



## VOLTAGE DIP MITIGATION TECHNIQUE USING DYNAMIC VOLTAGE RESTORER

Bhatt kandarp<sup>1</sup>,

<sup>1</sup>Electrical engineering, DJMIT

**Abstract** —as we know that Now a day's power requirement is increase day by day .so to produce and transmit the power is big advantage to achive. And to maintain the power quality problem has become a major issue to deal with, in order to maintain quality supply. Today's instruments or equipment is depends on electrical energy for improving their life style. Modern equipment like computer, electric motors etc.it cannot run without electric power . In order to improve the performance, the equipment demands quality supply. The power quality is mainly affected by many other factors of the electrical power network. The power quality problems like, voltage and frequency variation, harmonic contents affect the life of electrical utility and to reduce it's equipment performance. One of the most frequently power quality problems in transmission power network is voltage sag and voltage swell. This problems can damage heavy flow of current reduces the life time of the equipment or can damage over voltage affecting the insulation level of the equipment. Many modern custom devices are present in order to mitigate such problems. Among them, Dynamic Voltage Restorer (DVR) is efficient and cost effective. In this paper, I include an overview of DVR and it's control scheme in this paper.. The output result with the proposed control scheme is also shown.

**Keywords-** Power Quality, Dvr, Voltage Sag, Voltage Swell, Srf Theory, Spwm.

### I. INTRODUCTION

1) With the increasing demand of power we maintain the power and it increase use of non-linear loads and increase the complexity of the network. The power system faces challenges to deliver quality power to the consumers at the basis of commercial and industrial level.. Electric power been delivered is affected by many factors at the distribution network which has to be compensated to improve the quality and quantity of power been delivered. This chapter discuss about the power quality, its necessity, power quality issues and consequences. Power Quality concerns about the utility ability to provide 24hour power supply. The quality of electric power is characterized by parameters such as "continuity of supply, voltage magnitude variation, transients and harmonic contents in electrical signals". Synchronization of electrical quantities allows electrical systems to function properly and without failure or malfunction of an electric device.

#### 1.1 Importance of Power Quality:

Power Quality is to express the degree of similarity of practical power supply with ideal power supply. 1. If PQ is good then any load connected to the electric network runs efficiently without decreasing its performance and increase the life. 2. If Power Quality is poor means less than standard data, then any load connected to the network leads either to the failure of the equipment or reduction in its lifetime and performance. In order to prevent the consequences of poor Power Quality. To improve the utility performance of the electric power are we analyzed to resolve the PQ issues in order to determine the efficient compensation technique.

#### 1.2 Power Quality problems:

Poor PQ problems ultimately results in economic loss of the power system network. PQ mainly concerns to maintain voltage and current profile i.e. any deviation in these parameters can cause severe damage to the electrical utility and end consumers. An overview of many PQ problems along with their causes and consequences are presented.

#### 1.3 Voltage sag/dip:

The voltage sag or dip can be stated as decrease in nominal voltage level by 10-90% for short duration for half cycle to one minute as shown in fig.2.1. Sometime, voltage dip last for long duration such prolonged low voltage profile referred as 'under-voltage'. Voltage dip is further divided in three categories: instantaneous, momentary and temporary sags respectively.

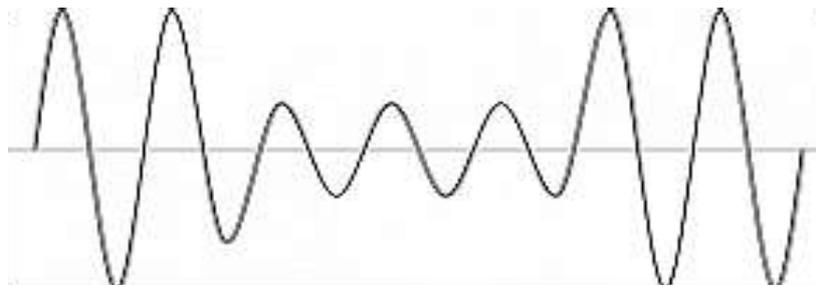


Fig1.1: Voltage Dip

Voltage sag are mainly caused due to occurrence of faults in power system, overloading of the electrical network and starting current drawn by heavy electrical loads like motors and refrigerators. Voltage sag in power system network results in failure of relays and contactor, dim light and fluctuating power.

