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A Review on Band Notch Antenna

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Abstract: These days, different antennas are preferred/devised for different wireless applications, which raise the complexity, bandwidth utilization, power and size of the device. The antenna can be used for various combinations of wireless applications such as Wi-Fi, WiMAX, and Bluetooth etc. within microwave S and C bands in the electromagnetic spectrum. Particular band rejection is very important from the security point of view and to evade interference, as interference can modify or disturb the signal propagating from source to destination through the channel. This review paper encapsulates different band rejection techniques, using split-ring resonator or Multiple Input Multiple Output (MIMO) antenna etc.
Keywords: Multiple Input Multiple Output (MIMO), Interference, Band Rejection, Microstrip Patch Antenna.

1. Introduction

Currently, there is an increased interest in different antenna applications for use in several fields like satellite communication, space application, and wireless communication as present and future applications. The micro strip antennas are the current day antenna designer's choice. The microstrip antenna gives Low dielectric constant substrates that are generally preferred for maximum radiation. In the micro strip antenna rectangular and circular configurations are the most commonly used configuration but the conducting patch can take any shape. Other configurations are complex to analyse and require heavy numerical computations.

In most of the application, interference is a major issue. Most of the bands interfere with other bands due to which degradation of the signal, less accuracy, distorted output, cross talks etc. occur. Different band rejection techniques are available to minimize the interference, using split-ring resonator, Multiple Input Multiple Output (MIMO) antenna or using any other microstrip patch antenna etc. In recent years, there has been a growing interest in utilizing MIMO antenna because of its specific characteristics. Multiple-input-multiple-output (MIMO) antenna can be used to improve isolation and increase impedance bandwidth [1]. MIMO technology, which involves the use of multiple antennas at both the transmitter and receiver, is used to enhance channel capacity and data transmission performance [2]. To avoid the interference between frequency bands, the band reject MIMO antenna is available. Antennas are used in satellite communication, military purposes, mobile communication, missile systems etc. For e.g. in military application if a particular band is being used for communication and the information has to be confidential, then that band can be rejected for other users so that they cannot interfere in the band where confidential information is shared. Another new technique to reject the band planar monopole antenna are used that covers 3G, Bluetooth, WiMAX, and the UWB bands by using one quasi-complementary split-ring resonator (CSRR) in the feed [3].

Isolation is an important parameter in antenna. Isolation between two antennas is a measure of how tightly coupled antennas are. To improve the isolation, decoupling element is introduced. One of the important factor is mutual coupling. Reduction in mutual coupling is preferred because energy that should be radiated away is absorbed by a nearby antenna, thereby reducing efficiency and performance of antennas. Microstrip antenna has proven to be excellent radiator for many applications because they are lightweight, have a small volume and have a low profile planar configuration. MSA has ease of mass production using printed-circuit band technology which leads to a low fabrication cost. MSAs are easier to integrate with other MICs on the same substrate and they also allow for dual- and triple-frequency operations [4].By varying the different parameters of the antenna or using a suitable structure, a particular band of the spectrum can be rejected [2].

First Section provides introduction of MIMO antenna as well as other important parameter of the antenna and also discuss about interference. The remainder of the paper provides depth study of various band reject techniques to avoid the interference. Throughout the discussion, band reject techniques are highlighted.

2. Band Rejection Techniques

Multiple Input Multiple Output (MIMO) communication systems use multiple antennas that are equipped at receiver and transmitter ends to enhance the available data rate in multipath environments [5]. The basic concept of MIMO is to use multiple antenna elements to transmit or receive signals with different fading characteristics [1]. The MIMO antenna offers good isolation (S21<-15dB) and dual band rejection at WiMAX (3.4–3.7 GHz) and WLAN (5.15–5.35 and 5.725–5.825 GHz) over the UWB system operation (3.1–10.6 GHz). Varying the different parameters of the antenna, the impedance of the band of interest can be controlled [4]. As shown in Figure 1, when length of branch 1 (Lf) is reduced, the notched band around 5.5 GHz is shifted toward higher frequencies, and it only slightly affects the antenna performance of the other band. Isolation improvement and dual band-rejection operation were achieved by using only a single structure Isolation improvement and band-rejection operation were achieved by using only a single structure [4].

