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Design of Broadband Rectangular Ring Patch Antenna for GSM-900, DCS- 1800 and Wi-Fi Bands

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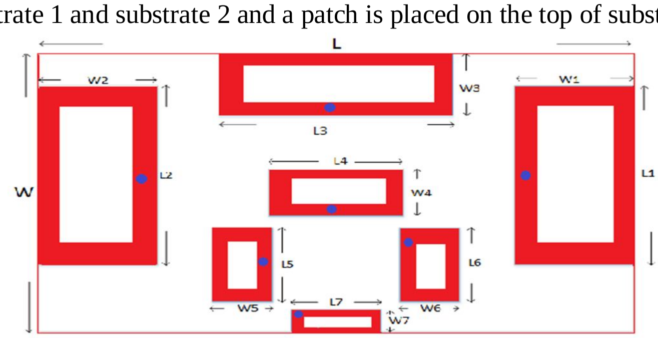
Abstract: ***The low-profiled broadband multi-frequency double-layer patch antenna which has seven patches with different resonant frequencies are placed together on one plane, operates at three bands that is GSM 900, DCS 1800 and Wi-Fi. These patches are arranged to have linear polarization and are perpendicular to each other. This structure not only avoids coupling but also takes full advantage of space. Simulation results show that good radiation performances and high gain are obtained owing to this design. HFSS software is used to design and simulate the antenna.***
Keywords: ***GSM - 900, DCS-1800, Wi-Fi, Multi-frequency double-layer patch antenna, Coaxial feed and HFSS.***

I. INTRODUCTION

Now a days with rapid development of wireless communication systems, we need higher performance and multi-frequency band operating antennas. As the front-end device of wireless communication system, high performance antenna is needed. Therefore, multi-band operation is the main goal of antenna. So to achieve this goal we proposed a multi-frequency patch antenna, named broadband rectangular ring patch antenna, it works at three bands namely GSM 900, DCS 1800 and Wi-Fi. However, it has limited bandwidth of only 3%-8% with the voltage standing wave ratio (VSWR) less than 2, which limits its applications. The three bands are described as GSM 900 for GSM device to base station (1.71-1.785GHz), DCS 1800 for base station to device (1.805-1.880GHz), and Wi-Fi (2.4-2.5GHz). The proposed design gives good performance in the aspects of return loss and gain. In order to operate at the frequencies of DCS 1800, GSM 900 and Wi-Fi which contain both omnidirectional and directive antennas, there are seven rectangular ring patches placed together on one plane and these antennas are arranged to have line polarization and be perpendicular to each other. This arrangement avoids coupling.

II. DESIGN OF AN ANTENNA

The dimensions of the designed patch antenna is shown in Fig.1. Considering that RF-35 is low-loss and stable, the antenna is built on the Taconic RF-35 substrate with permittivity 3.5 and loss tangent 0.0018. Out of many available substrate materials, Taconic RF-35 is chosen because it has very low moisture absorption. The antenna is composed of a patch with a shorting pin and a monopole element. The pin is connected with the micro strip line through the ground by a 1mm diameter copper cylinder. These antennas are arranged to have line polarization and be perpendicular to each other in order to avoid coupling. In this design ground plane is sandwiched between substrate 1 and substrate 2 and a patch is placed on the top of substrate 1.



(a) Vertical view

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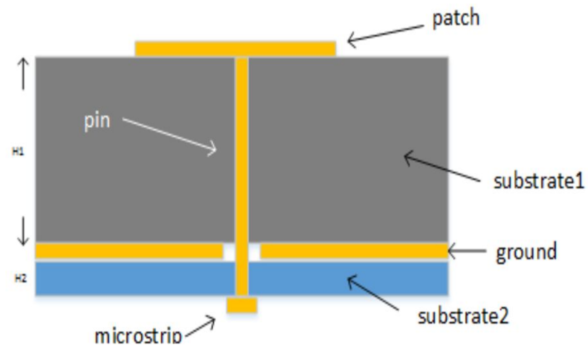
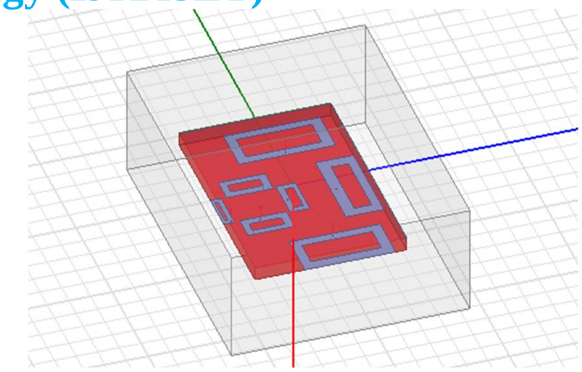


