Design and Simulation a Patch Antenna for Dual-Band Frequencies

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Abstract. In communication systems, wireless technology is the most thoroughly studied environment and communication schemes were not practiced without understatement of the antennas' operation. The proposed antenna can be used for Long Term Evolution (LTE), with strong coverage and improved power, for the indoor and outdoor regions. The antenna has Omni-directional pattern at lower and upper operation at frequency LTE band 7 (2.6 GHz) and band 3 (1.8 GHz). The concept antenna was produced with the substratum FR-4. The parameters of dispersion matrices, radiation pattern, gain, directive, VSWR, return loss can be calculated. The prototypes and calculations were done with Microwave Studio (CST). The shown array antenna can be extended in particular to mobile and small base stations.

Keywords: LTE, CST, Dual-band, Patch antenna.

1 Introduction

The rapid proliferation of interactive devices and emerging digital infrastructure growth and the increased usage of a mobile terminal have driven the research into modern network architectures and wireless world requirements [1]. Moreover, the creation of modern and exciting wireless service has been accelerating by rising processing capacity, memory and high-end graphics functionality. Personal video recorders, on request recordings, various programming, interactivity, mobile telephony and media broadcasting have allowed audiences to personalize their viewing and to communicate their desires to broadcasters [2-5]. Wireless networking infrastructure is a new need and has quickly expanded with fresh concepts, where it begins with the first LTE and LTE-

Advanced technology (LTE-A). LTE or LTE-A was the high-speed broadband network for cell phones and data terminals based on the Global Mobile Infrastructure (GSM). Global Cell Broadband has been project to amount mobile user growth over the next 3 years by an estimate of 50% each year [6, 7]. In wireless technology, especially in mobile devices, data traffic and signal coverage will be quite significant. Therefore, the Femtocell Network has been developed by the 3rd generation partnership project (3GPP) to support data traffic and signal coverage from macrocell base stations [8, 9]. LTE technology has potential peak data speeds for the downlink and uplink of 300 Mbps and 75 Mbps respectively. LTE technology has been used for the first time in Europe, and the 1.8 and 2.6 GHz frequency bands have been assigned. The 800-960 MHz and 3.4-3.8 GHz bands are now allowed to run LTE bands as the need for fast data rates grows [10-12]. The antenna developments are also an immense obstacle for them to support the high demand for these service classes. In recent years, a massive number of antennas have been built and produced to cover these LTE frequency bands which can only provide single and dual bands including single [13, 14] and double [15] bands.

Patch antennas perform a critical part in the wireless networking device environment in recent days. Microstrip antennas are very charming because of their low profile, their low weight and their superficiality. A significant number of microstrip antennas have been produced to be used in wireless applications [16-19]. Miniature antenna scale, broad band and multi band antennas are expected to fulfill potential advancement of wireless networking technologies. The microstrip antenna is going to be a high-quality rival for several connectivity products. Antenna contains both dielectric layer and ground plane on the other hand. The fine feature of microstrip patch antenna, such as small weight, stubby body planar configuration, cheap fabrication costs and the capacity to integrate with microwave integrated circuits technologies, make the patch antennas suitable for wireless networking applications, cellular phones, pagers, radar, and satellite communications equipment items.

The antenna's size is decreased effectively by cutting a slot on the microstrip road. The goal of this paper is to develop and simulate a dual-band microstrip patch antenna using a CST microwave studio at frequency LTE band 7 (2.6 GHz) and band 3 (1.8 GHz) on the FR4-epoxy substratum of 1.6 mm substrate height (h) = 1.6 mm and conductor height (t) = 0.035 mm. This antenna is design to function within the spectrum of frequencies between the two (1.8 to 2.6 GHz).

2 Related Work

Due to their versatility and its diverse uses, wireless networks have exciting research fields. However, there are also a variety of problems to be researched and analyzed. This unit explains the use of a patch antenna for different wireless applications.

In the study [20], a basic microstrip patch antenna with a resonant frequency of 2.4 GHz is constructed in the CST microwave studio. The benefit of the built antenna is 8.27 dB and 1.18 VSWR.

