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# Design Of Compact Quad Antenna For Diverse Generation Of Mobile Applications

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## ABSTRACT

A novel design of quad antennas used for mobile applications has been designed and proposed in this thesis. The designed antennas are implemented for the operation of 2G, 3G, 4G and 5G applications. In order to eliminate coupling effect different structures are used such as electromagnetic bandgap structures, split ring resonator structure. But in our approach, we achieved elimination of coupling effects without using any decoupling structures. The proposed design consists of four radiating elements. Each antenna is designed for specific band of frequencies utilized by specific generations of wireless communications. The designed radiating structures has a centre frequency of 0.9GHz, 1.7GHz, 2.7GHz and 3.5GHz. Ansoft High Frequency Structure Simulator (HFSS) software has been employed to obtain the simulation results. The same structure is analysed and is incorporated with feed network and performance is obtained which shows the same centre frequency and gain.

# I.INTRODUCTION

### 1.1 OVERVIEW OF ANTENNA

Antenna is a specialized transducer that converts radio-frequency (RF) fields into alternating current (AC) or vice-versa. There are both receiving transmission antennas for sending or receiving radio transmissions. As the electrons (tiny particles inside atoms) in the electric current wiggle back and forth along the antenna, they create invisible electromagnetic radiation in the form of radio waves.

### 1.2 GENERATIONS OF MOBILE COMMUNICATION

Mobile communication has transfigure the way people use to communicate each other to exchange information. From the very first technology 1G in which information was exchanged in form of basic voice signals while the 2G came up with many add on features with new capacity and coverage capability. This followed by the 3G which was designed to achieve greater speeds with mobile broadband experience. 4G which is developed later which provide wide range of telecommunication services. Though the technology of communication has developed in short period of time but it is not satisfactory for the customers growing population and mobile devices around the world using this communication facilities are expecting more speed and greater services than present technologies. This lead to the development of new research of communication given name 5G which will come up with much greater speed, exceptional applications, Quality of Service (QoS). This paper will provide a review of the earlier technologies of mobile communication and on the present technology and a glimpse on the upcoming technology in future.

### 1.3 MONOPOLE ANTENNA DESIGN

Monopole antenna is one of the types of wired antenna consisting of a straight rod shaped conductor**.** It is one half of a dipole antenna, almost always mounted above some sort ground plane and hence are attractive when a smaller antenna is needed. Antenna son older cell phones were typically monopole antennas, with an infinite ground plane approximated by the shell (casing) of the phone. Monopole antennas are specially used in airborne communication devices and also deployed in ground based communication at a wide range of frequencies. It is commonly used in radio broadcasting and Broadband planar monopole antennas have all the advantages in terms of their cost and ease of manufacturing besides, yielding very high bandwidth. If monopole antenna is designed using PCB technology, integrating it with other electronic components at the same time isn't hard or expensive to do. Here, the monopole antenna is deployed to get desired band of frequencies for mobile communications.

### 1.4 QUAD ANTENNAS

Quad antennas are mainly implemented for a collective operation of different bands of frequencies in same module. The antenna structure will be made so compact so that large construction structures are needed. The antennas implemented by these quad approach will be operated in its own individual frequencies. These antennas will be operated in 2.4GHz ISM band operation. The main objective of FIFA antenna is to reduce the negative effect caused by nearby objects. In a normal design procedure FIFA antenna can be redesigned by adding a ferrite layer at the bottom of flexible substrate. FIFA antennas are mainly implied to design antennas of lower frequencies. But as of today's scientific development world is going towards 5G communication, hence the importance of FIFA antennas are reduced.

## II. LITERATURE SURVEY

This letter presents a wideband/multiband quad antenna system for 4G/5G/GPS metal-frame mobile phones. The quad-antenna system has two kinds of antenna elements and four antenna elements. The proposed antenna system is a quad- antenna system is achieved under the condition of metal frame, and without using any decoupling structure, the desired bands for 4G/5G/GPS are covered The measured efficiencies are bigger than 40% at all the working bands. The measured envelope correlation coefficients are very suitable for multiple-input– multiple-output (MIMO) communication systems. [1].

