PHOTOVOLTAIC BASED MODULAR MULTILEVEL CONVERTER FOR BATTERY ENERGY STORAGE SYSTEM

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ABSTRACT

This paper proposes another arrangement and its control procedures for the photovoltaic Based Modular Multilevel Converter battery energy storage system. The existing system had various disadvantages such as when the application requires more voltage than 2.7 volts that a single cell can provide the floating capacitors are stacked in a series of 2 and more. In order to prevent the leakage current from causing damage to other cells via over voltage it is important to balance each cell. One of the other problems faced by the existing system is that it cannot be used in AC & high frequency circuits. In order to solves these problems a new system is proposed where every PV module is connected from its DC to various PV generators utilizing DAB (DC-DC converter). A BES framework installed into every converter (from the arm part) which is attached to the DC of the battery energy storage sub module using more than one Dual Active Bridge converter. It will help in smoothing the power output. It will also help to limit the power given to the grid. This paper also proposes the elimination of the mismatch of the power by exchanging the power in between the converter and the inner flow of modular multilevel converter. By eliminating the power mismatch and using current that is differential to reduce mismatch of power and to transfer the power among the legs and the arms of the converter. This power smoothing using the battery energy storage system and elimination technique is demonstrated in the paper. Our proposed system uses semiconductors that can be switched on and off autonomously, the converter can supply reactive power, it can operate with a delay and advance power factor and it can be used in isolated systems. We can further see from our simulation that a more smooth output has been obtained.

Keywords: Photovoltaic, Power electronics, Dual active bridge converter, modular multilevel converter, battery energy storage system[BES], power mismatch.


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1. INTRODUCTION

PV Solar energy is developing in a quick speed these most recent years. The development has been related to worries such as environmental alteration because of contamination brought about by petroleum product, capital expenses decrease, and authority motivating forces [1]. In conclusion use of solar energy is increasing quickly in our energy sector.

There are different challenges in the big scale PV system such as stability, reliability and degradation of power [2]. This leads to the fluctuation in the output power that in turn causes transients. To solve this transient we need a large variation in the power output to balance output power of load and power generation. One way to deal with the recurrent PV power is to stop generation of energy during the shady days [3]. This method is not reliable because it affects the revenue.

The subsequent methodology is utilizing of Photo Voltaic inverters in order to effectively direct the voltage of the framework in PCC. This action was restricted by the IEEE 1547 Standards. But the newer type consists of reactive power as well as control of the voltage [4]. One of the other methods can be to combine the Photovoltaic and the ESS (Energy storage system). This method can possibly relieve the previously mentioned difficulties in the paper. Some of the ESS technologies are super capacitor [6], batteries [7] and hydro pump [5]. Recently there is an increased consideration and application of batteries because of less expenses [8], high dependability as well as productivity [9] also non contaminating [10]. The main reason of combining the Energy storage system with PV is to smoothen the indefinite output energy of the Photovoltaic. These techniques are suggested to work Battery Storage system framework combined with the plants. The technique is to work the PV plant as partly planned generator while the subsequent technique is to get rid of most of the unexpected changes of the produced power [11]. The oscillating power of the PV system is removed using the smoothing technique and it will also limit the power given to the grid [12-13].

Our work that is based on PV MMC system removes big bulky transformers, gives better power and decreases manufacturing cost as well as makes it more reliable [14-16]. It is proposed in Reference [17] the utilisation of Modular Multilevel Converter to coordinate the generators to a DC. Inconsistent power created by the PV generator is associated with the arms of framework is among the difficulties faced by MMC and PV. The problem regarding the mismatch of the power in the middle of the legs side and the arms side of the PV is mentioned in the references [18 - 20].

Another structure to solve the above stated problems regarding the BES framework is mentioned in the paper where every PV module is connected from it’s DC various generators utilising the converters. One of the BES frameworks is to be installed in every converter (from the arm) and interlinked to the DC side of battery energy storage sub module using more than one Dual Active Bridge converter. It will help in smoothing the power output. It will also help to limit the power given in the grid.

