LINE LOSS MINIMIZATION USING FUZZY BASED UPFC

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Abstract - Since last decade, due to advancement in technology and increasing in the electrical loads and also due to complexity of the devices the quality of power distribution is decreases. A Power quality issue is nothing but distortions in current, voltage and frequency that affect the end user equipment or disoperation; these are main problems of power quality so compensation for these problems by UPFC is presented in this paper. The control circuits for UPFC are designed by using line currents, series reference voltages and these are controlled by conventional & Fuzzy controllers. The simulation results show the compensation performance of the UPFC and the control scheme under different operating conditions. The trigonometric calculation are eliminated and the computational efforts are reduced due to the effective time concept. Simulation result of both PI and Fuzzy logic control are compared.

Key Words: Power Quality, Voltage Sag, UPFC, voltage Swell.

INTRODUCTION

Load is increasing in present days so proportionally power quality issues are also increasing. Main Power Quality issues are voltage sags/swells and interruptions [1].

Because of these voltage distortions devices may fail or shut down or else a Large current unbalance is happened that could trip breakers or blow fuses. Some sort of compensation is necessary to meet PQ standard limits [2]. In order to maintain active power filtering and rectification a new concept called shunt active power filter is suitable and also it helps for reduction of negative load influence on the supply. But for filtering the supply voltage imperfections a series active power filter is proposed.

When compared to many other methods to compensate voltage sags and swells, using a custom Power device is the most efficient method. Energizing a large capacitor bank, Switching off a large inductive load is a typical system event that causes swells. So a new method is implemented in this paper i.e. UPFC [3].

To eliminate the transformer completely, a new transformerless UPFC based on an innovative configuration of two CMIs has been proposed. As shown in Figure 1, the transformerless UPFC consists of two CMIs, one is series CMI, which is directly connected in series with the transmission line; while the other is shunt CMI, which is connected in parallel to the sending end after series CMI. Each CMI is composed of a series of cascaded H-bridge modules as shown in Figure 2. The transformerless UPFC has significant advantages over the traditional UPFC such as highly modular structure, light weight, high efficiency, high reliability, low cost, and a fast dynamic response. The basic operation principle, operation range, and required VA rating for series and shunt CMIs have been studied in [28]. Nevertheless, there are still challenges for the modulation and control of this new UPFC: 1) UPFC power flow control, such as voltage regulation, line impedance compensation, phase shifting or simultaneous control of

WORKING PRINCIPLE OF UPFC

In transformerless UPFC the series converter is spitted into three individual single phase series converters as shown in figure 1 [4]. The controlling capacity of the UPFC is back-to-back connection of series and the shunt converters with a DC link, which is used for exchanging the power. In this unified power flow controller the common dc-link capacitor is eliminated. So, in unified power flow controller the active power is starts exchanged through the transmission line [5].

