Battery Energy Storage System With Power Quality Improvement Using UPQC

R. Harish[1], S. Akshatha[2], S. Selvapriya[3], V. Swathi[4]
[1]Assistant Professor, Dept of Electrical and Electronics Engineering
[2, 3, 4]Dept of Electrical and Electronics Engineering
[1, 2] Prince Shri Venkateshwara Padmavathy Engineering College

Abstract- *Generally, many problems are faced in power system regarding the power quality. Voltage sag, voltage swell and voltage unbalances are the some of the power quality problems which causes malfunction and affects the correct operation of the sensitive equipment. BES serves to store the surplus of power resulted by PV and to transfer it to the load if necessary, preventing voltage interruption, and adjusting charging and discharging energy in battery. Active power filters can be used in power system in order to improve the power quality of the system. The composition of both the shunt active filter and the series active filter is called Unified Power Quality Conditioner (UPQC). This project proposes the use of Battery Energy Storage on Unified Power Quality Conditioner (UPQC) supplied by Battery Energy Storage System (BESS) through a DC link to improve power quality on a three-phase three-wire distribution system. The series converter decreases the line voltage distortions from the load voltage and gives to the parallel branch of the device from where it consumes current harmonics results from the unbalance load. The series converter operates as a sinusoidal voltage source and shunt converter acts as a voltage-source converter (VSC) and it is connected in parallel to the AC supply line. It acts as a current source for eliminating current distortions. Hence the proposed method of Unified Power Quality Conditioner is simulated using MATLAB software and hardware model has been developed.*

Keywords- BESS, UPQC

I. INTRODUCTION

The main aim of this project is to improve the power quality by using unified power quality conditioner (UPQC) in the power system to protect the sensitive loads. A UPQC is a combination of shunt active power filter and series active power filters, having a common dc link. UPQC is considered to be a versatile device which compensates all power quality problems. This is to maintain the load bus voltage sinusoidal and at desired constant level in all the operating conditions. The proposed model of UPQC is supplied by the solar panel has a combination of two active power filters, connected in parallel and series shared a common DC voltage generated by the photovoltaic.

II. SYSTEM METHODOLOGY

The system methodology explains briefly about the existing system, disadvantages of the existing system, proposed system
and the advantages of the proposed system.

EXISTING SYSTEM

The STATCOM, with the battery energy storage system (BESS) is used in power system to improve the power quality. The ever-increasing size and complexity of electrical grid infrastructure as drawn much attention in power system operation stability and performance.

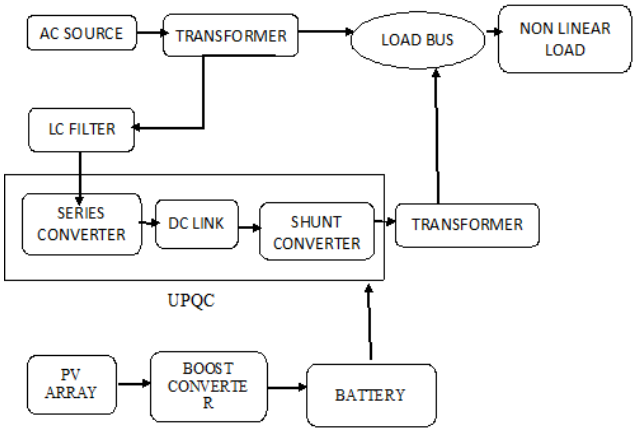
DISADVANTAGES OF EXISTING SYSTEM

Increasing complexity.
Poor voltage and frequency stability.
Low power quality.

PROPOSED SYSTEM

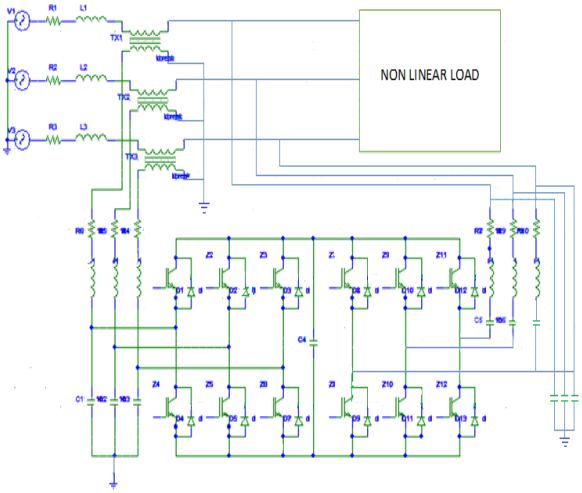
The Unified Power Quality Conditioner (UPQC), with the battery energy storage system (BESS) is used in power system to improve the power quality. The purpose of using two devices can be reduced by using UPQC.

