

## Technical information

Last changed on: 19.01.2018

# NHQ High Voltage Power Supplies

High Precision Single/Dual Channel HV Module in NIM Standard

- 1/2 channels, 2/3/4/5/6/8/10 kV and customized versions
- LCD for voltage and current display
- switchable polarity
- very low ripple and noise
- front panel control with high precise 10-turn potentiometers
- hardware voltage and current limits with 10% step
- RS232, analog I/O, CAN (optional)
- programmable parameters (current trip, ramp speed etc.)



## Document history

| Version | Date                     | Major changes                                                                                                               |
|---------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| 2.0     | 28.02.2017               | Relayouted version                                                                                                          |
| 2.1     | 20.09.2017<br>21.11.2017 | Technical data: $V_{set}$ Control information added, Warranty notice fixed, Accuracy Current Measurement for Option L added |
| 2.2     | 19.1.2018                | High Precision versions discontinued                                                                                        |

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**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.**

## Important security information

It is strongly recommended to read the operator's manual before operation. 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.

We decline all responsibility for damages and injuries caused by an improper use of the module. It is strongly recommended to read the operators manual before operation.

### WARNING!



WARNING!

The non-observance of the advices marked as "Warning!" could lead to possible injury or death.

### CAUTION!



CAUTION!

Advices marked as "Attention!" describe actions to avoid possible damages to property.

### INFORMATION



INFORMATION

Advices marked as "Information" give important information.

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# 1 General description

## WARNING!



WARNING!

The devices induce output voltages and currents which conformable to **EN61010-1** are not dangerous to life. But it is possible that they effect health damages to sensitive persons.

## ATTENTION!



ATTENTION!

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

The established NHQ single/dual channel HV module is cased in compact 1/12 NIM format. The NHQ series HV supplies are front panel controllable with a precise 10-turn potentiometer per channel for voltage setting and a common LCD for display of voltage or current. For remote control the NHQ comes with RS232, analog I/O or optional CAN-interface. The voltage ramp is hardware fixed and can be changed in remote operation. The high voltage output is short circuit and overload protected, the INHIBIT function over external digital signal triggers the HV switch-off.

## 2 Technical Data

| SPECIFICATIONS                                          | LOW COST                                                                                                                                                               | STANDARD                                                           | HIGH PRECISION<br>(discontinued since<br>Jan. 2018) |
|---------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|-----------------------------------------------------|
| Polarity                                                | Switchable                                                                                                                                                             |                                                                    |                                                     |
| Ripple and noise (f > 10 Hz)                            | < 50 mV <sub>p-p</sub>                                                                                                                                                 | < 2   5   50 mV <sub>p-p</sub>                                     | < 2   5 mV <sub>p-p</sub>                           |
| Stability [ΔV <sub>out</sub> vs. ΔV <sub>in</sub> ]     | < 3 •10 <sup>-5</sup> • V <sub>nom</sub>                                                                                                                               |                                                                    |                                                     |
| Stability - [ΔV <sub>out</sub> vs. ΔR <sub>load</sub> ] | < 2 • 10 <sup>-4</sup> • V <sub>nom</sub>                                                                                                                              | < 5 •10 <sup>-5</sup> • V <sub>nom</sub>                           |                                                     |
| Temperature coefficient                                 | < 100 ppm / K                                                                                                                                                          | < 50 ppm / K                                                       | < 30 ppm/ K                                         |
| LCD Display                                             | 4 digits with sign, switch controlled (voltage display in V, current display in μA)                                                                                    |                                                                    |                                                     |
| Resolution voltage setting                              | 1 V                                                                                                                                                                    | 1 V                                                                | 1 V (100 mV remote)                                 |
| Resolution voltage measurement display                  | 1 V                                                                                                                                                                    |                                                                    |                                                     |
| Resolution voltage measurement remote                   |                                                                                                                                                                        | 1 V                                                                | 100 mV                                              |
| Resolution current measurement display                  | 1 μA                                                                                                                                                                   |                                                                    | 1 μA<br>10nA (2MA)<br>1 nA (2MA0n1)                 |
| Resolution current measurement remote                   | 1 μA                                                                                                                                                                   |                                                                    | 100 nA<br>1 nA (2MA)<br>100pA (2MA0n1)              |
| Accuracy voltage measurement                            | ± (0.05 % • V <sub>out</sub> +0.02 % • V <sub>nom</sub> + 1 digit)                                                                                                     |                                                                    |                                                     |
| Accuracy current measurement                            | ± (0.05% I <sub>out</sub> + 0.05% I <sub>nom</sub> + 1 digit)                                                                                                          | ± (0.05 % • I <sub>out</sub> +0.02 % • I <sub>nom</sub> + 1 digit) |                                                     |
| Accuracy current measurement with option L              | ± (0.5% I <sub>out</sub> + 0.5% I <sub>nom</sub> + 1 digit)                                                                                                            |                                                                    |                                                     |
| Measurement Accuracy                                    | The meas. accuracy is guaranteed for 1 year                                                                                                                            |                                                                    |                                                     |
| Voltage ramp hardware                                   | 500 V / s                                                                                                                                                              |                                                                    |                                                     |
| Voltage ramp software                                   |                                                                                                                                                                        | 2 - 255 V / s                                                      |                                                     |
| Voltage Control switch MANUAL                           | Upper position: manual control by 10-turn potentiometer                                                                                                                |                                                                    |                                                     |
| Voltage Control switch REMOTE                           | Lower position: Control by analog set and monitor voltage<br><br>NHQ x12 – x14: V <sub>set/mon</sub> = Vout / 400<br>NHQ x15 - x16: V <sub>set/mon</sub> = Vout / 1000 |                                                                    |                                                     |
| Protection                                              | INHIBIT*, hardware V/I limits (10%steps)<br>*(ext.signal, TTL-Level Low=active → V <sub>out</sub> =0                                                                   |                                                                    |                                                     |
| Analog / Digital Interface                              | AIO                                                                                                                                                                    | RS232   CAN                                                        |                                                     |
| HV connector                                            | SHV                                                                                                                                                                    |                                                                    |                                                     |
| System connector                                        | NIM connector                                                                                                                                                          |                                                                    |                                                     |
| Inhibit connector                                       | Lemo 1pole: ERN.00.250.CTL                                                                                                                                             |                                                                    |                                                     |
| Interface connector                                     | Sub-D9                                                                                                                                                                 |                                                                    |                                                     |
| Power requirements Vinput                               | ± 24 V (< 800mA) and ± 6 V (< 100mA)<br>Option N24: ± 24 V required only                                                                                               |                                                                    |                                                     |
| Case                                                    | NIM Standard chassis: NIM 1/12                                                                                                                                         |                                                                    |                                                     |
| Operating temperature                                   | 0 – 50 °C                                                                                                                                                              |                                                                    |                                                     |
| Storage temperature                                     | -20 - 60 °C                                                                                                                                                            |                                                                    |                                                     |

