

MEDIUM VOLTAGE DYNAMIC VOLTAGE RESTORER (DVR) FOR POWER QUALITY IMPROVEMENT

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ABSTRACT

Power quality has become a noteworthy issue now a day to manage, in order maintain power quality of supplied power. Today's generation enormously relies on upon electrical energy for enhancing their way of life. Present day equipment like computers, electric engines and so on can't keep running without power. Keeping in mind the end goal to enhance the execution, the equipment and modern electronic devices demands quality supply. The power quality is influenced by different components of the electrical network. Control quality issues, for example, voltage and frequency variety, and harmonic contents influence the performance of electrical utility and reduces its life time. Such issue must be repaid to guarantee the quality supply.

KEYWORDS: flexible ac transmission systems (FACTS), Distribution Static Compensator (D-STATCOM) Voltage Restorer (DVR), transmission capacity,

Electrical energy is the straightforward and all around controlled type of energy, can be effectively changed to different structures. Alongside its quality and congruity needs to keep up for good economy. Control quality has turned out to be significant sympathy toward today's energy businesses and buyers. Control quality issues are created by progressively request of electronic types of gear and non-linear loads. Numerous aggravations related with electrical power are voltage droop, voltage swell, voltage flicker and harmonic substance. This debases the proficiency and abbreviates the life time of end client gear. It likewise causes information and memory loss of electronic hardware like PC.

Due to many-sided quality of power system network voltage sag/swell turned into the real power quality issue influencing the end purchasers and businesses. It occurs much of the time and results in high misfortunes. Voltage droop is because of sudden disengagement of load, fault in the system and voltage swell is because of single line to ground fault brings about voltage ascent of unfaulted stages. The congruity of power supply can

be kept up by clearing the faults at speedier rate. Other power quality issues i.e. voltage flickering, harmonics; transients and so on must be repaid to upgrade the power quality.

II. Harmonics

Harmonic is characterized as "a sinusoidal part of an intermittent wave or amount having a recurrence that is a necessary numerous of the essential recurrence" [1]. Single stage or three-stage rectifiers, thyristor converters and countless powered electronic-based equipments and devices that give static power are loads (non-linear) that offer ascent to colossal unsettling influence in the mains (ac). Current unsettling influences, which won't not be symmetric, impact voltage droppings over the given supply work/network impedance alongside other undesirable wonders (for example, shunt and arrangement reverberation, or some sort of flickering) adding up to distorted supply line voltages, and subsequently there is a reduction in the supply voltage quality.

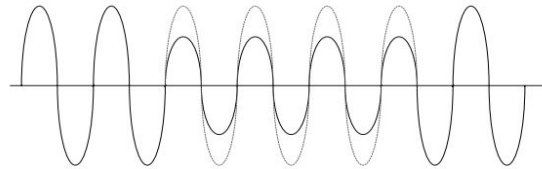
III. Power Quality Problems

Together with the innovative advancements, keeping up the power quality is one of the real necessities, the power shoppers are requesting of. The reason is current innovation requests for an un-intruded on, fantastic power supply for the effective operation of voltage delicate gadgets, for example, propelled control, mechanization, exact assembling systems [16]. Power quality might be corrupted because of both the transmission and the circulation side variations from the norm. The irregularities in the circulation system are load exchanging, engine beginning, stack varieties and non-linear loads [10]. Though lightning and system faults can be viewed as transmission variations from the norm.

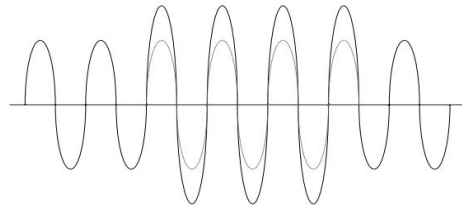
To defeat the power quality related issues happening in the transmission system, FACTS (Flexible AC Transmission System) gadgets assume a noteworthy part. These are likewise alluded to as utility based arrangements. Also Custom Power gadgets, which regularly focused to delicate prepared clients, are utilized to conquer power quality issues in the circulation network [3]. One of the fundamental points of interest of the FACTS gadgets is that they consider expanded controllability and ideal stacking of the lines without surpassing as far as possible. Though Custom Power gadgets guarantee a more noteworthy dependability and a superior quality of power stream to the heap focuses in the appropriation system by effectively making up for voltage lists/plunges, surges, harmonic twists, interferences and flicker, which are the regular issues related with circulation lines.