## II Dynamic Voltage Restorer

A DVR is a series connected custom device that injects the appropriate/desired voltage to the load bus in order to maintain the voltage profile. However, in standard condition it is in stand-by mode. The compensating voltage is injected by three single phase transformers whose property can be controlled. These voltages are in synchronism with the load voltage. DVR has three mode of operation.

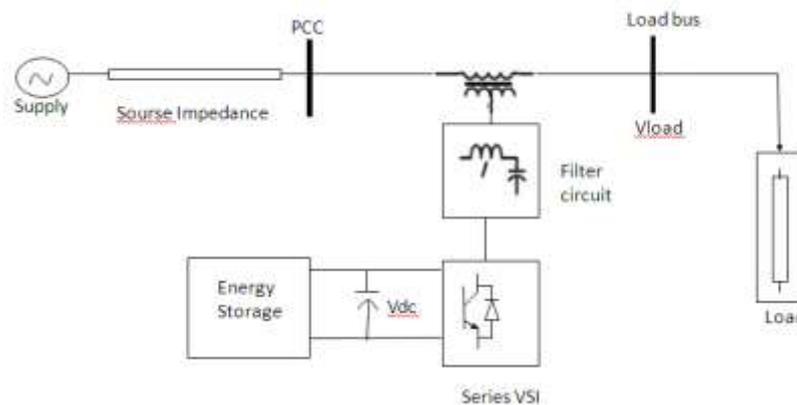


Fig.2.1 Dynamic voltage restorer

DVR is series connected compensating devices that restore/maintain the voltage profile at the sensitive loads under voltage unbalance. It is usually connected in the distribution network between Common Point of Coupling (PCC) and load. Shows the location of DVR in power system network. The disturbance in the system is detected by control scheme used which generates the triggering pulses for VSI. Passive filters are used to filter out the harmonic content of injected voltage. DVR injects the filtered output voltage through injection transformer.

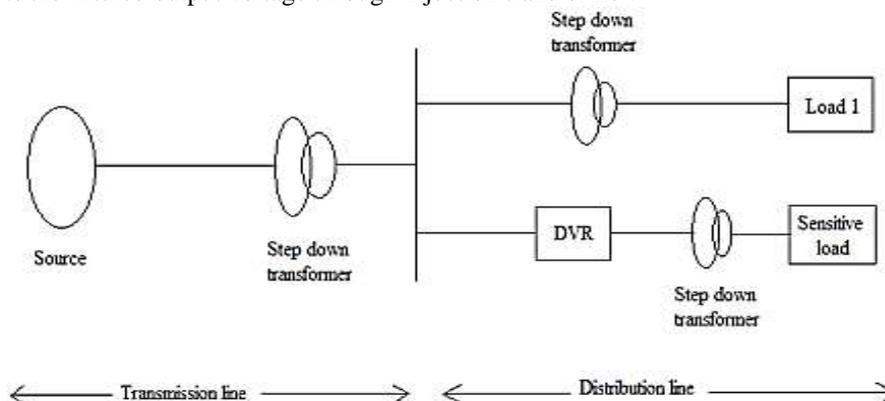


Fig. 2.2 Location Of DVR

DVR consists some additional equipment as follow.

1. VSI
2. Injection transformer
3. Passive filter
4. Energy storage unit

#### 5. Control unit

Control circuit steadily observe the system. Its function is to detect any disturbance in the system done by comparing the supply voltage with reference voltage and generate the switching command signals for VSI in order to generate the compensating voltage by DVR.

