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POWER QUALITY IMPROVEMENT OF SOLAR PHOTOVOLTAIC SYSTEM USING FC-TCR

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ABSTRACT

The current scenario of the world is that the power demand in the world is increasing at a very fast rate, to get an economical source of power; renewable energy sources are proving out to be a reliable option. Hence solar energy systems are very much important for the system engineers. In order to meet the demand of the world the solar energy is injected into the electric power grid. Along with the increase of power, the main issue arises due to power injection from solar power plant is that the power quality of the present electric grid falls from the standard. The goal is the minimization of THD values of the line current, controlling the firing angle value of the TCR branch. Some changes in the conventional architecture of the Conventional FC-TCR compensator were necessary to achieve it.

Keywords: Dynamic Stability, Optional Energy Sources, FC-TCR , MPPT, PV Array

I INTRODUCTION

Conventional energy sources are most frequently used to generate electrical power. These sources are usually fossil fuel which includes oil, gas and coal. Due to increase in demand of power we need to increase the power generation and decrease the losses so as to meet the increased demand and optimize the power transmission at different levels. Till now conventional energy sources are playing a vital role in power generation but due to its limitation of long time availability and various impact on environment like greenhouse gas emission, effect on flora and fauna etc. has diverted the mind of engineers to hunt for the optional energy sources to share a part of the increased power demand and thus to reduce the stress on conventional energy sources availability.

This hunt for optional energy sources, leads the engineers to discover the renewable energy sources. Solar, wind, rain, tides, waves and geothermal heat are the main sources of energy sources of renewable energy among which wind, solar and biomass are three emerging renewable sources of energy. These renewable energy sources are providing backup in electricity generation and rural (off-grid) energy services. Though these renewable energy sources are not much cost effective in comparison to traditional conventional energy sources and also there all time availability puts a question mark [1]. These disadvantages opens a new area of engineering and research like cost effective extraction of these energy sources, storage and conversion and thus it depends on us and it is our responsibility to advance for the alternative power. Among solar, wind, rain, tides, waves and geothermal heat sources of renewable energy, solar energy utilization is growing fastest due to its advantage of requirement of less time and space for installation and thus provides highest annual return on investment in industries as well residential.

II. SOLAR PHOTO VOLTAIC CELL

Today, we are for the most part reliant on non-renewable energy that have been and will keep on being a noteworthy reason for pollution and other natural corruption. Finding the supportable option is turning out to be progressively dire as a result of these issues and the decreasing supply of petroleum. Maybe, the best test is in contriving a reasonable future, which depends on incorporation and control of renewable energy sources in grid distribution generation. After hydro and wind power, Solar Photo Voltaic is third most imperative renewable energy sources as far as universally introduced capacity.

Solar Photovoltaic is a system which utilizes solar panels for changing over solar energy to electrical energy [6] .These solar panels comprise of photovoltaic cells (likewise now and again called as solar cells).PV cell is like a PN junction diode .PV (photo voltaic) cells are comprised of semiconductor materials which show the photovoltaic impact by temperance of which solar vitality is changed over into direct current electrical energy. Photovoltaic impact is a phenomenon in which electrons are energized into a higher state of energy by photons of light because of which these electrons go about as charge carriers for the flow of current.

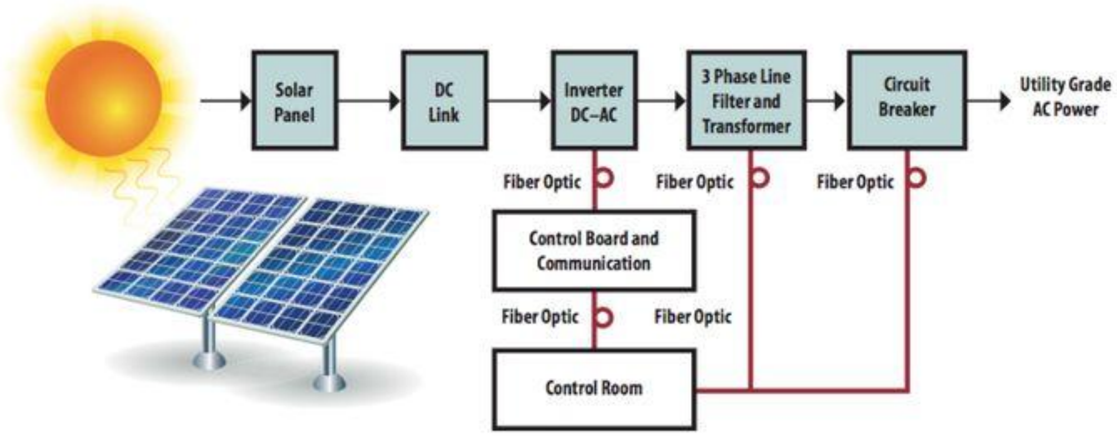

Fig.1 Solar Photovoltaic System

Mathematically the output current of the PV module can be shown as [1] :

