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High-performance Decoupling Strategy Inactive and Recharge Power Control for the 3-PH PV System

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ABSTRACT: The objective of this paper is to suggest a dynamic power decoupling methods for the 3 phase power system during the unbalanced grid fault condition. Basically it includes a dc-dc converter and a 3- phase dc-ac inverter is used for the PV power system. During the normal condition or during the normal operation the system will capture the maximum power and also

transfer the energy to the grid. If any unbalanced fault takes place in the grid, then the output power also contain the double line frequency oscillation. The only way to deal with this trouble is to increase the dc-hyperlink capacitance, but the main problem is that the cost of the circuits and the size of the circuits is also increase mean while there is a decrement in the reliability of the

system.

KEYWORDS: Dynamic power decoupling, MPPT, Converter, Inverter, MPP

I. INTRODUCTION

Solar energy is the inexhaustible and eternal energy of the earth. Most of the used energy comes directly or indirectly from the sun. Being one of the most attractive renewable energy, the use of photovoltaic (PV) power has become a trend around the world. A PV inverter converts the direct current (DC) of a photovoltaic power generation device (solar panel) into a utility frequency alternating current (AC) that can be fed into a grid or used by grid load [24]. Without a doubt, a PV inverter is the core of any PV power generation system (grid-connected). Since the grid inverter is, the primary equipment of photovoltaic grid connected systems, the research focus is the control strategy for grid inverters. The most important standard of the grid inverter is the quality of its output current. The IEEE 1547 standard in the USA allows a limit of 5% for the current total harmonic distortion (THD) factor with individual limits of 4% for each odd harmonic from 3rd to 9th and 2% for 11th to 15th while the European standard IEC61727 suggests a similar one [3].

A grid-connected PV system is connected to a large public grid (owned by a utility company) and feeds power into the grid. Grid connected systems vary in size from residential (2-10kW) to solar power stations (1-10MW). In the case of residential or building mounted grid-connected PV systems, the electricity demand of the building is met by the PV system. Only the excess is fed into the grid when there is an excess. The feeding of PV-generated electricity into the grid requires the transformation of DC into AC by a grid-controlled inverter. On the AC side, the function of the grid-connected inverter is to supply electricity in sinusoidal form, synchronized to the grid frequency, and limit the feed-in voltage to no higher than the grid voltage. On the DC side, because the power output of a module varies as a function of the voltage, power generation can only be optimized by varying the system voltage to find the \maximum power point". Most inverters, therefore, incorporate \maximum power point tracking". Most common way to control the inverter is proportional plus integral (PI) control. At first, people used PI controllers for the inverter system. However, for the PV inverter with an inductor-capacitor-inductor (LCL) filter, just by using a PI controller may not meet the harmonic standard for the output current. Then researchers come up with a method to combine the PI controller with a proportional resonant controller. This approach can decrease the harmonics for the inverter system. The proportional plus integral (PI) controller is the most widely used method for PV inverter systems due to its easy implementation. However, the classical PI controller can only achieve the zero steady-state error control for the fundamental frequency of the grid, that is, for tracking constant current values. Only using the PI controller, the

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current harmonic cannot be reduced. These kinds of harmonics, if connected to the grid, will cause some serious problem to the grid.

Demand for clean, economical, and renewable energy has increased consistently over the past few decades. Among a variety of renewable energy resources available, solar energy appears to be a major contender due to its abundance and pollution-free conversion to electricity through photovoltaic (PV) process. Increasing interest in PV systems, demands growth in research and development activities in various aspects such as Maximum Power Point Tracking (MPPT), PV arrays, anti-islanding protection, stability and reliability, power quality and power electronic interface. With increase in penetration level of PV systems in the existing power systems, these issues are expected to become more critical in time since they can have noticeable impact on the overall system performance. More efficient and cost-effective PV modules are being developed and manufactured, in response to the concerns raised by the PV system developers, utilities and customers. Numerous standards have been designed to address power quality and grid-integration issues. Extensive research in the field of MPPT has resulted in fast and optimized method to track the maximum power point. Regarding power electronic converter to interface PV arrays to the grid, Voltage Source Inverter (VSI) is a widely used topology to date. However, this topology has some limitation when it comes to PV application. The VSI topology has buck (step-down) characteristics; therefore to step-up the low voltage output from the PV array, an extra power electronic interface may be required.

