MEASUREMENT IN A PHOTOVOLTAIC ENVIRONMENT

WITH THE PHOTOVOLTAIC- TEST FTV500

Solar energy can be used for electricity production. Photovoltaic solar energy transforms solar radiation into electricity thanks to photovoltaic cells integrated in panels that can be installed on buildings or laid on the ground.

The principle is that some semiconductor materials such as silicon have the property of generating electricity when they receive sunlight: the photovoltaic effect is born.

After the installation of a photovoltaic structure, efficiency and safety are more than important elements. For this reason, it is now necessary to carry out verification tests before-during-after installation.

Sometimes it is difficult to read a data sheet of a photovoltaic module, but it is important to know the current and the power that will be available in order to size the entire project.

But there is one point that has not been defined for a long time, is that it is an electrical installation, and it must also fall within this level of safety.

As such, nowadays, a photovoltaic system must meet the safety criteria of any plant:

- Before connecting it to the mains, an electrical safety check must be carried out.
- A check of its effectiveness shall be made when connecting to the electricity grid.
- Subsequently, an inspection and then a periodic test of electrical installations is required to determine whether this (or part of it) is not damaged, which could endanger the safety of the user, and to check whether the plant complies with current standards.

That check shall also include an examination of the influence of any change in the use of the installation as compared to the application for which it was previously intended. It is also necessary to check the efficiency of the plant as the electricity production must be guaranteed to the standards of the initial project

STANDARDS

EN 61446

THIS STANDARD IS INTENDED FOR GRID-CONNECTED PHOTOVOLTAIC SYSTEM DESIGNERS AND INSTALLERS WHO CAN USE IT AS A MODEL TO PROVIDE EFFECTIVE DOCUMENTATION TO A CUSTOMER. IT SHALL DESCRIBE THE COMMISSIONING TESTS, THE INSPECTION CRITERIA AND THE DOCUMENTATION REQUIRED TO VERIFY THE SAFETY OF THE INSTALLATION AND THE PROPER FUNCTIONING OF THE SYSTEM. ITS LATEST VERSION ALSO DEFINES THE INFORMATION AND DOCUMENTATION TO BE DELIVERED TO A CUSTOMER AFTER THE INSTALLATION OF A GRID-CONNECTED PHOTOVOLTAIC SYSTEM.

EN 61010

THIS STANDARD SPECIFIES THE GENERAL SAFETY REQUIREMENTS FOR ELECTRICAL APPARATUS INTENDED FOR THE PROFESSIONAL, INDUSTRIAL (PROCESS) AND EDUCATIONAL USES OF ALL APPARATUS INVOLVED IN THE MEASUREMENT PROCESS. THIS STANDARD HAS BEEN ESTABLISHED TO DETERMINE THE GENERAL SAFETY STANDARDS FOR MEASURING INSTRUMENTS.

EN 61557

THIS STANDARD DEALS WITH ELECTRICAL SAFETY IN LOW-VOLTAGE DISTRIBUTION NETWORKS OF 1000 V C.A. AND 1500 V C.C. FOR CONTROL, MEASURING OR MONITORING DEVICES FOR PROTECTIVE MEASURES.

EN 61557 PART 2 INSULATION RESISTANCE

THIS CHAPTER OF THE STANDARD DEFINES THE REQUIREMENTS APPLICABLE TO EQUIPMENT FOR MEASURING THE INSULATION RESISTANCE OF EQUIPMENT AND INSTALLATIONS THAT ARE NOT LIVE.

EN 61557 PART 4 RESISTANCE (CONTINUITY) OF EQUIPOTENTIAL GROUND CONNECTIONS

THIS CHAPTER OF THE STANDARD DEFINES THE REQUIREMENTS APPLICABLE TO APPARATUS FOR MEASURING THE STRENGTH OF TRACK-SIDE CONDUCTORS, PROTECTIVE GROUND CONDUCTORS AND EQUIPOTENTIAL CONDUCTORS, INCLUDING THEIR CONNECTIONS AND TERMINALS, WITH INDICATION OF MEASURED VALUES OR LIMITS.

EN 60891

IT DEFINES THE PROCEDURES FOR TEMPERATURE AND RADIATION-RELATED CORRECTIONS TO BE APPLIED TO THE MEASURED I-V (CURRENT-VOLTAGE) CHARACTERISTICS OF PHOTOVOLTAIC DEVICES. IT SHALL ALSO ESTABLISH PROCEDURES FOR DETERMINING THE FACTORS NECESSARY FOR SUCH CORRECTIONS.

EN 60904

IT DESCRIBES THE PROCEDURES FOR MEASURING THE CURRENT-VOLTAGE CHARACTERISTICS OF PHOTOVOLTAIC DEVICES UNDER NATURAL OR SIMULATED SOLAR RADIATION. THESE PROCEDURES ARE APPLICABLE TO INDIVIDUAL SOLAR CELLS, SUBSETS OF SOLAR CELLS OR PHOTOVOLTAIC MODULES.

Measurements

Like any part of an electrical system, photovoltaic production modules must meet basic safety standards.

Continuity

Continuity is good when the plant continuity resistance is less than 2Ω.
All the masses of the installation protected by the same device shall be interconnected with a conductor connected to a ground outlet.
Continuity control must be performed under voltage and specific measuring current (4/ 24 V @ 200 mA).

Isolement

Periodic testing of the insulation resistance is recommended for both electrical materials and installations. In this context, the insulation resistance is measured between each active conductor and the ground (in off mode). The tests are performed with a test voltage of several hundred volts continuously.

The difficulty with a photovoltaic system is that it is impossible to stop the production of electricity. As long as the panel receives light, it produces electricity.

For this test, therefore, it is necessary to use devices that can perform insulation tests under voltage.

The STC conditions (Standard Test Conditions)

The standard test conditions define how photovoltaic modules are examined in the laboratory to determine their electrical properties. These are standard conditions that allow you to compare modules with each other.

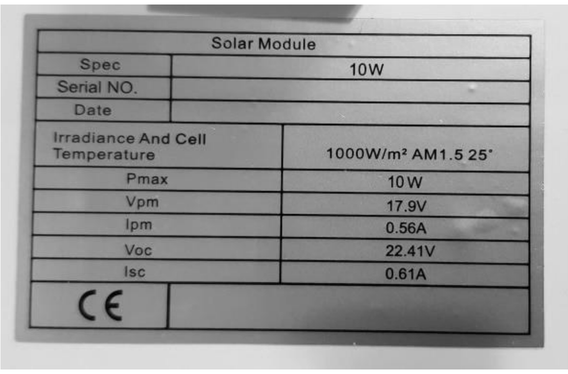
STC conditions include a number of test conditions, including in particular:

- Illuminance level of the module and therefore the amount of energy received on a surface of a solar panel is maximum when the radiation is perpendicular to that surface.
- Temperature of cells: today we know that the effect of temperature on a photovoltaic cell affects the profile of the current-voltage characteristic of the latter. Only a small part of the solar radiation is converted into electricity. The rest remains heat. Thus, a poorly ventilated photovoltaic cell sees its temperature rise very quickly. It is observed that the temperature of the photovoltaic cell induces a noticeable effect on the cell voltage. On the other hand, the effect of temperature on the current of the photovoltaic cell is negligible.
  It seems that the higher the temperature of the cell, the lower the empty voltage of the cell.
- Air Masses coefficient, which corresponds to the optical path of solar radiation through the Earth's atmosphere compared to this path when the Sun is at its zenith. It allows you to quantify the solar spectrum at a certain place after its radiation has passed through the atmosphere.

Module manufacturers always indicate in their product data sheet the general properties such as module size or weight, but above all their theoretical electrical characteristics.
There you will also find the performance (η) of the panel under STC condition (Standard Test Conditions)

The NOCT conditions (Normal Operating Cell Temperature)

NOCT is the abbreviation for Normal Operating Cell Temperature (nominal cell utilization temperature).
In fact, the STC conditions impose an illuminance level of 1000 W/m² and a cell temperature of 25 º C. In fact, the modules cells do not work in these conditions.



The profession introduced cell testing conditions closer to reality.
These are the NOCT conditions:

- Illuminance level: 800 W/m²
- Outside temperature: 20 ºC
- Wind speed: 1 m/s
- Air Masse: AM=1.5

There are no more conditions on cell temperature, but on the surrounding air temperature (20 º C) and wind speed (1 m/s). In these NOCT conditions, which are close to the operating conditions of photovoltaic systems, the cells constituting the photovoltaic modules must be heated and reach a stationary temperature that is called the nominal temperature of use of the cells (Normal Operating Cell Temperature, NOCT).

Efficiency of a cell

The efficiency of a cell or photovoltaic module is the ratio of the electrical energy produced by that cell or module to the light energy received on the corresponding surface. The actual performance therefore varies continuously, mainly depending on the weather (cloudy sails), the shadows that can appear. Today, the smallest controlled unit once the installation is installed is the solar panel, consisting of multiple photovoltaic cells.

Rif :

It is the variation of the resistance of the cell based on the short-circuit current and the no-load voltage

Tilt

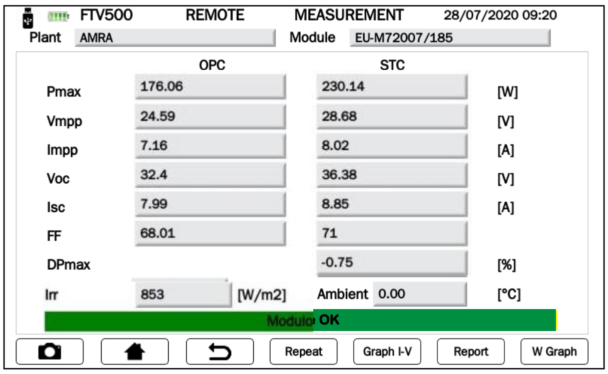
The tilt represents the angle formed by the panel and a horizontal surface. In Europe, we only refer to theory, and the perfect inclination of your future solar panels must be between 30 and 35 Kess. compared to a horizontal line (Near the equator, the sun is above our heads at noon: the ideal is that the panel is laid flat).
But it is mandatory to ensure at the time of testing that the sun is high enough on the horizon line. It is therefore necessary to use an inclinometer.
Azimuth also has its importance during installation.

No-load voltage Voc

This is the voltage at the terminals of the cell when it is in open circuit, that is, when the pole + and the pole - are electrically isolated from any other electrical circuit (the current passing through it is therefore zero).

Short-circuit current Isc

This is the current that passes through the photovoltaic cell when it is short-circuited, that is, when the + pole is connected to the pole - (the voltage at its terminals is therefore zero).
The short-circuit current (Icc) increases proportionally with illuminance, while the no-load voltage (Voc) varies very little.



Power [Wc]

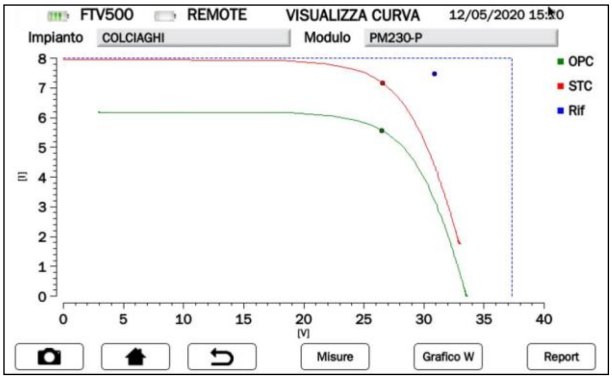
Peak power is defined as the electrical power produced by the cell (or panel) when it is subject to STC conditions. This value is used as a reference to compare photovoltaic panels with each other.
The peak power of a module, known as a Pc, is then defined as the maximum module power under STC conditions.

$$Pc = P_{MPP(STC)} = U_{MPP(STC)} \times I_{MPP(STC)}.$$

The peak power is expressed in Watts (W). However, since it is a little particular power, it is expressed in Watt-Crête (WC).

I-V Courbe

The current-voltage characteristic of a photovoltaic cell is determined by a series of measurements of the voltage and current parameters at its terminals. This allows you to draw a voltage-current curve (I-V). This will then be compared with a curve calculated on the basis of the STC elements.



The power supplied by the cell is the product of current and voltage. The maximum power point is defined by the product of the voltage Vmpp (maximum power voltage) and the current Impp (maximum power current). It will not be the same point where the FV (power-voltage) curve will pass.

The efficiency of the AC/DC inverter

Operation of a photovoltaic system
To produce more power, the cells are mounted to form a module or panel.

- Series connections of multiple cells increase the voltage for the same current.
- The parallel of the cells increases the current while maintaining the voltage.

Temperature effect

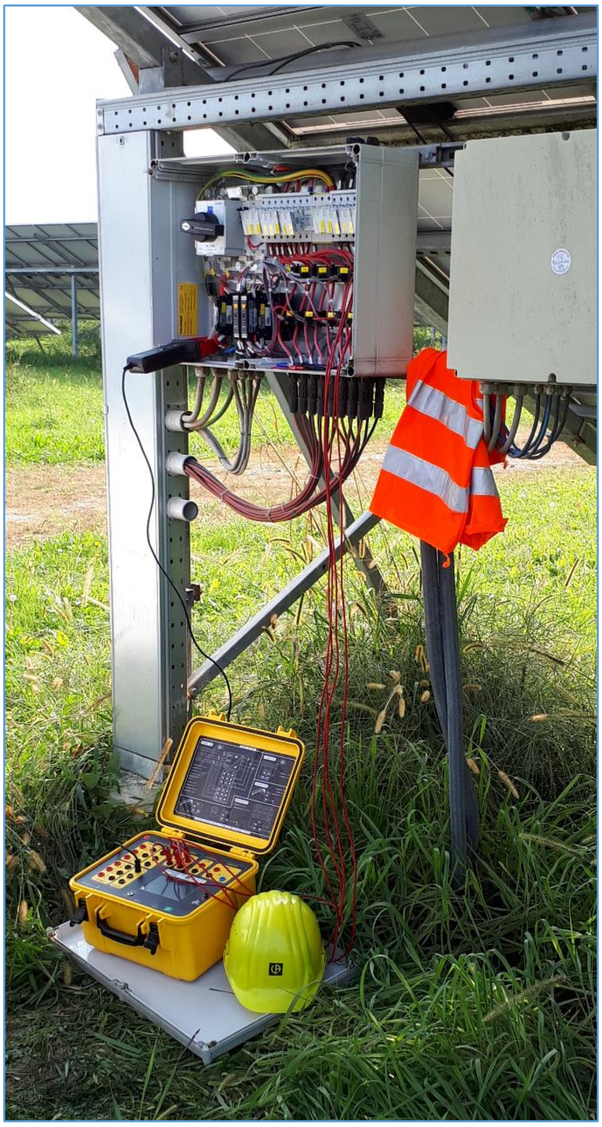
A photovoltaic cell converts radiative energy (radiation) into electricity with a variable efficiency depending on the technology. The rest of the untreated radiation into electricity is converted largely in the form of heat (the residual fraction that is reflected). Thus, a poorly ventilated photovoltaic cell sees its temperature rise very quickly. The temperature of the photovoltaic cell induces a noticeable effect on the voltage. On the other hand, the effect of temperature on the current of the photovoltaic cell is negligible. The higher the temperature of the cell, the lower the empty voltage of the cell and, at the same time, the lower the power of the cell.

The Photovoltaic-Test FTV500
5 mesurememts in 1 instrument

- I-V curve (also with quick test)
- Continuity
- Electrical insulation of the photovoltaic system outside and under voltage
- DC/AC inverter efficiency
- Programmable data logging

Efficiency, maintenance and electrical safety

- Multifunctional tool for controlling the electrical safety and performance of a photovoltaic system.
- Anti-glare screen
- Series of automatic tests:
    - DC/AC system efficiency measurement
    - Test curve I-V
    - Insulation measurement (live installation)
    - Vacuum voltage (Voc) and short circuit current (Isc)
    - Continuity of protection conductors under 200ma
- Management and reporting directly from the device
- Remote unit for measuring temperature and sunlight with WiFi transmission (irradiation/temperature)
- VNC for remote control viewing and sharing
- Compliance with international standards



ITALIA
AMRA SPA
Via Sant'Ambrogio, 23-25
20846 MACHERIO (MB)
Tel.: +39 039 245 75 45
Fax: +39 039 481 561
info@amra-chauvin-arnoux.it
www.chauvin-arnoux.it

CHAUVIN ARNOUX