A Study on Grid Connected PV System

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Abstract : The interest of renewable resources has been expanding quickly because of the ecological concerns and need of energy. Solar photovoltaic energy is as of now a standout amongst the most prominent and sustainable power resource on the earth. Inverter is the basic segment in grid associated PV system. At the point when PV is connected to grid through inverter some significant terms like total harmonic distortion, galvanic isolation, anti-islanding discovery and voltage, frequency ranges for continuous activity must be in determined limits as per principles. This paper reviews state of part of discussion about various components in grid connected photovoltaic systems.

IndexTerms - ***power quality, PV module, inverters, Converters, filters, controllers, grid*** .

1. INTRODUCTION

The current energy need of world is mostly fed by the conventional energy resources. These resources are limited on the earth. The environment is polluted by CO2 emission, global warming and other pollutions day by day. Among all renewable energy resources the solar energy has more attention than others, as it act as a best alternative to conventional energy because of its availability. Technical development in solar energy system makes it easy to implement in various application. Solar photovoltaic (PV) system is mainly used to change solar energy into electrical energy, as it can be used for small scale as well as large scale power generation. Due to the improvement in the semiconductor technology the cost of the solar photovoltaic is reducing. Also the wide improvement in power electronics helps to generate electricity at high efficiency and makes it possible to supply power straightly to the grid [1],[3]. Grid connection is needed because there is better utilization of PV power and more energy is harvested. Avoiding the usage of batteries in grid connected PV system has become cost effective with less maintenance. As the PV module normally generates low voltage, so a boost converter is needed to rise this DC voltage to a higher amplitude [2].

Fig.1 demonstrates the block diagram of a PV system connected to the grid which contains PV panels from which the DC power is obtained and then it is converted or boosted to a DC voltage having higher amplitude by using DC-DC converter. This high DC voltage is transformed into AC by utilizing inverter which is additionally nourished to the single The desired output from converter and inverter according to grid requirements is produced by using control circuit. Maximum power point tracking is also included which is needed for maximum energy producing by using several control techniques.

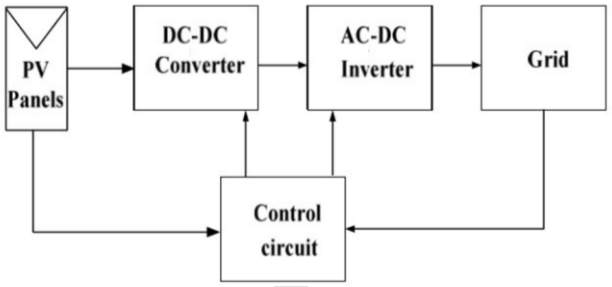

Fig. 1. Block diagram of a grid connected PV system

The most important element of grid connected PV systems are inverters. Inverter is a power electronic converter which changes over DC power from PV panels into AC power as compatible to grid. According to the architecture there are three main inverter topologies they are central inverter, string/multi-string inverter and module integrated micro inverter. Central inverter topologies is mostly suggested for large scale generation and it has centralized inverter and common MPPT for PV array (series-parallel connection of PV modules). String inverter is the reduced version of central inverter, and in this topology some number of modules are connected in series (string) and inverter is connected to that string, where each string has its own MPPT. Multi-string topology is advancement in string inverter for bigger framework in which strings have their very own DC-DC converter and these strings are associated with normal inverter lastly the module coordinated miniaturized scale inverter in which each PV modules has its very own inverter and individual MPPT [6].

2. PV MODULE

PV module represents the essential power transformation unit of a PV generator system. The output characteristics of PV module relies upon the sun based protection and the cell temperature. Since PV module has nonlinear qualities, it is important to demonstrate it for the structure and simulation of greatest power point following (MPPT) for PV system application. The principle reason of its popularity is that it doesn't utilize any outside source. We can utilize the power which is created by the PV exhibit by nourishing it to the AC source straightforwardly without utilizing any sort of battery. Sun energy is completely free and plentifully accessible. So as far as sustainable power source positioning daylight comes in first position. With no natural effect or in straightforward words with no ecological boundary it can produce continuous power, just we have to

uncover the PV array towards the daylight. It is extremely simple to introduce, cheap in cost, irrelevant maintenance cost [4], [5].

A. IMPLEMENTATION OF MFA TOWARD MPPT

The boost converter as interface between PV module and burden. The proposed calculation controls the DCDC help converter works at the ideal obligation cycle comparing to MPP. The means of the proposed calculation toward MPPT are portrayed as pursues:

Step 1: introductory parameter of the AMFA, in particular, β, α and populace estimate N. In this calculation, the situation of the firefly speaks to obligation cycle of DC-DC converter. In this paper, the quantity of fireflies is picked as 5. A.

