

# Fuzzy Logic Controller Based Dual Topology of UPQC with Power Quality Improvement Features

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**Abstract-** The SAF acts as high impedance for the current harmonics and indirectly compensates the harmonics, Unbalances, and interference of the network voltage since the connection transformer voltages is equal to the distinction between the grid voltage and the load voltage. Similarly, the PAF indirectly compensate the unbalances, displacement, and harmonics of the network current, provision of a low-impedance path for the harmonic load current. By employing Dual UPQC we can separate the complex harmonic extraction of the grid voltage

Conditioner, etc. out of these facts controller here for power quality enhancement we examine Dual topology of Unified Power Quality Conditioner.

## I. INTRODUCTION

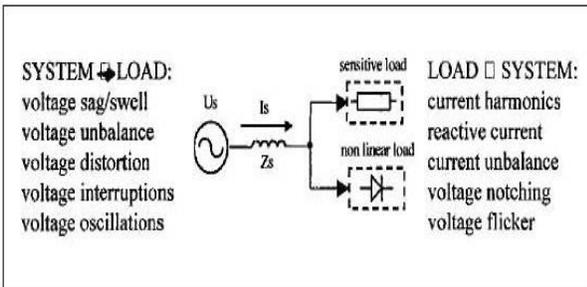
Due to use of nonlinear power electronics loads, like static rectifiers, variable speed drives, dc/ac converter, has produce many electric power quality problems such as high current harmonics, poor power factor and more neutral current, etc. "Power Quality is a set of limits of electrical properties that permits Electrical system to function in their intended manner without loss of performance or life". Trouble caused by power quality can have an adverse economic impact on utilities.

Power flow is controlled by the control actions employing FACTS devices, which incorporate (i) Static VAR Compensators, (ii) Thyristor Controlled

## II. CONCEPT OF POWER QUALITY

Power quality is the set of limits of electrical properties that allows electrical systems to function in their intended manner without significant loss of performance or life. The term is used to describe electric power that drives an electrical load and the load's ability to function properly with that electric power. Without the proper power, an electrical device (or load) may malfunction, fail prematurely or not operate at all. There are many ways in which electric power can be of poor quality and many more causes of such poor quality power

The electric power industry comprises electricity generation (AC power), electric power transmission and ultimately electricity distribution to an electricity meter located at the premises of the end user of the electric power. The electricity then moves through the wiring system of the end user until it reaches the load. The complexity of the system to move electric energy from the point of production to the point of consumption combined with variations in weather, generation, demand and other factors provide many opportunities for the quality of supply to be compromised.



Series Capacitors, (iii) Static Series Synchronous Compensators,(iv) Static Compensators, (v) Unified Power Flow controllers (vi) Unified Power Quality

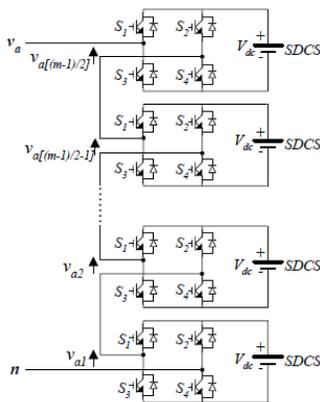
## III. CONCEPT OF MULTILEVEL CONVERTER

An inverter is an electrical device that converts direct current (DC) to alternating current (AC); the converted AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits.

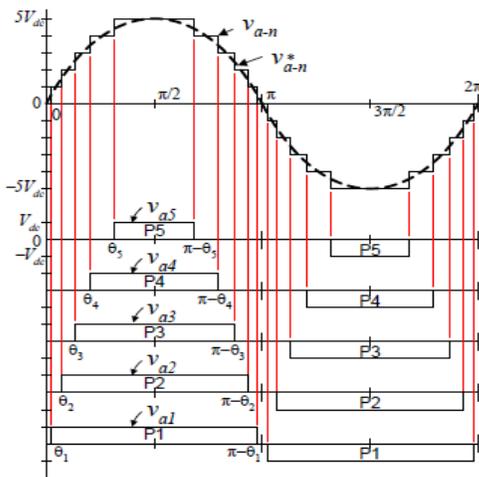
Static inverters have no moving parts and are used in a wide range of applications, from small switching power supplies in computers, to large electric utility high-voltage direct current applications that transport bulk power. Inverters are commonly used to supply AC power from DC sources such as solar panels or batteries.