Table 1: Technical data: Specifications

| CONFIGURATIONS                       |                  |                  |                      |           |              |
|--------------------------------------|------------------|------------------|----------------------|-----------|--------------|
|                                      | V <sub>nom</sub> | I <sub>nom</sub> | RIPPLE / NOISE       | INTERFACE | HV-CONNECTOR |
| <b>STANDARD</b>                      |                  |                  |                      |           |              |
| NHQ n02M                             | 2 kV             | 6 mA             | 2 mV <sub>p-p</sub>  | RS232     | SHV          |
| NHQ n03M                             | 3 kV             | 4 mA             | 2 mV <sub>p-p</sub>  | RS232     | SHV          |
| NHQ n04M                             | 4 kV             | 3 mA             | 2 mV <sub>p-p</sub>  | RS232     | SHV          |
| NHQ n05M                             | 5 kV             | 2 mA             | 5 mV <sub>p-p</sub>  | RS232     | SHV          |
| NHQ n06L                             | 6 kV             | 1 mA             | 5 mV <sub>p-p</sub>  | RS232     | SHV          |
| NHQ n08L                             | 8 kV             | 1 mA             | 50 mV <sub>p-p</sub> | RS232     | SHV          |
| NHQ n010x                            | 10 kV            | 0.5 mA           | 50 mV <sub>p-p</sub> | RS232     | L10          |
| NHQ n32M                             | 2 kV             | 6 mA             | 2 mV <sub>p-p</sub>  | CAN       | SHV          |
| NHQ n33M                             | 3 kV             | 4 mA             | 2 mV <sub>p-p</sub>  | CAN       | SHV          |
| NHQ n34M                             | 4 kV             | 3 mA             | 2 mV <sub>p-p</sub>  | CAN       | SHV          |
| NHQ n35M                             | 5 kV             | 2 mA             | 5 mV <sub>p-p</sub>  | CAN       | SHV          |
| NHQ n36L                             | 6 kV             | 1 mA             | 5 mV <sub>p-p</sub>  | CAN       | SHV          |
| NHQ n38L                             | 8 kV             | 1 mA             | 50 mV <sub>p-p</sub> | CAN       | SHV          |
| <b>HIGH PRECISION (discontinued)</b> |                  |                  |                      |           |              |
| NHQ n22M                             | 2 kV             | 6 mA             | 2 mV <sub>p-p</sub>  | RS232     | SHV          |
| NHQ n23M                             | 3 kV             | 4 mA             | 2 mV <sub>p-p</sub>  | RS232     | SHV          |
| NHQ n24M                             | 4 kV             | 3 mA             | 2 mV <sub>p-p</sub>  | RS232     | SHV          |
| NHQ n25M                             | 5 kV             | 2 mA             | 5 mV <sub>p-p</sub>  | RS232     | SHV          |
| NHQ n26L                             | 6 kV             | 1 mA             | 5 mV <sub>p-p</sub>  | RS232     | SHV          |
| NHQ n42M                             | 2 kV             | 6 mA             | 2 mV <sub>p-p</sub>  | CAN       | SHV          |
| NHQ n43M                             | 3 kV             | 4 mA             | 2 mV <sub>p-p</sub>  | CAN       | SHV          |
| NHQ n44M                             | 4 kV             | 3 mA             | 2 mV <sub>p-p</sub>  | CAN       | SHV          |
| NHQ n45M                             | 5 kV             | 2 mA             | 5 mV <sub>p-p</sub>  | CAN       | SHV          |
| NHQ n46L                             | 6 kV             | 1 mA             | 5 mV <sub>p-p</sub>  | CAN       | SHV          |
| <b>LOW COST</b>                      |                  |                  |                      |           |              |
| NHQ n12M                             | 2 kV             | 6 mA             | 50 mV <sub>p-p</sub> | AIO       | SHV          |
| NHQ n13M                             | 3 kV             | 4 mA             | 50 mV <sub>p-p</sub> | AIO       | SHV          |
| NHQ n14M                             | 4 kV             | 3 mA             | 50 mV <sub>p-p</sub> | AIO       | SHV          |
| NHQ n15M                             | 5 kV             | 2 mA             | 50 mV <sub>p-p</sub> | AIO       | SHV          |
| NHQ n16L                             | 6 kV             | 1 mA             | 50 mV <sub>p-p</sub> | AIO       | SHV          |

