RPSb

High accuracy Programmable DC Power Converters 750 W - 12 kW

With high 12-hour stability and accuracy, along with a fully modular architecture, the RPSb Power Converters family is the choice for customers with rigorous scientific or industrial applications who do not require all available functionalities.



Features

- Unipolar, bipolar option with polarity reversal switch
- Max current/voltage 300A / 100V
- Long term stability (12 h): 3ppm
- Thermal drift: 5ppm/K. **Zero thermal drift, optional.**
- DCCT Technology
- High resolution
- 7 control modes: Current, voltage, hybrid, power, function generator. **Analog current and analog voltage modes, optional.**
- Real time ppm dynamic accuracy calculation
- Active input filter, PFC = 1 in all operation range
- Very low harmonic distortion
- Noise immunity
- 94,5% efficiency
- ZVS switched topology
- Save Operation Area (SOA) and autoranging for current and voltage
- Floating / ground connection, manual. **Commanded by software, optional.**
- **Precision (nA) ground current monitoring for load ground insulation check, optional.**
- **Ground fuse permanent check, optional.**
- Remote sensing input channels
- Intelligent cooling by demanded power.
- **Intelligent cooling by internal temperature and air flow control with maintenance warning, optional.**
- **Centralized switch-on for a group of power sources, optional.**
- Multiple remote-control options: EPICS, TANGO Framework, MODBUS over TCP/IP, and EPowerSys Remote Control software
- User friendly local interface with 7-inch size display
- Ethernet & Wi-Fi network interfaces
- Data base store 16GB, >30 years without erasing
- Remote sensing input channels
- High Power density, small size, and weight

Linux ANDROID EPICS TANGO Modbus Wi-Fi CE

EPOWERSYS

your preferred electronics supplier

Optional modules

The RPSb converters family has been designed to meet the highest technical requirements, taking into consideration customers whose specific applications do not require all available functional modules. This design offers customers the option to include specific modules to tailor the supply to different application requirements in a more cost-effective manner.

■ ZERO Thermal drift – 0 ppm/K thermal deviation

ADC and burden resistor, used in data acquisition for the current digital control loop, are located inside a Peltier chamber to ensure operation at a stable temperature of 25 ºC with a ±0.1ºC deviation.

Thermal grease inside the chamber ensures thermal distribution and mitigates the impact of relative humidity on measurements.

■ External 0 – 10 V Trigger input for Analog Current and Analog Voltage control modes

External 0 – 10 V trigger input for Analog Current and Analog Voltage control modes, allowing a total of 7 control modes: Constant current (CC), Constant Voltage (CV), Constant Power (CP), Function generator, Hybrid CCV, Analog voltage, and Analog current.

■ Precision ground current monitoring (nA)

Permanent ground current monitoring for load´s ground insulation checking and ground fuse checking:

- Constant ground fuse checking, in case of fuse blowing an alarm is triggered.
- Constant ground leaks monitoring, from 20mA (accuracy 0,5%) to 40nA (accuracy 10%) (Megger level 100MOhm). Predictive load maintenance analysis can be performed, detecting winding insulation to ground.

■ Floating/ground output reference commanded by software

Floating or ground connected output is commanded by software from the control screen, avoiding any need of the power supply mechanical manipulation.

■ Additional input/output interlocks

By default, the converter is provided with 1 external input interlock. Optionally, up to 4 input and 3 output interlocks may be added:

- 1 output interlock is solid state, works at fast speed.
- 2 output interlocks are potential-free contacts, mechanical relays that work at slow speed.
- All interlock inputs are hardware (fast speed).

■ Internal air flow monitoring and maintenance warning

Real-time monitoring of internal air flow, using an anemometer (not fan speed), is displayed on the Power Flow Screen. If the air flow is <7m/s, a maintenance warning for filter cleaning is activated.

■ Power lock

Allows centralized switch ON/OFF of a group of power supplies. The power button of the units can be disabled allowing multiple devices to start simultaneously controlled from a master device.

