HIGH VOLTAGE POWER SUPPLY
Model 3002

Operator's Manual

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FIGURE LISTING

Section 1. Introduction

The Canberra Model 3002 is a NIM-bin-compatible high voltage power supply designed for operation with essentially all types of nuclear radiation detectors. Particularly well suited to high resolution system applications, the standard two-width NIM module supplies well-regulated stable detector bias with extremely low ripple and noise content.

A recessed slide switch on the bottom panel permits operation on either 115 or 230 V ac input power, furnished through a power line cord and connector. The unit has no audible noise and therefore can be operated in close proximity to users with no irritating, unpleasant ultrasonic or audio sounds. The power supply will withstand any overload or direct output short-circuit for an indefinite period of time and provide normal output automatically upon removal of the overload. Overvoltage protection is also provided.

Two front panel controls allow continuous adjustment of the output voltage over its 0 to 3000 V range. The output voltage can also be controlled over its full range by application of an external input dc level of 0 to -5 V through a rear panel BNC connector. This feature is desirable for control applications and is standard on all units.

A polarity reversal switch provides selection of positive or negative output polarity. To prevent inadvertent polarity reversal, the switch is top panel mounted and screwdriver activated. In addition, the front panel LED indicators allow visual monitoring of the output voltage polarity for the safety and convenience of the user.

The output voltage is available simultaniously through two parallel-wired MHV rear panel connectors. Having dual outputs plus an output load capacity of 10 mA makes the Model 3002 ideal for use with a pair of detectors having the same voltage level requirements - if the sum of the individual loads are within the operating limits of the power supply.

For protection of liquid-nitrogen-cooled detectors, the Model 3002's ac supply can be controlled by the Model 1786 Liquid Nitrogen Monitor. Note: for safe operation of the Model 1786, the ac line power must be 110 volts.

Section 2. Specifications

2.1 INPUTS

REMOTE CONTROL (J2) - Accepts external reference input to determine output amplitude when LOCAL/REMOTE switch is set to REMOTE; 0 to ≈ -5 V dc input provides 0 to ± 3000 V output; Z_{in} > 5000 ohms.

2.2 OUTPUTS

REGULATED H.V. OUTPUT - 0 to 3000 V dc, continuously adjustable; 0 to 10 mA output current capability; two parallel, rear panel, SHV-type high voltage coaxial connectors.

POLARITY INDICATORS - Front panel LEDs to indicate output voltage polarity.

2.3 CONTROLS

ON/OFF - Front panel 2-position toggle switch for main ac power input.

VOLTS - Front panel controls to set output amplitude when rear panel Control switch is set at LOCAL 0-2000 V in 500 V steps; 0-1000 V with 10-turn precision potentiometer; output voltage is sum of the two control settings ± 0.25%; minimum warranted output 50 V, but satisfactory performance to 10 V, minimum.

LOCAL/REMOTE - Rear panel switch selects LOCAL controls or REMOTE reference input (J2) to determine output voltage.

POLARITY - Top panel two-position screwdriver switch selects either POSitive or NEGative output polarity.

115/230 V ac - Bottom panel two-position screwdriver slide switch permits operation on either 115 or 230 V ac nominal input power.

2.4 PERFORMANCE

RIPPLE AND NOISE - < 10 mV peak-to-peak, 5 Hz to 5 MHz

OUTPUT STABILITY - Long term drift of output voltage is < 0.01%/hr. and < 0.02%/8 hr. period, at constant input line voltage, load, and ambient temperature, after a 30 minute warmup.

REGULATION - 0.001% variation in output voltage, for line variations and 0.01% for load variations within operating range at constant ambient temperature.

TEMPERATURE COEFFICIENT - ≤ ± 50 ppm/° C after 30 minute warmup, operating range 0 to 50° C.

OVERLOAD PROTECTION - Power supply will withstand any overload, including a short-circuit, for an indefinite period, and will automatically resume normal operation upon removal of the overload; output current is limited to ≈ 12 mA.

CALIBRATION ACCURACY - Output voltage will differ by < ± 0.25% from sum of control settings plus 0.05% of maximum voltage.

RESETABILITY - Output voltage can be reset to within ± 0.2 V.

OUTPUT LOAD CAPACITY - 0 to 10 mA.

