FAULT DETECTION AND MITIGATION IN MULTILEVEL CONVERTER STATCOMS

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ABSTRACT

An advanced power electronic components are developed by the FACTS controlled technologies. In this paper we are implemented an innovative fault detection and mitigation of multilevel inverter by using a static synchronous compensators (STATCOM) due the reasons there are proposed like as 1) they produce less harmonic content injection into the power system; 2) it operated under low voltages then corresponding the voltage stress in the STATCOM is also minimized; 3) it produces minimized lower switching losses; 4) by placing of active and reactive power compensation technique we can maintain and control the harmonics are very effective manner and hence the performance of the system is enhanced. One drawback of this paper the usage of number of power electronic components higher due to this the life time of the system is reduced. Whenever the single switch is damaged, the system does not goes to the entire (2n + 1)-level STATCOM offline. If suppose there reduced number of switches in the STATCOM, it has the capability to control and provide effective controllability to compensate the faulted currents in the multi-level inverters. The range of STATCOM can withstand up to the faulted switches as given as (2n - 1)-level STATCOM. In this implemented paper we can identify the which is under faulted then modified that corresponding switch by implementing the eleven-level STATCOM and the dynamic response of the system is also verified and total harmonic distortion (THD) and active and reactive power compensation techniques are analyzed.

Index Terms: Multi-Level Inverter, Static Synchronous Compensator (STATCOM), Fault Detection and Provide Active and Reactive Power Compensation Technique.

I. INTRODUCTION

The advanced power electronic semiconductors influence and performance is enhanced by the makes use of the proper power electronic switches called as FACTS technologies, they can control and maintain the required sufficient load requirements is maintained by providing the some additional static controllers and some compensators are placed in the system in order to get the desired load requirements. In this paper we are implemented a static synchronous compensator (STATCOM) has been healthy established as a power system controller for enhancing voltage compensation and reactive compensation provided to maintain the effective output. There are a number of compelling causes to believe a multilevel converter technology for the STATCOM.

These well-knownexplanationsconsisting the following: 1) they produce less harmonic content injection into the power system; 2) it operated under low voltages then corresponding the voltage stress in the STATCOM is also minimized; 3) it produces minimized lower switching losses; 4) by placing of active and reactive power compensation technique we can maintain and control the harmonics are very effective manner and hence the performance of the system is enhanced.

Different multilevel converters also eagerly lend themselves to a selection of PWM control strategies to enhance efficiency and control algorithm. An eleven-level cascaded multilevel STATCOM is proposed to produce the required output. This converter uses some full bridges in series to neutralize staircase characteristics. Since every full bridge be able to have produce three output voltages with singular switching combinations possibilities, the numeral of output voltage stages are produced is $2n + 1$ where n is the number bridged are associated with in the individual each phase.

The converter cells are equal and consequently modular. As advanced level converters are adopted for high output evaluation power application features, a higher number of power switching components shall be used. Each of these controlling elements areprobableto failure or damages can create. Therefore, it is significant to propose a complicated control to generate a fault-detecting STATCOM. A problem power cell is associated with efficient cascaded H-Bridge STATCOM can effectivelyaffects switch performances to expressed most important to the fault circumstances such as a short circuit or an overvoltage on the power system consequential in an luxurious down time. Consequently, it is crucial to recognize the subsistence and location of the responsibility for it to be disinterested.

Several fault discoverytechnologies have been implemented over the past few years Resistor sensing, current alteration, and *VCE* effecting are a number of the more common technologies. For instance, a technique based on the output current performance is used to recognize IGBT short circuits. The primary disadvantage with the implemented process is that the fault recognition time based on the time steady state of the load. Consequently, for loads with a higher*RL* time rated values, the affected power cell can go unobserved for numerous cycles, generally its going to leading to circuit creates problems. Another responsibility detection come up toinvented in is depended on aoperating frequency investigation of the required and produced output phase voltage. This technique was functional to flying capacitor converters and has not been comprehensive to cascaded converters. AI-based methods were implemented to extract pertinent signal applications to sense faults and monitor these sensors are used to determine each IGBT current and to commenceoperating if a fault is identified. A fault-detected neutral point-clamped converter was proposed a reconfiguration system based on bidirectional power electronic switches has been deliberatedfor the cascaded h-bridge inverters with considering the asymmetric condition also its maintains minimum operational voltage that uses to control shifted phase voltages and phase angles of the inverters.

