

19“ – High Voltage Power Supplies

HPS 1500 W series

19“ – C-Charger High Voltage Power Supplies

LPS 1500 W series

Operator's manual

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Operating see the attachment point 4 to 7

Attention!

- The unit must not be operated with the cover removed to avoid the possibility of lethal shock to the operator!
- We decline all responsibility for damages and injuries caused by an improper use of the module. It is strongly recommended to read the operator's manual before operation!

Note

All information in this document is subject to change without notice. We take no responsibility for any error in this document. We reserve the right to make changes in the product design without any notification to the users.

Filename HPx_1500W_06_eng.____; Version 5.15 as of 2009-02-05

1 Safety instructions

This High Voltage Power Supply has to be installed by skilled personnel only. Following instructions are made for the personal safety of the operator, the safe use of this product and the connected units.



Caution



Dangerous Voltage

This unit is supplied from line voltage of 230 V-AC and generates an output voltage of up to 15 kV.

The disregard of this voltage condition can cause death, heavy injuries or material damage.



Danger in case of missing connector at the HV output

The **LEMO-HV** connector will be used for units which generate output voltages $> 6\text{kV}$. It is forbidden to switch on this unit without a suitable connector inclusive a cable which is connected to the output connector and the load.

Before connecting to the local mains it must be proofed that the nominal line voltage of this unit is equal to the local mains.

Caution: After system-assembly the guard connections have to be checked if they are connected correctly!

The guard connection has to be proofed through a correct mains cable. An additional guard connection is possible via the depth bolt connector on the rear (\perp /PE-connector).

The unit is prepared to be mounted into a 19"-cabinet. In this case the necessary air flow conditions through the according air input and output slots have to be guaranteed.

If the unit will be used as desk top instrument then the enclosed unit bases have to be glued on the bottom sheet in order to guarantee a certain distance to the desk.

Before the cover of the unit will be removed the mains connection has to be disconnected, the discharge time of at least ($> 15\text{ s}$) of the output capacitance has to be kept and the discharge status has to be checked afterwards.

Only skilled and authorised people are allowed to do any service, repair or maintenance for this unit.

2 Technical data

19" / 3HE series HPx ¹ 1500 W	HPx ¹ 10 158	HPx ¹ 20 757	HPx ¹ 40 357	HPx ¹ 80 187	HPx ¹ 120 127	HPx ¹ 150 107
Output voltage V_{NOM} [kV]	1	2	4	8	12	15
Output current I_{NOM} [mA]	1500	750	350	180	120	100
HV-connector	SHV on the rear			Lemo HV connector on the rear		
	4 kV < V_{NOM} ≤ 16kV: Lemo ERA.1Y.416.CLL Attention: Use with connected HV connector only !					
Output power	max. 1500 W					
Polarity	factory fixed ⇒ ¹ x = p: positive ⇒ ¹ x = n: negative					
Ripple & noise (f > 10 Hz)	< 2 * 10 ⁻³ * V_{NOM} (V_{P-P})					
Voltage stability	< 1 * 10 ⁻⁴ * V_{NOM} (load to no load, ΔV_{IN} and repeatability) in the output voltage range: 5 V ≤ V_{OUT} ≤ V_{NOM}					
Current stability	< 2 * 10 ⁻³ * I_{NOM} ($R_{Lmin} \leq R_L <$ no load and ΔV_{IN}) in the output voltage range: 5 V ≤ V_{OUT} ≤ V_{NOM}					

19" / 3HE series LPx ¹ 1500 W	LPx ¹ 10 158	LPx ¹ 20 757	LPx ¹ 40 357	LPx ¹ 80 187	LPx ¹ 120 127	LPx ¹ 150 107
Output voltage V_{NOM} [kV]	1	2	4	8	12	15
Output current I_{NOM} [mA]	1500	750	350	180	120	100
HV-connector	SHV on the rear			Lemo HV connector on the rear		
	4 kV < V_{NOM} ≤ 16kV: Lemo ERA.1Y.416.CLL Attention: Use with connected HV connector only !					
Output power	max. 1500 W					
Discharge frequency	Max. one complete discharge per second, discharge current must be limited external to I_{NOM} otherwise					
Polarity	factory fixed ⇒ ¹ x = p: positive ⇒ ¹ x = n: negative					
Voltage stability	< 1 * 10 ⁻⁴ * V_{NOM} (load to no load, ΔV_{IN} and repeatability) in the output voltage range: 5 V ≤ V_{OUT} ≤ V_{NOM}					
Current stability	< 2 * 10 ⁻³ * I_{NOM} ($R_{Lmin} \leq R_L <$ no load and ΔV_{IN}) in the output voltage range: 5 V ≤ V_{OUT} ≤ V_{NOM}					

2.1 General technical data

19" / 3HE series HPx) ¹ 1500 W		19" / 3U series LPx) ¹ 1500 W	
Accuracy of measurement	Voltage	$\pm (0,05\% V_{OUT} + 0,02\% V_{NOM} + 1 \text{ digit})$ for one year	
	Current	$\pm (0,05\% I_{OUT} + 0,02\% I_{NOM} + 1 \text{ digit})$ for one year	
Temperature coefficient		$< 2 \cdot 10^{-4}/K$	
Display		8-digit LCD-Display for current and voltage	
Resolution of measurement voltage / current		4-digit	
Resolution of setting voltage / current	LOCAL	4-digit	
	REMOte	4-digit	
Switching of output voltage		with button "ON/OFF" or via remote control	
Control (REMOte) optional: AIF optional: IEEE	LOCAL	with rotary encoder for voltage and current	
	CAN	via CAN-Interface	
	RS232	via RS232-Interface	
	AIF	via indirect coupled analogue I/O additionally (male SUB-D-9 connector)	
	IEEE	via IEEE-Interface additionally (male Micro-D25 connector)	
Efficiency		up to 95 %	
Supply		$V_{IN} = 230V \pm 10\% - AC$ (ex works 115V \pm 10% - AC possible) $I_{IN} = \text{max. } 10 \text{ A at } 230 \text{ V-AC}$ via mains connector and switch "POWER", isolated from HV-output, fused with 2 * 16 A / slow.	
Dimension		3U -19" compatible / depth: 450 mm	
Weight		ca. 12 kg	
Cooling		Forced cooling with internal fan	
Protection		Over load and short circuit , voltage supply and temperature	
Environment conditions		Operating temperature: 5 up to 35 °C Humidity: 30% up to 80 %, no condensation	
Storage temperature		0 up to 60 °C	

3 Functional description

The High Voltage PS of the HPx¹ - 1500 W series provide an output voltage of 0 up to 15 kV-DC at max. 1500 W output power.

The control loop is designed to provide a constant voltage or current.

The High Voltage PS of the LPx¹ - 1500 W series charge capacitors in an output voltage range of 0 up to 15 kV-DC at max. 1500 W output power.

The control loop is designed to charge a capacity in constant current control mode. This capacity will discharge with the user circuit. You will find information to the discharge frequency dependence on the discharge level in chapter 2.

On LPS devices, the Software voltage ramp (0...3000V/s) can be disabled. The device then ramps to the chosen set voltages as fast as possible (see chapter 4 "Front panel operation" and 6 "Command sets").

Mains voltage is 230 V -AC \pm 10 % / 50 Hz (optional ex works with 115 V -AC \pm 10 %).

The output voltage and current are limited due to the hardware circuitry. The polarity is factory fixed (¹x=p: positive; ¹x=n: negative).

The shield of the HV output is always connected to the housing (L/PE-connector).

