Active Power Filter For Vehicle to Grid (V2G) Applications using Bidirectional Conversion Technique in Manufacturing Industries

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ABSTRACT-The objective of the paper is to compensate the reactive power to optimize the power demand. Voltage control in an electrical power system is important for proper operation for electrical power equipment to prevent damage such as overheating of generators, and to reduce transmission losses and to maintain the ability of the system to withstand and prevent voltage collapse. Electrical Vehicles are used for ware house management in manufacturing industries. The main purpose of bidirectional CUK converter is to enhance bidirectional current flow and to improve the system stability. The results are shown in simulation using MATLAB software and implemented in hardware.

KEY WORDS: Bidirectional conversion, CUK converter, VAR generators, V2G system, buck boost converter.

I. INTRODUCTION

The reactive power oscillates between the AC source and the capacitor or reactor, and also between them, at a frequency equals to two times the rated value (50 or 60 Hz). For this reason it can be compensated using VAR generators, avoiding its circulation between the load (inductive or capacitive) and the source, and therefore improving voltage stability of the power system. Reactive power compensation can be implemented with VAR generators connected in parallel or in series[1]. Compensation should be provided as close as possible to the consumption point to avoid having to distribute this power in the other part of the network[2]. Reactive power compensation in transmission systems also improves the stability of the AC system by increasing the maximum active power that can be transmitted. It also helps to maintain a substantially flat voltage profile at all levels of power transmission. In this paper reactive power is compensated by shunt compensation technique. According to the Vehicle to grid concept, power is not only consumed by electric vehicle, like a mobile distributed generators (DGs), EV’s also returns the extra power to the grid during the idle condition. This will improve the energy efficiency and management of the grid[5-7]. In grid it is necessary to maintain the power quality. For efficient and economic operation mode of the grid it is necessary to have the reactive power compensation which in turn improve the power quality.[9]. When there is power demand in the system...
Vehicle to grid concept plays a vital role in improving the efficiency of the system.[4]. A microgrid will act like a substation and it will individually operated even when there is no connection between the main power system and the grid. Micro grid can supply the required power demand to the load [10-11]. For flexible and efficient operation micro grids are provided with number of small power generating sources. Micro grid can be used to supply power to small community [12]. To reduce transmission losses and to provide high quality and reliable energy supply to critical load micro grids are normally developed.

![Figure 1. Framework of V2G](image)

**II. CONCEPT OF V2G**

Figure 1 shows the basic schematic for vehicle to grid system. It comprises of a grid-side converter and a battery-side converter. It also consists of a protective circuit. There are three modes of operation in V2G system. They are grid-connected mode, charging mode and reactive power compensation mode. In various operating modes, the circuit elements will operate in different manner. During grid-connected mode, the battery-side converter will be a boost converter and the grid-side converter will be a PWM inverter. During the charging mode of operation, the battery-side converter will act as a buck converter the grid-side converter will act as a PWM rectifier and. In reactive power compensation mode, the grid-side converter will be a reactive power compensator and the battery-side converter will be a boost converter.
III. EXISTING SYSTEM

In existing system for conversion technique bidirectional buck-boost converter is used. Buck-boost converter is a type of switched mode power supply used in order to boost and buck the magnitude of voltage depending upon the requirement. The disadvantage of buck boost converter is discontinuous input current and the settling time is low. Since large number of switches is used the switching losses are high and reduce the system reliability and performance. In simple words it is combination of both buck and boost converter in a single circuit. By combining these two types of regulator designs it is possible to have wide range of input voltages either higher or lower than that needed by the circuit. The common components of buck and boost are combined with the control unit which senses the level of input voltage.

Figure 2. Block Diagram of existing system

IV. PROPOSED SYSTEM

Figure 3. Circuit diagram of the proposed system
In proposed system a CUK converter which has continuous input and output current is used instead of buck boost converter. When the switch is open and closed energy is transferred. Due to the presence of LC filter in the CUK converter the peak-peak ripple current of inductor is reduced. Car battery is used as the main source of energy in this project. These batteries are connected to the loads like motor loads and other loads require reactive power for their operation. Here the PR control technique is used which normally controls the active and reactive power transfer between the grid and battery.

The high current and voltage at the generating station are sensed by current and potential transformers. The phase difference between the current and voltage are detected by zero crossing detector. The analog signal is converted into digital signal by the signal conditioning unit and which forms the input to the microcontroller. The microcontroller and the isolated gate drive circuits are supplied by regulated power supply. The gate driver produces the high current drive input for the gate of MOSFET. The high current is produced by MOSFET and given to the battery. The voltage from the battery is fed to the CUK converter and which get boosted. The boosted voltage is fed to the inverter. The inverter converts the voltage into AC signal. This AC signal is fed to the micro-grid, and reactive power compensation is achieved.

**Figure 4. Block diagram of the proposed system**

V. COMPARSION BUCK BOOST CONVERTER AND CUK CONVERTER
Figure 5. Simulation Circuit of the proposed system

Figure 6. Simulation circuit of proposed CUK Converter

VI. SIMULATION RESULT
Figure 7. Efficiency of Existing Buck Boost Converter

Since in the existing system the buck-boost converter is used, the switches are more thus it increases the switching losses and reduces the reliability and also the efficiency is less when compared to the CUK converter.

Figure 8. Efficiency of Proposed CUK Converter

The efficiency is 96% and the PR controller used here will control the active and reactive power and improves the system performance.
VII. CONCLUSION

In this paper, vehicle-to-grid (V2G) system uses a new multi-function conversion technique. This includes reactive power compensation, bi-directional conversion topology and control strategy. In the system, control scheme combined with instantaneous reactive power detection methods also adopted. The results show that the system can perform well in multi-function conversion. These vehicles can be deployed directly for warehouse management in manufacturing industries.
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