Table 2: Technical data: Configurations (n=channel 1/2)

| OPTIONS / ORDER INFO                            | INFO                                     | INFO                       |
|-------------------------------------------------|------------------------------------------|----------------------------|
| <b>±24 V SUPPLY ONLY</b>                        | <b>±24 V = N24</b>                       |                            |
| <b>VERY HIGH VOLTAGE RESOLUTION 10mV</b>        | <b>VHR</b>                               | High Precision only        |
| <b>LOWER OUTPUT CURRENT</b>                     | <b>L (100 µA) *</b>                      | Standard and Low Cost only |
| <b>2ND CURRENT MEAS. RANGE</b>                  | <b>2MA <math>\hat{=}</math> 100 µA</b>   | High Precision only        |
| <b>2ND CURRENT MEAS. RANG   HIGH RESOLUTION</b> | <b>2MA0n1 <math>\hat{=}</math> 10 µA</b> | High Precision only        |

Table 3: Technical data: Options and order information

## 3 NHQ Description

### 3.1 High Voltage Supply

For the high voltage generation a patented highly efficient resonance converter circuit is used, which provides a sinusoidal voltage with low harmonics for the HV-transformer. For the high voltage rectification high speed HV-diodes are used. A high-voltage switch, connected to the rectifier allows the selection of the polarity. The consecutive active HV-filter damps the residual ripple and ensures low ripple and noise values as well as the stability of the output voltage. A precision voltage divider is integrated in the HV-filter to provide a feedback voltage for the output voltage control, an additional voltage divider supplies the signal for the maximum voltage monitoring. A precision control amplifier compares the feedback voltage with the set value given by the DAC (remote control) or the potentiometer (manual control). Signals for the control of the resonance converter and the stabilizer circuit are derived from the result of the comparison. The two-stage layout of the control circuit results in an output voltage, stabilized with very high precision to the set point.

Separate security circuits prevent exceeding the front-panel switch settings for the current  $I_{\max}$  and voltage  $V_{\max}$  limits. A monitoring circuit prevents malfunction caused by low supply voltage.

The internal error detection logic evaluates the corresponding error signals and the external INHIBIT signal and impacts the output voltage according to the setup. In addition this allows the detection of short over currents due to single flashovers.

### 3.2 Digital control unit

A micro controller handles the internal control, evaluation and calibration functions of both channels. The actual voltages and currents are read cyclically by an ADC with a connected multiplexer. The readings are processed and displayed on the 4 digit LCD. The current and voltage hardware limits are retrieved cyclically several times per second. A reference voltage source provides a precise voltage reference for the ADC and the control voltage for the manual operation mode of the unit.

