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# Design of Photovoltaic System using Battery Energy Storage System along with Grid as Uninterruptable Supply System

Gunjan V. Patil
Electrical dept,
All India ShriShivaji Memorial Society, Institute of Information Technology.
Pune, India
*e-mail: gunjpatil@gmail.com*

***Abstract***—There is a need of alternative energy sources to meet the present day demands due to the depletion of fossil fuel resources. The alternative source used is solar energy, which is a clean inexhaustible and environment friendly potential resource. There are periodic variations in the output of standalone solar photovoltaic system or wind energy system so they cannot provide continuous supply of energy. Thus there are variations in the output of solar PV. Therefore to meet the load demands grid-interactive Photovoltaic using battery energy storage systems are now being implemented.

This paper presents practical implementation of Photovoltaic (PV) system using battery and grid, the grid is used as uninterruptable power supply to load. The objective of the system is to balance the power flow from utility and PV to battery and from PV, battery to load. Such that PV is utilized effectively and continuous power is given to load. The PV and battery comes in role for various cases depending on the load. This objective can be achieved by appropriate programming in microcontroller 16F877A. This system is consists of solar panel, Lead acid battery, buck converter ,voltage divider, current sensor and PIC microcontroller 16F877A as control unit.

***Keywords:****Battery energy storage system, grid, photovoltaic, Pic microcontroller*

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## I. INTRODUCTION

There are problems associated with power shortage and also power quality problems in some developing countries like India. The quality of the grid supply in some places is characterized by large voltage and frequency fluctuations, scheduled and unscheduled power cuts and load peak restrictions. Every year the gap between the demand for and the supply of power is increasing. Also, India faces problems of power cuts due to faults in distribution and / or generation of power and load shedding that have no immediate solution in the near future. This has led to rapid increase in the usage of standby petrol or diesel-generator sets and conventional battery inverter generator sets in both rural as well as urban areas of the country. The result is that the generators that use fossil fuels cause severe pollution and environmental degradation.

In India, Fuel generators with capacity varying between 1-5KW are widely used by shopkeepers, households and firms when utility exercises load shedding. A mixture of kerosene and petrol is commonly used in the petrol/ diesel generators. Kerosene, being a representative factor of poor population in rural areas of the country, is a highly subsidized fuel which has been used as an inappropriate substitute for petrol and diesel in their respective generators which has led to its increased misuse and subsequent pollution.

This paper explains the implementation of the photovoltaic system with battery to supply the load while the grid charges the battery to provide uninterruptable supply of energy to load. The battery is used as backup power storage. The microcontroller used in the implementation of the proposed system has low cost with low power requirement. The said microcontroller performs all the control functions necessary to maintain the continuous supply of energy to load through PV and battery depending on load conditions and the constant supply for battery charging through grid and solar

## II. LITERATURE REVIEW

In 1839, Edmond Becquerel accidently discovered photovoltaic effect when he was working on solid state physics. In 1878, Adam and Day presented a paper on photovoltaic effect. In 1883, Fxitz fabricated the first thin film solar cell. In 1941, Ohl fabricated silicon PV cell, but that was very inefficient. In 1954, Bell labs Chopin, Fuller, Pearson fabricated PV cell with efficiency of 6%. In 1958, PV cell was used as a backup power source in satellite Vanguard-1. This extended the life of satellite for about 6 years [2]

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**V.Nayar [1]**This paper presents a practical implementation of a grid interactive photovoltaic Uninterruptible Power Supply (UPS) system using battery storage and a back up diesel generator. The system incorporates 2.5 kWp of photovoltaic arrays, a 10 kVA power conditioning unit capable of operating in both inverting and charging modes, and a 300-Ah battery bank. Laboratory and field results haveclearly proven the multi-function capability of the system to provide continuous power to the load and stabilize the load voltage when the grid experience under/over voltage conditions. The results have also shown significant improvement in the power factor with reduction of the input line current harmonics under nonlinear loads.

**E. Koutroulis.[4]**In this paper a MPPT technique is used so that PV array output power can be maximized. The proposed system consists (Power conditioning system to interface PV output to load) of buck type DC-DC converter which is controlled by microcontroller unit The advantage of this technique is that the output power is used to directly control DC-Dc converter, thus the system complexity is reduced. Thus gives high efficiency, low cost system. The experimental results show that the use of proposed MPPT control increases the PV output power by as much as 15%. .

## III. SYSTEM DESCRIPTION

The system consists of solar , battery with separate inverters along with gate drive circuits respectively, sensing circuits, microcontroller, grid connection stepped down to 12 volt.

