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		<i>aloqadorligi</i>	
18	<i>Alqorov Qodir, Yusupov Kermom</i>	<i>Ta’lim tizimida ma’naviy barkamol avlodni tarbiyalashning pedagogik muammolari</i>	79-82
19	<i>Tugalov Farhod, Mamaidiyrov Uraljon</i>	<i>Физика ўқитишида талабаларнинг илмий дунёқарашини шакллантиришида муаммоли таълим технологияларининг ўрни</i>	83-86
20	<i>Tugalov Farhod, Berkiyeva Chexroza</i>	<i>Фундаментал фанларнинг аҳамияти</i>	87-91
21	<i>G’ofurova Aziza Xidirnazar qizi</i>	<i>Oliy ta’limda ixtisoslik fanlarni o’qitish jarayonini takomillashtirish</i>	92-95
22	<i>Ortiqova Ozoda, Nazirova Nafisa</i>	<i>Milliy liboslarda bezaklar va pardoz- andozlarning ishlatilishi</i>	96-100
23	<i>Doniyorova Shahnoza, Urinboyeva Gulsevar</i>	<i>To’quvchilik san’ati va uning o’ziga xosligi</i>	101-104
24	<i>Doniyorova Shahnoza, Urinboyeva Gulsevar</i>	<i>Kreativ yondashuv asosida bo’lajak o’qituvchilarning art-dizaynga oid bilimlarini rivojlantirish prinsiplari</i>	105-107
25	<i>Po’latov Ja’farbek Hasanboy o’g’li</i>	<i>O’quvchilarga mexanik ish mavzusini texnikalar bilan aloqadorlikda o’qitish texnologiyasi</i>	108-110
26	<i>Ismoilov To’ychi Jabborovich</i>	<i>Bo’lajak texnologiya o’qituvchilari uslubiy tayyorgarligining nazariy asoslari</i>	111-115
27	<i>Ismoilov To’ychi Jabborovich</i>	<i>Zamonaviy ta’lim sifat va camaradorlikka erishish omili</i>	116-122
28	<i>Eshtuxturova Orzigul, Mamatqulov Fatxulla</i>	<i>Fizika masalalar yechimining didaktik taxlili</i>	123-126
29	<i>Umurov Homid Musurmon o’g’li</i>	<i>Tabiiy fanlarni o’qitishda fanlar integratsiyalashuvi</i>	127-129
30	<i>Rajabov Nurmuhammed</i>	<i>Cheap the theory of creating solar panels</i>	130-132
31	<i>Rajabov Nurmuhammed</i>	<i>The effect of temperature on the cvc of a photoelectric converter</i>	133-139

## THE EFFECT OF TEMPERATURE ON THE CVC OF A PHOTOELECTRIC CONVERTER

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**Abstract:** *In this paper, a photovoltaic model analysis was carried out to simulate the actual behavior of a photovoltaic module using MatlabSimulink using the parameters of photovoltaic cells consisting of a single diode, series resistance and shunt resistance. The typical characteristics of a 150 W P 36 multicrystalline solar module were used to evaluate the model. The characteristic curves were obtained from the manufacturer's data sheet, which shows an exact match of the model, and this proves that the module is reliable.*

**Keywords:** *photovoltaic module, IV and PV performance, photovoltaic (PV), photovoltaic cells, Matlab, photovoltaic module, simulation.*

### 1. Introduction

Renewable energy sources are reliable and plentiful and have the potential to become very cheap once technology and infrastructure improves. Renewable energy is an important part of reducing global carbon emissions and the pace of investment has increased significantly as technology costs continue to fall and efficiency continues to rise. The photovoltaic solar cell has emerged as one of the most potential and promising renewable energy solutions. Photovoltaics offers the highest versatility among renewable energy technologies due to oil consumption and cost, increased energy demand, and the negative impact of pollution on the environment. Jordan is one of the first places in the world in dependence on alternative energy sources such as photovoltaic solar system.

Several previous studies have been carried out to develop and validate mathematical modeling of a photovoltaic module in order to better understand its operation.

For modeling a photovoltaic module, the use of equivalent circuits can be seen from the literature [1]-[4]. To make the photovoltaic model easy to solve, the equivalent circuit can be simplified to a single diode circuit [5]-[9]

In addition, single diode models can be divided into two categories. The first is a four-parameter model, in which the shunt resistance is neglected and considered to be infinite [8] [9]. The second is called the five-parameter model, where the shunt resistance is considered to be finite [10]-[12].

In this paper, a simplified model is presented, followed by a simulation of a photovoltaic cell in accordance with the photomodule PS - P 36-150 Wp .

In recent years, there has been a significant deployment of photovoltaic systems, especially in many developed countries. In addition, photovoltaic energy will become an important source of solar radiation in the coming years. This latter consists of photons of different energies, and some of them are absorbed at the PN junction. Photons with energies below the band gap of a solar cell are useless and generate neither voltage nor electric current. Photons with energies greater than the band gap generate electricity, but only the energy corresponding to the band gap is used [1].

Solar cells are mainly made from semiconductors, which are produced using a variety of processes. These semiconductors convert sunlight energy directly into electricity through the photovoltaic effect. Many mathematical models have been developed to represent the highly non-linear behavior resulting from semiconductor junctions in order to evaluate the performance of a solar cell. In our case, we consider a model with one diode [2]. Renewable energy sources are reliable and plentiful and have the potential to become very cheap once technology and infrastructure improves. Renewable energy is an important part of reducing global carbon emissions and the pace of investment has increased significantly as technology costs continue to fall and efficiency continues to rise. The photovoltaic solar cell has emerged as one of the most potential and promising renewable energy solutions. Photovoltaics offers the highest versatility among renewable energy technologies due to oil consumption and cost, increased energy demand, and the negative impact of pollution on the environment. Jordan is one of the first places in the world in dependence on alternative energy sources such as photovoltaic solar system.

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infinite [3]. The second is called the five-parameter model, where the shunt resistance is assumed to be finite. In this paper, a simplified model is presented, followed by a simulation of a photovoltaic cell in accordance with the photomodule PSP 36150 Wp .

The creation of new efficient photovoltaic cells is one of the urgent tasks in the development of solar energy. In recent years, photovoltaic cells have been used in water supply systems, pumping and air conditioning stations in remote and isolated areas where power lines are not available or not economically viable. In this regard, the evaluation of the effectiveness of their work is quite important. It is necessary to be able to determine the output dependences of solar panels (SP) under the influence of various environmental factors, compare the efficiency of using SP from different materials, and evaluate the behavior of photovoltaic converters in various operating modes. For the efficient use of photovoltaic cells, it is necessary to know the point of maximum power and ensure such a regime so that the output power when changing environmental conditions is the highest. When working out the joint venture, simulators of solar batteries are used, which make it possible to reproduce the characteristics of the joint venture under the influence of various external influences.

Determination of the behavior and reproduction of the characteristics of a solar cell (SC) and SP is carried out using simulation. Compared with the experiment, mathematical modeling is a faster, more flexible and cheaper way to work out the SP. To reproduce the characteristics of the ESS and SP, analytical models are most often used, which are built on the basis of an equivalent electrical circuit and the main SP equation. Work on modeling the characteristics of the joint venture is actively carried out abroad, the results of research are considered at international scientific and technical conferences [13]. The prospects [13] for the introduction of solar energy make Russian researchers also interested in the issues of SP modeling. This article discusses the issue of modeling a solar panel in the Matlab / Simulink program .

## **2 . Photocell circuit**

The basic photovoltaic cell is represented by a diode of the same type. It consists of n- type silicon and p- type silicon doped semiconductor with a resulting space charge layer. Typically, an unirradiated solar cell behaves much the same as a diode. Therefore, a simple diode can describe an equivalent circuit [3]. The semiconductor is temperature sensitive and the current generated by the illumination of the photocell is linear with solar radiation and also with temperature.

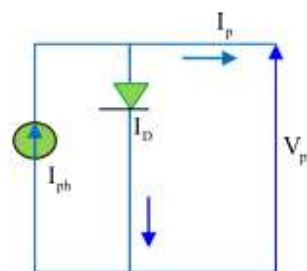


Fig.1. Ideal single diode model

### 3. CVC of the photovoltaic module

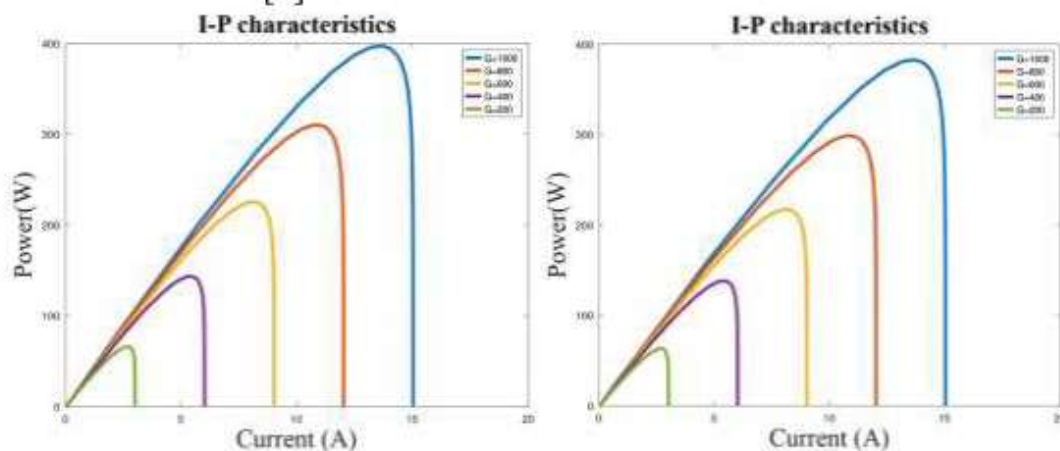
The IV characteristic of a photovoltaic module depends on the relationship between current and voltage generated in a typical solar cell. The characteristic IV curve and most of the parameters affecting the characteristics of the photovoltaic cell refer to  $R_s$ ,  $R_{sh}$  as well as on the intensity of the radiation level and temperature. The generated current  $I_{ph}$  of photocells, without taking into account series and parallel resistances, is difficult to determine. The specifications only state the standard short circuit current  $I_{SCM}$ , which is the maximum current available at the PV module's terminals. The semiconductor is temperature sensitive, and the current generated by the illumination of the photocell depends linearly on the solar radiation and also depends on  $I_{sc}$  the temperature.  $V_{oc}$

$$I_{ph} = (I_{ph} + K_i(T - T_{ref})) \frac{G}{G_{ref}} \quad (1)$$

$$E_g = E_g(0)(1 - 0.0002677(T - T_{ref})) \quad (2)$$

The three models maintain a constant temperature at  $25^\circ\text{C}$  and vary the intensity of the radiation ( $250\text{ W/m}^2$ ,  $500\text{ W/m}^2$ ,  $750\text{ W/m}^2$ ,  $1000\text{ W/m}^2$ ). On fig. 1 shows the results of the Matlab program under these conditions for the I–V characteristics and IV characteristics, respectively. It is clear that the current generated by the incident light depends on the irradiation, the higher the irradiation, the greater the current. On the other hand, the voltage remains almost constant and does not collect. The influence of irradiation on the point of maximum power is obvious, the higher the irradiation, the greater the point of maximum power [3]. Secondly, the irradiance is kept constant at  $1000\text{ W/m}^2$  and temperature changes ( $25^\circ\text{C}$ ,  $50^\circ\text{C}$ ,  $75^\circ\text{C}$ ,  $100^\circ\text{C}$ ) will generate characteristic curves. The effect of increasing temperature reduces voltage and power. On fig. 6 shows the influence of both irradiation and temperature, it can be noted that the I–V and PV curves are similar to the curves of the influence of irradiation with

slightly higher power values; the influence of temperature in this case is practically not taken into account [4].



Rice. 1. Influence of series resistance.

On fig. 1 shows the calculated characteristics of the current and power of the solar panel TCM 210 SB for the level of illumination of the solar cell  $E = 1000 \text{ W/m}^2$ . It can be seen from the figure that the greatest efficiency of the solar panel occurs at a fixed position of the operating point at maximum power.

the TCM 210 SB type was carried out at the Department of Electromechanics of the Ufa State Aviation Technical University with a change in the level of solar insolation from  $1000$  to  $300 \text{ W/m}^2$ , which is the most accessible at the latitude of the Republic of Bashkortostan. The comparison results are given in table. 2 and fig. 7

The table shows that the results of the model coincide with the results of the experiment with an accuracy of 5% to 15%, large deviations are obtained at low values of the solar insolation level. It is important to note that the operating range of this model with tolerances (less than 5%) is valid for solar insolation levels of more than  $300 \text{ W/m}^2$ . For values of  $S_x < 300 \text{ W/m}^2$  the model gives large deviations from the real SP, which is the main disadvantage of this model.

## CONCLUSION

This article presents a mathematical model of a photovoltaic cell. The proposed procedure provides an accurate photocell model. The results of the Matlab model show excellent agreement with the manufacturer's data from the table. This model has been designed so that it can be used to show the effect of temperature, irradiation, shunt and series resistances on IV characteristics. The maximum power output by the photovoltaic module is about  $150.04 \text{ W}$  at parameters close to the values provided by the manufacturer:  $I = 8.15 \text{ A}$  and  $V = 18.41 \text{ V}$



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