iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** VII **Month of publication:** July 2017

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue VII, July 2017- Available at www.ijraset.com

Improvement of Voltage Sag using Pre-Sag Compensation Technique Of DVR

Shweta Titre[1], Dr. Harikumar Naidu[2], Prof. Pratik Ghutke[3]
[1]Student- (M. tech), IPS, [2]HOD, [3]Assistant Professor, Dept. of Electrical Engineering., TGPCET, Nagpur

Abstract: ***Power quality problems become a major issue of industries due to enormous loss in terms of time and money. The power quality consists of a huge number of disturbances such as voltage sags, swells, harmonics, etc. There are the various methods to reduce the power quality problems, but the FACTS devices are the most excellent solution to reduce this problem. One of the most powerful FACTS devices is the DVR to alleviate the voltage sag and swell. This paper describes the study and performance on DVR and various compensation method of DVR which are used to mitigate the voltage sag and swell. The result is achieved by using Matlab Simulink.***
Keywords : ***FACTS, DVR, voltage swell and sag, Matlab, power quality improvement.***

I. INTRODUCTION

A power distribution system is a very complex system. It is important to remove any sort of fault so as to protect the power system properly. One of the major problem associated with the power distribution system is voltage swell and sag. The common cause of voltage sag are faults or short circuits in the system, starting of large load and faulty wirings. This will lead to increase both production and financial loss for industries. Thus it is very important to clear this fault quickly whenever it is generated to balance the power quality of the system.

The main characteristics of voltage swell and voltage sag are its depth and magnitude. It is very important to know the amount of depth or magnitude to correct the swell or sag. Generally the depth/magnitude of voltage sag is in between 0.1 to 0.9 per unit with time interval t with 0.5 cycles for duration of 1 minute. This classification is based on IEEE standard 1159-1995. The IEEE standards defines power quality as “The concept of powering and grounding sensitive electronic equipment in a manner that is suitable for the operation of the equipment.

Initially for the improvement of power quality or reliability of the system FACTS devices like static synchronous compensator (STATCOM) , static synchronous series compensator (SSSC) , interline power flow controller (IPFC) and unified power flow controller (UPFC) etc. were used. These facts devices are designed for transmission system. For improvement of power quality in distribution system, some new devices are used now-a-days which are modified and known as custom power devices. The main custom devices used in distribution system are distribution static synchronous compensator (DSTATCOM), dynamic voltage restorer (DVR), active power filter (AF), UPQC etc. Here we use DVR which gives 50% improvement in mitigation of voltage sag than other devices.

II. POWER QUALITY

The quality of electric power is becoming more important for both electric utilizes and end users of power system. The power quality has serious economic implications for customers, utilities and electrical equipment manufacturers. Power quality is described as the variation of voltage, current and frequency in a power system. It refers to a wide range of electromagnetic phenomenon that characterises the voltage and current at a given time and at a given location in the power system. Sensitive load such as computers, PLC, variable speed drives (VSD) etc. needs a high quality supplies. Power quality is a umbrella concept for multitude of individual type of power system
Disturbances

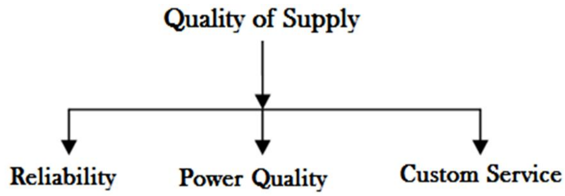


Fig 1. Quality of supply categories.

A. Voltage Sag

A voltage sag is a monetary decrease in the root mean square (RMS) voltage between 0.1 to 0.9 per unit, with a duration ranging from half cycle up to 1 min. It is considered as the most serious problem of the power system. It is caused by the faults in the power system or by starting of large induction motors.

B. Voltage Swell

Voltage swell is defined as an increase in root mean square (RMS) voltage from 1.1 to 1.8 per unit for distribution of 0.5 cycles to 1 minute. Voltage swells are less common in power system. The main cause for voltage swell are switching of large capacitors or start/stop of heavy loads.