$$I = n_p I_{pv} - n_p I_0 \left[\exp\left(\frac{V + IR_S}{aV_t}\right) - I\right] - \frac{V + IR_S}{R_P} \qquad \ldots(1)$$

where,

I = current,

V = voltage of the PV module

I_{pv} = photo-current

I_o = reverse saturation current

n_p = number of cells connected in parallel,

n_s = number of cells connected in series.

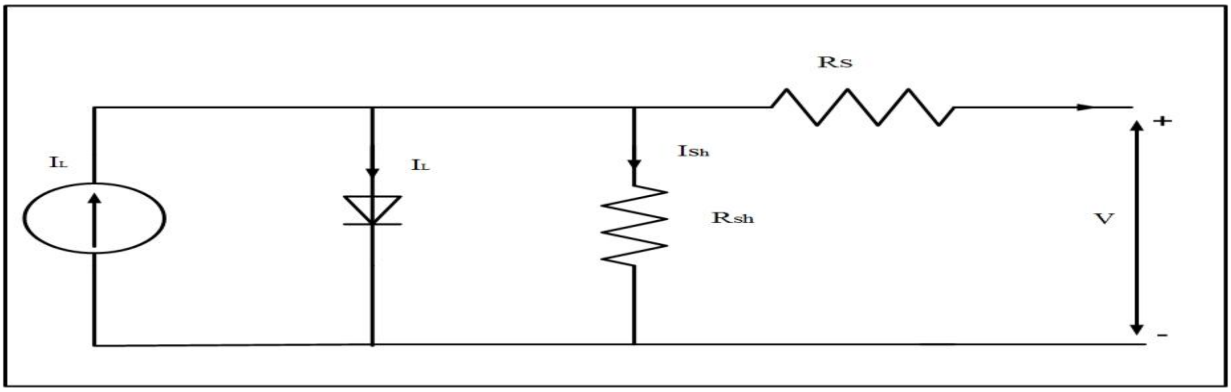

Fig.2 Electrical circuit of PV cell

III. FC-TCR

FC-TCR system gives ceaselessly controllable lagging VAr's through thyristor control of reactor current. Leading VAR's is supplied by two or more altered capacitor bank. The TCR is by and large appraised bigger than the aggregate of altered capacitance so net slacking VAr's can likewise be supplied. The variety of current through the reactor is gotten by phase angle control of back to back pair of thyristor associated in series with the reactor.

A FC-TCR can enhance power system transmission and distribution execution in various ways. Introducing a FC-TCR at one or more reasonable points in the system can build exchange ability and decrease losses while keeping up a smooth voltage profile under various system conditions. The dynamic stability of the grid can be enhanced and active power oscillations moderated. To condense the use of FC-TCR gives the accompanying advantages.

