CHAPTER: 2

FUNDAMENTAL THEORY OF METAMATERIAL

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Ch.Id:-ASU/GRF/EB/RPETHEAT/2022/Ch-02
DOI: https://doi.org/10.52458/9789391842888.2022.eb.grf.asu.ch-02

THEORY OF METAMATERIAL

The unaltered material existing in nature, fundamentally possess positive permeability and positive permittivity. In 1968, Veselago predicted the properties of a man-made material called as metamaterial which possess negative permittivity and/or negative permeability. Metamaterial are the composite structure of periodically arranged split ring resonators (SRRS) and wires having negative ratio (NRI). Research are verified the different metamaterial characteristics of various structured resonators like square, circular, rectangular, square split ring, MSRR,LR,SR, fractal E shaped MTM etc with their performances. Metamaterial split ring resonators are wont to load the microstrip patch antennas to scale back the scale and to boost the gain and bandwidth.

Metamaterial(MTM) term given by Rodger M. Walser, University of Texas at Austin, in 1999 and he elaborate MTM in term of "Macroscopic composites having an artificial, three-dimensional, periodic cellular architecture created to provide an optimized combination, which not present in nature, of many responses" like double negative material generate electromagnetic property .the employment of metamaterials (having property of EMT) within the antenna provides means to vary the near field boundary conditions leading to achieving a compact size. A device requires the radiating element to work on larger number of operating bands and the applications embedded – (use of multiband operation without increasing the size of the device). MTMs are defined as engineered artificial materials comprising of periodic or non-periodic structures of unit cells with its diameter but the wavelength of sunshine being propagated through it .An artificially implemented array of metamaterial unit cells can create an electromagnetic response for the signal wave which will be customized even handedly by magnetic and electric wave components for Metamaterial.

THEORY OF CSRR

The CSRR is formed by two complementary metallic rings (resonator) with a gap on either side. The total inductance contributed by the metallic rings, C0 and C1 are the distributed capacitances formed by the two halves of the CSRR structure and R represents the effective resistance. The outer and inner complementary split ring ends are modified into capacitor like shape to control the resonances at according to operating frequency, respectively. Due to complimentary rings the applied external H-field an EMF appears around the CSRR, which couples two rings with the current passing from outer ring to inner ring through a distributed capacitance formed due to the ring spacing, thus the complete structure behaves as LC circuit. Geometrical parameters Effect on SRR As the split gap increases, the value of the capacitance decreases leads to a decrease in total capacitance, and a decrease in capacitance value increases the resonant frequency. In RCSRR the increase in spacing between the rings reduces the mutual inductance and capacitance, respectively and set mutual impedance. Due to a decrease in inductance and capacitance resonant frequency increases as analytically according to MTM structure .

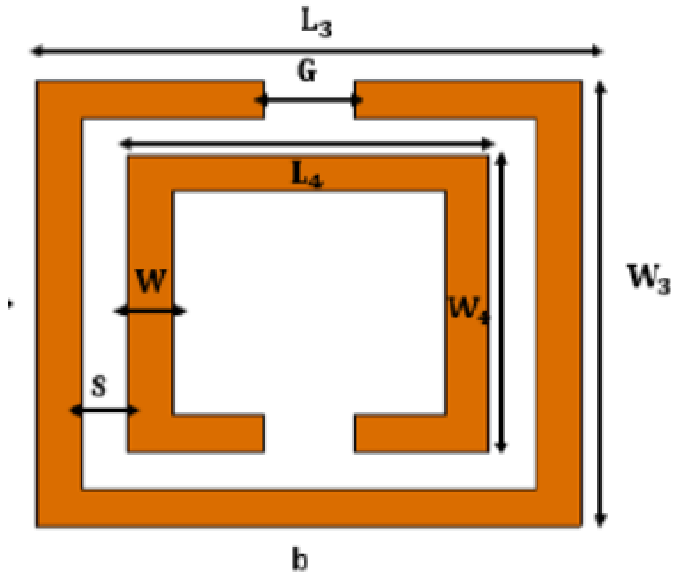

Figure -2.1 Complimentary split ring resonators

Table 2.2: CSRR structure's ring variation and its effect

Increasing the split-gap of CSRR MTM	As the split gap increases, the value of the capacitance decreases leads to a decrease in total capacitance, and a decrease in capacitance value increases the resonant frequency.
Increase in spacing between two adjacent rings of CSRR MTM	The increase in spacing between the rings reduces the mutual inductance and capacitance, respectively. Due to a decrease in inductance and capacitance resonant frequency increases as analytically expressed in
Increasing the side length of	Increasing the side length of SRR increases the effective value of inductance and thereby shifts cutoff frequency

CSRR MTM	towards the lower frequency.
Increase in metal width IN CSRR	The increase in metal width reduces mutual inductance and mutual capacitor and thereby increases the resonant frequency.
Multiple split ga	Multiple gaps in SRR intercept magnetic resonance because of the induced current by an electric field and shift resonant frequency towards the higher frequency

CONCLUSION

Metamaterial shows multiple different performance when operate on multiple frequency with sensors and antenna .Mostly used CSRR which have negative mu and negative epsilon shift the frequency to lower when gap length increases.