

Precision NIM High Voltage Supply NHQ STANDARD series

Operators Manual

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Attention!

- The unit shall not be operated with the cover removed.
- We decline all responsibility for damages and injuries caused by an improper use of the module. It is highly recommended to read the operators manual before any kind of operation.

Note

The information in this manual is subject to change without notice. We take no responsibility whatsoever 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 NHQ's are one or two channel high voltage supplies in a NIM chassis, one slot wide. The units offers manual control and operation via RS232 interface (option: CAN Bus interface instead RS232). The use of the interface supports more then the manual control functionality.

The high voltage supplies special provide high precision output voltage together with very low ripple and noise, even under full load. Separate 10%-steps hardware switches put voltage and current limits. An INHIBIT input protects connected sensitive devices. Additionally, the maximal output current per channel is programmable via the interface. The high voltage outputs protected against overload and short circuit. The output polarity can be switched over.

2. Technical Data

NHQ - one channel - two channel	102M	103M	104M	105M	106L
	202M	203M	204M	205M	206L
Output voltage V_{out}	0 .. 2 kV	0 ... 3 kV	0 ... 4 kV	0 ... 5 kV	0 ... 6 kV
Output current I_{out}	0 ... 6 mA	0 ... 4 mA	0 ... 3 mA	0 ... 2 mA	0 ... 1 mA
Ripple	typ.	< 0,5 mV _{SS}	< 0,5 mV _{SS}	< 1 mV _{SS}	< 2 mV _{SS}
	max.	2 mV _{SS}	2 mV _{SS}	2 mV _{SS}	5 mV _{SS}
LCD Display	4 digits with sign, switch controlled -voltage display in [V], -current display in [µA]				
Resolution of voltage measurement	1 V				
Resolution of current measurement	1 µA, optional 100 nA at $I_{out\ max} \leq 100\ \mu A$				
Accuracy	voltage	$\pm (0,05\% V_{out} + 0,02\% V_{out\ max} + 1\ \text{digit})$ for one year			
	current	$\pm (0,05\% I_{out} + 0,02\% I_{out\ max} + 1\ \text{digit})$ for one year			
Stability	$\Delta U_{out} / U_{INPUT}$	< 5×10^{-5}			
	ΔU_{out}	< 5×10^{-5} (idle to max. load)			
Temperature coefficient	< $5 \times 10^{-5}/K$				
Voltage control	CONTROL switch in: upper position - manual: 10-turn potentiometer, lower position - DAC: control via RS 232 (opt. CAN)				
Rate of change of output voltage	- HV -ON/OFF (hardware ramp):		500 V/s		
	- control via interface (software ramp):		2 - 255 V/s		
Protection	<ul style="list-style-type: none"> - separate current and voltage limit (hardware, rotary switch in 10%-steps), - INHIBIT (external signal, TTL-level, Low=active), - programmable current limit (software) 				
Power requirements V_{INPUT}	<ul style="list-style-type: none"> $\pm 24\ V$ (< 800 mA, one channel < 400 mA), $\pm 6\ V$ (< 100 mA), optional only $\pm 24\ V$ 				
Operating temperature	0 ... 50 °C				
Storage temperature	-20 ... +60 °C				
Packing	NIM Standard chassis: NIM 1/12				
Connector	NIM: 5-pin connector; RS 232: 9 pin female D-Sub connector				
HV connector	SHV-Connector on the flip side				
INHIBIT connector	1-pin Lemo-hub				

3. NHQ Description

The function is described at a block diagram of the NHQ. This can be found in Appendix A.

High voltage supply

A patented high efficiency resonance converter circuit, which provides a low harmonic sine voltage on the HV-transformer, is used to generate the high voltage. The high voltage is rectified using a high speed HV-rectifier, and the polarity is selected via a high-voltage switch. A 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 the set value of the output voltage, an additional voltage divider supplies the measuring signal for the maximum voltage control. A precision measuring and AGC amplifier compares the actual output voltage with the set value given by the DAC (computer 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. It allows the detection of short over-current due to single flashovers in addition.

