International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 05 | May 2019 www.irjet.net p-ISSN: 2395-0072

POWER QUALITY IMPROVEMENT USING DYNAMIC VOLTAGE RESTORER (DVR)

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Abstract – *In the present time quality of power is considered as one of the major burden. It becomes essential with the addition of advanced equipment's whose achievement is very conscious to power quality. Market competition and descending benefits has made it suitable for companies to become aware of good quality of power. This is only possible by protection so that continuous flow of power is continued at suitable voltage levels. To ensure high power quality supply to their customer's electric services are looking for solutions. Dynamic Voltage Restorer seems to be an especially better solution in the present scheme controller. Power quality issues occur due to abnormal voltage, current or frequency, due to which failure occurs in end use equipment's. Dynamic Voltage Restorer is one of the devices which are most adequate power custom device used in power distribution networks. Due to its small size, lesser cost, it includes fast dynamic response. This paper presents modeling, analysis, and simulation of DVR in MATLAB/SIMULINK, which includes PI controller and discrete PWM generator for control purpose of DVR.*

Key words: Power Quality, DVR, PWM, PI Controller, FACTS

1. INTRODUCTION

Both customers and electric organizations are worried about the electric power quality. Power quality term is one of the most plentiful slang in the electrical companies since 1980s. It is a concept of particular types of power system disorders. These problems falls under this idea are not new. New is that engineers are now system approach instead of handling them as independent issues. New generation load apparatus are main concerns. Power electronic and microprocessor based devices are more sensitive to power quality variations than the equipment's which were used in past. Rise in application of devices such as shunt capacitors are used for power factor correction so that losses reduce and hence high efficiency in adjustable speed motor drives. This results rise in harmonics on power systems. So any power issues exhibit in voltage, frequency, or current deviations that result in breakdown or disoperation of the consumer apparatus can be classified into power quality problem[1].In order to deliver pure and clean power i.e. pure sinusoidal voltage waveform, FACTS devices are used. Many FACTS devices are being used in electrical network, some of them are, Static Synchronous Series Compensator (SSSC), Static Synchronous Compensator (STATCOM), Unified Power Flow Controller (UPFC), Interline Power Flow Controller (IPFC) etc. In actual process FACTS apparatus were designed for the transmission system and it can be used in distribution system also, named as Custom Power Devices. Some commonly used Custom Power Devices are: Dynamic Voltage Restorer (DVR), Distribution Static Synchronous Compensator (DSTATCOM), and Active Filter (AF) etc. With the help of these devices the quality problems are improved to great extents. Due to its fast response, DVR is considered as one of the most effective and efficient power custom devices [2].distribution systems has lots of power quality issues e.g. swell, sag, transients, etc. but voltage sag is the serious disorder which is mainly due to transients. In order to check voltage sag and voltage swell in distribution system DVR is one of the effective and efficient custom power devices [9]. DVR is connected in series with the line in order to compensate the voltage sag or swell in the load side.

2. DYNAMIC VOLTAGE RESTORER (DVR)

The main activity of Dynamic voltage restorer is to decline the voltage sags of sensitive apparatus; controls load voltage by compensating frequency, amplitude and phase angle of the distribution line. DVR is mainly responsible for quality of voltage forwarded to the end user [6] [7], when source voltage is not suitable for sensitive loads. Practice of DVR authorizes consumers to protect and isolate from transients and disturbances caused by sags and swells on the distribution network. The major parts of dynamic voltage restorer (DVR) are: voltage source converter, harmonic filter, injection or boost transformer, energy storage unit, Dc charging circuit etc.

