AC-DC CONVERTER FOR ELECTRIC VEHICLE CHARGER

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Abstract – *As a global warming countermeasure, reduction of carbon dioxide emitted from vehicles and the improvement of fuel efficiency have become increasingly important for the electric vehicle. In such circumstances, many automakers have concentrated their efforts on the development of hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs) and electric vehicles (EVs). PHEVs and EVs are equipped not only with a DC/DC converter which supplies power for the accessories but also with an AC/DC converter which feeds power from a billboard power system to an on- board high- voltage battery. To improvise the power factor and to boost up the output voltage, this paper proposes a innovative design of an AC/DC converter with high frequency isolation with different loads like RL, RLE, battery and motor loads, which is suitable for on board EV/PHEV charges. This converter plays a double role as ac/dc converter for power factor correction and as well as dc/dc converter for output regulation. This converter circuit is simulated using MATLAB software and results has been observed. This paper has got a wider scope in future as it aims to set up a pollution free environment, which has become a necessity for a developing like ours.*

Key Words: AC/DC converter, Output Voltage, Power Factor, High frequency isolation.

1. INTRODUCTION

EVs release no tail pipe air pollutants at the place where they are converter. They also typically generate less sound pollution than an indoor combustion engine vehicle, whether at rest or in motion. Adaptation of EVs would have a big net environmental benefit. In modern era almost every household electronics works on DC but we got AC from power generation via transmission lines because AC can be transmitted more efficiently than DC in lower cost.AC to DC converter uses rectifier to turn on AC input into DC output regulators to adjust the voltage level and reservoir capacitor to smooth the pulsating DC [1].

AC/DC converter can have more than one output and may feature overcurrent and overvoltage [2]. High frequency transformer are found most prominently in any machinery or device that requires level of voltage or current. The transformer was originally intended to be connected to a H bridge which supplies the primary coil with high frequency voltage pulse to be converted into a higher voltage transferred to a rectifier unit. An electric-vehicle battery (EVB) additionally to the traction battery specialty systems used for industrial (or recreational) vehicles, are batteries want to power the system of a battery electric vehicle (BEVs) [3]. These batteries are usually a secondary (rechargeable) battery. Electric vehicle batteries also known as traction batteries is a battery that provides power to electric motors [4].

1.1 BLOCK DIAGRAM

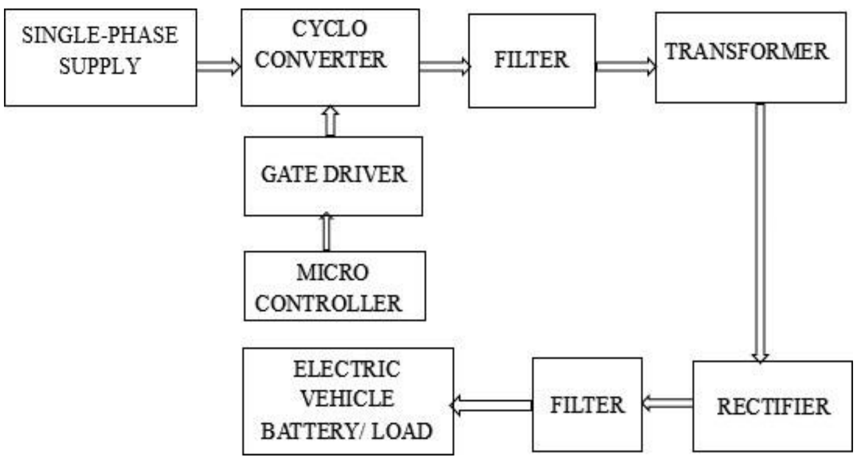

Fig -1: Block Diagram of AC/DC converter for EV charger

A 230V AC input from the input transformer is fed to the positive side switches S_1,S_4 and to the high frequency transformer that turns the negative side switches S_5,S_8. The AC input is being boosted using the high frequency transformer and this input from the transformer is being converted into DC using the rectifier in the secondary side of the transformer. This rectifier gives a DC output across the load.

The gate signal for switches are obtained by comparing reference voltage with carrier signal, if the carrier signal is greater than or equal to reference signal then the required output will be high otherwise the output will be low.

