Technical documentation
Last changed on: 2021-03-17

NHR series

Versatile High Precision HV Module in NIM Standard with reversible polarity

- 4 channel, polarity electronically switchable
- versatile 6kV-channel with switchable HV-generation modes: 6kV/2mA, 4kV/3mA and 2kV/4mA or fixed-mode 2kV/6mA-channel
- High Precision and Standard version (High Precision with second current measurement range 20µA for high resolution)
- common floating ground
- ultra low ripple and noise
- front panel control with 1,44" TFT display
- voltage and current control per channel
- programmable parameters
- hardware voltage and current limits
- USB and CAN interface

Document history

Version	Date	Major changes
2.5	2021-03-17	improved documentation, Item code revision and customization
2.4	2021-01-26	improved documentation, Added Accessories (Z515405), improved Glossary, SCPI control
2.3	2020-10-27	improved documentation, “IU” default configuration
2.2	2020-09-23	Improved description Option Lower output current
2.1	2020-04-14	improved documentation Technical data V_{nom}
2.0	2019-11-25	safety information, glossary, improved documentation
1.4	2019-11-12	improved documentation
1.3	2019-07-30	improved documentation
1.2	2019-05-21	troubleshooting
1.1	2018-10-01 2018-09-20	Notes revised Potential difference reduced, Layout fixes
1.0	2017-06-14	Initial version

Disclaimer / Copyright

The information in this manual is subject to change without notice. We take no responsibility for any mistake in the document. We reserve the right to make changes in the product design without reservation and without notification to the users. We decline all responsibility for damages and injuries caused by an improper use of the device.

Safety

This section contains important security information for the installation and operation of the device. Failure to follow safety instructions and warnings can result in serious injury or death and property damage.

Safety and operating instructions must be read carefully before starting any operation.

We decline all responsibility for damages and injuries caused which may arise from improper use of our equipment.

Depiction of the safety instructions

DANGER!

DANGER!

"Danger!" indicates a severe injury hazard. The non-observance of safety instructions marked as "Danger!" will lead to possible injury or death.

WARNING!

WARNING!

"Warning!" indicates an injury hazard. The non-observance of safety instructions marked as "Warning!" could lead to possible injury or death.

CAUTION!

CAUTION!

Advice marked as "Caution!" describe actions to avoid possible damages to property.

INFORMATION

INFORMATION

Advice marked as "Information" give important information.

Read the manual.

Attention high voltage!

Important information.

Intended Use

The device may only be operated within the limits specified in the data sheet. The permissible ambient conditions (temperature, humidity) must be observed. The device is designed exclusively for the generation of high voltage as specified in the data sheet. Any other use not specified by the manufacturer is not intended. The manufacturer is not liable for any damage resulting from improper use.

Qualification of personnel

A qualified person is someone who is able to assess the work assigned to him, recognize possible dangers and take suitable safety measures on the basis of his technical training, his knowledge and experience as well as his knowledge of the relevant regulations.

General safety instructions

- Observe the valid regulations for accident prevention and environmental protection.
- Observe the safety regulations of the country in which the product is used.
- Observe the technical data and environmental conditions specified in the product documentation.
- You may only put the product into operation after it has been established that the high-voltage device complies with the country-specific regulations, safety regulations and standards of the application.
- The high-voltage power supply unit may only be installed by qualified personnel.

Important safety instructions

WARNING!

To avoid injury of users it is not allowed to open the unit. There are no parts which can be maintained by users inside of the unit. Opening the unit will void the warranty.

WARNING!

The high-voltage cable must be professionally connected to the consumer/load and the connection insulated with the appropriate dielectric strength. Do not power the consumer/load outside of its specified range.

WARNING!

Before connecting or disconnecting HV cables or any operation on the HV output or the application, the unit has to be switched off and discharge of residual voltage has to be finished. Depending on application residual voltages can be present for long time periods.

WARNING!

Do not operate the unit in wet or damp conditions.

WARNING!

Do not operate the unit in an explosive atmosphere.

WARNING!

Do not operate the unit if you suspect the unit or the connected equipment to be damaged.

CAUTION!


CAUTION!

When installing the units, make sure that an air flow through the corresponding air inlet and outlet openings is possible.

CAUTION!


CAUTION!

When controlling, with software, the high voltage systems, make sure that nobody is near the high voltage or can be injured.

INFORMATION


INFORMATION

Please check the compatibility with the devices used.

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1. General description

CAUTION!
 CAUTION! The devices must only be used in combination with iseg approved crates.

The iseg NHR modules are multi-channel high voltage power supplies in 1/12 NIM standard cassette format.

The NHR provides up to 4 channels, each with an independent voltage and current control and electronically reversible polarity. The 6kV channel provides a maximum versatility: with three electronically switchable HV-output modes it can supply 4mA up to voltages of 2kV, 3mA up to 4kV and 2mA up to 6kV. Alternatively the NHR can be equipped with cost efficient 2kV/6mA channels.

Several NHR modules can be daisy-chained by CAN and controlled for example by iseg iCS system. The hardware is made of best components such as 24 bit ADC and 20 bit DAC, the approved front panel control of the NHR series with TFT display allows user-friendly intuitive operation.

The NHR is equipped with a comprehensive set of security features like over voltage and short circuit protection, hardware limits and much more.

2. Technical Data

SPECIFICATIONS	NHR Standard	NHR High Precision
Polarity	Electronically switchable	
Floating principle	Common Floating Ground	
Potential difference	Max. 39 V channel/GND	
Ripple and noise (f > 10 Hz)	< 10 mV_{p-p}	< 2 – 3 mV_{p-p}
Ripple and noise (f > 1 kHz)	< 3 mV_{p-p}	< 2 mV_{p-p}
Ripple and noise (10 Hz – 0.1Hz)		< 5 – 10 mV_{p-p}
Stablity		
Stability – [ΔV_{out} vs. ΔV_{in}]	$2 \cdot 10^{-4} \cdot V_{mode}$	$1 \cdot 10^{-4} \cdot V_{mode}$
Stability – [ΔV_{out} vs. ΔR_{load}]	$2 \cdot 10^{-4} \cdot V_{mode}$	$1 \cdot 10^{-4} \cdot V_{mode}$
Temperature coefficient	50 ppm/K	30 ppm/K | 10 ppm/K (OPTION TC, see chapter 4 Options)
Resolution		
Resolution voltage setting	$2 \cdot 10^{-6} \cdot V_{nom}$	
Resolution current setting	$2 \cdot 10^{-6} \cdot I_{nom}$	
Resolution voltage measurement [1]	$2 \cdot 10^{-6} \cdot V_{nom}$	$1 \cdot 10^{-6} \cdot V_{nom}$
Resolution current measurement - full range [1]	$2 \cdot 10^{-6} \cdot I_{nom}$	$1 \cdot 10^{-6} \cdot I_{nom}$
Resolution current measurement [I_{out} < 20 µA] (2nd range) [1] [3]	n/a	50 pA
Measurement accuracy – The measurement accuracy is guaranteed in the range 1% • V_{mode} < V_{out} < V_{mode} and for 1 year		
Accuracy voltage measurement	± (0.01 % • V_{out} +0.02 % • V_{nom})	± (0.01 % • V_{out} +0.01 % • V_{nom})
Accuracy current measurement – full range	± (0.01 % • I_{out} +0.02 % • I_{nom})	± (0.01 % • I_{out} +0.01 % • I_{nom})
Accuracy current measurement (2nd range) [3]	n/a	± (0.01 % • I_{out} + 4 nA)
Sample rates (SPS)	5, 10, 25, 50, 60, 100, **500** [2]	5, 10, 25, **50** [2], 60, 100, 500
Digital filter averages	1, 16, **64** [2], 256, 512, 1024	
Hardware limits	Potentiometer per module [V_{max} / I_{max}]; relative to V_{nom} / I_{nom}	
Voltage ramp	$1 \cdot 10^{-6} \cdot V_{nom}$/s up to 0.2 • V_{nom}/s | opt. up to 0.75 • V_{nom}/s	
Digital interface	USB interface (potential free), CAN interface (potential free)	
Power requirements of supply voltages	± 24 V: 1.5 A at full load (0.5 A with option L, see Table 3: Technical data: Options and order information), 0.5 A with no load at V_{nom}	
Operating mode	Full module and channel control via: Front panel, USB interface: iseg SCPI, CAN interface: EDCP (Enhanced Device Control Protocol)	
Module status	green LED turns on if the channel has the status “Ready” yellow LED turns on if the channel has the status “HV ON”	
HV connector	SHV	
System connector	NIM standard compliant connector	

