

Model 710
Quad 1-kV Bias Supply
Operating and Service Manual

Advanced Measurement Technology, Inc.

a/k/a/ ORTEC[®], a subsidiary of AMETEK[®], Inc.

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Before being approved for shipment, each ORTEC instrument must pass a stringent set of quality control tests designed to expose any flaws in materials or workmanship. Permanent records of these tests are maintained for use in warranty repair and as a source of statistical information for design improvements.

Repair Service

If it becomes necessary to return this instrument for repair, it is essential that Customer Services be contacted in advance of its return so that a Return Authorization Number can be assigned to the unit. Also, ORTEC must be informed, either in writing, by telephone [(865) 482-4411] or by facsimile transmission [(865) 483-2133], of the nature of the fault of the instrument being returned and of the model, serial, and revision ("Rev" on rear panel) numbers. Failure to do so may cause unnecessary delays in getting the unit repaired. The ORTEC standard procedure requires that instruments returned for repair pass the same quality control tests that are used for new-production instruments. Instruments that are returned should be packed so that they will withstand normal transit handling and must be shipped PREPAID via Air Parcel Post or United Parcel Service to the designated ORTEC repair center. The address label and the package should include the Return Authorization Number assigned. Instruments being returned that are damaged in transit due to inadequate packing will be repaired at the sender's expense, and it will be the sender's responsibility to make claim with the shipper. Instruments not in warranty should follow the same procedure and ORTEC will provide a quotation.

Damage in Transit

Shipments should be examined immediately upon receipt for evidence of external or concealed damage. The carrier making delivery should be notified immediately of any such damage, since the carrier is normally liable for damage in shipment. Packing materials, waybills, and other such documentation should be preserved in order to establish claims. After such notification to the carrier, please notify ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment, if necessary.

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SAFETY INSTRUCTIONS AND SYMBOLS

This manual contains up to three levels of safety instructions that must be observed in order to avoid personal injury and/or damage to equipment or other property. These are:

DANGER Indicates a hazard that could result in death or serious bodily harm if the safety instruction is not observed.

WARNING Indicates a hazard that could result in bodily harm if the safety instruction is not observed.

CAUTION Indicates a hazard that could result in property damage if the safety instruction is not observed.

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

In addition, the following symbol may appear on the product:



ATTENTION – Refer to Manual



DANGER – High Voltage

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

SAFETY WARNINGS AND CLEANING INSTRUCTIONS

DANGER Opening the cover of this instrument is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.

WARNING Using this instrument in a manner not specified by the manufacturer may impair the protection provided by the instrument.

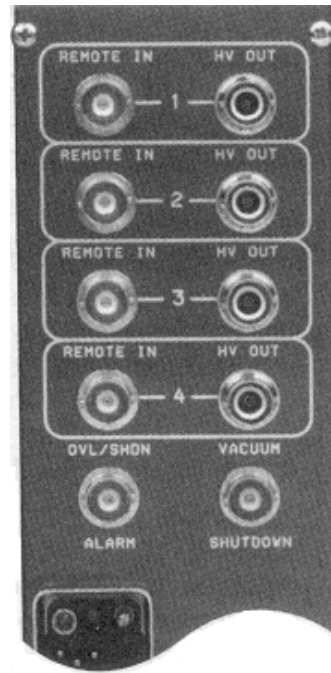
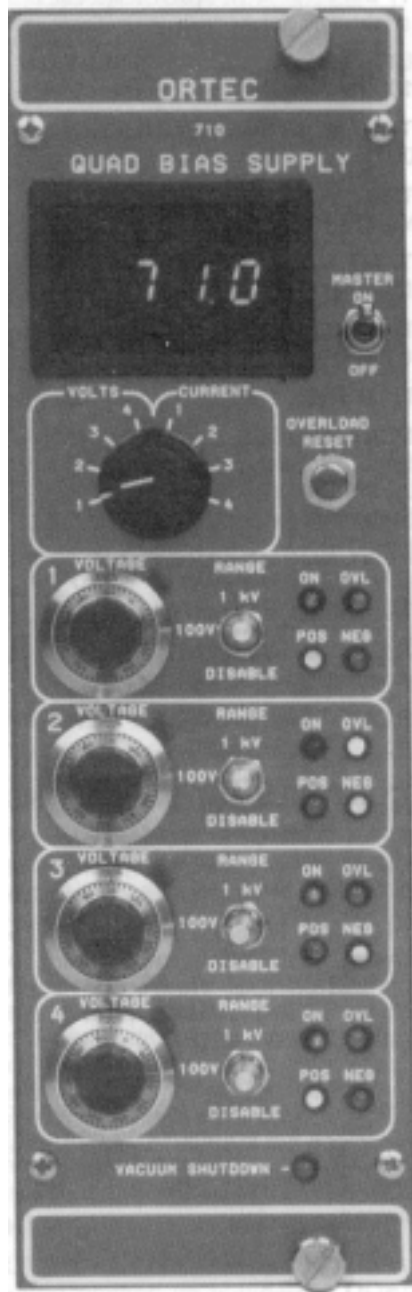
Cleaning Instructions