Digital control unit

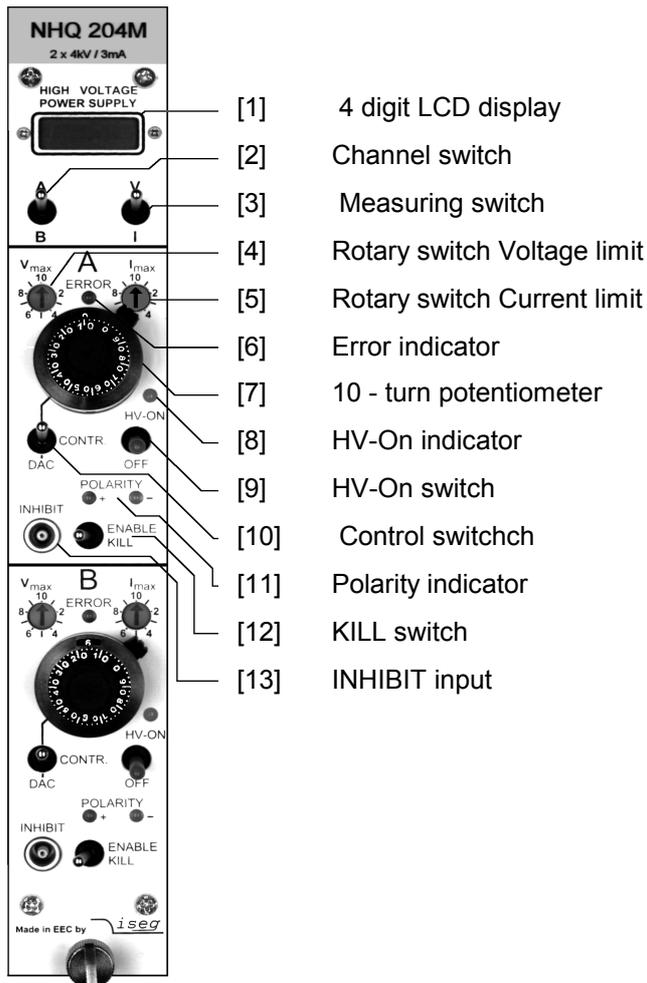
A micro controller handles the internal control, evaluation and calibration functions of both channels. The actual voltages and currents are read cyclically by an ADC with connected multiplexer and processed for display on the 4 digit LCD display. The current and voltage hardware limits are retrieved cyclically several times per second. The reference voltage source provides a precise voltage reference for the ADC and generation of the control signals in the manual operation mode of the unit.

The set values for the corresponding channels are generated by a 16-Bit DAC in computer controlled mode.

Filter

A special property of the unit is a tuned filtering concept, which prevents radiation of electromagnetic interference into the unit, as well as the emittance of interference by the module. A filtering network is located next to the connectors for the supply voltage and the converter circuits of the individual devices are also protected by filters. The high-voltage filters are housed in individual metal enclosures to shield even minimum interference radiation.

4. Front panel



5. Handling

The state of readiness of the unit is produced at the NIM connector, the 9 pin female D-Sub connector and the HV-output on the flipside.

The Output polarity is selectable with help of a rotary switch on the cover side (see appendix B). The chosen polarity is displayed by a LED on the front panel [11] and a sign on the LCD display [1].

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

An undefined switch setting (not at one of the end positions) will cause no output voltage.

High voltage output is switched on with HV-ON switch [9] at the front panel. The viability is signalled by the yellow LED [8].

Attention! If the CONTROL switch [10] is in upper position (manual control), high voltage is generated at HV-output on the flip side with a ramp speed from 500 V/s (hardware ramp) to the set voltage chosen via 10-turn potentiometer [7]. This is also the case, if RS232 control is switched over to manual control while operating.

