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GAIN IN BANDWIDTH OF A MICRO STRIP ANTENNA WITH NEGATIVE INDUCTOR

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ABSTRACT

4G communication necessitates the use of high gain, simple integrated array circuits. Various communication systems necessitate a single wide-band radiating element. Although the micro strip antenna has all of these advantages, it does have some limitations such as low gain, low bandwidth, and surface wave propagation. This disadvantage of the Micro strip antenna is overcome by using a negative inductor. An active integrated single patch Micro strip antenna is proposed in this paper, and its radiating pattern and gain performance are optimised using analysis. As a reference, a Micro strip antenna patch with 50 input impedance, 10. 5 GHz, and 13.4% bandwidth was used. The radiation pattern of the proposed antenna design can be approximately 1.75 times that of an antenna without inductive loading. This value is increased to 25% by using a negative inductor circuit at the reference antenna's input port.

Keywords: *Micro strip Antenna; Negative Inductance; gain; Negative Refractive Index; Micro strip Patch Antenna MPA*

INTRODUCTION

Microwave integrated circuits (MICS) are becoming increasingly popular in a variety of application systems. They are simple to manufacture and more dependable, with improved performance at a low cost. Inductive loading can be used to control the radiation pattern of a rectangular patch antenna. As a result of these considerations, integrated antennas will be used as RF (Right Front) at antenna terminals. The goal of this research is to look into the effects of loading a micro strip element with active inductive load on radiation performance.

MICRO STRIP PATCH ANTENNA

The MPA (Micro Strip Patch Antenna) is made up of a metallic patch on one side and a dielectric substrate on the other. The patch length (L) is one-half of the dielectric wavelength, which corresponds to the resonant frequency. The size and bandwidth of an antenna are determined by the dielectric substrate material. The larger the dielectric constant, the smaller the antenna size, but it reduces the bandwidth and efficiency of the antenna, whereas decreasing the dielectric constant increases the bandwidth and thus increases the size of the antenna. However, there is a limit to how much the dielectric constant can be increased. The input impedance and radiation pattern of the Micro strip antenna are determined by its width W. A greater width indicates a greater bandwidth. As illustrated in Figure 1. "h" represents the height of the substrate. A rectangular patch antenna is used in this case. Changing the shape of the patch, using multilayer structures, different feeding techniques, array method, using different dielectric substrates, and so on are all ways to improve the bandwidth and gain MPA. [1]

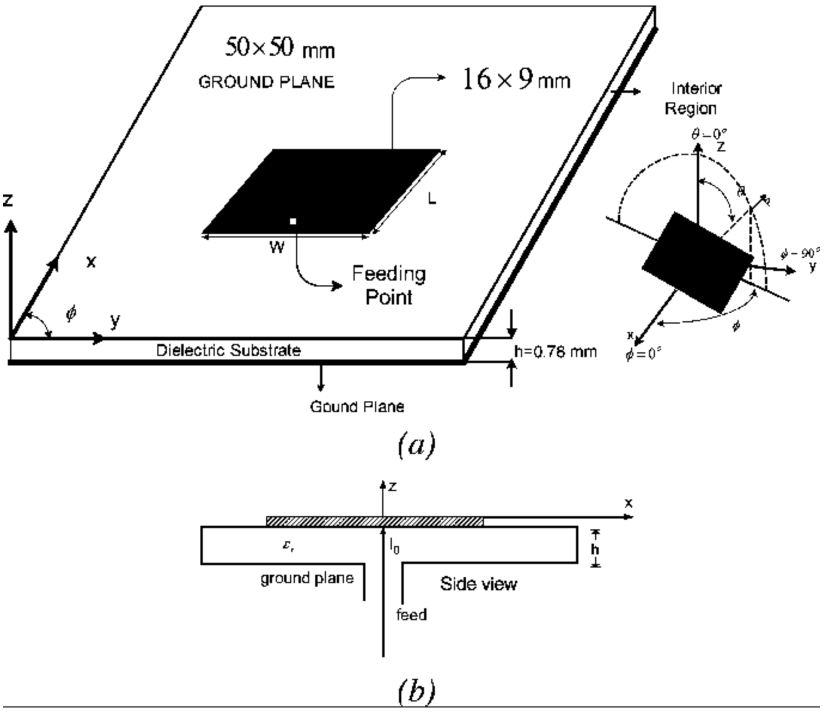

Figure 1: Antenna Configuration (a) top view and (b) side view.

