NCPE 2016, KLESCET, Belagavi

International Journal of Technology and Science, ISSN (Online) 2350-1111, (Print) 2350-1103 Volume 3, Issue 2, 2016 pp. 33-37

Single Phase Grid Connected Photovoltaic System

[1]Kavya S A, [2]Komal T, [3]Pooja A, [3]Sahana S N and [4] Mr Sachin Angadi
[1]ankalakote.kavya@gmail.com

***Abstract* — Due to global environmental concerns, photovoltaic systems (i.e., solar panels) are becoming more common as a renewable energy source. It is mainly driven by the demand of "clean" power generation. Grid-connected PV systems will become an even active player in the future mixed power systems, which are linked by a vast of power electronics converters. Even though the main drawbacks of PV energy are the high cost of manufacturing silicon solar panels and the low conversion efficiency and consumes large space for installation. However, with the latest techniques in manufacturing, PV systems are becoming more efficient, as well as cost effective .In order to achieve a reliable and efficient power generation from PV systems, stringent demands have been imposed on the entire PV system. It in return advances the development of power converter technology in PV systems.**

Interfacing a solar inverter module with the power grid involves injecting sinusoidal current into the grid. To trigger the inverter, complementary pulses are generated using digital controller (microHOPE).Inverter stack converts DC voltage from PV panel to AC voltage, which can be fed to grid.

***Index Terms*—Maximum power point; single phase inverter;**

I. Introduction

As the conventional energy sources are dwindling fast, the solar photovoltaic energy offers a very promising alternative, because it is free, abundant, pollution free and distributed throughout the earth. In the past, photovoltaic energy has been used as power supply for only some loads such as satellites or remote areas where conventional sources are very far. In these days of increasing environmental concern, governments and the scientific communities work to maximize the use of renewable energy resources. There is a growing recognition of the valuable role solar power can play in reducing pollution, particularly in the effort to stabilize the carbon dioxide levels. The technology is now available for industrial, commercial and residential consumers. Solar panels harness the sun's power to generate electricity provide clean power for homes, communities and businesses, and help to cut global carbon emissions. Solar photovoltaic (pv) modules generate electricity from sunlight, which can be fed into the mains electricity supply of a building or sold to the public electricity grid. Reducing the need for fossil fuel generation, the growing grid-connected solar PV sector across the globe is helping create jobs, enabling families and businesses to save money, and cut greenhouse emissions.

Photovoltaic (PV) power supplied to the utility grid is gaining more and more visibility due to many national incentives. With a continuous reduction in system cost (PV modules, DC/AC inverters, and installation), the PV technology has the potential to become one of the main renewable energy sources for the future electricity supply. The market for grid-connected PV power applications continues to develop at a high rate. Feeding the photovoltaic energy to the ac grid is not evident. It poses some problems in controlling the energy transfer and connecting the two systems together by using static converters. The classical connection between photovoltaic array and AC grid is shown in figure1. The main objective, from this interfacing, is to feed all the collected energy at the PV plant to the commercial AC grid.

I. BLOCK DIAGRAM

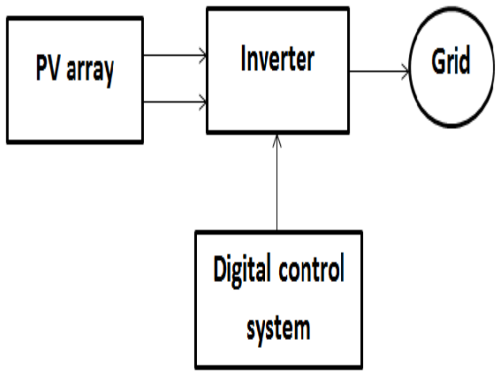


Fig. 1 Equivalent circuit of a single-phase induction generator including its excitation capacitor and load

PV cells are semiconductor devices, used to generate dc electricity from sunlight with electrical characteristics similar to a diode. A large area is needed to collect as much sunlight as possible, so the semiconductor is either made into thin, flat, crystalline cells, or deposited as a very thin continuous layer onto a support material. The cells are wired together and sealed into a weather proof module, with electrical connectors added. Modern modules for grid connection usually have between 48 and 72 cells and produce dc voltages of typically 25 to 40 volts, with a rated output of between 150 and 250 Wp. PV modules are specified by their „watt-peak" (Wp) rating, which is the power generated at a solar radiation level of 1000 W/m2, equivalent to bright sun in the tropics. They still work fine with less solar radiation. The voltage produced by a PV module is largely determined by the semiconductor material and the number of cells, and varies only slightly with the amount of solar radiation. The electrical current and the power generated are proportional to the amount of solar radiation.
The PV cell operates as a current source when it comes in contact with a UV light source. A PV cell will behave differently depending on the size of the

