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Design of Constant Power Generation controller for Grid Connected PV System

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Abstract:
With Increase in demand of clean electricity generation in many countries, the increasing techniques of new photovoltaic (PV) systems force the Distribution System for transmission and distribution of electricity. By considering this aspect, the distributors of electricity are Focused to ensure fast and smooth transformation between maximum power point tracking and constant power generation so the maximum feeding power of PV systems must be limited. Optimum performance and stable operations are achieved in spite of solar irradiance levels by the new control technique which is proposed. In this strategy, PV output power can be regulated as per desired set point and force to operate the PV system at left side of maximum power point without any stability issues. This system consists of solar PV panel, boost converter, MPPT controller, inverter, LCL filter and Load. Here, PV system as energy source. The power generated from solar photovoltaic system is controlled by DCDC boost converter. A modelling of this system is developed in MATLAB/Simulink. Constant power generation (CPG) control is much effective strategy in terms of stable transitions, high accuracy and fast dynamics which have been verified by experimental results.

***IndexTerms* - Active power control, constant power control, maximum power point tracking, PV systems, and power converters.**

INTRODUCTION

Energy is inevitable need for human. Use of fossil fuels in prolongation for meeting energy demand now lead to face multiple problems: depletion of fossil fuel reserve, rise in fuel cost, environmental concerns like global warming, change in weather patterns etc. These problems results in an unsustainable situation. Therefore there is an increasing need of renewable energy sources, as a result Photovoltaic (PV) generation is gaining significance, as a renewable source due to its various advantages like less running cost as there is no fuel required, no noise, less wear and tear due to absence of any rotating part, little maintenance etc. Solar energy is directly converted into electrical energy by photo- voltaic cell (a semiconductor device). PV cell is a semiconductor diode which can convert light into direct current (DC). Some PV cells can even convert infrared and ultraviolet radiation into electricity. Although in 1839, Alexander-Edmond Becquerel discovered the photovoltaic effect, in a junction formed between electrode made of platinum and an electrolyte solution of silver chloride. However in 1939 photovoltaic device is made by Russell ohl, by using a Silicon PN junction. The basic unit of PV module is the PV cell. Cells are grouped to form module or arrays. PV cells can be made from several types of semiconductor material using different manufacturing procedure. With an imperative demand of clean and reliable electricity generation in some countries, the increasing adoption of new photovoltaic (PV) systems pushes the Distribution System Operators (DSOs) to expand the transmission/distributed lines. However, the potential cost brought by such extensions and increased maintenances introduce new obstacles. In view of this concern, the DSOs starts to reduce PV installations in order to avoid an extension of the power infrastructure. Besides, another alternative solution is to limit the maximum feed-in power of the existing PV systems to a certain level. It can contribute to a weakened requirement of grid expansion and at the same time an increased penetration level. Therefore, to meet the need of this emerging ancillary service provided by future PV systems, a Constant Power Generation (CPG) control concept of PV inverters is proposed. Accordingly, it is worth investigating into two main issues: a) analyzing the reduction of the energy yield due to CPG control to study its feasibility from an economic point of view and b) developing robust CPG control methods, otherwise, it may introduce instabilities. Thereby, the implementation possibilities for PV systems in CPG operation mode. Maximum Power Point Tracking (MPPT) is effective for Photovoltaic (PV) inverters to maximize the energy harvested from PV panels. These control concepts can effectively avoid the over-loading issue with an acceptable reduction of the overall energy generation. However, the issue on the utilization of PV inverter remains and the thermal performance of the PV inverters is still unknown. This proposes a hybrid power control concept with the objective to improve the thermal performance and increase the utilization factor of PV inverters. It has the following features: 1) A Constant Power Generation (CPG) control mode is

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activated by using a direct power control when the DC power from PV panels reaches to a specific limit, the value of which depends on the trade of thermal loading (therefore lifetime) of switching devices, PV inverter utilization factor, and annual energy yield under yearly mission problem (i.e., solar irradiance and ambient temperature). The MPPT mode is active when the DC power is below the specific power level. The proposed MPPT-CPG control concept allows a reduction of required power ratings of PV inverters and also a reduction of junction temperature peaks and variations on the power devices (i.e., an extended lifetime Meanwhile, it could contribute to the system level power management to some extent, since its role in smoothing and limiting the power fed into the grid.

