GRID INTERFACED MULTIPORT FAST CHARGER BASED ELECTRIC VEHICLE USING ACTIVE POWER ELECTRONIC TRANSFORMER

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***Abstract*—A DC micro-grid essentially consists of power ports, bidirectional power converter and a controller structure that enables the control of dynamic power flow. This paper presents a new multiport fast charger for an electric vehicle based on the concept of the active power electronic transformer. Energy sources, chargeable batteries and storages are connected together via a common multi-winding transformer and simple full-bridge inverters. These new conversion apparatus perform either voltage transformation or power quality functions, using power electronics both on primary and secondary sides of a transformer operating at medium frequency. The power electronic transformer is utilized in a lot of different fields of application. Simplicity, effectiveness and high-resolution of the control are important aspects which can strongly improve performance of PETs. control strategy and the proposed topology are verified by Matlab simulations and hardware results.**

Keywords*— Power converters, Microgrid, Electric Vehicle, Active Power Electronic Transformer, Battery management systems.

I. INTRODUCTION

Smart grid connects the distributed energy sources, storages and consumers. Important energy conversion and routing nodes in the supply chain from the source to an electric vehicle are transformers. Conventional distribution transformers lack flexibility and bidirectional energy control capability that is required to comply with the smart grid concept. One possibility is to replace the conventional low frequency transformer by a medium or high frequency one and add appropriate power electronic converters [1] to the input and output of the transformer. The resulting active power electronic transformer (APET) complies with all requirements of the smart grid concept [2]. In every country, transformer is the main source for transmission and distribution. Nowadays distribution transformers are considered among the huge and expensive equipment because of their massive iron core and heavy copper windings. The main solution for voltage change in transformer is only possible by varying the number of turns. Active power electronic transformer is a programmable device that can vary the frequency and desired voltage and uses power electronic converters for the same. It has offered enabling technologies for the power quality enhancement, considerable reduction in size. In addition to voltage transformation and good isolation which they bring about, these transformers are also associated with significant advantages, including considerable reduction in the size, power quality improvement, etc. Active power electronic transformers, composing an important part of the smart grid, could have many roles in that variable system. Active power electronic transformer is used later as a standard building block in more complex systems to guarantee the power quality on the HV grid side. As the losses incurred in charging the Electric vehicle through Distribution transformer is higher, in this paper the active power electronic transformer has been implemented for charging the Electric Vehicle.

II. EXISTING SYSTEM

In this multi-input dc/dc converter based on the flux additive is given in this paper. Instead of combining input dc sources in the electric form, the proposed converter combines input dc sources in magnetic form by adding up the produced magnetic flux together in the magnetic core of the coupled transformer. Fig. 1 shows the circuit diagram of the existing system.

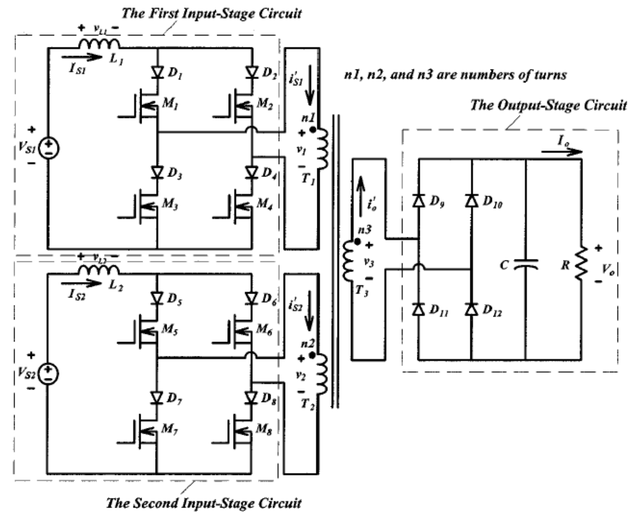

Fig. 1Existing system

With the phase-shifted pulse width-modulation (PWM) control, the proposed converter can draw power from two different dc sources and deliver it to the load individually and simultaneously. The operation principle of the proposed converter has been analyzed in detail. The output voltage regulation and power flow control can be achieved by the phase-shifted PWM control Transformers in different varieties of converters are used to deliver the electric power from the primary side to the secondary side to meet the desired voltage and current requirements as well as to provide the electric isolation for the application. According to Ampere's law, currents in the primary winding will produce magnetic flux in the magnetic core which will induce voltages in the secondary winding based on Faraday's law. The induced voltage on the fixed-turn-number secondary winding is determined by the total flux linkage produced by different magneto motive force (MMF) sources, which are created by currents in different windings. Consequently, the magnetic flux linkage provides a possible approach to combine energy from different sources

