Improvement in Power Quality in UPQC Based LVD Network Using Multi Level Converter

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Abstract- In this examination work focus for compensation of voltage and current simultaneously in multi-feeder/multi-bus systems a new multi-level converter based on unified power-quality conditioning (MLC-UPQC) system has proposed and implemented. In the proposed model utilized, at least two series VSCs and one shunt voltage-source converter are used. The system can be used to adjust feeders to compensate for load current and source-voltage flaws on the fundamental feeder and full compensation of supply voltage imperfections on different feeders. All converters in proposed model are associated consecutive on the dc side and offer a common dc-link capacitor. In this manner transfer of power can be done from one feeder to neighboring feeders to compensate for interruption and swell/sag.The proposed topology can be utilized for synchronous compensation of voltage and current pollution in the two feeders by sharing power compensation capacities between two contiguous feeders which are not associated. The system is likewise compensating for interruptions without the requirement for a battery storage system and subsequently without storage limit limitations. The MLC-UPQC performance as well as the adopted control algorithm in proposed model is evaluated based on simulation and represented in terms of THD.

Keywords- Power Quality, LVD Network, UPQC, Multi-Level Converter.

I. INTRODUCTION

In the present scenario non-linear loads have become extremely important and people are becoming dependent on it. Few of these non-linear loads are televisions, printing and fax machines, rectifiers, inverters, speed drives, AC, etc. Harmonics are introduced in the lines due to the extensive use of these loads in our everyday purpose. The stability of any electrical devices depends on its voltage and current waveforms. If the fundamental waveform is sinusoidal, and its harmonics are sinusoidal too then these harmonics occurs in integral multiples of the fundamental waveform. Due to this harmonic distortion created by nonlinear loads several problems are caused in the appliances used in our purpose like: motor getting overheated, increase in several types of losses, permanent damage of equipment in the worst case, high error in meter reading, etc. Hence removal of these harmonics or harmonic mitigation from voltage and current waveforms are of great concern for electrical engineers. Due to the harmonics introduction in the lines by the nonlinear loads other problems of concern are voltage swell, voltage sag, flicker occurring in voltage, etc and thereby disturbing he overall power supply.

Electric power distribution networks are broad and are a key piece of the foundation that underpins business, private and mechanical offices. These networks are continually developing, which is driven by a requirement for age-related reestablishment, utilization of perfect and inexhaustible resources of energy, power industry deregulation and expanded or diminished interest. These issues have brought about proposing new structures, devices, control systems, the board techniques and even power distribution system rebuilding, where once in a while new network design has been proposed or once in a while new devices have been introduced. In addition as of late, establishment of photovoltaic cells (PVs) has been altogether expanded, which strongly affects spiral distribution networks. Thusly it is a need to take a gander at the inexhaustible combination issues for proficient and safe power system task and upkeep, while monitoring modernization.

In recent years, low voltage dc distribution system is rising as an answer for guarantee premium power quality to the delicate consumers. This LV dc system joins the upsides of the supplies utilized for improving the voltage quality, supply progression and utilizations supportable power generating units. For AC systems, littler diesel based DG units can rapidly takeover when the system is confronting interference. Study has been done to affirm this progress easily.

Distributed Generation (DG) has additionally impacts on the presentation of associated distribution network, particularly as far as power quality issues. Study results demonstrate that relying upon the electrical separation between the busses, there is extraordinary impact of the area of fault on the voltage hang of the busses. It has likewise been appeared synchronous generator put together DG has poor execution with respect to amending voltage profile. Then again, voltage source converter (VSC) based DGs have are competent for their exceptional control mode, quick reaction time and isolated guideline calculation for active and reactive power. Voltage profile in a network can be improved by keeping a reactive power hold for the DGs. DGs for the most part don't participate in the voltage guideline of the distribution network. Rebuilding this distribution network to microgrids may take care of this issue. Rebuilding empowers DG to keep up its ability for suppressing voltage dips.

In this study, primary inspiration was fundamentally to design and to execute a basic, conservative, cheap and smooth power quality observing gadget for low voltage distribution system, which represents with a Power Quality. All handled PQ parameter logs are sent to this devices by utilizing power line as the correspondence medium, which makes the system less expensive and smaller, regarding network segments. A Simulink model based on UPQC LVD Network Using Multi Level Converter model has been proposed in this work.