To clean the instrument exterior:

- Unplug the instrument from the ac power supply.
- Remove loose dust on the outside of the instrument with a lint-free cloth.
- Remove remaining dirt with a lint-free cloth dampened in a general-purpose detergent and water solution. Do not use abrasive cleaners.

CAUTION To prevent moisture inside of the instrument during external cleaning, use only enough liquid to dampen the cloth or applicator.

- Allow the instrument to dry completely before reconnecting it to the power source.



Rear Panel

ORTEC MODEL 710 QUAD 1-kV BIAS SUPPLY

1. DESCRIPTION

The Model 710 Quad 1-kV bias supply contains four high-voltage power supplies that have independently selectable output voltages and polarities. Each supply can deliver an output voltage that is continuously adjustable over the range of from 0 to ± 100 V or from 0 to ± 1 kV, with a maximum output current of 20 μ A. The Model 710 is ideal for providing the bias voltage for solid-state charged-particle detectors. It can also be used with ionization chambers and proportional counters that operate within the range of voltage and current delivered by the Model 710.

On each supply, a 10-turn, locking dial adjusts the output voltage with a control resolution of 0.05% of full scale. Feedback regulation ensures an output voltage accuracy within $\pm 0.25\%$ of full scale. The output voltage or output current of any of the four supplies can be selected for monitoring on the 3½-digit LED display. This is useful when initially determining the correct bias voltage for a solid-state detector. Detector bias currents from 0.01 to 19.99 μ A can be measured with a 0.01- μ A resolution.

On each supply, a three-position, locking toggle switch selects the 1 kV or the 100 V range of output voltage, or disables operation of that supply. The outputs of all active supplies are also controlled by the MASTER ON/OFF switch. A red LED on each supply indicates when its bias voltage is turned on.

Several features are incorporated to protect the detectors served by the Model 710, and to ensure

the integrity of the data they are collecting. Green LEDs indicate the polarity of the output voltage for each supply whenever the bin power is on, and the output polarity selection jumpers are mounted on the printed circuit board. If the detector current exceeds 20 μ A, the bias voltage for that detector turns off, and the yellow overload LED turns on to indicate a shutdown condition. That particular channel remains shut down until the fault is cleared and the OVERLOAD RESET button is pushed. To protect the detectors and their associated preamplifiers against discharges in a partial vacuum, the vacuum shutdown feature can be utilized. A relay closure to ground, or a low TTL signal from a trip level on a vacuum gauge can be applied to the VACUUM SHUTDOWN input to turn off all bias supplies in the case of a vacuum failure in the detector vacuum chamber. A yellow, front-panel LED turns on to indicate that the vacuum shutdown has been activated. Also, for added safety, all the supplies are placed in the overload condition when a VACUUM SHUTDOWN occurs, and the OVERLOAD RESET button must be pressed to reactivate the bias voltages. The rear-panel overload/shutdown alarm output generates a low TTL level whenever an overload or vacuum shutdown has occurred in the Model 710. This output can be connected to a computer, or other suitable alarm, to stop the measurement and prevent the collection of faulty data. The overload/shutdown alarm outputs from a number of Model 710 modules can be connected together to generate a common alarm signal.

