

Dual Band Omni-Directional Planar Antenna for WiMAX Applications

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Abstract

In this paper, a novel and simple dual-band planar omni-directional antenna is proposed. Through proper adjustment of the couplings between the two coupling arms and the main dipole-based radiating section, the proposed antenna can operate either in the wideband mode or dual-band mode. Operated in the dual-band mode, the proposed antenna is able to cover both 3.25~3.85 GHz and 5.25~5.85 GHz for WiMAX applications with S_{11} less than -10dB. Omni-directional radiation patterns and maximum gain of 2.0dBi at both bands were also achieved.

Introduction

With the rapid development in wireless technology, large scale deployment of WiMAX (Worldwide Interoperability for Microwave Access) system is expected to take off in the near future [1]. In general, WiMAX system is believed to provide a low cost, broadband wireless access at high speed. Theoretically, for broadband services, WiMAX technology is able to achieve 30-mile radius coverage with data rates up to 75 Mbps. [2] Such superior system performance has spurred tremendous demands in mobile applications such as WiMAX enabled handsets, laptops and other consumer devices. [3] Recent development of WiMAX technology has been focused on the receiving end and thus the design of antennas to be embedded in various mobile devices has also been a popular research issue [4].

Quasi log-periodic antenna was first proposed by Hsu, et. al. [5]. This simple antenna structure basically consists of a regular center-fed half-wavelength dipole with two mutually-coupled stubs. The main advantage of the quasi log-periodic antenna is the ability to achieve relatively wide bandwidth (in the excess of 30% bandwidth in UHF band) with omni-directional radiation pattern and 2dBi gain. The very compact and simple structure of the antenna makes further integration with other systems rather easy, which is essential for embedded antennas for mobile devices.

In this paper, the concept of quasi log-periodic antenna is applied in the design of compact antennas for WiMAX applications. While the additional two mutually-coupled stubs can provide additional coupling to compensate for the coupling algorithm of the main dipole, the amount of coupling is adjustable through proper arrangement of the physical dimensions of the antenna. Generally, tighter

coupling tends to provide wideband mode of operation while looser coupling provides dual-band operation mode. Excellent performance achieved through the simple antenna structure has found itself great potential for applications in embedded WiMAX mobile devices.

Antenna Design

Fig. 1 shows the structure and definition of parameters of the proposed antenna. As can be seen, this simple structure basically consists of a regular half-wavelength dipole with two mutually-coupled stubs symmetrically connected to the original dipole. These two coupling stubs tend to generate an additional resonance mode which tends to modify the reactance of the dipole antenna. With proper adjustment of the induced coupling amount, either wideband mode or dual-band mode of operation can be achieved. Furthermore, the proposed design has the advantage of being very compact in size, low-profile, and can easily be fed by planar structures from the center.

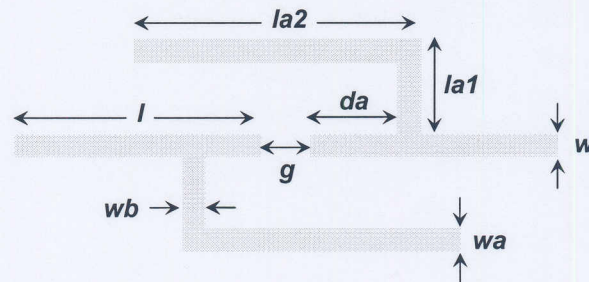


Fig.1 The structure and definition of parameters of the proposed antenna

The amount of coupling from the two additional stubs is adjustable by changing the parameters of $la1$, $la2$, and da as defined in Fig.1. In general, tighter coupling can be achieved with smaller $la1$, da and larger $la2$ values. On the contrary, looser coupling is achievable by choice of larger $la1$, da and smaller $la2$ values. Tighter coupling is desirable for wideband operation while looser coupling is necessary if dual-band operation is desired. The length l of the main dipole shifts the center frequency of the antenna while the widths (w , wa , wb) of the corresponding stubs modifies the impedance levels of the antenna.

Simulation and Experiment Results

CST Microwave Studio, a finite integration in time-domain (FIT) based numerical software was adopted for simulation. Fig. 2 shows the model of the antenna in CST MWS, where a discrete port at the center was applied as the excitation scheme of the antenna. Absorbing boundary conditions have been applied at the boundaries of calculation domain for antenna simulation. The antenna was designed on 0.4mm FR-4 substrate with dielectric constant 4.4. Fig.3 shows the

simulated result of the input return loss for wideband mode of operation with detailed dimensions included.