■ Active temperature monitoring and dynamic cooling control by temperature

The temperature of key components such as semiconductors, ZVS, Vienna, etc., is monitored within the converter and displayed on the Power Flow screen. Warnings or internal interlocks are activated based on these temperature values. The cooling algorithm is then commanded by the temperature to optimize fan speed

■ Technical specifications

OUTPUT	Max. Output Current	50A, 100A, 150A, 200A, 300A		
	Max. Output Voltage	15V, 40V, 60V, 100V *Note 1		
	Max. Output power	12kW (3x400V input)	10kW (3x200V input)	Up to 5kW (1x230V input) *Note 2
	Polarity	Unipolar *Note 3		
	Current adjustment range	0.5 – 100%		
	Voltage adjustment range	0.5 – 100%		
	Ripple & Noise	20 mVpp @ 2mV rms @ BW 20Mhz *Note 4 & 6		
	Switching Frequency	100kHz (200kHz Output)		
INPUT	Input Voltage	110V - 480V *Note 5		
	Input Frequency	50 - 60Hz		
	Input Module	Vienna rectifier technology		
	Power Factor Correction	Active		
	Power Factor	PFC = 1 (In all operation range)		
	Input Filter	Active		
	Harmonic Distortion THD	3%		
	Efficiency	94.5%		
	Max. AC Current	32 Arms		
	Inrush Current	Soft Start, no Inrush current		
Precision CC mode	Long Term Stability (12h)	3 ppm		
	Accuracy	25 ppm / 5 ppm with Thermalization *Note 6		
	Thermal Drift	5 ppm/K **Optional 0 ppm/K, Electronics Thermalized with Peltier 25ºC (±0.1ºC)**		
	Setting Range	0,5% - 100%		
	Setting Resolution	22-bit (<100uA)		
	Readback Resolution	31-bit slow loop 24-bit fast loop		
	Line Regulation ±10% mains voltage	±5 ppm/FS		
	Load Regulation ±10% load change	±5 ppm/FS		
	Remote Sensing Compensation	2V		
NOTE	1. Other voltage and current configurations are available upon request. Max 150V @ 12kW 2. 3 kW by default, ask EPowerSys for other configurations up to 5 kW 3. Bipolar option with a polarity reversal switch 4. Ripple&Noise measured at 100A and 500mΩ Vout < 100V - JEITA RC-9141 standard 5. Automatic power derating based on safe operating area (SOA) 6. Tests performed with 2 mH inductive load (Vout < 100V)			

Control	Programmable Ramp function	0.001A/s to 3000A/s or Step Response
	Control Modes	1 Constant current 2 Constant voltage 3 Hybrid 4 Constant Power 5 Function generator **6 Analog voltage, optional with 0 – 10 V trigger input** **7 Analog current, optional with 0 – 10 V trigger input**
	Loop adjustment	Open PIDs by software (Local or Remote configuration)
	Closed loop bandwidth	50 kHz (20µs)
	Precision Sensor	DCCT 2ppm
Ground connection	Default configuration	Floating
	Optional	**Floating / Ground selection by software (Local or Remote)**
	Ground Leaks Monitoring	**From 20mA (accuracy 0.5%) to 40nA (accuracy 10%), optional**
	Ground Insulation	1000V When floating
Local control	Display	7'' Touchscreen
	Operating System	Android (Linux)
Remote control	Digital Protocols	EPICS / TANGO (Ethernet Driver) MODBUS TCP
	Analog Control by voltage	**0-10V With Trigger, optional**
Ports	Type	3 USB, 1 HDMI, 1 ETHERNET, 1 Wi-Fi
Data Storage	Data Storage period	16 GB, 30 Years
Modularity	Parallel Connection	Yes, current and voltage control with current sharing
General	Dimensions	width ½ 19" rack, height 4U ~15Kg
	Operating temperature	0 - 55ºC 90% humidity (Non-condensing)
	MTBF	≥150,000 hrs.
	Air Flow control mode 1	Dynamic air flow control, fans speed by power consumption
	Air Flow control mode 2 (optional)	**Dynamic air flow control and monitoring with internal anemometer** **If air flow gauge <7 m/s, warning is displayed for filter cleaning**
	Freewheeling protection	300A Diode
	Output Leads	Gold plated 10 mm x 10 mm copper bus bar
	Applications	• Particle accelerator magnets supply • Test & Measurement systems • Medical Imaging and treatment systems • Semiconductor Processing

