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Research Article

New Design of Triband Rectangular Printed Antenna With DGS for Mobile Communications

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Abstract. A new design of a rectangular printed antenna for mobile communication is presented in this paper. The material substrate chosen is Rogers 3003c ($\epsilon r = 3$) and DGS (Defected Ground Structure) is used for bandwidth enhancement. The proposed antenna resonates over 900, 1800 and 2600 MHz frequencies for 2G/3G and 4G cellular phone. CST Microwave studio simulates the proposed rectangular printed antenna characteristics such as return loss S11, VSWR (voltage standing wave ratio), Gain and Radiation pattern.

Keywords. Printed antennas return loss; Radiation pattern; Rectangular patch

Mathematics Subject Classification (2020). 93B70; 68Q06

1. Introduction

The demand for very high speed in mobile networks is increasing day by day; therefore, the fourth generation (4G and 5G) was coming [8]. The search for high speed uses 3G and the need for very high mobile speed gives rise to 4G. Fifth generation should be more intelligent technology that interconnects the entire world. In recent years, demand for printed and small antennas on mobile communication has increased the interest of research work on patch antenna design [5]. There is various research on mobile patch antenna [1, 4, 6, 7]. In this paper, we proposed a rectangular patch antenna with DGS [3] for mobile communications "1G/2G/3G/4G". The materiel substrate used is Rogers with $\varepsilon r = 3$ of permittivity and $h = 0.75$ mm of higher. The proposed antenna geometry is very simple to fabricate and easy to integrate in mobile phone.

2. Proposed Rectangular Patch Antenna Geometry

We designed a rectangular patch antenna with Rogers RO3003 substrate ($\varepsilon r = 3$, $h = 0.75$ mm). it is fed by a miscrostrip line 50 Ω. The dimensions of the patch antenna are calculated from the equations ([2, 9]):

$$w = \frac{1}{2fr\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon r+1}}, \tag{2.1}$$

$$\varepsilon_{\text{eff}} = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\left[1+12\frac{h}{w}\right]^{-\frac{1}{2}}, \tag{2.2}$$

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon r_{\text{eff}}+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon r_{\text{eff}}-0.258)\left(\frac{w}{h}+0.8\right)}, \tag{2.3}$$

$$L = \frac{1}{2fr\sqrt{\varepsilon e_{\text{eff}}\sqrt{\mu_0\varepsilon_0}}} - 2\Delta L, \tag{2.4}$$

$$L_{\text{eff}} = L + 2\Delta L. \tag{2.5}$$

The antenna dimensions are shown in Table 1. The substrate is chosen such that it gives good efficiency and larger bandwidth.

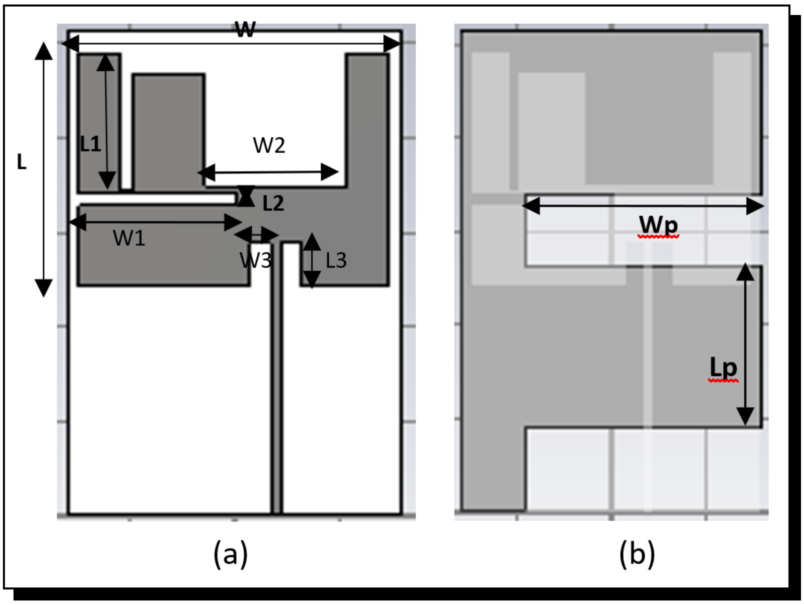

Figure 1. Proposed rectangular patch antenna, (a) Top view, (b) Rear view

Table 1. Proposed patch antenna Parameters

Length (mm)	Width (mm)
$L = 45$	$W = 42$
$L1 = 22.7$	$W1 = 30$
$L2 = 2.4$	$W2 = 19.46$
$L3 = 9$	$W3 = 4$
$Lp = 50$	$Wp = 50$

