CAEN
Tools for Discovery

Technical Information Manual

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N1470

PROGRAMMABLE HV POWER SUPPLY

NPO: 00112/07:N1470.MUTx/15

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CE

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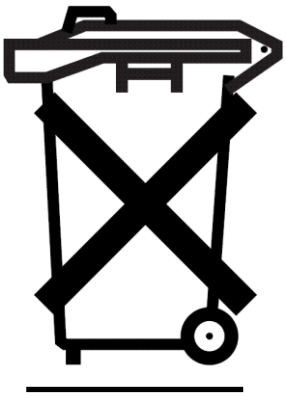

MADE IN ITALY : We stress the fact that all the boards are made in Italy because in this globalized world, where getting the lowest possible price for products sometimes translates into poor pay and working conditions for the people who make them, at least you know that who made your board was reasonably paid and worked in a safe environment. (this obviously applies only to the boards marked "MADE IN ITALY", we can not attest to the manufacturing process of "third party" boards).

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1 General description

1.1 Overview

Fig. 1.1: Mod. N1470 Series Programmable HV Power Supply

The Mod. N1470 provides 4 independent High Voltage channels in a single width NIM mechanics. Two and one channel versions (N1470A and N1470B) are also available.
Each channel can provide a ±8kV max voltage, a 3 mA max current and a 9 W max power (8 W max power when output voltage is larger than ±3 kV).
Channels have common floating return (common return insulated from the crate ground); HV outputs are delivered through SHV connectors.
The HV output RAMP-UP and RAMP-DOWN rates may be selected independently for each channel in the range 1÷500 V/s in 1 V/s steps.
Safety features include:
• OVERVOLTAGE and UNDERVOLTAGE warning when the output voltage differs from the programmed value by more than 2% of set value (minimum 10V).
• Programmable VMAX protection limit
• OVERCURRENT detection: if a channel tries to draw a current larger than its programmed limit, it enters TRIP status, keeping the maximum allowed value for a programmable time (TRIP), before being switched off
• Channels can be enabled or disabled individually through the Interlock logic.
Module control can take place either locally, assisted by a Graphic color display (not available on Mod.N1470AR) or remotely, via USB, RS232 or RS485 (not available on Mod.N1470AL); the RS485 port allows to build a N1470s' daisy chain network (up to 32 modules); in this case the SW1470 Control Software is necessary.
The Mod. A1480 is an optional DC Input Power Equalizer which allows to use a different input power distribution on the N147x modules (see § 2.2).

Table 1.1: Available items

Code	Item	Description
WN1470B08AAC	N1470B	1Ch Programmable Power Supply 8kV
WN1470A08AAC	N1470A	2Ch Programmable Power Supply 8kV
WN1470ALCLAC	N1470AL	2Ch Programmable Power Supply 8kV Local Control (LOW COST)
WN1470ALCRAC	N1470AR	2Ch Programmable Power Supply 8kV Remote Control (LOW COST)
WN1470X08AAC	N1470	4Ch Programmable Power Supply 8kV
WA1480XAAAAA	A1480	DC Power Input Equalizer for N147X Family
WPERS0147001	Customization	Imon Zoom x10
WSW1470XAAAA	SW1470	N147X Control Software

2 Technical specifications

2.1 Packaging

The Mod. N1470 boards are housed in single width NIM modules.

2.2 Power requirements

The following table resumes the power absorption in the 3kV/3mA, 4kV/2mA and 8kV/1mA ranges.

Table 2.1: Power absorption

Board type	N1470					
Channel configuration	*without A1480*			*with A1480*		
	Max n° CH ON[1]	Current (±12V)	Current (±6V)	Max n° CH ON	Current (±6V)	Current (±12V)
3kV/3mA	3 CH	2.80 A	<10mA	4 CH	4.30 A	1.85 A
4kV/2mA	4 CH	2.84 A	<10mA	4 CH	3.50 A	1.52 A
8kV/1mA	4 CH	3.16 A	<10mA	4 CH	3.90 A	1.68 A
Board type	N1470A, AL, AR					
Channel configuration	*without A1480*			*with A1480*		
	Max n° CH ON	Current (±12V)	Current (±6V)	Max n° CH ON	Current (±6V)	Current (±12V)
3kV/3mA	2 CH	1.92 A	<10mA	2 CH	2.32 A	1.04 A
4kV/2mA	2 CH	1.54 A	<10mA	2 CH	1.86 A	0.86 A
8kV/1mA	2 CH	1.58 A	<10mA	2 CH	1.90 A	0.85 A
Board type	N1470B					
Channel configuration	*without A1480*			*with A1480*		
	Max n° CH ON	Current (±12V)	Current (±6V)	Max n° CH ON	Current (±6V)	Current (±12V)
3kV/3mA	1 CH	1.09 A	<10mA	1 CH	1.28 A	0.62 A
4kV/2mA	1 CH	0.89 A	<10mA	1 CH	1.05 A	0.52 A
8kV/1mA	1 CH	0.98 A	<10mA	1 CH	1.17 A	0.57 A

WARNING: if the A1480 is not installed, ±6V power supplies are required only by older versions of the N1470; such boards can be recognized by the presence of power pins 10 and 11 on the backplane NIM connector (see figure 2.1). If the A1480 is not installed, new versions operate only with ±12V power supplies.

[1] The maximum number is considered with channels at FULL LOAD

PIN	FUNCTION
1	+3 Volts
2	-3 Volts
3	SPARE
4	RESERVED
5	COAXIAL
6	COAXIAL
7	COAXIAL
8	+200 Volts D.C.
9	SPARE
10	+6 Volts
11	-6 Volts
12	RESERVED
13	CARRY NO. 1
14	SPARE
15	RESERVED
16	+12 Volts
17	-12 Volts
18	SPARE
19	RESERVED
20	SPARE
21	SPARE
22	RESERVED
23	RESERVED
24	RESERVED
25	RESERVED
26	SPARE
27	SPARE
28	+24 Volts
29	-24 Volts
30	SPARE
31	CARRY NO. 2
32	SPARE
33	117 V A.C. (HOT)
34	POWER RET. GND
35	RESET
36	GATE
37	SPARE
38	COAXIAL
39	COAXIAL
40	COAXIAL
41	117 V A.C (NEUT.)
42	HIGH QUAL. GND
G	GROUND GUIDE PIN

