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IMPLEMENTATION AND COMPARE OF CONTROLLERS FOR POWER QUALITY IMPROVEMENT USING SHUNT ACTIVE FILTER

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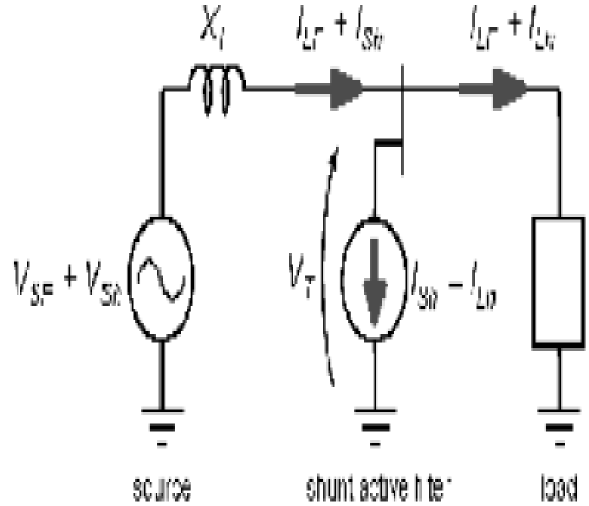
Abstract: In this paper, an implementation filter for source harmonic compensation in order to get power quality improvement under the different non liner load condition. Shunt active filter makes source harmonic current almost sinusoidal. Here the reference current generated by controller it is compared with the actual current. Switch of shunt active filer is controlled by the PWM current controller. Here we can use different controller like PI and hysteresis current controller and for different non liner load condition and compare that result and show the performance of the controller, get the idea about controller which one is good.
Keywords: Power quality, Shunt Active filer, VSC, hysteresis current controller, PI controller

I. INTRODUCTION

Power electronic loads and non-linear electronic devices cause a type of voltage and current waveform distortion in power systems [1] , [2] called as "harmonics" .Some of the nonlinear loads are rectifiers, cyclo converters, arc furnace, variable speed drives, asymmetrical loads, uninterruptable power supply. These nonlinear loads cause degradation of power quality in the distribution and transmission system like poor power factor and high degree of harmonics. Harmonics causes several problem in power system and consumer products, such as heating of thee electrical equipment, trip of circuit breaker, capacitor damage, eddy current loss, communication interference, effect on transformer, solid state devices malfunction, skin effect, damage of sensitive electronic equipments. Conventional passive filters have been used to eliminate current harmonics and are ineffective to filter different current harmonics. Also, there are chances of occurrence of resonance between the system impedance and passive filters. In order to overcome the disadvantages of passive filters [8], development and applications of Active Power filters (APF) have been made to improve the power quality at the consumer or distribution side. Due to the recent advancement in power semiconductor device technology, active power filters have been widely used. High-power switching devices such as power MOSFET's, MCI's, IGBT's, IGCT's, etc. available for the harmonic compensation. Today modern active filter [4] are superior in filtering performance, low implementation cost, smaller in size and more flexible in application compared to traditional passive filter. Active power filter detects the harmonic components from the distorted signals and injects these harmonic current components with a current of the same magnitude but opposite phase in the power system to eliminate harmonics.

II. CIRCUIT CONFIGURATION

Proposed [3] single phase APF consists of two major parts: power circuit and control circuit. Power circuit consists of a single phase voltage source converter operating a relatively high frequency to give the output which is used for cancelling low order harmonics in the power system network. A voltage source inverter having four MOSFET switches anan DC energy storage capacitor is implemented as a shun APF. The voltage source inverter in the shunt active filter is a bilateral converter and it is controlled in current regulate mode. Inverter switching is done in such a way that it delivers current which is equal to the set value of current in the current control loop. Placement of shunt active filter in the system is shown in fig.



Shunt APF [9] is a group of power electronic circuits consisting of power switching devices and capacitor as a energy storage element. The power switching devices are driven with specific control strategy in order to inject the current that is able to compensate for harmonic and poor power factor. Harmonic separator is used to sense the load current drawn by the nonlinear load. After detecting the inverse of the total harmonic current component, voltage source inverter is used to generate the compensating current and it is injected into the utility power grid. This cancels the harmonic current drawn by the nonlinear load and keeps the utility line current to be almost sinusoidal. The overall block diagram of shunt active filter.