IV. Voltage sags and surges

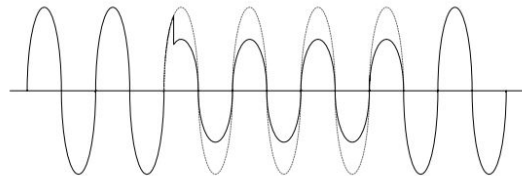
The most frequent power quality associated problem in the distribution network is voltage sags and surges and are shown in Figure.



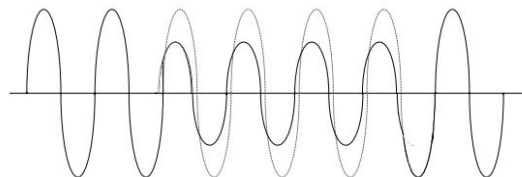
(a) Voltage sag occurs at the zero crossing point & without a phase shift



(b) Voltage surge occurs at zero crossing point & without a phase shift



(c) Voltage sag not at the zero crossing point & without a phase shift



(d) Voltage sag at zero crossing point with a phase shift

Figure: 1. (a) to (d) Different types of Voltage Sags.

V. Custom Power Devices

The most normal custom power devices to make up for the voltage hags and swells are the Uninterruptible Power Supplies (UPS), Dynamic Voltage Restorers (DVR) and Active Power Filters (APF) with voltage droop remuneration office. Among those the UPS is the notable. DVRs and APFs are less prominent because of the way that they are still in the creating stage, despite the fact that they are exceptionally productive and financially savvy than UPSs. Be that as it may, therefore of the quick improvement in the power electronic industry and ease power electronic devices will make the DVRs and APFs much prevalent among the enterprises sooner rather than later.

DVR what's more, APF are regularly used to dispense with two unique sorts of anomalies that influence the power quality. They are talked about in light of two distinctive load circumstances to be specific linear loads and non-linear loads. The heap is thought to be a linear when both the needy variable and the free factor demonstrate linear changes to each other. Resistor is the best case for a linear device. The non-linear load then again does not demonstrate a linear change. Capacitors and inductors are cases for non-linear devices.

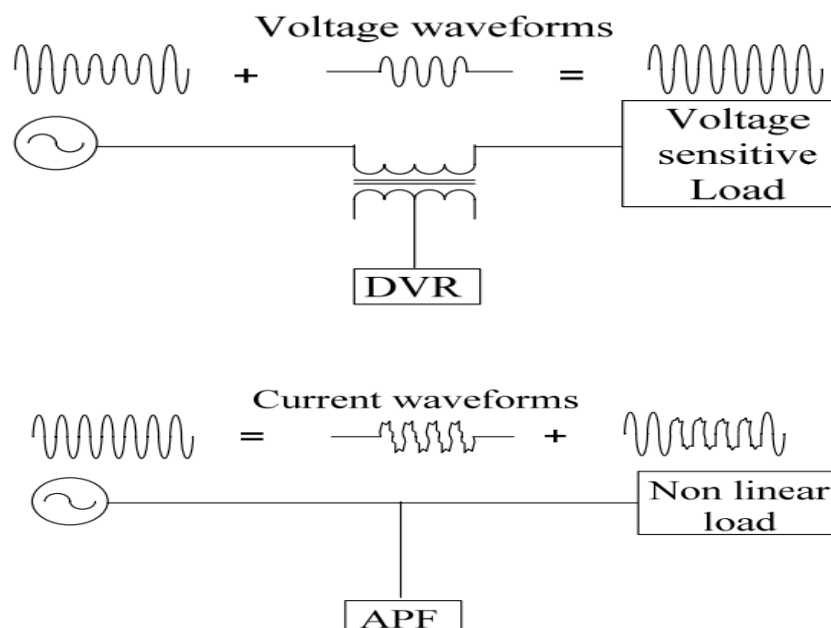


Figure: 2 Basic Operation of DVR

VI. Voltage Harmonics

A harmonic is a necessary various of basic recurrence of electrical amounts. This is because of nearness of non-linear loads which brings about overheating of electrical gear. Consequently its decrease is alluring. Change fit as a fiddle as appeared in fig 1.7. In a power system network, the voltage and current waveform ought to be sinusoidal in nature. Waveform twists are because of harmonic and commotion