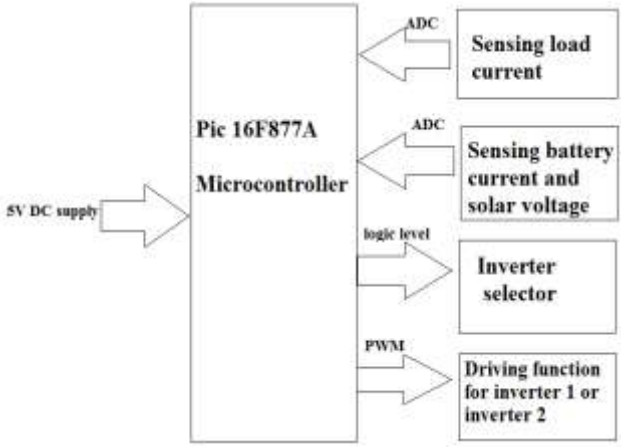



**Fig.1 functional block diagram for PV interactive grid system**

The grid supply, Battery and PV are connected in parallel to supply the load. DC-DC buck converter is used to interface the output of PV array and the battery. It maintains the charging power to the battery .as show in fig. 2

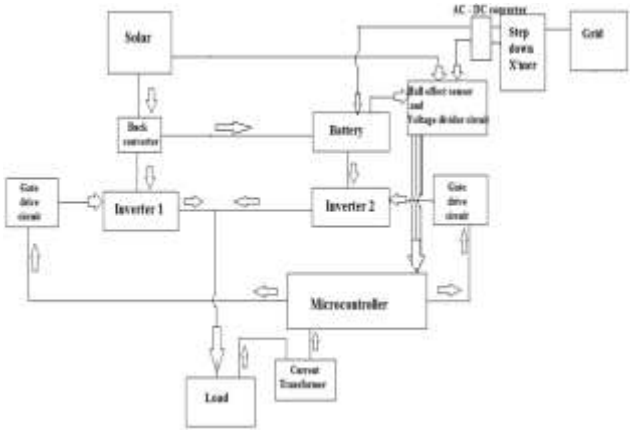



**Fig.2 Block Diagram of PV interactive grid system with battery backup**

The Battery and PV are connected in parallel to supply the load. The grid charged the battery. DC-DC buck converter is used to interface the output of PV array and the battery. It maintains the charging power to the battery and power supply to load.

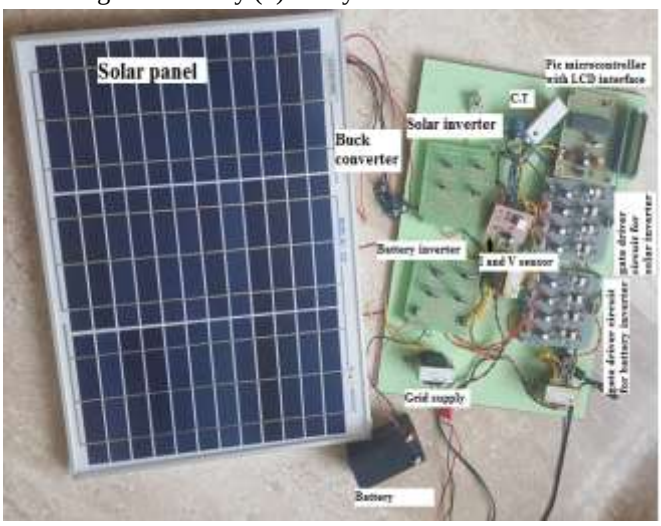
When PV array generates electric power the output from PV will be stored in battery and supplied to the load through buck converter. The PV output will supply to load through inverter 1.Also the battery will supply the load through inverter 2. The microcontroller used in the system is programmed such that if the load requirement is low, the load is supplied through PV using inverter 1, and if the load requirement is high then the load is supplied through battery using inverter 2. To sense the load requirement current transformer is used and is connected to microcontroller. The load is connected directly across the output terminals of the inverters. The Pulse Width Modulated (PWM) technique is used for inverters, the switches and are turned on/off using pulse width modulation (PWM) technique to generate the AC output voltage..

When grid is present, solar power is not available and also when the battery is discharged at that time the voltage of PV and grid is sensed by the voltage divider circuit and the current of battery will be sensed by the hall effect sensor and the output of the voltage divider circuit and the sensor is given to microcontroller. The grid will charge the battery when solar is absent to supply power to load through battery.

In presence of solar the grid is disconnected from charging the battery. Solar supplies the load and charges the battery. The solar and grid will not be ON simultaneously. The LCD used in the system displays the load supplied through solar/ battery and also the charging of battery through grid or solar. It also displays the status of battery i.e charging or fully charged.

