SOLOIST™

Alpha Spectrometer
Operating and Service Manual

Printed in U.S.A.

EG&G ORTEC Part No. 740180
Manual Revision A

4111 0693

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Standard Warranty for EG&G ORTEC Instruments

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

EG&G ORTEC's exclusive liability is limited to repairing or replacing at EG&G ORTEC's option, items found by EG&G ORTEC to be defective in workmanship or materials within **one year** from the date of delivery. EG&G ORTEC's liability on any claim of any kind, including negligence, loss, or damages arising out of, connected with, or from the performance or breach thereof, or from the manufacture, sale, delivery, resale, repair, or use of any item or services covered by this agreement or purchase order, shall in no case exceed the price allocable to the item or service furnished or any part thereof that gives rise to the claim. In the event EG&G ORTEC fails to manufacture or deliver items called for in this agreement or purchase order, EG&G ORTEC's exclusive liability and buyer's exclusive remedy shall be release of the buyer from the obligation to pay the purchase price. In no event shall EG&G ORTEC be liable for special or consequential damages.

Quality Control

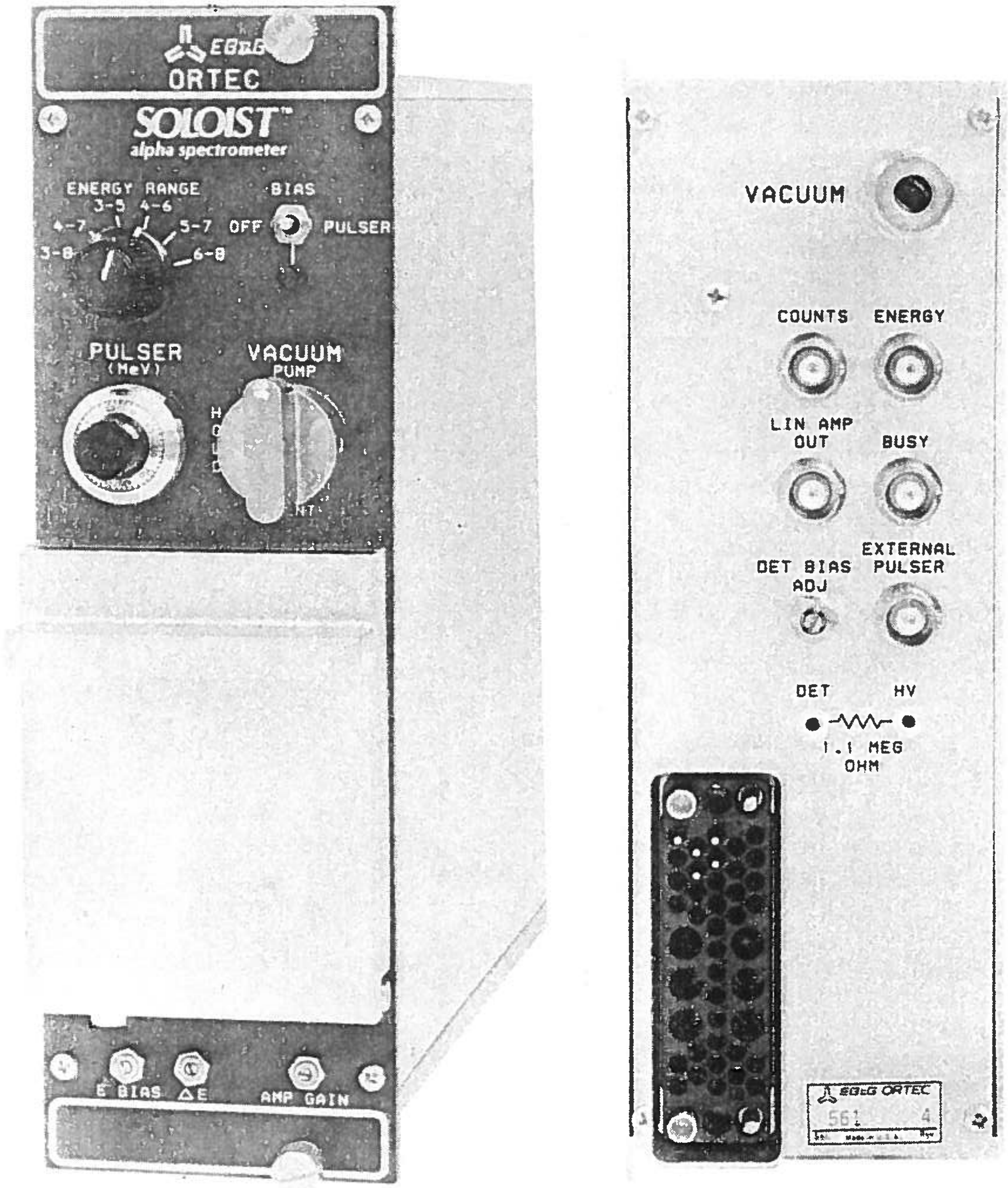
Before being approved for shipment, each EG&G ORTEC instrument must pass a stringent set of quality control tests designed to expose any flaws in materials or workmanship. Permanent records of these tests are maintained for use in warranty repair and as a source of statistical information for design 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, EG&G ORTEC must be informed, either in writing, by telephone [(615) 482-4411], by telex (6843140) or by facsimile transmission [(615) 483-0396], 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 EG&G 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 nearest EG&G 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 will be repaired at the standard charge unless they have been grossly misused or mishandled, in which case the user will be notified prior to the repair being done. A quotation will be sent with the notification.

