



## Operating Guide

# EL 9000 B 15U/24U

## Electronic DC load



Elektro-Automatik



Attention! This document is only valid for devices with TFT display and firmware "KE: 2.31", "HMI: 2.20" and "DR: 1.6.6" or higher.

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## 1. General

### 1.1 About this document

#### 1.1.1 Retention and use

This document is to be kept in the vicinity of the equipment for future reference and explanation of the operation of the device. This document is to be delivered and kept with the equipment in case of change of location and/or user.

#### 1.1.2 Copyright

Reprinting, copying, also partially, usage for other purposes as foreseen of this manual are forbidden and breach may lead to legal process.

#### 1.1.3 Validity

This manual is valid for the following equipment:

Model	Article nr.	Model	Article nr.
EL 9080-1530 B 15U	33240600	EL 9080-2550 B 24U	33240610
EL 9200-630 B 15U	33240601	EL 9200-1050 B 24U	33240611
EL 9360-360 B 15U	33240602	EL 9360-600 B 24U	33240612
EL 9500-270 B 15U	33240603	EL 9500-450 B 24U	33240613
EL 9750-180 B 15U	33240604	EL 9750-300 B 24U	33240614
EL 9080-2040 B 24U	33240605	EL 9080-3060 B 24U	33240615
EL 9200-840 B 24U	33240606	EL 9200-1260 B 24U	33240616
EL 9360-480 B 24U	33240607	EL 9360-720 B 24U	33240617
EL 9500-360 B 24U	33240608	EL 9500-540 B 24U	33240618
EL 9750-240 B 24U	33240609	EL 9750-360 B 24U	33240619

#### 1.1.4 Symbols and warnings

Warning and safety notices as well as general notices in this document are shown in a box with a symbol as follows:

	<b>Symbol for a life threatening danger</b>
	Symbol for general safety notices (instructions and damage protection bans) or important information for operation
	<i>Symbol for general notices</i>

## 1.2 Warranty

EA Elektro-Automatik guarantees the functional competence of the applied technology and the stated performance parameters. The warranty period begins with the delivery of free from defects equipment.

Terms of guarantee are included in the general terms and conditions (TOS) of EA Elektro-Automatik.

## 1.3 Limitation of liability

All statements and instructions in this manual are based on current norms and regulations, up-to-date technology and our long term knowledge and experience. The manufacturer accepts no liability for losses due to:

- Usage for purposes other than designed
- Use by untrained personnel
- Rebuilding by the customer
- Technical changes
- Use of not authorized spare parts

## 1.4 Disposal of equipment

A piece of equipment which is intended for disposal must, according to European laws and regulations (ElektroG, WEEE) be returned to the manufacturer for scrapping, unless the person operating the piece of equipment or another, delegated person is conducting the disposal. Our equipment falls under these regulations and is accordingly marked with the following symbol:



## 1.5 Product key

Decoding of the product description on the label, using an example:

**EL 9 080 - 3060 B 24U**

	Construction: <b>15U / 24U</b> = Cabinet with 15 U or 24 U of effective height
	<b>B</b> = Second generation
	Maximum current of the device in Ampere
	Maximum voltage of the device in Volt
	Series number: <b>9</b> = Series 9000
	Type identification: <b>EL</b> = Electronic Load, programmable <b>ELR</b> = Electronic Load with Recovery

## 1.6 Intended usage

The equipment is intended to be used, if a power supply or battery charger, only as a variable voltage and current source, or, if an electronic load, only as a variable current sink.

Typical application for a power supply is DC supply to any relevant user, for a battery charger the charging of various battery types and for electronic loads the replacement of an ohmic resistor by an adjustable DC current sink in order to load relevant voltage and current sources of any type.



- Claims of any sort due to damage caused by non-intended usage will not be accepted.
- All damage caused by non-intended usage is solely the responsibility of the operator.

**1.7 Safety****1.7.1 Safety notices****Mortal danger - Hazardous voltage**

- **Electrical equipment operation means that some parts can be under dangerous voltage. Therefore all parts under voltage must be covered!**
- **All work on DC connections must be carried out under zero voltage, i.e. DC input not connected to a source and may only be performed by qualified and informed persons. Improper actions can cause fatal injury as well as serious material damage.**
- **Never touch AC cables or AC connectors and terminal directly after unplugging from mains supply as the danger of electric shock remains!**
- **Never touch the contacts on the DC input terminal directly after switching off the DC input or disconnecting the source, because there still can be dangerous potential between negative DC input to PE or positive DC input to PE due to charged X capacitors!**
- **Always follow 5 safety rules when working with electric devices:**
  - **Disconnect completely**
  - **Secure against reconnection**
  - **Verify that the system is dead**
  - **Carry out earthing and short-circuiting**
  - **Provide protection from adjacent live parts**



- The equipment must only be used as intended
- The equipment is only approved for use within the connection limits stated on the product label.
- Do not insert any object, particularly metallic, through the ventilator slots
- Avoid any use of liquids near the equipment. Protect the device from wet, damp and condensation.
- For power supplies and battery chargers: do not connect loads, particularly such with low resistance, to devices under power; sparking may occur which can cause burns as well as damage to the equipment and to the user
- For electronic loads: do not connect power sources to equipment under power, sparking may occur which can cause burns as well as damage to the equipment and to the source.
- ESD regulations must be applied when plugging interface cards or modules into the relative slot
- Interface modules may only be installed or removed after the device is switched off. It'sn't necessary to open the device.
- Do not connect external power sources with reversed polarity to DC input or outputs! The equipment will be damaged.
- For power supply devices: avoid where possible connecting external power sources to the DC output, and never those that can generate a higher voltage than the nominal voltage of the device.
- For electronic loads: do not connect a power source to the DC input which can generate a voltage more than 120% of the nominal input voltage of the load. The equipment isn't protected against over voltage and may be irreparably damaged.
- Never insert a network cable which is connected to Ethernet or its components into the master-slave socket on the rear side of the device!
- Always configure the various protecting features against overcurrent, overpower etc. for sensitive loads to what the currently used application requires!

## 1.7.2 Responsibility of the user

The equipment is in industrial operation. Therefore the operators are governed by the legal safety regulations. Alongside the warning and safety notices in this manual the relevant safety, accident prevention and environmental regulations must also be applied. In particular the users of the equipment:

- must be informed of the relevant job safety requirements
- must work to the defined responsibilities for operation, maintenance and cleaning of the equipment
- before starting work must have read and understood the operating manual
- must use the designated and recommended safety equipment.

Furthermore, anyone working with the equipment is responsible for ensuring that the device is at all times technically fit for use.

## 1.7.3 Responsibility of the operator

Operator is any natural or legal person who uses the equipment or delegates the usage to a third party, and is responsible during its usage for the safety of the user, other personnel or third parties.

The equipment is in industrial operation. Therefore the operators are governed by the legal safety regulations. Alongside the warning and safety notices in this manual the relevant safety, accident prevention and environmental regulations must also be applied. In particular the operator has to

- be acquainted with the relevant job safety requirements
- identify other possible dangers arising from the specific usage conditions at the work station via a risk assessment
- introduce the necessary steps in the operating procedures for the local conditions
- regularly control that the operating procedures are current
- update the operating procedures where necessary to reflect changes in regulation, standards or operating conditions.
- define clearly and unambiguously the responsibilities for operation, maintenance and cleaning of the equipment.
- ensure that all employees who use the equipment have read and understood the manual. Furthermore the users are to be regularly schooled in working with the equipment and the possible dangers.
- provide all personnel who work with the equipment with the designated and recommended safety equipment

Furthermore, the operator is responsible for ensuring that the device is at all times technically fit for use.

## 1.7.4 User requirements

Any activity with equipment of this type may only be performed by persons who are able to work correctly and reliably and satisfy the requirements of the job.

- Persons whose reaction capability is negatively influenced by e.g. drugs, alcohol or medication may not operate the equipment.
- Age or job related regulations valid at the operating site must always be applied.



### **Danger for unqualified users**

**Improper operation can cause person or object damage. Only persons who have the necessary training, knowledge and experience may use the equipment.**

**Delegated persons** are those who have been properly and demonstrably instructed in their tasks and the attendant dangers.

**Qualified persons** are those who are able through training, knowledge and experience as well as knowledge of the specific details to carry out all the required tasks, identify dangers and avoid personal and other risks.

All work on electrical equipment may only be performed by qualified electricians.

## 1.7.5 Alarm signals

The equipment offers various possibilities for signalling alarm conditions, however, not for danger situations. The signals may be optical (on the display as text), acoustic (piezo buzzer) or electronic (status output pin of an analog interface). All alarms will cause the device to switch off the DC input.

The meaning of the signals is as follows:

Signal <b>OT</b> (OverTemperature)	<ul style="list-style-type: none"> <li>• Overheating of the device</li> <li>• DC input will be switched off</li> <li>• Non-critical</li> </ul>
Signal <b>OVP</b> (OverVoltage)	<ul style="list-style-type: none"> <li>• Overvoltage shutdown of the DC input due to high voltage entering the device or generated by the device itself due to a defect</li> <li>• Critical! The device and/or the source could be damaged</li> </ul>
Signal <b>OCP</b> (OverCurrent)	<ul style="list-style-type: none"> <li>• Shutdown of the DC input due to excess of the preset limit</li> <li>• Non-critical, protects the source from excessive current output</li> </ul>
Signal <b>OPP</b> (OverPower)	<ul style="list-style-type: none"> <li>• Shutdown of the DC input due to excess of the preset limit</li> <li>• Non-critical, protects the source from excessive power output</li> </ul>
Signal <b>PF</b> (Power Fail)	<ul style="list-style-type: none"> <li>• DC input shutdown due to AC undervoltage or defect in the AC input</li> <li>• Critical on overvoltage! AC input circuit could be damaged</li> </ul>

## 1.8 Technical Data

### 1.8.1 Approved operating conditions

- Use only inside dry buildings
- Ambient temperature 0-50°C
- Operational altitude: max. 2000 m above sea level
- Max 80% relative humidity, not condensing

### 1.8.2 Control panel

Display: Colour TFT touch screen with gorilla glass, 4.3", 480pt x 272pt, capacitive

Controls: 2 rotary knobs with pushbutton function, 1 pushbutton

The nominal values for the device determine the maximum adjustable ranges.

### 1.8.3 Technical specifications

<b>Global</b>	
<b>AC input</b>	
Voltage	90...264 V <sub>AC</sub> . 45 - 65 Hz
Connection	One phase supply (L, N)
Fusing	Circuit breaker,. 1x 16 A per unit (characteristics K)
Power factor	≈ 0.99
Leakage current	≤ 3.5 mA per unit, max. 21 mA per cabinet
<b>DC input</b>	
Temperature coefficient (Δ/K)	Set values: 30 ppm
Overvoltage protection range	0...1.03 * U <sub>Nom</sub>
Overcurrent protection range	0...1.1 * I <sub>Nom</sub>
Overpower protection range	0...1.1 * P <sub>Peak</sub>
Maximum allowed input voltage	1.1 * U <sub>Nom</sub>

Global	
<b>Voltage regulation</b>	
Accuracy <sup>(1)</sup> (at 23 ± 5°C)	< 0.1% U <sub>Nom</sub>
Load regulation at ΔI	< 0.05% U <sub>Nom</sub>
Display: Resolution	See section „1.9.6.4. Resolution of the displayed values“
Display: Accuracy <sup>(4)</sup>	≤ 0.1% U <sub>Nom</sub>
Remote sensing compensation	Max. 5% U <sub>Nom</sub>
<b>Current regulation</b>	
Accuracy <sup>(1)</sup> (at 23 ± 5°C)	< 0.2% I <sub>Nom</sub>
Load regulation at ΔU	< 0.15% I <sub>Nom</sub>
Display: Resolution	See section „1.9.6.4. Resolution of the displayed values“
Display: Accuracy <sup>(4)</sup>	≤ 0.1% I <sub>Nom</sub>
<b>Power regulation</b>	
Adjustment range	0...P <sub>Peak</sub>
Accuracy <sup>(1)</sup> (at 23 ± 5°C)	< 0.5% P <sub>Peak</sub>
Display: Resolution	See section „1.9.6.4. Resolution of the displayed values“
Display: Accuracy <sup>(4)</sup>	≤ 0.2% P <sub>Peak</sub>
<b>Internal resistance regulation</b>	
Accuracy <sup>(1)</sup>	≤ 1% of max. resistance ± 0.3% of rated current
Display: Resolution	See section „1.9.6.4. Resolution of the displayed values“
Display: Accuracy <sup>(2)</sup>	≤ 0.2% R <sub>Max</sub>
<b>Analog interface <sup>(3)</sup></b>	
Set value inputs	U, I, P, R
Actual value output	U, I
Control signals	DC on/off, remote control on/off, resistance control on/off
Status signals	CV, OVP, OCP, OPP, OT, PF, DC on/off
<b>Insulation</b>	
AC input <-> PE	Max. 2500 V, short-term
DC input <-> PE	DC minus: permanent max. ±400 V DC plus: permanent max. ±400 V + max. input voltage
<b>Digital interfaces</b>	
Featured	1x USB-B for communication, 1x USB-A for functions
Slot (master unit)	optional: CANopen, Profibus, Profinet, RS232, CAN, Ethernet, ModBus TCP, Ether-CAT
<b>Miscellaneous</b>	
Cooling	Temperature controlled fans, front inlet, rear exhaust
Ambient temperature	0..50°C
Storage temperature	-20...70°C
Humidity	< 80%, not condensing
Standards	EN 61010-1:2011-07, EN 61000-6-2:2016-05, EN 61000-6-3:2011-09 Class B
<b>Terminals</b>	
Rear side	Share Bus, DC input, AC input, remote sensing, analog interface, USB-B, master-slave bus, AnyBus module slot
Front side	USB-A
<b>Dimensions</b>	
Cabinet (WxHxD)	15U version: 60 x 95 x 69 cm (with emergency off option: 60 x 110 x 69 cm) 24U version: 60 x 135 x 69 cm with emergency off option: 60 x 150 x 69 cm)

(1) Related to the nominal values, the accuracy defines the maximum deviation between an adjusted values and the true (actual) value on the DC input

(2) The display error adds to the error of the related actual value on the DC input

(3) For technical specifications of the analog interface see „3.5.4.4 Analog interface specification“ on page 52

15 U cabinet	Model				
	EL 9080-1530 B	EL 9200-630 B	EL 9360-360 B	EL 9500-270 B	EL 9750-180 B
<b>Default assembly</b>	3 units	3 units	3 units	3 units	3 units
<b>AC inrush current @ 230 V</b>	≤ 207 A	≤ 207 A	≤ 207 A	≤ 207 A	≤ 207 A
<b>AC power consumption</b>	Max. 400 W	Max. 400 W	Max. 400 W	Max. 400 W	Max. 400 W
<b>Ratings</b>					
Input voltage $U_{Nom}$	80 V	200 V	360 V	500 V	750 V
Input current $I_{Nom}$	1530 A	630 A	360 A	270 A	180 A
Input power $P_{Peak}$	21.6 kW	18 kW	16.2 kW	10.8 kW	10.8 kW
Input power $P_{Steady}$	13.5 kW	13.5 kW	13.5 kW	10.8 kW	10.8 kW
<b>Adjustment ranges</b>					
Voltage	0...81.6 V	0...204 V	0...367.2 V	0...510 V	0...765 V
Current	0...1560.6 A	0...642.6 A	0...367.2 A	0...275.4 A	0...183.6 A
Power	0...22.03 kW	0...18.36 kW	0...16.52 kW	0...11.02 kW	0...11.02 kW
Resistance	0.005...1.666 Ω	0.0266...9.333 Ω	0.09...30 Ω	0.167...55.666 Ω	0.4...120 Ω
Overvoltage	0...88 V	0...220 V	0...396 V	0...550 V	0...825 V
Overcurrent	0...1683 A	0...693 A	0...396 A	0...297 A	0...198 A
Overpower	0...23.76 kW	0...19.8 kW	0...17.82 kW	0...11.88 kW	0...11.88 kW
$U_{Min}$ for $I_{Max}$ <sup>(1)</sup>	ca. 2.2 V	ca. 2 V	ca. 2 V	ca. 6.5 V	ca. 5.5 V
<b>Derating</b>	ca. 171 W/°K	ca. 171 W/°K	ca. 171 W/°K	ca. 171 W/°K	ca. 171 W/°K
<b>Current dynamics</b>					
Rise time 10...90% $I_{Nom}$	< 23 μs	< 40 μs	< 24 μs	< 22 μs	< 18 μs
Fall time 90...10% $I_{Nom}$	< 46 μs	< 42 μs	< 38 μs	< 29 μs	< 40 μs
<b>Weight</b>	approx. 120 kg	approx. 120 kg	approx. 120 kg	approx. 120 kg	approx. 120 kg
<b>Article number</b>	33240600	33240601	33240602	33240603	33240604

24 U cabinet	Model				
	EL 9080-2040 B	EL 9200-840 B	EL 9360-480 B	EL 9500-360 B	EL 9750-240 B
<b>Default assembly</b>	4 units	4 units	4 units	4 units	4 units
<b>AC inrush current @ 230 V</b>	≤ 276 A	≤ 276 A	≤ 276 A	≤ 276 A	≤ 276 A
<b>AC power consumption</b>	Max. 530 W	Max. 530 W	Max. 530 W	Max. 530 W	Max. 530 W
<b>Ratings</b>					
Input voltage $U_{Nom}$	80 V	200 V	360 V	500 V	750 V
Input current $I_{Nom}$	2040 A	840 A	480 A	360 A	240 A
Input power $P_{Peak}$	28.8 kW	24 kW	21.6 kW	14.4 kW	14.4 kW
Input power $P_{Steady}$	18 kW	18 kW	18 kW	14.4 kW	14.4 kW
<b>Adjustment ranges</b>					
Voltage	0...81.6 V	0...204 V	0...367.2 V	0...510 V	0...765 V
Current	0...2081 A	0...856.8 A	0...489.6 A	0...367.2 A	0...244.8 A
Power	0...29.38 kW	0...24.48 kW	0...22.03 kW	0...14.69 kW	0...14.69 kW
Resistance	0.0038...1.25 Ω	0.02...7 Ω	0.0675...22.5 Ω	0.125...41.75 Ω	0.3...90 Ω
Overvoltage	0...88 V	0...220 V	0...396 V	0...550 V	0...825 V
Overcurrent	0...2244 A	0...924 A	0...528 A	0...396 A	0...264 A
Overpower	0...31.68 kW	0...26.4 kW	0...23.76 kW	0...15.84 kW	0...15.84 kW
$U_{Min}$ for $I_{Max}$ <sup>(1)</sup>	ca. 2.2 V	ca. 2 V	ca. 2 V	ca. 6.5 V	ca. 5.5 V
<b>Derating</b>	ca. 228 W/°K	ca. 228 W/°K	ca. 228 W/°K	ca. 228 W/°K	ca. 228 W/°K
<b>Current dynamics</b>					
Rise time 10...90% $I_{Nom}$	< 23 μs	< 40 μs	< 24 μs	< 22 μs	< 18 μs
Fall time 90...10% $I_{Nom}$	< 46 μs	< 42 μs	< 38 μs	< 29 μs	< 40 μs
<b>Weight</b>	approx. 170 kg	approx. 170 kg	approx. 170 kg	approx. 170 kg	approx. 170 kg
<b>Article number</b>	33240605	33240606	33240607	33240608	33240609

(1 Minimum required input voltage for the load to draw the max. current. Also see 3.2.1.2

24 U cabinet	Model				
	EL 9080-2550 B	EL 9200-1050 B	EL 9360-600 B	EL 9500-450 B	EL 9750-300 B
<b>Default assembly</b>	5 units				
<b>AC inrush current @ 230 V</b>	≤ 345 A				
<b>AC power consumption</b>	Max. 660 W				
<b>Ratings</b>					
Input voltage $U_{Nom}$	80 V	200 V	360 V	500 V	750 V
Input current $I_{Nom}$	2550 A	1050 A	600 A	450 A	300 A
Input power $P_{Peak}$	36 kW	30 kW	27 kW	18 kW	18 kW
Input power $P_{Steady}$	22.5 kW	22.5 kW	22.5 kW	18 kW	18 kW
<b>Adjustment ranges</b>					
Voltage	0...81.6 V	0...204 V	0...367.2 V	0...510 V	0...765 V
Current	0...2601 A	0...1071 A	0...612 A	0...459 A	0...306 A
Power	0...36.72 kW	0...30.6 kW	0...27.54 kW	0...18.36 kW	0...18.36 kW
Resistance	0.003...1 Ω	0.016...5.6 Ω	0.054...18 Ω	0.1...33.4 Ω	0.24...72 Ω
Overvoltage	0...88 V	0...220 V	0...396 V	0...550 V	0...825 V
Overcurrent	0...2805 A	0...1155 A	0...660 A	0...495 A	0...330 A
Overpower	0...39.6 kW	0...33 kW	0...29.7 kW	0...19.8 kW	0...19.8 kW
<b><math>U_{Min}</math> for <math>I_{Max}</math> <sup>(1)</sup></b>	ca. 2.2 V	ca. 2 V	ca. 2 V	ca. 6.5 V	ca. 5.5 V
<b>Derating</b>	ca. 285 W/°K				
<b>Current dynamics</b>					
Rise time 10...90% $I_{Nom}$	< 23 μs	< 40 μs	< 24 μs	< 22 μs	< 18 μs
Fall time 90...10% $I_{Nom}$	< 46 μs	< 42 μs	< 38 μs	< 29 μs	< 40 μs
<b>Weight</b>	approx. 187 kg				
<b>Article number</b>	33240610	33240611	33240612	33240613	33240614

24 U cabinet	Model				
	EL 9080-3060 B	EL 9200-1260 B	EL 9360-720 B	EL 9500-540 B	EL 9750-360 B
<b>Default assembly</b>	6 units	6 units	6 units	6 units	6 units
<b>AC inrush current @ 230 V</b>	≤ 414 A	≤ 414 A	≤ 414 A	≤ 414 A	≤ 414 A
<b>AC power consumption</b>	Max. 800 W	Max. 800 W	Max. 800 W	Max. 800 W	Max. 800 W
<b>Ratings</b>					
Input voltage $U_{Nom}$	80 V	200 V	360 V	500 V	750 V
Input current $I_{Nom}$	3060 A	1260 A	720 A	540 A	360 A
Input power $P_{Peak}$	43.2 kW	36 kW	32.4 kW	21.6 kW	21.6 kW
Fall time 90...10% $I_{Nom}$	< 46 μs	< 42 μs	< 38 μs	< 29 μs	< 40 μs
Input power $P_{Steady}$	27 kW	27 kW	27 kW,	21.6 kW	21.6 kW
<b>Adjustment ranges</b>					
Voltage	0...81.6 V	0...204 V	0...367.2 V	0...510 V	0...765 V
Current	0...3121 A	0...1285.2 A	0...734.4 A	0...550.8 A	0...367.2 A
Power	0...44.06 kW	0...36.72 kW	0...33.04 kW	0...22.03 kW	0...22.03 kW
Resistance	0.0025...0.833 Ω	0.0133...4.666 Ω	0.045...15 Ω	0.0833...27.833 Ω	0.2...60 Ω
Overvoltage	0...88 V	0...220 V	0...396 V	0...550 V	0...825 V
Overcurrent	0...3366 A	0...1386 A	0...792 A	0...594 A	0...396 A
Overpower	0...47.52 kW	0...39.6 kW	0...35.64 kW	0...23.76 kW	0...23.76 kW
<b><math>U_{Min}</math> for <math>I_{Max}</math> <sup>(1)</sup></b>	ca. 2.2 V	ca. 2 V	ca. 2 V	ca. 6.5 V	ca. 5.5 V
<b>Derating</b>	ca. 342 W/°K	ca. 342 W/°K	ca. 342 W/°K	ca. 342 W/°K	ca. 342 W/°K
<b>Current dynamics</b>					
Rise time 10...90% $I_{Nom}$	< 23 μs	< 40 μs	< 24 μs	< 22 μs	< 18 μs
<b>Weight</b>	approx. 204 kg	approx. 204 kg	approx. 204 kg	approx. 204 kg	approx. 204 kg
<b>Article number</b>	33240615	33240616	33240617	33240618	33240619

(1) Minimum required input voltage for the load to draw the max. current. Also see 3.2.1.2

1.8.4 Views

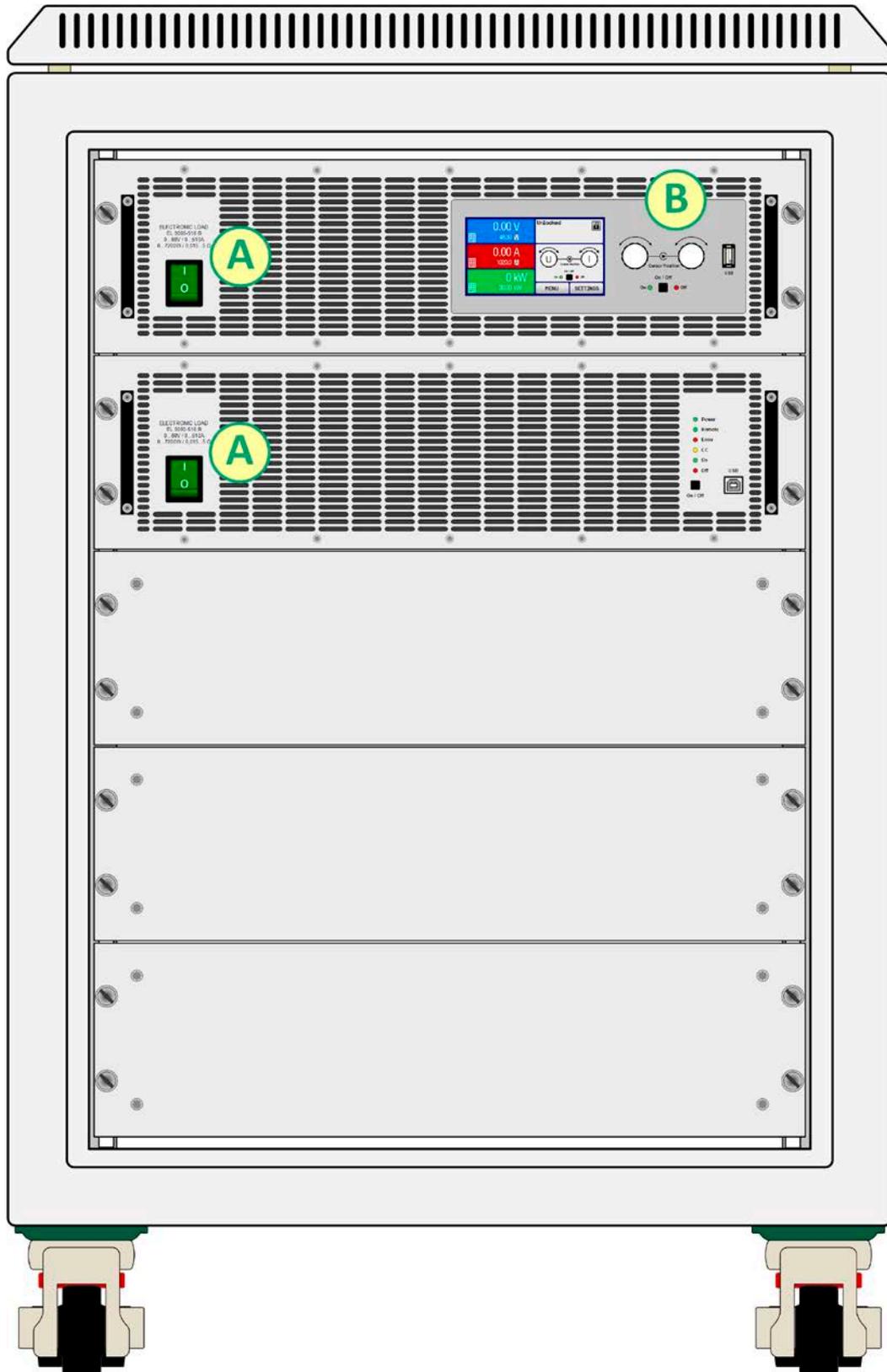


Figure 1 - Front side (example model in 15U)

