High Voltage Power Supply
SHQ HIGH PRECISION series
with RS232 Interface

Operator Manual

Contents:

WARNING!

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

-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.

Notice

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.

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1. General information

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

2. Technical Data

TECHNICAL DATA	HIGH PRECISION		
Single channel HV Power Supply	SHQ 122	SHQ 124	SHQ 126
Dual channel HV Power Supply	SHQ 222	SHQ 224	SHQ 226
Output voltage $V_{O\ nom}$	2 kV	4 kV	6 kV
Output current $I_{O\ nom}$	6 mA	3 mA	1 mA
Ripple and noise	typ.: < 2 mV_{P-P} max.: 5 mV_{P-P}		
Stability: $\Delta V_O / \Delta V_{INPUT}$	$< 3 * 10^{-5}$ (after a warm-up period of 30 min)		
ΔV_O (no load/ load)	$< 5 * 10^{-5}$ (after a warm-up period of 30 min)		
Temperature coefficient	$< 3 * 10^{-5}/_K$		
Voltage measurement resolution ADC:	100 mV / 6-digit LCD display (Option **VHR**: **10 mV** for SHQ x22 and x24 **only**)		
Voltage measurement accuracy:	$\pm$ (0,05% V_O + 0,02% $V_{O\ nom}$) for one year		
Voltage settings manual / DAC:	10-turn potentiometer / digital via serial interface		
Voltage settings resolution DAC:	100 mV / Option **VHR**: **SHQ x22M** with **30 mV**; **SHQ x24M** with **80 mV**		
Current measurement resolution ADC:	2 ranges / 6-digit LCD display		
	Range mA: $I_{O\ nom} \geq I_O \geq 100\ \mu A$, Resolution: 100 nA Option **0n1**: $I_{O\ nom} \geq I_O \geq 10\ \mu A$, Resolution: 100 nA Accuracy: $\pm$ (0,1% I_O + 0,02% $I_{O\ nom}$)		
	Range µA: $100\ \mu A > I_O > 20$ nA, Resolution:: 1 nA Accuracy: $\pm$ (0,1% I_O + 20 nA)		
	Option **0n1**: $10\ \mu A > I_O > 2$ nA, Resolution: 100 pA Accuracy: $\pm$ (0,1% I_O + 2 nA)		
Value scope	data are guaranteed in the range of (1% $* V_{O\ nom}$) < V_O < $V_{O\ nom}$ for one year		
Rate of change of output voltage	fixed: 500 $^V/_s$ (at HV-ON/OFF) variable: 2 ... 255 $^V/_s$ (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 $\mathbf{I_{SET}}$) -INHIBIT (external signal, TTL-level, LOW = active) -programmable current trip (software)		
Interface	RS 232-Interface (Option **CAN**: CAN-Interface ⇒ SHQ x**4**x)		
Line voltage AC (V_{INPUT})	230 V_{AC} $^{+10\%}/_{-15\%}$ (Option **ACW** **)1**: 95 V_{AC} . . . 265 V_{AC})		

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Connectors	HV output:	SHV-Connector
	INHIBIT:	1-pin Lemo-hub
	RS 232 (opt. CAN):	9-pin female D-Sub connector

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TECHNICAL DATA	HIGH PRECISION		
Single channel HV Power Supply	SHQ 122	SHQ 124	SHQ 126
Dual channel HV Power Supply	SHQ 222	SHQ 224	SHQ 226
Desk case	Size (W/H/D) : (236/100/320) mm		
Temperature ranges	Operating: 0 ... +50 °C	Storage: -20 ... +60 °C	

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

)1 Option **ACW:** After powering up the device at a AC line voltage from 110 V-AC ± 10% there is a 10 s delay until operational availability!

3. SHQ Description

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

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 in 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 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 impacts the output voltage according to the setup. In addition this allows the detection of short over currents due to single flashovers.

Digital control unit

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

Filter

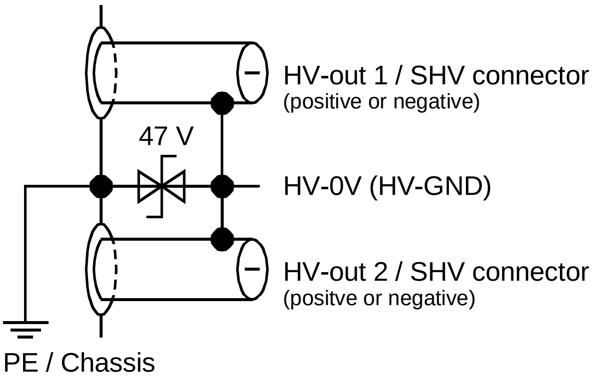
A special feature of the unit is a tuned filtering concept, which prevents perturbation of the unit by external electromagnetic radiation, as well as the emittance of interferences by the module. A filtering network for the supply voltages is located next to their connectors, the converter circuits of the individual channels are protected by additional filters. The high-voltage filters are housed in individual metal enclosures to shield even minimal interference radiation.