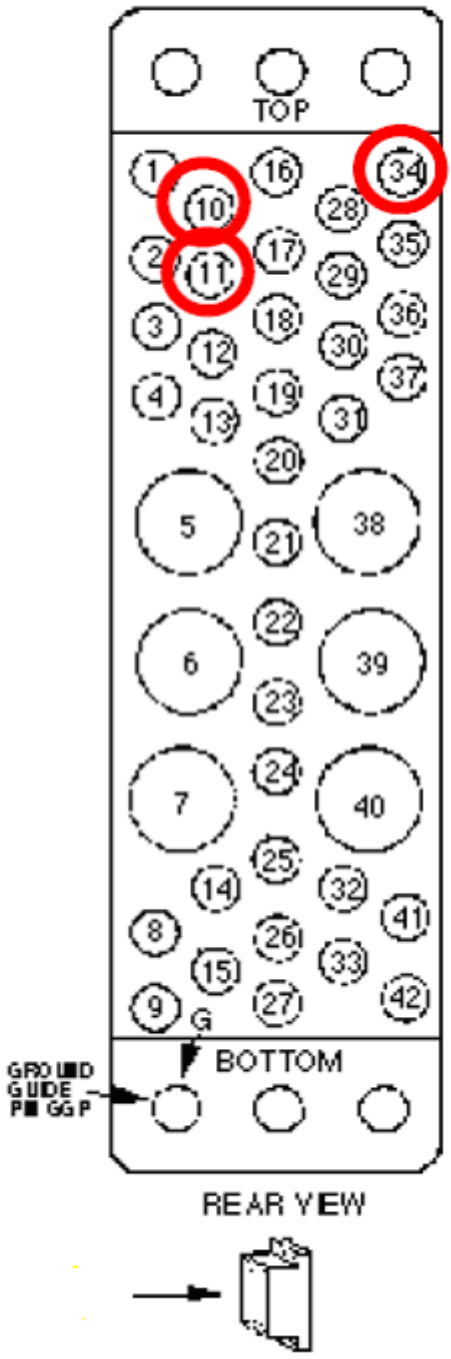


Fig. 2.1: Backplane NIM connector

2.3 Front and back panel

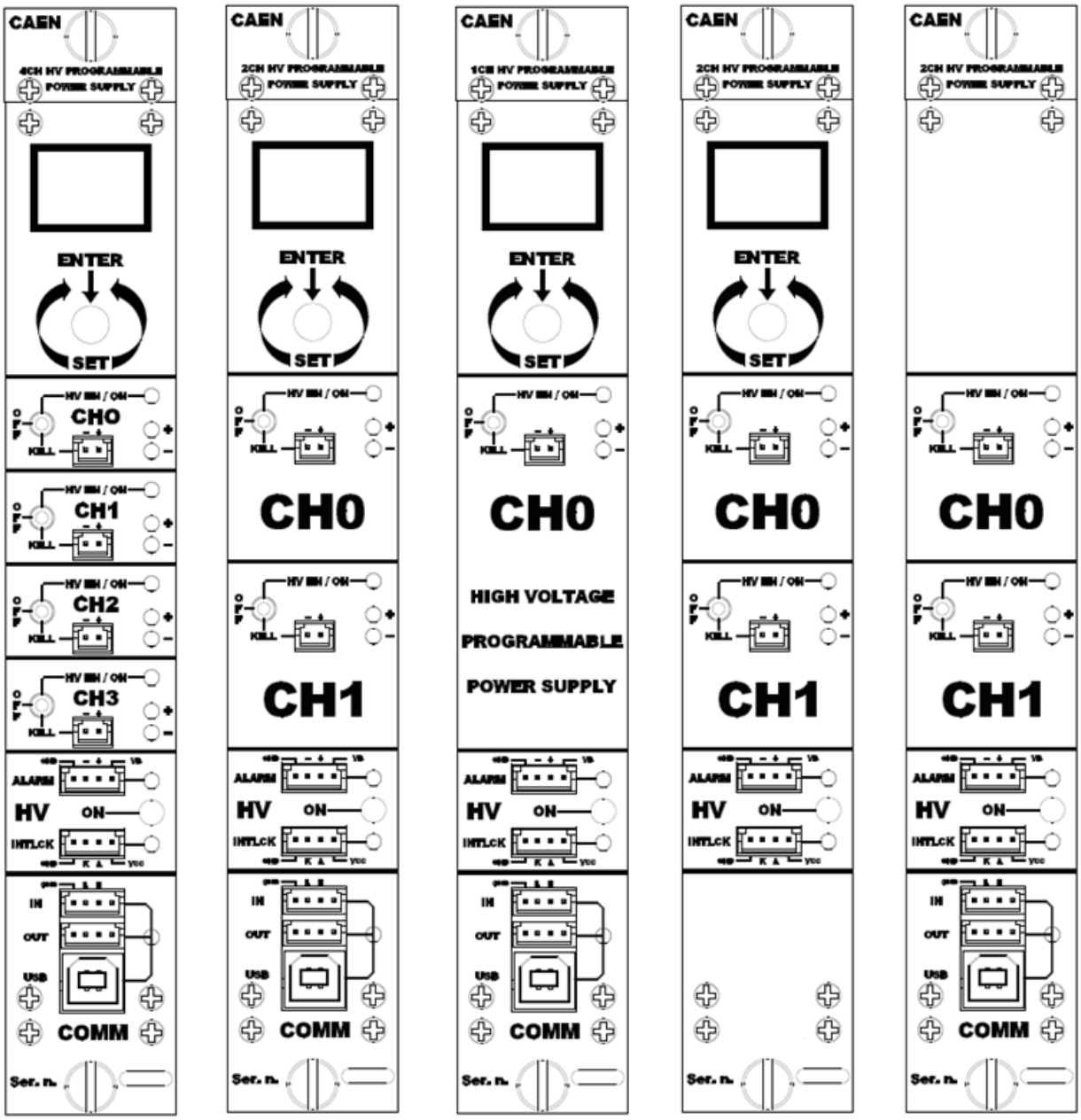


Fig. 2.2: Mod. N1470 series front panel

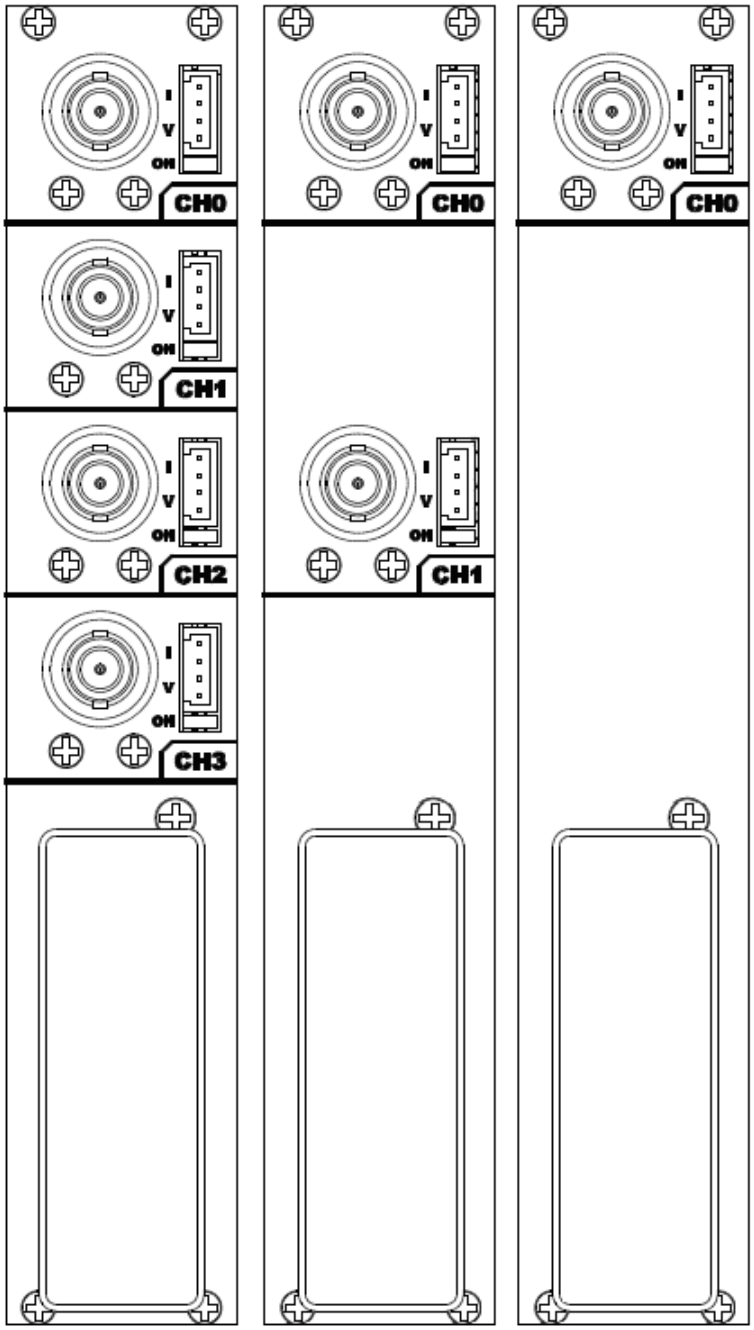


Fig. 2.3: Mod. N1470 series back panel (std., A, B)

2.4 Front panel connections

2.4.1 Local control section[2]

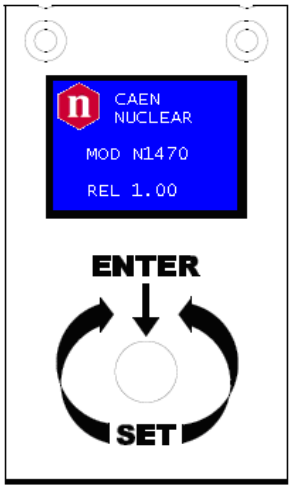


Fig. 2.4: Local control panel

NAME:	TYPE:	FUNCTION:
MONITOR	1" OLED DISPLAY (96x64)	*Local settings monitoring*
TUNE	ROTARY SWITCH	*Parameter and Mode setting*

2.4.2 Channel control section

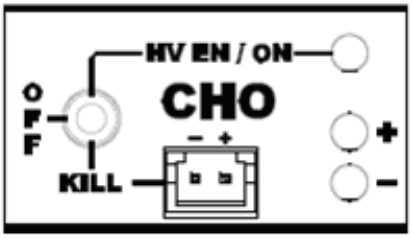


Fig. 2.5: Channel control panel and Kill *scheme*

NAME:	TYPE:	FUNCTION:
HV_EN/OFF/KILL	3 POS. SWITCH	*Channel Enable and turning OFF/KILL*[3]
ON	RED LED	*HV On enabled*
REMOTE KILL	AMP 280370-2	*The channel is KILLED either as the +/- contacts are open or as a +4÷6Vdc voltage is fed to pin - (see note)*
+	GREEN LED	*Positive polarity*
-	YELLOW LED	*Negative polarity*

[2] Not available on Mod. N1470AR
[3] OFF: Channel turned off according to RAMP DOWN setting; KILL: Channel turned off at fastest available rate

2.4.3 HV Status control section

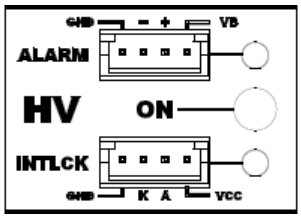


Fig. 2.6: N1470 HV Status control panel

NAME:	TYPE:	SIGNAL:	FUNCTION:
ON	RED LED		*HV On enabled (at least one channel ON)*
ALARM	RED LED/ AMP 280371-2.	Out	*Alarm status signaled (active LOW)*
INTERLOCK	RED LED/ AMP 280371-2	In	*Interlock signal*

2.4.3.1 Alarm signal

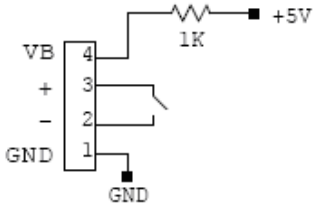


Fig. 2.7: N1470 ALARM electrical scheme

As an Alarm condition is detected (see § 3.4.3.1 and § 3.4.4.1) pins 2 and 3 (- and +) are closed; the contact can be used to switch an external device supplied by an external source, otherwise the VB and GND references can be used to provide a TTL compatible level on pin 2 and 3.

