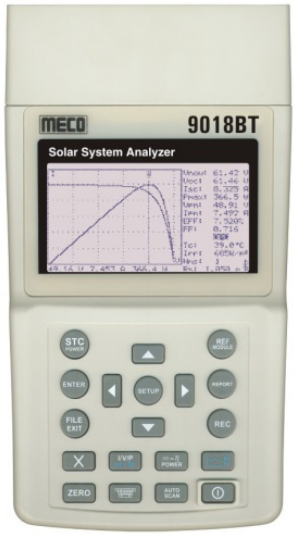
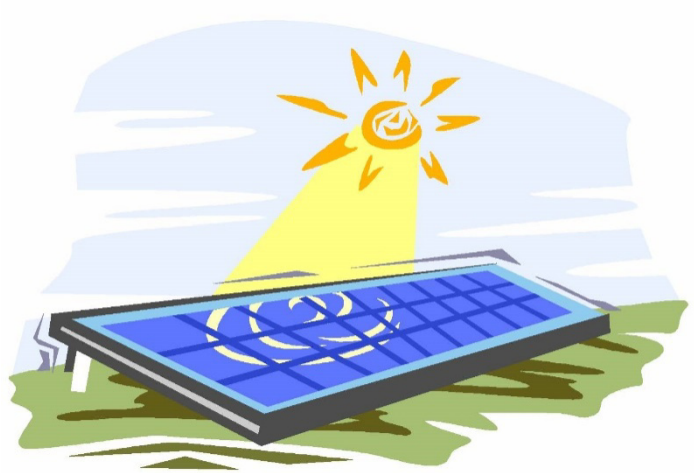
Tools for Solar Energy Measurements

&

Management Techniques





Presentation By
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Meco Instruments Pvt Ltd, Mumbai

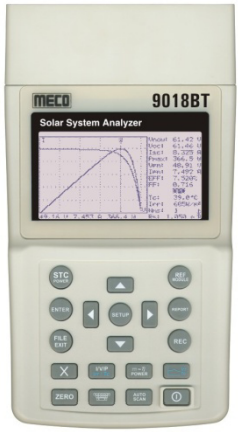
Solar System Analyzer

Specifications

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 or 3980 Mod files or 320 REC files or 3980 PWR files or 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
Temp. Coefficient	0.1% of full scale / ℃ (＜18℃ or ＞28℃)
Accessories	• Solar Irradiance Meter (Remote Solar Detector battery type: rechargeable lithium battery) • 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 • Solar 15: DC current probe • Solar 21: AC power clamp • Testing clips (1 black & 1 red)

Solar System Analyzer

Key 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

BLUETOOTH

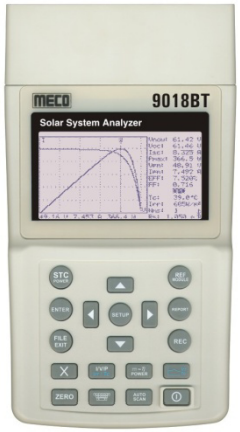
SOFTWARE

USB

CE

Solar System Analyzer

Key Features



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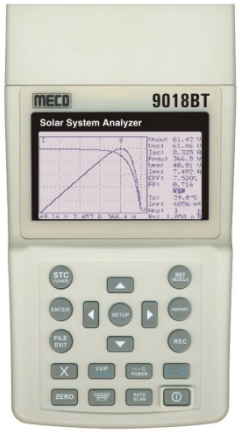
- With data logging/open function, the I-V curves of solar system can be analysed / recorded for a period of time (e.g. 60 min.)
- Conversion of I-V curve under OPC to data under standard test condition (STC) based upon IEC standard
- Provide Operating Condition (OPC) and Standard Test Condition (STC) 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.
- 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

Parameters Measured



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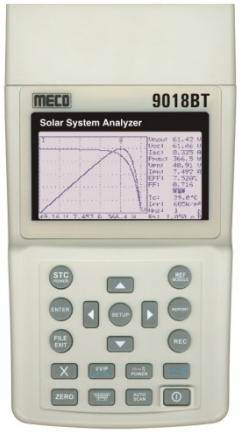
DC Voltage Measurement		
Range	Resolution	Accuracy
1 ~ 1000 V	0.01 V / 0.1 V / 1 V	± 1 % ± (1 % of Voc ± 0.1 V)

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

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 ℃

Parameters Measured



AC Voltage Measurement		
Range	Resolution	Accuracy (50/60Hz)
5 V ~ 250 V	0.1 V	± 0.5 % ± 5 dgts
250 V ~ 600 V	0.1 V	± 0.5 % ± 5 dgts
Range	Resolution	Accuracy (45-1KHz)
5 V ~ 250 V	0.1 V	± 1.5 % ± 5 dgts
250 V ~ 600 V	0.1 V	± 1.5 % ± 5 dgts

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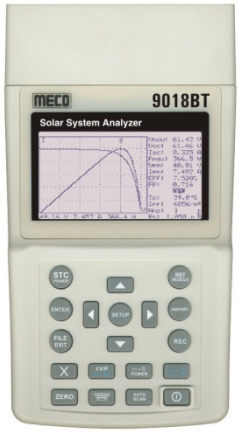
Harmonics of AC Voltage in Percentage (1 – 99th order)		
Range	Resolution	Accuracy
1 – 10th	0.1%	± 1 % of reading ± 1 %
11 – 20th	0.1%	± 5 % of reading ± 1 %
21 – 30th	0.1%	± 15 % of reading ± 1 %
31 – 40th	0.1%	± 35 % of reading ± 1 %

Parameters Measured



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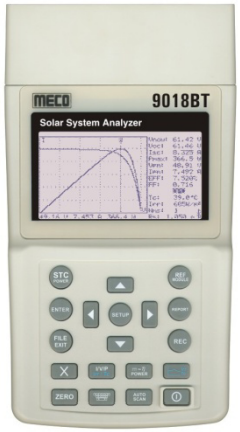
Harmonics of AC Current in Percentage (1 – 99th order)		
Range	Resolution	Accuracy
1 – 10th	0.1%	± 1 % of reading ± 1 %
11 – 20th	0.1%	± 5 % of reading ± 1 %
21 – 30th	0.1%	± 15 % of reading ± 1 %
31 – 40th	0.1%	± 35 % of reading ± 1 %

Phase Angle (50 or 60Hz)		
Range	Resolution	Accuracy
- 180 to 180	0.1	± 2
0 to 360	0.1	± 2

Parameters Measured



Frequency (Hz)			
Range	Resolution	Accuracy	Allowed Input
mA(45-65Hz)	0.1	± 2	20mA to 1.2A
A(45-65Hz)	0.1	± 2	1A to 100A

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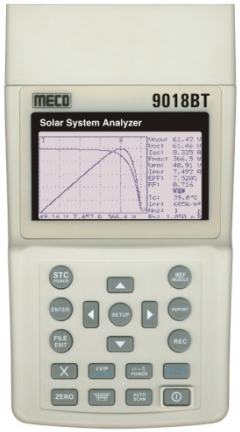
Total Harmonic Distortion (THD-F)		
Range (45-65Hz)	Resolution	Accuracy
0.0 – 10.0 %	0.1%	± 2%
10.0 – 40 %		± 5% of reading ± 5%
40 – 100 %		± 10% of reading ± 10%
100 – 999.9 %		± 20% of reading

Parameters Measured



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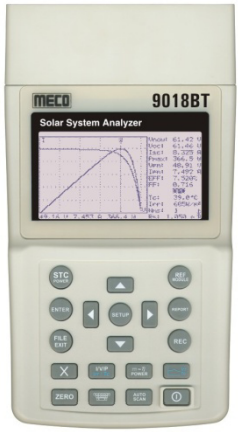
Power Factor		
Range	Resolution	Accuracy
0.000 – 1.000	0.001	± 0.04

Peak Value of AC Periodic Voltage		
Range	Resolution	Accuracy
50Hz	39us	± 5% ± 30 dgts
60Hz	33us	± 5% ± 30 dgts

Crest Factor (C.F) of AC Voltage		
Range (45 -65 Hz)	Resolution	Accuracy
1.00 – 99.99	0.01	± 5% ± 30 dgts

