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Design Of Multi-Frequency Band Antenna For Automobile Application

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Abstract

The design of multi-band antennas for automotive Communications is presented in this paper. The antenna design have resonant frequency band (0.9, 1.8, 2.1and 2.45 GHz). The antenna consist of monopole printed patch antenna with slotting technique is used to achieve multiband resonance. The Patch Uses three slotted lines for deriving four resonating frequencies which are as GSM, DCS, 3G, ISM band.by using Slots Technique we can get quad band for our antenna. The design antenna is fed by using normalized 50 ohm microstrip line. The antenna design is simulated using CST Microwave Studio

Keywords: *Slotted, monopole, strip, quad band*

1. Introduction

In Past few years the growth of wireless Services in automobile industry has increase very fast. The modern cars come with wide services such as FM/ AM , GPS , satellite radio ,remote keyless entry, remote start engine ,tire pressure sensor , automotive radar etc. use [1]–[3] for reviews on antenna designs for automotive applications. For above mentioned services require Special antenna with special design so it is not feasible to use separate antenna for each so multiband antenna system is feasible.

Now a day's multiband antenna in car come with AM/FM, GPS. Normally antenna is placed on top of car or truck or at back side of car. Commonly used antennas are helical antenna, monopole antenna and micro strip antenna. They are easy to use but drawback of this type is they operate on single frequency or application. There are different types of multiband antenna which can be categories as:

Printed dipole, loop antenna, slot antenna & printed inverted f antenna (PIFA).in past few year remarkable work has done on above mentioned antenna [5]. Compact antenna has small size compare to its wavelength but bandwidth is narrower compare to actual required.so to obtain good match with all desired frequency many technique are used as stack configuration, parasitic patch, introducing slot in structure.

In this paper we discuss a design of multiband antenna using slot & strip for automobile communication. The antenna structure cover volume of (75 x 35x 1.59) mm. the antenna is fed by microstrip line of 3mm width with input impendence of 50Ω.the antenna discuss in this paper is simple to design & offer effective control of four band by controlling dimension of three slot on patch. The antenna theory & geometry are discussed in following section. The current distribution, radiation pattern, VSWR are also disused in following section.

2. Antenna Design

2.1 Geometry Detail and Dimensions:

The discuss antenna design using FR4 substrate with dielectric constant of 4.4 & height of 1.59mm.The

volume of antenna is given as (75 x 35x 1.59) mm. the design has three slots on its patch & fed by microstrip line of width 3mm.the geometry is find out by 3 easy step by inserting slot on it. First lower band is found out then higher band. Figure 1 shows the geometry and dimensions for lower band. The Dimensions for below mentioned fig are as follows (L=21mm,W=35mm,L_f=53mm,W_f=3mm,L_{sub}=75mm ,L_g=7mm)

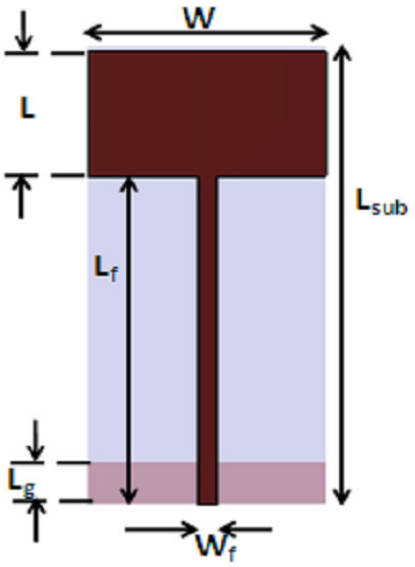

Figure 1 Geometry Detail for Lower Band 0.9 GHz

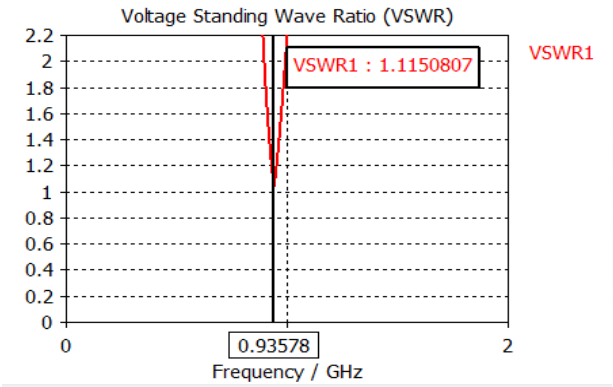

Figure 2 VSWR for 0.9GHz

Figure 2 shows the VSWR for frequency of 0.9GHz.here we get minimum VSWR Value is 1.115dB. Figure 3 shows S11 parameter for 0.9GHz. The Antenna resonates at 0.944 GHz with return loss of 32.457dB.The Bandwidth is 0.90249to.9923 GHz. Now slotting technique are used to generate higher mode of resonance.

