DYNAMIC CHARGING OF ELECTRIC VEHICLES

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Abstract - *The introduction and production of electric vehicles have created a major impact on automobile sector. Electric vehicles provide more cost efficient and sustainable solution for energy consumption and to reduce the amount of pollution. Establishing accessible and robust network of charging infrastructure is an essential pre requisite in transition from conventional to Electric vehicles. The proposed project aims at providing an alternate charging method of electric vehicles through wireless power transfer implemented through inductive power transfer technology.*

The proposed system works on the principle of electromagnetic induction. The implementation of the system is done by interfacing components like transmission and receiving coils, power electronic devices that form the transmission and receiving circuit. On practical implementation on roads this system requires specially designed roads with energized coils buried underneath. Electric vehicles in general take a considerably long charging time when compared to conventional vehicles. The proposed method aims to reduce the constraint in charging time and also to provide a future without needing to stop or search resources to charge the vehicle.

Prototype of the proposed charging method was developed to simulate and analyze the Rate of charging of batteries and efficiency of this method compared to the solutions available.

1. INTRODUCTION

Transition from conventional vehicles to electric vehicles has become a global factor for reducing the carbon emissions and trying to switch to alternative or less energy intensive options. India is the ranked as the fifth largest automobile industry in the world and is currently investing and also looking for future investment in electric mobility shift.

Due to commitment to global climate change and to reduce the constraints in oil import, India has framed policies to support the growth of E-mobility.

The existing EV ecosystem lacks accessible charging stations, effective battery technology and in terms of market they lacked investments. Emerging market players play a major role in the development of this technology and the shift if more likely to happen by 2030. Charging facilities for electric vehicles forms a major part of the transition. Charging methods for electric vehicles include charging stations, battery swapping, private and public charging stations.

In all the above methods a considerate amount of resources and time is required. The proposed project "Dynamic charging of Electric vehicles" aims to reduce these constraints. methods. As the method charges the vehicle as it travels along the road, it might not require to stop for charging stations. The battery forms and contributes the most in E-vehicles, the proposed method tends to reduce the battery size which reduces the size of the vehicle. Heavy duty vehicles that carry huge amount of load and carry long distances benefits the most from the technology.

1.1 OBJECTIVE

- The proposed method aims in achieving fast and efficient charging without any cost of time, money, scalability.
- To provide less expensive solution when compared with the current solutions.
- At present there are very less number of charging stations. The reason is it is a developing technology and also there is a fear or inconvenience among the drivers that the battery might run out of charge before reaching the destination or the upcoming charging station. The idea is proposed to reduce the range anxiety of drivers.
- To reduce the battery size which holds the major part in the total cost of vehicle.
- Through dynamic charging battery size could be reduced significantly.
- To reduce the energy being drawn from the grid for direct charging.

2. LITERATURE SURVEY

As part of the survey, we studied the practically implemented electrified roads in Sweden. The project is built as demonstration site for electric roads.

Electrified road system that allows electric vehicles to be charged from the road was built and implemented to test the behavior of electric vehicles on them. The electrified road system was also tested to check if they could adapt climate smart technology.

• Wireless charging stations implemented in Norway was studied. Charging was done wireless using induction technology. Charging plates installed in the ground charges the batteries of the EV taxis via receiver installed in them. The taxis are parked above the charging plates and charged using static charging.

• From the data studied on energy consumption, carbon emission and emission intensity of conventional vehicles we could estimate that the proposed project reduces all these constraints. The "E-Mobility" published by the Bureau of energy efficiency, Government of India Ministry of power was referred to understand the policies framed on different states of India.

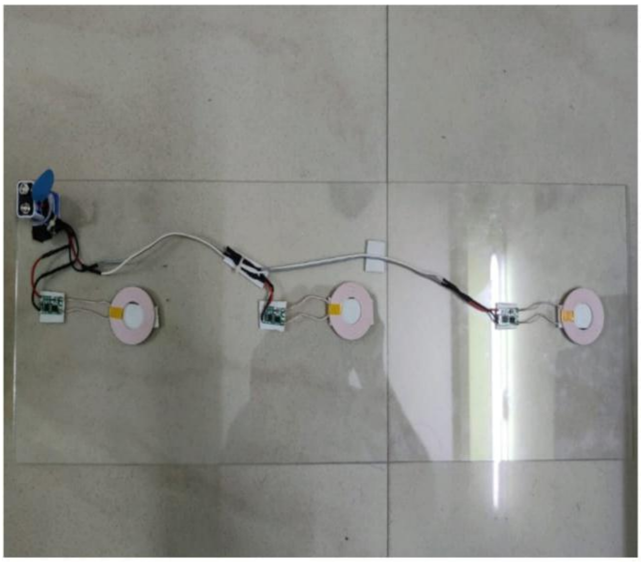
• The article "Handbook for EV charging infrastructure implementation" by Bureau of energy efficiency, Government of India, Ministry of power was referred to know the EV charging infrastructure roadmap, EV charging requirements, location planning and arranging electricity supply to models of on ground implementation.

