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# On-Road Efficient Wireless Charging System for Electric Vehicle

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**Abstract:** *With the growing popularity of Electric Vehicles (EVs), the need for a simple and robust charging scheme has become necessary. Consumers are dissatisfied with the typical recharging method at home or in station parks because it takes a long time to recharge. On a highway, waiting for a place to recharge the vehicle is not always a good idea. The super-fast recharge station has received positive feedback from drivers in terms of charging time; nevertheless, this is not always recommended, particularly in terms of battery security and durability. WPT (Wireless Power Transfer) technology has many inherent advantages over traditional means of power transfer. It has been proposed for use in a wide range of applications, ranging from low power biomedical implants (several watts) to electrical vehicle chargers (several kilowatts) to railway vehicles (several megawatts), with efficiency up to 95% or higher in some prototype systems. Capacitive coupling, magnetic coupling, frequency resonance matching, microwaves, lasers, and ultrasound waves are all methods for transferring electric power across a specified distance through air. However, resonant magnetic coupling appeared to be the most practical and promising method to date, with resonant magnetic coupling being used in the majority of medium to high power WPT systems constructed to date. In this project, a wireless charging system for lightweight electric vehicle is designed, built and tested. The problem with electrical vehicles is that it requires too much time to recharge the battery. Dynamic Charging could be the much anticipated concept that replaces the conventional method of charging of battery and reduces the time taken to change the battery. A solution to directly charge EVs as they travel along the highway will eliminate the two biggest barriers, travelling range anxiety and cost. This project is carried out using MATLAB Simulink software for simulation of the circuit. This project based on future infrastructure of EV's technology.*

**Keywords:** Wireless Charging, Electric Vehicles, Wireless Power Transfer, Magnetic Coupling.

## I. Introduction

The biggest challenge for the acceptance of EVs in the society is due to the anxiety related to its range. Making on-road charging as accessible and as quick as refuelling at petrol or gas stations will surely bring about the revolution in the EVs market which will not only make options of renewable energy production more prominent, but will also make cars more sustainable.

We will analyse and design dynamic wireless charging for EVs in order to determine a solution to the aforementioned challenge. To do this, we will use MATLAB Simulink software for the analysis of different power capacity charging system. Resonant compensation must be utilised to counteract the inherent low coupling and significant leakage inductance in order to transfer power effectively and efficiently. For this, Wireless Power Transfer works best. Magnetic WPT systems use magnetic field coupling to transfer electric power across a reasonably large air gap between two or more magnetically connected coils. This way, EVs can be charged even while running on the road. This document is a template. The conference website has an electronic copy available for download.

## II. Implementation

Magnetic induction works on the principle of a transmitting coil that produces a magnetic field and a receiving coil that induces current in the coils inside the magnetic field. Due to the amount of energy required to deliver a magnetic field, this typically results in a short range. As a result, the non-resonant approach is ineffective over longer distances, resulting in more energy being wasted while transmitting over greater distances. The resonance here improves efficiency drastically by channelling the electromagnetic field to the receiving coil resonating at a matching frequency thereby increasing the charging distance as compared to other strategies that will allow it to reach its full potential in the future. Power transfer impacts items functioning at a matching frequency and has no influence on objects operating at nearly matching frequencies due to resonance characteristics.

