Photovoltaic Simulators
PVS series
PVS 1000/LV

The High Speed Simulators

The relating standards:
IEC/EN 50530
IEC/EN 62116
VDE 0126-2
IEEE 1547

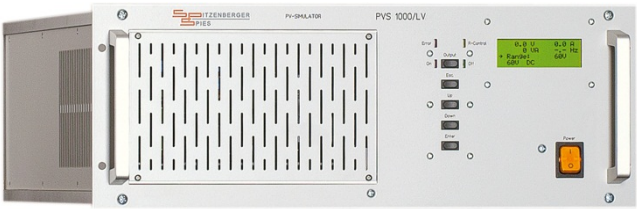


Fig. 1: PVS 1000/LV

Fig. 2: PVS 25000

- ✓ Free programmable I/V characteristics
- ✓ Different solar cells and also partly shadowed PV-generators can be simulated.
- ✓ Fast response time to load changes: typical less than 100µs
- ✓ 100Hz ripple on current and voltage of single phase inverters is reproduced realistically
- ✓ The I/V curve is simulated very accurately
- ✓ Ability to simulate dynamic irradiance and temperature, possibility of simulation of the behaviour of a PV-generator during a typical cloudy or clear day
- ✓ Evaluation of static and dynamic MPP-tracking efficiency
- ✓ Complies with the requirements according to IEC/EN 50530
- ✓ Available in standard version (up to 950V_{DC}) and low-voltage version (up to 150V_{DC}) for micro inverter testing

www.spitzenberger.de
Spitzenberger & Spies GmbH & Co. KG | Schmidstr. 32-34 | 94234 Viechtach | GERMANY | Tel. +49 9942 956-0 | info@spitzenberger.de

THE PV-SIMULATOR – FIELD OF APPLICATION

The PV-Simulator reproduces in real time the behaviour of many different solar panels.

The parameters influencing this behaviour in reality are the changing weather conditions, the variation of the irradiation during the day and also local conditions like shadowing and pollution.
To simulate this condition the PVS has a capability for fast control adjustments.

Fast response time
Due to the fast DSP based regulation system, the response time to load changes is very fast.
For the IEC/EN 50530 and the specified MPP tracking algorithm this fast response time is absolutely necessary.

See Spitzenberger & Spies Application note under:
http://www.spitzenberger.de/weblink/1005

The diagrams in Fig. 3-6 show the measured rise- and fall-times at different load conditions.

Load changes around MPP:

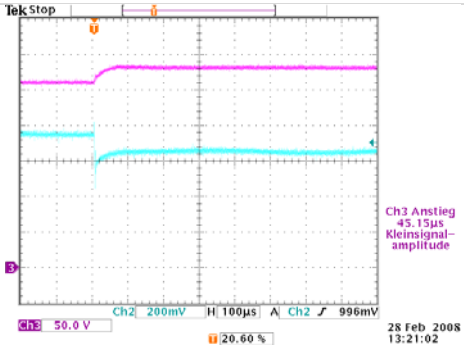


Fig. 3: Rise-time Voltage / Current

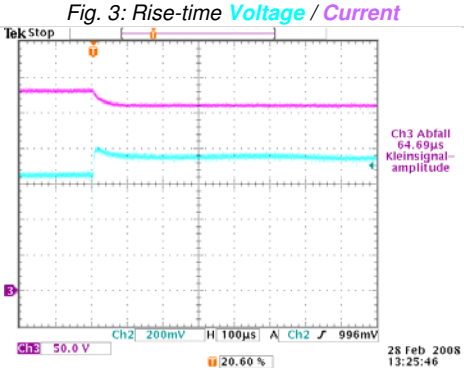


Fig. 4: Fall-time Voltage / Current

Load between open circuit and MPP:

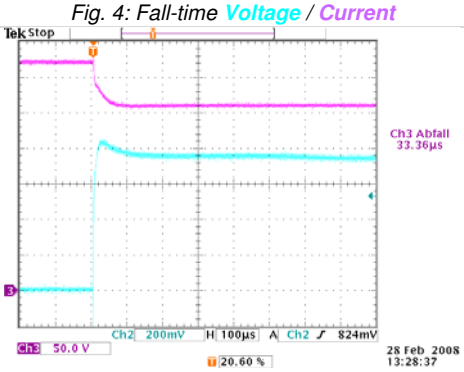


Fig. 5: Fall-time Voltage / Current

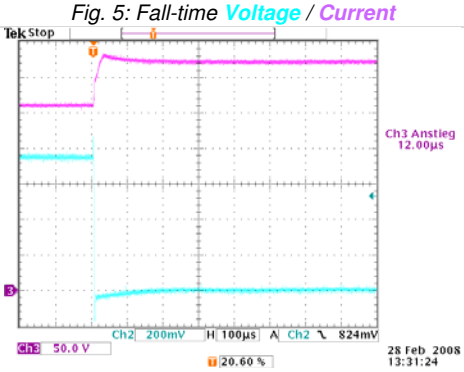


Fig. 6: Rise-time Voltage / Current

www.spitzenberger.de
Spitzenberger & Spies GmbH & Co. KG | Schmidstr. 32-34 | 94234 Viechtach | GERMANY | Tel. +49 9942 956-0 | info@spitzenberger.de

100HZ RIPPLE / FREE PROGRAMMABLE CURVES

100Hz Ripple

One of the requirements of the photovoltaic simulator according to the IEC/EN 50530 is:

"This requires a sufficient dynamic of the PV simulator in order to follow the dynamic voltage changes that occur in the measurement (e.g. the typical ripple of single phase inverters with twice the grid frequency)"

With real photovoltaic generators this typical 100Hz ripple on current and voltage when operating with a single phase inverter can be measured. Some inverters use this for a fast MPP tracking.

When operating with the PV-Simulator this ripple-behaviour is exactly as it is in reality, because of the very fast response time capability.

Free programmable curves

I/V-curves are adjustable via software over a wide range to simulate various conditions for dynamic irradiances and temperature changes.
This includes "in the field" measured I/V curves, stored and imported into the Spitzenberger & Spies control software.

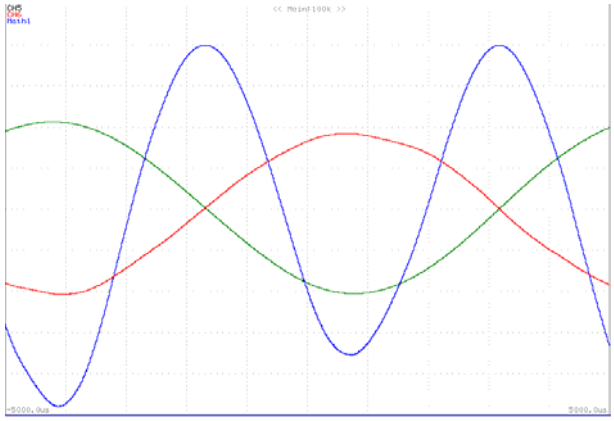


*Fig. 7: 100Hz ripple of voltage and current - **voltage**, **current**, **power***