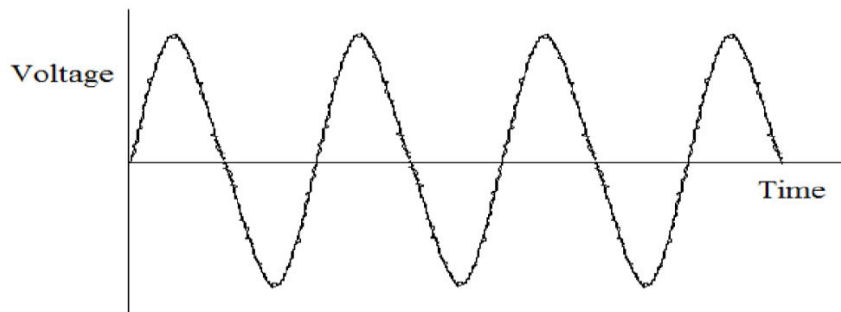


Figure: 3 Distorted Voltage Waveform.

VII. DYNAMIC VOLTAGE RESTORER (DVR)

Among the power quality issues (sags, swells, harmonics...) voltage sags are the most extreme disturbances. With a specific end goal to conquer these issues the idea of custom power devices is presented as of late. One of those devices is the Dynamic Voltage Restorer (DVR), which is the most proficient and compelling present day custom power device utilized as a part of power distribution networks. DVR is an as of late proposed arrangement associated strong state device that infuses voltage into the system with a specific end goal to control the load side voltage. It is typically introduced in a power distribution between the supply and the basic load feeder at the point of common coupling (PCC). Other than voltage sags and swells remuneration, DVR can likewise added different elements like: line voltage harmonics pay diminishment of drifters in voltage and fault current constraints. Figure 3.1 show the area of DVR in circuit and schematic outline of DVR is spoken to in figure 3.2. Demonstrates the location of the DVC in circuit. the figure is characterized in two parts a transmission line and a distribution line the DVR is connected between sensitive load and step dawn transformer inside distribution line section.

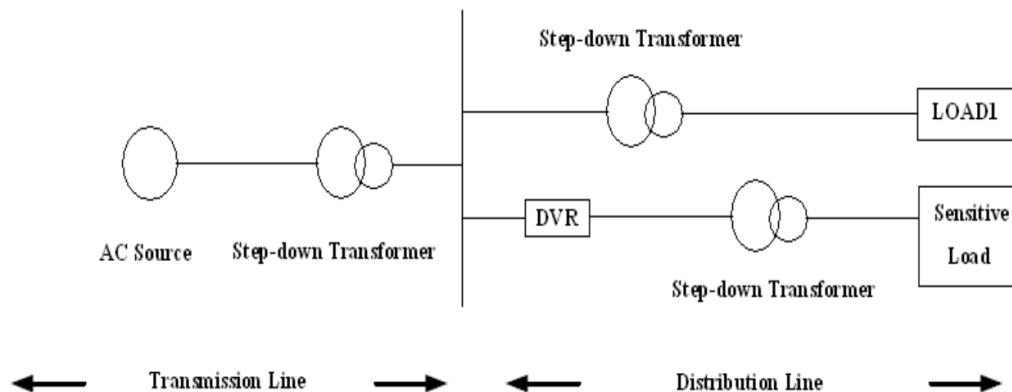


Figure: 4 Location of DVR.