OUTPUT RANGE - 0 to 3000 V dc.

2.5 CONNECTORS

INPUT POWER - Rear panel 3-wire captive ac line cord with standard NEMA male connector.

OUTPUT VOLTAGE - Two rear panel parallel-wired SHV type female high voltage coaxial connectors.

REMOTE CONTROL - Rear panel BNC

2.6 POWER REQUIREMENTS

103-129 V ac, 206-258 V ac, 47-65 Hz, 70 W, nominal; no dc power requirements; ac power line protection via rear panel slow-blow fuse.

2.7 PHYSICAL

SIZE - Standard double-width NIM module 6.86 cm x 22.13 cm (2.70 x 8.714 inches).

WEIGHT - 4.9 kg (10.8 lbs.)

Section 3.
Controls and Connectors

3.1 FRONT PANEL

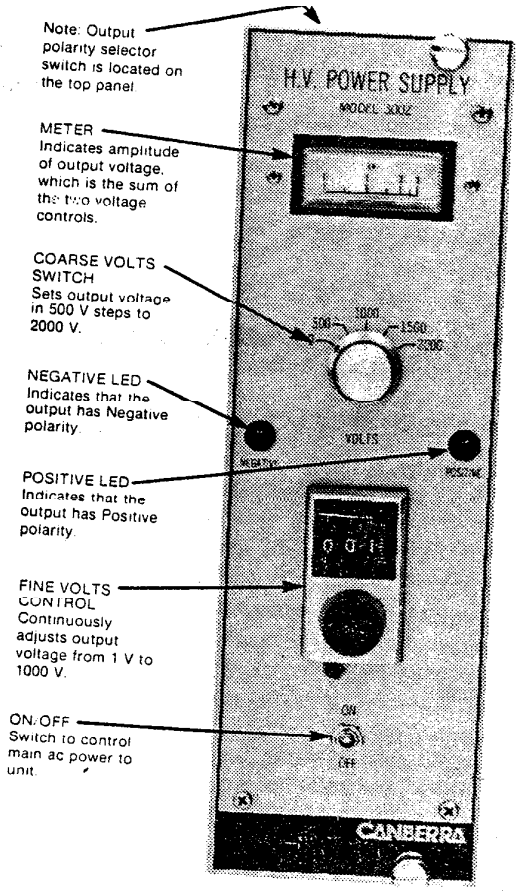

Figure 3.1
Front Panel Controls

3.2 REAR PANEL

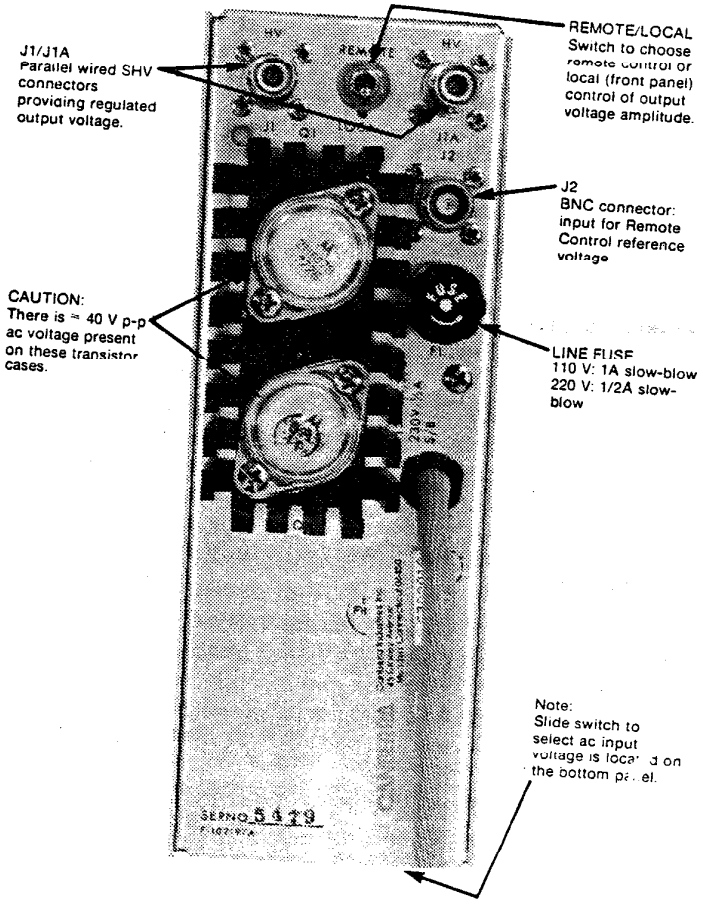

Figure 3.2
Rear Panel Controls

Section 4.
Operating Instructions

CAUTION

THIS UNIT PRODUCES HAZARDOUS VOLTAGE. DO NOT APPLY LINE VOLTAGE INPUT UNLESS ADEQUATE GROUND IS CONNECTED TO THE POWER SUPPLY AND THE HIGH VOLTAGE OUTPUT HAS BEEN APPROPRIATELY CONNECTED.

4.1 GENERAL

The purpose of this section is to familiarize the user with the installation and controls of the Model 3002 and to check that the unit is operating correctly. Since it is difficult to determine the exact system configuration in which the module will be used, explicit operating instructions cannot be given. However, if the following procedures are carried out, the user will gain sufficient familiarity with this instrument to permit its proper use in the system at hand.

4.2 INSTALLATION

The Model 3002 is normally used in conjunction with other modular electronics and may be installed in a Canberra Model 2000 Bin. As such, it can be rack mounted. Therefore any other equipment that may be installed in the same rack must be sufficiently cooled by circulating air to prevent any localized heating of the circuits in the Model 3002. The temperature of equipment operating in racks can easily exceed the recommended maximum unless precautions are taken. The Model 3002 should not be subjected to temperatures in excess of 50° C (120° F).

The Model 3002 contains all required power supplies to operate and receives input power by way of a 3-wire captive line cord with a standard NEMA male connector when connected to a suitable source. A bottom panel slide switch permits the selection of the proper input circuit for either 115 or 230 V ac nominal power input. This power supply may be operated entirely removed from a Model 2000 Bin if desired, since it is totally self-contained and requires no dc operating power levels from the Bin. However, precautions should be taken to ensure that personnel know of the shock hazard at the rear connectors, and air space should be provided at the top and bottom of the instrument.