SPECIFICATIONS (continued)	NHR Standard	NHR High Precision
Safety Loop connector	Lemo 2pole: EPG.00.302.HLN	
Safety Loop socket	Lemo 2pole: FGG.00.302.CLAD30	
Single channel inhibit connector	SUB-D9 male	
Protection	INHIBIT, Safety loop, short circuit, overload, hardware V/I limits Overload and short circuit protected (**ATTENTION: there is only one short circuit or arc per second allowed!**)	
Case	1/12 NIM standard cassette	
Operating temperature	0 … 40 °C	
Storage temperature	-20 … 60 °C	
Humidity	20 – 80 %, not condensing	

Notes:
[1)] The resolution of measurable values depends on the settings of the sampling rate and the digital filter!
[2)] Standard factory settings
[3)] not available with Option L

Table 1: Technical data: Specifications

CONFIGURATIONS NHR										
Type	**Ch**	**Precision**	**V_{nom}**	**I_{nom}**	**Ripple (mV_{p-p})**			**HV output mode (V_{mode} / I_{mode})**	**Item Code**	**Options**
					>1kHz	10Hz-1kHz	0.1Hz-10Hz			
NHR 20 20	2	Standard	2000 V	6 mA	3	10	n/a	2 kV / 6 mA	NR020020R605oooccrk	VCT, IU, ID
NHR 20 60	2	Standard	6000 V	4 mA	3	10	n/a	6 kV / 2mA 4kV / 3mA 2kV / 4mA	NR020060R405oooccrk	VCT, IU, ID
NHR 40 20	4	Standard	2000 V	6 mA	3	10	n/a	2 kV / 6 mA	NR040020R605oooccrk	VCT, IU, ID
NHR 40 60	4	Standard	6000 V	4 mA	3	10	n/a	6 kV / 2mA 4kV / 3mA 2kV / 4mA	NR040060R405oooccrk	VCT, IU, ID
NHR 22 20	2	High	2000 V	6 mA	2	2	5	2 kV / 6 mA	NR022020R605oooccrk	VCT, IU, ID, TC, L
NHR 22 60	2	High	6000 V	4 mA	2	3	10	6 kV / 2mA 4kV / 3mA 2kV / 4mA	NR022060R405oooccrk	VCT, IU, ID, TC, L
NHR 42 20	4	High	2000 V	6 mA	2	2	5	2 kV / 6 mA	NR042020R605oooccrk	VCT, IU, ID, TC, L
NHR 42 60	4	High	6000 V	4 mA	2	3	10	6 kV / 2mA 4kV / 3mA 2kV / 4mA	NR042060R405oooccrk	VCT, IU, ID, TC, L

Notes:
the Option "IU" is default
replacement characters: o – options, c – connector, r – revision, k – customization

Table 2: Technical data: Configurations

OPTIONS / ORDER INFO	INFO	EXAMPLE	ITEM CODE HEX CODE
SINGLE CHANNEL INHIBIT - down	**ID**		**400**
SINGLE CHANNEL INHIBIT - up	**IU** [2]		**000**
VOLTAGE CORRECTION by TEMPERATURE	**VCT**		**008**
LOWER TEMPERATURE COEFFICIENT [1]	**TC**		**004**
LOWER OUTPUT CURRENT [1]	**L** (I_{nom} = 100 µA)	NHR 4260 **L**	**–**
Notes: [1] Requires NHR "High Precision" Series [2] the Option "IU" is default			

Table 3: Technical data: Options and order information

3. Handling

3.1 Connection

The supply voltages are connected to the module via the NIM-connector on the rear side of the module. An USB connector and two 3,5mm audio jack connectors for the CAN interface are located on the front panel. The second CAN connector can be used to daisy-chain several NHR and/or NHS modules.

3.2 Front Panel Control

Front	Description

Context sensitive buttons left and right for navigation inside the menus

Display shows monitor and control values

Rotary encoder with push button to navigate in menu and set values

LED „OK“ signals condition of the corresponding channel

LED „HV ON“ signals a measured output voltage at the corresponding channel

LED „POS“ and **„NEG“** indicate the selected polarity of the corresponding channel

On/Off switches to turn the corresponding channel on or off

Hardware limit set screws V_{max} and I_{max} to set the maximum output voltage or current relatively to the absolute maximum values of the channel (V_{nom} / I_{nom})

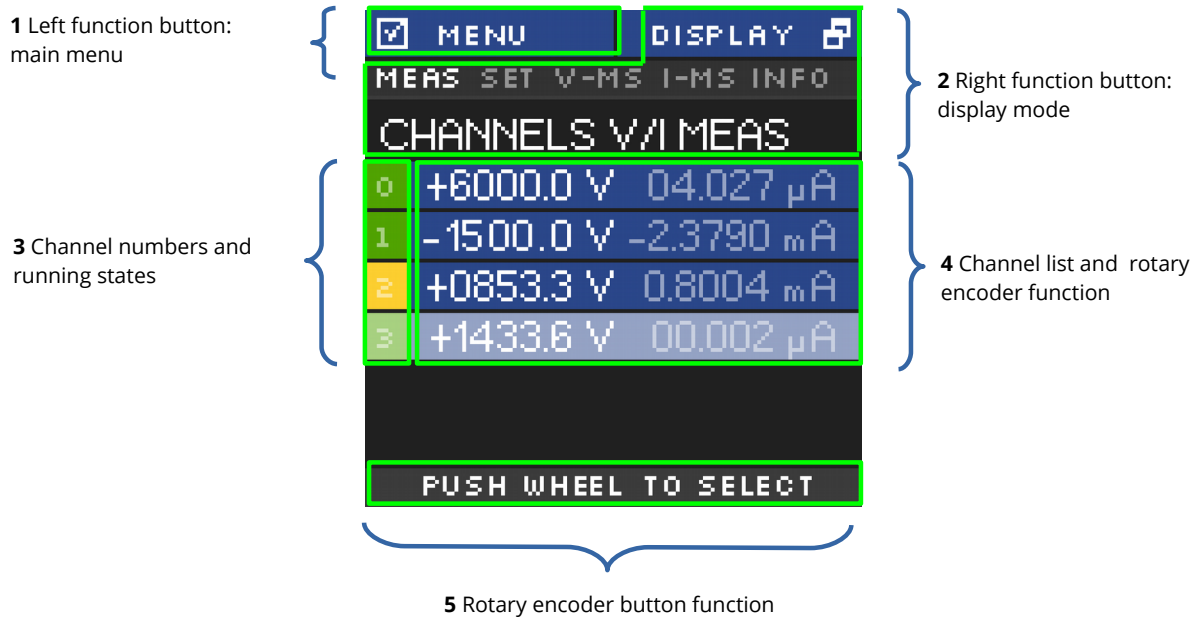
USB and **Safety Loop** connector

CAN connectors

Single channel Inhibit connector

3.2.1. Main Screen (Channel List)

After start up of the NHR the display will show a Main screen similar to the following image which consists of 5 elements:



1. Left function button: main menu

Shows the function of the left button. If the user pushes the left button in Main screen, the display will show the Menu screen.

