OGLEDNI PV SISTEM NAPAJANJA U LABORATORIJI ZA ELEKTRIČNE PRETVARAČE ETF U BEOGRADU

EXPERIMENTAL POWER SUPPLY PV SYSTEM IN LABORATORY FOR POWER CONVERTERS ETF IN BELGRADE

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U radu je predstavljen solarni sistem napajanja električnom energijom, projektovan i pušten u rad u Laboratoriji za energetske pretvarače, na Elektrotehničkom fakultetu u Beogradu. Sprovedena je detaljna analiza rada sistema sa akcentom na njegovu energetsku efikasnost. Takođe je prikazan računarski monitoring sistema na bazi LabVIEW paketa.

Ključne reči: *solarni sistem; LabVIEW; monitoring; baterije*

In this paper is presented solar system for power supply, designed and now in working condition in laboratory for power converters, School of electrical engineering in Belgrade. Detailed analysis of system is conducted with special attention dedicated to energy efficiency. Also PC monitoring with LabVIEW software tool is shown..

Key words: *PV system; LabVIEW; monitoring; batteries*

INTRODUCTION

Need for reduction of using fossil fuels for production of electrical energy and taking care of environment gives space for renewable sources of energy [1]. Most meaningful of them are photovoltaic (solar) panel, taking in account all technical and price parameters in consideration. Beside solar power plants which are connected to grid, photovoltaic panel are also suitable for supplying remote (autonomous) consumer (distant from any local power grid), which becomes more and more popular in modern society.

In this paper is shown model of solar system for supplying low consumers in condition where infrastructure of power grid is unapproachable. Improvement in production technology of photovoltaic cell, in terms of active surfaces of module and its utilization coefficient, in past few years is significant [2]. In order to demonstrate this type of energy production, in Laboratory for power converters from School of electrical engineering, University in Belgrade is set up experimental system with monitoring and data acquisition. This is accomplished with software package virtual instrument LabVIEW in order to determine energy efficiency of the whole system and every element.

PV SYSTEM

System elements are solar panel, battery, battery controller, inverter and LED bulb (Fig. 1).

Two polycrystalline silicon photovoltaic panel were used nominal voltage of 12V, maximum output power 125W. Serial or parallel connection were considered depending of output voltage level.

Calculation of average electrical power on panel terminals is given in following relation:

$$P_{PV} = \eta * A * \bar{I}_{PV}; \quad (1)$$

where:
η - photovoltaic panel utilization factor
A - active surface of photovoltaic panel
$\bar{I}_{PV}$ - totale average iradiation on photovoltaic panel surface

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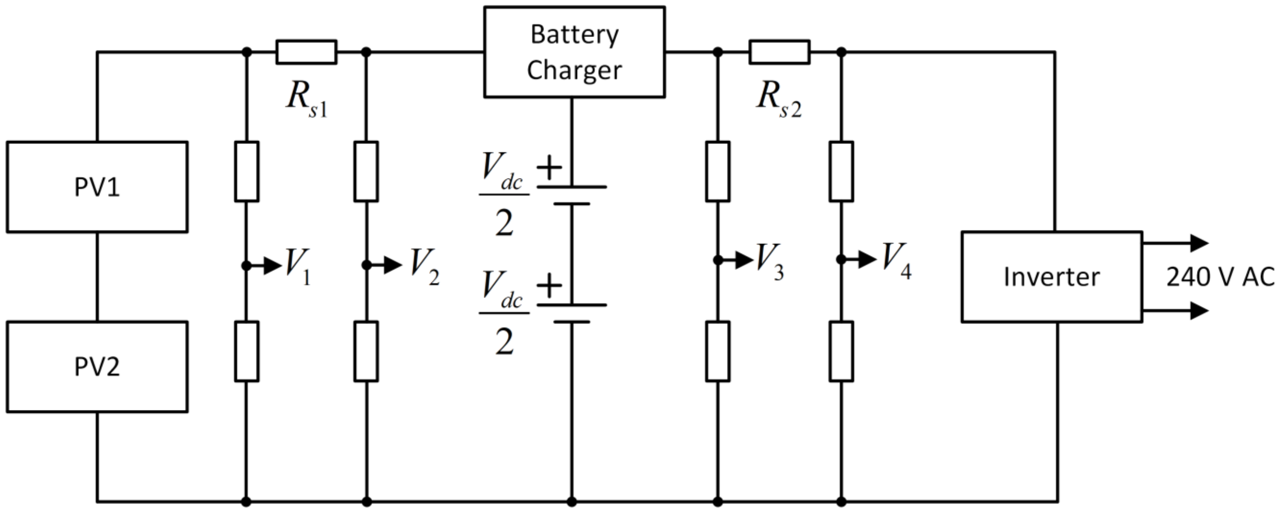

