

EA-ELR 9000 3.1 kW - 10.5 kW



可编程能量回馈式直流电子负载

Programmable electronic DC loads with energy recovery



EA-ELR 9200-210



- 可接1相，2相或3相电压使用（欧标和美标都有）
- 可将直流电量返回到本地电网
- 直流输入端为电隔离结构
- 每台产品的输入功率高达10.5kW，还可扩展至378 kW
- 输入电压高达1500 V
- 每台产品的输入电流能高达510 A
- 基于FPGA数字式控制
- 多语言TFT触摸屏
- 用户配置文档，真实函数发生器
- 电隔离
- 并联用主-从总线
- 前板有额外的USB端口，适合使用外置U盘
- 可选数字式即插即用型接口，或安装IEEE/GPIB端口
- 支持SCPI指令语言
- 可选自动隔离设⁽¹⁾

- For 1-, 2- or 3-phase supply (European and US models available)
- Energy recovery of the supplied DC energy into the local grid
- Galvanically isolated DC input
- Input power ratings up to 10.5 kW per unit, expandable to 378 kW
- Input voltages up to 1500 V
- Input currents up to 510 A per unit
- FPGA based digital control
- Multilingual TFT touch panel
- User profiles, true function generator
- Galvanically isolated
- Master-slave bus for parallel connection
- Extra USB port on the front for USB stick
- Optional, digital, plug & play interfaces or alternatively installed IEEE/GPIB port
- SCPI command language supported
- Optional automatic Insulation unit⁽¹⁾

概要

新系列直流电子负载具有将能量返回市电的功能，称为EA-ELR 9000，为不同的用途，输出新的额定电压、电流与功率。

这些产品具有四个常用调节模式：恒压、恒流、恒功率和恒阻。基于FPGA的控制电路带来了更多新的功能，如函数发生器，模拟非线性内阻的基于表格格式的调整电路。

General

The new series of electronic DC loads with energy recovery to mains, called EA-ELR 9000, offers new voltage, current and power ratings for a multitude of applications.

These devices incorporate the four common regulation modes constant voltage, constant current, constant power and constant resistance. The FPGA based control circuit provides additional features, such as a function generator, a table based regulation circuit for the simulation of non-linear internal resistances.

1) 前德文名叫：ENS

1) Former german name: ENS

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能量返回功能可使产生的直流电同步转化成正弦波电流，然后返回给当地电网。这不仅摆脱了以前的热耗散问题，同时还节省了用电成本。其彩色TFT触摸屏为用户提供一个不同于其他产品的直观手操媒介。

经模拟或数字接口控制的反应时间已由FPGA控制硬件得到很好的改善。

多台产品并联时，可经主-从总线组成一个更大的系统，此时实际值会被累加，设定值则会均衡分布。

功率、电压和电流等级

本系列有0...80 V DC至0...1500 V DC输出电压的产品型号，还有一款输入电流高达510 A的型号。本系列有三个功率级别，分别为3.5 kW，7 kW或10.5 kW（此为欧版，美版请参考规格参数表），单机外壳仅3U高。还可组合到机柜内扩展至高达168 kW（或更大）的功率，并形成更大的总电流。按照客户要求，能组成更大功率的系统。

供电

3.5 kW的欧版型号配230 V (L - N)单相电使用，而7 kW的则需两相电，10.5 kW的则需三相电。

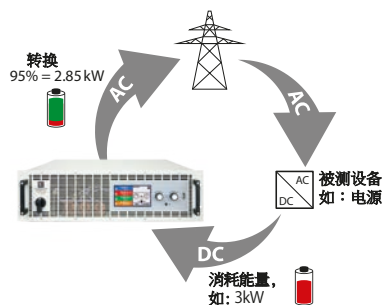
美版型号统一在208 V (L-L) 下工作，可提供3.1 kW、6.2 kW 或 9.3 kW功率。