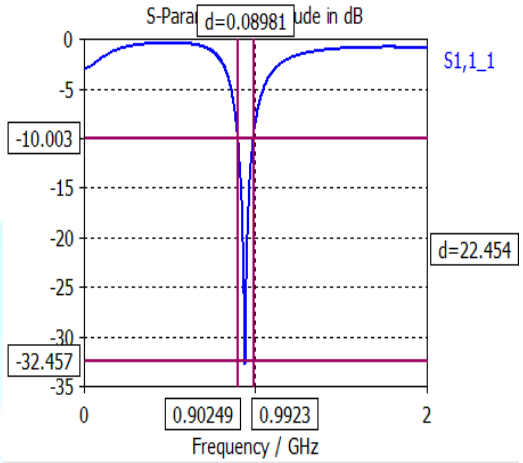

Figure 3 S_{11} Parameter for 0.9GHz

2.2 Creation of Higher Resonant Modes:

The width & length of patch are useful parameters for determining the resonant modes.in this antenna design we find resonant mode by using Slotting Technique. Chang in slot dimension & position is studied for achieving new resonant mode at the higher frequency.

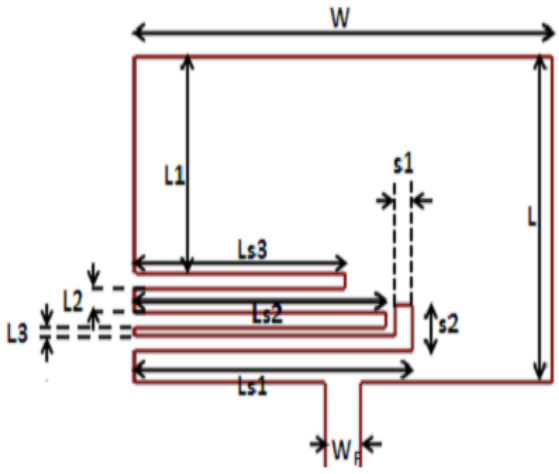

Figure 4Proposed Geometry Quad Band Antenna Design

Antenna Parameter in mm	
L	21
W	35
Lf	53
Wf	3
Lsub	75
Lg	7
L1	14
L2	1.45
L3	0.55
Ls1	24
Ls2	21.65
Ls3	18.2
s1	1.5
s2	3

Table 1Proposed Geometry Quad Band Antenna Design parameter in mm

The L shaped slot on patch provide Dual band frequency mode. L slot at patch gives us 1.8GHz resonant frequency .in L slot shape the horizontal section provide 1.8 GHz band & Vertical section provide impedance matching with more negative return loss. The next two horizontal slot provide us resonate mode at 2.1GHz & 2.45GHz respectively. The lengths of the slots are such that it optimize the structure with desired multiband frequency. The detail geometry of quad band antenna as shown in figure 4 & dimension of proposed Antenna is also given below at mentioned at above Table1. The simulated return loss plots & VSWR are shown in figure 5

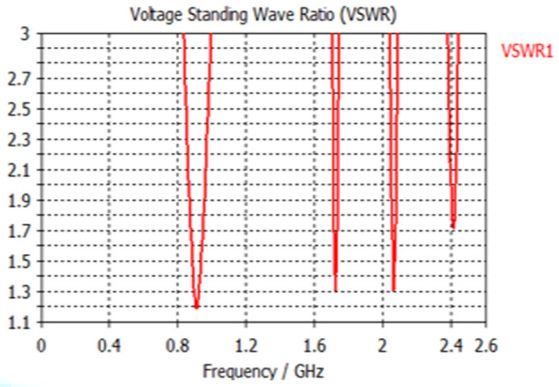

Figure 5 VSWR for Quad Band Design

Table 2 shows detail about $S_{11,}$VSWR & Bandwidth at resonance frequency.

Frequency Properties			
Frequency in GHz	RL in dB	VSWR(min)	BW in GHz
0.90984	-21.232	1.19	.8709-.96
1.8	-17.25	1.29	1.78-1.81
2.1	-17.5	1.3	2.05-2.1025
2.4	-11.06	1.7	2.403-2.4246

Table 2 $S_{11,}$ VSWR & BW Detail for Quad Band Antenna

3. Current Distributions

The physical behavior of the antenna is analyzed from the current distribution pattern. In simulation, antennas with different slot dimensions on patch are investigated for multiband characteristics. The current distribution pattern on the radiator provides a good agreement for the resonant mode corresponding to the slot position and dimension. The surface current distribution at 0.9GHz, 1.8 GHz, 2.1GHz, 2.45GHz are given below in figure 6.

