Technical Information Manual

Revision n. 0
1 March 1999

MOD. N 470A

*4 CHANNEL
PROGRAMMABLE
H.V. POWER SUPPLY*

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.

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

<u>WARNING</u>

It has been discovered that when a module, which has a crate number equal to 0, is present in a H.S. CAENET network controlled by Mod. C117B, Mod. V288, Mod. A1303 or Mod. A303A H.S. CAENET controllers, the communications may not operate correctly.

This could occur in particular conditions, so **it is suggested not to use the crate number 0 in the network.**

CONTENTS

1. __MODEL OVERVIEW__

The C.A.E.N. Mod. N 470A is a FOUR CHANNEL PROGRAMMABLE HIGH VOLTAGE POWER SUPPLY housed in a two-unit wide NIM module; the unit has 4 independent H.V. channels able to supply four output voltages from 0 up to ± 8 kV.

Its wide range of current and voltage along with a versatile protection scheme, monitoring and control functions make it ideal for powering the full spectrum of detectors used in the modern Physical research, such as photomultipliers (PMs), wire chambers, streamer tubes, silicon detectors and so on. The module is flexible enough to be adequate for both experiments where several channels are to be monitored by an on-line computer, and for the test labs, where simple manual operation of a limited number of channels is often required.

All the operational parameters can be programmed and monitored either locally, via the front panel keyboard and displays through specifically designed functions, or remotely via the High Speed CAENET network and relevant controllers.

Via the front panel keyboard can also be selected the standard, TTL or NIM, of the signals used as hardware controls and through a very small set-up the user can calibrate each channel of the unit and store the resulting data in an internal EEPROM (see Section 5).

Among its most relevant features there are:

• Wide Voltage-Current Capability.
> can operate in the range: ± 100V to ± 8 kV/ 800 μA.
> Therefore, the units can cover all available commercial PM tubes and any types of used detectors.

• Selection of polarity. The User can select positive or negative polarity for each channel by reversing the relevant diode bridge inside the unit (see Section 4). The selected channel polarity is shown by the relevant LED on the front panel.

• Displays. All operational parameters can be set and monitored on two alphanumeric 8–character LED display.

• A set of 9 LEDs on the front panel shows the status of the selected channel.

Flexibility in Functions and Controls which include for each channel :

• Two voltage setting levels (V_0 and V_1 respectively);

• Two preset current limits levels (I_0 and I_1 respectively);

• Variable RAMP-UP and RAMP-DOWN;

• Preset of a desired hardware HV limit that cannot be overridden by any software setting;

• Sophisticated Safety Feature.

Common to all channels :

• Local or Remote KILL;

• H.V. enable switch;

• Local or Remote RESET;

• Selection via an external VSEL signal between the V_0 and V_1 preset values;

• Selection via an external ISEL signal between the I_0 and I_1 preset values;

• Generation of an external ALARM signal when a danger condition occurs (OVer Voltage - OVV, UNder Voltage - UNV, TRIP, MAXV or when not calibrated module).

Handling safety is obtained through careful design. All HV components are incapsulated in silicon rubber and no HV is on the printed circuit board so that the maintenance personnel cannot accidentally be exposed to it.

The front and rear panels of the model N 470A are shown in Figure 1, on the two fold-out pages at the end of this Manual. For your convenience, keep the photograph of the unit folded out to easily associate descriptions and explanations with the model layout.

The High-Voltage output connectors, which are on the back panel, are SHV connectors. All other connectors are LEMO 00 type.

1.1. FRONT PANEL
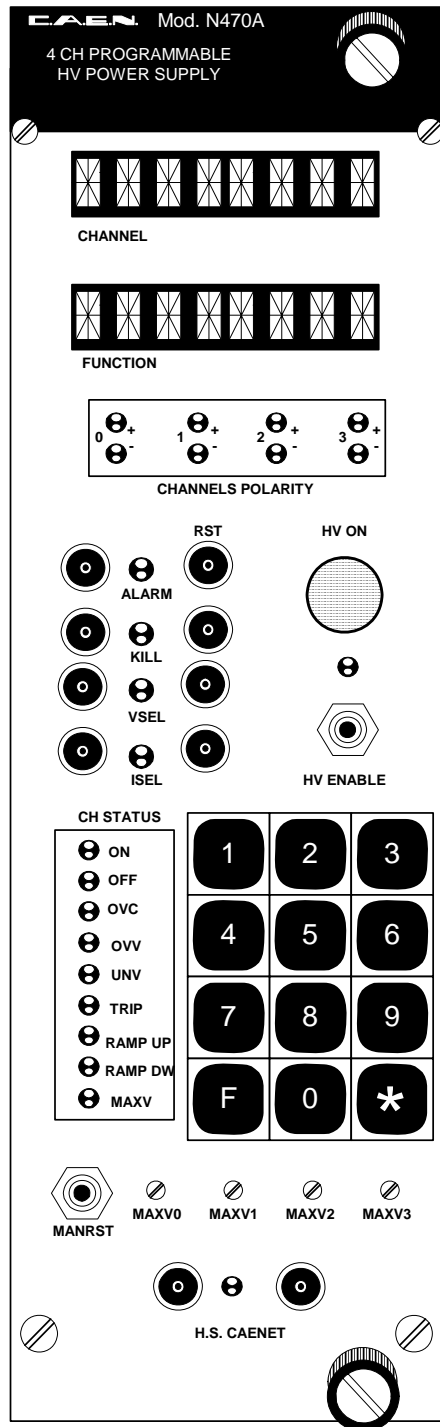
2. SPECIFICATIONS

2.1. HIGH VOLTAGE OUTPUTS

High Voltage ranges :   ±100V to ±8 kV   800 µA maximum output current;

