

PRELIMINARY

Technical Information Manual

Revision n. 3

11 May 2009

MOD. N1470
4 CH. PROGRAMMABLE
HV POWER SUPPLY
MANUAL REV.3

NPO:
00112/07:N1470.MUTx/03

CAEN will repair or replace any product within the guarantee period if the Guarantor declares that the product is defective due to workmanship or materials and has not been caused by mishandling, negligence on behalf of the User, accident or any abnormal conditions or operations.

CAEN declines all responsibility for damages or injuries caused by an improper use of the Modules due to negligence on behalf of the User. It is strongly recommended to read thoroughly the CAEN User's Manual before any kind of operation.



CAEN reserves the right to change partially or entirely the contents of this Manual at any time and without giving any notice.

Disposal of the Product

The product must never be dumped in the Municipal Waste. Please check your local regulations for disposal of electronics products.



TABLE OF CONTENTS

1. GENERAL DESCRIPTION.....	6
1.1. OVERVIEW	6
2. TECHNICAL SPECIFICATIONS.....	7
2.1. PACKAGING.....	7
2.2. POWER REQUIREMENTS	7
2.3. FRONT AND BACK PANEL.....	8
2.4. FRONT PANEL CONNECTIONS	9
2.4.1. Local control section	9
2.4.2. Channel control section.....	9
2.4.3. HV Status control section	10
2.4.3.1. Alarm signal	10
2.4.3.2. Interlock signal.....	10
2.4.4. Remote communication control section.....	11
2.5. REAR PANEL CONNECTIONS.....	12
2.5.1. HV Channel Output	12
2.6. TECHNICAL SPECIFICATIONS TABLE	13
3. OPERATING MODES.....	14
3.1. PROGRAMMABLE PARAMETERS	14
3.1.1. Boards parameters	14
3.1.2. Channel settings	15
3.2. LOCAL CONTROL	15
3.2.1. HV connection	16
3.2.2. Module settings.....	17
3.2.3. Channel settings	18
3.2.3.1. Group Settings.....	21
3.2.3.2. Smileys.....	24
3.3. REMOTE CONTROL	24
3.3.1. Serial Links.....	24
3.3.1.1. USB/ RS232 communication	24
3.3.1.2. RS485 communication	25
3.3.1.3. Ethernet communication.....	25
3.3.2. Communication Control	26
3.3.2.1. Remote Control: Main Menu.....	26
3.3.2.2. Remote Control: General Menu	26
3.3.2.3. Remote Control: Channels Menu	26
3.3.2.4. Remote Control: firmware upgrade.....	28
3.3.2.5. Remote Control: format EEPROM.....	28

3.4.	USB - RS485 COMMUNICATION PROTOCOL	29
3.4.1.	Command Format.....	29
3.4.2.	Format of response string.....	29
3.4.3.	MONITOR commands related to the Channels	29
3.4.3.1.	Meaning of STATUS bits (value read in decimal Format).....	30
3.4.4.	MONITOR commands related to the module (Ch = 4).....	31
3.4.4.1.	Meaning of Board Alarm bits.....	32
3.4.5.	SET commands related to the Channels	32
3.4.6.	SET commands related to the module.....	32
4.	INTERNAL SETTINGS.....	33
4.1.	POLARITY SELECTION.....	33
4.2.	INTERNAL SWITCHES	34
4.2.1.	Local Bus termination	34
4.2.2.	RS485 – RS232 conversion.....	34

LIST OF FIGURES

FIG. 1.1:	MOD. N1470 4 CHANNEL PROGRAMMABLE HV POWER SUPPLY.....	6
FIG. 2.1:	MOD. N1470 FRONT AND BACK PANEL	8
FIG. 2.2:	LOCAL CONTROL PANEL.....	9
FIG. 2.3:	CHANNEL CONTROL PANEL	9
FIG. 2.4:	HV STATUS CONTROL PANEL.....	10
FIG. 2.5:	ALARM ELECTRICAL SCHEME	10
FIG. 2.6:	INTERLOCK ELECTRICAL SCHEME	10
FIG. 2.7:	REMOTE COMMUNICATION CONTROL AND RS485 I/O – RS232 IN ELECTRICAL SCHEME	11
FIG. 2.8:	HV CHANNEL PANEL AND TEST POINT ELECTRICAL SCHEME	12
FIG. 3.1:	WELCOME SCREEN.....	15
FIG. 3.2:	CHANNEL OFF STATUS SCREEN	16
FIG. 3.3:	CHANNEL ON STATUS SCREEN.....	16
FIG. 3.4:	CHANNEL KILL STATUS SCREEN	16
FIG. 3.5:	MODE SETTINGS STATUS SCREEN	17
FIG. 3.6:	MODE SETTINGS ACCESS SCREEN	17
FIG. 3.7:	MODE SETTINGS EDIT SCREEN.....	17
FIG. 3.8:	CHANNEL SETTINGS EDIT SCREEN	18
FIG. 3.9:	CHANNEL VSET SELECT SCREEN.....	18
FIG. 3.10:	CHANNEL VSET ACCESS SCREEN	18
FIG. 3.11:	CHANNEL VSET DIGIT SELECTION SCREEN.....	19
FIG. 3.12:	CHANNEL VSET DIGIT ACCESS SCREEN	19
FIG. 3.13:	CHANNEL VSET DIGIT ADJUST SCREEN	19