2. Right function button: display mode

If the user pushes the right button in Main screen, the Main screen will switch to the next display mode, which is shown directly above the channel list.

Following display modes are available:

1. V/I-MEAS	→	voltage and current – measured values
2. V/I-SET	→	voltage and current – set values
3. V-MS	→	voltage – measured and set values
4. I-MS	→	current – measured and set values
5. INFO	→	maximal values of the selected output mode

3. Channel numbers and running states

This is part of the channel list (4) and shows the corresponding channel number. The background color signals the running state of each channel. The background colours means the following:

Black	→	the channel is switched off
Green	→	the channel is switched on
Yellow	→	the channel is switched on but no regulation (CV, CC) is active
Orange	→	the channel is switched on but has unmasked error event(s)
Red	→	the channel has at least one masked error event

4. Rotary encoder button function

If the user presses the button of the rotary encoder, the menu will switch to the channel menu of the marked channel.

5. Channel list and rotary encoder function

The channel list shows-dependent on the display mode-measure and/or set values of voltage and current for each channel.

In display mode VI-MEAS the following can be seen:

If a channel is switched off, the values of V_{meas} and I_{meas} are grey.

If a channel is in constant voltage regulation, V_{meas} value is white and I_{meas} value is grey

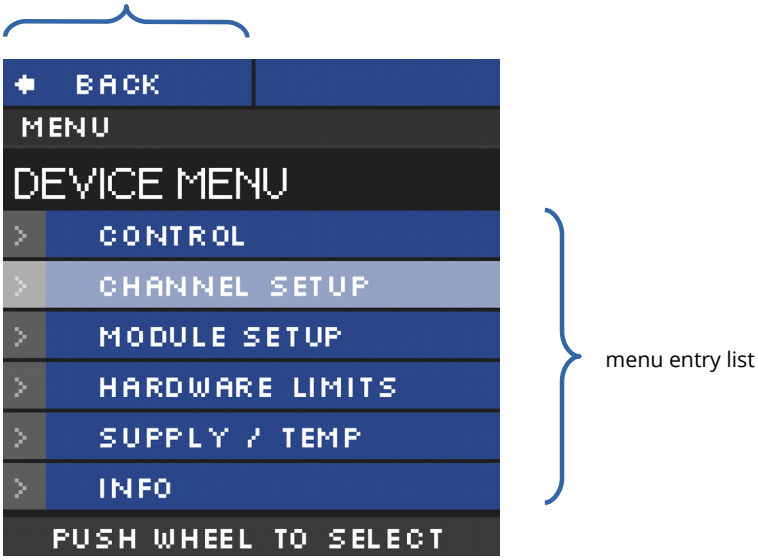
If a channel is in constant current regulation, V_{meas} value is grey and I_{meas} value is white

The channel row which is slightly brighter (in image channel 4) is the marked channel by the rotary encoder. Turning the rotary encoder counter-clockwise will mark the channel above the current channel and turning clockwise will mark the channel below the current channel.

3.2.2. Menu Screen

By pressing the left button in Main screen, the display will switch to the menu screen, that looks similar to the image below:

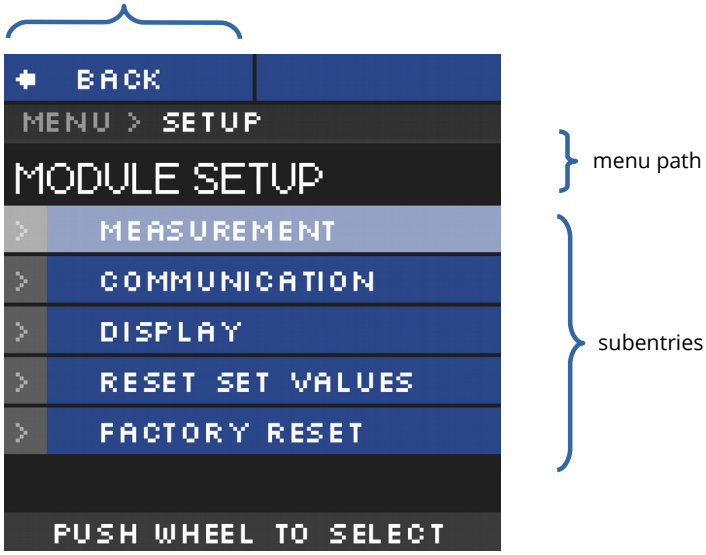
back to Main screen by pressing left button



The menu screen shows menu entries to set up behavior and check information of the device hardware.

To enter a menu entry, the user has to mark an entry by turning rotary encoder and then pressing the rotary encoder button. The selected entry is then shown in the menu path.

back to menu screen



3.2.3. Menu Structure

Available Menu entries are:

Entry	Sub-entry	Sub-entry		Content
CONTROL	VOLTAGE RAMP	–		Set voltage ramp speed
	CURRENT RAMP	–		Set current ramp speed
	CLEAR ALL EVENTS	–		Clear all events
	SET KILL ENABLE	–		Set mode Kill Enable/Disable
	DELAYED TRIP ACTION	–		Enable and define action for delayed trip
	DELAYED TRIP TIME	–		Set time for delayed trip
CHANNEL SETUP	ALL CHANNELS	POLARITY	POS	Set polarity of channel
			NEG	
	CHANNEL 0	OUTPUT-MODE		Set output-mode of channel (see Table 3: Technical data: Options and order information)
	CHANNEL 1			
	CHANNEL 2			
	CHANNEL 3			
MODULE SETUP	MEASUREMENT	ADC SAMPLE RATE		Set ADC sample rate
		DIGITAL FILTER		Set digital filter steps
	COMMUNICATION	CAN BUS BITRATE		Set CAN bus bitrate
		CAN BUS ADDRESS		Set CAN bus ID
		CAN BUS STATUS		Show the CAN BUS Bitrate, Address, Connect, RX and TX Information
	DISPLAY	POWER SAVE		Set display power safe mode
	RESET SET VALUES	–		Reset all set values
	FACTORY RESET	–		Reset all settings to factory default
HARDWARE LIMITS	–	–		Shows hardware limits V_{max} and $I_{max.}$. This screen is automatically shown, if the hardware limits were changed.
SUPPLY / TEMP	–	–		Shows supply voltages and temperature
INFO	–	–		Shows serial number, firmware name and release, nominal voltage and current

