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WREL (Wireless Energy Resonant Link)

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Abstract: With Nikola Tesla's leading ideas and experiments, the idea of transmitting power through the air has been running for more than a century, perhaps the most famous early attempt to do this. He had the vision to distribute wirelessly at a great distance using the Earth's ionosphere. Most of the approach of wireless power transfer uses the electromagnetic field (EM) of some frequency, through which the energy is transferred. Optical techniques at the end of high frequency of spectrum- Using lasers to send electricity from a remote detector through a compressed beam of light where the obtained photons are converted into electrical energy. With this approach, efficient transmission at large distances is possible; However, complex pointing and tracking mechanism is required to maintain proper alignment between transmitted transmitter and / or receiver. In addition, the objects found between the transmitter and the receiver can block the beam, inhibit the power transmission and, at the level of the power level- Depending on the basis, may possibly harm. At microwave frequencies, a similar approach can be used to efficiently transmit power at large distances using the irradiated EM field from the proper antenna [2]. However, the same warning about safety and system complexity applies to these radiation approaches. But what about going on a large distance or having more freedom in the source and device position relative to each other? The question is whether the Massachusetts Institute of Technology (MIT- In MIT, a group asked himself. He explored several techniques to transmit power at "mid-range" distance and reached a non-radiative approach, which uses resonance to increase the efficiency of energy transfer (see 3). High quality factor resonators can be otherwise possible at lower coupling rates, i.e. at greater distances and / or more situational independence (and therefore, this approach is sometimes referred to as "highly resonant" wireless energy transfer or "excessive" Efficient energy transfer- Enabling efficient energy transfer as "excessive" or resonant "Wireless Power Transfer (HR-WPT).

I. INTRODUCTION

Beyond an application space which reduces the power level to several kilowatts from the watt, a wireless energy transfer system based on the HR-WPT is often a common set of functional blocks. A normal picture is shown in Figure 1.

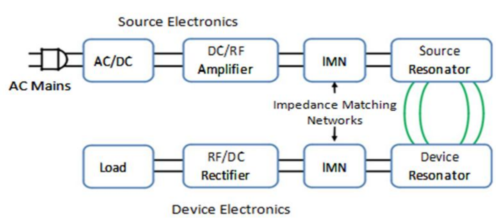

Figure 1. Block diagram of a wireless energy transfer system.

From the left to right side on the top line of the diagram, the input power in the system is usually either the power of the wall (AC main) which is converted into AC / DC rectifier block in DC, or alternatively, a DC voltage Battery or other DC supply directly from AC supply.

In high power applications, a power factor correction stage can also be included in this block. A high efficiency switching amplifier converts DC voltage into the RF voltage wave used to run the source resonator. Often an impedance matching network (IMN) is used effectively to amplify the amplifier output to enable effective switching-amplifier operation. Class D or E switching amplifiers are suitable in many applications and usually require a motivational load impedance for the highest efficiency. The IMN source amplifier works to change the source resonant impedance, loaded by coupling to load the device's resonator and output in such an impedance.

The magnetic field generated by the resonant couple's device resonance makes the resonator exciting and causes energy generation. To make this energy work useful, the device is coupled out of the resonator, for example, powering straight load or charging the battery. A second IMN can be used efficiently for doubling energy to be resonant here. This can change the actual load impedance to an effective load impedance, which is seen by the device resonator, which closely matches the loading for optimal efficiency (equation 5). For loads requiring DC voltage, a rectifier recovers AC power back into DC.

In the earliest work of MIT, the resonance matching was accomplished in a resonator and coupled with device resonator [3].

This approach provides a way to tune the input pairing, and therefore by adjusting the alignment between input impedance, source input coupling coil and source resonator, and so on, there is a way to tune output coupling, and therefore By adjusting the alignment between effective loading device resonance, device output coupling coil and device resonance. With the proper adjustment of coupling values, it is possible that the power transfer capability is achieved, the schematic representation of an inductive coupling approach to the near-reach impedance matching of the optimum possible efficiency represents the representation. M in this circuit! The source has been adjusted to provide the desired input impedance for the given load of the resonator. Device resonance is loaded by adjusting like this !, interpersonal coupling for load. In order to improve the efficiency of the series capacitors, the input and output coupling coil may be required in order until the responses to the coupling motivators are not very small compared to the generator and load resistors. It is also possible that the generators and directly related resonators should be loaded with IMN.

These usually include components (capacitors and indicators) that are arranged in "T" and / or "pi" configurations. The values of these components can be selected for optimal efficiency at a specific source-to-device coupling and load position ("fixed tune" impedance matching) or they provide more performance than a range of source-to-device positions. Can be adjustable and the position of the load ("tunable" impedance matching) The specific application requirements will determine which approach is most suitable from the perspective of performance and cost. One common question about wireless charging is: how efficient is it? The end-to-end efficiency of the wireless energy transfer system is the product of wireless efficiency (see the physics of the highly resonant power transfer for an explanation) and the efficiency of electronics (RF amplifier, rectifier and any other power conversion steps) if needed.

