

Power recuperation unit PRU series

Additional current sink capability
for AC 4-quadrant amplifiers

The relating standards:

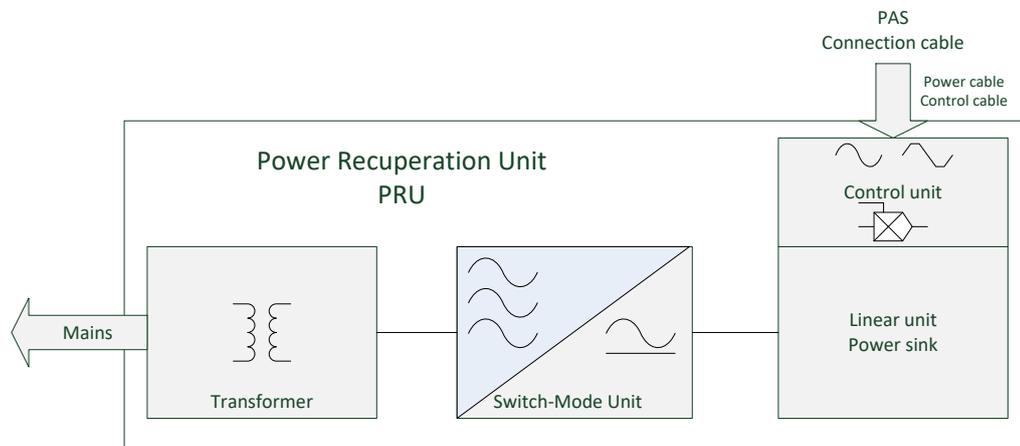
- IEC/EN 50530
- IEC/EN 62116
- IEEE 1547
- IEC/EN 61683
- IEC/EN 61727
- Sandia Report
- CGC/GF004:2011
- CEI 0-21
- VDE-AR-N 4105
- VDE 0126-2

When testing a solar inverter the generated power of the inverter has to be consumed by the mains simulation system. In this case the amplifiers of the simulation system are working as a current sink.

The consumed energy is converted to heat exhaustion over the amplifiers output stage.

To reduce the heat exhaustion and therefore the power losses of the system and to increase the sink power capability a power recuperation unit PRU is recommended.

The PRU feeds the input power of a mains simulation system back into the public grid without influencing the simulated voltage. It increases the sink power capability of the simulation system up to 6 times the nominal value.



SPECIFICATIONS:

<ul style="list-style-type: none"> ✓ desired input voltages 230V/115V AC 50/60Hz 	<p><i>The PRU can recuperate different input voltages and input frequencies with full power capability at 230V range</i> <i>AC range: 230V_{rms} ±10%, 115V_{rms} ±10%</i> <i>DC range: 240V...320V; 130V...150V</i> <i>Other voltages can be recuperated with lower power capability according to the recuperation power diagram.</i></p>
<ul style="list-style-type: none"> ✓ independent floating control inputs (three phase) 	<p><i>The power input of the power recuperation series PRU is connected in parallel to the output of the power amplifier PAS. A control line connects the PRU control input with the PAS and its current sense unit. The desired PRU connection cable must be used for personal safety against hazardous voltages.</i></p>
<ul style="list-style-type: none"> ✓ automated control signal from the amplifier 	<p><i>Each phase can be controlled by a separate control signal which is delivered by the according amplifier (a current sense unit is integrated in each amplifier).</i></p>
<ul style="list-style-type: none"> ✓ very fast response time less than 500 μs 	<p><i>The power recuperation unit PRU is a combination of switch-mode and linear elements. The regulation unit is a linear element necessary to reach the very fast response time. Within less than 500μs the recuperation unit can switch between recuperation and standby mode. The power flow direction will follow the input signal immediately. Theoretically, the power flow direction can change within one period several times.</i></p>
<ul style="list-style-type: none"> ✓ operating modes: <ul style="list-style-type: none"> - off - standby - recuperating 	<p><i>Pressing the “ON” button turns the recuperation unit into a standby mode waiting for a control signal on the input line. When the control signal is detected (which means power flows into the system) the PRU automatically feeds this power flow directly back to the mains. When the trigger signal goes missing (which means power flows out of the system) the recuperation is stopped immediately.</i></p>

