FPGA BASED EFFICIENT CONTROL STRATERGY FOR MULTI-MODE POWER FLOW MANAGEMENT IN SOLAR PV SYSTEM

S.S.Tharanidevi, T.R.Sumithra

Abstract— the growing concern of energy usage is augmented by victimization semiconductor diode street lights, fluorescent lamps, inverter-fed drives, etc. Hence, the load from the electrical grid is undergoing is notable changes as device from the DC load. Electrical phenomenon (PV) Being a significant energy supply, the same masses are often connected on to the DC bus. A grid connected (PV), stand alone PV sources; and thence; an influence flow management system is needed to balance the facility flow among the sources. It's developed by the two-way convertor by sensing the battery standing. Within which the standards of battery are maintained by multi mode to get the stand alone system. In this, the low-voltage-rated MOSFETs are often adopted for reductions of conductivity losses and price. Potency is often improved by reducing change loss and run loss. The management strategy digitally enforced on Field Programmable Gate Array board, and is verified for various modes of operation by varying the load and by battery level. Experimental results square measure conferred to bring out the quality of the management strategy.

Index Terms— Battery, Bi-directional Power convertor, Charge Controller, DC-DC convertor, FPGA controller, Photo Volatile.

1 INTRODUCTION

Photovoltaic cell is that the device that converts daylight into electricity directly of that magnitude of current and voltage depends on several factors like temperature, star irradiation, and wavelength of incident gauge boson etc. A photovoltaic cell module is that the basic component of every electrical phenomenon [5] system. By increasing issues of pollution and warming, cleaner inexperienced renewable sources of energy square measure expected to play a lot of vital role within the way forward for world energy. Most of them square measure environmentally benign and free from the atmospherically pollution, acid precipitation, and world [4] climate warming. What is more, attributes to public support and government incentives over recent decades, they're growing apace, not solely on technical execution, however additionally within the breadth of applications. The general public attention has remained targeted on these renewable technologies [3] as environmentally property and on the market choices. It's discovered that the management strategy for the facility flow management in battery storage and grid connected PV system. Attributable to the nonlinear relationship between this and also the voltage of the cell, it will observe that there's an associate degree FPGA controller at a specific atmosphere and this peak wall socket keeps dynamic with star illumination and close temperature. Battery charging and discharging is completed mistreatment BDC (Bidirectional converter). BDC [7] operates in 3 modes, namely; Buck, Boost and bidirectional. The formula was verified with MATLAB-SIMULINK that it will trail the $64000 FPGA in no time once the temperature changes. The closed-loop system performance of the projected theme is verified with MATLAB simulations as well as Load and supply disturbances. The first motive behind the execution of the task is to urge the facility efficiencies mistreatment PV module. The implementation of the management and observation strategy improves the potency of power flow. Multi mode power flow management is completed mistreatment FPGA controller. Therefore the generated power is kept within the battery for the any usage. This power is often given to the native load and grid. If the facility is low in PV, it will use the facility from grid to spice up the facility and keep within the battery. Solar power is one in all the renewable sources of energy that is harmless scrutiny for energy. It doesn't hurt the atmosphere and cannot emit any reasonably radiations to the character. The simplest thanks to utilize the solar power economical are by an electrical phenomenon panel. Economical powers are often generated mistreatment the solar power which can facilitate to bring down the facility crisis facing by our country today. Lower power consumption additionally suggests that lower cooling, that will increase system stability, and less energy use, that saves cash and reduces the impact on the atmosphere [6]. The lack of the standard sources to possess the power flow management, motivated the proposal of power management with the alternative energy is shown within the figure1.

