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Compact Asymmetric Coplanar Strip Fed Monopole Antenna for Multiband Applications

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Abstract-A compact asymmetric coplanar strip fed monopole antenna for multiband applications is designed ,The antenna exhibits three resonances around 1.8 2.4 and 5.6 GHz covering the DCS/PCS/UMTS/IEEE UWB of multiband applications, A multiband frequency design of coplanar waveguide(CPW) fed monopole antenna is proposed, and experimental study is carried out. The multiband characteristic of the antenna is due to the various meandered current paths excited in the radiating elements of the antenna .The antenna has an overall dimension of only 28x30 mm2 when printed on a substrate of dielectric constant 4.4 value. The uni-planar design simple feeding technique and compactness make it easy for the integration of the antenna into integrated circuit board. Details of the antenna design experimental and simulated results are presented and discussed here.
Index terms- ultra wide band(UWB) monopole antennas, multiband antennas, printed antennas, uni planar and Asymmetric coplanar strip (ACS).

I. INTRODUCTION

Monopole antennas have found widespread applications in wireless mobile communication systems. The increased use of mobile communication system has stimulated the interest in the dual and multi band design of monopole antenna system for application in multi band mobile communication network. It is noted that monopole antennas are mostly mounted above a large ground plane and excited by a strip feed. A monopole antennas are fed by a CPW-fed knows as coplanar waveguides, it is used in short distance communications like Bluetooth and WLAN at 5.2/5.8 GHz. This has further intensified the need for the integration of multi band antennas working at these frequencies into mobile gadgets and thereby combining data connectivity and user motion. The need for compactness along with multiple bands paved way for the design of various types of antennas such as monopole antennas system, planar inverted-F antennas (PIFAs) and patch antennas .The widely used monopole antenna have advantages like simple structure, omnidirectional radiation coverage, low profile, lightweight and comparatively higher operating range of frequency. These antennas are commonly excited by a probe feed or a micro strip feed with a larger ground plane and has a double layer designs. Uni planar feeding techniques gained attention due to advantages like single metallic layer structure and easy integration to monolithic microwave integrated circuit board. Coplanar waveguide feed (CPW) is the widely used uni planar feeding techniques .The various type of CPW feed antenna are dual frequency monopole antenna resonating in (DCS) digital communication system and 2.4 GHz WLAN band, another is a dual band Y-shaped monopole antenna to obtain resonance for the PCS/WLAN bands. Compact antennas can be designed using a meandered radiating structure and several antennas using this technique have been
Designed .The miniaturization of the antenna structure is the primary criterion as far as the design of a mobile antenna is concerned. All of the above mentioned antennas use a larger ground planes or a coaxial line feeder. Here in this paper a compact multi band monopole antenna is prepared and emphasis is given both to the design of the antenna feed and the radiating structure elements. Asymmetric coplanar strip (ACS) feeding is employed in this design so that a simplified single layer feed structure is prepared. A meandered inverted C is chosen as the radiating structure so as to excite lower frequencies within a smaller area of the fields. The proposed multi band antenna covers the digital communication system (DCS 1710–1880 MHz) personal communication system (PCS 1850–1990 MHz) universal mobile telecommunication systems (UMTS 1920–2170 MHz frequencies. A KADFEKO is used for the simulation and analysis of the structure of the antenna. In the succeeding section the ACS feed is discussed in details. An inverted-C patch is top loaded to the monopole constructed using the ACS feed to obtain the final multiband antenna design. A detailed study has been performed to identify the various resonant modes excited in the structure of the antenna.