Step 2: the situation of firefly the relating PV yield control. The splendor of the firefly is gotten from PV yield control. .

Step 3: the firefly, which has most extreme brilliance stays in its position while the rest of the fireflies update their position

Step 4: the streamlining calculation works until the last cycle

B. HILL CLIMBING TECHNIQUES

The hill climbing based techniques got its name because of the shape of the power-voltage (P-V) curve. This has mainly three technique: Perturb & Observe Algorithm (P&O)

Modified Adaptive P & O Method

Incremental Conductance Algorithm (INC) The efficiency of P&O and INC algorithms is 96.5% and 98.2% respectively. The average increase in energy extraction is found to be 16% to 43% by using conventional hill climbing MPPT.

C. FUZZY LOGIC CONTROLLER

From past few years by the help of modern microcontrollers fuzzy logic control is very popular. The benefit of using these controllers is that it works with very fluctuating inputs, it does not need any mathematical calculation [14].

To track the maximum power point there are many techniques at which the power output of the PV module is maximum. But the efficient technique among them is Fuzzy logic [15]. Its design is very simple or we can say that its working model is very simple as compared to the other conventional models. The components which are involved in FLCs are fuzzyfication, rule base, inference, and defuzzyfication.

III. CONVERTER

The topologies of DC-DC converter are designed to meet specific demand of DC loads. There are different verieties of DC-DC converter that can be functioned as switching mode regulators that can regulate the unregulated DC voltage with conversion to suitable utilization voltage through increase or decrease the value of DC output voltage by using power switching devices for PWM switching at a fixed frequency which are buck, boost, buck-boost, Single Ended Primary Inductor Converter (SEPIC) and fly back– help converter. Every converter requires the power exchanging gadgets for turn on and turn-off when it is required [13]. The power exchanging gadgets, for example, MOSFETs, IGBTs, BJTs and thyristors are utilized relying on the applications and parameters of structuring the circuit. So as to trigger the power exchanging gadgets, proper door drive motions by utilizing entryway driver circuit ought to be considered. The DC-DC converters are driven by Pulse Width Modulation (PWM) changing to control the converter voltage, recurrence and stage delay.

A. DC – DC BOOST CONVERTER

Fig.2 illusrates basic circuit topology of a DC-DC boost converter circuit contain of power switch (M), diode (D), inductor (L), capacitor (C), switching controller and load (R). This topology can be used for interface connection between low PV array voltage to a high battery bank input voltage or any DC load [10]. The DC-DC boost converter will increase or step up the voltage at the output to be greater than voltage at the input [8], [11]. Controller will function to control the switch for turn on and turnoff to increase the input voltage to the needed value of output voltage. While turning ON the switch it will reverse biased the diode and the inductor will store electrical energy. Then the load will get supply current from the capacitor. When turning OFF the switch the electrical energy stored in the inductor will be supplied to the load and capacitor. Continuous-conduction mode (CCM) and discontinuous conduction mode (DCM) are the two modes of operation of DC-DC boost converters. When the DC-DC boost converter operates in CCM, the inductor current will be greater than zero at all-time whereas during DCM, the inductor current will drop to zero after each switching cycle [7], [9], [12]. Current research trends for DC-DC boost converter with PV based power quality management are reported for harmonic elimination, power factor correction, zero voltage regulation and load balancing.

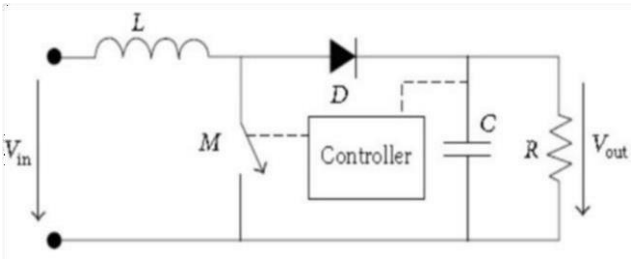

Fig. 2. Circuit topology of DC boost converter

Circuit Analysis

The imperative standard that works the converter has been penchant of the inductor to restrict variety in present by making and pummelling an alluring field. In this converter, the yield voltage is always more prominent when it is compared to the voltage inputted. A circuit of increased power stage is illustrated.

(a) While closing the switch current flows from inductor in clockwise direction. The inductor will store some of the energy which produces an alluring field. Furthest point in the lifter side of the inductor is certain.

