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# Power Quality Improvement for Renewable Source using Custom Power Devices

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**ABSTRACT:** Power quality is one of the major factor in power system transmission and distribution. This paper gives an idea on the effective control of PV cell for grid connected application. This system consist of custom power devices (DVR, DSTATCOM, and UPQC), three phase inverter, P&O controller and nonlinear loads. DVR is connected in series with inverter protect the sensitive loads from the supply side disturbances. Supply from the boost converter depends on the source of availability. UPQC consist of series and shunt combined active power filter connected back to back on the dc side for simultaneous compensation of voltage and current disturbances and reactive power. To compensate reactive and harmonic current PV system is used. In recent years power electronics converter plays a vital role for the production of harmonics. In order to make this problem less, custom power devices are introduced in order to improve the power quality. In open loop system, both DVR and UPQC are having high harmonics level where as in closed loop system, the DVR and UPQC have low harmonics level. By comparing the above systems, it is observed that the closed loop system is having reduced harmonics level. The effectiveness of the proposed method is verified by using SIMULATION/ MATLAB.

**KEYWORDS:** Power quality, harmonics, dc-dc boost converter, DVR, UPQC, P&O controller.

### I.INTRODUCTION

Power quality problem in any abnormal behavior on a power systems arising in the form of voltage, current or frequency deviations that results in failure or disoperation of customer equipment. Harmonic currents are caused by nonlinear loads connected by the distribution systems. A load is said to be non-linear when the current it drawn, does not have the same waveform as the supply voltage. Harmonic current through system impedances in turn creates voltage harmonics, which distort the supply voltage. Although harmonics problem can be difficult, they are not actually very numerous on utility systems. Only few percent of utility distribution feeders in the United States have a sufficiently severe harmonics problem to require attention. In contract, voltage sag and interruptions are nearly universal to every feeder and represent the most numerous and significant power quality deviations. The end user sector suffers more from harmonic problems. The primary sources were the transformer and primary problem was inductive interference with open –wire telephone systems. The modern arc lightning is also one of the important source for harmonic distortion. In recent years power electronics converter play a vital role for the production of harmonics.

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Fortunately, if the system is properly sized to handle the power demand of the load, there is a low probability that harmonics will cause problems with the power systems, although they may cause problems with telecommunications. Now a days, in all areas of our customer's businesses. There is a widespread use of microprocessor controlled devices. These devices are more sensitive when small variations occur in the electrical supply the devices may not operate properly. For example equipment failure, circuit board failure, software corruption, overheating of electrical distribution systems. These types of power quality issues can be reduced and may be terminated by using custom power devices. Custom power controllers like DSTATCOM (shunt active power filter), DVR (series active power filter), UPQC (combined of series and shunt active power filter). DSTATCOM is specially designed for load balancing and harmonics filtering. Similarly DVR can also be used to control the power (real and reactive) flow with harmonic voltage mitigation. We can reduce supply side disturbances using UPQC. This paper, we can reduce the harmonics produced due the presence of power quality issues in the distribution system by using various custom power devices. In this project electricity is generated by using PV power system. This project consists of solar PV and custom power devices. The main objective of this project is to reduce the power quality issues and maintain the THD (total harmonic distortion) within the IEEE standards. The IEEE standard level for the harmonics is below 5%. So, the THD is maintained within the IEEE standards and Power Quality issues are reduced by using CPD's

## II. MPPT TECHNIQUES

The solar panel converts only 30 to 40 percent of the incident solar irradiation into electrical energy. The efficiency of solar panel is improved by using Maximum power point tracking technique. According to Maximum Power Point Transfer theorem, the power output of a circuit is maximum when the Thevenin's impedance of the circuit matches with the load impedance. Hence our problem of tracking the maximum power point reduces to an impedance matching problem. In the source side we are using boost Converter connected to a solar panel in order to enhance the output voltage so that it can be used for different applications like motor load. By changing the duty cycle of the boost converter appropriately it match the source impedance with the load impedance. There are different techniques used to track the maximum power point. Few of the most popular techniques are:

- a) Perturb and Observe method (hill climbing method)
- b) Incremental Conductance method
- c) Fractional short circuit current
- d) Fractional open circuit voltage
- e) Neural networks
- f) Fuzzy logic

## III. PERTURB AND OBSERVE METHOD (P&O)

In this method we use only one sensor, that is the voltage sensor, to sense the PV array voltage and so the cost of implementation is less and hence easy to implement. The time complexity of this algorithm on reaching very close to the MPP it

Doesn't stop at the MPPT and keeps on perturbing on both the directions. When this happens the algorithm has reached very close to the MPPT and we set an appropriate error limit or can use a wait function which ends up increasing the time complexity of the algorithm. Figure 2 shows the flow chart of P&O controller Perturb and observe gives top level efficiency. It's depends on the rise of the curve of power point, and the fall above that point. P&O is the most commonly used MPPT method due its ease of implementation.

