



DESIGN OF CSRR EMBEDDED METAMATERIAL MONOPOLE ANTENNA FOR WiMAX APPLICATIONS

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ABSTRACT

A novel design and development of a simple monopole antenna based on composite metamaterial resonators for multiband operation is presented. The antenna has frequency notched function since the composite CPW (Co-Planar Waveguide) metamaterial resonators CSRR (closed-ring resonator and SRR) which is embedded on the planar monopole that resonates for multiple frequency bands. The antenna resonates for the frequency of (Wi-MAX) 3.4 to 3.5GHz and 5.725 – 5.875GHz which have good impedance matching and radiation performance.

Keywords: WiMAX, metamaterial antenna, square ring.

1. INTRODUCTION

The multiband or broadband antennas have aroused high interest in recent years for application to multimode communication systems. Because of low cost and process simplicity, printed monopole antennas are very popular candidates for these applications. The currently popular designs suitable for wireless local area network (WLAN) operation in the 2.4 GHz (2.4–2.484 GHz) and 5.2/5.8 GHz (5.15–5.35 GHz/ 5.725–5.825 GHz) bands have been reported.

The key design configurations in order to meet this dual-band operation include a monopole antenna fed with a meandered coplanar waveguide (CPW), a CPW-fed monopole antenna with two resonant paths, a CPW-fed tapered bent folded monopole antenna, a microstrip-fed double-T monopole antenna, a meander-line monopole antenna with a backed microstrip line, a C-shaped monopole antenna with a shorted parasitic element, and a branched monopole antenna with a truncated ground plane. However, to further support the worldwide interoperability for microwave access (WiMAX) applications, none of the above available designs can achieve a dual-band response with sufficiently large bandwidth to additionally cover the 3.5/5.5 GHz (3400–3500/5725–5850 MHz) WiMAX bands.

In [7], the authors presented a CPW-fed split ring monopole antenna with a square conductor-backed plane for dual-band WLAN applications. This design generally needs to consider many dimension parameters and the resulting bandwidth is still not sufficient to cover the 3.5 GHz WiMAX bands. In this letter, a new antenna is proposed for the purpose of WiMAX dual-mode operation.

One of the most common elements of metamaterials, which was introduced by Pendry et al. in 1999, is the split ring resonator (SRR). SRR is a nonmagnetic conducting unit, in which and its periodic array yields negative effective magnetic permeability with

an enhanced magnitude when the frequency of the incident electromagnetic field is close to the SRR resonance frequency. The resonance frequency of the SRR depends on its geometrical parameters.

The structure can show resonant behavior at frequencies that are much larger than its size. Experimental demonstration of this structure at microwave frequencies has been achieved by many groups. The application of metamaterials to increase antenna performance is of great interest. It was shown that introducing metamaterials could enhance the radiated power of the antenna.

Moreover, negative magnetic permeability materials are a candidate for obtaining properties such as an electrically small antenna size, high directivity, and tunable operational frequency. Furthermore, by utilizing a combination of right handed (RH) and left handed (LH) materials in a composite (CRLH) transmission line, a backward to forward scanning capability is obtained.

Antennas composed of single negative materials that resonantly couple to external radiation was invented by Isaacs. Even if the radiation wavelength is much larger than the antenna size, the antenna is sensitive to radiation due to the resonant coupling. By feeding such a resonator one can obtain an electrically small antenna when operating at microwave frequencies.

2. ANTENNA DESIGN

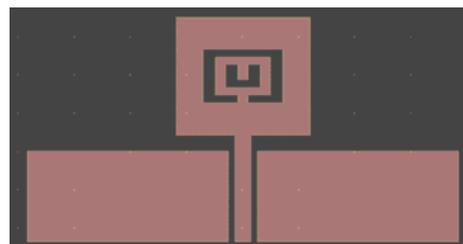


Figure-1. CSRR Embedded Monopole Metamaterial Antenna.



Figure-1 illustrates the geometry of the proposed dual wideband antenna for WiMAX dual-mode operation. The antenna was implemented on an inexpensive FR4 substrate with thickness of 1.6 mm and relative permittivity of 4.6. It can be seen from Figure-1 that the rectangular monopole and 50ohm CPW feedline are printed on the top side of substrate of the antenna.

In the proposed antenna configuration, the rectangular monopole can provide the fundamental band and next higher resonant band at 5.7 GHz is obtained by embedding the CSRR structure in the antenna respectively, This CSRR plane resonates based on electrically coupled to the rectangular monopole. By properly tuning the dimensions and spacing to semi-ground plane CSRR embedded plate, the antenna can create the second resonant frequency in individual resonant radiation band based on an over-coupling condition. This mechanism can remarkably increase the resonant radiation bandwidth. Figure-2 shows the simulated return losses for the proposed antenna which can be optimized with choosing the dimensions.

