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Dynamic Voltage Restorer Employing Multi Level Cascaded H-Bridge Inverter

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Abstract: ***With the highest levels of Industrial revolution and the rapidly changing power requirements due to the rise in new technological innovations, there has been a drastic increase in requirement of uninterrupted power supply as well as stable power supply. The proposed work presents a novel technique to be implemented at user end capable of making the power supply stable and defect free. The proposed technique uses a design of DVR that can work against the faults such as voltage swell/sag and compensate them to protect the user end from any distortion that can cause loss to the machinery in industries or induce faults in the working of machineries. This paper also compares the output with and without the DVR to identify and detect the noteworthy changes that can be brought using this technique.***
Keywords: DVR, Statcom, stable power, user-end.

I. INTRODUCTION

Industrial revolution has dynamically increased the power requirements owing to use of heavy and large scale machinery. Also the main problem faced by many industries, factories or small scale industry which deal in manufacturing, production or packaging processes is the constraint of unstable power supply. The interruption in power supply or sudden spike or drop in voltage is very dangerous for heavy machineries as it may cause them to get damaged. All the machineries, robotic arms, conveyor belt assembly can suddenly stop working due to continuous instability in power supply. This problem can be overcome by employing two strategies I.e., either at the transmission side or at the consumer end. When stability of power supply strategies are employed at transmission side, it does not guarantee hundred percent stability as there are various losses associated to the transmission line as well. Another technique that can be employed is the use of an efficient device at consumer end which can provide a stable power supply irrespective of changes or faults at the input. The cost of this technique has to be incurred by the consumer but it saves the costs of damages or losses to machineries. Paper mills, cloth mills, food packaging industries all undergo important power consumption requirements and also there are various crucial tasks which if halted suddenly like robotic arm movements can cause great losses and damage to the equipments and machineries. The machineries and equipments are rated as efficient under stable power supply and a degraded quality of power supply does not allow these machineries to work efficiently. Some of the degradation in power quality is the result of faults at the consumer end such as

Sr. no.	Parameters
1	Voltage Sags
2	Phase Outages
3	Voltage interruptions
4	Transients due to lightning etc
5	harmonics

The general losses associated to industries that are generally seen:

A. erroneous motion of robotic arms
B. damaged motors
C. data loss in volatile memories
D. Increased maintenance costs etc.

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II. TECHNIQUES EMPLOYED TO REMOVE THESE ANOMALIES

1) FACTS Devices (flexible AC transmission systems: these are controlled by utility
2) *Custom power Devices:* these are controlled by customer end. The general devices used in this category are:
a) *D-STATCOM:* If it is connected in shunt provision of good power quality in both transmission and distribution level is obtained.
b) UPQC is the key of custom power devices, it can compensate both voltage and current related problems at the same time and hence can be a point of great advantage.[1]

DVR (dynamic voltage restorer): an efficient approach for removing voltage sag is DVR. Owing to the advantages like less energy (VDC) than and hence DVR costs less observes a large voltage over shoot at the time of fault clearance. The effectiveness of a DVR system mainly depends upon the rating of DC storage rating and the percentage of voltage sag. [2].

III. METHODOLOGY

Simulation of any project before its hardware implementation helps to save costs and efforts for analysis of results. Simulations are done to analyze different design models against the existing ones, the result analysis can be compared and for real time condition analysis faults are induced in the testing phase. When three phase ac supply is considered and its power quality is maintained using a reliable consumer protection device it must be first tested on a simulation basis to identify the efficiency of the model and then compare it with the existing ones. Matlab is a software that has a provision of powerful simulation tools that are needed for electrical design model simulations. This paper analyzes the power quality without the DVR and with the DVR. Dynamic voltage restorers provide compensatory voltage and phase angle shifts during voltage sags.

Initially a normal power operating system is designed for simulation and the characteristics of this system are evaluated for future comparative analysis between a normal power operating system and the proposed system. Fig (i) shows a designed normal power operating system.

