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COMPARISION AND PERFORMANCE ANALYSIS OF DUAL BAND ANTENNAS DESIGNED ON ROGERS AND FR4 SUBSTRATE FOR RESONATING BETWEEN GSM 900 AND WI-MAX USING RCSRR IN THE GROUND PLANE

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Abstract- In this work an attempt has been made to compare the performance of two different dual band Antennas that have been designed,simulated and fabricated to resonate at GSM 900 and Wi-Max(3.5GHz) band on a FR4 and Rogers substrate whose permittivities are 4.4 and 2.2 respectively.The various Antenna performance parameters such as Gain,Bandwidth,VSWR and Return Loss are compared and the results are validated using Ansoft HFSS version 15.0.These Antennas are extensively used in Laptops and Mobile phones where the Antennas need to be multifunctional with Omnidirectional radiation pattern.

Index Terms - GSM, Wi-Fi, Reconfigurability, RCSRR

I. Introduction

Present day Wireless communication systems use dedicated Antennas for dedicated Applications.But with the widespread improvement in the growing number of wireless applications supporting different standards; the need for Reconfigurable Antennas has become inevitable.Reconfigurable Antennas have the ability to tune to multiple frequencies thereby resulting in miniaturization of the Antenna radiating structure.

In [1], A Microstrip patch Antenna loaded with split Ring resonator has been proposed on a 1.6mm thick FR4 substrate which has a permittivity of 4.4.A slot cut in the form of a split ring has been loaded on the surface of a patch resulting in multiple resonant frequencies of 2.4GHz, 3.5GHz and 5.2GHz. which finds application in Wi-Max, HIPERLAN/WLAN and Bluetooth applications. The Antenna resulted in a Gain of 4.41dB and -0.9dB for 2.4GHz and 3.5GHz bands. The Antenna resulted in a Bandwidth of 90 MHz and 60MHz for both the lower and the upper frequency bands respectively. The overall dimension of the structure was 50mm×50mm×1.6mm.The radiation pattern were omnidirectional in the H plane for both the bands and figure of 8 under E planes respectively. In [2], A compact tri band four port diversity based Antenna has been proposed on a FR4 substrate for MIMO related application. The split ring resonators were incorporated primarily to provide Isolation between the diagonal elements of the antenna. The structure resulted in a gain of 2.5dBi, 3.7dBi and 4.4dBi for 2.4GHz, 3.5GHz and 5.5GHz frequency bands covering the UMTS, LTE2300 and Wi-Max bands respectively. The proposed Antenna structure resulted in a return loss of -27dB and -18dB for the lower and the middle frequency bands along with a Bandwidth of 450 MHz and 480 MHz respectively. The maximum isolation achieved were 17 dB for the 2.4GHz band. The overall size of the compact multiport antenna system is 0.26λ × 0.26λ × 0.01λ with a minimum isolation of 22dB between its elements. In [3], a compact wide band concentric SRR based metamaterial antenna with dual band characteristic has been proposed for ISM band and WiMAX band. The novelty of proposed work lies in using three concentric spilt ring resonators and one closed ring resonator. The structure is designed on a FR4 substrate with permittivity 4.4. the antenna is compact in size with a dimension of 25.3mm×27mm×1.6mm, the reported gains were 1.12dBi, 1.48dBi and 2.42dBi for 2.89GHz, 3.7GHzand 5.7GHz. The bandwidths reported were 160MHz and 3.49GHz for the lower and upper bands respectively. The structure resulted in a return loss of -25dB, -38dB for the lower and upper bands respectively with a nearly omnidirectional radiation pattern. In [4], a dual band printed antenna incorporating square patch and spilt ring resonators has been used in the antenna design. The proposed antenna is designed on a FR4 substrate with a permittivity of 4.4 and having dimensions of 72mm×51mm×1.6mm. The reported gains were 2.35dBi, -1.49dBi for 1.5GHz and 2.5GHz. The bandwidths reported were 53.8MHz and 37.7MHz, a return loss of -19dB and -20dB for the lower and upper bands respectively. The radiation pattern reported was a hemispherical in E-plane and omni-directional in the H-plane for both the bands respectively. In [5], dual band monopole antenna is proposed. The antenna resonates at two frequencies 900MHz (GSM band) and 2.4GHz (Wi-Fi band). Substrate used is FR4.The proposed antenna gives a return loss less than -10 dB for both the frequencies. It also gives a good directivity. The antenna gives a gain of 1.40–1.64 dBi and