In [21], the patch antennas scheme and emulation are used for cell users. The return loss and the numerous benefit plots were analyzed along with the radiation style.
In the research [22], the antenna targeted at 2.4 GHz frequency resonance operation for wireless local area network (WLAN). Different shapes of an antenna exist in this design and this antenna is designed to maintain the above resonant frequency. Besides, this antenna is applied to the dielectric substratum of FR 4 Epoxy and this configuration has been tested according to the return loss and VSWR.
In work [23] proposed Π- Shaped Slot Dual Band Antenna, the antenna return losses are -16,2dB and -12,94dB, significantly less for 2X2 MIMO pi antenna. Gain values have been obtained, which satisfy the WLAN and Wi-Max applications. The antenna gain values are not very high.
The authors' proposed [24] is a dual-band dual-polarized planar antenna with sharp flat-top cut off radiation for the base stations. The range comprises of eight to eight antenna components organized with standardized spacing and is allocated with tailored uniform enthusiasm to achieve flat top and sharp cut off of low side lobes radiation patterns.

3 Antenna Parameters

This segment analyzes the different parameters such as VSWR, Return Loss, Antenna Gain, Directivity, Antenna Performance and Bandwidth [25].

- Gain: Antenna gain is characterized as a ratio of energy, in a given direction, to the intensity of radiation that would be received if the antenna power was isotopically radiated. G=4μ.U(first, next)/pin is the formula for the benefit, where, U(first), side), the pin is the input power.
- Radiation pattern: The radiation pattern is known as a mathematical feature or a graphical representation of the antenna's radiation characteristics according to its space co-ordinates.
- Antenna efficiency: It's a ratio of overall antenna output to an antenna's input power.
- VSWR: The VSWR=Vmax/Vmin voltage standing wave ratio is established. It could range from 1 to 2.
- Return loss: Return loss reflects signal strength as a system is embedded in a transmission cable. Therefore, the RL is a parameter close to the VSWR to demonstrate how well the transmitter and antenna matched. The RL is as follows: RL=-20 log10 (mode) dB for a perfect fit between transmitter and antenna = 0 and RL= oscillation of power, indicating that no control will be returned, whereas the value of an RL = 1 is RL= 0 dB, suggesting the representation of all power in the event. A VSWR 2 is permissible for practical applications since it meets an RL of -9.54 dB.

4 Proposed Antenna and Parameters

Figure 1 shows the geometry of the front view and architecture of the planned CST Microwave Studio software patch line antenna with dual-band operation. The antenna feed point measurements and location was intended to achieve the optimum antenna impedance. The following criteria are used for the design of the proposed antenna. A number of parameters have been evaluated in this report using CST Microwave Studio methods.

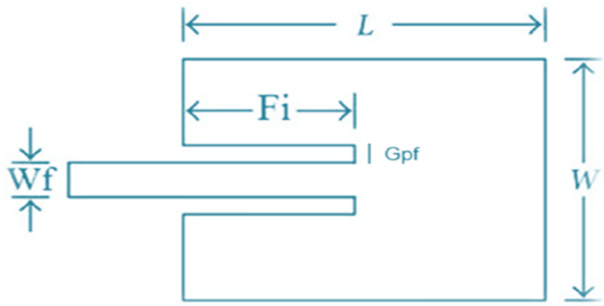

Fig. 1. Geometry of the antenna designed

A rectangular microstrip antenna is designed for a dual-frequency UWB device communication use. The suggested rectangular patch antenna has been conceived with dielectric substrate Fr4 = 4.3, substrate height (h) = 1.6 mm and conductor height (t) = 0.035 mm. This antenna operates at a frequency of 1.8 GHz and 2.6 GHz. The other parameters for the antenna are the patches' width (W) = 51 mm, the patches' length (L) = 39.4 mm, the ground plane's width and length, and the support (Wg) = 102 with (Lg) = 78.8, the patches' width and the microstrip field line (Gpt) = 1 mm, and the patch patching antenna and table 1 are shown as description parameters for the antenna. Figure 2 show the rectangular patch antenna.