2. SPECIFICATIONS*

The Model 710 contains four identical bias supplies with independently adjustable voltage and polarity. The specifications apply to each of the four channels unless noted otherwise.

2.1. PERFORMANCE

POLARITY Positive or negative polarity, independently selectable for each channel by printed circuit board jumpers.

OUTPUT VOLTAGE RANGE Front-panel switch selectable as 0 to 100 V, or 0 to 1 kV.

OUTPUT CURRENT RANGE Internally limited to 20 μ A on each output.

OUTPUT VOLTAGE ACCURACY $\pm 0.25\%$ of full scale.

*Specifications subject to change without notice.

VOLTAGE CONTROL RESOLUTION 0.5 V on 1000 V range; 0.05 V on the 100 V range.

OUTPUT VOLTAGE REGULATION <0.001% or 1 mV (whichever is greater).

OUTPUT VOLTAGE TEMPERATURE SENSITIVITY <30 ppm/°C FOR 0 TO 50°C.

OUTPUT VOLTAGE LONG-TERM INSTABILITY <0.001%/24 hours.

OUTPUT RIPPLE <2 mV peak-to-peak, 5 Hz to 100 MHz.

OUTPUT RISE TIME Nominally 100 ms.

DISPLAY RANGES 0 to 100 V in 0.1 V steps on the 100-V range, 0 to 1000 V in 1 V steps on the 1000-V range, and 0 to 19.99 μ A in 0.01 μ A steps for current.

DISPLAY NONLINEARITY <+ 0.05% of full scale for voltage from 0 to 100 V or from 0 to 1000 v, and current from 0 to 10 μ A.

DISPLAY UNCERTAINTY $\pm 1/2$ least significant digit.

DISPLAY TEMPERATURE SENSITIVITY ≤ 50 ppm/°C for 0 to 50°C.

2.2. CONTROLS AND INDICATORS

MASTER ON/OFF (Common to all channels) Front-panel, 2-position, toggle switch enables or disables all four supplies.

OVERLOAD RESET (common to all channels) Front-panel, momentary, push-button switch that clears the overload shutdown on any channel after a current overload. (See OVL LED.)

VOLTS/CURRENT (common to all channels) Front-panel, 8-position, rotary switch selects the parameter to be read from the display. Either the output voltage or the output current of each of the four supplies can be selected.

DISPLAY (common to all channels) Front-panel, 3 $\frac{1}{2}$ -digit, LED display monitors either the voltage or current of the supply selected by the VOLTS/CURRENT rotary switch.

POLARITY JUMPER (1 per channel) Internal, printed circuit board jumper selects either positive or negative output polarity.

POS/NEG LEDs (2 per channel) Front-panel, green LEDs indicate the polarity of the HV OUTPUT. POS is on for positive, or NEG is on for negative output polarity.

RANGE (1 per channel) Front-panel, 3-position, locking toggle switch selects a full-range output voltage of 0 to 100 V or 0 to 1 kV, or disables the output.

ON LED (1 per channel) Front-panel, red LED is on if the supply is enabled and has not experienced a vacuum shutdown or current overload.

VOLTAGE CONTROL (1 per channel) Front-panel, 10-turn, precision potentiometer with locking, graduated dial provides a continuously variable output voltage from 0 to 100 V or from 0 to 1 kV, depending upon the VOLTAGE RANGE setting. (Also see VOLTAGE CONTROL JUMPER.)

VOLTAGE CONTROL JUMPER (1 per channel) Internal, printed circuit board jumper selects either the REMOTE INPUT or the front-panel VOLTAGE CONTROL potentiometer as the source that sets the output voltage. Normally set to the VOLTAGE CONTROL potentiometer position.