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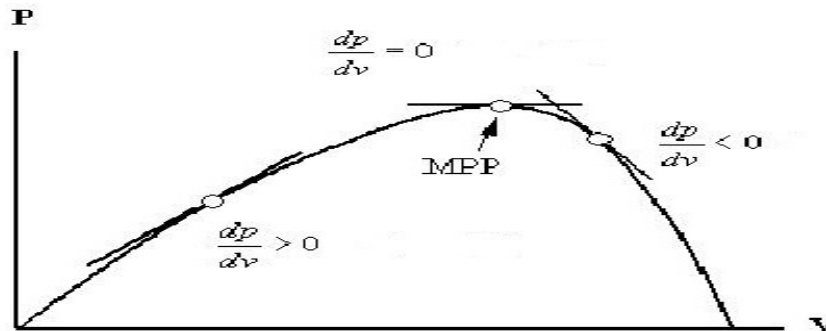


Figure 1. Sign of the  $dP/dV$  at different positions

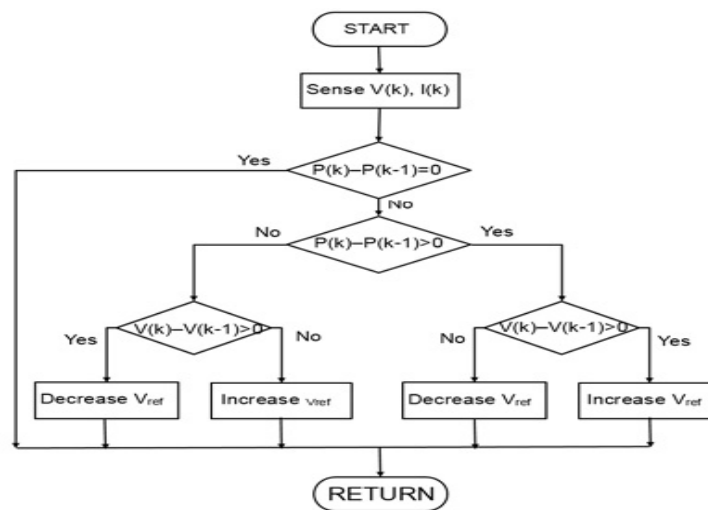


Figure 2. Flow chart for p&o controller

## IV. CUSTOM POWER DEVICE

The application of power electronics to power distribution system for the benefit of a customer is called custom power. Custom power devices play an important role in the concept of power quality improvement in delivering quality power at various levels. It can be classified into two major types one is network configuring type and another one is compensating type. Here we use compensating type devices which includes DVR, DSTATCOM, and UPQC. These devices are used for active filtering, load balancing, power factor correction, harmonic suppression. These are found to be very capable in integrating solar energy sources to the grid.

**DVR:**(Dynamic voltage restorer)is one of the custom power device which can help mitigating power quality problems. Figure 3 shows the block diagram of DVR. It is connected in series with solid state device and inject voltage into the system in order to regulate the load side voltage. DVR is installed between supply and the critical load feeder at the common coupling point. DVR had more features like line voltage, harmonic compensation.

**UPQC:**(Unified power quality conditioner) consists of series and shunt compensation capability for harmonics, reactive power, voltage disturbances and power flow control. Figure 4 shows the block diagram of UPQC. It injects

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current in the ac system such that the source current become balanced sinusoids and in phase with the source voltage. It performs multi task such as voltage and current related problems and also responsible for elimination of the supply side disturbances.

