

A Review on Solar Photovoltaic Generator and Battery Storage

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ABSTRACT: The distributed energy sources are commonly used small energy generating sources. Combination of these small energy sources will form microgrid to provide a required amount of demand power management. A grid connected PV system consist of solar panels, batteries with back up in case of emergencies, DC-DC converters for Demand power management. There is some unexpected behaviour of the system when subjecting to load changes, leads to negative impacts include power and voltage fluctuation, malfunctioning of protective devices. When the load resistance is changed from maximum to minimum load voltage goes below acceptable limit, battery current goes up suddenly and temporarily changes its state from charging to discharging and load voltages goes above acceptable limit. These current peaks on the battery and voltage variations on the load causes undesirable damage to the battery and critical load. Due to sudden variation in load high inrush current of battery leads to sudden charging/discharging of battery and leads to damage to the battery. In this review Maximum power is tracked from solar photovoltaic generators so as to increase efficiency and voltage and frequency is also controlled with the help of battery storage.

KEYWORDS: Maximum power point tracking (MPPT), Point of common coupling (PCC), Photovoltaics (PV), voltage/frequency V/F

I. INTRODUCTION

A microgrid (MG) is a smart grid included with the integrated large number of distributed generators (DGs) that can be operated in parallel with the utility grid or a small, independent power system. It increases reliability with distributed generation (DG), increases efficiency with reduced transmission length, and easier integration of alternative energy resources. Microgrid are widely used in generation systems, due to the benefits of high efficiency and increasing demand, distributed generation (DG) brings many potential benefits to both utility and consumers, however control and management of (DG) units pose a significant challenge. The need for increased number of small distributed and renewable energy resources can exceed the capabilities of an available computational resource. A microgrid at the point of common coupling (PCC) micro resources and storage devices are attached to medium level voltage utilities. A microgrid can connect and disconnect from the grid to enable it to operate in both grid connected and island-mode. Microgrid is a cluster of loads and micro sources, storage devices operating as a single controllable system that provides both power and heat to its local area. Microgrid enhances local reliability, reduce feeder losses, support local voltages, provide increased efficiency through using waste heat, voltage sag correction or provide uninterruptible power supply.

II. LITERATURE REVIEW

Microgrid is a cluster of loads and microsources, storage devices operating as a single controllable system that provides both power and heat to its local area. Microgrid can be designed to meet their special needs to customers such as enhance local reliability, reduce feeder losses, support local voltages, provide increased efficiency through using waste heat, voltage sag correction or provide uninterruptible power supply. With the increasing demand conventional

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generation brings about a continuous depletion of fossil fuel reserve, therefore most of the countries are looking for non-conventional /renewable energy resources over fossil fuels. The exploitation of DER Distributed Energy Resources would help to generate ecofriendly clean power with much lesser environmental impact. Distributed networks without any DG units are passive since the electrical power is supplied by national grid system to customers embedded in the distribution networks. [1]

Microgrid operates in interconnected mode with medium voltage network however scheduled or forced isolation can take place in such condition the microgrid should operate stably and autonomously. The key issue for successful MG islanded operation is the management of load shedding and state of charge of storage devices, voltage source inverters is used to provide reference voltage and frequency during islanded or forced islanded mode, storage devices such as batteries have finite storage capacity and can be loaded mainly by absorbing power from LV grid and correcting permanent frequency deviation during islanded operating condition. [2]

An efficient MPPT control algorithm called Perturb and Observe (P and O) method is used for solar PV system for extracting maximum power from the solar array. The algorithm involves introducing a perturbation in a panel voltage, modifying the panel voltage is done by modifying the converter duty cycle. [3]

III. SOLAR PHOTOVOLTAIC GENERATOR AND BATTERY

With the increasing demand renewable resource of energy such as solar energy plays a vital role in producing electricity.

