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Multi Parameter Monitoring in Solar Panel with IOT

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Abstract:

This paper describes about the analysis and online monitoring of photovoltaic system. This method gives a solution for the solar panels to get the maximum power and for effective utilization. The hardware is developed for PV array and various parameters like voltage, current, power(for both DC and AC), energy is measured. The system is connected to the controlling which monitoringthe solar panels functional working. PIC MCU is used as a controller. By incorporating the IOT technology the data received from the system are send to the cloud, from through internet the user can monitor the parameters. Thus, the main objective of the monitoring system is to ensure that solar panels operate smoothly and to easily detect critical problems.

Keywords — **Internet of Things (IOT), PV, SolarPanel, PIC MCU.**

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I. INTRODUCTION

Power generation are spreaded over India among the government departments that lead to many losses. Because of consuming more power by some others than they need this leads to loss of more power. There is no more alternative source available for producing an electricity in large amount. One of the top source available is sunlight with which we can take natural power for our daily life.

Solar power plants convert the solar energy into solar electricity. The sun is the largest source of energy in the form of heat and light energy. Solar Power has a high potential to make a more impact on the electricity requirements in home appliances and industries. That the sun gives as much energy onto the earth in one day that equals the annual energy requirement is enough to judge the amount of solar energy that goes untapped. It can be used to supply electricity to homes, commercial settings and so on.

In this project we have a solar panel for creating electricity from sunlight. The solar panel consists of an array of PV cells. Photovoltaic cells are connected electrically in series or parallel circuits to produce higher voltages, electricity and power levels. Photovoltaic modules consist of PV cell circuits sealed in an environmentally protective laminate, andare the fundamental building blocks of PV systems. Photovoltaic panels include one or more PV modules assembled as a pre-wired, field-installable unit.

A photovoltaic array is the complete power-generating unit, consisting of many number of PV modules and panels.The amount of current or voltage produced from solar panel is taken readingwhich is in the form of DC . This information is transformed to microcontroller. The power generated can be used for initiating some loads in home; the obtained power is converted to AC by an inverter. After converting the amount of current/ voltage is measured and given to microcontroller. The microcontroller in turn displays the amount of current and voltage produced from solar panel. It also display the power and energy consumed. Finally the acquired power can be used for another types of loads

II. PROPOSED SYSTEM

The proposed system can be used to measure both AC and DC electrical parameters and also the

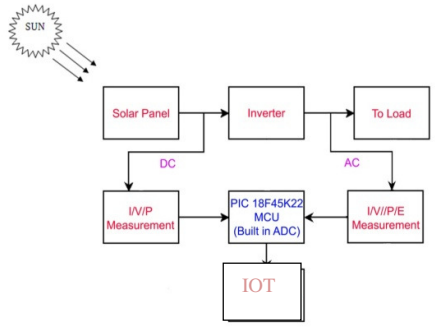
energy consumed.It can be adopted for any systems for the measurement of various electrical parameters.

III. EXISTING SYSTEM

The existing systems consist of separate monitoring systems for DC and AC.For renewable energy resources, the amount of energy consumed is measured using separate device.

IV. METHODOLOGY

A. BLOCK DIAGRAM



B. MICROCONTROLLER

1. PIC18F45K22

The controller has peripheral features like inbuilt ADC, required to get the signal from the various sensors.Maximum clock frequency is 40MHz and Therefore faster than 8051.Based on RISC and Harvard architecture and hence operate more faster.Embedded C is used for programming the microcontroller.

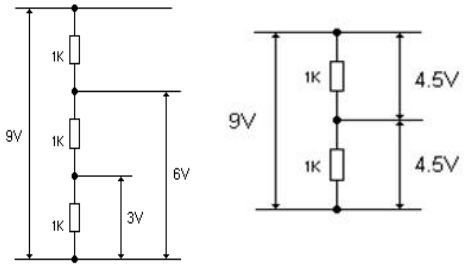
V. SENSOR

A. DC VOLTAGE MONITORING

1. POTENTIAL DIVIDER

The "Potential Divider" is a line of resistors in series that are used to give different voltages in parts of an electronic circuit. The voltages can either be set to fixed values or be adjustable. As the name says, it divides the "potential" (voltage) into different amounts.

