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PV-Active Power Filter for Non linear Load and Compensation of Utility Current

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Abstract:
The electrical phenomenon (PV) generation is progressively in style these days, whereas typical hundreds need additional high-powered quality. Basically, one PV generator supply to nonlinear hundreds is desired to be integrated with a operate as a full of life power filter (APF). during this paper, a three-phase three-wire system, together with a close PV generator, dc/dc boost device to extract most radiation power mistreatment most wall plug trailing, associate degreed dc/ac voltage supply device to act as an APF, is given. The instant power theory is applied to style the PV-APF controller that shows reliable, performances. The MATLAB/Sim power Systems tool has proven that the combined system will at the same time inject most power from a PV unit and compensate the harmonic current drawn by nonlinear hundreds.

Keywords: Active power filter (APF), instantaneous power theory, photovoltaic (PV), power quality, renewable energy.

I. INTRODUCTION:

The environmental issues become a worldwide issue. Whereas the energy demand is considerably increasing against the decreasing reserves of fossil and fissile resources, the electrical phenomenon (PV) energy as AN inexhaustible and clean supply will reply thereto demand. Joined of distributed sources, the PV power is more and more connected to the grid, either in large-scale and small-scale plants. Thus, the PV supply should give the most of its output power, and a most outlet chase (MPPT) technique is employed. MPPT formula allows extracting the most of power regardless of the operative environmental condition, star irradiance (g) and PV cell temperature. Power provides and power quality is vital problems in power grid recently. The grid-connected electrical phenomenon (PV) generator has today become a lot of widespread as a result of its reliable performance and its ability to get power from clean energy resources. The dc output voltage of PV arrays is connected to a dc/dc boost convertor employing a most outlet chase (MPPT) controller to maximise their made energy. Then, that converter is linked to a dc/ac voltage source converter (VSC) to let the PV system push electric power to the ac utility. The local load of the PV system can speci_cally is a non- linear load, such as computers, compact _uorescent lamps, and many other home appliances, that requires distorted currents. Development of a means to compensate the distribution system harmonics is equally urgent. In this case PV generators should provide the utility with distorted com- pensation capability, which makes currents injected/absorbed by the utility to be sinusoidal. Therefore, the harmonic compensation function can be realized through _ exible con- trol of dc/ac VSC.

PV array

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Structure of a typical single-stage PV system

The most used methods among them are: Perturb and Observe (P&O), Incremental Conductance (INC), and Fuzzy Logic (FL) based MPPT

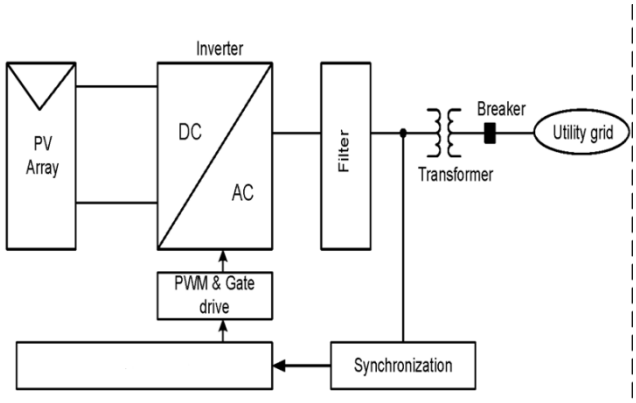


Figure.1. pvm&Gate dirve

Since the earliest MPPT method published in 1960s, we can count over than fifteen MPPT methods [1–4]. They can be classified following to MPP process seeking into indirect and direct method. The indirect methods, such short-circuit and open-circuit methods, need a prior evaluation of the PV panel, or are based on mathematical relationships or database not valid for all operating meteorological conditions. So, they cannot obtain exactly the maximum power of PV panel at any irradiance and cell temperature. On the other side, the direct methods operate at any meteorological condition.. Some direct MPPT can also be classified according to the method by which the command variable is changed.

The main contributions of this paper are threefold.
1) For the _rst time, a fully complete PV-APF combination system is presented.
2) The controller based on instantaneous power theory and instantaneous power balance is proposed to replace the conventional *dq*-current controller for a PV unit.
3) Flexible operation modes of the PV APF combination system are possible in the proposed model.