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3.13–4.24 dBi for GSM band and WLAN band, respectively. The VSWR is obtained between 1 and 2 for both the bands. The antenna gives a bandwidth of 113MHz and 360MHz for 900MHz and 2.4 GHz band The use of air as a dielectric gives minimum tangent loss.. This has been verified with the practical results obtained on the network analyzer.In [6], a novel 9-shaped multiband frequency reconfigurable monopole antenna for wireless applications, using 1.6 mm thicker FR4 substrate and a truncated metallic ground surface is proposed. The designed antenna operates in single and dual frequency mode based on switching states. The antenna operates in a single band (WiMAX at 3.5 GHz) when the switch is in the OFF state and it operates in dual frequency band (Wi-Fi at 2.45 GHz and WLAN at 5.2 GHz) when the switch is turned ON. The antenna gives gain of 1.48dBi, 2.47dBi and 3.26dBi are attained at frequencies 2.45 GHz, 3.5 GHz and 5.2 GHz respectively. The proposed antenna has VSWR< 1.5 for all the three frequencies. The antenna is simulated using CST 2014.The designed antenna is compact size, light weight, and highly efficient (84-92 %). It can be used in Wi-Fi, Wi-MAX and WLAN based wireless applications. In [7], a tri-band monopole antenna for WLAN/WiMAX applications is proposed which consists of a horizontal H-shaped patch, an L-shaped open end stub, and a deformed inverted T-shaped strip. The patch attached to the 50 ohms feed-line through a matching line can increase the bandwidth of the proposed antenna. The bandwidths of the proposed antenna are 340MHz (2.4-2.74 GHz), 340MHz (3.41-3.75 GHz), and 640MHz (5.24-5.88 GHz), respectively, indicating this antenna is suitable for WLAN (2.45-2.4835, 5.16-5.35, and 5.725-5.85 GHz) and WiMAX (2.5-2.69, 3.4-3.69, and 5.28-5.85 GHz) applications. The antenna gives return loss very less than -10dB for all the three frequencies and gain of 2.08dBi, 1.93dBi and 2.48dBi for 2.5GHz, 5.5GHz and 5.8GHz respectively. The antenna is successfully simulated and measured. The proposed antenna is compact in size, has nearly omnidirectional radiation characteristics and constant gains at all the operating bands.In [8], a novel compact dual-band monopole antenna using defected ground structure (DGS) is presented. DGS is used in this antenna which has a rectangular patch with dual J-shaped strips. It helps in achieving a good resonant mode and good impedance matching. The antenna gives a bandwidth of 400MHz and 530MHz for 2.5GHz and 3.5GHz respectively. It also gives omnidirectional pattern and constant gain for both the frequency bands.In [9], a compact triple-band printed monopole antenna for WLAN and WiMAX applications is proposed. The antenna consists of a rectangular patch with two straight open-ended slots whose position and size when changed gives three different current paths for desired frequency bands. The antenna gives the -10dB impedance bandwidth of 100 MHz (2.4-2.5 GHz), 500 MHz (3.25-3.75 GHz), and 610 MHz (5.22-5.83 GHz), covering 2.4/5.2/5.8 GHz WLAN and 3.5/5.5 GHz WiMAX bands. The antenna gives monopole radiation pattern and stable gains of 1.55dBi, 1.6dBi and 2.05dBi for 2.45GHz, 3.5GHz and 5.6GHz respectively.In [10], a novel triple-band microstrip-fed planar monopole antenna with defected ground structure (DGS) is proposed for WLAN and WiMAX applications. The proposed microstrip-fed antenna consists of a rectangular patch, dual inverted L-shaped strips and a defected ground. The designed antenna can generate three separate resonances to cover both the 2.4/5.2GHz WLAN bands and the 3.5GHz WiMAX bands while maintaining a small overall size of 20mm × 27mm. A prototype is experimentally tested, and experimental results show that the antenna gives good radiation patterns and enough antenna gains over the operating bands

