

T1CP vv v ccc x)¹ High Voltage Desk Top Power Supply

Operators Manual

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WARNING!

-It is not allowed to use the unit if the covers have been removed.

- It is not allowed to connect or disconnect the HV cable if HV is ON !

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

Note

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

Filename T1CPxx_10-30kV_HW_eng.____; Version 2.02 as of 09-12-16

1. General information

The model T1CP vvv is a high voltage desk top supply which offer a very stable output voltage up to 30 kV for use in industry and research. The output is generated by means of a high voltage module of the CPS-series, which is supplied by means of an AC/DC converter.

Main Characteristics:

- High voltage desk top power supplies with either front-panel control, via analogue I/O or RS232 Interface
- Output voltages with low ripple and noise
- Compact and ruggedized enclosure
- Output short circuit and overload protected
- Polarity factory fixed



Operation without the plugged-in HV-connectors can damage the unit

2. Technical Data

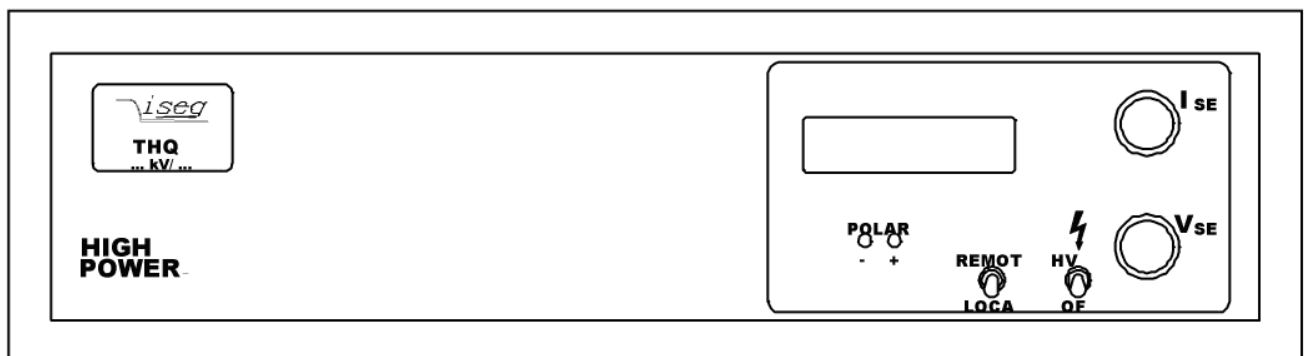
One channel HV-PS T1CP	100 105 x ¹	150 604x ¹	200 504x ¹	300 304x ¹
Output voltage V _{Onom}	10kV	15kV	20kV	30kV
Output current I _{Onom}	1mA	600 µA	500µA	300µA
Output polarity	factory fixed: x¹ = p: positive, x¹ = n: negative			
Ripple and noise	typical < 2 * 10 ⁻⁵ * V _{outnom} , max. 5 * 10 ⁻⁵ * V _{outnom}			
Stability: $\frac{\Delta V_O}{\Delta V_{INPUT}}$	< 1 * 10 ⁻⁴			
ΔV_O (no load/ load)	< 2 * 10 ⁻⁴			
Temperature coefficient	< 1 * 10 ⁻⁴ /K			
Voltage measurement	resolution:	10 V / 4-digit LCD display		
	accuracy:	± (1% * V _{Onom}) (for one year)		
Voltage settings	manual:	via 10-turn potentiometer ("LOC")		
	REMOTE:	via analog I/O with V _{SET/MON} = 0 to 5 V ("REM") or interface		
Current measurement	resolution:	I _{Onom} = 1mA: 1 µA 300 µA ≤ I _{Onom} ≤ 600 µA: 100 nA 4-digit LCD display		
	accuracy:	± (1% * I _{Onom}) (for one year)		
Current settings	manual:	via 10-turn potentiometer		
	REMOTE:	via analog I/O with V _{SET/MON} = 0 to 5 V ("REM") or interface		
Rate of change of output voltage	fixed: V _{Onom} / 4 s (at HV-ON/OFF)			
Protection	Output short circuit and overload protected.			
	Attention!	There is only one short circuit or arc per second allowed! The integral output current must limited to the max. output current of the module external otherwise.		
	Attention!	Units must not be used without HV-Connectors plugged in!		

