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POWER QUALITY PROBLEMS REDUCTION FOR MICROGRID USING FUZZY BASED UPQC CONTROLLER

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Abstract:
The primary goal of this research is to improve electricity quality in a micro grid system. This study presents a flexible ac distribution system for improving the distributed system to which the microgrid is connected's reliability and power quality. A new control algorithm for operating the Facts devices is being developed in order to increase the system's computational time and reaction. In this study, the Fuzzy Controller is used for frequency tracking as well as extracting the harmonic spectra of grid voltages and load currents in a micro grid. Matlab/Simulink is used to test the design concept in various scenarios.

Key Words: *Micro Grid System, FACTS device, Fuzzy Controller.*

INTRODUCTION

Basically, the microgrid system is a combination of loads and different micro sources operating as a single system providing power. The structure of a microgrid system consists of different parts such as interface control, control and protection devices for each micro sources as well as microgrid voltage control, power flow controlling devices, load sharing during islanding conditions, protection and stability [1]. The ability of the Microgrid to operate when connected to the grid, smooth transition to and from the island mode is another important function.

The main consideration for interconnection of microgrid to the distribution system is the impact of power quality problems on the overall power systems. Generally, these power quality problems are classified as voltage and frequency deviations in grid voltage and harmonic contents in load current. In order to overcome these type of power quality problems this paper proposes a concept of flexible ac distribution system for microgrid. This flexible ac distribution system is a combination of series and shunt converters shared by a common dc link capacitor [2]. The proposed dc link source of the FACTS device is obtained by a distributed energy source.This paper also proposes the concept of fuzzy controller for obtaining better harmonic distortions.

DISCRIPTION OF PROPOSED SYSTEM:

In an electrical power system the microgrid is commonly a group of electrical loads and power generations from different generating sources like solar, wind etc. these microgrid plays an important

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role to enhance the reliability, increasing efficiency and voltage sag correction. The complete structure of the proposed FACTS device and microgrid structure is shown in Figure 1 [3].