(b) Side view

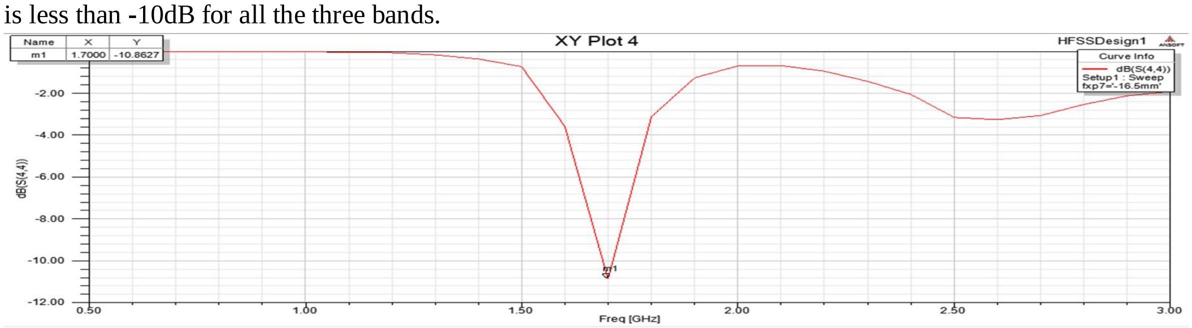


(c) 3D View

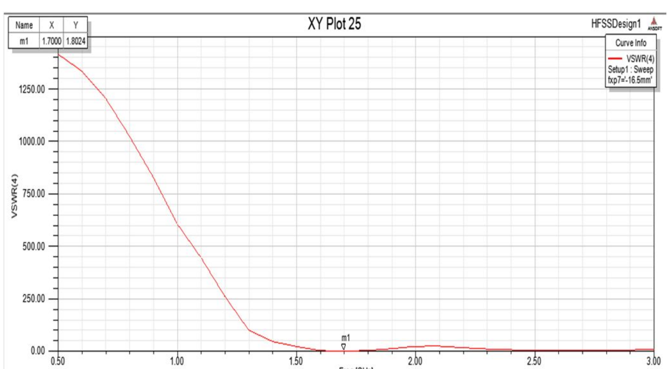
Fig.1. Dimensions of the antenna; (a) vertical view, (b) side view and (c) 3D view. (L=210mm, W=140mm, L1=84.8mm, W1=W2=43.5mm, L2=83.8mm, L3=84.5mm, W3=35mm, L4=40mm, W4=18mm, L5=L6=43mm, W5==W6=23mm, L7=37mm, W7=10mm, H1=11mm, H2=0.5mm).

III. SIMULATION AND RESULTS

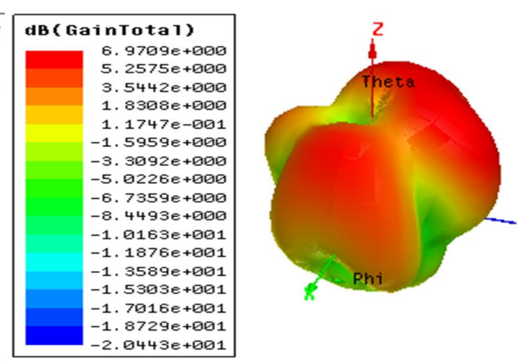
The antenna design and simulation is done by using HFSS software. HFSS is a commercial electromagnetic simulator produced by Ansys company. The output graphs like return loss, VSWR and gain patterns were plotted using this software. The results for the three operating bands GSM-900, DCS 1800 and Wi-Fi bands were shown in figure 2, figure 3 and figure 4 respectively. Return loss for GSM -900 band (1.7 GHz) is -10.86dB, for DCS-1800 (1.85GHz) is -11.1277dB, for Wi-Fi band (2.4 GHz) is -35.6828dB. The return loss is less than -10dB for all the three bands.