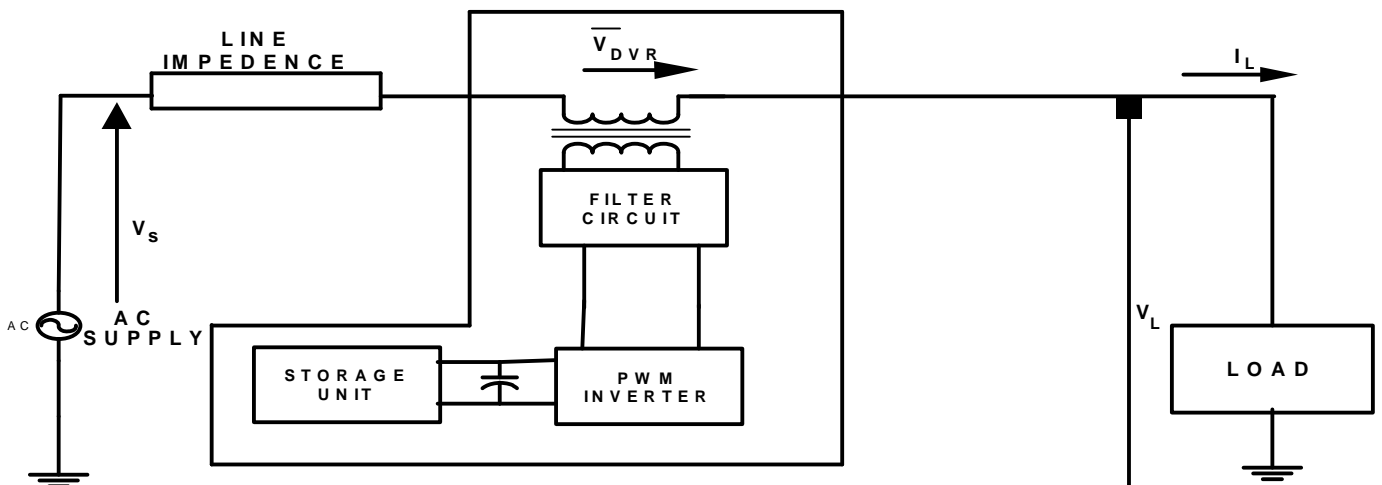
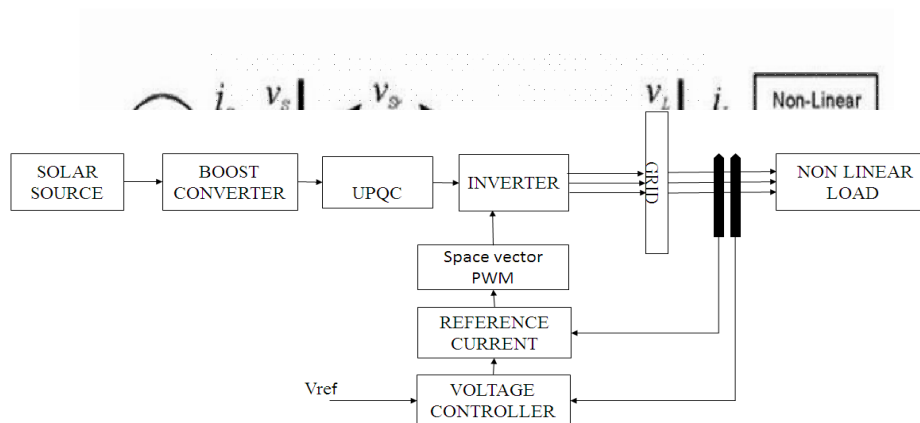


Figure 3. Block diagram of DVR

Figure 4. Block diagram of UPQC.



PV system means power system to design the supply usable solar power of photovoltaics. It consists of an arrangement of several components including solar panels to absorb and convert sunlight into electricity.

Solar panel works at MPP for any load with any value of irradiance, that produced DC power is transferred to the boost converter. Which increase the output without use of any step up transformer.

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## VII.SOLAR ENERGY SYSTEM

equation to calculate the output of the PV array:

$$P_{PV} = Y_{PV} f_{PV} \left( \frac{\bar{G}_T}{\bar{G}_{T,STC}} \right) [1 + \alpha_p (T_c - T_{c,STC})]$$

$Y_{PV}$  => is rated capacity of the PV array and its power output under standard test conditions [kW]

$\bar{G}_{T,STC}$  => is the incident radiation at standard test conditions [1 kW/m<sup>2</sup>]  $\alpha_p$  => is the temperature coefficient of power [%/°C]

$T_c$  => is the PV cell temperature in the current time step [°C]

$T_{c,STC}$  => PV cell temperature under standard test conditions [25 °C]

If on the PV Inputs window you choose not to model the effect of temperature on the PV array, assumes that the temperature coefficient of power is zero, so that the above equation simplified to:

$$P_{PV} = Y_{PV} f_{PV} \left( \frac{\bar{G}_T}{\bar{G}_{T,STC}} \right)$$

The design can also be extended to deliver power to AC system a typical inverter at the output of boost converter. In the UPQC the transferred power will meet the following component like series active filter and shunt active filter, DC link and injection transformer .Series active filter is the one of the inverters connected in series to supply, It behaves like voltage source to eliminate the voltage interruption. The inverter output is fed to the grid. The reference voltage and reference current from the grid is given feedback to the DVR and UPQC. In closed loop system the harmonic level can be minimized.

