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ANALYSIS AND DESIGN OF ELECTRIAL POWER SUPPLY TO AN ELECTRICAL GRID BY USING PV/BATTERY SYSTEM

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Abstract: This paper presents another multifunctional converter called reconfigurable solar converter (RSC) for photovoltaic (PV)-battery application, especially utility-scale PV-battery application. The primary idea of the new converter is to utilize a solitary stage three stage grid-attach solar PV converter to perform dc/ac and dc/dc operations. This converter solution is appealing for PV-battery application, on the grounds that it minimizes the amount of conversion stages, accordingly enhancing productivity and lessening cost, weight, and volume. In this paper, a combination of dissection and test tests is utilized to exhibit the attractive execution characteristics of the proposed RSC.

Index Terms—Converter, energy storage, photovoltaic (PV), solar.

I. INTRODUCTION

The development and generalization of decentralized generation leads to increased needs of energy storage. As photovoltaic or wind are intermittent power sources. A correct balancing of production and consumption can only be achieved through the use of storage facilities. Photovoltaic (PV) power supplied to the utility grid is gaining more and more attention nowadays. Numerous inverter circuits and control schemes can be used for PV power conditioning system.

PV systems are only a small part of today's electric infrastructure and have little effect on the overall quality or reliability of grid power. Nevertheless, state and federal efforts are currently underway to greatly increase the penetration of PV systems on Local and regional utility grids to achieve goals related to emissions reduction, energy independence, and improved infrastructure reliability. When PV penetration reaches high enough levels (e.g., 5 to 20% of total generation) however, the intermittent nature of PV generation can

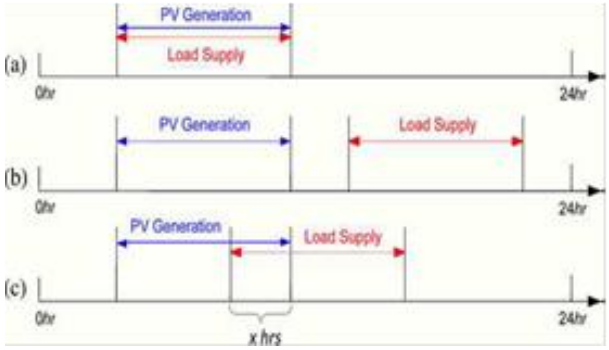


Fig. 1. Different scenarios for PV generation and load supply

Start to have noticeable negative effects on the entire grid. The distributed nature of PV can help to mitigate the negative consequences of high PV penetration to some degree; over large regions the effects of intermittent generation on the grid will be less noticeable. Nevertheless, utilities will still need to address worst-case possibilities. When transients are high, area regulation will be necessary to ensure that adequate voltage and power quality are maintained. When PV generation is low, some type of back-up generation will be needed to ensure customer demand is met. Additionally, because most utilities require an amount of 'spinning reserve' power that typically is equal to the power output of the largest generating unit in operation, the amount of spinning reserve necessary will increase with the amount of distributed PV generation that is brought online.

This paper introduces a novel multifunctional single stage converter basically called as Reconfigurable solar converter (RSC). The basic theory behind reconfigurable solar converter (RSC) is to use a single power conversion unit to perform different operations modes such as PV to grid, PV to battery, battery to grid, and battery/PV to grid. Fig 1 depicts the different scenarios for PV generated power time of use. In case (a), the power from the PV is always delivered to the grid and hence there is no requirement of storage unit. But in case (b) and (c) battery is used for energy storage from PV and then battery or both the PV and battery supply to the load.

Section 1 introduce a RSC circuit, different modes of operations and benefits in section 2 introduce a operation of the RSC, section 3 verifies the experimental results and performance characteristics. Section 4 conclusions.

II. RSC

A. Introduction

The proposed Reconfigurable solar converter (RSC) shown in figure 3. The RSC has the some changes to the conventional inverter. These modifications enables the RSC to -Involve the charging task in the usual three phase voltage source converter and its related parts, the RSC requires extra cables and mechanical switches as shown in figure 3.

