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SIMULATIVE STUDY OF PHOTOVOLTAIC MODULE BASED CONVERTER-INVERTER SYSTEM

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Abstract

In this work modelling and simulation for power generation application has been introduce here via electronic equivalent circuit the Photo-Voltaic mathematical model developed here. The developed model introduces the prediction of Photo-Voltaic cell behaviour by variation in temperature and radiation of solar circumstances. The output of Photo-Voltaic cell 56 volt (depending on the temperature variation) given to the BOOST converter with Inverter. Finally we get 230V AC output as per our requirement.

Keywords: *Improved boost converter, embedded controller, solar cell*

1. Introduction

Traditional conventional sources & non conventional sources of energy as follows:

A) Non-conventional sources of energy :

Tidal or lunar energy is called has been known to mankind since time immemorial. Various devices particularly mills were operated using tidal power.

The wind wheel like water wheel has been used by man for a long time for grinding corn & pumping water.

Many geothermal power plants are operating throughout the world. Although larger geothermal power plants are in operation in America today it is to credit of Italians that first impressive breakthrough in geothermal power exploitation was achieved.

B) Conventional sources:

Conventional sources until James Watt invented steam engine in the eighteenth century? In fact New World was explored by man using wind-powered ships only. Non-conventional sources are available free of cost are pollution-free & inexhaustible.

Thermal-electric power plants& hydro-electric power plants & nuclear power plants supply most of electrical energy used in Ontario.

Electrical energy is produced in hydro-electric power plants from energy stored in water behind a dam.

Nuclear energy is produced from nucleus of tiny particles that make up matter. nucleus of a particle stores large quantities of nuclear energy.

Solar energy is most readily available source of energy. It does not belong to anybody & is therefore free. It is also most important of non-conventional sources of energy because it is non-polluting & therefore helps in lessening the greenhouse effect. Antarctica southern & the Himalayas would produce 20 percent more energy than photovoltaic based at sea level.

Since Antarctica is too remote & is covered in darkness for six months of year the Himalayas are more practical.

Best place to put an array of solar panels may be on Mt. Everest instead of Sahara Desert according to new research that looks at geography of solar power.

The exponential growth of the solar industry has created a large variety of PV modules; however it is not well known how long these modules will last. Manufacturer warranties often guarantee 80% maximum power for 25 years; however relatively few PV modules have been in use for that long. As a result, there is a limited amount of data on PV module lifetimes. This thesis examines how solar modules degrade and how this degradation affects their performance. By using the Smart Grid, energy consumers will have an incentive to create power on their own with the use of wind turbines generated in excess to electrical companies. Many researches are being made to improve the system and reduce its cost and size. As a result, the photovoltaic (PV) system is becoming much easier to install but the efficiency of solar module is still low (about 13%). Furthermore, it is desirable to operate the module at the peak power point.

Fig-1.1 Solar panels at Bear River Migratory Bird Refuge in Utah

Solar energy has been used since prehistoric times but in a most primitive manner. Before 20 century some research & development was carried out in a few countries to exploit solar energy more efficiently but most of this work remained mainly academic now dramatic rise in oil prices in 20s several countries began to formulate extensive research & development programmers to exploit solar energy. Solar energy can also be used to meet our electricity requirements.

1.1 PV generation system

PV generation system is mainly composed of PV array inverter device with function of maximum power tracking system. System made up one or more solar panels an ac or dc power converter that holds solar panels & interconnections & mounting for other components. The energy prices keep rising as well as the consumer demand but thanks to the monetary advantages that the states or government channels offer market for solar power equipment is on the rise within the United States.

Solar inverters have special functions adapted for use with photovoltaic arrays including maximum power point tracking protection. Photovoltaic cell solar cells are building blocks of PV array. These are made up of semiconductor materials like silicon etc. A thin semiconductor wafer is specially treated to form an electric field positive on a side & negative on other. Electrons are knocked loose from atoms of semiconductor material when light strikes upon them.