The electrical inverter is a high-power electronic oscillator. It is so named because early mechanical AC to DC converters was made to work in reverse, and thus were "inverted", to convert DC to AC.

**CASCADED H-BRIDGES INVERTER:**



Single-phase structure of a cascaded H-bridge inverter

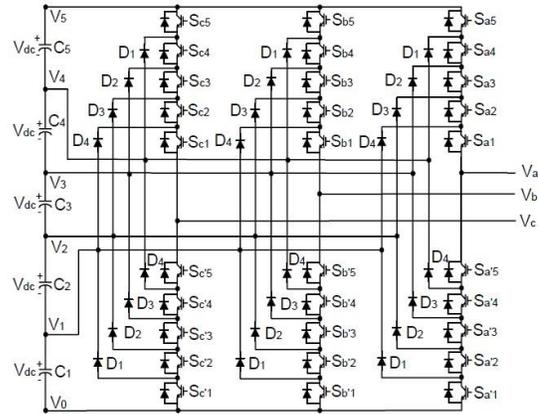


Output phase voltage waveform of an 11-level cascade inverter with 5 separate dc sources

**DIODE-CLAMPED MULTILEVEL INVERTER:**

The neutral point converter proposed by Nabae, Takahashi, and Akagi in 1981 was essentially a three-level diode-clamped inverter. In the 1990s several

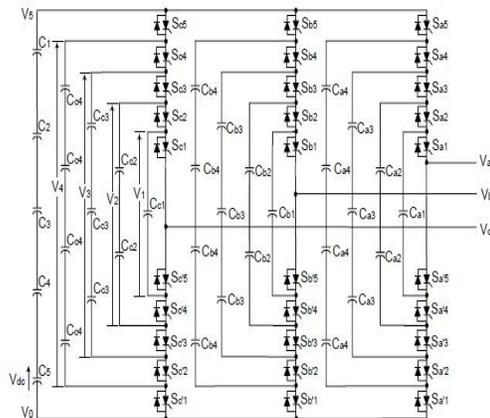
researchers published articles that have reported experimental results for four-, five-, and six-level diode-clamped converters for such uses as static VAR compensation, variable speed motor drives, and high-voltage system interconnections.



Three-phase six-level structure of a diode-clamped inverter.

**FLYING CAPACITOR MULTILEVEL INVERTER:**

Meynard and Foch introduced a flying-capacitor-based inverter in 1992. The structure of this inverter is similar to that of the diode-clamped inverter except that instead of using clamping diodes, the inverter uses capacitors in their place. The circuit topology of the flying capacitor multilevel inverter is shown in Figure 31.7. This topology has a ladder structure of dc side capacitors, where the voltage on each capacitor differs from that of the next capacitor. The voltage increment between two adjacent capacitor legs gives the size of the voltage steps in the output waveform



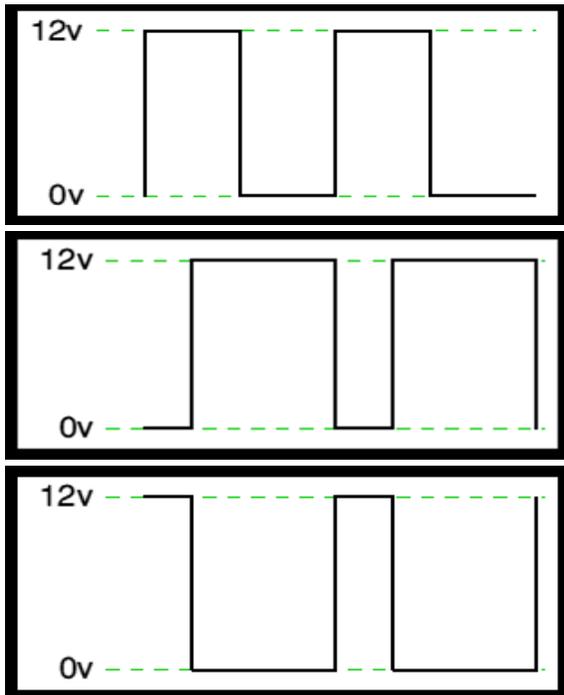
Three-phase six-level structure of a flying capacitor inverter

