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THD Mitigation In The Power Systems By Using The UPQC

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Abstract: **Power output from utilities has become a growing concern for modern businesses in the previous decade. Because of voltage imbalances, interruptions, and harmonics, equipment might fail due to voltage sag and flicker, two common power quality problems. Voltage level changes can lead Nonlinear-based loads to malfunction because of their highly sensitive electric components. The quality of the electrical grid's power is degraded by the large demand. Stability, voltage management, stable flow, and oscillation damping control are all factors that the FACTS stimulation functions take into account. Inductors and condensers are used to filter the output of four identical multi-level converter guns in this UPQC Modular Matrix converter. The TOTAL Harmonic Distortion of the load voltage and current is reduced by using the bracket currents and voltages to pick a multilayer converter. The UPQC based on a Modular Multilevel Matrix converter was simulated using MATLAB / SIMULINK. Comparison of THD values between the proposed approach and standard UPQC is used to demonstrate its efficacy.**

Index Terms: **UPQC, FACTS, damping control, Multilevel Matrix converter, electrical grid's.**

I.INTRODUCTION

The FACTS simulation functions compute critical clearing time, voltage control, steady power flow, and the management of damping oscillations. Reactive power management, voltage profile improvement, utilisation of existing transmission system assets, transmission system reliability, transient grid stability, and loopflow reduction are all made possible by the installation of these controllers in the power system. System power quality can be improved by using a UPQC single phase. AC 220V three-phase supply and RL load make up the system. The load current THD is first measured using FFT analysis on voltage sags generated by this system. The UPQC gadget from FACTS is now compatible with this system. Based on the multi-level converter principle [2-5], the UPQC is proposed. The voltage supply and nonlinear loads are both catered to in this proposed UPQC. There are identical multilevel converter arms and filtering inductors in the proposed UPQC, therefore it is also called a single-phase Modular Multilevel Matrix Converter (M3C)[6-9]. Each of the arms contains an equal number of cascade H-bridge submodules. A three-level converter with three converters linked in a cascade manner is proposed in the proposed system. Benefits in maintaining aspects and a logical redundancy concept are provided by this topology. This topology contains two identical terminal submodules with simple and robust connectivity, unlike other multilevel UPQC topologies.

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II POWER QUALITY

To put it another way, power quality refers to the set of restrictions placed on electrical attributes that ensures electrical systems perform and last as intended. An electrical load's ability to function effectively when supplied with this electric power is referred to as the "load's electrical power capacity." If a piece of electrical equipment (or load) does not have adequate power, it may not function properly. To generate low-quality electric power, there are a variety of methods and several causes to consider.

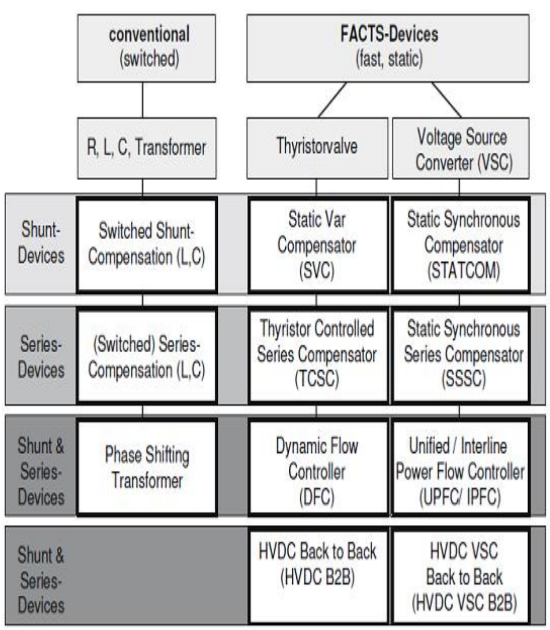
Electricity generation (alternating current power), transmission, and distribution are all components of the electric power industry. The end user's wiring system is responsible for delivering electricity to the end user's devices. Changes in weather, generation, demand, and other variables can affect the quality of the energy supply as it goes from the point of production to use.

