Precision CAMAC High Voltage Power Supply
CHQ 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 responsiblity 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´s are one or two channel high voltage power supplies in a CAMAC chassis. The unit is 2 slots wide, and both manual and operation via CAMAC interface are supported. The use of the interface allows for a larger function set than standalone manual control.
The high voltage supplies special properties are high precision output voltage and very low ripple, even under full load. Separate voltage and current limits and an EXINHIBIT input ensure high security for connected sensitive devices. Additionally, the maximal output current per channel is programmable via the interface. The high voltage supply features overload and short circuit protection. The output polarity is selected.

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)	< 5 ∗ 10-5				
$\Delta (V_{OUT}/V_{IN})$	< 5 ∗ 10^{-5}				
Temperature coefficient	< 5 ∗ 10^{-5}/K				
Voltage CONTROL switch in: upper position (manual):	10 - turn potentiometer				
control lower position (DAC):	control via CAMAC interface				
Rate of change of -HV -ON/OFF:	500 V/s (Hardware ramp)				
output voltage -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 function is described at a block diagram of the CHQ. 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 nvalues 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.

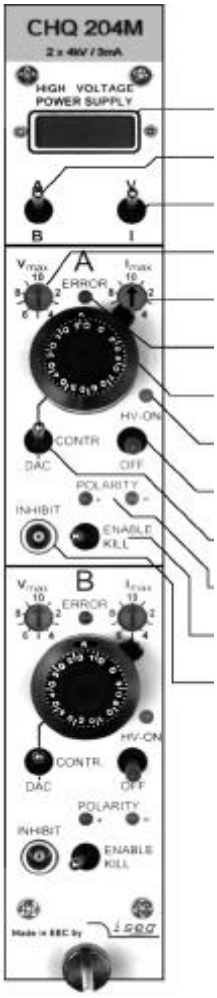
Digital control unit

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] 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

The state of readiness of the unit is produced at the CAMAC 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 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 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].

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 remote 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 the interface.

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 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 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 the 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 EXINHIBIT 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 LAM-Status**"** 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 EXINHIBIT no longer being present.

6. Operation under CAMAC control

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

CAMAC 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
4th Alarm function: LAM	

Front panel switches are having 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 canceld 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	Modul 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
	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
B	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
	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
A	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 formed by the logic or of _REG2ER_, _REG1ER_, _EXTINH_, _RANGE_ and _ILIM_ from the LAM register.

"V_{out}=0**"** is formed by DAC output = 0 and actual voltage < 5 V.

LAM register

Channel	Bit	Name	Description for bit = 1	Remark
	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)	
B	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} > $I_{max\ trip}$
	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)	
A	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 occurance 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	Number of the unit, 6 digit, BCD coded

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

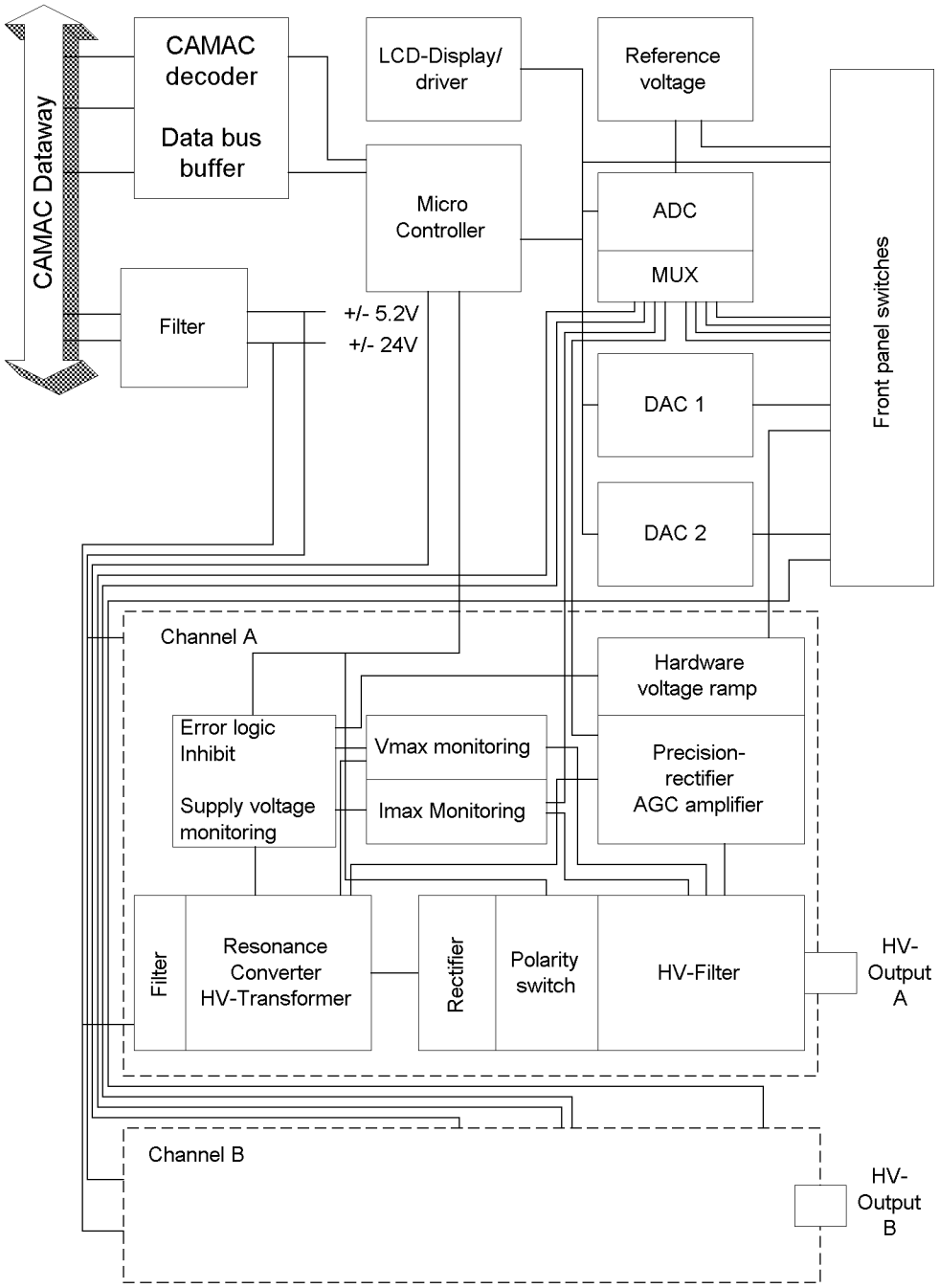
R12 ... R09	for channel B	R04 ... R01	for channel A

