high voltage

iseg Spezialelektronik GmbH

Operator's Manual

Power Supply of the device class

FPS, 19"/2U

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Attention

It is strongly recommended to read the manual before operation!

To avoid the possibility of lethal shock to the operator, the unit must not be operated with the cover removed.

There are no user maintainable parts inside the power supply!

The mains connector is equipped with basic insulation and a protective earth conductor. The unit may only be operated with protective earth conductor connected.

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

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.

Warning! **notes in the text call attention to hazards in operation of these units that could lead to possible injury or death.**

Caution! **notes in the text indicate procedures to be followed to avoid possible damage to equipment.**

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1 Safety instructions

This power supply has to be installed by trained and qualified personnel only.

Following instructions are made for the personal safety of the operator, the safe use of this product and the connected devices.

Before connecting to the local mains it must be made sure that the nominal line voltage of this unit matches to the local mains.

The power input has to be fused with not less than 2 A, with slow delay.

The delivered HV-cables have to be connected to the load properly and isolated according to proof-voltage.

The shield of the HV cable is always connected to the housing.

The return conductor can be isolated from the protective ground by opening the short circuit between “X” and “RTN” at the back panel of the power supply. The potential between the return conductor and the protective ground is not monitored by the device.

Warning! **The user has to ensure that no danger will occur because of the voltage between the return conductor and the protective ground!**

After system assembly the connections with the protective ground have to be checked for proper connection!

An air flow rate of 36 m³/h has to be guaranteed under any circumstances. Therefore do not cover any air input or output slots.

The unit can be operated with an ambient temperature of 0°C to 50°C.

Warning! **When operating with an ambient temperature above 35°C the temperature of the mains switch may rises above 45°C!**

Warning! **It is strictly forbidden to remove the cover of the power supply, to avoid the possibility of lethal shock to the operator! Before operations at the load or the high voltage output of the power supply are started, the high voltage output of the power supply must be properly grounded.**

2 Technical data

2.1 Power supply

Table 2.1: Technical data

Device Class FPS, 19“/2U				
Output voltage V_{nom} [V]		12	12.5	
Output current I_{nom} [A]		5	8	
Output power P_{nom} [W]		60	100	
Efficiency		> 85% (P_{nom}, V_{in} = 230 V)		
Ripple and noise		Current control: $\Delta i < 1.5\% * I_{nom}$ (at P_{nom}, $I_{out} > 0.1 * I_{nom}$)		
Stability current		$\Delta i < 0.1\% * I_{nom}$ (Δv_{in} and $0 < V_{out} \leq V_{nom}$)		
Accuracy		Voltage: < 1% ∗ V_{nom} for one year Current: < 1% ∗ I_{nom} for one year		
Temperature coefficient		$<1 * 10^{-4}$ /K [1)]		
Potential difference between output voltage and protective ground		± 10 kV		
Control (local, FP)		Optional front panel operation via rotary encoders and displays (LCD)		
Control (Remote)	AIO	Analogue signals	Level	0 V – 10 V
		Digital signals	Low level High level	0 V – 4 V 8 V – 24 V
	USB	Via USB interface		
	CAN	Optional, via CAN interface		
	Ethernet	Optional, via Ethernet Interface		
Supply		V_{in} = 85 V - 264 V – AC I_{in} < 2 A (P_{nom}, V_{in} = 230 V) Line frequency 47 Hz < f < 63 Hz Internally fused with 2 A slow		
Cooling		Forced cooling with a two-stage integrated fan (≤ 36 m³/h)		
Monitoring		Temperature		
Working conditions		Temperature: 0°C to 50°C Humidity: 20% to 90%, no condensation		
Storage conditions		Temperature: -25°C to 80°C Humidity: 20% to 90%, no condensation		
HV connector	Output	2 x LEMO PSA.3S.CTA.C62		
	Input	LEMO PSA.3S.CTA.C62		
Dimensions		2U –19“ compatible / depth:ca. 410 mm		
Weight [kg]		ca. 6		
Return of the high voltage		Electrically isolated		

Table 2.2 Continuation: technical data

Device class FPS, 19“/2U		
Electromagnetic compatibility	Emission	EN 55011 (curve B)
	Immunity	EN 61000 4-2, EN 61000 4-3, EN 61000 4-4, EN 61000 4-8
Safety standard		EN 61010-1 (VDE 0411)

