

IMPROVEMENT OF POWER QUALITY IN STANDALONE MICROGRID BY UPQC USING EPLL AND ALPHA-BETA THEORY

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ABSTRACT: The main theme of this paper presents an improved control method for unified power quality compensator(UPQC) with an unbalanced load. In today's power systems power quality plays a crucial role. Power quality used to attain better stability to system. If the power quality is improved then the system produces better performance. Microgrid is one among the widely used areas to reduce the loses. Microgrid is a small scale version of utility grid which can operate independently (Standalone mode) as well as in conjunction with main grid. Microgrid involves use of renewable energy sources like solar, wind, fuel etc. This paper involves reduction of load harmonics in standalone microgrid designed with solar and wind with UPQC using EpLL and alpha-beta theory.

Keyword : *Microgrid, Solar, Wind, Power quality, Upqc, EpLL, Alpha-beta theory .*

1.INTRODUCTION

Now a days electric Power quality is basically focus on the normal sinusoidal voltage or current source without any disturbances in it. Generally power quality refers to maintaining the bus voltage waveform purely sinusoidal at rated voltage and frequency. Bascially many of the power consumption equipments are designed to fundamental waveform i.e. pure sinusoidal voltage waveforms. With increase in power demand it is clearly seen that the use of fossil fuels is getting increased and if this increases at the same rate then there might be greater scarcity of non-renewable resources. These days people are showing interest towards renewable energy sources because of their abundancy and also they are nature friendly. Renewable sources include solar, wind, fuel, tidal etc.,. Solar energy is most abundantly available year long and wind is also one of the widely used sources of energy.

But these energies are intermittent in nature i.e., they are not available at same quantity throughout the year. So the issue now is if we employ these in power generation they may damage the connected loads as the loads are set to operate at certain operating voltage and frequency. So to minimize these kind of issues several control techniques have been employed in order to make the outputs from these renewable sources feasible.

In this paper a standalone microgrid is employed with solar and wind as sources and the performance of this grid is studied. Particularly load harmonics of both voltage and current are reduced. To reduce the load side voltage and current harmonics a facts device called unified power quality compensator(UPQC) is employed. The theory employed in the UPQC is enhanced phase locked loop(EPLL) and Alpha-beta theory.

2.MICROGRID

2.1. About Microgrid

In next generation electric distribution technology place predominate role for existing of new trends that will upgrade the energy requirements to the consume loads. The trends are taken place in both supply side and demand side. Provided that the higher energy availability and efficiency are desired.



Fig1. Microgrid power system

Generally microgrid is an interconnected system. The interconnection of the Distribution energy resources connected to microgrid is a little bit critical. These are the additional issues are taken this control, grouping and control of distribution energy resources in an efficient and reliable manner. Interconnection of wind turbines and PV systems with grid results in grid instability. Implementation of Microgrid is one of the solution to this problem can be achieved.

2.2. PV ARRAY

The interconnection of series and parallel of PV cell is known as PV module. The number of connections of PV array to get desired output because single PV array is not meet to required output of the commercial applications purpose in order to supply the load, modules should connected to form a array to meet the consumer demand. Basically first modules are connected series to meet desired output voltages and individual modules are connected in parallel to allow the more current to the system.

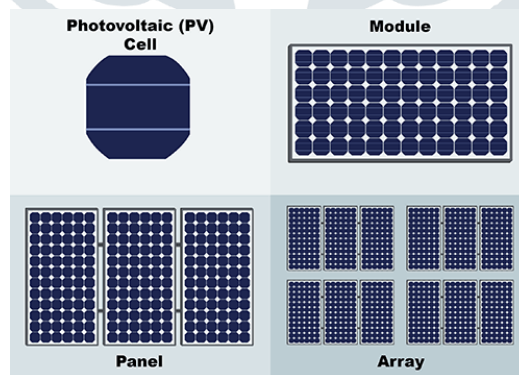


Fig.2. Photovoltaic system

2.2.1. Modeling of PV panel

The main advantage of photovoltaic system is no impact on environmental when generating direct current electricity. The normal building block of PV array is solar cell in which basically p-n junction that directly

convert light energy into electrical energy. The output characteristics is mainly depends on cell temperature, solar irradiation and output voltage of the module. The figure shows equivalent circuit

