Precision CAMAC High Voltage Power Supply
CHQ STANDARD series

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 CHQ are one or two channel high voltage power supplies in a CAMAC chassis. The unit is 2 slots wide, and supports manual operation via the front panel as well as operation via CAMAC interface. The use of the interface allows for a larger function set than the manual control.
The high voltage supplies features high precision output voltage and very low ripple, even under full load. Separate hardware switches allow to put voltage and current limits in 10%-steps. The EXINHIBIT input protects sensitive devices. Additionally, a maximum output current per channel can be specified via the interface. The high voltage source is protected against overload and short circuit. The output polarity can be switched over.

2. Technical data

CHQ - one channel - two channel	**102M** **202M**	**103M** **203M**	**104M** **204M**	**105M** **205M**	**106L** **206L**
Output voltage V_{OUT}	0 ... 2 kV	0 ... 3 kV	0 ... 4 kV	0 ... 5 kV	0 ... 6 kV
Output current per channel 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 max.	$2\ mV_{P-P}$			$5\ mV_{P-P}$	
Res. of voltage measurement	1 V				
Res. of current measurement	1 µA, with **option** 104: 100 nA at Iout max ≤ 100 µA				
Accuracy voltage measurement	± (0,05% V_{OUT} + 0,02% $V_{OUT\ max}$ + 1 digit) for one year				
current measurement	± (0,05% I_{OUT} + 0,02% I_{OUTmax} + 1 digit) for one year				
Display	4 digits with sign, switch controlled -voltage display in [V] -current display in [µA]				
Stability ΔV_{OUT} (no load / load) $\Delta (V_{OUT}/V_{IN})$	$< 5 * 10^{-5}$ $< 5 * 10^{-5}$				
Temperature coefficient	$< 5 * 10^{-5}$/K				
Voltage control CONTROL switch in:	upper position (manual): 10 - turn potentiometer				
	lower position (DAC): control via CAMAC interface				
Rate of change of output voltage	-HV -ON/OFF: 500 V/s (Hardware ramp) -Control via interface: 2 ... 255 V/s (Software ramp)				
Protection	- separate current und voltage limit (hardware, rotary switch in 10%-steps) - EXINHIBIT (ext. signal, TTL-level, Low=active) - programmable current trip (software)				
Power requirements V_{IN}	± 24 V (< 800 mA, one channel < 400 mA), ± 6 V (< 100 mA)				
Operating temperature	0 . . . +50 °C				
Storage temperature	-20 . . . +60 °C				
Case	CAMAC-Standard module: CAMAC #2				
Connectors	CAMAC: CAMAC interface HV output: SHV connector EXINHIBIT: 1 pin Lemo hub				

3. CHQ 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 EXINHIBIT signal and impacts the output voltage according to the setup. In addition this allows the detection of short over currents due to single flashovers.

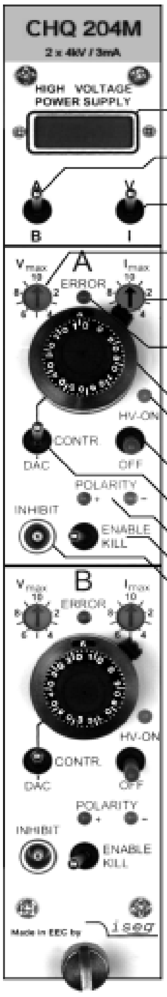
Digital control unit

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 16-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.

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 sitwch
[11] Polarity indicator
[12] KILL switch
[13] INHIBIT input

5. Handling

By connecting the CAMAC-connector on the backside the unit is set into the operating state.

Before the unit is powered the desired output polarity must be selected by the 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 [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, started with a ramp speed of 500 V/s (hardware ramp) to the set voltage given by the 10-turn potentiometer [7].
This is also the case, if CAMAC 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 CAMAC commands.

Attention! If the function ″Auto start″ has been activated in the previous operating session, the high voltage generation starts immediately with the saved parameters!

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

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

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 [10] 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 upper 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 LAM-Status″ and then ″Start voltage change″ via the interface. If ″Auto start″ is active, ″Start voltage change″ is not necessary.

The 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 red error LED on the front panel [6] signals if the output voltage or current approaches the limits.

