

Technical information

Last changed on: 04.07.2017

SHQ Series

DIGITAL CONTROLLABLE HIGH PRECISION AC DESKTOP HV SUPPLY

- 2 - 6 kV / 1 and 2 channel versions
- 2 line display for voltage and current
- RS232 or CAN interface
- switchable polarity
- high precision / very low ripple and noise
- high resolution: 1nA (opt. 100pA)/100mV (opt. 10mV)
- programmable voltage ramp



Table of Contents

Document history.....	3
Disclaimer / Copyright.....	3
Basic Information.....	3
Safety notes.....	4
1 General information.....	5
1.1 Short description.....	5
1.2 Technical Data and auxiliary information.....	5
2 Functional principle.....	6
2.1 High voltage supply.....	6
2.2 Digital control unit.....	7
2.3 Filter.....	7
2.4 Floating HV-outputs.....	7
3 Operation.....	8
3.1 Front panel.....	8
3.2 Power Up and operational conditions.....	9
3.2.1 Manual control ("CONTROL" in upper position).....	10
3.2.2 Remote control ("CONTROL" in lower position).....	10
3.2.3 Transition manual control / remote control.....	11
3.3 Current measurement ranges.....	11
3.4 Current measurement ranges and current trip.....	11
3.5 Safety functions.....	11
3.6 Operation check.....	13
4 Appendix.....	14
5 Connectors and cables.....	15
6 Accessories.....	15
7 Manufacturer´s contact.....	16

Document history

Version	Date	Major changes
2.0	04.07.2017	Relayouted version

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Basic Information

It is strongly recommended to read the operator's manual before operation.

To avoid injury of users it is not allowed to open the unit. There are no parts which can be maintained by users inside of the unit. Opening the unit will void the warranty.

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 module. It is strongly recommended to read the operators manual before operation.

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.

WARNING



WARNING

Violation of guidelines marked with „Warning“ can lead to death or severe injury

CAUTION!



CAUTION

Violation of guidelines marked with „Attention!“ can lead to damages of the unit or the application

INFORMATION



Advices marked with „Information“ give important information

INFORMATION

Safety notes

CAUTION!



CAUTION

To avoid injury of users it is not allowed to open the unit. Before any operations on the HV output or the application, the unit has to be switched off and discharge of residual voltage has to be finished. Depending on application residual voltages can be present for long time periods. These residual voltages can lead to severe injuries.

Only accessories which meet the manufacturer's specifications shall be used. If the equipment is used in a manner not specified by this manual, the protection provided by the equipment may be impaired. We decline all responsibility for damages and injuries caused by an improper use of the module.

1 General information

1.1 Short description

The modules of the series SHQ are desk top high voltage power supplies which offer output voltages up to 6 kV for the use in industry and research.

Main Characteristics:

- High voltage power supplies with front-panel operation and remote control via serial interface
- Output voltages with very low ripple and noise
- Compact housing with one or two independent high voltage sources
- Polarity is manually switchable with switches on the rear side of the housing
- Simultaneous display of current and voltage in a High Resolution format on the 2-line LCD
- Output short circuit and overload protection

