РОЗДІЛ 1: ІНТЕЛЕКТУАЛЬНІ ЕНЕРГЕТИЧНІ SMART GRID СИСТЕМИ ТА СУЧАСНІ ТЕХНОЛОГІЇ ВІДНОВЛЮВАЛЬНОЇ ЕНЕРГЕТИКИ

UDC 621.314

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IMPROVING THE ENERGY EFFICIENCY OF PHOTOELECTRIC PANELS USING A DISTRIBUTED MAXIMUM POWER TRACKING ARCHITECTURE

One of the most important goals of a photovoltaic (PV) power plant is to produce the maximum amount of energy. The energy efficiency of photovoltaic panels is often reduced due to phenomena associated with photovoltaic power plant systems. The most common reasons for reducing energy efficiency are shadows, dirt, temperature fluctuations, etc. [1, 2]. Thus, this problem can lead to a significant reduction in the amount of electricity produced by the PV plant.

The architecture of distributed maximum power point tracking (DMPPT) is one of the most promising solutions for overcoming the shortcomings associated with the low energy efficiency of photovoltaic panels [3, 4]. This architecture has a DC-DC converter designed to track the maximum power point of each PV panel. The converter must be able to step up and down to provide maximum flexibility.

In the architecture of photovoltaic installations of distributed tracking of maximum power, photovoltaic panels are isolated from each other, reducing the impact of negative phenomena on electricity generation (Fig. 1).

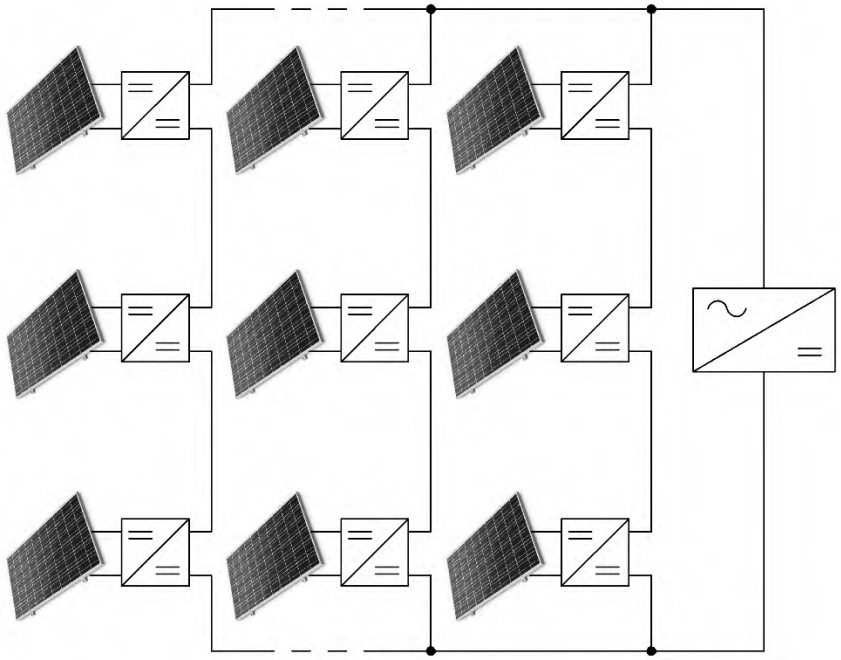

Figure 1 – Architecture of photovoltaic installations of distributed tracking of maximum power

An unshaded PV panel has only one point of maximum power, while a shaded PV panel has two points of maximum power. In this case, not only does the power decrease, but the absolute voltage also changes due to shading. Because of this behavior, some PV panels may not operate at their maximum power point even with a DMPPT architecture if the DC-DC converter can only step up or down the output voltage.

If the DC-DC converter only has a step-up function, the number of PV panels per circuit will be higher, since PV panels are at their lowest efficiency when shaded. Conversely, if a step-up converter is used, the number of PV panels per circuit is less and the number of circuits is greater [5, 6].

In order to more flexibly increase the number of photovoltaic panels in a photovoltaic circuit, voltage converters are needed that can increase and decrease the output voltage.

The main component of the topology of the autotransformer forward-flyback converter. The method of

connecting the autotransformer has two important consequences. On the one hand, due to the fact that the magnetizing inductance of the autotransformer demagnetizes the output filter, its size can be reduced. On the other hand, there is a path when switch *S* is turned on with direct energy transfer from the input source to the output filter without magnetic treatment by the autotransformer. Thus, the efficiency of the converter increases, since only part of the energy is processed magnetically. This principle is similar to converters of serial connection.

Transfer function of the output voltage is similar to the function of the step-down converter. The voltage increase factor depends on the value of the transformation factor of the autotransformer. These parameters also affect the overvoltages of the components of the autotransformer forward-flyback converter. Therefore, both parameters must be chosen carefully to minimize overvoltages in the converter components.

The shading effect involves a reduction in voltage and power at the point of maximum power. The values obtained for the photovoltaic panel depending on the percentage of shaded modules are shown in Table 1.

Table 1 – The shading effect of the photovoltaic panel

Parameter	Panel option 1 (100 % / 0 %)		Panel option 2 (75 % / 25 %)		Panel option 3 (70 % / 30 %)	
	unshaded	shaded	unshaded	shaded	unshaded	shaded
Output power P_{out}, W	225	–	225	67.5	225	67.5
Input voltage U_{in}, V	29.3	–	29.3	15	29.3	15
Output voltage U_{out}, V	33.3	–	40.4	12.12	42.19	12.66
Circuit current I_k, A	6.75	–	5.57	5.57	5.33	5.33

As can be seen from Table 1, regardless of the topology of the converter, with an increase in the proportion of shaded photovoltaic panels, less electricity can be generated. The increased efficiency of the converter means that more electricity can be generated in the solar power plant through the use of autotransformer forward-flyback converter.

The main features of the proposed converter are its high efficiency and the ability to increase or decrease the output voltage depending on the input voltage.

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