Spezialelektronik GmbH

Precision NIM High Voltage Supply
NHQ STANDARD series with CAN-Interface
Operators Manual

Contents:

Attention!

-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 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 NHQX3X is a one or two channel high voltage PS in NIM, one slot wide. The unit offers manual control and remote control via CAN-bus-interface (specification 2.0A). During remote control the unit is offering some more functionality than during manual control .
The high voltage supply provides high precision output voltage together with very low ripple and noise, even under full load. Separate 10%-steps hardware switches limit output voltage and output current. An INHIBIT input protects connected sensitive devices. Additionally, the maximum output current per channel is programmable via the interface. The high voltage outputs are protected against overload and short circuit. The output polarity can be switched.

2. Technical data

NHQ - one channel - two channel		**132M 232M**	**133M 233M**	**134M 234M**	**135M 235M**	**136L 236L**
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
		with option 104: max 100 µA				
Ripple and noise	typ.	< 0,5 mV_{pp}	< 0,5 mV_{pp}	< 1 mV_{pp}	< 2 mV_{pp}	< 2 mV_{pp}
	max.	2 mV_{pp}	2 mV_{pp}	2 mV_{pp}	5 mV_{pp}	5 mV_{pp}
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, with option 104: 100 nA at $I_{out\ max}$ ≤ 100 µA				
Accuracy	voltage	± (0,05% V_{out} + 0,02% $V_{out\ max}$ + 1 digit) for one year				
	current	± (0,05% I_{out} + 0,02% $I_{out\ max}$ + 1 digit) for one year				
Stability	$\Delta V_{out} / V_{INPUT}$	$< 5 * 10^{-5}$				
	ΔV_{out}	$< 5 * 10^{-5}$ (idle to max. load)				
Temperature coefficient		$< 5 * 10^{-5}$/K				
Voltage control		CONTROL switch in: upper position- manual: 10-turn potentiometer, lower position - DAC: control via CAN-interface				
Rate of change of		- HV -ON/OFF (hardware ramp): 500 V/s				
Output voltage		- control via interface (software ramp): 2 - 255 V/s				
Protection		- 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}		± 24 V (< 800 mA, one channel < 400 mA), ± 6 V (< 100 mA), with option N24: only ± 24 V				
Operating temperature		0 . . . 50 °C				
Storage temperature		-20 . . . +60 °C				
Packing		NIM Standard chassis: NIM 1/12				
Connector		NIM: 5-pin connector; CAN-interface: 9 pin female D-Sub connector				
HV connector		SHV-Connector on rear side				
INHIBIT connector		1-pin Lemo-hub				

3. NHQX3X general description

The function is described in a block diagram of the NHQ X3X. This is shown 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 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 provides 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 stabiliser circuit are derived from the result of the comparison. The two-stage layout of the control circuit results in an output voltage, stabilised 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 also allows the detection of short over-current due to single flash-over.

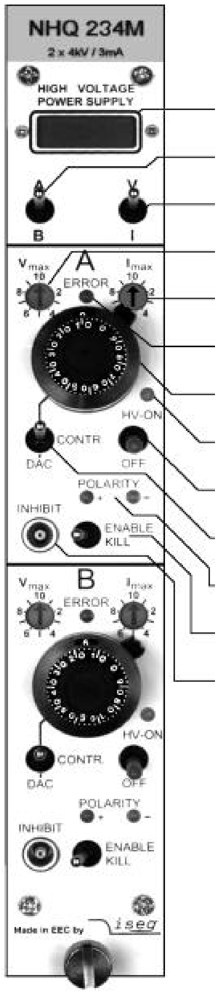
Digital control unit

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 generates the control signals during 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 radiant emitted interference of the module. A filtering network is located in serial to the connectors of 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] Channel switch
[3] Measuring switch
[4] Rotary switch Voltage limit
[5] Rotary switch Current limit
[6] Error indicator
[7] 10 - turn potentiometer
[8] HV-On indicator
[9] HV-On switch
[10] Control switch
[11] Polarity indicator
[12] KILL switch
[13] INHIBIT input

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 rear site.

The Output polarity is selectable with help of a rotary switch on the cover side (see appendix B). The chosen polarity is displayed by an 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 the HV-output on the rear side with a ramp speed of 500 V/s (hardware ramp) to the set voltage chosen via the 10-turn potentiometer [7].
This is also the case, if remote-control is switched over to manual control while operating.

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

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

The LCD [1] displays either the output voltage in [V] or the output current in [µA] depending on the position of the Measuring switch [3].

For the two channel units, the Channel switch [2] selects whether channel (A) or channel (B) is displayed.

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

If the CONTROL switch [10] has been switched over to DAC , the internal DAC is taking over the last set output voltage of manual control. Output voltage ramps with a programmable ramp speed (software ramp) from 2 to 255 V/s in a range of 0 to the maximum set voltage via remote-control.

The maximum output current per channel can be set with a programmable current trip via the interface with the possible resolution of the current measurement. If the output current exceeds the programmed limit, the output voltage will be shut off permanently by the software. Restoring the voltage is possible after "Read LAM-status" and then "Start voltage change" via interface. If "Auto start" is active, "Start voltage change" is not necessary.