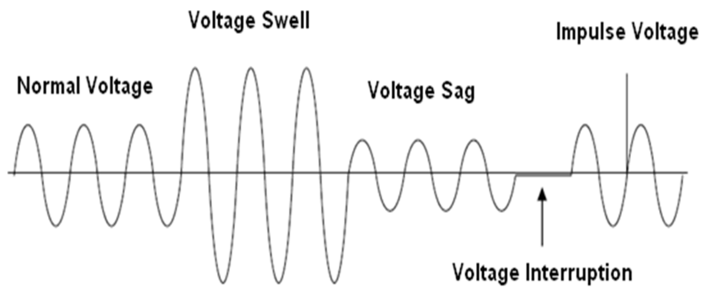
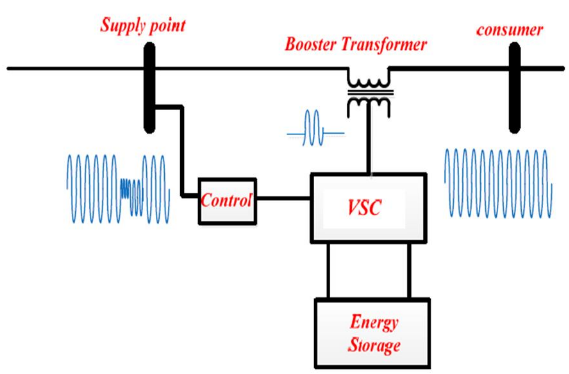


Fig 2. Regular power quality problems in power system.

This paper is structured as follows: section 3 presents an overview of DVR, its functions, configurations, components and operating mode of DVR. Voltage injection methods are presented in section 4. Section 5 presents closed loop control of DVR's output voltage. At the end, some conclusions are given in section 6.

III. DYNAMIC VOLTAGE RESTORER (DVR)

A dynamic voltage restorer (DVR) was introduced for mitigating voltage sag. DVR given in figure is based on voltage source converter (VSC) that has energy storage for supplying active power, an output filter to make output voltage wave sinusoidal, energy storage unit and a step up transformer connected in series with line.



A DVR is configured as a series connected voltage controller. To control the output voltage of DVR , the inverter supplies the missing load voltage using self-commutated electronic switches such as gate turn off thyristor (GTO) ,or an insulate bipolar transistor (IGBT) or an insulated gate commutated thyristor(IGCT). Basically the DVR consist of two types of circuits, one is power circuit and other is control circuit. Control circuit is used to derive the parameters as like magnitude, frequency, phase shift etc. of the control signal that has to be injected by the DVR. Due to control signal, the injected voltage is generated using switching in power circuit. The power circuit of DVR consist of

A. An injection transformer
B. AC harmonic filter
C. High speed switching pulse width modulation (PWM) inverter

D. DC energy storage unit and
E. Control unit

The advantage of DVR are fast response, ability to compensate for a voltage sag and a voltage phase shift using an inverter system.

1) In phase voltage injection
2) Phase invariant voltage injection
3) Phase advance voltage injection

In the in phase voltage scheme, the injecting voltage has the same phase angle of the source voltage. Therefore, the magnitude of the injected voltage is smallest among the three compensated schemes. In case of phase invariant voltage injection scheme, the DVR injects the missing voltage that keeps the magnitude of the voltage as well as the phase of the supply voltage. This scheme needs a large injected voltage and may cause over injection of reactive power. If the injected voltage is in quadrature with the load current, the DVR does not inject active power.

IV. PRINCIPLE OF OPERATION

The basic concept of series compensator is simple; series compensator is to inject a dynamically controlled voltage V_{DVR}. For most of the time the DVR does not inject any voltage. The DVR has three modes of operations which are:

A. Protection mode
B. Standby mode
C. Boost mode

In protection mode scheme, a bypass switch is used as a protection device to protect the DVR. A large inrush current flows at the load side if a short circuit occurs on the load side.

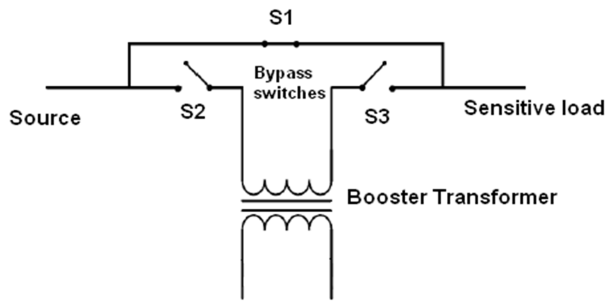


Fig 3. Protection mode of DVR

In standby mode (V_{DVR}=0), the low voltage winding of the booster transformer is short circuited through the converter. So there are no switching of semiconductors occurs in this mode of operation. The DVR will be performing most of the time in this mode.