(b) When switch is in open position, current might be decay because of greater impedance. The alluring field at one time made will be destroyed to keep current upstream towards the stack. By this way the furthest point would be shifted (means inductor will have non positive extremity as an afterthought) therefore sources would be in arrangement making high voltage.

IV. INVERTER

Inverters are static devices that convert DC output into AC output at desired voltage or current and frequency. Periodic waveform will be the output voltage of the inverter. There are several types of inverters, and they are classified according to number of phases, power semiconductor devices using, principals of communication, and output waveform.

INVERTERS BASED ON PV SYSTEM TYPE

Based on the mode of operation, inverters are classified into three different categories: 1. Stand-alone inverters 2. Grid-connected inverters 3. Bimodal inverters. Various types of inverters, its disadvantages and advantages are studied in the following sections.

TYPES OF GRID CONNECTED INVERTERS

Apart from the operation mode, grid-connected inverters are further classified into four main categories based on configuration topology.

1. Central inverters (several kW to 100 MW range).
2. String inverters (a few hundred Watts to a few kW).
3. Multi-string inverters (1 kW to 10 kW range).
4. Module Inverters or Micro Inverters (50 W to 500 W).

A. CENTRAL INVERTER

Central inverter system is the type of inverter system which consist of number of panels which forms strings when it is connected in series and to form large system, these strings are connected in parallel using string diode. PV panels with series–parallel connection is illustrated in Fig.3. To this arrangement of PV panel's single centralized inverter is connected. A unique solution to the three phase high power PV module on big scale is offered by the centralized inverter. With convenient operation the system is mainly robust and the structure is easy. This inverter technology has some hurdles mainly as use high voltage DC cable between PV modules and inverter, non-synchronizing losses between PV panels, use of inverter's life span reducing high rated bulky electrolyte capacitor. Centralized inverters are huge, heavy, not easy to install, power factor is poor, and harmonic content is high in AC output current, design is not flexible and difficulties in integrating the system in future. One of the main drawback of centralized inverter system is that to each PV module Maximum Power Point Tracking is not present. The overall performance of the PV system can be affected by the partial shading and clouding effect on PV module and hence the generation of power will get decreased. Due to the above limitations, the overall system efficiency decreases thereby other inverter topologies are promoted [19], [20].

Advantages of a Central Inverter

1. Traditional inverter topology
2. System design and implementation is easy
3. Less cost per Watt
4. Maintenance and troubleshooting can be easily accessible

Disadvantages of a Central Inverter

1. Cost of DC wiring is high and Voltage Drop cause power loss.
2. For the entire PV system single MPPT is present.
3. In the case of string mismatch and partial shading, output of the system can be drastically decreased
4. For the future expansion it is difficult to add strings and arrays
5. For the entire system single failure point
6. Monitoring at array level
7. Bulky (It is a drawback because, the huge size requires more space and shading issue is created for the PV array.)

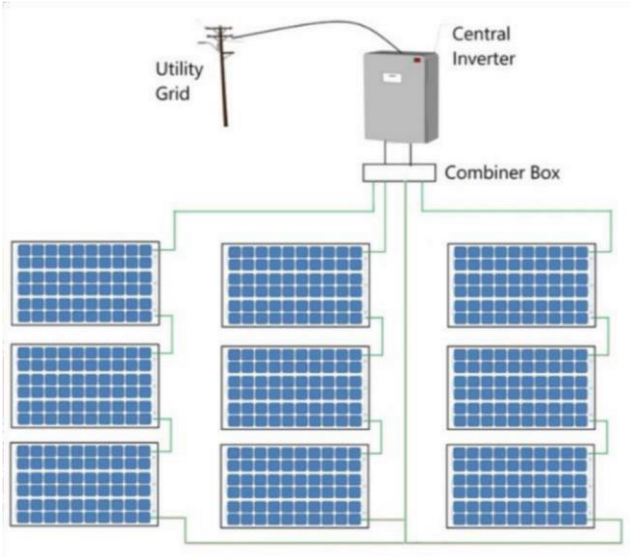

Fig. 3. Grid Connected Centralised Inverter System

B. STRING INVERTER

The drawbacks of central inverter system are not completely overcome by the string inverter system. As illustrated in Fig. 4 the string inverter system consists of number of series connected panels to produce a string and the inverter is connected to that string giving AC power to the grid. The power rating of inverter is low up to 5kW as the single string is connected to the inverter. The Maximum Power Point Tracking is connected to every string gives most accurate maximum power point operation when compared with centralized inverter system. Thereby we can reduce the partial shading or clouding effect. The energy harvesting to the grid is high in the entire system, string diode losses is reduced, the electrolyte capacitor size is minimised, and the inverter life span increases. String inverter efficiency is more than that of the central inverter topology [21], [17].

