Multiband and Wideband MIMO Radio Wire's for Versatile Applications

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Abstract

An MIMO antenna based on meander lines with an L-shaped metallic strip for multiband operation is shown in this study. A monopole antenna with numerous sections of short-circuited transmission line works as an inductor and changes the antenna's impedance characteristics; this configuration is called a meander line. By using a line slot DGS (Defective Ground Structure) to decrease the mutual coupling between the antenna components and inserting two U slots on the ground plane, a 69% reduction in antenna size miniaturisation was accomplished. Well below the stated limit, we get the values of the envelope correlation coefficient (ECC) and specific absorption rate (SAR).

Keywords: MIMO; mobile antenna; multiband antenna; wireless communications; high isolation; miniaturization

Introduction

Wireless service-based communication technologies are experiencing their pinnacle of expansion. Because of this meteoric rise, not only have the fundamental needs of the wireless sectors, but it also raised the bar for antenna makers. Currently, there is a need for a small antenna that can operate over a broad range of frequencies. When more than one electromagnetic band has to be covered in a single application, a wideband antenna is a great choice. An ultra-wideband (UWB) antenna may connect to any and all major communication applications, including WLAN, WiMAX, satellite, radar, and more [1]. The typical operating frequency range for a UWB antenna is between 3.1 and 10.6 GHz. Numerous publications from the past and present have proposed wideband monopole antennas. Researchers mostly use the introduction of slots or faults in the resonating surface or with the bottom plane as a means to enhance the antenna's effective or fractional BW [2-3]. Antenna features such as a smaller operating frequency area, an expanded operating band, and a patch that is coupled to a finite impedance via slots cut into the ground plane are described in references [4-5]. Using asymmetric slots or several patches with varying forms is another way to increase the bandwidth

Antennas with wide bandwidths have also been obtained by several researchers using CSRR or EBG structures.

One potential issue with these methods is that they might cause fading when dealing with multipath circumstances. Antenna arrays are used to address this issue. Another option is to use a multiple-input multiple-output (MIMO) antenna, which may significantly increase the antenna's bandwidth but isn't always a solution to the issue. In addition to being very efficient, these antennas are also superior in terms of directivity.

In order to demonstrate multi-band operability and enhance the antenna fractional bandwidth, this study proposes a MIMO antenna configuration. The antenna is capable of functioning across many bands within the electromagnetic spectrum. Antennas in the X, Ku, K, and Ka bands are covered by it. I have submitted the results of the simulation of the suggested design that was conducted using the hfss v15 software to this document.

Proposed Geometry of MIMO Antenna

Based on its relative dielectric constant, the 2×2 compact multi-band MIMO resonator is built on an inexpensive and readily accessible FR-4 epoxy glass substrate has a loss-tangent of 0.02 and a thickness of 1.6 mm, with a period of 4.4.

Two patches with a hexagonal form and 50Ω impedance microstrip lines make up the structure. To minimise spurious emission as much as possible, the antenna patches are arranged to match the impedance with the microstrip lines. To achieve maximum efficiency and expanded bandwidth with lowest effective ground area, the antenna's ground plane is constructed in a certain way.

Table 1 below organises the general geometrical features of the virtual work. As seen in Figure 1 below, the MIMO structure from top view and hfss design of antenna extracted from the hfss software.

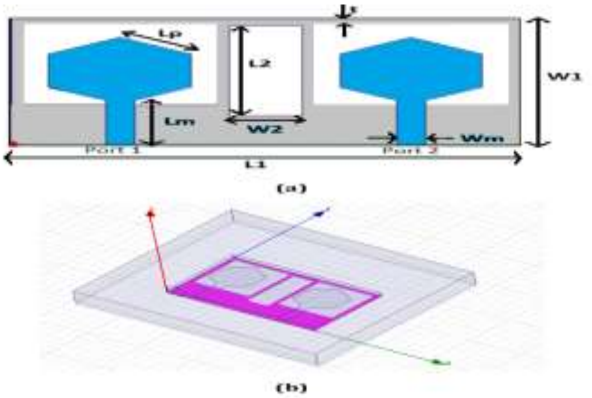

Fig.1. Proposed 2×2 MIMO Antenna (a) UPPER SURFACE showing patch with the ground structure, (b) HFSS mode