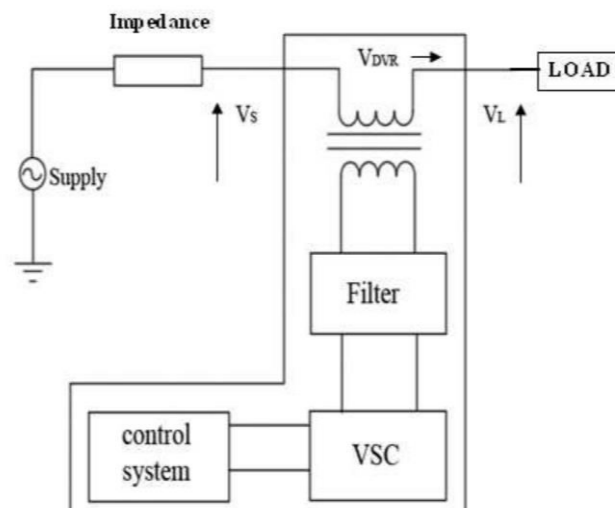


Figure: 5 Schematic Diagram of DVR.

VIII. STRUCTURE OF THE DVR

The DVR essentially comprises of a power circuit and a control circuit. Control circuit is utilized to determine the parameters (magnitude, frequency, phase shift, etc...) of the control signal that must be infused by the DVR. Based on the control signal, the infused voltage is created by the switches in the power circuit. Additionally control circuit depicts the essential structure of the DVR and is talked about in this area. Control circuit for the most part including five units as in Figure 3.3 and the capacity and the necessity of every unit is examined underneath.

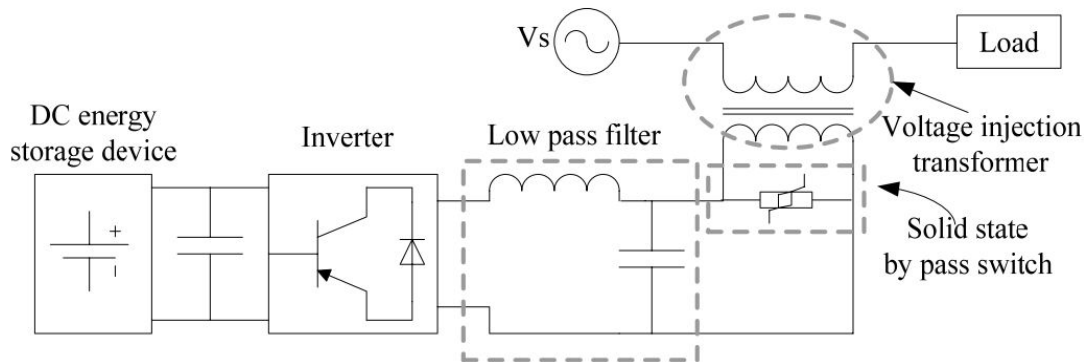


Figure: 6 DVR Power circuit.

Increase in the stable power transfer limit (in megawatts) for study system i with different pv-statcom controls.

PV STATCOM CONTROL	NIGHT	DAY	
		Solar Power Output 19 MW	Solar Power Output 91 MW
Voltage Control	107	87	7
Damping Control	159	100	142
Voltage Control with Damping Control	168	97	41

Table :1 different pv-statcom controls.

IX. Equation Equivalent Circuit of DVR

The impedance Z_{th} of system depends on the level fault of the load bus. At the time of System voltage (V_{th}) drops, the DVR infuses an arrangement voltage V_{DVR} through the infusion transformer so that the coveted load voltage greatness V_L can be kept up. The arrangement infused voltage of the DVR can be composed as -

$$V_{DVR} = V_L + Z_{TH} I_L - V_{TH} \dots \dots \dots (3.1)$$

V_L : The desired load voltage magnitude Z_{TH} : The load impedance.

I_L : The load current

V_{TH} : The system voltage during fault condition

The load current I_L is given by,

$$I_L = \frac{[P_L + jQ_L]}{V} \dots \dots \dots (3.2)$$

When V_L is considered as a reference equation can be rewritten as,

$$V_{DVR} \angle 0 = V_L \angle 0 + Z_{TH} \angle (\beta - \theta) - V_{TH} \angle \delta \dots \dots \dots (3.3)$$

α, β, δ are the angles of V_{DVR} , Z_{TH} V_{TH} respectively and θ is load power angle.