3.1 Operation states

The device has the following operation states:

- POWER-ON Device initialises the connected Hardware (Booting)
- LOCAL Device is controlled with buttons and rotary encoders at the front panel
- REMOTE Device is remote controlled via interface (CAN, RS-232, IEEE-488)

The states LOCAL and REMOTE are further divided into:

- HV-OFF No high voltage is produced
- HV-ON High voltage according to Set values is produced

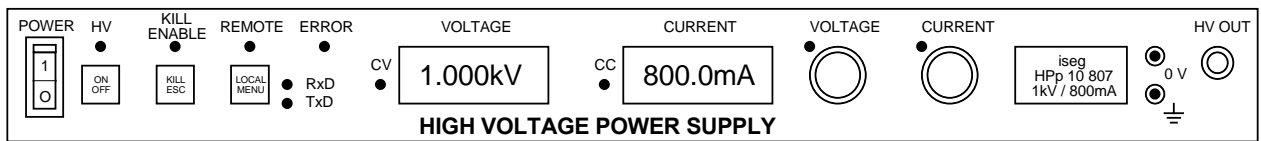
In the HV-ON state there are two modes for high voltage creation:

1. Voltage control CV:
Control of output voltage according to set value V_{SET}
(Output current $I_{OUT} < I_{SET}$), LED „CV“ lighting.
2. Current control CC (only with "Kill disable"):
Control of output current according to set value I_{SET}
(Output current $V_{OUT} < V_{SET}$), LED „CC“ lighting.

The KILL function is be set with the KILL/ESC button:

- Disable: The output voltage will be limited after reaching I_{SET}
- Enable: The yellow LED „KILL ENABLE“ is lighting.
The output voltage will be shut off permanently without ramp, if $I_{OUT} \geq I_{SET}$.
The re-setting of the output voltage is possible after pushing button HV ON again.

4 Front panel operation



Picture: HPS/LPS front panel.

Optional and if $V_{NOM} > 7kV$:
connections on the rear

After pushing the POWER button the device is booting. During boot, the integrated hardware is initialised. After start-up the device is working in LOCAL mode and the KILL function is “disable”.

In LOCAL mode, the set values for voltage and current can be adjusted with the rotary encoders VOLTAGE for V_{SET} and CURRENT for I_{SET} .

Generation of high voltages starts by pushing the ON/OFF button. While generating high voltage, the green LED “HV” is lighting.

**Caution! The high voltage which has been selected with the rotary encoders is going to ramp to the chosen voltage with the programmed ramp speed!
Factory setting for ramp speed is $0.2 \cdot V_{NOM}$ per second.**

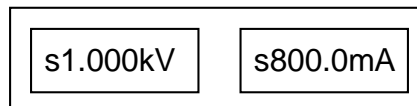
By pressing ON/OFF again, the high voltage generation is turned off, the green LED “HV” goes off. The high voltage is ramped down with the programmed ramp speed.

4.1 Displays

The device has two eight digit displays for voltage and current as well as for Menu control.

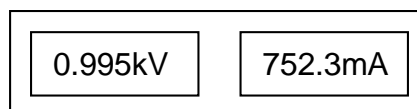
In HV-OFF state, the set values are shown on display for easy changes with the rotary encoders VOLTAGE and CURRENT. These set values are stored in processor’s EEPROM and reloaded at next start-up.

While displaying the set values for voltage and current, a small ‘s’ is flashing at the left display side:



Picture: Set values on display in HV-OFF state

In HV-ON state the measured values of voltage and current are displayed:



Picture: Measured values on displays in HV-ON state

By pressing the rotary encoder VOLTAGE or CURRENT in HV-ON state, the corresponding set value is displayed for a short time to allow exact adjustment.

If the set values aren’t changed, the device shows the measured values again after four seconds. By pressing the corresponding rotary encoder again, this delay can be shortened.

After turning high voltage off, the displays show the measured values while ramping down. After four seconds and with measured voltage lower than 60 V, the device shows the set values again.

4.2 Menu

In HV-OFF mode the device menu is activated by pressing the button MENU.

If no button is pressed, the display switch back to HV-OFF mode after 30 seconds. The menu can also be closed without changing any value by pressing the button ESC.

By turning the rotary encoder VOLTAGE you can scroll through the menu. By pressing the rotary encoder VOLTAGE the displayed menu point is selected. The setting can be changed by the active rotary encoder (shown by yellow LED). By pressing the active rotary encoder the changes are stored and the main menu is displayed again.

Menu	Display	Description
Software Voltage Limit	F01 Set Limit V	Adjust Software-voltage limit V_{OUTmax} with rotary encoder VOLTAGE. V_{SET} will be limited to this value.
Software Current Limit	F02 Set Limit I	Adjust Software-current limit I_{OUTmax} with rotary encoder CURRENT. I_{SET} will be limited to this value.
Voltage Ramp set	F03 Set Ramp V	Adjust voltage ramp speed with rotary encoder VOLTAGE in the range of 1 ... 3000 V/s.
Current Ramp set	F04 Set Ramp I	Adjust current ramp speed with rotary encoder CURRENT. On LPS devices, the software voltage ramp can be disabled. In this case, the device changes it's output voltage as fast as possible. The software ramp can be disabled be changing the ramp speed greater than 3000 V/s: "max." will be displayed. To enable the software ramp again, choose a ramp speed between 1...3000 V/s.
Generate HV with Power-On automatically	F05 Auto Start	Not implemented yet.
Control with analogue I/O automatically	F06 Auto AIF	AIF ON: Turn on HV by pushing the ON/OFF button or with INHIBIT on analogue I/O Low to High AIF OFF Turn on HV by pushing the ON/OFF button The INHIBIT signal on analogue I/O has priority in both cases! INHIBIT High to Low: turn off HV Low to High: turn on HV (KILL disable) LOW static: HV=0
Change Interface	F07 Set Interfce	Select external Interface with rotary encoder VOLTAGE: "CAN" control via CAN-Interface "RS-232" control via RS232-Interface "IEEE 488" control via IEEE-Interface "AIF" control via Analogue I/O
Change Instruction set	F08 Set Instruct	Select instruction type for RS-232 and IEEE-488 with rotary encoder VOLTAGE: "EDCP" SCPI command set with EDCP (recommended) "SCPI" old SCPI command set "ET" old ET command set
Change IEEE Address	F09 Addr IEEE	Select IEEE address with rotary encoder VOLTAGE: 01 to 30
Change CAN Address	F10 Addr CAN	Select CAN address with rotary encoder VOLTAGE: 00 to 63
Echo on/off for RS232	F11 Set Echo	Select Echo state with rotary encoder VOLTAGE: "on" ⇒ "off" ⇒ "on"

Menu	Display	Description
Set Password	F12 Set Password	The MENU settings are safed with 4 pin password. Setting position by position with rotary encoder VOLTAGE. Given the code „0000“ the password function is not active (ex works).
Show Power	F13 Show Power	Change the display to V_{OUT} and $Power_{OUT}$ (on/off)

4.3 Error states

The following Errors cause the High Voltage to shut down and have to be cleared before turning it on again with Button KILL/ESC or a remote command (e. g. *CLS):

- Emergency Off (EMCY)
- Current Trip (TRIP)
- Voltage Limit (VLIM)
- Current Limit (ILIM)
- Safety Loop (ILK)
- Over temperature (TEMP)

5 Interface control

For remote control, the corresponding interface (CAN, RS-232, USB, IEEE-488, Ethernet) has to be selected first in Menu “F07 Set Interfce”. The device switches to REMOTE state when receiving the first command from the selected interface. The yellow LED “REMOTE” is lighting.

By pressing the LOCAL button the remote control is suspended. The device can now be controlled via front panel. When receiving new commands via Interface, the device switches back to REMOTE state.

If the device is in “HV-ON” state via interface, high voltage can be turned off by pressing the ON/OFF button. In this case the device goes to LOCAL state as well.

Exception: If local control is disabled (Local Lockout, see chapter 6.3), the device can only be turned off via mains switch POWER!

While receiving or transmitting data via RS-232 or IEEE-488, the LED’s RxD (Receiving) or TxD (Transmitting) are flashing.

5.1 CAN Interface

Attention: Turn off the device with mains switch POWER before connecting/disconnecting the interface cable.

For CAN interface, please see the description of the EDCP protocol in the manual

CAN-Interface
Multi-Channel High Voltage Power Supply Module
EHS xxx and EDS xxx

Thus, the device can be controlled with the program isegCANHVControl or with the iseg OPC server.

