International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169
Volume: 3 Issue: 2 132– 136

A Review on Application of SVPWM based DVR to enhance the Voltage profile in power distribution system

Md Iltaf
RTMNU Nagpur Dept of Electrical Engineering
Abha- Gaikwad Patil College of Engineering
NAGPUR, INDIA
mdiltaf@gmail.com

Prof. U.V.Reddy
RTMNU Nagpur Dept of Electrical Engineering
Abha- Gaikwad Patil College of Engineering
NAGPUR, INDIA
venkat.u@hotmail.com

Abstract— The Power Quality Analysis aspires to bring out electricity consumers for improved power quality with application of power electronics .In present scenario, the quality of power has to be very good due to introduction of sophisticated devices which performance affected due to bad power quality and these are very sensitive to the power quality. There is various form power quality problem or disturbances like Voltages Sags, swells, harmonic distortion, flicker and interruptions. Voltage sag is more frequent than voltage swell and hence its impact is more on power distribution system.

The custom power devices has been proposed to sole the power quality problems as one of the means to protect sensitive loads from power quality problems such as voltage sags and swells. The Dynamic Voltage Restorer is basically controlled voltage source converter that is connected in series with the network. It injects a voltage on the system to compensate an disturbance affecting the load voltage. The compensation capacity depends on maximum voltage injection ability and real power supplied by the DVR. The principal component of the DVR is a voltage source inverter that generates three phase voltages and provides the voltage support to a sensitive load during voltage sags and swells. Pulse Width Modulation Technique is very critical for proper control of DVR.

In this project work, the operation of DVR will be presented and the Space Vector PWM control technique will be used for voltage source inverter. SVPWM method can utilize the better dc voltage and generates the fewer harmonic in inverter output voltage than other techniques. This work describes the DVR based on Space Vector PWM provides voltage support to sensitive loads and will be simulated by using MATLAB/SIMULINK.

Keywords- *DVR, SVPWM, MATLAB,SAG, SWELL*

*****

I. INTRODUCTION

Due to increasing complexity in the power system, voltage sags are now becoming one of the most significant power quality problems. Voltage sag is a short reduction voltage from nominal voltage, occurs in a short time. Short-lived voltage sags may not cause much harm other than cause a slight flickering of lights; temporary voltage sag is bound to have a greater impact on the industrial customers [1].

Power quality problems such as sag, swell, harmonic distortion, unbalance, transient and flicker may have impact on customer devices, cause malfunctions and also cost on loss of production [2]. With the deregulation of the electric power energy market, the awareness regarding the quality of power is increasing day by day among different categories of customers. A major volume of work is reported to understand the importance & relevance of power quality in deregulated market [3].

Due to the fact that voltage swells are less common in distribution systems, they are not as important as voltage sags. Voltage sag and swell can cause sensitive equipment (such as found in semiconductor or chemical plants) to fail, or shutdown, as well as create a large current unbalance that could blow fuses or trip breakers [4].

The Dynamic Voltage Restorer (DVR) is a power electronic device that is used to inject 3-phase voltage in series and in synchronism with the distribution feeder voltages in order to compensate for voltage sag and similarly it reacts quickly to inject the appropriate voltage component (negative voltage Magnitude) in order to compensate voltage swell [5].

The basic principle of a series compensator is simple, by inserting a voltage of required magnitude and frequency; the series compensator can restore the load side voltage to the desired amplitude and waveform even when the source voltage is unbalanced or distorted .Sinusoidal PWM and space vector PWM control techniques are used for controlling the DVR [6].

Power Quality Problems & Solution

Any Power system can be understood from one line diagram in Fig-1. There are various steps in Transmission part as well as in distribution part as per the power requirement. We know that generally power can be generated at 11 kV to 25 kV but its transition at low voltage will be difficult for long distance.

Hence during power transmission it will be Step up to high voltage 220 kV and further during distribution it will be step down. For Medium Scale industries the voltage will be 220/33kV and it will further step down to 33/11kV for Small scale Industries and finally it will be step down to 400V line voltage and 230V Phase voltage.

