Technical Information Manual

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MOD. N471A/N471G

2 CHANNEL HV 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.

Disposal of the Product

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





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1. MODEL OVERVIEW

The C.A.E.N. MODEL N 471A is a two channel general-purpose low cost high-voltage NIM Power Supply housed in a one-unit wide NIM module

Each channel can deliver 8 μ A up to 8 kV with an excellent current resolution of 1 nA.

The User can select positive or negative output voltage polarity by changing the position of an internal diode bridge inside the unit (see § 3.3). The selected channel polarity is shown by the relevant LED on the front panel.

The module can be controlled only in local mode, acting on the relevant front-panel potentiometers and switches present for each channel.

The output voltage "HV SET" is adjustable by means of a 10-turn potentiometer. The current limit "ISET" and the maximum output voltage "MAXV" are adjustable with a screwdriver potentiometer. The output voltage cannot exceed the preset value MAXV. MAXV is a hardware limit which cannot be overridden.

The rate of change of the output voltage is preset by the factory (approx. 200 V/s). It is possible to modify this value by inserting appropriate resistors in the pads present on the printed circuit board.

When the current drain of a channel exceeds the preset value, an OVERLOAD condition occurs. In this case 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.

The output voltage of the channel can be controlled by a three-position lever switch which can change the channel to either the ON or OFF position (Up and Down positions) or to INHIBIT it (in the central INH position). A remote INHIBIT is also present.

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.

The current can be remotely monitored through an analog signal (sensitivity: 1nA / 1mV).

Some LEDs on the front panel refer to their relevant channel (A and B) and give information about polarity, HV ON, current limit reached condition and MAXV reached condition.

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.

The N 471A 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 model layout.

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

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N471G 2 Channel HV Power Supplies for Germanium Detectors

The Mod. N471G is a special version designed to be used with Germanium Detectors. It houses 2 independent High Voltage channels. The output voltage ranges (automatic selection) is ±8 kV / 8 μ A with 1 nA resolution.

The output polarity is independently selectable for each channel. The unit has slow HV ramps, in order to be used with Germanium Detectors, coupled with the Mod. A483 External 8 kV HV filter; using such filter output voltage ripple is kept under 5 mV (28 μ s period ripple < 2 mV).

Two 10-turn potentiometers (one per channel) located on the front panel allow the HV setting, while 4 trimmers (2 per channel) allow the current and the max. voltage limit settings. The channel polarity, the overcurrent and overvoltage status are displayed by front panel LEDs. One front panel connector per channel allows the current monitoring. The channel inhibit can be done either individually for each channel via a front panel switch, or in common to all channels, both locally via front panel switch and remotely via an external signal. A common four digit display indicates the value of the parameter under control. The selection of the channel, the parameters and the set/monitor mode is performed via front panel switches. The module is intrinsically safe: the High Voltage is present only on the SHV output connectors.

Number of channels	2
HV range	±50 V to ±8 kV
Maximum output current	8 μΑ
Polarity	positive or negative selectable by the User
HV Set Resolution	±1 V
HV Mon resolution	±1 V
I Set resolution	±1 nA
I Monitor resolution	±1 nA
Vmon accuracy	0.5% ±8 V
Imon accuracy	2% ±10 nA
Vmax accuracy	1% ±8 V (Vmax > 1000 V)
Ripple	5 mVpp (with A483 filter); 50 mVpp (no filter) 28µs-period ripple: 2mVpp (with A483); 40 mVpp (no filter)
A483 input impedance	200 KOhm
RAMP-UP	Fixed (5 V/s)
RAMP-DOWN	Fixed (5 V/s)
Humidity range	10% to 80%
Operating temperature	0 to 45 °C
HV Out ttemp. Coeff.	max 0.005% / °C
HV Long term stability	±2 V

N471G - Technical Specifications



TRIMMERS:

2, "HV SET", one per channel, multi-turn potentiometers to set the HV outputs in the range from 0 V to 8 kV.

2, "ISET", one per channel, multi-turn potentiometers to set the current outputs in the range from 0 to 8 μ A.

2, "MAXV", one per channel, multi-turn potentiometers to set the allowed absolute maximum HV outputs in the range from 0 V to 8 kV.

SIGNALS:

"INHIBIT", std. TTL Level.

"IMON", voltage level. Range: 0 to +8 V. Rate: 1 nA/mV.

2.3 OUTPUTS CHARACTERISTICS

Number of channels:	2
High Voltage ranges:	±50 V to ±8 kV
Maximum output current:	8 μ Α
Polarity:	positive or negative selectable by the User as described in § 3.3
HV Set resolution:	±1V
HV Mon resolution:	±1V
I Set resolution:	± 1 nA
I Monitor resolution:	± 1 nA
Vmon accuracy:	$0.5\% \pm 8V$
Imon accuracy:	2% ± 10 nA
Vmax accuracy:	1% ± 8V (Vmax > 1000 V)
HV Ripple:	60 mV _{pp} at full load.
RAMP-UP:	Fixed (200 V/s)
RAMP-DOWN:	Fixed (200 V/S)
Humidity range:	10% to 80%
Operating temperature:	0 to 45 ^o C
H.V. out temp. coeff.:	max 0.005% / [°] C
H.V. long term stability:	±2V

2.4 POWER REQUIREMENTS

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



Current = Range 0:8 µA set/monitor value

Voltage = Range 0÷8 KV set/monitor value

Area A = Area with voltage and current regulation according to accuracy values reported in the table (defined within $10 \div 90\%$ of FSR)

Area B = Area with voltage and current regulation; accuracy values reported in the table are not guaranteed.

Area C = Area without voltage and current regulation

2.5. 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 to allow the monitoring and the setting of all the operational parameter. The three switches are:

-V/I/MAXV: to select the parameter Voltage, Current and HV limit;

-MON/SET: to select the operating parameter mode monitor or set;

- A/B: to select the channel A or B.

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

- V_{Out}, the settable value of the output voltage (0 to 8000 expressed in Volt);

- V_{Max}, the preset value of the output voltage limit (0 to 8000 expressed in Volt);

- IOut , the settable value of the maximum output current (0 to 8000 expressed in nanoamp);

- IMon, the current values of the output current (0 to 8000 expressed in nanoamp).
- V_{Mon.} the current values of the output voltage (0 to 8000 expressed in Volt).

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 nA/mV.

3. OPERATING MODES

3.1 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 that is a function of the time constant resulting from the load resistance and capacitance, the output channel resistance and capacitance and the cable capacitance.

3.2 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.

3.3 SELECTION OF POLARITY

The Model N 471A 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 present on the Board. This is the High-Voltage multiplier and bears a "High-Voltage Danger" sign. Its cover is fixed by 4 screws.



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 of the diode bridge towards the output connector.



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.

3.4 OUTPUT VOLTAGE RATE

The rate-of-change of output voltage is preset at the factory to $\cong 200 \text{ V/s}$. The value is the same for both channels and obtained using a 1 M Ω resistor in parallel to a 1 μ F capacitor. In the printed circuit board (see fig. 2) 4 pads labelled TP1 to TP4 are present 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 M Ω resistor the rate of change is increased at ~400 V/s.



3.5 SUMMARY TABLES



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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.				
lOut	0 to max current limit					

 $^{^{1}}V_{Max}$ overrides V _{Out} . V_{Out} stops at V _{Max} if |VOut| > |VMax|.

3.6 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 IVOutl > IVMaxl , 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.

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APPENDIX B: COMPONENTS LOCATION



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Mod. N471 N9041MB03/3 SERIGRAFIA LATO COMPONEN