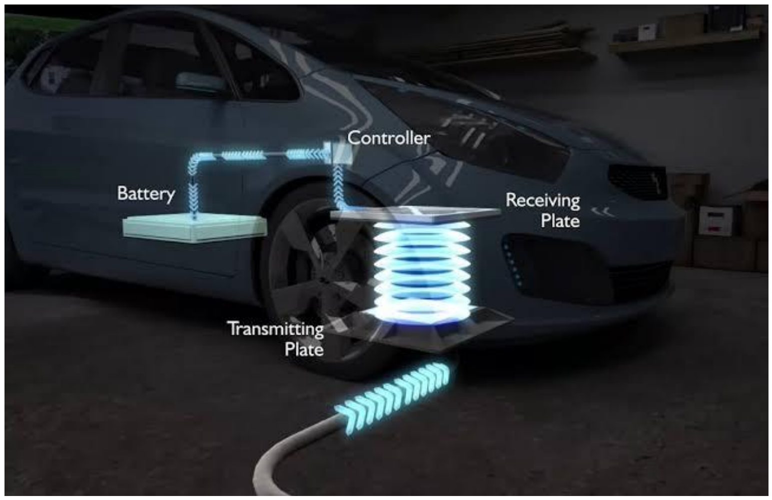


**Figure 1:** Setup inside the chassis

The above Fig. 1. represents a basic structure of the magnetic resonance coupling. The primary coils are used as a transmitting pad beneath the ground and the secondary coils are the receiver pad. When the electric vehicle is parked at a fixed location, electric power is transferred from the pad beneath the ground to the one positioned on the chassis of the car without any contact between the two pads. The resonant compensation aids in the removal of large inductance leakage and the efficient transmission of power via the tiny coupling.

## III. WORKING

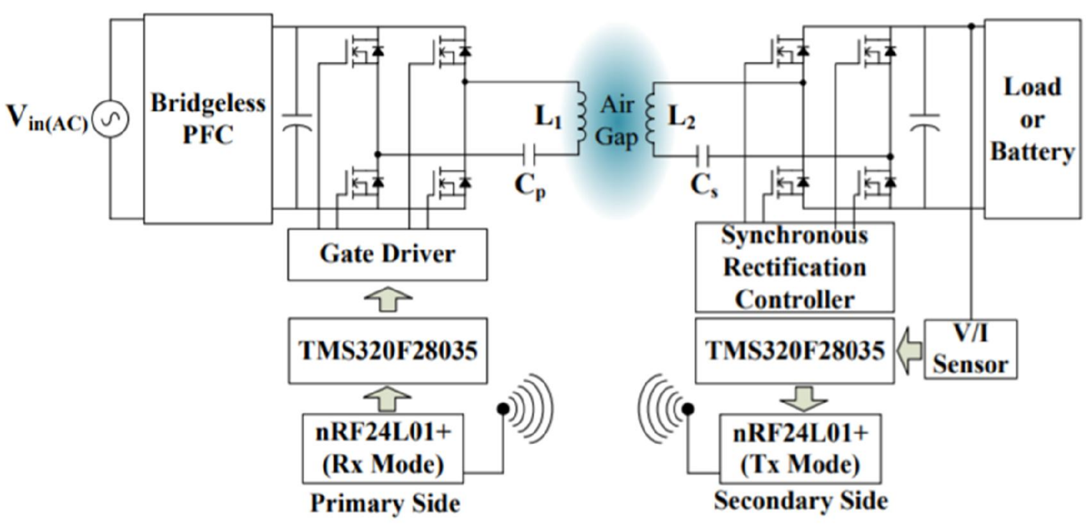


**Figure 2:** Circuit Block Diagram

Fig. 2. gives an overview of the WPT charging system that has been designed for electric car applications. Texas Instruments TMS320F28035 digital signal processor (DSP) chips manage both the primary and secondary sidess. The battery voltage and charging current are sensed to realize constant current (CC)/ constant voltage (CV) charging schemes. A RF module is used to transmit wireless feedback from the secondary to the primary side. Frequency modulation of the WPT DC/DC stage controls the output voltage and current. The bridgeless PFC step converts the AC input voltage to

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400VDC, which is subsequently transformed to AC high frequency square wave by the full-bridge inverter and supplied into the primary resonant tank. Because of the circuit simplicity and low component count, the series-series resonant compensation topology is used in this research. When operating at resonance frequency of leakage inductance and compensating capacitance, series-series topology has the property that the voltage transfer ratio is constant, only dependent on the turns ratio of WPT coils, and irrespective of load. If a consistent output voltage is wanted, this is advantageous. Under misaligned conditions, however, this may not be true because equivalent leakage inductance and magnetising inductance may alter dramatically. Only a little amount of this can be accounted for by changing the switching frequency.

