International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-8 Issue-6, August 2019

Voltage Sag Compensation Using Dynamic Voltage Restorer

D.Arulselvam, J.Harinarayanan, M.Rajasekaran, M.Subramanian

Abstract*—Power quality plays a very important vital role in the modern utility grid where sensitive loads are employed. Equipment damage, temporary shutdowns, product quality degradation and Voltage Sag are the major problem associated with power quality. Dynamic Voltage Restorer (DVR) is a powerful device which is used to improve voltage mitigation of weak buses associated in a multi-bus system. This paper incorporates the functional performance of DVR during voltage sag in the power system. Penetrating a voltage of required magnitude and frequency to restore the voltage across the load within the desired amplitude is the main objective of DVR. The proposed work based on modeling and simulation of DVR, in a closed-loop control of an eight bus system. Voltage compensation is done effectively using DVR in the Closed loop FLC controlled system and its analyzed with PID Controlled system. The simulation result shows Closed loop FLC system using DVR is observed to be faster than PID controlled systems.

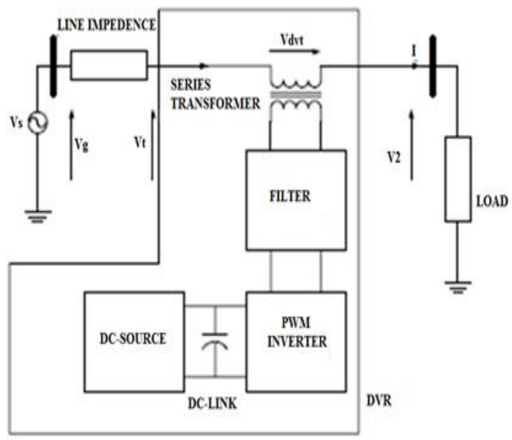
***Keywords*—DVR, VoltageSag, FLC, Multibus System, PID.**

I. INTRODUCTION

Most of the Modern power system, faces many issues in power quality. All the power quality issues include problems that are related to the voltage. The result of this voltage quality issue leads to the most frequent and common problem called the voltage sag. Voltage dip or Voltage sag is the reduction in certain level of voltage, which reduces the quality of power. As there is voltage reduction there is also increase in voltage called as voltage swell. The connection of non-linear loads in the system and the short circuit faults are considered as the major cause for the occurrence of voltage sag. This issue may collapse the entire system causing malfunction or failure of the equipment[1]. Many devices are used for compensating the voltage disturbances. DVR is the device which is found to be less cost effective and technically advanced device for the problems faced by modern power system. Dynamic Voltage Restore is the one of the power electronic devices used for compensating the voltage sag problem in transmission lines. DVR is a solid state device which is series connected, used to inject additional voltage into the supply system depending on the load demand to adjust the load voltage to the required amplitude and waveform even when the load is unbalanced or distorted. DVR protects the sensitive loads in the supply side from voltage disturbances such as voltage sag, voltage swell, voltage flickers, harmonics ,etc.

II. VOLTAGE SAG

Voltage dip or Voltage sag is a very short reduction in root mean square value of the voltage which is caused by short circuit, overloading or at the event electric motors starting. This Condition occurs when the rms line voltage reduces from the nominal line voltage during a short span of time. Voltage sag arises when RMS voltage decreases between ten and ninety percent of the nominal voltage for one-half cycle to one minute. A fault on the utility system causes interruptions and voltage sag. Voltage sags are caused due to temporary or transient faults on the same or parallel feeders. It is also possible that voltage sags may occur as a result of starting large loads. In some cases, voltage sag occurs due to energizing the transformer in a weak power system. The utility feeder design and fault clearing practice influence the voltage sag and interruption performance [2][3].