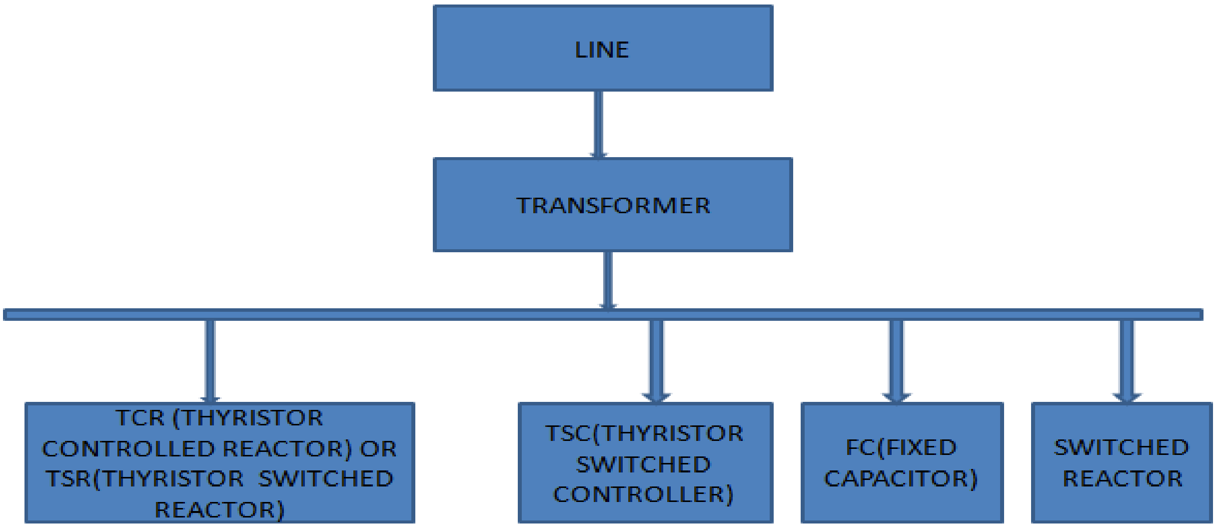

Fig.3 Fixed Capacitor Thyristor Controlled Reactor

IV MAXIMUM POWER POINT TRACKING

Maximum Power Point Tracking, every now and again alluded to as MPPT, is an electronic system that works the Photovoltaic (PV) modules in a way that permits the modules to create all the power they are prepared to do. MPPT is not a mechanical following system that "physically moves" the modules to make them point all the more specifically at the sun. MPPT is a completely electronic system that fluctuates the electrical working purpose of the modules so that the modules can convey most extreme accessible power. Extra power collected from the modules is then made accessible as expanded battery charge current. MPPT can be utilized as a part of conjunction with a mechanical following system, yet the two systems are totally distinctive.

The studies on the photovoltaic system are widely expanding in light of a huge, secure, basically modest and extensively accessible asset as a future vitality supply. Nonetheless, the yield power affected in the photovoltaic modules is impacted by a force of solar cell radiation, temperature of the solar cells and so on. Accordingly, to boost the proficiency of the renewable energy system, it is important to track the most max. Power point of the input source. The electric power supplied by a photovoltaic power system relies on upon the solar radiation and temperature. Moreover, an ease control unit is created, in view of a solitary chip to change the output voltage of the solar cell array. As of late, the energy emergency on the planet has prompted the ascent being used of renewable energy sources. With the progression in power electronic innovation, the solar photovoltaic energy has been perceived as a critical renewable energy asset since it is spotless, bottomless and contamination free. The effectiveness of the photovoltaic system might be expanded by utilizing Maximum Power Point Tracker (MPPT).

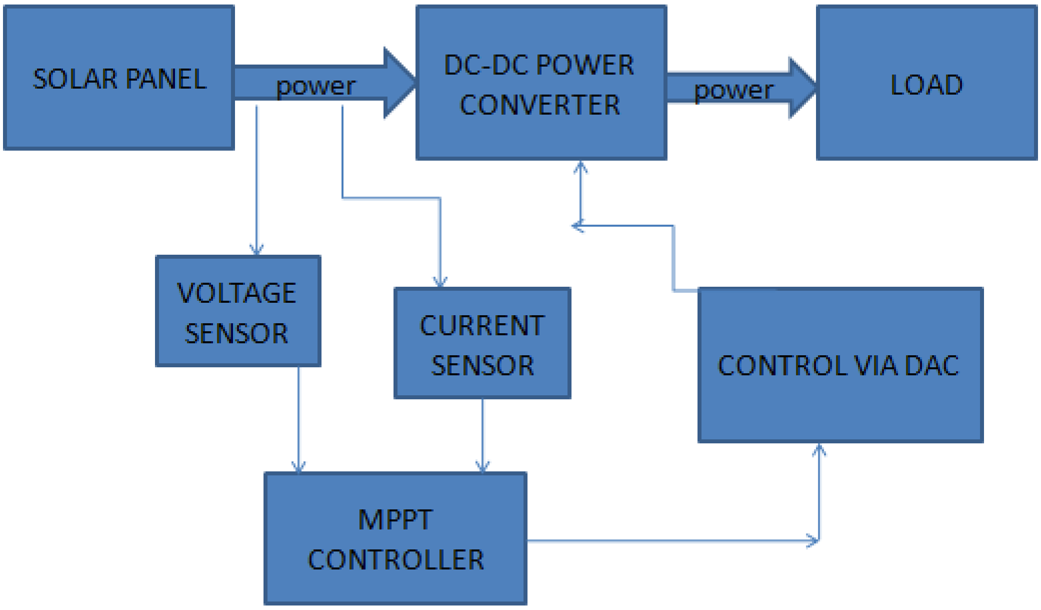

Fig. 4 Block diagram of MPPT

V. SIMULATION

In this work FC-TCR circuit is attached to PV system. Here comparison of THD values take place. Two cases are considered in this work :

1.Model of PV system without compensator.