III. PROPOSED SYSTEM

The proposed system consist of active power electronic transformer that could be integrated to the electric vehicle fast charging station topology, thus creating multiport topology where EV batteries, energy storages, energy grid and renewable energy sources are tied together by one high frequency transformer Smart grid ties together distributed energy sources, storages and consumers. Important energy conversion and routing nodes in the supply chain from the source to an electric vehicle are transformers. Conventional distribution transformers lack flexibility and bidirectional energy control capability that is required to comply with the smart grid concept. One possibility is to replace the conventional low frequency transformer by a medium or high frequency one and add appropriate power electronic converters to the input and output of the transformer. The resulting active power electronic transformer (APET) complies with all requirements of the smart grid concept. The problems in the fast charging stations of the state-of-the art electric vehicle are: low frequency sub-station transformer; additional energy losses due to many energy conversion states; separate isolation transformers in each charging converter; low intermediate DC-bus voltage. To overcome those problems, the APET could be integrated to the electric vehicle fast charging station topology, thus creating multiport topology where EV batteries, energy storages, energy grid and renewable energy sources are tied together by one high frequency transformer. The proposed systemis shown in Fig.2

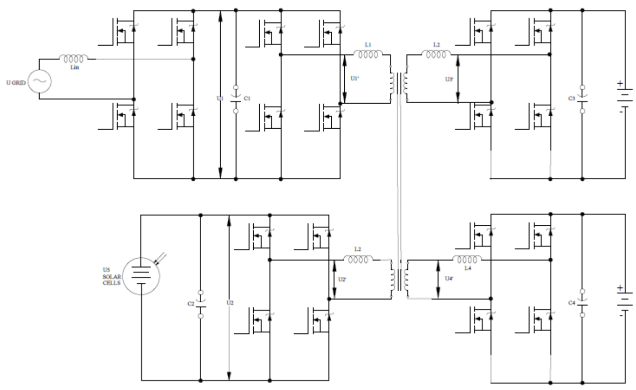

Fig.2 Proposed Circuit Topology

The main purpose of the proposed topology is to deliver energy from the grid to the EV battery. The energy overflow can be stored in the energy storage. Energy storage between the charging cycles is replenished by the solar cell array or the grid. The charging system can be organized into small logical blocks, so called power electronic blocks. The power electronic block is a system with clearly defined functionally that consists of power devices, gate drivers, control and other devices. Implementing power electronic block in various customer applications can result in reduced costs, losses, weight, size and engineering effort of power electronic system. The proposed system includes a power circuit that consists of a full bridge inverter with a DC-link capacitor. A transistor driver circuits, power supply, a cooling unit, and a simple independent low level control board. The charging station consists of four power electronic blocks. They are grid converter, renewable energy converter, an energy storage device and an electric vehicle battery charger.

IV. SIMULATION RESULTS AND DISCUSSION

To evaluate the performance of the EV multiport fast charger based on the APET, the planned downscaled 250 W laboratory model was simulated in the Matlab software with the parameter values shown in Table 1. The simulated PV model is shown in Fig. 3 in which perturb and observe maximum power point algorithm is used to track maximum power from the PV panel. The simulated circuit of the grid is also shown in Fig. 4.

Table 1 Design Specification

Parameter	Values
Input Voltage	230 V
Grid Voltage	400 V
PV panel	300 V
Electric Vehicle battery	50 V
Grid port inductor	100 mH
Capacitance	50μH
switching frequency	30 kHz