Floating HV-outputs

The 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.



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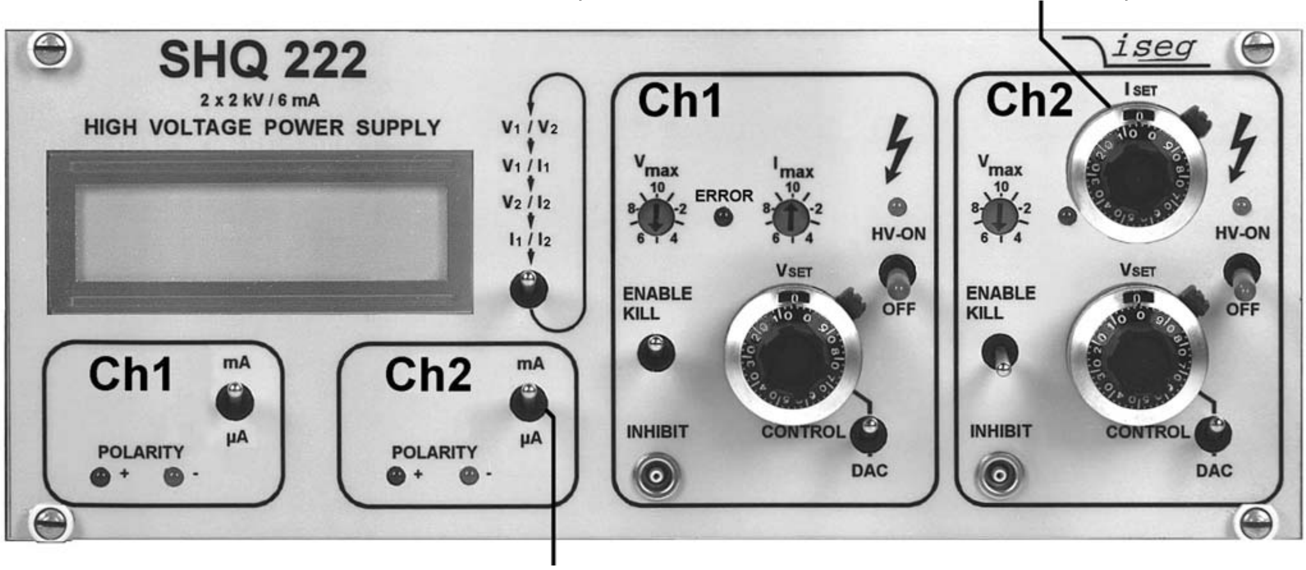
4. Front panel

Option IWP: Hardware current limit with 10-turn potentiometer



Current measurement range selection

Channel 1 shows the panel for the SHQ module in the standard version. With option IWP ″Hardware current limit setting with 10-turn potentiometer″ the panels for both channels would be of the version as shown on the panel for Channel 2.

5. Operation

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.

Option ACW: After powering up the device at a AC line voltage from 110 V-AC ± 10% there is a 10 s delay until operational availability!

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.

WARNING! It is not allowed to change the polarity under power!

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

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

WARNING! If the CONTROL switch is in upper position (manual control), high voltage is generated at the HV-output on the rear side, started with a ramp speed from 500 V/s (hardware ramp) to the set voltage chosen via the 10-turn potentiometer.
This is also the same, if the unit is switched from interface control via RS232 to manual control.

If the CONTROL switch is in lower position (DAC), high voltage will be activated only after receiving corresponding RS232 commands.

WARNING! If the function ″Autostart″ has been activated in the previous operating session, the high voltage generation starts immediately with the saved parameters.

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 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}.

In the manual control mode the output voltage can be set via 10-turn potentiometer [7] in a range from 0 to the maximum voltage.

If the CONTROL switch is switched over to remote control, the DAC takes over the last set output voltage of the manual control. The output voltage can be changed remotely with a programmable ramp speed (software ramp) from 2 to 255 V/s in a range from 0 to the maximum voltage.

The maximum output current for each channel (current trip) can be set via the remote interface in units of the resolution of the selected measurement range. If the output current exceeds the programmable limit, the output voltage will be shut off permanently by the software. A recovery of the voltage is possible after ″Read status word″ and then ″Start voltage change″ via serial interface. If ″Auto start″ is active, ″Start voltage change″ is not necessary.