5.2 RS-232- / USB Interface

Attention: Turn off the device with mains switch **POWER** before connecting/disconnecting the interface cable.

Attention: If you device is equipped with RS-232 and USB Interface, only one of them must be connected to the HPS at the same time.

RS-232

The RS-232 interface is located at a D-SUB-9 connector at the device rear.

The electrical transfer is working indirectly coupled via RxD and TxD related to GND. The D-SUB-9 pin assignment is in the following table.

The cable connection to the computer is 1:1 (no zero modem-cable!). If no 9-pole cable is available, then the connections shown in the table have to be made.

Signal RS-232	HV-PS		PC		Connection 3-pol. cable
	D-SUB-9	Internal	D-SUB-9	D-SUB-25	
RxD	2		2	3	
TxD	3		3	2	
GND	5		5	7	
	4	┌	4	20	┌
	6	┌	6	6	┌
	8	┌	8	5	┌

USB

The USB interface is realized with a female USB-B connector at the device rear. Internal, the USB is implemented as an USB-serial converter FTDI FT232R.

This device functions as virtual serial port in PC, and thus can be used with every program that supports a serial port, e. g. a terminal program or LabVIEW.

Programming

The following description applies both to RS-232 and USB interface.

For remote control, "RS-232" must be selected in Menu "F07 Set Interface". The device switches to REMOTE state when receiving the first command via interface.

The (virtual) serial Interface is set to 9600 Bit/s, 8 Bit/character, no parity, 1 Stop-Bit.

The data transfer is character oriented, while the synchronization in direction "Computer to HV PS unit" (Input direction) is made by echoes. The transfer direction "HV-PS to computer" (Output direction) is free running.

The Echo can be permanently disabled (Factory setting is "Echo on"):

1. On front panel via Menu "F11 Set Echo".
2. Via SCPI instruction set with EDCP

The command transfer works with ASCII code. Commands are terminated by <CR><LF> (\$0D \$0A or 13 10). On input side, no leading zeros are needed. Output is fixed format without leading zero.

A minimum time delay of 20 ms between write and read instructions is needed.

Windows USB driver installation

The FTDI VCP driver (Virtual COM Port) can be downloaded from:

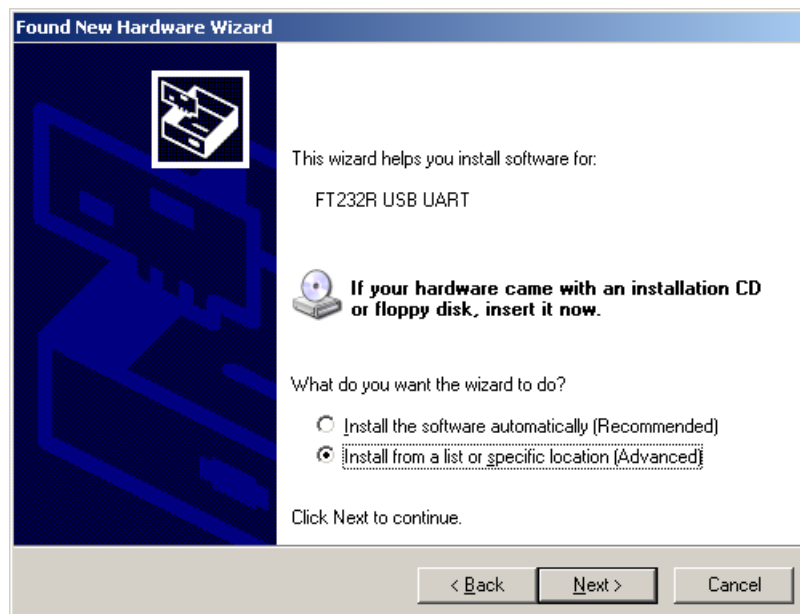
<http://www.iseg-hv.com> → Download → Software → USB driver for THQ/EHQ

The following steps are necessary for installation:

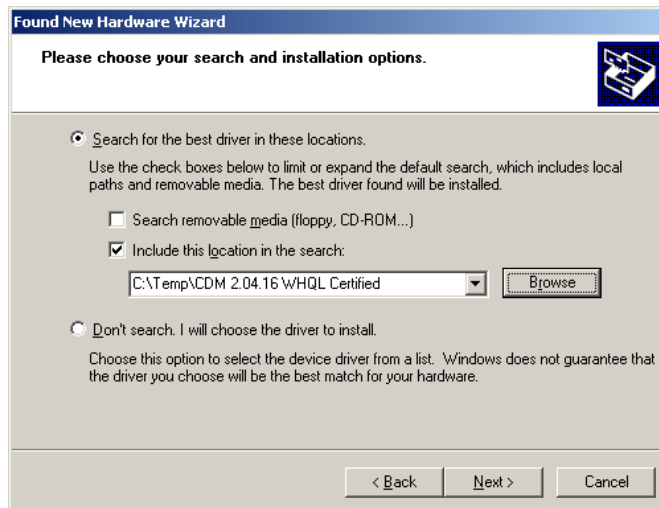
1. Extract the FTDI driver “CDM 2.04.16 WHQL Certified.zip“, e. g. to C:\Temp\
2. Connect the HV device to the computer via USB
3. The Found new Hardware wizard appears.
Please choose “No, not this time” in the first dialog and then click Next.



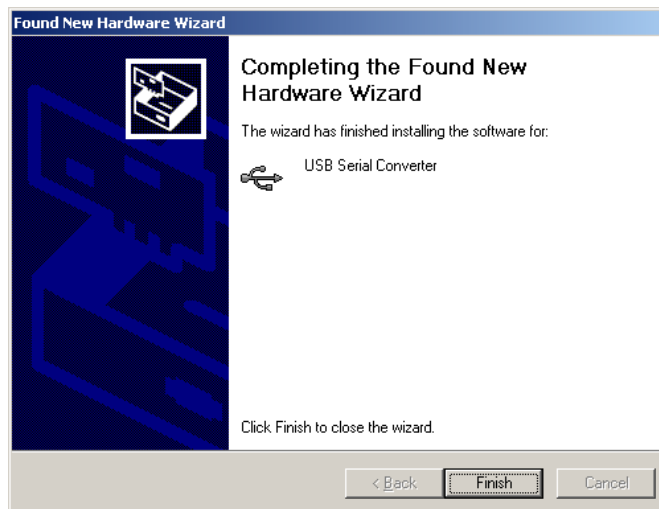
4. Choose “Install from a list or specific location” in the next dialog and then click Next:



5. Please choose the directory you extracted the driver to and the click Next:



6. After some copying you get the final dialog:



It may be necessary to do the steps 3 to 6 again, before the device can be used (the first time, a bus driver is installed, the second time, the virtual COM port driver is installed).

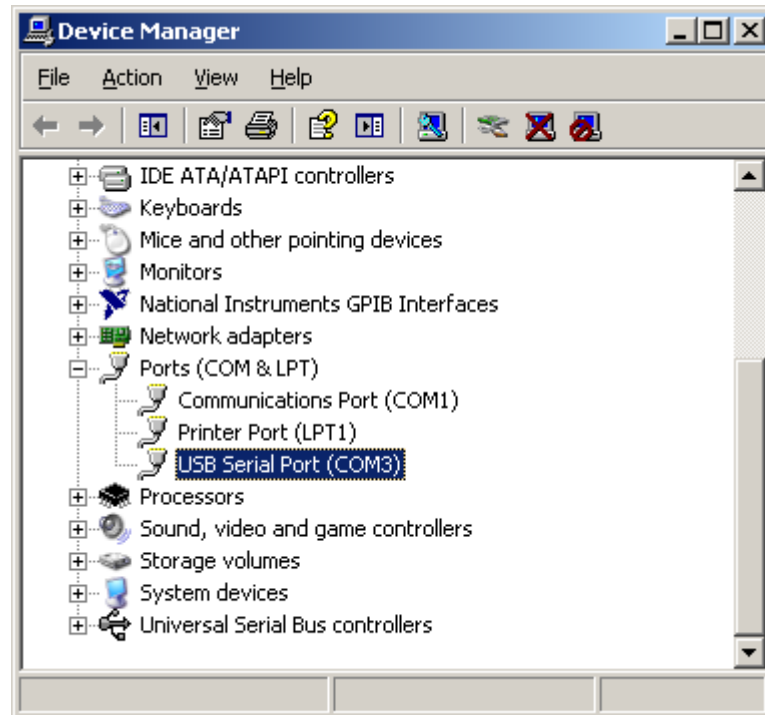
RS-232/USB Interface Test under Windows

Determine the serial USB interface with Device Manager

Start the Device Manger with:

Start → Settings → Control Panel → System → Device Manager

All HPS devices with USB interface get an USB Serial Port assigned in section Ports (COM & LPT), in this case COM3:

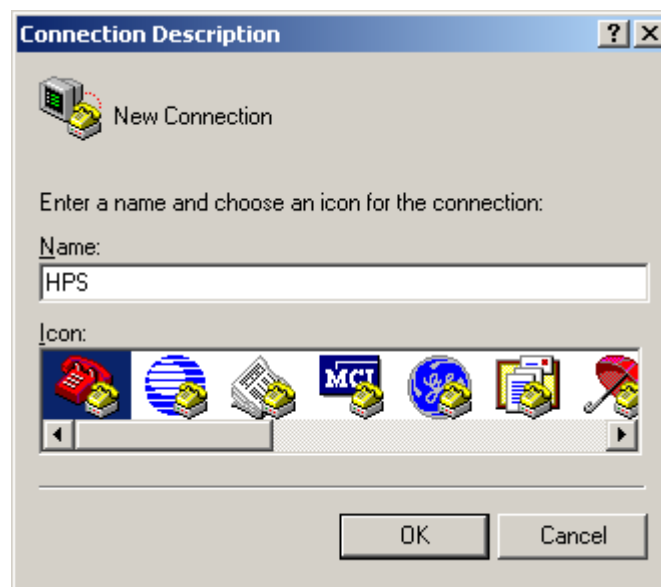


Test with HyperTerminal

HyperTerminal is included in Windows 2000 / XP and can be started with:

Start → Programs → Accessories → Communications → HyperTerminal

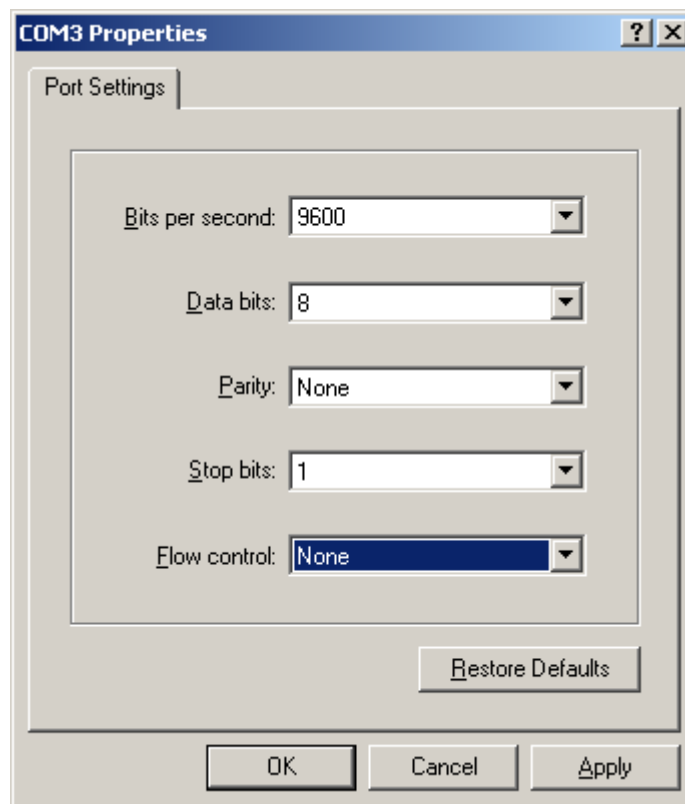
Create a new connection with menu „File → New Connection“, name it e. g. “HPS” and click OK.



The following dialog appears. Choose your serial port and click OK:



Please enter the interface parameters in the following dialog:

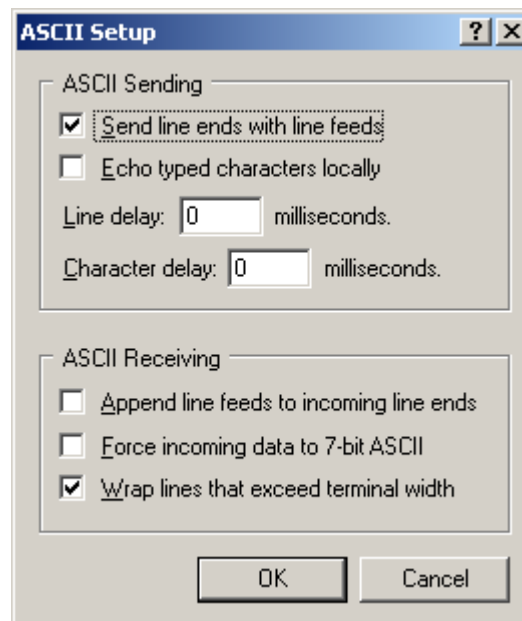


After clicking OK, the interface setup is finished.

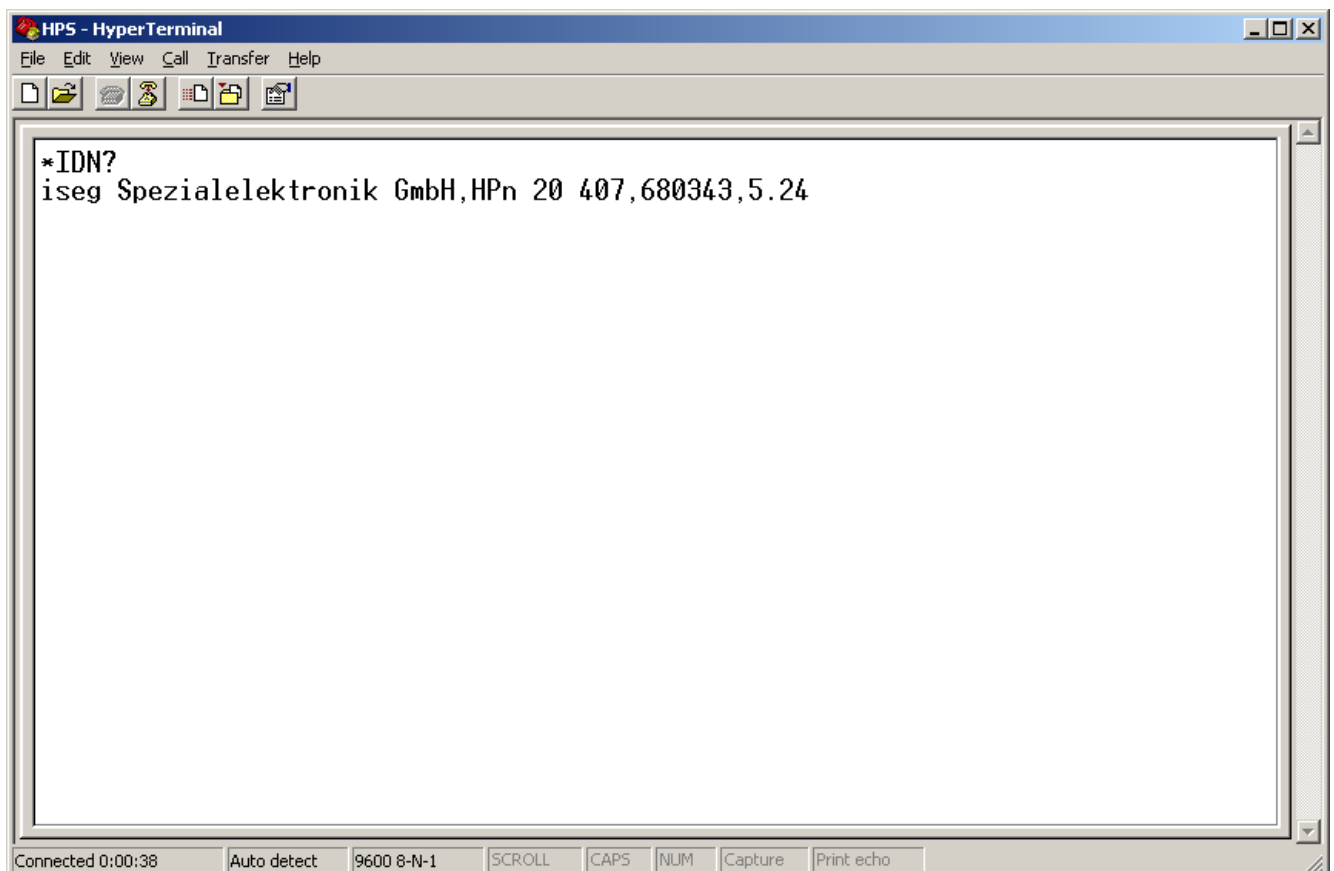
As last step, under:

File → Properties → Settings → ASCII Setup

the setting “Send line ends with line feeds” has to be made (see following picture).



You can now test the communication with the device:



5.4 IEEE-488 Interface (GPIB)

Attention: Turn off the device with mains switch **POWER** before connecting/disconnecting the interface cable.

IEEE-488 Interface

The IEEE-488 bus interface was implemented with a NEC 7210 compatible IEEE controller. The following interface functions according to IEC 625 are available:

SH1	Source Handshake:	all functions (no polling)
AH1	Acceptor Handshake:	all functions (no polling)
T6	Talker:	standard equipment
L4	Listener:	standard equipment

To connect the device to the IEEE bus, a Micro-D25 male connector is located at the device rear. An adapter cable with a 24 pin connector following IEEE-488.2 standard is available optional.

For remote control, the IEEE interface must be selected in Menu "F09 Set Interfce" by choosing "IEEE". The IEEE address (0...30) can be selected in Menu "F11 Addr IEEE". The device ships from the factory with a IEEE address of 15.

When receiving control commands over IEEE, the device switches to REMOTE state and the yellow LED "REMOTE" is lighting.

By pushing the LOCAL button, remote control is suspended and the device switches to LOCAL state.

If the device is in REMOTE state and high voltage is on, pushing ON/OFF turns off the HV generation and the device switches to LOCAL state.

In both cases, when receiving new commands via interface, it switches back to REMOTE state.

Programming

The command transfer works with ASCII code. Commands are terminated by <CR><LF> (\$0D \$0A or 13 10). Alternatively, the control line EOI (End or Identify) can be set together with the command's last character. On input side, no leading zeros are needed. Output is fixed format without leading zero.

A minimum time delay of 5 ms between two IEEE commands is needed.

5.5 Ethernet Interface

Attention: Turn off the device with mains switch **POWER** before connecting/disconnecting the interface cable.

The Ethernet Interface with 10-MBit/s, Full-Duplex, is connected via RJ-45 socket on the device rear.

The device can be connected to a switch via patch cable. If it shall be connected to a PC directly, a crossover cable has to be used.

“Ethernet” has to be set in menu “F09 Set Interfce“. The additional settings (IP address, net-mask, default gateway) have to be made with the SCPI Instruction set with EDCP. This can be done over Ethernet or RS-232. Ex works settings are as follows:

IP-address:	192.168.16.13
Net mask:	255.255.255.0
Default Gateway:	192.168.16.1
Command port:	5006 (fixed)

The connection can be tested with the ping command (Start → programs → accessories → command).

```
C:\>ping 192.168.16.13
```

```
Ping will done for 192.168.16.13 with 32 bytes data:
```

```
Answer from 192.168.16.13: bytes=32 time=4ms TTL=128
```

```
Answer from 192.168.16.13: bytes=32 time=4ms TTL=128
```

```
Answer from 192.168.16.13: bytes=32 time=4ms TTL=128
```

```
Answer from 192.168.16.13: bytes=32 time=4ms TTL=128
```

```
Ping statistic for 192.168.16.13:
```

```
Package: sent = 4, received = 4, lost = 0
```

```
Time in millisecond:
```

```
minimum = 1ms, maximum = 4ms, average = 1ms
```

During communication the HV unit act as server, the control PC act as client. The following table shows the principle sequence of communication PC to HV unit.

Step	Function call	Computer → HV-Unit	HV-Unit → Computer
1.	connect()	SYN	
2.			SYN, ACK
3.		ACK	
4.	send()	"*IDN?"	
5.	recv()		"iseq Spezialelektronik GmbH [...]"
6.	closesocket()	FIN, ACK	
7.			FIN, ACK
8.		ACK	

The first three packages are for the establishing of a TCP-Connection (three way handshake). Fourth step is the inquiry from PC to HV unit. The order is ASCII coded in data field of the TCP packet. The answer is also ASCII coded send to the PC in step 5. Package No. 6 confirms the receipt of the packet and sends a FIN for termination of connection. Step 7 and 8 are the confirmation of termination of connection from HV unit and PC.

The communication can be monitored with a network sniffer (e. g. Wireshark). Control is done with the instruction sets described later. The preferred command set for Ethernet is “SCPI with EDCP”, as you can build longer Frames which reduces Ethernet Overhead.

Programming

Simple programming example (without error handling) for communication with the HV device over Ethernet. This program was compiled and tested with Microsoft Visual C++ 6.0 on Windows XP.

```
#include <stdio.h>
#include <winsock.h>

int main(int argc, char *argv[])
{
    WSADATA    wsadata;
    SOCKET     sock;
    SOCKADDR_IN sockaddr_in;
    int        retcode;
    char       cmd[255] = "*IDN?";
    char       ans[255];

    // init sockets (Berkeley style, UNIX compatible)
    WSStartup(2, &wsadata);

    // create TCP socket
    sock = socket(AF_INET, SOCK_STREAM, IPPROTO_TCP);

    // bind socket to dynamic port
    memset(&sockaddr_in, 0, sizeof(sockaddr_in));
    sockaddr_in.sin_family = AF_INET;           // UDP, TCP
    sockaddr_in.sin_port   = htons(5006);      // remote Port
    sockaddr_in.sin_addr.S_un.S_un_b.s_b1 = 192; // IP address
    sockaddr_in.sin_addr.S_un.S_un_b.s_b2 = 168;
    sockaddr_in.sin_addr.S_un.S_un_b.s_b3 = 16;
    sockaddr_in.sin_addr.S_un.S_un_b.s_b4 = 13;

    // connect to server (three way handshake)
    connect(sock, (SOCKADDR *)&sockaddr_in, sizeof(SOCKADDR_IN));

    // send command to server
    send(sock, cmd, strlen(cmd) + 1, 0);

    // read answer from server
    retcode = recv(sock, ans, sizeof(ans), 0);

    // close socket (three way handshake) and clean up
    closesocket(sock);
    WSACleanup();

    // print answer to screen
    printf("%s\n", ans);

    return 0;
}
```

5.6 Analogue I/O Interface

Attention: Turn off the device with mains switch **POWER** before connecting/disconnecting the interface cable.

Attention: All control inputs and outputs are indirect coupled to the HV-OUT.

All control inputs and outputs are available at the male D-SUB-9 connector on the rear side of the unit according to the following table.

Analogue I/O with male SUB-D-9 connector			
Pin 1 / 6	@GND	Ground	
Pin 2	V _{I-MON}	Current monitor	
Pin 3	INHIBIT	TTL level / Input	Low = active: ⇒ V _{OUT} = 0 High / offen: ⇒ V _{OUT} according set values
Pin 4	V _{I-SET}	Current control	
Pin 5	Cmode	TTL level / Output	Low = Current control (CC), High = Voltage control (CV) reaction time < 100 ms
Pin 7	V _{V-MON}	Voltage monitor	
Pin 8	V _{V-SET}	Voltage control	
Pin 9	V _{REF}	Internal reference voltage	V _{REF} = 5 V / 1 mA

Operation with analogue I/O

You can choose control with the analogue interface "AIF" in the menu „F07 Set Interface“ and then switch push button "LOCAL" in order to switch to analogue remote control, the yellow LED "REM" is flashing now (exception see "Auto AIF").

