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Solar Pv System By Grid Connected To Droop Control Strategy For Shunt Active Power Filter Application

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ABSTRACT

Solar energy technologies are need of the hour due the depletion of the existing conventional energy resources. The major advantage of solar energy is the eco friendly nature and abundant availability. The problem of harmonics persists everywhere in the power system whenever non linear load or static devices are involved. The ultimate goal of the power system to deliver quality power to the consumer. The paper describes the novel method of using Shunt active power filter in gird interfaced PV system in presence of static loads which exhibit non linearity between voltage and current. This system provides VAR compensation and also takes care about harmonics using droop control technique. The solar module is connected the power filter, where the DC-DC converter acts an interfacing medium.The solar module is combined with an appropriate power tracking algorithm which surpases the disadvantages of the usual traditional method. The simulation study shows the effectiveness of the proposed system. MATLAB Simulink platform is utilized to demonstrate the uniqueness of the proposed system

I. INTRODUCTION

The power demand is always behind the electric power supply in ever growing and developing country like India. This calls for the essence of the non conventional energy sources like solar, wind ,hydro etc. The conventional methods of power generation are taking backstage due to depleting nature and preference is given by the Indian government to promote new and alternate energy generation methods in sustainable manner. The growth and development of SCR in thyristor family generally accounts for extensive use of static equipment. This also leads of the problem of harmonics or distortions in the voltage and current waveforms. Another major problem at the load side is the watt-less power requirement. The shunt active power filter is generally used in the power system as it takes care of both these problems. The main aim of this equipment is that it supplies a current which is same as harmonic distorted current in terms of value but anti parallel in direction in order to nullify the effect of harmonics. There are various names for Shunt active power filter such as active power filter, power filter, active filter, SAPF, APF are predominantly used in this paper. The system considered here is the solar system connected the gird and SAPF mitigates reactive power requirement as well as harmonic content.

The AC supply is fed the static load; in this case, it is the diode-based rectifier with resistive and inductive load,

I_S–current of the AC source

I_L - current of the static load

I_C– current fed by the shunt active filter for harmonic reduction

L_S–inductance of the source

L_L – inductance of the load

L_1 –inductance of the coupling between load and source.

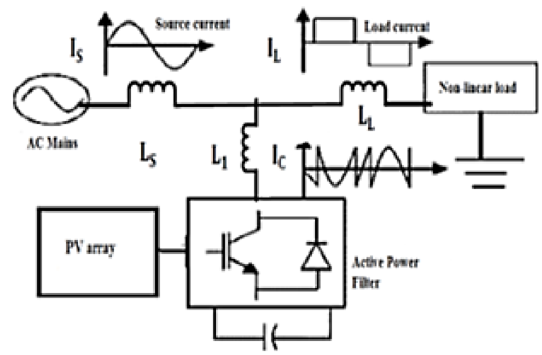

Fig.1 Schematic diagram of active power filter

Here, the shunt APF produced compensating currents of equal in magnitude however contrary in-segment to those harmonics which are present because of non-linear masses which leads to mitigation of harmonics at load modern. Typically, the voltage source inverters (VSI) are used to transform the power of the PV device to inject it to the distribution device. However here, the VSI act as a multifunctional device that is used for power conversion and also for harmonics elimination in addition to reactive electricity repayment simultaneously. This control strategy contains p-q answer as in shunt active electricity clear out technique. This control approach is identical as method utilized in shunt filter out to reduce harmonics in the distribution network due to non-linear loads inside the system.

This paper is prepared as follows phase II presents evaluation on PV cell, its primary principle, connections modeling and effect of temperature and irradiation on PV panel. Segment III defined mppt p & o algorithm and its implementation for max power extraction from a PV device linked to a DC/DC improve converter and its need in PV energy technology in conjunction with its waveforms.Segment IV offers shunt APF design and its manipulate set of rules with implementation of shunt APF control method for inverter control. Phase V describes the received simulation outcomes and its discussions section VI presents the conclusion along side scope for further work.

