Model 4002A
Power Supply
Operating and Service Manual

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Manual Revision F

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Advanced Measurement Technology, Inc.

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

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Quality Control

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.

CONTENTS

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.

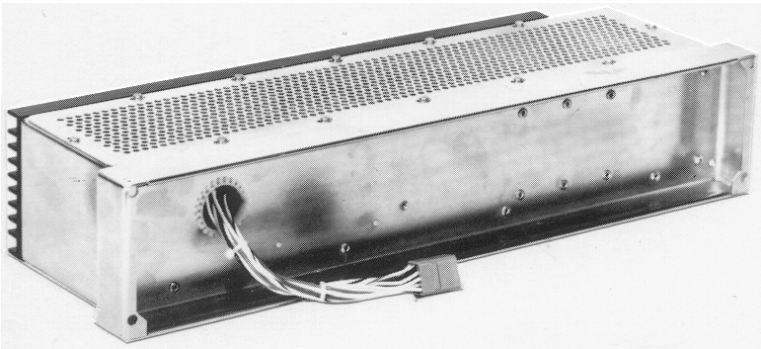
Cleaning Instructions

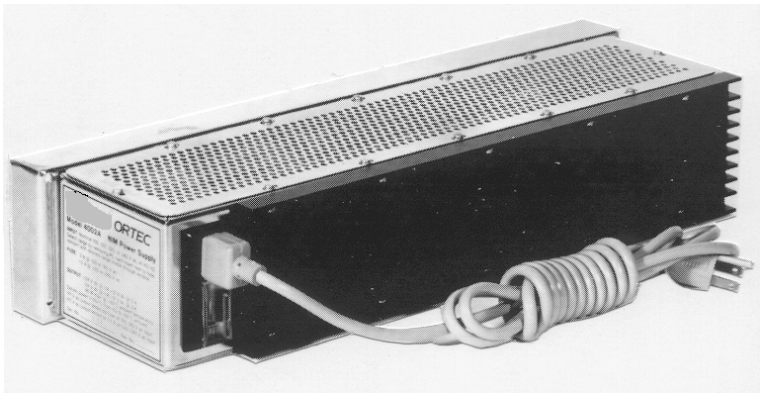
To clean the instrument exterior:

- 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.

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ORTEC MODEL 4002A
POWER SUPPLY

1. DESCRIPTION

The ORTEC 4002A Power Supply is designed to be mounted in the space provided on the rear of the 4001 Series Modular System Bin. The power supply meets or is superior to the recommended power supply specifications in Appendix A of TID-20893 (Rev), Type 1, Class A, adopted by the AEC Committee on Nuclear Instrument Modules.

Designed for international use, the 4002A can accept input mains voltages of 100, 120, 220, or 240 Vac at 47-63 Hz. A connector block at the rear of the 4002A is used to select the intended mains voltage range (Section 3). The connector meets standard 22 of the International Commission on Rules for the Approval of Electrical Equipment. In addition, it incorporates the primary voltage selector and primary fuse. By using this CEE-22 standard connector on the chassis, virtually any type of mains plug can be conveniently mated to the 4002A.

The power supply furnishes four standard dc voltages: +12V at 2A; -12V at 2A; +24V at lA; and -24V at lA. No power derating is necessary for operation between 0 and +50°C ambient temperature. The dc outputs are regulated, short-circuit protected, current limited, and thermally protected.

A nominal 117 V ac is supplied to the bin connector independent of input mains. The 117 V ac power available is limited only by the power supply fuse when operating f rom 100 or 120 V ac mains. When operating f rom 220 or 240 V ac mains, the 117 V ac is derived by auto-transformer action and is limited to 50 VA output with a dc load on the power supply of 96 W.

A control panel is provided on the 4001 or 401 Series Bins for operating and monitoring the 4002A power supply. An On-Off switch, power-indicating lamp, thermal warning lamp, and convenient dc monitor jacks are provided. The thermal warning lamp is lighted when the internal temperature rises to within 20°C of the maximum safe operating temperature. The power supply is automatically cut off by an internal switch should the temperature exceed the maximum safe operating temperature.

Fast disassembly for maintenance purposes is made possible by the use of quick-disconnect connectors. The control circuitry uses high-quality integrated circuits and power semiconductors for simple and reliable operation.

