

Modeling And Design of Hybrid Control Strategy for Power Quality Improvement in Grid Connected Renewable Energy Source

Y. N. S. Mounika, J. Ayyappa, S. N. V. Bramareswara Rao

Abstract: The demand for power is growing rapidly due to fast depletion of fossil Fuels. Under such conditions environment friendly and pollution free Renewable Energy Sources (RES) have emerged. In this paper a new control strategy for 3 phase 4 wire inverter is introduced for effective utilization of renewable energy source with grid. In the proposed control strategy load current (i.e reduce harmonics), load voltage (i.e reduce harmonics) are compensated using Shunt Active Power Filter(SAPF). The Renewable Energy Source used in this paper is Wind of capacity 1.5MW. The main objective of this paper is nonlinear unbalanced load compensation for power quality improvement. All these works of the inverter is done either individually or combined to overcome the unbalanced effects of nonlinear loads at distribution level. This new hybrid control strategy is simulated in MATLAB/Simulink and compared the results at different times with existing methods.

Keywords: Renewable Energy Sources, Wind energy, Active Power Filter, Nonlinear loads, Power quality.

I. INTRODUCTION

There is a growing interest in Renewable energy around the world. New strategies for operation and management of electricity grid for increasing number of renewable energy sources and distributed generators in order to maintain or even to improve the power supply reliability and quality .It is a challenging task to integrate RES into power grid infrastructure because of its intermittent nature. The power electronic technology plays a prominent role in distributed generation and integration of RES into electrical grid. It is one the most regular problem when connecting small RES to the electric grid which is the interface unit between the power sources and the grid because it can inject harmonic components that may deteriorate the power quality. However, the immense use of power electronics based equipment and nonlinear loads at PCC generate harmonic currents, which may deteriorate the quality of power. To control the inverter in such a way that to maximum utilize Renewable energy with grid a conventional PI control strategy is presented in paper [1-3].

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Active Power Filters (APF) are tremendously used to compensate current harmonics and load unbalance. The Active power filter topology[4] can be connected either in series or shunt and also in combination of both. Shunt Active filter is most advantageous than Series Active filter because most of the industrial application require current harmonics compensation. In distribution system Current controlled Voltage Source Inverter (VSI) is used to interface the variable RES with the system. This paper suggests the new control strategy for four leg VSI which is capable of simultaneously compensating problems like current imbalance and current harmonics to improve power quality and also to inject the energy generated by renewable energy power sources with a very low Total Harmonic Distortion (THD).

II. POWER QUALITY

The quality assurance of electric power demands a deep research and study on the subject "Electric Power Quality". The interesting discussions and their proposals lead to various definitions of "Power Quality". It is term which different people described in different ways as follows: Institute of Electrical and Electronic Engineers(IEEE) Standard IEEE1100 defines power quality as "the concept of powering and grounding sensitive electronic equipment in a manner suitable for the equipment."Electric Power Quality (EPQ) is a term that refers to maintaining the near sinusoidal waveform of power distribution bus voltages and currents at rated magnitude and frequency. Thus PQ is often used to express voltage quality, current quality, reliability of service, quality of power supply etc. Power quality problem is an occurrence manifested as a nonstandard voltage, current or frequency that results in a failure or a bad operation of end user equipment. Otherwise a PQ problem means voltage flickers, transients, poor power factor and harmonics. The integrated solution to the power quality problems encountered in the distribution area is "custom power" technology which mainly focuses on power quality and reliability. The concept of custom power was introduced by N.G.Hingarani [5].[6] described the power electronics-based equipment, which are called power conditioners are use to solve power quality problems. Power conditioners are also called Distribution FACTS(DFACTS) devices. The comparison of the operating modes and applications of FACTS was explained in [7].Like flexible ac transmission systems (FACTS) for transmission systems, the term custom power (CP) pertains to the use of power electronic controllers for distribution systems.



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The custom power enhances the reliability and quality of power that is delivered to the customers.

III. PROPOSED CONFIGURATION

The schematic diagram of proposed system which consists of RES connected to dc-link of a grid interfacing inverter with non-linear load as shown in fig 1. Grid is connected to step down transformer with reduce voltage level for distribution side. VSI interfaces the renewable energy sources to grid and also delivers the generated power as it is considered as a key element of Distribution Generation (DG) system. The RES may be DC source or AC source with rectifier coupled to dc link. Power conditioning (dc/dc or ac/dc) is required for power generated from wind energy renewable source because of variable ac power from variable wind turbine before it was connected to dc link. The dc capacitor allows independent control of converters on either side of dc-link and decouples the RES from the grid.

