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# Analysis of Power Flow of Distributed Generation System With UPQC

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**ABSTRACT**

This work present comprehensive studies of sizing, stability analysis, and power flow through series and parallel power converters in a multifunctional three-phase distributed generation (DG) system employing a single-stage photovoltaic (PV) system integrated into a unified power quality conditioner in this paper. combining the PV system and a single power quality controller (UPQC). When the DG system is located between the grid and general loads or an ac micro grid, the UPQC acts as a bidirectional link. If the distributed generation system is in grid-connected mode, it is hardwired into the electrical grid and actively conditions the power lines while also providing the grid with electricity generated by the PV array. Through the utilization of a parallel inverter, the system is able to operate in island mode as an AC grid former regardless of whether or not a battery is present. To fully grasp the system's operation and to appropriately design the power converters, a thorough analysis of the power flow through the PV-UPQC is required. Size distribution curves are introduced and studied for this purpose. In addition, we provide two methods for controlling the amount of energy that our series and parallel inverters can handle. Total harmonic distortion is reduced with the use of an artificial neural network (ANN) controller, as presented in this research (THD). With a firm grasp on how the PV-UPQC works, we can conduct in-depth analyses of the active power flow via the converters. Dynamic Response's efficacy is assessed by simulation results that are presented.

Key words- Power flow, stability analysis, and integrated photovoltaic-unified power quality conditioner (UPQC) systems are some of the key concepts that define a distributed generation (DG) system. Connected Brains (ANN).

## I. INTRODUCTION

At now, Power Quality and System Reliability are the two most crucial aspects of any power distribution network. Every buyer is worried about the reliability of their supply chain. Today's consumers need not only a reliable power source, but also improved power quality. As a result, distribution networks experience a significant increase in power quality problems. Commonly accepted is the IEEE-519 standard for regulating the quality of the power.

Hence Scientists from all around the world had been working on this issue to enhance the quality of the electricity supplied. While there are conventional approaches to improving power quality, they often rely on passive components and may not react as intended if the power system's natural conditions shift. Because of the low cost, high efficiency, and high controllability of today's semiconductor devices, power electronic converters can be used on a massive scale. In contrast, it seems that semiconductor-based technology is particularly vulnerable to environmental impacts. Reactive power requirements for equivalent loads are raised when non-linear equipment, like power electronics converters, are introduced into the distribution network. Due to the distortion of the voltage waveform caused by harmonic currents, the power quality is degraded.

The requirement for perfect sinusoidal supply voltages has increased as demand for sensitive loads grows. This boosts the need for power conditioning systems. Accordingly, some form of compensation is essential to manage the power quality within the limitations given by the necessary standards. UPQC, first proposed by Hirofumi Akagi in 1995, is a cutting-edge device that addresses both load currents and supply voltage irregularities. This can aid in mitigating power quality problems such voltage dips and spikes, flickering lights, and harmonic distortions. UPQC is made up of a series active filter and a shunt active filter coupled in series by a shared dc link capacitor. Rather than letting voltage imbalances effect the load's final voltage. Shunt active filters are designed to regulate the common dc link voltage by adjusting for the reactive power requirement of the load, which in turn removes supply current harmonics.

