Technical Information Manual

MOD. N 471

2 FOLD H.V.
POWER SUPPLY

12th February 1993

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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MODEL OVERVIEW

C.A.E.N. MODEL N 471 is a two channel general-purpose high-voltage NIM Power Supply housed in a one-unit wide NIM module; each channel can reach up to 8 KV.

Its wide range of current and voltage, compactness and low cost make it ideal for powering a huge spectrum of detectors, such as photomultipliers (PMs), wire chambers, streamer tubes, silicon detectors and so on.

Among its most relevant features there are:

• Wide Voltage-Current Capability. The module can deliver 1 mA from 3 to 8 KV, or 3 mA if the voltage output is limited to3 KV.
Therefore, the units can cover all available commercial PMs tubes and all types of resistive chains.

• Selection of polarity. The user can select positive or negative voltage levels by changing the specific "Diode Bridge" component inside the unit (see Section 5).

• Digital Display. All operational parameters (output voltage, current limit and maximum voltage setting) can be monitored on a 4-digit LED display. The unit displays both set and monitor values.

• Flexibility in Functions and Controls which include:

* Local channel INHIBIT.
* Local or Remote module INHIBIT.

• Sophisticated Safety Features. Operational safety includes:

* presetting of a specified HV limit.

• The "IMON" LEMO 00 front panel connector allows the remote control of the output current monitoring through an analog signal.

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

The N 471 front and rear panels are shown in figure 1 , on the two fold-out pages at the end of this Manual. For your convenience, keep the photograph folded out to easily associate descriptions and explanations with the layout of the model.

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

2 SPECIFICATIONS

The Module can to deliver 1 mA up to 8 KV. The channel is limited only by the maximum available power, consequently the unit can deliver 3 mA up to 3 KV. The limitation of the output current is performed automatically according to the output voltage set value.

Positive or Negative Polarity Selection. The polarity selection of each channel can be executed by the user following the procedure detailed in section 5.

PARD (Periodic and random Deviation) data are:

- 300 mVpp at full load at 8 KV/1 mA;
- 200 mVpp at full load at 3 KV/3 mA;

OUTPUT VOLTAGE CONTROL (for each section)

- The output voltage, V_{Out} is adjusted with the 10-turn potentiometer on the front panel labelled HV SET.

- The current limit, I_{Out} is set with the screwdriver adjustable potentiometer on the front panel labelled ISET.

- The maximum output voltage, V_{Max} is set with the screwdriver adjustable potentiometer on the front panel labelled MAXV. The output voltage cannot however exceed the preset value V_{Max}. Accuracy is ± 2 % (for $V_{Max} \geq 1000$ V) . V_{Max} is a hard limit which cannot be overridden.

- The output of the channel can be controlled by a three position lever switch which can switch the channel ON or OFF, Up and Down positions, or to INHIBIT it in the central INH position.

OUTPUT VOLTAGE RATE

The rate-of-change of output voltage is preset at the factory to ≅ 200 V/s . The value is the same for both channels and obtained using a 1 MΩ resistor in parallel to a 1 µF capacitor. In the printed circuit board (see fig. 2) 4 pads labelled TP1 to TP4 are foreseen to modify the rate-of-change of the channels. Inserting a resistor in the TP1/TP2 pad pair the user modifies the resistive value of channel A ; performing the same on the TP3/TP4 pair does the same for channel B. E.g. inserting a 2 MΩ resistor the rate of change is increased at ≅ 400 V/s.