PV panel or type of load connected to it and the intensity of sunlight (illumination). This behavior is called the PV cell characteristics. The characteristics of a PV cell are described by the current and voltage levels when different loads are connected. When the cell is exposed to sunlight and is not connected to any load, there is no current flowing and the voltage across the PV cell reaches its maximum. This is called an open circuit (*Vopen*) voltage. When a load is connected to the PV cell, current flows through the circuit and the voltage drops. The current is maximum when the two terminals are directly connected with each other and the voltage is zero. The current in this case is called a short-circuit (*ISC*) current, as shown in Figure 2.

The light irradiation as well as temperature affects the PV cell characteristics. Current is directly proportional to light irradiation. Voltage also changes with fluctuating light levels, but the change in the voltage is less. Voltage is more affected by changes in the temperature of the PV cell than the current. An increase in cell temperature decreases the voltage and increases the current by a very small amount. How these influences affect an I-V curve is illustrated in Figure 3. It can be observed that changing (decreasing) the light intensity has a much greater effect than changing (increasing) the temperature. This is true for all commonly used PV materials.

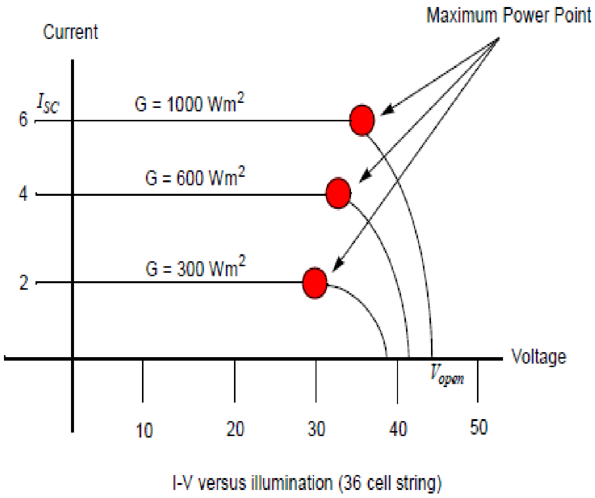


Fig 2: PV module electric characteristics with variation in incidence irradiance

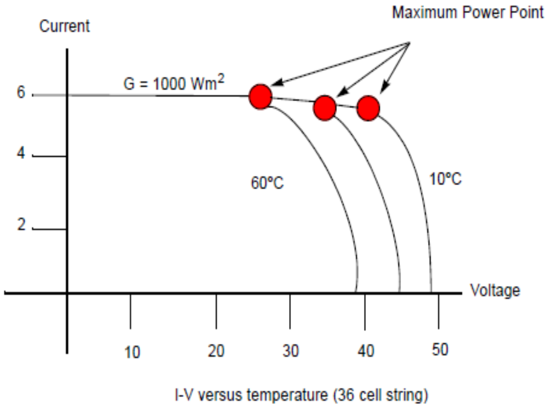
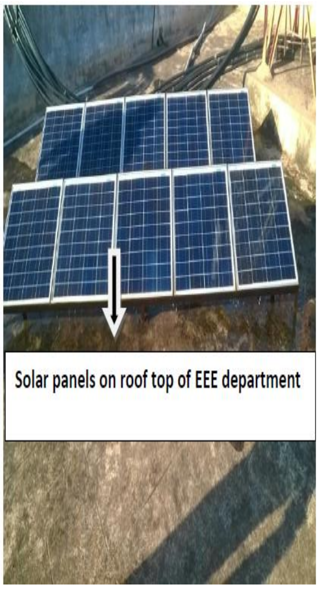


Fig 3: PV module electric characteristics with variation in temperature



Maximum power(P_{max})	50.00 W
Voltage at P_{max}	17.00 V
Current at P_{max}	2.94 A
Short circuit current	3.17 A
Open circuit voltage	21.00 V
Maximum system voltage	1000 V

