PVA INTEGRATED UPQC FOR HARMONICS MITIGATION AND VOLTAGE PROFILE IMPROVING USING SVPWM

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Abstract - This article describes how a Unified Power Quality Controller is linked to a test system that has harmonics and voltage changes that induce sags and swells in the source and load voltages. The UPQC is supported by PVA, which is connected at the DC connection and feeds the grid with active and reactive electricity. Individual controllers are modeled for shunt and series converters using feedback from the source and load voltages and currents. Both converters work in tandem with the source voltage and the SRF controller using the sinusoidal PWM approach. Moreover, an MPPT is used to determine the reference current's age. By substituting traditional sinusoidal PWM with space vector PWM, the model is further improved by lowering the harmonic content of the source voltages and currents. The design is modeled using time-varying graphs created in the MATLAB Simulink environment.

***Key Words*:** Power Quality, Series Compensator, Shunt Compensator, UPQC, MPPT SVPW, Solar PV.

1.INTRODUCTION

Growing energy-related problems have prompted experts to explore for alternative energy solutions to reduce reliance on traditional energy sources. Environmentally friendly power sources (RES) have recently been shown to have a variety of uses where they can replace conventional energy sources. Electric power quality is the extent to which the voltage, frequency, and waveform of a power supply system meet specified levels. A smooth voltage curve waveform, ideally a sinusoidal wave, a stable AC frequency that remains near to the rated value, and a constant supply voltage that remains within the designated range are all signs of high-quality power. Stated differently, it may alternatively be described as the level of compatibility between the output of an electric outlet and the load that is plugged in. Insufficient power increases the likelihood that an electrical gadget may malfunction, break down too soon, or stop working altogether. Although "power quality" is a fair word, what is actually conveyed by it is not power or electric flow, but rather the characteristics of the voltage.

1.2 Series Compensation

Series compensation refers to the method of connecting a capacitor in series with the transmission line in order to increase the framework voltage. For series compensation, the system's impedance is increased by connecting reactive power in series with the transmission line. It also improves the power transmission capability of the line. It is frequently used in super high voltage and extra high voltage lines.

1.3 Unified Power Quality Conditioner

A device that is quite similar in development to a Bound together Power Stream Conditioner (UPFC) is a Brought together Power Quality Conditioner (UPQC). Two voltage source inverters in the UPQC are coupled to the energy storage capacitor. With the air conditioner structure, one of them is connected in series and the other in shunt. The UPQC, one of the strongest bespoke power devices, can simultaneously resolve problems with voltage and current. APFs connected in series and shunt configurations to a standard DC connect voltage make up the UPQC. All voltage music is compensated by the series APF, while current-based mutilations are dropped by the shunt APF. Moreover, raise power factor by making up the current component of the reactive load. In this work, without using transformer voltage, load, and channel current estimation, the UPQC framework's better simultaneous reference-outline with SPWM based control technique is streamlined, lowering the quantities of ongoing estimations and elevating the framework's execution to a new level. Figure 1.1 illustrates the UPQC setup. The series dynamic channel's primary driving force is the harmonious disengagement of a conveyance framework from a sub transmission framework. The series active filter at the utility-consumer point of common coupling (PCC) may also control voltage, correct for harmonics, and adjust for voltage flicker and imbalance. The main purposes of the shunt active filter are to absorb harmonics, compensate for reactive power and negative sequence current, and regulate the dc connection voltage between the two active filters.

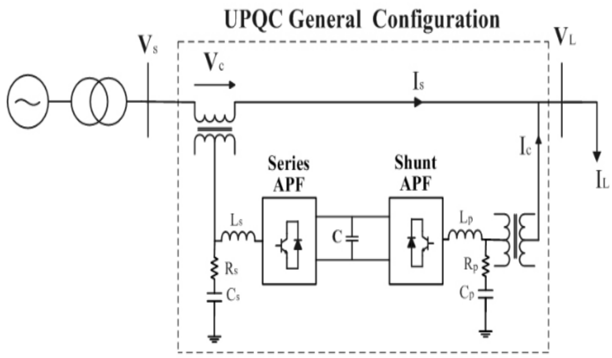

Figure:- 1.1 UPQC Model.