One advantage of the flying-capacitor-based inverter is that it has redundancies for inner voltage levels; in other words, two or more valid switch combinations can synthesize an output voltage. Table 31.2 shows a list of all the combinations of phase voltage levels that are possible for the six-level circuit shown in Figure 31.7. Unlike the diode-clamped inverter, the flying-capacitor inverter does not require all of the switches that are on (conducting) be in a consecutive series.

**PULSE WIDTH MODULATION (PWM):**

Pulse Width Modulation (PWM) is the most effective means to achieve constant voltage battery charging by switching the solar system controller's power devices. When in PWM regulation, the current from the solar array tapers according to the battery's condition and recharging needs. Consider a waveform such as this: it is a voltage switching between 0v and 12v. It is fairly obvious that, since the voltage is at 12v for exactly as long as it is at 0v, then a 'suitable device' connected to its output will see the average voltage and think it is being fed 6v - exactly half of 12v. So by varying the width of the positive pulse - we can vary the 'average' voltage.

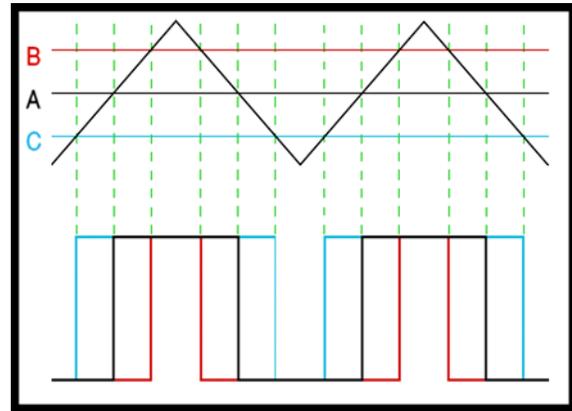
Similarly, if the switches keep the voltage at 12 for 3 times as long as at 0v, the average will be 3/4 of 12v - or 9v, as shown below and if the output pulse of 12v lasts only 25% of the overall time, then the average is



Pulses with different duty cycles

**Pulse Width modulator:**

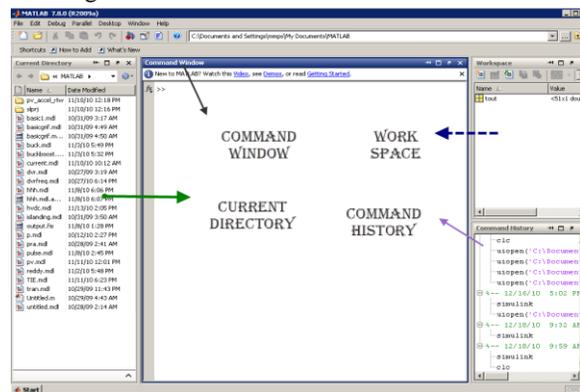
So, how do we generate a PWM waveform? It's actually very easy, there are circuits available in the TEC site. First you generate a triangle waveform as shown in the diagram below. You compare this with a d.c voltage, which you adjust to control the ratio of on to off time that you require. When the triangle is above the 'demand' voltage, the output goes high. When the triangle is below the demand voltage, the



