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Design and Development of Fuzzy System Based Unified Power Quality Conditioner for Harmonic Elimination

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Abstract

The proposed system used to design a Fuzzy logiccontroller system based intelligent power quality conditioner is consist both the series and shunt active filter using a common DC link capacitors. The proposed system used to eliminate the harmonics, voltage which is developed because of fault which causes failure of the power system. Intelligent controllers are used in nonlinear control system mostly. The proposed fuzzy controller is not in the need of a mathematical model and the produce a good dynamic response. The simulations carried out using the MATLAB software. The real time implementation of the proposed system is carried out with the use of power electronic components. The proposed system simulation and hardware results are similar to each other. The power quality conditioner is able to improve the power quality on power systems in industrial and in the distribution area.

Keywords: Dynamic Response, Filter, Fuzzy Logic, Intelligent Controller, Power Quality.

1. Introduction

Mihir Hembram et. al[1] distribution of the power is the main problem now a day because of the harmonics, power factor, Interruption in the voltage, unbalanced current and voltage sag etc., The earlier methods proposes some of the best solution for the power quality problems. The filter circuit is used to eliminate the power quality problems. Both shunt and series active filter used in the circuit to eliminate the power quality issues. Generally the power quality conditioners are implemented in the circuit to fully eliminate the harmonics, improving the power factor, compensating the reactive power and to compensate the voltage imbalances.

The Unified Power Quality Conditioner (UPQC) is a device combined with shunt and series converters which uses a capacitor in common dc link proposed by Ewald Fusch et.al.[2]. The powerful device UPQC can able to eliminate the power factor problem, voltage unbalance, voltage sag and flickers, reactive power compensation etc., proposed by Lee et.al.[3]. The proposed system main concept is to control and monitoring the load bus voltage in a way at sinusoidal nature and another important thing is to make the way of compensating the active and reactive power in Mohammadi et.al.[4]. The proposed UPQC system effectively works in improving the power quality by making the voltage and current compensation effectively. The commonly configured two voltage source converters connected with the DC link capacitor used effectively proposed by Kumar et.al.[5]. The problem with the UPQC is it is having a slow control in the inverter output voltage and not having the protection for the short circuit. The rectifier in the UPQC is used as the device for the power factor correction also. The direct current

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bus voltage oscillations which is appear in the UPQC also marks the governor of the sequence filter output voltage as difficult one Montero et.al.[6]. The system using a closed loop control system to eliminate the error. The Pulse Width Modulation (PWM) signs used to produce the error rectification signals to reimburse the error like a closed loop system. This can able to eliminate all the real and reactive power issues. This is a unique controller to manage all the power quality problems by Wu et.al[7].

Tey et.al.[8] and many other people proposed Fuzzy Logic Controller (FLC) which is working effectively to utilize the information of a system to implement the real-world controller. The FLC is works based on the experience of the designer, operator and researcher. Ravi et.al.[9] the advantage of the fuzzy logic system controller is it not requires the mathematical model of the system or the plant. It sets well for the system which is not having the model and having complex dynamics. The proposed system implements the FLC in both at simulation and real time implementation for the active filters using shunt and series type. The proposed system using FLC controller for shunt and series lively control filters for the power quality in the three phase system. The proposed system simulation and hardware results give the output without oscillation and improved one.

2. Unified Power Quality Conditioner

Edaware Reid[10] proposed a system consist of two voltage supplied inverters they are organized back to back and commonly using a dc link is commonly called as UPQC. The converter shunt of UPQC should be connected near to the nonlinear load and instead of connecting it with the network side. UPQC is the best powerful tool for compensation. V_s is the supply voltage and it is unstable and inaccurate is supplied to the critical load which requires high power quality. The total load included as nonlinear load which is injecting more amounts of harmonics in to the network should be filtered. So all the loads acting as nonlinear load is should be compensated. The Figure 1 shows the block diagram of unified power quality conditioner. The UPQC shunt active filter compensates all the harmonics, negative and zero sequence components, unbalanced currents.

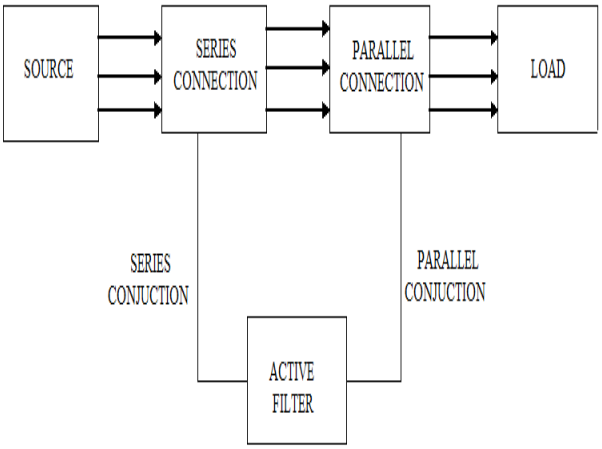

Figure 1. Block Diagram of Unified Power Quality Conditioner.