In the first case (externally supplied device) the maximum allowed ratings are:

- Maximum voltage between + and -: 12V
- Maximum sink current across + and -: 100mA

In the latter case, in order to produce a TTL compatible Alarm Out, pin 3 (+) must be connected with pin 4 (VB) and pin 1 (GND) with pin 2 (-); see the diagram below:

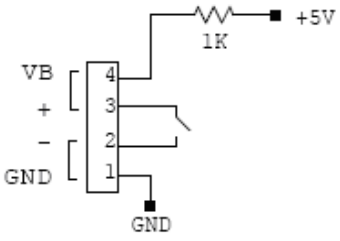


Fig. 2.8: N1470 ALARM TTL configured

2.4.3.2 Interlock signal

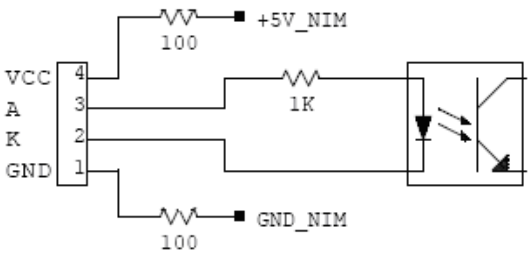


Fig. 2.9: N1470 INTERLOCK electrical scheme

A schematic diagram of the Interlock input is shown in the figure above, where the diode is part of optocoupler stage.
Interlock means that channels are hardware disabled. The interlock operation is explained by the following table:

Table 2.2: Interlock operation

CONFIGURATION ↓	INTERLOCK MODE (§ 3.1.1) →	OPEN	CLOSE
leave contact open		INTERLOCK	ENABLED
voltage level (0÷1V, ~5mA current) between pin 2 and pin 3		INTERLOCK	ENABLED
short circuit pin 1 with pin 2, and pin 3 with pin 4		ENABLED	INTERLOCK
voltage level (4÷6V, ~5mA current) between pin 2 and pin 3		ENABLED	INTERLOCK

The front panel Interlock LED is ON when the INTERLOCK is enabled; as INTERLOCK is enabled, channels are turned off at the fastest available rate, regardless the RAMP DOWN setting.

2.4.4 Remote communication control section[4]

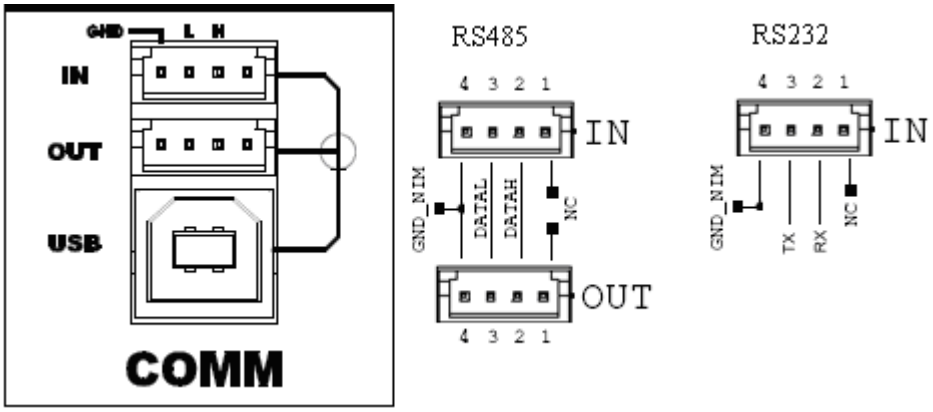


Fig. 2.10: Remote communication control and RS485 I/O – RS232 IN electrical scheme

NAME:	TYPE:	FUNCTION:
IN	AMP 280371-2	*RS485 Input[5]; adaptable to RS232 standard (see also § 4.2.2)*
OUT	AMP 280371-2	*RS485 Output*
USB	B TYPE USB	*USB2.0 compliant realized via USB ↔ RS232 FT232BM converter*

[4] Not available on Mod. N1470AL
[5] RS 485 Serial Port Interface allows to control up to 32 modules connected by a twisted pair cable; the first and last modules must be terminated, see § 4.2.

2.5 Rear panel connections

2.5.1 HV Channel Output

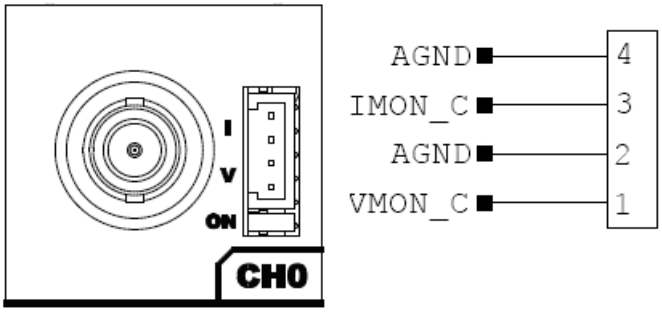


Fig. 2.11: HV Channel panel and test point electrical scheme

NAME:	TYPE:	FUNCTION:
MON	AMP 280371-2	*Vout/Iout Test point*
OUT	SHV RADIALL R317580 Impedance: 50 Ohm Frequency range: 0 – 2 GHz VSWR: <1.20 + 0.3 F (GHz) – (plug and jack) Test voltage: 10kV DC – 1mn (unmated connectors) 12kV DC – 1mn (mated pairs) Current rating: 10 A	*HV Channel Output*
ON	Red LED	*HV Channel ON*

The test points allow to monitor the Channel Output Voltage and Current according to the following conversion:

VMON: Voltage level (1V = 2kV ±1% readout; same polarity as channel)

IMON: Voltage level (1V = 660 µA ±3% readout; positive, 0÷5 V range)

2.6 Imon Zoom

Imon Zoom is an optional feature that allows to monitor the channel current with an increased resolution (10x) in the 0 – 300 µA range; if the Imon Zoom is installed, by selecting Imon Range = LOW (see § 3.1.2), the output current is monitored with 5nA resolution (instead of 50 nA), in the 0 – 300 µA range. It is important to notice that, if Imon Range = LOW is selected, and the channel draws a current larger than 300 µA, then Overcurrent is signalled.

2.7 Technical specifications table

Table 2.3: Mod. N1470 series channel technical specifications

Output channels:	Positive or Negative Polarity (requires internal setting, see § 4.1)			
Output ranges:	8 kV / 3 mA			
Max. Ch. Output Power:	9 W (Vset ≤ 3 kV) 8 W (Vset > 3 kV)			
Vset / Vmon Resolution:	200 mV			
Iset / Imon Resolution:	If IMON RANGE = High is selected resolution is 50 nA If IMON RANGE = Low is selected resolution is 5 nA			
Vmax:	0 ÷ 8100 V Absolute maximum HV level that the channel is allowed to reach, independently from the preset value Vset. Output voltage cannot exceed the preset value Vmax. The accuracy is 1 % ± 5 V			
Vmax resolution:	± 1 V			
Alarm output:	Open collector, 100 mA maximum sink current			
Interlock input:	LOW: <1V; current~5mA; HIGH: 4÷6 V			
Ramp Up/Down:	1÷500 Volt/s, 1 Volt/s step			
Trip:	Max. time an "overcurrent" is allowed to last (seconds). A channel in "overcurrent" works as a current generator; output voltage varies in order to keep the output current lower than the programmed value. "Overcurrent" lasting more than set value (1 to 9999) causes the channel to "trip". Output voltage will drop to zero either at the Ramp-down rate or at the fastest available rate, depending on Power Down setting; in both cases the channel is put in the OFF state. If trip= INFINITE, "overcurrent" lasts indefinitely. TRIP range: 0 ÷ 999.9 s; 1000 s = Infinite. Step = 0.1 s			
Vmon vs. Vout Accuracy: [6]	±0.02% of read value ±2V			
Vset vs. Vmon Accuracy: [6]	±0.02% of read value ±2V			
Imon vs. Iout Accuracy: [6]	If IMON RANGE = High: ±2% of read value ±2µA If IMON RANGE = Low: ±2% of read value ±200nA			
Iset vs. Imon Accuracy: [6]	If IMON RANGE = High: ±2% of read value ±2µA If IMON RANGE = Low: ±2% of read value ±200nA			
Voltage Ripple: [7]	<10mVpp	3kV/200µA		
	<15mVpp	4kV/200µA	6kV/200µA	8kV/200µA
	<25mVpp	3kV/3mA	4kV/2mA	
	<30mVpp	6kV/1mA	8kV/800µA	
Humidity range:	0 ÷ 80%			
Operating temperature:	0 ÷ 45°C			
Storage temperature:	-10 ÷ 70°C			
Vout / Temperature coefficient:	max. 50ppm / °C			
Vout /voltage coefficient:	max 2ppm/V			
Imon / Temperature coefficient:	max 100ppm/C°; max 300ppm/C° with Imon X10 zoom (optional)[8]			
Long term stability Vout vs. Vset:	± 0.02% (after one week @ constant temperature)			

[6] From 10% to 90% of Full Scale Range
[7] Measured with: 1m cable length; 2nF capacitance, 100MHz band width
[8] Typical data for IMON X10: Imon-Zoom Offset = ±100nA; ppm/C° Imon-Zoom <300ppm/°C; Imon leakage +5nA/2kV

3 Operating modes

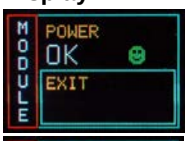
CAUTION: N1470 MUST BE USED ONLY IN CRATES WITH FORCED COOLING AIR FLOW!

Module control can take place either locally, or remotely, via USB or RS485 (see § 3.3).