In this paper, a novel technique of collocating a millimeter wave end-fire 5G beam steerable array antenna with a low-frequency planar inverted-F antenna (PIFA) is presented. A quad-element mm-wave array with end-fire radiation patterns operating in 22–31 GHz is integrated with a dual-band low-frequency PIFA in a mobile terminal. The coverage efficiency of the proposed mm-wave 5G antenna is better than 50% and 80% for a minimum gain of 4 and 0 dBi in 22–31 GHz, respectively. The gain of the high-frequency antenna array is better than 9.5 dBi at 28 GHz [2].

In this paper, a quad-mode endfire planar phased antenna array with wide scan angle and 1.2 mm clearance is proposed for 5G mobile terminals. The proposed antenna can obtain over 8 GHz of impedance bandwidth. In the array, similar and wide embedded radiation patterns are obtained for the all four modes. The coverage efficiency of around 50% for the threshold gain of 5 dBi is achieved in the chosen frequency range. [3].

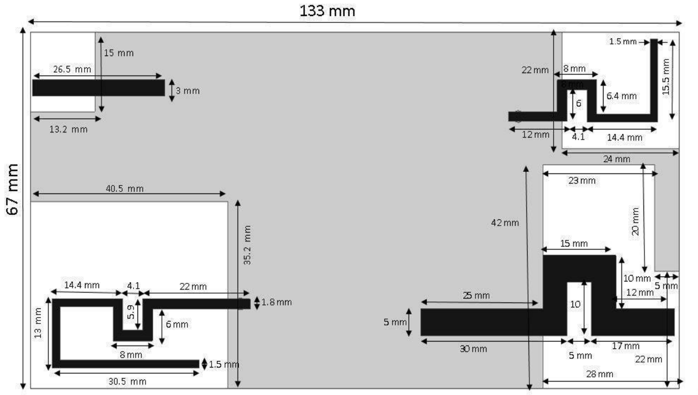
An LTE MIMO antenna array, which is adaptive to the effects of the user's body, is presented for mobile terminals. The bands of 750–960 MHz and 1700–2700 MHz are covered with a good efficiency in free space. Three kinds of user effects are studied, namely, "SAM head and PDA hand," "PDA hand," and "dual hands" [4].

In this letter, a four-antenna system with high isolation for mobile phones is presented. The antenna system, which consists of one main antenna and three auxiliary antennas, is located on the phone circuit board. By suitable arrangement and design, the isolation between antennas of higher than 15 dB can be obtained By suitable arrangement and design, the isolation between antennas of higher than 15 dB can be obtained, and the efficiency of the antenna system in the working frequency band reaches 40% or above [5].

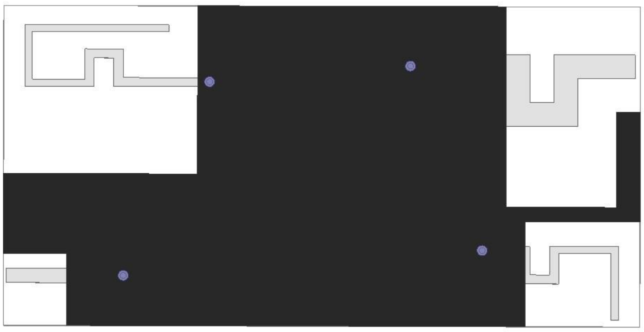
A wideband quad-antenna system for mobile terminals is studied. Because a quad-antenna system could consist of two dual-antenna systems, the dual-antenna systems in the open literature are utilized as a fundamental building block. The mutual coupling between them is analyzed, and a decoupling method is adopted. To validate the design, a wideband quad-antenna system, consisting of two symmetry wideband dual-antenna systems and a decoupling element, is fabricated and tested [6].

### III. DESIGN METHODOLOGY OF THE PROPOSED ANTENNA

In this design, the antenna has been simulated using the High Frequency Structure Simulator (HFSS) and also the results are fully verified. To further improve the bandwidth, ground defection technique has been used. These antennas has an advantage of small size and simple structure for fabrication.