A parallel LCR circuit is present in micro strip antennas. An antenna's input impedance can be expressed in this way:

Z = Rmax/1+jQ ………. (1)

Where, Rmax is the resonant resistance

Q = Quality factor

$v = f/f_r – f_v/f$ ………… (2)

Where f_r = resonant frequency.

For lower and upper band edge frequencies f_1 and f_2 = S

And relative bandwidth (BW) can be written as:

$BW = f_2 – f_1/f_r$ . . . . (3)

The quality factor can be expressed as:

$Q = 1/BW \sqrt{} (S. R_{norm} - 1). (S – R_{norm})/S$ ……. (4)

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Eqn. (4) shows that decreasing the quality factor is also an effective way to increase the antenna's impedance bandwidth.

Eqn. (4) reduces to BW (Rnorm=1) = 1/Q. S – 1/√S ……. (5)

The Admittance:

A parallel RLC circuit of a narrow band frequency can be written as:

$$Y_{ant}\,(\,f_r + \Delta f\,) = G_{ant} - jB_{ant}$$

$$\approx \frac{1 + 4Q^2\,(\Delta f/f_r\,)^2}{R_{norm} - 2jR_{norm}Q(\,\Delta f/f_r\,)} \quad \ldots\ldots\ldots.\ (6)$$

Where the frequency shift from resonance is:

Δfmax = f – fr

And, Δfmax /fr = 1/2Q√2Rnorm - 1 ……. . (7)

For parallel type resonance, the bandwidth is –

BW = 2Gant/w0 (dB/dw) w0 . . . . (8)

PROPOSED ACTIVE COMPENSATION ANTENNA

The antenna's 50 input impedance is determined. As a substrate material, TLYA - 5CH200 with a permittivity of 3.20 and a thickness of 0.78 mm was used.

The patch dimensions of w = 16 mm and L = 9 mm were chosen, with ground plane dimensions of 5050 mm being used. The designed antenna operates at 10.5GHz with a resonant frequency of -21.5 dB. [2]

The equivalent inductance and capacitance can then be written as follows:

Leq = - Cgs/gm

Ceq = Cgs

A negative inductance compensation circuit with two FETs of the same type has been simulated.

Objectives:

1. To investigate the proposed active compensation antenna.

2. Be familiar with the MPA (Micro Strip Patch Antenna).

3. to investigate variations in resonant frequency with respect to CDNG-MTM radius, variations in antenna impedances, and NRI superstreet.

RESEARCH METHODOLOGY

Books, educational and development journals, government papers, and print and online reference resources were just a few of the secondary sources we used to learn about comparative public policy studies.

The internal and external validity of comparative studies determines their quality. The extent to which conclusions can be drawn correctly from the study setting, participants, intervention, measures, analysis, and interpretations is referred to as internal validity. The extent to which the conclusions can be generalised to other settings is referred to as external validity.

REVIEW OF LITERATURE

Enoch proposed that the gain of the antenna be increased by using a metamaterial with a near zero refractive index. He used the thin wire structure to mount the metamaterial on a dipole antenna to boost the gain. Several structures have been proposed. Omega -shape, S -shape, Fishnet -shape, Labyrinth -shape, the combination of modified square rectangular Split Ring Resonator (SRR) and the Capacitance Loaded Strip (CLS), triangular-shape, and all of them exhibit NRI properties. Because of the unique properties of NRI metamaterial, numerous studies have been conducted to improve microwave devices such as antennas and filters. [3]

Patel et al. proposed and designed an MPA embedded in an MTM superstrate. An SRR is used in the metallic integration of MTM in the superstrate, which improves antenna performance. The proposed MPA's bandwidth increased by up to 60%. Alam et al. proposed a triangular-shaped MTM-inspired trib and MPA with a dielectric substrate of Roger RT/Duroid 5870. [4] [5].

