IJCTA, 9(29), 2016, pp. 353-359

Performance Enhancement in a Multi bus Micro Grid by the control of DG

K. Sainadh Singh * Ch. N. Narasimharao B. Venkata Prasanth*** J. Viveka ******

Abstract : Today India's eye laid on Green Energy resource development due to the Power Market scenario. Still in India the renewable energy generation is at Distribution level only. Due to the increase in the distributed generation systems at micro grid the power quality issues are arising. In our paper a new control topology has been developed for Distributed generating systems in a multi bus micro grid systems where UPQC has placed at utility grid. The proposed control topology for distributed generating systems will compensates the voltage and current harmonics in the multi bus micro grids. The SIMULINK version of our proposed model has presented in this paper. SIMULINK results shows the proposed control topology gives the good performance.

Keywords : DG; Micro Grid; UPQC.

1. INTRODUCTION

The International Renewable Power resources alliance changed the power generation scenario. Day by day researchers are developing new techniques for the generation of Renewable energy. But the generation from Renewable energy sources comprises more complexity due to the power electronic converters. Today in India 80% percentage of the load are inductive loads, but day by day the usage of Non-linear loads are increasing gradually. Due to the Nonlinear loads harmonics injects into the system and distorts the current and voltages.

The next question is whether we can have 175 GW of renewable capacity by 2022. We have used three measures to encourage renewable power: feed-in tariff (FIT), renewable portfolio obligation (RPO) and accelerated depreciation allowance.

Under FIT, a fixed tariff is guaranteed to the power producer for a certain number of years. For him or her, this is desirable as it ensures assured income that eliminates market risk and he or she is able to raise finance easily.

In the solar mission launched in 2009, when I was Member of the Planning Commission in charge of energy, we had ensured that FIT does not compromise the incentive to cut down costs and that competition prevails by requiring reverse bidding for the FIT. Thus firms were asked to bid for the FIT they would need to generate solar power. In the first bidding, where the expected level of FIT was Rs.15/kWhr, the lowest bid came to Rs.13.5/kWhr. In subsequent bids it has come down lower and lower and now a recent bid for a 70 MW project at the Bhadla Solar Park in Rajasthan asked for an FIT of Rs.4.34 per kWhr.

Under the RPO, an electricity distribution company (DISCOM) is required to purchase a certain percentage of its total distributed electricity from renewable sources. The price that a renewable power

* Asst Professor, Department of E.E.E, Padmasri Dr. B. V. Raju Institute of Technology, Hyderabad, India
** Asst. Professor, Department of E.E.E, Vignan's University, Vadlamudi, India
*** Professor & Head, Department of E.E.E, QIS College Of Engineering and Technology, Ongole, India
**** Research Scholar, Department of E.E.E, QIS College Of Engineering and Technology, Ongole, India.

producer will receive is determined by the market. Thus there is also incentive to supply electricity at completive rates. However, this creates uncertainty of revenue for the power producers, and banks are reluctant to finance them.

The way out is to guarantee a certain minimum price to be paid to a renewable power producer. Also, for RPO to be effective, it should be enforced. This would require that a DISCOM that does not meet its RPO obligation is made to pay a sufficiently high fine for the extent of the shortfall. If properly implemented, RPO will ensure that the renewable electricity generated will have a market and will be paid for.

Another advantage of RPO is that it can be neutral to technology. One does not have to prescribe whether it is solar or wind or biomass. Competitive market forces will select the most economical option. Thus there is no need to prescribe separate levels of RPO for wind, solar, small hydro, and so on.

Accelerated depreciation allowance, which helped boost wind power in the country, provides incentive to set up the plant but not to maintain it or generate electricity.

In this paper a Multi bus micro grid system has been considered where UPQC has been place at the Utility grid and Distributed generators are placed at Micro Grids. The proposed control topology for Distributed generators reduces the encumbrance on UPQC.