## IV. HARDWARE SETUP

Hardware comprises of (1)solar panel. (2)buck converter. (3)potential divider and current sensor circuit. (4)Pic microcontroller 16F877A to control power mosfet switching duty cycle. (5)gate drive circuit and (6) rechargeable battery.(7) utility connection




### 4.1 Solar Panel

A solar panel consists of 36 cells connected in series and has rating of 0.5-0.6 volt for each cell.

| | |
|---|---|
| Maximum power (Pmax) | 20 W |
| Maximum Power voltage (Vmp) | 16.25V |
| Nominal Voltage | 12 V |
| Open circuit voltage (Voc) | 21 V |
| Short Circuit current (Isc) | 1.29 A |

### 4.2 Buck converter

The buck converter is also referred as step down dc–dc converter, it consists of dc input voltage source , voltage controlling pot , diode, filter inductor , filter capacitor , and load. Using this converter the output voltage is maintained constant as the converter provides the pot for adjusting output voltage.

The output voltage from solar panel is stepped down and controlled through buck converter and is used to charge battery and supply load.

### 4.3 Current sensor and Potential Divider

The voltage from solar panel and utility voltage is given to microcontroller through potential divider circuit. The circuit consists of resistances R1 and R2 which decreases the voltage and provides maximum voltage i.e 5V to microcontroller. This 5V voltage is suitable for the built in ADC of the microcontroller. The software program is used to feed the reference voltage according to required output voltage in the microcontroller. also the current of battery is fed into the microcontroller through current sensor.

### 4.4 PIC16F877A Microcontroller

PIC16F877A has a built-in hardware, called Capture /Compare /PWM (CCP) module. To generate a pulse signal the CCP module most be work in PWM mode . The code for the control system has been written in mikroC PRO v4.15 which was burnt into the PIC16F877A to sense (measure) the solar panels voltage ( Vpv) and generate the pulse signal. The hex code of the control system is then downloaded to the PIC microcontroller chip from the PC by using Top programmer version 6.

### 4.5 Gate Drive Circuit

IC TLP 250 is a Gate driver IC and is used to amplify and translate the pulse signal from PIC16F877A microcontroller to the gate of the IRF840 power MOSFET switch of the inverter.

### 4.6 Rechargeable Battery

The battery used is the system is Lead Acid battery and it is rechargeable battery. The battery used in the proposed system has rating of 12V-1.3Ah and operates DC load by converting stored chemical energy into electric energy.

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## V. RESULTS

Case1.

When solar power is present, battery is fully charged and utility power is also present at that time the first preference for load to be supplied will be given to solar and battery depending on load requirement.

Load requirement

i. If load requirement is up-to 500 mA – load is supplied by solar
ii. If load requirement more than 500 mA up-to 1A – load is supplied by battery

Case 2.

i. When solar is absent and battery is discharged or up-to float voltage and utility present then utility charges the battery to maintain battery charged and load is supplied through battery.

Thus the continuity of supply to load is maintained in every condition

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## VI. CONCLUSION

A Photovoltaic interactive grid as uninterruptable power supply system with battery storage is presented in this paper. Thus with appropriate programming in microcontroller with various operating cases the system helps to provide continuous power to load. The output of the solar PV produces constant output voltage even if there are changes in irradiation and temperature. This is possible through the use of buck converter used in the system whose control system is flexible and produces constant output at the end of the converter to supply to load and charge the battery.

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## REFERENCES

[1] C.V Nayar and M Ashari,A Grid- interactive photovoltaic uninterruptable Power Supply System using battery storage and a Backup Diesel Generator," in IEEE. Power Electron. Appl., sep 2000,p.11

[2] L. Umanand, CEDT-IISc Photovoltaic System Design. Date: 12/11/2007

[3] S. J. Chiang, H.J. Shieh and M. C. Chen, Modeling and Control of PV Charger System With SEPIC Converter IEEE Transactions On Industrial Electronics, vol: 56, no: 11, 2009.

[4] E Koutroulis, K. Kalaitzakis, N.C. Voulgaris, "Development of a Microcontroller Based Photovoltaic MPPT Control System", IEEE Transactionson Power Electronics, Vol. 16, No. 1, pp.46-54, January1,2001

[5] S. M. Çınar and E. Akarslan, "On the Design of an Intelligent Battery Charge Controller for PV Panels", University of Afyon Kocatepe, October 2012, Turkey, Journal of Engineering Science and Technology Review, pp. 30–34.

[6] H. Masheleni and X. F. Carelse, Microcontroller-Based Charge Controller For Stand-Alone Photovoltaic Systems, Solar Energy Vol. 61, No. 4, pp. 225–230, 1997.