simple pwm pulse generation

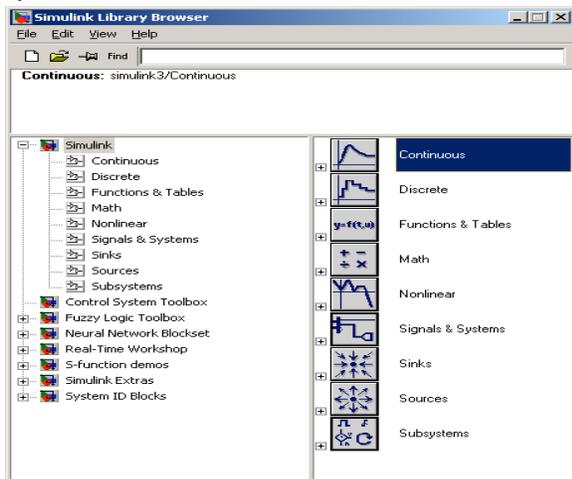
**IV. INTRODUCTION TO MATLAB**

Matlab is a high-performance language for technical computing. The name mat lab stands for matrix laboratory. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include Math and computation Algorithm development Data acquisition Modeling, simulation, and prototyping Data analysis, exploration, and visualization Scientific and engineering graphics Application development, including graphical user interface building



Block diagram of Mat lab components

In Simulink, data/information from various blocks are sent to another block by lines connecting the relevant blocks. Signals can be generated and fed into blocks dynamic / static).Data can be fed into functions. Data can then be dumped into sinks, which could be scopes, displays or could be saved to a file. Data can be connected from one block to another, can be branched, multiplexed etc. In simulation, data is processed and transferred only at discrete times, since all computers are discrete systems. Thus, a simulation time step (otherwise called an integration time step) is essential, and the selection of that step is determined by the fastest dynamics in the simulated system.



Simulink library browser

The nonlinear Simulink blocks of the powerlib library are stored in a special block library named powerlib models. These masked Simulink models are used by SimPowerSystems software to build the equivalent Simulink model of your circuit. See Improving Simulation Performance for a description of the powerlib models library.

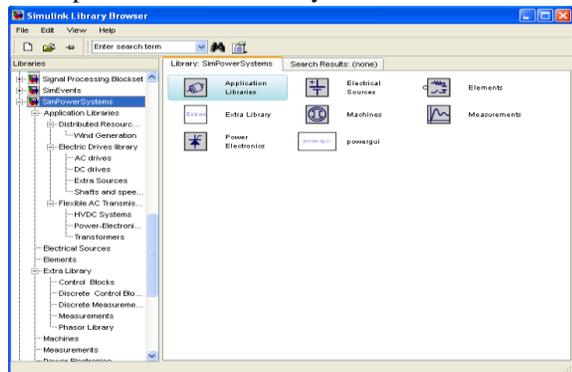
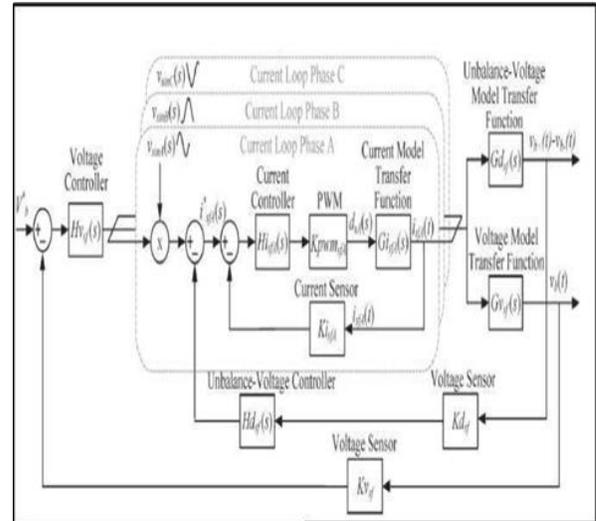