In high power applications, such as charging of electric vehicles at multi kilowatt level, more than 94% end-to-end capacity (d) AC input for SCI output has been demonstrated. For such efficiency, it is necessary that the efficiency of each stage in the system is 98-99% or more. To achieve such performance, careful planning is required in each stage to reduce the loss.

In mobile electronic devices, space is usually of utmost importance, so to include the resonator, usually involves some tradesoff in resonant size and system efficiency to accommodate space restrictions. In addition, there may be a wide range of magnetic coupling between application usage-case, source and device can also offer a challenge for the design of impedance matching network. However, coil-to-coil affilmals of more than 90% or more and 80% of end-to-end efficiencies are available in these lower power applications.

II. PHYSICS OF HIGHLY RESONANT WIRELESS POWER TRANSFER

A. Resonance

Resonance is an event that occurs in many different forms in nature. In general, the resonance involves energy oscillation between two modes, a familiar example is a mechanical pendulum in which energy vibrates between potential and kinetic forms. In a system on resonance, it is possible to have a large buildup of stored energy when there is only one weak stimulus in the system. Build-up occurs when the rate of energy injection in the system is higher than the rate of energy loss by the system.

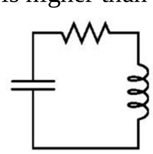

Figure 2. Circuit equivalent of an electromagnetic resonator.

In this circuit, the energy is resistant to the resonant frequency between the inductor (stored energy in the magnetic field) and the capacitor (energy stored in the electric field).

In highly resonant wireless power transfer systems, the system must be a high quality factor to efficiently transfer energy to the resonator. Hi-Q electromagnetic resonators are usually made from conductor and components with less absorbers (sometimes also known as ohmic, resistive, chain resistant, etc.) damage, exhibit less radiative damage, and This results in relatively narrow vowel frequency width. Apart from this, the resonator can be designed to reduce its interaction with external objects, which can lead to losses.

B. Coupled Resonators

If two resonators are kept in proximity to each other as if there is a coupling between them, then exchange of energy is possible for those who resonate. The efficiency of energy exchange depends on the specific parameters for each resonator and the energy coupling rate between them.

The dynamics of the two-resonance system can be described using the coupled-mode theory [3], or by analyzing a circuit equal to the coupled system of the resonator. Equivalent circuit for coupled resonance is the series resonance circuit shown in Figure 3.

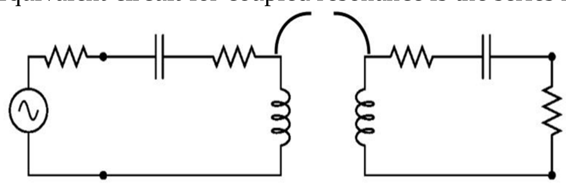

Figure 4. Equivalent circuit for the coupled resonator system.

After knowing the quality of the magnetic coupling between the resonant quality factors and between them for a particular application, one can determine the best efficiency for the system.

The analysis given above is the coupling factor for wireless power transfer using the magnetic resonance Reflecting the importance of the resonant quality factor, the magnetic coupling coefficient is a non-dimensional parameter, which is a copy of the part of the magnetic flux Which is coupled between the source and the device resonator, and there is a magnitude between zero (no coupling) and 1 (all the flow is coupled). Coupling is an act of size relative to the resonator, and their The distance between their relative orientation. Wireless power transmission systems based on traditional induction (e.g., cordless toothbrush) usually design for larger values of coupling And resulted in close spacing and exact alignment between the source and the device as a result. Using a high-quality resonator also allows for efficient operation.

At lower coupling values, eliminating the need for precise position between source and equipment and providing greater freedom of movement. The ability to achieve high efficiency on low coupling factors also extends the application space for wireless power beyond conventional induction.

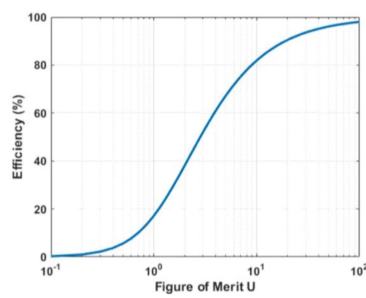

Figure 5. Optimum efficiency of energy transfer as a function of the figure-of- merit.

C. Human Safety Consideration

A general question about wireless power transfer using the magnetic resonance system is: Are they safe? Maybe Because these systems can efficiently exchange energy at a distance of mid-range, people may assume that the use of these systems While doing so, they are exposed to large and potentially dangerous electromagnetic fields. In the form of "electricity-in- the-air", the initial popularization of technology has greatly reduced the potential fear of people. With the mature technology base and a broad application space,

wireless power transfer will become popular in many areas of life in the coming years.