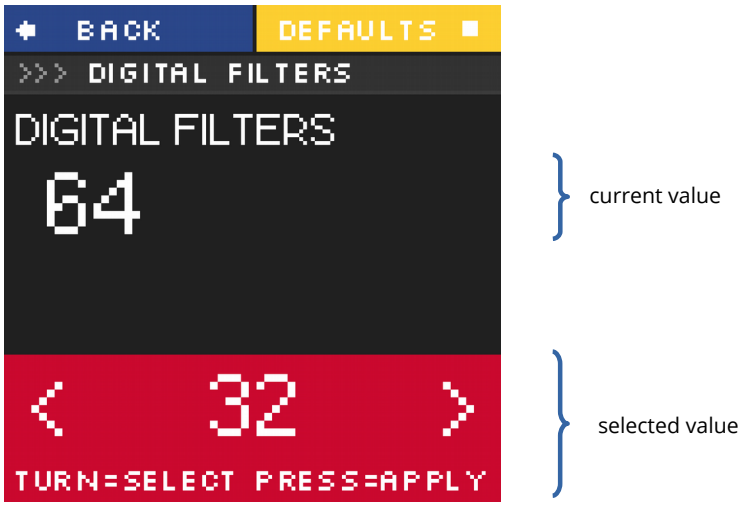
Table 4: Menu Structure

3.2.4. Editing Menu Entries

A Menu entry that has a fixed amount of possible values can be easily edited by turning the rotary encoder, the selected value will be shown at the bottom of display screen.

A submit and save of the selected value is done by pressing the rotary encoder button.

A reset to its default value is done by pressing the right button.



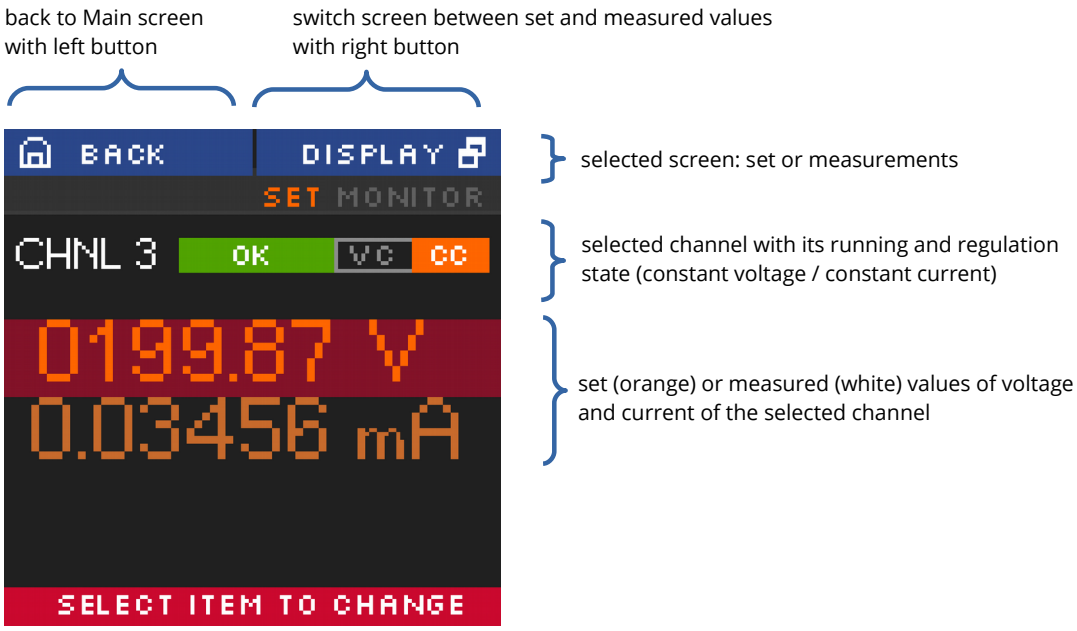
A menu entry with a none-fixed amount of values e.g. voltage ramp speed is edited a little bit different.

The selected value is also shown at the bottom of the display but with a digit highlighted by a cursor. A short press on the rotary encoder button and the cursor will jump to the next lower digit. Turning the rotary encoder changes the selected value in the resolution of the corresponding digit.

A submit and save of the selected value is done by pressing and holding the rotary encoder button for more than one second.

3.2.5. Channel Details

To change the set values of a channel or to monitor one single channel with larger digits, the Channel screen needs to be entered. This can be done in Main screen by turning the rotary encoder until the wished channel is marked and then pressing the rotary encoder button to select it. A screen similar to the following will be shown.



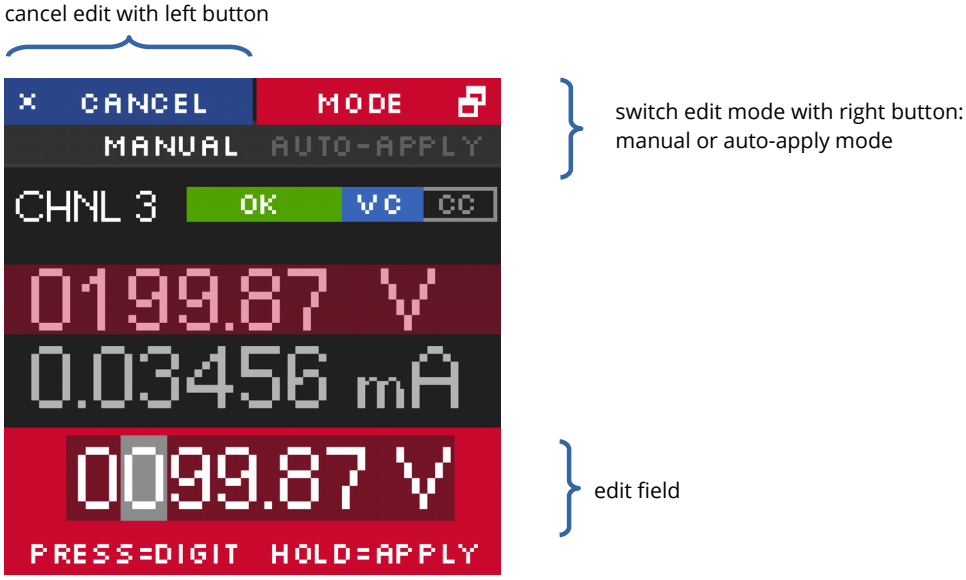
3.2.6. Editing Channel Set Values

In the channel screen it is possible to edit set values of the selected channel. This is done by marking current or voltage value by turning rotary encoder and applying this by pressing the rotary encoder button. An edit field beneath the shown values will be displayed.

The edit value is shown with a digit hi-lighted by a cursor. A short press on the rotary encoder button and the cursor will jump to the next lower digit. Turning the rotary encoder changes the selected value in the resolution of the digit.

Submit and apply of the edit value is done by pressing and holding the rotary encoder button for more than one second.

There are two modes of editing available: manual and auto-apply. In manual mode, the edited value is not accepted until the user applied it with pressing and holding the rotary encoder button. In auto-apply mode the edit value is immediately accepted as turning the rotary encoder.



3.3 Channel Switches and LEDs

The front panel of the NHR device is equipped for each channel with a “On/Off” switch to turn the channel on and off, two status LEDs (“OK” and “HV ON”) and two LEDs (“POS” and “NEG”) to indicate the selected polarity.

The green LED “OK” signals the general condition of the channel and the yellow LED “HV ON” signals measured output voltage at the corresponding channel or is flashing shortly every time the user presses the corresponding “On/Off” switch.