Fig.3: PV array specifications

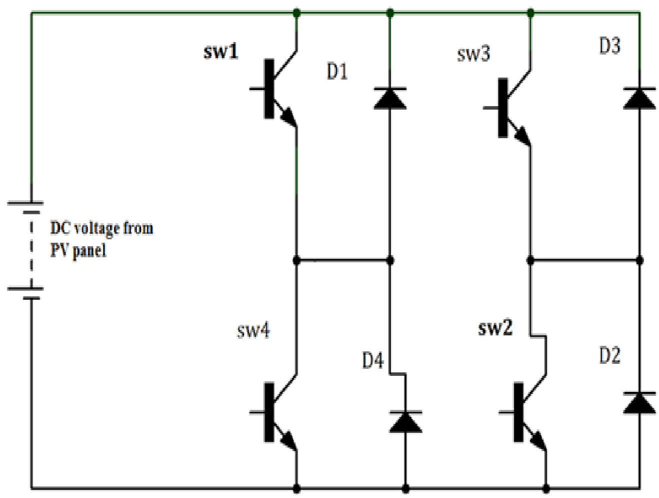


Fig 5: single phase inverter

Single phase inverter consists of two arms with a two semiconductor switches on both arms with antiparallel freewheeling diodes for discharging the reverse current. In case of resistive-inductive load,

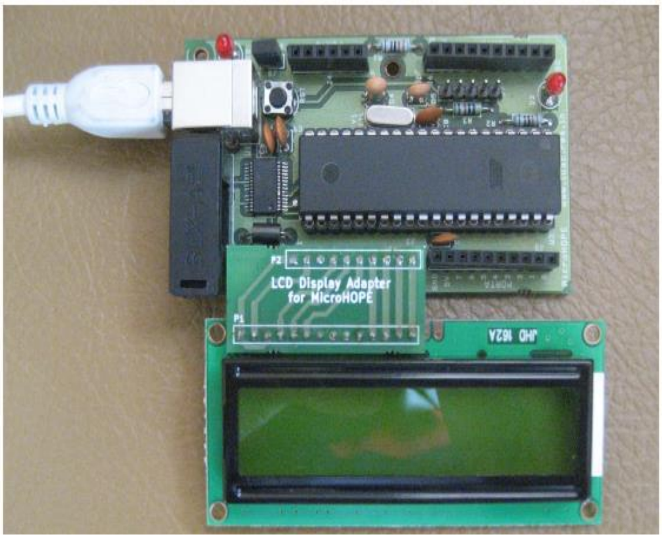
International Journal of Technology and Science, ISSN (Online) 2350-1111, (Print) 2350-1103 Volume 3, Issue 2, 2016 pp. 33-37

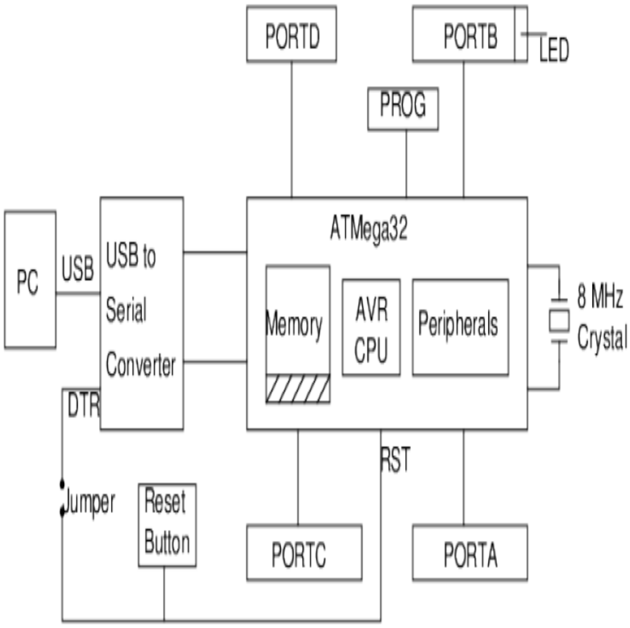
the reverse load current flow through these diodes. These diodes provide an alternate path to inductive current which continue so flow during the Turn OFF condition.

T1	T2	T3	T4	V_A	V_B	V_{AB}
ON	OFF	OFF	ON	$\frac{Vs}{2}$	$-\frac{Vs}{2}$	V_S
OFF	ON	ON	OFF	$+\frac{Vs}{2}$	$+\frac{Vs}{2}$	$-V_S$
ON	OFF	ON	OFF	$\frac{Vs}{2}$	$-\frac{Vs}{2}$	0
OFF	ON	OFF	ON	$-\frac{Vs}{2}$	$+\frac{Vs}{2}$	0

Table of switching states

The switches are T1, T2, T3 and T4. The switches in each branch is operated alternatively so that they are not in same mode (ON /OFF) simultaneously .In practice they are both OFF for short period of time called blanking time, to avoid short circuiting . The switches T1 and T2 or T3 and T4 should operate in a pair to get the output. These bridges legs are switched such that the output voltage is shifted from one to another and hence the change in polarity occurs in voltage waveform. If the shift angle is zero, the output voltage is also zero and maximal when shift angle is π.