Proposed design of PV-APF combination.

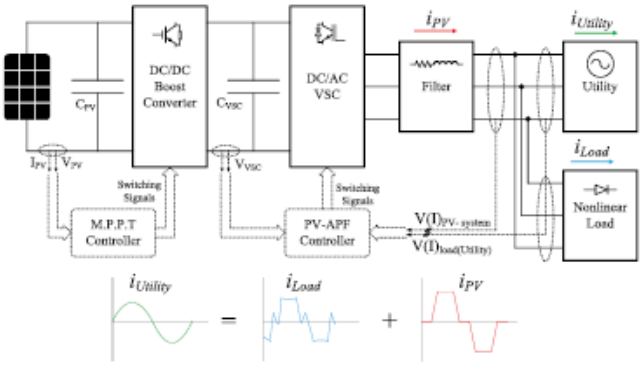


Figure.2. PV-APF

The environmental problems become a worldwide issue. whereas the energy demand is significantly increasing against the decreasing reserves of fossil and fissile resources, the physical phenomenon (PV) energy as associate degree inexhaustible and clean offer can reply to that demand. Joined of distributed sources, the PV power is additional and additional connected to the grid, either in large-scale and small-scale plants. Thus, the PV offer ought to provide the foremost of its output power, and a most outlet chase (MPPT) technique is used. MPPT formula permits to extract the foremost of power no matter the operative status, star irradiance (g) and PV cell temperature. power give and power quality square measure very important issues in installation recently. The grid-connected physical phenomenon (PV) generator has these days become lots of widespread as a results of its reliable performance and its ability to urge power from clean energy resources. The dc output voltage of PV arrays is connected to a dc/dc boost converter using a most outlet chase (MPPT) controller to maximise their created energy. Then, that convertor is connected to a dc/ac voltage supply convertor (VSC) to let the PV system push electrical power to the ac utility. The native load of the PV system will speci_cally be a non- linear load, like computers, compact _uorescent lamps, and plenty of alternative home appliances, that needs distorted currents. Development of a method to compensate the distribution system harmonics is equally imperative. during this case PV generators ought to give the utility with distorted com- pensation capability, that makes currents injected/absorbed by the utility to be curving. Therefore, the harmonic compensation operate may be realised through _exible con- trol of dc/ac VSC.

II. PV-APF COMBINATION SYSTEM

The detailed PV-APF con_guration is shown in Fig. 1, which consists of the following.

1) The PV 5series-66parallel array, which is SunPower SPR-305-type, delivers a maximum of 100-[kW] power at 1000-W/m2 solar irradiance, assuming that there is no battery storage system connected to the dc bus.

2) A 5-kHz boost dc/dc converter implements MPPT by an incremental conductance_integral regulator tech- nique, which automatically varies the duty cycle in order to generate the required voltage to extract maxi- mum power.

3) The dc bus is connected to a two-level three-phase dc/ac VSC with a *C*VSC capacitor. The dc/ac VSC converts the 500 [V] dc to 260 [V]/60 [Hz] ac supplying to
Local nonlinear loads and connects to a stiff utility. The *dq*-current and PV-APF and APF controllers are applied for this dc/ac VSC subsequently.

4) A 10-kVAr capacitor bank filters out switching harmonics produced by the dc/ac VSC.

5) The loads include a three-phase diode rectifier supplying a current of 450 or 50 [A] at dc side and one- phase diode rectifier with 50-[A] dc current connecting Between phase A and phase B to make an overall unbalanced load.

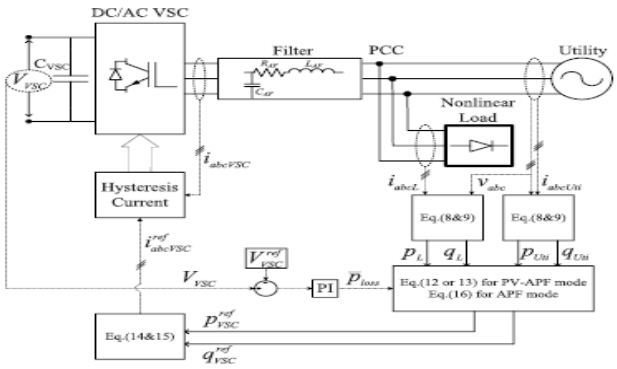
6) This PV-APF combination system is connected directly to the utility for shunt active filter implementation.

