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Original Article

An Optimised PV Energy Stored System by Using DC-DC Module Fed to E-Automotive Vehicle with Enhanced Fault Protection Mechanism

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Abstract: *New topology suggested to compensate for the input fluctuations of a solar photovoltaic unit caused by variations in solar irradiation and to make the terminal voltage grid consistent with the required frequency, power electronic converters are utilized. Low power quality and excessive voltage stress are typical issues with traditional two-level converters. This article proposes a novel multilevel inverter topology for solar PV power conversion systems: the Dual Source Multilevel Inverter (DS-MLI), which uses fewer power switches. It has the capability of cascading-free symmetric and asymmetric operation. This minimizes the number of switches needed to generate a staircase voltage waveform. We evaluate the dynamic behavior of the system during a step change and use the state-space averaging method to construct a closed-loop control mechanism.*

The worldwide electrical power generation industry has become more interested in solar photovoltaic (SPV) energy sources in recent years due to their rapidly expanding installed capacity. Due to fears about the reliability and safety of the grid's current infrastructure, rigorous grid-codes have been enacted due to the widespread use of grid-interactive SPV systems. SPV systems require power electronic based energy conversion systems because to their stochastic nature and compliance with stringent grid-codes. The requirement for multi-level inverters and associated management mechanisms is further necessitated by the rise in SPV system power levels. For high power industrial applications, multi-level inverters are a tried and true method of energy conversion. One of the most popular and frequently adopted multi-level inverter designs for grid-connected SPV a system is the neutral point clamped (NPC) architecture. Effective energy conversion relies heavily on the control systems used by these grid-connected NPC inverters. The creation of novel control methods for grid-connected the study of SPV inverters is underway.

Keywords: *Energy Stored System, DC-DC Module, Automotive Vehicle, Protection Mechanism.*

I. INTRODUCTION

Due to rising costs of petroleum and concerns about the impact of vehicle emissions on the environment, automakers have been exploring alternative propulsion systems for the better part of two decades. In response, there was a meteoric rise in the advancement of technology related to electric and hybrid vehicles. Whereas conventional cars get their traction power from an internal combustion engine (ICE), an EV gets its power from the electrical energy storage system (EESS) [1].

HEVs rely on ICEs and EESSs in the same way. As a result, EV/HEV technology may enhance the efficiency of energy conversion and driving performance while decreasing emissions of dangerous gases. There is potential for even greater system efficiency because to the incorporation of EESS, which allows for electrical regeneration during braking. Electric energy storage systems (EESS, often battery packs) are a common component of commercial vehicles, typically linked to the high voltage dc bus through a bidirectional dc-dc converter [2].

To obtain galvanic isolation and high voltage gain, dc-dc converters are necessary in several applications. Therefore, dc-dc converters with a phase shift, such as Fly-back, forward, or complete bridge, are useful in many situations. When power flows in both directions but galvanic isolation is not necessary, the standard bidirectional buck/boost dc-dc converter can be used. Similar applications are possible with other common bidirectional dc-dc converters used in energy storage systems.

In terms of voltage gain, component count, and voltage stress, each type of converter has benefits and drawbacks [6]. The three level [7], four level [8], and multilevel [9] converters expand the working range and voltage gain of the standard buck/boost converter by using extra capacitors and power switches. However, in order to keep the voltage stresses between the power switches and capacitors in multilayer dc-dc converters in equilibrium, more power switches, extra hardware circuits, and management mechanisms are required. Although Cuk/Sepic/Zeta and other dc-dc converters may be adapted into bidirectional topologies, their distinctive architectures may constrain their efficiency [10], [11], and [12].

II. RELATED WORK

In this article, B. V. Kumar et al. introduced a novel non-isolated minimum phase bidirectional DC-DC converter. Since the RHP zero has been eliminated, the bidirectional DC-DC converter exhibits minimal phase behavior. The bidirectional DC-DC converter provides top-notch dynamic performance even when subjected to extreme loads because to its minimum-phase characteristic.