- A - Power switch
- B - Control panel

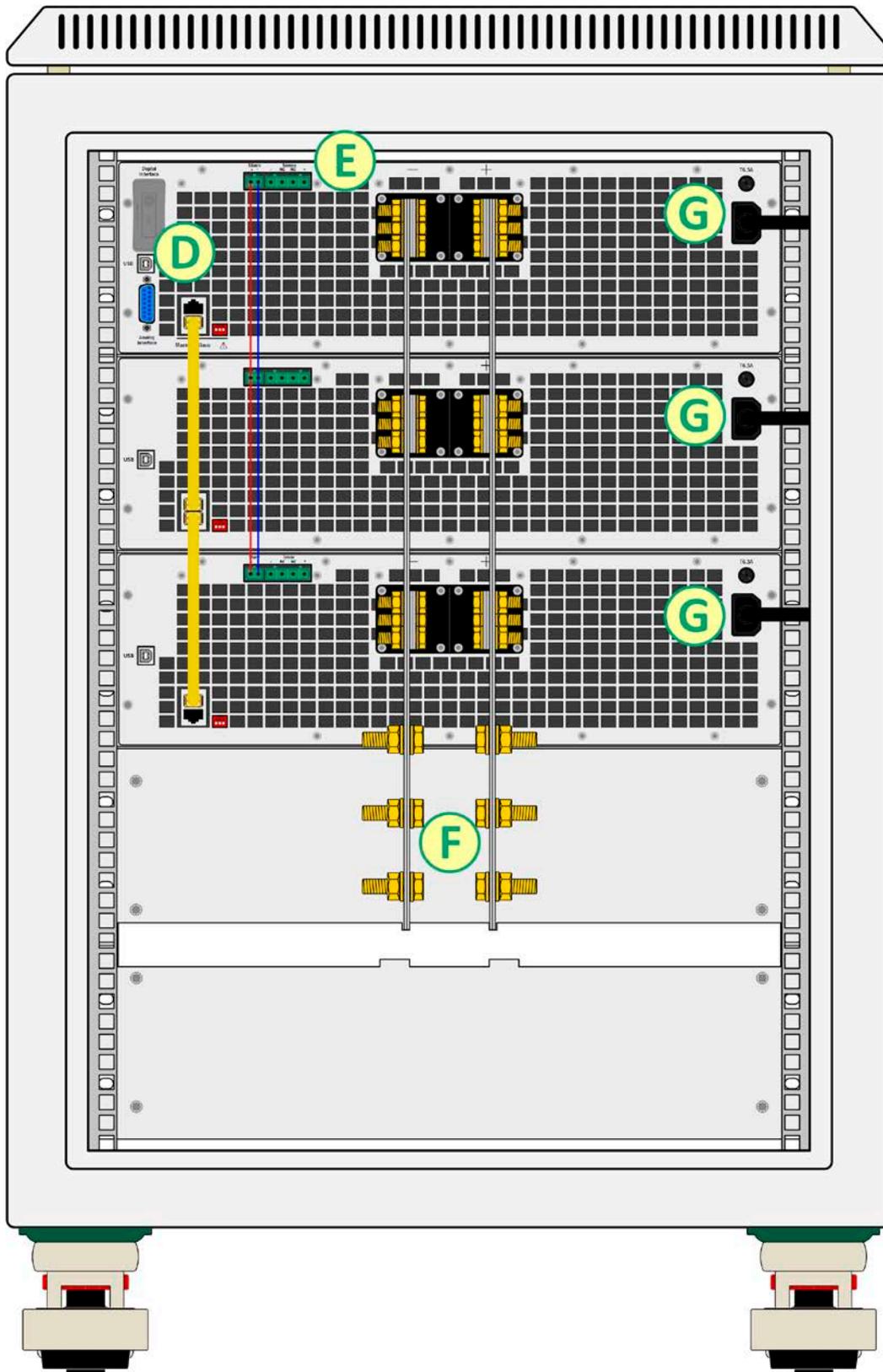
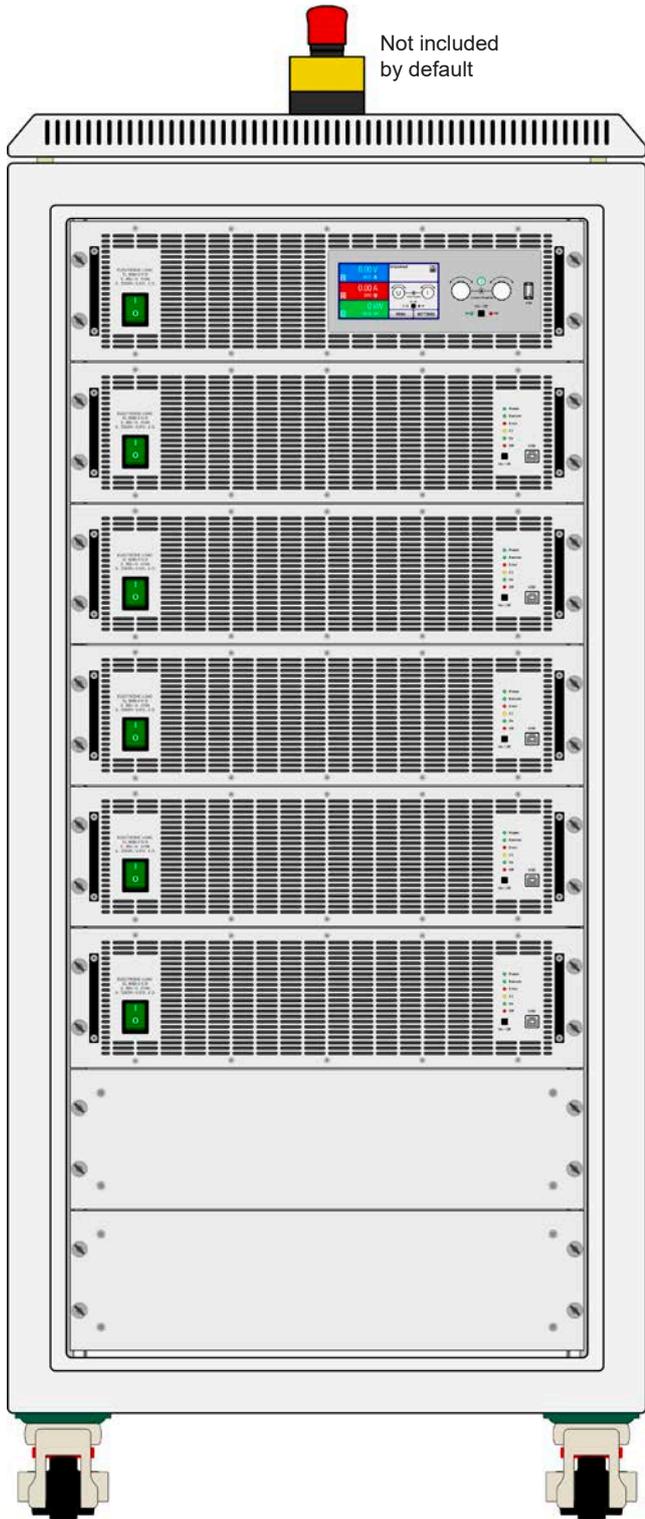


Figure 2 - Rear side (example model in 15U)

- D - Digital and analog interfaces
- E - Share Bus and remote sensing connection
- F - DC input
- G - AC input connection of the single units



Not included  
by default

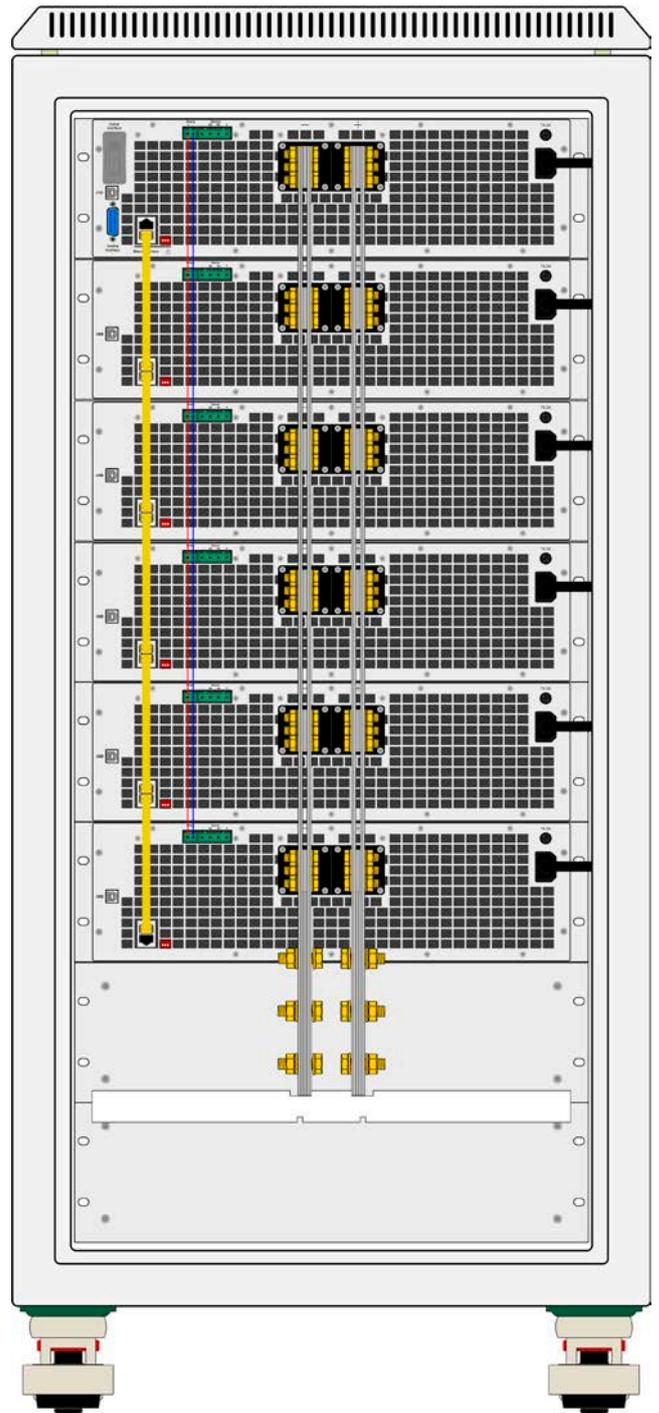


Figure 3 - Front side (example model in 24U with optional emergency off switch)

Figure 4 - Rear side (example model in 24 U)

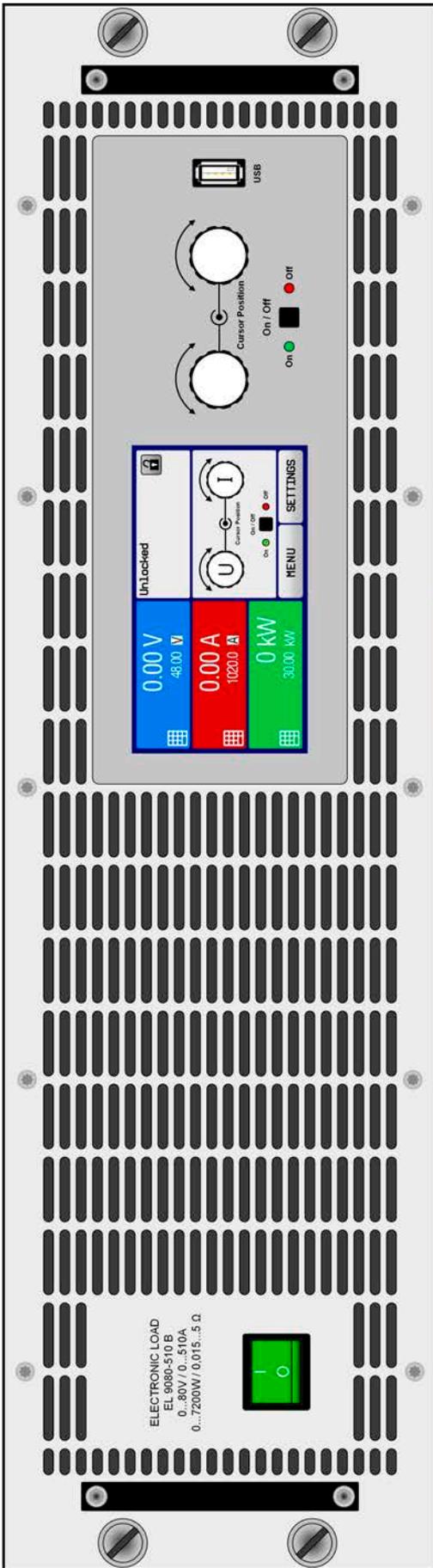


Figure 5 - Front side of master unit, with control panel

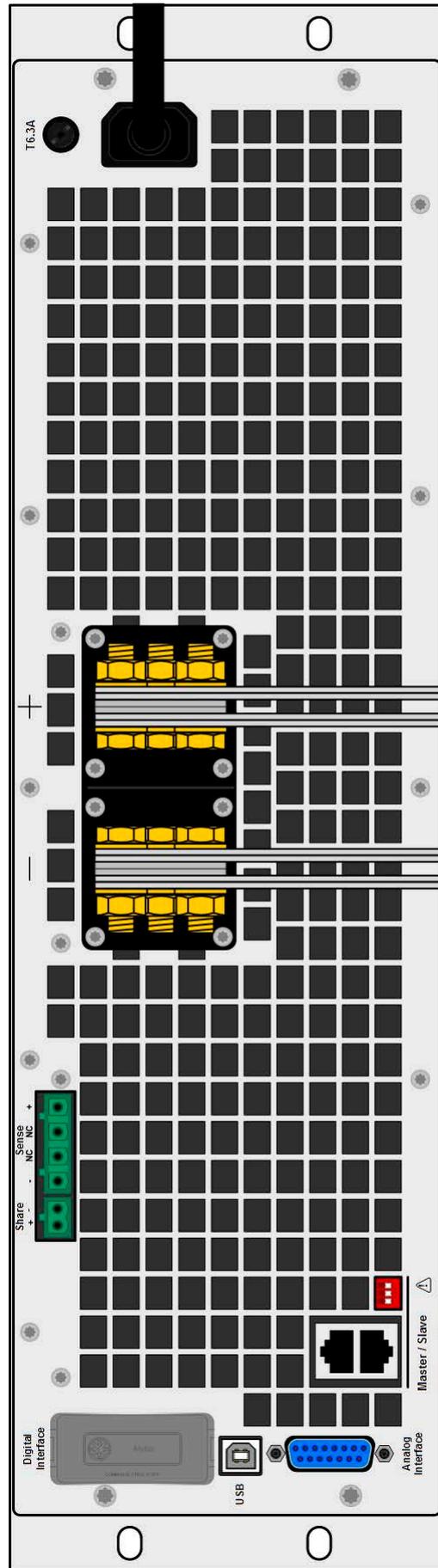


Figure 6 - Rear side of master unit, with all connectors

1.8.5 Control elements

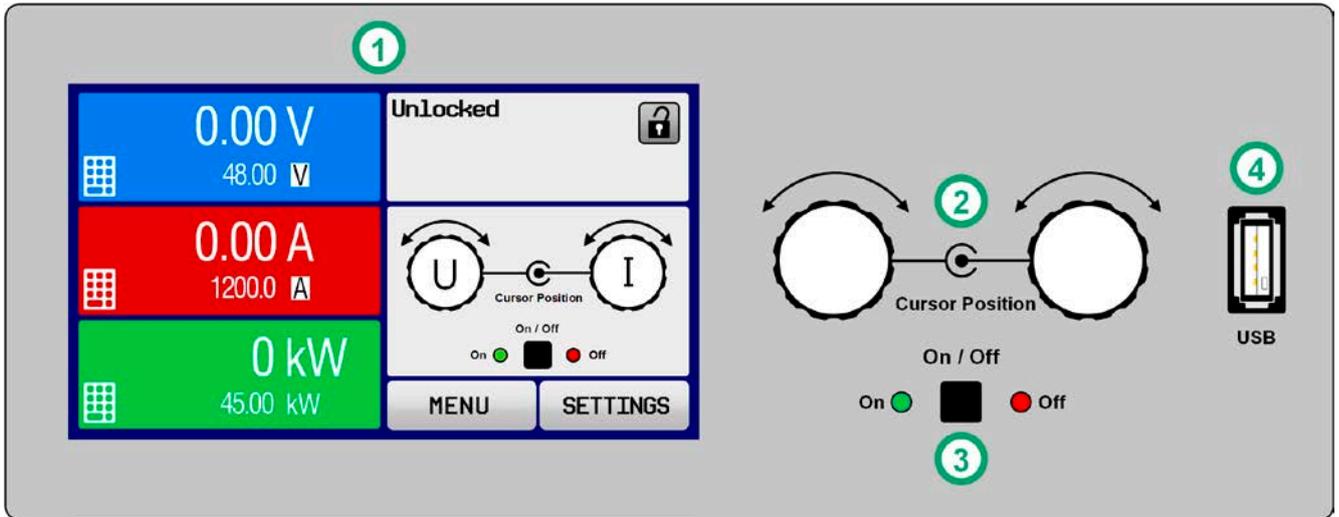


Figure 7- Control Panel

Overview of the elements on the control panel

For a detailed description see section „1.9.6. The control panel (HMI)“.

(1)	<p><b>Touchscreen display</b></p> <p>Used for adjustment of set values, setup in menus, as well as display of actual values and status. The touchscreen can be operated with the fingers or with a pen (Stylus).</p>
(2)	<p><b>Rotary knob with push button function</b></p> <p>Left knob (turn): adjusting the voltage, power or resistance set values, or setting the parameter values in the menu.</p> <p>Left knob (push): selection of the decimal position to be changed (cursor) in the current value selection.</p> <p>Right knob (turn): adjusting the current set value, or setting parameter values in the menu.</p> <p>Right knob (push): selection of the decimal position to be changed (cursor) in the current value selection.</p>
(3)	<p><b>On/Off Button for DC input</b></p> <p>Used to toggle the DC input between on and off, also used to start a function run. The LEDs “On” and “Off” indicate the state of the DC input, no matter if the device is manually controlled or remotely</p>
(4)	<p><b>Port for USB sticks</b></p> <p>For the connection of standard USB sticks. See section „1.9.6.5. USB port (front side)“ for more details.</p>

## 1.9 Construction and function

### 1.9.1 General description

The electronic DC loads of the EL 9000 B 15U and EL 9000 B 24U series have been designed for industrial high current and high power demands. Configured as mobile 19" cabinets in either 15 or 24 units of height they allow for operation in many different situations, such as high current battery or motor tests.

Both series are based on the 7.2 kW models of series EL 9000 B and thus offer the same set of functions and control options.

For remote control using a PC or PLC the devices are provided as standard with an USB slot on the rear side of the master unit, as well as a galvanically isolated analog interface.

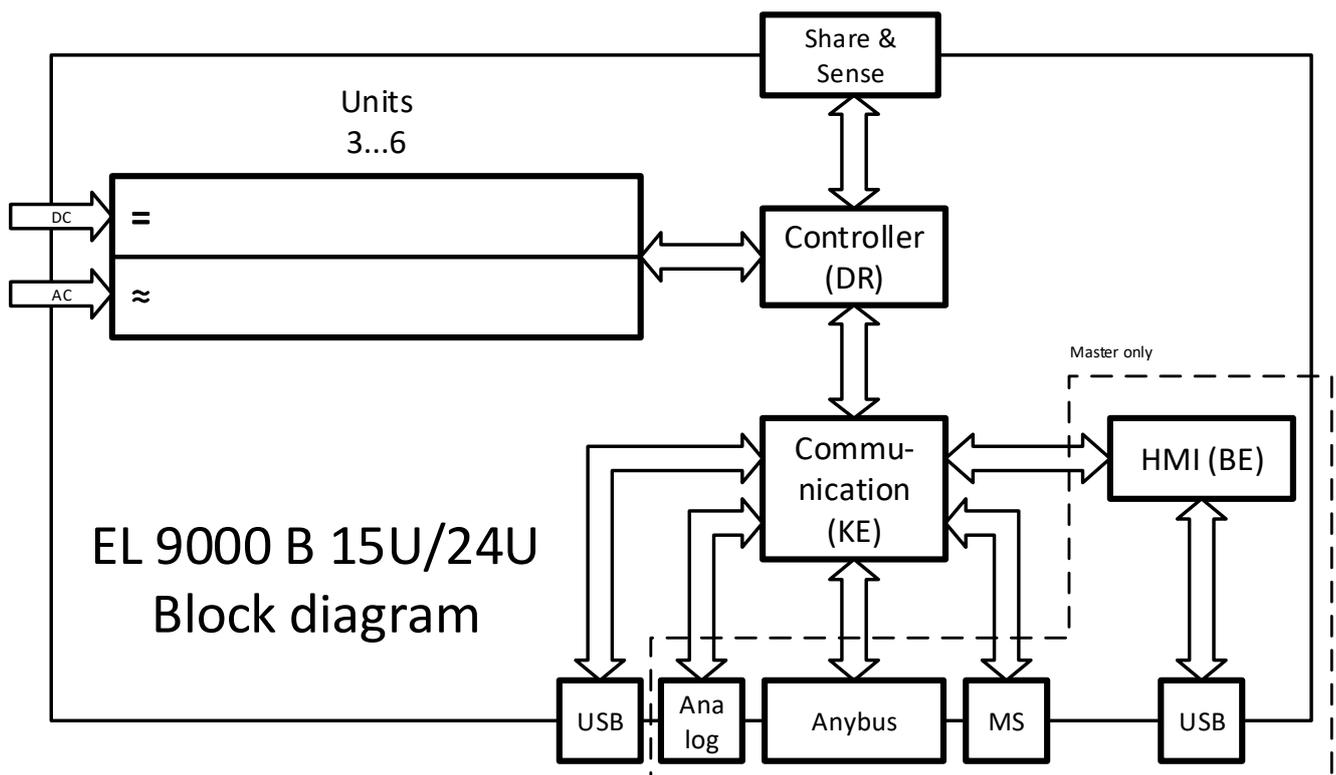
Via optional plug-in modules, another digital interface with either Ethernet, RS232, Profibus, ProfiNet, ModBus TCP, CANopen, CAN or EtherCAT can be added. These enable the devices to be connected to standard industrial buses simply by changing or adding a small module. The configuration, if necessary at all, is quick and easy. Thus the electronic load cabinets may, for example, be controlled in connection with other load devices or even other types of equipment, all via a PC or PLC and using the digital interfaces.

All models are controlled by microprocessors. These enable an exact and fast measurement and display of actual values.

### 1.9.2 Block diagram

The block diagram illustrates the main components inside the device and their relationships.

There are digital, microprocessor controlled components (KE, DR, HMI) inside which can be target of firmware updates. The units are separate power modules, each with their own AC input and DC input. There is a master unit and up to 5 slave units which don't feature a control panel (HMI).



## 1.9.3 Scope of delivery

1 x Electronic load cabinet with 2-6 installed PSI 9000 3U units

1 x 1.8 m USB cable

1 x USB stick with documentation and software (for the cabinet, further USB sticks from the power module may be included)

## 1.9.4 Accessories

For these devices the following accessories are available:

<b>IF-AB</b> Digital interface modules	Pluggable and retrofittable, digital interface modules for RS232, CANopen, Ethernet, Profibus, ProfiNet, ModBus TCP, EtherCAT or CAN are available. Details about the interface modules and the programming of the device using those interfaces can be found in separate documentation. It's usually available on the USB stick, which is included with the device, or as PDF download on the manufacturers website.																				
<b>EL 9000 B SLAVE</b> Additional slave units	Some models in this series have a spare slot for one additional slave unit which can be retrofittable by the operator of the cabinet (see „2.3.16. Adding new units“). The slave unit can be ordered by its article number and retrofittable on location. A patch cable for master-slave bus connection of the additional slave is included. Retrofitting may also require to install further DC bus bars to match the DC bus to the final current the system will have. Contact us for details and a proper quote. Following slave units are available: <table border="1" data-bbox="533 898 1466 1335"> <thead> <tr> <th>Model</th> <th>Article number</th> <th>Can be installed in</th> </tr> </thead> <tbody> <tr> <td>EL 9080-510 B 3U Slave</td> <td>33290270</td> <td>EL 9080-1530 B 15U EL 9080-2550 B 24U</td> </tr> <tr> <td>EL 9200-210 B 3U Slave</td> <td>33290271</td> <td>EL 9200-630 B 15U EL 9200-1050 B 24U</td> </tr> <tr> <td>EL 9360-120 B 3U Slave</td> <td>33290272</td> <td>EL 9360-360 B 15U EL 9360-600 B 24U</td> </tr> <tr> <td>EL 9500-90 B 3U Slave</td> <td>33290273</td> <td>EL 9500-270 B 15U EL 9500-450 B 24U</td> </tr> <tr> <td>EL 9750-60 B 3U Slave</td> <td>33290274</td> <td>EL 9750-180 B 15U EL 9750-300 B 24U</td> </tr> </tbody> </table>			Model	Article number	Can be installed in	EL 9080-510 B 3U Slave	33290270	EL 9080-1530 B 15U EL 9080-2550 B 24U	EL 9200-210 B 3U Slave	33290271	EL 9200-630 B 15U EL 9200-1050 B 24U	EL 9360-120 B 3U Slave	33290272	EL 9360-360 B 15U EL 9360-600 B 24U	EL 9500-90 B 3U Slave	33290273	EL 9500-270 B 15U EL 9500-450 B 24U	EL 9750-60 B 3U Slave	33290274	EL 9750-180 B 15U EL 9750-300 B 24U
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## 1.9.5 Options

These options are usually ordered along with the device, as they are permanently built in or preconfigured during the manufacturing process.

<b>EMERGENCY OFF</b> Emergency off system	Optional emergency off system consisting of a manual emergency off switch (mounted on top of the cabinet), a contactor and a connector for additional external contacts (breaker) to extend the circuit. In an emergency off situation the contactor will cut all units in the cabinet from AC supply so they stop supplying DC power.
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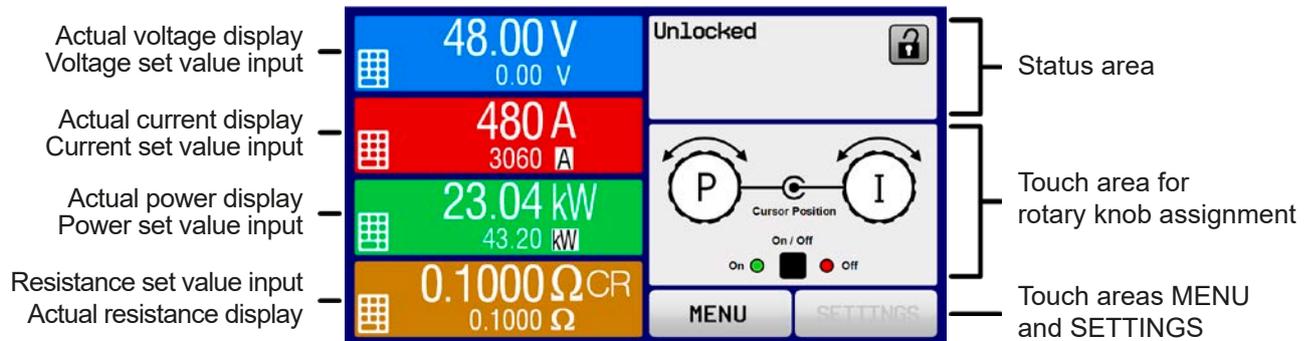
## 1.9.6 The control panel (HMI)

The HMI (Human Machine Interface) consists of a display with touchscreen, two rotary knobs, a pushbutton and an USB port.

### 1.9.6.1 Touchscreen display

The graphic touchscreen display is divided into a number of areas. The complete display is touch sensitive and can be operated by finger or stylus to control the equipment.

In normal operation the left hand side is used to show actual values and set values and the right hand side is used to display status information:



Touch areas may be enabled or disabled:



**MENU**

Black text or symbol = Enabled

**SETTINGS**

Grey text or symbol = Disabled

This applies to all touch areas on the main screen and all menu pages..

#### • Actual / set values area (left hand side)

In normal operation the DC input values (large numbers) and set values (small numbers) for voltage, current and power are displayed. The two resistance related values are only displayed in active resistance mode.

When the DC input is switched on, the actual regulation mode, **CV**, **CC**, **CP** or **CR** is displayed next to the corresponding actual values, as shown in the figure above.

The set values can be adjusted with the rotary knobs next to the display screen or can be entered directly via the touchscreen. When adjusting with the knobs, pushing the knob will select the digit to be changed. Logically, the values are increased by clockwise turning and decreased by anti-clockwise turning.

General display and setting ranges:

Value	Unit	Range	Description
Actual voltage	V	0.2-125% $U_{Nom}$	Actual value of DC input voltage
Set value of voltage	V	0-102% $U_{Nom}$	Set value for limiting the DC input voltage
Actual current	A	0.2-125% $I_{Nom}$	Actual value of DC input current
Set value of current	A	0-102% $I_{Nom}$	Set value for limiting the DC input current
Actual power	kW	0.2-125% $P_{Peak}$	Calculated actual value of input power, $P = U_{IN} * I_{IN}$
Set value of power	kW	0-102% $P_{Peak}$	Set value for limiting DC input power
Actual resistance	$\Omega$	$x^{(1)}$ ...99999 $\Omega$	Calculated actual internal resistance, $R = U_{IN} / I_{IN}$
Set value resistance	$\Omega$	$x^{(1)}$ -102% $R_{Max}$	Set value for the target internal resistance
Adjustment limits	A, V, kW, $\Omega$	0-102% nom	U-max, I-min etc., related to the physical values
Protection settings 1	A, kW	0-110% nom	OCP and OPP, related to the physical values
Protection settings 2	V	0-103% nom	OVP, related to the input voltage

<sup>(1)</sup> The minimum resistance set value varies according to model. See technical specifications in section 1.8.3

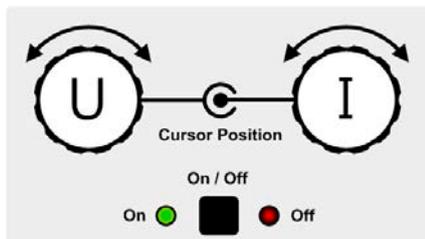
## • Status display (upper right)

This area displays various status texts and symbols:

Display	Description
<b>Locked</b>	The HMI is locked
<b>Unlocked</b>	The HMI is unlocked
<b>Remote:</b>	The device is under remote control from....
<b>Analog</b>	....the built-in analog interface
<b>USB &amp; others</b>	....the built-in USB port or a plug in interface module
<b>Local</b>	The device has been locked by the user explicitly against remote control
<b>Alarm:</b>	Alarm condition which has not been acknowledged or still exists.
<b>Event:</b>	A user defined event has occurred which isn't yet acknowledged.
<b>Master</b>	Master-slave mode activated, device is master unit
<b>Function:</b>	Function generator activated, function loaded
 / 	Data logging to USB stick active or failed

## • Area for assigning the rotary knobs

The two rotary knobs next to the display screen can be assigned to various functions. This area shows the actual assignments. These can be changed by tapping this area, as long as it's not locked:



The physical quantities on the depiction of the knobs show the current assignment. With an electronic load, the right-hand knob is always assigned to the current I, while the left knob can be switched by tapping the depiction.

The area will then show the assignment:

**U I**

Left rotary knob: voltage  
Right rotary knob: current

**P I**

Left rotary knob: power  
Right rotary knob: current

**R I**

Left rotary knob: resistance  
Right rotary knob: current

The other set values can't be adjusted via the rotary knobs, unless the assignment is changed. However, values can be entered directly with a ten-key pad by tapping on the small icon . Alternatively to the knob depiction, the assignment can also be changed by tapping the coloured set value areas.

### 1.9.6.2 Rotary knobs



As long as the device is in manual operation, the two rotary knobs are used to adjust set values, as well as setting the parameters in SETTINGS and MENU. For a detailed description of the individual functions see section „3.4. Manual operation“.

### 1.9.6.3 Pushbutton function of the knobs

The rotary knobs also have a pushbutton function which is used in all value adjustment to move the cursor by rotation as shown:



## 1.9.6.4 Resolution of the displayed values

In the display, set values can be adjusted in fixed increments. The number of decimal places depends on the device model. The values have 4 or 5 digits. Actual and set values always have the same number of digits.

Adjustment resolution and number of digits of set values in the display:

Voltage, OVP, UVD, OVD, U-min, U-max			Current, OCP, UCD, OCD, I-min, I-max			Power, OPP, OPD, P-max			Resistance, R-max		
Nominal	Digits	Min. increment	Nominal	Digits	Min. increment	Nominal	Digits	Min. increment	Nominal	Digits	Min. increment
80 V	4	0.01 V	180 A - 270 A	5	0.01 A	all	4	0.01 kW	0.8333 Ω - 9.33 Ω	5	0.0001 Ω
200 V	5	0.01 V	300 A - 840 A	4	0.1 A				15 Ω - 90 Ω	5	0.001 Ω
360 V	4	0.1 V	1050 A - 2550 A	5	0.1 A				120 Ω	5	0.01 Ω
500 V	4	0.1 V	3060 A	4	1 A						
750 V	4	0.1 V									

## 1.9.6.5 USB port (front side)

The frontal USB port, located to the right of the rotary knobs, is intended for the connection of standard USB sticks and can be used for loading or saving sequences for the arbitrary generator, as well as for logging data. USB 2.0 sticks are well accepted, but must be **FAT32** formatted and should have a **maximum capacity of 32 GB**. USB 3.0 sticks are accepted as well, but not from all manufacturers.