## VII.SIMULINK MODEL

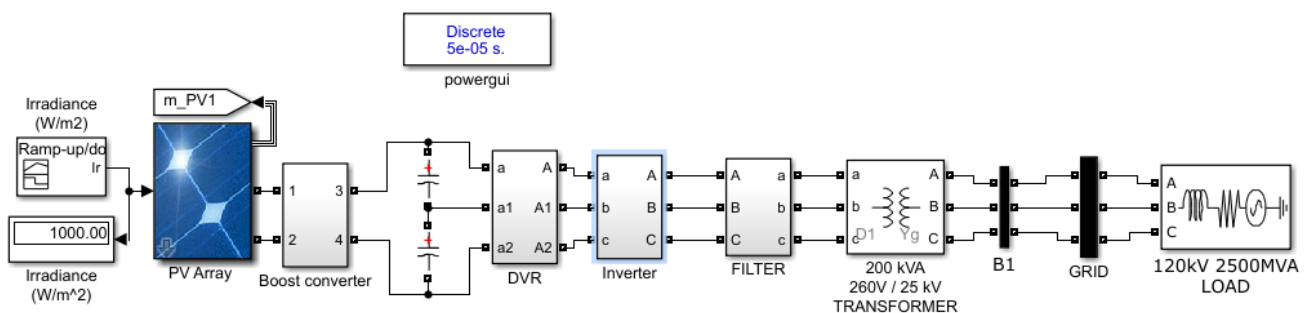


Figure 6.Simulation for DVR without feedback

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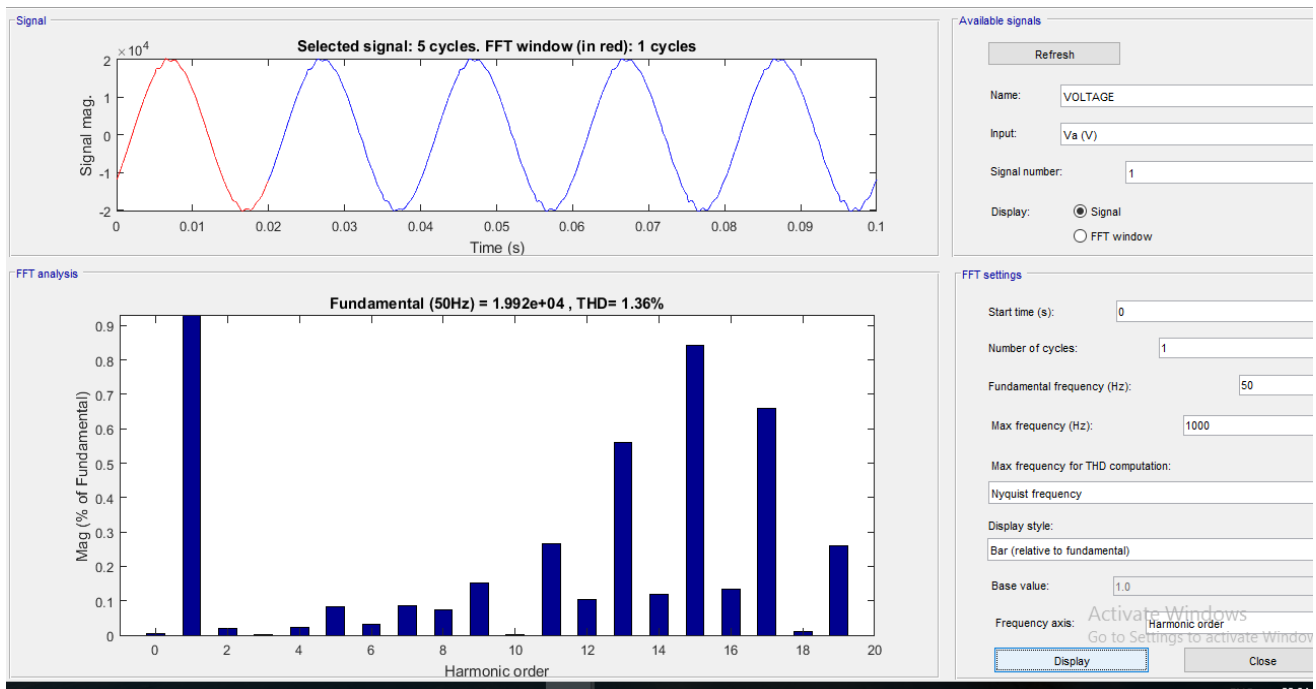


