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THREE-PHASE SINGLE STAGE SOLAR PV INTEGRATED UPQC

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ABSTRACT

A fractional open circuit algorithm-based solar PV (photovoltaic) integrated UPQC (unified power quality conditioner) is proposed in this research, and its performance is evaluated. Matlab Simulink is used to simulate steady-state and dynamic settings. software. Shunt and series voltage sources are used in UPQC.A dc link connects two converters (VSC) back to back.in common. The shunt compensator has two functions: It draws power from a solar PV array and supplies current. compensation, whereas a series compensator provides voltage compensation compensation through voltage injection (in phase/out of phase) during voltage, the grid via the point of common connection sags/swells. Single-stage fractional open circuit algorithm. The topology is used to collect power from a PV array. Fractional The open circuit algorithm is not only simple to implement but also effective. provides smoothness and oscillation.

Keywords: Maximum Power Point Tracking (MPPT), Power Quality(PQ), Photo-Voltaic (PV), Unified Power Quality Conditioner (UPQC), Fractional Open Circuit Voltage(FOCV), Dynamic Voltage Restorer(DVR), Moving Average Filter(MAF), Total Harmonic Distortion(THD), Series Active Power Filter(SAPF), Parallel Active Power Filter(PAPF).

I. INTRODUCTION

Power quality concerns and problems appear to be the result of the increased use of solid state semiconductor devices, switched mode power supply (SMPS), adjustable speed drives, and so on. The introduction and widespread usage of power electronic products and electronic loads enhanced the penetration of nonsinusoidal currents into the power system. Power quality concerns can cause equipment malfunctions, false activation of electronic switches, data loss and memory malfunctions in sensitive equipment such as computers, programmable logic devices, protection and relaying equipment, and so on. It also accelerates the deterioration of transformers, cables, and other transmission equipment. If this failing occurs in biomedical equipment, the situation will be even worse. According to the history of the power system, power quality is a two-pronged issue in which electronic instruments play both villian and victim. Despite their high efficiency, power electronic devices draw current in bursts and modify the electricity that flows through them. As a result, the output returned to the grid is distorted. As a result, utilities are being obliged to spend more money on filters and capacitors to 'clean' this 'dirty' power.

Another key issue that power system engineers are emphasising is the necessity for renewable energy generation. The primary option for this is to install rooftop solar panels in both business buildings and modest apartments. However, the intermittent nature of solar photovoltaic systems can cause voltage quality issues, particularly in older distribution systems. When both of these scenarios are considered, it is evident that there is a great demand for a system that can contribute clean energy to the power system while also improving power quality. Many studies have been conducted in the subject of active power filtering to address power quality issues. The disadvantage of active shunt power filtering was that it introduced reactive power into the system. It also cannot perform voltage compensation at PCC and current compensation (to keep the grid current at unity power factor) at the same time.

DVRs and STATCOM devices were invented. opened a new chapter in the realm of PQ mitigation. The first DSTATCOM installation was at a saw mill in British Columbia. Canada's Columbia. A solar photovoltaic system with DVR was installed. suggested in [19].Multifunctional single and three phase There were also single stage solar energy conversion technologies. proposed[4]-[8]. FACTS stands for Flexible AC Transmission System. gadgets have been adjusted in order to be served indistribution networks, as well as through changing UPFC (Unified Power Distribution). Flow Controller), the UPQC was introduced in 1998. Such Different PQ phenomena can be compensated for via solutions. In [10]-[12] The usage of PV integration to the grid results in of the UPQC. A comparison of major MPPT technologies [20] discusses this. DVRs and STATCOM devices were invented. opened a new chapter in the realm of PQ mitigation. The first DSTATCOM installation was at a saw mill in British Columbia. Canada's Columbia. A solar photovoltaic system with DVR was installed suggested in [19].Multifunctional single and three phase There were also single stage solar energy conversion technologies. proposed[4]-[8]. FACTS stands for Flexible AC Transmission System gadgets have been adjusted in order to be served in distribution networks, as well as through changing UPFC (Unified Power Distribution).