II. Photovoltaic Systems

PV cells are made of semiconductor materials, for example, silicon. For sun based cells, a thin semiconductor wafer is uniquely treated to shape an electric field, positive on one side and negative on the other. At the point when light vitality strikes the sun-based cell, electrons are thumped free from the molecules in the semiconductor material.

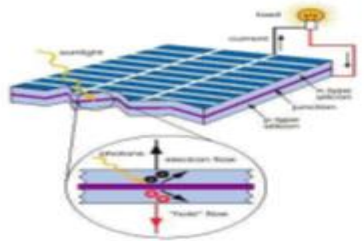

Figure 2 Basic Structure of PV Cell

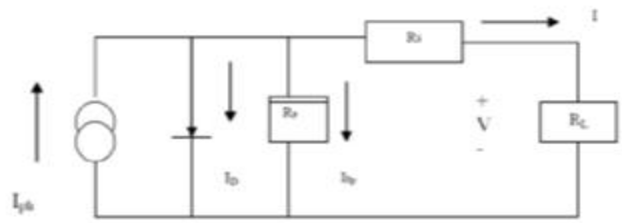

Figure 3 Equivalent circuit of a PV cell

In the event that electrical transmitters are connected to the positive and negative sides, shaping an electrical circuit, the electrons can be caught as an electric current - that is, power. This power would then be able to be utilized to control a heap. A PV cell can either be roundabout or square in development.

A. Modeling of PV Array

The building piece of PV exhibits is the sun based cell, which is essentially a p-n intersection that straightforwardly changes over light vitality into power: it has a comparable circuit as appeared underneath in Figure 3. The present source Iph speaks to the cell photograph current; Rj is utilized to speak to the non-straight impedance of the p-n intersection; Rsh and Rs are utilized to speak to the natural arrangement and shunt protection of the cell individually. Normally the estimation of Rsh is substantial and that of Rs is little, subsequently they might be fail to disentangle the investigation. PV cells are assembled in bigger units called PV modules which are additionally interconnected in arrangement parallel design to frame PV clusters or PV generators[3].The PV numerical model used to disentangle our PV exhibit is spoken to by the condition:

$$I = n_p I_{ph} - n_p I_{rs}[\exp(\frac{q}{KTA} * \frac{V}{n_s}) - 1] \quad (1)$$

where I is the PV cluster yield current; V is the PV exhibit yield voltage; ns is the quantity of cells in arrangement and np is the quantity of cells in parallel; q is the charge of an electron; k is the Boltzmann's consistent; An is the p-n intersection ideality factor; T is the cell temperature (K); Irs is the cell invert immersion current. The factor An in condition (3.5) decides the cell deviation from the perfect p-n intersection attributes; it extends between 1-5 however for our case A=2.46 [3].The cell turn around immersion current Irs shifts with temperature as indicated by the accompanying condition:

$$I_{rs} = I_{rr}[\frac{T}{T_r}]^3 \exp(\frac{qE_G}{KA}[\frac{1}{T_r} - \frac{1}{T}]) \quad (2)$$

Where Tr is the cell reference temperature, Irr is the cell turn around immersion temperature at Tr and EG is the band hole of the semiconductor utilized as a part of the cell. The temperature reliance of the vitality hole of the semi conductor is given by [20]:

$$E_G = E_G(0) - \frac{\alpha T^2}{T+\beta} \quad (3)$$

The Iphcurrent which majorily depends on the irradiance factor and temperation of PV cell is given by:

$$I_{ph} = [\, I_{scr} + K_i(T - T_r)] \frac{S}{100} \quad (4)$$

Where Tr is the cell reference temperature, Irr is the cell turn around immersion temperature at Tr and EG is the band hole of the semiconductor utilized as a part of the cell. The temperature reliance of the vitality hole of the semi conductor is given by [20]:

$$P = IV = n_p I_{ph} V[(\frac{q}{KTA} * \frac{V}{n_s}) - 1] \quad (5)$$

The current to voltage graph for a sun based cluster is non-straight, which makes it hard to decide the MPP. The Figure underneath gives the trademark I-V and P-V bend for settled level of sun powered light and temperature

