Metamaterial inspired triband offset feed rectangular monopole for wireless applications

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Abstract

A rectangular monopole engraved with an open complementary split-ring resonator (OCSRR) metamaterial is designed and proposed for multiband radio applications. The proposed antenna has a rectangular monopole feed with offset microstrip feed, and the OCSRR designed at 3.14 GHz is engraved in the radiating element. The OCSRR is a special type of metamaterial with small electrical size. The OCSRR modifies the current direction due to its negative permittivity, which creates another resonance at 3.16 GHz. The left offset feed and abridged ground length creates another resonance at 3.82 GHz and responsible for good impedance matching are achieved in all the resonating bands. The entire antenna is designed and fabricated on the FR4 substrate with a complete measurement equal to 27.84 mm x 23.25 mm x 1.6 mm. The proposed structure shows the multiband characteristics at 3.16 GHz, 3.82 GHz, and 5.14 GHz with a S₁₁ of -19.83 dB, -17.90 dB, and -55.73 dB, respectively. The critical parameters of the OCSRR are decided using the parametric analysis, and the simulated results are presented. The OCSRR negative permittivity extraction is done with NRW wave guide extraction method, and the result is validated with the help of OCSRR resonant frequency calculation. The uniformity is well maintained between the measured and simulated results. The multiband characteristics, reasonable gain, compactness, low design complexity, and small size are the significant features of the proposed antenna

Full Text

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Figures

Figure 1

(a) OSRR topology (b) Equivalent circuit of OSRR (c) OCSRR topology (d) Equivalent circuit of OCSRR

Figure 2

Design stages of OCSRR inspired rectangular printed antenna

Figure 3

Front and Back View of OCSRR inspired rectangular printed antenna geometry

Figure 4

S11 Comparison (Ant A vs Ant B vs Proposed Antenna)

Figure 5

Return loss (simulation) Comparison of various ground length

Figure 6

Waveguide setup - permittivity extraction

Figure 7

s11 & s21 - characteristics of OCSRR

Figure 8

Permittivity Characteristics of proposed OCSRR

Figure 9

s11 evaluation for different values of x1

Figure 10

s_{11} evaluation for different values of x

Figure 11

s11 evaluation for different values of y

Figure 12

OCSRR inspired rectangular printed antenna equivalent circuit

a) 3.16 GHz

b) 3.82 GHz

c) 5.41 GHz

Figure 13

Surface current distribution at resonating frequency

Figure 14

Return loss Comparison of the Ant A and Proposed antenna

a) 3.16 GHz

b) 3.82 GHz

c) 5.41 GHz

Figure 15

E-plane & H-plane pattern (Measured and simulated) at resonating frequencies

Figure 16

Prototypes of the OCSRR inspired Rectangular antenna

Figure 17

Simulated Vs. Measured S11

Figure 18

Gain of the OCSRR inspired Rectangular antenna