2. SPECIFICATIONS

The specifications for the 4002A power supply meet or are superior to those set forth by the AEC Committee on Nuclear Instrument Modules in TID-20893 (Rev), Appendix A, Type 1, Class A.

INPUT

Nominal Voltage (ac)	Regulation Range (V ac)
100	88-110
120	103-129
220	191-239
240	206-258

The regulation range is determined by changing the nominal voltage +10% to -12% where the nominal voltages are defined as 100, 117, 217, 234. (TID-20893 defines the U.S. standard nominal voltages are 117.) To avoid confusion when reading the mains voltage selector of the 4002A, nominal voltages are designated as 100, 120, 220, and 240.

FREQUENCY RANGE 47-63Hz. Input current at 120 V ac is typically 1.8 A rms with a 96 W load (43% efficiency).

DC OUTPUT Output at the following ratings: +12 V at 2 A, -12 V at 2 A, +24 V at 1 A, -24 V at 1 A; maximum output power to 50°C ambient, 96 W; operation to 60°C ambient with current derated 2.5%/°C.

117 VOLT AC OUTPUT 117 V ac output limited only by the supply fuse when operating from 100 or 120 V ac mains. Output is limited to 50 VA at 96 W dc load while operating from 220 or 240 V ac mains.

REGULATION <±0.05% over the combined range of zero to full load and input voltage of 103-129 V ac over any 24-h period at a constant ambient temperature and rated line and load after a 60-min warm-up.

INSTABILITY <±0.3% after a 24-h warm-up of constant line, load, and ambient temperature over a six-month period.

TEMPERATURE COEFFICIENT <0.01%/°C over a range of 0°C to 60°C.

THERMAL PROTECTION A thermal warning switch will be activated when the ambient temperature approaches within 20°C of the safe operating temperature. A thermal cutout switch disables the power supply when the temperature exceeds the safe operating temperature.

NOISE AND RIPPLE The output noise and ripple are <3 mV peak-to-peak, as observed on a 50-MHZ bandwidth oscilloscope.

VOLTAGE ADJUSTMENT ±0.5% minimum range, resettability ±0.05% minimum of supply voltage.

RECOVERY TIME <50 µs to return to within ±0.1% of rated voltage for any change in input voltage within the specified range and load current from 10 to 100%full load.

CIRCUIT PROTECTION The input line to the power supply is fused with Fuse Rating : 3 A (FAST) size 3AG fuse for 100 V or 120 V operation; 2.0 A (SLOW) size 5X20 mm fuse for 220V or 240V operation. In addition electronic circuitry provides output current limiting to prevent damage to the supply and provides automatic recovery when the demand is removed.

OUTPUT IMPEDANCE <0.3 Ω at any frequency to 100 kHz.

OUTPUT CONNECTOR All power and control circuits terminate in a connector, specified by TID-20893 (Rev), which mates with the bin interface connector, completing the necessary control and power supply wiring.

LINE VOLTAGE SELECTION To change selected voltage: disconnect the power cord, open cover of the power entry module on rear of the instrument using a small blade screwdriver or similar tool. Insert the tool into the voltage selection slot and remove wheel from unit; select desired voltage, replace wheel into unit and close cover, making sure the selected voltage appears in connector window. See Fig. 1.

CHANGING FUSE To change the fuse. disconnect the power cord; open cover of the power entry module on rear of the instrument using a small blade screwdriver or similar tool. Remove fuse holder and replace fuse. If changing to the metric type fuse, change the fuse holder to the metric version and insert the proper fuse as specified in the

manual. After replacing the fuse/fuse holder, insert the fuse holder into the unit and close cover. See Fig. 1.

DIMENSIONS 16.825 in. wide, 3.438 in. high, 5.500 in. deep; conforms to AEC Drawing ND515.

WEIGHT 13 lb net; with 4001C bin 27 lb net. Shipping weight for 400IC/4002A 35 lb gross.

3. INSTALLATION

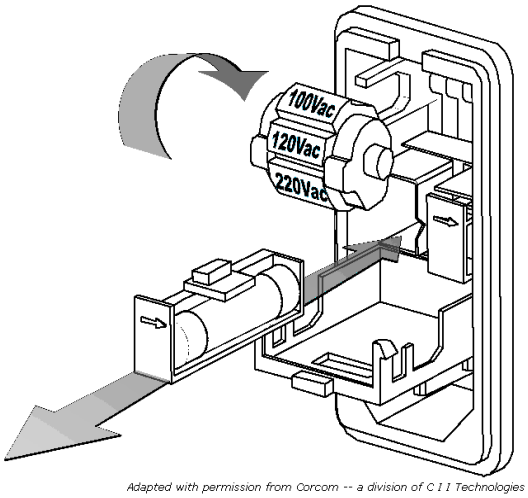
3.1. PACKING

Unpack the unit, being careful to retain all packing materials until the unit has been checked for possible concealed damage. The power cord is packed with the unit and attaches to a 3-pin connector that is mounted on the rear of the 4002A.