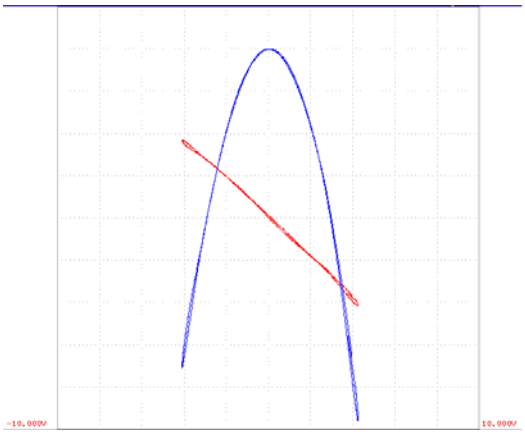


*Fig. 8: XY-view: no hysteresis observably - **current**, **power***

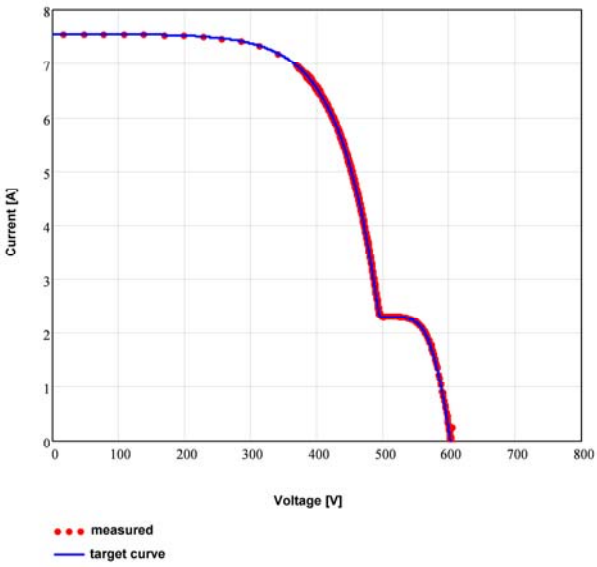


Fig. 9: free programmable I/V curves

www.spitzenberger.de
Spitzenberger & Spies GmbH & Co. KG | Schmidstr. 32-34 | 94234 Viechtach | GERMANY | Tel. +49 9942 956-0 | info@spitzenberger.de

SIMULATION OF DYNAMIC IRRADIATION

Irradiation

The intensity of the solar radiation density – the irradiation – is varying during the day.

Slow variations occur because of the changing position of the sun.

Fast variations can occur at cloudy days, when the sun is shadowed within seconds and cleared some minutes later and again shadowed.

Various curves – corresponding to different irradiance - can be defined with specified time course.

Transition between two curves will be interpolated; the transition time is freely programmable.

The specified curves are met exactly during the complete measurement duration.

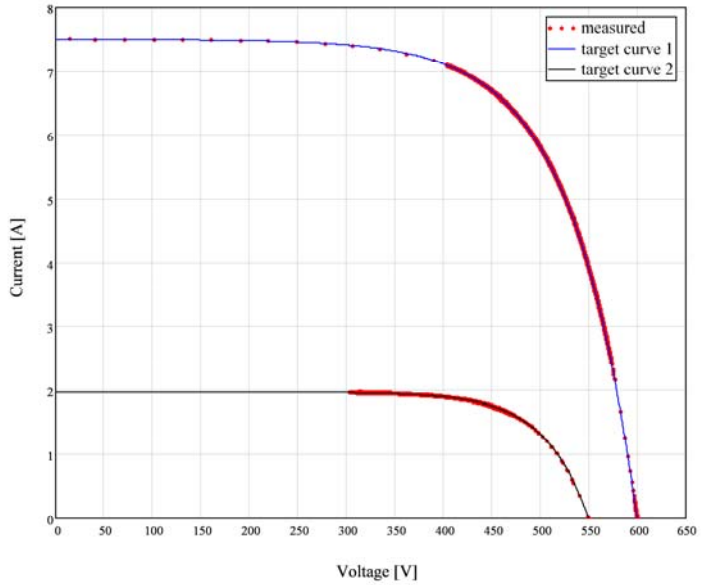


Fig. 10: various I/V curves

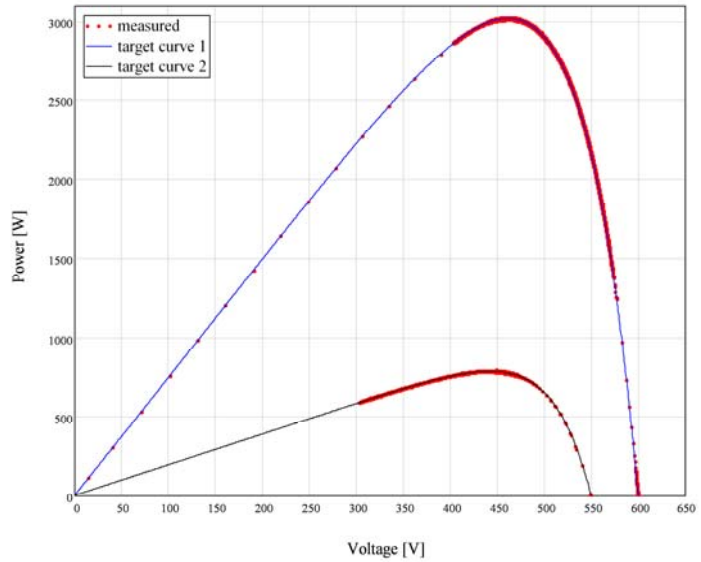


Fig. 11: various V/P curves

www.spitzenberger.de
Spitzenberger & Spies GmbH & Co. KG | Schmidstr. 32-34 | 94234 Viechtach | GERMANY | Tel. +49 9942 956-0 | info@spitzenberger.de

