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Design of a Monitoring and Test system for PV based Renewable Energy Systems

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Abstract. To optimize the energy production and usage, of a Renewable Energy System (RES), it is essential that an effective monitoring and control strategy is employed. In order to develop new control algorithms the designer needs to evaluate the RES parameters and at the same time simulate real test condition load profiles.

The developed system is composed of a monitoring tool that measures and displays, in real-time, the parameters of Photo-Voltaic (PV) solar panels, and of an electronic load that can simulate load profiles such as the averaged domestic or stepped power consumption.

The monitoring system is implemented using a µcontroller and the electronic load is composed of a MOSFET, driven using a Pulse Width Modulated (PWM) output of a PIC µcontroller. Furthermore, the power consumption profiles are stored in the internal memory of the PIC µcontroller.

The obtained results demonstrate the ability of the system to monitor the current, voltage and temperature of PV panels as well as the ability to simulate different electronic load profiles.

Key words

Renewable energy, monitoring, electronic load.

1. Introduction

At present, world energy production is mainly based on the use of limited resources, namely fossil fuels. With the ever increasing demand for energy, some predictions show that world oil reserves will be exhausted by 2030 or at best by 2100 if the consumption is radically reduced from present day levels. Given that the oil is the main resource for energy production, it is obvious that new energy sources need to be developed. However, new sources of energy need to be cost effective and sustainable [1]. The research into sustainable energy sources includes nuclear power production as well as other unlimited energy sources such as wind, tidal, biomass and solar energies [2]. While the sustainability factor is important when developing Renewable Energy Sources (RES), the economic factor remains the key to the large scale adoption of a technology. It is important to note that the economic viability of the system is directly linked to the overall system efficiency; a good example being Photo-Voltaic (PV) solar installation payback time [4]. The energy efficiency and optimized usage are important, when developing and designing RES systems, hence many monitoring systems have been developed [7-8]. However the main focus, of this work, is the monitoring and control of energy production for a PV installation. The power from a PV system can reduce significantly if the connected load is modified [3]. Hence, an effective load control strategy plays an important role in the system efficiency [5].

For a fixed PV system there are two possible ways of increasing the efficiency:

- Improving the control strategy.
- Modifying the load profile (demand side management)

In both cases the designer requires a reliable monitoring tool in order to assess the overall system efficiency as well as an electronic load capable of simulating the desired load profile. Furthermore, the load profile for the RES needs to be set to simulate real applications, thus a test bed is an effective technique for testing control strategies in hybrid RESs [6]. Hence the aim of this research is to design and develop such a monitoring and test system.

2. System Description

The developed system is composed of three modules; firstly the acquisition module, which is physically connected to the RES under test, through a series of sensors. Once the different sensor signals are digitalized and processed the data is then sent to the PC interface module, in order to be displayed, on a PC, using a LabVIEW graphical user interface. The PC interface module is also fitted with a LCD to allow remote monitoring and also data access when the PC is off. The data transition between the two modules is undertaken using IEEE 802.15.4-2003 standard ZigBee devices.