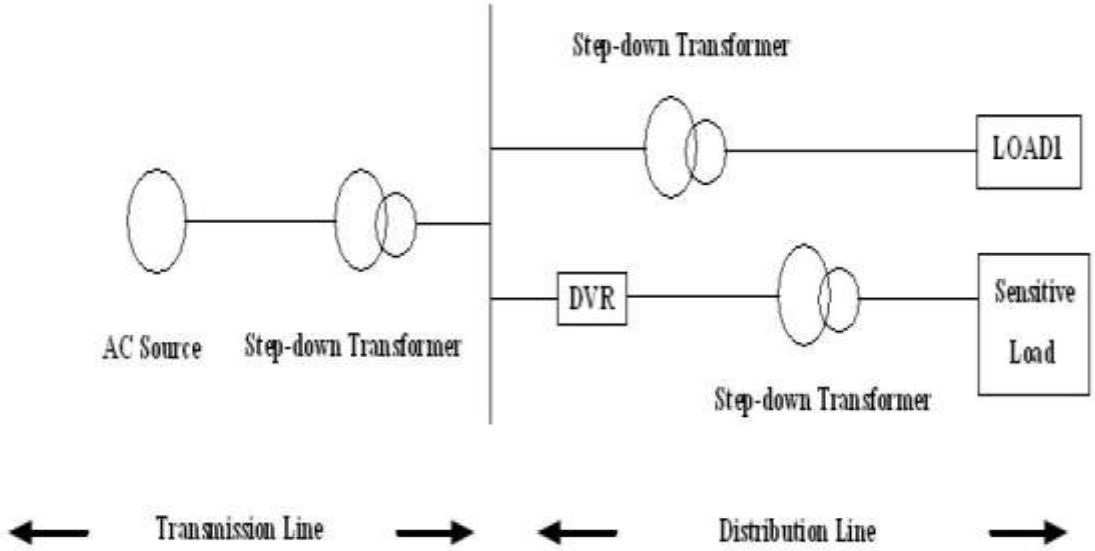

Fig. –1: Basic structure of A DVR

The basic structure of a DVR is shown in Fig.-1

Voltage source converter (VSC):

A Voltage Source Converter is a power electronic device mainly consists, switching and storage devices. These devices can generate a sinusoidal voltage at any prescribed frequency, magnitude, and phase angle.

Harmonic filter:

Harmonic filters main job to keep the harmonic voltage constant, generated by the Voltage source inverter.

Injection or booster transformer:

The Injection or Booster transformer is a device that decreases the transient energy and noise coupling from the primary side to the secondary side [3]. The main function of booster transformer is to connect the DVR to the distribution network via the HV windings.

Energy storage unit:

Energy storage unit is responsible to store energy in DC form. For energy storage purpose, Batteries, superconducting magnetic energy storage (SMES), Flywheels and super capacitors can be used

DC charging circuit:

After sag compensation, dc circuit charges the energy source and thus maintains dc link voltage at the nominal dc link voltage [4] [5].

3. SIMULATION & RESULTS OF DYNAMIC VOLTAGE RESTORER

A simple distribution network was simulated by using MATLAB R2016b [Fig.2a].In order to show the performance of Dynamic Voltage Restorer, Simulation was done on a simple circuit model with two loads. One an ordinary load capable of withstanding the voltage distortions and voltage sags and another, a sensitive load which is prone to voltage sags, and affects it performance seriously. In order to protect that sensitive load from voltage sag Dynamic Voltage Restorer was used. The components required for constructing DVR test Model is shown in Fig (2a) and Table-1.

Table -1: System Parameters

Sr.No	Parameters	Standards
1	Source	3 phase,22.5kv,50 Hz
2	Inverter Parametrs	IGBT based, 3arms,6 pulse, carrier frequency=1080Hz, Sample time=50 µs, Vdc= 5KV Amplitude, Rs=10Ω, Cs=750µF
3	PI controller	Kp=40, Ki=154, Sample Time=50µs
4	RL Load	R=2500ohm, L=30H
5	Two Winding Transformer	2.5VA, 50Hz, 20KV/380V

Fault Analysis: A case of various faults was simulated. The simulation diagram is shown in fig.(2a).

