RVG WITH DVR TECHNIQUE FOR MITIGATION OF VOLTAGE SAG

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ABSTRACT

The most noticeable topic for electrical engineering is power quality in recent year. Power quality problem is an occurrence manifested as a nonstandard voltage, current or frequency. Utility distribution networks, sensitive industrial load and critical commercial operation suffer from various types of outages and service interruption can cost significant financial losses. The electronic equipment like computers, battery chargers, electronic ballasts, variable frequency drives, and switch mode power supplies, generate perilous power quality problems and cause enormous economic loss every year. This work concentrates on the power quality problem such as voltage sag. Many of the devices such as STATCOM, tap changing transformer, UPFC and DVR are available to mitigate voltage sag problems. Among these, dynamic voltage restorer can provide the most commercial solution to mitigate voltage sag by injecting voltage as well as power in to the system. In this thesis proposed utilizes the error signal to control the triggering of the switches of an inverter using Sinusoidal Pulse Width Modulation (SPWM) technique.It works effectively and reduces the sag and minimise the harmonic which come from voltage source converter through the method reference vector generation (RVG)modelling and simulation of proposed DVR is implemented in MATLAB SIMULINK.

Keywords*: *MATLAB; Power Quality; RVG; Voltage Sag

I INTRODUCTION

Voltage sag is much more of a global problem. Therefore for proper working of end side equipment the proper solution along with accuracy and economical solution of voltage sag is necessary. Thereare different mitigation techniques used to for voltage sag or the other power quality problem. Every technique is having their own advantages and certain limitations. This paper work on DVR along with RVG technique for mitigation of sag. The previous study of Sag detection techniques by using DVR reference from load side areinadequate, inaccurate. In this paper DVR along with RVG , the reference voltage is taken from load side.

The main purpose of this paper that it uses the methodology which maintain the accuracy in supplying the voltage during sag period.In the IEEE Standard 1159-1995, the term “sag” is defined as a decrease in rms voltage between the values 0.1 to 0.9 p.u., for durations of 0.5cycles to 1 min. Voltage sag is characterized by RMS voltage magnitude, duration, Point on wave and Phase angle jump.In existing power-quality IEC Standard 60050, 1999 & IEEE Standard 1346, 1998 a voltage sag is defined as a short duration reduction of voltage magnitude in any or all of the phase voltages of a single-phase or a poly phase power supply at a point in the electrical system

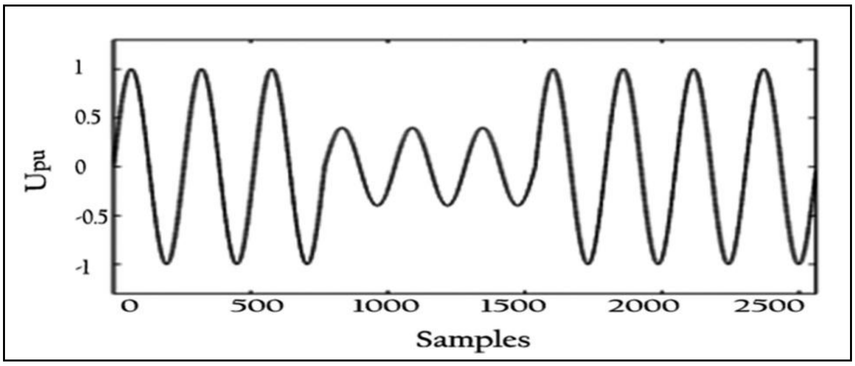

Fig (1): Occurrence of Voltage Sag

II LITERATURE SURVEY

H. Kim exploited various operation modes and boundaries such as inductive operation, capacitive operation, and minimal power operation. The power flow of a voltage sag is analysed both in Minimal Energy Control method and In-Phase Control method. The operation of the Minimal Energy Control method is compared with that of the In-Phase Control method.