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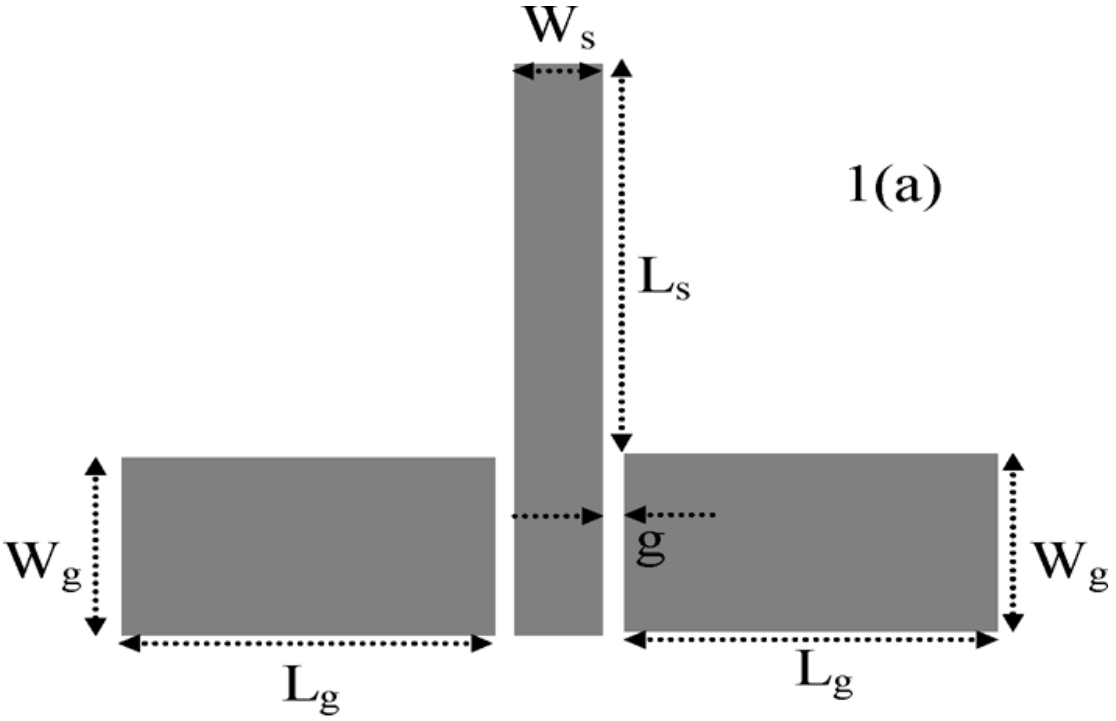
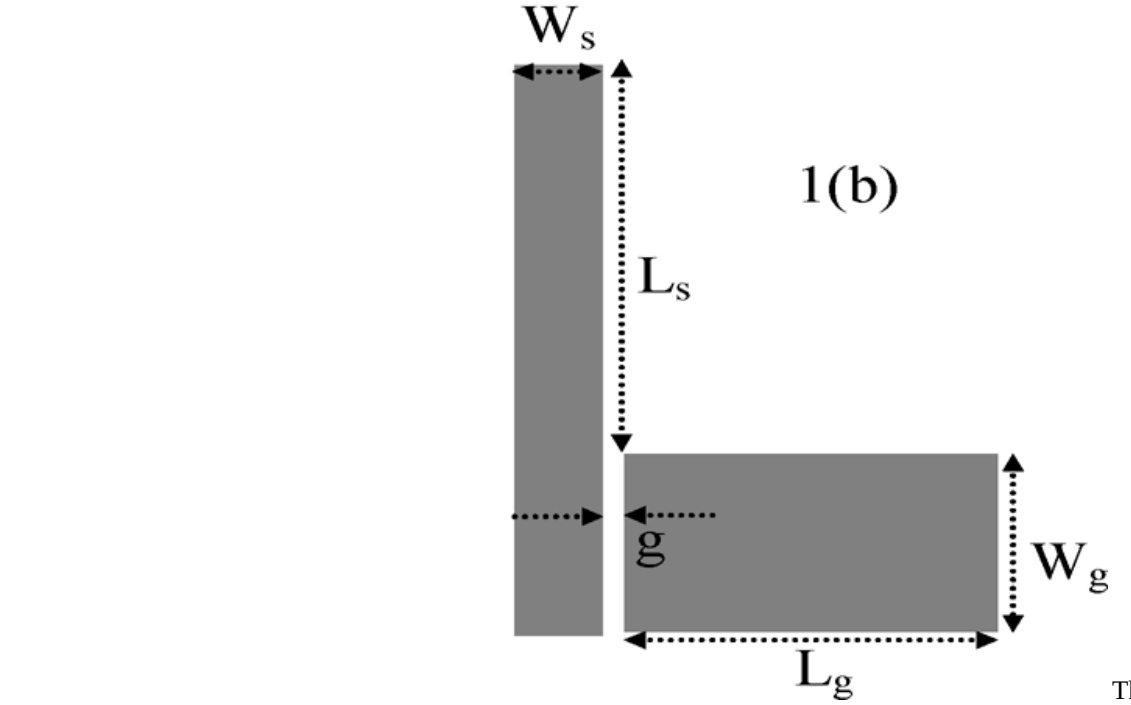
II. THE ASYMMETRIC COPLANAR STRIP (ACS) FEED