2. MULTI BUS MICRO GRID

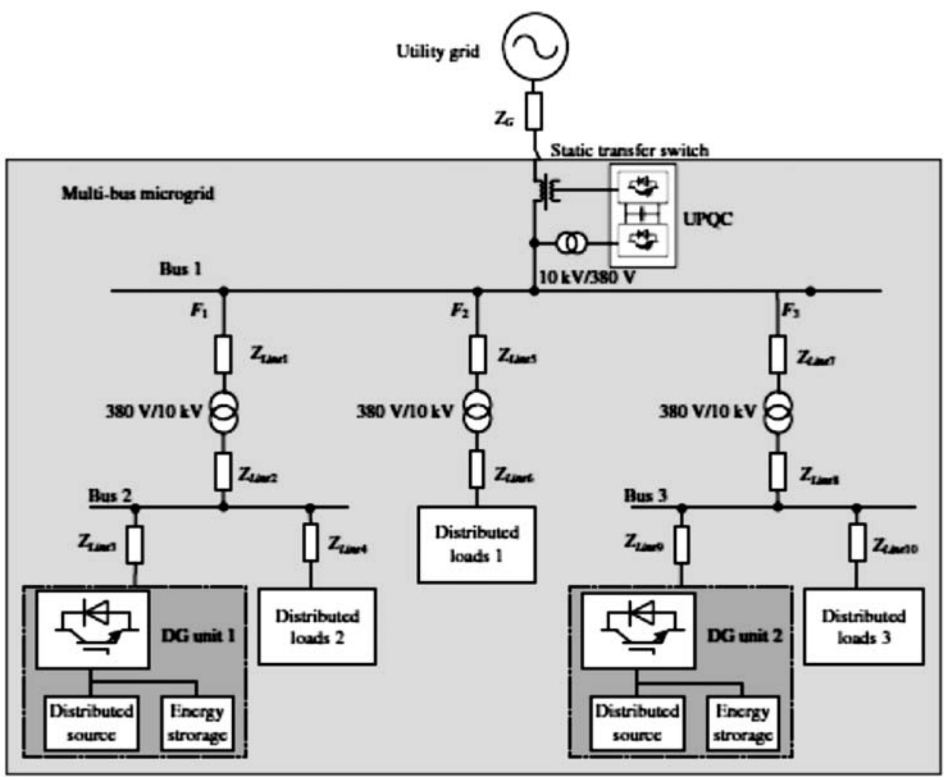


Fig. 1. General illustration of a multi-bus microgrid with power electronics interfaced DG systems.

In the multi bus micro grid systems distributed generators are used at the distribution level. The single-line diagram of a general multi-bus micro- grid is shown in Fig. 1 as an example for illustration. The multi-bus microgrid comprises one 10 kV bus, two 380 V buses and three feeders. Two 380 V buses are connected to the 10 kV bus through step-up transformers. Three combinations of linear and nonlinear loads are supplied by the multi-bus microgrid. Two DG units are equipped with a grid-interfacing converter and a hybrid energy resource which contains energy sources and energy storage system. Each DG unit is able to supply any amount of real power within the pre-specified limits. ZLinen (n = 1, 2,…, i) represents the line impedance which cannot be neglected in the multi-bus microgrid.

As shown in Fig. 1, a static switch is inserted between the utility grid and the multi-bus micro- grid to connect/disconnect the multi-bus microgrid during the online/offline operation. With the increasing applications of nonlinear loads, the power quality of the multi-bus microgrid would be significantly deteriorated due to the harmonics propagation. A unified power quality conditioner (UPQC) can be installed at the main bus to compensate harmonics.

However, the complex structure of the multi-bus microgrid increases the difficulty of harmonics compen- sation. For example, the UPQC installed at Bus 1 as shown in Fig. 1 can improve the current and voltage quality of Bus 1, however, it cannot restraint the harmonic propaga- tion within the multi-bus microgrid and guarantee the power quality of sub-buses (*e.g*. Bus 2 and Bus 3), which directly supply the distributed loads. With the harmonic current flowing in the multi-bus microgrid, the voltage of sub buses will be distorted due to the voltage drop on the line impedance. The distorted bus voltage will seriously affect the normal operation of distributed loads.

In order to illustrate the harmonic propagation within the microgrid, a two-bus network interconnected through an isolation transformer is shown in Fig. 2 as a simple example. The DG unit and distributed loads are connected to the sub-bus, and a diode rectifier with an RC load is considered as the nonlinear load to produce harmonic currents.