**FRONT VIEW OF THE PROPOSED QUAD ANTENNA WITH MODIFIED GROUND PLANE**



**2 BACK VIEW SHOWING THE FEED POINTS AND THE GROUND PLANE**

### 3.1 PROPOSED METHOD

A monopole antenna is a class of radio antenna consisting of a straight rod-shaped conductor, often mounted perpendicularly over some type of conductive surface, called a ground plane as shown in Fig 2.2. The driving signal from the transmitter is applied, or for receiving antennas the output signal to the receiver is taken, between the lower end of the monopole and the ground plane. One side of the antenna feed line is attached to the monopole, and the other side is attached to the ground plane, which is often the Earth. This contrasts with a dipole antenna which consists of two identical rod conductors, with the signal from the transmitter applied between the two halves of the antenna. The monopole is a resonant antenna; the rod functions as an open resonator for radio waves, oscillating with standing waves of voltage and current along its length. Therefore, the length of the antenna is determined by the wavelength of the radio waves it is used with. The most common form is the quarter-wave monopole, in which the antenna is approximately one quarter of the wavelength of the radio waves. Common types of monopole antenna are the whip, rubber ducky, helical, random wire, umbrella, inverted-L and T-antenna, inverted-F, mast radiator and ground plane antennas.

## 3.2 RESULT AND DISCUSSION

### ANTENNA DESIGN 1

**Fig.1.1 Antenna 1 with Standard cuts**

This Fig.1.1 shows monopole antenna designed on FR4 substrate with dielectric constant (Ɛr) = 4.4 and thickness 0.8 mm, patch, feed and the ground plane are made from copper and have a thickness of 0.03

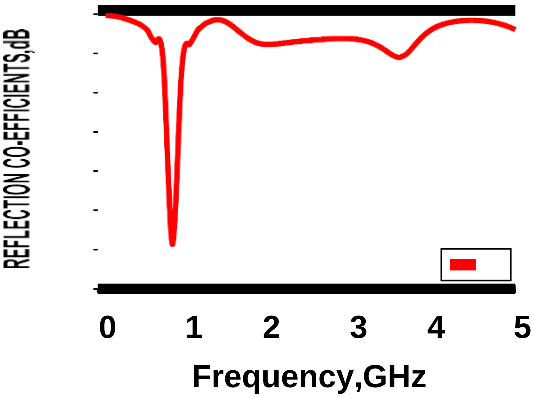



Fig 1.2 Simulated Output of Antenna 1 and Antenna 1

This Fig.1.2 shows antenna design 1 has been working at a centre frequency of 0.9GHz required for GSM 900 with a bandwidth of 0.8 – 0.9GHz

**ANTENNA DESIGN 2**

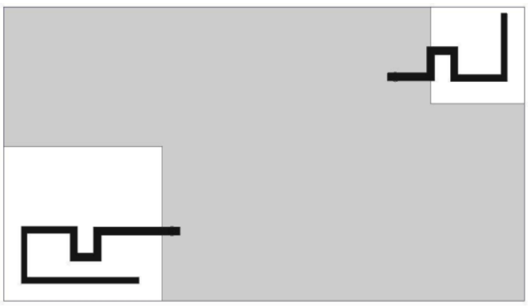


Fig 1.3 Antenna 1 and Antenna 2 with standard cuts

This Fig.1.3 shows monopole antenna designed on FR4 substrate with dielectric constant (Ɛr) = 4.4 and thickness 0.8 mm, patch, feed and the ground plane are made from copper and have a thickness of 0.035mm.

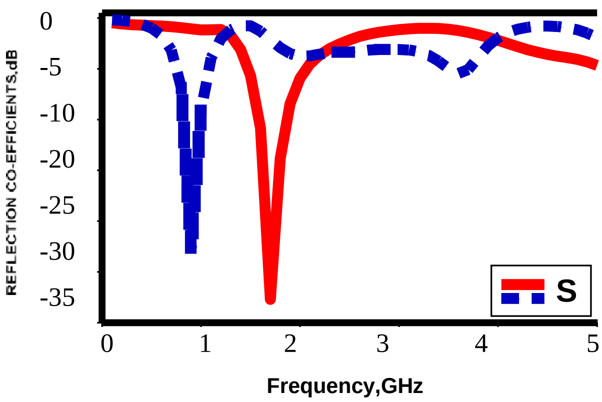



Fig 1.4 Simulated Output of Antenna 1 and Antenna 2

This Fig.1.4shows antenna design 2 with two antennas has been working at a centre frequency of 0.9GHz and 1.7GHz required for GSM 900 and GSM 1800 with a bandwidth of 0.8 – 0.9GHz and 1.58 – 1.88GHz.

## ANATENNA DESIGN 3

Fig.1.5 Antenna 1, 2 and 3 with standard cuts than design 2

This Fig.1.5 shows monopole antenna designed on FR4 substrate with dielectric constant (Ɛr) = 4.4 and thickness 0.8 mm, patch, feed and the ground plane are made from copper and have a thickness of 0.035mm.