The feeding mechanism of an antenna is a critical factor as far as the compactness is taken. Normally the feed structure consumes much of the overall antenna size. This Antenna design is compact and effective feeding technique is applied here. Asymmetric coplanar strip feed used has all the advantages of an uni planar feed along with compactness is taken into consideration. The feeding system is analogous to the coplanar wave guide (CPW) feed except that the ACS feed has a single lateral ground strip plane compared to the twin lateral ground strips in the CPW feed mechanism system for a comparative study a simple monopole of length Ls = Yd/4 and width Ws is excited using both the feeder. This antenna is simulated using KADFEKO software and the reflection and radiation characteristics are obtained here Fig. 1(a) and (b) given below shows the geometry of the CPW

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and ACS feed monopole antennas having length Ls and width Ws of feeds. In this paper Ls is taken as 21.5 mm and Ws as 3 mm. This feeds of both the antennas are designed using standard design equations. The ground plane dimensions of both the antennas are optimized for good matching antennas system. This antenna is designed on an FR4 substrate having dielectric constant 4.4 and thickness 1.6 mm. This has to be noted that the overall antenna dimension is greatly reduced in the case of the second antenna using the ACS feed since it uses only a single lateral ground plane of feed systems. The simulated principal plane radiation patterns of the two monopole antennas are shown in Fig. 2, The CPW fed antenna has a bidirectional E plane pattern and an omnidirectional H plane pattern of radiation. The ACS fed antenna also exhibits similar radiation patterns but the E plane pattern is slightly asymmetric due to the asymmetry of the ACS feed structure of the antenna.

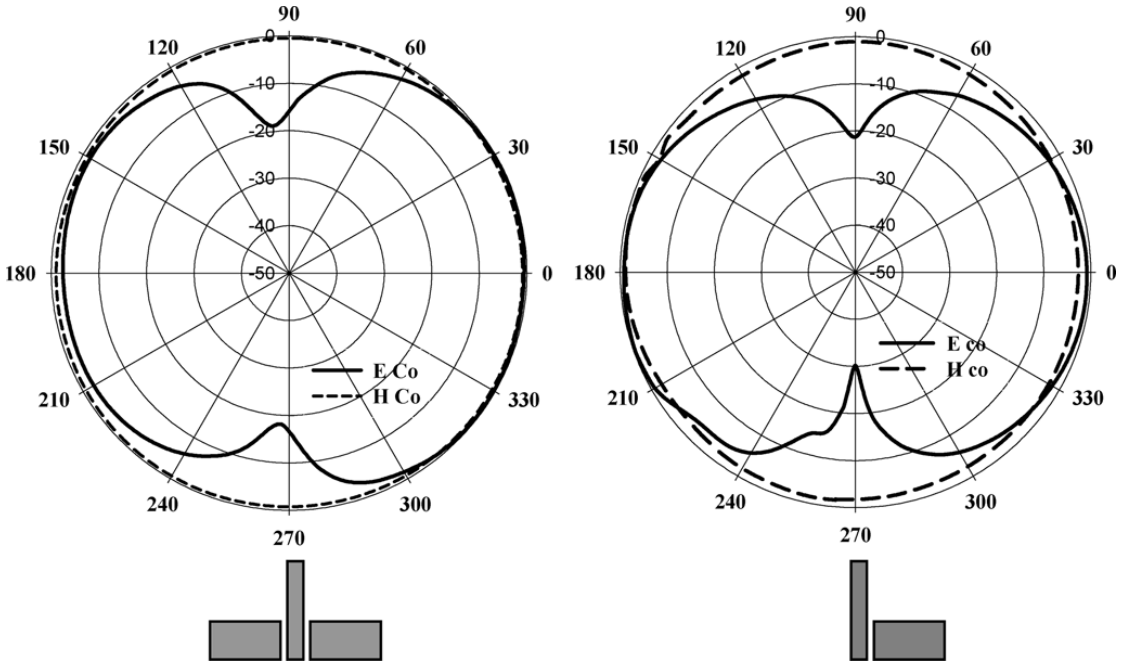

Fig-2 Simulated principal plane of radiation pattern of the proposed CPW and ACS feed monopole antenna

