gain. The feeding network of the antenna is based on step-loaded matching structure to achieve good impedance matching between the input port and the radiation (out) ports.
2. ANTENNA DESIGN

The geometry of the proposed array antenna is shown in the Figure 1. It consists of four symmetrical patch elements, with dimensions (Pw and Pl), and the feeding network. The dielectric material Rogers TMM 4 with 1.57 mm thickness and relative permittivity (ε_r) 4.5 is used as substrate material with the dimensions W and L. The feeding network based on 6-section stepped loaded structure. Each section well optimized in order to provide required impedance matching and dual band feature. The geometrical dimensions (W and L) are considered the crucial dimensions to maintain the matching of the antenna. The bottom layer of the structure is a ground with dimension Lg and Wg. A rectangular notch (Ws and Ls) in the ground layer helps the antenna to achieve better impedance mating. All the dimensions of the antenna are listed in the Table 1.

![Geometry of the proposed antenna](image)

**Table 1: parameters of the proposed antenna**

| Parameters | Value (mm) | Parameters | Value (mm) |
|------------|------------|------------|------------|
| W          | 100        | L3         | 5.1        |
| L          | 47.3       | L4         | 8.9        |
| WS         | 0.6        | L5         | 1.65       |
| LS         | 22.5       | L6         | 4.53       |
| Lg         | 22.5       | W1         | 2.4        |
| Wg         | 90         | W2         | 44.55      |
| Pl         | 13.5       | W3         | 1.75       |
| Pw         | 11         | W4         | 2.4        |
| L1         | 8.9        | W5         | 18.4       |
| L2         | 4.1        | W6         | 0.3        |

3. SIMULATION RESULT

The simulation results of the antenna proposed in this paper has been presented in this section. Due to the fact that the antenna design shown here has new configuration, its performance is not possible to be compared with the previous conducted works.

The return loss of proposed array antenna shown in Figure 2.

![Return loss versus Frequency](image)

As can be seen from the figure, the antenna has dual operating frequency bands. The first Resonance Frequency is 4.35 GHz with minimum
return loss -25dB and second frequency is 9.8 GHz dB with -23dB. The Frequency Range of the two bands is 4.29-4.43 GHz and 9.75-9.95 GHz. The obtained Bandwidths are 0.14 GHz and 0.2 GHz With a percentage bandwidth %3 and %2 respectively. The return loss of the antenna is below -10 dB in three other bands, but they are not considered as an operation frequency due to inefficient behavior of the antenna in these bands.

The voltage standing wave ratio, which is presented in Figure 4, is 1.06 at 4.35 GHz and 1.03 at 9.8 GHz. This indicates that the antenna is very efficient in these two frequency bands. Another important parameter, which influences antenna performance, is gain. As shown in figure 5, the maximum obtained a realized gain of the antenna is 8.3 at 4.35 GHz and it is 5.9 dB at 9.8 GHz.

![Figure 4. VSWR of the array antenna](image1)

![Figure 5. Realized gain of the proposed antenna](image2)

Figure 6 illustrates the visualisation of the plane current lines based on the two fundamental radiator structure which are dipole and slots (Mahmud, 2016). The E- and H-planes of the first band shown in figure 7. It can be observed that the antenna has omnidirectional radiation pattern in both planes. Figure 8. Demonstrates E plane and H plane radiation pattern of the antenna on the second band. The field strength of the antenna is divided between two major and three minor lobes. It can be noted that from both figures that the H plane radiation patterns in the second bands slightly distort, this may because of the pick magnitude of higher modes and the fractal of the antenna structure.

![Figure 6: Illustration of electric and magnetic filed planes for both dipole and slot structure (taken from Rashad, 2016).](image3)

![Figure 7. Radiation pattern of the antenna at 4.35](image4)

The electric and magnetic field planes (E plane) and (H plane) are two important parameters to investigate the radiation pattern of the antenna.
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4. CONCLUSIONS

This paper has presented New configuration of 4x1 array antenna. The proposed antenna operated in dual band with enhanced gain. The feeding network utilized in the array is based on the step-loaded matching structure in order to maintain a good matching impedance between the input port and the radiation (out) port. The obtained realized gain of the first frequency band, which has the center frequency 4.35 GHz, is 8.3 dB, while the second band is 5.9 dB at the center frequency 9.8 GHz. These features make the antenna good candidate for Radar applications.