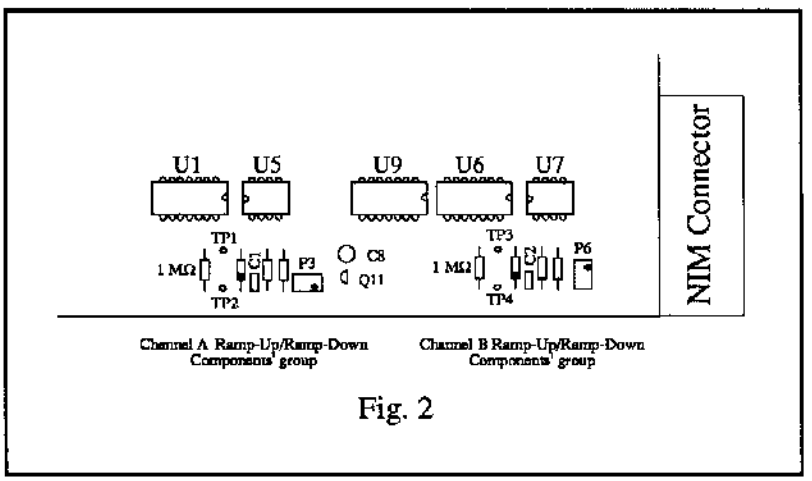

Fig. 2

POWER REQUIREMENTS:

+24 V	950 mA
-24 V	500 mA
+12 V	400 mA
-12 V	60 mA
+ 6 V	110 mA

3 MONITORING and DISPLAYS

In order to monitor the relevant parameters and functions the unit features a number of displays and monitor lines for maximum convenience, easy use and efficiency.

At the top of the front panel unit there is a 4 digit LED display and a set of three switches arranged in two rows that allow the monitoring and the setting of all the operational parameter. The three switches are :

- the parameter selector on the left of the first row (V, I, MAXV);

- the mode selector switch, on the right of the first row (MON, SET);

- the channel selector switch on the second row (A, B).

The user can select :

-the channel, A or B, to which the display refers by acting on the two position channel selector switch;

-the meaning of the displayed parameter selecting, through the mode selector switch, if the displayed value is a monitor or set one;

-the parameter to be displayed (voltage or current output, both set and monitor, and V_{Max} only set).

Consequently the parameters that can be displayed on the 4 digit display are:

- V_{Out}, the settable value of the output voltage;

- V_{Max}, the preset value of the output voltage limit;

- I_{Out} , the settable value of the maximum output current;

- and finally I_{Mon} and V_{Mon}, the actual values of the output current and voltage.

Values are shown in Volts and micro Amperes for voltage and current data respectively.

This display is instrumental not only when visualizing preset values, but also when actually getting the operational parameters. Indeed, to preset any one of them, the user must select, through the switches, the specific channel parameter and then, by acting on the relevant potentiometer, turn until the desired value appears on the display.

Some LEDs on the front panel refer to the relevant channel (A and B) and give the following information:

- POLARITY (green for positive, yellow for negative)

- HVON High-Voltage ON (red),

- ISET Current limit reached condition (red),

- MAXV reached condition (red).

1 connector per channel, "IMON", supplies an analog signal which is proportional to the output current delivered to the load with a sensitivity of1 µA/1 mV.

4 OPERATING MODES

4.1 NORMAL, RESTART, KILL and INHIBIT

NORMAL mode. Except at power-on, this is the default state of the Module, when voltage and current are supplied to the load under the constraints imposed by the operational parameters.

When the unit is initially powered the Module is in a Reset state, where no High-Voltage or power is supplied to the load. In order to return to normal operations press the three position switch labelled INHIBIT, housed at the bottom of the front panel, to the RST unstable position. This clears the internal memories and lets the Module resume normal operations, under the constraints imposed by the operational parameters. NOTE that the voltage is brought to the preset level at the fixed rate-of-change.

IMPORTANT: before starting this operation, check and/or adjust all the operational parameters in each channel. This can be done with the usual procedures, without affecting the load in any way. This is important at POWER-ON; the old pre-set values may damage the load.

INHIBIT mode. The channels can be forced to inhibit condition by acting on the relevant three position switch housed in both sections A and B. Selecting the central position of the three position switch the relevant channel is inhibited and the output voltage drops to zero at the fixed rate-of-change.