Figure 7.Simulation output for DVR without feedback

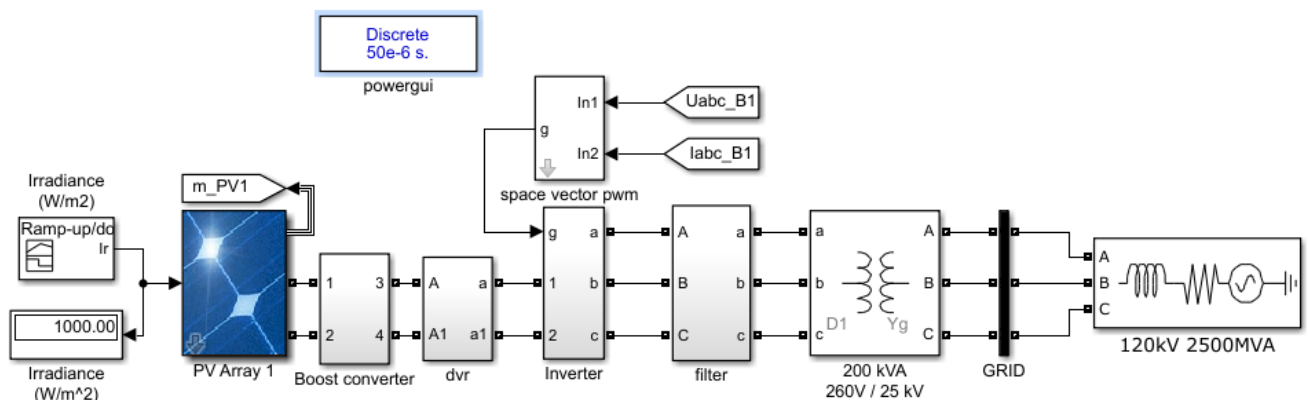


Figure 8.Simulation for DVR with feedback

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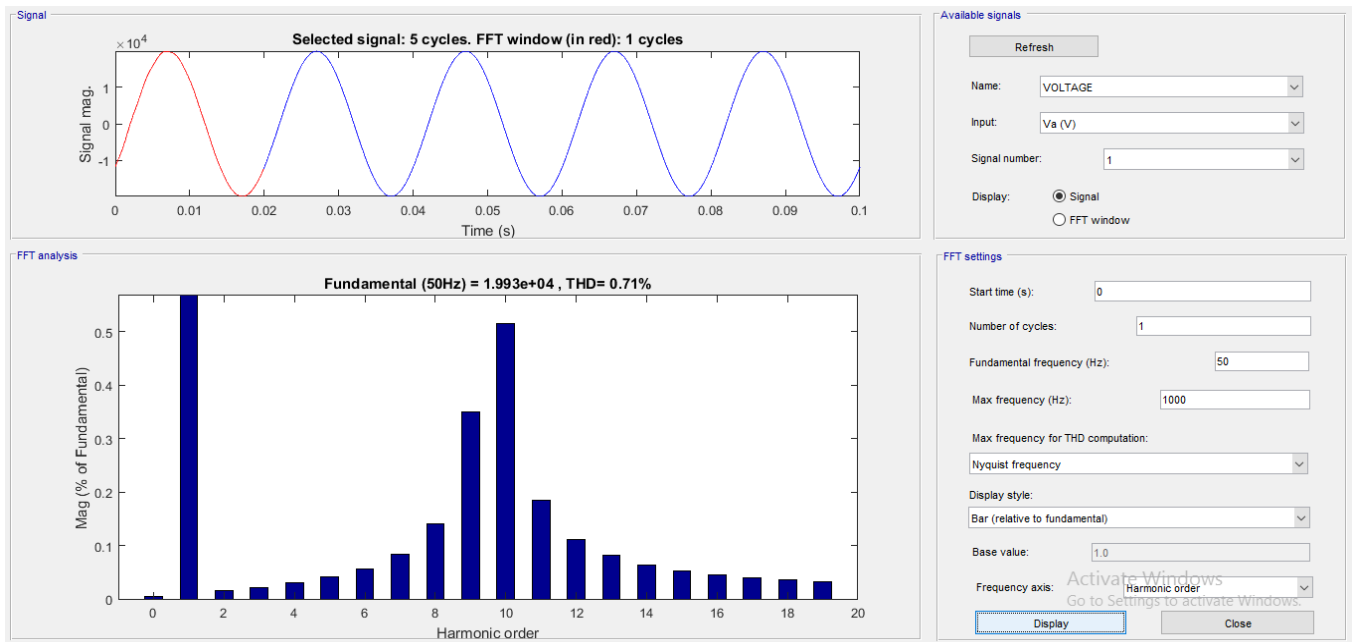