Maximum output voltage and current can be selected in 10%-steps with help of the rotary switches V_{max} [4] and I_{max} [5] (switch position to 10 corresponds to 100%) independently of programmable current trip. The output voltage or current which exceeds 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 I_{max} or in the presence of an INHIBIT signal (Low active) at the INHIBIT input [13]. Restoring of the output voltage is possible after operating the switches HV-ON [9] or KILL [12] or "Read LAM-status" and then "Start voltage change" by DAC control. If "Auto start" is active, "Start voltage change" is not necessary.
Note:	If a capacitance is present at the HV-output or if 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 this capacitance. In this case use a small rate of output change (software ramp) or select ENABLE KILL not until output voltage is equal to set voltage.
Switch to the left position: (DISABLE KILL)	The output voltage will be limited to V_{max}, or the output current to I_{max} respectively; INHIBIT shuts the output voltage off without ramp. If INHIBIT is no longer being present, then the former voltage value will be set with hardware or software ramp.

6. CAN - Interface

6.1 Device Control Protocol DCP

The communication between the controller and the module works according to the Device Control Protocol DCP, which has been designed for the use of multi-level-hierarchy systems of instruments.

This protocol works according to the master slave principle. Therefore, the controllers which are on higher hierarchy always are masters while devices, which are in lower hierarchy, are working as slaves.

In the event of the control of the HV device through a controller, the controller will have the master function in this system, while the module (as a Front-end device with intelligence) will be the slave.

The data exchange between the controller and the Front-end (FE) device is working with help of data frames. These data frames are assembled of one direction bit DATA_DIR, one identifier bit DATA_ID and further data bytes. The direction bit DATA_DIR defines whether the data frame is a write or read-write access. The DATA_ID carries the information of the type of the data frame and occasionally sub addresses (G0, G1). It has been characterised through the first byte of the data frame with bit 7=1. The function of the module as part of a complex system has been defined through the DATA_ID .
In such systems with many hierarchical levels a single function of a single module can be addressed by using group controllers (GC). Then, for each GC on the way to the module, the data frame is created through nesting of the address fields of the GC-addresses followed by the DATA_ID (not necessary in case of control of a single module).

DATA _DIR	DATA_ID Bit								Access
	7	6	5	4	3	2	1	0	
x	**0**	x	x	x	x	x	x	x	**No** DATA_ID
0	1	0	x	x	x	x	x	x	**Write access** on Front-end device
1	1	0	x	x	x	x	x	x	**Read-write access** on Front-end device (Request at Write)
0	1	1	x	x	x	x	**G1**	**G0**	**Write access** on group
1	1	1	x	x	x	x	**G1**	**G0**	**Read-write access** on group (Request at Write)
									G0, G1 sub address, only needed if group controller (GC) is used

These data frames correspond to a transfer into layer 3 (Network Layer) respectively layer 4 (Transport Layer) of the OSI model of ISO. The transmission medium is CAN Bus according to the specification 2.0A, related to level1 (Physical Layer) and level 2 (Data Link Layer).

The Device Control Protocol DCP has been matched to the CAN Bus according to specification CAN 2.0A, but it is also possible to be matched to further transmission media (e.g. RS232). Therefore specials of layer 1 and 2 are only mentioned if absolutely necessary and if misunderstandings of functions between the Transport Layer and functions of the Data Link Layer might be possible. The communication between the controller and a module on the same bus segment will be described as follows.

6.2 Function range

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

CAN-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 have priority over software control.

Manual control mode

While the unit is operating in manual control mode, only CAN Read-write accesses are interpreted. Write accesses are accepted, but do not result into a change of the output voltage.

6.3 Overview over used CAN data frames

DATA_DIR	DATA_ID Bit 7	6	5	4	3	2	1	0	Access	read/ write/ active	DATA - Bytes
	0	x	x	x	x	x	x	x	no DATA_ID		
	1	**0**	**C2**	**C1**	**C0**	**0**	**N1**	**N0**	**Single access CHANNEL:** **N1=0, N0=1 ⇨ Channel A** **N1=1, N0=0 ⇨ Channel B**		
1	1	0	0	0	0	0	N1	N0	Actual voltage	r	3
1	1	0	0	1	0	0	N1	N0	Actual current	r	3
1/0	1	0	1	0	0	0	N1	N0	Set voltage	r/w	3
1/0	1	0	1	1	0	0	N1	N0	Ramp speed	r/w	2
0	1	0	0	0	1	0	N1	N0	Start voltage change	w	1
1	1	0	0	1	1	0	N1	N0	Hardware limits	r	4
1/0	1	0	1	0	1	0	N1	N0	Current trip	r/w	3
1/0	1	0	1	1	1	0	N1	N0	Auto start	r/w	2
	1	**1**	**C3**	**C2**	**C1**	**C0**	**G1**	**G0**	**Group access MODULE:** **G1 = G0 = 0,** only needed if group controller (GC) is used		
1	1	1	0	0	0	1	G1	G0	Module status Channel A and B	r	3
1	1	1	0	0	1	0	G1	G0	LAM-status Channel A and B	r	3
1	1	1	0	1	1	0	G1	G0	Log-on Front-end device in superior layer	a	2
0	1	1	0	1	1	0	G1	G0	Log-off superior layer at Front-end device	w	2
0	1	1	0	1	1	1	G1	G0	new bit rate	w	3
1	1	1	1	0	0	0	G1	G0	Serial number (6 BCD) and Software release (3 BCD)	r	6
							C_i		Accesses		
							N_i		Channels A and B		
							G_i		Group 0 to 3 Only needed if group controller (GC) is used		

6.4 Detailed CAN data frames description

Log-on and Log-off Front-end (FE) device (active/write access)

Log-on frame module (DLC = 2)

Byte		DATA_ID								DATA_0
Bit		7	6	5	4	3	2	1	0	0
Designation	DATA_DIR							G1	G0	
Data	1	1	1	0	1	1	0	0	0	x
Description	active	G1 to G0: Group 0 to 3 Only necessary if group controller (GC) is used								x=1: Sum status-bit = 1 in the group access 'General status module': no current limit/trips and no voltage limit have been exceeded in the module x=0: current limit/trips or voltage limit have been exceeded at least one channel

After POWER ON the module will give this group access cyclically on the bus (ca. 2...10 sec).