The creation of reference signals is critical in the UPQC control methodology. It is possible to use either time domain or frequency domain techniques[3]. Time domain-based approaches are commonly used for real-time implementations since they require less processing time. In this study, a time domain strategy based on synchronous reference (d-q theory) frame theory[13] is applied. This method will produce double harmonic components in the d-axis component of current under unbalanced load conditions. A low pass filter with a very low cut off frequency will be employed to filter out these undesired signals. The use of standard LPF will result in lower dynamic performance. As a result, MAF (movig average filter) is employed in this paper to filter out the double harmonic components of d-axis current[14]. MAF can give maximal attenuation while maintaining bandwidth[15]. The performance of PLL in grid synchronisation is also increased by using MAF[16],[17]. The MAF is distinguished by being a simple-to-implement filter capable of rejecting frequency components that are multiples of the cutoff frequency.

The purpose of this research is to develop and simulate a three phase single stage solar PV integrated UPQC using d-q theory based control. MAF is also utilised to improve dynamic performance during active current load extraction. One of the important features of this system is the simultaneous control of voltage and current quality enhancement, and it is stable under various dynamic conditions such as voltage sags or swells, unbalanced loads, and so on. The suggested system is modelled with Matlab Simulink software and its features are investigated under dynamic and steady-state settings. The goal of this study is to design and simulate a three-phase single-stage solar PV integrated UPQC based on d-q theory. MAF is also used to improve dynamic performance when extracting active current loads. The simultaneous control of voltage and current quality enhancement is an essential feature of this system, and it is stable under various dynamic conditions such as voltage sags or swells, unbalanced loads, and so on. The proposed system is modelled using Matlab Simulink software, and its characteristics are explored in both dynamic and steady-state situations.

II. BASIC TOPOLOGY AND DESIGN

Figure 1 depicts the fundamental topology of the proposed system's power circuit, which is built for a three-phase grid. PV-UPQC's power circuit includes shunt and series compensators (essentially voltage source converters), also known as series active power filters (SAPF) and parallel active power filters (PAPF), which are linked by a DC link capacitor (which works as a dc bus).

The shunt compensator is connected to the load side, whereas the series compensator is connected to the grid side via an injection transformer in each phase, which injects the voltage produced by the series compensator into the grid. The PV array is directly connected to the dc bus via a diode, which inhibits power transfer in the opposite way. The series compensator, which is in voltage control mode, compensates for sags or swells in the grid side voltage. Interconnecting inductors are installed between the grid and both converters. The switching action of the converters might produce harmonics in the system, which are removed by the RC ripple filters. A bridge rectifier with an RL load is linked to the load side and serves as a nonlinear load.

PV-UPQC design includes PV module selection and sizing, MPPT algorithm selection, dc-link capacitor design, and dc-link voltage level selection. The next step is to develop interfacing inductors, injection transformers, and ripple filters[3]. Because the MPP voltage must be equal to the DC link voltage, the size of the PV module is determined by the DC link voltage. The shunt compensator should be sized so that it can handle the maximum power output of the PV array while also compensating for reactive power and load current harmonics. [1] describes the design of parameters for a single stage PV-UPQC. The ripple filters are chosen based on [3].

