University of Applied Sciences and Arts of Southern Switzerland
Department for Environment Constructions and Design
Institute for Applied Sustainability to the Built Environment

SUPSI

MPPT3000

User Manual

High Accuracy, Customizable
MULTIFUNCTION TESTING DEVICE FOR PHOTOVOLTAIC MODULES

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CH - 6952 Canobbio

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Important safety notice

Warning :
In all cases the assembly and installation must be done by qualified technicians, observing the national requirements and rules stipulated.

Opening the MPPT3000 or using it incorrectly will result in the immediate loss of the warranty, (unless for upgrades in agreement with manufacturer)

Warranty:
1 year.

Limitation of liability :
ISAAC - SUPSI cannot control the installation, use and maintenance of the MPPT3000.
Thus, we are not responsible for damages, costs or losses resulting from an installation which is not in accordance with the regulations or inappropriate use or maintenance.

The customer is always responsible for the use of the MPPT3000 and any other related additional device.
This device has not been designed nor warranted for use in any critical apparatus with potential risks of serious harm to people or to the environment.

ISAAC - SUPSI reserves the right to modify their products without previous notice.

Short description

The MPPT 3000 is a multifunction testing device for photovoltaic modules. A photovoltaic module, when connected to the MPPT 3000, is set to work in a MPP tracking mode. The MPPT 3000 also allows a customized I-V Tracer function. It is possible to connect RTD temperature sensors, pyranometers or other external sensors. The interaction with the MPPT is possible directly using its LCD and buttons or through a simple graphical user interface. The PV module energy is dissipated using an external resistor load with heat sink that must be always connected. This device has been developed for specific PV module testing at the ISAAC - SUPSI laboratory (TISO group).

- accurate MPP tracking: maximum 0.5 % error on P_{MPP} tracking
- wide voltage and current scalable ranges: up to 200V / 20A / max 250W
- optoisolated analog auxiliary outputs in order to measure, using an external measurement system, the PV module working condition and the auxiliary sensors
- built-in independent data logging: internal data storage allowing the use of the MPPT as datalogger
- transportable, compact, wide operating ambient temperature range (from -20°C to +40 °C)
- galvanically isolated RS-485 interface: dialog between PC master and one or more MPPTs
- I-V Tracer : use of the MPPT3000 as settable IV Tracer
- simultaneous Im and Vm measurement
- non isolated analog output (optional)
- run-time selectable ranges (automatic or manual)
- possibility to measure, thanks to a built-in micro-converter and independently from data loggers or external peripherals, the main meteorological parameters (T, G, …) by means of auxiliary sensors (sensors are not included)
- user friendly management software
- IP 20 case

Applications

This electrical equipment is extremely useful for anyone who needs to accurately test photovoltaic modules such school laboratories, module manufacturers or module providers, testing laboratories and so on.
Typical applications are:

- sc-Si, mc-Si, a-Si, thin-film accurate module testing
- I-V characterization
- Energy production test and comparison at outdoor real conditions
- Meteorological measurements during module test
- Comparison of an existing PV plant behaviour with respect to a reference PV module under test using the MPPT3000.

Technical specifications

General		
MPPT power supply	-	+24VDC / 8 W +/-10%
Operating ambient temperature	°C	from -20 to +40
Case protection grade	-	IP20
Load output resistor	Ω	from 18 to 47 (**Load must always be connected !**)
Dimensions	mm	194 x 221 x 162 without cableglands nor cables
Weight	kg	5
Photovoltaic module values		
P_{MAX} in	W	250 (continuous);
V_{MAX} @ 250W	V	150
$I_{SC\ MAX}$	A	5 / 10 / 20 (depends on the model)
$V_{m\ MIN}$	V	5
Measurements		
Voltage measurement ranges	V	200 / 100 / 50 / 25
Current measurement ranges	A	20A Model: 20 / 10 / 5 /2.5 10A Model: 10 / 5 / 2.5 /1.25 5A Model: 5 / 2.5 / 1.25 / 0.625
Accuracy	%	0.2
IV Tracer		
Scan rate	min	2 / 3 / 4 / 5 / 6
Points number	-	128 / 256 / 512
Sweep Time	s	1.0 to 3.0
IV tracing ad hoc available using the MPPT manager software.		
MPP Tracker		
Types	-	Full I-V curve search Fast MPP fine adjust
Control	-	Power and voltage
Customizable MPP adjust and Vm adjust available.		
Auxiliary opto-isolated analog outputs		
4 analog outputs (Vm, Im, RTD 1, RTD 2)	VDC	from 0 to 10 (proportional to the default represented input ranges)
Short circuit protected outputs. High impedance load required.		
Auxiliary analog measurement inputs		
Auxiliary input 1		RTD only (PT100)
Auxiliary input 2		RTD only (PT100)
Auxiliary input 3		voltage 0…1V max (autorange from 0..10mV to 0..1V)
Galvanically isolated RS-485 port		
Bit rate	bps	115200
Data length	bit	8
Stop bit	bit	1
Parity	-	Even
Flow control	-	None

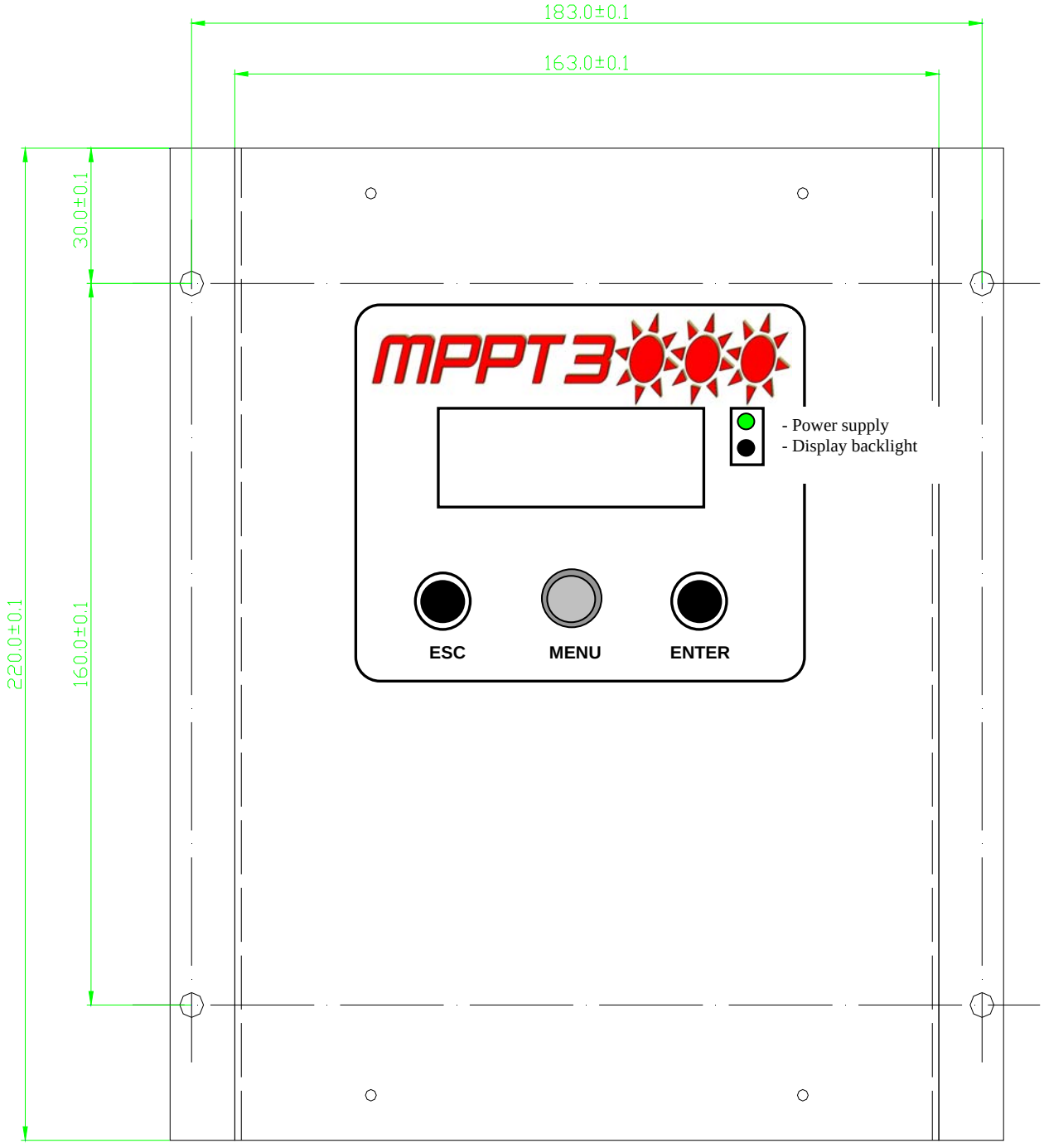
Performance

MPP Tracking		
Static MPP tracking efficiency	%	> 99.5
Dynamic MPP tracking efficiency	%	> 98.0
IV Tracer		
IV tracing difference	%	±0.2
DC / DC conversion		
Typ. Efficiency (Pout/Pin)	%	90.0

This performance test has been carried out at specific conditions, please see the specific data-book for details.

Box and connections

Front

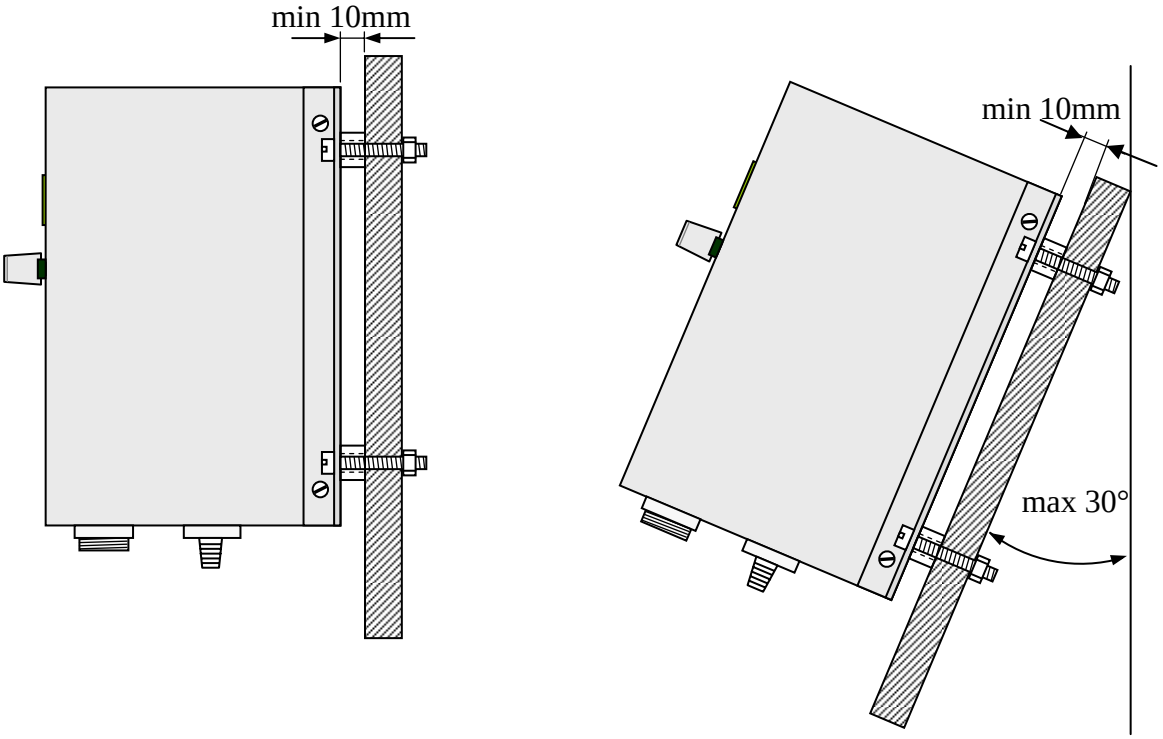


- The reset button of the main part (DSP) is placed on the left side of the box.
- On the right side, there is the reset button of the auxiliary part (µController).

⚠ When accessing a reset button, please use a **non-conductor** stick.

Mounting the MPPT3000

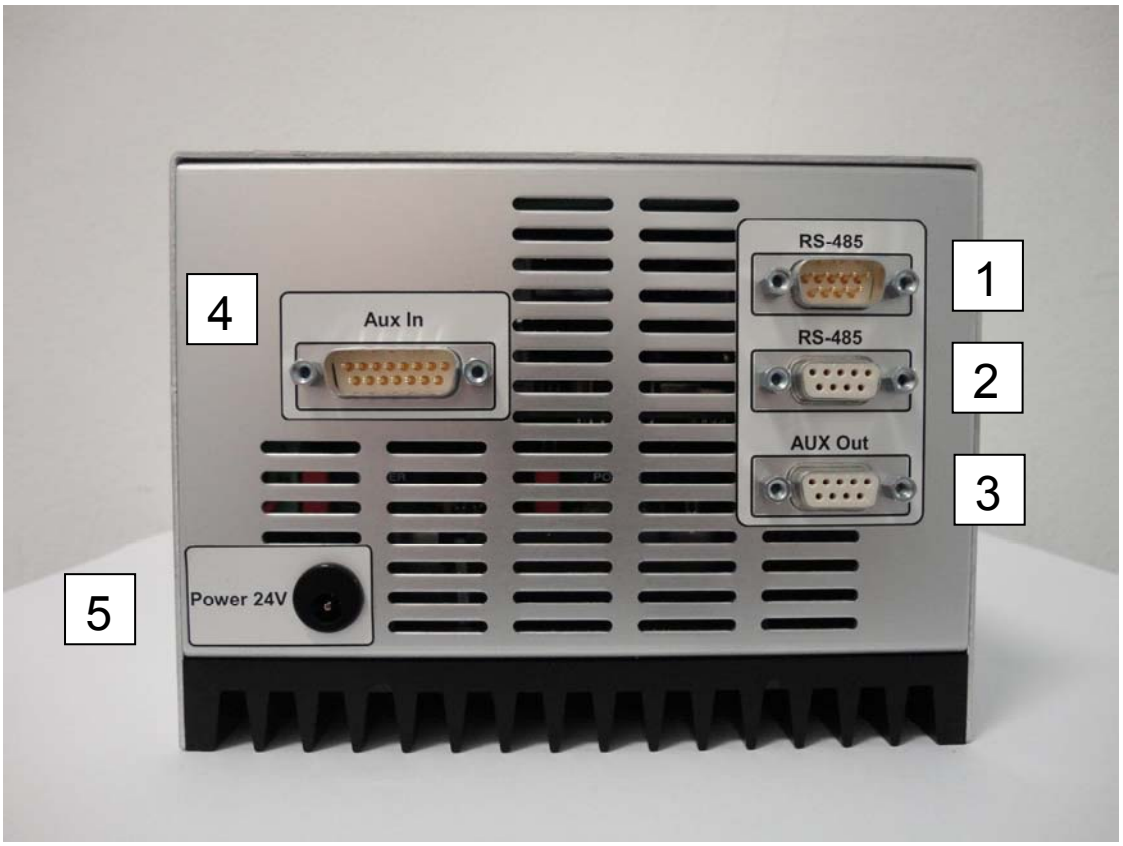
The MPPT3000 is provided with integrated heat sink for power dispersion.
In order to get maximum power dispersion the box must be mounted in vertical position or with a maximum tilt of 30° from vertical position , see also following schematics.
Moreover please allow 1 cm minimum gap from heat sink to mounting wall.



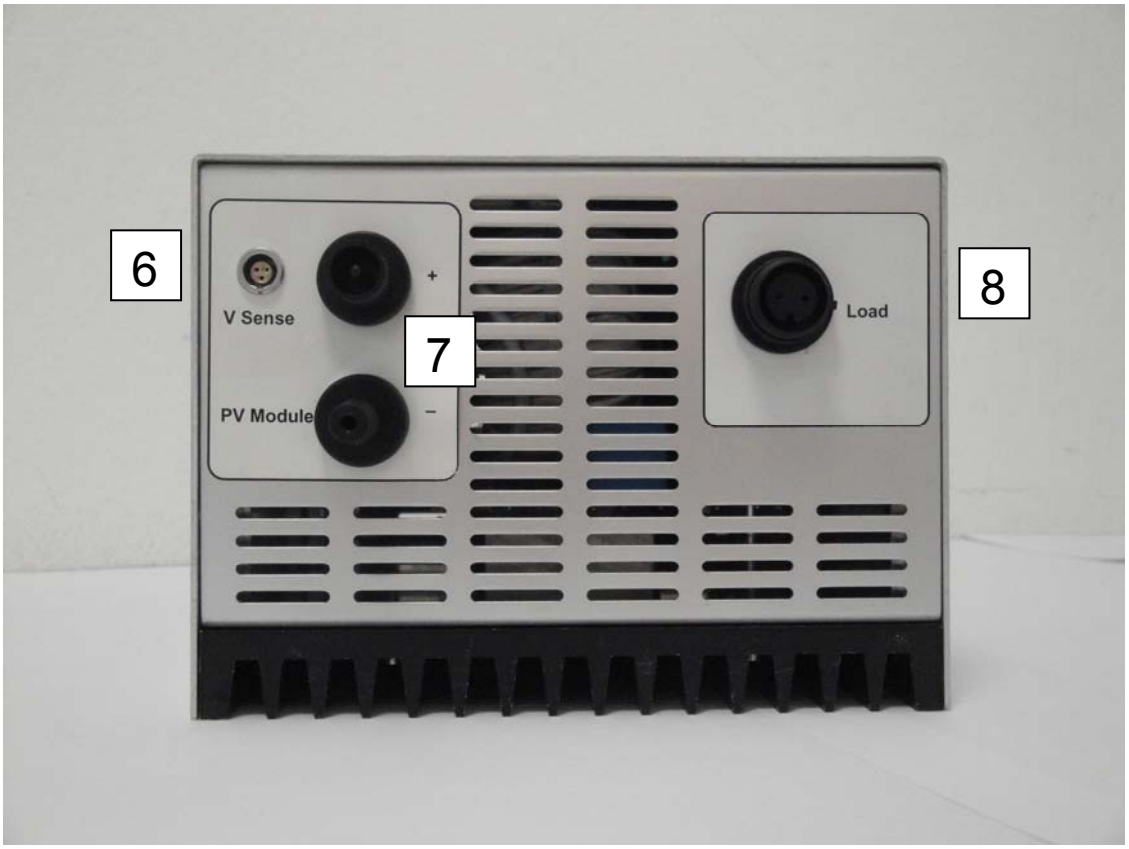
Mounting schematics

The electrical operating temperature of the MPPT goes from -20°C to +70°C but the ambiance temperature must not exceed 40°C at maximum power (250 W)

Top lateral



Bottom lateral



Wiring description

Connector	Description
1	RS-485 line, DB9 male
2	RS-485 line, DB9 female
3	Auxiliary analog outputs, DB9 female
4	Auxiliary input/output of auxiliary part (µController), DB15 male
5	Power supply of MPPT3000
6	Input for PV voltage sense measurement
7	Input for power connection PV module
8	Output power part (to the load resistor) **WARNING! THE LOAD RESISTOR MUST ALWAYS BE CONNECTED TO THE MPPT3000 ! Using the MPPT3000 without the load resistors leads to serious damages.**

Connector 1 and 2 :

See chapter **RS-485 line**.