FIG. 3.14: CHANNEL VSET DIGIT CONFIRM SCREEN.....	19
FIG. 3.15: CHANNEL VSET CONFIRM SCREEN	20
FIG. 3.16: CHANNEL VSET DE-SELECT SCREEN	20
FIG. 3.17: CHANNEL KILL SCREEN	20
FIG. 3.18: CHANNEL EXIT SCREEN	21
FIG. 3.19: GROUP SELECTION	21
FIG. 3.20: GROUP ACTIVE	21
FIG. 3.21: GROUP VSET ACCESS SCREEN	22
FIG. 3.22: GROUP VSET DIGIT SELECTION SCREEN	22
FIG. 3.23: GROUP CHANNEL VSET DIGIT ACCESS SCREEN	22
FIG. 3.24: GROUP VSET DIGIT ADJUST SCREEN.....	22
FIG. 3.25: GROUP VSET DIGIT CONFIRM SCREEN	23
FIG. 3.26: CHANNEL VSET DE-SELECT SCREEN	23
FIG. 3.27: GROUP EXIT SCREEN	23
FIG. 3.28: RS232 PORT CABLE ADAPTER	25
FIG. 3.29: MAIN MENU.....	26
FIG. 3.30: BOARD STATUS MENU	26
FIG. 3.31: CHANNELS MENU	27
FIG. 3.32: PC KEYBOARD	27
FIG. 3.33: CHANNELS GROUP SETTING.....	27
FIG. 3.34: FIRMWARE UPGRADE MENU/1.....	28
FIG. 3.35: FIRMWARE UPGRADE MENU/2.....	28
FIG. 3.36: FORMAT EEPROM MENU	28
FIG. 4.1: POLARITY SELECTION INSTRUCTIONS.....	33
FIG. 4.2: DIP SWITCH POSITION.....	34

LIST OF TABLES

TABLE 1.1: AVAILABLE ITEMS	6
TABLE 2.1: OUTPUT CHANNELS POWER ABSORPTION	7
TABLE 2.2: MOD. N1470 CHANNEL TECHNICAL SPECIFICATIONS	13
TABLE 3.1: SMILEYS LIST	24

1. General description

1.1. Overview



Fig. 1.1: Mod. N1470 4 Channel Programmable HV Power Supply

The Mod. N1470 provides 4 independent High Voltage channels in a single width NIM mechanics. Each channel can provide a $\pm 8\text{kV}$ max voltage, a 3 mA max current and a 9 W max power (8 W max power when output voltage is larger than $\pm 3\text{ kV}$).

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 $1\text{--}500\text{ V/s}$ 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 through the Interlock logic.

Module control can take place either locally, assisted by a Graphic color display or remotely, via USB, RS232 or RS485, the latter allowing to build a N1470s' daisy chain network.

An optional DC Input Power Equalizer (Mod. A1471) is available (see § 2.2).

Table 1.1: Available items

Code	Description
WN1470B08AAC	N1470B - 1Ch Programmable Power Supply 8kV
WN1470A08AAC	N1470A - 2Ch Programmable Power Supply 8kV
WN1470X08AAC	N1470 - 4Ch Programmable Power Supply 8kV
WA1480XAAAAA	A1480 - DC Power Input Equalizer for N147X Family
WPERS0147001	N1470 - Customization - Imon Zoom x10

2. Technical specifications

2.1. Packaging

The Model N1470 is housed in a single width NIM module.