欧版型号230 V 的供电电网连接端，可以安装一监控设备（AIU, ENS），该设备为模块式的，可拆卸。

如选择安装“ENS2”，电网将变成三相电（L1, L2, L3, N, PE）供给每个型号。

能量返回

本负载最主要的特点是其AC输入端，即电网连接端，也可用作直流电返回的输出端，转换效率接近93%。这种能量转换方式有助于降低用电成本，且避免使用昂贵的制冷系统，因为普通电子负载使用过程中会将直流输入电量转化成热量，从而需要制冷系统进行冷却。下面为其原理示意图：



此类回馈式负载不可用作发电。我们还有另外一个监控设备（自动隔离件，ENS），能加强对人体与设备的安全，特别是在运行此类隔离操作的时候。不管用户是否装此类监控设备，我们产品上都配有一简易无冗余关闭功能，遇到电网连线突然断开时会关闭产品。本产品可监控AC电压和频率，当超过功率上限或下限时，会自动关闭功率模块。

The energy recovery function converts the supplied DC energy into a synchronous sine current and feeds it back into the local grid. This eliminates the usual heat dissipation to a minimum and saves energy costs at the same time. The large colour TFT touch panel offers a different and intuitive kind of manual operation, compared to other devices.

Response times for the control via analog or digital interfaces have been improved by the FPGA controlled hardware.

In parallel operation of multiple devices, a master-slave bus is used to connect the units to a bigger system where the actual values are totalled and the set values distributed.

Power ratings, voltages, currents

The available voltage range portfolio goes from models with 0...80 V DC up to models with 0...1500 V DC. Input currents up to 510 A with only one unit are available. The series offers three power classes with 3.5 kW, 7 kW or 10.5 kW (EU models, for US model see techn. specs) in only 3U for single devices, which can be extended up to 168 kW (in cabinets for a significantly high total current. Upon request, even higher total power can be realised.

Supply

EU models with 3.5 kW are intended for use with 1-phase mains supplies of 230 V (L-N), while 7 kW models require a 2-phase and 10.5 kW models a 3-phase supply.

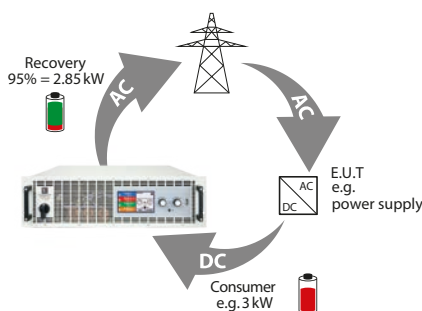
US models work with 208 V (L-L) and offer 3.1 kW, 6.2 kW or 9.3 kW power.

The grid connection of european models for 230 V supply can be equipped with a supervision unit (AIU, ENS) which is optionally available, retrofittable and modular.

With option „ENS2“ installed, the grid connection will become three-phase (L1, L2, L3, N, PE) for every model.

Energy recovery

The most important feature of these electronic loads is that the AC input, i.e. grid connection, is also used as output for the recovery of the supplied DC energy, which will be converted with an efficiency of approximately 93%. This way of energy recovery helps to lower energy costs and avoids expensive cooling systems, such as they are required for conventional electronic loads which convert the DC input energy into heat. Principle view:



Operation of these recovering loads in terms of power generation is not intended. There is an additional supervision unit (automatic Insulation unit, ENS) available for optional installation and to achieve additional safety of persons and equipment, especially when running the so-called isolated operation. Regardless of whether the user has installed that supervision unit or not, the devices feature a simple and non-redundant switch-off function for the case of an interruption in the grid connection cable. The device supervises AC voltage and frequency and will automatically switch off the power stages in case upper or lower limits are exceeded.