From the various paper review it can be concluded that the asymmetric coplanar strip feed can be used as an effective feeding technique for compact antenna design system. The antenna constructed using the ACS feed exhibits all the advantages of the CPW fed antenna together with more compactness of the size. The compact ACS fed monopole antenna discussed above exhibits good radiation characteristics for a single band operation mode. The following section describes the design and analysis of a multi band antenna using the ACS feed mechanism of the antenna. The aim of the design is to realize a compact multi band antenna that can be easily housed within the space allocated in a wireless gadget meeting the stringent specifications like large impedance bandwidth and good radiation characteristics of the antenna.

III. PROPOSED ACS FEED INVERTED-C PATCH TOP LOADED MONOPOLE ANTENNA

In this section the proposed inverted-C patch top loaded monopole antenna with the ACS feed is studied.

Antenna Design

The geometry of the proposed multi band antenna is shown in Fig. 3, the antenna comprises of an inverted C patch top loaded monopole excited by a compact ACS feed mechanism, The C patch is used

To effectively bring down the resonant frequency keeping the antenna dimensions within the desired specifications limit. The feeding arrangement comprises of a signal strip of width S and length Wg separated from the ground plane of length Lg and width Wg by a gap g, the radiating structure comprises of two vertical strips of dimensions L7xS and L2xW2 and two horizontal strips L1xW1 and L3xW3. The length of the individual strip is selected to obtain resonances at the desired frequencies. The width of the strips is adjusted to obtain the required bandwidth of operation, The width of the vertical strip (L0xS) is set as that of the signal strip for design easiness. The optimum dimensions of the strips and the ground plane are obtained after the exhaustive simulation study. The antenna has an overall dimension of 28x30 mm2 including the ground plane

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when constructed on an FR4 substrate of dielectric constant 4.4 and thickness 1.6 mm of design. The uni planar antenna can be easily printed on the single side of a substrate.