Any attempt to set a current/voltage value incoherent with the relevant voltage/current generates a flashing of the displays. The system in this case is waiting for a correct value; the user can only press the "F" key to abort the operation or give the rigth parameter value (see note on pag. 8)

Polarity :   positive or negative selectable by the user as described in section 4

HV Set and Mon resolution: ± 1 V

I Set and Mon resolution: ± 100 nA

Ramp-Up, Ramp-Down: up to 500 V/sec

Vmon, HVout accuracy: 1% ± 5V

Imon accuracy: 2% ± 1 µA

Vmax accuracy: 1% ± 5V

RST min. width: 100 µs

KILL min. width: 15 µs

Max Delivered Power: 26 W

Humidity range: 0 to 80 %

Operating temperature: 0 to 45 °C

H.V. Out temp. Coefficient: max 0.005 % °C

Ripple: 300 mV$_{pp}$ at full load.

2.2. PROGRAMMABLE PARAMETERS

For each channel the following parameters can be programmed and monitored either locally or remotely

V_0 First High Voltage programmed value - Expressed in Volt

I_0 First Current Limit programmed value - Expressed in microamp

V_1 Second High Voltage programmed value - Expressed in Volt

I_1 Second Current Limit programmed value - Expressed in microamp

RAMP-UP   Maximum High Voltage increase rate - Expressed in V/s

RAMP-DOWN   Maximum High Voltage decrease rate - Expressed in V/s

TRIP   Maximum time an   "overcurrent" is allowed to last expressed in hundreds of a
               second. When a channel is in "overcurrent" condition it works as a current generator;
               the output voltage is enabled to vary in order to keep the output current less than the
               active programmed value (I_0 or I_1). If an   "overcurrent" lasts more than the
               programmed value (from 1 to 9998) it will cause the channel to "trip". The output
               voltage will drop to zero at the programmed rate (Ramp-down) and the channel will
               be put in the off state.
               If this parameter is set to 9999, the "overcurrent" may last indefinitely. If it is set to
               0, the channel will be switched off as soon as an overcurrent is detected, irrespective
               of the programmed ramp down value.

VMAX   Absolute maximum High Voltage level which the channel is allowed to reach,
               independently from the preset values V_0 or V_1. **The MAXV can be set in the range
               from 0 V to 8 kV. Setting a value less than 300 V on the parameter can generate
               a unit malfunction.** The output voltage cannot however exceed the preset value
               VMAX set with the relevant screwdriver adjusted potentiometer, labelled   from
               MAXV0 to MAXV3 on the front panel. The accuracy is 1 % $\pm$ 5 V. VMAX is a hard
               limit which cannot be overridden.

VMON   High Voltage Monitored value - Expressed in Volt

IMON   Current Monitored value - Expressed in microamp

2.3.   EXTERNAL COMPONENTS

All the external components are located in the front panel of the unit except the SHV output
connectors and the relevant Channel On/Off LEDs which are housed in the rear one.

CONNECTORS: **All the input signals except the RST and the ALARM
                                   are provided with two bridge connectors for daisy
                                   chaining. TTL or NIM standard selectable for the input
                                   output signals. When the NIM standard is selected the
                                   last daisy chained module on the RST, KILL, VSEL and
                                   ISEL lines must be terminated with a 50 Ω impedance
                                   load.**

                                   1,"ALARM" Lemo 00 type; output. TRUE when a danger
                                   condition occurs in a channel (OVV, UNV, TRIP, MAXV
                                   or non calibrated module).

                                   1, "RST" Lemo 00 type; remote reset input. All the channels
                                   are switched OFF and the H.V. is not present at the outputs.

                                   2, "KILL" Lemo 00 type; input. When it becomes TRUE all
                                   the channels are switched off irrespective of the Ramp-
                                   Down value programmed.

                                   2, "VSEL" Lemo 00 type; input. Selects the active
                                   programmed value between V_0, FALSE, and V_1, TRUE, for
                                   all the channels. The H.V. outputs vary between the two
                                   values with the programmed Ramp Up and Ramp Down.

                                   2, "ISEL" Lemo 00 type; input. Selects the active

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programmed value between I_0, FALSE, and I_1, TRUE, for all the channels.

2, "H.S. CAENET" Lemo 00 type; High Speed CAENET line.

1, SHV type for each channel distributing the H.V. output.

DISPLAYS: **2**, 8-character alphanumeric LED displays showing all the operational parameters and functions

LEDs:

Channel Polarity   **1**, "+" GREEN for each channel; when it lights up the relevant channel has been preset as positive.

1, "-" YELLOW for each channel; when it lights up the relevant channel has been preset as negative.

Channel Status   **The meaning of the following LEDs refers to the channel number shown in the left hand side of the upper display**
1, "ON" RED, when it lights up the channel is switched ON.

1, "OFF" GREEN, when it lights up the channel is switched OFF.

1, "OVC" RED, when it lights up the channel is draining a current equal to the preset active current limit (I_0 or I_1).

1, "OVV" RED, when it lights up the channel is supplying a voltage at least 100 V greater than the preset active value (V_0 or V_1).

1, "UNV" RED, when it lights up the channel is supplying a voltage at least 100 V smaller than the preset active value (V_0 or V_1).
1, "TRIP" RED, when it lights up the channel is switched OFF at the end of the programmed TRIP time.

1, "RAMP UP" YELLOW, when it lights up the channel is ramping up to reach the preset active value.

1, "RAMP DW" YELLOW, when it lights up the channel is ramping down to reach the preset active value or to be switched off.

1, "MAXV" RED, when it lights up the channel has reached the relevant preset VMAX limit.