3.1 Programmable parameters

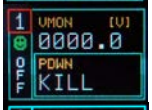
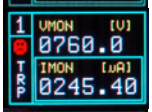
3.1.1 Boards parameters

General board parameters (CONTROL can be operated both in LOCAL and REMOTE mode; other monitor and settings are allowed in LOCAL mode only; see § 3.2.2) include:

Parameter:	Function:	Display:
Power (Monitor)	Module power supply status	
Termination (Monitor)	Local Bus termination status (ON/OFF)	
HV Clock (Monitor)	Sync clock frequency (200±10 kHz correct value)	
Local Bus Baud Rate (Monitor/Set)	9600, 19200. 38400, 57600, 115200 Baud	
Local Bus Address (Monitor/Set)	Local Bus address for remote communication (0÷31)	
USB Baud Rate (Monitor/Set)	9600, 19200, 38400, 57600, 115200 Baud	
INTERLOCK (Monitor/Set)	CLOSED / OPEN OPERATION (see § 2.4.3)	
CONTROL (Monitor/Set)	REMOTE: the module is controlled remotely; local monitor is allowed; *LOCAL/REMOTE* switch is enabled LOCAL: the module is controlled locally; remote monitor is allowed	

3.1.2 Channel settings

For each channel the following parameters can be programmed and monitored either locally or remotely (see § 3.2.3):

Parameter:	Function:	Unit:	Display:
Vmon	High Voltage Monitored value	Volt	
Imon	Current Monitored value	µA	
V_{set}	High Voltage programmed value	Volt	
I_{set}	Current Limit programmed value	µA	
MaxV	Absolute maximum High Voltage level that the channel is allowed to reach (see § 0)	V	
Ramp-Up	Maximum High Voltage increase rate	V/s	
Ramp-Down	Maximum High Voltage decrease rate	V/s	
Power Down	Power Down mode after channel TRIP	KILL or RAMP	
Trip	Maximum time an "overcurrent" is allowed to last expressed in seconds (see § 0)	s	
Imon Range[9]	Current Monitor Zoom 10x (optional)	High or Low	

3.2 Local Control

Insert the unit inside a powered NIM crate, and switch it ON. At the power the Display shows for a few seconds the following screen.

Fig. 3.1: Welcome screen

At this point the module is ready to be operated locally. The TUNE ROTARY SWITCH (see § 2.4.1) is lit up as long as Local Control is enabled.

[9] This feature is available as optional; code WPERS0147001 N14XX Customization - Imon Zoom

3.2.1 HV connection

Verify the channels polarity (polarity setting is explained in § 3.4) checking that the polarity LEDs are switched on according to the programmed configuration (see § 2.4.2); verify the HV_EN/OFF/KILL 3 POS. SWITCH of each channel is set to OFF; the Display will show the following message in the left lower row:

Fig. 3.2: Channel OFF status screen

now connect the HV cable linking the outputs to the loads to be supplied and enable the HV outputs switching the HV_EN/OFF/KILL 3 POS. SWITCH in the HV_EN position; the Display will show the following message in the left lower row:

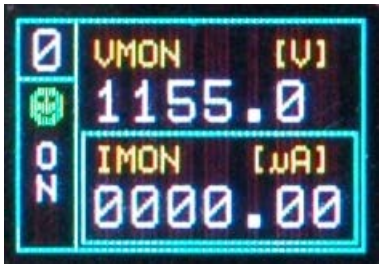


Fig. 3.3: Channel ON status screen

The KILL position of the HV_EN/OFF/KILL 3 POS. SWITCH allows to turn off the module at the fastest available rate; the Display will show the following message in the left lower row:

Fig. 3.4: Channel KILL status screen

3.2.2 Module settings

Module settings are general board settings; turn the TUNE ROTARY SWITCH until this screen is shown:

Fig. 3.5: Mode settings status screen

Push the TUNE ROTARY SWITCH in order to access MODULE parameters; the MODULE frame becomes red:

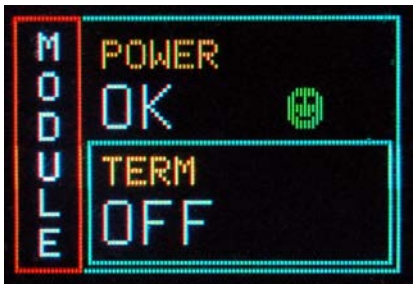


Fig. 3.6: Mode settings access screen

The TUNE ROTARY SWITCH allows to select the parameter to be set; turn the ROTARY SWITCH until such parameter is displayed (for example CONTROL), then select it by pushing the ROTARY SWITCH (the parameter is shown with a red frame as long as it is active):

Fig. 3.7: Mode settings edit screen

Select the desired value by turning the TUNE ROTARY SWITCH and confirm it by pushing the switch itself.

3.2.3 Channel settings

In order to operate Output Channel settings:
Turn the TUNE ROTARY SWITCH until the channel number to be set is displayed in the left upper row (for example Channel 0)
Push the TUNE ROTARY SWITCH: at this point the frame of the left upper row (channel number) becomes red and the channel is selected

Fig. 3.8: Channel settings edit screen

Turn the TUNE ROTARY SWITCH until the parameter to be set (for example VSET) is displayed in the right lower row

Fig. 3.9: Channel VSET select screen

Push the TUNE ROTARY SWITCH: at this point the parameter is selected, its frame is shown in red and its name in blue; it is now possible to change the parameters value

Fig. 3.10: Channel VSET access screen

Turn the TUNE ROTARY SWITCH until the value digit to be edited is shown in blue, the parameter name in yellow

Fig. 3.11: Channel VSET digit selection screen

Push the TUNE ROTARY SWITCH: at this point the value digit becomes yellow and can be edited

Fig. 3.12: Channel VSET digit access screen

Turn the TUNE ROTARY SWITCH until the digit reaches the desired value

Fig. 3.13: Channel VSET digit adjust screen

Confirm it by pushing the TUNE ROTARY SWITCH, the edited digit returns blue

Fig. 3.14: Channel VSET digit confirm screen

Once all the digits are set to the desired value, turn the TUNE ROTARY SWITCH until the parameter name returns blue

Fig. 3.15: Channel VSET confirm screen

Push the TUNE ROTARY SWITCH in order to de-select the parameter, the frame returns to blue

Fig. 3.16: Channel VSET de-select screen

It is now possible to set another parameter; note that the POWER DOWN and IMRANGE setting has not digits to be edited, but two options, TRIP/KILL and HIGH/LOW respectively:

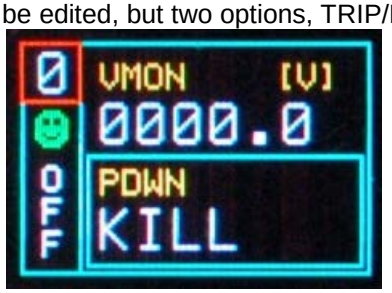


Fig. 3.17: Channel KILL screen

In order to access another channel, the EXIT parameter has to be selected

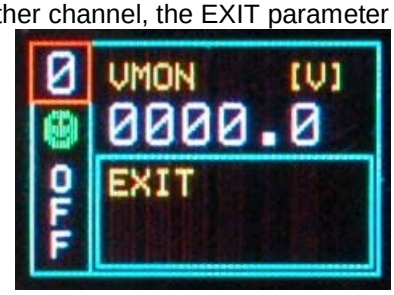


Fig. 3.18: Channel EXIT screen

Now by turning the TUNE ROTARY SWITCH another channel number to be set can be selected.
If CONTROL MODE (see § 3.1.1) is set to REMOTE, the left lower row reports DIS (Disabled), since the channel can be accessed only via the serial links (see § 3.3.1). If the INTERLOCK MODE is changed while one channel is ON, the channel is turned OFF and the left lower row reports ILK (Interlock); if the channel is OFF, it can not be turned ON, until it is enabled according to the Interlock logic (see § 3.1.1).

3.2.3.1 Group Settings[10]

Group settings allow to broadcast the same parameter value to all channels.
In order to operate Group settings:
Turn the TUNE ROTARY SWITCH until ALL is displayed in the left column

Fig. 3.19: Group selection

Push the TUNE ROTARY SWITCH: at this point the frame of the left column becomes red and the GROUP is selected. Turn the TUNE ROTARY SWITCH until the parameter to be set (for example VSET) is displayed in the right column (all four channels values).

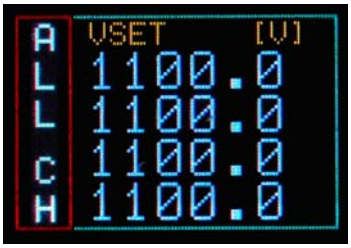


Fig. 3.20: Group active

Push the TUNE ROTARY SWITCH: at this point the parameter is selected, its frame is shown in red and its name in blue (only one value common to all channels; pre-set value is picked from Channel 0); it is now possible to change the parameters value.

Fig. 3.21: Group VSET access screen

Turn the TUNE ROTARY SWITCH until the value digit to be edited is shown in blue, the parameter name in yellow

Fig. 3.22: Group VSET digit selection screen

[10] Mod. N1470B has not group settings; Mod. N1470A has group settings, 2 channels values are displayed

Push the TUNE ROTARY SWITCH: at this point the value digit becomes yellow and can be edited

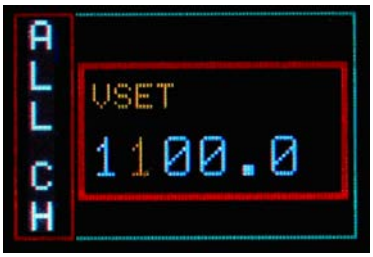


Fig. 3.23: Group Channel VSET digit access screen

Turn the TUNE ROTARY SWITCH until the digit reaches the desired value

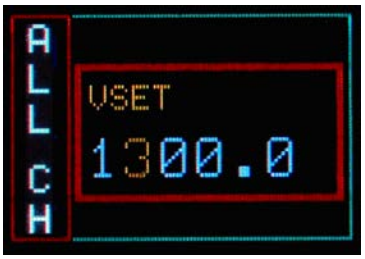


Fig. 3.24: Group VSET digit adjust screen

Confirm it by pushing the TUNE ROTARY SWITCH, the edited digit returns blue

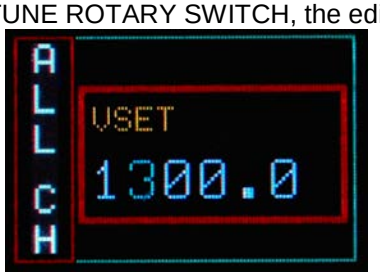


Fig. 3.25: Group VSET digit confirm screen

Once all the digits are set to the desired value, turn the TUNE ROTARY SWITCH until the parameter name returns blue. Push the TUNE ROTARY SWITCH in order to de-select the parameter, the frame returns to blue; when the parameter is not active, the parameter status of the four channels is shown.