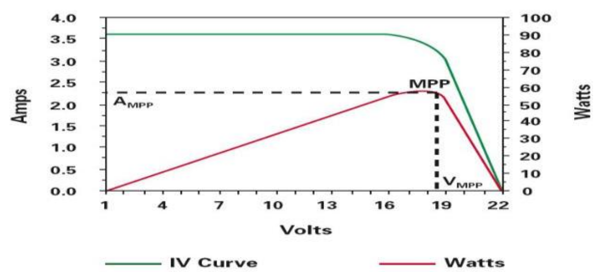

Figure 4 I-V and PV curves

III. Maximum Power Point Tracking System

Most extreme power point following is a basic piece of a photovoltaic framework. Photovoltaic frameworks have a particular working point that gives greatest power. A MPPT effectively looks for this working point. Most extreme Power Point Tracking, regularly known as MPPT, is an electronic game plan that discover the voltage (VMPP) or current (IMPP) routinely at which a PV modules should work to accomplish the greatest power yield (PMPP) under quickly changing ecological conditions. It works the PV modules in a way that allows the modules to produce all the power they are prepared to do.

Sunlight based light that hits the photovoltaic modules has a variable character contingent upon the scope, introduction of the sun oriented field, the season and hour of the day. Over the span of a day, a shadow might be thrown on the cell that might be predicted, as on account of a working close to the sun based field or unforeseeable as those made by mists. Likewise the vitality delivered by each photovoltaic cell relies upon the light and temperature. From these contemplations, the need to distinguish moment by moment that specific point on the V-I normal for the PV generator in which there is the greatest measure of energy exchange to the matrix happens. The created vitality from PV frameworks must be amplify as the proficiency of sun oriented boards is low. Hence to get the most extreme power, PV framework is more than once furnished with greatest power point (MPP) tracker. A few MPP interest procedures are proposed and executed as of late.

In light of the approach utilized for age of the control motion and in addition the PV framework conduct around the enduring state conditions, they are generally ordered into the accompanying gatherings:

1. Offline methods
   - Open circuit voltage (OCV) method
   - Short circuit current method (SCC)
   - Artificial intelligence
2. Online methods
   - Perturbation and observation method (P&O)
   - Extremum seeking control method (ESC)
   - Incremental conductance method (Inc Cond).
3. Hybrid methods

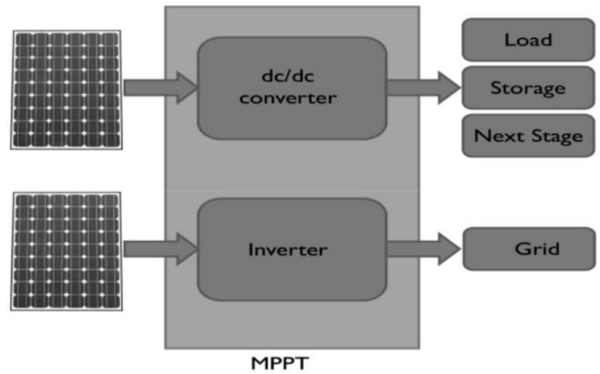

Figure 5 Need of MPPT

A. Perturb and Observe (P&O)

The most generally utilized MPPT calculation is P&O strategy. This calculation utilizes straightforward criticism course of action and minimal measured parameters. In this approach, the module voltage is intermittently given a bother and the relating yield control is contrasted and that at the past irritating cycle. In this calculation a slight irritation is acquaint with the framework. This annoyance causes the energy of the sunlight based module different. In the event that the power increments because of the annoyance then the irritation is proceeded a similar way. After the pinnacle control is achieved the power at the MPP is zero and next moment diminishes and henceforth after that the irritation inverts.

At the point when the steady condition is arrived the calculation wavers around the pinnacle control point. Keeping in mind the end goal to keep up the power variety little the annoyance estimate is stay little. The strategy is progressed in such a style, to the point that it sets a reference voltage of the module relating to the pinnacle voltage of the module. A PI controller at that point demonstrations to exchange the working purpose of the module to that specific voltage level. It is watched some power misfortune because of this bother additionally the neglects to track the most extreme influence under quick changing barometrical conditions. However, remain this method is exceptionally well known and straightforward.