VOLTAGE RANGES – CURRENT CHARACTERISTICS

Due to different types of solar generators the PVS standard series has five voltage ranges:

- 400V
- 500V
- 600V
- 800V
- 950V

The diagrams show the maximum possible current capability in the according voltage ranges, depending on the adjusted output voltage. This correlates also to the maximum available power capability of the PVS depending on the adjusted output voltage.

The current capability of the PVS is specified as:

- Continuous current capability
- Short time current capability *(up to 2 minutes)*
- Peak current capability *(up to 50ms)*

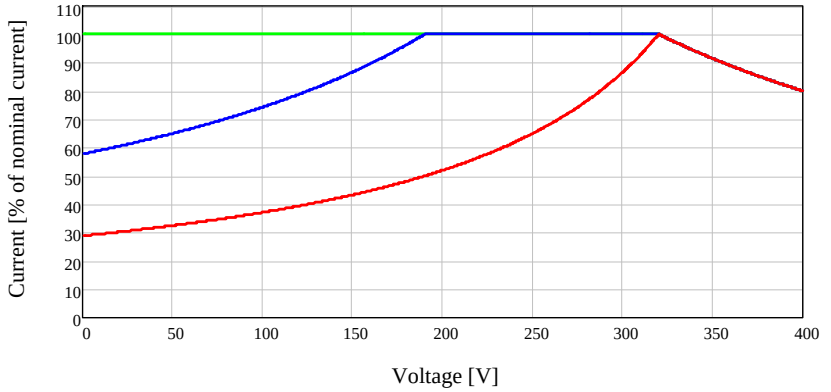


Fig. 12: current performance of the PVS in the 400V range

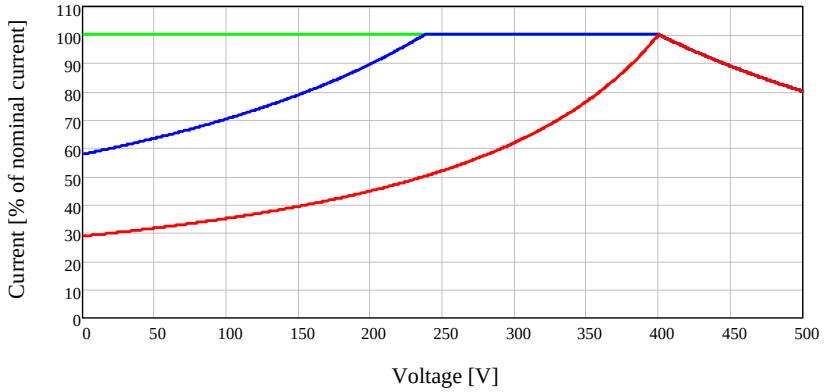


Fig. 13: current performance of the PVS in the 500V range

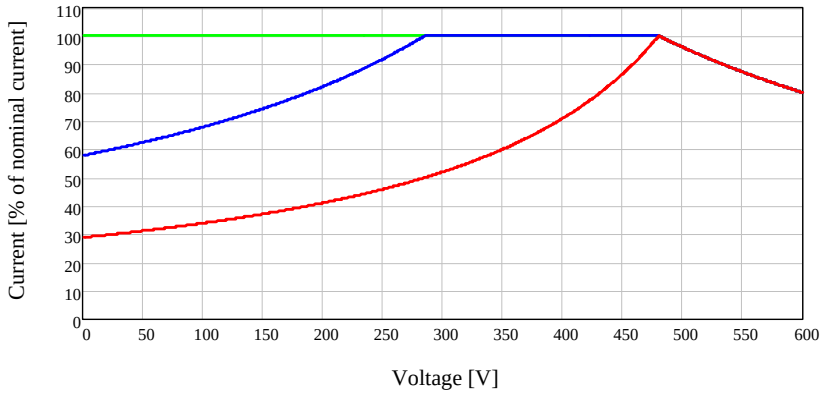


Fig. 14: current performance of the PVS in the 600V range

www.spitzenberger.de
Spitzenberger & Spies GmbH & Co. KG | Schmidstr. 32-34 | 94234 Viechtach | GERMANY | Tel. +49 9942 956-0 | info@spitzenberger.de

