

Operator's Manual

High Voltage Power Supply SHQ HIGH PRECISION series



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!

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



Attention!

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



Note!

Text marked with „Note!“ point at specialties or options.



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1 Safety notes

Warning!



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.

2 General information

2.1 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

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

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

3 Functional principle

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

3.1 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.

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.

3.2 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 16-Bit DAC.

3.3 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.

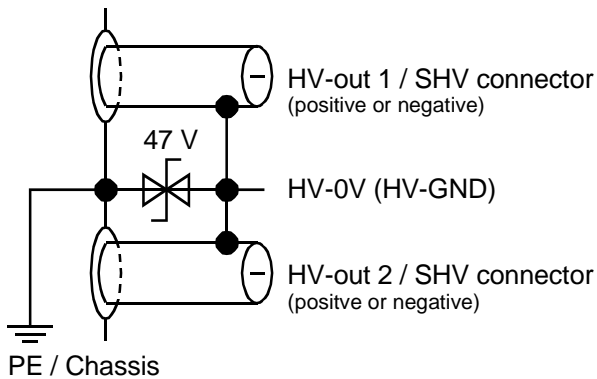
3.4 Floating HV-outputs

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.

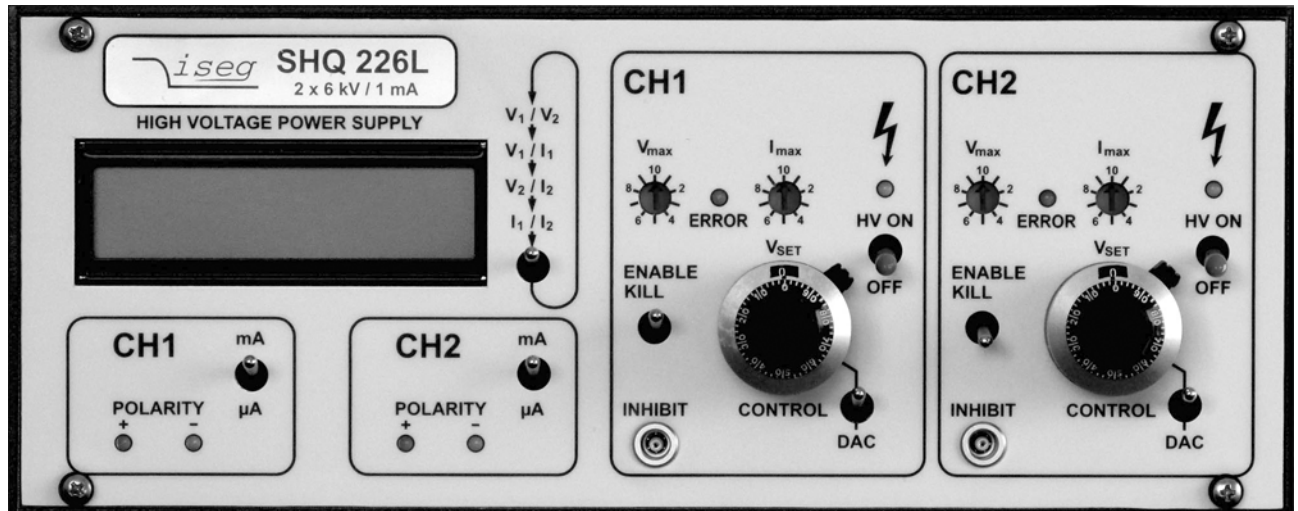
Picture 1: Scheme of potentials



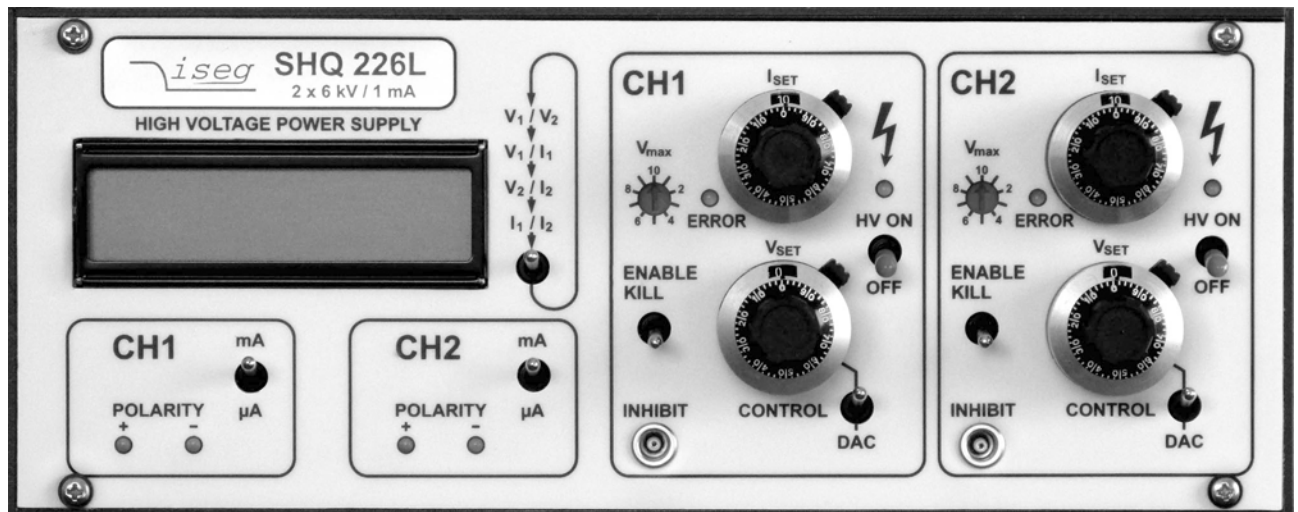
4 Operation

4.1 Front panel

Picture 2: Front panel



Option IWP: Hardware current limit with 10-turn potentiometer



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.

The mains supply (including switch and fuse), a 9-pin female D-Sub connector for the RS 232 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.

Attention!



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

Note!



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

4.2 Power Up and operational conditions

Attention!



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.

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.

Attention!



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).

Note!



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.

4.2.1 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.

Attention!



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.

4.2.2 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.

A detailed description of remote control commands can be found in chapter 5.1.2

4.2.3 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

Attention!



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.

4.3 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. In position "µA" current measurement will stay in the "µA" range, in case of measurements higher than the threshold "Overflow" will be displayed.

4.3.1 Current measurement ranges and current trip

With the current measurement range switch it is also chosen which current trip is active. (see chapter 4.4)

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

4.4 Safety functions

Each channel has separate safety functions

- Hardware-voltage limit V_{max}
The maximum output voltage can be selected in 10%-steps with the rotary switches V_{max} (switch dialed to 10 corresponds to 100%). The output voltage is then limited to V_{max} .