II. MLC-UPQC

a. UPQC

Basically UPQC (Unified Power Quality conditioner) is a equipment which is used for compensate for voltage distortion and voltage unbalance in a power system so that the voltage at load side is completely balance and sinusoidal & perfectly regulated and also it is used to compensate for load current harmonics so that the current at the source side is perfectly sinusoidal and free from distortions and harmonics. UPQC is a combination of a Shunt Active power filter and Series Active power filter. Here Shunt Active power filter (APF) is used to compensate for load current harmonics and make the source current completely sinusoidal and free from harmonics and distortions. Shunt APF is connected parallel to transmission line. Here Series APF is used to mitigate for voltage distortions and unbalance which is present in supply side and make the voltage at load side perfectly balanced, regulated and sinusoidal. Series APF is connected in series with transmission line. UPQC consists of two voltage source inverters connected back to back through a DC link capacitor in a single phase, three phase-three wire, three phase-four wire configuration. The inverter in shunt APF is controlled as a variable current source inverter and in series APF is controlled as a variable voltage source inverter. Earlier passive filters where also used for compensation of harmonics and voltage distortion but due to their many disadvantages they are not used nowadays.

b. Multilevel Converter

In 1980s, power electronics concerns were focused on the converters power increase (increasing voltage or current). In fact, Current Source Inverters were the main focus for researchers in order to increase the current. However, other began to work on the idea of increasing the voltage instead the current. In order to achieve this objective, authors were developing new converter topologies.

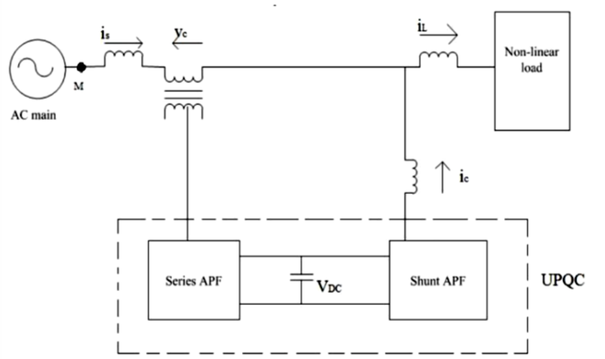

Fig.2.1 Basic Configuration of UPQC

For a medium voltage grid, it is troublesome to connect only one power semiconductor switches directly. As a result, a multilevel power converter structure has been introduced as an alternative in high power and medium voltage situations such as laminators, mills, conveyors, pumps, fans, blowers, compressors, and so on. As a cost effective solution, multilevel converter not only achieves high power ratings, but also enables the use of low power application in renewable energy sources such as photovoltaic, wind, and fuel cells which can be easily interfaced to a multilevel converter system for a high power application.

The elementary concept of a multilevel converter to achieve higher power is to use a series of power semiconductor switches with several lower voltage dc sources to perform the power conversion by synthesizing a staircase voltage waveform. Capacitors, batteries, and renewable energy voltage sources can be used as the multiple dc voltage sources. The commutation of the power switches aggregate these multiple dc sources in order to achieve high voltage at the output; however, the rated voltage of the power semiconductor switches depends only upon the rating of the dc voltage sources to which they are connected. A multilevel converter has several advantages over a conventional converter that uses high switching frequency pulse width modulation (PWM).

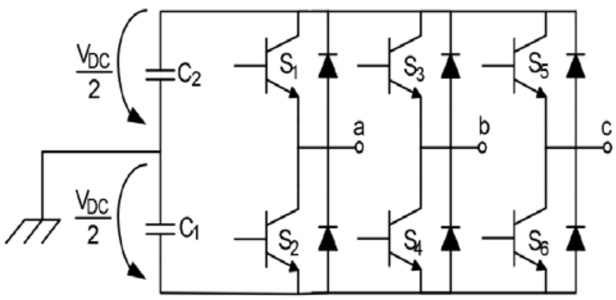

Fig. 2.2 Two-level conventional converter

This converter was based on a modification of the classic two-level converter topology. In conventional two-level case (see Figure 2.2), each transistor must have at the most a voltage stress equal to VDC and they should be dimensioned to tolerate this voltage

III. PROPOSED METHODOLOGY

A MATLAB SIMULINK model for low voltage distribution network LVD using MLC-UPQC has been proposed in this work. Circuit of proposed Simulink model has shown in Fig. 3.1. The controlling method for the operation of UPQC model is very similar to instantaneous reactive power theory method. A major feature of this algorithm seeks is that only load current is fundamental here for the generation of reference current and subsequently distortions present in source or disturbances present in voltage not impact on the proposed UPQC system performance. In the given proposed MLC method for UPQC have optimized the system , load, and filter current measurement, .This reduces numbers of measurements are and thereby improving system performance. UPQC is equipment which is formed by combining series APF and Shunt APF together. UPQC removes both problems which are caused due to voltage and current harmonics. UPQC mitigate the problems of source voltage unbalance and make load side voltage completely balanced and it also mitigate the problems which is caused due to load current harmonics and make current drawn from source completely sinusoidal.