Diagram of simpower system

V. CONTROL SCHEMES

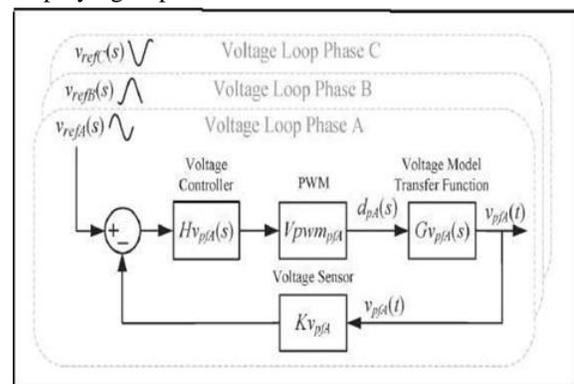
SAF Control: The SAF control strategy contains of three identical grid current loops and two voltage loops. The current loops are liable for tracking the reference to each grid input phase in order to control the grid currents. One voltage loop is responsible for regulating the total dc link voltage, and the other is liable for avoiding the unbalances between the dc link capacitors.



Control of SAF controller

When the load increases, overcoming the input grid current, the dc link provides momentarily the active power utilization, resulting in diminish of its voltage. This voltage controller proceed to raise the grid current reference, when the load diminish, the voltage controller reduces the grid current reference to modulate the dc link voltage.

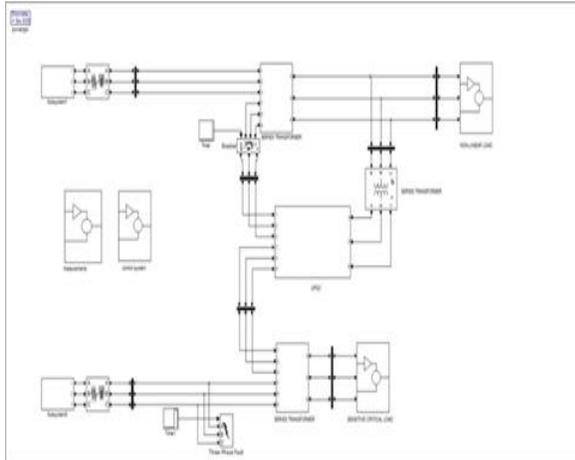
The dynamic model is achieved by the circuit analysis using average values related to the switching period. Through small signal scrutiny and by employing Laplace.



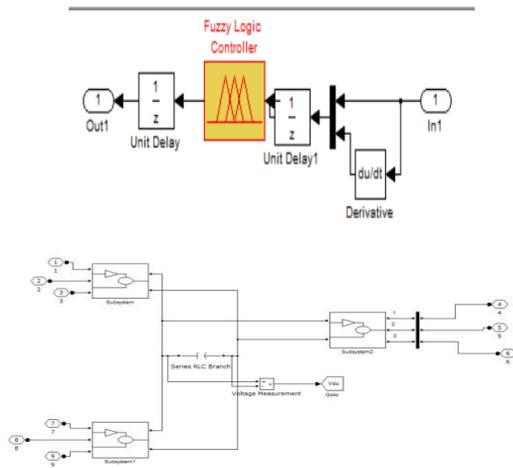
Control block diagram of the PAF voltage loop

VI. MODELING OF DUAL UPQC

Simulation was built in several steps from grid source to load, Dual UPQC operation at various loads is as shown in fig 5. Power Circuit of iUPQC is consist of two four wire three-phase converter connected b a c -back and their respective output filters as shown in figure



Simulink Design of Iupqc



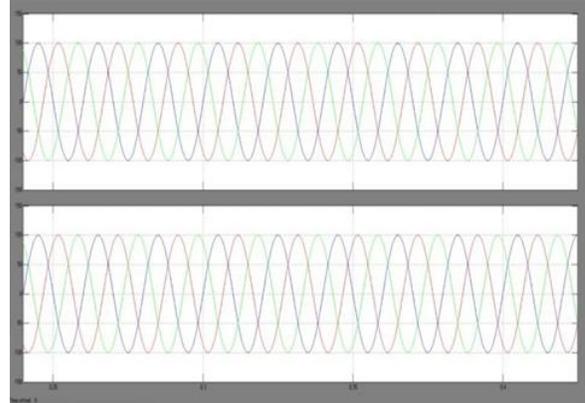
Power Circuit of Iupqc

VII. RESULTS

The results are taken out by considering sudden changes in load conditions. Such as low voltage, rapid load