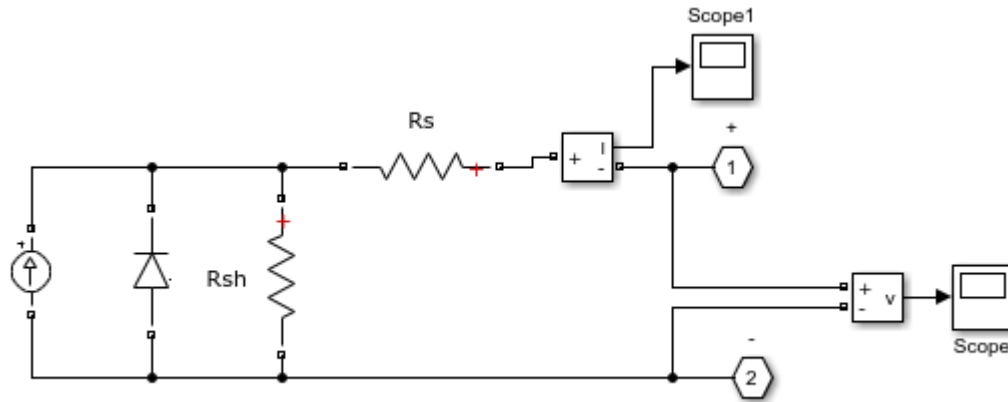


Fig 3. Basic pv model

Generally the equivalent circuit of a PV model is consists of a photocurrent, a diode, a parallel resistor will gives a leakage current, and a series resistor will gives an internal resistance to the current flow. The shunt resistance R_{sh} of the cell is inversely proportional with the shunt leakage current with respect to the ground. A small variation in series resistance R_s will significantly affect output power of PV cell.

3.WIND TURBINE

The device which converts kinetic energy to mechanical energy from the wind is known as wind turbine. And it is called wind energy convert into mechanical energy and this process is called wind power. If the mechanical energy is used to generate an electrical energy then it is called as wind power plant. Now-a-days the manufacturing of wind turbines are wide range of vertical and horizontal axis types.

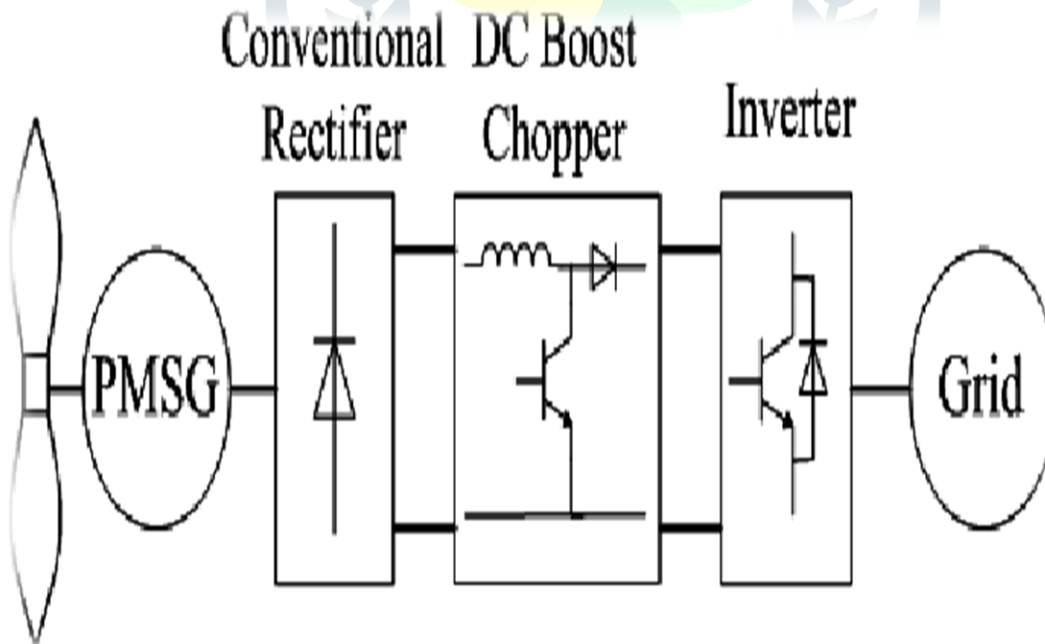


Fig.4. working principle of Wind Energy System.

