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Esa Based Upqc Controller to Improve Power Quality in Microgrid System

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Abstract: Generally, Power Quality is the main concern parameter in present power system scenario, the main causes for effecting the power quality is due to either harmonic distortion, voltage imbalances, reactive power variations. There are many techniques applied to maintain this power quality in literature. In Facts family, the UPQC controller plays a key role, because it uniquely controls all the transmission parameters. The UPQC controller is combination of series-shunt converters with common dc link. The signals required for these converters are generated by reference and actual signals of bus and dc link capacitor. Phase locked loop helps to provide the phase angle sequence required to improve power factor. In addition with, this paper is implemented with extended search algorithm to better control the dc link voltage for improving power quality. Mat lab/Simulink is used to test the system conditions and performance.

Key words: Micro grid System, Power Quality, Extended Search Algorithm, Unified Power Quality Conditioner.

I. INTRODUCTION

The latest power distribution system is fetching very susceptible to the various PQ (Power-Quality) problems [1]. PQ in distribution systems is a focal concern for industrial, commercial and residential purposes. Increased affair above this matter has run to quantifying PQ variations, reviewing the features of power disturbances and specifying solutions to these power quality problems. PQ is mostly exaggerated by the increased usage of non-linear loads operated by Electronic Component, motor applications and gear mechanised systems. Indigent power quality can disturb the security, reliability, and efficiency of several categories of equipment. Many parts of PQ are harmonics; flicker and imbalance have turn out to be stern concerns. The causes for power quality problems are mainly due to either lightning effect, switching of capacitor banks, may effects the system voltage transients, sag/swell conditions, voltage interruptions [2].In consequence of the growth of powered electronic devices such as FACTS and custom power devices, deregulated power systems with multipurpose new-fangled control abilities have performed.

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Reasonably slight concentration, however, has been fervent to system sag enhancement [3]. It is recognised that FACTS-based devices, viz., STATCOM, SVC, DVR and DSTATCOM can deliver an effectual solution to voltage sag difficulties.

Therefore, a recent distribution system needs a better steadiness of voltage being provided and the current drawn which is an elemental viewpoint to the end user.

One latest and the very assuring solution is UPQC (Unified Power-Quality Conditioner). UPQC is a combination of series and shunt APF with a common dc link capacitor. The purpose of shunt APF is to inject an anti-harmonic current at the PCC to meet the reactive power demand sharing. The compensation of load voltage under both sag/swell conditions is going to resolve with the help of series APF.

Conveniently, UPQC has been ultimate solution to progress the PQ in the electrical distribution system. The control method is not suitable for UPQC system for the motive that the dc sources are exchanged by capacitors in the UPQC system [4]. Accordingly, there is a requirement to consider several PQ mitigation procedures to convalesce the quality of power supplied. This shortage can be overwhelmed by unique intelligent optimization algorithms known as heuristic approaches are executed to solve PQ distributions. Some sounds regarded optimization systems are Evolutionary Programming (EP), Genetic Algorithm (GA), Simulated Annealing (SA), Differential Evolution (DE), Particle Swarm Optimization (PSO) and Artificial Bee Colony (ABC), etc. The improvement of UPQC PQ problem in a viable environment includes in the minimization of power losses [5].

II. MICRO-GRID SYSTEM:

The micro-grid is a combination of multi sources connected to meet the required load demand. In this paper, the micro-grid is a structure of combined PV and Wind Hybrid systems. The proposed structure of basic hybrid system is shown in figure 1.

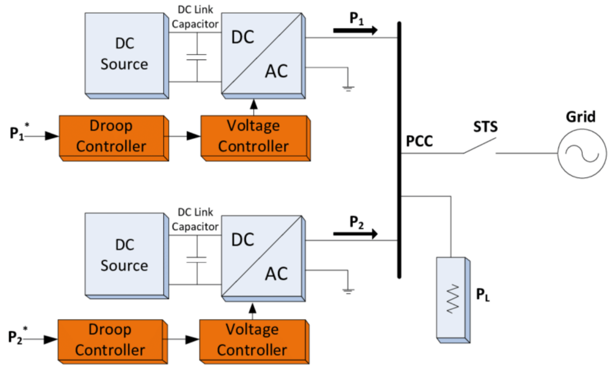

Figure 1: Structure of Micro-Grid System

In this above structure, the micro-grid is combination of hybrid pv and wind energy systems. These two systems are interlinked at a common dc bus called as point of common coupling. And an inverter is used to achieve the synchronization with the grid. The modelling of pv and wind systems are explained below.