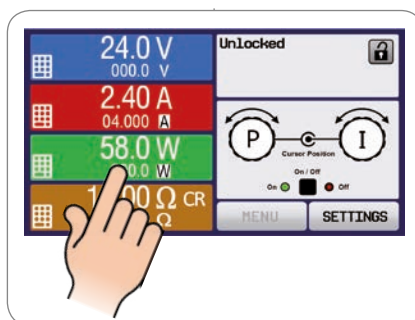
EA-ELR 9000 3.1 kW - 10.5 kW



操作面板 (HMI)

手动操作通过阻性触摸屏、两个旋钮与一个按钮来完成。这个彩色显示器能一次性显示所有设定与实际值。在人机界面也可完成整个设置，包括函数发生器（方波，三角波，正弦波等）的配置。

显示器有多种语言可选（德文，英文，俄文，中文）。



Operation (HMI)

Manual operation is done with a Gorilla glass touch panel, two rotary knobs and a pushbutton. The large colour display shows all relevant set values and actual values at a glance. The whole setup is also done with the human-machine interface, as well the configuration of functions (square, triangle, sine) etc.

The display is multilingual (German, English, Russian, Chinese).

函数发生器与表格控制

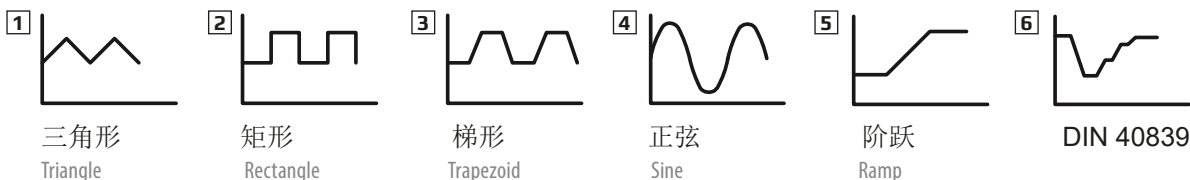
本产品还具有基于FPGA的数字函数与任意发生器。它可控制和运行用户定制的负载配置文档，并产生任意顺序的正弦、方形、锯齿形以及跳跃型函数。

通过3276个有效点数自由编程的数值表，能实时嵌入到控制电路中，然后可重现非线性内阻，如：电池或LED灯条中的内阻。

Function generator and table control

A special feature is the comfortable, FPGA based, digital function and arbitrary generator. It enables to control and run user-customisable load profiles and can generate sine, square, saw tooth and ramp functions in arbitrary order.

With a freely programmable, digital value table of 3276 points, which is embedded in the control circuit, the devices can reproduce non-linear internal resistances, such as those of batteries or LED chains.



Share-Bus-共享总线

产品后板有一个模拟连接端子叫“Share Bus”，用来均衡多台类似产品并联时的电流，如：本系列的负载产品与EA-ELR 9000系列并联。

还可通过此端子连接EA-PSI 9000，EA-PS 9000与EA-PSE 9000系列电源，以便组建两象限系统。该系统专门利用源-沉原理进行测试用途。

Share Bus

The so-called „Share Bus“ is an analog connection at the rear of the devices and is used to balance current across multiple similar units in parallel connection, such as with loads of this series and series EA-ELR 9000.

It can also be used to build a two-quadrants system in connection with power supplies of series EA-PSI 9000, EA-PS 9000 and EA-PSE 9000. This system is dedicated for testing purposes using the source-sink principle.

电池测试

本产品还有一电池测试模式，可以通过恒流或恒阻放电来测试各类电池。它会显示累计的测试时间与消耗的容量 (Ah)。

Battery test

For purposes of testing all kinds of batteries, such as for example constant current or constant resistance discharging, the devices offer a battery test mode. This shows extra values for elapsed testing time and consumed capacity (Ah).

Data recorded by the PC during tests with, for example, EA Power Control can be exported as Excel table in CSV format and analysed later in MS Excel or similar tools and even visualised as a discharge diagram.

For more detailed setup, there is also an adjustable threshold to stop the battery test on low battery voltage, as well an adjustable maximum test period.