Hardware Interlocks	Input	1 hardware (fast peed) **Optional:** **3 hardware (fast peed)** **1 External trigger (for analog control)**
	Output	**Optional:** **2 mechanical relay (slow speed) NO-NC** **1 solid state (fast speed)**
	Isolated	Optoisolated 1000VDC
	Energy activation	All input and output interlocks have their own floating power supply with 1000VDC isolation
Software Interlocks	Errors (RPSb forces emergency stop)	*Vienna Interlocks:* Overcurrent, Overvoltage, Voltage Symmetry, Communications, Synchronization. **Optional: Temperature >90ºC, Synchronization.** *ZVS Interlocks:* Primary Current, 1-Hardware Interlocks, watchdog, Overvoltage, communications. **Optional: Temperature >90 ºC, 3-extra Hardware interlocks.** *Control Interlocks:* ADC 31-bit, ADC 24-bit, DCCT, Peltier Temperature inside and outside >60ºC, Software Overcurrent, Software Overvoltage, Current deviation, Voltage deviation, Power deviation, Loop oscillation, Communications. **Optional: Peltier temperature >60 ºC inside and outside.**
	Warnings (RPSb shows notification)	*Vienna Warnings:* Phase lost, Underfrequency, Overfrequency, Relay soft start, Setpoint Bus. **Optional: Temperature >85ºC, Air Flow <7 m/s** *ZVS Warnings:* ***Optional:*** **Temperature >85ºC.** *Control Warnings:* Current loop, Communications 8 Fans, Failure 8 fans **Optional: Fuse Ground, Peltier Temperature inside and outside >55ºC, Under Ground Impedance (Programmable)**
Cooling	Cooling	Forced air or water cooling
	Fans Speed	Dynamic speed controlled by demanded power
	Fans Speed	**Dynamic speed controlled by internal temperature, optional**
Extra features	Input	Waveform generator, standard curves or point-by-point configuration
	Output	Real-time PPM displayed on the screen. All variables are presented in a graphical display

Main features description

■ High current output

The RPSb can deliver up to 300A and 1000V output, with maximum power of 12kW. Optionally, it can be equipped with a bipolar output stage for two-quadrant operations, enabled by a polarity reversal switch.

■ AC Mains input

Single-phase or three-phase mains input supported.
Note: In a single-phase input configuration, as a safety precaution, the maximum power is default limited to 3.5 kW. For configurations up to 5 kW in single phase, please consult EPowerSys.

■ Accuracy and resolution

- Long-term stability (12 h): 2ppm.
- Accuracy: 2 ppm using DCCT.
- Thermal Drift: 5ppm/K
  ZERO thermal drift (0 ppm/K), with optional module. Output precision remains unaffected by room temperature changes. Data acquisition electronics actively thermally stabilized using a Peltier chamber and digital temperature control loop at constant 25 °C (±0.1 °C), temperature drift is negligible.
- Readback Resolution: 31 bits for Slow accuracy loop, 24 bits for Fast loop.
- Current and Voltage Setting resolution: 22 bits (<100uA).

■ Control modes

7 control modes supported:

- Constant current: Often used for powering magnets.
- Constant voltage: typically used in industrial applications.
- Hybrid: Allows programming of both voltage and current.
- Power: Enables setpoint programming in watts.
- Function generator: Dynamic setpoint follows programmed curves or point-by-point configuration, any curve can be programmed (up to 50Hz). Available in current, voltage, and power modes.
- Analog voltage and Analog current: Functions as regular current or voltage mode, but the set point is programmed using the optional analog 0 – 10V trigger input (0-10V).

■ Control loop

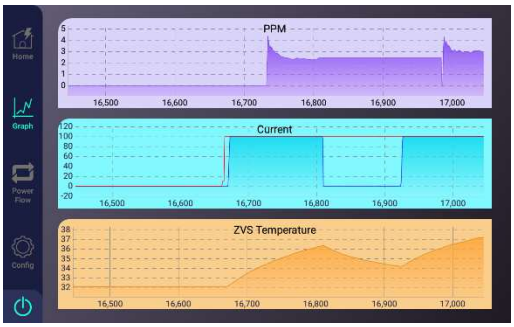
- Innovative double-loop control algorithm for active current ripple cancellation in inductive loads.
- Pre-defined control loop configurations (PID) can be selected based on the load to achieve maximum accuracy.
- User-adjustable control loop (PID) with modification options for time constants.
- Oscillation detection algorithm safeguards the power supply during PID adjustment in case of unstable parameter settings.
- Real-time digital control loop operates at 50kHz (20us).
- Unique self-calibration algorithm for auto calibrating the fast current transducer.

