iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** III **Month of publication:** March 2020

DOI:

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue III Mar 2020- Available at www.ijraset.com

Wireless Power Transmission with a Monitoring System

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Abstract: ***Given the colossal increment in the quantity of versatile gadgets, wired chargers would limit their movability or portability. To function or to enable the units work, they ought to be associated with power plugs. It takes time, money, room and personnel to drive the units this makes the procedure both troublesome and expensive. In case of fluctuations or failures, wires perhaps compromise while the wireless devices may be unplugged under any adverse conditions. Wireless Power Transfer innovation can diminish the utilization of wires in this manner one probably improves portability, accessibility, and security for all clients of electronic gadgets. In the WPT project, we wirelessly transfer electricity to a cell phone to charge it and also to glow LEDs employing a two-way-switch.***

I. INTRODUCTION

A transmitting coil or unit, powered by electric force, creates a time changing electromagnetic field (emf) in a transmission framework, which transmits or sends power in the form of magnetic flux through space to a recipient unit. The advancement in wireless transmission will diminish the usage of wires and batteries, right now the adaptability, comfort, and protection for all customers of an electronic unit. It helps drive electrical or electronic gadgets where integrating wires is uncomfortable, unsafe or not feasible. This transmission framework represents power movement from a solitary resounding source loop to numerous resonant recipients, focusing on the resonant frequency splitting issues that emerge in various collector applications. The model thinks about equal coupling between all curls and doesn't, for the most part, make approximations related to the coupling mode technique. The model investigation shows that high-Q full coupling is a key factor for device execution, through a usage where the essential loop is inductively coupled with the source and the recipient curls are inductively combined with the output devices. The research developed can help to identify the mechanism of resonant coupling and extend that to numerous mobile recipients or receivers. The primary challenge is to vary or change lumped capacitances near the receiver's terminals as they go according to the source loop and corresponding to one another.

WPT is an innovation equipped for transferring capacity to areas that are exceptionally outlandish or difficult to reach. The following enormous thing could be charging low capacity devices through coupling strategies like inductive or capacity over mid-power devices. This framework's goal is to create or develop a strategy for transmitting wireless electrical force across space and charging an ideal low-power gadget. Two curls will be utilized to transfer electrical force from an AC source to the output device. Achievement in doing, all things considered, would eliminate the utilization of connections in mobile charging methodology accordingly making it less complex and less demanding for charging a low capacity device. It would ensure the less multifaceted nature of the device since it would wipe the danger of short circuits. The objective moreover joins the likelihood of charging distinctive low capacity gadgets simultaneously utilizing a solitary source that could utilize a solitary electrical fitting. It is additionally conceivable to associate numerous inputs and outputs curls to expand the sum and effectiveness of the ability to be transmitted wirelessly. It's very critical that the efficiency is high for the short-range power transfer. Applications of high-efficiency wireless devices use special materials. Multiple coils improve the robustness of WPT. The electrical force which is transmitted wirelessly between the transmitting and accepting end curls isn't impacted by any substance or individual. Any impacts may happen if these substances are exceptionally near the loops. Different techniques may be utilized for transmitting electrical force wirelessly to make a supply of electrical force less difficult for different level applications.

II. WIRELESS POWER TRANSFER METHODS

A. Inductive Coupling

In electromagnetic coupling or inductive coupling, the energy is transmitted by a magnetic field between wired spindles or coils. The transmitter is coiled along with a receiver to create a transformer. By Ampere's law, the time-changing current passing through the transmitter loop generates an oscillating magnetic field.

The field passing through the coil generates an alternating EMF across the transmitting coil, which thereby causes a time-varying current to flow in the receiver coil or recipient. The induced current will either power the load directly or be changed to direct current employing a rectifier attached to a receiver that powers the output devices.

