

Dual-Broadband Planar Antenna For 2G/3G/LTE Base Stations

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Abstract-A novel dual-broadband planar antenna is proposed for 2G/3G/LTE (4G) mobile base stations. The proposed antenna consists of two elements one for the upper band and another for lower band. It can also be arrayed without grating lobes. The lower band has the pair of printed dipoles with a pair of parasitic elements for bandwidth enhancement. The upper band consists of a pair of folded dipoles. Both the dipoles and the microstrip line are etched on the same substrate. The upper band elements are nested inside the lower band elements forming a compact structure. The dual-broadband antenna achieves a bandwidth of around 2 GHz. The designed antenna can be implemented in mobile base stations. The antenna gain achieved around ~12 dBi which is suitable for the mobile communication base station systems.

Keywords-Planar antenna, Printed dipoles, Parasitic elements, Base stations, Folded dipoles.

1. Introduction

The development of mobile systems requires broadband and low cost compact antenna structure. The various mobile communication systems have been designated with different frequency bands. The 2G systems, such as GSM900/GSM1800, CDMA, and PCS, operate in the 900 MHz (825–960 MHz) and 1800 MHz (1710–1920 MHz) bands [1], while the 3G systems, such as TD-SCDMA, WCDMA, and cdma2000, operate in the 2 GHz (1880–2170 MHz) band [2]. The future LTE (4G) systems will operate in the 2.3 GHz (2300–2400 MHz) and 2.6 GHz (2570–2690 MHz) bands. Hence base station antennas can simultaneously cover various separated frequency bands centered at 900 MHz (810–960 MHz) and 2.2 GHz (1710–2690 MHz) that are necessary for modern communication systems that can provide 2G/3G/LTE (4G) multifunctional services.

The extremely fast changes in technical requirements and strong demands in the application market the latest advances in antenna technologies for a variety of base stations in mobile wireless communication systems has been a challenge in radio frequency industry. A base station antenna is a complex device that must provide highly reliable service over a period of many years. The dual broadband planar antenna is used for the mobile communications such as 2G/3G/LTE applications. In these systems, antennas play a vital role as one of the key components or subsystems. The rapid proposal of new applications has also spurred strong demands for new high-performance antennas. Although the fundamental

physical principles of antennas have not changed, designing the antenna have been experiencing the rapid advancement of antenna technologies. The design has been implemented using the Agilent ADS. As for as bandwidth enhancement, impedance matching network, thick substrate, and capacitive compensation, multiple patches or aperture coupling technique. Reducing antenna height gives rise to a decrease in bandwidth and this effect is independent of the technology used. In fact, the narrow bandwidth characteristic of microstrip antennas can't meet the continuously increasing bandwidth demand of most modern multiband systems. Therefore, it is highly desirable to develop dual broadband planar antennas.

In the existing systems, the antenna is consists of a pair of folded dipoles that are coupled and fed by an L-shaped microstrip line. The broadband antenna has the planar configuration for bandwidth enhancement. The return loss RL >15dB, bandwidth is 53% and the antenna gain is about 9 dBi. The dipoles are coupled with a L-shaped microstrip line. The dipoles and the feeding structure of the antenna are etched on the same substrate. This antenna can realize dual polarizations with an isolation of 30 dB by employing two elements which are perpendicular to each other. The height (H) of the antenna element above the reflector has an effect on the impedance matching of the broadband antenna element [1].

The high-gain and broadband small elements array for a slot loop antenna is used. The antenna can cover LTE bands at the expense of small size. Gain is ~12dbi & ~14dbi for lower & upper bands. Systems like LTE are

multiband systems utilizing variety of frequency bands increases the capacity and allow addition of much functionality. In such multiband systems, a antenna is definitely one of the key devices since it is compatible with many frequency bands such as GSM (890–960 MHz), DCS (1710–1880 MHz) and LTE at 2.7 MHz [2].

In this paper, a simple low profile multiband antenna fed by transmission line is designed. Few methods have been reported to broaden the bandwidth, by utilizing two circular elements such as a wideband planar dipole antenna with parasitic patches which exhibit acceptable radiation pattern with a broaden impedance. Furthermore, to combat the narrowband according to Yagi antenna, a novel high-gain and broadband small elements array for a slot loop antenna is investigated. The antenna can cover LTE's bands at the expense of smaller size [2].

The antenna has a stacked geometry with a smaller patch located above the large one. Forwide-band performance each patch is excited by an independent L-shaped probe. A new feature is added in this design is the lower patch is supported by four shorting vias. In doing so, the feeding probe for exciting the upper L-probe can go through one of the shorting vias without affecting the performance of the larger patch which is responsible for radiating the lower-band frequencies. In impedance matching network, capacitive compensation, multiple patches and aperture coupling technique is used for bandwidth enhancement [3].