III. SOLAR PHOTOVOLTAIC SYSTEM:

Generally, the PV panel is a group of cells, which are connected in series to meet the demand. The solar panel coverts the photon effect to electrical energy. It produces the current when light absorbed at the junction. And later, it converted to electrical voltage with the help of solar electrical equivalent circuit. A PN junction diode is placed in the circuit to oppose the return currents. The structure for solar equivalent electrical circuit is shown in figure 2. The main problem in solar panel is the output is not fixed because of variable temperature and irradiance. In order to get constant DC voltage from the panel, an MPPT based DC-DC converter is used, later it is applied to inverter for operating loads.

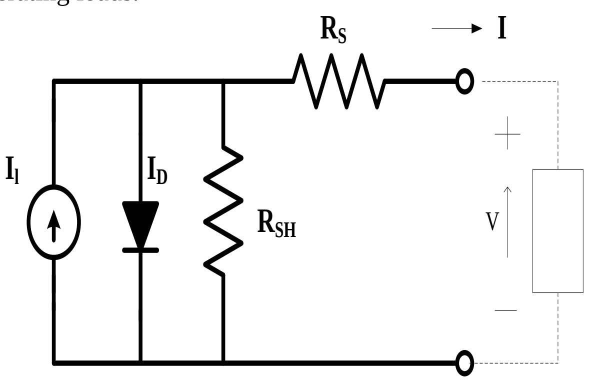

Figure 2: Electrical Circuit of PV System

Wind Energy System:

The wind energy system converts wind energy to mechanical energy with turbine and further it converted to electrical energy with help of generator. It consists of gear box mechanism for converting low speed shaft to high speed shaft and it applied to generator. The classification of generators are mainly two type ’si.e synchronous generator and induction generator. And pitch angle controller also used to get the maximum efficiency irrespective of wind direction. Pitch angle moves the blades position w.r.t wind direction. Basically, wind systems are classified into two types (a) Horizontal Axis and (b) Vertical axis wind turbines.

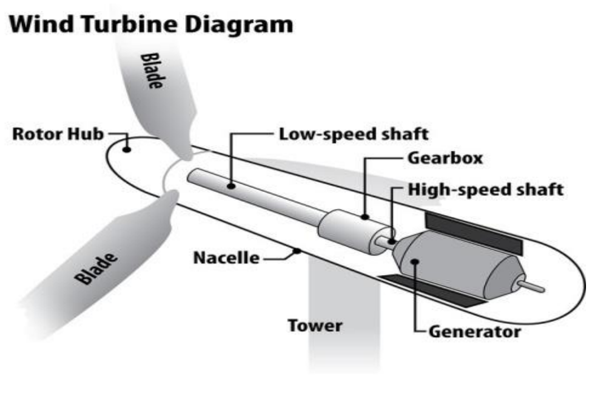

Figure 3: Basic diagram of wind turbine

Custom Power Device (UPQC):

In the proposed method, the UPQC is used to compensate the PQ issues with the help of the Extended Search algorithm. The UPQC is structure of two back to back converters with common dc link capacitor. The two converters are controlled with the help of PLL based PWM generation technique. The power sharing between the sources to the load is by achieves through maintain the dc link voltage. Initially, the normal voltage and current characteristics are analyzed, and then the PQ issues are created using the non-linear load, unbalanced load or critical load. The PQ issues are mitigated in the use of UPQC device and bull algorithm is assist to the mitigation process via power sharing, dc link voltage regulation. The connected structure of UPQC with distribution system is shown in figure 4.

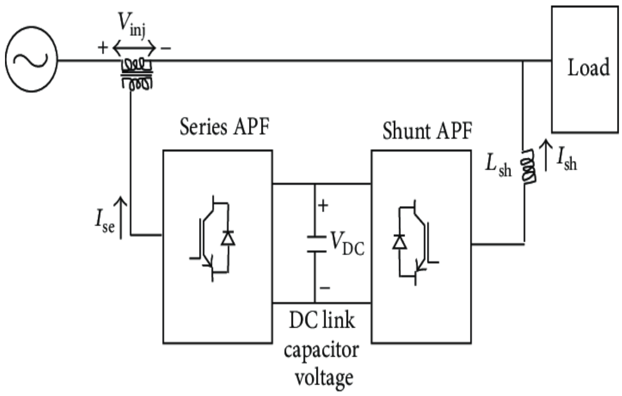

Figure 4:Structure of the proposed method

UPQC control techniques:

Control Diagram of the Series APF controller

In this series APF converter, the gate signals are obtained by controlling of system bus and grid voltages. This converter can effectively regulate the problems in voltage such as sag/swell or variations in system voltages. It includes PLL and PWM controllers. The control diagram for series converter is shown in figure 5. In this figure, the system voltages i.e actual and reference load voltages are transformed into dq-transformation and then these are compared with the help of dc link voltage. Later converted to abc-form and applied to PWM generation.