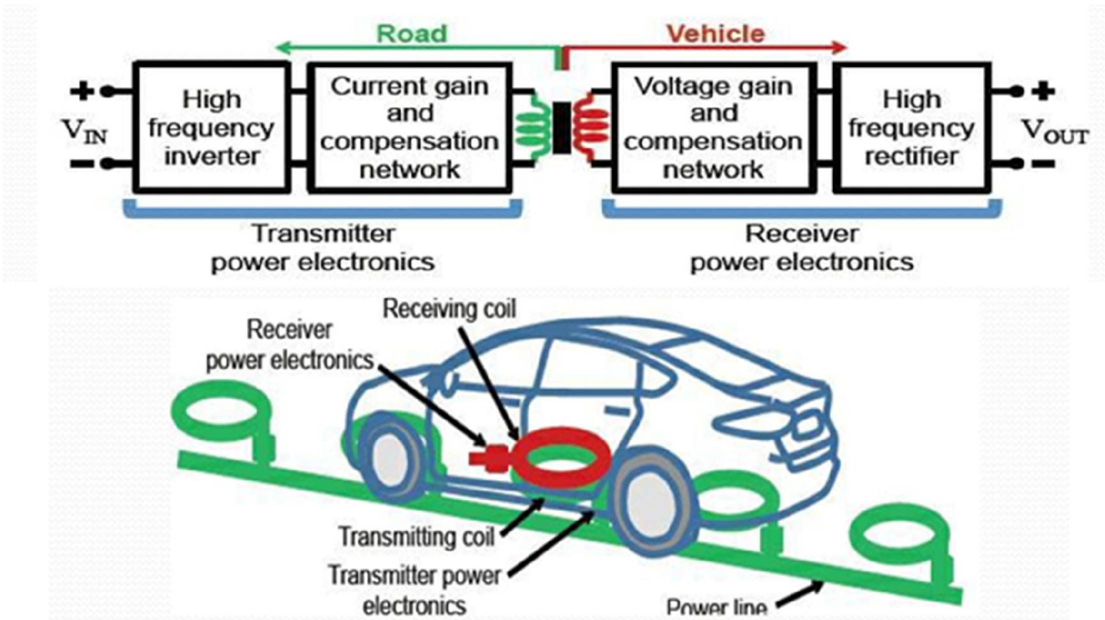


**Figure 3:** Simplified Block Diagram and Car Setup

## IV. Specifications

| Parameters | Value |
|---|---|
| Input Voltage | 240V, AC |
| Output Volatge | 120V, DC |
| Primary Self Impedance | L1=73.43µH ,R1= 80Ω |
| Secondary Self Impedance | L2=73.43 µH ,R2=80Ω |
| Mutual Impedance | Rm=50 Ω , Lm =14.6 µH |
| N2:N1 | 1:1 |
| Cp | 0.2mF |
| Cs | 2.2 µF |
| C(Filter) | 2mF |