2.2 Electrical wiring of the high voltage part

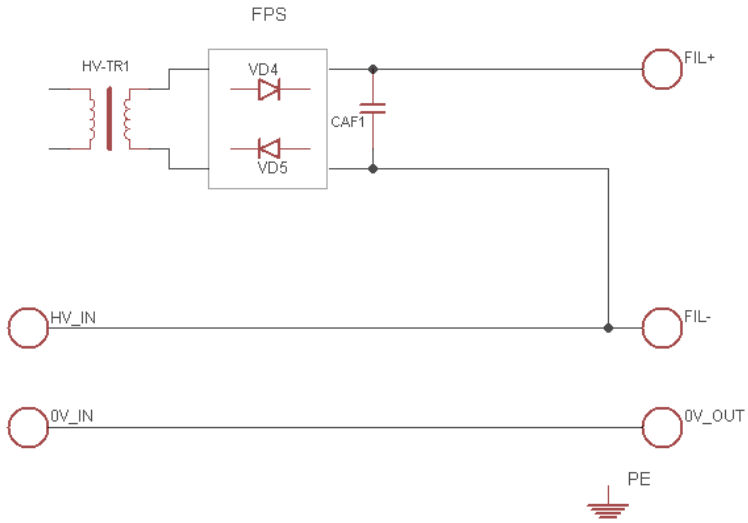

Figure 2.1: Electrical wiring of the high voltage part

2.3 Dimensions

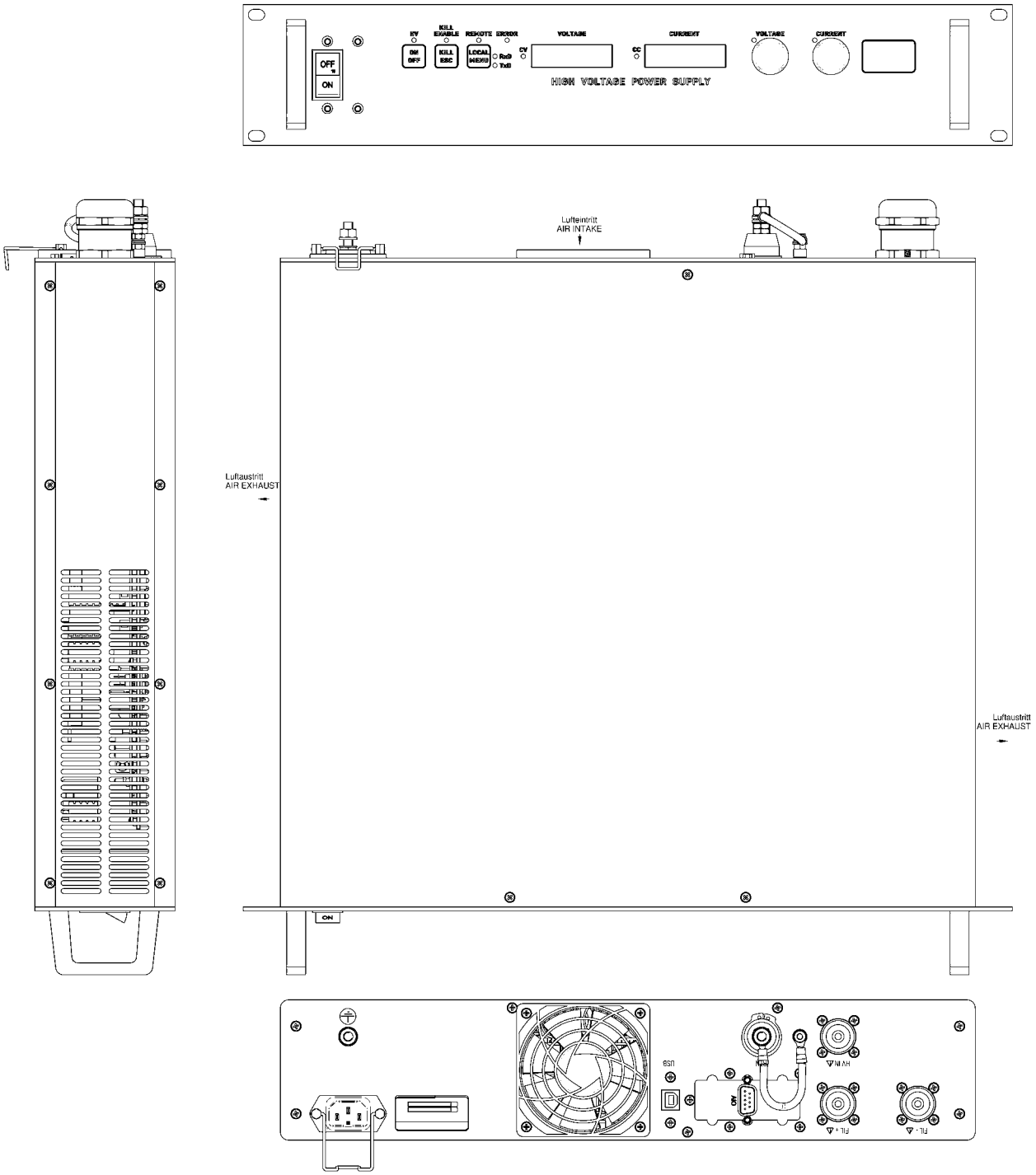

Figure 2.2: Dimensioned drawing (in mm), with option front panel control

3 Functional description

Powered by a single phase mains the filament power supply generates a floating output voltage up to 12.5 V DC and an output current up to 8 A.

The unit can be controlled via

- front panel operation with rotary encoders and displays (optional)
- one D Sub 9 connector with analogue and digital signals or
- digital interfaces.

In the following, the working principle of the module will be described.

Next to the mains there is a EMI/RFI filter. Two single phase power relays separate the EMI/RFI filter from the power factor correction unit (PFC) and the inrush current limitation circuit.

An inverter with a connected resonance circuit transforms the DC-Link voltage into a controllable sinusoidal voltage. The transformer and synchronous rectifier provide an output current corresponding to the external Set-current. Output voltage and current are measured by voltage dividers and a shunt and are fed back to the control circuit.

The output parameters are controlled via a frequency modulation. This control technology guaranties a nearly loss free switching of the power semiconductors.

The control circuit controls and limits the output voltage and current corresponding to the set values. Normalized monitor voltages for voltage and current are provided for read back.

The power supply is turned ON/OFF with a switch installed at the front panel of the power supply.

4 Features

4.1 Operation states

The power supply has the following operation states:

- POWER-ON Device initializes the connected Hardware (Booting)
- LOCAL Device is controlled via the front panel
- REMOTE Device is remote controlled via the analogue or digital interfaces

There are two modes for voltage generation:

1. Constant voltage control CV:
   Control of output voltage according to its set value.
2. Constant current control CC:
   Control of output current according to its set value.