用EA Power Control测试期间，由电脑记录的数据，可以CSV格式导出Excel表。后续可在MS Excel或类似工具下进行分析，甚至能创建可视化的放电图。关于更详细的设置，还可设定一可调极限值，当电池电压低时停止测试，或者停止可调最大测试期。

远程控制 & 连接

进行远程控制时，可使用产品后板默认配置的两个接口端口（1x模拟，1xUSB）。也可选择可插拔式数字接口模块（指定插槽）进行扩展。

Remote control & connectivity

For remote control, there are by default two interface ports (1x analog, 1x USB) available on the rear of the devices, which can also be extended by optional, pluggable and retrofittable, digital interface modules (dedicated slot).

Alternatively to the interface modules slot, all models can be equipped with a three-way interface (option 3W, see below), which then offers 1x GPIB/IEEE, 1x USB and 1x Analog on the rear side of the device.

For the implementation into the LabView IDE we offer ready-to-use components (VIs) to be used with the interface types USB, RS232, GPIB and Ethernet. Other IDEs and interfaces are supported by documentation about the communication protocol.

产品上还有一个接口模块插槽，可给所有型号装上一个三路接口（3W选项，见下文），为产品后板提供1xGPIB/IEEE，1xUSB，1x模拟端口。应用到LabView IDE时，用户可以结合USB，RS232，GPIB，Ethernet使用即用版(VIs)。通过通讯协议文档还可支持其它IDE与接口。

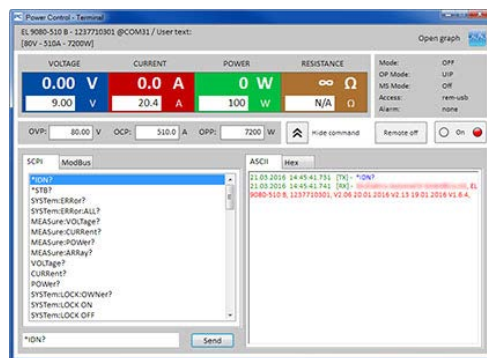
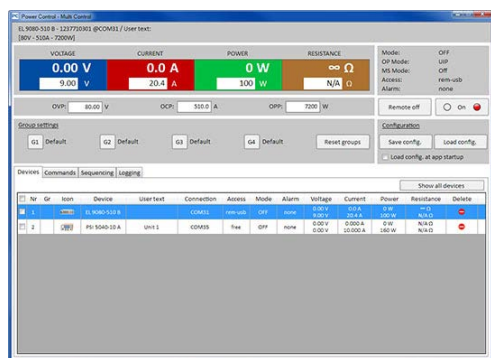
EA-ELR 9000 3.1 kW - 10.5 kW

Windows用户还可使用“EA Power Control”免费软件。它具有“排序”功能，通过CSV格式的半自动化表格控制产品。此表能代表简易的测试程序，可在MS Excel或其它CSV编辑器下创建与编写，然后导入软件工具内。

该软件利用“多功能控制”特性（需注册码，非免费），可一次性监控多达20台产品。更多信息见136页。

Windows users can profit from the free software “EA Power Control”. It offers a feature called “Sequencing”, where the device is controlled through a semi-automatic table in CSV format. This table represents a simple test procedure and can be created and edited in MS Excel or other CSV editors and then imported into the software tool.

This software also allows for the control of up to 20 units at once with an optional feature called “Multi Control” (licensed, not free of charge). See page 136 for more information.



可选项

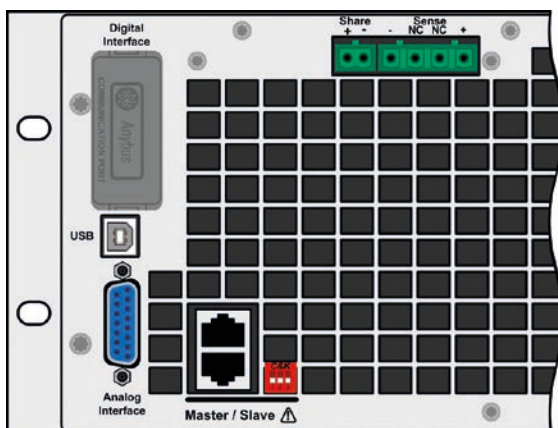
- 可插拔、可替换的数字接口模块，适合CAN，CANopen，Ethernet（1个或2个端口），Profibus，ProfiNet（1个或2个端口），RS232，EtherCAT 或ModBus TCP。见第134页。
- 可选择带固定GPIO端口的三路接口（3W），代替可拆装接口模块的默认插槽。
- 自动隔离件，三相电（AIU/ENS，见第133页）