- Hardware-current limit I_{max}
The maximum output current for each channel can be selected in 10%-steps with the rotary switches I_{max} (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

Note!



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

- 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:

Table 2: Overview KILL function

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 Status = ERR	Output voltage switched Off Status = INH	manual control: Activation of output voltage via switching of „KILL“ or „HV ON“ 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 Status = QUA	Output voltage switched Off Status = INH	manual control: output voltage restored with 500V/s remote control: output voltage restored with software voltage ramp

Note!



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!

4.5 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 $0.2\% I_{nom}$.

5 RS232 interface

The following functionality is provided for the operation of the high voltage units via the RS232 interface.

RS232 control mode

- - Write function: set voltage; ramp speed; maximal output current (current trip); auto start
- - Switch function: output voltage = set voltage, output voltage = 0
- - Read function: set voltage; actual output voltage; ramp speed; actual output current; current trip; auto start ; hardware limits current and voltage; status

Front panel switches have priority over software control.

Manual control mode

While the unit is operated in manual control mode, RS232 read cycles are interpreted only. Commands are accepted, but do not result in a change of the output voltage.

5.1 Specification RS232 interface

The data exchange is character based, the synchronisation for the transfer direction PC to HV-source (input) is performed using an echo. The data transfer to the PC (output) is asynchronous. Between two characters a programmable delay time (break) is included to allow the computer to receive and evaluate the incoming data. The default break time setting is 3 ms.

The hardware setting of the RS232 interface is 9600 bit/s, 8 bit/character, no parity, 1 stop bit.

Signal transmission is performed potential free via the RxD and TxD, relative to GND.

The HV-supply is equipped with a 9 pin female D-Sub connector, the connection can be set up using a 1:1 extension cord (no null modem cable) when a PC is used. The pin assignment is given in table 1. Control signals have to be bridged on the PC side when a three lead cable is used, also given in table 1.

Table 3: Signal pin assignment

Signal RS 232	HV-supply		PC DSUB9	PC DSUB25	Connection 3-lead cable
	DSUB9	Internal			
RxD	2		2	3	
TxD	3		3	2	
GND	5		5	7	
	4	┌	4	20	┌
	6	└	6	6	└
	8	└	8	5	└

5.1.1 Syntax

The commands are transmitted in ASCII. All commands are terminated by the sequence <CR> <LF> (0x0D 0x0A , 13 10 respectively). Leading zeros can be omitted on input, output is in fixed format.

