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A COMPARATIVE STUDY OF VOLT-AMPETE CHARACTERISTIC OF THE W, Sn, C, Cr SELF-DIRECTED CHANNEL MEMRISTORS

The characteristics of tungsten, chromium, tin, and carbon self-directed channel Knowm memristors were studied at up to 10 kHz. Besides, we have studied the switching voltages, resistances of HRS/LRS, and retention times. The characteristics were compared and the possibility of their application in logic embedded into memory devices were investigated.

Keywords: memristor, self-directed channel, volt-ampete characteristic (I-V), hysteresis.

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DESIGN OF A SYSTEM FOR MEASURING THE MAXIMUM POWER POINT OF SOLAR PANELS

The maximum power point is an important parameter of solar panels. The solar panel works at its highest efficiency at that point. However, depending on the external conditions, such as irradiation and temperature, the maximum power point is constantly changing. Finding the maximum power point of a solar panel is practically necessary for the solar panel always to work at its maximum power.

In the scope of the current work, we have designed and implemented a system for measuring the maximum power point of solar panels. The tests of the designed system show the repeatability of the measurements and the dependance of the maximum power point of solar panels from the irradiation.

Keywords: maximum power point, solar panel, system for measuring maximum power point, solar panel efficiency.

Introduction

The rapid growth of solar energy is due to several important factors. First of all, renewable energy is incomparably preferable, besides, the price of natural fuels is increasing day by day, and the above-mentioned circumstances, the energy policy is pursued by large countries [1].

The total cumulative installed capacity for PV in 2009 was 2.6GW, in 2010 was 7,8GW and at the end of 2020 reached at least 760,4 GW [2].

The need for more available energy raises the issue of creating more up-to-date solar platforms that will be able to extract all the energy produced by the solar panel.

In order to ensure the best efficiency of the work of a solar panel, it is necessary that it always work at the maximum possible power: Maximum Power

Point (MPP). This power can be calculated from the volt-ampere characteristic of the solar panel and determines the effective values of the current and voltage (1.1):

$$P_{Max} = I_{Eff} \times V_{Eff} \quad (1.1)$$

where I_{Eff} and V_{Eff}, respectively, are the effective values of the current and the voltage (the values at which the power has its maximum value) [3].

The value of maximum power and its position (V_{Eff}) depend on the impact of the external environment, and the latter is subject to constant change. The so-called Maximum Power Point Tracking (MPPT) method is used to track the MPP and adjust the system to gather the maximum available power. The efficiency of using this method can reach up to 98%, ensuring the operation of the solar panel at the maximum power point.

System Design

To have the MPP of the solar panel at given external conditions, one needs to change the load on the solar panel and measure the values of current and voltage [4, 5]. By changing the load resistance from 0Ω (short circuit) to several MΩ (open circuit) while measuring the values of current and voltage, one can build the volt-ampere characteristic of the system. From the measured volt-ampere characteristic curve, the MPP, I_{Eff} and V_{Eff} can be easily derived, as the point where the output power has the maximum value [6, 7].

The schematic representation of the designed system is shown on Fig. 1.

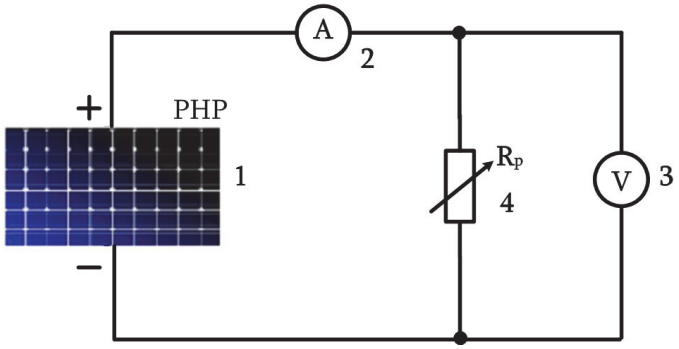


Fig. 1. The schematic representation of the designed system for MPP measurement

Fig. 1: (1) solar panel, (2) amperemeter, (3) voltmeter and (4) variable load.

To build the system, we have used two “NI USB-4065” Digital Multimeters (DMM): one as amperemeter and other as voltmeter. The “NI USB-4065” is 6½-Digit, ±300 V, USB digital multimeter device.