Bit 0 in DATA_0 describes the module status. If a controller identifies this access then it is able to register this module as a Front-end device and is able to address it with FE_ADR.

(Module address, see also item 4.4, description 11bit-Identifier)

Remote-frame Log-on controller (DLC = 2)

Byte		DATA_ID								DATA_0
Bit		7	6	5	4	3	2	1	0	0
Designation	DATA_DIR							G1	G0	
Data	0	1	1	0	1	1	0	0	0	1
Description	write	G1 to G0: Group 0 to 3 Only necessary if group controller (GC) is used								Module is log-on

The module will not send further 'Log-on controller" accesses after the successful registration as long as it receives accesses from the external CAN Bus in periods shorter than one minute and until the controller will send a 'Log-off controller" access to the Front-end device, respectively.

Remote-frame Log-off controller (DLC = 2)

Byte		DATA_ID								DATA_0
Bit		7	6	5	4	3	2	1	0	0
Designation	DATA_DIR							G1	G0	
Data	0	1	1	0	1	1	0	0	0	0
Description	write	G1 to G0: Group 0 to 3 Only needed if group controller (GC) is used								Module is log-off

Single access CHANNEL: Actual voltage (Read-write access)

Byte		DATA_ID							
Bit		7	6	5	4	3	2	1	0
Designation	DATA_DIR							N1	N0
assignment	1	1	0	0	0	0	0	x	x
Description	read	N1=0, N0=1 ⇨ Channel A N1=1, N0=0 ⇨ Channel B							

Controller (DLC = 1):
Read actual voltage at the corresponding channel

⇓ Response module (DLC = 3)

Byte		DATA_ID								DATA_1			DATA_0		
Bit		7	6	5	4	3	2	1	0	7	...	0	7	...	0
Designation	DATA_DIR							N1	N0						LSB
Data	0	1	0	0	0	0	0	x	x	x					
Description	write	N1=0, N0=1 ⇨ Channel A N1=1, N0=0 ⇨ Channel B								Actual voltage [V] in DATA_1 and DATA_0					

Single access CHANNEL: Actual current (Read-write access)

Byte		DATA_ID							
Bit		7	6	5	4	3	2	1	0
Designation	DATA_DIR							N1	N0
Data	1	1	0	0	1	0	0	x	x
Description	read	N1=0, N0=1 ⇨ Channel A N1=1, N0=0 ⇨ Channel B							

Controller (DLC = 1):
Read actual current at the corresponding channel

⇓ Response module (DLC = 3)

Byte		DATA_ID								DATA_1								DATA_0		
Bit		7	6	5	4	3	2	1	0	7	6	5	4		2	1	0	7	..	0
Designation	DATA_DIR							N1	N0											LSB
Data	0	1	0	0	1	0	0	x	x	x										
Description	write	N1=0, N0=1 ⇨ Channel A N1=1, N0=0 ⇨ Channel B								Actual current [A] in DATA_1 and DATA_0										

Single access CHANNEL: Set voltage (Read-write/Write access)

Read-write

Byte / Bit		DATA_ID 7	6	5	4	3	2	1	0
Designation	DATA _DIR							N1	N0
Data	1	1	0	1	0	0	0	x	x
Description	read	N1=0, N0=1 ⇨ CHANNEL A N1=1, N0=0 ⇨ CHANNEL B							

Controller (DLC = 1):
Read set voltage at the corresponding channel

⇓ Response module (DLC = 3)

Byte / Bit		DATA_ID 7	6	5	4	3	2	1	0	DATA_1 7	...	0	DATA_0 7	...	0
Designation	DATA _DIR							N1	N0						LSB
Data	0	1	0	1	0	0	0	x	x	x					
Description	write	N1=0, N0=1 ⇨ CHANNEL A N1=1, N0=0 ⇨ CHANNEL B								Set voltage [V] in DATA_1 and DATA_0					

Write [Controller (DLC = 3): Write set voltage at corresponding channel]

Byte / Bit		DATA_ID 7	6	5	4	3	2	1	0	DATA_1 7	...	0	DATA_0 7	...	0
Designation	DATA _DIR							N1	N0						LSB
Data	0	1	0	1	0	0	0	x	x	x					
Description	write	N1=0, N0=1 ⇨ CHANNEL A N1=1, N0=0 ⇨ CHANNEL B								Set voltage [V] in DATA_1 and DATA_0					

Set voltages which are higher than the maximum channel voltage (nominal module voltage or V_{max}) will be set to nominal module voltage or V_{max} under software control.

Single access CHANNEL: ramp speed (Read-write/Write access)

Read-write

Byte / Bit		7	6	5	4	3	2	1	0
		DATA_ID							
Designation	DATA_DIR							N1	N0
Data	1	1	0	1	1	0	0	x	x
Description	read	N1=0, N0=1 ⇨ CHANNEL A N1=1, N0=0 ⇨ CHANNEL B							

Controller (DLC = 1):
Read actual ramp speed at the corresponding channel

⇓ Response module (DLC = 2)

Byte / Bit		7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
		DATA_ID								DATA_0							
Designation	DATA_DIR							N1	N0								LSB
Data	0	1	0	1	1	0	0	x	x	x7	x6	x5	x4	x3	x2	x1	x0
Description	write	N1=0, N0=1 ⇨ CHANNEL A N1=1, N0=0 ⇨ CHANNEL B								x7 ... x0: Ramp speed (2 to 255 V/s)							

Write [Controller (DLC = 2): Write ramp speed at the corresponding channel]

Byte / Bit		7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
		DATA_ID								DATA_0							
Designation	DATA_DIR							N1	N0								LSB
Data	0	1	0	1	1	0	0	x	x	x7	x6	x5	x4	x3	x2	x1	x0
Description	write	N1=0, N0=1 ⇨ CHANNEL A N1=1, N0=0 ⇨ CHANNEL B								x7 ... x0: Ramp speed (2 to 255 V/s)							

Ramp speed lower than 2 V/s will be set on 2 V/s with help of the software.
This value will be pre selected also after connecting to the supply voltages if - during the last use - the function „Auto start“ did not store a different voltage ramp.
If – during the process of change of the output voltage – a new voltage ramp will be initialised by software then this change will be taken immediately and the set voltage will be made with the new software ramp.