At the bottom of the front panel there is a section labelled INHIBIT housing the commands to inhibit the module locally or remotely .
The local command is a three position lever-switch. In the central position the module is in NORMAL mode, in the left position the module is in INHIBIT mode, in the right unstable position the switch acts as a RESTART module command.
The remote INHIBIT module command is a standard TTL signal which has to be fed to the relevant input LEMO 00 connector. Minimum pulse width at INHIBIT input is 60 ns.
A pulse fed to the INHIBIT connector after the power on phase exits the module from the inhibit condition; a continuous level at the same connector set the module in INHIBIT mode.
When the unit is in INHIBIT mode both channels are inhibited and the relevant red LED is switched on.

KILL mode. The channel can be individually killed selecting the OFF position from the HV ON switch . The relevant channel is then switched off immediately and independently from the preset rate-of-change; the output voltage drops with a speed function of the time constant resulting from the load resistance and capacitance, the output channel resistance and capacitance and the cable capacitance.

4.2 OVERLOAD PROTECTION

When the current drain of a channel exceeds the preset value, an OVERLOAD condition occurs. In this condition the relevant ISET LED lights up.

At OVERLOAD, the unit acts like a constant-current generator. The output voltage drops to a value determined by the product of the programmed current limit and the resistive value of the load.

5 SELECTION OF POLARITY

The Model N 471 allows the user to select the High-Voltage polarity of each channel with simple operations which are detailed in this Section. Note that the polarity of each channel is indicated by two LEDs on the front panel.

1. In order to change the polarity of a channel the user must switch off the unit and remove the side covers, thereby making access to the Printed Circuit Board.

2. Lay the PCB, components side up and refer to Figure 3. As you will see, a large, module (labelled F in the figure) is conspicuous on the Board. This is the High-Voltage multiplier and bears a "High-Voltage Danger" sign. The cover of it is fixed by 4 screws.