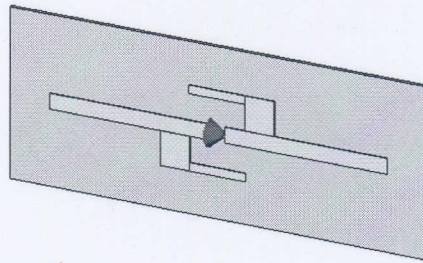


Fig. 2 Antenna model for simulation in CST MWS

It is observed that the operation band extends from 3.2 GHz up to 5.9 GHz with S_{11} less than -10dB, corresponding to 59.3% bandwidth. The simulated maximum directivity for this case is about 2dBi across the band with relatively omnidirectional performance.

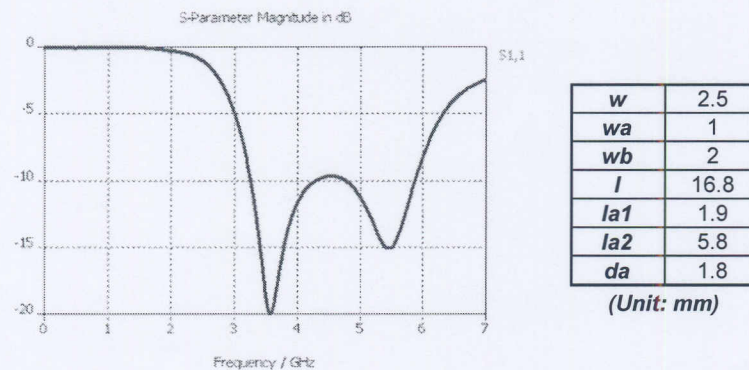


Fig. 3 Simulated response with detailed dimensions for wideband operation

Fig.4 shows the simulated response with dimensions included for dual-band operation mode. For certain applications where channel filters after the antenna are not desired, such operation mode offers a good choice in terms of channel selection. The design has been fabricated and measured with network analyzer. Fig. 5 shows the prototype of the fabricated antenna and the measured response. It is observed that both bands (3.25~3.85 GHz and 5.25~5.85 GHz) as defined by 802.16e standard has been covered with S_{11} less than -10dB. A slight shift in frequency is observed dual to the difference in excitation scheme between the simulation and measurement. A coaxial cable feeding from the center was adopted for real measurement case.

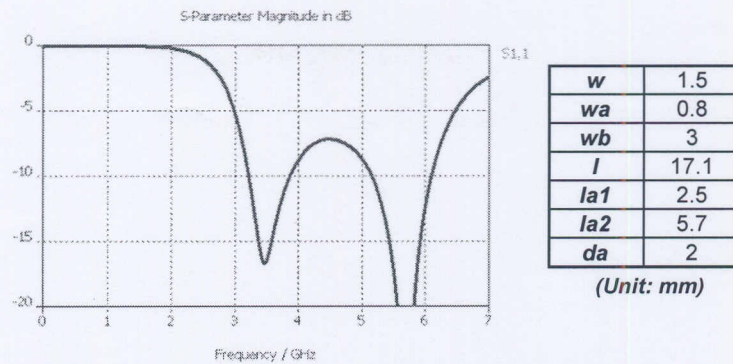


Fig. 4 Simulated response with detailed dimensions for dual-band operation

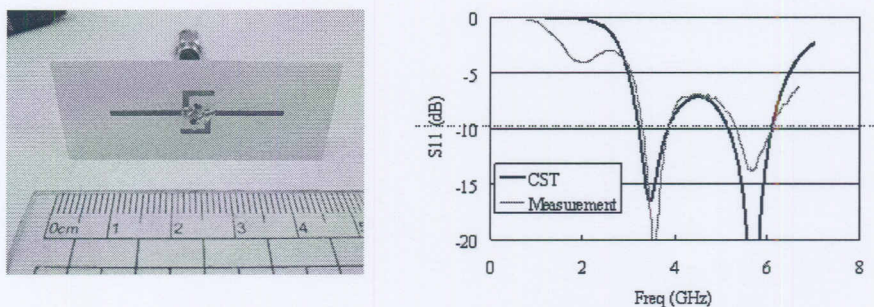


Fig. 5 Fabricated antenna prototype and measured response.

Conclusion

Quasi log-periodic antenna structure was applied for the design of dual-band WiMAX applications. The antenna could be operated either in wideband mode or the dual-band mode through proper adjustment of the physical parameters. Simulated and measured responses showed promising results.

References:

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