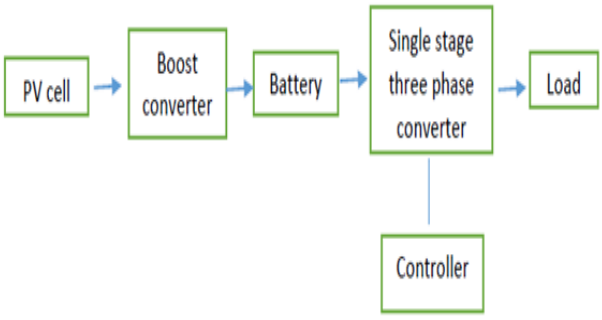


Fig. 2. Block schematics

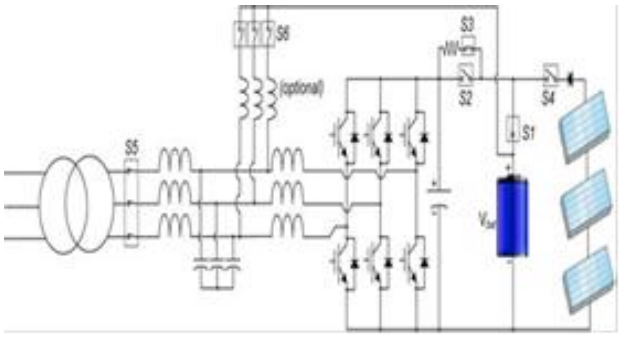


Fig. 3. RSC block diagram

III. OPERATION MODES OF RSC

All conceivable operation stages for the converter are introduced. In Stage 1, the PV is specifically joined with the grid through a dc to ac operation of the converter with probability of maximum power point tracking (MPPT) control here the S1 and S6 switches are open. In Stage 2, the battery is charged from the PV panels through the dc to dc operation of the converter by shutting the S6 switch and opening the S5 switch. In this stage, the MPPT capacity is performed; accordingly, most extreme power is created from photovoltaic. The alternate stage that both the photovoltaic and battery give the ability to the load or grid by shutting the switch S1. This operation is indicated as Stage 3. In this stage, the dc-link voltage that is the same as the photovoltaic voltage is implemented by the battery voltage; accordingly, control of MPPT is Impractical. Stage 4 speaks to an operation stage that the energy supplied to the grid is by battery.

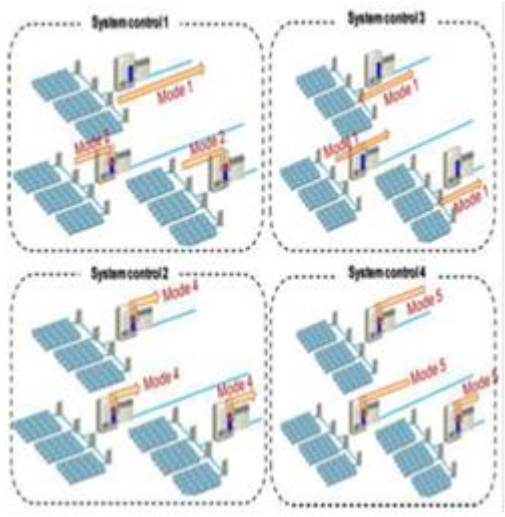


Fig.4. Different operation modes

IV. SYSTEM PROFITS OF PV POWER PLANT WITH THE RSC METHOD 1

The RSC method 1 offers major gains to system planning of utility –scale solar PV power plants. The current state of the art technology is to combine the energy storage into the ac side of solar PV systems. An example of viable energy storage solutions is the ABB issued energy storage (DES) solution is that is a complete package up to 4MW, which is linked to the grids directly with its communication means, can be used as a mean for peak shifting in solar PV power plants.

The RSC method 1 permits not only the system owners to have an flexible ability that assist them to arrange and run the power plant correspondingly although manufacturers to preset a cost –aggressive dispersed PV energy storage solution with the RSC and the current state of art tools the technical and financial gains that the RSC solutions is able to offer are more apparent in larger solar PV power plant using the RSCs can be monitor more economically since of the flexible operation Developing a full operation characteristics of a Solar PV power plant with the RSC is further than the scope of this project. But, different system monitor s as shown in figure 6 can be suggested based on the requested power from the grid operator p required and available generated power from the plant p generation these two values being results of an optimization problem (such as a unit commitment method Serve as variables to monitor the solar PV power plant accordingly. In other words, in response to the request of the load requirement, different system monitor plans can be utilized with the RSC –based solar PV power plant as follows:

- System monitor 1 for p gen > p req;
- System monitor 2 for p gen < p req;
- System monitor 3 for p gen = p req;