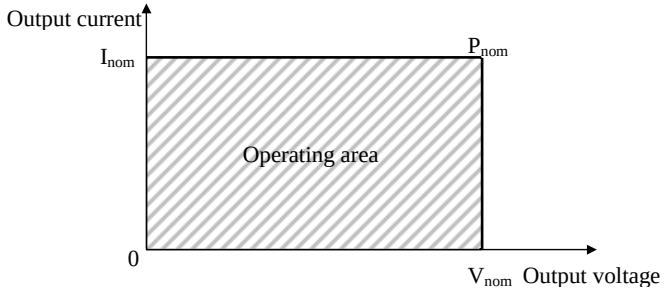

Figure 4.1: Operating area of the device

4.2 Monitoring

Temperature

Temperature is monitored at several points within the unit. High voltage generation is stopped and the error “OVERTEMP” is generated in case of external air temperature exceeds 50°C or internal temperature of several modules exceeds a predefined limiting value (section 9.1).

Caution! **The unit is equipped with an air filter. Depending on amount of dust in the environment and the number of operating hours, the filter has to be replaced on a regular basis. The filter can be purchased from iseg Spezialelektronik GmbH. The replacement can be done by the operator.**

5 Pinout

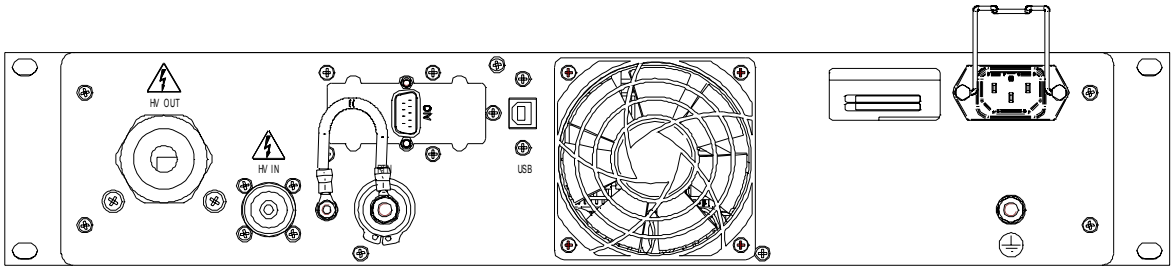

Figure 5.1: Back panel of the device, (device with output cable)

5.1 Supply

The power supply is connected to the mains net using an IEC connector on the back panel. An earth stud marked with “PE” can be connected to the grounding system. The thread of the protective ground stud PE is M5.

5.2 HV connection

The unit has two HV outputs (FIL- and FIL+). The HV cables have to be connected to the load properly and isolated according to proof-voltage.

The shield of the HV cable is always connected to the housing and should not be connected to the load.

The return conductor can be isolated from the protective ground by opening the short circuit at the back panel of the power supply (“RTN” and “X”). The potential between the return conductor and the protective ground is not monitored by the device.

Warning! **The user has to ensure that no danger will occur because of the voltage between the return conductor and the protective ground!**

At the HVIN connector the HV generator must be connected. The HV cable has to be connected to the power supply and the HV generator properly.

5.3 USB / RS232 connection

See section 5.3, description of the USB / RS232 connection

5.4 CAN connection

See section 7.2, description of the CAN interface

5.5 Ethernet connection

See section 7.3, Description of the Ethernet interface

5.6 AIO connection

See section 7.4, Description of the Analogue I/O interface (AIO)

6 Front panel control

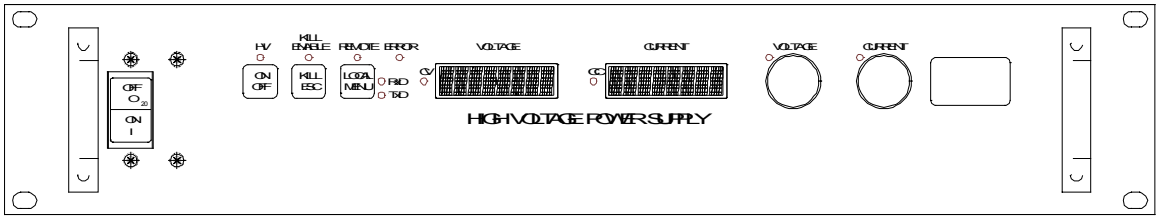

Figure 6.1: Front panel with rotary encoder and displays (LCD), height of the device 2U

After closing the mains switch the device is booting and the integrated hardware is initialised.

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

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

Warning!

The output voltage will ramp with the specified ramp speeds (voltage and current ramp) to the selected set voltage (constant voltage control) or set current (constant current control). Factory setting for the voltage ramp speed is 0.2 • V_{NOM} per second and 100 • I_{NOM} per second for the current ramp speed.

By pressing ON/OFF again, the voltage generation is turned off, the green LED “HV” turns off. The voltage ramps down with the specified voltage ramp speed, if the device operates in the state constant voltage control or specified current ramp speed, if the device operates in the state constant current control.

6.1 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 the display and can be changed with the rotary encoders VOLTAGE and CURRENT. These set value for the voltage is stored in processor’s EEPROM and is reloaded at the next start-up.

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

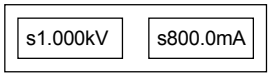

Figure 6.2: Set values on display

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

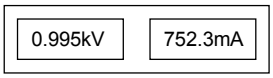

Figure 6.3: Measured values on display

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 are not changed, the device will show again the measured values after four seconds. By pressing the corresponding rotary encoder again, this delay can be shortened.