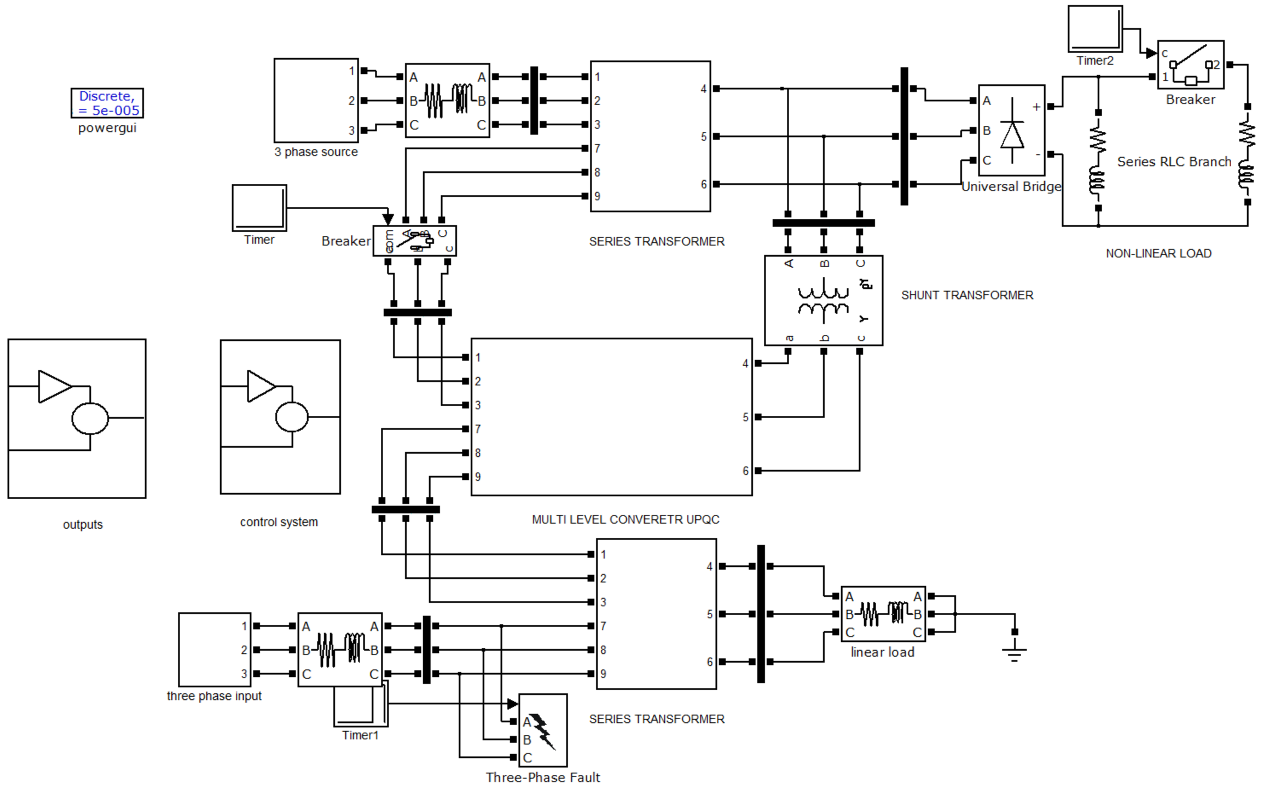

Fig.3.1 Proposed Circuit with LVD Network with MLC-UPQC

Multilevel converters present several advantages compared to classical two-level converters. They improve the harmonic substance of the yield signals and they acknowledge a power increment in the DC-link because of its voltage can be shared between more transistors. The control procedures to achieve the balance the DC capacitors voltage for multilevel converters are reported in this examination work. These strategies use the well known technique based on choosing the correct redundant vector using VSCs (Voltage Source Converters) algorithms in order to reduce the voltage unbalance. It is important to Notice that the proposed strategies are totally generalized and because of it, they are independent of the load and independent of the number of converter levels. Some simulation and experimentsl results demonstrate the achieved balance utilizing the proposed systems. If any unbalance in the DC capacitors voltage shows up, the yield phase voltages have distortion and the harmonic substance of the output signals diminishes its quality. Actually, if the switching control is not be made cautiously and a control algorithm is not done, the issue quickly shows up and the DC capacitors voltage will be unbalanced.

