GRID INTERCONNECTION OF RENEWABLE ENERGY SOURCES AT DISTRIBUTION LEVEL WITH POWER QUALITY IMPROVEMENT FEATURES

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ABSTRACT:
Fossil fuel resources are our main source of energy and they are depleting. Fossil fuels are non renewable and environmentally damaging. As huge increase in global warming and air pollution, fossil fuels are diminishing and their continuous increase in money value have made it necessary to take step towards renewable sources in coming future. There are numerous renewable energy sources (RES) such as solar, wind, tidal and biomass etc. Wind energy has great potential to supply energy with minimum impact on the environment, since it is clean and pollution free. Many researchers are finding solutions to overcome a global energy crisis, the recent developments in systems of wind energy have attracted many researchers in recent years. The government is providing subsidiaries to further increase the use of grid-connected wind and solar systems.

KEYWORDS: PV Solar System, Wind Systems, Shunt active filter, Series active filter etc.

INTRODUCTION:
With increase in wind and solar generation, Renewable Energy Sources have witnessed tremendous growth in integrated power system grid connected network at distribution level due to increase in load demand which utilize power electronic converters. Because of large uses of power electronic devices basically non linear load causes disturbances in supply network. All non linear loads induces harmonics in power system grid, which causes a equipment overheating, EMI, Damage to voltage sensitive devices etc. Few of the researchers consider harmonics is biggest problem in the power system, and some of the researchers consider it as a opportunity for development of harmonic filter. Harmonics in power distribution system are voltage or current, which are integer multiples of fundamental frequency, e.g. 50 Hz, then 3rd harmonic is 150Hz, 5th is 250Hz. Typically, voltage and current waveforms are considered to be perfect sinusoidal. Moreover, because of the increased uses of power electronic devices and non linear loads, the current waveforms have become distorted. The deviation from a perfect sine wave is a result of content of the harmonic components having a frequency that is an integer multiple of the fundamental frequency. Several methods are described in various papers to solve these problems. There are standards that determine the maximum allowable level for each harmonic in the Alternative Current (AC).

SHUNT ACTIVE POWER FILTER
The shunt connected active power filter, with a controlled dc bus, is a topology to be considered for static compensator (STATCOM) mainly used for compensation of the active power compensation in power system network. Shunt active filters nullifies the harmonics produced by load current by introducing opposite harmonic compensating current. Shunt active filter is operated as a current source for injecting the harmonic components which are being generated by the load but with phase shift of 180 degree. Fig.1. shows the basic component basic principle shunt active power filter. It can be controlled the compensating current in phase with incoming from utility so it will help to transfer the load on the AC side. .

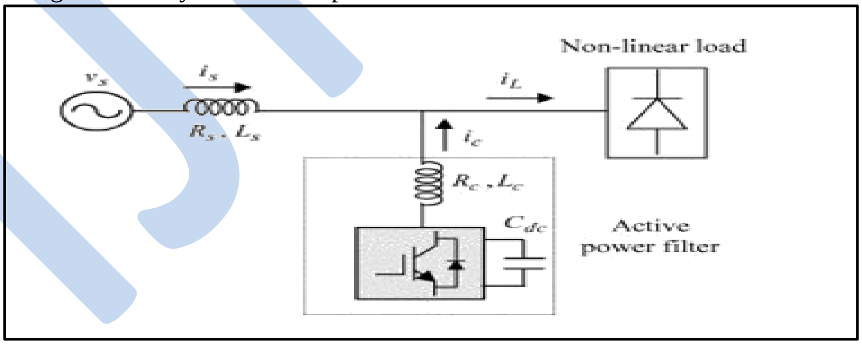

Fig. 1. Shunt Active Power Filter Working Principle

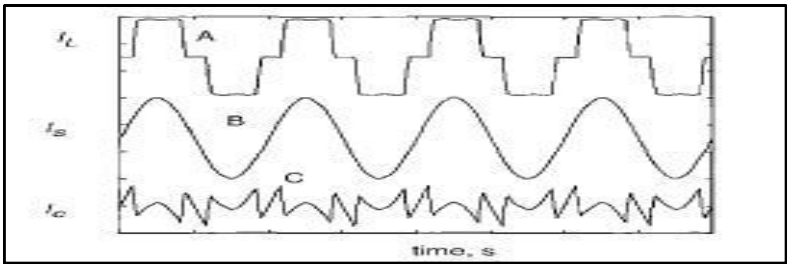

Fig.2. Shunt Active Power Filter Output Waveforms.