J. Nielsen, F. Blaabjerg and N. Mohan state different control strategies for dynamic voltage restorer are analyzed with emphasis put on the compensation of voltage sags with phase jump. Voltage sags accompanied by a phase jump are in some cases more likely to trip loads and satisfactory voltage compensation is more difficult to achieve. Different control methods to compensate voltage sags with phase jump are proposed and compared. Two promising control methods are tested with simulations carried out in Sober and finally tested on a 10 KVA rated Dynamic Voltage Restorer in the laboratory. Both methods can be used to reduce load voltage disturbances caused by voltage sags with phase jump. A generalized voltage restoration method is proposed by B. H. Li, S. S. Choi, and D. M. Vilathgamuwa. It can satisfactorily alleviate the phase angle jump and voltage wave form discontinuity associated with the energy-saving voltage restoration method used in the DVR. The method takes into account the characteristics of the voltage sag magnitude and phase-shift that may appear at the load bus as well as the voltage amplitude injection capability of the injection transformer

The solution to the power quality can be done from customer side or from utility side. First approach is called load conditioning, which ensures that the equipment is less sensitive to power disturbances, allowing the operation even under significant voltage distortion. The other solution is to install line conditioning systems that suppress or counteracts the power system disturbances. A flexible and versatile solution to voltage quality problems is offered by active power filters. Currently they are based on PWM converters.[6]

III RELATED WORK

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Some of the effective and economic measures can be as follows:

3.1 Thyristor Based Static Switches

The static switch is a versatile device for switching a new element into the circuit when the voltage support is needed. It has a dynamic response time of about one cycle. To correct quickly for voltage spikes, sags or interruptions, the static switch can used to switch one or more of devices such as capacitor, filter, alternate power line, energy storage systems etc. This switch can be used in the power line application. [3]

3.2 Active Power Filters (APF)

Active filters have become a viable alternative for controlling harmonic levels in industrial and commercial facilities. However, there are many different filter configurations that can be employed and there is no standard method for rating the active filters. The active filter concept uses power electronics to produce harmonic components which cancel the harmonic components from the nonlinear loads. The active filter is most effective when the load current waveform does not have abrupt changes. As a result, it is very effective for most voltage source inverter-type loads, even when the distortion is high.

3.3 Distribution Synchronous Compensators (DSTATCOM)

When the STATCOM is applied in distribution system is called DSTACOM (Distribution-STACOM) and its configuration is the same, or with small modifications, oriented to a possible future amplification of its possibilities in the distribution network at low and medium voltage, implementing the function so that we can describe as flicker damping, harmonic filtering and short interruption compensation. Distribution STATCOM (DSTATCOM) exhibits high speed control of reactive power to provide voltage stabilization, flicker suppression, and other types of system control. The DSTATCOM utilizes a design consisting of a GTO or IGBT based voltage sourced converter connected to the power system via a multi-stage converter transformer. [1]

3.3 Dynamic Voltage Restorer

Dynamic Voltage Restorer (DVR) The DVR will detect and compensate, almost instantaneously, voltage sags. The DVR injects ac, three-phase, voltage of controllable magnitude and frequency through a coupling transformer (boost). So the DVR is able to improve the quality of the voltage in the load (taking into account the capacity of DVR: voltage injection, storage capacity, and bandwidth) when the quality voltage is out of the specified limits. For large voltage sags, the DVR can supply part of the active power to the load from the energy storage system, which will be recharged through the network during normal conditions. DVR is a recently proposed series connected solid state device that injects voltage into the system in order to regulate the load side voltage. It is normally installed in a distribution system between the supply and the critical load feeder at the point of common coupling (PCC). Other than voltage sags and swells compensation, DVR can also be added in other features like line voltage harmonics compensation, reduction of transients in of the overall control system largely depends on the quality of the applied control strategy, a high performance controller with fast transient response and good steady state characteristics voltage and fault current limitations.. The main considerations for the control system of a DVR include: sag detection, voltage reference generation and transient and steady-state control of the injected voltage. The typical power quality disturbances are voltage sags, voltage swells, interruptions.