2.2. Power requirements

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

Table 2.1: Output Channels power absorption

Channel configuration	without A1471		with A1471		
	Max n° CH ON	Current (±12V)	Max n° CH ON	Current (±6V)	Current (±12V)
3kV/3mA	3 CH	2.80 A	4 CH	4.30 A	1.85 A
4kV/2mA	4 CH	2.84 A	4 CH	3.50 A	1.52 A
8kV/1mA	4 CH	3.16 A	4 CH	3.90 A	1.68 A

2.3. Front and back panel

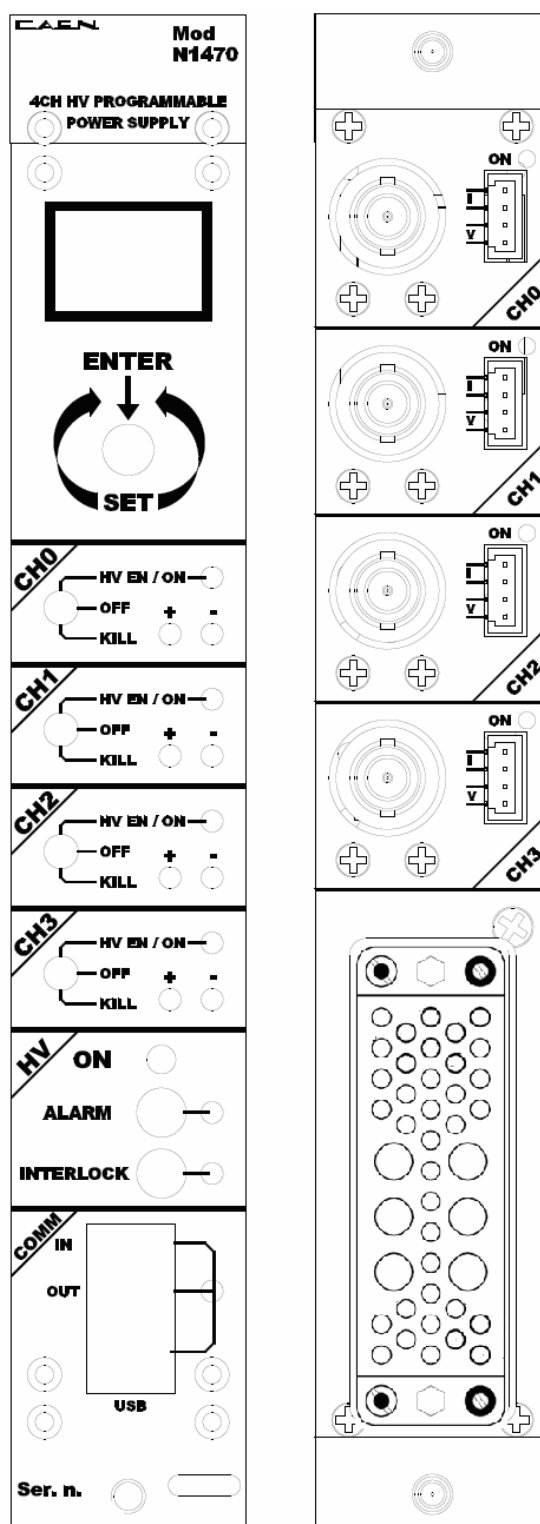


Fig. 2.1: Mod. N1470 Front and back panel

2.4. Front panel connections

2.4.1. Local control section

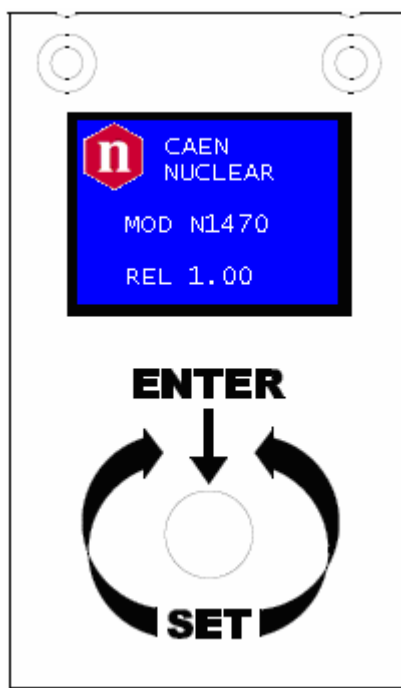


Fig. 2.2: Local control panel

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

2.4.2. Channel control section

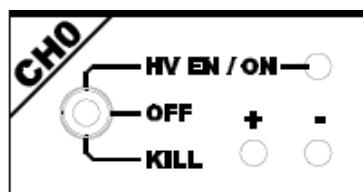


Fig. 2.3: Channel control panel

NAME:	TYPE:	FUNCTION:
HV_EN/OFF/KILL	3 POS. SWITCH	Channel Enable and turning OFF/KILL ¹
ON	RED LED	HV On enabled
+	GREEN LED	Positive polarity
-	YELLOW LED	Negative polarity