II. Antenna Design

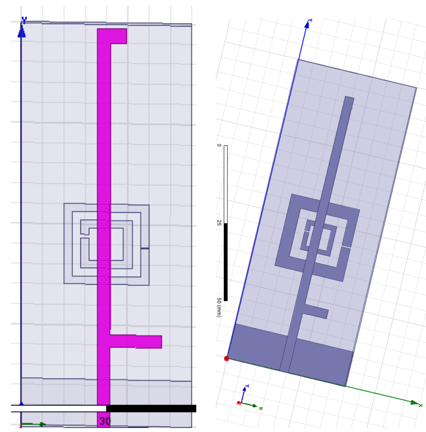


Fig. 1 (a) (b)

Figure 1(a) and (b) showing the snapshot of the Antenna designed on Rogers and FR4 substrate respectively

III. Simulated Results:

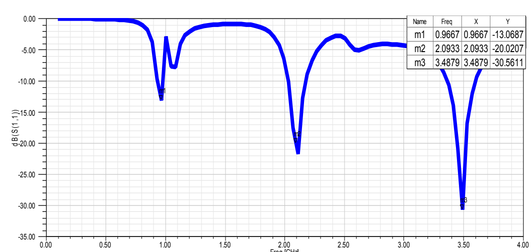


Fig 2. Return loss of Antennas Designed on FR4 substrate 0.9GHz and 3.5GHz

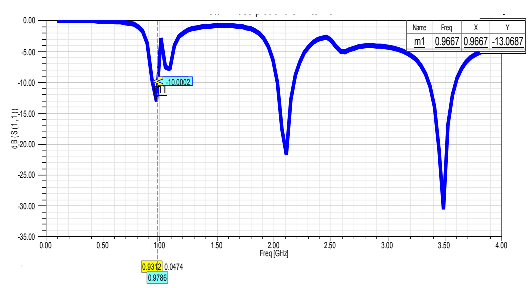


Fig.3 Bandwidth of the Antenna designed on FR4 substrate resonating at 0.9GHz

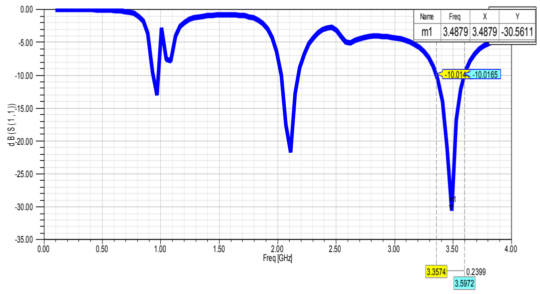


Fig. 4 Bandwidth of the Antenna designed on FR4 substrate resonating at 3.5GHz.

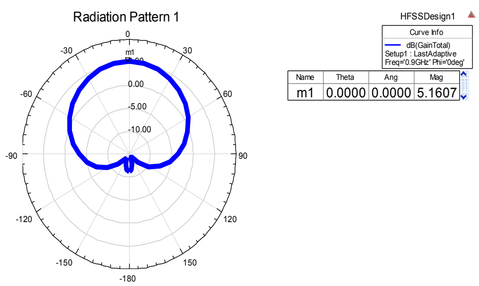


Fig.5Radiation pattern of the Antenna designed on FR4 substrate under E plane at 0.9GHz