1 channel HV-PS	T1CP 100 105x ¹ T1CP 150 604x ¹	T1CP 200 504x ¹ T1CP 300 304x ¹
Connectors HV output: analogue I/O / RS232:	HV-plug socket 16 kV: LEMO ERA.1Y.416.CLL 9-pin D-Sub connector	HV-plug socket 30 kV: LEMO ERA.3Y.425.CLL 9-pin D-Sub connector
Remote control	via analogue I/O or RS232 (“ RS232 ”) resp. USB (“ USB ”) interface	
Line voltage AC (V_{INPUT})	100 to 240 V-AC; 50/60 Hz; fused with 2 A-slow	
Desk case	Size (W/H/D) : (310/90/280, 310 with SHV) mm	
Operating temperature	-20 ... +40 °C	
Storage temperature	-40 ... +85 °C	

9-pin male D-Sub connector “analog I/O“ on the rear side

PIN	Name	Description 9-pin male D-Sub connector “analog I/O“
1	n.c.	
2	V_{I_MON}	Monitor voltage corresponding I_O : $I_O = 0$ to I_{Onom} ($R_i = 10\text{ k}\Omega$) $\Rightarrow V_{2,6} = 0$ to 5 V
3	INH	INHIBIT (TTL level, LOW $\Rightarrow V_O = 0$, [LOW to] HIGH or open $\Rightarrow V_O = V_{SET}$ with ramp)
4	V_{I_SET}	Setting current ($R_{IN} = 10\text{ k}\Omega$ to V_{REF}): $V_{4,6} = 0$ to 5 V $\Rightarrow I_O = 0$ to I_{Onom} n.c. $\Rightarrow I_{Onom}$ is possible
5	n.c.	
6	GND	GND = V_{SET_0V} Signal 0 V (connected to the metal module box)
7	V_{V_MON}	Monitor voltage corresponding V_O : $V_O = 0$ to V_{Onom} ($R_{OUT} = 10\text{ k}\Omega$) $\Rightarrow V_{7,6} = 0$ to 5 V
8	V_{V_SET}	Setting voltage: $V_{8,6} = 0$ to 5 V $\Rightarrow V_O = 0$ to V_{Onom} ($R_{IN} \approx 300\text{ k}\Omega$)
9	V_{REF}	$V_{9,6} = 5\text{ V}$ (1 mA) Reference voltage for a external potentiometer (Sliding contact on V_{V_SET} and/or V_{I_SET})

3. Front panel



4. Operation

The power supply line with the mains switch and the fuse are located at the device's rear. After power-on, the displays light up at the front and the chosen polarity is displayed on the according polarity LED.

The two-line displays for measured voltage and current, the potentiometer V_{SET} and I_{SET} , the button REMOTE/LOCAL and the button HV-ON/OFF are located on the front panel. Devices with option EPU also have a button POLARITY.

The high voltage output is located at the device front or rear, depending on the high voltage source.

The analogue I/O interface is a nine pin male D-SUB connector on the device rear.

The button REMOTE/LOCAL switches between control

- with local potentiometer on the front panel (“**LOC**” on display)
- with remote control via analogue I/O on the device rear (“**REM**” on display)

The chosen control mode is saved internal and restored at next power-on.

The high voltage generation is started with the internal signal INHIBIT when switching the button HV-ON. As another requirement, the external signal INHIBIT must not be active (HIGH level or open).

With LOW level at the external INHIBIT, the high voltage generation can be stopped anytime.

Warning! If the control mode is local (“**LOC**”), the high voltage generation starts with a ramp speed of $V_{Onom} / 4s$ (hardware ramp) to the set voltage chosen with the potentiometer V_{SET} .
The device also ramps to this value when switching back from analogue I/O (“**REM**”) to local (“**LOC**”) control.

The high voltage and current can now be set with the potentiometer V_{SET} and I_{SET} . The actual voltage and actual current are shown on the display. They can also be monitored with the voltages V_{V-MON} and V_{I-MON} on the analogue I/O.

Warning! The displays also use the analogue monitor voltages. If these voltages ($R_i = 10\text{ k}\Omega$) are load with external loads, the displayed values will change also.

If the operating mode is switched to analogue I/O (“**REM**”), the output voltage and current are set to the analogue set voltages V_{V-SET} and V_{I-SET} .

In the simplest case, two potentiometers are connected between the internal reference voltage V_{REF} and ground and the sliding contacts are connected to V_{V-SET} and V_{I-SET} .

When receiving the command $D1=\{\text{voltage}\}$, the device switches to the computer remote control mode (“**USB/232**”). By pressing the button REMOTE/LOCAL, the device switches back to local mode “**LOC**” or analogue I/O mode “**REM**”. After power-on, the device starts in computer remote control mode, if the Autostart command is activated with command A1.

The voltage (D1), current (C1) and polarity (P1) set values for the computer control mode are saved in the internal EEPROM.