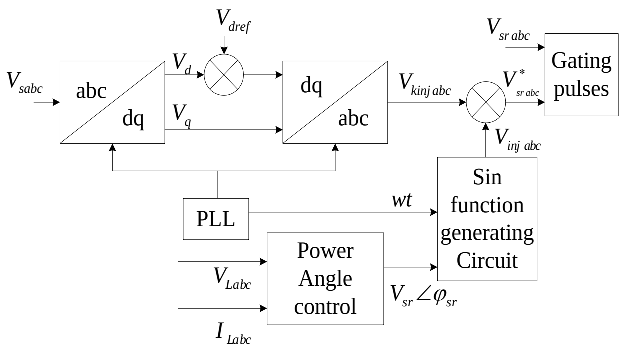

Figure 5: control structure of the series inverter

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Controlling of the Shunt APF controller

The shunt converter control diagram for UPQC is shown in figure 6. This control diagram is used to regulate, the current harmonics. The reference signal required for current controller is obtained by the general PQ-theory transformation. The expressions for calculating powers using currents are shown. In this case the voltage and currents are converted to αβ-coordinates with the help of parks transformation.

$$p = v_\alpha \cdot i_\alpha + v_\beta \cdot i_\beta = \overline{p} + \widetilde{p}$$

$$q = v_\beta \cdot i_\alpha - v_\alpha \cdot i_\beta = \overline{q} + \widetilde{q}$$