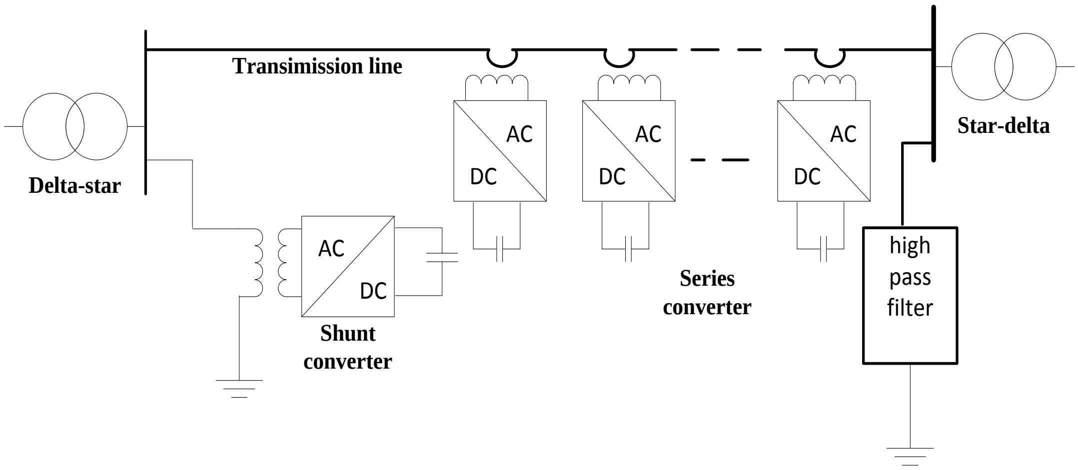

Figure 1: Schematic Diagram for UPFC

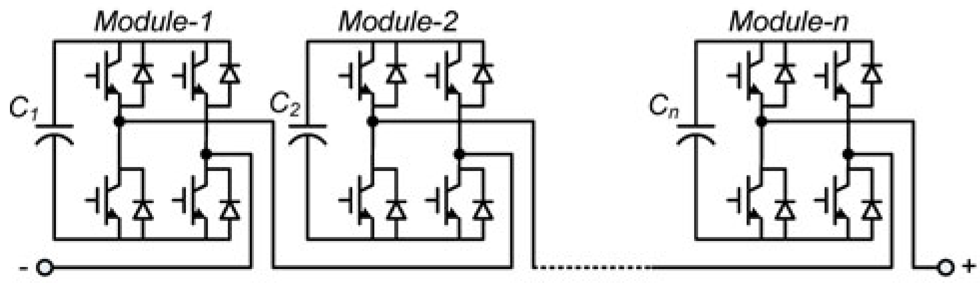

Figure 2: Schematic Diagram for UPFC

CONTROL CIRCUIT FOR UPFC

The control strategies for UPFC is divided into three main categories as shown in figure 3 i.e A) Central controller, B) series controller and C) shunt controller [7].

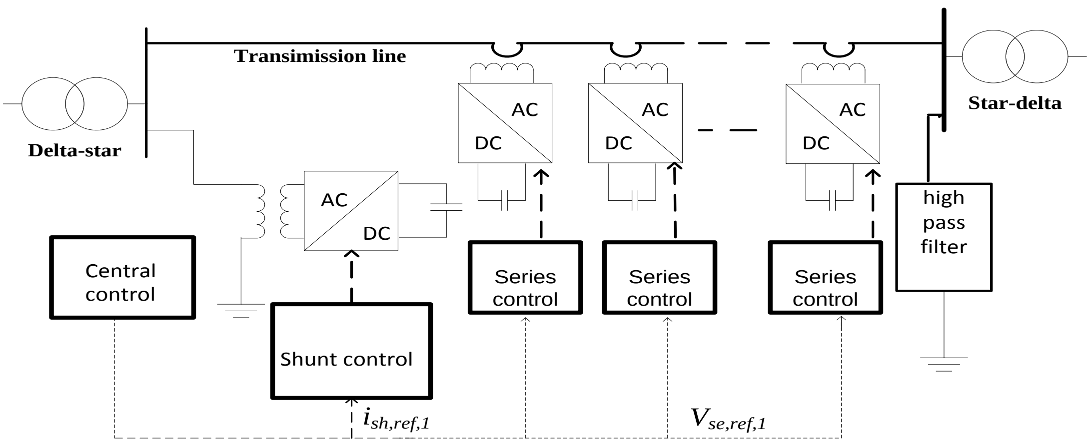

Figure 3: Closed Loop Control Diagram of UPFC

A. MAIN CONTROLLER FOR UPFC

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For controlling series and shunt controllers all the reference signals are generating in this central controller.

B. SERIES CONTROLLER

By maintaining the capacitor voltage to a rated value series controller controls the voltage issues. Capacitor voltages in both quadrature and direct frame generates the reference signals generated and that reference signals are used to operation of this controller. Basically, natural and 3rdorder harmonic currents in these series controllers [8] are created by first order low pass and third order band pass filters as shown in figure 4.