Solar cells convert light energy into electricity. Cells are connected in series or parallel to form module and number of module connected together to form array. Batteries used for grid storage stabilise the electrical grid by levelling out peak loads for hours .Batteries plays an important role as they charge during periods when generation exceeds demands and feed their excess stored energy into grid when demand is higher than generation.

Due to sudden increase in demand there is sudden rise in high inrush current which can damage the battery .So a Charge controller is required such as MPPT which prevents battery from overcharging ,undercharging and increases life of battery.

A partially depleted battery supplying a large inrush current will struggle to cope and its supply voltage will like to drop below the undervoltage threshold will result damage of device. DC-DC converters uses a simple soft start regime that relies on a maximum current detector. The maximum current limited is released after a fixed time or at a set output voltage. When the inrush current increases battery voltage to drop and under voltage mechanism to activate if battery has little capacity to remaining. DC-DC converter can employ a well-controlled precise and reduces damage to the battery.

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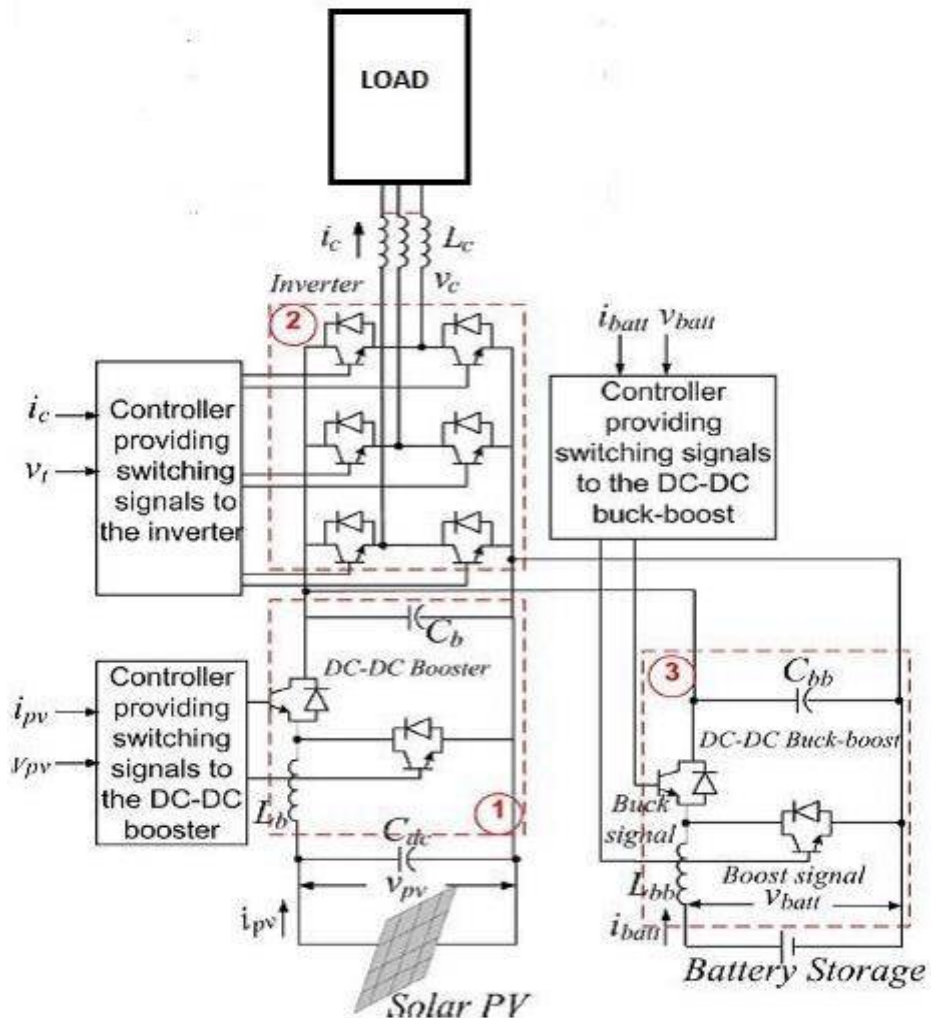


Figure 1. Schematic Diagram of PV system with Battery

The above figure shows the PV system configuration with PV operating at its maximum power point including a battery storage. A DC-DC boost converter is used for MPPT control. A battery is connected in parallel to the PV system to inject or absorb power through Bi directional DC-DC converter. When the battery is absorbing power, the converter operates in buck mode and when the battery is injecting power it operates in boost mode.