IV RVG with DVR

The High sensitivity of electronic devices, employed for various applications such as computing, control, and power conversion, has made "quality power" an inevitable requirement. Voltage sag is one of the power quality problems that cause serious economic loss due to failure of equipment. Since it can occur even due to a remote fault in a system, it is more often than an interruption and can occur 20–30 times per year with an average cost of about $50 000 each in an industry. Voltage sag is a decrease in voltage (rms) between 0.1 and 0.9 per unit (p.u.) at power frequency. [2]

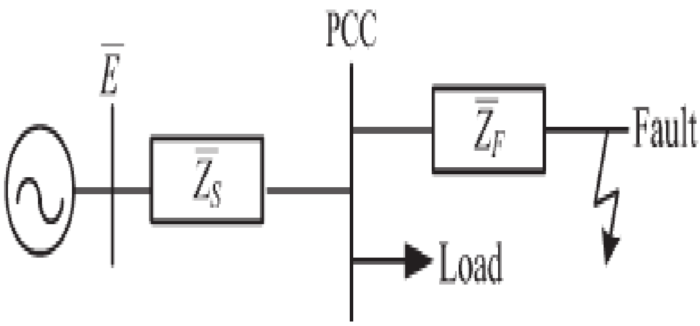

Fig (2): Single-phase model for voltage sag at the PCC

A model of voltage sag at the point of common coupling (PCC) is illustrated in Fig.(2) Typically, every sag is accompanied with phase jump. The phase jump occurs due to the difference in X/R ratio of the source (ZS) and feeder (ZF) impedances. Studies on effects of sags and the associated phase jumps at various point-on-wave instants reinforce the need to mitigate sags with phase jump. It substantiates that the phase jump creates imbalance [6].In voltages, leading to transient overshoots in currents and resulting in detrimental effects on sensitive This can be done by using the method called RVG (reference voltage generation). The schematic diagram is shown in the fig.(3)below.

The injected voltage is the vector sum of two phase voltages, and it is implemented using two injection transformers per phase. The topology shares the power to be injected among two phases at any instant of time. It can compensate complete range of sag in phase-a when the other two phases are healthy.

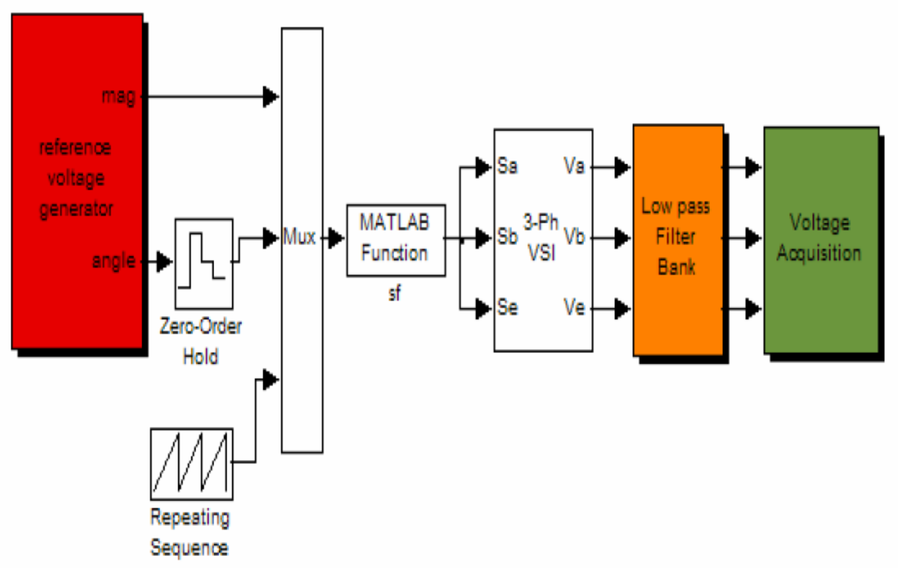

Fig (3): Reference Voltage Generation in the Form of Vector

However, when there are sags in the other phases too, the compensation capability of the topology is compromised. Since line voltages can provide increased compensation range [6], a topology is proposed in this paper to overcome the limitations in the compensation capability of the inter phase ac–ac topology. The ac–ac choppers in the sag supporters are fed with line voltages. Also it retains the merit of the inter phase.

