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Maintain Constant Power Output and Monitor Statistical Performance of PV System

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Abstract: ***Solar Energy is free to use because it is a natural permanent source, which is available in a wide variety of locations in the world. Solar Energy is inexhaustible and pollution free energy, so renewable energy systems are becoming the best way to generate electricity. To improve the efficiency of solar systems, it is very important to get more information about solar panel performance, tracking and maintenance. This paper is on the development of a simple grid tied solar system, which obtains parameters(i.e., Irradiance, generated current and voltage by solar panel and battery voltage) in real time, display and store the parameters in personal computer. In this paper data monitoring of solar power system is performed by combination of PIC MICRO-CONTROLLER18f2520 and wireless communication.***

Keywords: Renewable energy, Grid tied solar system, Photovoltaic(PV), data monitoring, sensors, wireless-network.

I. INTRODUCTION

Solar power is emerging as the number one competitive renewable energy source. Today, PV is one of the fastest growing renewable energy technologies and it is expected that it will play a major role in the future global electricity generation. Solar PV has been recognized as an important route for generation of substantial quantities of power by utilizing the light energy from solar radiation. So to improve the utilization of solar energy resources, solar power monitoring system is more important.

According to the International Energy Agency(IEA), Renewable will be the fastest-growing source of electricity, in which wind and solar PV are technologically mature and economically affordable. But still there is increase in world's demand for energy. Adopting Renewable Energy technologies is one advance way of reducing the environmental impact. The latest edition of the IEA's Medium Term Renewable Market Report now sees renewable growing 13% more till 2021 than it did in past few year's forecast. The share of renewable in overall electricity generation will rise from over 23% from last few year to almost 28%in 2021.

The objective of this study is to develop a microcontroller-based PV monitoring system which requires to record a vast number of parameters based on IEC617247 standard. In this system different parameters of solar panel like current, PV battery voltage, and light intensity are monitored in real time and to display and store the parameters in personal computer. The goal of this paper is to facilitate common small scale installations with more efficient and cost effective and reliable monitoring system. The main feature of this mechanism is continues monitoring of solar system as well as controlling action will take place against faults occurring in some parameter.

In this paper, the solar power monitoring systems adopts modular design concept, the entire consists of two modules : The master control module which has the PIC MICRO-CONTROLLER18f2520 which is designed to acquire and display real-time performance parameters whereas the wireless communication module adopts RF transducer as the wireless communication device which is responsible for real-time data transmission to the monitoring centre, whereby the displayed data could be monitored and controlled some parameters from a remote distance over the internet. Applications of the monitoring system are in the Rooftop Solar, Ground mounted solar, Micro grids and Solar street lights.

II. METHOD AND MATERIAL

The proposed PV monitoring system consists of a PIC microcontroller18f2520 , voltage sensing circuit (voltage divider), current sensing circuit, irradiation sensor (light dependant resistor), analog-to-digital converter circuit, and serially interfaced personal computer. Fig.1 shows the block diagram of the developed PV monitoring system.

The microcontroller program is developed using Dip Trace software. The parameters obtained from the developed system are collected with the aid of sensors that are interfaced with the microcontroller unit and transferred to personal computer via a serial/USB cable.

The sensors obtain the PV system parameters, namely; PV panel and battery voltages, while the voltage and current sensing circuit obtain the electrical parameters (load current and battery voltage) of the PV battery. Once the different sensor signals are obtained and processed by the microcontroller, the data is then sent serially to the PC for display and storage.