2.Model of PV system with FC-TCR.

The thesis proposes a novel approach to apply FC-TCR and without compensator in renewable fed grid. The grid has a PV system and other sources which are connected via transmission lines. The lines are compensated using a FC-TCR.

[1] Model of PV system without compensator:

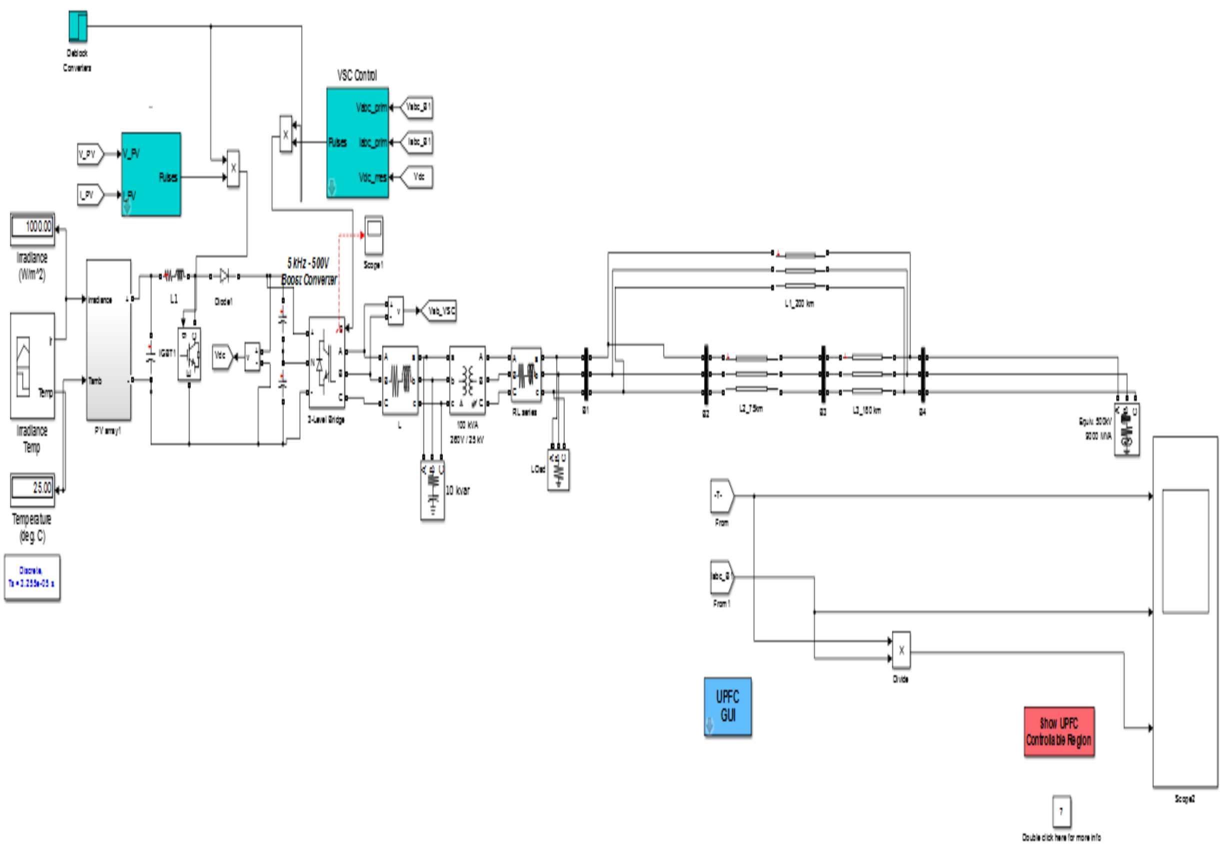

Fig. 5 Model of PV cell without compensator

[2] Model of PV system with FC-TCR:

Fig.6 shows the arrangement of PV array with FC-TCR. PV array has been designed according to its characteristics equation. As the output of PV array is low to be utilized for load. So a boost converter has been used to boost the voltage up to the required value. To get the AC output from DC output of boost converter, 11-level cascaded multi level inverter has been used.

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The output of MLI has been connected to 100KVA transformer has been used. The feeder length is 19 KM. To give for reactive power compensation FC-TCR has been designed and connected to the step-down transformer. To analyze the effect of FC-TCR, 3-phase induction motor with step change has been used. The step time is 0.5 sec. FC-TCR has been connected to transformer with the help of switch which is having step time of 0.5 sec.