3.2. SELECTING THE MAINS VOLTAGE

The 4002A Power Supply is designed so that the transformer primary can be connected in a configuration that is compatible with the available mains voltage. Check the voltage level to be used and select the appropriate range on the 4002A.

The power entry module(Fig. 1) contains the power connector; a small, removable drum for setting the line voltage; and a line fuse. The removable drum lets you configure the instrument for a nominal 100, 120, 220, or 240 V ac. The module door has a small window that shows the line voltage setting now in use.



Adapted with permission from Corcom -- a division of C I I Technologies

Fig. 1. Changing the Fuse.

To change the ac input voltage:

WARNING: DISCONNECT THE INSTRUMENT FROM THE AC POWER SOURCE. Use a small flat-blade screwdriver or similar tool to pop open the module door. Remove the plastic drum: pinch the sides of the drum with your fingernails and pull, or insert a flat-blade screwdriver in the slot between the **120Vac** and **240Vac** settings and gently pry the drum loose, one end at a time. Rotate the drum until the desired line voltage setting will show in the door window, and firmly press the drum back into the holder. Close the module door. You are now ready to reconnect the instrument to the ac power source.

> **NOTE** The spindles on each side of the drum are octagonal, not round. This gives each of the 4 settings a definite detent. To avoid eroding these detents, always remove the drum before rotating it.

The 4002A power supply is normally supplied factory connected to an ORTEC 4001C Modular System Bin. However, the supply is designed to TID-20893 (Rev) specifications and may be attached, in the space provided, to any bin manufactured to those specifications.

For attachment to a bin other than an ORTEC 401 or 4001 Series Bin, please refer to the appropriate instruction manual. The On-Off switch and other controls necessary to operate the supply are part of the bin and not furnished with the power supply.

To attach the 4001C bin:

CAUTION Always disconnect the power cord at the power supply chassis before connecting or disconnecting the bin-power supply connector (PG13-PG14). Failure to do so will result in a shock hazard at PG14 and can also damage the power supply and/or bin contents.

1. Place the bin on a table with the back part facing you. Place the power supply in the proper mounting position, leaving enough space between the two pieces to attach the interface connector.

2. After ensuring that the power cord is disconnected, mate the interface connector, being careful to align the polarizing pins. Fold and form all wiring close to the connector edges to prevent any wires from being pinched and producing a short circuit in succeeding steps.

3. Mount the power supply to the bin by securely tightening the four 10-32 screws, being careful not to pinch any wires or to use undue force on any parts.

When attaching the 4002A power supply to very old 401 bins, it is necessary to first remove the left and right side covers and stand the bin on its front face (handles down). From this point on, assembly is the same; upon completion the side plates should be replaced.

4. OPERATING INSTRUCTIONS

The available current from the power supply is specified in Section 2, "DC OUTPUTS." Care must be used to ensure natural convection of heat dissipation by the heat sinks and power transformer. When used at maximum power loading on a bench or tabletop, the bin and power supply should be in an open space, placed upon blocks at least 1 in. off the table mounting surface to allow maximum ventilation. When used in a rack, attention should be paid to placement of other heat-generating equipment Adequate unobstructed space on all sides is necessary for convection ventilation and cooling. If the bin contains other heat-generating equipment, a blower may be advisable to remove the dissipated heat.

When it is necessary to rack mount several bins and power supplies, especially when other heat-generating equipment is located within the rack, the term “ambient temperature" becomes less clearly defined. A better guide to maximum power loading capability is to monitor the heat sink temperature. Never allow the heat sink temperature to run continuously above 85° C. Although this is not the maximum operating temperature, any additional temperature rise due to other conditions of the system may force the supply out of tolerance and may cause it to automatically shut down operation. Should your operation produce a heat sink temperature of 85° C, a blower to remove the heat is necessary. The ORTEC Model M127/N Rack-Mountable Cooling Fan is recommended in this situation.