4.HYBRID MICROGRID

Here in this paper it is explained about hybrid micro grid operated in standalone mode. This Hybrid microgrid is a combination of solar and wind.

4.1. OPERATION

Hybrid grid consists of solar and wind operated in standalone mode. Here the load harmonics of both voltage and current are calculated. These harmonics(total harmonic distortion) are reduced using a Fact devices called UNIFIED POWER QUALITY COMPENSATOR(UPQC). This UPQC is implemented in series with the grid and the load harmonics are reduced. Enhanced phase locked loop(EPLL) and Alpha-beta theory is used in UPQC.

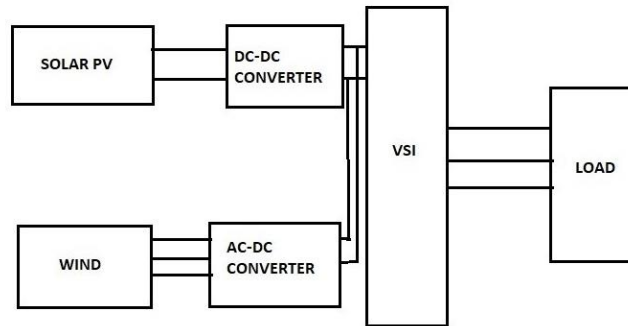


Fig.5.Block diagram of hybrid grid without UPQC

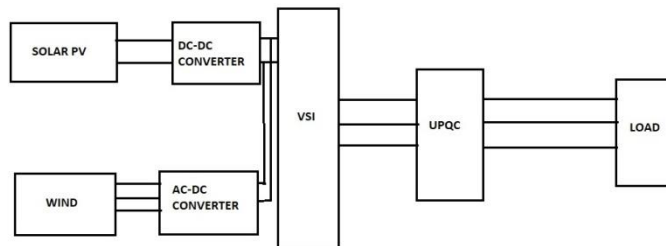


Fig.6. Block diagram of hybrid grid with UPQC.

4.2. COMPONENT PARAMETERS OF HYBRID GRID

- 1.AC current source = 450volts
- 2.frequency = 50hertz
- 3.solar shunt resistance, $R_{sh} = 1e3ohms$
- 4.solar series resistance, $R = 1ohm$
- 5.capacitor across DC link = $9000e-6farads$
- 6.Transformer ratio($n1/n2$) = 500/500
- 7.Load = 30kw

5.UNIFIED POWER QUALITY COMPENSATOR (UPQC)

UPQC is a device to improve the power quality. So it is called as power quality device. UPQC is mainly used in industries areas for protecting against disturbances of voltage and current related to remote system faults and harmonic mitigation. The operating principle of UPQC is combination of shunt and series compensator. The series device is keeps the consumer load voltages problems such as sag and swells spikes, notches, fluctuations and unbalance voltages. The main objective of series device is injected a compensating voltage between consumer load to supply, and it restores the load voltage of consumer to its reference value. The series device is known as DVR. The shunt device will provide reactive power compensation and load compensation and also elimination of harmonics in system. The shunt device is connected to parallel to load. The shunt device is also called as DSTATCOM. In this proposed model Enhanced phase locked loop(EPLL) and alpha-beta theory is applied.

