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# Design of Duplex Patch Antenna for Wireless Communication

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ABSTRACT

In this paper, the design of duplex patch antenna with circle and rectangular slots were proposed for wireless communication. This antenna consists of one radiating patch, two dielectric substrates i.e., upper substrate and lower substrate and set of T-shaped probes establish the connectivity between the two substrates. The microstrip filtering network isused to feed the antenna. The isolation between two ports is improved by using this resonator based filtering channel as feeding network. The overall dimension of the antenna is 100× 100 ×5.2mm.The proposed antenna achieves 36dB isolation between two ports and the return loss is -27dB over the operation band. The antenna was designed and simulated by using HFSS simulation software.

Keywords: Duplex antenna, port isolation.

## 1. INTRODUCTION

Wireless communication systems, particularly mobile and satellite communication, have experience rapid improvement in the past years. In base stations, where the Uplink and Downlink channels occupy two separate frequency bands, the duplexer is often used for the transmitter and the receiver to share an antenna. The duplexer is typically required to have a high isolation between the transmitting and receiving ports to reduce the channel interference.

Full duplex (Simultaneous Transmission and Reception i.e. STAR) communication is one of the essential operating modes in modern wireless communications. The STAR mode has the advantages of double data throughput and improved communication efficiency [1-3]. The main challenge in this type of system is to enhance the isolation between the transmitter (TX) and receiver (Rx) to reduce mutual interference.

To achieve high Tx and Rx isolation, the antenna integrated with triplexer have been employed to realize STAR performance [4] In base stations, where the uplink and downlink channels occupy two separate frequency bands, a duplexer is often used for the transmitter and the receiver to share an antenna. It is common to use antennas cascaded with duplexers or filters to distinguish the full-duplex communication. Due to the different bandwidth of the duplexer, filter, and the antenna, they are generally not well matched; then it will decrease the system performances of the system and also increase the size and weight of the overall system.

In the decade, diplexing antennas have been designed with dual-polarization for achieving high isolation. In [5], the anisotropic feature of photonic bandgap (PBG) structures was used in a dual linear polarization diplexer microstrip antenna exhibiting enhanced receiving/transmitting (Rx/Tx) isolation. Port isolation was comprehensively enhanced in [6] by placing a spiral-shaped defected ground structure (DGS) pattern under the feed line of a dual-frequency orthogonally polarized rectangular patch antenna. In [7] a dual band filtering diplexing patch antenna is proposed. It utilizes microstrip resonators and a slot loaded patch to generate the

Two-order bandpass filter response, resulting in high frequency selectivity and low interference between the Tx and Rx ports. In [8] an integrated filtering microstrip duplex antenna array with high isolation and same polarization was designed. A Transmission Line (TL) model is adopted to design the PDDN to achieve the functions of power division, frequency selectivity, and port isolation. The implemented antenna achieves an average gain of 10 dBi, a cross-polarization ratio of 20dB, and an isolation of 35 dB within the operation band.

## 2. DESIGN OF DUPLEX PATCH ANTENNA

The proposed Duplex Patch antenna consists of one radiating patch, the two substrates i.e. upper substrate and lower substrate and two set of T shaped probes. The dimension of the substrate is (100×100×1.6) mm which is made up of using FR4 Epoxy dielectric material with Relative permittivity as 4.4 and relative permeability as 1 and two set of T-shaped probes are used between the upper substrate and lower substrate. An air gap with height of 2 mm is introduced between the two substrates. The Patch is printed at top of the upper substrate which has dimension as (48.4×48.4) mm is made up of using copper with thickness of 0.035mm.The overall dimension of the antenna is (100× 100 ×5.2) mm.

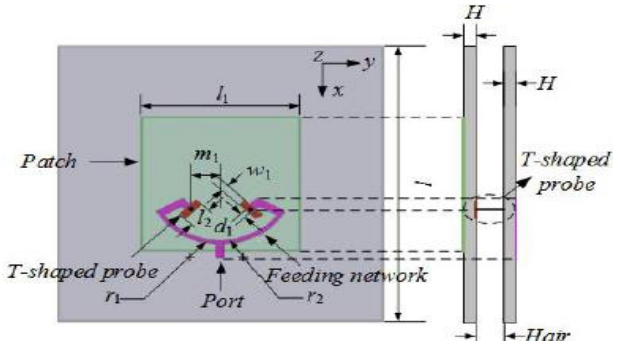


Fig: 1. Basic Broadband Antenna

The T shaped probe consist of horizontal stripline and vertical metalized arm, the one end of the vertical metalized arm centrally connected with the horizontal stripline which is printed backside of the upper substrate, and the other end is connected to the microstrip feeding network through a circle slot etched on the ground plane and a via-hole in the lower substrate. The feeding network is printed on back side of lower substrate. When the port is excited, the signal transmits through the feeding network to the T-shaped probes, then couples to the patch.