Veselago investigated the properties of isotropic media in which the permittivity and permeability are both negative at the same time, resulting in unusual physical properties such as negative refraction. These materials' propagation vector k, electric field, E, and magnetic field, H vectors form a left handed set of vectors that are the inverse of the commonly known right handed material. As a result, these materials are also known as lefthanded materials (LHM). Smith created the first left-handed metamaterial prototype in 2000 using a split ring resonator (SRR) and thin wire (TW). [6][7]

RESULT AND DISCUSSION

This section discusses the results obtained with Variation in resonant frequency with respect to radius of CDNG-MTM, Variation of antenna impedances, and NRI superstreet.

The antenna resonance is investigated for various parameter changes. Parametric analysis of various parameters is performed. It can be seen that the radius of the CDNG structure has a significant impact on the antenna resonance frequency. The slot length L4 = R2 W2/2 varies with radius as well. In two resonances, changing the radius shifts the resonances to lower frequencies.

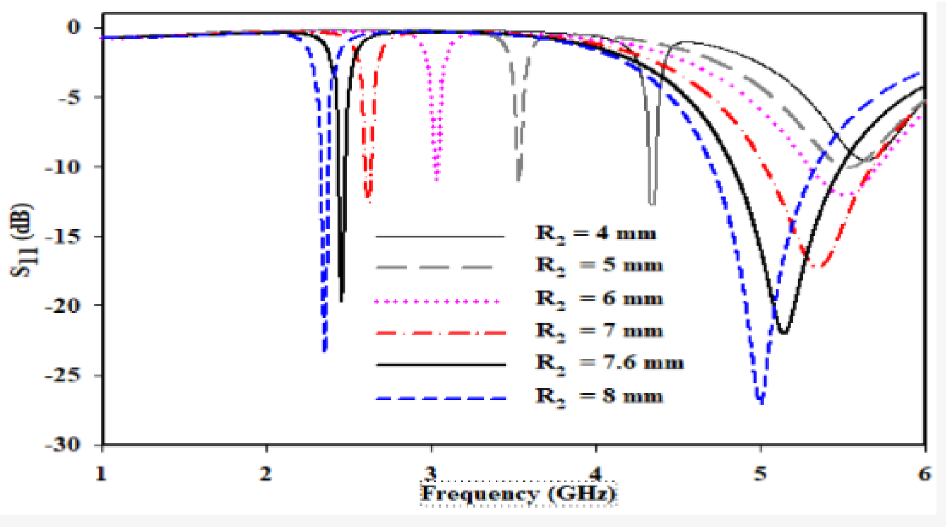

Figure 2: Variation in resonant frequency with respect to radius of CDNG-MTM

Figure 9 depicts the variation in resonant frequencies with respect to the radius of CDNG-MTM (R2) while keeping all other parameters constant. According to the parametric analysis shown in Figure 9, the shift in the lower band is more significant than the shift in the higher band. The 10 dB bandwidth of the higher band is gradually increased as R2 is increased from 4 mm to 8 mm. [8]

According to comparative analysis, using negative inductance in MPA can improve bandwidth from 13.1% to 25.2% with a minimum dip point of -36. 33 dB has resulted in surprising improvements in various parameters such as gain, bandwidth, radiation, and so on.

