ISSN 2395-695X (Print)
ISSN 2395-695X (Online)

International Journal of Advanced Research in Biology Engineering Science and Technology (IJARBEST)

Vol. 2, Special Issue 10, March 2016

POWER QUALITY ENHANCEMENT IN POWER DISTRIBUTION SYSTEM USING DYNAMIC VOLTAGE RESTORER

Jayapriya.M
PG Student,
Priyadarshini Engineering College, Vaniyambadi, Vellore-635751.
mjayapriyajtj@gmail.com
Ashok kumar.A
Assistant Professor,
Priyadarshini Engineering College, Vaniyambadi, Vellore-635751.
ashok9994638230@gmail.com

Abstract - Dyanamic voltage restorer(DVR)is one product that can provide improved voltage sag and swell compensation with energy storage integration. Ultracapacitors (UCAP) have low-energy density and high-power density ideal characteristics for compensation of volt-age sags and voltage swells, which are both events that require high power for short spans of time. The novel contribution of this paper lies in the integration of rechargeable UCAP-based energy stor-age into the DVR topology. With this integration, the UCAP-DVR system will have active power capability and will be able to inde-pendently compensate temporary voltage sags and swells without relying on the grid to compensate for faults on the grid like in the past.

1.INTRODUCTION

The concept of using inverter-based dynamic voltage restorers (DVRs) for preventing customers from momentary voltage disturbances on the utility side was demonstrated for the first time by Woodley et al.. The concept of using the DVR as a power quality product has gained significant popularity since its first use. In , the authors propose the usage of the DVR with rechargeable energy storage at the dc-terminal to meet the active power requirements of the grid during voltage disturbances. In order to avoid and minimize the active power injection into the grid, the authors also mention an alternative solution which is to compensate for the voltage sag by inserting a lagging voltage in quadrature with the line current.

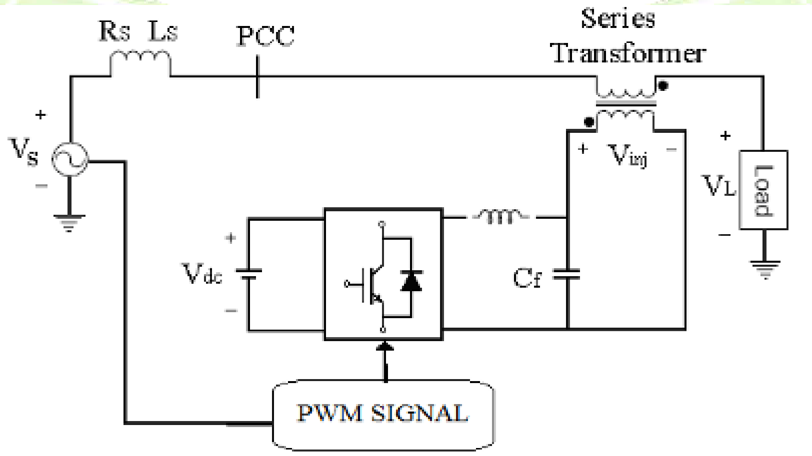

Fig.1 Proposed circuit diagram

ISSN 2395-695X (Print)
ISSN 2395-695X (Online)

International Journal of Advanced Research in Biology Engineering Science and Technology (IJARBEST)