■ DCCT Technology

To close the slow control loop, a DCCT is used, achieving long-term stability lower than 2ppm.

Real time PPM calculation

- RPSb displays real-time accuracy in PPM for the present load on the screen and in the graph.
- This feature is particularly useful for adjusting control loops (PID) for a fine tuning adapted to the used load.



LDO references

Digital converters, ADC and DAC, are powered by LDOs (Low-Dropout Regulators). This linear technology prevents commutations and noise, ensuring high accuracy and a clean voltage in the converter instrumentation.

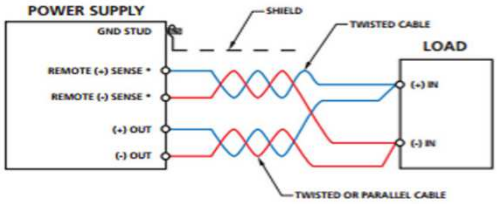
Active temperature monitoring

key points temperature is monitored in the converter: semiconductors, ZVS, Vienna, internal temperature, etc. This feature allows a deeper control about the converter operation status by:

- Temperatures are displayed in the power flow screen for a visual operation status control.
- Internal control algorithm which activates a Warning interlock when ZVS or Vienna Temp reaches 85 °C and a Stop interlock when temperature reaches 90 °C.
- Dynamic air flow control algorithm is commanded by internal temperature.

Remote sensing

Remote voltage sensing is implemented to prevent voltage drop in cables by measuring the actual voltage at the load.



Vienna rectifier

RPSb features an active power factor corrector (PFC=1) across its entire operating range, based on a Vienna Rectifier topology.

This design includes an active input filter, ensuring very low harmonic distortion.

Efficiency is rated at 97%.

Digital ZVS

The power module is based on a ZVS converter. The ZVS performance has been tailored to our architecture and is processed in a DSP, optimizing the converter operation for reliability, robustness, efficiency, and noise immunity.

RPSb employs ZVS technology across the entire load range, even at no-load conditions.

Performs seamlessly from 0 to 100%.

Outstanding dynamic performance and accuracy.

Noise immunity

Switching semiconductors are driven by means of a fiber optic digital transmitter, achieving the highest performance in terms of speed, bandwidth, attenuation, and noise immunity.

Optic fiber drivers.

The power supply uses a high frequency transformer designed to minimize the dispersed flow, preventing induced currents and noise generation.

ZERO thermal drift

Measurement electronics is thermally controlled, ensuring consistent performance and excellent ratings with negligible thermal drift, 0 ppm/K. The ADC and burden resistor, used in data acquisition for the current digital control loop, are positioned within a Peltier chamber to maintain a constant temperature of 25 °C (±0.1°C).

Selectable ground connection

Selectable floating or ground-connected output reference, selectable by software and accessible from both local and remote interfaces. No user-initiated mechanical connection is required.

For the floating output configuration, RPSb avoids ground loops, with a maximum output insulation of 1000VDC.

Constant ground fuse checking, triggering an alarm in case of fuse blowout.

Continuous ground leaks monitoring, ranging from 20mA (accuracy 0.5%) to 40nA (accuracy 10%) (Megger level 100MOhm). Predictive load maintenance analysis is possible, facilitating the detection of winding insulation issues to the ground, contributing to equipment and personnel protection.

In the case of a superconducting load, the quench voltage can be split, reducing the insulation requirement to the casing by half.

Save Operating Area (SOA) & Autoranging

The power supply can automatically control and adapt the output current and voltage to the maximum supported power or to a user preset power (always lower than max. supported power), providing high safety capabilities and enormous flexibility for converter configuration.