1.2 Circuit Diagram

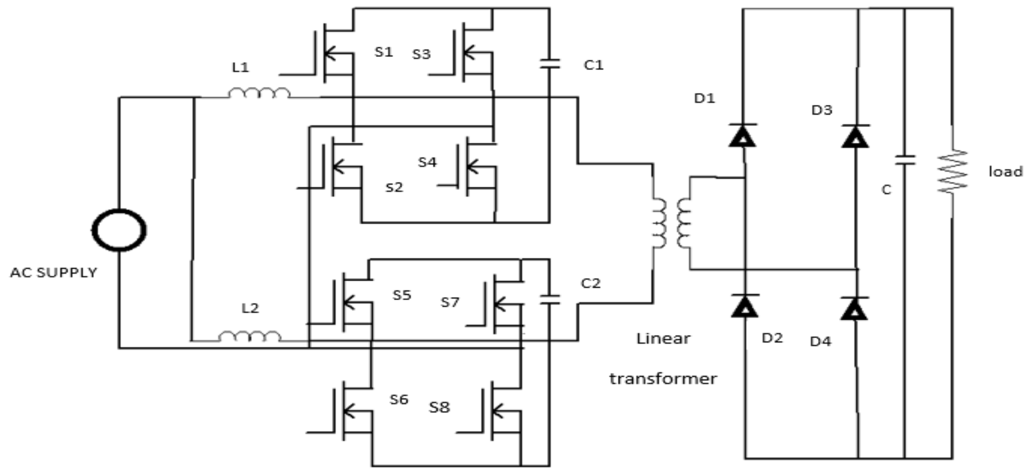

Fig -2: Circuit Diagram of AC/DC converter for EV charger

It consists of a 230V input transformer, RPS, gate driver unit, cyclo-converter, ZCD, PIC controller, rectifier, load, high frequency transformer with 2:1 ratio, a 6 winding transformer to give supply to the gate driver that in turns triggers the gate of the cyclo-converter. It has got two more transformers one for Zero crossing detector (ZCD) and other for the controller.

2. SIMULATION

The circuit for AC/DC converter for EV charger has been simulated using MATLAB. Fig 3 shows the simulation circuit with cyclo- converter, diodes, high frequency transformer and a load. The gate signal for switches are obtained by comparing reference voltage with carrier signal, if the carrier signal is greater than or equal to reference signal then the required output is going to be high otherwise are going to be low be low.

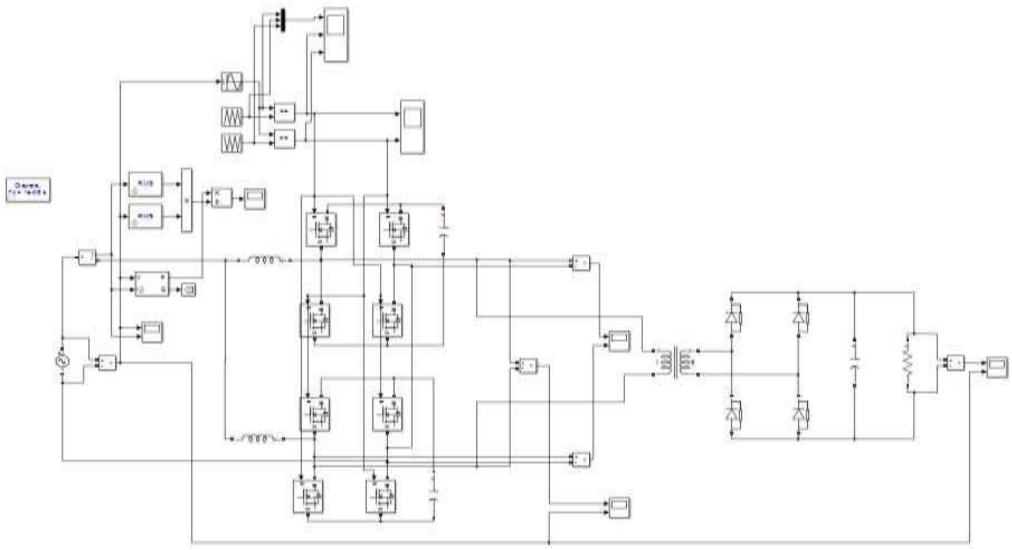

Fig -3: Simulation circuit of AC/DC converter for Charger

2.1 Design Calculation

r = 0.01%,
R =100Ω,
fs = 20KHz,
E1=1000,
E2=500,

$$r = \frac{1}{4\sqrt{3} * fs * C * R}$$

$$0.001 = \frac{1}{4\sqrt{3} * 20 * 1000 * C * 100}$$

$$C = \frac{1}{4\sqrt{3} * 20 * 1000 * 100 * 0.001}$$

$$T_s = \frac{1}{fs}$$

$$T_s = \frac{1}{20 * 1000}$$

E1 = 4.44N1Φf
1000 = 4.44*N1*30*10-6*20*1000

N1 =375 turns

E2 = 4.44N2Φf

500 = 4.44*N2*30*10-6*20*1000

N2=188 turns

2.2 Simulation Results

The input voltage is set to 220V and the waveform for the same is shown in fig 4. It is observed that the output voltage is a pulsating DC voltage, has been boosted up to 700V and is shown in fig 5. The power factor for AC/DC converter is improvised to 0.87 which is shown in fig 6.