Vol. 2, Special Issue 10, March 2016

2. BLOCK DIAGRAM

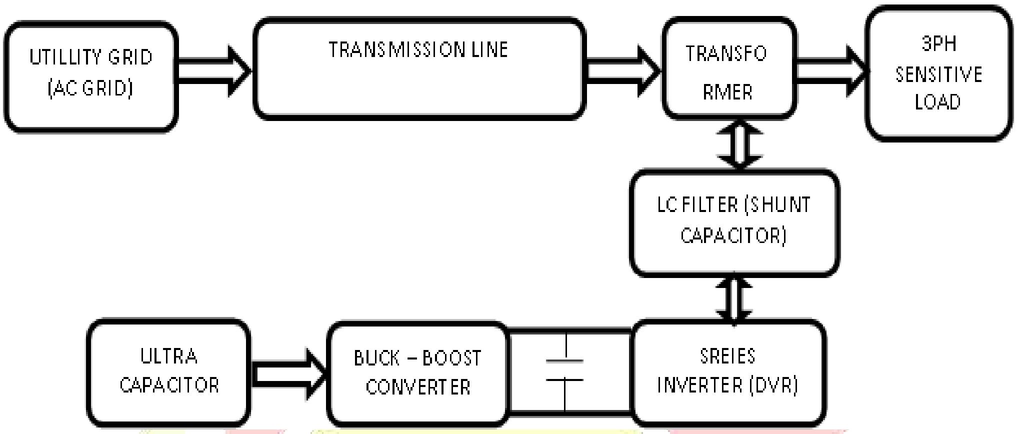

Fig.2.General block diagram

A UCAP cannot be directly connected to the dc-link of the inverter like a battery, as the voltage profile of the UCAP varies as it discharges energy. Therefore, there is a need to integrate the UCAP system through a bidirectional dc–dc converter, which maintains a stiff dc-link voltage, as the UCAP voltage decreases while discharging and increases while charging. The model of the bidirectional dc–dc converter and its controller are shown in Fig.3, where the input consists of three UCAPs connected in series and the output consists of a nominal load of 213.5 Ω to prevent operation at no-load, and the output is connected to the dc-link of the inverter. The amount of active power support required by the grid during a voltage sag event is dependent on the depth and duration of the voltage sag, and the dc–dc converter should be able to withstand this power during the discharge mode. The series voltage controller is connected in series with the protected load. Usually the connection is made via a transformer, but configurations with direct connection via power electronics also exist. The resulting voltage at the load bus bar equals the sum of the grid voltage and the injected voltage from the DVR. The converter generates the reactive power needed while the active power is taken from the energy storage. The energy storage can be different depending on the needs of compensating. DVR can compensate voltage at both transmission and distribution sides. Usually a DVR is installed on a critical load feeder. During the normal operating condition (without sag condition) DVR operates in a low loss standby mode during this condition the DVR is said to be in steady state. When a disturbance occurs (abnormal condition) and supply voltage deviates from nominal value, DVR supplies voltage for compensation of sag and is said to be in transient state.

3. MODULE DESCRIPTION

A. DC TO DC CONVERTER

DC to DC converters are important in portable electronic devices such as cellular phones and laptop computers, which are supplied with power from batteries primarily. Such electronic devices often contain several sub-circuits, each with its own voltage level requirement different from that supplied by the battery or an external supply (sometimes higher or lower than the supply voltage). Additionally, the battery voltage declines as its stored energy is drained. Switched DC to DC converters offer a method to increase voltage

ISSN 2395-695X (Print)
ISSN 2395-695X (Online)

International Journal of Advanced Research in Biology Engineering Science and Technology (IJARBEST)

Vol. 2, Special Issue 10, March 2016

from a partially lowered battery voltage thereby saving space instead of using multiple batteries to accomplish the same thing. Most DC to DC converters also regulate the output voltage. Some exceptions include high-efficiency LED power sources, which are a kind of DC to DC converter that regulates the current through the LEDs, and simple charge pumps which double or triple the output voltage. DC to DC converters developed to maximize the energy harvest for photovoltaic systems and for wind turbines are called power optimizers.

B. BOOST CONVERTER

1.1 Switched mode supplies can be used for many purposes including DC to DC converters. Often, although a DC supply, such as a battery may be available, its available voltage is not suitable for the system being supplied. For example, the motors used in driving electric automobiles require much higher voltages, in the region of 500V, than could be supplied by a battery alone. Even if banks of batteries were used, the extra weight and space taken up would be too great to be practical. The answer to this problem is to use fewer batteries and to boost the available DC voltage to the required level by using a boost converter. Another problem with batteries, large or small, is that their output voltage varies as the available charge is used up, and at some point the battery voltage becomes too low to power the circuit being supplied. However, if this low output level can be boosted back up to a useful level again, by using a boost converter, the life of the battery can be extended.The DC input to a boost converter can be from many sources as well as batteries, such as rectified AC from the mains supply, or DC from solar panels, fuel cells, dynamos and DC generators. The boost converter is different to the Buck Converter in that it's output voltage is equal to, or greater than its input voltage. However it is important to remember that, as power (P) = voltage (V) x current (I), if the output voltage is increased, the available output current must decrease.