The SOA operation is performed three different ways:

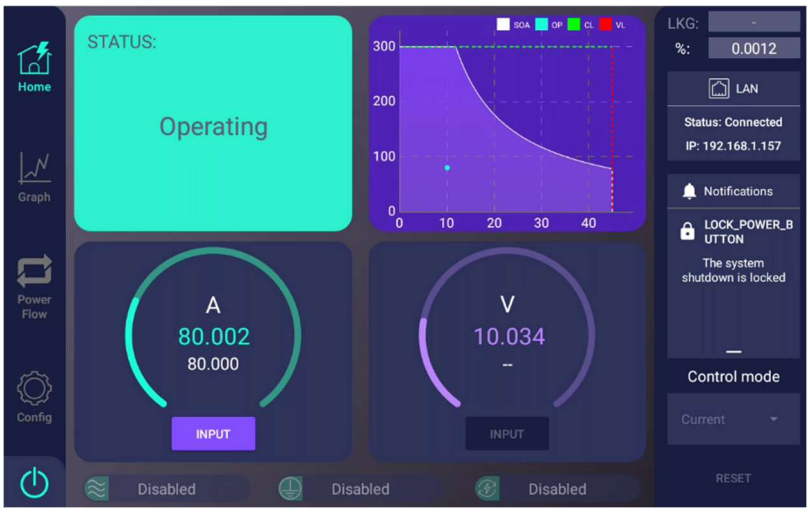
- *Automatic SOA:* Automatic current or voltage autoranging. If demanded current - voltage configuration exceeds the maximum power, the supply will automatically adapt the other output according to the defined maximum power limit (e.g. for a 12 kW 100V - 150A supply, if 150A are demanded, the output voltage will automatically be limited to 80V). This feature works independently of the selected control loop, current or voltage.

- *Manual SOA configuration:* voltage, current or power can be manually limited by user, this functionality is interesting for load protection.

- *Automatic input voltage detection:* 400V or 200V input voltage detection and maximum power adjustment. Depending on the input voltage the converter automatically adjusts the operation limits for device own protection.

SOA limits, configured software protection limits, and operation point are displayed in the screen. If the operating point is within the displayed SOA, the converter will perform normally.

Voltage and current are monitored every 20µs.



■ Dynamic load functionality for controlling the voltage loop

Precise regulation of the output voltage loop even when no load is connected.
Power supplies have difficulty regulating the output voltage loop without a load, that´s why many manufacturers generally require a load to be connected to be able to carry out correct voltage loop regulation. By means of the dynamic load functionality, RPSb power supplies have always a precise regulation of the voltage output loop, regardless of whether a load is connected or not.

■ Hardware Input and Output interlocks

By serial, the RPSb models come with 1 input hardware interlock, which can be expanded to 4 input interlocks and 3 output interlocks through the optional module.

- All interlock inputs are hardware (fast speed) and optoisolated (or relay, optional) with 1000V insulation.

- 1 output interlock is solid state, works at fast speed.
- 2 output interlocks are potential-free contacts, mechanical relays that work at slow speed.
- Same control signal for all hardware output interlocks.

Energy Activation: All input and output interlocks are powered by floating power supply 1000VDC isolation.
Hardware primary overcurrent interlock provides the converter with absolute robustness against short-circuits.

■ Software interlocks (Errors & Warnings)

ERRORS (RPSb forces emergency stop)

Vienna Interlocks: Temperature > 90ºC Overcurrent, Overvoltage, Voltage Symmetry, Communications, Synchronization.

ZVS Interlocks: Temperature > 90ºC, Primary Current, 4 Hardware Interlocks, Watchdog, Overvoltage, Communications.

Control Interlocks: ADC 31bits, ADC 24bits, DCCT, Peltier Temperature inside and outside > 60ºC, Software Overcurrent, Software Overvoltage, Current Deviation, Voltage Deviation, Power Deviation, Loop Oscillation, Communications**.**

WARNINGS (RPSb shows notification)

Vienna Warnings: Phase lost, Underfrequency, Overfrequency, Relay softstart, Setpoint Bus, Temperature > 85ºC, Air Flow < 7 m/s

ZVS Warnings: Temperature > 85ºC.

Control Warnings: Fuse Ground, Peltier Temperature inside and outside > 55ºC, Current loop, Communications 8 Fans, Under Ground Impedance (Programmable), Failure 8 fans.

Note: it should be noted that some of the errors or warnings will only be generated if the converter includes the corresponding expansion modules.

■ Long term data storage

RPSb stores all parameters in a database. These parameters can be visualized on charts, allowing users to select which parameters to display. All parameter data is recorded from the initial day of operation and can be downloaded via the USB port.