2. DESCRIPTION OF PROPOSED SYSTEM

The construction of the PV-UPQC is shown in Figure 2.1 The PV-UPQC is designed to operate in a three-phase system. The PVUPQC's series compensator and shunt are connected by a shared DC-bus. The shunt compensator is attached to the load side. By using an opposing inhibiting diode, the solar-powered PV cluster is simply coordinated to the DC-connection of UPQC. In voltage control mode, the series compensator extends and compensates for matrix voltage lists. The grid is linked to the shunt and series compensators by interacting inductors. The voltage generated by the series compensator is infused into the framework using a series infusion transformer. Swell channels are used to transmit music produced by converters sharing information. Using a voltage-fed load and a bridge rectifier, a nonlinear load is used.

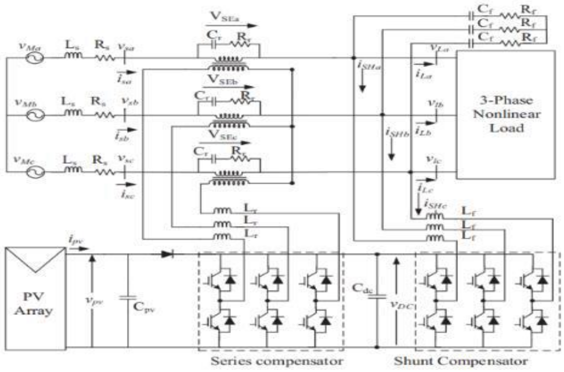

Figure:- 2.1 Proposed system of PV array with UPQC.

PV-UPQC Plan The proper measurement of the PV show, DC interface capacitor, DC connection voltage level, and other components is the first step in the PV-UPQC plan technique. In order to manage the peak power production from the PV cluster apart from compensating for the heap current receptive power and current sounds, the shunt compensator is measured. Since the PV cluster is directly connected to the UPQC DC-connection, the PV exhibit is calculated such that the desired DC interface voltage and MPP voltage match. Because of its rating, the PV array can both supply the load's active power and, in most cases, electricity to the grid. The specifics of the PV show are provided in Reference section. The series infusion transformer of the series compensator and the connecting inductors of the shunt and series compensators are the other intended components. Below is a detailed description of the PV-UPQC design.

Voltage Extent of DC-Connection: The DClink voltage Vdc is determined by the depth of modulation utilized and the per-phase voltage of the system. The DC-link voltage should be more than double the peak per-phase voltage of the three-phase system, where depth of modulation (m) is assumed to be 1, and VLL is the grid line voltage [8]. The required least worth DC-transport voltage for a line voltage of 415 V is 677.7 V. At 700 V (about), the DC-transport voltage is tuned to match the PV's MPPT operating voltage under STC circumstances. The PV array's voltage when it operates under STC conditions. 2) DC-Bus Capacitor Rating: The DC-interface capacitor is rated based on the DC-transport voltage level and the force requirement. The required DC-bus voltage is given below, along with the overloading factor (a), per-phase voltage (Vph), minimum time required to reach a steady value following a disturbance (t), per-phase current (Ish) of the shunt compensator, and the k factor (which accounts for energy variation during dynamics) in the energy balance equation for the DC-bus capacitor.

2.1 Space Vector Pulse Width Modulation (SVPWM)

Perhaps the most complex and time-consuming PWM technology available, space vector pulse width modulation (SVPWM) is the ideal choice for applications needing variable frequency drives. Its exceptional performance has led to its widespread adoption in recent years.

2.2 Advantages of space vector PWM

The following advantages make space vector PWM an excellent choice for PWM implementation:

- A higher voltage for the center result.
- A larger harmonic range.
- Conventional approaches employ lookup tables to produce this ideal switching sequence; microcontrollers and digital signal processors integrate more easily.