By pushing LOCAL again the mode runs back to menu and „HV-OFF“. To use the unit in LOCAL mode again you must choose an other interface in the menu „F07 Set Interface“ (e.g. RS-232).

The generation of high voltage will start with pushing "HV ON" (exception see "Auto AIF") according to the analogue set values and will stop with pushing "HV OFF" or with external INHIBIT (LOW = active).

The reaction to the active INHIBIT signal is according to the setting of the KILL function:

- KILL disable: generation of HV will be stopped, with Low to High on INHIBIT the output will be ramp to the chosen voltage/current with the programmed ramp speed!
- KILL enable: generation of HV will be stopped, with Low to High on INHIBIT the output will be volt-free. The generation of high voltage will start with pushing "HV ON" only (exception see "Auto AIF").

Automatic function "Auto AIF"

If the control mode is chosen with analogue interface "AIF" in the menu „F07 Set Interface“ you can set the automatic function "Auto AIF" in the menu „F06 Auto AIF“ to "ON".

Now it is able to start the generation of HV according to the set values with the INHIBIT signal Low to High, without pushing "HV ON"!

Caution! The high voltage generation will start with each Low to High Signal on INHIBIT!

If you choose an other interface in the menu „F07 Set Interface“, the function "Auto AIF" will be set to "OFF" automatically. If you will use „Auto AIF“ again, you must choose "AIF" in the menu „F07 Set Interface“ before and than set the automatic function "Auto AIF" in the menu „F06 Auto AIF“ to "ON".

Control inputs

- **Remote Control Voltage (CV) $V_{V-SET} = 0 \text{ to } 5 \text{ V}$**

The output voltage is proportionally to the external control voltage of 0 to 5 V DC between pin 8 (+ V_{V-SET} , indirect coupled) and pin 6 (@GND, indirect-coupled).

Example: HPp 40 357, maximum voltage = 4 kV

V_{V-SET} (V)		Output voltage (kV)
5.0	corresponds to	4.0
2.5	corresponds to	2.0
1.0	corresponds to	0.8

- **Remote Control Current (CC): $V_{I-SET} = 0 \text{ to } 5 \text{ V}$**

The output current is proportionally to the external control voltage of 0 to 5 V DC between pin 4 (+ V_{I-SET} , indirect coupled) and pin 6 (@GND, indirect-coupled).

Example: HPp 40 357, maximum current = 350 mA

V_{I-SET} (V)		Output current (mA)
5.0	corresponds to	350
2.5	corresponds to	175
1.0	corresponds to	70

- **INHIBIT TTL level**

High voltage generation will be **shut off** with help of the TTL-level **LOW** on pin 3 related to GND - analogue (@GND-analogue indirect-coupled to GND-HV and metal box).

High voltage generation will be **started** according to the settings with TTL-level Low to **High** or **open** on pin 3 in case of "KILL" is disabled. If "KILL" is enabled also the push button "HV-ON" has to be pushed.

Monitor outputs

- **Voltage monitor output $V_{V-MON} = 0 \text{ to } 5 \text{ V}$**

An analogue monitor signal proportionally to the output voltage is available. This monitor voltage is measured between pin 7 (V_{V-MON} , indirect-coupled) and pin 6 (@GND, indirect-coupled).

Example: HPp 40 357, maximum output voltage = 4 kV

V_{V-MON} (V)		Output voltage (kV)
5.0	corresponds to	4.0
2.5	corresponds to	2.0
1.0	corresponds to	0.8

- **Current monitor output $V_{I-MON} = 0 \text{ to } 5 \text{ V}$**

An analogue monitor signal proportionally to the output current is available. This monitor voltage is measured between pin 2 (V_{I-MON} , indirect-coupled) and pin 6 (@GND, indirect-coupled).

Example: HPp 40 357, maximum output current = 350 mA

V_{I-MON} (V)		Output current (mA)
5.0	corresponds to	350
2.5	corresponds to	175
1.0	corresponds to	70

6 Command sets

6.1 SCPI command set with EDCP

This is the recommended command Set.

To use this command set, choose "EDCP" in the menu or the *INSTR command. (EDCP = Enhanced Device Communication Protocol). This command set is oriented on the iseg EDCP CAN Protocol with Status and Event handling.

The Status and Event Status Fields are explained after the SCPI table.

Common Commands	
*IDN?	Query Module Identification
*CLS	Clear Module (Event-)Status
*RST	Reset device to save values (Turn HV off with ramp, Vset= 0, Iset= Inominal)
*LLO	Local Lockout (disable front panel buttons)
*GTL	Goto Local (enable front panel buttons)
*INSTR?	Query instruction set
*INSTR,EDCP	Switch to EDCP SCPI command set
SCPI Commands	
:VOLTage	
<Voltage>[V]	Set Channel Voltage
:LIMit <Voltage>[V]	Set Voltage Limit
:BOUnds <Voltage>[V]	Set Channel Voltage Bounds
{ ON OFF }	Set Channel On / Off (with configured ramp speed)
EMCY OFF	Shut Channel Emergency Off (without ramp)
EMCY CLR	Leave state emergency off
:CURRent	
<Current>[A]	Set Channel Current
:LIMit <Current>[A]	Set Current Limit
:BOUnds <Current>[A]	Set Channel Current Bounds
:EVent	
CLEAR	Clear Channel Event Status
:MASK <Word>	Set Channel Event Mask
:MEASure	
:VOLTage?	Query Measured Channel Voltage (V)
:CURRent?	Query Measured Channel Current (A)
:CONFigure	
:RAMP	Set/Get module configuration
:VOLTage <RampSpeed>[V/s]	Set Module Voltage Ramp Speed
:CURRent <RampSpeed>[A/s]	Set Module Current Ramp Speed
:EVent	
:CLEAR	Clear Module Event Status
:MASK	
:KILL?	Query Module Kill Status
:KILL { 0 1 }	Set Kill Disable (0) or Kill Enable (1)

¹⁾, ²⁾ If the high voltage is shut down with :VOLTEMCY OFF, the channel is hold in state Emergency Off. To turn on the High Voltage again, the state Emergency Off must be leaved with :VOLTEMCY CLR. Furthermore, the Channel EventStatus Bit EEMCY must be cleared e. g. with *CLS.

:CONFigure		
:ETHernet		
	:ADDRESS <xxx.xxx.xxx.xxx>	Set Ethernet IP Address
	:ADDRESS?	Query Ethernet IP Address
	:NETmask <xxx.xxx.xxx.xxx>	Set Ethernet IP Netmask
	:NETmask?	Query Ethernet IP Netmask
	:GATEway <xxx.xxx.xxx.xxx>	Set Ethernet IP Default Gateway
	:GATEway?	Query Ethernet IP Default Gateway
	:MAC?	Query Ethernet MAC Address
:SERIAL		
	:BAUDrate?	Query Serial Baudrate
	:ECHO { 0 1 }	Set Serial Echo Off (0) or Echo On (1)
	:ECHO?	Query Serial Echo
:GPIB		
	:ADDRESS?	Query IEEE-488/GPIB Address
:CAN		
	:ADDRESS?	Query CAN Address
:READ		
	:VOLTage?	Query Set Voltage (V)
	:LIMit?	Query Voltage Limit (V)
	:NOMinal?	Query Nominal Voltage (V)
	:BOUnds?	Query Voltage Bounds (V)
	:CURRent?	Query Set Current (A)
	:LIMit?	Query Current Limit (A)
	:NOMinal?	Query Nominal Current (A)
	:BOUnds?	Query Current Bounds (A)
:RAMP		
	:VOLTage?	Query Voltage Ramp Speed (V/s)
	:CURRent?	Query Current Ramp Speed (A/s)
:MODule		
	:STATus?	Query Module Status Word
	:EVEnt	
	:STATus?	Query Module Event Status
	:MASK?	Query Module Event Mask
	:SUPply?	Query Module Supply State (1 = good, 0 = not good)
	:TEMPerature?	Query measured Module Temperature (°C)
:CHANnel		
	:STATus?	Query Channel Status Word
	:EVEnt	
	:STATus?	Query Channel Event Status Word
	:MASK?	Query Channel Event Status Mask