3. Block Diagram Explanation

The proposed system working model is shown in Figure2. The UPQC is used as a widespread controlling device to eliminate current and voltage harmonics. The controller for the proposed model is implemented in the end of the power system network. The compensation is done quickly and accurately by the UPQC.

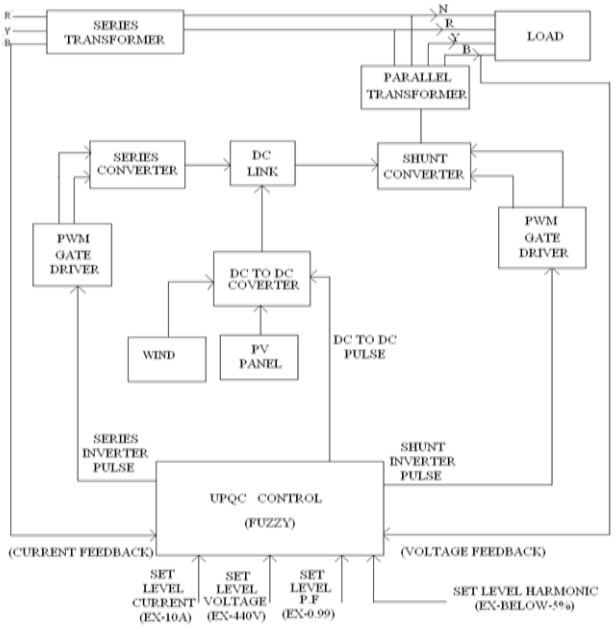

Figure 2. Proposed System Blok Diagram Model.

The selection of the power semiconductor devices makes the performance of the UPQC as the best. The PWM signals used to control the switches. The control strategies for the compensation related in fuzzy rules, about the voltage and current regulating systems. The band is modulated in a way to make the frequency of the modulation as nearly constant always. The intelligent controller based on fuzzy logic can compensate the harmonics of the voltage and current magnitude.

4. Proposed System Circuit Diagram

The proposed system circuit diagram is shown in Figure3. The common UPQC structure and links are carried out. The current feedback is used for the voltage control and voltage feedback is used for the current control. The intelligent controller fuzzy model system used to find the error. The supporting sources used in the system are dc link, wind source and solar cell.

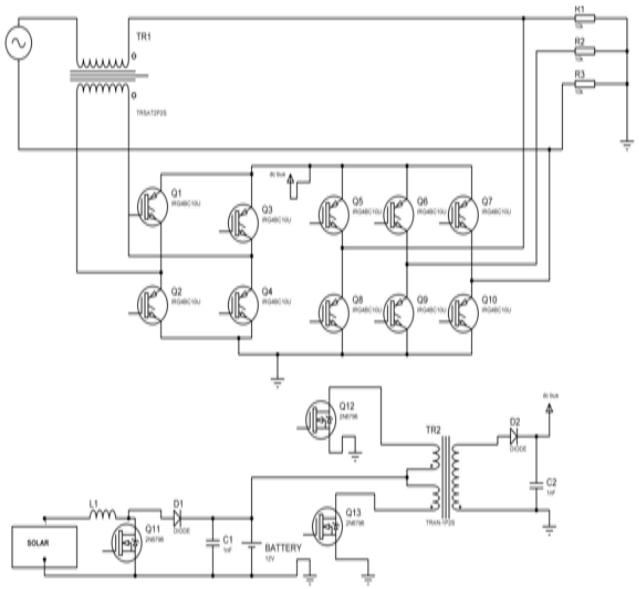

Figure 3. Proposed System Circuit Diagram.

The H bridge inverter producing a pure AC The output of the solar wind is converted to a higher level with the help of the DC-DC converter. The output of the converter is connected to a common DC link capacitor used as the input source for the distribution system. The power electronic Metal Oxide Semiconductor Field Effect Transistor (MOSFET) switches get the control signals from the PWM.

4.1 Control of DC Voltage

The shunt active filter in UPQC is used to manage the DC bus. The shunt active filter is used to determine the active power to make the DC voltage to be constant under both in steady and transient state. The DC capacitor voltage fluctuations is affected by three different factors. The alternating power of the load is compensated first then the during transient time the active power imbalance is managed. Finally the voltage sag is compensated by series active filter. Because of changing the load and voltage dips makes the power imbalance. This must be compensated or real power should be supplied. The intelligent fuzzy logic controller is having the nature of human thinking and use the natural language. Compared to other intelligent logical systems fuzzy is different. This helps to provide effective way to capture the approximate the system.