Fig. 17: PVS / Basic EMC System

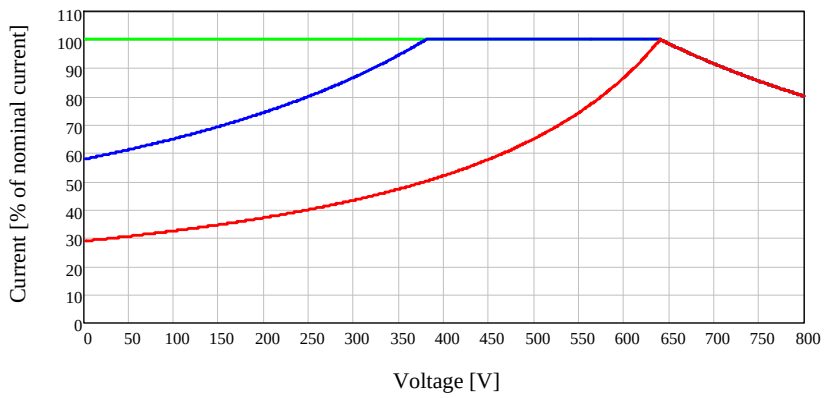


Fig. 15: current performance of the PVS in the 800V range

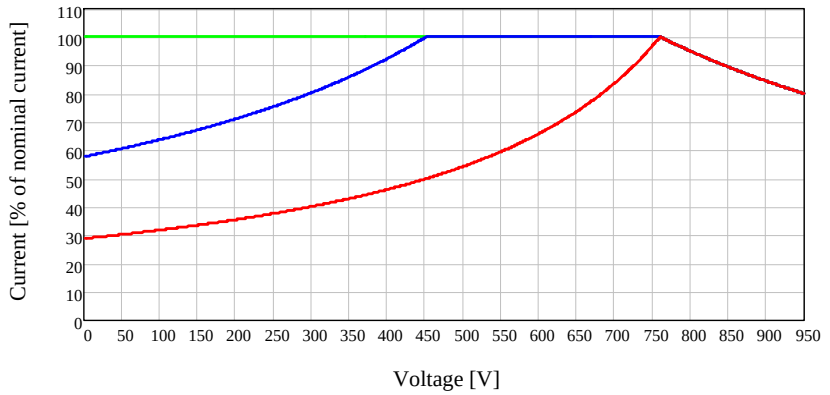


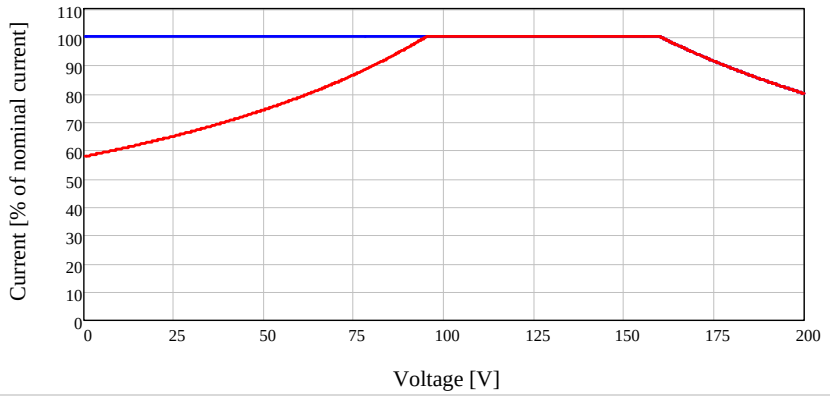
Fig. 16: current performance of the PVS in the 950V range

OPTIONAL VOLTAGE RANGES – CURRENT CHARACTERISTICS

	PVS 1000	PVS 3000	PVS 7000	PVS 10000	PVS 15000	PVS 25000
- Option 11-200/DC at $160V_{DC}$	$3.2A_{DC}$	$9.4A_{DC}$	$22A_{DC}$	$31A_{DC}$	$50A_{DC}$	$80A_{DC}$