A portion of the Flash memory is occupied by the Boot Loader Code

Fig 6. MicroHOPE

A block diagram of microHOPE hardware is shown in figure5. Programs can be uploaded from the PC through the USB port, using the pre-loaded boot loader code on the microcontroller. To load a new program, the PC asserts the DTR signal of FT232 that resetsATmega32. On reset, the boot loader code will start to receive the new code from PC. After loading the new code, control is transferred to it.Atmega32 has 32 Input/output pins, organized as 4 ports, each 8 bit wide.

The IC is available in DIP package, that can be socket mounted. The ATmega32 has 32 kb of Flash memory, 512 bytes EEPROM and 2 kb Static RAM. Three Timer/Counters, a serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-channel10-bit ADC and an SPI serial port are some of the peripheral devices on the chip. The processor on the microHOPE board runs at 8MHz, using the external crystal. All the I/O pins, except the UART Rx/Tx pins, are available to the user on the four I/O connectors. An LED is connected to Bit 0 of Port B, for quick testing of the board.

A reset button is also provided. The 5V USB power is connected to both VCC and AVCC inputs. A jumper is provided to disable the reset option from the PC. This is required when the final product is used for communicating to a PC. An alphanumeric LCD display is available as an accessory to microHOPE, to help the program development. It can be connected to the PORTC socket and C functions are provided to access the display.

International Journal of Technology and Science, ISSN (Online) 2350-1111, (Print) 2350-1103 Volume 3, Issue 2, 2016 pp. 33-37

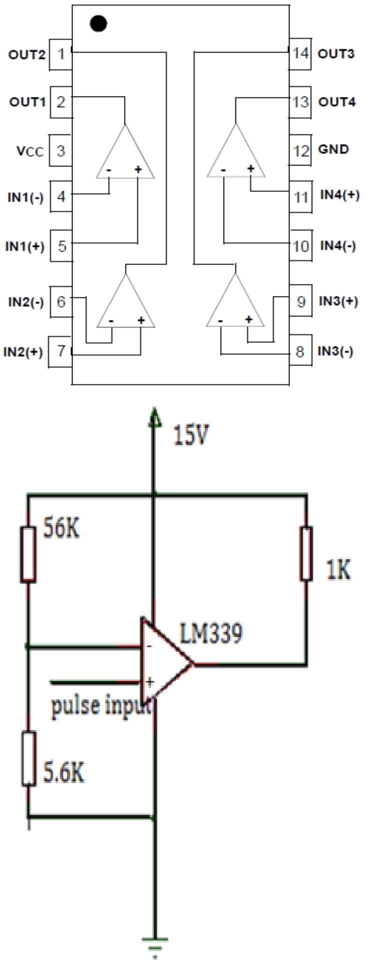


Fig 7. Pin configuration of LM339 and level shifting circuit

Figure 7 shows a basic comparator circuit for converting low level analog signals to a high level digital output. The output Pull-up resistor should be chosen high enough so as to avoid excessive power dissipation yet low enough to supply enough drive to switch whatever load circuitry is used on the comparator output. Resistors R1 and R2 are used to set the input threshold trip voltage (VREF) at any value desired within the input common mode range of the comparator.

II. Prototyping And Results

Hardware implementation:

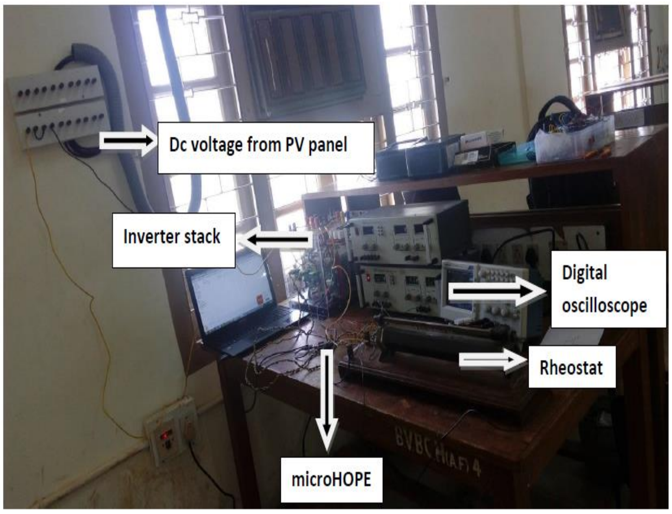


Fig 8.Hardware implementation of block diagram

Components used

1	PV panel	Maximum(Pmax)-50W Voltage at Pmax -17V Current (Pmax)-02.94A
2	Voltage source inverter	
3	LM339 comparator ic	Vcc=18 or -18V
4	Rheostat	100ohm 2.8A
5	Resistance	56K,5.6K,1K
6	MicroHOPE	