IV. MAXIMUM POWER POINT TRACKING (MPPT)

MPPT is an algorithm included in charge controller used for extracting maximum power from the solar PV module. The voltage at which PV can produce maximum power is called maximum power point voltage. Maximum power point voltage varies with solar radiation, temperature. MPPT is a fully electronic system that varies the electrical operating

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point of the modules so that the modules are able to deliver maximum available power. When the amount of sunlight varies the load characteristics that gives highest transfer efficiency changes so efficiency of system is optimized when load characteristics changes to keep the power transfer at highest efficiency. This load characteristics is called maximum power point and MPPT is the process of finding this point and keeping the load characteristics there.

V. PERTURB AND OBSERVE METHOD

Pand O method is the most common and efficient algorithms for MPPT. The algorithm involves a perturbation in the panel operating voltage. Panel voltage is modified by modifying the converter duty cycle. By increasing the voltage, the algorithm compares the current power with the previous power, if the power increases, then the voltage is perturbed in that direction and when power decreases the voltage is perturbed in opposite direction. The process is repeated till MPP is reached. The algorithm uses a fixed step size to increase or decrease voltage. If smaller step size is taken then it will reduce oscillation, but slow down tracking, while bigger step size will reach MPP faster but increase power loss.

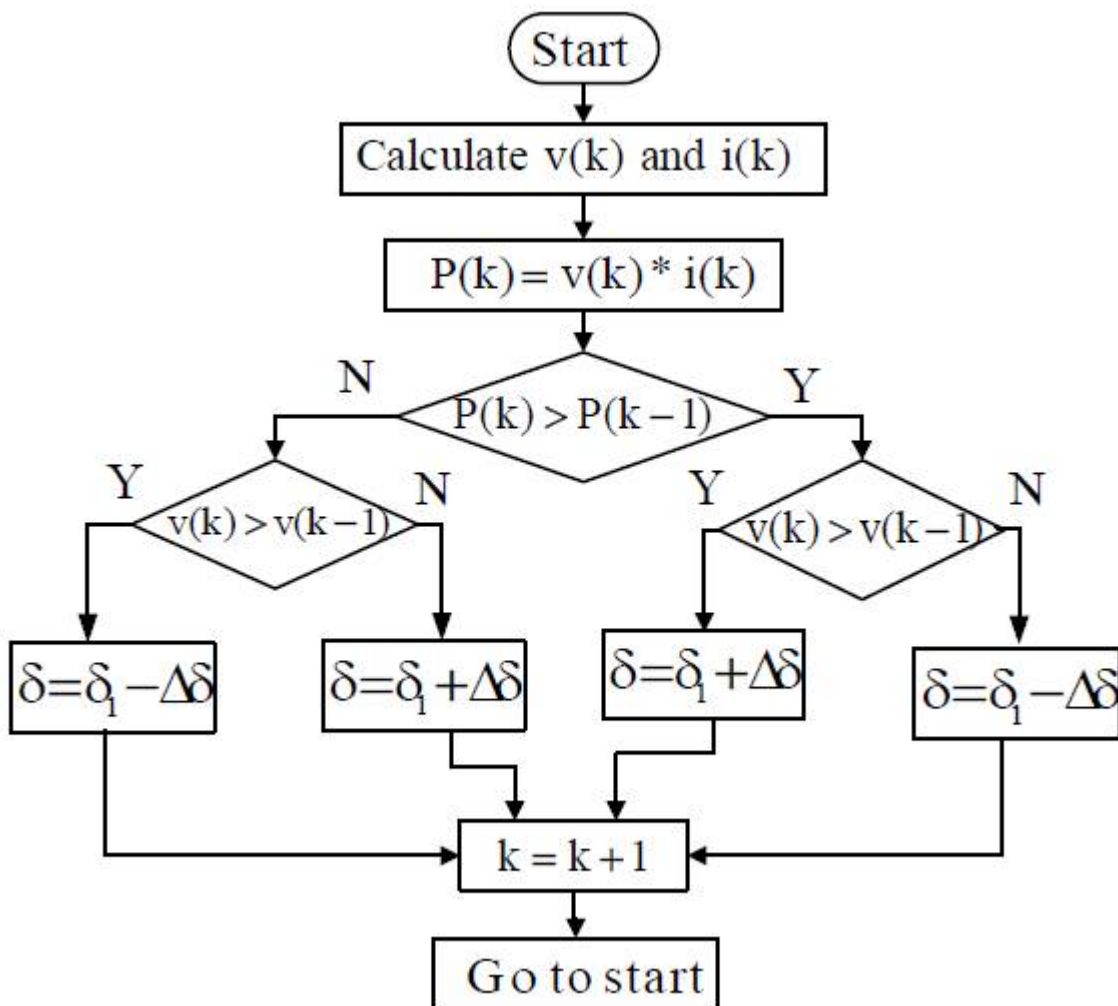


