Design and Simulation of Band-notched Ultra Wideband Ring Monopole Antenna

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Abstract—With the increasing improvement of computer and computational method, many electromagnetic simulators solving antenna problems are widely used. In this paper, the electromagnetic simulator CST is applied to the analysis and design of a planar circular ring antenna with stub for ultra wideband applications with band notch performance. The antenna parameters are adjusted to achieve return loss of 10 dB over the desired frequency range (3.1 – 10.6 GHz) except the notch frequency band. The simulated result for return loss is in good agreement with the measured result.

Index Terms—Band notched antenna, Circular ring monopole antenna, electromagnetic simulator.

I. INTRODUCTION

Recent advancements in computing power have led to the implementation of computational modeling and simulation techniques in various scientific and engineering areas. These computational techniques have enabled scientists and engineers to simulate quantities those are difficult to measure physically. The electromagnetic simulators are widely used nowadays for solving antenna and propagation problems [1], [2]. The desired antenna parameters e.g. radiation pattern, impedance data, resonance frequency etc. can be computed accurately using these simulators. The simulation results for field and current distribution on a radiating structure provides the essential insight into the radiating mechanisms, whereas it is quite difficult to experimentally measure electromagnetic field quantities near an antenna without altering its operation. However, users need to have adequate experience of using the simulator and to be acquainted with its application.

In recent years, the ultra wideband (UWB) wireless technology has grown rapidly. As the front-end to the UWB communication, the design of ultra wideband antenna has become an important research area [3]-[5]. The planar monopole antennas are used to cover the entire UWB bandwidth (3.1–10.6 GHz) defined by FCC. The antennas with band rejection characteristics are achieved by the introduction of a rectangular tuning stub of length L and width W. The length of tuning stub is taken approximately as quarter wavelength at the desired notch frequency. All these parameters are optimized to achieve the best performance.

II. ANTENNA GEOMETRY

The structure of the antenna is shown in Fig. 1. The circular ring monopole is mounted on a circular ground plane of radius = 75 mm with a feed gap of 2 mm. The band notch characteristics are achieved by the introduction of a rectangular tuning stub of length L and width W. All these parameters are optimized to achieve the best performance.

III. RESULTS AND DISCUSSIONS

The antenna is modeled using electromagnetic simulation software CST microwave studio that utilizes the finite integral technique (FIT) to evaluate the currents on the structures [11]. For the simulation, the antenna is considered to be excited by a waveguide port. Fig. 2(a) shows the plot of simulated S11 versus frequency of ring monopole with different inner radii (without notch). The graph shows that by adjusting the inner radius of the ring, an impedance bandwidth defined by 10 dB return loss is achieved over UWB frequency range 3.1 – 10.6 GHz. Next, keeping the inner radius r = 8 mm (the value is chosen to acquire the

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desired bandwidth) the stub is introduced to achieve the band
notch characteristics. The plot of $S_{11}$ versus frequency for
various stub lengths is shown in Fig. 3. A hike in the return
loss over a certain frequency band is achieved by including
the stub of suitable dimension. The surface current
distributions on the ring monopole (with and without stub) at
the notch frequency and also at another frequency in the ultra
wideband are presented in Fig. 4 – 5. At the resonant
frequency of the stub, the surface-current distribution of the
ring monopole is disturbed. The 3D gain pattern of the ring
antenna (without and with the stub) at the same frequency is
shown in Fig. 6 – 7. The gain pattern is almost identical for
the two cases. The radiation pattern at different frequencies
of the band-notched antenna within the UWB range (Fig. 8)
shows good omni directional radiation pattern, which are
about the same as those of the corresponding simple
round-disk monopole antenna (Fig. 9). Next, a prototype
antenna is fabricated for experimental verification. The
design parameters of the prototype antenna are same as Fig.
4. A circular finite ground plane of radius of 75 mm is used
for the measurement. The circular ring with the stub is
supported on the ground plane by a SMA connector. The
circular ring is soldered with the pin of the connector
protruding through the hole made in the ground plane. The
length of the pin is 2 mm which determines the height of the
ring above the ground plane. A comparison between the
simulated and measured $S_{11}$ using HP 8757 C network
analyzer is presented in Fig. 10. Fig. 10 shows good
agreement between the measured and simulated results,
though a small shift of the notch frequency band is noticed
for the measured data. The slight deviation of the fabricated
antenna structure from the simulated one causes this
difference. However, the measured return loss data shows the
same impedance bandwidth as that of the simulation data.
Fig. 7. Gain pattern at 10 GHz of the band notched circular ring monopole.

Fig. 8. Radiation pattern in the vertical plane at different frequencies of the band notched circular ring monopole. The angle is measured from the vertical z axis.

Fig. 9. Radiation pattern in the vertical plane at different frequencies of the circular ring monopole with R = 18 mm, r = 8 mm.

IV. CONCLUSION

This paper presents the performance of a modified planar ring monopole antenna as an UWB band-notched antenna based on the simulation results using electromagnetic simulator. The simulated results for the return loss show that the desired bandwidth with desired frequency notch can be achieved and easily controlled by adjusting stub length and the other parameters of the antenna. The omni directional radiation pattern of a conventional monopole antenna is maintained over the frequency range.

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REFERENCES


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