For the conventional control method, the DG unit is controlled to generate real power and its output current iDG injected to the sub-bus is sinusoidal, as shown in Fig. 2*a*. Hence, the harmonic currents introduced by the nonlinear load mainly flow to the main bus due to the lower impe- dance of the utility grid. The harmonic propagation within the multi-bus network will unavoidably generate the voltage harmonics.

3. PROPOSED CONTROL TOPOLOGY

In order to illustrate the control principle, a two-bus network is derived from Fig. 1. In specific, the configuration of two buses network and its control block diagram are shown in Fig. 2. It can be seen that Bus 2 is connected to Bus 1 through a step-up transformer. The DG unit 1 and the distributed loads 2 composed of linear and nonlinear loads are connected to Bus 2. The nonlinear load represented by a rectifier circuit with an RC load could introduce current harmonics. The DG unit 1 connects to Bus 2 through a distribution line represented by Z Line 3. When properly controlled, the DG unit can compensate the harmonic currents.

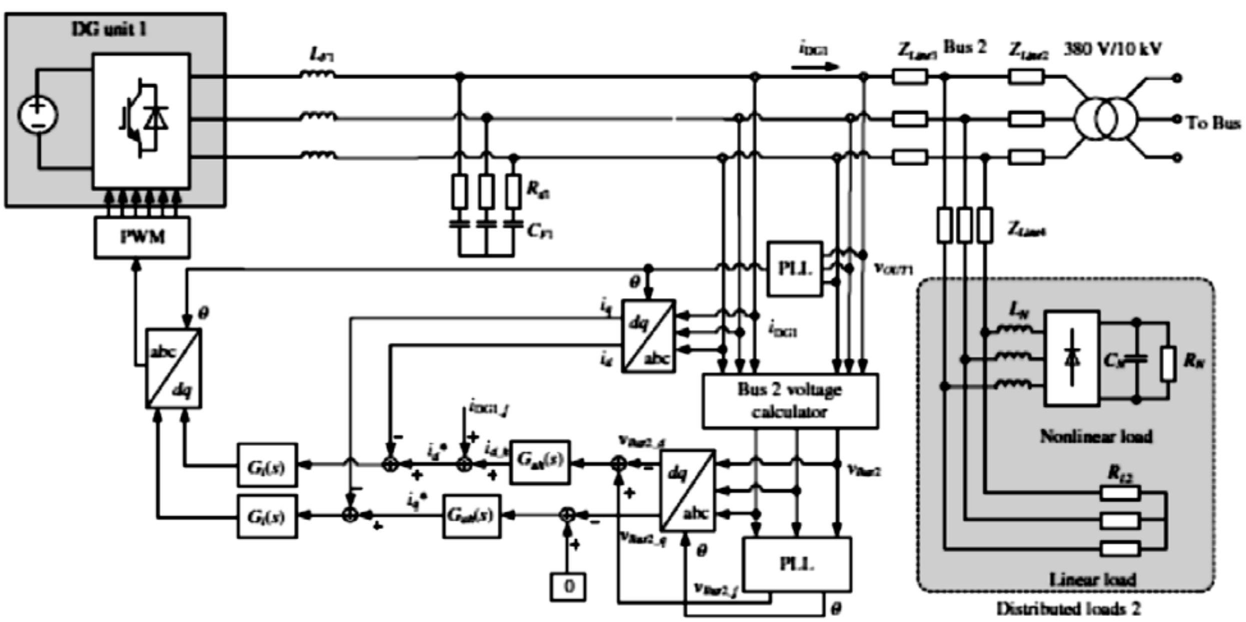


Fig. 2. Overall illustration of the circuit configuration and control diagram.

In the proposed approach, the voltage and current con- troller are designed in the rotating *dq* reference frame. The estimation of *ac* voltage parameters, such as voltage amplitude and phase angle, will act as a crucial role in the overall performance of the synchronization algorithm. With a low pass filter used to eliminate the harmonics synchronous reference frame phase locked loop (SRF-PLL) [21–23] as shown in Fig. 5 is used in the proposed control strategy. In spite of the good behavior of the SRF-PLL under sinusoidal conditions, its performance is deteriorated when the three phase input signal becomes distorted. When the three-phase instantaneous voltage waveforms are transformed from the abc reference frame into the rotating *dq* reference frame by means of the Park transformation [24, 25], the fundamental and $(6n \pm 1)$th harmonics in the abc reference frame are represented by DC component and 6nth harmonics in the rotating *dq* reference frame.