(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]

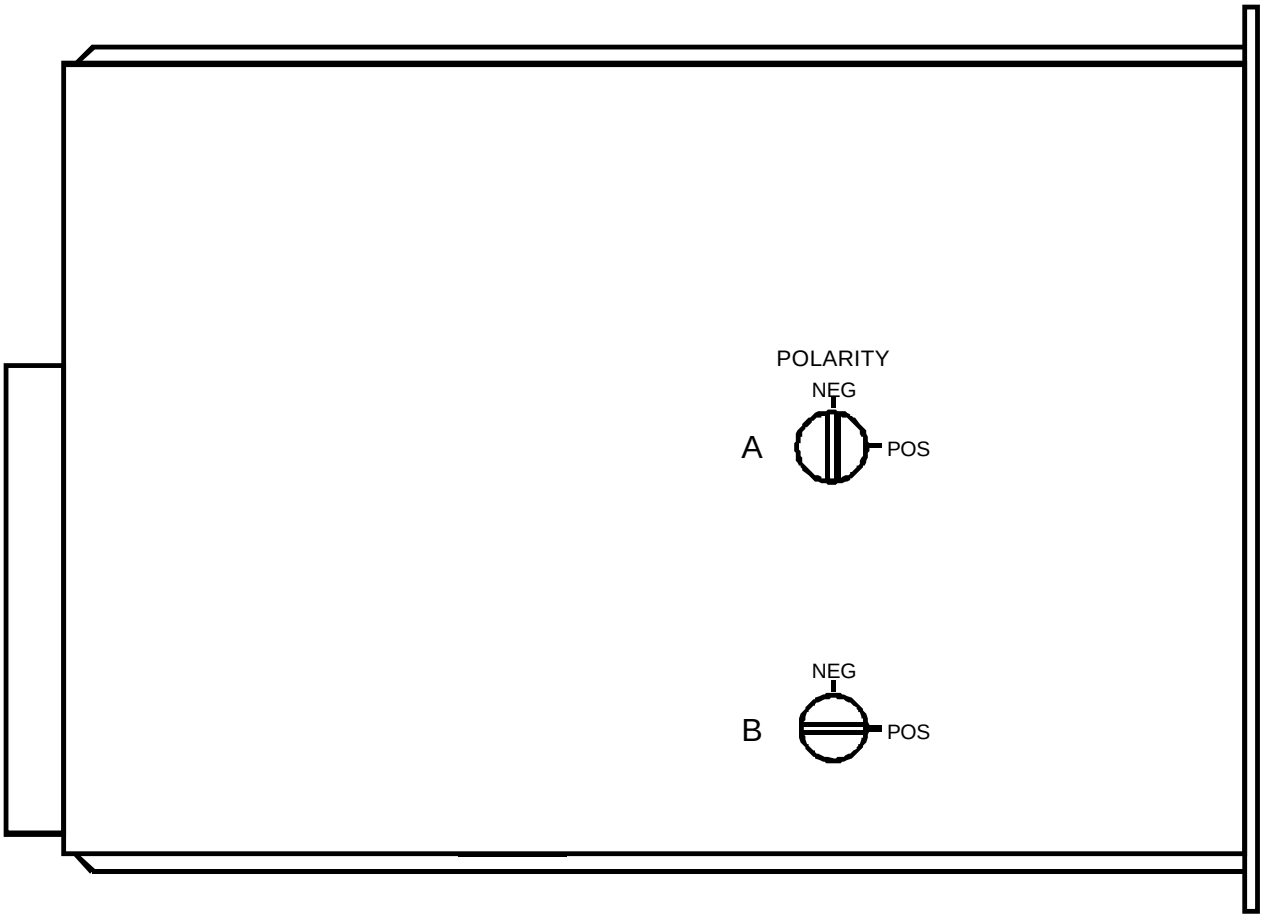
(R11 / R03) = 1	Current trip saveing in EEPROM	⎫
(R10 / R02) = 1	Set voltage saveing in EEPROM	⎬ Values loading in corresponding
(R09 / R01) = 1	Ramp speed saveing in EEPROM	⎭ registers at POWER-ON !
	(EEPROM guarantee 1 million saveing cycles !)	

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 cannot be any valid data in this cycle (Q=0). Valid data can be collected with the same command after circa 200µs (Q=1). After reading measured data (voltage or current), this data will be updated only after circa 400ms (ADC changed time). Up to then, the last measured data is put out.



Appendix A : CHQ block diagram



Appendix B: CHQ side coffer, Polarity rotary switch

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