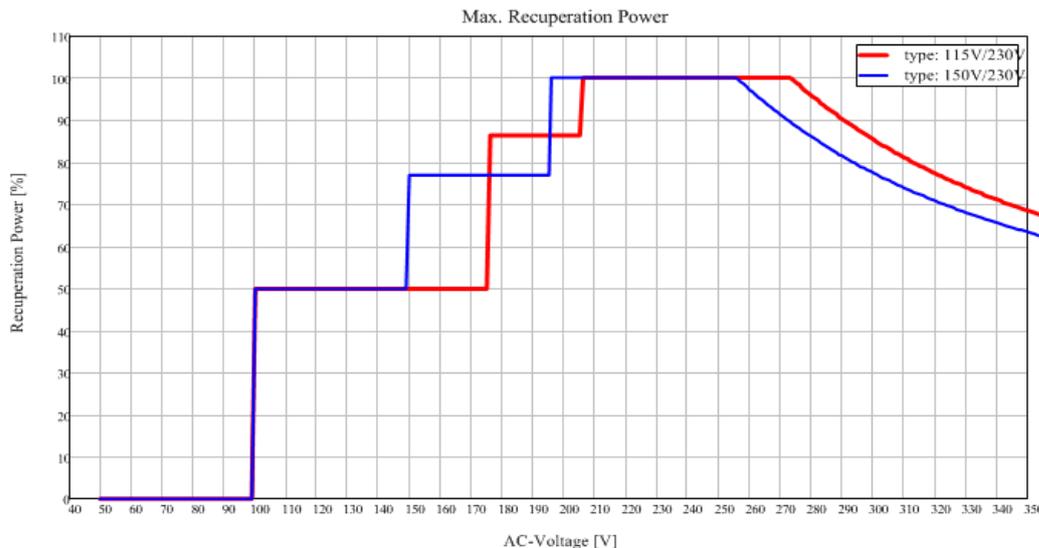


Diagram: Maximum recuperation power

TECHNICAL DATA PRU - TYPE SPECIFIC

		PRU 33000	PRU 51000	PRU 63000	PRU 78000
Power AC ¹⁾	<i>continuous</i>	3 x 11000W	3 x 17000W	3 x 21000W	3 x 26000W
Power AC ²⁾	<i>continuous</i>	3 x 5000W	3 x 8000W	3 x 10000W	3 x 13000W
Input current AC		<i>at specified input voltage</i>			
- rms		3 x 48A	3 x 74A	3 x 92A	3 x 114A
- peak		3 x 68A	3 x 105A	3 x 130A	3 x 161A
Digital instrument Measuring ranges	<i>Voltage</i>	280V			
	<i>Current</i>	60A	90A	120A	150A
	<i>Power</i>	40kW	60kW	80kW	100kW
Digital instrument accuracy		max.		typ.	
	<i>Accuracy V</i> ³⁾	0.5%		0.2%	
	<i>Accuracy I</i> ³⁾	0.8%		0.4%	
	<i>Accuracy P</i> ⁴⁾	3.0%		1.0%	
Power supply ($\pm 10\%$, 50Hz ... 60Hz)		400V			
	<i>Protection</i>	3 x 63A	3 x 80A	3 x 100A	3 x 125A
	<i>Contactor type</i>	CEE			
Housing	<i>Recuperation unit 19"</i>	42U	46U	46U	46U
	<i>approx. dimensions (mm)</i>	2175x805x1050	2352x805x1050	2352x1581x1050	2352x1581x1050
Weight	<i>Recuperation unit (approx.)</i>	800kg	1000kg	1800kg	2100kg

		PRU 102000	PRU 127500	PRU 175000	PRU 255000
Power AC ¹⁾	<i>continuous</i>	3 x 34000W	3 x 42500W	3 x 58333W	3 x 85000W
Power AC ²⁾	<i>continuous</i>	3 x 17000W	3 x 20000W	3 x 28000W	3 x 40000W
Input current AC		<i>at specified input voltage</i>			
- rms		3 x 148A	3 x 185A	3 x 255A	3 x 370A
- peak		3 x 210A	3 x 262A	3 x 360A	3 x 525A
Digital instrument Measuring ranges	<i>Voltage</i>	280V			
	<i>Current</i>	180A	240A	350A	480A
	<i>Power</i>	120kW	160kW	240kW	320kW
Digital instrument accuracy		max.		typ.	
	<i>Accuracy V</i> ³⁾	0.5%		0.2%	
	<i>Accuracy I</i> ³⁾	0.8%		0.4%	
	<i>Accuracy P</i> ⁴⁾	3.0%		1.0%	
Power supply ($\pm 10\%$, 50Hz ... 60Hz)		400V			
	<i>Protection</i>	3 x 160A	3 x 200A	3 x 300A	3 x 400A
	<i>Contactor type</i>	Direct wire connection			
Housing	<i>Recuperation unit 19"</i>	46U	46U	46U	46U
	<i>approx. dimensions (mm)</i>	2352x1581x1050	2352x1581x1050	2352x2357x1050	2352x2357x1050
Weight	<i>Recuperation unit (approx.)</i>	2150kg	2250kg	2700kg	3300kg