II. CONNECTIONS

The system which is able to flow the power in the flexible network topology as per the international council on large electric systemcan be defined as the active distributions systems. The flexible network topology is basically the combination of the differentDER's, different loads, and different type of storage units. The connection between the different parts of the system is shown below.



The primary sources such as solar energy, wind energy and many more are connected to the grid connected converter with the helpof the various different transmission line, then the grid connected converter system is further connected to the active distributionssystem. The primary energy sources, grid connected system and the active distribution system is connected with the advance controlstrategies as shown in the diagram. The advance control strategy basically contains various type of latest equipment which is able togive us sufficient information and also increase the distortions in the supply and many other factors which are very beneficial for the power system.

III. DIFFERENT STRATEGIES

power system to reduce the oscillation of the dc link produced by the unbalanced grid fault without increasing the level of dc linkcapacitance.



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A. Existing Methods

The power (active & reactive) ripple occurred due to the unbalanced grid fault can be suppressed by the double loop feed forwarddecoupling method. But in this method the active & reactive power ripple can't be removed both at a time. The main drawback of this method is not eliminating power ripple at a time. This particular drawback is removed in the proposed drawback is removed in the proposed method discussed below.

B. Proposed Method

This paper proposed a DPD (dynamic power decoupling) method strategy for the 3 phase PV power system without increasing thelevel of the dc-link capacitance. During normal operation, the converter (interleaved boost converter) will get the maximum powerpoint (MPP) from the PV array and a 3 phase inverter will give the power to the grid. During the abnormal condition, the current the power of the boost converter will be handled by the proposed dynamic power decoupling to get the power decoupling capability and also to remove the dc link voltage oscillation. The block diagram of the three phase PV system shown below.



Fig. Three phase PV system

The PV system contains many parts such as PV array, Converters, inverters, feedback circuit, gate driver, dynamic power decoupling (DPD) control and many more. Every part perform a specific work and that work help in reducing the oscillation in the dc-link voltage without increasing the dc-link capacitance. The Dynamic power decoupling method is better than the other method, but the main effect is that the cost of the circuit and the size of the circuit will increases.

IV. PV OUTPUT POWER FLUCTATIONS

The expressions of the voltage fluctuation for the DC-link in fluctuating PV power terms is give by-

$$\Delta V_{dc,fluct} = \frac{T_{ac}\Delta P}{C_{dc}V_{dc}}$$
(i)

Where,

 $\Delta V dc, \, fluct$: the average value of change in the DC-link capacitance.

Vdc : Voltage of AC- main supply.

Cdc : DC-link capacitance.

Tac : Time period.

 ΔP : PV output power fluctuation.

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The boost converter mainly performing the MPPT task (i.e. maximum power point tracking). If any change is occurred in the radiation then the MPPT slowly changes its operating point to another new maximum power point (MPP). The fluctuations in the PV output power can be reduced by using the large dc link. But we can't use the large dc capacitance because of the point of view of the reliability of the system. This can be seen from the above equations (i), the relation between the Δ Vdc, fluct is inversely proportional to the term Cdc from the above equations we observed that when we increases the value of the DC-link capacitance the voltages decreases.

V. EFFECT OF DC-LINK VOLTAGES RIPPLE ON THE PHOTOVOLATIC SYSTEM

When we allow the dc-link voltage with the ripple then it will impose ripple at the terminal of the PV array, due to this the instantaneous power at the both end (i.e. input & output) of the boost converter is same. There is no any effect of the ripple on the panels but the obtain output power from the modules or panel will be less or in other word we can say that if the magnitude of the ripple is high in the photovoltaic voltage and current, the average power obtained from the panels would be less than the MPP power which is available as shown in the figure below.



VI. PROPOSED DESIGN & RESULTS

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Fig. Voltage ripple and power oscillations

VII. CONCLUSION

In this thesis, a DPD strategy for the three-phase PV power system under unbalanced grid fault scenarios. Under normal operation, the front-end interleaved boost converter will act as an MPPT and the rear-end inverter will transfer the PV energy to the grid. As soon as the unbalanced grid fault occurs, the frequency oscillation will appear on the dc-link voltage and the output active/reactive power due to the negative sequence component inside the power system. In order to decouple the input-output power imbalance, the input current and power will be controlled via the DPD strategy to eliminate the dc-link oscillation.

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