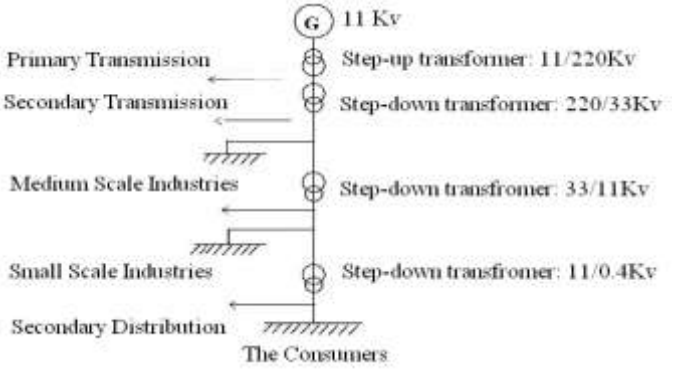

Figure 1 Single Line Diagram of Power Supply System

We have observed that there are vicarious disturbances in power distribution system and it affect the quality of power distributed. It is essential to improve the power quality by mitigating the disturbances. There are two ways to improve the power quality, either at customer end or at utility end. In normal practice we do the load conditioning to ensure that equipment which are being used are less sensitive to the power disturbances. There are two types of conditioning system Series & Shunt of power conditioning system used in low and medium voltage distribution system.

We use the power electronics controller in power distribution system which improves the reliability and quality of power that is distributed to customer. There are various Custom power devices known as Active Power Filters (APF), Distribution Series Capacitor (DSC), Battery Energy Storage System (BESS), Distribution Static Synchronous Compensators (DSTATCOM), Surge arrestor (SA), Dynamic Voltage Restorer (DVR), Solid State Fault Current Limiter (SSFCL), Static Var Compensator (SVC).

Dynamic Voltage Restorer

In all Power custom devices DVR is the most effective and efficient Device to control the power quality problem in distribution System. DVR used in series with power distribution system to protect sophisticated equipments. Its main function is to provide the voltage compensation as per the requirement in the network. If there is power sag then it will add the Voltage in the system and ensure its maintain its pre-fault value. When there is Swell in the system it will add negative voltage magnitude in the system and again it will ensure the voltage is being maintain at its pre fault level. The voltage injection by DVR will be depending on the ability to inject the Voltage.

In Fig- 2, Location of Dynamic Voltage Restorer is shown where DVR has been used in series in distribution line to protect the sensitive load.

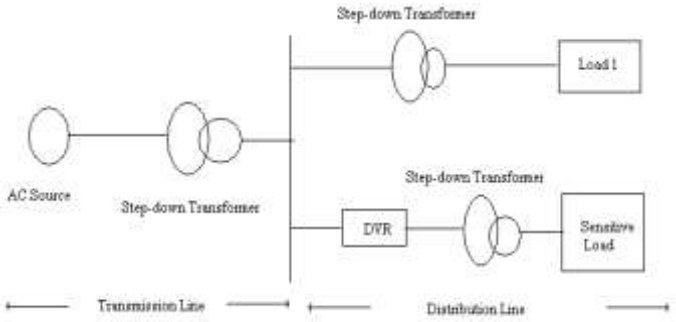

Figure 2 Location of Dynamic Voltage Restorer

Working Principle of Dynamic Voltage Restorer

A DVR consist of following units having different functions to perform.

1. An Injection or Booster Transformer
2. Harmonic Filter
3. Voltage Source Converter
4. Storage device
5. Control & Protection unit

Injection or Booster Transformer will connect the DVR to the Network system and it will also isolate the Load from control & Protection system. Harmonic filters will control the harmonics of Voltages generated by the SVC. Storage device will provide the DV input toe SVC which converts and generate the voltages of different magnitude, frequency & phase angle. Control & Protection unit will perform the protection of the Transformer and the short circuit current on the load.

Space vector modulation technique will be used as the control of Pulse Width modulation (PWM). It is used for the creation of alternating current (AC) waveforms to drive 3 Phase AC powered motors from DC using multiple class-D amplifiers. Due to developments and improvements in Microprocessor Space Vector Technique is being used extensively.