IV. SIMULATION AND RESULTS ANALYSIS

To show the performance of the proposed cascaded converter, total harmonic distortion percentage has calculated. The proposed converter combines a three-phase multilevel waveform from the determined switching angles. The converter thus generates the variable-amplitude, variable frequency voltage waveforms. The MATLAB- Simulink is used to simulate multiple- level inverters, where all parameters and blocks are modeled based on basic concepts. One of the key features is that it allows the user to simulate the design over a specified period of time. This way it is possible to analyze the time response of control system.

On the basis fundamental concepts of modulation schemes, four signal pulses are generated in MATLAB. Theses generated pulses are given to the switches in one phase leg of a multilevel level inverter. In the same way for rest of two phases the pulses are generated, just by changing phase angle of shifting of modulating signal.

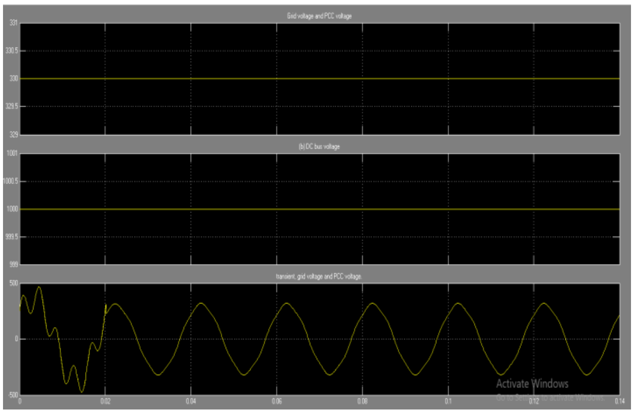

Fig.4.1 Grid, PCC Voltage, DC Bus Voltage and Transient Voltage.

Fig. 4.1 shows the simulation of proposed modelscope waveform of Grid, PCC Voltage, DC Bus Voltage and Transient Voltage. at the top of the waveform grid voltage and PCC voltage are shown in the middle of the waveform DC bus voltage is shown and ay bottom of the waveform transient grid voltage and PCC voltage are shown.

Another simulation waveform of proposed model is shown in Fig. 4.2reactive power (Q) injection and effects on voltage regulation, 10 samples per hour on MATLAB scope. Fig 4.3 shows the Shunt unit transitions, on line to Island using proposed model. Fig.4.4 shows the waveform of Shunt unit transitions, Island to Online. Fig.4.5 shows the scope waveform of series unit transient behavior, adding 50 % load. Fig.4.6 shows the scope waveform of Voltage Series unit transient behavior, removing 50 % load.Fig. 4.7 shows the THD of proposed system 1.8% which is much better as compared previous reference work.

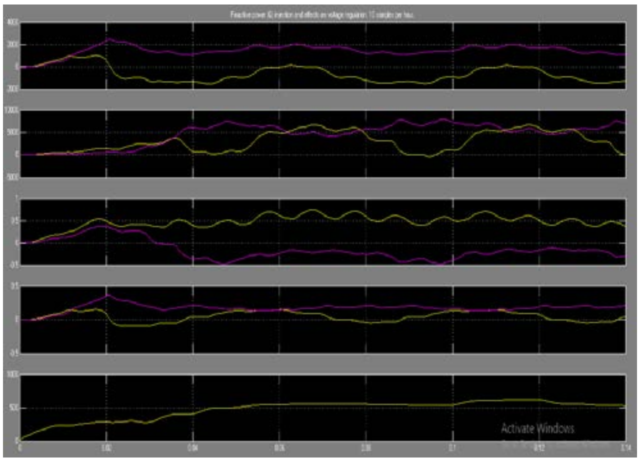

Fig.4.2 Reactive power (Q) injection and effects on voltage regulation, 10 samples per hour