SERIES ACTIVE POWER FILTER

Series active power filters have found their application in power system at the end of the 1980s and operate mainly as a voltage regulator and it acts as a harmonic filter amidst nonlinear load and the power system. The series active power filter protects the supply customer from an poor supply voltage quality. This type of advancement is done for compensating voltage sags and voltage unbalances from the ac supply and for low-power applications and represents an economically attractive alternative to uninterruptable power supply(UPS), in series active power filter there is no necessity of energy storage (battery) and hence, the overall rating of the components becomes smaller. The series active filter is designed in a such way that it injects a voltage component in series with the supply voltage thus it treated as a controlled voltage source, and it well compensates voltage sags and swells on the load side. In various cases, series active filters works with hybrid topology model in conjunction with passive LC filters. If passive LC filters are connected in parallel to the load, the filter acts as a harmonic isolator. The major advantage of using this scheme is, rated power of the series active power filter is a small fraction of the load KVA rating, about 5%. However, if it is used for voltage compensation rating may increase as apparent power handling capacity will increase.

HYBRID POWER FILTER

Hybrid power filters are a combination of active and passive filters. With this topology the passive filters have dynamic low impedance for current harmonics at the load side, increasing their bandwidth operation and improving their performance. This behavior is reached with only a small power rating PWM inverter, which acts as an active filter in series with the passive filter. Multilevel inverters are being investigated and recently used for active filter topologies. Multi lever inverters are extensively used today, for most inverter applications, e.g. machine drives and power factor compensators. The major advantage of using multilevel inverter is they can reduce the harmonic content. This feature helps in reduction of harmonics created by own system. Another advantage is that they can reduce the voltage or current ratings of the semiconductors and the switching frequency requirements. The more levels the multilevel inverter has, the better quality of voltage generated as cab create number of steps in voltage.

LITERATURE REVIEW:

U. Borup, F. Blaabjerg, and P. N. Enjeti:
In previous research and literature, no specific solution is mentioned for distinguishing harmonic current that flow to load and between converters. These controllers are struggling to distinguish the harmonic current. So it is needed to solve this problem that arises when two converters with harmonic compensation are connected in parallel. The load current is divided equally between the two inverters. The author had presents equal sharing of linear and nonlinear loads in three-phase power converters connected in parallel, without communication between the converters.

P. Jintakosonwit, H. Fujita, H. Akagi, and S. Ogasawara: The previous search more focused on equal sharing of harmonic load current throughout the parallel connected controllers. But this search has not suggested that how harmonics at distribution system is damp out. This fact introduces that there is need of active power filter in distribution system. The author in this paper have suggested a complete co-operative control of multiple active filters based on voltage detection for harmonic damping throughout a power distribution system.

J. M. Guerrero, L. G. de Vicuna, J. Matas, M. Castilla, and J. Miret,: It was observed that PV inverters under certain circumstances switched off undesirably or exceeded harmonic regulations. As a result there was more focused has been made by researchers on power quality standards at PCC. For that purpose analysis on PV inverters, distributed network, and simulation study was required. Author had analyzed the phenomena of harmonic interference of large populations of these inverters in order to compare the network interaction of numerous inverters topologies and their control strategy. In order to improve the inverter PQ characteristics in a network; in the inverter design, the author concluded that, parallel and series resonance phenomenon between the network and these inverters are responsible for higher than expected current and voltage distortion levels in DP networks.

P. Rodríguez, J. Pou, J. Bergas, J. I. Candela, R. P. Burgos, and D.Boroyevich: This paper deals with a crucial aspect in the control of grid connected power converters, i.e., the detection of the fundamental-frequency positive sequence component of the utility voltage under unbalanced and distorted conditions. Specifically, it proposes a positive-sequence detector based on a new decoupled double synchronous reference frame phase-locked loop (DDSRF–PLL), which completely eliminates the detection errors of conventional synchronous reference frame PLL's (SRF–PLL). This is done by transforming +ve and –ve sequence components of utility in the doubly fed SRF system. From where decoupling network begins for extracting and separating the +ve and –ve sequence components. The resultant DDSRF–PLL conducts then to a precise and fast and robust, voltage deviation detection even when system is unbalanced.