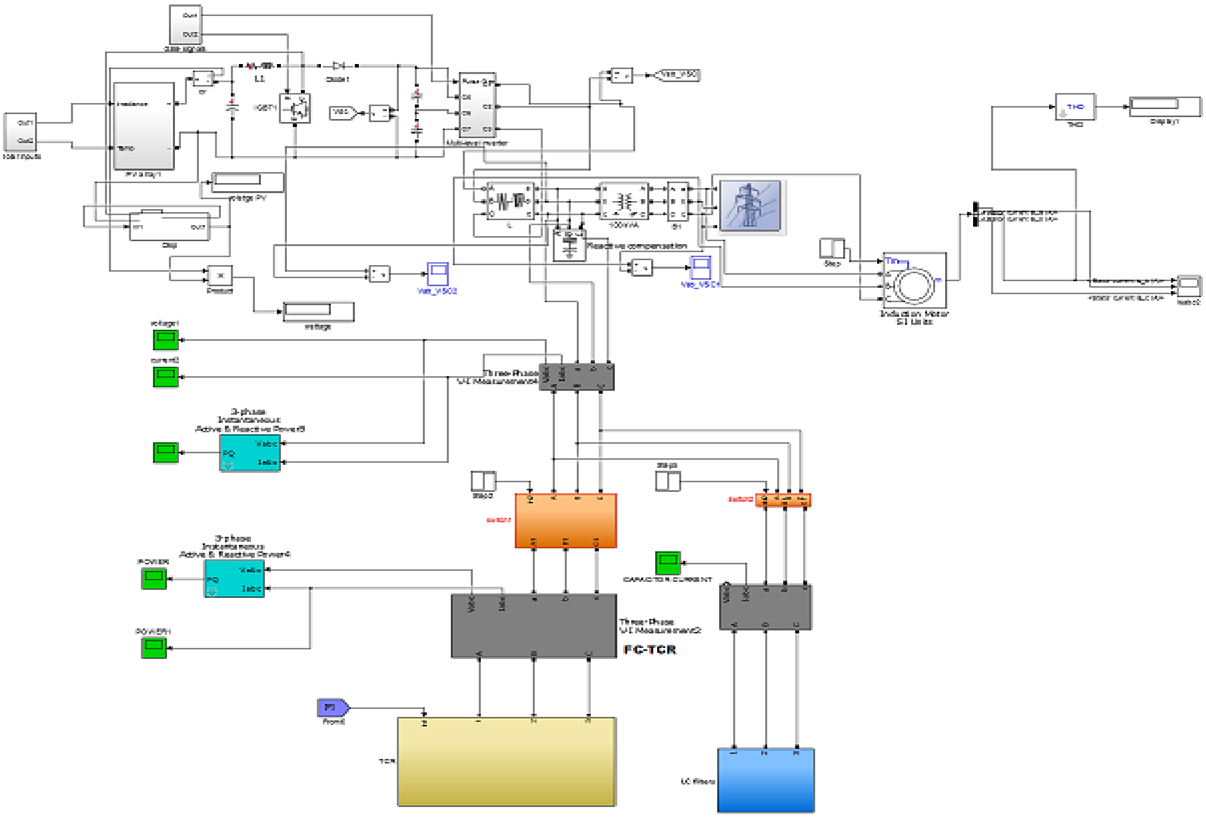
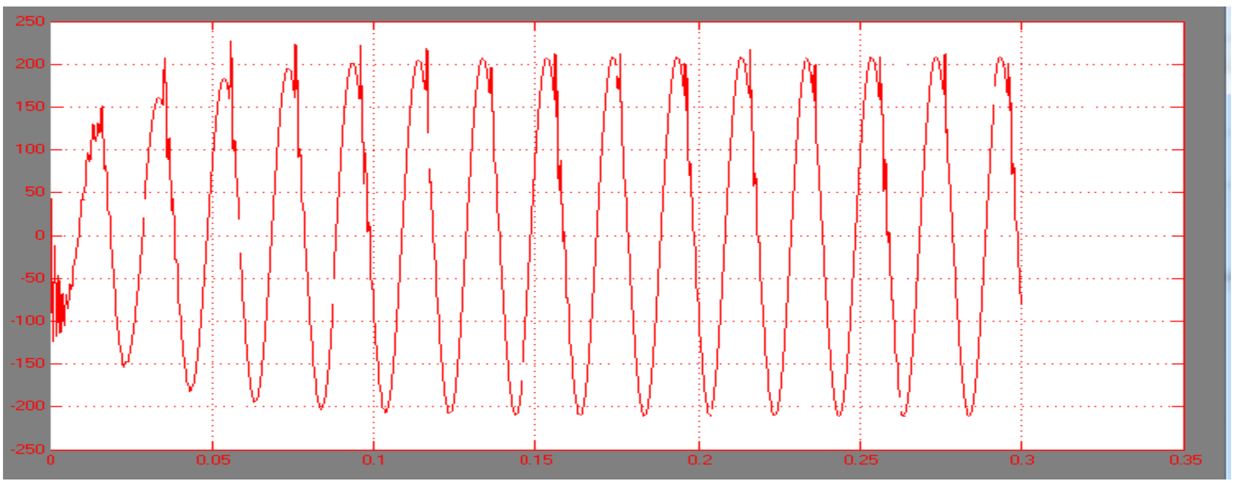