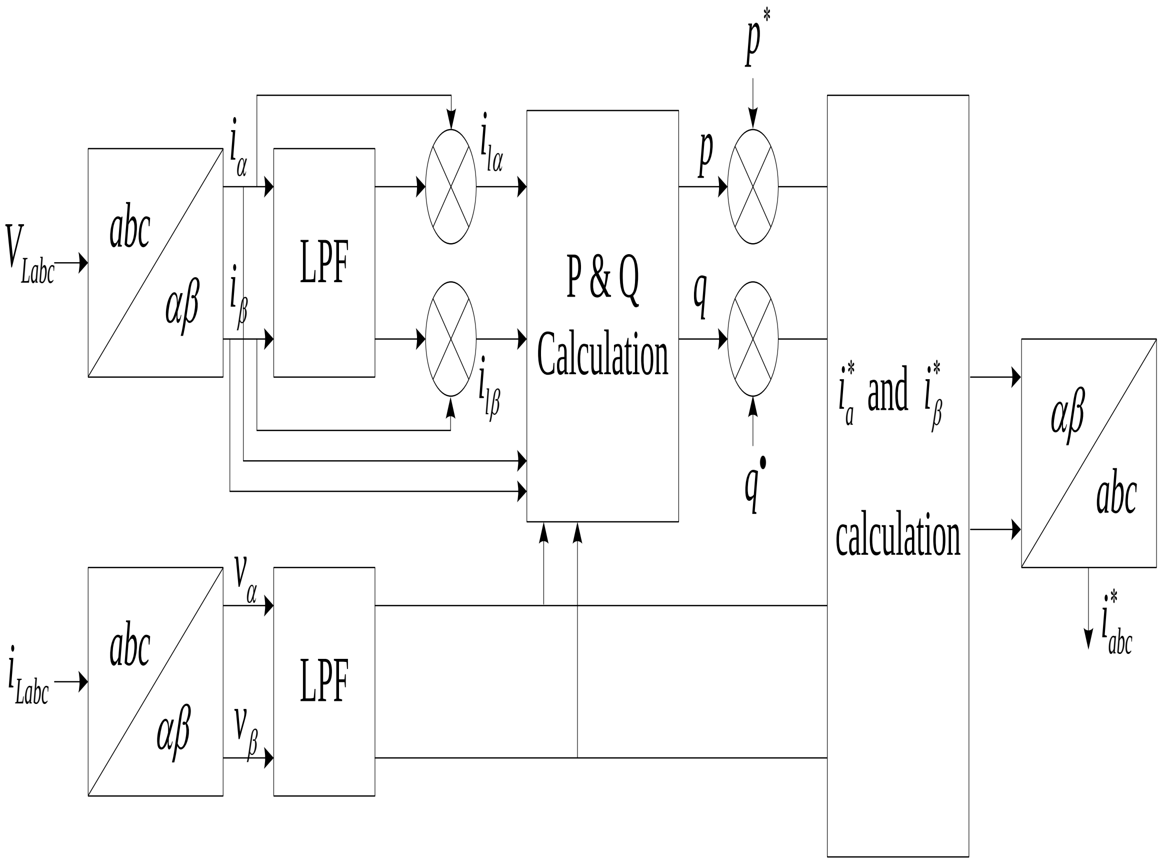


Figure 6:control structure of the shunt inverter

Process of Extended Search Algorithm:

The ESA set of rules is utilized to keep the dc hyperlink voltage as a regular. The reference dc hyperlink voltage and regular dc link voltage is fed the input of the set of guidelines. The mistakes voltage or voltage difference of the dc hyperlink voltage is decreased and maintained in the ordinary manner. Basically, the ESA is the evolutionary set of guidelines. It is applied the genetic operators, crossover and mutation. The ESA emerge as advanced to cast off the weaknesses of the ga. One of the important risks of the ga is that it does now not use the brilliant individual to provide a ultra-modern technology. But, the quality character is actively used inside the proposed set of policies. The first-rate man or woman determined to this point is used to supply a contemporary individual in the crossover operation. All humans produced try to get higher humans via taking a fantastic part of the awesome person.

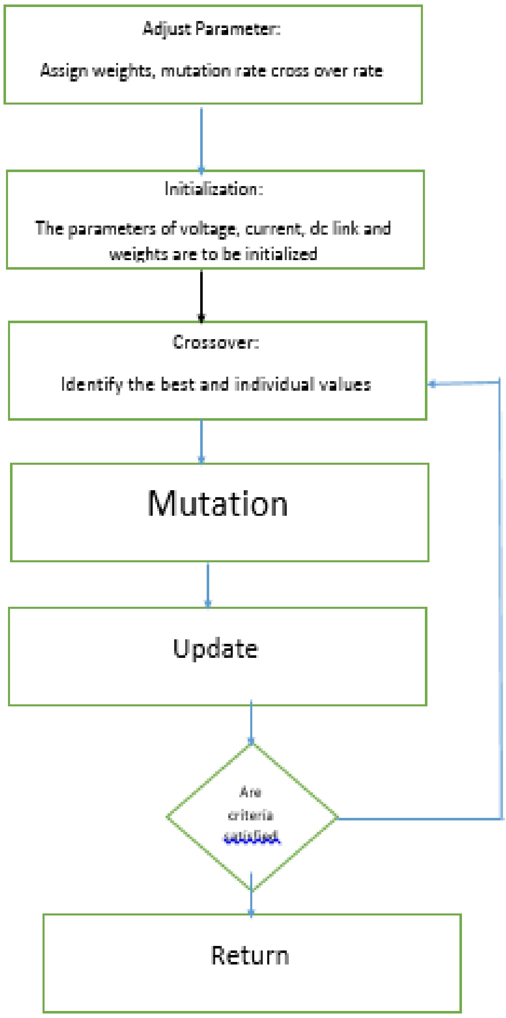


Figure 7: Flow chart of the ESA algorithm

Based on the flow chart, the process of the Extended Search Algorithm is maintaining the dc link voltage in the UPQC. The input is the dc link voltage and it is compared reference dc link voltage, the error value is minimized with the utilization of the ESA algorithm

IV. RESULTS AND DISCUSSIONS

The proposed micro-grid system with Extended Search Algorithm with UPQC system is implemented using Matlab/Simulink. The proposed system is tested under two cases.

Case 1: In this case, the proposed system, is tested and verified for application of voltage variations because of fault conditions. The experimental results for these variations are shown below. The following tests are done for Swell/sag conditions.

Case 2: The application of non-linear load to the proposed UPQC based micro-grid system. In this case, the harmonics generated by the non-linear load is going to eliminate with the help of UPQC controller and the test results are shown below.

Case 1:Swell at feeders 1 and 2

The swell is initiated in the system use of the non-linear load, unbalanced load or critical load in the load side. The voltage swell signal is shown in Figure 9. The mitigation is achieved through the use of proposed controller.