B. Renders, K. De Gusseme, W. R. Ryckaert, K. Stockman, L. Vandevelde, and M. H. J. Bollen: Due to the application of sophisticated and more advanced software and hardware for control systems, the power quality becomes one of the most important issues for power electronic engineers. With great advancement in all areas of engineering, particularly, in signal processing, control systems, and power electronics, the load characteristics have changed completely. In addition to this, loads are becoming very sensitive to voltage supplied to them. The fast switching of power electronic components may create harmonic problems. This makes voltages and currents at point of common coupling (PCC) highly distorted. The UPQC can be installed to protect the sensitive load inside the plant as well as to restrict entry of any distortion from load side. This technique uses a unified approach for load and source compensation using Unified Power Quality Conditioner (UPQC).

CONCLUSION:

In the operation of the inverter, it is observed that there is high imbalance grid currents, after inverter acts as a shunt or series active power filter, and it appears as a pure sinusoidal balanced set of currents on grid side and grid current side THD's will get reduced. The unbalance in current may introduce the harmonics in current as well as load in reactive power because of the unbalanced and non linear load connected at the PCC, this will get compensated by the grid side currents and that will be always maintained as balanced and sinusoidal at power factor of one. When the power generated from wind and solar basically from renewable energy sources is far more than the total load power demand, the grid inverter interfacing inverter with the proposed inverter with the proposed approach not only fulfills the total load active power and reactive power demand but also delivers the surplus generated sinusoidal active power to the grid at unity power factor.

REFERENCES:

1) J. M. Guerrero, L. G. de Vicuna, J. Matas, M. Castilla, and J. Miret (Sep. 2004.) "A wireless controller to enhance dynamic performance of parallel inverters in distributed generation systems," IEEE Trans. Power Electron., vol. 19, no. 5, pp. 1205–1213,

2) J. H. R. Enslin and P. J. M. Heskes (Nov. 2004.) "Harmonic interaction between a large number of distributed power inverters and the distribution network," IEEE Trans. Power Electron., vol. 19, no. 6, pp. 1586–1593.

3) U. Borup, F. Blaabjerg, and P. N. Enjeti (Nov./Dec. 2001) "Sharing of nonlinear load in parallel-connected three-phase converters," IEEE Trans. Ind. Appl., vol. 37, no. 6, pp. 1817–1823.

4) P. Jintakosonwit, H. Fujita, H. Akagi, and S. Ogasawara (Mar./Apr. 2003) "Implementation and performance of cooperative control of shunt active filters for harmonic damping throughout a power distribution system," IEEE Trans. Ind. Appl., vol. 39, no. 2, pp. 556–564.

5) J. P. Pinto, R. Pregitzer, L. F. C. Monteiro, and J. L. Afonso(2007)"3-phase 4-wire shunt active power filter with renewable energy interface," presented at the Conf. IEEE Rnewable Energy & Power Quality, Seville, Spain.

6) F. Blaabjerg, R. Teodorescu, M. Liserre, and A. V. Timbus (Oct. 2006)"Overview of control and grid synchronization for distributed power generation systems," IEEE Trans. Ind. Electron., vol. 53, no. 5, pp. 1398–1409.

7) J. M. Carrasco, L. G. Franquelo, J. T. Bialasiewicz, E. Galván, R. C. P. Guisado, M. Á. M. Prats, J. I. León, and N. M. Alfonso (Aug. 2006) "Powerelectronic systems for the grid integration of renewable energy sources: A survey," IEEE Trans. Ind. Electron., vol. 53, no. 4, pp. 1002–1016.

8) B. Renders, K. De Gusseme, W. R. Ryckaert, K. Stockman, L. Vandevelde, and M. H. J. Bollen (Jul. 2008) "Distributed generation for mitigating voltage dips in low-voltage distribution grids," IEEE Trans. Power. Del., vol. 23, no. 3, pp. 1581–1588.

9) V. Khadkikar, A. Chandra, A. O. Barry, and T. D. Nguyen, (2006)"Application of UPQC to protect a sensitive load on a polluted distribution network," in Proc. Annu. Conf. IEEE Power Eng. Soc. Gen. Meeting, pp. 867–872.

10)M. Singh and A. Chandra, (2008)"Power maximization and voltage sag/swell ride-through capability of PMSG based variable speed wind energy conversion system," in Proc. IEEE 34th Annu. Conf. Indus. Electron. Soc, pp. 2206–2211.

11) P. Rodríguez, J. Pou, J. Bergas, J. I. Candela, R. P. Burgos, and D. Boroyevich (Mar. 2007) "Decoupled double synchronous reference frame PLL for power converters control," IEEE Trans. Power Electron, vol. 22, no. 2, pp. 584–592.