2 MATERIALS AND METHODS

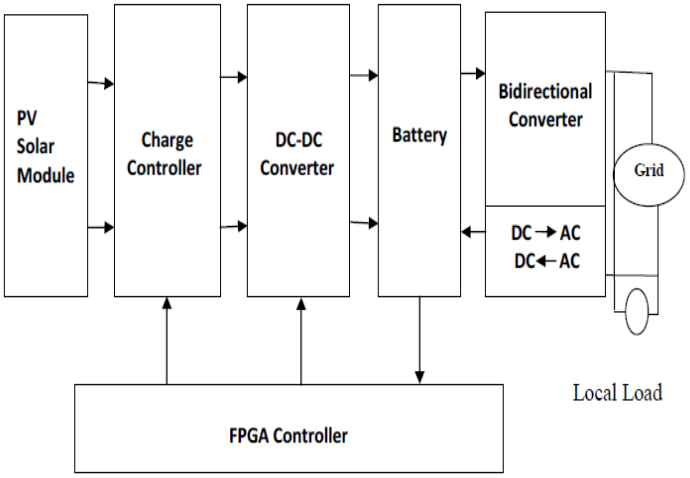

Fig.1. Block diagram of system

This method will be based on both stand alone system and grid to the Grid connected system. The main purpose of this method is to validate the performance evaluation through a methodology based on efficient Power Flow Management and constant maximum power of the PV module. In this PV system consists of three power source grid, PV array, and battery, three powers sinks grid, battery, and load, and a power flow management system (PMS) to balance the power flow between these. These systems propose an efficient power flow management for providing uninterrupted power supply to the battery and grid. A high efficiency DC-DC converter low voltage to high. For selecting the operating mode of the bidirectional converter by sensing the battery voltage. A modified proportional and FPGA controller is suggested for fast output voltage and power flow management. This system proposes the efficient power and constant voltage output.

3 PV MODULES

In these systems, to boost the employment of solar power, the output power pair between PV modules as a result of the non-identical star radiance must be seen. To, avoid the pair issues, PV-DC [1] module system victimization DC-DC device. Typical PV-battery power generation system with PV power management team is delineated in figure 2. This method is tough to expand battery capability as a result of the fastened size of the large battery bank. PV -battery system cannot perform the most power with battery charging. To avoid this DC-DC boost device is employed to unravel this drawback. The PV voltage is adjusted by applicable shift of the DC/DC device to maximize the typical power output of the array.

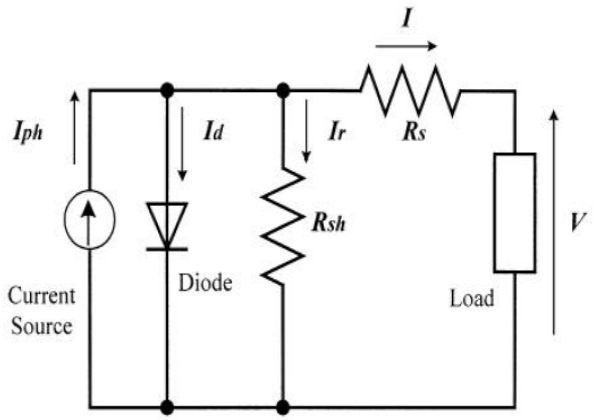

Fig.2. Equivalent circuits for PV module

The PV panel is modelled by the single-diode model with series resistance Rs and therefore the parallel resistance RP. For a given level of star irradiance and temperature, examination of the PV array characteristic reveals that the FPGA is about [8] achieved with an associate degree output voltage that is proportional to the open-circuit voltage of the PV array.

4 DC–DC CONVERTER

DC-DC converters are a unit one among the necessary electronic circuits, which area unit wide employed in power physical science. The most drawbacks with the operation of DC-DC device is an unregulated power offer, which contributes to improper perform of DC –DC converters. There is unitary [2] numerous analogue and digital management ways used for DC-DC converters and a few are appropriated by trade together with voltage- and current-mode techniques.