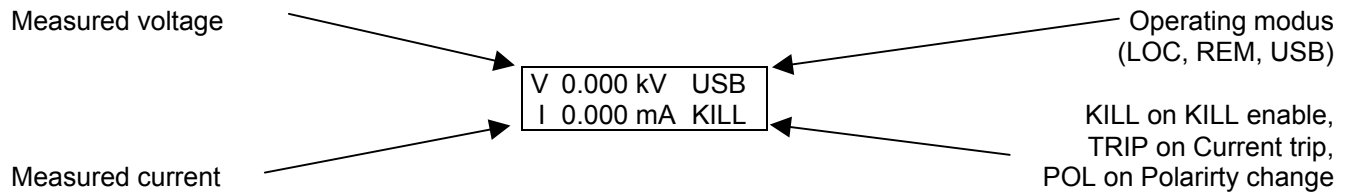
Before switching to computer control mode, the preset voltage and current should be checked first (read back with D1 and C1)!

Switching HV-ON to “**OFF**” and an active INHIBIT-signal only switches off the high voltage generator, however, the output is not put to ground. The internal (approx. 2 nF) and external capacitors discharge by the internal measurement resistor ($50\text{ M}\Omega \pm 30\%$) and the external load. Therefore, extended discharge times may occur.

Attention! Hence, long discharging times are possible! Control the discharging status on the display respectively the monitor voltages before touching any parts under tension.

Display

The Display area consists of four subdivisions:



Software Trip function

It is possible to turn off High voltage when reaching the preset current limit (KILL enable). This function can only be used with computer interface. The delay for detecting a trip is about 50...100 ms.

If KILL is enable (KILL is shown in Display), the high voltage will shut down if the current limit is achieved. In this case, the bit TRIP in status word is set. This bit can be cleared by setting the KILL function again (T1=1) or by disabling KILL (T1=0). In both cases, the high voltage has to be set again (Vset is set to zero at Trip).

By switching to mode local, the KILL function is turned off (KILL disable). A pending Trip is cleared by switching HV-ON/OFF → OFF → ON.

Reset to factory settings

If the button HV-ON/OFF is set to OFF and REMOTE/LOCAL is pressed during power-on, the following settings are reset:

- Saved voltage for computer interface to zero
- Saved current for computer interface to nominal current
- Operating mode local, compatibility mode off

5. Polarity setting for DPS with Option EPU (if available)

The output voltage polarity can be changed with the POLARITY switch at front panel, over analogue I/O or with the computer interface (with command P1) if **Vout = 0 V**. Previously, set the voltage to zero and control the discharge process.

Attention! Don't switch POLARITY when displayed voltage is greater than 100 V!

The chosen polarity is signalled by the corresponding status LED at the front panel and can be requested over computer interface with the command P1.

For safety purposes, the high voltage generation is stopped for about one second before the polarity is switched. After another second, the device is operating again.

If the control mode is switched to analogue I/O („**REM**“) with button REMOTE/LOCAL and PIN 5 is not connected, the device switches to **positive** polarity.

6. Remote control via computer interface

The computer interface allows to control all relevant parameters of the high voltage source. Up to three high voltage channels can be controlled over one computer interface.

The interface is implemented as RS-232 (serial port) or as USB interface (virtual serial port).

The data exchange is character-orientated, with echo in direction “computer to HV source”. The direction “HV source to computer (answer)” is free-running.

The serial port’s hardware settings are: 9600 bit/s, 8 bit/character, no parity, 1 stop bit. No handshake is used.

When using the HV source via computer interface, the following functions are possible:

1. Write functions: Set voltage, Set current, Polarity (with option EPU); Autostart active
2. Read functions: Set voltage, Actual voltage, Set current, Actual current, Polarity, Status, Identifier; Autostart active

When operating in local or analogue I/O mode, the read functions are possible via computer interface.

When setting a voltage value over interface (command D1), the device switches to mode computer control.

Autostart function

With active Autostart, the device switches to mode computer remote control after power-up and restores the last settings of voltage and current. The Autostart function can be activated for every channel separately (with command A1).

Attention! If the switch “HV ON/OFF“ is in position ON, the high voltage generation ramps automatically to the preset voltage value.!

RS-232 interface

The RS-232 interface is located on a female nine pin D-SUB 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.

Table: RS-232 interface pin assignment

Signal RS-232	HV source		PC D-SUB-9	PC D-SUB-25	Connection 3 wire cable
	D-SUB-9	Internal			
RxD	2		2	3	
TxD	3		3	2	
GND	5		5	7	
	4	⌋	4	20	⌋
	6	⌋	6	6	⌋
	8	⌋	8	5	⌋

USB interface

The USB interface is realized with a female USB-B connector at the device rear. Internal, the USB is implemented with 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.