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## V. Simulink Schematic

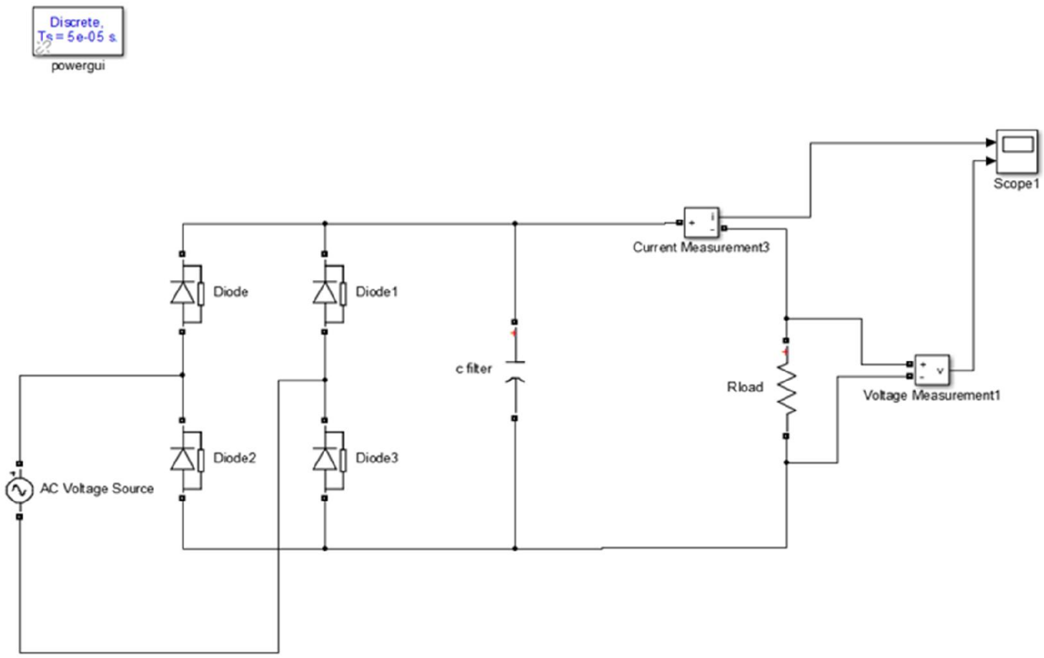


**Figure 5:** Rectifier Schematic

Firstly, AC supply is given to the rectifier (Fig. 5.) that converts AC to DC.

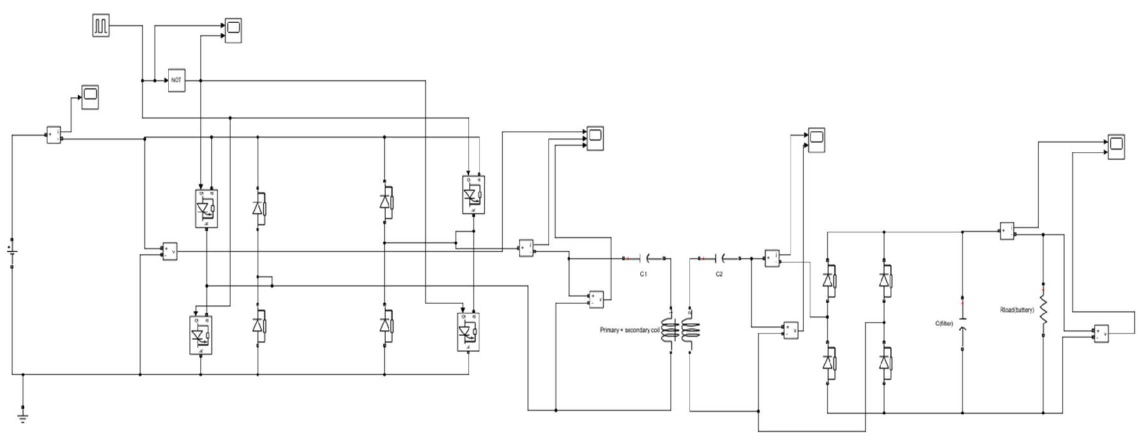

**Figure 6:** Main and Complete Schematic

Then, the DC supply (after filtering) given to the power inverter circuit (Fig. 5) that convert the DC to high frequency AC supply. This frequency is near to the Resonance Frequency (Fr). This high frequency AC supply is given to the primary coil. The compensation network contains the capacitor for arranging the resonance frequency (SERIES-SERIES CONFIGURATION).