To measure the I-V characteristics and calculate the MPP, I_{Eff} and V_{Eff} values, we have developed a software in NI LabVIEW environment. When the

operator executes the “Start Measurements” command, the developed software starts registering the voltage and current values form the DMMs and calculates the power for each value. The obtained values of each parameter are being saved in separate arrays (one array per parameter). When the operator terminates measurements, the designed software builds the I-V characteristic curve and the power dependence on the voltage curve. And finally, the software derives the MPP, I_{Eff} and V_{Eff} values.

The functionality of the designed software is determined by its block-diagram shown in Fig. 2.

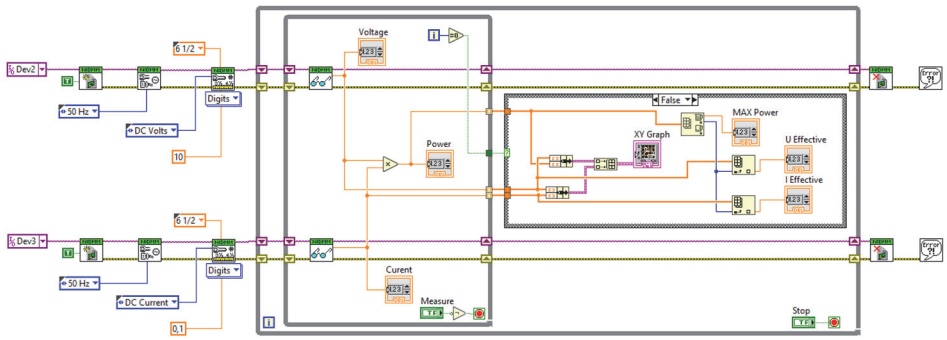


Fig. 2. The block-diagram of the designed in LabVIEW environment software

The left part of the block-diagram, which precedes loop structures, is responsible for the configuration of the DMMs: top part – voltmeter, bottom part – amperemeter. Here the software selects the appropriate physical device, activates the built-in hardware filter for powerline noise reduction, chooses the DMM measurement mode (DC Volts and DC Current), sets the input range (±10 V and ±0.1 A) and resolution (6½ digits).

The inner “While loop” executes when the “Measure” button (Fig. 3) is pressed (“Start Measurements” command). At each iteration of this loop the software reads measurement data from our amperemeter and voltmeter and calculates the power. The obtained values are then sent to the corresponding indicators on the front panel (Fig. 3) of the software: “Current”, “Voltage” and “Power”. At the completion of each iteration the obtained values of each parameter are being saved in separate arrays (one array per parameter). When the “Measure” button is released this “While loop” finishes its execution and passes the arrays of the obtained values to the next part of the block diagram: “Case structure”.

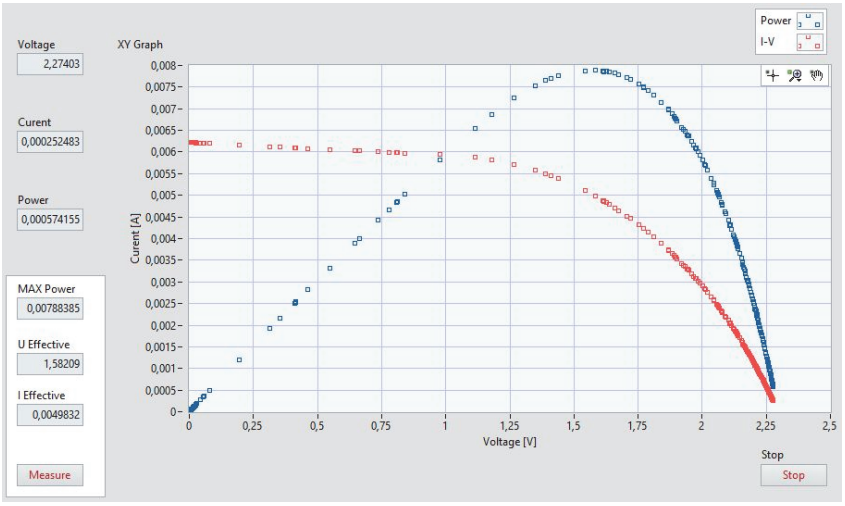
Each time the “Case structure” receives new data, it builds the I-V characteristic curve and the power dependance from the voltage curve on the “XY Graph” of the front panel (Fig. 3). Next, by finding the maximum value of the array in which the power values are saved the software derives the MPP, I_{Eff} and V_{Eff} values. Then,

these values are sent to the corresponding indicators on the front panel (Fig. 3) of the software: “MAX Power”, “I Effective” and “U Effective”.