To transport electricity from the grid to an EV and back again while maintaining the grid's increased power factor, A. K. Verma et al. suggested a design comprising a single-phase bidirectional AC-DC converter and bidirectional DC-DC converter.For the purpose of charging electric vehicle batteries (whether in on-board or off-board constructions), V. Monteiro et al. offer a bidirectional three-level (B3L) dc-dc converter. The B3L dc-dc converter is just one component of on-board or off-board chargers, and it may be housed in galvanically isolated or non-isolated electrical systems, as this study demonstrates.

C. F. Oliveira et al. proposed a bipolar DC grid with fault-tolerance analysis that takes into account a novel bidirectional multilevel DC-DC converter. While this converter may be used to interact with several technologies, the EV battery charger is the focus of this study.For these uses, B. B. T. Shekin et al. developed a simplified DC-DC converter using a Multi input bidirectional switching capacitor (MIBSC).

In this research, M. Moradpour et al. present a two-phase dc-dc converter with one phase using a MOSFET based on SiC and the other using a transistor based on GaN. Power will be split between the two phases according to the GaN device's current rating, allowing for optimal efficiency.

D. Das et al. plan to use a compensator-based dual loop controller in PSIM to create a close loop simulation of this isolated bi-directional dc-dc converter prototype.To include a DC collecting platform into a bipolar MVDC transmission line, E. C. Mathew et al. offer an isolated hybrid bidirectional modular converter with half-bridge submodules. In addition to insulating DC collecting platforms from the MVDC grid, the converter also offers galvanic isolation. This paper explains the operation of the control method for a brand-new DC-DC converter.

Power inductor core size improvement in bidirectional dc-dc converters was the topic of research by M. S. Perdigo et al. Methods for obtaining a power inductor inductance reference value for use in simulation studies of dc-dc converters, as well as an experimental large-signal characterisation process, are presented. Important restrictions, such as core size and saturation, are described, and the significance of the inductor design project is discussed. Simulation and experimental findings on an interleaved two-phase configuration with a 4.5 kW rating are presented by G. -J. Su et al. The advantages of using a nonstandard duty ratio on the transformer and a preferred multiphase arrangement to reduce capacitor ripple currents are also mentioned.

In this study, T. Muthamizhan et al. discussed a bidirectional single-stage dc/dc converter for a grid-tied inverter and an electric vehicle charging station. For energy storage and transformation, the proposed grid-tied inverter uses a bidirectional single-stage SEPIC-ZETA dc/dc converter. The direct current (dc) from the battery modules is changed into high frequency pulsing dc current via an H-bridge inverter.

In order to accommodate the bidirectional energy flows present in hybrid electric vehicles (EVs), Y. Zhang et al. presented a switched-capacitor/switched-quasi-Z-source bidirectional dc-dc converter. The suggested converter only utilizes a switched-capacitor cell at the output of the high-voltage side, in contrast to the conventional quasi-Z-source bidirectional dc-dc converter, and the primary power switch is moved. Two rechargeable batteries and an ultracapacitor (UC) are proposed for use in a bidirectional dc/dc converter designed by T. Anno and colleagues. Between the battery and UC, this converter is linked via a cell-voltage equalizer. The energy transmission between the battery and UC is made possible by the cell-voltage equalizer.