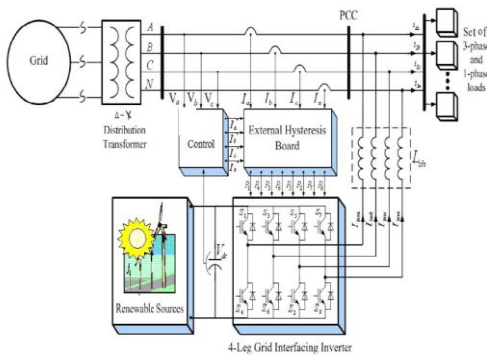


Fig.1 Schematic Diagram of Proposed System

The proposed control approach compensates harmonics, unbalance and neutral current when a nonlinear load is connected to Point OF Common Coupling (PCC). The essentiality of fourth leg of an inverter is compensation of neutral current of load. The information regarding the active power in between renewable source and grid carries by the dc-link voltage. The error between dc-link reference voltage (V_{dc}^*) and actual dc-link voltage (V_{dc}) is given to Proportional Integral (PI) controller and error and change in error are given to fuzzy controller which are inputs to the proposed controller (hybrid controller). The Hybrid PI-Fuzzy control scheme uses fuzzy as a adjustor to adjust the parameters of proportional gain K_p and integral gain K_i based on the error and change of the error.

To track the reference grid currents accurately by the actual grid currents a hysteresis current controller is taken along with the duty of triggering the gate pulses of VSI. This enables the grid to supply or absorb the fundamental active power, while the RES interfacing inverter fulfills the unbalance, reactive, nonlinear current requirements of 3phase 4wire load at PCC.

A. Wind Energy Generating System

In this configuration, wind generations taken is constant speed with pitch control turbine. In the proposed scheme due to simplicity nature an induction generator is used in wind energy source. Wind Energy Conversion Systems exhibit variability in their output power as a result it poses a lot of challenges to the utility operators in terms of the

power system grid integrity i.e. power system security, power system stability and power quality[8]. Induction generator does not require a separate field circuit as of synchronous machine. Constant or variable loads will be given to induction generator. Another advantage of induction generator is that it is having natural protection against short circuit. The available power of wind energy system is as

$$P_{wind} = 0.5\rho A V_{wind}^3 \quad (1)$$

Where ρ =air density (kg/m^3), A =area swept out by turbine blade(m), V_{wind} =wind speed(m/s). It is not possible to extract all kinetic energy of wind. The fraction of power which is extracted by wind turbine is called power coefficient ' C_p ' of wind turbine and is given by

$$P_{mech} = P_{wind} * C_p \quad (2)$$

The mechanical power produced by the wind turbine is

$$P_{mech} = 0.5\rho\pi R^2 V_{wind}^3 C_p \quad (3)$$

In the fixed-speed wind turbine operation, all the fluctuations are in mechanical torque, electrical power on the grid and leads to large voltage fluctuations. Grid-connected wind turbines are having fluctuations in the output powers depending on the wind turbine type. The reasons for power variations are by the effect of turbulence, wind shear and tower-shadow in the power system. In transmission and distribution network the power quality issues due to the wind generation are voltage sag, swells, flickers, harmonics etc. The wind generator introduces disturbances in the distribution network. So, one of the regular methods of running the wind generating system is with the induction generator connected directly to the grid system. For selection of the induction generator in the wind energy system the reasons are effective cost and robustness. For magnetization purpose induction generators require reactive power. When the generated active power of an induction generator is having variable nature due to wind, absorbed reactive power and terminal voltage of an induction generator can be affected. So under normal operating condition in wind energy generating system a proper control scheme for the active power production is required. The capacity of wind energy which is modeled in this paper is of 1.5MW with pitch angle zero degrees. Fig.2 shows the wind energy generation modeling in simulink.

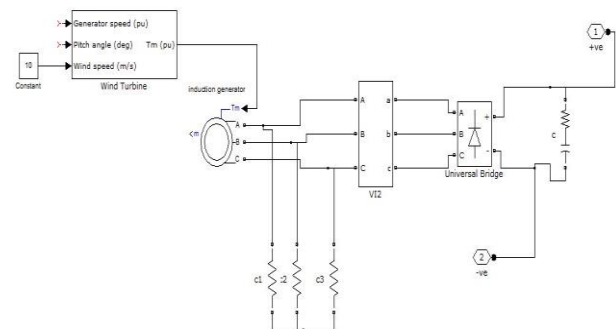


Fig.2 Simulink model of a wind energy generating system



B. Shunt Active Power Filter (DSTATCOM)

The objective of SAPF is to minimize the distortion in power supply using four main components are DC capacitor, Voltage source inverter (VSI), Coupling transformer, Reactor. A Distribution Static Compensator is in short known as D-STATCOM. It is a power electronic converter based device used to protect the distribution bus from voltage unbalances. It is connected in shunt to the distribution bus generally at the PCC. D-STATCOM is used to compensate load current harmonics by injecting equal but opposite compensating current. The active filter has an additional capability to regulate the distribution line voltage by means of adjusting reactive power.