If the CONTROL switch [10] is in lower position (DAC), high voltage will be activated only after receiving corresponding RS232 commands.

Attention! If at the last working of the unit activated the function "Autostart", the high voltage will be generated with the saved parameters immediately!

On the LCD [1] output voltage in [V] or output current in [μ A] will be displayed depending on the position of the Measuring switch [3].

For the two channel units, one can choose with Channel switch [2], if channel (A) or channel (B) is displayed.

If working with manual control, output voltage can be set via 10-turn potentiometer [7] in a range from 0 to the set maximal voltage.

If the CONTROL switch [10] is switched over to RS232 control, the DAC takes over the last set output voltage of manual control. Output voltage can be generated with a programmable ramp speed (software ramp) from 2 to 255 V/s in a range from 0 to the maximal set voltage via RS232 control.

The maximum output current per channel can be set with a programmable current trip via the interface with the resolution of current measurement. If the output current exceeds the programmable limit, the output voltage will be shut off permanently by the software. Restoring 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.

Maximum output voltage and current can be selected in 10%-steps with the rotary switches V_{max} [4] and I_{max} [5] (switch dialed to 10 corresponds to 100%) independently of programmable current trip. The output voltage or current which exceed the limits is signalled by the red error LED on the front panel [6].

Function of KILL switch [12]:

Switch to the right position: (ENABLE KILL) The output voltage will be shut off permanently without ramp on exceeding V_{max} , I_{max} or in the presence of an INHIBIT signal (Low=active) at the INHIBIT input [13]. Restoring the output voltage is possible after operating the switches HV-ON [9] or KILL [12] or "Read status word" and then "Start voltage change" by DAC control. If "Auto start" is active, "Start voltage change" is not necessary.

Note: When capacitance is effective at the HV-output or when the rate of change of output voltage is high (hardware ramp) at high load, then the KILL function will be released by the current charging the condenser. In this case use a small rate of output change (software ramp) or select ENABLE KILL not until output voltage is set voltage.

Switch to the left position: (DISABLE KILL) The output voltage will be limited to V_{max} , output current to I_{max} respectively; INHIBIT shuts the output voltage off without ramp, the previous voltage setting will be restored with hard- or software ramp on INHIBIT no longer being present.

6. RS232 interface

The most important parameters of the high voltage supply can be set and read under computer control via the RS232 interface.

RS232 control mode

1st Write function: set voltage; ramp speed; maximal output current (current trip); auto start
2nd Switch function: output voltage = set voltage, output voltage = 0
3rd 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 are having 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, synchronization between the computer and the supply (input) is performed using echo. The data transfer to the computer (output) is asynchronous, breaks between two characters, programmable of the break time, allow the computer to receive and evaluate the incoming data. Break time is setting 3 ms at works.

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 given in table 1 also.

Table 1:

Signal pin assignment

Signal RS 232	HV-supply		PC DSUB9	PC DSUB25	Connection 3-lead cable
	DSUB9	Int.			
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. The end of command is formed 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 ; softwarerel. ; V _{out} [V] ; I _{out} [μA])
Read break time	W *	W * nnn * (break time 0 ... 255 ms)
Write break time	W=nnn *	W=nnn ** (break time = 0 - 255 ms)
Read actual voltage channel 1	U1 *	U1 * {polarity / voltage} * (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 * {voltage} * (in V)
Write set voltage channel 1	D1=nnnn *	D1=nnnn ** (voltage 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 channel 1	L1=nnnn *	L1=nnnn ** (corresponding resolution current > 0)
Read current trip channel 1	L1 *	L1 * nnnn * (s.a., for nnnn=0 ⇒ no current trip)
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 * n * (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 falling
	LAS	Look at Status (only after G-command)
	TRP	Current trip was active

If output voltage shut off permanently (by ERR or INH at ENABLE KILL or TRP) you must do "Read status word" before the output voltage restoring is possible.