II. LITERATURE SURVEY

Performance of Dynamic Voltage Restorer (DVR) against Voltage sags and swells using Space Vector PWM Technique**.** *P. Ananthababu, B. Tr inadha, K. Ram charan Dept of Electrical & Electronics, A U College of Engineering Andhra University,Visakhapatnam Published in 2009 IEEE.*

In this paper Power quality problem has been discussed and it has been observed that Voltage Sag & Swell are the most significant quality Problem. DVR has been proposed as customer power device to mitigate the voltage Sag & Swell in the Power system. Two pulse width modulation based control techniques ie. Sinusoidal PWM and space vector PWM are presented for controlling of the DVR.

Space vector pulse width modulation based DVR to mitigate voltage sag & swell**.** *Uppunoori Venkata Reddy, Paduchuri.Chandra Babu, IEEE Student Member, S.S.Dash Department of Electrical and Electronics Engineering SRM University, Kattankulathur, Chennai, India. Published in 2013 IEEE.*

In this paper, the operation of DVR is presented and the control technique used for voltage source inverter is Space vector PWM. Space vector PWM techniques can utilize the better dc voltage and generates the fewer harmonic in inverter output voltage. Phase jump compensation is achieved by using Phase Locked Loop. This work describes the DVR based on Space Vector PWM incorporating the PLL provides voltage support to sensitive loads.

A Review of Compensating Type Custom Power Devices for Power Quality Improvement**.** *Yash Pal, A. Swarup, Senior Member, IEEE, and Bhim Singh, Senior Member, IEEE Published in 2008.*

In this paper author presents a comprehensive review of compensating custom power devices mainly DSTATCOM, DVR and UPQC. It is aimed at providing a broad perspective on the status of compensating devices in electric power distribution system, classified references presented in this paper would serve quick and useful applications.

Analysis of Multi-Carrier PWM Methods for Asymmetric Multi-Level Inverter**.** *M. G. Hosseini Aghdam, S. H. Fathi, G. B. Gharehpetian Electrical Engineering Department, Amirkabir University of Technology, Hafez Avenue, No. 424, Tehran 15914, Iran. Published in 2008 IEEE*

In this paper multi-carrier PWM method for asymmetric multi-level inverter has been studied. PD-PWM, POD-PWM and APOD-PWM methods have been discussed considering switching frequencies, spectrum of the output waveform, and the use of inverter state redundancies. In different carrier-based PWM methods for asymmetric multi-level inverters, the switching actions are unbalanced among half bridges. Also, the switching action is a function of the frequency modulation index and amplitude modulation index. Comparing different methods from harmonics point of view, the significant harmonic energy of PD-PWM is concentrated on the carrier frequency.

Hybrid Cascaded H-Bridge Multilevel Inverter Motor Drive DTC Control for Electric Vehicles**.** *F. Khoucha, University of Brest, Brest Cedex 03, France. S.M. Lagoun, K. Marouani, A. Kheloui, Electrical Engineering Department, Polytechnic Military Academy, 16111 Algiers, Algeria. Published in 2008 IEEE*

This paper presented a hybrid cascaded H-bridge multilevel motor drive DTC control scheme for Electric (EV) or Hybrid Electric Vehicles (HEV). The control method is based on Direct Torque Control operating principles. The stator voltage vector reference is computed from the stator flux and torque errors imposed by the flux and torque controllers. This voltage reference is then generated using a hybrid cascaded H-bridge multilevel inverter, where each phase of the inverter can be implemented using a DC source, which would be available from fuel cells, batteries, or ultra capacitors. This inverter provides nearly sinusoidal voltages with very low distortion, using less switching devices. Therefore a high performance and also efficient torque and flux controller is obtained, enabling a DTC solution for multilevel inverter powered motor drives.

A Survey on Cascaded Multilevel Inverters. *Mariusz Malinowski, K. Gopakumar, Jose Rodriguez, Senior Member, IEEE, and Marcelo A. Pérez, Member, IEEE. VOL. 57, NO. 7, JULY 2010.*

This paper has reviewed the recent developments and applications of these inverters, including new proposed topologies, modulation techniques, and control strategies. The cascaded multilevel inverters have evolved from a theoretical concept to real applications due to several remarkable features like a high degree of modularity, the possibility of connecting directly to medium voltage, high power quality, both input and output, high availability, and the control of power flow in the regenerative version.