H.S. CAENET   **1**, RED, when it lights up the relevant module is the actual addressed unit on the line.

H.V. Enable   **1**, RED signalling when the unit is enabled to supply the High Voltage on the outputs.

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Alarm	**1**, RED it lights up on when the "ALARM" output becomes TRUE.
Channel On/Off	**4**, "CH0, CH1, CH2, CH3", when it lights up the relevant channel is switched on.
LAMPS:	**1**,"HV ON" RED, when it lights up at least one of the channels is in the ON status. When the H.V. is disabled through the relevant front panel switch or the channels are switched off the lamp is alighted until one of the HV outputs is greater than 100 V.
SWITCHES:	**1**, "HV ENABLE", to enable/disable all the unit channels to reach the preset active HV level; when in the ON position the relevant LED is switched ON.
PUSH-BUTTONS:	**1**, "MAN RST", manual unit RESET.
TRIMMERS:	**4**, "MAXV0, MAXV1, MAXV2, MAXV3", multi-turn potentiometers to set the allowed absolute maximum HV outputs in the range from 0 V to 8 kV.
KEYBOARDS:	**1**, 12 key[1] front panel keyboard to program and monitor all the operational parameters of the unit.

2.4.   POWER REQUIREMENTS

The following power comsuptions are referred to the unit with all the channels supplying 3 kV and 3 mA to the loads (maximum deliverable power).

+ 24 V 1.7 A	- 24 V 0.9 A
+ 12 V 0.2 A	- 12 V 0.2 A
+ 6 V 1 A	- 6 V 50 mA

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[1] Note that older versions feature the "*" key instead of the "#" key, its function, however, is the same.

3. MONITORING and DISPLAYS

3.1 MANUAL OPERATIONS

The unit can be operated manually through a 12-key keyboard and two 8-character LED displays located on the front panel.

All the relevant parameters of each channel may be displayed and modified by calling the appropriate "functions". A function is called by pressing the "F" key followed by a number and by the "#" key. The numbers and their associated functions are shown in the following table:

				TABLE. 1 FUNCTIONS and MESSAGES
NUMBER	MNEMONIC	MESSAGE	RANGE	MEANING
0	CH	Channel	0 to 3	Selects the channel
1	V_0	V0-Set	0 V to 8000 V	Programs the first High Voltage value
2	I_0	I0-Set	0 to 3000 µA	Programs the first Current Limit value
3	I_1	I1-Set	0 to 3000 µA	Programs the second Current Limit value
4	TR	Trip	0 to 9999	Programs the Trip Time
5	V_1	V1-Set	0 V to 8000 V	Programs the second High Voltage value
6	VM	V mon		Reads the H.V. Monitor
7	IM	I mon		Reads the Current Monitor value
8	RU	Ramp up	1 to 500 V/s	Programs the H.V. Increase rate
9	RD	Ramp down	1 to 500 V/s	Programs the H.V. Decrease rate
10	ON	On		Turns the channel ON
11	OFF	Off		Turns the channel OFF
12	KILL	Kill		All H.V. channels are switched off
13	MAXV	V-Max		Reads the VMAX value
14	CL ALARM	Cl Alarm		Resets the status of the ALARM output signal
15	LEV	Lev ()		Selects the standard TTL or NIM of the hardware monitor signals.
89	Lumin.	Sel Lum	1 to 7	Adjusts the luminosity of the 2 displays (1 to 7)
90	V Calib	V Calib		Performs the calibration of the output voltage
91	I Calib	I Calib		Performs the calibration of the output current
92	MaxV Calib	MaxV Cal		Performs the calibration of the MAXV
99	Cr.	Cr. Num.	0 to 99	Sets the CAENET address

NOTE: The channel number to which all the commands and information on the displays and LEDs are referred is always shown on the left hand side of the upper display .

The digitised data becomes active only after the "#" key has been hit. So, for example, to select the channel 1, the "CHANNEL" function is first called by typing "F0#" (see table 1) followed by the desired channel number 1 and confirmed pressing the "#" key.
Then, for example, to set the V_0 value (High Voltage), type "F1#" followed by the desired value in Volt.

As soon as the "F" key has been hit, the word "FUNCTION" will appear on the lower display to indicate that a function is expected. After typing "1", the message "V0 SET" will replace the "FUNCTION" message, an "F" appears on the right hand side of the upper display and the "1 " is shown on the most right character of the upper display. Once the "#" key has been pressed to confirm the selection of this function, the message will disappear and only a two character mnemonic code (V_0) will be shown on the left-hand side of the lower display, while the right-hand side will show the current value of the selected parameter. The new value typed, if any, will appear on the upper display (right-hand side) .
The current value of the parameter will be actually changed only if the key "#" will be pressed again. To cancel the operation before actually affecting the current value of the parameter, just type "F" and select another function.

If an unknown function code is digitised the system gives an "INVALID" message. If the invalid function is confirmed the function number itself, on the upper row, start to flash untill the "F" key is hit again or another legal function number is digitised and confirmed.

3.2. REMOTE OPERATIONS

The model N 470A is provided with a HIGH SPEED CAENET interface. The H.S. CAENET line uses a simple 50 Ω coaxial cable as physical medium through which the unit can be controlled by the following CAEN modules:

> **Mod. C 117 B** - H.S. CAENET CAMAC Controller
> **Mod. V 288** - H.S. CAENET VME Controller
> **Mod. A 303** - H.S. CAENET PC Controller.

NOTE:	the address number (station number selected by the F99 function) must be the only one in the line in which you wish to insert the module. Due to high transmission speed of the data in line it is necessary to terminate this line on a 50 Ω impedance at the end to avoid reflections.