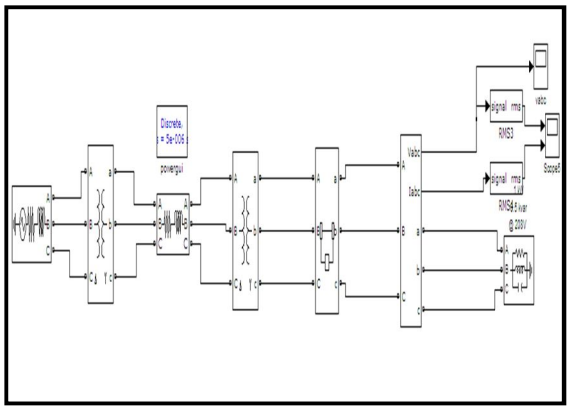

Fig (i): Normal power operating system

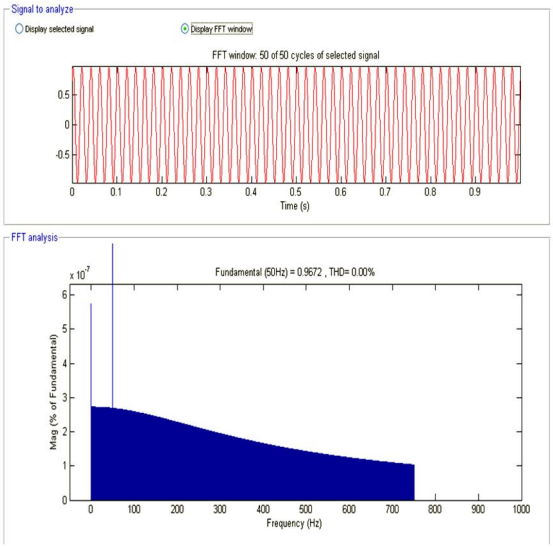

Fig (ii): FFT Analysis for Normal Operating Power System

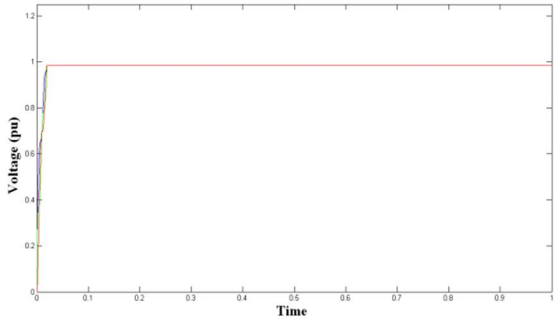

Fig (iii): P.U Voltage at Load Point, without 3-Ø Fault, Without DVR

It is observed that there is no fault in the system and the normal working of the model takes place. For comparative analysis the system has to be subjected to some fault in order to analyze its working under those conditions.