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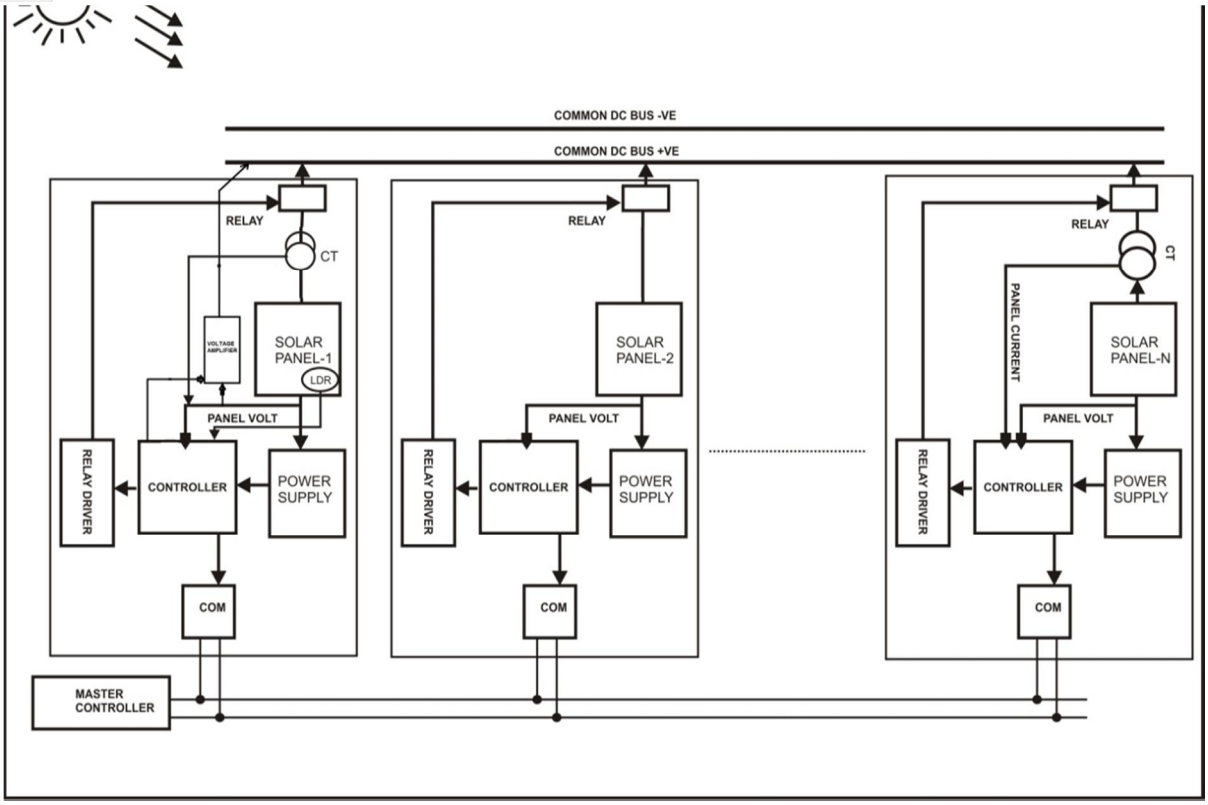

Fig.1 Block Diagram of PV Monitoring System

The work flow of the solar energy monitoring system is presented in the form of step below:

1) Radiation falling on the solar panels will be monitored through micro-controller.
2) Monitoring the panels will give the voltage of the specific panel.
3) For the operation of micro-controller some amount of voltage is needed, so this will be fulfilled by taking it from the panel itself.
4) The voltage level of the panel will be high whereas the micro-controller works only on 5V.
5) As the relay is switched ON, the amount of voltage coming from solar panels will go into bus bar which have loads ex. Inverter through C.T. which is in contact with relay.
6) From all this we can observe that the panel is giving its total output or not.
7) Whatever data will be collected in the micro-controller it will send the data to master controller through communication port.
8) Master controller will ask every panel for its data submission. We can say it will take attendance from each panel and this is what is called data logging.
9) According to the collected data from the panels, if it is found that the panel voltage is less than first it will turn OFF the relay and due to this current flowing from C.T. will be cut off. For this we have to amplify the voltage .
10) For amplifying, we are directly sending the panels output voltage to voltage doubler.
11) And when the micro-controller gets to know that sufficient amount of voltage has been generated. Then it will send the voltage directly from voltage doubler to bus bar.

A. System Design

In this system the core processor PIC micro-controller 18f2520 collects the data from different sensors such as solar irradiance, generated voltage from solar panel, battery voltage. Here micro-controller is responsible
for data automatic analysis, processing, displaying and sending to the monitoring centre by using two-way communication technique. RS232 is used for two-way communication. Figure.2 shows the hardware setup of the PV monitoring system. At the monitoring centre the received data is displayed in digital way and save the database.