A Voltage Source Converter [10-11] (VSC) is a power electronic device that is connected in shunt to the system. It can be used for injection of the controllable ac voltage and also generates a sinusoidal voltage with any required frequency, magnitude and phase angle. The DC voltage across the storage devices can be converted into a set of three phase AC output voltages by VSC. It has also capable to generate or absorbs reactive power. If the output voltage of the VSC is greater than the AC bus terminal voltages, it is said to be in capacitive mode. so, it will compensate the reactive power through AC system. The type of power switch used is an IGBT in anti-parallel with a diode. VSC can also be used for mitigation of some of the power quality issues like flicker, interruption of harmonics. The three phase four leg VSI is modeled in Simulink by using IGBT switches.

IV. CONTROL STRATEGY

Due to intermittent nature of RES, the generated power is of variable nature. To transfer the variable power generated from renewable energy source to the grid dc-link plays a prominent role. The representation of RES will be as current sources connected to the dc-link of a grid-interfacing inverter. The dc-link capacitor decouples the RES from grid and allows the independent control of inverter on either side of dc-link. P_1 to P_8 are switching signal of inverter for three leg where as P_7 and P_8 are for fourth leg which are multiplied with constant zero to compensate neutral current [11].

A. Control Of Grid Interfacing Inverter

The control diagram of grid-interfacing inverter for 3-phase 4-wire system using hybrid PI-Fuzzy method is shown in Fig.3. The fourth leg of inverter is used to compensate the neutral current of load. The main aim of proposed approach is to regulate the power at PCC during:

- 1.) $P_{RES}=0$;
- 2.) $P_{RES}<total\ load\ power(P_L)$
- 3.) $P_{RES}>P_L$

While performing the power management operation, the inverter is actively controlled in such a way that it always draws/supplies fundamental active power from/to grid. If the load connected to the PCC is non-linear or unbalanced or combination of both, the given control approach also compensates the harmonics, unbalance and neutral current. The duty ratio of inverter switches are varied in a power

cycle such that the combination of load and inverter injected power appears as balanced resistive load to grid. The regulation of dc-link voltage carries the information regarding the exchange of active power in between renewable source and grid. Thus the output of dc-link voltage regulator results in an active current (I_m). The multiplication of active current component (I_m) with unity grid voltage vector templates (U_A, U_B, U_C) generates the reference grid currents (I_A^*, I_B^*, I_C^*). The reference grid neutral current (I_N^*) is set to zero, being the instantaneous sum of balanced grid currents. In three phase balanced system, the RMS voltage source amplitude is calculated at sampling frequency from source phase voltage (V_a, V_b, V_c) and is expressed is V_m peak voltage.

$$V_m = \{2/3(V_a^2 + V_b^2 + V_c^2)\}^{1/2} \quad (4)$$

The in-phase unit vectors are obtained from AC source phase voltages and RMS values of unit vectors are obtained as

$$U_A = V_a / V_m \quad (5)$$

$$U_B = V_b / V_m \quad (6)$$

$$U_C = V_c / V_m \quad (7)$$

The actual dc-link voltage (V_{DC}) is sensed and passed through a first-order low pass filter (LPF) to eliminate the presence of switching ripples on the dc-link voltage and in the generated reference current signals. The difference of this filtered dc-link voltage (V_{DC}^*) is given to a discrete -PI regulator to maintain a constant dc-link voltage under varying generation and load conditions. The dc-link voltage error $V_{DCerr(N)}$ at nth sampling instant is given as :

$$V_{DCerr(N)} = V_{DC(N)}^* - V_{DC(N)} \quad (8)$$

The output of discrete PI regulator at nth sampling instant is expressed as

$$I_m(N) = I_m(N-1) + K_{PVdc}(V_{DC(N)} - V_{DC(N-1)}) + K_{IVdc} V_{DCerr(N)} \quad (9)$$

Where $K_{PVdc}=10$ and $K_{IVdc}=0.05$ are proportional and integral gains of dc-voltage regulator. The instantaneous values of reference three phase grid currents are computed as

$$I_A^* = I_m^* U_A \quad (10)$$

$$I_B^* = I_m^* U_B \quad (11)$$

$$I_C^* = I_m^* U_C \quad (12)$$

The neutral current, present if any, due to the loads connected to the neutral conductor should be compensated by fourth leg of grid interfacing inverter and thus should not be drawn from the grid. The neutral current compensation is explained in [12]. In other words, the reference current for the grid neutral current is considered as zero and can be expressed as:

$$I_N^* = 0 \quad (13)$$

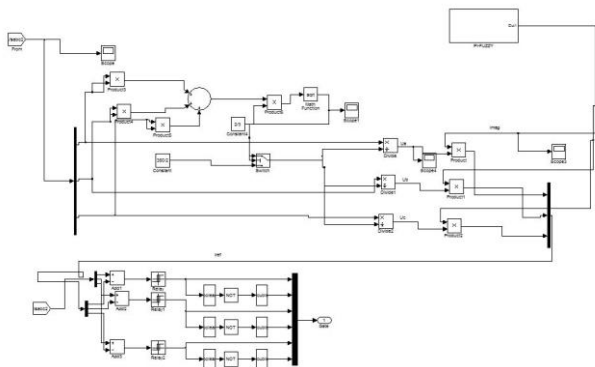


Fig.3 shows the simulink model of an controlling of grid interfacing inverter of proposed hybrid controller method.

