Cascaded Two-Level Inverter-Based Multilevel STATCOM for High-Power Applications

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Abstract **-** In this paper, a simple changeless var advantage arrangement appliance a cascaded two-level inverter-based multilevel inverter is proposed. The cartography consists of two accustomed two-level inverters affiliated in avalanche through open-end windings of a three-phase transformer. The dc-link voltages of the inverters are adapted at altered levels to access four-level operation. The simulation abstraction is agitated out in MATLAB/SIMULINK to adumbrate the achievement of the proposed arrangement beneath counterbalanced and agee supply-voltage conditions. A class ancestor is developed to validate the simulation results. The ascendancy arrangement is implemented appliance the TMS320F28335 agenda arresting processor .Further, adherence behavior of the cartography is investigated. The activating archetypal is developed and alteration functions are derived. The arrangement behavior is analyzed for assorted operating conditions.

Keywords—DC-link voltage balance, multilevel inverter, power quality (PQ), static compensator (STATCOM).

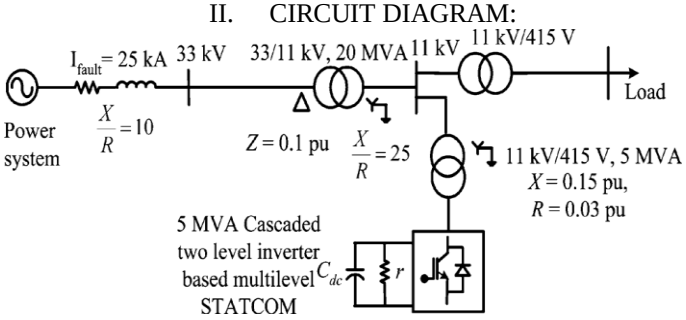
I. INTRODUCTION

Advanced Power systems are of updated networks, with many power stations and number of load centers is interconnected through long power transmission, grid and distribution networks. Power distribution system should offer a reliable power supply to reach customer requirements like rated supply voltage and frequency. Power Quality problem is outlined as drawback in voltage, current or resulting in changes of frequency that causes instability. Passive components like RLC elements are used on the line for injecting voltages and filtering the harmonics in the line. But by using these components line weight & cost will increase, efficiency of the system will decrease and leakage currents will be high. To resolve these problems Flexible AC Transmission Systems (FACTS) are suitable. There are so many FACTS devices like series compensator, shunt compensator and combination of series & shunt compensator. By series compensator only voltage can be injected, by shunt compensator current can be injected then voltage can be controlled, by the combination of series & shunt compensator both voltage and current can be injected into the line. In this paper, analysis is done on one of the FACTS device which is STATCOM. STATCOM can operate in both rectifier and inverter mode. In inverter mode of operation it is injecting voltages into the line, but usually output of inverter is square wave form whose Total Harmonic Distortion is high. In order to get near sinusoidal waveform, multilevel inverters are proposed. In this topology cascaded connection of H-bridge inverters based on multilevel STATCOM is proposed to improve the power quality and reducing harmonics in the system. DC link voltages of inverters are controlled by PID with fuzzy logic controller. this cartography is that by advancement agee voltages at the dc links of the inverters, the bulk of levels in the achievement voltage waveform can be increased

Features of Multilevel Inverter

The most attractive features of multilevel inverters are as follows. They can generate output voltages with extremely low distortion and lower *dv/dt*. They draw input current with very low distortion. They generate smaller common-mode (CM) voltage, thus reducing the stress in the motor bearings. In addition, using sophisticated modulation methods, CM voltages can be eliminated. They can operate with a lower switching frequency.

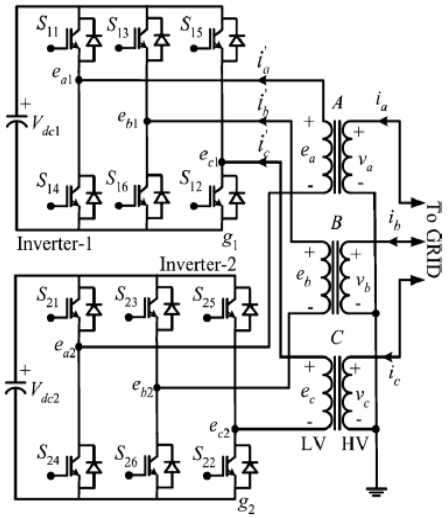
II. CIRCUIT DIAGRAM:



PID controller:

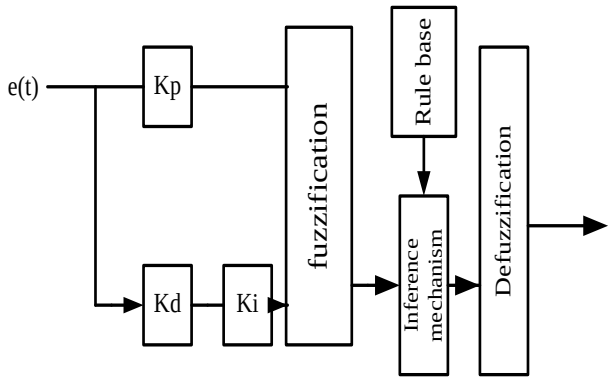
Proportional–integral–derivative controller (PID controller) is a control loop feedback mechanism. As the name suggests, PID algorithm consists of three basic coefficients: proportional, integral and derivative which are varied to get optimal response. The entire idea of this algorithm revolves around manipulating the error. The error as is evident is the difference between the Process Variable and the Setpoint. ERROR = PV - SP T

Circuit diagram multilevel:



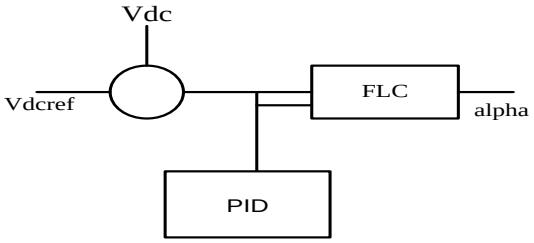
Fuzzy logic systems:

Normally logics are used for statements like yes or no, true or false conditions and "1 or 0" conditions. For example statements like 'room temperature is cool or hot' for this the answers is like 'yes' or 'no' ,'may be' 'not sure' that depends. The exact answer can't say so that fuzzy logic controllers are used to obtain the accurate answer. The fuzzy logic controller excellently deals to control the machines and consumer goods. Fuzzy logics are very easy to design and understand. Non technical persons can also easily implements that control system will not be optimal but that is acceptable. Fuzzy logic is a controller that controls based on fuzzy rules, it changes analog input values to 0's & 1's and it performs based on it. The schematic diagram of fuzzy controller is shown in Figure-3.5. Different types of fuzzy logics are used; usually Sugeno and Mamdani type of fuzzy is used. The main distinction between Sugeno and Mamdani is, Sugeno type is mathematical analysis process and Mamdani is human input type. In this project Mamdani type fuzzy logic controller is used

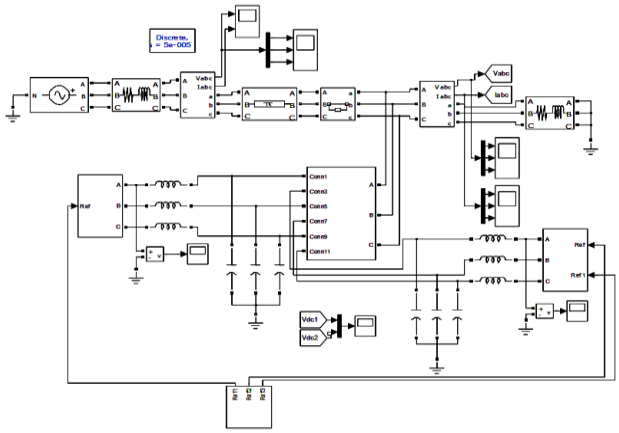


III. SIMULATION RESULTS

STATCOM based Cascaded two level inverter with PI and PID with fuzzy controller as shown in Figure-4.

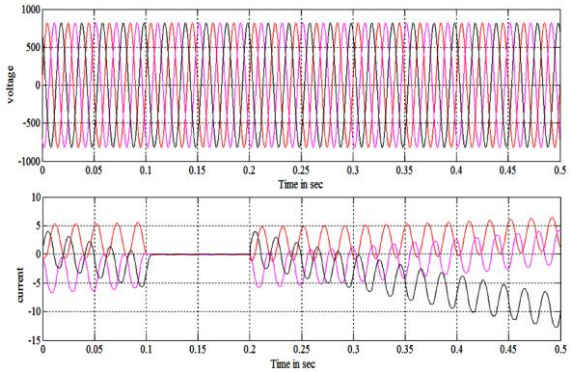


Simulation diagram of proposed technique is shown in Figure-4.7.

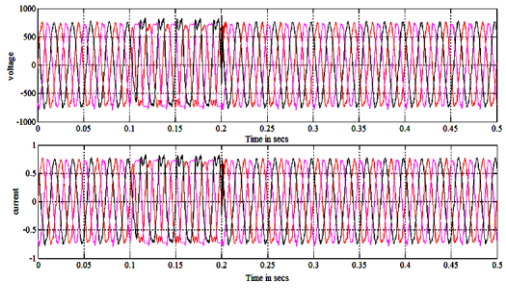


Simulink model with multilevel STATCOM

Figure-4.8 shows the source side voltage and current waveforms when the fault occurs between 0.1 to 0.2 sec. In this time period amplitude of the phase voltages reduces as compared to the normal state conditions.

