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Inductive power transfer for massive electric vehicle charging by single phase inverter

S. Sumathy
sumaa_ss@rediffmail.com
KCG College of Technology, Chennai, Tamil Nadu

Jitha Varghese
jitha.eee@kcgcollege.com
KCG College of Technology, Chennai, Tamil Nadu

ABSTRACT

The studies for the Hybrid Electrical Vehicle (HEV) have attracted considerable attention because of the necessity of developing alternative methods to generate energy for vehicles due to limited fuel-based energy, global warming and exhaust emission limits in the last century. Charging infrastructure for electric vehicles (EV) will be the key factor for ensuring a smooth transition to e-mobility. This paper focuses on charging technologies that will play a fundamental role in this regard: smart charging, contactless charging and on-road charging of EVs. Smart charging of EVs is expected to enable larger penetration of EVs and renewable energy, lower the charging cost and offer better utilization of the grid infrastructure. On the other hand, stationary contactless charging and on-road inductive charging of EV will remove the necessity for any cables, eliminate range anxiety issues and pave the way for automated driving. The electromagnetic and power converter design for contactless power transfer systems for future highways is reviewed in this paper. Contactless charging is also known as wireless charging. Wireless power transfer works on the Inductive Power Transfer (IPT) principle, as found in the conventional transformers. An IPT charging method suitable for charging massive EBs is proposed to achieve Constant Current (CC) and Constant Voltage (CV) output with feedback control strategies or communication link between the transmitter side and receiver side. Two AC Switches (ACSs) and an auxiliary capacitor utilized at the receiver side are employed to be operated once to change the charging modes from CC mode to CV mode.

Keywords— *HEV, IPT, EV, CC, CV, ACSs*

1. INTRODUCTION

1.1 General

The electric vehicle is the first solution for today and upcoming problems like fuel availability, pollutions and so on. But the only disadvantage of the electric vehicle is charging. Because it needs more time to charge and in the conventional charging method the vehicle should stay while charging. There this some technologies like fast charging, wireless transmission has been introduced but it did not give an exact solution due to low efficiency in wireless transmission. The distance of wireless transmission is reduced and it is called Inductive Power Transfer (IPT) for high efficiency this technique won't need to stay in single place for charging. We can able to charge while travelling the electric vehicle. The single inverter in the transmitter side only enough for multiple receivers in our proposed model

1.2 Existing system

- In the existing system, the vehicle batteries are charged by the plug the batteries to DC sources.
- The batteries are directly connected to the DC sources through conventional wires.

1.3 Disadvantages of existing system

- There is no isolation between the source and the battery.
- The battery will be only charged through in steady position.
- Not possible to the charging at all the times.
- Charge according to the voltage only.

1.4 Proposed system

- This system provides isolation between source and battery
- The proposed system the energy will be transferred to wireless technology.
- The vehicle will charge at the running condition also.
- Charge at both Voltage and Current methods.

1.5 Objective

- This project is designed and implemented the Inductive Power Transfer (IPT)for charging
- Implement the multiple charging units at the receiver side by using single inverter at the transmitter side
- The design like being one charging unit should not affect another charging unit.

