Annals of the University of Craiova, Electrical Engineering series, No. 33, 2009; ISSN 1842-4805

7TH INTERNATIONAL CONFERENCE ON ELECTROMECHANICAL AND POWER SYSTEMS
October 8-9, 2009 - Iaşi, Romania

PARAMETER MONITORING OF STAND ALONE PHOTOVOLTAIC SYSTEM

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Abstract **– The work includes aspects as concern the implementation of a monitoring system for parameters of photovoltaic generator, in order to increase the efficiency of converting solar energy.**

Keywords: parameters monitoring, photovoltaic system, microcontroller, sensors.

1. INTRODUCTION

The researches regarding the conversion of the sun energy into electrical energy are a priority at national and European level that offers non-pollutants alternatives at use of the fossil fuel. Optimization of the energetically efficiency of the conversion systems can be made by means of performant material and by increasing of the sun radiation use. For realisation of these objective is necessary to monitoring of photovoltaic system parameters.

2. STRUCTURE OF PHOTOVOLTAIC SYSTEM PREPARATION OF PAPERS

A Photovoltaic (PV) System must provide efficient energy available to different consumers.
The PV System should provide electricity as more consumers characterized by different nominal supply voltages. Also must by ensure a high degree of autonomy in the mud or at night, low weight, easy way of transportation.
In figure 1 is shown the structure of Stand Alone photovoltaic system.
The Stand Alone PV System consists of two PV panels, one fixed mounted with a tilt angle corresponding to the latitude location and the other is provided with a tracker system.
The two PV panels charging batteries through load regulators.
Diodes D_1 and D_2 ensure the functioning of PV panels only in generator mode.
DC consumers are supplied directly from the batteries and the AC customers are supplied by inverter.
To monitor the status of Stand Alone PV system and the parameters for conversion using sensors and transducers.
Monitoring system uses sensors to measure ambient temperature and PV cell temperature, the TC_1 and TC_2 current transducers, the TU transducer voltage, the pyranometer and the transducer position for DC motor.

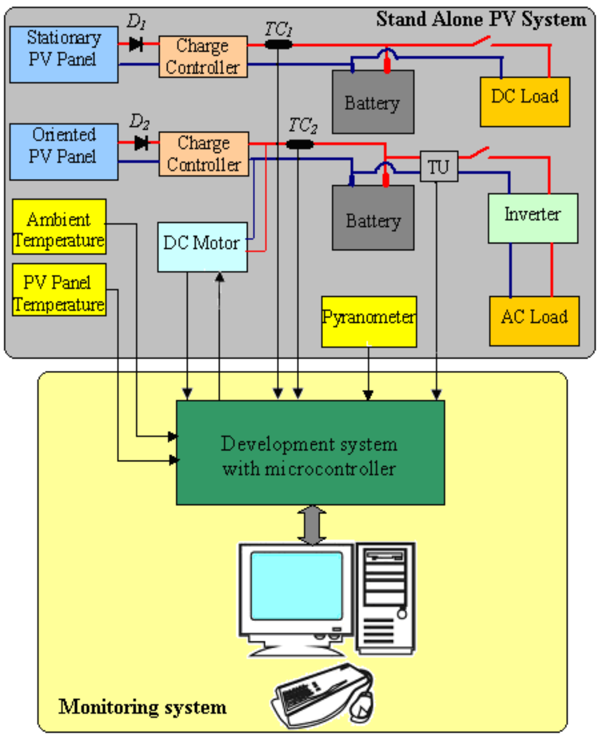

Figure 1: Diagram bloc of the Stand Alone Photovoltaic System.

The monitoring system allows local monitoring by means of development system with microcontroller or remote by way of PC.

3. STRUCTURE OF MONITORING SYSTEM

The automatic system for parameters monitoring will be made by a digital system based on a microcontroller belonging to the ATMEL family, achieved through SMD technology.
The microcontroller development system includes three modules (fig.2):
- Central Unit Module;
- Interface Module with the monitoring system;
- Power Supply Module.

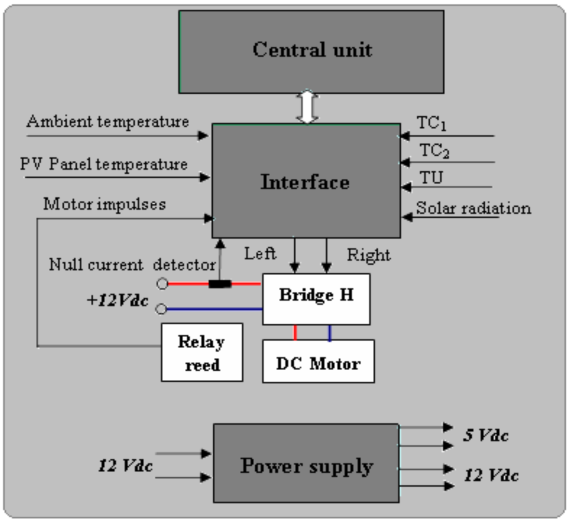

Figure 2: Diagram bloc of the development system for parameters monitoring.

Structure of development system with microcontroller is based on the separate modules in order to achieve an easy troubleshooting and to ensure high flexibility.