Fig.6 Complete Model of PV cell with FC-TCR

VI. RESULTS



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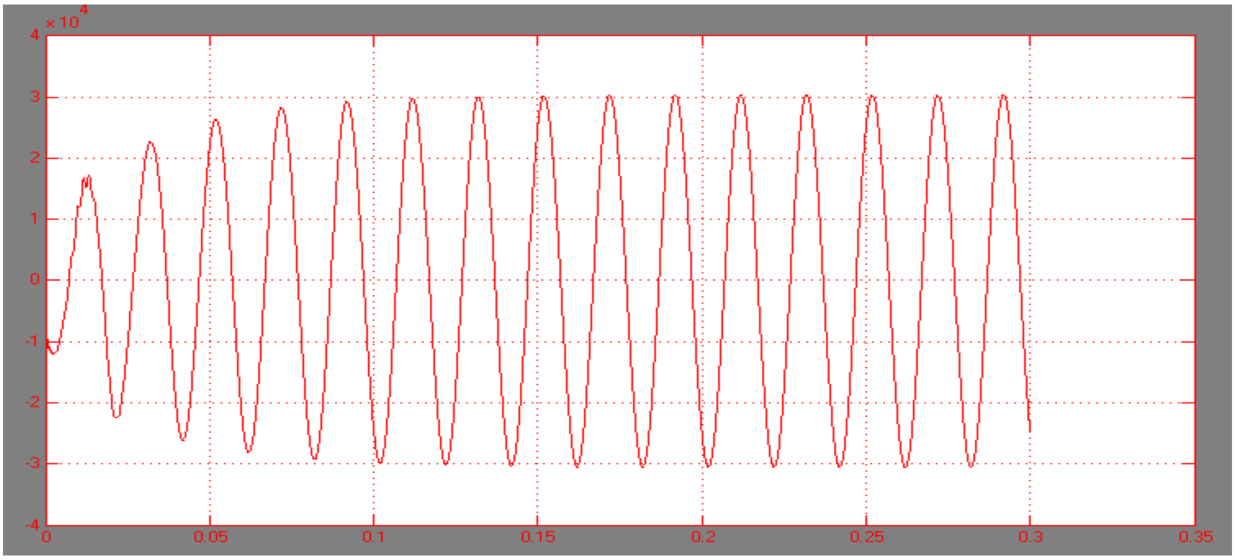