For enhancing the bandwidth a pair of printed dipoles with parasitic elements is used. The different mobile communication systems have been designated with different frequency bands. The 2G systems that is GSM900 band operate on (800-900 MHz),3G systems operate on(1.8-2.5 GHz) and 4G i.e. LTE systems operate on (2-8 GHz).The future LTE systems operate on 2.3 GHz and 2.6 GHz. Therefore base station antennas that simultaneously cover two separated frequency bands centered at 900 MHz and 2.2 GHz are necessary for mobile communication systems that can provide 2G/3G/LTE multifunctional services.

A number of dual-broadband antennas for base stations is employed .In this paper, dual-broadband antenna for 2G/3G/LTE (4G) base station applications. The proposed dual-broadband antenna consists of a pair of printed dipoles for the lower band and a pair of folded dipoles for the upper band, forming a dual-band antenna unit. As a result, the dual-band antenna unit can be arrayed in the E-plane (or the vertical plane for base stations) without the appearance of grating lobes [4].

The design of antennas consisting of two strip dipoles the arms of which are printed on opposite sides of an electrically thin dielectric substrate and connected through a parallel stripline is used. The antennas are designed to have broad-band or dual-band capability suitable for application in base stations of wireless communication systems.

An important advantage of these antennas is their simple structure, allowing them to be manufactured as printed circuits. Broad-band antennas with bandwidths greater than 30% for VSWR less than 1.5 operate near 2.0 GHz and dual-frequency antennas operating at 0.9 GHz/1.5 GHz and 0.9 GHz/1.8 GHz bands. This paper is done on printed circuit antennas featuring broad-band or dual-band operation where constructional simplicity and low manufacturing cost are retained. The antennas consist of standard series-fed arrays of two strip dipoles realized in double-sided configuration.

Two analysis techniques are applied to design these antennas. One is a full-wave moment method in the spectral domain, similar to the approach used for analysis of strip dipoles printed on a grounded dielectric substrate. In the other technique, the printed strip conductors are transformed to circular conductors coated with dielectric or magnetic covers based on the principle of quasi-static energy [5].

A new compact dual-band dual-polarized patch antenna suitable for the 900 and 1800-MHz band operations. The proposed antenna has two coplanar radiating patches, one rectangular-ring patch for the 900-MHz operation and one notched rectangular patch placed within the rectangular-ring patch for the 1800-MHz operation. To feed the antenna, the aperture-coupled feed method is used. Four H-shaped coupling slots are cut in the antenna's ground plane to couple the electromagnetic energy from the feed network to the two radiating patches. To obtain good port decoupling in both of the 900 MHz and 1800MHz bands, these H-shaped coupling slots are carefully oriented.

The feed network is also designed such that the 1800-MHz signal into the radiating patch for the 900-MHzband operation (the rectangular-ring patch) is blocked, so is the case for the 900 MHz signal into the radiating patch for the 1800 MHz band operation (the notched rectangular patch). In this condition, the possible excitation of unwanted modes can be suppressed, and easy impedance matching in both of the 900 MHz and 1800 MHz bands can also be obtained[6].The proposed antenna is described in section 2.

2. Dual-band antenna unit

The dual-broadband antenna consists of upper and lower bands. The lower band consists of printed dipoles and the upper band consists of folded dipoles. The folded dipole structure influences impedance matching. The parasitic elements are used for bandwidth enhancement.

The two dipoles of each element are connected through a coplanar strip line and are coupling fed by a microstrip line. The dual-band antenna elements are printed on a FR4 substrate with a dielectric constant of 4.4, a loss tangent of 0.018, and a thickness of 0.76mm.The height of the antenna is 45mm.The size of the substrate is 360 x 280 mm. The length of the microstrip line and the width of the slot of the coplanar strip line can be adjusted so that good impedance matching can be achieved. The antenna unit is placed above a reflector for unidirectional radiation.

The first important parameter that affects the antenna performance is $L1$. Since there are three antenna elements in a dual-broadband antenna unit, i.e., port 1 for the lower-band element, ports 2 and 3 for two upper-band elements. The most important parameter for bandwidth enhancement at the lower band is $L1$ which is the length of the parasitic elements. By adjusting $L1$, a broadband performance at the lower band can be achieved.

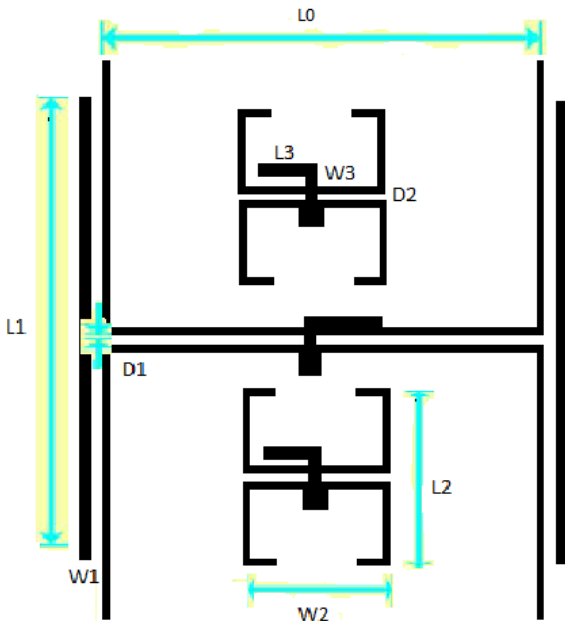


Figure.1 Dual-band antenna unit

If $L1$ increases, the additional resonance moves closer to the original resonance. The proper combination of additional and original resonance leads to better bandwidth enhancement. The second parameter that affects the impedance matching is $L0$, the distance between two dipoles of the lower-band element. It affects the magnitude of S_{11} .