Connector 3 :

1 Output AUX1 (0...10V represents 0...$Ufull_{scale}$)
2 Output AUX1 (GND)

3 Output AUX2 (0...10V represents 0...$Ifull_{scale}$)
4 Output AUX2 (GND)

5 Output AUX3 (0...10V represents 0...$AUX\_Ch0\_full_{scale}$)
6 Output AUX3 (GND)

7 Output AUX4 (0...10V represents 0...$AUX\_Ch1\_full_{scale}$)
8 Output AUX4 (GND)

9 not connected

All auxiliary outputs are short circuit protected by means of a 2 kΩ series resistor.
Therefore to measure the output voltage value high impedance input instruments are required.

Connector 4 :

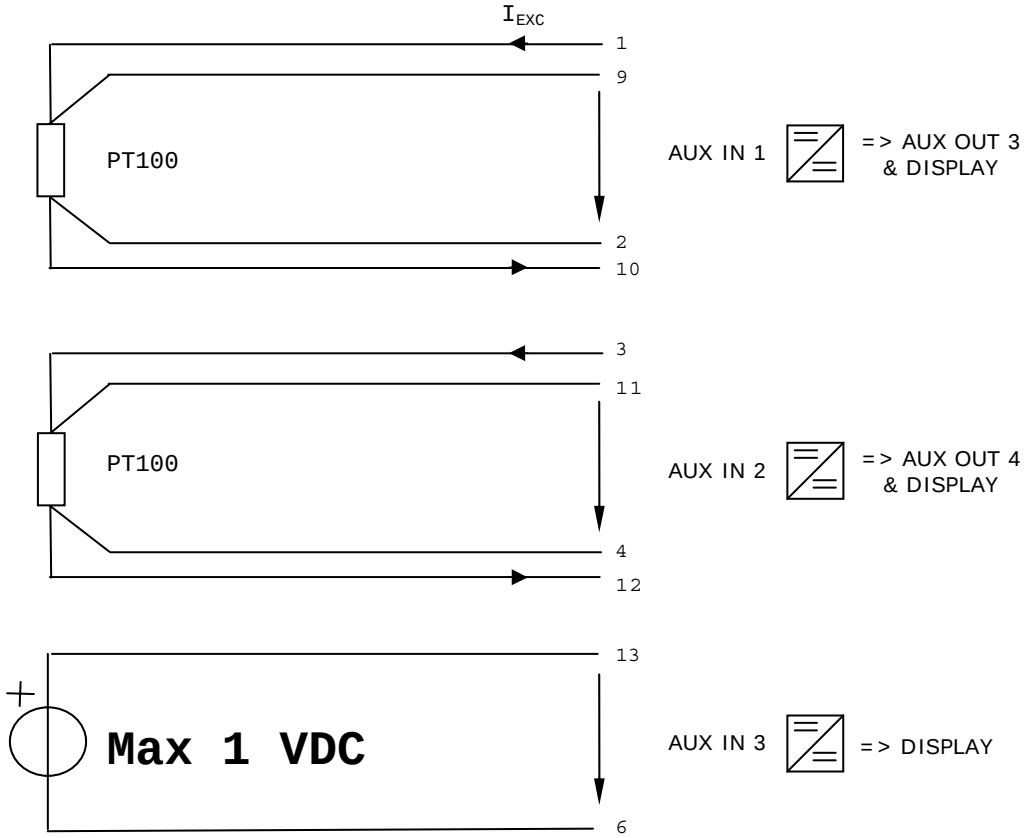
Auxiliary measurement part (µC) inputs. Configuration :

_ RTD on AUX IN 1 (AUX_Ch0)

_ RTD on AUX IN 2 (AUX_Ch1)

_ general voltage input on AUX IN 3

The next picture shows how to connect the RTDs and the general purpose voltage input (typically a pyranometer).



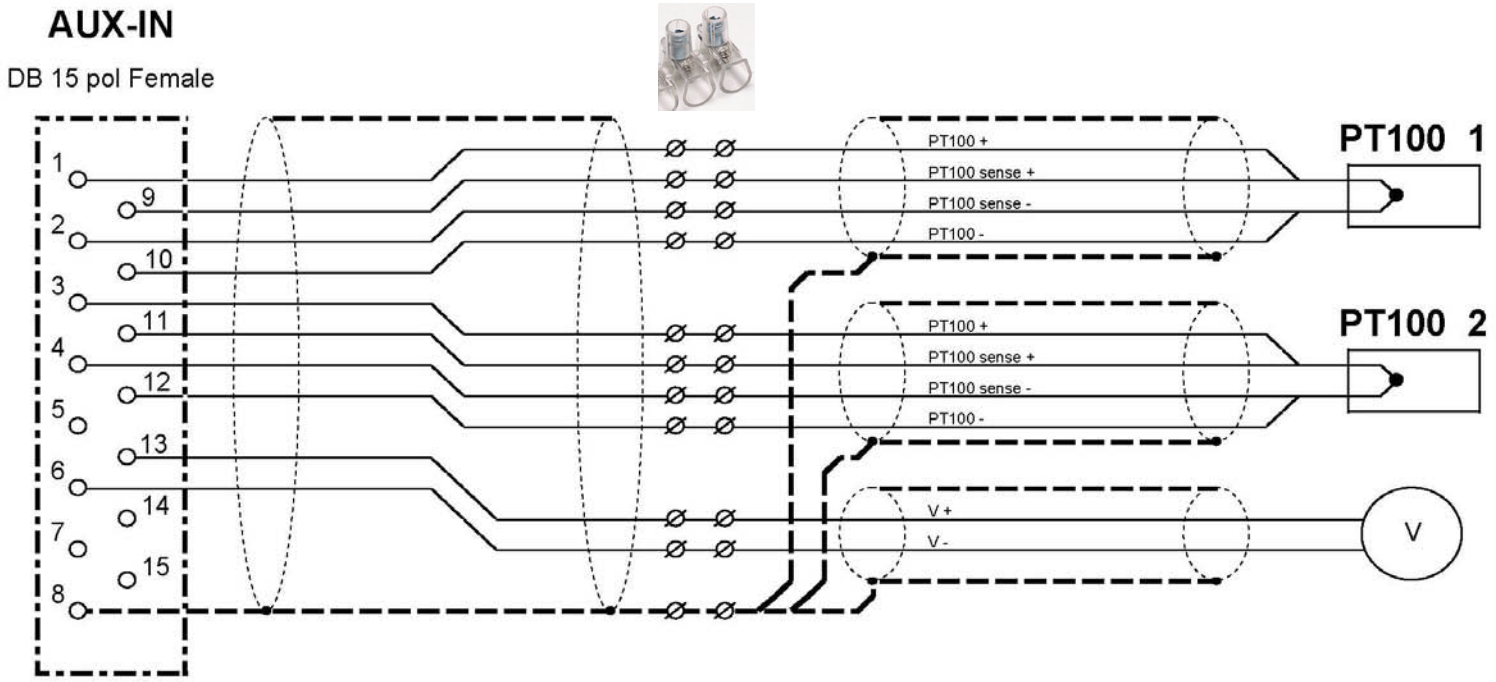
AUX IN 3:

The minimum voltage input range is 0..10 mV, the maximum voltage input range is 0..1V. The input range selection is automatic, **just avoid to exceed 1 VDC or the device will be damaged** . The voltage must be always positive (unipolar). The MPPT itself provides the excitation current for the RTDs.

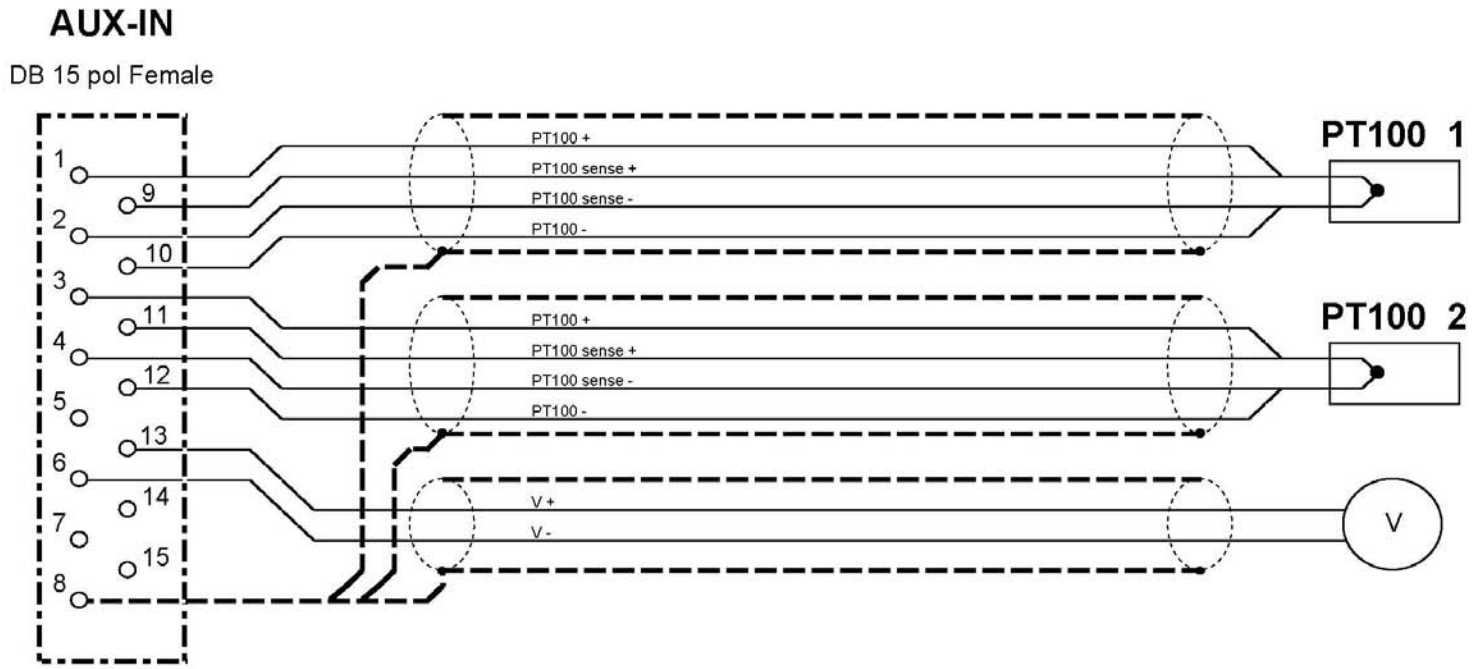
In the following annexes (A to I) you find all the possibility

how to do right connections.

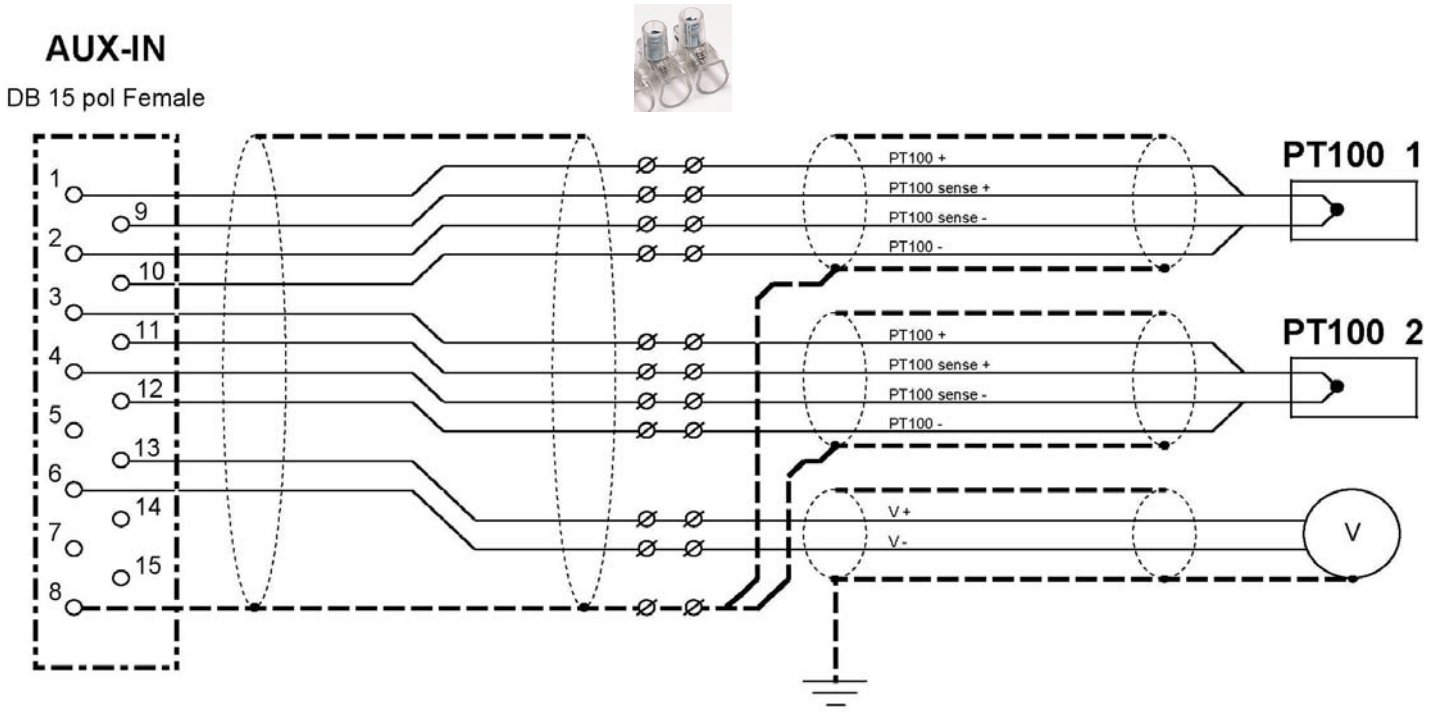
A- AUX-IN CONNECTION → 2xPT100, 1x Sensor[V] with intermediaries clamps and shield connected together



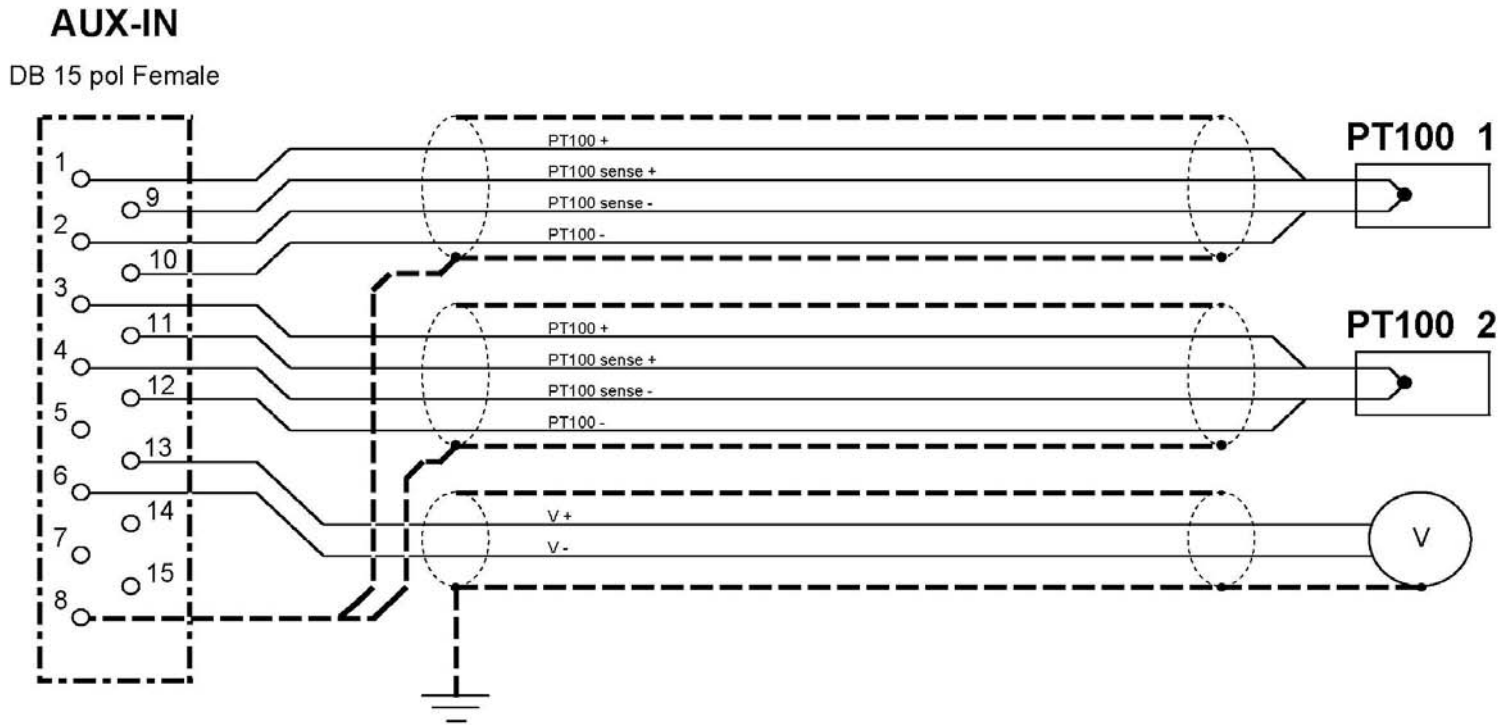
B- AUX-IN CONNECTION → 2xPT100, 1x Sensor[V] with intermediaries clamps and shield connected together