■ Cooling control

The unit is cooled by dynamically controlled forced air using regulated DC fans, with water cooling available upon request. By default, fans speed is controlled based on the demanded power at each moment. Optionally, the temperature and internal airflow control module can be added, enabling temperature-based control algorithm.

Fans speed and air flow are constantly monitored, controlling the cooling function. The inlet filter obstruction degree is controlled by an internal anemometer, showing a maintenance warning if the air flow is lower than 7 m/s. This ensures that RPSb is continuously conducting a predictive fans test.

Scheduled maintenance helps reduce the risk of failure and unexpected shutdowns.

Switch button



Smooth switch on/off button instead of a circuit breaker switch, enabling the placement of a 7” touchscreen in the front panel.

Lock power feature that allows centralized switch ON/OFF control for a group of power supplies.

User friendly local interface

Extremely user-friendly and easy-to-use local control interface with a 7’’ touch screen. It provides more information than conventional interfaces, allowing for both graphical and numerical representations of data.

This interface offers the most comprehensive visual information and is remarkably user-friendly, avoiding the need for buttons and complex menus.

Front panel

The 7-inch touchscreen offers a highly user-friendly interface, making it easy to use and configure. The unit includes HDMI output for duplicating the screen on an auxiliary display, as well as three USB ports for database dumping or connecting peripherals like a keyboard or mouse (plug and play).

The status and information of every system are displayed, including control, rectifier, HF inverter, fans, output, thermal box, regenerative current, operating time indicator, etc. This feature is not available in competitors.

Additional features include screen and LED lighting brightness control, language selection, and the ability to display graphical information over the operation time, simplifying the converter's operation control.



Pulsed operation

RPSb can be upgraded to work as a pulsed power supply.

Parallel mode configuration

RPSb models can be connected in parallel to achieve higher output voltages and currents. The parallel mode is supported with current and voltage control with current sharing.
Master – slave protocol to allow centralized control. This feature combined with the **Lock Power option**, allows a centralized control and switch-on/off.

■ Reliable connections

Gold-plated 10 x 10 mm output copper bus bars, to enhance electrical connectivity and prevent oxidation.

■ Android (Linux) Operating system

The user interface is based on the Android (Linux-based) operating system.
This feature ensures the best user experience in terms of user-friendliness, connectivity, remote control, updates, reliability, etc.

■ Remote control

Ethernet and Wi-Fi interfaces.

Remote control capabilities: MODBUS over TCP/IP. EPICS, TANGO Framework, and EPowerSys Remote control software.

EPICS or TANGO controls are sets of software tools and applications that provide a software infrastructure for building distributed control systems. These systems operate devices such as particle accelerators, large experiments, and major telescopes.

Distributed control systems typically involve tens or even hundreds of nodes networked together to facilitate communication and provide control and feedback for various parts of the device. This can be managed from a central control room or even remotely over the internet.

■ Applications

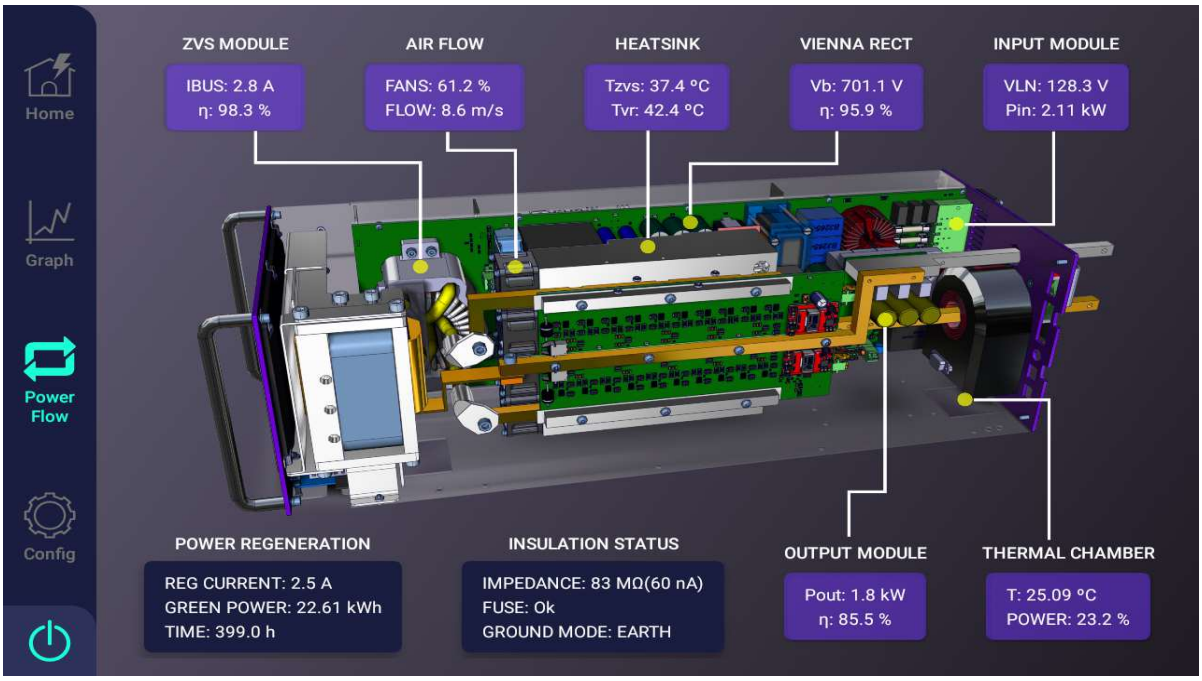
- Particle accelerator magnets supply
- Scientific installations
- Test & Measurement systems
- Medical Imaging and treatment systems
- Semiconductor Processing