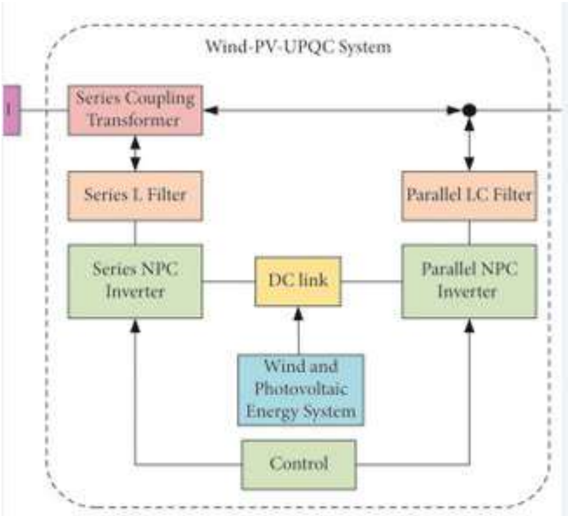


Fig 1:- UPQC system Architecture

Using a dual compensation method and feed forward control loop, it suggests a solar system. Improving electricity quality, which has become an urgent issue recently, is the primary focus of this research. The primary distinction between this design and its rival is the employment of a PV system, which, being a conventional energy source, helps to completely do away with the pollution issue. The primary goal of this model is to increase efficiency, which in turn reduces line losses and the occurrence of voltage imbalance, voltage sags, transients, and harmonic imbalances. This model's primary utility is in high-power settings; hence it makes use of an IGBT that can be fired based on the reference voltages. Therefore, IGBT is preferable over MOSFET in order to achieve better outcomes.

## II.MODELING OF A PROPOSED TOPOLOGY

### 2.1 PV-UPQC System Analysis:

As can be seen in Figure 2.1, the UPQC is a specialized power device that combines series and shunt active filters that are wired in series and shunt on the dc side and share a common DC capacitor. To do this, it uses a DC energy storage capacitor shared by two voltage source inverters (VSIs). In this configuration, one VSI is connected in series with the other, and the other is connected in parallel.

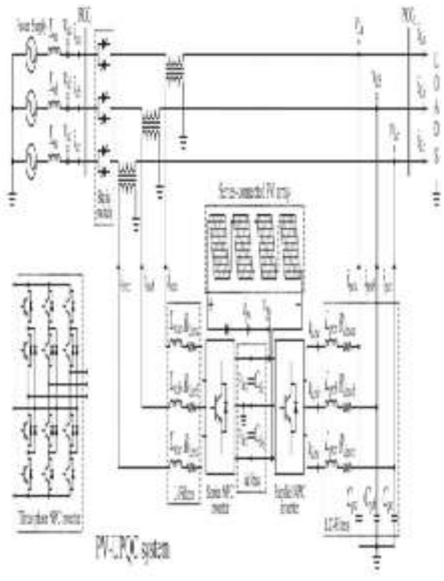

Figure 2.1 UPSC – power circuit

Connecting a shunt active filter serves primarily as a power factor correction device, mitigating the effects of harmonics and imbalances in the load current and correcting for them. In addition to this, it contributes to the stability of the average voltage that is found in capacitor. which is an inverter for the dc voltage, which is wired to a shared capacitor. On the ac side of the UPQC, couple the shunt section in parallel with the load. The shunt interface inductor and shunt filter capacitor's primary function are the identification of the quality of the power flow in to the circuit.

The series active filter makes up for the imbalance in the load voltages by injecting voltage into the supply voltages in series. This prevents the load voltages from becoming distorted and helps to keep their magnitudes at the level that was intended. We have included a dc storage capacitor and a series VSI to our system, which allows us to inject the required voltage. In order for the series VSI switches to carry out their duties, the control mechanism generates switching signals based on the current voltages being monitored. Once the series filter is applied to the VSI's output voltages, the switching harmonics are removed, and the original signal shape is recovered.

2.2 Method of Regulation:

Since the reference template and modulation methodology employed in an active power filter are both products of the current controller's design, this approach is crucial to the filter's performance. Shunt active power filters are used to generate the gating signals for inverters; their control schemes are responsible for regulating the dc voltage and establishing the waveforms of the current references used by the inverters in each phase. The efficiency with which an active power filter corrects for distortion in the load current is contingent on its accuracy and speed in tracking the reference signal used to determine that correction.

It turns out that hysteresis control is the best option when working with a shunt active filter, therefore we'll talk about it in Section 2.2.1. Accordingly, a hysteresis controller has been implemented in the UPQC simulation model. Hysteresis control is commonly employed due to improvements in system stability, dependability, and response time.

To achieve a balanced, distortion-free load voltage of the correct magnitude, is manipulated to inject the necessary voltage between the "point of common coupling" (PCC) and the load. Based on the orientation of the injected voltage, we distinguish between two UPQC notations: UPQC-Q and UPQC-

P. To avoid any active power consumption during steady-state operation, the series compensator must have its injected voltage phase-shifted by 90 degrees with regard to the supply current in the first scenario (denoted 'UPQC-Q'). Therefore, the shunt compensator via the dc connection is used by the series compensator in the second situation, referred to as UPQC-P. In the case of quadrature voltage injection, the VA rating of the shunt compensator can be decreased because the series compensator's active power consumption is minimised while also compensating for a portion of the load's reactive power requirement (UPQC-Q).