Fuzzy Logic MPPT:

During recent years, the FL MPPT has used increasingly for the PV systems. The FL MPPT can handle with imprecise inputs, works with the non-linear systems, and offers a robust control; however, the designer must have large knowledge and experience on PV system. The FL consists of mapping the input space and the output space through logical operations. The inputs/outputs are expressed as linguistic variables, called fuzzy sets, overlapped between each other. Using logical operations, the relationship is done between the input fuzzy sets and the outputs sets. Then, values are assigned to the outputs. This is why the design of FL MPPT requires

experience and knowledge on PV power system operation. The FL MPPT generally consists of three stages: fuzzifi- cation, fuzzy reasoning and defuzzification.

Controller topology of dc/ac VSC in the PV-APF combination.



Utility acting as a source:
PV-A PF: 0-0.1sec
APF: 0.1-0.2sec
Utility alone: 0.2-0.3sec

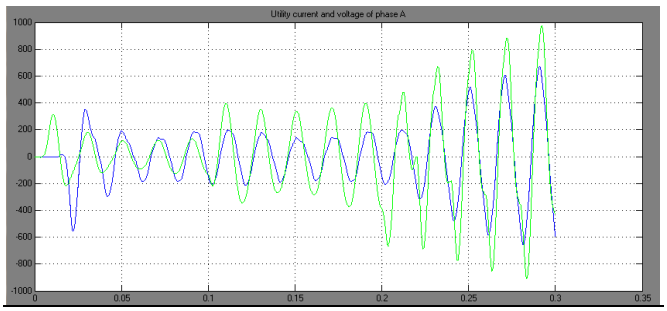


Figure.3. Utility supplied current and PCC voltage waveform.

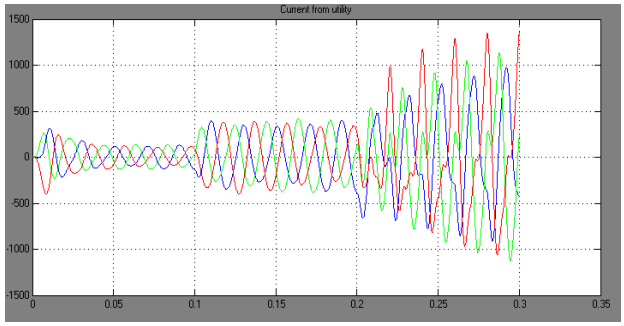


Figure.4. Utility supplied current waveform.

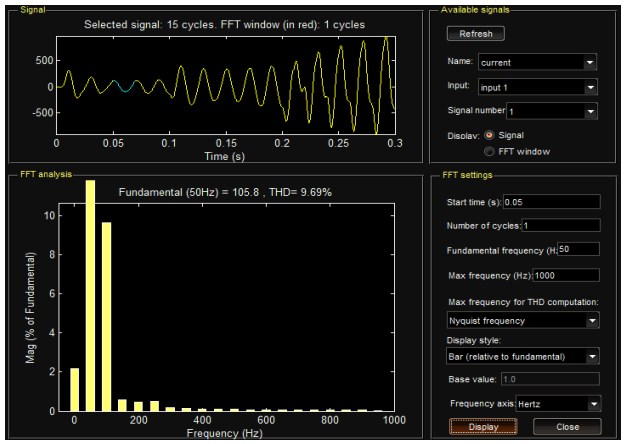


Figure.5. THD in APF mode.