The KILL switch [12] specifies the response on exceeding limits or on the external protection signal (EXINHIBIT) at the INHIBIT input [13] as follows:

Switch to the right position: (ENABLE KILL)	When exceeding V_{max}, I_{max} or in the presence of an EXINHIBIT signal (Low=active) the output voltage will be shut off permanently without ramp. The output voltage is only restored after switching HV-ON [9] or KILL [12] or ″Read LAM-Status″ and then ″Start voltage change″ when using 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 left position: (DISABLE KILL)	The output voltage is limited to V_{max}, the 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 once EXINHIBIT is no longer being present.

6. Operation under CAMAC control

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

CAMAC control mode

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

Front panel switches have priority over software control.

Manual control mode

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

CAMAC commands

Z S(2) general reset

Channel B canceled for the one channel high voltage supply !

N AF	Type	Description	Remark
A(0)F(0)	R	Set voltage channel A	
A(1)F(0)	R	Set voltage channel B	
A(2)F(0)	R	Ramp channel A	2 ... 255 V/s
A(3)F(0)	R	Ramp channel B	2 ... 255 V/s
A(4)F(0)	R	Actual voltage channel A	
A(5)F(0)	R	Actual voltage channel B	
A(6)F(0)	R	Actual current channel A	
A(7)F(0)	R	Actual current channel B	
A(8)F(0)	R	Limits channel A	⇒ Bit assignments
A(9)F(0)	R	Limits channel B	⇒ Bit assignments
A(10)F(0)	R	Current trip channel A	with the resolution of current measurement,
A(11)F(0)	R	Current trip channel B	for I = 0 not current trip
A(0)F(1)	R	Module status	⇒ Status register
A(1)F(1)	R	Auto start	⇒ Bit assignments
A(12)F(1)	R	LAM-Status	⇒ LAM register
A(13)F(1)	R	LAM-Mask	
A(14)F(1)	R	LAM-Request	
A(15)F(1)	R	Module identifier	⇒ Bit assignments
A(0)F(16)	W	Set voltage channel A	
A(1)F(16)	W	Set voltage channel B	
A(2)F(16)	W	Ramp channel A	2 ... 255 V/s
A(3)F(16)	W	Ramp channel B	2 ... 255 V/s
A(10)F(16)	W	Current trip channel A	with the resolution of current measurement,
A(11)F(16)	W	Current trip channel B	for I = 0 not current trip
A(1)F(17)	W	Auto start	⇒ Bit assignments
A(13)F(17)	W	LAM-Mask	
A(0)F(25)	0	Start voltage change channel A	
A(1)F(25)	0	Start voltage change channel B	
A(15)F(8)	0	Test LAM	Q=LAM

Status register

Channel	Bit	Name	Description	0	1
B	R16	ERROR_2	Error in Channel B	channel ok	error
	R15	STATV_2	Status V_{out}	V_{out} stable	V_{out} in change
	R14	TRENDV_2	Ramp up/down V_{out}	V_{out} falling	V_{out} rising
	R13	KILL_2	KILL switch setting	disabled	enabled
	R12	ON_OFF_2	HV-ON/OFF switch setting	on	off
	R11	POL_2	Polarity Output voltage	negative	positive
	R10	IN_EX_2	CONTROL switch setting	DAC	manual
	R9	VZ_2	Output voltage Channel B equal to 0	V_{out}<>0	$V_{out}=0$
A	R8	ERROR_1	Error in Channel A	channel ok	error
	R7	STATV_1	Status V_{out}	V_{out} stable	V_{out} in change
	R6	TRENDV_1	Ramp up/down V_{out}	V_{out} falling	V_{out} rising
	R5	KILL_1	KILL switch setting	disabled	enabled
	R4	ON_OFF_1	HV-ON/OFF switch setting	on	off
	R3	POL_1	Polarity Output voltage	negative	positive
	R2	IN_EX_1	CONTROL switch setting	DAC	manual
	R1	VZ_1	Output voltage Channel A equal to 0	V_{out}<>0	$V_{out}=0$

This register is representing the general status of the CHQ.

″Error“ is a combination with a logic OR of _REG2ER_, _REG1ER_, _EXTINH_, _RANGE_ and _ILIM_ from the LAM register.

″$V_{out}=0$″ is true when DAC output = 0 AND actual voltage < 5 V.

