RoentDek
Handels GmbH

Supersonic Gas Jets
Detection Techniques
Data Acquisition Systems
Multifragment Imaging Systems

The RoentDek HV3
High Voltage Power Supply

(Version 2025-03-27)

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1 Safety instructions

Working with high voltages (HV) poses the risk of electric shock. Injuries or even death can be the consequence. Make sure that this device is only used by trained personal that was instructed in the handling of high voltage sources.

Never open the HV3. Never perform a self-repair.

Never operate the device in humid conditions.

Never connect or disconnected SHV-cables while the SHV-output channels are switched on.

Never operate the HV3 without a good and reliable connection to ground.

2 General Description

The **RoentDek HV3** High Voltage power supply offers three output channels. The form factor is 19"/3HU. In the standard configuration, it is equipped with one negative output and two positive output channels with a maximum voltage of 4kV each. Variants with ±6kV are also available. The **HV3** can be remote controlled in various ways: either directly via a DC-input voltage or by software through the USB-port or over the ethernet (Telnet or web browser interface). This way, it is well suited for the integration into larger data acquisition-systems (e.g. Tango).

3 Installation

The **HV3** is a 3HU-device and can be mounted into a 19"-rack if an appropriate mounting frame is used (please inquire at **RoentDek** for this option).
Connect the external power supply to the 9-pin D-Sub-connector on the rear panel of the **HV3**. The other 9-pin D-Sub-connector is only used if another device shall be provided with power, too (daisy chaining).

4 Front and back panel

The front panel features 4 buttons for menu control and 3 sets of controls for the Hight Voltage channels.

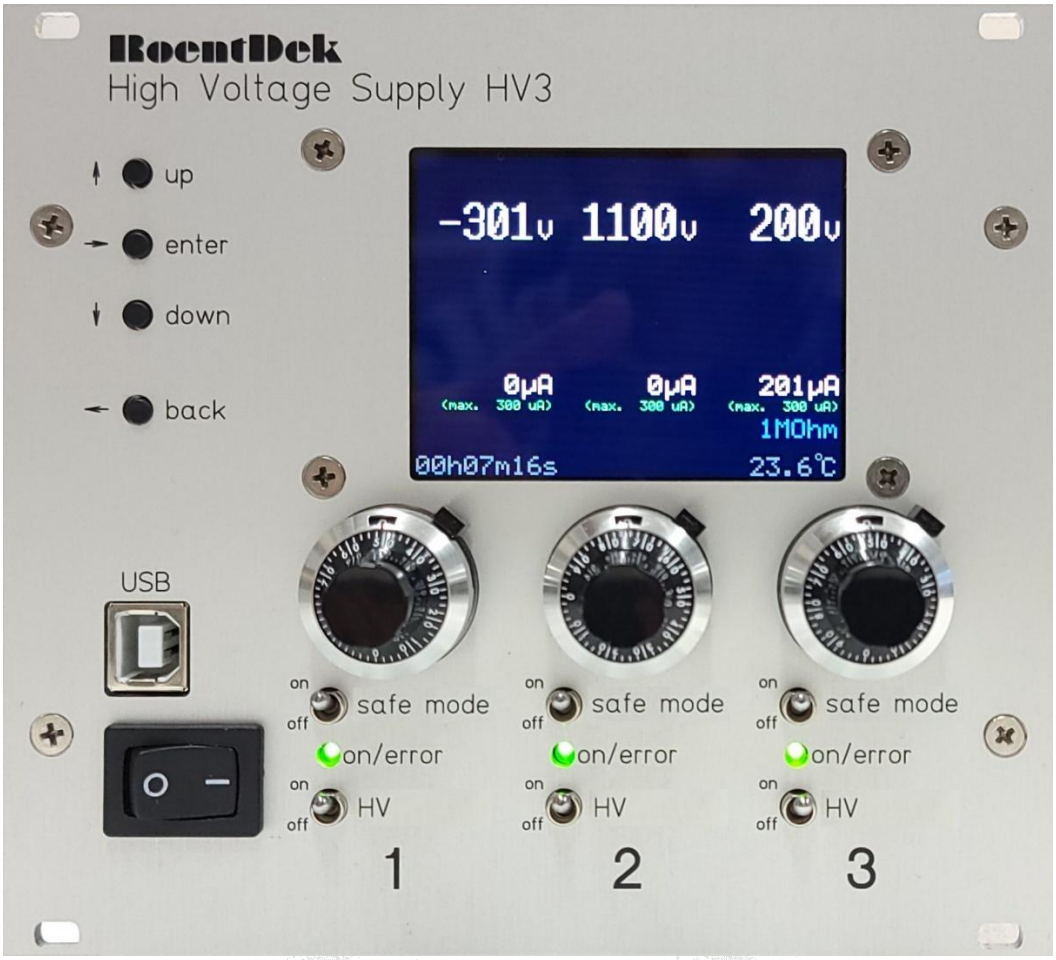

Figure 1: The front panel of the HV3

The **front USB-connector** can be used for serial communication.

The **'safe mode'** switches activate the `over-current´ detection. The threshold value (in µA) can be set in the settings menu on the first menu page. Please also refer to chapter 8.

LED green: HV voltage is on
LED flashing: Error (e.g. erroneous over-current)

Pressing the button **'enter'** enters the settings menu.

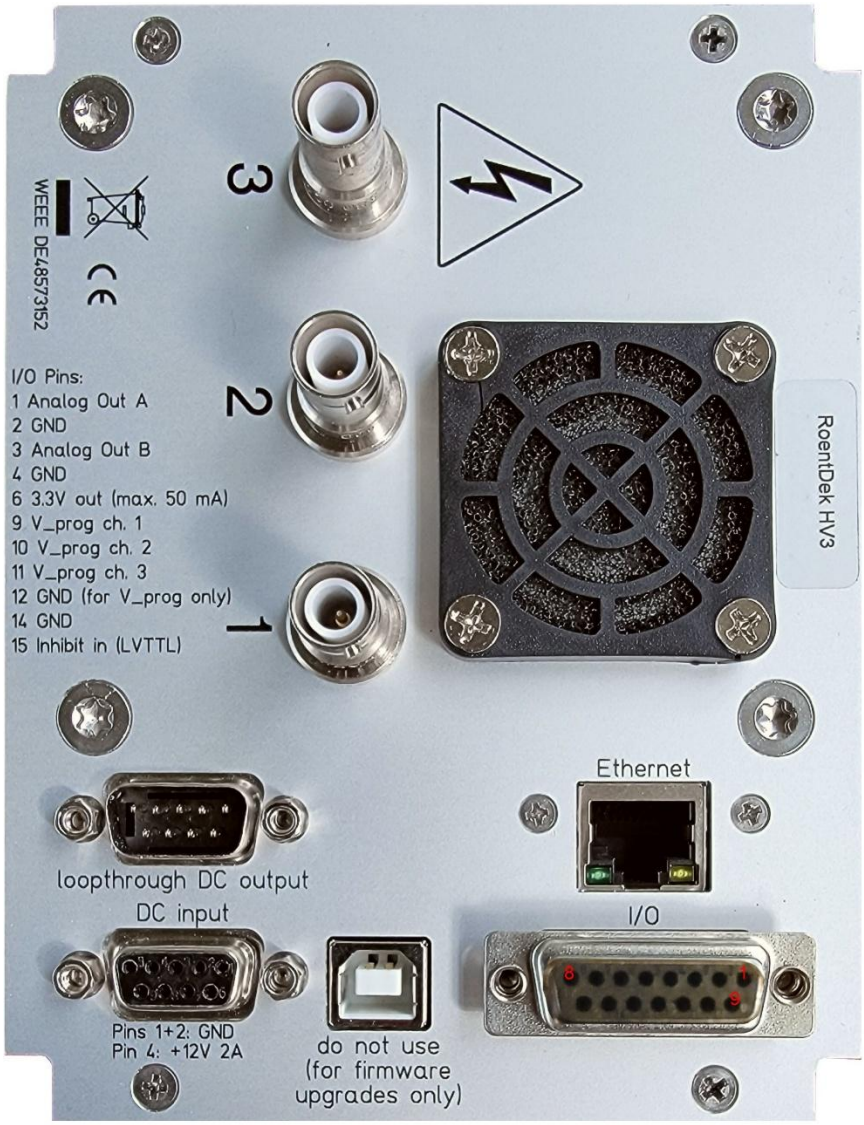

Figure 2 The rear panel of the HV3

The back panel of the **HV3** consists of three SHV-outputs, the Ethernet connector, a secondary USB-connector (used only for firmware updates), power supply input (GND, +12 V) and a D-Sub-connector.

I/O D-Sub-pin 1:	Analog output 1 (0 to +3.3V, can be configured to monitor one of the 3 voltages or currents). +3.3V corresponds to either 4 kV (6 kV) or 1000 μA.
I/O D-Sub-pin 3:	Analog output 2 (0 to +3.3V, can be configured to monitor one of the 3 voltages or currents). +3.3V corresponds to either 4 kV (6 kV) or 1000 μA.
I/O D-Sub-pin 6:	Permanent +3.3V DC out. (Can be used for the interlock circuit.)
I/O D-Sub-pins 9, 10, 11:	DC-inputs for remote control. +3.3V corresponds to 4 kV (6 kV).
I/O D-Sub-pins 12:	Clean GND for precise (noise free) control of pins 9, 10, 11.
I/O D-Sub-pins 15:	Inhibit / Interlock. (Threshold at +1.4 V.)

The above functions can be activated/configured in the settings menu.

5 The display of the HV3

During the first seconds of the start-up sequence, the **HV3** will display information for diagnosis purposes. In case of technical problems, **RoentDek** support might ask for photos of this output.
The main display shows three columns of identical controls for the three high voltage outputs.

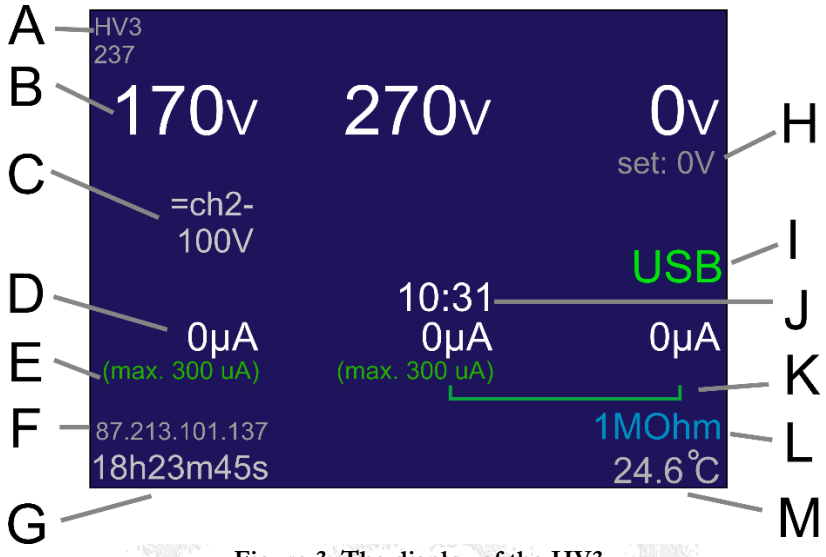

Figure 3: The display of the HV3

A The model name and the serial number of the **HV3**.

B The actual (true) output voltage. This value is measured by the device. Values displayed in **yellow** indicate a deviation between set and actual voltage by more than 50V.

C If the channel is configured to operate relative to another channel, then this will be shown here.

D The output current in µA.

E If the 'safety mode' is switched on (using the switch on the front panel) then the current limit will be shown here. The channel will switch off if this current is exceeded. The value can be set in the settings menu.

F The IP-address of the **HV3**. If this value is not shown, then the TCP/IP-access is not activated. The address will be displayed in grey color if the Ethernet cable is disconnected. Blue color indicates that the **HV3** is waiting for a client to connect. Green color indicates an active connection.

G The time since the last power on.

H The set voltage – only shown when the channel switched off.

I This field shows the currently activated type of remote control for this channel.

J If a shut-down timer is enabled for this channel, then it will be shown here.

K Horizontal bars indicate which channels are configured for combined safety shut-down.

L The value of the internal load resistor. Usually, the 3rd channel is configured with such an internal resistor (typically 1 MΩ). Please see chapter 6 for a detailed description of this feature.

M The internal temperature of the **HV3**.

The brightness of the display can be adjusted by pressing the up/down buttons on the front panel.

6 Channels with internal load resistors (HVT-function)

Most high voltage power supplies can only stabilize voltage in one direction (against the flow direction of the current).

The typical use cases of high voltage power supplies can be simplified to this schematic:

Here, the HV3 must stabilize the voltage against the current that is flowing towards ground potential, or in general, a potential that is closer to ground than the currently set voltage on the **HV3**.

However, in some applications, there might be a current flowing in the same direction where the voltage is pointing to - towards the potential of another high voltage source:

In this example, the current will flow towards the higher potential. The HV3 cannot stabilize the voltage in this direction. Consequently, the desired voltage of +300V cannot be set – it will be pulled up to a higher value.

One example is the situation in which a Channeltron or an MCP stack shall be biased to as example +300 V / +2700 V.

Please note that this behavior is characteristic for almost all high voltage power supplies – it is not specific to the **HV3**.

To compensate for this effect, the output channels of the **HV3** can be equipped with internal resistors to ground. In the standard configuration of the **HV3** this is channel 3. The presence of such a resistor prevents the output voltage from being pulled up in the presence of a higher potential. There will be current flowing through this resistor towards ground potential (GND). This will reduce the maximum effective current and the maximum voltage that can be output on the SHV-connector. Therefore, channels equipped with such a load resistor can only reach about 1000 V.

7 The settings menu

Pressing the button 'enter' enters the settings menu.
Some settings can only be changed when the high voltages are switched off. These lines will be greyed out if a HV-channel is switched on. The lower line shows the current voltage. This allows to monitor the high voltage even while accessing the settings menu.
The menu consists of several pages. The next page can be accessed by stepping to the line at the bottom of each page and pressing enter. Values can be changed/modified by pressing enter and using the up/down buttons. Press enter afterwards to enable the new value or press the back button to leave this menu option without change.

Settings menu - page 1:

Line 1:	[uA] current limit ch1	
Line 2:	[uA] current limit ch2	
Line 3:	[uA] current limit ch3	
Line 4:	[ ] combined safety	(please also see chapter 8)
Line 5:	[V] voltage lim. ch1	
Line 6:	[V] voltage lim. ch2	
Line 7:	[V] voltage lim. ch3	
Line 8:	ch1 is relative to [ ]	
Line 9:	ch2 is relative to [ ]	
Line 10:	ch3 is relative to [ ]	

Lines 1 to 3:
Here, the safety limit can be set in µA. It will become active when switch 'safety mode' is switched on. If the output current exceeds this value, then the channel will be turned off and will remain off (error state).

Line 4:
Usually, each channel shuts down independently from the other channels. But in some applications, this is of disadvantage and can even damage the biased devices*. In this line, multiple channels can be combined so that if one shuts down all will shut down.

Lines 5 to 7:
These settings allow to set a maximum voltage. This is a safe-guard against accidental over voltage.

Lines 8 to 10:
In the standard configuration each channel is individually controlled. In these lines here, channels can be configured to operate relative to another channel. So, by adjusting only one channel, another (or all channels) will change the voltage, keeping relative voltages constant. This is very useful because it allows for example controlling several biased parts of an MCP-detector while modifying only one specific potential.

* Example: If the two sides of a Channeltron or an MCP-detector shall be set to +500 V /+2900 V, then it could damage the detector if the +500 V potential fell to 0 V since this would increase the effective voltage across the detector - possibly beyond specified safe operation.

Settings menu - page 2:

Line 1: [m] timer for channel 1
Line 2: [m] timer for channel 2
Line 3: [m] timer for channel 3
Line 4: ch1 remote control [ ]
Line 5: ch2 remote control [ ]
Line 6: ch3 remote control [ ]
Line 7: [5V] = max HV in ADC 1
Line 8: [5V] = max HV in ADC 2
Line 9: [5V] = max HV in ADC 3
Line 10: [no] invert display

Lines 1 to 3:
In this section, operation times can be set for each channel (minutes). After the set time, the channel will turn off. This is useful if a measurement shall stop without supervision. After turning off, the channel will switch into error-mode. This is intended and signals the user that the high voltage switch is still in the on-position.
Timers cannot be used if the channel is configured for remote control.
The remaining time will be shown in the display above the µA-value.

Lines 4 to 6:
Different modes of remote control can be activated for each channel:

- Web interface
- Telnet
- Serial communication via USB
- DC analog input voltage at the D-Sub-connector on the rear panel (pins 1 and 3).

Lines 7 to 9:
The **HV3** can be configured to for remote control via a DC input voltage at the pins 9, 10, 11 on the Sub-D-port on the rear panel. In this menu, the voltage can be set that corresponds to the maximum output voltage of the module. In the standard configuration an input voltage of +5V corresponds to an output voltage of 4kV.

Lines 10:
Option to invert the color scheme of the display.

Settings menu - page 3:

Line 1: [V/s] ramp speed
Line 2: [ ] inhibit mode
Line 3: [ ] SubD-pin 1 out
Line 4: [ ] SubD-pin 3 out
Line 5: [ ] show time and temp.
Line 6: Display calibration tables
Line 7: Allow EEprom programming
Line 8: Reset all user settings !
Line 9: [PIN] maintenance level
Line 10: www-Ethernet configuration

Line 1:
The speed of voltage changes can be adjusted in Volts per second. The standard value is 500 V/s.

Line 2:
In this line, the inhibit/interlock mode can be selected (off, when high, when low). If the interlock is activated, all channels will shut off and fall into error state.

Lines 3 and 4:
Configures the output mode of pins 1 and 3 on the D-Sub connector on the rear panel of the **HV3**.

Available modes:
- Permanent 0V (default)
- Voltage of channels 1 to 3, +3.3V corresponds to the maximum voltage of this channel.
- Current of channels 1 to 3, +3.3V corresponds to 1000 μA.
- Permanent +3.3V
- Error-indicator: 0V signals 'no Error', +3.3Vsignals 'Error on at least one channel'.
- Remote controlled: Allows this pin to be controlled via USB/Telnet/Curl.

Lines 5:
Selects if the time and the internal temperature of the **HV3** are shown in the main display.

Line 6:
Displays the internal calibration values. RoentDek support may ask you to take photos of these lists for Diagnosis purposes.

Line 7:
Allows the reprogramming of the EEprom contents with a backup program via the front USB-port for 60 seconds.

Line 8:
Resets all user settings. Attention: This cannot be undone. The internal calibration will not be changed.

Line 9:
Access to the maintenance level. Not accessible by the user.

Line 10:
Access to the Ethernet configuration.

Ethernet settings menu - page:

```
Line  1:          [ off  ]   Ethernet mode
Line  2:          [  80  ]   IP port number
Line  3:          [         ]      HV3-IP
Line  4:          [         ]      subnet
Line  5:          [         ]       contr.
Line  6:          [         ]   MAC-add.
```

Line 1:
Sets the Ethernet TCP/IP mode: off / DHCP / static IP4 address.
In DHCP mode, the IP address will be dynamically requested from the local DHCP server.

Line 2:
The IP port number where the **HV3** can be accessed at. The standard value is 80.

Line 3:
The IP4-address where the **HV3** can be accessed.

Line 4:
The IP4 subnet.

Line 5:
The IP4 address of the PC that can control/set voltages. All other clients can read data from the **HV3**. But only this client can set voltages.

Line 6:
The MAC address of the **HV3**. This value is fixed and cannot be changed. It may be required by the local DHCP server.

8 Combined safety

By using the safety switches on the front panel, channels can be set to detect over-current. The actual threshold value can be set on the first page of the settings menu.

If the HV3 detects that the current has become too large, the channel will shut down and indicate and error (orange LED flashing).
This safety feature can help to avoid damages e.g. to Micro channel plates or Channeltrons.

However, shutting down the channel may have unwanted effects in the apparatus/setup.

Example:
A particle detector using a set of Micro Channel Plates (MCPs) shall be biased for electron detection. A common voltage configuration is +300V on the front MCP and about +2700V on the back MCP. If the voltage for the front MCP shuts down, then the effective voltage across the MCP stack would increase (!). This may damage the MCP stack.

To avoid such a situation, channels can be configured to shut down in parallel if one of them shuts down. This can be configure in the settings menu in the option 'combines safety'.

This feature can be activated in the settings menu (page 1) in the section 'combined safety'.

Green horizontal bars in the display show which channels are configured for combined safety shut down.

9 Modes of remote control/access

The **HV3** module can be remote controlled in various ways:

- via serial connection (front USB port)
- Web interface (http)
- Telnet
- CURL
- Using the three DC-voltages at the rear D-Sub connector (pins 9, 10, 11)

9.1 Readout and control via front USB-cable (serial communication)

Monitoring or remote controlling via serial communication can be activated in the settings menu. All commands must be terminated by a byte value of either 0 (NUL, \0), 10 (LF, \r), or 13 (CR, \n) or any combination of these. As example on Windows OS often the combination CR/LF (\r\n) is used.
All replies will be 0-terminated.
All commands except **'HV3_nnn_set'** will work even if remote control via USB is deactivated because they are only passive and cannot alter the state of the device.

Settings for the serial connection: 115200 baud, 8 stop bits, 1 stop bit, parity: none

Unknown commands will be replied to with **'ERR0'**.
Known commands sent in conjunction with wrong parameters will be replied to with **'ERR1'**.

nnn: the serial number of the HV3 device
m: the channel number 0, 1 or 2
vvvv: the voltage in Volts
aaaa: current in μA

All replies are preceded by the serial number nnn and a comma.

List of commands:

(all commands are case in-sensitive)

Command	Reply	comment
HV3GS	nnn	reports the serial number of the **HV3.**
HV3C	no reply	closes the Telnet connection (ignored when USB-connected).
HV3E yyyy	yyyy	echoes the string yyyy. yyyy can be any string. This is for testing and software development purposes.
HV3nnnGU *m*	nnn,vvvv	reads the voltage of channel m in Volts.
HV3nnnGU	nnn,vvvv,vvvv,vvvv	reads the voltages of all channels

HV3nnnGI *m*	nnn,aaaa	reads the current of channel m in µA
HV3nnnGI	nnn,aaaa,aaaa,aaaa	reads the currents of all channels in µA.
HV3nnnS *m*	nnn,ok	sets a voltage of channel m in Volts.
HV3nnnGS	nnn,XYZ	reads the status of the module. The status string consists of one digit for each output channel: 0 = off, 1 = on, 2 = error Examples: **110** The high voltage in channels 1 and 2 is on. Channel 3 is off. **112** The high voltage in channels 1 and 2 is on. Channel 3 shows error.
HV3nnnD *p,ww*	nnn,ok	sets the voltage on pin 1 or 3 on the D-Sub connector on the read panel. Possible values range from 0V to +3.3V. Possible values for ***p***: 0 (for pin 1) or 1 (for pin 3). Possible values for ***ww***: Any number ranging from 0 to 3.3. Example: **0,2.5** Sets Pin 1 to +2.5 V. **1,1.7** Sets Pin 3 to +1.7 V. Exponents (e.g. 31.2e-1) are not allowed.
HV3nnnR *m*	nnn,ok	clears an error on channel m. Attention: The high voltage will resume to the old set voltage immediately!

9.2 Web interface (http)

The **HV3** can be controlled through a web interface. In this case it acts as a simple HTTP web server. The Ethernet settings can be accessed on page 2 of the settings menu.

Please be aware of the general risk that the access via Ethernet poses. Unknown persons may attempt to gain control of the device and to change the voltages.
For this reason, the settings allow to limit the access to read only mode or full control (read and set).

The **HV3**can act as a simple web server. Any web browser (Edge, Firefox, Chrome, …) can be used to access the **HV3**at the IP address that is displayed in the display. Please note that only HTTP-connections are supported. HTTPS-request will not be processed.

It is possible to control voltages if the channel was configured for remote control (on page 2 of the settings menu) and if the IP address of the controlling PC was entered in page 3 of the settings menu.

9.3 Telnet (TCP/IP)

The **HV3** can receive commands and read data via the TELNET protocol.
The set of available commands is the same as in the serial communication mode (see chapter 9.1).
The Ethernet settings can be accessed on page 2 of the settings menu.

Please be aware of the general risk that the access via Ethernet poses. Unknown persons may attempt to gain control of the device and to change the voltages.
For this reason, the settings allow to limit the access to read only mode or full control (read and set).

Telnet communication is very simple. It consists of characters which are sent via TCP/IP. There is no protocol overhead. For testing, any simple Telnet client can be used.

On Windows operating systems, open the black DOS terminal window and type

telnet aaa.bbb.ccc.ddd port

aaa.bbb.ccc.ddd is the IP number oft he **HV3** and ***port*** is the port number (configurable in the ethernet settings menu of the **HV3**).

Once the connection is established, commands can be typed. It is recommended to use the echo-command for testing (see the list of commands in chapter 9.1).
Note, that most Telnet-clients do not show (echo) the typed characters.

It is possible to control voltages if the channel was configured for remote control (on page 2 of the settings menu) and if the IP address of the controlling PC was entered in page 3 of the settings menu.

It is recommended to close the Telnet connection after each command. An open connection will interfere with parallel request over HTTP.

9.4 Control via DC-voltage D-Sub connector (rear panel)

The voltages of the HV3 can be controlled by applying a voltage to the pins 9, 10 and 11 on the D-Sub-connector on the back side of the device.

An input voltage of 0V corresponds to an output voltage of 0V.
In the standard setting, +5 V input voltage corresponds to 100% of the maximum output voltage (±4 kV or ±6 kV depending on the type and polarity of the module).
In the settings menu, the calibration can be adjusted so that e.g. +3.3V results in the maximum output voltage.

10 Upgrading the firmware

The firmware version of the **HV3** is displayed during the first seconds after powering on the unit. It can be upgraded using a flash program on a PC. Please contact **RoentDek**. The latest version will be sent to you.

Please follow these instructions:

I. Power on the **HV3** and connect it with the PC using an USB-cable. It is important to use the USB-port on the back side of the **HV3**. Do not use the front USB-port. If there is another USB-cable connected to the front port of the **HV3** then please disconnect it.

II. Go into the Device Manager of Windows. The **HV3** will appear as "Arduino Due Programming Port".
You will find it either in the section "Ports (COM & LPT)" or in "other devices".

Please make sure that no other Arduino-Device is connected to the PC as it might be damaged during the flash procedure!

If it is visible in "Ports (COM & LPT)" then the necessary driver is already installed and you can continue with step VI.

III. Right click on "Arduino Due Programming Port" and select "Update Driver Software"

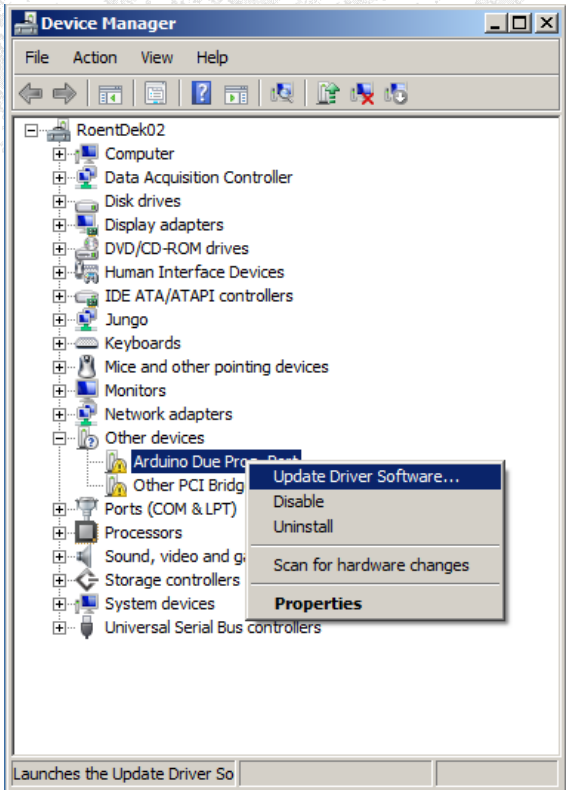

Figure 4.1: Windows Device Manager for "Arduino Due Programming Port"