3. Simulations and Results

Return Loss

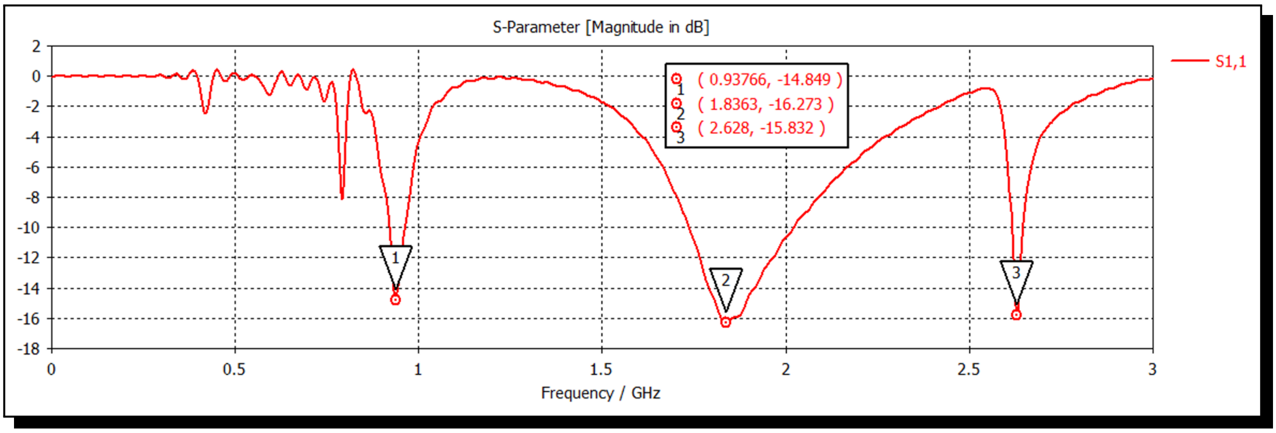

Figure 2. Return loss S11 of the proposed printed antenna

Figure 2 shows the return loss of the microstrip rectangular patch antenna, the proposed antenna is operating at three resonance frequencies 0.93, 1.83 and 2.62 GHz. For our proposed antenna: The first band cover the standard GSM (Global System for Mobile Communications), the second cover DCS/PCS (Digital Cellular System) and UMTS (3G) standard and third band for LTE-Advanced 4 G. Table 2 resume the results of simulations. The bandwidths are sufficient to cover mobile systems for GSM 900 MHz, UMTS (Universal Mobile Telecommunications System) 1800 MHz and 4G LTE (Long Term Evolution) 2600 MHz frequencies.

Table 2. Frequency and bandwidth of the proposed printed rectangular antenna

Frequency Band (GHz)	Bandwidth (GHz)	S11 (dB)	Standard
0.93	0.88-0.97	−14.85	2G
1.83	1.72-2.04	−16.27	3G
2.62	2.53-2.6	−15.83	4G

VSWR

The VSWR of all frequencies obtained is ≤ 2 as shown in Figure 3.

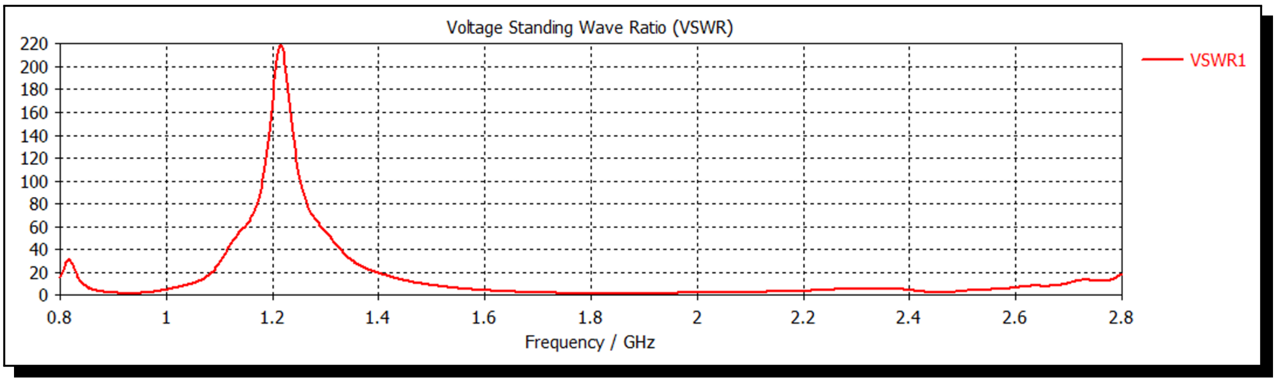

Figure 3. The VSWR of proposed antenna

Radiation Pattern

Figure 4 plots both E and H plane radiation patterns for the proposed patch antenna at 0.93, 1.83 and 2.62 GHz, respectively. The figure reveals nearly Omni-directional and stable radiation patterns in the entire operation band making the antenna a strong candidate for mobile communications.

