International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)
doi : https://doi.org/10.32628/IJSRST

A Compact Dual Band-Notched MIMO Diversity Antenna for UWB Wireless Applications

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Article Info

Publication Issue
Volume 10, Issue 1
January-February-2023

Page Number
576-582

Article History
Accepted: 01 Feb 2023
Published: 28 Feb 2023

ABSTRACT

A compact multiple-input multiple-output (MIMO) spatial diversity antenna with dual band-notches modelled and studied numerically for the proposed WCDMA is included in this research. Two radiating components supported by two tapered micro strip lines consisting of the antenna. The WLAN and IEEE INSAT / Super-Extended C-band of two inverted L-shaped slits are being used to implement notches. By implementing a T-shaped decoupling system on the ground plane, an isolation of further 15 dB is accomplished across the entire working band. It also discusses the MIMO antenna's envelope correlation coefficient (ECC), diversity gains (DG), multiplexing performance, TARC, peak gain and radiation efficiency. The modelled and calculated analysis shows that a successful candidate for WCDMA implementations of the proposed antenna.

Keywords : Isolation, band, Multiple-input - multiple-output (MIMO), GSM, wide-band code-division multiple access (WCDMA).

I. INTRODUCTION

In recent years, ultra wideband (UWB) communication systems have been investigated to meet the demand for high data rate, low cost, and low power. Since the Federal Communications Commission (FCC) allowed 3.1–10.6 GHz unlicensed band for UWB communication, UWB communication has become a hot topic in the wireless communication area [1]. In recent days UWB antennas certainly have drawn considerable interest in analysis as an essential component of the UWB communications networks. Broad characteristic impedance, emission control, low profile, portable size, and low cost [2] are the constraints of the practicable UWB antenna structure. In addition, UWB systems like other wireless communication systems often recover with multipath fading. Multiple-input - multiple-output (MIMO) model is designed in UWB systems to offer multiplexing gain and diversity gain, thereby improving ability and connecting quality [3].

Several strategies have been proposed to overcome the challenges listed previously. Such strategies of decoupling could be focused on three key groups. The very first approach is the use of [4]–[6] UWB diversity antennas. This predictive algorithm's principle is close with those of dual-polarized antennas. The antennas implementing this approach might achieve high isolation efficiency. Conversely, since differentiation systems typically have complicated realization types, miniaturization is difficult to realize the size of the antenna. The latest process is frequently established, and could be regarded as a proposed algorithm incorporating the two former methods [3], [6]–[7].

Ultra-wideband (UWB) technology plays an important role in modern communication networks, owing to multiple benefits, also including low price and high data rate [1]. Multipath fading and channel fading can therefore enable Wireless communication to become unstable. Multiple-input - multiple-output (MIMO) architecture has indeed been suggested to address this problem. MIMO is a critical instrument for UWB wireless communication systems by the use of several positional beams to receive complimenting that use different radiation characteristics to enhance multipath fading problem and co-channel interference [2]. Terminal devices have continued to be miniaturized in latest days, so severe reciprocal interaction amongst antenna arrays and other electrical co-operators can happen.

Different methods to reducing the interconnection among widely spaced antenna elements so far have been suggested, including such alternative explanation structure [3],[4], synthesis line[5], disconnecting network [6], including met material [7]. Since these strategies are helpful in decreasing reciprocal correlation, they typically take up extra space to organize the different functions.