Revised Manuscript Received on August 30, 2019.
* Correspondence Author
D.Arulselvam*, Assistant Professor Department of Electrical and Electronics Engineering, Sri Sairam Engineering College, Chennai, Tamilnadu, India
(email: arulselvam.eee@sairam.edu.in)
J.Harinarayanan, Assistant Professor Department of Electrical and Electronics Engineering, Sri Sairam Engineering College, Chennai, Tamilnadu, India
(email: hari.eee@sairam.edu.in)
M.Rajasekaran, Assistant Professor Department of Electrical and Electronics Engineering, Sri Sairam Engineering College, Chennai, Tamilnadu, India
(email: rajasekaran.eee@sairam.edu.in)
M.Subramanian, Assistant Professor Department of Electronics and Instrumentation Engineering, Sri Sairam Engineering College, Chennai, Tamilnadu, India
(email: subramanian.ei@sairam.edu.in)

III. DVR STRUCTURE

Dynamic Voltage Restorer is the one which helps in overcoming voltage sags that occur in the electrical power distribution. It is a series voltage controller device. This device injects the voltage that is required, to the supply system in order to compensate the voltage to the desired Magnitude. DVR is used as compensation device for voltage swells or sags in order to inject or absorb the required level of voltages along with supply voltage and load point and thereby preventing the reliability of the power system. Whenever there is an imbalance in the supply voltage, DVR supports the power system by penetrating or removing the real power. The load voltage is at a predetermined level, any abnormal source voltage conditions such as voltage sags/swells or distortion are maintained by the DVR. During the operation, DVR can supply and absorb active and reactive power. It rectifies the load voltage by supplying reactive power during the occurrence of a small fault. DVR also generates active power in the case of balancing larger faults[4].

IV. SIMULATION RESULTS

OPEN LOOP SIMULATION

1) This section illustrates the performance of the DVR of a two-bus system and shows the result against voltage sags. The load is considered to be a resistive and an inductive load. Simulation is done using Matlab Simulink tools. The Total harmonic distortion (THD), Real power and Reactive power (P&Q) of a single pulse and a multi-pulse is compared and shown.

A.These results deal with a single pulse system. Figure.1 Shows the line model without using a compensation circuit (DVR). Figure.2 Indicates the system performance after the injection of voltage through DVR and shows the Variation of voltage sag compensation. Figure.3a shows the real power and reactive power variation. Figure.3b. reveals the difference in total harmonic distortion.

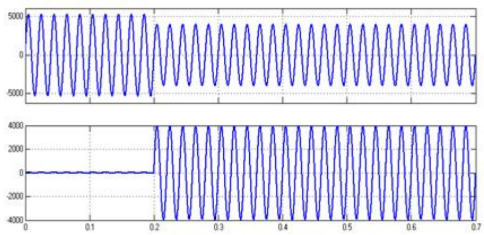


Figure.1 Voltage across load without DVR

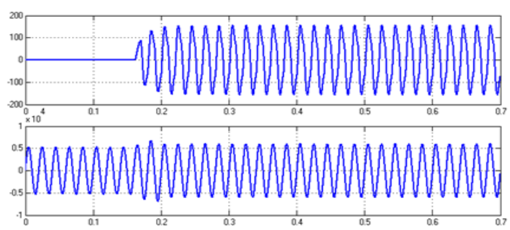


Figure.2 Voltage across load with DVR

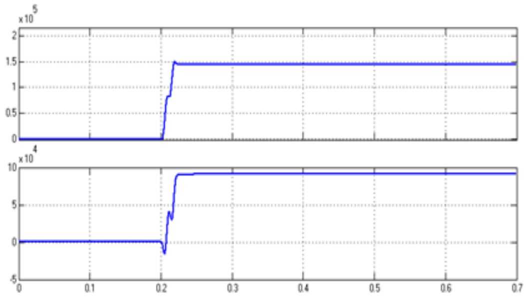


Fig.3a.Real and Reactive power

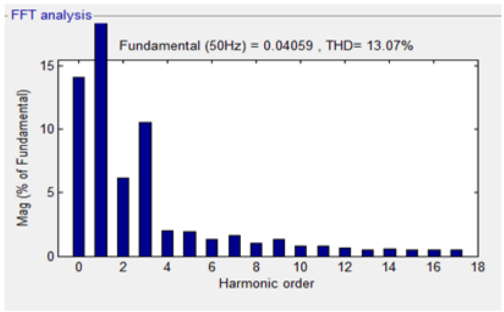


Figure.3b.Total Harmonic Distortion (THD)