Following behaviors are possible:

LED “OK”	LED “HV ON”	Meaning
not illuminated	not illuminated	An error event occurred, the channel cannot be switched on.
not illuminated	illuminated	An error occurred but there is still a measured voltage at the channel.
illuminated	not illuminated	The channel is switched off and can be turned on.
illuminated	illuminated	The channel is turned on and there is output voltage at the channel.
	flashing	The channel is ramping up or down

Table 5: LED Status information

3.4 Remote Control

The NHR devices offer two remote control interfaces: USB and CAN.

With the USB connector, one NHR can be controlled with the "iseg SCPI instruction set" (see chapter "5.1. SCPI Instruction Set"). Available control applications are "isegTERMINAL" and "iseg SCPI Control". Please consider the "SCPI Programmers-Guide" (see chapter 9 Appendix) for further details.

With the CAN interface connectors, up to 64 NHR/NHS devices can be controlled on one CAN line. Therefore every device has to have a unique CAN Bus address, which can be configured in the Device Menu. Please consider "CAN EDCP Programmers-Guide" (see chapter 9 Appendix) for further details.

3.5 Polarity and Output-Mode selection

For all channels of NHR devices the polarity can be electronically switched. This can be done via the front panel (*MENU* ➞ *CHANNEL SETUP* ➞ *CHANNEL X* ➞ *POLARITY*) or via remote control.

Modules with V_{nom} = 6kV (except option **L**) also provide switchable HV-output modes which allow to switch the nominal values of a channel between 2kV/4mA, 4kV/3mA and 6kV/2mA. This can be done via the front panel (*MENU* ➞ *CHANNEL SETUP* ➞ *CHANNEL X* ➞ *OUTPUT-MODE*) or via remote control.

Switching the polarity or output mode is only allowed if the corresponding channel is switched off and discharged below $0.002 \cdot V_{nom}$. The module blocks all switching attempts if these conditions are not satisfied.

CAUTION!

CAUTION!

The device is not designed to operate as a current sink.
Never apply external voltages of opposite polarity to the selected one or with values greater than the maximum value of the selected output mode. This can damage the module.

3.6 Protection Features

3.6.1. Hardware Limit

The maximum output voltage for all channels (hardware voltage limit) is defined through the position of the corresponding potentiometer V_{max}. The maximum output current for all channels (hardware current limit) is defined through the position of the corresponding potentiometer I_{max}. The greatest possible set value for voltage and current is given by V_{max} – 2% and I_{max} – 2%, respectively. The percentage values always refer to the nominal values of the channel, V_{nom} and I_{nom}. E.g. for a 6kV/4mA module the reference values are 6kV and 4mA, independent of the selected output mode. The output voltage and current are limited to the specified value. If the maximum voltage or current of the selected output mode (V_{mode} or I_{mode}) is below this limit, this will further limit the output.

If a limit is reached or exceeded in any channel the corresponding green LED on the front panel turns off.

3.6.2. Safety Loop

A safety loop can be implemented via the safety loop socket (SL) on the front panel.

If the safety loop is active, then an output voltage in any channel is only present if the safety loop is closed and an external current in a range of 5 to 20 mA of any polarity is driven through the loop. The loop connectors are potential free, the internal voltage drop is approx. 3 V.

If the safety loop is opened during the operation, the output voltages are shut off without ramp. Furthermore, the corresponding bits in the „*ModuleStatus*" and „*ModuleEventStatus*" registers are set ("CAN EDCP Programmers-Guide", see chapter 9 Appendix). After closing the loop again, the „*ModuleEventStatus*" register must be reset to turn the channels on again. By factory setup the safety loop is not active (the corresponding bits are always set). The loop can be activated by removing the internal jumper. The jumper can be accessed via a ventilation slot on the bottom of the module (see Detail of Figure 1, 2 for "SL" Jumper for exact position.

3.6.3. Single channel Inhibit

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INHIBIT is an external signal, that switches off the high voltage for the device or a specific channel.

The Sub-D connector on the bottom of the front panel allows to install an Inhibit for each channel. The pin assignment is as follows:

Channel 0 – 3 / GND	0	1	2	3	GND				
SUB-D9 connector pin	1	2	3	4	5	6	7	8	9

Table 6: INHIBIT connector pinout

The INHIBIT signals are TTL-level, the signal logic is defined by selected option. The following configurations are possible:

Option 1 – IU (default)

INHIBIT signal logic:	LOW-active (LOW ➞ HV-generation stopped)
default state:	HIGH (internal pull-up resistor applied)
open INHIBIT signal input:	HV enabled

Option 2 – ID

INHIBIT signal logic:	LOW-active (LOW ➞ HV-generation stopped)
default state:	LOW (internal pull-down resistor applied)
open INHIBIT signal input:	HV disabled

Option 3 – NIU

INHIBIT signal logic:	HIGH-active (HIGH ➞ HV-generation stopped)
default state:	HIGH (internal pull-up resistor applied)
open INHIBIT signal input:	HV disabled

Option 4 – NID

INHIBIT signal logic:	HIGH-active (HIGH ➞ HV-generation stopped)
default state:	LOW (internal pull-down resistor applied)
open INHIBIT signal input:	HV enabled

The INHIBIT signal must be applied for at least 100 ms to guarantee a detection. If an Inhibit signal is detected, the channel status bit "*isExternalInhibit*" and the channel event status bit "*EExternalInhibit*" are set. One of the following reactions to this signal can be programmed (see chapter "3.5.1.11 External channel inhibit" in the "CAN EDCP Programmers-Guide", see chapter 9 Appendix)

- No Action (default)
- Turn off the channel with ramp
- Shut down the channel without ramp
- Shut down all channels without ramp

When the INHIBIT is no longer active, the Inhibit flag must be reset before the voltage can be switched on again.

3.7 Floating GND configuration

The NHR module is a module with Common Floating Ground (CFG). All HV-channels have a common return potential (module GND), which is galvanically isolated from the crate GND. A protection circuit prevents differences between the two GND potentials of more than 56V. The galvanic isolation can be removed by placing a jumper on a two-pin connector located in a ventilation slot on the top of the module (see Detail of Figure 1, 2 for "CFG - CG" Jumper for exact position).

The GND of the digital interfaces (USB and CAN) is isolated from both, the module GND and the crate GND.

3.8 Current limitation

3.8.1. Constant Current Mode

The Constant Current Mode (CC) is the default response on an increased output current. If the output current would exceed the set current (I_{set}) at the specified set voltage (V_{set}) the channel operates as a constant current source at I_{set}. For modules with one current measurement range the module can operate in CC Mode for I_{set} values in the range $I_{nom} \geq I_{set} \geq 5E\text{-}04 \cdot I_{nom}$. Although the modules accepts smaller values I_{set}, the CC Mode can only operate down to the given limitation. Smaller set value will only affect the functions KillEnable and Delayed Trip, described below.

Modules with two current measurement ranges can operate in CC Mode with I_{set} values down to 200 nA. The following limitations must be considered when operating a channel with I_{set} values in the lower current measurement range (i.e. typically <20µA):

- If I_{set} < 20µA the maximum voltage ramp speed is limited to 1 % of V_{nom}. If the load has a significant capacitance it might be necessary to further reduce the voltage ramp speed to avoid ramp instabilities.
- While a channel is operating in CC Mode it is not possible to switch between the two current measurement ranges, i.e. the set current cannot be changed from a value > 20 µA to a value < 20 µA or vice versa. To change the set current across the measurement range boundary the channel must stop operation in CC mode (i.e. by switching off the channel or reducing the voltage such, that it operates in Constant Voltage Mode (CV)).