Despite its popular usage, the term "power quality" refers to voltage rather than electricity or current. Energy flow is what constitutes power, and the amount of current required by a charge is frequently random.

FACTS devices emerged in tandem with the development of higher-capacity power electronic components. For high-powered gadgets, there exist converters capable of converting voltages up to the greatest possible levels. Beginning points are nodes in a network that have an effect on a certain system component's reactive power or impedance (or subsystem). Figure 1.2 and FACTS are the two categories where you'll find devices. Some clarification is needed on the FACTS taxonomy of "dynamic" and "static." For FACTS-devices, the term "dynamic" refers to the fast controllability provided by power electronics. With this feature, it stands apart from other comparable gadgets.

Devices with no moving parts, such as mechanical switches, are referred to as "static" because they lack dynamic control. Therefore, the most majority of FACTS devices are capable of being static or dynamic in nature, as a result.

A. Types of Facts Devices



This figure shows the conventional devices that include transformers and other fixed or mechanically switchable elements such as induction or performance. Even though these components are also used in FACTS devices, they must be switched using additional electronic valves or converters in small steps or alternating current cycles with switching patterns in order to function. Thyristor converters or valves are used in FACTS devices in the left column. It has been a while since we've seen one of these converters or valves. The converters' once-per-cycle switching frequency or the use of Thyristors to merely bridge valve impedances results in low losses.

There are two principal voltage source converters today: IGBTs and IGCTs, and the devices in the right column of the FACTS diagram use more recent voltage source converter technologies (IGCT). In order to produce a voltage that is both variable in amplitude and phase, Voltage Source Converters make use of IGBTs or IGCTs to regulate the pulse width. With high modulation frequencies, low harmonics in the output signal are possible and can even compensate for network outages. However, as the frequency increases, so does the amount of loss. Unique converter designs are therefore required to counteract this.

B. Static synchronous Compensator (STATCOM):

Electric storage device, transformer for VSC coupling and DC are the three components of the STATCOM. Since the small dc condenser serves as an energy storage system, STATCOM is able to change reactive power via a power line. Real and reactive power can be switched from two to four quadrants by replacing the dc condenser with a dc battery or other dc voltage source. The STATCOM model in Figure 1 is shown in action.

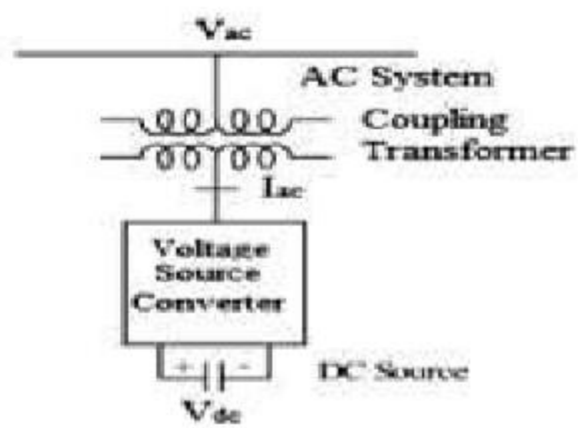


Figure 1. Basic Operation of STATCOM

III PV BASED UPQC

The UPQC topology proposes a single-phase device with four converter weapons and inductive and condenser filters. There are five waveform converters in each converter arm[14,15]. The multi-level converter is powered by an appropriate control circuit. The PI controller does not interfere with the control circuit's ability to supply the appropriate pulses. Separate DC sources are provided for each H-bridge. The output is a square wave since each H-Bridge output is multiplied. It is therefore necessary to filter out the output voltage before it can be used for UPQC purposes. IEEE standard 519 completely eliminates the system's power drop and reduces the overall harmonic distortion of the load.