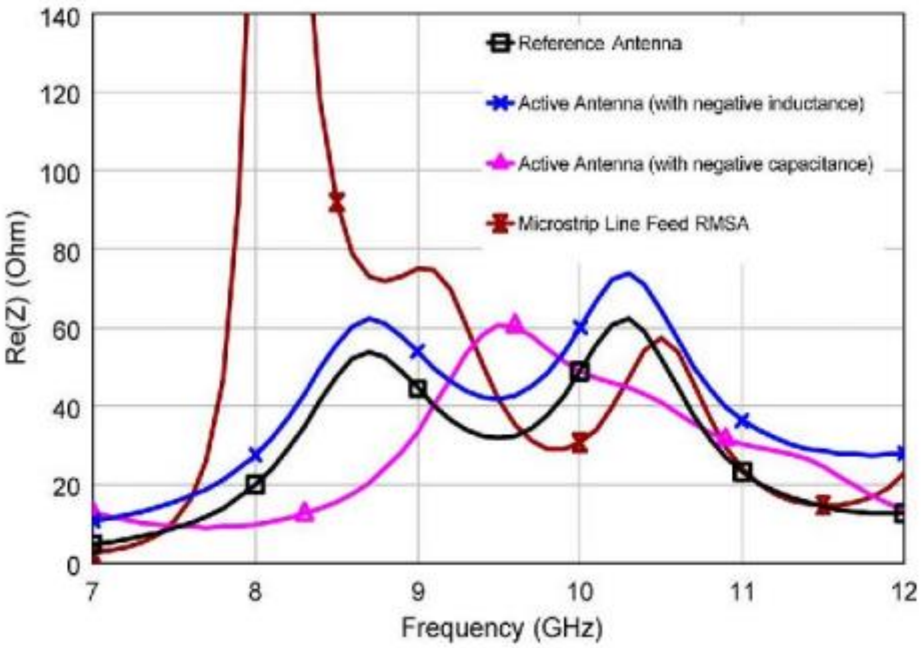

Figure 3: Variation of antenna impedances

The figure above depicts the variation of antenna impedances using various parameters. [9]

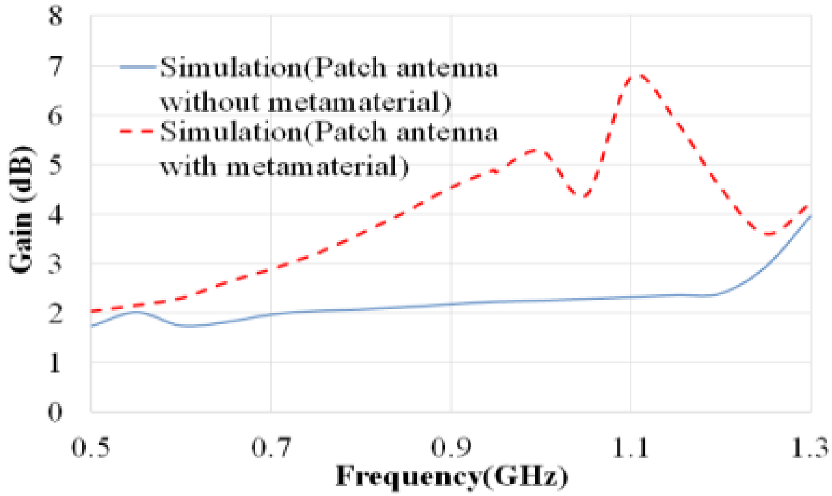

Figure 4: Comparison of the gain of C shape antenna and C- shape antenna with NRI superstreet

Figure 13 shows a gain comparison of the proposed antenna versus a conventional patch antenna in the desired frequency band of 935 MHz to 960 MHz. This clearly shows that the NRI superstreet is operating in this frequency band. [10]

CONCLUSION

An intriguing research area is the use of a negative inductor to overcome the limitations of a microstrip patch antenna. Because of its unique properties, researchers from various disciplines are drawn to it. This paper discusses negative inductance, various types, and methods to overcome the limitations of microstrip patch antennas. According to comparative analysis, using negative inductance in MPA can improve bandwidth from 13.1% to 25.2% with a minimum deep point of -36.33 dB. have resulted in surprising improvements in various parameters such as gain, bandwidth, radiation, and so on.

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