When voltage is turned off, the displays show the measured values while ramping down. Four seconds after the measured voltage falls below 10 V, the device displays the set values again.

6.2 Menu

In HV-OFF mode the device menu is accessed by pressing the button “LOCAL/MENU”.

If no further button is pressed, the menu will be closed after 30 seconds. The menu can also be closed without changing any value by pressing the button KILL/ESC.

The rotary encoder VOLTAGE is used to scroll through the menu. Pressing the rotary encoder VOLTAGE selects the displayed menu item. Settings can be changed turning 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**.**

Table 6.1: Description of the individual menu items

Display		Description
Set	Limit V	Adjust Software-voltage limit V_{OUTmax} with rotary encoder VOLTAGE. V_{SET} will be limited to this value.
Set	Limit I	Adjust Software-emission current limit I_{OUTmax} with rotary encoder CURRENT. I_{SET} will be limited to this value.
Set	Ramp V	Adjust voltage ramp speed with rotary encoder VOLTAGE (min. ramp speed … max. ramp speed kV/s).
Set	Ramp I	Adjust current ramp speed with rotary encoder CURRENT (min. ramp speed … max. ramp speed A/s).
Set	Control	“LOCAL” control via the front panel or the digital interfaces “AIO” control via Analogue I/O
Set	Addr 488	Select IEEE-488 (GPIB) address with rotary encoder VOLTAGE: 01 to 30
Set	CAN	Select CAN address with rotary encoder VOLTAGE: 00 to 63
Set	Password	Lock Menu access with four-digit Password. “0000” disables the Password function, every other combination enables the password function. Each digit must be entered separately with the rotary encoder VOLTAGE. By pressing the rotary encoder VOLTAGE, the next digit is selected for input.
Show	Power	Show measured power instead of measured current “off” ⇒ “on”.
Quit	Menu	Leave Menu by pressing rotary encoder VOLTAGE.

7 Interface control

For remote control, the control mode “LOCAL” must be specified first via the menu item “Set Control”. The device switches to “REMOTE” mode when receiving the first command from the selected interface. The yellow LED “REMOTE” is illuminated.

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

If “HV-ON” is activated while the device is controlled via a remote interface, high voltage can be turned off by pressing the “ON/OFF” button. In this case the device switches to “LOCAL” mode.

7.1 Description of the RS-232- / USB interface

Warning! **Turn off the device with mains switch before connecting/disconnecting the interface cable.**

Caution! **If the device is equipped with RS-232 and USB Interface, only one of them must be connected to the power supply.**

RS-232

The RS-232 interface is located at a D Sub 9 connector on the back panel.

The electric transfer is performed via RxD and TxD, which are related to floating GND of the Interface. The D-Sub 9 pin assignment is given in Table 7.1.

The cable connection to the computer is 1:1 (no zero modem-cable!). If no 9-pin cable is available, connections must be set up as shown in the table.

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

Table 7.1: Electrical wiring of the RS232 Interface

Signal	HV-PS		PC	Connection	Signal
RS-232	D-SUB-9	Internal	D-SUB-9	RS-232	D-SUB-9
RxD	2		2	RxD	2
TxD	3		3	TxD	3
GND	5		5	GND	5
	4	┐	4		4
	6	┤	6		6
	8	┘	8		8

USB

The USB interface is realized with a female USB-B connector on the back panel. Internally, the USB is implemented by a USB-serial converter FTDI FT232R.

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

Programming

The following description applies to both, RS-232 and USB 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 the direction "Computer to HV PS unit” (Input direction) is established by echoes. The transfer direction “HV-PS to computer“ (Output direction) is free running.

The command transfer uses ASCII characters. Commands are terminated by <CR><LF> ($0D $0A or 13 10).

A new command may be sent immediately after the last answer was completely received (including <CR><LF>). For commands that don't return an answer, the simplest thing is to add *OPC? in EDCP instruction set:

Table 7.2: Programming seriell interface

Instruction (with Echo)	:VOLT 500;:VOLT ON;*OPC?<CR><LF>
Answer	1<CR><LF>

7.2 CAN interface

Warning! **Turn off the device with mains switch before connecting/disconnecting the interface cable.**

The connector (SUB D 9) for the CAN interface is located at the back panel of the module and has the following pinout:

Table7.3: Pinout CAN connector

PIN	Signal
2	CAN_L (CAN Low)
3	CAN_GND
5	CAN_Shield
7	CAN_H (CAN High)

The operating and the command set is equivalent to the EDCP protocol, which is described in the manuals

CAN-Interface

Multi-Channel High Voltage Power Supply Module

EHS xxx and EDS xxx.

7.3 Description of the Ethernet interface

Warning! **Turn off the device with mains switch before connecting/disconnecting the interface cable.**

The 100 MBit/s Full duplex Ethernet Interface is connected via a RJ-45 socket at the back panel of the device.

The device can be connected to a switch via a patch cable. If it shall be connected to a PC directly, a crossover cable has to be used. The configuration of the Ethernet interface is done with a web browser or the tools of Lantronix company:

http://www.lantronix.com/support/downloads/?p=XPORT.

Please change only the settings on the network page!

