isofotón

INSTALLATION, USE AND MAINTENANCE MANUAL FOR STANDARD SERIES ISOFOTON PHOTOVOLTAIC MODULES

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1. INTRODUCTION AND GENERAL RECOMMENDATION

ISOFOTON, a pioneering Spanish company and leader in the photovoltaic sector, has been manufacturing cells and modules since its foundation in 1981. Due to years of experience, the use of top-quality materials and exhaustive quality control tests, the photovoltaic modules manufactured by ISOFOTON have a useful life of over 20 years with optimum operation from day one.

Please read all of the instructions presented in this document carefully before installing, connecting or using the photovoltaic module. The recommendations given for a photovoltaic module can be applied to multiple modules.

ISOFOTON does not assume responsibility for loss, breaking, deterioration, or additional costs due to the improper use of the product by persons not connected with the company.

2. TECHNICAL DATA

The photovoltaic modules manufactured by ISOFOTON use pseudosquared cells of high-efficiency monocrystalline silicon to transform energy from solar radiation into electrical energy with continuous current.

The circuit of cells is laminated using E.V.A (ethylene vinyl acetate) as an encapsulant in a set formed by a tempered glass on its front and a plastic polymer (TEDLAR) on the back which provides resistance against environmental agents and electrical insulation.

The laminate is inserted into an anodized aluminium structure. The terminal boxes with IP-65 protection are made using plastics that are resistant to high temperatures and contain the connection terminals and the protection diodes (bypass diodes).

The frame has various holes in order to attach the module to the support structure, and to its ground-mounting if necessary.

Figure 1 shows a schematic diagram of a cross-section of a photovoltaic module.

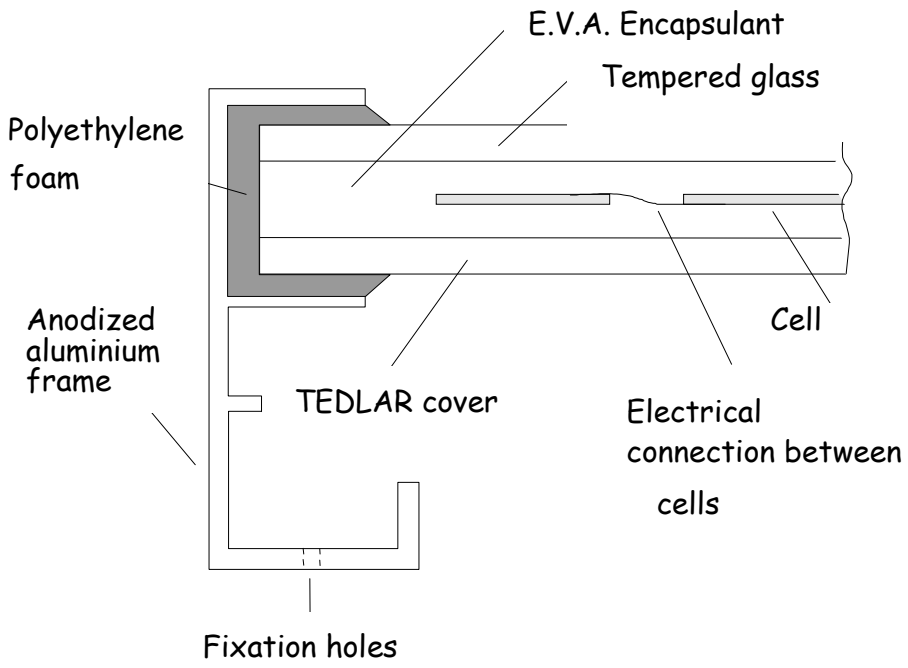

Figure 1 : Cross section of photovoltaic module

The electrical values are obtained under standard conditions of measurement which consist of a radiance of 1000 W/m^2, spectrum of 1.5 M.A. and a cell temperature of 25ºC.

It is true that the real working conditions of the modules, once installed, can be very different from those observed in the laboratory. Therefore, it is beneficial to know the variations that can occur, in order to make the necessary corrections to the calculations.

On the other hand, while the current generated by a photovoltaic module is proportional to the intensity of solar radiation, the voltage varies with cell temperature. Both effects are represented in the following figures:

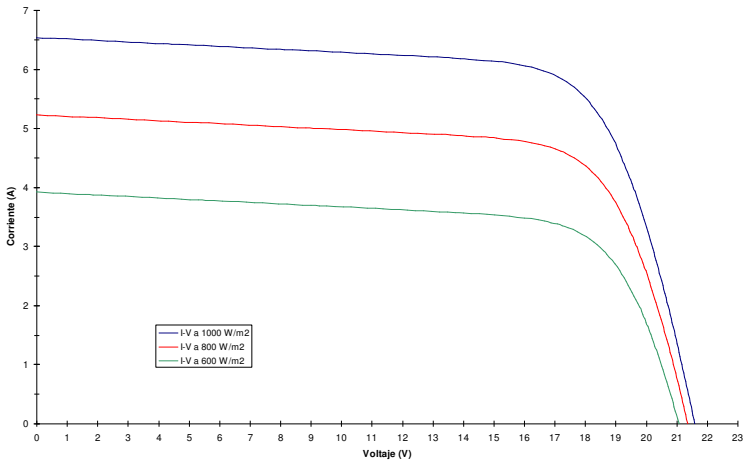

Figure 2- Variation of A-V curve depending on incident solar radiation at constant cell temperature

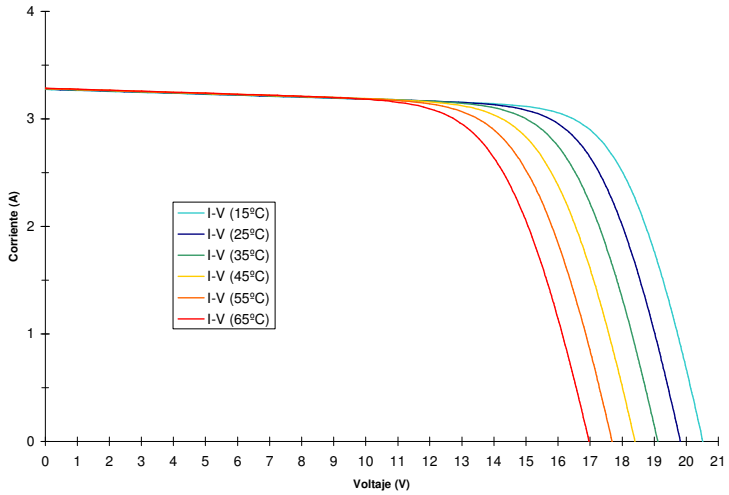

Figure 3-Variation of A-V curve depending on cell temperature at constant incident radiation.

The variation with the temperature of the electrical magnitudes of the modules is the following:

- The voltage decreases at a rate of 2.22 mV/ºC for each cell in series that the module contains and for each degree over 25º C.
- The current increases at a rate of 17μA/cm^2·ºC per area of cells in parallel and each degree over 25º C.

It is necessary to take into account that the cell temperature that has been referred to is not the same as the ambient temperature due to the fact that the cell's temperature increases when sunlight falls on it.

The increase in cell temperature compared to the air temperature depends on the characteristics of the cell and on the construction characteristics of the module itself.

Depending on the incident radiation, the temperature, and the charge that it is supplying, a photovoltaic module can display different current and voltage values.

Figure 4 shows a schematic diagram of a characteristic A-V curve of a photovoltaic module with the power output curve and two different points of work, A and B.

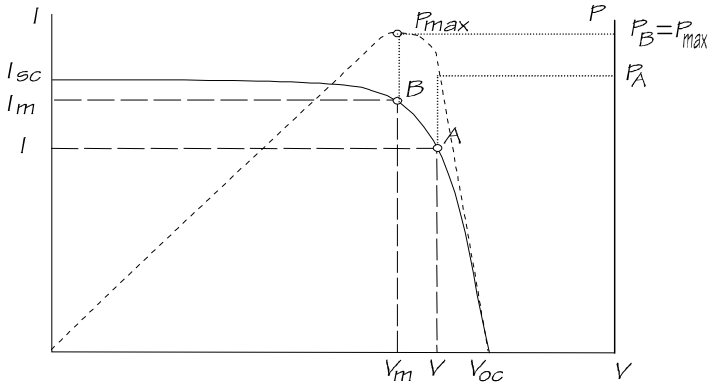

Figure 4 – Characteristic A-V curve and power output curve.

It can be observed that the closer the photovoltaic module works to the voltage of maximum power, the more power it produces.

In summary, depending on the solar radiation, the cell temperature (which, in turn, depends on the ambient temperature, humidity, wind velocity, etc.) and on the equipment to which it is connected, the photovoltaic module will generate a certain current at a certain work voltage, whose product will set the power generated by the module.

On the technical specifications sheet for each module are the characteristic A-V curves depending on the incident radiation and the cell temperature, as well as the physical characteristics of each module.

3. PROTECTION DIODES

The shading of a cell can cause it to have reverse voltage. This cell will therefore consume the power generated by the other cells in the series, producing an undesired heating of the shaded cell.

This effect, called hot spot, will increase with the amount of incident radiation received by the rest of the cells, and decrease that received by the cell due to the shade. In an extreme case the cell could even break from overheating.

The use of protection, or bypass, diodes reduces the risk of heating of the shaded cells, limiting the current that can circulate through them and thereby avoiding breaks.

All modules with 33 or more cells in series manufactured by ISOFOTON are supplied with protection diodes which are located in the junction boxes, as shown in the diagrams included in the next chapter.

In modules with a lower number of cells in series, bypass diodes are not necessary, as the hot spot effect does not reach the level at which cells would break.

4. JUNCTION BOXES

The junction boxes of the modules are located in the back of the modules. As previously shown, these are watertight boxes prepared for severe weather with an IP-65, whenever the watertightness of the grommets or stuffing boxes is respected when passing the cables through them. ISOFOTON is not responsible for the improper installation of the cable (in the case of modules supplied without cable).

In each module there is one junction box for both terminals or one box for the positive terminal and another one for the negative terminal. The polarity should be respected in the connections to ensure the correct operation of the modules.

The covers to the junction boxes have an indicative diagram. They can be opened by inserting a flat screwdriver into the rim, in the direction indicated by the arrow, applying light pressure in order to open it. To close the cover, it is sufficient to press the cover until it closes. The cover has a flange which supports the base of the junction box while the inside is being worked with. This flange should not be cut.

The junction boxes should not be subjected to any type of pressure when installing the module onto its support structure. No part of the support structure should touch the junction box.

Figure 5 shows junction box model supplied with product ranges ISF-30/12 IS-36/12, IS-75/12, ISF-60/12, IS-150/12(two junction boxes, positive and negative) and ISF-120/12.

Figure 6 shows junction box model supplied with product range: IS-150/24, IS-200/32 e ISF-180/18.

Junction boxes showed in figure 6, and figure 5 for product range IS-150/12, are supplied with cables of 100 cm length, with positive and negative connectors.

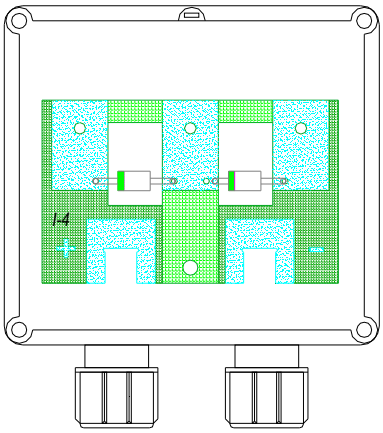

Figura 5. Junction box for product ranges: ISF-30/12, IS-36/12, IS-75/12, IS-150/12, ISF-60/12 e ISF-120/12. Diode circuit for IS-150/12 does not correspond with the one showed in figure.

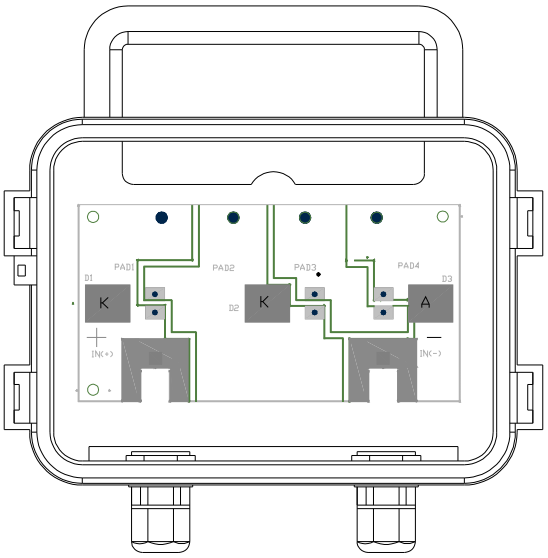

Figura 6. Junction box for product ranges IS-150/24, IS-200/32 e ISF-180/18 (diode circuit depend on product range, the one showed is corresponding to range ISF-180/18)

5. RECOMMENDATIONS FOR USE

- Place the module in a location that never has shade. Pay attention to nearby trees and buildings. Remember that the sun changes position during the year and that trees grow.
- Orient the module correctly. The front of the module should face south in the northern hemisphere and face north in the southern hemisphere.
- The module should be installed in such a manner that the air can circulate around it freely, thereby decreasing the work temperature of the cells and consequently, improving the module's performance.
- If various modules are set up, avoid them casting shadows on eachother.
- If there is a charge controller being used, place it in an easily accessible location so that the user can check the control parts. At the time of connection, all electrical polarities should be respected, connecting them in the following order: battery, modules, and consumption.
- The section of conductors used should ensure that the drop in voltage of the installation does not surpass 2% of its nominal voltage.
- The connection of modules to other modules will be done in the air using the provided cables with connectors.
- Install the module on the support structure using specific screws. Recommended 6x20 meters. The module frame should not be pierced. The height measurements of the modules can be found on their technical data sheets.
- For more information about the connection cables and diodes consult the module's technical specifications sheet.

6. WARNINGS AND ELECTRICAL RISKS

- The equipment should be installed and operated by a qualified person.
- ISOFOTON modules are sent in boxes that are specially designed to provide the proper protection during shipping. It is advised to not remove the modules from the boxes until installation.
- Never leave a module in a place in which it is not properly supported; if it falls the glass can break. A module with broken glass can not be used.
- Do not allow modules to fall or throw objects at them. Do not stand or walk on them.
- Use the module only for its meant purpose. Do not take the module apart or remove any part, label or piece installed by the manufacturer, including the protection diodes, without prior authorization from the manufacturer.
- If using a protection fuse in the installation, follow the instructions on the technical specifications sheet attached.
- Do not concentrate light onto the module.
- A photovoltaic module generates electricity when it is exposed to sunlight or to other sources of light. Completely cover the surface of the module with an opaque material during the installation, disassembly, or handling.

- Use tools that are properly coated with insulating material when working with the module.
- Always work in dry conditions, for both the module and the tools.
- Do not install the module where there are gases or flammable vapours, as they can create sparks.
- Avoid electrical discharges when installing, cabling, starting-up, or performing maintenance on the module.
- Do not touch the terminals while the module is exposed to light. Provide the installation with appropriate protection devices to avoid the production of a discharge of 30 or more volts of continuous current to people. When the modules are connected in series, the voltages are added together and when they are connected in parallel, the intensities are added together. This is a system made up of photovoltaic modules that can produce high voltages and intensities, which produces an additional danger.
- If batteries are used with the modules, follow all recommendations indicated by the battery manufacturer for safety.
- In normal conditions, a photovoltaic module is susceptible to conditions that produce more current and/or voltage than those indicated under standard conditions. Therefore, the Isc and Voc values shown on the label of characteristics of the module should be multiplied by a factor of 1.25 to determine the maximum admissible values of the components of the installation, with respect to voltage, current, sections of the conductors, fuses, and size of the controls connected to the exit of the photovoltaic generator.
- If installing on a roof, ensure that the module is attached with a mechanical fastening. The roof should have an adequate level of fire-resistance for the application.
- Isofoton modules are supplied with cables with the characteristics indicated on the technical specifications sheet for each module, with a work temperature range of between at least -40 y 90 ºC.
- Fix the conductor to the corresponding hole (figure 7) into the frame using a mechanical fastening system such as nuts and bolts (not provided)

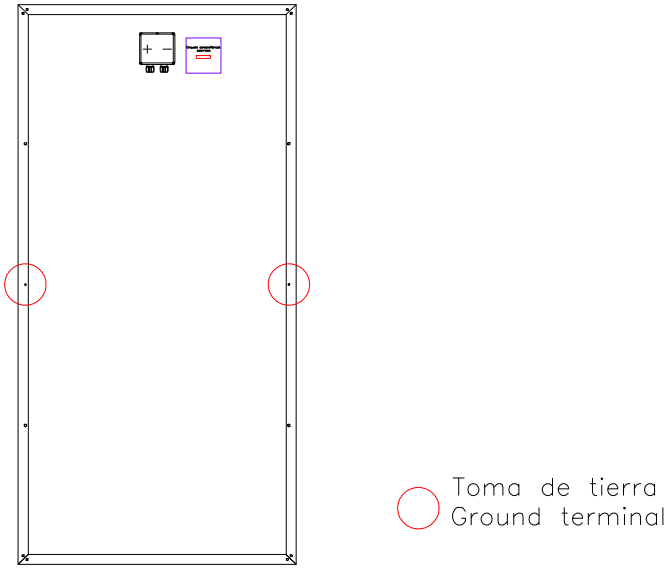

Figure 7 Placement of ground terminal

7. CONNECTION LIMIT OF MODULES IN SERIES

Isofoton's photovoltaic modules are manufactured to support high voltages. The maximum voltage of the system is indicated on the label of the module's characteristics. Therefore, modules can be connected in series until that voltage is reached.

8. CONNECTION OF MODULES IN PARALLEL AND WIRING SECTION

The number of modules in parallel to be used can be as many as allowed by the charge controller, frequency variator, or the corresponding equipment to which the modules are connected.

A cable with an adequate section for the conduction of the total current generated by the modules should be used.

In all cases, the conductor to be used should never be a section less than 4 mm^2. Should a larger section be needed to transport the energy to the corresponding equipment, external junction boxes should be used which will allow for longer cable sections for longer distances.

9. MAINTENANCE OF PHOTOVOLTAIC GENERATOR

Photovoltaic modules require very little maintenance with respect to their configuration, except for parts and the interior circuits of the cells and the connection weldings insulated by layers of protective material. At the same time, ISOFOTON's quality control is thorough and therefore, problems occur very infrequently.

Maintenance covers the following processes:

- Periodic cleaning of the module.
- Visual inspection of possible internal deterioration of the water-tightness of the module.
- Control of the state of the electrical connections and wiring.
- Eventually, control of the electrical characteristics of the module.

Periodic cleaning of the module

The dirt accumulated on the transparent cover of the module reduces its performance and can produce reverse effects similar to those produced by shading. The problem can become serious in the case of industrial waste or waste caused by birds. The intensity of the effects depends on the opaqueness of the residue. The layers of dust that reduce the intensity of the sun are not dangerous and the reduction in power is not usually very significant. The regular recurrence of the cleaning process depends, logically, on the intensity of the process.

It is best to avoid bird waste by installing small elastic antennae on the highest part of the module, which impede the birds from resting there.

Rainfall can help in many cases to reduce or eliminate the need to clean the modules.

The cleaning in general should be done by the user of the module and consists of washing the modules with water and a non-abrasive detergent, always trying to avoid the accumulation of the water on the module. It is not advisable to use pressure hoses under any circumstances.

Visual inspection of the module.

The visual inspection is meant to detect possible failures, specifically:

- Possible breaks in the glass.
- Rust on the circuits and welding of the photovoltaic cells: they are normally due to humidity entering the module through breaks in the encapsulation layers occurring during the installation or transportation.

Connection and wiring controls

Perform preventative maintenance every 6 months, including the following operations:

- Check the fastening and state of the module's terminals of the connection cables.
- Check the water-tightness of the terminal box.

Should water-tightness failures be observed, the affected components should be replaced and the terminals should be cleaned. It is important to take care of the terminal box seal, using new clamps or a silicon seal.

10. POSSIBLE FAILURES

Due to the exhaustive quality testing that the photovoltaic modules undergo before being sold to the public, failures occur very infrequently.

However, the following scenarios can happen, due to causes not related to the manufacturing process:

- Breaks in the module glass.
- Penetration of water into the interior of the module and resulting rust of the interior circuit of the cells and connection weldings.
- Failures in the connections and entrance of water into the module's connection terminals.
- Dust or partial shading.

Breaks in the glass

Breaks in the glass are usually caused by outside actions, improper installation, hits, impacts with stones, etc. Some cases of damage during transportation have also been detected.

Breaks in the glass, as it is tempered, always result in a complete splintering of the surface, with the location of the impact perfectly visible. The splintering reduces the performance by approximately some 30%, but the module can continue to be used, although it would be advisable to change it as soon as possible to ensure the operation of the installation.

Humidity on in the interior of the module

Although this failure is not common, it can be caused by external impacts, scratches on the back TEDLAR by external aggressions. When humidity penetrates deep enough to reach the circuit of the cells and its connections, corrosions appear which reduce and even break the electrical contact between the electrodes and the cell material, impeding the collection of electrons and making the module useless in this sense. The voltage and intensity fall to zero and the module should be replaced immediately.

It should be indicated that, as this failure results in the complete lack of function of the module, when serious problems are detected in a revision or check, it is advisable to replace the module at that time, to avoid the costs of another visit.

Failures in the connections of modules

Due to the thermal differences between, for example, day and night, the module's wiring connectors can come loose. Therefore, it is necessary to check the connections, tightening them periodically (once every six months), if necessary.

During the installation, the water-tightness of the junction boxes through the grommets should be verified. Should water entering the junction box be detected, the presence of water in the contacts causes voltage drops in the circuit, and consequently, a reduction in power output. The repair consists of cleaning the terminals or connection terminals and changing the clamp of the junction box or grommet, if one of them is found to be defective. Sprays for terminals used electronically or silicon seals are also useful.

Shading effect

The shading or hot spot effect is caused by precise shading on one or various cells of the module while the rest receive high radiation. This situation should be fixed by eliminating the cause of the shading.

To avoid deterioration of the cells, it is advisable to use the protection diodes described in Chapter 3.

Manufacturing defects

Manufacturing defects, should they appear, appear during the first few days of operation and are very infrequent, less that one in on thousand, due to the exhaustive quality control performed at the ISOFOTON factory. Should one be detected, ISOFOTON will provide a new replacement module, as stated in the product's guarantee.

11. CERTIFICATES

The following certificates correspond to the modules:

- ISO 9001:2000 Quality Certificate of ISOFOTON.
- ISO 14001:2004 Environmental Certificate of ISOFOTON.
- Certificates of compliance, IEC 61215 edition 2, for photovoltaic modules manufactured by ISOFOTON, granted by the test laboratory internationally recognized by TÜV.
- The photovoltaic modules manufactured by ISOFOTON are approved by the electrical security Standard IEC61730 certified for application class A, and comply with the requirements for security class II awarded by the same laboratory.