Output formats for voltage and current:

Vnominal	Output format voltage values
$100\text{ V} \leq V_{\text{nom}} < 1\text{ kV}$	123.456V
$1\text{ kV} \leq V_{\text{nom}} < 10\text{ kV}$	1.23456E3V
$10\text{ kV} \leq V_{\text{nom}} < 100\text{ kV}$	12.3456E3V

Inominal	Output format current values
$1\text{ mA} \leq I_{\text{nom}} < 10\text{ mA}$	1.23456E-3A
$10\text{ mA} \leq I_{\text{nom}} < 100\text{ mA}$	12.3456E-3A
$100\text{ mA} \leq I_{\text{nom}} < 1\text{ A}$	123.456E-3A
$1\text{ A} \leq I_{\text{nom}} < 10\text{ A}$	1.23456A
$10\text{ A} \leq I_{\text{nom}} < 100\text{ A}$	12.3456A

Examples:

Read Module Identification:

```
:IDN?
iseq Spezialelektronik GmbH,HPp 40 207,680001,5.24
```

Set Voltage to 1000.501 V

```
:VOLT 1000.501
```

Set Current to 1.58 mA

```
:CURR 0.00158
```

Set Voltage Ramp speed to 300 Volt per second

```
:CONF:RAMP:VOLT 300
```

Advanced Examples:

Set and read back Voltage and Current:

```
:VOLT 2000.5; :READ:VOLT?; :CURR 0.2; :READ:CURR?
2.00050E3V;200.000E-3A
```

Read actual measured Voltage and Current:

```
:MEAS:VOLT?; CURR?
2.00028E3V;19.997E-3A
```

Channel status (read access)

:READ:CHANnel:STATus?

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
isVLIM	isCLIM	isTRP	isEINH	isVBND	isCBND	res	res
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
isCV	isCC	isEMCY	isRAMP	isON	isIERR	res	res

The ChannelStatus register describes the *actual* status. Depending on the status of the channel the bits will be set or reset.

Bit	Name	Bit is 1	Bit is 0
isVLIM	IsVoltageLimitExceeded	Voltage limit set by V_{max} is exceeded	Voltage limit not exceeded
IsCLIM	IsCurrentLimitExceeded	Current limit set by I_{max} is exceeded	Current limit not exceeded
isTRIP	IsTripExceeded	Trip is set when Voltage or Current limit or Iset has been exceeded (when KillEnable=1)	No Trip
isEINH	IsExtInhibit	External Inhibit active	No External Inhibit
isVBND	IsVoltageBoundsExceeded	Voltage out of bounds	Voltage in bounds
isCBND	IsCurrentBoundsExceeded	Current out of bounds	Current in bounds
IsCV	IsControlledVoltage	Voltage control active (evaluation is guaranteed when no ramp is running)	Voltage control not active
IsCC	IsControlledCurrent	Current control active (evaluation is guaranteed when no ramp is running)	Current control not active
isEMCY	IsEmergencyOff	Emergency off without ramp	No Emergency Off
isON	IsOn	HV is On	HV is Off
isRAMP	IsRamping	Ramp is running	No Ramp is running
isIERR	InputError	Input error	No Input error
res	Reserved		

Channel event status (read/write access)
:READ:CHANnel:EVent:STATus?

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
EVLIM	ECLIM	ETRP	EEINH	EVBNDs	ECBNDs	res	res
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
ECV	ECC	EEMCY	EEOR	EOn2Off	EIER	res	Res

The Channel EventStatus register describes the *captured* status. Depending on the status of the channel the bits will be set but not reset. A reset has to be done by the user by writing an 1 to this event bit. All Events can be cleared by :EVENT:CLEAR.

Bit	Name	Description
EVLIM	EventVoltageLimit	Event: Voltage limit has been exceeded
ECLIM	EventCurrentLimit	Event: Current limit has been exceeded
ETRIP	EventTrip	Event: Trip is set when Voltage or Current limit or Iset has been exceeded (when KillEnable=1)
EEINH	EventExtInhibit	Event: External Inhibit
EVBNDs	EventVoltageBounds	Event: Voltage out of bounds
ECBNDs	EventCurrentBounds	Event: Current out of bounds
ECV	EventControlledVoltage	Event: Voltage control
ECC	EventControlledCurrent	Event: Current control
EEMCY	EventEmergencyOff	Event: Emergency off
EEOR	EventEndOfRamp	Event: End of ramp
EOn2Off	EventOnToOff	Event: Change from state "On" to "Off" without ramp
EIER	EventInputError	Event: Input Error
res	Reserved	

An event bit is permanently set if the corresponding status bit is 1 or is changing to 1. Different to the status bit an event bit isn't automatically reset. A reset has to be done by the user by writing an 1 to this event bit.

If one of the EventStatus Bits EVLIM, ECLIM, ETRIP, EEINH, EVBNDs, ECBNDs, EEMCY is set, it prevents turning on the High Voltage again until the corresponding bit is cleared.

ModuleStatus (read access)

:READ:MODule:STATus?

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
isKILena	isTEMPgd	isSPLYgd	isMODgd	isEVNTact	isSFLPgd	isnoRAMP	isnoSERR
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
res	res	res	isSrvc	res	res	res	isADJ

The status bits as there are IsTemperatureGood, IsSupplyGood, IsModuleGood, IsEventActive, Is-SafetyLoopGood, IsNoRamp and IsNoSumError indicate the single status for the complete module.

Bit	Name	Bit is 1	Bit is 0
isKILena	IsKillEnable	Module is in state Kill enable	Module is in state Kill disable
isTEMPgd	IsTemperatureGood	Module temperature > 55°C High voltage is turned off	Module Temperature < 55 °C
isSPLYgd	IsSupplyGood	Power Supply is good	Power Supply is not good
isMODgd	IsModuleGood	Module status is good	Module status bad
isEVNTact	IsEventActive	At least one masked Event is active	No masked Event is active
isSFLPgd	IsSafetyLoopGood	Safety Loop is closed	Safety Loop is open
isnoRAMP	IsNoRamp	All channels stable, no ramp active.	At least one channel is ramping
isnoSERR	IsNoSumError	No sum error	Sum error active
isSrvc	IsServiceNeeded	Hardware failure detected: consult manufacturer	No Hardware failure detected
isADJ	IsFineAdjustment	Adjustment is on	Adjustment is off
Res	Reserved		

Module EventStatus (read/write access)
:READ:MODule:EVent:STATus?

The Module EventStatus register describes the *captured* status. Depending on the status of the module the bits will be set but not reset. A reset has to be done by the user by writing an 1 to this event bit. All Events can be cleared by :CONFIGURE:EVENT:CLEAR.

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
Res	ETMPngd	ESPLYngd	res	res	ESFLPngd	res	res
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
res	res	res	res	ESrvc	res	res	res

ETEMPngd	EventTemperatureNotGood	Event: Temperature is above 55°C
ESPLYngd	EventSupplyNotGood	Event: at least one of the supplies is not good
ESFLPngd	EventSafetyLoopNotGood	Event: Safety loop is open
ESrvc	EventService	Event: A hardware failure of the HV module has been detected. The HV is switched off without the possibility to switch on again. Please consult the iseg Spezialelektronik GmbH.
res	Reserved	

6.2 ET command set (Compatibility to old HPS)

This command set is selected via Menu "F10 Set Instruct" → "ET".