4.3 OPERATION

Polarity selection is done by moving the Polarity switch on top of the unit, just behind the front panel.

NOTE: BEFORE ATTEMPTING TO REVERSE THE OUTPUT POLARITY,

1. TURN OFF THE HIGH VOLTAGE POWER SUPPLY
2. DISCHARGE THE UNIT TO GROUND AT THE OUTPUT CONNECTOR

This will protect both the Model 3002 and any equipment connected to it.

After selecting the Output Polarity:

1. Plug the ac power cord into the ac line supply.
2. Set the Output Voltage Controls to zero.
3. Turn on the front panel ON/OFF switch.
4. Check the Polarity indicator LEDs for correct Output Polarity.
5. Connect a high-voltage cable from either of the rear panel Output connectors to the instrument to be powered.
6. Two instruments may be powered, if their combined loads do not draw more than a maximum current of 10 mA.
7. Set the Output Voltage Controls for the desired voltage level. The Output High Voltage will be the sum of the settings of both controls.

4.4 EXTERNAL REFERENCE OPERATION

The output voltage level can be controlled by an external reference level that is furnished through the rear panel BNC connector when the Control switch is set at REMOTE. The range of input voltage is 0 to -5 V dc to provide an output level 0 to ± 3000 V. The front panel voltage level controls are ineffective for REMOTE reference operation.

For positive output the Polarity selector slide switch on the top panel is set at POSitive; for negative output the Polarity switch is set at NEGative. The external reference voltage should be stable and filtered since the output is linearly proportional to this reference.

4.5 AUTOMATIC SHUTDOWN

The Model 3002 contains automatic protection against sustained overloading (short-circuited output). A sustained overload will cause the high voltage to shut down completely. This will be clearly indicated by the zero output reading on the front panel meter whatever the voltage control settings may be. A short duration arc-over or turn-on charging transient will not cause shutdown. When the overload is removed, the preset output will resume.

Further protection is provided by the overvoltage circuitry. If the output should try to go higher than the Control settings, the overvoltage sensing circuit will shut the unit down. To reset, the unit must be turned OFF for approximately five seconds then turned back ON.