Same as primary side, the secondary side also contains a capacitor in series (SERIES-SERIES CONFIGURATION). The output of the secondary is connected to the high frequency rectifier circuit to convert the high frequency AC to the DC for charging the battery that is connected in the EV.

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## VI. Simulation Results

### 6.1 Output at Rectifier

**A. For converting AC to DC**

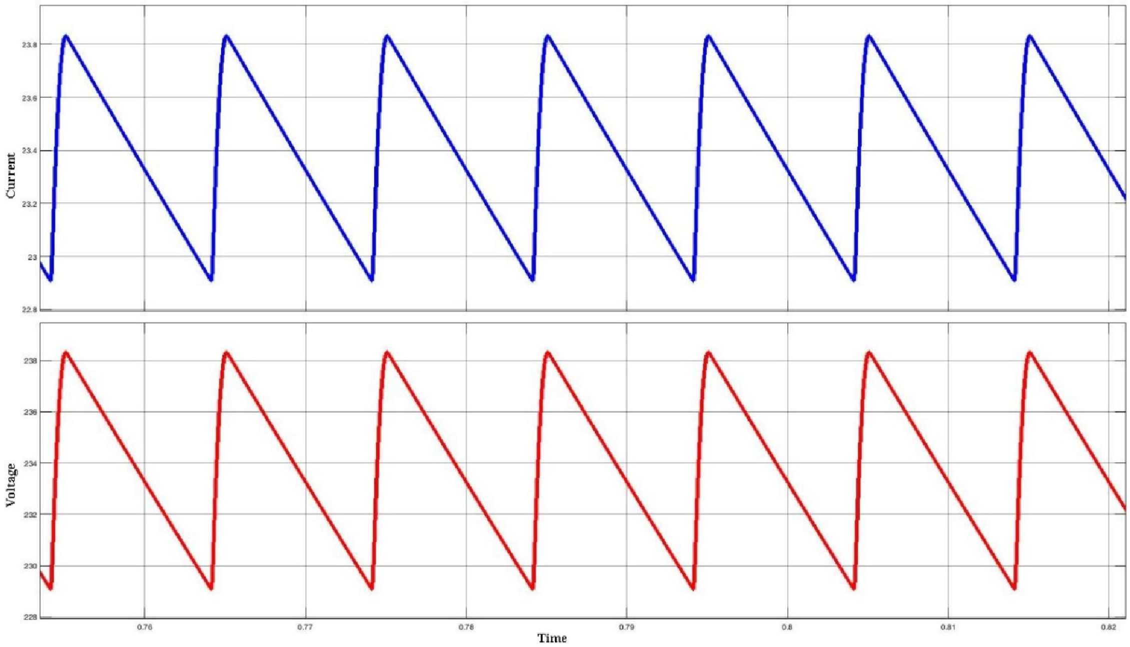


**Figure 7:** Output from Rectifier

**B. Input and Output of Inverter**

DC is converted to high frequency AC and given to the primary coil. Capacitor is connected in series for arranging the resonance frequency.

