Use Of FSS To Improve Signal Transmission And Reception In Wireless Charging Pad

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Abstract — Mobile phone is used by everyone and it is the major source for communication for all the people. In the same era, wireless charging is also an emerging technology and have been recently developed for users convenience. This paper illustrates the charging of mobile phones using wireless charging pad. The Electromagnetic shield under the charging pad creates interference, which leads to the reduction in the transmission and reception signal. Here we use a structure called Frequency Selective Structure (FSS) the interference is found to be reduced and the transmission and reception of signals are increased.

Index Terms: FSS, Impedance matching, Sensitivity, S parameter, Wireless charging pad

I. INTRODUCTION

In recent days the most of the countries strengthens their effort to increase the electricity from renewable sources. This motivated us to realize power generation by different ways. According to a survey in 2010, nearly 2.5 billion of portable electronic products with chargers are made. But the charging protocol is not convenient for the consumer. 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. 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, an introduction to Wireless charging pad, in Section III Frequency Selective Surface (FSS) is given. In Section IV, different types of FSS, In Section V Domain Description and Section VI explains the result.

II. WIRELESS CHARGING PAD

Wireless charging pads for portable consumer electronics is a multidisciplinary emerging technology that involves power electronics planar magnetic designs and radio-frequency circuits and technologies. For communication products such as mobile phones, one obvious concern is the radiated radio-frequency interference (RFI) that arises from the switching actions and transients of the power electronic circuits below the charging surface.

Fig.1. Wireless Charging pad

According to the Qi standard, the operating range of the charging flux is within the range of 110-205 kHz. This ac magnetic flux is generated by the ac current in the transmitter coil driven by a power
This relatively low-frequency ac magnetic flux path is a normal energy transfer mechanism in a wireless charging system for mobile phones. Since the power converter is designed to generate a high-quality sinusoidal current waveform, the resultant magnetic flux will not impact adversely on the antenna of the mobile phone. However, the real problem arises from radiated RFI from the power converter.

**RADIO FREQUENCY INTERFERENCE**

Interference in radio astronomy, where it is commonly referred to as Radio-Frequency Interference (RFI), is any source of transmission that is within the observed frequency band other than the celestial sources themselves. Because transmitters on and around the Earth can be many times stronger than the astronomical signal of interest, RFI is a major concern for performing radio astronomy. Natural sources of interference, such as lightning and the sun, are also often referred to as RFI.

The FSS is employed as an RFI filter to block the radiated interference arising from the power electronic circuit of the wireless charging pad. The objective is to improve the maximum sensitivity and the total isotropic sensitivity of a mobile phone while being charged on the wireless charging pad. Although there are so many alternatives of FSS, the periodic unit of the FSS that can be employed for wireless charging pad must satisfy three criteria.

**FREQUENCY SELECTIVE SURFACE**

Traditional FSS’s are usually fabricated from resonant elements, whose dimensions are usually comparable with half a wavelength, arranged in a periodic fashion.
1) The topology of the unit should not have any conduction closed loop. Otherwise, the charging signal will induce large current in the loop to reduce the charging efficiency or even damage the FSS.
2) The FSS must be an omnidirectional structure in order to stop near-field random noise.
3) The unit must be compact so that there can be enough number of units within the small area of charging pad to form an effective FSS. The FSS unit is based on the Jerusalem Cross.

**Group of FSS Elements**

The first group, the center connected elements, are a viable candidate for both radiating and non-radiating arrays. This is by nature a narrow banded element, but when placed in a well designed array this element is capable of reaching a ratio of 4:1 without the addition of a dielectric matching section added in front of the array of a bandwidth or a decade or better with a dielectric matching section. This is mentioned to demonstrate that the bandwidth of an individual element does not necessarily determine the bandwidth of the array. However, element bandwidth does provide a good starting point for designing wide-band arrays. These elements are typically smaller in the x and y directions than the center connected elements with respect to a wavelength and thus can be spaced close to one another.

![Group 1: Center Connected or N-Poles](image1.png)

![Group 2: Loop Types](image2.png)

**Jerusalem Cross Structure**

This explains why the resonant frequencies of the ring and Jerusalem cross are much different to their values in a combination ring-Jerusalem cross. Based on uni planar compact high-impedance surface characteristics, the resistance loss material layer can be directly attached to the surface of JCS structure, thus absorbing electromagnetic waves effectively. The improved design is characterized by its wider bandwidth and adjustable range. The absorption frequency band can be flexibly adjusted by the slot parameters. The loaded resistance can be adjusted to obtain the optimum absorbing performance. The validation and effectiveness of the proposed design are conducted by using X-band waveguide simulation and measurement.

1) It is symmetric with regard to the principal polarization directions and shows the same equivalent circuit for both of the vertically and horizontally polarized waves.
2) This FSS unit is compact in size and will be shown to provide good RFI blocking capability for a wide bandwidth.
Another advantage is that when the number of unit cells is increased the bandwidth may be increased. They may also be employed to regain the broad band region of an antenna. These regions got affected while using traditional antennas such as log periodic. Optimization is also achieved using a Jerusalem cross Frequency Selective surface. Some of the advantages of this cross include the availability of more tuning parameters as a result of which band pass transmission capability is enhanced and any choice of band stop frequency is achieved. Another advantage is that the same cross can be used to maximize the reflection and minimize the transmission at various frequencies. Plane waves are used to calculate the near fields present inside the structure. Such plane wave excitations have infinite power and extent.

**IV. DIFFERENT TYPES OF FSS**

**SFSS and DFSS:**
SFSS – Single sided FSS

**V. DOMAIN DESCRIPTION**

**ADS**
Advanced Design System (ADS) is an electronic design automation software system produced by Keysight, a division of Keysight Technologies. It provides an integrated design environment to designers of RF electronic products such as phones, pagers, wireless networks, satellite communications, radar systems, and high-speed data links.

Keysight ADS supports every step of the design process: schematic capture, layout, design rule checking, frequency-domain and time-domain circuit simulation, and electromagnetic field simulation allowing the engineer to fully characterize and optimize an RF design without changing tools. As a result, the system has found wide acceptance in industry.

**MATLAB**
MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment and fourth-generation programming language. Developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, Fortran.
and Python. An additional package, Simulink, adds graphical multi-domain simulation and Model-Based Design for dynamic and embedded systems.

The MATLAB application is built around the MATLAB language, and most use of MATLAB involves typing MATLAB code into the Command Window (as an interactive mathematical shell), or executing text files containing MATLAB code, including scripts and/or functions.

VI. RESULT

1) Charging efficiency is measured by S parameter, in MATLAB

2) Interference is found to be reduced by impedance matching circuit in ADS.

3) SFSS and DFSS are simulated and concluded that DFSS is better by finding the Sensitivity in ADS.

S PARAMETER FOR TWO DIFFERENT RANGES (2.45 Ghz And 300Mhz) IN MATLAB:

Interference is found to be reduced by Impedance matching in ADS:
CONCLUSION

The proposed 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 design guideline and procedure of the FSS structures have been explained. 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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