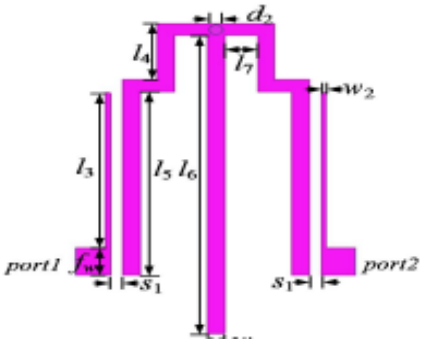


Fig: 2.a Lower Channel Filter

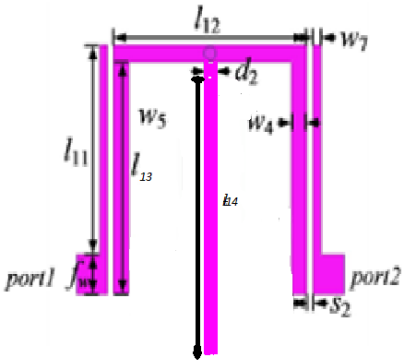


Fig: 2.b Higher Channel Filter

The dimensions of the T-shaped probe are as follows: l2= 7 mm, w1= 2 mm, m1=9.2 mm and d1 = 1 mm. The horizontal stripline of the T-shaped probes are along the diagonal direction and symmetrical to the center of the patch. The above fig 2.a shows the parameters for lower channel filtering networks as: fw =2.25 mm, s1= 0.2 mm, d2= 0.8 mm, l3=12.75 mm, l4= 4.6 mm, l5= 15.1 mm, l6= 24.3 mm, l7= 1.9 mm, w2= 0.3 mm, w3= 1 mm. The parameters for high channel filter are shown in Fig. 2.b: s2= 0.4 mm, s3= 0.2mm, l11= 12.05mm, l12= 12.5 mm, l13= 4.75 mm, l14=24.3 mm, w4= 1 mm, w5= 0.6 mm, w6= 1.4 mm, w7= 0.5 mm.

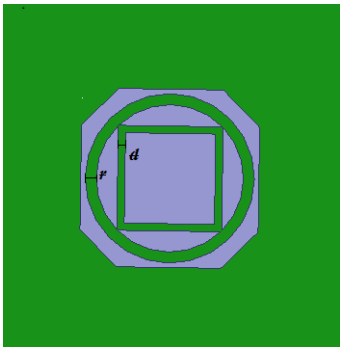


Fig: 3.a Front View

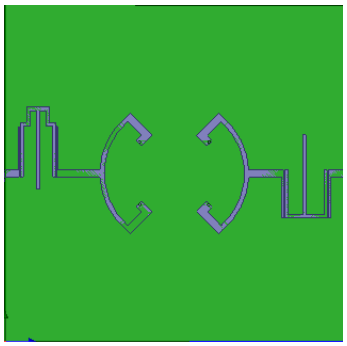

Fig: 3.b Back view

Rectangular and circle slots were introduced in patch which is placed on top of the upper substrate which is shown in fig 3.a. The dimensions of the rectangular slots are 28.5 ×28.5 mm and the circle has radius as r=3mm (r1=23mm, r2=20mm).

## 3. RESULTS AND DISCUSSION

The following results show the return loss and isolation between the two ports of the duplex antenna using HFSS simulation software.

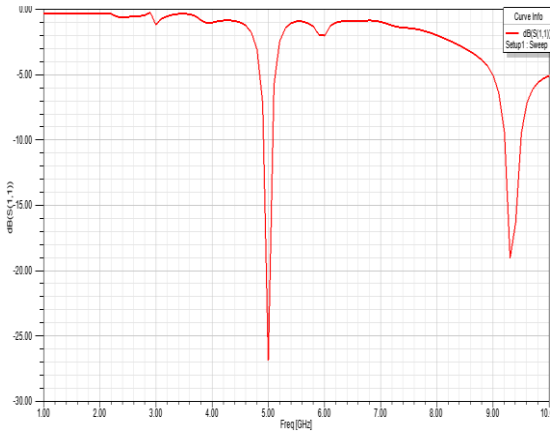


Fig: 4.a Return loss

The return loss in the lower band is −27db and in higher band is −19dB.The impedance bandwidth of lower band is3% (4.93−5.08GHz) and higher band 3.2% (9.22-9.52GHz) respectively.

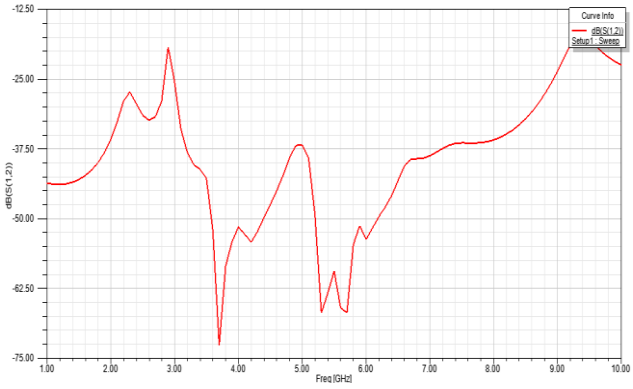


Fig:4.b Isolation between two ports

The above Fig 4.b illustrates the isolation between the two ports of the compact

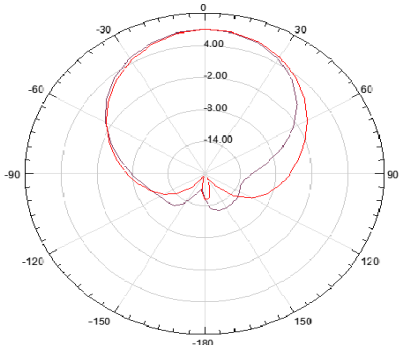


Fig: 5. Radiation Pattern at 5GHz duplex patch antenna. The isolation in the lower band is higher than 36dB, and that in the higher band is 19dB.

## 4. CONCLUSION

The Compact Duplex Patch Antenna was proposed in this project. This antenna were composed of two dielectric substrates, one radiating patch, four T-shaped probes and two set of resonators based filtering channel. The return loss -27dB and -19dB for lower and higher band are obtained. The isolation between two ports are -36dB obtained using resonator based filtering channel as feeding network and the impedance bandwidth are calculated by using simulation results from HFSS simulation software. These obtained results of duplex patch antenna are useful for IEEE802.11a Wi-Fi networks, Wi-Max, WLAN and airborne radar applications.

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