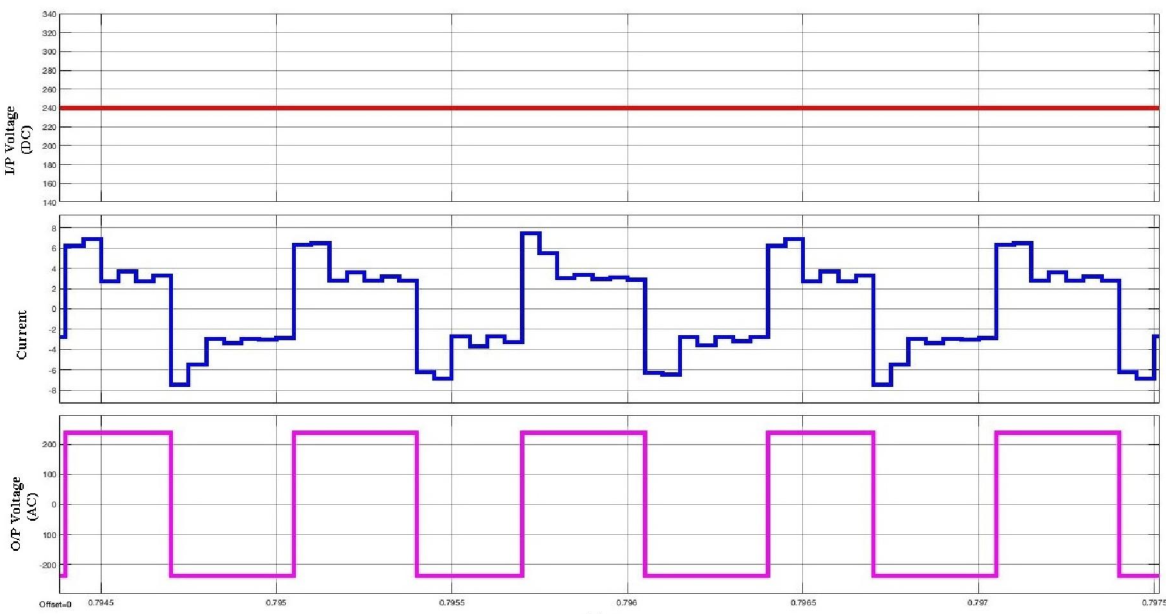


**Figure 8:** Input and Output at Inverter

**C. Output through the Secondary Coil.**

Waveform of current & voltage at the secondary coil.

