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VALIDATION OF NON-STANDARD PV (SOLAR) PANELS BY IEC 61215

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Abstract:
The spreading of photovoltaic (PV) systems as solar panels can be seen around the entire world. The product authorisation and validation process in the case of standard size roof solar panels is a well-established practice, however there are an endless variety of non-standard size PV panels. The validation of such units is not always a standard and straightforward procedure, as it is not always clear whether a PV panel is an electrical device or a building material. This paper discusses a possible methodology of the validation of non-standard size PV elements according to the IEC 61215 standard [1].

Keywords: Photovoltaic; 61215; solar-panel.

1. INTRODUCTION

The IEC 61215 standard [1] is generally – but not exclusively – used for the validation of standard-size solar panels (~1.6 x 1 m). There are 19 different Module Quality Tests (MQT) defined in this standard. They describe in detail the tests to be conducted, defining their logical sequence. These tests are used for standard size solar panels installed on buildings (typically on roofs or facades). Today solar units can be found in sizes and shapes different from these panels, with validation being the problematic point. This article discusses the various options of adapting the tests required by the IEC 61215 standard [1], via a type of solar panel that can be integrated into roof tiles, so that non-standard PV panels can also be validated.

2. WHERE THERE IS NO NEED FOR CHANGES

The 19 MQT chapters of the IEC 61215 standard [1] include some where the specified tests can be used for any non-standard PV panel without any need for changes. These MQTs are the following:

- MQT 01 Visual Inspection
- MQT 10 UV preconditioning
- MQT 13 Damp heat test
- MQT 14 Robustness of termination

The tests listed above are not covered in this study.

The other MQTs (2-9; 11; 15-19) include recurring elements, as a result, this study focuses on tasks and not MTQs. All of these recurring elements can be associated with the performance measurement of PV panels.

This paper explores the potential of using a solar simulator and indoor conditions as a substitute for natural light and outdoor conditions.

3. WHERE THERE IS A NEED FOR CHANGES

The most important task during a test is to measure the output power of a given PV panel under various conditions. This includes introduction of:

- solar simulator AAA (IEC 60904-9) [3]
- pyranometer or reference cell
- dummy load.

The additional tools needed are the same as the ones used for testing standard PV panels.

During the test, the standard solar panels must be inspected under natural conditions, using natural sunlight (e.g., MQT 08). The relevant part of the standard specifies acceptable environmental conditions, such as wind speed, solar radiance, etc. Taking into account the environmental effects, i.e., the weather, can significantly increase the time needed to carry out the test. This affects the schedule and makes it difficult to perform a given validation. It is recommended to use indoor testing instead of an outdoor test utilizing a climatic chamber with solar simulation, so that changing and incidental environmental conditions will not hinder the testing process. Tests are currently underway, and this article does not yet provide concrete results, but only describes the theoretical setup and preliminary simulations.

Climatic chambers are suitable for maintaining temperature and humidity at a constant level or changing them according to a pre-defined algorithm. When using solar simulation, the intensity of irradiation and its distribution on the surface of the solar panel being tested can easily be measured at any moment. The (surface) temperature of the solar panel does not change either, as there is no air movement. Under these conditions, environmental effects can be eliminated, and the repeatability of the tests is definitely improved.

3.1. Climatic chamber

The climatic chamber is not sized primarily according to the size of the products to be tested in it but that of the irradiation unit, i.e., the solar simulator. When positioning the solar simulator, it is important that the panels must be exposed to vertical irradiation; as a result, it must be placed on top of the climatic chamber. Since the solar simulator needs cooling during operation (see Chapter 3.2), it cannot be placed inside the climatic chamber. To make the climatic chamber suitable for solar simulation tests, an opening must be designed on top of it, with a useful size of approx. 500 x 595 mm (W x L) and proper sealing. After the sealing has been removed, the solar simulation panel can be installed (Figure 1). The solar simulator can be inserted into the opening and the solar radiation test of the solar panels can be conducted at controlled temperature and humidity levels.

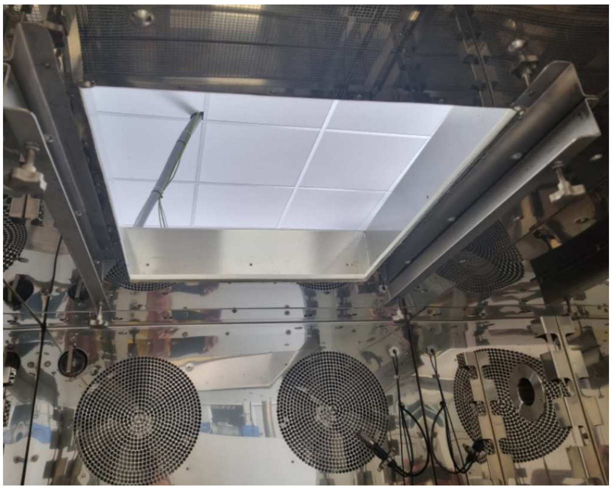

Figure 1: Opening on top of the climatic chamber – open

When designing the opening, care must be taken to provide proper sealing and closure for occasions when the solar simulator is not in use (Figure 2).

Figure 2: Opening on top of the climatic chamber – with sealing

In both cases, this solution must be designed in a way that it will not have any impact on the basic operating parameters of the climatic chamber during operation.

3.2. Solar simulator

MQT 2 / 6 / 7 / 9

The solar simulator is used for measuring the output power of solar panels (Figure 3) and determining the maximum power point of a given solar panel.

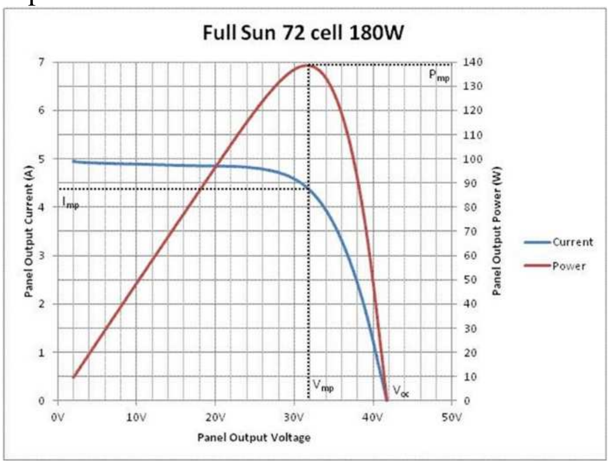

Figure 3: [2] Trevor Barcelo, Solar panel I-V curve showing maximum power

In Fig. 3 Pmp is the maximum power point, Vmp is the panel voltage at maximum power, Voc is the panel’s open circuit voltage and Imp is the current at Pmp point.

The next figure shows the operating principle of the solar simulation test (Figure 4).

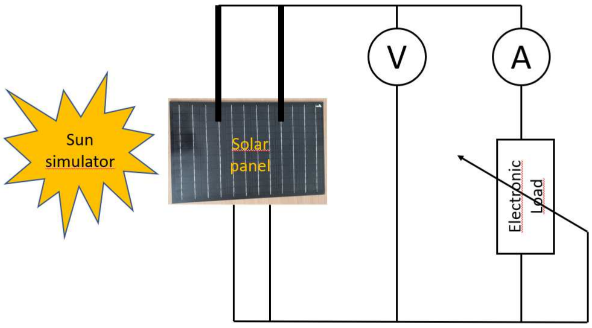

Figure 4: Operating principle of the solar simulation test

In Fig.4 A is the High precision current meter and V is the High precision voltmeter. The Electronic load is for example, Siglent SDL1020X E (150V/30A, 200W DC Load, 1 mV, 1 mA).

The selection of the LEDs used for the solar simulator and their arrangement on the surface of the solar simulator are of critical importance. This study does not deal with their design and selection aspects or parameters; however, a possible layout is shown in Figure 5.

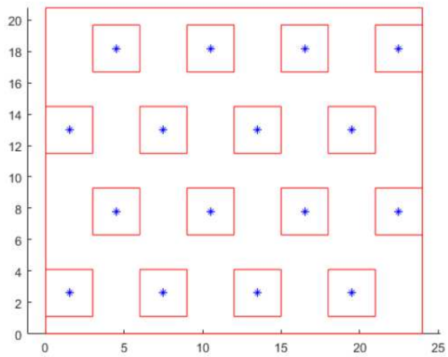

Figure 5: Solar simulator – a possible arrangement of LEDs [units in cm] (15.05.2022 University of Pannonia, Faculty of Engineering, Department of Process Engineering)

It is essential to know the area where the direction of radiation can be considered as vertical. The precise calibration of this and its adjustment relative to the solar panel being tested may require ad-hoc design efforts.

A possible design of the solar simulator can be seen in the following image (Figure 6). The solar simulator presented in the photo is suitable for insertion into the opening on top of the climate chamber.

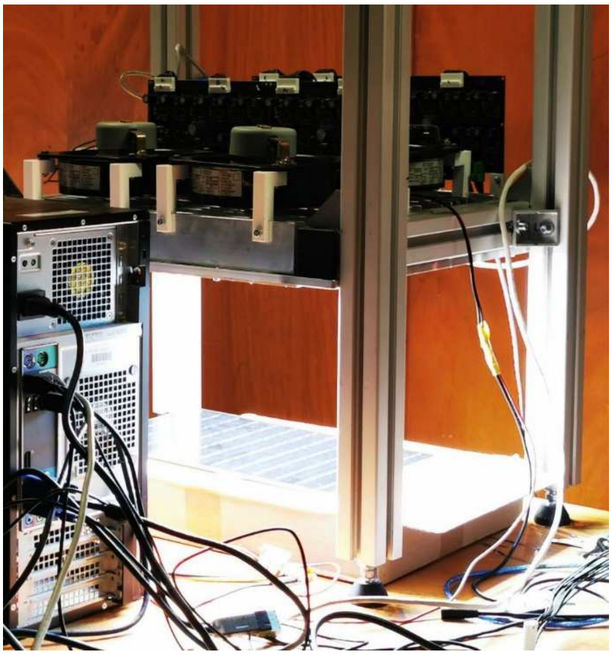

Figure 6: Solar simulator design (University of Pannonia, Faculty of Engineering, Department of Process Engineering)

The sunlight simulator is currently being tested and optimised. Mainly under industrial conditions, during the mass production of individual solar cells, in the form of a so-called "flash-test" solution.

4. SUMMARY

Besides the power measurement of photovoltaic systems, the IEC 61215 standard [1] deals also with the testing of other parameters, such as electrical insulation, the mechanical resistance of connectors or hail impact. Such tests can also be product-specific; however, the methods used for testing standard panels can be efficiently applied with smaller or bigger modifications.

The greatest difference in testing standard and non-standard panels lies in determining their electrical output. We intend to reduce this difference through tests carried out in a climatic chamber, using dummy load and solar simulation. Experiments with a 500 x 595 mm sunlight simulator integrated into the climate chamber are encouraging. Based on the simulations and preliminary measurements, a solar simulator of this size seems to be sufficient to illuminate the solar cell integrated in the selected roof tile. The solar simulator is expected to be connected to the climate chamber at the end of 2022. Solar validation tests will start in early 2023. The first results of the analysis of the differences between the results of the outdoor tests as described in IEC 61215 and the proposed indoor tests (with the solar simulator integrated in the climate chamber) are expected in summer 2023.

The methods discussed in this study are in an experimental phase. The expected completion date of the project is the first quarter of 2024.

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