2. SYSTEM DESCRIPTION

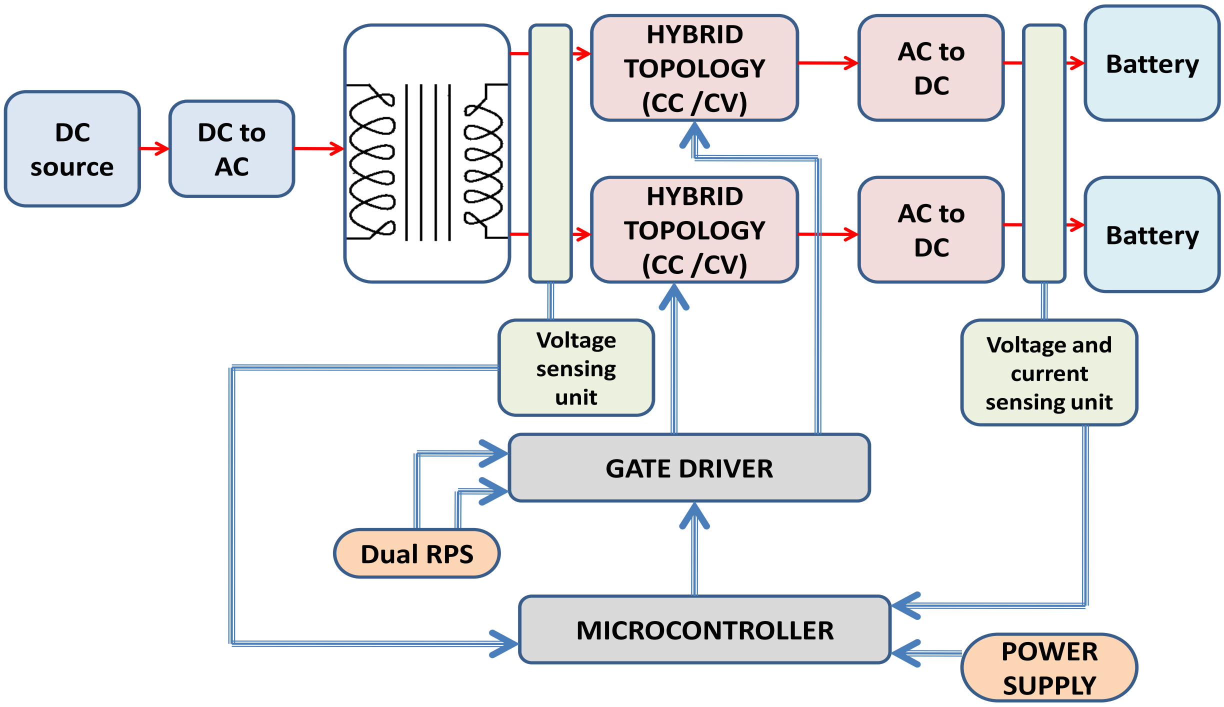

Fig. 1: Block diagram of the proposed system

2.1 Description

- The DC source will be converted to the AC and feed to the transformer
- The transformer provides isolation to source and battery unit
- The transformer output again rectified to DC source and charges the battery
- constant current charging mode and constant voltage charging mode are present

2.2 Circuit diagram

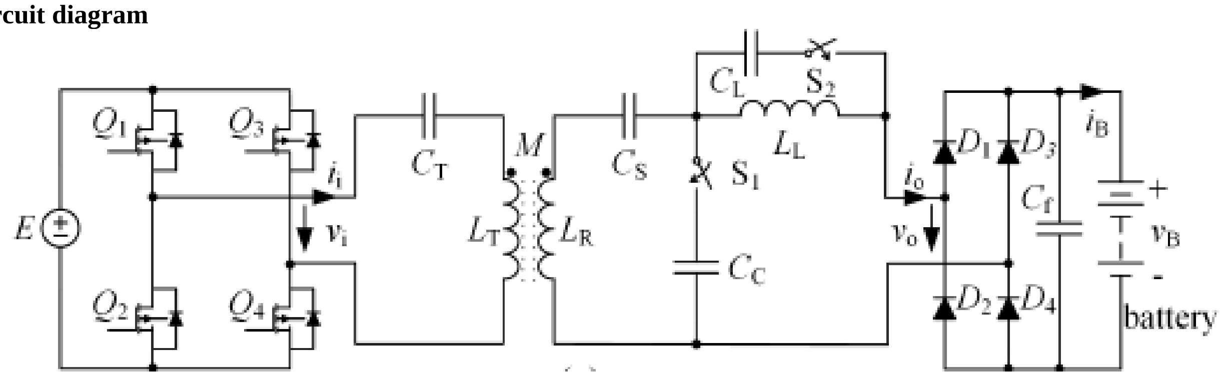

Fig. 2: Circuit diagram of the proposed system

- DC supply (E) is converted into HIGH-FREQUENCY AC by Q1 and Q4 switches create a positive cycle and Q3 and Q2 create a negative cycle of AC
- The transformer is used as inductive power transfer (without a step up and step down)
- The S1 and S2 switch control the Constant Current (CC) and Constant Voltage (CV) mode

