Spezialelektronik GmbH

# Precision High Voltage Sources in 3U Eurocard Format

# Operators Manual

## Contents:




## 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 EHQ´s are one channel high voltage supplies in a 3U Eurocard Chassis, 8TE 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 is programmable via the interface. The high voltage output protected against overload and short circuit. The output polarity can be switched over.

## 2. Technical data

| **Type (with RS 232)** | | **EHQ 102M** | **EHQ 103M** | **EHQ 104M** | **EHQ 105M** |
|---|---|---|---|---|---|
| Output voltage $V_O$ | | 0 ... 2 kV | 0 ... 3 kV | 0 ... 4 kV | 0 ... 5 kV |
| Output current $I_{O\,24}$ | | 0 ... 6 mA | 0 ... 4 mA | 0 ... 3 mA | 0 ... 2 mA |
| Ripple and noise | | < 2 $mV_{P\text{-}P}$ | | | < 5 $mV_{P\text{-}P}$ |
| Resolution of current measurement | | 1 µA; Option 0n1: $I_{O\,max}$ = 100 µA ⇒ 100 nA | | | |
| Resolution of voltage measurement | | 1 V | | | |
| Accuracy | current measurement | ± (0,05% $I_O$ + 0,02% $I_{O\,max}$ + 1 digit) for one year | | | |
| | voltage measurement | ± (0,05% $V_O$ + 0,02% $V_{O\,max}$ + 1 digit) for one year | | | |
| LCD display | | 4 digits with sign, switch controlled<br>- voltage display in [V]<br>- current display in [µA] | | | |
| Stability | $\Delta V_O$ (no load / load) | $< 5 \ast 10^{-5}$ | | | |
| | $\Delta V_O/V_{INPUT}$ | $< 5 \ast 10^{-5}$ | | | |
| Temperature coefficient | | $< 5 \ast 10^{-5}$/K | | | |
| Voltage control | | CONTROL switch in position<br>-manual: 10-turn potentiometer,<br>-DAC: control via serial interface | | | |
| Rate of change of output voltage | HV -ON/OFF | 500 V/s (hardware ramp) | | | |
| | remote control | 2 ... 255 V/s (software ramp) | | | |
| Protection | | -separate current and voltage limit (hardware, rotary switch in10%-steps)<br>-INHIBIT (external signal, TTL level, Low=active)<br>-programmable current limit (software) | | | |
| Power requirement $V_{INPUT}$ | | ± 24 V (< 500 mA), **Option:** ± 12 V ⇒ $I_{O\,12} = I_{O\,24}/2$ | | | |
| Operating temperature | | 0 . . . 50 °C | | | |
| Storage temperature | | -20 . . . +60 °C | | | |
| Packing | | 3U Euro cassette / 160 mm depth / 40,8 mm wide | | | |
| Connector | | 96-pin connector according to DIN 41612 | | | |
| HV connector | | SHV-Connector at the front panel | | | |
| Inhibit connector | | 1-pin Lemo-hub | | | |

## 3. EHQ Description

The function is described at a block diagram of the EHQ. 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 overcurrent due to single flashovers in addition.

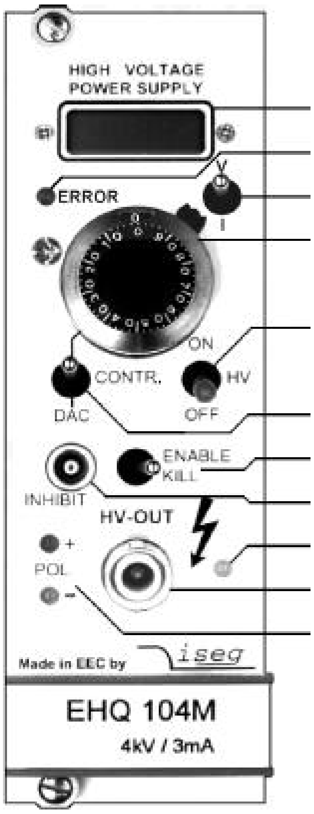
### Digital control unit

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




[1] 4 digit LCD display
[2] Error indicator
[3] Measuring switch
[4] 10-turn potentiometer
[5] HV-ON switch
[6] CONTROL switch
[7] KILL switch
[8] INHIBIT input
[9] HV-ON indicator
[10] HV output
[11] Polarity indicator

## 5. Handling

The state of readiness of the unit is produced at the 96-pin connector according to DIN 41612 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 [5] at the front panel. The viability is signalled by the yellow LED [9].