OVL LED (1 per channel) Front-panel, yellow LED is on if the supply has been shut down because the current demanded from the HV OUTPUT exceeded 20 μ A. (See OVERLOAD RESET.)

VACUUM SHUTDOWN LED (common to all channels) Front-panel, yellow LED is on if a vacuum shutdown has been triggered. (See VACUUM SHUTDOWN input.)

2.3. INPUTS

VACUUM SHUTDOWN (common to all channels) Rear-panel, BNC connector disables all supplies and turns on the VACUUM SHUTDOWN LED if a low TTL signal or a resistance to ground less than 75 Ω is applied. The supplies are enabled and the VACUUM SHUTDOWN LED turns off when a high TTL signal or a resistance to ground greater than 5 K Ω is connected to this input. Used with the trip level on a vacuum gauge to turn off the detector bias voltage when vacuum is lost in the chamber containing the detectors.

REMOTE INPUT (1 per channel) Rear-panel, BNC connector accepts a 0 to +10-V input that controls the output voltage from 0 to full scale. Active only when the REMOTE INPUT is selected by the VOLTAGE CONTROL JUMPER.

2.4. OUTPUTS

HV OUTPUT (1 per channel) Rear-panel, SHV connector supplies the 0 to ± 100 V or 0 to ± 1000 V bias voltage output.

OVL/SHDN ALARM (common to all channels)

Rear-panel, BNC connector provides an open-collector, active-low, TTL-compatible signal if a vacuum shutdown or an overcurrent shutdown on any of the four channels has occurred. An external pull-up resistor to +5 V is required. OVL/SHDN ALARM outputs from other Model 710 modules can be connected in parallel to produce a common

alarm to signal a detector failure or a vacuum failure in the experiment.

2.5. ELECTRICAL AND MECHANICAL

POWER REQUIRED The Model 710 derives its power from a NIM bin supplying ± 24 V and ± 12 V, such as the ORTEC Model 4001A/4002A NIM Bin/Power Supply. The power required is +24 V at 90 mA, +12 V at 390 mA, -12 V at 360 mA, and -24 V at 90 mA.

WEIGHT

Net 1.4 kg (3.2 lb).

Shipping 2.9 kg (6.4 lb).

DIMENSIONS Standard double-width NIM module, 6.90 x 2.13 cm (2.70 X 8.714 in.) front panel per DOE/ER-0457T.

3. INSTALLATION

3.1. POWER CONNECTION

The Model 710 operates on power that must be provided by a NIM-standard bin and power supply such as the ORTEC 4001A/4002A series. Convenient test points on the bin power supply control panel should be used to check that the dc voltage levels are not overloaded. The bin and power supply are designed for relay rack mounting. If the equipment is rack mounted, be sure that there is adequate ventilation to prevent any localized heating of the components that are used in the Model 710. The temperature of equipment mounted in racks can easily exceed the maximum limit of 50°C unless precautions are taken.

3.2. INTERNAL JUMPER SELECTIONS

Before the Model 710 is installed in the NIM-standard bin, the polarity and programming mode (local or remote) printed circuit board jumpers should be set. Refer to Section 4 for information about the proper setting of these jumpers.

3.3. VACUUM SHUTDOWN, SHUTDOWN ALARM, AND REMOTE PROGRAMMING

The vacuum shutdown input, shutdown alarm output, and remote programming inputs are located on the rear panel of the Model 710. It is more convenient to make these connections before the instrument is installed in the NIM bin. Refer to Section 4 for more information about these features.

4. OPERATION

4.1. INITIAL TESTING

Refer to Section 5 of this manual for information concerning testing performance.

4.2. POLARITY SELECTION AND INDICATION

The polarity of each of the four channels is independently selected by a printed circuit board jumper. The left side panel must be removed to set the polarity jumpers. The side panels should not be removed until the supply is fully discharged. The jumper for each channel is positioned as shown in Fig. 4.1 for the polarity desired.