Performance Enhancement of DVR for Mitigating Voltage Sag/Swell using Vector Control Strategy**.** *Krischonme Bhumkittipich, Faculty of Engineering, Rajamangala University of Technology Thanyaburi , Thailand, Nadarajah Mithulananthan, School of Information Technology and Electrical Engineering, Brisbane , Australia. 2011 Published by Elsevier Ltd. Published by Elsevier Ltd. In 2011*

In this paper dynamic voltage restorer (DVR) with vector control strategy for mitigating power quality in power distribution systems has been presented. Whenever there is voltage Sag/Swell occurrence DVR has to detect it and inject voltage components. The control strategy adopted for driving the DVRs plays a very important role in its performance and any delay in the process or incorrect injection would be harmful to sensitive loads that are vulnerable to voltage sag/swell.

Design of PI & Fuzzy controllers for Dynamic Voltage Restorser. *K Sandhya, Research Scholar, Department of Department of Electrical & Electronics, JNTU Hyderbad, India.Published by Elsevier Ltd in 2012*

In this paper DVR has been presented as most efficient and effective modern custom power devices to mitigate the power quality problems due to its lower cost, smaller size and fast dynamic response to disturbances. PI and fuzzy controllers has been used for control of DVR.

Simulation and Analysis of DVR for Mitigating Voltage Sags and Swells**.** Shakti Prasad Mishra, PG Student, Department of EEE, Chennai, India. Published by Elsevier Ltd in 2013.

This paper presented the modelling and simulation of DVR for mitigating of voltage sag & swell which are is major

problem and issues on the non linear loads using Feed-forward Instantaneous power theory. The performance of DVR depends on the efficiency of control technique used for switching the Inverters. A comparative study has been carried out using Fuzzy Controller and other conventional controller and it is concluded that using Fuzzy Controller performance of DVR is more satisfactory than conventional methods.

Minimization of voltage sag induced financial losses in distribution systems using FACTS devices. *A.K. Goswami, C.P. Gupta, G.K. Singh, Department of Electrical Engineering, Indian Institute of Technology Roorkee, Roorkee 247667, Uttarakhand, India. Published in Elsevier 2010.*

This paper presented the modelling of FACTS devices to minimize the voltage sag induced financial losses. Two types of FACTS devices D-STATCOM AND SVC are used for mitigating of voltage sag. With D-STATCOM and SVC connected at particular bus the D-STATCOM provides better support to reduce the financial loss than SVC. D-STATCOM is giving 21.59% reduction in financial losses where as SVC is giving 12.12% reduction in financial losses for highly sensitive equipment. In the case of medium sensitive equipment D-STATCOM is giving 50.74% reduction in financial losses where as SVC is giving 35.12% reduction in financial losses.

III. RESEARCH OBJECTIVE

The objectives of this project are as follows:

I. To study the operation of DVR systems.
II. To simulate mitigation of voltage sag/swell in the distribution system by DVR system using MATAB SIMULINK software.
III. To analyze the voltage sag/swell problems and solve it using SVPWM based DVR system.

IV. PROJECT METHODOLOGY

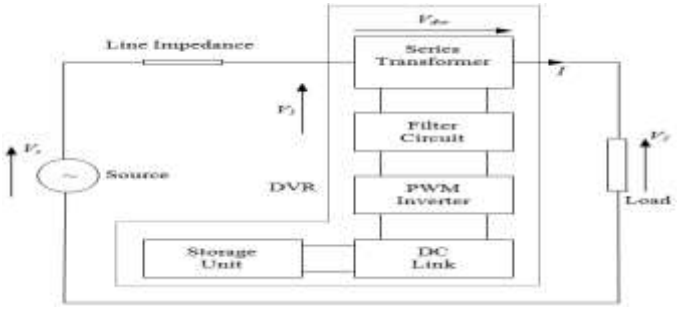

Figure 3. Basic Model of DVR application in Power Distribution System

Fig 3 shows the basic model of DVR application in power distribution system. DVR has to perform Voltage compensation as required for Voltage sag and swell. In DVR there is five units which are mentioned as Storage Unit, DC Link, PWM Inverter, Filter Circuit and Series Transformer. In this project the Switching Signals for Inverter will be generated by using below SVPWM Algorithms

1. Transform abc reference frame to stationary dq frame
2. Find Vref and α
3. Identify sector in which Vref is lying
4. Calculate Switching time
5. Generate switching pulse for the Inverter