All supported files must be held in a designated folder in the root path of the drive in order to be found. This folder must be named **HMI\_FILES**, such that a PC would recognize the path G:\HMI\_FILES if the drive were to be assigned the letter G.

The control panel of the device can read the following file types and names from an USB stick:

wave_u<your_text>.csv wave_i<your_text>.csv	Function generator for an arbitrary function on voltage (U) or current (I) The name must begin with <i>wave_u</i> / <i>wave_i</i> , the rest is user defined.
iu<your_text>.csv	IU table for the XY function generator. The name must begin with <i>iu</i> , the rest can be user defined.
ui<your_text>.csv	UI table for the XY function generator. The name must begin with <i>ui</i> , the rest can be user defined.
profile_<nr>.csv	Saved user profile. The number in the file name is a counter and not related to the actual user profile number in the HMI. A max. of 10 files to select from is shown when loading a user profile.
mpp_curve_<your_text>.csv	User-defined curve data (100 voltage values) for mode MPP4 of the MPPT function

The control panel of the device can save the following file types and names to an USB stick:

battery_test_log_<nr>.csv	File with log data recorded from the battery test function. For a battery test log, data different and/or additional to log data of normal logging is recorded. The <nr> field in the file name is automatically counted up if equally named files already exist in the folder.
usb_log_<nr>.csv	File with log data recorded during normal operation in all modes. The file layout is identical to the those generated from the Logging feature in EA Power Control. The <nr> field in the file name is automatically counted up if equally named files already exist in the folder.
profile_<nr>.csv	Selected user profile. The number in the file name is a counter and not related to the actual user profile number in the HMI.
wave_u_<nr>.csv wave_i_<nr>.csv	Sequence point data of the arbitrary function generator, according to the current selection of voltage (U) or current (I). Already existing files are listed and can be overwritten.
mpp_result_<nr>.csv	Result data from mode MPP4 (MPPT function) with 100 sets of Umpp, Impp and Pmpp

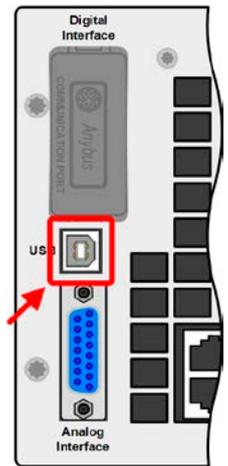
## 1.9.7 USB port type B (rear side)

The USB-B port on the rear side of the topmost unit (master) is provided for communication with the device and for firmware updates of the master. For the other units (slaves) in the cabinet, firmware updates are applied via the particular USB port of the units.

The included USB cable can be used to connect the master unit to a PC (USB 2.0 or 3.0). The driver is delivered with the device on USB stick and installs a virtual COM port. Details for remote control can be found on the web site of the manufacturer or also on the included USB stick.

The device can be addressed via this port either using the international standard ModBus RTU protocol or by SCPI language. The device recognises the message protocol used automatically.

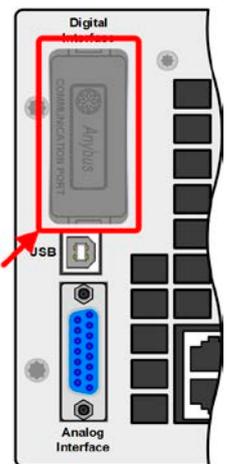
If remote control is in operation the USB port has no priority over either the interface module (see below) or the analog interface and can, therefore, only be used alternatively to these. However, monitoring is always available.



## 1.9.8 Interface module slot

This slot on the rear side of the topmost unit (master) can be used to install a digital interface module of the IF-AB interface series. The following options are available:

Article number	Name	Description
35400100	IF-AB-CANO	CANopen, 1x Sub-D 9pole male
35400101	IF-AB-RS232	RS 232, 1x Sub-D 9pole male (null modem)
35400103	IF-AB-PBUS	Profibus DP-V1 Slave, 1x Sub-D 9pole female
35400104	IF-AB-ETH1P	Ethernet, 1x RJ45
35400105	IF-AB-PNET1P	ProfiNET IO, 1x RJ45
35400107	IF-AB-MBUS1P	ModBus TCP, 1x RJ45
35400108	IF-AB-ETH2P	Ethernet, 2x RJ45
35400109	IF-AB-MBUS2P	ModBus TCP, 2x RJ45
35400110	IF-AB-PNET2P	ProfiNET IO, 2x RJ45
35400111	IF-AB-CAN	CAN 2.0 A / 2.0 B, 1x Sub-D 9-pole, male
35400112	IF-AB-ECT	EtherCAT, 2x RJ45



The modules are installed by the user and can be retrofitted anytime. A firmware update of the device may be necessary in order to recognize and support certain modules. In this case it's sufficient to update the master unit.

If remote control is in operation the interface module has no priority over either the USB port or the analog interface and can, therefore, only be used alternately to these. However, monitoring is always available.



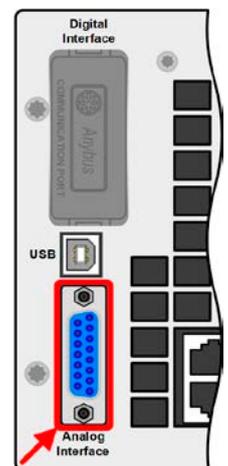
Switch off device before adding or removing modules!

## 1.9.9 Analog interface

This 15 pole Sub-D socket on the rear side of the topmost unit (master) is provided for remote control of the device via analog or digital signals.

If remote control is in operation this analog interface can only be used alternately to the digital interface. However, monitoring is always available.

The input voltage range of the set values and the output voltage range of the monitor values, as well as reference voltage level can be switched in the settings menu of the device between 0-5 V and 0-10 V, in each case for 0-100%.



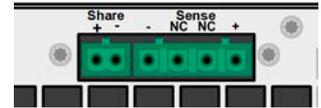
## 1.9.10 Share bus connector

This 2 pole WAGO connector "Share" on the rear side of the units is used by the master to balance the DC power consumption between all units. It must not be connected externally or used in a different way and must always remain plugged at all units to ensure safe and proper operation of the electronic load cabinet. In case additional power modules are added (where possible) to extend the available total power, the Share bus connection must also be extended to integrate the additional unit(s). The required wires are not included with the new slave, but it's recommended to use the wire type, same colour and same cross section.



## 1.9.11 "Sense" connector (remote sensing)

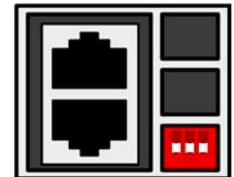
In order to compensate for voltage drops along the DC cables from the source to the DC load, the Sense input can be connected to the source. The maximum possible compensation is given in the technical specifications.



In order to ensure safety and to comply to international directives, insulation of high voltage models, i. e. such with a nominal voltage of 500 V or higher, is ensured by using only the two outer pins of the 4-pole terminal. The inner two pins, marked with NC, must remain unconnected.

## 1.9.12 Master-Slave bus

A master-slave bus is provided on the rear side of the units, which enables the master units to control the slave via the included standard CAT5 cables. The bus configuration is in permanent use and must not be modified, unless single slave units are temporarily removed from the cabinet for repair or maintenance purposes. In these situations it may be required to activate the bus termination feature, at least when the master unit reports bus problems and missing slave(s).



The master-slave bus must not be connected to units outside of the cabinet!

## 2. Installation & commissioning

### 2.1 Transport and storage

#### 2.1.1 Transport



- The handles on the front side of the units are **not** for carrying, but only for insertion into or removal from the cabinet!
- Because of the weight of the units, transport by hand should be avoided where possible. If unavoidable then only the housing should be held and not on the exterior parts (handles, DC input terminal, rotary knobs).
- Do not move the cabinet when switched on or connected!
- The cabinet must only be operated on horizontal surfaces which are capable of carrying the total weight of the cabinet plus at least a few persons who are operating it
- In case the cabinet is going to be moved to a different location, make sure for the entire way that the carrying capacity of the ground and possible elevators is sufficient as well the cabinet is secured against tipping and rolling off
- Use suitable safety clothing, especially safety shoes, when carrying the equipment, as due to the weight of an unit or the entire cabinet a drop can have serious consequences.

#### 2.1.2 Storage

In case of long term storage of the equipment it's recommended to use the original packaging or similar. Storage must be in dry rooms, if possible in sealed packaging, to avoid corrosion, especially internal through humidity.

### 2.2 Unpacking and visual check

After every transport, with or without packaging, or before commissioning, the equipment should be visually inspected for damage and completeness using the delivery note and/or parts list (see section „1.9.3. Scope of delivery“). An obviously damaged device (e.g. loose parts inside, damage outside) must under no circumstances be put in operation.

### 2.3 Installation

#### 2.3.1 Safety procedures before installation and use



- The cabinet has a considerable weight. Therefore the proposed location of the equipment, as well as the entire way of transport must be able to support the weight without restriction.
- After putting the cabinet into final position it's recommend to secure it against rolling off by unscrewing the retractable pedestals
- Before connecting to the mains ensure that the supply voltage is as shown on the product label. Overvoltage on the AC supply can cause equipment damage.

#### 2.3.2 Preparation

For the **AC supply** connection of the cabinet there are three screw clamps for L, N and PE accessible from the rear side of the cabinet. Qualified personnel can there either put a custom made cable with suitable length and cross section to be connected to a main distribution or use a standard 16 A (13 A for UK) mains cord with 1.5 mm<sup>2</sup> or 2.5 mm<sup>2</sup> of cross section, which is allowed to be plugged into a wall socket or power strip. In both cases it's required to consider the AC power consumption of the cabinet, especially when other devices are also connected to the same power strip, wall socket or main distribution, in order to not exceed the max. allowed current.

For the **DC side** connection to the source suitable cables have to be made which are not included in the delivery.

Dimensioning of the DC wiring to the power source has to reflect the following:



- The cable cross section should always be specified for at least the maximum current of the device.
- Continuous operation at the approved limit generates heat which must be removed, as well as voltage loss which depends on cable length and heating. To compensate for these the cable cross section should be increased and the cable length reduced.

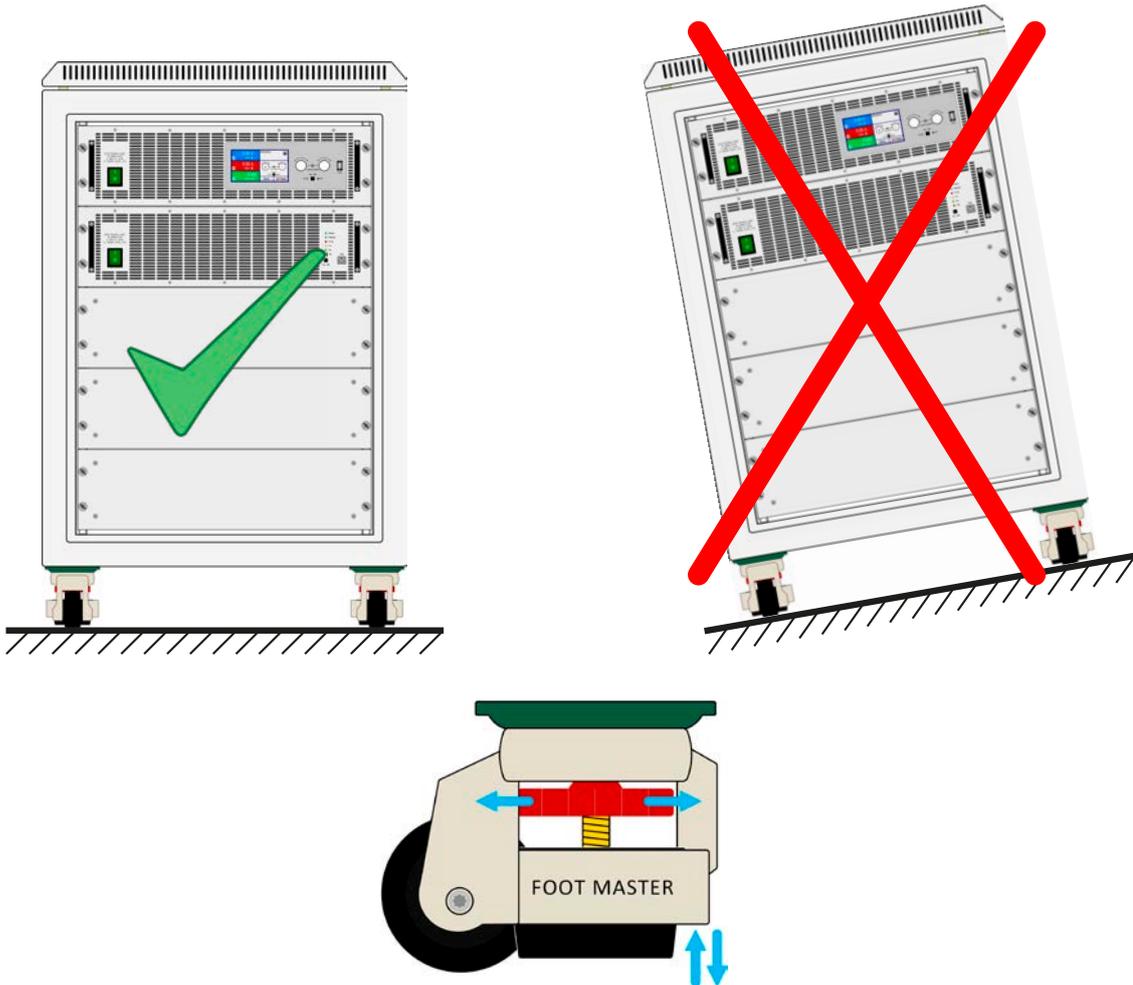
## 2.3.3 Installing the device



- Select the location for the device so that the connection to the source is as short as possible
- Leave sufficient space behind the equipment for ventilation, at least 50 cm
- Never place the cabinet's rear in front of flammable material (wood, paper, fabric, plastic etc.), because the power dissipation of up to 43 kW, depending on the model, is exhausted in form of hot air
- For models with installed emergency off switch (optional, see 1.9.5) it's required to leave an additional space of at least 30 cm on top of the cabinet

The cabinet must only be installed and operated on horizontal grounds. Even when secured against rolling off it could start sliding when being installed on a slanting ground.

It's recommended to secure the cabinet against rolling off **after** transport to the target location and **before** starting to connect any wiring. It can be done by unscrewing the pedestals in the wheels.



## 2.3.4 Connection to AC supply



- Connection to an AC mains supply must only be carried out by qualified personnel!
- Cable cross section must be suitable for the maximum input current of the device (see table below)!
- Before plugging in the input plug ensure that the device is switched off by its mains switch!

The cabinet is delivered with a 3 pole screw terminal to connect AC supply, which is accessible from the rear side. This terminal is normally going to be connected to a 3-phase main supply point via suitable cables according to the labeling on the terminal. Required are following conductors:

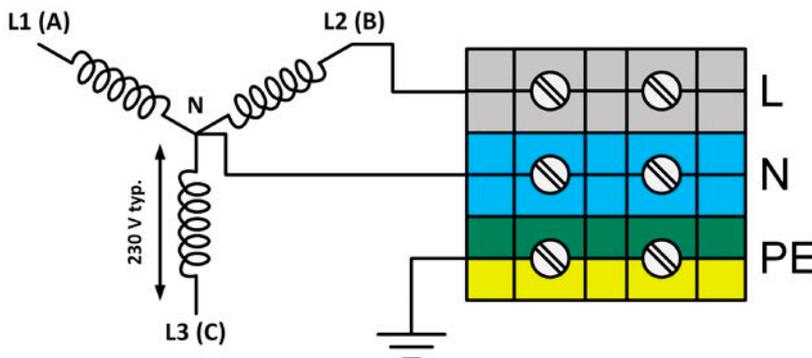
Rated power	Phases	Supply type
all	L, N, PE	Wall socket or similar



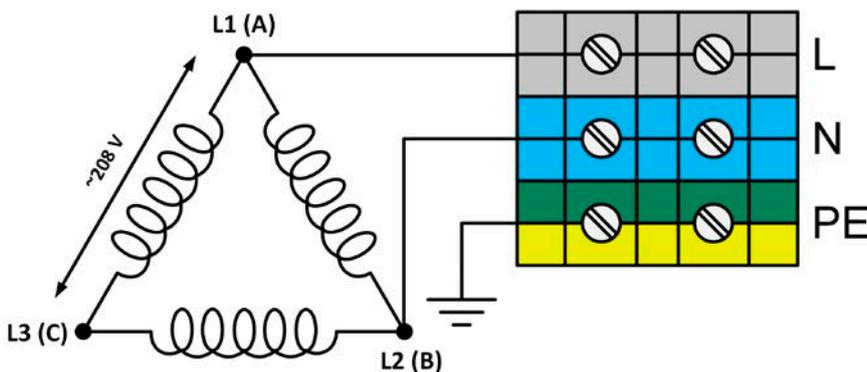
**The PE conductor is imperative and must always be wired!**

For the sizing of the wiring **cross section**, the maximum AC power consumption of the cabinet is decisive. However, with even 6 units equipped in one cabinet it only uses up to 800 W, so a standard 10 A mains cord with 0.75 mm<sup>2</sup> cross section would suffice for 230 V grids or one for 16 A and 1.5 mm<sup>2</sup> for 120 V grids. In case there is only a 230 V three-phase supply available, the cabinet is connected to any of the phases and N. If there are multiple cabinets to connect, it's recommended to take care for a balanced AC current distribution by using all available phases.

Connection scheme of one cabinet on a 230 V three-phase supply:



In case only a 120 V three-phase supply (208 V L-L) is available, like it's common in the US, the operation of the cabinet is alternatively allowed using this connection scheme:



### 2.3.4.1 Inrush current

The inrush current of models in this series can be very high. See „1.8.3. *Technical specifications*“ for the value of your particular model. This current is caused by every unit having internally three power blocks and every power block having an auxiliary supply for reasons of redundancy. With up to 6 units per cabinet the total inrush current increases accordingly. It's limited by a 10 Ohm resistor per power block, but one unit already can cause an inrush of up to 69 A.

The 16 A circuit breaker in the cabinet is with characteristics K and can cope the high inrush current and wouldn't trigger, but probably another externally installed circuit breaker would because it has a different characteristics.

The highest inrush current is caused when switching the AC for the entire cabinet externally, for instance by means of a contactor as part of an emergency stop system. The only option to lower the inrush current is to power the units one by one with their power switch, which is the default, even if the cabinet features its own emergency stop system.

## 2.3.5 Connection to DC sources

The DC input is located on the rear side of the cabinet and **is not** protected by any kind of fuse. The cross section of the connection cables is determined by the DC current consumption, cable length and ambient temperature.

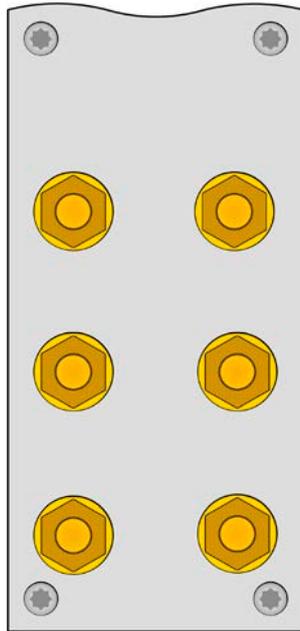
For cables **up to 5 m** of length and an average ambient temperature **up to 30°C** we recommend cross sections **per DC pole** (multi-conductor, insulated, openly suspended, standard cable) as listed in the table below. For longer cables or higher ambient temperatures the cross section must be increased accordingly in order to avoid high voltage loss and overheating.

The cables are usually crimped with ring lugs and are tightened to the connection point at the lower end of the DC bus bars. The mounting hole diameter of the ring lug should match the one of the connection point. This restricts the number of applicable cable cross sections, for example because a M8 ring lug can take a max. of 95 mm<sup>2</sup> or 150 mm<sup>2</sup>, depending on the manufacturer of the ring lug. The number of cables which are required increases when using a smaller cross section per cable, but the cables also become better manageable.

Rated power	I <sub>Max</sub>	Connection points	Minimum required cross section <u>per</u> DC pole
15U	180 A	3x M8	1x 70 mm <sup>2</sup> or 2x 25 mm <sup>2</sup>
	240 A	6x M10	1x 95 mm <sup>2</sup> or 2x 35 mm <sup>2</sup>
	270 A	3x M8	2x 50 mm <sup>2</sup> or 3x 25 mm <sup>2</sup>
	360 A	6x M10	2x 70 mm <sup>2</sup> or 3x 35 mm <sup>2</sup>
	480 A	6x M10	2x 70 mm <sup>2</sup> or 3x 50 mm <sup>2</sup>
	630 A	6x M10	2x 150 mm <sup>2</sup> or 3x 70 mm <sup>2</sup>
	840 A	6x M10	3x 150 mm <sup>2</sup> or 4x 70 mm <sup>2</sup>
	1530 A	6x M10	5x 120 mm <sup>2</sup> or 6x 95 mm <sup>2</sup>
	2040 A	6x M10	6x 150 mm <sup>2</sup> or 8x 95mm <sup>2</sup>
24U	300 A	3x M8	2x 50 mm <sup>2</sup> or 3x 25 mm <sup>2</sup>
	360 A	3x M8	2x 70 mm <sup>2</sup> or 3x 35 mm <sup>2</sup>
	450 A	3x M8	2x 95 mm <sup>2</sup> or 3x 50 mm <sup>2</sup>
	540 A	3x M8	2x 120 mm <sup>2</sup> or 3x 70 mm <sup>2</sup>
	600 A	6x M10	2x 150 mm <sup>2</sup> or 3x 70 mm <sup>2</sup>
	720 A	6x M10	3x 95 mm <sup>2</sup> or 4x 70 mm <sup>2</sup>
	1050 A	6x M10	4x 120 mm <sup>2</sup> or 6x 50 mm <sup>2</sup>
	1260 A	6x M10	4x 150 mm <sup>2</sup> or 6x 70 mm <sup>2</sup>
	2550 A	6x M10	8x 150 mm <sup>2</sup> or 10x 95 mm <sup>2</sup>
	3060 A	6x M10	10x 150 mm <sup>2</sup> or copper bar of min. 720 mm <sup>2</sup>

## 2.3.5.1 Connection points

Every cabinet has bus bars on the DC input, which have 3 or 6 connection points on their lower end. Each connection point can be used to screw one or two cables. The table in section 2.3.5 lists the number and size of the connection points for every rated input current and power. The connection points as seen from the side:

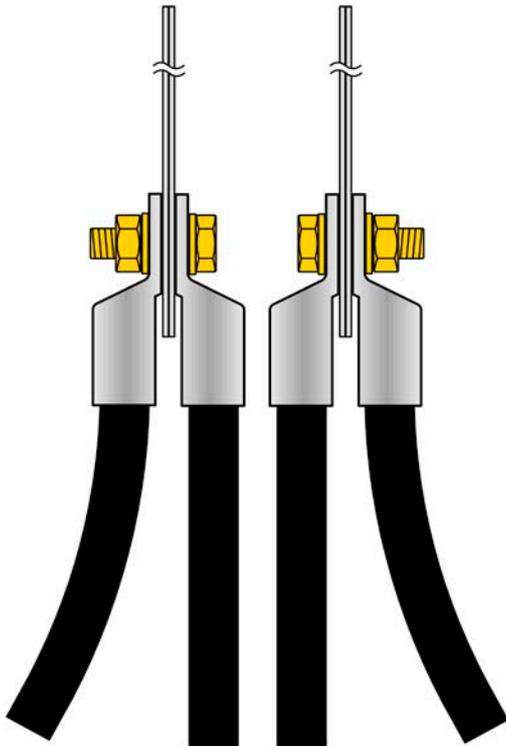


6x M10 for up to 12 cables



3x M8 for up to 6 cables

Connection example for two cables on one connection point with M10 ring lugs for 150 mm<sup>2</sup> cables:



The included cover for the DC input bars must always be installed when operating the cabinet, no matter if the rear door is closed or not!



The copper bars can become very hot, especially with models rated for high currents. This is mostly due the bars being positioned in the warm or hot stream of air exhausted on the rear of the units. This heat submits to the DC cables and can lead to damage or even dissolution of the sheathing. It's thus recommend to use cables with higher temperature capability, such as ones for 105°C.

## 2.3.6 Grounding of the DC input

The device's DC input can always be grounded on the minus pole, i.e. can be directly connected to PE. The DC plus pole, however, if it's to be grounded, may only be so for input voltages up to 400 V, because the potential of the minus pole is shifted into negative direction by the value of the input voltage. Also see technical specification sheets in 1.8.3, item "Insulation".

For this reason, for all models which can support an input voltage higher than 400 V grounding of the DC plus pole isn't allowed.

## 2.3.7 Connecting or extending the "Share" bus

The "Share" bus on the rear side is intended to balance the current of the units in the cabinet and must be wired between all of them, unless a unit's going to be removed for repair or maintenance purposes. The cover which is mounted on top of the connectors "Sense" and "Share" with some models must always be thoroughly installed.

In case of adding a unit to the cabinet, where possible, the Share bus must also be extended.

## 2.3.8 Connection of remote sense

Though every unit in the cabinet has a "Sense" connector, remote sensing when being used is only wired to the master unit. This unit's responsible for the voltage regulation and remote sensing compensation in constant voltage operation. It forwards the regulation signal to the slave units via the Share bus.



- Both pins „NC“ of the Sense connector must not be wired!



- Remote sensing is only effective during constant voltage operation (CV) and for other regulation modes the sense input should be disconnected, if possible, because connecting it generally increases the oscillation tendency.
- The cross section of the sense cables is noncritical. Recommendation for cables up to 5 m: use at least 0.5 mm<sup>2</sup>
- Sense cables should be twisted and laid close to the DC cables to damp oscillation. If necessary, an additional capacitor should be installed at the load or the source to eliminate oscillation
- The + sense cables must be connected to + on the source and - sense to - at the source, otherwise both, sink and source could be damaged

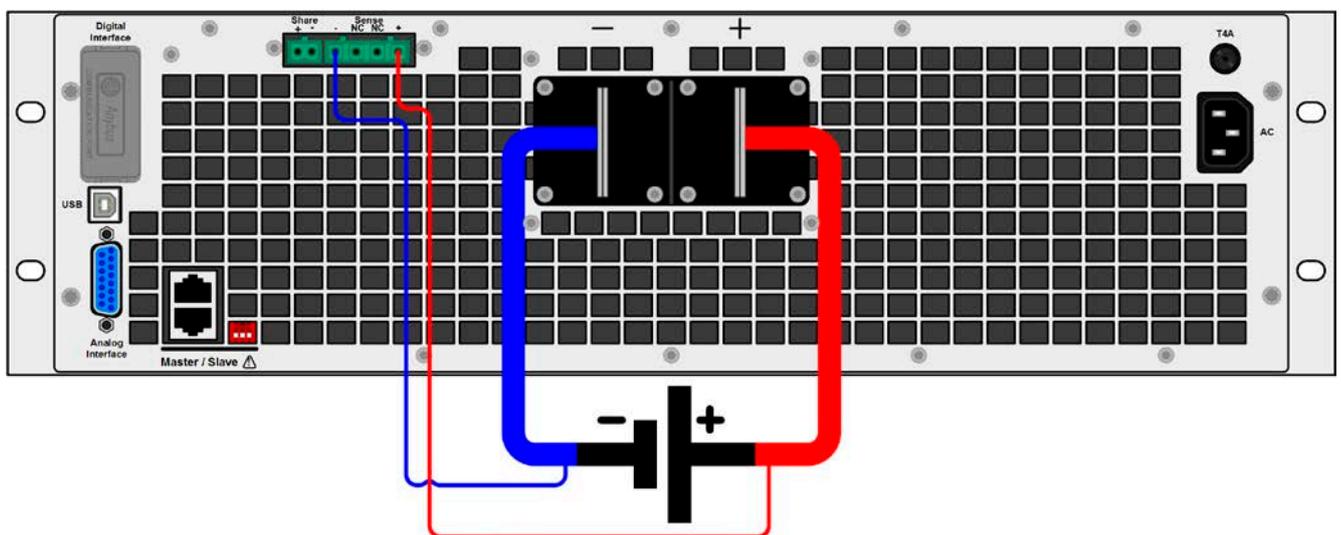


Figure 8 - Principle of remote sensing wiring on the master unit

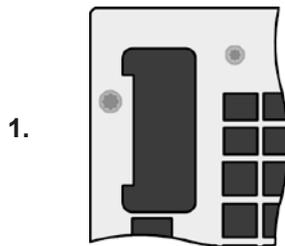
## 2.3.9 Installation of an interface module

The optionally obtainable interface modules can be retrofitted by the user and are exchangeable with each other. The settings for the currently installed module vary and need to be checked and, if necessary, corrected on initial installation and after module exchange.



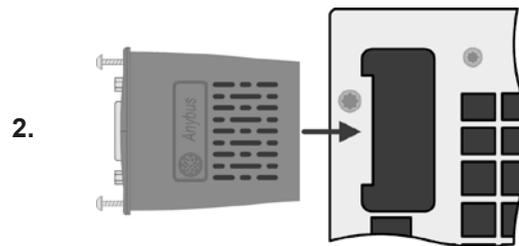
- Common ESD protection procedures apply when inserting or exchanging a module.
- The device must be switched off before insertion or removal of a module
- Never insert any other hardware other than an IF-AB series module into the slot
- If no module is in use it's recommended that the slot cover is mounted in order to avoid internal dirtying of the device and changes in the air flow.

Installation steps:



Remove the slot cover. If needed use a screw driver.

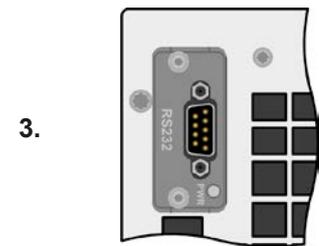
Check that the fixing screws of an already installed module are fully retracted. If not, unscrew them (Torx 8) and remove module.



Insert the interface module into the slot. The shape ensures correct alignment.

When inserting take care that it's held as close as possible to a 90° angle to the rear wall of the device. Use the green PCB which you can recognize on the open slot as guide. At the end is a socket for the module.