III. CONTROL STRATEGIES

In this section, shunt active filter system is simulated with three controllers: PI, Hysteresis, under three different nonlinear loading conditions. The nonlinear loads considered are:
a) Diode bridge rectifier with RC load
b) Buck converter load
c) AC voltage controller load

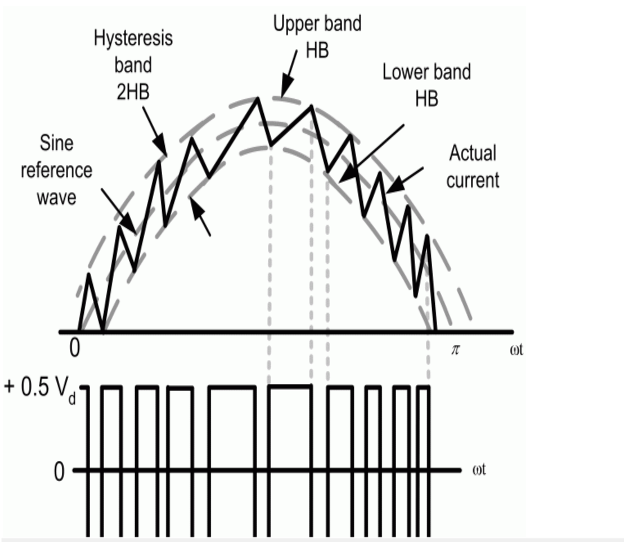
A. PI controller:

PIcontroller [6] drives the system to be controlled with a weighted sum of the error and the integral of that value. It has simple arithmetic and high reliability in steady state. It does not require any transformation and it simplifies the controller design. The simulation of shunt active filter for diode bridge rectifier with RC load using P controller is shown in fig. 3 . The same circuit is simulated for other nonlinear loads such as buck converter, AC voltage controller load.

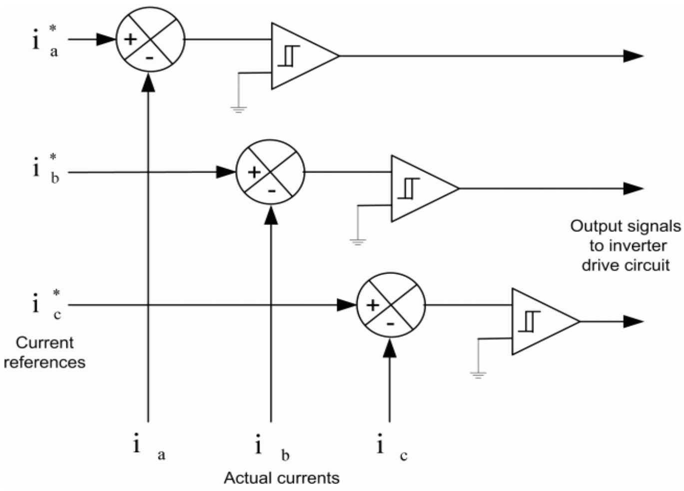
B. Hysteresis current controller:

The hysteresis modulation is a feedback current control method where the motor current tracks the reference current within a hysteresis band. The following figure shows the operation principle of the hysteresis modulation. The controller generates the sinusoidal reference current of desired magnitude and frequency that is compared with the actual motor line current. If the current exceeds the upper limit of the hysteresis band, the upper switch of the inverter arm is turned off and the lower switch is turned on. As a result, the current starts to decay. If the current crosses the lower limit of the hysteresis band, the lower switch of the inverter arm is turned off and the upper switch is turned on. As a result, the current gets back into the hysteresis band. Hence, the actual current is forced to track the reference current within the hysteresis band.

