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Ultra-wideband Antenna with Tunable Artificial Magnetic Conductor

R. Dewan, M.K.A. Rahim, M.R. Hamid, H.A. Majid and M.F.M. Yusoff
Department of Communication Engineering, Faculty of Electrical Engineering,
Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor.

***Abstract* – This paper presents a tunable Artificial Magnetic Conductor (AMC) unit cell design by means of four copper strips. With the inclusion of copper strips, the initial reflection phase of dual band AMC changes from 2.45 GHz and 5.8 GHz to single frequency of 3 GHz. To facilitate the tunable function on antenna performance, an Ultra-Wideband (UWB) antenna has been designed and analyzed. Performance comparison is carried out with and without incorporation of AMC. The AMC is tuned to change frequency using copper strips. Result in terms of reflection phase, return loss and radiation pattern are discussed.**

***Index Terms* — AMC, Antenna, copper strips, tunable.**

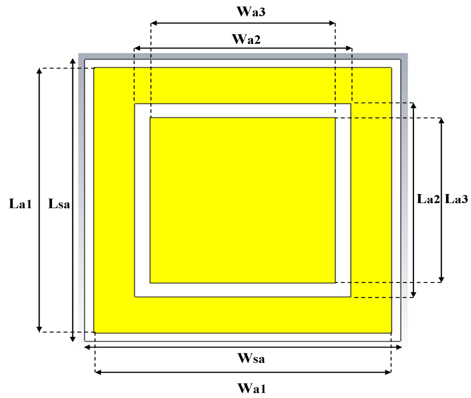
I. Introduction

Artificial Magnetic Conductor (AMC) is a metamaterial which exhibits zero degree reflection phase characteristics of Perfect Magnetic Conductor at resonance frequency [1]. Reconfigurable antenna is an antenna that can be dynamically varied in term of radiation pattern, polarization, or operating frequency. Frequency reconfigurable antennas typically tune its resonance frequency with the aid of pin diodes or MEM devices [2].

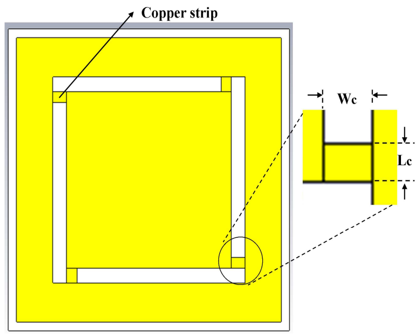
This paper proposed the design of tunable AMC. The initial dual band AMC is tuned to single band AMC using copper strips which herein refer as AMC with copper strips (AMCC). A UWB antenna as reference antenna is integrated to both AMCC and AMC. Performance comparison between UWB antenna, antenna with AMC (A-AMC) and antenna with AMCC (A-AMCC) are analyzed in term of return loss and beam pattern. The AMC approach provides tunable alternative solution for antenna with improvement in radiation pattern.

II. AMC and UWB Antenna Design

The AMC and antennas are designed on FR-4 substrate with thickness, dielectric permittivity and copper thickness of 1.6 mm, 4.5 and 0.035 mm respectively. Computer Simulation Technology (CST) Microwave Studio software is used to simulate all the designs. Fig. 1 (a) and Fig. 1(b) show the design of AMC and AAMC respectively. Four copper strips per unit cell are used to facilitate tenability of AMC. Fig. 2 (a) shows the diagram of UWB antenna while Fig. 2(b) shows the diagram for integrated structure of A-AMCC and A-AMC with air gap of *g* mm.

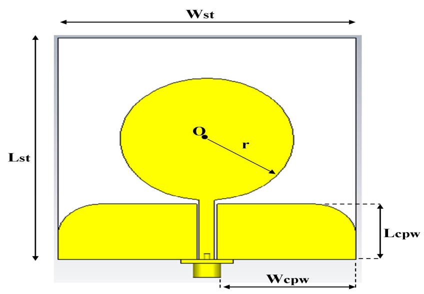


(a)

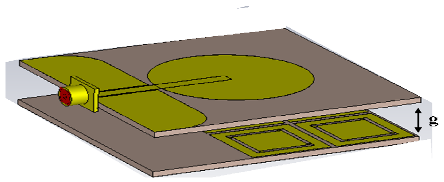


(b)

Fig. 1. (a) AMC without copper strips and (b) AMC with copper strips. Dimensions: La1 = Wa1 = 17.9 mm, La2 = Wa2 = 13.0 mm, La3 = Wa3 = 11.2 mm, Lc = 0.7 mm, Lsa = Wsa = 19.0 mm, Wc = 0.9 mm.



