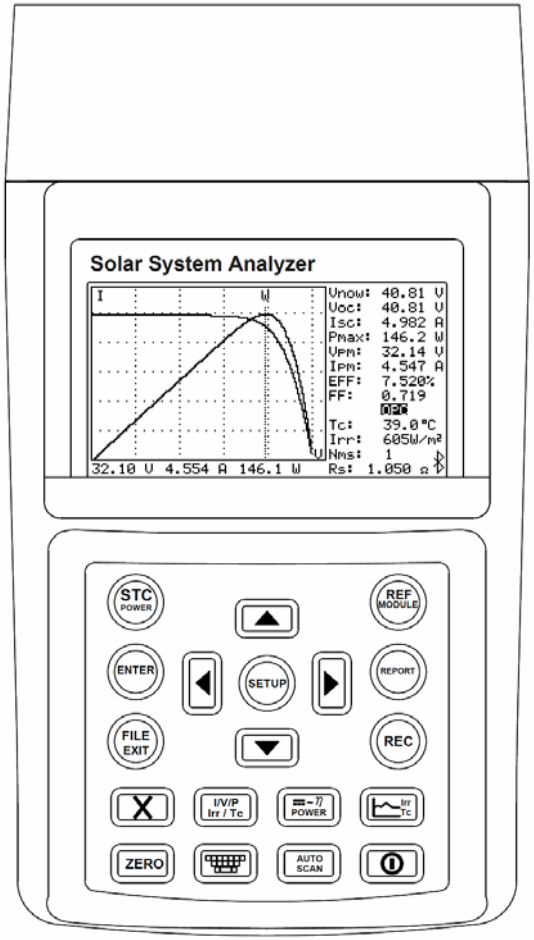
PROVA 1011

Solar System Analyzer

Users Manual



PROVA INSTRUMENTS INC.

This unit (excluding Remote Solar Detector 1012) passes the following tests:

EN 61010-1: 2010
EN 61010-2-030: 2010
CAT II 1000V, CAT III 300V
Pollution Degree 2

EN61326-1: 2006 Class B
(CISPR 11: 2009/A1: 2010 Group 1 Class B, EN 61326-1: 2006, IEC 61000-4-2: 2008, IEC 61000-4-3: 2006+A1:2007+A2:2010, IEC 61000-4-8: 2009)

Safety Symbols

⚠ WARNING

Please read the statement thoroughly to prevent injury or loss of life, and prevent damage to this product.

Earth (ground)

DC (Direct Current)

Conforms to relevant European Union directives.

Do not dispose of this instrument as unsorted municipal waste. Contact a qualified recycler for disposal.

Caution:

1. The ventilation openings on the unit should not be blocked.
2. Please pay attention to polarity of DC input, follow the polarity info by the input jack.

Caution, Risk of Electric Shock.

This equipment is not for measurements performed for CAT IV.
Please remove all the test leads before performing maintenance, cleaning, battery replacement, fuse replacement, etc.
Do Not plug in the AC adapter when the ambient temperature exceeds 45℃ / 113℉.

Do Not charge the lithium battery when the ambient temperature exceeds 45℃ / 113℉.

I. Preparation

This Solar system analyzer and the Remote solar detector use rechargeable lithium batteries.

The rechargeable lithium batteries are pre-installed in the solar system analyzer and the Remote solar detector at the factory.

The Solar System Analyzer

Before using the new rechargeable lithium battery, please charge it for 10~12 hours continuously for better battery life.

Users can plug in the AC adaptor and no need to turn on the Analyzer. Then the rechargeable lithium battery is charged automatically.

The Remote Solar Detector (RSD)

Before using the new rechargeable lithium battery, please charge it for 4 hours continuously for better battery life.

Users can connect the USB power cord with the RSD and a PC USB port, then the rechargeable lithium battery is charged automatically.

II. Features

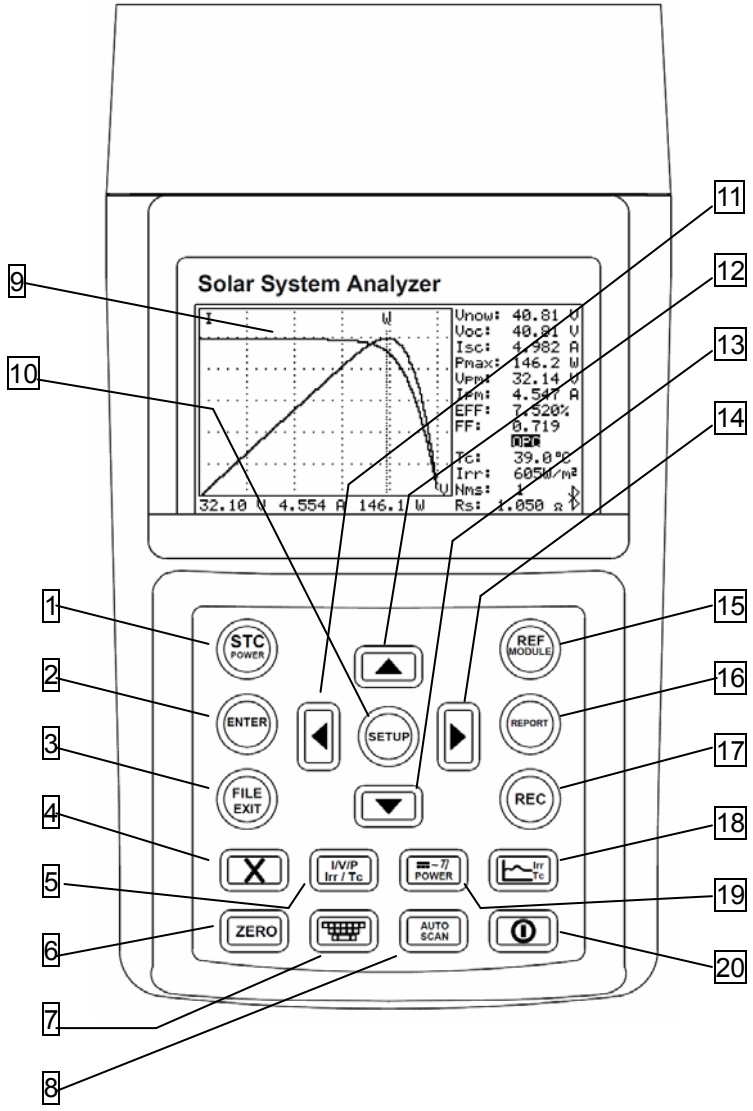
- **I-V curve test** for solar system
- Max. solar system power (Pmax) search by Auto-scan: **1000V, 12A** (**12000W** capability)
- The analyzer and the Remote Solar Detector is connected by **Bluetooth** wireless communication (Bluetooth 2.1 + EDR Class 1).
- The Remote Solar Detector is moisture-proof.
- **Intelligent test logic** with no personnel attendance required in the field. Solar system analyzer waits and tests the system until appropriate sunlight irradiance is detected.
- Max. voltage (**Vpm**) at Pmax
- Max. current (**Ipm**) at Pmax
- Voltage at open circuit (**Voc**)
- Current at short circuit (**Isc**)
- **Efficiency** (%) calculation of solar system
- **Temperature** measurement of solar panels
- **Irradiance** measurement of sun light
- **Series resistance** (Rs) calculation of solar panels
- **I-V curve with cursor** to display each data point
- With **data logging/open** function, the I-V curves of solar system can be analyzed/recorded for a period of time (e.g. 60 min.)
- Conversion of I-V curve under OPC to data under standard test condition (STC) based upon **IEC standard**
- Provide OPerating Condition (**OPC**) and Standard Test Condition (**STC**) test reports for verification of solar panel performance (**OK**, or **NO OK**)
- Users can set up the **parameters** of solar panels

- Users can set up the **series number** of solar panels. Parameters of many solar panels can be measured in one measurement.
- The irradiances and temperatures of solar panels can be continuously measured, monitored and recorded.
- Built-in **calendar clock**
- AC power adaptor
- **Rechargeable lithium battery**, low battery warning
- Optical **USB** cable for PC
- With optional power clamps (**SOLAR 15** DC Current Probe and **SOLAR 21** AC Power Clamp), continuously **measure/monitor/record** the **DC power** output of solar system and the **AC power** output of inverter (1 phase or balanced 3 phases); calculate the efficiency of **DC to AC power conversion** and the efficiency of the **max. output power**

III. Panel Description

A. Solar system analyzer

A-1 FRONT PANEL



1. 

STC POWER button

Press this button to switch the display to STC or OPC curves; or press it to enter POWER mode.

2. 

ENTER button

(In the FILE LIST) Press this button to open a chosen file (REC file or Mod file).

3. 

FILE EXIT button

Press this button to display File List. Press it again to exit File List.

4. 

DELETE button

(In the FILE LIST) Press this button to delete the data of a chosen file.

5. 

I/V/P Irr/Tc button

After AUTO-SCAN, press this button to select I-V curves or P-V curves, or display both. When under Irradiance/Temperature (Irr Tc) Mode, press this button to select Irradiance curves or Temperature curves.

6. 

ZERO button

For Zero calibration and Timer reset. Connect two testing clips with each other and press this button, the zero calibration of voltage and current will be performed. Regular zero calibration would maintain the accuracy of the instruments. Under POWER mode or Irr Tc mode, press this button to reset the Timer and curve drawings.

7. 
SOFTWARE KEYBOARD button

Press this button to display or conceal the SOFTWARE KEYBOARD which be used to type in characters.

8. 

AUTO SCAN button

Auto scan I-V curve test. Press this button for 2 sec. to perform the auto scan of intelligent test logic.

9. **LCD**

LCD displays measurement data and curves.

10. 

SETUP button

Enter/Exit (parameter) SETUP menu.

11. 
button

(1) In a curve, press it to move the cursor left.

(2) In SETUP menu or REF MODULE function or FILE LIST, press it to decrement value by 1 or display the file of previous page.

12. 
button

In “SETUP menu” or “REF MODULE function” or “File List”, press ▲ button to select the previous item or file.

13. 
button

In “SETUP menu” or “REF MODULE function” or “File List”, press ▼ button to select the next item or file.

14. 
button

(1) In a curve, press it to move the cursor right.

(2) In SETUP menu or REF MODULE function or FILE LIST, press it to

increment value by 1 or display the file of next page.

15. **REF MODULE button**

Enter/Exit the editing function of solar panel parameters.

16. **REPORT button**

Press this button to display Standard Test Condition (STC) report and OPerating Condition (OPC) report, or search the Remote Solar Detector again.

17. **REC button**

(1) Press this button to start data logging. Press it again to stop data logging.

(2) How to clear recorded data: keep pressing REC button and turn on the Analyzer, then all the data recorded in the Analyzer will be completely deleted. And the factory defaults will be restored.

18. **Irr Tc button**

Press this button to enter or exit Irradiance/Temperature mode.

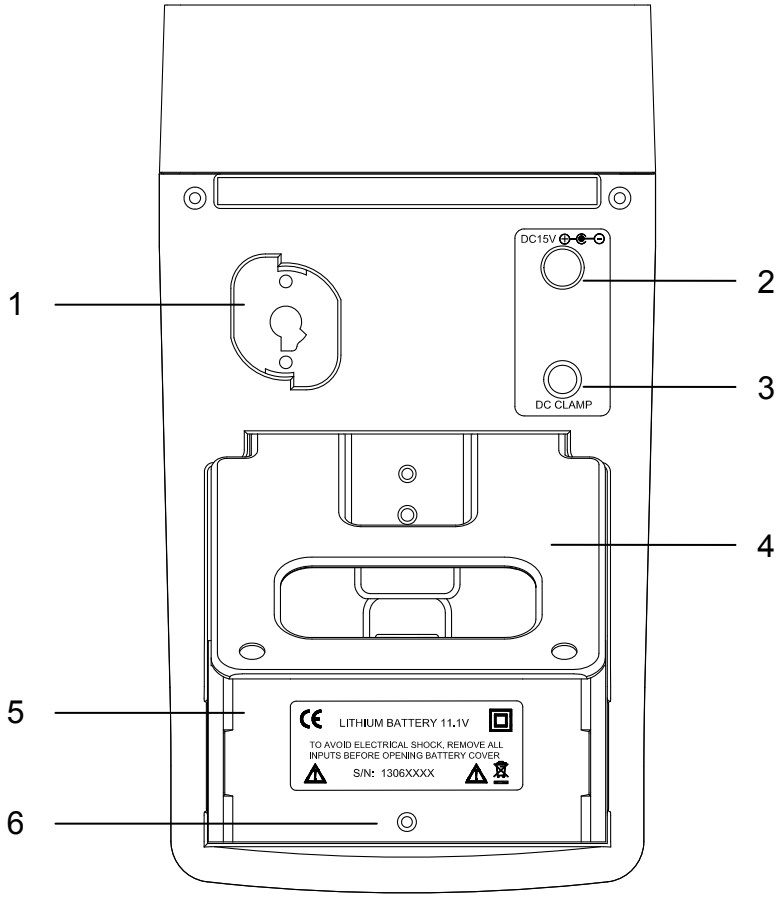
19. **DC graph/ AC graph/ Efficiency button**

Press this button to display “DC power graph” or “AC power graph” or “Efficiency”.

20. **Power button**

Turn on/off the power of the Analyzer.

A-2 REAR PANEL



1. Communication window:

(1) Connecting the Analyzer with PC via USB cable.

(2) Or under POWER mode, connecting the Analyzer with the communication cable of **Solar 21** AC Power Clamp.

2. AC to DC adaptor input.

3. Terminal for connecting **Solar 15** DC Current Probe

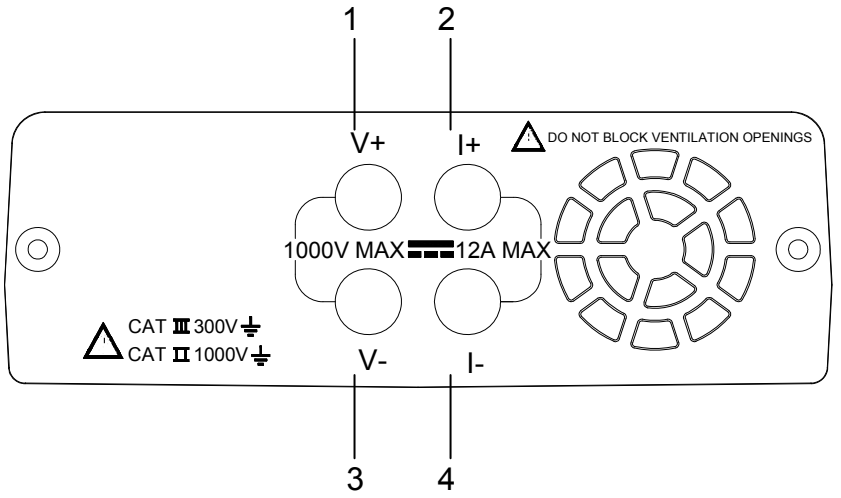
4. Stand

5. Battery cover

6. Screw of battery cover

> **Note:**
> When the Analyzer is under POWER mode, the PC Application Software can not communicate with the Analyzer.

A-3 TOP PANEL



1. V+ terminal

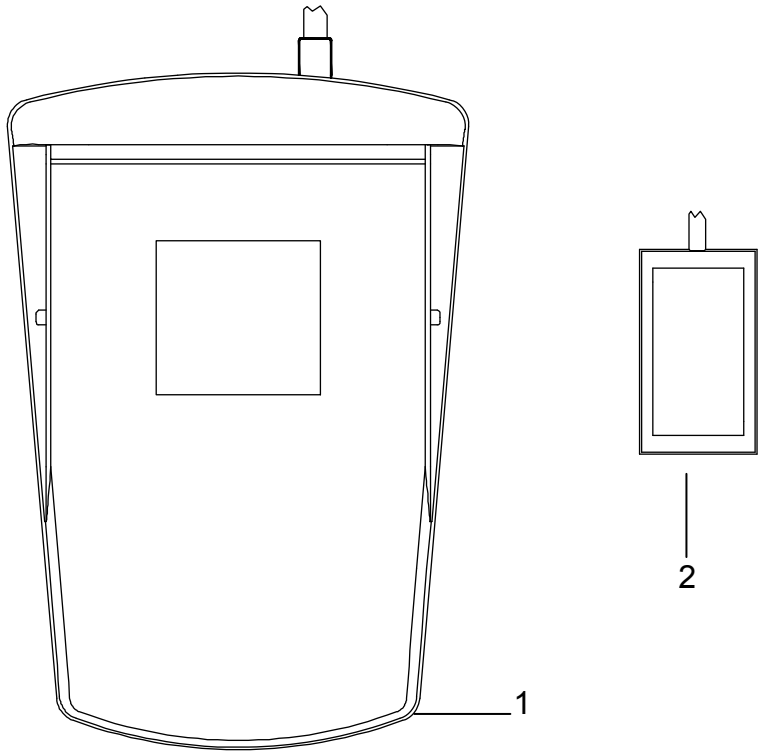
2. I+ terminal

3. V- terminal

4. I- terminal

B. Remote Solar Detector 1012 (with Thermometer)

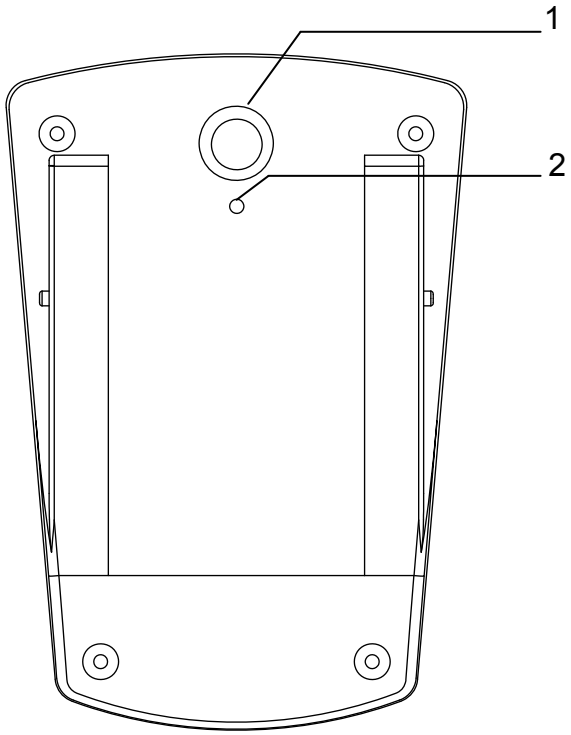
Remote Solar Detector (RSD for short)



1. Box for Remote Solar Detector.

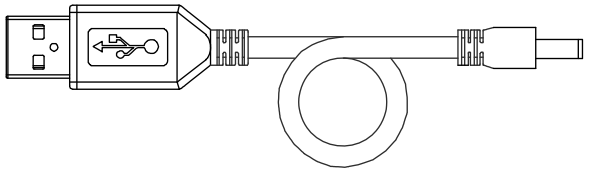
2. Auxiliary Thermometer.

Note: Apply Thermal conductive gel on the metal part of Auxiliary thermometer, then stick it on solar panel (back side) to detect the temperature of solar panel. And Thermal conductive gel can be removed easily.



1. Power switch of RSD

2. The hole to plug in USB power cord



USB power cord

IV. Operation

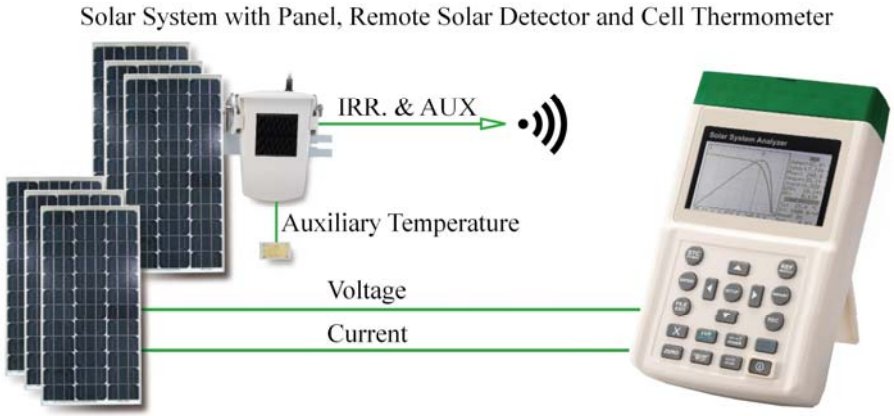
Warning: To avoid risk of electric shock and damage to the unit, do not touch any internal components with tools of any kind through the ventilation opening.

Warning: AC adaptor is used for lithium battery recharging only. The power source of the Solar System Analyzer is always the (rechargeable) lithium battery, NOT AC adaptor.

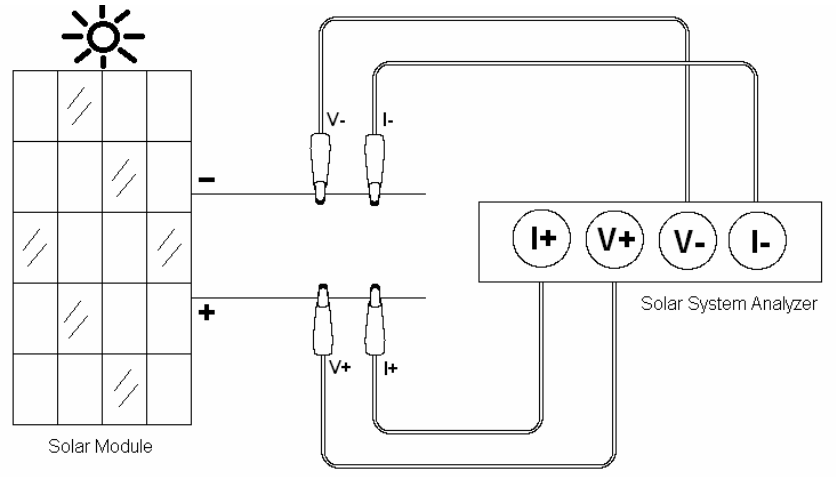
Warning: When using a lithium battery as the power source, please do not plug in an AC adaptor. If users plug in an AC adaptor during operation, power to the analyzer will be interrupted and the data during operation will be lost.

Note: When pressing any button, users will hear a sound of buzzer. When keeping pressing it for more than 2 seconds, users will hear another sound of buzzer. This status is normal.

A. Connecting Diagram



Solar (DC) System



4-wire Testing Clips Connecting Diagram

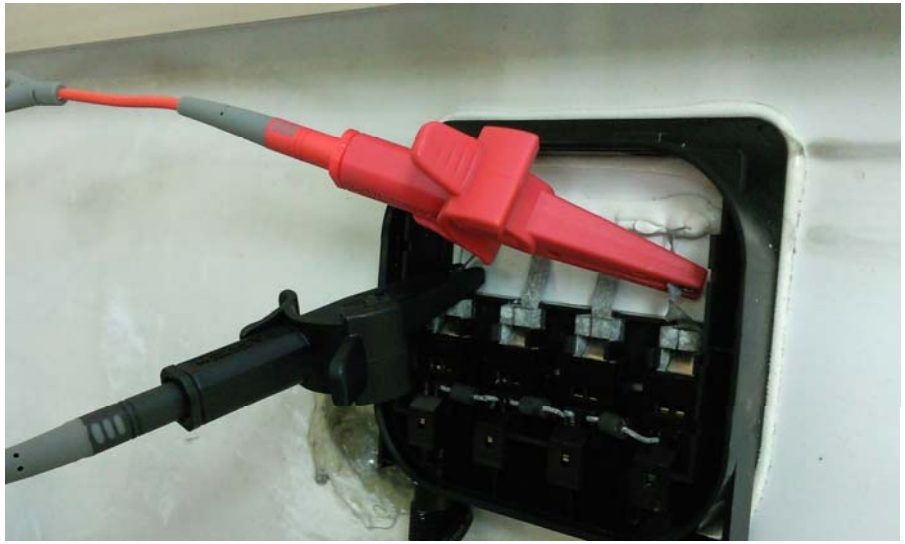
Two Wire Measurement

With the “4-wire to 2-wire connecting cable”, users only need 2 testing clips which must touch the metal parts of the output terminals of a solar panel.

The “4-wire to 2-wire connecting cable” can convert four wire measurement to two wire measurement. First, plug the 4-wire testing cable into Analyzer’s 4 terminals (black to black, red to red), and connect its other side with “4-wire to 2-wire connecting cable”. And then connect “4-wire to 2-wire connecting cable” with 2 testing clips (black & red).

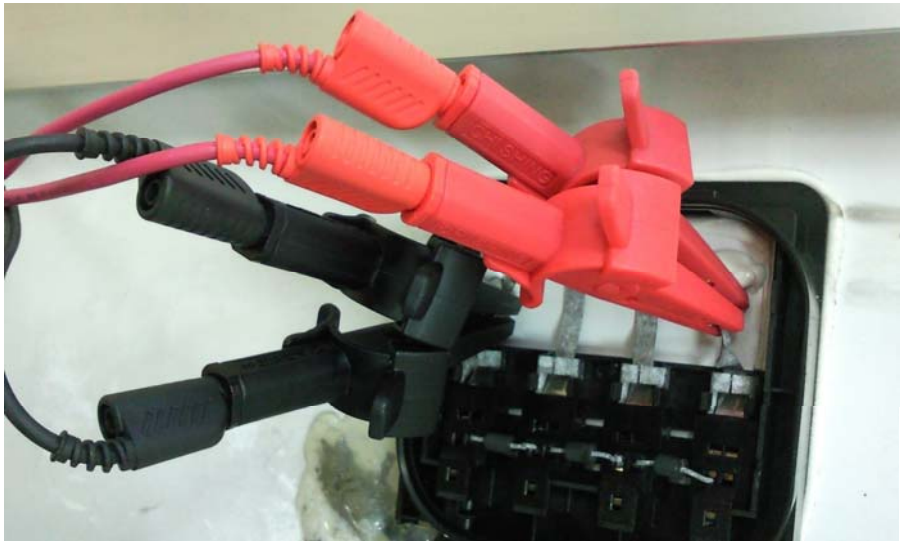
4-wire to 2-wire Connecting Cable

Then two wire measurement will be performed by using 2 testing clips which touch the metal parts of the output terminals of a solar panel (see below).

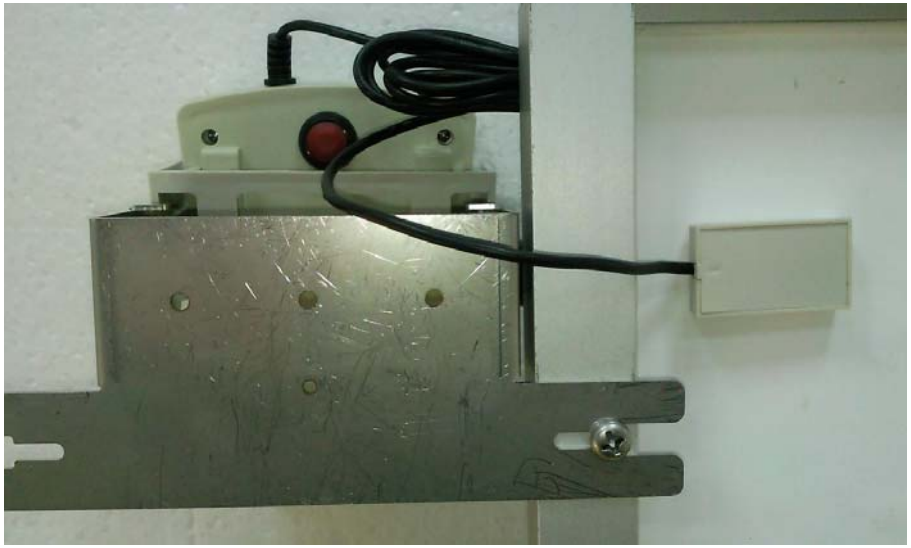


Four Wire Measurement (with 2 optional testing clips)

All 4 testing clips must touch the metal parts of the output terminals of a solar panel.



Connect the Solar panel (front side) with Remote solar detector



Use Thermal conductive gel to stick Auxiliary thermometer on the Solar panel (back side)

B. AUTO SCAN

1. Put solar panel(s) under sunlight to let the light source illuminate on solar panel(s) uniformly.
2. Properly connect testing clips to solar panel and Analyzer. The red clip is for positive pole and the black clip for negative pole. (refer to above Connecting Diagram).
3. Turn on the switch of Remote Solar Detector.
4. Press  button to turn on Analyzer. After appr. 3 sec., the Bluetooth connection symbol on the analyzer will change from  to  which means the Bluetooth connection is successful.
5. Press  (**AUTO SCAN**) button to perform Auto-scan. After the scanning is finished, the OPC measurement result will display like below.
6. Analyzer will automatically measure:

   Voc: Voltage at open circuit.

   Isc: Current at short circuit.

   Pmax: Max. solar system power.

   Vpm: Max. voltage at Pmax.

   Ipm: Max. current at Pmax.

   EFF: Efficiency of solar panel.

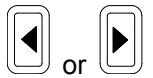
   FF: Fill Factor.

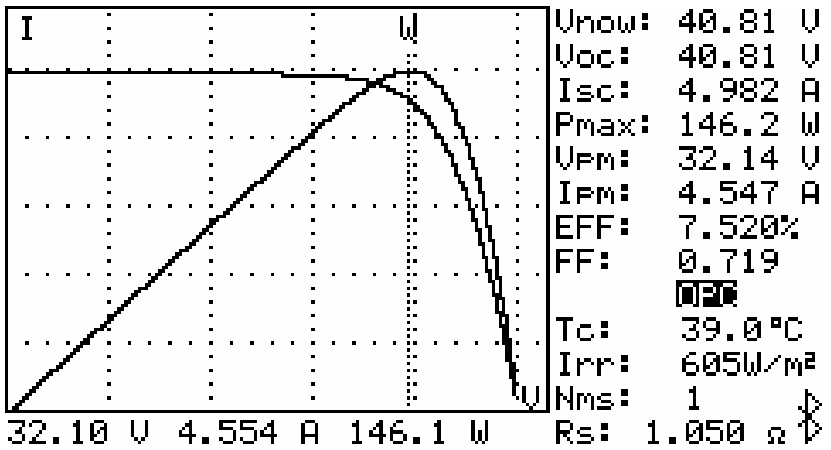
   Tc: Temperature.

   Irr: Irradiance.

   Rs: Series resistance.

Based upon above parameters, Analyzer will scan again to draw two curves on LCD: the 1st one is I-V curve; the 2nd one is P-V curve.

7. Users can Press  button to move the cursor along the curve to view the values (voltage/current/power) of each point. (The values will display below the curve.)
8. Users can press **STC POWER** button to switch the display to STC values/curves; press **STC POWER** button again to switch the display to OPC values/curves. But if Irr shows "-----", or Irr $\leqq$ 10 W/m^2, STC values/curves can not be displayed.



Note:

1. If the analyzer power on is before the RSD power on, users can press REPORT button to search the RSD again.
2. The display of STC values/curves is based on the calculation of solar panel parameters. In order to get correct STC values/curves, first users have to nominate a Mod file in the FILE LIST as the solar

panel parameters.

3. After turn on the power of Analyzer, if Irr shows ”-----“ then please turn on the Analyzer again to let Irr shows normal values.
4. When the display shows STC values/curves: the values are STC values but the curves are OPC curves.
5. For both OPC and STC, the calculation of solar panel efficiency (EFF) is based on Irradiance = 1000 W/m^2 .
6. When Irr or Tc shows ”-----“, it means the Remote Solar Detector can not be detected or the measured irradiance/ temperature is over the spec.
7. If the display shows “OL” in OPC or STC values/curves, it means the values of this measurement are not accurate.
8. If there is a “*” symbol next to Rs, it means the Rs value is from the irradiance calculation. If there is no symbol, it means the Rs value is from the calculation of loading voltage and current.
9. When Isc is over 12A, AUTO SCAN can not be performed.
10. When there is a Low battery warning, AUTO SCAN can not be performed automatically.

AUTO SCAN of Intelligent Test Logic

This Analyzer can perform the AUTO SCAN of intelligent test logic to get a more accurate Pmax. The Analyzer will wait till the irradiance is over 800 W/m^2 , then it starts AUTO SCAN. And it will continuously AUTO SCAN 5 times, then find out the best Pmax.

1. Put solar panel(s) under sunlight to let the light source illuminate on solar panel(s) uniformly.
2. Properly connect testing clips to solar panel and Analyzer. The red clip is for positive pole and the black clip for negative pole. (refer to above Connecting Diagram).
3. Turn on the switch of Remote Solar Detector.
4. Press  button to turn on Analyzer. After appr. 3 sec., the Bluetooth connection symbol on the analyzer will change from  to  which means the Bluetooth connection is successful.
5. Press  (**AUTO SCAN**) button for 2 sec. to perform AUTO SCAN of intelligent test logic. After the scanning is finished, the best OPC measurement result will be displayed.
6. If the irradiance can not be over 800 W/m^2 which makes AUTO SCAN can not be performed, users can press  (**DELETE**) button to perform AUTO SCAN 5 times based on the current irradiance. After the scanning is finished, the best OPC measurement result will be displayed.

C. REPORT

1. After AUTO SCAN finished and curves displayed, or after open a REC file under FILE LIST, press 

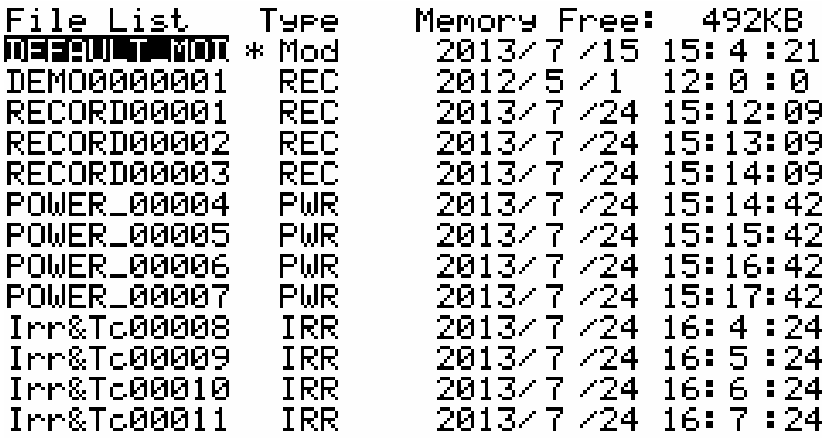
(**REPORT**) button to display test report like below: it shows NOMINAL parameters, OPC / STC report. But if Irr shows "-----", or Irr ≦ 10 W/m^2, the report can not be displayed.
2. In the report:
   Delta Irrad represents the irradiance variation volume during AUTO SCAN process. If this value is bigger, it may cause an abnormal I-V curve.
   Irr < 800 W/m^2 means the irradiance is small than 800 W/m^2.
   Pmax @ STC: if OK it represents the Pmax of STC meets the Pmax spec. of solar panel parameters; if NO OK it means the Pmax of STC do not meet the Pmax spec. of solar panel parameters.
3. Users can press  button to switch the display shows STC report, or OPC report (Nms = Nms of solar panel parameters) or OPC report (Nms=1). Press  button to switch the display in reverse order.


```
                Test Report
Delta Irrad:   0W/m²  2013/5/1  12:0:0
DEFAULT_MOD  NOMINAL          STC
  Nms:           1            1
  Pmax:        272 W        272.4 W
  Vpm:       35.90 V        35.79 V
  Ipm:       7.570 A        7.611 A
  Voc:       43.97 V        43.98 V
  Isc:       8.150 A        8.131 A
  Irr:        1000 W/m²      1000 W/m²
  Tc: AUTO    25.0°C         25.0°C
  Ptol:  +  3.0% -  3.0%      0.1%
 Pmax @ STC   OK*            Irr < 800W/m²
```

D. FILE LIST

1. Press (FILE EXIT) (**FILE EXIT**) button to display the File List as below.
2. In the File List you can see: File names, File types, File dates/times.
3. There are four file types:
   ”Mod” : File of Solar panel parameters.
   ”REC” : File of I-V curve record.
   ”PWR” : File of Power record.
   ”IRR” : File of Irradiance/Temperature record.
4. If there is a “*” symbol next to a ”Mod” file, it means this file of solar panel parameters is the one currently used by the Analyzer.
5. Users can press (▲) or (▼) button to select a file. The chosen file will be highlighted. Press (◀) or (▶) button to display the files of previous page or next page.
6. Press **ENTER** button to open the file data. Open a ”Mod” file means you select it as the file of solar panel parameters currently used by the Analyzer. Open a “REC” file to display a I-V curve record. The ”PWR” and “IRR” files can not be opened by the Analyzer, users have to read them from the Application Software.
7. Press (X) (**DELETE**) button to delete a chosen file.

※Note: When users enter the FILE LIST, the previous AUTO-SCAN testing results will be deleted.

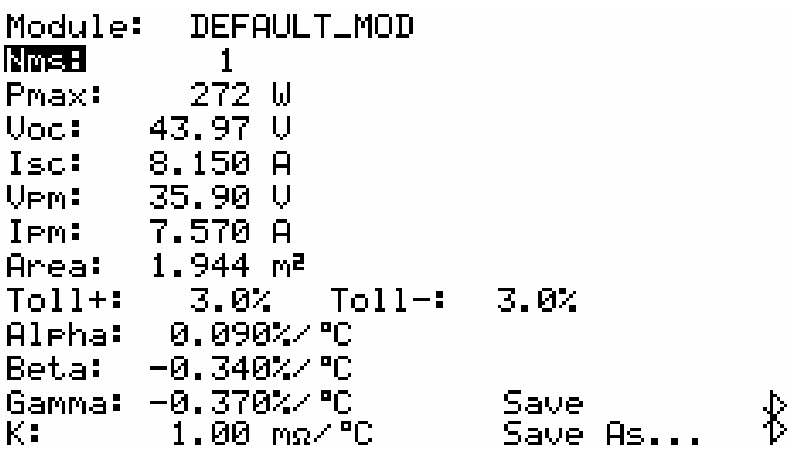


E. REF MODULE

After the parameter tests of OPerating Condition (OPC), the Analyzer can convert them to I-V curve and parameter display of Standard Test Condition (STC). And then based on the parameters of solar panel to verify the solar panel is OK or NO OK. Users can open, modify, delete the parameters of solar panels. The default parameter file (DEFAULT_MOD) can not be modified or deleted.

1. Press REF MODULE (**REF MODULE**) to enter the function of editing solar panel parameters.
2. The parameters of Solar panels are:
   - Module： The name of solar panel which can be edited by SOFTWARE KEYBOARD.
   - Nms： The series number of solar panels.
   - Pmax： Max. solar system power.
   - Voc： Voltage at open circuit.
   - Isc： Current at short circuit.
   - Vpm： Max. voltage at Pmax.
   - Ipm： Max. current at Pmax.
   - Area： Area of solar panel(s). (Based on this Area data and Irradiance, the Analyzer can calculate the conversion efficiency of solar panels.)
   - Toll+： Positive tolerance of solar panel **Pmax**.
   - Toll-： Negative tolerance of solar panel **Pmax**.
   - Alpha： Temperature coefficient of solar panel **Isc**.
   - Beta： Temperature coefficient of solar panel **Voc**.
   - Gamma： Temperature coefficient of solar panel **Pmax**.
   - K： Temperature coefficient of solar panel **Rs**.
3. Users can press ▲ button or ▼ button to select a parameter.

   Press ◀ button or ▶ button to change the parameter values; or press these 2 buttons for 2 sec. to quickly change the setting values.
4. After editing the parameters, select **Save** and then press ENTER button to replace the original parameter file; or select **Save As** and then press ENTER button to save it as another new parameter file.
5. Press REF MODULE (**REF MODULE**) button to exit REF MODULE function.



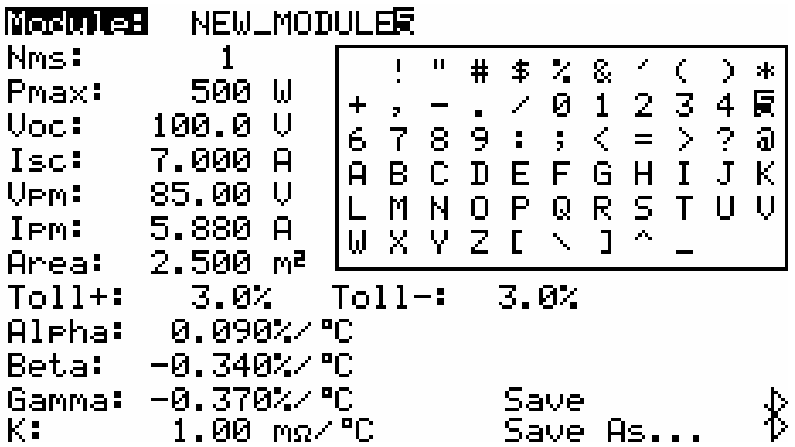
※Note: When users enter the REF MODULE function, the previous AUTO-SCAN testing results will be deleted.

> **Note:** If users exit REF MODULE function before SAVING the parameter file, the changed parameters will be restored to the original defaults.

F. SOFTWARE KEYBOARD

Users can use SOFTWARE KEYBOARD to type in characters, numbers and symbols.

1. Move to the item where you want to change the characters (e.g. Module).
2. Press  button or  button to move the cursor to the place where you want to type in a character.
3. Press  **(SOFTWARE KEYBOARD)** button then the display will be as below.
4. In the SOFTWARE KEYBOARD display, press  or  or  or  button to select a character, then press  **(SOFTWARE KEYBOARD)** button again to confirm this change.



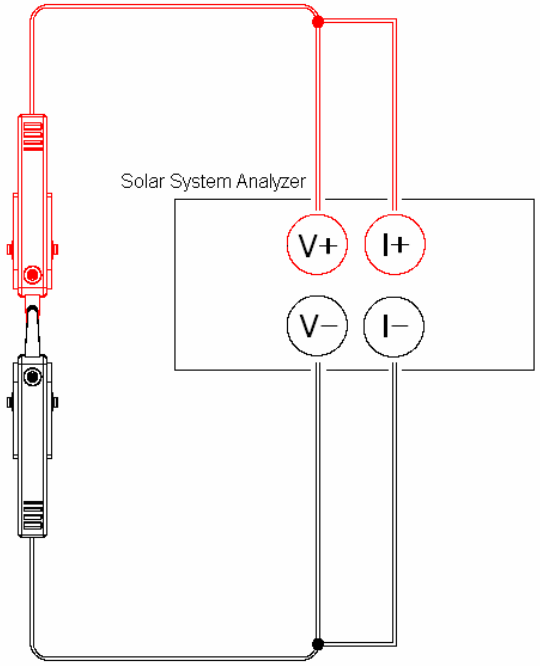
G. ZERO Calibration

Calibration of voltage and current zero would improve the accuracy of the instrument before usage.

First connect “4-wire to 2-wire cable” with the Analyzer, then connect 2 testing clips (black & red) with ““4-wire to 2-wire cable”. Connect these 2 testing clips with each other and press 

button. The LCD will display “ZERO CAL…” message. When this message disappears, the ZERO Calibration is completed.

Regular ZERO Calibration would maintain the accuracy of the instruments.



H. Data Logging

Users can perform Data Logging to:
record the I-V curves of solar system;
or (under POWER mode) record the DC/AC output power, Efficiency;
or (under Irr Tc mode) record Irradiance/Temperature
over a period of time (e.g. every 60 minutes).

1. Set Sampling Time (e.g. 60 min.) in SETUP menu.

2. Exit SETUP function, press REC button then AUTO SCAN will be performed and the I-V curves of solar system will be recorded. In the above example, data is recorded once every 60 minutes. Press REC button again to stop Data Logging.

3. Under Efficiency display of Power mode, press REC button then (in the above example) the data is recorded once every 60 minutes. Press REC button again to stop Data Logging.

4. Under Irr Tc mode, press REC button then the data is recorded once every 60 minutes. Press REC button again to stop Data Logging.

Note:

1. If the Sampling Time is set to 0 (minutes), then only 1 set of I-V curve/data or 1 set of power data or 1 set of Irradiance/Temperature data is recorded.
2. Users can use the application software provided with the Analyzer to read the saved testing results. (Please refer to the Software Manual)
3. Do not communicate with PC during data logging.

I. Clear Recorded (File) Data and Restore Defaults

Users can clear the recorded data saved in the Analyzer and restore the factory defaults.

The procedures are:

1. Keep pressing **REC** button and turn on the Analyzer at the same time.
2. After turning on the Analyzer, users will be asked if they really want to Restore Factory Settings & MEMORY FORMAT. If users choose YES, then all the data recorded in the Analyzer (memory) will be completely deleted. And the factory default settings will be restored.

Note:

1. After performing this CLEAR function, all the recorded data in Analyzer (memory) will be deleted completely and can not be restored. If it is necessary to keep the testing data, please use the Application Software to download/save them before deleting them from the Analyzer. (refer to the Software Manual)

2. After the factory defaults are restored, the parameters (like Irr. Correction, Tc Offset, …) in SETUP will be restored to the defaults set at factory. Hence, users will have to set the parameters in SETUP again.

J. SETUP Parameters

1. Press 

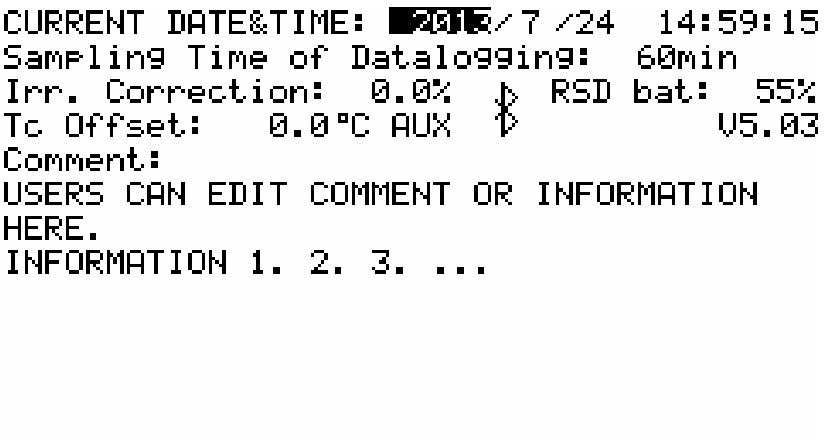
(**SETUP**) button to enter the Parameter Setting.

2. Press  or  buttons to select the setting item.

   Press  or  buttons to change the setting values. Or press these two buttons for 2 sec. to promptly change setting values.

3. After setting up parameters, press 

(**SETUP**) button to exit SETUP menu.



(1) **CURRENT DATE&TIME**：the Date and Time of the Analyzer will be set up (except the Second can not be set).

(2) **Sampling Time of Datalogging**：can be set up from 0 to 99 minutes.

(3) **Irr Correction**：the factory default of Irr Correction is 0. However, after recalibration if users find there is a measurement deviation on the Irradiance, users can adjust this Irr Correction parameter in order to measure the correct irradiance. Please note: after the factory defaults are restored, the Irr Correction value will be restored to 0.

(4) **Tc Offset**：the factory default of Tc Offset is 0. However, after recalibration if users find there is a measurement deviation on the Temperature, users can adjust this Tc Offset parameter in order to measure the correct temperature. Please note: after the factory defaults are restored, the Tc Offset value will be restored to 0.

(5) **Comment**：Users can use the SOFTWARE KEYBOARD to write down their comments here. Max. 128 characters can be typed in. When data logging (REC) I-V curves of solar system, the comment will be recorded as well.

(6) **AUX** in the SETUP menu means the auxiliary thermometer (attached to Remote Solar Detector) is selected for Cell Temperature. **V5.03** means the firmware version of the Analyzer. **RSD bat** means the remaining battery power of the Remote Solar Detector.

K. THERMOMETER Setup

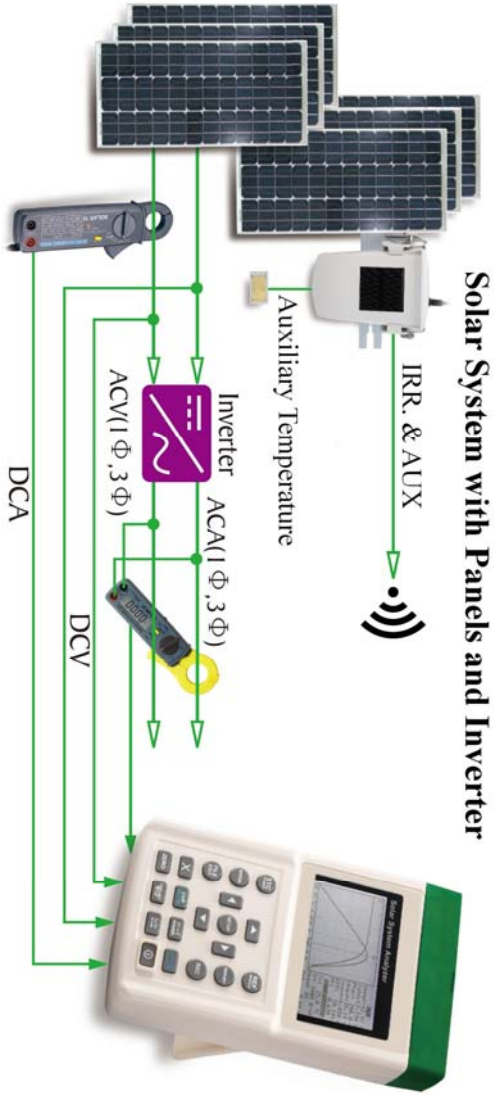
1. Keep pressing 

(**REF MODULE**) button (do not release it) and turn on the power of Analyzer.
2. After the power is on, users will be asked to select AUTO or AUX for ”Cell Temperature”. Choosing AUTO means the Analyzer will automatically detect the temperature of solar panel. Choosing AUX means the Analyzer will detect the temperature of solar panel through the auxiliary thermometer of Remote Solar Detector.

Note:
In order to get more accurate temperature of solar panel, users are suggested to select AUTO. When users select AUTO, they have to make sure the **Voc** parameter of REF MODULE is correct.

L. POWER Mode

Solar System with Panels and Inverter



The connection of Solar 21 (AC Power Clamp), Analyzer and Solar 15 (DC Current Probe) are as below:

The POWER mode is used to continuously measure/monitor/record the DC power output of solar system and the AC power output of Inverter (1 phase or balanced 3 phases); calculate the efficiency of DC to AC power conversion, the efficiency of the max. output power, DC/AC output power, and Watt/hour, etc.

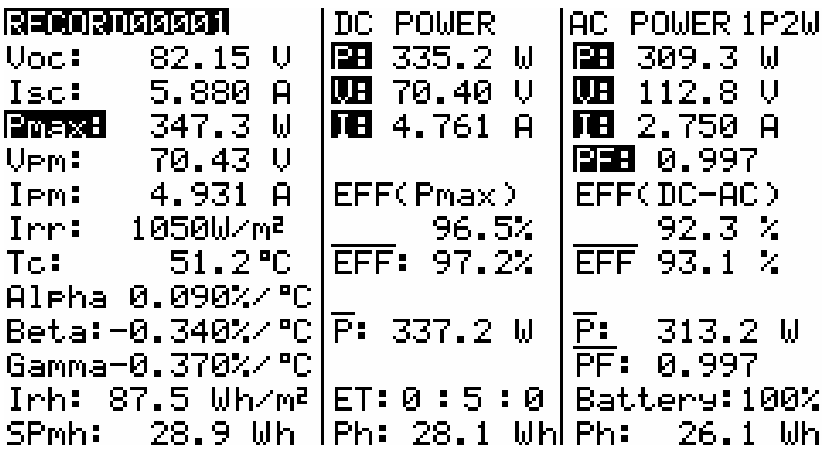
Please connect all the cables according to the drawing of “Solar System with Panels and Inverter”. Solar 15 (DC Current Probe) turned to 12A range; Solar 21 (AC Power Clamp) turned to W-mA or W-A range; the sliding switch on the side turned to a proper frequency.

Press the 3-Phase button of **Solar 21** (AC Power Clam) to switch to 1P2W or 3P3W.

1. Turn on the switch of Remote Solar Detector.

2. Press  button to turn on the Analyzer. After appr. 3 sec., the Bluetooth connection symbol on the analyzer will change from  to  which means the Bluetooth connection is successful.

3. Press  (**STC POWER**) button to enter the Efficiency display of POWER mode as below.



On the top left of the display, “RECORD00001” means the current output calculation of solar panels are based on: I-V curve record file “RECORD00001” and the measured irradiance/temperature. Every sec. the calculation and display is updated once. Hence users must perform AUTO SCAN first, press REC button to record a “REC” file, select this “REC” file in FILE LIST, then press ENTER button to finish the nomination.

Parameters from left to right on the display are described on below:

Output of solar panels:

Voc： Voltage at open circuit

Isc： Current at short circuit

Pmax： Max. solar system power

Vpm： Max. voltage at Pmax

Ipm： Max. current at Pmax

Irr： The measured Irradiance

Tc： The measured Temperature

Alpha： Temperature coefficient of solar panel **Isc**.

Beta： Temperature coefficient of solar panel **Voc**.

Gamma： Temperature coefficient of solar panel **Pmax**.

Irh： Watt/ hour of Irradiance

SPmh： Watt/ hour at Pmax

DC Input of Inverter:

P： Power

V： Voltage

I： Current

EFF(Pmax)： Efficiency, (DC Power / Pmax)x100

$\overline{EFF}$ ： Average Efficiency, (Ph(DC)/SPmh)x100

$\overline{P}$ ： Average Power

ET： Duration (hour: min.: sec.). Users can press ZERO button to reset this value.

Ph： Watt/ hour

AC Output of Inverter:

P： Power

V： Voltage

I： Current

PF： Power Factor

EFF(DC-AC)： Efficiency, (P(AC)/P(DC))x100

$\overline{EFF}$ ： Average Efficiency, (Ph(AC)/Ph(DC))x100

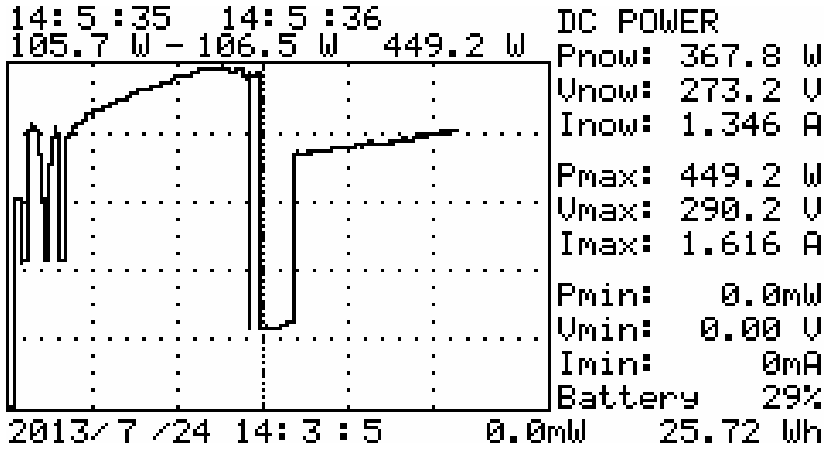
$\overline{P}$ ： Average Power

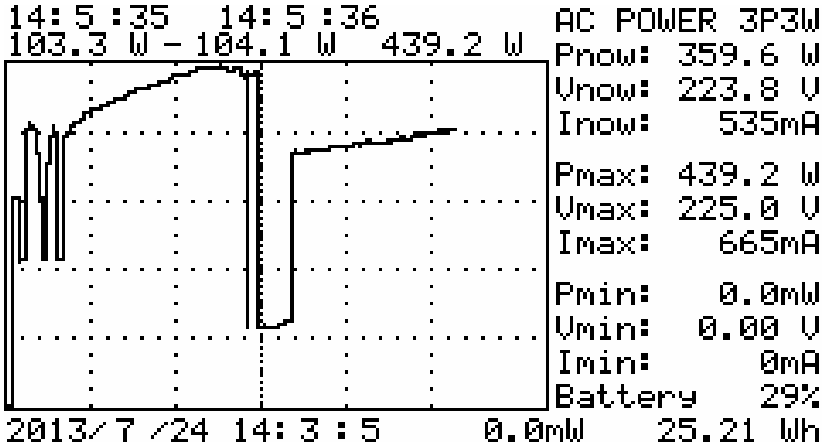
$\overline{PF}$ ： Average Power Factor

Ph： Watt/ hour

4. Press POWER button to switch the display to DC power curve as below.

   Press POWER button again to switch the display to AC power curve as below.





Users can press I/V/P Irr/Tc (**I/V/P Irr/Tc**) button to switch the display to Current/Voltage/Power curves. On the left bottom it shows the starting date/time of the curve. Users can press ZERO button to Reset (i.e. redraw) the curve. Press ◀ or ▶ button to move the cursor. On the top left it shows the Time Interval of the cursor position, and the min./max. values of the Time Interval. On the right bottom it shows Watt/ hour.

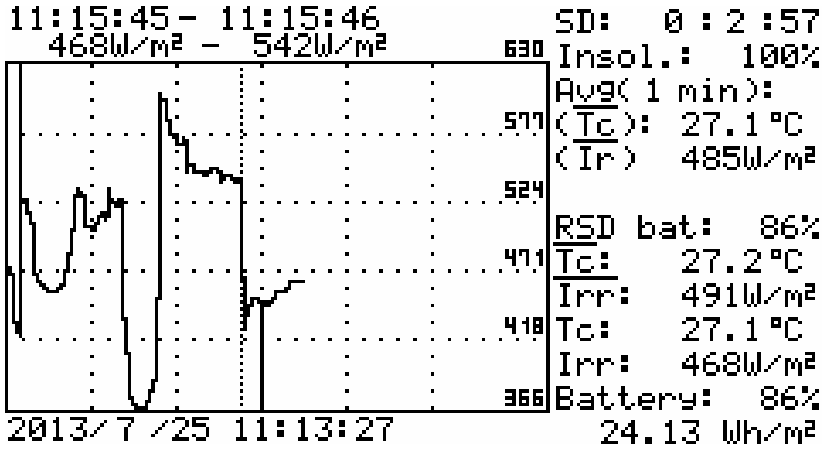
Note:

1. Under POWER mode if the display shows “Clamp X”, it means the Analyzer can not detect Solar 15 or Solar 21, please check the connection or replace batteries.
2. Solar 15 ”can be turned to 12A range only”, Solar 21 ”can be turned to W-mA or W-A range only”, or the Analyzer can not measure correctly.

M. Irradiance/Temperature (Irr Tc) Mode

The Irradiance/Temperature (Irr Tc) mode is to continuously measure, monitor, record the irradiance, temperature, SD (sunshine duration), insol. (insolation) of solar panels.

1. Turn on the switch of Remote Solar Detector.
2. Press button to turn on the analyzer. After appr. 3 sec., the Bluetooth connection symbol on the analyzer will change from to which means the Bluetooth connection is successful.
3. Press (**Irr Tc**) button to enter the Irradiance/Temperature mode (the display like below).



In the display of Irradiance/Temperature mode, the parameters are:

SD： sunshine duration

Insol.：	insolation
($\overline{Tc}$)：	Average temperature value of the latest time period
($\overline{Ir}$)：	Average irradiance value of the latest time period
RSD bat：	Remaining battery power of RSD
$\overline{Tc}$ ：	Average temperature value since pressing ZERO button until now
$\overline{Irr}$ ：	Average irradiance value since pressing ZERO button until now
Tc：	Real-time Temperature
Irr：	Real-time Irradiance

Sunshine duration (SD) means the time period when Irradiance ≧ 120 W/m^2. This value (120 W/m^2) can be changed via the Threshold Value of Sunshine Duration in the software. After the factory defaults are restored, 120 W/m^2 will be restored.

The calculation formula of **insolation (Insol.)** is:

(SD / (the time period when Irradiance > 5 W/m^2)) x 100

This value (5 W/m^2) can be changed via the Threshold Value of Sunshine in the software. After the factory defaults are restored, 5 W/m^2 will be restored.

The time periods of ($\overline{Tc}$) and ($\overline{Ir}$) can be set up in the parameter SETUP function by setting up Sampling Time of Datalogging. For example, if the Sampling Time of Datalogging is set up to 2 min.: ($\overline{Tc}$) and ($\overline{Ir}$) will be the average temperature/irradiance values of the latest 2 min.; and the average values will be re-calculated every 2 min. If the Sampling Time of Datalogging is set up to 0 min.: then there won't be any averages.

On the left bottom of the display shows the starting date/time of the curves.

Users can press ZERO button to Reset (i.e. redraw) the curves. Press  or  button to move the cursor. On the top left of the display shows the Time Interval of the cursor position, and the min./max. values of the Time Interval. On the right bottom it shows the Watt/hour of Irradiance.

4. Press  (**I/V/P Irr/Tc**) button to select displaying Irradiance curves or Temperature curves.

5. Press  (**Irr Tc**) button to exit Irr Tc mode.

Note:

1. When the analyzer fails to detect the RSD, users can not enter Irradiance/Temperature mode.
2. Under Irr Tc mode: if the connection of RSD fails, the bottom display will show the starting time of the connection fail (in reverse type); if the RSD connection is successful again, the Irradiance/Temperature curves will continue to display, but the Time Interval of the cursor position on the top left of the display will be meaningless.

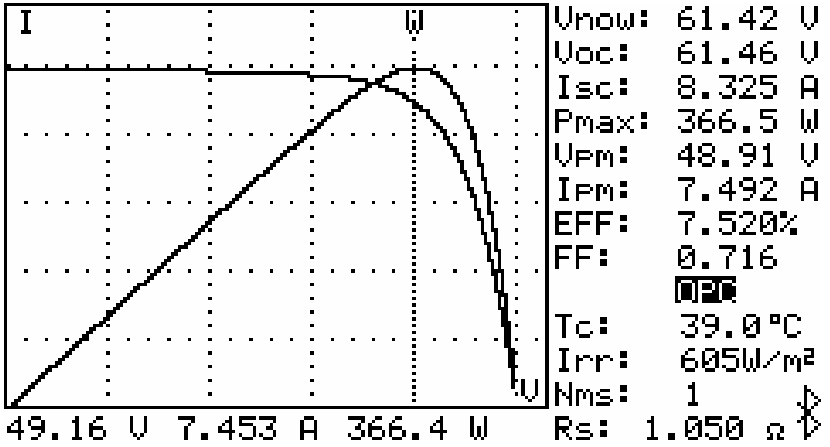
V. Application Notes

A. Quality Control at Production Line, Warehouse, or Site of Installation.

Manufacturers of solar panels can test the characteristics for quality control purpose at the production line. Due to the portability advantage of the unit, quality inspectors can randomly pick samples of solar panels and test them at the warehouse to assure quality before shipment.

Installation engineers can randomly test samples of solar panels at site to verify the quality of solar panels used at site of installation.

B. Identify Requirements of Solar Power System



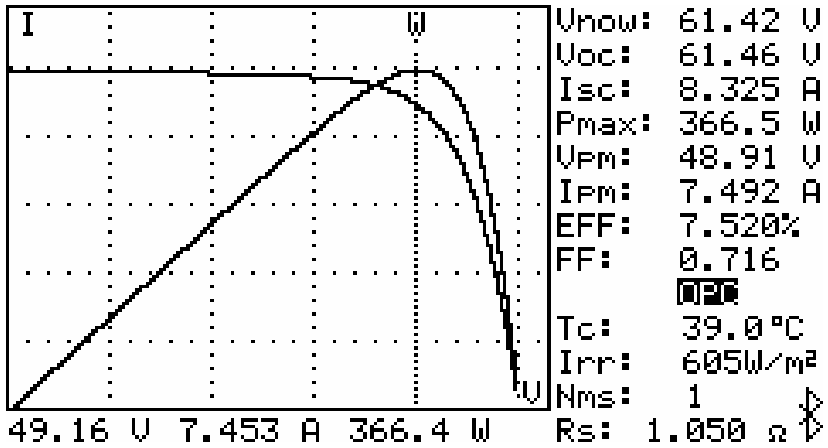
The unit can measure actual max. power (Pmax), voltage (Vpm) and current (Ipm) at max. power. Instead of the rated max. power, system designers need to be aware of the actual solar power from solar panels under actual operating conditions. So designers can actually know how many pieces of solar panels are required to generate specific power.

The voltage and current under actual operating conditions (in the morning, at noon, and in the afternoon) are required for system designers to design the optimal charging system, so most of the solar power can be absorbed and stored in the battery.

Users can test the characteristics of solar panels at different time of each day and store the data. Then the designers can know if the solar system can generate appropriate power at any time.

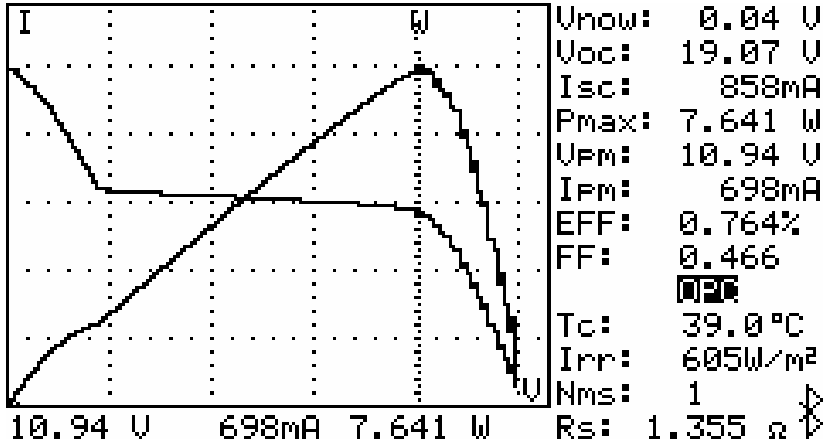
C. Maintenance of Solar Panels

Normal I-V Curve



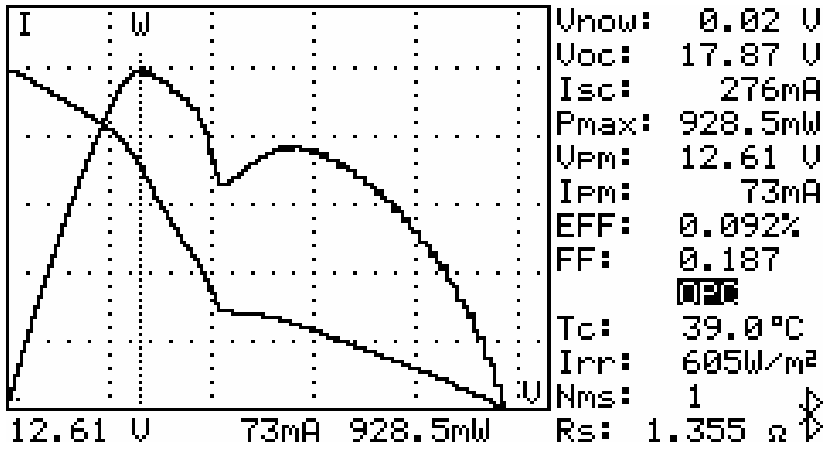
Abnormal I-V Curve

(Cells at the corner of solar panel are defected)



Abnormal I-V Curve

(Defected cells scattered over the solar panel)



Maintenance engineers can store the characteristics data of solar panels in the beginning. And compare the characteristics data in weekly, monthly or yearly maintenances. If the characteristics of any solar panels are different from the previous data, maintenance engineers can further identify the problems of solar panels.

For example, if any cells of solar panels are damaged, the I-V curve would be very different from a typical curve. If the solar panels are covers by a lot of dust, the I-V curve or the max. power would be much lower than previously stored data. Once defected panels are found, maintenance engineers can replace them with new panels.

D. Verify the Best Installation Angles of Solar Panels

Engineers can collect data of the installation angles at different dates and time by using the unit at site of installation. The data can be used as a reference to design the automated angle adjustment system. Or the data can be used to select an optimal angle for a fixed angle installation.

VI. Specifications

A. Electrical Specifications

A1. Solar System Analyzer

(23℃±5℃, Irradiance ≥ 800 W/m^2, Four-wire measurement, the Max. power limit is 12000W)

DC Voltage Measurement

Range	Resolution	Accuracy
1 ~ 1000 V	0.01 V / 0.1 V / 1 V	± 1 % ± (1 % of Voc ± 0.1 V)

Voc: open circuit voltage of solar cell or module.

If users use testing clips to measure voltage only, they must make V+ clip connect with I+ clip; V- clip connect with I- clip. Thus, 4-wire measurement is converted to 2-wire measurement.

DC Current Measurement

Range	Resolution	Accuracy
0.1 ~ 12 A	1 mA / 10mA	± 1 % ± (1 % of Isc ± 9 mA)

Isc: short circuit current of solar cell or module.

Circuit resistance is compensated in the AUTO SCAN.
Isc is the current of solar panel's power cable measured at zero circuit resistance.

DC Current Simulation

Range	Resolution	Accuracy
0.1 ~ 12 A	1 mA / 10 mA	± 1 % ± 9 mA

If current is greater than 12A, testing can not be performed.

Maximum power limit is 12000W. If the power exceeds 12000W, then the scanning will be stopped.

The min. current for Auto Scan is 100mA.

Irradiance Measurement

Range	Resolution	Accuracy
0 ~ 2000 W/m^2	1 W/m^2	± 3 % ± 20 dgts

Temperature Measurement

Range	Resolution	Accuracy
-22 ~ 85 ℃	0.1 ℃	± 1 % ± 1 ℃

A2. DC Current Probe (Solar 15) (23℃±5℃)

Range	Resolution	Accuracy
DC 12A	1 mA / 10 mA	±2.0%±30mA

A3. AC Power Clamp (Solar 21) (23℃±5℃)

AC Watt (50 or 60 Hz, PF 0.6 to 1. CT = 1, Voltage is greater than AC 4V, Current is greater than AC 1mA for mA range, and Current is greater than AC 0.04A for A range. Spec. applies to continuous waveforms.)

Range (0 to 30A)	Resolution	Accuracy of Readings[1, 2]
0.050 – 9.999 W	0.001W	±2% ± 0.025W
10.00 – 99.99 W	0.01W	±2% ± 0.25W
100.0 – 999.9 W	0.1W	±2% ± 2.5W
1.000 – 9.999 KW	0.001 KW	±2% ± 0.025KW
10.00 – 99.99 KW	0.01 KW	±2% ± 0.25KW
100.0 – 999.9 KW	0.1 KW	±2% ± 2.5KW
1000 – 9999 KW	1 KW	±2% ± 25KW

[1] **For CT ≠1, the accuracy in percentage is the same (±2%). But the additional wattage should be multiplied by the CT ratio.**

For example, ±0.025W becomes ±0.025W * CT ratio

[2] **If Auto Hz is selected, the AC voltage must be greater than 50V, and add 2° phase angle error to the accuracy.**

Range (30 ~ 50A)	Resolution	Accuracy[3, 4]
0.050 – 9.999 W	0.001W	±2% of VA ± 5dgts
10.00 – 99.99 W	0.01W	±2% of VA ± 5dgts
100.0 – 999.9 W	0.1W	±2% of VA ± 5dgts
1.000 – 9.999 KW	0.001 KW	±2% of VA ± 5dgts
10.00 – 99.99 KW	0.01 KW	±2% of VA± 5dgts
100.0 – 999.9 KW	0.1 KW	±2%of VA ± 5dgts
1000 – 9999 KW	1 KW	±2% of VA ± 5dgts

[3] **For CT ≠1, the accuracy in percentage is the same (±2%). But the additional digits should be multiplied by the CT ratio.**

For example, ±5 digits becomes ±5 digits * CT ratio

[4]**If Auto Hz is selected, the AC voltage must be greater than 50V.**

Range of CT Ratio: 1 to 250

H.P. (Horse Power): 1 H.P. = 746 W

AC Apparent Power (VA, from 0.000VA to 9999 KVA)

VA = V r.m.s. x A r.m.s

AC Reactive Power (VAR, from 0.000 VAR to 9999 KVAR)

VAR = $\sqrt{(VA^2 - W^2)}$

AC Active Energy (mWH, WH, or KWH, from 0 mWH to 999,999 KWH)

WH = W * Time (in hours)

Power Factor

(PF, ACV > 4V, AC mA > 1mA, AC A > 0.04A, Watt > 50 digits)

Range	Resolution	Accuracy
0.000 – 1.000	0.001	±0.04

B. General Specifications

B1. Solar System Analyzer

Battery Type:	Rechargeable Lithium Battery (3400mAh)
Battery Life:	400 times of linear scan (1000V ~ 1V, 0.1A ~ 12A), 8 hours for standby mode.
Memory Size:	512K Bytes 3980 Mod files 320 REC files 3980 PWR files 3980 IRR files
AC Adaptor:	AC 100 ~ 240V input DC 15V / 1~3A output
Dimension:	257(L) x 155(W) x 57(H) mm
Weight:	1525g / 53.7 oz (Batteries included)
Operation Environment:	5℃ ~ 50℃, 85% RH
Temperature Coefficient:	0.1% of full scale / ℃ (＜18℃ or ＞28℃)
Storage Environment:	-20℃ ~ 60℃, 75% RH
Accessories:	Remote Solar Detector (battery type: rechargeable lithium battery, 1000mAh) with Thermometer, USB power cord, User manual, AC adaptor, Optical USB cable, Rechargeable lithium battery (3400mAh), Software CD, Software manual, Carrying bag, Thermal conductive gel, Testing clips (1 black & 1 red),

	4-wire to 2-wire connecting cable, 4-wire testing cable
Option:	**Solar 15**: DC current probe **Solar 21**: AC power clamp Testing clips (1 black & 1 red)

B2. DC Current Probe (Solar 15)

(Indoor Use)

Conductor Size:	23mm max. (approx.)
Battery Type:	two 1.5V SUM-3 AA
Range Selection:	Manual
Power Consumption:	10mA (approx.)
Low Battery Indication:	Red LED
Operation Temperature:	-10◦C to 50◦C
Operation Humidity:	＜85% RH
Storage Temperature:	-20◦C to 60◦C
Storage Humidity:	＜75% RH
Altitude:	up to 2000M
Dimension:	183mm(L) x 61.3mm(W) x 35.6mm (H)
	7.2" (L) x 2.5" (W) x 1.4" (H)
Weight:	190g (battery included)
Accessory:	Carrying bag x 1
	Manual x 1
	1.5V AA battery x 2

B3. AC Power Clamp (Solar 21)

(Indoor Use)

Conductor Size:	30mm (approx.)
Battery Type:	two 1.5V SUM-3 AA
Display:	4+2+2 digits LCD
Range Selection:	Auto
Overload Indication:	OL
Power Consumption:	10mA (approx.)
Lower Battery Indication:	
Display Update Time:	2 times / sec.
No. of Samples per period:	512 (V or A)
	256 (W)
Temperature Coefficient (＜18℃ or ＞28℃):	
	0.15 x (Specified Accuracy) / ℃
Operation Temperature:	-10◦C to 50◦C
Operation Humidity:	＜85% RH
Altitude:	up to 2000M
Storage Temperature:	-20◦C to 60◦C
Storage Humidity:	＜75% RH
Dimension:	210mm(L) x 62mm(W) x 35.6mm(H)
	8.3" (L) x 2.5" (W) x 1.4" (H)
Weight:	200g (battery included)
Accessory:	Test leads, Carrying bag, Manual,
	1.5V AA battery x 2
Option:	Alligator clips

VII. Battery Replacement (Recharging)

If the lithium battery can not be charged, users should always purchase a new lithium battery from the distributor or importer. The charging circuit built-in is designed only for the lithium battery.

The lithium battery of the analyzer is always sold with the plastic battery cover. Do not purchase a lithium battery from a source which is not approved by the manufacturer.

Non-approved lithium battery could cause damage to the instrument or hazard to the users.

Analyzer

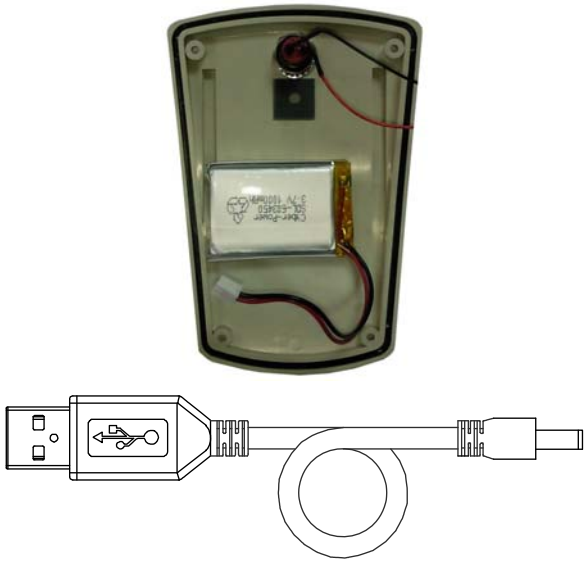
Steps of Battery Replacement:

1. Unscrew and remove the lithium battery (with plastic battery cover).
2. Put in a new rechargeable lithium battery (with plastic battery cover).
3. Screw the battery cover.

Please follow below steps to charge the lithium battery:

1. Connect the AC Adaptor with the Analyzer.
2. The battery can be charged without turning on the Analyzer.
3. The recharging takes 10 hours. After recharging, remove the AC Adaptor.
4. Turn on the Analyzer, and the LCD displays “Battery: 100%”.

Remote Solar Detector (RSD)



USB power cord

Steps of Battery Replacement:

1. Unscrew and remove the lithium battery of RSD.
2. Put in a new rechargeable lithium battery.
3. Screw the rear cover.

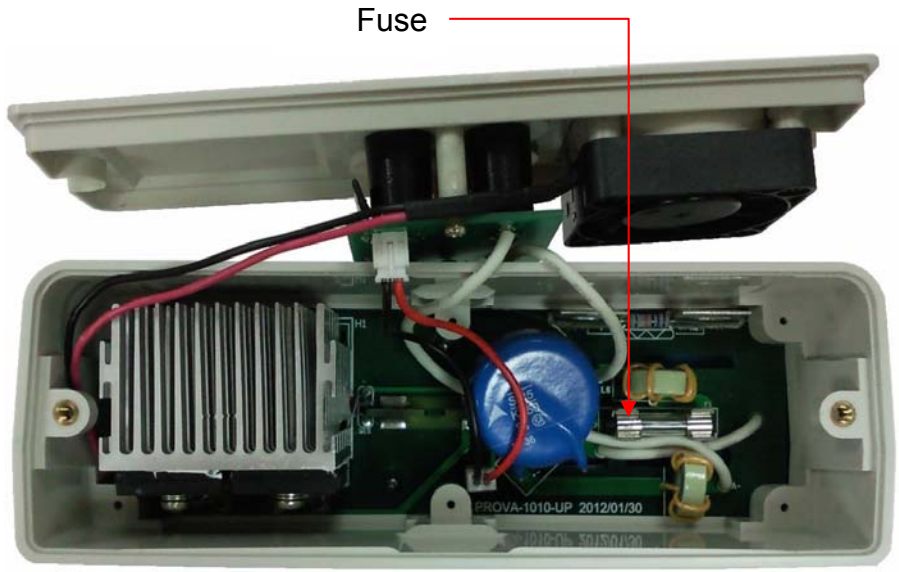
Please follow below steps to charge the lithium battery:

1. Connect the USB power cord with the RSD and a PC USB port.
2. The battery can be charged without turning on the Remote Solar Detector.
3. The recharging takes 4 hours. After recharging, disconnect the USB power cord.
4. Turn on the Remote Solar Detector.
5. Turn on the Analyzer. After Bluetooth is successfully connected, enter the parameter setup (SETUP) function, and the LCD displays “RSD bat: 100%”.

VIII. Fuse Replacement

When the voltage can not be measured (Vnow = 0V) after properly connecting the Analyzer and solar panel, please check the fuse. If the fuse is damaged (burned), please replace a new fuse by following the procedures:

1. Turn off the Analyzer and remove all the connecting wires and power sources.
2. Unscrew the (2pcs.) screws of the top panel. Remove the top panel.
3. Remove the damaged (burned) fuse.
4. Put in a new fuse of the same specifications (5A / 250V).
5. Restore the top panel and screw the (2pcs.) screws of the top panel.



IX. Maintenance & Cleaning

1. Servicing not covered in this manual should only be performed by qualified personnel. Repairs should only be performed by qualified personnel.
2. Periodically wipe the case and cable with a damp cloth and detergent; do not use abrasives or solvents.
3. Please remove the batteries if users won't use the solar analyzer and optional clamps for a long time.

Address of Agent, Distributor, Importer, or Manufacturer