■ Small size and weight

The highest power density available in the market, 12 kW in ½ 19” rack width, 4U height, and weight ~15 kg.

■ Power Flow screen

The Power Flow screen provides comprehensive control status information for the converter in a unified single screen.



MODELS

Model	Voltage (V)	Current (A)	Power (W)	Heigh (U)	Weight (Kg)
RPSb 15-50	15	50	750	4	~15
RPSb 15-100	15	100	1.500	4	~15
RPSb 15-150	15	150	2.250	4	~15
RPSb 15-200	15	200	3.000	4	~15
RPSb 15-300	15	300	4.500	4	~15
RPSb 40-50	40	50	2.000	4	~15
RPSb 40-100	40	100	4.000	4	~15
RPSb 40-150	40	150	6.500	4	~15
RPSb 40-200	40	200	8.000	4	~15
RPSb 40-300	40	300	12.000 *	4	~15
RPSb 60-50	60	50	3.000	4	~15
RPSb 60-100	60	100	6.000	4	~15

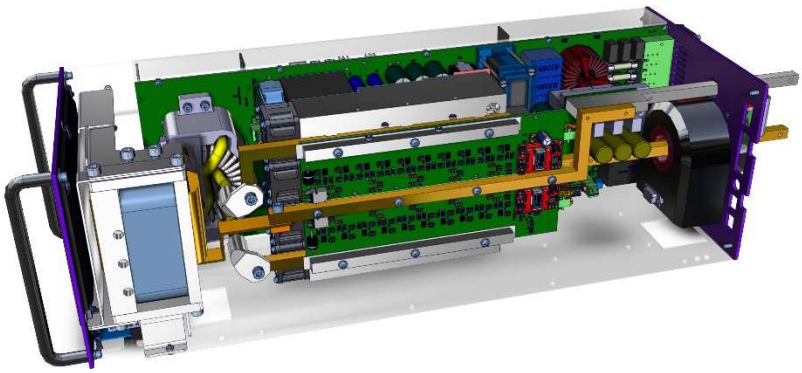
RPSb 60-150	60	150	9.000	4	~15
RPSb 60-200	60	200	12.000 *	4	~15
RPSb 100-100	100	100	10.000	4	~15
RPSb 100-150	100	150	12.000 *	4	~15
RPSb 150-100	150	100	12.000*	4	~15

Consult EPOWERSYS for other configurations, max 1000V 300A at 12Kw

* 12kW available with 3x400V input, 10kW with 3x200 input

Model numbering

RPSb	50	-	200	-	Z-T-I-G-L-T-A-S
Model	Output voltage		Output current		**Optional modules selected:** •Z – ZERO Thermal drift for 0 ppm/K •T - External 0 – 10 V Trigger •I - Additional input/output interlocks •G - Precision ground current monitoring •L - Power lock •T - Active temperature monitoring and dynamic cooling control by temperature •A - Internal air flow monitoring and maintenance warning •S - Floating/ground output reference commanded by software



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