	PVS 32500	PVS 42500	PVS 50000	PVS65000	PVS 85000	PVS100000
- Option 11-200/DC at $160V_{DC}$	$100A_{DC}$	$135A_{DC}$	$157A_{DC}$	$200A_{DC}$	$270A_{DC}$	$314A_{DC}$

Fig. 18:
Optional voltage range 200V
Current performance



www.spitzenberger.de
Spitzenberger & Spies GmbH & Co. KG | Schmidstr. 32-34 | 94234 Viechtach | GERMANY | Tel. +49 9942 956-0 | info@spitzenberger.de

TECHNICAL DATA – GENERAL

		PVS Series
Nominal voltage	*DC:*	+400V_{DC} / +500V_{DC} / +600V_{DC} / +800V_{DC} / +950V_{DC}
Voltage accuracy:		0,2% / 0,5% (typ. / max.) upper range value
Current accuracy:		0,2% / 0,5% (typ. / max.) upper range value
Slew rate:		< 250µs / typical < 100µs
Protection circuits:		Overload / Short Circuit / Over temperature
Interface:		IEEE488
Measurement (via Software)	*Voltage:*	0.1V resolution
	Current:	0.01A resolution
	Power:	1W resolution
Memory capacity for I/V curves:		up to 1024 curves
Ambient temperature:		0°C up to 40°C

Options		
10:	Internal resistance compensation	available
11	Special voltage	
11-200/DC	Additional DC voltage range	0 … 200V_{DC}
18	Special line voltages	In the range from 110V … 300V
	Precision Power Analyser for efficiency measurement	

Remarks:

1) *at nominal voltage*
2) *max. voltage between earth and ground of the amplifier output -950V_{DC}, +400V_{DC}*
3) *to increase the output power of an amplifier, up to three similar amplifiers may be connected in parallel*
4) *with measurement adaptation to PAS*
5) *at 230V input voltage*
6) *max. / typ. (of measured value ±2 digit)*

www.spitzenberger.de
Spitzenberger & Spies GmbH & Co. KG | Schmidstr. 32-34 | 94234 Viechtach | GERMANY | Tel. +49 9942 956-0 | info@spitzenberger.de

TECHNICAL DATA – PVS 1000 / 3000 / 7000

		PVS 1000	PVS 3000	PVS 7000
Power DC [1) 5)]	*- continuous:*	1000W	3000W	7000W
Continuous Current	*U_{OUT} = 320V_{DC}:*	3.2A_{DC}	9.4A_{DC}	22A_{DC}
	U_{OUT} = 400V_{DC}:	2.5A_{DC}	7.5A_{DC}	17.5A_{DC}
	U_{OUT} = 480V_{DC}:	2.1A_{DC}	6.3A_{DC}	14A_{DC}
	U_{OUT} = 640V_{DC}:	1.6A_{DC}	4.7A_{DC}	11A_{DC}
	U_{OUT} = 760V_{DC}:	1.3A_{DC}	4A_{DC}	9.25A_{DC}
Digital instrument Measuring ranges	*Voltage range:*	1000V		
	Current range:	5A	12A	25A
	Accuracy Voltage[6]:	0,5% / 0,2%		
	Accuracy Current[6)]:	0,8% / 0,4%		
Power Supply *(±10%, 50Hz 60Hz)*		230V	230V/400V	
Protection:		16A	3 x 16A	3 x 20A
Contactor type:		Schuko	CEE	
Housing	*Amplifier:*	19", 7U	19", 5U	19",7U
	approx. dimensions (mm):	311x483x600	222x483x600	311x483x600
	Power Supply	included	19", 5U	19" 5U
	approx. dimensions (mm):	-	222x483x600	222x483x600
Weight	*Amplifier (approx.)*	50kg	30kg	45kg
	Power Supply (approx.)	-	85kg	100kg

