APPLICATION NOTE:

CONNECTION OF AN ELR 9000 ENERGY RECOVERY DC ELECTRONIC LOAD

Elektro-Automatik

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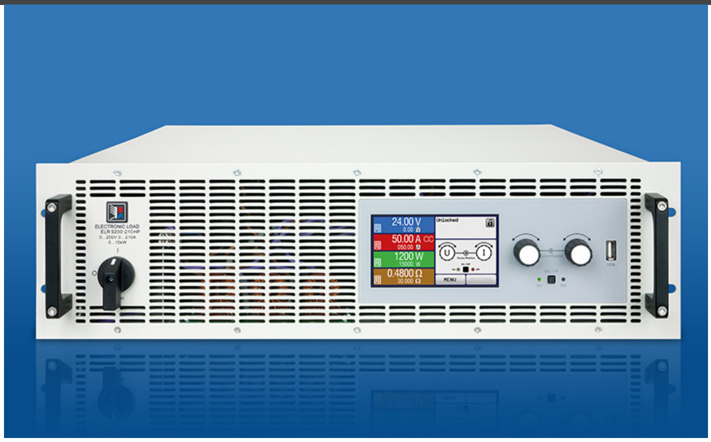
ABSTRACT

This application note describes the necessary procedure and safety concerns to connect a regenerative DC Electronic load to the mains. As this electronic load has the unique option of back-feeding converted energy into the grid, there are various concerns about its appropriate connection to the local or public grid, so clarification is needed on how correctly connect the load in order to enable it achieving such task.



ELR 9000 3U HP Regenerative Electronic DC Load

INTRODUCTION

The electronic loads of the Elektro-Automatik (EA) ELR-9000 Series are especially suitable for test systems and industrial controls due to their compact construction. Apart from having basic functions of electronic loads, the electronic loads have an integrated function generator which can produce other several types of curves. In addition, these units are capable of achieving really high power ratings.

Though as power to be tested increases, it comes with the concern of wasted energy as heat dissipation [2]. EA offers electronic DC loads with an added eco-friendly solution which consist of converting supplied DC energy into AC and feeding it back into the local or public grid .

That solution eliminates the usual heat dissipation to a minimum and saves energy costs at the same time. However, connecting this to the mains might not be an easy task at first; hence the purpose of the next paragraphs is to give clear instructions on how to connect the device, as well as taking appropriate safety measures.

The new series of electronic DC loads with energy recovery offers new voltage, current and power ratings for a variety of applications. These devices include four common operating modes: constant current, power, voltage and resistance. In addition, the FPGA based control circuit provides additional features such as a function generator, which is simply a table based regulation circuit for the simulation of non-linear internal resistances. Even response times for the control via analogue or digital interfaces have been improved thanks to the DSP controlled hardware. There is one characteristic that despite making the loads applicable to higher power scenarios, it comes with a disadvantage.

Multiple devices in the ELR-9000 Series are capable of operating in parallel in a master-slave configuration, which allows the user to parallel the loads for UUTs that might require higher power capabilities. This capability can be extended up to 480 kW in cabinets for a significantly higher total current, with the option to realize higher power capability upon request. However, as power levels to be tested increase, dissipating this energy may not be an attractive option for some customers, as this certainly implies a not so eco-friendly or 'green' approach .

The solution implemented in these devices makes the loads to be known as regenerative or energy recovery loads. The most important feature of these electronic loads is that the AC mains connection, i.e. grid connection, is also used as output for the back-feed of the supplied DC energy, which will be converted with an approximate efficiency of up to 95%. Energy recovering allows to lower energy costs and avoid expensive cooling systems, like the ones required for conventional electronic loads, which convert the DC input energy into heat.

PRINCIPLE OF ENERGY RECOVERY OPERATION

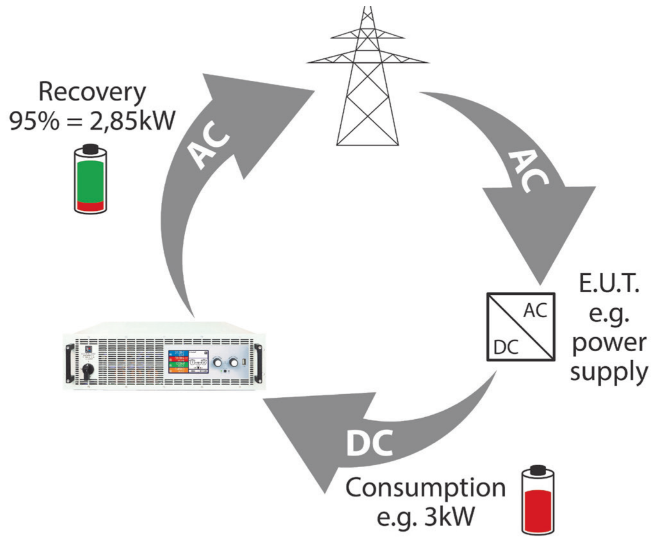


Figure 1: Principle of Energy recovery operation.