B. Capacitive Coupling

Capacitive coupling or electrical coupling uses electrical fields to send electrical energy between the electrodes like metal plates to form a capacitance for energy transmission. A condenser is formed by the transmitter and the collector terminals, with space intervening as dielectric. The transmitter delivers a varying voltage on the transmitting metal, and the electrostatic enlistment of the wavering electrical field produces a rotating potential on the recipient metal, which permits varying current to course through the output circuit. The measure of intensity transmitted increments with the square of potential and the capacitance between the plates, which is corresponding to the smaller plate region and contrarily relative to the partition. Capacitive coupling was just generally utilized in a couple of low capacity or power applications, on the grounds that the extremely high voltages required on the cathodes to transmit noteworthy force may be hazardous and may cause disagreeable symptoms. Also, in contrast to magnetic fields, because of dielectric polarization, electrical fields meddle seriously with most objects, including the human body.

III. BLOCK DIAGRAM OF WIRELESS POWER TRANSFER SYSTEM

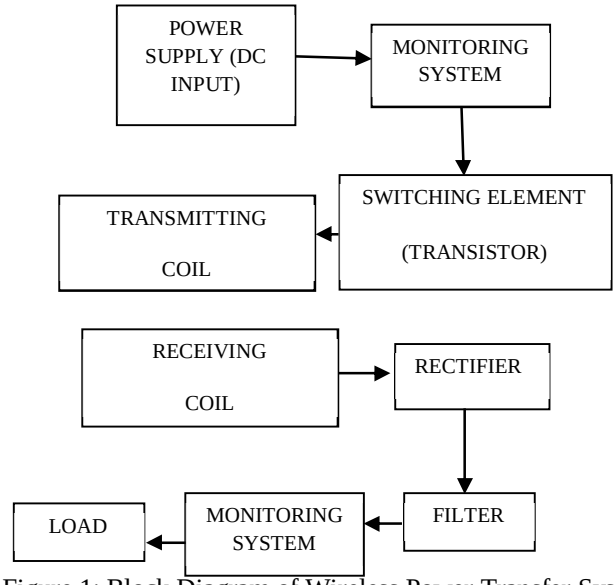

Figure 1: Block Diagram of Wireless Power Transfer System

The wireless power transmission framework deals with the principle of mutual induction of two coils. It comprises of two sections, i.e., Transmission section and Receiver section. In the transmission section, the supply (DC input) is connected to the NPN transistor which acts as a switching element to generate magnetic flux around the transmitting loop. This magnetic flux transfer power wirelessly from transmitting curl to the receiver loop.

In the receiver section, the electromotive force is received by the receiver curl or the recipient in the form of magnetic flux from the transmitter. At the receiver end, the time-varying field is converted into DC using a rectifier, which is used to drive an output device.

IV. IMPLEMENTATION OF MONITORING SYSTEM

A voltage sensor (detector) or potential divider circuit is interfaced with Arduino to measure source voltage and receiver voltage.

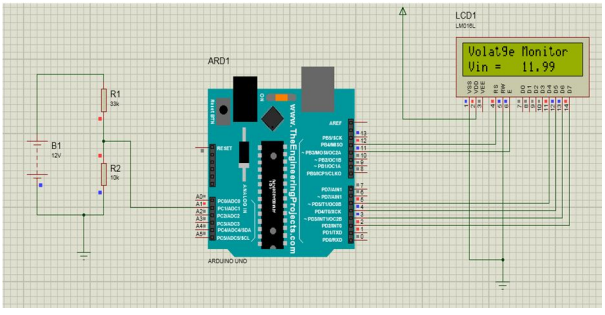

Figure 2: Interfacing Potential Divider (Voltage Sensor) With Arduino

A. Mathematical Model of Monitoring System

Consider a voltage divider circuit acting as a voltage sensor to calculate the input voltage.