Fig. 3.26: Channel VSET de-select screen

In order to go to individual channel settings, the EXIT parameter has to be selected

Fig. 3.27: Group EXIT screen

3.2.3.2 Smileys

Three types of Smileys in the display indicate:

Table 3.1: Smileys list

Smiley	Meaning
	OK Status
	WARNING Status
	ALARM Status

3.3 Remote Control

Module control can take place remotely, via USB or RS485; the latter allows to build a N1470s' daisy chain network. The CAEN NIM8301 7U 12 Slot Smart Fan Unit 300/600 W Crate allows also to communicate with the module via Ethernet.

3.3.1 Serial Links

3.3.1.1 USB communication

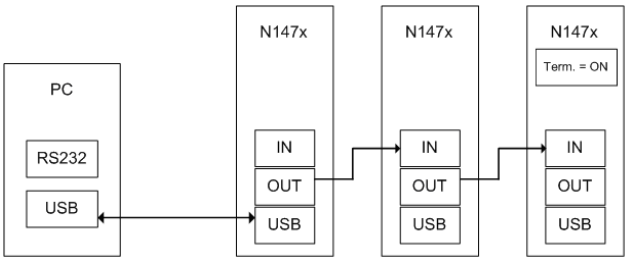


Fig. 3.28: USB communication diagram

The module is provided with a USB2.0 compliant interface (see § 2.4.4). The N1470 can be programmed via PC by connecting the PC USB port with the N1470 USB B-type port; the featured controller, the FT232BM chip requires drivers freely available at www.ftdichip.com (Drivers section); the site also provides installation instructions for all OS's (Documents section)
The connection can be performed via terminal emulator, such as HyperTerminal, configured as follows:

- baud rate 9600 (the same set on the N1470! See § 3.2.2)
- Data bits: 8
- Parity: none
- stop bit: 1
- Flow control: Xon Xoff

It is also possible to build a daisy chain of up to 32 N1470's, with the first module connected to the PC USB port and the subsequent ones daisy chained through the COMM IN/OUT, as explained in § 3.3.1.3; in this case communication with the chained modules is achieved through the USB - RS485 Communication Protocol, see § 3.4. All modules must be assigned a LOCAL BUS ADDRESS (see § 3.1.1) different from one another and the last one must be terminated (see § 4.2.1).

3.3.1.2 RS232 communication

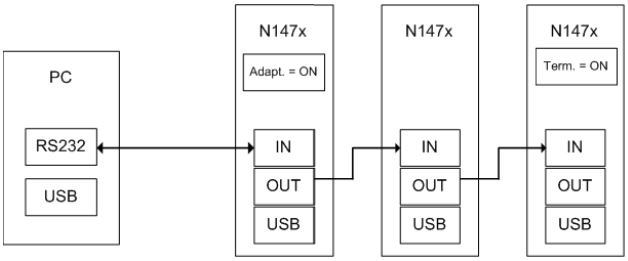


Fig. 3.29: RS232 communication diagram

In order to control the module via RS232 it is necessary to use the module's COMM IN port (refer to § 2.4.2 for RS232 signals) and to follow adaptation instructions (see § 4.2.2).
The connection can be performed via terminal emulator, such as HyperTerminal, configured as follows:

- baud rate 9600 (the same set on the N1470! See § 3.2.2)
- Data bits: 8
- Parity: none
- stop bit: 1
- Flow control: Xon Xoff

It is also possible to build a daisy chain of up to 32 N1470's, with the first module connected to the PC RS232 port and the subsequent ones daisy chained through the COMM IN/OUT, as explained in § 3.3.1.3; in this case communication with the chained modules is achieved through the USB - RS485 Communication Protocol, see § 3.4. All modules must be assigned a LOCAL BUS ADDRESS (see § 3.1.1) different from one another and the last one must be terminated (see § 4.2.1).

3.3.1.3 RS485 communication

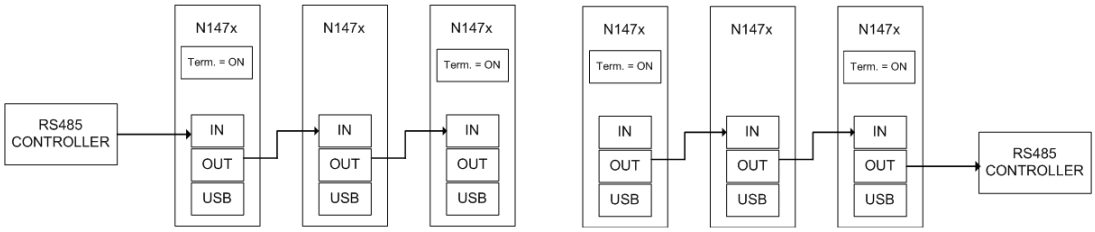


Fig. 3.30: RS485 communication diagram

The COMM IN / OUT connectors implement a RS485 type LOCAL BUS which allows to build a 32 modules daisy chain. This can be achieved through the following steps:

- Connect the connector OUT of a module to corresponding the IN connector of the next one
- Assign to each module a different address (LOCAL BUS ADDR); see § 3.1.1
- Ensure that the LOCAL BUS BIT RATE is the same for all modules; see § 3.1.1
- Terminate the first and the last module in the chain (see § 4.2)

The module control can be done in one of the following ways:

  - by connecting a RS485 controller to the first module's COMM IN port
  - by connecting a RS485 controller to the last module's COMM OUT port

Communication with the chained modules is achieved only through the USB - RS485 Communication Protocol, see § 3.4.

3.3.1.4 Ethernet communication

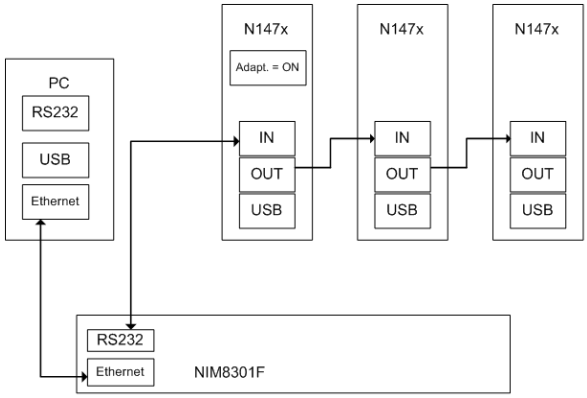


Fig. 3.31: Ethernet communication diagram

It is possible to communicate via Ethernet with one or more daisy chained N1470 modules through the NIM8301 Fan Unit[11]. Communication via Ethernet is possible only through the USB - RS485 Communication Protocol. The single module or the first module of the daisy chain must be connected to the Fan Unit RS232 port through the cable adapter (see figure below) connected to the N1470 COMM IN port; SW[200, 201] switch placed on the Microcontroller board inside the module must be set to Adaptation ON (see § 4.2.2).

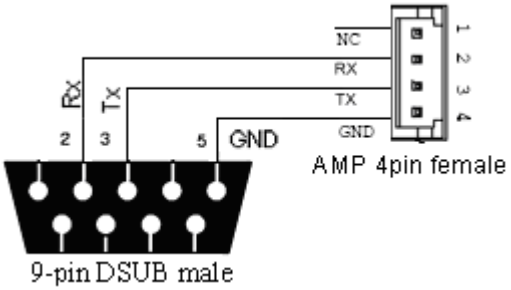


Fig. 3.32: RS232 port cable adapter

[11] The CAEN Mod. NIM8301 is a 7U (5+2) full size NIM crate (19"-12 slot) available with pluggable 300W and 600W power supplies, ventilated by pluggable 2U fan unit. Remote control and monitoring take place through CAN bus, Ethernet, USB and RS232 interfaces.

3.3.2 Communication Control

In order to launch the communication, type *CAEN* and then <Enter>.
As the communication is established, the Main Menu will be displayed.

3.3.2.1 Remote Control: Main Menu

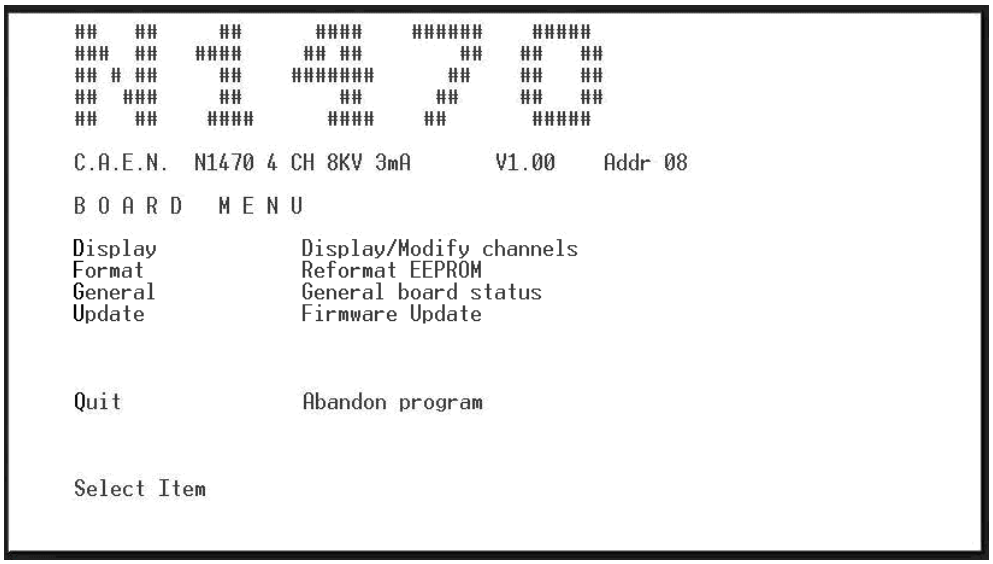


Fig. 3.33: Main Menu

Type **D** to set/monitor channels parameters
Type **F** to format the EEPROM
Type **G** to monitor board status
Type **U** to upgrade the firmware
Type **O** to perform the current offset calibration
Type **Q** to exit the program

3.3.2.2 Remote Control: General Menu

By typing **G** it is possible to access the General Menu which includes the board's general settings.