3. SIMULATION RESULTS

3.1 Unified power quality conditioner UPQC system with PVA

The reconstruction model of the suggested UPQC framework is shown below, with PVA linked at DC connect assisting the matrix architecture by giving the network dynamic and responsive capability. It also comprises the series capacitor and shunt capacitor, which are covered in the next section, as vital parts of this system. A grid-interfaced PV-INC MPPT system with a PMSM motor drive PI controller is shown in the figure. Higher voltage with fewer ripple is produced by the PFC circuit, which is linked to both the grid and the PVA. The PVA uses an MPPT approach based on gradual conductance to regulate the PFC converter that is connected to it. Voltage-situated control is employed by the network-associated PFC converter to regulate the output voltage. The MPPT method and voltage-oriented control models are outlined below.

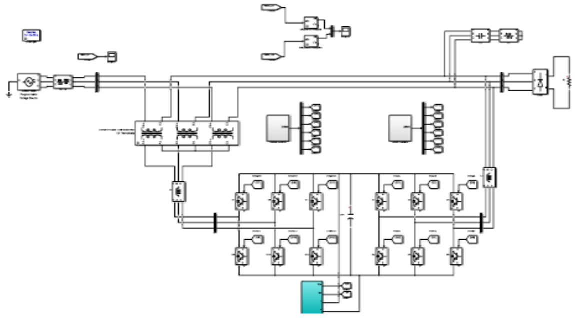

Figure:- 3.1 Proposed PV with UPQC.

A.) Shunt Controller

the shunt compensator's simulation model. It corrects for load power quality issues such as load reactive power and load current harmonics, as the name implies. Using the MPPT algorithm, it also draws power from the solar PV array in PV-UPQC scenarios.

C.) Internal model of PVA

The mathematical modeling of PVA linked at the DC link of UPQC is shown in Fig. 3.1 reverse blocking diode is used to facilitate the direct integration of the solar PV array with the UPQC DC-link. In addition to providing active electricity to the load, the PV array feeds power into the grid.

Case I: System analysis without PVA-UPQC

Without the PVA-UPQC, the source and load voltage magnitudes are compared in the graph below (Figure 3.2). There are sags and swells caused by the overlap of the two voltages' magnitudes at the same levels. The simulation runs for one second, introducing swell from 0.6-0.8 seconds and sag from 0.2-0.4 seconds. The source currents connected to the grid system without UPQC are displayed in the graph (Figure.3.3) below. The harmonic content of the source current is extremely high.

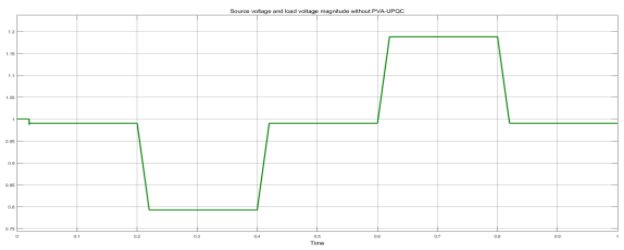

Figure:- 3.2 Source voltage and load voltage magnitude without PVA-UPQC

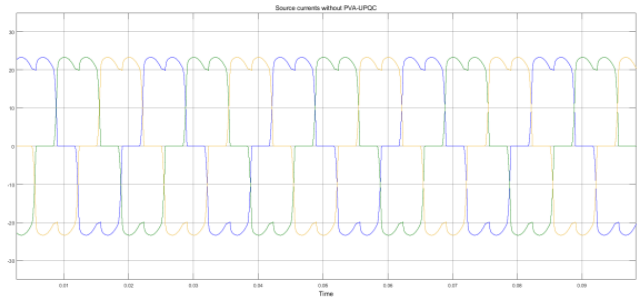

Figure:- 3.3 Source currents without PVA-UPQC

Case II: System analysis with PVA-UPQC

When comparing the source and load voltages under sag and swell circumstances, the system connected to a PVA-UPQC, in contrast to the system previously described, generates the graph seen in Figure 3.4. The graph shows that although the supply voltage varies, the load voltage remains constant at 0.97pu. The source current in Fig. 3.5 displays sin waveforms with reduced harmonics when the grid system is connected with PVA-UPQC.