4.6 PERFORMANCE TESTS

The following test equipment is required to perform the measurements.

a. Oscilloscope
b. Digital Voltmeter (DVM).
c. High impedance, high voltage 1000:1 precision dc voltage divider with capacitive coupled ac viewing circuit.
d. High voltage load resistor, 300k ohms, 50 watts.
e. High voltage shorting stick.

Connect the high voltage output of the Model 3002 to the 1000:1 dc voltage divider. Connect the low voltage end of the divider to the DVM and the scope to the ac viewing output of the divider. Make sure a good ground is provided for all instruments.

Turn the front panel voltage controls to their maximum positions. The DVM should indicate an output of 3000 volts.

Connect one end of the load resistor to ground and the other end to the shorting stick. Then connect the load resistor to the high voltage output with the shorting stick and observe the change in output voltage. During this no-load to full-load test, the DVM reading should not change more than 0.001%.

With the load connected, measure the ac ripple on the oscilloscope. The ripple should be 10 mV peak-to-peak.

Section 5. Theory of Operation

5.1 GENERAL

This section describes the overall functional operation and circuitry of a Model 3002. The section gives background information to assist in the application and maintenance of the equipment. A complete circuit schematic is included at the rear of the manual.

5.2 FUNCTIONAL DESCRIPTION

The unit is basically a dc-dc converter which converts low voltage dc power to a high voltage dc output. This output voltage is highly regulated and filtered and can be varied either by the front panel VOLTS controls or through the REMOTE input on the rear panel.

The input to the dc-dc converter is obtained from a conventional low voltage power supply with ac line input. An oscillator determines the high frequency (approximately 20 kHz) at which all amplification, high voltage transformation, rectification, and filtering occurs. The amplification is a function of a control voltage which performs the function of control and regulation. A sample of the output is compared against a reference voltage in the sensing circuit. The sensing circuit generates the control voltage to set and maintain a fixed high voltage output.

5.3 CIRCUIT DESCRIPTION

The ac line provides the 36 V dc supply by a full-wave bridge rectifier and ± 20 V dc for the ± 12 V regulators by a dual full-wave grounded center-tap rectifier circuit. Both rectifier circuits are on the chassis. IC 121 and IC 122 are voltage regulators supplying the ±12 V regulated supplies.

The output of the oscillator (IC 102B) goes to the Automatic Gain Control (AGC) amplifier, IC 105, which has two outputs of opposite phase. The gain of the AGC amplifier is a function of the control generator voltage as seen at the output of IC 102A. Power transistors Q1 and Q2 are driven directly by the opposite phase outputs of IC 105.

The encapsulated high voltage assembly includes a high-voltage power transformer, a rectifier circuit, a ripple filter and a sampling (voltage-divider) circuit. These are all critical custom-designed components. It is recommended that trouble-shooting be avoided by personnel who are not thoroughly familiar with highly regulated high-voltage techniques.

The sensing circuit output is compared to the control generator voltage developed at the output of IC 103B. Output voltage control is obtained by varying the reference voltage fed to IC 103A.

IC 104 and CR 101 provide the reference voltage for the front panel voltage control resistors. R 172 calibrates the reference to provide 3 kV maximum output.

The front panel selection switch (S5) and control potentiometer (R 11) provide a linear reference at IC 103A appropriate for a 0 to 3000 V output.

Overload protection is provided by A107A and CR118. When the voltage controlling the gain of IC 105 exceeds the threshold established by CR118, Q103 turns on and sinks the oscillator output, turning off IC 105. When the overload is removed, the circuit automatically returns to normal operation.

Overvoltage protection is provided through IC 107B, Q105 and Q104. If the output voltage exceeds the programmed setting as dictated by the control generator, IC 107B turns on Q105 which in turn inhibits the output of IC 105. Q105 also turns on Q104 which shunts away IC 105's gain voltage produced by IC 102A. The power supply will remain in this condition until the ac power to the unit is turned off and then on again.

In the REMOTE mode, the control voltage on PCB 100 is determined by the voltage at the REMOTE input (J2). The LOCAL mode uses the internal reference voltage from the reference generator with the output voltage adjustments being controlled through S5 and R11.