B. These results deal with a multi- pulse system. Figure.4 shows the performance of the system after injecting voltage through DVR. Here the variation of voltage sag compensation is shown. Figure.5a. shows the real and reactive power variation. Figure.5b Reveals the difference in total harmonic distortion. Table.1.Shows the variations of THD of a single and a multi-pulse system.

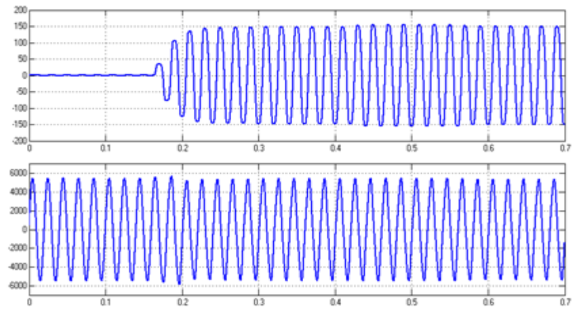


Figure.4 Voltage across load with DVR (multi pulse)

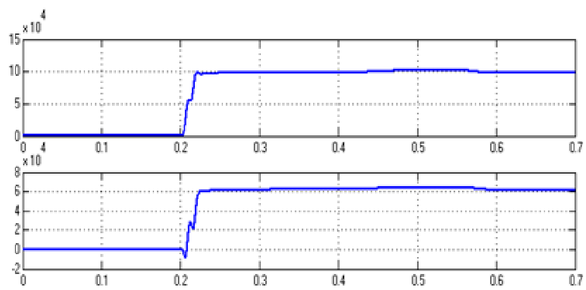


Figure.5a.Real power and Reactive power

International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-8 Issue-6, August 2019

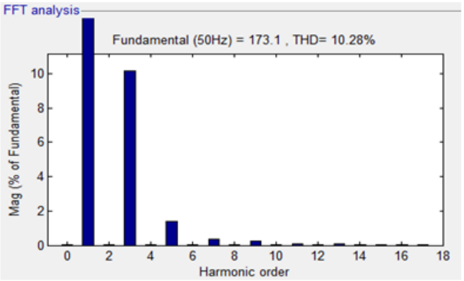


Figure.5b Total Harmonic Distortion (THD)

PULSES	THD
Single pulse	13.07%
Pwm pulse	10.28%

Table.1 THD comparison

2) This section shows the simulation results to demonstrate voltage sag and to illustrate the DVR performance of of an eight bus system. The load is considered to be a resistive and an inductive load. Real and Reactive power (P&Q) is shown and compared.

C. Figure.6 Shows the line model without using a compensation circuit (DVR). Fig.7. shows the reactive and real power variation across the load without DVR.

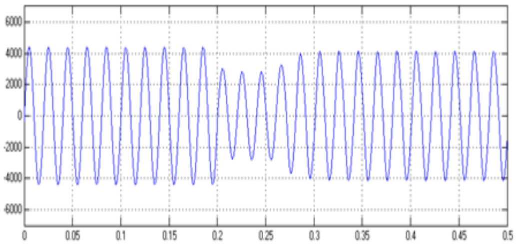


Figure.6.Voltage across load without DVR

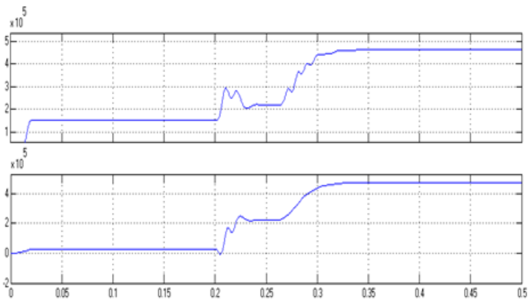


Figure.7.Real and Reactive power without DVR

D. Figure 8. Shows the line model without using a compensation circuit (DVR). Figure.9. shows the real and reactive power variation without DVR. Table 2. Shows the comparison of Real and Reactive power with and without DVR