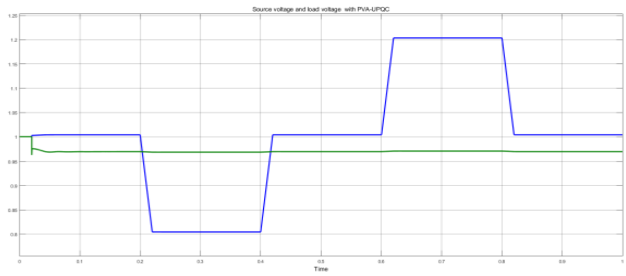

Fig. 3.4 Source voltage (blue) and load voltage (green) magnitudes with PVA-UPQC

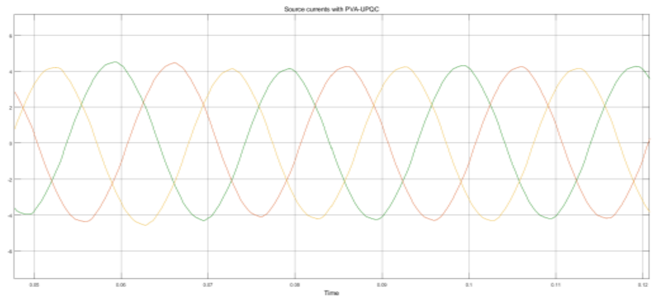

Fig. 3.5 Source currents with PVA-UPQC

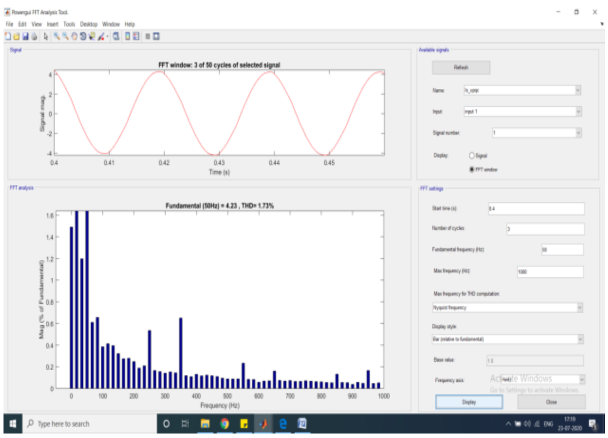

Figure:- 3.6 THD of source current with PVA-UPQC controlled by sinusoidal PWM technique

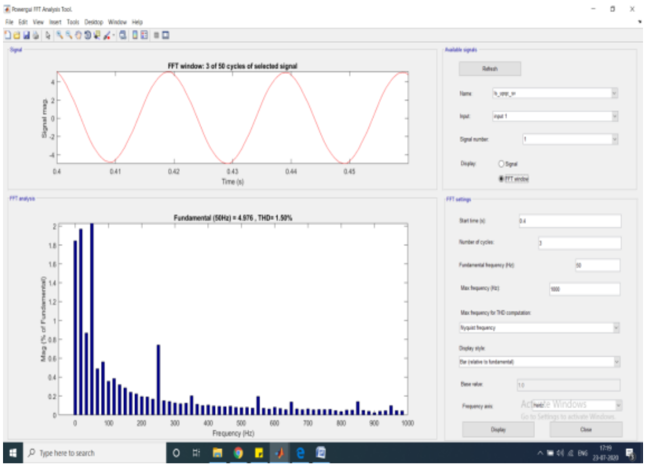

Figure:- 3.7 THD of source current with PVA-UPQC controlled by space vector PWM technique

4. CONCLUSIONS

With the aforementioned outcomes, even when the source voltage is experiencing voltage sag and swell, the load voltage is kept constant at 0.97pu, which is within the permitted voltage range of 0.95pu-1.05pu. By injecting the deficit voltage into the load side while preserving the voltage magnitude, the series converter sustains the load voltage. With PVA-UPQC coupled to the grid system, even the source current's THD is kept at a very low value of 1.73%, down from 27.14%. When the space vector PWM approach is used to update the series controller, the harmonics are further decreased to a smaller value of 1.5%. When the grid system is linked to PVA Integrated UPQC, the voltage profile and harmonics in the system are improved thanks to the simulation results above, which were produced by the Powergui Toolbox.

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