Single access CHANNEL: Start (Write access)

Byte		DATA_ID							
Bit		7	6	5	4	3	2	1	0
Designation	DATA_DIR							N1	N0
Data	0	1	0	0	0	1	0	x	x
Description	write	N1=0, N0=1 ⇨ CHANNEL A N1=1, N0=0 ⇨ CHANNEL B							

Controller (DLC = 1):
Start voltage change in the corresponding CHANNEL.

If the output voltage has been switched off permanently through the exceeding of V_{max} or I_{max} respectively through INHIBIT in case of ENABLE KILL or the programmable current trips , it is necessary to READ the LAM-Status of the register LAM_REG1ER, LAM_EXTINH or LAM_ILIM to set them back, before it is possible to reset an output voltage again.

If the output voltage has been limited through the exceeding of V_{max} or I_{max} in case of DISABLE KILL (ERROR-LED flashes and LAM_REG2ER_= 1),it is possible to decrease the output voltage through the writing of a lower set voltage and following „Start“ (Error-LED flashes no more!!). But before the voltage can be set higher afterwards the register LAM_REG2ER must be reset through READ of register LAM-status.

Single access CHANNEL: Limit (Read-write access)

Byte		DATA_ID							
Bit		7	6	5	4	3	2	1	0
Designation	DATA_DIR							N1	N0
Data	1	1	0	0	1	1	0	x	x
Description	read	N1=0, N0=1 ⇨ CHANNEL A N1=1, N0=0 ⇨ CHANNEL B							

Controller (DLC = 1):
check Hardware limit settings of the corresponding CHANNEL

⇓ Response module (DLC = 4)

Byte		DATA_ID								DATA_2			DATA_1						DATA_0					
Bit		7	6	5	4	3	2	1	0	7	...	0	7	..	4	3	..	0	7	..	4	3	..	0
Designation	DATA_DIR							N1	N0			LSB		..			..			..	LSB		..	
Data	0	1	0	0	1	1	0	x	x	x			x			x						x		
Description	write	N1=0, N0=1 ⇨ CHANNEL A N1=1, N0=0 ⇨ CHANNEL B								mantissa V_{max} (8 bit)			Exp.V_{max}			mantissa I_{max} (8 bit)						exp I_{max}		

exp. (4 bit), for exp. > 7 results in: negative exponent in 2´er complement

Single access CHANNEL: Current trip (Read-write//Write access<<)

Read-write access

Byte		DATA_ID							
Bit		7	6	5	4	3	2	1	0
Designation	DATA _DIR							N1	N0
Data	1	1	0	1	0	1	0	x	x
Description	read	N1=0, N0=1 ⇨ CHANNEL A N1=1, N0=0 ⇨ CHANNEL B							

Controller (DLC = 1):
Read maximum output current (current trip)
of the corresponding CHANNEL .

⇓ Response module (DLC = 3)

Byte		DATA_ID								DATA_1			DATA_0		
Bit		7	6	5	4	3	2	1	0	7	...	0	7	...	0
Designation	DATA _DIR							N1	N0						LSB
Data	0	1	0	1	0	1	0	x	x	x					
Description	write	N1=0, N0=1 ⇨ CHANNEL A N1=1, N0=0 ⇨ CHANNEL B								max. current value in [A] in DATA_1 and DATA_0					

Write access [Controller (DLC = 3): set max. output current (current trip) of corresponding CHANNEL]

Byte		DATA_ID								DATA_1			DATA_0		
Bit		7	6	5	4	3	2	1	0	7	...	0	7	...	0
Designation	DATA _DIR							N1	N0						LSB
Data	0	1	0	1	0	1	0	x	x	x					
Description	write	N1=0, N0=1 ⇨ CHANNEL A N1=1, N0=0 ⇨ CHANNEL B								max. current value in [A] in DATA_1 and DATA_0					

If the output current exceeds the programmed max. current limit then the output voltage will be switched off via the software (current trip). The highest resolution of the current measuring determines the possible resolution of maximum current limit. For the max. current limit = 0 A no current trip is programmable.
If the output voltage has been switched off through the exceeding of the max. current then the LAM–status must be read again in order to reset the output voltage with „Start“ or active „Auto start“ again.

Single access CHANNEL: Auto start (Read-write//Write access)

Read-write access

Byte / Bit		DATA_ID 7	6	5	4	3	2	1	0
Designation	DATA _DIR							N1	N0
Data	1	1	0	1	1	1	0	x	x
Description	read	N1=0, N0=1 ⇨ CHANNEL A N1=1, N0=0 ⇨ CHANNEL B							

Controller (DLC = 1):
Check if „Auto start“ of corresponding CHANNEL is active.