V. RSC OPERATIONS

A. RSC in the dc/ac Operation Methods

The RSC dc to ac operation is used for conveying power from battery to grid, solar PV to grid, grid to battery and PV and battery to grid. The RSC implements the MPPT calculation to convey maximum electric power to grid from the PV. Like the accepted photovoltaic inverter control, the control of RSC is actualized by the synchronous reference frame. The proportional integral current control is utilized in the synchronous reference frame. As it is known in reference frame rotating synchronously with the crucial excitation, the principal excitation indicators are changed to dc signal. Therefore, the current controller structuring the inner loop of the control system can manage ac current over a wide frequency range with high bandwidth and zero steady-state failure. For the pulse width modulation (PWM) plan, the customary space vector PWM plan is used. Fig. displays the general control outline of the RSC in the dc to ac operation.

B. RSC in the dc/dc Operation Method

The RSC DC TO DC is additionally utilized for delivering the greatest power to battery from PV. The RSC in the dc to dc operation acts as a support converter that manages the current streaming into the battery. In this analysis, Li-ion battery is utilized for the PV-battery system. Li-ion batteries oblige a consistent current, steady voltage kind of algorithm for charging.

At the end of the day, a Li-ion battery ought to be charged at a set current level until it reaches its last voltage. At the last voltage, the charging procedure ought to switch over to the steady voltage stage, and necessary current should be provided to maintain the battery at this last voltage. In this way, the dc to dc converter which performing charging methodology must be fit for giving stable control to keeping up either current or voltage at a consistent value, contingent upon the state of the battery. Regularly, a couple of percent capacity losses can be seen happen due to the non-performance of steady voltage charging. The utilization of constant current charging for the simplification of the charge control and methodology is

however not uncommon. The following has been utilized to charge the battery. Consequently, it is more than enough to control the inductor current from the prospective of control.

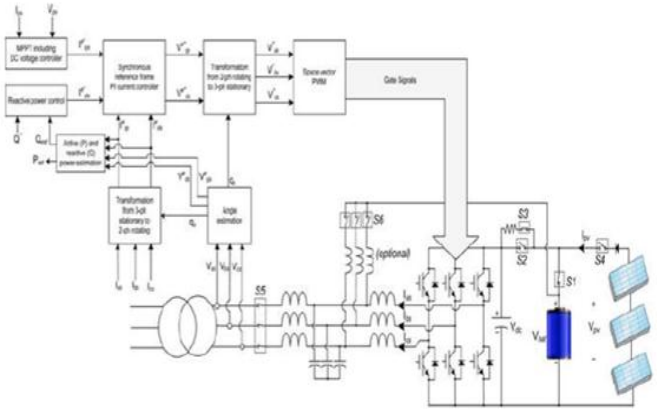


Fig. 5. RSC in dc/ac operation

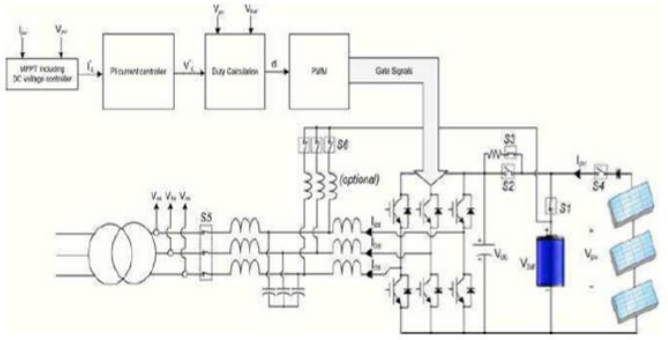


Fig. 6. RSC in dc/dc operation

C. Changes and deliberate issues to the Usual Three Phase PV Converter

The most important condition of the project is that a new converter for PV battery system must consist less difficulties and changes to the conventional three phase solar PV converter system. Thus, it is important to know the working of three phase dc/ac converter as a dc/dc converter and changes to be considered. It is common to use a LCL filter for a high power three phase PV converter and the RSC in the dc /dc operation also utilizes the inductors already existing in the LCL filter. As we know there are mainly two types of inductors, coupled three phase inductor and three single phase inductors that can be used in the RSC circuit. The Usage of all three phase of the coupled three phase inductors in the dc/dc operation affects a major drop in the inductance value due to inductor core saturation. The reduction in inductance value needs inserting additional inductors for the dc/dc operation, only one phase can do the dc/dc operation. But when only one phase, for example phase B, is used for the dc/dc operation with only either upper or lower insulated –gate bipolar transistor (IGBT) are turned OFF as balancing switching, the flowing current occurs in phase A and C through filter capacitor, the coupled inductor, and switches ensuing in radically high current ripple in phase B current.