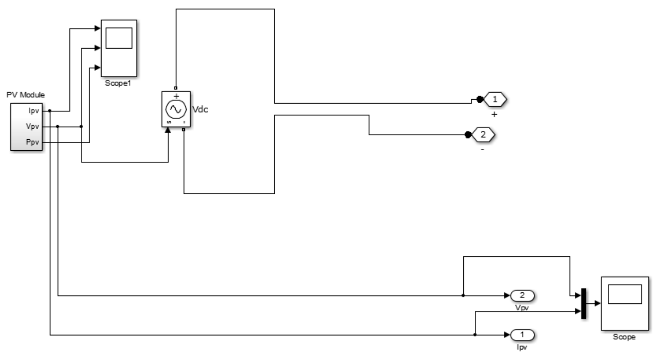

Fig. 3 PV system

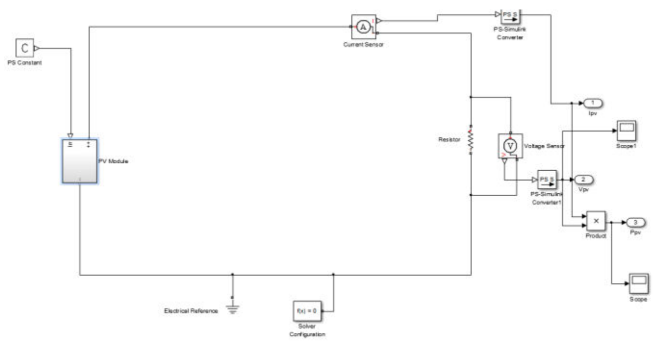

Fig.4 Grid System

The simulated proposed circuit interfacing PV , EV with the grid system is shown in Fig. 5.The obtained output voltage waveform and current waveform is shown in Fig. 5 and the derived voltage of 300V is obtained and current of 3A is obtained. Similarly, the simulation result of AC grid is also shown in Fig. 6 and the obtained voltage is 400V.