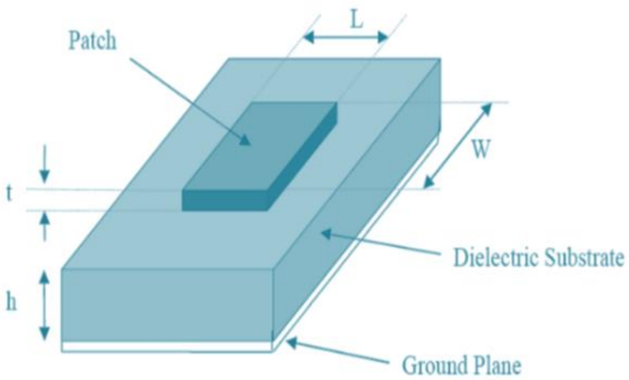

Fig. 2. Rectangular patch antenna

Table 1. Parameters values

Parameters	mm
W	51
L	39.4
FI	12.0075
Wf	3.1
Lg	2*L
Gpf	1
Wg	2*W
Ht	0.035
Hs	1.6

This research was carried on the philosophy, operating concept and characteristics of this antenna. There are several microstrip antenna research methods, so we can conveniently select the transmission line mode list. The equations of the transmission line as follows:
Step 1: At the first, the C = 299792458, $f_{\circ}$ = 1.8 with 2.4 GHz, and Ɛr = 4.3. To find Width (W) we used equation (1).

$$W = \frac{c}{2f^{\circ}\sqrt{\frac{Er+1}{2}}} \tag{1}$$

Step 2: Equation (2) establishes the efficient dielectric constant:

$$\mathcal{E}_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\left(\frac{h}{w}\right)\right]^{-\frac{1}{2}} \tag{2}$$

Step 3: The sufficient length calculated from equation (3):

$$L_{eff} = \frac{C}{2f_r\sqrt{\varepsilon_{reff}}} \tag{3}$$

Step 4: The fringing length (ΔL) from equation (4):

$$\Delta L = 0.1412h\frac{(\varepsilon_{reff} + 0.3)\left(\frac{w}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{w}{h} + 0.8\right)} \tag{4}$$

Step 5: The actual length Land the width and length of the Ground calculated by used equation (5):

$$L = L_{eff} - 2\Delta L \tag{5}$$

Step 6: The microstrip feed line (inset-fed) with input impedance 50 Ω and Gpf 1mm by equation (6):

$$fi = 10^4(0.001699 * \varepsilon_r^7 + 0.13761 * \varepsilon_r^6 - 6.1783 * \varepsilon_r^5 + 93.187 * \varepsilon_r^4 - 682.69 * \varepsilon_r^3 + 2561.9 * \varepsilon_r^2 - 4043 * \varepsilon_r + 6697) * \frac{L}{2} \quad (6)$$

Step 7: The width of Microstrip width from equation (7):

$$Zc = \frac{120\pi}{\sqrt{\varepsilon_{eff}}\left[\frac{Wf}{h} + 1.393 + 0.667 * \ln\left(\frac{Wf}{h} + 1.444\right)\right]} \quad (7)$$

5 Simulated Results

Patch antenna efficiency in figure 3 is measured in terms of coefficient of reflection (S11), radiation properties and gain. Figure 4 displays S11's simulated result. The antenna shows a dual-band operating frequency at 1.8 GHz and 2.6 GHz respectively -15.327dB and -18.724 dB. The simulated frequency ranges of 1.77 GHz - 1.83 GHz and 2.55 GHz - 2.65 GHz are acceptable.