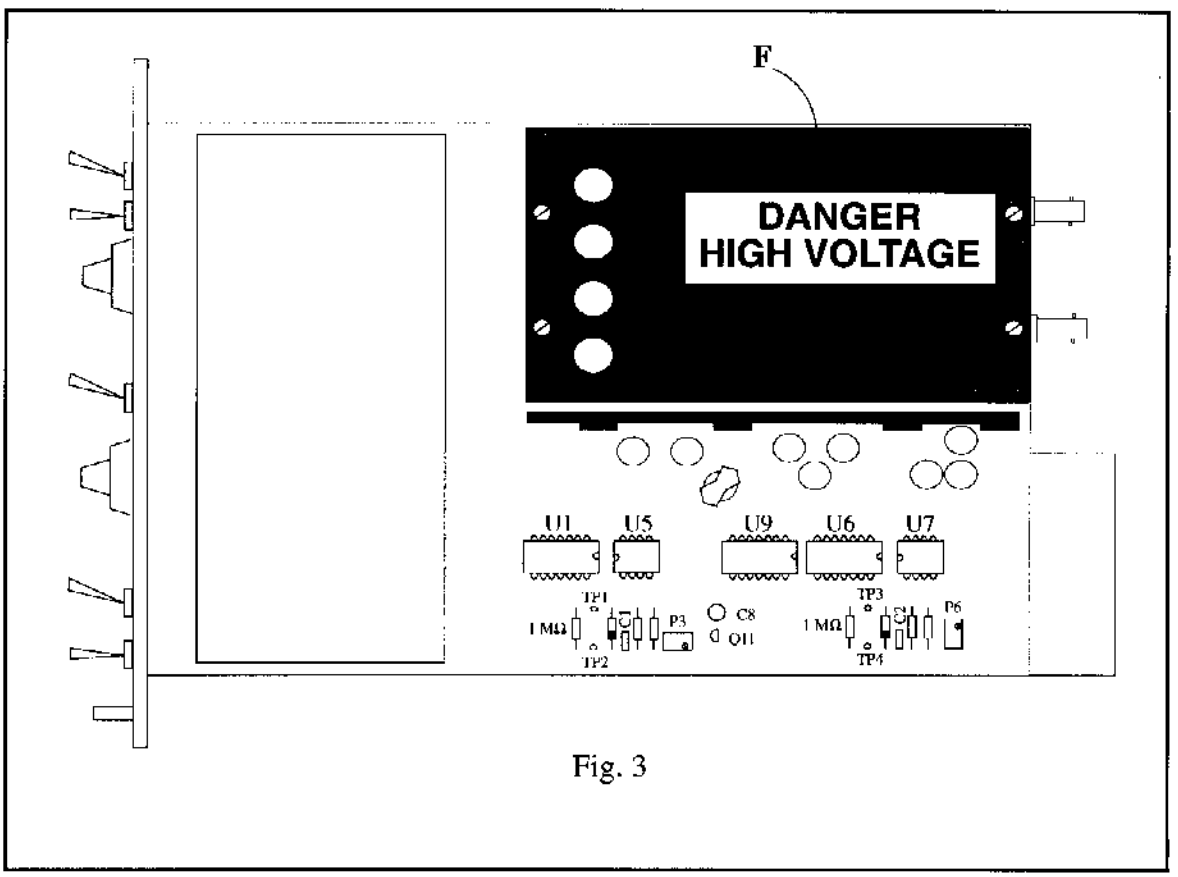

Fig. 3

3. If the polarity must be changed, remove the four screws and the cover. The two multipliers enclosed in silicon black rubber will appear, channel A on the top, and a large diode bridge with a white dot at one side (see fig. 4) will be available in the middle of each multiplier section. A positive channel has the white dot on the diode bridge towards the output connector.

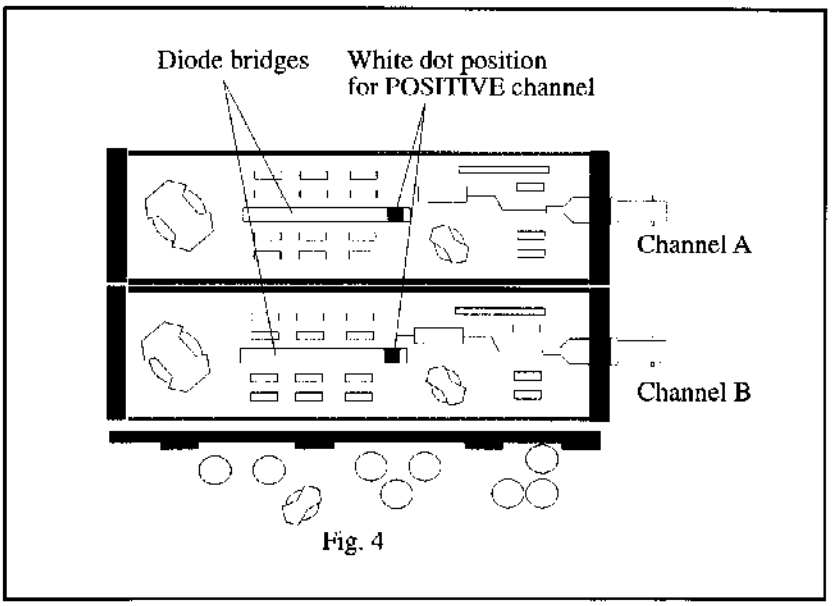

Fig. 4

4. Remove the diode bridge reverse it and place it once again in its connector. The polarity of the relevant channel has been changed.

5. Repeat for the other channel if required.

6. Reassemble the unit.

7. At power-on, check that the correct polarity LED is ON.

6 SUMMARY TABLES

The Operational Parameters control the ways and limits with which the voltage and current are supplied to the load. They are set by means of the screwdriver-adjustable potentiometers on the front panel, V_{Out} is however set with the 10-turn potentiometer. The value of each operational parameter can be monitored on the 4-digit LED display, after being chosen with the switch selectors.

Table 1: Features of the Operational Parameters		
NAME	**RANGE**	**REMARKS**
VOut	0 to max HV range	
VMax	0 to max HV range	Hard High-Voltage protection.VOut cannot exceed VMax.[1]
Ramp-Up	200 V/s	Output Voltage rate away from zero. For negative polarity is absolute value.
Ramp-Down	200 V/s	Output Voltage rate towards zero. As above. Overridden by KILL mode.
IOut	0 to max current limit	

7 OPERATIONAL HINTS

This Section includes a number of useful hints, which are provided to help the reader familiarize himself with the usage of the Module and to avoid common mistakes, which may cause load damage. Read this Section first if you are having problems using the Units. Refer to the previous Sections for more detailed information on the features and commands of the Model.

