

# Grid Connected PV Microinverter with Quadrupler

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**ABSTRACT:** The conventional grid connected system consist of a DC-DC converter, which will boost the voltage to a large value, but the major problem associated to it is its efficiency and the pulsating output. The efficiency of the conventional system reduces as the duty cycle approaches unity. And also the voltage stress the across the diodes will be high. Many topologies are implemented to counter this problem. A high value of step up voltage gain can be achieved by means of DC-DC fly back converter, but the voltage stress remain as such. The quadrupler used in the proposed paper can reduce the voltage stress since it has a switched capacitor, and also the automatic current sharing capability will increases the overall conversion efficiency. The output of the quadrupler can be approximated to steady since the duty ratio is close to unity. In the proposed paper the output so obtained will be 400V

## I. INTRODUCTION

The solar energy is the cheap source of energy available in a huge amount. So it is advisable to utilise it in a useful manner to counter the energy crisis. PV on-grid rooftop solar power system is one of the most popularly used solar solutions for houses and commercial establishments. Grid-tie solar , also knows as on-grid, works in connection with the main grid. It offers the advantage of running load directly through solar and selling excess solar power back to electricity company by feeding the grid. The conversion of solar energy to electrical energy can be implemented by using an inverter. The PV module along with a dc-ac converter system can feed a ac load. The dc-dc converter system is used to boost the voltage output from the panel to a higher value to meet the increasing load demand. The DC-DC converter has enough drawback such as the low efficiency and the high voltage stress. So we go for the next topologies like Fly back inverter etc, there also we failed to reduce the voltage stress but the we get high step-up voltage gain.

The proposed micro inverter in this paper replaces the DC-DC converter with a voltage quadrupler that can counter all the disadvantages of DC-DC converter, the higher value of duty cycle will reduce the voltage stress and also the automatic current sharing capability will enhance overall conversion efficiency. The proposed micro inverter consist of a PV panel, an MPPT controller converter inverter and the protection schemes. The PV panel modules are designed for high efficiency and high power output to utilize limited space while giving a greater return on investment. Photovoltaic systems use cells to convert solar radiation into electricity. The greater the intensity of the light, the greater will be the flow of electricity. Inverter section in the proposed paper consist of four switches in which two of them will be working at a time. The gate pulse to the switches is being given through the SPWM. The inverter uses sinusoidal pulse from the grid and compares with the triangular to get the SPWM signal. The value of voltage stress us comparatively low.

## II. BLOCK DIAGRAM AND DISCRPTION

The grid connected PV Micro inverter utilises a DC-DC Converter ,inverter a MPPT controller and a protection schemes. The output from the PV panel is provided to the DC-DC converter section, which converter converts the small value of input to the desired value by adjusting the duty ratio. The third stage is a DC-AC inverter stage that converts the dc value to an n ac value.

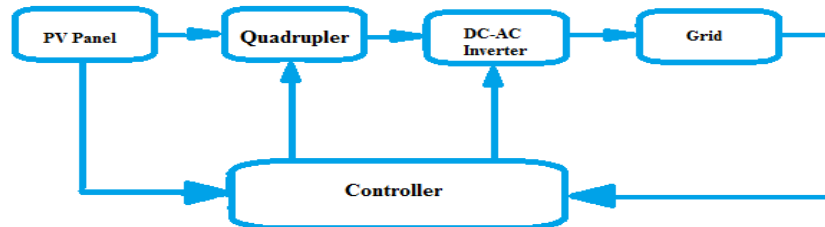


Fig: Block diagram

The PV panel of specification of 24V is being used. Photovoltaic systems use cells to convert solar radiation into electricity. The Solar cell consists of one or two layers of a semiconducting material. When light shines on the cell it creates an electric field across the layers, causing electricity to flow. Greater the intensity of the light, greater will be the flow of electricity. The most common semi conductor material used in photovoltaic cells is silicon. Silicon is the second most abundant material in the earth's mass.. It can also generate electricity on cloudy days.

The voltage obtained from the PV is 24V. In order to generate a large value we need to boost the voltage output of PV. So we go for a converter it may be either a DC-DC converter or a quadrupler. The convention system utilises a DC-DC converter . the conventional DC-DC converter can generate a voltage of 170 from a 24V input. As it is low to drive our power requirement. High step up DC-DC converter with switched capacitor is being used. The coupled inductor along with switched capacitor can achieve a high step up duty ratio. The voltage stress across the diodes remain as such.

Quadrupler circuits are used to multiply the voltage values. The quadrupler output will be four times as compared to the DC-DC converter. It consists of two multiplier circuits. The quadrupler has enough advantages it includes high voltage gain and automatic current sharing capability. The overall conversion efficiency is high. The quadrupler consist of two multiplier diodes. And two inductors with which it will be storing energy.