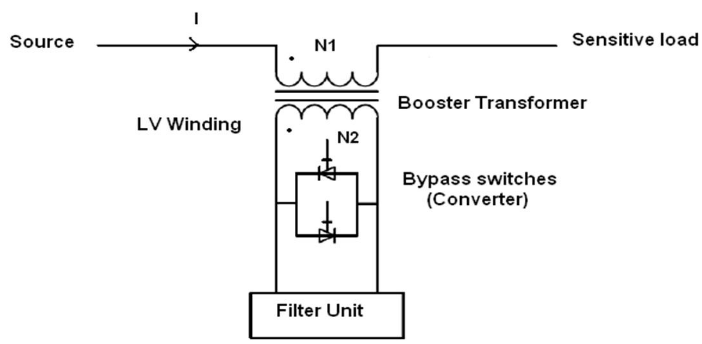


Fig 4. Standby mode of DVR

In boost mode (V_{DVR}>0), the DVR is injecting a compensation voltage through the booster transformer due to detection of supply voltage interruption.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue VII, July 2017- Available at www.ijraset.com

V. VOLTAGE INJECTION METHODS OF DVR

The way in which dynamic voltage restorer (DVR) is used during the voltage injection mode depends upon several limiting factors such as: DVR power rating,

Load conditions and voltage sag type. For example some loads are sensitive to phase-angle jump, some others are sensitive to a change in voltage magnitude and some others are tolerant to all this disturbances. Therefore the control strategies to be applied depend upon the load characteristics. There are four different methods of DVR voltage injection.

A. Pre-Sag Compensation Method

The pre-sag method tracks the supply voltage continuously and if it detects any disturbance in that voltage it will inject the difference voltage between the sag or voltage at PCC and the ideal pre-fault condition. In this way the load voltage can be restored back to the pre-fault condition. Compensation in voltage sag in both phase angle and an amplitude sensitive load has to be achieved by pre-sag compensation method. In this method, the active power injected by the DVR cannot be controlled and it is determined by external conditions such as the type of faults and the load conditions. Given figure shows the single phase vector diagram of compensation method.

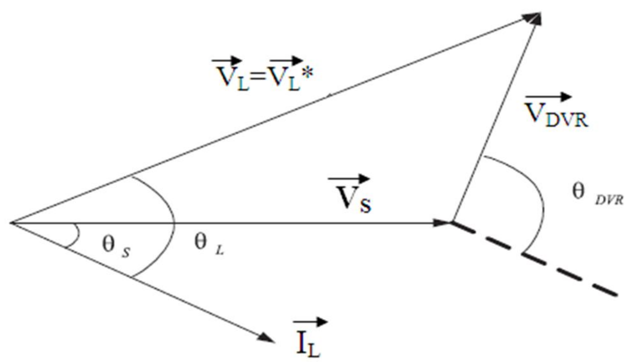


Fig. Single phase vector diagram of PDC method.

B. In Phase Compensation Method

In this method the injected voltage is in phase with the PCC voltage regardless of the load current and pre-fault voltage. The phase angle of the pre sag and load voltage are different but the attention is placed on maintaining a constant voltage magnitude on the load. One of the advantage of this method is that the amplitude of DVR injection voltage is minimum for a certain voltage sag in comparison with other strategies. Practical application of this method is in loads which are not sensitive to phase angle jump. Given figure shows the single phase vector diagram of this method.

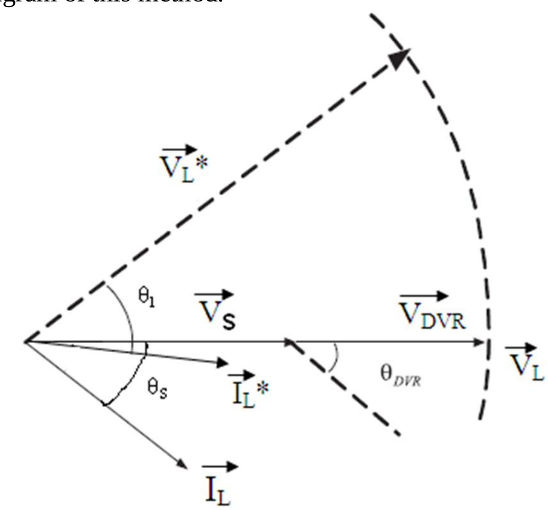


Fig. single phase vector diagram of IPC method.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue VII, July 2017- Available at www.ijraset.com