- When the Module is powered at switch-on, the unit is in a reset state: no High Voltage is supplied to the load. BEFORE restarting the unit CHECK AND ADJUST POLARITY and ALL OPERATIONAL PARAMETERS as required.

- The user has to set a High-Voltage (V_{Out}) and a current limit (I_{Out}) value for each channel. Note that V_{Out} is set with the 10-turn potentiometer. When enabled the output switches from zero to the programmed HV value and the transition takes place at a rate given by the preset rate-of-change.

- V_{Max} is provided to set a hard limit to the output voltage, for maximum load protection. Remember that if $|VOut| > |VMax|$, the output voltage will actually reach a threshold at V_{Max}.

- Local monitoring of all the Module parameters is made with the 4-digit LED display and the switches Selector.

- It is also possible to set the unit in KILL or INHIBIT mode, both manually or electrically.

- KILL mode overrides Ramp-down and all other modes.

8 CALIBRATION PROCEDURES

The Modules have been thoroughly and carefully tested before delivery to ensure maximum reliability and precision. Particular care is given to the High-Voltage calibrations, which are made with C.A.E.N. instrumentation and a standard reference HV voltmeter .

If the unit (or one of its components) gets damaged and/or parts need replacements, the user must remember that calibrations are usually lost.

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[1] V_{Max} overrides V_{Out} . V_{Out} stops at V_{Max} if $|VOut| > |VMax|$.

Consequently, if such a situation occurs, or if the calibration is suspected, the user is advised to return the unit to C.A.E.N. labs. Our Technical Service shall take care of repairing the Module and shall also check all the calibrations.

If the user Intends to proceed independently, the following guidelines are provided to test the calibration of his unit.

8.1 Equipment Requirements

- One High-Voltage Voltmeter,
- One 4.5-digit Voltmeter,
- One Oscilloscope (20 MHz min.),
- One H.V. resistive load 1MΩ/ 10 W,
- One H.V. resistive load 8MΩ/ 10 W.

8.2 Module Calibration

The user must refer to the Electrical Diagrams and the component silkscreen reported in sect. 9 to identify the various components.

IMPORTANT: the following tests must be performed strictly sequentially.

- REFERENCE VOLTAGE CALIBRATION.

1. Using the 4.5-digit voltmeter, act on R 77 trimmer to set the voltage at the pin 6 of U14, equal to 8.100 Volts.

- PRELIMINARY CALIBRATIONS

2. Display the signal present at pin 1 of U15 on the oscilloscope . Adjust the P10 trimmer in order to obtain a triangular wave with a period equal to 29 µs. Act on P11 trimmer to obtain a wave symmetrical with respect to the GND reference.

3. Set the scope in AC mode and display the signal at negative pin of C23: adjust P12 in order to remove the distortion eventually present on the low level and bring it near to the rising edge of the signal (see fig. 5).

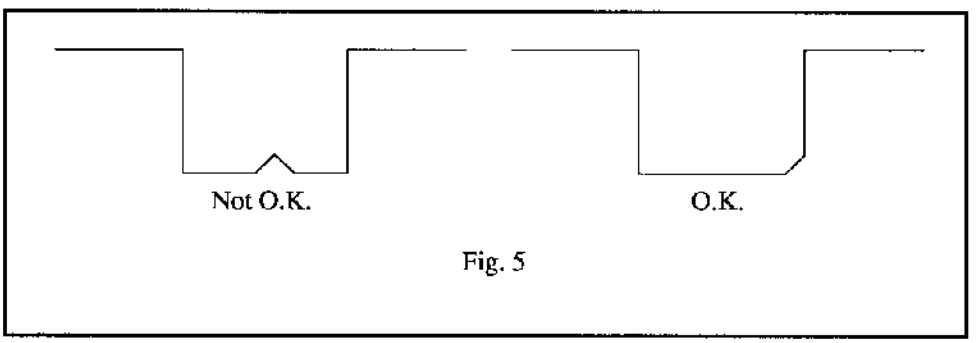


Fig. 5

4. Select channel A, mode SET and voltage display via the front panel switches. Connect the 1 MΩ load to the output of the channel A, set its Vout to 3000 V.