SETUP Parameters



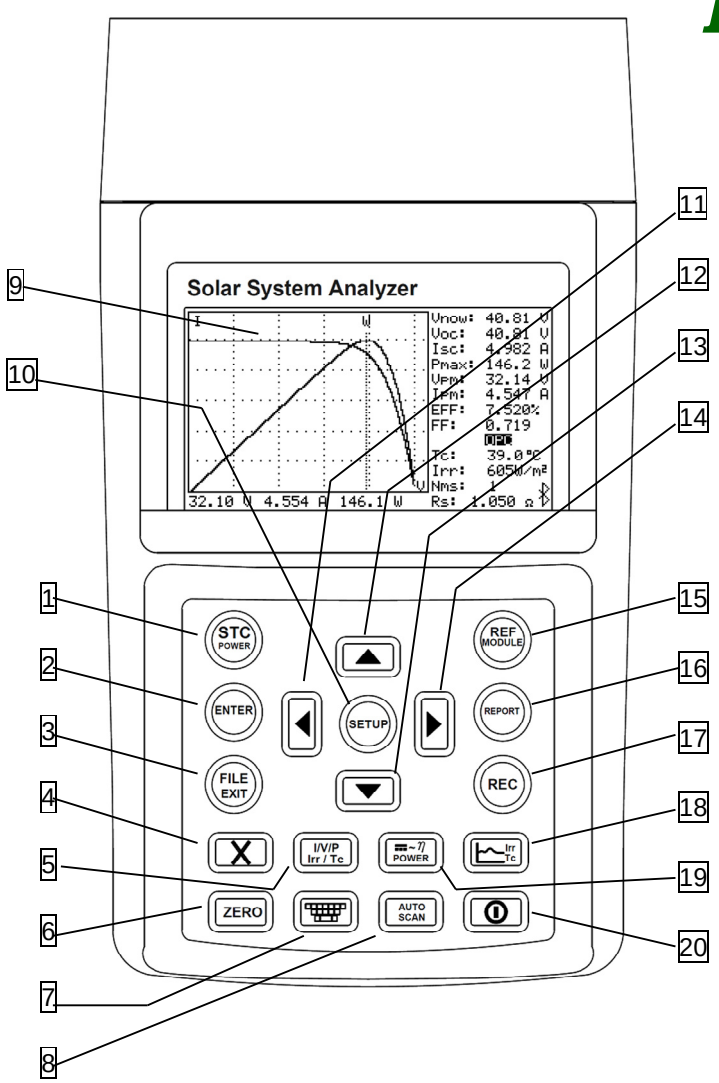

```
CURRENT DATE&TIME: 2013/ 7 /24  14:59:15
Sampling Time of Datalogging:  60min
Irr. Correction:  0.0%   RSD bat:  55%
Tc Offset:   0.0°C AUX            V5.03
Comment:
USERS CAN EDIT COMMENT OR INFORMATION
HERE.
INFORMATION 1. 2. 3. ...
```

Current Date & Time : The Date and Time of the Analyzer will be set up

- **Sampling Time of Datalogging** : can be set up from 0 to 99 minutes
- **Irr Correction** : the factory default of Irr Correction is 0
- **Tc Offset** : the factory default of Tc Offset is 0
- **Comment** : Users can use the SOFTWARE KEYBOARD to write down their comments here. We can record comment as well.
- **AUX** in the SETUP menu means the auxiliary thermometer (attached to Remote Solar Detector) is selected for Cell Temperature.
- **RSD bat** means the remaining battery power of the Remote Solar Detector.

FRONT PANEL

Display & Key Pad Operation



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**

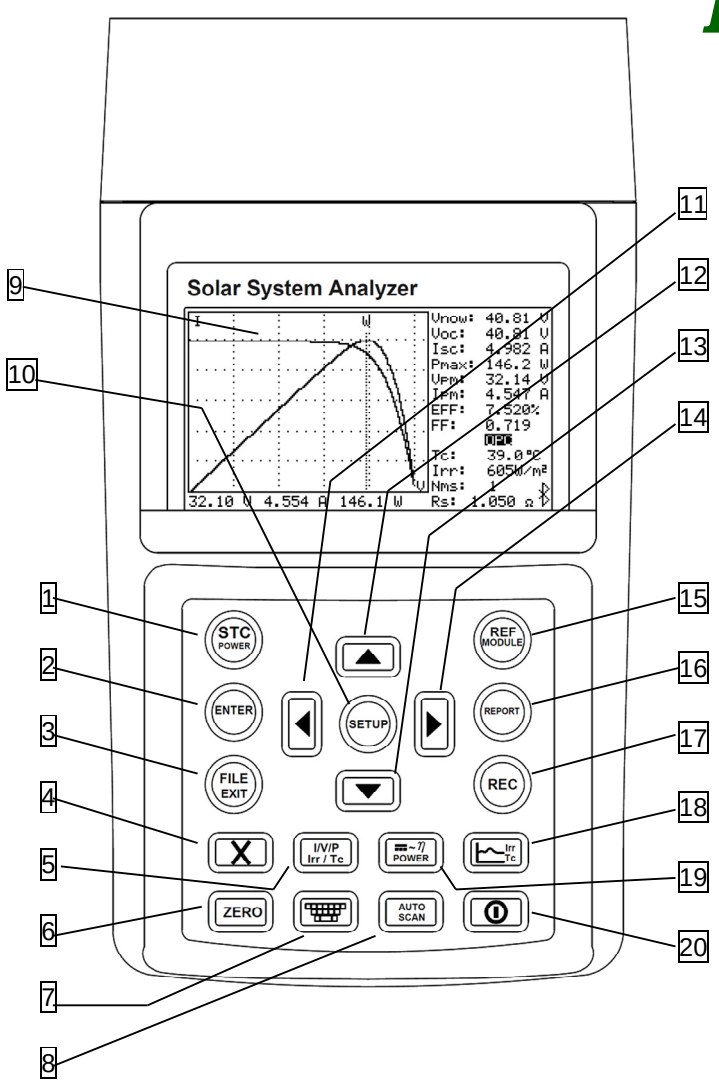
   After AUTO-SCAN, press this button to select I-V curves or P-V curves, or display both. When under Irradiance/Temperature (Irr Tc) Mode, press this button to select Irradiance curves or Temperature curves.

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.

FRONT PANEL

Display & Key Pad Operation



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.