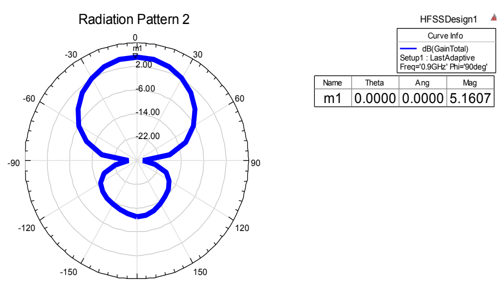


Fig. 6 Radiation pattern of the Antenna designed on FR4 substrate under H plane at 0.9GHz

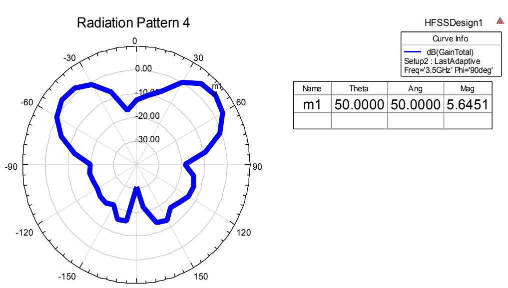


Fig.7 Radiation pattern of the Antenna designed on FR4 substrate under E plane at 3.5GHz

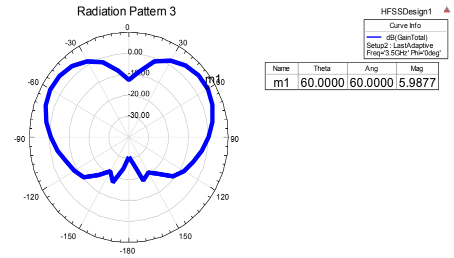


Fig.8 Radiation pattern of the Antenna designed on FR4 substrate under H plane at 3.5GHz

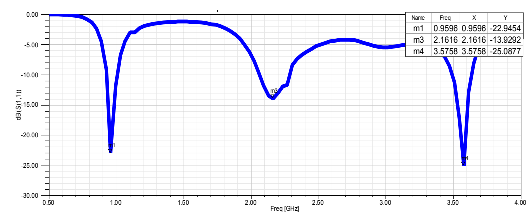


Fig.9 Return loss of Antennas Designed on Rogers substrateresonating at 0.9GHz and 3.5GHz

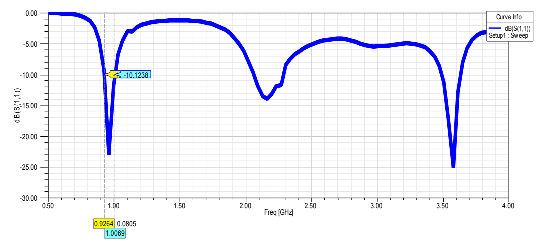


Fig.10 Bandwidth of the Antenna designed on Rogers substrate resonating at 0.9GHz

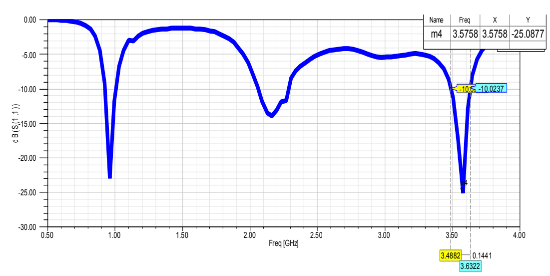
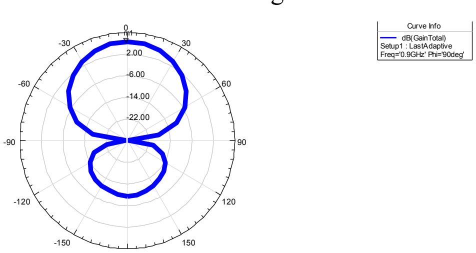
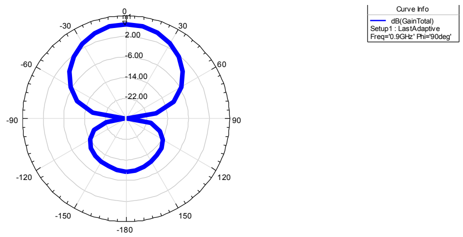
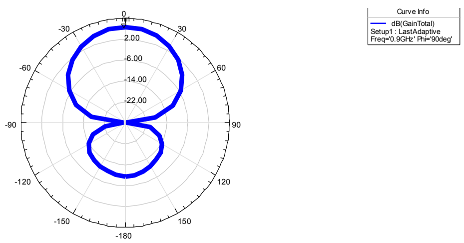
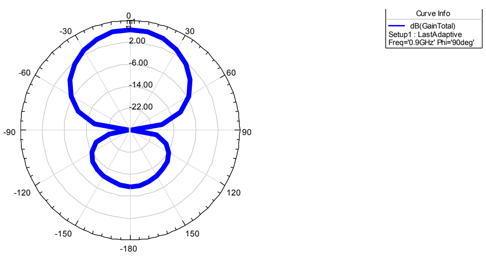