(a) Return losses



(b) VSWR Plot



(c) 3D polar plot

Fig 2 (a), (b), (c) Results of GSM band

Return loss, VSWR plot and 3D polar plots for GSM band at 1.7 GHz were shown in fig 2. At 1.7 GHz return loss obtained is -10.8627dB, VSWR is 1.8024 and gain is 6.9709dB

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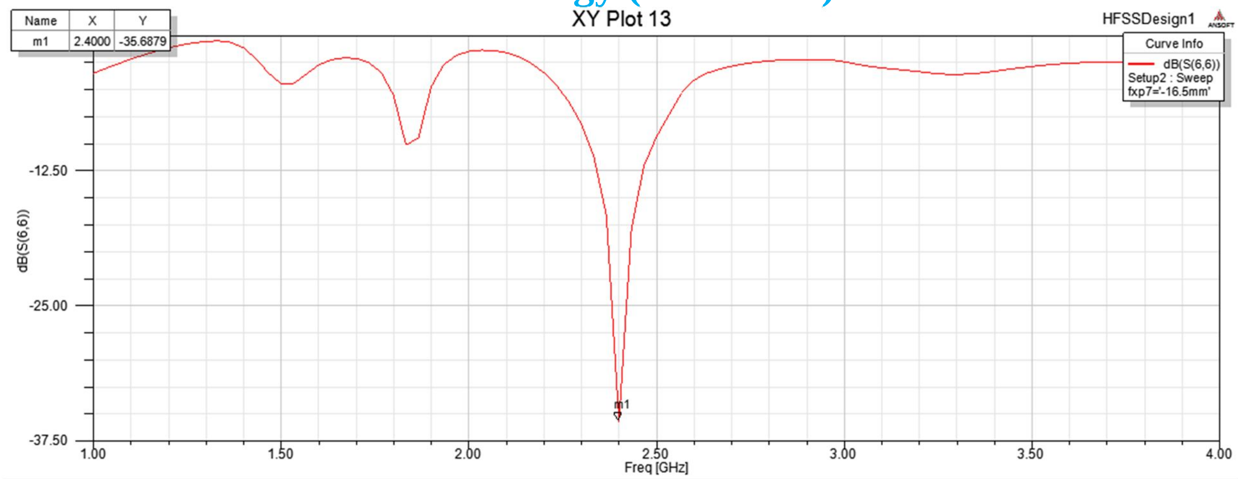
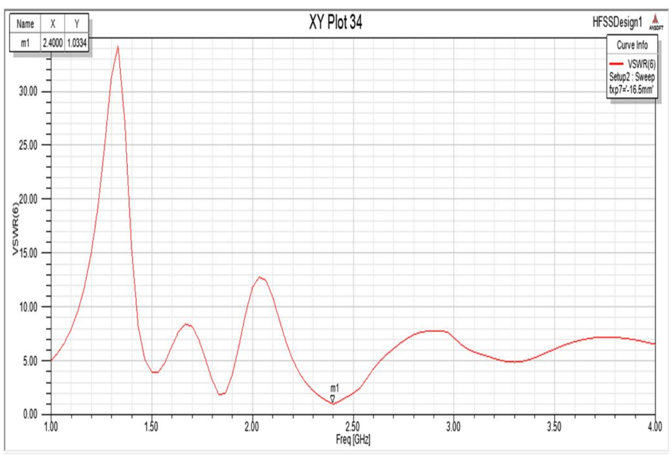
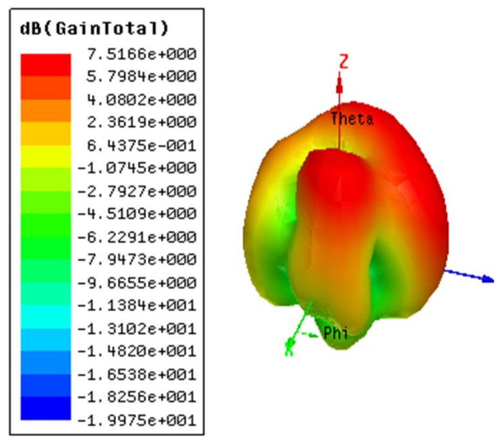