$$\theta = \tan^{-1} \left(\frac{\theta_L}{P_L} \right) \dots \dots \dots (3.4)$$

the complex power injection of the DVR can be written as,

$$S_{DVR} = V_{DVR} I_L \dots \dots \dots (3.5)$$

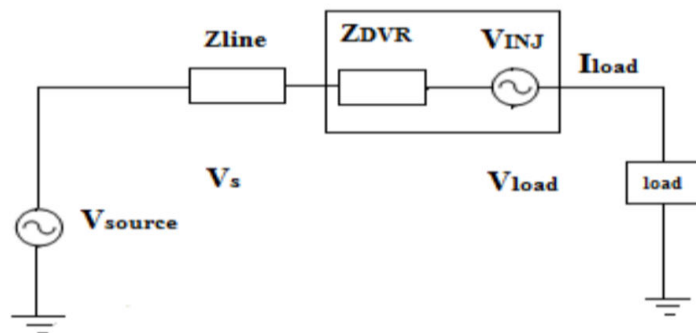


Figure: 7 Equivalent Circuit Diagram of DVR.

X. SIMULATION AND RESULTS

The THD present in the output of H-bridge based DVR is high. In order to reduce the THD value further inverter configuration is improved by using a Multilevel DVR. Hence this section presents the usage of multilevel DVR system for the applications home appliance. The pulses are designed such that the duration of each mode. The cascaded multilevel DVR has been simulated using MATLAB software. The simulation circuit is illustrated in Figure 5.1. The voltage of the cascaded multilevel DVR can be synthesized from the following switching combinations. The figure 5.2 shows the waveform of proposed multilevel DVR. THD is further reduced due to elimination of third harmonic voltage.

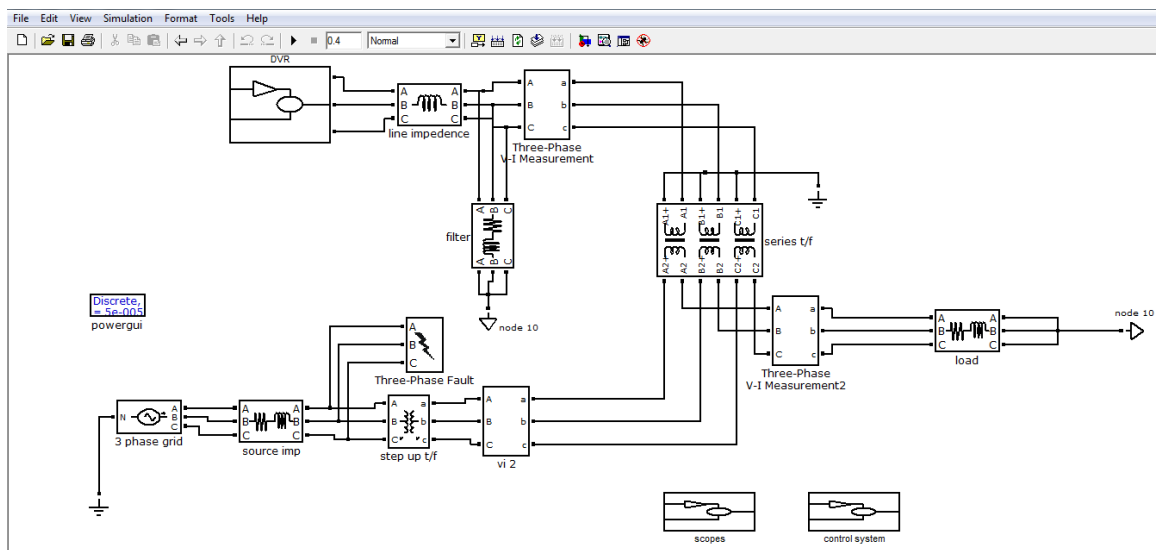


Figure: 8 with sag & swells & external faults still the wave forms are exact without any distortion.

Shallow and deep balanced voltage sag with a phase jump in all three-phases of grid voltages is considered to occur as a power quality issue. The system is subjected to shallow balanced voltage sag which takes place.