4. SIMULATION RESULTS

To verify the performance of the proposed power quality control approach in a multi-bus microgrid, Matlab simulations were first conducted according to the configuration of multi-bus microgrid shown in Fig. 1.

A. Performance of DG without Compensation

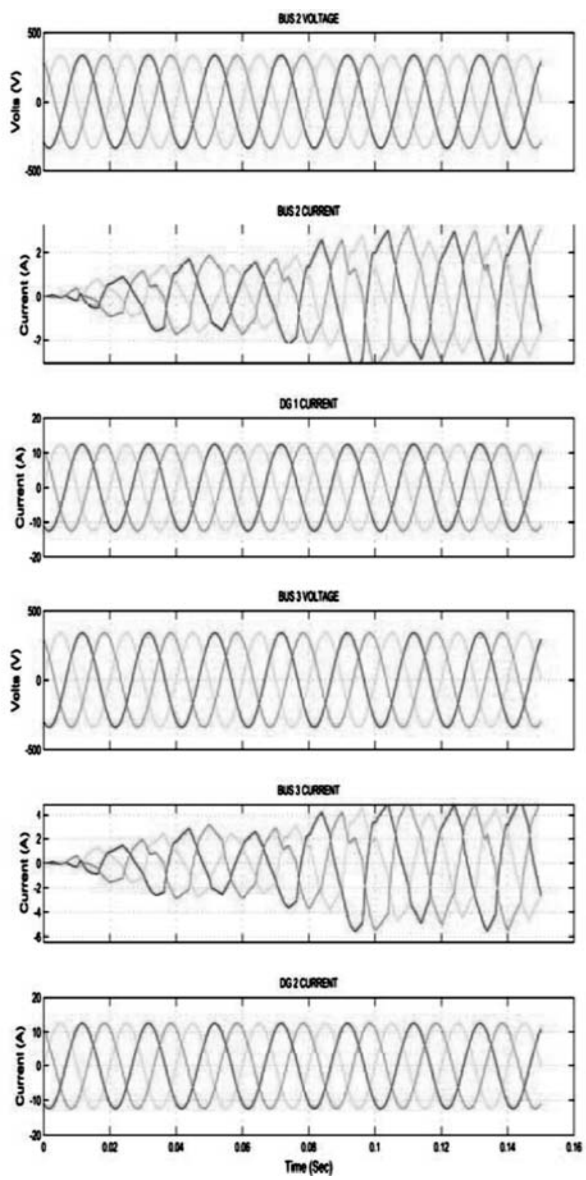


Fig. 3. Performance of DG with out Compensation.