Given that the series compensator contributes nothing toward meeting the reactive power demand of the load in the 'UPQC-P' scenario, the shunt compensator is used instead. Series compensators require active power from the shunt compensator before they can inject that power into the system. Since the VA rating of the series compensator decreases in this case, the VA rating of the shunt compensator increases.

ANN III. An Overview:

There is a wide variety of electrical uses for neural networks. ANNs are a type of artificial intelligence technology. Over the years, researchers have studied artificial neural networks (ANNs) in an effort to understand and achieve human-like computational performance. More recently, the term "intelligent control" has come to encompass these and other methodologies by combining conventional control with emergent techniques based on physiological metaphors. The benefits of these include high rates of speed, fault tolerance, and flexibility. Information is processed by an ANN's dynamic state in response to inputs, and the network itself is made up of a large number of basic, highly interconnected processing components. Because of their promise to solve challenges in computer science and artificial intelligence that have so far defied traditional serial computers, research into ANN models has recently seen a surge in popularity. Speech processing, picture recognition, machine vision, robotic control, etc., are all areas where neural networks excel, allowing them to achieve human-like performance.

Controlled by an ANN:

A multilayer back propagation type ANN controller is employed to boost the compensating device's efficiency. When instructing ANN, the MATLAB toolbox is employed. Levenberg-Marquardt Back propagation is the training algorithm employed in the ANN controller. The Gradient Descent (GD) Method searches for the local minimum of a function using a first-order optimization process. When starting from a large distance away from the ultimate minimum, this technique is quite stable, but it converges very slowly. Second-order optimization, which lies between the GD and the Gauss Newton (GN) algorithms, is achieved by use of the LM back propagation algorithm. Even if it starts off far from the ultimate optimum, the LM algorithm will find a solution because of its greater robustness. LM is superior to the GN algorithm and the GD approach.

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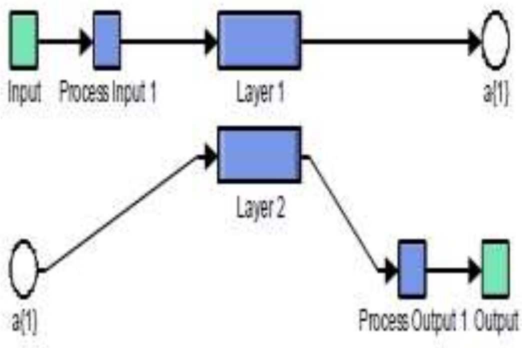


Fig 3.1 ANN controller

1V. SIMULATIONS AND RESULTS

To examine UPQC circuit waveforms and learn about their dynamic and steady-state performance, voltage and current ratings, and more, a MATLAB/Simulink simulation model of a UPQC circuit has been developed.

The following examples of typical cases have been simulated, and the findings are reported.

1) Three-phase faults that last only a little while.

Long-term, three-phase fault situations.

A three-phase fault with a fluctuating load.

The Fourth Harmonic Compensation

Fifth, we confirm that the DC link voltage is regulated under these conditions.