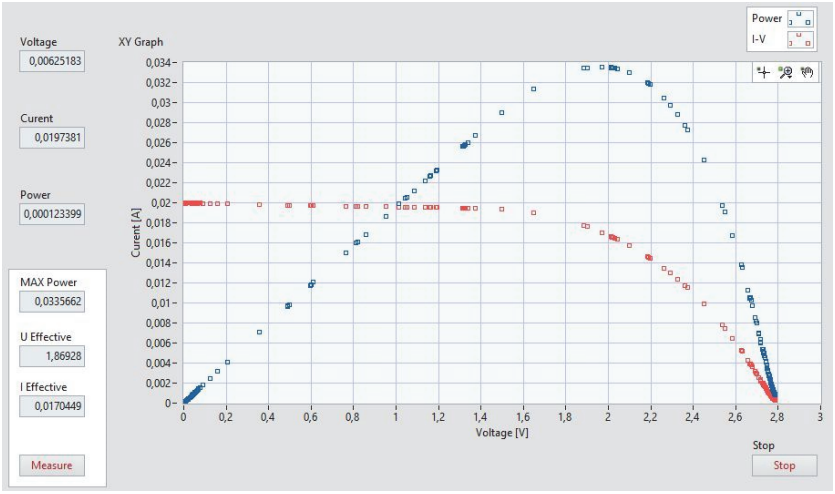
System Testing and Results

To test our system for measuring the maximum power point of solar panels, we have used a light source with a controllable intensity. We have placed the light source and the solar panel under the test in an opaque box to eliminate the influence of ambient lighting. During the measurements we have set different constant levels of illumination and gradually changed the load of the solar panel.

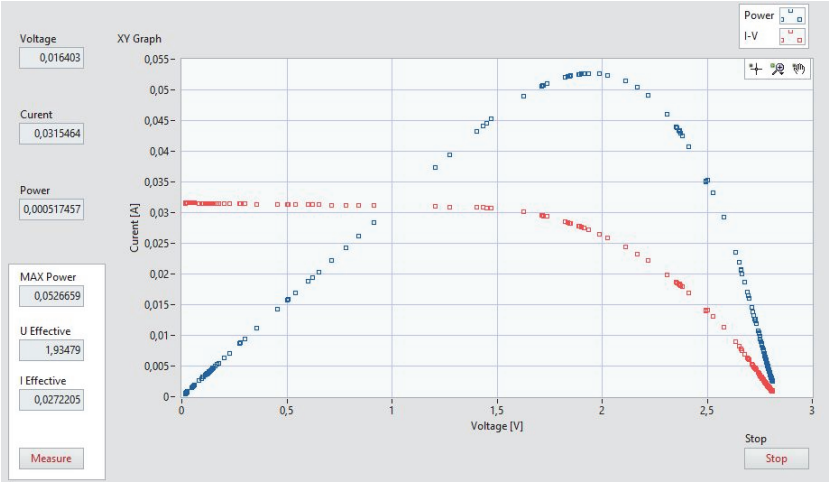
The results of such measurements for 50%, 80% and 100% illumination levels are presented in Fig. 3-a), -b) and -c) respectively.



a)



b)



c)

Fig. 3. The measured volt-ampere characteristics (red) and power curves (blue) at different illumination levels: (a) 50%, (b) 80%, (c)100%

Conclusion

We have designed and implemented a system for measuring the maximum power point of solar panels. To have the I-V characteristic curve and the power dependence on the voltage curve and to automatize the calculations of the MPP, I_{Eff} and V_{Eff} values, we have also developed a software in NI LabVIEW environment.

To test the designed system, we have made measurements on a solar panel under different illumination levels. The results of these tests show the repeatability of the measurements and the dependance of the maximum power point of solar panels from the irradiation level.

REFERENCES

1. **Venugopal S., Aspalli A.S., Raveendra R**. Maximum Power Point Tracking For Photovoltaic Systems // GRENZE scientific society. - 2017.- N3 ICCTEST. -P. 432-441.
2. **Salehi R., Jahanbakhshi A., Golzarian M.R., Khojastehpour M.** Evaluation of solar panel cooling systems using anodized heat sink equipped with thermoelectric module through the parameters of temperature, power and efficiency // Energy Conversion and Management.- 2021.- X.- P. 1-7.
3. **Nasr Allah A.A.; Saied Mohamed M.H.; Mostafa, M. Z.; Abdel- Moneim, T. M**. A survey of maximum PPT techniques of PV systems // A Survey of Maximum PPT techniques of PV Systems, IEEE Xplore.- 2012, ISBN 978-1-4673-1835-8. S2CID 10207856.- P. 1–17.
4. **Surawdhaniwar, Sonali; Diwan, Ritesh**. Study of Maximum Power Point Tracking Using Perturb and Observe Method // International Journal of Advanced Research in Computer Engineering & Technology.- 2012.- 1 (5).-P.106–110.

5. **Ramaprabhu R., Gothandaraman V., Kanimozhi K., Divya R., Mathur B.L**. Maximum Power Point tracking using GA-Optimized Artificial Neural Network for Solar PV System // Proc. IEEE int'l conf. on Electrical Engineering System.- 2011.- P. 320-324.
6. **Fu Q., Tong N.** A Complex-Method-based PSO algorithm for the maximum power point tracking in photovoltaic system // Proc. IEEE, Second International Conference on Information Technology and Computer Science.- 2010.- P. 134.
7. **Xiao W. , Zeineldin H. H., Zhang P.** Statistic and Parallel Testing Procedure for Evaluating Maximum Power Point Tracking Algorithms of Photovoltaic Power Systems // IEEE Journal of Photovoltaics.- 2013.- 13583161.- P. 1062 – 1069.

Ա.Տ. ՍԻՄՈՆՅԱՆ

ԱՐԵՎԱՅԻՆ ՎԱՀԱՆԱԿՆԵՐԻ ԱՌԱՎԵԼԱԳՈՒՅՆ ՀԶՈՐՈՒԹՅԱՆ ԿԵՏԻ ՈՐՈՇՄԱՆ ՀԱՄԱԿԱՐԳԻ ՆԱԽԱԳԾՈՒՄԸ

Առավելագույն հզորության կետը արևային վահանակների կարևոր պարամետր է: Առավելագույն հզորության կետում արևային վահանակն աշխատում է իր ամենաբարձր արդյունավետությամբ: Այնուամենայնիվ, կախված արտաքին պայմաններից, ինչպիսիք են ճառագայթումը և ջերմաստիճանը, առավելագույն հզորության կետն անընդհատ փոխվում է: Այդ իսկ պատճառով գործնականում անհրաժեշտ է մշտապես հայտնաբերել այդ կետը, որպեսզի արևային վահանակը միշտ աշխատի իր առավելագույն հզորությամբ:

Նախագծվել և ներդրվել է արևային վահանակների առավելագույն հզորության չափման համակարգ: Նախագծված համակարգի թեստերը ցույց են տալիս չափումների կրկնելիությունը և արևային վահանակների առավելագույն հզորության կետի կախվածությունը ճառագայթումից:

Առանցքային բառեր. առավելագույն հզորության կետ, արևային վահանակ, առավելագույն հզորության չափման համակարգ, արևային վահանակների արդյունավետություն:

А.Т. СИМОНЯН

ПРОЕКТИРОВАНИЕ СИСТЕМЫ ИЗМЕРЕНИЯ МАКСИМАЛЬНОЙ МОЩНОСТИ СОЛНЕЧНЫХ ПАНЕЛЕЙ

Точка максимальной мощности - важный параметр солнечных панелей. В этой точке солнечная панель работает с максимальной эффективностью. Однако в зависимости от внешних условий, таких как облучение и температура, точка максимальной мощности постоянно меняется. На практике определение точки максимальной мощности солнечной панели необходимо для того, чтобы солнечная панель всегда работала на максимальной мощности.

В рамках текущей работы разработана и реализована система измерения максимальной мощности солнечных панелей. Испытания разработанной системы показывают повторяемость измерений и зависимость точки максимальной мощности солнечных панелей от облучения.

Ключевые слова: точка максимальной мощности, солнечная панель, система измерения точки максимальной мощности, эффективность солнечной панели.