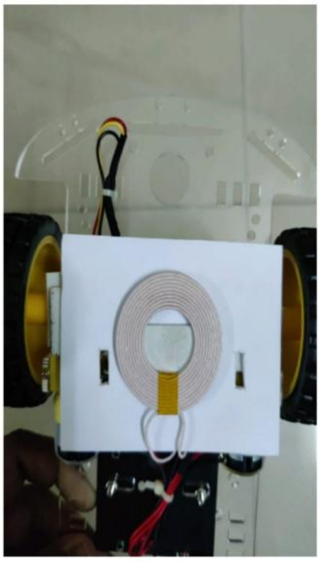
3. PROPOSED METHODOLOGY

The Alternating current is provided from the source that is the grid to the transmitter circuit placed in the road or in the pavement of the road. As the power is transferred wirelessly using inductive power transfer method, we might need alternating current of high frequency for effective energy transfer. The 50hz AC provided from the mains is rectified first that is that is alternating current is converted to direct current.

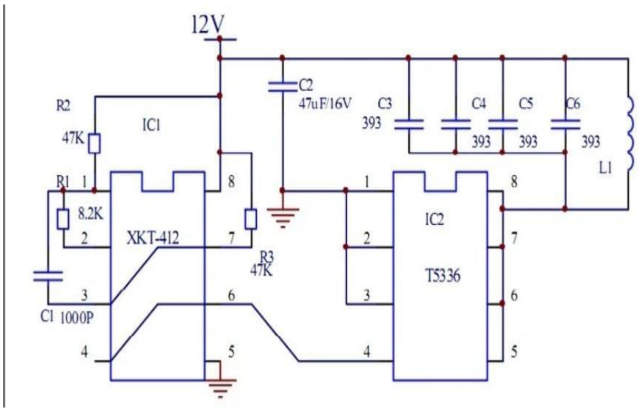
Then to convert the direct current from the rectifier to alternating current of high frequency, power electronics based inverter circuit is used. The high frequency AC wave is supplied to the primary coil.

The alternating current supplied in the primary coil produces alternating flux and this flux gets linked to the secondary coil. There will be an induced emf in the secondary coil due to electromagnetic induction. As the coils were separated by air gap the primary and secondary coils are loosely coupled. The Ac output received in the secondary coil is again rectified (converted from AC to DC) and stored in the battery of the Electric vehicle.

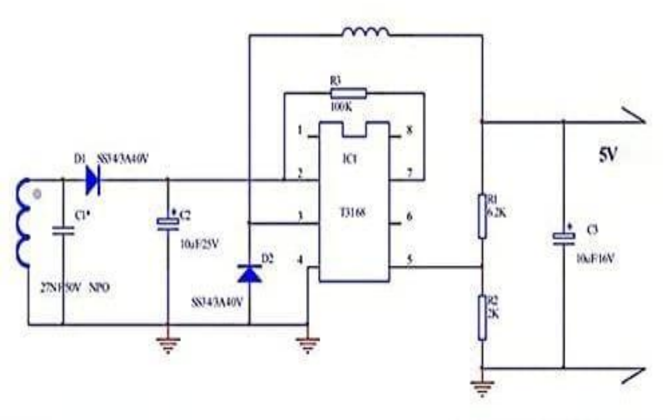




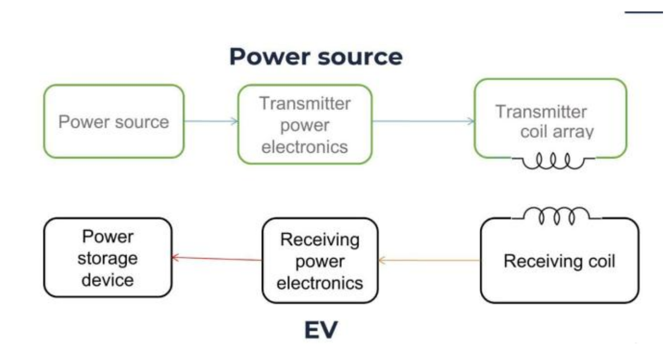
3.1 TRANSMITTER CIRCUIT



3.2 RECEIVER CIRCUIT



4. BLOCK DIAGRAM



BLOCK-A: Transmitter circuit placed on the road

BLOCK-B: Receiver circuit with storage placed on the Electric vehicle.