In an electrical circuit is made attaching a conductor to both sides of semiconductor electrons flow will start causing an electric current silicon. Circular or square in construction but mono-crystalline silicon & polycrystalline are mainly used for commercial use.

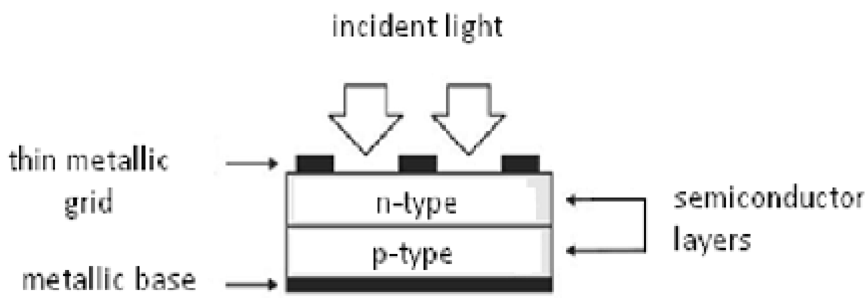

Fig-1.1 Basic PV Cell Structure

1.2 Photovoltaic module

Single solar cell generates only 0.5 volts which is very low. So a number of solar cells are connected both in series & parallel connections to achieve desired output. Partial shading diodes may be needed to avoid reverse current in array. Good ventilation behind solar panels is provided to avoid possibility of less efficiency at high temperatures.

1.3 Photovoltaic array

Again power produced by a single photovoltaic module is not sufficient to meet power demands for most of practical purposes. PV array can use inverters to convert dc output into ac & use it for motors lighting & other loads. Modules are connected in series for more voltage rating & then in parallel to meet current specifications.

2.5 Working of PV cell Working of PV cell is based on basic principle of photoelectric effect.

Photoelectric effect can be defined as a phenomenon in which an electron gets ejected from conduction b & as a consequence of absorption of sunlight of certain wavelength by matter. So in a photovoltaic cell when sunlight strikes its surface some portion of solar energy is absorbed in semiconductor material absorbed energy is greater than band gap energy of semiconductor electrons from valence band & jumps to conduction band.

By this pair of whole electrons is created in illuminated region of semiconductor. electrons thus created in conduction band are now free to move. Now free electrons are forced to move in a particular direction by action of electric field present in PV cell.

2. Photocurrent generation principles

Typically a PV cell generates a voltage 0.5 V to 0.8 V depending on the semiconductor and the built-up technology. Now voltage is low enough as it cannot be of use to get benefit from this technology tens of PV cells (involving 36 to 72 cells) are connected in series to form a PV module. In case these modules are connected in series their voltages are added with the same current. Not only this when they are connected in parallel their currents are added while the voltage is the same. There are Three major families of PV cells are mono-crystalline technology polycrystalline technology and thin film technologies. polycrystalline technologies are based on microelectronic manufacturing technology and their efficiency is in general between 10% and 15% for mono-crystalline and between 9% and 12% for polycrystalline. Basically For thin film cells the efficiency is 10% for a-Si 12% for CuInSe2 and 9% for CdTe. Thus the mono-crystalline cell that has the highest efficiency is the focus of this paper carried out a Matlab/SIMULINK model of mono-crystalline PV cell that made possible the prediction of the PV cell behavior under different varying parameters such as solar radiation ambient temperature series resistor shunt resistor diode saturation current etc.

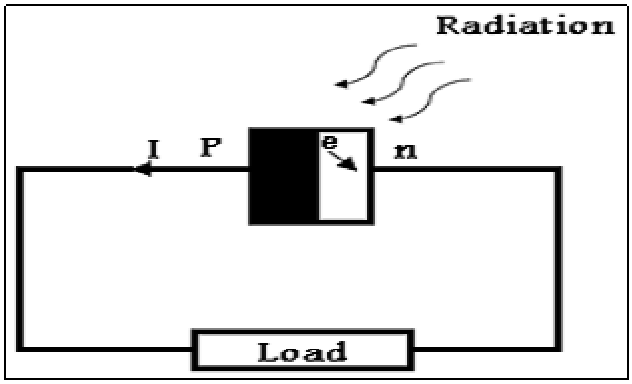

Fig -2.1 PV cell process

The equivalent circuit of a PV cell is shown It includes a current source a diode a series resistance and a shunt resistance

$$I = I_{ph} - I_s\left(\exp\frac{q(V+R_sI)}{NKT} - 1\right) - \frac{(V+R_sI)}{R_{sh}} \qquad 2.1$$