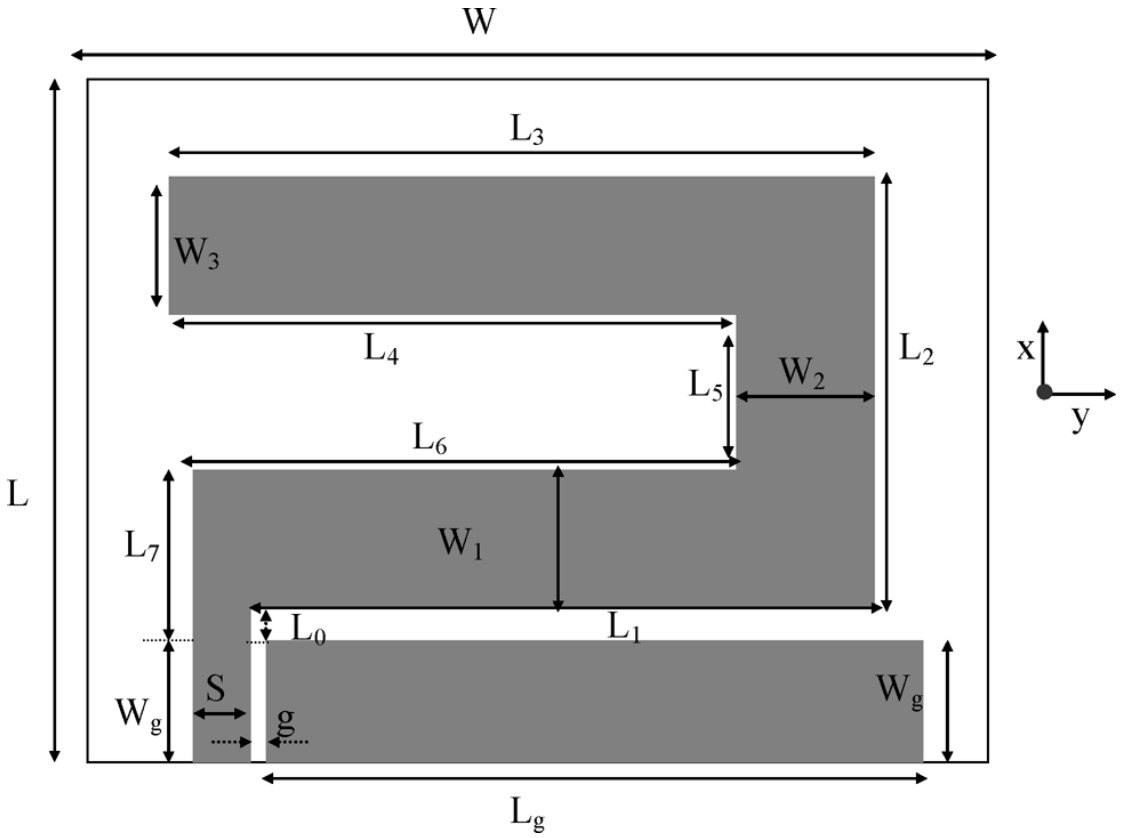
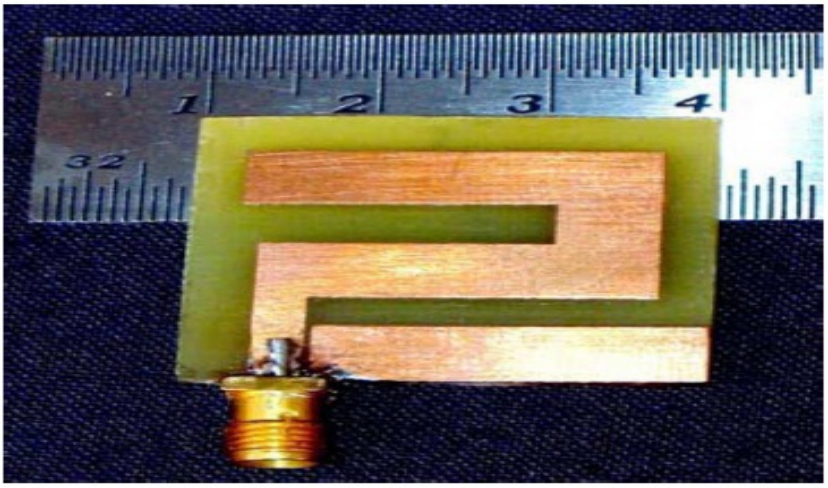


Fig-3 Geometry of proposed inverted-C multiband antenna

The ACS fed multi band antenna is as shown below



i. Photograph of the proposed ACS fed multiband antenna.