Block A of the diagram represents the transmitter side and it consists of power source, Transmitter power electronics, and transmitter coil array. The Power source is provided from the grid in practical implementation. The transmitter side power electronics circuit rectifies the AC input to DC. The capacitor placed filters the DC. In the inverter circuit DC to AC conversion takes place and the frequency is increased for transmission.

Block B of the diagram represents the receiver side and it consists of receiving coil, receiving side power electronics and power storage device. The AC power is transferred from the transmitter to receiver through the receiver coil. In the receiver side power electronics circuit AC to DC conversion takes place and the Voltage is stepped down in a way suitable for storing in the battery.

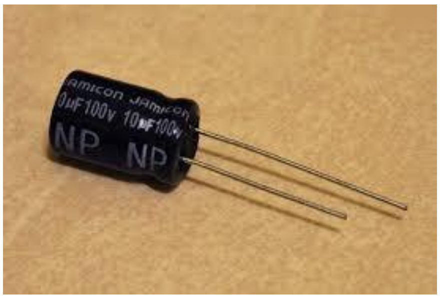
5. HARDWARE DESCRIPTION

Bridge rectifier:

Bridge rectifier circuit converts the incoming alternating current to direct current. Bridge rectifiers are circuits consisting of four or more diodes arranged in the bridge circuit configuration. The output wave is of the same polarity irrespective of the input polarity.

The Bridge rectifier rectifies the supplied AC voltage at the source to DC voltage in the transmitter side and rectifies the AC voltage at the receiver side to DC voltage.

Polarized Capacitor:



Polarized capacitors are used in the transmitter side to filter out the rectified DC output. In receiver

Side they are used to filter out the DC output from the rectifier and then pass it to the battery.

T5336 11025 IC:

This IC has an operating voltage of 5V- 12.0V operating voltage and an operating current of 1.2A - 2.0A operating current. It has an operating frequency of about 70Khz - 110Khz. It is placed on the transmitter side of the dynamic charging circuit and converts the Direct current to alternating current and produces high frequency.

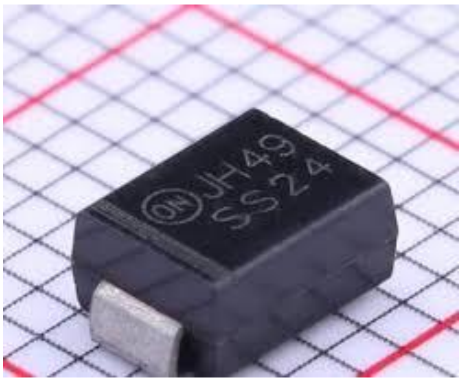
XKT408A1215A IC:

This IC has an operating voltage of 3.0V- 15.0V operating voltage and an operating current of 1.0mA - 10.0A operating current. It amplifies the DC voltage and current.

T3168I2022 IC:

This IC has an operating voltage of 5V- 12.0V operating voltage and an operating current of 1.2A - 2.0A. It has an operating frequency of about 70Khz -110Khz. It converts the alternating current to direct current and acts as an amplifier.

SS24 diode:

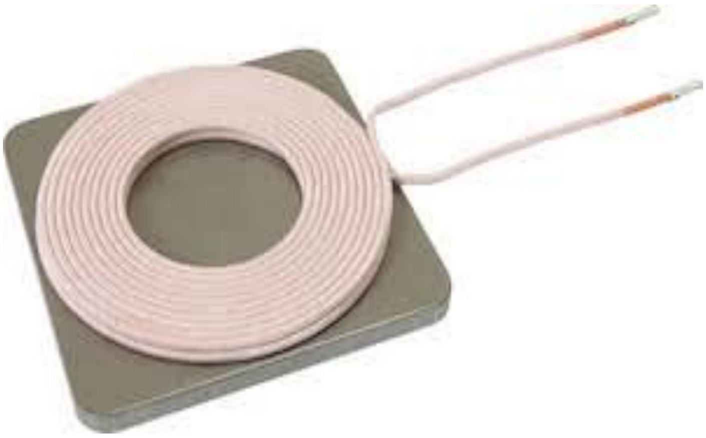


It has maximum voltage limit of 40V and maximum current of 1.2A to 2A. It converts the alternating current to direct current and acts as voltage rectifier.