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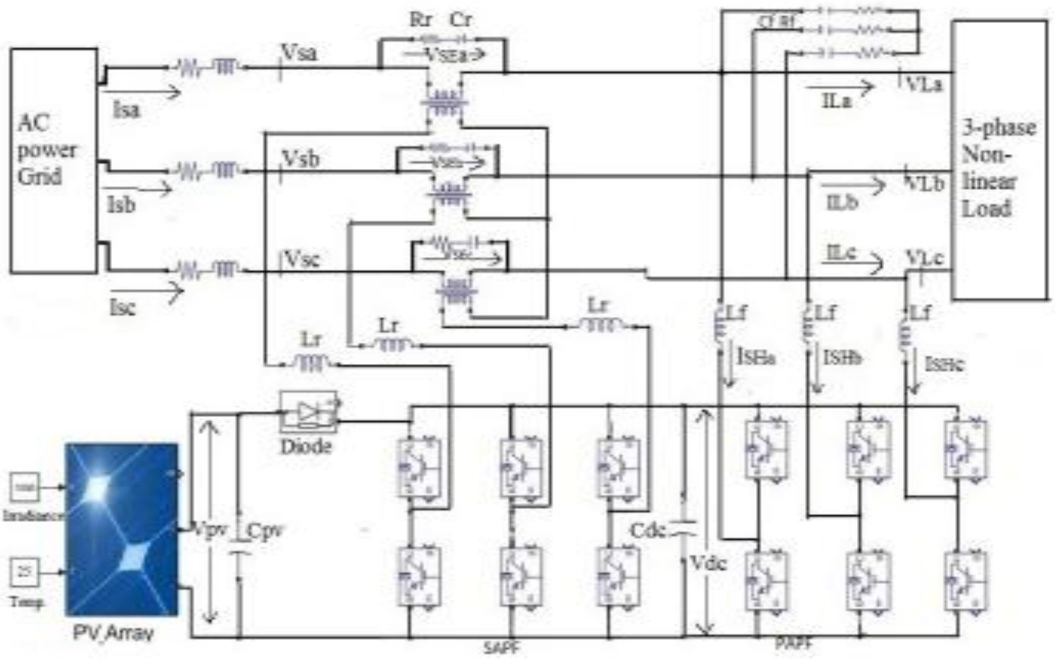

Fig. 1. Basic Topology

III. CONTROL OF PV-UPQC

The primary subsystems in the simulation and modelling of the proposed system are shunt and series active power filters, as well as their control circuitry and FOCV-based MPPT algorithm. Shunt VSC or PAPF injects current into the system, compensating for current harmonics on the load side and maintaining the sinusoidal current waveform, ensuring unity power factor. Series VSC or SAPF reduces voltage harmonics and injects power into the grid to cancel out the effect of grid voltage sag or swell. During a sag in grid voltage, the voltage injected from SAPF will be in phase with the grid voltage; but, during a swell condition, the voltage injected from SAPF will be out of phase with the PCC voltage.

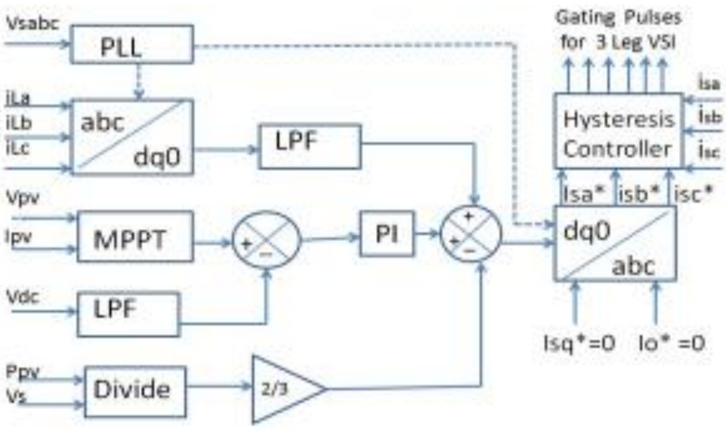

Fig. 2. Control for shunt compensator.

IV. CONCLUSION

The three phase solar photovoltaic system integrating UPQC was constructed and tested using Matlab software under various scenarios of grid voltage sags and swells and unbalanced load, and the system was determined to be stable under these conditions. The fractional open circuit voltage technique was used to obtain the maximum power from the PV. The THD values of grid current and load voltages are within the IEEE standard limits. . This solar PV integrated UPQC is a promising system for the current electric power distribution system, since it can incorporate renewable energy generation while improving power quality.

V. FUTURE SCOPE

Despite the fact that the FOCV algorithm is the simplest of all and provides smooth and faster responses without oscillation, measuring Voc was a hurdle that was overcome by incorporating a pilot cell. Pilot cell was replaced by semi-pilot cell to improve accuracy and reduce power loss [22],[23]. During normal operation, it will function as a component of the PV array, contributing to electricity generation.

Voc is calculated by unplugging the semi-pilot cell from the PV array. Because of this practise, the outcome is unaffected. For the best results, the FOCV method employed in this research can be replaced with more advanced FOCV algorithms.

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