Windows USB driver installation

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

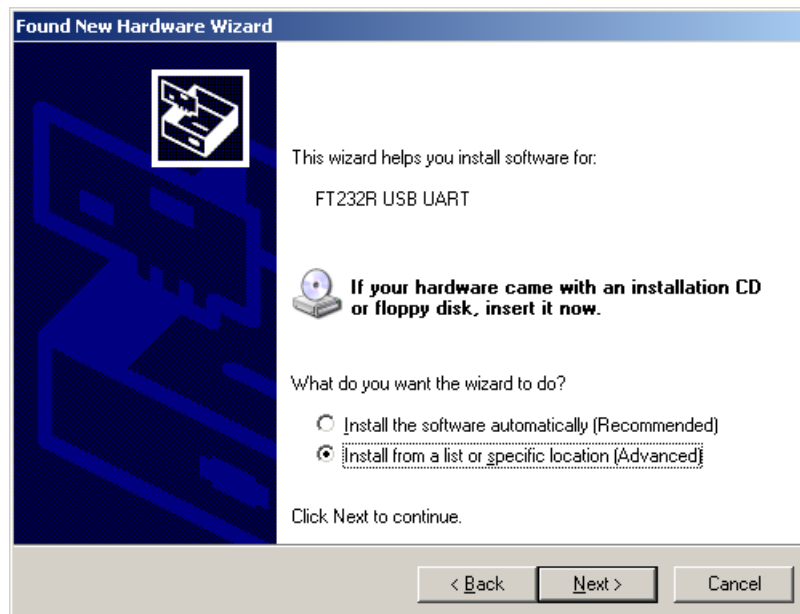
<http://www.iseg-hv.com> → Download → Software → USB driver for THQ/EHQ

The following steps are necessary for installation:

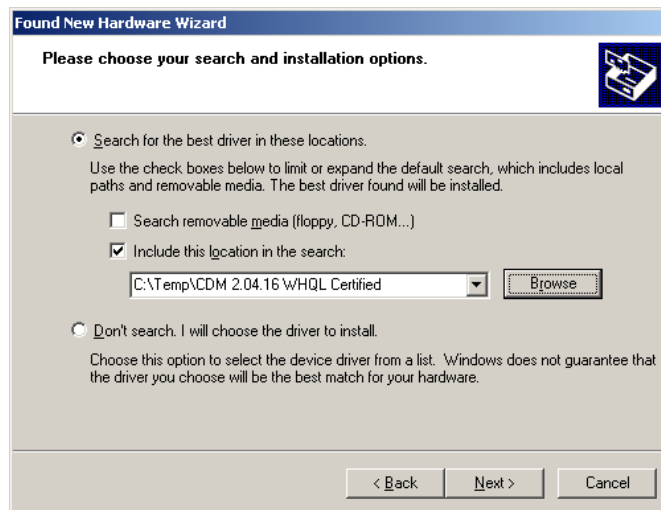
1. Extract the FTDI driver “CDM 2.04.16 WHQL Certified.zip“, e. g. to C:\Temp\
2. Connect the HV device to the computer via USB
3. The Found new Hardware wizard appears.
Please choose “No, not this time” in the first dialog and then click Next.



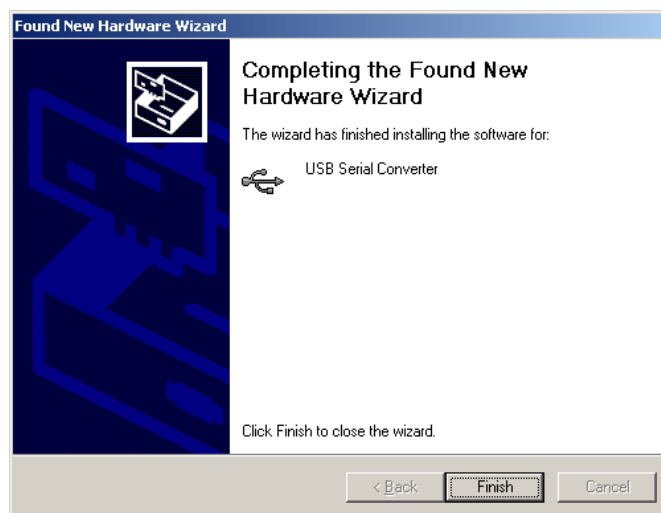
4. Choose “Install from a list or specific location” in the next dialog and then click Next:



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).

Linux USB driver installation

The driver is already included in Kernel series 2.6 and should be loaded automatically when connecting the device. The driver provides a virtual serial port `/dev/ttyUSB0` that can be accessed with an Terminal program (e. g. CuteCom).