3.1 Structure of Central Unit Module

The central unit diagram block is shown in figure 3 and it consists of the following blocks:
- microcontroller Atmega 128;
- memory RAM;
- memory Flash, high sizes for data storage;
- LCD with 2x16 characters;
- clock for real time RTC 72421;
- battery for RTC and RAM;
- serial communication port RS 232 ;
- integrated circuit 691;
- 8 digital inputs from the interface;
- 8 digital outputs for the interface.

The ATmega128 microcontroller provides the following features: 128K bytes of In-System Programmable Flash with Read-While-Write capabilities, 4K bytes EEPROM, 4K bytes SRAM, 53 general purpose I/O lines, 32 general purpose working registers, Real Time Counter (RTC), four flexible Timer/Counters with compare modes and PWM, 2 USART's, a byte oriented Two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain, programmable Watchdog Timer with Internal Oscillator, an SPI serial port.

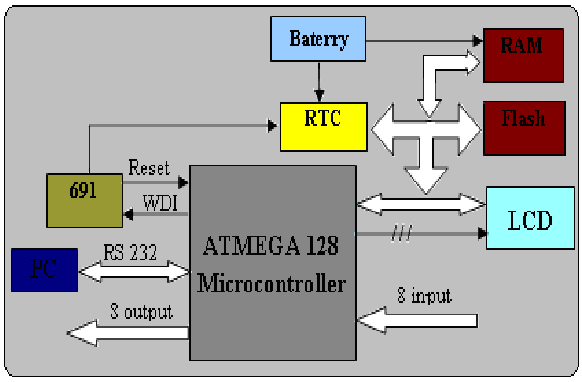

Figure 3: Central Unit block diagram.

The device is manufactured using Atmel's high-density non-volatile memory technology. The Onchip ISP Flash allows the program memory to be reprogrammed in-system through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip Boot program running on the AVR core.
The ATmega128 is a highly complex microcontroller where the number of I/O locations supersedes the 64 I/O locations reserved in the AVR instruction set.
Another remarkable quality of this microcontroller is the very low energy consuming.
Range of supply voltages is between 1.8 and 5V. This presents 6 different ways of stand-by which shows that this microcontroller will not consume energy only when needed.
Frequency control software ensures a maximum speed of execution when needed, and rest time microcontroller can switch in stand-by mode, where energy consumption is minimal.

3.2 Structure of Interface Module

The Interface Module assures the data acquisition and adapts signals to be processed by the Central Unit
The Interface Module with the photovoltaic system must enable:
- galvanic separate of the modules with optocuplers;
- conversion and signals adaptation provide of the sensors;
- PWM control with optocuplers for the orientation motor supply;
- control for the orientation motor revolution direction;

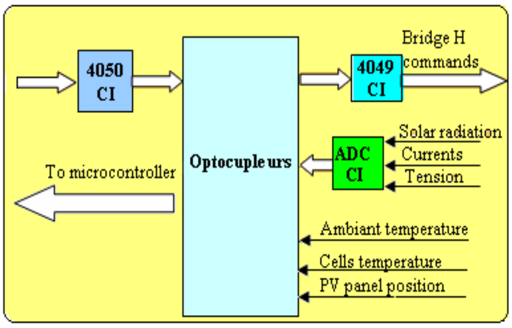

Figure 4: Interface block diagram.

The 4050 and 4049 hex inverting or non-invering buffers are monolithic complementary CMOS integrated circuits constructed with N- and P-channel enhancement mode transistors.
These devices feature logic level conversion using only one supply voltage. Numerical signals from the system are provided by temperature sensors, position transducer for the actuators order.
Numerical information received from temperature sensors is received by the microcontroller and retransmitted through the sensor circuit switched and galvanic separation.
Analogue signals acquired from the process comes from transducers current, from pyranometer for measuring solar radiation and the circuit for measuring battery voltage at the terminals.

3.3 Structure of Power Supplied DC-DC

For the orientation motor power supply and of the development system a DC-DC source galvanically separated is used, being supplied by the storage batteries giving at the output 5Vdc, respectively 12Vdc. The power supply diagram block is shown in figure 5.

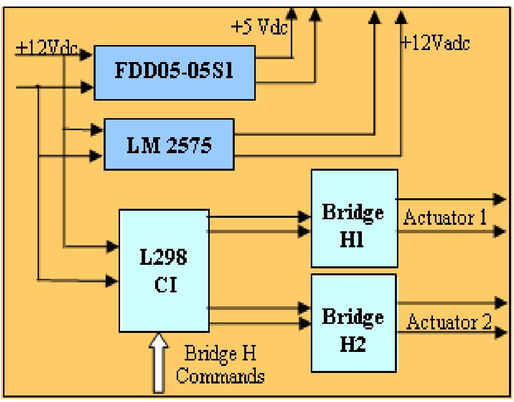

Figure 5: Power supply block diagram.

Development system with microcontroller is presented in figure 6.

The parameters monitored of PV system are displayed local on the display of development system with microcontroller or remote on the computer screen.