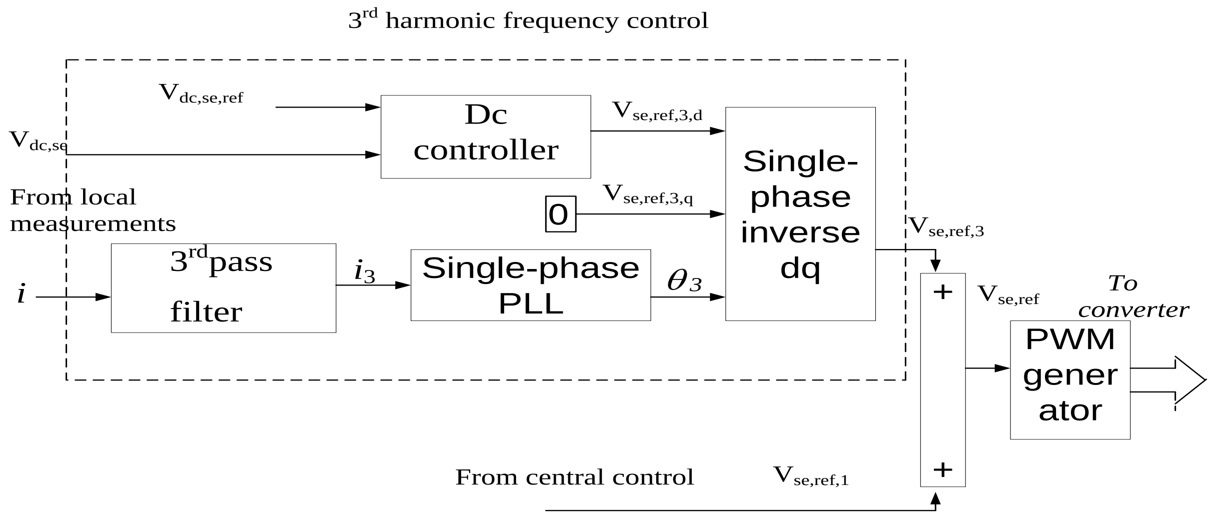

Figure 4: UPFC Series Control Structure

C. PARALLEL CONTROLLER

The control structure for parallel converter is shown in figure 5. For generating suitable active power to DVR converter a 3rd order harmonic current [9] is inserting into the transmission line it is the basic theme to use this control. The static converter is basically a3ϕ converter and it is connected back to back with another 1ϕ converter.

