

PV-SIM

Operating and Information Manual for PV-Simulator



Hazardous Voltage. Inverters without transformers are to be operated only by electrically isolated supply terminals. In order to avoid the arising of dangerous voltages on the PV-SIM, the controller outputs and the measured variables for the control of the power supply have to be connected via an insulation amplifier.



For a Master-Slave operation using power supplies that are not electrically isolated, it is mandatory to use a Master-Slave Series Adapter, which provides the electrical isolation externally.

Overview of Changes

Documents No. PV-SIM	Edition and Type of Change ¹⁾		Notes	Issued by
PV-Sim_B_E	1.2	A	Second Edition	

¹⁾ A: Changes due to incorrect documentation or improvement of documentation

B: Changes to ensure a complete or an advanced replaceability.

C: Changes limiting or excluding the replaceability.

	Name	Date	Signature
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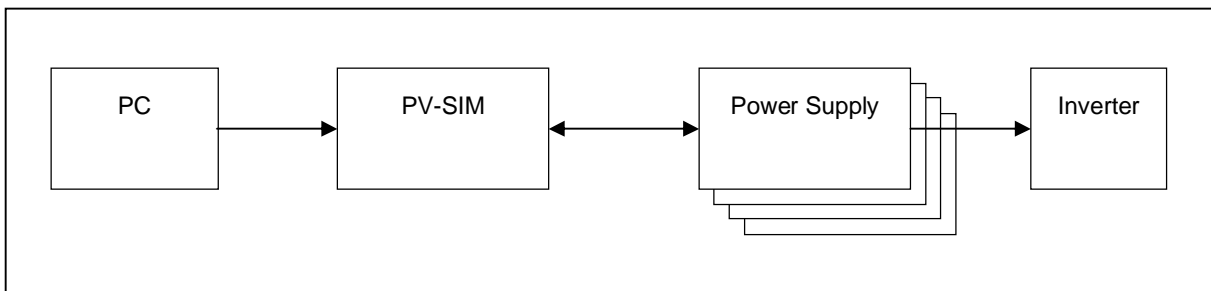
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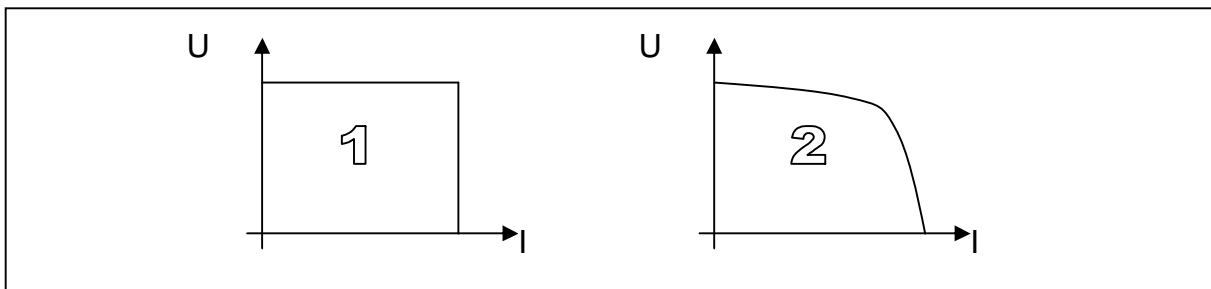
1 Overview of Functions

1.1 General Information

PV-SIM is controlling one or several DC-power supplies in a way, that their characteristics simulate those of a PV-generator.



The table below shows the characteristic of a power supply [1] and the load-independent characteristic generated by PV-SIM [2] for simulating a PV-generator:



1.2 Operation

In general the PV-SIM can be operated in two different ways:

By using the operating panel the operator is able to effect “on-the-fly” changes concerning environmental influences such as solar irradiation [W/m^2] and temperature [$^{\circ}\text{C}$]. For this procedure, two potentiometers are used and the LC-display is monitoring the set values in real-time. Using the key “MANUELL” the operating mode can be changed from remote to manual control.

The RS-232-Interface enables the remote control of the PV-simulation. By means of an instruction set, various devices are enabled to preset a PV scenario.