Battery:

In the prototype built lithium ion battery of 6V capacity is used as the voltage source. It is connected to the receiver side of the circuit.

Transmitting Coil and Receiver coil:



For transmitting and receiving American wire gauge coil that is copper coil of size 20mm is used. The thickness of the coil is about 2.3mm, the inner diameter is about 43mm and outer diameter is about 20mm.The transmitter coil is designed in such a way it is longer than the receiver coil to reduce the cost and this results in coupling coefficient between the transmitter coil and receiver coil.

6. SIMULATION

6.1 SIMULATION DESIGN

The power transfer from the transmitter to receiver side in linear transformer is simulated using MATLAB to show the simulation of inductive power transfer between the charging coils in the road the batteries of electric vehicle. It consists of transmitter circuit, receiver circuit and the transfer coils.

Transmitter:

The supply is provided using an AC voltage source of 230V, 50HZ. The source is connected to the Bridge rectifier which rectifies the AC input to DC. The diodes D1, D2, D3, D4 are arranged in the bridge circuit configuration. D1 and D2 are forward biased to rectify the positive sine wave and the diodes D3 and D4 are

reverse biased to rectify the negative sine wave. The series RLC branch is used to filter the DC. The rectified DC output is fed to the inverter circuit. The inverter is formed by arranging the S1, S2, S3 and S4 MOSFET switches. The switches S1, S2 and S3, S4 are switched (S1, S2 ON and S3, S4 OFF) alternatively using pulse generator to produce alternating current of high frequency. The two modes of switching are:

1)In the first mode S1 and S2 are in ON state, S3 and S4 are in OFF state. When S1 and S2 are in ON mode the current flows from the switch S1 to the positive side of the load. From positive side current flows to the negative side and then flows to the switch S2.

2)In the second mode S3 and S4 are in ON state, S1 and S2 are in OFF state. In this mode current flows from the switch S3 to the negative side of the load. From the negative side current flows to the positive side of the load and then flows to the switch S2. For switching sinusoidal pulse width modulation technique is used.

The voltage transfer from the primary side to the secondary side is done using the transformer.

RECEIVER:

The transferred AC voltage from the primary side is then passed through a capacitor and then fed to the rectifier circuit.

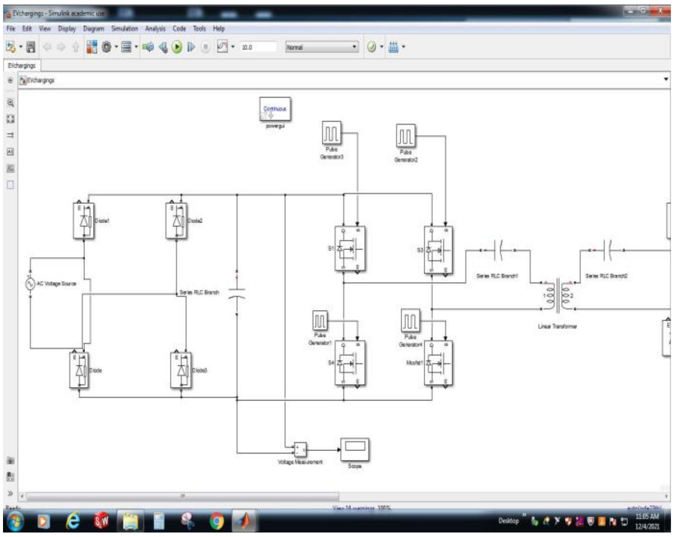
The rectifier circuit is formed by arranging the four diodes. It rectifies the Alternating current to direct current.

A diode, capacitor, MOSFET switch, and an inductor are arranged to form the buck converter. The buck converter steps down the rectified DC voltage for charging the battery.