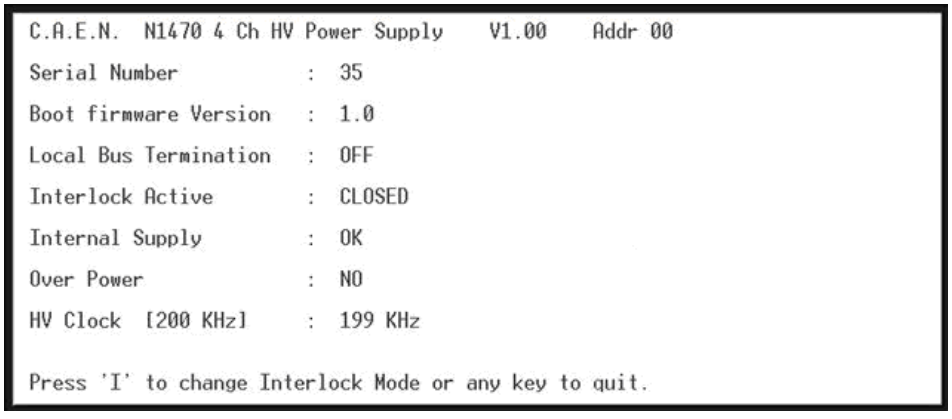


Fig. 3.34: Board Status Menu

3.3.2.3 Remote Control: Channels Menu

By typing **D** it is possible to monitor and set all the channels parameters listed in § 3.1.2

```
C.A.E.N.  N1470 4 CH 8KV 3mA       V1.00     Addr 08

                  Ch0            Ch1            Ch2            Ch3

Polarity           +              +              +              +
Vmon          0000.0 V       0000.0 V       0000.0 V       0000.0 V
Imon         0000.00 mA     0000.00 uA     0000.00 uA     0000.00 uA
Status

Power             Off            Off            Off            Off
Vset         1000.0 V       2005.0 V       4000.0 V       2000.0 V
Iset        2751.55 uA     0997.00 uA     1000.00 uA     2112.00 uA
Maxv          8100 V         8100 V         8100 V         8100 V
Ramp Up        500 V/S        500 V/S        500 V/S        500 V/S
Ramp Down      500 V/S        500 V/S        500 V/S        500 V/S
Trip          Inf. S         Inf. S         Inf. S         Inf. S
Power Down    Kill           Kill           Kill           Kill



_Group Mode    Reset Alarm     Quit
```

Fig. 3.35: Channels Menu

In order to change one parameter: point the parameter with the arrow keys (see figure below), and type the desired value, confirm by pressing <Enter>; Power and Power Down can be changed using the <Space> bar.

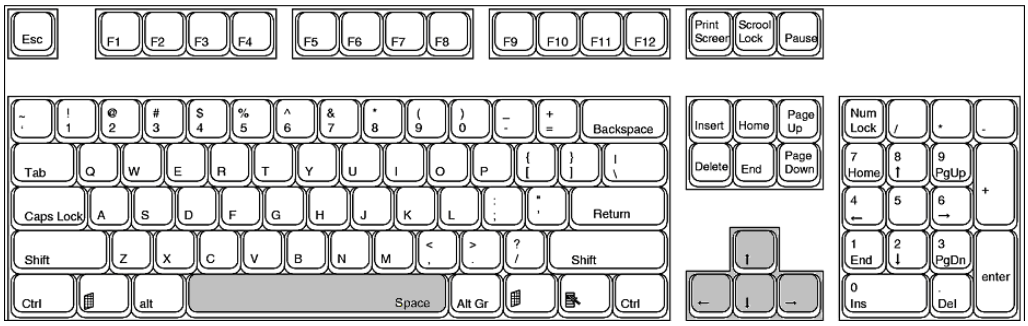


Fig. 3.36: PC keyboard

When one parameter is active, by typing G it is possible to make a “group setting”, i.e. broadcast the same value to all channels (the parameter becomes active on all channels, see figure).

```
C.A.E.N.  N1470 4 Ch HV Power Supply    V1.00     Addr 00

                  Ch0            Ch1            Ch2            Ch3

Polarity           +              +              +              -
Vmon          0000.0 V       0000.0 V       0000.0 V       0000.0 V
Imon         0000.00 uA     0000.00 uA     0000.00 uA     0000.00 uA
Status           Dis            Dis            Dis            Dis

Power             Off            Off            Off            Off
Vset         1100.0 V       1100.0 V       1100.0 V       1100.0 V
Iset        3000.00 uA     3000.00 uA     3000.00 uA     3000.00 uA
Maxv          8100 V         8100 V         8100 V         8100 V
Ramp Up        500 V/S        500 V/S        500 V/S        500 V/S
Ramp Down      500 V/S        500 V/S        500 V/S        500 V/S
Trip          Inf. S         Inf. S         Inf. S         Inf. S
Power Down    Kill           Kill           Kill           Kill
Imon Range    High           High           High           High

Group Mode    Reset Alarm     Quit
```

Fig. 3.37: Channels group setting

Type **Q** to exit the Menu.

3.3.2.4 Remote Control: firmware upgrade

By typing **U** it is possible to access the firmware upgrade menu:

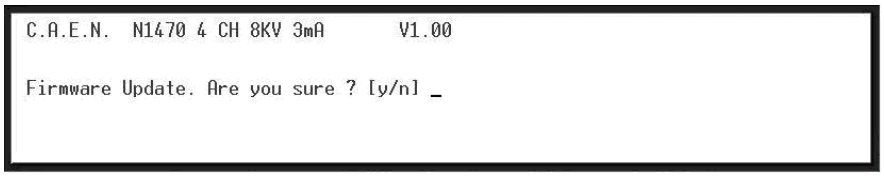


Fig. 3.38: Firmware Upgrade Menu/1

If <y> is typed, then the following menu is shown:

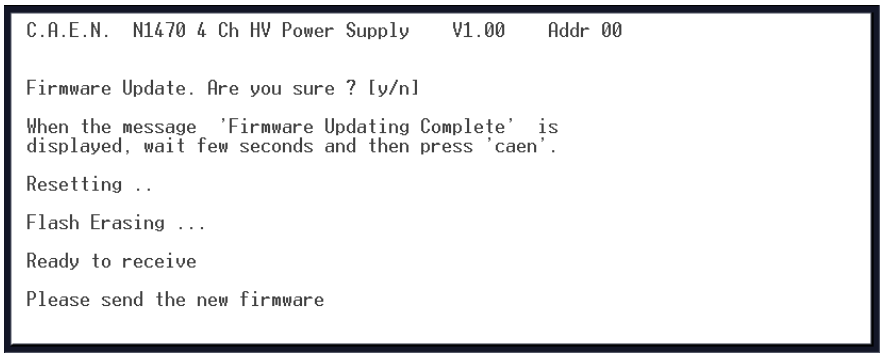


Fig. 3.39: Firmware Upgrade Menu/2

At this point it is necessary to upload the updated firmware.
If "HyperTerminal" is used it is necessary to perform "Transfer" and "Send Text File" operations by selecting the file "N1470.xxx"

3.3.2.5 Remote Control: format EEPROM

By typing **F** it is possible to access the format EEPROM menu:

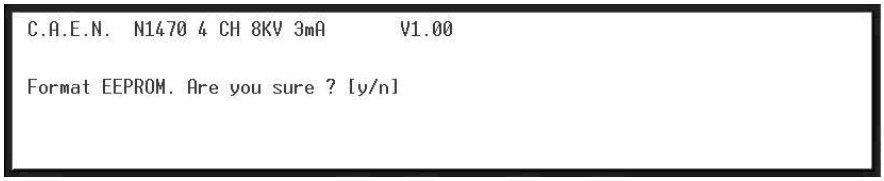


Fig. 3.40: Format EEPROM Menu

After the FORMAT command, all the channels have the following settings:
Vset = 0 V
Iset = 300 µA
Ramp Up / Down = 50 V/s
Trip = 10 s
MaxV = 8100 V
Power Down = Kill

Module setting:
Interlock Mode = Active CLOSED

3.4 USB - RS485 Communication Protocol

The following Protocol allows to communicate with up to 32 daisy chained modules. The Protocol is based on commands made of ASCII characters strings. The protocol requires firmware revision 1.0.1 or greater.

3.4.1 Command Format

The Format of a command string is the following :

$BD:,CMD:***,CH*,PAR:***,VAL:***.**<CR, LF >**

The fields that form the command are :

BD : **0..31** module address (to send the command)
CMD : **MON, SET**
CH : **0..4** (4 for the commands related to all Channels)
PAR : (see parameters tables)
VAL : (numerical value must have a Format compatible with resolution and range)

3.4.2 Format of response string

Format response in case of error

String	Function (Units)
#BD:**,CMD:ERR	Wrong command Format or command not recognized
#BD:**,CH:ERR	Channel Field not present or wrong Channel value
#BD:**,PAR:ERR	Field parameter not present or parameter not recognized
#BD:**,VAL:ERR	Wrong set value (<Min or >Max)
#BD:**,LOC:ERR	Command SET with module in LOCAL mode

Each string is terminated by **< CR, LF >**

Format response in case of correct command

String	Function (Units)
#BD:**,CMD:OK	command Ok
#BD:**,CMD:OK,VAL:***	command Ok *** = value for command to individual Channel
#BD:**,CMD:OK,VAL:***;*;*;***	command Ok ***;*;*;*** = values Ch0,1,2,3 for command to all Channels

Numerical value Field **'VAL'** has Format compatible (comma and decimal part) with the resolution and the range related to the parameter.
Each string is terminated by **< CR, LF >**

3.4.3 MONITOR commands related to the Channels

The following table contains the strings to be used to handle monitor commands related to the Channels.
The '**X**' in the Field 'Channel' can be set in the '**0..(N-1)**' range[12].
When '**X=N**' the module returns the values of the parameter of all N Channels.