C. In Phase Advanced Compensation Method

In this method the real power spend by DVR is minimized by decreasing the power angle between the sag voltage and the load current. In the two previous case, active power is injected into the system by DVR during the disturbances. Moreover, the active power supplied is limited to the stored energy in the DC link and this part is one of the most expensive part of the DVR. The minimization of the injected energy is achieved by making the injection voltage phasor perpendicular to the load current phasor. In this method, the value of load current and voltage are fixed in the system so one can change only the phase of the sag voltage. This method uses only reactive power not all the sag can be mitigated without real power. This method is only suitable for limited sag range.

D. Energy Optimization Compensation Method

Pre-sag and in phase compensation method injects the active power to loads. But in the energy optimization method to make the injection active power zero, the use of real power the voltages are injected at 90^o phase angle to the supply current. The main advantage of this method is that it does not require any active power during compensation and it minimizes the injected energy. The main drawback of this strategy is the fact that it increases the magnitude of injected voltage apparent power of compensator.

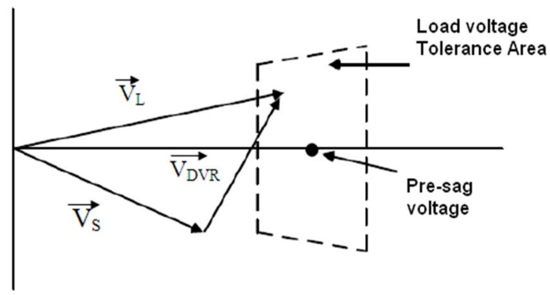


Fig. EPC method

E. Closed Loop Control of DVR Output Voltage

The control system of DVR plays an important role, with the requirement of fast response in the face of voltage sags and variations in the connected load. Generally, two control schemes are used in DVR applications, namely, open loop controller and closed loop controller. A repetitive controller is used in a DVR system to ameliorate voltage sags, harmonic voltages, and voltage imbalances. It has a wide range of applicability, a fast transient response and ensures zero error in steady state. In the proposed controller combines fuzzy logic with a classical PI controller to adjust the PI gain. Authors report that the main advantage of an adaptive fuzzy PI controller over the classic one is its ability to compensate notching when the DVR is connected to a weak power system. In the proposed control algorithm based on space vector pulse width modulation (SVPWM) technique to generate pulse for mitigating voltage sags, are presented. The simulation and experimental results by using PSCAD / EMTDC showed clearly the performance of the dynamic voltage restorer (DVR) in mitigating voltage sags. A control method is developed and implemented in order to mitigate voltage sag in distribution system. The main parts of the controller are maximum block, filter, lead lag, PI controller and phase lock loop (PLL). The simulation result showed that the DVR compensates the voltage sag quickly and provides excellent voltage regulation and better efficiency. According to a survey about DVR authors reported that the inverter is the core component of DVR, this reference presents the inverter control strategies used in DVR recently, which are linear control and non-linear control and their types. A fast repetitive controller based feedback control loop for DVR is proposed. This has fast dynamic response when compared with traditional repetitive controller.

VI. RESULTS

The performance of DVR is shown in the results. The result is achieved by in phase compensation method. The load has been considered with the capacity of 8kva at 0.8pf lagging. The load voltage, source voltage and injected voltage magnitude is considered as 1pu.

Voltage sag- figure shows the 3-phase figure (a) shows 30% voltage sag initiated at 0.15s and it is kept until 0.30s,duratu with the total voltage sag duration of 0.15s. Figure (b) and (c) shows the series of voltage components injected by the DVR and compensated load voltage, respectively.