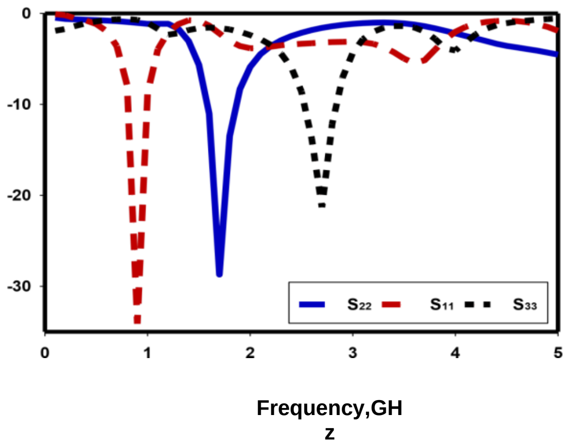



Fig.1.6 Simulated Output of Antenna 1, 2 and 3

This Fig.1.6 shows antenna design 1,2,3

with three antennas has working at centre frequency of 0.9GHz, 1.7GHz and 2.7GHz required for GSM 900, GSM 1800 and GSM 2500 with a bandwidth of 0.8 – 0.9GHz, and 2.5 – 2.8GHz.

### Antenna Design 4

This FiG.1.7 shows monopole antenna designed on FR4 substrate with dielectric constant (Ɛr) = 4.4 and thickness 0.8 mm, patch, feed and the ground plane are made from copper and have a thickness of 0.035mm.

**Fig.1.7 Antenna 1, 2, 3 and 4 with standard cuts than design 3**

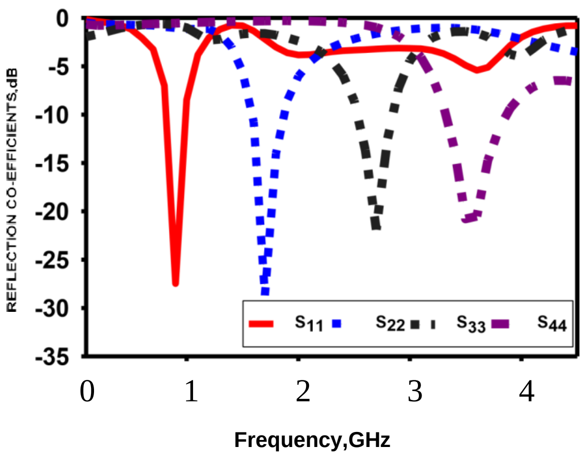
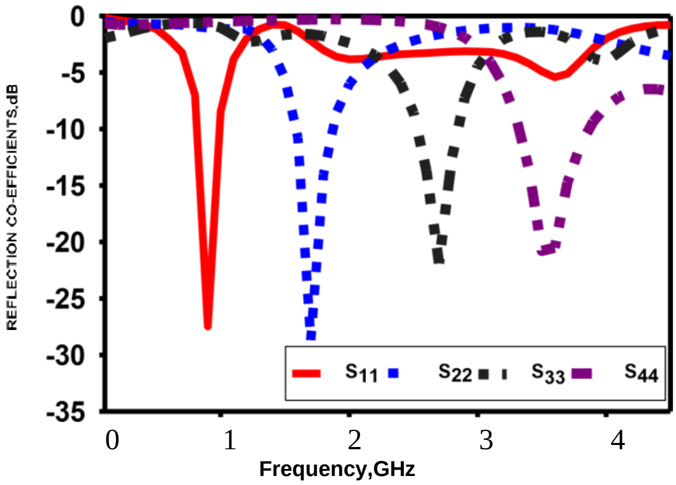



Fig.1.8 Simulated Output of Antennas 1, 2, 3 and 4

This Fig.1.8 shows antenna design 1,2,3 and 4 with four antennas has been working at a centre frequency of 0.9GHz, 1.7GHz, 2.7GHz and 3.5GHz required for GSM 900, GSM 1800, GSM 2500 and 5G with a bandwidth of 0.8 – 0.9GHz, 1.58 – 1.88GHz, 2.5 – 2.8GHz and 3.3 - 3.38GHz.