BLOCK DIAGRAM OF UPQC



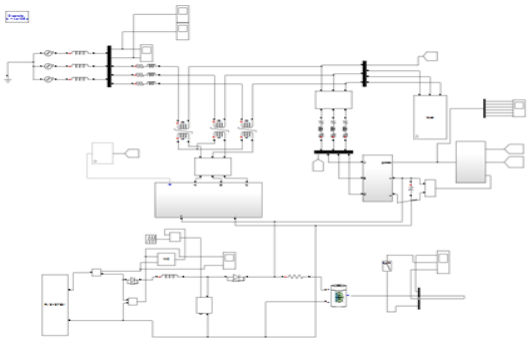
The ac supply is given to the transformer. The step down transformer is used to step down the voltage. It is given to the load bus and then given to the non-linear load. The low pass filter is used to get high attenuation. The high pass filter is used to reduce the harmonics. The series converter is used to produce the pure sinusoidal current. The shunt converter is used to produce the pure sinusoidal voltage. The solar panel is used for renewable resources. The boost converter is used to boost the voltage and the energy is stored in the battery. It is given to the Unified Power Quality Conditioner. The voltage is stepped down by using step down transformer and it is given to the non-linear load. Thus the pure sinusoidal voltage and current is obtained.

CIRCUIT DIAGRAM OF UPQC



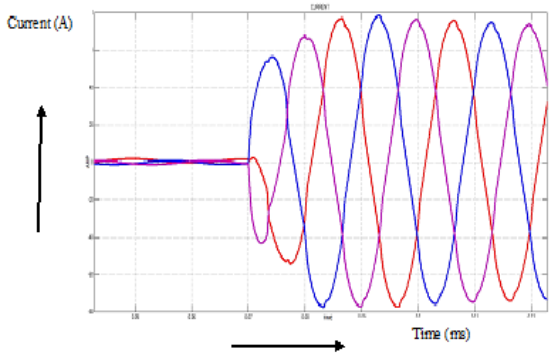
This is the circuit diagram of the Unified Power Quality Conditioner. It consists of both shunt and series converter with a common dc link. The step down transformer is used to step down the voltage. It is given to the non-linear load. The non-linear load is the inductive load used in industrial applications.

III. SIMULATION CIRCUIT OF UPQC

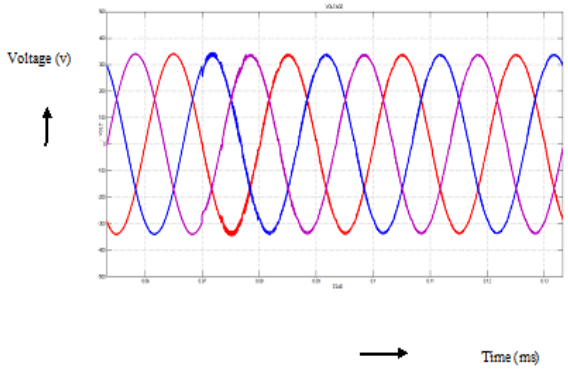


This is the simulation circuit diagram of Unified Power Quality Conditioner. This uses three phase three wire system of distribution system. The three phase voltage isgiven to the step down transformer and given to the series converter. The series converter pulse is given by PWM generator. It acts as rectifier. The dc link is given by the constant dc supply. It is given to the shunt converter which acts as the inverter and the pulse is given by the PWM inverter. The triggering pulse are given to the UPQC block according to the output voltage provided by the shunt converter. The output of the UPQC is given to the load bus where the power quality are mitigated and the required voltage to the non-linear load is supplied. The output scope of the voltage and current waveform are simulated.