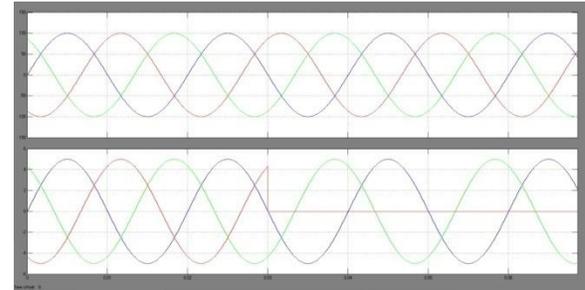
STEP. A. Consider three phase source voltages. Out of those three phases voltage lower accure in phase A after two cycles and its magnitude goes to zero. But by Dual UPQC compensation modulated load voltage is taken out. Figure 7 shows the source

voltage with rapid voltage deep in phase A and modulated load voltage after compensation.



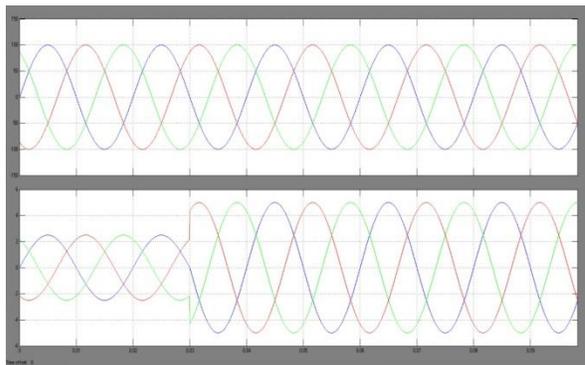
source voltage and load voltage during voltage dip in phase A

STEP B. Consider a three phase source current. Out of those three phases, phase A has dip after two cycles. But by Dual UPQC compensation modulated load voltage is taken out. Figure 8 shows the load voltage and source current by considering dip in source current and modulated load voltage.



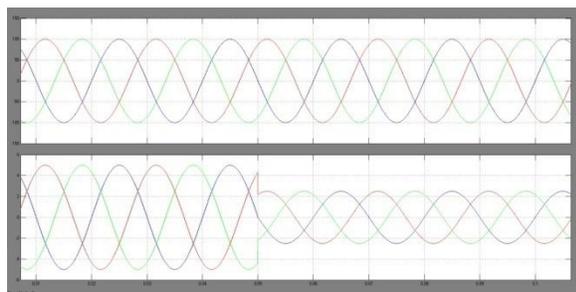
Load voltage and source current dip

STEP C. Consider a three phase load current. There is immediate increase in a magnitude of current. But by Dual UPQC compensation modulated load voltage without change in magnitude is taken out. Figure9 shows the load voltage and load current by considering load current step from 50% to 100%



Load voltage and load current step

*STEP D.* Consider a three load current. There is a rapid decrease in magnitude of current. But by Dual UPQC compensation modulated load voltage without change in magnitude is separated. Figure 10 shows the load voltage and load current by considering load current steps from 100% to 50%



Load voltage and load current step

### VIII.CONCLUSIONS

The results obtained with the iUPQC able to compensate the nonlinear load currents and also certain the sinusoidal voltage for the load in all three phases. The control also had a great operation during the load steps and voltage disturbances at the source. The main advantages of this initiate control in relation to the other proposed schemes were the utilization of sinusoidal references for both series and shunt active filter controls without the requirement of complicated calculations or coordinate transformations. By the use of Dual UPQC, it can confirm that current source linear with respect to nonlinear load, Constant load voltage; this model Eliminates harmonic load voltage.

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