LAM register

Channel	Bit	Name	Description for bit = 1	Remark
B	R16	LAM_REG2ER_2	Quality of output voltage channel B not given at present	
	R15	LAM_REG1ER_2	V_{max} or I_{max} is / was exceeded	
	R14	LAM_EXTINH_2	EXINHIBIT signal was / is active (0 = inactive)	
	R13	LAM_RANGE_2	Set voltage channel B exceeds voltage limit	W(A1F16) > V_{max}
	R12	LAM_KEY_CHANGED	Front panel switch was changed channel B	ON_OFF_2, IN_EXT_2, KILL_2
	R11	LAM_EOP_2	V_{out} channel B according to set voltage	end of process_2
	R10	LAM_ILIM_2	Current trip was active channel B	$I_{out} > I_{max\ trip}$
A	R8	LAM_REG2ER_1	Quality of output voltage channel A not given at present	
	R7	LAM_REG1ER_1	V_{max} or I_{max} is / was exceeded	
	R6	LAM_EXTINH_1	EXINHIBIT signal was / is active (0 = inactive)	
	R5	LAM_RANGE_1	Set voltage channel A exceeds voltage limit	W(A0F16) > V_{max}
	R4	LAM_KEY_CHANGED	Front panel switch was changed channel A	ON_OFF_1, IN_EXT_1, KILL_1
	R3	LAM_EOP_1	V_{out} channel A according to set voltage	end of process_1
	R2	LAM_ILIM_1	Current trip was active channel A	$I_{out} > I_{max\ trip}$

The individual bits are set on the occurrence of the event. A general clear is performed after readout.

If the Output voltage was permanently switched off by exceeding V_{max} or I_{max} (ENABLE KILL resp. Current trip), or EXINHIBIT respectively, the error bits (REG1ER_, EXTINH_, ILIM_) have to be reset by reading ″ LAM register ″ before an output voltage can be set again.

Bit assignments

A(15)F(1) Module identifier

R24 ... R01	BCD coded	3 digit: firmware version 3 digit: last three digit of serial number

A(8)F(0) / A(9)F(0) Limits channel A / B

R24 ... R17	mantissa,	R16 ... R13	exponent:	Maximal voltage in [V]
R12 ... R05	mantissa,	R04 ... R01	exponent:	Maximal current in [A]

A(1)F(1) Auto start read

R12 = 1	Auto start channel B is active	R04 = 1	Auto start channel A is active

A(1)F(17) Auto start write

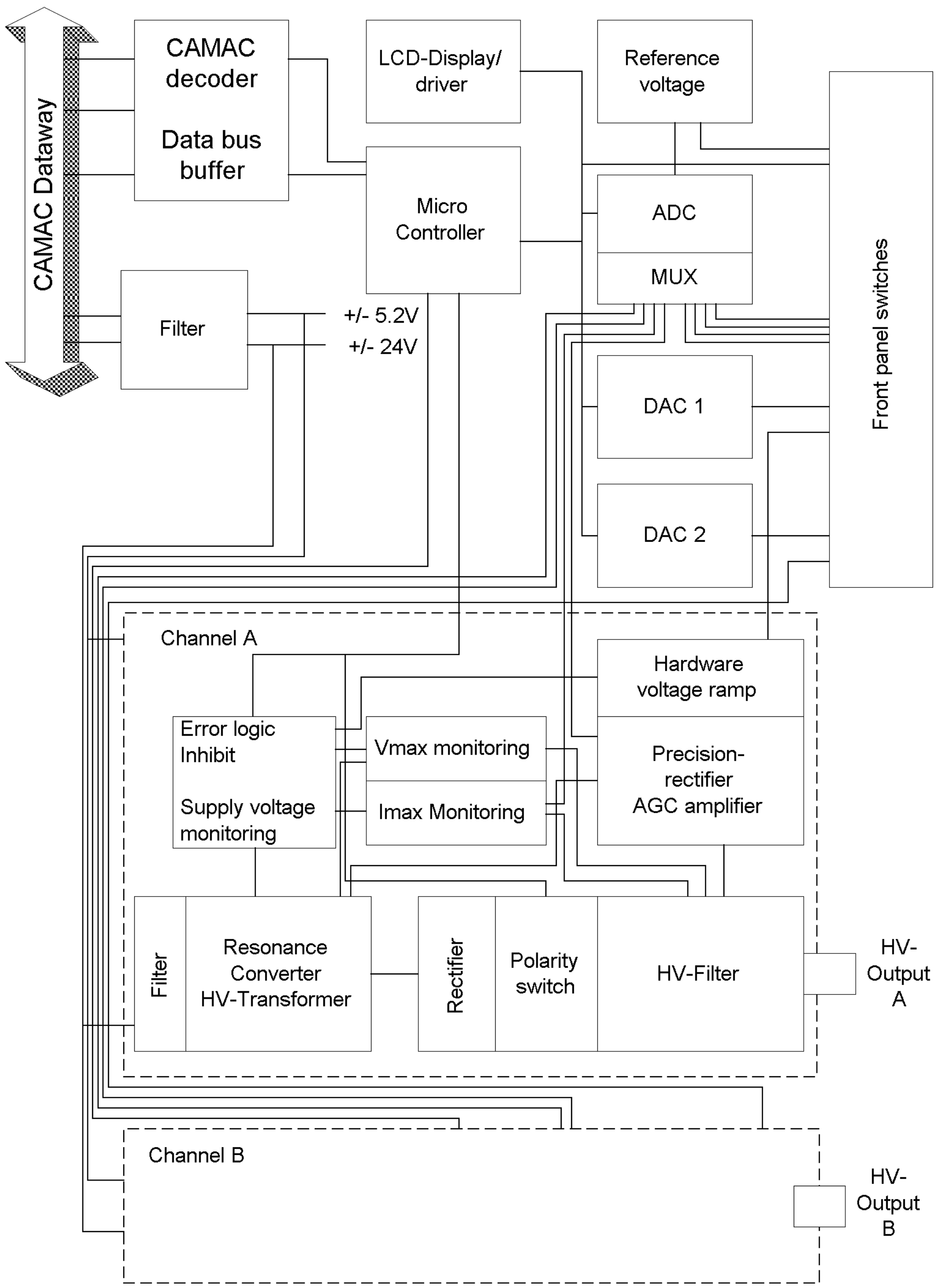
R12 ... R09	for channel B	R04 ... R01	for channel A