On the bottom side of the module are two plastic nibs which must click into the green PCB so that the module is properly aligned on the rear wall of the device.



The screws (Torx 8) are provided for fixing the module and should be fully screwed in. After installation, the module is ready for use and can be connected.

Removal follows the reverse procedure. The screws can be used to assist in pulling out the module.

## 2.3.10 Connecting the analog interface

The 15 pole connector (type: Sub-D, D-Sub) on the rear side is an analog interface. To connect this to a controlling hardware (PC, electronic circuit) and a standard plug are necessary (not included in the scope of delivery). It's generally advisable to switch the device completely off before connecting or disconnecting this connector, but at least switch off the DC input.



The analog interface is galvanically isolated from the device internally. Therefore do not connect any ground of the analog interface (AGND) to the DC minus input as this will cancel the galvanic isolation.

## 2.3.11 Connecting the USB port (rear side)

In order to remotely control the device via this port, connect the master unit to a PC using the included USB cable and switch the device on. The USB ports on the slave units are only for service purposes, such as firmware updates.

### 2.3.11.1 Driver installation (Windows)

On the initial connection with a PC the operating system will identify the device as new hardware and will try to install a driver. The required driver is for a Communications Device Class (CDC) device and is usually integrated in current operating systems such as Windows 7 or 10. But it's strongly recommended to use and install the included driver (on USB stick) to gain maximum compatibility of the device to our softwares.

### 2.3.11.2 Driver installation (Linux, MacOS)

We can't provide drivers or installation instructions for these operating systems. Whether a suitable driver is available is best carried out by searching the Internet. Newer versions of Linux or MacOS may already include a suitable CDC driver.

### 2.3.11.3 Alternative drivers

In case the CDC drivers described above are not available on your system or for some reason do not function correctly commercial suppliers can help. Search the Internet for suppliers using the keywords "cdc driver windows" or "cdc driver linux" or "cdc driver macos".

## 2.3.12 Initial commission

For the first start-up after installation of the cabinet, the following procedures have to be executed:

- Confirm that the connection cables to be used are of a satisfactory cross section!
- Check if the factory settings of set values, safety and monitoring functions and communication are suitable for your intended application of the device and adjust them if required, as described in the manual!
- Before using remote control via PC, read the additional documentation for interfaces and software!
- Before using remote control via the analog interface, read the section in this manual concerning analog interfaces!

During every boot phase, the master unit will show a language selection. The default language **English** can be changed here or later in the MENU, in the HMI Setup.



*Every text below concerning display is related to language setting "English".*

## 2.3.13 Commission after a firmware update or a long period of non-use

In case of a firmware update, return of the equipment following repair or a location or configuration change, similar measures should be taken to those of initial start up. Refer to „2.3.12. Initial commission“.

Only after successful checking of the device as listed may it be operated as usual.

## 2.3.14 Removing units

In case of a defect of a slave unit it's possible for the cabinet to continue running with the remaining units. In order to remove an unit for repair or to replace it, a certain procedure is required (see below). After that and when powering the cabinet again, the master unit will automatically detect the altered configuration and present itself accordingly in the display or to remote control software. With the standard configuration being temporarily unavailable, the rated current and power of the cabinet are reduced, as well as the device name will change according to the product key as described in 1.5.

Following steps are to perform to remove a slave unit:

1. Power off the cabinet with an external main switch or by switching off all units with their rotary mains switch on the front.
2. For the unit going to be removed:
  - a. Remove the strain relief (strap) from the AC supply cable.
  - b. Loosen the fixture that fixes the AC input connector plug.
  - c. Remove the AC connector plug.
  - d. Remove the plug from connector "Share". If master unit: remove plug from connector "Sense", if being used.
  - e. Remove the patch cable or both, if unit's in the middle, from the master-slave bus connectors. Later, for the operation of the cabinet without the removed unit, the bus must be connected again from the upper to the lower unit by using a longer cable.
  - f. If master unit: remove any other possibly connected cable from the digital or analog
  - g. Loosen the nuts/bolts on the DC input and remove them (2-6 pieces). Before doing so make sure that the DC input doesn't have dangerous voltage anymore, probably by checking it with a multimeter.
  - h. Remove the screws on the front (4x).
  - i. Carefully and slowly retract the unit from the cabinet.

## 2.3.15 Inserting units

The procedure of inserting units again is the same like when removing an unit, only vice versa. See steps described in „2.3.14. Removing units“. Before going to insert an unit make sure the cabinet is completely switched off or better, disconnected from AC supply.

## 2.3.16 Adding new units

Some models have a spare position for another slave unit to install later in order to extend the total power. The new slave unit can be purchased and delivered separately and installed on location. See „1.9.4. Accessories“ for details. There are a few things to consider before extending the cabinet:

- When installing the additional slave, the previous cabinet configuration will be modified regarding total current, total power and the device name. The ratings as printed on the type label will become invalid. Actually, even the article number isn't valid anymore. This doesn't affect operation, but in cases of seeking support or returning a cabinet for repair, it's an important detail
- Existing cables for the DC connection would probably have to be replaced by bigger ones matching the higher current
- The slave unit to add must be of the same model as the already existing slave units
- Depending on the resulting current after the installation of the additional unit, further bars on the DC bus have to be installed. Contact us so we can assemble the correct set for you.

Adding a unit follows the same procedure as described in 2.3.14 and .2.3.15.

## 2.3.17 Emergency stop

An emergency stop system is optionally available and factory built-in (also see 1.9.5). It consists of an emergency stop switch (manual operation, mounted on top of the cabinet), two door contacts (rear door) and a contactor. The three contacts are wired in series and will cut the units in the cabinet from AC supply once any of the breaker contacts is acted.

### 2.3.17.1 External emergency stop contacts

It's possible to extend the stop circuit with external contacts using two screw terminals located inside the cabinet (accessible from the rear). These terminals are bridged by default. The bridge would be replaced by one or several external breaker contacts in series, in order to have the emergency stop system act also when initiated from outside.

The external contacts must be of type "dry contact", i.e. potential-free, and suitable for 24 V DC.

### 3. Operation and application

#### 3.1 Personal safety



- In order to guarantee safety when using the device, it's essential that only persons operate the device who are fully acquainted and trained in the required safety measures to be taken when working with dangerous electrical voltages
- For models which can generate a voltage which is dangerous by contact, or is connected to such, the included DC terminal cover or an equivalent must always be used
- Whenever the DC input is being re-configured, you must switch off or even better, disconnect the source!

#### 3.2 Operating modes

The device is internally controlled by different control or regulation circuits, which shall bring voltage, current and power to the adjusted values and hold them constant, if possible. These circuits follow typical laws of control systems engineering, resulting in different operating modes. Every operating mode has its own characteristics which are explained below in short form.

##### 3.2.1 Voltage regulation / Constant voltage

Constant voltage operation (CV) or voltage regulation is a subordinate operating mode of electronic loads. In normal operation, a voltage source is connected to the electronic load, which represents a certain input voltage. If the set value for the voltage in constant voltage operation is higher than the actual voltage of the source, the value can't be reached. The load will then take no current from the source. If the voltage set value is lower than the input voltage then the load will attempt to drain enough current from the source to achieve the desired voltage level. If the resulting current exceeds the maximum possible or adjusted current value or the total power according to  $P = U_{IN} * I_{IN}$  is reached, the load will automatically switch to constant current or constant power operation, whatever comes first. Then the adjusted input voltage can no longer be achieved.

While the DC input is switched on and constant voltage mode is active, then the condition "CV mode active" will be shown on the graphics display by the abbreviation **CV**, as well it will be passed as a signal to the analog interface and stored as internal status which can be read via digital interface.

##### 3.2.1.1 Speed of the voltage controller

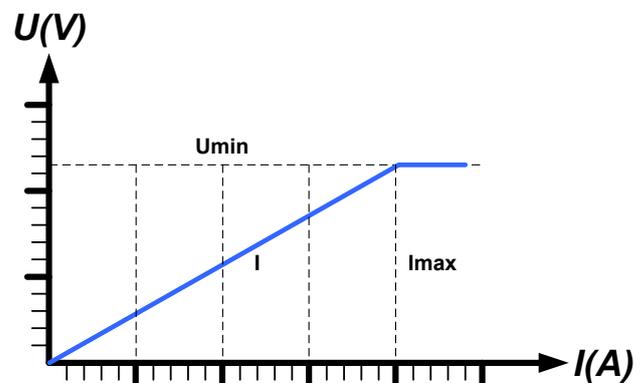
The internal voltage controller can be switched between "Slow" and "Fast" (see „3.4.3.1. Menu "General Settings""). Factory default value is "Slow". Which setting to select depends on the actual situation in which the device is going to be operated, but primarily it depends of the type of voltage source. An active, regulated source such as a switching mode power supply has its own voltage control circuit which works concurrently to the load's circuit, but both could work against each other and thus lead to oscillation. If this occurs it's recommended to set the controller speed to "Slow".

In other situations, e.g. operating the function generator and applying various functions to the load's input voltage and setting of small time increments, it might be necessary to set the voltage controller to "Fast" in order to achieve the expected results.

##### 3.2.1.2 Minimum voltage for maximum current

Due to technical reasons, all models in this series have a minimum internal resistance that makes the unit to be supplied with a minimum input voltage ( $U_{MIN}$ ) in order to be able to draw the full current ( $I_{MAX}$ ). This minimum input voltage varies from model to model and is listed in the technical specifications. If less voltage than  $U_{MIN}$  is supplied, the load proportionally draws less current, which can be calculated easily.

See principle view to the right.



### 3.2.2 Current regulation / constant current / current limiting

Current regulation is also known as current limitation or constant current mode (CC) and is fundamental to the normal operation of an electronic load. The DC input current is held at a predetermined level by varying the internal resistance according to Ohm's law  $R = U / I$  such that, based on the input voltage, a constant current flows. Once the current has reached the adjusted value, the device automatically switches to constant current mode. However, if the DC power consumption reaches the adjusted power level or the maximum possible power in derating condition (see 3.2.4.1), the device will automatically switch to power limitation and adjust the input current according to  $I_{MAX} = P_{SET} / U_{IN}$ , even if the maximum current set value is higher. The current set value, as determined by the user, is always and only an upper limit.

While the DC input is switched on and constant current mode is active, the condition "CC mode active" will be shown on the graphics display by the abbreviation **CC**, as well it will be passed as a signal to the analog interface and stored as internal status which can be read via digital interface.

### 3.2.3 Resistance regulation / constant resistance

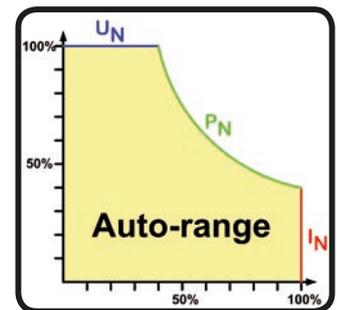
Inside electronic loads, whose operating principle is based on a variable internal resistance, constant resistance mode (CR) is almost a natural characteristic. The load attempts to set the internal resistance to the user defined value by determining the input current depending on the input voltage according to Ohm's law  $I_{IN} = U_{IN} / R_{SET}$ . The internal resistance is naturally limited between almost zero and maximum (resolution of current regulation too inaccurate). As the internal resistance can't have a value of zero, the lower limit's defined to an achievable minimum. This ensures that the electronic load, at very low input voltages, can consume a high input current from the source, up to the rating.

While the DC input is switched on and constant resistance mode is active, the condition "CR mode active" will be shown on the graphics display by the abbreviation **CR**, as well it will be stored as internal status which can be read via digital interface.

### 3.2.4 Power regulation / constant power / power limitation

Power regulation, also known as constant power (CP), limits the DC input power of the device to the adjusted value so that the current flowing from the source, together with the input voltage, achieves the desired value. The device would also regulate the input current according to  $I_{IN} = P_{SET} / U_{IN}$  upon voltage changes on the input.

Power limitation operates according to the auto-range principle such that at lower input voltages higher current can flow and vice versa, in order to maintain constant power within the range  $P_N$  (see diagram to the right).



While the DC input is switched on and constant power operation is active, the condition "CP mode active" will be shown on the graphic display by the abbreviation **CP**, as well it will be stored as internal status which can be read via digital interface.

Constant power operation impacts the internal set current value. This means that the maximum set current may not be reachable if the set power value according to  $I = P / U$  sets a lower current. The user defined and displayed set current value is always the upper limit only.

#### 3.2.4.1 Temperature dependent derating

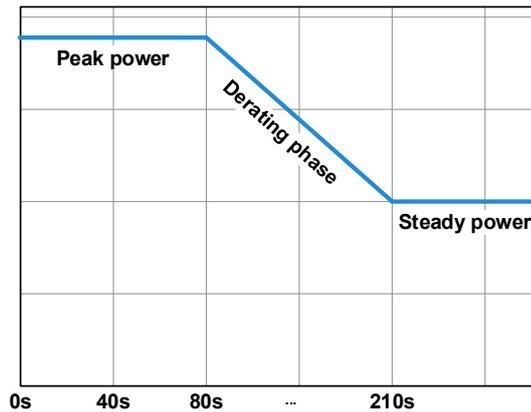
This series consists of conventional electronic loads which convert the consumed electrical energy into heat and dissipate it. In order to avoid overheating, the device will automatically reduce, i.e. derate the actual input power when heating up. It means, at a cold start it can take the peak power (see technical specs) for a certain time before it starts reducing.

This derating is depending on the ambient temperature. It means, that at 10°C the load can take the peak power for a much longer time than at 20°C ambient temperature or higher. Disregarding the ambient temperature, the derating will be constant at a certain power per degree Kelvin ( $\times W/^{\circ}K$ , see technical specifications), down to the steady power which is rated for the typical ambient temperature of 25°C (77°F) and further down.

The time which elapses during the derating phase, is typically between 150 and 200 seconds. It includes the peak power time.

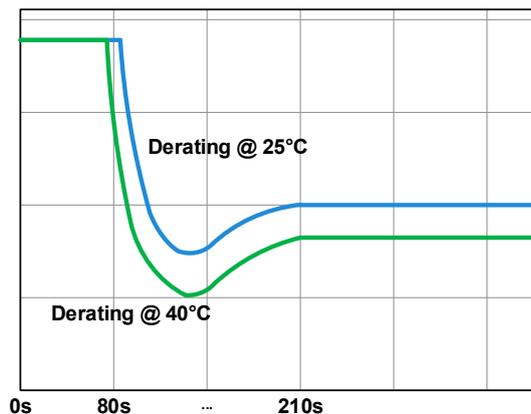
However, if the device is supplied with less power than the corresponding steady power for the ambient temperature of the device's location, the derating won't impact the operation. Though the internal power reduction is always imminent. For example, if you would run a model with 13500 W steady power at 8000 W constant actual power, while the power limit's set to 21600 W, and your source would make a voltage step or the load a current step, the power limit of 21600 W could still not be achieved.

See the diagrams below for clarification.



Principle derating progression, depicted on the example of one load unit. All models of this series have multiple load units equipped which not necessarily start derating at the same time.

The peak power is absorbed by the load device for a time  $x$ , until derating starts. After the start of derating, the max. power of the load will settle around the point of steady power. The momentary true value of steady power can only be read from the device's actual power value (display or via interface). In case the ambient temperature rises, the derating will continue.



Derating progression after a cold start of the device at 25°C (blue) and 40°C (green) ambient temperature.

The temporal progression shows that the peak power at 40°C is only available for a short time before derating starts. At this ambient temperature, the steady power will settle at a lower value than with 25°C.

### 3.2.5 Dynamic characteristics and stability criteria

The electronic load is characterized by short rise and fall times of the current, which are achieved by a high bandwidth of the internal regulation circuit.

In case of testing sources with own regulation circuits at the load, like for example power supplies, a regulation instability may occur. This instability is caused if the complete system (feeding source and electronic load) has too little phase and gain margin at certain frequencies. 180 ° phase shift at > 0dB amplification fulfills the condition for an oscillation and results in instability. The same can occur when using sources without own regulation circuit (eg. batteries), if the connection cables are highly inductive or inductive-capacitive.

The instability isn't caused by a malfunction of the load, but by the behavior of the complete system. An improvement of the phase and gain margin can solve this. In practice, a capacity is directly connected to the DC input of the load. The value to achieve the expected result isn't defined and has to be found out. We recommend:

80 V models: 1000  $\mu$ F...4700  $\mu$ F  
 200 V models: 100  $\mu$ F...470  $\mu$ F  
 360 V models: 68  $\mu$ F...220  $\mu$ F  
 500 V models: 47  $\mu$ F...150  $\mu$ F  
 750 V models: 22  $\mu$ F...100  $\mu$ F

### 3.3 Alarm conditions



*This section only gives an overview about device alarms. What to do in case your device indicates an alarm condition is described in section „3.6. Alarms and monitoring“.*

As a basic principle, all alarm conditions are signaled optically (text + message in the display), acoustically (if activated), via the digital interface, plus also as status on the analog interface. For later acquisition, an additional alarm counter can be read from the display or via digital interface.

#### 3.3.1 Power Fail

Power Fail (PF) indicates an alarm condition which may have various causes:

- AC input voltage too low (mains undervoltage, mains failure)

As soon as a power fail occurs, the device will stop to sink power and switch off the DC input. In case the power fail was an undervoltage and is gone later on, the alarm will vanish from display and doesn't require to be acknowledged.

The condition of the DC input after a gone PF alarm can be determined in the MENU. See 3.4.3.



*Switching off the device with the power switch can't be distinguished from a mains blackout and thus it will signalize a PF alarm every time it's switched off, which is ignored in this situation.*

#### 3.3.2 Overtemperature

An overtemperature alarm (OT) can occur due to an excess temperature inside the device and causes it to stop sinking power temporarily. After cooling down, the device will automatically continue to supply power, while the condition of the DC input remains and the alarm doesn't require to be acknowledged.

#### 3.3.3 Overvoltage protection

An overvoltage alarm (OVP) will switch off the DC input and can occur if:

- the connected voltage source provides a higher voltage to the DC input than set in the overvoltage alarm threshold (OVP, 0...103%  $U_{NOM}$ )

This function serves to warn the user of the electronic load acoustically or optically that the connected voltage source has generated an excessive voltage and thereby could damage or even destroy the input circuit and other parts of the device.



The device isn't fitted with protection from external overvoltage and could even be damaged when not powered.

#### 3.3.4 Overcurrent protection

An overcurrent alarm (OCP) will switch off the DC input and can occur if:

- The input current in the DC input exceeds the adjusted OCP limit.

This function serves to protect the voltage and current source so that this isn't overloaded and possibly damaged, rather than offering protection to the electronic load.

#### 3.3.5 Overpower protection

An overpower alarm (OPP) will switch off the DC input and can occur if:

- the product of the input voltage and input current in the DC input exceeds the adjusted OPP limit.

This function serves to protect the voltage and current source so that this isn't overloaded and possibly damaged, rather than offering protection to the electronic load.

## 3.4 Manual operation

### 3.4.1 Switching on the device

The cabinets of this series are master-slave systems with one master unit and up to 5 slave units. In order for the master to find and initialise the slaves the fastest way after powering the cabinet, it should be powered last. **Recommendation: power the units in the cabinet from bottom to top, one by one.**

After switching on, the display firsts show the manufacturers logo and device related information, as well as a language selection screen (for 3 s) and will then be ready for use. In the setup (see section „3.4.3. Configuration via MENU“) in the second level menu **General settings** is an option **DC input after power ON** in which the user can determine the condition of the DC input after power-up. Factory setting here is **OFF**, meaning that the DC input will remain switched off after power-up. **Restore** means that the last condition of the DC input will be restored, either on or off. All set values are always saved and restored.



*It's allowed to only switch on a lesser number of slave units or just the master unit if the demand for power with the current application is lower than what the cabinet can bring. Every unit can sink a certain power (formula: total power of cabinet ÷ number of units). The master unit will automatically detect the situation.*



*During boot phase the analog interface will signal undefined statuses on the output pins, such as ALARMS 1. Those signals must be ignored until the device has finished booting and is ready to work.*

### 3.4.2 Switching off the device

On switch-off the last input condition and the most recent set values are saved. Furthermore, a PF alarm (power failure) will be reported, but can be ignored.

Due to the master-slave configuration of the cabinet it's recommended to switch off the master first.

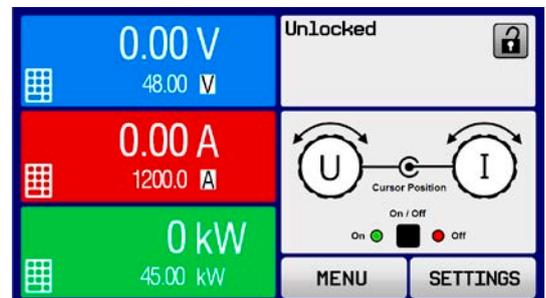
**Recommendation: switch off the units in the cabinet from top to bottom, one by one.**

### 3.4.3 Configuration via MENU

The MENU serves to configure all operating parameters which are not constantly required. These can be set by finger touch on the MENU touch area, but only if the DC input is switched OFF. See figure to the right.

If the DC input is switched on the settings menu will not be shown, only status information.

Menu navigation is by finger touch. Values are set using the rotary knobs. The assignment of the knobs to adjustable values in the sub menus isn't extra depicted, but there is an assignment rule: upper value -> left-hand knob, lower values -> right-hand knob.



Some setting parameters are self-explanatory, others are not. The latter will be explained on the pages following.

## 3.4.3.1 Menu "General Settings"

Setting	Description
<b>Allow remote control</b>	Selection <b>No</b> means that the device can't be remotely controlled over either the digital or analog interfaces. If remote control isn't allowed, the status will be shown as <b>Local</b> in the status area on the main display. See also section 1.9.6.1
<b>Analog interface range</b>	Selects the voltage range for the analog set input values, monitoring outputs and reference voltage output. <ul style="list-style-type: none"> <li>• <b>0...5 V</b> = Range is 0...100% set /actual values, reference voltage 5 V</li> <li>• <b>0...10 V</b> = Range is 0...100% set /actual values, reference voltage 10 V</li> </ul> See also section „3.5.4. Remote control via the analog interface (AI)“
<b>Analog interface Rem-SB</b>	Selects how the input pin REM-SB of the analog interface shall be working regarding levels (see „3.5.4.4. Analog interface specification“) and logic: <ul style="list-style-type: none"> <li>• <b>Normal</b> = Levels and function as described in the table in 3.5.4.4</li> <li>• <b>Inverted</b> = Levels and function will be inverted</li> </ul> Also see „3.5.4.7. Application examples“
<b>Analog Rem-SB action</b>	Selects the action on the DC input that is initiated when changing the level of analog input REM-SB: <ul style="list-style-type: none"> <li>• <b>DC OFF</b> = the pin can only be used to switch the DC input off</li> <li>• <b>DC AUTO</b> = the pin can be used to switch the DC input off and on again, if it has been switched on before at least from a different control location</li> </ul>
<b>Analog interface pin 6</b>	Pin 6 of the analog interface (see section 3.5.4.4) is by default assigned to only signal the device alarms OT and PF. This parameter allows to also enable signaling only one of both (3 possible combinations): <ul style="list-style-type: none"> <li>• <b>Alarm OT</b> = Enable/disable signaling of alarm OT on pin 6</li> <li>• <b>Alarm PF</b> = Enable/disable signaling of alarm PF on pin 6</li> </ul>
<b>Analog interface pin 14</b>	Pin 14 of the analog interface (see section 3.5.4.4) is by default assigned to only signal the device alarm OVP. This parameter allows to also enable signaling further device alarms (7 possible combinations): <ul style="list-style-type: none"> <li>• <b>Alarm OVP</b> = Enable/disable signaling of alarm OVP on pin 14</li> <li>• <b>Alarm OCP</b> = Enable/disable signaling of alarm OCP on pin 14</li> <li>• <b>Alarm OPP</b> = Enable/disable signaling of alarm OPP on pin 14</li> </ul>
<b>Analog interface pin 15</b>	Pin 15 of the analog interface (see section 3.5.4.4) is by default assigned to only signal the regulation mode CV. This parameter allows to enable signaling a different device status (2 options): <ul style="list-style-type: none"> <li>• <b>Regulation mode</b> = Enable/disable signaling of CV reg mode on pin 15</li> <li>• <b>DC status</b> = Enable/disable signaling of DC input status on pin 15</li> </ul>
<b>DC input after OT alarm</b>	Determines how the DC power stages shall react after an overtemperature (OT) alarm has occurred and the power stages have cooled down again: <ul style="list-style-type: none"> <li>• <b>OFF</b> = DC power stage(s) will be off</li> <li>• <b>AUTO</b> = The device will automatically restore the situation before the OT alarm, which usually means the DC power stage(s) to be on</li> </ul>
<b>DC input after power ON</b>	Determines the condition of the DC input after power-up. <ul style="list-style-type: none"> <li>• <b>OFF</b> = DC input is always off after switching on the device</li> <li>• <b>Restore</b> = DC input condition will be restored to the condition prior to switch off</li> </ul>
<b>Voltage controller setting</b>	Selects the regulation speed of the internal voltage regulator between <b>Slow</b> and <b>Fast</b> . See „3.2.1.1. Speed of the voltage controller“.
<b>DC input after PF alarm</b>	Determines how the DC input shall react after a power fail (PF) alarm has occurred: <ul style="list-style-type: none"> <li>• <b>OFF</b> = DC input will be switched off and remain until user action</li> <li>• <b>AUTO</b> = DC input will switch on again after the PF alarm cause is gone and if it was switched on before the alarm occurred</li> </ul>
<b>DC input after remote</b>	Determines the condition of the DC input after leaving remote control either manually or by command. <ul style="list-style-type: none"> <li>• <b>OFF</b> = DC input will be always off when switching from remote to manual</li> <li>• <b>AUTO</b> = DC input will keep the last condition</li> </ul>

Setting	Description
<b>Enable R mode</b>	Activates ( <b>Yes</b> ) or deactivates ( <b>No</b> ) the internal resistance control. If activated, the resistance set value of the simulated internal resistor can be adjusted additionally to the other set values. For details refer to „3.2.3. Resistance regulation / constant resistance“
<b>USB file separator format</b>	Switches the decimal point format of values and also the CSV file separator for USB logging and for other features where CSV file can be loaded <ul style="list-style-type: none"> <li>• <b>US</b> = Comma separator (US standard for CSV files)</li> <li>• <b>Default</b> = Semicolon separator (german/european standard for CSV files)</li> </ul>
<b>USB logging with units (V,A,W)</b>	CSV files generated from USB logging by default add physical units to values. This can be deactivated by setting this option to <b>No</b>
<b>Calibrate device</b>	Touch area <b>Start</b> starts a calibration routine (see „5.3. Calibration“), but only if the device is in U/I or U/P mode.
<b>Reset device to defaults</b>	Touch area <b>Start</b> will initiate a reset of all settings (HMI, profile etc.) to factory default
<b>Restart device</b>	Will initiate a warm start of the device
<b>Master-slave mode</b>	Selecting <b>OFF</b> disables the master-slave mode (MS) in which the cabinet is running by default. Since the MS mode is essential for the operation of the cabinet, this setting should never be altered.
<b>PSI / EL system</b>	This item will only be displayed if the device is set as <b>MASTER</b> Must remain deactivated for correct operation of the cabinet.
<b>Repeat master init.</b>	This item will only be displayed if the device is set as <b>MASTER</b> Touch area <b>Initialize</b> will repeat the initialization of the master-slave system in case the automatic enumeration of the slave units by the master is once unsuccessful so the system would have less total power than expected or has to be repeated manually in case the master unit couldn't detect a missing slave

### 3.4.3.2 Menu “User Events”

See „3.6.2.1 User defined events“ on page 57.

### 3.4.3.3 Menu “Profiles”

See „3.9 Loading and saving a user profile“ on page 59.

### 3.4.3.4 Menu “Overview”

This menu page displays an overview of the set values (U, I, P or U, I, P, R) and alarm settings as well as settings limits. These can only be displayed, not changed.

### 3.4.3.5 Menu “About HW, SW...”

This menu page displays an overview of device relevant data such as serial number, article number etc., as well as an alarm history which lists the number of device alarms that probably occurred since the device has been powered.

### 3.4.3.6 Menu “Function Generator”

See „3.10 The function generator“ on page 60.

### 3.4.3.7 Menu “Communication”

This sub menu offers settings for digital communication via the optional or built-in interface. The button for the installed interface module opens one or more settings pages, depending on the interface type. There are furthermore adjustable communication timeout settings, of which the one for USB can make it possible to successfully transfer fragmented messages using higher values. In the screen for **Com Protocols** it's possible to enable both or disable one of the two supported communication protocols, ModBus RTU and SCPI. This can help to avoid mixing both protocols and to receive unreadable messages, for example when expecting a SCPI response and getting a ModBus RTU response instead.



