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A FUZZY APPLICATION TO EV CHARGING STATIONS EMPLOYING MULTI-PORT CONVERTER WITH MULTI-DIRECTIONAL POWER FLOW CAPABILITIES

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ABSTRACT

EVs and other dispersed energy storage devices can be used in a smart microgrid to supply power to users during peak times, minimizing the effects of load dumping and improving the quality of the electricity. To achieve these goals, a distinct hybrid multi-port converter is required to control power transfers and manage the energy between renewable energy sources, EVs, and the infrastructure. This paper proposes a novel separated multi-port converter that can control power transfer in various ways. A fuzzy-based system administration is recommended to increase the battery effectiveness of the system. Modeling the converter in the MATLAB/Simulink software system allows for the validation of the technology using a lab sample test tool. The results, preparation, and execution are all carefully examined.

INTRODUCTION

Because conventional power systems lack large-scale energy storage units, all of the electricity that is generated has to be used by either real or dummy loads in order to be used. It is possible that insufficient generation will lead to load shedding, particularly during peak hours. This results in a significant increase in the price of electricity and negatively impacts the reliability of the power grid. On the other hand, excessive generation will lead to the waste of energy. In addition to this, the rapid consumption of fossil fuels is contributing to the severe energy shortages that are plaguing developing countries.

Smart micro-grids, which are growing more and more popular around the world and are based on renewable energy sources, energy storage units, and electric vehicles (EVs), are becoming recognized as a viable means of resolving these massive difficulties. Electric vehicles have the potential to produce no greenhouse gas emissions and make a significant contribution toward the protection of green spaces if their batteries are charged by renewable forms of clean energy. In a smart microgrid, electric vehicles (EVs) and other distributed energy storage units

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can work together to supply electricity to loads during peak hours. This helps to reduce the negative effects of load shedding and improves the overall quality of the electricity. However, in order to control the power flows and maintain a balance of energy between renewable energy sources, electric vehicles (EVs), and grids, an intelligent hybrid multiport converter is necessary.

This converter used a relay to change the direction of power flow between an electric vehicle (EV) and either an alternating current (AC) or direct current (DC) grid. Interconnecting electric vehicles in parking lots is one of the uses that the solar photovoltaic (PV) system that is interfaced with a dc microgrid has found an application for because of its efficiency. Yet, the constant-power operation of dc–dc converter-based electric vehicle chargers might have an impact on the distribution system's steadiness. The purpose of the research that was conducted in

[6] was to design a high-power, three-level dc–dc converter-based rapid charger for a parking lot in order to alleviate the range anxiety that EV drivers experience. Even if a high-power charger is capable of simultaneously charging numerous electric vehicles (EVs), the rapid connection of many fast EV chargers might cause oscillations in the voltage and power of the distribution system.

A DC-to-DC converter is a device that accepts a DC input voltage and produces a DC output voltage. Typically the output produced is at a different voltage level than the input. In addition, DC-to-DC converters are used to provide noise isolation, power bus regulation, etc.In this circuit the transistor turning ON will put voltage Vin on one end of the inductor. This voltage will tend to cause the inductor current to rise. When the transistor is OFF, the current will continue flowing through the inductor but now flowing through the diode.We initially assume that the current through the inductor does not reach zero, thus the voltage at Vxwill nowbe only the voltage across the conducting diode during the full OFF time. The average voltage at Vx will depend on the average ON time of the transistor provided the inductor current is continuous.

TOPOLOGY

This section presents detail operation modes of the proposed approach, which combines general multiport dual active bridge (DAB)/triple active bridge (TAB) converter, bidirectional dc– dc converter, and dc–dc unidirectional converter. The circuit diagram of the proposed approach is illustrated. In the proposed approach, a bidirectional dc–dc converter is employed to interface the EV battery to provide bidirectional power flow capability with the utility grid and the energy storages. In addition, a conventional dc–dc boost converter is employed to interface the photovoltaic module. In order to provide bidirectional power flow capability with the utility grid, a bidirectional ac–dc converter is used to generate sinusoidal ac current in the grid side for high- quality power conversion. In this approach, a bidirectional dc-dc converter is used to interface the energy storage devices, which is used to control the charging and discharging operations of the storages. Moreover, the proposed approach can be extended to N different dc buses through a multi-winding transformer (MWT) to handle a wide variety of dc voltage sources.

Pulse Width Modulation (PWM) is the most effective means to achieve constant voltage battery charging by switching the solar system controller’s power devices. When in PWM regulation, the current from the solar array tapers according to the battery’s condition and recharging needs consider a waveform such as this: it is a voltage switching between 0v and 12v. It is fairly obvious that, since the voltage is at 12v for exactly as long as it is at 0v, then a 'suitable device' connected to its output will see the average voltage and think it is being fed 6v - exactly half of 12v. So by varying the width of the positive pulse - we can vary the 'average' voltage.

The triangle waveform, which has approximately equal rise and fall slopes, is one of the commonest used, but you can use a saw tooth (where the voltage falls quickly and rinses slowly). You could use other waveforms and the exact linearity (how good the rise and fall are) is not too important.