## SIMULATED OUTPUT




**Simulated output showing antennas working at different frequencies**

## RADIATION PATTERN

The radiation property of most concern is the two or three dimensional spatial distribution of radiated energy as a function of the observer's position along a path or surface of constant radius. Various parts of a radiation pattern are referred to as lobes, which may be classified into major or main, minor, side, and back lobes. A radiation lobe is a portion of the radiation pattern bounded by regions if relatively weak radiation intensity.

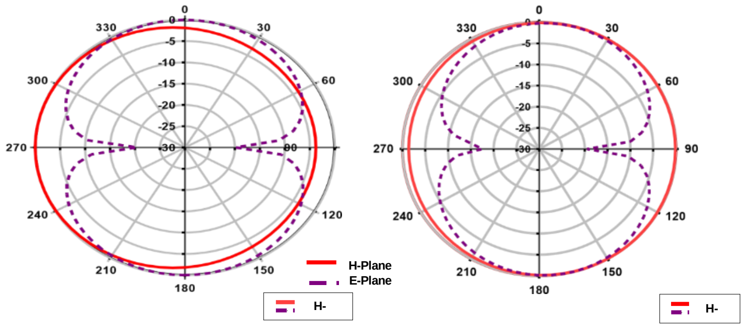



Fig.1.11 RADIATION PATTERN OF ANTENNA 1

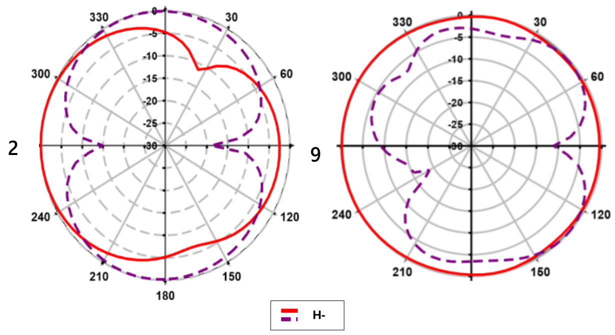


Fig.1.14 RADIATION PATTERN OF ANTENNA 4

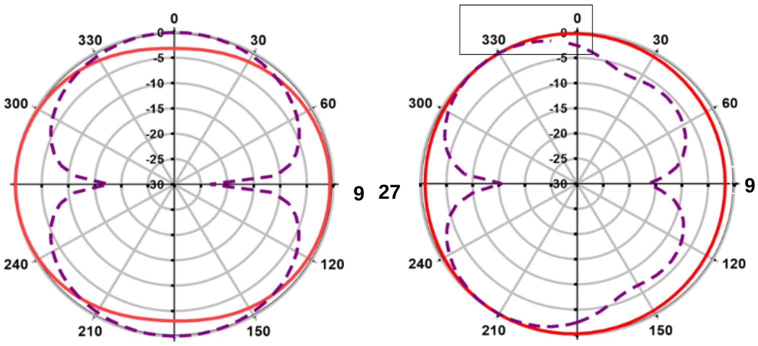


Fig.1.12 RADIATION PATTERN OF ANTENNA 2

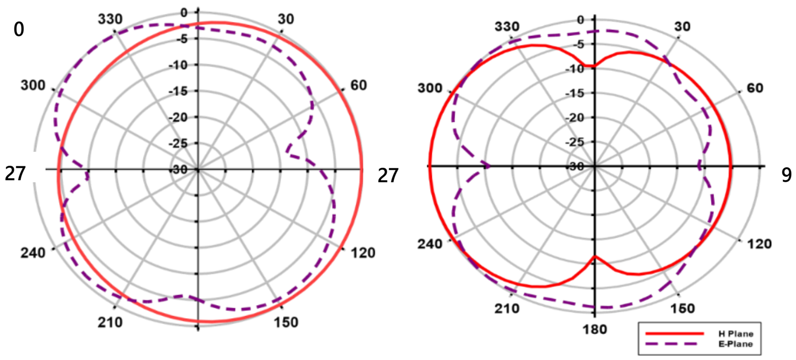



Fig.1.13 RADIATION PATTERN OF ANTENNA 3

# IV. CONCLUSION

Thus a compact quad antennas is designed for 4 different range of frequencies which have been implemented fo different generations of wireless communications for mobile applications. The characteristics of easy to fabricate, can be implemented in mobile phones of small size and stable radiation pattern make the propose antennas suitable for mobile communications. The proposed quad antenna has a simple structure and minimized size of 133×67 in comparison with other mobile antennas. Simulated result for Envelope Correlation Coefficient for four antennas are demonstrated.

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