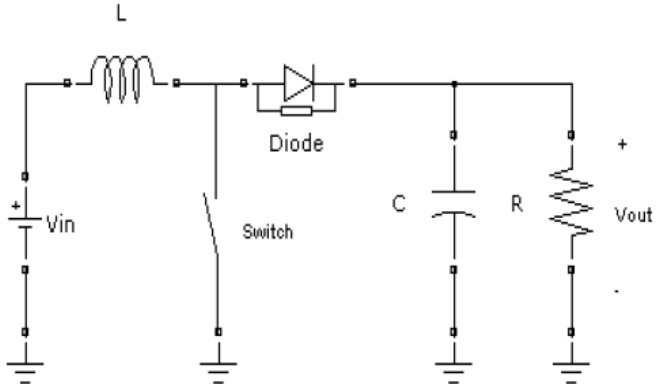

Fig .3.Equivalent circuits for DC-DC boost converter

The DC-DC device input area unit typically unregulated DC voltage input and also the needed outputs ought to be a continuing or mounted voltage. Figure 3 depicts the final circuit of DC/DC Boost device. Its three main components: electrical device, Capacitor, Diode and Switch (MOSFET). This MOSFET switch is digitally controlled by the PWM generator circuit blocks. ZVS DC/DC full-bridge device could be a kind, soft switch circuit topology that seems earlier in high power applications. Through part shifting management, the ability has complete soft switches stimulant and off, reduces the switch losses, improves potency [10]. Converters with switched capacitors develop important current peaks that limit the potency and also the most processed power

5 BATTERY

In nearly all applications involving battery storage, a charge controller is important and at identical time should be able to discontinue power flow once the battery is completely charged or has reached a prescribed state. The controllers have to be compelled to even be adjustable to form positive optimum battery system performance below varied charging, discharging, and temperature conditions. If the charging [9] mechanism is that the grid, then full current square measure getting to be used for charging. The primary stage is that the bulk charging part. Once the charging voltage reaches a planned level, the majority voltage, the charging mode is switched to constant voltage mode or absorption charge stage. Once the absorption mode is sustained to a pre programmed time, the charging voltage is diminished to the float voltage. This float voltage is maintained by the charge controller and should be set to tier that may not hurt the battery. Throughout the discharge cycle, the charge controller, ideally, have to be compelled to stop the discharging of the batteries at precisely at the prescribed point. The lithium-ion battery provides relating to 2 to a number of times the power of the nickel metal binary compound battery during a very smaller package many advantages to the lithium-ion battery square measure its high potency, superior specific energy and power, long life, lower initial material value and fewer replacements, high cell voltage that finally ends up in fewer cells, higher energy-to weight magnitude relation, suffers little or no or no memory result which could occur once batteries lose their most

energy capability.

6 BI-DIRECTIONAL POWER CONVERTERS

For many power physical science applications, particularly PV systems, the basic demand for efficient management is that the circuit ought to be capable of handling duplex power flow. Energy transfer ought to be attainable from the grid to battery during charging mode and battery to grid in discharging mode. A [11] duplex charger can have to be compelled to perform smoothly in both directions. Whereas in discharge mode, the charger ought to come back current in an exceedingly similar curved form that complies with rules is shown in figure 4. The DC waveform is then responded to suffered the electrical converted back into a unipolar modulated signal and out through the filter producing an AC waveform acceptable to the grid. A converter is necessary for any PV system involving a conversion between DC and AC power. Looking at the load needs and application it's used for, the converter selection, as with any other systems, should be chosen fastidiously. For this project, a Pulse-Width-Modulated electrical converter (PWM) is discussed. PWM inverters are appropriate for PV applications since it's desired to deliver a curved waveform with an inevitable amplitude and frequency. A PWM waveform will produce different waveforms by dominant the duty of sequential pulses. The amplitude is controlled by dominant the overall duty cycle, whereas the frequency will be adjusted by dominant the repetition time for the pulse sequence.