B. Hysterisis Current Controller

The current control strategy plays an important role in the development of shunt Active filter. Hysterisis current control is one of the most common current control strategy. This is a method of generating the required triggering pulses by comparing the error signal with that of the hysteresis band and it is used for controlling the voltage source inverter so that the output current is generated from the filter will follow the reference current waveform .The reference grid currents ($I_A^*, I_B^*, I_C^*, I_N^*$) are compared with actual grid currents (I_A, I_B, I_C, I_N) to compute the current errors as:

$$\left. \begin{aligned} I_{Aerr} &= I_A^* - I_A \\ I_{Berr} &= I_B^* - I_B \\ I_{Cerr} &= I_C^* - I_C \\ I_{Nerr} &= I_N^* - I_N \end{aligned} \right\} \Rightarrow (14)$$

This method controls the switches of the voltage source inverter asynchronously to ramp the current up and down ,so that it follows the reference current. Hysterisis current control method is the easiest control method to implement in the real time. Fig 4 illustrates the ramping of the current between the two limits where the upper limit is the sum of the reference current and the maximum error or the difference between the upper limit and the reference current and for the lower hysteresis limit, it is the subtraction of the reference current and the minimum error. Fig.4 shows the hysteresis current controller.

According to the operating principle of the inverter, the output voltages of the each phase are significant to the switching pulses of the switches in each leg. As a result, the switching gates for the active power filter can be obtained. The switching pattern of each IGBT inside inverter can be formulated on the basis of error between actual and reference current of inverter, which can be explained as:

If $I_{INVA} < (I_{INVA}^* - h_b)$ then upper switch will be OFF ($P_1=0$) and the lower switch S_4 will be ON ($P_4=1$) in the phase "A" leg of the inverter.

If $I_{INVA} > (I_{INVA}^* + h_b)$, then upper switch will be ON ($P_1=1$) and lower switch S_4 will be OFF ($P_4=0$) in the phase "A" leg of the inverter. Where h_b is the width of the hysteresis band. similarly, switching pulses are derived for other three leg.

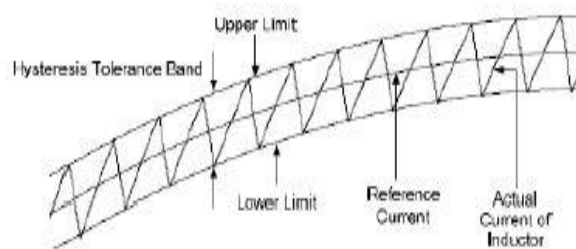


Fig.4 schematic diagram of hysteresis current controller

C. Controllers

There are three controllers used in this paper which are

1. PI Controller
2. Fuzzy Logic Controller
3. Hybrid Controller

PI Controller: A PI Controller is a proportional gain in parallel with an integrator. The proportional gain provides fast error response. The integrator drives the system to zero steady state error. The error signal is usually processed using a Proportional-Integral (PI) Controller whose parameters can be adjusted to optimize the performance and stability of the system. Conventionally a PI controller is used to maintain the dc- link voltage to the reference value. The error signal is given to discrete PI regulator to maintain a constant dc-link voltage under varying generation and load conditions but its transient response is poor.

Fuzzy Logic Controller: Today control systems are usually described by mathematical models that follow the laws of physics, stochastic models or models which have emerged from mathematical logic. A general difficulty of such constructed model is how to move from a given problem to a proper mathematical model. Fuzzy logic is a complex mathematical method that allows solving difficult simulated problems with many inputs and output variables. Fuzzy logic is able to give results in the form of recommendation for a specific interval of output state, so it is essential that this mathematical model is strictly distinguished from the more familiar logics, such as Boolean algebra. This paper contains a basic overview of principles of fuzzy logic. Usually fuzzy logic control system is created from four major elements which are presented in Fig.5