⇓ Response module (DLC = 2)

Byte / Bit		DATA_ID 7	6	5	4	3	2	1	0	DATA_0 7	6	5	4	3	2	1	0
Designation	DATA _DIR							N1	N0								LSB
Data	0	1	0	1	1	1	0	x	x					x3			
Description	write	N1=0, N0=1 ⇨ CHANNEL A N1=1, N0=0 ⇨ CHANNEL B								x3 = 1: Auto start is active x3 = 0: Auto start not active							

Auto start active means:

- if the ‘Auto start’ conditions (module-status ON_OFF_+ IN_EX_= 0 and LAM-Status _REG2ER_+_REG1ER_+_EXTINH_+_ILIM_= 0) are made, then the output voltage of the CHANNEL will be ramped to the actual set voltage, i.e. „Start“ is not necessary after ‘Write set voltage’ **,** Power-ON and Power OFF⇒ ON.
- if the output voltage of the CHANNEL has been switched off permanently through the exceeding of V_{max} or I_{max} respectively through INHIBIT (in case of ENABLE KILL or Current Trip) then it will be reset with software ramp after READ of LAM-status.
- if the output voltage will be limited through exceeding of V_{max} or I_{max} in case of DISABLE KILL (ERROR-LED flash and LAM_REG2ER_= 1), then it is possible to ramp to a lower voltage (write a lower set voltage, Error-LED does not flash any more). But only Read LAM status of LAM_REG2ER reset the register and allows to increase the voltage.

Write access [Controller (DLC = 2): activate Auto start for corresponding CHANNEL]

Byte / Bit		DATA_ID 7	6	5	4	3	2	1	0	DATA_0 7	6	5	4	3	2	1	0
Designation	DATA _DIR							N1	N0								LSB
Data	0	1	0	1	1	1	0	x	x					x3	x2	x1	x0
Description	write	N1=0, N0=1 ⇨ CHANNEL A N1=1, N0=0 ⇨ CHANNEL B								x3 = 1: Auto start activate							
										x2 = 1: actual current trip x1 = 1: actual set voltage x0 = 1: actual voltage ramp } store in EEPROM one time							
										Values will be restored in corresponding register after supply voltages will have been connected! (for EEPROM 1 Million write cycles guaranteed)							

Group access: module status CHANNEL A and B (Read-write access)

Controller (DLC = 1):
READ module - status of channels

Byte		DATA_ID							
Bit		7	6	5	4	3	2	1	0
Designation	DATA_DIR								
Data	1	1	1	0	0	0	1	0	0
Description	read								

⇓ Response module (DLC = 3)

Byte		DATA_ID								DATA_1			DATA_0		
Bit		7	6	5	4	3	2	1	0	7	...	0	7	...	0
Designation	DATA_DIR									CHANNEL B			CHANNEL A		
Data	0	1	1	0	0	0	1	0	0	x					
Description	write									see list					

Description				Module-status CHANNEL A and B (read)		
CHANNEL	DATA	Bit	Name	Description	0	1
B	**_1**	b7	ERROR_2	error in CHANNEL B	channel ok	error
		b6	STATV_2	status V_{out}	V_{out} stable	V_{out} in change
		b5	TRENDV_2	Moving direction of V_{out}	V_{out} falling	V_{out} rising
		b4	KILL_2	switch position KILL	disabled	enabled
		b3	ON_OFF_2	Switch position HV-ON/OFF	on	off
		b2	POL_2	Polarity of output voltage V_{out}	negative	positive
		b1	IN_EX_2	Switch position CONTROL	DAC	manual
		b0	VZ_2	Output voltage V_{out} CHANNEL B	V_{out}<>0	V_{out}=0
		b7	ERROR_1	Error in CHANNEL A	channel ok	error
A	**_0**					
		b6	STATV_1	status V_{out}	V_{out} stable	V_{out} in change
		b5	TRENDV_1	Moving direction of V_{out}	V_{out} falling	V_{out} rising
		b4	KILL_1	switch position KILL	disabled	enabled
		b3	ON_OFF_1	Switch position HV-ON/OFF	on	off
		b2	POL_1	Polarity of output voltage V_{out}	negative	positive
		b1	IN_EX_1	Switch position CONTROL	DAC	manual
		b0	VZ_1	Output voltage V_{out} CHANNEL B	V_{out}<>0	V_{out}=0

Group access: LAM-status CHANNEL A and B (Read-write access)

Byte		DATA_ID							
Bit		7	6	5	4	3	2	1	0
Designation	DATA _DIR								
Data	1	1	1	0	0	1	0	0	0
Description	read								

Controller (DLC = 1):
READ module - Status of channels

⇓ Response module (DLC = 3)

Byte		DATA_ID								DATA_1			DATA_0		
Bit		7	6	5	4	3	2	1	0	7	...	0	7	...	0
Designation	DATA _DIR									CHANNEL B			CHANNEL A		
Data	0	1	1	0	0	1	0	0	0	x					
Description	write									See list					