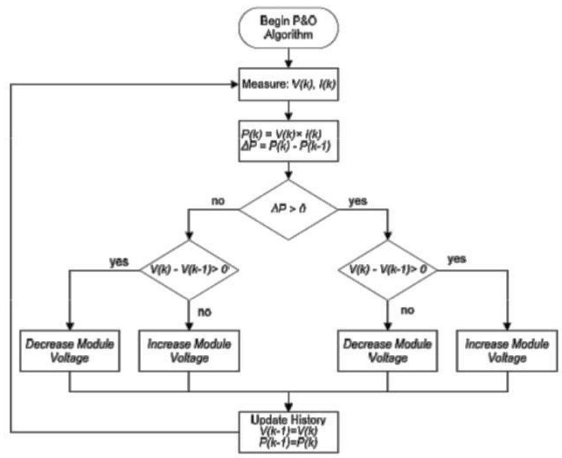

Figure 6. The flow chart of the P&O algorithm

IV. SHUNT ACTIVE POWER FILTER WITH PV SYSTEM

A Shunt Active Filter (SAPF) is the bidirectional current converter with six switches having mix of both exchanging system and channel parts. Structure of this power channel is reliant on the control system of VSI having a capacitor with the end goal of DC vitality stockpiling and the inverter yield has been associated with Non-direct load having diode rectifier connect with a RL-stack. In each of the switches the diodes are associated in against parallel game plan with the IGBTs to allow current stream in either bearing. For pay of responsive power the PV interconnected shunt APF infuses genuine PV energy to a conveyance line at PCC and furthermore diminishes symphonious in stack streams caused by nonlinear loads by infusing repaying current. This channel is associated in shunt that implies in parallel with the nonlinear load. This dynamic channel has capacity of distinguishing the consonant streams caused by the nonlinear loads and after that infuses a current of equivalent greatness and inverse in stage with the non-direct load current which is called remunerating current to diminish the music show in stack ebbs and flows because of Non-straight load. Subsequently, the subsequent current is in type of a basic recurrence sinusoidal current which is attracted at PCC conveyance nerwork.

A Shunt APF generally consists of the following Blocks:
i) IGBT based voltage source inverter (VSI)
ii) DC energy storage
iii) Active control unit

1*p*–*q* theory Based Control

Akagi et al in 1983 [3] created P-Q hypothesis or "immediate active-reactive Power hypothesis" for controlling the dynamic channels. This can be accomplished by changing the voltage and load current into α-β co-ordinates.