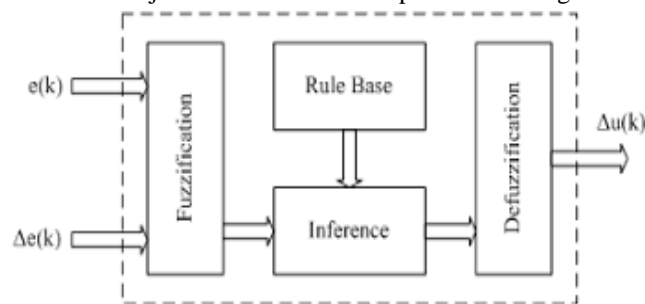


Fig.5 Block diagram of fuzzy logic controller

Fuzzification method: Firstly, a crisp set of input data are gathered are converted to a fuzzy set using a set of linguistic variables and membership functions this process is defined as fuzzification. Pre-defined membership functions will be helpful.



to the input parameters which are given based on output to be fuzzified. The most common membership functions are: triangular shape, trapezoidal, sinusoidal and exponential. In this paper the membership function used is of triangular shape. The degree of membership function is determined by placing a chosen input variable on the horizontal axis, while vertical axis shows quantification of grade of membership of the input variable. Membership function degree can vary between zero and one. Membership function will be unique to every input parameter associated. The membership functions associate a weighting factor with values of each input and the effective rules. The membership functions used in FLC for the two inputs can be shown in Fig.6 and Fig.7

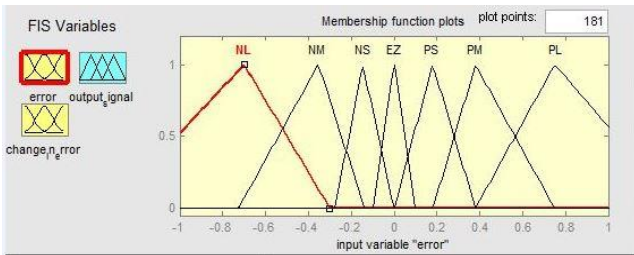


Fig.6 Membership function for input error

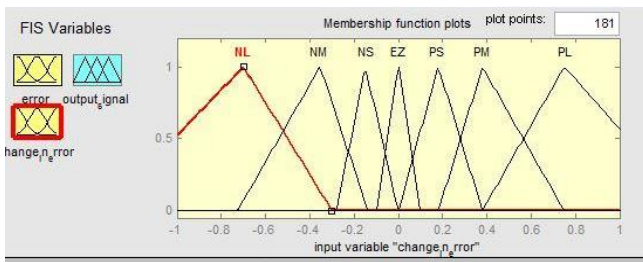


Fig.7 Membership function for change in error

Rule matrix: It is used to describe fuzzy sets and fuzzy operators in the form of conditional statements. A single fuzzy IF-THEN rule can be as follows

if x is A then y is Z

where A is a set of conditions that have to be satisfied and Z is a set of consequences that can be inferred. The rule matrix is a simple graphical tool for mapping the fuzzy logic control system rules. It accommodates two or more input variables and express their logic product (AND or OR) as one output response variable. Here seven fuzzy subsets have been used for two inputs which are Positive Large(PL), Positive Medium(PM), Positive Small(PS), Extreme Zero(EZ), Negative Large(NL), Negative Medium(NM), Negative Small(NS). The following Fig shows the rules used in this rule matrix of fuzzy logic controller.

e / Δe	NL	NM	NS	EZ	PS	PM	PL
NL	NL	NL	NL	NL	NM	NS	NL
NM	NM	NL	NL	NM	NS	EZ	NM
NS	NL	NL	NM	NS	EZ	PS	NS
EZ	NL	NM	NS	EZ	PS	PM	EZ
PS	NM	NS	EZ	PS	PM	PL	PS
PM	NS	EZ	PS	PM	PL	PL	PM
PL	EZ	PS	PM	PL	PL	PL	PL

Fig.8 Rules used in Fuzzy logic controller

Inference Mechanism: Inference mechanism allows mapping given input to an output using fuzzy logic. It uses

all pieces described in previous sections: membership functions, logical operations and if-then rules. The most common types of inference systems are Mamadani and Sugeno. They vary in ways of determining outputs. In this paper mamadani inference mechanism is used.

Defuzzification Mechanisms: Defuzzification task is to find one single crisp value that summarizes the fuzzy set. There are several mathematical techniques available: centroid, bisector, mean, maximum and weighted average. In this paper the defuzzification method used is centroid. Centroid defuzzification is very commonly used method, as it is very accurate. It provides centre of the area under the curve of membership function. For complex membership functions it puts high demands on computation. It can be expressed by the following formula

$$Z_0 = \frac{\int u_i(x)xdx}{\int u_i(x)dx}$$

Where z_0 is defuzzified output, u_i is a membership function and x is output variable.