The following `dmesg` output shows, how the device is recognized and the driver loaded:

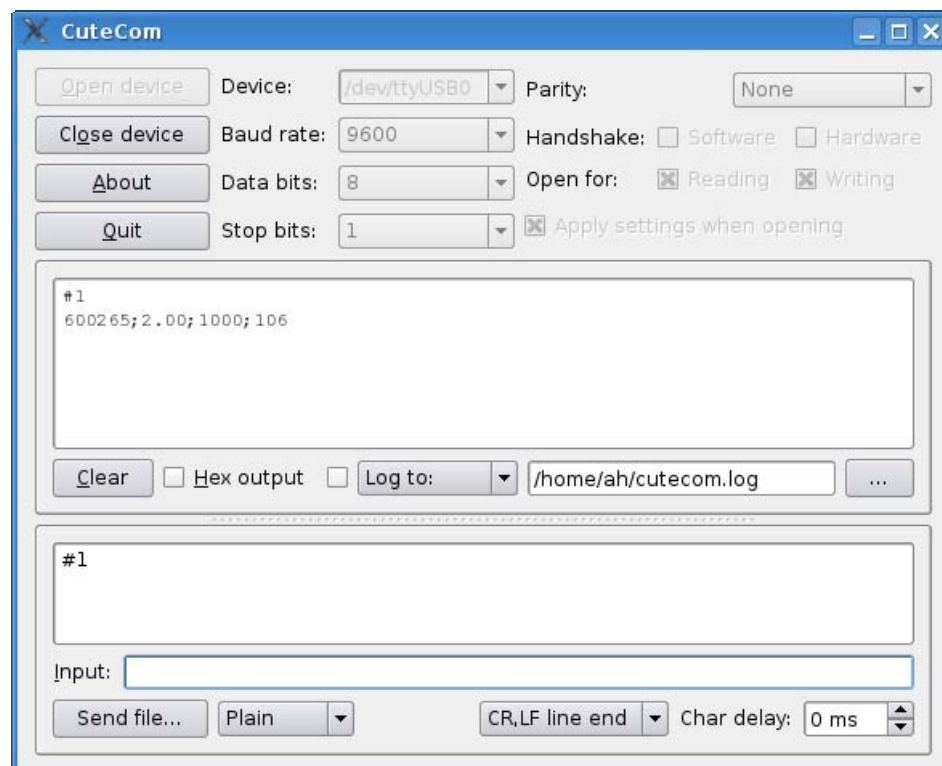
```
[234.496011] usb 1-2: new full speed USB device using uhci_hcd and address 2
[234.694884] usb 1-2: configuration #1 chosen from 1 choice
[234.704371] usb 1-2: New USB device found, idVendor=0403, idProduct=6001
[234.704376] usb 1-2: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[234.704380] usb 1-2: Product: FT232R USB UART
[234.704382] usb 1-2: Manufacturer: FTDI
[234.704385] usb 1-2: SerialNumber: A60075cx
[234.807627] usbcore: registered new interface driver usbserial
[234.807649] usbserial: USB Serial support registered for generic
[234.807679] usbcore: registered new interface driver usbserial_generic
[234.807683] usbserial: USB Serial Driver core
[234.816739] usbserial: USB Serial support registered for FTDI USB Serial Device
[234.816774] ftdi_sio 1-2:1.0: FTDI USB Serial Device converter detected
[234.816805] ftdi_sio: Detected FT232RL
[234.816855] usb 1-2: FTDI USB Serial Device converter now attached to ttyUSB0
[234.816872] usbcore: registered new interface driver ftdi_sio
[234.816876] ftdi_sio: v1.4.3:USB FTDI Serial Converters Driver
```

The following picture shows the connection to the THQ with the graphical Terminal program CuteCom (Download at <http://cutecom.sourceforge.net>).

The following settings are needed to connect to the THQ:

Device	/dev/ttyUSB0 (or other interface, see <code>dmesg</code> output)
Baud rate:	9600
Data bits:	8
Stop bits:	1
Parity:	None
Handshake:	None
Line end:	CR,LF

Now the serial interface can be opened by „Open device” and the communication tested:



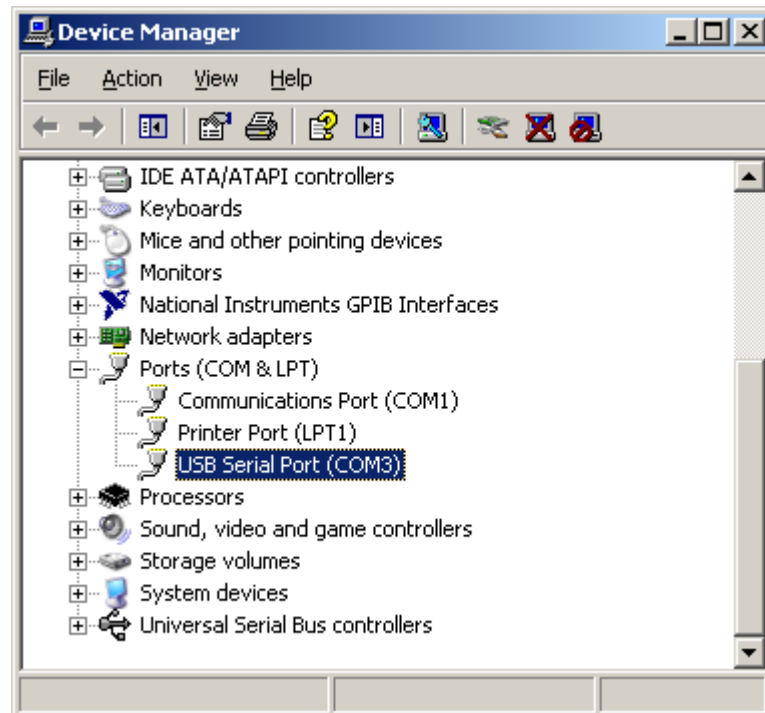
Interface Test under Windows

Determine the serial USB interface with Device Manager

Start the Device Manager with:

Start → Settings → Control Panel → System → Device Manager

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

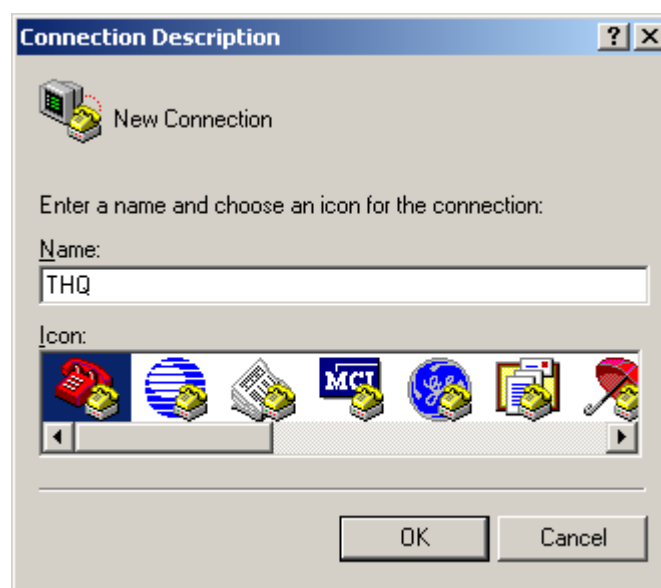


Test with HyperTerminal

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

Start → Programs → Accessories → Communications → HyperTerminal

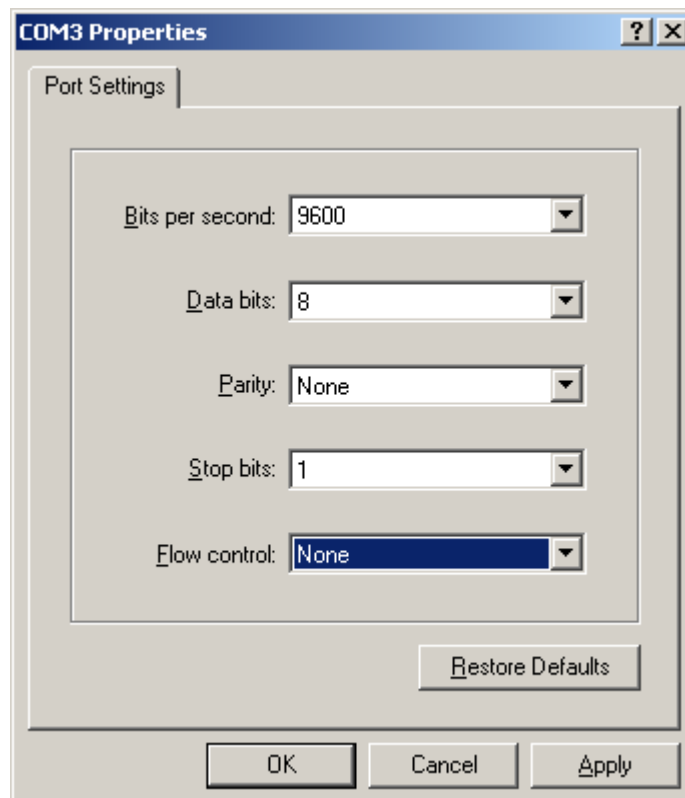
Create a new connection with menu „File → New Connection“, name it e. g. “THQ” and click OK.