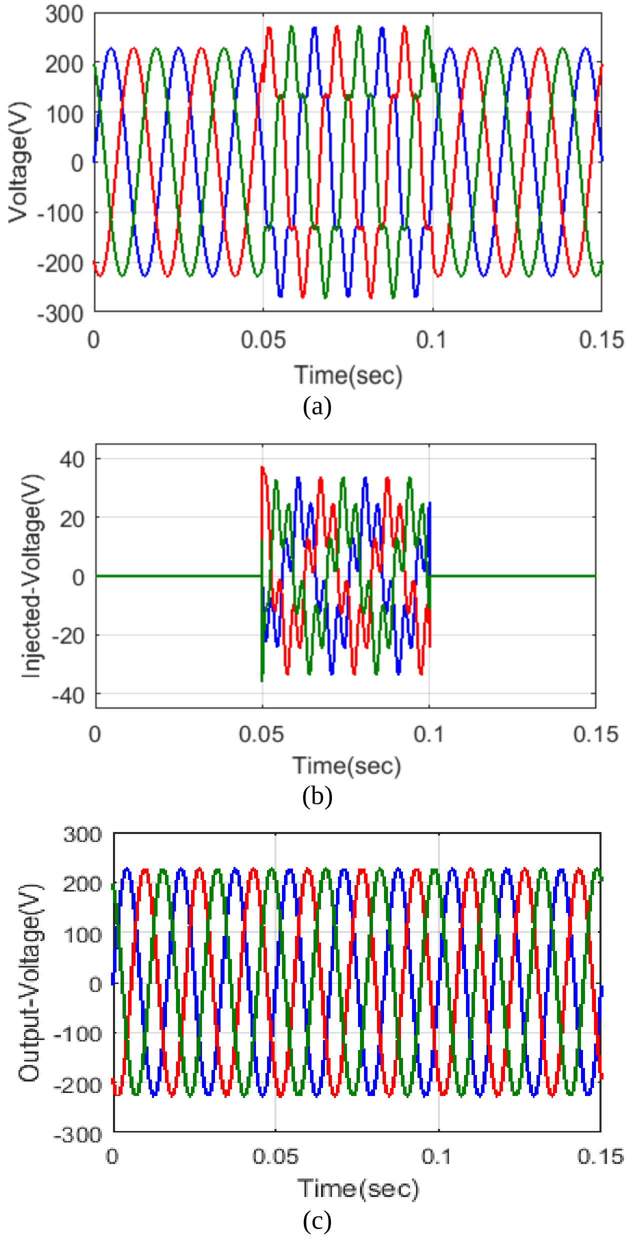
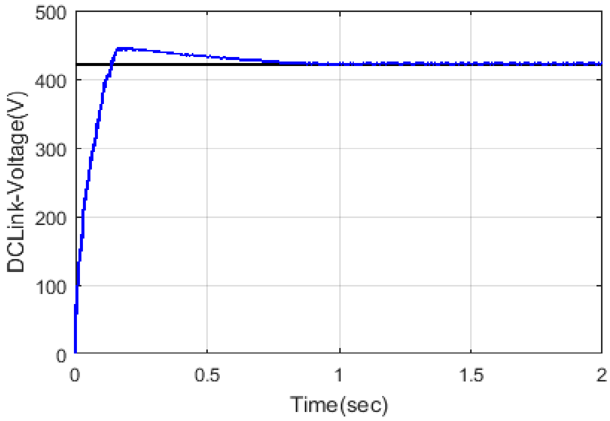


Figure 8: Analysis of the (a) Voltage swell, (b) Injected voltage and (c) Output voltage

Figure 8(a) illustrates the disturbance voltage. Initially, 230V is maintained in the constant level to at 0-0.05s, then it is increased the voltage to 30V (i.e. 260V) at 0.05s-0.1s due to the load variation. The increased voltage is compensated with the help of the UPQC device through the series filter. The injected voltage from the series filter is 30V, it is compensated the voltage swell and the excess voltage is stored in the capacitor of the UPQC is presented figure 8(b). The compensated output is illustrated in the figure 8(c).Then the proposed ESA algorithm is utilized to maintain the dc link voltage as a constant level. The variation of the dc link voltage is illustrated in the figure 9.