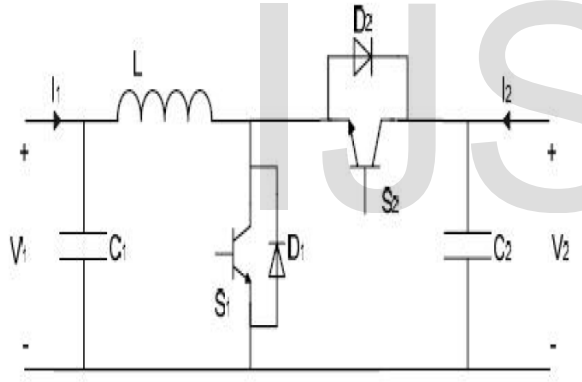

Fig.4.Bidirectional converter circuit

7 CHARGE CONTROLLERS

A charge controller, charge regulator or battery regulator limits the speed at that current is additional to or drawn from electrical batteries. Charge controllers are sold to customers as separate devices, typically in conjunction with star, for uses like self-propelled vehicle, boat, and off-the-grid home battery storage systems. In star applications, charge controllers might also be known as star regulators. Straightforward charge controllers stop charging battery once they [12] exceed a collection high voltage level, and re-enable charging once battery voltage drops back below that level. Pulse breadth modulation (PWM) and most power hunter technologies are additional electronically refined, adjusting charging rates counting on the battery's level, to permit charging nearer to its utmost capability. Charge controllers might also monitor battery temperature to forestall heating. Some charge controller systems additionally show information; transmit data to remote displays, and information work to trace the electrical flow over time. Star charge controllers that merely switch [13] FETs otherwise than the on-off algorithmic rule claim to be a PWM charger. Solely some controllers are literally employing a Pulse breadth Modulated (PWM) constant voltage charging algorithmic rule. The remainders are switch FETs with varied algorithms that are cheaper and less effective. Charge acceptance may be a term overtimes accustomed describes the potency of recharging the battery. Since star batteries perpetually recharge with a restricted energy supply (e.g. Chance is charged with on the market sunlight), a high charge acceptance is crucial for needed battery reserve capability and system performance. The batteries remained at low charge states and therefore the charge controller senses amendment mode into the charging stand. The controller can mechanically accommodate a nominal battery voltage.

8 FPGA CONTROLLER

The FPGA device kind is chosen according to the PV machine management unit implementation space and value requirements. The advances in FPGA technology enable the synchronise development, design and implementation of compact high performance [14] intelligent controllers for power systems. The resulting post-layout most PWM signal frequency achieved victimization the proposed architecture for varied FPGA devices. The corresponding most current and voltage sampling frequency achieved. The FPGA has the flexibility to run faster than a microchip. Owing to the flexibility of the FPGA, further practicality and computer programmed controls may be integrated into the FPGA minimizing the necessity for additional external parts. In which, FPGA management the ability flow [15] management and maintaining the battery status in charging and discharging mode.