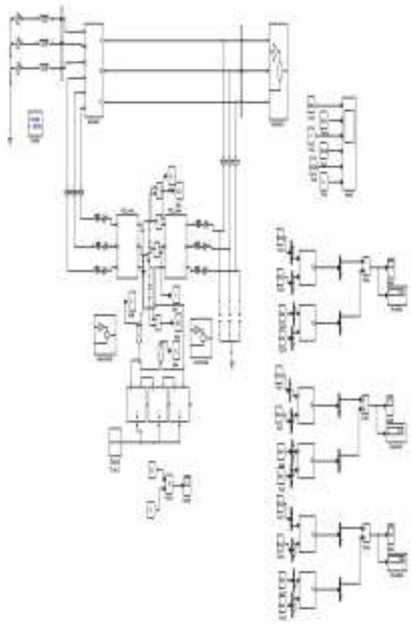

Figure 4.1: PV-UPQC system block diagram

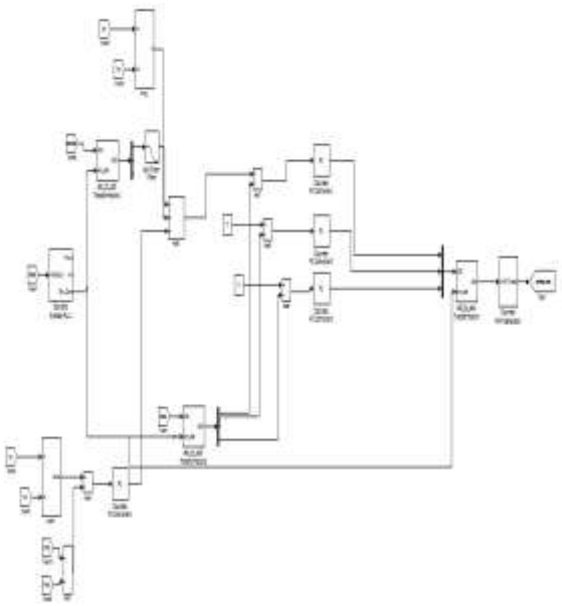

Figure 4.2: configuration of NPV inverter.

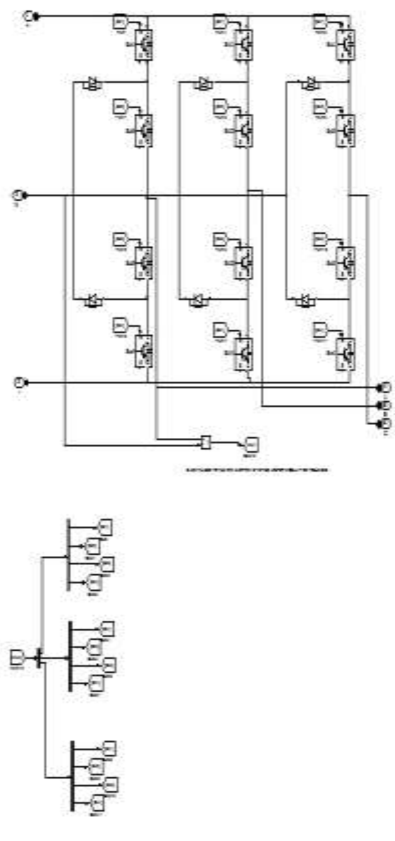

Figure 4.3 : Block diagram of series converter

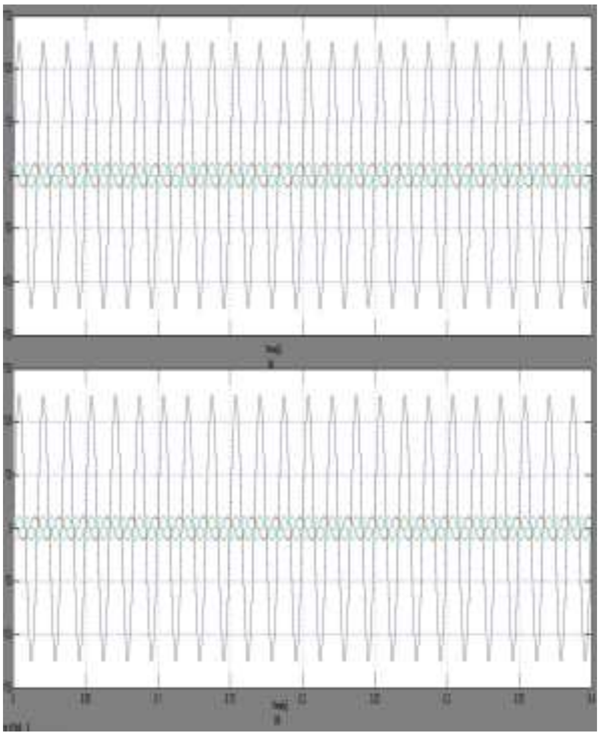

Figure 4.4: PV-UPQC performing active power injection into grid with various constraints.

Power is injected by removing the load, the source currents are sinusoidal and are out of phase with the respective utility voltage.