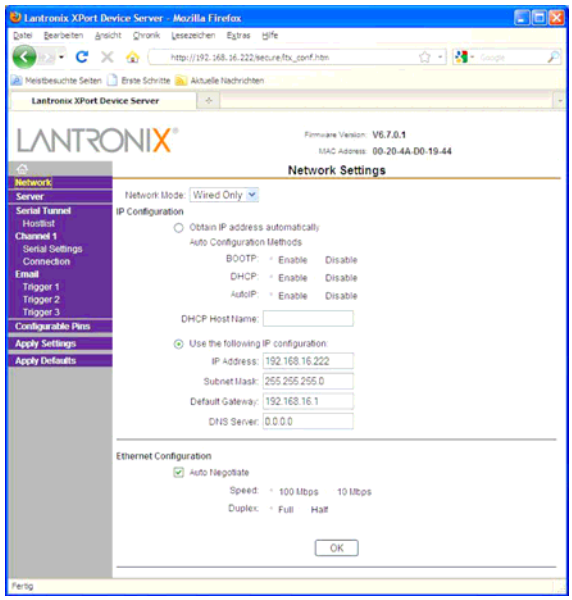

Figure 7.1: Ethernet configuration

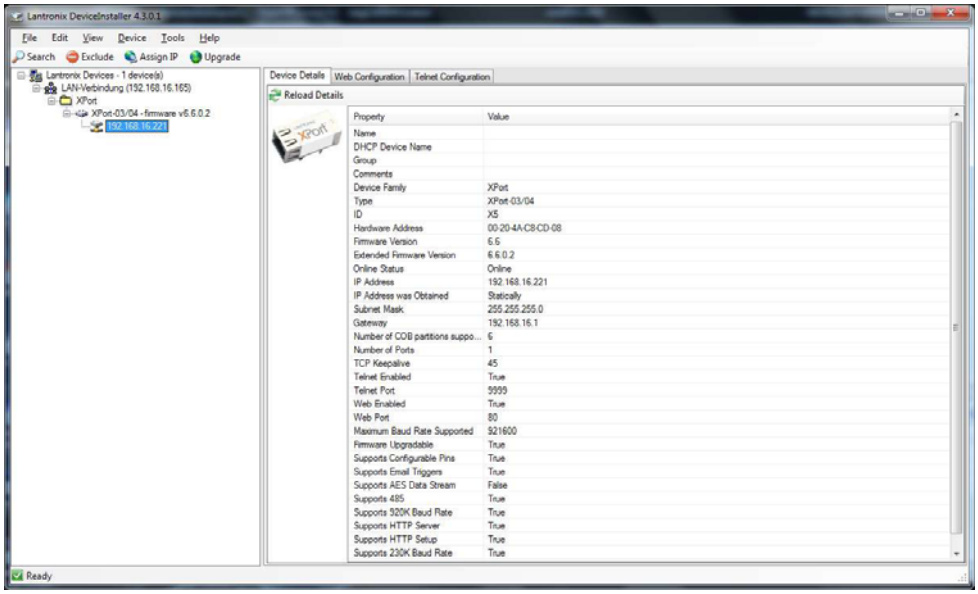

Figure 7.2: Lantronix configuration program

Factory Ethernet settings are shown in the following table:

Table 7.4: Factory Ethernet Settings

IP-address	192.168.16.221
Net mask	255.255.255.0
Default Gateway	192.168.16.1
Command port	10001 (fixed)

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

C:\>ping 192.168.16.221
Ping will done for 192.168.16.221 with 32 bytes data:
Answer from 192.168.16.221: bytes=32 time=4ms TTL=128
Answer from 192.168.16.221: bytes=32 time=4ms TTL=128
Answer from 192.168.16.221: bytes=32 time=4ms TTL=128
Answer from 192.168.16.221: bytes=32 time=4ms TTL=128
Ping statistic for 192.168.16.221 :
Package: sent = 4, received = 4, lost = 0
Time in millisecond:
minimum = 1ms, maximum = 4ms, average = 1ms

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

Table 7.5: Principle sequence of communication between PC and HV unit

Step	Function call	Computer → HV unit	HV unit → Computer
1	connect()	SYN	
2			SYN, ACK
3		ACK	
4	send()	"*IDN?\r\n"	
5	recv()		"iseg Spezialelektronik GmbH[…]\r\n"
6	closesocket()	FIN, ACK	
7			FIN, ACK
8		ACK	

The first three packages establish a TCP-Connection between Computer and HV unit (three way handshake). Fourth step is the inquiry from PC to HV unit. The command 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 longer frames can be build which reduces Ethernet overhead.

7.4 Description of the Analogue I/O interface (AIO)

Warning! **Turn off the device with mains switch before connecting/disconnecting the interface cable.**

All analogue and digital inputs and outputs are electrically isolated from the protective ground. The user is responsible that no danger will occur due to a voltage between the AIO and the protective ground!

All control inputs and outputs are located at the male D Sub 9 connector labelled “AIO” on the back side of the device. The pin assignment of this connectors is shown in Table 7.6.

Table 7.6: Pinout AIO, male D Sub 9 connector

AIO, male D Sub 9 connector			
Pin 1	GND		Return of pins 2-9
Pin 2	V_{MON_I}	(0 .. 10 V)	Monitor output current
Pin 3	INHIBIT		Digital input signal
Pin 4	V_{SET_I}	(0 .. 10 V)	Set value output current
Pin 5	CV / CC		Digital output signal
Pin 6	GND		Return of pins 2-9
Pin 7	V_{MON_V}	(0 .. 10 V)	Monitor output voltage
Pin 8	V_{SET_V}	(0 .. 10 V)	Set value output voltage
Pin 9	V_{REF}	10,2 V	

Figure 7.3 shows the electrical wiring of the analogue and digital in- and outputs.