(a)

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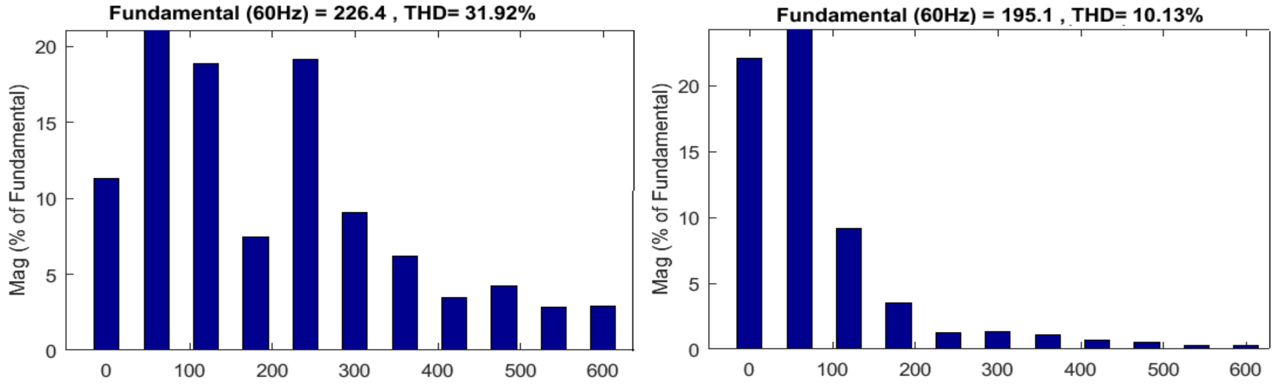
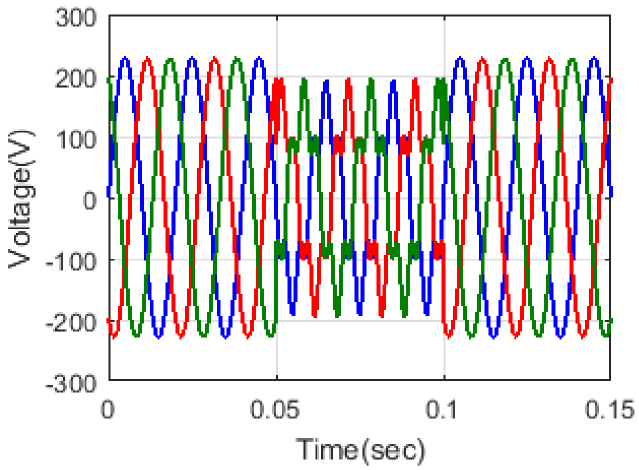


(b)

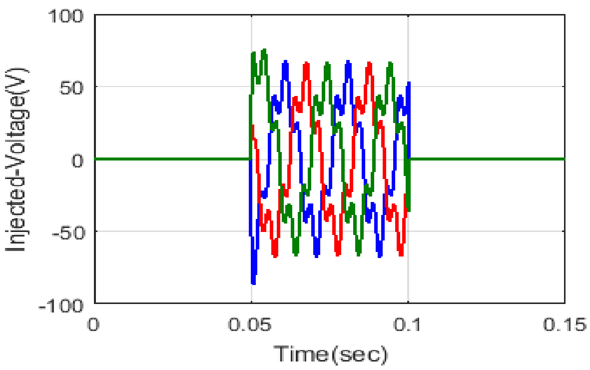
Figure 9: Analysis of the (a) dc link voltage and (b) THD ratio

Case 2: Harmonic Distortion Analysis

The second case is the voltage sag condition in feeder 1 and feeder 2. Normally, the sag is defined as a decrease the voltage level 10% to 90% within the period of the half or full cycle. The UPQC device is compensated the voltage via PAC control. In figure 10 (a) is describes the normal source voltage of the system. The voltage sag is presented in the figure 10(b).



(a)



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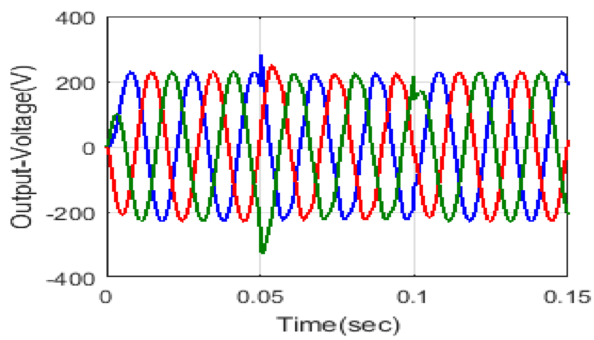