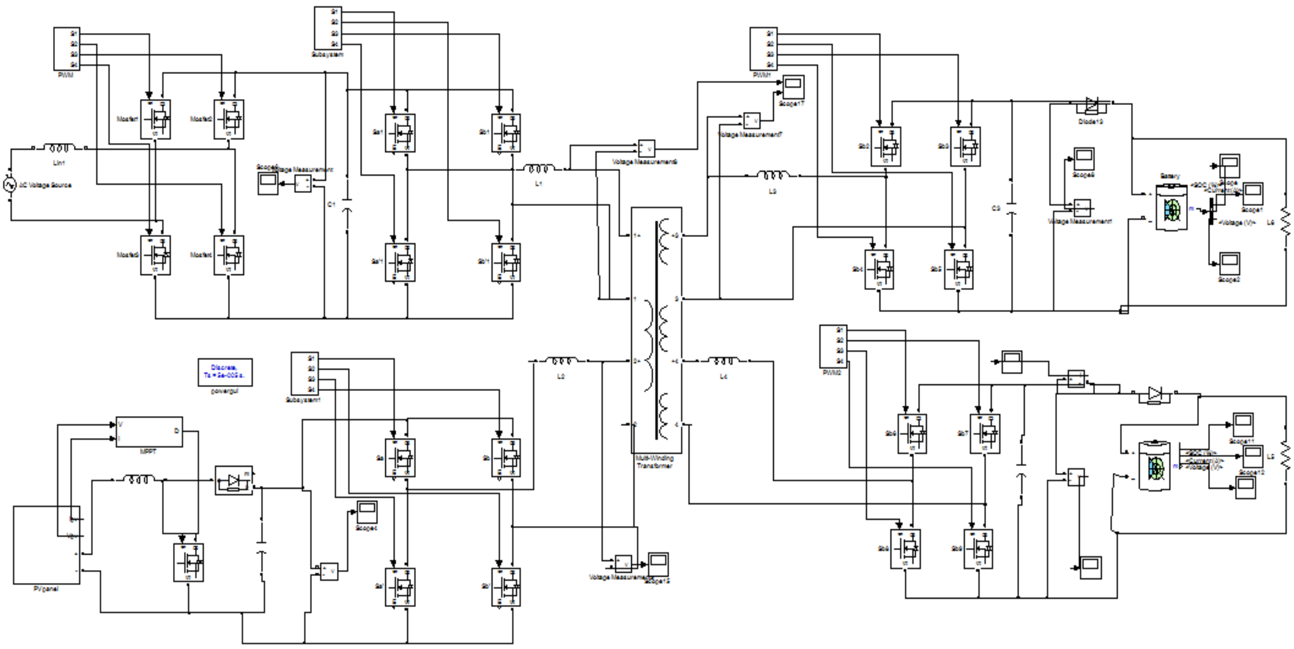

Fig.5 Proposed system

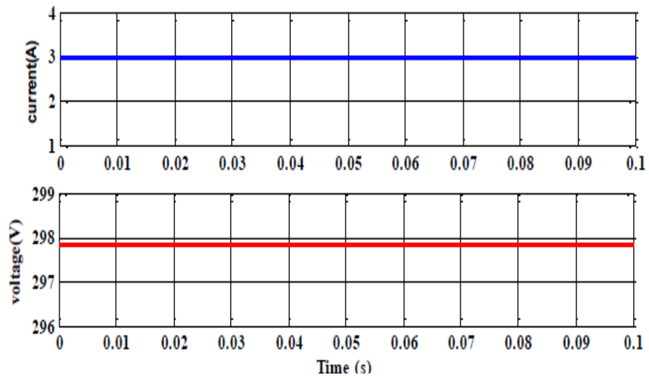

Fig. 5. Output voltage and current waveform

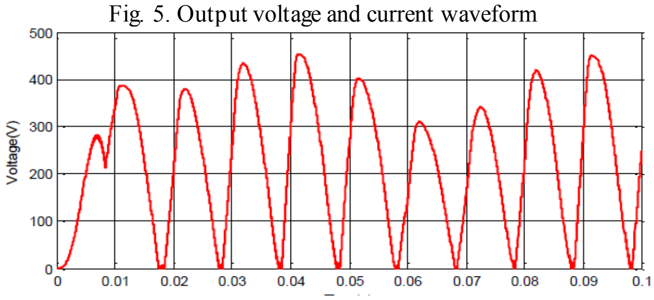

Fig.6 Grid voltage

The simulation result of Electric Vehicle is shown in the Fig.8 and the obtained voltage is 50V.

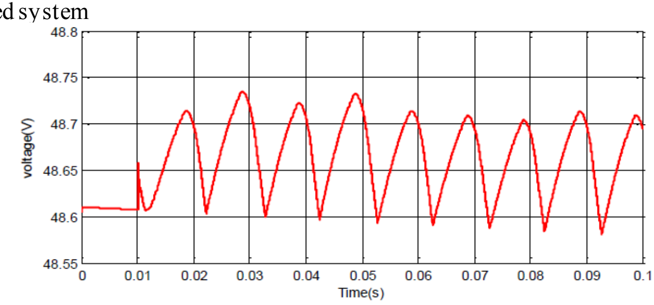

Fig.5 EV2 output voltage

The simulation result of Electric Vehicle is shown in the Fig.7 and the obtained voltage is 50V.

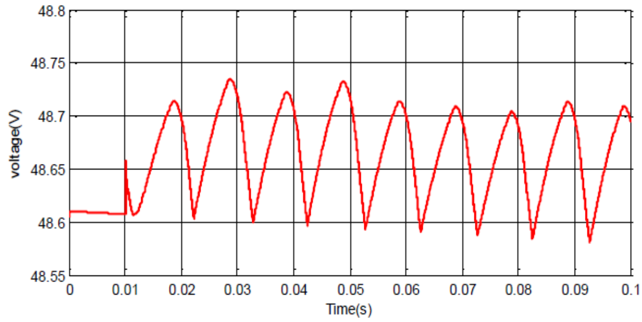

Fig.7. EV1 output voltage

V. HARDWARE RESULTS AND DISCUSSION

The prototype model of the proposed circuit has been validated with the hardware setup shown in Fig.6. The PIC microcontroller PIC30F2010 has been used to generate the control signals. The developed experimental setup is shown in Fig.8. The obtained output voltage of the electric vehicle. is shown in Fig.9.

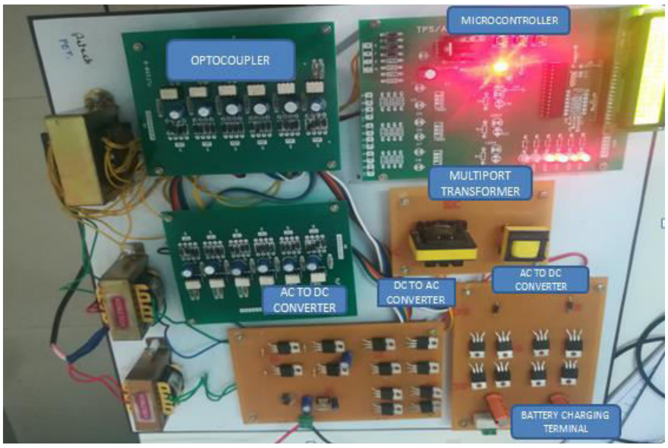

Fig.8 Hardware Setup

Fig 9. Output voltage

IV. CONCLUSION

In this work a multiport fast charger for the electric vehicle based on the concept of the active power electronic transformer is designed and implemented. This concept offers the following benefits: power control (active and reactive power); voltage control (compensation of voltage sags and peaks); current control (short-circuit current limitation).The multiport topology enables the reduction of power losses and the complexity of the power circuit and increases power density. The grid converter works as a synchronous rectifier supplying the multiport converter part with energy. Maximum power point Tracking is implemented by which the voltage obtained from PV module can produce maximum power

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