

ON-LINE MEASURING SYSTEM

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ABSTRACT

The paper describes an on-line measuring system that evaluates the effect of operating conditions on the loading characteristics of solar energy converters. In solar cells the loading characteristics are greatly affected by the action of changes in the operating temperature of the cell and in illumination. The data measured are presented on-line on the web pages of the laboratory.

1 PHOTOVOLTAIC CELL

A photovoltaic cell is essentially a large-surface semiconductor diode operating in the generator mode. Its volt-ampere characteristic exhibits limit quantities, which give the magnitude of open-circuit voltage and the value of short-circuited current. These quantities change in dependence on the change in solar intensity and cell temperature.

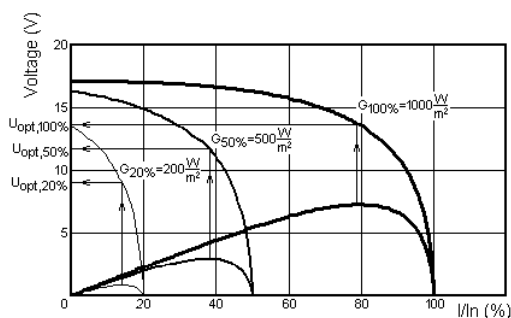


Figure 1: The influence of the light exposition on the optimum working point of a typical PV generator.

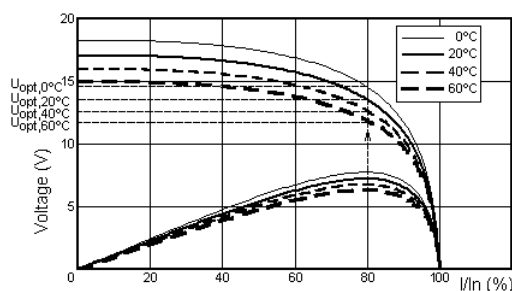


Figure 2: The influence of the temperature on the optimum working point of a typical PV generator.

In addition to the volt-ampere characteristic the power characteristic is usually also given. It is obtained by multiplying the instantaneous voltage and current values. The highest point of the

power characteristic represents the maximum value of potential power which the photovoltaic generator can deliver into the load under the given operating conditions. If this maximum power is to be obtained, the voltage across the appliance must be equal exactly to U_{opt} , which can be achieved by connecting an optimization circuit that works on the principle of DC/DC converter. The essence of the solution thus consists in the electronic power control of the load of photovoltaic generators with respect to their instantaneous operating conditions.

2 OPTIMIZATION CIRCUIT

The optimization circuit compensates electronically the effect of operating conditions on the loading characteristics of solar cells. The circuit consists of the power part and the control part. The power part is formed by a step-up converter connected between the photovoltaic cell and a pair of 12 V accumulators, which are connected in series. The control part is supplied directly from the PV cell and consists of a processor, an analogue amplifier, and a digital amplifier.

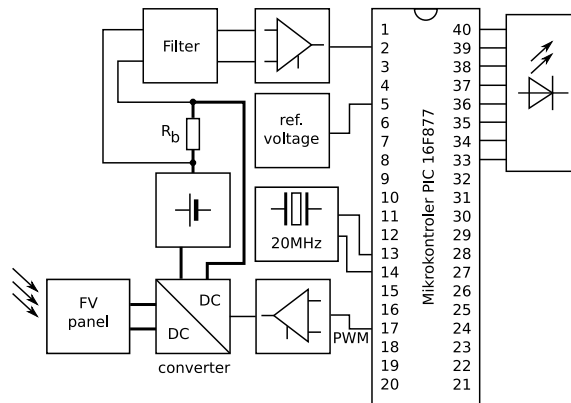


Figure 3: Block diagram of optimization circuit.

3 MEASURING CIRCUIT

Using separating multiplexer, the quantities being measured are transferred from the detectors into the measuring system, which is formed by the N1-6023E plug-in card and a PC. The measuring program written in the Matlab environment controls the multiplexer module and relay settings, and records, processes and stores the values from 9 detectors (see Fig. 4).

1 The pyranometer is designed to detect the total intensity of incident direct and diffused solar radiation. The spectral sensitivity of the pyranometer is constant over the whole defined frequency range, and the intensity measured corresponds to the intensity of incident solar radiation in the wavelength range (300nm - 5000nm). 2, 3, 4 are resistance temperature detectors with an almost linear characteristic, which measure in the temperature range from -55 to 150 °C.