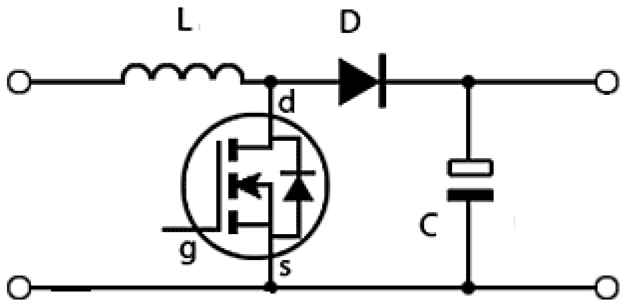

Fig.3.Boost converter diagram

C. ULTRACAPACITOR

An ultracapacitor, also called a supercapacitor, is an electrical component capable of holding hundreds of times more electrical charge quantity than a standard capacitor. This characteristic makes ultracapacitors useful in devices that require relatively little currentand low voltage. In some situations, an ultracapacitor can take the place of a rechargeable low-voltage electrochemical battery. An excellent example of the use of an ultracapacitor can be found in so-called electricalsmart meters. These devices, unlike their electromechanical counterparts, store information about home and business electrical power and energy consumption, and contain no moving parts. In the event of a power failure, an ultracapacitor allows the meter to send a final status communication to the utility company, preventing data loss and the confusion that could result. While a rechargeable backup battery can serve the same purpose, most electrochemical batteries fail at extremely low temperatures, such as commonly occur in the winter in much of the United States and virtually all of Canada. Ultracapacitors keep working at temperatures far below freezing. Ultracapacitors can be found in emergency radios and flashlights. The ultracapacitor charges up with the help of a miniature direct-current (DC) generator that the user can manually operate for a couple of minutes by turning a small crank. Once the ultracapacitor has acquired a full charge, the device can function for quite awhile (in some cases over an hour) before it needs a recharge.

D. POWER QUALITY PROBLEMS

Power quality determines the fitness of electric power to consumer devices. Synchronization of the voltage frequency and phase allows electrical systems to function in their intended manner without significant loss of performance or life. The term is used to describe electric power that drives an electrical load and the load's ability to function properly. Without the proper power, an electrical device (or load) may malfunction, fail prematurely or not operate at all. There are many ways in which electric power can be of poor quality and many more causes of such poor quality power.

1. VOLTAGE SAG

Voltage sag is a short duration reduction in rms voltage which can be caused by a short circuit, overload or starting of electric motors.A voltage sag happens when the rms voltage decreases between 10 and 90 percent of nominal voltage for one-half cycle to one minute.Some references defines the duration of a sag for a period of 0.5 cycle to a few seconds, and longer duration of low voltage would be called a "sustained sag”.

2.VOLTAGE SWELL

Voltage swell is the opposite of voltage sag. Voltage swell, which is a momentary increase in voltage, happens when a heavy load turns off in a power system.

3.DVR

Dynamic Voltage Restoration (DVR) is a method and apparatus used to sustain, or restore, an operational electric load during sags, or spikes, in voltage supply. Often used in manufacturing areas requiring significant power to run tools/equipment, and utility plants, this custom device mitigates potential damage to equipment and undesirable slowdowns to the production line caused by an abrupt change in electric load.

ISSN 2395-695X (Print)
ISSN 2395-695X (Online)

International Journal of Advanced Research in Biology Engineering Science and Technology (IJARBEST)