Hybrid controller: Here in this paper a controller i.e Hybrid PI with Fuzzy logic controller has been introduced. Such that it can take both advantages of PI controller and Fuzzy controller. The objective of hybrid controller[10] is to utilize the best attributes of the PI and Fuzzy logic controllers to provide a controller which will produce better response than either the PI or fuzzy controller. There are different types of fuzzy logic controller. This new hybrid control strategy comes under the category of “Add-on controller” of FLC. The block diagram of ADD-ON Controller is as shown in Fig.9 There are two major differences between the tracking ability of the conventional PI controller and fuzzy logic controller. Both the controllers provide reasonably good tracking for steady

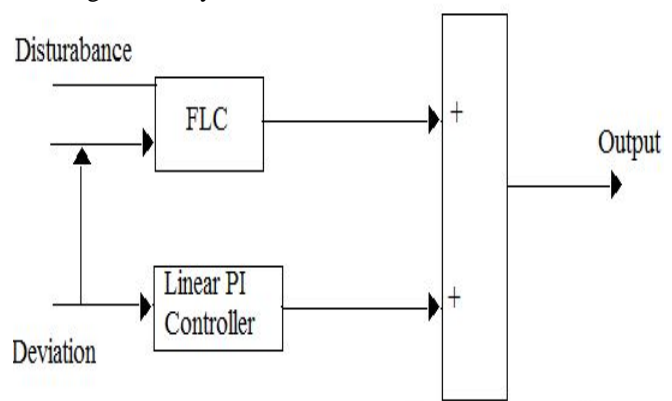


Fig.9 Block diagram of ADD-ON Controller

or slowly varying operating conditions. However, when there is a step change in any of the operating conditions, such as may occur in the set point or load, the PI controller tends to exhibit some overshoot or oscillations. The fuzzy controller reduces both the overshoot and extent of oscillations under the same operating conditions. Although the fuzzy controller has a slower response by itself,

it reduces both the overshoot and the extent of oscillations under the same operating conditions. The desire is that by combining the two controllers, one can get the quick response of the PI controller by eliminating the overshoot possibly associated with it. Switching control strategy the switching between the two controllers needs a reliable basis for determining which controller would be more effective. The answer could be derived by looking at the advantages of each controller. Both controllers yield good response to steady state or slowly changing conditions. To take advantage of rapid response of the PI controller, one needs to keep the system responding under the PI controller for a majority of time and use the fuzzy controller only when the system behavior is oscillatory or tends to overshoot. Hybrid PI-Fuzzy base control scheme uses fuzzy as a adjustor to adjust the parameters of proportional gain K_p and integral gain K_i based on the error e and change in error δe . Hybrid controller has been designed by taking inputs as error which is difference between measured voltage and reference voltage for voltage regulator and its derivative while ΔK_p and ΔK_i as output for voltage regulator where K_p and K_i are proportional gain integral gain respectively.

V. SIMULATION RESULTS

The proposed system of a 3phase 4wire grid interfacing inverter with hybrid control strategy results are verified in MATLAB Simulation. The Simulink model is as shown in fig.10

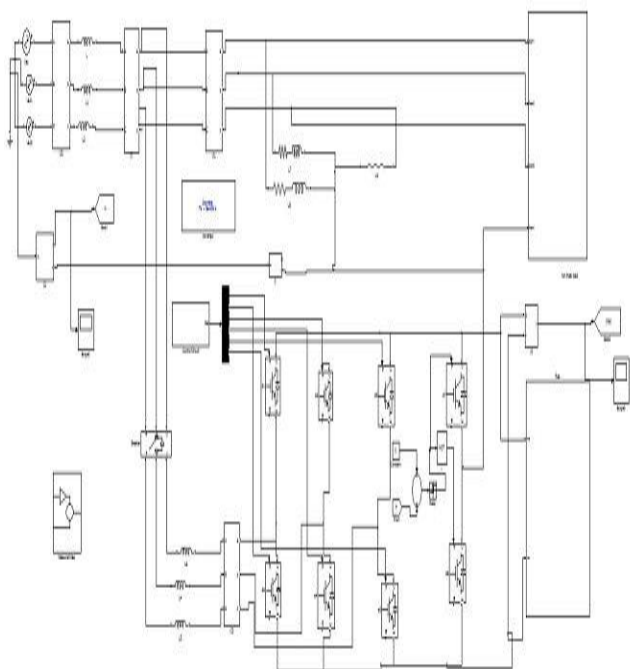


Fig.10 Simulink model of proposed system

The inverter is turned on at $t=0.1$ sec such that it effectively controlled and compensated the harmonics due to unbalance nature of non-linear load. So, a non-linear load is connected to 3 phase 4 wire grid interfacing inverter with shunt active filter topology to compensate load harmonics, current unbalance and to inject power from RES to grid with low THD and the results are shown from fig.11 to fig.13