**Attention!** If the CONTROL switch [6] is in upper position (manual control), high voltage is generated at HV-output [10] with a ramp speed from 500 V/s (hardware ramp) to the set voltage chosen via 10-turn potentiometer [4].
This is also the case, if RS232 control is switched over to manual control while operating.

If the CONTROL switch [6] 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 [µA] will be displayed depending on the position of the Measuring switch [3].

If working with manual control, output voltage can be set via 10-turn potentiometer [4] in a range from 0 to the set maximal voltage.

If the CONTROL switch [6] 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 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 $V_{max}$ and $I_{max}$ (switch dialled to 10 corresponds to 100%) on the cover side (see appendix B) 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 [2].

Function of KILL switch [7]:

| | |
|---|---|
| Switch to the right position:<br>(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 [8]. Restoring the output voltage is possible after operating the switches HV-ON [5] or KILL [7] 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:<br>(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;<br>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.

## Pin assignment 96-pin connector on the flip side

| | |
|---|---|
| A3 B3 C3 | +24V |
| A5 B5 C5 | GND |
| A7 B7 C7 | -24V |

| | | |
|---|---|---|
| A9 | @GND | potential free |
| B9 | @RXD | |
| C9 | @TXD | |

## Specification RS232 interface

The data exchange is character based, synchronisation 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 pin assignment when a PC is used 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 | PC DSUB9 | PC DSUB25 | Connection 3-lead cable |
|---|---|---|---|
| RxD | 2 | 3 | |
| TxD | 3 | 2 | |
| GND | 5 | 7 | |
| | 4 | 20 | |
| | 6 | 6 | |
| | 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 *<br>(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 cannel 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>

## 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.

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## 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 |
| T1: U/I | Display dialled to | voltage measurement | 0=1 | 1 |
| | | current measurement | | 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.<br>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!