Vol. 2, Special Issue 10, March 2016

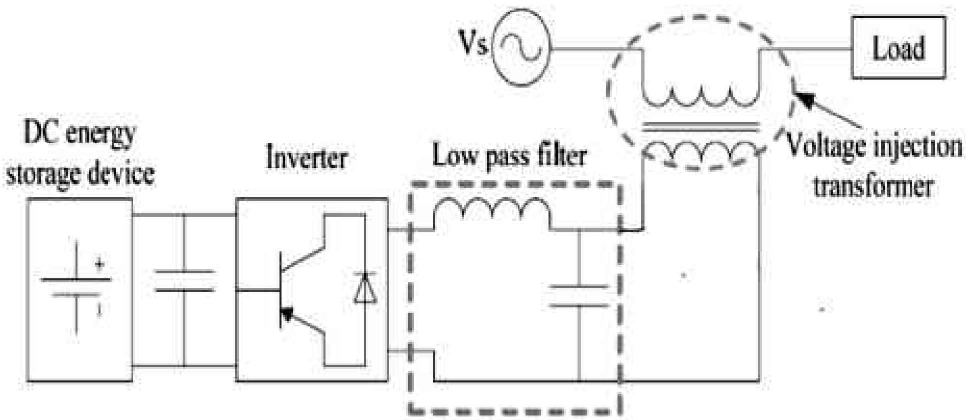

Fig.4.DVR diagram

This method uses critical devices such as an automatic Transfer switch and IGBT Modules in order to operate. DVR (Dynamic Voltage Restorer) is a static var device that has seen applications in a variety of transmission and distribution systems.

It is a series compensation device, which protects sensitive electric load from power quality problems such as voltage sags, swells, unbalance and distortion through power electronic controllers that use voltage source converters (VSC)

E. SERIES INVERTER

The inverter plays a vital role in Uninterrupted Power Supply (UPS). It is used to convert the direct current (DC) to alternating Current (AC) of required voltage. In series inverter, the commutating elements L and C are connected in series with the load. This constitutes a series RLC resonant circuit. The Two SCRs are used to produce the halves (positive and negative half cycle) in the output.

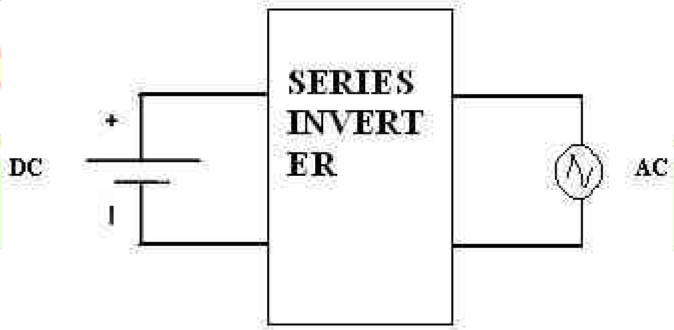

Fig.5.Series inverter

4. RESULT ANALYSIS

ISSN 2395-695X (Print)
ISSN 2395-695X (Online)
International Journal of Advanced Research in Biology Engineering Science and Technology (IJARBEST)
Vol. 2, Special Issue 10, March 2016

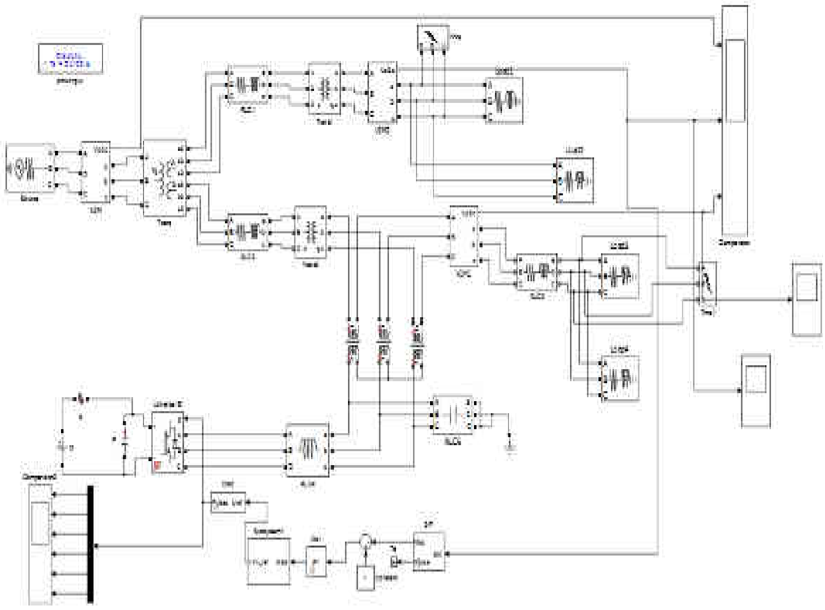

Fig.6. Simulation Diagram

In figure 6, 7, 8, 9 and 10 shows the simulation diagram and graph of the DVR and series inverter. In the graph results shows the exact output waves of the converter. The simulation and experimental results confirm to verify the feasibility of the proposed converter. The simulation and output waveform s are done by MATLAB software.