The control from an A 250 HS CAENET MANUAL CONTROLLER has not been implemented due to the complexity of the unit and the relative high number of parameters that must be controlled and monitored. Any attempt to control the unit from an A 250 gives the following message on the controller display:

Crxx	No Control
N470A	by A250

The only parameter that can be modified is the Crate number to select a different module on line. Controlling the unit from remote a 16 bit STATUS word is available to monitor the status of the selected channel or of the unit globally. The following table reports the meaning of each bit of the STATUS word

	TABLE 2 N 470A STATUS WORD		
BIT No	**CODE**	**IF**	**MEANING**
0	ON/OFF	0	The channel is OFF
1	OVC	1	The channel is in OVC condition
2	OVV	1	The channel is in OVV condition
3	UNV	1	The channel is in UNV condition
4	TRIP	1	The channel has been switched OFF for TRIP condition
5	RUP	1	The channel is ramping up
6	RDW	1	The channel is ramping down
7	MAXV	1	The channel has reached the preset MAXV
8	POL	0 1	Positive channel Negative channel
9	VSEL	0 1	Vset = V_0 Vset = V_1
10	ISEL	0 1	Iset = I_0 Iset = I_1
11	KILL	1	Module KILLed by external pulse still active
12	HVEN	1	Module enabled to supply HV by the front panel switch
13	NIM/TTL	0 1	NIM standard selected TTL standard selected
14	OUTCAL	1	Non calibrated module
15	ALARM	1	Module in alarm condition

3.2.1. USING THE H.S. CAENET CAMAC CONTROLLER (Mod. C 117 B)

The model N 470A can be controlled via CAMAC through the Mod. C 117 B H.S. CAENET CAMAC Controller.
The standard CAMAC functions listed in table 3 allow the user to perform the required control and setting operations according to the typical MASTER/SLAVE communication protocol, where the CAMAC controller assumes the MASTER function.

<table>
<tr><td colspan="2" align="center">**TABLE 3   Mod. C 117 B CAMAC FUNCTIONS**</td></tr>
</table>

F(0) N	Reads the data stored in the Mod. C 117 B DATA buffer. Q response until the buffer contains data.
F(8) N	Tests the LAM line. Q response if LAM is true.
F(9) N	Resets the Mod. C 117 B (clears buffer and LAM; disables the LAM line).
F(16) N	Stores the data into the Mod. C 117 B DATA buffer. Q response until the buffer is full (256 16-bit words).
F(17) N	Transfers data to the serial line.
F(24) N	Disables the LAM line.
F(26) N	Enables the LAM line.
C, Z	Same as F(9) N.

Via CAMAC functions, the C 117 B module (MASTER) transmits or receives data packs composed of subsequent 16-bit words to/from the addressed Mod. N 470A (SLAVE). Up to 256 words can be stored into the Mod. C 117 B DATA buffer.

The MASTER-to-SLAVE data have to be written into the DATA buffer by performing subsequent F(16) N functions as follows:

TABLE 4 MASTER -to-SLAVE DATA COMPOSITION			
WORD ORDER	**CAMAC FUNCTION**	**W16 TO W1**	**MEANING**
1	F(16) N	0000000000000001	HOST COMPUTER CONTROLLER IDENTIFIER CODE
2	F(16) N	xxxxxxxxxxxxxxxx	ADDRESS NUMBER OF THE MODULE TO BE ADDRESSED
3	F(16) N	xxxxxxxxxxxxxxxx	CODE OF THE OPERATION TO BE PERFORMED (see TABLE 5).
4	F(16) N	xxxxxxxxxxxxxxxx	EVENTUAL SET VALUE

In the following table 5 the CH reported as high byte in some of the allowed operation codes is a binary number from 0 to 3 selecting the channel number to which the operation is referred to.

OPERATION CODE	HIGH BYTE	LOW BYTE	RESULT
			TABLE 5 BINARY CODE OF THE OPERATION TO BE PERFORMED TO CONTROL THE MOD. N 470A
0	00000000	00000000	READS THE IDENTIFICATION MODULE'S NAME AND THE SOFTWARE VERSION'S NUMBER
1	00000000	00000001	READS Vmon,Imon,MaxV and STATUS FOR ALL THE CHANNELS
2	CH	00000010	READS ALL THE OPERATIONAL PARAMETERS OF THE SELECTED CHANNEL
3	CH	00000011	SETS THE V_0 VALUE OF THE SELECTED CHANNEL
4	CH	00000100	SETS THE I_0 VALUE OF THE SELECTED CHANNEL
5	CH	00000101	SETS THE V_1 VALUE OF THE SELECTED CHANNEL
6	CH	00000110	SETS THE I_1 VALUE OF THE SELECTED CHANNEL
7	CH	00000111	SETS THE TRIP OF THE SELECTED CHANNEL
8	CH	00001000	SETS THE RAMP UP OF THE SELECTED CHANNEL
9	CH	00001001	SETS THE RAMP DOWN OF THE SELECTED CHANNEL
10	CH	00001010	SETS THE SELECTED CHANNEL ON
11	CH	00001011	SETS THE SELECTED CHANNEL OFF
12	00000000	00001100	KILLS ALL THE CHANNELS
13	00000000	00001101	CLEARS THE ALARM OUTPUT SIGNAL
14	00000000	00001110	ENABLES THE FRONT PANEL KEYBOARD
15	00000000	00001111	DISABLES THE FRONT PANEL KEYBOARD
16	00000000	00010000	SELECTS THE TTL LEVEL
17	00000000	00010001	SELECTS THE NIM LEVEL

After the required F(16)N functions have been performed, it is necessary to carry out an F(17) N function in order to transfer the stored data to the addressed module.
The answer data coming from the Mod. N 470A or Mod. C 117 B itself are automatically stored into the Mod. C 117 B DATA buffer and are read-out in Q STOP mode through the functions F(0) N.