(a)

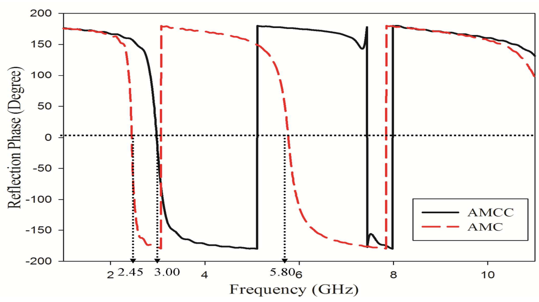


(b)

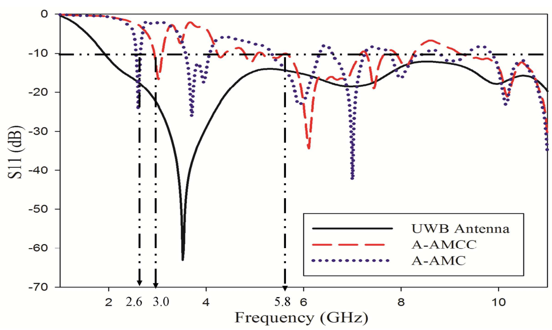
Fig. 2. (a) UWB antenna, (b) A-AMC and A-AMCC. Dimensions: g = 2 mm, Lcpw = 15.0 mm , Lst = Wst = 57.0 mm , r = 16.6 mm, Wcpw = 26.6 .mm

III. RESULTS AND DISCUSSION

Fig.3 (a) shows the simulated reflection phase of AMC and AMCC. It can be observed that the initial dual band AMC design at 2.45 GHz and 5. 8 GHz is tune to new single band frequency at 3 GHz by means of copper strips. Fig. 3(b) shows the corresponding simulated reflection coefficient of UWB antenna, A-AMCC and A-AMC. The tuning of AMC via copper strips at 3.0 GHz is successfully achieved. However, a shift from 2.45 GHz to 2.6 GHz (lower band) is occurred while in the upper band, A-AMC successfully resonates at 5.8 GHz.



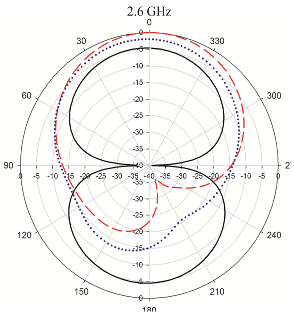
(a)



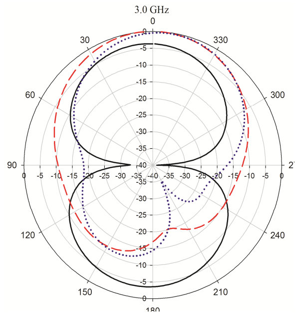
(b)

Fig. 3. (a) The simulated reflection phase curve and (b) reflection coefficient of UWB antenna, A-AMC and A-AMC.

The frequency shift is due to the expected performance of simulated of integrated structure is not proportionately linear with the individual performance of AMC and antenna [3]. Complex simulation involves optimization of the entire integrated antenna-AMC can be used to solve the frequency shift at the lower band while at the same time satisfy the antenna performance at middle and upper band. Therefore, the radiation pattern will be observed at 2.6 GHz, 3.0 GHz and 5.8 GHz as in Fig. 4. It can be observed that the inclusion of AMC to the antenna improves the radiation pattern of the antenna by reducing the magnitude of back lobe (2.6 GHz and 3.0 GHz) and increasing the antenna's gain (5.8 GHz).



(a)



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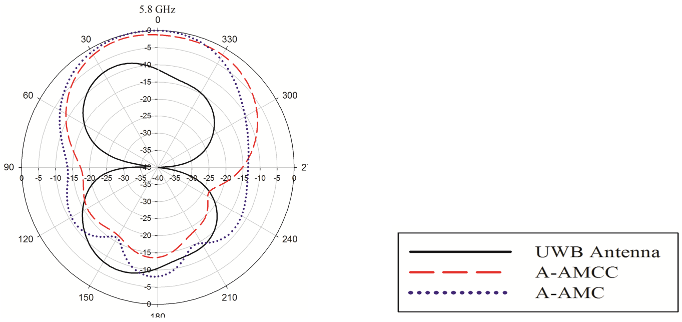

(c)

Fig. 4. The simulated radiation pattern in E-field for UWB antenna, A-AMCC and A-AMC at (a)2.6 GHz, (b) 3.0 GHz and (c) 5.8 GHz.

IV. CONCLUSION

A tunable AMC has been designed by means of copper strips which enable the initial dual band AMC to be tuned to new single resonance frequency. Integrated structure of tunable AMC realizes a minimum of three narrow band frequencies which can be used in wireless communication services. The integration of AMC improve the radiation characteristics of the antenna.

ACKNOWLEDGMENT

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