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High Gain DC-DC Converter for Three Phase Grid Interactive PV Battery System

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ABSTRACT: This paper presents an implementation of an high gain DC DC Converter for 3 phase improved power quality grid interactive solar PV – battery supported system catering the balanced and unbalanced three phase four wire (3P – 4W) nonlinear loads and single phase loads of various nature simultaneously. Moreover the source currents remain balanced and sinusoidal for all operating and loading conditions such as in highly unbalance loading conditions where a load on one of the phase is disconnected. An AL – BP control technique is used to control the voltage at point of common coupling and to improve power quality under various loading conditions through mitigation of harmonic currents, reactive power compensation, active power balancing and neutral current compensation in the 3P – 4W system. It also improves the system power factor in highly nonlinear and unbalanced loading conditions. The AL –BP control scheme has the capability to self tune the arbitrary nonlinear systems such as grid – interactive critically unbalanced 3 phase 4 wire system feeding highly nonlinear loading systems. Therefore, the proposed control technique is found capable of dealing with above said large unknown – nonlinearity of 3 phase 4 – wire system. This scheme significantly improves the steady state and dynamic performances of the 3 phase 4 wire (3P – 4W) grid interactive solar PV battery supported system. The proposed AL – BP control technique has been implemented using DSP processor in real time in order to validate the claims. Index Terms – Solar PV, VSC, power quality, non – linear loads, integrated system.

KEYWORDS: Solar panel, Landsman Converter, Inverter, Battery, Filter

I. INTRODUCTION

Over the past few decades, the demand for renewable energy has increased significantly due to the disadvantages of fossil fuels and greenhouse effect. Among various types of renewable energy sources (RES), solar energy and wind energy have become the most promising and attractive because of advancement in power electronic technique. Photovoltaic (PV) sources are used nowadays in many applications as they own the advantage of being maintenance and pollution free. In the past few years, solar energy sources demand has grown consistently due to the following factors: increasing efficiency of solar cells; manufacturing technology improvement; a economies of scale. Meanwhile, more and more PV modules have been and will be connected to utility grid in many countries. Now the largest PV power plant is more than 100MW all over the world. Furthermore, the output of PV arrays is influenced by solar irradiation and weather conditions. More importantly, high initial cost and limited life span of PV panels make it more critical to extract as much power from them as possible. Therefore, maximum power point tracking (MPPT) technique should be implemented in DC/DC converter to achieve maximum efficiency of PV arrays. Several algorithms have been developed to achieve MPPT technique.

As the capacity of PV system growing significantly, the impact of PV modules on power grid can't be ignored. They can cause problems on the grid like flicker, increase of harmonics, and aggravated stability of the power system. To both increase the capacity of PV arrays and maintain power quality, it's necessary to comply with the technique requirements of the PV system, such as fault-ride-through capability and harmonic current regulation. Especially when a large scale PV module is connected to the grid, the effects on the grid may be quite severe. Therefore, the system operation and system stability under fault conditions should be examined when PV modules are interface with power grid.

II. EXISTING STSTEM

In general, due to increasing energy requirements, public awareness of climatic protection, the depletion nature of conventional resources, and the world political and social issues of nuclear power safety and because of lot of merits, solar PV (Photovoltaic) generation systems are getting increased attention. Moreover, from last few decades, solar photovoltaic energy generation system (SPEGS) is one of the focused area of research community as it is pollution free, renewable, inexhaustible and has a lot of other advantages, which are discussed in. The cost factor is one of the main aspect of any technology for its success or failure. Now a days, because of technology development, solar PV power is one of the feasible and alternative option among all non-traditional sources for power generation. The grid participation of solar PV power generation systems (SPEGSs), is reported in. SPEGSs may be majorly divided in two categories, in which one is off-grid and another one is interfaced to the distribution feeder. However, due to the certain pitfalls of standalone SPEGSs, grid interfaced solar PV systems are more preferred. The non-linear relation between solar PV array voltage and its current, which depend on climatic condition, there is a need of MPPT (Maximum Power Point Tracking) scheme for harnessing the crest energy from the solar source. The initial expenditure of solar PV installation is also very high.