3.8.2. KillEnable

The function "*KillEnable*" forces the shut down of a channel at the fastest hardware response time (smaller than 1 ms) if a specified trip current is exceeded. If "*KillEnable*" is active the value of the set current (I_{set}) defines the trip current. An approach or exceed of this current (detected by a hardware signal) will immediately shut off the channel without ramp. However, the actual discharge time strongly depends on the connected load.

The following limitations must be considered if the function "*KillEnable*" is activated:

- Maximum voltage ramp speed is limited to 1 % of V_{nom}. To avoid unintended current trips during ramps it might be necessary to further reduce the ramp speed for very small trip currents or capacitive loads. Alternatively "*KillEnable*" can be activated only after the completion of the ramp.
- The minimum trip currents for a hardware detection is $5E\text{-}04 \cdot I_{nom}$ for modules with one current measurement range and 200 nA for modules with two current measurement ranges. It is possible to specify smaller trip values, however there is no hardware current limitation below the hardware detection limits. Also, the response time on a trip that does not trigger the hardware detection can be up to 1s.
- Modules with two current measurement ranges do not change the current measurement range if "*KillEnable*" is active. The channel remains in the high measurement range if I_{set} > 20µA and in the low measurement range for $I_{set} \leq$ 20µA. It is not possible to switch the current measurement while a channel is switched on and "*KillEnable*" is active, i.e. the set current cannot be changed from a value > 20 µA to a value < 20 µA or vice versa. If it is intended to switch the current measurement range, the channel must be switched off or "*KillEnable*" must be deactivated for altering the current set value.

3.8.3. Delayed Trip

The function "*Delayed Trip*" provides a user-configurable, time-delayed response to an increased output current (I_{out}) higher than the set current (I_{set}). The response to this kind of event can be, for example, to ramp down the channel with the programmed ramp. A detailed description for the configuration can be found in the “CAN EDCP Programmers-Guide”, see chapter 9 Appendix.

By a programmable timeout with one millisecond resolution, the trip can be delayed up to four seconds. During this time, the output current is limited to the value of I_{set} (constant current mode).

The hardware regulation signals, constant voltage (CV) or constant current (CC), are sampled every millisecond by the microprocessor. Once the constant current mode is active, the programmed timeout counter is decremented. If the HV channel returns to constant voltage mode before timeout (i.e. $I_{out} < I_{set}$), the counter will be reset. So this process can be restarted if the current rises again.

To guarantee a sufficient resolution for the current set values, a nominal current adequate to the application should be selected. iseg offers HV modules with nominal currents reduced to 100 µA in all voltage classes. These are designated e.g. for semiconductor detectors, which only require a few microampere operating current.

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INFORMATION

An activated KillEnable feature disables the Delayed Trip function.

4. Options

4.1 VCT – voltage correction by temperature

This option allows a temperature dependent correction of the output voltage. The temperatures are measured with a distinct sensor for each channel. An user-adjustable VCT-coefficient allows to specify a linear relationship between the measured temperature and the output voltage. As an option one sensor per module can be ordered.

4.1.1. Technical data

Sensor type	EPCOS B57867S0502F140
Temperature range	-40 ... 80°C
Accuracy of temperature measurement	±0.5 K (0 ... 60°C)
Resolution of temperature measurement	1 mK (0 ... 60°C)
Temperature update rate	15 updates/min

Table 7: Technical data VCT sensor

4.1.2. Operation

The connector of the temperature sensor must be plugged in the slot of the corresponding channel on the VCT-connector at the rear panel of the HV-module.

A programmable VCT-coefficient for each channel defines the rate and the direction of the voltage correction. The temperatures, measured at the sensors can be read out from the module.

At the time a HV-channel is switched on or the output voltage is set by the user, the module registers the temperature (T_{ref}) of the corresponding sensor and the set voltage as reference values.

If the temperature (T) at the sensor changes, the output voltage is automatically adjusted according to the formula:

$$\mathbf{V = V_{ref} + a \bullet (T - T_{ref})} \qquad \textbf{(a...VCT-coefficient)}$$

Example: A channel is set to 60V. At the time it is switched on a temperature of 25°C is measured. The VCT-coefficient is set to +1V/K. If the temperature now increases to 26°C the output voltage will increase to 61V. (For channels with a negative output voltage the voltage changes from –60V to –61V).

A VCT-coefficient of -1V/K would decrease the voltage to 59V.

Notes:

- During operation the values for V_{set} are adjusted. If a channel is switched off the adjusted set value will be kept, not the original value set by the user.
- If the VCT-coefficient if modified during operation, V_{ref} and T_{ref} are reset to the present values to prevent a sudden voltage change.
- If the temperature sensor is dis- and reconnected during operation, V_{ref} and T_{ref} are reset to the present values to prevent a sudden voltage change.
- The temperature dependent voltage correction can be deactivated by setting the VCT-coefficient to 0 or by disconnecting the temperature sensor. If this is done during operation, the channel will keep the actual voltage set.
- If the temperature sensor is disconnected a temperature of -273.15°C is shown for that channel.
- The VCT data points are described in the reference manual “CAN EDCP Programmers-Guide” (see chapter 9 Appendix) and in the manual “iseg Hardware Abstraction Layer” (see chapter 9 Appendix).

4.2 Single Channel Inhibit (IU, ID, NIU, NID)

INFORMATION

INHIBIT is an external signal, that switches off the high voltage for the device or a specific channel.

This option specifies the logic of single channel INHIBIT signal see chapter 3.6.3 Single channel Inhibit for details.

4.3 L – Lower output current (HP only)

The output current is limited to a lower value, e.g. 100 µA. With this option only one current measurement range available.

4.4 T10 – Lower temperature coefficient (HP only)

Improved temperature coefficient of 10ppm/K.