IMPORTANT NOTE: For each operation to be performed (see TABLE 5) on the Mod. N 470A it is necessary, each time, to carry out the functions indicated in TABLE 4, in that order, and afterwards an F(17) N.

The first word of the answer data is shown in TABLE 6.

TABLE 6 WORD 1 CONTENT		
HIGH BYTE	**LOW BYTE**	**MEANING**
00000000	00000000	Successful operation
11111111	00000000	BUSY module (it has tried to effect an operation while the module is still busy registering previous data inside the EEPROM)
11111111	00000001	Code not recognised or message incorrect.
11111111	00000010	Incorrect set value.
11111111	11111101	No data to be transmitted.
11111111	11111110	The H.C. Controller identifier is incorrect.
11111111	11111111	The addressed module does not exist. This message is generated after a period of 500 ms.

In the case of a successful operation, the contents of the subsequent words are the functions of the command that has been sent.

3.2.1.1. PARAMETER SETTING and READING

SINGLE PARAMETER SETTING

Operation codes 3 to 9   :   Word 4   must contain the new 16 bit binary value of the various parameters.
The ranges of the allowed values are reported in the following table 7

TABLE 7 ALLOWED VALUES RANGES			
V_0/V_1 (V)	I_0/I_1 (µA)	TRIP (s/100)	RAMP UP/DOWN (V/s)
4000 to 8000	0 to 1000	0 to 9999	1 to 500
3000 to 4000	0 to 2000	"	"
0 to 3000	0 to 3000	"	"

Operation codes from 10 to 17:   they not require the word 4 in the data pack. When the codes 10 and 11 are requested the N 470A gives back in the answer data pack the "Successful operation" code in the first word and the system Status in the second one.

MULTIPLE PARAMETER READING

Operation code 0	: Word 2 to Word 17	contains on the low byte the ASCII code of the string of characters identified by the name of the module and the software version "N 470A version n.m".
Operation code 1	: Word 2 to Word 17	contains the values of Vmon,Imon,MaxV and STATUS for the channels 0,1,2,3 in the order.
Operation code 2	: Word 2 to Word 12	contains the values of STATUS, Vmon, Imon,V_0 set, I_0 set,V_1 set, I_1 set, TRIP, ramp up, ramp down, and MaxV in that order of the channel selected by the code from 0 to 3 held in the high byte of the operation code.

3.2.1.2.OPERATIONS TO BE PERFORMED

1. Insert a Mod. C 117 B H.S. CAENET CAMAC Controller into a CAMAC slot.

2. Connect the C 117 B "SERIAL LINE" connector to the "SERIAL IN-OUT" input connector, located on the front panel of the Mod. N 470A, using a 50 Ω coaxial cable .

3. Turn on CAMAC crate and Mod. N 470A.

4. By performing the appropriate CAMAC functions, configure the Mod. N 470A as required.

3.2.2. USING THE H.S. CAENET VME CONTROLLER (Mod. V 288)

The Mod. N 470A can be controlled remotely via VME through the Mod. V 288 H.S. CAENET VME controller. Standard VME cycles allow the user to perform the required control and setting operations on each Mod. N 470A in the network, according to the typical MASTER/SLAVE communication protocol, where the VME controller assumes the MASTER function. The Mod. V 288 VME interface is provided with the following registers:

<table>
<tr><td colspan="4" align="center">TABLE 8 Mod. V 288 REGISTERS</td></tr>
<tr><th>NAME</th><th>TYPE</th><th>ADDRESS</th><th>FUNCTION</th></tr>
<tr><td>DATA BUFFER</td><td>READ/WRITE register</td><td>Base Address +00</td><td>DATA STORAGE</td></tr>
<tr><td>STATUS REGISTER</td><td>READ only register</td><td>Base Address +02</td><td>AFTER A H.S. CAENET OPERATION HAS BEEN PERFORMED, THIS REGISTER INDICATES WHETHER THE OPERATION IS VALID OR NOT (FFFE = VALID OPERATION; FFFF = NO VALID OPERATION)</td></tr>
<tr><td>TRANSMISSION REGISTER</td><td>WRITE only register</td><td>Base Address +04</td><td>BY WRITING INTO THIS REGISTER, THE DATA BUFFER CONTENT IS TRANSFERRED TO THE ADDRESSED SLAVE</td></tr>
<tr><td>RESET REGISTER</td><td>WRITE only register</td><td>Base Address +06</td><td>MODULE'S RESET</td></tr>
<tr><td>INTERRUPT VECTOR REGISTER</td><td>WRITE only register</td><td>Base Address +08</td><td>INTERRUPT VECTOR PROGRAMMING</td></tr>
</table>

By WRITE/READ cycles, the Mod. V 288 (MASTER) transmits or receives data packs composed of subsequent 16-bit words to/from the addressed N 470A (SLAVE). Up to 256 words can be stored into the Mod. V 288 DATA buffer.