¹ OFF: Channel turned off according to RAMP DOWN setting; KILL: Channel turned off at fastest available rate

2.4.3. HV Status control section

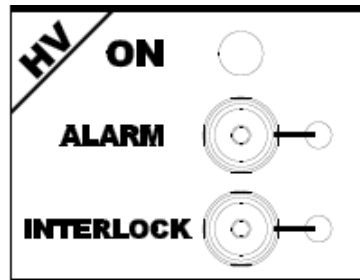


Fig. 2.4: HV Status control panel

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

2.4.3.1. Alarm signal

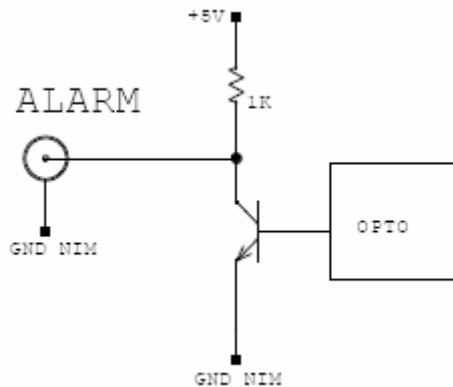


Fig. 2.5: ALARM electrical scheme

Alarm signal is an open collector output signal (100 mA maximum sink current); up to 12 Alarm output signals of N1470 modules can be OR'ed via LEMO splitters.

2.4.3.2. Interlock signal

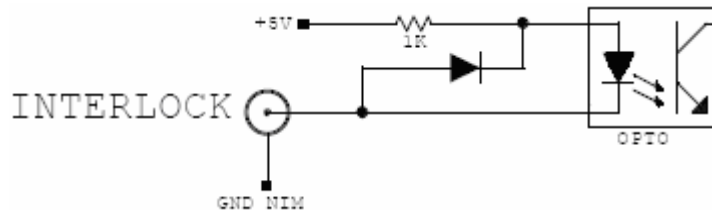


Fig. 2.6: INTERLOCK electrical scheme

INTERLOCK allows to disable the channels in the two following ways:

CLOSED OPERATION: INTERLOCK is enabled either with a 50Ohm termination inserted into the relevant connector or with a LOW level (<1V; 5mA current) fed to the connector (see § 2.4.3).

OPEN OPERATION: INTERLOCK is enabled either with a HIGH level (4÷6 V) is provided to the relevant connector or leaving the connector open.

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

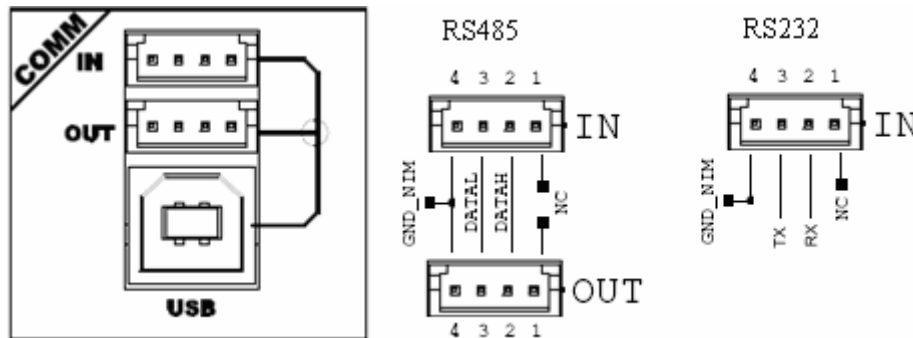


Fig. 2.7: Remote communication control and RS485 I/O – RS232 IN electrical scheme

NAME:	TYPE:	FUNCTION:
IN	AMP 280371-2	RS485 Input ² ; 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

² 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

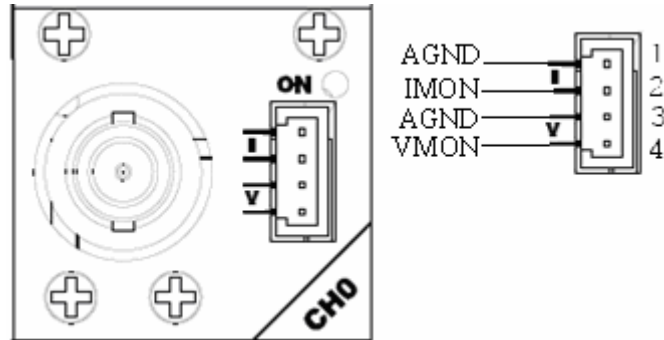


Fig. 2.8: HV Channel panel and test point electrical scheme

NAME:	TYPE:	FUNCTION:
MON	AMP 280371-2	<i>Vout/Iout Test point</i>
OUT	SHV	<i>HV Channel Output</i>