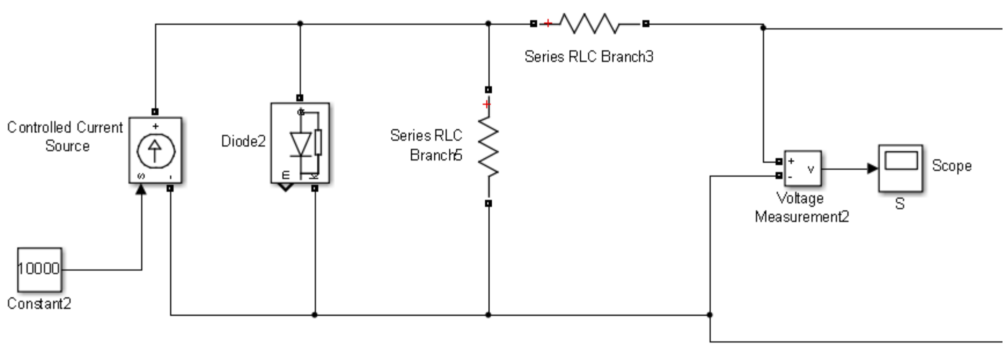

Fig-2.2 PV cell equivalent circuit

In this equation Iph is the photocurrent Isis the reverse saturation current of the diode q is the electron charge V is the voltage across the diode K is the Boltzmann's constant This the junction temperature N is the ideality factor of the diode and Rs and R share the series and shunt resistors of the cell respectively As a result the complete physical behavior of the PV cell is in relation with Iph IsRs and Rsh from one hand and with two environmental parameters as the temperature and the solar radiation from the other hand.

3. Simulation and results

Modelling and simulation for power generation application has been introduced here via electronic equivalent circuit. The Photo-Voltaic mathematical model developed here. The developed model introduces the prediction of Photo-Voltaic cell behaviour by variation in temperature (26-48 Tu) and radiation (1000) of solar circumstances. The output of Photo-Voltaic cell 56-58 volt (depending on the temperature variation) given to the BOOST converter and output of converter is given to the inverter circuit which gives sinusoidal output. Finally we get 230V AC output.