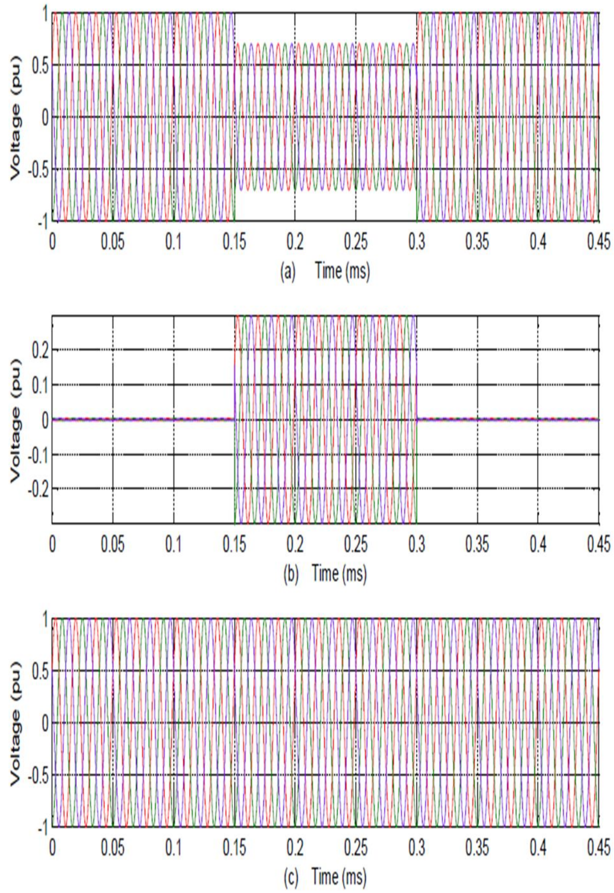


fig. 3-phase voltage: sag(a)source voltage (b)injected voltage and (c)load voltage

Voltage swell – the performance of DVR in a voltage swell condition is shown in the figure given below. The voltage swell is generated in supply voltage as shown in figure(a). The voltage amplitude is increased about 30% of supply voltage. Figure (b) and (c) shows the injected and load voltage respectively.