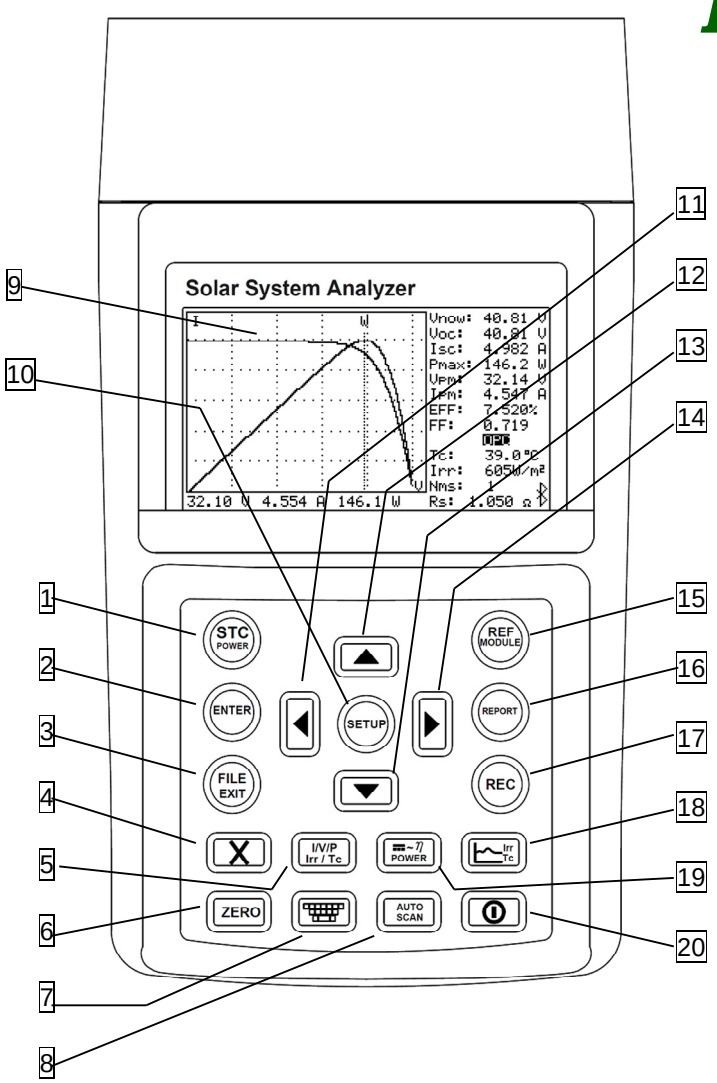
13. **button**

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

14. **button**

FRONT PANEL

Display & Key Pad Operation



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**

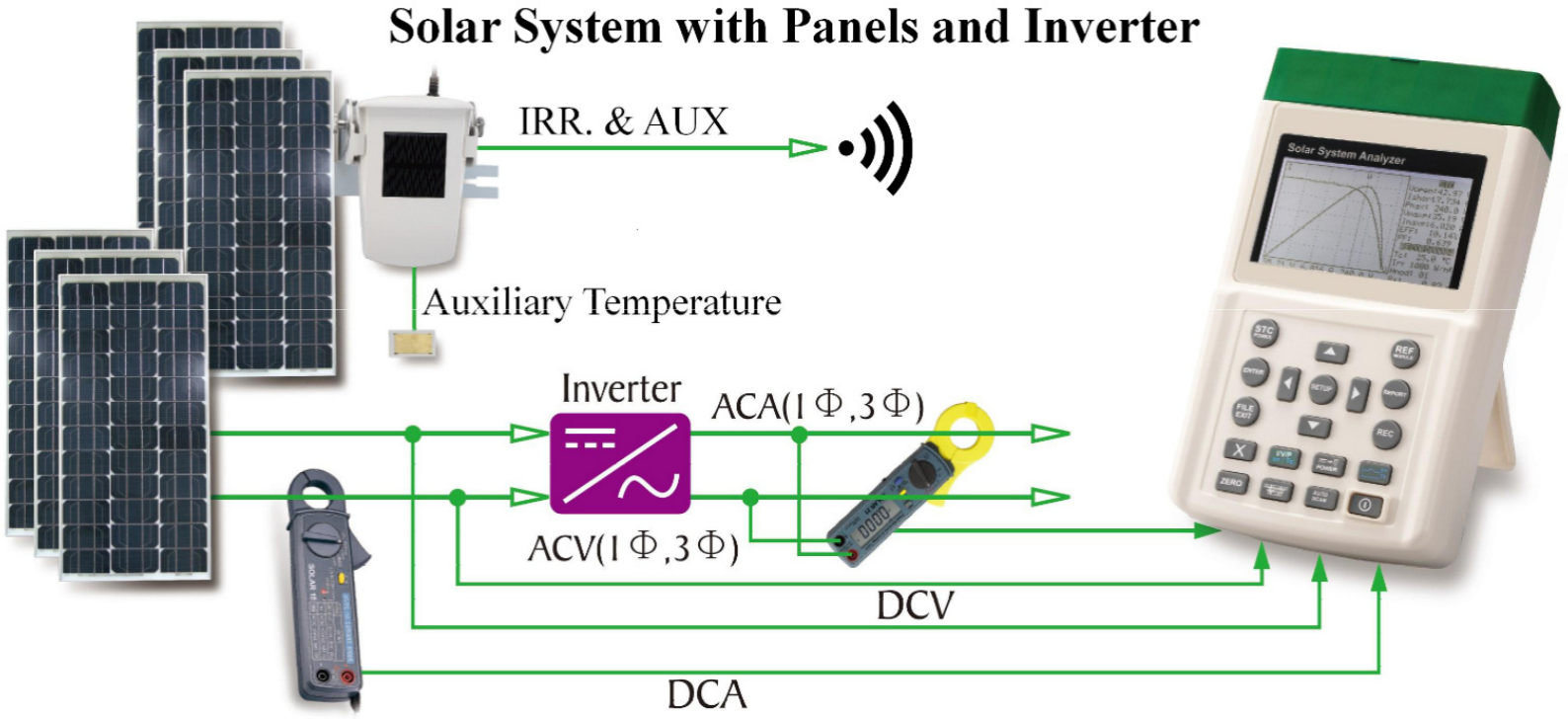
Press this button to display “DC power graph” or “AC power graph” or “Efficiency”.

20. **Power button**

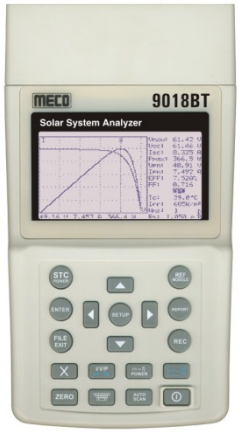
Turn on/off the power of the Analyzer.

Solar System with Panels and Inverter

Software



Applications



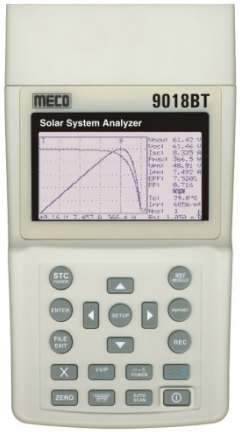
CE

Software

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

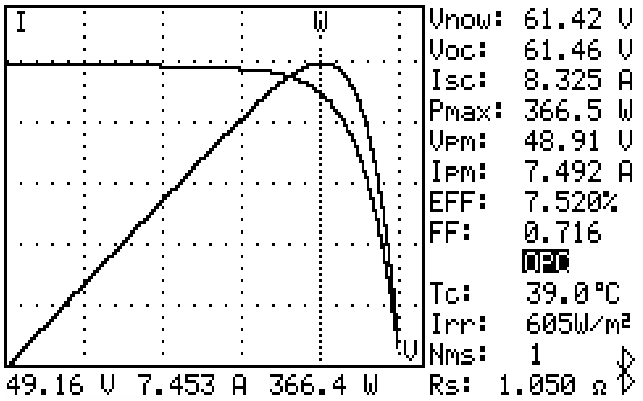
- Manufacturers of solar panels can test the characteristics for quality control purpose at the production line.
- Installation engineers can randomly test samples of solar panels at site to verify the quality of solar panels used at site of installation.

Applications



CE

Software

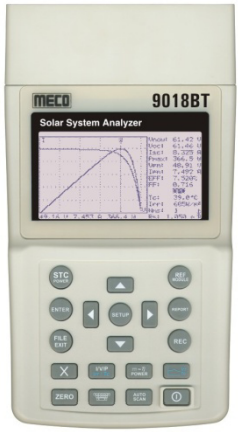


B. Identify Requirements of Solar Power System

- 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.
- Designers can actually know how many pieces of solar panels are required to generate specific power.
- Users can test the characteristics of solar panels at different time of each day and store the data.

Applications

C. Maintenance of Solar Panels



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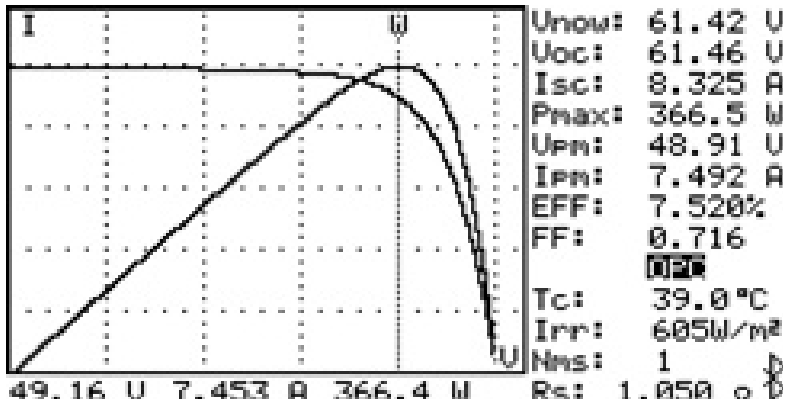
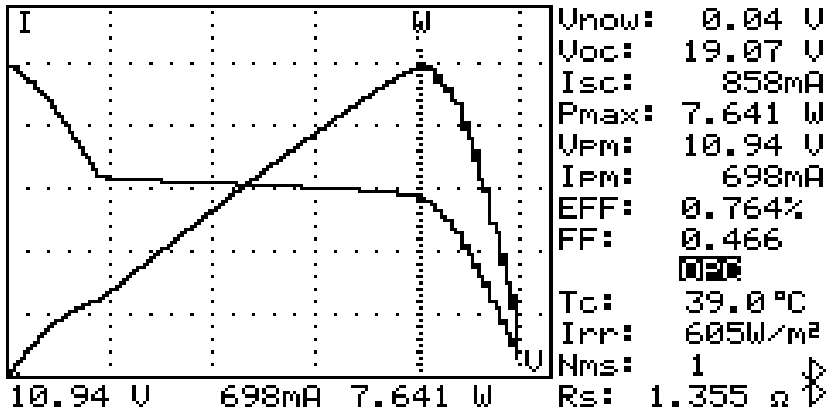
Software

- Maintenance engineers can store the characteristics data of solar panels in the beginning.
- compare the characteristics data in weekly, monthly or yearly maintenances.
- Maintenance engineers can further identify the problems of solar panels.