Three strings can be controlled via a USB hub and USB serial adapters.

A calibration set is included in the instruction set of the PV-SIM.

3 Signals Layout of Interfaces

3.1 Supply Voltage

The supply voltage of the PV-SIM is 85 VAC ... 265 VAC; 50/60Hz

3.2 RS-232

The use of the serial interface requires a zero modem cable and the following interface parameters:

- 19200 Baud
- 8 data bits
- 1 stop bit
- no parity
- no handshake

D-SUB pin	type	function
1	-	NC
2	PV-SIM > Remote PC	TxD
3	PV-SIM < Remote PC	RxD
4	-	NC
5	Masse	GND
6	-	NC
7	PV-SIM > Remote PC	CTS
8	-	NC
9	-	NC

3.3 Power Supply

PV-SIM is equipped with an interface for power supplies. In order to avoid the arising of dangerous voltages on PV-SIM, the controller outputs and the measured variables for the control of the power supply have to be connected via an insulation amplifier.

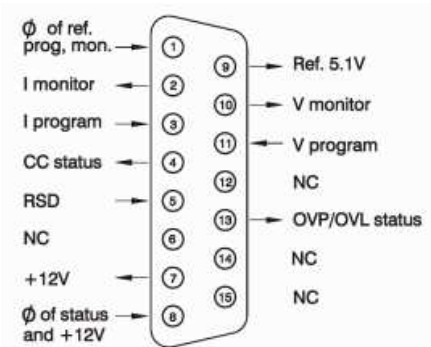
In case you plan to connect 2 Delta Elektronika power supplies for Master-Slave Series Operation, it is mandatory for you to use a Delta Elektronika Master-Slave Series Adapter.



For a Master-Slave operation using power supplies that are not electrically isolated, it is mandatory for you to make sure that the programming signals between each of the power supplies are electrically isolated. As for Delta Elektronika power supplies this electrical isolation can be effected by means of a Master-Slave Series Adapter,

The signals layout of interfaces is optimised for the use of the below mentioned power supply with the signals layout as follows:

- Manufactured by: Delta Elektronika
- Type: SM 300-10 D



Basically, it is possible to use power supplies other than those manufactured by Delta Elektronika if you make sure, that the following adjustments are carried out:

- Changing the layout of interfaces on PV-SIM's printed circuit board (soldering points for rewiring should be made in the area of X104 and X106)
- Adjusting the analog value scale of the power supply's interface (I-, V-Monitor and I-, V-Program) by means of instructions via RS-232 interface

3.3.1 Master

D-SUB Stift	Type	Function
1	Mass	V _{REF} GND
2	PV-SIM ← Power Supply	I _{MONITOR}
3	PV-SIM ← Power Supply	I _{PROGRAM}
4	-	NC
5	-	NC
6	-	NC
7	-	NC
8	Mass	Status GND
9	-	NC
10	PV-SIM → Power Supply	V _{MONITOR}
11	PV-SIM → Power Supply	V _{PROGRAM}
12	-	NC
13	-	NC
14	-	NC
15	-	NC

4 Operation

4.1 Mains Switch

The Mains Switch is to be found on the left side of the front panel. The lighted display serves as current control light.

4.2 Pushbuttons

Pushbuttons	Function
RUN/STOP	Control of the connected power supply via analog interface / no control
MANUELL	The parameterization of the characteristic simulated by the power supply is switched from RS-232 to manual. The power supply's characteristic is now defined by the potentiometers for SOLAR IRRADIATION and TEMPERATURE.



As soon as the serial interface receives an instruction, the operation is switched over from manual to remote control.

When pressing the button MANUELL for switching over from remote to manual operation, the simulation stops in order to avoid any unwanted operating status on the power supply's output.

4.3 Potentiometer

In the manual operation mode the parameters of simulation can be manually changed by means of the potentiometers. First press the button MANUELL. PV-SIM switches over from remote to manual operation mode. The set values are monitored on the LC-display in real-time.