### III. SINUSOIDAL PULSE WIDTH MODULATION

In this SPWM technique are multiple numbers of output pulse per half cycle and pulses are of different width. The width of each pulse is varying within proportion to the amplitude of a sine wave. The output signals are generated by comparing a sinusoidal reference with a high frequency triangular signal. The rms ac output voltage.

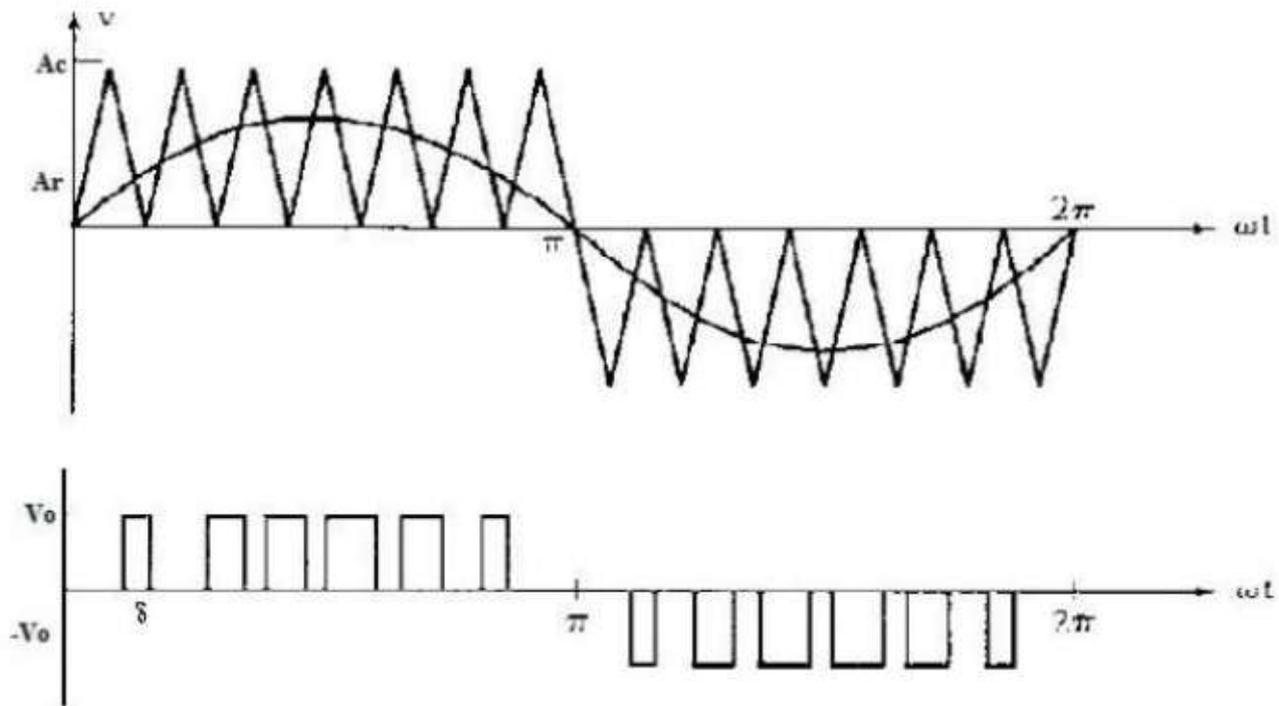


Fig.3.1 SPWM technique

The most common technique for generating sine wave is Pulse Width Modulation (PWM). Sinusoidal Pulse Width Modulation is the best technique for this. This PWM technique involves generation of a digital waveform, for which the duty cycle can be modulated in such a way so that the average voltage waveform corresponds to a pure sine wave. The simplest way of producing the SPWM signal is through comparing a low power sine wave reference with a high frequency triangular wave. This SPWM signal can be used to control switches. Through an LC filter, the output of Full Wave Bridge Inverter with SPWM signal will generate a wave approximately equal to a sine wave. This technique produces a similar AC waveform from others waveform. The 1<sup>st</sup> harmonic is still present and there is relatively high amount of higher level harmonics in the signal.