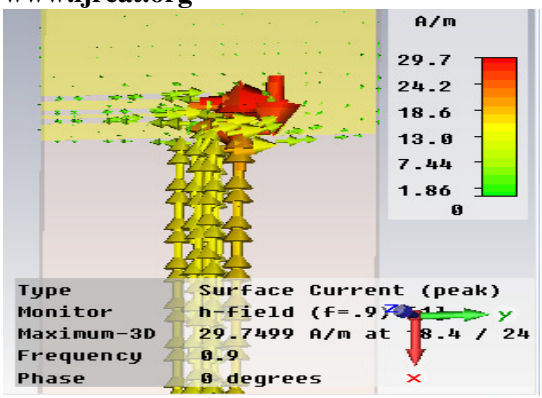

Figure 6a) current distribution at 0.9GHz

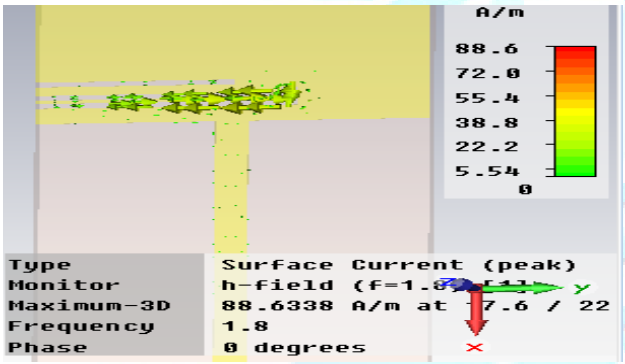

Figure 6b) current distribution at 1.8 GHz

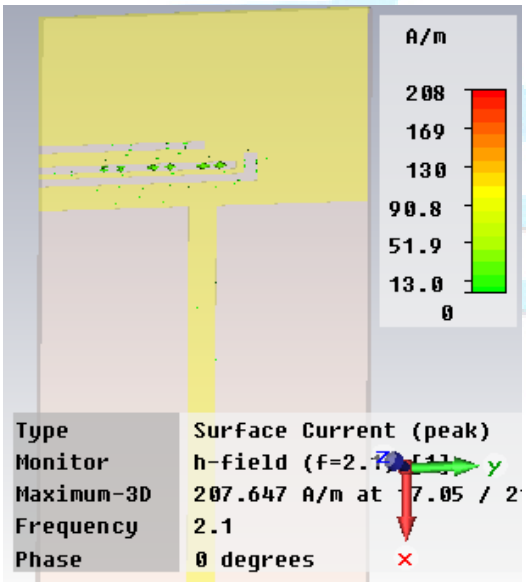

Figure 6c) current distribution at 2.1GHz

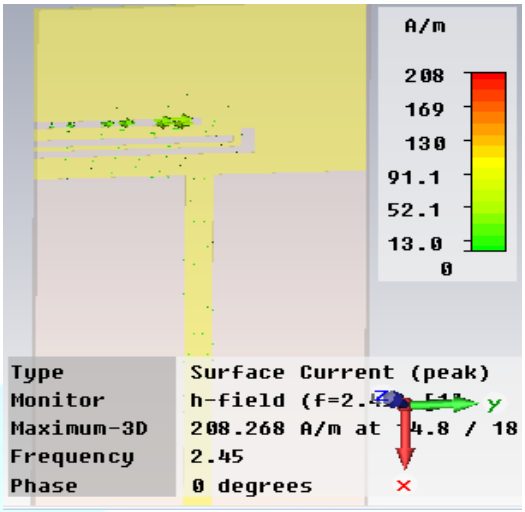

Figure 6d) current distribution at 2.45GHz

From figure 6(a), (b), (c), (d) it is observed that the surface current distribution at different frequencies is associated with the particular antenna configuration generated using slots for that resonant mode. The initial design for the lower mode is for 0.9 GHz band, The L slot covering radiator is denser with surface current distribution at the 1.8 GHz. The other two horizontal slots also provide good agreement of current distribution on the patch for the corresponding resonant modes. The middle slot just above the L slot satisfies the 2.1 GHz where surface current distribution on the patch is observed around the slot and the top most horizontal slot on patch is for 2.45 GHz band.