TECHNICAL DATA – PVS 10000 / 15000 / 25000

		PVS 10000	PVS 15000	PVS 25000
Power DC [1) 5)]	*- continuous:*	10000W	15000W	25000W
Continuous Current	*U_{OUT} = 320V_{DC}:*	31A_{DC}	50A_{DC}	80A_{DC}
	U_{OUT} = 400V_{DC}:	25A_{DC}	38A_{DC}	63A_{DC}
	U_{OUT} = 480V_{DC}:	21A_{DC}	32A_{DC}	53A_{DC}
	U_{OUT} = 640V_{DC}:	16A_{DC}	25A_{DC}	40A_{DC}
	U_{OUT} = 760V_{DC}:	13.25A_{DC}	21A_{DC}	33A_{DC}
Digital instrument Measuring ranges	*Voltage range:*	1000V		
	Current range:	40A	60A	100A
	Accuracy Voltage[6]:	0,5% / 0,2%		
	Accuracy Current[6)]:	0,8% / 0,4%		
Power Supply *(±10%, 50Hz 60Hz)*		230V/400V		
Protection:		3 x 40A	3 x 50A	3 x 63A
Contactor type:		CEE		
Housing	*Amplifier:*	19", 10U	19" 17U	19", 23U
	approx. dimensions (mm):	444x483x600	755x483x600	1022x483x600
	Power Supply	19", 10U	19", 12U	19", 12U
	approx. dimensions (mm):	444x483x600	533x483x600	533x483x600
Weight	*Amplifier (approx.)*	60kg	80kg	120kg
	Power Supply (approx.)	220kg	240kg	250kg

www.spitzenberger.de
Spitzenberger & Spies GmbH & Co. KG | Schmidstr. 32-34 | 94234 Viechtach | GERMANY | Tel. +49 9942 956-0 | info@spitzenberger.de

TECHNICAL DATA – PVS 32500 / 42500 / 50000

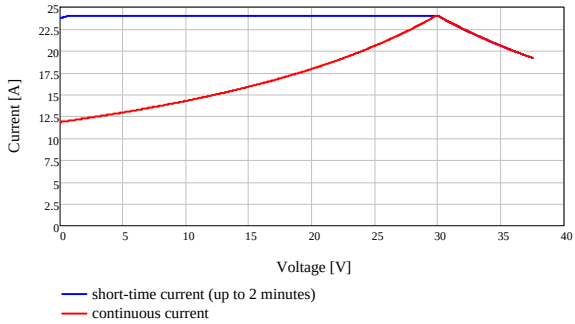
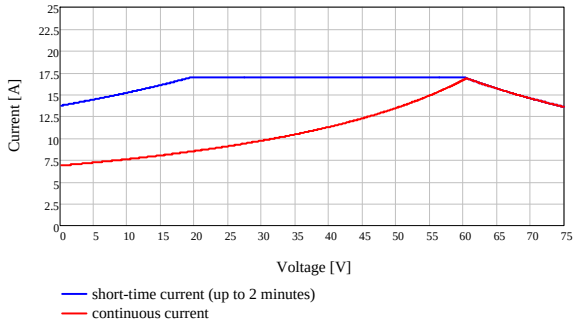
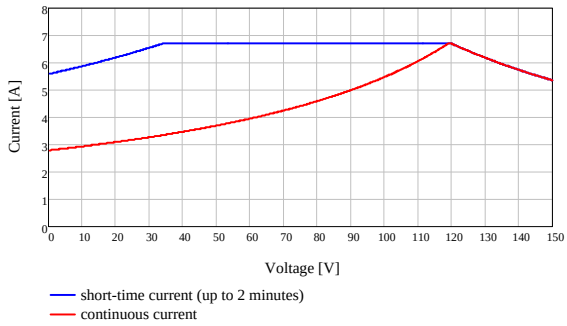
		PVS 32500	PVS 42500	PVS 50000
Power DC [1) 5)]	*- continuous:*	32500W	42500W	50000W
Continuous Current	*U_{OUT} = 320V_{DC}:*	100A_{DC}	135A_{DC}	157A_{DC}
	U_{OUT} = 400V_{DC}:	82A_{DC}	108A_{DC}	125A_{DC}
	U_{OUT} = 480V_{DC}:	68A_{DC}	90A_{DC}	105A_{DC}
	U_{OUT} = 640V_{DC}:	51A_{DC}	67A_{DC}	79A_{DC}
	U_{OUT} = 760V_{DC}:	43A_{DC}	56A_{DC}	66A_{DC}
Digital instrument Measuring ranges	*Voltage range:*	1000V		
	Current range:	120A	150A	180A
	Accuracy Voltage[6]:	0,5% / 0,2%		
	Accuracy Current[6)]:	0,8% / 0,4%		
Power Supply *(±10%, 50Hz 60Hz)*		230V/400V		
Protection:		3 x 100A	3 x 125A	3 x 160A
Contactor type:		CEE		
Housing	*Amplifier:*	19", 33U	19", 39U	19",46U
	approx. dimensions (mm):	1467x483x600	1733x483x600	2042x483x600
	Power Supply	19", 2x12U	19", 39U	19",46U
	approx. dimensions (mm):	1066x483x600	1733x483x600	2042x483x600
Weight	*Amplifier (approx.)*	160kg	200kg	300kg
	Power Supply (approx.)	2 x 250kg	2 x 250kg	800kg