Fig.7 Output waveforms of PV system without compensator

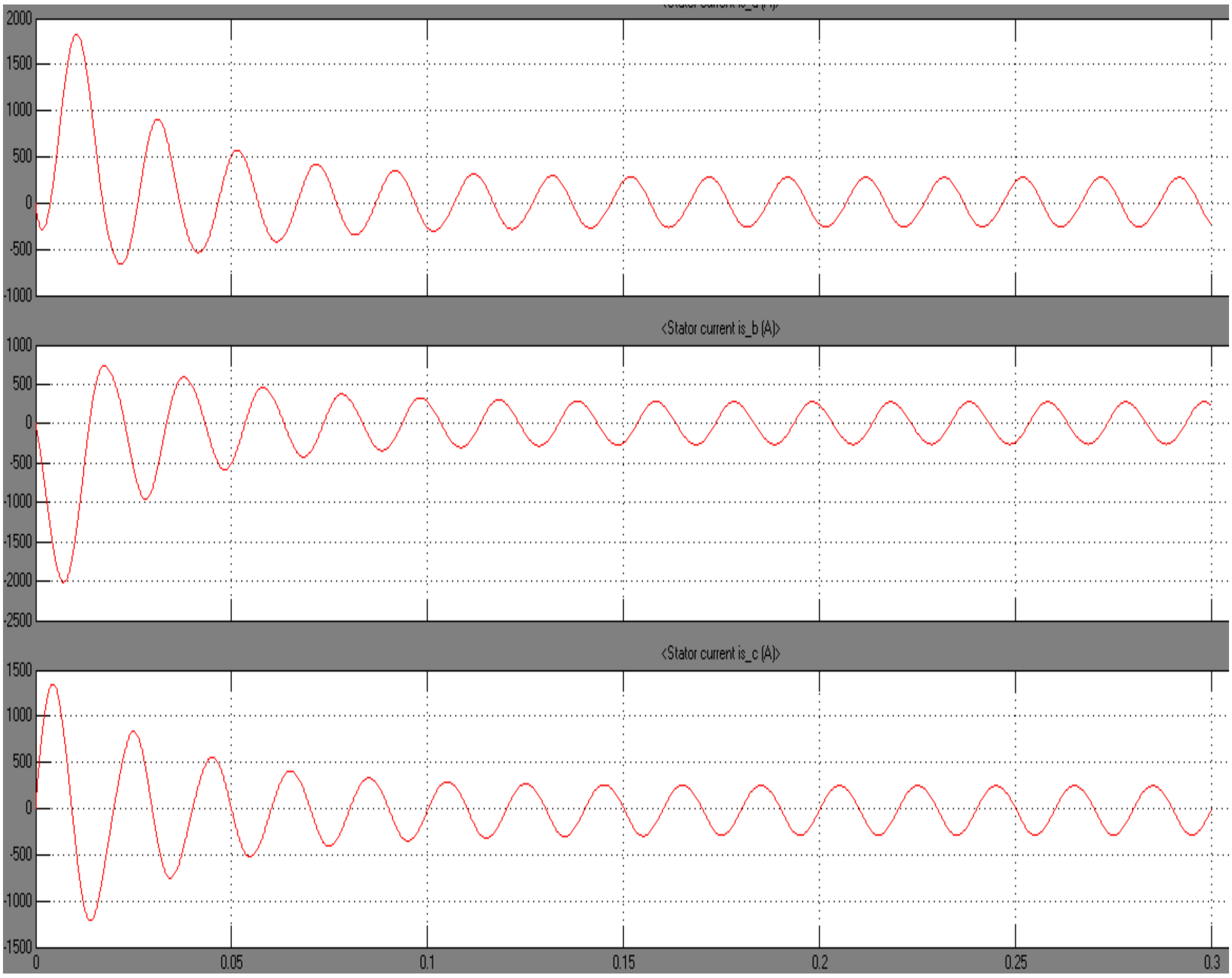

Fig.8 Output waveform with FC-TCR compensator

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From the above simulation results we have observed that the output waveform without using compensator has more disturbances as compared to the wave form comes from the model where the FC-TCR compensator is used.