In the computer controlled mode the set values for the corresponding channels are generated by a 18-Bit DAC.

### 3.3 Filter

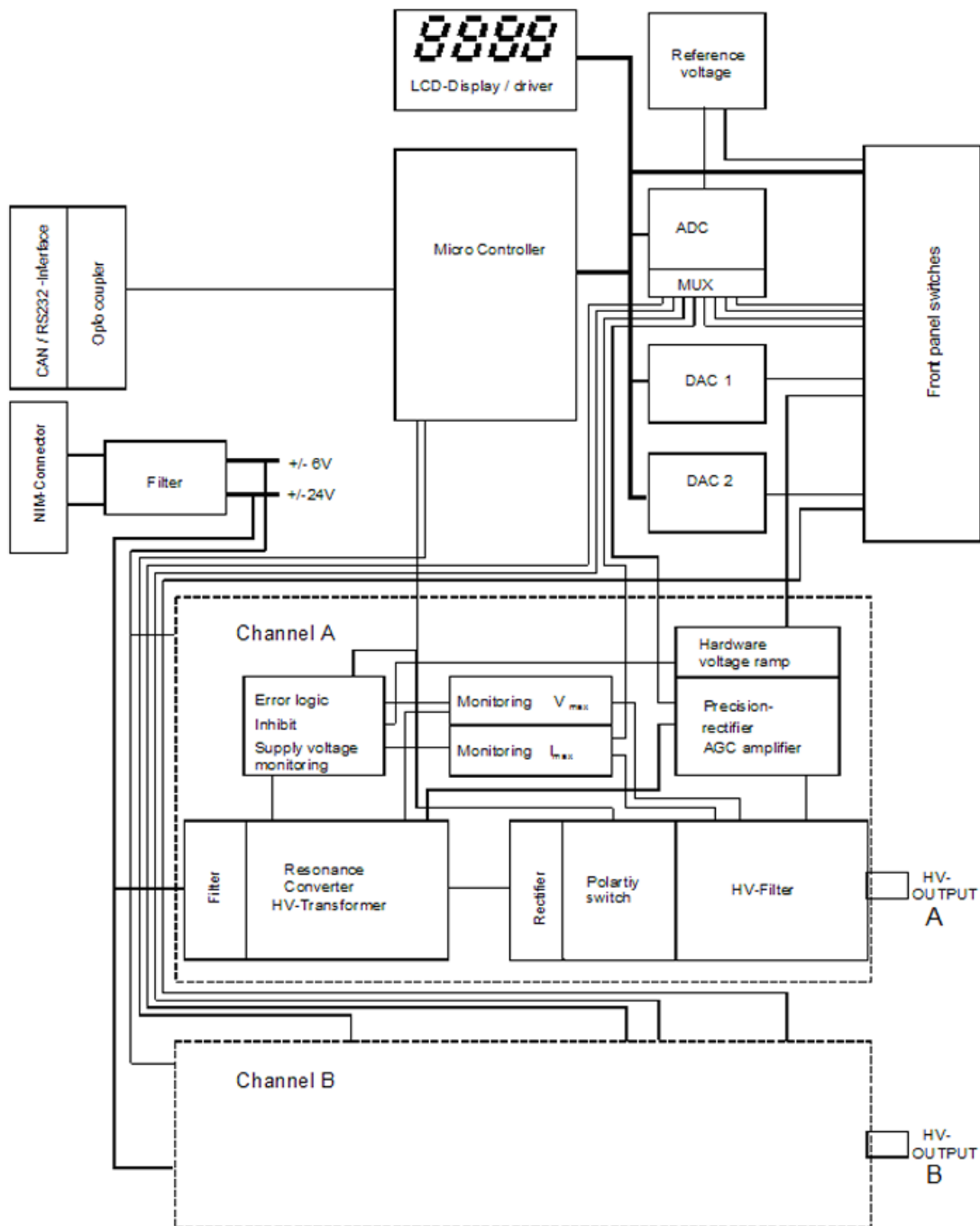


Figure 3: Block diagram

A special feature of the unit is a tuned filtering concept, which prevents perturbation of the unit by external electromagnetic radiation, as well as the emittance of interferences by the module. A filtering network for the supply voltages is located next to their connectors, the converter circuits of the individual channels are protected by additional filters. The high-voltage filters are housed in individual metal enclosures to shield even minimal interference radiation.

## 4 Handling

The NIM connector, the HV-outputs and the 9 pin female Sub-D connector for the RS 232, CAN or Analog I/O interface are located on the rear panel. Before the unit is powered the desired output polarity must be selected by the rotary switch on the cover side. The chosen polarity is displayed by a LED on the front panel and a sign on the LCD.