CASE 1: BY USING PI CONTROLLER

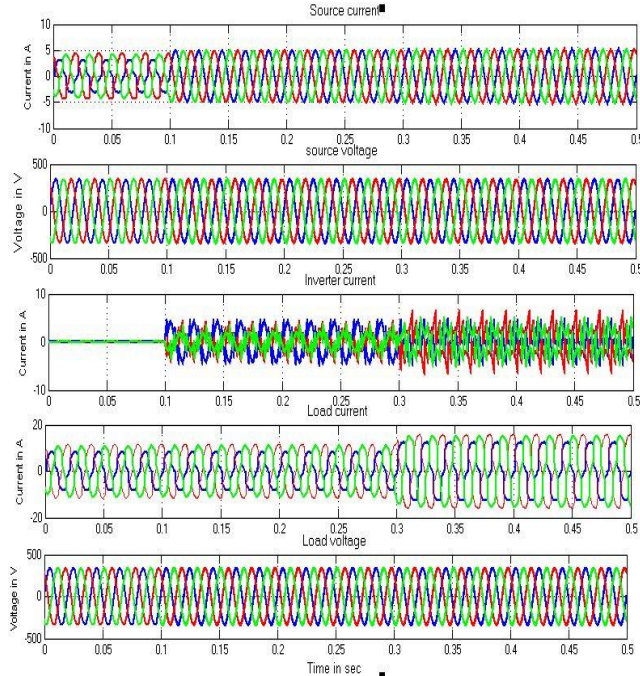


Fig.10 Simulation results of PI controller a.) Source current b.) Load current c.) Inverter current d.) Source voltage e.) Load voltage.

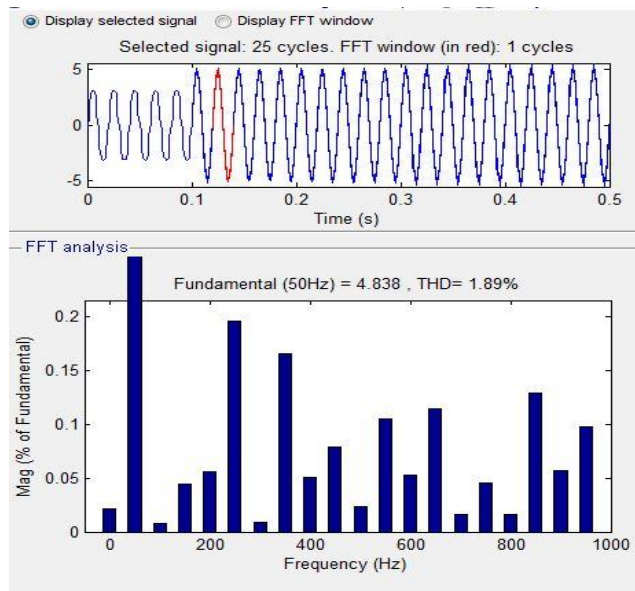


Fig.11 THD Analysis of source current of PI controller

Sources of harmonics are non-linear loads, DGs which use power electronic converters. In this paper, non-linear load of diode bridge rectifier have influence the source current waveform and produce harmonics. Harmonics generate problems like distortions in voltage, current, overheat, ageing of insulation and resonance. So, in this paper DSTATCOM is used to reduce THD by producing equal and opposite action to harmonics developed due to non linear load. THD is an index is used to measure the deviation of a periodic wave form containing harmonics from a perfect sine wave. For a perfect sine wave at fundamental frequency,

the THD is zero. By using FFT analysis, source THD is calculated as 1.89% due to non-linear load diode bridge rectifier for PI controller at time $t=0.1$ second.

Case 2: By using Hybrid controller

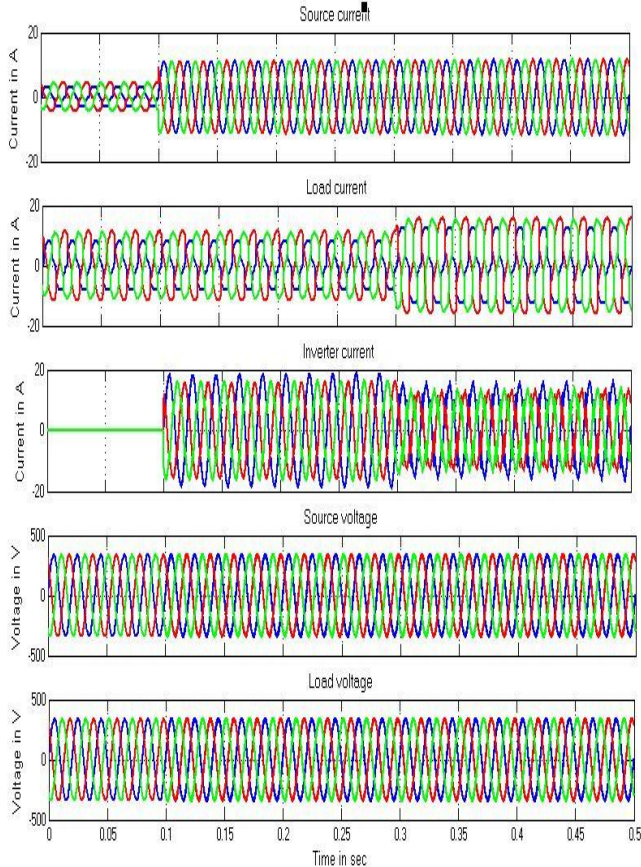


Fig.12 Simulation results of Hybrid controller a.)Source current b.)Load current c.)Inverter current d.)source voltage e.)Load voltage.