*For all Ethernet interfaces with two ports: „P1“ is related to port 1 and „P2“ to port 2, like printed on the module face. Two-port interfaces will use one IP only, because they operate as Ethernet switch*

IF	Level 1	Description
Profibus DP	<b>Node Address</b>	Selection of the Profibus or node address of the device within range 1...125 via direct input
	<b>Function Tag</b>	String input box for a user-definable text which describes the Profibus slave function tag. Max. length: 32 characters
	<b>Location Tag</b>	String input box for a user-definable text which describes the Profibus slave location tag. Max. length: 22 characters
	<b>Installation Date</b>	String input box for a user-definable text which describes the Profibus slave installation date tag. Max. length: 40 characters
	<b>Description</b>	String input box for a user-definable text which describes the Profibus slave. Max. length: 54 characters

IF	Level 1	Level 2	Description
CANopen	<b>Node Address</b>		Selection of the CANopen node address in the range 1...127
	<b>Baud Rate</b>	<b>AUTO</b>	Automatic detection of the bus baud rate or speed
		<b>LSS</b>	Automatically sets baud rate and node address
		<b>Manual</b>	Manual selection of the baud rate that is used by the CANopen interface. Possible selections: 10 kbps, 20 kbps, 50 kbps, 100 kbps, 125 kbps, 250 kbps, 500 kbps, 800 kbps, 1Mbps (1Mbps = 1 Mbit/s, 10 kbps = 10 kbit/s)

IF	Level 1	Level 2	Level 3	Description
Ethernet / ModBus-TCP, 1 & 2 Port	<b>IP Settings 1</b>	<b>DHCP</b>		The IF allows a DHCP server to allocate an IP address, a subnet mask and a gateway. If no DHCP server is in the network then network parameters will be set as defined in item "Manual"
		<b>Manual</b>	<b>IP address</b>	This option is activated by default. An IP address can be manually allocated.
			<b>Gateway</b>	Here a gateway address can be allocated if required..
			<b>Subnet mask</b>	Here a subnet mask can be defined if the default subnet mask isn't suitable.
		<b>DNS address 1</b> <b>DNS address 2</b>		Here the addresses of the first and second Domain Name Servers (DNS) can be defined, if needed. A DNS is only necessary if the device shall be registered with its domain and host name, in order to access it in a browser more comfortably.
		<b>Port</b>		Range: 0...65535. Default ports: <b>5025</b> = Modbus RTU (all Ethernet interfaces)  Reserved ports which must not be set with this parameter: <b>502</b> = Modbus TCP (Modbus-TCP interface only) other typical reserved ports
		<b>IP Settings 2-P1</b> <b>IP Settings 2-P2</b>	<b>AUTO</b>	
	<b>Manual</b>		<b>Half duplex</b>	Manual selection for transmission speed (10MBit/100MBit) and duplex mode (full/half). It's recommended to use the "AUTO" option and only revert to "Manual" if these parameters fail.
			<b>Full duplex</b>	
			<b>10MBit</b>	
		<b>100MBit</b>		
<b>Host name</b>		Free choice of host name (default: Client)		
<b>Domain name</b>		Free choice of Domain (default: Workgroup)		
<b>TCP Keep-Alive</b>		<b>Enable TCP keep-alive</b>		

IF	Level 1	Description
<b>RS232</b>	-	The baud rate is selectable, other serial settings can't be changed and are defined like this: 8 data bits, 1 stop bit, parity = none  Baud rates: 2400, 4800, 9600, 19200, 38400, 57600, 115200

IF	Level 1	Description
Profinet/IO, 1 & 2 Port	<b>Host name</b>	Free choice of host name (default: Client)
	<b>Domain name</b>	Free choice of Domain (default: Workgroup)
	<b>Function Tag</b>	String input box for a user-definable text which describes the Profinet slave function tag. Max. length: 32 characters
	<b>Location Tag</b>	String input box for a user-definable text which describes the Profinet slave location tag. Max. length: 22 characters
	<b>Station Name</b>	String input box for a user-definable text which describes the Profinet station name. Max. length: 54 characters
	<b>Description</b>	String input box for a user-definable text which describes the Profibus slave. Max. length: 54 characters
	<b>Installation Date</b>	String input box for a user-definable text which describes the Profibus slave installation date tag. Max. length: 40 characters

IF	Ebene 1	Level 2	Level 3	Description		
CAN	<b>Base ID</b>			Setup of the CAN base ID (11 Bit or 29 Bit, hex format). Default: <b>0h</b>		
	<b>Baud Rate</b>			Setup of the CAN bus speed or baud rate in typical value between 10 kbps and 1Mbps. Default: <b>500 kbps</b>		
	<b>Termination</b>			Activates or deactivates CAN bus termination with a built-in resistor. Default: <b>OFF</b>		
	<b>Broadcast ID</b>			Setup of the CAN broadcast ID (11 Bit or 29 Bit, hex format). Default: <b>7ffh</b>		
	<b>ID Format</b>			Selection of the CAN ID format between <b>Base</b> (11 Bit ID, 0h...7ffh) and <b>Extended</b> (29 Bit, 0h...1ffffffh)		
	<b>Cyclic Communication</b>	<b>Base ID Cyclic Read</b>			Setup of the CAN base ID (11 Bit or 29 Bit, hex format) for cyclic read of up to 5 object groups (see " <b>Cyclic Read Timing</b> "). The device will automatically send specific object data to the IDs defined with this setting. For more information refer to the programming guide. Default: <b>100h</b>	
			<b>Base ID Cyclic Send</b>		Setup of the CAN base ID (11 Bit or 29 Bit, hex format) for cyclic send of the three set values for U, I and P along with status in one single message. For more information refer to the programming guide. Default: <b>200h</b>	
		<b>Cyclic Read Timing</b>	<b>Status</b>			Activation/deactivation and time setting for the cyclic read of status to the adjusted „ <b>Base ID Cyclic Read + 1</b> “ Range: 20...5000 ms. Default: 0 (deactivated)
			<b>Actual val.</b>			Activation/deactivation and time setting for the cyclic read of actual values to the adjusted „ <b>Base ID Cyclic Read + 2</b> “ Range: 20...5000 ms. Default: 0 (deactivated)
			<b>Set val.</b>			Activation/deactivation and time setting for the cyclic read of set values of U & I to the adjusted „ <b>Base ID Cyclic Read + 3</b> “ Range: 20...5000 ms. Default: 0 (deactivated)
			<b>Limits 1</b>			Activation/deactivation and time setting for the cyclic read of adjustment limits of P & R to the adjusted „ <b>Base ID Cyclic Read + 4</b> “ Range: 20...5000 ms. Default: 0 (deactivated)
	<b>Limits 2</b>			Activation/deactivation and time setting for the cyclic read of adjustment limits of P & R to the adjusted „ <b>Base ID Cyclic Read + 4</b> “		
	<b>Data Length</b>				Determines the DLC (data length) of all messages sent from the device.  <b>AUTO</b> = length varies between 3 and 8 bytes, depending on object <b>Always 8 Bytes</b> = length is always 8, filled up with zeros	

Element	Description
<b>Com Timeout</b>	<b>Timeout USB/RS232 [ms]</b> Default value: <b>5</b> , range: 5...65535 ms Defines the max. time between two subsequent bytes or blocks of a transferred message. For more information refer to the external programming documentation "Programming Guide ModBus & SCPI".
	<b>Timeout ETH [s]</b> Default value: <b>5</b> , range: 0 / 5...65535 s If there was no communication between the controlling unit (PC, PLC etc.) and the device for the adjusted time, it will close the socket connection. This timeout will be ineffective as long as the option "TCP keep-alive" (see above, table for Ethernet module) is activated and "keep-alive" is working as expected within the network. Setting <b>0</b> deactivates the timeout permanently.
	<b>Enable interface monitoring</b> Default value: off Enable or disables the interface monitoring feature. For details refer to section 3.5.3.4.
	<b>Timeout interface monitoring [s]</b> Default value: <b>5</b> , range: 5...65535 s Defines the timeout in seconds for the interface monitoring featured. The timeout would only be active if the interface monitoring itself is enabled. See above at <b>Enable interface monitoring</b> . Further details can be found in section 3.5.3.4.
<b>Com Protocols</b>	<b>Enabled</b> Default setting: both enabled Enables or disables <b>SCPI</b> or <b>ModBus</b> communication protocols for the device, if not needed. The change is immediately effective after submitting it with ENTER button.
	<b>ModBus specification compliance</b> Default setting: <b>Limited</b> Switches between <b>Limited</b> and <b>Full</b> compliance to the ModBus specification in terms of message format when using ModBus RTU or TCP and also the use of the Read Coils function. For details and the background refer to the external documentation "Programming Guide ModBus & SCPI"
<b>Logging</b>	Enables/disables the "log to USB stick" feature. Once enabled, you can define the log interval (multiple steps, 500 ms ... 5 s) and the control method. For more refer to „3.4.10. Recording to USB stick (logging)“.

### 3.4.3.8 Menu "HMI Setup"

These settings refer exclusively to the control panel (HMI).

Element	Description
<b>Language</b>	Selection of the display language between German, English (default), Russian or Chinese
<b>Key Sound</b>	Activates or deactivates sounds when touching a touch area in the display. It can usefully signal that the action has been accepted.
<b>Alarm Sound</b>	Activates or deactivates the additional acoustic signal of an alarm or user defined event which has been set to <b>Action = ALARM</b> . See also „3.6 Alarms and monitoring“ on page 55.
<b>HMI Lock</b>	See „3.7 Control panel (HMI) lock“ on page 58
<b>Backlight</b>	The choice here is whether the backlight remains permanently on or if it should be switched off when no input via screen or rotary knob is made for 60 s. As soon as input is made, the backlight returns automatically. Furthermore, the backlight intensity can be adjusted here.

Element	Description
<b>Status page</b>	<p>Enables/disables two display related options for the main screen with actual and set values:</p> <p><b>Show meter bar:</b> in U/I/P mode, i. e. resistance mode not activated, a meter bar for 0-100% actual values of voltage, current and power is shown. See „3.4.8. The meter bars“.</p> <p><b>Alternative status page:</b> switches the main screen of the device with its actual and set values of voltage, current, power and - if activated - resistance to a simpler display with only voltage and current, plus status. See „3.4.7. Switching the main screen view“.</p> <p>Default setting: both disabled</p>
<b>Limits Lock</b>	See „3.8 Limits lock“ on page 58

## 3.4.4 Adjustment limits

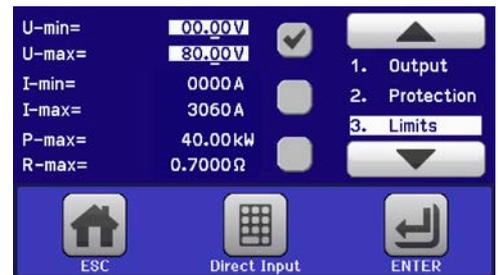


Adjustment limits are only effective on the related set values, no matter if using manual adjustment or remote control!

Defaults are that all set values (U, I, P, R) and the corresponding adjustment limits are adjustable from 0 to 102%.

The full range may be obstructive in some cases, especially for protection of applications against overcurrent. Therefore upper and lower limits for current (I) and voltage (U) can be set separately, which then limit the range of the adjustable set values.

For power (P) and resistance (R) only upper value limits can be set.



### ► How to configure the adjustment limits

1. On the main screen, tap **SETTINGS** to access the SETTINGS menu.
2. Tap the arrows   to select "3. Limits".
3. In each case a pair of upper and lower limits for U/I or the upper limit for P/R are assigned to the rotary knobs and can be adjusted. Tap the selection area for another choice .
4. Accept the settings with .



The set values can be entered directly using the ten-key pad. This appears when the touch area "Direct Input" is tapped (bottom center)



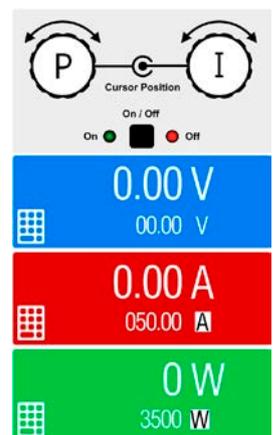
The adjustment limits are coupled to the set values. It means, that the upper limit may not be set lower than the corresponding set value. Example: If you wish to set the adjustment limit for power (P-max) to 30.00 kW while the currently adjusted power set value is 40.00 kW, then the set value first would have to be reduced to 30.00 kW or less, in order to set P-max down to 30.00 kW.

## 3.4.5 Changing the operating mode

In general, the manual operation of the device distinguishes between the three operating modes U/I, P/I and R/I which are connected to set value adjustment using the rotary knobs or ten-key pad. This assignment must be changed if one of the four set values currently not assigned to a knob is going to be adjusted.

### ► How to change the operating mode

1. Unless the device is in remote control or the panel is locked, you switch the operation anytime. There are two options: either tap the depiction of the left-hand knob (see figure to the right) to change its assignment between U, P and R, or
2. You directly tap on the colored areas with the set values, like shown in the figure to the right. The unit next to the set values, when inverted, indicates the assignment of the knobs. In the example to the right they have P and I assigned, which means P/I mode.



Depending on the selection the left rotary knob will be assigned different setting values, the right knob is always assigned to the current.



In order to avoid constant changing of the assignments it's possible, e.g with selection R/I, to change the other values U and P by direct input. Also see section 3.4.6.

The actual operating mode of the load, which is only indicated while the DC input is switched on, solely depends on the set values. For more information see section „3.2. Operating modes“.

## 3.4.6 Manual adjustment of set values

The set values for voltage, current, power and resistance are the fundamental operating possibilities of an electronic load and hence the two rotary knobs on the front of the device are always assigned to two of the four values in manual operation. Default assignment is power and current.

Set values can be entered manually in two ways: via **rotary knob** or **direct input**. The important difference is, that rotating the knob adjusts a value *gradually*, while direct input causes a *step / jump*.



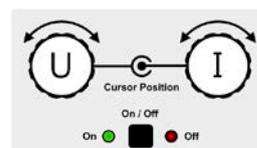
Entering a value changes it immediately, no matter if the DC input is switched on or off.



When adjusting set values, upper or lower limits may come into effect. See section „3.4.4. Adjustment limits“. Once a limit's reached, the display will show a note like "Limit: U-max" etc. for 1.5 seconds next to the adjusted value.

### ► How to adjust values with the rotary knobs

1. First check if the value you want to change is already assigned to one of the rotary knobs. The main screen displays the assignment as depicted in the figure to the right.
2. If, as shown in the example, the assignment is voltage (U, left) and current (I, right), and it's required to set the power, then the assignments can be changed by tapping this touch area. A set of selection fields then appears.
3. After successful selection, the desired value can be set within the defined limits. Selecting a digit's done by pushing the rotary knob which shifts the cursor from right to left (selected digit will be underlined):



35.00 kW → 35.00 kW → 35.00 kW

### ► How to adjust values via direct input

1. In the main screen, depending on the rotary knob assignment, values can be set for voltage (U), current (I), power (P) or resistance (R) via direct input by tapping on the small keypad symbol in the set/actual value display areas, e.g in the uppermost area of voltage.
2. Enter the required value using the ten-key pad. Similar to a pocket calculator the key **c** clears the input.



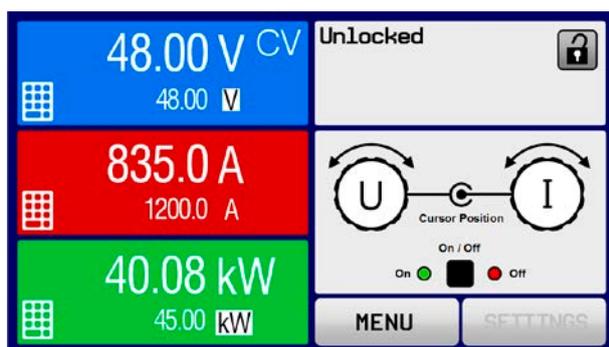
Decimal values are set by tapping the point key. For example, 54.3 V is set with **5** **4** **.** **3** and **ENTER**.

3. The display reverts to the main page and the set values take effect.

## 3.4.7 Switching the main screen view

The main screen, also called status page, with its set values, actual values and device status can be switched from the standard view mode with three or four values to a simpler mode with only voltage and current display. The advantage of the alternative view mode is that actual values are displayed with **much bigger characters**, so they read be read from a larger distance. Refer to „3.4.3.8. Menu "HMI Setup"“ to see where to switch the view mode in the MENU. Comparison:

Standard status page



Alternative status page



Limitations of the alternative status page:

- Set and actual values of power are not displayed and the set value of power is only indirectly accessible
- Set value of resistance isn't displayed and only indirectly accessible
- No access to the settings overview (MENU button) while the DC input is on



*In alternative status page mode, the set values of power and resistance are not adjustable while the DC input is switched on. They can only be accessed and adjusted in SETTINGS while the DC input is off.*

Rules for manual handling of the HMI in alternative status page mode:

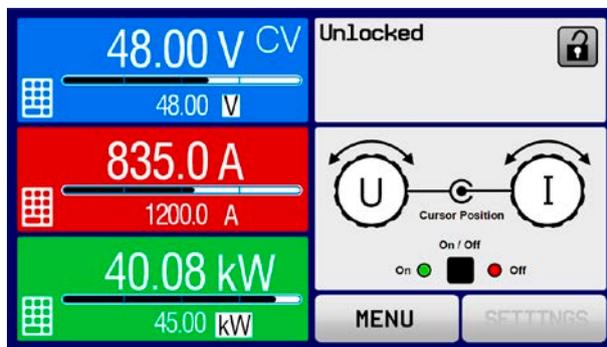
- The two rotary knobs are assigned to voltage (left knob) and current (right knob) all the time, except for menus
- Set values input is the same as in standard status page mode, with knobs or by direct input
- Regulation modes CP and CR are displayed alternatively to CC in the same position

### 3.4.8 The meter bars

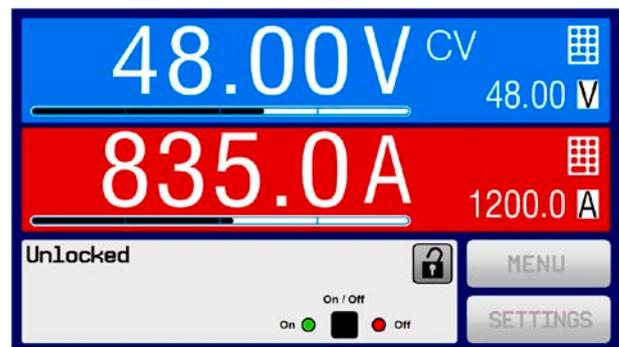
Additionally to the actual values being displayed as numbers, meter bars for U, I and P can be enabled in the MENU. Refer to „3.4.3.8. Menu “HMI Setup”“ to see where to enable the meter bars in the MENU.

Depiction:

Standard status page with meter bar



Alternative status page with meter bar



*The meter bars remain hidden as long as resistance mode, i. e. U/I/R is activated.*

### 3.4.9 Switching the DC input on or off

The DC input of the device can be manually or remotely switched on and off. This can be restricted in manual operation by the control panel being locked.



*Switching the DC input on during manual operation or digital remote control can be disabled by pin REM-SB of the built-in analog interface. For more information refer to 3.4.3.1 and example a) in 3.5.4.7.*

#### ► How to manually switch the DC input on or off

1. As long as the control panel isn't fully locked press the button On/Off. Otherwise you are asked to disable the HMI lock first.
2. This button toggles between on and off, so long as a change isn't restricted by an alarm or the device is locked in **Remote**. The current condition is displayed on the screen, as well as with the LEDs next to the On/Off button.

#### ► How to remotely switch the DC input on or off via the analog interface

1. See section „3.5.4 Remote control via the analog interface (AI)“ on page 51.

#### ► How to remotely switch the DC input on or off via the digital interface

1. See the external documentation “Programming Guide ModBus & SCPI” if you are using custom software, or refer to the external documentation from LabView VIs or other software provided by the manufacturer.

## 3.4.10 Recording to USB stick (logging)

Device data can be recorded to USB stick (2.0 / 3.0 may work, but not all vendors are supported) anytime. For specifications of the USB stick and the generated log files refer to section „1.9.6.5. USB port (front side)“.

The logging stores files of CSV format on the stick. The layout of the log data is the same as when logging via PC with software EA Power Control. The advantage of USB logging over PC logging is the mobility and that no PC is required. The logging feature just has to be activated and configured in the MENU.

### 3.4.10.1 Configuration

Also see section 3.4.3.7. After USB logging has been enabled and the parameters **Logging interval** and **Start/Stop** have been set, logging can be started anytime from within the MENU or after leaving it, depends on the selected start/stop mode.

### 3.4.10.2 Handling (start/stop)

With setting **Start/stop with DC input ON/OFF** logging will start each time the DC input of the device is switched on, no matter if manually with the front button On/Off or remotely via analog or digital interface. With setting **Manual start/stop** it's different. Logging is then started and stopped only in the MENU, in the logging configuration page.

Soon after logging has been started, the symbol  indicates the ongoing logging action. In case there is an error while logging, such as USB stick full or removed, it will be indicated by another symbol (). After every manual stop or switching the DC input off the logging is stopped and the log file closed.

### 3.4.10.3 Log file format

Type: text file in european CSV format

Layout:

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	U set	U actual	I set	I actual	P set	P actual	R set	R actual	R mode	Output/Input	Device mode	Error	Time
2	2,00V	11,92V	1,20A	1,20A	7344W	15W	N/A	N/A	OFF	ON	CC	NONE	00:00:00,942
3	2,00V	11,90V	1,20A	1,20A	7344W	15W	N/A	N/A	OFF	ON	CC	NONE	00:00:01,942
4	2,00V	11,89V	1,20A	1,20A	7344W	15W	N/A	N/A	OFF	ON	CC	NONE	00:00:02,942
5	2,00V	11,87V	1,20A	1,20A	7344W	15W	N/A	N/A	OFF	ON	CC	NONE	00:00:03,942

Legend:

**U set / I set / P set / R set:** Set values

**U actual / I actual / P actual / R actual:** Actual values

**R mode:** Status of resistance mode being activated or not

**Output/Input:** Status of the DC output/input

**Error:** Device alarms

**Device mode:** Actual regulation mode (also see „3.2. Operating modes“)

**Time:** Elapsed time since logging start

Important to know:

- R set and R actual are only recorded if UIR mode is active (refer to section 3.4.5)
- Unlike the logging on PC, every log start here creates a new log file with a counter in the file name, starting generally with 1, but minding existing files

### 3.4.10.4 Special notes and limitations

- Max. log file size (due to FAT32 formatting): 4 GB
- Max. number of log files in folder HMI\_FILES: 1024
- With setting **“Start/stop with DC input ON/OFF”**, the logging will also stop on alarms or events with action **“Alarm”**, because they switch off the DC input
- With setting **“Manual start/stop”** the device will continue to log even on occurring alarms, so this mode can be used to determine the period of temporary alarms like OT or PF

## 3.5 Remote control

### 3.5.1 General

In this cabinet device, remote control is only considered for the master unit. Slave unit can only be monitored, by any available interface. Remotely controlling the master is possible via its built-in analog or USB port or via one of the optional interface modules (IF-AB series).

Important here is that only the analog or one digital interface can be in control. It means that if, for example, an attempt were to be made to switch to remote control via the digital interface whilst analog remote control is active (pin REMOTE = LOW) the device would report an error via the digital interface. In the opposite direction, a switch-over via pin REMOTE would be ignored. In both cases, however, status monitoring and reading of values are always possible.

### 3.5.2 Control locations

Control locations are those from where the device can be controlled. Essentially there are two: at the device (manual operation) and external (remote control). The following locations are defined:

Displayed location	Description
-	If neither of the other locations is displayed then manual control is active and access from the analog and digital interfaces is allowed. This control location isn't explicitly displayed
<b>Remote:</b>	Remote control via any interface is active
<b>Local</b>	Remote control is locked, only manual operation is allowed

Remote control may be allowed or inhibited using the setting **Allow remote control** (see „3.4.3.1. Menu “General Settings”). In inhibited condition the status **Local** will be displayed top right. Activating the inhibit can be useful if the device is remotely controlled by software or some electronic device, but it's required to make adjustments at the device or deal with emergency, which would not be possible remotely.

Activating condition **Local** causes the following:

- If remote control via the digital interface is active (**Remote:**), then it's immediately terminated and in order to continue remote control once **Local** is no longer active, it has to be reactivated at the PC
- If remote control via the analog interface is active (**Remote: Analog**), then it's temporarily interrupted until remote control is allowed again by deactivating **Local**, because pin REMOTE continues to signal “remote control = on”, unless this has been changed during the **Local** period.

### 3.5.3 Remote control via a digital interface

#### 3.5.3.1 Selecting an interface

All models of this series support the following optionally available interface modules in the interface slot on the master unit:

Short ID	Type	Ports	Description*
IF-AB-CANO	CANopen	1	CANopen slave with generic EDS
IF-AB-RS232	RS232	1	Standard RS232, serial
IF-AB-PBUS	Profibus	1	Profibus DP-V1 slave
IF-AB-ETH1P	Ethernet	1	Ethernet TCP
IF-AB-PNET1P	ProfiNet	1	Profinet/IO slave
IF-AB-MBUS	ModBus TCP	1	ModBus TCP
IF-AB-ETH2P	Ethernet	2	Ethernet TCP, with switch
IF-AB-MBUS2P	ModBus TCP	2	ModBus TCP, with switch
IF-AB-PNET2P	ProfiNet	2	Profinet/IO slave, with switch
IF-AB-CAN	CAN	1	CAN 2.0 A / 2.0 B
IF-AB-ECT	EtherCAT	2	Basic EtherCAT slave with CoE

\* For technical details of the various modules see the extra documentation “Programming Guide Modbus & SCPI”

## 3.5.3.2 General information about the interface modules

The master unit in the cabinet can have one of the plug-in and retrofittable modules listed in 3.5.3.1 installed. It can take over remote control of the device alternatively to the built-in USB type B on the rear side or analog interface. For installation see section „2.3.9. *Installation of an interface module*“ and separate documentation.

The modules require little or no settings for operation and can be directly used with their default configuration. All specific settings will be permanently stored such that, after changeover between the various models, no reconfiguration will be necessary.

## 3.5.3.3 Programming

Programming details for the interfaces, the communication protocols etc. are to be found in the documentation “Programming Guide ModBus & SCPI“ which is supplied on the included USB stick or which is available as download from the manufacturer’s website.

## 3.5.3.4 Interface monitoring

Interface monitoring is a configurable functionality introduced in firmwares KE 2.31 and HMI 2.20. Its goal is to monitor (or supervise) the communication line between the device and a superior control unit, such as PC or PLC, and to ensure that the device wouldn’t continue working uncontrolled in case the communication line fails. A failing line can mean that it’s either physically interrupted (damaged cable, bad contact, cable pulled) or the interface port inside the device hangs.

The monitoring is always only valid for one of the digital interfaces, the one being used for remote control. It thus means that the monitoring can become temporarily inactive when the device leaves remote control. It’s furthermore based on an user-definable timeout which would run out if not at least one message is sent to the device within the given time frame. After every message, the timeout would start again and reset with the next message coming. In case it runs out, following reaction of the device is defined:

- Exit remote control
- In case the DC input is switched on, either switch the DC input off or leave it on, as defined by the parameter **DC input after remote** (see 3.4.3.1)

Notes for the operation:

- The monitoring can be deactivated or activate anytime via remote control
- The timeout of the monitoring can be changed anytime via remote control; the new value would only be valid after the current timeout has elapsed
- The interface monitoring doesn’t deactivate the Ethernet connection timeout (see 3.4.3.7), so these two timeouts can overlap

### 3.5.4 Remote control via the analog interface (AI)

#### 3.5.4.1 General

The built-in, galvanically isolated, 15-pole analog interface (short: AI) is on the rear side of the device offers the following possibilities:

- Remote control of current, voltage, power and resistance
- Remote status monitoring (CV, DC input on/off)
- Remote alarm monitoring (OT, PF, OVP, OCP, OPP)
- Remote monitoring of actual values
- Remote on/off switching of the DC input

Setting the **three** set values of voltage, current and power via the analog interface always takes place concurrently. It means, that for example the voltage can't be given via the AI and current and power set by the rotary knobs, or vice versa. The internal resistance set value can additionally be adjusted, if resistance mode is activated via pin R-ACTIVE.

The OVP set value and other supervision (events) and alarm thresholds can't be set via the AI and therefore must be adapted to the given situation before the AI will be in control. Analog set values can be supplied by an external voltage or generated from the reference voltage on pin 3. As soon as remote control via the analog interface is activated, the displayed set values will be those provided by the interface.

The AI can be operated in the common voltage ranges 0...5 V and 0...10 V, both representing 0...100% of the nominal value. The selection of the voltage range can be done in the device setup. See section „3.4.3. Configuration via MENU“ for details. The reference voltage sent out from pin 3 (VREF) will be adapted accordingly:

**0-5 V:** Reference voltage = 5 V, 0...5 V set value signal for VSEL, CSEL, PSEL and RSEL correspond to 0...100% nominal value, 0...100% actual values correspond to 0...5 V at the actual value outputs CMON and VMON.

**0-10 V:** Reference voltage = 10 V, 0...10 V set value signal for VSEL, CSEL, PSEL and RSEL correspond to 0...100% nominal values, 0...100% actual values correspond to 0...10 V at the actual value outputs CMON and VMON.

All set values are always additionally limited to the corresponding adjustment limits (U-max, I-max etc.), which would clip setting excess values for the DC input. Also see section „3.4.4. Adjustment limits“.

#### Before you begin, please read these important notes about the use of the interface:



*After powering the device and during the start phase the AI signals undefined statuses on the output pins such as ALARMS 1. Those must be ignored until is ready to work.*

- Analog remote control of the device must be activated by switching pin REMOTE first. Only exception is pin REM-SB, which can be used independently
- Before the hardware is connected that will control the analog interface, it shall be checked that it can't provide voltage to the pins higher than specified
- Set value inputs, such as VSEL, CSEL, PSEL and RSEL (if R mode is activated), must not be left unconnected (i.e. floating) during analog remote control. In case any of the set values isn't used for adjustment, it can be tied to a defined level or connected to pin VREF (solder bridge or different), so it gives 100%

#### 3.5.4.2 Resolution

The analog interface is internally sampled and processed by a digital microcontroller. This causes a limited resolution of analog steps. The resolution is the same for set values (VSEL etc.) and actual values (VMON/CMON) and is 26214 when working with the 10 V range. In the 5 V range this resolution halves. Due to tolerances, the truly achievable resolution can be slightly lower.

#### 3.5.4.3 Acknowledging device alarms

In case of a device alarm occurring during remote control via analog interface, the DC input will be switched off the same way as in manual control. The device would indicate an alarm (see 3.6.2) in the front display and, if activated, acoustically and also signal most of them on the analog interface. Which alarms actually are signaled can be set up in the device configuration menu (see 3.4.3.1).

Some device alarms (OVP, OCP and OPP) have to be acknowledged. Also see 3.6.2. Acknowledgment is done with pin REM-SB switching the DC input off and on again, means a HIGH-LOW-HIGH edge (min. 50ms for LOW), when using the default level setting for this pin.