1.2 Technical Data and auxiliary information

SPECIFICATIONS		SHQ		
Single channel HV Power Supply		SHQ 122	SHQ 124	SHQ 126
Dual channel HV Power Supply		SHQ 222	SHQ 224	SHQ 226
Output voltage V_{nom}		2 kV	4 kV	6 kV
Output current I_{nom}		6 mA	3 mA	1 mA
Ripple and noise		Typ.: < 2 mV _{p-p} max.: 5 mV _{p-p}		
Stability:	$[\Delta V_{out} \text{ vs. } \Delta V_{in}]$	< $3 \cdot 10^{-5}$		
	$[\Delta V_{out} \text{ vs. } \Delta R_{load}]$	< $5 \cdot 10^{-5}$		
Temperature coefficient		30 ppm/K		
Voltage measurement	resolution ADC:	100 mV / 6-digit LCD display (Option VHR : 10 mV for SHQ x22 and x24 only)		
	accuracy:	$\pm (0,05\% V_{OUT} + 0,02\% V_{nom})$ for one year		
Voltage Settings	Manual / DAC:	10-turn potentiometer / digital via serial interface		
	resolution DAC:	100 mV / Option VHR : SHQ x22M with 30 mV ; SHQ x24M with 60 mV		
Current measurement	2 ranges / 6-digit LCD display			
	resolution ADC:	Range mA:	$I_{nom} \geq I_{OUT} \geq 100 \mu A$, Resolution: 100 nA Option 0n1 : $I_{nom} \geq I_{OUT} \geq 10 \mu A$ Resolution: 100 nA Accuracy: $\pm (0,05\% I_{OUT} + 0,02\% I_{nom})$	
		Range μA :	$100 \mu A > I_{OUT} > 20 \text{ nA}$ Resolution: 1 nA Accuracy: $\pm (0,1\% I_{OUT} + 20 \text{ nA})$ Option 0n1 : $10 \mu A > I_{OUT} > 2 \text{ nA}$, Resolution: 100 pA Accuracy: $\pm (0,05\% I_{OUT} + 2 \text{ nA})$	
Value scope		data are guaranteed in the range of $(1\% \cdot V_{nom}) < V_{OUT} < V_{nom}$ for one year		
Voltage Ramp		fixed: 500 V/s (at HV-ON/OFF) variable: 2 ... 255V/s (at remote control)		
Protection		hardware voltage limit (V_{max} rotary switch in 10%-steps) hardware current limit (I_{max} rotary switch in 10%-steps, Option IWP : setting with 10-turn potentiometer I_{SET})		

	INHIBIT (external signal, TTL, LOW = active) programmable current trip (serial interface)	
Interface	RS 232-Interface (Option CAN : CAN-Interface → SHQ x4x)	
Line voltage AC (V_{IN})	100 V_{AC} ·-· 240 V_{AC} / 0,7 – 0,4 A max / 50 – 60 Hz	
Fuse	T 1A L 250V / microfuse 5mm x 20mm, 250V / 1AT	
Mains connection	matching used socket according IEC 60320 C13 (125V/10A or 250V/16A)	
Connectors	HV output: V_{nom} resp. Typ/AMP/Tyco SHV-Connector (225059-3) INHIBIT: V_{max} 5V/1-pin Lemo-hub (ERN.00.250.CTL) RS 232/CAN : V_{max} +/-20V/9-pin Sub-D connector	
Accessories see Appendix	HV output: Rosenberger SHV coupler 57K101-006N3 assembled on HV cable INHIBIT: LEMO FFA.00.250.CTA, standard cable 5V RS 232: custom commercially available RS232 cable, uncrossed, female to male	
Temperature ranges	Operating: 0 ... +40 °C	Storage: -20 ... +60 °C
Desk case	Size (W/H/D) : (236/100/320) mm ³	
Further environmental conditions	equipment is for use in closed environment only, maximum altitude of use 2000m, relative humidity 20% to 90% (no condensation), maximum Pollution degree level 2	
Requirements for assembly, location and mounting	Desk top power supply, backside fan must not be covered (distance of fan to any object at least 3cm), unit should be placed close to an accessible power socket in order to be able to pull the mains plug or operate the main switch in case of emergency	
Cleaning instructions	Use a soft, dry, lint-free cloth to clean the units exterior. Avoid getting moisture in any openings. Do not spray any type of liquid directly on the device. Don't use solvents, aerosol sprays or abrasives	

Table 1: Specification

The built-in options are marked on the rear side next to the type label.

2 Functional principle

The functional principle is described in the block diagram, Appendix.

2.1 High voltage supply

For the high voltage generation a patented highly efficient resonance converter circuit is used, which provides a sinusoidal voltage with low harmonics for the HV-transformer.

For the high voltage rectification high speed HV-diodes are used. A high-voltage switch, connected to the rectifier allows the selection of the polarity.

The consecutive active HV-filter damps the residual ripple and ensures low ripple and noise values as well as the stability of the output voltage. A precision voltage divider is integrated into the HV-filter to provide a feedback voltage for the output voltage control, an additional voltage divider supplies the signal for the maximum voltage monitoring.