B. Performance of DG with Compensation:

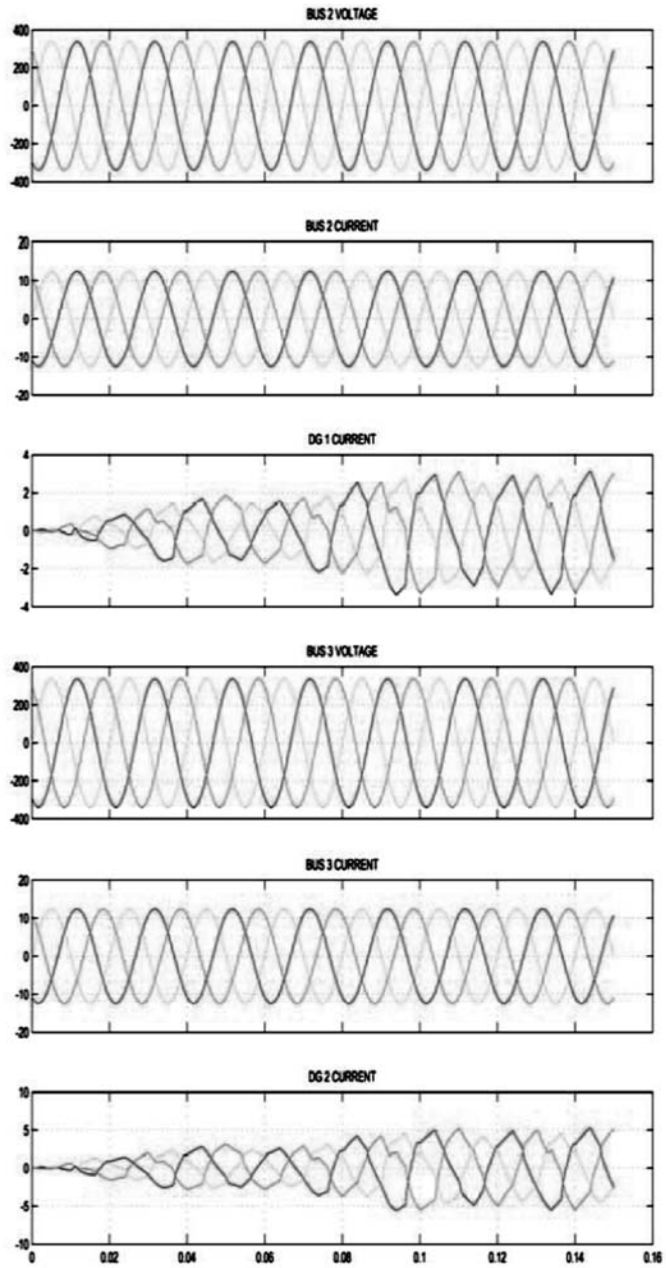
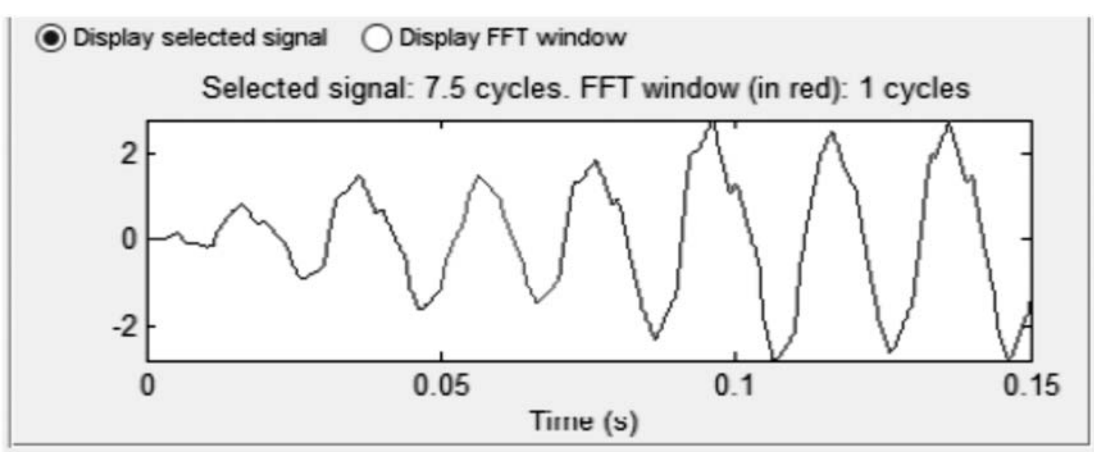


Fig. 4. Performance of DG with Compensation.



