A triangular MIMO array antenna with a double negative metamaterial superstrate to enhance bandwidth and gain

Rasheed Ojo[a], Mohd Faizal Jamlos[b], Ping Jack Soh[a], Mohd Aminudin Jamlos[c], Norfatihah Bahari[c], Yeng Seng Lee[c], Samir Salem Al-Bawri[d,e], Mohamad Shaiful Abdul Karim[b], Khairil Anuar Khairi[f]

[a] Advanced Communication Engineering Centre (ACE), School of Computer and Communication Engineering, Universiti Malaysia Perlis (UniMAP), Kangar, Perlis, Malaysia

[b] College of Engineering, Universiti Malaysia Pahang, Gambang, Malaysia

[c] Department of Electronics, Faculty of Technology Engineering, UniMAP, Padang Besar, Malaysia

[d] Faculty of Engineering, Multimedia University, Cyberjaya, Malaysia

[e] Department of Electronics and Communication Engineering, Faculty of Engineering and Petroleum, Hadhramout University, Mukalla, Yemen

[f] VAT Malaysia Manufacturing, 720 Persiaran Cassia Selatan 1, Industrial Zone, Penang, Malaysia

ABSTRACT

Multiple-input-multiple-output (MIMO) array antenna integrated with the double negative metamaterial superstrate is presented. The triangular metamaterial unit cell is designed by combining two triangular elements positioned in complementary on the same plane at different sizes. Such design with more gaps is used to excite rooms for more capacitance effects to shift the resonance frequency thus enlarging the bandwidth of the MIMO antenna. The unit cell is arranged in 7 × 7 periodic array created a superstrate metamaterial plane where the C_{stray} exists in parallel between the two consecutive cells. It is found that the existence of C_{stray} and gaps for each unit cells significantly influenced the bandwidth of the MIMO antenna. The higher value of the capacitance will lead to the negativity of permittivity. The superstrate plane is then located on top of the 4 × 2 MIMO with a gap of 5 mm. The integration resulted in improving the bandwidth to 12.45% (5.65-6.4GHz) compared to only 3.49% bandwidth (5.91-6.12GHz) of the MIMO antenna itself. Moreover, the negative permeability characteristic is created by a strong magnetic field between the complementary unit cells to have 14.05-dBi peak gain. Besides that, the proposed antenna managed to minimize the mutual coupling and improve the mean effective gain, envelope correlation coefficient, and multiplexing efficiency.

KEYWORDS

Array antenna; Double negative (DNG) metamaterial superstrate; MIMO

ACKNOWLEDGEMENT

This project is supported in part by the CREST P12C2-17, RDU 160398, RDU182404, RDU190349, RDU192815, RDU192809, UIC191205, FRGS/1/2019/STG02/UMP/01/1, FRGS/1/2019/STG02/UMP/02/4, CREST T14C2-16/006, UIC190821, UIC190810, PRGS/1/2018/ICT06/UNIMAP/02/5, PRGS/1/2015/SKK05/UNIMAP/02/1, FRGS/1/2015/SG02/UNIMAP/02/1, and FRGS/ 2/2013/SG02/UNIMAP/02/1. The authors would like to acknowledge the contributions of the Advanced Communication Engineering Centre (ACE) for the support and great working environment.