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A METAMATERIAL INSPIRED COMPACT OPEN SPLIT RECTANGULAR RESONATOR ANTENNA FOR MULTIBAND OPERATION

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ABSTRACT

In this work, a metamaterial impressed compact open rectangular resonator (RR) antenna is investigated for multiband operation. The projected antenna uses closely used open split rings as a divergent part that provides economical size reduction and broader information measure performance. The projected antenna with the general size of 27.5 9 16.08 9 1.6 mm3 is fancied and tested. The measured results indicate that it covers 2.4/5.2/5.8 gigacycle (Wireless LAN), 5.5 gigacycle (WiMAX) and 7.4 gigacycle (X-band downlink) applications. The RR antenna has achieved size reduction of 38.83% and 52.83% compared to the split ring resonator and ring antennas severally. it's determined that the projected antenna produces higher performance than the present antennas within the literature. The antenna consists of a rectangular patch with metamaterial impressed ELC ground plane. The antenna is written on a FR-4 substrate that incorporates a stuff constant of 4.4 . the dimensions of the projected antenna is 23x12.7x1.6 mm3 .The antenna is fed by a fifty ohm microstrip printing operation.

Keywords: —Metamaterials , Multi band , Compact , rectangular resonator

INTRODUCTION

Many hand-held and wireless communication devices like mobile phones, lap-tops and modems need purposeful, compact and multiband antennas competent to figure in numerous communication standards. The challenges embrace simple style, integration and price effectiveness with optimum performance. Wireless native space network (WLAN) is one in every of the wide used network for web access that uses the band of (2.4–2.484) GHz, for the IEEE 802.11b/g standards, and (5.15–5.35) GHz, (5.725–5.825) GHz, for the IEEE 802.11a normal. completely different strategies to realize multiband operation are reported in literature. to get twin band resonance particularly within the WiFi vary, many strategies are adopted within the literature, which has, diverging components with multiple parasitic branches [1, 2], with many slots [3-5], winding components [6] and pattern structures [7]. However, sophisticated structural style [1,5] or larger sizes [2,4,6,7] have continually been a drag in manufacturing these antennas much. albeit introducing reactive slots as mentioned in [3], is reported to yield compact dimensions, it yields poor ohmic resistance matching at few resonant bands. The exploration of magnetic attraction metamaterials impressed structures and their complementary counter components to be used as radiators for achieving compact and multi-band antennas is big. These structures have reported to realize size reduction [8,9], multiband operations [10], and performance enhancements like gain and information measure [11]. The fast advancement in wireless technology demands that the multiband antennas be compact, straightforward to integrate and fewer value. The multiband Associate in Nursingtenna is an accepted technique that covers completely different standards in a very single device. The antenna performances may be complete through varied approaches, namely, properly designed slots, strips, etc. Inverted formed slots carved on the diverging component were wont to get tri-band operation [1]. Metamaterials are artificial materials that have distinctive properties of negative permittivity and negative porosity. These properties facilitate to realize each compact and broader information measure responses at the same time [5, 6]. SRR and complementary SRR (CSRR) are the fundamental building blocks of metamaterials. SRR is employed to understand negative porosity and CSRR contains a twin nature of SRR that produces negative permittivity. Hence, the device performance may be improved while not meddling the device structure [7]. These structures were wont to realise antennas that are electrically little [8], information measure increased [9], and re-configurable [10]. The SRR/CSRR based mostly multiband antennas were mentioned in [11–15]. A compact flattened antenna was conferred in [11] for the improved information measure and multiband nature employing a single SRR structure. The reconfigurable and multifunctional antennas were conferred by victimization SRR structure beside a diverging component and as monopole severally in [12, 13]. The parallelogram [14] and triangle [15] formed SRR antennas were used as main diverging component for attaining broader information measure additionally on cowl WLAN/WiMAX applications with larger antenna size. A CSRR loaded monopole antenna was used as a diverging component for realising wireless fidelity and WiMAX applications in [6]. Multiband

and size reduction performances were obtained by loading CSRR structure within the diverging component and ground plane of the antenna . Although, most of the literatures recommend varied strategies to realize the compact antenna structure, an in depth analysis like broadband nature with multiple applications integrability into one compact device are rarely mentioned.