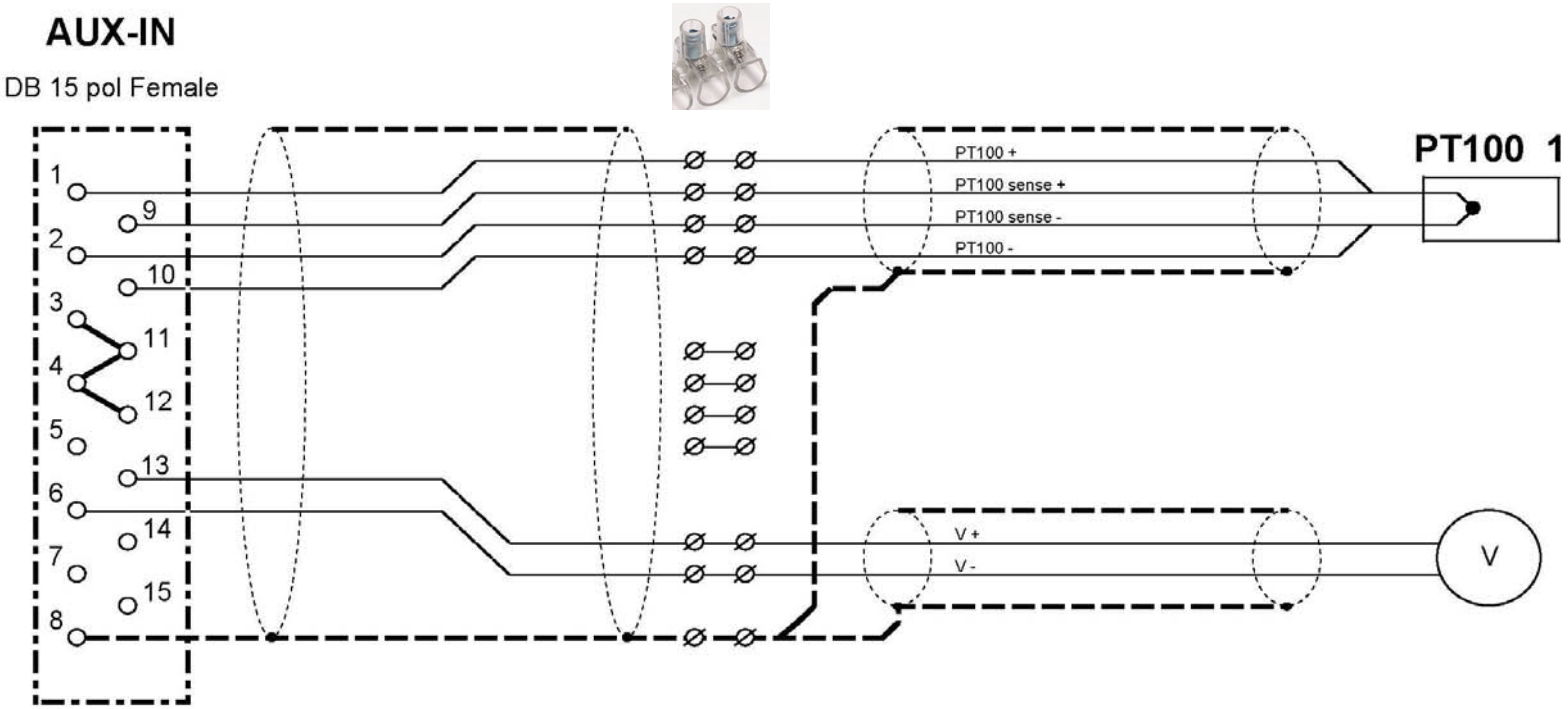
C- AUX-IN CONNECTION → 2xPT100, 1x Sensor[V] with intermediaries clamps and shield split



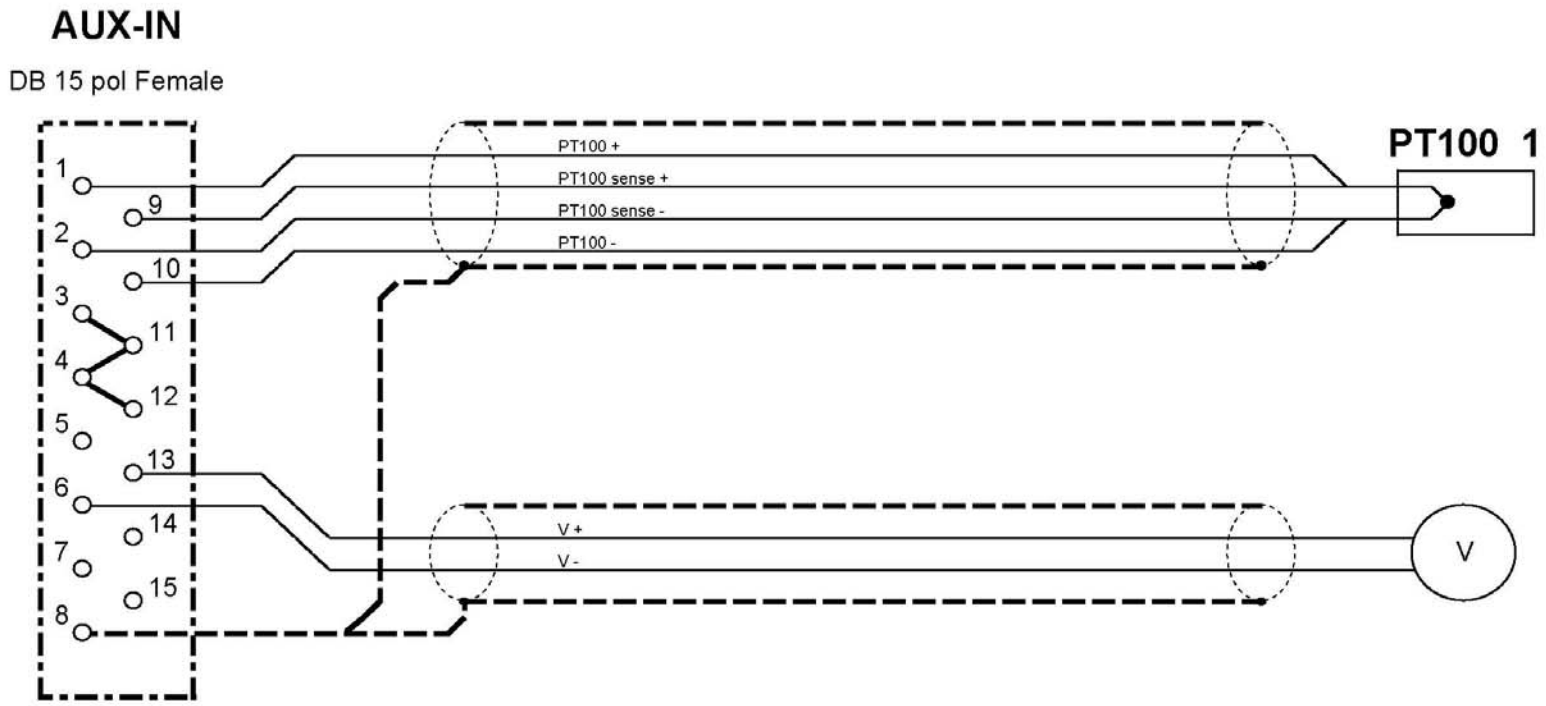
D- AUX-IN CONNECTION → 2xPT100, 1x Sensor[V] with intermediaries clamps and shield split



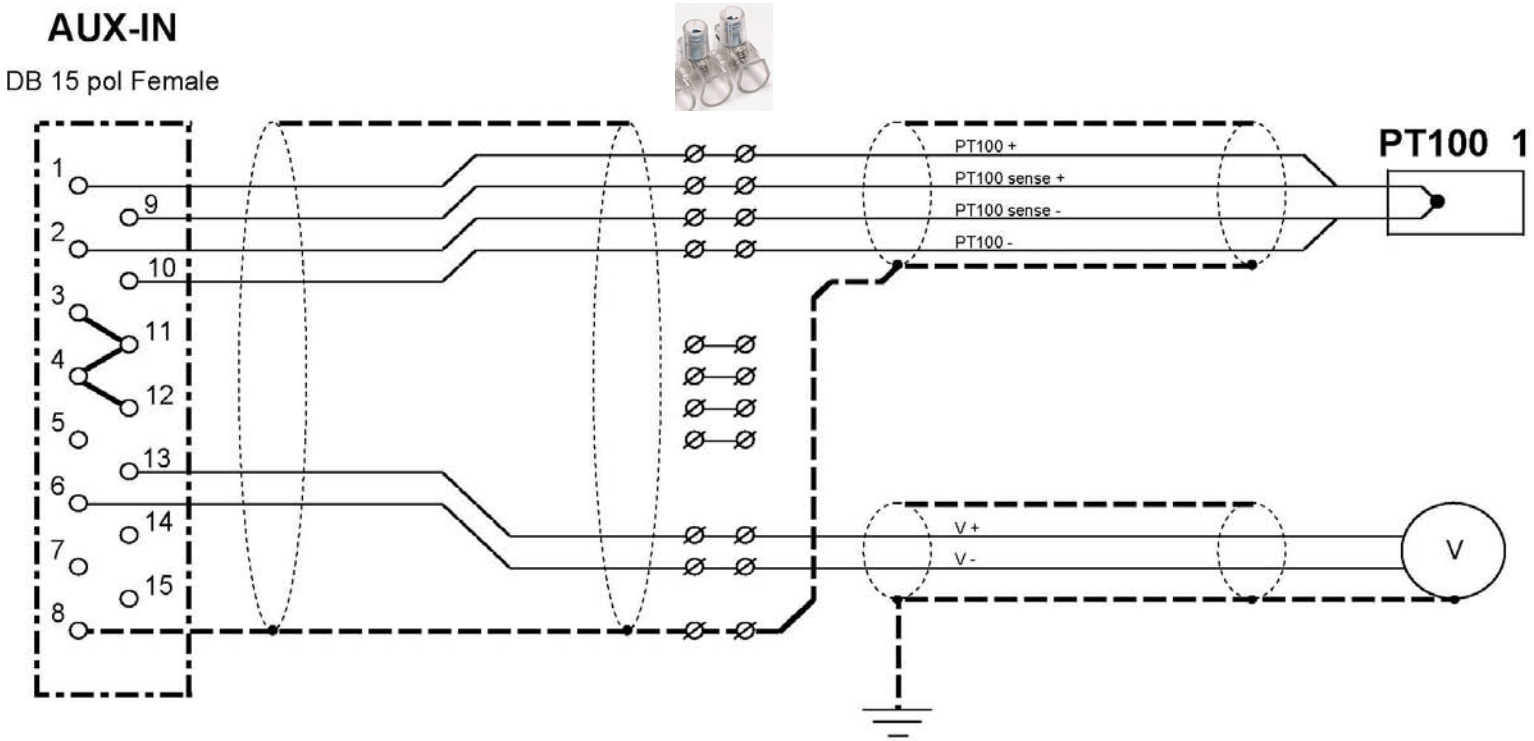
E- AUX-IN CONNECTION → 1xPT100, 1x Sensor[V] with intermediaries clamps and shield connected together



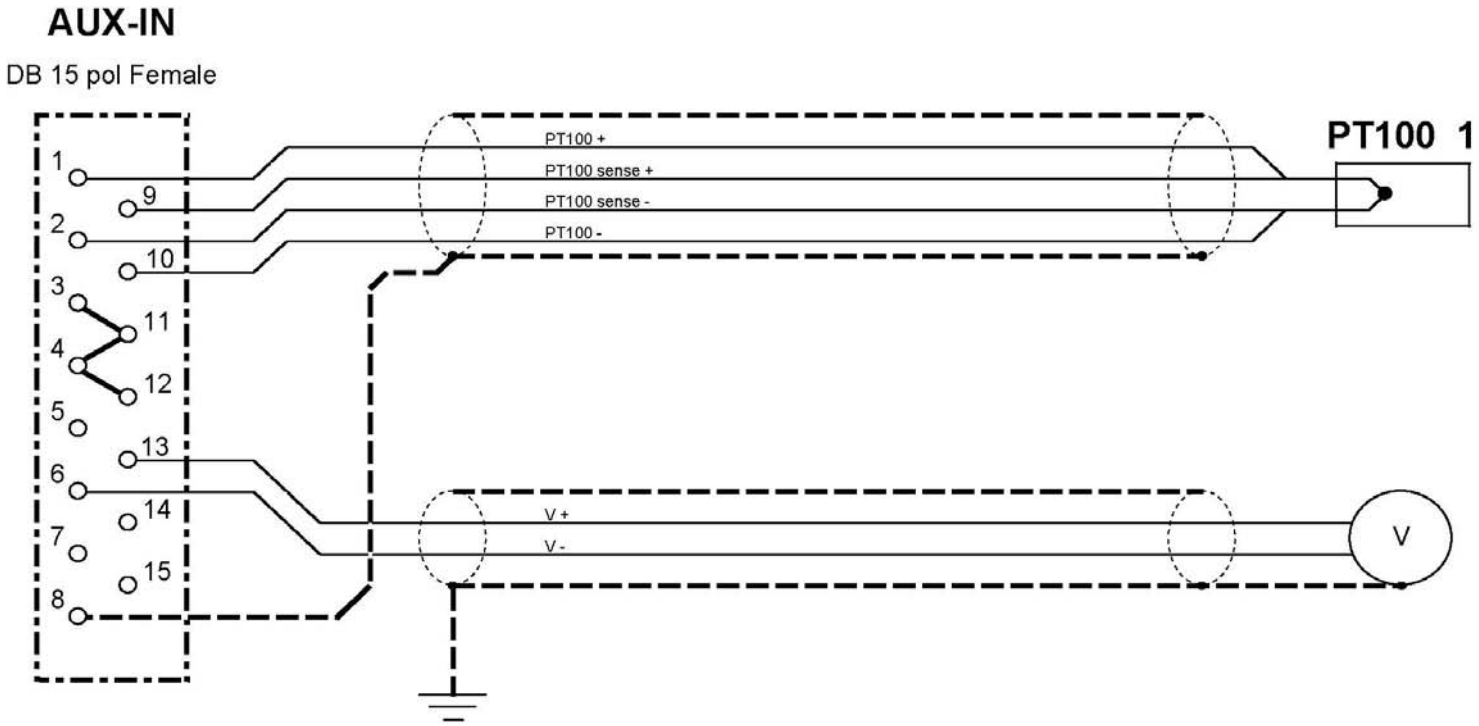
F- AUX-IN CONNECTION → 1xPT100, 1x Sensor[V] and shield connected together



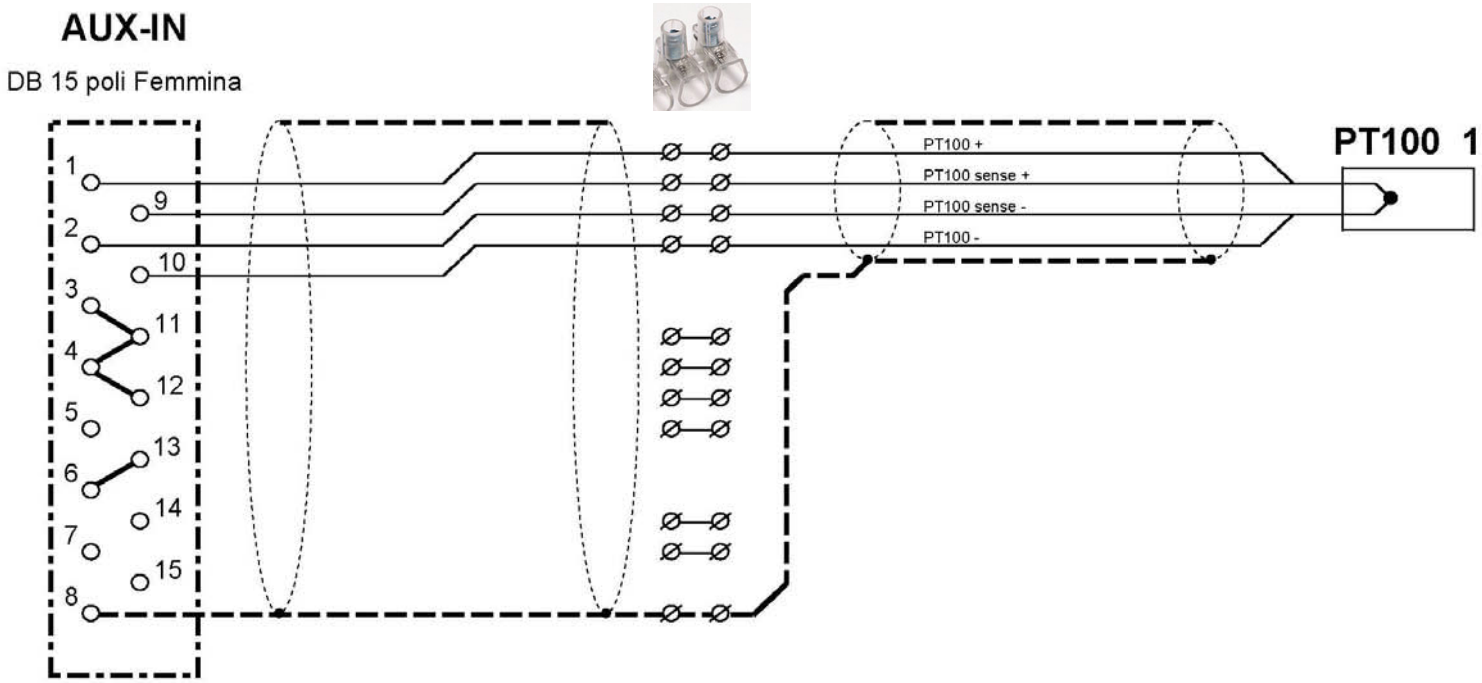
G- AUX-IN CONNECTION → 1xPT100, 1x Sensor[V] with intermediaries clamps and shield split



H- AUX-IN CONNECTION → 1xPT100, 1x Sensor[V] and shield split



I- AUX-IN CONNECTION → 1xPT100 with intermediaries clamps and shield connected together



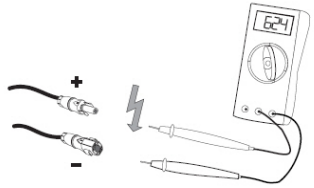
Connector 5 - Power Supply

- Simply connect 2:1 connector to the Power 24V of the MPPT.

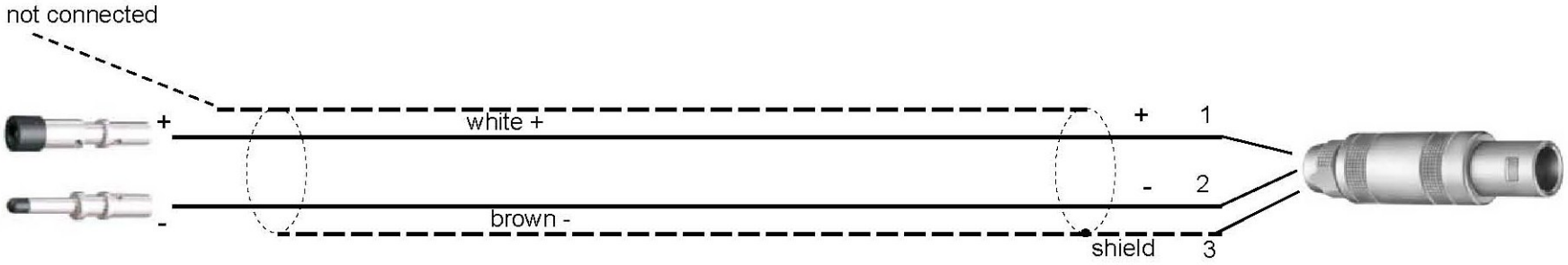
- The AC 220V has to be connected only after the Load, PV and Sense.