Figure 9.Simulation output for DVR with feedback

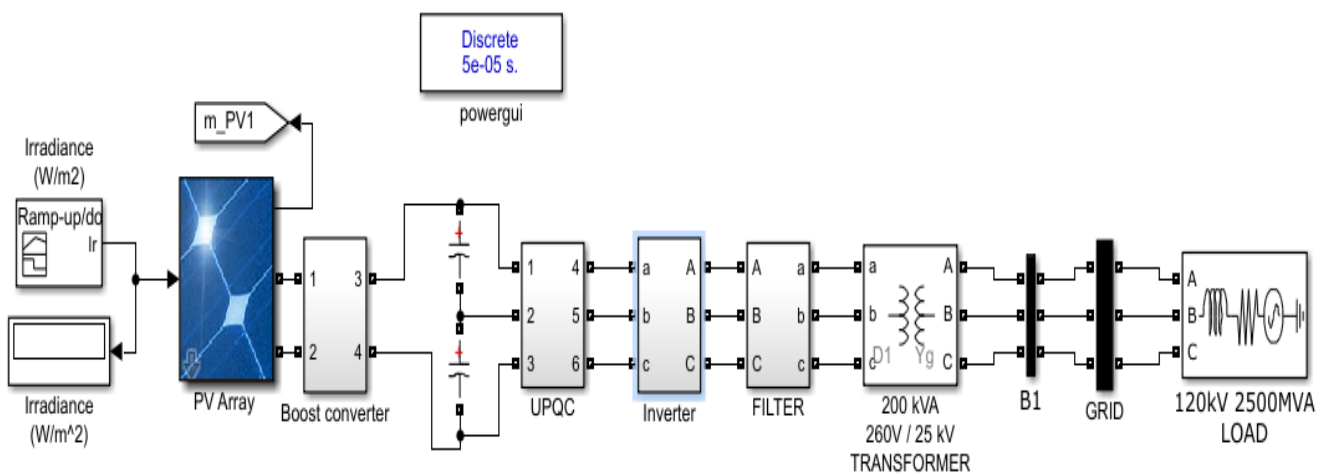


Figure 10.Simulation for UPQC without feedback