Fig.11 Bandwidth of the Antenna designed on Rogers substrate resonating at 3.5GHz









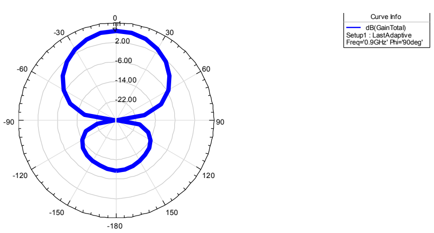


Fig.12 Radiation pattern of the Antenna designed on Rogers substrate under E plane at 0.9GHz

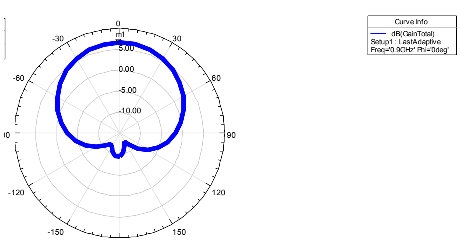


Fig.13 Radiation pattern of the Antenna designed on Rogers substrate under H plane at 0.9GHz

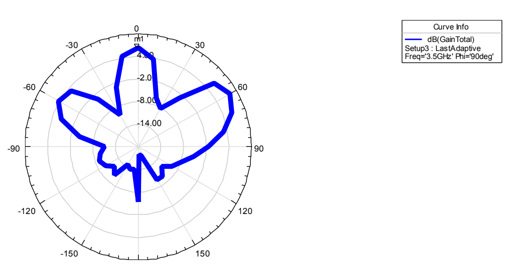


Fig.14 Radiation pattern of the Antenna designed on Rogers substrate under E plane at 3.5GHz

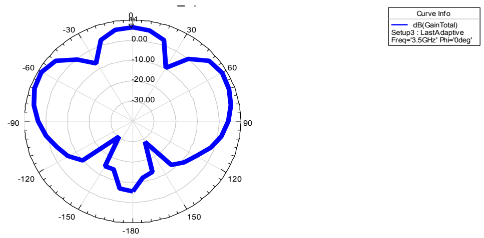
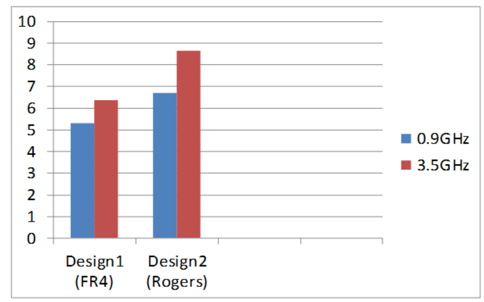


Fig. 15 Radiation pattern of the Antenna designed on Rogers substrate under H plane at 3.5GHz