PROPOSED ANTENNA CONFIGURATION

The proposed RR antenna uses FR-4 substrate within the style with of 4.4, fed by a 50 X two-dimensional conductor (CPW) line. it's feed length (FL) of eleven.50 millimeter and feed breadth (FW) of one.48 mm. varied formed antennas area unit shown in Fig. 1. Antenna illustrates a hoop antenna that consists of variety of rectangular formed rings as its main divergent component. Antenna is SRR based mostly antenna, that differentiates from ring antenna structure with splits gap (G4) thereon. Antenna is that the planned RR antenna, that is obtained by incorporating changes within the split gap dimensions of SRR antenna by keeping the dimensions (L nine W) unmoved. The planned antenna pure mathematics is illustrated in Fig. and its parameters and dimensions area unit tabulated in Table1. All the size area unit confirmed supported the constant studies and a number of vital parameters area unit mentioned within the below section. The image of the unreal RR antenna device is shown in fig.

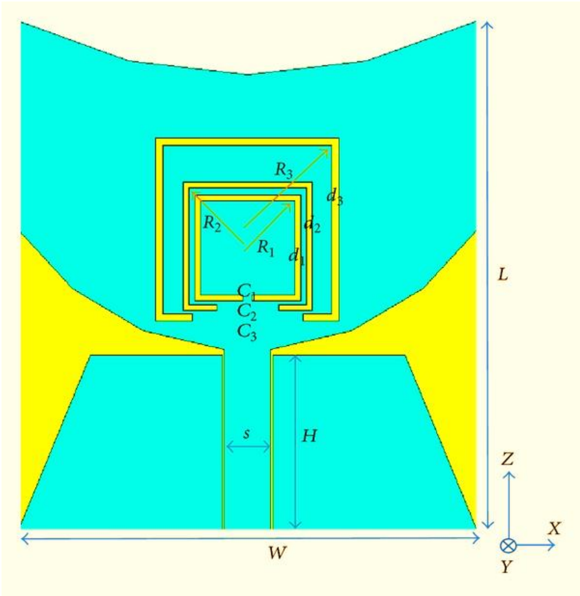

FIG.1.CONFIGURATION OF THE PROPOSED ANTENNA

PROPOSED ANTENNA DESIGN

The configuration one may be a typical rectangular divergent patch. FR4 substrate is employed for antenna style, having nonconductor constant of 4.4.In the configuration a pair of the new metamaterial component called field Coupled Resonator (ELC) has been introduced within the ground plane. This alters the normal ground plane resonance characteristics and provides higher resistance matching and twin band resonance characteristics.The planned antenna may be a written microstrip sort with terribly compact dimensions of 20×20×0.8 mm. The substrate chosen may be a low value FR-4 with relative nonconductor constant four.4 and loss tangent zero.018. Fig. one shows the evolution in coming up with the planned antenna. Configuration #1 consists of 2 bimetallic rings, during which the outer ring is open and therefore the inner ring is closed, with a object plane. within the second step, the bottom plane is inscribed with a sq. SRR, giving rise to its complementary structure (CSRR), that reports for miniaturisation, as well as, the existence of another band with poor resistance matching. The length and dimension of the CSRR in conjunction with the split gap is found to possess goodish impact on the miniaturisation magnitude relation and therefore the lower resonant band. the ultimate planned antenna style is portrayed in configuration #3, wherever the outer split ring is introduced with 2 additional symmetrical split gaps of dimension L4 × W3, on either aspect of its centre split, leading to a much better resistance match at the lower ringing frequency. The antenna is happy by a microstrip feed line of dimensions a pair of millimeter × a pair of millimeter to match with the sensible the sensible connexion. The layout and therefore the geometrical details of the planned configuration square measure shown in Fig. 2. The structural dimensions square measure finalized once a series of constant quantity studies victimisation the optimetrics choice on the market in High Frequency Structure simulator (HFSS) package and square measure tabulated in Table one. Photograph of the invented antenna is shown in Fig.