4. Radiation Pattern

The far field radiation patterns in terms of 3D view for the proposed quad band antenna are shown in figure 6a, 6b, 6c and 6d for frequency of 0.9GHz for GSM band, 1.8GHz for DCS (Digital Communication System) band and 2.1GHz for 3G application. 2.4GHz for ISM Band

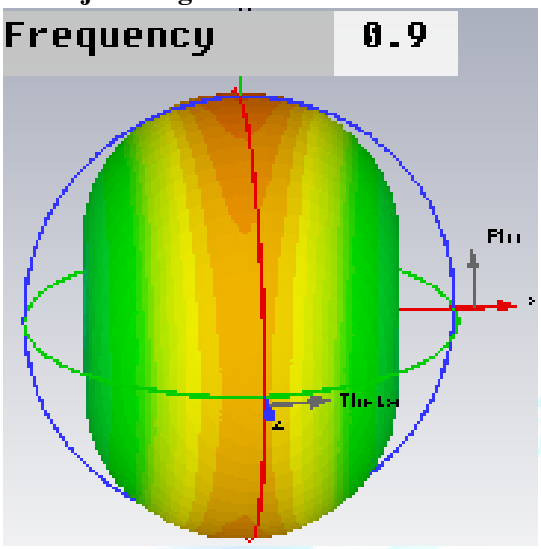

Figure 7a) Radiation Pattern at 0.9GHz

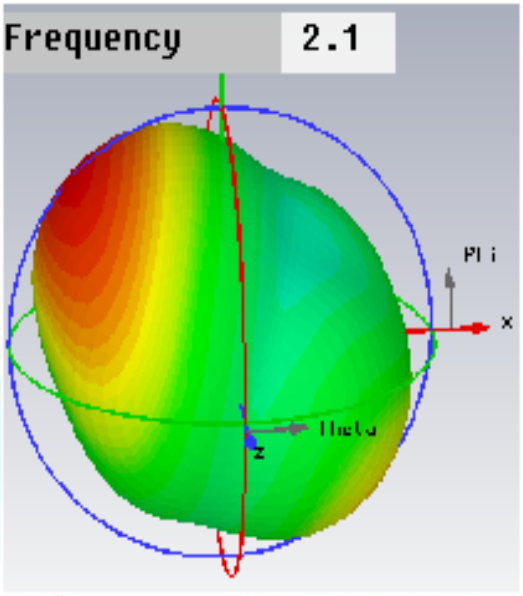

Figure 7c) Radiation Pattern at 2.1GHz

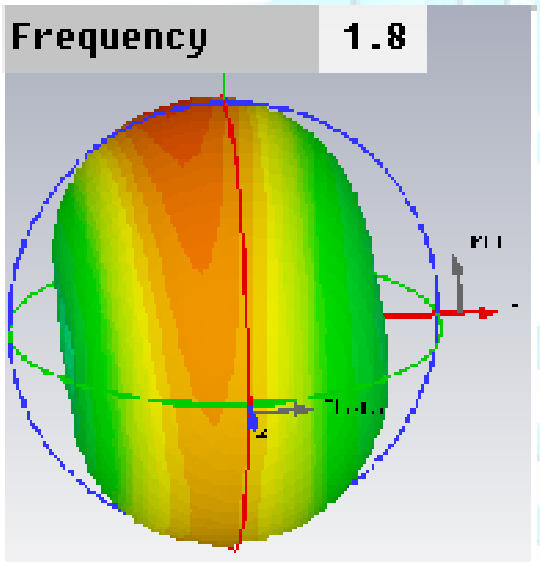

Figure 7b) Radiation Pattern at 1.8GHz

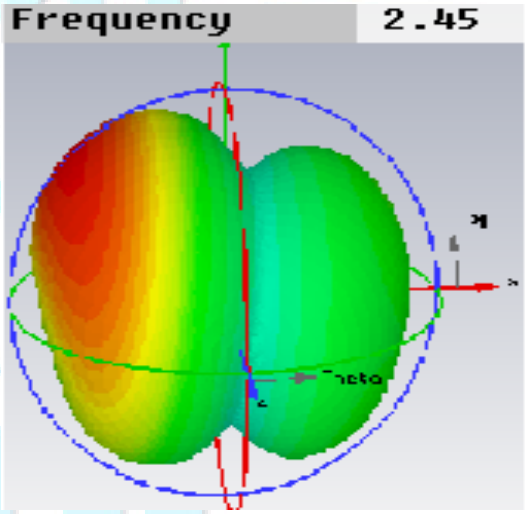

Figure 7d) Radiation Pattern at 2.45GHz

5. Conclusion

The designed antenna satisfies quad band operation. Also the antenna is compact in size which can be suitable for integration with the packaging device in Vehicle. In this paper, Slotting technique is used on the patch for achieving multiband operation. The antenna resonates at 0.9 GHz (E-GSM) 1.8 GHz (DCS), 2.1 GHz (3G) and 2.45 GHz (ISM) with good return loss and VSWR is (< 2) which can be suitable for Automobile communication applications

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