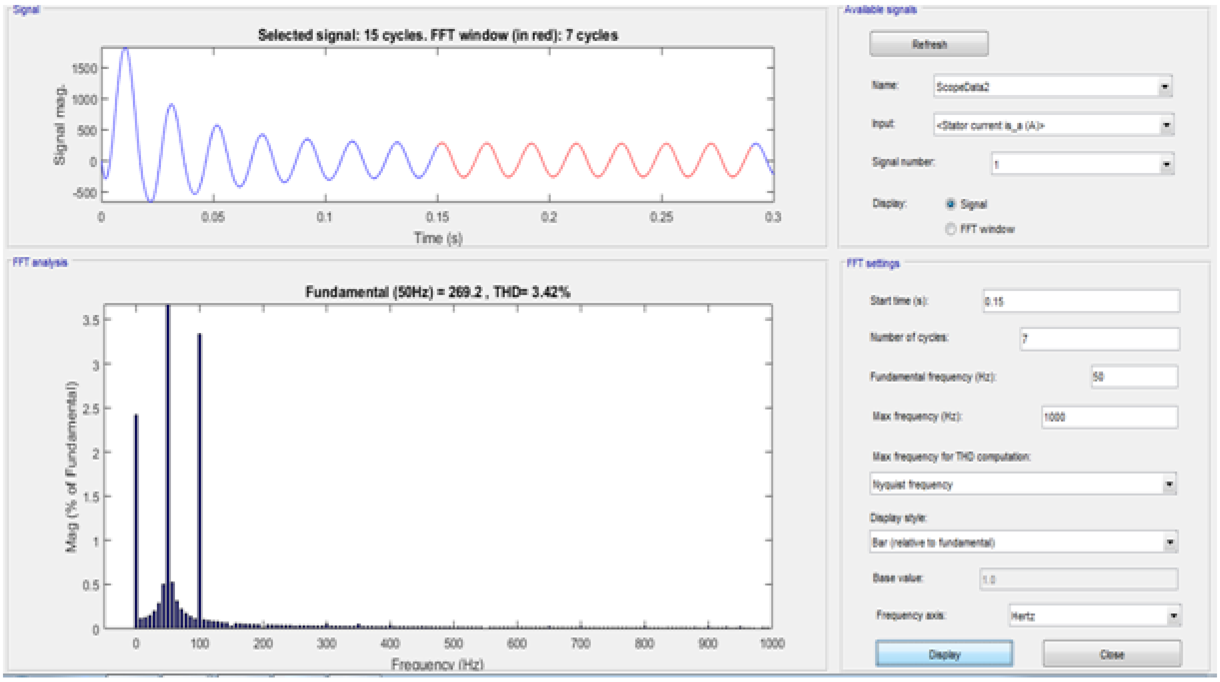

Fig.9 Graph showing the THD value of solar PV with FC-TCR

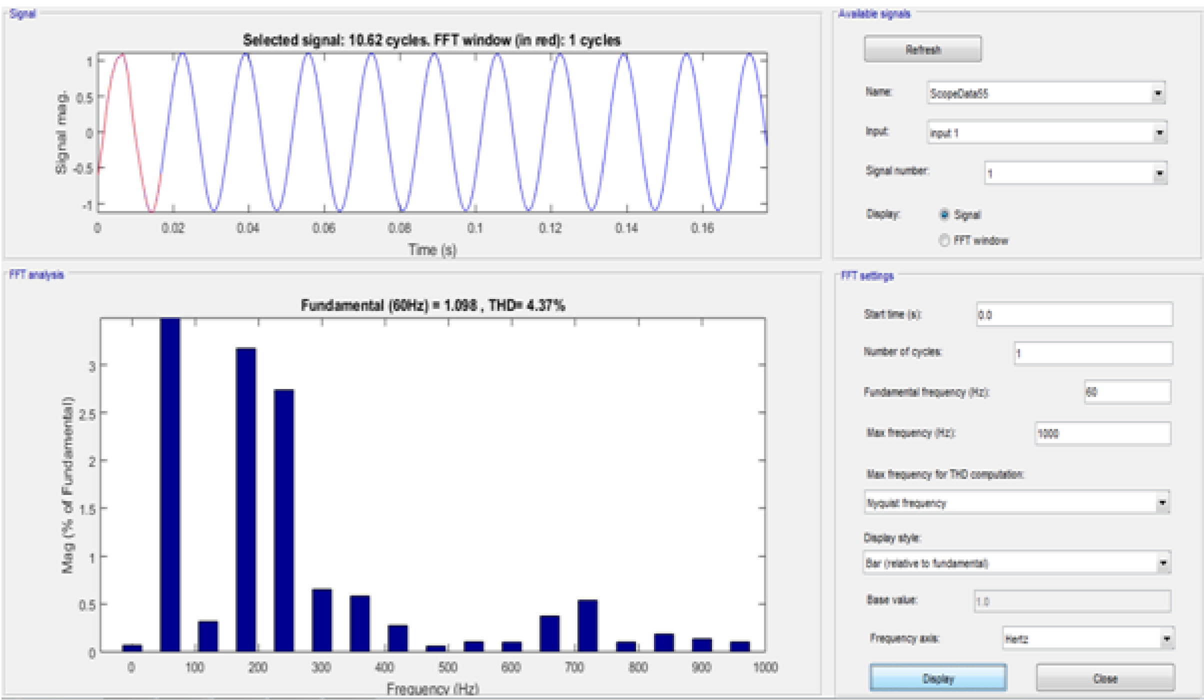

Fig. 10 Graph showing the THD value of solar PV without compensator

Table1. Total harmonics distortion values of PV system

Without any compensator	4.37%
With FC-TCR	3.42%

VII.CONCLUSION

Table 1 shows the values of total harmonic distortion in the PV system. From this table it is cleared that THD value of the PV system connected to the FC-TCR is lesser than the system without compensator. From here it is proven that FC-TCR enhances more system stability significantly and the system can be utilized in other grids also. This work represents a PV system connected to grid. In this work FC-TCR is used to enhance the stability of PV system. From the simulation it is cleared that the harmonics are more in output waveform where no FACT device is there for compensation purpose. So for reducing harmonics FC-TCR is used which reduce harmonics in current waveform.

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