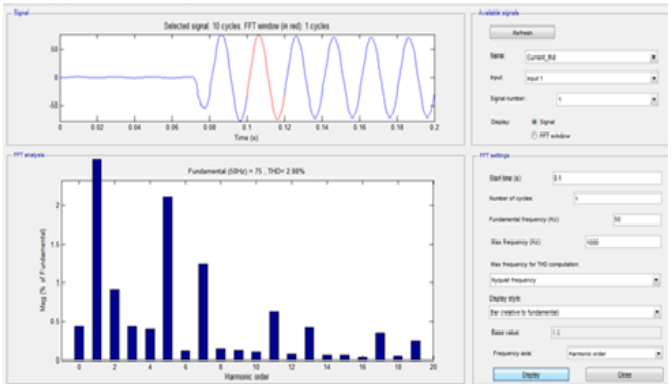
SIMULATION RESULTS



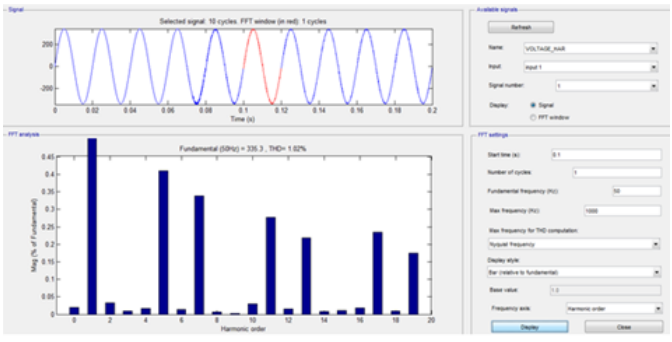
This represents the current waveform of UPQC. This shows the distortion of current at both the conditions of with UPQC and without UPQC. Before 0.09s UPQC will not acts. So the waveform will be non-sinusoidal before 0.09s. After 0.09s the UPQC will act and the pure sinusoidal current is produced.



This represents the voltage waveform of UPQC. This shows the distortion of voltage at both the conditions of with UPQC and without UPQC. Before 0.09s UPQC will not acts. So the waveform will be non-sinusoidal before 0.09s. After 0.09s the UPQC will act and the pure sinusoidal voltage is produced.



This represents the current analysis with UPQC. The fundamental frequency is 50HZ. The total harmonic distortion produced here is only 2.88 %.



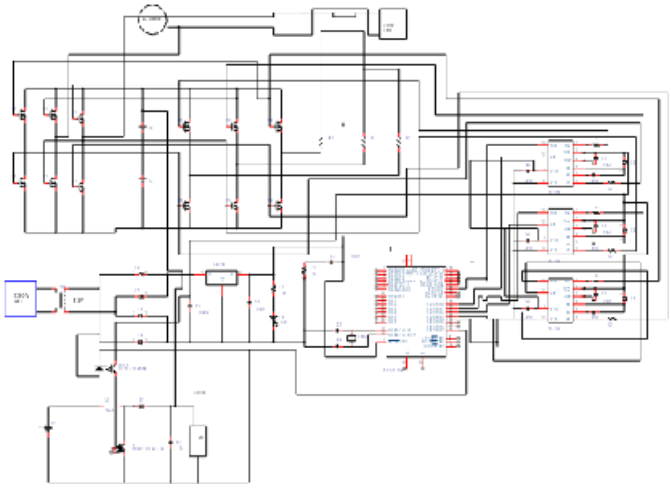
This represents the voltage analysis with UPQC. The fundamental frequency is 50HZ. The total harmonic distortion produced here is only 1.02%.