In this suggested paper, the technique we implementednecessary only that the developed output dc link voltage of each phase be considered. This dimension is typically consummatenevertheless for control conditions of the system. If a fault is identified, the specified control blocks of this algorithm in which the fault can monitor the produced and is then isolated and detached from service. This approach is dependable with the modular proposeof cascaded multi-level inverters are proposed to investigate the problems of fault currents with by using the advanced PWM control strategies in the STATCOM this is used to functioned at that the time of fault conditions, it can injects that corresponding additional required voltages by maintain the current injection process.

In synopsis, this method can generates the advantages are as follows.

- They produce less harmonic content injection into the power system;
- It operated under low voltages then corresponding the voltage stress in the STATCOM is also minimized;
- It produces minimized lower switching losses;
- By involvingthe efficient controlling strategy i.e. active and reactive power compensation procedure we can sustain and control the harmonics are very effective manner.
- No supplementary sensing necessities;
- Supplementary hardware is incomplete to two by-pass controlling switches per each phase;
- Is dependable with the modular process of cascaded multilevel converters;
- The dynamic presentation and THD of the STATCOM is not appreciably effected.

1.1 The Major Power Circuit Parameters in This Project

This suggested paper consist of four basic and important parameters are plays key role in the project. Those are given as voltage source inverter (VSI), passive filters and energy storage devices.

II. VOLTAGE SOURCE INVERTER (VSI)

The voltage source inverter designs are developed like three phase three wire arrangement or like as three phase four wire arrangement. The design of voltage transformer is maintained as less voltage and high current application purpose. Because to inject the additional required voltages from the injection transformers to the load. There is no necessity of using external extensive multi-level inverters because we are using the conversions are possible by make use of flexible alternating current transmission systems. These systems are utilized the converters generally like as three phase converters required to fulfill our requirements.

III. PASSIVE FILTERS

The filtering technique in the multi-levelSTATCOM is possible by placed at high voltage side of the shunt connected transformer or else by connected inverter side of the transformer. The usage of the inverter side connected transformer is on low voltage side to the series connected transformer in order to reduce the high current harmonic losses in the inverters when we compensate these losses before giving to the shunt connected transformers it is very effective and good requirement for to reduce the voltage stresses in the transformers.

Even though when the STATCOM is performed as a source of the introduction of the filter as the inductance which effects to produce the voltage drops and phase-angle is shifted without required specified outputs in the inverter. These kind voltage effects the to produce the higher harmonic contents in the load side so we have to take considerations in order to maintain the output is possible to generate the output is effective manner.

IV. ENERGY STORAGE REQUIREMENTS

Energy storage requirement is possible by maintain to provide the real power is effective manner by maintain the controlling of the fault currents. We have design the batteries like lead-acid batteries, SMES, flywheel etc. energy storage arrangement is possible by designing the lead-acid batteries by this we can maintain the stored energy in the electro mechanical form by allowing the current by electric charged ions. The battery operated by charging and discharging by our requirements, the discharging is controlled by the effective maintenance of the chemical reaction of the battery and hence the discharging rate is generates the available required sufficient voltage.

V. EXISTED SYSTEM

A converter cell building block cans generatedifferent types of problems. Each power electronic switch in the cell can damaged in an open or closed condition. The triggering closed condition is the most important failure because it mightbe lead to shoot throughout and short circuit the complete cell. An open circuit can be vanished by selecting a proper gate circuit to organize the gate current of the power electronic switch throughout the problem. If a short circuit problempresented, the capacitors will quickly discharge throughout the conducting switch pair if no defensiveaccomplishment is considered. Therefore, the complement switch to the damaged switch should be quickly turned off to neglecting system importance collapse because appropriate to sharp current surge impedance. Classification for the implemented method is specified.