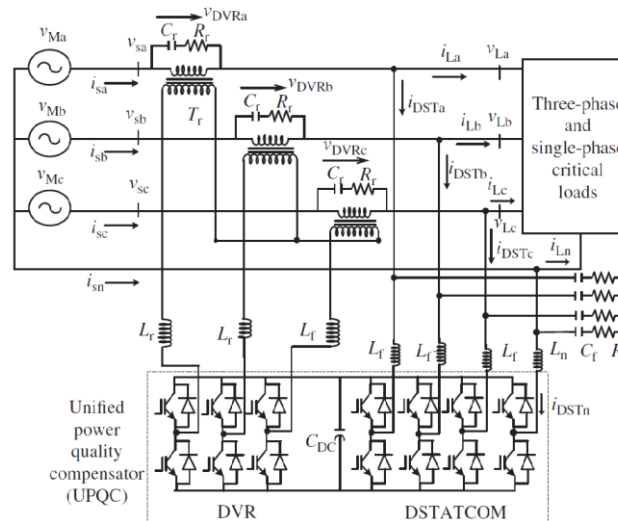


Fig.7. Basic block diagram of UPQC

6.SIMULATION AND OBSERVATIONS

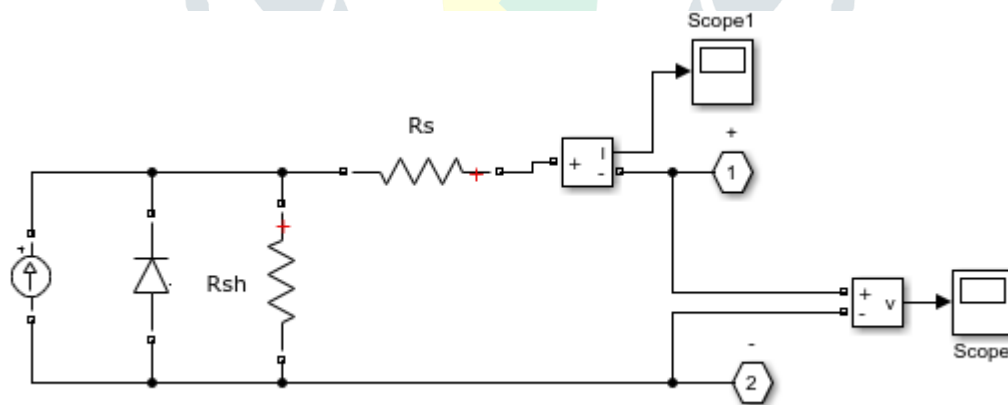


Fig.8. Basic Solar PV array

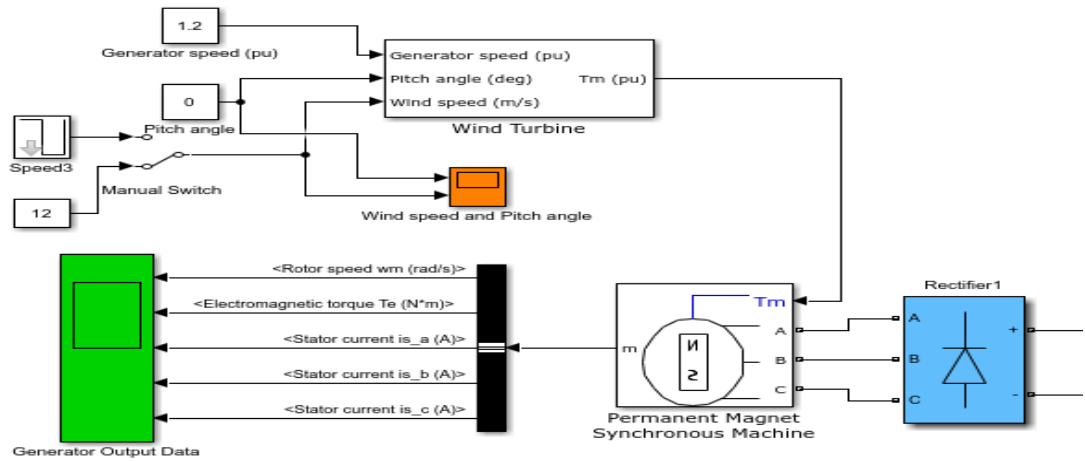


Fig.9. Basic wind turbine

The above shown diagrams are basic figures of solar and wind used in hybrid microgrid. This grid is operated and the voltage and current waveforms are seen and its harmonics are calculated.

