

# SOLAR I-V

## MULTIFUNCTION INSTRUMENT FOR TESTING AND VERIFYING SINGLE-PHASE PHOTOVOLTAIC INSTALLATIONS

SOLAR I-V has been designed to meet any requirement of photovoltaic installation specialists. Further to providing the possibility of measuring and recording the efficiency of single-string and single-phase photovoltaic systems, SOLAR I-V also measures the I-V characteristic both of a single module and of module strings. Thanks to SOLAR I-V, the operator can test the photovoltaic system and, should it give a negative result, immediately identify the problems of the system in order to promptly solve them. SOLAR I-V is provided with the remote unit SOLAR-02 which permits the remote measuring of irradiation and temperature with preliminary automatic synchronization between main unit and remote unit. SOLAR-02 is positioned next to the photovoltaic modules and it is connected to the probes for measuring environmental parameters. The synchronization between the two units guarantees the necessary contemporaneity of measurements. In the case of PV efficiency recordings, this grants the right efficiency calculation. For I-V curve measurements, the synchronization permits to extrapolate the I-V curve at STC without using long extension cords cable. SOLAR I-V allows carrying out efficiency recordings over time with programmable integration period from 5 seconds to 60 minutes. Each value is automatically saved in the internal memory and can be downloaded onto the PC for subsequent analyses. The measured I-V characteristic is not affected by the resistance of the measurement cables, as the measurement is carried out with the 4-terminal measuring method. SOLAR I-V also manages a database of photovoltaic modules, which can be updated at any time. The measured values, correctly reported at standard test conditions, are immediately compared with the values declared by the manufacturer to give the OK / NO result of the test. The operator must not do any calculation, the instrument carries out the comparison rapidly and automatically. The instrument can be interfaced with accessory MPP 300, which extends the characteristics of SOLAR I-V by enabling recordings on single-phase and three-phase, single-string and multi-string (up to three strings), single-inverter and multi-inverter photovoltaic systems (therefore also in three-phase systems provided with three single-phase inverters).

### FUNCTIONS

#### Photovoltaic efficiency recording

- Measurement of DC/AC TRMS voltage and current
- Measurement of DC/AC powers on single-phase systems
- Measurement of solar irradiation [W/m<sup>2</sup>] with reference cell
- Measurement of environmental and module temperature by means of external probe
- Synchronization with remote unit SOLAR-02
- Display of real-time irradiation and temperature
- Use of PDC compensation ratios according to environmental and module temperature
- Three-phase up to three strings PV systems (with MPP300)
- Recording of parameters with programmable IP (5s – 60min)

#### I-V curve measurement

- Measurement of output voltage from module/string up to 1000V DC
- Measurement of output current from module/string up to 10A DC
- Measurement of solar irradiation [W/m<sup>2</sup>] with reference cell
- Measurement of module temperature, automatic or by means of external probe
- Measurement of output DC and nominal power from module/string
- Synchronization with remote unit SOLAR-02
- Numerical and graphical display of I-V characteristic
- Quick test mode
- Measurement of the resistance of photovoltaic module series
- Mechanical inclinometer for the detection of the incidence angle of solar irradiation
- 4-terminal measuring method
- Extrapolation to standard test conditions (STC)
- Evaluation of testing result: OK / NO
- Management of up to 30 types of photovoltaic modules in the internal database

#### Common characteristics

- Internal memory for data saving
- Recalling results on the display
- Optical/USB port for PC connection
- Help on line on the display

### GENERAL CHARACTERISTICS

Display:	LCD custom, 128x128pxl, backlit
Power supply:	6x1.5V alkaline bat. type AA LR06
Auto power off:	after 5 minutes in stand-by
PV testing duration:	1.5 hours (@IP=5s); 8 days (@IP=10min)
Curves which can be saved:	> 200 curves
PC interface:	optoisolated optical/USB port
Safety:	IEC/EN61010-1
Measuring accessory safety:	IEC/EN61010-031, IEC/EN61010-032
Measures on PV modules:	IEC/EN60891, IEC/EN62446
Insulation	double insulation
Pollution degree:	2
Measurement category:	CAT II 1000V DC, CAT III 300V (to earth) Max 1000V between inputs
Dimensions:	235x165x75mm
Weight (batteries included):	1.3kg