Options

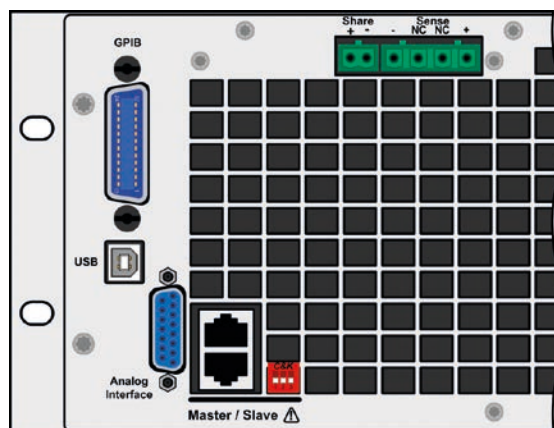
- Pluggable and retrofittable, digital interface modules for CAN, CANopen, Ethernet (1 or 2 ports), Profibus, ProfiNet (1 or 2 ports), RS232, EtherCAT or ModBus TCP. See page 134.
- Three-way interface (3W) with a rigid GPIO port installed instead of the default slot for retrofittable interface modules
- Automatic Insulation unit, 3-phase (AIU / ENS, see page 133)

数字接口模块

Digital interface modules



标准型号的后板连接器 /
Rear connectors of the standard models



带3W选项型号的后板连接器 /
Rear connectors of models with option 3W

EA-ELR 9000 3.1 kW - 10.5 kW



技术参数	Technical Data	Series EA-ELR 9000 / 系列
交流：供电	AC: Supply	
- 电压（欧版）	- voltage (European models)	230 V L->N, +10%/-15%, 1ph-3ph+N
- 电压（美版）	- voltage (US models)	208 V L->L, ±10%, 45...66 Hz, 2ph-3ph
- 功率因素（PFC）	- Frequency	>0.99
直流：电压	DC: Voltage	
- 精确度	- Accuracy	<额定值的0.3% / <0.3% of rated value
直流：电流	DC: Current	
- 精确度	- Accuracy	<额定值的0.4% / <0.4% of rated value
- 1-100% ΔU_{DC} 的负载调整率	- Load regulation 1-100% ΔU_{DC}	<额定值的0.15% / <0.15% of rated value
- 10-90% 上升时间	- Rise time 10-90%	<300 μ s
直流：功率	DC: Power	
- 精确度	- Accuracy	<额定值的1.5% / <1.5% of rated value
直流：内阻	DC: Resistance	
- 精确度	- Accuracy	≤最大阻值的1% + 额定电流的0.3% / ≤1% of max. resistance + 0.3% of nominal current
显示器与控制面板	Display and control panel	带触摸屏的彩色显示器 / Graphics display with touch panel
数字接口	Digital interfaces	
- 内置（前板）	- Built-in	1x 通讯用B类USB端口 / 1x USB type B for communication 1x GPIB (3W选项功能用) / 1x GPIB (optional with option 3W)
- 插槽	- Slot	1x 内置可拆装模块（仅针对标准型号） / 1x for retrofittable plug-in modules (standard models only)
模拟接口	Analog interface	内置，15极D-Sub连接器，电隔离 / Built-in, 15-pole D-Sub (female), galvanically isolated
- 信号范围	- Signal range	0...5 V 或 0...10 V (可转换) / 0...5 V or 0...10 V (switchable)
- 输入脚	- Inputs	U, I, P, R, 远程开-关, 直流输出开-关, 内阻模式开-关 / U, I, P, R, Remote on-off, DC input on-off, resistance mode on-off
- 输出脚	- Output	U, I, 过压, 报警, 参考电压 / U, I, overvoltage, alarms, reference voltage
- U / I / P / R 精确度	- Accuracy U / I / P / R	0...10 V: <0.1% 0...5 V: <0.2%
制冷方式	Cooling	温控风扇 / Temperature controlled fans
环境温度	Ambient temperature	0...50 °C
储存温度	Storage temperature	-20...70 °C
后板端子	Terminals on rear	
- 直流输入	- DC input	螺丝端 / Screw terminal
- 共享总线&感测	- Share Bus & Sense	2&4位插头连接器 / Plug connector 2 pole & 4 pole
- 模拟接口	- Analog interface	15极Sub-D连接器 / Sub-D connector 15 pole
- 数字接口	- Digital interfaces	50位模块插座或24位的GPIB, USB / Module socket 50 pole or GPIB 24pole, USB
尺寸(宽 x 高 x 深)	Dimensions (W x H x D)	19" x 3 HE/U x 609 mm