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 aktive	5=1	32	
		inaktive		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	
T1:	U/I	Display dialed to	voltage measurement	0=1	1
			current measurement		0
T2:	A/B	Channel dialed to	channel A	0=1	1
			channel B		0

Auto start:

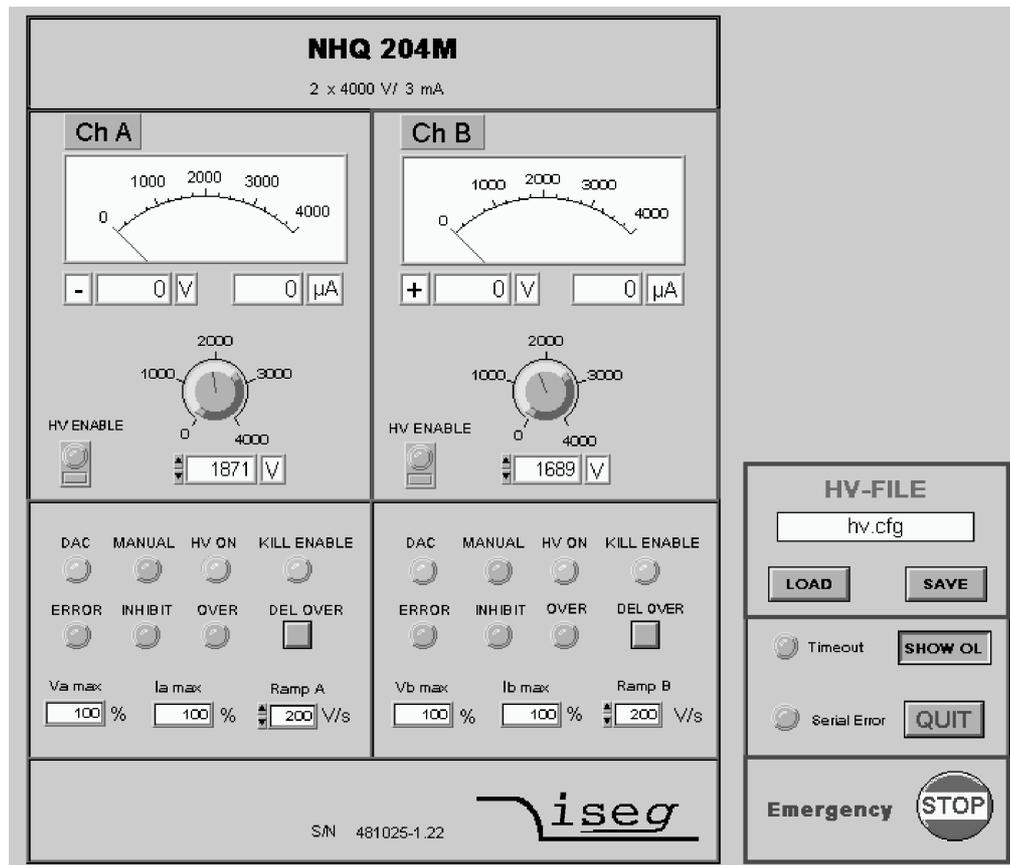
Description		Bit	Valency
If module status OFF + ERR + INH + MAN = 0, output voltage of the channel ramping at set voltage. G-command is not necessary after D-command, POWER-ON and OFF ⇒ ON. If output voltage shut off permanently (by ERR or INH at ENABLE KILL or TRP), the previous voltage setting will be restored with software ramp after "Read status word".		3=1	8
Values loading in corresponding registers at POWER-ON!	Current trip saving in EEPROM	2=1	4
	Set voltage saving in EEPROM	1=1	2
	Ramp speed saving in EEPROM	0=1	1

(EEPROM guarantee 1 million saving cycles)

Software

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

As an example remote control and monitoring via PC are possible by the LabVIEW program ISEGLABV. In this program a VI (virtual instrument) is provided for easy setting of parameters by simple mouse click. The VI allows remote control and monitoring by a graphic surface (see picture) - own programming is unnecessary.