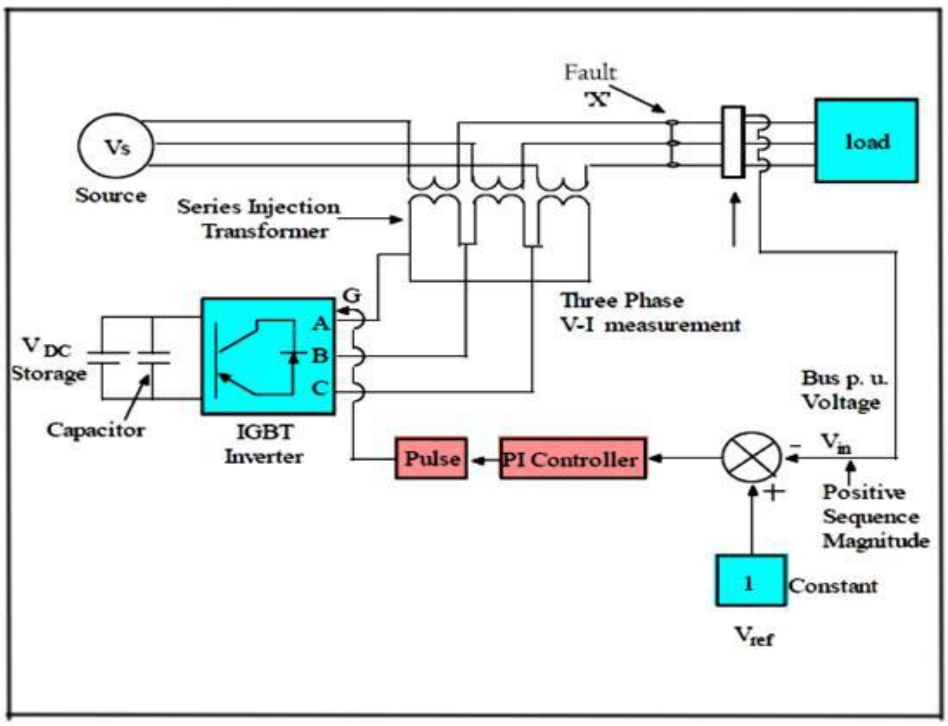

Fig (4): Reference Vector Generation Topology

Deriving the injected voltage from two voltage sources facilitates the realization of the desired reference voltage with phase shift. In this scheme, compensation of fundamental quantities has been considered. In case of harmonics, fundamental components are extracted and compensated by the scheme.

4.1 IGBT

An insulated-gat bipolar transistor (IGBT) is a three-terminal power semiconductor device primarily used as an electronic switch which, as it was developed, came to combine high efficiency and fast switching. Since it is designed to turn on and off rapidly, amplifiers that use it often synthesize complex waveforms with pulse-width modulation and low-pass filters.

4.2 VSI

The Voltage Source Inverter or simply the inverter converts the dc voltage from the energy storage unit (or the dc link) to a controllable three phase ac voltage. The inverter switches are normally fired using a sinusoidal Pulse Width Modulation (PWM) scheme. Since the vast majority of voltage sags seen on utility systems are unbalanced, the VSI will often operate with unbalanced switching functions for the three phases, and must therefore treat each phase independently. The converter is most likely a Voltage Source Converter (VSC), which Pulse Width modulates (PWM) the DC from the DC-link/storage to AC-voltages injected into the system.[3]

4. 3 Controller Design by RVG

The control system of the DVR includes the detection of the voltage sags, injected voltage reference vref generation and control of this injected vCf voltage. When the source voltage is at its normal level, the DVR should be offline. When the voltage sag is detected, the DVR must go online very quickly and inject the required voltage to maintain the critical load voltage with the required level.

4.4 Voltage Sag Detection Method

The proposed method for the detection of voltage sags is based on the alfa/beta vector magnitude $v\alpha\beta$ which has a constant nominal value when no voltage sags occur. Therefore, it is only necessary to apply the Concordia transformation, and to calculate the alfa/beta vector magnitude to be able, by comparison with the nominal value, to detect symmetrical or asymmetrical voltage sags. In the Concordia transformation, the subscripts a, b and c denote the source phase voltages.This method is complemented with a PLL to obtain constant amplitude sinusoidal alfa/beta reference voltages $Vref\alpha$, $Vref\beta$.