A slot radiator loaded with an AMC reflector reported in [16] can achieve 10 dBi gains, 5% bandwidth, with a height of 0.063λ. A stub-loaded AMC reflector was proposed in [7], where the antenna backed with the AMC can achieve 17% impedance bandwidth and 12.4 dBi gain with a low profile. In MIMO proposed antenna, therefore, isolation amplification will become one of the critical problems. Thus since then there have been studies of different forms of decoupling techniques [5]-[7]. In [5]-[8], it is sufficient to decrease the reciprocal coupling by considering innovative decoupling components, such as tree-like [7] and floating parasite [8] frameworks. In addition, to exclude interfering with current wireless communication systems including the 5.15-5.85 GHz Wireless Local Area Networks (WLAN), antennas are necessary filter out the unwanted band. Many other UWB MIMO antennas have recently been established with band-reject processing [1]-[3]. Conversely, assigning probabilities in above-mentioned methods to conventional MIMO / diversity antennas is quite challenging, since it will result in powerful mutual coupling amongst radiating components. It also significantly influences the band-rejection mechanisms to get high isolation and decoupling characteristics. When antennas are built compactly, that has seldom been documented, this will become more difficult. A published flattened dielectric substrate antenna was previously suggested that meets the UWB specification with the WLAN band-rejection [12]. Recently published initiatives on the miniaturisation of UWB components have been influenced by the explosive development of wearable electronics and a wireless personal area network (WPAN) [5]. Such a good 5.5-GHz band-notched improvement is measured by inscribing two SRR positions on the corresponding radiators, including powerful capacitor technology. Simulation model and calculated findings reliably indicate that this antenna performs with a notched band of 5.1–6 GHz, from 2.5 to 12 GHz.

II. RELATED WORK

It is produced with such a comparative dielectric constant of 4.4 and a loss tangent of 0.02 on a low-cost FR4 substrate. The total size is 26 × 28 × 0.8mm3 or 0.27λ0 × 0.29λ0 × 0.01λ0, where λ0 is the free-space wavelength at 3.1 GHz. It comprises of 2 radiating half-rectangle components, each fed by curved micro strip feeding lines that boost corresponding input impedance. Every other radiator has two L-shaped reversed slits together introducing a band notch. A T-shaped stub is placed on the ground to ensure high insulation through the operating frequency. The figure below explains antenna configuration.

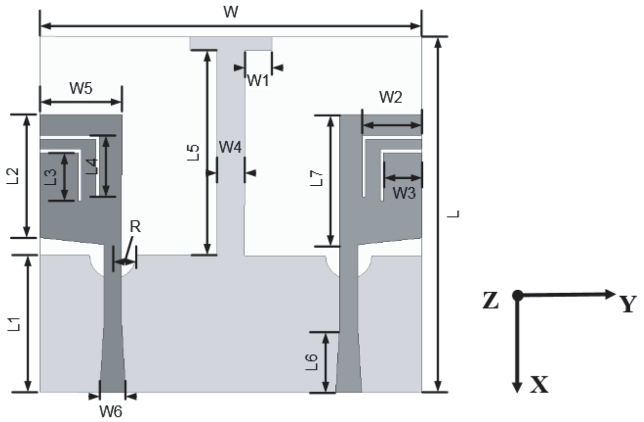

Figure 1 : Structure of the antenna.

Three antenna structures are modelled and simulated by ANSYS HFSS software to properly appreciate the conceptual design for the radiating portion. First, in effort to accomplish UWB features, a half-rectangle radiating portion supported by a tapered micro strip line (Antenna A) is intended. After realizing UWB performance, the antenna is modified to introduce the WLAN (5.15–5.85 GHz) band with an inverted L-shaped slit (Antenna B).

In the designed antenna, two inverted L-shaped slits etched in each radiator incorporate the dual band-notched characteristics. As a λ/4 resonator, these L-shaped slits incorporate impedance overlapping between both the feeding lines and the radiating portion, to acquire band-notched characteristics. The slit length is about $\lambda/4$ at the centre of the rejected band and can be calculated by

$$L = \frac{c}{4f_{center}\sqrt{\epsilon_{eff}}} \quad (1)$$

$$\epsilon_{eff} \approx \frac{\epsilon_r + 1}{2} \quad (2)$$

Where εeff is the effective dielectric constant and c is the speed of light. The upper etched slit rejects the WLAN band, and the shorter etched slit rejects the IEEE INSAT / Super-Extended C band. According to Eq. (1), the length of the upper slit is 8.3mm, and the lower slit is 6.6 mm. In order to observe the impact of the etched slits in detail, the current antenna distributions are plotted. The surface current is distributed at 5.5GHz on the upper split as well as at 6.9GHz on the lower split. In addition, the currents for both frequencies are in different directions on the two sides of the slit. As a consequence, the radiation on both sides in the far regions could mitigate it. Therefore, little radiation occurs, and return loss deteriorates.