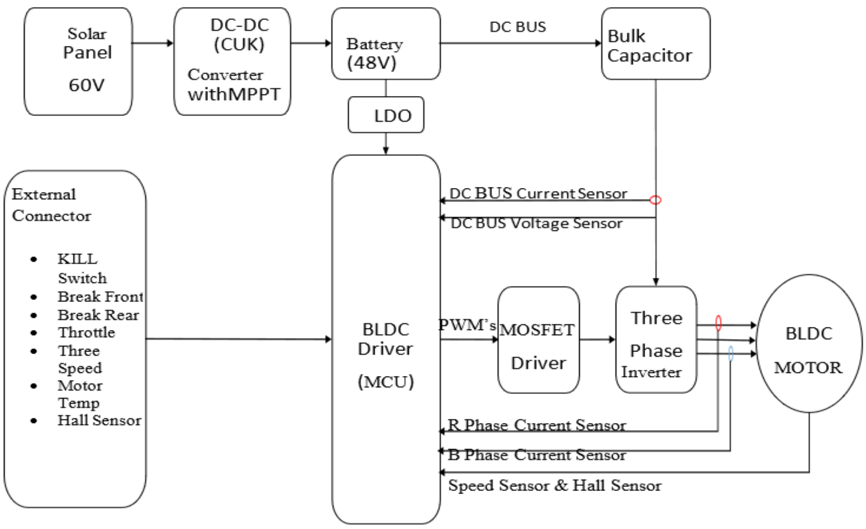
In this study, U. Vamsi et al. suggest charging EV batteries with a PV system that features a bidirectional DC-DC converter. With a bidirectional DC-DC converter, the proposed PV system can supply both DC loads and EV battery charging. During peak hours, the DC loads and the electric vehicle's battery are charged using electricity from the PV array. For use in EVs, R. Rezaii et al. designed a Bidirectional DC-DC Converter (BDC). Advantages of both switched-inductor and switched-capacitor converters are included into this one convenient device. The suggested converter features minimal voltage stress on the power switches, a high voltage gain range, and a common ground between the input and output.

III. AN OPTIMISED PV ENERGY STORED SYSTEM BY USING DC-DC MODULE FED TO E-AUTOMOTIVE VEHICLE WITH ENHANCED FAULT PROTECTION MECHANISM

PV panel installed capacity is expanding dramatically as a result of environmental concerns and the scarcity of fossil resources. As a result, researchers have dedicated a lot of attention to the topic in recent years. PV systems require inverters for grid connection since their output voltage is dc. Both the amount of sunlight and the temperature have a non-linear effect on solar cells. As a result, PV electricity at various degrees of heat and sunshine. The P&O technique and incremental conductance (IC) have garnered a lot of interest as two ways to get the most out of your PV cells when it comes to power output. The management and organization of these converters are crucial to the successful operation of the whole system. The requirement for a converter with a large output gain range is felt since the voltage of an array varies with temperature and the flow varies with the amount of radiation.

Technologies like battery charging, uninterrupted power supply (UPSs), and solar energy systems all make use of high gain converters. High gain converters are necessary in solar applications because of the AC network transmission, and these converters may increase a modest output voltage to a big DC value. Methods like using charge pump cells are used to enhance the DC voltage. The previous setup makes use of a step-up converter and a bidirectional DC-DC converter to boost the DC voltage. The efficiency drops as the number of switches rises with the use of more cells. The first inrush current is drawn because of the huge capacitance of the structure.

Gain has recently been achieved by the introduction of a magnetic element. Some of these initiatives include using a flyback capacitor and a linked inductor. These converters all have their drawbacks, though. The floating output terminals given in make the presented structure suitable for a wide variety of E-vehicle applications. The complex structures shown in are well suited for use as energy storage. The solar system should make use of a battery in light of the uncertainty. To that end, this article offers the high-gain and energy-storage-capable structure depicted in Figure 1. P&O technique was used to create the suggested structure. The proposed system consists of a 60-volt solar array, a DC-DC (CUK) converter with maximum power point tracking (MPPT), a bulk capacitor, a brushless DC (BLDC) drive (MCU), a low-dropout (LDO) regulator, a metal oxide semiconductor (MOSFET) drive, a three-phase inverter, and.