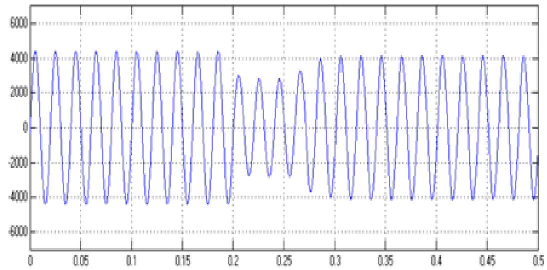


Figure.8.Voltage across load with DVR

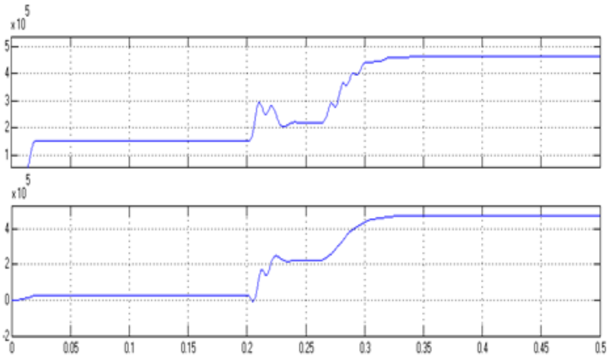


Fig.9.Real and Reactive power with DVR

BUS NO	REAL POWER (MW)LINE	REACTIVE POWER (MVAR)LINE	REAL POWER (MW) DVR	REACTIVE POWER (MVAR) DVR
BUS-1	0.0921	0.0962	0.567	0.571
BUS-2	0.0369	0.0477	0.477	0.589
BUS-3	0.0221	0.0313	0.695	0.701
BUS-4	0.0312	0.0351	0.589	0.612
BUS-5	0.0471	0.0493	0.419	0.541
BUS-6	0.0417	0.0523	0.397	0.411
BUS-7	0.0301	0.0435	1.115	2.213
BUS-8	0.0321	0.0431	0.862	1.386

Table.2 Comparison of real and Reactive Power

E. CLOSED LOOP SIMULATION

3) This section shows the comparison of output voltage by using PID and FLC.