The following figure shows the modelled S-parameters, namely S11 and S12. The consequence of the framework of the ground on the insulation is higher than the specifications of reflection. Ground 1's S11 has the largest cut-off frequency at almost 4.3 GHz and isolation at specific concentration in particular is quite small. The reflection parameters improves with both the inclusion of the rectangle stub in Ground 2, but that still does not achieve the UWB specifications, as well as the isolation is weak in the frequency band under 3.4GHz. A T-shaped (Ground 3) decoupling approach is obtained on the ground plane to increase the impedance bandwidth and isolation at low frequencies. The modelled figures show that the –10 dB impedance bandwidth and 15 dB isolation are reached from 2.9 to 10.8 GHz, which satisfies the UWB MIMO systems implemented.

An Agilent AV3672B vector network analyser is used to calculate the S-parameters of the antenna. Associated with manufacturing flexibility there is an appropriate difference between the estimated and calculated performance. As antenna has an impedance bandwidth ($|S11| \leq -10$ dB) from 2.9 GHz to 10.8GHz.

At frequencies of 3 GHz, 6.5 GHz, and 10 GHz, respectively, the predicted and calculated radiation patterns of the manufactured model are plotted, including the X-Z (E plane) and Y-Z (H plane) planes. Because of the logarithmic configuration of the antenna, the radiation patterns are determined in an antenna design while port 1 is stimulated and port 2 ends with a 50Ω load.

III.METHODOLOGY

It is to design a Multiband MIMO Antenna for various applications like GSM, WCDMA and LTE Indoor Applications. The below describes the different bands for x, y co-ordinates. A comprehensive study is given of smart antennas for wide-band code-division multiple accesses (WCDMA). It analyses, tests, and introduces methods and approaches for the implementation of smart antennas there and for subsequent generations of WCDMA third-generation wireless communication systems. The first 3GPP implementation of the Wide-Band Multiple Access Code Division (WCDMA) framework proposed the existence of unique common channels, such as the Secondary Common Pilot Channel (S-CPICH), which would be transmitted over an unique region of the cell to facilitate the UE in radio channel estimation. Actually, for the specific multi beam definition, the S-CPICH will maintain an ideal phase reference. The use of the dedicated channel (DCH) as a phase reference was recently acknowledged. Additionally, the implementation of WCDMA smart antennas demands that the effect of the current channels on overall performance be taken into consideration.

While previous studies used dynamic system simulation models to quantify the gains of FB systems in WCDMA, the influence of the allocations of AS, scrambling code (SCO) and the power configurations of common channels remained widely ignored. It is possible to find other previous articles examining the device efficiency of FB programs in WCDMA. The assessment was carried out in these experiments by terms of quasi-static simulation environment and a generalized channel model was considered in most of these experiments. In addition, the Radio Resource Management (RRM) component was ignored (e.g., power control, handover). Significant RRM functional requirements were frequently taken into consideration, whereas a mean AS was presumed and therefore no optimal scrambling code allocation strategies or optimized power configurations of the network connection were observed. In WCDMA, in two phases, multiple accesses are implemented. The data is first distributed (i.e. channelized) with a multiplexing code corresponding to the code family of the orthogonal variable spreading factor (OVSF). The second step is to scramble the data with a SCO corresponding to the family of the Gold code. A unique SCO is correlated with each user and one or more unique SCOs are aligned with each BS. A small proportion of OVSF codes are available for the channelling code tree. Therefore, either new members are restricted or a fresh SCO should be accessed whenever the tree is occupied.