The DC-AC inverter is used to convert the DC value to AC. The inverter consist of four switches in which two of them will be on simultaneously and others will be off and having frequency equal to grid frequency. The SPWM signal is used to fire the MOSFETs. The SPWM signal is the compared output of the sinusoidal and the repeating sequence. The sinusoidal pulse is from the grid, it is compared with the repeating sequence. The output of the DC-AC-inverter will be an AC value. Also an islanding protection and abnormal state detection is also provided in this stage.

### III. WORKING OF PV INVERTER

The PV micro inverter utilises solar energy for the entire working process. The system is initiated by the solar irradiations. Whenever the solar radiations are received by the panel the electronic excitation will takes place results in the generation of electric current. The voltage output from the PV panel is provided to the quadrupler as well as it is provided to the microcontroller through a sensing device. The Quadrupler will boost the output from PV to a desired value. This desired value of output(400) voltage is provided to the inverter session so that it will be converted to the AC waveform. The inverter is fired by using an SPWM signals, which is being a compared output of sinusoidal waveform from the grid and a repeating signal.

The AT mega 16 controller is used for controlling the duty cycle of the inverter stage, the voltage being sensed from the panel is checked whether it provide a maximum power point or not. I order to check the maximum power we use MPPT Algorithm. The MPPT is attained by the P&O algorithm, the major advantage of the P&O algorithm is the that it provide a continuous output with les amount of perturbations. And the algorithm checks the value of power with the current value and the previous value in order to maintain a constant power. The controller also provide a required pulse to the inverter depending upon the PV output.

The inverter output is provided to the grid by means of a circuit breaker as a protection mechanism. Whenever a fault occurs in grid such as over voltage, under voltage, over current or the variation in the frequency, the circuit should be isolated. In order to isolate the inverter from grid al this conditions are checked before connecting to grid and then it is connected to the inverter side by means of the breaker.

**IV. PROTECTION SCHEMES**

The major protection schemes that are used are anti islanding and abnormal state detection.

The islanding scheme is one of the protection scheme used in the proposed converter. Active islanding and passive islanding are the two main types of islanding protection used widely. In this the passive method only senses the settling frequency whereas the active method go for both the settling range of frequency and the abnormal state detection. In this converter the active method is being used. The frequency shift algorithm is preferred here and it works in such a way that whenever the frequency shift exceeds 100 in both positive and negative direction the islanding is triggered. According to IEEE std the total current distortion will be less than 5% within a time period of 2s. The Fig 3 (a) represents the islanding detection program

In abnormal state detection program detect the problem in the system ie. Over voltage, over current etc. The protection schemes are use to protect and isolate the system from the fault. Whenever a fault occurs in the system the entire circuitry is being isolated . The synchronised output of inverter and the grid is tied together so the fault in the grid side can damage the inverter, in order to avoid that, the islanding and abnormal state detection is used. In abnormal state the fault, over voltage, under voltage over current and frequency perturbation is being checked. According to the IEEE std.929,the voltage range should be (88-100)% of rated voltage, otherwise it is considered as fault. The frequency range is 49.5Hz-50.5Hz. Also the system voltage and frequency can withstand constantly out of settling range for more than 330ms and 100ms successively then only the system will shutdown.fig 3(b) represents it