5. Turn the channel ON and after a few seconds act on the R117 to obtain a signal similar to that reported in fig. 6 placing the scope probe on the Q1 or Q2 drain.

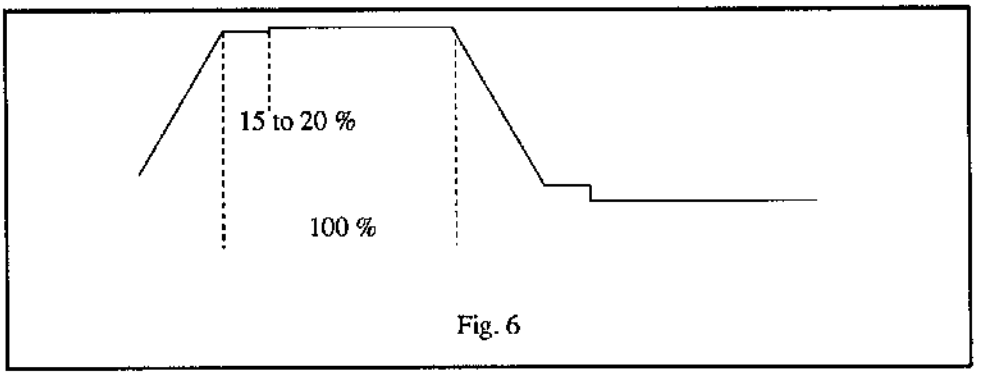


Fig. 6

6. Switch off channel A, connect the 8 MΩ load to its output, set Vout to 8000 V and repeat step 5; adjust the calibration of the R117 trimmer when necessary .

7. Repeat steps 4, 5 and 6 referring to the channel B. The corresponding trimmer is labelled R149.

DIGITAL VOLTMETER CALIBRATION

8. Select channel A, mode SET and voltage display on the front panel switches. Adjust the Vout setting to the minimum via the front panel HVSET (P7) potentiometer. Using the 4.5 digit voltmeter verify the voltage on pin 7 of U1; act on P7 in order to obtain -20 mV.

9.Adjust P1 on the Digital Voltmeter Board to read 20 on the front panel display of the unit.

10. Set the Vout to the maximum.

11. Place the probe on pin 7 of U1 and adjust P2 on the Digital Voltmeter Board to read the same value displayed on the 4.5-digit voltmeter on the front panel display .

VOLTAGE AND CURRENT CALIBRATION

12. Switch off the unit and with the procedure described in section 5 set the NEGATIVE polarity on both unit channels.

13.Select channel A, mode SET and voltage display on the front panel switches. Remove the load eventually present and switch on the unit.

14.Set Vout to zero via the front panel HVSET potentiometer. Switch ON the channel and select the mode MON.

15.Adjust P16 to read Imon equal zero on the front panel display. Switch OFF the channel, select I on the potentiometer selector and adjust P15 to read Vmon equal 0/1 on the front panel display.

16. Connect the HV voltmeter to its output connector. Set a Vout = 5000 V and switch the channel ON .

17. Adjust P3 to read the same Vmon value on the front panel display; adjust R96 in order to read 5000 V on the HV voltmeter.

18.Switch off the channel and connect the 1 MΩ load to its output. Set the channnel Vout to 3000 V.

19. Switch on the channel and verify its Imon value on the front panel display. The correct value must be 3000 μA

20. Switch off the channel.

21. Select the channel B and repeat steps from 13 to 20 acting on the trimmers P21, P20, P6 and R128.

22.Switch off the unit and repeat step 12 setting the positive polarity on the channels and select channel A.