String	Function (Units)
$BD:xx,CMD:MON,CH:X,PAR:VSET	Read out VSET value (XXXX.X V)
$BD:xx,CMD:MON,CH:X,PAR:VMIN	Read out VSET minimum value (0 V)
$BD:xx,CMD:MON,CH:X,PAR:VMAX	Read out VSET maximum value (8000.0 V)
$BD:xx,CMD:MON,CH:X,PAR:VDEC	Read out VSET number of decimal digits
$BD:xx,CMD:MON,CH:X,PAR:VMON	Read out VMON value (XXXX.X V)
$BD:xx,CMD:MON,CH:X,PAR:ISET	Read out ISET value (XXXX.XX µA)
$BD:xx,CMD:MON,CH:X,PAR:IMIN	Read out ISET minimum value (0 µA)
$BD:xx,CMD:MON,CH:X,PAR:IMAX	Read out ISET maximum value (3000.00 µA)
$BD:xx,CMD:MON,CH:X,PAR:ISDEC	Read out ISET number of decimal digits
$BD:xx,CMD:MON,CH:X,PAR:IMON	Read out IMON value (XXXX.XX µA)
$BD:xx,CMD:MON,CH:X,PAR:IMRANGE	Read out IMON RANGE value (HIGH / LOW)

[12] **N** is the number of channels

String	Function (Units)
$BD:xx,CMD:MON,CH:X,PAR:IMDEC	Read out IMON number of decimal digits (2 HR, 3 LR)
$BD:xx,CMD:MON,CH:X,PAR:MAXV	Read out MAXVSET value (XXXX V)
$BD:xx,CMD:MON,CH:X,PAR:MVMIN	Read out MAXVSET minimum value (0 V)
$BD:xx,CMD:MON,CH:X,PAR:MVMAX	Read out MAXVSET maximum value (8100 V)
$BD:xx,CMD:MON,CH:X,PAR:MVDEC	Read out MAXVSET number of decimal digits
$BD:xx,CMD:MON,CH:X,PAR:RUP	Read out RAMP UP value (XXX V/S)
$BD:xx,CMD:MON,CH:X,PAR:RUPMIN	Read out RAMP UP minimum value (1 V/S)
$BD:xx,CMD:MON,CH:X,PAR:RUPMAX	Read out RAMP UP maximum value (500 V/S)
$BD:xx,CMD:MON,CH:X,PAR:RUPDEC	Read out RAMP UP number of decimal digits
$BD:xx,CMD:MON,CH:X,PAR:RDW	Read out RAMP DOWN value (XXX V/S)
$BD:xx,CMD:MON,CH:X,PAR:RDWMIN	Read out RAMP DOWN minimum value (1 V/S)
$BD:xx,CMD:MON,CH:X,PAR:RDWMAX	Read out RAMP DOWN maximum value (500 V/S)
$BD:xx,CMD:MON,CH:X,PAR:RDWDEC	Read out RAMP DOWN number of decimal digits
$BD:xx,CMD:MON,CH:X,PAR:TRIP	Read out TRIP time value (XXXX.X S)
$BD:xx,CMD:MON,CH:X,PAR:TRIPMIN	Read out TRIP time minimum value (0 S)
$BD:xx,CMD:MON,CH:X,PAR:TRIPMAX	Read out TRIP time maximum value (1000.0 S)
$BD:xx,CMD:MON,CH:X,PAR:TRIPDEC	Read out TRIP time number of decimal digits
$BD:xx,CMD:MON,CH:X,PAR:PDWN	Read out POWER DOWN value (RAMP / KILL)
$BD:xx,CMD:MON,CH:X,PAR:POL	Read out POLARITY value ('+' / '-')
$BD:xx,CMD:MON,CH:X,PAR:STAT	Read out Channel status value (XXXXX)

3.4.3.1 Meaning of STATUS bits (value read in decimal Format)

Bit	Function
Bit 0 → ON	1 : ON 0 : OFF
Bit 1 → RUP	1 : Channel Ramp UP
Bit 2 → RDW	1 : Channel Ramp DOWN
Bit 3 → OVC	1 : IMON >= ISET
Bit 4 → OVV	1 : VMON > VSET + 250 V
Bit 5 → UNV	1 : VMON < VSET - 250 V
Bit 6 → MAXV	1 : VOUT in MAXV protection
Bit 7 → TRIP	1 : Ch OFF via TRIP (Imon >= Iset during TRIP)
Bit 8 → OVP	1 : Power Max Power Out > 9.3W for VOUT ≤ 3KV Power Out > 8.2W for VOUT > 3KV
Bit 9 → OVT	1: TEMP > 105°C
Bit 10 → DIS	1 : Ch disabled (REMOTE Mode and Switch on OFF position)
Bit 11 → KILL	1 : Ch in KILL via front panel
Bit 12 → ILK	1 : Ch in INTERLOCK via front panel
Bit 13 → NOCAL	1 : Calibration Error
Bit 14, 15 → N.C.	

3.4.4 MONITOR commands related to the module

The following table shows the strings to be used to handle monitor commands related to the module.

String	Function (Units)
$BD:xx,CMD:MON,PAR:BDNAME	Read out module name (N1470…)
$BD:xx,CMD:MON,PAR:BDNCH	Read out number of Channels present (4, 2, 1)
$BD:xx,CMD:MON,PAR:BDFREL	Read out Firmware Release (XX.X)
$BD:xx,CMD:MON,PAR:BDSNUM	Read out value serial number (XXXXX)
$BD:xx,CMD:MON,PAR:BDILK	Read out INTERLOCK status (YES/NO)
$BD:xx,CMD:MON,PAR:BDILKM	Read out INTERLOCK mode (OPEN/CLOSED)
$BD:xx,CMD:MON,PAR:BDCTR	Read out Control Mode (LOCAL / REMOTE)
$BD:xx,CMD:MON,PAR:BDTERM	Read out LOCAL BUS Termination status (ON/OFF)
$BD:xx,CMD:MON,PAR:BDALARM	Read out Board Alarm status value (XXXXX)

3.4.4.1 Meaning of Board Alarm bits

Bit	Function
Bit 0 → CH0	1 : Ch0 in Alarm status
Bit 1 → CH1	1 : Ch1 in Alarm status
Bit 2 → CH2	1 : Ch2 in Alarm status
Bit 3 → CH3	1 : Ch3 in Alarm status
Bit 4 → PWFAIL	1 : Board in POWER FAIL
Bit 5 → OVP	1 : Board in OVER POWER
Bit 6 → HVCKFAIL	1 : Internal HV Clock FAIL (≠ 200±10kHz)

3.4.5 SET commands related to the Channels

The following table contains the strings to be used to handle set commands related to the Channels.
The '**X**' in the Field 'Channel' can be set to the '**0..(N-1)'** values.
When '**X=N**' the command is issued to all N Channels.

String	Function (Units)
$BD:xx,CMD:SET,CH:X,PAR:VSET,VAL:XXXX.X	Set VSET value
$BD:xx,CMD:SET,CH:X,PAR:ISET,VAL:XXXX.XX	Set ISET value
$BD:xx,CMD:SET,CH:X,PAR:MAXV,VAL:XXXX	Set MAXVSET value
$BD:xx,CMD:SET,CH:X,PAR:RUP,VAL:XXX	Set RAMP UP value
$BD:xx,CMD:SET,CH:X,PAR:RDW,VAL:XXX	Set RAMP DOWN value
$BD:xx,CMD:SET,CH:X,PAR:TRIP,VAL:XXXX.X	Set TRIP time value
$BD:xx,CMD:SET,CH:X,PAR:PDWN,VAL:RAMP/KILL	Set POWER DOWN mode value
$BD:xx,CMD:SET,CH:X,PAR:IMRANGE,VAL:HIGH/LOW	Set IMON RANGE value[13]
$BD:xx,CMD:SET,CH:X,PAR:ON	Set Ch ON
$BD:xx,CMD:SET,CH:X,PAR:OFF	Set Ch OFF

[13] parameter 'IMRANGE' can be changed only on modules featuring IMON zoom (optional)

3.4.6 SET commands related to the module

String	Function (Units)
$BD:xx,CMD:SET,PAR:BDILKM,VAL:OPEN/CLOSED	Set Interlock Mode
$BD:xx,CMD:SET,PAR:BDCLR	Clear alarm signal

4 Internal Settings

4.1 Polarity selection

The output polarity is independently selectable for each channel. Note that the polarity is indicated by two LEDs for each channel on the front panel.
In order to change the polarity:

- Wear Antistatic Gloves
- Switch off the unit
- Wait for the complete discharge of the capacitors.
- Lay down the unit, right side up
- Remove screws 1, 2, 3, 4, 5, 6, see figure (red):