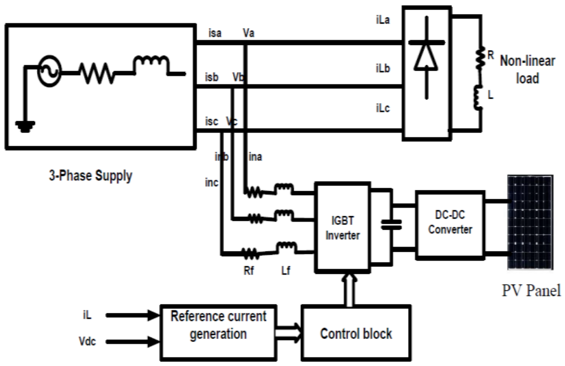

Fig.7 PV system connected to a Shunt APF

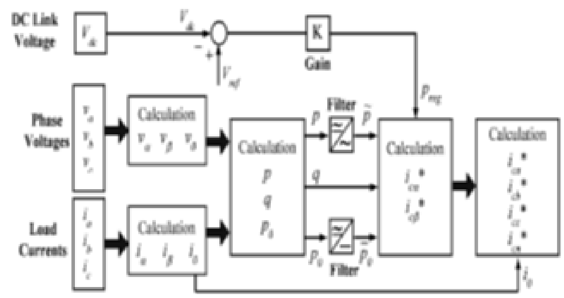

Fig.8 Block diagram of p-q compensation theory

V. Simulation Results

A. Conventional Simulation Circuit

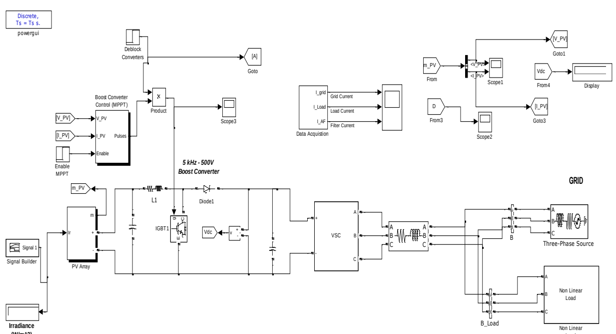

Fig 9 Conventional Simulation Circuit

(i) Case Study for Balanced and unbalanced load:

To analyze the performance of the proposed system under balanced and unbalanced load conditions, source voltage as well as source current is set as sinusoidal but not in phase. The SAF is required to compensate the reactive power only. At t=0.05 to 0.4, the inverter is switched on. At this instant the inverter starts injecting the compensating current so as to compensate the phase difference between the source voltage and current. The supply current is the sum of load current and injected SAF output

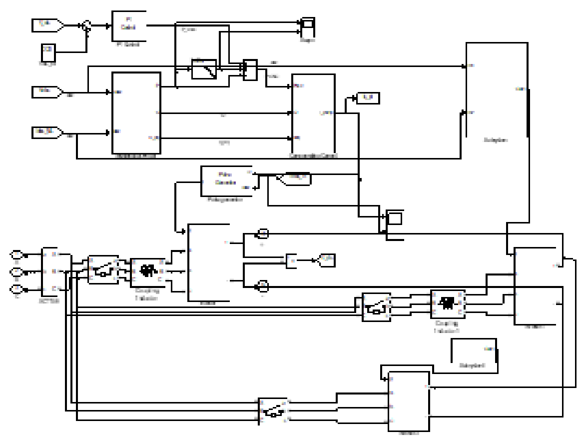

Fig 10 VSC with Filter

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current. During the initial period, there is no load deviation in the load. Hence, the programmable three-phase AC voltage source feeds the total active power to the load. Figure 7.shows the waveforms of (a) Grid Current, (b) Load Current, (c) Inverter current. The real power generated from PV system is supply to the load required demand.

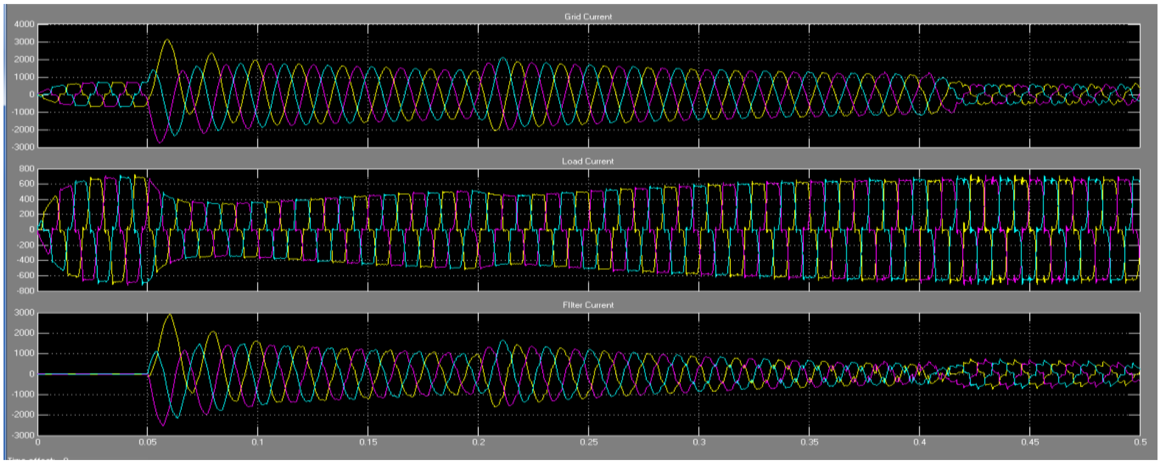

Fig 11 Grid, Load, Filter Current waveforms (Filter on from 0.05 to 0.4)