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

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

IMON: Voltage level (1V = 660 μ A $\pm$ 3% readout; positive, 0÷5 V range)

2.6. Technical specifications table

Table 2.2: Mod. N1470 Channel technical specifications

Output channels:	Four channels; Positive or Negative Polarity (requires internal setting, see § 4.1)			
Output ranges:	8 kV / 3mA			
Max. Ch. Output Power:	9 W (Vset ≤ 3 kV) 8 W (Vset > 3 kV)			
Vset / Vmon Resolution:	200 mV			
Iset / Imon Resolution:	50 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.			
Voltage Ripple:³	<10mVpp	3kV/200µA		
	<15mVpp	4kV/200µA	6kV/200µA	8kV/200µA
	<25mVpp	3kV/3mA	4kV/2mA	
	<30mVpp	6kV/1mA	8kV/800µA	
Vmon vs. Vout Accuracy: ⁴	±0.02% of read value ±2V			
Vset vs. Vmon Accuracy: ⁴	±0.02% of read value ±2V			
Imon vs. Iout Accuracy: ⁴	±2% of read value ±2µA			
Iset vs. Imon Accuracy: ⁴	±2% of read value ±2µA			
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) ⁵			
Long term stability Vout vs. Vset:	± 0.02% (after one week @ constant temperature)			

³ Measured with: 1m cable length; 2nF capacitance, 100MHz band width

⁴ From 10% to 90% of Full Scale Range

⁵ Typical data for IMON X10: Imon-Zoom Offset = ±100nA; ppm/C° Imon-Zoom <300ppm/C°; Imon leakage +5nA/2kV

3. Operating modes

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

3.1. Programmable parameters

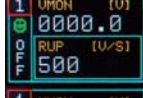
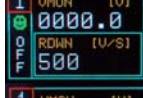
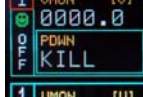
3.1.1. Boards parameters

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	
Vset	High Voltage programmed value	Volt	
Iset	Current Limit programmed value	μA	
MaxV	Absolute maximum High Voltage level that the channel is allowed to reach (see § 2.6)	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 § 2.6)	s	
Imon Range	Current Monitor Zoom 10x (optional)	H or L	

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.

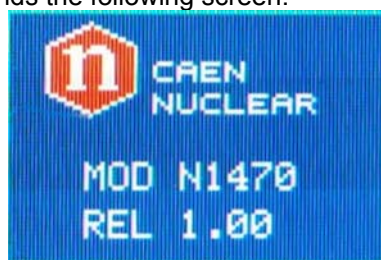


Fig. 3.1: Welcome screen

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.

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:

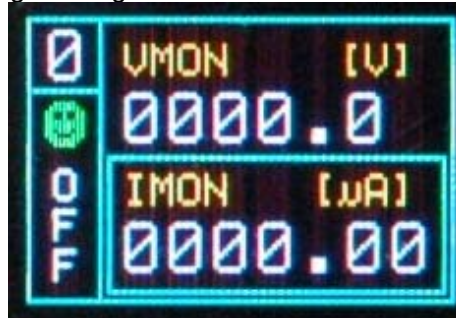


Fig. 3.2: Channel OFF status screen

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:

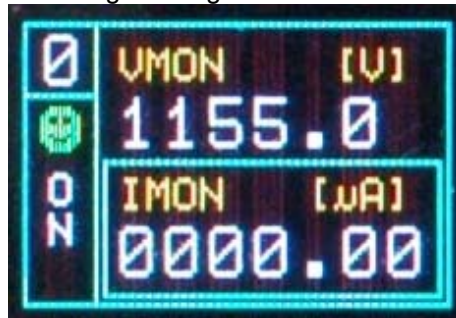


Fig. 3.3: Channel ON status screen

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:

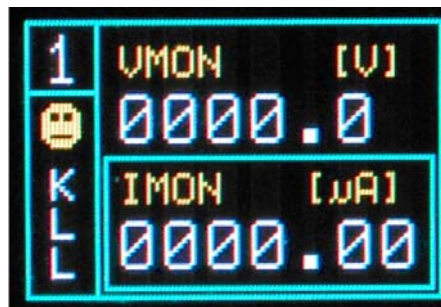


Fig. 3.4: Channel KILL status screen

3.2.2. Module settings

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

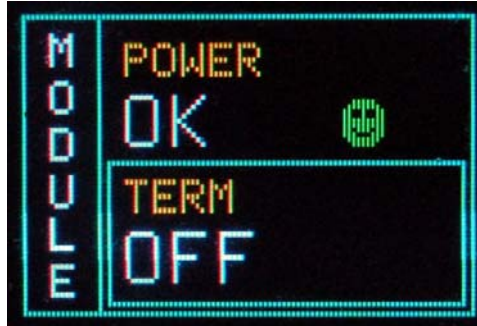


Fig. 3.5: Mode settings status screen

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:

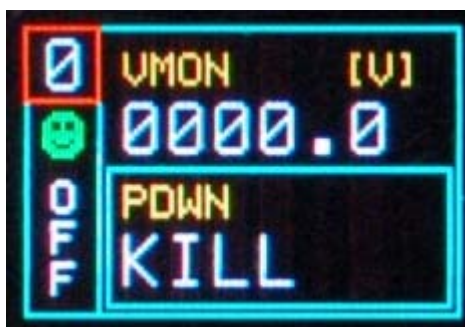


Fig. 3.17: Channel KILL screen

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

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

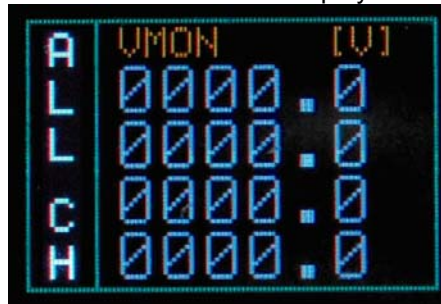


Fig. 3.19: Group selection

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).

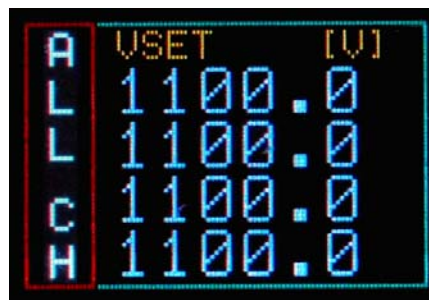


Fig. 3.20: Group active

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

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/ RS232 communication

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:

<http://www.ftdichip.com/Drivers/VCP.htm>

The connection can be performed via 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 § 3.3.1.2; 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).

In order to control the module via RS232 it is necessary to use the first module's COMM IN port (refer to § 2.4.2 for RS232 signals) and to follow adaptation instructions (see § 4.2.2).

3.3.1.2. RS485 communication

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 (see § 2.4.4)
- 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:

- o by connecting a RS485 controller to the first module's COMM IN port
- o by connecting a RS485 controller to the last module's COMM OUT port
- o via USB (as explained in § 3.3.1.1).

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

3.3.1.3. Ethernet communication

It is possible to communicate via Ethernet with one or more daisy chained N1470 modules through the NIM8301 Fan Unit⁶. 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).

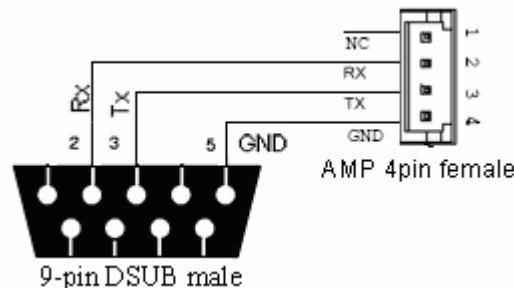


Fig. 3.28: RS232 port cable adapter

⁶ 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

As the communication is established, the Main Menu will be displayed.

3.3.2.1. Remote Control: Main Menu

```

  ##  ##  ##  #####  #####  #####
  ### ##  ####  ##  ##  ##  ##
  ##  ##  ##  #####  ##  ##  ##
  ##  ##  ##  ##  ##  ##  ##
  ##  ##  ##  #####  ##  #####

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

B O A R D   M E N U

Display          Display/modify channels
Format          Reformat EEPROM
General         General board status
Update          Firmware Update

Quit            Abandon program

Select Item

```

Fig. 3.29: 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 **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.

```

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

Serial Number      : 35
Boot firmware Version : 1.0
Local Bus Termination : OFF
Interlock Active   : CLOSED
Internal Supply     : OK
Over Power          : NO
HV Clock [200 KHz]  : 199 KHz

Press 'I' to change Interlock Mode or any key to quit.