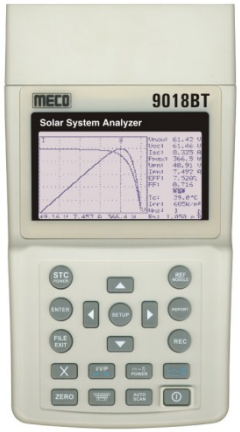
Normal I-V Curve



Abnormal I-V Curve (Cells at the corner of solar panel are defected)



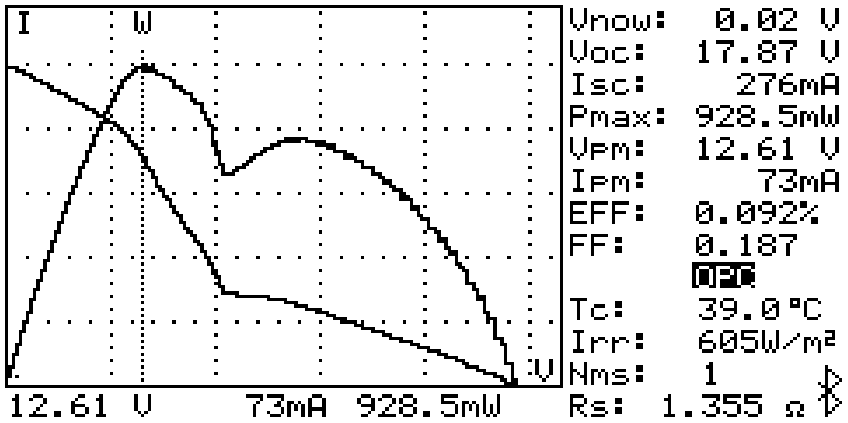
Applications



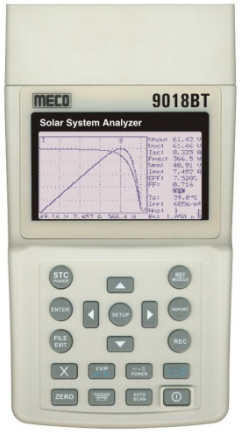
- For example, if any cells of solar panels are damaged, if the solar panels are covers by a lot of dust
- Once defected panels are found, maintenance engineers can replace them with new panels.

Software

Abnormal I-V Curve (Defected cells scattered over the solar panel)



Applications



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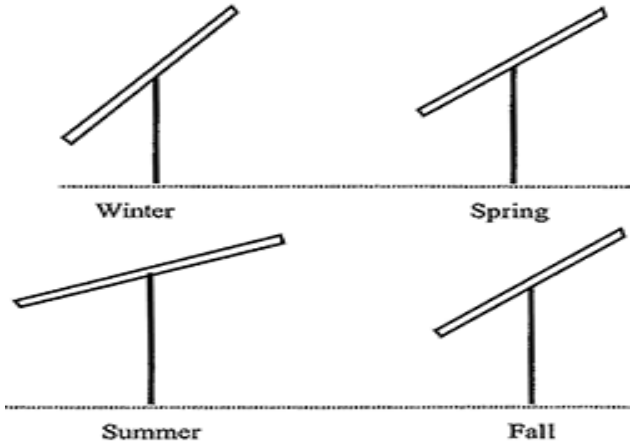
Software

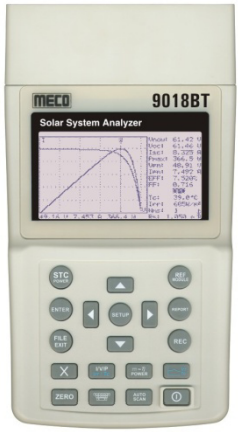
D. Verify the Best Installation Angles of Solar Panels

- 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



Accessories

Standard Accessories :-



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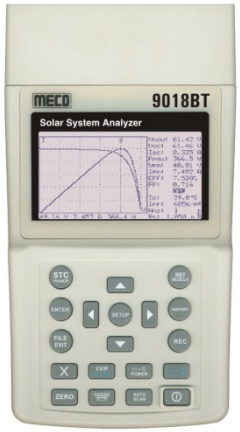
- Solar Irradiance Meter (Remote Solar Detector) x 1
- Thermometer x 1
- USB power cord x 1
- User manual x 1
- AC adaptor x 1
- Optical USB cable x 1
- Rechargeable lithium battery x 1
- Software CD x 1
- Software manual x 1
- Carrying bag x 1
- Thermal conductive gel x 1
- Testing clips (1 black & 1 red) x 1
- 4-wire to 2-wire connecting cable x 1
- 4-wire testing cable x 1
- Solar 15: DC current probe x 1
- Solar 21: AC power clamp x 1
- Testing clips (1 black & 1 red) x 1

Solar System Analyzer

User Interface & Data Acquisition Software



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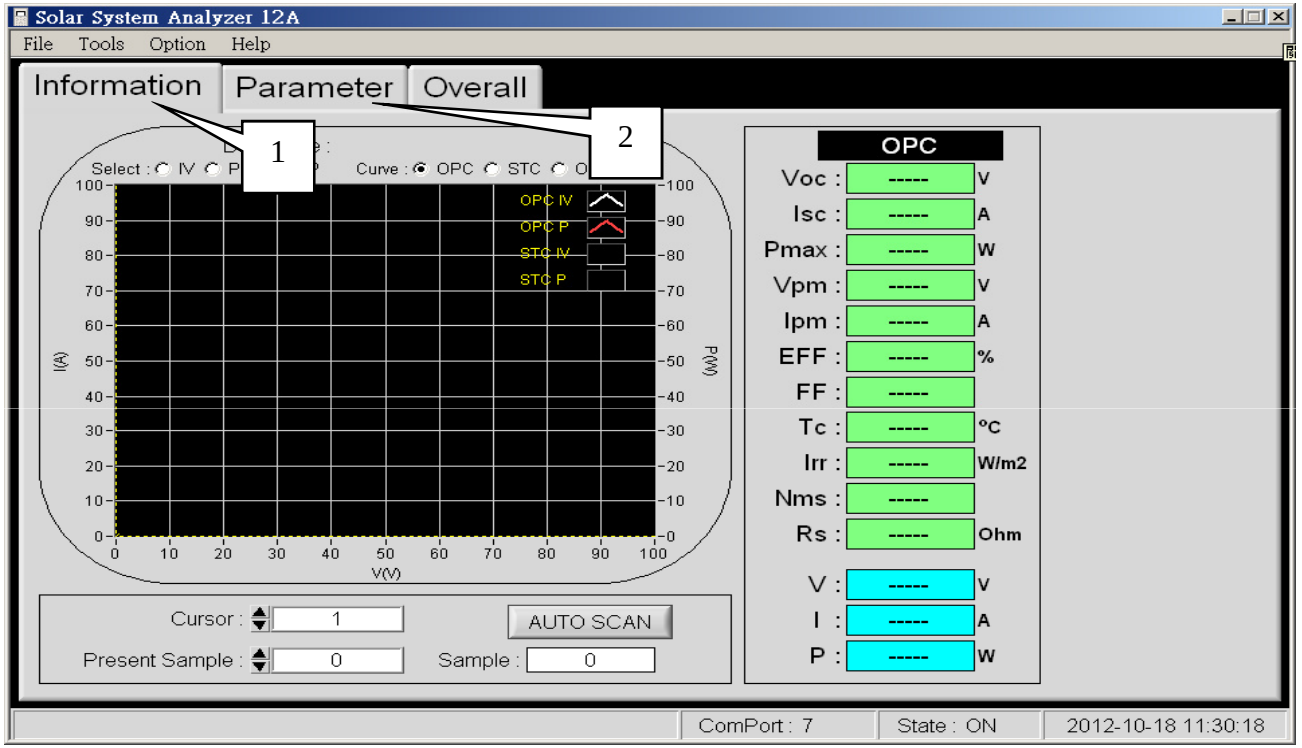
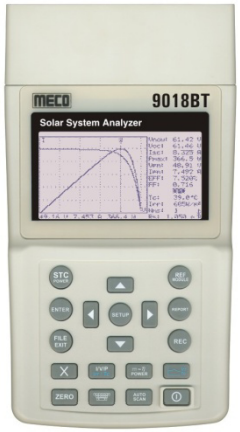