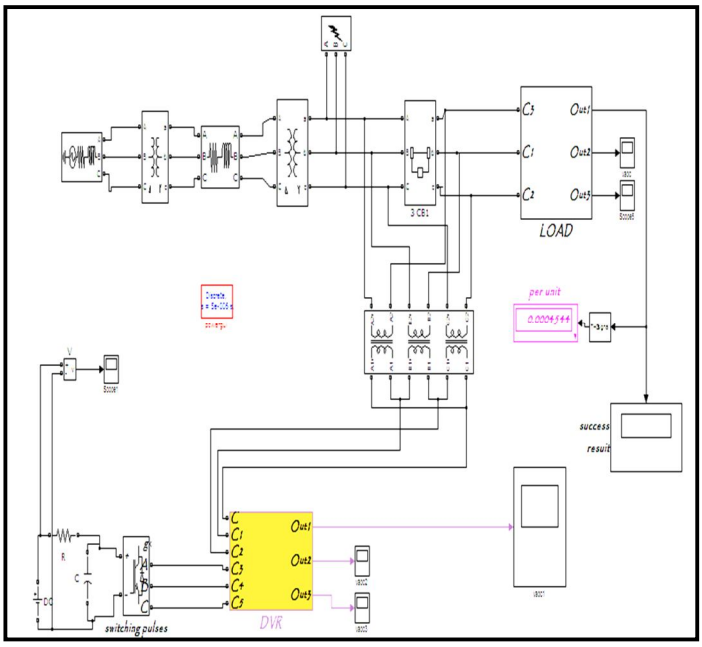

Fig (iv): Simulink for Fault on Power System with DVR with traditional inverter

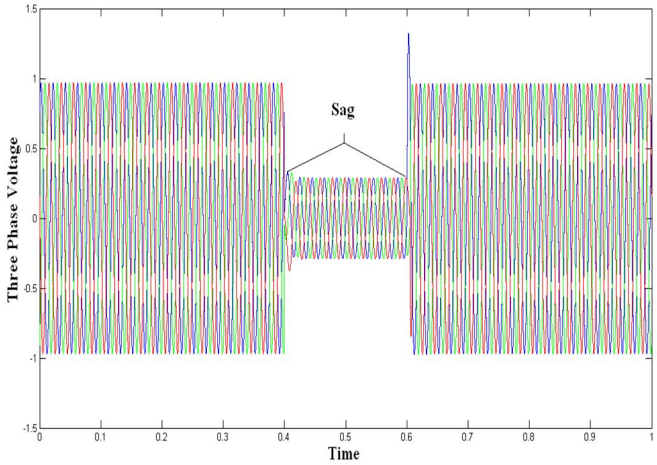

Fig (v): -Ø Voltage at Load Point, With 3-Ø Fault, Without mitigation technique

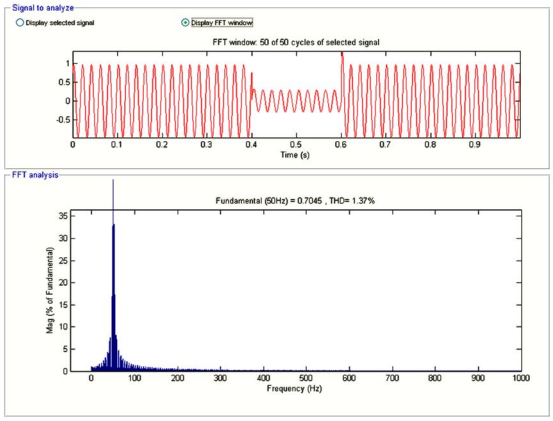

Fig (vi): FFT Analysis for Fault On Power System

Fig (vi) represents the fault analysis. To overcome this problem another technique has to be employed. The proposed model indicates a novel approach to compensate for the faults occurring in the system. The three phase fault is applied to the system at point with fault resistance of 0.66 p.u for a time duration of 200 ms.

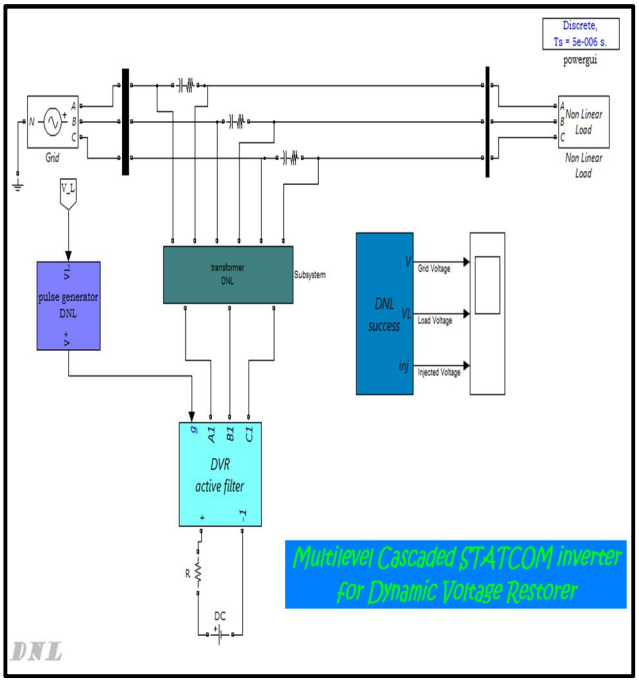

Fig (vii) Simulink Model of DVR with CASCADED MULTILEVEL STATCOM method in Power System

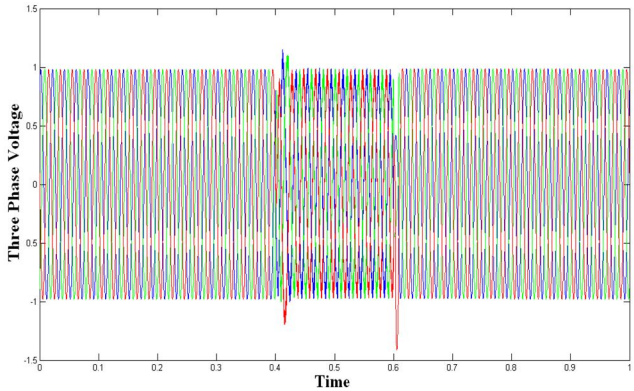

Fig. (viii) 3-Ø Voltage at Load Point, With controlled 3-Ø Fault, with Cascaded Multilevel Statcom For Sag