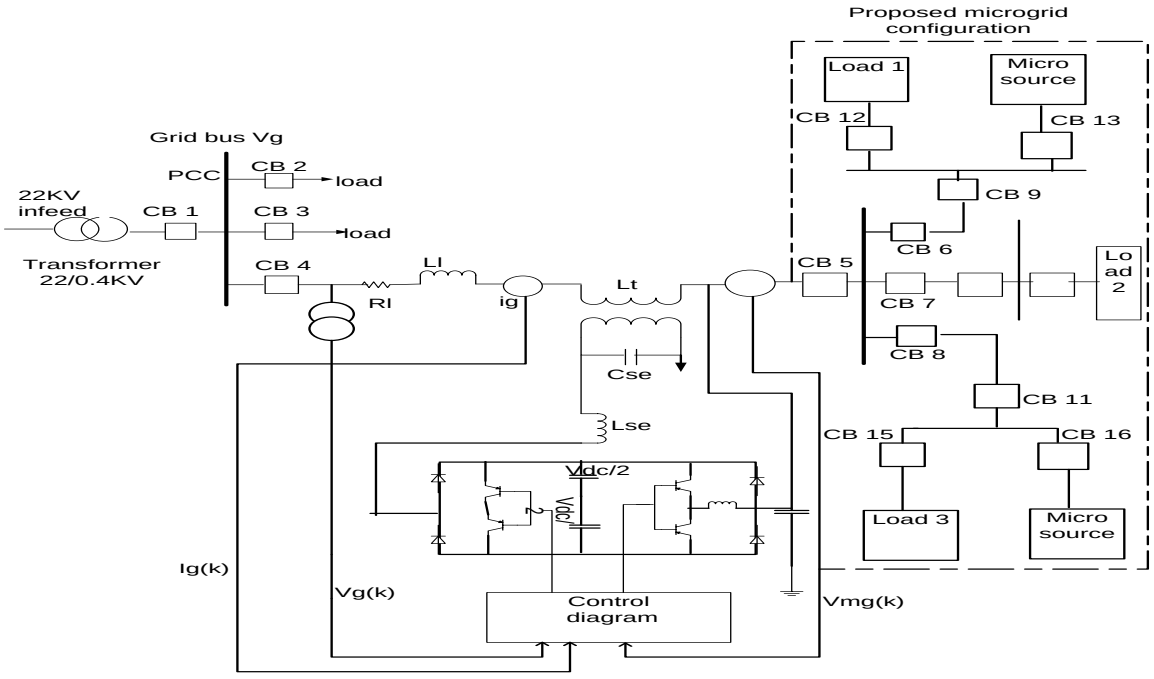

Figure 1 Configuration of Proposed FACTS device based Microgrid system

From this figure 1, the structure of microgrid consists of three feeder terminals. And the flexible ac transmission system is used for power quality compensation. And the device is also used for compensating harmonic content in both gird voltage and load currents [4].

Unified Power Quality Controller

One of the compensating devices from the FACTS family, called Unified Power Quality Conditioner, is the efficient method to improve power quality [5]. The Unified power quality controller is a combination of series and shunt controller separated by a common dc-link for exchanging reactive power.

A shunt device is one of the compensated equipment which is connected at the transmission system. This shunt compensated system has the capability of either absorbing or generating active power at the point of connection thereby controlling the voltage magnitude. To compensate for the inductive voltage drop, a capacitor can be inserted in the line to reduce the line impedance.

The series compensated device is connected in series with the line for controlling the transmission parameters such as transmission impedance [6] by controlling reactance, fluctuations in system voltage. The structure of the unified power quality conditioner is shown in figure 2.

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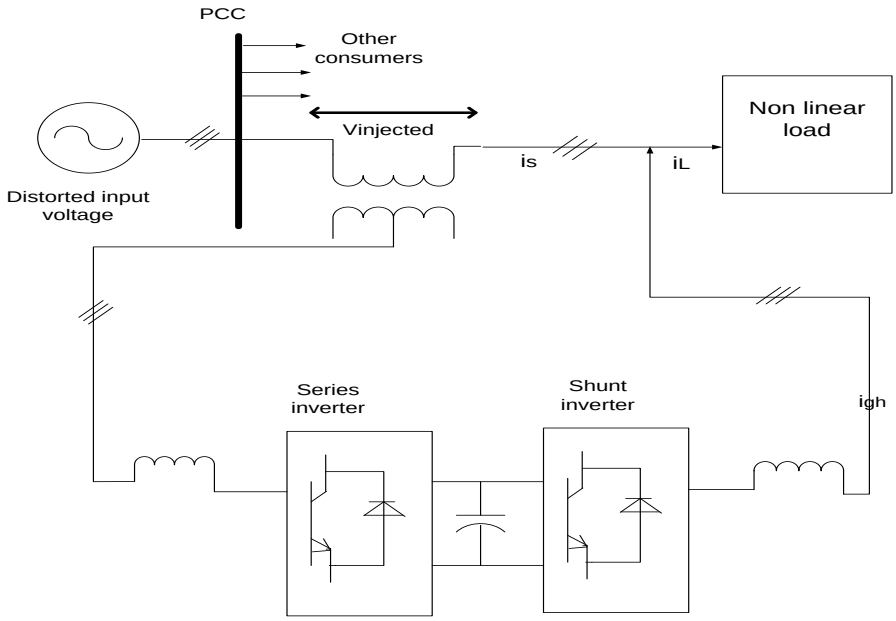

Figure 2 structure of unified power quality conditioner

The control structure of the shunt converter is shown in figure 3. The park's transformation technique is used for converting three phase current coordinates to two phase currents commands for calculating the error signals. These reference signals are compared with carrier signal in pulse width modulation technique which generates the gate signals to shunt voltage source converter [8].