### ATTENTION!



ATTENTION!

It is not allowed to change the polarity under power!

If the switch setting is undefined (not at one of the end positions) high voltage cannot be switched on.

High voltage output is switched on with the HV-ON switch at the front panel. The viability is signaled by the yellow LED.

### ATTENTION!



ATTENTION!

If the CONTROL switch is in upper position (manual control), high voltage is generated at the HV-output on the rear side, started with a ramp speed from 500 V/s (hardware ramp) to the set voltage chosen via the 10-turn potentiometer.

This is also the case, if RS232 control is switched over to manual control while operating.

Output voltage in [V] or output current in [ $\mu$ A] will be displayed on the LCD depending on the position of the Measuring switch.

For two channel units the Channel switch selects whether channel (A) or channel (B) is displayed.

In the manual control mode the output voltage can be set via 10-turn potentiometer in a range from 0 to the maximum voltage.

If the CONTROL switch is switched over to remote control, the DAC takes over the last set output voltage of the manual control. The output voltage can be changed remotely with a programmable ramp speed (software ramp) from 2 to 255 V/s in a range from 0 to the maximum voltage.

The maximum output current for each channel (current trip) can be set via the remote interface in units of the resolution of the upper measurement range. If the output current exceeds the programmable limit, the output voltage will be shut off permanently by the software. A recovery of the voltage is possible after "Read status word" and then "Start voltage change" via serial interface. If "Auto start" is active, "Start voltage change" is not necessary.

The maximum output voltage and current can be selected in 10%-steps with the rotary switches  $V_{max}$  and  $I_{max}$  (switch dialed to 10 corresponds to 100%) independently of programmable current trip. The red error LED on the front panel signals if the output voltage or current approaches the limits.

The KILL switch specifies the response on exceeding limits or on the external protection signal at the INHIBIT input as follows:  
Switch to the right position: (ENABLE KILL)

When exceeding  $I_{max}$  or in the presence of an INHIBIT signal (Low=active) the output voltage will be shut off permanently without ramp. The output voltage is only restored after switching HV-ON or KILL or "Read status word" and then "Start voltage change" by DAC control. If "Auto start" is active, "Start voltage change" is not necessary.

Note:

If a capacitance is effective at the HV-output or when using a high voltage ramp speed (hardware ramp) under high loads, then the KILL function may be triggered by the capacitor charging currents. In this case smaller output voltage change rates (software ramp) should be used or ENABLE KILL should only be selected once the set voltage is reached at the output.

Switch to the left position: (DISABLE KILL)

The output voltage is limited to  $V_{max}$ , the output current to  $I_{max}$  respectively; INHIBIT shuts the output voltage off without ramp, the previous voltage setting will be restored with hard- or software ramp once INHIBIT no longer being present.

## 4.1 Control elements

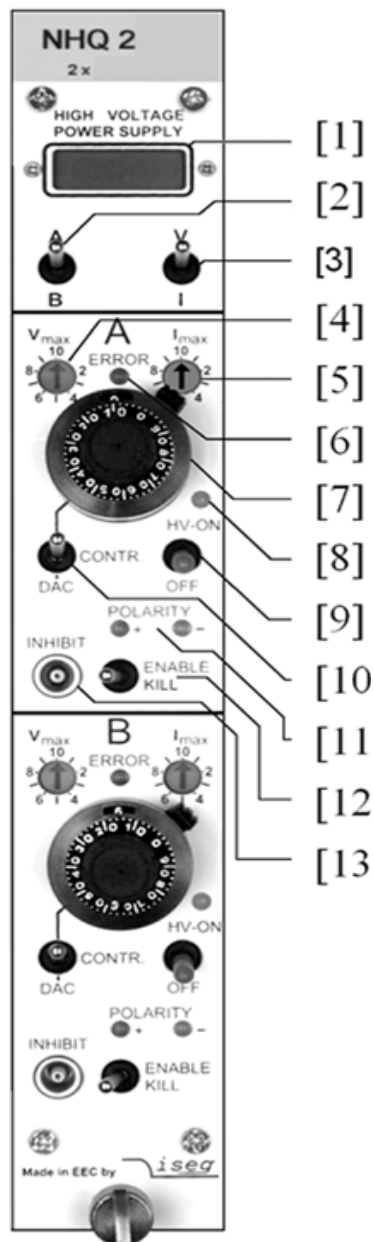


Figure 1: Frontpanel

| ELEMENT # | DESCRIPTION                 |
|-----------|-----------------------------|
| 1         | 4 digit LC display          |
| 2         | Channel switch              |
| 3         | Measurement switch          |
| 4         | Voltage limit rotary switch |
| 5         | Current limit rotary switch |
| 6         | Error indicator LED         |
| 7         | 10 - turn potentiometer     |
| 8         | HV-On indicator LED         |
| 9         | HV-On switch                |
| 10        | Control switch              |
| 11        | Polarity indicator LEDs     |
| 12        | KILL switch                 |
| 13        | INHIBIT input               |