The MASTER-to-SLAVE data have to be written into the DATA buffer by performing subsequent WRITE cycles as follows:

<table>
<tr><td colspan="5" align="center">TABLE 9   MASTER-to-SLAVE DATA COMPOSITION</td></tr>
<tr><th>ORDER</th><th>OPERATION</th><th>ADDRESS</th><th>DATUM</th><th>MEANING</th></tr>
<tr><td>1</td><td>WRITE</td><td>Base address + 00</td><td>0000000000000001</td><td>HOST COMPUTER CONT-ROLLER IDENTIFIER CODE.</td></tr>
<tr><td>2</td><td>WRITE</td><td>Base address + 00</td><td>xxxxxxxxxxxxxxxx</td><td>THE ADDRESS NUMBER OF THE MODULE TO BE ADDRESSED.</td></tr>
<tr><td>3</td><td>WRITE</td><td>Base address + 00</td><td>xxxxxxxxxxxxxxxx</td><td>CODE OF THE OPERATION TO BE PERFORMED (see table 5 par. 3.2.1)</td></tr>
<tr><td>4</td><td>WRITE</td><td>Base address + 00</td><td>xxxxxxxxxxxxxxxx</td><td>EVENTUAL SET VALUE (see table 6 par. 3.2.1.1)</td></tr>
</table>

As soon as the data pack has been stored in the DATA buffer, it can be transferred to the addressed module by performing a WRITE operation on the TRANSMISSION register.

IMPORTANT NOTE: For each operation to be performed (see codes in TABLE 5 par. 3.2.1) on the Mod. N 470A it is necessary, each time, to carry out the WRITE cycles indicated in TABLE 8 in the same order and afterwards a WRITE operation on the TRANSMISSION register.

The answer data coming from the Mod. N 470A or Mod. V 288 itself are automatically stored into the Mod. V 288 DATA buffer. As soon as the data pack is stored in this buffer, a VME interrupt (if enabled) is generated and then the data can be read.

The first word of the answer data is shown in TABLE 6 par. 3.2.1.

In the case of a successful operation, the contents of the subsequent words are the functions of the command that has been sent.

See par. 3.2.1.1 for Parameter Setting and Reading.

3.2.2.1.OPERATIONS TO BE PERFORMED

1. Insert a Mod. V 288 H.S. CAENET VME Controller into a VME slot. Make sure that the V 288 base address is set as required.

2. Connect the Mod. V 288 "SERIAL LINE" connector to the "SERIAL IN-OUT" input connector, located on the front panel of the Mod. N 470A, with a 50 Ω coaxial cable.

3. Turn ON VME crate and Mod. N 470A.

4. By performing the appropriate VME WRITE/READ cycles, configure each Mod. N 470A as required.

3.2.3.   USING THE H.S. CAENET PC CONTROLLER (Mod. A 303)

The Mod. N 470A can be controlled via an IBM PC (XT, AT or 80386) or compatible through the Mod. A 303 H.S. CAENET PC controller.

This is an interface board directly insertable into a std. I/O PC slot and is mapped in the MS-DOS I/O or memory address space. Thereby it is controllable by all the languages (high level or assembly) through the proper instructions, independently from the computer type (XT, AT or 80386 family).

Dip-switches located on the printed circuit board allow the user to set the unit according to the computer to be used.

The controller is composed of a collection of registers, managing the commands acknowledged by the unit, and two memory buffers arranged in FIFO logic 512 bytes deep (see TABLE 10).

<table>
<tr><td colspan="4" align="center">TABLE 10   Mod. A 303 REGISTERS</td></tr>
<tr><td>REGISTER/BUFFER</td><td>ADDRESS</td><td>OPERATION</td><td>DESCRIPTION</td></tr>
<tr><td>TX DATA BUFFER</td><td>Base address + 0</td><td>WRITE</td><td>FIFO Logic (512 byte max. depth)</td></tr>
<tr><td>START TX</td><td>Base address + 1</td><td>WRITE</td><td>Starts the transmission of the TX BUFFER data.</td></tr>
<tr><td>RESET CAENET INTERFACE</td><td>Base address + 3</td><td>WRITE</td><td>Clears TX and RX buffers and reset all the interrupt signals</td></tr>
<tr><td>RX DATA BUFFER</td><td>Base address + 0</td><td>READ</td><td>FIFO logic (512 byte max. depth)</td></tr>
<tr><td>STATUS REGISTER</td><td>Base address + 1</td><td>READ</td><td>8-bit register (see the STATUS REGISTER CONFIGURATION table 10)</td></tr>
<tr><td>STATUS REGISTER</td><td>Base address + 2</td><td>READ</td><td>Reads the STATUS REGISTER and resets a present interrupt.</td></tr>
<tr><td>CLEAR RX DATA</td><td>Base address + 3</td><td>READ</td><td>Reads and clears the RX buffer.</td></tr>
</table>

The two buffers are the TRANSMITTER (TX) data buffer and the RECEIVER (RX) one.

WRITE and READ operations allow the user to perform the required controls and settings on each Mod. N 470A in the network, according to the typical MASTER/SLAVE communication protocol, where the PC controller assumes the MASTER function.

By WRITE/READ operations, the Mod. A 303 (MASTER) transmits or receives data packs composed of subsequent 16-bit words to/from the addressed N 470A module (SLAVE). Up to 256 words can be stored into the Mod. A 303 DATA buffers.

The MASTER-to-SLAVE data have to be written into the TX data buffer by performing subsequent WRITE operations as described in the table below:

<table>
<tr><td colspan="5" align="center">TABLE 11   MASTER-to-SLAVE DATA COMPOSITION</td></tr>
<tr><td>ORDER</td><td>OPERATION</td><td>ADDRESS</td><td>DATUM</td><td>MEANING</td></tr>
<tr><td>1</td><td>WRITE
WRITE</td><td>Base address + 00
Base address + 00</td><td>Low Byte: 00000001
High Byte: 00000000</td><td>HOST COMPUTER CONTROLLER IDENTIFIER CODE.</td></tr>
<tr><td>2</td><td>WRITE
WRITE</td><td>Base address + 00
Base address + 00</td><td>Low Byte:
XXXXXXXX
High Byte: 00000000</td><td>THE ADDRESS NUMBER OF THE MODULE TO BE ADDRESSED.</td></tr>
<tr><td>3</td><td>WRITE
WRITE</td><td>Base address + 00
Base address + 00</td><td>Low Byte Oper. Code
High Byte Oper. Code</td><td>CODE OF THE OPERATION TO BE PERFORMED (see TABLE 5 par. 3.2.1)</td></tr>
<tr><td>4</td><td>WRITE
WRITE</td><td>Base address + 00
Base address + 00</td><td>Low Byte:
XXXXXXXX
High Byte: 00000000</td><td>EVENTUAL SET VALUE (see par. 3.2.1.1)</td></tr>
</table>

As soon as the data pack has been stored in the TX DATA buffer, it can be transferred to the addressed module by performing a WRITE operation on the START TX register (base address + 1).