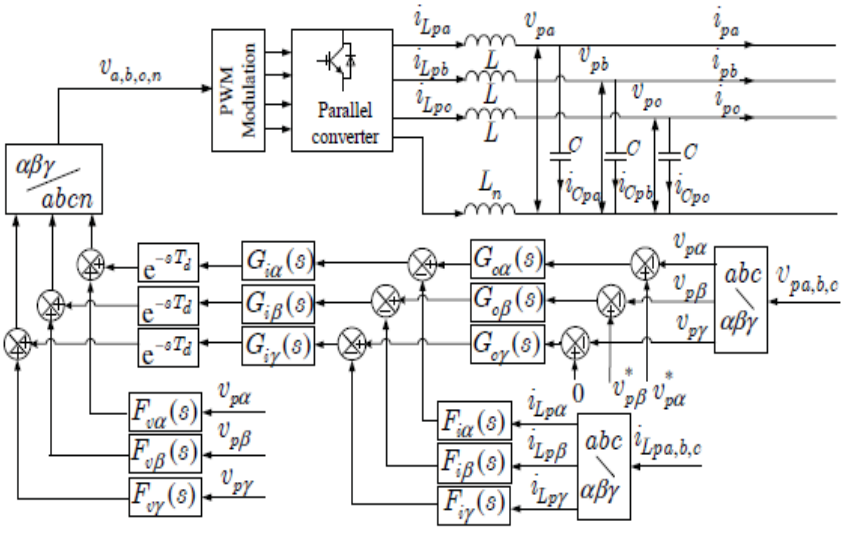

Figure 3 Control Diagram of shunt converter

Basically, the unified power quality conditioner has a capability to compensate harmonics in load current, reactive power, voltage variations and controlling the power flow [9]. But the unified power quality conditioner has no capability in compensating the voltage fluctuations in a system because there is no energy storage. Now, this paper presents a concept of UPQC that is incorporated with distribution, generation system as a dc-link through the rectifier [10].

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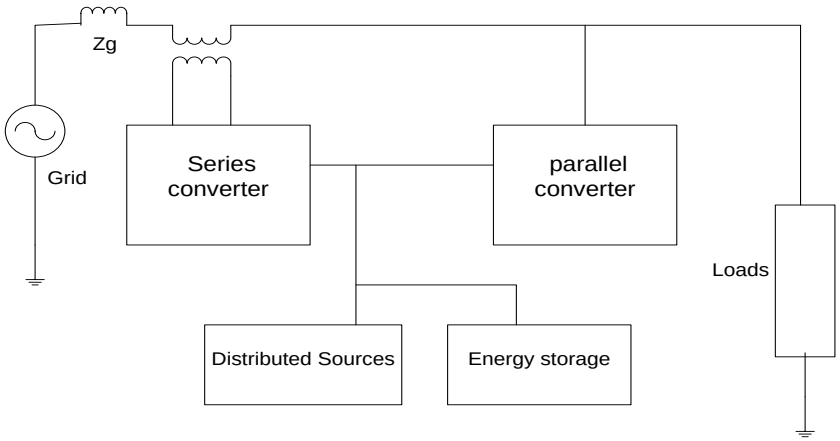

Figure 4: configuration of UPQC system with DG

FUZZY INFERENCE SYSTEM:

The fuzzy logic controller is one of the advanced soft computing controller which is used for controlling the system output. As compared with the other conventional controllers, fuzzy logic controller has the advantage of fast computing, better response, low settling time and high running response. The fuzzy logic controller operation can be explained in mainly four ways i.e 1. Fuzzification, 2. Membership function, 3. Rule-base formation and 4. Defuzzification.

