Reduction of Interference in Wireless Charging Pad and Broadband Elliptical Antenna Using DFSS

Sowmiya. P[1],
PG student[1],
Parisutham Institute of Technology and Science,
Thanjavur, Tamil Nadu, India

Mrs. Arokia Magdaline[2]
Assistant Professor[2]
Parisutham Institute of Technology and Science,
Thanjavur, Tamil Nadu, India

Abstract: **The growth of portable wireless communication devices has pushed designers to design miniature size antennas. The most prized among miniature antenna choices is the micro-strip patch antenna. This paper compares the performance of micro-strip patch antenna having different shapes of the patch (Square, Elliptical, Circular, Triangular ,Bowtie) at a frequency of 2.43 GHz. To compare and analyze the performance, ADS software was used. The results show that the Elliptical antenna has more bandwidth than other antennae. These results can be very useful while designing Elliptical antenna. If bandwidth is more then there will be absolute Interference. It is reduced using the DFSS (Double Frequency Selective Surface) structure. It is also designed and placed at the wireless charging pad.**

Index Terms: ADS software , Bandwidth,DFSS, Elliptical Antenna, Wireless charging pad.

I. INTRODUCTION

With the advancement in wireless communication technology, the need for light weight and miniature size antennas has become a mandatory requirement in today's world. The most popular antenna in this category is micro - strip patch antenna. The microstrip patch antenna is a type of radio antenna with a low profile that can be mounted on a flat surface. These antennas have several advantages over other antennas such as low profile, low weight, relatively low manufacturing cost, simple fabrication process, polarization diversity and can be easily modified and customize.

This paper considers five shapes of the patch used in micro-strip patch antenna and are designed in ADS software,that are as follows:

- Square shaped micro-strip patch antenna.
- Triangular shaped micro-strip patch antenna.
- Circular shaped micro-strip patch antenna.
- Bowtie shaped microstrip patch antenna
- Elliptical shaped micro-strip patch antenna.

The bandwidth of the antenna are verified using the ADS and the antenna with more bandwidth is preferred. Mobile phone is a portable device which is most commonly in use and a major source of business & personal communication. Wireless charging is an emerging technology and have been recently developed for charging portable electronic devices such as mobile phones, laptop and computers. This paper is a contribution to the concept of the wireless energy transmission.

The growth of mobile phones are phenomenal in recent years and there is a need for charging mobile battery is required anytime and anywhere. The battery life is the factor which encourages the companies and researchers to come up with new idea and technology to drive wireless mobile devices for enhanced period of time. The industries is expecting to provide a common wireless charging for a wide range of portable electronic devices , leading to the possibility of the drastic reduction of electronic waste arising from the number of portable electronic products.

The number of mobile phones manufactured in 2010 is approximately exceeded to 1.2 million. Electronic waste caused by the large variety of battery chargers for portable electronic products has become an increasing Global problem. Our universe is running out of all natural resources due to its maximum utilization. So, there is a need for an alternative for the production of electricity. Practically it is not possible to carry chargers wherever we go and expect availability of power supply everywhere. Contactless power transfer technology has been developed to supply power.

This paper is organized as follows. In Section II, different types of antenna and its bandwidth representation is given. In Section III, discussion about FSS is given. In Section IV Sensitivity calculation and impedance matching is given. Section V block diagram of the overall concept is given .Section VI explains the results.