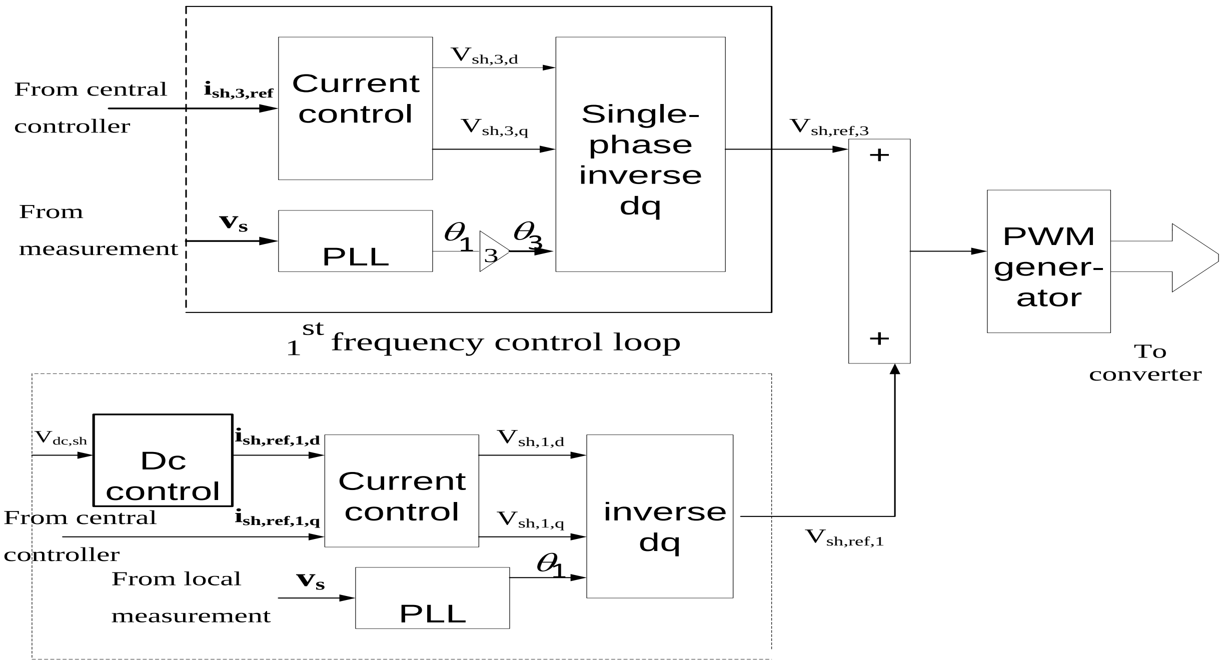

Figure 5: UPFC Shunt Control Structure

FUZZY LOGIC CONTROLLER

In the previous section, control strategy based on PI controller is discussed. But in case of PI controller, it has high settling time and has large steady state error. In order to rectify this problem, this paper proposes the application of a fuzzy controller shown in Figure 6. Generally, the FLC is one of the most important software based technique in adaptive methods. As compared with previous controllers, the FLC has low settling time, low steady state errors.

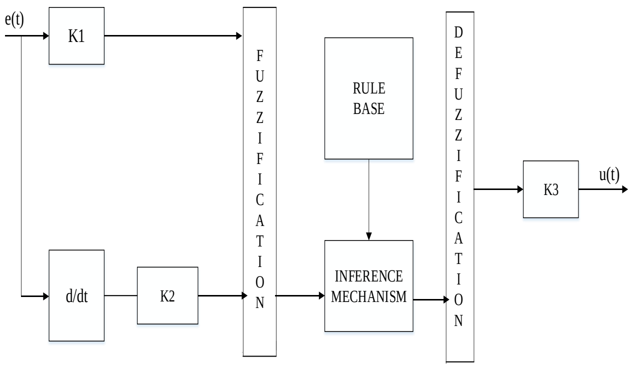

Figure 6: basic structure of fuzzy logic controller

In this paper, the membership function is considered as a type in triangular membership function and method for defuzzification is considered as centroid. The input variables such as error and error rate are expressed in terms of fuzzy set with the linguistic terms VN, N, Z, P, and Pin this type of mamdani fuzzy inference system the linguistic terms are expressed using triangular membership functions. In this paper, single input and single output fuzzy inference system is considered. The number of linguistic variables for input and output is assumed as 3.The numbers of rules are formed as 9. This input is related with the logical operator AND/OR operators. AND logic gives the output as minimum value of the input and OR logic produces the output as maximum value of input.

In this experiment we creating a condition that a system is having voltage sag by connecting a three phase fault to the system and observation analysis is shown in figure 7.