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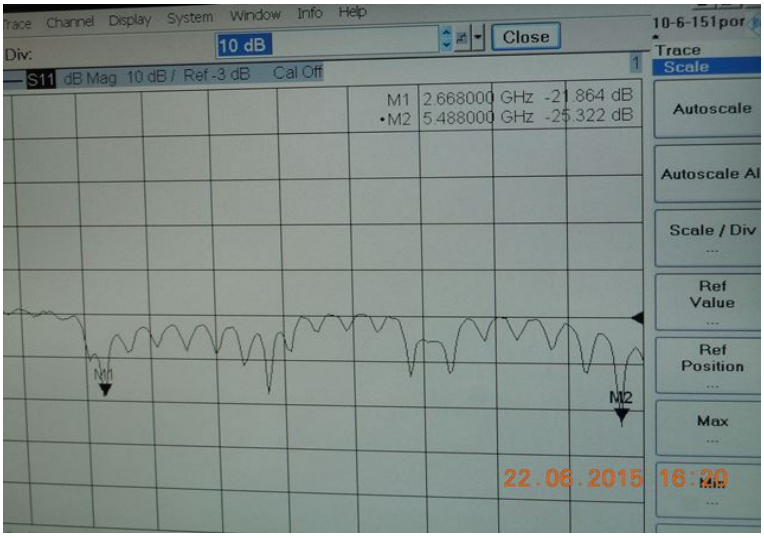
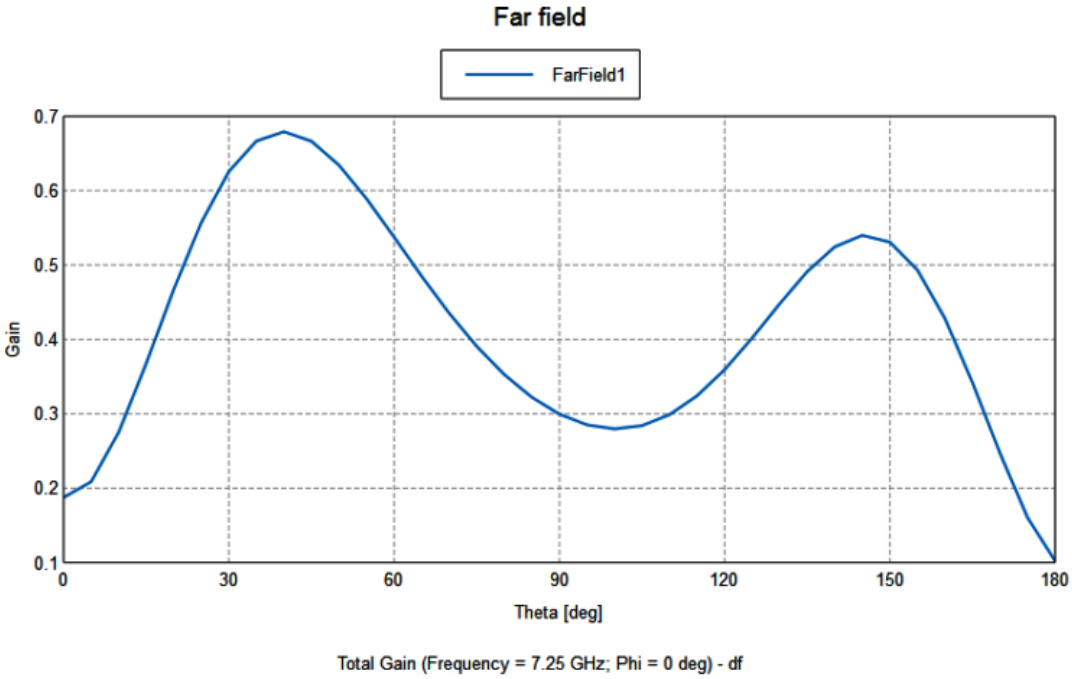
IV Results and analysis





Total Gain (Frequency = 7.25 GHz; Phi = 0 deg) - df

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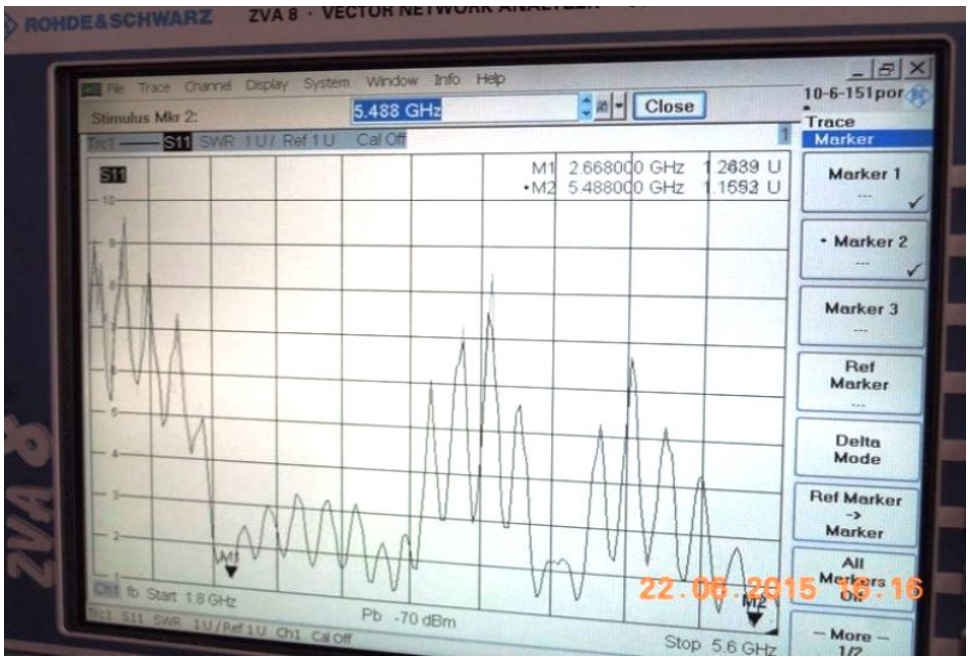