Operation Principle of Hysteresis Modulation:



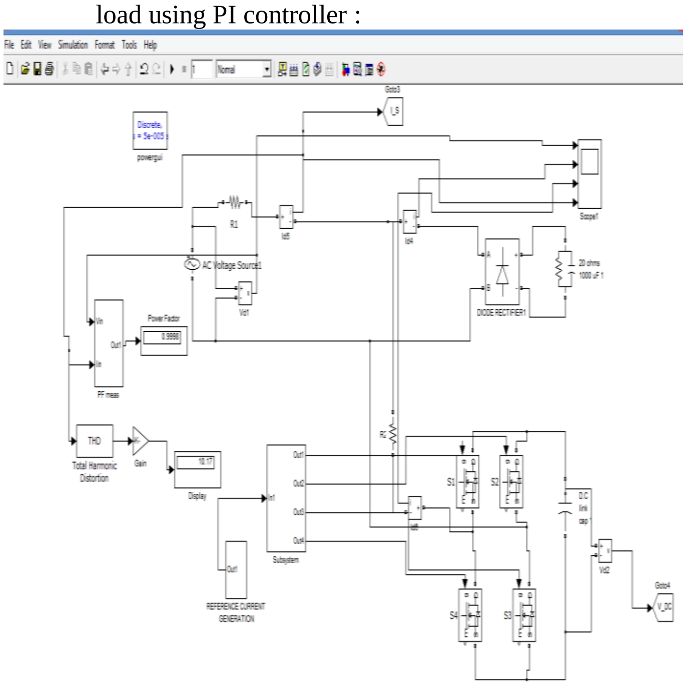
Typical Hysteresis Current Controller:



IV. SIMULATED RESULTS

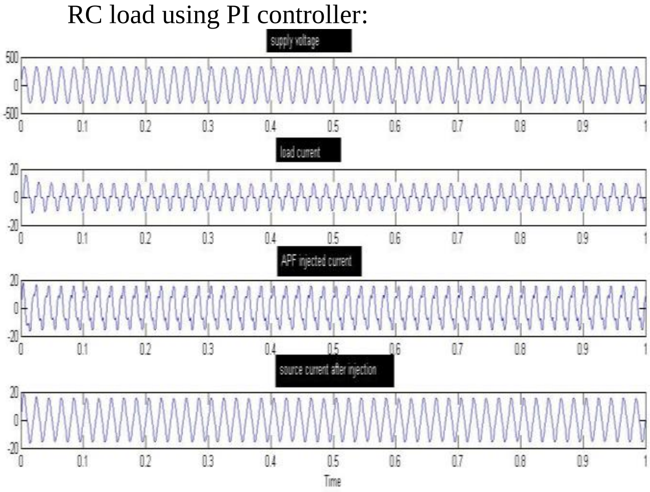
This section deals with the simulation results of active filter configuration, Active filter configuration has been tested with non linear loads using different control techniques by using MATLAB/Simulink The system parameter values are :
Supply voltage=23 0V,
Supply frequency=50HZ,
Shunt APF DC capacitance=5 0 /lF,
Load resistance=20!1,
Load capacitance= l OOO/lF.
Simulated waveform of supply voltage, load current, injected current, source current for diode bridge rectifier with RC load using PI controller is shown in fig. a,b,c,d. The magnitude of APF injected current will vary depends upon the nonlinear load condition.

- Simulink model for diode bridge rectifier with RC load using PI controller :