A precision control amplifier compares the feedback voltage with the set value given by the DAC (remote control) or the potentiometer (manual control). Signals for the control of the resonance converter and the stabilizer circuit are derived from the result of the comparison. The two-stage layout of the control circuit results in an output voltage, stabilized with very high precision to the set point.

When switching the High Voltage ON or OFF the voltage changes are made with a fixed set ramp, which defines the maximum change rate of the output voltage.

Separate security circuits prevent exceeding of the front-panel switch settings for the current I_{max} and voltage V_{max} limits. A monitoring circuit prevents malfunction caused by low supply voltage.

The internal error detection logic evaluates the corresponding error signals and the external INHIBIT signal and changes the output voltage according to the setup. This also allows the detection of short over currents due to single flashovers.

2.2 Digital control unit

A micro controller handles the internal control, evaluation and calibration functions of both channels.

The effective voltages and currents are read cyclically by an ADC with a connected multiplexer. The readings are processed and displayed on the 4 digit LCD. The current and voltage hardware limits are retrieved cyclically several times per second.

A reference voltage source provides a precise voltage reference for the ADC and the control voltage for the manual operation mode of the unit. In the computer controlled mode the set values for the corresponding channels are generated by a 18-Bit DAC.

2.3 Filter

A special feature of the unit is a tuned filtering concept, which prevents perturbation of the unit by external electromagnetic radiation, as well as the emittance of interferences by the module. A filtering network for the supply voltages is located next to their connectors, the converter circuits of the individual channels are protected by additional filters.

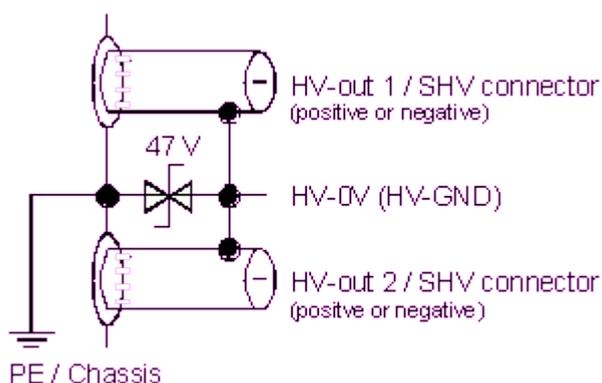
The high-voltage filters are housed in individual metal enclosures to shield even minimal interference radiation.

2.4 Floating HV-outputs

Both HV outputs are related to the same ground HV-0V (HV-GND), provided on the outer connector (screen of HV cable) of SHV connectors. The channels can be switched independently in polarity, the output voltages, related to HV-0V (HV-GND), are also independently controlled.

The SHV connectors are mounted isolated to chassis (PE) in order to have a floating HV-0V.

If the floating voltage is increased above 47V a suppressor diode connects HV-0V to PE (chassis) to avoid dangerous voltages between HV-0V and PE/chassis.