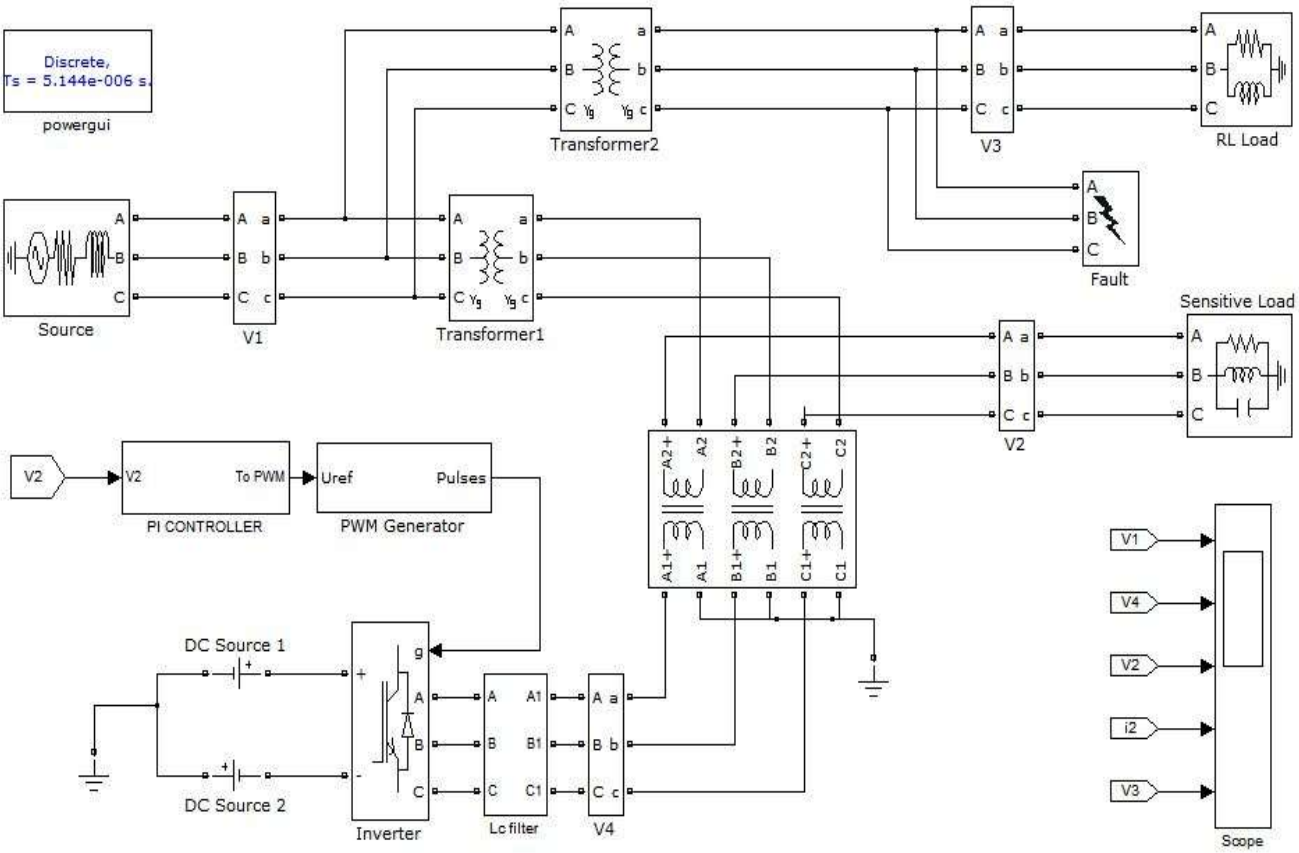

Fig. -(2a): Simulink diagram

Here fault is introduced only in phase. However, the fault can be converted in to any of the required type. The fault is a single line to ground fault and the fault resistance is 4.6 ohms and the ground resistance is 0.1 ohms.