5.1.2 Command set

Table 4: Command set

Command	Computer	HV-supply	
Read module identifier	# *	# * nnnnnn ; n.nn ; U ; I * (unit number; software rel. ; V _{nom} ; I _{nom})	
Read break time	W *	W * nnn * (break time 2 ... 255 ms)	
Write break time	W=nnn *	W=nnn ** (break time = 2 - 255 ms)	
Read actual voltage channel 1	U1 *	U1 * { polarite / mantisse / exp. with sign } * (in V)	
Read actual current channel 1	I1 *	I1 * { mantisse / exp. with sign } * (in A)	
Read voltage limit channel 1	M1 *	M1 * nnn * (in % of V _{nom})	
Read current limit channel 1	N1 *	N1 * nnn * (in % of I _{nom})	
Read set voltage channel 1	D1 *	D1 * { mantisse / exp. with sign } * (in V)	
Write set voltage channel 1	D1=nnnn.nn *	D1=nnnn.nn ** (voltage corresponding resolution in V; <M1)	
Read ramp speed channel 1	V1 *	V1 * nnn * (2 ... 255 V/s)	
Write ramp speed channel 1	V1=nnn *	V1=nnn ** (ramp speed = 2 - 255 V/s)	
Start voltage change channel 1	G1 *	G1 * S1=xxx * (S1 , ⇒ Status information)	
Write current trip	L1=nnnnn *	L1=nnnnn ** (trip corresponding resolution range mA > 0)	
Cannel 1	Range "mA"	LB1=nnnnn ** (trip corresponding resolution range mA > 0)	
	Range "µA"	LS1=nnnnn ** (trip corresponding resolution range µA > 0)	
Read current trip	L1 *	L1=nnnnn ** (see above, for nnnnn=0 ⇒ no current trip)	
	Cannel 1	Range "mA"	LB1 * (see above, for nnnnn=0 ⇒ no current trip)
		Range "µA"	LS1 * (see above, for nnnnn=0 ⇒ no current trip)
Read current trip channel 1	L1 *	L1 * { mantisse / exp. with sign } * (s.a., current trip in A)	
Read status word channel 1	S1 *	S1 * xxx * (S1 , ⇒ Status information)	
Read module status channel 1	T1 *	T1 * nnn * (code 0...255, ⇒ Module status)	
Write auto start channel 1	A1=nn *	A1=nn ** (conditions ⇒ Auto start)	
Read auto start channel 1	A1 *	A1 * nnn * (8 ⇒ auto start is active; 0 ⇒ inactive)	

* = <CR><LF>

The second channel of the supply is addressed by replacing 1 with 2 !

Status information:	ON	Output voltage according to set voltage
	OFF	Channel front panel switch off
	MAN	Channel is on, set to manual mode
	ERR	V _{max} or I _{max} is / was exceeded
	INH	Inhibit signal was / is active
	QUA	Quality of output voltage not given at present
	L2H	Output voltage increasing
	H2L	Output voltage decreasing
	LAS	Look at Status (only after G-command)
	TRP	Current trip was active

Note! If output voltage has been shut off permanently (by ERR or INH at ENABLE KILL or TRP) the command "Read status word" must be executed before the output voltage can be restored



Error codes:

????	Syntax error
?WCN	Wrong channel number
?TOT	Timeout error (with following reinitialization)
?<SP>UMAX=nnnn	Set voltage exceeds voltage limit

Module status:

Status	Description	Bit	Valency
QUA	Quality of output voltage not given at present	7=1	128
ERR	V_{max} or I_{max} is / was exceeded	6=1	64
INH	INHIBIT signal	was / is active	5=1 32
		Inactive	0
KILL_ENA	KILL-ENABLE is	On	4=1 16
		Off	0
OFF	Front panel HV-ON switch in	OFF position	3=1 8
		ON position	0
POL	Polarity set to	Positive	2=1 4
		Negative	0
MAN	Control	Manual	1=1 2
		via RS 232 interface	0
		0=0	0