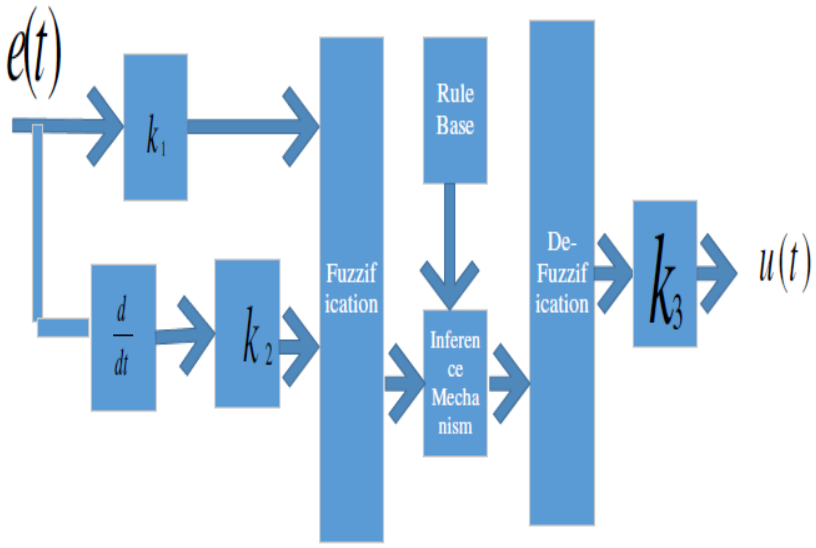

Figure 5 Block diagram of Fuzzy Logic Controller

The inputs for the fuzzy system are represented as error and error rate and its rule base formations are shown in above table. The fuzzy rules are obtained with the statement of if-then statements. The given fuzzy inference system is a combination of two inputs and one output. These two inputs are related with the logical AND/OR operators. AND logic gives the output as minimum value of the two inputs and OR logic produces the output has maximum value of two inputs. I.e if the

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input1 is zero and input2 is zero then the output is zero. The input and output membership function are shown in figure 7 and figure 8.

EXPERIMENTAL VERIFICATION:

The experimental verification for the proposed Fuzzy based UPQC micro-grid system is verified in Matlab/Simulink in two cases. The simulation diagram for this proposed system is as shown in figure 6.

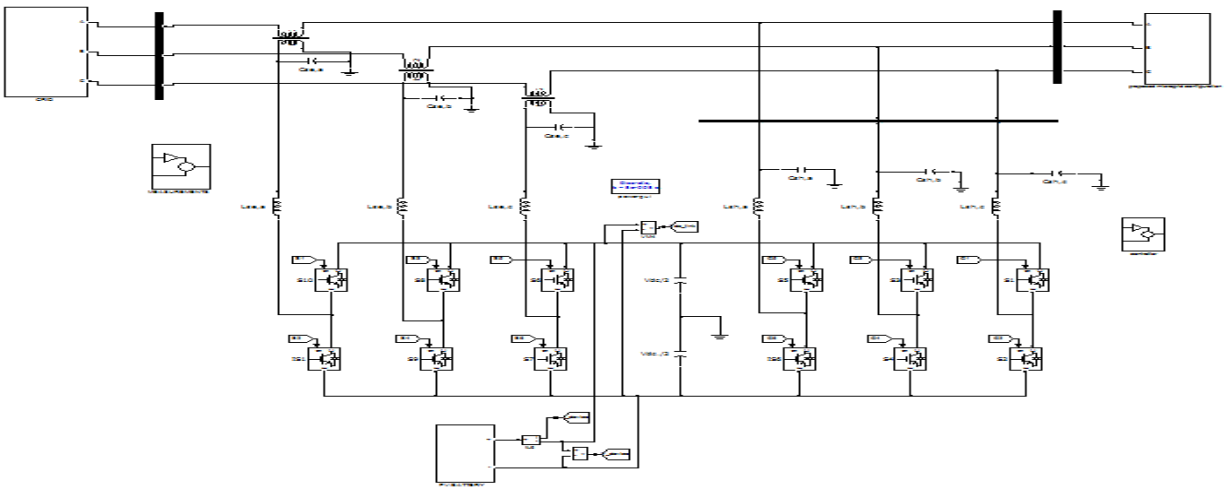

Figure 6 Simulink structure of proposed Micro-Grid System with UPQC controller

Case 1: with PI Controller

In this case the proposed grid interfaced system is implemented with PI controller and the results are shown below.