Potentiometer	Function
EINSTRABLUNG (SOLAR IRRADIATION)	Simulated Solar Irradiation displayed in W/m ²
TEMPERATUR (TEMPERATURE)	Simulated Temperature displayed in °C

4.4 Display

PV-SIM is equipped with a 2x16 signs wide and LED-lighted LC-display. During the simulation operation the following data will be monitored in the first line:

- E: simulated solar irradiation
- T: simulated temperature

Depending on the operation mode you chose (remote or manual control) the current simulation parameters are displayed in the first line. The line below shows data of operation status or if necessary error messages. In the different operation modes the following instructions can be requested:

INSTRUCTION	STOP	RUN
P_Set/Get	X	
Ustell_Set/Get	X	
I_stell_Set/Get	X	
HW_INF	X	
Uin_Adj	X	
Iin_Adj	X	
Ustell_Adj	X	
Istell_Adj	X	
Mode_Set/Get	X	X
Kontanter_Set/Get	X	
U0_Set/Get	X	
IK_Set/Get	X	
Impp_Set/Get	X	
Umpp_Set/Get	X	
Tk_Set/Get	X	
ER_Set	X	X
T_Set/Get	X	X
E_Set/Get	X	X

4.5 LED-Functions

LED	Displayed Function
RUN	Control of the power supplies connected via the analog interfaces
STOP	No control of the power supplies connected
MANUELL	The characteristic simulated by PV-SIM can be parameterized by means of the two potentiometers SOLAR IRRADIATION and TEMPERATURE

4.6 DIP-Switch

When using several PV simulators a clear device-ID can be defined by pressing S100:1 and S100:2. By entering the instruction HW_INF the device-ID can be requested via the serial interface or the USB-adapter.

The switches S100:3 and S100:4 can be used to load fixed parameter sets from EPROM for the following functions:

- Power Supply's Parameters
- PV Generator's Parameters



When choosing a fixed configuration, the remote control via RS-232 interface is deactivated and the unit can be controlled only in manual operation mode.

Switch	Status	Function
S100:1 / S100:2	ON / ON	Device-ID A
	ON / OFF	Device-ID B
	OFF / ON	Device-ID C
	OFF / OFF	Device-ID D
S100:3 / S100:4	OFF / OFF	configuration via RS-232
	ON / OFF	fixed configuration 1
	OFF / ON	fixed configuration 2
	ON / ON	fixed configuration 3

4.7 Power Supply

The Delta Elektronika power supplies not being electrically isolated conduct DC_{MINUS} -potential on the analog programming interface. In case there is no electrical isolation, if connected to an inverter without transformer, the clocked supply voltage is joined with the analog interface!

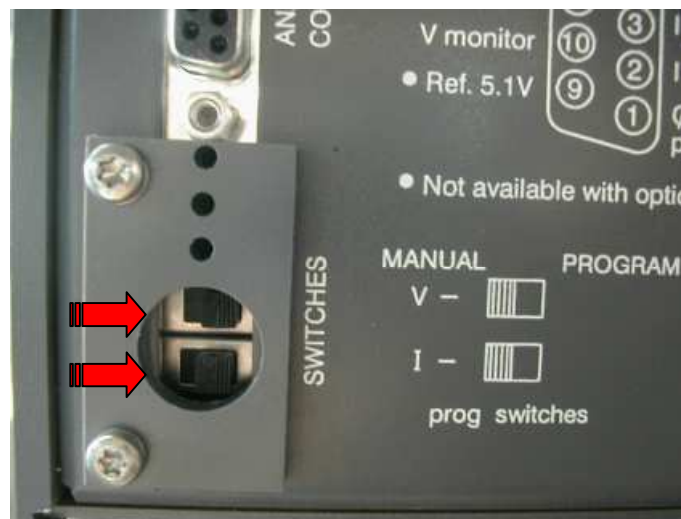


In order to avoid the arising of dangerous voltages on the PV-SIM, the controller outputs and the measured variables for the control of the power supply have to be effected via an insulation amplifier.

In order to be able to simulate various PV scenarios, it is necessary to connect the power supplies either parallel or in series depending on the consumer currently used. For this, please check the operational manual of the power supplies you use.