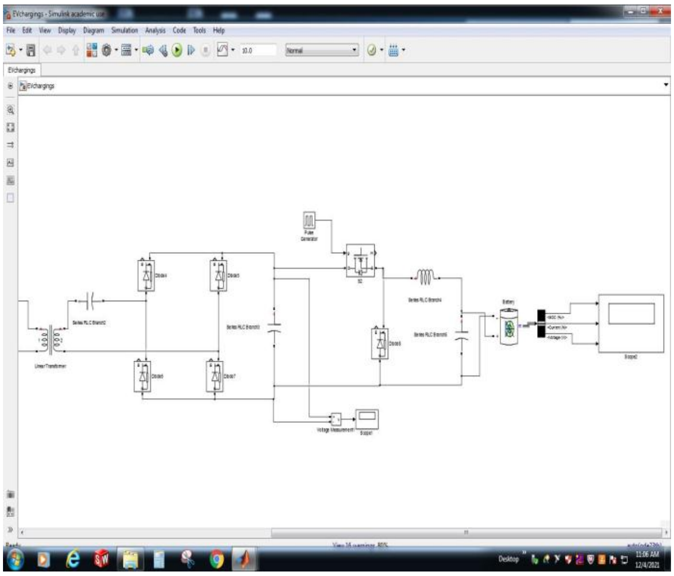
The bus selector is connected to the battery to select the battery signal. The State of charging, current and voltage is known from the scope connected to the bus selector.

6.2 SIMULATION PROCESS:

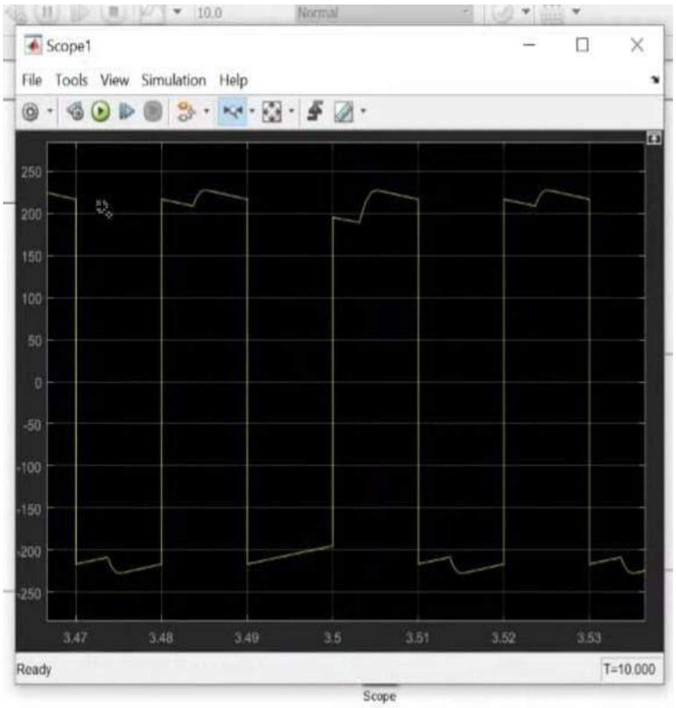
1) Transmitter:



2) Receiver:



3) Scope (Transmitter side)



3) **Scope (Receiver side) -To view the state of charging:**

7. CONCLUSION

This concludes the overview of the dynamic wireless charging EV system. We concluded that the dynamic charging system is more beneficial for large-scale EV systems and the battery costs could be significantly reducible when the power track cost drops. Although there are some commercialized dynamic charging EVs, they are still in the very early stages of the commercialization and their system designs have been focused on proving the reliability of the systems rather than on economic values.

8. FUTURE SCOPE

Although wireless dynamic charging is still in its early stages of development, it is likely to become one of the most essential solutions for meeting the growing need for charging infrastructure within next years. Although extra expenditures in dynamic charging infrastructure would be made during the installation stage, we discovered that the longer battery life can save significantly more money.

REFERENCES

[1] Review of static and dynamic wireless electric vehicle charging system ChiragPanchal, SaschaStegen, JunweiLu Griffith School of Engineering, Griffith University, Nathan Campus, Brisbane4111, Australia.

[2] T. batra, "Design of Static Wireless Charging System for Electric Vehicles with Focus on Magnetic Coupling and Emissions," Doctor of Philosophy Ph.D, Department of Energy Technology Aalborg University, Aalborg University, 2015.

[3] Costanzo, A.; Dionigi, M.; Masotti, D.; Mongiardo, M.; Monti, G.; Tarricone, L.; Sorrentino, R. Electromagnetic Energy Harvesting and Wireless.

[4] Power Transmission: A Unified Approach. Proc. IEEE 2014, 102, 1692–1711.

[5] Kuncoro, C.B.D.; Sung, M.-F.; Kuan, Y.-D.; Battery Charger Prototype Design for Tire Pressure Sensor Battery Recharging. Sensors 2019, 19, 124, doi:10.3390/s19010124. Garnica, J.; Chinga, R.A.; Lin, J. Wireless Power Transmission: From Far Field to Near Field. Proc. IEEE 2013, 101, 1321–1331.