To limit the flowing current in the dc/dc operation, the following two solutions are suggested; 1) all unused Upper and lower switches must be turned OFF; 2) the replacement of the coupled inductor by three phase inductors. Whereas the primary solution with a coupled inductor is straight forward, using three single –phase inductors makes it possible to use all three phase legs for the dc/dc operation:

- Synchronous operations;
- Interleaving operation;

VI. IMPLEMENTATION IN MATLAB/SIMULINK

A. RESULTS

The multifunctional reconfigurable solar converter for the PV/battery is executed and tried for the obliged results utilizing MATLAB/SIMULINK. MATLAB is an elite dialect for specialized figuring. It coordinates computation, visualization, and programming in a simple to-utilize environment where issues and solutions are communicated in familiar numerical notation. Ordinary utilization incorporate Math and computation Algorithm improvement Data acquisition Modeling, simulation, and prototyping Data investigation, exploration, and visualization Scientific and designing design Application advancement, including graphical client interface building. The trial results are indicated in fig. 7 to fig. 14.

DC TO AC

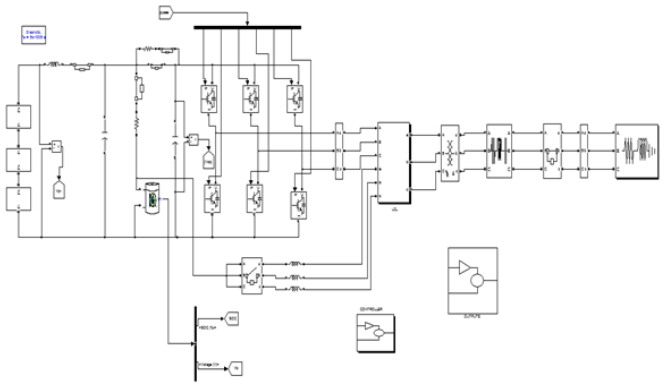


Fig. 7. DC to AC conversion model

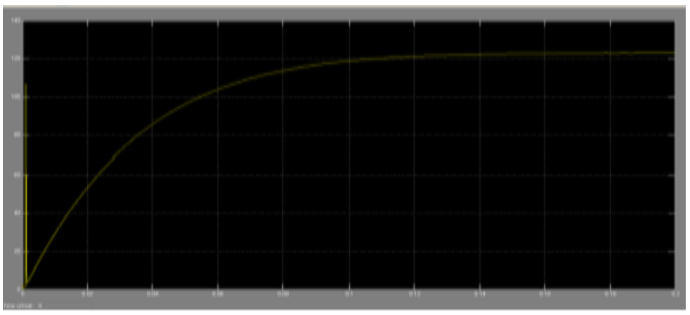


Fig. 8. PV voltage

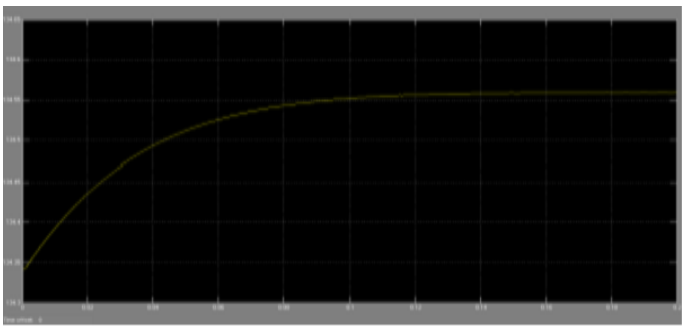
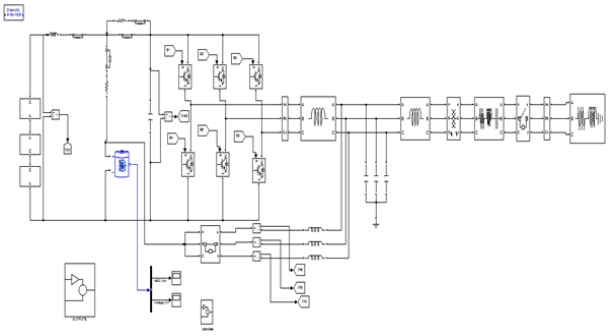