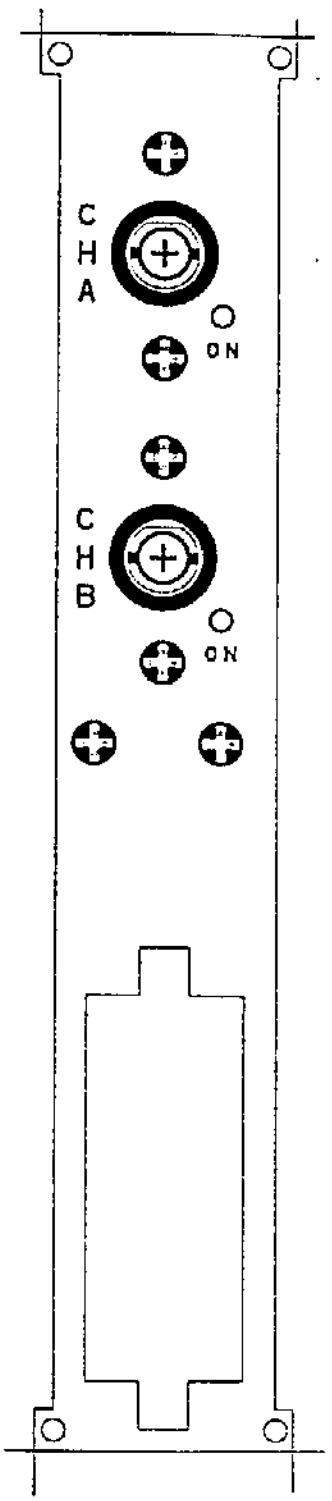
23.Switch on the unit and set the Vout = 0 . Switch OFF the channel and calibrate P14 to read Vmon = 0 .

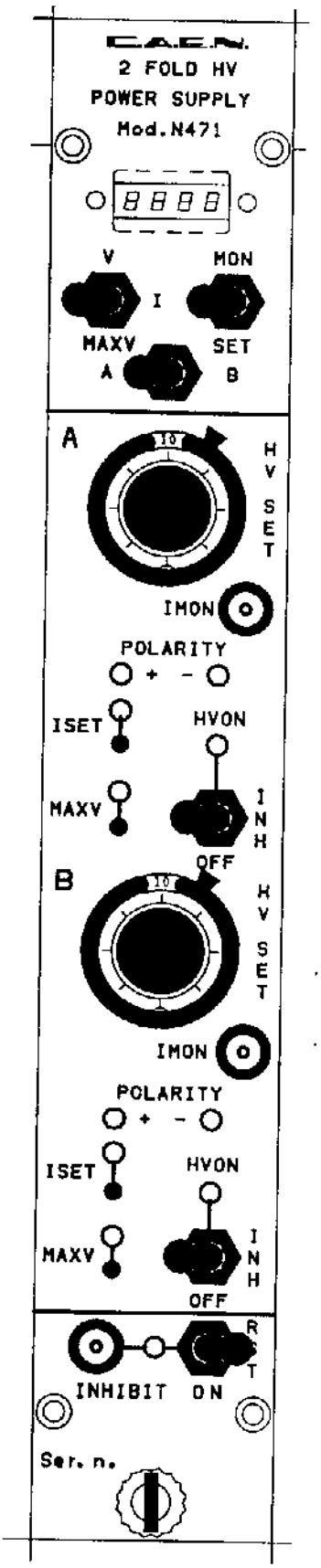
24.Switch ON the channel, select I on the potentiometer selector and adjust P17 to read Imon equal 0/1 on the front panel display.

25. Connect the HV voltmeter to the selected channel . Set Vout = 5000 V and adjust P13 to get 5000 V on the HV voltmeter.

26. Switch off channel A, select channel B and repeat steps 22, 23 and 24 acting on P19, P22 and P18 respectively.

27.Repeat steps from 4 to 7 adjusting the trimmer calibration if necessary.


CHA
ON
CHB
ON


C.A.E.N.
2 FOLD HV
POWER SUPPLY
Mod.N471
V
I
MON
MAXV
SET
A
B
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HV SET
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POLARITY
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fig. 1