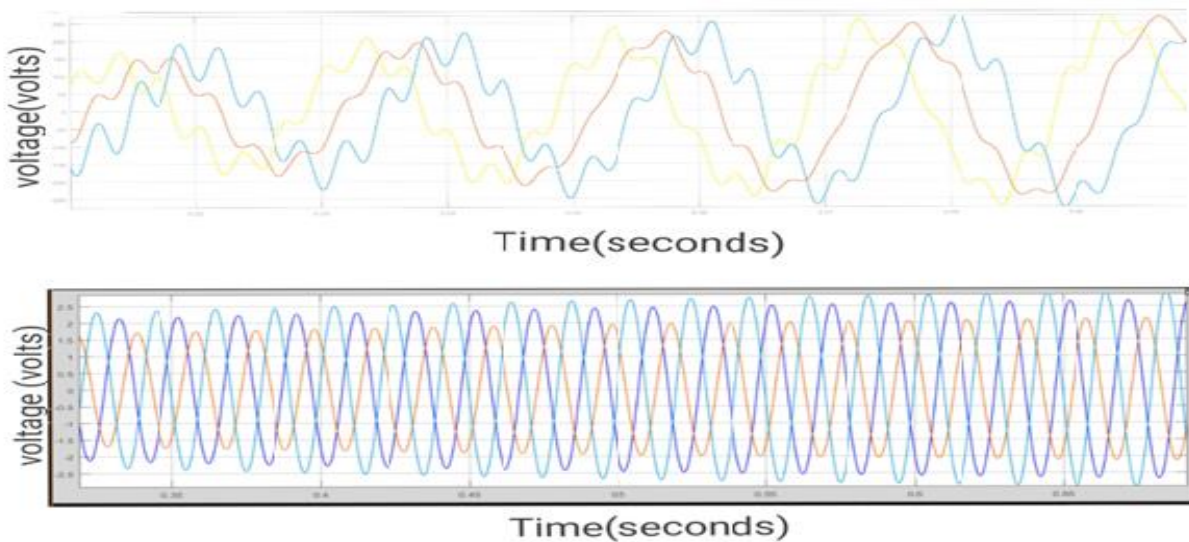


Fig.10. load voltage and current waveforms of microgrid without UPQC

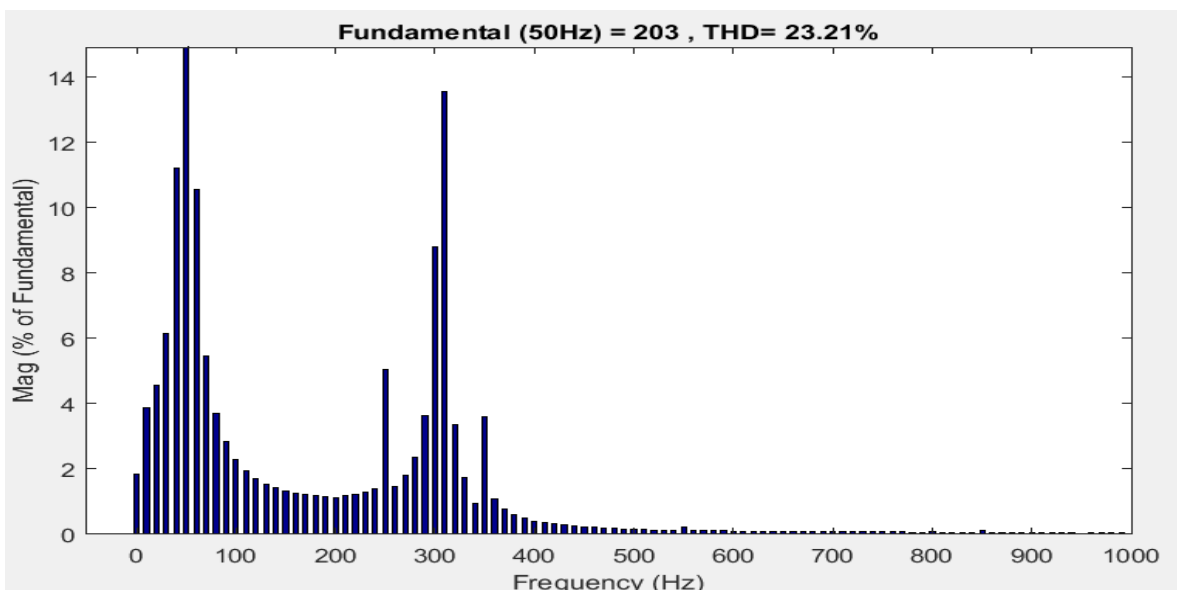


Fig.11. FFT analysis of load voltage without UPQC