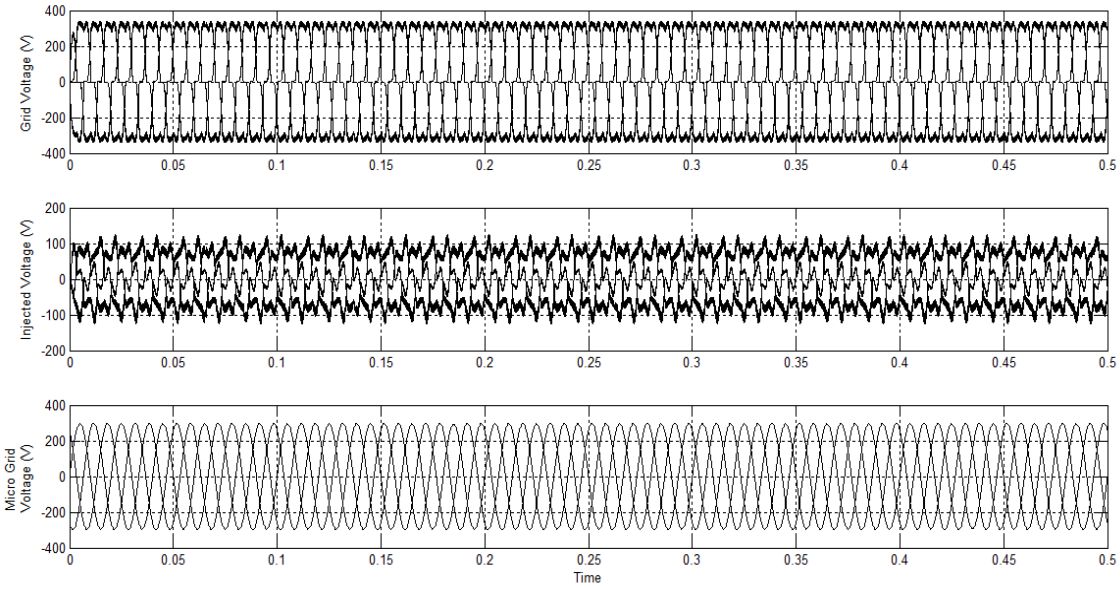

Figure 7. Simulation result for Feeder currents

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Figure 7 shows the simulation results for the system feeder currents under without and with compensation.

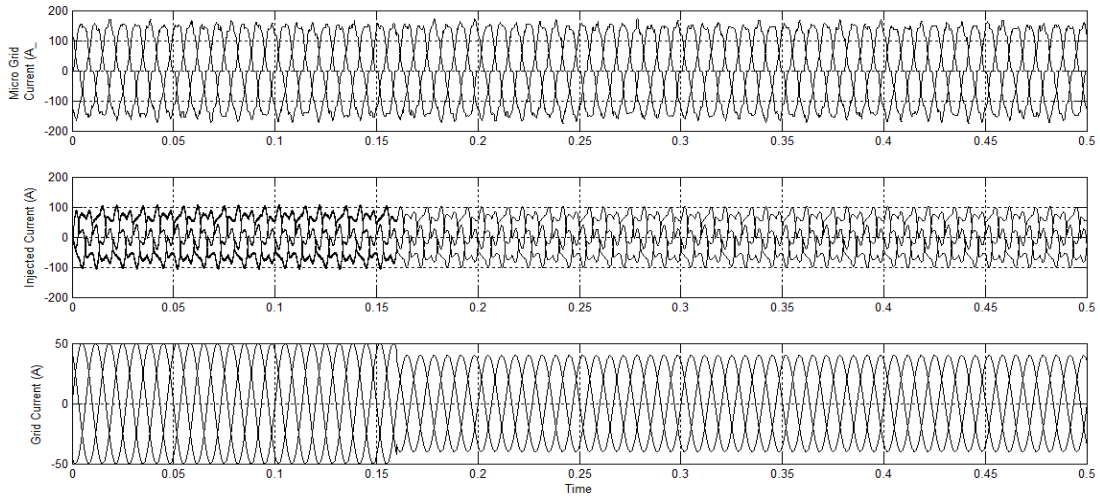

Figure 8 Simulation result for Grid, Series Converter and Micro-Grid Voltage

Figure 8 shows the simulation results for the system micro grid voltage under without and with compensation.