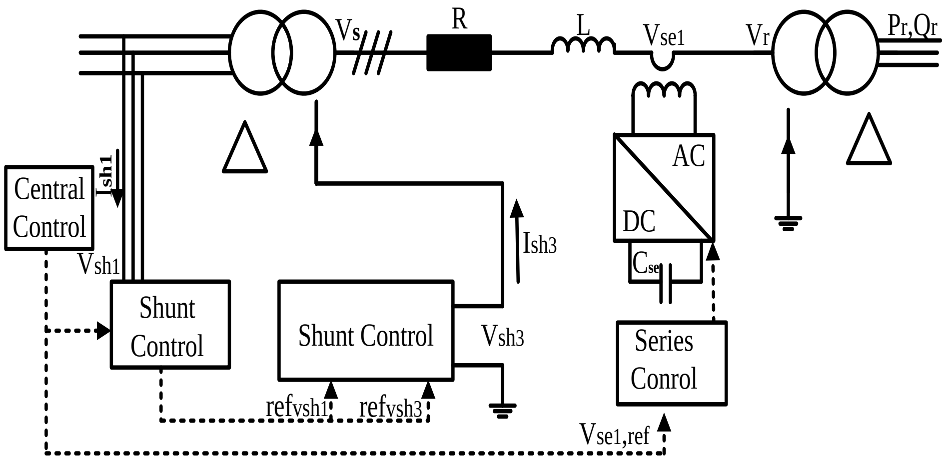

Figure 7: UPFC Control Structure

The experimental diagram for this system with UPFC based on the figure shown in 7. The upfc is connected to the system at 0.3s.When fault occurred in the system then sag will appear in output voltage shown in figure 8. The magnitude of voltage is reduced by 0.65 percent of its nominal value during this fault time.