Power Rating: 3.2KW continuous & 5KW

PeakVoltage: 48V

Under Volt:36V

Over Volt: 56V

Over Current :115Amps

MPPT: P& O algorithm

Figure1:Block Diagram of PV Energy Stored System by Using Dc-Dc Module Fed to E-Automotive Vehicle with Enhanced Fault Protection Mechanism

A. Proposed PWM Strategy

Modulation, the process by which PWM patterns are created, is essentially just an amplitude to width transformation. The proper carrier-based PWM approach, in other words, is one that sets the "per carrier cycle average output voltage" to be the same as the reference voltage. Unipolar sinusoidal PWM (SPWM) compares a triangular carrier to a sinusoidal reference to produce gating pulses. Fundamental improvement in the SPWM switching techniques necessitates a wider pulse width in the areas surrounding the reference wave's center. Before the reference voltage's magnitude surpasses the modulator's linearity limit, the reference output voltage relationship is linear. There is no simple PWM algorithm which maintains voltage gain linearity until the full utilization of dc input for single-phase inverter system. The transition from PWM to square wave mode operation was an unresolved problem limiting the performance of ac drive systems. Modified regular sampled SPWM scheme named amplitude modulated inverted sine carrier PWM (AISCPWM) has been proposed to give single mode operation of SPWM inverter. It offers linear gain characteristics in comparison to the conventional SPWM without involving complex computations and significant changes in device losses.

B. Amplitude Modulated Inverted Sine Carrier Function

It is demonstrated in Fig.2 that the carrier of the innovative Amplitude Modulated Inverted Sine Carrier (AMISC) Function is an amplitude modulated inverted sine signal, whereas the reference signal is the standard sine wave. The carrier is (amplitude) modulated by a reference-frequency sinusoidal modulating signal, which is it a high-frequency inverted sine.

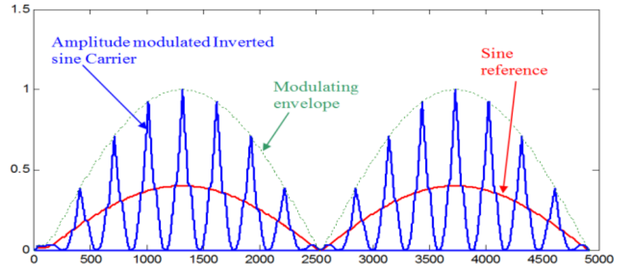


Figure 2: Concept of AMISC Function

C. Amplitude Modulated Inverted Sine Carrier PWM Method

Single-mode functioning of SPWM inverter has been achieved by the development of a modified regular sampled SPWM scheme known as Amplitude Modulated Inverted Sine Carrier (AMISC) PWM. Unlike conventional SPWM, it can provide linear gain characteristics without requiring complex computations or observable changes to device losses. This PWM system combines the advantages of ISCPWM and AMTCPWM, both of which were covered in the previous chapters. Figure 3 depicts the unipolar pulse waveform used by the AMISCPWM method.At the nodes where the high-frequency amplitude-modulated inverted sine carrier and the sinusoidal reference waveform intersect, positive and negative group switching pulses are generated for the single-phase inverter. Modulation index (Ma) and frequency ratio (Mf) establish the switching angle's location and duty cycle.

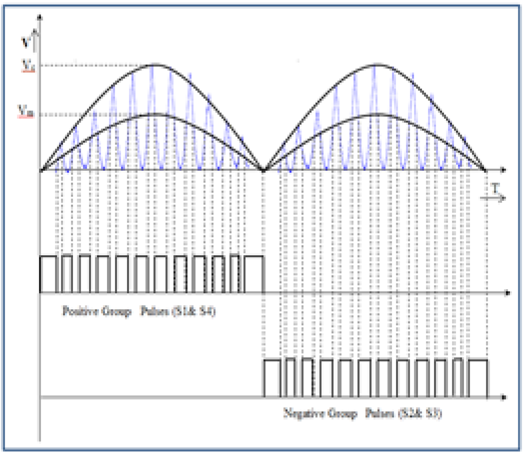


Figure3:L AMISC-PWM Pulse Pattern

Matlab 7.9 has been used for the performance study of the AMISC-PWM method. The harmonic spectrum and waveform at output are displayed for the parameters of Ma=0.8, Mf=15, Vdc=300V, and Rload=100. We show how AMISC-PWM performs in contrast to SPWM and AMTC-PWM. With maximal dc supply usage, the AMTCPWM generates basic output voltage values and linearly approaches the square wave inverter border.