During this shallow balanced voltage sag, voltage amplitudes drop to 90% of their rated values coinciding with a -15° phase shift in voltage angles in all three-phases. Moreover, to demonstrate

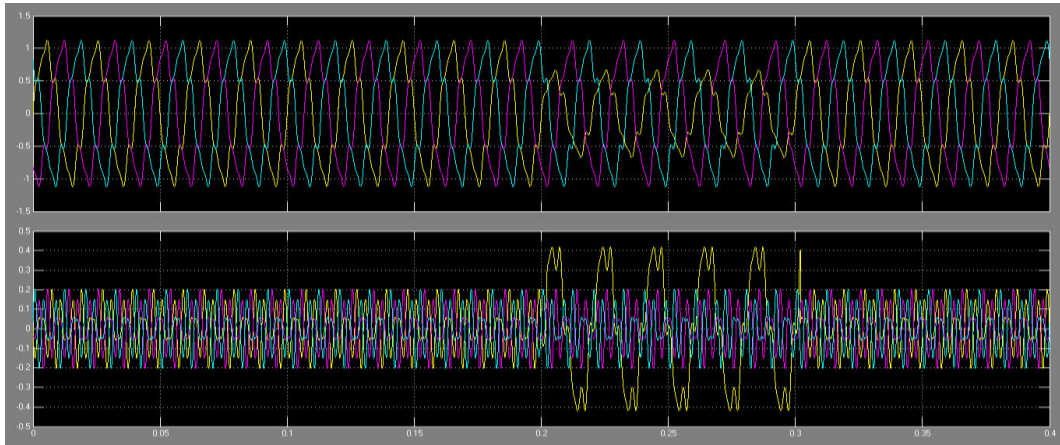


Figure: 9 with LG (AG or BG r CG) fault.

(LG is a line to ground fault for a three phase power supply there are three phases if accordingly it may be either phase A to ground, phase B to ground or Phase c to ground fault.)

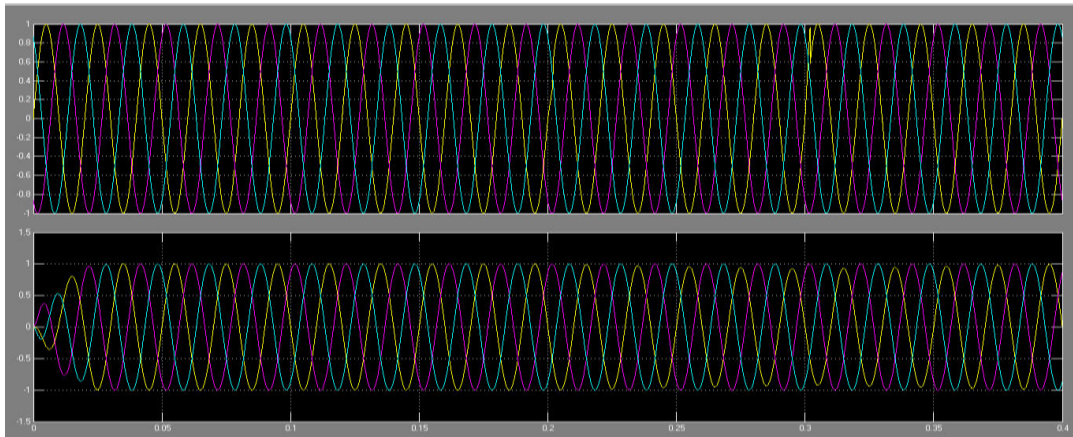


Figure: 10 with multi level DVR no sags & swells Exact graphs without any distortion