Example: Delta Elektronika Power Supply SM 300-10 D while using a Master-Slave Serial Adapter:

- A power supply produces 300V (10A) on the output.
- In order to reach a maximum of simulated PV-voltage of 600V (10A), both power supplies are connected in series on the output and
- the configuration switches for current and voltage on the rear panel of **both** power supplies are set to PROGRAM.



- On the rear panel of PV-SIM, the Master connector is connected to the Programmer plug of a Master Slave Serial Adapter.
- The adapter connection Master is joined to the first power supply, the adapter connection Slave is joined to the second power supply.

Example: Delta Elektronika SM 300-10 D (being electrically isolated) connected in series:

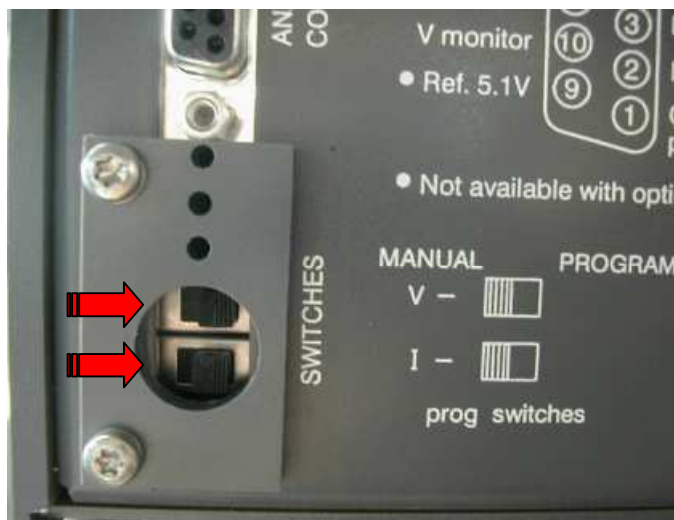
- A power supply produces 300V (10A) on the output.
- In order to reach a maximum of simulated PV-voltage of 600V (10A), both power supplies are connected in series on the output and
- the configuration switches for current **and** voltage on the rear panel of the Master power supply are set to PROGRAM,
- on the rear panel of the Slave power supply the configuration switch for voltage is set to PROGRAM, the configuration switch for current is set to MANUAL.



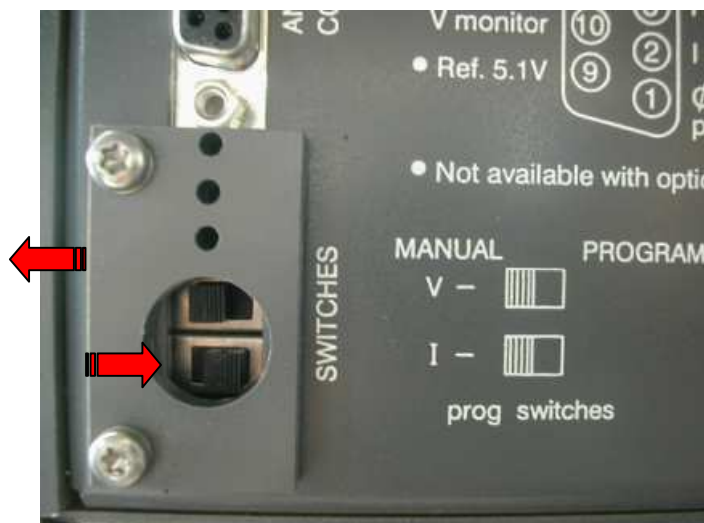
- On the rear panel of PV-SIM, the Master connector is connected to the Master power supply, whereas the Slave connector is joined to the Slave power supply.

Example: Delta Elektronika SM 300-10 D (being electrically isolated) connected parallel:

- A power supply produces 300V (10A) on the output.
- In order to reach a maximum of simulated PV-voltage of 300V (20A), both power supplies are connected parallel on the output and
- the configuration switches for current **and** voltage on the rear panel of the Master power supply are set to PROGRAM,



- on the rear panel of the Slave power supply the configuration switch for current is set to PROGRAM, the configuration switch for voltage is set to MANUAL.



- on the rear panel of PV-SIM, the Master connector is connected to the Master power supply, whereas the Slave connector is joined to the Slave power supply.