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



Please enter the the interface parameters in the following dialog:

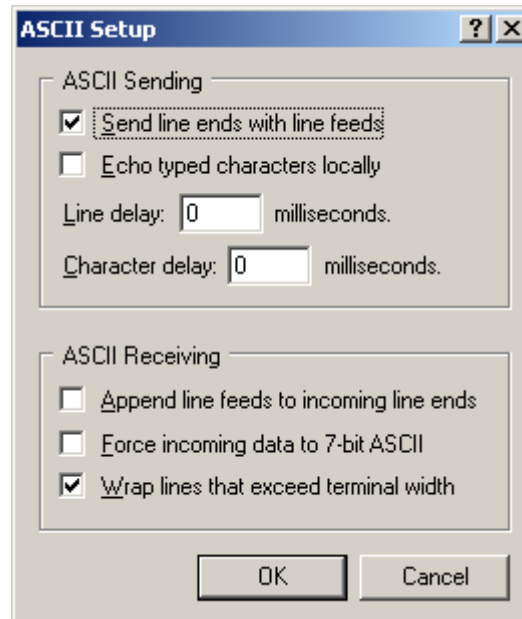


After clicking OK, the interface setup is finished.

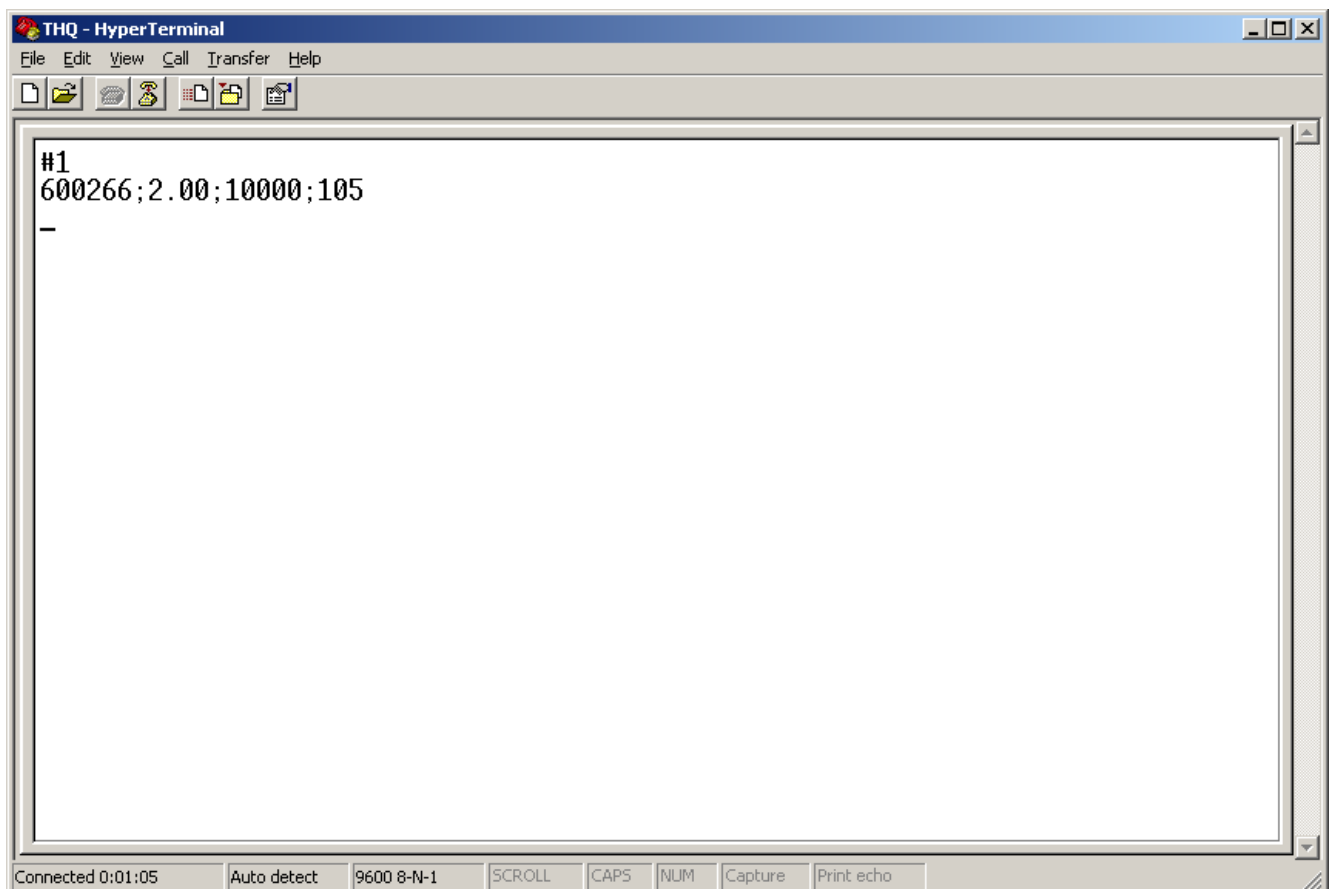
As last setting,

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:



Command set

The commands are transmitted in ASCII coding. The command end is detected by the characters <CR><LF> (\$0D \$0A bzw. 13 10) (shown by * in the following table)

Command	Computer	HV device	
Read device identification	#1 *	600000 ; 2.01 ; 3000 ; 205 * (serial no. ; Firmware ; V _{Onom} ; I _{Onom})	
Read actual voltage channel 1	U1 *	{Measured voltage} *	(in V)
Read actual current channel 1	I1 *	{Measured current} *	(in A)
Read set voltage channel 1	D1 *	{Set voltage} *	(in V)
Write set voltage channel 1 (Channel goes to mode 232/USB)	D1={voltage} *	0 ≤ voltage ≤ V _{Onom}	(in V)
Read set current channel 1	C1 *	{Set current} * (in A)	
Write set current channel 1	C1={current} *	0 < current ≤ I _{Onom}	(in A)
Read polarity channel 1	P1 *	{+ -} *	positive or negative polarity
Write polarity channel 1	P1={+ -} *		set positive or negative polarity (Option EPU only)
Read Autostart channel 1	A1 *	{1 0} *	1=USB active after power-on 0=Local mode after power-on
Write Autostart channel 1	A1={1 0} *		1= USB active after power-on 0= Local mode after power-on
Read module status channel 1	S1 *	HL *	(Hex Code → module status)
Set double echo (see compatibility mode)	E1={1 2}	E1=1 * E1=2 *	single Echo (ex works) double Echo (as in THQ 1.xx)
Read Kill function channel 1	T1 *	{1 0} *	1=KILL enabled 0=KILL disabled
Write Kill function channel 1 (computer control only)	T1={1 0} *		1=enable KILL (and clear Trip) 0=disable KILL (and clear Trip)

* = <CR><LF>

Other channels can be used in devices with two or three high voltage channels by replacing channel '1' with '2' or '3', e. g.: "#1" → "#2".

In case of error (wrong input, wrong channel, invalid value), "???? *" is returned.

Input examples

(Italic is answer from HV device to computer)

#1	Read identification
600138;2.01;3000;405	<i>(Serial number 600138, Firmware version 2.01, 3000 V, 4 mA)</i>
D1=1000	Set voltage to 1000 V (device switches to mode USB)
C1=1E-3	Set current to 1 mA
U1	Read measured voltage
999.7	
I1	Read measured current
0.028E-3	
S1	Read status
31	<i>(HV ON + NEGATIVE + USB)</i>

Device status

The device status is an 8 bit word and is transmitted hexadecimal. The meaning of the status bits is explained in following table:

Status	Description	Bit	Wert		
TRIP	In mode Kill Enable the current limit was reached and the High voltage is turned off.	Limit reached → HV off	7	8	H
		Limit not reached		0	
KILL	Kill-Enable/Disable	Kill enable	6	4	
		Kill disable		0	
INH	INHIBIT	HV-ON	5	2	
		HV-OFF		0	
POLN	Polarity negative	Negative (positive / unknown)	4	1 0	
POLP	Polarity positive	Positive (negative / unknown)	3	8 0	
AUTO	Computer interface active after power-on	Active	2	4	
		Not active		0	
MODE	Control via ...	analogue I/O (REM)	1	3	
		Local Control (LOC)		2	
		Computer interface (USB/232)	0	1	
		Reserved		0	

Examples for status:

11 Computer remote control, negative
71 Computer remote control, negative, HV-ON, KILL enable
0A Positive, Local control
2B HV-ON, positive, analogue I/O

Compatibility to THQ 1.xx

The instruction set was simplified with Version 2.00. It is recommended to use the new instruction set for communication with the device.

However, it is possible to emulate the behaviour of THQ firmware 1.xx. To do so, the command E1=2 has to be sent to the device. If the device has more than one channel, the command has to be executed for every channel.

The following differences apply in compatibility mode:

- For every answer, the command is repeatet first
- The current limit is transmitted in mA (for $I_{Onom} \geq 1$ mA) respectively in μ A (for $I_{Onom} < 1$ mA)

Examples:

(Italic is answer from HV device to computer)

#1	Query identifier
#1	
<i>600123;2.01;5000;205</i>	Serial no. 600123, Version 2.01, 5000 V, 2 mA
C1=2	Set current limit to 2 mA
C1=2	
C1	Query current limit
C1	
2.0	Current limit = 2 mA