The fuzzy membership function values for input functionvariables and the output function variable is shown in Figure 4. The fuzzy logic controller use three steps like fuzzification, fuzzy inference system and defuzzification. The fuzzy controller is giving the output based on the error in the voltage and from the derivation. Different type of membership function can be used. Widely triangular membership function is used for the application. The arithmetical values of the variables are changed into changeable variables in the fuzzification process. The numerical values assigned is between zero and one. The maximum minimum method is used to imply fuzzy sets of the triangles.

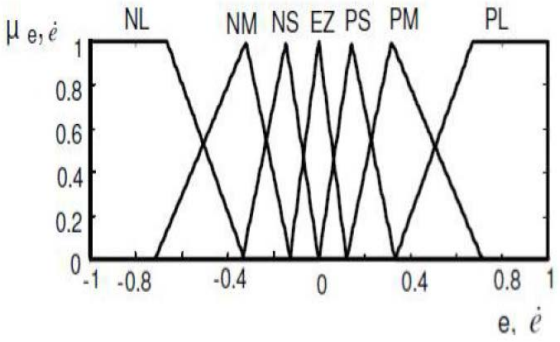

Figure 4. Fuzzy Membership Values for Input and Output Variables.

4.2 PWM Generation

PWM is used to control the thickness of the pulse always used to control the MOSFET switch. The Figure 5 shows the format of pulse width modulation. The power supplied

to electrical devices is controlled. The switch among the supply and to the load is in turned on and off. The switch is in off for long time and highest power is supplied to the load. The PWM algorithms used in photo voltaic solar battery chargers.

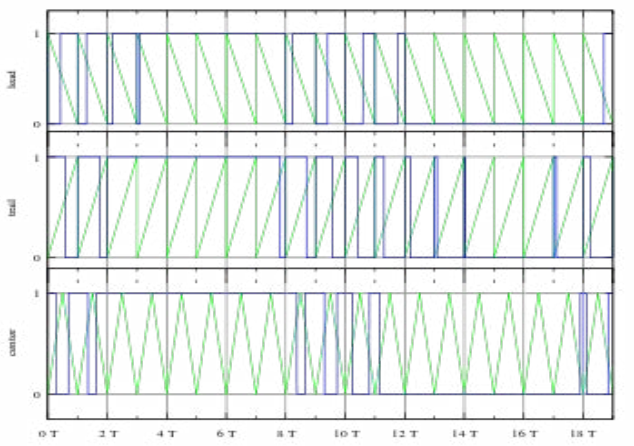

Figure 5. Format of Pulse Width Modulation.

5. MATLAB Simulation Model Diagram and Results

The proposed system simulation model of the system is shown in Figure 6. The fuzzy controller for the proposed system is shown in Figure 7. The Figure 8 shows the input voltage waveform. Figure 9 shows the injected voltage output waveform. The Figure 10 shows the waveform for the load voltage. The fuzzy logic system controller is used to control the output voltage.

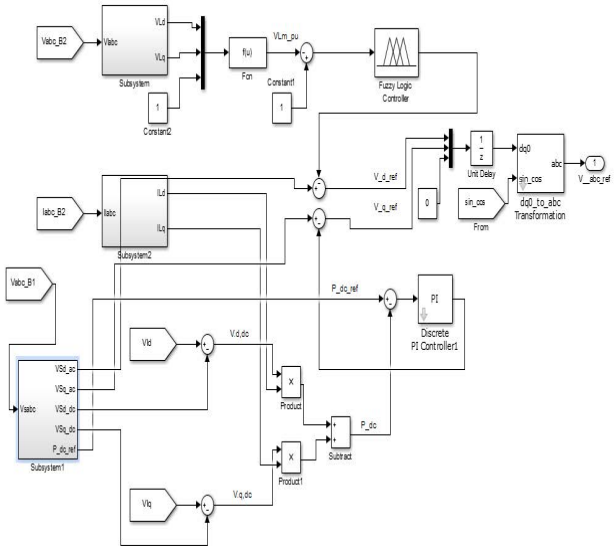

Figure 6. Simulation Model of Proposed System.

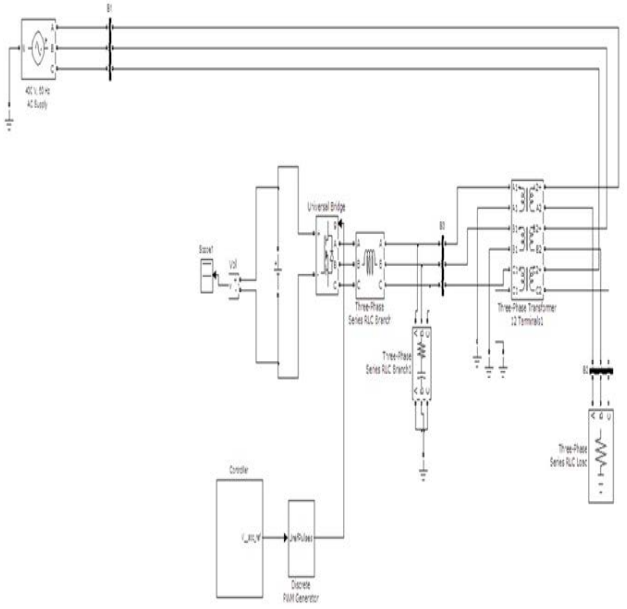

Figure 7. Fuzzy Controller for the Implemented System.