Connectors 6 and 7: PV Module power (Input) - Voltage Sense (Input)

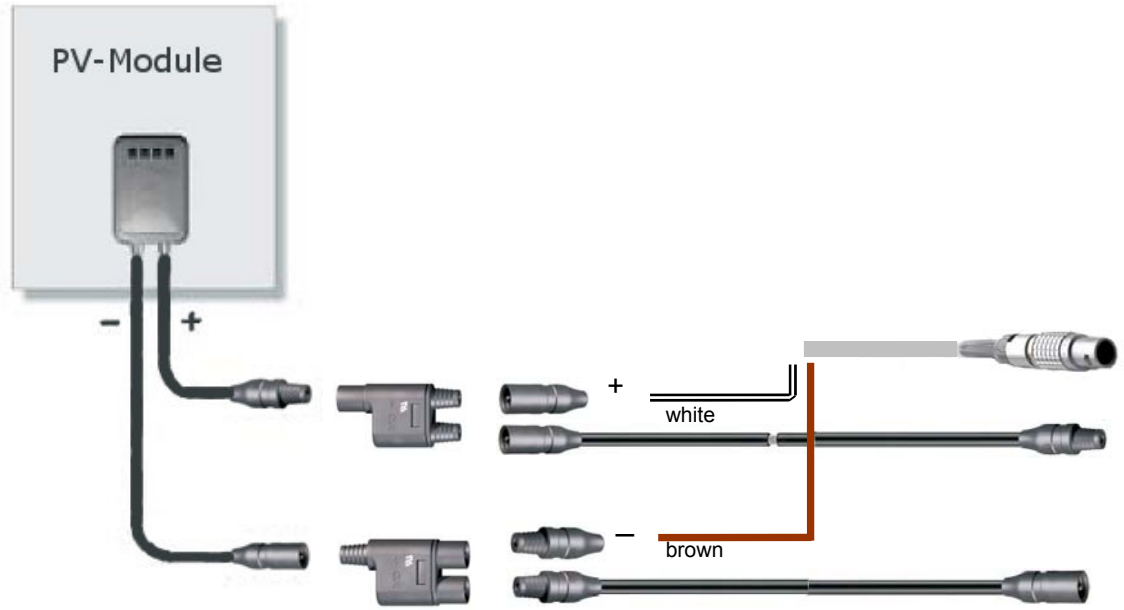
- Check the voltage and the polarity of the photovoltaic module.
- The voltage of the photovoltaic module should in any case NOT exceed the value of 200 VDC (Voc voltage).
- These connections should be done very carefully observing the polarity, any inappropriate voltage or polarity can damage the device.
- All the PV wires for 20A must to be minimum 2.5mm2, greater is better because you have less losses.



- The Sense wires 0.25mm2
- The Sense connections have to be connected with the PV connections near as possible to the module.
  The shied of the sense has to arrive till the the PV connection, **but it isn't to be connected!**

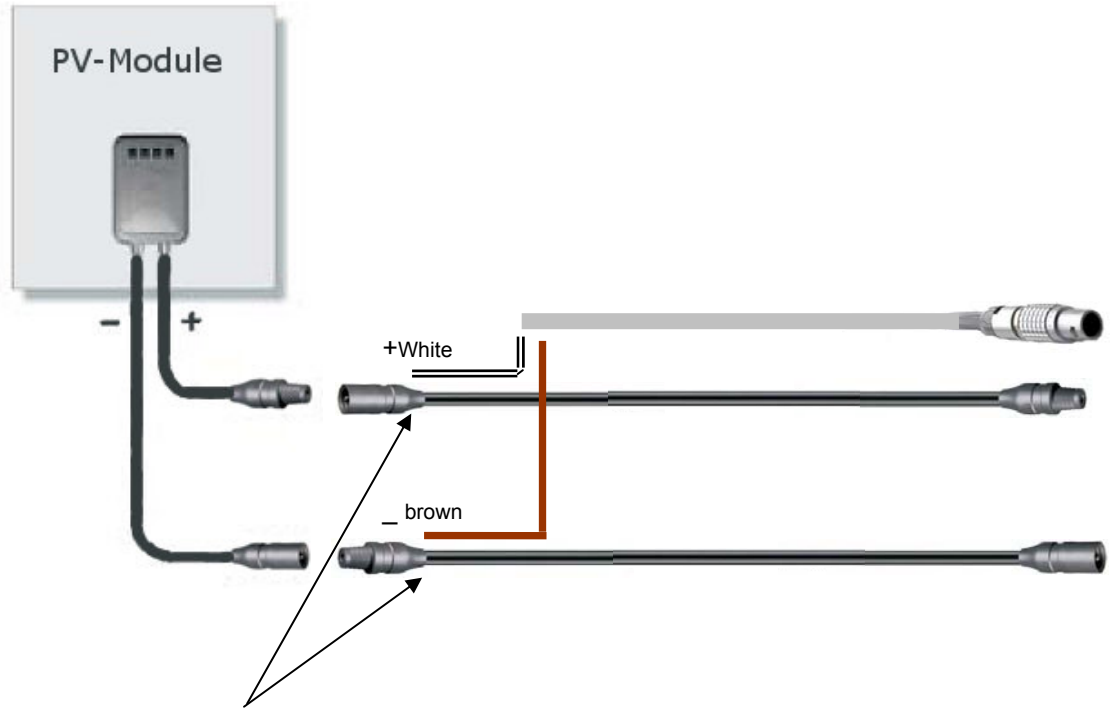


A- Connection MC3 (MPPT3000)- MC3 (PV-Module)



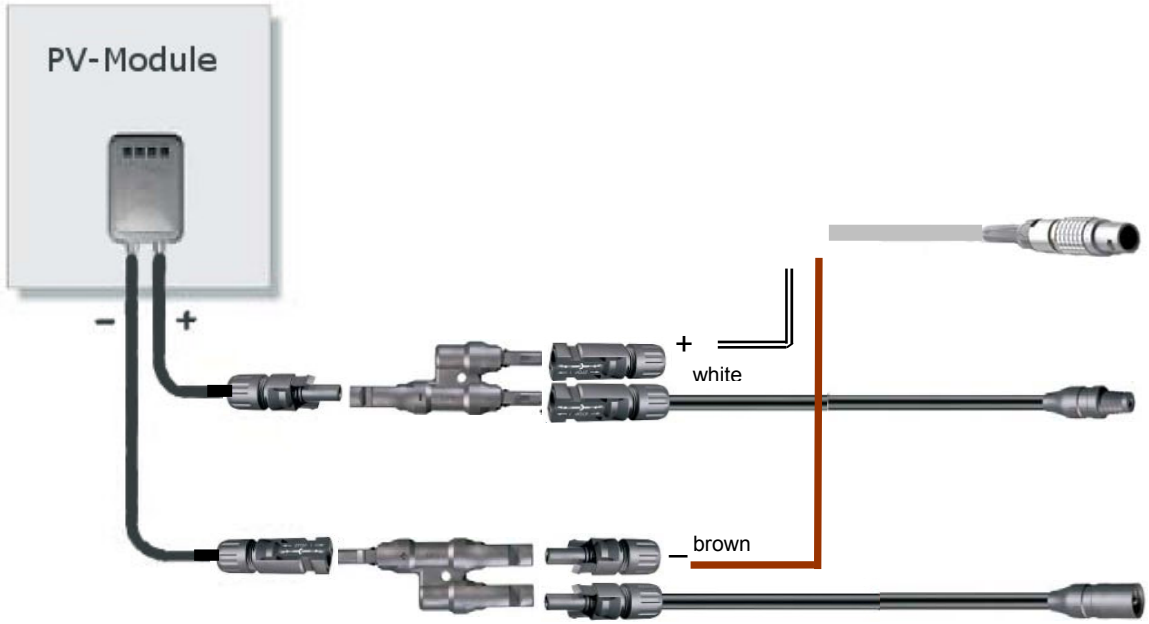
This connection solution is the more easier to assembly and simple if you have to change or dismount the system, but the most expensive.<u>With the MPPT3000 we supply only the 'Sense' connector and cable.</u>
The cost of the Multi-Contact accessories will be around 60-70 EUR, depending on the length of the cables

Connection MC3 (MPPT3000)- MC3 (PV-Module)



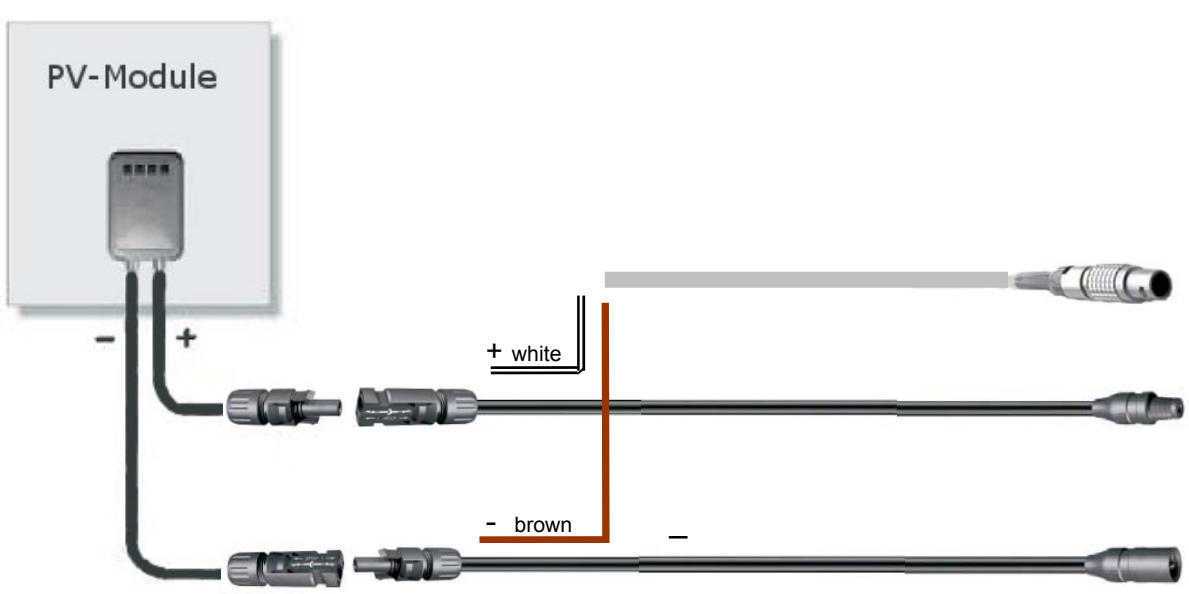
***This connection solution* is to weld or crimp the sense wirings directly with the MC3 connectors.**
You have to weld yourself the MC connector with the cables 'PV'and 'Sense', but is cheaper than the first solution.
With the MPPT3000 we supply only the 'Sense' connector and cable.
The cost of the Multi-Contact accessories will be around 30-40 EUR, depending on the length of the cables.

C-Connection MC3 (MPPT3000)- MC4 (PV-Module)



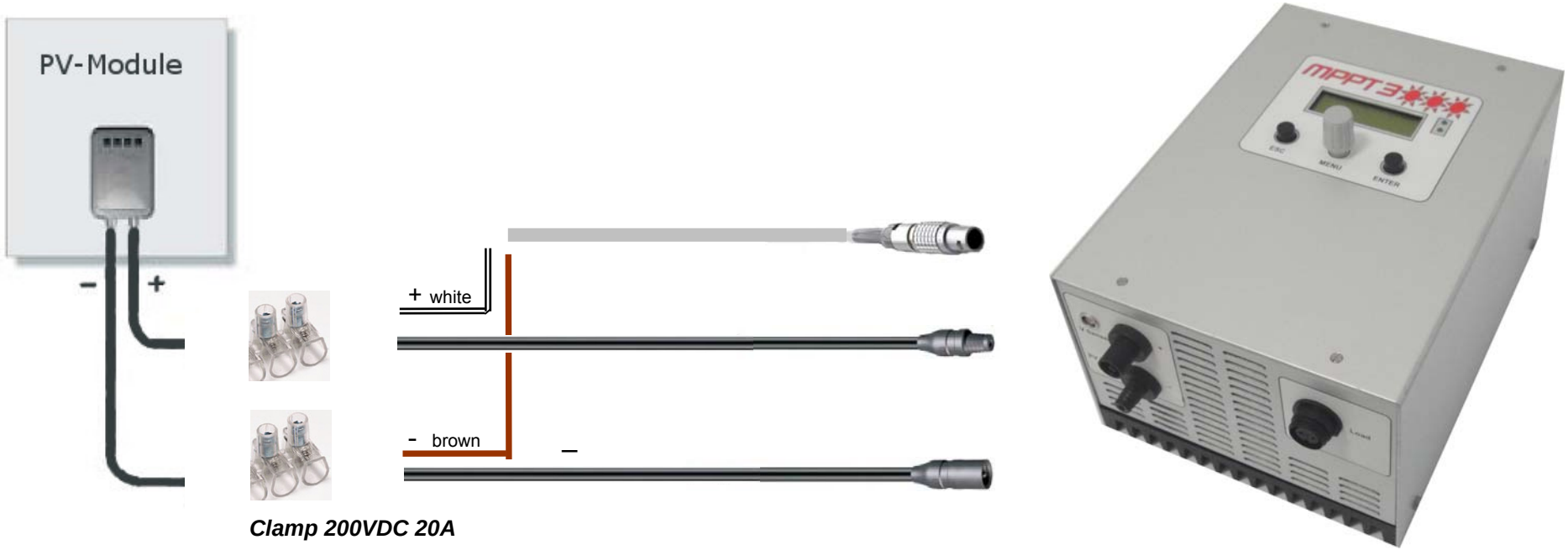
This connection solution is exactly as the solution 'A', but with MC4 connectors
The costs are similar.

D-Connection MC3 (MPPT3000)- MC4 (PV-Module)



This connection solution is exactly as the solution 'B', but with MC4 connectors.
The costs are similar.

E-Connection MC3 (MPPT3000)- without (PV-Module)



Clamp 200VDC 20A

This connection solution is the faster and cheaper, but is the less secure, do to the clamp that has to be isolated!!!

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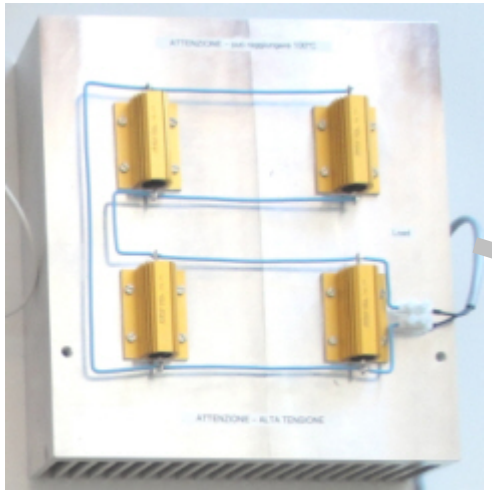
Cable 8 : LOAD (Output)

IMPORTANT : THE LOAD MUST ALWAYS BE CONNECTED !!!!!!

Load connection :

The load MUST always be connected. Using the MPPT3000 without the load resistors leads to serious damages. There is no polarity.



Choose of the load resistor

How to chose a load resistor

A load resistor must always be connected to the power output of the MPPT3000.
Please chose a resistor value between 18 and 47 Ω in order to :

_ **not to exceed I_{out} (I_{load}) < 3.5 A $_{DC}$**
_ **not to exceed V_{out} (V_{load}) < 108 V $_{DC}$**

according to the power output to disperse.

Example : Power of module = 250 W
Vmpp max > 5 V (ex : 17 V)
I mpp max < 20 A (ex : 14.7 A)

R load min = 250 / (3.5^2) = 20.4 Ω
R load max = (108^2) / 250 = 46.6 Ω

→ thus we choose for example 33 Ω / 250 W (or more powerfull)

→ check in the two charts below if the value of R load chosen is within required parameters

Example of resistor to use :

ARCOL

HS series heatsink mount resistors

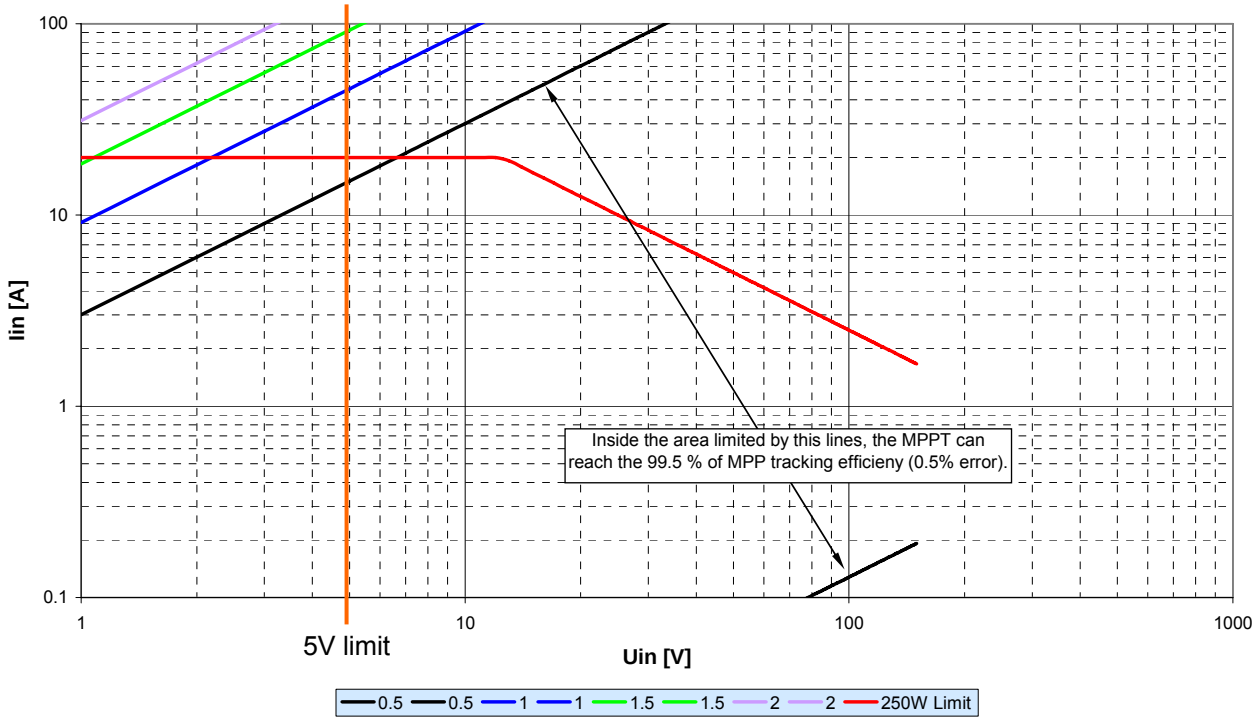
- Resistance range R005 to 100K Ohms
- To 600W
- Tolerance from 0.5%
- High power to volume ratio
- All welded construction
- Available in Non-Inductive Style (Type N)
- High pulse withstand capability
- Connection variation available

→ ***REMEMBER TO MOUNT LOAD RESISTORS ON A SUITABLE HEAT SINK***

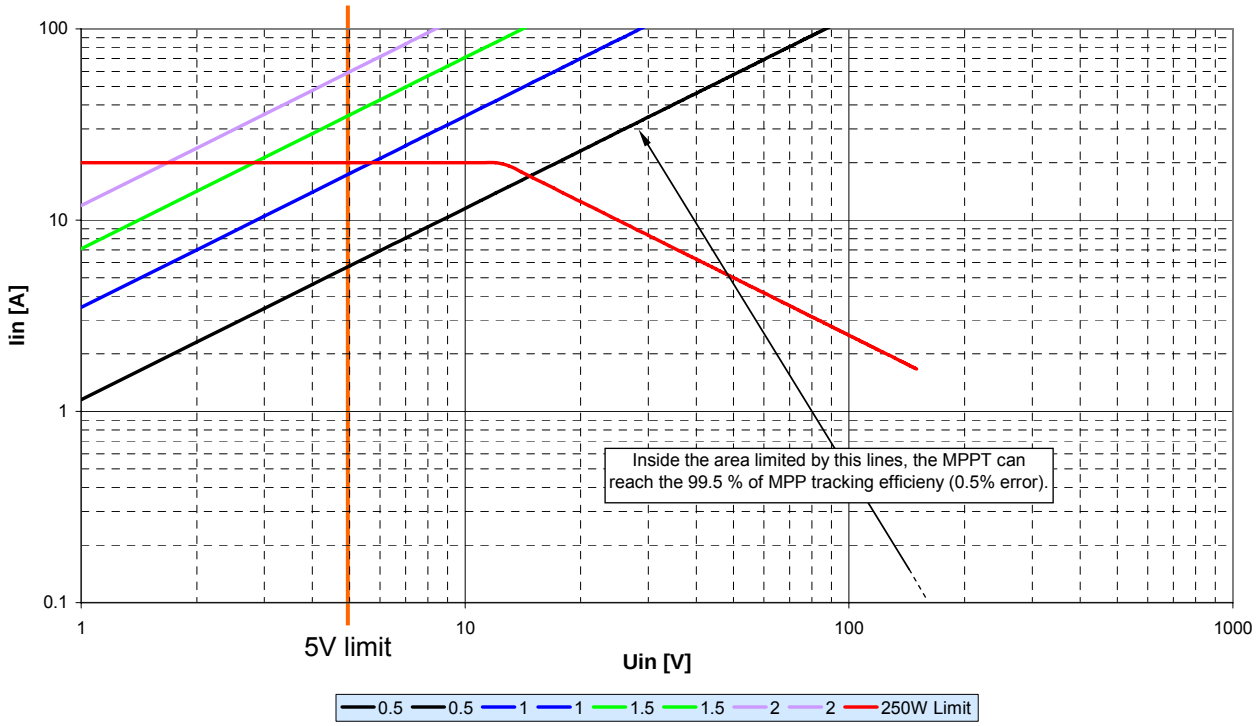
Reachable MPP tracking efficiency vs. output load resistor

The maximum power point tracking efficiency depends also on the chosen output load resistor.
As mentioned in the previous sub-chapter, the value of this resistor can vary between 18 and 47 Ω.
The following charts show the MPP tracking efficiency limits vs. output load resistor.

Iin = f(Uin) with maximum MPP tracking error percentage limits using 18 Ω output resistor



Iin = f(Uin) with maximum MPP tracking error percentage limits using 47 Ω output resistor



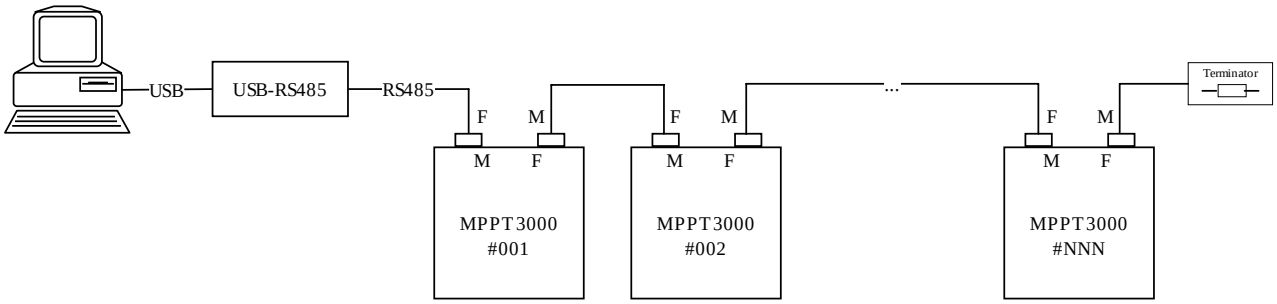
It can be seen that most of the working area is inside the by the black lines, which describe the 99.5 % efficiency limits. Only in extreme conditions the efficiency can go slightly below this limit. However, if the MPPT is used properly, the declared MPP tracking efficiency is respected, as it has been proved during the MPPT practical test.

Table how to calculate the load resistor

	Umax 108V	Imax 3.5A
P load max	**R load max**	**R load min**
[W]	[Ω]	[Ω]
	Umax*Umax/Pload	Pload/Imax/Imax
30	389	2
40	292	3
50	233	4
60	194	5
70	167	6
80	146	7
90	130	7
100	117	8
110	106	9
120	97	10
130	90	11
140	83	11
150	78	12
160	73	13
170	69	14
180	65	15
190	61	16
200	58	16
210	56	17
220	53	18
230	51	19
240	49	20
250	47	20

RS485 network

The MPPT3000 devices can be connected to a master PC through a RS485 network. In this way it is possible to fully exploit the potential of the device using the specific user friendly management software. The following scheme shows the correct wiring of the MPPT3000 to the RS485 network.



At the end of the RS485 line there must be a terminal resistor, which can varies depending on the manufacturer of the USB/RS485 adapter and on the cables length. This terminal resistor must be wired between pin 1 (DATA+) and pin 9 (DATA–) of the DB9 connector.

Pin	DB9 for RS232 pinout[1]	DB9 for RS485 pinout[2]
1	Data Carrier Detect	DATA+
2	RxD	Not connected
3	TxD	Not connected
4	Data Terminal Ready	Not connected
5	Signal Ground	GND
6	Data Set Ready	V+
7	Request to Send	Not connected
8	Clear to Send	Not connected
9	Ring Indicator	DATA-

To dialog with one or more MPPTs use only the “MPPT Manager” software. This software allows the user to manage one or more MPPTs easily.

RS-485

Standard	EIA RS-485
Physical Media	Twisted Pair
Network Topology	Point-to-point, Multi-dropped, Multi-point
Maximum Devices	32 drivers or receivers
Maximum Distance	1200 metres (4000 feet)
Mode of Operation	Differential
Maximum Baud Rate	100 kbit/s - 10 Mbit/s
Voltage Levels	-7 V to +12 V
Mark(1)	Positive Voltages (B-A > +200 mV)
Space(0)	negative voltages (B-A < -200 mV)
Available Signals	Tx+/Rx+, Tx-/Rx- (Half Duplex) Tx+, Tx-, Rx+, Rx- (Full Duplex)

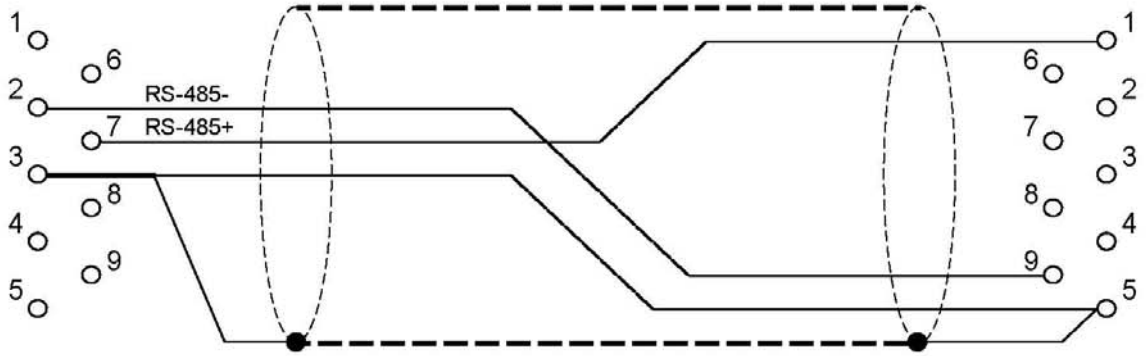
[1] Defined by the RS232 standard.
[2] Selected for the MPPT3000 project.

TRINAMIC
o adapter

DB 9 pol Female

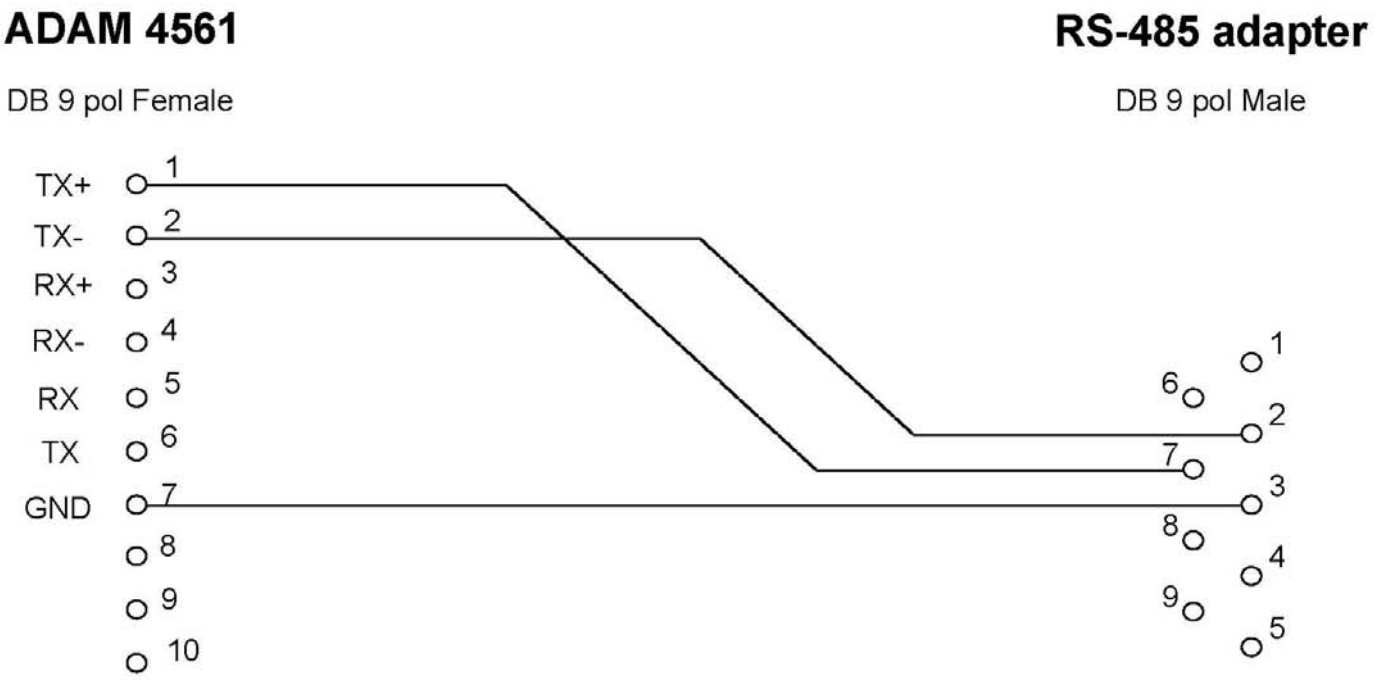
MPPT3000

DB 9 pol Male



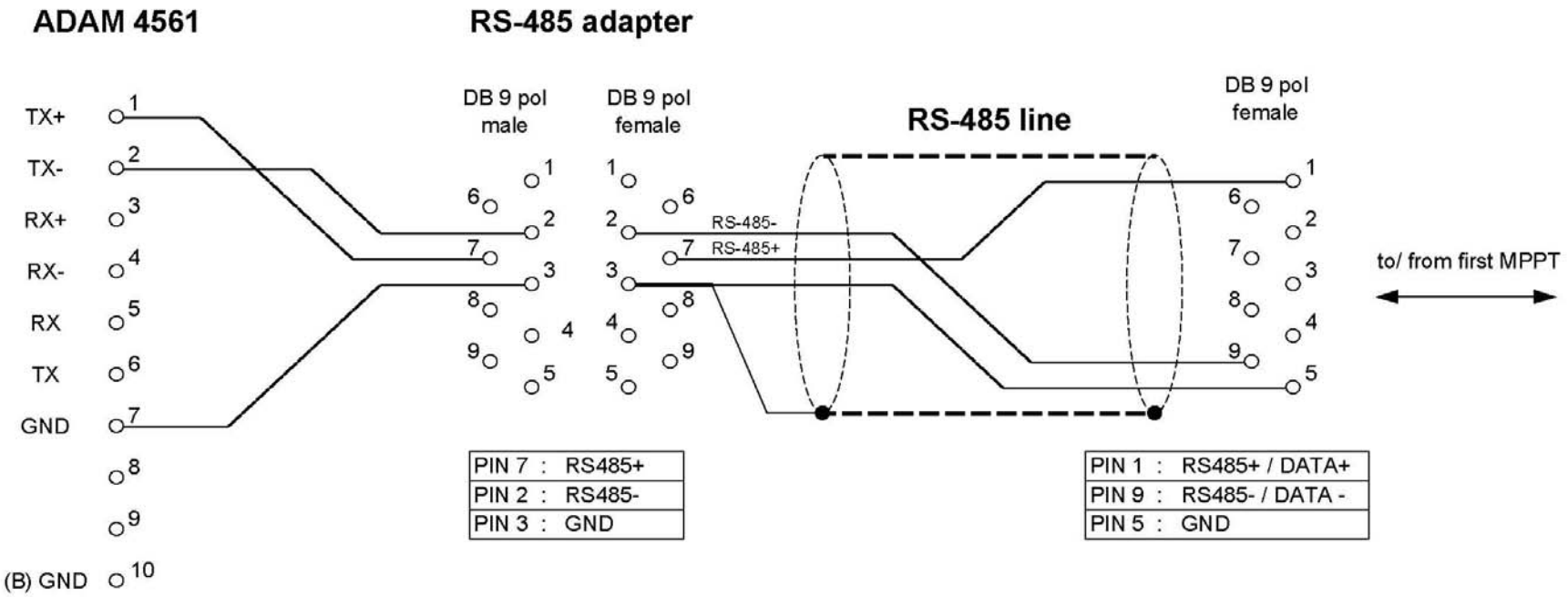
PIN 7 :	RS485+
PIN 2 :	RS485-
PIN 3 :	GND

PIN 1 :	DATA+
PIN 9 :	DATA-
PIN 5 :	GND

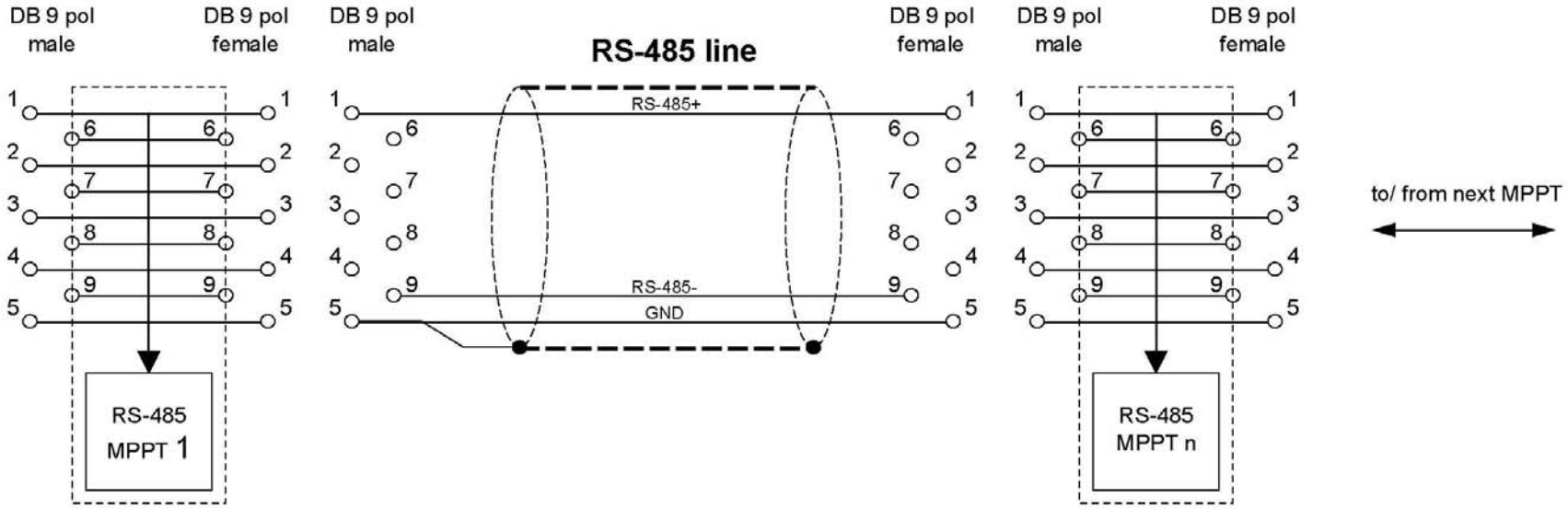


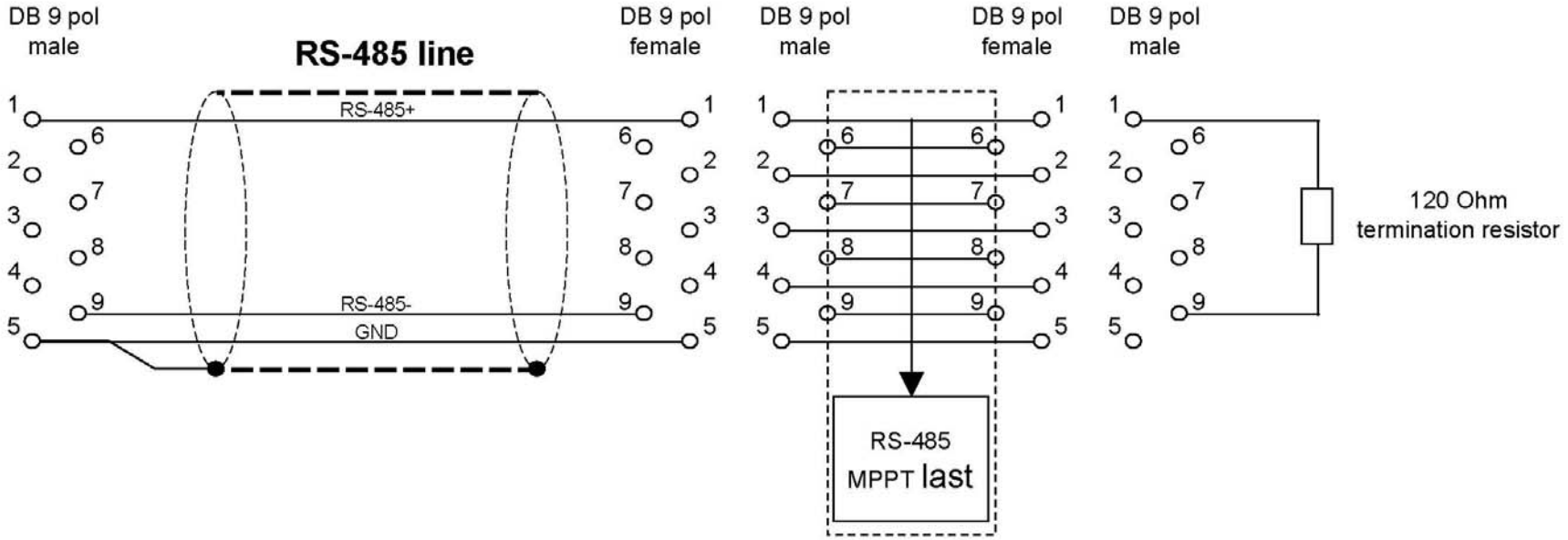
PIN 1 :	TX+ (RS485+)
PIN 2 :	TX- (RS485-)
PIN 7 :	GND

PIN 7 :	RS485+
PIN 2 :	RS485-
PIN 3 :	GND



PIN 1 : TX+ (RS485+)
PIN 2 : TX- (RS485-)
PIN 7 : GND


DB 9 pol male
DB 9 pol female
DB 9 pol male
RS-485 line
DB 9 pol female
DB 9 pol male
DB 9 pol female
RS-485+
RS-485-
GND
RS-485 MPPT 1
RS-485 MPPT n
to/ from next MPPT
PIN 1 : RS485+ / DATA+
PIN 9 : RS485- / DATA -
PIN 5 : GND
PIN 1 : RS485+ / DATA+
PIN 9 : RS485- / DATA -
PIN 5 : GND



Total max. length of RS-485 line = 1km

Turning on the MPPT3000

1. After wiring the device according to the manual specifications, unplug the PV module from the MPPT3000.
2. **Verify that the full-scale voltage ($U_{full\ scale}$) and the full-scale current ($I_{full\ scale}$) are never exceeded. Every time a PV module is replaced, verify again that the settings for $U_{full\ scale}$ and $I_{full\ scale}$ are correct.** If these requirements are met, go to 7.
3. Turn the device on and wait until the default writing appears on the display[3].
4. Set the $U_{full\ scale}$ and $I_{full\ scale}$ in order that the PV module never exceeds the chosen values. The set-up can be done directly on MPPT3000 or on the graphical interface of the provided software.
5. Save the settings for $U_{full\text{-}scale}$ and $I_{full\text{-}scale}$. Here again this can de done directly on the MPPT3000 or by the software.
6. Turn the MPPT3000 off.
7. Turn the device on and wait until the default writing appears on the display[4].
8. Verify that the settings for $U_{full\text{-}scale}$ and $I_{full\text{-}scale}$ have been loaded correctly.
9. Plug the PV module to the device.
10. At this stage, the MPPT is operating and can communicate with the master PC through the provided software, performing the requested instructions.

Turning off the MPPT3000

To switch the MPPT off is recommended to use the shutdown command, this command disables the data logging and prepares the MPPT to be switched off.

1. Open the MPPT Manager software.
2. Select the Terminal Folder.
3. Press the “Shutdown” button.
4. Wait the MPPT answer.

Now is safe to turn off the MPPT3000.

Note: After the shutdown command is sent, the data logging is disabled. To restore the normal function mode the MPPT must be restarted either switching off and re-switching on the power supply or using the reset button.

[3] The time necessary for starting (software load to the processor and initialization) may varies slightly but it is generally about 30 sec.
[4] See previous remark.

Menu on the MPPT's display

Introduction about the MPPT Menu

Three alphanumeric characters help the user to browse the menu.
The first character is used to define the level (Level 0 → no sign, Level 1 → single point, Level 2 → 2 points).
The second and the third characters show the position number of the selected lower level.

Examples:

1	2	0	' 0 2
2	2	0	' 0 2
2	2	1	" 0 1
3	0	0	0 3

This is an indicative representation, not a full representation.

Level 0 is the higher level, it represents the main groups.
Level 1 is the level used to browse and select the voices inside a main group.
Level 2 is the lower level, when the user is in this level he can modify the chosen voice. **Only the voices that are available in level 2 can be modified directly through the MPPT.**
Only the most important voices can be modified directly using the MPPT interface (buttons and scroll).
The other voices are only accessible using the MPPT Manager software, which also provides an easy access to all the features of the MPPT3000.

Menu Levels			Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	ESC	Enter	Scroll
0	1	2																				
Default																						
0	0	0	Um, Pm (Normal functioning)	x	x	x	.	x	x		V		x	x	x	.	x		W	Next	Nothing	Next / Previous L0
			Im, Power part duty cycle	x	x	x	.	x	x		A		x	x	x	.	x		%			
0	0	0	Um, Pm (Power adjustment)	x	x	x	.	x	x		V	→	x	x	x	.	x		W	Next	Nothing	Next / Previous L0
			Im, Power part duty cycle	x	x	x	.	x	x		A		x	x	x	.	x		%			
0	0	0	Um, Pm (Voltage adjustment)	x	x	x	.	x	x		V	←	x	x	x	.	x		W	Next	Nothing	Next / Previous L0
			Im, Duty Cycle	x	x	x	.	x	x		A		x	x	x	.	x		%			
0	0	0	Um, Pm (MPP full search)	x	x	x	.	x	x		V	#	x	x	x	.	x		W	Next	Nothing	Next / Previous L0
			Im, Power part duty cycle	x	x	x	.	x	x		A	#	x	x	x	.	x		%			
0	1	0	Date, Week day	d	d	.	m	m	.	y	y		A	b	c					Next	Nothing	Next / Previous L0
			Hour	h	h	:	m	m	:	s	s											
0	2	0	E tot	E	t	x	x	x	x	x	x	x	x	.	x		W	h		Next	Nothing	Next / Previous L0
			E day	E	d	x	x	x	x	x	x	x	x	.	x		W	h				
0	3	0	PV module Type	M	o	d	u	l	e		T	y	p	e						Next	Nothing	Next / Previous L0
				a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p			
0	4	0	DSP Software version	D	S	P		S	W		a	b	c	d	e	f	g	h		Next	Nothing	Next / Previous L0
			uController Software version	u	C		S	W		a	b	c	d	e	f	g	h					
Low Refresh Info																						
1	99	0		L	o	w		R	e	f	r	e	s	h				0	1	Level UP	Level DOWN	Next / Previous L0
				I	n	f	o		(	S	e	t	u	p	1	)						
1	0	0	RS485 network ID	M	P	P	T		I	D							'	0	0	Level UP	Level DOWN	Next / Previous L1
																	x	x				
1	0	1		S	e	t		M	P	P	T		I	D			"	0	1	Level UP (don't load in RAM)	Enter	Change state
																	x	x				
1	1	0	PV module manufacturer	M	a	n	u	f	a	c	t	u	r	e	r		'	0	1	Level UP	Nothing	Next / Previous L1
				a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p			
1	2	0	PV module type	M	o	d	u	l	e		T	y	p	e			'	0	2	Level UP	Nothing	Next / Previous L1
				a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p			
1	3	0	PV module serial number	S	e	r	i	a	l		N	r					'	0	3	Level UP	Nothing	Next / Previous L1
				a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p			
1	4	0	PV module database ID	D	a	t	a	b		M	o	d		I	D		'	0	4	Level UP	Nothing	Next / Previous L1
																	x	x	x			
1	5	0	PV module ID code	M	o	d		I	D		C	o	d	e			'	0	5	Level UP	Nothing	Next / Previous L1
				a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p			
1	6	0	PV module position	P	o	s	i	t	i	o	n						'	0	6	Level UP	Nothing	Next / Previous L1
				a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p			
1	7	0	Auxiliary output 2 external datalogger associated channel	C	h		A	u	x		2						'	0	7	Level UP	Nothing	Next / Previous L1
																	x	x	x			
1	8	0	Auxiliary output 3 external datalogger associated channel	C	h		A	u	x		3						'	0	8	Level UP	Nothing	Next / Previous L1
																	x	x	x			
1	9	0	PV module MPP power @ STC.	P	m		@		S	T	C						'	0	9	Level UP	Nothing	Next / Previous L1
														x	x	x	.	x	x	W		
1	10	0	PV module MPP current @ STC.	I	m		@		S	T	C						'	1	0	Level UP	Nothing	Next / Previous L1
														x	x	x	.	x	x	A		
1	11	0	PV module MPP voltage @ STC.	V	m		@		S	T	C						'	1	1	Level UP	Nothing	Next / Previous L1
														x	x	x	.	x	x	V		
1	12	0	PV module short circuit current @ STC	I	s	c		@		S	T	C					'	1	2	Level UP	Nothing	Next / Previous L1
														x	x	x	.	x	x	A		
1	13	0	PV module open circuit voltage @ STC	V	o	c		@		S	T	C					'	1	3	Level UP	Nothing	Next / Previous L1
														x	x	x	.	x	x	V		
1	14	0	PV module fill factor.	F	F												'	1	4	Level UP	Nothing	Next / Previous L1
														x	x	x	.	x	x	%		
1	15	0	MPPT current mesuring shunt resistor.	R	s	h	u	n	t								'	1	5	Level UP	Level DOWN	Next / Previous L1
																x	x		m	Ω		
1	15	1		S	e	t		R	s	h	u	n	t				"	0	1	Level UP (don't load in RAM)	Enter	Change state
																x	x		m	Ω		
1	16	0	Default voltage range (Auxiliary output 0 refers to this value)	V		R	a	n	g	e							'	1	6	Level UP	Level DOWN	Next / Previous L1
														x	x	x	.	x		V		
1	16	1		S	e	t		V		R	a	n	g	e			"	0	1	Level UP (don't load in RAM)	Enter	Change state
														x	x	x	.	x		V		
1	17	0	Default current range (Auxiliary output 1 refers to this value)	I		R	a	n	g	e							'	1	7	Level UP	Level DOWN	Next / Previous L1
														x	x	x	.	x	x	A		
1	17	1		S	e	t		I		R	a	n	g	e			"	0	1	Level UP (don't load in RAM)	Enter	Change state
														x	x	x	.	x	x	A		
1	18	0	PV module cell area	C	e	l	l		A	r	e	a					'	1	8	Level UP	Nothing	Next / Previous L1
														x	x	x	.	x	x	c	m	2
1	19	0	PV module area	M	o	d	u	l	e		A	r	e	a			'	1	9	Level UP	Nothing	Next / Previous L1
														x	x	x	.	x	x		m	2
1	20	0	PV module cells in serie	C	e	l	l	s		i	n		s	e	r		'	2	0	Level UP	Nothing	Next / Previous L1
																	x	x	x	x	x	
1	21	0	PV module cells in parallel	C	e	l	l	s		i	n		p	a	r		'	2	1	Level UP	Nothing	Next / Previous L1
																	x	x	x	x	x	
1	22	0	Output resistor	R	o	u	t										'	2	2	Level UP	Level DOWN	Next / Previous L1
																	x	x		Ω		

Setup

2	99	0		High Refresh Info (Setup2) 02	Level UP	Level DOWN	Next / Previous L0
2	0	0	PWM duty cycle manual setting. (use this only for debug purposes)	Manual PWM '00	Level UP	Level DOWN	Next / Previous L1
2	0	1		xxx.xxxV xxx.xxW xxx.xxxA xxx.xx%	Level UP	Change Quad Encoder Step	Change Duty Cycle B
2	1	0	MPP full search.	MPP FS '01 ABC	Level UP	Level DOWN	Next / Previous L1
2	1	1		Set MPP FS "01 ABC	Level UP (don't load)	Load into RAM	Change state
2	2	0	MPP full search type	MPP FS Type '02 xx	Level UP	Level DOWN	Next / Previous L1
2	2	1		Set MPP FS Type "01 xx	Level UP (don't load)	Enter Load into RAM	Change state
2	3	0	MPP full search scan rate	MPP FS Scan Rate '03 xxx s	Level UP	Level DOWN	Next / Previous L1
2	3	1		Set MPP FS Scan Rate "01 xxx s	Level UP (don't load)	Enter Load into RAM	Change state
2	4	0	MPP full search sweep time	MPP FS Sweep T '04 xx.x s	Level UP	Level DOWN	Next / Previous L1
2	4	1		Set MPP FS Sweep T "01 xx.x s	Level UP (don't load)	Enter Load into RAM	Change state
2	5	0	MPP full fearch dead time	MPP FS Dead T '05 xx.xx s	Level UP	Level DOWN	Next / Previous L1
2	5	1		Set MPP FS Dead T "01 xx.xx s	Level UP (don't load)	Enter Load into RAM	Change state
2	6	0	MPP adjustement state (ON/OFF)	MPP Adj '06 ABC	Level UP	Level DOWN	Next / Previous L1
2	6	1		Set MPP Adj "01 ABC	Level UP (don't load)	Load into RAM	Change state
2	7	0	MPP adjustement start window	MPP Adj S Win '07 xxxxxxxxx	Level UP	Level DOWN	Next / Previous L1
2	7	1		Set MPP Adj S Win "01 xxxxxxxxx	Level UP (don't load)	Load into RAM	Change state
2	8	0	MPP adjustement end window	MPP Adj E Win '08 xxxxxxxxx	Level UP	Level DOWN	Next / Previous L1
2	8	1		Set MPP Adj E Win "01 xxxxxxxxx	Level UP (don't load)	Load into RAM	Change state
2	9	0	Voltage adjustement state (ON/OFF)	Vm Adj '09 ABC	Level UP	Level DOWN	Next / Previous L1
2	9	1		Set Vm Adj "01 ABC	Level UP (don't load)	Load into RAM	Change state
2	10	0	Voltage adjustement start window	Vm Adj S Win '10 xxxxxxx	Level UP	Level DOWN	Next / Previous L1
2	10	1		Set Vm Adj S Win "01 xxxxxxx	Level UP (don't load)	Load into RAM	Change state
2	11	0	Voltage adjustement end window	Vm Adj E Win '11 xxxxxxx	Level UP	Level DOWN	Next / Previous L1
2	11	1		Set Vm Adj E Win "01 xxxxxxx	Level UP (don't load)	Load into RAM	Change state
2	12	0	Automatic IV Tracer state (ON/OFF)	IV Tr State '12 ABC	Level UP	Level DOWN	Next / Previous L1
2	12	1		Set IV Tr State "01 ABC	Level UP (don't load)	Load into RAM	Change state
2	13	0	Automatic IV Tracer Scan Rate	IV Tr Scan Rate '13 xxhxxm	Level UP	Nothing	Next / Previous L1
2	14	0	Ad hoc IV Tracer points number (Automatic IV Tracer always has 256 pts)	IV Tr Points '14 xxx	Level UP	Nothing	Next / Previous L1
2	15	0	IV Tracer seweep time	IV Tr Sweep T '15 xx.x s	Level UP	Nothing	Next / Previous L1
2	16	0	Main datalogging scan rate	Data Logging Rate '16 xxm	Level UP	Level DOWN	Next / Previous L1
2	16	1		Set Data Logging Rate "01 xxm	Level UP (don't load)	Load into RAM	Change state
2	17	0	Autorange state (ON/OFF)	Autorange '17 ABC	Level UP	Level DOWN	Next / Previous L1
2	18	0	Restore default setup	Restore Default Setup? '20	Level UP	Level DOWN	Next / Previous L1
2	18	1		Press Enter to Restore Setup "01	Level UP (don't restore)	Restore default LRI into RAM	Nothing

Save/Load

3	99	0		Save/Load DSP Part 03	Level UP	Level DOWN	Next / Previous L0
3	0	0	Save Low Refresh Info (Setup1) into MPPT flash memory	Save LRI into Flash? '00 Abc	Level UP	Level DOWN	Next / Previous L1
3	0	1		Press Enter to Save LRI "01	Level UP (don't save)	Enter (Save)	Nothing
3	1	0	Load Low Refresh Info (Setup1) from flash memory to MPPT RAM	Load LRI into DSP RAM? '01 Abc	Level UP	Level DOWN	Next / Previous L1
3	1	1		Press Enter to Load LRI "01	Level UP (don't load)	Enter (Load)	Nothing
3	2	0	Save High Refresh Info (Setup2) into MPPT flash memory	Save Setup into Flash? '02	Level UP	Level DOWN	Next / Previous L1
3	2	1		Press Enter to Save Setup "01	Level UP (don't save)	Enter (Save)	Nothing
3	3	0	Load High Refresh Info (Setup2) from flash memory to MPPT RAM	Load Setup into DSP RAM? '03 Abc	Level UP	Level DOWN	Next / Previous L1
3	3	1		Press Enter to Load Setup "01	Level UP (don't load)	Enter (Load)	Nothing

uConverter

4	99	0		uConverter 04	Level UP	Level DOWN	Next / Previous L0
4	0	0	T ch0, T ch1 U ch3, T internal sensor	xxx.xx°C xxx.xx°C x.xxxV xxx.xx°C	Level UP	Nothing	Next / Previous L1

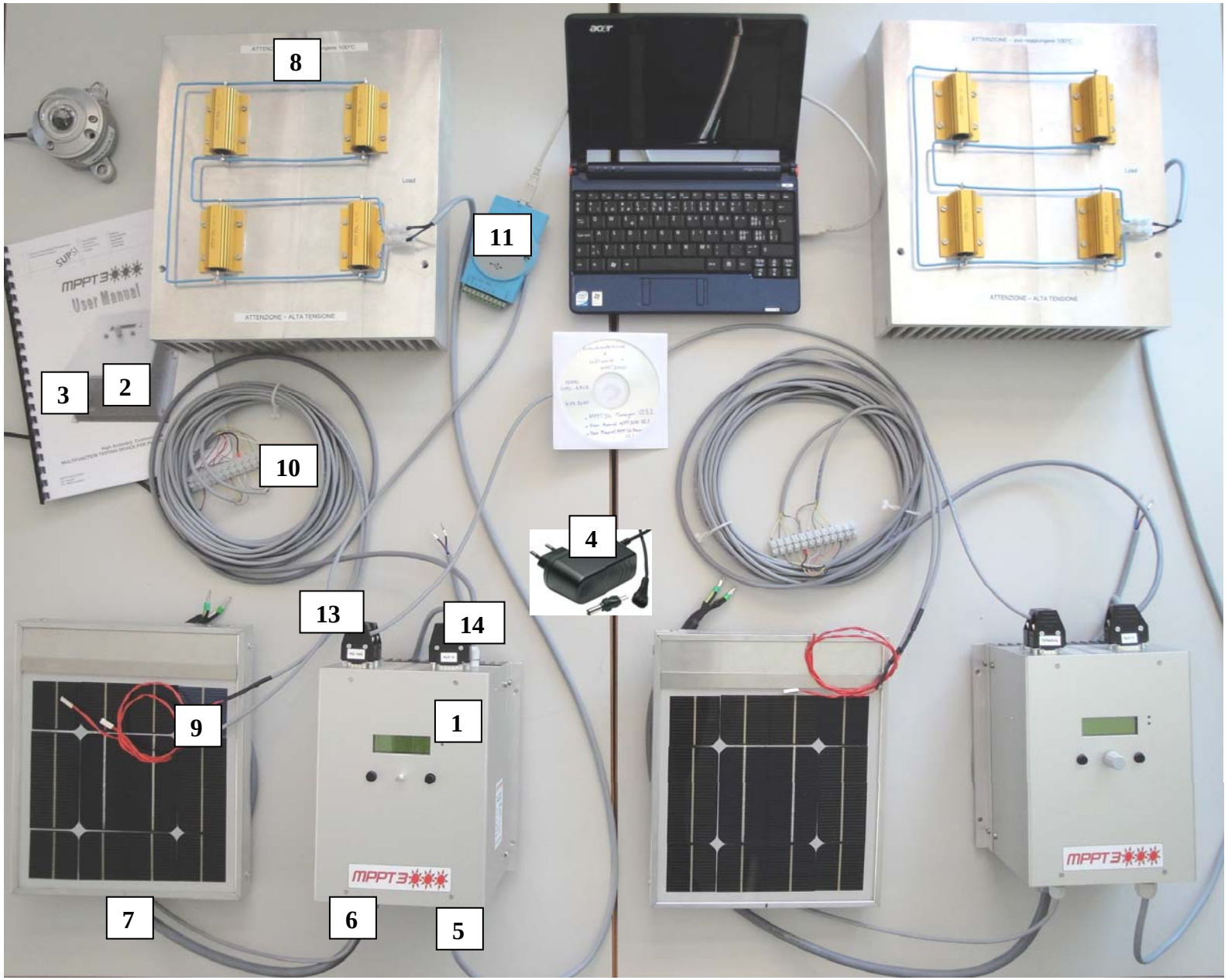
Device & Accessories

included:

1) MPPT3000 Device
2) MPPT3000 User Manual
3) MPPT3K Manager Software (CD and user Manual)
4) power supply 24V
5) load cable 1.5m
6) sense cable 1.5m

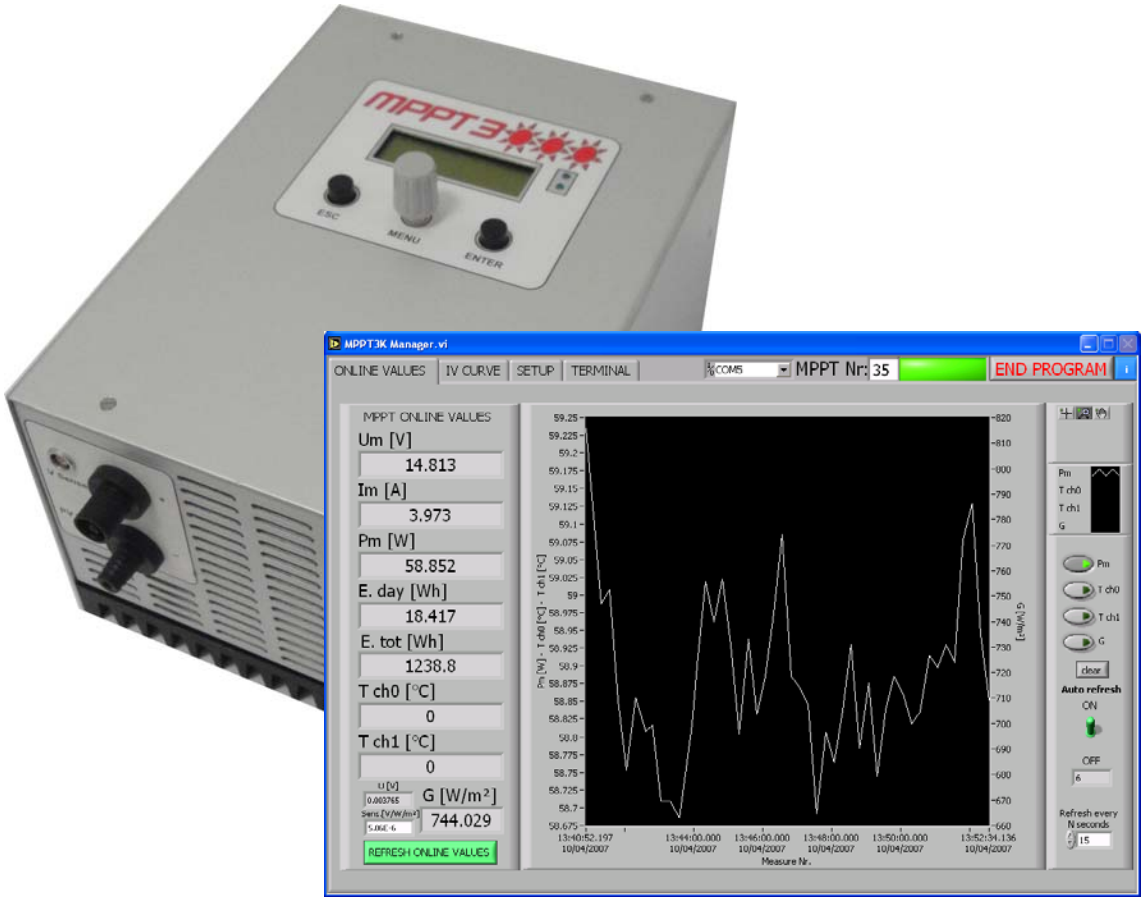
extras (on demand):

7) MC connectors or assembled cablings
8) Customized Load with ARCOL resistors
9) PT100 (temperature sensor)
10) Wiring and clamps to connect 2 PT100 and 1 phyranometer
11) RS485 → USB converter (ADAM)
12) RS485 → USB converter (Trinamic)
13) RS485 → MPPT3000 cable and connectors 10.0m (or only connectors)
14) AUX-IN cable configurated 1.0m (or only connectors)


8
11
3
2
10
4
13
14
9
1
7
6
5

Software for

MPPT3K Manager v2.5.3



SUPSI – DACD – ISAAC 2011

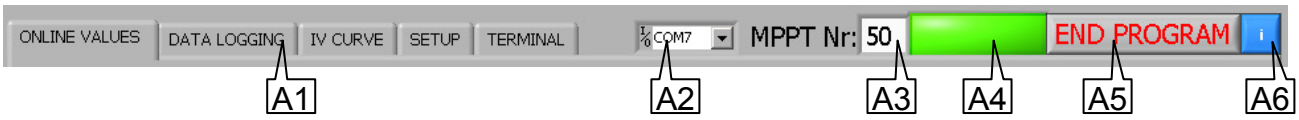
MPPT3K simple graphical user interface

MPPT3K Manager

MPPT3K Manager is an utility that allows to remotely control an MPPT 3000 device, and to easily perform tasks that otherwise would require a terminal program and a deep knowledge of the MPPT 3000 communication protocols.
The communication with the MPPT 3000 is done via the RS-485 port (normally an adapter USB <-> RS-485 is utilized, see MPPT 3000 manual for more information).

NOTE: This manual does not intend to explain how to test photovoltaic modules, but only to explain the program functionalities.

Main Commands:



A1. Tab selector
Clicking on this area gives access to the five main areas of the program:
- *Online values*: show data that is currently measured by the MPPT
- *Data logging*: store data measured by the MPPT with an adjustable time step
- *Remote IV curve control*: allows to request the MPPT to execute IV curves
- *Setup*
- *Terminal*

A2. Serial port for RS485 or adapter
This control allows to select the port that connects the PC with the MPPTs (via RS-485 or adapter)
Note: this field is editable, click on the text to modify it with another port number

A3. MPPT number
To communicate with a specific MPPT, it is necessary to insert its identification number in this field

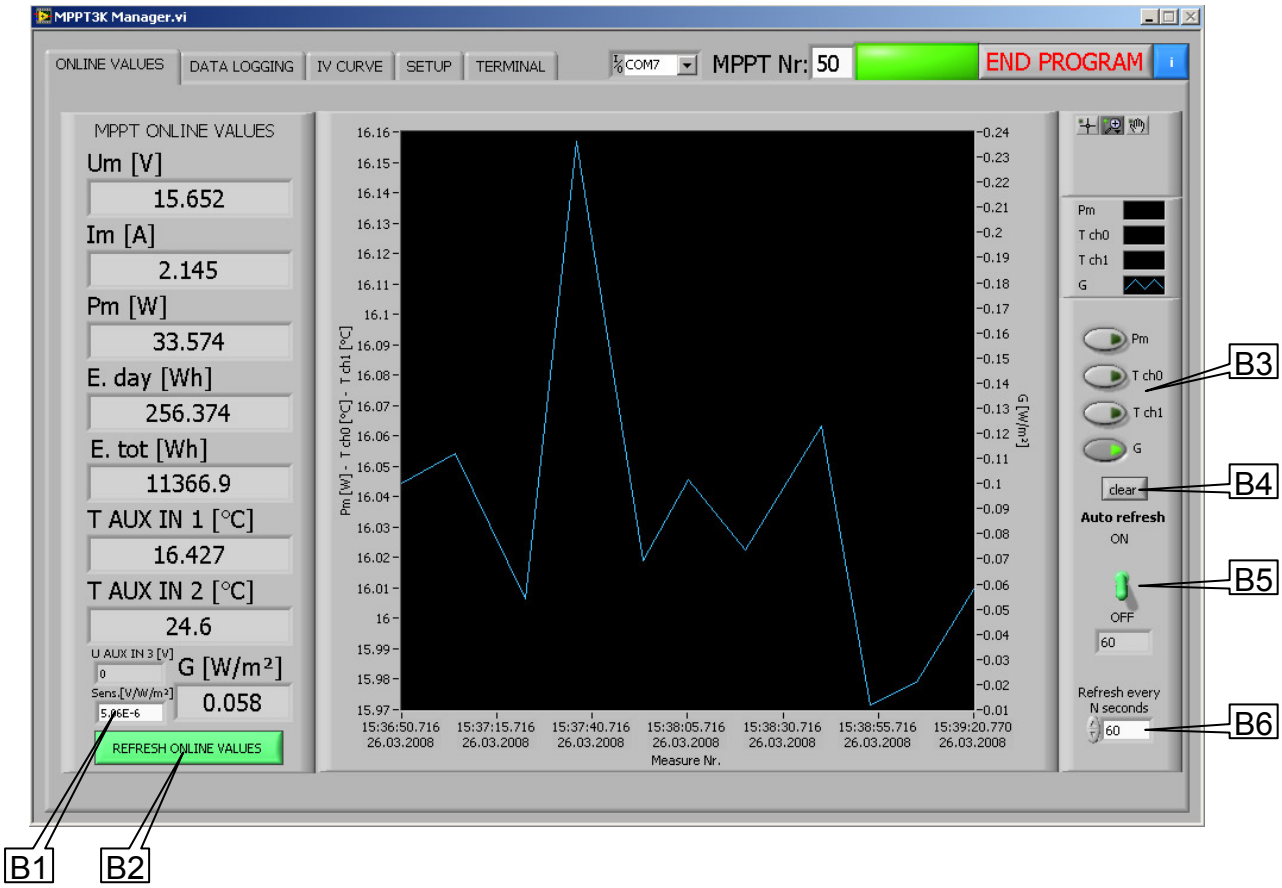
A4. Status led
The led is green when the program is ready
The led is grey when the program is communicating or computing
The led is red when an error occurs (e.g. communications errors)
Note: It is not possible to communicate with a MPPT when the device is adjusting the MPP, executing an IV-tracer, executing a full MPP search or internal special sub-routines

A5. Close the program
Stop the execution of MPPT3K manager

A6. Information button
Open a window with information about the software

DISPLAY ONLINE VALUES:

This section of the program gives the access to the values currently measured from the connected device. It is also possible to plot multiple measurements to visualize variations.



B1. Pyranometer sensibility
Set the pyranometer sensibility to show the correct irradiance values in W/m²

B2. Refresh online values
Retrieve the values currently measured from the selected MPPT. These values are shown on the left panel and added to the plot

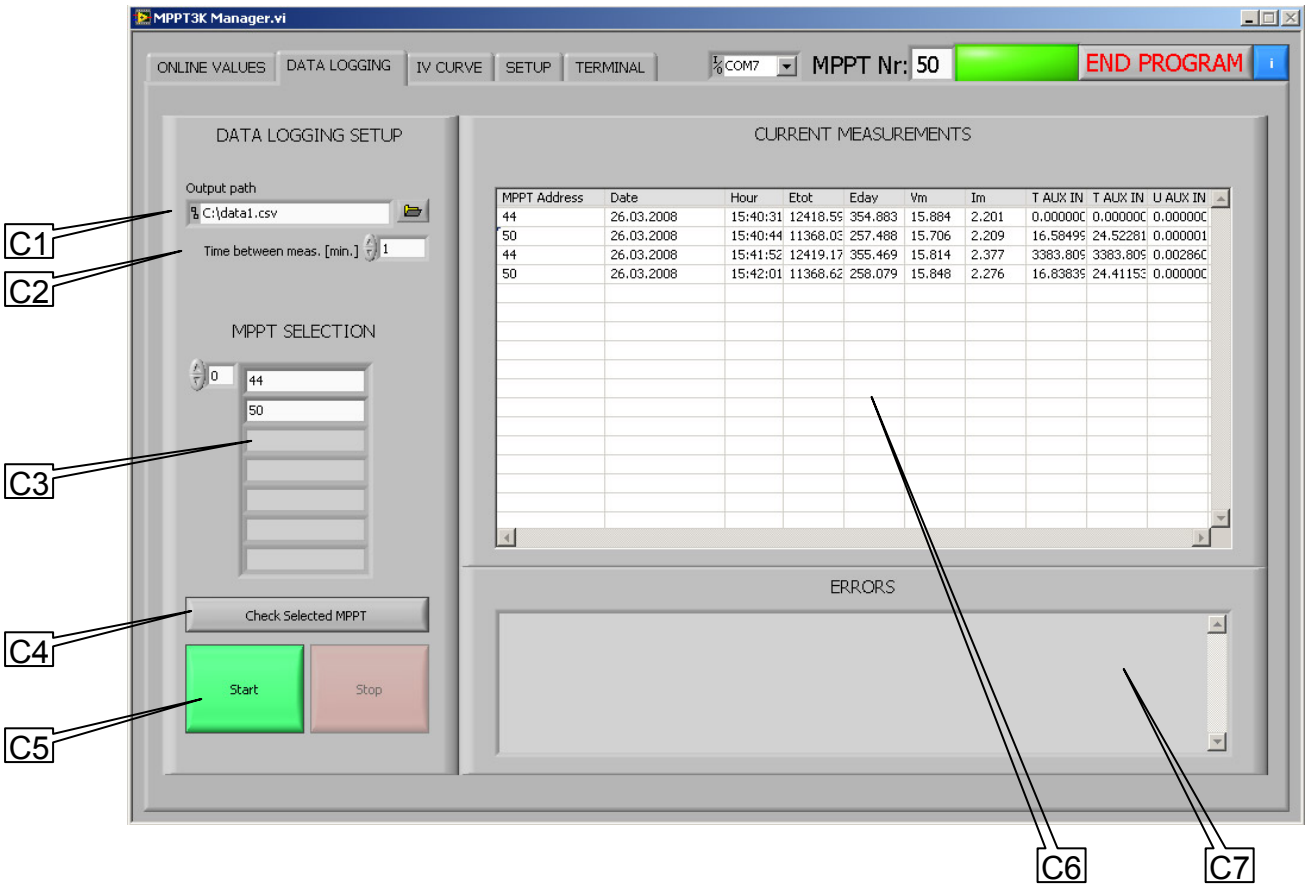
B3. Show plot buttons
Show/hide selected plots

B4. Clear
Clear the graph

B5./B6. Auto refresh
When activated, the online values are automatically fetched every N seconds. The refresh frequency is set in the *refresh every N seconds (B6)* box.

DATA LOGGING:

This function allows to retrieve and store data from the MPPT with an adjustable frequency.



C1. Output path selection
Set the output .cvs file

C2. Time between measurements
Set the frequency between measurements in minutes

C3. MPPT selection
When using the datalogging function, the *MPPT Nr. (A3)* control box is disabled. Instead, it is possible to select multiple MPPTs to query, adding their identification number to the list.
Remark: always consider the communication time between the program and the MPPT: when selecting a large number of MPPTs, the *time between measurements (C2)* has to be adjusted to avoid that a new cycle of queries will begin before the end of the current one.
Remark: each MPPT is queried sequentially, so do not expect to obtain measurements from multilple MPPTs exactly at the same time

C4. Check selected MPPT
This function checks the values entered in the previous list *(C3)*. If an MPPT number does not correspond to a reachable MPPT, the program asks to remove it from the list.

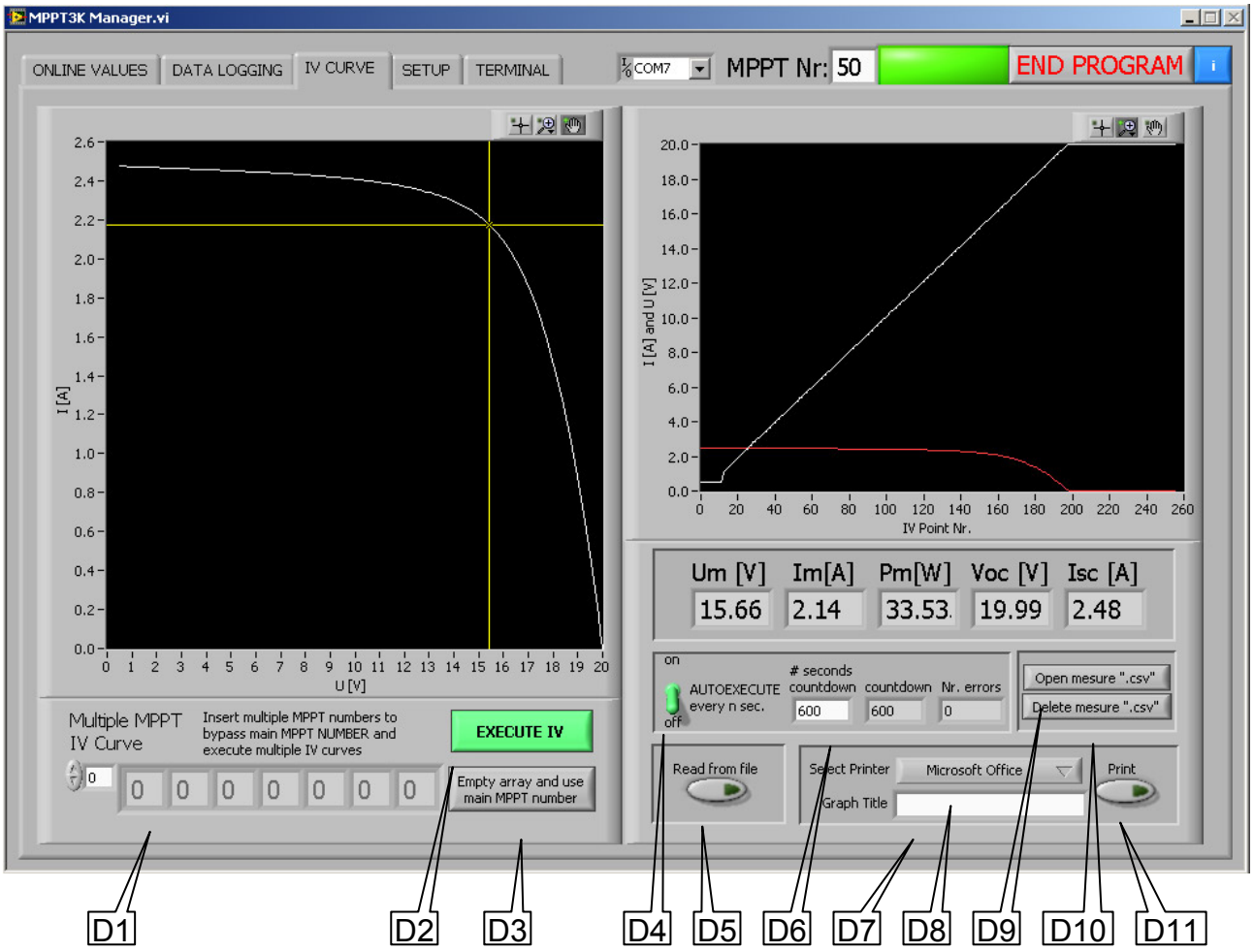
C5. Start/Stop buttons
Use these buttons to start/stop data acquisition

C6. Current measurements window
Shows data acquired during execution

C7. Errors list
Connection errors are shown in this list

REMOTE IV CURVE CONTROL:

The MPPT3K Manager allows to execute remote ad-hoc IV curve measurements. It is possible to save the output values to file, and to plot graphs. This Ad-hoc IV curve has not to be confused with the IV-tracer function embedded in the MPPT (for this feature see the setup section, MIVE commands).
Note: The periodically MPPT3K IV-curve execution feature of the MPPT3K is not available yet.



D1. Multiple MPPT IV Curve
To execute an ad-hoc IV Curve on multiple MPPTs, insert the identification number of the devices in the array. The IV curve will be executed on every selected MPPT sequentially (not in the same time!). If the array is empty, the IV Curve will be executed on the MPPT selected in *MPPT number (A3)* control box.
Use button *Empty array (D3)* to empty the array

D2. Execute IV
Begin the execution of the IV curves

D3. Empty array and use main MPPT number
Use this button to empty the array *Multiple MPPT IV curve (D1)*

D4. Autoexecute
When activated, an IV curve is executed every N seconds, where N is the value set in *# seconds countdown (D6)*

D5. Read from file
Read a measurement file previously stored and plot the graph

D6. # seconds countdown
Select the seconds between each IV curve (used only with *autoexecute (D4)*)

D7. Graph title
Insert a title for the printed graph

D8. Select printer
Select the printer for the *print (D11)* function

D9. Open measure ".csv"
Open a selected .csv file in excel (excel must be installed)

D10. Delete measure ".csv"
Delete a selected .csv file

D11. Print
Print the IV curves shown on the chart on the left

IV tracer headers

Data received from a MPPT via RS-485:

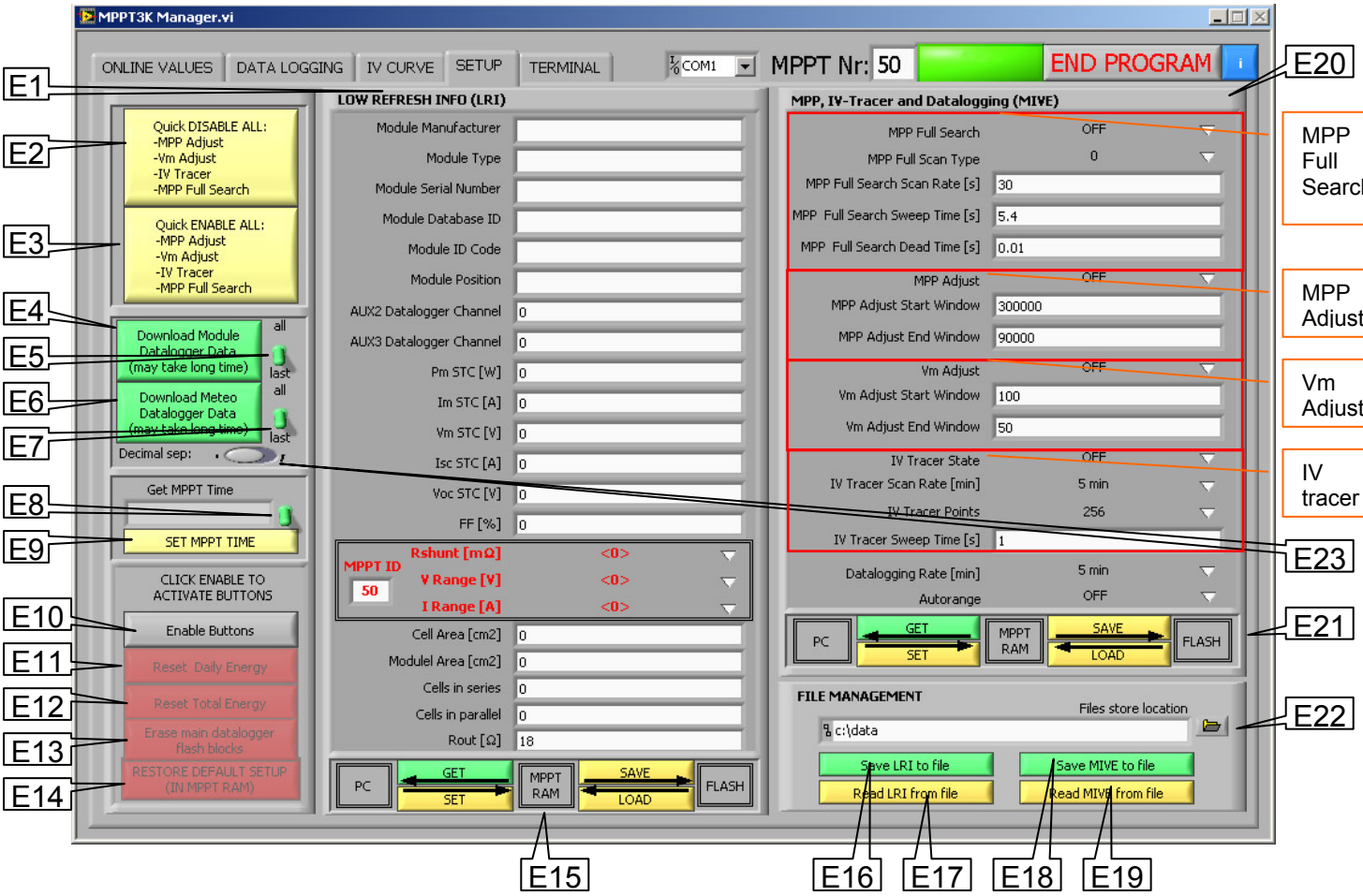
```
BEGIN
09:51 MPPT: 1
10/05/07/          4  09:51:43  -          SweepTime:       2000
       50       1.25
        0          0           0
    0.012   -246.702        0.04
0,000000   1,144043
0,000000   1,144043
0,000000   1,144165
…          …
```

```
BEGIN
[time] MPPT: [mppt number]
[date] [day (1=mon, 2=tue, …)] [time] – SweepTime: [IV Sweep Time]
[Um_coef ] [Im_coef]                                          //multiplication coefficient*
[aux0_unit_code] [aux1_unit_code] [aux2_unit_code]            //not used yet
[aux_value0] [aux_value1] [aux_value2]                        //meteo data (T1, T2, G)
[iv_U] [iv_I]
…
[iv_U] [iv_I]
```

* The values received from the MPPT need to be multiplied by a coefficient to obtain a correct value (this multiplication is already done by the MPPT3K manager)

SETUP:

Setup allows to manage the most important settings of the MPPT3K (MPP search, IV-Tracer and Energy settings). It is also possible to setup informations about the modules that are connected to the device. These settings are stored in the MPPT RAM and are saved into the MPPT flash memory.



E1. Low refresh info (LRI)

Read or set the values of the low refresh information (see MPPT user manual for more details)

E2. Quick disable all

Disable MPP Adjust, Vm Adjust, IV tracer and MPP full search on the MPPT3K. This can be useful, when communicating with the MPPT, to avoid communication problems (the MPPT3K doesn't respond when executing MPP adjusting, commands, and other internal sub-routines).

E3. Quick enable all

Enable all the adjustment and search features on the MPPT

E4./E6. Download main datalogger data (Main=module / uC=meteo)

Download the stored datalogger values to a file in *file store location (E22)*

The all/last switch allows to select the download mode

It is possible to change the rate that these informations are stored, changing the value of the field *Datalogging rate*.

File row format: Date;time;E.Total;E.Day;Vm;Im / Date;time;IN1;IN2;IN3

E5./E7. Download all/last

When the option *all* is selected, all the datalogger memory is downloaded from the MPPT.

When *last* is selected, the program reads the last measure present in the output file, and downloads only the missing measurements.

Warning: If the datalogging rate has been changed use *download all (E5/E7)* to avoid data loss.

In both modes data is added to the previous downloaded data file, if present.

E8. Get MPPT time
Ask date and time to the MPPT3K Real Time Clock

E9. Set MPPT time
Sets the time of the PC to the MPPT

E10. Enable buttons
Enable following critical/special buttons (*E11, E12, E13, E14*)

SPECIAL BUTTONS:
ATTENTION: The following buttons will permanently erase the selected MPPT memory!

E11. Reset daily energy
Reset the daily energy counter
E12. Reset total energy
Reset the total energy counter
E13. Erase energy flash blocks
Erase all flash blocks where datalogger data is stored

E14. Restore default setup (in MPPT ram)
Restore the default MIVE setup in ram. The MPPT internal flash memory is not modified.
Warning: Use *save (E15)* to store default values into the flash too, or at the next reboot of the device, old flash data will be charged into the ram

E15. LRI management
GET: fetch LRI values from MPPT RAM, and display them into the MPPT3K manager
SET: load LRI values from the MPPT3K manager to the MPPT RAM
SAVE: Save MPPT3K RAM LRI values to the flash (in the next reboot these values will be charged in MPPT RAM)
LOAD: fetch MPPT3K LRI flash values, and set to the MPPT3K MPPT RAM

E16. Save LRI to file
Download MPPT3K LRI RAM values to the MPPT3K manager, and store them into a file

E17. Read LRI from file
Read LRI information from a file, and show them in the MPPT3K manager

E18. Save MIVE to file
Download MPPT3K MIVE RAM values to the MPPT3K manager, and store them into a file

E19. Read MIVE from file
Read MIVE information from a file, and show them in the MPPT3K manager

E20. MPP search, IV-tracer and Energy (MIVE)
Read or set the values of the MPP, IV-tracer and energy (MIVE). See MPPT user manual for more information

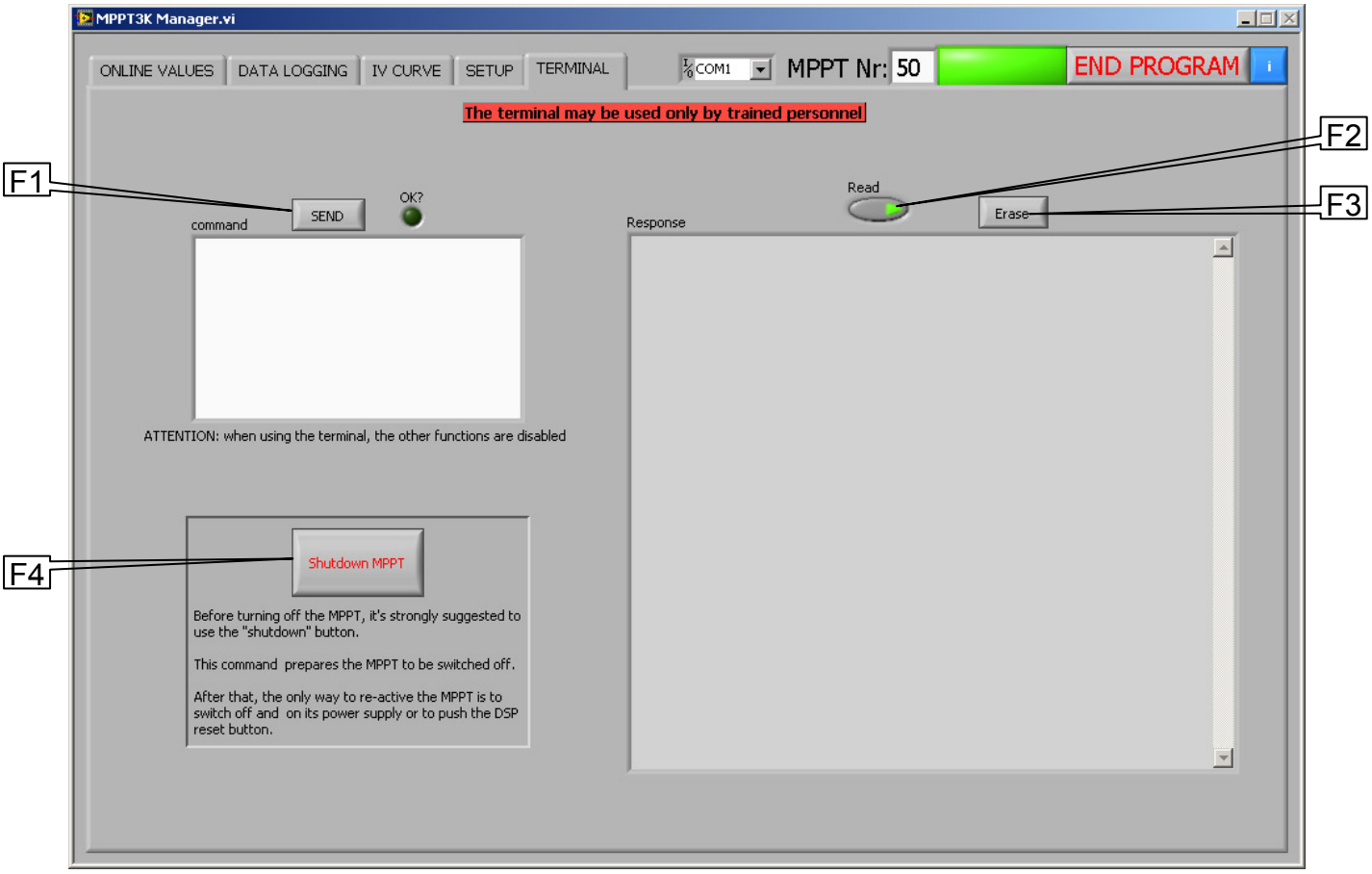
E21. MIVE management
GET: fetch MIVE values from MPPT3K RAM, and displays them into the MPPT3K manager
SET: load MIVE values from the MPPT3K manager to the MPPT3K RAM
SAVE: Save MPPT3K RAM MIVE values to the flash (at the next reboot these values will be charged in MPPT RAM)
LOAD: fetch MPPT3K MIVE flash values, and set to the MPPT3K MPPT RAM

E22. File store location
Directory where IV Curve, datalogger values, and settings files are stored

E23. Decimal sep
International settings: Use “.” or “,” as decimal separator in the datalogging csv files

TERMINAL:

This is an integrated remote terminal, for communicating with the selected MPPT.
IMPORTANT: The terminal should be used only by trained personnel



Note: When using the Terminal, all other MPPT3K manager functions are disabled

F1. Send
Send the command to the selected MPPT3K (*A3.*)

F2. Read
Activate the button to read responses on the serial port

F3. Erase
Delete history from the response window

F4. Shutdown MPPT
Prepare the MPPT to be switched off

Example of that can be executed in the terminal:

Format:
‘command’’values’
Example:
170
(PING, communication test)
Example:
48010
(read last 10 datalog values)

MPP ADJUSTMENT

MPP and Vm Adjust

Pm ADJUST (MPP Adjust):
Is a local search used to correct irradiation variations more than 0.5% (with default start window).
Tested every 200ms

Vm ADJUST:
Is a local search used to correct temperature variations more than 0.5% (with default start window).
Tested every 200ms

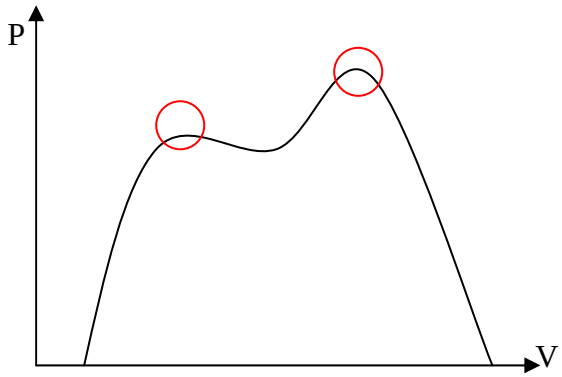
This two adjustments are enough to follow the MPP in every conditions, but for morning, shadow or other conditions a third control is suggested: the **mpp full search**

MPPT FULL SEARCH

This is useful in certain conditions:

- In case of defective module,
- partial shadows
- morning and evening or bad weather
- low irradiance

e.g. in case of two peaks in the power, the mpp full search assure to follow the highest



As said, the MPP Full Search is not necessary in normal conditions , and can be set up to the max value of 10 minutes.

MPP FULL SEARCH SWEEP TIME

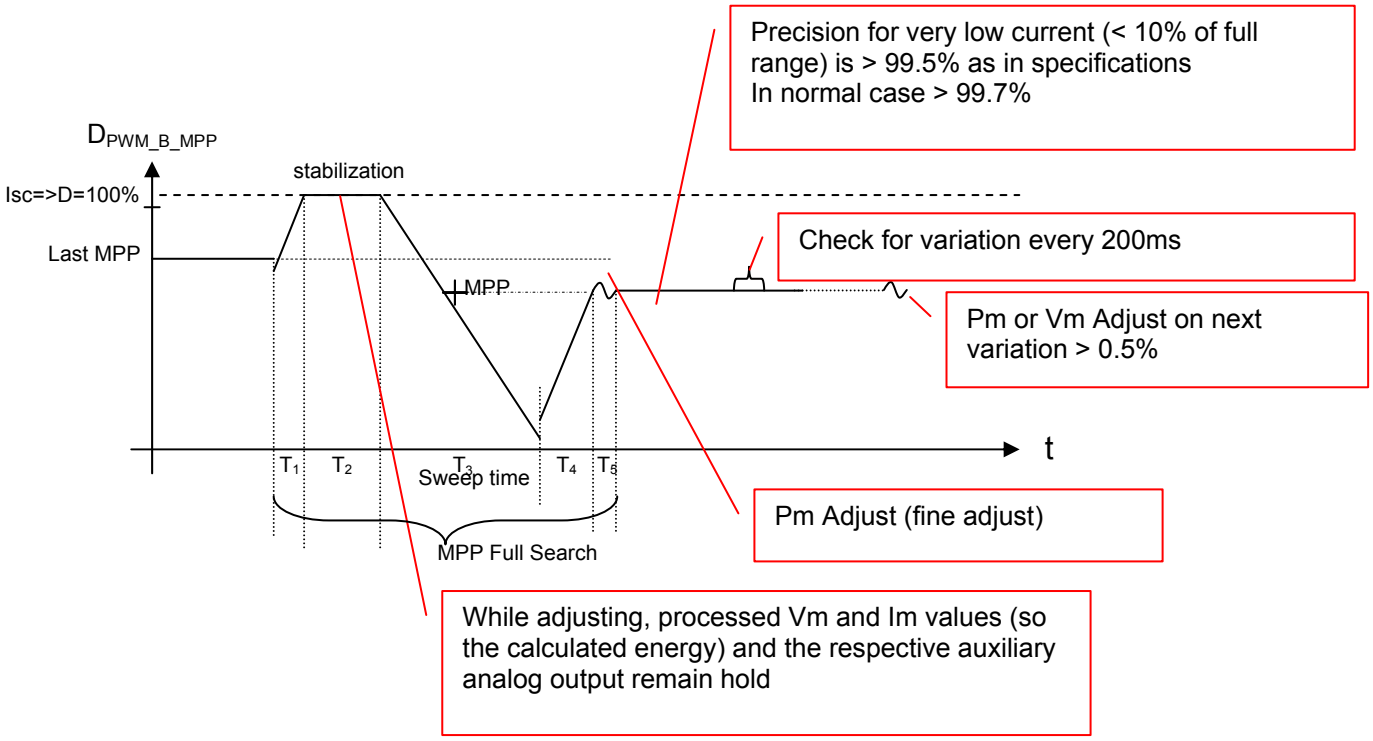
The sweep time can be set from 1.347 to 10 seconds depending on the MPP Full Scan Type:

MPP Full Scan Type	Measure's number of points	Minimum sweep time [s]	Max sweep time [s]
0	512	5.263	10
1	256	2.652	10
2	128	1.347	10

The sweep time can be set depending on module characteristics and technology.

NOTE: when the MPPT3K is executing a MPP FULL SEARCH, the analog out and the datalogged values are set to the last value before the search.

MPP Full Search scheme:



In case of low irradiation, without autorange is better to have high “Measure’s number of points” and high sweep time. This is not necessary with autorange.

Working with the lowest “MPP Full Scan Sweep Time”, lowest number of points and low current, the error will always be <0.5%. In case of need the sweep time can be adjusted in order to improve the result quality.

Notes:

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