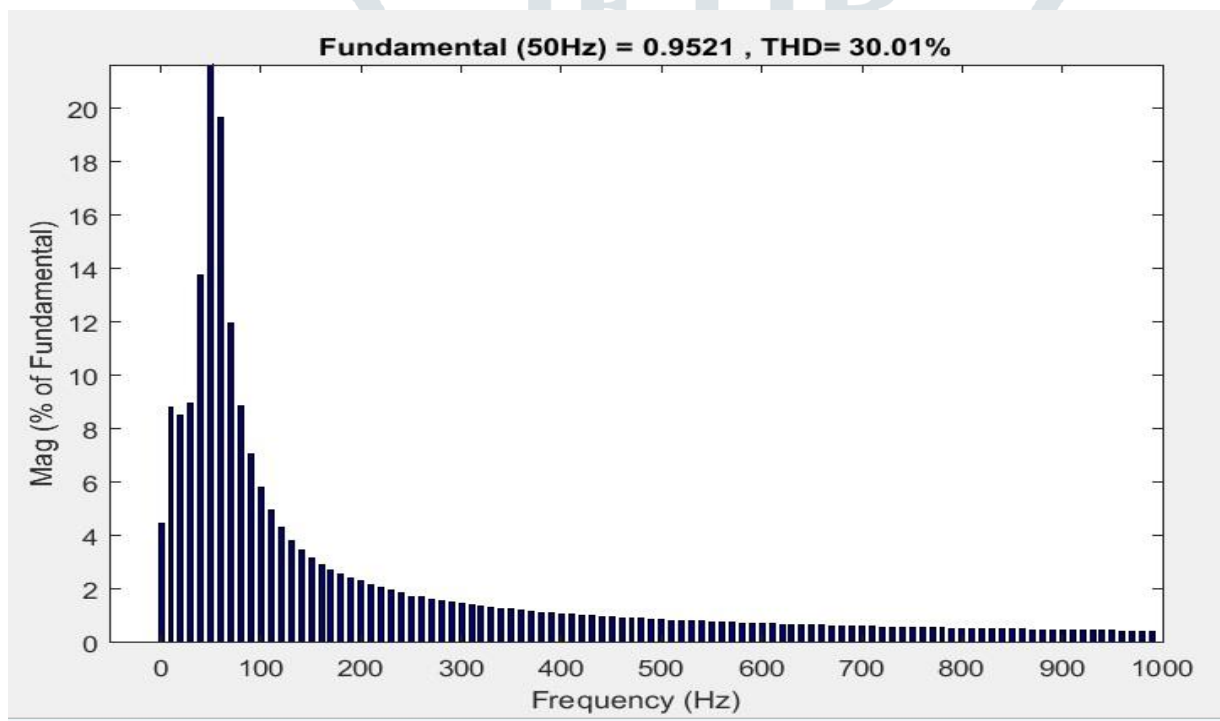


Fig.12. FFT analysis of load current without UPQC

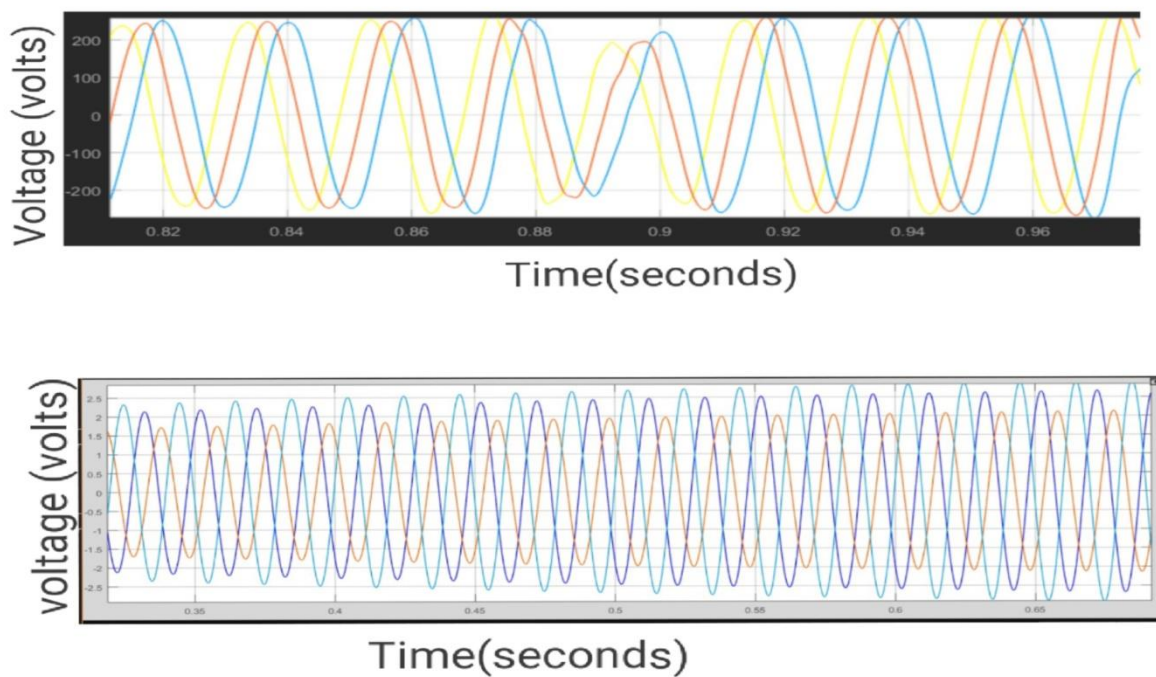


Fig.13. load voltage and current waveforms of microgrid with UPQC.