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 EG&G ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment, if necessary.


EG&G
ORTEC
SOLOIST™
alpha spectrometer
ENERGY RANGE
3-5 4-6
4-7 5-7
3-8 6-8
BIAS
OFF PULSER
PULSER
(MeV)
VACUUM
PUMP
E BIAS ΔE AMP GAIN
VACUUM
COUNTS ENERGY
LIN AMP OUT
BUSY
DET BIAS ADJ
EXTERNAL PULSER
DET HV
1.1 MEG OHM
EG&G ORTEC
561 4

EG&G ORTEC
SOLOIST™ Alpha Spectrometer

1. DESCRIPTION

The SOLOIST is an integrated spectrometer for measuring low-activity samples that decay by alpha-particle emission. It incorporates all the necessary functions within a NIM-standard double-width module. The module includes vacuum chamber, detector, bias supply for the detector, complete amplifying chain (preamplifier, amplifier, and biased amplifier), and calibration pulser.

The SOLOIST offers three flexible methods for recording the alpha emission activity. The simplest is to record the gross counting rate above the 2.5-MeV threshold using an external counter and timer. To achieve much lower detection limits, the linear amplifier output can be fed to a multichannel pulse-height analyzer (MCA) for quantitative analysis of specific isotope peaks in the 0- to 10-MeV energy spectrum. The biased amplifier output of the SOLOIST offers selection of a restricted energy range (containing only the peaks of interest) for analysis on the MCA. This feature allows a larger number of alpha spectrometers to be multiplexed into the limited memory size of a single MCA. A front-panel switch provides 6 selectable energy ranges at the biased amplifier output (3 to 8 MeV, 4 to 7 MeV, 3 to 5 MeV, 4 to 6 MeV, 5 to 7 MeV, and 6 to 8 MeV). Three front-panel adjustments permit precise calibration on any selected energy range.

The SOLOIST includes a robust, low-background, sample chamber. The chamber is cast in brass, then machined to close tolerances, before being nickel plated to ensure easy decontamination. In the event of severe contamination, the chamber may be easily isolated from vacuum, and then removed from the module. A compressed, high-performance O-ring, retained in a dove-tailed groove in the face of the chamber, provides an ultra-reliable vacuum seal for the chamber door. Nickel-plated brass sample trays slide into the chamber to provide an adjustable and precisely reproducible sample-to-detector spacing. Trays are available to handle sample sizes from 13 mm (0.5 in.) to 51 mm (2 in.), with sample-to-detector spacing selectable from 1 to 41 mm in increments of 4 mm. The front-panel PUMP/HOLD/VENT valve makes it easy to insert, count, and remove samples without disturbing the vacuum on other SOLOIST chambers attached to the same vacuum pump. A standard Swagelok® fitting on the rear panel simplifies connection of the valve and chamber to an external vacuum pump. An optional pump station (Model 576A/676A-PPS) is available for this function, and the Model 576-VM Vacuum Manifold can be added to connect up to four SOLOIST modules to the same vacuum pump.