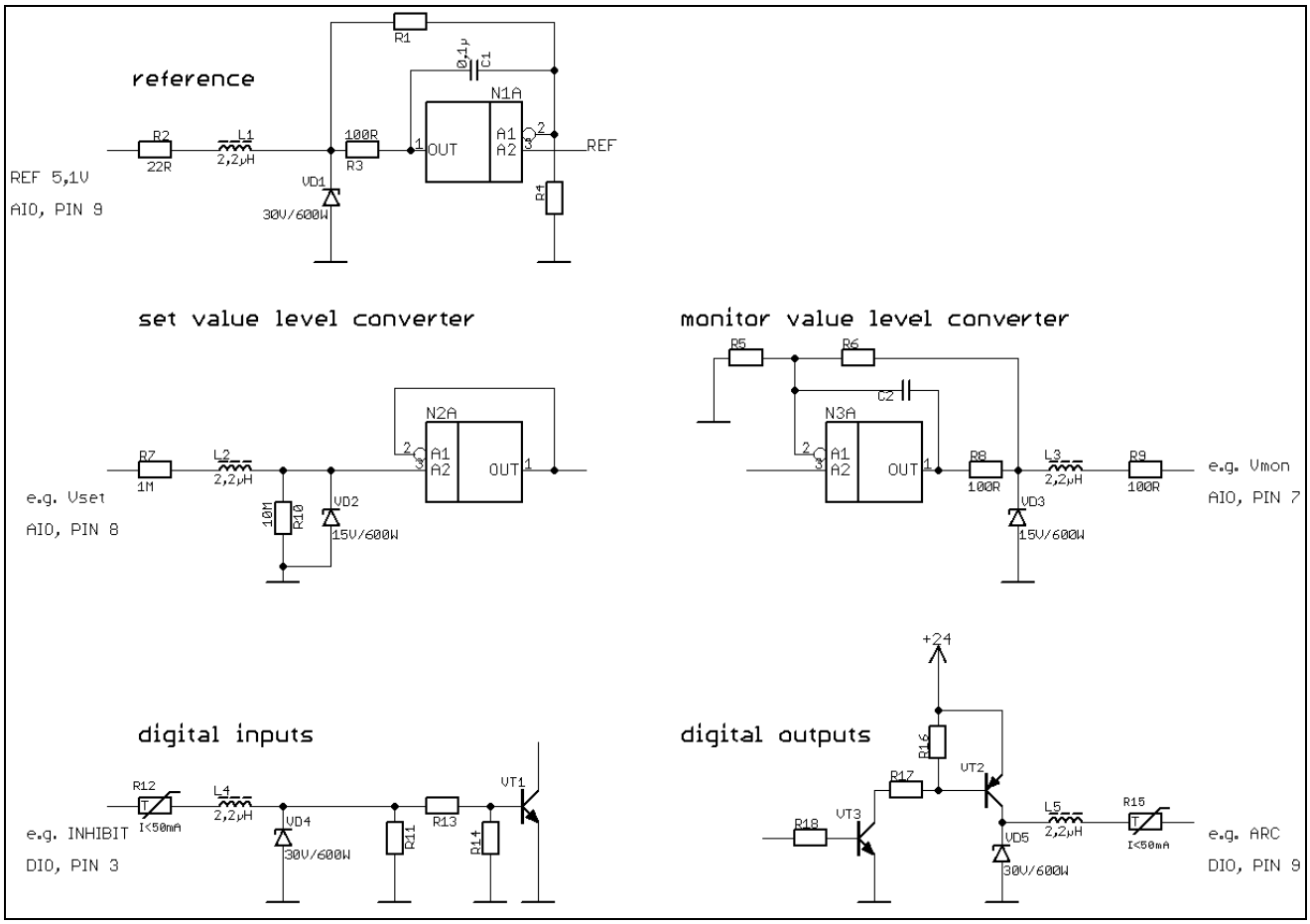

Figure 7.3: Electrical wiring of the output signals

The high voltage is turned on/off with the analogue interface control signal “INHIBIT”.

Set values

A voltage between 0 - 10 V at Pin 8 (reference potential Pin 6) of the connector “AIO” controls the output voltage between 0 – V_{NOM}. Similarly, at Pin 4 the output current is controlled between 0 -I_{NOM}.

Monitor voltages

Monitor voltages (0 - 10 V) proportional to the output voltage and output current are available at Pin 7 and Pin 2 of the connector “AIO”, respectively (reference potential Pin 6).

INHIBIT

By applying a low level signal at pin 3 of the connector “AIO“, the voltage ramps down with the specified voltage ramp speed, if the device operates in the state constant voltage control or specified current ramp speed, if the device operates in the state constant current control. Voltage generation is activated with a high level signal or open contact at pin 3 of the connector “AIO“.

Warning! **Do not use the Inhibit function as a safety loop.**

Cv / CC

Pin 5 of connector “AIO” will be high if the device operates in the state constant current control. Pin 5 of connector “AIO” will be low if the device operates in the state constant voltage control.

8 SCPI command set with EDCP

8.1 Introduction

This command set is based on the iseg EDCP CAN Protocol with Status and Event handling. The Status and Event Status fields are explained below the SCPI table.

By entering values (e.g. set voltage) it is not necessary to add the corresponding units. The response of the device always includes the unit.