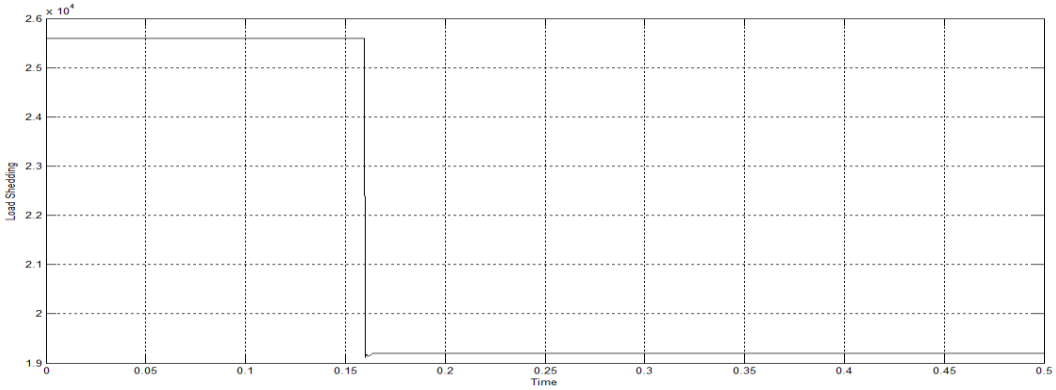

Figure 9 Simulation result for Active Power under Islanded condition

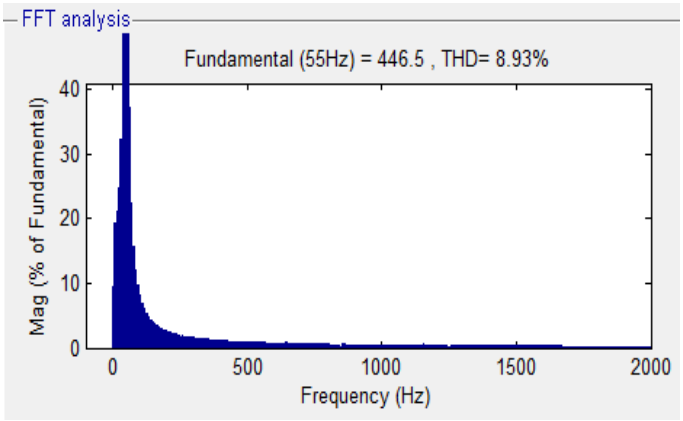

Figure 10 FFT Analysis

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Case 2: with fuzzy controller:

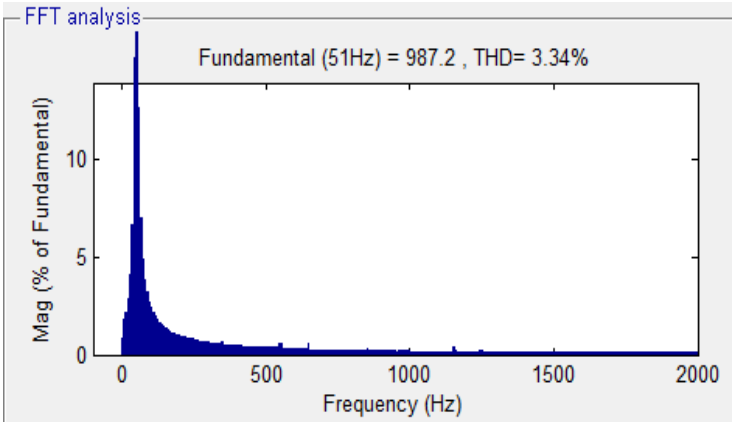

Figure 11 FFT Analysis

CONCLUSION

This paper has successfully implemented the microgrid based unified power quality conditioner along with the fuzzy logic controller. Generally, the microgrid concept mainly concentrates on the reduction of power quality problems associated with the system, the later are compensated by unified power quality controller. The fuzzy logic controller is used for getting better performance by the reduction of total harmonic distortion in the system.

The simulation results are obtained for the Grid interfacing using series and parallel converter system with conventional PI controller and Fuzzy logic controller. Due to the presence of non-linearity in the system, harmonics are produced which lead to voltage distortions. By using conventional PI controller in the system we can reduce these distortions. However, it is found, through the simulation results, that fuzzy logic controller can do better in reducing harmonics & improves THD.

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