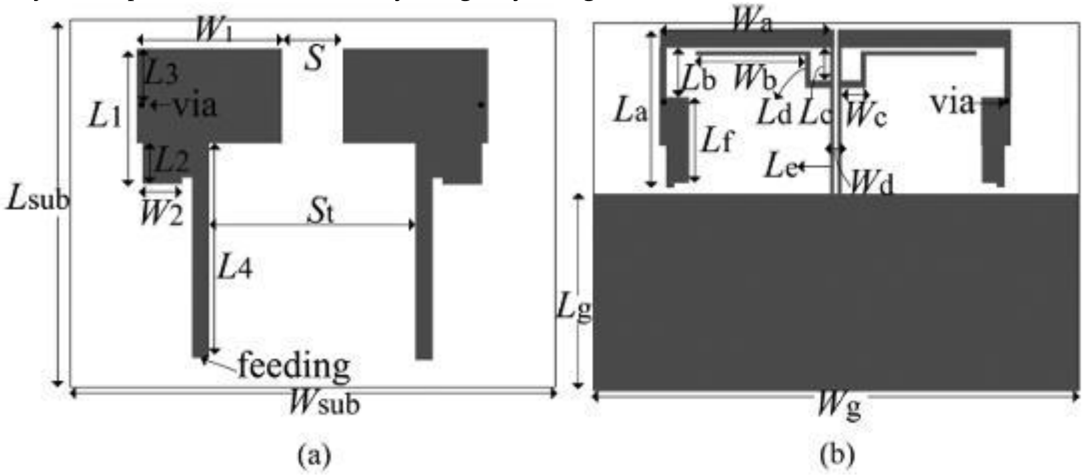

Figure 1. Band reject MIMO antenna (a) top view (b) bottom veiw [4]

The another author has proposed the antenna that consists of a printed folded monopole antenna coupled with a parasitic inverted-L element, with an open stub inserted in the antenna to reject the WLAN (5.15–5.85 GHz) band that interferes with the UWB band. This antenna was modified to enhance the bandwidth and reject the WLAN (5.15–5.85 GHz) band [2]. Good isolation can be achieved by the antenna which consists of two planar-monopole (PM) antenna elements with microstrip-fed printed on one side of the substrate and placed perpendicular to each other. Along with isolation enhancement, impedance bandwidth can also be increased by two long protruding ground stubs that are added to the ground plane on the other side. A short ground strip is also used to connect the ground planes of the two PMs together to form a common ground [1].

A new type of ultra-wideband (UWB) antenna with a novel small square monopole antenna with single and dual band-notched characteristics and wide bandwidth capability for UWB applications is proposed. In design, the proposed antenna can operate from 2.75 to 18.46 GHz. Two notched frequency bands are obtained by embedding two Lshaped slots in the radiation patch and a T-slot in the feed line and a V-shaped strip in the ground plane as shown in fig.2 [5].

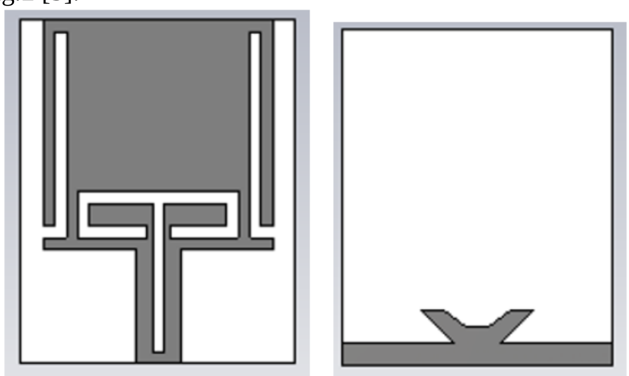

Figure. 2. Geometry of Microstrip monopole antenna (a) top view (b) back view [5]

Yong Qiang Hei proposed another technique to avoid interference by introducing a new planar monopole antenna that covers 3G, Bluetooth, WiMAX, and the UWB bands but exhibits dual band-notched characteristic. By using one quasi-complementary split-ring resonator (CSRR) in the feed line, dual notched frequency bands centered at 5.3 and 7.4 GHz are obtained as shown in figure 2 below [6].