Voltage sag is one of the severe fault that occurs in a power system. In terms of power system transients can be defined as action or situation in power system with variation in power system and which is not desirable in nature

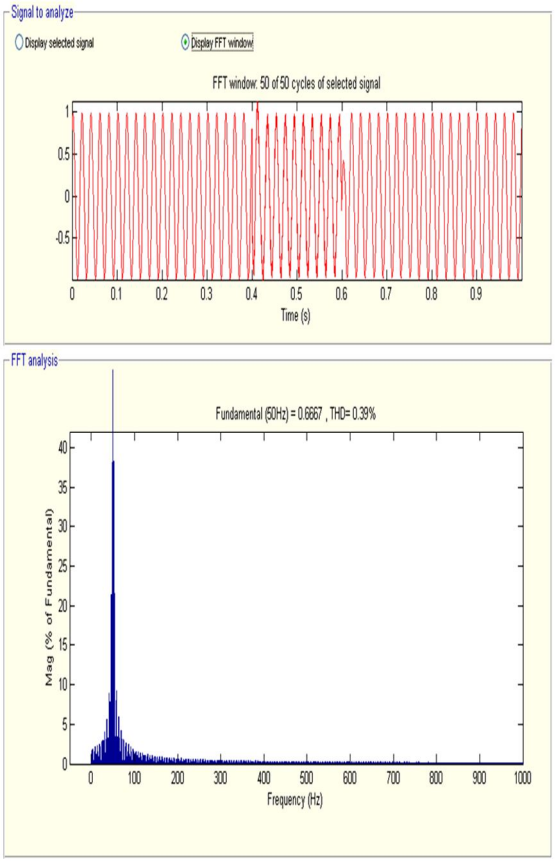

Fig (ix): FFT Analysis for Power System with DVR With controlled 3-Ø Fault, with CASCADED MULTILEVEL STATCOM

A. When the DVR is in Operation

1) the voltage interruption is compensated almost completely

2) RMS voltage at the sensitive load point is maintained at normal condition.

3) THD reduces to 0.39%.

4) The harmonics are reduced from 1.37% to 0.39%.

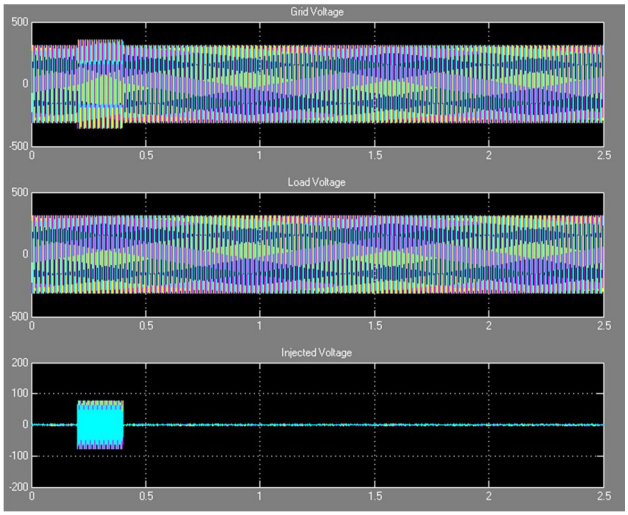

Fig (x): 3-Ø Voltage at source, Load Point and injection, With controlled 3-Ø Fault, with CASCADED MULTILEVEL STATCOM for Swell

Test system for DVR, with CASCADED MULTILEVEL STATCOM: Single line diagram of the test system for DVR with CASCADED MULTILEVEL STATCOM method

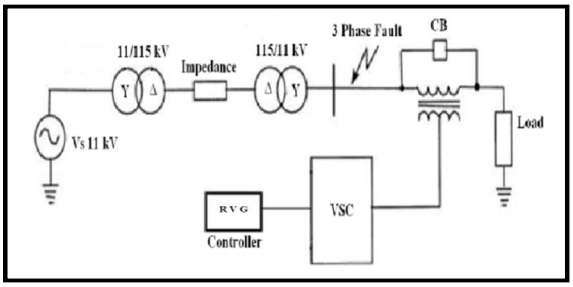

Fig (xi): Single Line Diagram of Test System

To verify the working of DVR for voltage compensation a fault is applied at point X at resistance 0.66 p.u for time duration of 200 ms. The DVR is simulated to be in operation only for the duration of the fault.