(c)

Figure10: Analysis of the (a) Voltage sag, (b) Injected voltage and (c) Output voltage

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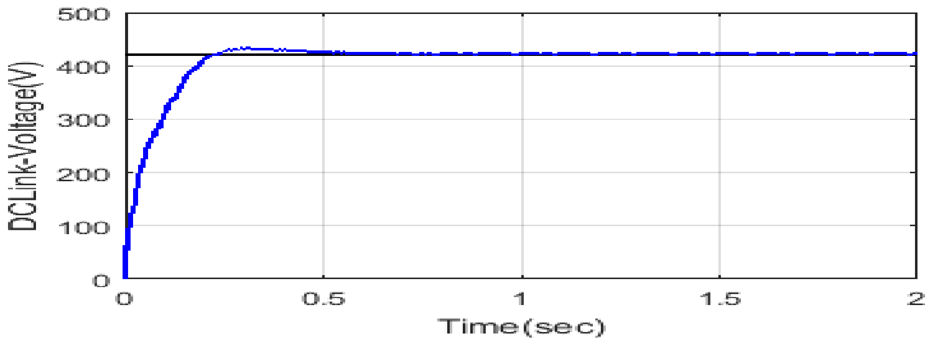
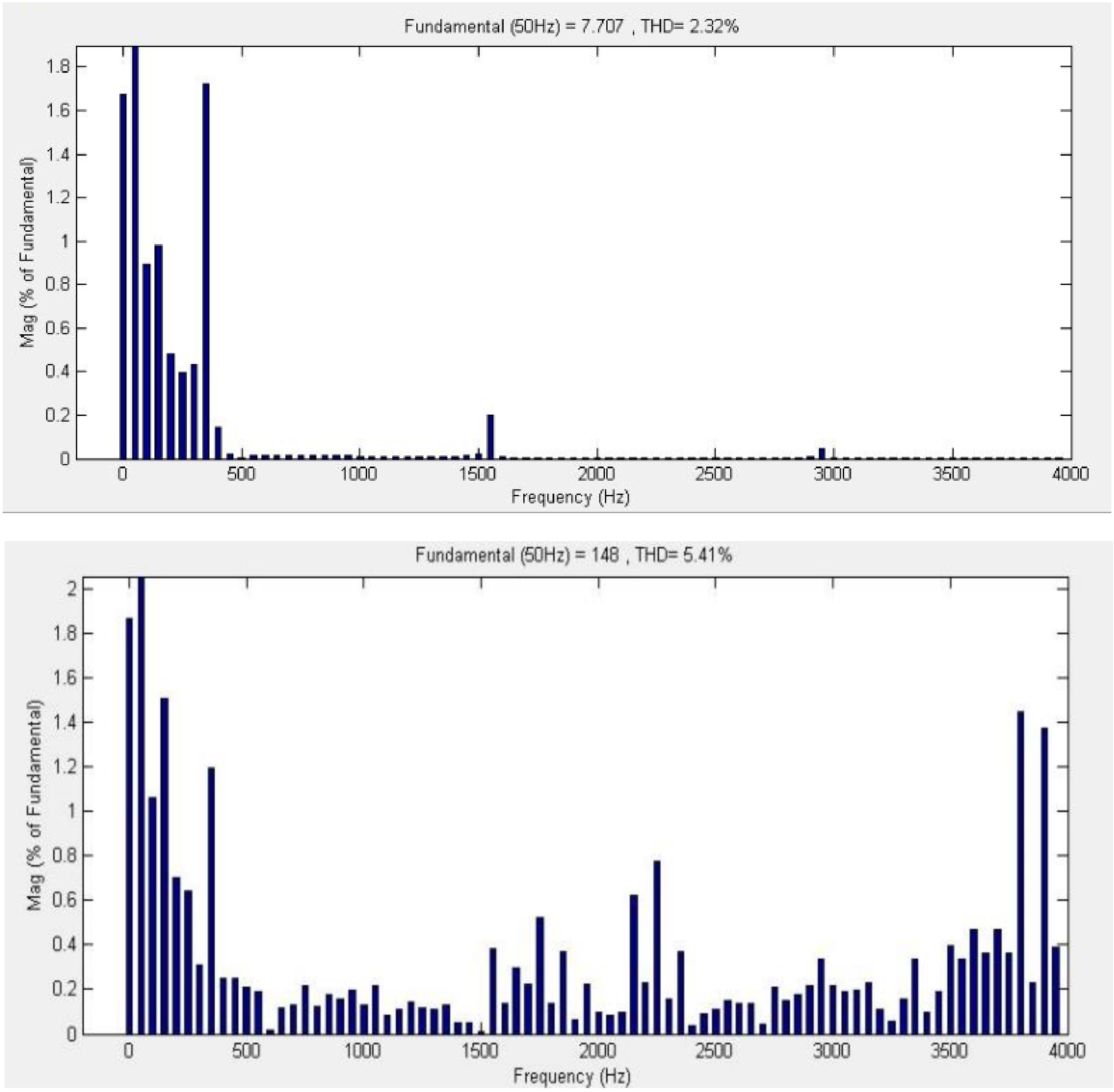