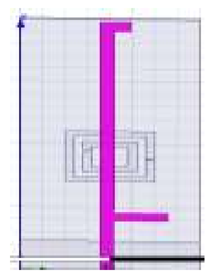
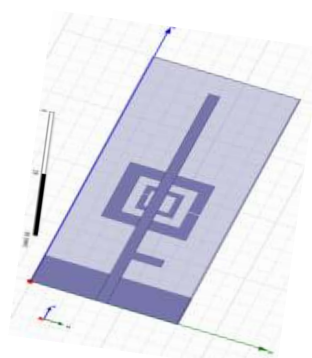
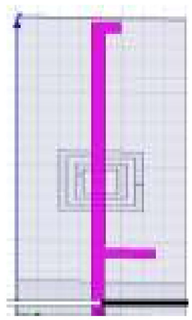


Fig. 16 Comparision of gain plots of both FR4 and Rogers substrate





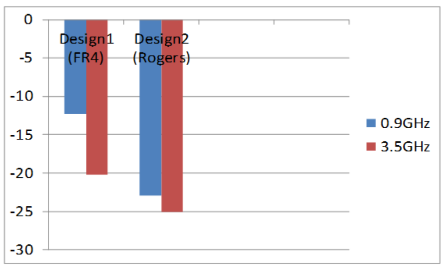
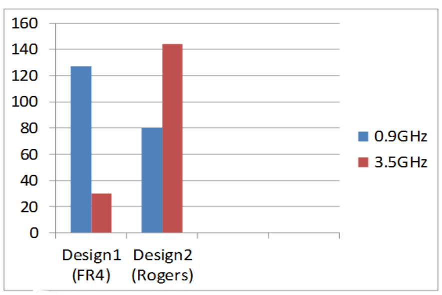


Fig. 17 Comparision of Return Loss plots of both FR4 and Rogers substrate



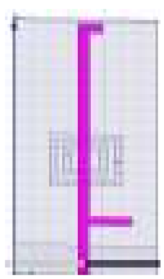


Fig. 18 Comparision of Bandwidth plots of both FR4 and Rogers substrate

IV.Results and Discussion

Table.1 Showing the comparision of simulated and measured results of the dual band antennas designed on FR4 substrate

Antenna parameters	Simulated		Measured	
Resonant Frequency	0.9GHz	3.5GHz	0.94 H	3.48 H
Return Loss	-13.06 dB	-30.56 dB	-10. dl	-33 dl
VSWR	1.5	1.0	1.7	1.0
Bandwidth	47.4M	239.9	40M	256M
Gain	5.16	5.98	5.16	5.98

Table.2 Showing the comparision of simulated and measured results of the dual band antennas designed on Rogers substrate

Antenna parameters	Simulated		Measured	
Resonant Frequency	0.9GHz	3.5GHz	0.805G Hz	3.327G Hz
Return Loss	-22.94 dB	-25.08 dB	-14.626 dB	-13.40 dB
VSWR	1.3	1.1	1.48	1.54
Bandwidth	805MHz	144MHz	133M Hz	200M Hz
Gain	6.7dB	7.71dB	6.7dB	7.71dB

Comparing Table1 and Table2 we can infer that return loss of antennas designed on FR4 substrate is comparativeil greater than the return loss of the antennas designed on rogers substrate. The bandwidth of the antennas resonating at 0.9GHz of FR4 substrate is found to be 40MHz, where as the bandwidth of the antennas resonating at 0.9GHz on Rogers substrate is found to be 133MHz. Thus the bandwidth of FR4 substrate is less than that of Rogers. Finally the gain of antennas resonating at 0.9GHz and 3.5GHz on FR4 substrate are 5.16dB and 5.98dB respectively, where as the gain of antennas resonating at 0.9GHz and 3.5GHz on Rogers substrate are 6.7dBdB and 7.71dB respectively. This shows that the gain of antennas on Rogers substrate is greater than that of FR4 substrates.

V. Conclusion

From the results and the various antenna parameters investigated, we conclude that antennas designed on Rogers exhibit higher gain and bandwidth as compared to FR4 substrate which makes them suitable for most of the wireless communication applications.

VI. Scope

In future we will further investigate various other structures such as EBG based metamaterials, fractals, slot etc…

The proposed antenna designs can be helpful in SDR(Software Defined Radio) applications.

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