Amid the uneven load condition, the transient load current changes happen. The Active Power channel is exchanged on at time between t = 0.05 to 0.4. From figure 11 it is watched that the Grid current is twisted from t= 0 to 0.05. At 0.05 channel is exchanged on then the current wavers at 0.05 and it balances out at 0.1 and again the network current gets mutilated because of the turn off of channel at 0.4

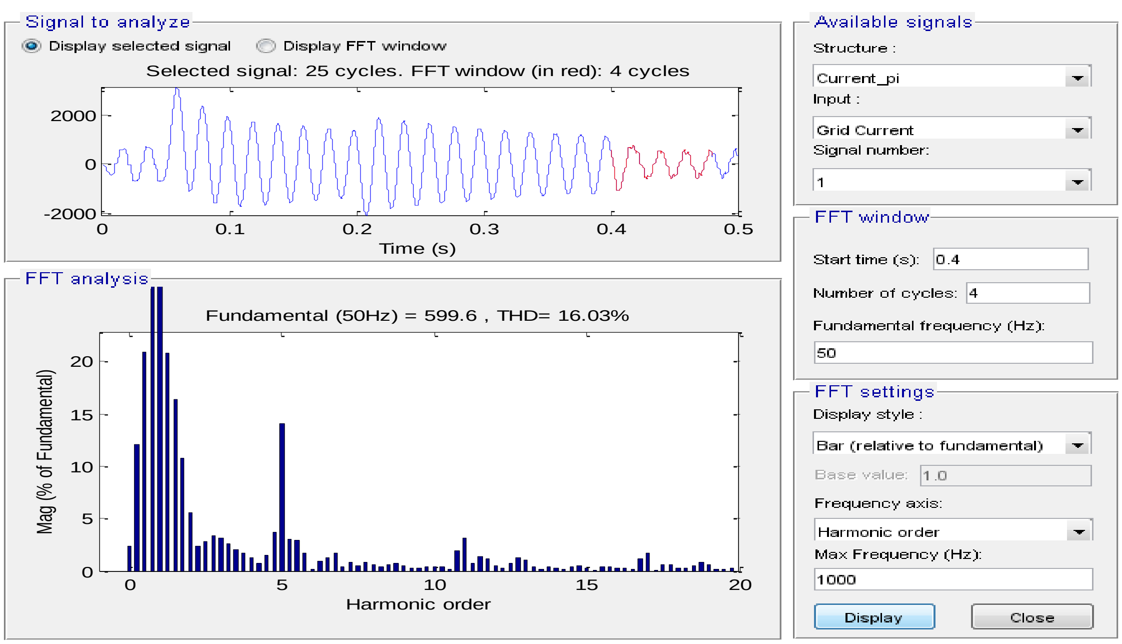

Fig 12 Conventional Circuit THD analysis without filter (16.03%)

The Active Power channel reacts to the present transient and infuses a responsive energy of to reestablish the receptive energy of the heap. The outcomes affirm the great dynamic execution of the APF for a fast change in the heap current. The FFT of the matrix current prior and then afterward pay is done. The present THD is decreased from 16.03% to 2.93% as appeared in Fig.14.