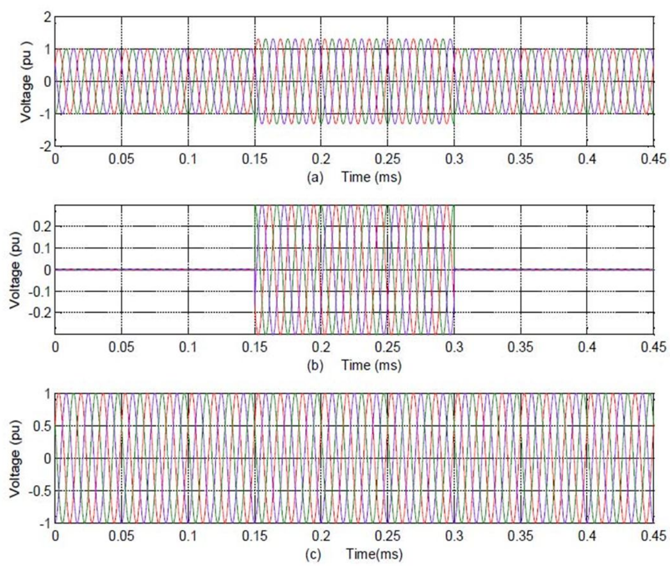


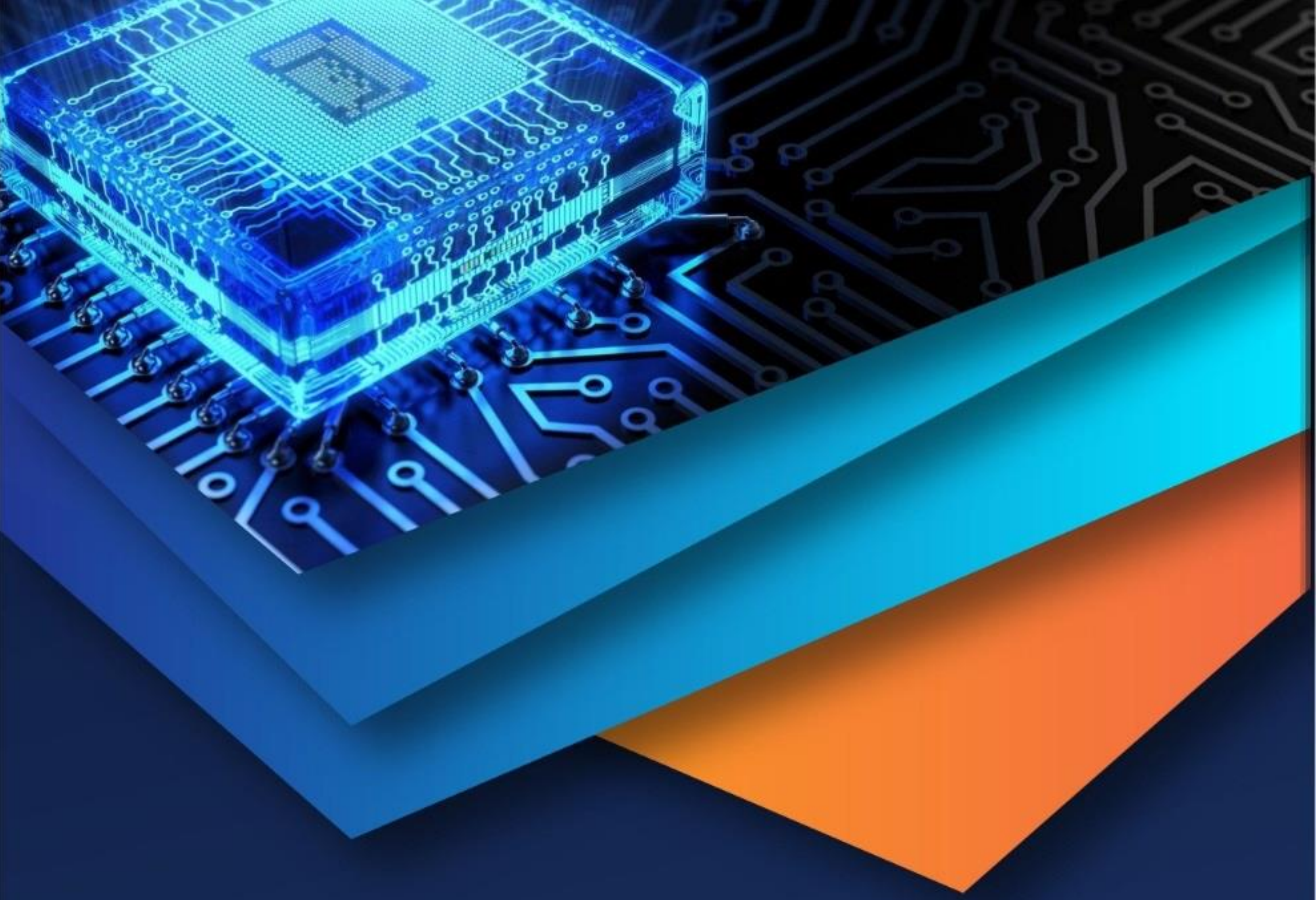
Fig. 3-phase voltage swell: (a) source voltage (b) injected voltage and (c) load voltage.

VII. CONCLUSION

This paper presents power and voltage quality problems such as voltage sag, voltage swell and others. Also an overview of dynamic voltage restorer (DVR) is presented. DVRs are effective recent custom devices for voltage sags and swells comparison. They inject the appropriate voltage component to correct rapidly any anomaly in the supply voltage to keep the load voltage balanced and constant at the nominal value. The Dynamic Voltage Restorer (DVR) is considered to be an efficient solution due to its relatively low cost and small size, also it has a fast dynamic response.

REFERENCES

[1] Sajid Ali and Yogesh Chauhan, "Study & Performance of DVR for Voltage Quality Enhancement,"IEEE 978-1-4673-6150. 7 July 2013.
[2] A.M. Sharaf, Pierre Kreidi, "Power quality enhancement and harmonic reduction using dynamic power filters," 7th International Conference on Modeling and Simulation of Electric Machines, Converters and Systems. August, 2002.
[3] K.K.Vasishta Kumar, Ch. Prasad, and D.Satish Reddy "Power Quality Enhancement using Dynamic Voltage Restorer" Int. J. of Recent Trends in Engineering and Technology, Vol. 4, No. 3, Nov 2010.
[4] B. Han and et al. "Dynamic Voltage Compensator for Sudden Voltage Drop", IEEE Trans. on Electrical Engineering, Vol. 47, No. 8, August, 1998
[5] H. Ezoji, A. Sheikholeslami et. al. "Simulation of Dynamic Voltage Restorer Using Hysteresis Voltage Control" European Journal of Scientific Research ISSN 1450-216X Vol.27 No.1, 2009
[6] P. Jayaprakash, B. Singh, D. P. Kothari, et.al "Control of Reduced Rating Dynamic Voltage Restorer with Battery Energy Storage System" IEEE 2008
[7] Ghosh and G. Ledwich, Power Quality Enhancement Using Custom Power Devices, Kluwer Academic Publishers, 2002.
[8] N.G Hingorani, "Introducing Custom Power", IEEE Spectrum, June, pp.: 41-48, 1995.



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY