

E-1500 | E-1000

Smart I-V curve tracer
Entec Solar

Quick Guide

V1.2



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1. Important security information



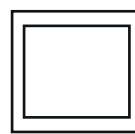
IMPORTANT: Entec Solar does not take any responsibility on the damage to the device or people due to an incorrect usage of the devices. It is responsibility of the user to follow all the indications stated on the manual to make a proper use of the devices.

- Read and keep the manual and follow all the instructions stated on it.
- Use the device only on solar photovoltaic installations.
- Make use of the Personal Protection Equipment (PPE) recommended for electrical measurements as well as the connection and disconnection of the electrical circuit under test.
- Disconnect the photovoltaic circuit under test from any other circuit, p.e. invertir, combiner box, grounding and other string on parallel before connecting the I-V curve tracer.
- Make sure that the photovoltaic circuit does not surpass the technical limit of the device used. In the case of E-1000, the limits are 1000V and 20A.
- Never disconnect the measurement wires while performing a measurement.
- Do not perform measurements under moisture conditions or under the rain. Make sure that no liquid enters inside the device.
- Do not perform measurements under the presence of gas, explosives or dust in the environment.
- Protect the wires from the power and measurement, from the damage and pressure.
- Use the product only with the products and accessories provided or allowed by the manufacturer.

- In order to improve the quality of the measurements, use the I-V curve tracer only with the battery. This means, not connected to the power charging cable.
- Under no conditions open the case of the device. If you do it the warranty will immediatly void. Dangerous voltajes may still be present in the equipment even after disconnecting to the test circuit.
- In order to perform any maintenance operation on the device, make contact with the technical support of Entec Solar.

1.1. Symbols used

- **Double electrical isolation** (class of protection II).



- **Attention danger! Pay attention to the documentation!**
This symbol appears in front of the instructions that need special attention to avoid damage to materials or people.



- **Keep in mind all the documentation attached to the measuring device.**



- **Attention, high voltaje, danger of death.**



- **Measurment devices can not be treated as wasted, they have to be eliminated as electronics**



2. Technical specifications

Specifications E-1500

Input voltage range	0-1500 V
Input current range	0.1-20A (up to 35A optional)
Operating temperature	-10 a +65 °C

Specifications E-1000

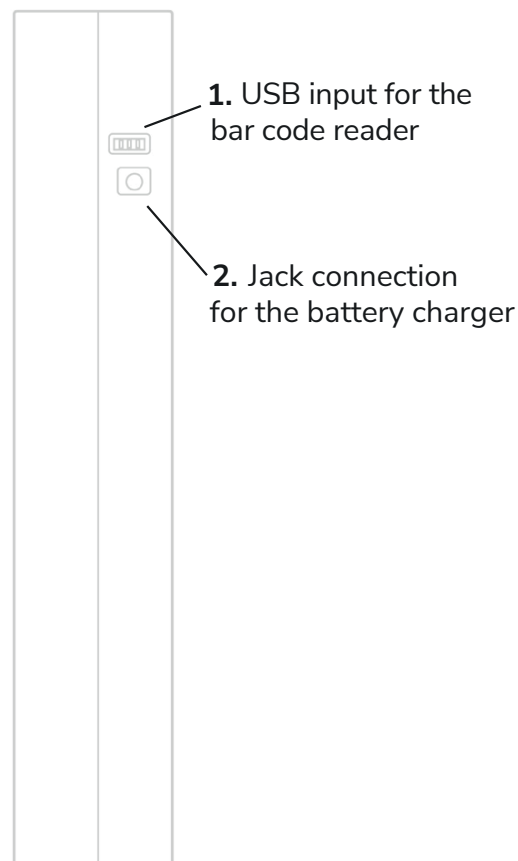
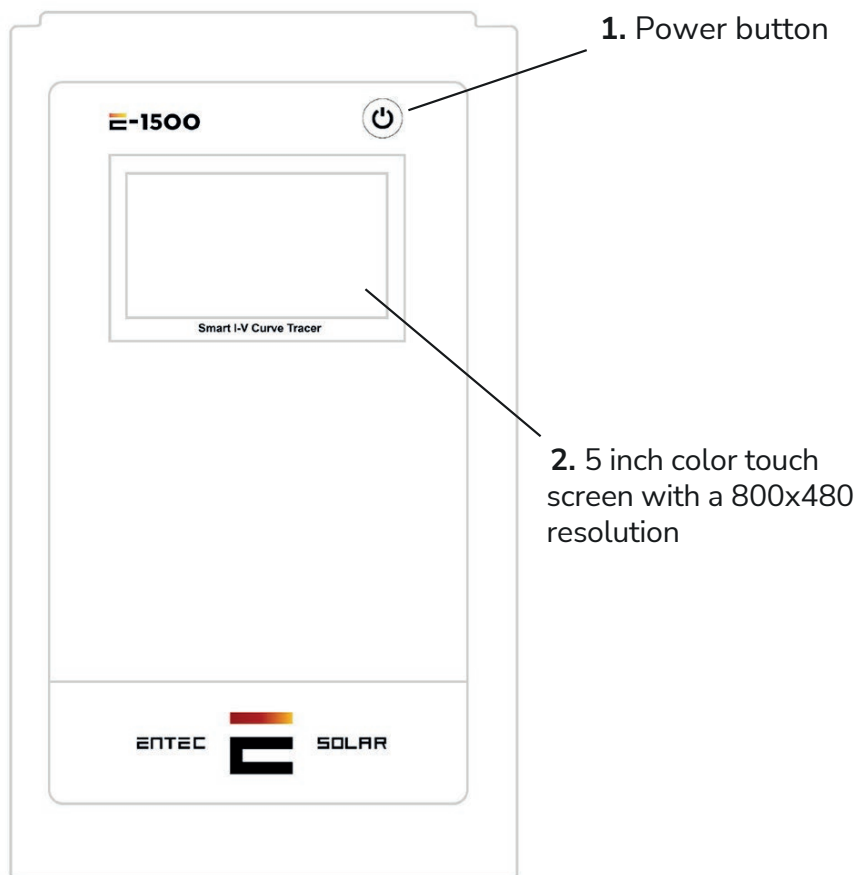
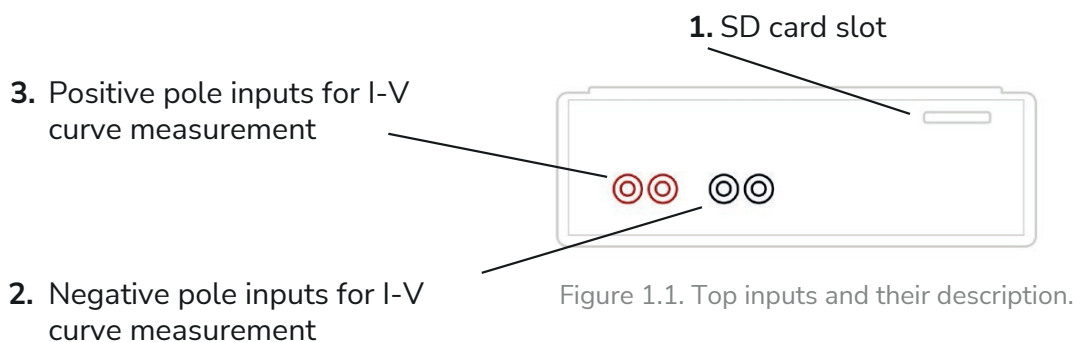
Input voltage range	0-1000 V
Input current range	0.1-20 A
Operating temperature	-10 a +65 °C

Specifications E-Sens

Voltage Inputs	Channel for measuring solar radiation MAX 2V
Temperature Inputs	1 x PT-1000 reference cell 3 x PT-1000
Operating temperature	-10 a +65 °C

3. External connectors and parts description

E-1500



! ATTENTION: Do not expose the device to direct sunlight for long periods of time

E-1000

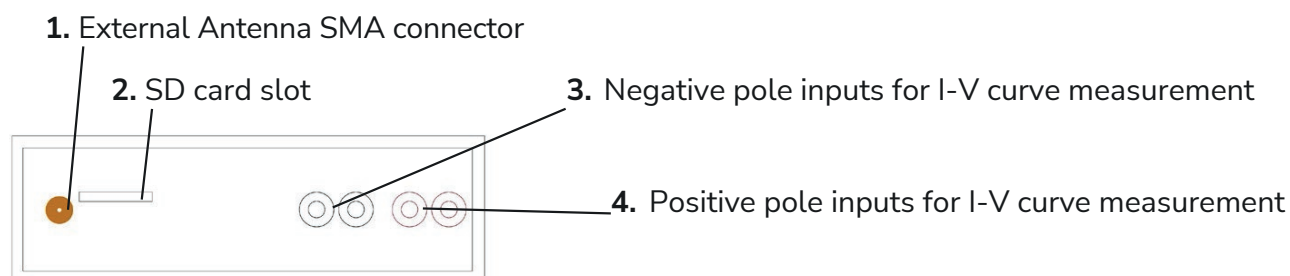


Figure 2.1. Top inputs and their description.

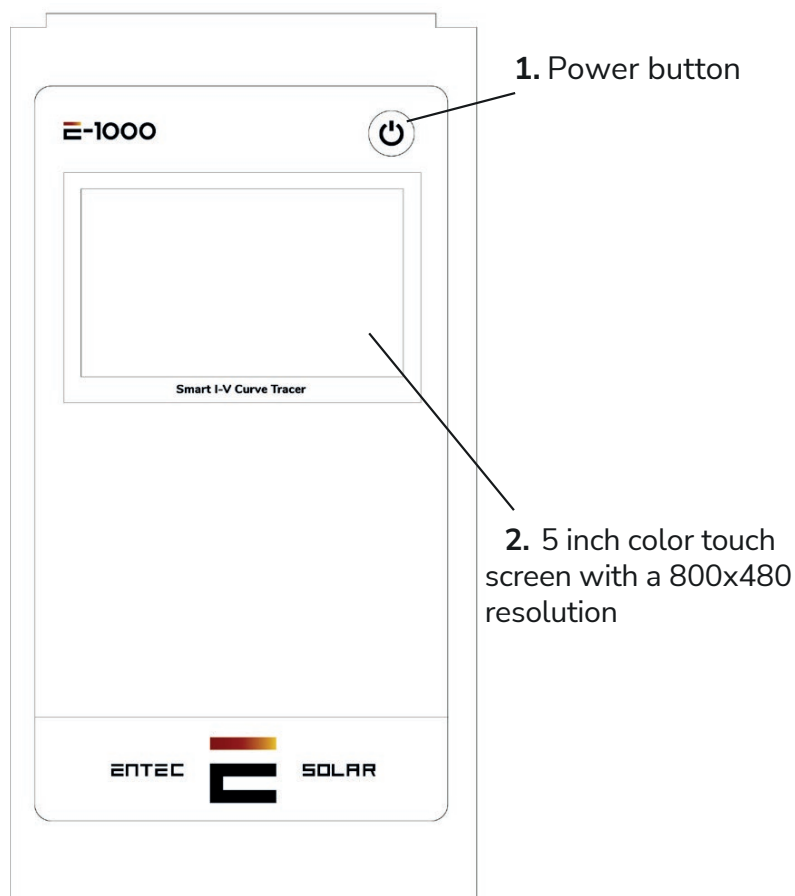


Figure 2.2. Frontal inputs and their description

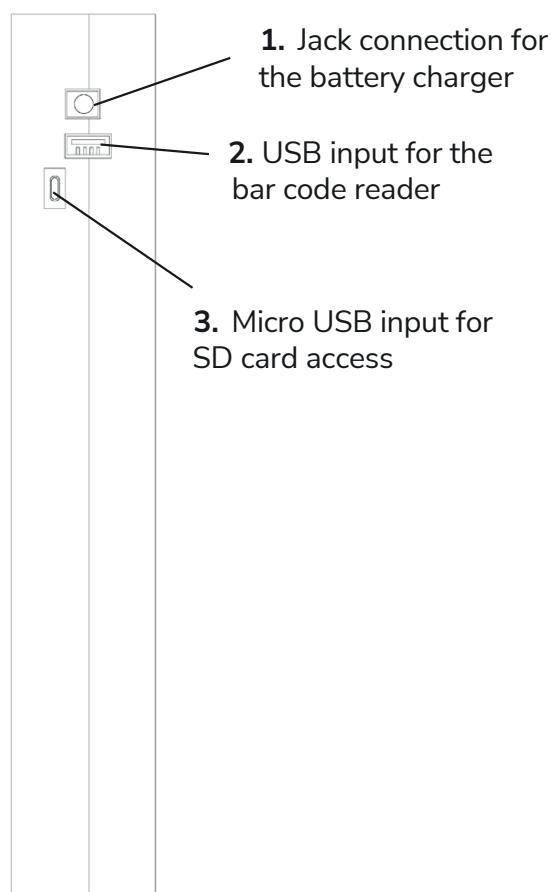


Figure 2.3. Lateral inputs and their description



ATTENTION: Do not expose the device to direct sunlight for long periods of time

E-Sens

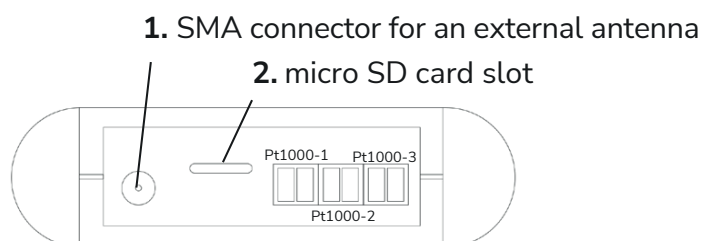


Figure 3.1. Top inputs and their description

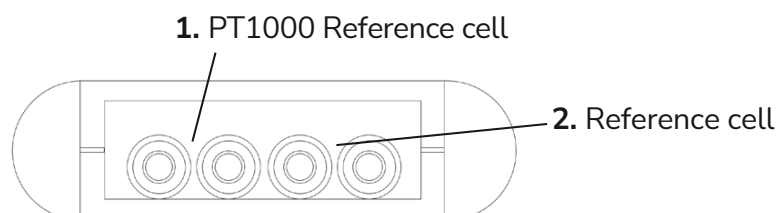


Figure 3.2. Shows bottom inputs and their description

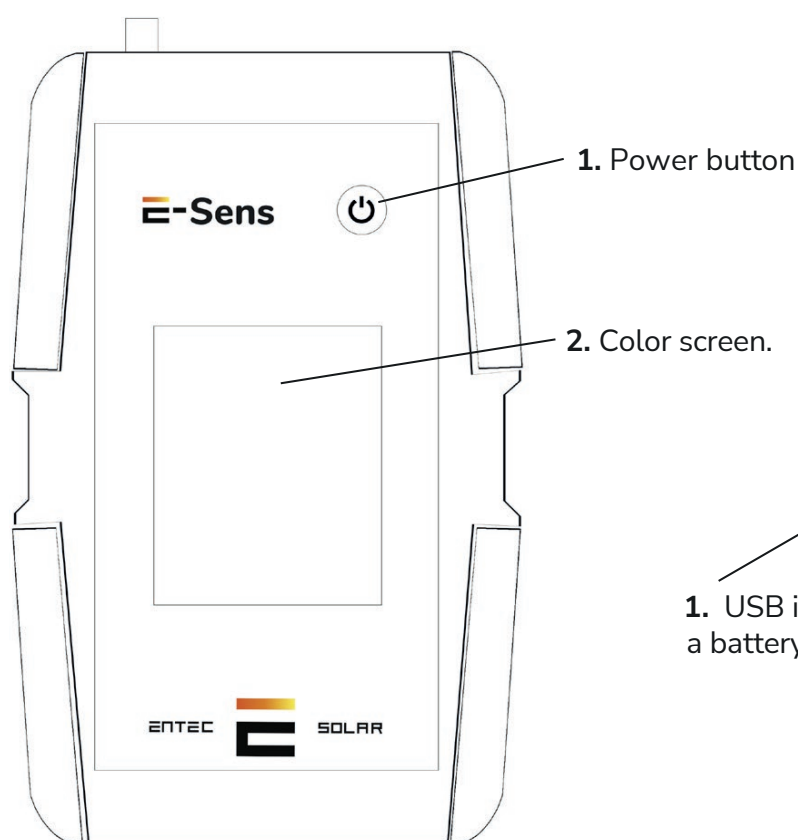


Figure 3.3. Frontal inputs and their description

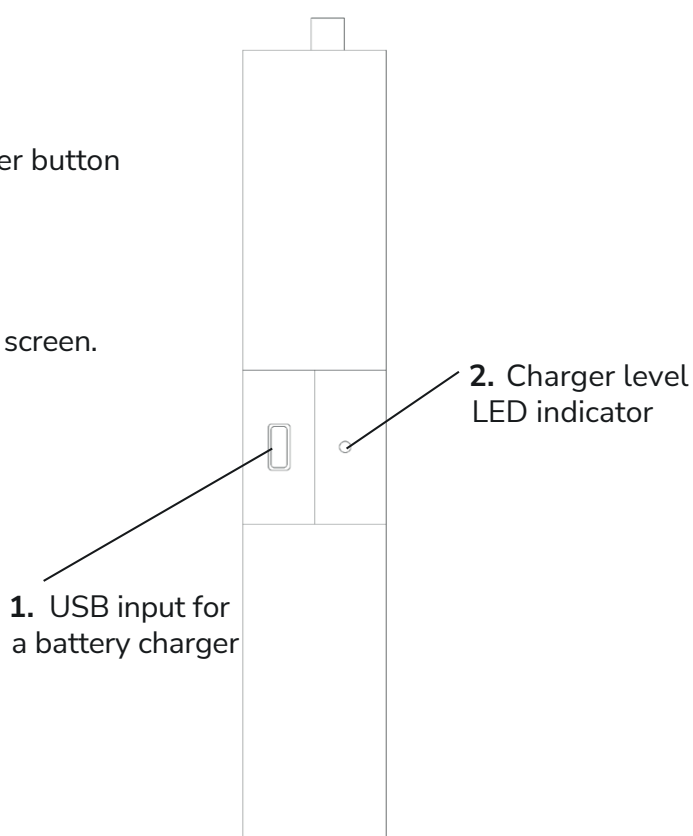


Figure 3.4. Lateral inputs and their description



ATTENTION: Do not expose the device to direct sunlight for long periods of time

4. General recommendations



The interface of the E-1500 / E-1000 is designed based on rectangles as buttons.

You may press the desired button to use the associated function.

There are functions, like for example "Autosave", that when they are pressed they change the background to the red color. This means that the function is active. Press on it again to disable it and the color will change to blue.


When numbers are introduced to set up a parameter, all the gaps must be filled, even if the value of them are zero.


5. Quick Start Guide

5.1. Pre-Measurement Setup

It is strongly recommended to read the entire manual before proceeding with this guide and consult the corresponding section in case of any doubts.

1. Turn on the equipment.
2. Check the battery level of the equipment and ensure that the SD cards are inserted. (Section 4.2 and 4.3).
3. If you are going to perform measurements on bifacial modules or strings, activate the bifacial measurement button. Settings -> Bifacial Measurement (Section 5.5.1).
4. Set the equipment's time to the local time and synchronize it with the E-Sens. To do this, go to Settings -> Others -> Set Time/Date (Section 5.5.11A).

 **IMPORTANT:** Before starting a new measurement campaign, make sure that the values configured in this section match those of the circuit under test.

 **IMPORTANT:** It is necessary to enter values in all fields, even if they are zeros to the left or right of the decimal point.

5. Configure the characteristics of the module under test (VOC, ISC, VM, IM, α , β , and NS). Settings -> Module Settings (Section 5.5.4). And save the values in a memory slot for modules (Section 5.5.2).
6. Configure the generator's characteristics (number of modules in series and parallel). Settings -> Generator Settings (Section 5.5.5).
7. Verify the calibration of the irradiance sensor (reference cell) Settings -> Sensor Settings (Section 5.5.2).
8. Select E-Temp or Pt1000 based on the temperature sensor you want to use. This can be done either from the main screen or from the sensor settings screen (Section 5.5.2).
9. Configure tolerance values for Isc, Voc, and Pm. Settings -> Others -> Measurement Tolerance (5.5.3.C).

10. Select the file name for data storage. (Section 5.2.2.E)
11. Select and configure measurement options (manual measurement, auto-measurement, or continuous measurement). (Sections 5.5.7 and 5.5.9)
12. Choose the saving options (manual saving or auto-saving). (Section 5.5.8)

5.2. Measurement Procedure

1. Disconnect the test circuit from any other elements to which it may be connected.
2. Place the radiation and temperature sensors in a representative location of the circuit under test, ensuring that the cell is installed coplanar to it and does not cast a shadow on any part of it. For bifacial measurements, place the bifacial reference cell coplanar to the modules and pointing in the rearward direction.
3. Connect the reference cell, as well as all PT1000 sensors, to their respective channels on the E-Sens. For bifacial measurements, connect both cells and their respective PT1000 connectors following the color code.
4. Connect the four-point cable supplied to the I-V curve tracer with the banana plugs and to the circuit under test with the MC-4 connector. If you need to measure directly from a bus-bar, you can use crocodile terminals.
5. If you are going to use the E-Temp, turn it on before taking the measurement.
6. If you are going to use a barcode reader, connect it.
7. Insert the SD card into the equipment.
8. Turn on the equipment.
9. Verify that the curve tracer receives a signal from the E-Sens.
10. Perform the curve measurement.
11. Perform the measurement with the E-Temp or barcode reader if applicable.
12. Verify that the data is consistent.
13. Save the data on the SD card.

! IMPORTANT: Incorrectly connecting the positive and negative poles of the circuit under test to the E-1500 / E-1000 can cause irreparable damage to the equipment. The color red represents the positive pole, and the color black represents the negative pole.

! WARNING: There is a risk of electric shock during these maneuvers. The necessary personal protective equipment (PPE) should be used to minimize this risk, and the established sequence for disconnecting the circuit under test from the rest of the elements must be followed.

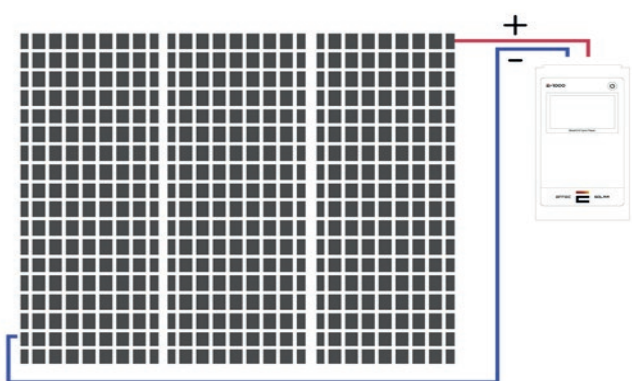


Figura 4. Connection of the circuit under test to E-1000.

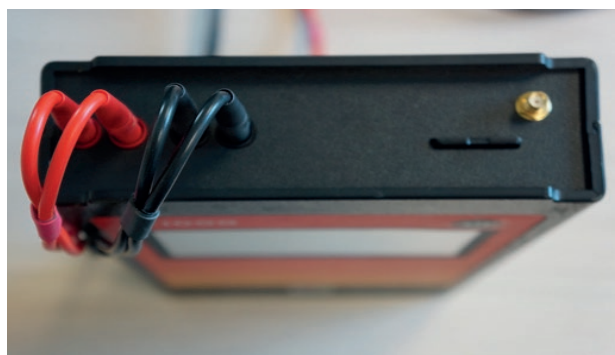


Figura 5. Correct Connection E-1000.

5.3. Recommendations for Measurements

- Conduct measurements during periods of clear sky and low wind.
- Ensure coplanarity and proximity between the radiation and temperature sensors and the circuit under test.
- Measure the temperature at different points of the circuit under test.
- Perform measurements with a radiation level between 800 and 1200 W/m², never below 600 W/m².
- Avoid a solar incidence angle greater than 40°.
- When measuring the temperature of module strings, it is recommended to take the temperature of at least three modules in the string. One module near the end of the string and two modules in the center of the string. It is also recommended to measure the points indicated in the following image:

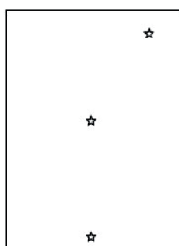


Figura 6. Temperature Measurement Points.

5.4. E-Temp Usage Recommendations

Entec Solar recommends using the E-Temp for the temperature measurement of modules quickly and reliably.

To turn on the E-Temp, briefly press the power button once and wait for a couple of seconds until the startup screen is displayed. Similarly, to turn off the equipment, you should hold down the same button for 5 seconds.



IMPORTANT: During startup, it is important not to press the button repeatedly or for an extended period, as this can turn off the equipment.

Once on the standby screen, you can take measurements by pressing the central button of the equipment once. When measuring an i-V curve, if you have configured the equipment to use the E-Temp (See Section 5.5.6.B), the curve tracer will emit a beep, and a message will appear on the curve tracer's screen indicating that it is waiting for the E-Temp measurement. This is when you should perform the measurement with it. During the measurement, the data will be displayed on the screen for approximately five seconds. After this period, the equipment returns to standby mode.

Please note that the same button is used to turn on the equipment, measure, and turn it off, so you must be careful when pressing it. It is important not to press the button multiple times in succession or hold it down for an extended period.

6. Configuration and Measurement of Bifacial Curves

To perform bifacial measurements, it is necessary to have a curve tracer with this option enabled, as well as the associated material. (See Section 6 of the Manual).

Required Material:

- Bifacial option enabled on the equipment.
- E-Sens with the capability to connect multiple calibrated cells.
- Calibrated cells for bifacial measurements.

Assembly and Connection:

During the assembly, both cells must be placed coplanar to the surface of the photovoltaic modules, and both cells should be connected to the E-Sens and positioned appropriately. The monofacial cell should face the sun, and the bifacial cell should face the backside of the module.

Connect the banana plugs according to their corresponding color code.



Figure 7: Colored connectors.

Connect the green connectors to measure the temperature of the calibrated cells. The front irradiance cell should be connected to Pt1000-3, and the albedo or rear irradiance cell should be connected to Pt1000-1.

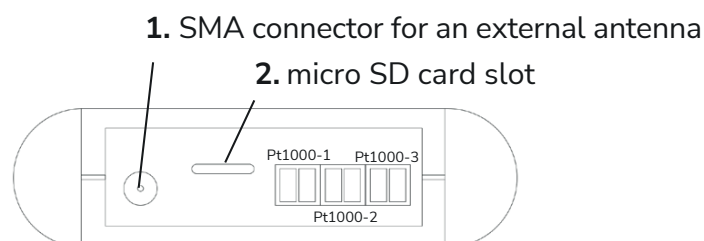


Figure 8: Top inputs and their description

Entec Solar recommends using the E-Temp to measure the module temperature during bifacial measurements, as this will prevent shading during the I-V curve measurements.

Operatilonal Procedure:

Configure the values of the calibrated cells in the Settings -> Sensor Settings section, both for the monofacial and bifacial cells.

Once the assembly and equipment configuration are completed, the operating procedure for measuring the curves is the same as for monofacial curves.

However, there are some particularities, such as the irradiance displayed on the equipment's main screen, which will be the sum of the front and rear irradiance considering the bifaciality factor (BF). Also, the extrapolation of the curve to STC is performed using the total irradiance.


For more details on the calculations performed in the bifacial measurement and the additional information added in the curve files, please refer to [Section 6.3](#) of the Manual.

7. APK Connect Measuring

The I-V Curve Tracer E-1500, as well as the E-1000, have their respective mobile or tablet Apps that allow remote control of the equipment. This enables the operator to transport the equipment in a backpack or case and have hands-free operation for connecting and disconnecting the circuit under test. The connection between the E-1500 / E-1000 and the App is done through a WiFi-Direct connection, and it is necessary for the mobile phone or tablet to have a WiFi connection, although it does not require internet access.

To use the APK, follow these steps (see Section 8 of the Manual):

1. Download and install the E-1000 or E-1500 app from the Android Play Store.
2. Turn on the WiFi adapter of your phone.
3. Connect your mobile phone to the equipment's WiFi network using the password "carga1234."
4. You may see a message on Android. Click on "Maintain the connection to the current WiFi network."
5. Open the downloaded app from the Play Store and allow access to GPS location.
6. If the app does not display a successful connection message or the second hand does not progress, click on "Settings" -> "Connect" to restart the connection.

 **IMPORTANT:** The remote device's App can only perform functions from the main screen, and no menu configuration settings can be carried out. (Figure 5.8). All necessary adjustments must be configured on the E-1500 / E-1000 before establishing a connection with the remote device.

8. Field report creation



At the end of the day, after finishing measuring, it is recommended to generate a report with all the measurements performed that day.

The report is generated as a '.csv' file and includes the most important values of the measured curves.

To generate a daily report, you may follow these steps:

1. Make sure that all the curves are on the SD card, and that the card is properly inserted into the device.
2. Inside the Settings menu, press "Report generation"
3. Select the date you wish to create the report.
4. Press the generate button and wait for it to be generated. Once it is done, it will be automatically saved to the SD card.

9. I-V Curve App



The I-V Curve Tracer has a web application for automatic processing of measured I-V curves. This software tool operates in the cloud within the PVET platform, developed by QPV.

The application allows generating a report that includes statistical analysis, numerical summary, and visualization of the curves, all within the same PDF report with the option to generate only desired parts.


To do this, it is necessary to create the plant in the application, add the characteristics of the photovoltaic module of the plant, upload the curves, and generate and upload the Rosetta file. Subsequently, the application will process the data, and you can download the report.

For detailed information on the process, please refer to Section 9 of the Manual.

10. Download data to the PC

In order to obtain the measurement data extracting the SD card of the device follow these steps:

1. Make sure the device is turned off.

 **IMPORTANT:** The extraction of the SD card with the device turned on, may cause irreversible damage to the card and permanent loss of the data.

2. Push lightly the SD card to the inside of the device until you hear *click*. In the case of the E-Sens it is necessary to use an object that allows to push it to the inside of the device.
3. Release the pressure and wait for the card to slide out of the slot.
4. Extract the card from the device.
5. Insert the card inside a card reader on your laptop or PC or use a USB card reader.
6. The Pc will detect the inserted card automatically.
7. Open the file explorer on your PC and search the SD card directory.
8. Copy the files from the card directory to your desired folder on your computer.
9. Open the files with a spreadsheet program like Excel.

11. Common errors and solutions

1. Booting your device displays the message "SD card error":
 - a. Make sure there is an SD card inserted into the device slot.
 - b. If the SD card is absent, turn off the device, insert an SD card and restart the device.
 - c. If the error message persists once the card is inserted, try another SD card.
 - d. If the message persists, contact the technical d. service.
2. The radiation value shown in the E1500 / E-1000 device is not correcto or it is not showing anything.
 - a. Make sure that there is communication between E-Sens and the E-1500 / E-1000. For a proper communication the colour shown in the background of the radiation has to be yellow or green.
 - b. Check that the sensor configuration is properly set up. Select Settings -> Sensor Settings, and check that the values of Isc and Alpha are correct. If not, modify them.
 - c. If there is no communication, shut down and turn on the device. It may also be an issue with the distance. Check again with both devices close together and make sure the antennas are installed properly.
 - d. It may also be the case that several E-Sens and E-1500 / E-1000 are working together in the same place. This may result in noise between the communications. As a result, you should only use one E-Sens, despite working with several I-V curve tracers at the same time.
 - e. In the situation that the error still persists, please contact with the technical service.

3. The value of the temperatura shown is not correct.

- a. Make sure that there is communication between E-Sens and the E-1500 / E-1000. For a proper communication the colour shown in the background of the radiation has to be yellow or green.
- b. Check that the sensor configuration is properly set up. Select Settings -> Sensor Settings, and check that the temperature mode selected is the one you actually use (PT1000, IR Sens, Mod Ref) and with the proper configuration. Check the [section 5.5.6.B](#) of the manual.
- c. If there is no communication, shut down and turn on the device. It may also be an issue with the distance. Check again with both devices close together and make sure the antennas are installed properly.
- d. It may also be the case that several E-Sens and E-1500 / E-1000 are working together in the same place. This may result in noise between the communications. As a result, you should only use one E-Sens, despite working with several I-V curve tracers at the same time.
- e. In the situation that the error still persists, please contact with the technical service.

4. After pressing the button to measure, the device beeps and does not show the curve and buttons do not work on the screen.

- a. Check just above the settings button if the E-Temp option is selected. Also check if there is a message on the screen stating that the device made a measurement and it is waiting for the temperature value of the E-Temp. If that is the case, the device is in the standby mode and it is waiting for the E-Temp data to make the extrapolation of the curve values to continue measuring. If you do not own an E-Temp or you do not need to use it, you have to disable it inside the sensor settings before starting to measure.

5. The device does not save the barcode scanner data inside the CSV files, even if it is shown on the device screen.

- a. When you are going to make a measurement saving the barcode scanner data, you have to use the scanner only when the device asks for it through a message on the screen. Otherwise, if you use the scanner too soon, you will still see the code on the screen but it will not be saved on the csv file as it will not be associated with the measurement performed.

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