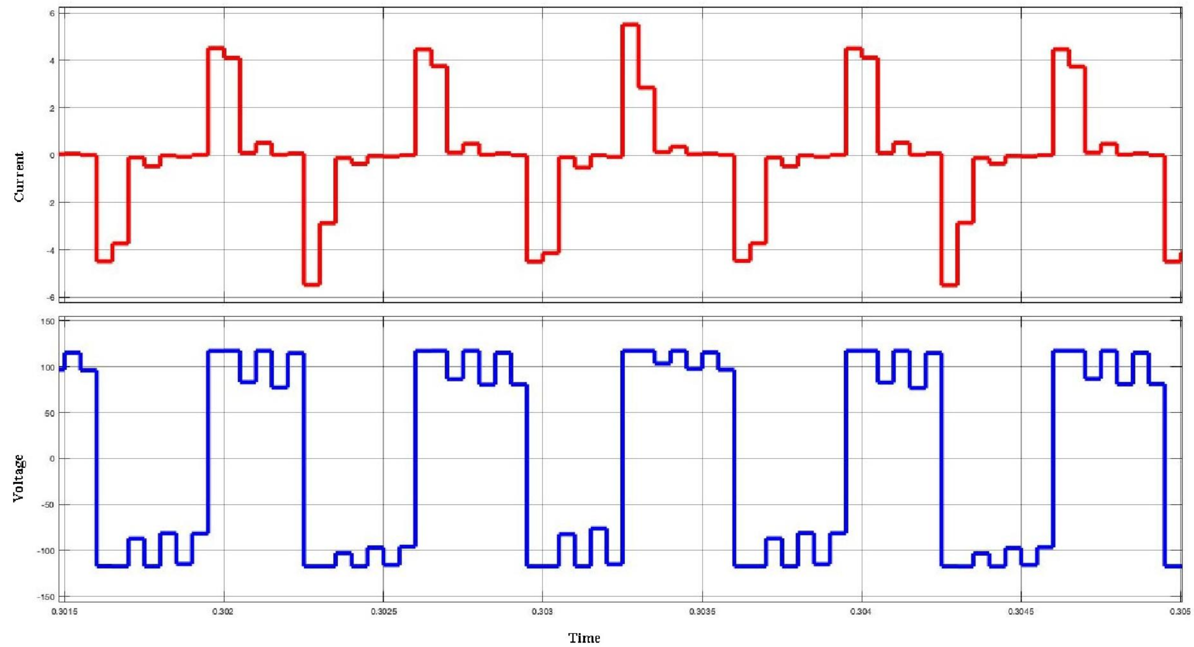


**Figure 9:** Output at Secondary Coil

**D. Output at the Charging Plug**

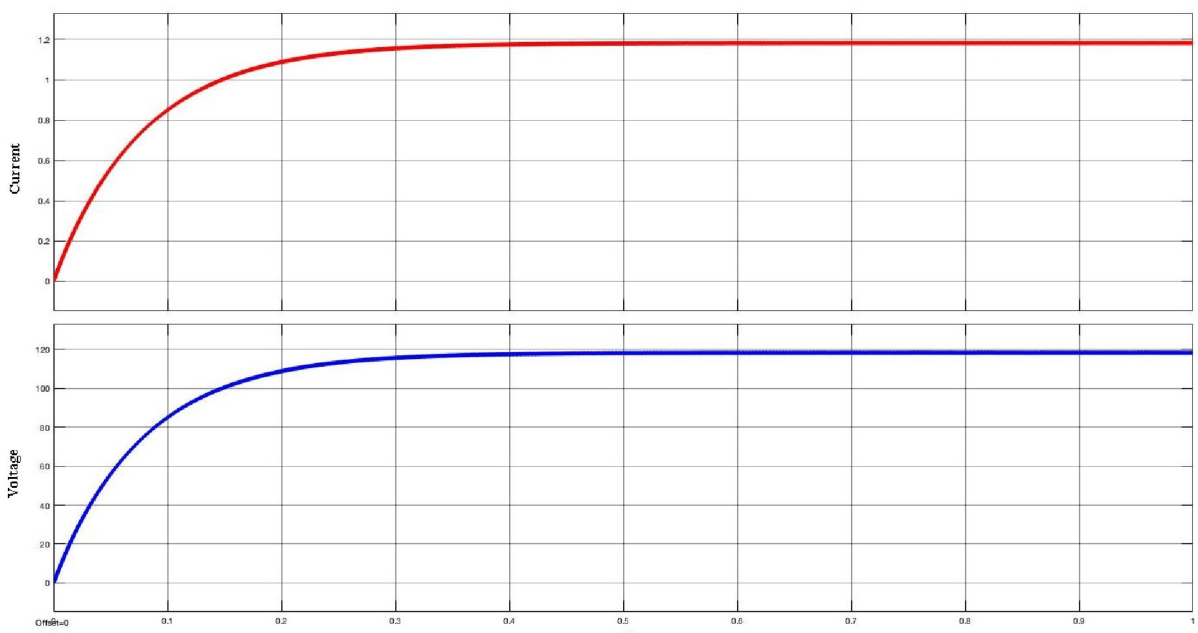


**Figure 10:** Output at Battery Side

At the battery side, we finally get a voltage of 120V and a current reading of 1.2A, which gives us a charging power of 144W.

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## VII. Summarized Results

| Parameters | Voltage Level |
|---|---|
| Supply at Rectifier | 240V, AC |
| O/P Voltage at Rectifier | 238V, DC |
| I/P of Inverter | 238V, DC |
| O/P of Inverter | 238V, AC |
| Voltage through Primary Coil | 238V, AC |
| Voltage through Secondary Coil | 120V, AC |
| Final O/P Voltage at Rectifier | 120V, DC |

## VIII. Conclusion

This project presented a concept of wireless charging of electric vehicles. Because of environmental and energy concerns, car electrification is clearly unavoidable. When opposed to wired charging, wireless charging will offer numerous advantages When highways are electrified with wireless charging capability, it will lay the groundwork for mass market adoption of electric vehicles, regardless of battery technology. As technology progresses, wireless charging of electric automobiles may become a reality. In the near future, more research is required in topology, control, inverter design, and human safety.

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