Sometimes this case would result in the loss of orthogonality that will contribute in the capability of the device being diminished. Since FB programs are designed to increase the load, there may be more than one SCO needed to support Smartphone users. In order to mitigate restricted users due to channelization code limitations, most studies have concentrated on OVSF code reassignment (or allocation). Recently, WCDMA systems fitted with a single antenna have examined the effect of accessing a secondary SCO. The process consisted essentially of adding new applications to the secondary SCO when another primary SCO's code tree was completely occupied. However, the approach includes recommendations for optimising the specification of the WCDMA indoor network antenna. A multiple antenna network with a specific number of antennas is connected to a radiating cable and a number of indicators evaluate the system's behaviour. The results demonstrate that, comparison to radiating cables, the distributed antenna system is a positive alternative. Furthermore, it can be reached the conclusion that the increased bandwidth is not extremely proportional to the amount of antennas in the distributed antenna structure, but the coverage area is more affected width is much wider than the coherence bandwidth of the radio channel. The coherence bandwidth of macrocellular environment varies between 0.053 MHz and 0.16 MHz, which is clearly less than the bandwidth of WCDMA (wideband code division multiple access) system (3.84 MHz). There- fore, WCDMA system is robust for frequency selective fast fading in typical outdoor environments. System is considered wideband, if the transmission band- width is much wider than the coherence bandwidth of the radio channel. The coherence bandwidth of macrocellular environment varies between 0.053 MHz and 0.16 MHz, which is clearly less than the bandwidth of WCDMA (wideband code division multiple access) system (3.84 MHz). There- fore, WCDMA system is robust for frequency selective fast fading in typical outdoor environments. System is considered wideband, if the transmission band- width is much wider than the coherence bandwidth of the radio channel. The coherence bandwidth of macrocellular environment varies between 0.053 MHz and 0.16 MHz, which is clearly less than the bandwidth of WCDMA (wideband code division multiple access) system (3.84 MHz). There- fore, WCDMA system is robust for frequency selective fast fading in typical outdoor environments. System is considered wideband, if the transmission band- width is much wider than the coherence bandwidth of the radio channel. The coherence bandwidth of macrocellular environment varies between 0.053 MHz and 0.16 MHz, which is clearly less than the bandwidth of WCDMA (wideband code division multiple access) system (3.84 MHz). There- fore, WCDMA system is robust for frequency selective fast fading in typical outdoor environments.

IV. RESULTS AND DISCUSSION

We propose a WCDMA method for Compact Dual Band-Notched MIMO Diversity Antenna for UWB Wireless Applications. In WCDMA we are using different band at different co-ordinate points.

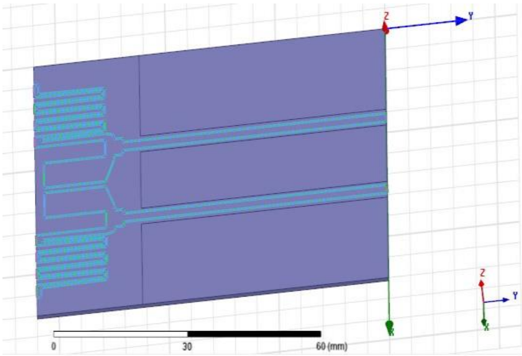

Figure 2 : front view of the antenna.

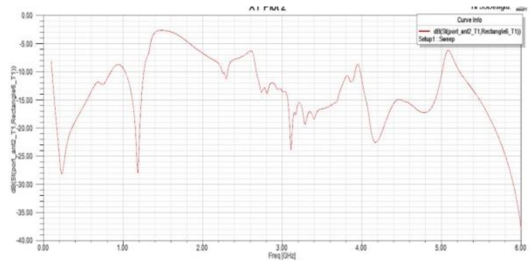

Figure 3 : xy plot between frequency and gain.

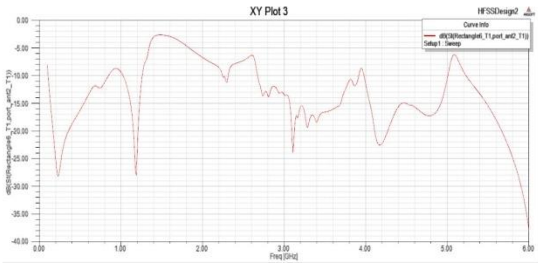

Figure 4 : xy plot between frequency and gain.