II.DIFFERENT TYPES OF ANTENNA

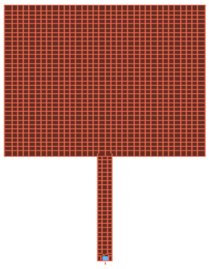

Fig. 1(a).Rectangular patch antenna

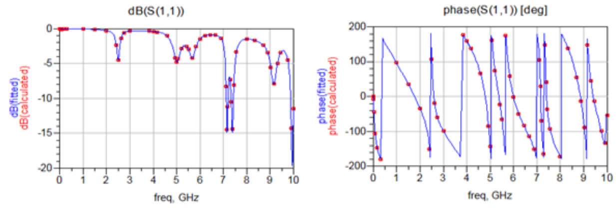

Fig.1(b).Bandwidth of Rectangular antenna

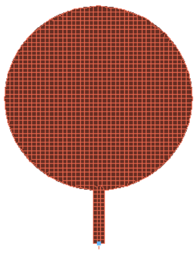

Fig. 2(a).Circular patch antenna

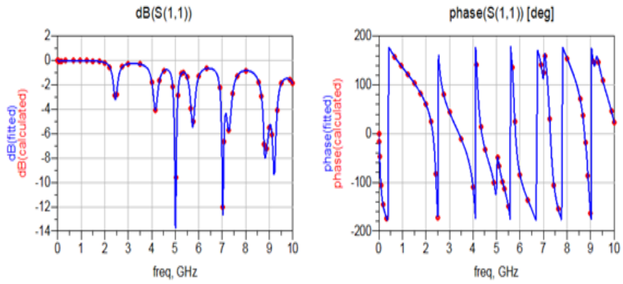

Fig.2(b).Bandwidth of Circular antenna

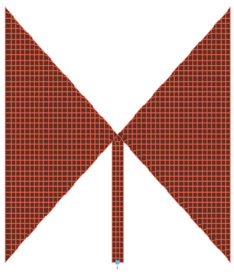

Fig. 3(a).Bowtie patch antenna

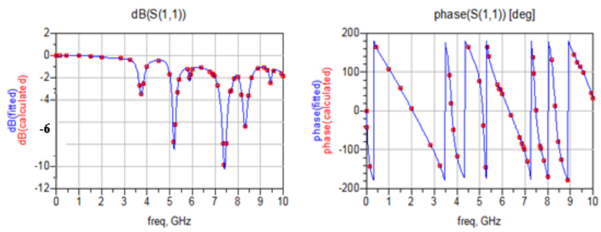

Fig.3(b).Bandwidth of Bowtie antenna

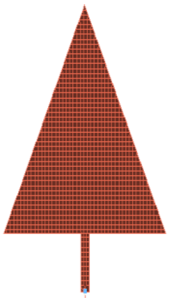

Fig. 4(a).Triangular patch antenna

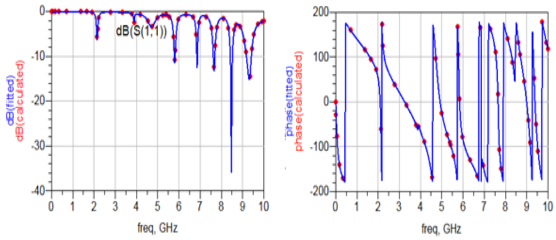

Fig.4(b).Bandwidth of Triangular antenna

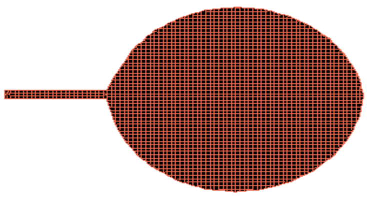

Fig. 5(a).Elliptical patch antenna

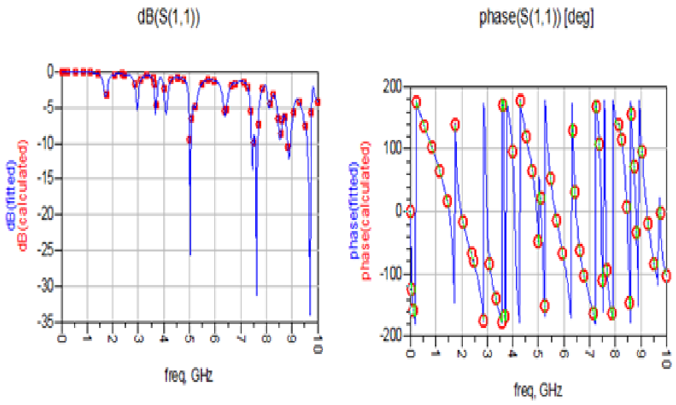

Fig.5(b).Bandwidth of Elliptical Antenna

It is shown that the Elliptical antenna has more bandwidth than any other antenna. If the bandwidth is more then the there will be absolute interference.

III. FSS

This interference is reduced by using the FSS (Frequency Selective Surface) structure. This Frequency Selective Surface unit is based on the Jerusalem cross structure. The reason for selecting the Jerusalem structure is

1) It is compact in size.
2) It provides good RFI blocking capability for a wide bandwidth .
3) The polarization is symmetric for both vertical and horizontal polarization.

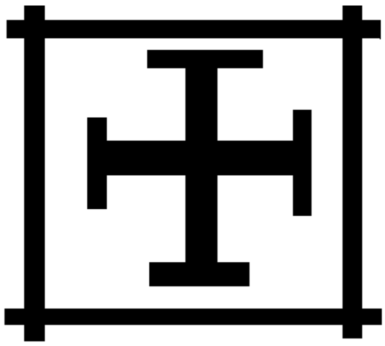

Fig.6.Jerusalem cross structure

This FSS(Frequency Selective Surface) is of two types.