3. RESULTS AND DISCUSSIONS

The simulated return losses for the proposed antenna with the conventional and the proposed CSRR embedded on the plane are shown in Figure-2.

The resemble result between the conventional and proposed is shown in Table-1. The antenna gain across the 3.4 – 3.5 GHz and 5.725 – 5.875 GHz dual band of the proposed antenna comparison with convention monopole are also studies.

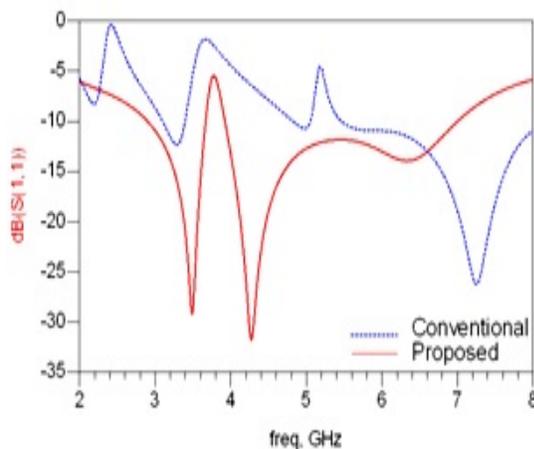


Figure-2. Simulation result of conventional and proposed CSRR results.

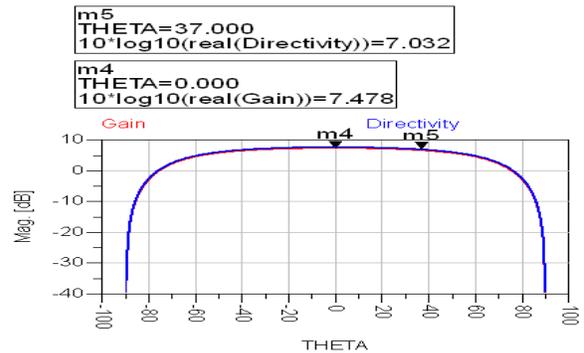


Figure-3. Gain and directivity in dB.

It is clearly seen that the SRR metamaterial layer antenna, the antenna gain is merely high. In the proposed methodology, the antenna with CSRR metamaterial embedded on the monopole increases the gain to 7.9 dBi.

The radiation efficiency of the conventional antenna is about 68%. But, the proposed antenna increases the radiation efficiency to 93% as shown in Figure-4.

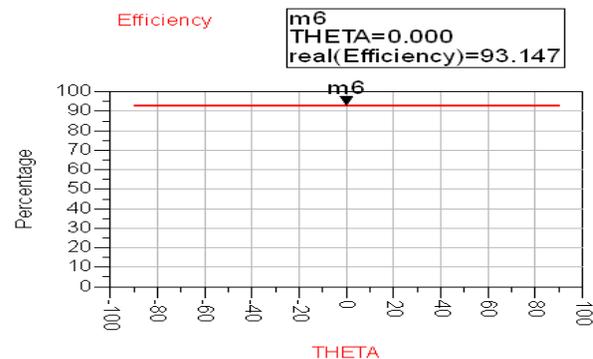


Figure-4. Efficiency in percentage.

More specifically, the antenna gain of proposed CSRR embedded metamaterial antenna is equivalently high when compared to a CSRR antenna.

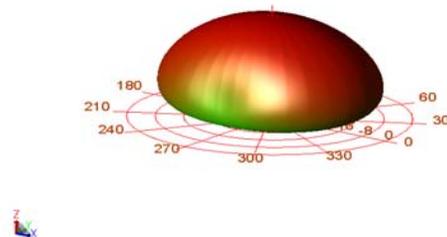


Figure-5. Radiation pattern.

From Figure-5, red colour region specifies the maximum radiation and green colour indicates medium level of power radiation.

**Table-1.**

Comparison of Conventional and proposed metamaterial antenna		
Parameter	Conventional Monopole	CSRR Embedded Monopole
Gain (dBi)	5.6	7.4
Directivity (dB)	7.0	7.8
Efficiency (%)	68	93

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4. CONCLUSIONS

A simple printed monopole antenna with a CSRR metamaterial embedded on the monopole plane for WiMAX dual-mode operation has been presented. The use of CSRR metamaterial structure produces the dual band has increased impedance bandwidth very remarkably to sufficiently cover the 3.4 – 3.5 & 5.725 – 5.875 GHz WiMAX bands. The final results show satisfactory performance and good agreement with the simulated results. Using this antenna in Laptop we can achieve the WiMAX utility and the CPW feed makes the board compatible with Printed Circuit Board fabrication.

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