On the one hand, the sun radiation intensity and the instantaneous panel power are measured (which are for us the primary measured data) and on the other hand the air temperature and the panel temperature are measured (which are for us complementary measured quantities). The temperature detector for measuring the air temperature is placed in a protective “casing” in

order to eliminate the effects of air flow, rain and direct sun exposure. The temperature of the PV panel is measured too. The temperature detector is located practically in the centre of the PV panel, on its upper (sun-exposed) surface area. For the sake of interest, the temperature of the lower (non-exposed) area of the panel is also measured, but these values are not given in the graphs. 5, 6 are current detectors. 7, 8, 9 are point where voltage is measured directly, using a voltage divider. The relay is controlled directly from the measuring PC card and it switches the supply from the PV panel between the direct path and the path optimized by the DC/DC converter in order to maintain identical conditions for the evaluation.

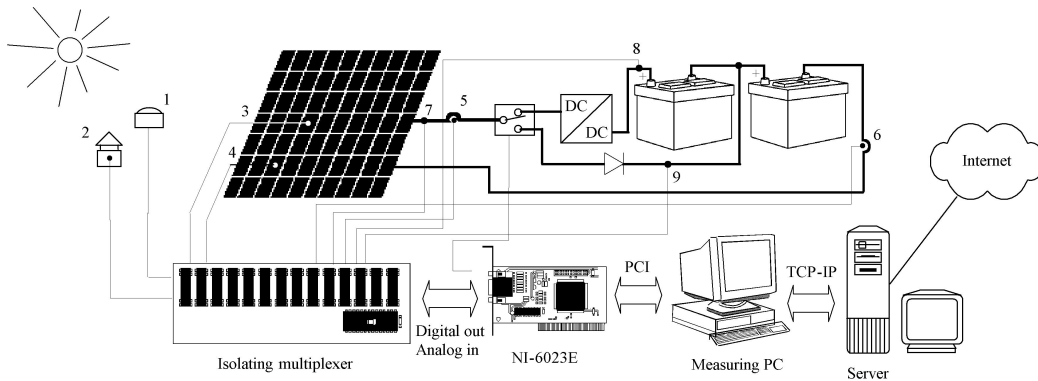


Figure 4: Schematic of measuring circuit.

4 INTERNET APPLICATION

The third part of the system is the Web application, which is programmed in the PHP script language. The web takes over the data from the measuring part of the system and stores them in the MySQL database, which can be used to further process the data and subsequently to show them on the web pages (see Fig. 5, 6). The transfer, processing and imaging of data are fully automatic. The Matlab control program immediately sends the data measured to the ftp server. On the server, the data are taken over by the PHP script, which will automatically store them in the database. As soon as the data are stored in the database, the queries of the MySQL language can be used to further work with the data (calculations, selection, etc.).

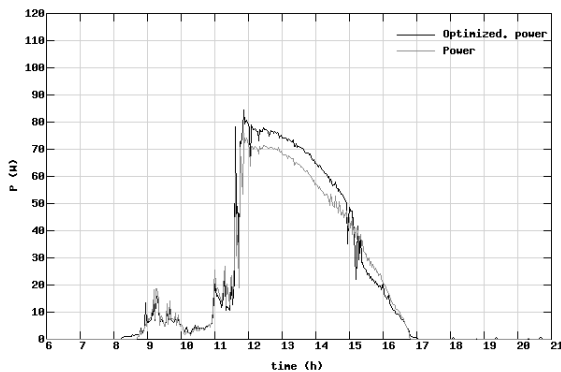


Figure 5: Power characteristics of FV panel (optimized and without optimizing).

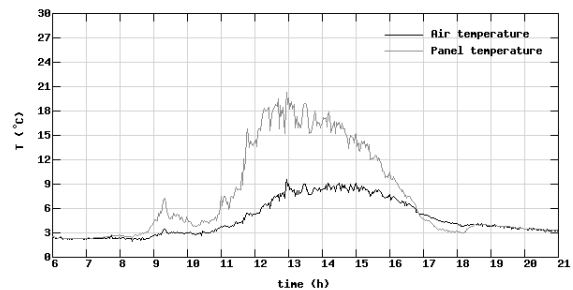


Figure 6: Temperature measuring (panel and air).

5 CONCLUSION

The on-line measuring system of solar energy converter with power optimization is currently in full operation. It is also presented on the web pages of our laboratory (<http://www.ueen.-feec.vutbr.cz/laboratory-of-unconventional-energy-conversion/mereni1.php>), where the values measured are displayed on-line. Thus we endeavour to verify the function of the system with power optimization in long-term measurement. The great amount of data will enable us to perform further calculations, for which data of a more long-term nature are required. We also intend to extend and update the web page with graphs from these calculations and to innovate the optimization program. All the results will be presented on the web pages of our laboratory.

ACKNOWLEDGEMENT

The paper includes the solution results of the Ministry of Education, Youth and Sport research project No. MSM 0021630516.

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