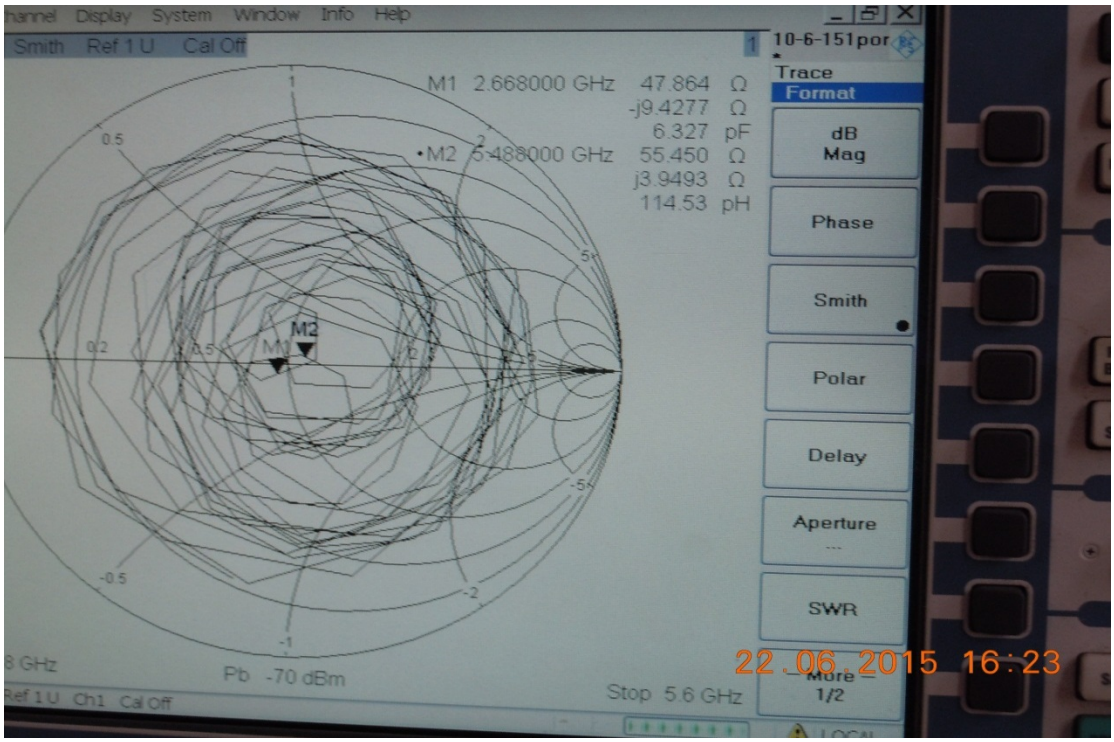

Impedance of the antenna

At M1 of 2.668 GHz we get impedance of 47.864 ohm-j9.427 ohm and at M2 of 5.488 GHz we get impedance of 55.450 ohm+j3.949 ohm.

Return loss (S11) of the antenna at two band of frequencies we get

1. At M1 of simulated frequency 2.668 GHz we get the return loss of -21.864dB.
2. At M2 of simulated frequency of 5.488 GHz we get the return loss of -25.322 dB

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V Conclusion

A compact multiband antenna designed for digital communication system, personal communication systems and universal mobile telecommunication (DCS, PCS and UMTS) applications is presented. Compactness of the antenna is achieved by using the ACS feed and a meandered radiating elements. The antenna has a simple geometry and easy to design, low cost and most importantly small in size which is easy to fit into the space of the wireless gadgets.

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