LITRATURE SURVEY

A fast maximum power point tracking (MPPT) control algorithm for the photovoltaic (PV) in a hybrid wind PV system, in which the PV generator may also need to work in a reduced power mode (RPM) to avoid dynamic overloading. The two control modes, MPPT and RPM, are inherently compatible and can be readily implemented, without the need of a dumping load for the RPM. Transient analysis and perturbation parameter design for this proposed method have been carried out. [1] A hybrid power control concept for grid-connected Photovoltaic (PV) inverters. The control strategy is based on either a Maximum Power Point Tracking (MPPT) control or a Constant Power Generation (CPG) control depending on the instantaneous available power from the PV panels. The essence of the proposed concept lies in the selection of an appropriate power limit for the CPG control to achieve an improved thermal performance and an increased utilization factor of PV inverters, and thus to cater for a higher penetration level of PV systems with intermittent nature. [2] It comprises of imperative demand of clean and reliable electricity generation in some countries, the increasing adoption of new photovoltaic (PV) systems pushes the Distribution System Operators (DSOs) to expand the transmission/distributed lines. However, the potential cost brought by such extensions and increased maintenance introduce new obstacles. In view of this concern, the DSOs start to reduce PV installations in order to avoid an extension of the power infrastructure. Besides, another alternative solution is to limit the maximum feed-in power of the existing PV systems to a certain level. [3].

It demonstrates the significant expansion of PV-grid installations has escalated new problems of PV penetration because of intermittent nature of the PV source and inertia less interface. A novel active and reactive power control scheme for a single stage PV grid system is counter the potential PV penetration problems for the futuristic grid with large distributed generation system (DGS) contributions. These features significantly overcome power and voltage uctuations, reverse power ow problems and overvoltage issues, which are considered as major potential PV penetration problems and the main reason for limiting large PV installations. [4] The PV emulator is intended to be used in a converter-based power grid emulation system Hardware Test-bed (HTB), in order to investigate the inuence of solar energy sources on the power grid. Both physical components and control strategies of the two-stage PV inverter system are modeled in the converter controller, which enables the emulator to represent the behaviors of the two-stage PV inverter system accurately. A converter based two-stage PV inverter system emulator is designed and implemented in a HTB using the technique of converter-based power grid emulation. [5] Many situations such as stand-alone systems or microgrids increasingly require the PV system to operate below maximum power. The problem here is that the power regulation becomes unstable when the MPP power is lower than the reference power as a result of a decrease in irradiance. A control strategy for a PV array connected to a DC/DC boost converter which makes it possible to operate in both modes: at either maximum or limited power point tracking. The strategy obtains high dynamics for the power response. [6] The inverter technologies for connecting photovoltaic (PV) modules to a single-phase grid. The Various inverter topologies are presented, compared, and evaluated against demands, lifetime, component ratings, and cost. Finally, some of the topologies are pointed out as the best candidates for either single PV module or multiple PV module applications. This is believed to be one of the solutions for the future. Another trend seen in this field is the development of the ac module, where each PV module is interfaced
to the grid with its own dc-ac inverter. [7].

SYSTEM ARCHITECTURE

Figure 1shows the basic Block diagram of a two-stage single-phase grid-connected PV system. The CPG control is implemented in the boost converter. The control of the full bridge inverter is realized by using a cascaded control where the dc-link voltage is kept constant through the control of the ac grid current, which is an inner loop. LCL Filter is used to filter the output from the inverter. Notably, only an active power is injected to the grid, meaning that the PV system operates at a unity power factor. the two-stage configuration can extend the operating range of both the MPPT and CPG algorithms. In the two-stage case, the PV output voltage vpv can be lower (e.g. at the left side of the MPP), and then, it can be stepped up by the boost converter to match the required dc-link voltage. This is not the case for the single-stage configuration, where the PV output voltage Vpv is directly fed to the PV inverter and has to be higher than the grid voltage level (e.g. 325 V) to ensure the power delivery.