(a)



(b)

Figure 11: Analysis of the (a) dc link voltage and (b) THD ratio

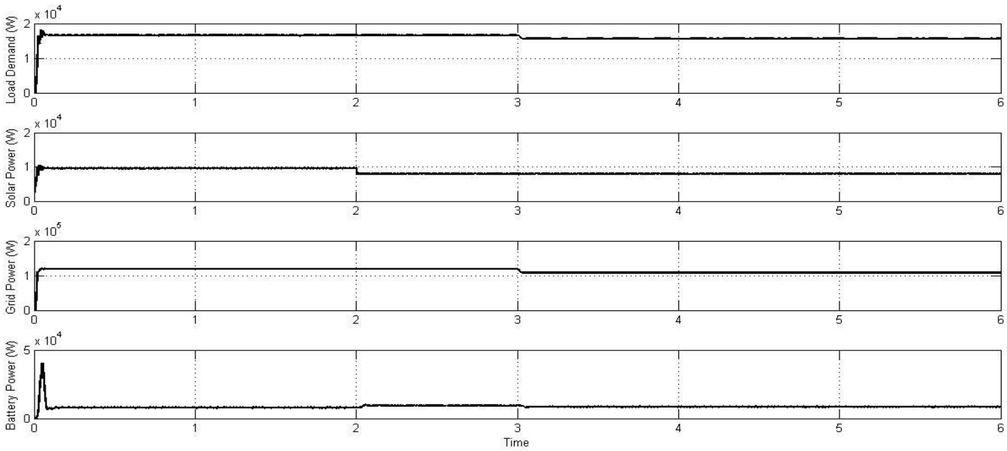


Figure 12: Load Sharing Capability of Hybrid System

Figure 12, load sharing capacity between PV, Grid and battery to Meet Load demand. In this case, we consider different load conditions and according load changes the micro-grid system changes its management capability

V. COMPARISON ANALYSIS

In the sub section, the comparison analysis is done for the above three cases. The comparison is done with the existing control techniques of the ESA and PI algorithms. The dc link voltage and generated power are compared with the existing method. This analysis is used to know about the performance of the proposed method.

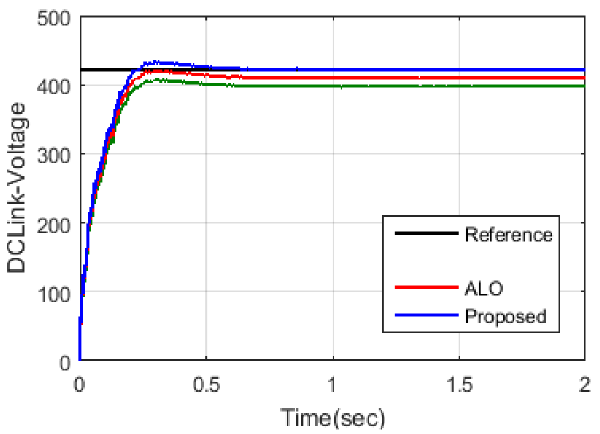


Figure 13: Comparison analysis of Dc-link voltage

VI. CONCLUSION

An ESA based UPQC controller is proposed in this paper controlling power quality improvement in grid interconnected hybrid system. To improve the efficiency of hybrid system an MPPT based DC-DC converter is proposed in this paper. And a control strategy is developed for maintaining synchronization between the systems. The proposed method with optimization based series and shunt APF controllers are developed using ESA for mitigating current harmonics and voltage imbalances. The control signals of the UPQC are compensate the voltage variations and the current perturbations. The gain of the proposed manage technique is the robustness, the reliability and the adaptability for diverse forms of problems. The proposed system is successfully tested in Matlab/Simulink Environment and results are verified.

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