D. The Future

Since the original demonstration in MIT, the magnetic resonance technique has moved into a production line from a scientific experiment where it will be included in large-scale consumer electronics such as laptops and mobile phones. Both electric vehicles, both plug-in hybrids And full battery electric vehicles, will soon offer wireless charging so that plugging is not required for charging Gee. In these areas, the development of world-wide standards for wireless power is going to ensure the difference between products and brands, wireless charging facilitates the deployment of infrastructure and technology to accelerate adoption.

Another promising application area for wireless power transfer is in the medical field. The use of medical implants for innovative therapy for various types of old conditions is increasing, and the ability to safely obtain such electrical power from these devices opens the door for new treatment options. For example, wireless power provides the ability to extend the useful lifetime of an implant because its batteries can be recharged, or in some cases can eliminate the need for the battery.

Of course, for wireless power There will be a possibility of the application which we can not imagine today. With the pace of technology innovation, not only in the areas mentioned here but also in many more applications. Not even expect to see wireless power technology.

III. ACKNOWLEDGMENT

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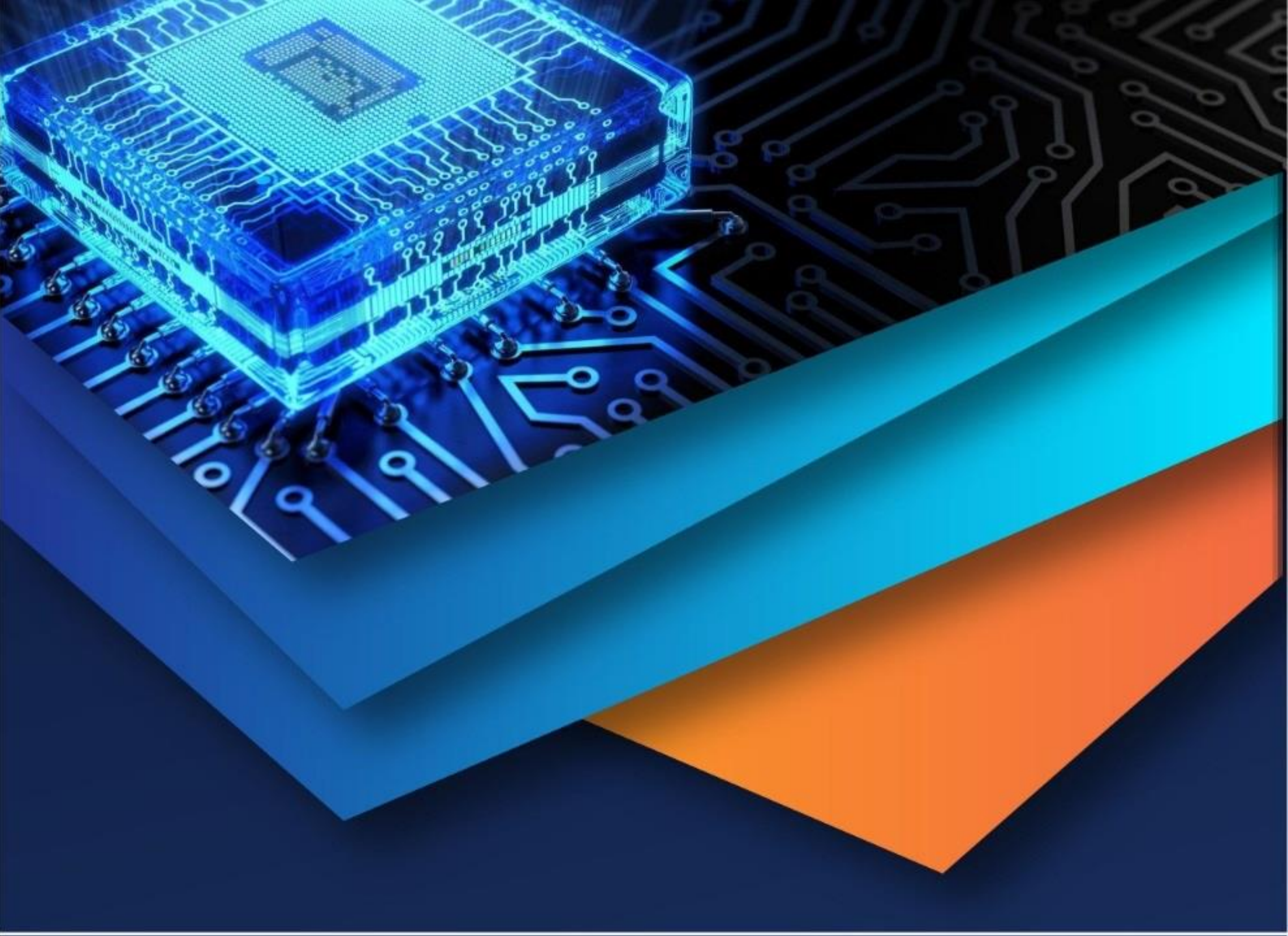

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