Table 1: Dimensions of the proposed antenna

PARAMETERS	DIMENSIONS(mm)
L_s	23
L_c	8
L_f	10.3
L_p	12.7
Wp, W_s	12.8
W_1	1.5
W_2	5
T	2

METAMATERIAL PROPERTY VERIFICATION

The divergent component and therefore the RR within the ground plane fits the metamaterial property severally, that is, the split ring divergent component exhibits negative permeableness, whereas the RR exhibits negative permittivity. Simulation results of a similar area unit briefed during this section. to substantiate negativity within the projected split ring divergent component, it's placed within an oblong conductor, with no air gaps within the walls of fixture [15]. excellent electrical and excellent magnetic conducting boundaries area unit assumed on either facet of the conductor walls . The projected rectangular radiator is worked up through one port, and therefore the corresponding transmission (S21) and reflection coefficients (S11) area unit measured through the opposite port. These values area unit then exported to MATLAB to calculate the advanced permeableness values victimisation the relation. The orientation of the field perpendicular to the split ring axis, induces dipole moments, that successively creates negative permeableness for frequencies but its plasmonic frequency. the amount of split gaps within the prime arm has AN influence on this negative permeableness region. this is often valid that shows the important a part of extracted permeableness as a operate of frequency. aside from the projected case, the remaining 2 configurations have sharp negative permeableness bring to an end at 2.5 gigacycle and a pair of.6 gigacycle that lies within the desired frequency vary of interest. This has resulted in poor electrical resistance matching for the primary 2 configurations. Whereas, for the projected technique, the negative permeableness region lies fully outside of our in operation band (2.38–2.64) gigacycle and therefore the permeableness is constant and positive over this vary. This junction rectifier to correct electrical resistance matching at 2.5 GHz. replacement the divergent component within the conductor with the bottom plane RR, the S11 and S21 values area unit obtained within the same manner. in contrast to the split ring components, their complementary structures area unit electrically excited that exhibits sturdy dispersion close to its resonant frequency and offers rise to negative permittivity values. Upon plotting the important a part of permittivity Vs frequency for varied length L6 , we have a tendency to determined a shift within the negative permittivity region to lower frequencies for increasing order of L6. Also, 2 negative peaks among short vary of frequency will be attributed to the sturdy mutual coupling between the 2 slots within the RR. Length L6 of 16mm is chosen as a result of it covers the specified frequency vary of interest (5–5.9) GHz. This reduces the guided wavelength on the substrate that accounts for lowering the resonant frequency.

SIMULATION AND RESULT

The simulated reflection co-efficient (S11) sound unit of the configurations is shown in fig a pair of. It shows that the standard rectangular patch antenna doesn't supply sensible resistivity matching. The introduction of ELC within the ground plane offers a twin resonant frequencies of 3.5 rate and 5.43 GHz.

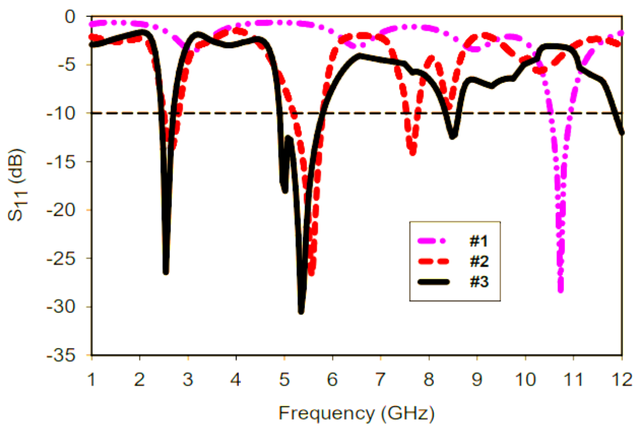

Fig.2. Simulated reflection characteristics of the 3 configurations

CONCLUSION

A compact metamaterial galvanized RR antenna has been designed and conferred for wireless fidelity, WiMAX and X- band downlink applications. The projected antenna has broader information measure moreover as compact size of 28.5 9 16.08 mm2 . significantly, RR antenna has achieved size reduction of 53.83 and 38.83% compared to the ring and SRR antenna with same overall dimension. moreover, higher radiation characteristics were ascertained within the desired frequency bands. The on top of characteristics shows that the RR antenna may be sensible different for SRR and Ring based mostly styles.

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