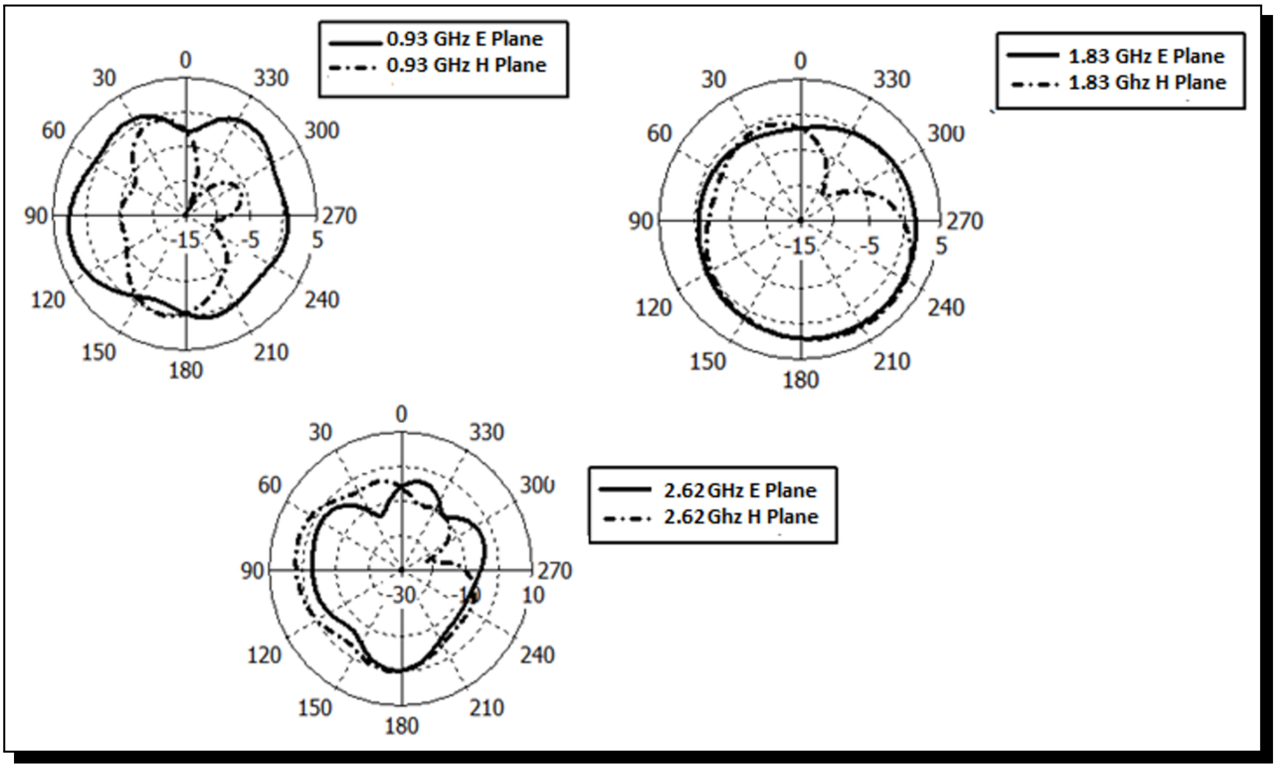

Figure 4. Polar Radiation pattern

4. Conclusion

New design of a tri-band rectangular microstrip antenna for mobile communication 2G/3G and 4G is presented in this paper. For this antenna, a sufficient bandwidth was achieved by using DGS and Rogers RO3003 material substrate. Simulations results are very satisfactory in terms of S11, VSWR, Gain and bandwidth. The proposed antenna is very compact and easy to fabricate and to use for cellular phone.

Competing Interests

The authors declare that they have no competing interests.

Authors' Contributions

All the authors contributed significantly in writing this article. The authors read and approved the final manuscript.

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