Picture 1: Scheme of potentials

3 Operation

3.1 Front panel

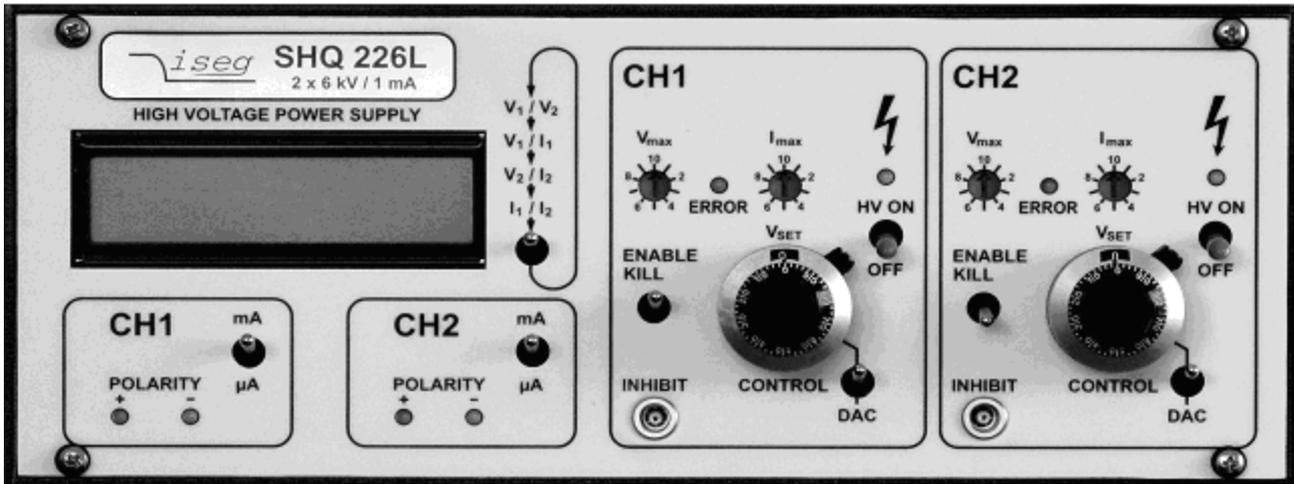


Figure 2: Front panel

Option IWP: Hardware current limit with 10-turn potentiometer

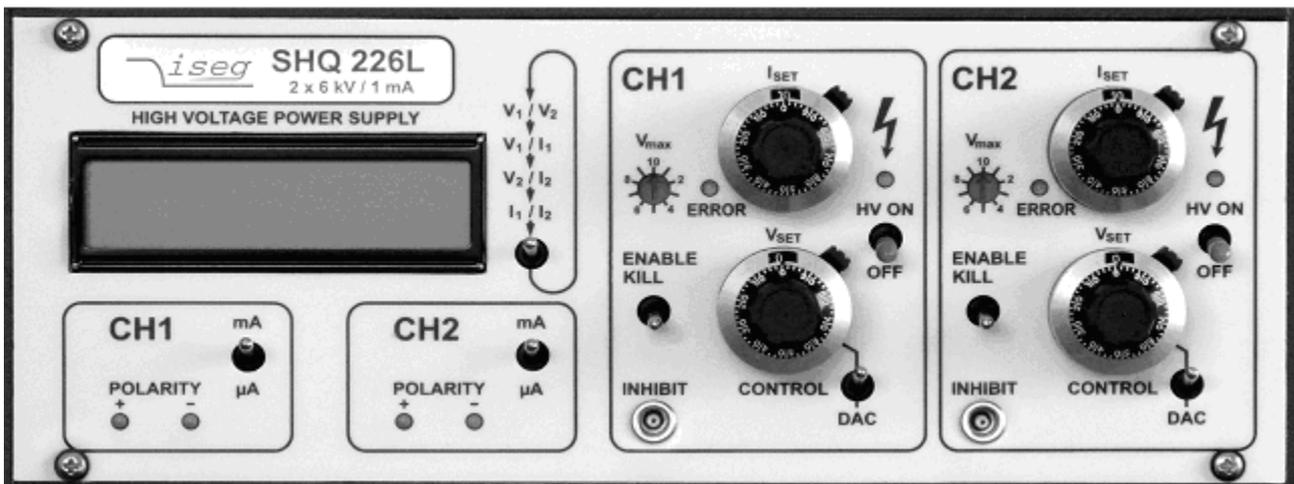


Figure 3: Front panel with option IWP

The upper figure shows the panel for the SHQ module in the standard version with 10 percent switches for voltage and current limit.

The front panel for modules with option IWP "Hardware current limit setting with 10-turn potentiometer" is shown in the lower figure.



Figure 4: Rear side

The mains supply (including switch and fuse), a 9-pin Sub-D connector for the RS 232 or CAN interface, the HV-outputs and the polarity switches are located on the rear side.

Before the unit is powered the desired output polarity must be selected by the rotary switch on the rear side. The selected polarity is displayed by a LED on the front panel and a sign on the LCD.

CAUTION!



It is not allowed to change the polarity when channels are switched ON and residual voltage is present!

CAUTION

INFORMATION



If the polarity switch setting is not defined (not at one of the end positions) high voltage cannot be switched on.