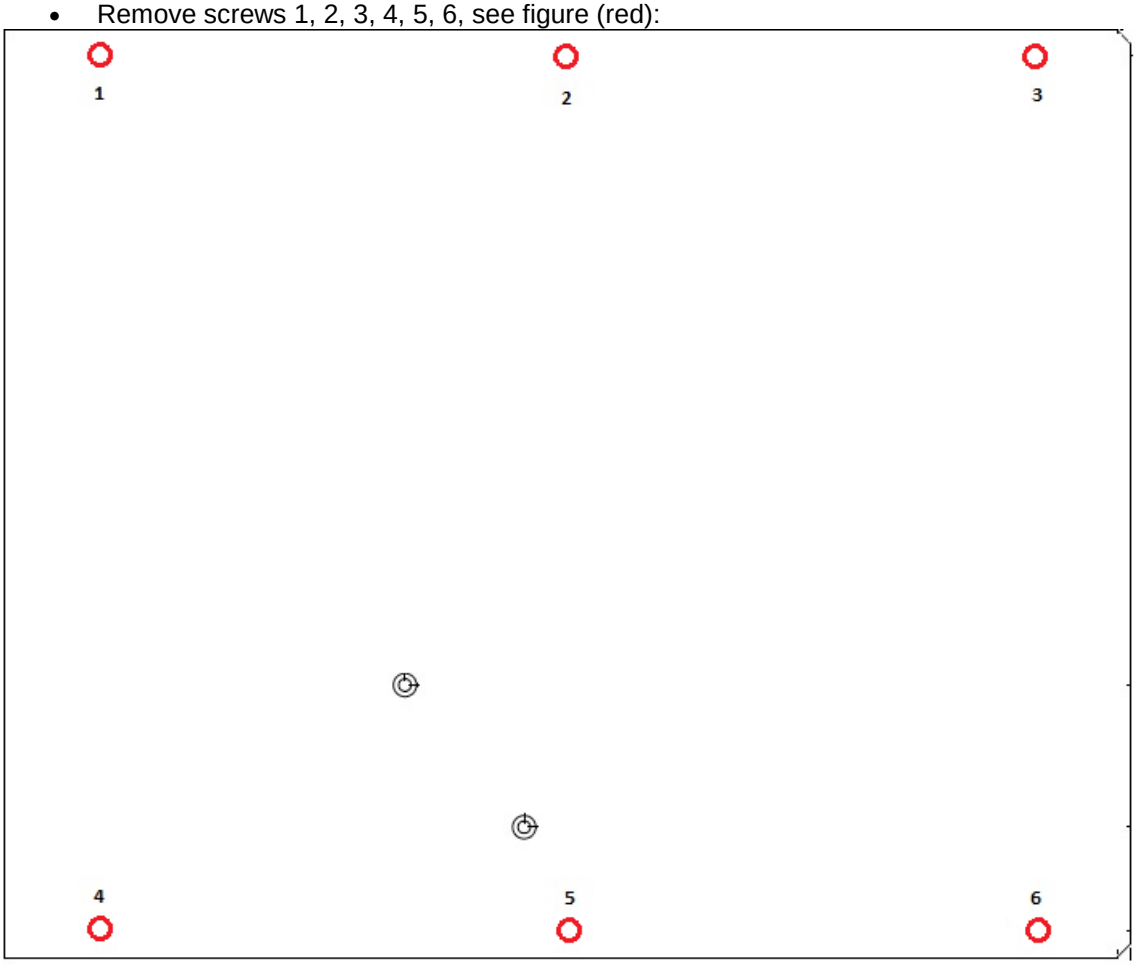


Fig. 4.1: Side cover removal instructions

- Lift the side cover gently
- At this point it is possible to change the channel polarity: refer to the following figure (the blue arrow indicates diode bridge box placed to configure channel as POSITIVE).
- During this operation pay attention not to bend the pins, as they are plugged completely in their sockets

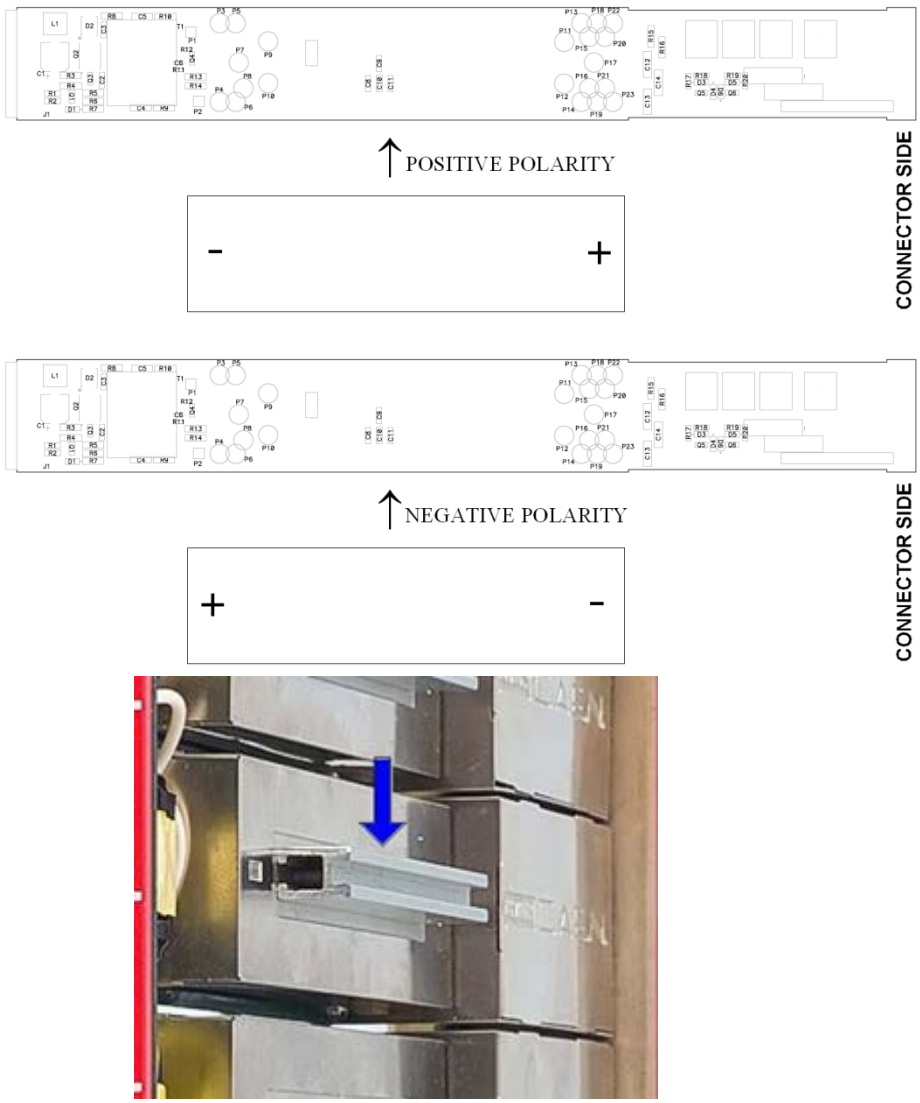


Fig. 4.2: Polarity selection instructions

- In order to choose the POSITIVE POLARITY, plug the diode bridge box, with the + symbol towards the connector side.
- In order to choose the NEGATIVE POLARITY, plug the diode bridge box, with the - symbol towards the connector side.
- Always pull and plug the diode bridge box by holding it on the handle pointed by the arrow in Fig. above.
- Once settings are done, put the right side cover back in place with screws 1, 2, 3, 4, 5, 6.

4.2 Internal switches

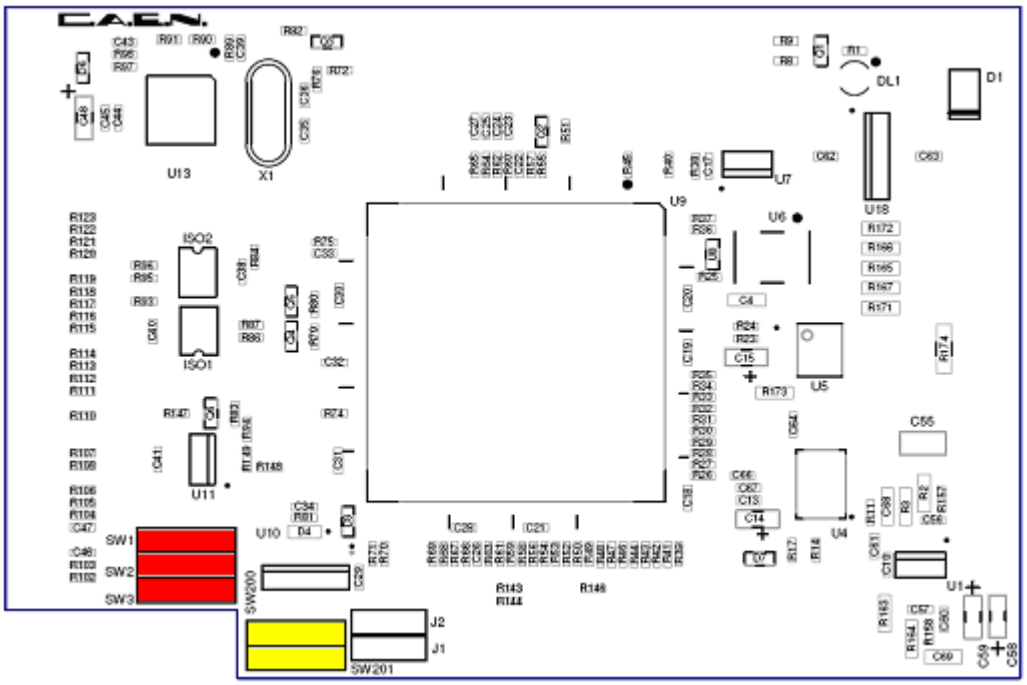


Fig. 4.3: Dip switch position

4.2.1 Local Bus termination

The SW[1..3] switch placed on the Microcontroller board inside the module (behind the *Remote communication control section*, see § 2.4.4), allows to terminate the Local Bus for daisy chain purposes (see § 3.3.1); dot NOT visible = Termination ON.

4.2.2 RS485 – RS232 conversion

The SW[200, 201] switch placed on the Microcontroller board inside the module, allows to adapt RS485 signals to RS232; dot visible = Adaptation ON.