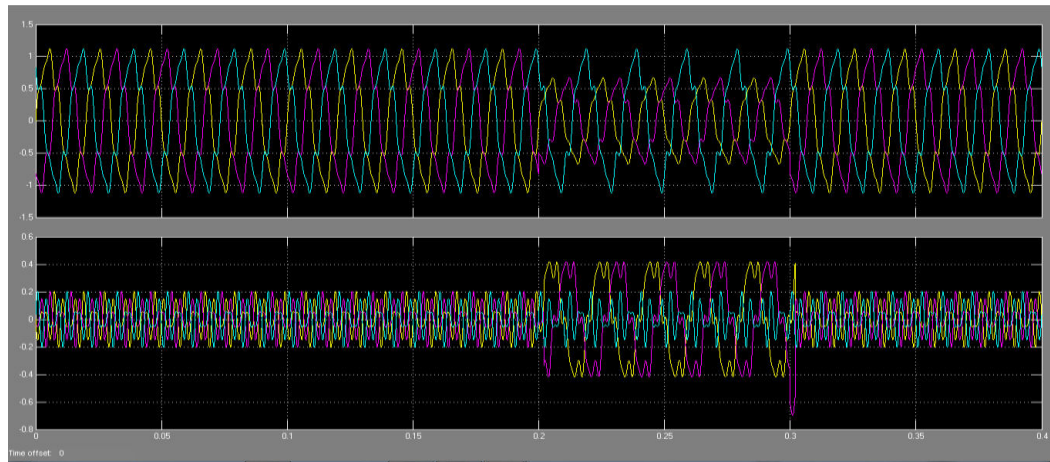
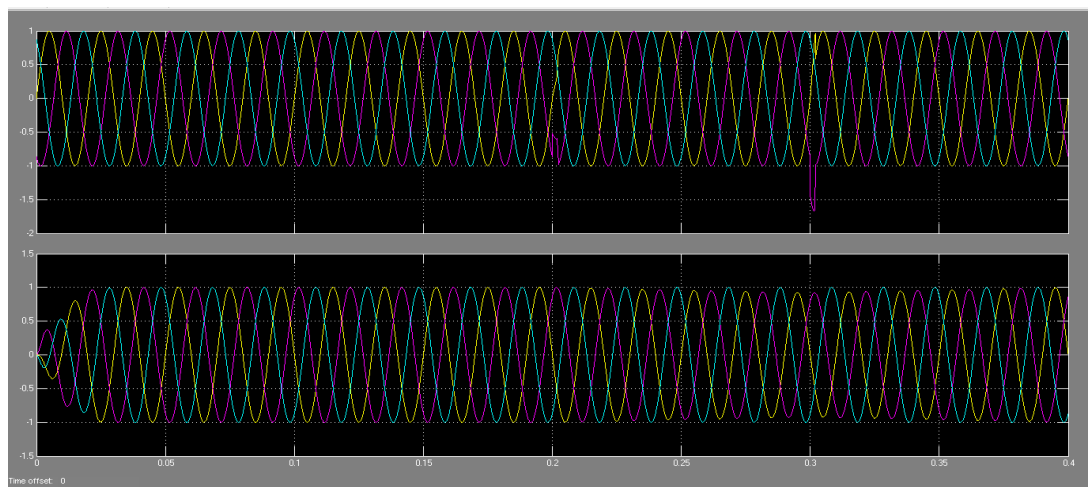


Figure: 10 The FFT analysis of source voltage

(LLG or Line to line ground fault these are classified further three categories as first lines A and Second line's B to ground similarly first lines B second Lines C to ground and second line's C and first line's A with



ground and vice versa)

Figure: 11 with multi level DVR no sags & swells Exact graphs without any distortion.

Shallow and deep unbalanced voltage sag with a phase jump in two phases of grid voltages is considered to occur as a power quality concern. The system is subjected to shallow unbalanced voltage sag which takes place. Proposed voltage sag detection method is able to detect voltage sag promptly and the SRF- based approach determines three reference voltages for DVR