Description				LAM-Status CHANNEL A and B (read)	
CHAN NEL	DATA	Bit	Name	Description for Bit = 1	Remarks
B	_1	b7	LAM_REG2ER_2	Quality of output voltage of CHANNEL B is not guaranteed at time	
		b6	LAM_REG1ER_2	exceeding of V_{max} or I_{max} was/is present	
		b5	LAM_EXTINH_2	external Inhibit-signal was / is active	
		b4	LAM_RANGE_2	relation V_{nom} to V_{max} > 1	Set voltage > V_{max}
		b3	LAM_KEY_CHANGED	A front panel switch of CHANNEL B has been activated	ON_OFF_2, IN_EXT_2, KILL_2
		b2	LAM_EOP_2	V_{out} CHANNEL B arrived at set voltage	end of process_2
		b1	LAM_ILIM_2	I_{out} has been higher than programmed I_{max} (current trip CHANNEL B)	
		b0			
A	_0	b7	LAM_REG2ER_1	Quality of output voltage of CHANNEL A is not guaranteed at this moment.	
		b6	LAM_REG1ER_1	Exceeding of V_{max} or I_{max} was/is present.	
		b5	LAM_EXTINH_1	external Inhibit-signal was/ is active	
		b4	LAM_RANGE_1	Relation V_{nom} to V_{max} > 1	Set voltage > V_{max}
		b3	LAM_KEY_CHANGED	A front panel switch of CHANNEL A has been activated	ON_OFF_1, IN_EXT_1, KILL_1
		b2	LAM_EOP_1	V_{out} CHANNEL A arrived at set voltage	end of process_1
		b1	LAM_ILIM_1	I_{out} has been higher than programmed I_{max} (current trip CHANNEL A)	
		b0			

Status bits will be set if a corresponding event happens and reset if LAM-status will be read afterwards. If the event is still existing or if it happens again the corresponding bits will be set again.

Group access: New bit rate (Write access)

Controller (DLC = 3): „ write new bit rate“ into EEPROM.

Byte		DATA_ID								DATA_1								DATA_0							
Bit		7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Designation	DATA _DIR																								LSB
Data	0	1	1	0	1	1	1	0	0								x8	x7	x6	x5	x4	x3	x2	x1	x0
Description	write									x8 ... x0:-7 Bit rates are possible 20 : 20 kBit/s 50 : 50 kBit/s 100 : 100 kBit/s 125 : 125 kBit/s 200 : 200 kBit/s 250 : 250 kBit/s 400 : 400 kBit/s -the new Bit rate is active after RESET or POWER OFF/ON and - it has to be sure, that - before a RESET or POWER OFF/ON – all modules of one segment have been set to the same Bit rate. -the factory fixed Bit rate is labelled on the connector.															

Group access: Serial number and Software release (Read-write access)

Controller (DLC = 1):
Read Unit No. and software version

Byte		DATA_ID							
Bit		7	6	5	4	3	2	1	0
Designation	DATA _DIR								
Data	1	1	1	1	0	0	0	0	0
Description	read								

⇓ Response module (DLC = 6)

Byte		DATA_ID								DATA_4		DATA_3		DATA_2		DATA_1		DATA_0	
Bit		7	6	5	4	3	2	1	0	BCD	BCD	BCD	BCD	BCD	BCD	BCD	BCD	BCD	BCD
Designation	DATA _DIR																		
Data	0	1	1	1	0	0	0	0	0	z6	z5	z4	z3	z2	z1	0	y3	y2	y1
Description	write									6 BCD unit No.							3 BCD		Soft-ware-Rel.

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6.5 CAN-Bus implementation

The data frame structure is matched to the message frame of the standard-format according to CAN specification 2.0A, whereas looking from the point of view of the CAN protocol a pure data transmission will be done, which is not applying to the protocol.

The data frame of the DCP will be transferred as data-word with n bytes length in the data field of the CAN frames according to the specific demands of the respective access. Therefore this results into a Data Length Code (DLC) of the CAN-protocol of n.
It is possible to transfer 8 data bytes that apply to the DLC field with falling values.

The RTR Bit is always set to zero.
The information for the direction of the data transfer (DATA_DIR) is written into the lowest bit ID0 of the 11 Bit CAN-Identifier.
The controller therefore will start a read-write access for data with DATA_DIR = 1 and will send with DATA_DIR = 0.

The Front-end device responds to the data request by sending the corresponding data with DATA_DIR = 0.
Only if the Front-end device is not registered at the controller respectively if it does not receive valid data during a longer time period (ca. 1 min), then it will actively send the registration frame with DATA_DIR = 1 (see also item 4.3)
Therefore it follows that all even CAN-ports (Identifier) are interpreted as 'Write ports' all odd CAN ports as ' Read ports'.
The addressing of the Front-end device is also made with the 11 bit identifier of the CAN protocol.
In order to keep the CAN segment open also for other protocols, the addressing room was limited to 64 nodes.

ID9 to ID10 are 0,
ID3 to ID8 allows the addressing of 64 Front-end devices (ID3: A0 = 2^0 ;...; ID8: A5 = 2^5),
ID1 and ID2 are not used.

Within one CAN segment only modules are allowed with different identifiers and identical bit rates. The factory fixed bit rate is written on the sticker of the 96-pin connector.

Following data frame is valid for the control of the Front-end device in this lowest CAN segment.

S	Identifier	R			DLC	n – data bytes				CRC	Ack
O		T	0	0	(n = 1 - 8)	DATA_ID	DATA_(n-2) ≥ 0	DATA_(n-3) ≥ 0	DATA_ ...		F.
F	b11 b0	R	reserve		b3 b0	**b7=** b0	b7 b0	b7 b0	b7 b0	15 bit	

ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0
0	0	A5	A4	A3	A2	A1	A0			DATA _DIR
Acceptance-Filter of the used CAN-Controller is set to Front-end-address										

The Front-end device must do:

- Processing of the single commands with direct channel values.
- Processing of group information of the channels.
- Self registration in the higher level through sending the module address.
- Building of status information.

The electrical transmission is floating and works with signal CAN_L and CAN_H, with reference to CAN_GND. The pin assignment of connector D-Sub 9 is shown in this list.