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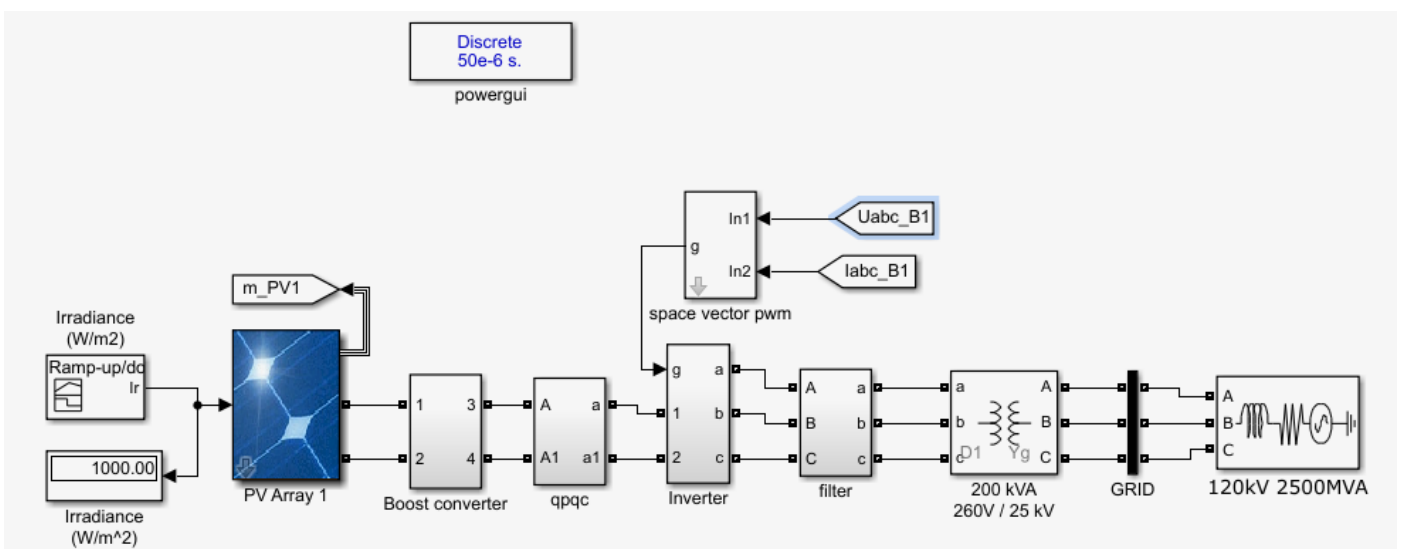
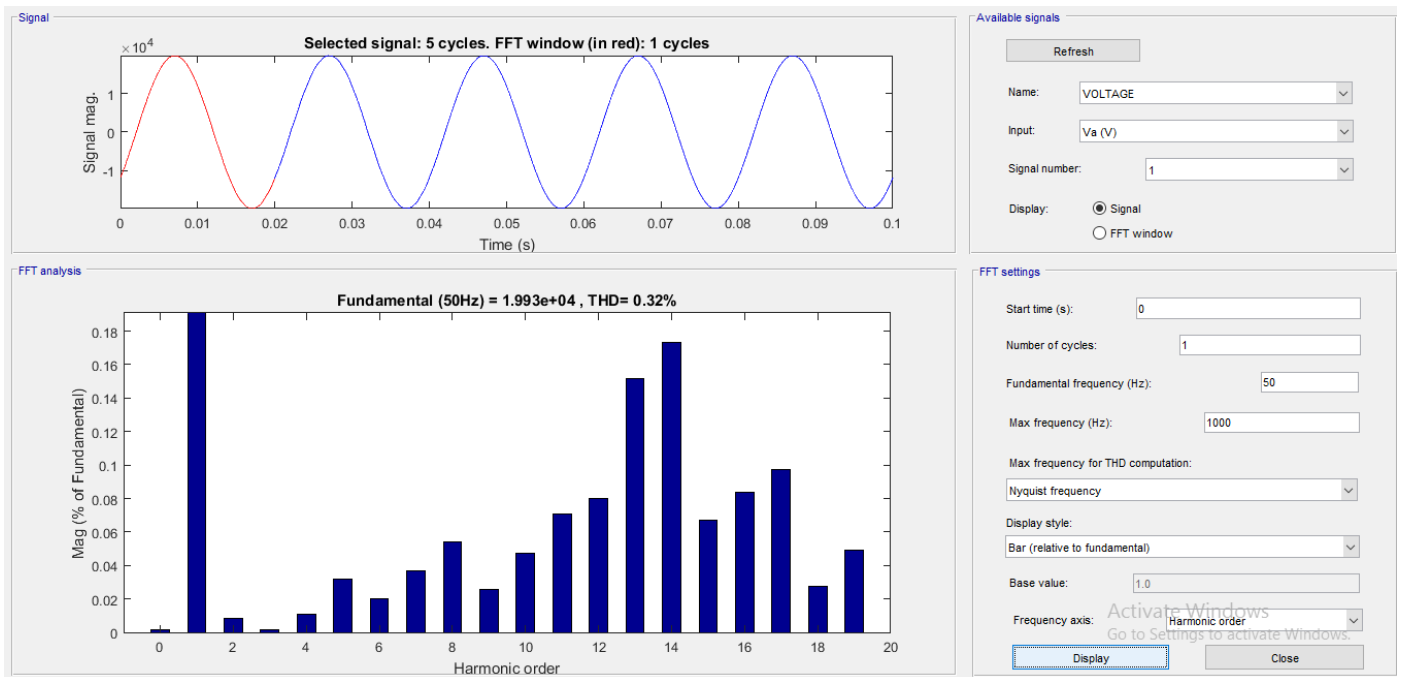