The maximum output current can be selected independently of programmable current trip
- in 10%-steps with the rotary switches I_{max} (switch dialed to 10 corresponds to 100%) or
- optionally with the 10-turn potentiometer I_{SET}.

The current limit values 100% I_{max} or I_{SET}, respectively, always correspond to the maximum output current in the selected measurement range, determined by the switch „Current measurement range selection". If the output current exceeds the limit, is this signaled by the red error LED on the front panel.

The switch „Current measurement range selection" thus determines the possible maximum current, the resolution of the current measurement and the range for the hardware current limit.

If this switch is on the position "mA", the measurement range will change automatically if the output current falls below or exceeds the switching threshold. The range for the hardware current limit remains being relative to the nominal output current. Also, the programmable current trip for this range, set by the command „LBn" always remains valid.

If this switch is on the position "µA", the programmable current trip set by the command „LSn" is valid.

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

Switch to the upper position: (ENABLE KILL)	When exceeding V_{max}, I_{max} / I_{SET} or in the presence of an INHIBIT signal (Low=active) the output voltage will be shut off permanently without ramp. The output voltage is only restored after switching HV-ON or KILL or ″Read status word″ and then ″Start voltage change″ by DAC control. If ″Auto start″ is active, ″Start voltage change″ is not necessary.
Note:	If a capacitance is effective at the HV-output or when using a high voltage ramp speed (hardware ramp) under high loads, then the KILL function may be triggered by the capacitor charging currents. In this case smaller output voltage change rates (software ramp) should be used or ENABLE KILL should only be selected once the set voltage is reached at the output.
Switch to the lower position: (DISABLE KILL)	The output voltage is limited to V_{max}, the output current to I_{max} / I_{SET} respectively; INHIBIT shuts the output voltage off without ramp, the previous voltage setting will be restored with hard- or software ramp once INHIBIT no longer being present.

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6. 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.

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 is included to allow the computer to receive and evaluate the incoming data. The default delay 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 to be bridged on the PC side when a three lead cable is used, are also given in table 1.

Table 1:

Signal pin assignment

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

Syntax

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

Command set

Command	Computer	HV-supply
Read module identifier	# *	# * nnnnnn ; n.nn ; U ; I * (unit number ; software rel. ; $V_{out\ max}$; $I_{out\ max}$)
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 * { polarity / 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 $V_{out\ max}$)
Read current limit channel 1	N1 *	N1 * nnn * (in % of $I_{out\ max}$)
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 cannel 1	L1=nnnnn *	L1=nnnnn * * (trip corresponding resolution range mA > 0)
Range “mA”	LB1=nnnnn *	LB1=nnnnn * * (trip corresponding resolution range mA > 0)
Range “µA”	LS1=nnnnn *	LS1=nnnnn * * (trip corresponding resolution range µA > 0)
Read current trip cannel 1	L1 *	L1=nnnnn * * (see above, for nnnnn=0 ⇒ no current trip)
Range “mA”	LB1 *	LB1=nnnnn * * (see above, for nnnnn=0 ⇒ no current trip)
Range “µA”	LS1 *	LS1=nnnnn * * (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:

xxx:
- ON<SP> 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

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

Auto start:

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. 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″.		3=1	8
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)

Software

Contact us for an overview on our user friendly control and data acquisition software!

7. Program example

```
/*****************************************************************************************************************/
/*                                                                                                                */
/*          shq.cpp                                                                                               */
/*                                                                                                                */
/*          example program for iseg shq hv power supply, written by Jens Römer, 27.2.97  */
/*                                                                                                                */
/*          this code was compiled under BC, please contact iseg for the source file                              */
/*                                                                                                                */
/*****************************************************************************************************************/

#include <dos.h>
#include <stdio.h>
#include <conio.h>
#include <stdlib.h>
#include "int14.h"                                        // COM2 handling

const       etx= 0x03;
const       f = 0x0a;
const       cr = 0x0d;
unsigned    char readU[]={'U','1',cr,lf,etx};             //read voltage
unsigned    char sendU[]={'D','1','=','1','0',cr,lf,etx}; //set voltage to 10V
unsigned    char *ptr;
unsigned    char rby;
int         i, cnt;
boolean     ok;

void main(void)
{
      clrscr();
      COM2_init();
      COM2_set(9600);                                     // COM2:     9600 baud, 8 databits, no parity, 1 stopbit
      ok=True_;
      ptr=readU;
      for (;;)
      {
            if (*ptr==etx) break;
            COM2_send(*ptr);                              //send one byte
            rby=COM2_read();                              //read one byte
            if (rby!=*(ptr++)) ok=False_;                 //compare sent with read data
            else switch (rby)
            {
                  case lf : printf("%c",lf); break;
                  case cr : printf("%c",cr); break;
                  default : printf("%c",rby); break;
            }
            if (ok==False_)
            {
                  printf("No coincident read data found!");
                  exit(1);
            }
      }
      cnt=8;
      do
      {
            rby=COM2_read();                                    //read voltage data
            switch (rby)
            {
                  case lf : printf("%c",lf); break;
                  case cr : printf("%c",cr); break;
                  default : printf("%c",rby); break;
            }
            cnt--;
      } while (cnt>=1);
}
```