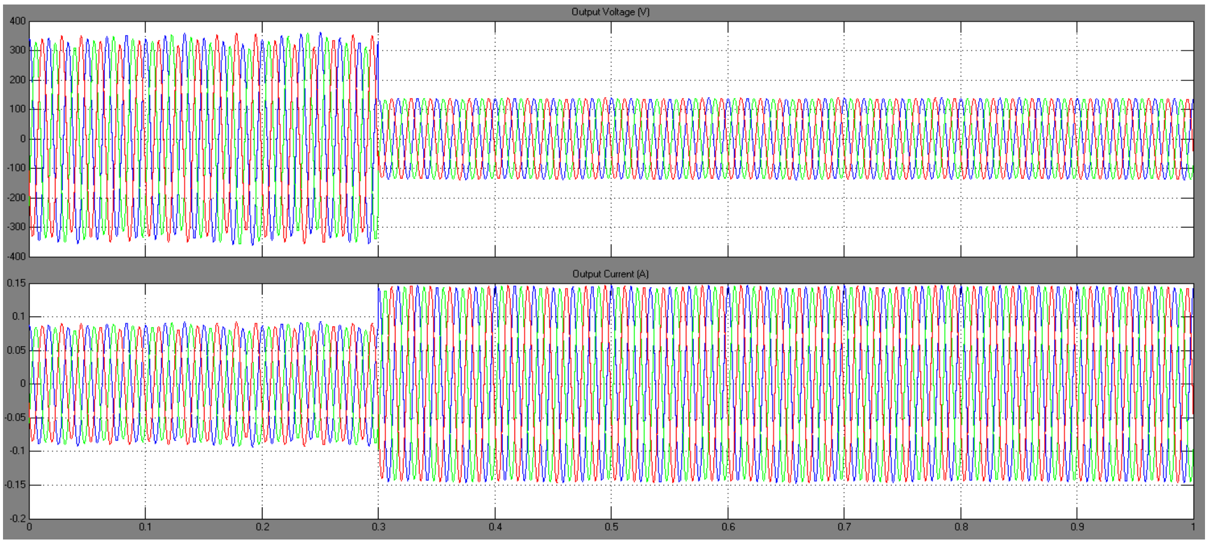

Figure 8: Output Voltage & Current with & without UPFC

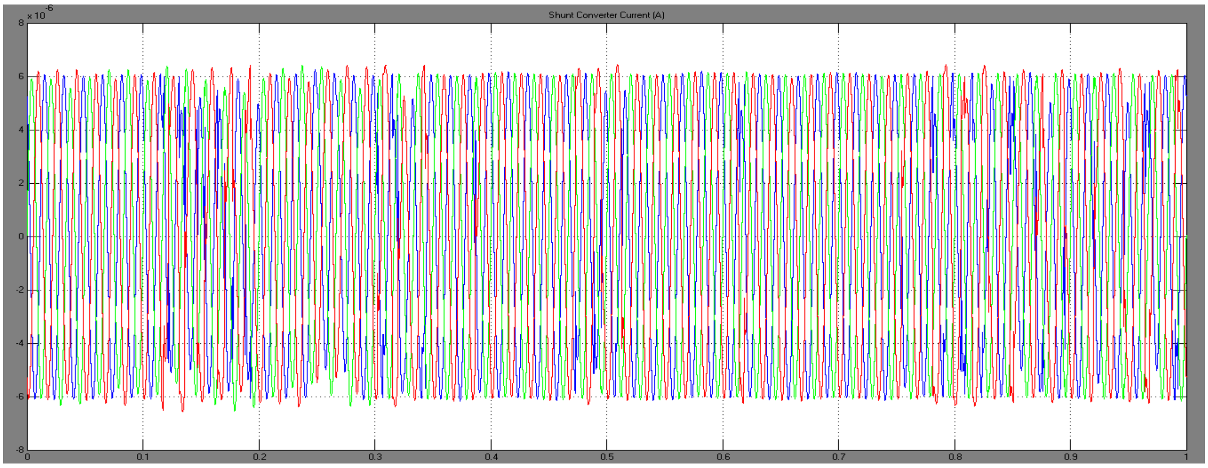

Figure 9: Simulation Waveform for Shunt Converter Injected Current

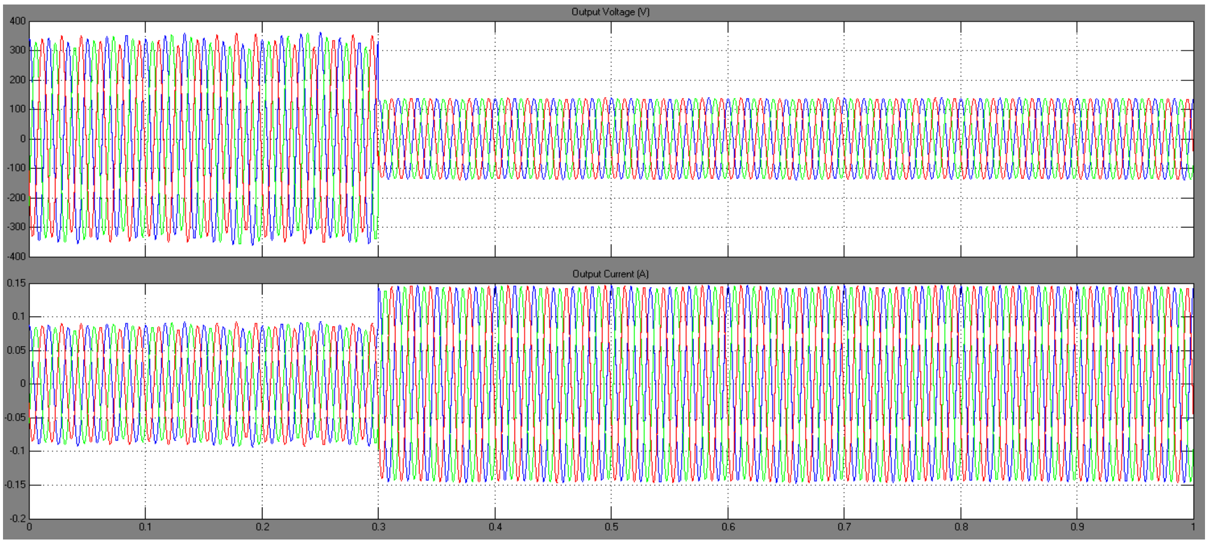