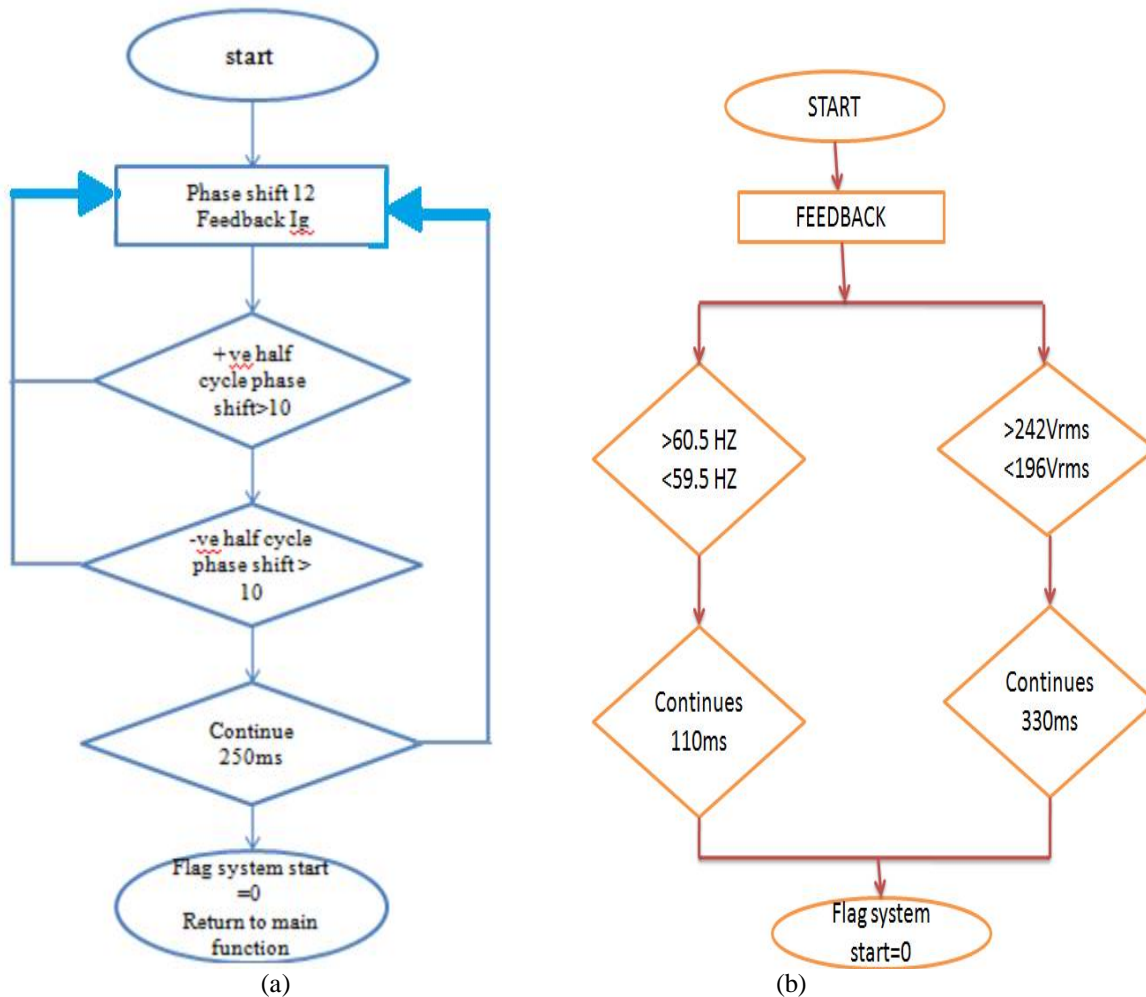


Fig 3(a) anti islanding (b) abnormal state detection

**COMPONENTS**

**Table1 Components list of hardware**

Sl no	Components
1.	PV Panel
2.	AT Mega 16
3.	CT1213

(a)

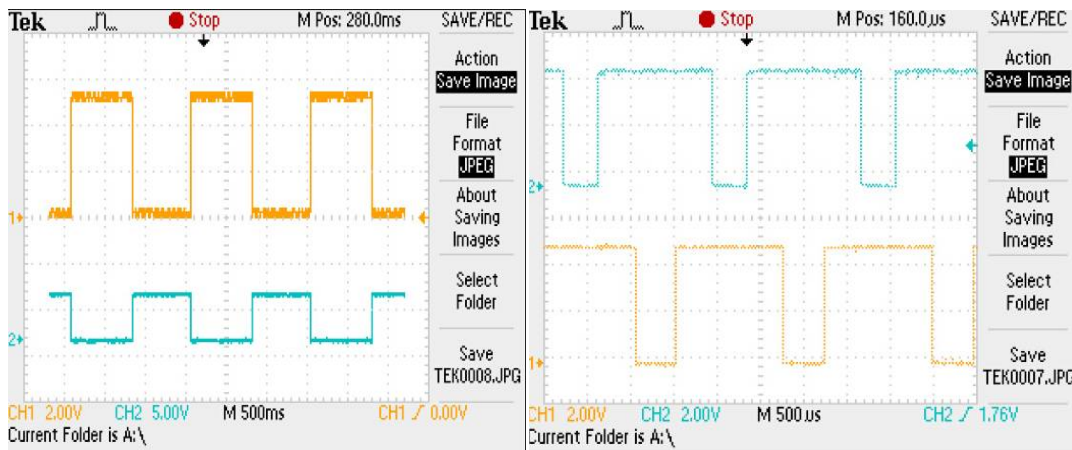
Components	Specification
Boost inductor	CH330060,253uHz
Active switches	IXFH150N15P,150V
Capacitors	10uF/250V,250uF/250V
Power diodes	DSEP60-25A

(b)

**SENSORS**

There are two sensors used in this paper in order to sense the voltage and current. One from the grid and the other from the PV panel the sensor in the PV side senses the value of voltage and current in order to check whether it provides a maximum power or not. In the second section is the current and voltage from the grid. The sensor in the grid checks whether there is any fault in the grid side or not. The sensor used is CT1213(.5-2.)mA.

**V. RESULTS**



(a)

(b)

Fig 2 (a) and (b) Inverter output and pulses used

**VI. CONCLUSION**

In this paper the grid connected micro inverter using quadrupler is accomplished. The solar energy of the sun is being converted with the help of a quadrupler circuit, DC-AC inverter and some protection schemes. The proposed paper utilises the P&O algorithm to achieve maximum power also some protection schemes such as anti-islanding and abnormal state detection is used. The output of the proposed converter can be connected to grid by synchronising it with the grid. The output of the PV is 24V and its being multiplied by the entire system to get an output of 400V from the system. And the quadrupler used here can reduce the voltage stress across the diodes.

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