4.8 Power Supply's Parameters

At delivery, the simulator's parameters for the power supply are programmed as follows:

- Maximum output voltage (U_{max}) : 300V
- Maximum output current (I_{max}): 10A
- Set voltage for U_{max} : 5V
- Set voltage for I_{max} : 5V
- Measured voltage at U_{max} : 5V
- Measured voltage at I_{max} : 5V

By using a terminal, these values can be adjusted for other power supplies (see below).

4.9 Calibration

For calibrating the whole section of PV-simulator and power supply, the following procedure is used:

Before aligning the voltage, it is necessary to define and set the current limit

- **Ucal_set 1:** sets ca. 5% of the output voltage
- **Ucal_adj 1 Wert:** at this step, the actual value of the output voltage has to be entered. If the output for example shows 30,0 V, the instruction you have to enter would be Ucal_Adj 1 300.
- **Ucal_set 2:** sets ca. 95% of the output voltage
- **Ucal_adj 2 Wert:** at this step, the actual value of the output voltage has to be entered
- **Ucal:** calculating and saving of the adjustment values



For calibrating the current limit, short-circuiting of the power supply has to be carried out.

WARNING! Before short-circuiting, the output voltage has to be reduced i.e. to 10 Volts.

- **Ical_set 1:** sets ca. 5% of the output current
- **Ical_adj 1 Wert:** at this step, the actual value of the output current has to be entered
- **Ical_set 2:** sets ca. 95% of the output current
- **Ical_adj 2 Wert:** at this step, the actual value of the output current has to be entered
- **Ical:** calculating and saving of the adjustment values

Cal_Get: provides the status of the calibration procedure



As soon as the power supply's parameters are changed, the alignment becomes invalid. Be aware of the fact, that now the device is not calibrated.

4.10 PV Generator's Parameters

At delivery, the simulator's parameters for the PV generator are programmed as follows:

- off-load voltage (U_0): 295V
- short-circuit current (I_k): 8A
- U_{MPP} : 240V
- I_{MPP} : 7,2A
- temperature coefficient: $-1V/^\circ C$

By using a terminal, these values can be adjusted for other generators (see below).

5 Instruction Overview

If not described otherwise, an entry of tenth Volt and hundredth Ampere is mandatory for the input of the voltage and current values. (For example: the value 120 equalizes 12,0 Volt and the value 1200 equalizes 12,00 Ampere). The parameters have to be entered as integers.

When transmitting the instructions, you have to make sure that PV-SIM is running in the correct operating status (RUN/STOP) (cf. table of instructions).



In order to make sure that the simulator is able to accept the instructions, you first have to send the keyword "remote". If not, the simulator displays "lokal".

5.1 1 Instructions for Transmission of Power Supply's Parameters

Instruction	Description	R u n	S t o p	Example
Umax_Set <1...65000>	Max. output voltage of power supply		X	Umax_Set 3000 The power supply provides a maximum output voltage of 300,0 V
Imax_Set <1...65000>	Max. output current of power supply		X	Imax_Set 100
Ustell_Set <1...65000>	Voltage in mV, at which power supply sets Umax		X	Ustell_set 5000
Umess_Set <1...65000>	Measured voltage in mV after power supply has set Umax		X	Umessl_Set 5000
Istell_Set <1...65000>	Voltage in mV, at which power supply sets Imax		X	Istell_Set 5000
Imess_Set <1...65000>	Measured voltage in mV when power supply provides Imax		X	Imess_Set 5000
Kr_Save	Saving of power supply's parameters		X	

5.2 Instructions for Calibration

Instruction	Description	R u n	S t o p	Example
Ucal_Set 1	sets ca. 5% of the output voltage Umax		X	
Ucal_Adj 1 Wert	at this step, the actual value of the output voltage has to be entered		X	Ucal_Adj 1 200 The power supply actually outputs 20,0 Volt
Ucal_Set 2	sets ca. 95% of the output voltage Umax		X	
Ucal_Adj 2 Wert	at this step, the actual value of the output voltage has to be entered		X	Ucal_Adj 2 2950 The power supply actually outputs 295,0 Volt
Ucal	calculating and saving of the adjustment values. Now the calibration process for voltage has been finished.		X	
Cal_Get	status inquiry		X	

