

**Model 4002P  
Portable Power Supply  
Operating and Service Manual**

# **Advanced Measurement Technology, Inc.**

a/k/a/ ORTEC<sup>®</sup>, a subsidiary of AMETEK<sup>®</sup>, Inc.

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ORTEC\* warrants that the items will be delivered free from defects in material or workmanship. ORTEC makes no other warranties, express or implied, and specifically NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

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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.

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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.

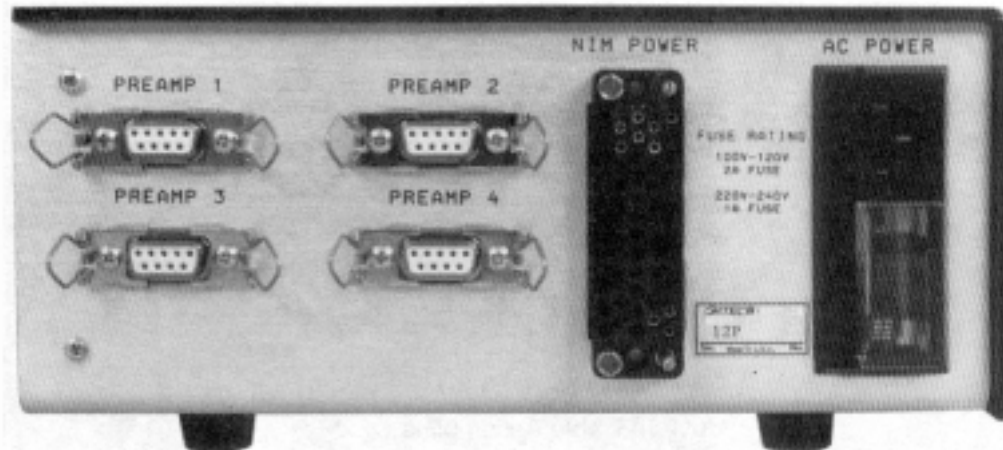
### Cleaning Instructions

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.



# ORTEC MODEL 4002P PORTABLE POWER SUPPLY

## 1. DESCRIPTION

### 1.1. GENERAL

The ORTEC Model 4002P Portable Power Supply is ideally suited for providing power to preamplifiers, or to a NIM module in a remote location. It is an effective solution when the additional power, size, or cost of a standard NIM bin is inconvenient.

DC power is provided by the Model 4002P for four preamplifiers through standard 9-pin connectors on the rear panel. These connectors deliver  $\pm 12$  and  $\pm 24$  V dc, and are compatible with ORTEC standard preamplifier power cables, as well as those of most NIM manufacturers. The Model 4002P can supply power for up to 12 preamplifiers by adding an optional Model 4002P-C1 Preamp Power Fan-Out Cable to each connector. The fan-out cable converts a single preamp power output connector to three separate preamp power output connectors.

A standard NIM bin power connector is incorporated for supplying  $\pm 12$  V dc and  $\pm 24$  V dc to a NIM module. Connection between the 4002P and the NIM module is made with the ORTEC Model 401-C3 Module Extender Cable, which can be ordered as an accessory. The output power is sufficient to operate a four-wide NIM module and four preamplifiers.

Designed for international use, the 4002P Portable Power Supply can accommodate input voltages of

100, 120, 220, and 240 V ac at 47 to 63 Hz. A connector block on the rear panel is used to change and display the selected input voltage. Also incorporated in this connector block are a fuse holder and the input power cord connector. The 4002P uses an international standard IEC power connector to permit the use of power cords and plugs that meet local electrical standards.

The Model 4002P has maximum output current ratings of 1 A on +12 V, 1 A on -12 V, 0.5 A on +24 V, and 0.5 A on -24 V.

There are three levels of protection against overload. A fuse on the ac power connector limits the input current. All dc outputs include a current foldback circuit to limit the output current to nominally 150% of the rated value. This feature provides short-circuit and overload protection. Recovery is automatic after removal of the overload condition. Test points are conveniently located on the front panel to allow monitoring the status of the dc outputs. A temperature warning light on the front panel turns on when the heat sink temperature rises above 82°C. When the temperature of the heat sink exceeds 95°C, the power supply is automatically turned off. Recovery is automatic when the load is reduced and the temperature decreases to a safe value.