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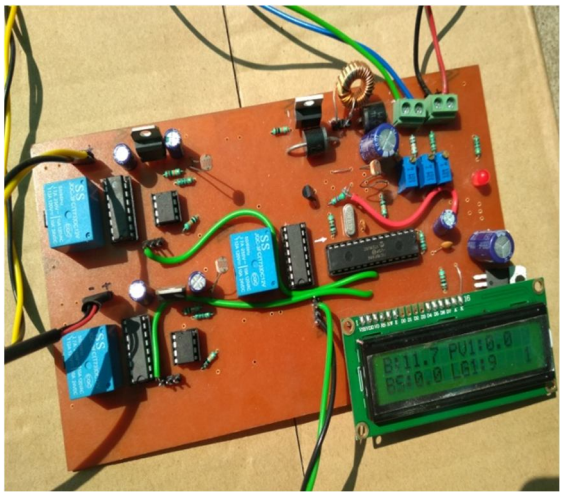

Fig.2 Hardware Configuration Setup.

In order to implement a successful monitoring system, devices known as sensors need to be used. In this section presents the system components for the Solar Photovoltaic Monitoring System.

1) *PIC Microcontroller 18f2520:* In this microcontroller current sourcing at each pin is equal to 30mA. It also has a high speed operation, maximum up to 64MHz.It has 16Kb flash ROM. It has 328bytes RAM and 256 bytes EPROM. Its single clock cycle is of 200ns.Voltage operating is from 3.3V to 6V of PIC microcontroller. It has inbuilt A-D converter whereas in 8085 there is no A-D converter. It has a DMA (direct memory addressing).
2) *Relay:* Relay is a switch that controls (open and close) circuits electromechanically. The main operation of this device is to make or break contact with the help of a signal which is received from microcontroller when sensors sense over current, overvoltage and over-temperature then relay trip without any human involvement. This relay is of SPDT (single port double throw coil voltage) of 12V. It is used to connect or disconnect the panel with common bus .If voltage level is greater than 12V then the relay will TURN ON. If voltage level is less than 12V then the relay will TURN OFF.
3) *MOSFET:* MOSFET is used for switching of inductor. It is a N-type enhancement MOSFET. Resistance drain to source is less than 0.005Ω. Current rating is 52A.
4) *Inductor:* It is a 100mH, 20Amp inductor. DC coming from solar panel is stored in inductor by switching it with MOSFET to simulate an AC current, in positive half cycle only.
5) *Driver IC:* Driver IC is used to amplify the current as well as voltage level of signals coming from PIC micro controller which is of 5V to convert it into 12V to drive the relay. Its maximum current is 500mA. Minimum input voltage is 1.7Volt Vcc (max).

B. Software Design

The project also consists of communication which a serial communication. It is a two way communication system. The type of communication used is RS232 which is an international protocol designed on DOT NET software. This is used because is easily available and also a fast way to communicate. It can also be called as bi-directional communication as it can receive the data while sending it.

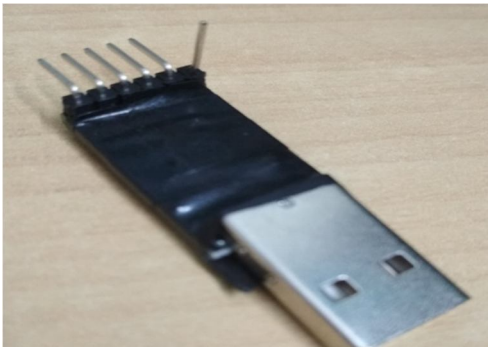

Fig.3 Two-way port

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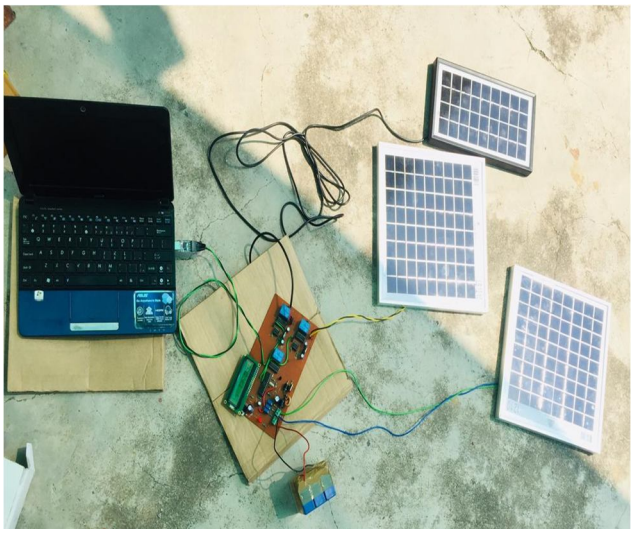

Fig.4 PV Monitoring System

Figure.4 represents the entire setup of the proposed system.