4.5 Voltage Reference Generation

The dc/ac converter should control the transformer voltages in order to compensate for any disturbance affecting the load voltage. The voltage reference signals for the sliding mode controller are obtained in the alfa/beta reference frame, as shown in Fig. (5).

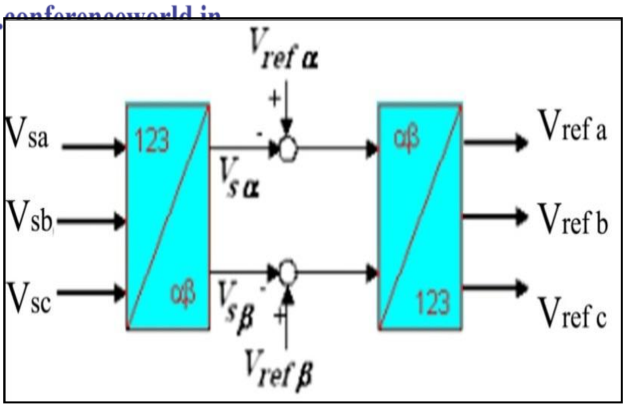

Fig (5) Principle of the Voltage Reference Frame

The choice of the voltage injection strategy for sags and swells mitigation is directly related to the energy storage system dimensioning strategy and directly influences the amount of stored energy, the choice of its tapping from the mains, and the allowable minimum DC voltage on the DC link. The injected voltage can be in phase or may have a phase shift with respect to the mains voltage during the voltage sag. As the injected voltage is phase shifted with respect to the mains voltage from zero to 90° degrees, the required stored energy varies from the maximum to its minimum value. If the injected voltage is kept with a 90° shift from the load current, it is possible to replenish load voltages without the need of active power injection. In this case the minimum allowable DC link voltage amplitude and the inverter apparent power increase. In this DVR prototype, the energy is stored in a capacitor bank which is charged by means of a bridge rectifier connected to the mains. The dimensioning criterion's based on injection in phase with respect to the mains voltage. [4]

V EXPERIMENTAL RESULTS

To assess the performance of the proposed reference vector generation strategy, Digital simulation is done using the blocks of Matlab/simulink and the results are presented here.The first simulation was done with no DVR and no three phase fault is applied to the system. This system shows the normal operating power system without DVR and three phase fault. Fig (6) shows the simulation results of normal operating system with no DVR.The second simulation is done with no RVG and a three phase fault is applied to the system at point with fault resistance of 0.66 p.u for a time duration of 0.4s to 0.6s.The results of this are as shown in Fig.(7).The third simulation is carried outat the same scenario as above but a RVG method is now introduced at the load side to compensate the voltage sag occurred due to the three phase fault applied .When the DVR is in operation the voltage interruption is compensated almost completely and the RMS voltage at the sensitive load point is maintained at normal condition. The results of DVR with RVG are shown in Fig.(8).From Fig(8) it is clear that during the fault time i.e. from 0.4 to 0.6sag is 100% compensated by using DVR with RVG.From Fig (10)and Fig(11) it is clear that during fault period THD is 113% which reduces to 13% as shown in Fig(11).

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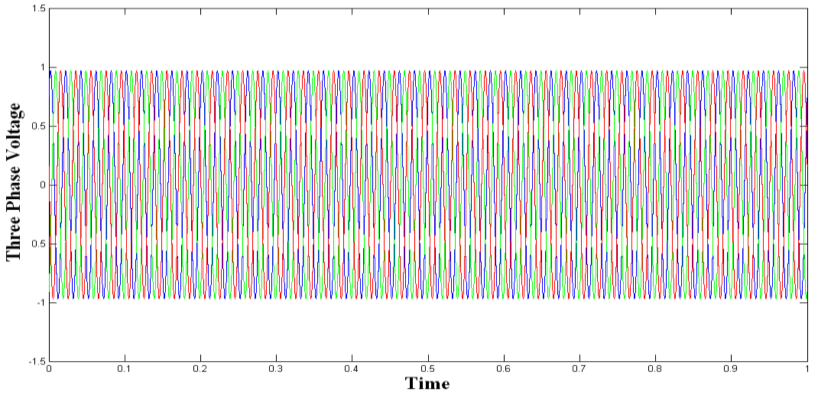

Fig.(6): 3-Ø Voltage at Load Point, Without 3-Ø Fault.