Case 3:

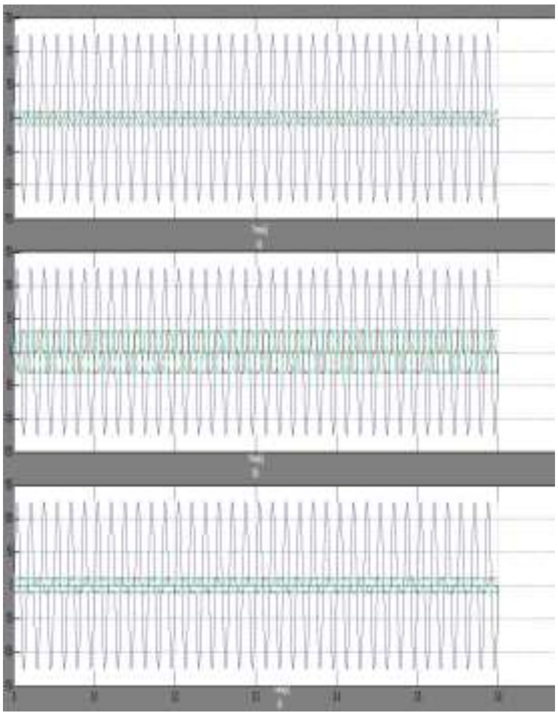

Figure 4.5 PV-UPQC performs active power injection and active filtering with various parameters.

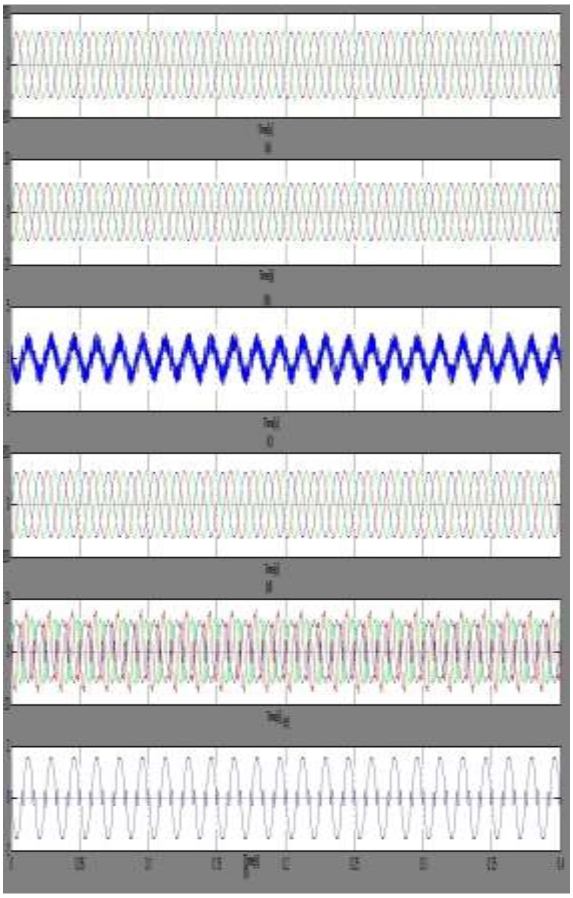

Figure 4.4: PV-UPQC performing active power filter with various constraints.

V.CONCLUSION

In this study, a single-stage, three-phase, four-wire PV grid-tied system is developed that can also function as a UPQC using a dual-compensating method and a frequency-following current-limiting regulator (FFCL). Two three-level NPC inverters connected in series formed the basis of the PV-UPQC system. Along with providing active power from the PV system, the PV-UPQC system was also able to condition the power lines in a series-parallel arrangement. Therefore, experimental testing was conducted to evaluate the system's static and dynamic performance in response to different grid voltage conditions, including sags, unbalances, and harmonics. Series compensation, suppression of load harmonic currents, and load reactive power compensation were all used to successfully implement a power factor correction. The effect of the FFCL on the series converter current references was determined under conditions of sudden changes in solar irradiation. In this study, an artificial neural network (ANN) controller is used to lessen THD (THD). Therefore, the proposed PV-UPQC system provides a feasible option that might be applied to DG systems and AC micro grids.

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