IV. HARDWARE IMPLEMENTATION

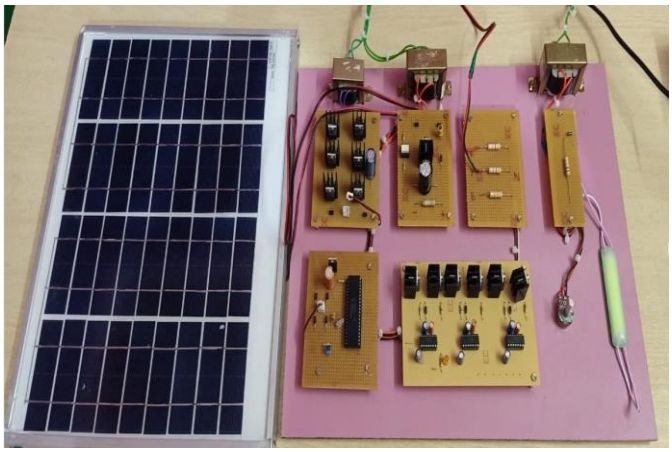
The hardware circuit diagram consists of PIC microcontroller, single phase power supply, rectifier, inverter, boost converter, transformer and nonlinear load. The first end of the source is connected to the primary side of the series transformer. The other end of the source is connected to the load. The primary winding of the series transformer is connected to the current transformer.

The current transformer is used to measure the flow of current. The secondary winding of the current transformer is connected to the PIC Microcontroller. An AC supply, which is of 230V is given to the Bridge rectifier and Regulator. Then it is given as an input to PIC microcontroller.

Therefore, pulse provided by the MOSFET switches, the inverter is acted based on its input and voltage and current distortion are reduced at load side.

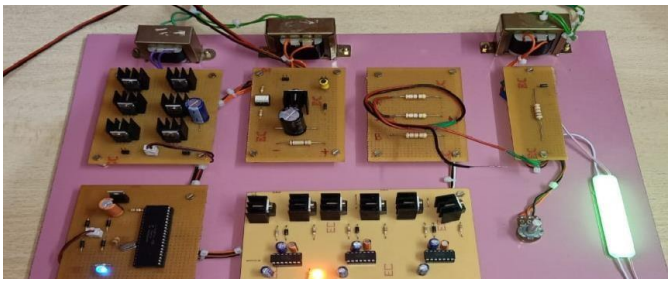


A) HARDWARE SNAPSHOT

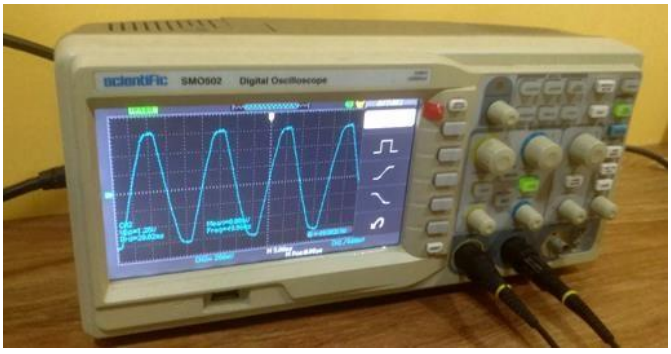


The three phase three wire distribution system flows from power generation to non-linear loads. The Low-pass filter (LPF) is made use to get high attenuation in high

frequency components at the output side of series converter which are produced by high-frequency switching mode. The high pass filter is used to reduce the harmonics produced. The boost converter steps up the voltage and given to the non-linear load. The battery is used to store the energy and it is used when the power supply is cut off. The solar panel is also used as a renewable energy source of supply.



This represents the basic functionality of Unified Power Quality Conditioner when the supply is given. This light indication in the non-linear load indicates that the UPQC is functioning.



This represents the pure sinusoidal voltage in digital storage oscilloscope. Thus the pure sinusoidal voltage is achieved when the Unified Power Quality Conditioner is used in the power system.

V. CONCLUSION

A new unified power quality conditioner (UPQC) supplied by photovoltaic system has been realized at the limits of standards. In the proposed system, the overall PVs with the PV panel, boost converter, which is exported to the network through the shunt APF function of the UPQC. The UPQC is composed of back-to-back connected series APF and shunt APF, which are share a common DC voltage generated by the PVs. Thus, the PV system does not provide only the active power to the grid but also guarantees a regulated DC link to the power circuit of the UPQC. The series APF has been controlled by the unit vector templates algorithm for determining the reference compensation voltage signals, which have been used in the carrier based modulation PWM technique for launching the switching orders in order to counter the voltage harmonics disturbances.

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