### IV. SYNCHROOUS REFERENCE FRAME THEORY (SRF):

Shows the control block of the DVR proposed in synchronous reference frame theory which is used for the control of self supported DVR. The voltage at Power control converter is converted to rotating reference frame using abc-dqo conversion. Using low pass filter(LPF)we can eliminate the harmonics and oscillatory components of voltage. The components in d-axis and q-axis are

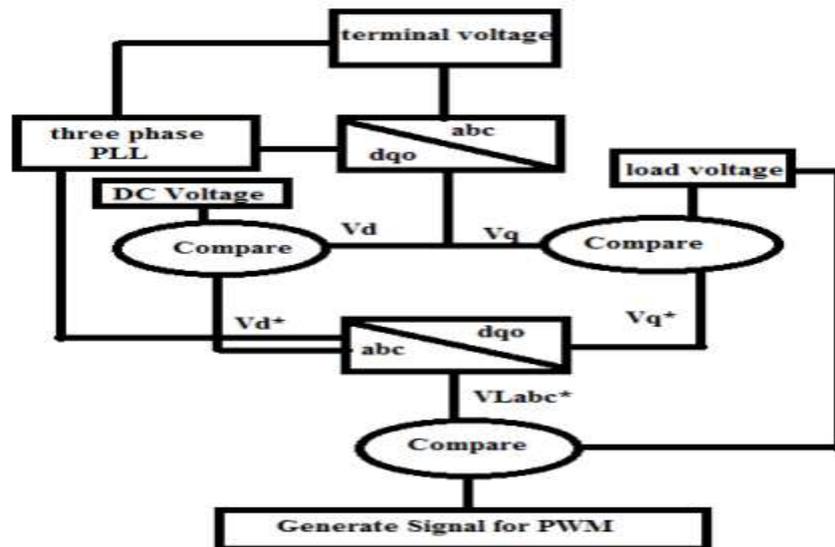


Fig. 4.1 SRF control strategy

3-phase supply voltage ( $V_{La}^*, V_{Lb}^*, V_{Lc}^*$ ) are derived using load voltages, terminal voltage ( $V_{ta}, V_{tb}, V_{tc}$ ) and dc bus voltage ( $V_{dc}$ ) of the DVR. Synchronous REF method is used to obtain the direct axis ( $V_d$ ) and quadrature axis ( $V_q$ ) components of load voltage. By Park's transformation three phase load voltage is converted to dqo frame. To synchronise these signals with the terminal voltage a three phase PLL is used. The dq components are passed through LowPassFilter to extract dc components of  $V_{d}^*$  and  $V_{q}^*$ .

## V. Dynamic voltage restorer simulation and result:

### (A) System parameter and rating:

Sr No.	Parameter	Parameter rating
1	Supply Voltage( $V_{rms}$ )	415 Volt
2	Line Impedance	$R=0.01\text{ohms}$ $L=1\text{e-}3\text{H}$
3	Filter Inductance	$2\text{e-}3\text{H}$
4	DC Bus Voltage	700 Volt
5	Series transformer turns ration	1:1
6	Filter capacitance	$35\text{e-}6\text{ F}$
7	Load active power	1000Watt
8	Load inductive reactive power	5000VAR
9	Line Frequency	50Hz