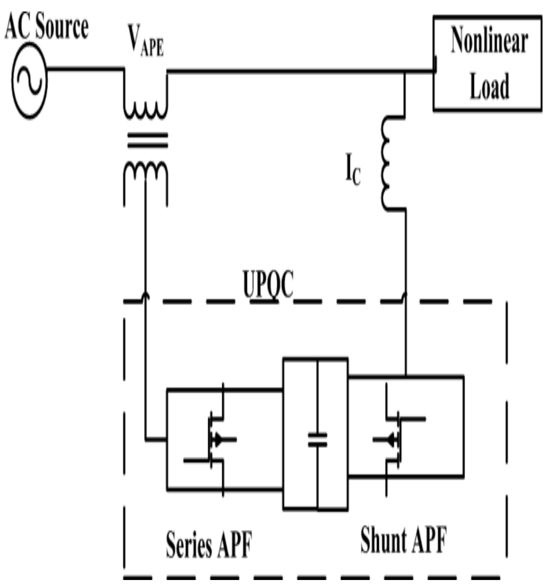


Figure 2 Block digram for proposed UPQC

A. Capacitor Voltage Balancing

The MMC adds and removes modules on a regular basis. Consistent condenser voltage distribution should not be maintained at any moment in time by a module. New or skipped modules must be chosen. Changing the output voltage and damaging the device are both possible outcomes if the module insert goes wrong. Using the current arm's trajectory, this choice is made.

B. Phase-shifted pulse-width sinusoidal modulation (PSSPWM)

A triangular high frequency waveform is used to compare the signal to be modulated with conventional SPWM. In order for converters to use the higher levels, PS-SPWM makes use of as many waveforms as possible. The output signal harmonics can be minimised by shifting the phase of the waveforms to offset the moment of switching between the various modules. For example, a 360Hz waveform is only 6 times as fast as the modulation frequency. While the apparent switching frequency is higher, the lower harmonic frequency is centralised at roughly 1800 Hz, which is five times as fast as the five modules per arm are accessible, as shown in the graph. One of the most important benefits of using this method is that the MMC suffers just a small percentage of all frequency equivalents when modules are turned on. Increasing the output rate or decreasing the switching frequency of the individual modules increases the number of modules. From the image, it's clear to see a sinusoidal waveform. Compared to SPWM, the harmonic content of this signal shows that it has a reduced number of harmonics. With only five stages, the transformation is immediately apparent. A reduction in the number of modules and/or elimination of the need for filters makes this even more apparent.

IV SIMULATION OF MODULAR MULTILEVEL CASCADE CONVERTER BASED UPQC

MMC topology intrinsic capacitive voltage is balanced and equilibrated with the circulating current by means of an internal balancing control. Achieving an equal active power transfer across the converter arms without affecting the overall circuit's external compensation is the primary goal. The M3C UPQC arm groups are balanced using the differential voltage.

External compensation for voltage and current stabilisation of total power must take into account the equations of summated capacitive voltage and shunt currents for this purpose. Capacitive voltages are indicated by common mode voltages and circulating current, which are represented by differential mode voltages. The M3C UPQC equivalent circuit consists of two positive and negative groups, as was previously stated.

1) System of Constant State

The Sag system, on the other hand,

3) System for detecting and correcting errors

Source and UPQC voltages are reduced by 0.25 kV to 1.5 kV, and the load voltage is reduced by 0.25 – 0.40 sec, as shown in Figs. 1, 2, and 3.