(R12 / R04) = 1 if Status register (R12 / R4) + (R10 / R2) = 0
and LAM register (R16 / R8) + (R15 / R7) + (R14 / R6) + R10 / R2) = 0, then
Output voltage is ramping to Set voltage [A(1)F(25) / A(0)F(25) - is not necessary]

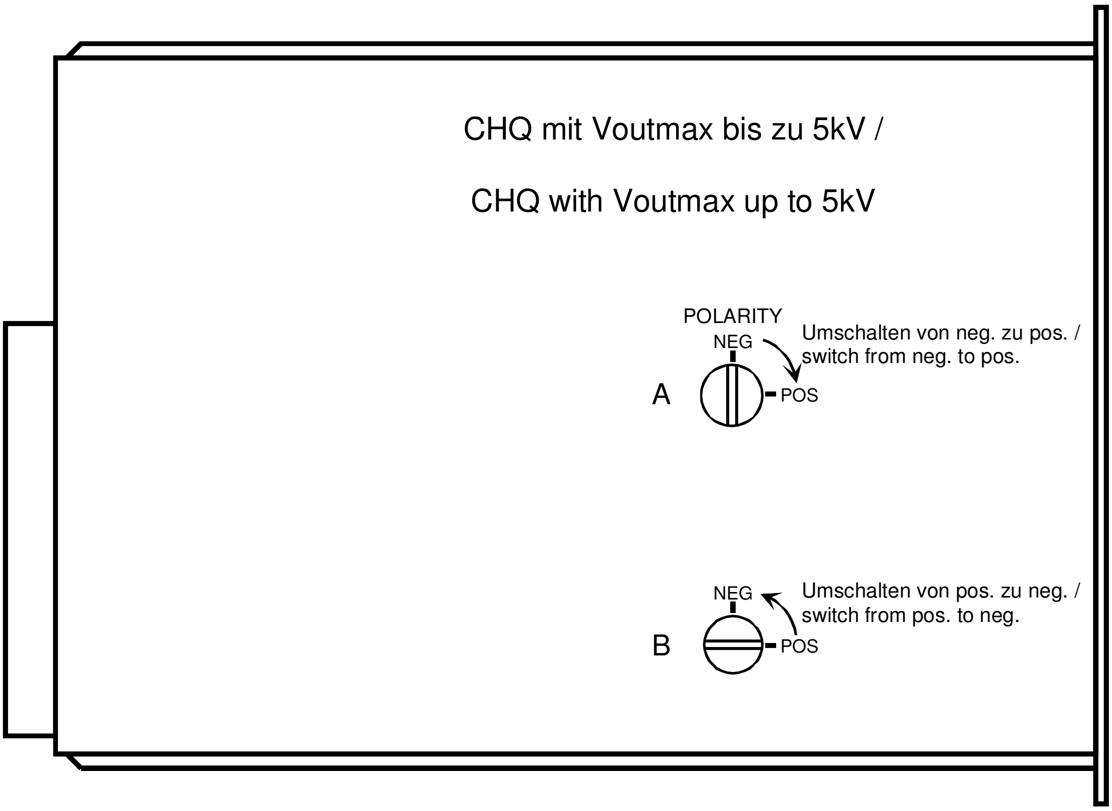
(R11 / R03) = 1 save Current trip in EEPROM
(R10 / R02) = 1 save Set voltage in EEPROM
(R09 / R01) = 1 save Ramp speed in EEPROM
} Values loading in corresponding registers at POWER-ON !
(EEPROM guarantee 1 million saving cycles !)

