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Dual band Planar Slot Aperture Antenna for Wireless Communication Applications

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ABSTRACT

Rapid developments in the communication industry lead towards the design of compact devices with multi-functionalities. Mobile phones are equipped with different services like GSM, DCS, Blue tooth, GPS, DVB-H etc. Since antenna being the key component of wireless gadgets, these demand an increasing need for compact, conformal antennas with multiband characteristics. Printed antennas are popular due to its conformal characteristics which allow easy integration with the planar circuit board. In most of the designs ground plane is the main hindrance for compactness. This leads towards the designs with finite ground plane. In this Paper printed planar MSP antenna with finite ground plane is analyzed and modified to a compact dual band antenna by taking slot aperture.

Keywords: *Dual band, slot aperture, GSM, DCS, GPS.*

1. INTRODUCTION

Microstrip antennas are the most rapidly emerging area in the antenna field in the most recent years due to their light weight, low volume, thin profile configuration and low fabrication cost. Because of these advantages they are extensively used in the communication systems such as personal communication systems, mobile satellite communications, wireless communication systems, direct broadcast television, wireless local area networks etc.. On the other hand, MSAs suffer from very narrow impedance bandwidth (1-2%) with respect to center frequency [1-4]. This poses a design challenge for the antenna designer to meet size reduction with acceptable bandwidth and gain characteristics. The present trend of wireless application system also needs to have multiple functionality that presents challenges to have dual-frequency antenna in a simple manner. There are several methods to obtain dual frequency, size reduction with improvement in bandwidth and gain by the use of thick substrate, cutting a resonant slot inside the patch, the use of a low dielectric substrate, multi- resonator stacks configurations, the use of various impedance matching and feeding techniques, and the use of slot antenna geometry. Proposed design uses probe feeding method with slot on the patch to improve the different parameters of microstrip antenna [5-6].

With the wide proliferation of wireless technologies in modern life, one cannot afford to be offline for long, even during flights. Although present regulations do not allow the use of wireless devices, there is a distinct possibility that several wireless bands would be released soon for use during flights. An ideal possibility in this regard would be to integrate the antenna with materials used in existing cabin panels [7-8]. In this context, the present study investigated the possibility of designing a wireless antenna catering to applications at frequencies 1.7-2.2GHz, 2.4-2.5GHz, 5.15-5.35GHz, and 5.45-5.85 GHz, making use of typical panel materials employed in such an environment. A dual wide-band antenna operating at 1.7-2.5GHz and 2.8-3.5 GHz bands would meet the requirements for all the above applications.

2. ANTENNA DESIGN:

The proposed antenna is designed on Rogers RT-duroid substrate with permittivity 2.2 and loss tangent 0.009. The total dimension of the antenna is 78X67 mm with substrate height of 2mm. Patch dimension of 45.6 mm length and 38.1mm of width. The slotted section is having dimensions as follows.

L1=6.8mm, L2= 4mm, L3=6mm, L4=19mm, L5=33mm, L6=26mm, L7=7.5mm, L8=5mm, L9=12mm, L10=8mm.

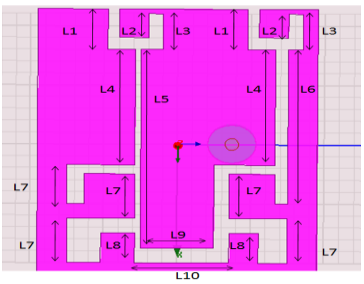

Figure 1 Slot Aperture Antenna

3. RESULTS AND ANALYSIS

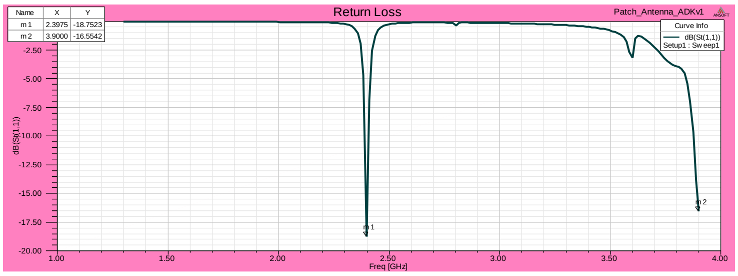

Figure 2 Return Loss Vs Frequency

A good antenna might have a return loss value of -10dB as 90% of the signal is absorbed and 10% is reflected back. The proposed antenna is giving the excellent return loss curve in the specified frequency range. The curve has deep and wide dips at frequencies 2.3 and 3.9 GHz. The return loss obtained at these frequencies are -18.75, -16.55 dB respectively. Input impedance is defined as the impedance presented by the antenna at its terminals or the ratio of the voltage to current at its terminals. If the antenna is not matched to the interconnecting transmission line, a standing wave is induced along the transmission line. The ratio of the maximum voltage to the minimum voltage along the line is called the Voltage Standing Wave Ratio. The VSWR obtained for this antenna is maintaining the ratio of 2:1 at both the frequencies.

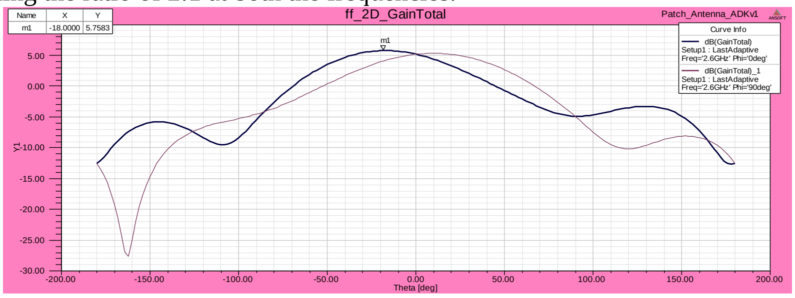

Figure 3 Two Dimensional gain

Gain is ratio measure of input & output power of antenna. A gain of 5.7 dB is obtained in this case.

$$G(\theta,\phi)=\eta D(\theta,\phi)=\frac{P_{rad}}{P_{input}}=4\pi\frac{I^{rad}(\theta,\phi)}{P_{input}}=\frac{P_{rad}}{P_{rad}^{avg}}$$

Where $\eta=\frac{P_{rad}^{avg}}{P_{input}}$ is Antenna Efficiency and $I_{rad}(\theta,\phi)$is the radiation intensity. Gain can be given as

$20\log(v/v_{dipole})$ where V is induced voltage at the input of antenna.

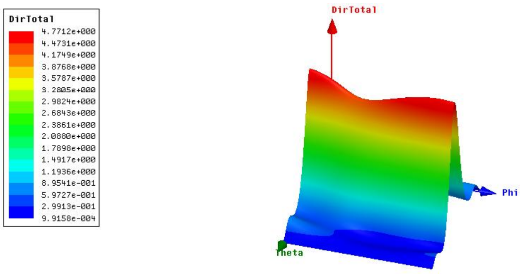

Figure 3. Directivity

Directivity is ratio of radiation power in a given direction to the ratio of radiation power averaged overall direction. Figure 3 shows the directivity of the antenna in three dimensional view.

$$D(\theta,\phi)=\frac{P_{rad}}{P_{rad}^{avg}}=\frac{4\pi}{\Lambda_{solid}}|F(\theta,\phi)|^2$$

Where $\Lambda_{solid}=\iint_{\Lambda}|F(\theta,\phi)|^2 d\Lambda$. When $D(\theta,\phi)$ is quoted as a single number, the maximum directivity can be considered $D=\frac{P_{rad}^{\max}}{P_{rad}^{avg}}=\frac{I_{rad}^{\max}}{I_{rad}^{avg}}=\frac{4\pi I_{rad}^{\max}}{P_{rad}}=\frac{4\pi I_{rad}^{\max}}{I_{rad}^{\max}\Lambda_{solid}}=\frac{4\pi}{\Lambda_{solid}}$

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Then $D(\theta,\phi) = D\,|F(\theta,\phi)|^2$. If no direction is specified, the direction of maximum radiation is taken into account

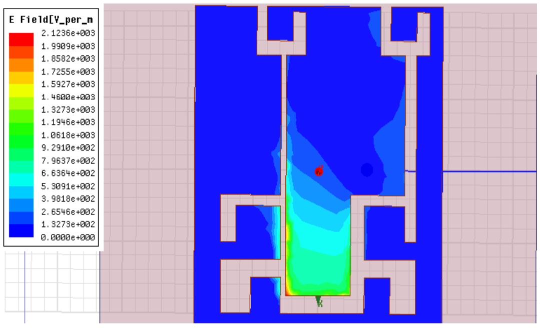

Figure 4. E-Field Distribution

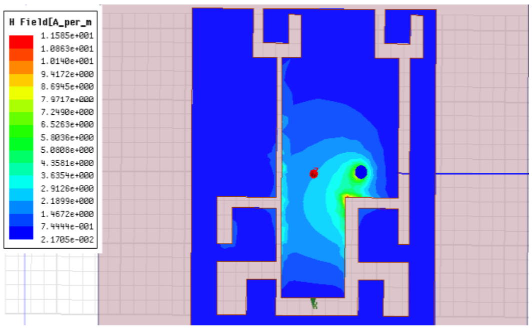

Figure 5. H-Field Distribution

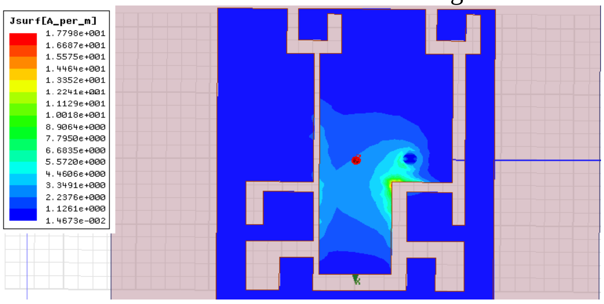

Figure 6. Current Distribution

Figure 4, 5 and 6 shows the E-Field, H-Field and Current distribution of the antenna at fundamental resonant frequency. Table 1 shows the antenna output parameters.

Quantity	Value	Units
Max U	7.8155E-005	W/sr
Peak Directivity	4.7712	
Peak Gain	3.7926	
Peak Realized Gain	0.099239	
Radiated Power	0.00020585	W
Accepted Power	0.00025896	W
Incident Power	0.0098967	W
Radiation Efficiency	0.79489	
Front to Back Ratio	31.827	

Table 1. Antenna Parameters

CONCLUSION

Dual band planar slot aperture antenna is designed to operate for the wireless communication applications. The proposed model is giving acceptable measurement results of return loss and VSWR at both the resonating frequencies with moderate gain. The field distributions and directivity are showing the applicability of this antenna in the real world environment. The size reduction is attained for this model with the help of slots on the patch aperture and resonant frequency is shifted towards lower side.

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