Hence, this is also one of the reason for harnessing the maximum power from total installed capacity. Various MPPT schemes are reported in the literature. However, due to simplicity and easy implementation, P & O (Perturb and Observe) scheme is more preferred. In this work, the P&O method is utilized for extracting peak energy from the PV source.

III. PROPOSED SYSTEM

The proposed method describes about the smooth power movement of the solar PV source toward the AC grid by means of Landsman converter. RES like solar PV model acts as source of the proposed method. The fluctuating output DC voltage obtained from the solar PV source is nurtured to the Landsman converter (DC - DC converter). The PWM generator fed the PWM pulses to the transistor or IGBT switch present in the Landsman converter. The greater extent power is attained from the solar PV system through Fuzzy Logic Control MPPT algorithm where the voltage and the current from the solar PV system is served as the input to the Fuzzy Logic Controller (FLC). The boosted voltage from the Landsman converter is fed to the Voltage Source Inverter (VSI) and later the power is fed to the AC grid. L and C filters are existing in between the VSI and AC grid to prevent the harmonics from the output voltage of the VSI. To balance the energy course in the intended model which is achieved by the BESS attached to the DC link by Bidirectional DC converter. The system acts as an Energy Management System by means of the Battery storage present in the system.

IV. BLOCK DIAGRAM

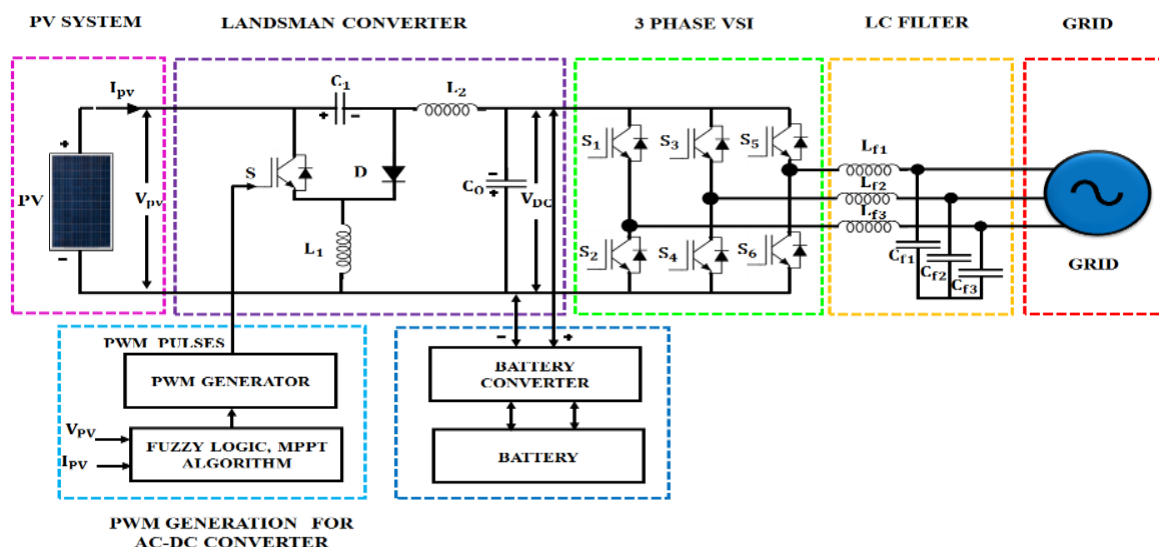


Fig No.1 The Proposed block diagram

V. SOLAR PV SYSTEM

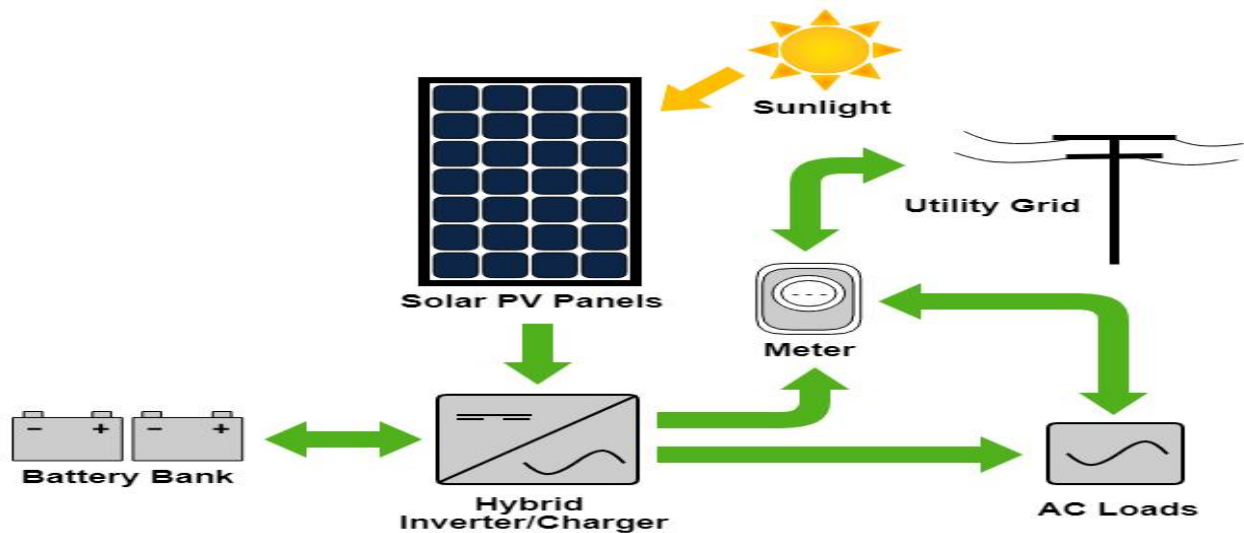


Fig No.2 Solar PV System connected to the grid

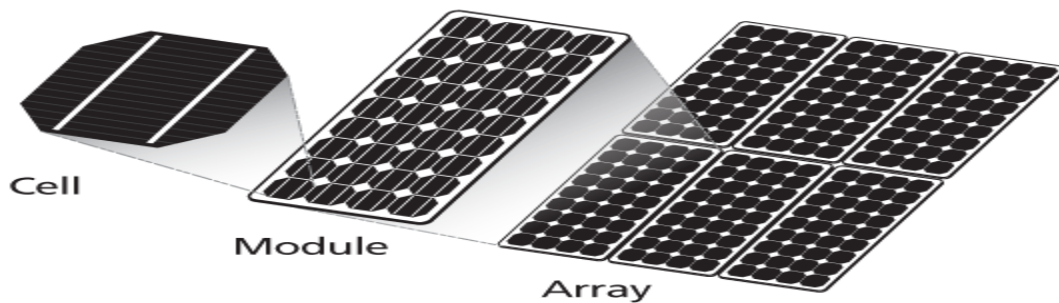


Fig. No.3 Photovoltaic system

VI. DESIGN OF LANDSMAN CONVERTER

Landsman converter is the DC – DC converter that steps high the voltage received from the solar PV system. This converter functions at higher efficiency and provides a noiseless operation. This electric power converter fed the step up DC voltage to the three phase Voltage Source Inverter (VSI). The transistor or IGBT switch is fed by the PWM pulses generated by PWM generator. The maximum power (P_{mpp}) input is fed to the PWM generator by the MPPT algorithm organized by FLC. The input V_{pv} and I_{pv} for the FLC is fed from the solar panel