5. Dimensional drawings

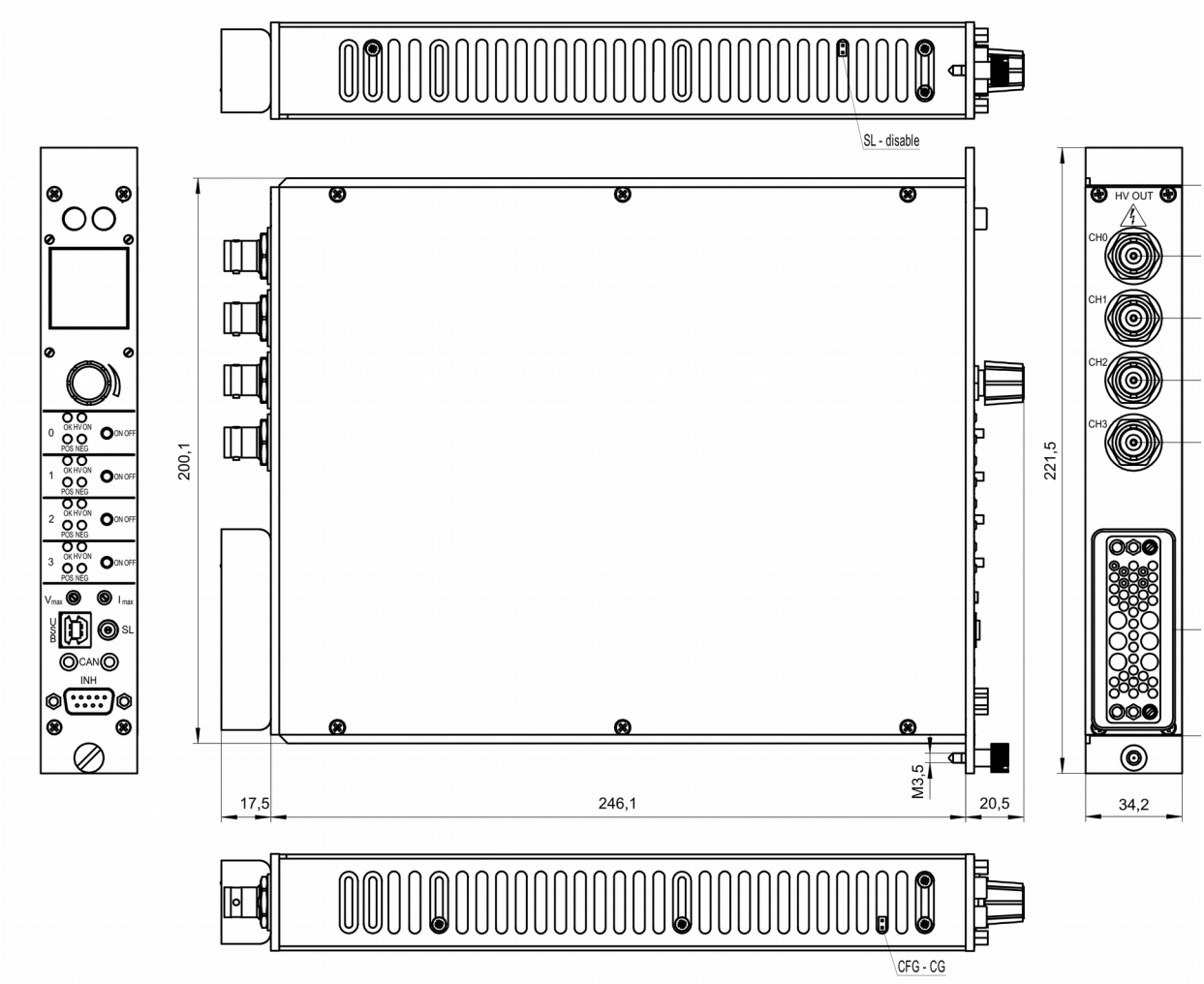


Figure 1: Dimensional drawings, NHR 4 channels

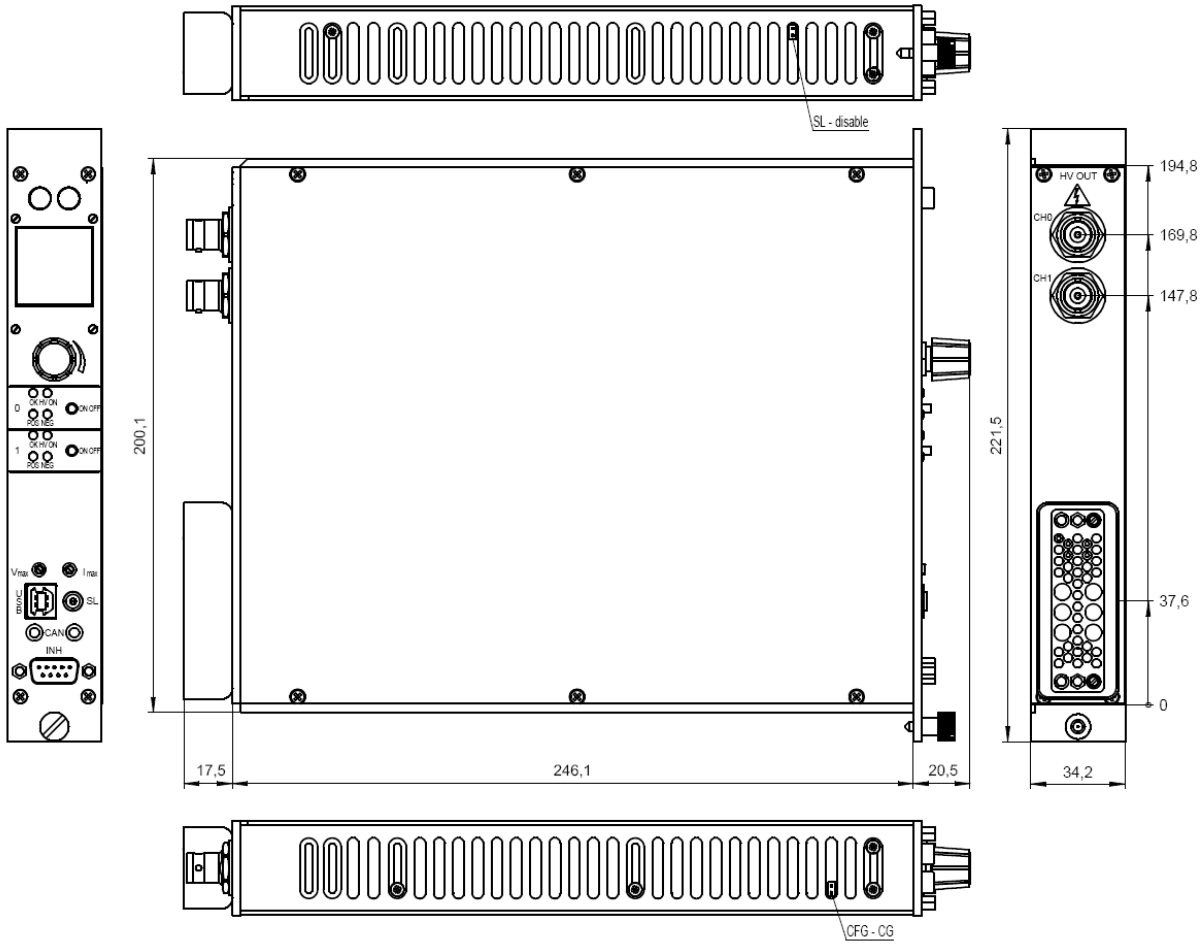


Figure 2: Dimensional drawings, NHR 2 channels

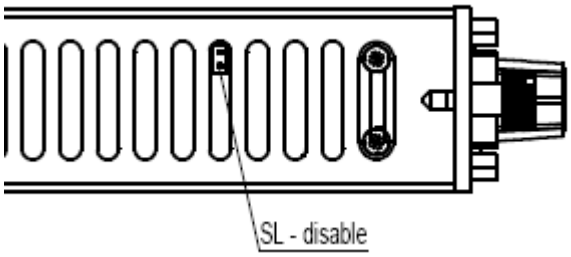


Figure 3: Detail of Figure 1, 2 for "SL" Jumper

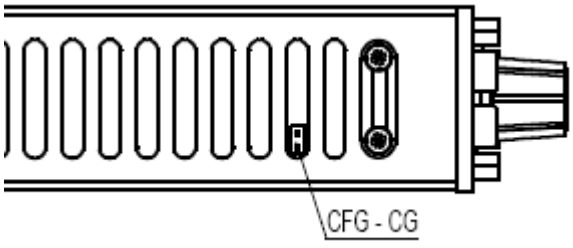


Figure 4: Detail of Figure 1, 2 for "CFG - CG" Jumper

6. Connectors and PIN assignments

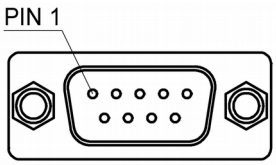
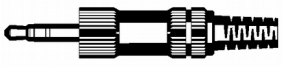
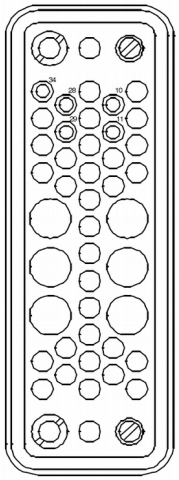
	HV CONNECTOR ASSIGNMENTS			
Name	SHV			
Figure				
	INHIBIT		**SAFETY LOOP**	**CAN**
Name	INHIBIT connector- DSUB9	INHIBIT connector- DSUB9	Safety Loop socket	CAN connectors
Figure	**PIN** **INHIBIT 1** 1 CHANNEL 0 2 CHANNEL 1 3 CHANNEL 2 4 CHANNEL 3 5 GND 6 GND 7 GND 8 GND 9 GND			
	NIM standard compliant connector			
	PIN **Signal** 10 +6 V 11 -6 V 28 +24 V 29 -24 V 34 GND			