(a) Return loss

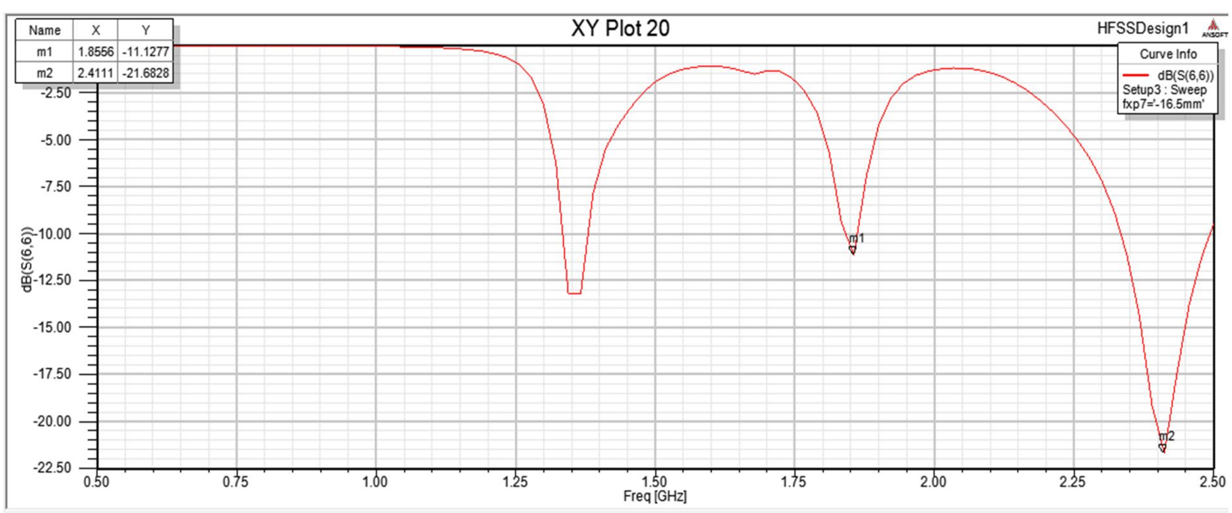




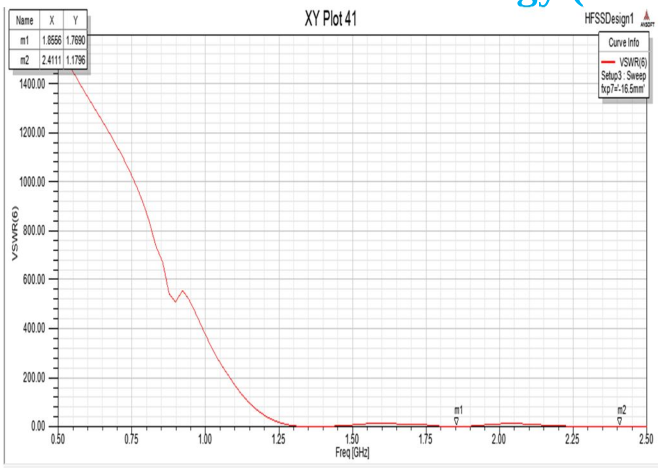
(b) VSWR plot (c) 3D polar plot

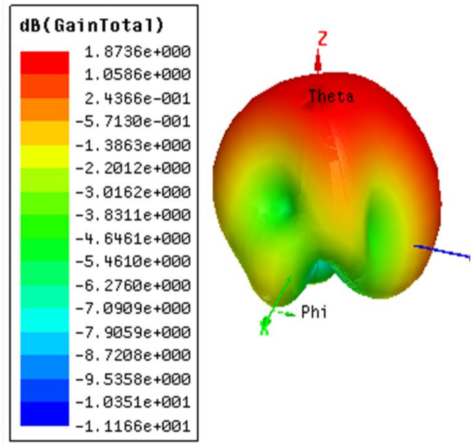
Fig 3 (a), (b), (c) Results of Wi-Fi band

Return loss, VSWR plot and 3D polar plots for Wi-Fi band at 2.4 GHz were shown in fig 3. At 2.4 GHz return loss obtained is -35.6879dB, VSWR is 1.0334 and gain is 7.5166dB



(a) Return loss





(b) VSWR Graph (c)3D polar plot

Fig 4 (a), (b), (c) Results of DCS 1800 band

Return loss, VSWR plot and 3D polar plots for DCS 1800 band at 1.8 GHz were shown in the figure 4. At 1.8 GHz return loss obtained is -11.1277dB, VSWR is 1.7690 and gain is 1.8736dB.

IV. CONCLUSION

This paper presents a design framework of a broadband rectangular ring patch antenna. In order to operate at the frequencies of GSM 900, DCS 1800 and Wi-Fi, which contain both omnidirectional and directive antennas, there are seven patches placed together on one plane and these patches are arranged to have line polarization and be perpendicular to each other. By forming different patch antennas, which have different resonant frequencies to the array, miniaturization and broadband can be realized. By this design good radiation performances and high gain are obtained. This type of arrangement avoids coupling.

V. BIOGRAPHIES

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