## 3.5.4.4 Analog interface specification

Pin	Name	Type*	Description	Default levels	Electrical specifications
1	VSEL	AI	Set voltage value	0...10 V or. 0...5 V correspond to 0..100% of $U_{Nom}$	Accuracy 0-5 V range: < 0.4% ***** Accuracy 0-10 V range: < 0.2% *****
2	CSEL	AI	Set current value	0...10 V or. 0...5 V correspond to 0..100% of $I_{Nom}$	Input impedance $R_i > 40 \text{ k} \dots 100 \text{ k}$
3	VREF	AO	Reference voltage	10 V or 5 V	Tolerance < 0.2% at $I_{max} = +5 \text{ mA}$ Short-circuit-proof against AGND
4	DGND	POT	Ground for all digital signals		For control and status signals
5	REMOTE	DI	Switching manual / remote control	Remote = LOW, $U_{Low} < 1 \text{ V}$ Manual = HIGH, $U_{High} > 4 \text{ V}$ Manual, if pin not wired	Voltage range = 0...30 V $I_{Max} = -1 \text{ mA}$ bei 5 V $U_{LOW \text{ to } HIGH \text{ typ.}} = 3 \text{ V}$ Rec'd sender: Open collector against DGND
6	ALARMS 1	DO	Overheating alarm Power fail alarm	Alarm= HIGH, $U_{High} > 4 \text{ V}$ No alarm= LOW, $U_{Low} < 1 \text{ V}$	Quasi open collector with pull-up against $V_{cc}^{**}$ With 5 V on the pin max. flow +1 mA $I_{Max} = -10 \text{ mA}$ at $U_{CE} = 0,3 \text{ V}$ $U_{Max} = 30 \text{ V}$ Short-circuit-proof against DGND
7	RSEL	AI	Set internal resistance value	0...10 V or. 0...5 V correspond to 0..100% of $R_{Max}$	Accuracy 0-5 V range: < 0.4% ***** Accuracy 0-10 V range: < 0.2% *****
8	PSEL	AI	Set power value	0...10 V or. 0...5 V correspond to 0..100% of $P_{Nom}$	Input impedance $R_i > 40 \text{ k} \dots 100 \text{ k}$
9	VMON	AO	Actual voltage	0...10 V or. 0...5 V correspond to 0..100% of $U_{Nom}$	Accuracy 0-5 V range: < 0.4% ***** Accuracy 0-10 V range: < 0.2% *****
10	CMON	AO	Actual current	0...10 V or. 0...5 V correspond to 0..100% of $I_{Nom}$	at $I_{Max} = +2 \text{ mA}$ Short-circuit-proof against AGND
11	AGND	POT	Ground for all analog signals		For -SEL, -MON, VREF signals
12	R-ACTIVE	DI	R mode on / off	Off = LOW, $U_{Low} < 1 \text{ V}$ On = HIGH, $U_{High} > 4 \text{ V}$ On, if pin not wired	Voltage range = 0...30 V $I_{Max} = -1 \text{ mA}$ bei 5 V $U_{LOW \text{ to } HIGH \text{ typ.}} = 3 \text{ V}$ Rec'd sender: Open collector against DGND
13	REM-SB	DI	DC input off (DC input on) (ACK alarms ****)	Off = LOW, $U_{Low} < 1 \text{ V}$ On= HIGH, $U_{High} > 4 \text{ V}$ On, if pin not wired	Voltage range = 0...30 V $I_{Max} = +1 \text{ mA}$ at 5 V Rec'd sender: Open collector against DGND
14	ALARMS 2	DO	Overvoltage alarm Overcurrent alarm Overpower alarm	Alarm = HIGH, $U_{High} > 4 \text{ V}$ No alarm = LOW, $U_{Low} < 1 \text{ V}$	Quasi open collector with pull-up against $V_{cc}^{**}$ With 5 V on the pin max. flow +1 mA
15	STATUS***	DO	Constant voltage regulation active	CV = LOW, $U_{Low} < 1 \text{ V}$ CC/CP/CR = HIGH, $U_{High} > 4 \text{ V}$	$I_{Max} = -10 \text{ mA}$ at $U_{CE} = 0,3 \text{ V}$ , $U_{Max} = 30 \text{ V}$ Short-circuit-proof against DGND
			DC input	Off = LOW, $U_{Low} < 1 \text{ V}$ On = HIGH, $U_{High} > 4 \text{ V}$	

\* AI = Analog Input, AO = Analog Output, DI = Digital Input, DO = Digital Output, POT = Potential

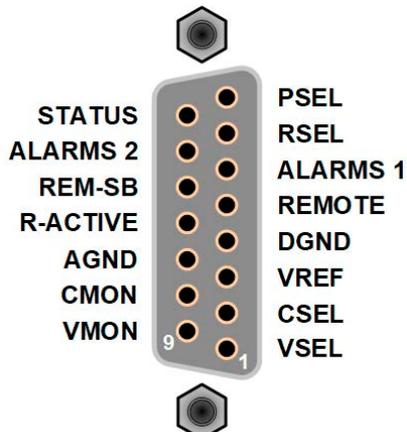
\*\* Internal  $V_{cc}$  approx. 10 V

\*\*\* Only one of both signals possible, see section 3.4.3.1

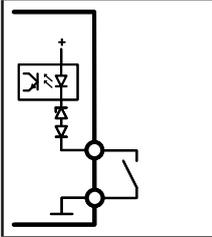
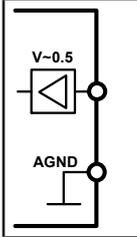
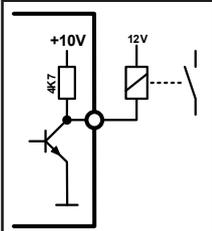
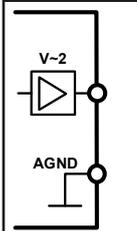
\*\*\*\* Only during remote control

\*\*\*\*\* The error of a set value input adds to the general error of the related value on the DC input of the device

## 3.5.4.5 Overview of the Sub-D Socket



## 3.5.4.6 Simplified diagram of the pins

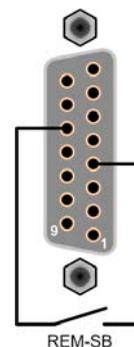
	<p><b>Digital Input (DI)</b></p> <p>The DI is internally pulled up and thus it requires to use a contact with low resistance (relay, switch, contactor etc.) in order to clearly pull the signal down to DGND.</p>		<p><b>Analog Input (AI)</b></p> <p>High resistance input (impedance &gt;40 kΩ....100 kΩ) for an operational amplifier circuit.</p>
	<p><b>Digital Output (DO)</b></p> <p>A quasi open collector, realised as high resistance pull-up against the internal supply. The design doesn't allow the pin to be loaded, but to switch signals by sinking current.</p>		<p><b>Analog Output (AO)</b></p> <p>Output from an operational amplifier circuit, with low impedance. See specifications table above.</p>

## 3.5.4.7 Application examples

### a) Switching the DC input with pin REM-SB



*A digital output, e.g. from a PLC, may be unable to cleanly pull down the pin as it may not be of low enough resistance. Check the specification of the controlling application. Also see pin diagrams above.*



In remote control, pin REM-SB is used to switch the DC input of the device on and off. This function is also available without remote control being active and can on the one hand block the DC input from being switched on in manual or digital remote control and on the other hand the pin can switch the DC input on or off, but not standalone. See below at "Remote control has not been activated".

It's recommended that a low resistance contact such as a switch, relay or transistor is used to switch the pin to ground (DGND).

Following situations can occur:

- **Remote control has been activated**

During remote control via analog interface, only pin REM-SB determines the states of the DC input, according to the level definitions in 3.5.4.4. The logical function and the default levels can be inverted by a parameter in the setup menu of the device. See 3.4.3.1.



*If the pin is unconnected or the connected contact is open, the pin will be HIGH. With parameter "Analog interface Rem-SB" being set to "Normal", it requests "DC input on". It means, when activating remote control, the DC input will instantly switch on.*

- **Remote control has not been activated**

In this mode of operation pin REM-SB can serve as lock, preventing the DC input from being switched on by any means. There are following possible situations:

DC input	+	Level on pin REM-SB	+	Parameter „Analog interface Rem-SB“	→	Behavior
is off	+	HIGH	+	Normal	→	The DC input isn't locked. It can be switched on by pushbutton "On/Off" (front panel) or via command from digital interface.
		LOW	+	Inverted		
	+	HIGH	+	Inverted	→	The DC input is locked. It can't be switched on by pushbutton "On/Off" (front panel) or via command from digital interface. When trying to switch on, a pop-up in the display resp. an error message will be generated.
		LOW	+	Normal		

In case the DC input is already switched on, toggling the pin will switch the DC input off, similar to what it does in analog remote control:

DC input	+	Level on pin REM-SB	+	Parameter „Analog interface Rem-SB“	→ Behavior
is on	+	HIGH	+	Normal	→ The DC input remains on, nothing is locked. It can be switched on or off by pushbutton or digital command.
		LOW	+	Inverted	
	+	HIGH	+	Inverted	→ The DC input will be switched off and locked. Later it can be switched on again by toggling the pin. During lock, pushbutton or digital command can delete the request to switch on by pin.
		LOW	+	Normal	

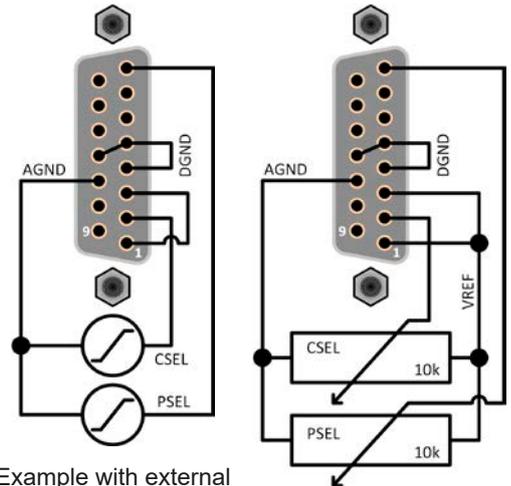
## b) Remote control of current and power

Requires remote control to be activated (Pin REMOTE = LOW)

The set values PSEL and CSEL are generated from, for example, the reference voltage VREF, using potentiometers for each. Hence the device can selectively work in current limiting or power limiting mode. According to the specification of max. 5 mA of load for the VREF output, potentiometers of at least 10 kΩ must be used.

The voltage set value VSEL is directly connected to VREF and will thus be permanently 100%.

If the control voltage is fed in from an external source it's necessary to consider the input voltage ranges for set values (0...5 V oder 0...10 V).



Example with external voltage source

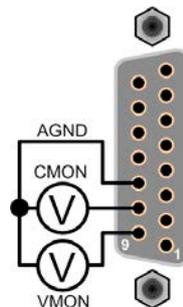
Example with potentiometers



*Use of the input voltage range 0...5 V for 0...100% set value halves the effective resolution.*

## c) Reading actual values

The AI provides the DC input values as current and voltage monitor. These can be read using a standard multimeter or similar, as well as electronic data acquisition hardware.



## 3.6 Alarms and monitoring

### 3.6.1 Definition of terms

There is a clear distinction between device alarms (see „3.3. Alarm conditions“), such as overvoltage protection, and user defined events such as **OCD** (overcurrent detection). Whilst device alarms primarily serve to protect the connected DC source by switching the DC input off, user defined events can do the same (**Action = ALARM**), but can also simply give an acoustic signal to make the user aware. The actions driven by user defined events can be selected:

Action	Impact	Example
<b>NONE</b>	User defined event is disabled.	
<b>SIGNAL</b>	On reaching the condition which triggers the event, the action <b>SIGNAL</b> will show a text message in the status area of the display.	
<b>WARNING</b>	On reaching the condition which triggers the event, the action <b>WARNING</b> will show a text message in the status area of the display and pop up an additional warning message, plus additionally emit an acoustic signal (if activated)	
<b>ALARM</b>	On reaching the condition which triggers the event, the action <b>ALARM</b> will show a text message in the status area of the display with an additional alarm pop-up, and additionally emit an acoustic signal (if activated). Furthermore the DC input is switched off. Certain device alarms are also signaled to the analog interface or can be queried via the digital interface.	

### 3.6.2 Device alarm and event handling

**Important to know:**



- The current drained from a switching power supply or similar sources can be much higher than expected due to capacities on the source's output, even if the source is current limited, and might thus trigger the overcurrent shutdown OCP or the overcurrent event OCD of the electronic load, in case these supervision thresholds are adjusted to too sensitive levels
- When switching off the DC input of the electronic load while a current limited source still supplies energy, the output voltage of the source will rise immediately and due to response and settling times in effect, the output voltage can have an overshoot of unknown level which might trigger the overvoltage shutdown OVP or overvoltage supervision event OVD, in case these thresholds are adjusted to too sensitive levels

A device alarm incident will usually lead to DC input switch-off, the appearance of a pop-up in the middle of the display of the master unit and, if activated, an acoustic signal to make the user aware. The alarm must always be acknowledged. If the alarm condition no longer exists, e.g. the device has cooled down following overheating, the alarm indication will disappear. If the condition persists, the display remains and, following elimination of the cause, must be acknowledged again.

#### ► How to acknowledge an alarm in the display (during manual control)

1. If the alarm is indicated as a pop-up, tap **OK**.
2. If the alarm has already been acknowledged, but is still displayed in the status area, then first tap the status area to display the pop-up, and then acknowledge with **OK**.



In order to acknowledge an alarm during analog remote control, see „3.5.4.3. Acknowledging device alarms“. To acknowledge in digital remote control, refer to the external documentation “Programming Guide ModBus & SCPI”.

Some device alarms are configurable:

Short	Long	Description	Range	Indication
<b>OVP</b>	<b>OverVoltage Protection</b>	Triggers an alarm as soon as the DC input voltage reaches the defined threshold. The DC input will be switched off.	$0 \text{ V} \dots 1.1 * U_{\text{Nom}}$	Display, analog & digital interface
<b>OCP</b>	<b>OverCurrent Protection</b>	Triggers an alarm as soon as the DC input current reaches the defined threshold. The DC input will be switched off.	$0 \text{ A} \dots 1.1 * I_{\text{Nom}}$	
<b>OPP</b>	<b>OverPower Protection</b>	Triggers an alarm as soon as the DC input power reaches the defined threshold. The DC input will be switched off.	$0 \text{ W} \dots 1.1 * P_{\text{Nom}}$	

These device alarms can't be configured and are based on hardware:

Short	Long	Description	Indication
PF	Power Fail	AC supply over- or undervoltage. Triggers an alarm if the AC supply is out of specification or when the device is cut from supply, for example when switching it off with the power switch. The DC input will be switched off which could be only temporarily, depending on the situation and setting <b>DC input after PF alarm</b> (see 3.4.3.1).	Display, analog & digital interfaces
OT	OverTemperature	Triggers an alarm if the internal temperature of at least one unit in the cabinet reaches a certain limit. The DC input will be switched off which could be only temporarily, depending on the setting <b>DC input after OT alarm</b> (see 3.4.3.1).	Display, analog & digital interfaces
MSP	Master-Slave Protection	Triggers an alarm if the master unit loses contact to any slave unit. The DC input will be switched off. The alarm can be cleared by re-initializing the MS system.	Display, digital IF

### ► How to configure the device alarms

1. While the DC input is switched off tap the touch area  on the main screen.
2. On the right side tap the arrows to select **2. Protect**.
3. Set the limits for the equipment alarm relevant to your application if the default value of 103% resp. 110% is unsuitable.



*The set values can also be entered using a numeric pad, which appears when tapping the numpad symbol on this screen.*

The user also has the possibility of selecting whether an additional acoustic signal will be sounded if an alarm or user defined event occurs.

### ► How to configure the alarm sound (also see „3.4.3. Configuration via MENU“)

1. While the DC input is switched off tap the touch area  on the main screen.
2. In the menu page, tap **HMI Setup**.
3. In the following menu page, tap **Alarm Sound**.
4. In the settings page tap the button to select between alarm sound on or off and confirm with .



## 3.6.2.1 User defined events

The monitoring functions of the device can be configured for user defined events. By default, events are deactivated (**Action = NONE**). Contrary to device alarms, the events only work while the DC input is switched on. It means, for instance, that you can't detect undervoltage (UVD) anymore after switching the DC input off, while the voltage is still present.

The following events can be configured independently and can, in each case, trigger the actions **NONE**, **SIGNAL**, **WARNING** or **ALARM**.

Event	Meaning	Description	Range
UVD	UnderVoltage Detection	Triggers an event if the input voltage falls below the defined threshold.	$0 V \dots U_{Nom}$
OVD	OverVoltage Detection	Triggers an event if the input voltage reaches the defined threshold.	$0 V \dots U_{Nom}$
UCD	UnderCurrent Detection	Triggers an event if the input current falls below the defined threshold.	$0 A \dots I_{Nom}$
OCD	OverCurrent Detection	Triggers an event if the input current reaches the defined threshold.	$0 A \dots I_{Nom}$
OPD	OverPower Detection	Triggers an event if the input power reaches the defined threshold.	$0 W \dots P_{Nom}$



*These events should not be confused with alarms such as OT and OVP which are for device protection. User defined events can, however, if set to action ALARM, switch off the DC input and thus protect the source application, such as sensitive electronic hardware.*

### ► How to configure user defined events

1. While the DC input is switched off tap the touch area **SETTINGS** on the main screen.
2. On the right side tap the arrows   to select **4.1 Event U** or **4.2 Event I** or **4.3 Event P**.
3. Set the monitoring limits with the left hand rotary knob and the triggered action with the right hand knob relevant to the application (also see „3.6.1. Definition of terms“).
4. Accept the settings with .



*User events are an integral part of the actual user profile. Thus, if another user profile, or the default profile, is selected and used, the events will be either differently or not configured.*



*The set values can be entered using the ten-key tab. This will appear after tapping the touch area “Direct input” on the particular page.*

### 3.7 Control panel (HMI) lock

In order to avoid the accidental alteration of a value during manual operation the rotary knobs or the touchscreen can be locked so that no alteration of values will be accepted without prior unlocking.

#### ► How to lock the HMI

1. In the main page, tap the lock symbol  (upper right corner).
2. In the settings page **HMI Lock Setup** you are then asked to chose between a complete HMI lock (**Lock all**) or one where the On/Off button is still usable (**ON/OFF possible**), resp. chose to activate the additional PIN (**Enable PIN**). When enabling the **PIN**, the device would later request to enter it every time you are going to unlock the HMI, until the **PIN** is disabled again.
3. Eventually activate the lock by tapping . The status **Locked** will then be shown in the display, like in the figure above.



If an attempt is made to alter something whilst the HMI is locked, a requester appears in the display asking if the lock should be disabled.

#### ► How to unlock the HMI

1. Tap any part of the touchscreen of the locked HMI, or turn one of the rotary knobs or press the button “On/Off” (only in **Lock all** situation).
2. This request pop-up will appear: .
3. Unlock the HMI by tapping on **Tap to unlock** within 5 seconds, otherwise the pop-up will disappear and the HMI remains locked. In case the additional **PIN** lock has been activated in the menu **HMI Lock**, another requester will pop up, asking you to enter the **PIN** before it finally unlocks the HMI.

### 3.8 Limits lock

In order to avoid the alteration of the adjustment limits (also see „3.4.4. Adjustment limits“) by an unprivileged user, the screen with the adjustment limit settings (short: Limits) can be locked by a PIN code. The menu pages **3.Limits** in SETTINGS and **Profiles** in MENU will then become inaccessible until the lock is removed by entering the correct PIN or in case it has been forgotten, by resetting the device as last resort.

#### ► How to lock the Limits

1. While the DC input is switched off, tap the touch area  on the main screen.
2. In the menu tap first on **HMI Setup**, then on **Limits Lock**.
3. In the next page set the check mark for **Lock**.



*The same PIN as with the HMI lock is used here. It should be set before activating the Limits lock. See „3.7. Control panel (HMI) lock“*

4. Activate the lock by leaving the settings page with .



Be careful to enable the lock if you are unsure what PIN is currently set. In doubt use ESC to exit the menu page. In menu page “HMI Lock” you can define a different PIN, but not without entering the old one.

#### ► How to unlock the limits settings

1. While the DC input is switched off, tap the touch area  on the main screen.
2. In the menu tap first on **HMI Setup**, then on **Limits Lock**.
3. In the next page tap on touch area **Unlock** and then you will be asked to enter the 4-digit PIN.
4. Deactivate the lock by entering the correct PIN and submitting with ENTER.

### 3.9 Loading and saving a user profile

The menu “**Profiles**” serves to select between a default profile and up to 5 user profiles. A profile is a collection of all settings and set values. Upon delivery, or after a reset, all 6 profiles have the same settings and all set values are 0. If the user changes settings or sets target values then these create a working profile which can be saved to one of the 5 user profiles. These profiles or the default one can then be switched. The default profile is read-only.

The purpose of a profile is to load a set of set values, settings limits and monitoring thresholds quickly without having to readjust these. As all HMI settings are saved in the profile, including language, a profile change can also be accompanied by a change in HMI language.

On calling up the menu page and selecting a profile the most important settings can be seen, but not changed.

#### ► How to save the current values and settings as a user profile:

1. Tap the touch area  on the main screen.
2. In the menu page, tap .
3. In the selection screen (right) choose between user profile 1-5 in which the settings are to be saved. The profile will then be displayed and the values can be checked, but not changed.

4. Save using the touch area .



## 3.10 The function generator

### 3.10.1 Introduction

The built-in **function generator** (short: **FG**) is able to create various signal forms and apply these to the set value of voltage or current.

In manual operation, all generator functions are available for access on the front panel. In remote control, only the customizable **arbitrary** generator and a **XY** function are available. The arbitrary generator can replicate all manually serviceable functions, except UI and IU. For those, the XY function is assigned.

The following functions are retrievable, configurable and controllable:

Function	Short description
Sine wave	Sine wave generation with adjustable amplitude, offset and frequency
Triangle	Triangular wave signal generation with adjustable amplitude, offset, rise and fall times
Rectangular	Rectangular wave signal generation with adjustable amplitude, offset and duty cycle
Trapezoid	Trapezoidal wave signal generation with adjustable amplitude, offset, rise time, pulse time, fall time, idle time
DIN 40839	Simulated automobile engine start curve according to DIN 40839 / EN ISO 7637, split into 5 curve sequence points, each with a start voltage, final voltage and time
Arbitrary	Generation of a process with up to 99 freely configurable curve points, each with a start and end value (AC/DC), start and end frequency, phase angle and total duration
Ramp	Generation of a linear rise or fall ramp with start and end values and time before and after the ramp
UI, IU	XY generator, USB stick loadable current or voltage curves (table, CSV)
Battery test	Battery discharge test with constant or pulsed current, along with Ah, Wh and time counters
MPP Tracking	Simulation of the characteristic tracking behaviour of solar inverters when seeking to find the maximum power point (MPP) when being connected to typical sources such as solar panels



*Whilst R mode is activated, access to the function generator isn't available.*

### 3.10.2 General

#### 3.10.2.1 Limitations

The function generator isn't accessible, neither for manual access, nor for remote control, if resistance mode, also called UIR mode, is active.

#### 3.10.2.2 Resolution

Amplitudes generated by the arbitrary generator have an effective resolution of approx. 52428 steps. If the amplitude is very low and the time long, the device would generate less steps and set multiple identical values after another, generating a staircase effect. It's furthermore not possible to generate every possible combination of time and a varying amplitude (slope).

The XY generator, which works in table mode, has an effective resolution of 3276 steps for the set value range of 0-100% rated value.

#### 3.10.2.3 Minimum slope / maximum ramp time

When using a rising or falling offset (i.e. DC part) at functions like ramp, trapezoid, triangle and even sine wave, a minimum slope, calculated from the rated values of voltage or current, is required or else the adjusted settings would be neglected by the device. Calculating the minimum slope can help to determine if a certain ramp over time can be achieved by the device or not. Example: model EL 9080-1530 B 15U is going to be used, with 80 V and 1530 A rating. **Formula: minimum slope = 0.000725 \* rated value / s.** For the example model it results in  $\Delta U/\Delta t$  of 58 mV/s and  $\Delta I/\Delta t$  of 1,1 A/s. The maximum time which can be achieved with the minimum slope then calculates as approximately 1379 seconds according to formula  $t_{\text{Max}} = \text{rated value} / \text{min. slope}$ .

## 3.10.3 Method of operation

In order to understand how the function generator works and how the value settings interact, the following should be noted:

**The device always operates with the three set values U, I and P, also in function generator mode.**

The selected function can be used on one of the values U or I, the other two are then constants and have a limiting effect. That means, if, e.g. a voltage of 10 V is applied to the DC input and a sine wave function should operate on the current with an amplitude of 800 A and offset 1000 A, then the function generator will create a sine wave progression of current between 200 A (min) and 1800 A (max), which will result in an input power between 2 kW (min) and 18 kW (max). The input power, however, is limited to its set value. If this were 15 kW then the current would be limited to 1500 A and, if clamped to an oscilloscope, it would be seen to be truncated at 1500 A and never reach the target of 1800 A.

Master-slave systems have further characteristics which have to be considered:



At the end of the configuration of every standard function you are requested to set up global set values, the so-called "U/I/P Limits". These limits are transferred to all slave units of master-slave systems. It's recommended to carefully configure them so the MS system can work as expected and the slaves wouldn't impact the function run in a negative way.

## 3.10.4 Manual operation

### 3.10.4.1 Function selection and control

Via the touch screen one of the functions described in 3.10.1 can be called up, configured and controlled. Selection and configuration are only possible while the DC input is switched off.

#### ► How to select a function and adjust parameters

1. While the DC input is switched off tap touch area  on the main screen.



2. In the menu overview tap on the touch area  and then on the desired function.
3. Depending on the choice of function there follows a request to which value the function generator is going to be applied:  or .
4. Adjust the parameters as you desire, like offset, amplitude and frequency for a sine wave, for example.



*For the AC part of a function and if the difference between start and end value of amplitude or frequency is too low (min.  $\Delta Y/\Delta t$ ), depending on the time that is defined for one function run, the function generator will not accept the settings and pop up an error.*

5. As last step you are requested to adjust the overall limits of voltage, current and power of which the one that belongs to the set value that is going to be controlled by the function will be used to configure the slave units with a limit. This value has to be set up carefully and high enough so the slaves can work without restrictions. Example: you set up a rectangle with an offset of 20 A and an amplitude of 100 A. The peak of that would read 120 A. The same current value would have to be adjusted in U/I/P Limits page.

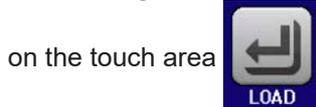


*When entering function generator mode, those global limits are reset to safe values, which might prevent the function from working at all. For example, if you apply the selected function to the input current, then the overall current limit should not interfere and should at least be as high as offset + amplitude.*

Setting the various functions is described below. After setting it up, the function can be loaded.

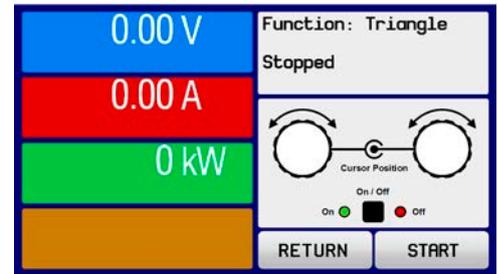
## ► How to load a function

1. After setting the values for the required signal generation, tap



on the touch area

The device will then load the data into the internal controller and changes the display. Shortly afterwards the static values are set (power and voltage or current), the DC input is switched on and the touch area **START** enabled. Only then can the function be started.



*Because the DC input is automatically switched on in order to settle the start situation, the static values are effective to the source immediately after loading the function. These static values represent the situation before start and after the end of the function, so it doesn't need to start from 0. Only exception: when applying any function to the current (I), there is no adjustable static current value, so the function would always start from 0 A.*

## ► How to start and stop a function

1. The function can be **started** either by tapping **START** or pushing the On/Off button, if the DC input is currently switched off. The function then starts immediately. In case START is used while the DC input is still switched off, it will be switched on automatically.
2. The function can be **stopped** either by tapping **STOP** or pushing the On/Off button. There is different behaviour:
  - a) The **STOP** button stops only the function, the DC input remains ON with the static values in effect.
  - b) The On/Off button stops the function and switches the DC input off.



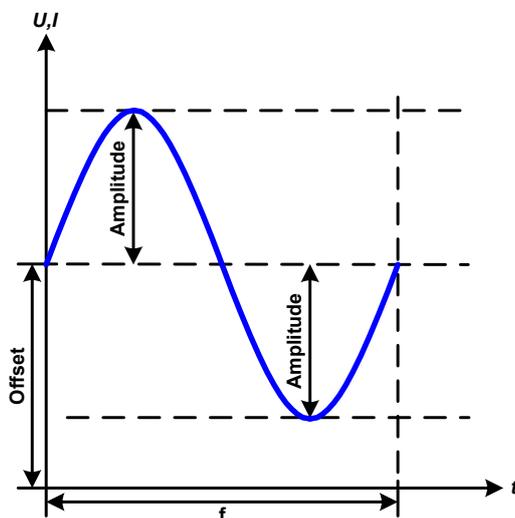
*Any device alarm (overvoltage, overtemperature etc.), protection (OPP, OCP) or event with action = Alarm stops the function progress automatically, switches off the DC input and reports the alarm.*

### 3.10.5 Sine wave function

The following parameters can be configured for a sine wave function:

Value	Range	Description
I(A), U(A)	0...(Nominal value - (Off)) of U, I	A = Amplitude of the signal to be generated
I(Off), U(Off)	(A)...(Nominal value - (A)) of U, I	Off = Offset, based on the zero point of the mathematical sine curve, may not be smaller than the amplitude.
f (1/t)	1...10000 Hz	Static frequency of the signal to be generated

Schematic diagram:



Application and result:

A normal sine wave signal is generated and applied to the selected set value, e.g. current (I). At a constant input voltage the input current of the load will follow a sine wave.

For calculating the maximum power input the amplitude and offset values for the current must be added.

Example: with an input voltage of 15 V and sin(I) selected, set the amplitude to 250 A and the offset to 300 A. The resulting maximum input power is then achieved at the highest point of the sine wave and is  $(300 \text{ A} + 250 \text{ A}) * 15 \text{ V} = 8.25 \text{ kW}$ .

## 3.10.6 Triangular function

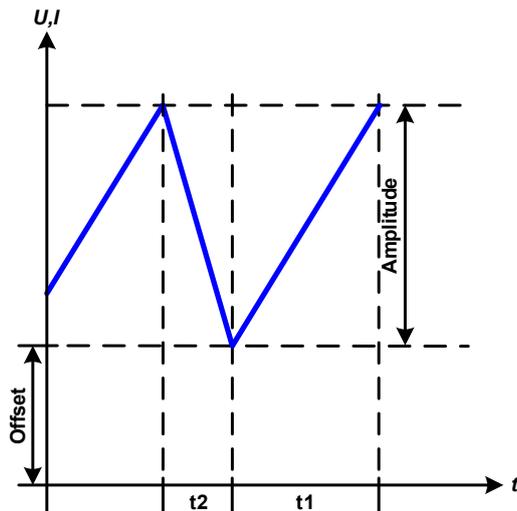
The following parameters can be configured for a triangular wave function:

Value	Range	Description
I(A), U(A)	0...(Nominal value - (Off)) of U, I	A = Amplitude of the signal to be generated
I(Off), U(Off)	0...(Nominal value - (A)) of U, I	Off = Offset, based on the foot of the triangular wave
t1	0.01 ms...36000 s	Rising edge time $\Delta t$ of the triangular wave signal
t2	0.01 ms...36000 s	Falling edge time $\Delta t$ of the triangular wave signal



*When adjusting very short time value for t1 and t2 not every adjustable amplitude can be gained on the DC input. Rule of thumb: the smaller the time value, the lower the true amplitude.*

Schematic diagram:



Application and result:

A triangular wave signal for input current (only effective in current limiting) or input voltage is generated. The positive and negative slope times can be set independently.