IMPORTANT NOTE:	For each operation to be performed (see codes in TABLE 5 par. 3.2.1) on the Mod. N 470A it is necessary carry out the WRITE operations indicated in TABLE 11 in the same order and afterwards a WRITE operation on the STATUS TX register.

The answer data coming from the Mod. N 470A is automatically collected in the RX DATA buffer. As soon as the data pack is stored in this buffer, the controller unit gives an interrupt (if enabled) to the CPU in the computer and then the data can be read.

The first word in the answer data pack is always the Host Computer Controller Identifier Code resent back to the master by the addressed unit.
The second word of the answer data is shown in TABLE 12.

<table>
<tr><th colspan="3">TABLE 12   WORD 2 CONTENT</th></tr>
<tr><th>HIGH BYTE</th><th>LOW BYTE</th><th>MEANING</th></tr>
<tr><td>00000000</td><td>00000000</td><td>Successful operation</td></tr>
<tr><td>11111111</td><td>00000000</td><td>BUSY module (it has tried to effect an operation while the module is still busy registering previous data inside the EEPROM).</td></tr>
<tr><td>11111111</td><td>00000001</td><td>Code not recognised or message incorrect.</td></tr>
<tr><td>11111111</td><td>00000010</td><td>Incorrect set value.</td></tr>
</table>

NOTE:	Any other error condition, which is not mentioned in table 12, must be controlled by the user.

In the case of a successful operation, the contents of the subsequent words are the functions of the command that has been sent.

See par. 3.2.1.1 for the Parameter Setting and Reading.

The STATUS REGISTER of the controller unit gives the current communication status as shown in TABLE 13.

	TABLE 13 - STATUS REGISTER CONFIGURATION	
BIT	BIT STATUS	MEANING
7	0	Transmission in progress
6	0	Reception in progress.
5	0	Transmission end. Interrupt generation.
4	0	TX FIFO empty.
3	0	RESTART in progress. In this status the module cannot accept commands.
2	0	Reception end. Interrupt generation.
1	0	The RX FIFO has been unloaded. Interrupt generation.
0	0	RX FIFO empty.

3.2.3.1.OPERATIONS TO BE PERFORMED

1. Set the H.S. CAENET PC Controller according to the computer type to be used, then insert it into an I/O slot.

2. Connect the Mod. A 303 output connector to the "SERIAL IN/OUT" input connector located in the front panel of the Mod. N 470A with a 50 Ω coaxial cable.

3. Turn ON the computer and the Mod. N 470A.
4. By performing the appropriate WRITE/READ operations, configure each Mod. N 470A as required.

4. OPERATING MODES

The model N 470A lets the user select the High-Voltage polarity with simple operations which are detailed in this Section. Note that the polarity is indicated by two LEDs for each channel on the front panel.

1. In order to change polarity the user must switch off the unit and wait for the complete discharge of the capacitors then remove the side covers thereby making access to the Printed Circuit Boards.

2. Lay down the unit, NIM crate connector on the left and the front panel on the right, components side up and refer to Figure 3.