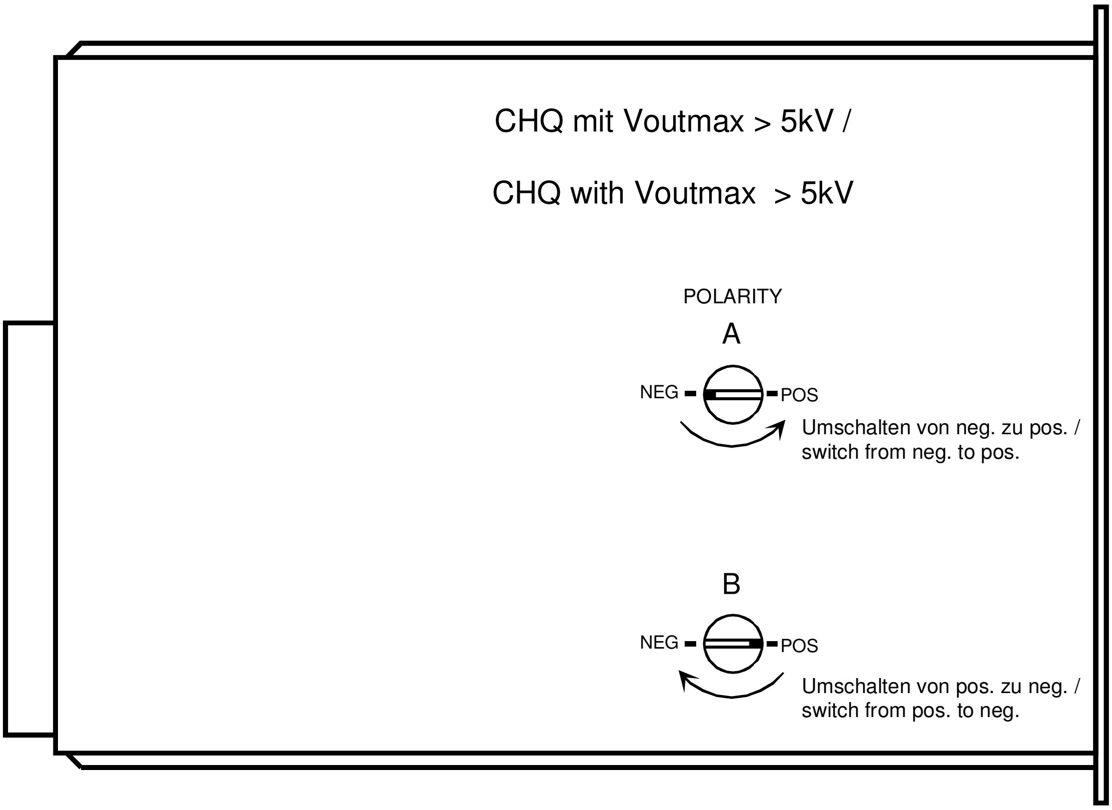
Command execution

When a reading command is carried out for the first time, the respective data has to be made available first, so that there no valid data in this cycle (Q=0). Valid data can be collected with the same command after approx. 200µs (Q=1). After reading measured data (voltage or current), this data will be updated only after approx. 400ms (ADC converting time). Until this the last measured data is read.



Appendix A : CHQ block diagram





Appendix B: CHQ side coffer, Polarity rotary switch

eg.: channel A ⇒ polarity negative
channel B ⇒ polarity positive