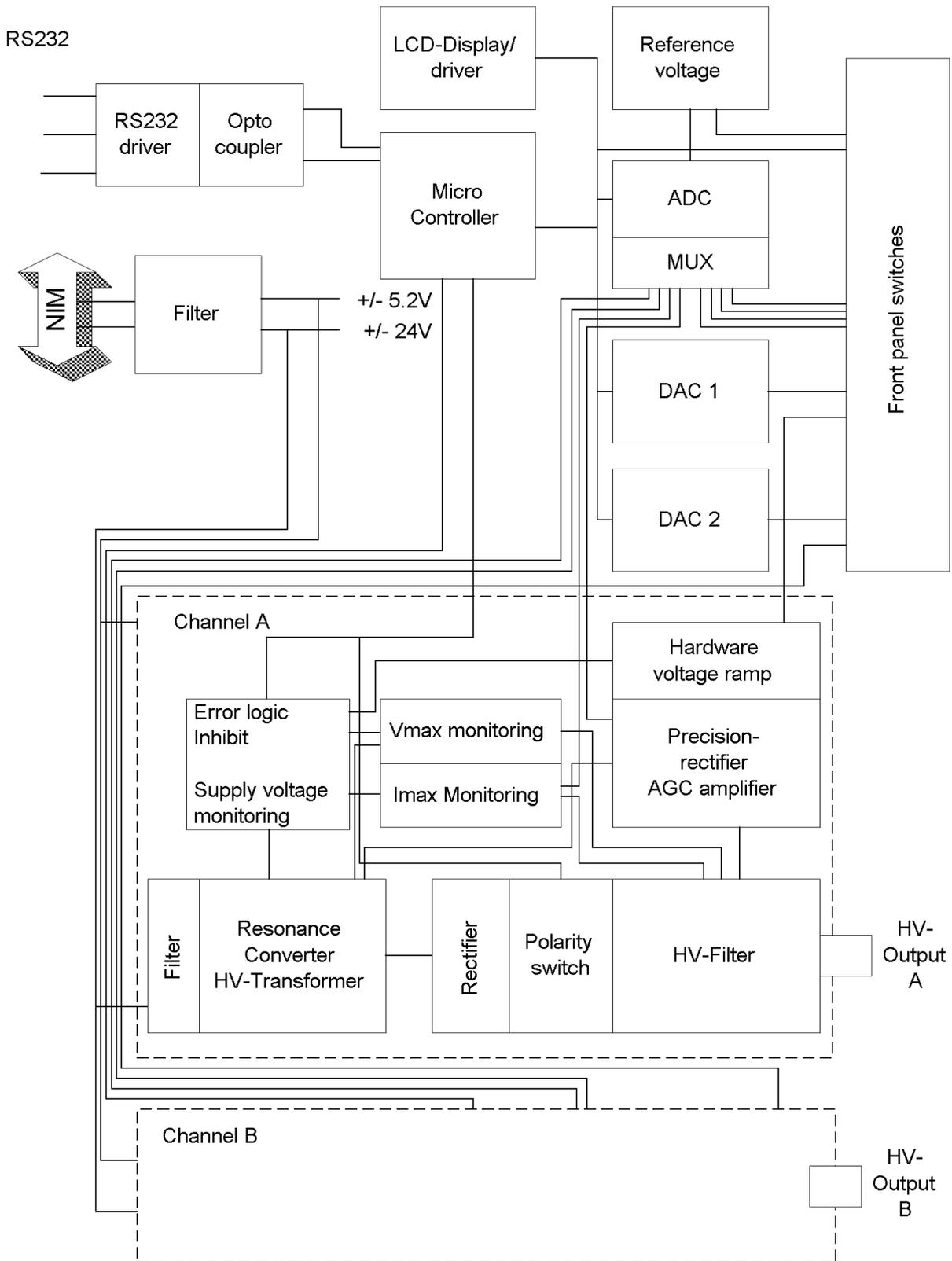
7. Program example

```
/*
*****/
/*
nhq.cpp
*/
/*
example program for FAST nhq hv boards, written by Jens Römer, 27.2.97
*/
/*
this code was compiled under BC, please contact FAST for the source file
*/
/*
*****/

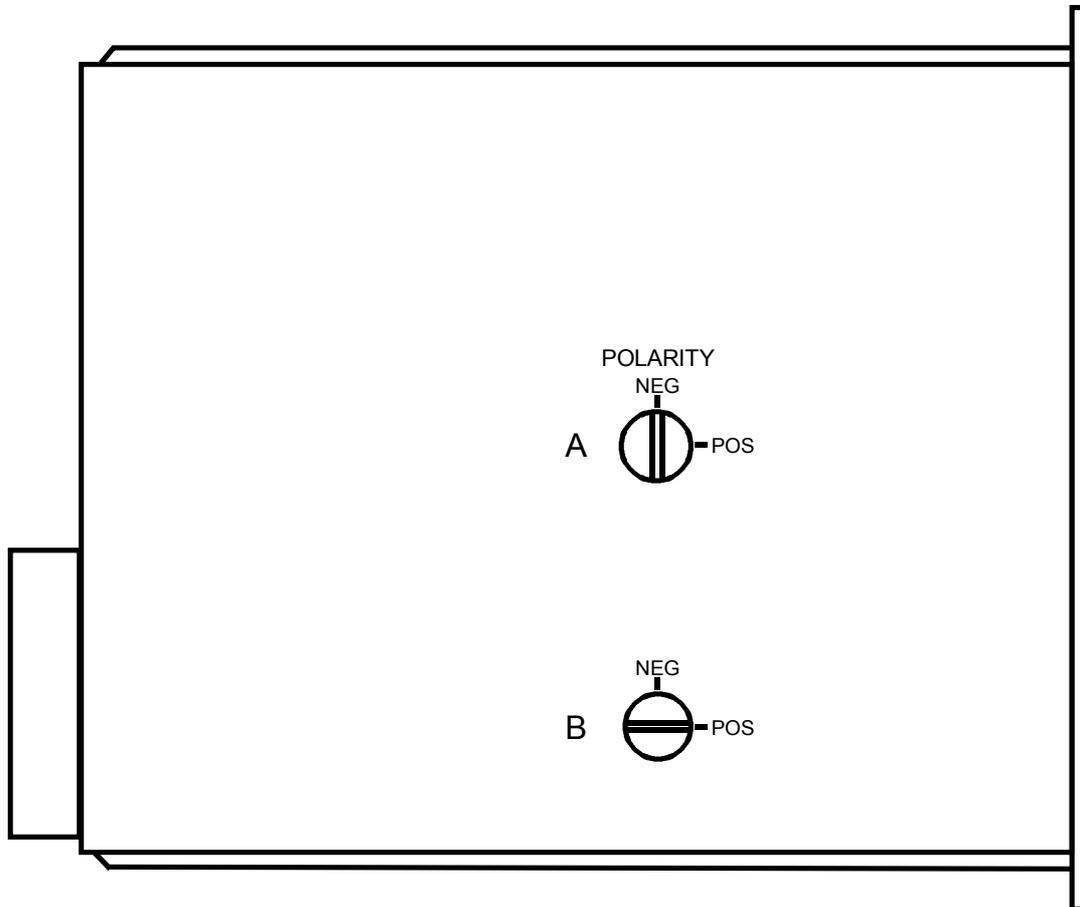
#include <dos.h>
#include <stdio.h>
#include <conio.h>
#include <stdlib.h>
#include "int14.h" // COM2 handling

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);
}
```



Appendix A: Block diagram NHQ

**Appendix B:**

NHQ side cover,

Polarity rotary switch

eg.:

channel A, polarity negative
channel B, polarity positive