9 SIMULATION DIAGRAM

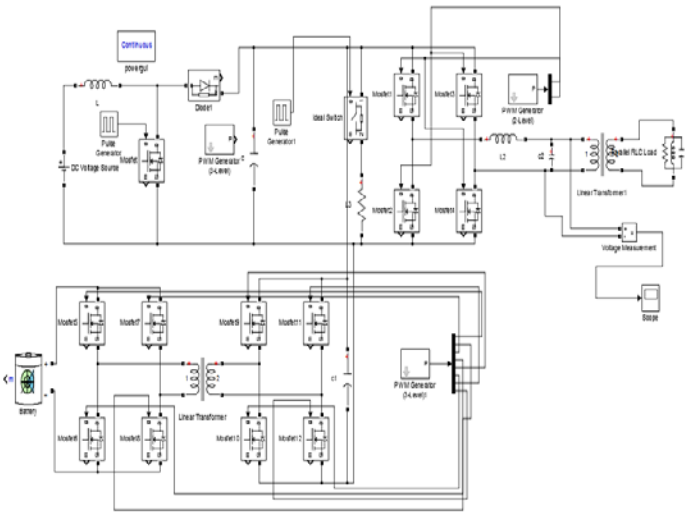

Fig.5.Simulation Diagram of Proposed System

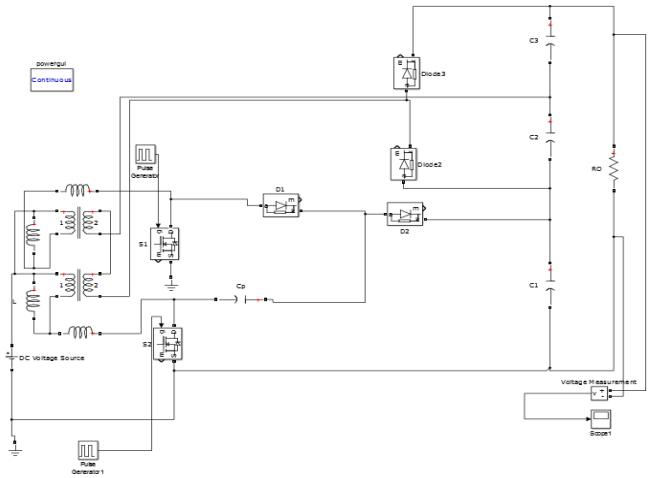

Fig.6.Simulation for PV Boost Converter

10 RESULTS AND ANALYSIS

The MOSFET and internal diode in parallel with a series RC snubber circuit. Once a gate signal is applied to the MOSFET conducts and acts as a resistance (Ron) in each direction. If the gate signal falls to zero once current is negative, current is transferred to the parallel diode. Generate pulses for PWM-controlled convertor. A carrier-based three-level PWM technique is employed. The modulating signal (Uref input) is of course sampled and compared with 2 symmetrical in-phase level-shifted triangle carriers. The blocks will manage change devices of 3 completely different bridge types: single-phase half-bridge, single-phase full-bridge or three-phase Bridge. Once the synchronous mode of operation is chosen, the synchronization signal is applied at the input (wt). Pulse sort determines the machine technique used. Time-based is usually recommended to be used with a variable step convergent thinker, whereas Sample-based is usually recommended to be used with a set step convergent thinker or inside a separate portion of a model employing a variable step solver. Ideal switch is employed to change controlled by a gate signal in parallel with a series RC snubber circuit. In on-state the Switch model has an interior resistance (Ron). In off-state this internal resistance is infinite. The interior resistance should be larger than zero. The switch model is in-state once the gate signal (g) is about to one. Implements a generic battery that model most well liked battery varieties. Uncheck the "Use parameters supported Battery sort and nominal values" parameter to edit the discharge characteristics. The output undulation at the several scopes.

11 SIMULATION OUTPUT

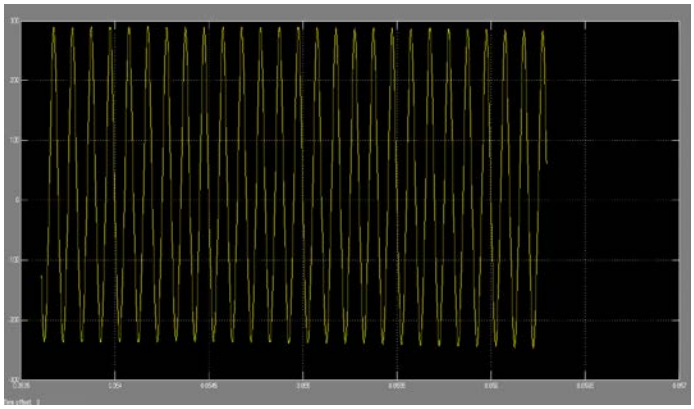

Fig.7.Output Waveform for Proposed System

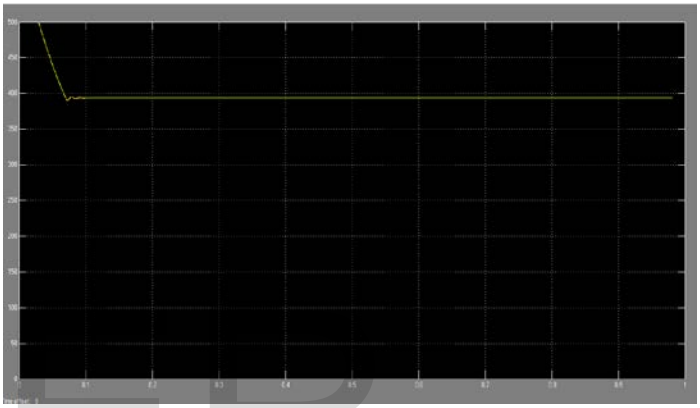

Fig.8.Output Waveform for Boost Converter Circuit

10 CONCLUSIONS

Thus the projected system for the ability flow management with the employment of FPGA based mostly dominant of the grid-connected PV system fed with DC masses has been simulated victimization the MATLAB tool. The results of the simulation have tried the importance of the theme in providing multi mode steady-state performance of the convertor. The biface convertor plays a significant role in providing biface flow of power so as to compensate the low power level within the battery by getting the desired level of DC power from the grid. The management strategy has been digitally enforced on an FPGA board and located to be engaging from the angle of providing uninterruptible power to DC masses, whereas guaranteeing the evacuation of excess PV power of prime quality into the grid. For the long run work, the simulated circuits are going to be enforced over hardware and aim is to attain smart correlation between the results of simulation and experiments. Conjointly to accomplish smart performance by maintaining the ThD of the injected grid current at intervals allowable limits by the choice of a minimum current reference for injection.