S1 switch

- The S1 switch will control CV charging mode
- During the S1 close, the S2 will be open
- During S1 close the C_c in parallel will be connected
- The voltage will be control

S2 switch

- The S1 switch will control CC charging mode
- During the S2 close, the S1 will be open

- During S2 close the C_L in series will be connected
- The current will be control
- The switch S1 and S2 are an anti-series connection. i.e., if S1 on, S2 should be OFF vice versa
- The controlled AC is converted into DC by BRIDGE RECTIFIER by (D1, D2, D3, and D4)

2.3 Overall description

Initially, From E, the DC source is inverted into a high-frequency AC supply. It will be transmitted from Lt i.e., primary side into Lr i.e., secondary side by Inductive Power Transfer (IPT). The high-frequency AC is controlled based on constant voltage and constant current. For constant current mode, it will automatically work when battery takes more current the switch S2 will active and for constant voltage mode, it will automatically work when battery takes more voltage the switch S1 will active. By this control, we can plug and unplug the multiple battery units with respect to different time

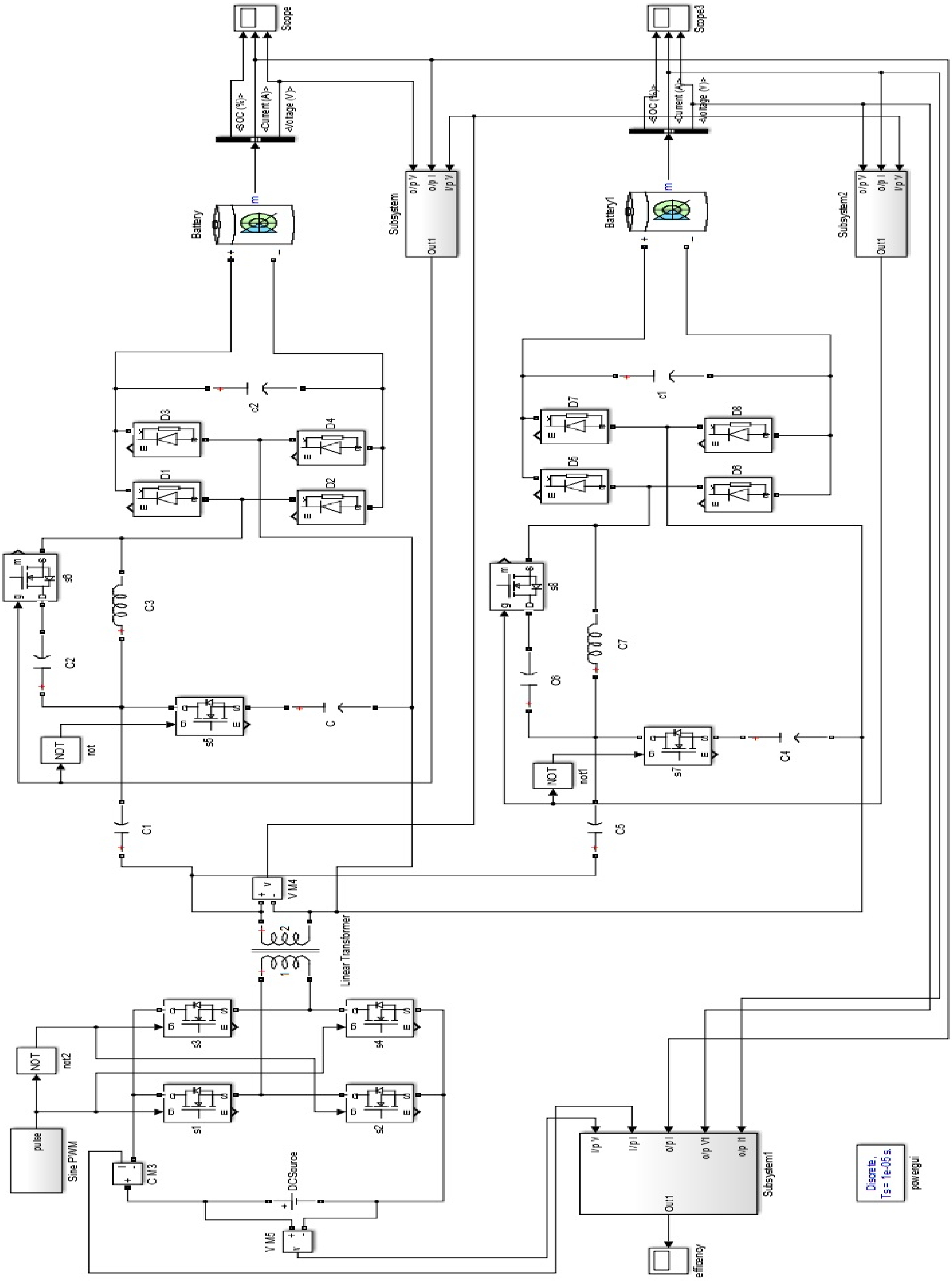

Fig. 3: Circuit diagram for Matlab simulation

3. RESULTS AND DISCUSSION

3.1 Battery-1

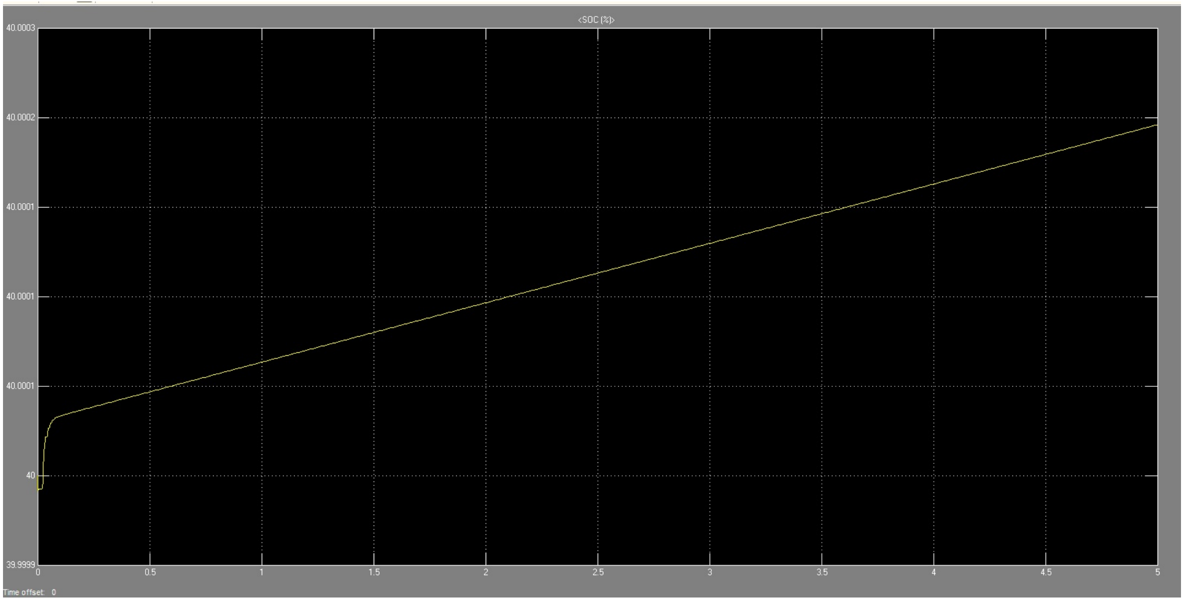

Fig. 4: State Of Charge (SOC %)

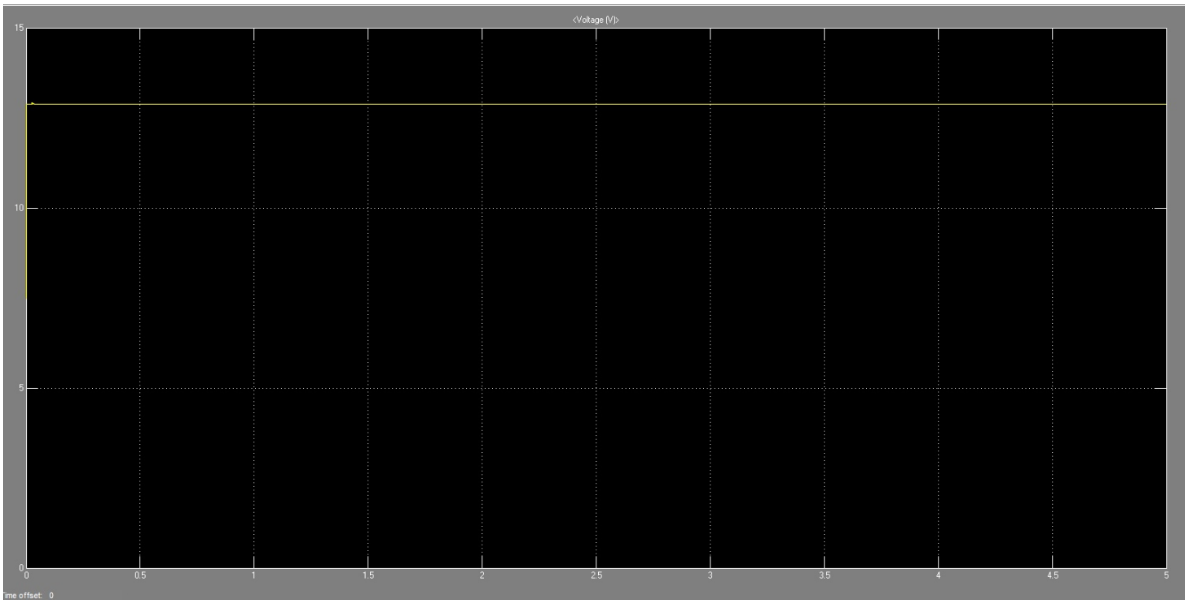

Fig. 5: Voltage

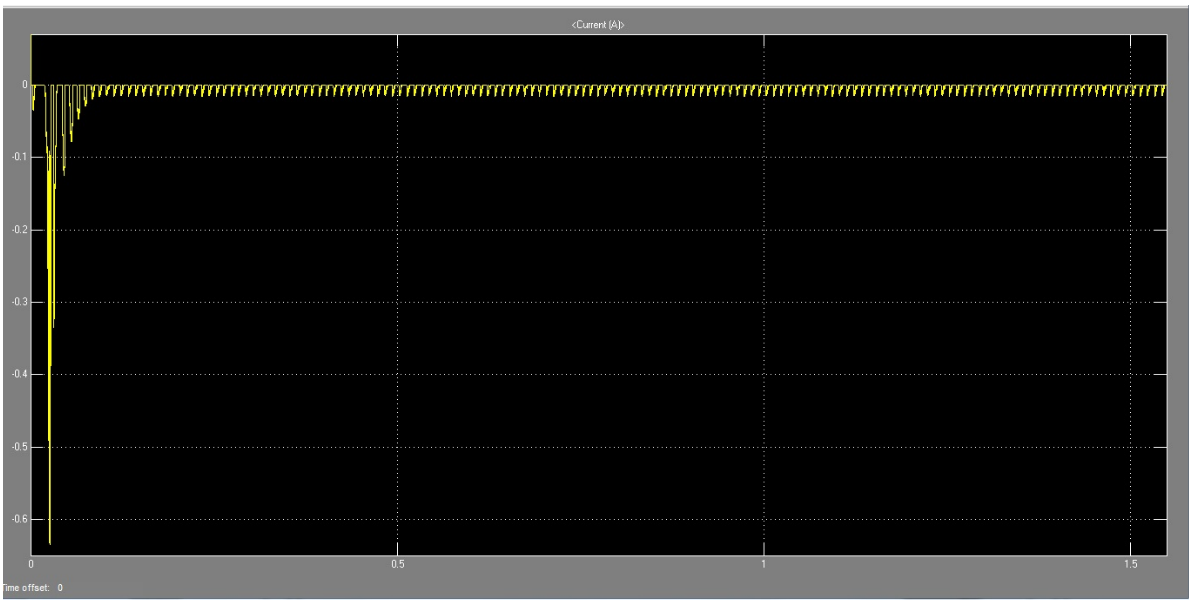

Fig. 6: Cuurent

3.2 Battery-2

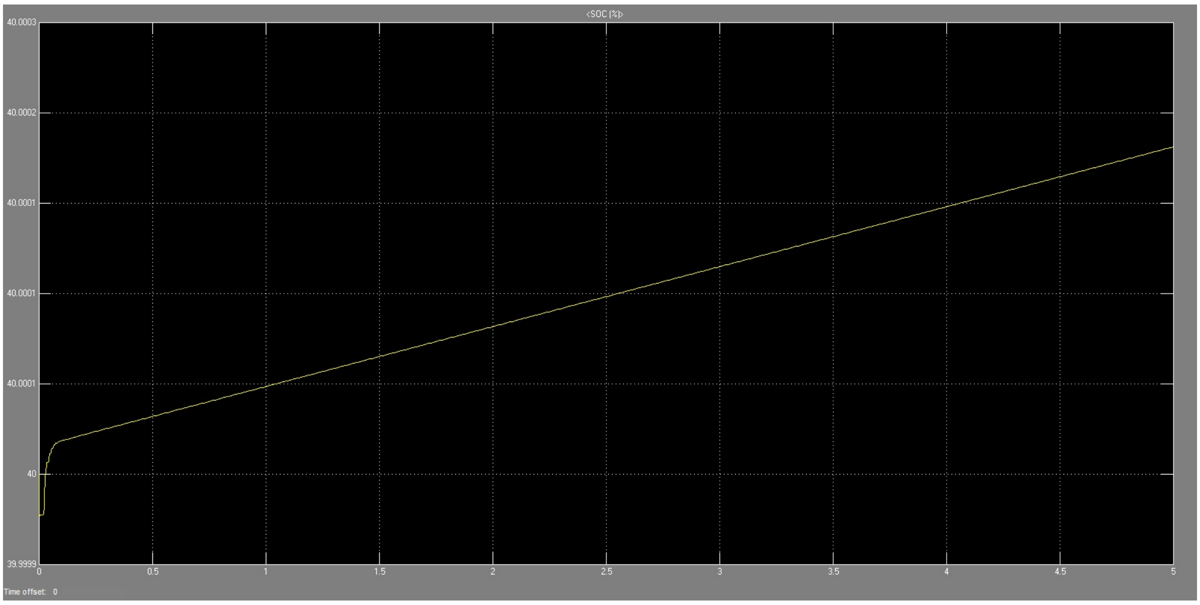

Fig. 7: State Of Charge (SOC %)