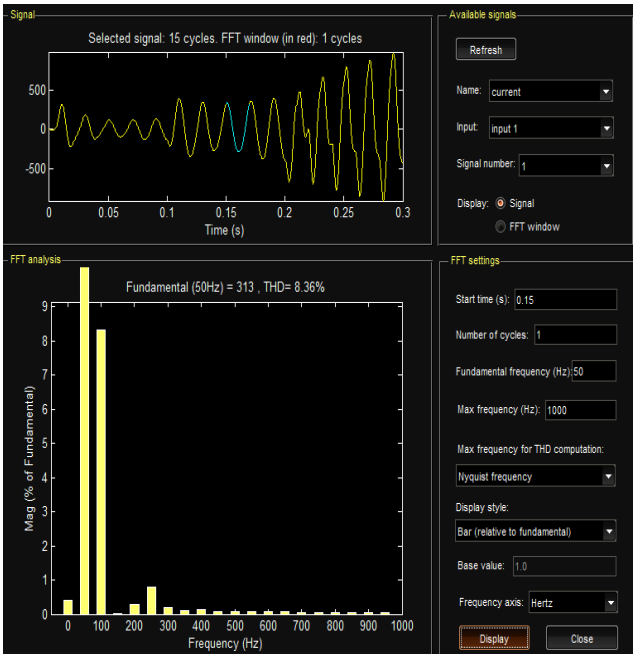


Figure.6. THD in Only utility supplies load.

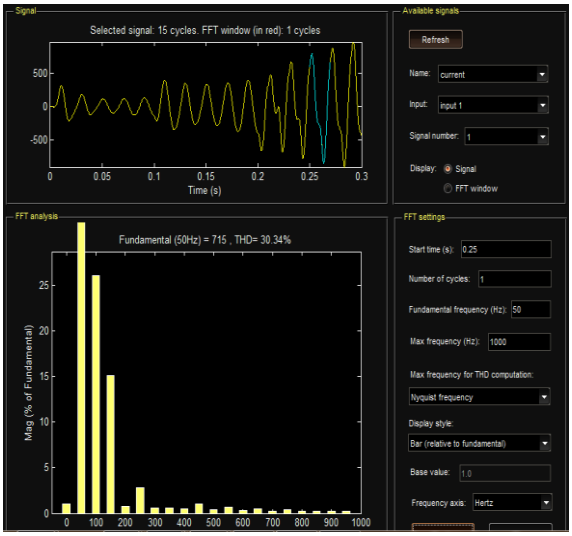


Figure.7. Real power from the utility, while the utility supplies power.

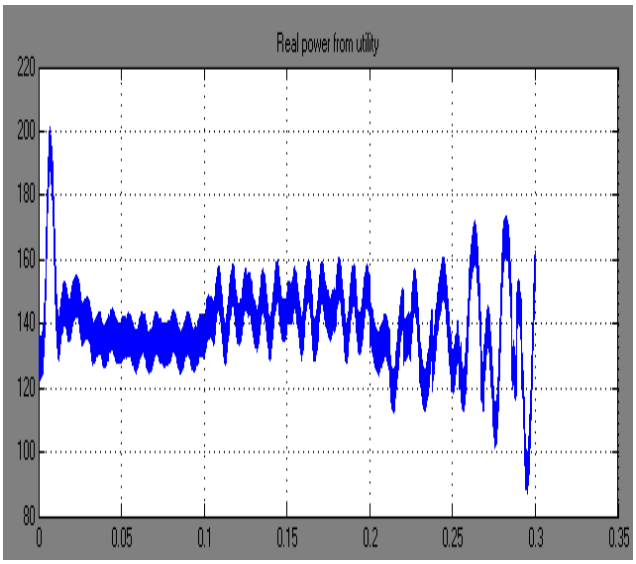


Figure.8. Real power from the load, while the utility supplies power.

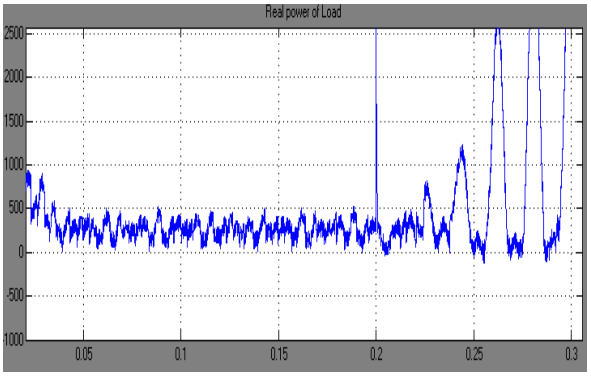


Figure.9. Imaginary power from the utility, while the utility supplies power.