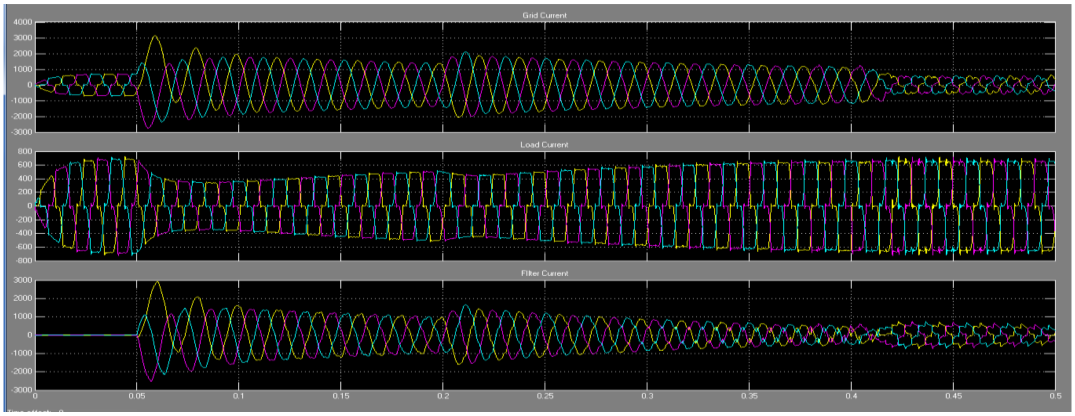

Fig 13 Grid, Load, Filter Current waveforms (Filter on from 0.05 to 0.4)

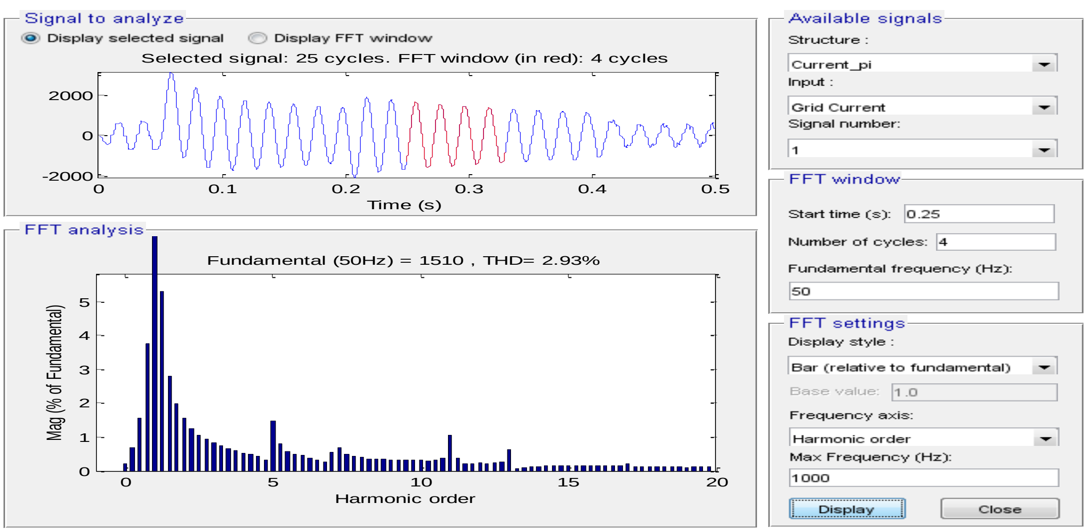

Fig 14 Conventional Circuit THD analysis with filter (2.93%)

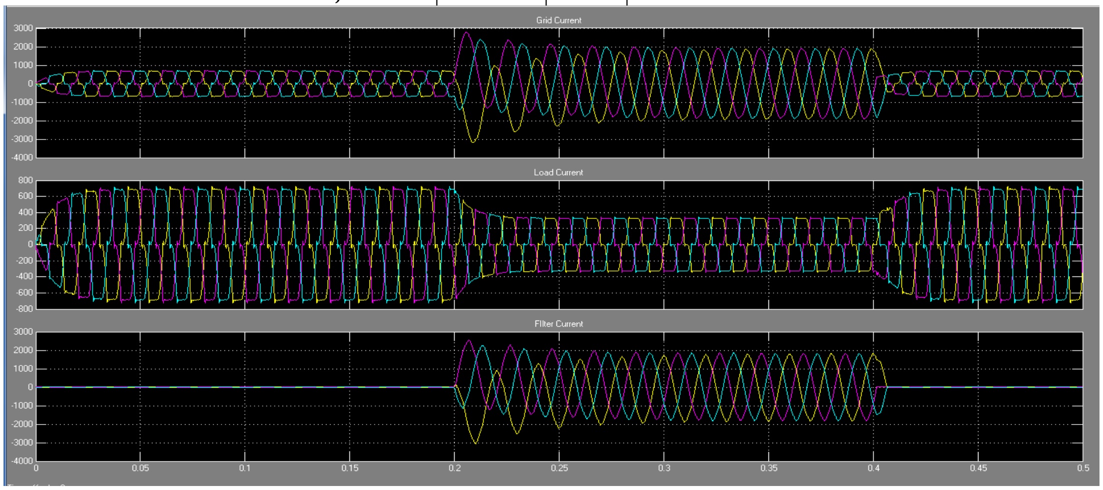

Fig 15 Proposed Method Grid, Load, Filter Current waveforms (Filter on from 0.2 to 0.4)