Table 8: Connector and pin assignments

CONNECTORS PART NUMBERS (manufacturer code / iseg accessory parts item code)			
POWER SUPPLY SIDE		**CABLE SIDE**	
SHV (ROSENBERGER)			
Socket		Connector	57K101-006N3 / Z590162
Safety Loop (LEMO)			
Socket		Connector	FGG.00.302.CLAD30
CAN			
		Connector	KLS44

Table 9: Connectors part number information

7. Accessories

CAUTION!

CAUTION!

Only use genuine iseg parts like power cables, CAN cables and terminators for stable and safe operation.

ACCESSORY ITEM	ORDER ITEM CODE
CAN to host: from Jack plug 3.5mm to D-SUB female	Z515404
CAN daisy-chain: from Jack plug 3.5mm to Jack plug 3.5mm	Z515554
VCT Sensor cable: 10m: from Jack plug 2.5mm (2pol) to Probe	Z585877
Lemo plug 2-pole (Safety Loop)	Z201466
SHV coupler screw for RG58	Z590162
SHV coupler screw for RG58 (>5kV)	Z592474
Can Bus termination Jack plug 3.5mm (120 Ω)	Z515405

Table 10: Accessory

8. Order guides

CABLE ORDER GUIDE					
POWER SUPPLY SIDE CONNECTOR	**V_{max}**	**CABLE CODE**	**CABLE DESCRIPTION**	**LOAD SIDE CONNECTOR**	**ORDER CODE** *LLL = length in m* [1]
SHV	≤ 5kV	04	HV cable shielded 30kV (HTV-30S-22-2)	open	SHV_C04-*LLL*
S08	≤ 8kV	04	HV cable shielded 30kV (HTV-30S-22-2)	open	S08_C04-*LLL*
Notes: 1) Length building examples: 10cm ➜ 0.1, 2.5m ➜ 2.5, 12m ➜ 012, 999m ➜ 999					

Table 11: Guideline for cable ordering

CONFIGURATION ORDER GUIDE (item code parts)									
NR	**04**	**0**	**020**	**R**	**605**	**000**	**02**	**0**	**0**
High Voltage, Distinct Source	Numbers of channels	Class	V_{nom}	Polarity	I_{nom} (nA)	Option (hex)	HV-Connector	Revision	Customized Version
	02 = 2ch 04 = 4ch	0 = Standard 4 = High Precision	three significante digits • 100V For Examle: 020 = 2000V	R = reversible	two significante digits + number of zeros For Examle: 605 = 6mA	Sum of the hex codes (see Table 3: Technical data: Options and order information)	02 = SHV	one digit 0 = no revision A = first revision B = second revision	one digit 0 = no customization

Table 12: Item code parts for different configurations

9. Appendix

For more information please use the following download links:

This document
https://iseg-hv.com/download/SYSTEMS/NIM/NHR/iseg_manual_NHR_en.pdf
iCS (iseg Communication Server)
https://iseg-hv.com/download/?dir=SOFTWARE/iCS
SCPI Programmers-Guide
https://iseg-hv.com/download/SOFTWARE/isegSCPI/SCPI_Programmers_Guide_en.pdf
CAN EDCP Programmers-Guide
https://iseg-hv.com/download/SOFTWARE/isegEDCP/CAN_EDCP_Programmers-Guide.pdf
isegHAL (Hardware Abstraction Layer)
https://iseg-hv.com/download/SOFTWARE/iCS/doc/isegHAL/index.html
iCSservice-API
https://iseg-hv.com/download/SOFTWARE/iCS/doc/iCSservice/iCSapiWebsocket_Docu.html https://iseg-hv.com/download/SOFTWARE/iCS/doc/iCSservice/iCSapiWebsocket_Example.html
isegIOC (EPICS Input / Output Controller)
https://iseg-hv.com/download/SOFTWARE/iCS/doc/isegIOC/isegIOC_doc.pdf https://iseg-hv.com/download/SOFTWARE/iCS/doc/isegIOC/isegIOC_sampleScript.zip
isegTERMINAL
https://iseg-hv.com/download/?dir=SOFTWARE/isegTERMINAL/current
iseg SCPI Control
https://iseg-hv.com/download/?dir=SOFTWARE/isegSCPIcontrol/current/
Iseg SNMP control
https://iseg-hv.com/download/?dir=SOFTWARE/isegSNMPcontrol/current/

10. Glossary

SHORTCUT	MEANING
V_{nom}	nominal output voltage
V_{out}	output voltage
V_{set}	set value of output voltage
V_{mon}	monitor voltage of output voltage
V_{meas}	digital measured value of output voltage
V_{p-p}	peak to peak ripple voltage
V_{in}	input / supply voltage
V_{type}	type of output voltage (AC, DC)
V_{ref}	internal reference voltage
V_{max}	limit (max.) value of output voltage
ΔV_{out} – $[\Delta V_{in}]$	deviation of V_{out} depending on variation of supply voltage
ΔV_{out} – $[\Delta R_{load}]$	deviation of V_{out} depending on variation of output load
V_{bounds}	Voltage bounds, a tolerance tube $V_{set} \pm V_{bounds}$ around V_{set}.
I_{nom}	nominal output current
I_{out}	output current
I_{set}	set value of output current
I_{mon}	monitor voltage of output current
I_{meas}	digital measured value of current
I_{trip}	current limit to shut down the output voltage
I_{in}	input / supply current
I_{max}	limit (max.) value of output current
I_{limit}	Current Limit.
I_{bounds}	Current bounds, a tolerance tube $I_{set} \pm I_{bounds}$ around I_{set}.
P_{nom}	nominal output power
P_{in}	input power
P_{in_nom}	nominal input power
T	temperature
T_{REF}	reference temperature
ON	HV ON/OFF
/ON	HV OFF/ON
CH	channel(s)
HV	high voltage
LV	low voltage
GND	signal ground
INH	Inhibit
POL	Polarity
KILL	KillEnable

11. Warranty & Service

This device is made with high care and quality assurance methods. The standard factory warranty is 36 months. Please contact the iseg sales department if you wish to extend the warranty.

CAUTION!

CAUTION!

Repair and maintenance may only be performed by trained and authorized personnel.

For repair please follow the RMA instructions on our website: www.iseg-hv.com/en/support/rma

12. Disposal

INFORMATION

INFORMATION

All high-voltage equipment and integrated components are largely made of recyclable materials. Do not dispose the device with regular residual waste. Please use the recycling and disposal facilities for electrical and electronic equipment available in your country.

13. Manufacturer´s contact

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