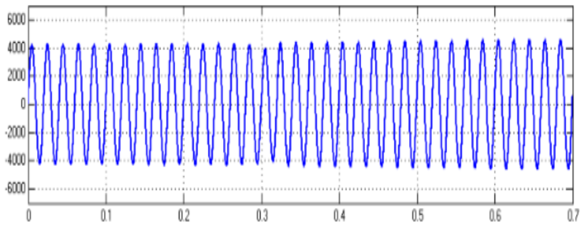


Figure.10 Output voltage across load with PID

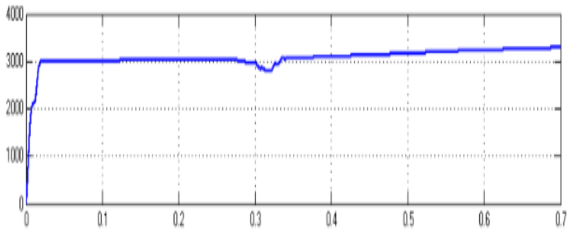


Figure.11 RMS voltage across load with PID

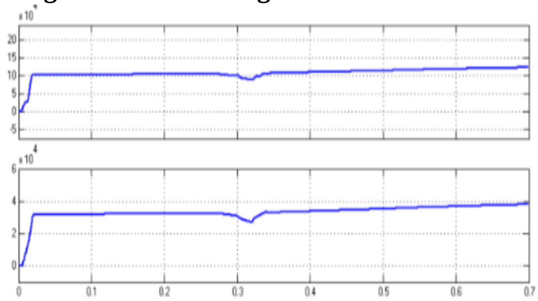


Figure.12 Real and Reactive power using PID

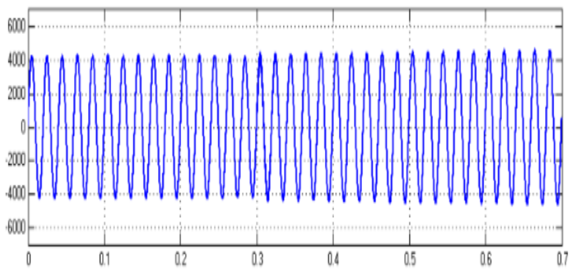


Figure.11 Output voltage across load with FLC

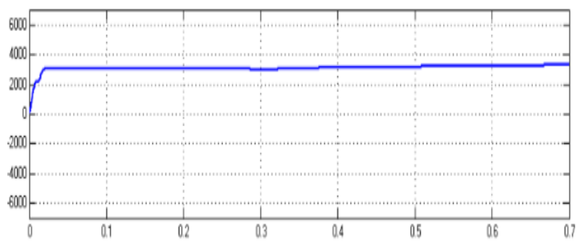


Figure.12 RMS voltage across load with FLC

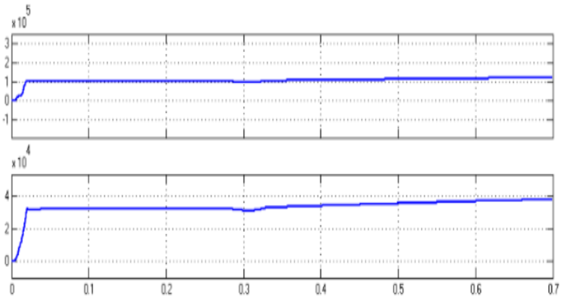


Figure.13 Real and Reactive power using FLC

Summary of time domain parameters

Controller	Peak time (s)	Setting time (s)	Steady state error (V)
PID	0.33	0.34	3.2
FLC	0.31	0.32	0.8

Table.3 Comparison of domain parameters

V. CONCLUSION

In this paper compensation of voltage dip using DVR is simulated using matlab and its performance is analyzed. Comparison of real power and reactive power, Total harmonic distortion is made using MATLAB/Simulink and Simpower System toolboxes. The effective reduction in total harmonic distortion is shown by using a multi-bus system. The DVR establishes the compensation of voltage in an efficient manner. The DVR is examined as an efficient flexible AC transmission system device. The simulation result reveals that the DVR proves to be good in regulating the voltage.

REFERENCES

1. Ashwini R Patil, Mahajan G K, and Wani N S, "Voltage Sag Compensation Using Dynamic Voltage Restorer", International research journal of Engineering and Technology. Vol.3,(2), pp.840-845, May 2016.
2. Santhanalakshmi C and Nagarajan C "Neural Controlled Multi-level Inverter Based DVR for Power Quality Improvement," International Conference on Emerging Devices and smart, pp. 42-47, March 2018.
3. Remya V K, Parthiban P, Ansal V and chiti babu B "Dynamic voltage restorer –A review," Journal of green engineering,Vol.8, (4), pp. -519-572,October 2018.
4. Benachiba C and Ferdi B, "Power Quality Imrovement using DVR",American journal of Applied Science, Vol. 6,(3), pp. 296-400, 2009.
5. Anish Prasai and Deepak Divan, "Zero Energy sag Correctors Optimizing DVR for industrial applications", IEEE Annual Industrial meeting. Vol. 44,(3), pp.1585-1592,2007.

Retrieval Number: F9351088619/19©BEIESP
DOI: 10.35940/ijeat.F9351.088619
Journal Website: www.ijeat.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication