
stahl-electronics
Electronics for Science and Research

– Rev B –

HV and BS Series Programmers Guide

HV/BS Series Programmers Guide
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Contents

1 Introduction

Remote controlling the Stahl-Electronics 16-bit HV-/BS-Series or 19-Bit BSA-Series multichannel voltage sources is accomplished by sending commands through its remote interface. These commands are outlined and described in this guide. The Examples section shows how to get started with simple commands to use the basic functions of the device and explores more advanced topics for users who wish to build more complex systems. HV-Series devices are referenced as HV and BS-/BSA-Series devices as BS. This must not be confused with the device identifier which always starts with HV, followed by three digits, for **all** devices and is used as a prefix for all commands. The command set described here can be used for devices with the major firmware version 2 and builds on the legacy command set from older firmware versions. For instructions on how to setup the remote interface itself, refer to the device manual.

ATTENTION

Please download the latest version of this guide from https://stahl-electronics.com/products/dc/bs/.

2 Command Overview

2.1 Description

Command	Description
IDN	Identify device
HVxxx IDN	Identify device on a bus interface
HVxxx A <hex>	Set voltage to all channels
HVxxx RA	Read back "A" command
HVxxx CHyy z.zzzzzz	Set voltage (legacy)
HVxxx Vyy	Read back "CH" command
HVxxx SETyy <float>	Set voltage
HVxxx GETyy	Read back "SET" command
HVxxx Qyy	Query all measurements
HVxxx Uyy	Query voltage measurement
HVxxx Iyy	Query current measurement (BS devices only)
HVxxx RMPyf <uint> aa:<float>,<float>;	Setup ramping (Option BS devices)
HVxxx RMPn?	Read "RMPn" time base
HVxxx RMP TRG	Ramping software trigger
HVxxx RMP TRG My	Ramping trigger-out mode
HVxxx RMP Vy	Ramping verbose mode
HVxxx CORRyy z.zzzzz <+/->a.aaaaa	Calibrate "CH" / "SET"
HVxxx RCORRyy	Read back "CH" / "SET" calibration
HVxxx CUyy <float> <float>	Calibrate "U" query voltage
HVxxx RUyy	Read back "U" calibration
HVxxx CIyy <float> <float>	Calibrate "I" query current (BS devices only)
HVxxx RIyy	Read back "I" calibration (BS devices only)
HVxxx LOCK	Read back LOCK status
HVxxx OW	Check for manual overwrite
HVxxx TEMP	Read back device temperature
HVxxx DIS L Chyy<string>	Write display line (legacy)
HVxxx DIS Lyy <string>	Write display line
HVxxx DIS AUTO y	Update left display column, following "CH" command
HVxxx DIS AUTO DEFAULT y	Set "DIS AUTO" startup value
HVxxx RTC UPTIME	Get device uptime
HVxxx RTC OPTIME	Get device total operational hours

2.2 Answers

Command	Answer
IDN	HVxxx yyy zz f
HVxxx IDN	HVxxx yyy zz f
HVxxx A <hex>	<ACK>
HVxxx RA	<hex>
HVxxx CHyy z.zzzzzz	<ACK>
HVxxx Vyy	z.zzzzzz
HVxxx SETyy <float>	<ACK>
HVxxx GETyy	<float>
HVxxx Qyy	<float>V or <float>V <float>mA
HVxxx Uyy	<float>V
HVxxx Iyy	<float>mA
HVxxx RMPyf <uint> aa:<float>,<float>;	<ACK>
HVxxx RMPn?	<uint>us
HVxxx RMP TRG	<ACK>
HVxxx RMP TRG My	<ACK>
HVxxx RMP Vy	<ACK>
HVxxx CORRyy z.zzzzz <+/->a.aaaaa	<ACK>
HVxxx RCORRyy	z.zzzzz <+/->a.aaaaa
HVxxx CUyy <float> <float>	<ACK>
HVxxx RUyy	<float> <float>
HVxxx CIyy <float> <float>	<ACK>
HVxxx RIyy	<float> <float>
HVxxx LOCK	$B_0B_1B_2B_3$
HVxxx OW	$X_{16}X_{15}X_{14}X_{13}X_{12}X_{11}X_{10}X_9X_8X_7X_6X_5X_4X_3X_2X_1$
HVxxx TEMP	<float>C, <float>C
HVxxx DIS L Chyy<string>	<ACK>
HVxxx DIS Lyy <string>	<ACK>
HVxxx DIS AUTO y	<ACK>
HVxxx DIS AUTO DEFAULT y	<ACK>
HVxxx RTC UPTIME	Uptime: <uint>d <uint>h <uint>m <uint>s
HVxxx RTC OPTIME	Optime: <uint>h

3 Abbreviations

3.1 <float>

Description

<float> is an ASCII string of variable length representing a floating-point number. Valid characters are '0'-'9', '+', '-' and 'e'. <float> may be a positive or negative integer, a floating-point number or a number in e notation. A positive sign may be omitted. The number of significant digits is seven (24 bits).

Examples

- Positive and negative integers: `147` , `-3210`
- Positive and negative floating-point numbers: `315.738` , `-2.78392`
- Positive and negative e notation: `1.326e3` , `-3.25325e2`
- E notation with a positive or negative exponent: `17.353e3` , `182.327e-6`
- Omitting positive signs: `+32.12` = `32.12` and `13.4e+3` = `13.4e3`

3.2 <uint>

Description

<uint> is an ASCII string of variable length representing an unsigned integer (a positive whole number). Valid characters are '0'-'9'.

3.3 <hex>

Description

<hex> is an ASCII string representing one or more 16-Bit words in hexadecimal notation. Valid characters are '0' - '9', 'A' - 'F' (case sensitive!). Each 16-Bit word is four ASCII characters long. Within each 16-Bit word the left most character is the most significant and the right most character is the least significant nibble. Therefore <hex> has a length of $4 \cdot n$ characters where n is the number of 16-Bit words. The minimum length is four and the maximum length is $4 \cdot n_{ch}$ where n_{ch} is the number of channels the device has.

Examples

- 0_{DEC}: `0000`
- 24132_{DEC}: `5E3B`

- 253_{DEC}, 12593_{DEC}, 17_{DEC}: `00FD31310011`
- 0_{DEC}, 0_{DEC}, 0_{DEC}, 0_{DEC}, 0_{DEC}, 57321_{DEC}: `0000000000000000000DFE9`

3.4 <string>

Description

<string> is an ASCII string of variable length. Valid character are all ASCII characters (' ' - '~', decimal 32 - 126, hexadecimal 0x20 - 0x7E) except for control characters. The String does not need to be null-terminated, but the complete command must be terminated according to the protocol specified in the device manual (e.g. with an ASCII carriage return).

3.5 <ACK>

Description

<ACK> is the ASCII control character Acknowledge (ACK, decimal 6, hexadecimal 0x06). This character is returned upon commands which are not queries and therefore do not return any answers.

4 Examples

4.1 Getting Started

After configuring the communication interface (e.g. USB, RS-232, RS-485, ..) according to the device manual the first step is to send `IDN` to retrieve the device identifier. The device might answer `HV190 005 16 b` . The first 5 characters can now be used to address the device.

- Setting channel 5 to 3.75V is as easy as sending the following command:
  `HV190 SET05 3.75` » `<ACK>`
- Read out the applied voltage for all channels:
  `HV190 GET00` » `0,0,0,0,3.75,0,0,0,0,0,0,0,0,0,0,0`
- Read back the voltage measurement of channel 5:
  `HV190 U05` » `3.75001V`
- Read back the current measurement of channel 5:
  `HV190 I05` » `0.342mA`
- Read back the combined voltage and current measurement of channel 5:
  `HV190 Q05` » `3.75001V 0.342mA`

4.2 Setting an Output Voltage

There are three different commands to set an output voltage:

- **"SET"**
  This command sets one channel to a voltage specified by a variable length floating-point number. It can also set all channels of a device to the **same** voltage.
- **"CH"**
  This command is used mainly for legacy proposes to ensure compatibility with software written for older firmware versions. The output voltage is determined by a fixed length fixed point decimal number which needs to be calculated from the maximum voltage of the device and the desired output voltage using a formula. It can also set all channels of a device to the **same** voltage. For applications where a decreased response time of the device (compared to the "SET" command) is required this command can be used together with the "DIS AUTO" command. The disadvantage of this approach is that the set output voltage entry on the display is no longer updated with the "CH" command.
- **"A"** This command can be used for updating multiple channels at once as fast as possible. It writes one or multiple 16 bit values directly into the internal DAC with minimal overhead. However, it requires the user to apply the calibration parameters and calculate the specific DAC values for each channel before sending the command to the HV/BS device.

4.3 Working with Digital Manual Controls (Steering Wheel)

For devices with digital manual controls installed, the user can change the voltage independently of the remote pc controls. In case the pc controls must know if a channel was changed the manual controls and to which voltage, the following procedure should be followed.

1. Check, which channels were overwritten by the manual controls with the "OW" command.
2. Query the last voltage applied to these channels with either the "GET" or "V" command.

ATTENTION

After using the "A" command all output voltages should be applied again using the "SET" or "CH" command **before** the manual controls might be used. Otherwise the voltage will jump to last value which was applied by the manual controls, the "SET" or "CH" command since the "A" command bypasses the manual controls.

Examples

- Check which channels were overwritten by the manual controls:
  `HV190 OW` » `0000000000010010`
  Channel 2 and 5 were overwritten.
- Read back to which voltages these channel were set last:
  - `HV190 GET02` » `0.05`
  - `HV190 GET05` » `-2.5`

  or
  - `HV190 V02` » `0.505000`
  - `HV190 V05` » `0.250000`

  Channel 2 was set to 50mV and channel 5 to -2.5V.

5 Command Details

5.1 Notes

Syntax

The Syntax section will not contain information about protocol, frame or termination. Please refer to the device manual for more information. In case of using a virtual serial port via USB each command and answer is usually terminated with an ASCII carriage return (CR, decimal 13, hexadecimal 0x0D).

Examples

The Examples may contain command-answer pairs, only commands (e.g. for non queries) or only answers (e.g. for commands which do not have any parameters).

ATTENTION

Always read the ATTENTION section of a command description before apply the command to a device in order to avoid damage to the device itself or connected equipment.

5.2 "A" : Set voltage to all channels

Syntax

Command	Answer
HVxxx A <hex>	<ACK>

Description

The "A" command writes 16bit words directly into the internal DACs, depending on the length of <hex>. This means that the calibration values should be applied by the user to create a 16-bit DAC word from a voltage (via software on the control PC), since the calibration values being stored in the device are ignored. Setting a voltage using this command is recommended when the update rate of the output voltages must be faster than achieved with the "SET" or "CH" command. For beginners, the "SET" command is strongly recommended to obtain precise output voltages easily, by just sending voltage values to the device without the need to account for the device calibration. 19-Bit BSA devices do not support the "A" command.

Parameters

<hex> is an ASCII string representing one or multiple 16-bit words in hexadecimal notation. One word is always comprised of four ASCII characters. Thus <hex> must be a multiple of four characters long, up to the number of channels times four. The first word will be written in the DAC of channel one, the second in channel two, etc..

ATTENTION

Great care has to be taken in order to avoid that the device output voltages exceed dangerous levels, using this command. Max/min values of the hex value must be calculated in advance, using the admissible maximum and minimum output voltages of the device. Hex values larger/smaller than admissible will result in output voltages larger/smaller than the admissible output range of the device and could cause fatal damage to the device and connected equipment.
The "A" command bypasses the digital manual controls.

Notes

Due to the fast nature of the command, each 16-bit word results in a voltage change already during the process of parsing the <hex> string. If there is a syntax error during the parsing process the command will be aborted, but keeps the previously recognized voltages.
Voltages applied with the "A" command can not be read back using the "V" or "GET" command.

To calculate a DAC word from a Voltage follow these steps:

1. Read back the $span$ and $offset$ parameter with the "RCORR" command.
2. Scale the desired output voltage to a floating-point number (x) in the same manner as the "CH" command with the following formula:

   $$x = \frac{V_o}{2 \cdot V_{max}} + 0.5 \qquad \text{(Bipolar)} \qquad\qquad x = \frac{V_o}{V_{max}} \qquad \text{(Unipolar)}$$

   Where V_o is the desired output voltage and V_{max} the maximum output voltage of the device.
3. Make sure to clip the scaled voltage (x):

   $$0 \leq x \leq 1$$

4. Calculate the DAC value with the following formula.

   $$DAC = x \cdot span \cdot 62500 + offset \cdot 65535$$

5. Truncate the DAC value to an integer.
6. Convert the DAC value to a hexadecimal string with a fixed length of 4 characters. E.g. "0C3A or "7FFF".

Examples

- Set Channel one DAC to 12573
  `HVxxx A 311D`
- Set all channels of an 8 channel device to 32767
  `HVxxx A 7FFF7FFF7FFF7FFF7FFF7FFF7FFF7FFF`
- Calculate the DAC word for an output voltage of 3.25V at channel one of a +/-5V device and set it as described in the procedure above:
  1. Read out the calibration parameters for channel 1:
     `HVxxx RCORR01` » `0.97324 +0.04733`
     $span$ = 0.97324, $offset$ = 0.04733
  2. Scale the described output voltage:

     $$x = \frac{3.25}{2 \cdot 5} + 0.5 = 0.825$$

  4. Calculate the DAC value:

     $$DAC = 0.825 \cdot 0.97324 \cdot 62500 + 0.04733 \cdot 65535 = 53284.459$$

  6. Convert to hexadecimal:

     $$53284_{10} = D024_{16}$$

  `HVxxx A D024` sets channel one to 3.25V.

5.3 "CH" : Set voltage (legacy)

Syntax

Command	Answer
`HVxxx CHyy z.zzzzzz`	`<ACK>`

Description

The "CH" command applies a voltage to an output channel.

Parameters

The "CH" command has two parameters:

- `yy` is the channel number ranging from `00` to the number of available channels. If the channel number `00` is applied the same voltage will be applied to all channels.
- `z.zzzzzz` is a number between `0.000000` and `1.000000` representing the voltage. It can be calculated by the following formula:

  $$Z = \frac{V_o}{2 \cdot V_{max}} + 0.5 \quad \text{(Bipolar)} \qquad Z = \frac{V_o}{V_{max}} \quad \text{(Unipolar)}$$

  V_o is the desired output voltage, V_{max} the maximum device output voltage, which can be acquired with the "IDN" command.

Notes

The "CH" command is a legacy command from previous firmware versions it, can be substitized with the "SET" command for easier use. For application where a fast response from the device is required the "CH" command should be used in combination with the "DIS AUTO" command. In contrast to previous firmware versions before version 2.0 the "CH" command no longer returns the send string.

Examples

The following examples are for a +/- 5V device, 16 channels (HV196):

- `HV196 CH00 0.500000` sets all 16 channels to 0V.
- `HV196 CH05 0.730000` sets channel 5 to 2.3V.
- `HV196 CH12 0.200000` sets channel 12 to -2V.
- `HV196 CH00 0.000000` sets all 16 channels to -5V.

5.4 "CI" : Calibrate "I" query current (BS devices only)

Syntax

Command	Answer
`HVxxx CIyy <float> <float>`	`<ACK>`

Description

The "CI" command applies calibration parameters for the current read back of a channel.

Parameters

- `yy` is the channel number ranging from `01` to the number of available channels.
- The first `<float>` is the span parameter, which determines the slope of the transfer function (Actual sourced or sinked current to measured read back value).
- The second `<float>` is the offset parameter, which shifts the transfer function (Actual sourced or sinked current to measured read back value) up or down, depending on the optional sign of the value.

ATTENTION

Sending this command changes the factory calibration! Before any calibration is made the current values should be read out with the "RI" command and noted to avoid loosing the current calibration values. Calibration should only be performed by qualified personnel.

Examples

- `HV241 CI01 1.6e-4 -0.001` will set the span of channel 1 to `0.00016` and the offset to `-0.001` .
- `HV246 CI13 0.0012 0.0142` will set the span of channel 13 to `0.0012` and the offset to `0.0142` .

5.5 "CORR" : Calibrate "CH" / "SET"

Syntax

Command	Answer
`HVxxx CORRyy z.zzzzz <+/->a.aaaaa`	<ACK>

Description

The "CORR" command applies calibration paramters to an output channel.

Parameters

- `yy` is the channel number ranging from `01` to the number of available channels.
- `z.zzzzz` is the span parameter, which determines the slope of the transfer function (Voltage applied to actual output voltage).
- `<+/->` is the mandatory sign of the offset parameter. It must be either `+` or `-` .
- `a.aaaaa` is the offset parameter, which shifts the transfer function (Voltage applied to actual output voltage) up or down, depending on the offset sign (see above).

ATTENTION

Sending this command changes the factory calibration! Before any calibration is made the current values should be read out with the "RCORR" command and noted to avoid loosing the current calibration values. Calibration should only be performed by qualified personnel.

Examples

- `HV196 CORR05 0.98439 +0.00032` will set the span parameter of channel 5 to `0.98439` and the offset parameter to `0.00032` .
- `HV196 CORR12 0.98442 -0.00008` will set the span parameter of channel 12 to `0.98442` and the offset parameter to `-0.00008` .

5.6 "CU" : Calibrate "U" query voltage

Syntax

Command	Answer
`HVxxx CUyy <float> <float>`	`<ACK>`

Description

The "CU" command applies calibration parameters for the voltage read back of a channel.

Parameters

- `yy` is the channel number ranging from `01` to the number of available channels.
- The first `<float>` is the span parameter, which determines the slope of the transfer function (Actual output voltage to measured read back value).
- The second `<float>` is the offset parameter, which shifts the transfer function (Actual output voltage to measured read back value) up or down, depending on the optional sign of the value.

ATTENTION

Sending this command changes the factory calibration! Before any calibration is made the current values should be read out with the "RU" command and noted to avoid losing the current calibration values. Calibration should only be performed by qualified personnel.

Examples

- `HV241 CU03 1.6e-4 -0.001` will set the span of channel 3 to `0.00016` and the offset to `-0.001` .
- `HV246 CU11 0.0012 0.0142` will set the span of channel 11 to `0.0012` and offset to `0.0142` .

5.7 "DIS AUTO" : Update left display column, following "CH" command

Syntax

Command	Answer
`HVxxx DIS AUTO y`	<ACK>

Description

The "DIS AUTO" command enables or disables the function which will automatically update the left column on the display when a "CH" command is applied.

Parameters

- Writing an ASCII '1' to `y` enabled the function, writing an ASCII '0' disables the function.

Notes

- Disabling this function will improve the response time for the "CH". The timing for all other commands will not change.
- When the device is power cycled the function will be reset to its default startup behavior. See "DIS AUTO DEFAULT" on how to change the default startup value.
- The "DIS AUTO" command does not affect the "SET" command. It will always update the left column when a voltage is applied with the "SET" command.
- If this function is disabled the "GET" command will no longer read back voltages set with the "CH" command. The "GET" command will only read back values set with the "SET" command.

Examples

- `HV230 DIS AUTO 0` disables the automatic update of the left display column until the next device startup.
- `HV230 DIS AUTO 1` enables the automatic update of the left display column until the next device startup.

5.8 "DIS AUTO DEFAULT" : Set "DIS AUTO" startup value

Syntax

Command	Answer
`HVxxx DIS AUTO DEFAULT y`	<ACK>

Description

The "DIS AUTO DEFAULT" command writes the default startup value for the "DIS AUTO" command to non volatile memory. Every time the device is power cycled the "DIS AUTO" function will use the value stored with the "DIS AUTO DEFAULT" command. The factory default is an enabled "DIS AUTO" function.

Parameters

- Writing an ASCII '1' to `y` enables and writing an ASCII '0' disables the "DIS AUTO" function and writes the startup value to non volatile memory.

ATTENTION

The "DIS AUTO DEFAULT" command should be only used to set a desired default behavior. NEVER use this function in an automatic process. The non volatile memory has a limited number of wrtie cycles. If the behavoir will be altered by an automatic process use the volatile DIS AUTO command instead.

Notes

See DIS AUTO for more details.

Examples

- `HV230 DIS AUTO DEFAULT 0` disables the automatic update of the left display column and saves it to non volatile memory.
- `HV230 DIS AUTO DEFAULT 1` enables the automatic update of the left display column and saves it to non volatile memory.

5.9 "DIS L" : Write display line (legacy)

Syntax

Command	Answer
`HVxxx DIS L Ch y<string>`	`<ACK>`
`HVxxx DIS L Chyy<string>`	`<ACK>`
`HVxxx DIS L CH y<string>`	`<ACK>`
`HVxxx DIS L CHyy<string>`	`<ACK>`

Description

The "DIS L" legacy command displays a line in the left most column of the display.

Parameters

- `Ch y` , `Chyy` is the channel/line number ranging from `Ch01` to the number of available channels. Single digit number can be either written as space and the number `Ch 1` or with a leading zero `Ch01` . The 'h' may be lower or upper case as preferred.
- `<string>` is the string which will be displayed after the channel number. It must not be null-terminated (the command as a whole must be terminated as required by the protocol (e.g. with an ASCII carriage return)).

Notes

To Display an arbitrary string without the channel number the "DIS Lyy" command should be used instead.

Examples

- `HV230 Ch 1 12.000 V` will display `Ch 1 12.000 V` in the left column in line 1.
- `HV230 CH01 X-Axis` will display `CH01 X-Axis` in the left column in line 1.
- `HV230 Ch14 13.000 V` will display `Ch14 13.000 V` in the left column in line 14.

5.10 "DIS Lyy" : Write display line

Syntax

Command	Answer
`HVxxx DIS Lyy <string>`	`<ACK>`

Description

The "DIS Lyy" command displays a line in the left most column of the display.

Parameters

- `yy` is the line number ranging from `00` to the number of available channels. If the line number `00` is applied the same string will be applied to all lines.
- `<string>` is the string which will be displayed after the channel number. It must not be null-terminated (the command as a whole must be terminated as required by the protocol (e.g. with an ASCII carriage return)).

Notes

See also the "DIS L" legacy command.

Examples

- `HV230 L01 Ch 1 12.000 V` will display `Ch 1 12.000 V` in the left column in line 1.
- `HV230 L07 Ch01 12.000 V` will display `Ch01 12.000 V` in the left column in line 7.
- `HV230 L00 Testing` will display `Testing` in the left column in all lines.
- `HV230 L12 y-Axis` will display `y-Axis` in the left column in line 12.

5.11 "GET" : Read back "SET" command

Syntax

Command	Answer
`HVxxx GETyy`	`<float>`

Description

The "GET" command reads the last "SET" or "CH" command for one or all channels back, in the same numerical format as the "SET" command.

Parameters

- `yy` is the channel number ranging from `00` to the number of available channels. If the channel number `00` is applied the value of all channels will be read back separated by a "," starting with channel 1.

Answer

`<float>` is a float string representing the current output voltage in volts.

ATTENTION

If the "DIS AUTO" function is disabled the "CH" command bypasses the "GET" command and it will only read back values applied with the "SET" command.

Examples

The following examples are for a +/- 40V device, 4 channels (HV235):

- Command: `HV235 GET03` Answer: `23.031`
  Channel 3 was set to 23.031V.
- Command: `HV235 GET02` Answer: `5e-3`
  Channel 2 was set to 5mV.
- Command: `HV235 GET00` Answer: `12.3,0.5,33.5,-13.02`
  Channel 1 was set to 12.3V, channel 2 to 0.5V, channel 3 to 33.5 and channel 4 to -13.02V.

5.12 "HVxxx IDN" : Identify device on a bus interface

Syntax

Command	Answer
`HVxxx IDN`	`HVxxx yyy zz f`

Description

The "HVxxx IDN" command returns the device identification string, which includes serial number, maximum voltage, number of channels and a flag.

Answer

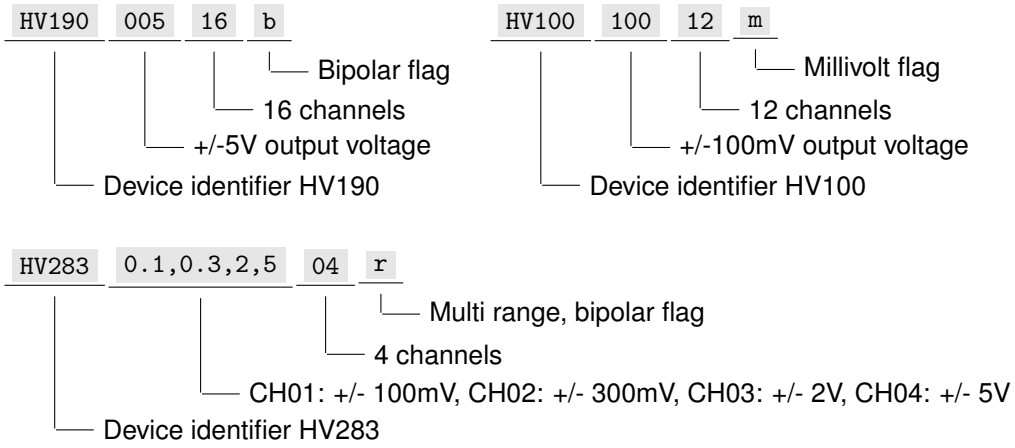
The Answer `HVxxx yyy zz f` consists of the following parts:

- `HVxxx` is the USB identification.
- `yyy` is the maximum output voltage.
- `zz` is the number of channels.
- `f` is a flag indicating one of the following options:
  - `b` : Bipolar supply
  - `m` : Millivolt range, bipolar. Divide maximum output voltage by 1000.
  - `u` : Unipolar supply
  - `r` : Multi range device, bipolar. Caution the voltage string `yyy` changes in this case to `<float>,<float>,<float>,<float>` . Each floating-point string represents the maximum output voltage of a single channel (CH01 to CH04). See example below.

Notes

This command is intended for bus communication interfaces (e.g. RS-485) and returns the same values as the "IDN" command.
This command is included with firmware version 2.2 and later.

Examples


HV190 005 16 b
Bipolar flag
16 channels
+/-5V output voltage
Device identifier HV190
HV100 100 12 m
Millivolt flag
12 channels
+/-100mV output voltage
Device identifier HV100
HV283 0.1,0.3,2,5 04 r
Multi range, bipolar flag
4 channels
CH01: +/- 100mV, CH02: +/- 300mV, CH03: +/- 2V, CH04: +/- 5V
Device identifier HV283

5.13 "I" : Query current measurement (BS devices only)

Syntax

Command	Answer
`HVxxx Iyy`	`<float>mA`

Description

The "I" command queries the current measurement of one or all output channels.

Parameters

- `yy` is the channel number ranging from `00` to the number of available channels. If the channel number `00` is applied, the value of all channels will be measured and read back separated by a "," starting with channel 1.

Answer

`<float>mA` is the measured current of channel `yy` . Positive values means the current is sourced from the device, negative values are sinked currents.

Notes

For a combined measurement of both the "U"(Voltage) and "I"(Current) command the "Q" command can be used.

Examples

The following examples are for a +/- 40V device, 4 channels (HV235):

- Command: `HV235 I02` Answer: `0.013mA` channel 2 reads back 13µA.
- Command: `HV235 I00` Answer: `1.2mA,-0.0321mA,7.32mA,0.12mA`
  - Channel 1 reads back 1.2mA
  - Channel 2 reads back -32.1µA
  - Channel 3 reads back 7.32mA
  - Channel 4 reads back 120µA

5.14 "IDN" : Identify device

Syntax

Command	Answer
`IDN`	`HVxxx yyy zz f`

Description

The "IDN" command returns the device identification string, which includes serial number, maximum voltage, number of channels and a flag.

Answer

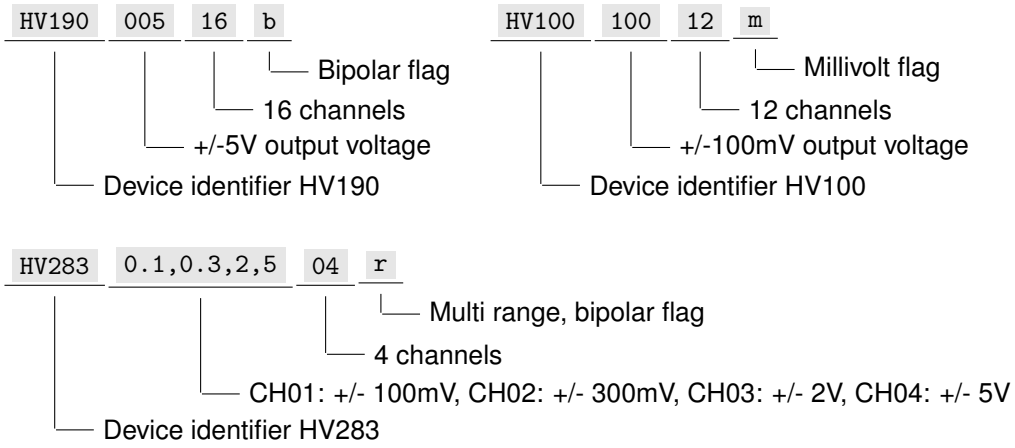
The Answer `HVxxx yyy zz f` consists of the following parts:

- `HVxxx` is the USB identification.
- `yyy` is the maximum output voltage.
- `zz` is the number of channels.
- `f` is a flag indicating one of the following options:
  - `b` : Bipolar supply
  - `m` : Millivolt range, bipolar. Divide maximum output voltage by 1000.
  - `u` : Unipolar supply
  - `r` : Multi range device, bipolar. Caution the voltage string `yyy` changes in this case to `<float>,<float>,<float>,<float>` . Each floating-point string represents the maximum output voltage of a single channel (CH01 to CH04). See example below.

Notes

This command should not be used on bus communication interfaces (e.g. RS-485) since all devices would answer at the same time. The "HVxxx IDN" command should be used instead.

Examples


HV190 005 16 b
Bipolar flag
16 channels
+/-5V output voltage
Device identifier HV190
HV100 100 12 m
Millivolt flag
12 channels
+/-100mV output voltage
Device identifier HV100
HV283 0.1,0.3,2,5 04 r
Multi range, bipolar flag
4 channels
CH01: +/- 100mV, CH02: +/- 300mV, CH03: +/- 2V, CH04: +/- 5V
Device identifier HV283

5.15 "LOCK" : Read back LOCK status

Syntax

Command	Answer
`HVxxx LOCK`	$B_0B_1B_2B_3$

Description

- HV: The "LOCK" command reads the PID status (OK or overloaded) of the output channels back.
- BS: The "LOCK" command read the over current status of the output channels back.

Answer

$B_0B_1B_2B_3$ is the status of all channels encoded into four bytes. Each byte consists of eight bits: $b_7b_6b_5b_4b_3b_2b_1b_0$. The upper nibble [b_7:b_4] is always `0001` to avoid the lower ASCII control characters. The lower nibble of each byte [b_3:b_0] encodes the status of four channels. A `1` represents a non-locked or overloaded channel, while a `0` represents a correctly working channel.

Byte	b_3	b_2	b_1	b_0
B_0	Ch 4	Ch 3	Ch 3	Ch 1
B_1	Ch 8	Ch 7	Ch 6	Ch 5
B_2	Ch 12	Ch 11	Ch 10	Ch 9
B_3	Ch 16	Ch 15	Ch 14	Ch 13

Table 1: Channel assignment

Examples

The examples below are in hexadecimal notation (`\x1F` = 31_{10} = 00011111_2).

- `\x11\x10\x10\x10` :
  - HV: PID of channel one can not reach target voltage.
  - BS: Over current at channel one.
- `\x10\x12\x10\x15` :
  - HV: PID of channel 6, 13 and 15 can not reach target voltage.
  - BS: Over current at channel 6, 13 and 15.

5.16 "OW" : Check for manual overwrite

Syntax

Command	Answer
`HVxxx OW`	$X_{16}X_{15}X_{14}X_{13}X_{12}X_{11}X_{10}X_9X_8X_7X_6X_5X_4X_3X_2X_1$

Description

The "OW" command identifies channels which were overwritten by the digital manual controls. Manual controls are currently only available for BS devices.

Answer

$X_{16}X_{15}X_{14}X_{13}X_{12}X_{11}X_{10}X_9X_7X_6X_5X_4X_3X_2X_1$ is the status of all channels. Each X_n character is either

- `0` : Channel n was not overwritten by the digital manual controls.

or

- `1` : Channel n was overwritten by the digital manual controls.

Notes

- Once a channel was overwritten by the digital manual controls, it will read as `1` until the channel is written to by either the SET or the CH command.
- See the GET and V commands on how to read out the last voltage set by the digital manual controls.
- Devices without the digital manual controls option will always read a string of 16 zeros back.

Examples

- `0000000000001010` : Channels two and four were overwritten by manual controls.

5.17 "Q" : Query all measurements

Syntax

Device	Command	Answer
HV	`HVxxx Qyy`	`<float>V`
BS	`HVxxx Qyy`	`<float>V <float>mA`

Description

The "Q" command queries the voltage measurement for HV devices or the voltage and current measurement for BS devices.

Parameters

- `yy` is the channel number ranging from `00` to the number of available channels. If the channel number `00` is applied, the value of all channels will be measured and read back separated by a "," starting with channel 1.

Answer

- HV: `<float>V` is the measured output voltage of channel `yy` .
- BS: `<float>V <float>mA` the first <float> is the measured output voltage followed (by the unit) and the second <float> is the measured sourced or sinked current (followed by the unit) of channel `yy` .

Notes

For HV devices the "Q" command can be exchanged with the "U" command. Only on BS devices the two commands differ.

Examples

The following examples are for a +/- 40V device, 4 channels (HV232):

- Command: `HV232 Q02` Answer: `13.532V 0.013mA` channel 2 reads back 13µA at 13.532V.
- Command: `HV232 Q00`
  Answer: `13V 1.2mA,-2.3V -0.0321mA,25.3V 7.32mA,0.21V 0.12mA`
  - Channel 1 reads back 1.2mA at 13V.
  - Channel 2 reads back -32.1µA at -2.3V.
  - Channel 3 reads back 7.32mA at 25.3V.
  - Channel 4 reads back 120µA at 210mV.

5.18 "RA" : Read back "A" command

Syntax

Command	Answer
HVxxx RA	<hex>

Description

The "RA" command reads the last "A" command back.

Answer

<hex> is an ASCII string representing one or multiple 16-bit words in hexadecimal notation. One word is always comprised of four ASCII characters. Thus <hex> will be a multiple of four characters long, up to the number of channels times four. The first word is the value of the first channel, the second of channel two, etc..

Notes

Keep in mind that after writing a shorter "A" command (for less channels) only the channels accessed by the last "A" command will be read back. See the example below for details.

Examples

- `0A3F5D23` : Channel one was set to 2623 and channel two to 23843 by the last "A" command.
- After sending the commands `HV123 A 012B04A2D2A3F001` and `HV123 A 7FFF35C2` the "RA" command will only read `7FFF35C2` .

5.19 "RMPn" : Setup ramping (Option BS devices)

Syntax

Command	Answer
HVxxx RMPyf <uint> aa:<float>,<float>;	<ACK>

Description

The "RMPn" command sets up one or more channels for ramping. Up to four channels can be ramped simultaneously. The length of the ramp is specified in number of steps of a fixed time base depending on the number of channels to ramp.

Parameters

- `y` is the number of channels to be ramped, from 1 to 4.
- `f` is the flag to indicate the trigger mode. Options are:
  - `S` for single shot, thus the ramp can only be triggered once either by hard- or software trigger.
  - `M` for multiple shot, thus the ramp can be triggered multiple times either by hard- or software trigger.
  - `F` for force trigger, this the ramp will be immediately triggered once by the command. This is equivalent to a single shot ramp followed a software trigger.
- `<uint>` is the number of steps of the ramp. The time base of one step depends on the number of ramps and can be found out with the "RMPn?" command.
- `aa:<float>,<float>;` are the ramping parameters for each channel. This block repeats `y` times, the same number as channels to be ramped. The parameters are:
  - `aa` is the channel number, from 1 to the number of channels of the device.
  - `<float>` is the start voltage of the ramp in volts.
  - `<float>` is the end voltage of the ramp in volts.

ATTENTION

Sending any other command to the device while a ramp is running will abort the ramp and discard the command. This can be used to stop an ramp prematurely. Just sending an empty command (consiting just of a termination character, e.g. carriage return) will abort the current ramp. The output of the channels will be wherever the ramp was at the time of the abort.

Notes

The first Value of the ramp is applied to the channel as soon as it is triggered. In case the channel has a voltage diffrent from starting voltage of the ramp the voltage will suddenly jump to starting voltage of the ramp. It is recommended to either set the channel to the starting voltage before triggering to ensure a smooth ramp or plan the ramps in a way that the first value of the ramp is the same as the last value of the previous ramp.

Examples

- `HV289 RMP1F 8000 08:-2.5,2.5;` sets up and soft triggers channel 8 for a ramp from -2.5V to 2.5V in 8000 steps which would correspond to a 1s ramp in case the time base of RMP1 is 125us.
- `HV289 RMP2M 100000 01:0,1.2345;02:0,6.789;` sets up channel 1 and 2 for ramps from 0V to 1.2345V and 0V to 6.789V in 100000 steps. The ramp can be triggered multiple times by either hard- or software trigger.
- `HV289 RMP4S 100000 03:1,2;05:2,1;07:-2,2;08:0,20;` sets up channels 3, 5, 7 and 8 for ramps from 1V to 2V, 2V to 1V, -2V to 2V and 0V to 20V in 100000 steps. The ramp can only be triggered once by either hard- or software trigger.

5.20 "RMPn?" : Read "RMPn" time base

Syntax

Command	Answer
`HVxxx RMPn?`	`<uint>us`

Description

The "RMPn?" command reads back the time base for a specific number of channels in microseconds.

Parameters

- `y` Number of Channels to be ramped from 1 to 4.

Answer

`<uint>us` Time between two steps of the ramp in microseconds.

Examples

- `HV289 RMP2?` might read `125us` to indicate that the time base for a ramp of two channels is 125µs.
- `HV289 RMP4?` might read `250us` to indicate that the time base for a ramp of four channels is 250µs.

5.21 "RMP TRG" : Ramping software trigger

Syntax

Command	Answer
`HVxxx RMP TRG`	`<ACK>`

Description

The "RMP TRG" command software triggers the ramp previous set up with the "RMPn" command.

Notes

To change the trigger-out behavior for software triggered ramps, use the "RMP TRG M" command.

Examples

- `HV289 RMP TRG` will software trigger the ramp.

5.22 "RMP TRG M" : Ramping trigger-out mode

Syntax

Command	Answer
`HVxxx RMP TRG My`	`<ACK>`

Description

The "RMP TRG M" command sets the trigger-out behavior for software triggered ramps.

Parameters

- `y` Trigger-out behavior:
  - `0` The trigger-out signal is disabled.
  - `1` The trigger-out signal will pulse at the beginning of the ramp.
  - `2` The trigger-out signal will pulse at the end of the ramp.
  - `3` The trigger-out signal will pulse at the beginning and end of the ramp.

Notes

This command only affects software triggered ramps. Hardware triggered ramps will always pulse the trigger-out signal at the end of the ramp. This command is volatile. After a restart of the device the default behavior is 3, the trigger-out signal will pulse at the beginning and end of the ramp.

Examples

- `HV289 RMP TRG M2` will set the trigger-out behavior to pulse at the end of the ramp.

5.23 "RMP V" : Ramping verbose mode

Syntax

Command	Answer
`HVxxx RMP Vy`	<ACK>

Description

The "RMP V" command enables or disables the verbose function. This means when the ramp is finished the device will send a message to the PC.

Parameters

- `y` Verbose function:
  - `0` The verbose function is disabled.
  - `1` The verbose function is enabled.

Answer

The Answer of this command is an ASCII <ACK>. If enabled the device will send without any query `RMP END` each time a ramp is finished.

Notes

The verbose function is volatile and disabled by default. The answer will be sent to the PC without a query from the user.

Examples

- `HV289 RMP V1` will enable the verbose function.
- `HV289 RMP V0` will disable the verbose function.

5.24 "RCORR" : Read back "CH" / "SET" calibration

Syntax

Command	Answer
`HVxxx RCORRyy`	`z.zzzzz <+/->a.aaaaa`

Description

The "RCORR" command reads the output calibration for a channel back.

Parameters

- `yy` is the channel number ranging from `00` to the number of available channels. If the channel number `00` is applied, the value of all channels will be read back separated by a "," starting with channel 1.

Answer

- `z.zzzzz` is the span parameter which determines the slop the the transfer function (Voltage applied to actual output voltage).
- `<+/->` is the sign of the offset parameter. It is either `+` or `-` .
- `a.aaaaa` is the offset parameter, which shifts the transfer function (Voltage applied to actual output voltage) up or down, depending on the offset sign (see above).

Examples

- Command: `HV196 RCORR05` Answer: `0.98439 +0.00032`
  The span parameter of channel 5 is `0.98439` and the offset parameter is `0.00032` .
- Command: `HV196 RCORR12` Answer: `0.98442 -0.00008`
  The span parameter of channel 12 is `0.98442` and the offset parameter is `-0.00008` .
- Four channel device:
  Command:
  `HV232 RCORR00`
  Answer:
  `0.97324 +0.00003,0.97319 +0.00012,0.97331 -0.00009,0.97327 +0.00001`

5.25 "RI" : Read back "I" calibration (BS devices only)

Syntax

Command	Answer
`HVxxx RIyy`	`<float> <float>`

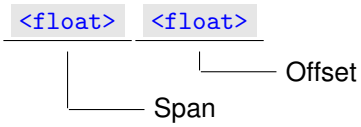
Description

The "RI" command reads the current read back calibration for a channel back.

Parameters

- `yy` is the channel number ranging from `00` to the number of available channels. If the channel number `00` is applied, the value of all channels will be read back separated by a "," starting with channel 1.

Answer



- Span: Determines the slope of the transfer function (Actual sourced or sinked current to measured read back value).
- Offset: Shifts the transfer function (Actual sourced or sinked current to measured read back value) up or down, depending the sign of the value.

Examples

- Command: `HV241 RI01` Answer: `1.6e-4 -0.001`
  The span of channel 1 is `0.00016` and the offset is `-0.001`
- Command: `HV246 RI13` Answer: `0.0012 0.0142`
  The span of channel 13 is `0.0012` and the offset is `0.0142`

5.26 "RTC OPTIME" : Get device total operational hours

Syntax

Command	Answer
`HVxxx RTC OPTIME`	`Optime: <uint>h`

Description

The "RTC OPTIME" command returns the total operational time of the device. This value is updated every time one full hour passes on the uptime counter.

Answer

- `<uint>h` : Operational ours.

Notes

See also: "RTC UPTIME"

5.27 "RTC UPTIME" : Get device uptime

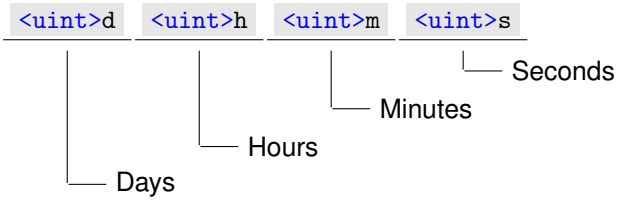
Syntax

Command	Answer
`HVxxx RTC UPTIME`	`Uptime: <uint>d <uint>h <uint>m <uint>s`

Description

The "RTC UPTIME" command returns the current device uptime. This time starts from 0 every time the device is powered up.

Answer



Notes

See also: "RTC OPTIME"

5.28 "RU" : Read back "U" calibration

Syntax

Command	Answer
`HVxxx RUyy`	`<float> <float>`

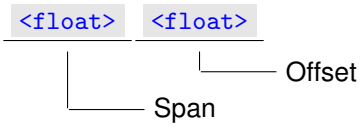
Description

The "RU" command reads the voltage read back calibration for a channel back.

Parameters

- `yy` is the channel number ranging from `00` to the number of available channels. If the channel number `00` is applied, the value of all channels will be read back separated by a "," starting with channel 1.

Answer



- Span: Determines the slope of the transfer function (Actual output voltage to measured read back value).
- Offset: Shifts the transfer function (Actual output voltage to measured read back value) up or down, depending the sign of the value.

Examples

- Command: `HV241 RU03` Answer: `1.6e-4 -0.001`
  The span of channel 3 is `0.00016` and the offset is `-0.001`
- Command: `HV246 RU11` Answer: `0.0012 0.0142`
  The span of channel 11 is `0.0012` and the offset is `0.0142`

5.29 "SET" : Set voltage

Syntax

Command	Answer
`HVxxx SETyy <float>`	`<ACK>`

Description

The "SET" command applies a voltage to an output channel.

Parameters

- `yy` is the channel number ranging from `00` to the number of available channels. If the channel number `00` is applied the same voltage will be applied to all channels.
- `<float>` is a float string representing the voltage in volts.

Notes

This command can be substitized with the "CH" command for legacy applications or faster response times in conjunction with the "DIS AUTO" command.

Examples

The following examples are for a +/- 5V device, 16 channels (HV196)

- `HV196 SET00 0` sets all 16 channels to 0V.
- `HV196 SET05 2.3` sets channel 5 to 2.3V.
- `HV196 SET12 -2` sets channel 12 to -2V.
- `HV196 SET00 -5` sets all 16 channels to -5V.
- `HV195 SET01 0.01` sets channel 1 to 10mV.
- `HV195 SET03 -12e-3` sets channel 3 to -12mV.

5.30 "TEMP" : Read back device temperature

Syntax

Command	Answer
`HVxxx TEMP`	`<float>C, <float>C`

Description

The "TEMP" command reads the temperature at the two internal controllers back.

Answer

- The first <float> is the temperature at the Glue controller (located in the center of the main board) in °C.
- The second <float> is the temperature at the Master controller (located in the rear part of the device) in °C.

Examples

- `26.5C, 29.6C`
  - The temperature at the Glue controller is 26.5°C.
  - The temperature at the Master controller is 29.6°C.

5.31 "U" : Query voltage measurement

Syntax

Command	Answer
`HVxxx Uyy`	`<float>V`

Description

The "U" command queries the voltage measurement of one or all output channels.

Parameters

- `yy` is the channel number ranging from `00` to the number of available channels. If the channel number `00` is applied the value of all channels will be measured and read back separated by a "," starting with channel 1.

Answer

`<float>V` is the measured output voltage of channel `yy` .

Notes

BS devices only: For a combined measurement of both the "U"(Voltage) and "I"(Current) command the "Q" command can be used.

Examples

The following examples are for a +/- 40V device, 4 channels (HV235):

- Command: `HV235 U03` Answer: `13.532V` channel 3 reads back 13.532V.
- Command: `HV235 I00` Answer: `-1.2V,0.0381V,23.1V,0.2V`
  - Channel 1 reads back -1.2V
  - Channel 2 reads back 38.1mV
  - Channel 3 reads back 23.1V
  - Channel 4 reads back 200mV

5.32 "V" : Read back "CH" command

Syntax

Command	Answer
`HVxxx Vyy`	`z.zzzzzz`

Description

The "V" command reads the last "CH" or "SET" command for one or all channels back, in the same numerical format as the "CH" command.

Parameters

- `yy` is the channel number ranging from `00` to the number of available channels. If the channel number `00` is applied the value of all channels will be read back separated by a "," starting with channel 1.

Answer

`z.zzzzzz` is a number between `0.000000` and `1.000000` representing the voltage. It can be calculated by the following formula:

$V_o = (Z - 0.5) \cdot 2 \cdot V_{max}$ (Bipolar) $V_o = Z \cdot V_{max}$ (Unipolar)

V_o is the current output voltage, V_{max} the maximum device output voltage, which can be acquired with the "IDN" command.

Examples

The following examples are for a +/- 40V device, 4 channels (HV232):

- Command: `HV232 V01` Answer: `0.500000` channel 1 is set to 0V.
- Command: `HV232 V04` Answer: `0.528750` channel 4 is set to 2.3V.
- Command: `HV232 V00` Answer: `0.000000,1.000000,0.000000,1.000000` channels 1 and 3 are set to -40V, 2 and 4 to +40V.