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型号	功率 (EU)	功率 (US)	电压	电流	内阻	效率	重量	订购编号 ⁽¹⁾	
								EU	US
Model	Power (EU)	Power (US)	Voltage	Current	Resistance	Efficiency	Weight	Ordering number ⁽¹⁾	
								EU	US
EA-ELR 9080-170	0...3.5 kW	0...3.1 kW	0...80 V	0...170 A	0.01...12 Ω	92.5%	17 kg	33200401	33208401
EA-ELR 9250-70	0...3.5 kW	0...3.1 kW	0...250 V	0...70 A	0.09...120 Ω	93.5%	17 kg	33200402	33208402
EA-ELR 9500-30	0...3.5 kW	0...3.1 kW	0...500 V	0...30 A	0.42...480 Ω	94.5%	17 kg	33200403	33208403
EA-ELR 9750-22	0...3.5 kW	0...3.1 kW	0...750 V	0...22 A	0.8...1100 Ω	94.5%	17 kg	33200404	33208404
EA-ELR 9080-340	0...7 kW	0...6.2 kW	0...80 V	0...340 A	0.005...6 Ω	92.5%	24 kg	33200405	33208405
EA-ELR 9250-140	0...7 kW	0...6.2 kW	0...250 V	0...140 A	0.04...60 Ω	93.5%	24 kg	33200406	33208406
EA-ELR 9500-60	0...7 kW	0...6.2 kW	0...500 V	0...60 A	0.21...240 Ω	94.5%	24 kg	33200407	33208407
EA-ELR 9750-44	0...7 kW	0...6.2 kW	0...750 V	0...44 A	0.43...550 Ω	94.5%	24 kg	33200408	33208408
EA-ELR 91000-30	0...7 kW	0...6.2 kW	0...1000 V	0...30 A	0.83...950 Ω	94.5%	24 kg	33200409	33208409
EA-ELR 9080-510	0...10.5 kW	0...9.3 kW	0...80 V	0...510 A	0.003...4 Ω	92.5%	31 kg	33200410	33208410
EA-ELR 9250-210	0...10.5 kW	0...9.3 kW	0...250 V	0...210 A	0.03...40 Ω	93.5%	31 kg	33200411	33208411
EA-ELR 9500-90	0...10.5 kW	0...9.3 kW	0...500 V	0...90 A	0.14...160 Ω	94.5%	31 kg	33200412	33208412
EA-ELR 9750-66	0...10.5 kW	0...9.3 kW	0...750 V	0...66 A	0.29...360 Ω	94.5%	31 kg	33200413	33208413
EA-ELR 91500-30	0...10.5 kW	0...9.3 kW	0...1500 V	0...30 A	1.2...1450 Ω	94.5%	31 kg	33200414	33208414

(1) 为标准版型号的订购编号，带3W选项的则不同 / Ordering number of the base version, models with option 3W installed have different ordering numbers