The staircase corresponding voltage characteristicsexposed is modified by adjusting the voltages of the assorted cells into the preferred level of required output voltage. At the middle levels of the voltage characteristic, appropriate to the switching conditionconsistency, there are supplementary than one position of switching arrangements that may be included to assemble the preferred voltage level. Consequently, by changing the switching arrangements, the loss of any personality cell will not appreciablycrash the middle voltages of the produced output voltage. Conversely, the peak voltages necessitate that all cells give to the required voltage; consequently, the short circuit problem of any one cell will directed to the damage of the primary and $(2n + 1)$ output corresponding and cause poverty in the capability of the STATCOM to construct the full developed output voltage level.

Consider the easiest eleven-level converter is implemented. The procedure for checking and vanishing the defective cell block is explained in the input to the identification control strategy is $\hat{E}out$ for every phase, where $\hat{E}out$ is the STATCOM regulated and filtered RMS receiving voltage. If suppose the STATCOM RMS generated voltage drops less at preset minimum operated threshold value ($E\_$), then, a responsibility is identified to have presented. Once a problem has been identified to have presented, then, the next step is to recognize the effected cell. By considering the operating signals in each converter cell, (i.e., $S1$ and $S2$), it is probable to analyze all of the promising voltages that can be created at any given immediate as demonstrated.Consequently, the generated voltage of a cell is and because the cells of the STATCOM are serially associated, the total generated output voltage per each phase is calculated as

$vax= vax+ -v - \ ax$ (1)

$vy0 = n \_ x=1\ vyx, y\in[a, b, c]$ (2)

Where' n'identifiesthe number of blocks.

By considering the operating signals in every converter conducting cell, (i.e., $Sj1$ and $Sj2$, j is the cell number), it is possible to calculate all of the probable voltages that can be created at any given immediate. Once there is any problem is created the multilevel converter, the capacitor at the defective block arrangement will quickly discharge. This discharge consequences in a phase shift in the generated ac voltage as well as a modify voltage in magnitude of voltage. The position of all achievablephase effected voltages for an implemented eleven-level inverter is given by

$f1=V\mathrm{dc}0(S21 - S22 + S31 - S32 + S41 - S42 + S51 - S52)$ (cell 1 faulted)

$f2=V\mathrm{dc}0(S11 - S12 + S31 - S32 + S41 - S42 + S51 - S52)$ (cell 2 faulted)

$f5=V$dc0$(S11 - S12 + S21 - S22 + S31 - S32 + S41 - S42)$ (cell 5 faulted)

Moreconciselyas fi= Vdc0 n _ j=1 j_=I (Sj1 − Sj2), i= 1, n (3)

Where Vdc0 is the normal ideal voltage across a single cell block. If there is aeffected cell, only one fi will be close to the actual STATCOM generated additional phase voltage Eout; all of the others will be too elevated. Consequently, to conclude the position of the fault cell, each fi is verified against Eout to acquiescexi = |Eout− fi|, i= 1, n. (4) thenegligiblexi denotes that the location of the effected block since this shows that the fi which most directlyidentifies the actual Eout.

The alternative of minimum operated voltage E_ based on the usage of numberof cells in the inverter. The natural output voltage is

ˆEout,0 = n√Vdc02. (5)

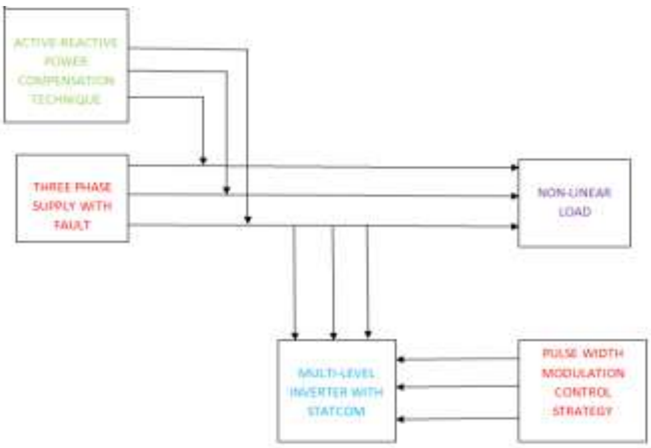
Throughout a fault, Eout will diminish by Vdc0 acquiescent