### ACCESSORIES

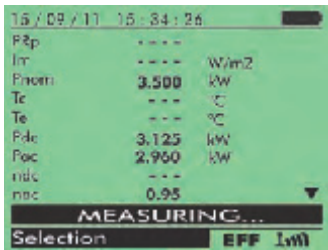
Standard	Code
Remote unit to record irradiation and temperature	SOLAR-02
Kit of 4 cables with 4mm banana plugs + 4 alligator clips	KITGSC4
Kit of 2 adapters with MC3 compatible connectors	KITPVMC3
Kit of 2 adapters with MC4 compatible connectors	KITPVMC4
Transducer for AC 0÷200A, diameter 40mm	HT4005K
Transducer for AC/DC currents 0÷10 - 0÷100A, diameter 32mm	HT4004N
Reference cell for irradiation measurement	HT304N
Probe PT1000 for environmental and module temperature	PT300N
Mechanical inclinometer	M304
Windows software + optical/USB cable C2006	TOPVIEW2006
Rigid transport suitcase	VA500
User manual on CD-ROM	
Calibration certificate ISO9000	
Rapid user guide	
<b>Optional</b>	
Multi-string three-phase adaptor	MPP300
Transducer for 0÷5A, 0÷100A AC currents Ø 20mm	HT4005N
Transducer for 0÷200A, AC currents Ø 40mm	HT4005K
Transducer for 0÷1A, 0÷100A, 0÷1000A AC currents Ø 54mm	HT96U
Transducer for 0÷10A, 0÷100A, 0÷1000A AC currents Ø 54mm	HT97U
Transducer for 0÷200A, 0÷2000A AC currents Ø 70mm	HP30C2
Transducer for 0÷3000A AC currents Ø 70mm	HP30C3
Transducer for 0÷1000A DC currents Ø 50mm	HT98U
Transducer for 0÷1000A DC currents Ø 83mm	HP30D1
Kit of belts for slinging the instrument over one's shoulder	SP-0400
Kit of 2 cables banana 4mm, green/black, 25m	KITPVEXT25M
Rigid transport suitcase	VA400
Magnetic adapter for connection to screw heads	606-IECN

Multistring with MPP300

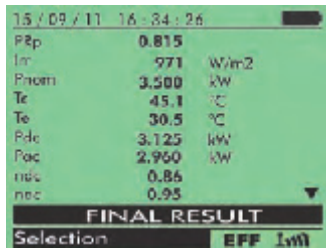


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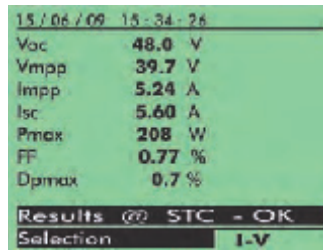
台北：三重區重新路五段609巷16號6樓之1 新竹：新竹縣竹北市台元26號4樓之10  
 TEL: 02-2782269 FAX: 02-22782059 TEL: 03-552-6779 FAX: 03-552-6739  
 http://www.wfl.uke-teknorix.tw http://www.radi.tek.com.tw



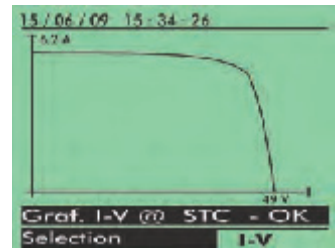
Testing / Recording in progress



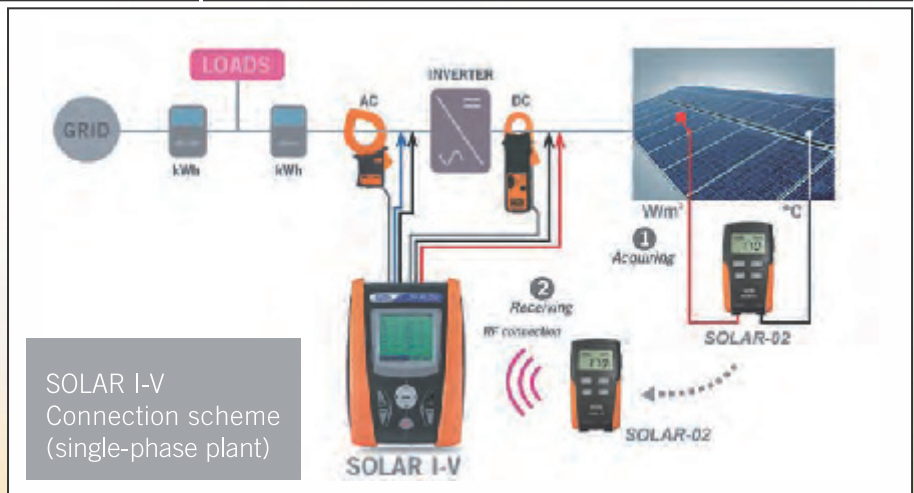
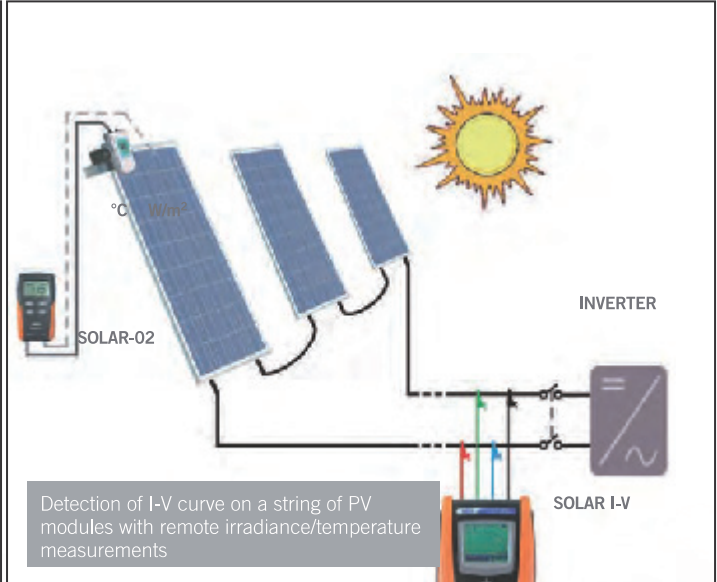
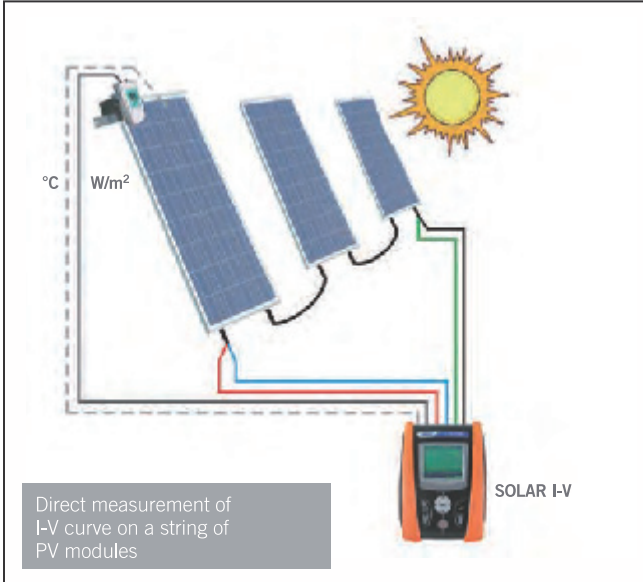
Testing result of photovoltaic system



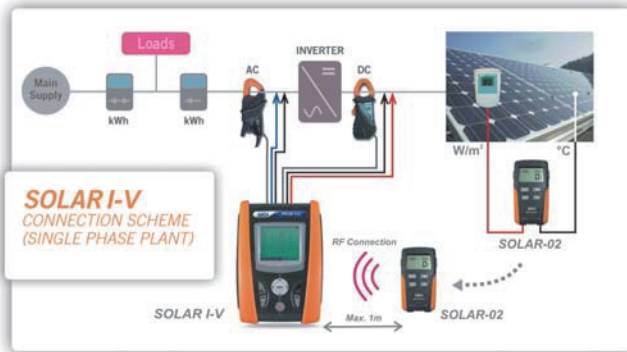
Numerical display of results with OK result



Graphical display of an I-V curve with OK result



## 1. SOLAR I-V MAIN FEATURES

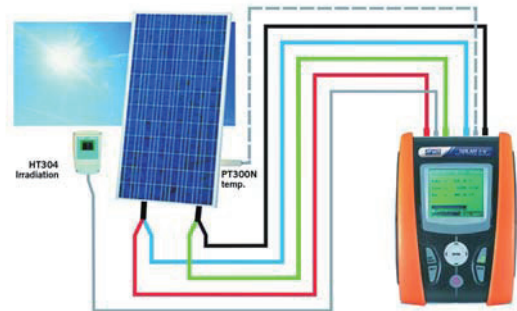


### SOLAR I-V: use as PV certifier

SOLAR I-V performs all tests on Single phase PV plants by using of SOLAR-02 remote unit which, after a preliminary synchronisation, save in independent way the values of irradiance and temperature. Only at the end of test the remote unit should be connected via wireless RF with the master to download the recorded data

### SOLAR I-V: use as I-V curve checker

SOLAR I-V allows the on field measurement of I-V curve as well as of the main parameters of a single module and of a whole photovoltaic system up to a maximum of 1000V and 10A



With SOLAR-02 remote unit the irradiance and temperature measured values are shown at display also in independent mode (ideal solution during a pre-test on installation) besides test/recording with SOLAR I-V

The HT304N reference cell permits to performs solar irradiance measurements both on PV modules in Monocrystalline and Polycrystalline silicon material





## 2. ELECTRICAL SPECIFICATIONS

Accuracy is calculated as  $\pm$  [% readings + (no. of digits) \* resolution] at 23°C  $\pm$  5°C, con relative humidity <80%HR

### 2.1. CERTIFIER OF SINGLE PHASE PV INSTALLATION

#### DC Voltage

Range (V)	Resolution (V)	Accuracy
15.0 $\div$ 999.9	0.1	$\pm$ (0.5%rdg + 2dgt)

#### AC TRMS Voltage

Range (V)	Resolution (V)	Accuracy
50.0 $\div$ 265.0	0.1	$\pm$ (0.5%rdg + 2dgt)

Max crest factor: 1.5

#### DC Current (by external transducer clamp)

Range (mV)	Resolution (mV)	Accuracy
-1100 $\div$ -5	0.1	$\pm$ (0.5%rdg + 0.6mV)
5 $\div$ 1100		

The value of current is ALWAYS displayed with positive sign ; The value of current transduced in voltage less then 5mV is zeroed

#### AC TRMS Current (by external transducer clamp)

Range (mV)	Resolution (mV)	Frequency (Hz)	Accuracy
1 $\div$ 1200	0.1	47.5 $\div$ 63.0	$\pm$ (0.5%rdg + 0.6mV)

Max crest factor: 2.0 ; The value of current transduced in voltage less then 5mV is zeroed

FS DC & AC clamp (A)	Resolution (A)	Minimum read value (A)	
		DC	AC
1 < FS $\leq$ 10	0.001	0.05	0.01
10 < FS $\leq$ 100	0.01	0.5	0.1
100 < FS $\leq$ 1000	0.1	5A	1

#### DC Power (Vmeas > 150V)

FS clamp (A)	Range (W)	Resolution (W)	Accuracy
1 < FS $\leq$ 10	0.000k $\div$ 9.999k	0.001k	$\pm$ (0.7%rdg+3dgt) (I <sub>meas</sub> < 10%FS)
	10.00k $\div$ 99.99k	0.01k	
10 < FS $\leq$ 100	0.000k $\div$ 9.999k	0.001k	$\pm$ 0.7%rdg (I <sub>meas</sub> $\geq$ 10%FS)
	10.00k $\div$ 99.99k	0.01k	
100 < FS $\leq$ 1000	0.00k $\div$ 99.99k	0.01k	
	100.0k $\div$ 999.9k	0.1k	

V<sub>meas</sub> = voltage correspondent to measured power

#### AC Single phase power (@ PF = 1, Vmeas > 200V)

FS clamp (A)	Range (W)	Resolution (W)	Accuracy
1 < FS $\leq$ 10	0.000k $\div$ 9.999k	0.001k	$\pm$ (0.7%rdg+3dgt) (I <sub>meas</sub> < 10%FS)
	10.00k $\div$ 99.99k	0.01k	
10 < FS $\leq$ 100	0.000k $\div$ 9.999k	0.001k	$\pm$ 0.7%rdg (I <sub>meas</sub> $\geq$ 10%FS)
	10.00k $\div$ 99.99k	0.01k	
100 < FS $\leq$ 1000	0.00k $\div$ 99.99k	0.01k	
	100.0k $\div$ 999.9k	0.1k	

V<sub>meas</sub> = voltage correspondent to measured power



# SOLAR I-V

Rel. 1.02 – 18/06/12

PV single phase certifier and I-V curve checker

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## Frequency

Range (Hz)	Resolution (Hz)	Accuracy
47.5 ÷ 63.0Hz	0.1	$\pm(0.2\%rdg+1dgt)$

## Irradiance (by reference cell)

Range (mV)	Resolution (mV)	Accuracy
1.0 ÷ 100.0	0.1	$\pm(1.0\%rdg + 5dgt)$

## Temperature (by external probe PT1000)

Range (°C)	Resolution (°C)	Accuracy
-20.0 ÷ 100.0	0.1	$\pm (1.0\%rdg + 1^{\circ}C)$





## 2.2. I-V CURVE and IVCK MEASUREMENTS

### VDC Voltage @ OPC

Range (V) (***)	Resolution (V)	Accuracy
5.0 ÷ 999.9	0.1	±(1.0%rdg+2dgt)

(\*\*\*) The I-V curve and Rs measurements start for VDC > 15V and the accuracy is defined for VDC > 20V

### IDC Current @ OPC

Range (A)	Resolution (A)	Accuracy
0.10 ÷ 10.00	0.01	±(1.0%rdg+2dgt)

### Max Power @ OPC (Vmpp >30V, Impp >2A)

Range (W) (*, **)	Resolution (W)	Accuracy
50 ÷ 9999	1	±(1.0%rdg+6dgt)

Vmpp = Maximum power voltage, Impp = Maximum Power Current

(\*) Max measurable value of Power must include FF value (~ 0.7) → Pmax = 1000V x 10A x 0.7 = 7000W

(\*\*) Test is stopped and the message "Thermal instability" occurs if the instrument detects Voltage > 700V and Current I > 3A, I > -0.038\*V + 37.24 - 0.5

### VDC Voltage (@ STC and OPC), IVCK

Range (V) (***)	Resolution (V)	Accuracy (*, **)
5.0 ÷ 999.9	0.1	±(4.0%rdg+2dgt)

### IDC Current (@ STC and OPC), IVCK

Range (A)	Resolution (A)	Accuracy (**)
0.10 ÷ 10.00	0.01	±(4.0%rdg+2dgt)

### Max Power @ STC (Vmpp >30V, Impp >2A)

Range (W) (*, **)	Resolution (W)	Global accuracy (**)
50 ÷ 9999	1	±(5.0%rdg+1dgt)

Vmpp = Maximum power voltage, Impp = Maximum Power Current

(\*) Measurements start for VDC > 15V and the accuracy is defined for VDC > 20V

(\*\*) Test conditions:

- > Test cond.: Steady Irrad. ≥ 700W/m<sup>2</sup>, spectrum AM 1.5, solar incidence vs perpendicular. ≤ ± 25°, Cells Temp. [15..65°C]
- > Global accuracy include contribute of solar sensor and its measuring circuit

### Irradiance (with reference cell)

Range (mV)	Resolution (mV)	Accuracy
1.0 ÷ 100.0	0.1	±(1.0%rdg+5dgt)

### Temperature of module (with auxiliary PT1000 probe)

Range (°C)	Resolution (°C)	Accuracy
-20.0 ÷ 100.0	0.1	±(1.0%rdg+1°C)



## 3. GENERAL SPECIFICATIONS

### DISPLAY AND MEMORY:

Features:	128x128pxl custom LCD with backlight
Memory capacity:	256kbytes
Saved data:	max 99 yield test ; 249 curves (I-V curve test), 999 IVCK

### POWER SUPPLY:

SOLAR I-V internal power supply:	6x1.5V alkaline batteries type LR6, AA, AM3, MN 1500
Autonomy of SOLAR I-V:	> 249 curve (I-V curve test), 999 IVCK test approx 120 hours (yield test)
SOLAR-02 power supply:	4x1.5V alkaline batteries type AAA LR03
SOLAR-02 max recording time (@ IP=5s):	approx 1.5h

### OUTPUT INTERFACE

PC communication port:	optical/USB
Interface with SOLAR-02 :	wireless RF communication (max distance 1m)

### MECHANICAL FEATURES

Dimensions (L x W x H):	235 x 165 x 75mm
Weight (batteries included):	1.2kg

### ENVIRONMENTAL CONDITIONS:

Reference temperature:	23°C ± 5°C
Working temperature:	0° ÷ 40°C
Working humidity:	<80%HR
Storage temperature (batt. not included):	-10 ÷ 60°C
Storage humidity:	<80%HR

### GENERAL REFERENCE STANDARDS:

Safety:	IEC/EN61010-1
Safety of measurement accessories:	IEC/EN61010-031
I-V curve measurement:	IEC/EN60891 (I-V curve test) IEC/EN60904-5 (Temperature measurement)
Insulation:	double insulation
Pollution degree:	2
Overvoltage category:	CAT II 1000V DC, CAT III 300V AC to ground Max 1000V among inputs P1, P2, C1, c2
Max altitude of use:	2000m

**This instrument complies with the requirements of the European Low Voltage Directives 2006/95/EEC (LVD) and EMC 2004/108/EEC**