Figure 1: Schematic of PV system

Battery is very important part of autonomous system for power supply. Insurance of uninterrupted power supply and its duration depends mostly on battery. In today`s market there is a lot different types of battery with different characteristic which makes it more difficult to choose. Special VRLA battery (Valve Regulated Lead-Acid) is used with indication “long life” (*LONG WP40-12N 12V 40Ah*), which period of duration (lifespan) should be around 20 years. In 24V configuration, 2 serially connected battery were used with 12V nominal voltage and 40Ah capacity. These batteries, considering consummation of lighting (LED bulb 20W), will provide approximately 3 days of autonomy, if it`s consider that lights will work 12 hours a day, which is real case scenario during winter season.

Battery controller (controlled charger for battery) (*Steca Solar Charge Controller PR 3030 12/24V 30A*) is electronic device which regulates voltage level for charging battery. Also it controls charging current to avoid overcharging and damaging battery, which extend lifespan of battery. Voltage level of battery is monitored as well during discharging to prevent excessive discharge.

LED light represents consumer. LED bulb represents great improvement in energy efficiency and environmental awareness [3]. Low power of this sources and long lifespan, significantly reduce expense compared with conventional sources. LED Spotlight 20W nominal power is used.

SYSTEM MONITORING

System monitoring keeps track of V_1-V_4 voltages (Figure 2) and PV modules, batteries and load currents. These voltages and currents doesn’t exceed 50 V and 10 A, respectably. Currents are measured with 0.1 Ω shunt resistor, so voltage on shunt goes up to 1 V. Shunts terminals are connected to a pair of voltage dividers, with attenuation 10, in order to adapt to acquisition card voltage level (±10 V). Capacitors with capacitance 10 μF are set in parallel with lower resistors in voltage dividers, for purposes of filtering. After filtering, these signals are brought to analog inputs of acquisition card (AI1…AI4). Analog input AI0 is reserved for temperature measuring signal, that is brought from IC LM35 [4]. For A/D conversion, acquisition card NI USB 6009 is used [5]. This card is connected to PC via USB interface. For every channel, sampling frequency is equal to 5 kHz.

Acquisition software is developed in LABVIEW® 2015 software package [6]. Program calculate average values of voltages and currents, based on measured signals that are brought to card. Acquisition card creates multiplexed signal which is demultiplexed into 5 arrays, that correspond to the PV system voltages, and these arrays are further processed. First block in processing chain is averaging voltage arrays with 100 values, in order to reduce measuring noise. To obtain real value of voltages, every arrays is multiplied with 10. After that, voltages V1…V4 are presented in front panel VI instrument. Currents in PV system are further calculated from these voltages (Figure 3).