DANGER HIGH VOLTAGE
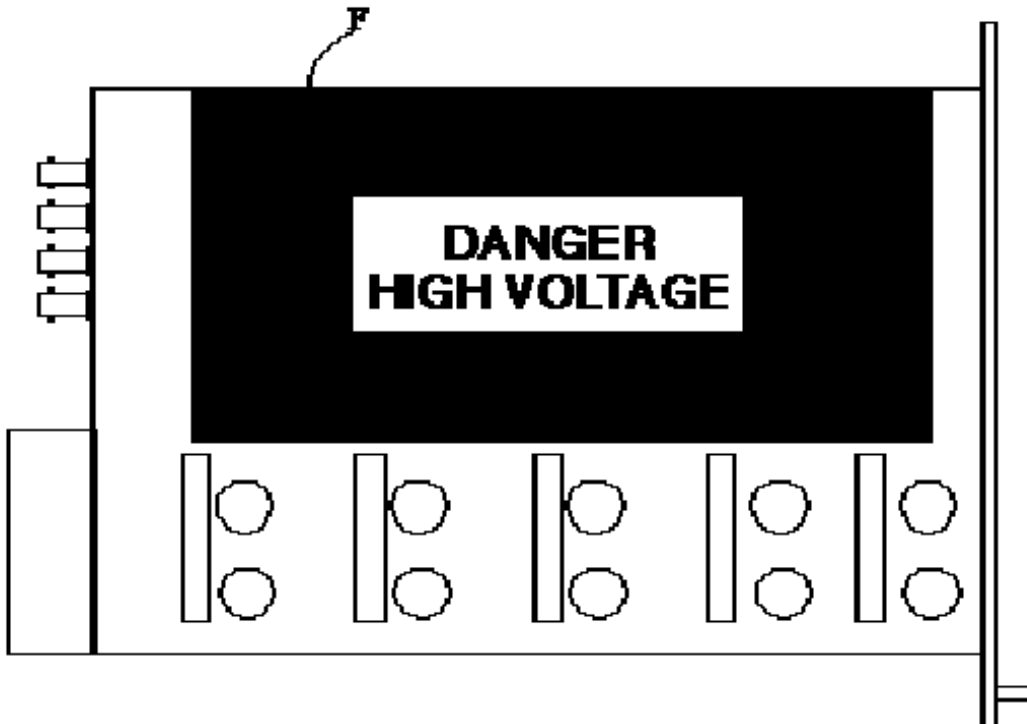
Fig. 3

A large module (labelled F in the figure) appears on the Board. This is the High-Voltage block housing the four multipliers of the channels and bears a "High-Voltage Danger" sign. The cover if fixed to the base through several screws; remove them and the cover.
   The four multipliers will appear as shown in figure 4 with the channel 0 multiplier on the right.
All the HV components are encapsulated in a silicon black rubber and only the DIODE BRIDGE labelled BDG in figure 4 is accessible to the user.

The diode bridge itself is encapsulated in a silicon rubber with a white dot located on one side. If the diode bridge is inserted inside the multiplier block with the white dot towards the transformer the relevant channel is selected as a POSITIVE channel, otherwise the channel is selected as a NEGATIVE one.

3. Configure the unit to satisfy to your requirements eventually mixing positive and negative channels in the same unit.

4. If the polarity of one or more channels must be changed, extract the module Bdg from its contacts

and insert it in the opposite position according to the figure 4.

5. Reassemble the unit.

Fig. 4
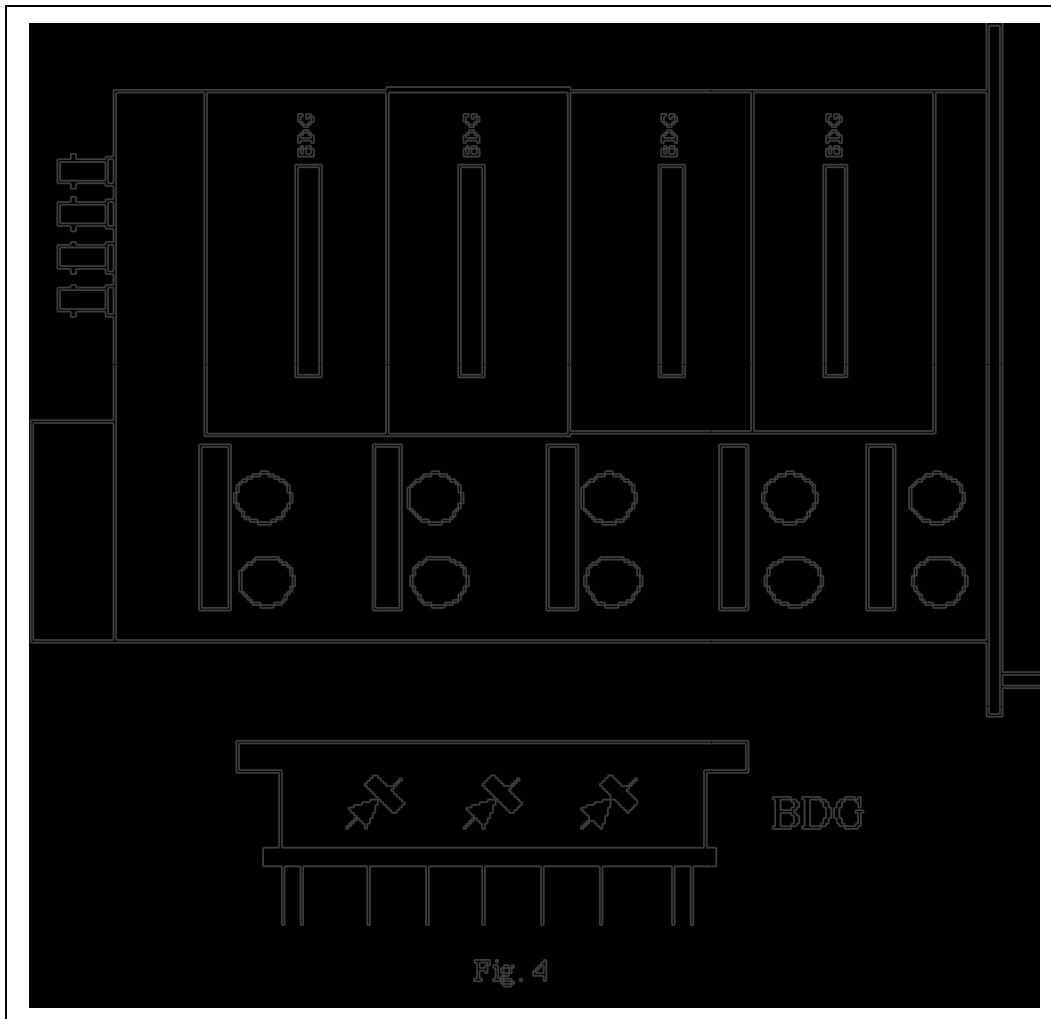
Insert the unit inside a NIM crate, and switch it ON.

At the power the two displays show for a few seconds the following messages

Mod. N 470A

Ver   n.m

and after that the two displays will show

Ch 0

Vm   xxxx

Verify the channels polarity checking that the polarity LEDs are switched on according to the programmed configuration; connect the H.V. cable linking the outputs to the relevant loads to be supplied and enable the H.V. outputs switching the HV ENABLE front panel switch in the position in which the relevant LED lights up.

NOTE:	After a reset all the channel are in OFF condition irrespective of the last saved configuration. In this way the user must switch on all the channels he needs either by the specific function or by the remote operation .

Perform all the programming steps, either locally or remotely, you need to obtain the wished configuration.