5.3 Instructions for Transmission of PV Generator's parameters

Instruction	Description	R u n	S t o p	Example
U0_Set <1...65000>	setting of the off-load voltage for the activated parameter set		X	U0_Set 1000. sets the voltage to 100,0 Volt
Umpp_Set <1...65000>	setting of the MPP voltage for the activated parameter set		X	Umpp_Set 1600 sets the mpp Voltage to 160,0 Volt
IK_Set <1...65000>	setting of the short circuit current for the activated parameter set		X	IK_Set 500. sets the short circuit current to 5,00 A
Impp_Set <1...65000>	setting of the MPP current for the activated parameter set		X	
Tk_Set <0...65000>	setting of the temperature coefficient in mV/°C. As the temperature coefficient is always expressed by a negative figure, the sign shall not be entered		X	TK_SET 100. sets the drifting of voltage to -100 mV / degrees
PV_Save <1,2>	the currently valid PV parameters are saved on storage location <1,2>. Thus, these parameters can be accessed to after switching the PV Simulator off and on again.		X	PV_Save 1

5.4 Instructions for Controlling the Power Supply

Instruction	Description	R u n	S t o p	Example
Urem_Set	direct setting of the output voltage of the power supply (in correspondence to the setting of the potentiometer on the power supply)		X	Urem_Set 2000 sets output voltage to 200,0 V
Urem_Get	displays the last entered value		X	Urem_Get -> 2000 displays 200,0 V as the set value
Urem_Rd	displays the scaled value of the measured voltage of the power supply		X	Urem_Rd -> 1990 the output actually provides 199,0 V
Irem_Set	Setting of a defined and fixed current limit		X	
Irem_Get	displays the last entered value		X	
Irem_Rd	displays the scaled value of the measured voltage for the output current of the power supply		X	

5.5 Instructions for Simulating the Characteristics

Instruction	Description	R u n	S t o p	Example
E_Set	Solar Irradiation in W/m ²			E_set 500 sets irradiation to 500 W/m ²
E_Get	displays the last entered value	X	X	
Mode_set <RUN, STOP>	switch over from operation mode RUN to operation mode STOP. As soon as operation mode RUN is chosen, the simulation starts.	X	X	
T_Set -40...90	setting of temperature in °C	X	X	
T_Get	displays the last entered value	X	X	
ER_Set E1 E2 T	ramping of solar irradiation from the start value E1<0...2000> up to the stop value E2<0...2000> within the time scale T 0...65000	X		ER_Set 10 1000 60 ramping from 10 to 1000 W/m ² in 60 s

5.6 General Instructions

Instruction	Description	R u n	S t o p	Example
P_SET <1,2>	activate parameter set 1 or 2. When switching on the unit, parameter set 1 is automatically activated. 2 parameter sets are being administered.		X	P_SET 1
HW_INF	defines a unit-ID		X	Hw_inf BFS_PV A
Post_Get	displays the result of the initialisation. If values are unequal 0, an error has occurred. Now, the unit is not configured correctly.		X	

6 Technical Data

Voltage Supply:

AC-voltage 85 – 264 VAC

Drawing of Current 100 mA

Fuse F200 1,25 A semi time-lag

RS-232 Interface:

Baud Rate 19200

Data Bits 8

Stop Bits 1

Parity None

Handshake None

Power Supply Interface:

V_{MONITOR} 0...5 Vmax

I_{MONITOR} 0...5 Vmax

V_{PROGRAM} 0...5 Vmax

I_{PROGRAM} 0...5 Vmax

Electrical Isolation By means of insulation amplifier in the unit.

Environmental Conditions during Operation:

Ambient Temperature 0 °C – 55 °C

Relative Humidity of Air 5 – 95 %, not condensing

Normative Requirements:

EMV Interference Resistance DIN EN 61000-6-1
(interference resistance for living areas)

EMV Emitted Interference DIN EN 61000-6-3
(emitted interference for living areas)

Device Security DIN EN60950

Dimensions:

Height x Width x Depth 110 mm x 350 mm x 250 mm

Weight 3,7 kg