PIN	Signal	description
2	CAN_L	
3	CAN_GND	GND
5	CAN_SHLD	shield
7	CAN_H	

6.6 Store the module address (identifier) in EEPROM

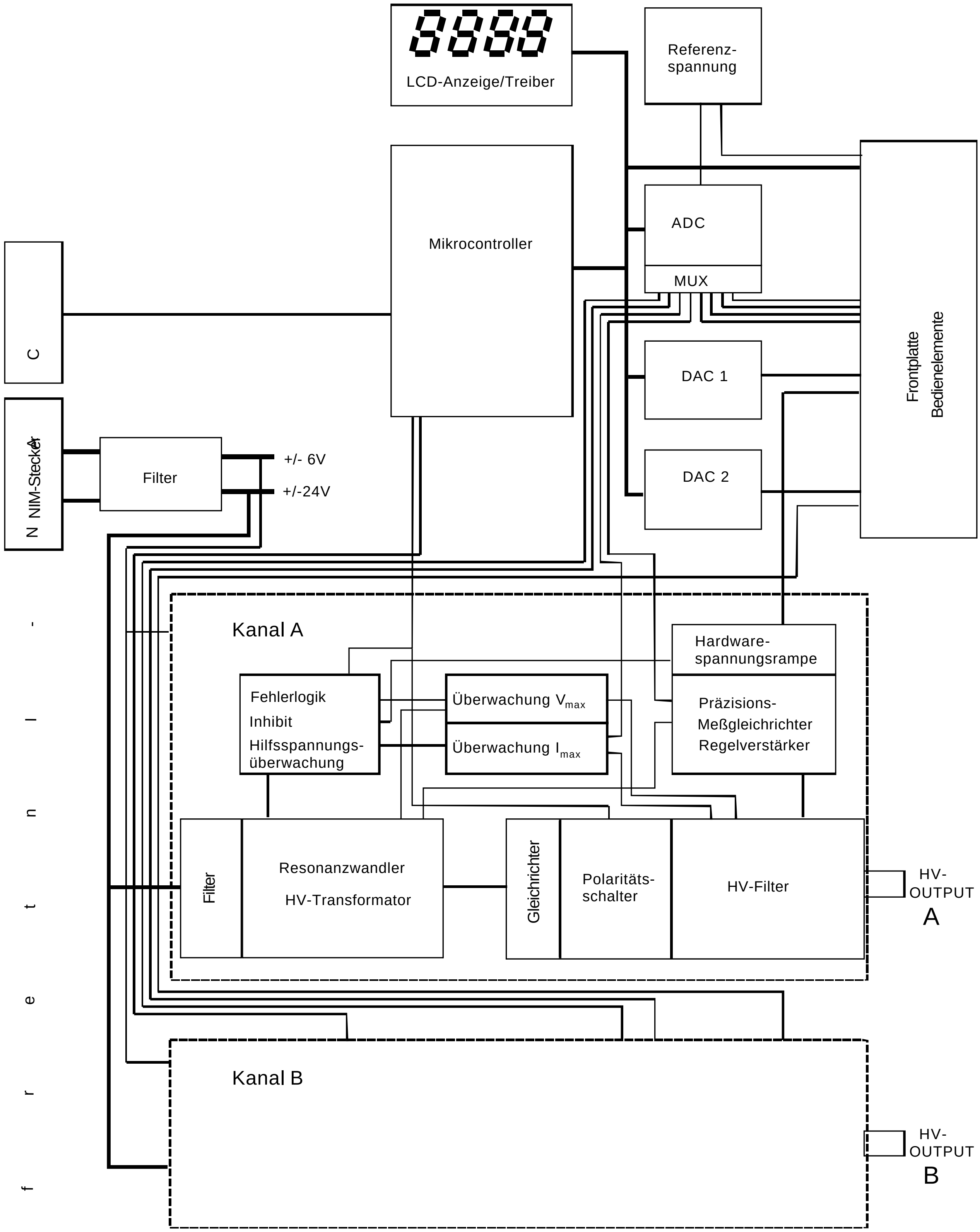
1. Pre-settings of both channels before switch ON , module switched OFF to (± 24V; ± 6V) :
   ⇨ switch CONTROL [10] on MANUAL; ⇨ switch HV-ON [9] on OFF;
   ⇨ switch KILL [12] on ENABLE.
2. Switch ON of supply voltages.
3. The LCD-display [1] shows on left hand side an ‘A’ and on right hand side the actual address in HEX, e.g. 00. In between flash a hyphen.
4. Switching of measuring switch [3] the address will increase address step by step up to 3F , then the address jumps back to 00.
5. If there is no change during 10s or if switch CONTROL, KILL or HV-ON will be set, then the chosen address will be taken into EEPROM and the module is ready to operate.