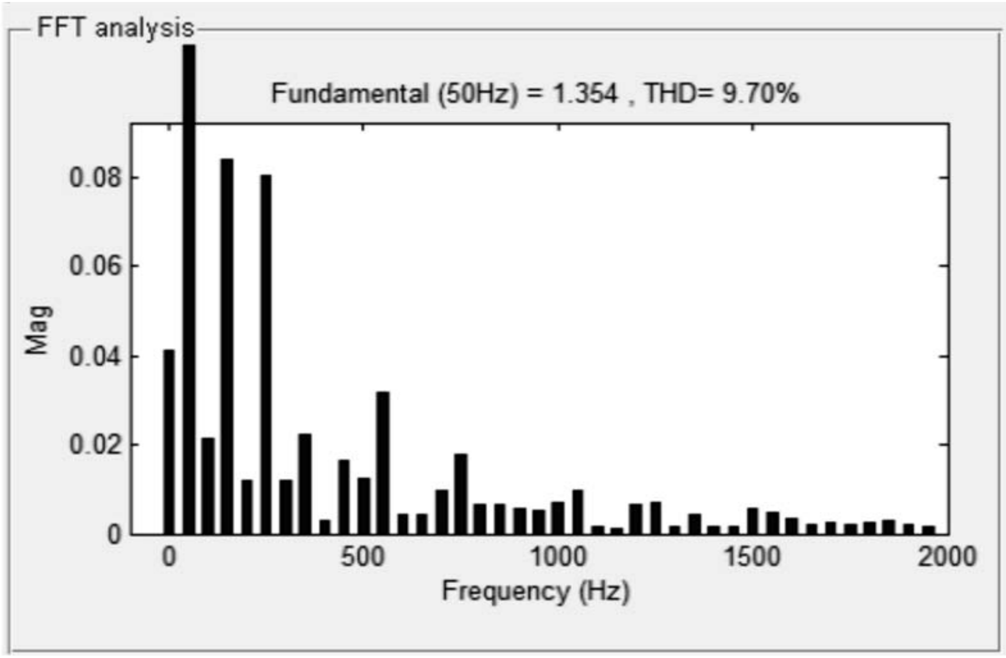


Fig. 5. THD analysis of DG with out compensation.

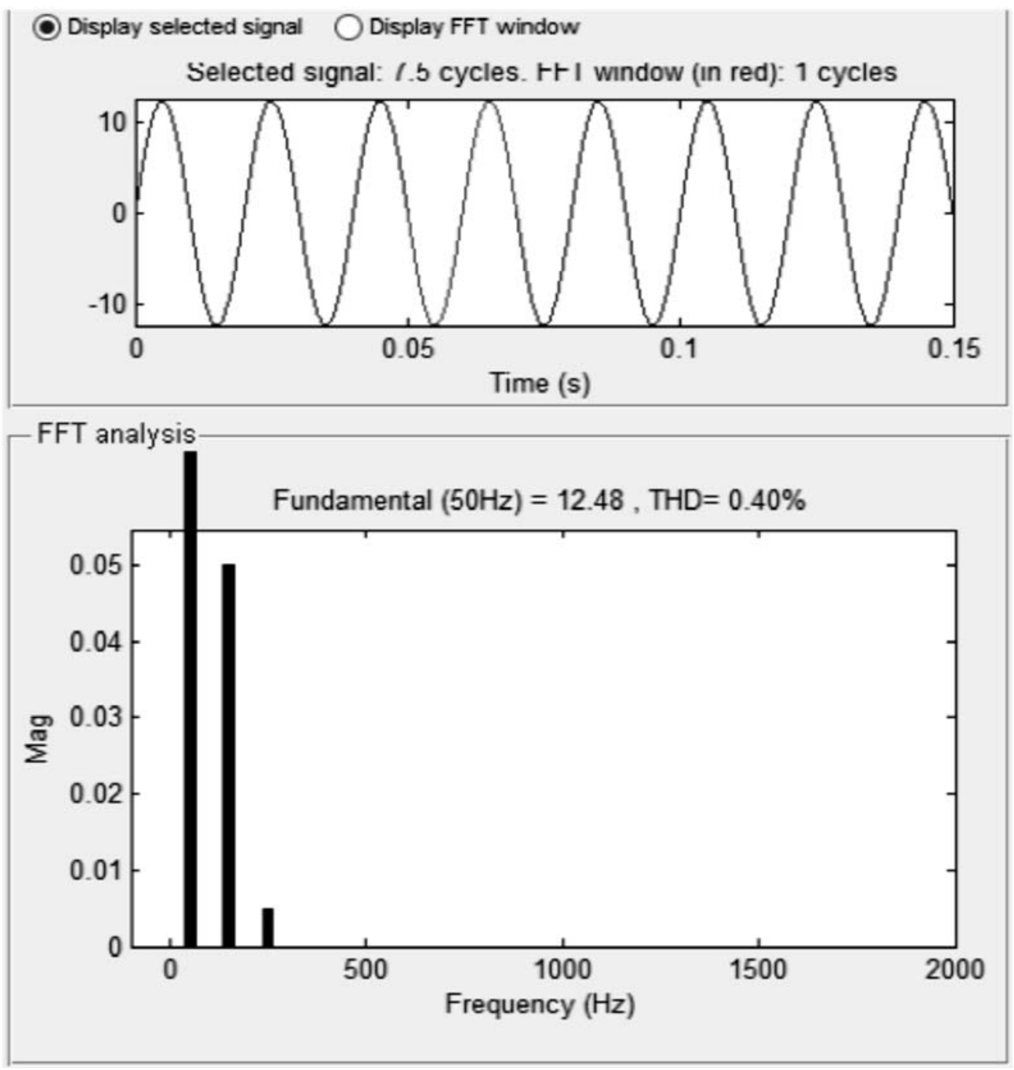


Fig. 6. THD analysis of DG with compensation.