The model of project work is given below,

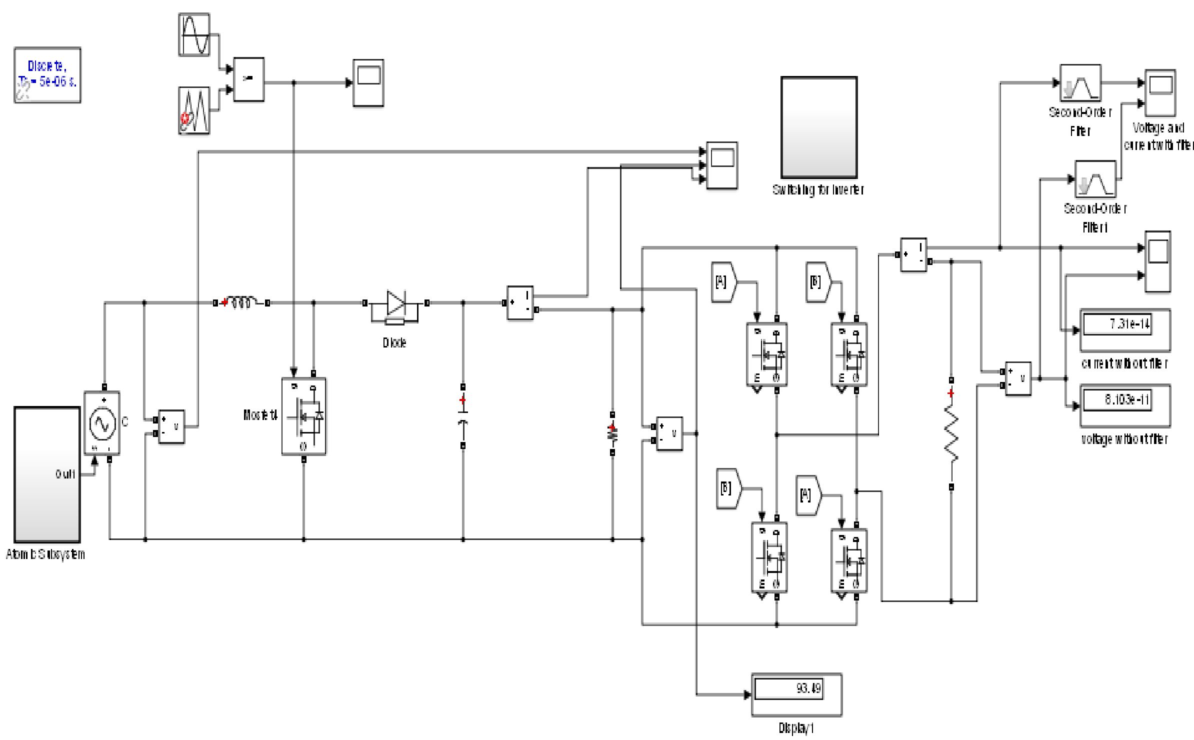

Fig-3.1 Detailed simulation model of work

3.1 Out Put of Boost Converter

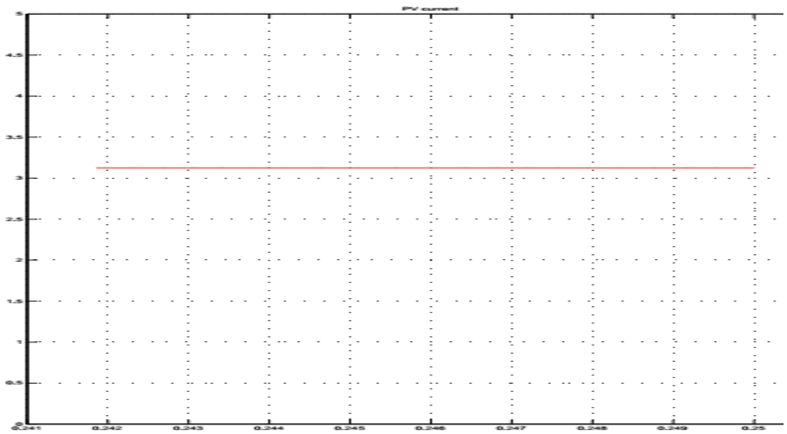

Fig-3.2 PV Output Current

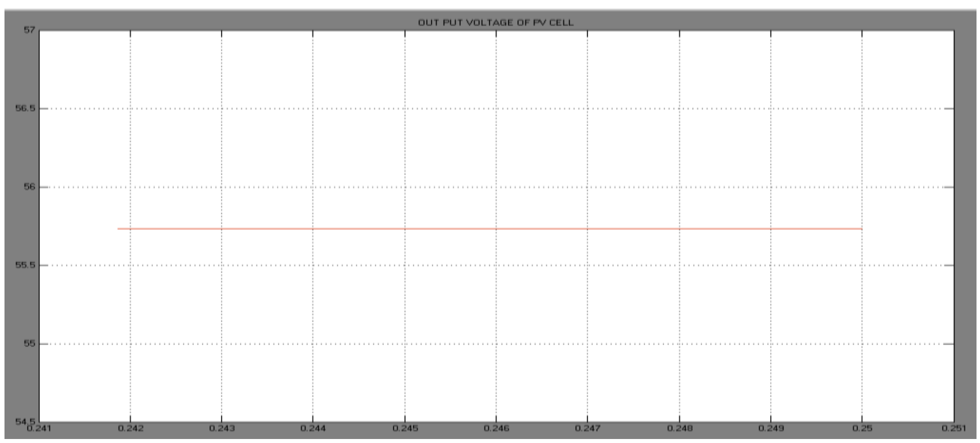