2. MMC SYSTEM

The general network that is associated with the SPV framework is given in figure 1. The phase one photovoltaic array is associated with the framework that interfaces the inverter and it’s input. The stage 3 VSI is utilised to not only change the DC into AC and also provide the power to the grid as well as the load using the filter circuit [21-22]. To obtain good quality we need to ensure that the voltage is consonant less. In order to achieve it we need to control the inverter. In order to shift the inverter different PWM strategies are utilised [23].
3. PROPOSED SYSTEM

In our proposed framework we will be utilising a DC - DC converter that will step up the voltage and will improve it in the ratio of one is to six 1:6. The output power will even out and also the output will be liberated from any of the consonant loss that is not needed.

![Figure 1 MMC system](image)

**Figure 1** MMC system

3.1. Modes of Operation

**Mode I:** Switch is ON, Diode is Off

![Figure 3 (a) ON mode of Proposed system](image)

**Figure 3** (a) ON mode of Proposed system

Here the circuit is short circuited offering zero resistance to current flow. This suggests when the current will flow it will from switch and back to the dc input source. Here the inductor is getting charged.
MODE II: Switch is OFF, Diode is on

Here the polarity of the inductor is reversed. The charge stored in the inductor is released and is finally dissipated in the series load resistive load. This helps us maintain the current flow direction in circuit and also stepping up the output dc voltage because now the inductor is acting as a power source.

3.2. Power Smoothing

The main purpose of combining the PV with the BSS that is our battery energy storage system is even out the sudden changes of the output. The various variances tend to disrupt the regulation of the frequency and the voltage. We are attempting to execute the BES along with the PV panel in order to even out the sudden changes faced by the power output. In order to measure the amount of energy we will be utilising the SMA (simple moving average strategy), where we need the system to infuse so that we can restrict the pace of the power that will be given to the grid. The generators produces the power and the output is obtained by the SMA. The contrast between these two is utilised as the power reference. Then this difference is equally partitioned in order to restrain the power conveyed. The SMA is

$$ p_{me}(t) = \frac{1}{m} \sum_{i=1}^{m} P_v(t) $$

Where, $m = \text{number of the various samples}$  
$P_v = \text{vector that contains the m number of samples}$

3.3. Pulse Width Modulation

It is known as the technique where the administered AC voltage is acquired when a constant DC voltage is provided. This is one of the most mainstream strategies for administering the output and is also recognized as the PWM control. There are 3 types namely Single, Multiple and sinusoidal. In this work we will be adjusting the PWM that is sinusoidal due to the decrease of the shifting gadgets and the losses. The PWM signal is created with the help of the oscillator which is then given to the door of the MOSFET that is utilised. The main aim of doing so is to convert the delay obtained by the current to the voltage. Subsequently the power factor of the system is better. Figure 3 shows us the transporter signal (carrier).
Photovoltaic Based Modular Multilevel Converter for Battery Energy Storage System

4. SIMULATION RESULT AND DISCUSSION

![Simulation diagram](image)

**Figure 5** Simulation diagram

The following figure shows us the DC - DC that is step up which is utilised in our framework is simulated in MATLAB. The result of the simulation shows the success of our system that we have proposed in this paper. It shows the effectiveness of the procedure to even out the output power.
5. CONCLUSION
A new procedure to even out the output voltage using the PV - BES framework is presented in this paper. In our paper every PV module is connected from it’s DC to various PV generators utilising DAB (DC - DC converter). A BES framework that is installed into every converter which is attached to the DC of the battery energy storage sub module using more than one dual active bridge converter. It will help in smoothing the power output. It will also limit the power given to the grid. It also eliminates the mismatch of the power in between the converter and the inner flow of the modular multilevel converter. This viability of the proposed framework is checked utilising the MATLAB software. There is also an extension for additional improvement in the framework by eliminating the mismatch of the power.

REFERENCES

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