5. CIRCUIT DESCRIPTION

The 4002D power supply produces four dc output voltages. A power transformer changes the input ac line voltage into four separate low-voltage sources. The sources or windings are full-wave-rectified, capacitor-filtered, and regulated by electronic series regulator circuits. The regulator circuits provide short-circuit and current limiting protection.

Each of the four series regulator circuits are nearly identical in operation; they are physically different only in component values for each supply. The regulator can operate in two modes: First and normal is the voltage regulation mode; second is the current-foldback or current-limiting protection mode.

The regulator will operate in the voltage regulation mode at any current output up to and including the full rated output of a particular supply. When current output beyond ~150% of the rated output is required, which includes a direct short across the output terminals, the regulator automatically converts to a current-foldback mode. This provides power limiting and protection of the regulator's circuitry and components. When excessive current demands are removed, the regulator resumes the voltage regulation mode.

For convenience, only the +24 V regulator will be discussed. An explanation of the regulation in the normal voltage regulation mode is given.

A 6.9-V reference voltage is set by the precision reference, U1. This reference voltage is divided by R3 and R4 and fed to pin 3 of the controller, U2, and compared with the voltage at pin 3 to produce an error signal at pin 6. Pin 6 of U2 drives the Darlington transistor, Q1, to maintain the same voltage at pins 2 and 3. Line regulation is improved by the zener regulator, D4, which receives its unregulated voltage from a voltage-doubler circuit consisting of C1, C2, D1, and D2.

Current flow to the output is monitored by sensing the voltage drop across R11. When the potential between pins 10 and 1 of U2 exceeds ~80 mV, the output current and voltage will decrease, limiting the power dissipated in Q1.

Capacitors C4, 16, and 5 tailor the frequency response of the system to provide excellent recovery time and output impedance characteristics. D5 provides reverse-current protection for the power supply and load in the event that a voltage source of the wrong polarity is connected to the output terminal. If loss of the sense lead should occur (pin 3 of CN2 or pin 13 of PG14) R47 provides continued operation with some loss of regulation.

6. MAINTENANCE

6.1. DISASSEMBLY AND TROUBLESHOOTING

The 4002A Power Supply needs no routine maintenance or adjustment. If a problem develops and troubleshooting becomes necessary, the top and bottom screen covers should be removed to provide access to the components.

WARNING While probing inside the 4002A chassis, use extreme caution. There are two shock-hazard locations to regard: the wiring side of the input line cord connector block and the two thermal switches (Sl and S2) mounted against the heat sink. These two locations contain exposed primary circuit conductors.

A test point (TP1) is provided on the circuit board to connect the reference lead of any probe. Table 6.1 shows typical do voltages measured with respect to ground reference potential (TP1). These voltage levels are typical of a circuit that is operating properly; the precise values will vary between individual units.

If the power transformer (T1) or any component mounted on the heat sink is found to be defective, the heat sink/PC board assembly must be removed. First disconnect the free-hanging connector (P/J3) and the printed circuit board connectors (P1 and P2). Then remove the ten screws that fasten the heat sink to the chassis and slide the heat sink/PC board assembly out of the chassis. The heat sink-mounted components will then be accessible for replacement.

6.2. FACTORY REPAIR

This instrument can be returned to the ORTEC factory for service and repair at a nominal cost. Our standard repair procedures ensure the same quality control and checkout that are used for a new instrument. Before returning an instrument for repair, *always* contact the ORTEC Customer Service Department at (865) 482-4411 to obtain shipping instructions and the required Return Authorization Number. Write this number on both the address label and package to ensure proper handling when the instrument reaches the factory.

Table 6.1. Typical DC Voltages (measured with respect to TP1).

Node	Voltage
U2 pin 8	+36.5
3	+ 2.5
5	0
7	0
2	+ 2.5
1	+24.0
10	+23.9
6	+25.3
U4 pin 8	+36.5
3	+ 2.5
5	0
7	0
2	+ 2.5
1	+12.0
10	+11.8
6	+13.5
U6 pin 8	+ 9.5
3	- 9.5
5	- 12.0
7	- 12.0
2	- 9.5
1	0
10	- 0.2
6	+ 1.4
U8 pin 8	+ 9.5
3	- 21.5
5	- 24.0
7	- 24.0
2	- 21.5
1	0
10	- 0.2
6	+ 1.3