Complementary waveforms to trigger the inverter

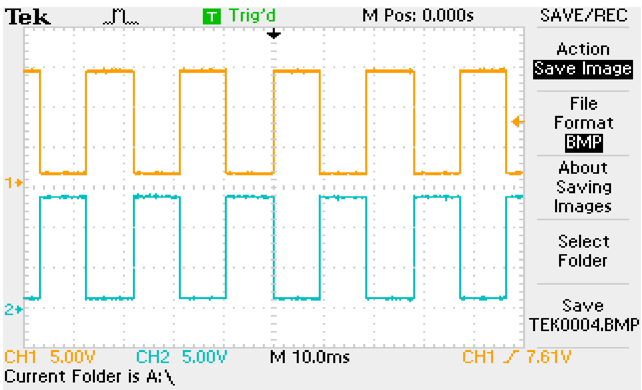


Fig 9.Complementary waveforms

The complementary waveforms generated here are of +15V. These are used to trigger the

International Journal of Technology and Science, ISSN (Online) 2350-1111, (Print) 2350-1103 Volume 3, Issue 2, 2016 pp. 33-37

inverter stack leg. Other two sets of same type of waveforms are used to trigger another leg of inverter stack.

Inverter output voltage:

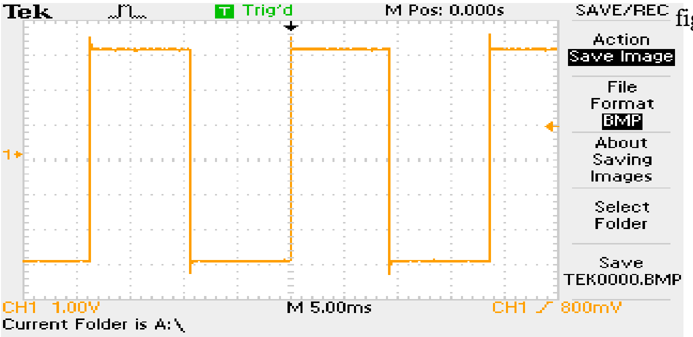


Fig 10.Inverter output voltage

The input given to the inverter is the DC voltage of 40V from the PV panel. This DC voltage is converted to AC using the inverter stack. Here we get a voltage of 40V for positive half cycle i.e VA, similarly 40V for negative half cycle i.e VB. Hence we get total VAB=VA-VB=40-(-40)=80V. as shown in below figure Fast Fourier transform for output voltage of inverter

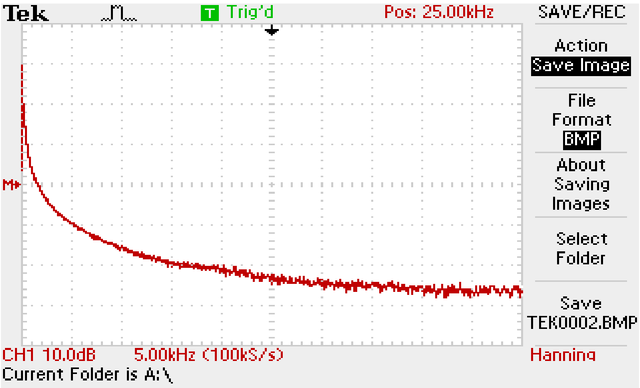


Fig 11.Fast Fourier transform for output voltage of inverter

Pulse of 50% duty cycle is given to the legs of inverter stack, the output voltage of the inverter contains harmonics in it which can be observed using Fast Fourier Transform shown in the above figure.

CONCLUSION

- Due to global environmental concerns, photovoltaic systems (i.e., solar panels) are becoming more common as a renewable energy source which tends to "Clean" power generation.
- But there are drawbacks of PV energy are the high cost of manufacturing silicon solar panels and the low conversion efficiency. However, with the latest techniques in manufacturing, PV systems are becoming more efficient, as well as cost effective.
- Interfacing a solar inverter module with the power grid involves injecting sinusoidal current into the grid.
- To trigger the inverter , complementary pulses are generated using microHOPE. Inverter converts DC voltage from PV panel to AC voltage which can be fed to grid.

REFERENCES

[1] Meksarik, s. masri, s. taib, and c. m. hadzer(2003). "simulation of parallel-loaded. resonant inverter for photovoltaic grid connected," national power and energy conference (pecon), malaysia

[2] Castañer and s. santiago, „modelling photovoltaic systems using pspice, ed. j. wiley, 2002.