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3.2 Power Up and operational conditions

CAUTION!



It must be ensured that the air ventilation slots on the top, rear and bottom side of the HV unit are not covered. A distance of at least 15 mm to other objects must be provided.

CAUTION

The unit is powered up with the mains switch on back panel. After Power Up the unit is initialised and a brief function test of the hardware is performed. The display will show manufacturer, serial number, nominal voltage and nominal current.

After a successful function test the unit is in standby mode.

CAUTION!



CAUTION

If the HV-ON switch is in position "ON" and CONTROL switch is in upper position (manual control), at the HV-output on the rear side high voltage is generated according to the set voltage chosen via the 10-turn potentiometer with a ramp speed of 500 V/s (hardware ramp).

INFORMATION



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After powering up the device on an AC line voltage of 110 V-AC \pm 10% there is a 10 s delay until standby mode!

High voltage output is switched on with HV-ON switch at the front panel. This condition is indicated by the yellow LED above the switch.

Further control is depending on position of the CONTROL switch.

3.2.1 Manual control ("CONTROL" in upper position)

In the manual control mode the output voltage can be set via 10-turn potentiometer from 0V to the maximum voltage. The final position of the potentiometer equals maximum output voltage.

CAUTION!



CAUTION

If the HV-ON switch is switched into position "ON" and CONTROL switch is in upper position (manual control), at the HV-output on the rear side high voltage is generated according to the set voltage chosen via the 10-turn potentiometer with a ramp speed of 500 V/s (hardware ramp).

The effective values for voltage and current are indicated on the two line display. The type of display can be selected by tripping the switch next to the 2 line LCD display. Voltages and / or currents are displayed with the resolution of voltage- and current measurement of the corresponding SHQ series device. The polarity of the output voltage is also indicated.

3.2.2 Remote control ("CONTROL" in lower position)

If the CONTROL switch is in lower position (DAC), high voltage will be activated only after receiving corresponding RS232 commands. There are several commands offering an enhanced control in comparison to front panel control, such as:

- voltage ramp
The ramp speed of the output voltage can be chosen in a range of 2V/s to 255V/s
- current trip
current trip sets a current threshold. If the threshold is reached the channel will be switched off.

3.2.3 Transition manual control / remote control

In manual control mode the internal control voltage is depending on the effective output voltage. Therefore only very low voltage drops occur during transition to remote control mode.

During transition from remote control mode to manual control mode, the output voltage will change to the value set with the voltage control potentiometer with a voltage ramp of 500V/s.

CAUTION!



CAUTION

During transition from remote control mode to manual control mode, the output voltage will change to the value set with the voltage control potentiometer with a voltage ramp of 500V/s. This can affect the application.

3.3 Current measurement ranges

Each channel has two current measurement ranges. The range can be chosen with the switch labeled with "mA" and "μA" in the channel control field under the display. In "mA" position, there is an automatic switching between the current measurement ranges in case of crossing of the threshold. A switching into the lower measurement range will not take place with option IWP for the case a current limit below the switching threshold is set and this limit already takes effect on the output current. In position "μA" current measurement will stay in the "μA" range, in case of measurements higher than the threshold "Overflow" will be displayed.

3.4 Current measurement ranges and current trip

With the current measurement range switch it is also chosen which current trip is active.

- Position „mA“
The commands Lx and LBx are active
- Position „μA“
The command LSx is active

3.5 Safety functions

Each channel has separate safety functions

- Hardware-voltage limit Vmax
The maximum output voltage can be selected in 10%-steps with the rotary switches Vmax (switch dialed to 10 corresponds to 100%). The output voltage is then limited to Vmax.
- Hardware-current limit Imax
The maximum output current for each channel can be selected in 10%-steps with the rotary switches Imax (switch dialed to 10 corresponds to 100%) Depending on the position of KILL switch, the unit switches into current control mode or the channel is switched Off

INFORMATION



INFORMATION

Option IWP: With this Option, the 10 percent switch of Imax is replaced with a 10-turn potentiometer. Smaller steps for current limitation are possible.

CAUTION!