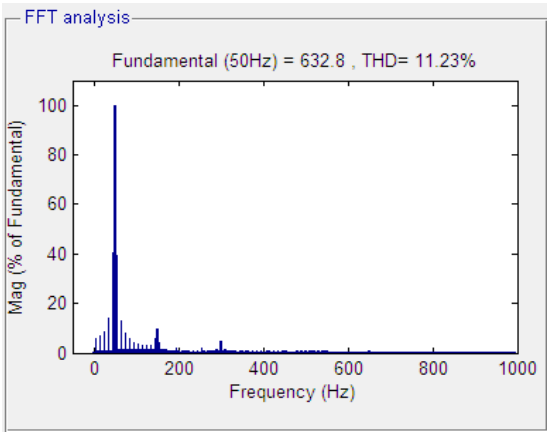


Source side voltage and current waveforms shows that at time of fault occur at 0.1 to 0.2 sec, STATCOM clears the fault by injecting the voltage.



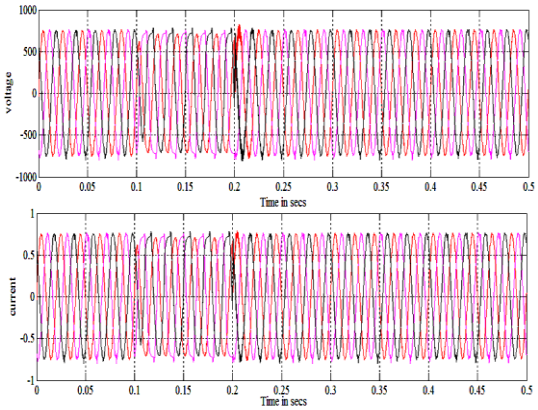
Load side voltage and current waveform

Total Harmonic Distortion can be calucultaed by using Fast Fourier Transform(FFT) analysis for Cascaded Multilevel STATCOM with PI controller is 11.23% as shown in Figure-4.10.

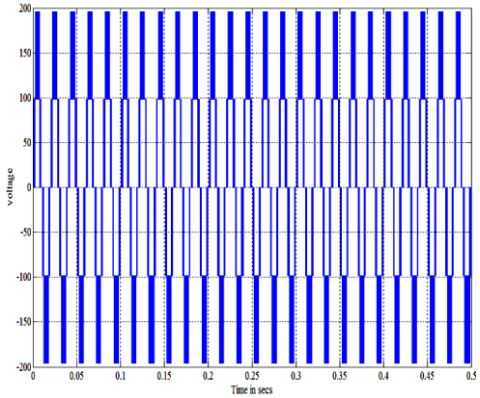


THD spectrum of PI STATCOM

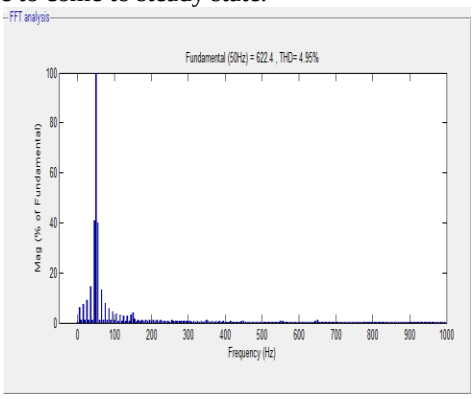
To maintain the THD value as per the IEEE-519 standard a new hybrid PID controller (i.e., PID with Fuzzy Controller) has been proposed. The proposed controller clears the fault at 0.1 to 0.2 sec better than the conventional controller as shown in the



Load side voltage and current waveforms with proposed controller shows that multilevel output voltage waveform of proposed converter by multilevel operation of inverter results the reducing of THD in system.



Output voltage of STATCOM shows the output voltage waveform of the multilevel inverter. In PI controller response time is more, thus when fault occurs in the system it takes more time to come to steady state.



THD spectrum of proposed controller

It is concluded that PI controller takes more Rise Time, Settling Time and Overshoot Time, but by using PID with fuzzy controller Rise Time, Settling Time decreases, so proposed controller gives best performance than conventional controller. PI and PID controller of STATCOM

Type	PI	PID with Fuzzy
Rise Time	2.6761	0.0533
Settling Time	3.9625	2.800
Overshoot	14.8515	0
THD	11.23	4.95

IV. CONCLUSION

The proposed multilevel STATCOM for cascaded two level inverter based multilevel inverter is implemented by using PID with fuzzy logic controller. This proposed system clears the fault under faulty conditions. Proposed controller is compared with conventional PI controller, by this it is

concluded that proposed controller gives less Total Harmonic Distortion, response time, settling time and rise time.

FUTURE SCOPE

The proposed converter can be implemented with two level based cascaded multilevel STATCOM with pi controller can be replaced by pid+fuzzy logic controller for reducing the total harmonic distortion for high power applications

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