TECHNICAL DATA PRU - GENERAL

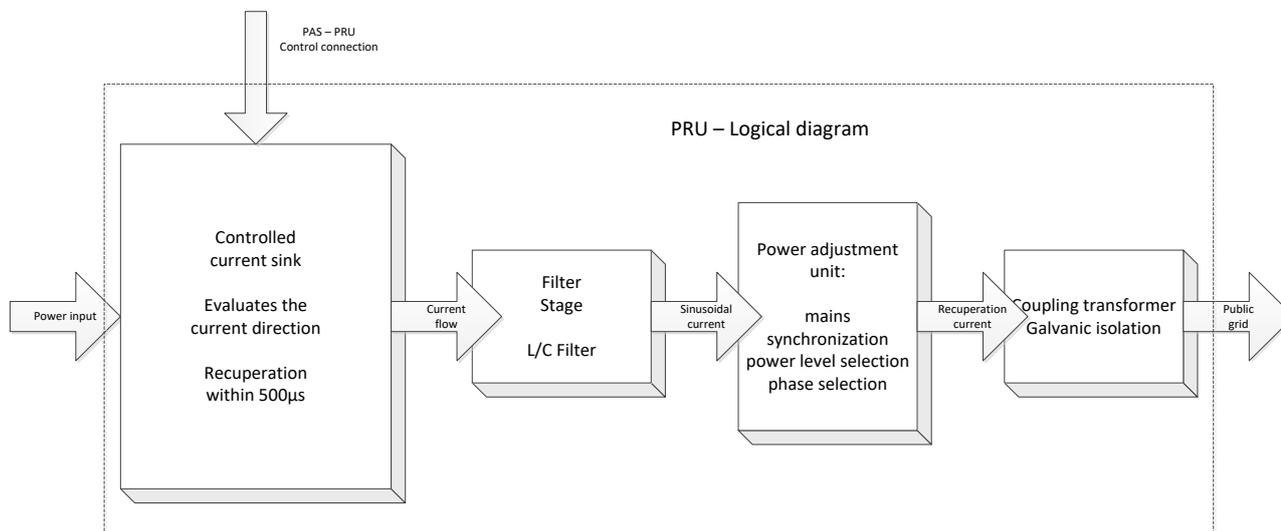
Power AC at other input voltages		According to the maximum power recuperation diagram	
Nominal input voltage type 115V/230V	AC	115V _{rms} / 230V _{rms} ±10%	
	DC	±(130V..150V) / ±(240V..320V)	
Nominal input voltage type 150V/230V	AC	150V _{rms} / 230V _{rms} ±10%	
	DC	±(100V..120V) / ±(235V..310V)	
Frequency range		DC and 15Hz... 85Hz	
Response time		max. / typ.	
		500µs / 350µs	
Protection circuits		Thermal protection unit	
Control input signal		Range / max.	
		-2 V .. +2 V / -3 V .. +3 V	
Efficiency of recuperation (at full current)		at 230V / at 115V	
		>70% / >50%	
Ambient temperature		0°C ... 40°C	

The PAS amplifier as a current sink is converting the consumed energy 100% into heat exhaustion. The PRU is recuperating this energy into the mains with a recuperation efficiency of 70%. The PRU unit evaluates the solar inverter's current flow direction and the polarity of the voltage and calculates the energy flow direction.

If the energy flow direction is out of the public grid into the solar inverter – the PAS amplifier as the grid simulator is delivering this energy – the PRU current sink is set to zero: no current consumption.

If the energy flow direction is into the public grid the PRU is acting as a current sink consuming the same current value as delivered from the solar inverter.

The maximum consumable power with a PRU is up to 6 times higher than with a PAS only.



Remarks:

- 1) at 230V nominal voltage
- 2) at 115V nominal voltage
- 3) (of measured value ±2 digit) DC; 50Hz ... 60Hz
- 4) (of measured value ±2 digit) 50Hz ... 60Hz