Note! ***Module* is the description of the complete high voltage power supply. It may consist of several voltage *channels*, but devices of the FPS series only have one voltage *channel.***

Table 8.1: SCPI command set with EDCP

Common Commands		
*IDN?		Query device identification
*CLS		Clear all events (module and channel)
*RST		Reset device to save values (Turn voltage off with ramp, V_{SET} = 0, I_{SET} = I_{NOM})
*LLO		Query operation complete status. Answer is "1" after all preceding commands are executed
*GTL		Local lockout (disable front panel buttons)
*INSTR?		Goto local (enable front panel buttons)
*INSTR,EDCP		Query current instruction set (always "EDCP")
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) [1]
	EMCY CLR	Leave state emergency off [2]
: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)

[1, 2] By shutting down the high voltage with :VOLT EMCY OFF, the channel stays in state emergency off. To turn on the high voltage again, the state emergency off must be leaved with :VOLT EMCY CLR. Next, the ChannelEventStatus bit EventEmergencyOff has to be cleared e. g. with *CLS.

Table 8.2: continuation command set with EDCP

:CONFigure			Set/read module configuration
	:RAMP		
		:VOLTage <RampSpeed>[V/s]	Set voltage ramp speed
		:CURRent <RampSpeed>[A/s]	Set current ramp speed
	:Event		
		CLEAR	Clear the ModuleEventStatus register
		:MASK	Query the ModuleEventMask register
	:KILL?		Query Module Kill Status
	:KILL { 0 | 1 }		Set Kill Disable (0) or Kill Enable (1)
	:AVERage?		Query number of steps of averaging of the measured values
	:AVERage { 1 | 16 | 64 | 256 }		Set number of averaging steps of the measured values
	:SERIAL		RS-232/USB Configuration
		:BAUDrate?	Query Serial Baudrate
		:ECHO?	Query Serial Echo
		:ECHO { 0 | 1 }	Set Serial Echo Off (0) or Echo On (1)
	:CAN		
		:ADDRess?	Query CAN Address
		:ADDRess { 0…63 }	Set new CAN Address
		:BITrate?	Query CAN Bitrate
		:BITrate { 125000 / 250000 }	Set new CAN Bitrate
:SYStem			
	:USER		
		:CONFig <SerialNumber>	Enable configuration mode (to set CAN address and bitrate). Only possible, if HV generation is turned off.
		:CONFig 0	Exit configuration mode
		:CONFig?	1 if configuration mode is enabled, otherwise 0

Table 8.3: continuation command set with EDCP

: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 (section 8.5)
		:EVent		
			:STATus?	Query Module Event Status (section 8.6)
			: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 (section 8.3)
		:EVent		
			:STATus?	Query Channel Event Status Word (section 8.4)
			:MASK?	Query Channel Event Status Mask
	:FIRMware			
		NAME?		Query firmware name
		RELease?		Query firmware version

8.2 Output formats for voltage and current:

Table 8.4: Output format for voltage

Vnominal	Output format for voltages
10 V ≤ V_{nom} < 100 V	12.3456V
100 V ≤ V_{nom} < 1 kV	123.456V
1 kV ≤ V_{nom} < 10 kV	1.23456E3V
10 kV ≤ V_{nom} < 100 kV	12.3456E3V

Table 8.5: Output format for current

Inominal	Output format for currents
1 mA ≤ I_{nom} < 10 mA	1.23456E-3A
10 mA ≤ I_{nom} < 100 mA	12.3456E-3A
100 mA ≤ I_{nom} < 1 A	123.456E-3A
1 A ≤ I_{nom} < 10 A	1.23456A

Examples:

Read Module-Identification:

```
*IDN?
iseg Spezialelektronik GmbH,F030020p0100C1040000,9100000,2.04
```