1)SFSS(Single Frequency Selective Surface)

2)DFSS(Double Frequency Selective Surface)

III.BLOCK DIAGRAM

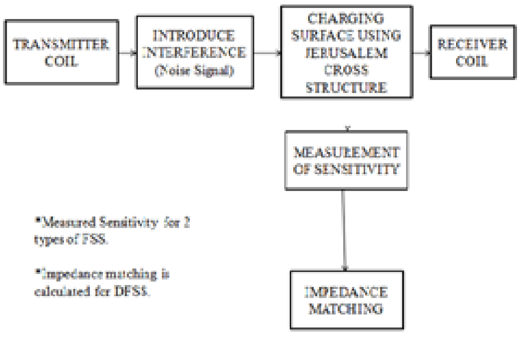

Fig.7.Block Diagram

IV. SENSITIVITY CALCULATION AND IMPEDANCE MATCHING FOR DFSS AND SFSS

A.Sensitivity:

It is defined as the minimum input signal required to produce a specified signal-to-noise S/N ratio at the output port of the receiver.

Sensitivity= $(S/N)_{min} KT_0 B$ NF

- $(S/N)_{min}$ minimum signal to noise ratio
- K boltzmn constant
- T_0 temperature of the receiver input
- B bandwidth
- NF noise factor

B.Impedance matching:

Impedance matching is very important for sensitivity analysis. The sensitivity gain is maximum when input and output impedance is matched.

$$Zin = Zo\frac{ZA + jZo.\tan\left(\frac{2\pi f}{c}L\right)}{Zo + jZA.\tan\left(\frac{2\pi f}{c}L\right)}$$

C.SFSS structure

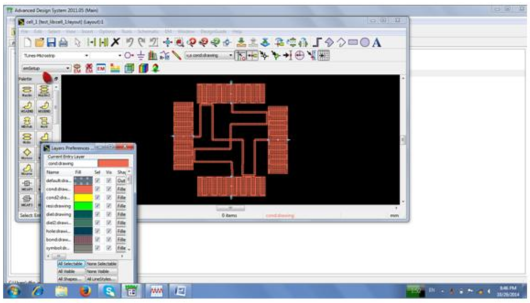

Fig.8. SFSS Structure

D.DFSS structure

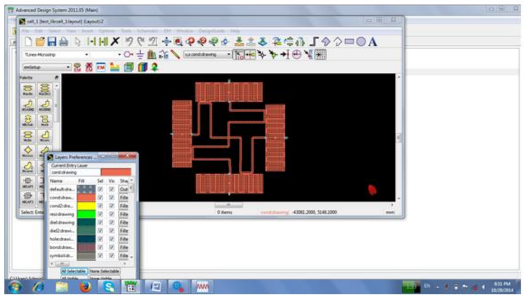

Fig.9. DFSS Structure

E.Sensitivity of SFSS:

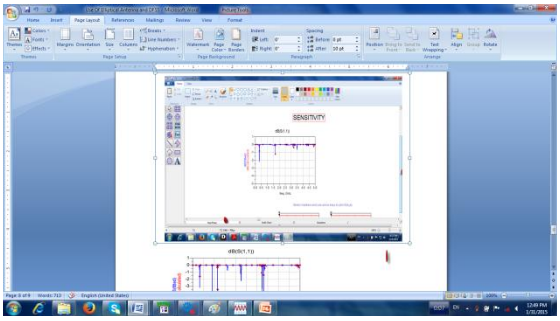

Fig.10. Sensitivity of SFSS

F.Sensitivity of DFSS:

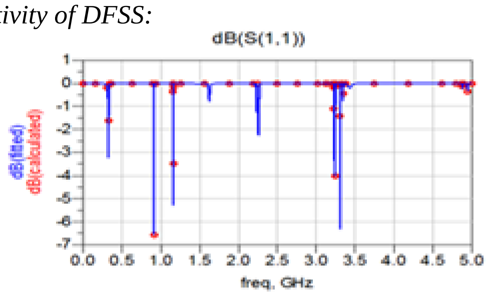

Fig.11. Sensitivity of DFSS

The sensitivity is found to be more in DFSS than the SFSS. It is also shown that the impedance is found to be matched in the DFSS structure. For the verification of the DFSS, the impedance matching circuit is designed in ADS software.

G.Impedance Matching Circuit

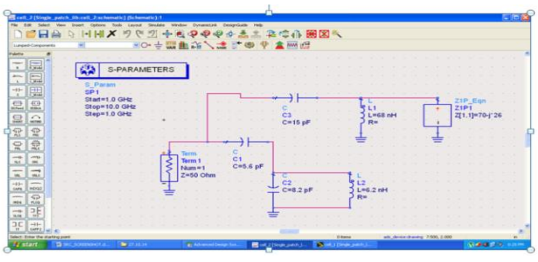

Fig.11. Impedance Matching Circuit

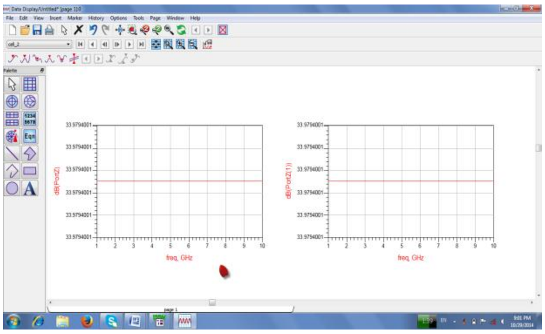

Fig.11. Impedance Matched

The impedance is matched and it is used to reduce the Interference of the RF signal which reaches the mobile and the DFSS structure is placed in the wireless charging pad.