Figure 12. Simulation for UPQC with feedback



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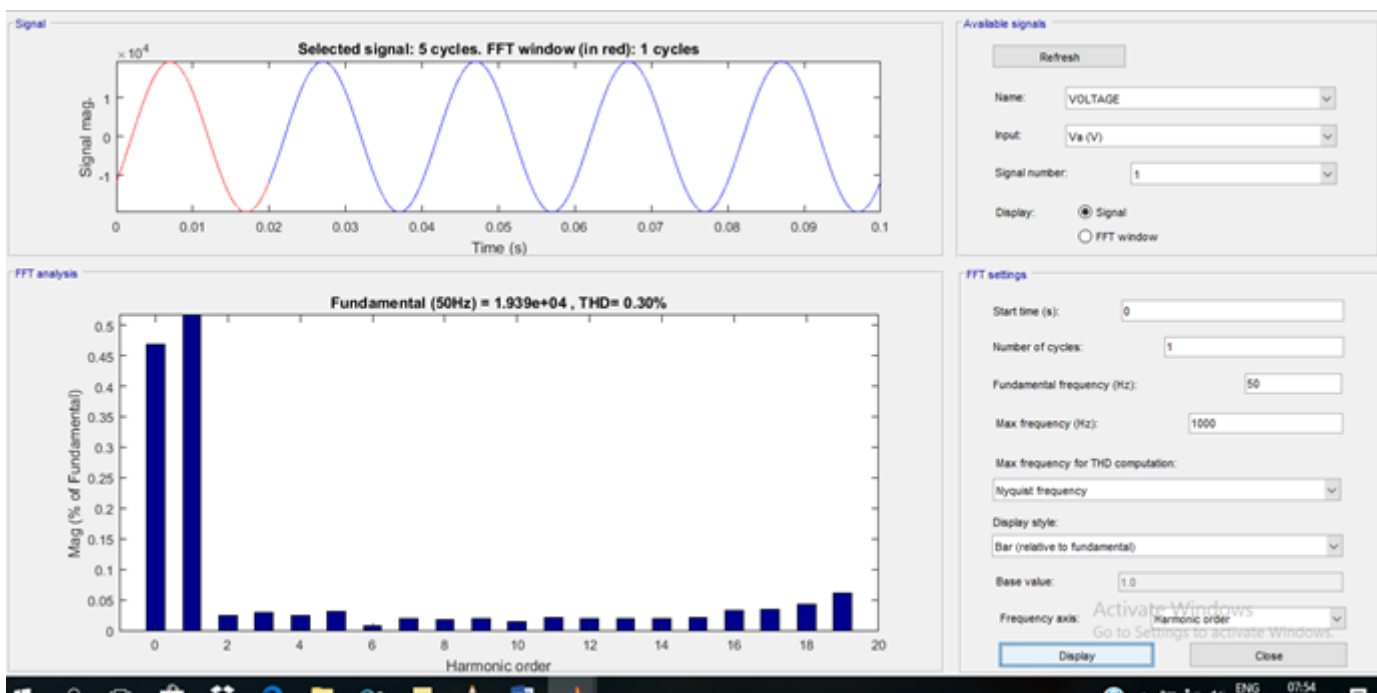


Figure 13. Simulation output for UPQC with feedback

## COMPARISON OF THD LEVELS

CUSTOM POWER DEVICES	THD (%)	
	Without feedback	With feedback
DVR	1.36	0.71
UPQC	0.32	0.30

## VIII. CONCLUSION

Harmonics are one of the major problems occurred in power transmission system. In this paper comparison between DVR and UPQC to reduce the harmonic at distribution side. By using this comparison, an analysis can be done on the values of by using solar power system with compensating type custom power devices. In the solar power generation system, MPPT technique is used for solar PV for tracking the maximum Power generated. The main reason for choosing the solar power generation is to reduce the use of non-renewable energy sources, and to encourage the generation of electricity by using renewable energy sources. Also, by choosing the renewable energy resources, the cost of energy production can be reduced to a very low amount.

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## IX. FUTURE SCOPE

In this paper, the presence of harmonic distortion in higher values are reduced to a very low level by using P&O controller techniques – Space vector modulation. In future , feedback circuit can be connected with a the hybrid system which consists of a wind and solar feedback circuit consist of .filter, current controller, hysteresis controller with more advanced Space vector PWM, ANN controller, Fuzzy logic controller, etc. Using these methods can reduce the harmonics level to a much lower level.

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