4.3. VOLTAGE RANGE AND DISABLE

The voltage range for each channel is independently selected by front-panel, 3-position toggle switches. Full-scale voltages of 100 or 1000 V can be selected. Each of the four channels can also be disabled by this switch.

4.4. DISPLAY SELECTION

One front-panel LED display is provided to monitor the voltage and current of each channel. The parameter to be displayed is selected by a front-panel, 8-position rotary switch. If one of the four voltages is being displayed, the full-scale range of the display is determined by the voltage range selected for that channel. The full-scale current range is always $19.99 \mu\text{A}$.

4.5. BIAS VOLTAGE SELECTION

The bias voltage for each channel can be set by the front-panel, VOLTAGE potentiometer for that channel, or a 0 to 10-V remote programming signal can be injected into the rear-panel, REMOTE INPUT BNC for that channel. The potentiometer or remote programming control for each channel is selected by internal printed circuit board jumpers as shown in Figure 4.2. The Model 710 is calibrated so that the dial reading or remote programming voltage should correspond to the output voltage. One volt of the remote programming signal is equivalent to one turn of the potentiometer.

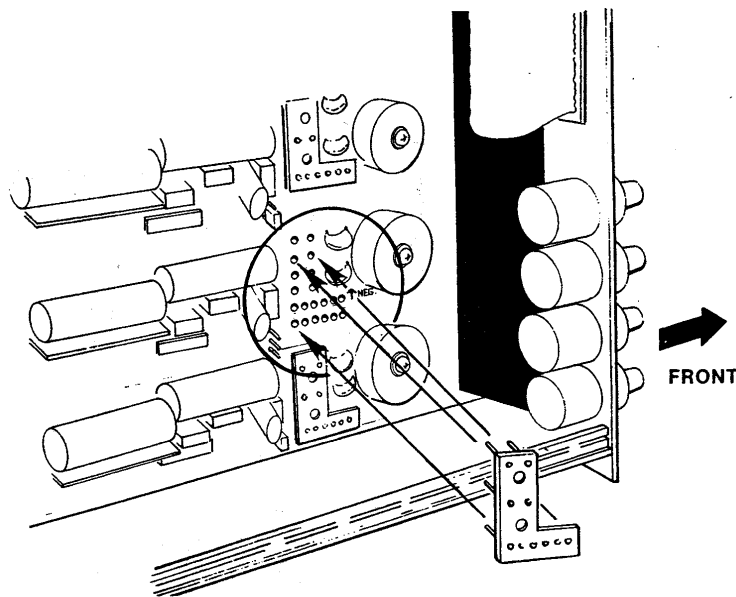


Fig. 4.1. Changing the High Voltage Output Polarity: (A) For Positive HV, plug the Printed Wiring Board (PWB) into the lowermost (toward the bottom of the module) set of pin sockets; (B) For Negative HV, plug the PWB into the uppermost (toward the top of the module) set of pin sockets.

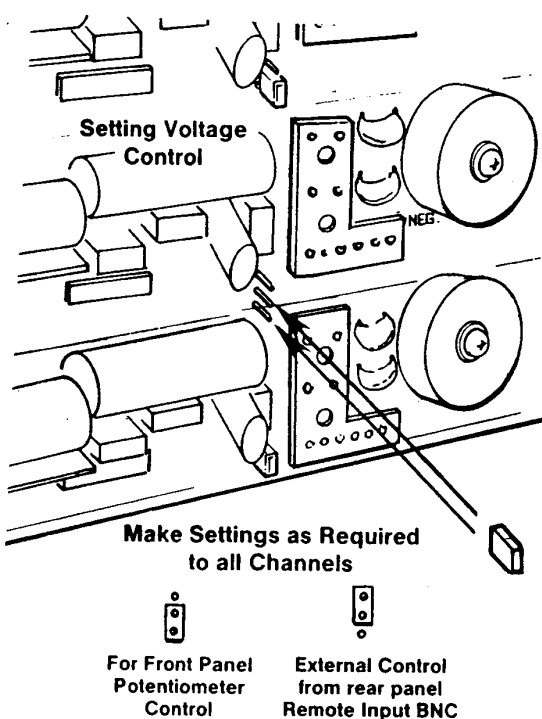


Fig. 4.2. Jumper Positions for Selecting the Remote Input or the Front-Panel VOLTAGE Potentiometer to Control the Output Voltage.