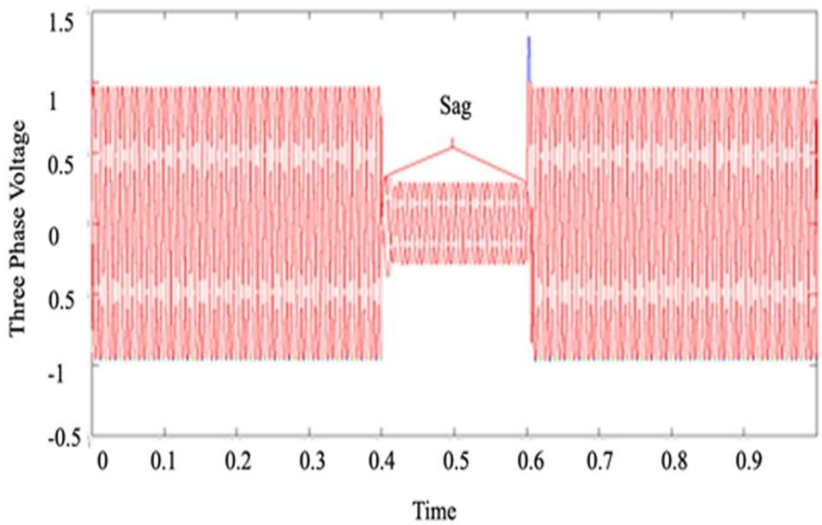

Fig.(7): 3-Ø Voltage at Load Point, With 3-Ø Fault, Without DVR

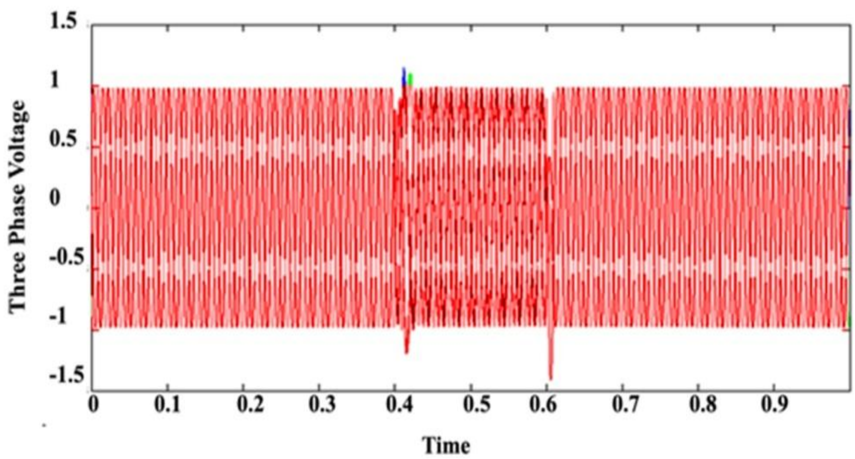

Fig.(8): 3-Ø Voltage at Load Point, With3-Ø Fault, With DVR RVG

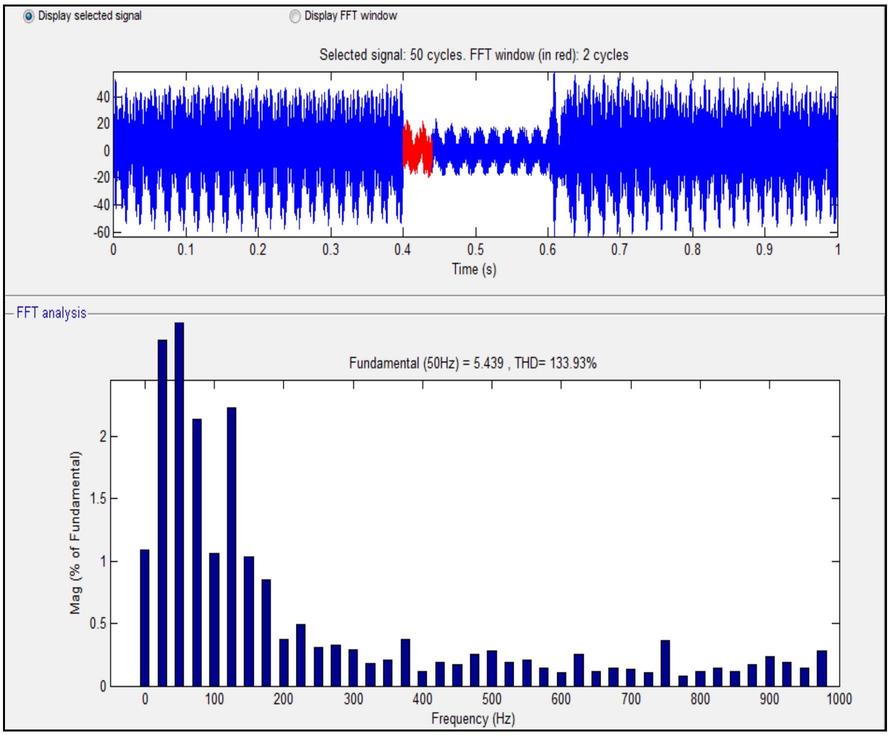

Fig.(9): FFT analysis during 3-Ø fault Without RVG

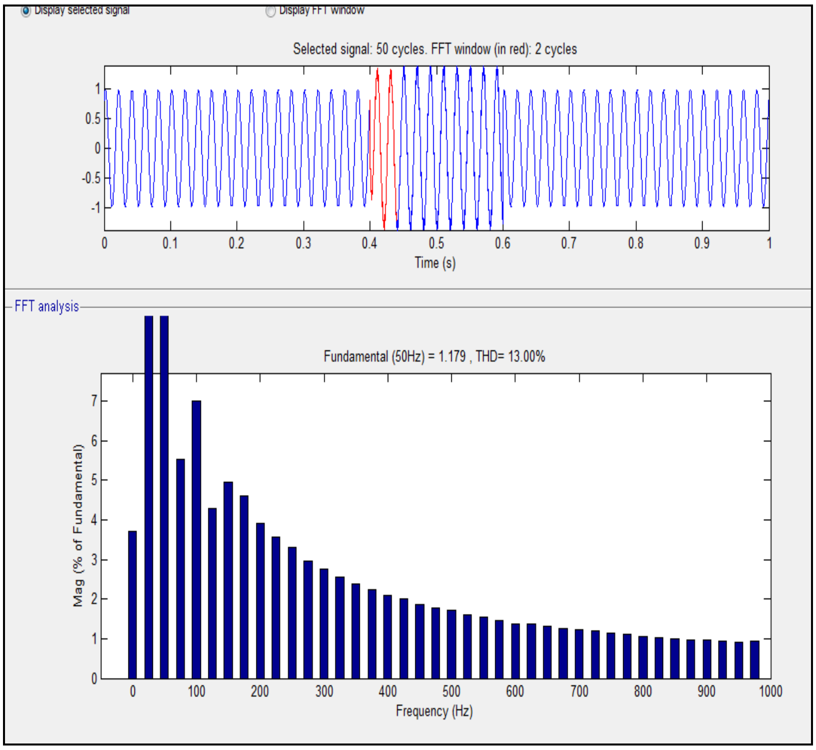

Fig.(10): FFT analysis during 3-Øfault With RVG

VI CONCLUSION

An reference vector generation strategy is proposed in this paper, from the various research paper related to power quality problems, it has found that there are so many power quality issues like voltage sag, swell, spikes, transient and harmonic which is very harmful to power system. In this regard, so many techniques are used to eliminate the power quality problems like lightning arrester, Active Power Filters (APF), Energy Storage Systems, Thyristor Based Static Switches, Distribution STATIC Synchronous compensators (DSTATCOM) etc Dynamic voltage restorer with reference vector Generation RVG is a effective method use to solve major power quality problem i.e. voltage sag. In this research, dynamic voltage restorer model is used to eliminate power quality problems. It works effectively and reduces the sag and minimizes the harmonic which come from voltage source converter through the method reference vector generation (RVG).

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BIOGRAPHY

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