V. BLOCK DIAGRAM

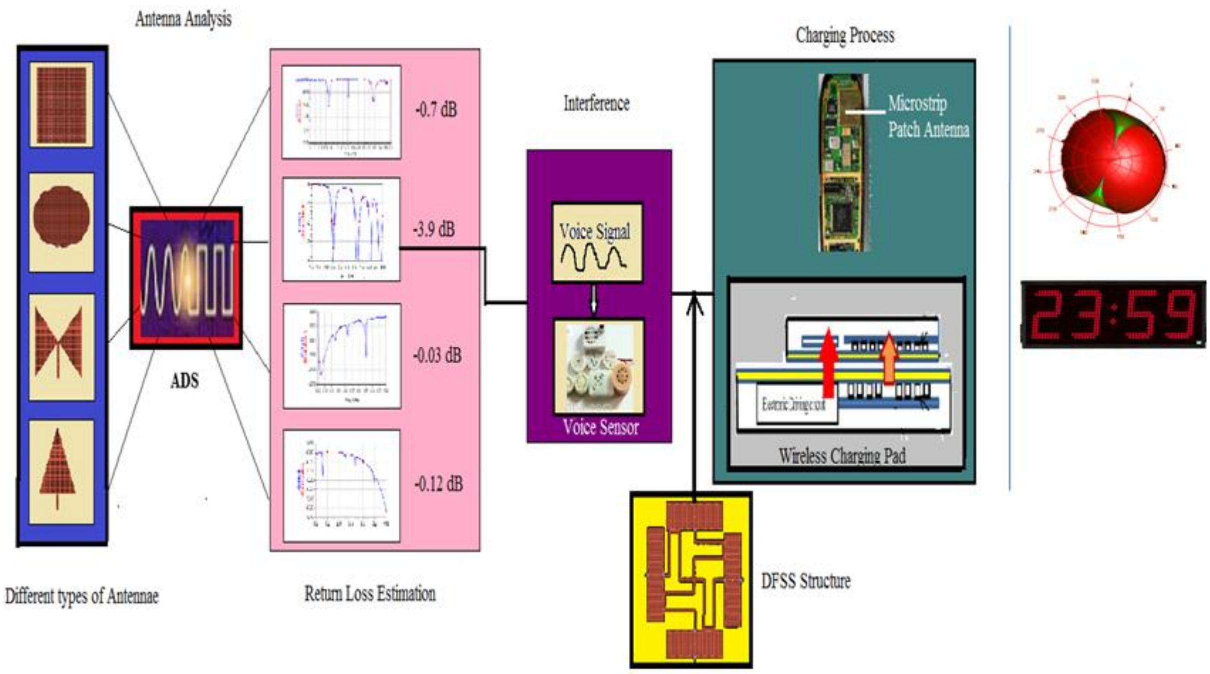

Fig.12. Block Diagram of charging and Interference Reduction Process

VI. EXPECTED OUTCOMES

- Elliptical antenna should have more bandwidth than any other antenna.
- DFSS structure should have more Sensitivity than the SFSS structure.
- The Radiation pattern for the circuit with a noise producing circuit may vary.
- The mobile is charged using the Wireless charging pad incorporated with DFSS.
- Interference is reduced and charging takes place and the Radiation pattern is verified.

CONCLUSION

The proposed system uses elliptical antenna for mobile phone due to its maximum bandwidth. As the bandwidth is more, the Interference is also more. So FSS can become a low-cost accessory to the wireless charging pads for portable electronics. Based on the use of the frequency selection surface, a simple and yet effective solution to suppressing the RFI emission from the wireless charging pad has been proposed and practically verified. The results show that both the SFSS and DFSS can be incorporated into a wireless charging pad to reduce the RFI emission. The proposed FSS structures can be fabricated in flexible materials. They can either be integrated into the wireless charging pad structure or used separately as an accessory to the charging pad. The same FSS concept can, in principle, be used to block the RFI of specific frequency bands in other power electronics systems.

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AUTHOR DETAILS

P.Sowmiya received B.E (ECE) from A.R.J college of Engineering and Technology,Anna University in 2013. She is currently persuading M.E – Communication Systems in Parisutham Institute of Technology and Science.