3. Results and discussion

The main objective to design a dual-band planar antenna and it should be capable of serving 2G/3G/LTE mobile base stations.

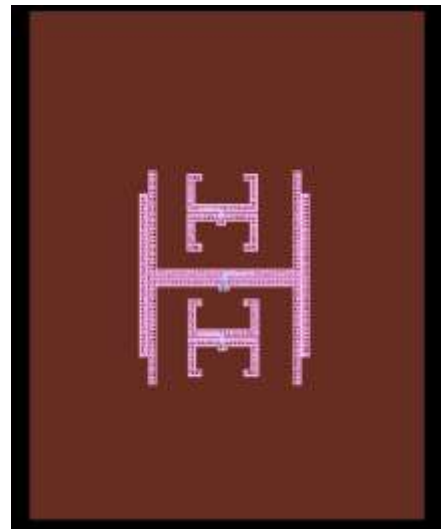


Figure.2 Layout design of dual broadband antenna

Figure 2 depicts the dual broadband antenna unit. This structure consists of two upper bands and two lower bands. The upper bands consist of a pair of printed dipoles and the lower band consists of a pair of folded dipoles. The parasitic elements are used for bandwidth enhancement. Since the planar antenna is integrated with the coplanar waveguide the port 2 and 3 is given as ground with the port 1. It will be treated as a coplanar waveguide.

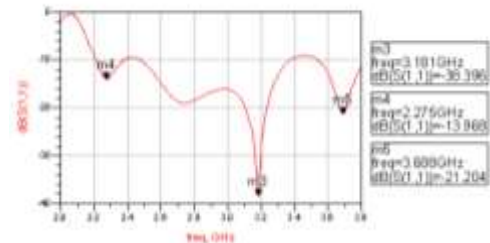


Figure.3 Performance of the antenna for 3G & 4G antenna

Figure 3 depicts the performance of the broadband planar antenna for 3G & 4G mobile base stations. The practical 4G systems can cover from 2-8 GHz. Within that frequency range itself the 3G frequency band is covered. Hence a single antenna system supports multiple wireless standards. The theoretical bandwidth is 5 GHz. But the practical bandwidth achieved here is 2 GHz.

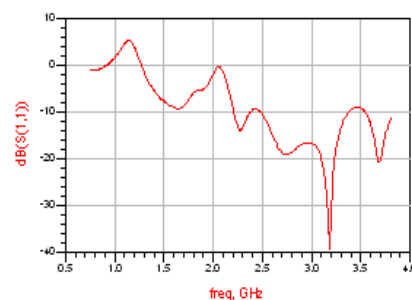


Figure.4 One input for antenna system

Figure 4 depicts the one port output for the designed planar broadband antenna. The bandwidth achieved here is around 1.8 GHz. It has the better gain performance than the three port system. The bandwidth can be enhanced by varying the microstrip slot. The pair of parasitic elements is added to the lower band element to enhance the bandwidth of the lower band. The bandwidth enhancement of the upper band is due to the coupling feed and the reflector.

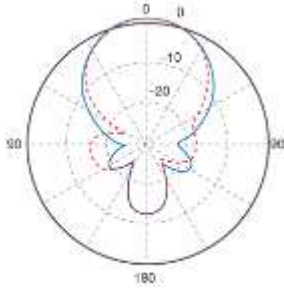


Figure.5 Radiation pattern on x-z plane

Figure 5 depicts the radiation pattern of the base station antenna. The radiation pattern obtained is the figure of eight pattern. This designed antenna is mainly used for base station antennas. This antenna is a reconfigurable one. For the upcoming radio wireless technologies this antenna can be supported. A single base station antenna serves for 2G/3G/4G handsets with compact size, bandwidth enhancement and impedance matching.

4. Conclusion

The dual broadband planar has been designed and simulated using Agilent ADS tool. The performance of the antenna is found to be good in the case of 3G/4G base station antennas. The bandwidth achievement is the important factor in the antenna design. This antenna provides better coverage capability than the conventional planar configuration antenna. The planar antenna is used for base stations because it provides better bandwidth enhancement, impedance matching and effective gain of the antenna. The structure of the antenna is compact so as to be mounted on the tower of the base station. This proposed antenna can be extended as future work by enhancing the 2G frequency and also as the dual broadband planar antenna as array of antennas for bandwidth enhancement and impedance matching.

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