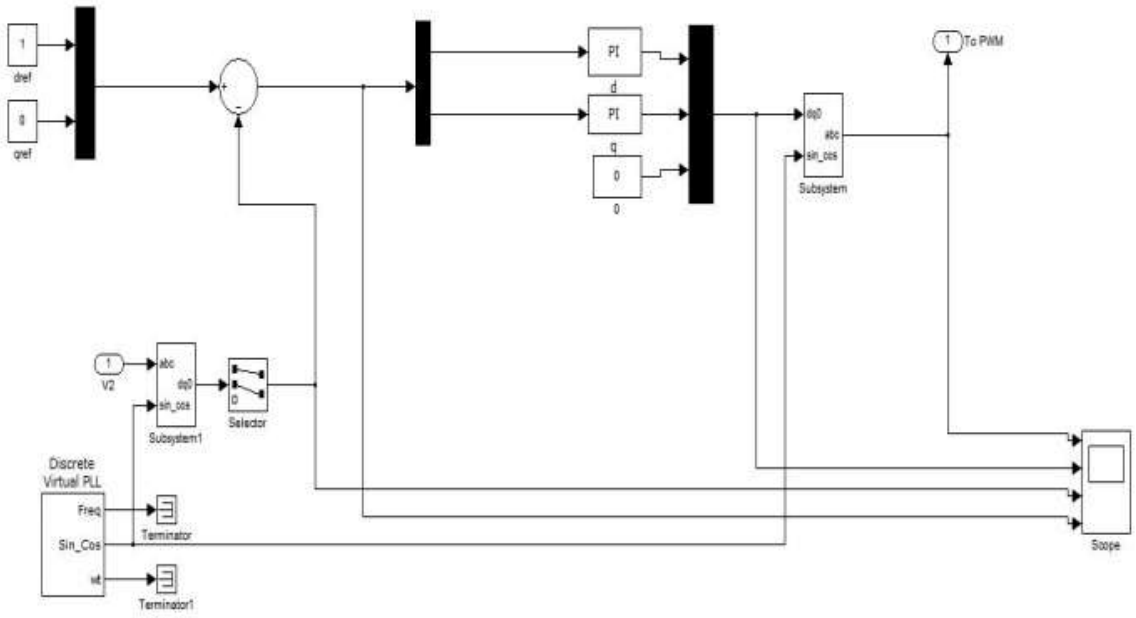

Fig. -(2b) Subsystem (PI Controller Block)

As shown in Fig.(2b),PI controller is used for controlling the IGBT based universal bridge[8]. The output of the PI controller is given to discrete PWM generator (mask) in order to send the controlling pulses to the DVR.