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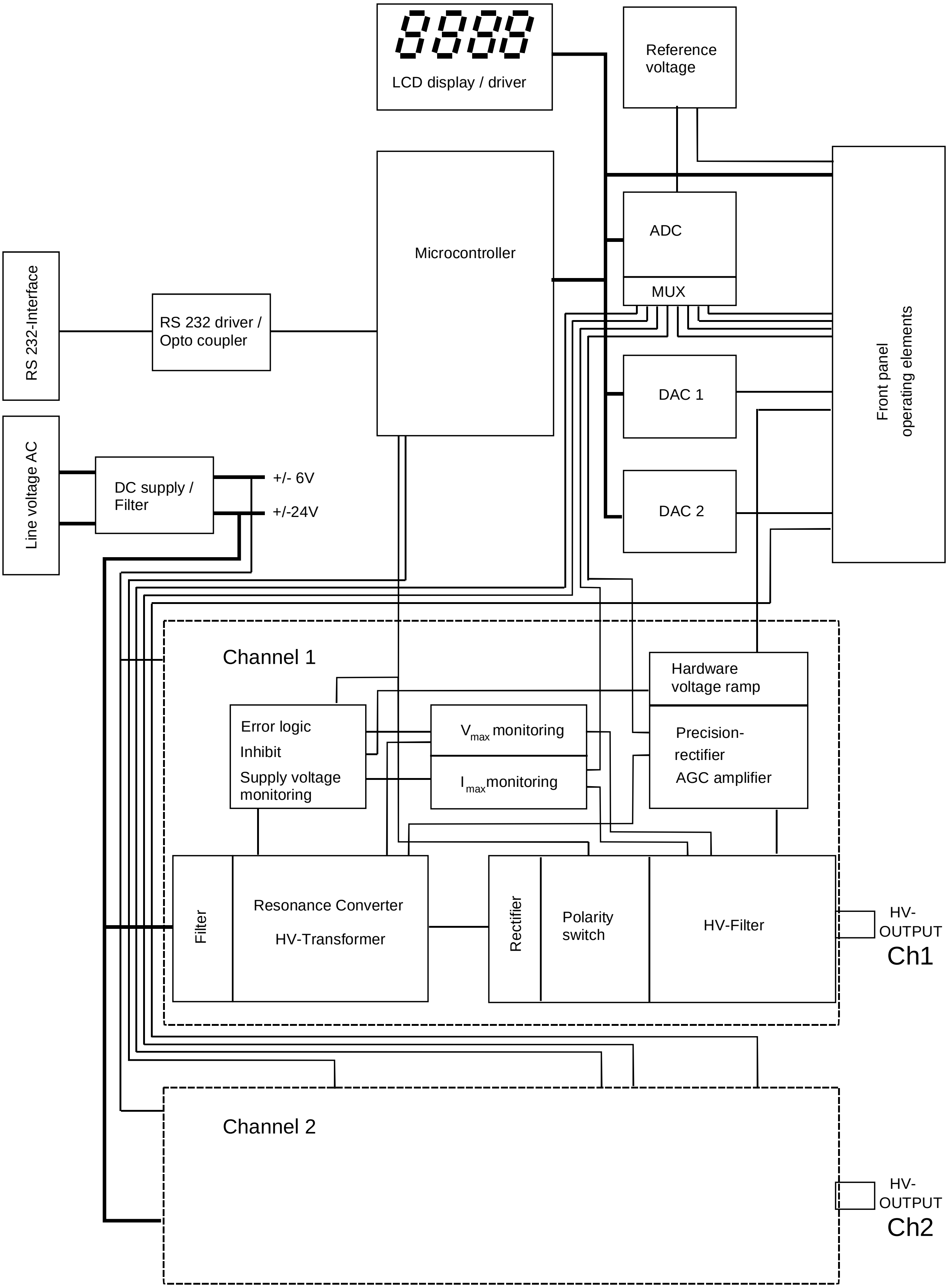

Appendix A: Block diagram SHQ