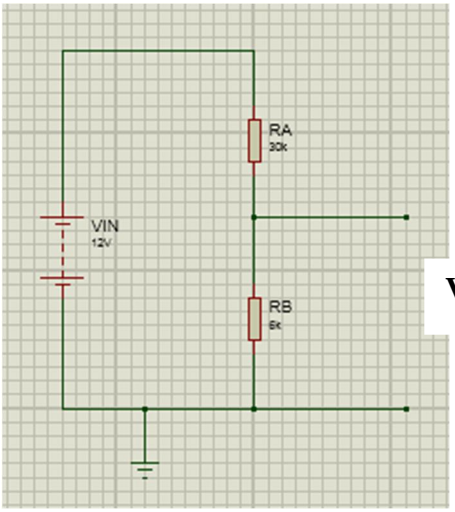

Figure 3: Divider Circuit To Calculate Voltage

Where,

V_{IN} = Input Voltage

V_{Out} = Output Voltage

V_{RA}= Potential drop at resistor R_A

V_{RB} = Potential drop at resistor R_B

I_{RA}= Current passing through the R_A

I_{RB}= Current passing through the R_B

From fig, Mesh equation will be,

$$V_{IN} = V_{RA} + V_{RB} \quad (1)$$

Voltage across R_A,

$$V_{RA} = I * R_A$$

Voltage across R_B,

$$V_{RB} = I * R_B$$

Substitute V_{RA} and V_{RB} in (1)

$$V_{IN} = I * R_A + I * R_B$$
$$V_{IN} = I(R_A + R_B)$$
$$I = \frac{V_{IN}}{R_A + R_B}$$

Current passing through R_B

$$I_{RB} = \frac{V_{RB}}{R_B} = \frac{V_{IN}}{R_A + R_B}$$
$$V_{RB} = V_{IN} * \frac{R_B}{R_A + R_B}$$

Current passing through R_A

$$I_{RA} = \frac{V_{RA}}{R_A} = \frac{V_{IN}}{R_A + R_B}$$
$$V_{RA} = V_{IN} * \frac{R_A}{R_A + R_B}$$

Output voltage across resistor R_B,

$$V_{Out} = V_{RB} = V_{IN} * \frac{R_B}{R_A + R_B}$$

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue III Mar 2020- Available at www.ijraset.com

Therefore, the source voltage is determined as,

$$V_{IN} = \frac{V_{Out}}{\frac{R_B}{R_A + R_B}} = \frac{V_{0ut}(R_A + R_B)}{R_B}$$

$$\therefore V_{IN} = \frac{V_{0ut}\,(R_A+R_B)}{R_B}$$

V. HARDWARE COMPONENTS

The design of WPT consist of

A. Rectifier with Filter
B. Voltage Regulator
C. Arduino Uno
D. Voltage Sensor or Potential Divider Circuit
E. Transistor
F. Transmitting and Receiving Coil