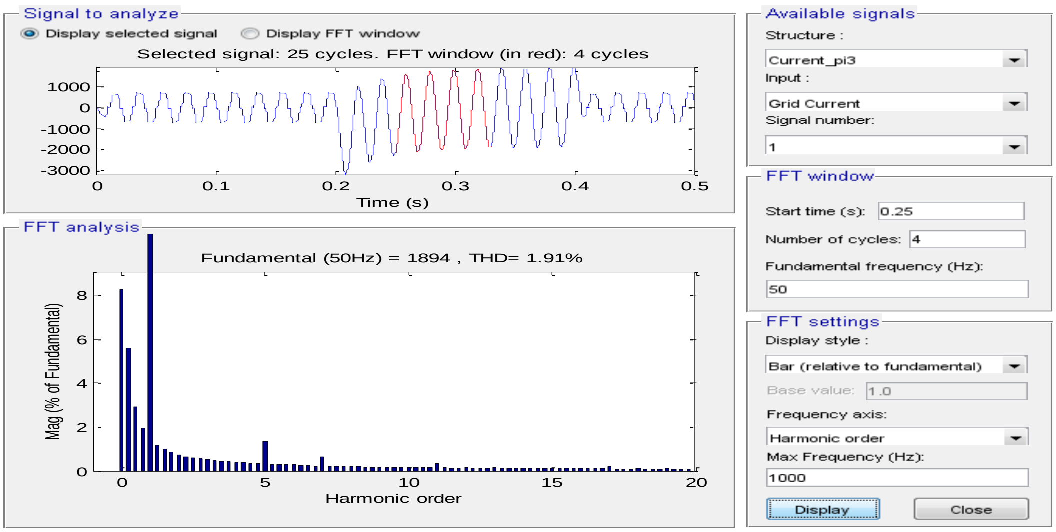

Fig 16 Proposed Circuit THD analysis with filter (1.91%)

It is watched that it demonstrates a decent powerful reaction of APF when a hang control technique is connected to it. The FFT of the matrix current with traditional and proposed strategy is completed. The present THD is lessened from 2.93% to 1.91% as appeared in Fig.16.

Comparison Table

	THD Value
Without Filter THD	16.03
Conventional circuit THD	2.93
Proposed circuit THD	1.91

VI. CONCLUSION

In this paper the Simulink usage of gird associated inverter control strategy has done where the inverter control includes the P-Q compensation hypothesis and hysteresis control for pulse generation for the VSI. This inverter control is connected at the PCC to get the sinusoidal load current. The load current previously, then after the fact inverter control application is finished by Simulink and the waveforms demonstrates the impact of inverter control, where the outcome after inverter control is practically sinusoidal with less harmonic percentage. For the THD examination of load current prior and then afterward the inverter control method application, on the SIMULINK page FFT investigation alternative in the powergui is picked which brings about THD level of the load current previously, then after the compensation. Subsequently, it is seen that in the event of inverter control method add up to consonant mutilation in stack current is 13.69% preceding inverter control and it diminishes to 2.86% after inverter control and furthermore network current is in same stage with gird voltage that is solidarity unity power factor(UPF) happens. So inverter assumes a novel part to control the harmonics and VAR compensation to give just real power at the PCC of the distribution framework. Consequently, it can be inferred that by utilization of Shunt APF the sounds due to a non-linearity of load is remunerated to an extensive incentive to give sinusoidal yield current of various of sinusoidal in nature and furthermore VAR compensation is achieved to give just real power at the distribution system framework.

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