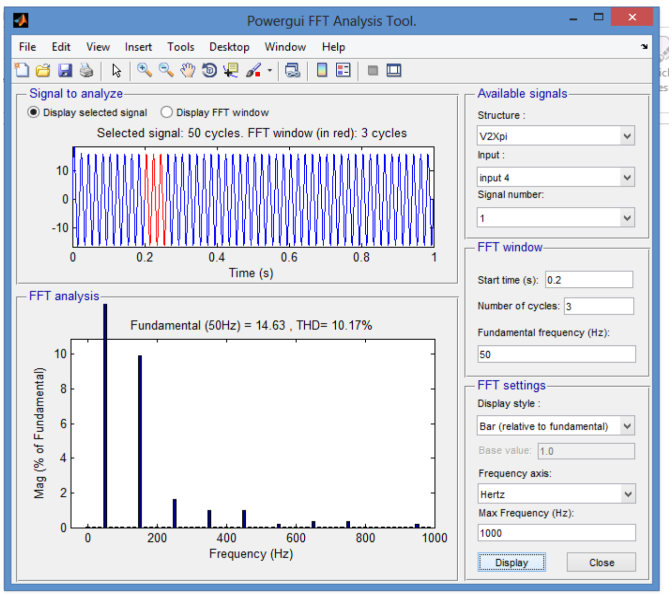


- Simulated waveforms for diode bridge rectifier with

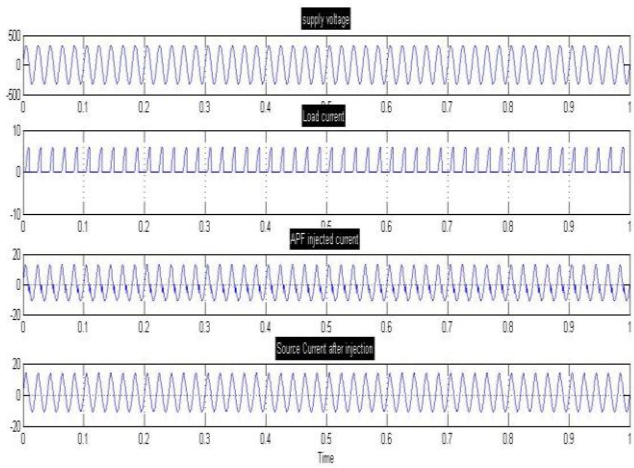
RC load using PI controller:



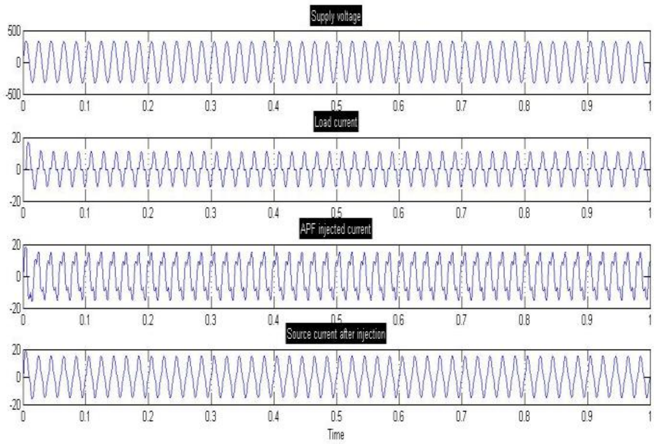
FFT Analysis:



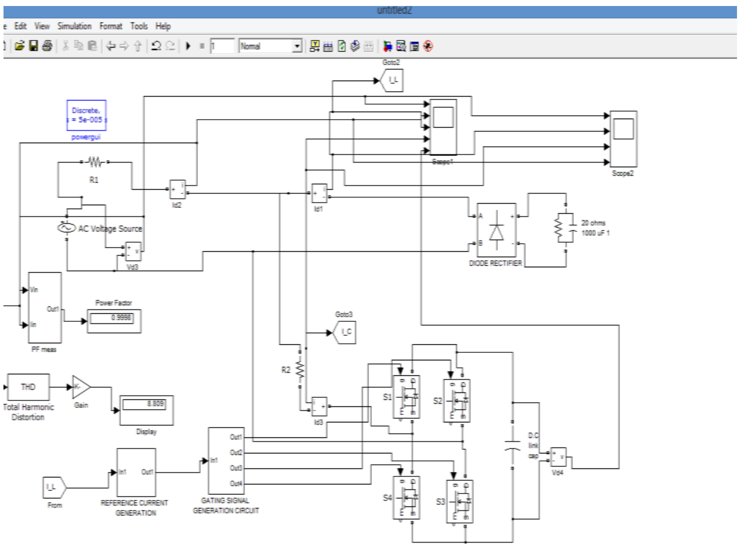
- Simulated waveforms for buck converter load using PI controller:



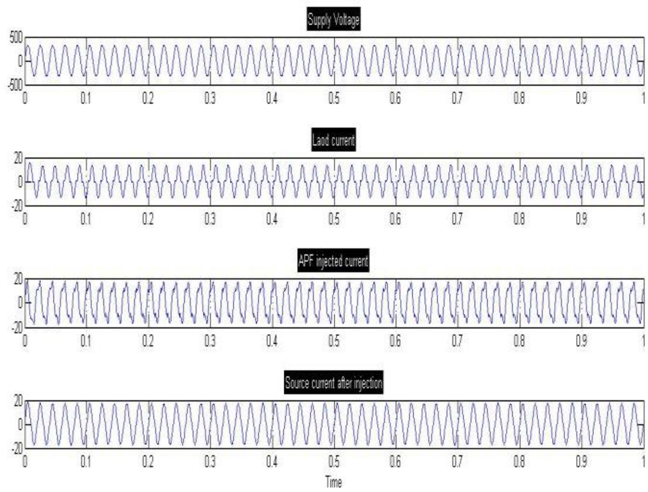
- Simulated waveforms for AC voltage controller load using PI controller:



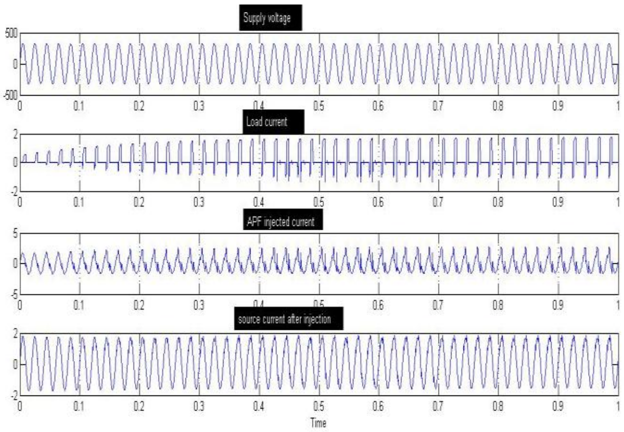
- Simulink model for diode bridge rectifier with RC load using hysteresis current controller :



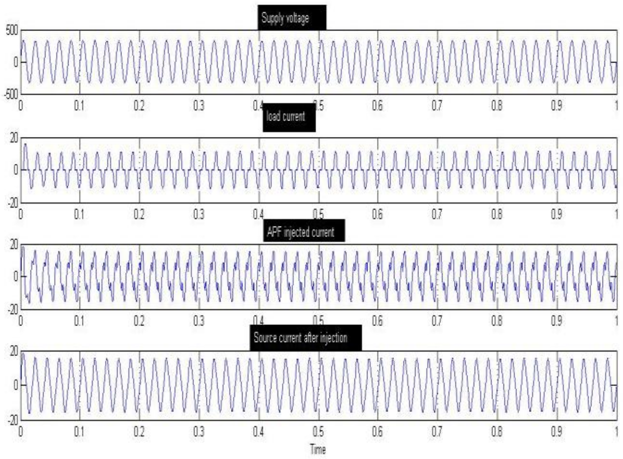
- Simulated waveforms for diode bridge rectifier with RC load using hysteresis current controller:



- Simulated waveforms for buck converter load using hysteresis current controller:



- Simulated waveforms for AC voltage controller load using hysteresis current controller:



Comparison Table:

CONTROL SCHME NON LINEAR LOAD	PI CONTROLLER Pf	PI CONTROLLER THD	HYSTERESIS CONTROLLER Pf	HYSTERESIS CONTROLLER THD
Diode rectifier with RC Load	0.99	10.17	0.99	8.82
Buck converter load	0.99	8.53	0.99	7.82
AC voltage controller	0.99	14.25	0.99	10.53

V. CONCLUSION

Here in this paper shunt active filter compensate the harmonic current in the power system based on describe controller. Comparison table show the using hysteresis current controller THD is reduced compare to the PI controller. In this paper for the future work we can use the fuzzy logic controller for the different nonlinear load condition and compare the result get idea about that controller.

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