**(B) DVR Simulation :-**

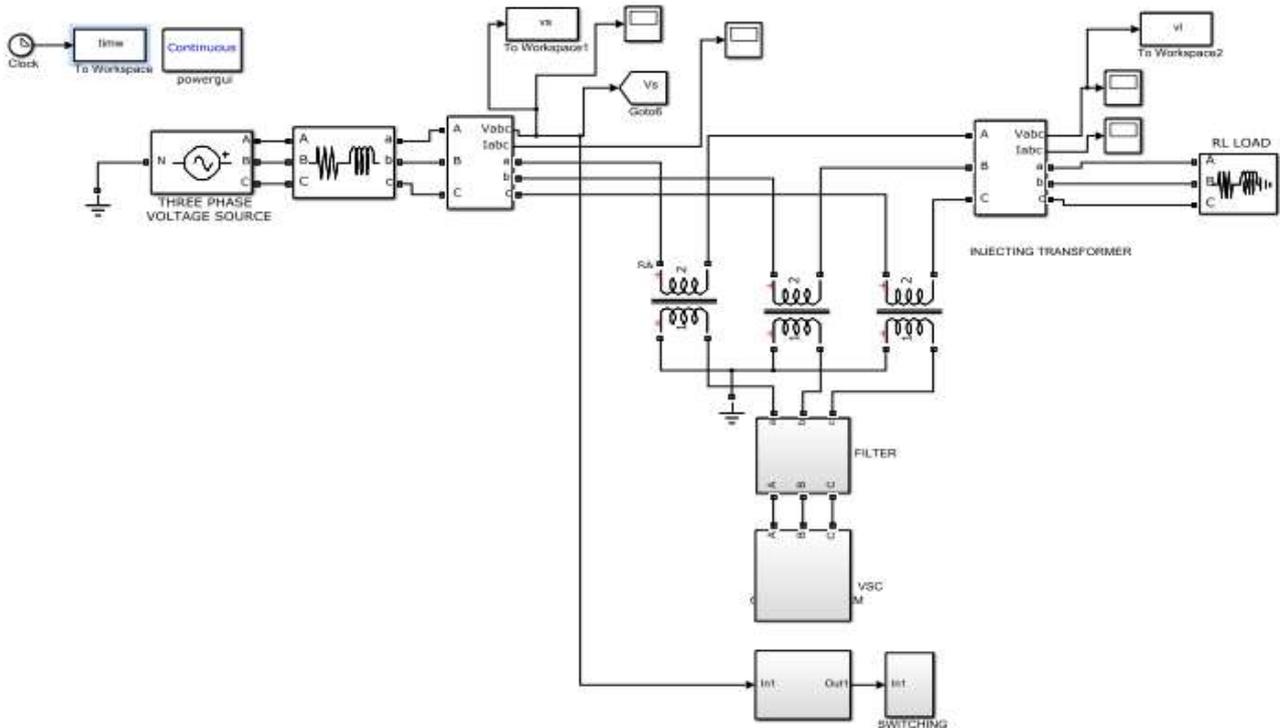


Fig. 5.1 DVR Simulation

A simulation has been carryout without and with dynamic voltage restorer. It has 3phase, 415V, 50 Hz, distribution line. Check the system performance at time of sudden load increase on the system. Inductive load connect via programmable source for 0.05 to 0.1 ms to the normal healthy system. Analyze the performance of system at time of sudden load connected.