The SOLOIST is available with an ULTRA-AS™ Series detector installed. These ion-implanted silicon detectors from EG&G ORTEC are specially designed

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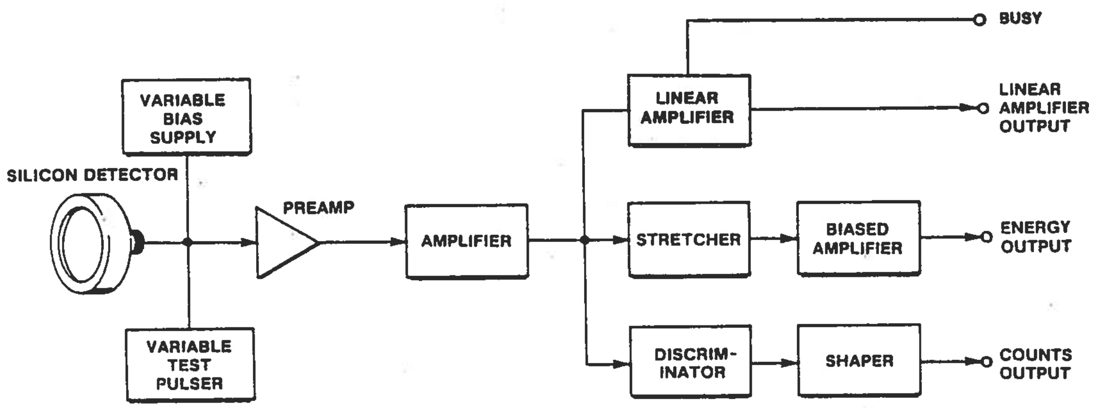

Fig. 1.1. A Simplified Block Diagram of the SOLOIST Electronics.

and fabricated for low-background applications in alpha spectrometers. Detector sizes up to 1200 mm^2 in active area can be accommodated. The SOLOIST is also available without the detector to permit installation of alternative types of silicon detectors, such as EG&G ORTEC Ruggedized™ R-Series surface barrier detectors, or other ORTEC surface barrier detectors. A front-panel adjustment and internal jumpers accommodate detectors requiring positive or negative bias voltage in the range of 0 to 100 V.

A variety of single- or multiplexed-input multichannel analyzers are available from EG&G ORTEC for use with the SOLOIST. Quantitative alpha-spectroscopy software is also offered with most of these MCAs. Please consult the appropriate section of the EG&G ORTEC catalog for further information on these products.

2. SPECIFICATIONS*

2.1. PERFORMANCE

Unless otherwise specified, the performance** is measured using a low-background, 450 mm^2, ULTRA-AS Series detector, a good-quality ^{241}Am point source, and a detector-to-source spacing equal to the detector diameter.

MAXIMUM SAMPLE SIZE 51 mm (2.030 in.).

MAXIMUM SAMPLE-TO-DETECTOR SPACING 44 mm.

MAXIMUM DETECTOR SIZE 1200 mm^2.

ENERGY RANGES Biased amplifier (ENERGY) output: 3 to 8 MeV, 4 to 7 MeV, 3 to 5 MeV, 4 to 6 MeV, 5 to 7 MeV, and 6 to 8 MeV. Linear amplifier output (LIN AMP OUT): 0 to 10 MeV.

INTEGRAL NONLINEARITY <±0.1% of full scale in each energy range.

ENERGY RESOLUTION <20 keV.

DETECTOR EFFICIENCY >25% for a detector-to-source spacing <10 mm and a ^{241}Am point source.

BACKGROUND <24 counts in 24 hours above 3 MeV. Measured from the COUNTS output with no radioactive source in the chamber.

2.2. VACUUM CHAMBER

CONSTRUCTION Cast brass, with nickel plating for ease of decontamination. High-performance O-ring seal. Three-position PUMP/HOLD/VENT valve.