Fig. 9. Battery voltage



DC TO DC

Fig. 10. DC to DC conversion model

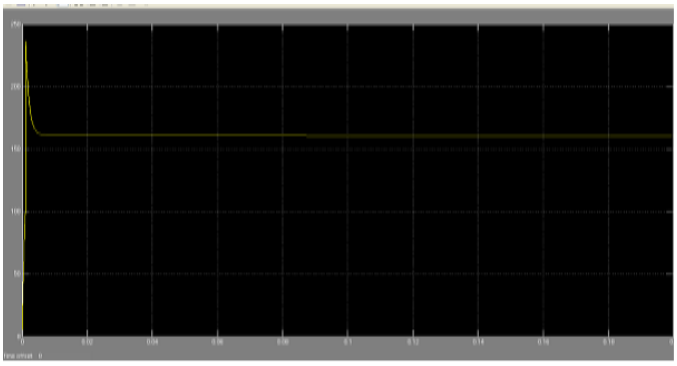


Fig. 11. PV voltage

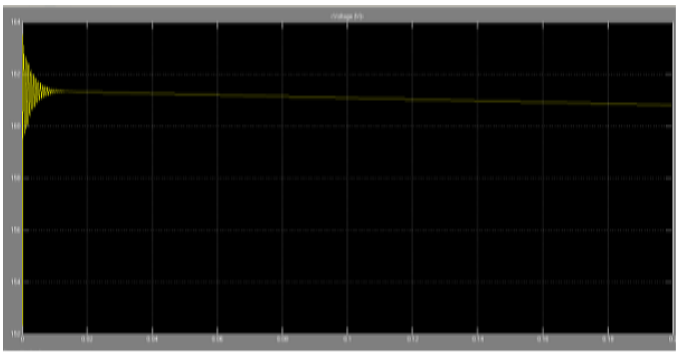


Fig. 12. Battery voltage

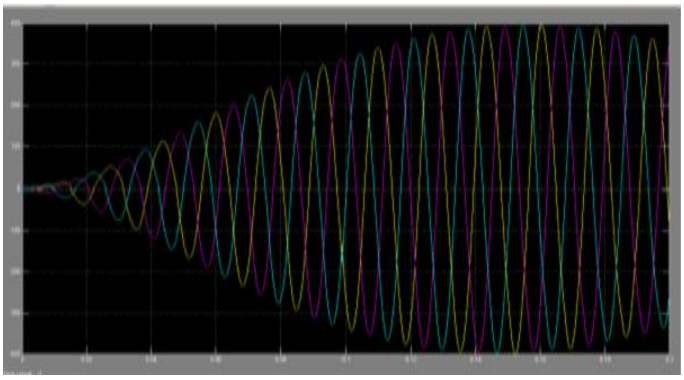


Fig. 13. Grid voltage

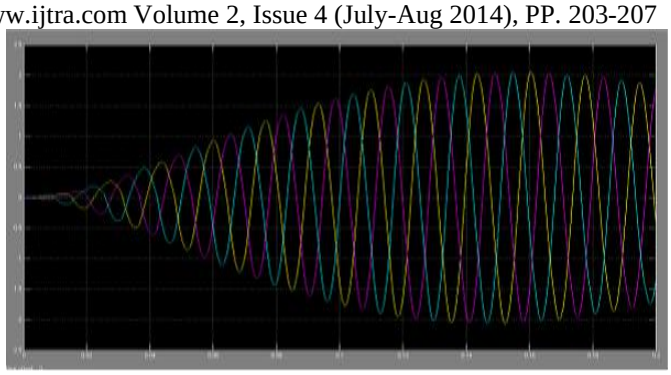


Fig. 14. Grid current

VII. CONCLUSION

This paper is the preface of the new multifunctional converter which uses passive MPPT technique to harness maximum energy. It is essentially based on the energy storage capabilities of batteries that are proposed to be put in parallel to a proper number of PV subs –fields, so as to be used in a distributed manner. Although this paper focuses on three-phase application, the main concept can be applied to single-phase application. The proposed solution is also capable of providing potential benefits to other intermittent energy sources including wind energy.

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