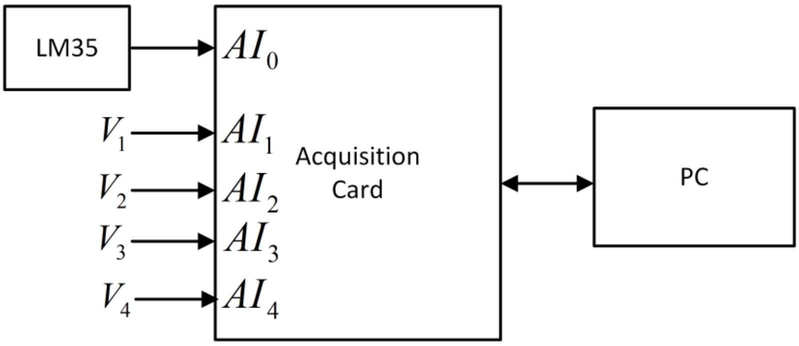

Figure 2: Acquisition block diagram

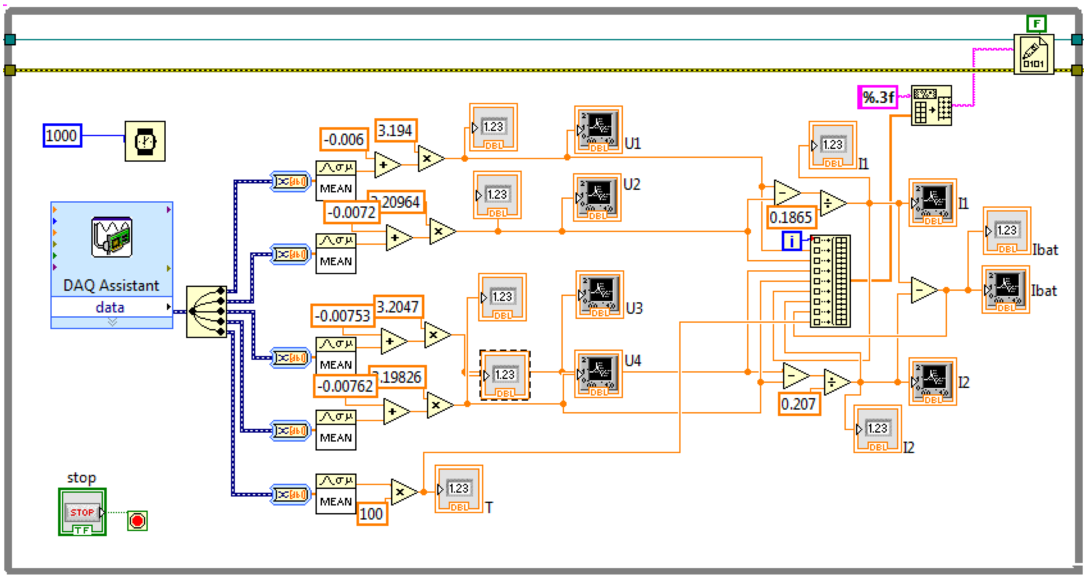

Figure 3: LabVIEW block diagram of acquisition system

Calibration of acquisition system is performed at the first (test) measurement with two phases included. During first phase, analog inputs of acquisition cards are short circuited to the ground, in order to determine the offset of the system. Second phase is performed in order to calculate ratios of actual voltages and currents that are being monitored, and their corresponding measuring signals that are brought to acquisition card. Acquisition system calibrated like this, is now fully operational. Besides the time diagrams and instant values of measured voltages and currents, every one second, all data is stored in the text file. Every line in this file includes actual value of voltage/current and exact time of measuring. Thermovision control (Figure 4) showed poor panel homogeneity.

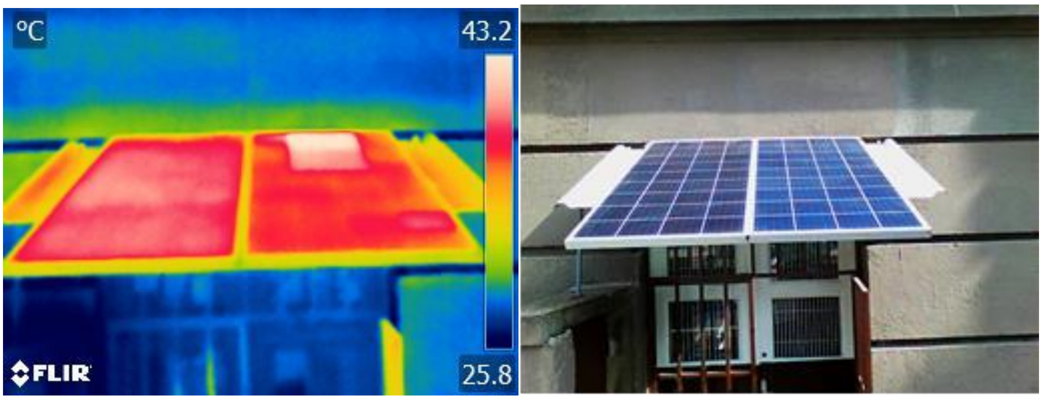

Figure 4: Thermovision scan of PV module

CONCLUSION

PV power system is designed and realized with feature to access all modules, i.e. to measure currents and voltages throughout the system. By analyzing the results from the monitoring system, it can be concluded that conditioning of signals, measurements, display and storage of data is realized correctly. That data is suitable for further analysis and usage, for purposes of comprehension and improvement of power efficiency of elements in PV power system.

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