The proposed system simulated using the MATLAB. The result shows the imbalance input voltags, injected voltage waveform and the balanced output voltage.

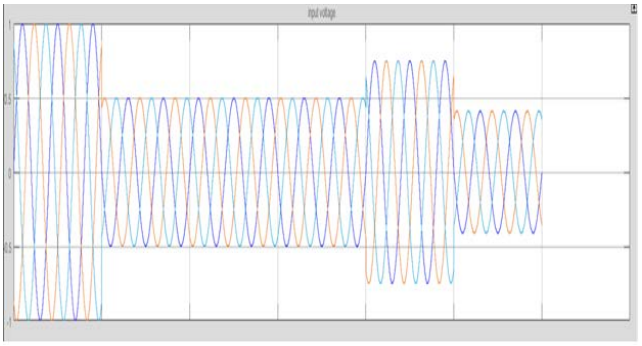

Figure 8. Input Voltage Waveform.

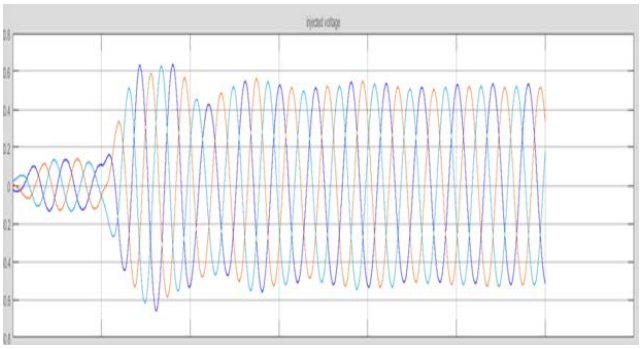

Figure 9. Injected Voltage Waveform.

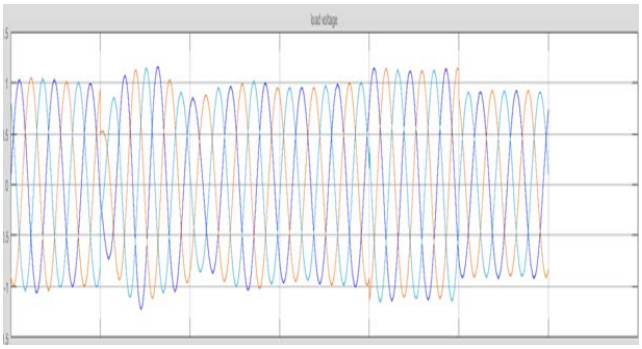

Figure 10. Voltage Output Waveform at Load Connected.

6. Hardware Explanation

UPQC is developed with the help of series and shunt connections with multiple transformers. The hardware diagram of the implemented model of the system is shown in Fig.11. The MOSFET switches and capacitors are connected together as per the circuit diagram. The hardware output shows the good efficiency, reliability and stability for the controller. The proposed H-bridge inverter gives best output. The output graph shows the constant three phase output voltage is obtained with fewer harmonic of 3.4%. The voltage output is analysed for different devices. Fuzzy controller used to control the output.

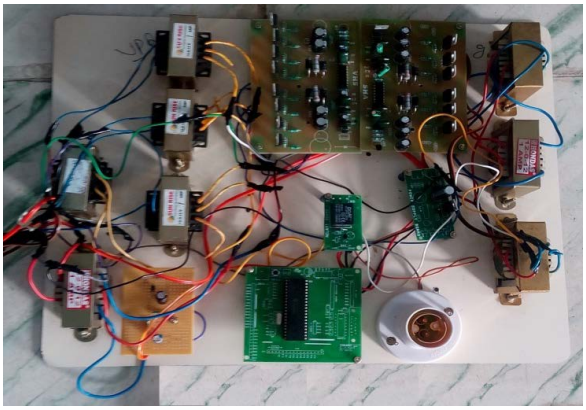

Figure 11. Hardware of the System.

7. Conclusion

The proposed system UPQC shows the accurate control on power quality. The FLC used to make the compensation and maintain the power quality. FLC is adjusted with a huge number of collected data. The voltage and current harmonica eliminated with the help of the proposed system in simulation and hardware results. Compared to other controllers like conventional controller like PI the proposed system gives better results. The power quality is improved with the help of the proposed system.

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