V .CONCLUSION

After doing literature survey it has been concluded that the Power distribution system has many quality issues and it becomes especially important to mitigate the disturbances with the introduction of sophisticated devices, whose performance is very sensitive to the quality of power supply. Voltage sag is considered as one of the most significant power quality disturbances due to its high occurrence frequency compared with other power quality disturbances. This work will present the power quality problems such as voltage sag and swell, consequences and mitigation techniques of Dynamic Voltage Restorer (DVR). The performance of dynamic voltage restorer against voltage sags and voltage swells using SVPWM Technique will be presented.

REFERENCES

[1] PERFORMANCE OF DYNAMIC VOLTAGE RESTORER (DVR) AGAINST VOLTAGE SAGS AND SWELLS USING SPACE VECTOR PWM TECHNIQUE". P. ANANTHABABU, B. TR INADHA, K. RAM CHARAN DEPT OF ELECTRICAL & ELECTRONICS, A U COLLEGE OF ENGINEERING ANDHRA UNIVERSITY,VISAKHAPATNAM PUBLISHED IN 2009 IEEE.

[2] Space vector pulse width modulation based DVR to mitigate voltage sag & swell". Uppunoori Venkata Reddy, Paduchuri.Chandra Babu, IEEE Student Member, S.S.Dash Department of Electrical and Electronics Engineering SRM University, Kattankulathur, Chennai, India. Published in 2013 IEEE

[3] "A Review of Compensating Type Custom Power Devices for Power Quality Improvement". Yash Pal, A. Swarup, Senior Member, IEEE, and Bhim Singh, Senior Member, IEEE Published in 2008. 'Effective Control Strategy to enhance Power Quality

[4] Improvement using Dynamic Voltage Restorer'. Ram Hemantkumar Mistry, Prof. Hemin D. Motiwala 2014 IJEDR | Volume 2, Issue 2

[5] 'Dynamic Voltage Restorer Based on Space Vector Pulse Width Modulation Technique' B.N S P Venkatesh , International Journal of Engineering Science and Technology (IJEST) 2013.

[6] 'Performance Analysis of Dynamic Voltage Restorer (DVR) using Sinusoidal and Space vector PWM Techniques'. B.Rajani, (IJERT) Vol. 1 Issue 3, May – 2012.

[7] "Analysis of Multi-Carrier PWM Methods for Asymmetric Multi-Level Inverter". M. G. Hosseini Aghdam, S. H. Fathi, G. B. Gharehpetian Electrical Engineering Department, Amirkabir University of Technology, Hafez Avenue, No. 424, Tehran 15914, Iran. Published in 2008 IEEE

[8] "Hybrid Cascaded H-Bridge Multilevel Inverter Motor Drive DTC Control for Electric Vehicles". F. Khoucha,

University of Brest, Brest Cedex 03, France. S.M. Lagoun, K. Marouani, A. Kheloui, Electrical Engineering Department, Polytechnic Military Academy, 16111 Algiers, Algeria. Published in 2008 IEEE

[9] "A Survey on Cascaded Multilevel Inverters". Mariusz Malinowski, K. Gopakumar, Jose Rodriguez, Senior Member, IEEE, and Marcelo A. Pérez, Member, IEEE. VOL. 57, NO. 7, JULY 2010.

[10] "Performance Enhancement of DVR for Mitigating Voltage Sag/Swell using Vector Control Strategy". Krischonme Bhumkittipich, Faculty of Engineering, Rajamangala University of Technology Thanyaburi , Thailand, Nadarajah Mithulananthan, School of Information Technology and Electrical Engineering, Brisbane , Australia. 2011 Published by Elsevier Ltd. Published by Elsevier Ltd. In 2011

[11] Design of PI & Fuzzy controllers for Dynamic Voltage Restorser". K Sandhya, Research Scholar, Department of Department of Electrical & Electronics, JNTU Hyderbad, India.Published by Elsevier Ltd in 2012

[12] "Simulation and Analysis of DVR for Mitigating Voltage Sags and Swells". Shakti Prasad Mishra, PG Student, Department of EEE, Chennai, India. Published by Elsevier Ltd in 2013

[13] .