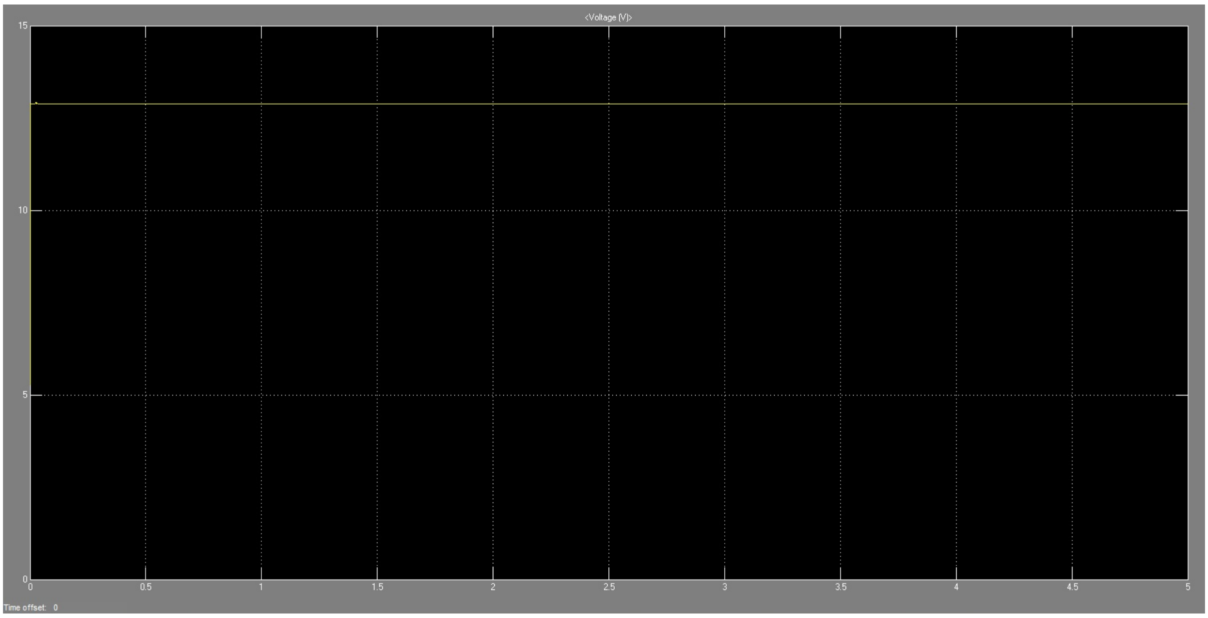

Fig. 8: Voltage

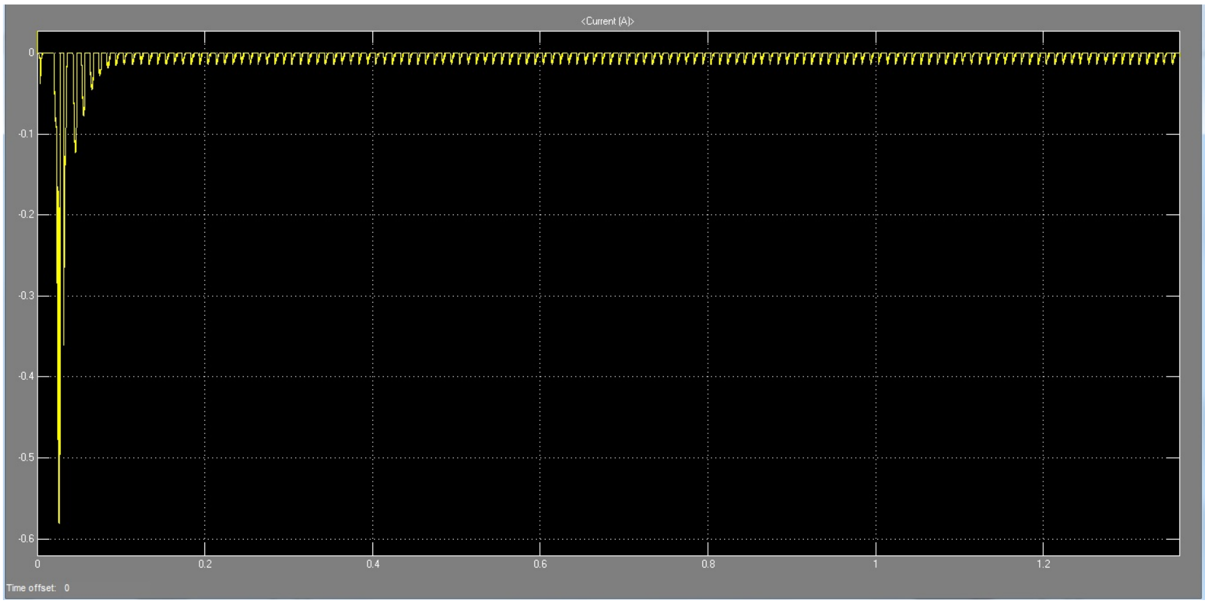

Fig. 9: Cuurent

4. CONCLUSION

In this paper, Inductive Power Transfer (IPT) system has been analyzed with Hybrid Topology. A hybrid topology with two ACSs and an additional capacitor at the receiver side is proposed. The characteristics of CC output and CV output are obtained by switching two ACSs for CLC- LCL topology to CLC topology. Besides, in both CC and CV modes, the IPT charging system can be operated under (Zero Phase Angle) ZPA, which helps to improve the system efficiency and reduce the magnetic interference. The simulation results validate the performance of the proposed method and show that it is feasible to adopt only one inverter to charge multiple EBs at the same time to improve the economic efficiency of the whole system by reducing construction cost and maintenance cost. After all, the proposed method might be one of the most promising solutions to charge multiple EBs with one inverter at a relatively low cost to meet the demand.

5. REFERENCES

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