The way a regenerative electronic load operates can be easily explained using figure 1 as a reference.
Assume the device under test is a battery cell which consumes roughly 3KW of power. As seen on figure 2, the DC energy becomes an input to a DC-DC converter, which conditions the power so that this one can be processed to the next stage of the conversion. The last stage of conversion consists of an inverter which transforms the DC energy into appropriate AC energy. By appropriate, it is meant that the AC energy must be conditioned to meet the respective voltage and frequency levels of the local mains.

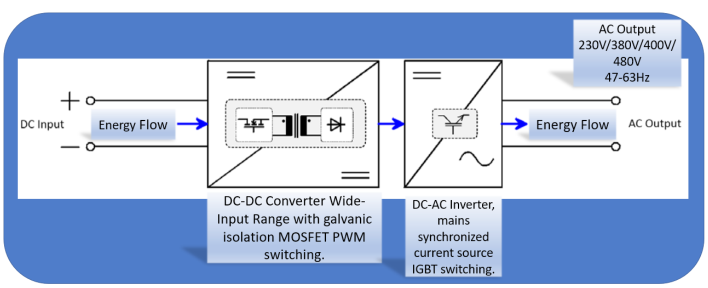


Figure 2: Power conversion process.

At this point, the recovered energy is fed-back into the factory grid and it ends up being utilized by the users inside the correspondent industrial or factory premises (in-house grid recovery). In the case the recovered power is higher than the consumed by the users inside the in-house grid, that one ends up consumed by users in the vicinities through the public grid, outside of the premises where the equipment is currently being tested. It could also occur the factory is not connected to the public grid and, for instance, the load is being used as a device-under-test with a fuel cell. In such case, the ELR 9000 Series load limit the recovered power to the one that is consumed solely by the users inside in the inhouse grid. Furthermore, depending on the usage given to the load the equipment could end up paying itself in a few years.

Connecting the Electronic DC Load to the mains

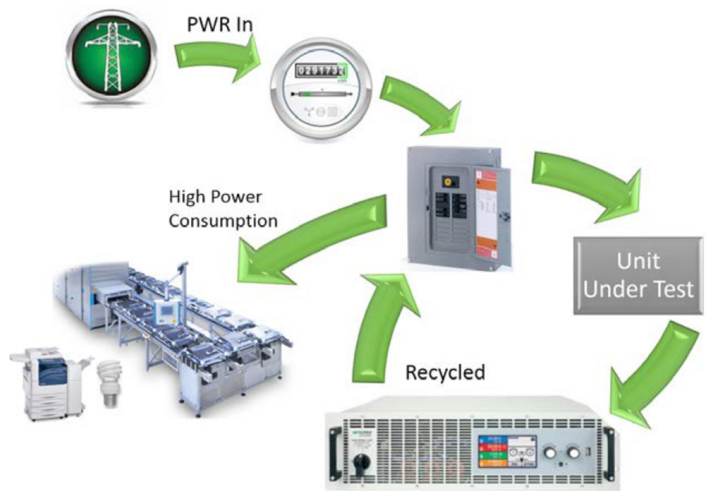


Figure 3: Recovering energy from Laboratory I

Figure 3 shows the process of energy recovery. In the High Power Consumption production line, it can be seen an energy recovery load being tested as part ofthe Unit Under Test. The arrow coming out of UUTS to the ELR 9000 load is connected after the meter and in-line with the main fuse box and the energy recovered is being fed back into the factory grid (in-house grid). Connecting the unit in such way is imperative if the unit is going to be used as part of continuous test operations. The recovered energy will then be used by production, laboratories or even office equipment.

Safety procedures before installation and use

There are several safety procedures before installation and use of the unit and they are as follows:

The device may, depending on the model, have a considerable weight. Therefore the proposed location of the equipment (table, cabinet, shelf, 19" rack) must be able to support the weight without restriction.