Traditional solenoid driver electronics rely on linear control, which is the application of a constant voltage across a resistance to produce an output current that is directly proportional tothe voltage. Feedback can be used to achieve an output that matches exactly the control signal. However, this scheme dissipates a lot of power as heat, and it is therefore very inefficient.

A more efficient technique employs pulse width modulation (PWM) to produce the constant current through the coil. A PWM signal is not constant. Rather, the signal is on for part of its period, and off for the rest. The duty cycle, D, refers to the percentage of the period for which the signal is on. The duty cycle can be anywherefrom 0, the signal is always off, to 1, where the signal is constantly on. A 50% D results in a perfect square wave.

The PWM is a large amplitude digital signal that swings from one voltage extreme to the other. And, this wide voltage swing takes a lot of filtering to smooth out. When the PWM frequency is close to the frequency of the waveform that you are generating, then any PWM filter will also smooth out your generated waveform and drastically reduce its amplitude. So, a good rule of thumb is to keep the PWM frequency much higher than the frequency of any waveform you generate.

Finally, filtering pulses is not just about the pulse frequency but about the duty cycle and how much energy is in the pulse. The same filter will do better on a low or high duty cycle pulse compared to a 50% duty cycle pulse. Because the wider pulse has more time to integrate to a stable filter voltage and the smaller pulse has less time to disturb it the inspiration was a request to control the speed of a large positive displacement fuel pump. The pump was sized to allow full power of a boosted engine in excess of 600 Hp.

At idle or highway cruise, this same engine needs far less fuel yet the pump still normally supplies the same amount of fuel. As a result the fuel gets recycled back to the fuel tank, unnecessarily heating the fuel. This PWM controller circuit is intended to run the pump at a low speed setting during low power and allow full pump speed when needed at high engine power levels.

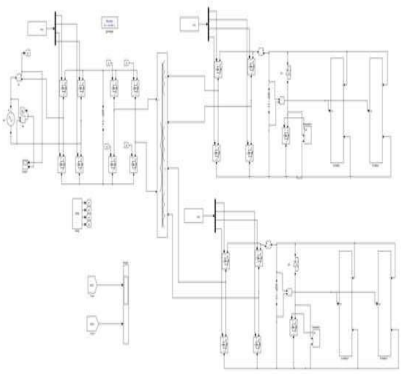


Fig 1. simulaton circuit

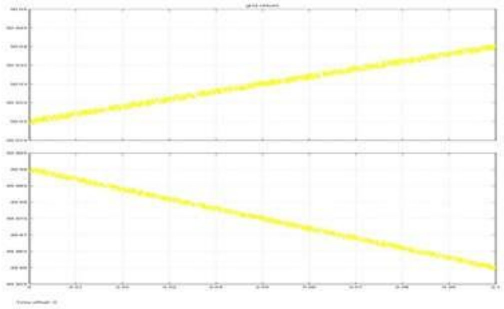
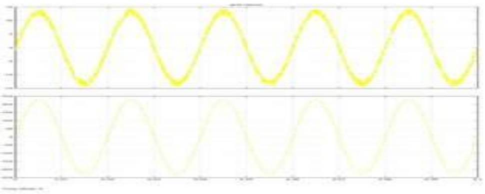


Fig 2. Battery voltage and soc

Running a simulation in the computer always requires a numerical technique to solve a differential equation. The system can be simulated as a continuous system or a discrete system based on the blocks inside. The simulation start and stop time can be specified. In case of variable step size, the smallest and largest step size can be specified. A Fixed step size is recommended and it allows for indexing time to a precise number of points, thus controlling the size of the data vector. Simulation step size must be decided based on the dynamics of the system. A thermal process may warrant a step size of a few seconds, but a DC motor in the system may be quite fast and may require a step size of a few milliseconds.

To verify the functionality of the proposed technology, the detailed simulation studies have been conducted in the MATLAB/Simulink software environment. During the grid to vehicle (G2V) operation mode, the EV battery is charged from the grid and the energy storage battery is disconnected. the EV battery state of charge (SOC) in this mode. In the proposed concept, the EV and energy storage batteries can be charged from the grid at the same time. Shows the charging currents of the batteries in this mode. The PV energy can be used to charge the energy storage with the proposed architecture. In this mode, the perturb and observe algorithm was implemented to control the unidirectional converter to extract the maximum available power from the PV to charge the energy storage battery. Fig. 2(c) shows the charging current in this mode. The EV battery and energy storage battery SOCs in this mode. As it can be seen that the energy storage battery SOC is decreasing and EV battery SOC is increasing due to the discharging and charging process. During energy storage to grid power transfer mode, the energy storage is discharged at a constant current rate, which depends on the desired value of the active power, and the ac-dc converter is controlled to generate sinusoidal ac current in the grid-side. During PV to grid power transfer mode, the ac-dc converter in the grid side is controlled to generate sinusoidal grid current.



CONCLUSION

This paper presents a new architecture of an isolated multidirectional power conversion system, which is suitable for smart electric vehicle charging station. This architecture is designed to interface EV battery, energy storage systems, and renewable energy sources to interface with the grid through an isolated system. This approach can be extended to N different dc buses through a MWT to handle a wide variety of dc voltage sources and provides the necessary isolation to meet the grid standards.

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