## 2. SPECIFICATIONS

### 2.1. PERFORMANCE

**INPUT AC VOLTAGE** The primary voltage selection card and indicator located in the AC POWER connector assembly permit operation with 100 V, 120 V, 220 V, or 240 V nominal input voltages. Input voltage ranges accommodated on each setting are:

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

**FREQUENCY RANGE** Operating range for ac input voltage frequency is 47–63 Hz.

**INPUT CURRENT** Typically, 0.8 A rms with a 48-W dc load and a 120-V ac input. Protected with a 2-A fuse on the 100- and 120-V ac settings, and by a 1-A fuse on the 220- and 240-V ac settings.

**DC OUTPUT** Maximum rated output currents are:

DC Voltage	Maximum Current
+12 V	1 A
-12 V	1 A
+24 V	0.5 A
-24 V	0.5 A

Maximum dc output power from 0 to 50°C is 48W. Derate 2.5%/°C for 50 to 60°C.

**DC REGULATION** Variations in dc output voltages are  $\leq \pm 0.1\%$  over the combined range of zero through full load and input voltages from the minimum to maximum limits of the allowed input voltage range. Measurements are made within a 1-minute period. Regulation  $\leq \pm 0.3\%$  over any 24-hour period at constant ambient temperature for the same load and input voltage ranges after a 60-minute warmup.

**LONG-TERM STABILITY** DC output voltages change  $\leq \pm 0.5\%$  (after a 60-minute warmup) over a 6-month period at constant load, input voltage, and ambient temperature.

**OUTPUT IMPEDANCE**  $< 0.3 \Omega$  at any frequency up to 100 kHz for the dc outputs.

**TEMPERATURE COEFFICIENT**  $< 0.02\%/^{\circ}\text{C}$  from 0 to 60°C for the dc outputs.

**NOISE AND RIPPLE**  $< 3$  mV peak-to-peak for any dc output, as observed on a 50-MHZ bandwidth oscilloscope.

**VOLTAGE ADJUSTMENT**  $\pm 5\%$  minimum range. Range typically  $\pm 1$  V about the nominal supply voltage. Resettability  $\leq \pm 0.05\%$  of the supply voltage.

**RECOVERY TIME**  $< 50 \mu\text{s}$  to return to within  $\pm 0.1\%$  of the rated voltage for all dc outputs for any input voltage change within the rated range, or for a change of load current from 10 to 100% of full load.

**THERMAL PROTECTION** The red, front-panel, TEMP light turns on when the temperature of the

side-panel heat sink is within 13°C of the maximum operating temperature limit. When the heat sink temperature exceeds the 95°C maximum limit, a thermal switch automatically turns off the power supply. Under this thermal shut-down condition, both the TEMP and the POWER lights are turned off. Recovery from thermal shut-down is automatic once the load is reduced, so that the heat sink temperature drops below the maximum operating limit.

**CIRCUIT PROTECTION** Fuse Rating: 2 A (FAST) size 3AG fuse for 100-V or 120-V operation; 1 A(F) size 5x20 mm fuse for 220-V or 240-V operation. All dc outputs include a current foldback circuit to limit the output current to nominally 150% of the rated value. This feature provides short-circuit and overload protection. Recovery is automatic after removal of the overload condition.

## 2.2. CONTROLS AND INDICATORS

**POWER** Front-panel two-position rocker switch turns power on or off. Adjacent red light indicates power On condition when illuminated. Power indicator light and output power turn off if the heat sink temperature exceeds 95°C.

**TEMP** Front-panel red light turns on when the heat sink temperature exceeds 82°C to warn that the shutdown temperature limit is being approached. TEMP light turns off if power has been shut off by exceeding the heat sink temperature limit.

## 2.3. INPUTS

**AC POWER** Rear-panel, Corcom™, international-standard IEC power connector, type CEE-22, accepts power cables wired according to local electrical standards. A power cable is shipped with the 4002P. The Corcom CEE-22 connector meets standard 22 of the International Commission on Rules for the Approval of Electrical Equipment. The primary voltage selector and primary fuse are incorporated into the AC POWER connector. The primary voltage selected (100, 120, 220, or 240 V) is visible through the rear door. U.S.A. standard in-line fuse is 2 A for 100 or 120 V ac and 1 A for 220 or 240 V ac. See Sections 3.2 and 3.3, respectively, for instructions on changing the voltage setting and fuse.

## 2.4. OUTPUTS

**PREAMP 1, PREAMP 2, PREAMP 3, PREAMP 4** Rear-panel, 9-pin, "D" connectors (Amphenol



17-10090) provide power for up to four preamplifiers. Connectors mate with power cords on all standard ORTEC preamplifiers. Compatible with preamplifier power cables of most other NIM manufacturers. Pin assignments are listed in Table 1. Each preamp power output connector can be expanded to three output connectors by using the optional Model 4002P-C1 Preamp Power Fan-Out Cable. Using four of the Model 4002P-C1 allows the 4002P to supply power to 12 preamplifiers.