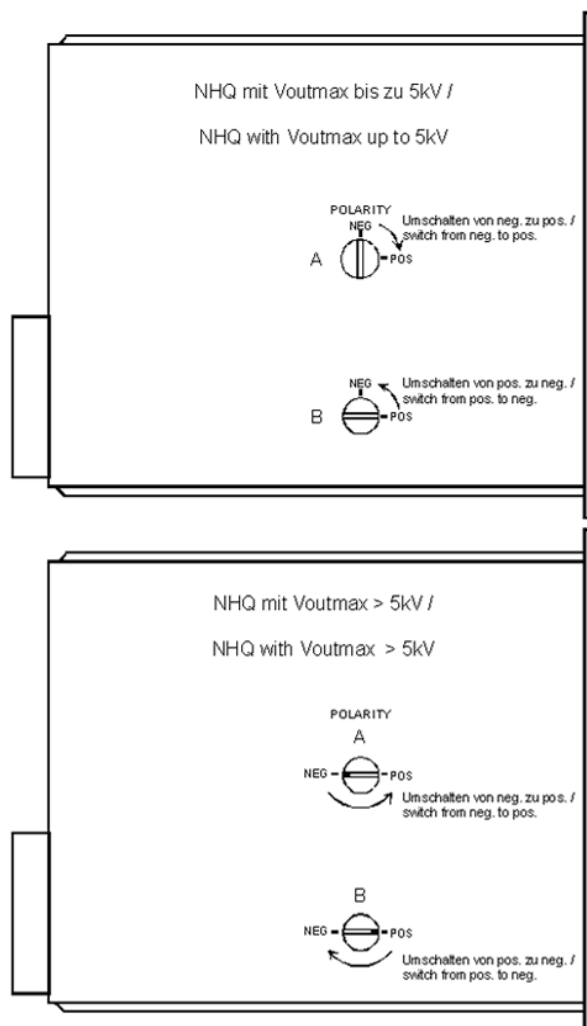


Figure 2: Polarity Switch – Side view

## 5 Dimensional drawings

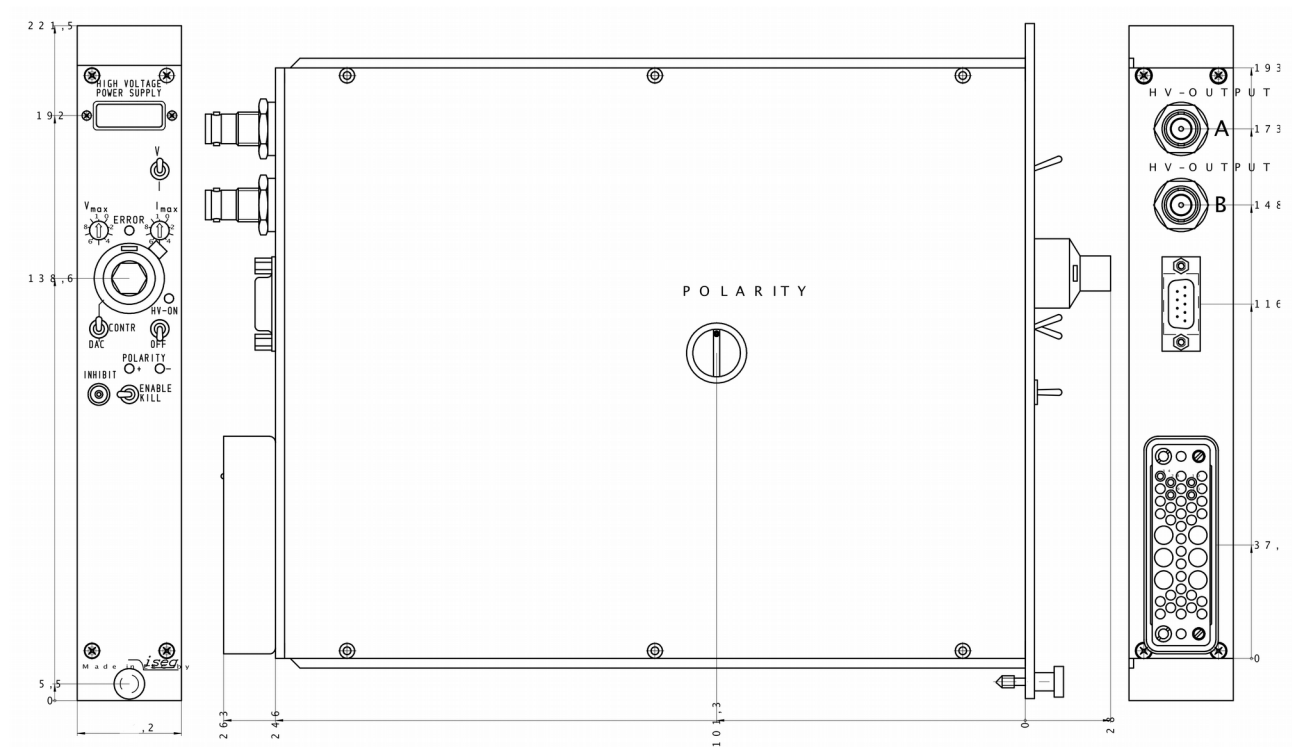


Figure 3: Dimensional drawing – NHQ 1 channel

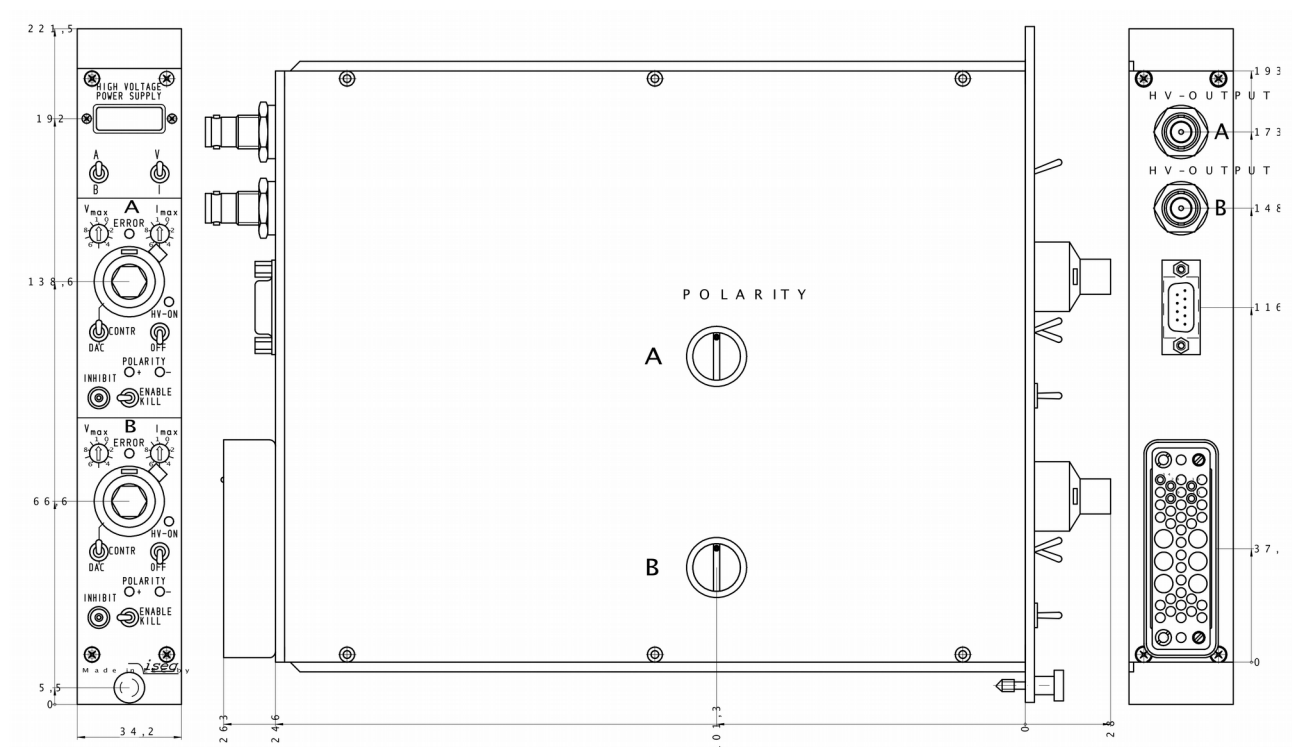


Figure 4: Dimensional drawing – NHQ 2 channels

## 6 PIN assignments

### 6.1 Analog I/O

| PIN |                   | DESCRIPTION       |
|-----|-------------------|-------------------|
| 1   | VSET <sub>A</sub> | Set voltage A     |
| 2   |                   |                   |
| 3   | VMON <sub>A</sub> | Monitor voltage A |
| 4   |                   |                   |
| 5   | GND               | Ground            |
| 6   |                   |                   |
| 7   | VSET <sub>B</sub> | Set voltage B     |
| 8   |                   |                   |
| 9   | VMON <sub>B</sub> | Monitor voltage B |