5. CONCLUSION

In this paper a Multi bus micro grid system has been considered where UPQC has been place at the Utility grid and Distributed generators are placed at Micro Grids. Simulation results clearly shows that the proposed control topology for Distributed generators reduces the encumbrance on UPQC. Finally Power quality has been improved.

6. REFERENCES

1. Singh, K. Sainadh, K. Lavanya, and M. Uma Maheswara Rao. "BATS Echolocation Algorithm Tuned PI controller for PQ Improvement in a grid connected Wind Energy System.
2. J Molenda, Material Problems and Prospects Of Li-ion Batteries for vehicles applications. World scientific-2011
3. D. Ra and K. S. Han, "Used lithium ion rechargeable battery recycling using Etoile-Rebatt technology", Journal of Power Sources, Elsevier, vol. 163, 2006 pages. 284-288.
4. R. Kuiava, R. A. Ramos, N. G. Bretas, "Control Design of a STATCOM with Energy Storage System for Stability and Power Quality" Industrial Technology, 2009. ICIT 2009, pp: 1-6.
5. Karen L. Butler, Mehrdad Ehsani, Preyas Kamath, "Matlab-Based Modeling and Simulation Package for Electric and Hybrid Electric Vehicle Design", published in IEEE transactions on vehicular technology, vol. 48, no. 6, pp. 1770-1778, November 1999.
6. S. W. Mohod and M. V. Aware, "A STATCOM-Control Scheme for Grid Connected Wind Energy System for Power Quality Improvement", Published in. Systems Journal, IEEE (Volume: 4 Issue : 3), pp. 346-352, sept 2010.
7. Chen, Min, and G. A. Rincon-Mora. 2006. Accurate electrical battery model capable of predicting runtime and I-V performance. IEEE Transactions on Energy Conversion 21 (2):504-511.
8. Schweighofer, B., K. M. Raab, and G. Brasseur. 2003. Modeling of high power automotive batteries by the use of an automated test system. IEEE Transactions on Instrumentation and Measurement 52 (4):1087-1091.
9. Tremblay, O, Dessaint, L.-A. "Experimental Validation of a Battery Dynamic Model for EV Applications." World Electric Vehicle Journal. Vol. 3 - ISSN 2032-6653 - © 2009 AVERE, EVS24 Stavanger, Norway, May 13 - 16, 2009.
10. T. Kinjo and T. Senjyu, "Output leveling of renewable energy by elec- tric double layer capacitor applied for energy storage system," IEEE Trans. Energy Conv., vol. 21, no. 1, Mar. 2006.
11. R. S. Bhatia, S. P. Jain, D. K. Jain, and B. Singh, "Battery energy storage system for power conditioning of renewable energy sources," in Proc. Int. Conf. Power Electron Drives System, Jan. 2006, vol. 1, pp.501–506.
12. Fu. S. Pai and S.-I. Hung, "Design and operation of power converter for microturbine powered distributed generator with capacity expansion capability," IEEE Trans. Energy Conv., vol. 3, no. 1, pp. 110–116, Mar.2008.
13. J. Zeng, C. Yu, Q. Qi, and Z. Yan, "A novel hysteresis current control for active power filter with constant frequency," Elect. Power Syst. Res., vol. 68, pp. 75–82, 2004.
14. M. I. Milands, E. R. Cadavai, and F. B. Gonzalez, "Comparison of control strategies for shunt active power filters in three phase four wire system," IEEE Trans. Power Electron., vol. 22, no. 1, pp. 229–236, Jan.2007.
15. S. W. Mohod and M. V. Aware, "Power quality issues & it's mitigation technique in wind energy conversion," in Proc. of IEEE Int. Conf.Quality Power & Harmonic, Wollongong, Australia, 2008.