ˆEout,fault =(n −√1)Vdc02= n –1nˆEout,0. (6)

Consequently, the minimum operatedthreshold voltage E_ must be selected like that(n −1/n)Eout,0≤ E_ ≤ Eout,0. In andeveloped eleven-level converter,n = 5 and the effected RMS voltage will diminish by approximately20%. As a result, anexcellentoption for E_ is 85% of the required sufficient outputSTATCOM voltage. The last step is to activate the component bypass semiconductor switch gihas a slight time delay is supplementary to the reason to ignorefor momentary spikes that mightbe presented. It is excellent technique to desertedmomentary sag problems in the dc link voltage, but react to sag ofimprovedamount that designate a faulted unit. The use of the detection measurement is identified that the problem modified by the generation of the additional required output voltage corresponding to the multi-level inverters this leads to the interrupt the problems and enhances the performance of the developed paper.

VI. PROPOSED SYSTEM

In the proposed block diagram majorly consist of the three phase power supply is presented with having some faults are also injected to generate the problems. The multi-level inverter is proposed with STATCOM.The STATCOM is a current controlled shunt connected facts device in this the major parameters are voltage source converter and also the passive elements as inductance and capacitance and energy storage elements plays the key role for the operating system.



The STATCOM is utilized to identify the faults and compensate those faults in order improve the system performance. It is maintained and controlled with use of proper controlling pulses from the pulse width modulation control strategy. Here the usage of inductance and common dc –link capacitor are performed to maintain the required sufficient load voltage. If the load voltage is reduced the capacitance is injects that corresponding additional voltages by injecting the current manner to the load if the load voltage is exceeded then the inductor component is used to absorb the unnecessary voltages in the load side. The faults are detected and protected by the STATCOM with the proper controlling pulses from the PWM strategy to the power electronic switches to generate the proper output without presence of the harmonics.

Here we are placing the load is non-linear which loads does not obeys the ohms law conditions, so we have to consider the generation of harmonics by the placing of non –linear loads due to this the efficiency of the system is reduced. The nonlinear loads generate the fluctuations in the receiving end side. So, we have required some extra technologies to compensate those corresponding problems in the load side. The harmonics are compensated by the active and reactive power compensation technique and total harmonic distortion (THD) techniques are provided in the load side to compensate the load problems. The harmonic contents are minimized by the reactive power compensation in the source and the load side this leads to the current controlled and hence automatically the losses, distortions are regulated. Then the performance is increased then the reliability of the system is enhanced.

VII. CONCLUSION

The proposed eleven level multi converter is developed by the advanced power electronic switches by the conducting pulses are generated by the makes use of Pulse Width Modulation control strategy. In this suggested paper the generation fault currents are detected and interrupted by the proper controlling and regulating of the SATCOM. The STATCOM has the capability to operate even faulted switches are presented in the working conditions also it has ability to operate accurately without generating the harmonic contents and the faults are also compensated. By providing the active and reactive power compensation technique and also provided total harmonic technique strategies with the STATCOM the presence of some harmonic contents are vanished and hence the performance of the system is enhanced.

•The implemented control system identified and successfullycontrols the different downstream arcing fault currents within limited range of two cycles (of 50 Hz);

•The implemented fault current detection and compensation strategy controls the STATCOM dc-link voltage increase, affected by active power incorporation, to lower than 15% and operates the STATCOM to re-establish the PCC voltage without disturbing the controlling of the multi-level inverter.

•The implemented control arrangement also operatedadequatelyless than downstream arcing fault circumstances.

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