Set Voltage to 10.51 V:

```
:VOLT  10.51
```

Set current to 1.58 A:

```
:CURR  1.58
```

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;19.9973E-3A
```

8.3 Channel Status (read access)

:READ:CHANnel:STATus?

Table 8.6: Channel Status register

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
isVoltageLimit	isCurrentLimit	isTrip	IsExternal-Inhibit	isVoltage-Bounds	isCurrent-Bounds	isArcError	res
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
isConstant-Voltage	isConstant-Current	isEmergency-Off	isRamping	isOn	isInputError	isArc	res

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

Table 8.7: Explanation of individual bits of the Channel Status register

Bit	Bit ist 1	Bit ist 0
isVoltageLimit	Voltage limit Vmax is exceeded	Voltage limit not exceeded
isCurrentLimit	Current limit Imax is exceeded	Current limit not exceeded
isTrip	High voltage has been shut down without ramp because voltage or current limit or current set has been exceeded in Kill-Enable	No Trip
isExternalInhibit	External Inhibit is active	No External Inhibit
isVoltageBounds	Voltage out of programmed bounds	Voltage is within programmed bounds
isCurrentBounds	Current out of programmed bounds	Current is within programmed bounds
isConstantVoltage	Voltage control active (evaluation is guaranteed when no ramp is running)	Voltage control not active
isConstantCurrent	Current control active (evaluation is guaranteed when no ramp is running)	Current control not active
isEmergencyOff	Emergency off without ramp	No Emergency Off
isOn	Voltage is actively generated or measured voltage is above 60 Volt	Voltage is not actively generated and measured voltage is below 60 Volt
IsRamping	Ramp is running	No Ramp is running
isInputError	Input error	No Input error
res	Reserved	Reserved

8.4 Channel Event Status (read/write access)

:READ:CHANnel:EVent:STATus?

Table 8.8: Channel Event Status register

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
EventVoltage-Limit	EventCurent-Limit	EventTrip	EventExternal Inhibit	EventVoltage-Bounds	EventCurrent-Bounds	EventArcError	res
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
EventCon-stantVoltage	EventConstant-Current	Event-EmergencyOff	EventEnd-OfRamp	EventOnToOff	EventIput-Error	EventArc	res

The Channel Event Status register describes the captured status. An event bit is set if the corresponding ChannelStatus 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. All channel events can be cleared by :EVENT CLEAR. With the command *CLS the Module Event Status and the Channel Event Status registers are cleared at once.

Table 8.9: Explanation of individual bits of the Channel Event Status registers

Bit	Event description
EventVoltageLimit	Voltage limit has been exceeded
EventCurrentLimit	Current limit has been exceeded
EventTrip	High voltage was shut down without ramp in Kill-Enable because the voltage or current limit or current set value was exceeded
EventExternalInhibit	An external inhibit was or is active
EventVoltageBounds	Voltage bounds has been exceeded
EventCurrentBounds	Current bounds has been exceeded
EventArcError	The number of allowed ARCs was exceeded. High voltage was turned off
EventConstantVoltage	Channel was or is in constant voltage control
EventConstantCurrent	Channel was or is in constant current control
EventEmergencyOff	High voltage was shut down without ramp by emergency off
EventEndOfRamp	End of ramp
EventOnToOff	High voltage was shut down without ramp
EventInputError	An input error occurred
EventArc	At least one ARC occurred
res	Reserved

If one of the Channel Event Status Bits EventVoltageLimit, EventCurrentLimit, EventTrip, Event-ExternalInhibit, EventVoltageBounds, EventCurrentBounds, EventArcError or EventEmergency is set, it prevents turning on the voltage again until the bit is cleared.

8.5 Module Status (read access))

:READ:MODule:STATus?

Table 8.10: Module Status register

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
isKillEnable	isTemperature-Good	isSupplyGood	isModuleGood	isEventActive	isSafetyLoop-Good	isNoRamp	isNoSumError
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
res	isInputError	res	isService	isVoltageOn	res	res	isFineAdjust

The Module Status register describes the actual status for the complete device.

Table 8.11: Explanation of the individual bits of the Module Status register

Bit	Bit ist 1	Bit ist 0
isKillEnable	Module is in state Kill enable	Module is in state Kill disable
isTemperatureGood	Module temperature is above 55 °C	Module temperature is below 55 °C
isSupplyGood	Power supply is good	Power supply is not good
isModuleGood	Module status is good	Module status bad
isEventActive	At least one masked event is active	No masked event is active
isSafetyLoopGood	Interlock (Safety loop) is closed. Voltage generation is possible	Interlock (Safety Loop) is open: No voltage generation is possible
isNoRamp	All channels are stable, no ramp is running	At least one channel is ramping
isNoSumError	No sum error active	Sum error active
IsInputError	An input error occurred	No input error
isService	Hardware failure detected. Contact manufac-turer	No Hardware failure
isVoltageOn	Voltage is actively generated or measured voltage is above 60 Volt	Voltage is not actively generated and measured voltage is below 60 Volt
isFineAdjust	Adjustment is on	Adjustment is off
res	Reserved	Reserved

8.6 ModuleEventStatus (read/write access)

:READ:MODule:EVent:STATus?

The ModuleEventStatus register describes the captured status for the complete device.

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 in this register can be cleared by :CONFIGURE:EVENT CLEAR. With the command *CLS the ModuleEventStatus and the ChannelEventStatus registers are cleared at once.

Table 8.12: Module Event Status Register

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
res	EventTempera-tureNotGood	EventSupply NotGood	res	res	EventSafety-LoopNotGood	res	res
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
res	EventInputError	res	res	EventService	res	res	res

Table 8.13: Explanation of the individual bits of the module status event Registers

EventTemperatureNotGood	Temperature is or was above 55 °C
EventSupplyNotGood	At least one of the supplies is or was not good
EventSafetyLoopNotGood	Safety loop is or was open
EventService	A hardware failure of the device has been detected. Contact the manufacturer..
Reserved	res
EventInputError	An input error occurred

All events bits except input error prevents turning on the high voltage again until the bit is cleared.

9 Error

9.1 Error acknowledgement

With the following options an error event can be reset or acknowledged:

- Rising edge of the INHIBIT function (section 7.4),
- Via the digital interfaces with the command *CLS (section 8.1) or
- By pressing the button “Kill Esc” at the front panel (optional) (section 6):

9.2 Error messages on the LC-Displays

Table 9.1: Error messages on the LC-Displays

Error messages during operation	
Display:	Explanation:
OVERTEMPERATURA	High voltage has been shut down because of over temperature (section 4.2).
EXTERNAL INHIBIT	No high voltage can be generated due to an external inhibit (analogue I/O).
EMERGNCY OFF	High voltage has been shut down with Emergency Off
CURRENT TRIP	Set current value was reached with Kill Enable. High voltage has been shut down immediately
SERVICE NEEDED	Device ether receives an firmware update or Device must be shipped to the factory for service.

9.3 Further errors

Table 9.2: Trouble-shooting

Unit does not provide output voltage and the fans are not working	⇒	- Check supply voltage and connection
Unit does not provide output voltage but the fans are working	⇒	- Check supply voltage - Check environmental temperature ($T_U \leq 50°C$)
External fuses trip during switch on.	⇒	- Use fuses with slow characteristic (inrush current 10 A)
Unit does provide output voltage only for a short time	⇒	- Check air filter

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

10 Maintenance

For compliance of the specified accuracy of set and monitor signals, the unit has to be recalibrated once a year.

Repair and maintenance may only be performed by trained and authorized personnel.