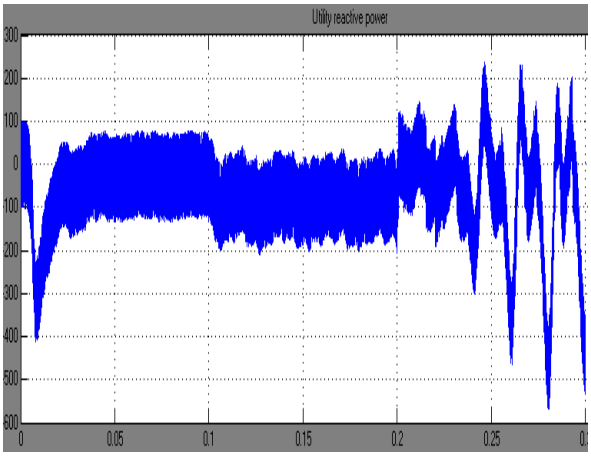


Figure.10. Imaginary power from load, while the utility supplies power.

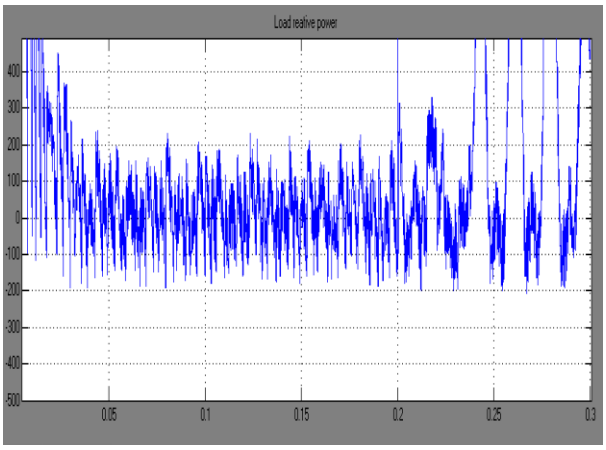


Figure.11. Load

Utility acting as a Load

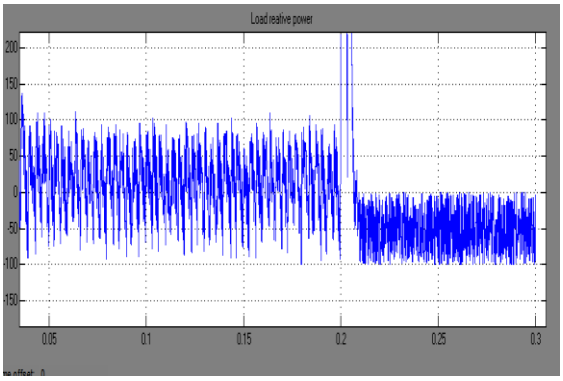


Figure.12. Output power of PV during running time

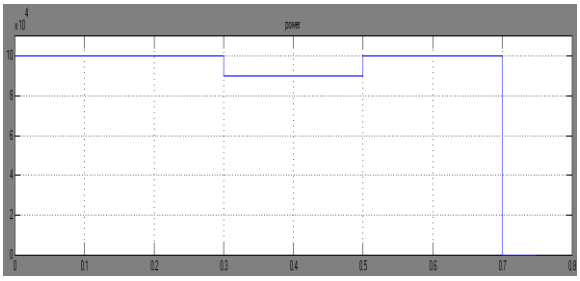


Figure.13. Output voltage of PV unit.

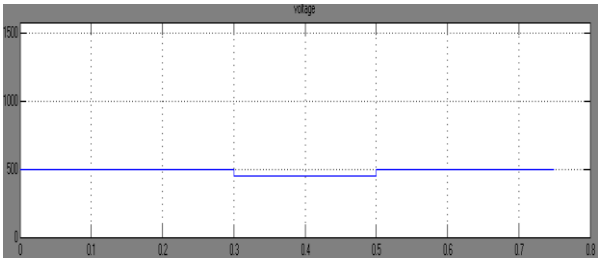


Figure.14. Utility supplied current waveform.