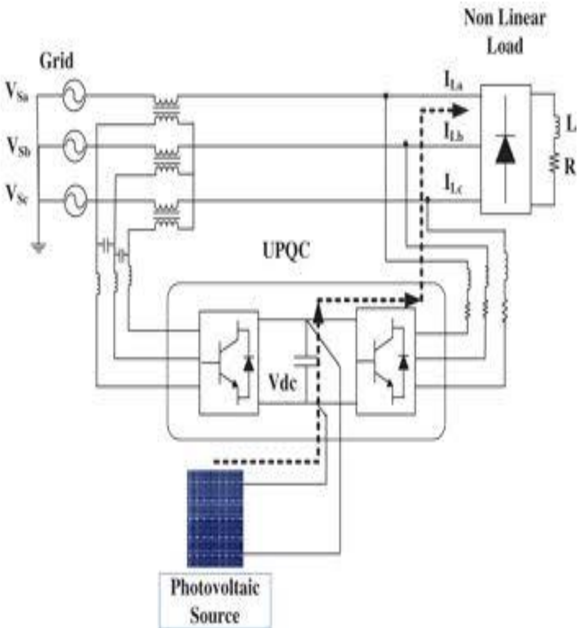


Figure 3 simulation Diagram

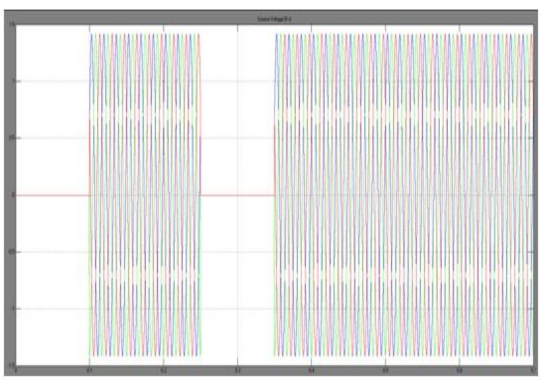


Figure 4 Voltage sags in source voltage

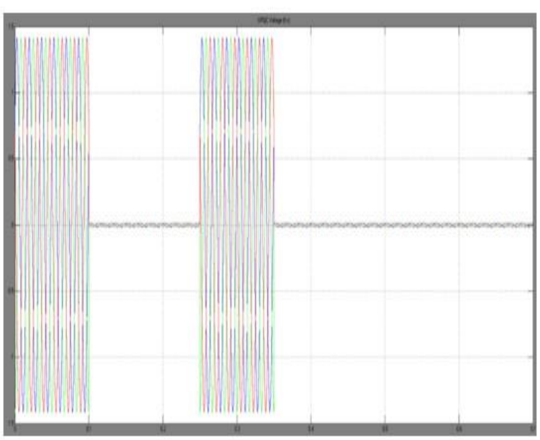


Figure 5 Voltage sag compensation by UPQC

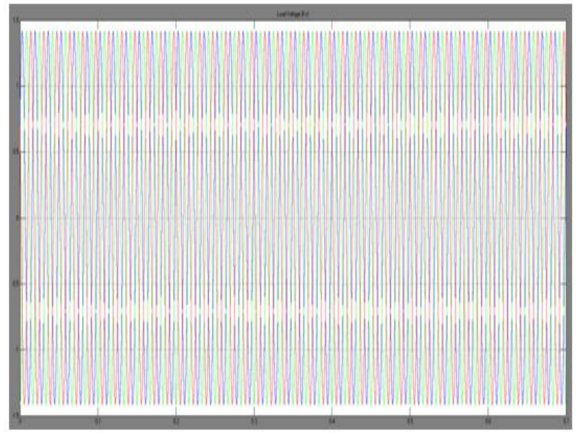


Figure 6 Voltage sag compensation at loads

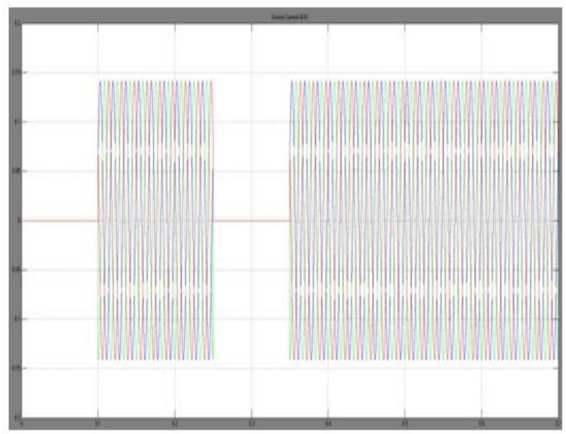


Figure 7 Source current drops and the THD of 2.57%

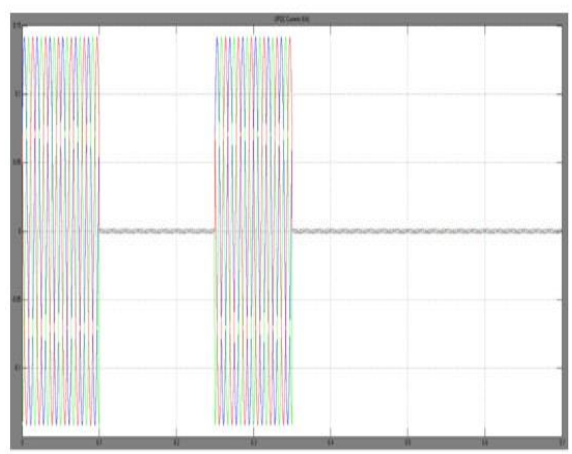


Figure 8 UPQC Currents

A. FFT analysis of the source currents and load currents

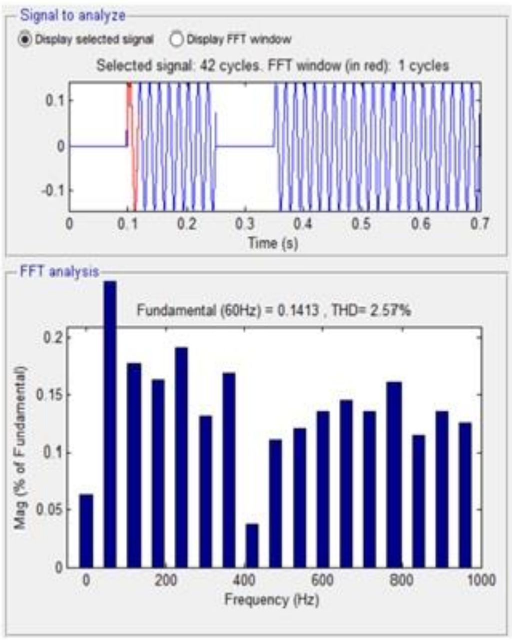


Figure 9 THD of the source current of 2.57%

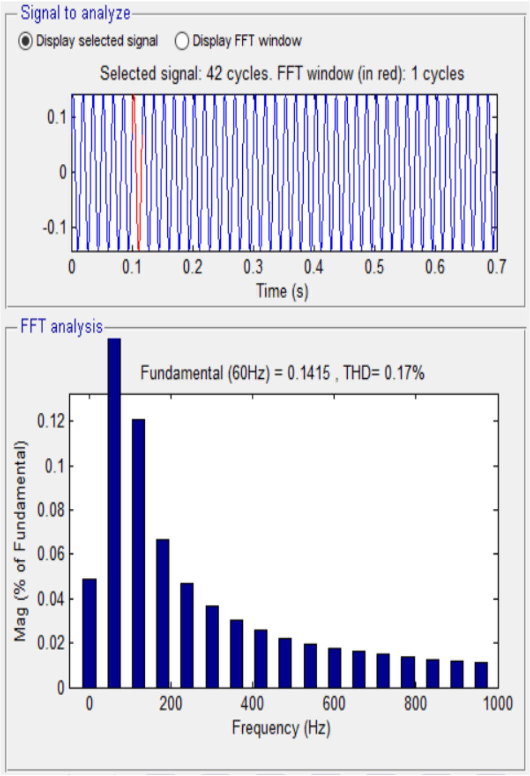


Figure 10 THD of the load current 0.17%

B. Current load THD

Figures 9 and 10 of the preceding FFT analysis show that the voltage decreases completely, regardless of whether UPQC is used or not. According to the Total Harmonic Load Distortion in both cases, the proposed UPQC has less distortion than either STATCOM or the current proposal.

CONCLUSION

As a result, the UPQC topology, based on a modular multi-level converter, was successfully implemented in MATLAB. With a nonlinear load, a voltage drop and harmonics in the current are caused by the suggested three-phase device, rather than the conventional single-phase AC system. When it comes to voltage drops and overall harmonic distortion, the IEEE standards provide a topology that must be followed. Comparing the simulation results of the FACTS-free System and the UPQC system is another way to determine how they compare. The proposed UPQC system allows for superior performance over competing devices.

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