Figure 6: Development system with microcontroller

4. SOFTWARE FOR MONITORING SYSTEM

4.1 Software for Atmega 128 microcontroler

The main program for microcontroller is done in high level language Visual C + +. This requires working with functions and procedures which use variables of different types, which requires defining both an internal and an external definition.
For greater flexibility in achieving the tests, was chosen the solution of data storage acquired at PC level. Also, the orientation commands of the PV panel are summarized by the PC.
For programming ATMEGA 128 microcontroller was used AVR 3 Studio software.
The program was designed in "C", being aware that ATMEGA family has been optimized to use higher level languages.

4.2 Software for PC

The chosen language for developing the application is Visual Basic. This is commonly encountered in industry, being extremely quick and easy to use in equipment – user interface construction.

Noteworthy is that this object contains a specialized serial liaise with other numerical equipments, making it virtually the only convenient way of transferring information between the PC and the involved technological processes.
The program is useful including in the design phase, determined by the transparency of the large number of information available.This is possible because of high rate serial transfer
In figure 6 is present the main program window.
The main program window contains:
- name of application „*Monitorizare sistem PV autonom*";
- menu of monitoring parameters of PV system;
- menu of PV Panel control "Control panou";
- menu of control data transfer "Control transfer date".
The menu of monitoring parameters of PV system allows displaying the numerical information related to: currents to PV panel; current of battery discharge; voltage of battery; solar radiation; ambient temperature; temperature of PV cells; annual data (Y/M/D); hourly data (H/M/S); state of orientation motor; position of PV panel components used in the PV system has a high degree of accessibility and performance using software and standard interfaces.

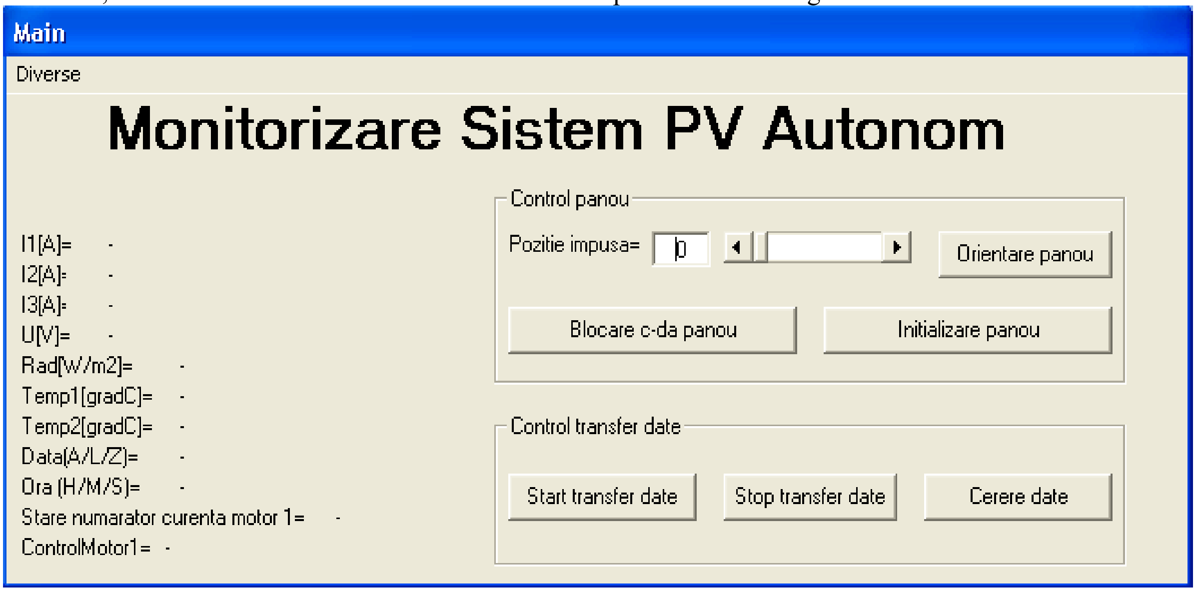

Figure 7: The main window of program.

The menu of PV Panel control has 3 push-buttons that provides orientation of panel.
The push-button "Initializare panou" ensure the command for initial position of PV panel (the PV panel is oriented to East).
The push-button "Orientare panou" ensure the command for orientation of PV panel.
Prescribed position for the PV panel is made using a slider button.
The menu of control data transfer contains 3 buttons („Start transfer date", „Stop transfer date" and „Cerere date").
The program is useful in the process including design, transparency caused by the large number of information. This is possible because of high rate serial transfer.

5. CONCLUSIONS

Infrastructure hardware and software used allows monitoring and control of PV system in real time.
Sensors, electrical equipment and electronic

Using a pyranometer and temperature sensors can study the influence of solar radiation and temperature on the process of converting solar energy.
By using two identical PV panels, one fixed mounted with the possibility of targeting a single axis, while the other guided by the two axes can study the influence of orientation on the panels to convert solar energy into electricity.
Safe supply of electricity to electric consumers is through the use of an development system with microcontroller that made its command and control PV system
Using a microcontroller for automation and monitoring system made a PV solution that can significantly reduce the number of electronic components and cost of design and development of the made equipment.

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