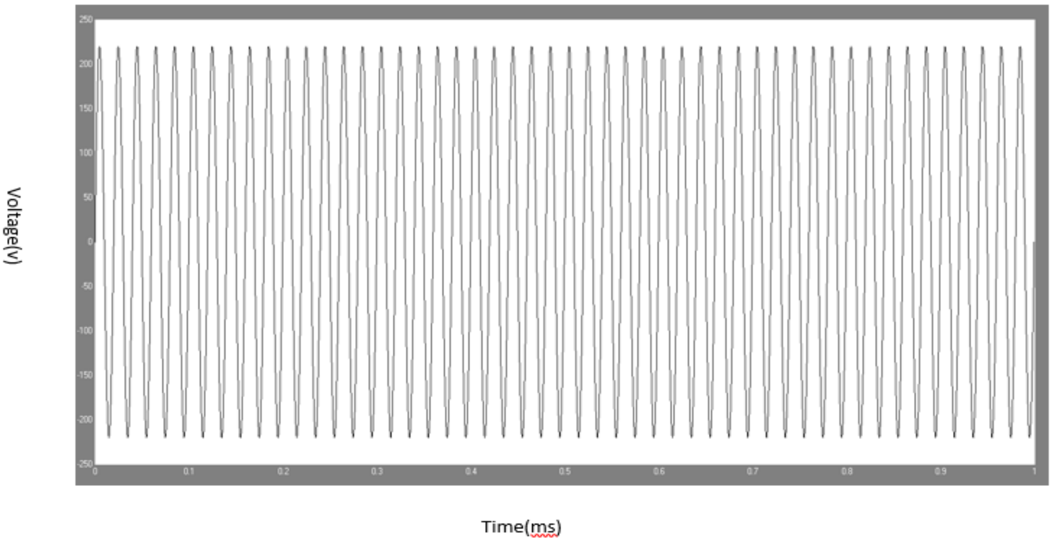

Fig -4: Waveform for input voltage

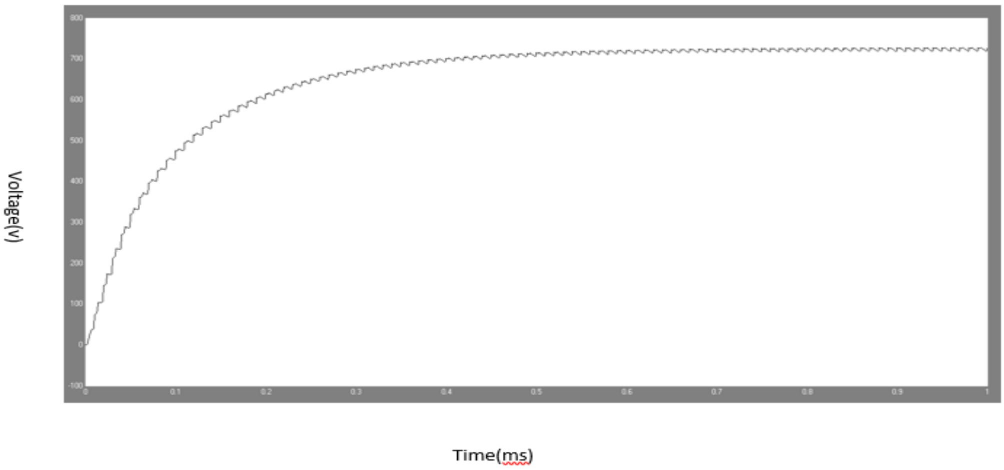

Fig -5: Waveform for output voltage

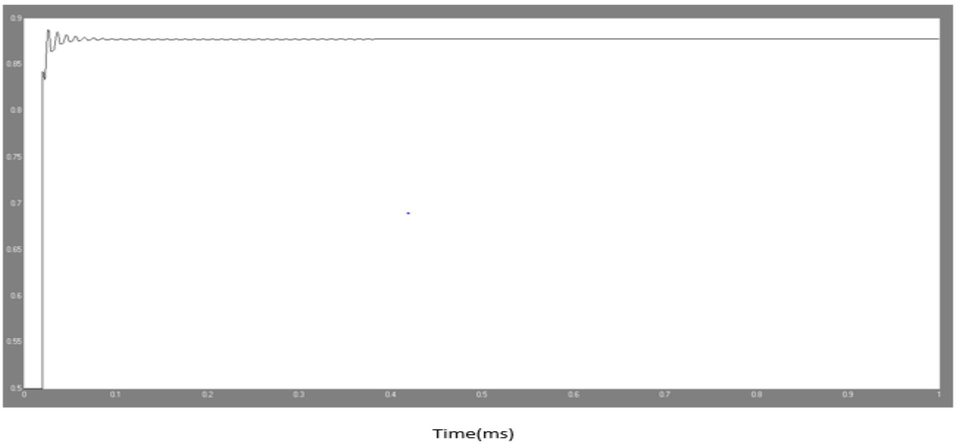

Fig -6: Waveform for power factor

2.2.1 Simulation Results for other loads

The observation has been done for loads like RL, RLE and motor load. Fig 8 shows the waveform for RL and RLE load. From the waveform it can inferred that the output voltage has been raised to twice the input voltage.

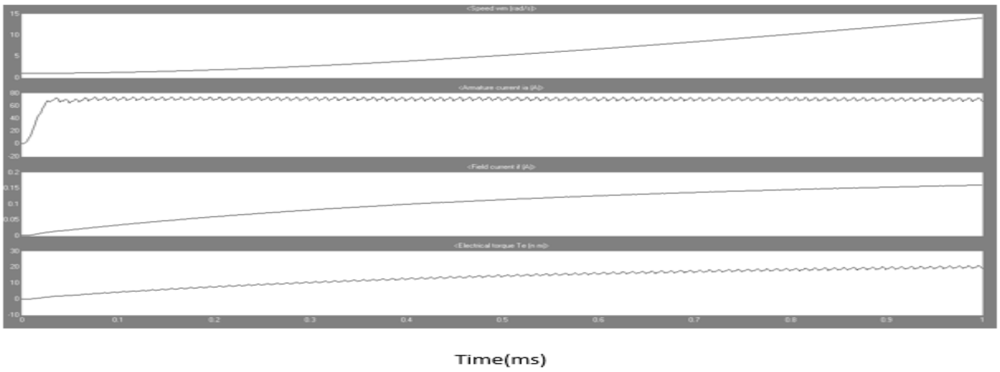

Fig -7: Waveform for AC/DC converter for motor load