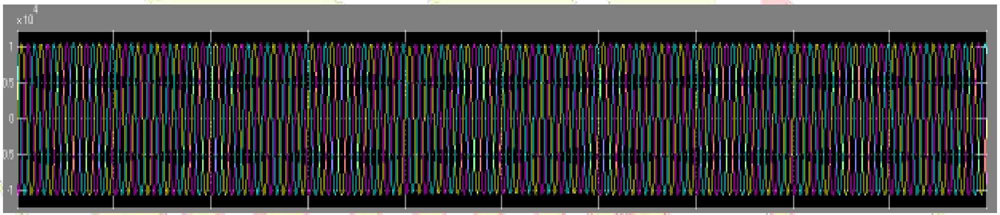

Fig.7. Simulation Graph

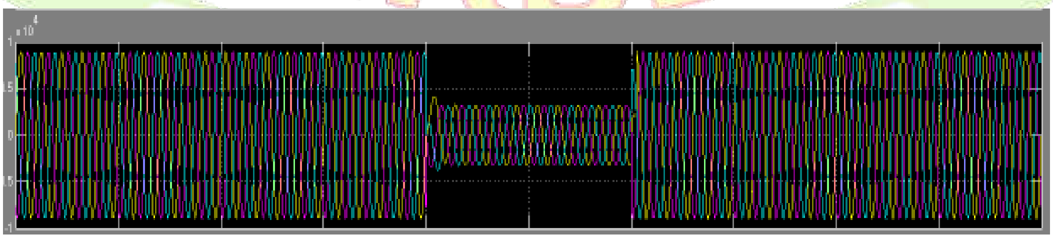

Fig.8. Simulation Graph

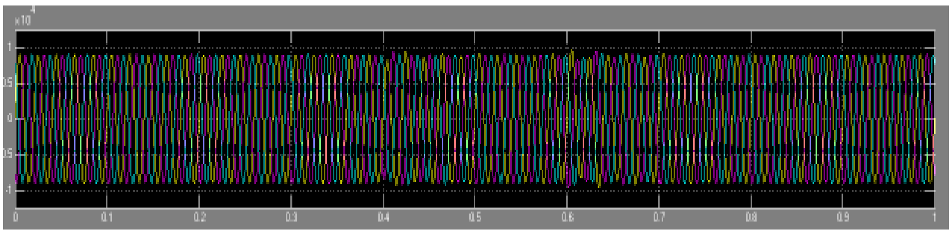

Fig.9. Simulation Graph

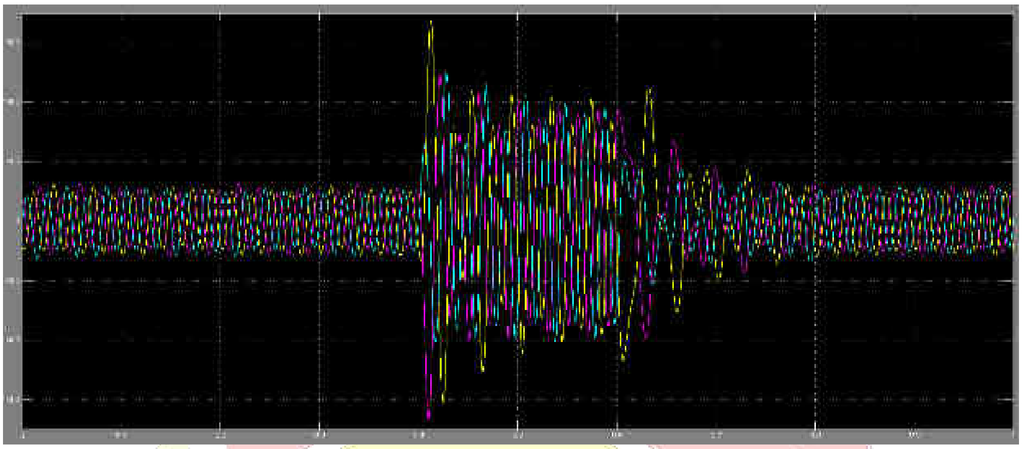

Fig.10. Simulation Graph

5. CONCLUSION

In this project, the concept of integrating UCAP-based rechargeable energy storage to the DVR system to improve its voltage restoration capabilities is explored. With this integration, the DVR will be able to independently compensate voltage sags and swells without relying on the grid to compensate for faults on the grid. The UCAP integration through a bidirectional dc–dc converter at the dc-link of the DVR is proposed. The power stage and control strategy of the series inverter, which acts as the DVR, are discussed. The control strategy is simple and is based on injecting voltages in-phase with the system voltage and is easier to implement when the DVR system has the ability to provide active power. A higher level integrated controller, which takes decisions based on the system parameters, provides inputs to the inverter and dc–dc converter controllers to carry out their control actions. Designs of major components in the power stage of the bidirectional dc–dc converter are discussed. Average current mode control is used to regulate the output voltage of the dc–dc converter due to its inherently stable characteristic.

REFERENCES

[1]. Deepak Somayajula, Mariesa L. Crow 'An Integrated Dynamic Voltage Restorer-Ultra capacitor Design for Improving Power Quality of the Distribution Grid' IEEE TRANSACTIONS ON SUSTAINABLE ENERGY, VOL. 6, NO. 2, APRIL 2015

[2] J. G. Nielsen, M. Newman, H. Nielsen, and F. Blaabjerg, "Control and testing of a dynamic voltage restorer (DVR) at medium voltage level," IEEE Trans. Power Electron., vol. 19, no. 3,p.806, May 2004. [3] A. Ghosh and G. Ledwich, "Power Quality Enhancement Using Custom Power Devices," Kluwer Academic Publishers, 2002.