**(C) Open loop simulation:-**

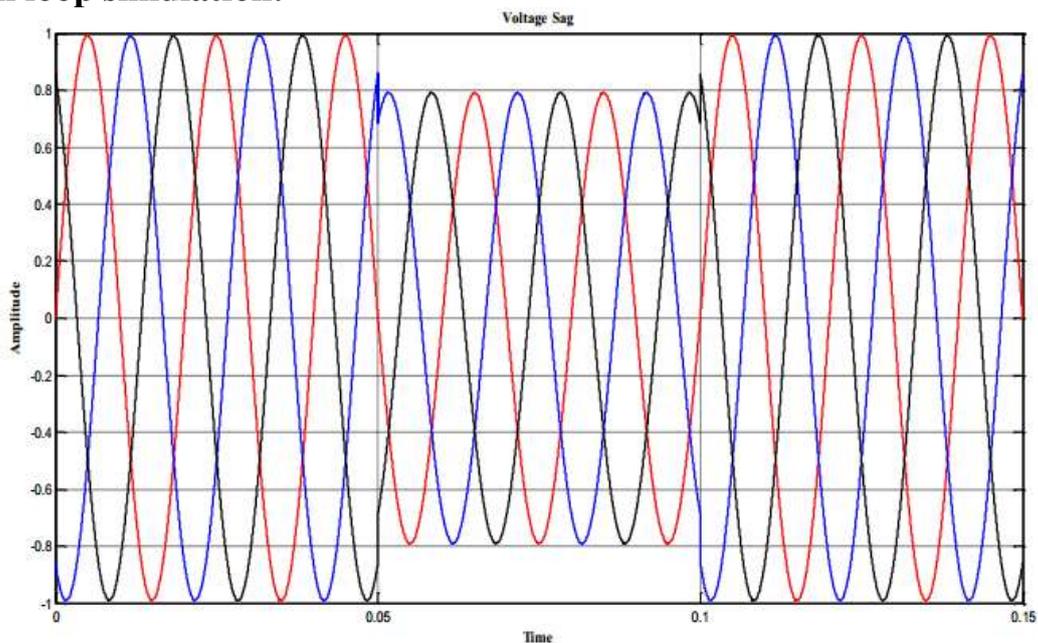


Fig. 5.2 output voltage without DVR

**(D). DVR Injected Voltage:-**

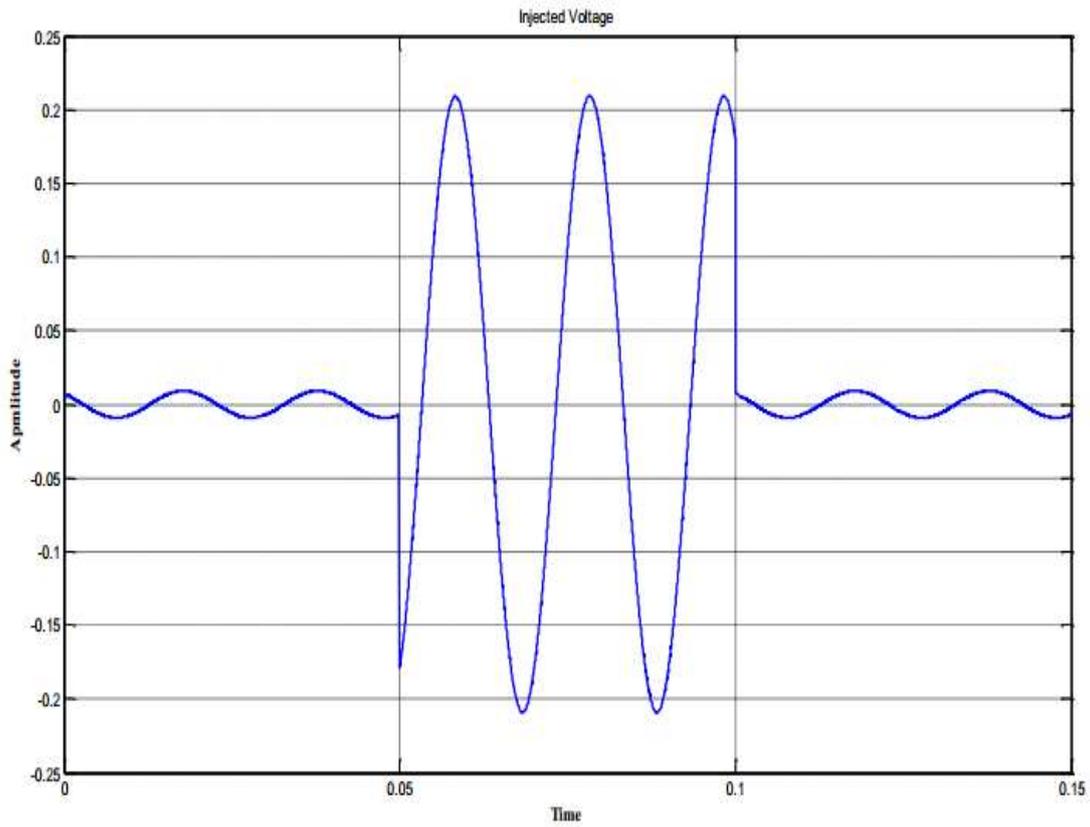


Fig. 5.3 one phase voltage injected by DVR

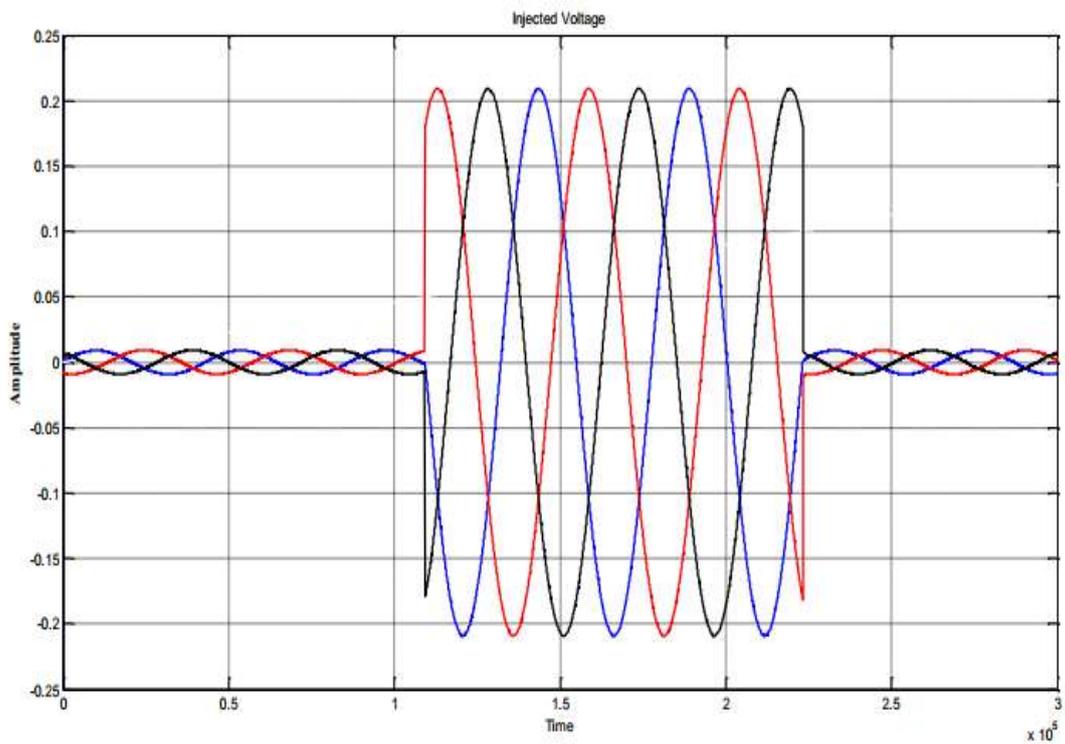


Fig. 5.4 three phase voltage injected by DVR

**(F). Closed loop System Output Voltage:-**

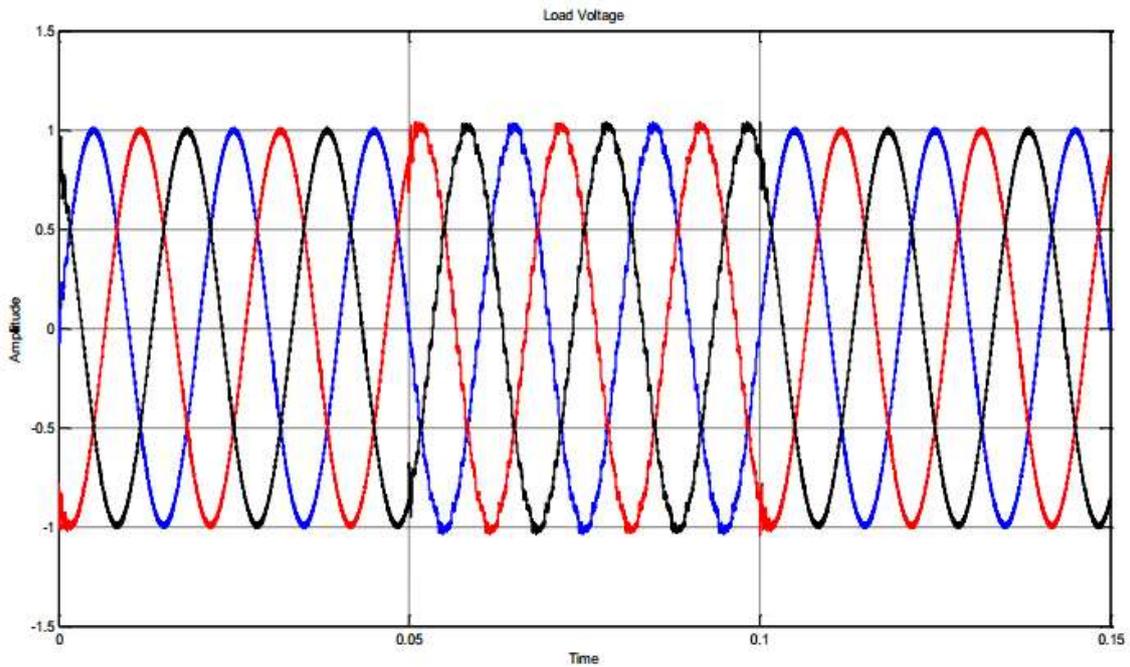


Fig. 5.5 System output with DVR

## VI. CONCLUSION

A new methodology has been developed to control DVR, named SRF theory to inject active power and to eliminate the three phase disturbances in the utility side. The three phase distortions created using the three phase fault block and the performance of DVR was analyzed. The sinusoidal PWM technique is used to provide the gate signals for the inverter. The overall performance is satisfactory to protect the load from utility voltage problems.