1) *Rectification:* Rectification is the process of converting alternating current (AC) to pulsating direct current (DC) that flows in a solitary direction. Rectifiers are mainly utilized for radio signal detectors in power supplies and adapters. These rectifiers are made of different sorts of diodes, for example, solid-state diodes, vacuum diodes, and mercury arc diodes with other components like resistors and capacitors. The rectifier circuit assists in bringing down the AC voltage to the necessary level. The energizing voltage is provided across capacitor terminals of a rectifier which is utilized as a filter or screen to diminish AC noise. This balances out the yield of the rectifier and changes over the output to a steady dc voltage.
2) *Voltage Regulator:* A voltage controller or a regulator is a device that is intended to keep a level of voltage constant automatically. A voltage controller may either utilize a fundamental feed-forward setup or negative input. An electromechanical device, or electronic parts, might be utilized. The controller perhaps utilized to control at least one AC or DC voltages, contingent upon the design.
3) *Voltage Sensor:* The voltage detector (sensor) operates according to voltage divider law. It (otherwise called a potential divider) is an inactive linear circuit that delivers a voltage output (Vout) which is a small amount or fractional part of its input (Vin). The division of potential is the product obtained by the distribution of the source voltage between the divisor components. Two resistors associated in the arrangement are a straightforward case of a voltage divider, with the input applied over the resistor pair and the yield voltage leaving the contact between them.
4) *Transistor:* A transistor is a device utilized for switching and enhancing electronic and electrical signals. It is typically a semi-conductor device comprising of at least three terminals for associating with an outer circuitry. Transistor base (B) is associated with one end of the transmitting loop alongside a resistor while Collector (C) is associated straightforwardly to another end. Emitter (E) is associated with ground and the yield of the voltage controller is associated with the center loop of the transmitting curl.
5) *Transmitting and Receiving Coil:* Transmitting and receiving curl is developed utilizing 25 gauge copper wire. The transmitting loop is 160 turns and 5 cm in diameter whereas the accepting coil is 150 turns and 5 cm in diameter. The transmitting loop-powered up by electricity produces a time-changing magnetic flux that transmits electrical energy in form of EMF through space to the beneficiary curl, which generates energy from the field and supplies to an output device (electrical load).
6) *Filter:* The yield isn't pure DC at receiving curl. It has a lot of AC components. The output device is sensitive and requires an unadulterated direct current. A capacitor is connected parallel to the heap to filter out ripples. The AC component of high frequency is bypassed through this capacitor as noise.
7) *Loads:* The current at the output terminals ranges from 0.3-1.2A and voltage from 5-10V. Initially, two loads are associated in parallel with each other i.e., a cell phone charger and LEDs (set of three) employing a two-way switch.

VI. IMPLEMENTATION OF WPT

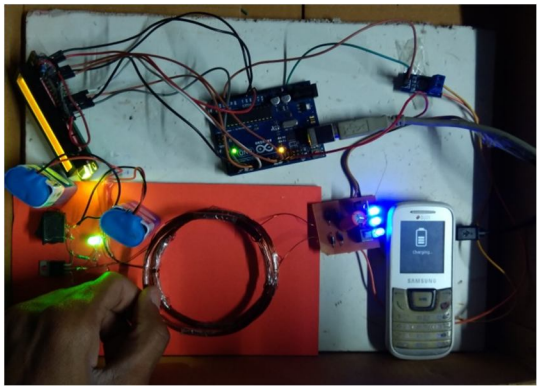

Figure 4: Working Of Wireless Power Transfer With A Monitoring System

The energy from the non-rechargeable battery passes through a transistor, which acts as a switching element is associated with the coil to generate an oscillating magnetic flux. This flux causes emf in the receiver to generate time-varying current. This AC is rectified to DC so that to drive a load (basically a charger).

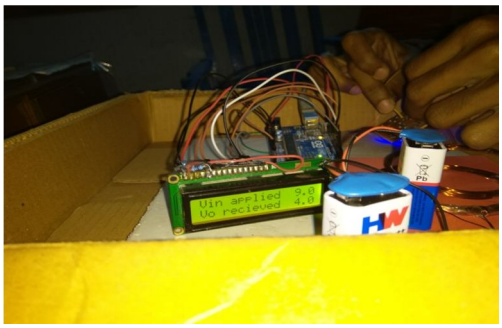

Figure 5: LCD showing the measure of voltage transferred between transmitter and collector.

VII. RESULTS

Electrical energy is transmitted from the transmitter to the recipient coil as an electromagnetic field. Furthermore, the voltage over the transmitting and receiving curl is determined and verified utilizing the monitoring system.

VIII. CONCLUSION

This project is meant to plan and execute a wireless power transfer along with a monitoring framework through electro-magnetic coupling and to monitor the sum of energy that is being transmitted from the transmitting loop to the accepting curl. We energized a lot of LEDs and charged the cell phone that is connected parallelly employing a two-way switch.

IX. ACKNOWLEDGMENT

We are very thankful to Mall Reddy Institute of Technology and Science for providing us with sources for research.