Fig1.Potential divider circuit



2. FIXED POTENTIAL DIVIDER

The Supply voltage is 9V. The two resistors in series have equal values and they divide the supply voltage into two equal parts allowing a voltage of 4.5V to be supplied to another part of the circuit. Three resistors of equal value would divide the supply voltage into three, allowing 3V, 6V and 9V to be used by the rest of the circuit.

Potential dividers are often placed directly after the supply source to allow different voltages to be feed directly to different parts of the circuit. In the Op-Amp comparator circuit below, the potential divider network of two 10K resistors give a fixed voltage on Pin 3 equal to half the supply voltage.

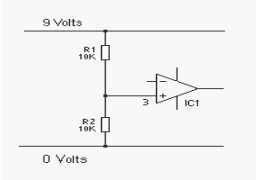


FIG.2

In practice, the measured output voltage of the Potential Divider (P.D.) network will be lower than calculated. This is because the components feed by the P.D. output will act as a resistance in parallel to the P.D. The current through R2 will drop causing the voltage to drop. One way to solve this problem is to use a variable or preset resistor instead of R2 by adjusting it when the circuit is running under load. Remove the variable resistor and find its resistance using a multi-meter and replace it with a fixed resistor R2.

In most circuit drawings the P.D. networks have a total resistance of 20k. The higher value resistance, the lower the current passing through the P.D. so reducing battery drain. If the current is too low, this

can cause a problem in not allowing sufficient current to be feed to the rest of the circuit.

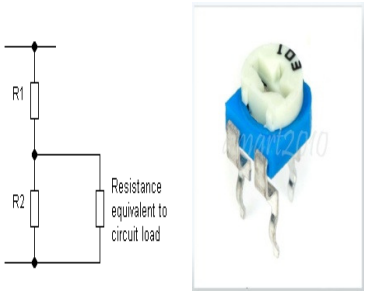


Fig3.Variable Resistor

The Potential divider shown above is used to measure the DC voltage. The higher DC voltage is reduced using a potential divider circuit and is fed to the ADC pins of the microcontroller. For example, 5V applied across this potential divider is divided into 4.55V and 0.54V by varying the resistance of this potential divider.

B. DC CURRENT MONITORING

The following explains about the measurement of current using a power resistor.

The current through a resistor is in direct proportion to the voltage across the resistor's terminals. This relationship is represented by Ohm's law:

$$I = \frac{V}{R}$$

The resistor drops some voltage because of the current flowing through it. The current flow cannot be measured directly and hence the voltage drop in the resistor is measured. As the source voltage and the resistance are constant values and known, the only unknown parameter in the formula is the current and it can be easily calculated by any device after getting the voltage at that point of place.

This is done by the ADC conversion and the converted value is used to calculate the voltage.

With the help of calculated voltage and resistance value, the current running through the resistor is calculated by using a form of Ohm's Law. V=IR or voltage = current x resistance. Expressing the formula in another way to solve for current which is I = V/R.

$$\frac{\text{Voltage}}{\text{Resistance}} = \text{Current (Amps)}$$

WARNING – The precision power resistor gets very hot when running a lot of voltage and current through it.

The power resistor used for measuring the current is

Fig4. Power Resistor

For example a current of 0.45A produces a potential drop of 0.45V when passed through the power resistor of 1ohm and 10W.

The overall monitoring circuit for the DC side is shown below:

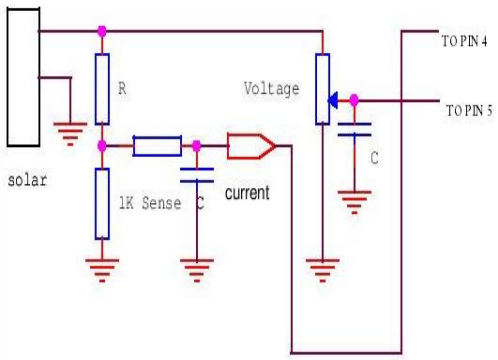


Fig5.overall DC monitoring circuit.