Figure 10: Output Voltage & Current with & without UPFC with Fuzzy Controller

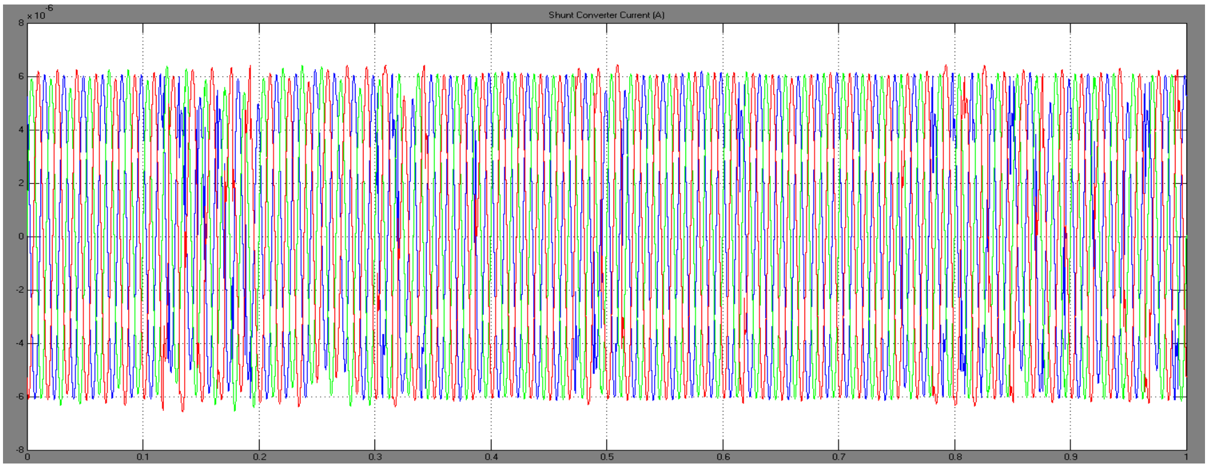

Figure 11: Simulation Waveform for Shunt Converter Injected Current with Fuzzy Controller

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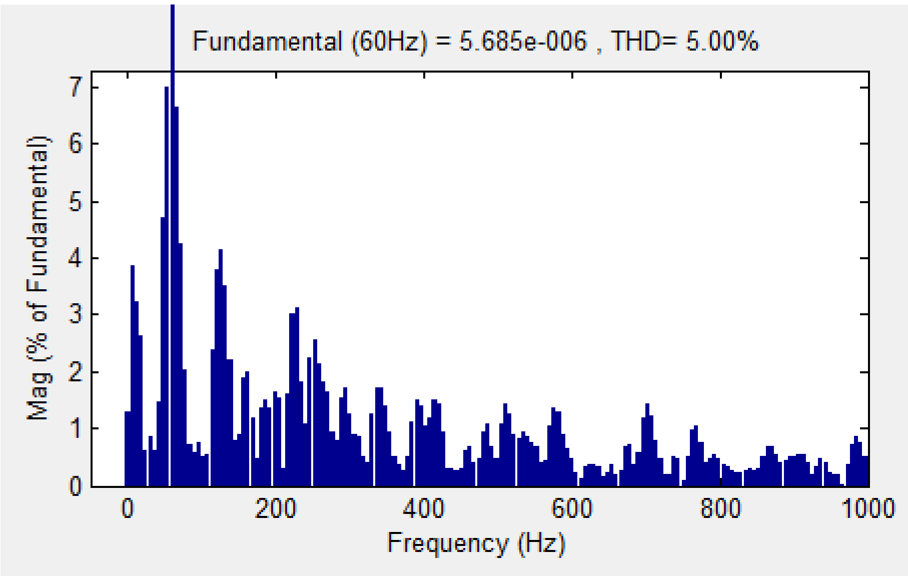

