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PLC BASED SMART MONITORING SYSTEM FOR PHOTOVOLTAIC PANEL USING GSM TECHNOLOGY

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***Abstract*- A PhotoVoltaic System has been widely deployed in residential areas to reduce energy cost. The photovoltaic monitoring system wants to yield detailed monitoring of each PV panel as well as user-friendly way of access to the monitored data. To achieve these needs, this project proposes the PLC modules are used at PV panels. The aim of this project is to monitor the PV panel status to the user by GSM technology. The PLC module can measure the status of each PV panel based on Voltage, & Watt. Users can view the status of the each PV panel through mobile phones by messaging using GSM technology. If any abnormal conditions can occur in any of the panel based on these parameters then the information also send by messaging to the user.**

***Keywords* – Photovoltaic system, User friendly, PLC module, GSM technology, Monitoring.**

I. INTRODUCTION

In today's world, residential electricity consumption has been increasing constantly whereas other energy wastes have been continue to be flat or have decayed .The cause of this increasing electricity consumption trend is attributed to the more and more number of home appliances and consumer electronics. To solve these problems, we can use Photovoltaic system in place of the electricity generation. Nowadays, residential households play a role of an electricity generator as well as a consumer.

The photovoltaic (PV) energy is one of the most prominent renewable energies in the residential sector. The PV generation system has been widely deployed in the residential sector to negate the consumption of the utility's electricity. The residential PV system is required to maintain its maximum performance to minimize the electricity cost. Monitoring is inevitable to manage the performance of the PV system. However, in many cases, residential PV systems have not been monitored or managed. Even if they are monitored, in some cases, only total PV generation data from a PV inverter are monitored. It is difficult to figure out the status of the PV system only with the data from the PV inverter and to localize abnormal PV module.

In general, each PV module affects the total electricity generation of the entire PV system for the whole generation current rely on the current of each PV module. One abnormal PV module degrades the performance of the whole PV generation. Therefore, monitoring of each PV module is necessary and inevitable to maintain the maximum performance of the PV system. In addition, a user-friendly user interface (UI) is also necessary to provide an easy way of access to the monitored data. Various communication technologies can be a candidate to monitor the status of each PV module. Several wired or wireless communication technologies are taken into consideration.

Power line communication (PLC) is considered as an adequate communication technology [3]. PLC is a communication technology that enables communication over existing power lines and requires no additional communication lines. Numerous PV monitoring systems based on PLC have been studied [4]-[8]. However, they adopt a communication modem which modulates signals to encode digital data and demodulates signals to decode them. The communication modem is expensive and makes the cost of the PLC monitoring module high. Moreover, those PV monitoring systems do not provide a user-friendly way of access to the monitored data. Therefore, a low-cost PLC technology targeted at a PV system monitoring and a easy to use monitoring system are required to maintain the performance of the PV system.

II.RELATED WORKS

Traditionally, PLC technologies have been used for smart metering in smart grid and home network in residential areas. International standard PLC technologies, both narrowband and broadband, are well-known and popular technologies. Other PLC technologies are also used in many fields. This section reviews various types of PLC technology adopted forPV monitoring system in the previous literatures.

Roman et al [8] developed the intelligent module that the capacity of maximum power point tracking (MPPT) and PLC communication. The adopted PLC technology was based on frequency shift keying

(FSK) communications with features of 132 kHz carrier frequency and 2,400 bps of baud rate. A monitoring UI was not provided.

Jonke et al [5] developed one master unit (string box) and slave units (module box). A power line transceiver was added to the Micro Controller Unit (MCU) in both units for communication. The power line transceiver provided bit rates from 9.6 kbps to 115.2 kbps. It uses a multi phase modulation scheme in the frequency range from 1.75 MHz to 13.0 MHz. A monitoring UI was implemented in the desktop PC to control the system and visualize the data from the master unit.

Sanchez-Pacheco et al [6] developed a smart monitoring and communication module working in the CENELEC EN 50065 having the frequency range of 3 kHz to 148.5 kHz. It supported a baud rate of up to 16 kbps; it used FSK modems. The measured PV module's status was transferred to the string monitoring PLC module. The desktop PC was connected to the string monitoring PLC module, and users can check the status of each PV module.

Napoli et al [7] elaborate a PLC on DC bus with series connected PV modules. A half duplex FSK modem was adopted in the frequency of 132.5 kHz within CENELEC standard Cband. An MCU was connected to the PLC FSK modem through serial peripheral interface and sends data. A monitoring UI to show the status of each PV module was not provided.

Herndon et al [4] developed a smart combiner adopt a FSK modem for data exchange over DC power line. The FSK modem offered optimized filters, amplifiers, and cyclic redundancy check (CRC); it also provided a carrier sense multiple access (CSMA) scheme. It modulated the signal at 131.8 kHz for logic '1' and133.3 kHz for logic '0'. Its baud rate was 2,400 bps. No monitoring UI was provided.

III.SYSTEM DESCRIPTION

Power line communication modem is serviceable to despatch and accept serial data over existing AC mains power lines of the building. It has excellent immunity toelectrical noise enduring in the power line and built in error checking so it never gives out of low character data.

The modem is in form of willing to use circuit module, which is capable of providing 9600 baud rate for bi-directional data communication.

The PLC module consists of DC to DC unit, Microcontroller unit and Analog coupling circuit. The DC/DC unit converts tens of volts of the PV module down to +5 V, -5 V, and +3.3 V. Then voltages of +5 V and -5 V are used for operational amplifiers the voltage of +3.3 V is used for the MCU and logic gates.