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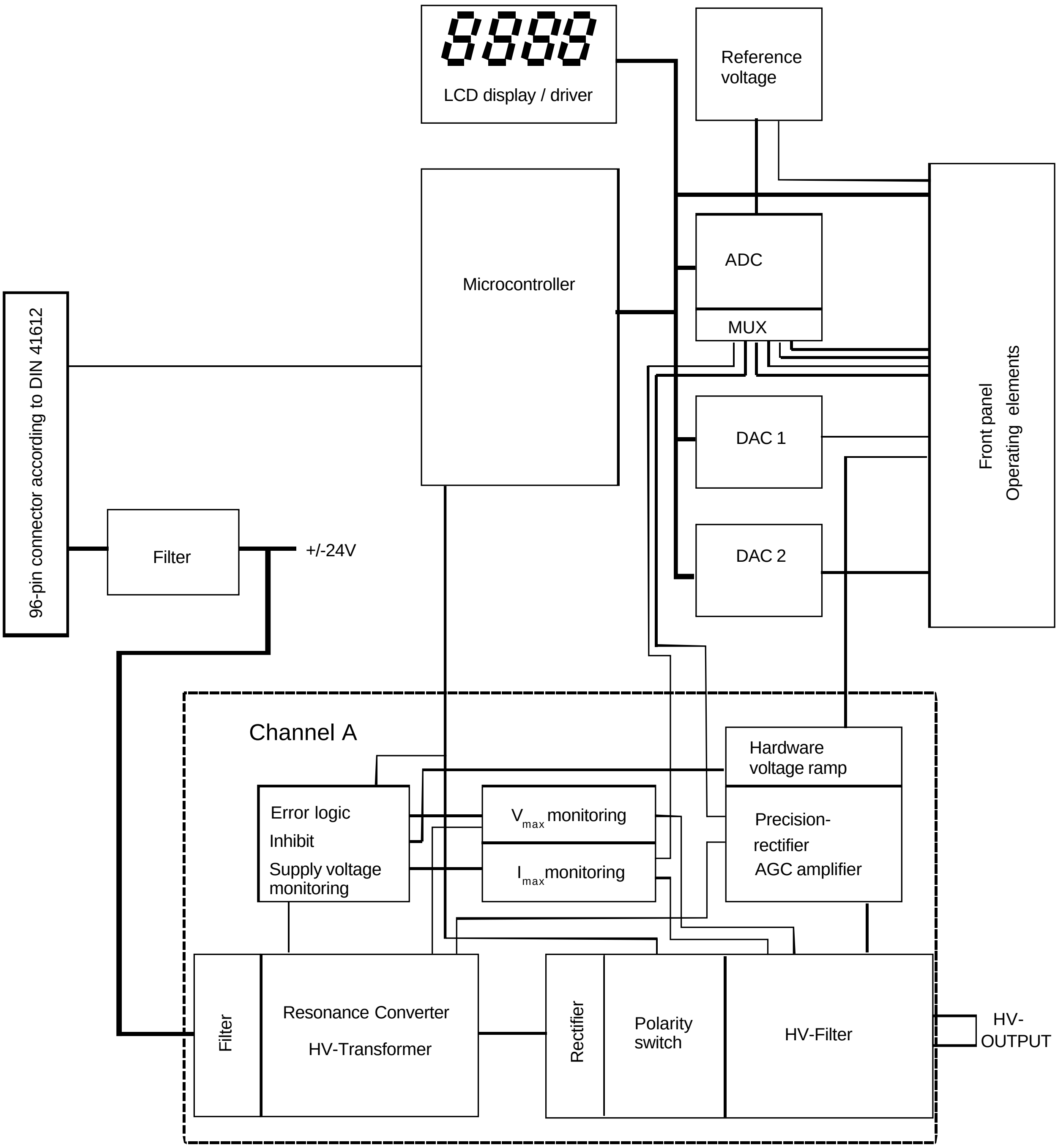
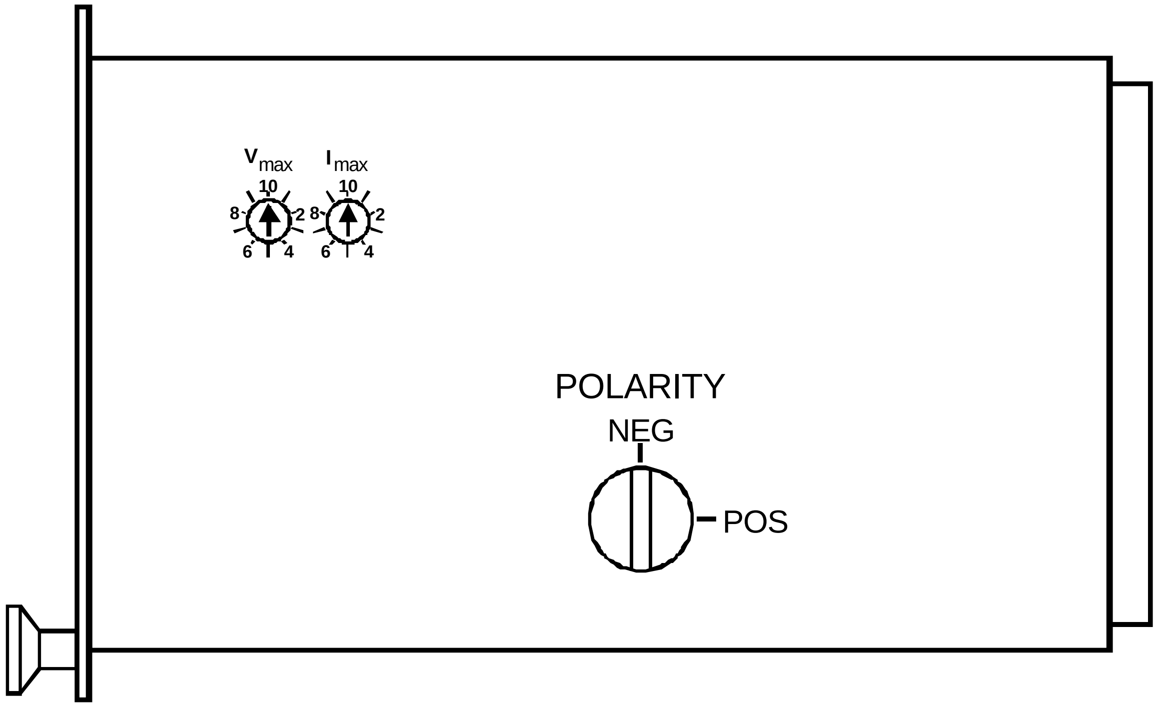
# 7. Program example

```
/*************************************************************************************************/
/*                                                                                               */
/*        ehq.cpp                                                                                */
/*                                                                                               */
/*        example program for iseg ehq hv boards, 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);
}
```




Appendix A: Block diagram EHQ




Appendix B: EHQ side cover

Polarity rotary switch (e.g.: polarity negative)
Rotary switches for $V_{max}$ and $I_{max}$