6.7 Software

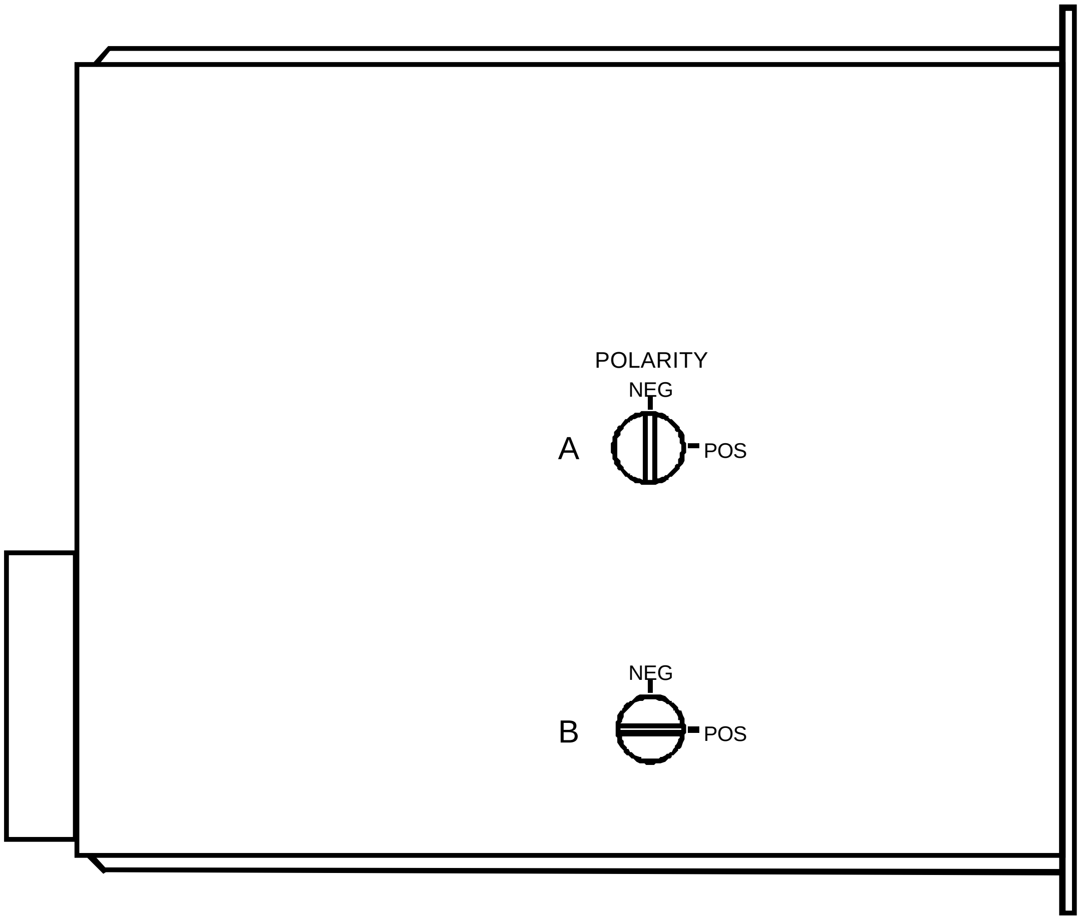
Have a look also to our comfortable control and test software.

6.8 Programme example

Controller										explanation
Transmission memory					Receiver memory					
Identi-fier	DLC	DATA_n _ID			Identi-fier	DLC	DATA_n _ID			Scheme of identifier look at 6.5
					031h	2h	D8h	01h		module No. 6 wants to lock on with general status o.k. at controller
030h	2h	D8h	01h							Module is locked on as No. 6
031h	1h	99h			030h	4h	99h	14h	23h	CCh Limits CHANNEL A ⇒ 2000 V / 6 mA (e.g. each limit 100% for NHQ 232M)
031h	1h	9Ah			030h	4h	9Ah	0Ah	21h	ECh Limits CHANNEL B ⇒ 1000 V / 3 mA (e.g. each limit 50 % for NHQ 232M)
031h	1h	C4h			030h	3h	C4h	11h	05h	module - Status ⇒ CHANNEL B: ok, KILL enabled, ON V_{out} neg., DAC, V_{out} = 0 CHANNEL A: ok, KILL disabled, ON V_{out} pos., DAC, V_{out} = 0
030h	2h	B1h	14h							Write Voltage ramp CHANNEL A with 20 V/s
030h	2h	B2h	C8h							Write voltage ramp CHANNEL B with 200 V/s
030h	3h	A1h	01h	2Ch						Set voltage CHANNEL A: 300 V
030h	3h	A2h	03h	84h						Set voltage CHANNEL B: 900 V
030h	1h	89h								Start change voltage CHANNEL A
030	1h	8Ah								Start change voltage CHANNEL B
031h	1h	C4h			030h	3h	C4h	70h	64h	module - status ⇒ (changes) CHANNEL B: ok, V_{out} in change V_{out} rising, V_{out} <> 0 CHANNEL A: ok, V_{out} in change V_{out} rising, V_{out} <> 0
031h	1h	C8h			030h	3h	C8h	40h	04h	LAM - status ⇒ exceeded CHANNEL B: V_{max} or I_{max} CHANNEL A: signal quality V_{out} arrives at set voltage
031h	1h	82h			030h	3h	82h	00h	00h	nominal – voltage of CHANNEL B ⇒ 0 V
030h	3h	A2h	03h	20h						Set voltage CHANNEL B: 800 V
030	1h	8Ah								Start voltage change CHANNEL B
031h	1h	C4h			030h	3h	C4h	70h	04h	module - status ⇒ (changes) CHANNEL B: ok, V_{out} in change V_{out} rising, V_{out} <> 0 CHANNEL A: ok, V_{out} stable, V_{out} <> 0
031h	1h	C8h			030h	3h	C8h	04h	00h	LAM - Status ⇒ CHANNEL B: V_{out} arri. at nom. volt CHANNEL A: signal quality
030h	3h	A1h	00h	00h						Set voltage CHANNEL A: 0 V
030h	3h	A2h	00h	00h						Set voltage CHANNEL B: 0 V
030h	1h	89h								Start voltage change CHANNEL A
030	1h	8Ah								Start voltage change CHANNEL B
031h	1h	C8h			030h	3h	C8h	04h	04h	LAM - Status ⇒ CHANNEL B: V_{out} arr. at nom. volt CHANNEL A: signal quality V_{out} arri. at nom. volt
030h	2h	D8h	00h							module is locked off
					031h	2h	D8h	01h		module No. 6 wants to lock on with general status ok at controller.



Appendix A: Block diagram NHQ



appendix B: cover side NHQ polarity switch

chosen polarity: CHANNEL A, negative
CHANNEL B, positive