- When using a 19" rack, rails suitable for the width of the housing and the weight of the device are to be used. Before connecting to the mains, ensure that the connection is as shown on the product label. Overvoltage on the AC supply can cause equipment damage.
- For electronic loads: Before connecting a voltage source to the DC input make sure, that the source cannot generate a voltage higher than specified for a particular model or install measures which can prevent damaging the device by overvoltage input
- For energy recovering electronic loads: Before connecting the AC mains/output to a public grid, it is essential to find out if the operation of this device is allowed at the target location and if it is required to install supervision hardware. The ELR 9000 is CE certified and meets strict EN 50160 and EN 60950 standards.

Preparation and mains connection (AC)

Mains connection of an energy back-feeding electronic load is done via the included 4 or 5 pole plug on the back of the device. In addition, the wiring of the plug must be at least 3 strand or for some models, 4 or 5 strand of suitable cross section and length. In order to connect the unit to the mains, there are several key points that need to be taken into account:

- Connection to an AC mains supply may only be carried out by qualified personnel.
- Cable cross section must be suitable for the maximum input/output current of the device (see table below).
- Before plugging in the input plug ensure that the device is switched off by its mains switch.
- Ensure that all regulations for the operation of and connection to the public grid of energy back-feeding equipment have been applied and all necessary conditions have been met.

The equipment comes with a 4 or 5 pole plug. Depending on the power rating of the load model, this will be connected to a 2Φ or 3Φ mains supply, which has to be connected according to the labelling on the plug and the table below

Required for the mains connectio are the following phases (Φ): Included are both ELR 9000 3U and ELR 9000 3U HP

	L1		L2		L3		PE
Rated power	ø	I_{max}	ø	I_{max}	ø	I_{max}	ø
5 kW	-	-	1.5 mm²	13.2 A	1.5 mm²	13.2 A	same as phase
10 kW	2.5 mm²	23 A	2.5 mm²	16 A	2.5 mm²	23 A	same as phase
15 kW	2.5 mm²	23 A	2.5 mm²	23 A	2.5 mm²	23 A	same as phase

Table 1: Required phases for mains connection ELR 9000 3U HP

	L1		L2		L3	
Nominal power	ø	I_{max}	ø	I_{max}	ø	I_{max}
3100 W	-	-	AWG 14	16 A	AWG 14	16 A
6200 W	AWG 13	28 A	AWG 13	16 A	AWG 13	28 A
9300 W	AWG 13	28 A	AWG 13	28 A	AWG 13	28 A

Table 2: Maximum current rating and minimum cross section ELR 9000 3U

The included connection plug can receive cable ends up to 4 mm2. It is known that the longer the connection cable, the higher the voltage loss due to the cable resistance. If the voltage loss results to be too high, the load could dedect a low voltage error. Hence the mains cables should be kept as short as possible. Figure 5 shows an example of a supply connection cable.

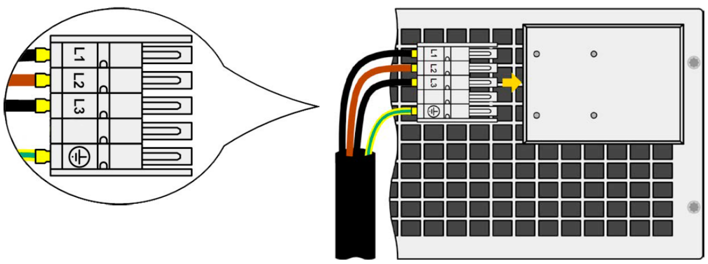


Figure 4: Supply connection cable ELR 9000 3U HP

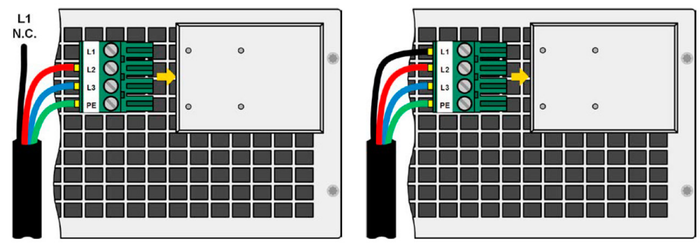


Figure 5: Supply connection cable ELR 9000 3U

If you have questions on wiring the ELR 9000, please contact EA Elektro-Automatik and will be happy to provide step by step support.

EA

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