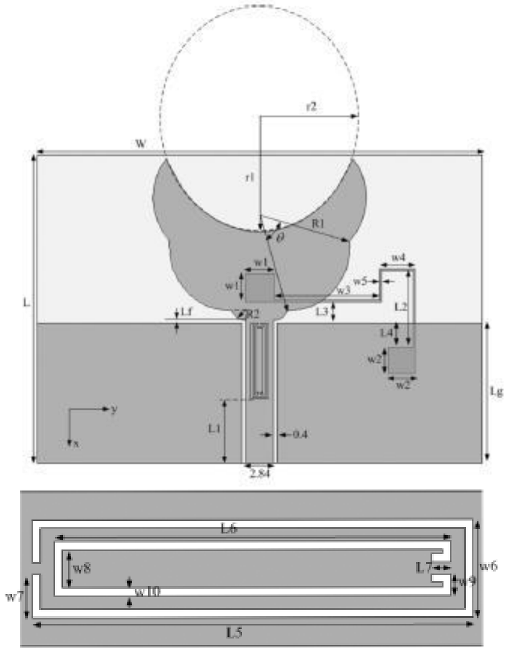

Figure. 3. Planar monopole antenna using Geometry of quasi-CSRR [6]

To achieve high isolation a compact dual band-notched UWB MIMO antenna is presented which gives high data rate for wireless communication system.

The author has achieved a good isolation for frequencies 4.0 GHz, where two protruded ground parts are used to increase electrical length of the radiator [7]. MIMO-UWB antenna presents the WLAN band rejection based on Electromagnetic Bandgap (EBG) structure [8]. A mushroom-like EBG structure is used to reject the WLAN frequency at 5.5 GHz and to reduce the mutual coupling of the antenna. A stub structure acting as a multi-mode microstrip resonator (MMR) is inserted to suppress the effect of surface current to the elements of the antenna [8]. By implementing V-inverted shape slot in the patch plane, band rejection is obtained for WLAN. MIMO configuration also achieves high isolation between two antennas [9].

To enhance the isolation between two closely packed antennas which operates at the same frequency band, a coupling element is introduced. Inserting a coupling element artificially creates an additional coupling path between the antenna elements. The idea is to use field cancellation and hence the isolation can be improved. This antenna can operate in WLAN with maximum 30 dB isolation, 2 dBi peak gain and 60% peak efficiency [10]. To achieve excellent broadband isolation performance MIMO antenna is design. The broadband insulators can efficiently reduce the coupling of MIMO antennas. Here the Metamaterial (MTM)- inspired resonators can function as insulators and are placed periodically into a compact MIMO antenna system. T-shaped branch added behind the insulators improves the isolation bandwidth markedly. An isolation bandwidth under 20 dB can achieve 19.3% relative to the center frequency [11]. For the Long Term Evolution (LTE)/Worldwide Interoperability a compact dual-band multiple-input–multiple-output (MIMO) antenna array with eight elements is proposed. The dual-band MIMO array consists of four U-slit etched planar inverse-F antennas (PIFAs) and four L-slit etched PIFAs. To reduce mutual coupling, the two types of PIFA are placed orthogonally between them. The presented decoupling methods give the excellent element isolation (above 20 dB) and good return loss (above 10 dB) across the operating bands (2.6–2.8 and 3.4–3.6 GHz) for all the PIFA elements [12].

To enrich the port isolation a compact decoupling network between two closely spaced antennas is proposed [13]. Here two transmission lines (TLs) are individually connected to the input ports of two strongly coupled antennas. To change the trans-admittance between ports at the antenna inputs from a complex one to a pure imaginary one, suitable length of transmission lines (TLs) can be designed and to cancel the resultant imaginary trans-admittance a shunt reactive component is attached in between the TL ends. At the end a simple lumped-element circuit is added to each port for input impedance matching. High antenna isolation and good input return loss is achieved [13].

Here the antenna structure simulated by using IE3D or HFSS. Then it is fabricated on the FR4 substrate which has a dielectric constant (εr) of 4.2 - 4.4 and loss tangent (tan δ) of 0.02. The substrate thickness is available in the range of 1.6 mm - 2.4 mm. The FR4 substrate is abundantly available, relatively cheaper and provides ease in fabrication. The performance of the fabricated antenna is measured by using the Vector Network Analyser (VNA).

3. Conclusion

This paper analyses the study of Band Reject Microstrip Patch Antenna as the particular band rejection is important from the security point of view and to avoid interference. It has also offered a review of recent research techniques to reject particular band. By parametric study good isolation and dual band rejection at WiMAX (3.4–3.7 GHz) and WLAN (5.15–5.35 GHz and 5.725–5.825 GHz) can be achieved. Whole paper consist of different band reject antennas like monopole band reject antenna MIMO band reject antenna to avoid the interference between the bands. To reduce mutual coupling between antennas decoupling structure used. Other techniques to reduce mutual coupling as well as to improve isolation are discussed in the paper. This review has shown that issues related to the interference of different frequency bands in antennas and also band reject techniques to play a significant role in it.

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