IV. RESULTS AND CONCLUSION

An efficient consumer end protection device has been designed using simulation and successful results have been obtained. A system which is capable of maintaining stable and uninterrupted power supply has been designed which will be beneficial for use by industries and manufacturing and production plants. I would like to extend my heartfelt gratitude to my guide and Head of the department for their continuous valuable support throughout the project.

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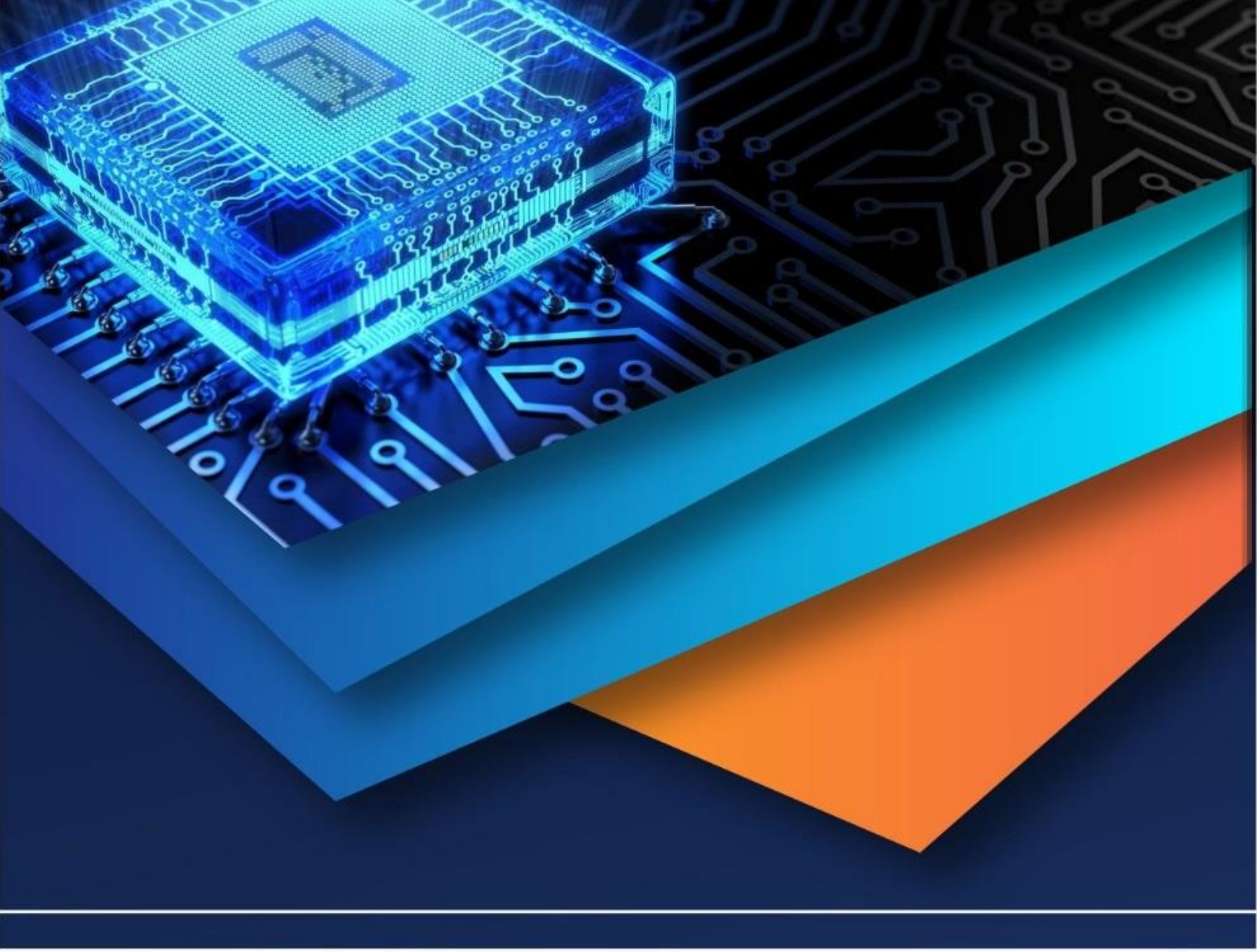

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