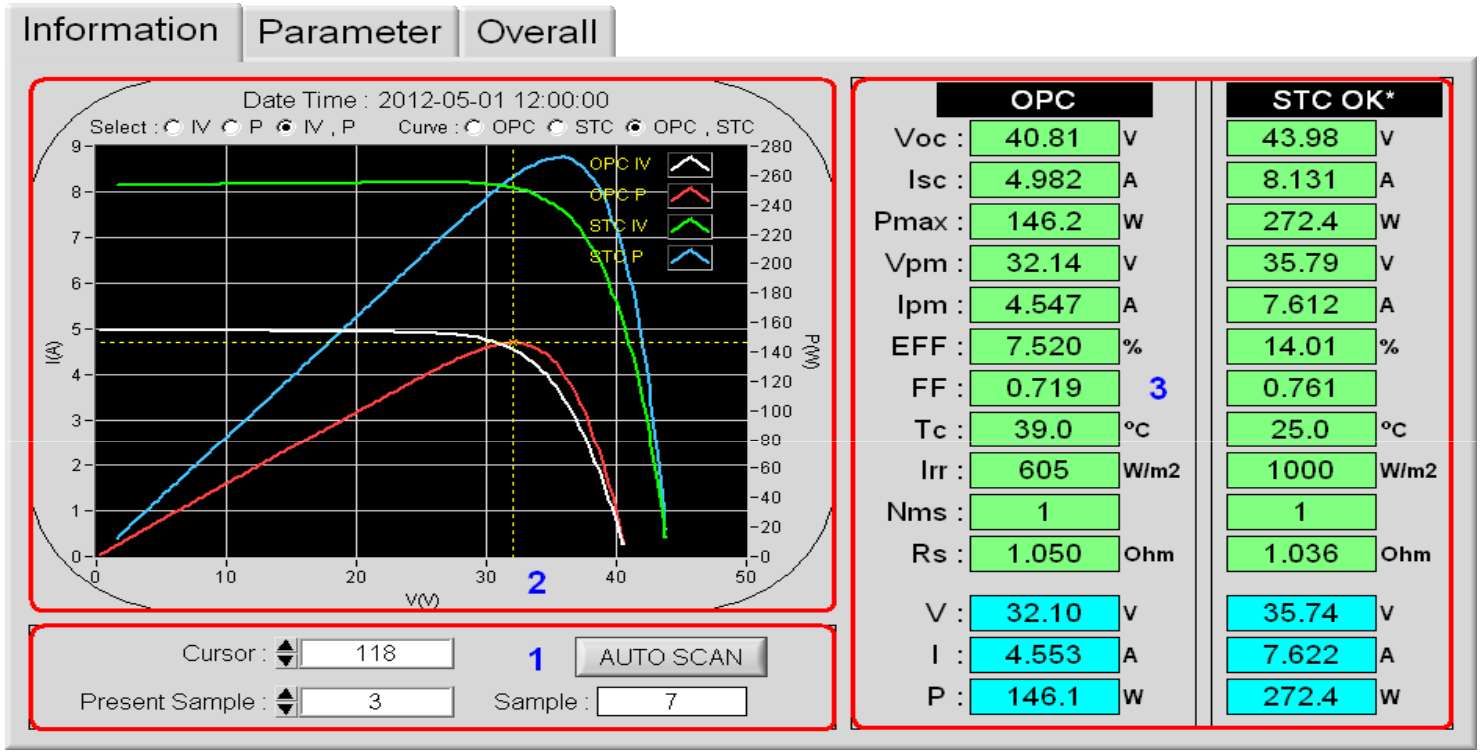
1. Information, Parameter, Overall
2. Tool bar: including File, Tools, Option, Help

1. Information



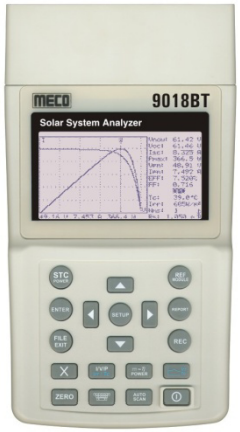
CE

Software



Information : Voc (voltage at open circuit), Isc (current at short circuit), Pmax (max. power), Vpm (max. voltage at Pmax), Ipm (max. current at Pmax), EFF (efficiency), FF (Fill Factor), Tc (Temperature), Irr (Irradiance), Nms (number of solar panels), Rs (series resistance)

2. Parameters



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Set up parameters for the Analyzer

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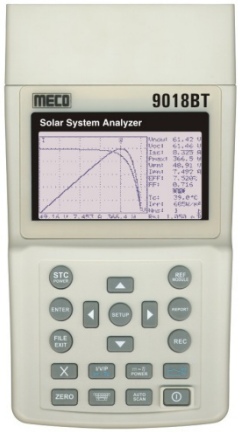
Software

Information | Parameter | Overall

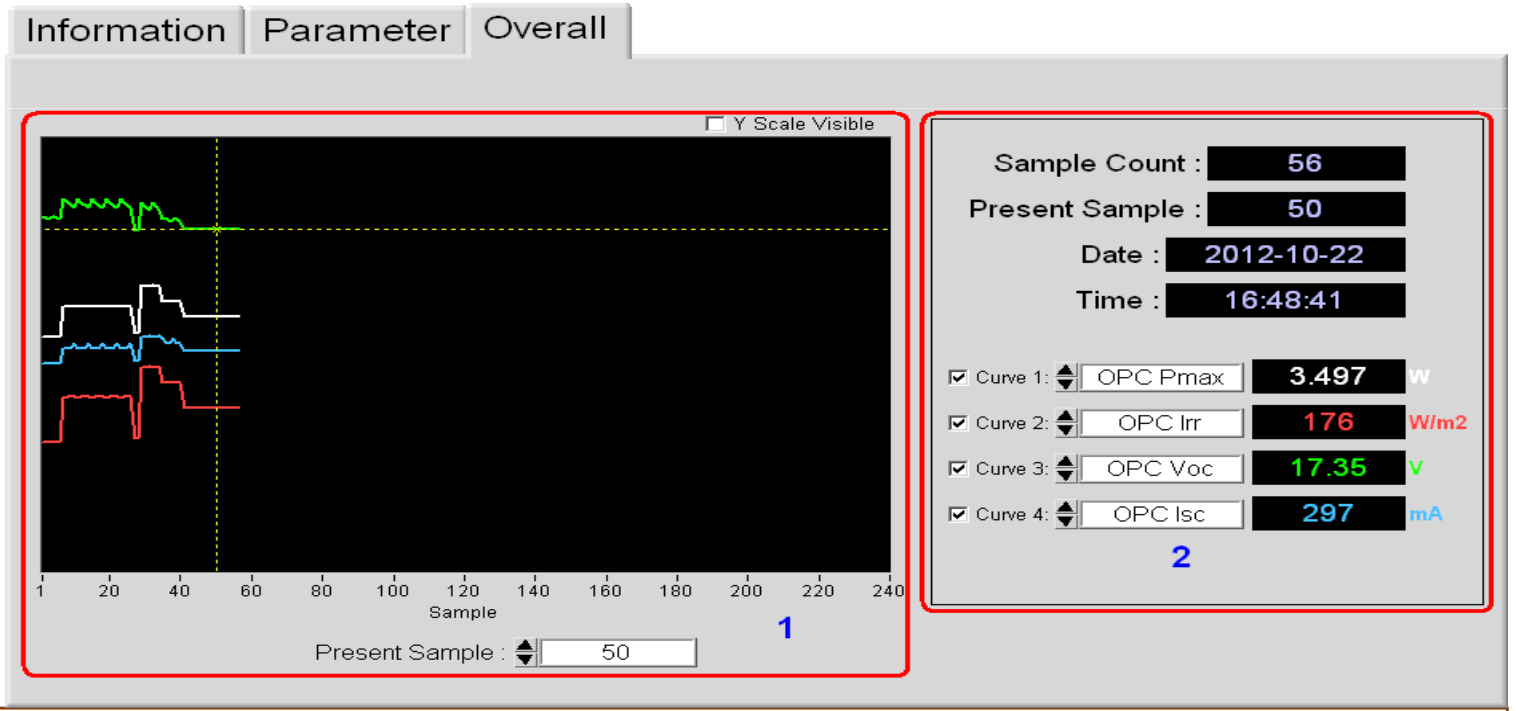
Module :	DEFAULT_MOD		
Nms :	1		(1 ~ 99)
Pmax :	272	W	(20 ~ 999 W)
Voc :	43.97	V	(0.00 ~ 999.0 V)
Isc :	8.150	A	(0.000 ~ 15.00 A)
Vpm :	35.90	V	(0.00 ~ 999.0 V)
Ipm :	7.570	A	(0.000 ~ 15.00 A)
Area :	1.944	m2	(0.001 ~ 9999 m2)
Toll+ :	3.0	%	(0.0 ~ 25.0 %)
Toll- :	3.0	%	(0.0 ~ 25.0 %)
Alpha :	0.090	%/°C	(0.001 ~ 1.000 %/°C)
Beta :	-0.340	%/°C	(-0.001 ~ -1.000 %/°C)
Gamma :	-0.370	%/°C	(-0.001 ~ -1.000 %/°C)
K :	1.00	mOhm	(0.00 ~ 10.00 mOhm)

Load | Save | Save As

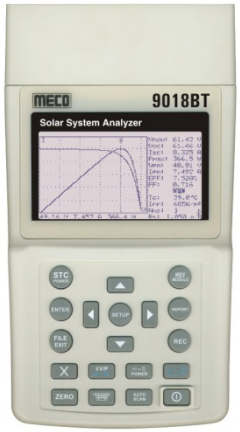
3. Overall Trends



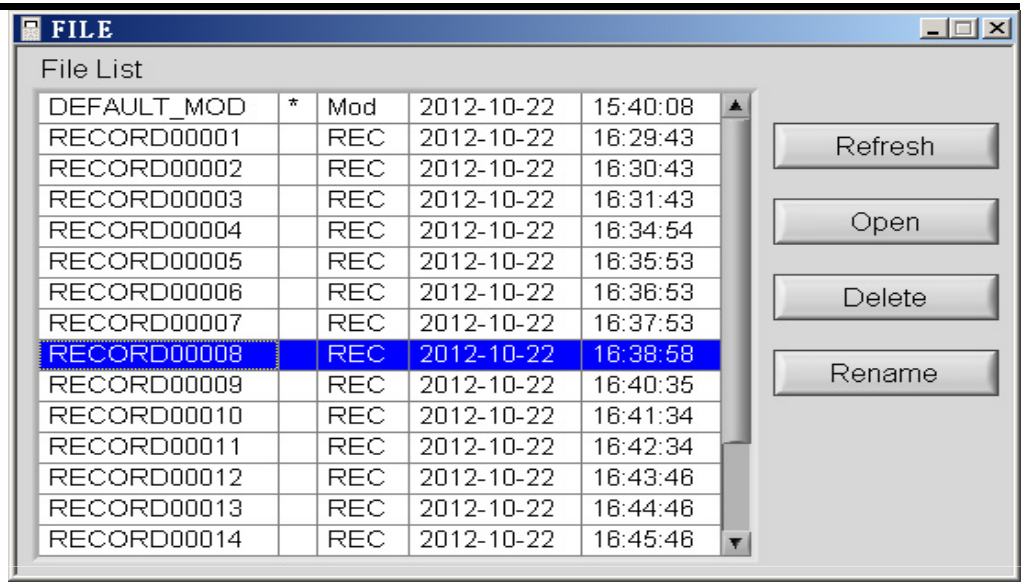
- Sample Count (total number of samples)
- Present Sample (displayed on Curve area)
- Date & Time (recording time of the present sample)
- Next to the 4 data, users can choose: a curve name for display; display functions; tick to display the data curve.



4. Tools



1. File List



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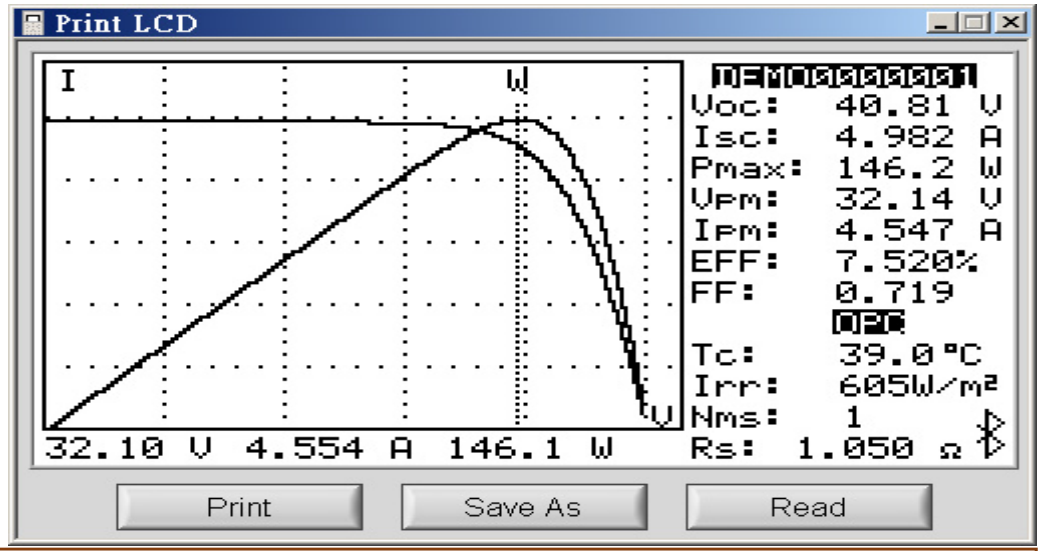
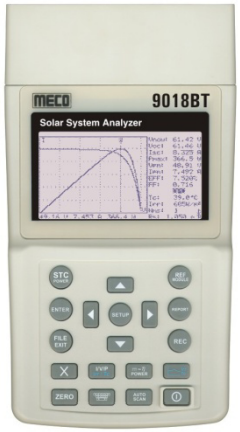
Software

2. Print LCD



4. Tools



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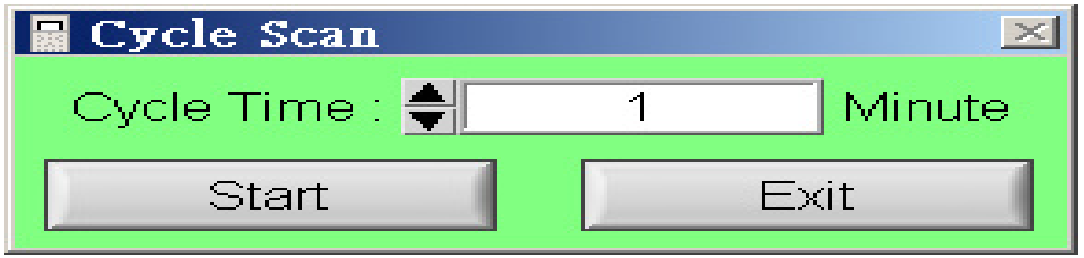
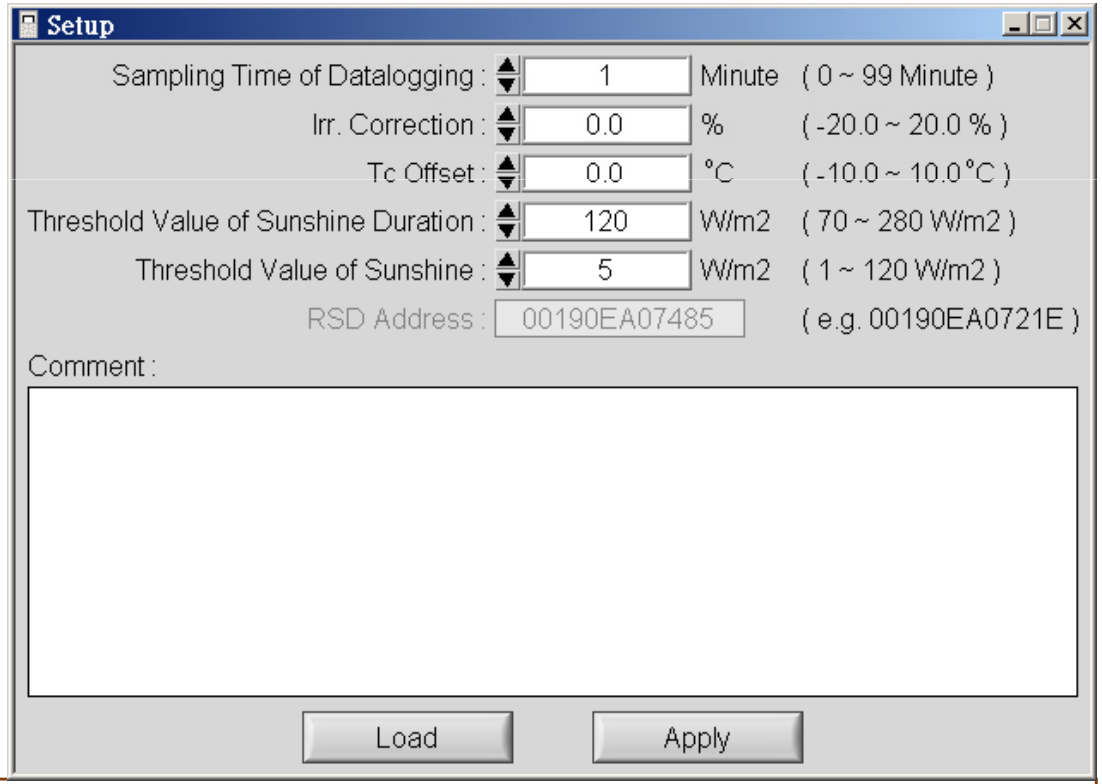
Software

3. Cycle Scan

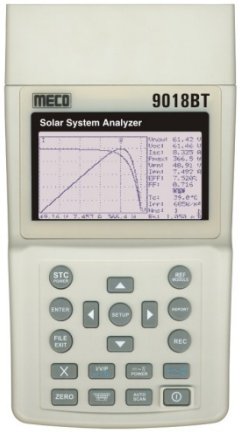


4. Setup

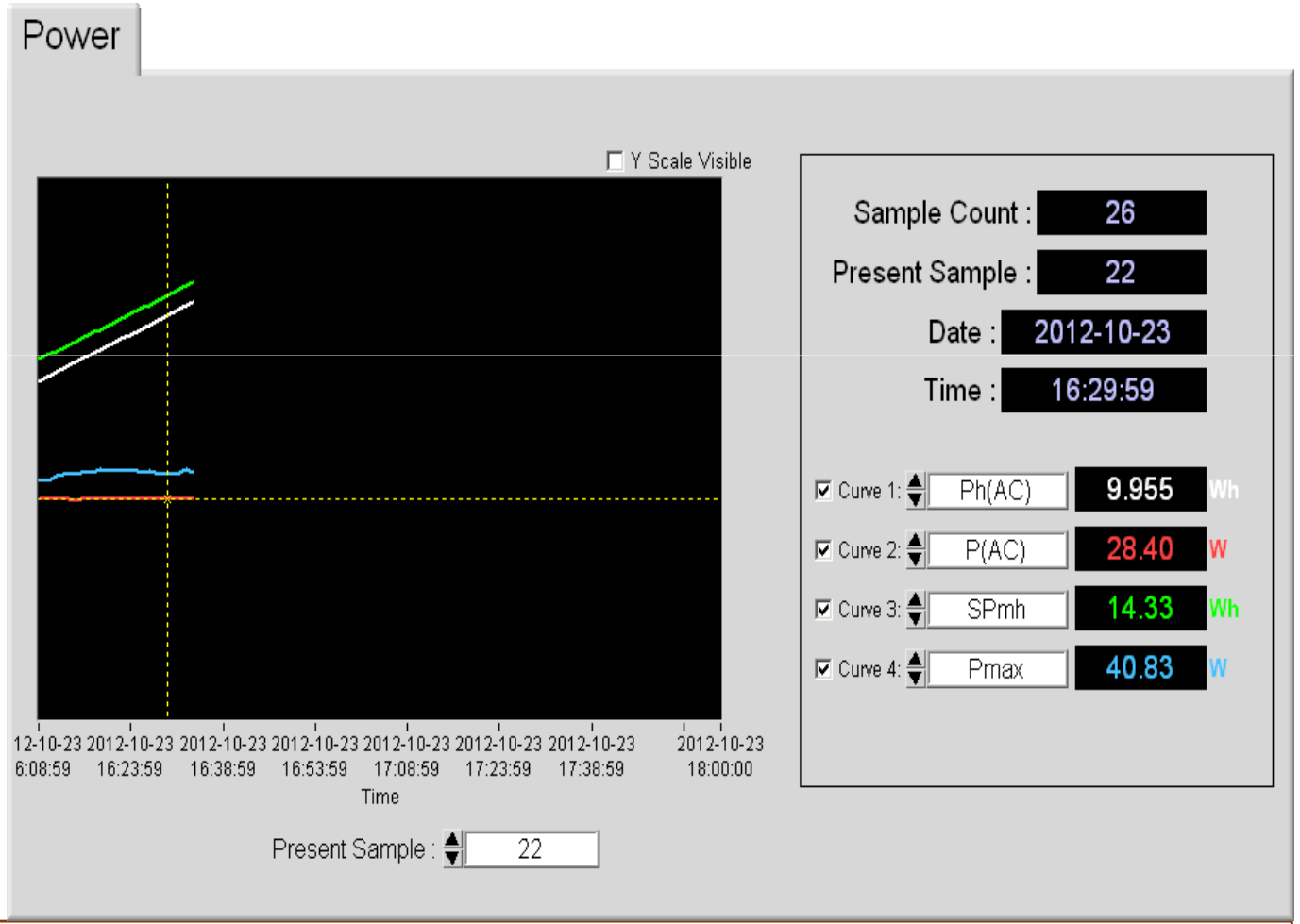


4. Tools

5. Power Curves

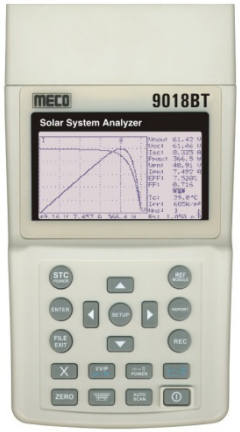


- After opening a PWR file in File List, the Power curves will display

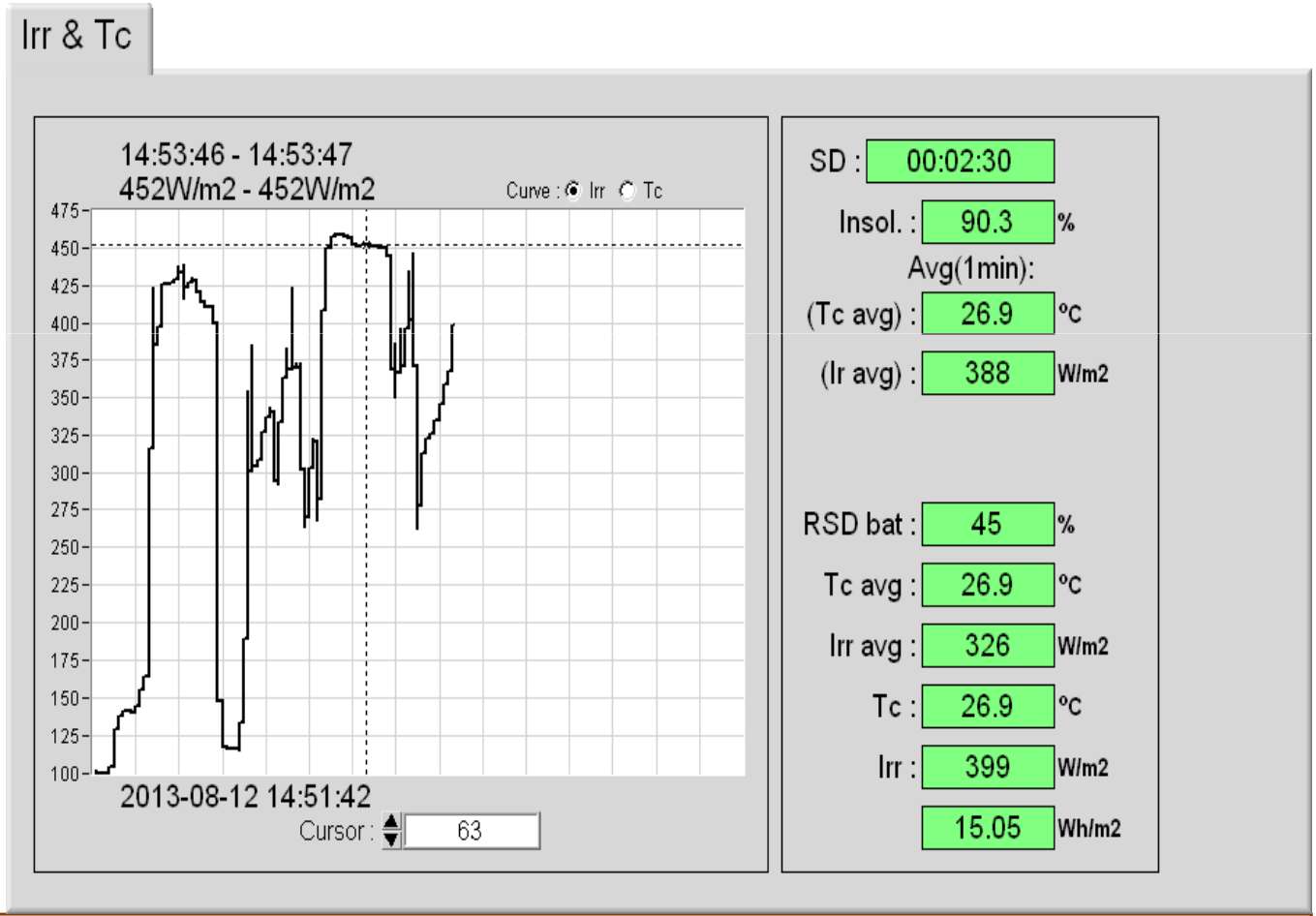


4. Tools

6. Irradiance/Temperature Recording

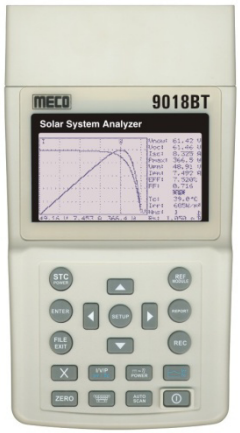


- The software will record irradiance / temperature per second and draw curves accordingly



Solar System Analyzer

Solar Panel Test Report



CE

Software

- Generate a report with the testing data and curves of “Information”
- This report can be viewed by Browser and printed out

Solar Panel Test Report

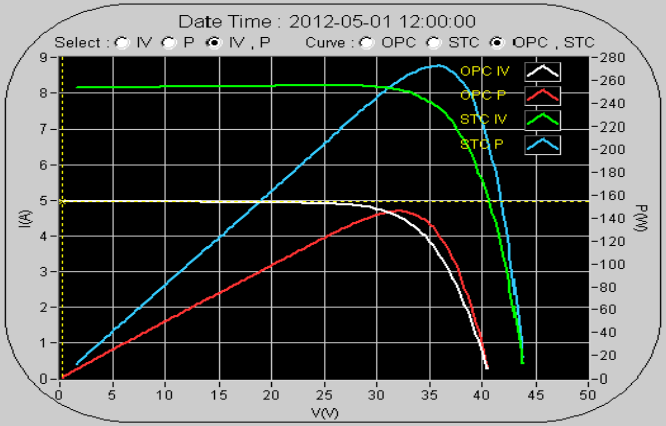
Date and Time of Testing: 2012-5-1 12:00:00
File Name: PS10 solar power tower test report-20120501
Name of Operator: John
Name of Company: SOLAR CAPITAL CO. LTD.
Address of Company: address

Comment:
Tested by John at PS10 solar power tower

Date & Time:"2012-05-01 12:00:00

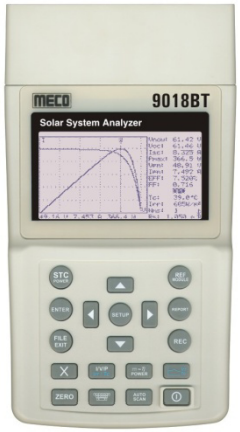
Data Type:OPC	Data Type:STC Test Result:OK*
Voc (V):40.81	Voc (V):43.98
Isc (A):4.982	Isc (A):8.131
Pmax (W):146.2026	Pmax (W):272.4598
Vpm (V):32.14	Vpm (V):35.79
Ipm (A):4.547	Ipm (A):7.612
EFF (%):7.520	EFF (%):14.015
FF:0.719	FF:0.761
Tc (degC):39.0	Tc (degC):25.0
Irr (W/m2):605	Irr (W/m2):1000
Nms:1	Nms:1
Rs (Ohm):1.0500	Rs (Ohm):1.0360

Information | Parameter | Overall



	OPC		STC OK*	
Voc :	40.81	V	43.98	V
Isc :	4.982	A	8.131	A
Pmax :	146.2	W	272.4	W
Vpm :	32.14	V	35.79	V
Ipm :	4.547	A	7.612	A
EFF :	7.520	%	14.01	%
FF :	0.719		0.761	
Tc :	39.0	°C	25.0	°C
Irr :	605	W/m2	1000	W/m2
Nms :	1		1	
Rs :	1.050	Ohm	1.036	Ohm
V :	0.27	V	1.50	V
I :	4.981	A	8.132	A
P :	1.355	W	12.25	W

Advantages



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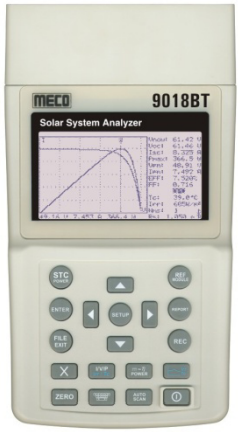
Software

Consultants	Easy to Use
Engineers	Latest Technology
Buyer	Saves Time and Money
Commissioning Staff	Easy Programming
End User	No Maintenance

Solar System Analyzer

Customer Testimonials/ Appreciation Letters



CE

Software

भारत सरकार
अन्तरिक्ष विभाग
इसरो उपग्रह केन्द्र
पोस्ट बॉक्स नं. 1795, हवाई पत्तन मार्ग
विमानपुरा डाक घर, बेंगलूरु - 560 017, भारत
दूरभाष :
फैक्स :

सत्यमेव जयते

Government of India
Department of Space
ISRO Satellite Centre
Post Box. No. 1795, Airport Road, Vimanapura Post
Bangalore - 560 017. India
Telephone :
Fax : 25084024
25205283/84

ISCP-2012-0-24809-0101 LO 17/07/2013

WHOM SO EVER IT MAY CONCERN

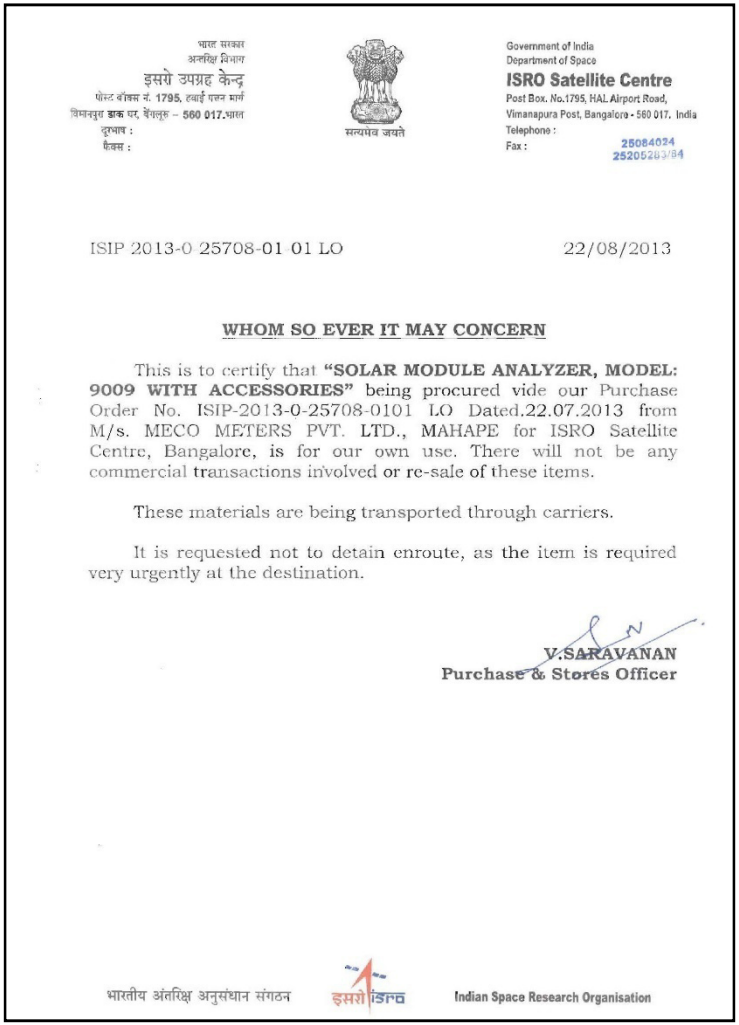
This is to certify that **"SOLAR MODULE ANALYSER" (SMA) LOW POWER SMA AND HIGH POWER SMA** which is procured vide our Purchase Order No. ISCP-2012-0-24809-0101 LO Dated.17.06.2013 from **M/s. MECO METERS PVT LTD., MAHAPE** for ISRO Satellite Centre, Bangalore, is for our own use. There will not be any commercial transactions involved or re-sale of these items.

These materials are being transported through carriers.

It is requested not to detain enroute, as the item is required very urgently at the destination.

V.SARAVANAN
Purchase & Stores Officer

भारतीय अन्तरिक्ष अनुसंधान संगठन इसरो ISRO Indian Space Research Organisation



भारत सरकार
अन्तरिक्ष विभाग
इसरो उपग्रह केन्द्र
पोस्ट बॉक्स नं. 1795, हवाई पत्तन मार्ग
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दूरभाष :
फैक्स :

सत्यमेव जयते

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Department of Space
ISRO Satellite Centre
Post Box. No.1795, HAL Airport Road,
Vimanapura Post, Bangalore - 560 017. India
Telephone :
Fax : 25084024
25205283/84

ISIP 2013-0 25708-01 01 LO 22/08/2013

WHOM SO EVER IT MAY CONCERN

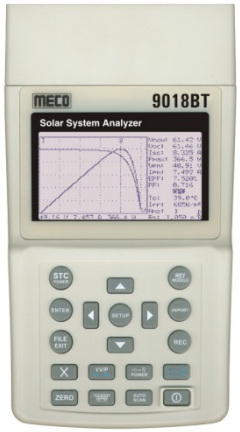
This is to certify that **"SOLAR MODULE ANALYZER, MODEL: 9009 WITH ACCESSORIES"** being procured vide our Purchase Order No. ISIP-2013-0-25708-0101 LO Dated.22.07.2013 from M/s. MECO METERS PVT. LTD., MAHAPE for ISRO Satellite Centre, Bangalore, is for our own use. There will not be any commercial transactions involved or re-sale of these items.

These materials are being transported through carriers.

It is requested not to detain enroute, as the item is required very urgently at the destination.

V.SARAVANAN
Purchase & Stores Officer

भारतीय अंतरिक्ष अनुसंधान संगठन इसरो ISRO Indian Space Research Organisation



We look forward for your a collaborative approach for Efficient Energy Management

&

Better Instrumentation

Meco Instruments Pvt Ltd., Mumbai