III. RESULTS AND DISCUSSION

The results of PV parameters testing and measurement results are shown in fig. 10,11(a)and(b). As shown in fig.10, the LCD screen shows the output of panels as well as battery parameters which includes battery voltage, panels voltage, boost voltage and light intensity of panels.

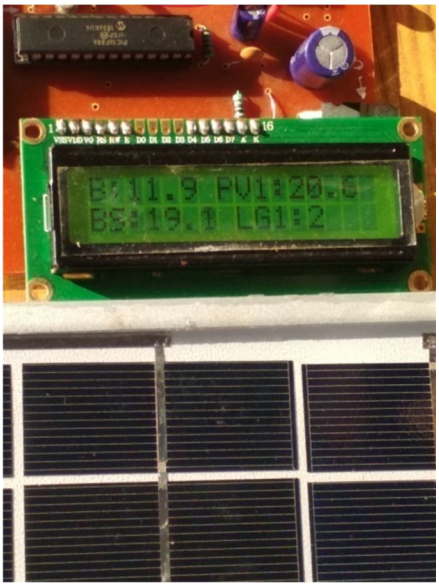

Fig.5 Panel and Battery Result on LCD

In fig. 6(a) and 6(b) are the results are shown in Proteus which is connected to the hardware directly by the two-way communication. We use Proteus because it is very handy software as well as if our system is tested by using Proteus and it gives good performance, it will probably give the same result in the experiment.

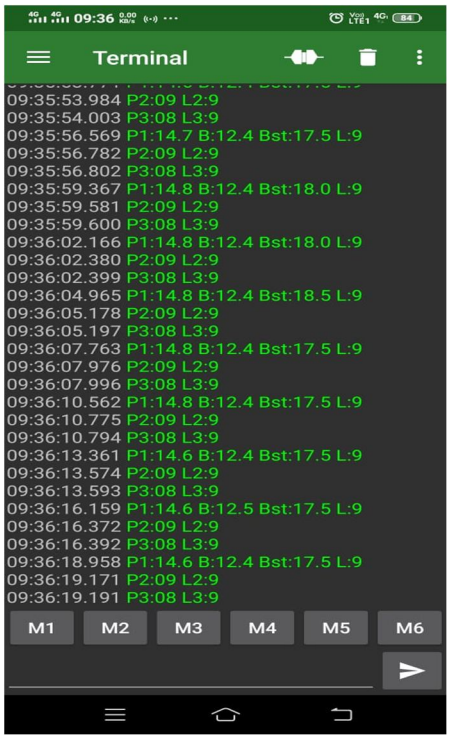

Fig.6(a) Real time data in Android mobile.

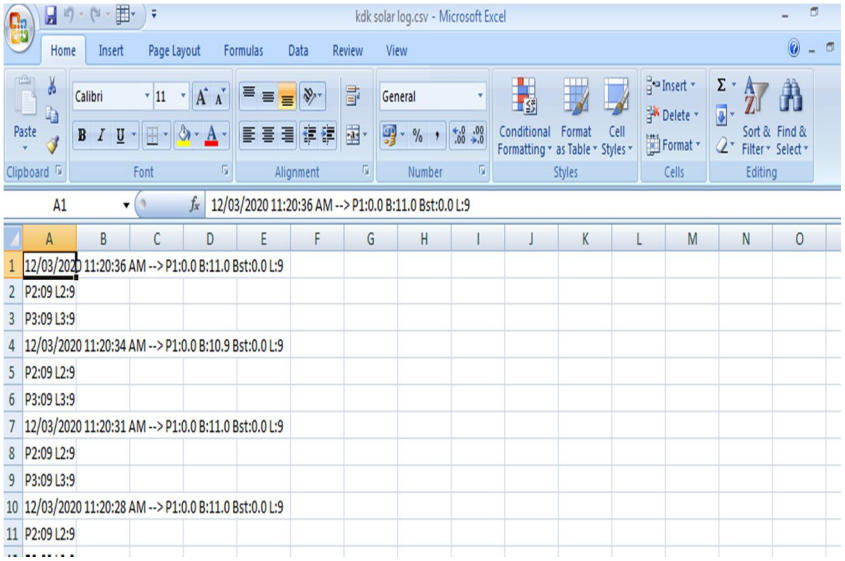

Fig. 6(b) Real time data in Excel format using Proteus.