**Table 1. Pin Assignments for Preamp Power Connectors.**

Pin Number	Power Voltage
1	Ground
2	Ground
3	No connection
4	+12 V
5	No connection
6	-24 V
7	+24 V
8	No connection
9	-12 V

**NIM POWER** Rear-panel, NIM standard bin connector compatible with the power connector on the rear of NIM modules, per TID-20893 (Rev). For use with a Module Extender Cable, such as ORTEC Model 401-C3, to power a single NIM module. Pin assignments are listed in Table 2. Pins not listed have no connection in the Model 4002P, but may be assigned to a specific function by TID-20893 (Rev).

**Table 2. Pin Assignments as Wired for the NIM POWER Connector on the Model 4002P.**

Pin Number	Power Voltage
16	+12 V
17	-12 V
28	+24 V
29	-24 V
34	Power Return Ground
42	High-Quality Ground

**OUTPUT TEST POINTS** Front-panel jacks provide test points to monitor each of the dc voltages delivered to the rear-panel connectors..

## 2.5. ELECTRICAL AND MECHANICAL

### WEIGHT

Net 10.9 kg (24 lb)

Shipping 13 kg (29 lb).

**DIMENSIONS** 21.5 cm W x 26 cm D x 10.2 cm H (8.4 in. W x 10.2 in. D x 4.0 in. H).

## 2.6. ACCESSORIES

**121-C1 PREAMPLIFIER POWER CABLE EXTENDER** Provides a 3-m (10-ft) extension cable to connect a preamplifier power cable to the PREAMP 1, 2, 3, or 4 power output on the 4002P Portable Power Supply. Compatible with all standard ORTEC preamplifiers.

**401-C3 MODULE EXTENDER CABLE** Connects the 4002P NIM POWER output to the standard bin power connector on the rear of a NIM module. Permits powering a NIM module in a remote location using the 4002P Portable Power Supply. Cable length is 91 cm (3 ft).

**4002P-C1 PREAMP POWER FAN-OUT CABLE** Plugs into a standard ORTEC preamplifier power output connector and provides three preamplifier power output connectors. Use four of the optional 4002P-C1 with the 4002P to power 12 preamplifiers.

## 2.7. ORDERING INFORMATION

To order the 4002P Portable Power Supply and/or accessories, specify the following model numbers and descriptions.

<u>Model</u>	<u>Description</u>
4002P	Portable Power Supply
121-01	Preamplifier Power Cable Extender
401 -C3	Module Extender Cable
4002P-C1	Preamp Power Fan-Out Cable

### 3. INSTALLATION

#### 3.1. UNPACKING

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 4002P Portable Power Supply

#### 3.2. SELECTING THE MAINS VOLTAGE

The 4002P uses a Corcom Power Entry Module (Fig. 1), which 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.

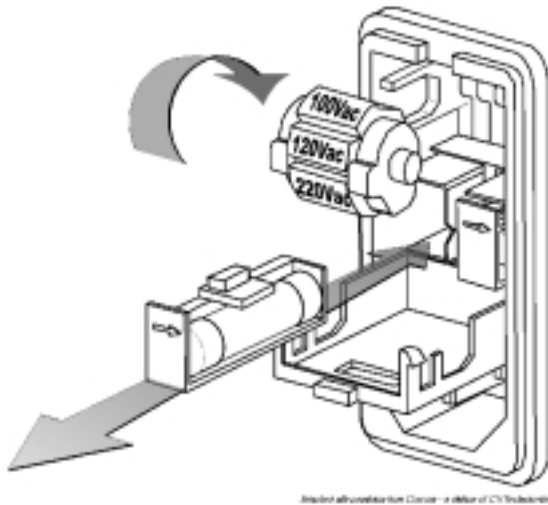


Fig. 1. Setting the Line Voltage and Replacing the Fuses.

To change the ac input voltage:

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.

#### 3.3. REPLACING THE FUSES

The 4002P requires the following fuses:

- For 100 or 120 V ac line voltage, a 2-A (FAST) size 3AG fuse.
- For 220 or 240 V ac line voltage, a 1 A(F) size 5×20-mm fuse.

The 3AG fuse requires a Corcom LA200 fuseholder. The 5×200-mm fuse requires a Corcom LA201 fuseholder. (We supply the appropriate fuse and fuseholder based on your order specifications.)