## **VII. REFERENCES**

- [1] Dr. S. Sankar Mr. Y. Prakash, "Power Quality Improvement Using DVR in power
- [2] L. Ramesh M. Venmathi, "The impact of Dynamic Voltage Restorer on Voltage Sag Mitigation," Third International Conference on Sustainable Energy and Intelligent System, 2012.
- [3] C.F. Baraket, A.M. Massoud M.A. Messiha, "Voltage sag mitigation employing DVR with minimum energy requirement analysis and implementation," *IEEE*, pp. 1-6, 2013.
- [4] Reza Sedaghati Mojtaba Hakimzadeh, "Performance Study of Dynamic Voltage Restorer (DVR) in order to Power Quality Improvement," *IEEE*, pp. 1830-1834, 2012.
- [5] Joffie Jacob, Reshmi V. Nisha Prakash, "Comparison of DVR Performance with Sinusoidal and Space Vector PWM Techniques.," International Conference on magnetics, 2014.
- [6] V. Suresh kumar, S. Kannan J. Kohila, "Control of Dynamic voltage restorer for injecting active power using synchronous reference frame theory," International Conference on Circuit, Power and Computing Technologies, 2015.
- [7] Bhim Singh, Ambrish Chandra, Kamal Al Haddad Parag Kanjiya, "SRF Theory Revisited" to Control Self Supported Dynamic Voltage Restorer (DVR) for Unbalanced and Nonlinear loads., *IEEE*, pp. 1 -6, 2013.
- [8] Seyed Hossein Hosseini, Mehdi Farasat, Ehsan Mokhtarpour Arash Khoshkbar Sadigh, "Voltage Flicker Mitigation with Dynamic Voltage Restorer," Power Electronic & Drive Systems & Technologies Conference, pp. 388-392, 2010.
- [9] Bhim Singh, Ambrish Chandra Parag Kanjiya, "SRF Theory Revisited to Control Self Supported Dynamic Voltage Restorer (DVR) for Unbalanced and Nonlinear Loads," *IEEE*, pp. 1-9, 2013.
- [10] Vahid Dargahi, Keith Corzine Arash Khoshkbar Sadigh, "New configuration of dynamic voltage restorer for medium voltage application," *IEEE*, 2016.
- [11] Manorma Kushwah Ragini Saxena, "Optimization of voltage sag/swell using dynamic voltage restorer (DVR)," *IEEE*, 2016.