```

Fig. 3.30: 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. 3.31: 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.

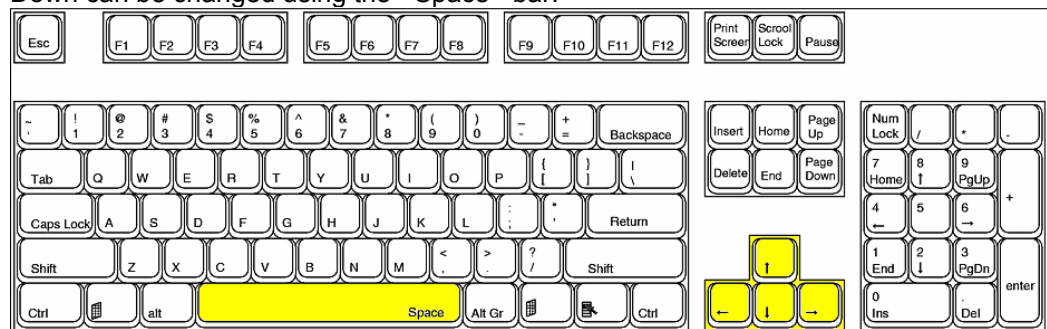


Fig. 3.32: PC keyboard

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. 3.33: 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:

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

Firmware Update. Are you sure ? [y/n] _
```

Fig. 3.34: Firmware Upgrade Menu/1

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

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

Firmware Update. Are you sure ? [y/n]

When the message 'Firmware Updating Complete' is
displayed, wait few seconds and then press 'caen'.

Resetting ..

Flash Erasing ...

Ready to receive

Please send the new firmware
```

Fig. 3.35: 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 **U** it is possible to access the format EEPROM menu:

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

Format EEPROM. Are you sure ? [y/n]
```

Fig. 3.36: Format EEPROM Menu

After the FORMAT command, all the channels have the following settings:

Vset = 0 V

Iset = 300 μ A

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..4**' range.

When '**X=4**' the module returns the values of the parameter of all 4 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 μ A)
\$BD:xx,CMD:MON,CH:X,PAR:IMIN	Read out ISET minimum value (0 μ A)
\$BD:xx,CMD:MON,CH:X,PAR:IMAX	Read out ISET maximum value (3000.00 μ A)
\$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 μ A)
\$BD:xx,CMD:MON,CH:X,PAR:IMRANGE	Read out IMON RANGE value (HIGH / LOW)
\$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:RDWN	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 → RDWN	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)
\$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 ($\neq 200 \pm 10\text{kHz}$)

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..4' values.

When 'X=4' the command is issued to all 4 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:RDWN,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 ⁷
\$BD:xx,CMD:SET,CH:X,PAR:ON	Set Ch ON
\$BD:xx,CMD:SET,CH:X,PAR:OFF	Set Ch OFF

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

⁷ parameter 'IMRANGE' can be changed only on modules featuring IMON zoom (optional)

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 (see § 2.4.2).

In order to change the polarity the unit must be switched off and wait for the complete discharge of the capacitors then remove the side covers thereby making access to the Printed Circuit Boards. Antistatic Gloves must be worn before touching any internal part. Lay down the unit, NIM crate connector on the right and the front panel on the left, components side up and refer to the following figure (the blue arrow indicates diode bridge box placed to configure channel as POSITIVE).

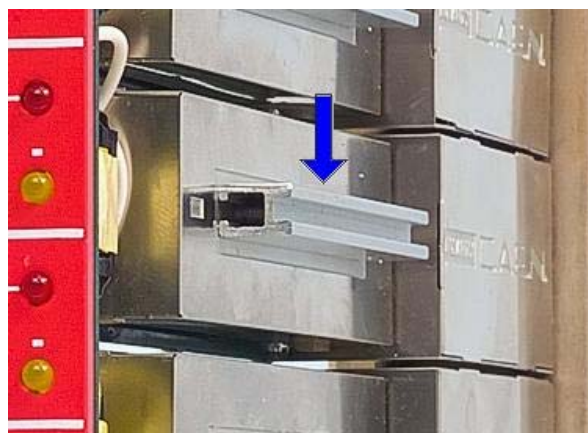
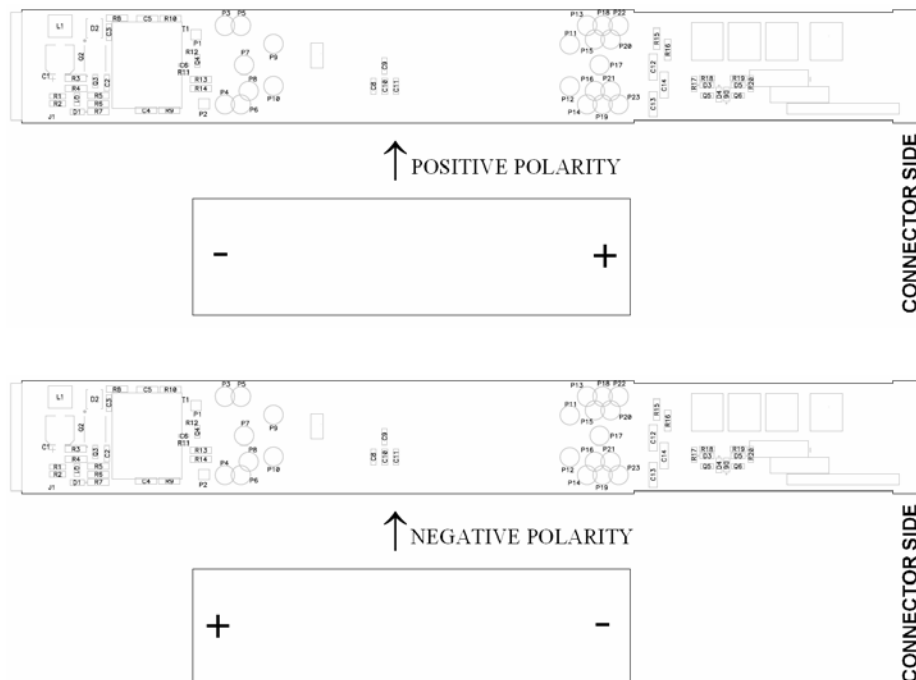


Fig. 4.1: Polarity selection instructions

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.4.1, wearing antistatic gloves.

4.2. Internal switches

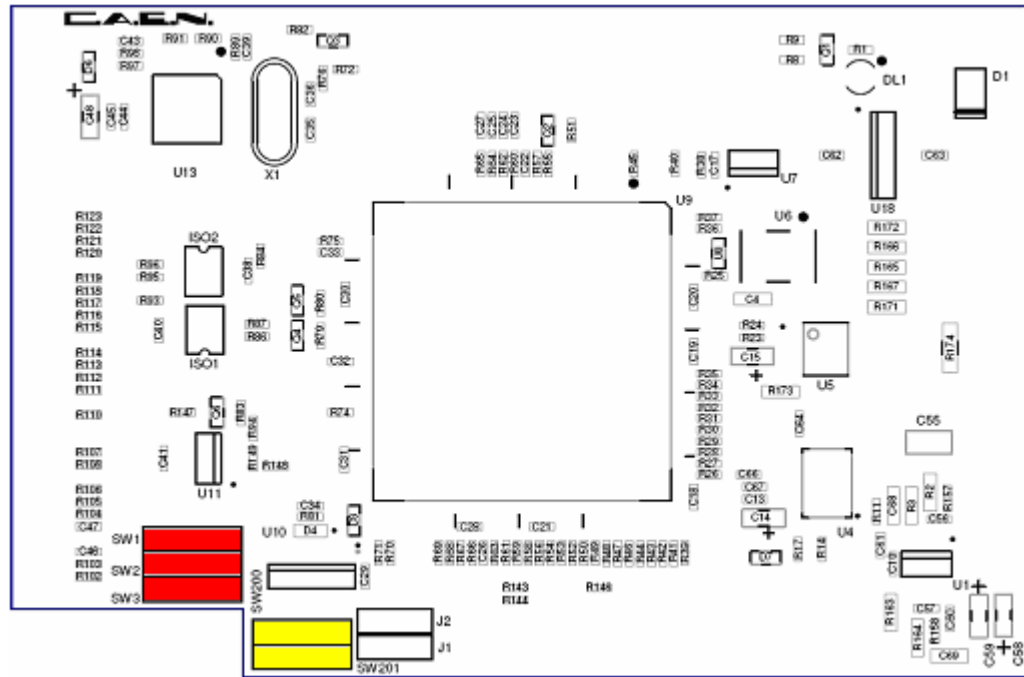


Fig. 4.2: Dip switch position

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 § 3.3.1.2); 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.