Fig-3.3 PV Output Voltage

3.2 Out Put of Boost Converter

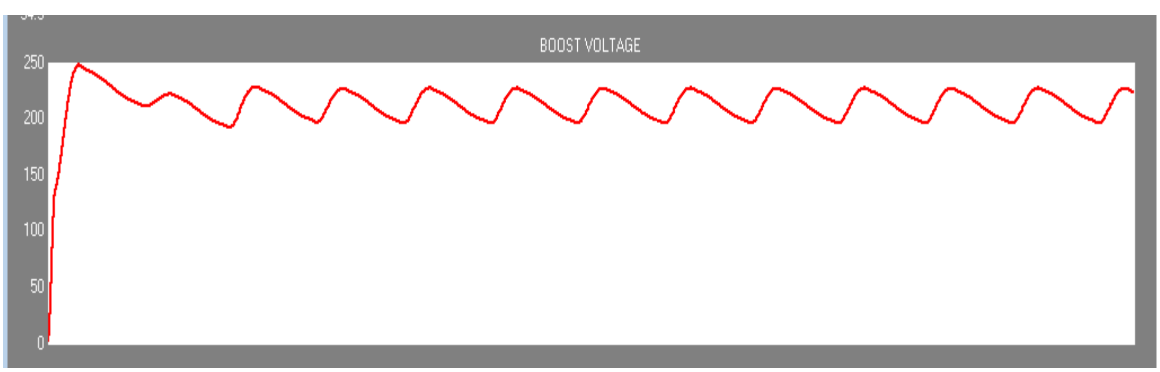

Fig-3.4 Boost converter voltage

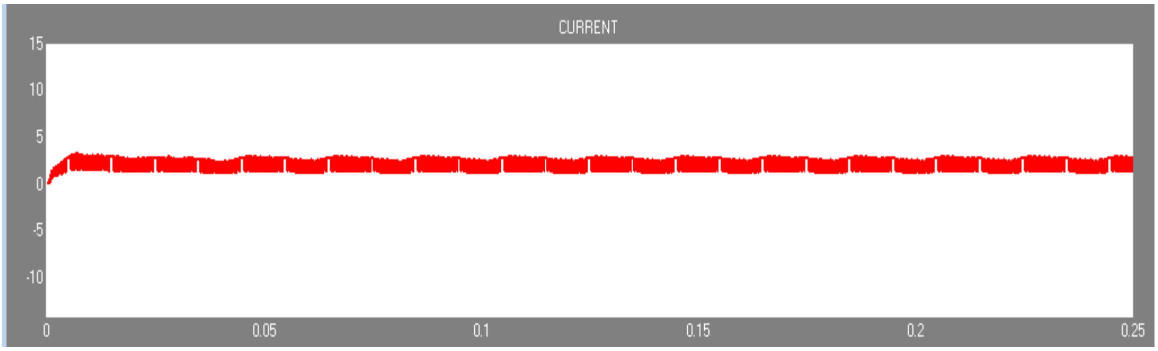

Fig-3.5 Boost converter current

3.3 Inverter output

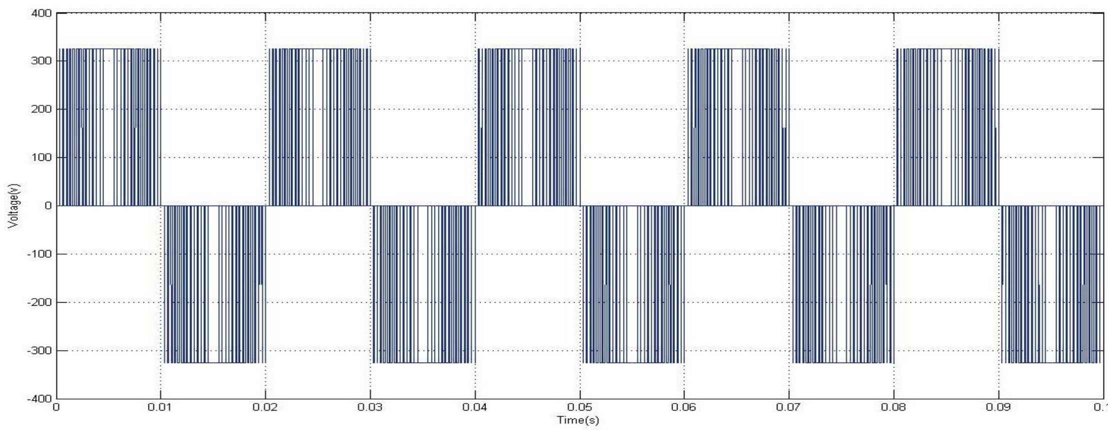