A current limit in the upper measurement range ("mA"-position) will only take effect down to the lower threshold of the range, i.e. down to 100 μ A or 10 μ A, depending on the model option. A lower current limit can only be set with the switch in the position " μ A".

CAUTION

- external interrupt signal INHIBIT

The INHIBIT signal is low-active (TTL low level or connected to signal GND). If INHIBIT is active, output voltage is switched off immediately. After change of INHIBIT to TTL high level, the behaviour of the output voltage is depending on position of KILL switch. If KILL is disabled, in manual control mode the value set with voltage set potentiometer will be restored with hardware ramp (500V/s), in remote control mode the voltage value set via interface will be restored with the software ramp. If KILL is enabled, in both modes the channel will stay switched Off.

- The KILL switch specifies the response on exceeding limits or on the external protection signal at the INHIBIT input as follows

position switch KILL	voltage or current limit exceeded	Inhibit active	voltage and current limit not exceeded any more and Inhibit not active
ENABLE (switch in upper position)	Output voltage switched Off	Output voltage switched Off	manual control: Activation of output voltage via switching of „KILL“ or „HV ON“
	Status = ERR	Status = INH	remote control: Activation of output voltage via read out of „Sx“ and Start of ramp „Gx“
DISABLE (switch in lower position)	limitation of output current, depending on condition decrease of output voltage. Quality of output voltage not guaranteed	Output voltage switched Off	manual control: output voltage restored with 500V/s
	Status = QUA	Status = INH	remote control: output voltage restored with software voltage ramp

Table 2: Overview KILL function

INFORMATION



Interface Control: If "Autostart" is activated (see Command List), the voltage ramp is already started after Status read out (command "S1" or "S2"), the Command to start the voltage change (Command "G1") is not necessary!

INFORMATION

3.6 Operation check

The correct operation of the module and the LC display can be verified as follows:

The "CONTROL"-switches must be in the upper position for manual control. For each channel turn the 10-turn potentiometer for V_{SET} by one revolution such that the number in vision panel shows "1" and the circular scale is in position "0". This setting corresponds to 10% of the nominal Voltage. I_{SET} must be set to a value $>10\%$. No cables are connected to the HV-output. After switching on high voltage with the switch "HV-ON" the yellow LED turns on and a voltage of $10\% \pm 1\% V_{nom}$ is shown in the LCD. The read LED ("ERROR") must stay off and the displayed value for the current of the channel should be below $0.2\% I_{nom}$.