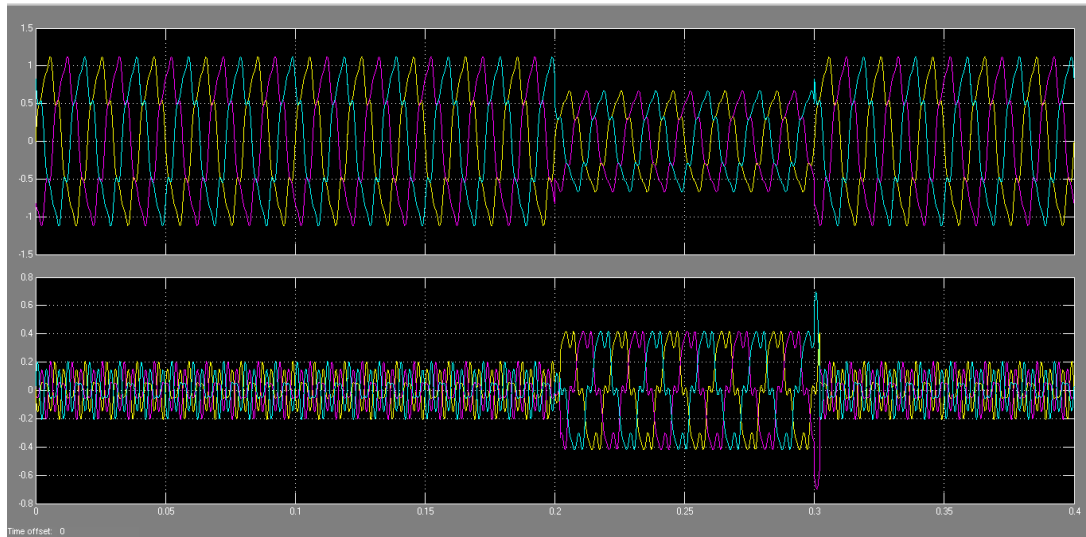


Figure: 12 With LLLG (ABCG) fault.

(LLLГ stand for three lines with ground fault each three line having three component ABC with ground collectively the fault is characterized as LLLГ (ABCG) fault the waveform of the fault is demonstrated in figure.

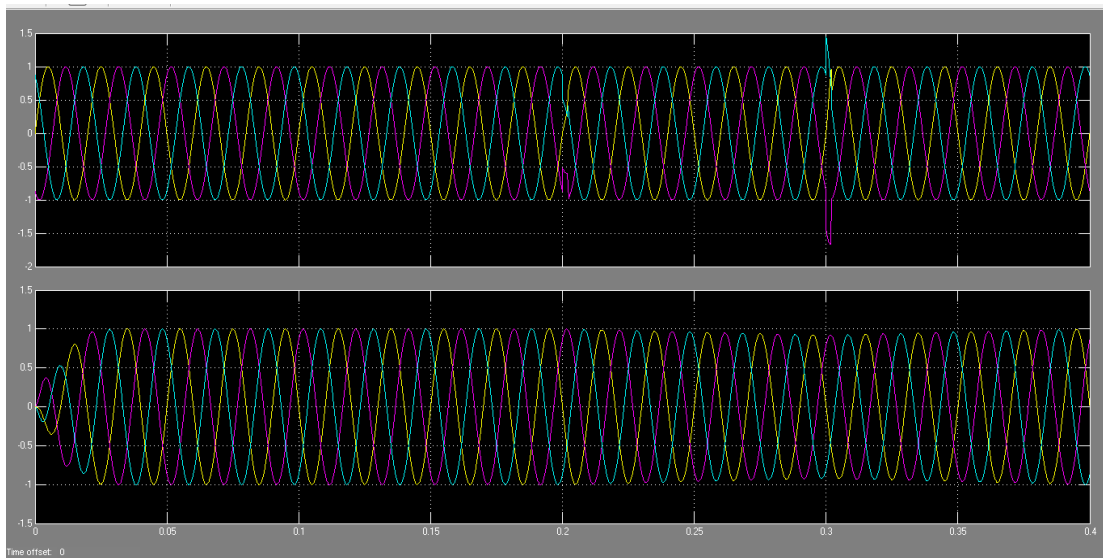


Figure: 13 with multi level DVR no sags & swells Exact graphs without any distortion.

XI. CONCLUSION

The interest for quality power has turned into a testing issue for mechanical range and customers. Among them voltage unbalance is considered as the major influencing issue leads to degradation in execution of

electrical types of gear. Actualities devices utilized for remuneration are the best technique to conquer such issue. Among them DVR considered the most productive and cost effective.

Voltage unbalances, for example, voltage list/swell are considered here. Voltage unbalance under both adjusted and lopsided condition is considered and recreation results are appeared. Displaying and remunerating method utilized by DVR for repaying such unbalance are additionally exhibited. The simulation result demonstrates that DVR repay list/swell adequately and give great voltage direction. The execution of DVR is satisfactory.

XII. FUTURE SCOPE

Other power quality problem that occurs in power system network has to be compensated. Fuzzy controller and PI controller can be used as a mitigation technique for DVR.

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