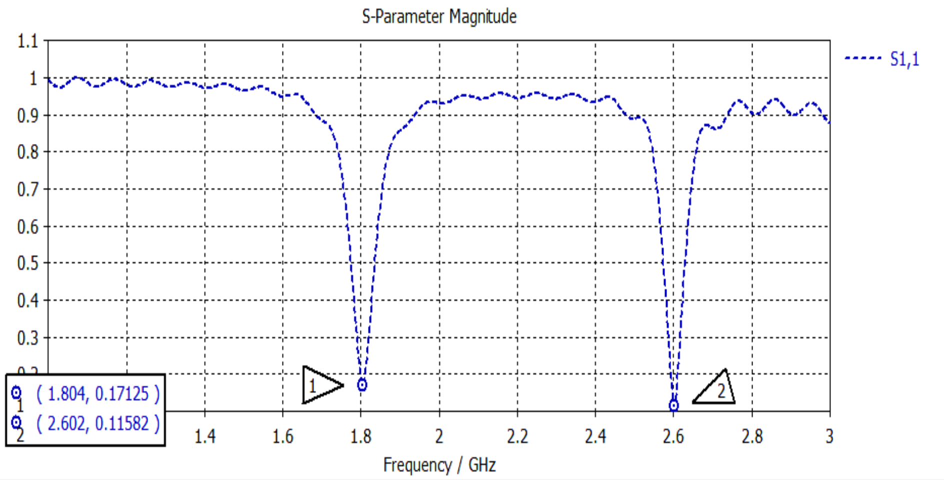

Fig. 3. S-parameter Magnitude

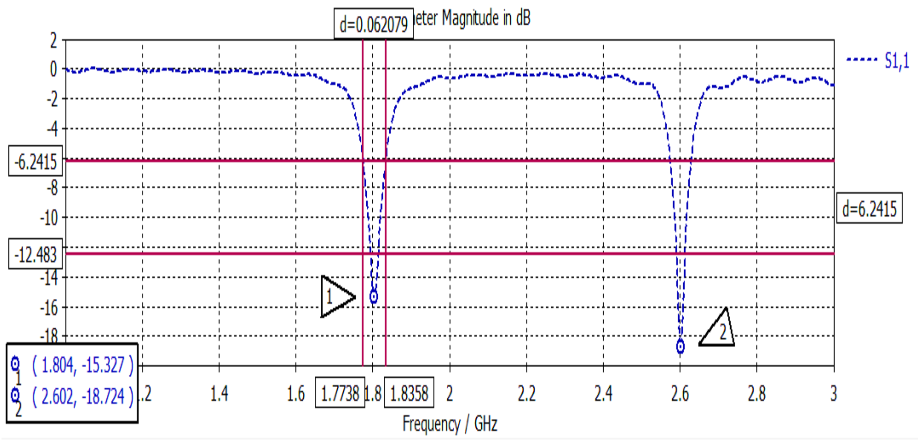

Fig. 4. S11 simulated result with bandwidth 62 MHz

The simulated patch antenna gave a resonant frequency of 1.8 GHz. The simulated return loss is found to be –15.327 dB. We get return loss peaks of the dual-band patch antenna at 1.8 GHz, and 2.6 GHz are - 15.327dB and -18.724 dB respectively. The radiation pattern at both frequencies in polar form is shown in the figure above. Figure 5 to 8 shows the excitation signal of the proposed antenna, the excitation signal S-Parameter, the Fairfield Radiation (Abs) pattern when the frequency is 1.8 GHz, and Fairfield Radiation (Abs) pattern when the frequency 2.6 GHz is present. Based on our results and when compare it with work which done by [26], the dual band recorded a batter value in dB.

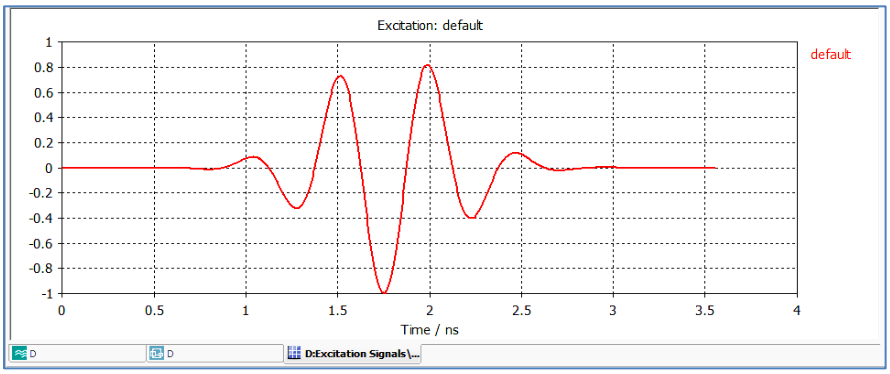

Fig. 5. Excitation signal of the proposed antenna

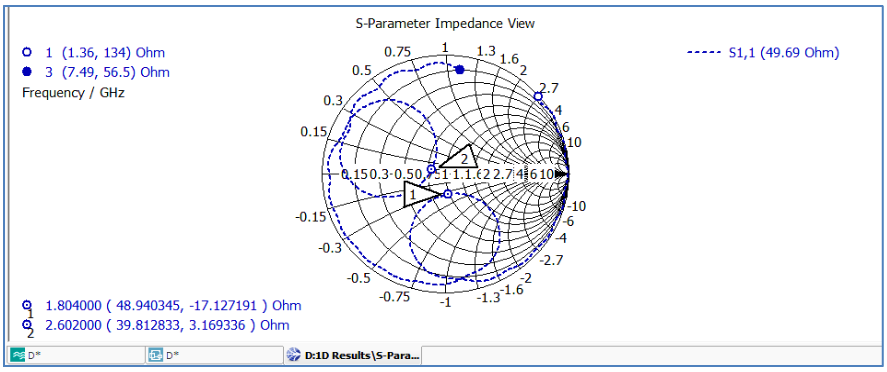

Fig. 6. The excitation signal S-Parameter of the proposed antenna.