Setting commands

Command:

Command example:

Command to set an output voltage:

U,<Voltage>kV

U,1.000kV

Command to set a voltage limit:

UL,<Voltage>kV

UL,1.000kV

Command to set an output current:

I,<Current>mA

I,30mA

Command to set a current limit:

IL,<Current>mA

IL,30mA

Command to set the Voltage ramp speed:

RAMP,<Rampspeed>V/s

RAMP,3000V/s

Command to switch the high voltage on and off:

HV,ON

HV,OFF

Command for setting the KILL function „Enable“ or „Disable“:

KILL,ENable

KILL,DISable

KILL,EN

Command for Emergency off (The HV generation is shut off permanently and the set values for voltage and current are set to Zero):

EMCY OFF

Read out the setting commands

Command:

Response example:

Read out the set voltage:

STATUS,U

U, RANGE=3.000kV, VALUE=2.458kV

Read out the voltage limit:

STATUS,UL

UL, RANGE=3.000kV, VALUE=2.458kV

Read out the set current:

STATUS,I

I, RANGE=100.0mA, VALUE=30.0mA

Read out the current limit:

STATUS,IL

IL, RANGE=100.0mA, VALUE=30.0mA

Read out the voltage ramp speed:

STATUS,RAMP

RAMP, RANGE=3000V/s, VALUE=1000V/s

Read out the measurement values

Read measured output voltage:

STATUS,MU

UM, RANGE=3.000kV, VALUE=2.458kV

Read measured output current:

STATUS,MI

IM, RANGE=100.0mA, VALUE=25.3mA

Read out the device status

STATUS,DI

DI, b₁₅ b₁₄ b₁₃ b₁₂ b₁₁ b₁₀ b₉ b₈ b₇ b₆ b₅ b₄ b₃ b₂ b₁ b₀

			0	1
#define	IERR	b15	no Input Error	Input error
#define	RAMP	b14	no Ramp	Ramp
#define	EMCY	b13	no Emergency	Emergency
#define	TRIP	b12	no Trip error	Trip error
#define	RES5	b11	Reserved	
#define	RES4	b10	Reserved	
#define	RES3	b9	Reserved	
#define	RES2	b8	Reserved	
#define	SERR	b7	no Sum error	Sum error
#define	IREG	b6	no Current control	Current control
#define	VREG	b5	no Voltage control	Voltage control
#define	POL	b4	negative Polarity	positive Polarity
#define	INH	b3	no external Inhibit	external Inhibit
#define	RES1	b2	Reserved	
#define	KILena	b1	Kill disable	Kill enable
#define	ON	b0	no High voltage active	High voltage active

Read out the LAM status

STATUS,LAM

LAM,ERROR	External Inhibit occurred during Kill enable
LAM,EMERGENCY	High Voltage was shut down with Emergency Off
LAM,SAFETY LOOP	Safety Loop was opened
LAM,INHIBIT	External Inhibit occurred
LAM,TRIP ERROR	Software current trip occurred
LAM,VOLTAGE LIMIT	Voltage has exceeded set value
LAM,CURRENT LIMIT	Current has exceeded set value
LAM,INPUT ERROR	Wrong command received
LAM,OK	Status OK

Read out the device identification

ID

ID, iseg Spezialelektronik r5.01 sn.680041 Typ HPn 30 107

6.3 SCPI command set (Compatibility to old HPS)

This instruction set is selected with Menu "F10 Set Instruct" → "SCPI".

Setting commands

Command: *Command example:*

Command to set an output voltage:

:VOLTage <Voltage>kV :VOLT 1.000kV

Command to set a voltage limit:

:LIMIT:VOLTage <Voltage>kV :LIMIT:VOLT 1.000kV

Command to set an output current:

:CURRent <Current>mA :CURR 30mA

Command to set a current limit:

:LIMIT:CURRent <Current>mA :LIMIT:CURR 30mA

Command to set a voltage ramp speed:

:CONFigure:RAMP <Rampspeed>V/s :CONF:RAMP 3000V/s

Command to turn high voltage on and off:

:VOLTage ON
:VOLTage OFF

Command for Emergency off (The HV generation is shut off permanently and the set values for voltage and current are set to Zero):

:VOLTage EMCY OFF

Command for setting KILL function "Enable" or "Disable":

:CONFigure:KILL ENable :CONF:KILL EN
:CONFigure:KILL DISable

Read out the setting commands

Command: *Response example:*

Command to read out the set voltage:

:READ:VOLTage? *U, RANGE=3.000kV, VALUE=2.458kV*

Command to read out the voltage limit:

:READ:LIMIT:VOLTage? *UL, RANGE=3.000kV, VALUE=2.458kV*

Command to read out the set current:

:READ:CURRent? *I, RANGE=100.0mA, VALUE=30.0mA*

Command to read out the current limit:

:READ:LIMIT:CURRent? *IL, RANGE=100.0mA, VALUE=30.0mA*

Command to read out the voltage ramp speed:

:READ:RAMP? *Ramp, RANGE=3000V/s, VALUE=3000V/s*

Read out the measurement values

Read measured output voltage:

:MEASure:VOLTage? *UM, RANGE=3.000kV, VALUE=2.458kV*

Read measured output current:

:MEASure:CURRent? *IM, RANGE=100.0mA, VALUE=25.3mA*

Read out the device status

:READ:STATus? *DI, b₁₅ b₁₄ b₁₃ b₁₂ b₁₁ b₁₀ b₉ b₈ b₇ b₆ b₅ b₄ b₃ b₂ b₁ b₀*

For status field description, see chapter 6.1, device status.

Read out the LAM status

:READ:LAM?

For LAM status description, see chapter 6.1, LAM status.

Read out the device identification

:READ:IDNT? *ID, iseg Spezialelektronik r5.01 sn.680042 Typ HPn 30 107*

6.4 Common command set (Compatibility to old HPS)

The Common commands can be used all the time, independently from selected instruction set (ET or SCPI).

A response example for commands that returns an answer is shown at the right side (*printed Italic*).

Command

Response example:

Read out the device identification

*IDN? *ID, iseg Spezialelektronik r5.01 sn.680043 Typ HPn 30 107*

Device control

*LLO Local Lockout: disable local buttons

*GTL Go to Local: enable local buttons

*CLS Clear Status: clear error status

*RST Reset: Device is rebooting

Read/change Instruction set

*INSTR? Query current instruction set *Instruction type, SCPI*

*INSTR,SCPI Change to SCPI instruction set

*INSTR,ET Change to ET instruction set

Read/change RS-232 Echo state

*ECHO? Query Echo status *Echo off*

*ECHO*ON Turn on Echo

*ECHO*OFF Turn off Echo

7 Troubleshooting

7.1 Error messages on Displays

Error messages during operation	
Display:	Meaning:
ERROR SAFETYLP	Safety loop (Interlock) is not closed. Device cannot create high voltage.
ERROR INHIBIT	No high voltage can be created because of external inhibit (analogue I/O).
ERROR EMERGENCY	High voltage has been shut down with Emergency Off.
ERROR I-TRIP	Current limit reached during "Kill enable. High voltage has been shut down.
ERROR V-LIMIT	Voltage Limit V_{max} has been exceeded.
ERROR I-LIMIT	Current Limit I_{max} has been exceeded.
ERROR OVERTEMP	High voltage has been shut down because of over temperature. Let device cool down.
ERROR SUPPLY	Internal power supply is bad. Device must be shipped to service.
Error messages during boot	
Display:	Meaning:
ERROR RTC	Real time clock battery is low. Contact service.
CONTACT SERVICE	Device must be shipped to the factory for service.
ERROR AIF	Analogue interface (optional) is not working. Contact service.
ERROR IEEE	IEEE interface (optional) is not working. Contact service.

7.2 General errors

Unit does not provide output voltage, and the displays are not flashing ⇒ - check mains voltage and connection

Unit does not provide output voltage but the displays are flashing. ⇒ - Check of environmental temperature ($T_u \leq 35^\circ\text{C}$)
- Check of Control

During switch ON external fuses are blowing ⇒ - Replace to slow blow fuse (switch ON current peak 25 A)

If these provisions do not lead to a good result, this unit has to be checked from an authorised agent or must be shipped to the factory.