IV. In the next window select “Browse my computer for driver software”.

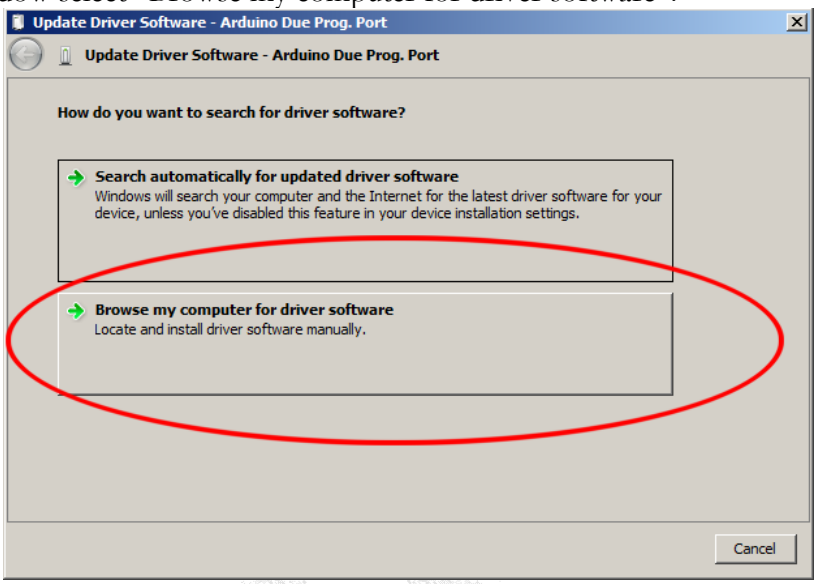

Figure 4.2: Update Arduino Due Prog. Port driver software

V. Point it to the “driver”-folder which is in the same folder as this document.
Now the driver will be installed. Please confirm all messages during the installation

VI. Double click on the file “update_firmware_HV3.bat”. Now a black window will open.
At the end of the flash procedure (it will take some seconds) the output should look as in the following image:

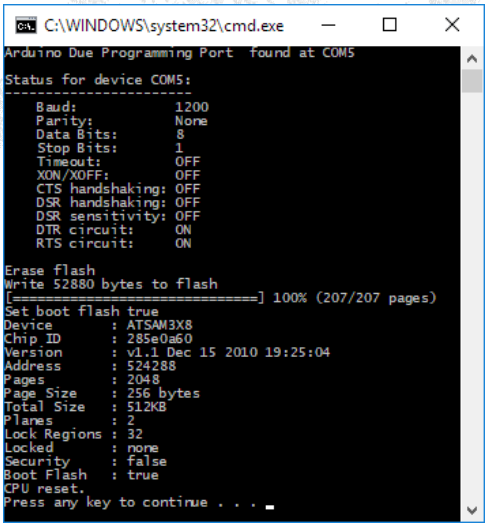

Figure 4.3: Batch file output window

VII. Disconnect the USB-cable from the back USB-port of the **HV3**. Switch off the HV3. Wait for about 10 seconds before powering it on again.

11 Specifications / Recycling / Troubleshooting

11.1 Specifications

Number of SHV output channels	3
Type of connector	SHV-5
Maximum voltage	±4 kV in the standard configuration, ±6 kV on request The polarities are factory fixed.
Available (fixed) polarities	+ + + or + + - or +-- or ---
Output current	Max. 1 mA for 4 kV and 0.67 mA for 6 kV
Operating temperature	10 to 35 degrees Celsius
Modes of remote control	Web interface (http)
	Telnet, Curl
	Serial connection (via front USB)
	DC-analog in at read D-Sub connector. 3.3 V or 5 V correspond to 4 kV/ 6 kV.
Interlock/Inhibit	Yes, can also be set inverted (veto/gate)
Ramp speed	Adjustable in the settings. Default is 500V/s.
Current limitation / auto shut off	Yes, can be enabled/disabled in the settings
Additional DC-outputs (0V to +3.3V)	2 multi-purpose pins on the rear panel. Can be used to monitor the voltages or currents via a DC-voltage (0V to +3.3V) or to signal an error.
Adjustment accuracy	1 V
Ripple / Noise typical	< 5 mVp-p
Ripple / Noise max.	<10 mVp-p
Power requirements:	+12 V / 2 A. The external mains adapter requires 100 V to 250 V AC.

11.2 Troubleshooting

Please contact **RoentDek** support if there are any problems or unexpected behaviour.

If the device shows an error during the start sequence (shown in red letters), please turn it off and remove any USB-cable that might be connected to the front or the read USB-input. Wait for about 10 seconds. Then turn on the device. Contact RoentDek support if the problem persists.

11.3 Recycling

RoentDek is registered with the "Stiftung Elektro-Altgeräte Register" as a manufacturer of electronic systems with the registration ID DE48573152. The **HV3** belongs to the category 9 "Überwachungs und Kontrollinstrumente für ausschließlich gewerbliche Nutzung". The last owner of a **HV3** must recycle or treat the module in compliance with §11 and §12 of the German ElektroG law or return it to **RoentDek**: The device must NOT be discarded into the standard trash.

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List of Figures