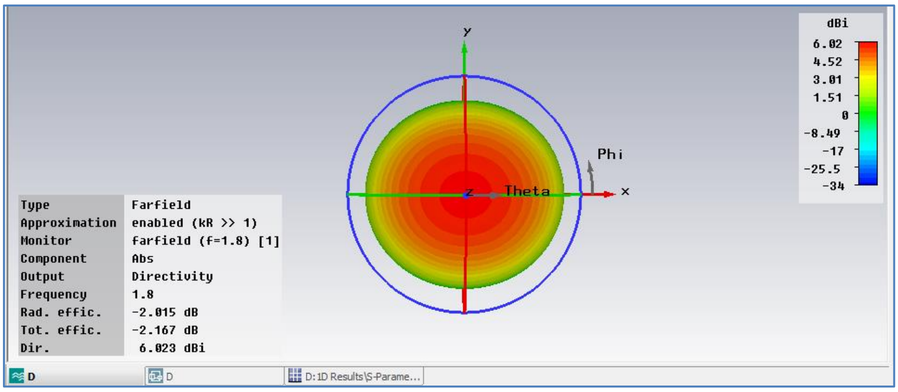

Fig. 7. Fairfield Radiation (Abs) pattern when the frequency is 1.8 GHz.

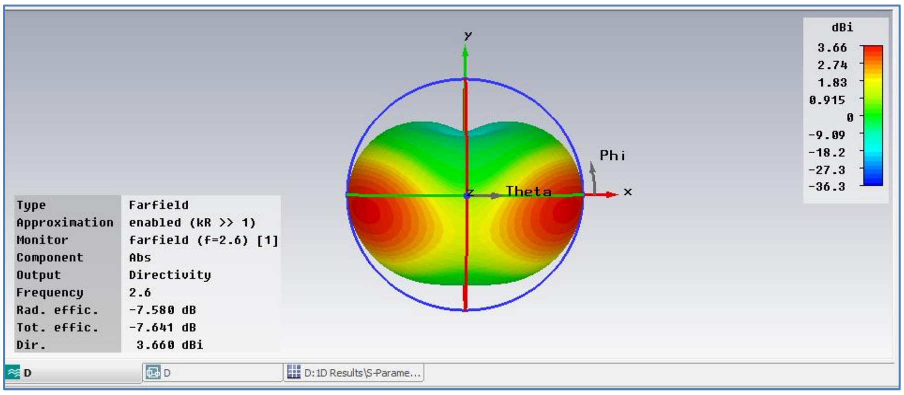

Fig. 8. Fairfield Radiation (Abs) pattern when the frequency is 2.6 GHz.

6 Conclusions

Dual-band creation and dual-polarized LTE Patch antenna are present. The planned antenna works are - 15.327dB and -18.724 dB respectively return losses spanning Wi-Max bands under the linearly polarized 1.8 GHz to 2.6 GHz range. Robust radiation pattern findings have been produced that seems to be sufficient for the applications envisaged. The antenna then suggested displays dual-polarized operational activity on LTE bands. Present LTE band antenna distributions are in linear directions. Furthermore, the antenna features good directional radiation patterns, good matching impedance and high gains, making it a right candidate for LTE communication applications with three-band. The more findings are discussed in depth in our paper. For future work, this antenna may be developed in the laboratory. Further research may be carried out to calculate and examine the function antenna, such as radiation pattern, bandwidth, and return loss. This is essential for the antenna to operate in the required features. To test the fabricated antenna, the Vector Network Analyzer (VNA) may be used to show the real return failure, the S11 and the bandwidth relative to the simulation data. This is necessary to ensure that the antenna functions according to the desired features.

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