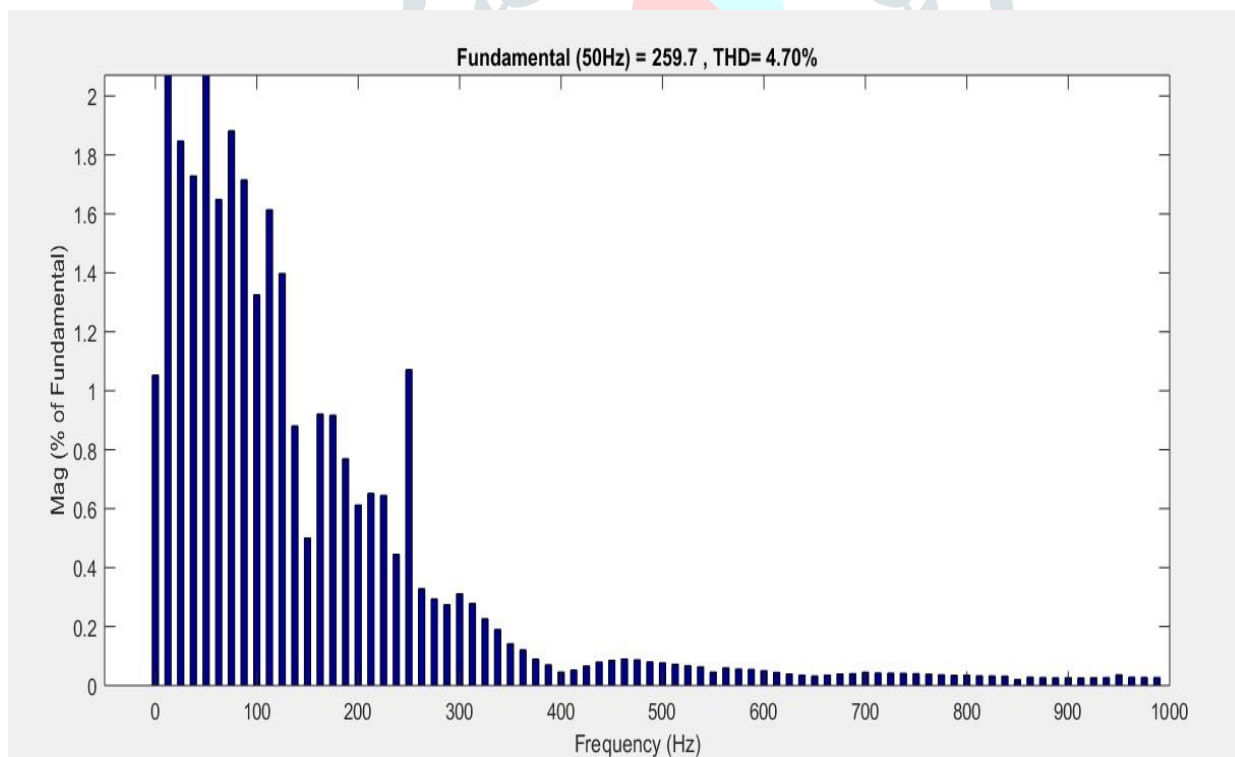


Fig.14. FFT analysis of load voltage with UPQC

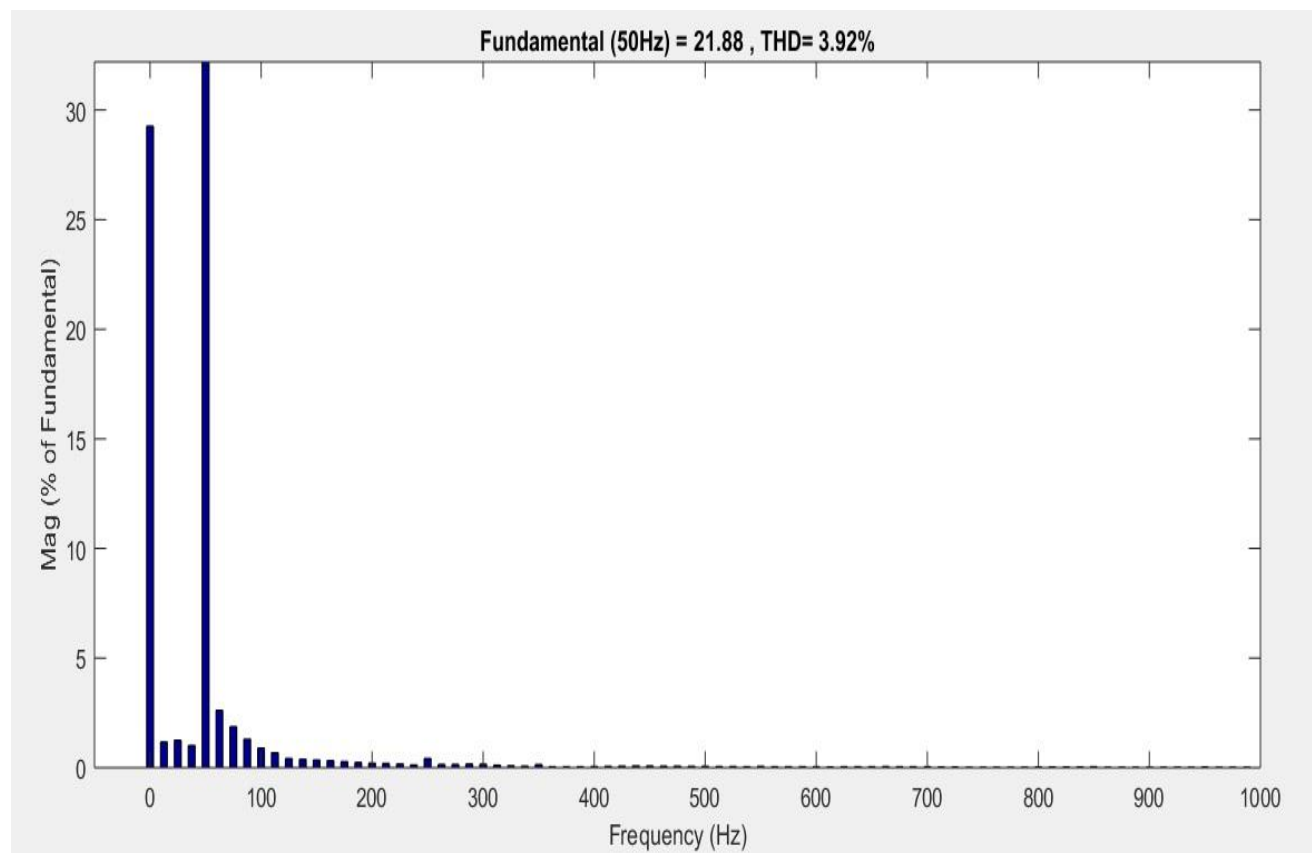


Fig.15.FFT analysis of load current with UPQC

5.1.OBSERVATIONS TABLE

	LOAD VOLTAGE THD(%)	LOAD CURRENT THD(%)
WITH OUT UPQC	23.21	30.01
WITH UPQC	4.70	3.92

6.CONCLUSION

In this paper, the hybrid grid system configuration is done in MATLAB/SIMULINK environment. FACTS devices are one of the best methods to upgrade the power quality in a system. Here in this paper load side system voltages and currents are calculated and the harmonics are reduced using Unified Power Quality Compensator with series compensator Enhanced Phase Locked Loop and shunt compensator Alpha-beta theory. Inspecting the future horizons and technology achievements are micro grid is more advantages. There is special importance of microgrid like protection issues, power system stability. In future by using the facts devices and further its implementation can improve the power quality. The simulation results obtained for microgrid interfacing with UPQC using EPLL and Alpha-beta theory controller. Due to the presence of unbalanced load in the system harmonics will be produce and its leads to voltage distortions by using EPLL and Alpha beta theory controller we can reduce distortions. ALL factors are analyzed in MATLAB

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