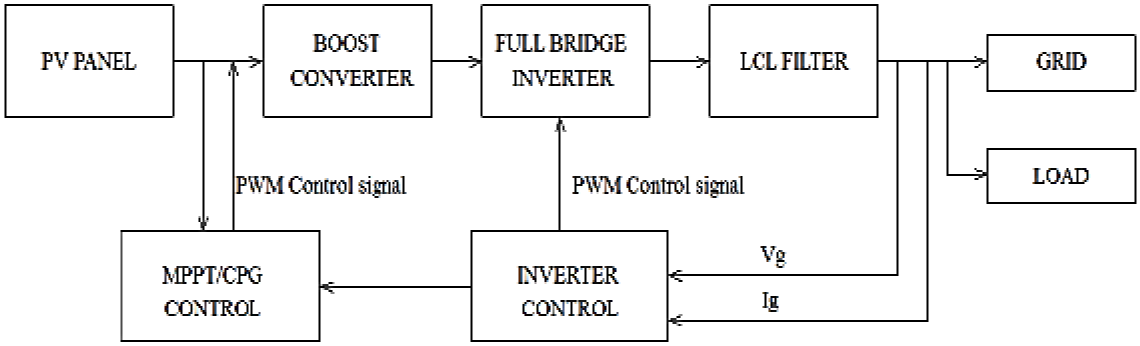

Fig1: Block diagram of a two-stage single phase grid-connected PV system.

PV installations requires to advance the power control schemes as well as the regulations in order to avoid adverse impacts from PV systems like overloading the power grid and requirement of large size PV panels to produce more power output. So it is essential to second alternative to overcome this problem in such a way that it produces maximum output with constant magnitude. So the issues related to grid instability, overloading and grid synchronization can be avoided. To tackle this, MPPT and CPG based on a perturb and observe (P&O-CPG) algorithm was introduced in two-stage PV systems. As the operating area of the CPG control is limited to be at the right side of the maximum power point (MPP) of the PV arrays (CPP-R), due to the single-stage configuration. Unfortunately, this decreases the robustness of the control algorithm when the PV systems experience a fast decrease in the irradiance. The operating point may go to the open-circuit condition. This drawback applies also to other CPG algorithms since all the control algorithms regulate the PV power Ppv at the right side of the MPP. To tackle the mentioned issues, a two-stage grid connected PV system is used along with the MPPT and CPG Algorithm. a two-stage grid connected PV system is employed to extend the operating area of the P&O-CPG algorithm. By regulating the PV output power at the left side of the MPP, a stable CPG operation is always achieved, since the operating point will never fall of the hill during a fast decrease in the irradiance. Thus, the P&O CPG algorithm can be applied to any two-stage single-phase PV system. Also power output can be improved without increasing the size of PV Panel.

SIMULATION RESULTS & DISCUSSION

Fig. 2 (a & b) shows the performance of the conventional P&O-CPG method and Fig. 3 (a&b) shows the proposed high performance P&O-CPG method with two daily conditions. The overshoots and power losses are significantly reduced by the proposed solution and a stable operation is also maintained. The algorithm also has a selective behavior to only react, when the fast irradiance condition is detected.