The offset shifts the signal on the Y-axis.

The sum of the intervals **t1** and **t2** gives the cycle time and its reciprocal is the frequency.

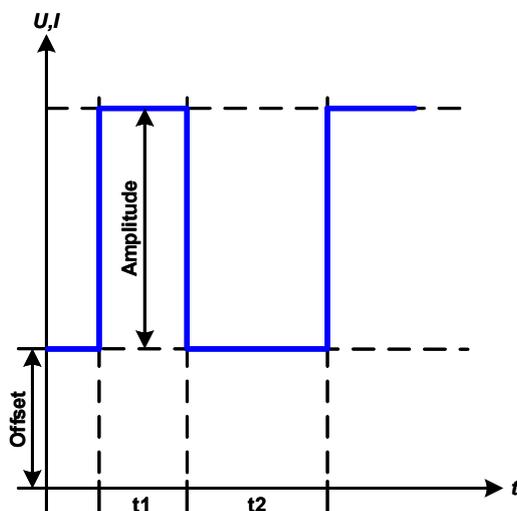
Example: a frequency of 10 Hz is required and would lead to periodic duration of 100 ms. This 100 ms can be freely allocated to **t1** and **t2**, e.g. 50 ms:50 ms (isosceles triangle) or 99.9 ms:0.1 ms (right-angled triangle or sawtooth).

## 3.10.7 Rectangular function

The following parameters can be configured for a rectangular wave function:

Value	Range	Description
I(A), U(A)	0...(Nominal value - (Off)) of U, I	A = Amplitude of the signal to be generated
I(Off), U(Off)	0...(Nominal value - (A)) of U, I	Off = Offset, based on the foot of the rectangular wave
t1	0.01 ms...36000 s	Time (pulse width) of the upper level (amplitude)
t2	0.01 ms...36000 s	Time (pause width) of the lower level (offset)

Schematic diagram:



Application and result:

A rectangular or square wave signal for input current (direct) or input voltage (indirect) is generated. The intervals **t1** and **t2** define how long the value of the amplitude (pulse) and how long the value of the offset (pause) are effective.

The offset shifts the signal on the Y axis.

Intervals **t1** and **t2** can be used to define a duty cycle. The sum of **t1** and **t2** gives the period and its reciprocal is the frequency.

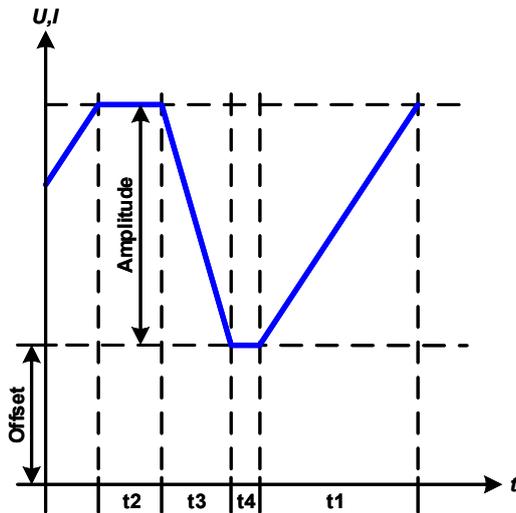
Example: a rectangular wave signal of 25 Hz and a duty cycle of 80% are required. The sum of **t1** and **t2**, the period, is  $1/25 \text{ Hz} = 40 \text{ ms}$ . For a duty cycle of 80% the pulse time (**t1**) is  $40 \text{ ms} \cdot 0.8 = 32 \text{ ms}$  and the pause time (**t2**) is 8 ms.

**3.10.8 Trapezoidal function**

The following parameters can be configured for a trapezoidal curve function:

Value	Range	Description
I(A), U(A)	0...(Nominal value - (Off)) of U, I	A = Amplitude of the signal to be generated
I(Off), U(Off)	0...(Nominal value - (A)) of U, I	Off = Offset, based on the foot of the trapezium
t1	0.01 ms...36000 s	Time for the positive slope of the trapezoidal wave signal.
t2	0.01 ms...36000 s	Time for the top value of the trapezoidal wave signal.
t3	0.01 ms...36000 s	Time for the negative slope of the trapezoidal wave signal.
t4	0.01 ms...36000 s	Time for the base value (offset) of the trapezoidal wave signal

Schematic diagram:



Application and result:

Here a trapezoidal signal can be applied to a set value of U or I. The ramps of the trapezium can be different by setting different times for rise and fall.

The periodic duration and repetition frequency are the result of four time elements. With suitable settings the trapezium can be deformed to a triangular or rectangular wave. It has, therefore, universal use.

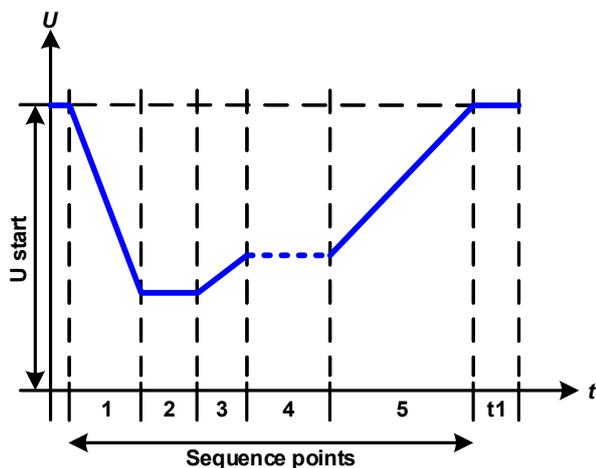
**3.10.9 DIN 40839 function**

This function is based on the curve defined in DIN 40839 / EN ISO 7637 (test impulse 4), and is only applicable to voltage. It shall replicate the progress of automobile battery voltage during engine starting. The curve is divided into 5 sequence points (see diagram below) which each have the same parameters. The standard values from the DIN are set already as default values for the five sequence points.

The following parameters can be configured for the DIN40839 function:

Value	Range	Seq	Description
Ustart	0...Nominal value of U	1-5	Start voltage of the ramp
Uend	0...Nominal value of U	1-5	End voltage of the ramp
Seq.time	0.01 ms...36000 s	1-5	Time of the ramp
Seq.cycles	∞ or 1...999	-	Number of repetitions of the entire curve
Time t1	0.01 ms...36000 s	-	Time after cycle before repetition (cycle > 1)

Schematic diagram:



Application and result:

The function isn't suitable for standalone operation of an electronic load, but optimal in conjunction with a power supply, for example one from PSI 9000 series. The load acts as a sink to achieve a rapid fall of the output voltage of the power supply enabling it to progress as defined by the DIN curve.

The curve conforms to test impulse 4 of the DIN. With suitable settings, other test impulses can be simulated. If the curve in sequence point 4 should be a sine wave, then these 5 points have to be transferred to the arbitrary generator.

## 3.10.10 Arbitrary function

The arbitrary, i. e. freely definable function offers the user a wider scope. There are 99 freely configurable sequence points available. While all have the same set of parameters, they can be configured differently so that a complex function process can be created. The 99 sequence points or a part of them can run one after another in a sequence point block and this block can then be repeated up to 999 times or infinitely. A sequence point or sequence point block is always assigned to either current or voltage, thus a mix of assignment to current or voltage isn't possible.

The arbitrary curve overlays a linear progression (DC) with a sine curve (AC), whose amplitude and frequency are shaped between start and end values. If the start frequency ( $f_s$ ) = end frequency ( $f_e$ ) = 0 Hz, the AC values have no impact and only the DC part is effective. Each sequence point is allocated a time in which the AC/DC curve from start to finish will be generated.

The following parameters can be configured for each sequence in the arbitrary function (the table lists parameters for current, for voltage it would be  $U_s$ ,  $U_e$  etc.):

Value	Range	Description
<b>Is(AC)</b>	0...50% Nominal value of I	Start amplitude of the AC part of the curve
<b>Ie(AC)</b>	0...50% Nominal value of I	End amplitude of the AC part of the curve
<b>fs(1/T)</b>	0 Hz...10000 Hz	Start frequency of the AC part of the curve
<b>fe(1/T)</b>	0 Hz...10000 Hz	End frequency of the AC part of the curve
<b>Angle</b>	0°...359°	Start angle of the AC part of the curve
<b>Is(DC)</b>	Is(AC)...(Nominal value - Is(AC)) of I	Start value of the DC part of the curve
<b>Ie(DC)</b>	Ie(AC)...(Nominal value - Ie(AC)) of I	End value of the DC part of the curve
<b>Seq.time</b>	0.01 ms...36000 s	Time for the selected sequence point



*The sequence point time (seq. time) and the start and end frequency are related. The minimum value for  $\Delta f/s$  is 9.3. Thus, for example, a setting of  $f_s = 1$  Hz,  $f_e = 11$  Hz and  $Seq.time = 5$  s would not be accepted as  $\Delta f/s$  is only 2. A seq. time of 1 s would be accepted, or, if the time remains at 5 s, then  $f_e = 51$  Hz must be set.*



*The amplitude change between start and end is related to the sequence time. An arbitrarily small change over an extended time isn't possible. See section „3.10.2.3. Minimum slope / maximum ramp time“ for more information.*

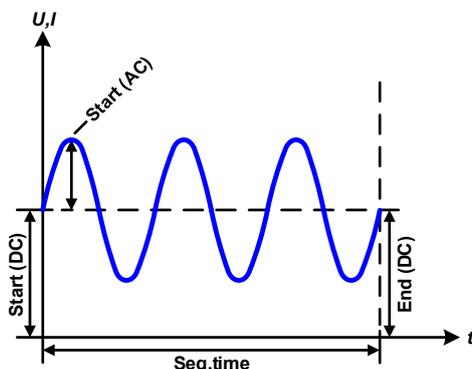
After the settings for the selected sequence point are accepted with SAVE, further ones can be configured. If the button NEXT is touched a second settings screen appears in which global settings for all points are displayed.

The following parameters can be set for the total run of an arbitrary function:

Value	Range	Description
<b>Start seq.</b>	1...End seq.	First sequence point in the sequence point block
<b>End seq.</b>	Start seq...99	Last sequence point in the sequence point block
<b>Seq. cycles</b>	$\infty$ or 1...999	Number of cycles of the sequence point block.

After continuing with **NEXT** there are global set values to define as last part of the function generator setup.

Schematic diagram:



Applications and results:

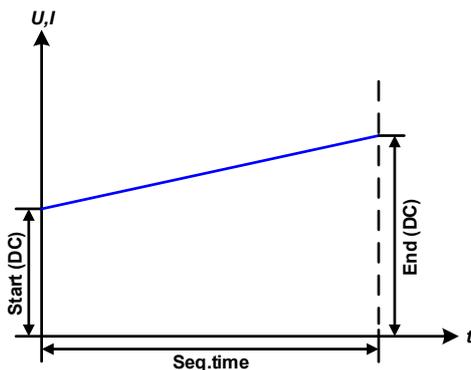
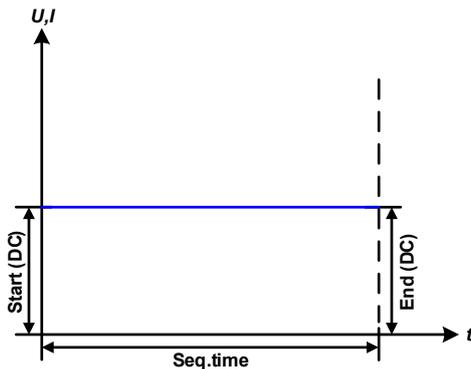
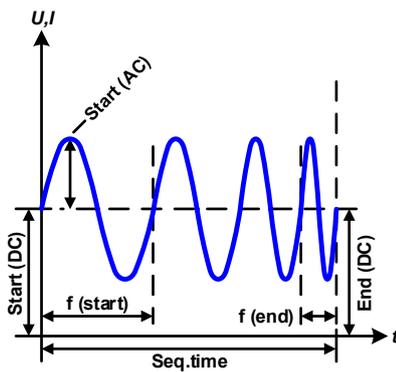
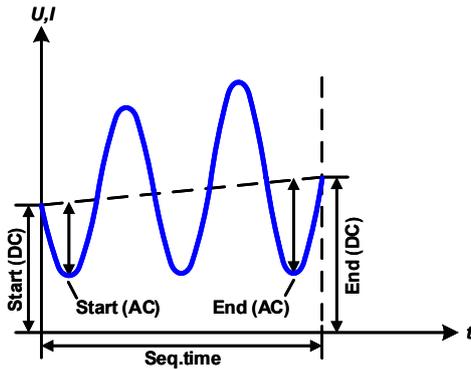
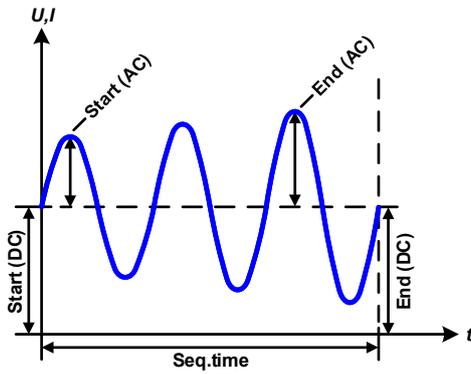
### Example 1

Focusing 1 cycle of 1 sequence point:

DC values for start and end are the same, also the AC amplitude. With a frequency  $>0$  a sine wave progression of the set value is generated with a defined amplitude, frequency and Y shift (offset, DC value at start and end)

The number of sine waves per cycle depend on the sequence point time and the frequency. If the time were 1 s and the frequency 1 Hz, there would be exactly 1 sine wave. If the time were 0.5 s at the same frequency, there would only be a half sine wave.

Schematic diagram:



Applications and results:

## Example 2

Focusing 1 cycle of 1 sequence point:

The DC values at start and end are the same but the AC (amplitude) not. The end value is higher than the start so that the amplitude increases with each new half sine wave continuously through the sequence point. This, of course, only if the sequence point time and frequency allow for multiple waves to be created. e.g. for  $f=1$  Hz and **Seq. time** = 3 s, three complete waves would be generated (for angle =  $0^\circ$ ) and reciprocally the same for  $f=3$  s and **Seq. time**=1 s.

## Example 3

Focusing 1 cycle of 1 sequence point:

The DC values at start and end are unequal, as are also the AC values. In both cases the end value is higher than the start so that the offset increases from start to end (DC) and the amplitude also with each new half sine wave.

Additionally the first sine wave starts with a negative half wave because the angle is set at  $180^\circ$ . The start angle can be shifted at will in  $1^\circ$  steps between  $0^\circ$  and  $359^\circ$ .

## Example 4

Focusing 1 cycle of 1 sequence point:

Similar to example 1 but with another end frequency. Here this is shown as higher than the start frequency. This impacts the period of the sine waves such that each new wave will be shorter over the total span of the sequence point time.

## Example 5

Focusing 1 cycle of 1 sequence point:

Similar to example 1 but with a start and end frequency of 0 Hz. Without a frequency no sine wave part (AC) will be created and only the DC settings will be effective. A ramp with a horizontal progression is generated.

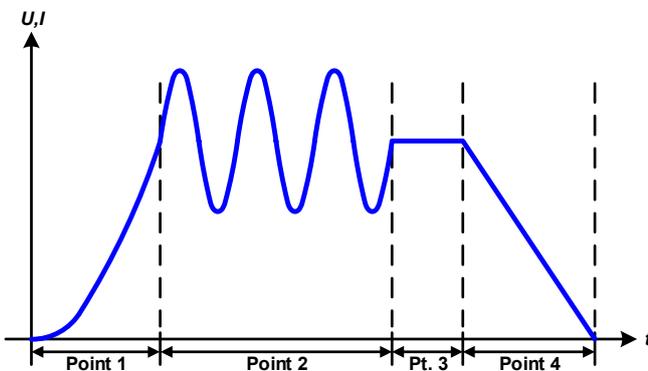
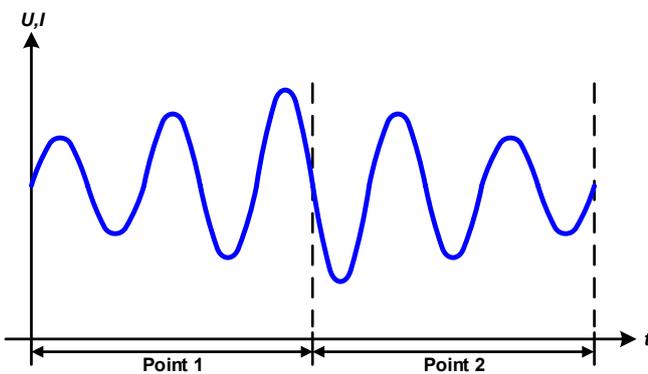
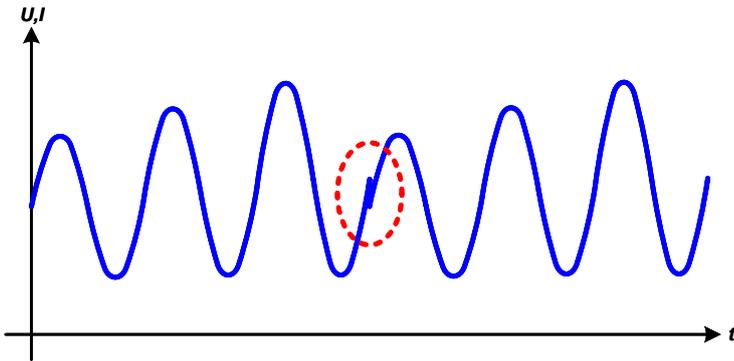
## Example 6

Focusing 1 cycle of 1 sequence point:

Similar to example 1 but with a start and end frequency of 0 Hz. Without a frequency no sine wave part (AC) will be created and only the DC settings will be effective. Here start and end values are unequal and a steadily increasing ramp is generated.

By linking together a number of differently configured sequence points, complex progressions can be created. Smart configuration of the arbitrary generator can be used to match triangular, sine, rectangular or trapezoidal wave functions and thus, e.g. a sequence of rectangular waves with differing amplitudes or duty cycles could be produced.

Schematic diagram:



Applications and results:

## Example 7

Focusing 2 cycles of 1 sequence point:

A sequence point configured as in example 3 is run. As the settings demand that the end offset (DC) is higher than the start, the second sequence point run will revert to the same start level as the first, regardless of the values achieved at the end of the first run. This can produce a discontinuity in the total progression (marked in red) which may only be compensated with careful choice of settings.

## Example 8

Focusing 1 cycle of 2 sequence points:

Two sequence points run consecutively. The first generates a sine wave with increasing amplitude, the second with a decreasing amplitude. Together they produce a progression as shown left. In order to ensure that the maximum wave in the middle occurs only once, the first sequence point must end with a positive half wave and the second start with a negative half wave, as shown in the diagram..

## Example 9

Focusing 1 cycle of 4 sequence points:

Point 1: 1/4th sine wave (**Angle** =  $270^\circ$ )

Point 2: 3 Sine waves (ratio frequency to sequence point time: 1:3)

Point 3: Horizontal ramp ( $f = 0$ )

Point 4: Falling ramp ( $f = 0$ )

## 3.10.10.1 Loading and saving the arbitrary function

The 99 points of the arbitrary function, which can be manually configured with the control panel of the device and which are applicable either to voltage (U) or current (I), can be saved to or loaded from a common USB stick via the front side USB port. Generally, all 99 points are saved or loaded using a text file of type CSV (semicolon separator), which represents a table of values.

In order to load a sequence point table for the arbitrary generator, following requirements have to be met:

- The table must contain 99 rows (100 are also accepted for compatibility to previous firmwares), with 8 subsequent values in 8 columns and must not have gaps
- The column separator (semicolon, comma) must be as selected by parameter **USB file separator format**; it also defines the decimal separator (dot, comma)
- The files must be stored inside a folder called HMI\_FILES which has to be in the root of the USB drive
- The file name must always start with WAVE\_U or WAVE\_I (not case-sensitive)
- All values in every row and column have to be within the specified range (see below)
- The columns in the table have to be in a defined order which must not be changed

Following value ranges are given for use in the table, related to the manual configuration of the arbitrary generator (column headers like in Excel):

Column	Parameter	Range
A	0...50% Nominal value of I	Start amplitude of the sine wave part of the curve
B	0...50% Nominal value of I	End amplitude of the sine wave part of the curve
C	0 Hz...10000 Hz	Start frequency of the sine wave part of the curve (AC)
D	0 Hz...10000 Hz	End frequency of the sine wave part of the curve (AC)
E	0°...359°	Start angle of the sine wave part of the curve (AC)
F	Is(AC)...(Nominal value - Is(AC)) of I	Start value of the DC part of the curve
G	Ie(AC)...(Nominal value - Ie(AC)) of I	End value of the DC part of the curve
H	0.1 ms...36000 s	Time for the selected sequence point

For details about the parameter and the arbitrary function refer to „3.10.10. Arbitrary function“.

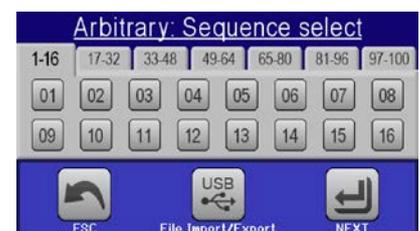
Example CSV:

	A	B	C	D	E	F	G	H
1	20,00	30,00	5	5	90	50,00	50,00	50000000
2	30,00	20,00	5	5	90	50,00	50,00	30000000
3	0,00	0,00	0	0	0	0,00	0,00	1000
4	0,00	0,00	0	0	0	0,00	0,00	1000
5	0,00	0,00	0	0	0	0,00	0,00	1000
6	0,00	0,00	0	0	0	0,00	0,00	1000

The example shows that only the first two sequence points are configured, while all others are set to default values. The table could be loaded as WAVE\_U or WAVE\_I when using, for example, the model EL 9080-1530 B, because the values would fit both, voltage and current. The file naming, however, is unique. A filter prevents you from loading a WAVE\_I file after you have selected “Arbitrary --> U” in the function generator menu. The file would not be listed at all.

### ► How to load a sequence point table from an USB stick:

1. Do not plug the USB drive yet or remove it.
2. Access the function selection menu of the function generator with MENU -> Function Generator -> Arbitrary -> U/I, to see the main screen of sequence selector, as depicted to the right.



3. Tap touch area  File Import/Export, then  and follow the instructions on screen. If at least one valid files has been recognized (for file and path naming see above), the device will show a list of files to select from with .

4. Tap touch area  in the bottom right corner. The selected file is then checked and loaded, if valid. In case it'sn't valid, the device will show an error message. Then the file must be corrected and the steps repeated.

## ► How to save a sequence point table to an USB stick:

1. Do not plug the USB stick yet or remove it.
2. Access the function selection menu of the function generator via MENU -> Function Generator -> Arbitrary



3. Tap on **File Import/Export**, then **SAVE to USB**. The device will request you to plug the USB stick now.
4. After plugging it, the device will try to access the stick and find the folder HMI\_FILES and read the content. If there are already WAVE\_U or WAVE\_I files present, they will be listed and you can either select one for overwriting with , otherwise select **-NEW FILE-** for a new file.



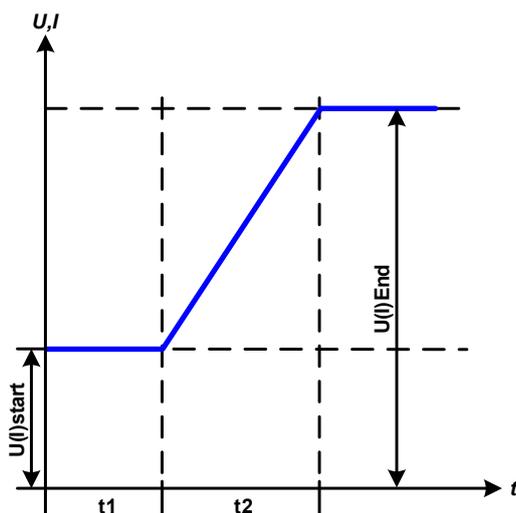
5. Finally save the sequence table with **SAVE to USB**.

### 3.10.11 Ramp function

The following parameters can be configured for a ramp function.

Value	Range	Description
<b>Ustart / Istart</b>	0...Nominal value of U, I	Start value (U,I)
<b>Uend / Iend</b>	0...Nominal value of U, I	End value (U, I)
<b>t1</b>	0,1 ms...36000 s	Time before ramp-up or ramp-down of the signal
<b>t2</b>	0.1 ms...36000 s	Ramp-up or ramp-down time

Schematic diagram:



Application and result:

This function generates a rising or falling ramp between start and end values over the time **t2**. Time **t1** creates a delay before the ramp starts.

The function runs once and stops at the end value. To have a repeating ramp, function Trapezoid would have to be used instead (see 3.10.8).

Important to consider are the static values of U and I which define the start levels at the beginning of the ramp. It's recommended that these values are set equal to those in **Ustart/Istart**, unless the source at the DC input should not be loaded before the start of the ramp. In that case the static values should be set to zero.



*10h after reaching the ramp end, the function will stop automatically (i.e. I = 0 A resp. U = 0 V), unless it has been stopped manually before.*

### 3.10.12 UI and IU table functions (XY table)

The UI and IU functions offer the user the possibility to set a DC input current dependent on the DC input voltage, or a DC input voltage dependent on the DC input current. The function is table driven with exactly 4096 values, which are distributed over the whole measured range of actual input voltage or input current in the range of 0...125% Unom or Inom, of which only 0...102% are effective. The table can either be uploaded from an USB stick through the front side USB port of the device or via remote control (ModBus protocol or SCPI). The functions are:

UI function:  $U = f(I)$  -> the device will work in CV mode, regulating the voltage of a source in CC mode

IU function:  $I = f(U)$  -> the device shall work in CC mode with a source that is in CV mode

In the **UI function**, the equipment measuring circuit determines the level from 0 to maximum of the input current. For each of the 3277 effective values for input current a voltage value is maintained by the user in the UI table which can be any value between 0 and nominal value. The values uploaded from an USB stick will always be interpreted as voltage values even if the user calculated them as current values and incorrectly loaded them as an UI table.

In the **IU function** the assignment of the values is the other way round, the behavior, however, the same.

Thus the behavior of the load or the DC current and power consumption can be controlled with dependence on input voltage and step changes can be created.



Uploading of a table from an USB stick must use text files in CSV format (.csv). Plausibility is checked on loading (values not too high, number of values correct), and possible errors reported in which case the table will not be loaded.



The 4096 values in the table are only checked for size and count. If all the values were to be graphically plotted a curve would be created which could include significant step changes in current or voltage. That could lead to complications in the loading of the source if, e.g., the internal voltage measurement in the electronic load fluctuates slightly so that the load jumps backwards and forward between two values in the table which, in the worst case, could one be 0 A and the other maximum current.

### 3.10.12.1 Loading UI and IU tables from USB drive

The so-called UI or IU value tables can be loaded from a file via a standard USB stick that is formatted as FAT32. In order to load the file, it has to meet following specifications:

- The file name always begins with IU or UI (not case-sensitive), depending on which of the two function you load the table for
- The file must be a text file of type Excel CSV (semicolon as separator) and must only contain one column with exactly 4096 values without gaps
- Values with decimal places must use a decimal separator as depending on the selection with parameter "USB file separator format" (**US**: separator = comma, decimal separator = dot)
- No value may exceed 102% nominal value of the device. For example, if you have an 80 V model and you are going to load a table with values for voltage, none of the 4096 values may be higher than 81.6 (the adjustment limits from the device's front panel do not apply here)
- The file(s) has/have to be put inside a folder named HMI\_FILES in the root of the stick



If these specifications are not met, the device won't accept the file and put out an error message in the display. Files with names beginning different to UI or IU are not recognized for this purpose. The USB drive may contain multiple UI/IU files with different names and list them for the selection of one.

#### ► How to load an UI or IU table from an USB drive:

1. Do not plug the USB drive yet or pull it out if already plugged.
2. Open the function selection menu of the function manager with **MENU** -> **Function Generator** -> **XY Table**
3. In the next screen select the desired function with either **UI Table** or **IU Table**.
4. Configure the global parameters for U, I and P.



5. Tap touch area **LOAD from USB** and plug the USB drive when requested, in order to select one out of X compatible files from the drive. In case the file isn't accepted, the device will report an error in the display and also tell what's wrong with the file.
6. Once the file is accepted, you will be requested to remove the USB drive.



7. Submit and load the function with **LOAD** to start and control it as with other function (also see „3.10.4.1. Function selection and control“).

**3.10.13 Battery test function**

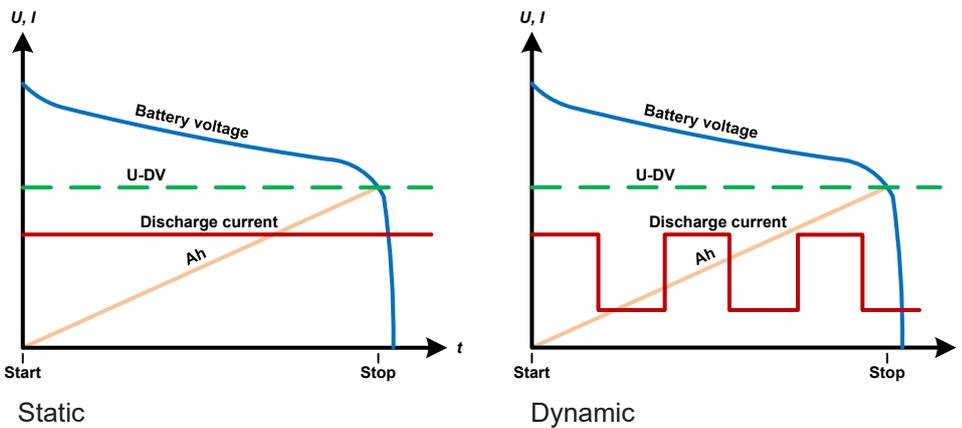
The purpose of the battery test function is to discharge various battery types in industrial product tests or laboratory applications. It's only available via access on the HMI, at least as setup and use are described below, but can also be achieved in remote control using the arbitrary function generator. The only disadvantage in remote control are the missing counters of battery capacity (Ah), energy (Wh) and time. But those can be calculated by custom remote control software when programming a time counter and regularly querying actual values from the device.