Fig-3.6 Inverter output voltage

3.3.1 Inverter output current with and with out filter

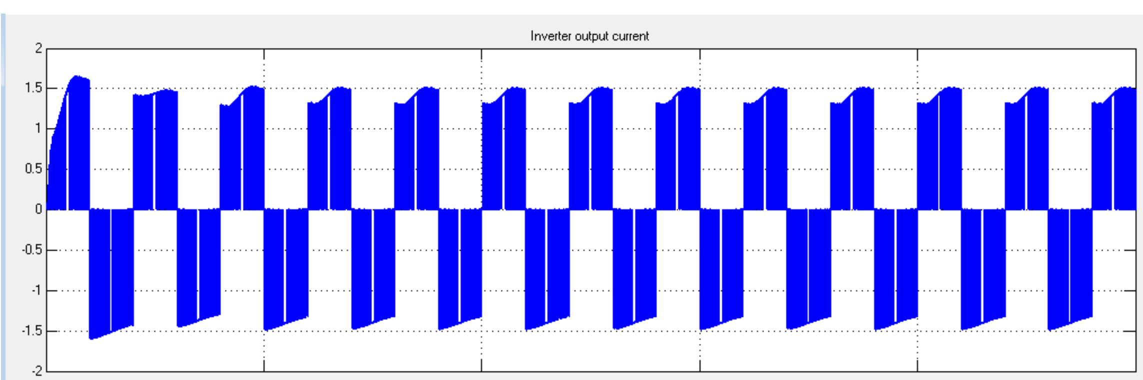

Fig-3.7 output current waveform (without filter)

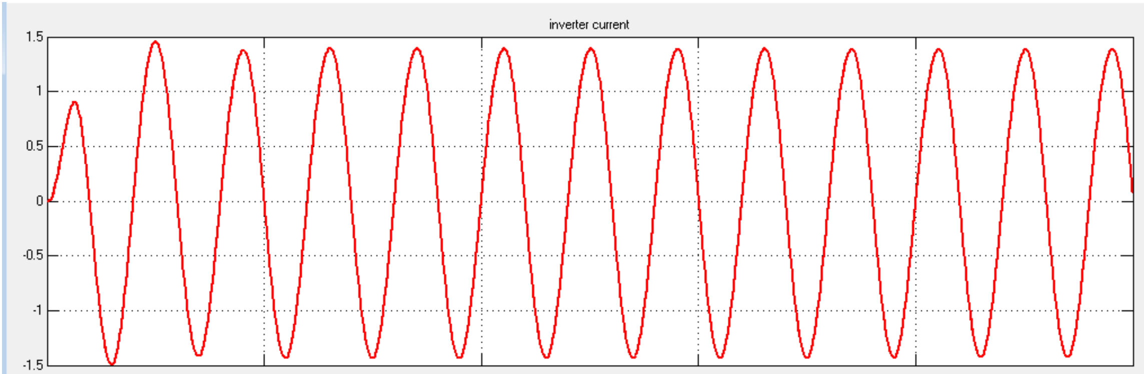

Fig-3.8 output current waveform (with filter)