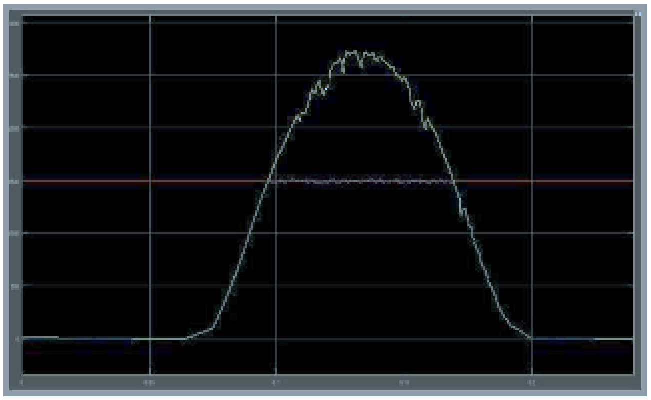

Fig. a

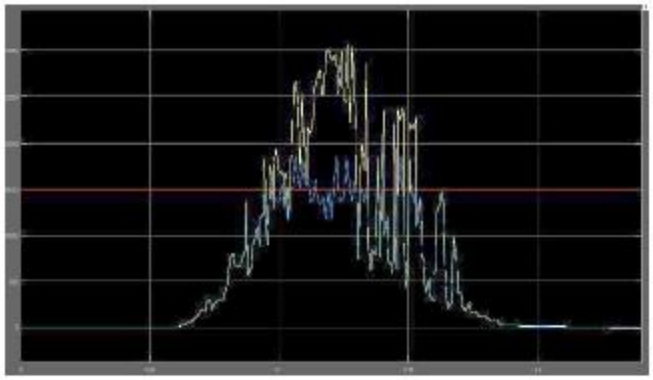

Fig. b

Fig. 2: Results of the P&O-CPG algorithm under two daily conditions: (a) clear day and (b) cloudy day.

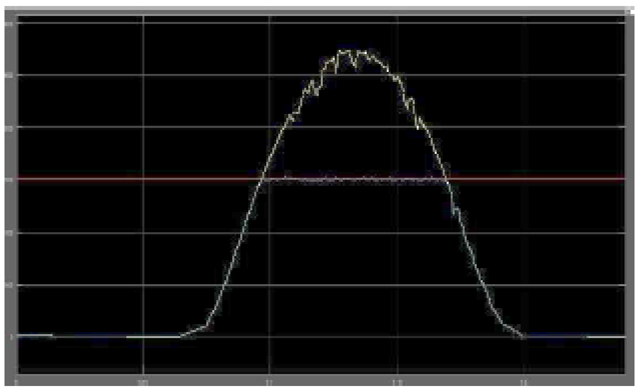

Fig. a

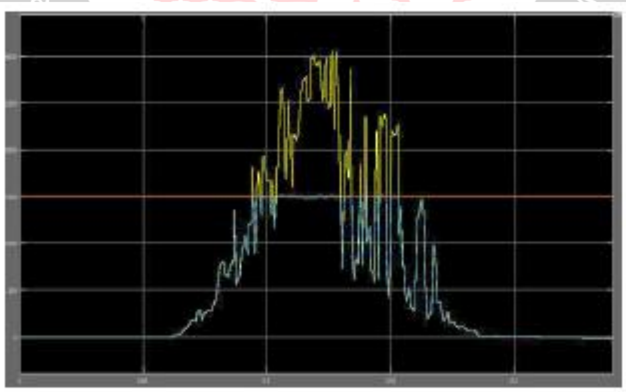

Fig. b

Fig.3: Results of the proposed high-performance P&O-CPG algorithm under two daily conditions: (a) clear day and (b) cloudy day.

Graphical Results

The following graph shows the V-T characteristics of photovoltaic panel without using MPPT and V-T characteristics of photovoltaic panel with using MPPT.