4.6. OVER-CURRENT AND VACUUM SHUTDOWN

If an over-current is detected, the channel with the over-current is disabled. This channel will remain disabled until the front-panel, push-button reset switch is pressed. The over-current threshold is set at the factory to 20 μ A.

When NIM power is applied, the Model 710 turns On in the over-current conditions. Thus, the supply must be reset for operation.

In addition to the over-current condition, all four channels of the Model 710 can be disabled by applying a low TTL signal or a resistance of less than 75 Ω to ground to the rear-panel, vacuum shutdown, BNC connector. In this condition, the supplies will remain disabled until the TTL signal goes high, or the resistance to ground becomes greater than 5 k Ω , and the OVERLOAD RESET button has been pressed.

4.7. UNDESIRABLE LEAKAGE CURRENTS

The detector current-metering circuit indicates currents due to all leakage paths beyond the meter in the circuit. Included is any leakage in the filter components or wiring of the detector control unit, as well as the leakage due the insulation resistance of all cables, connectors, and components which connect the unit to the detector. These currents must be made negligibly small, or be accounted for in the determination of the actual detector current. Because the meter can indicate currents as low as 10 nA, and the voltage can be as high as 1000 V, resistances on the order of $1 \times 10^{11} \Omega$ are significant.

It may not always be practical to reduce the leakage in external cables and connections to insignificant magnitudes. In such cases, it may suffice to note the residual current with all wiring in place and the detector unconnected, and subtract this current from the indicated current to obtain the actual detector current. If the leakage phenomenon is essentially a resistance, then its value may be computed from Ohm's law for use in determining the residual current at various voltages, without the necessity of actual measurements.

4.8. DETERMINATION OF ACTUAL DETECTOR BIAS

In addition to its use as an indicator of the physical condition of the detector, the current reading allows accurate determination of the actual detector bias voltage. This actual voltage differs from that indicated, by the amount of voltage dropped across the detector load and filter resistors due to the detector current. Accurate determination of the actual detector voltage is needed, since it is an important parameter in both the depleted (sensitive) depth of the detector and the collecting field strength.

To calculate the actual detector voltage, the sum of all series resistance between the bias supply and the detector must be known. The internal resistance of the Model 710 is extremely small, and can be neglected. The value of the detector filter resistors can usually be obtained from the schematic diagram of the preamplifier. After the total series resistance is known, the bias voltage across the detector can be calculated using Ohm's law.

4.9. DETECTOR CONSIDERATIONS AT HIGH BIAS VOLTAGES

Semiconductor radiation detectors that utilize more than a few hundred volts of bias usually require some care in the application of the bias to reduce the risk of damaging the detector. It is helpful to observe the noise output of the main amplifier with an oscilloscope while the bias is being increased. Small breakdown phenomena, which decay in less than one minute, can be observed after a bias increase. For greatest safety, it is advisable to

approach the final bias in small increments, with brief aging periods between the steps. A rapid increase in output noise from the main amplifier, or a rapid increase in detector current indicates that the detector is approaching the destructive breakdown voltage. It is important to follow the detector manufacturer's directions when applying voltage to the detector.

5. MAINTENANCE

5.1. TESTING PERFORMANCE OF BIAS SUPPLIES

The following is intended as a guide in the installation and checkout of the Model 710 Quad Detector Bias Supply.

The following or equivalent test equipment is needed:

NIM-Standard Bin and Power Supply, such as ORTEC Models 4001A/4002A.

Oscilloscope with an input coupling capacitor rated at $>1000\text{ V}$.