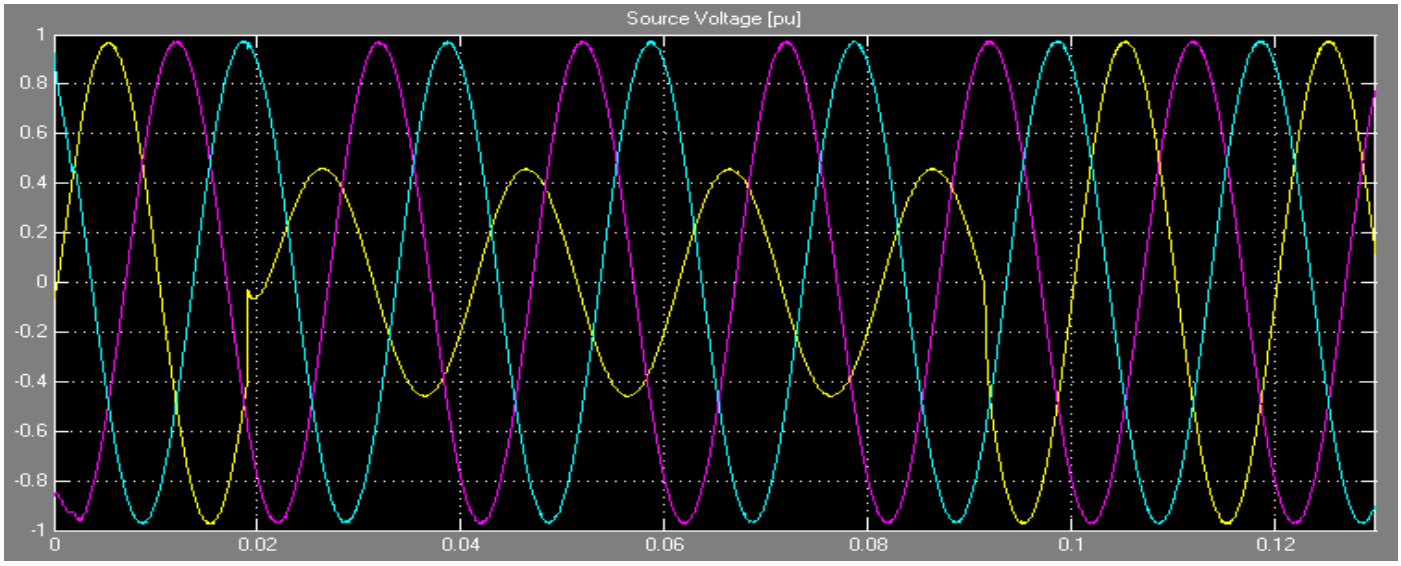

Fig.-(2c) Source voltage

Fig.(2c) shows the source voltage given to the system. A fault on the system at t=0.019 seconds appears on the system and it is cleared at t=0.085 seconds. During fault period the voltage of one phase is decreased to 0.4 pu. This voltage is to be injected by the DVR.

Fig.(2d) below shows the voltage injected in to the system, to eliminate the effect the voltage sag on the sensitive load.