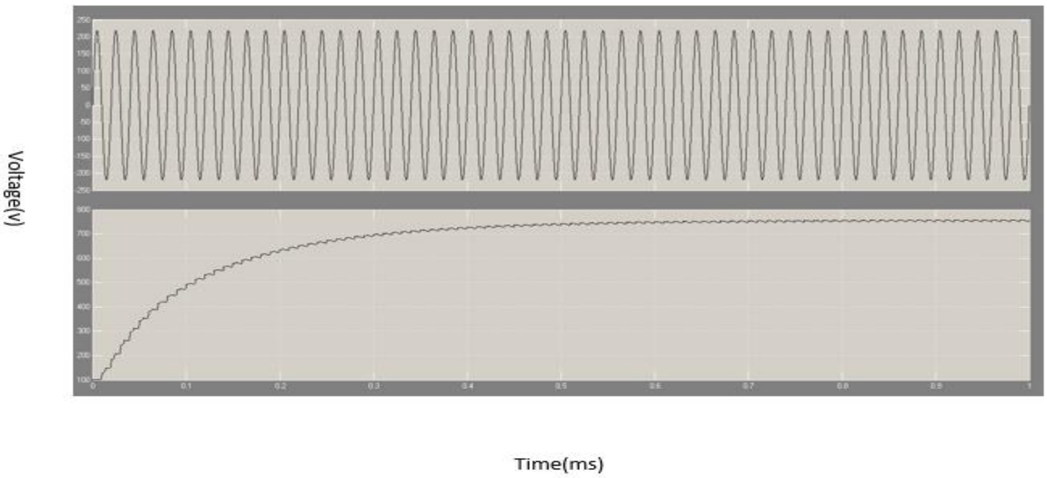

Fig -8: Waveform for AC/DC converter for RL and RLE load

3. CONCLUSION

The software results are simulated successfully and the results shows the voltage has been boosted up with the improvised power factor. The converter topology used here is the AC/DC converter with high frequency isolation which has been popular in recent trends in hybrid electric vehicle. With the increasing demand of power electronics in electric vehicle the AC/DC converter with high frequency isolation plays a major role in the advancement of future.

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