Voltmeter with an input impedance of $\geq 50\text{ M}\Omega$ on the 2000-V scale.

Before making the performance test, take the following preliminary steps:

1. Visually check the module for possible damage due to shipment.
2. Set the polarity jumpers of all four supplies to positive and the mode jumpers to internal.
3. Connect ac power to the NIM-standard Bin.
4. Plug the Model 710 into the Bin and check for proper mechanical alignment.
5. Ensure that the ON/OFF switch is in the OFF position and that all four voltage range switches are in the DISABLE position.
6. Switch on the ac power and check the dc power supply voltages at the test points on the NIM-standard power supply control panel.

To check the performance of the Model 710, make the following test.

1. Set the bias selector potentiometers to zero.
2. Set the voltmeter to the 2000-V scale and

- connect it to output 1.
3. Set the voltage range switch to 1000 V.
4. Reset the power supply.
5. Increase the potentiometer associated with channel 1 to 1000 V and check for the output voltage for $1000\pm 3\text{ V}$. Also check for agreement between the Model 710's voltage meter and the test voltmeter.
6. Reduce the potentiometer back to zero, stopping occasionally to check the potentiometer linearity by comparing the output voltage to the potentiometer dial reading.
7. Repeat the above steps for channels 2,3, and 4.
8. Turn the master ON/OFF switch to the OFF position and turn the voltage range switch of each channel to DISABLE.
9. Remove the Model 710 from the NIM-standard bin and allow 30 seconds for the supply to fully discharge; then remove the right side panel and set the polarity of each channel to negative.
10. Repeat steps 1-7.
11. Set the output voltage to zero and connect output 1 to the ac-coupled input of a 100-MHz oscilloscope with a coaxial cable. Increase the output voltage of all four channels to 1000 V and check the ripple of channel 1. It should be less than 2 mV peak-to-peak.

5.2. TROUBLESHOOTING SUGGESTIONS

1. Ensure that the proper dc voltages are being supplied to the module.
2. Turn the master ON/OFF switch to the OFF position and wait for 30 seconds; then ensure that the output is not shorted.

5.3. REPAIRS

This instrument can be returned to the ORTEC factory for service and repair at a nominal cost. Our standard procedure for repair ensures the same quality control and checkout that are used for a new instrument. Always call Customer Service at

ORTEC, 865/482-4411, before sending in an instrument for repair to obtain shipping instructions so that the required Return Authorization Number can be assigned to the unit. This number should be marked on the address label and on the package to ensure prompt attention when the unit reaches the factory.

**Bin/Module Connector Pin Assignments
For Standard Nuclear Instrument Modules
per DOE/ER-0457T.**

| Pin | Function | Pin | Function |
|-----|--------------|-----|---------------------|
| 1 | +3 V | 23 | Reserved |
| 2 | - 3 V | 24 | Reserved |
| 3 | Spare bus | 25 | Reserved |
| 4 | Reserved bus | 26 | Spare |
| 5 | Coaxial | 27 | Spare |
| 6 | Coaxial | *28 | +24 V |
| 7 | Coaxial | *29 | - 24 V |
| 8 | 200 V dc | 30 | Spare bus |
| 9 | Spare | 31 | Spare |
| *10 | +6 V | 32 | Spare |
| *11 | - 6 V | *33 | 117 V ac (hot) |
| 12 | Reserved bus | *34 | Power return ground |
| 13 | Spare | 35 | Reset (Scaler) |
| 14 | Spare | 36 | Gate |
| 15 | Reserved | 37 | Reset (Auxiliary) |
| *16 | +12 V | 38 | Coaxial |
| *17 | - 12 V | 39 | Coaxial |
| 18 | Spare bus | 40 | Coaxial |
| 19 | Reserved bus | *41 | 117 V ac (neutral) |
| 20 | Spare | *42 | High-quality ground |
| 21 | Spare | G | Ground guide pin |
| 22 | Reserved | | |

Pins marked (*) are installed and wired in ORTEC's 4001A and 4001C Modular System Bins.