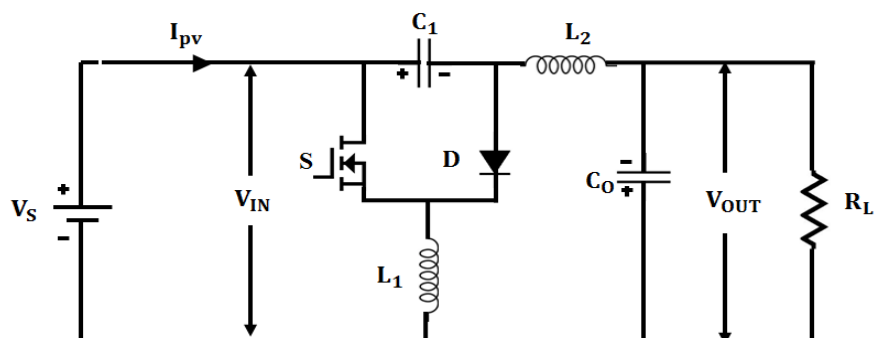


Fig No.4 Circuit Diagram

6. Fuzzy Logic Control:

Fuzzy Logic Control (FLC) has proven effective for complex, non-linear and imprecisely defined processes for which standard model based control techniques are impractical or impossible. Fuzzy Logic, unlike Boolean or crisp logic, deals with problems that have vagueness, uncertainty and use membership functions with values varying between 0 and 1. Fuzzy Logic tends to mimic human thinking that is often fuzzy in nature. In fuzzy logic a particular object has a degree of membership in a given set, which is in the range of 0 to 1. The essence of fuzzy control algorithms is a conditional statement between a fuzzy input variable A and a fuzzy output variable B. In general a fuzzy variable is expressed through a fuzzy set, which in turn is defined by a membership function μ .

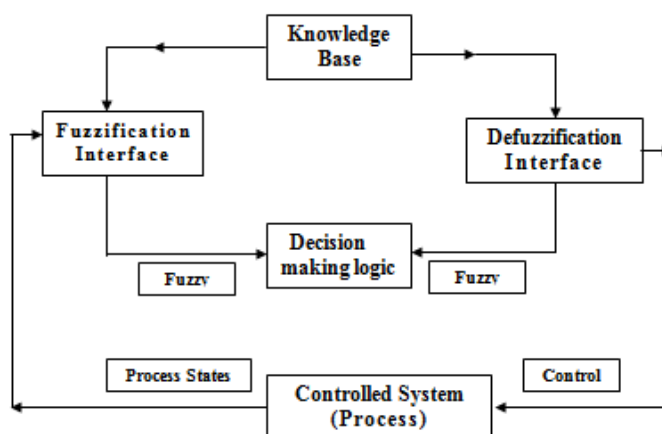


Fig No. 5 Basic Configuration of Fuzzy Logic Controller

VII. CLASSIFICATION OF VOLTAGE SOURCE INVERTERS

Voltage source inverters can be classified according to different criterions. They can be classified according to number of phases they output. Accordingly there are single-phase or three-phase inverters depending on whether they output single or three-phase voltages. It is also possible to have inverters with two or five or any other number of output phases. Inverters can also be classified according to their ability in controlling the magnitude of output parameters like, frequency, voltage, harmonic content etc. Some converters can output only fixed magnitude (though variable frequency) voltages whereas some others are capable of both variable voltage, variable frequency (VVVF) output. Output of some voltage source inverters is corrupted by significant amount of many low order harmonics like 3rd, 5th, 7th, 11th, 13th order of the desired (fundamental) frequency voltage. Some other inverters may be free from low order harmonics but may still be corrupted by some high order harmonics. Inverters used for ac motor drive applications are expected to have less of low order harmonics in the output voltage waveform, even if it is at the cost of increased high order harmonics. Higher order harmonic voltage distortions are, in most ac motor loads, filtered away by the inductive nature of the load itself. Inverters may also be classified according to their topologies. Some inverter topologies are suitable for low and medium voltage ratings whereas some others are more suitable for higher voltage applications.

L AND C FILTERS:

The harmonics generated from the three phase voltage source inverter will be reduced by means of the L and C filters present before the AC grid. So the voltage generated will be free from harmonics before feeding the AC grid.

AC GRID:

The load side of the system acts as the grid. The AC grid is otherwise known as the power grid and it meets the load demand by means of using RES like solar PV system, wind energy system etc. AC grid is used to transmit the electric power to the distribution side of the customers.