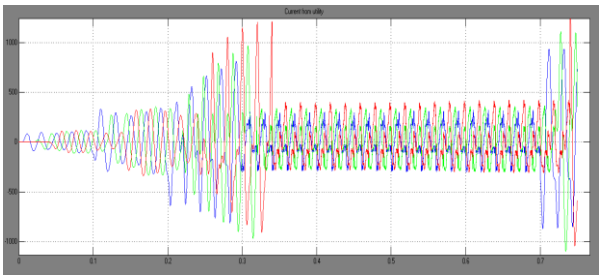


Figure.16. Utility supplied current and PCC voltage waveform.

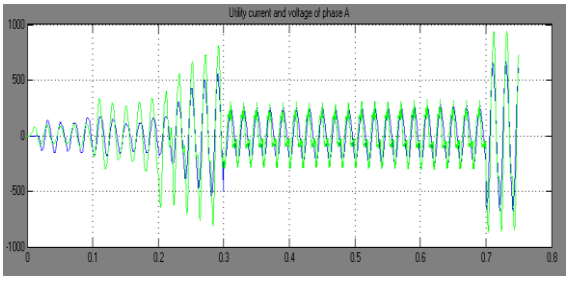


Figure.17.THD in PV system operation while dq-current mode:

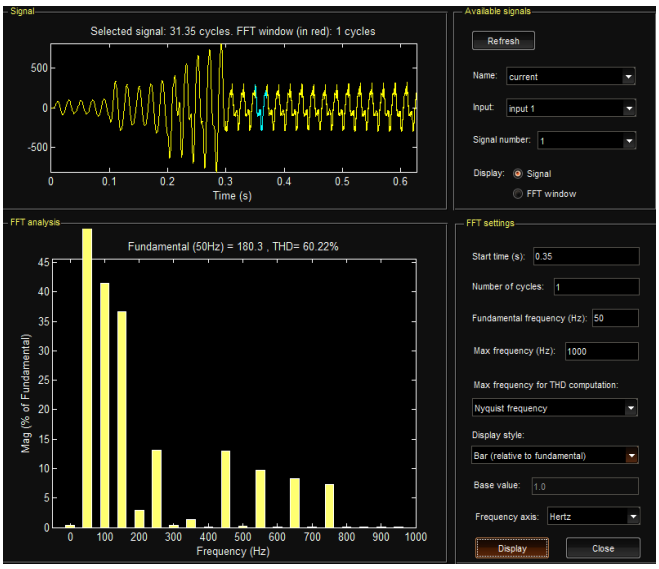


Figure.18. Real power from the utility:

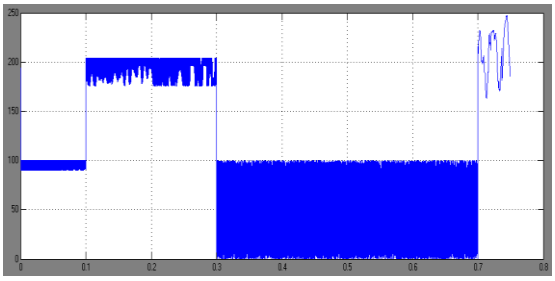


Figure.19. Real power from PV unit

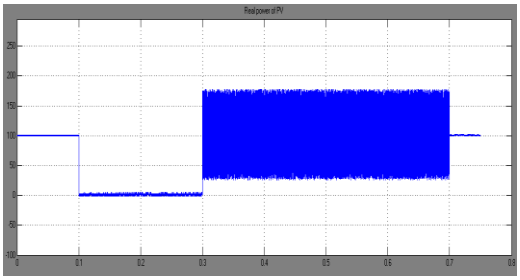


Figure.20. Real power to Load

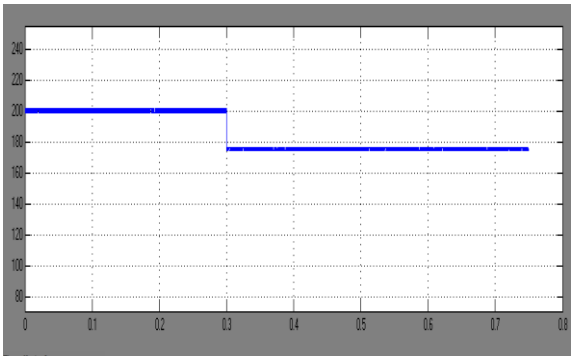


Figure.21. Imaginary power from utility

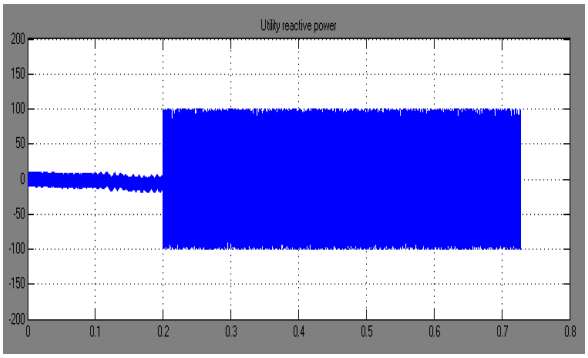


Figure.22. Imaginary power from PV unit

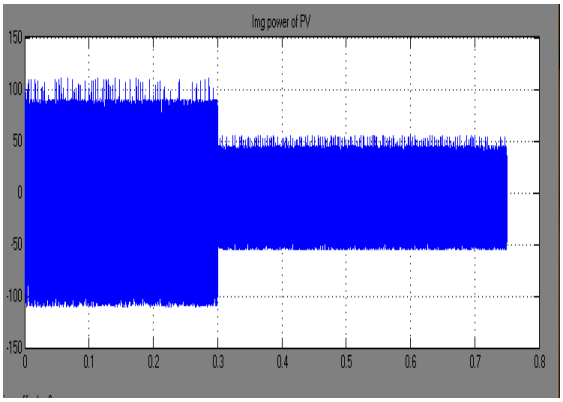


Figure.23. Imaginary power Load

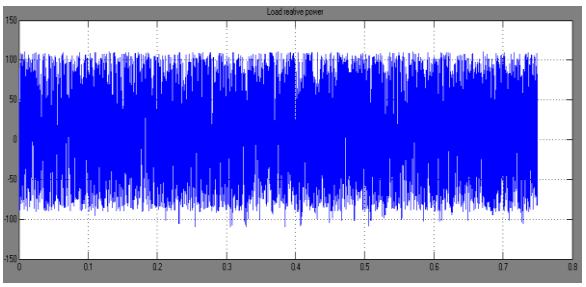
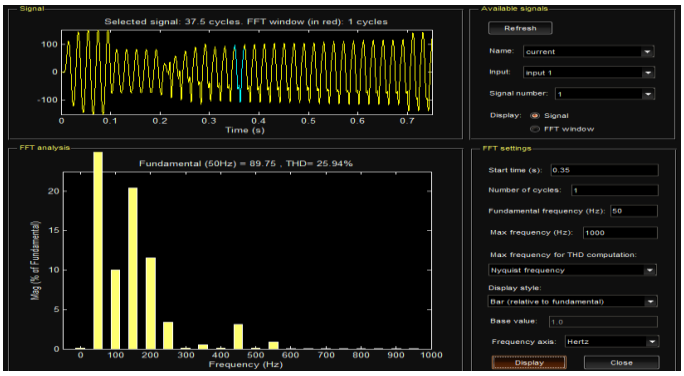


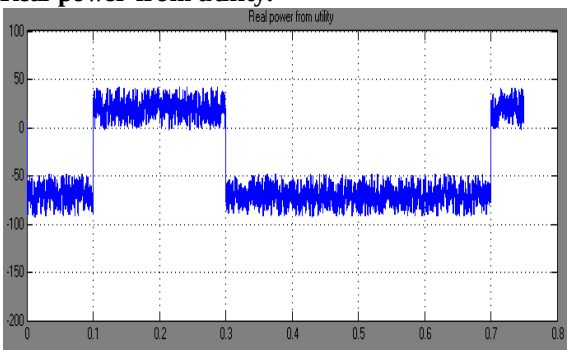
Figure.24. Utility received current waveform