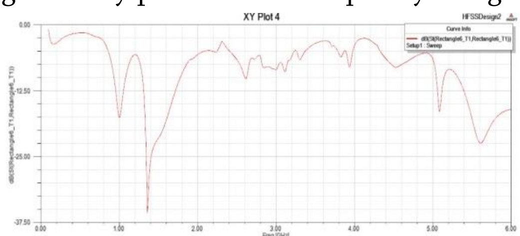

Figure 5 : xy plot between frequency and gain.

Figure 6 : total rE of the antenna.

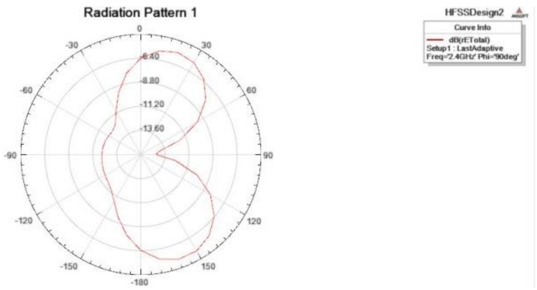

Figure 7 : radiation pattern.

Figure 8 : total gain of the antenna.

Figure 9 : total Dir of the antenna.

V. CONCLUSION

In this work we investigate a dual band-notched compact MIMO antenna for WCDMA. To enhance impedance matching, the problematic ground plane and contoured micro strip feeding lines have been used, and the T-shaped stub on the ground is being used to enhance isolation. The ECC, DG, efficiency in multiplexing, TARC and peak gain demonstrate the performance in diversity is exceptional. All the above characteristics suggest the designed antenna is a successful candidate for such applications as GSM, WCDMA and LTE Indoor Applications.

VI. REFERENCES

[1]. Ma, T.-G. And S.-K. Jeng, "Planar miniature tapered-slot-fed annular slot antennas for extremely wideband radios," IEEE Transactions on Antennas and Propagation, Vol. Fifty three, No. 3, 1194–1202, Mar. 2005.

[2]. Yang, Y., Q. Chu, and J. Li, "Dual band-notched extraordinarily wideband MIMO antenna array," 2013 IEEE International Wireless Symposium (IWS), 1–four, Beijing, 2013.

[3]. Li, J., Q. Chu, and T. Huang, "A compact wideband MIMO antenna with novel bent slits," IEEE Transactions on Antennas and Propagation, Vol. 60, No. 2, 482–489, Feb. 2012.

[4]. Ren, J., W. Hu, Y. Yin, and R. Fan, "Compact posted MIMO antenna for UWB applications," IEEE Antennas and Wireless Propagation Letters, Vol. 13, 1517–1520, 2014.

[5]. Zhu, J., S. Li, S. Liao, and Q. Xue, "Wideband low-profile distinctly remoted MIMO antenna with synthetic magnetic conductor," IEEE Antennas and Wireless Propagation Letters, Vol. 17, No. 3, 458–462, Mar. 2018.

[6]. Toktas, A., M. Yerlikaya, K. Sabanci, A. Kayabasi, E. Yigit, and M. Tekbas, "Reducing mutual coupling for a square UWB MIMO antenna the use of diverse parasitic systems," 2017 10th International Conference on Electrical and Electronics Engineering (ELECO), 982–986, Bursa, 2017.

[7]. Iqbal, A., O. A. Saraereh, A. Bouazizi, and A. Basir, "Met cloth primarily based absolutely drastically remoted MIMO antenna for transportable wi-fi communication," Electronics, Vol. 7, No. 10, 2018.

[8]. Sokhi, I. K., R. Ramesh, and K. Usha Kiran, "Design of UWB-MIMO antenna for wireless applications," 2016 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET), 962–966, Chennai, 2016.

Cite this article as :

Sagar Waghchavare, P. D. Bahirgonde, "A Compact Dual Band-Notched MIMO Diversity Antenna for UWB Wireless Applications", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 10 Issue 1, pp. 576-582, January-February 2023.
Journal URL : https://ijsrst.com/IJSRST22948