Figure 2. Flow chart of P and O algorithm

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P and O is an algorithm for extracting maximum power from the solar module, with the help of DC-DC converter by changing the duty cycle. Power is calculated, if power increases compared with the previous measured power then voltage is perturbed further in that direction till power starts decreasing and voltage is perturbed in opposite direction till MPP is reached at $dP/dV = 0$.

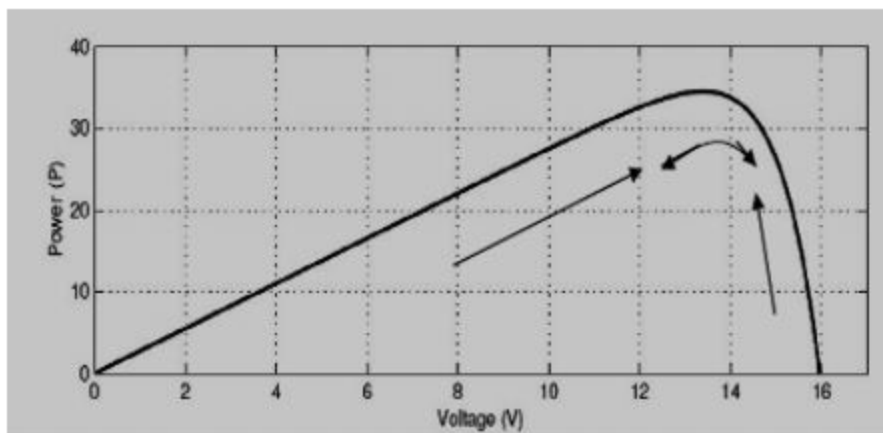


Figure 3. Graph power versus voltage for P and O Algorithm

P and O technique is developed by checking slope dP/dV on the PV characteristics of the PV module. The slope $dP/dV > 0$ on the left of MPP and $dP/dV < 0$ in the right of MPP.

VI. CONCLUSION

Solar Photovoltaic Generators with Battery for back up plays a very important role in microgrid for maintaining voltage and frequency. There is some unexpected behaviour of the system when subjected to load changes, leads to negative impacts include power and voltage fluctuation, malfunctioning of protective devices. When the load resistance is changed from maximum to minimum load voltage goes below acceptable limit, battery current goes up suddenly and temporarily changes its state from charging to discharging. These current peaks on the battery and voltage variations on the load causes undesirable damage to the battery and critical load. Maximum power point tracking technique is used for extracting maximum power from photovoltaic generator with the help of dc-dc converter with proper charging/discharging of battery and maintaining voltage and frequency of the system.

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