**CAUTION** Do not use makeshift fuses or short-circuit the fuse holders.

**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.

To replace a fuse:

Disconnect the instrument from the ac power source. Use a small flat-blade screwdriver or similar tool to pop open the module door. The line fuse is in a plastic fuseholder drawer marked with an arrow (➡). Gently pull the fuseholder out and replace the fuse. If changing to the metric type fuse be sure to install the corresponding fuse holder. Slide the fuseholder back into the module and close the module door. You are now ready to reconnect the instrument to the ac power source.

#### 3.4. LOCATION

The ORTEC 4002P Portable Power Supply is a completely portable, self-contained unit that is designed for table-top installation. The basic design of the cabinet provides for cooling of the power supply by natural convection flow. The power supply should not be positioned so as to block the flow of air around and through the cabinet. Avoid locating the power supply near or above heat-

producing equipment without accounting for the temperature rise.

### **3.5. COMPATIBILITY**

The ORTEC 4002P Portable Power Supply is compatible with the principles of DOE Report TID-20893 (Rev), January 1968, "Standard Nuclear Instrument Modules." This report, the work of a committee of equipment users from AEC-related institutions, establishes standards for a modular instrument system which allow electrical and mechanical interchangeability of units made in conformance with the standards. The standards prescribe the necessary mechanical dimensions and connector types to ensure mechanical

interchangeability. They also specify standard power supply voltages and pin assignments in the connector so that electrical interchangeability is assured, at least with respect to the main connector joining the module to the bin.

The 4002P Portable Power Supply is a complete assembly. It furnishes the power that is distributed to the module connectors through the assigned pins. A power ground return, a high-quality signal ground, and +12 V, -12 V, +24 V, and -24 V are included in the distribution circuits. The power supply accepts input power from 100, 120, 220, or 240 V ac mains, 47-63 Hz.

## **4. OPERATING INSTRUCTIONS**

### **4.1. CONTROL PANEL FUNCTIONS**

An On-Off switch interrupts both sides of the input power line. A Power pilot lamp indicates that ac input power is being supplied to the power transformer primary. Either a blown fuse or a temperature cutout will extinguish this lamp.

A Temp (temperature) warning pilot lamp is illuminated when the power supply temperature rises to within approximately 13°C of the maximum safe operating temperature. When the maximum safe temperature is reached, an internal cutout in the power supply removes power and neither lamp will be illuminated.

Test jacks on the panel allow convenient checking of the power supply voltages from the front panel without disassembly of the unit.

### **4.2. POWER SUPPLY LIMITATIONS**

The power supply capability is stated on the front control panel. The user should verify that the power supply capability is not exceeded when module connections are made.

### **4.3. CONNECTION AND DISCONNECTION**

No damage will result to the power supply from the connection or disconnection of modules while the power is on. However, since the sequence of power application to a module is indeterminate when connected with the power on, it is prudent to turn the power supply off when connecting, disconnecting, or changing modules.

## **5. CIRCUIT DESCRIPTION**

The power supply produces four dc output voltages. A power transformer transforms 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, current-limiting, and reverse-current protection.

Each of the four series regulator circuits are 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 excess 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. Simultaneously, the output is divided by R8, R9, and R10, fed to pin 2 of 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, C16, and C5 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 J2), R47 provides continued operation with some loss of regulation.

## 6. CALIBRATION AND MAINTENANCE

### 6.1. POWER SUPPLY DISASSEMBLY AND TROUBLESHOOTING

The 4002P Power Supply needs no routine maintenance or adjustment. If a problem develops and trouble shooting becomes necessary, the two module side covers should be removed to provide access to the components.

**DANGER** Use extreme caution when probing inside the 4002P power supply. ***The primary circuit is exposed in two locations:*** (1) the wiring side of the input line cord connector block, and (2) the two thermal switches, S1 and S2, mounted against the heat sink.

A test point (TP1) is provided on the circuit board to connect the reference lead of any probe. Table 3 shows typical dc 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.

Table 3. Typical dc Voltages  
(measured with respect to TP1).

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

### 6.2. DC OUTPUT VOLTAGE LEVEL ADJUSTMENTS

Under normal conditions, no adjustment of any of

the four dc voltage levels should be required. However, a slight readjustment could be necessary due to component aging after a long period of use. When the dc voltage levels, as monitored at the front panel test points, are not within the prescribed tolerances listed in Section 6.1, each can be adjusted. The four calibrating screwdriver potentiometers are mounted on the printed wiring board and are accessible with the left side panel removed from the 4002P Portable Power Supply module.

### **6.3. FACTORY REPAIR**

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