TABLE I

2×2 Compact MIMO Antenna: DIMENSIONS

Side	Units (mm)	Side	Units (mm)
L_1	28	L_m	5.9
W_1	17	W_m	1.6
L_2	12	L_p	4.25
W_2	4	t	0.75

In the era of ever-evolving mobile communication standards and the increasing demand for high-data-rate applications, the design of efficient Multiple Input Multiple Output (MIMO) antennas has become paramount. MIMO technology, which utilizes multiple antennas at both the transmitter and receiver ends, has proven to be a key enabler for achieving higher data rates, improved spectral efficiency, and enhanced reliability in wireless communication systems. This paper focuses on exploring the advancements in MIMO antenna technology, with a specific emphasis on Multiband and Wideband MIMO antennas tailored for mobile applications.

Multiband and Wideband Multiple Input Multiple Output (MIMO) antennas play a crucial role in modern mobile communication systems, addressing the challenges posed by diverse frequency bands and the demand for higher data rates. This section presents the theoretical foundations and key concepts related to Multiband and Wideband MIMO antennas for mobile applications.

1.1 Spatial Multiplexing:

MIMO technology leverages spatial multiplexing by employing multiple antennas at both the transmitter and receiver. The fundamental concept involves transmitting multiple data streams simultaneously, exploiting the spatial dimensions to enhance communication capacity and throughput.

1.2 Diversity Techniques:

Diversity techniques in MIMO are designed to combat fading and improve link reliability. Spatial diversity, achieved through the use of multiple antennas, enhances the likelihood of receiving a strong signal at least one of the antennas, mitigating the impact of fading and interference.

2. Challenges in Mobile Communication:

2.1 Spectrum Fragmentation:

The proliferation of different communication standards and frequency bands has led to spectrum fragmentation. Mobile devices need to support multiple frequency bands to ensure compatibility with various networks, necessitating the development of Multiband antennas.

2.2 Carrier Aggregation:

Carrier Aggregation (CA) is a technique employed to combine multiple frequency bands to achieve higher data rates. Wideband antennas are essential for accommodating the wide frequency range required for carrier aggregation.

3. Multiband MIMO Antennas:

3.1 Antenna Element Design:

Resonant Structures:

Multiband antennas often employ resonant structures capable of operating efficiently across different frequency bands.

Matching Networks:

Matching networks are used to adapt the impedance of the antenna to different frequency bands, ensuring optimal power transfer.

3.2 Band Switching Techniques:

Switchable Components:

Multiband antennas may incorporate switchable components, such as varactors or PIN diodes, to dynamically switch between different resonance frequencies.

Discuss the trade-offs involved in implementing band switching techniques, considering power consumption and complexity.

4. Wideband MIMO Antennas:

4.1 Wideband Antenna Design:

Wideband Elements:

Wideband antennas are designed to operate over a broad frequency range.

Explore different antenna elements, such as planar monopoles or printed dipoles, suitable for wideband applications.

4.2 Impedance Matching:

Balun Structures:

Balun structures are often employed to achieve impedance matching in wideband antennas.

Discuss the importance of impedance matching for maximizing power transfer and efficiency.

Conclusion

The development and integration of Multiband and Wideband Multiple Input Multiple Output (MIMO) antennas for mobile applications have been at the forefront of advancing wireless communication systems. In this paper, we explored the theoretical foundations, design considerations, and challenges associated with these antennas, aiming to enhance the efficiency, spectral utilization, and reliability of mobile communication networks.It is proposed in the study to use a 2×2 MIMO antenna for several bands. Using hfss software, the radiation is calculated during the modelling phase of the planned antenna personality traits. In regards to its return loss, ECC, DG, radiation pattern, and VSWR, the suggested antenna has excellent radiation characteristics. Miniaturisation of the antenna size is another outcome.

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