3.3.2 Inverter output voltage with and with out filter

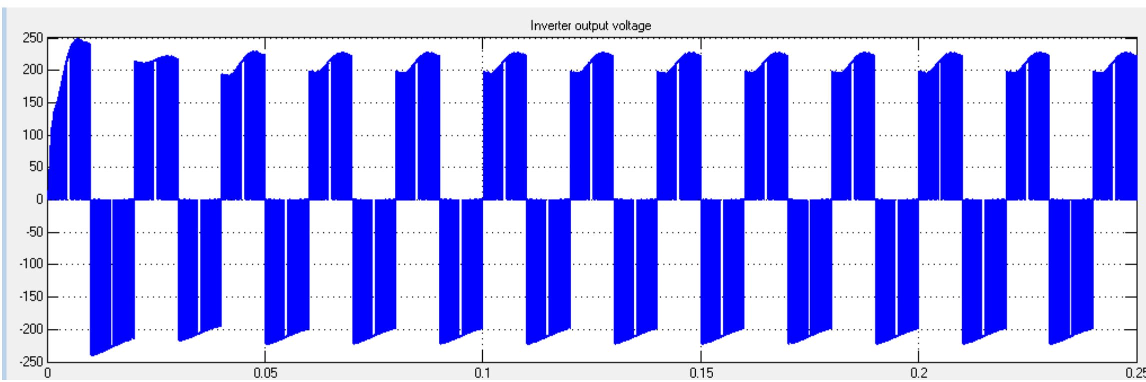

Fig-3.9 output voltage waveform (without filter)

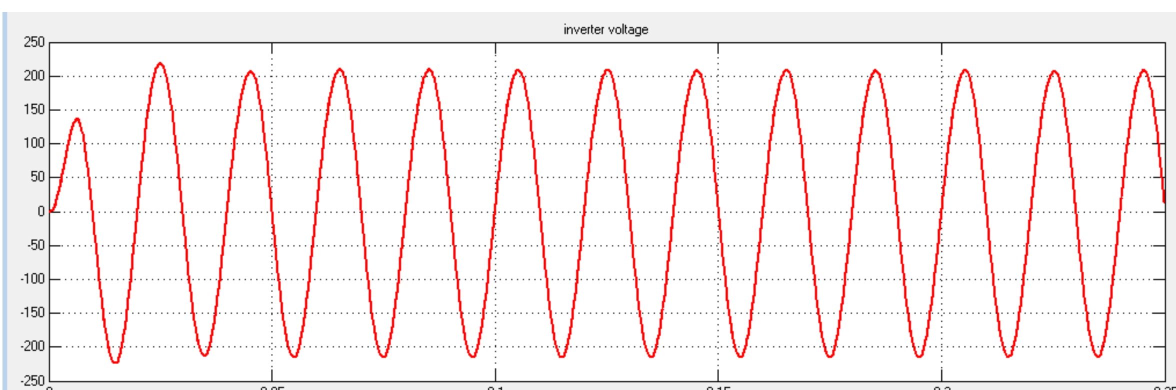

Fig-3.10 output voltage waveform (with filter)

3.4 Advantages & Disadvantages

Advantages

- Improved power factor
- Fast response
- High efficiency
- Provides one polarity output voltage & unidirectional output current

Disadvantage –

Boost conveter demands larger filter capacitor and a larger inductor

Applications

- Solar cells
- Regulated switch mode power supplies
- Electric automobiles
- Trolley cars & marine hoists
- Regenerative braking of dc motors

4. Conclusion

In the dissertation, study in modelling and simulation model for power generation is carried out. Photovoltaic model derived from various current and voltage equations (Is, I_{ref} and voltage). The output of photovoltaic model is 56 volt at temperature 48 Tu which is boost and inverted at 230 volt AC output. The variation in voltage of PV cell due to temperature change is also studied which is shown below:

S.N.	Temperature	Output voltage
1	25	49
2	40	52
3	48	56

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