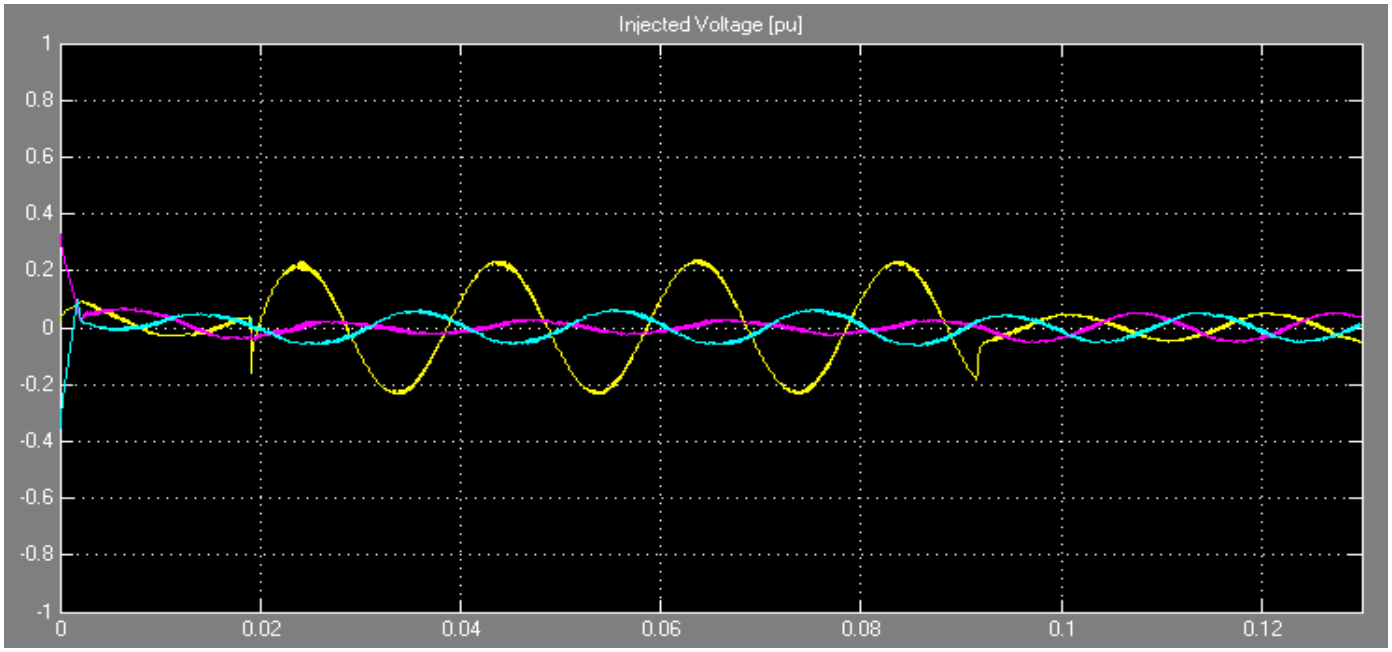

Fig.-(2d) Injected voltage

Fig.(2e)below shows the Sensitive Load Voltage and Currents. The values of the sensitive load voltage and current in pu values. It is seen that the fault has no effect on the load voltage and currents.