REFERENCES

1. Baek, J.W., Ryoo, M.H., Kim, T.J., Yoo, D.W. and Kim, J.S. "High boost converter using voltage multiplier", IEEE *Transactions on Power Electronics*, vol. 20,pp.320-570,2005.

2. Bialasiewicz, J.T. "Renewable Energy Systems with Photovoltaic Power Generators: Operation and Modelling", IEEE *Transactions on Industrial Electronics*, Vol. 55, No. 7, pp. 1290-1420, 2008.

3. Bratcu, A.I., Munteanu, I., Bacha, S., Picault, D. and Raison, B. "Cascaded DC–DC Converter Photovoltaic Systems: Power Optimization Issues", IEEE *Transactions on Industrial Electronics*, Vol. 58, No. 2, pp. 1434-1520, 2011.

4. Carrasco, J.M. and Franquelo, L.G. "Power-electronic systems for the grid integration of renewable energy sources:a survey",IEEE *Transactions On Industrial Electronics*, Vol. 53, No. 4, pp. 2334-4620,2006.

5. Changchien,S.K., Liang,T.J., Chen,J.F. and Yang,L.S. "Novel High Step-Up DC–DC Converter for Fuel Cell Energy Conversion System", IEEE *Transactions On Industrial Electronics*, Vol. 57, No. 6, pp. 1378-1695,2010.

6. Chen,S.M., Liang,T.J., Yang,L.S. and Chen,J.F. "A safety enhanced, high step-up dc–dc converter for ac photovoltaic module application",IEEE *Transactions on Power Electronics*, Vol. 27, No. 4, pp. 434-520,2012.

7. Femia, N., Petrone, G., Spagnuolo, G. And Vitelli, M. "Optimization of perturb and observe maximum power point tracking method", IEEE *Transactions on Power Electronics*, Vol. 20, No. 4, pp. 334-520,2005.

8. Ganesh, D., Moorthi, S. and Sudheer, H. "A Voltage Controller in Photo-Voltaic System with Battery Storage for Stand-Alone Applications" *International Journal of Power Electronics and Drive System* (IJPEDS) Vol.2, No.1, pp. 9-18, 2012.

9. Gao, L., Dougal, R.A., Liu,S. and Iotova,A.P. "Parallel-Connected Solar PV System to Address Partial and Rapidly Fluctuating Shadow Conditions",IEEE *Transactions On Industrial Electronics*, Vol. 56, No. 5, pp. 434-820,2009.

10. Ghoddami, H. And Yazdani,A. "A single-stage three-phase photovoltaic system with enhanced maximum power point tracking capability and increased power rating", IEEE *Transactions On Power Delivery*, Vol. 26, No. 2, pp. 234-520,2011.

11. Hsieh, Y.P., Chen, J.F., Liang, T.J. and Yang, L.S. "Novel High Step-Up DC–DC Converter with Coupled-Inductor and Switched- Capacitor Techniques for a Sustainable Energy System", IEEE *Transactions on Power Electronics*, Vol. 26, No. 12, pp. 1034-1620, 2011.

12. Jang, Y. And Jovanovic, M.M. "Interleaved boost converter with intrinsic voltage-doubler characteristic for universal-line pfc front end", IEEE *Transactions On Power Electronics*,Vol. 22, No. 4, pp. 654-1834,2007.

13. Jiang,Z. and Dougal,R.A. "A compact digitally controlled fuel cell/battery hybrid power source", IEEE *Transactions On Industrial Electronics*, Vol. 53, No. 4, pp. 1034-1320,2006.

14. Kuo-Ching Tseng, Chi-Chih Huang and Wei-Yuan Shih "A high step-up converter with a voltage multiplier module for a photovoltaic system", IEEE *Transactions on Power Electronics*, Vol. 28, No. 6, pp. 334-620,2013.

15. Lai, C.M., Pan, C.M. and Cheng, M.C. "High-Efficiency Modular High Step-Up Interleaved Boost Converter for DC-Microgrid Applications", IEEE *Transactions on Industry Applications*, Vol. 48, No. 1, pp. 124-184, 2012.