C. AC VOLTAGE MONITORING

Potential transformer is used to measure the AC voltage.The potential transformer is an ordinary centre tapped step down transformer. The transformer converts 230V into 6V ac components at the secondary side. The transformer has losses and non-linear characteristics and it has to be taken care of the designer. Hence calibration is necessary before feeding the voltage to ADC. Only after knowing the voltage output any particular controller can calculate the corresponding load voltage.

1. LEVEL CONVERTER

A level converter is a half wave rectifier. A step down transformer is used to convert the high voltage AC to a much lesser AC voltage of approximately 6V. A center tapped transformer is used for the step down purpose. The low voltage AC then has to be rectified. For this a half wave rectifier constructed with a diode is used. The diode used for the rectifier is IN4007, which is a very easily available diode used for rectifiers.

The rectified voltage is a DC voltage but it is not a constant and smooth DC. Hence a capacitor is used to convert the voltage to a constant and smooth DC voltage. After the filter the voltage is a constant DC. This output voltage varies if the input voltage varies. This variation is proportional and it is used to calculate the input voltage with the help of ADC and microcontroller.

Fig6. Potential Transformer

For example, 230V fed to the potential transformer is converted into 6V and this 6V is rectified and produces an output of around 4V. This 4V is again reduced into 1.7V and 2.3V with the help of potential divider of 100K in order to fed to the ADC pins of the microcontroller.

D. AC CURRENT MONITORING

ACS712 Current Sensor is used to measure the AC current in the circuit.Current sensors are designed to produce either an alternating current or alternating voltage proportional to the current being measured. The current sensor used in this project can measure current upto 5Amps. For the amount of current flowing into the input side there is a current output correspondingly. The current output has to be converted into a voltage output before getting on to the ADC.

1. INTERFACING CIRCUITRY

The interfacing circuitry for the current sensor also consists of a half wave rectifier. This rectifier converts the ac current into the average dc voltage. The average dc voltage gives a proportional value for the input current flowing through the current sensor. The RC filter at the end smoothes the AC wave and provides a constant dc voltage there by reducing the ripples associate withthe power lines.

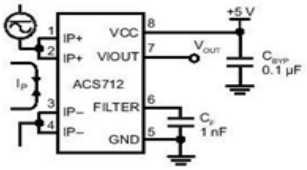


Fig 6. ACS712 Current sensor

VI. IOT

The Internet of things (IOT) is interrelated of all machines, living things and non-living things that are embedded with Sensors, actuators, electronics, software and network connectivity and the capability to change the data transversely a network without compiling human-to-human or human-to-computer interaction. The IOT permits something to be sensed or controlled remotely over existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic plus point in addition to diminish human interference. When IOT is reinforced with sensors and actuators, the technology becomes an occasion of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities. Each thing is uniquely trackable through its embedded computing system but is able to interpreter within the existing Internet infrastructure. The major part of IOT is HMI (Human Machine Interface). HMI The user interface (UI), in the industrial design field of human–computer interaction, is the space where communication between humans and machines occur. The goal of this communication is to allow effective operation and control of the machine from the human end, while the machine continuously feeds back information that aids the operators' decision-making process. collective aspects of computer operating systems, hand tools, heavy machinery operator controls, and process controls are best examples if Human Machine Interaction. Our objective is to monitor power plant. It needs an Interface, Here we are considering Thingspeak as

Interface because of its commit an advanced simplifies and free service.

VII. CONCLUSION

The hardware is advanced and the other parameters like DC voltage and current, AC voltage and current, DC and AC power (considering the power factor as unity based on the application), energy were displayed on the IOT.

It is further developed by monitoring the power factor with the help of above said formulae and it can be approve everywhere. The module can also be advanced for the 3phase system and for the grid synchronization.The device has many improvement like import substitution, two way monitoring, both DC as well as AC monitoring at a time and so on.

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