The proposed PV monitoring system architecture helps users to view whether each PV module is normal or abnormal in a user-friendly manner. Fig.1shows the proposed PV monitoring system block diagram.

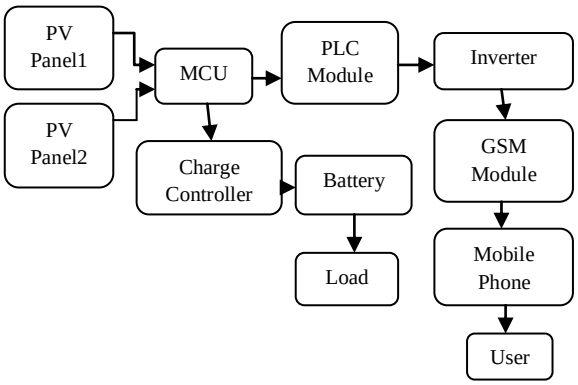

Fig. 1 Block Diagram of Proposed system

A. PHOTO VOLTAIC SYSTEM

A photovoltaic (in short PV) panels constitute the solar array of a photovoltaic panel that produces and providing solar electricity in relating to commerce and residing applications. A photovoltaic cell consist of P-type and N-type semiconductors with dissimilar electrical properties, connected together. The joint betwixt these both semiconductors is called the "P-N junction." Sunlight conspicuously the photovoltaic cell is imbibing by the cell.

The energy of the sucked up light produces a very small portion of matter with positive or negative charge (holes and electrons), which change in position about or contrive freely in all directions inside the cell. Therefore, when an external load, like as an electric bulb or an electric motor, is joined between the front and back electrodes, electricity flows in the cell.

B. MICROCONTROLLER UNIT

The MCU measures the voltage, current, and watt of each PV module using embedded analog-to-digital converters (ADC). For data communication, the MCU uses a Universal Asynchronous Receiver & Transmitter (UART) serial communication. The software for sensing algorithm, data communication and data processing is installed into the MCU.

The Program was written in Keil software andit can be dumped into microcontroller by VP812. Atmega 8 Microcontroller can be used. One of the most powerful communication solutions is USART and ATmega8 assists both synchronous and asynchronous data exchange schemes. ATmega8 holds three communication devices integrated. One of them is Serial Peripheral Interface.

C. DC-DC UNIT

A DC-to-DC converter is an electronic circuit which alters a source of Direct Current (DC) out of one voltage level to another. It is a class of energy converter. DC to DC converters are of great consequence in portable electronic devices such as cellular phones and laptop which are provided with power from batteries. Such electronic devices often

contain many sub-circuits, each with its own voltage

Additionally, the battery voltage declines as its stored energy is drained.

D. GSM MODULE

GSM uses a variation of time division multiple access (TDMA) and is the most widely employs the three digital wireless telephony technologies (TDMA, GSM, and CDMA). 2G networks developed as a replacement for first generation cellular networks, and the GSM standard formerly explains a digital, circuit-switched network optimized for full duplex voice telephony.

The mobile phone can be used to view the status of each PV panel by messaging. For every 10 Seconds the message will send to the user. The message contains Voltage and watt values for each PV panel.

IV. RESULT

The developed PV monitoring system composed of PLC module, Microcontroller unit, Inverter, GSM module , Charge controller and the dual Photo Voltaic panel. It consists of three sections: a DC/DC converter, an ADC part, and an analog coupling circuit.

The DC/DC converter is implemented with a transistor, a transformer, and several passive components. It drops down the high PV voltage to +5 V, -5 V, and +3.3 V. The Photo Voltaic panel can receive the light energy. The inverter can invert the voltage from the Photo Voltaic panels. The Power line communication modem can communicate the information of the PV module to the microcontroller units.

Fig. 2 Developed PV Monitoring System

Fig. 2 shows the developed PV monitoring system. The MCU generates a 100 kHz carrier; the power amplifier amplifies the carrier strong enough to be transmitted through the power line. The BPF including an amplifier uses a multiple feedback BPF scheme which has an advantage of controlling a gain level needs different from that provided by the battery.

and a frequency independently. It rejects out-of-band noises and amplifies only the carrier signal.

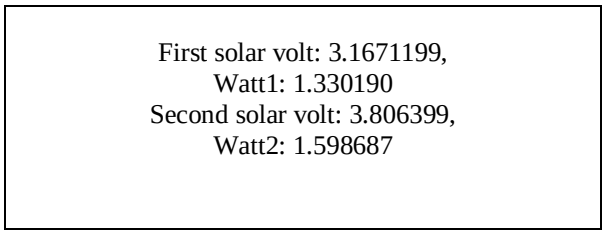

Fig. 3 Output Message

Fig. 3 shows the output message of the mobile phone. The mobile phone having the GSM module and it can send the status of the panels by messaging to the user. For every 10 seconds the above message can send to the user with different values.

CONCLUSION & FUTURE ENHANCEMENT

The PLC module can measure the status of each PV panel based on Voltage & Watt. ATMEGA 8 microcontroller can be used for exchanging the data. Users can view the status of the each PV panel through mobile phones by messaging using GSM technology. If any abnormal conditions can occur in any of the panel based on these parameters then the information can send by messaging to the user. The future enhancement is to monitor and also regulate the Photo Voltaic panel by using GSM technology and also change the software.

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