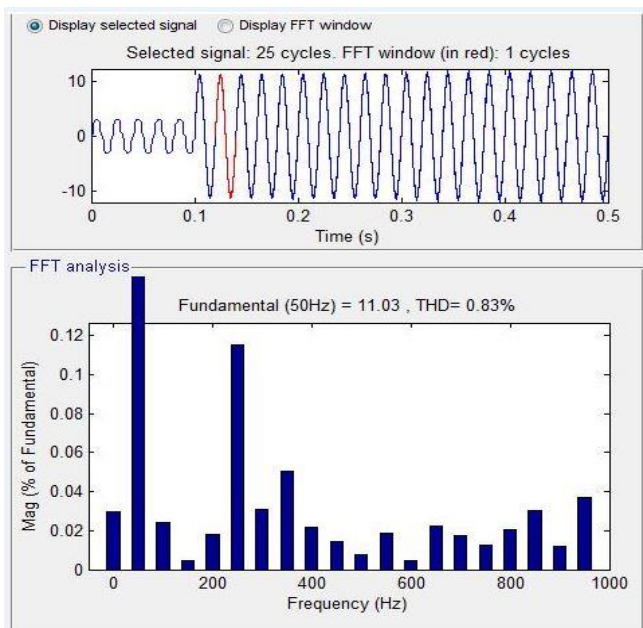


Fig.13 THD Analysis of Source current of Hybrid controller

The THD Analysis of proposed controller for source current is analyzed as shown in fig.13 which is 0.83% reduced than PI controller.

Table1 Comparitive analysis of THD with PI, Fuzzy, Hybrid controllers without DSTATCOM.

Controllers	Source current	Load current	Load voltage
PI Controller	16.50%	26.51%	0.44%
Fuzzy controller	16.50%	26.21%	0.44%
Hybrid controller	16.50%	26.21%	0.44%

By using three controllers which are PI, Fuzzy logic, Hybrid controllers for source currents, load currents, inverter current and load voltage THD values are evaluated without DSTATCOM .Source current is unbalanced without the presence of DSTATCOM and so it has THD value 16.50%.

Table2 Comparitive analysis of THD with PI, Fuzzy, Hybrid controllers with DSTATCOM

controllers	Source current	Load current	Inverter current	Load voltage
PI Controller	1.89%	16.73%	34.92%	2.84%
Fuzzy controller	0.06%	16.73%	34.92%	2.84%
Hybrid controller	0.83%	16.72%	7.24%	2.80%

Table 2 shows the comparative analysis of currents and voltages for different controllers in the presence of DSTATCOM at time $t=0.1$ s. At time $t=0.1$ s the inverter is connected to grid. It balances the source current from time $t=0.1$ s. THD value is measured for source current, load current, inverter current, load voltage. For PI controller the source current has high THD value when compared to our proposed Hybrid controller.

Table3 Comparitive analysis of THD with PI, Fuzzy, Hybrid controllers with DSTATCOM at $t=0.3$ s

Controllers	Source current	Load current	Inverter current	Load voltage
PI controller	3.19%	21.14%	219.82%	2.83%
Fuzzy controller	0.09%	21.14%	219.84%	2.82%
Hybrid controller	1.32%	21.19%	17.39%	2.81%

At time $t=0.3$ s the load is increased. so there will be changes in the load current and THD values for currents and voltages are analyzed at this time in presence of DSTATCOM.

Inverter current and source current has high THD values at this time than $t=0.1$ s. When compared with three controllers the THD value is low for proposed hybrid controller.

VI. CONCLUSION

This paper presented the effective control of grid interfacing 3 phase 4 wire inverter which is connected to non-linear load by introducing a new hybrid control strategy with power quality improvement features. The inverter functions as a multi function device by performing the actions like power transfer from RES to grid and shunt active filter (DSTATCOM) topology thereby eliminating the unbalance nature due to nonlinear load, harmonics elimination and injection of power to grid with low THD. Also, Harmonics level of source current is 1.89% with PI controller. After implementing hybrid controller in place of PI controller the harmonic level is reduced to 0.83%. All these works are performed in MATLAB/SIMULATION and compared the THD analysis of different controllers at different times along with new hybrid control strategy by compensating current harmonics that facilitates improvement of power quality in the distribution network.

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