Case-b:

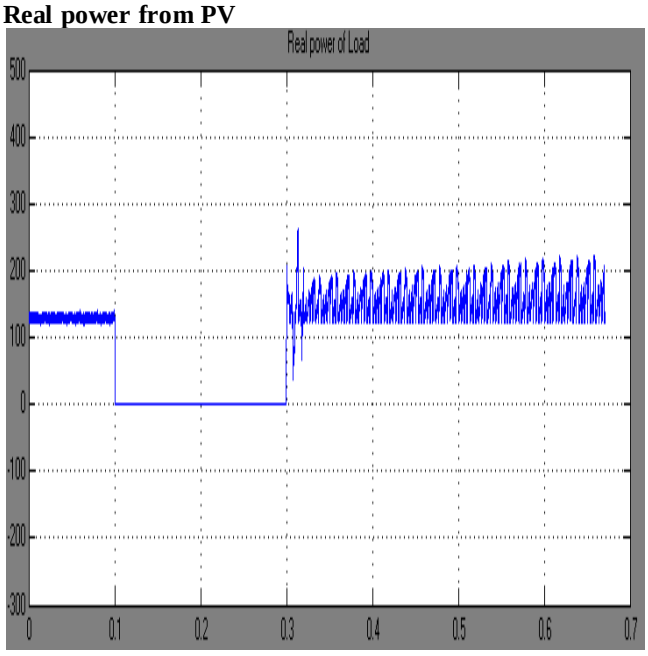
THD in PV system operation while utility receives power dq-current mode.



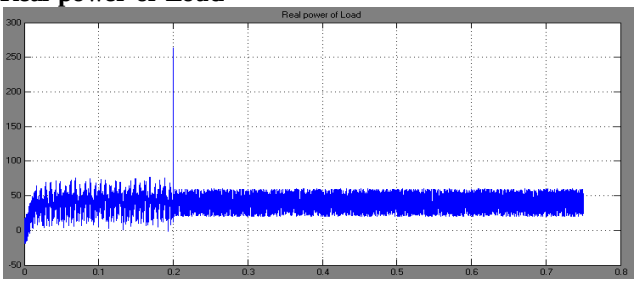
Real power from utility:



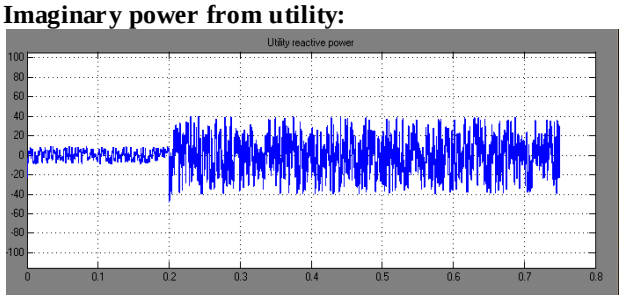
Real power from PV



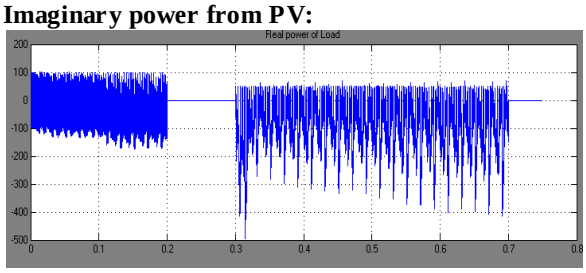
Real power of Load



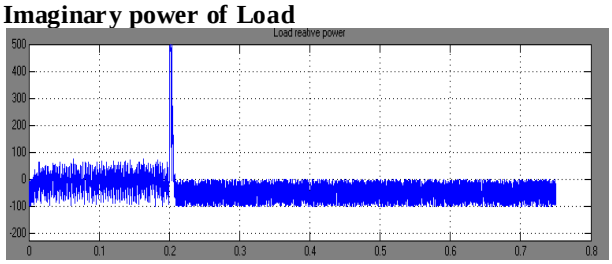
Imaginary power from utility:



Imaginary power from PV:



Imaginary power of Load



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