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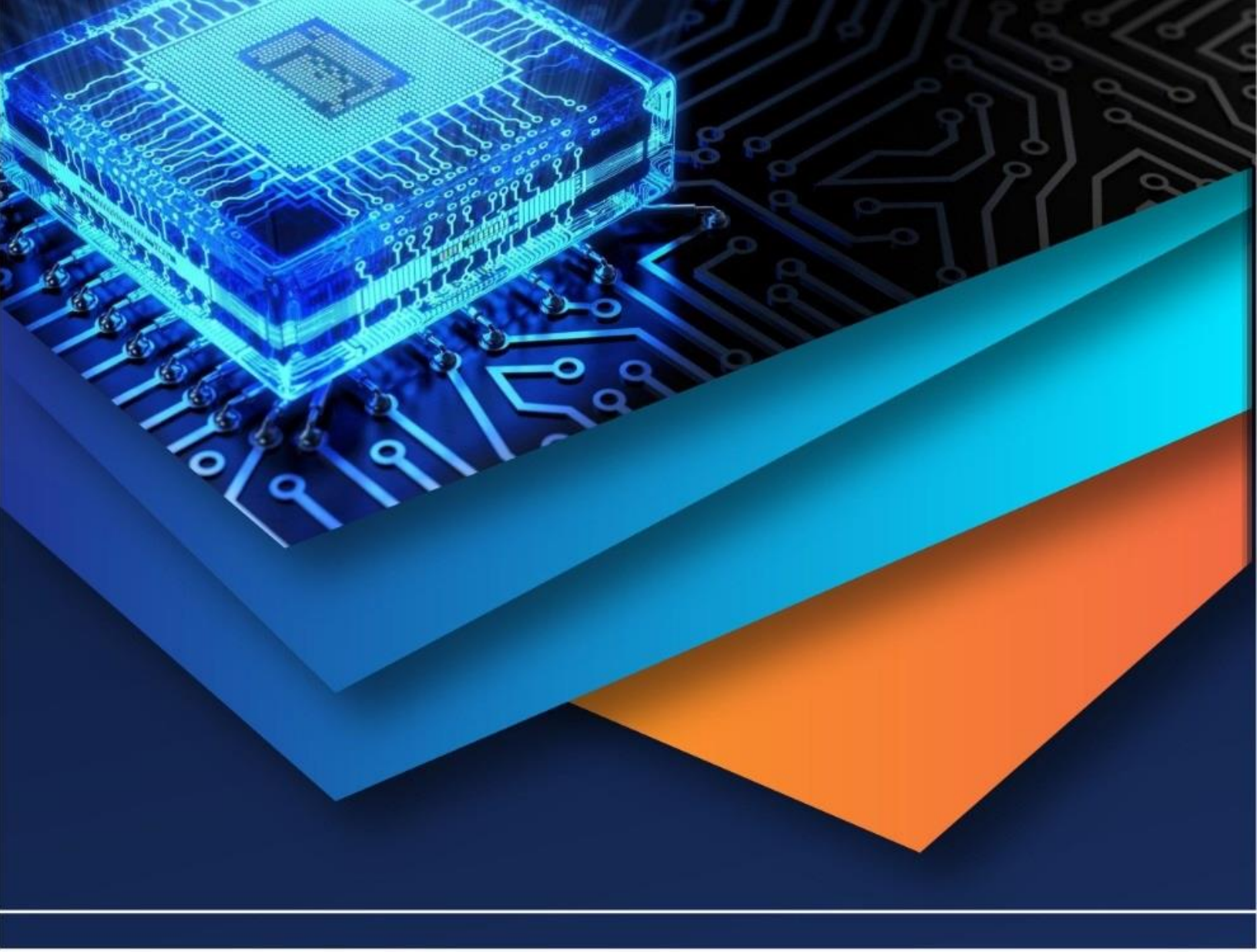

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