Figure 12: THD value of system Shunt Current with UPFC

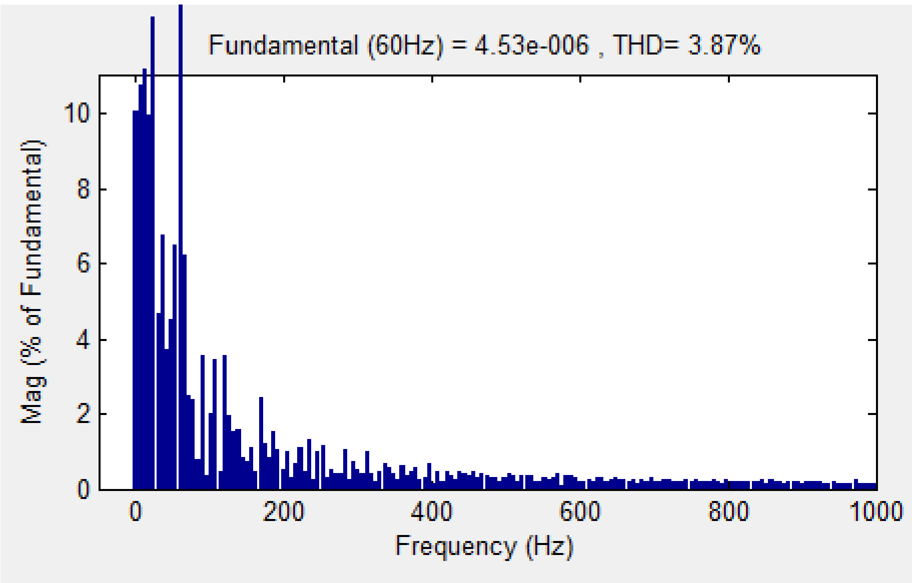

Figure 15: THD for Shunt Converter Current under Fuzzy controller

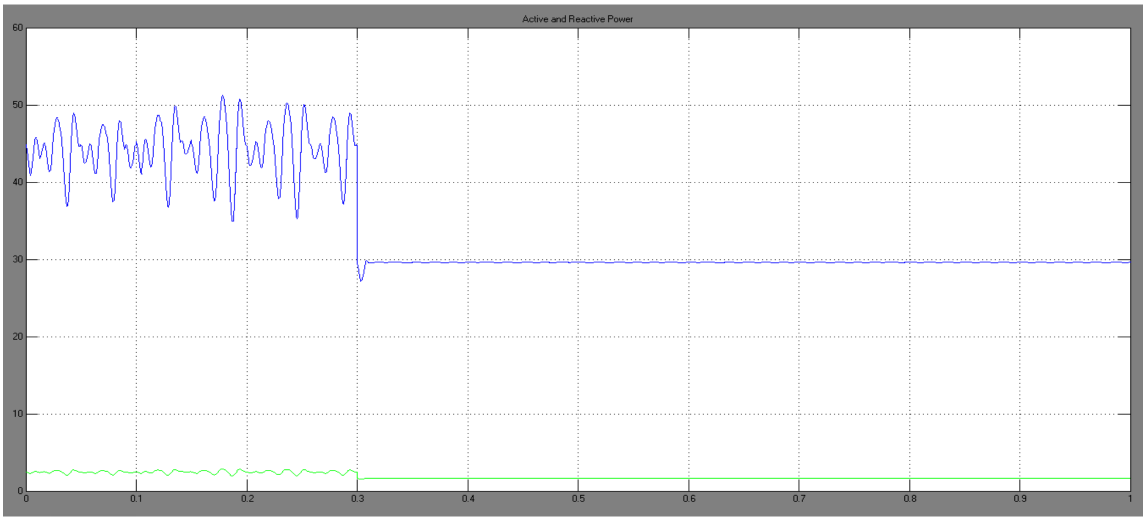

Figure 16: Simulation Waveform for Active and Reactive Powers

CONCLUSION

This paper present a new control strategy for the fuzzy based transformerless UPFC, which provides the advantages such as: Getting low THD of output voltage & current using CMI converters, All UPFC functions, such as voltage regulation, line impedance compensation, phase shifting or simultaneous control of voltage, impedance, and phase angle, thus achieving independent active and reactive power flow control over the transmission line. The transformerless UPFC with proposed fuzzy modulation installed in the grid to optimize energy transmission over the existing grids.

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