Advantages of String Inverter

1. When compared to central inverters, string inverters are smaller in size
2. MPPT capability per string is good
3. By adding parallel strings Short DC wires future expansion is scalable.

Disadvantages of a String Inverter

1. For each string special racking is required for the inverter
2. At partial shading the flexibility is poor

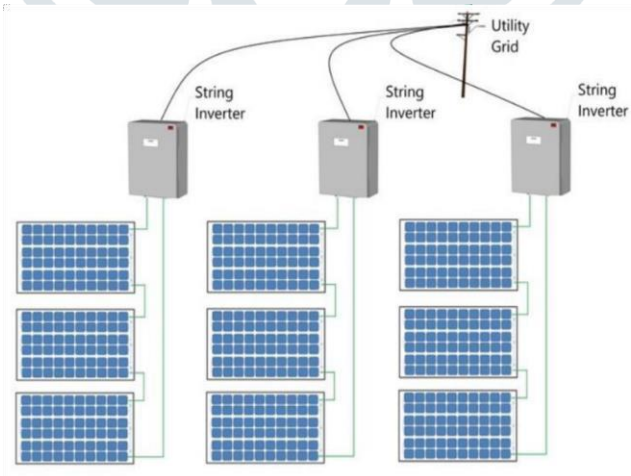

Fig. 4. String Inverter Topology

C. MICRO INVERTER

Finally, we can look into the micro inverters. These are also considered as module inverters. Here, each module is connected on the back of the one dedicated inverter. To the DC side of the inverter module's DC terminals are connected and then all AC wires are combined and then joined to the utility interconnection point as shown in Fig.5 [20], [21].

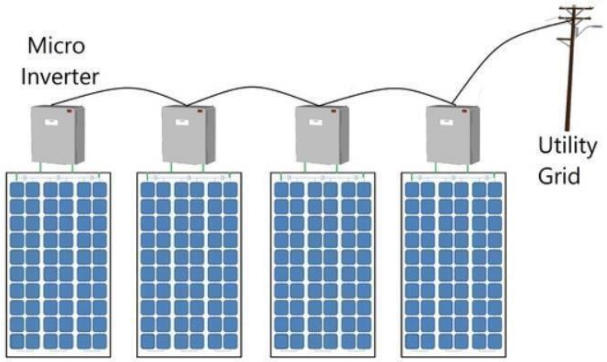

Fig. 5. Micro Inverter Topology

V. LCL FILTER

The lessening of the LCL-channel is 60 dB/decade for frequencies above resounding recurrence, accordingly lower exchanging recurrence for the converter can be utilized. It likewise gives better decoupling between the channel and the lattice impedance and lower current swell over the matrix inductor. In this way LCL-channel fits to our application. The LCL channel has great current swell lessening even with little inductance esteems. Anyway it can bring additionally resonances and temperamental states into the framework. In this way the channel must be planned exactly as indicated by the parameters of the particular converter. In the specialized writing we can discover numerous articles on the structure of the LCL channels. Significant parameter of the channel is its cut-off recurrence. The cut-off recurrence of the channel must be insignificantly one portion of the exchanging recurrence of the converter, in light of the fact that the channel must have enough weakening in the scope of the converter's exchanging recurrence. The cut-off recurrence must have an adequate separation from the lattice recurrence [20].

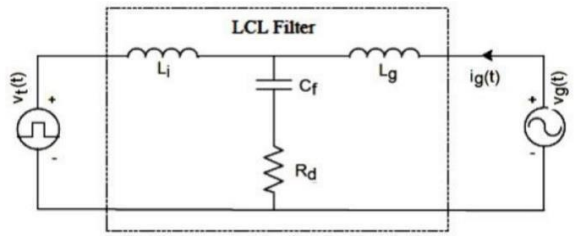

Fig. 6. LCL Filter and Components

VI. CONCLUSION

This paper examines about the segments that present in matrix associated photovoltaic framework. The sun oriented PV has appeared tremendous potential and advantages for society and is en route to assume a standard job inside the power framework. The definite investigation of dc – dc converter, inverters and its grouping are examined. PV inverter, as the weakest connection of PV framework, is of incredible concern. In this paper, the fundamental issues identified with the dependability of PV inverter are presented. As indicated by the gauges of IEEE 1547 and IEC 61727 the THD ought not to be surpass 5% and the symphonious substance of infused current ought to be limited. The guidelines additionally have restriction to DC current infusion whose most extreme breaking point is 1 % as indicated by IEC 61727 and 0.5% as per IEEE 1547 norms.

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