4 Appendix

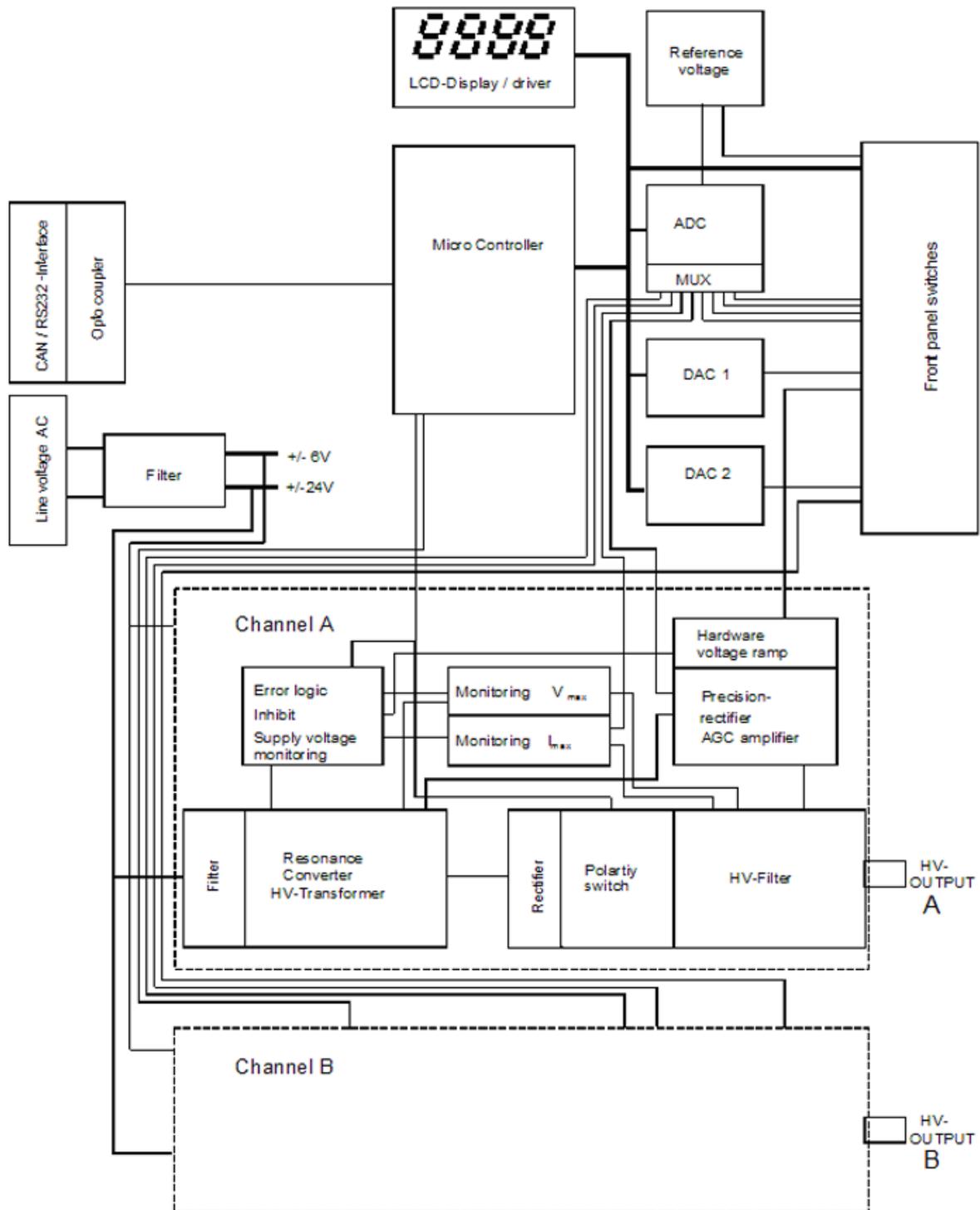


Figure 4: Block diagram SHQ CAN /RS232 interface

5 Connectors and cables

HV CONNECTOR ASSIGNMENTS					
Name	SHV	S08			
Figure					

Table 2: Connector and pin assignments

CONNECTORS PART NUMBERS (manufacturer code / iseg accessory parts item code)			
POWER SUPPLY SIDE		CABLE SIDE	
SHV (ROSENBERGER)			
Socket	57S501-200N3	Connector	57K101-006N3 / Z590162
S08 (RADIALL)			
Socket	R317.580.00	Connector	R317.0500 / Z592474

Table 3: Connectors part number information

CABLE ORDER GUIDE				
POWER SUPPLY SIDE CONNECTOR	CABLE CODE	CABLE DESCRIPTION	LOAD SIDE CONNECTOR	ORDER CODE <i>LLL = length in m *</i>
SHV	04	HV cable shielded 30kV (HTV-30S-22-2)	open	SHV_1C04-LLL
S08	04	HV cable shielded 30kV (HTV-30S-22-2)	open	S08_1C04-LLL

^{*)} Length building examples: 10cm => 0.1, 2.5m => 2.5, 12m => 012, 999m => 999

Table 4: Guideline for cable ordering

6 Accessories

Item	iseg order number
RS 232 cable 3m	Z200295
LEMO FFA.00.250.CTAC31	Z200793
Power Supply Cord HG/TR-SJT3x16AWG-C13M/3,05m	Z595088

For more information please use the following download links:

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7 Manufacturer's contact

iseg Spezialelektronik GmbH

Bautzner Landstr. 23

01454 Radeberg / OT Rossendorf Germany

Direct

Fon: +49 351 26996-0

Fax: +49 351 26996-21

Internet

www.iseg-hv.com

www.iseg-hv.de

E-Mail

info@iseg-hv.de

support@iseg-hv.de

sales@iseg-hv.de