TECHNICAL DATA – PVS 65000 / 85000 / 100000

		PVS 65000	PVS 85000	PVS 100000
		= 2 x PVS 32500	*= 2 x PVS 42500*	*= 2 x PVS 50000*
		External parallel connection		
Power DC [1) 5)]	*- continuous:*	65000W	85000W	100000W
Continuous Current	*U_{OUT} = 320V_{DC}:*	200A_{DC}	270A_{DC}	314A_{DC}
	U_{OUT} = 400V_{DC}:	164A_{DC}	216A_{DC}	250A_{DC}
	U_{OUT} = 480V_{DC}:	136A_{DC}	180A_{DC}	210A_{DC}
	U_{OUT} = 640V_{DC}:	102A_{DC}	135A_{DC}	158A_{DC}
	U_{OUT} = 760V_{DC}:	86A_{DC}	112A_{DC}	132A_{DC}
Digital instrument Measuring ranges	*Voltage range:*	1000V		
	Current range:	2x120A	2x150A	2x160A
	Accuracy Voltage[6]:	0,5% / 0,2%		
	Accuracy Current[6)]:	0,8% / 0,4%		
Power Supply *(±10%, 50Hz 60Hz)*		230V/400V		
Protection:		3 x 200A	3 x 250A	3 x 320A
Contactor type:				
Housing	*Amplifier:*	19", 2x33U	19", 2x39U	19", 2x46U
	approx. dimensions (mm):	1467x483x600	1733x483x600	2044x483x600
	Power Supply	19", 42U	19", 42U	19", 46U
	approx. dimensions (mm):	1867x483x800	1867x483x800	2044x483x600
Weight	*Amplifier (approx.)*	2x160kg	2x200kg	2x300kg
	Power Supply (approx.)	1000kg	1200kg	1500kg

www.spitzenberger.de
Spitzenberger & Spies GmbH & Co. KG | Schmidstr. 32-34 | 94234 Viechtach | GERMANY | Tel. +49 9942 956-0 | info@spitzenberger.de

TECHNICAL DATA – **PVS 1000/LV**

Nominal voltage	*DC*	$+37.5V_{DC}$ / $+75V_{DC}$ / $+150V_{DC}$
Measurement resolution (via Software)		U: 0.01V / I: 0.01A / P: 0.1W
Power DC [2) 9)]	*- continuous*	1000W
Continuous Current	*UOUT = 30VDC* *$24A_{DC}$* *Fig. 19:*	
	U_{OUT} = $60V_{DC}$ *$16.7A_{DC}$* *Fig. 20 :*	
	U_{OUT} = $120V_{DC}$ *$6.7A_{DC}$* *Fig. 21:*	
Digital instrument Measuring ranges	*Voltage range:*	150V
	Current range:	40A
	Accuracy Voltage [6)]*:*	0,5% / 0,2%
	Accuracy Current [6)]*:*	0,8% / 0,4%
Power Supply *(±10%, 50Hz 60Hz)*		230V
Protection / Contactor type:		16A / Schuko
Housing	*Amplifier incl. Power supply:*	19", 4U
	approx. dimensions (mm):	178x483x700
Weight	*Amplifier (approx.)*	55kg

„We can make weather"

www.spitzenberger.de/weblink/1056

www.spitzenberger.de
Spitzenberger & Spies GmbH & Co. KG | Schmidstr. 32-34 | 94234 Viechtach | GERMANY | Tel. +49 9942 956-0 | info@spitzenberger.de