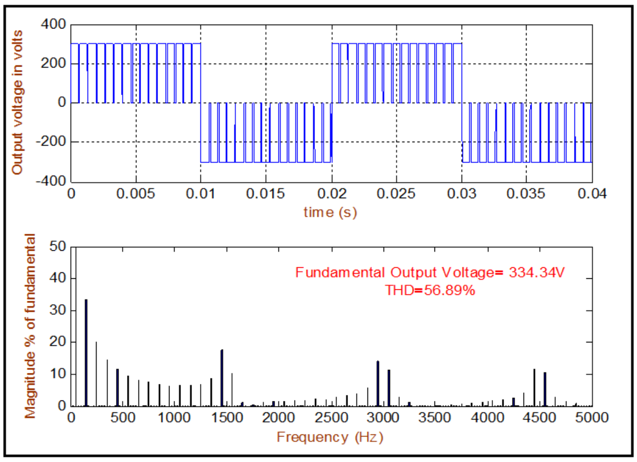


Figure4: Output Voltage and Frequency Spectrum

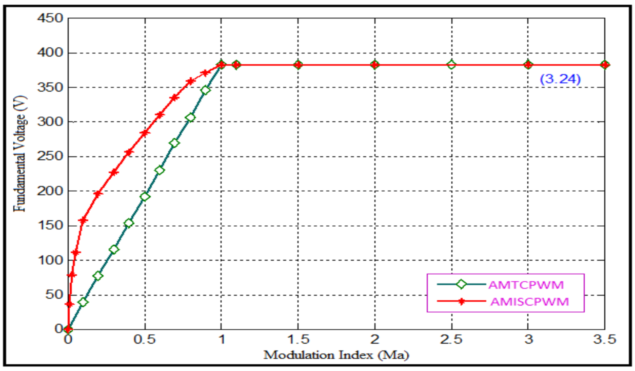


Figure 5: Variation of Fundamental with Modulation Index

IV.CONCLUSION

As a result, researchers have dedicated a lot of attention to the topic in recent years. PV systems require inverters for grid connection since their output voltage is dc. Both the amount of sunlight and the temperature have a non-linear effect on solar cells. As a result, PV electricity at various degrees of heat and sunshine. The P&O technique and incremental conductance (IC) have garnered a lot of interest as two ways to get the most out of your PV cells when it comes to power output. The management and organization of these converters are crucial to the successful operation of the whole system. The requirement for a converter with a large output gain range is felt since the voltage of an array varies with temperature and the flow varies with the amount of radiation. Technologies like battery charging, uninterrupted power supply (UPSs), and solar energy systems all make use of high gain converters. High gain converters are necessary in solar applications because of the AC network transmission, and these converters may increase a modest output voltage to a big DC value. Methods like using charge pump cells are used to enhance the DC voltage. The former technique uses a step-up boost DC-DC converter to raise the DC voltage. The application to achieve high productivity. The first inrush current is drawn because of the huge capacitance of the structure. Gain has recently been achieved by the introduction of a magnetic element. These initiatives include, for instance, the employment of flyback capacitors and linked inductors.

The floating output terminals given in make the presented structure suitable for a wide variety of E-vehicle applications. The complex structures shown in are well suited for use as energy storage. The solar system should make use of a battery in light of the uncertainty. In this study, we provide a structure with excellent gain and energy storage. P&O technique was used to create the suggested structure. The proposed system consists of a 60-volt solar array, a DC-DC (CUK) converter with maximum power point tracking (MPPT), a bulk capacitor, a brushless DC (BLDC) drive (MCU), a low-dropout (LDO) regulator, a metal oxide semiconductor (MOSFET) drive, a three-phase inverter.

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