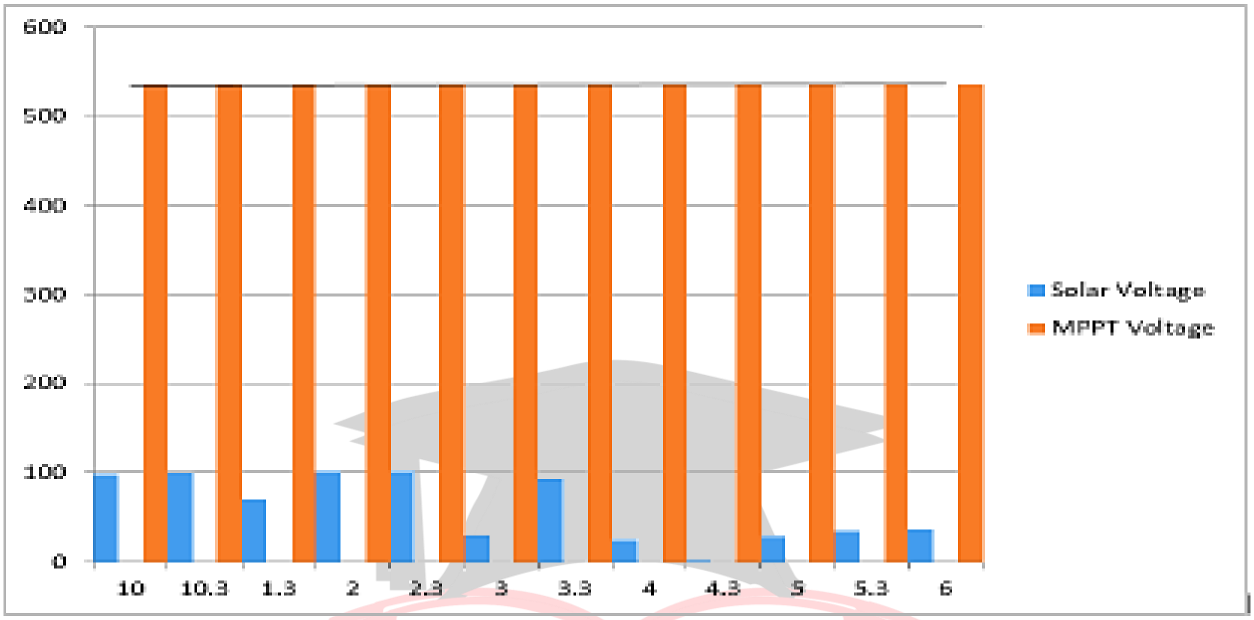

Fig.4 Bar graph when PV is static, and second when only MPPT is connected toPV panel

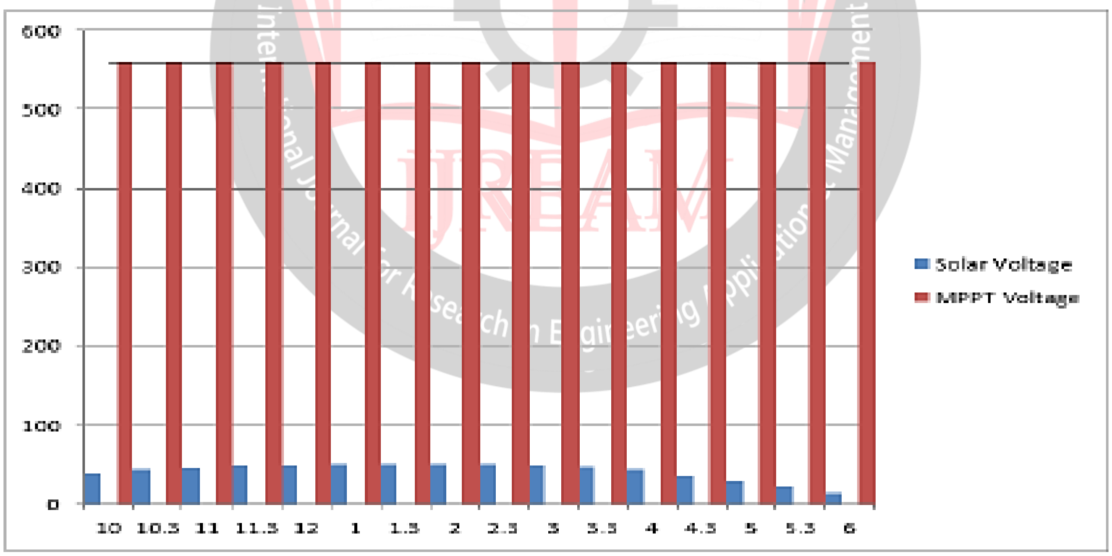

Fig. 5 Bar graph of Results at different day times

CONCLUSION

In a single phase two stage grid connected PV System MPPT and CPG controller is implemented. P & O algorithm of MPPT controls the output of PV Panel at constant magnitude irrespective of sun irradiance. This P & O algorithm is provided at the boost converter. he MPPT technique must be implemented with every PV system. As MPPT technique enhances the overall Performance of PV system. Model of classical MPPT technique is established using single diode model of PV cell. Two PV panels are taken with 110 V and 66 V voltage rating. Though the size and ratings of two panels are different, both the PV panels are produced nearly same DC voltage with higher magnitude after boost converter because of P & O algorithm of MPPT. Hence high voltage amplification is mandatory for grid synchronization and to achieve low total harmonic distortion (THD). From the simulation result, effectiveness of the proposed control solution in terms of reduced over-shoots, minimized power losses, and fast dynamics have been verified. proposed system can ensure a stable constant power generation operation.

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