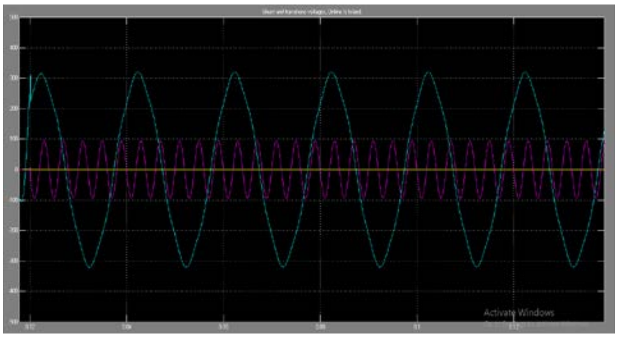

Fig.4.3 Shunt unit transitions, Online to Island

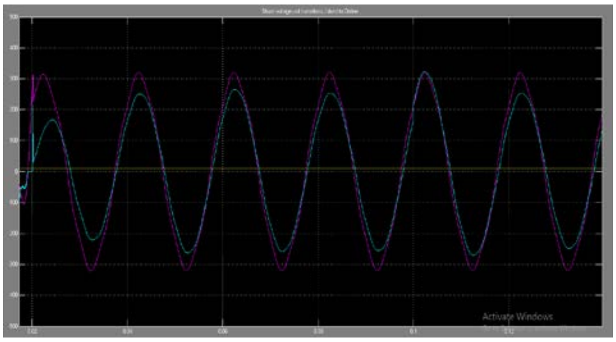

Fig.4.4 Shunt unit transitions, Island to Online

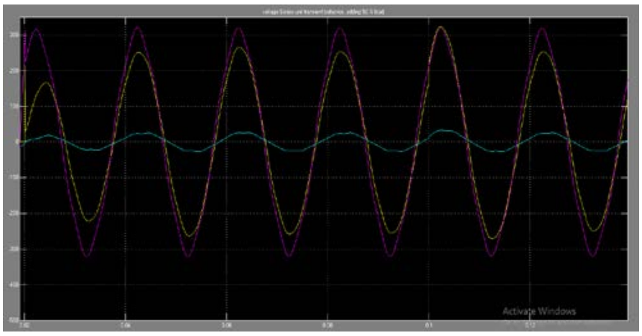

Fig.4.5 Series unit transient behavior, adding 50 % load.

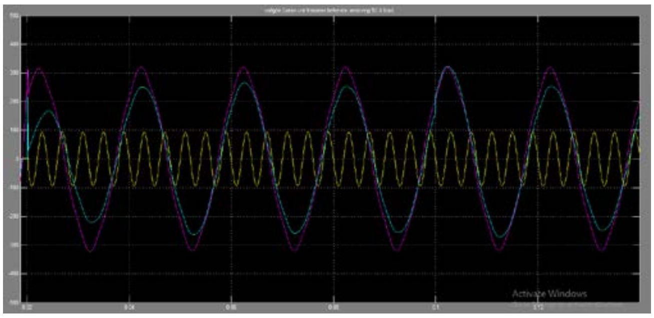

Fig.4.6 Voltage Series unit transient behavior, removing 50 % load.

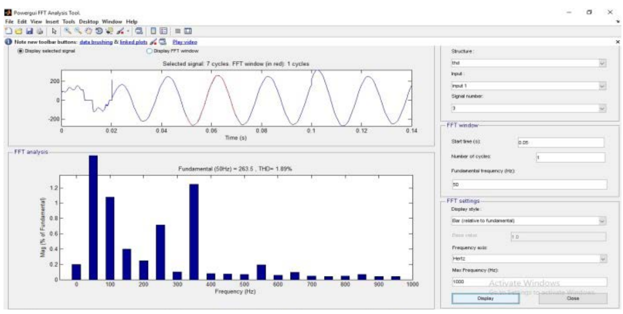

Fig 4.7 THD of Proposed System.

V. CONCLUSION

In this examination modeling of a Simulink model for improvement in power quality in UPQC based LVD network using multi level converter has done and performance analysis of proposed model has done based on simulation. The fundamental objective of this work to reduce harmonic distortion in power and quality improvement. The total harmonic distortion THD of proposed work is evaluated is 1.89% which shows the significant improvement in power quality as compared to previous work. This work is focused on the study of multilevel converters. First of all, an overview of the most typical converter topologies has been presented. The way of switching depending on the multilevel converter topology. Finally, a new multilevel UPQC topology is presented achieving an output voltage range increase and an improvement in the output waveforms quality to an increase of the number of output levels in the converter.

As future works, other new multilevel converter topologies can be studied. New MatLab/Simulink models can be developed and finally a complete comparison between all topologies can be done. Firstly, more real models can be developed taking into account real power devices substituting ideal switches. The complete control loop of a system includes the techniques proposed in this work but an external control loop is needed. So, other possible future work is to implement all these strategies in a complete system including classical PID controllers

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