IV. CONCLUSION

In this paper, a low power consumption and cost-effective PV-two way monitoring and control system using RS232 technology is introduced. Implementing renewable energy technologies is one recommended way of reducing the environmental impact. Because of solar energy is abundant, free and readily available source of energy. Solar cells are clean sources of energy with no harmful emissions of greenhouse gases. This system can monitor solar panel parameters related to solar power plant operation and maintenance with the help of multiple sensors. Appropriate monitoring improves efficiency of plant and operating conditions. Tests were performed to evaluate the response of the small-scale PV plant under several environmental conditions. The results of experiments on the system allow proving a concept of a promising low-cost two-way system solution for remote performance monitoring, fault detection and distributed control of smart photovoltaic systems.

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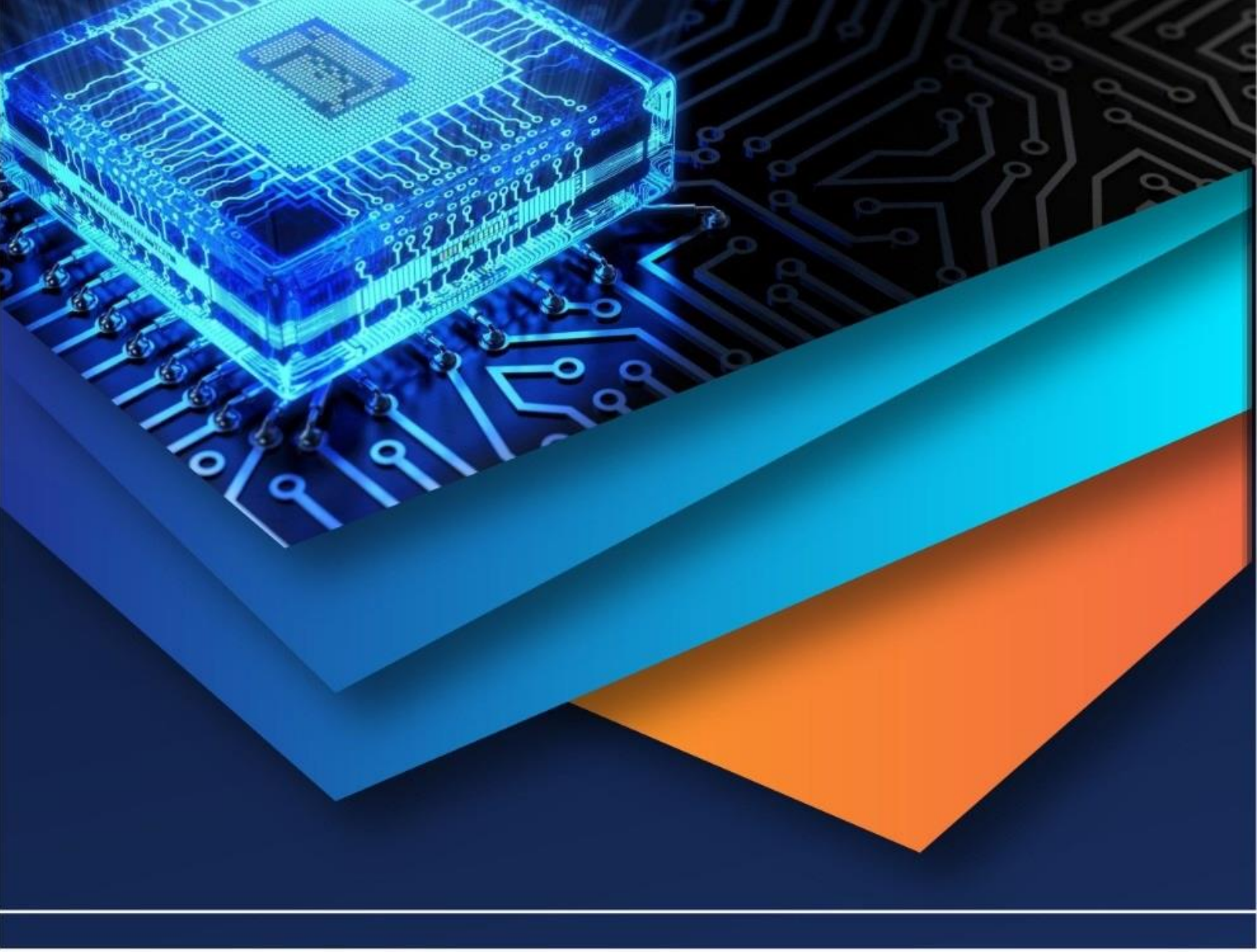

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