[4] S. Chen, G. Joos, L. Lopes, and W. Guo, "A nonlinear control method of dynamic voltage restorers," in 2002 IEEE 33rd Annual Power Electronics Specialists Conference, 2002, pp. 88- 93.

[5] R. Buxton, "Protection from voltage dips with the dynamic voltage restorer," in IEE Half Day Colloquium on Dynamic Voltage Restorers – Replacing Those Missing Cycles, 1998, pp. 3/1- 3/6.

[6] H. Awad, J.Svensson, M. Bollen, "Mitigation of Unbalanced Voltage Dips Using Static Series Compensator", IEEE Trans. On Power Elec., Vol. 19, No. 13, May 2004.

ISSN 2395-695X (Print)
ISSN 2395-695X (Online)

International Journal of Advanced Research in Biology Engineering Science and Technology (IJARBEST)

Vol. 2, Special Issue 10, March 2016

[7] P. R. Sanchez, E. Acha, J. E. O. Calderon, V. Feliu, and A. G. Cerrada, "A versatile control scheme for a dynamic voltage restorer for power quality improvement," IEEE Trans. Power Del., vol. 24, no. 1, pp. 277–284, Jan. 2009.
[8] C. S. Lam, M. C. Wong, and Y. D. Han, "Voltage swell and overvoltage compensation with unidirectional power flow controlled dynamic voltage restorer," IEEE Trans. Power Del., vol. 23, no. 4, pp. 2513–2521, Oct. 2008.
[9] K. Sahay and B. Dwivedi, "Supercapacitor energy storage system for power quality improvement: An overview," J. Elect. Syst., vol. 10, no. 10, pp. 1–8, 2009.
[10] P. F. Ribeiro, B. K. Johnson, M. L. Crow, A. Arsoy, and Y. Liu, "Energy storage systems for advanced power applications," Proc. IEEE, vol. 89, no. 12, pp. 1744–1756, Dec. 2001.
[11] H. K. Al-Hadidi, A. M. Gole, and D. A. Jacobson, "A novel configuration for a cascaded inverter-based dynamic voltage restorer with reduced energy storage requirements," IEEE Trans. Power Del., vol. 23, no. 2, pp. 881–888, Apr. 2008.
[12] R. S. Weissbach, G. G. Karady, and R. G. Farmer, "Dynamic voltage compensation on distribution feeders using flywheel energy storage," IEEE Trans. Power Del., vol. 14, no. 2, pp. 465–471, Apr. 1999.