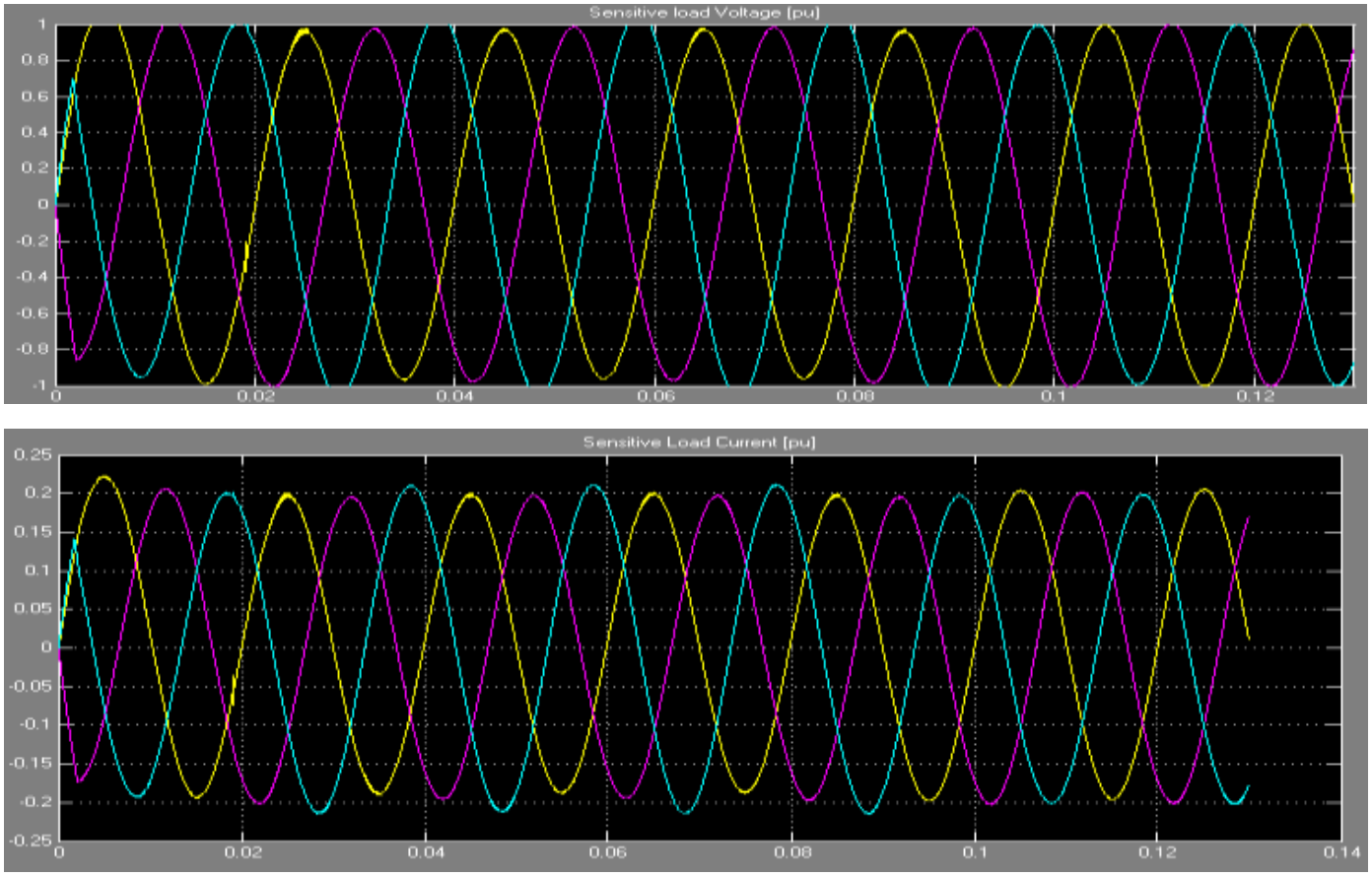

Fig.-(2e) Sensitive load voltage and sensitive load current

Fig. (2f) shows normal voltage, the load does not use the DVR system. Therefore, the effect of fault is clearly seen on the load.

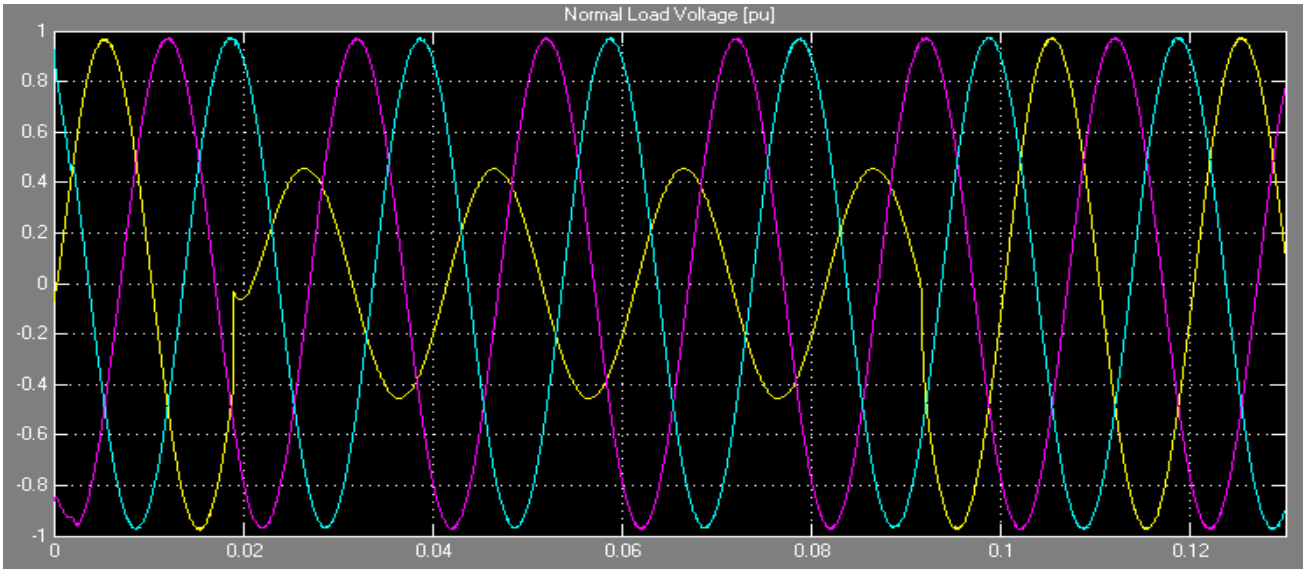

Fig.-(2f) Normal load voltage

4. CONCLUSION

The requirement for power quality has turn into a challenging problem for industries and customers. Voltage unbalance is considered as the bigger affecting issue among them leads to deterioration in achievement of electrical apparatus. FACTS devices used for compensation are the best procedure to overcome such issues. Among them DVR considered the most competent and cost effective. Voltage instabilities such as voltage sag/swell are considered here. Both balanced and unbalanced voltage conditions are considered and simulation results are shown. Simulation results shows that DVR provide good voltage regulation by compensating voltage sag and swell. The performance of DVR is satisfactory.

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BIOGRAPHIES

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