IX. HARDWARE OUTPUT

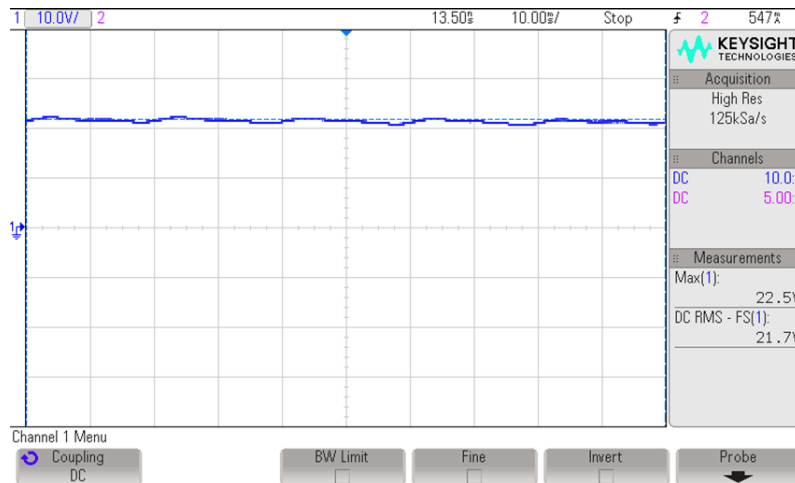


Fig No.7 Input voltage from the solar panel

The Fig No.7 shows the output voltage from the hybrid energy system, its having higher order ripples due to oscillatory renewable energy resources. This voltage is given to the Landsman converter, this converter will reduce the ripples.



Fig No.8 Landsman Converter output voltage

The Fig No.8 shows the Landsman converter output voltage. The converter is the second order filter, this will suppress the ripple contents in the DC voltage from the input DC voltage. The MPPT Algorithm maintains voltage source inverter.



Fig No.9 PWM pulses to the inverter

The Fig No.9 shows the PWM pulses to the voltage source inverter, the pulses having 180 degree phase displacements. The pulse has produced using sinusoidal pulse width modulation technique.

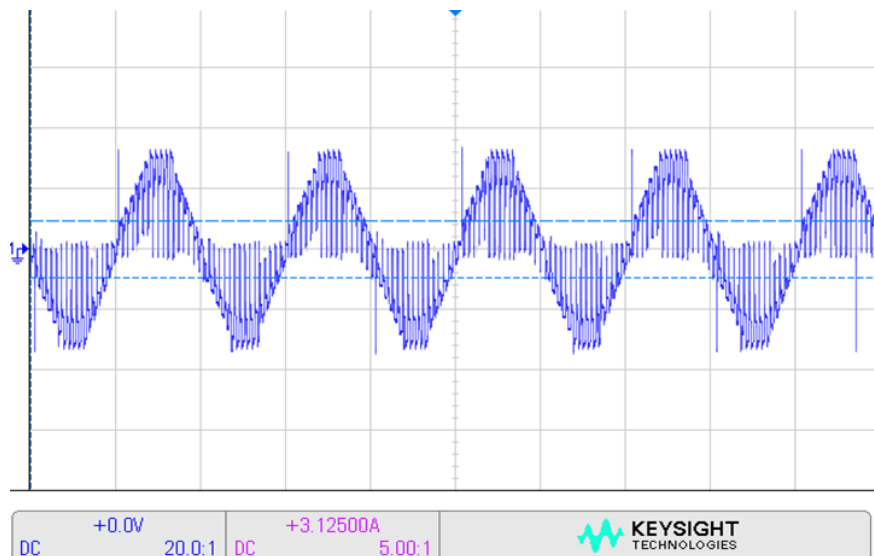


Fig No.10 Inverter output voltage

The Fig No.10 shows the inverter output voltage, it has some noises due to the THD. This AC voltage is given to the load.

X. CONCLUSION

The proposed model involves the AC grid which feeds from the solar PV Renewable Energy Source. The purpose of the grid is to fulfill the load demand from the distribution side. The proposed micro-grid system is fed from RES is found fit for meeting load requirement of a far-flung remote location involving few households. FLC based MPPT is used to extract the maximum power from the solar PV system and then the controlled output is served to the switch present in the Landsman converter as a PWM signal from PWM generator. The suggested automated system model maintains the performance of the entire system irrespective of the environmental situations.

The power feature of the system is maintained due to the steady power flow balanced by the battery storage system and the harmonics are reduced due to the LC filters present in the system. The proposed system acts as an Energy Management System as the power flow is smooth and continuous irrespective of the change in the input. This is



the most effective method and it is proved by the test results taken. The future of the system can enhance with the hybrid renewable energy sources where wind energy system, biomass etc. like other sources can be added in addition in future for providing the most effective. Instead of using Fuzzy Logic Controller MPPT based Algorithm, other standard and recent Controller can be implemented. The AC grid can be replaced by smart grid or microgrid or super microgrid in future as a trending change over.

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