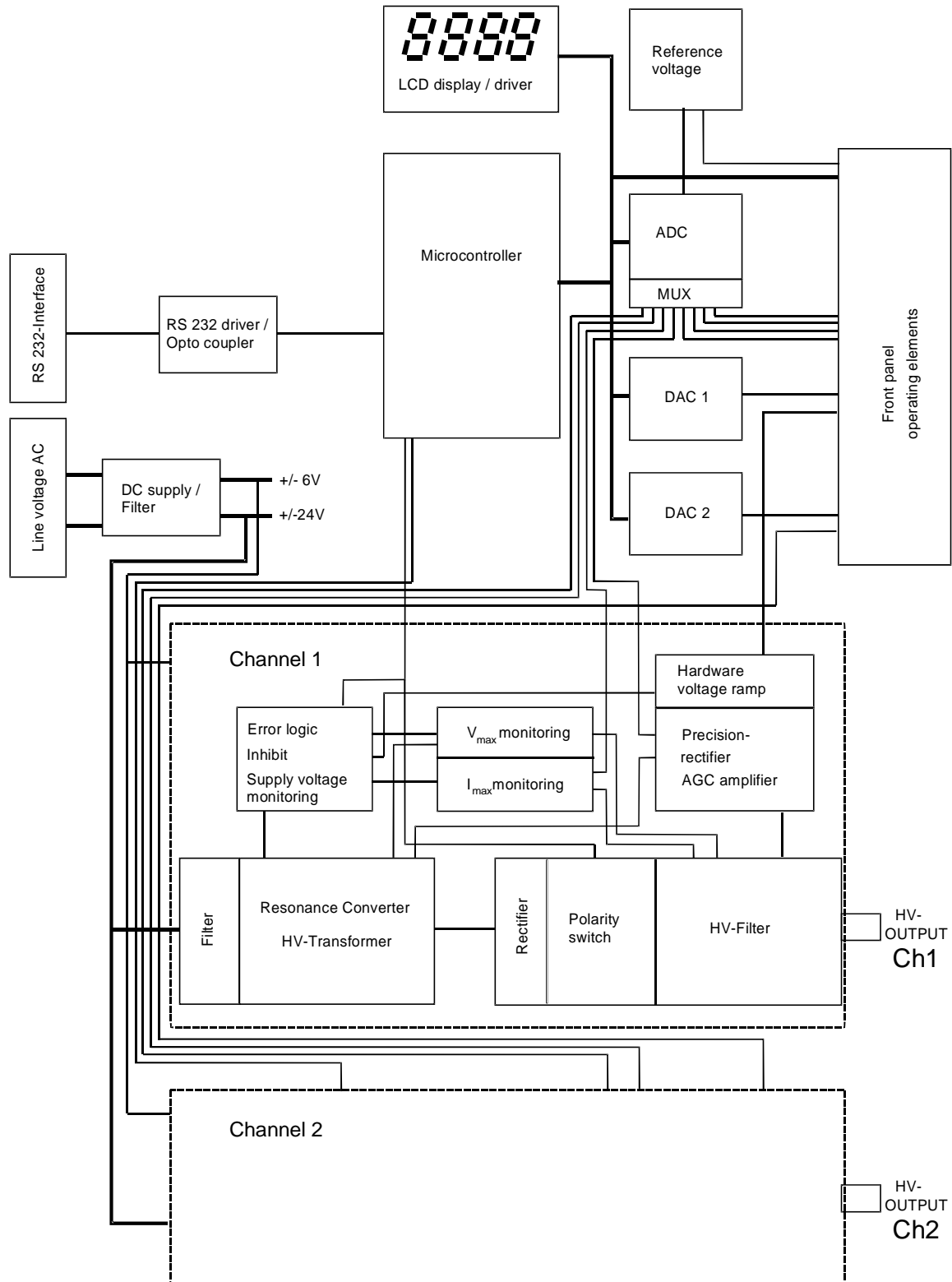
Read out of "module status" ("Tx") does **not** reset the flags "ERR" and "INH" like the read out of status word ("Sx") of the corresponding channel.

Auto start:

Autostart offers the possibility to set a specific voltage which is automatically achieved with a set ramp after Power Up and Initialization of the unit. This enables working in remote control mode without a control PC connected.

Description	Bit	Valency
If the precondition for Auto start (module status: OFF + ERR + INH + MAN = 0) is satisfied, the output voltage is automatically ramped to the set voltage. Thus the G-command or POWER-ON and OFF ⇒ ON are not required.	3=1	8
If output voltage has been shut off permanently (by ERR or INH at ENABLE KILL or TRP), the previous voltage setting will be restored with software ramp after "Read status word".		
Values are written to the registers only at POWER-ON!	Save Current trip to EEPROM	2=1 4
	Save Set voltage to EEPROM	1=1 2
	Save Ramp speed to EEPROM	0=1 1
(EEPROM guarantees 1 million saving cycles)		

Appendix A: Block diagram SHQ



Appendix B

Accessories

Item	iseg order number
HV cable 5m SHV-coupling one sided up to 6kV	SHV_CAB5
HV cable 5m SHV-coupling both sides up to 6kV	SHV2_CAB5
RS 232 cable 3m	200295
LEMO FFA.00.250.CTAC31	200793
Power Supply Cord HG/TR-SJT3x16AWG-C13M/3,05m	595088

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Standard(s):	UL 61010-1 Issue:2012/05/11 Ed:3 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements and CSA C22.2#61010-1 Issue:2012/05/11 Ed:3 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use Part 1: General Requirements
Product:	Desktop high voltage power supply
Models:	SHQ 122; SHQ 124; SHQ 126; SHQ 222; SHQ 224; SHQ 226