Table 4: PIN assignment Analog I/O

### 6.2 RS 232

| Signal RS 232 | HV-supply Sub-D9 | Int. | PC Sub-D9 | PC Sub-D25 | Connection 3-lead cable |
|---------------|------------------|------|-----------|------------|-------------------------|
| RxD           | 2                |      | 2         | 3          |                         |
| TxD           | 3                |      | 3         | 2          |                         |
| GND           | 5                |      | 5         | 7          |                         |
|               | 4                | }    | 4         | 20         | }                       |
|               | 6                |      | 6         | 6          |                         |
|               | 8                |      | 8         | 5          |                         |

Table 5: PIN assignment RS232

### 6.3 CAN

| PIN | DESCRIPTION        |
|-----|--------------------|
| 2   | CAN L              |
| 3   | CAN 0 (CAN Ground) |
| 7   | CAN H              |

Table 6: PIN assignment CAN

## 7 Connectors and cables

| HV CONNECTOR ASSIGNMENTS |                                                                                   |                                                                                   |  |  |  |
|--------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--|--|--|
| Name                     | SHV                                                                               | L10                                                                               |  |  |  |
| Figure                   |  |  |  |  |  |

Table 7: Connector and pin assignments

| CONNECTORS PART NUMBERS (manufacturer code / iseg accessory parts item code) |                   |            |                        |
|------------------------------------------------------------------------------|-------------------|------------|------------------------|
| POWER SUPPLY SIDE                                                            |                   | CABLE SIDE |                        |
| SHV (ROSENBERGER)                                                            |                   |            |                        |
| Socket                                                                       | 57S501-200N3      | Connector  | 57K101-006N3 / Z590162 |
| L10 (LEMO)                                                                   |                   |            |                        |
| Socket                                                                       | PSA.1Y.410.CLLC57 | Connector  | FFA.1Y.410.CLAC57?     |

Table 8: Connectors part number information

| CABLE ORDER GUIDE                                                              |            |                                       |                     |                                                       |
|--------------------------------------------------------------------------------|------------|---------------------------------------|---------------------|-------------------------------------------------------|
| POWER SUPPLY SIDE CONNECTOR                                                    | CABLE CODE | CABLE DESCRIPTION                     | LOAD SIDE CONNECTOR | ORDER CODE<br><i>LLL = length in m</i> <sup>(*)</sup> |
| SHV                                                                            | 04         | HV cable shielded 30kV (HTV-30S-22-2) | open                | SHV_1C04-LLL                                          |
| L10                                                                            | 04         | HV cable shielded 30kV (HTV-30S-22-2) | open                | L10_1C04-LLL                                          |
| *) Length building examples: 10cm => 0.1, 2.5m => 2.5, 12m => 012, 999m => 999 |            |                                       |                     |                                                       |

Table 9: Guideline for cable ordering

## 8 Appendix

For more information please use the following download links:

|                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>This document</b>                                                                                                                                                    |
| <a href="http://download.iseg-hv.com/SYSTEMS/NIM/NHQ/iseg_datasheet_NHQ_en_2.2.pdf">http://download.iseg-hv.com/SYSTEMS/NIM/NHQ/iseg_datasheet_NHQ_en_2.2.pdf</a>       |
| <b>CAN Programmers-Guide</b>                                                                                                                                            |
| <a href="http://download.iseg-hv.com/SYSTEMS/NIM/NHQ/NHQ-CAN-Programmers-Guide.pdf">http://download.iseg-hv.com/SYSTEMS/NIM/NHQ/NHQ-CAN-Programmers-Guide.pdf</a>       |
| <b>RS232 Programmers-Guide</b>                                                                                                                                          |
| <a href="http://download.iseg-hv.com/SYSTEMS/NIM/NHQ/NHQ-RS-232-Programmers-Guide.pdf">http://download.iseg-hv.com/SYSTEMS/NIM/NHQ/NHQ-RS-232-Programmers-Guide.pdf</a> |

## 9 Warranty & Service

This device is made with high care and quality assurance methods. The factory warranty is up to 36 months, starting from date of issue (invoice). Within this period a 5 years warranty extension can be ordered at additional charge. Please contact iseg sales department.

| CAUTION!                                                                          |                                                                                                                                                                                                                                                  |
|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Repair and maintenance may only be performed by trained and authorized personnel.</p> <p>For repair please follow the RMA instructions on our website: <a href="http://www.iseg-hv.com/en/support/rma">www.iseg-hv.com/en/support/rma</a></p> |

## 10 Manufacturer's contact

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