The function is usually applied on the DC input current and can either be selected and run in **Static** (constant current) or **Dynamic** (pulsed current) mode. In static mode, the settings for power or resistance can also let the device run the function in constant power (CP) or constant resistance (CR). Like in the normal operation of the load the set values determine what regulation mode (CC, CP, CR) is resulting on the DC input. If, for example, CP operation is projected, the set values of current should be set to maximum and resistance mode should be turned off, so that both don't interfere. For a projected CR operation it's similar. There current and power should be set to maximum.

For dynamic mode there is also a power setting, but it can't be used to run the dynamic battery test function in pulsed power mode or at least the result would not be as expected. It's recommended to adjust the power values always according to the test parameters, so it doesn't interfere with the pulsed current, i. e. dynamic mode.

When discharging with high currents, compared to the nominal battery capacity and in dynamic mode, it may happen that the battery voltage shortly drops below the U-DV threshold and the test will unintentionally stop. Here it's recommended to adjust U-DV accordingly.

Graphical depiction of both battery test modes:



**3.10.13.1 Parameters for static mode**

The following parameters can be configured for the static battery test function.

Value	Range	Description
<b>I</b>	0...Nominal value of I	Maximum discharge current in Ampere
<b>P</b>	0...Nominal value of P	Maximum discharge power in Watt
<b>R</b>	Min....max. nominal value of R	Maximum discharge resistance in Ω (can be deactivated --> <b>OFF</b> )

**3.10.13.2 Parameters for dynamic mode**

The following parameters can be configured for the dynamic battery test function.

Value	Range	Description
<b>I<sub>1</sub></b>	0...Nominal value of I	Upper resp. lower current setting for pulsed operation (the higher value of both is automatically used as upper level)
<b>I<sub>2</sub></b>	0...Nominal value of I	
<b>P</b>	0...Nominal value of P	Maximum discharge power in Watt
<b>t<sub>1</sub></b>	1 s ... 36000 s	t1 = Time for the upper level of the pulsed current (pulse)
<b>t<sub>2</sub></b>	1 s ... 36000 s	t2 = Time for the lower level of the pulsed current (pause)

### 3.10.13.3 Other parameters

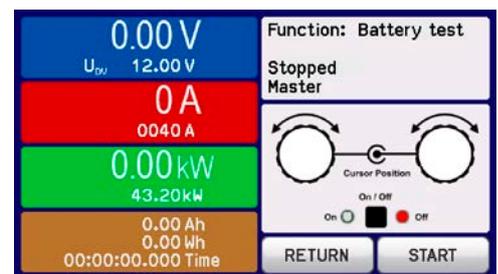
These parameters are separately adjustable in each battery test mode.

Parameter	Range	Description
<b>Discharge voltage</b>	0...Nominal value of U	Variable voltage threshold to make the test stop when reached (is connected to the battery voltage on the DC input of the load)
<b>Discharge time</b>	0...10 h	Maximum test time after which the test can stop automatically
<b>Discharge capacity</b>	0...99999 Ah	Maximum capacity to consume from the battery after which the test can stop automatically
<b>Action</b>	<b>NONE, SIGNAL, End of test</b>	Separately defines an action for parameters <b>Discharge time</b> and <b>Discharge capacity</b> . It determines what shall happen with the test run once the adjusted values for those parameters are reached: <b>NONE</b> = No action, test will continue <b>SIGNAL</b> = Text <b>Time limit</b> will be displayed, test will continue <b>End of test</b> = The test will stop
<b>Enable USB logging</b>	on/off	By setting the check mark, USB logging is enabled and will record data on a properly formatted USB stick, if plugged in to the front USB port. The recorded data differs from the USB log data recorded during "normal" USB logging in all other operation modes of the device.
<b>Logging interval</b>	100 ms - 1 s, 5 s, 10 s	Writing interval for USB logging

### 3.10.13.4 Displayed values

During the test run, the display will show a set of values and status:

- Actual battery voltage on the DC input in V
- Actual discharge current in A
- Actual power in W
- Discharge voltage  $U_{DV}$  in V
- Consumed battery capacity in Ah
- Consumed energy in Wh
- Elapsed time in HH:MM:SS,MS
- Regulation mode (CC, CP, CR)



### 3.10.13.5 Data recording (USB logging)

At the end of the configuration of both, static and dynamic mode, there is the option to enable the USB logging feature. With an USB stick plugged and formatted as required (see 1.9.6.5), the device can record data during the test run directly to the stick and in the defined interval. Active USB logging is indicated in the display with a small disk symbol. After the test has stopped, the recorded data will be available as text file in CSV format.

Log file format:

	A	B	C	D	E	F	G
1	Static:Uset	Iset	Pset	Rset	DV	DT	DC
2	0,00V	0,00A	1200W	OFF	0,00V	10:00:00	99999,00Ah
3							
4	Uactual	Iactual	Pactual	Ah	Wh	Time	
5	0,34V	0,00A	0W	0,00Ah	0,00Wh	00:00:00,800	
6	0,28V	0,00A	0W	0,00Ah	0,00Wh	00:00:01,800	
7	0,28V	0,00A	0W	0,00Ah	0,00Wh	00:00:02,800	
8	0,28V	0,00A	0W	0,00Ah	0,00Wh	00:00:03,800	

Static = Selected mode  
 Iset = Max. current  
 Pset = Max. power  
 Rset = Desired resistance  
 DV = Discharge voltage  
 DT = Discharge time  
 DC = Discharge capacity  
 U//Pactual = Actual values  
 Ah = Consumed battery capacity  
 Wh = Consumed energy



Regardless the setting for the recording interval, the values "Ah" and "Wh" are only calculated by the device once per second. When using an interval setting of < 1 s, several identical values of Ah and Wh are written into the CSV.

### 3.10.13.6 Possible reasons for a battery test stop

The battery test function run can stop or be stopped by different reasons:

- Manual stop on the HMI with touch area STOP
- After the max. test time has been reached and action **End of test** was set for it
- After the max. battery capacity to consume has been reached and action **End of test** was set for it
- Any device alarm which would also switch off the DC input, like OT
- Approaching the threshold  $U_{DV}$  (discharge voltage)

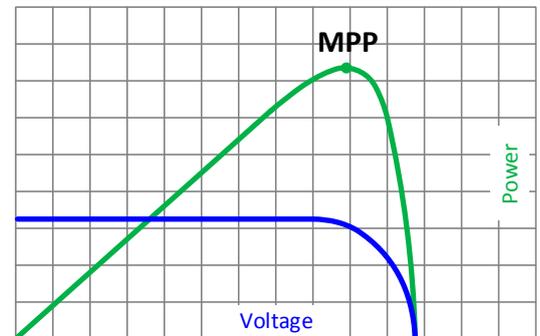
### 3.10.14 MPP tracking function

MPP stands for the maximum power point (see principle view to the right) on the power curve of solar panels. Solar inverters, when connected to such panels, constantly track this MPP once it has been found.

The electronic load simulates this behaviour by a function. It can be used to test even huge solar panels without having to connect a usually big solar inverter device which also requires to have a load connected to its AC output. Furthermore, all MPP tracking related parameters of the load can be adjusted and it so is much more flexible than an inverter with its limited DC input range.

For evaluation and analysis purposes, the load can also record measured data, i. e. DC input values such as actual voltage, current or power, to USB stick or provide them for reading via digital interface.

The MPP tracking function offers four modes. Unlike with other functions or general use of the device, values for the MPP tracking are only entered by direct input via the touch screen.



#### 3.10.14.1 Mode MPP1

This mode is also called “find MPP”. It’s the simplest option to have the electronic load find the MPP of a connected solar panel. It requires to set only three parameters. Value  $U_{OC}$  is necessary, because it helps to find the MPP quicker as if the load would start at 0 V or maximum voltage. Actually, it would start at a voltage level slightly above  $U_{OC}$ .

$I_{SC}$  is used as an upper limit for the current, so the load would not try to draw more current than the panel is specified for.

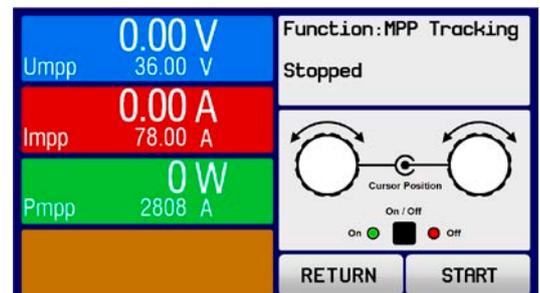
Following parameters can be configured for tracking mode **MPP1**:

Value	Range	Description
$U_{OC}$	0...Nominal value of U	Voltage of the solar panel when unloaded, taken from the panel specs
$I_{SC}$	0...Nominal value of I	Short-circuit current, max. specified current of the solar panel
$\Delta t$	5 ms...65535 ms	Interval for measuring U and I during the process of finding the MPP

Application and result:

After the three parameters have been set, the function can be started. As soon as the MPP has been found, the function will stop and switch off the DC input. The acquired MPP values of voltage ( $U_{MPP}$ ), current ( $I_{MPP}$ ) and power ( $P_{MPP}$ ) are then shown in the display.

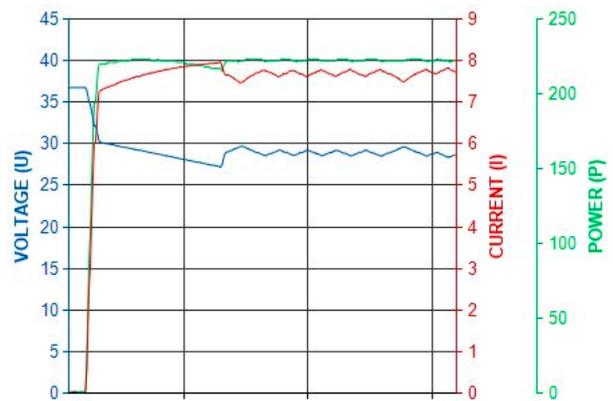
The time of a function run depends on the parameter  $\Delta t$ . Even with the minimum setting of 5 ms one run take already a few seconds.



### 3.10.14.2 Mode MPP2

This mode tracks the MPP, so it's closest to the operation of a solar inverter. Once the MPP is found, the function won't stop, but try to track the MPP permanently. Due to the nature of solar panels this can only be done below the level of the MPP. As soon as this point is reached, the voltage starts to sink further and so does the actual power. The additional parameter  $\Delta P$  defines how much the power may sink before the direction is reversed and the voltage starts to rise again until the load reaches the MPP. The result are zigzag shaped curves of both, voltage and current.

A typical curve display is shown in the picture to the right. For the example, the  $\Delta P$  was set to a quite small value, so the power curve looks almost linear. With a small  $\Delta P$  the load would always track close to the MPP.



Following parameters can be configured for tracking mode **MPP2**:

Value	Range	Description
$U_{OC}$	0...Nominal value of U	Voltage of the solar panel when unloaded, taken from the panel specs
$I_{SC}$	0...Nominal value of I	Short-circuit current, max. specified current of the solar panel
$\Delta t$	5 ms...65535 ms	Interval for measuring U and I during the process of finding the MPP
$\Delta P$	0 W...0.5 $P_{Nom}$	Tracking/regulation tolerance below the MPP

### 3.10.14.3 Mode MPP3

Also called "fast track", this mode is very similar to mode MPP2, but without the initial step which is used to find the actual MPP, because mode MPP3 would directly jump to the power point defined by user input ( $U_{MPP}$ ,  $P_{MPP}$ ). In case the MPP values of the equipment under test are known, this can save a lot of time in repetitive tests. The rest of the function run is the same as with MPP2 mode. During and after the function, the least acquired MPP values of voltage ( $U_{MPP}$ ), current ( $I_{MPP}$ ) and power ( $P_{MPP}$ ) are shown in the display.

Following parameters can be configured for tracking mode **MPP3**:

Value	Range	Description
$U_{MPP}$	0...Nominal value of U	Voltage in the MPP
$I_{SC}$	0...Nominal value of I	Short-circuit current, max. specified current of the solar panel
$P_{MPP}$	0...Nominal value of P	Power in the MPP
$\Delta t$	5 ms...65535 ms	Interval for measuring U and I during the process of finding the MPP
$\Delta P$	0 W...0.5 $P_{Nom}$	Tracking/regulation tolerance below the MPP

### 3.10.14.4 Mode MPP4

This mode is different, because it does not track automatically. It rather offers the choice to define a user curve by setting up to 100 points of voltage values, then track this curve, measure current and power and return the results in up to 100 sets of acquired data. The curve points can be entered manually or loaded from USB stick. Start and end point can be adjusted arbitrarily,  $\Delta t$  defines the time between two points and the function run can be repeated up to 65535 times. Once the function stops at the end or by manual interrupt, the DC input is switched off and the measured data is made available. After the function, the acquired set of data with the highest actual power will be shown in the display as voltage ( $U_{MPP}$ ), current ( $I_{MPP}$ ) and power ( $P_{MPP}$ ) of the MPP. Going back on the screen with RETURN then allows for data export to USB stick.

Following parameters can be configured for tracking mode **MPP4**:

Value	Range	Description
$U_1...U_{100}$	0...Nominal value of U	Voltage for the up to 100 user definable curve points
Start	1-100	Start point for the run of x out of 100 subsequent points
End	1-100	End point for the run of x out of 100 subsequent points
$\Delta t$	5 ms...65535 ms	Time before the next point
Rep.	0-65535	Number of repetitions for the run from Start to End

## 3.10.14.5 Load curve data from USB stick for mode MPP4

Alternatively to manual adjustment of the 1-100 available curve points, which can be quite time-consuming, the curve point data (only one voltage value per point) can be loaded from USB stick in form of a CSV file. See section 1.9.6.5 for the naming convention. Contrary to manual adjustment where you can define and use an arbitrary number of points, loading from USB requires the CSV file to always contain the full number of points (100), because it can't define which one is start and end. However, the on-screen setting for **Start** and **End** point remain valid. It means, if you actually want to use all 100 points from your loaded curve, you must set the parameters according.

File format definition:

- The file must be a text file with appendix \*.csv
- The file must contain only one column of voltage values (0... rated voltage)
- The file must exactly 100 values in 100 rows, no gaps
- The decimal separator of broken values must follow the setting **USB file separator format** where selection **US** means dot as decimal separator and selection **Standard** means comma

### ► How to load a curve data file for MPP4

1. While the DC terminal is switched off, enter the **MENU** and the **Function Generator** and access **MPP Tracking**.
2. In the screen switch to tab MPP4. In the lower part a button labeled **Import/Export** will appear. Tap it.
3. In the next screen tap on **LOAD MPP4 voltage values from USB**, have your USB stick ready and follow the instructions.

## 3.10.14.6 Save result data from MPP4 mode to USB stick

After the MPP4 function has run through, the result data can be saved to USB stick. The device will always save 100 data sets consisting of the actual values of voltage, current and power belonging to the points it has run through. There is no extra numbering. In case the settings **Start** and **End** were not 1 and 100, the true result data can later be filtered from the file. Points which were not adjusted are automatically set to 0 V, thus it's very important to carefully adjust start and end point because with a voltage setting of 0 V an electronic load would draw its rated current. That's because in this mode, current and power are always set to max.

Format of the result data file (for naming convention see section 1.9.6.5):

	A	B	C
1	1,01V	20,960A	21,0W
2	2,99V	20,970A	63,0W
3	3,99V	20,970A	84,0W
4	5,99V	20,940A	125,0W
5	7,00V	20,920A	146,0W
6	8,00V	20,930A	168,0W
7	9,00V	20,950A	188,0W
8	9,99V	20,960A	210,0W
9	10,99V	20,970A	231,0W

Legend:

- Column A: actual voltage of points 1-100 (=  $U_{MPP}$ )
- Column B: actual current of points 1-100 (=  $I_{MPP}$ )
- Column C: actual power of points 1-100 (=  $P_{MPP}$ )
- Rows 1-100: result data sets of all possible curve points



*The values in the example table to the left are with physical units. If that's not wanted, they can be turned off in the "General settings" of the device with parameter "USB logging with units (V,A,W)".*

### ► How to save a curve data file for MPP4

1. After the function has run through, it will stop automatically. Tap on the **RETURN** button to go back to the MPP4 configuration screen.
2. Tap on the button labeled **Import/Export**.
3. In the next screen tap on **SAVE MPP4 results to USB**, have your USB stick ready and follow the instructions. You will have the choice to either overwrite any of the displayed files or to create a new one by tapping on **-NEW FILE-**.

## 3.10.15 Remote control of the function generator

The function generator can be remotely controlled, but configuration and control of the functions with individual commands is different from manual operation. The external documentation "Programming Guide ModBus & SCPI" on the included USB stick explains the approach. In general the following items apply:

- The function generator isn't directly controllable via the analog interface; the only impact to the function run can come from pin REM-SB switching the DC input off, which will pause the function, so it could continue later with pin REM-SB switching the DC input on again and in case the function hasn't been stopped otherwise.
- The function generator is unavailable if R mode (resistance) is activated

### 3.11 Other applications

#### 3.11.1 Parallel operation in master-slave (MS)

Parallel operation of multiple cabinets isn't intended and not supported. In case the total power of one cabinet is insufficient for the planned application, certain models can be extended by another unit. See „1.9.5. Options“ and „2.3.16. Adding new units“.

For other solutions, please contact our support. See „6. Contact and support“.

#### 3.11.2 Series connection



Series connection isn't a permissible operating method for electronic loads and must not be installed or operated under any circumstances!

## 4. Other information

### 4.1 Special characteristics of master-slave operation

The units in the cabinet run in master-slave operation. This can cause additional problem situations which do not occur when operating units outside of master-slave. For such occurrences the following regulations have been defined:

- If the DC part of one or more slave units is switched off due to a defect or overheating etc., the entire cabinet shuts down the power input and human interaction is required
- If one or more slave units are cut from AC supply (power switch, blackout, supply undervoltage) and come back later, they're usually automatically initialised and included again in the MS system. In situations where the automatic initialisation fails, it can be repeated manually in the MENU of the master unit.
- If the DC input of the master unit's switched off due to a defect or overheating, then the cabinet can't sink power anymore
- If the master unit's cut from AC supply (power switch, blackout) and comes back later, it will automatically initialise the MS system again, finding and integrating all active slaves and making it possible to continue running the cabinet if being supervised by a control software which can handle such events

In situations of device alarms like OV or PF etc. following applies:

- Alarms can be generated by any slave unit in the cabinet, whereas the slave unit can't indicate anything and the master unit only displays the alarm itself, but not which unit actually caused it. This can only be monitored by software and when reading the alarm status of all units in the cabinet separately, because every unit has its own alarm counter
- If multiple alarms happen simultaneously, the master only indicates the most recent alarm in the display, but the alarm counter collects them all
- All units in the MS system supervise their own values regarding overvoltage, overcurrent and overpower and in case of alarm slave units report to the master unit. In situations where the current is probably not balanced between the units, it can occur that one unit generates an OCP alarm though the global OCP limit of the cabinet was not reached. The same can occur with the OPP alarm.

## 5. Service and maintenance

### 5.1 Maintenance / cleaning

The device needs no maintenance. Cleaning may be needed for the internal fans, the frequency of cleanse is depending on the ambient conditions. The fans serve to cool the components which are heated by the inherent dissipation of power. Heavily dirt filled fans can lead to insufficient airflow and therefore the DC input would switch off too early due to overheating or possibly lead to defects.

Cleaning the internal fans can be performed with a vacuum cleaner or similar. They are located behind the front panels of the units. For this the device can be opened on the front.

### 5.2 Fault finding / diagnosis / repair

If the equipment suddenly performs in an unexpected way, which indicates a fault, or it has an obvious defect, this can't and must not be repaired by the user. Contact the supplier in case of suspicion and elicit the steps to be taken.

It will then usually be necessary to return the device to the supplier (with or without guarantee). If a return for checking or repair is to be carried out, ensure that:

- the supplier has been contacted and it's clarified how and where the equipment should be sent.
- the device is in fully assembled state (complete cabinet) or in disassembled state (units removed and separate) and in suitable transport packaging.
- optional extras such as a digital interface module are included if this is in any way connected to the problem.
- a fault description in as much detail as possible is attached.
- if shipping destination is abroad, the necessary customs papers are attached.

#### 5.2.1 Replacing a defect mains fuse

In situations when the master unit suddenly reports an alarm or there is suddenly less power available than expected from the cabinet, one or probably several fuses could have blown. This situation is very rare, because the blackout of a unit usually has a more severe cause, like other broken components. However, after finding out which unit's concerned and having removed and opened it and the first visual inspection shows no obvious damage, it could suffice to replace a blown fuse to make the cabinet work again.

All units in the cabinet are protected by six 6.3 x 32 mm fuses (T16 A, 500 V, ceramic), located inside. To replace a fuse the unit must first be disconnected from AC supply, removed from the cabinet (see „2.3.14. Removing units“) and then opened. Inside are 3 power modules in black plastic housings, each holding two of the fuses.



Opening the device and replacing the fuses must only be carried out by technically trained personnel!

Tools required: Torx 10 screwdriver, flat screwdriver (approx. 5 mm), multimeter

#### ► Step 1: Opening the unit

1. Switch off at the mains switch and remove AC plug. Disconnect the DC input brackets from the DC bus bar.
2. Remove unit from cabinet. See „2.3.14. Removing units“ for details.
3. Remove the top cover of the device by (5 screws at the back, 5 on the front, 7 on each side, all Torx 10)
4. Remove the plastic cover(s) of the power modules.

#### ► Step 2: Replacing a defect fuse.

1. As it's usually unknown which fuse is defect, they should all be checked. The fuses are on the front side wall (looking from the front of the device) of the power modules and are covered with a soft plastic cap.
2. Remove the soft plastic cap from the fuse to be tested and carefully prise out the fuse with a flat screwdriver.
3. Check whether the fuse is intact with a multimeter, and if defective, replace with a similar type (size, values, lag)
4. Repeat step 2 for all fuses.

Once all fuses have been checked and replaced, and if no other defect is apparent, the device can be reassembled (step 1 in reverse order).

## 5.2.2 Firmware updates



Firmware updates should only be installed when they can eliminate existing bugs in the firmware in the device or contain new features.

The firmware of the control panel (HMI), of the communication unit (KE) and the digital controller (DR), if necessary, is updated via the rear side USB port. For this the software EA Power Control is needed which is included with the device or available as download from our website together with the firmware update, or upon request.

However, be advised not to install updates promptly. Every update includes the risk of an inoperable device or system. We recommend to install updates only if...

- an imminent problem with your device can directly be solved, especially if we suggested to install an update during a support case
- a new feature has been added which you definitely want to use. In this case, the full responsibility is transferred to you.

Following also applies in connection with firmware updates:

- Simple changes in firmwares can have crucial effects on the application the devices are use in. We thus recommend to study the list of changes in the firmware history very thoroughly.
- Newly implemented features may require an updated documentation (user manual and/or programming guide, as well as LabView VIs), which is often delivered only later, sometimes significantly later

## 5.3 Calibration

### 5.3.1 Preface

The devices of this series feature a function to re-adjust the most important DC input related values, which can help in case these values are out of tolerance. The procedure is limited to compensate small differences of up to 1% or 2% of the ratings. There are several reasons which could make it necessary to readjust a unit: component aging, component deterioration, extreme ambient conditions, high frequent use.

In a cabinet there can be 3-6 units which each could have a tolerance, either in positive or negative direction. Hence it's required to calibrate the units separately. While the calibration of the master unit can be done on the control panel, the slave units can only be calibrated via USB and EA Power Control. The calibration procedure, as described below, refers to the master unit. The actual calibration can be done while the master unit remains in the cabinet and all slave units are powered off.

In order to determine if a value is out of tolerance, the parameter must be verified first with measurement tools of high accuracy and with at least half the error of the EL device. Only then a comparison between values displayed on the EL device and true DC input values is possible.

For example, if you want to verify and possibly readjust the input current of unit model EL 9080-510 B (the model name is printed on the front) which has 510 A maximum current, stated with a max. error of 0.2%, you can only do that by using a high current shunt with max. 0.1% error or less. Also, when measuring such high currents, it's recommended to keep the process short, in order to avoid the shunt heating up too much. It's furthermore recommended to use a shunt with at least 25% reserve.

When measuring the current with a shunt, the measurement error of the multimeter on the shunt adds to the error of the shunt and the sum of both must not exceed the max. error of the device under calibration.

### 5.3.2 Preparation

For a successful calibration and re-adjustment, a few tools and certain ambient conditions are required:

- A measurement device (multimeter) for voltage, with a max. error of half the EL's voltage tolerance. That measurement device can also be used to measure the shunt voltage when re-adjusting the current
- If the current is also going to be calibrated: a suitable DC current shunt, ideally specified for at least 1.25 times the max. input current of the EL and with a max. error that is half or less than the max. current error of the EL device
- Normal ambient temperature of approx. 20-25 °C
- An adjustable voltage & current source which is capable of providing at least 102% of the max. voltage and current of the EL device, or separate voltage source and current source units

Before starting the calibration procedure, a few measures have to be taken:

- Let the EL device warm up for at least 10 minutes under 50% power, in connection with the voltage / current source
- In case the remote sensing input is going to be calibrated, prepare a cable for the remote sensing connector to DC input, but leave it yet unconnected
- Abort any form of remote control and deactivate resistance mode
- Install the shunt between source and EL device and make sure the shunt is cooled somehow. For example, you might want to place it in the warm air stream coming out of the rear of the EL device. This helps the shunt to warm up as well to operation temperature
- Connect suitable measurement devices to the DC input and to the shunt, depending on whether the voltage is going to be calibrated first or the current

### 5.3.3 Calibration procedure

After the preparation, the device is ready to be calibrated. From now on, a certain sequence of parameter calibration is important. Generally, you don't need to calibrate all three parameters, but it's recommended to do so.

Important:



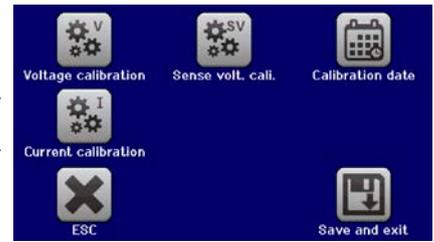
*The input current calibration should be done before any voltage calibration, because the calibrated input current is used for voltage calibration.  
When calibrating the input voltage, the remote input sense on the rear of the device has to be disconnected.*

The calibration procedure, as explained below, is an example for a master unit model EL 9080-510 B (the unit model is printed on the front of every unit). Other master unit models from other cabinet models are treated the same way, with values according to the particular master unit model and the required power source.

### 5.3.3.1 Calibrating the set values

#### ► How to calibrate the voltage

1. Adjust the connected voltage source to approx. 102% of the maximum voltage specified for the EL device. For the example with an 80 V EL this would be 81.6 V for the source. Set the current limitation of the voltage source to 5% of the nominal current specified for EL device, for this example it's approx. 25 A. Check again, that for voltage calibration, the sensing connector on the rear of the device isn't connected.
2. In the display, tap MENU, then **General Settings**, then go down to **Calibrate device** and then tap **START**.
3. In the next screen select: **Voltage calibration**, then **Calibrate input value** and **NEXT**. The load will switch the DC input on and start to measure the input voltage (**U-mon**).
4. The next screen requests you to enter the measured input voltage at **Measured value=** from the multimeter. Enter it using the keypad, that appears when tapping the value. Assure yourself the value is correct and submit with **ENTER**.
5. Repeat point 4. for the next three steps (total of four steps).



#### ► How to calibrate the current

1. Adjust the current source to approx. 102% nominal current of the EL device, for the 510 A model this would be approx. 520 A. Make sure the source can provide more current than the EL can draw, else the source's voltage will collapse. Set the output voltage of the current source to 10% of the nominal voltage specified for EL, in the example 8 V, and switch the DC input of the source on.
2. In the display, tap MENU, then **General Settings**, then go down to **Calibrate device** and then tap **START**.
3. In the next screen select: **Current calibration**, then **Calibrate input value** and **NEXT**. The load will switch on the DC input and start to measure (**I-mon**).
4. The next screen requests you to enter the input current **Measured value=** measured with the shunt. Enter it using the keypad, assure yourself the value is correct and submit with **ENTER**.
5. Repeat point 4. for the next three steps (total of four steps).

### 5.3.3.2 Calibrate the remote sensing

In case you are generally using the remote sensing feature (Sense), it's recommended to readjust this parameter too, for best results. The procedure is identical to the calibration of voltage, except for it requires to have the sensing connector on the rear to be plugged and connected with correct polarity to the DC input of the EL.

#### ► How to calibrate the remote sensing voltage

1. Adjust the connected voltage source to approx. 102% of the maximum voltage specified for the EL device. For example with an 80 V EL this would be 81.6 V for the source. Set the current limitation of the voltage source to 5% of the nominal current specified for EL device, for this example it's approx. 25 A. Check again, that for voltage calibration, the sensing connector on the rear of the device isn't connected.
2. In the display, tap MENU, then **General Settings**, then go down to **Calibrate device** and then tap **START**.
3. In the next screen select: **Sense volt. calibration**, then **Calibrate input value** and **NEXT**.
4. The next screen requests you to enter the measured sensing voltage **Measured value=** from the multimeter. Enter it using the keypad, that appears when tapping the value. Assure yourself the value is correct and submit with **ENTER**.
5. Repeat point 4. for the next three steps (total of four steps).

### 5.3.3.3 Calibrating the actual values

The display values of the actual input voltage (with and without remote sensing) and input current are calibrated almost the same way as the set values, but here you don't need to enter anything, just confirm the displayed values. Please proceed the above steps and instead of **Calibrate input val.** select **Calibrate actual val.** in the sub menus. After the device shows the measured values on display, wait at least 2 seconds for the measured value to settle and then tap **NEXT** until you are through all steps.

## 5.3.3.4 Save and exit

After calibration you may furthermore enter the current date as “calibration date” by tapping  in the selection screen and enter the date in format YYYY / MM / DD.

Last but not least save the calibration data permanently by tapping



Leaving the calibration selection menu without tapping “Save and exit” will discard calibration data and the procedure would have to be repeated!

## 6. Contact and support

### 6.1 Repairs

Repairs, if not otherwise arranged between supplier and customer, will be carried out by the manufacturer. For this the device must generally be returned to the manufacturer. No RMA number is needed. It's sufficient to package the equipment adequately and send it, together with a detailed description of the fault and, if still under guarantee, a copy of the invoice, to the following address.

### 6.2 Contact options

Questions or problems with operation of the device, use of optional components, with the documentation or software, can be addressed to technical support either by telephone or e-Mail.

Headquarter	e-Mail	Telephone
EA Elektro-Automatik GmbH Helmholtzstr. 31-37 41747 Viersen Germany	Support: support@elektroautomatik.de All other issues: ea1974@elektroautomatik.de	Switchboard: +49 2162 / 37850 Support: +49 2162 / 378566





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