SAMPLE TRAYS Slide-in, nickel-plated brass sample trays are available to accommodate sample diameters from 13 mm (0.5 in.) to 51 mm (2 in.) (See Table 2.1). One sample tray (Model SOL-ST-1) is included with the SOLOIST.

SAMPLE-TO-DETECTOR DISTANCE Adjustable from nominally 1 mm to 41 mm in increments of 4 mm using slide-in sample trays. Maximum distance from detector to bottom of chamber is approximately 44 mm.

*Specifications subject to change without notice.
**Test are performed in accordance with IEEE Std. 300-1988.

DETECTOR SIZES The SOLOIST is available with high-performance, low-background, ULTRA-AS Series detectors. Select an active area of 300, 450, 600, 900 or 1200 mm^2. See Table 2.1.

2.3. CONTROLS

ENERGY RANGE Front-panel, six-position switch selects the energy range at the biased amplifier output. Selectable ranges for zero to full-scale amplitude at the ENERGY output are 3 to 8 MeV, 4 to 7 MeV, 3 to 5 MeV, 4 to 6 MeV, 5 to 7 MeV, and 6 to 8 MeV.

OFF/BIAS/PULSER Front-panel, three-position toggle switch controls the on/off conditions of the detector bias and the pulser.

Switch Position:	OFF	BIAS	PULSER
Detector Bias:	off	on	on
Pulser:	off	off	on

The associated red LED turns on when the bias voltage is on.

PULSER Front-panel, 10-turn locking dial controls the pulser amplitude for energy calibration. Range: 0 to 10 MeV.

VACUUM PUMP/HOLD/VENT Front-panel, three-position valve controls the pumping or venting of the vacuum chamber. The HOLD position can be used to isolate the chamber from the vacuum pump when evacuating other chambers.

E BIAS Front-panel, 20-turn screwdriver control provides a ±10% adjustment of the biased amplifier threshold, to calibrate the lower limit of the energy range at the ENERGY output.

ΔE Front-panel, 20-turn screwdriver control adjusts the biased amplifier gain, to calibrate the upper limit of the energy range at the ENERGY output. The amplitude for the upper energy limit can be adjusted from 7.75 V to 10.25 V to match the input range of the ADC being used.

AMP GAIN Front-panel, 20-turn screwdriver control adjusts the full-scale calibration of the linear amplifier output (LIN AMP OUT) from 5 MeV to 10 MeV for a 10-V output pulse amplitude. Factory set for 10 MeV at 10 V.

DETECTOR POLARITY JUMPERS (+/–) Five printed circuit board jumpers select the polarity of the amplifier gain and the detector bias voltage to match the polarity of voltage required by the detector. Normally shipped in the "+" position for ULTRA-AS Series detectors.

DET BIAS ADJ Rear-panel, one-turn screwdriver control permits adjustment of the detector bias to the value specified for the installed detector. Variable from 0 to 100 V. Bias polarity is set to match the detector via the Detector Polarity Jumpers.

2.4. INPUTS

VACUUM Rear-panel vacuum connector (Swagelok connector for 0.25-in. OD tubing) for connecting the vacuum chamber in the module to a vacuum pump.

EXTERNAL PULSER Rear-panel BNC connector accepts external pulser signals. Input impedance is 100 Ω, dc-coupled. Input pulse polarity must be opposite that of the detector bias polarity.

2.5. OUTPUTS

COUNTS Rear-panel BNC connector provides a NIM-standard positive logic pulse for any detected particle having an energy greater than 2.5 MeV. Used for gross alpha counting, or routing in a multichannel analyzer. Pulse width is 3.5 μs. Output impedance is 50 Ω, dc-coupled.

ENERGY Rear-panel BNC connector provides the linear output signal from the biased amplifier for connection to an ADC or multichannel analyzer. Output amplitude range is factory set for 0 to +10 V, which corresponds to the energy ranges selected by the front-panel ENERGY RANGE switch. See E BIAS and ΔE controls for output range adjustment and calibration. Output impedance is 100 Ω, dc-coupled.

LIN AMP OUT Rear-panel BNC connector delivers the linear amplifier output signal for connection to an ADC or multichannel analyzer. Factory adjusted for 0 to 10 MeV, corresponding to a 0- to +10-V output pulse amplitude. See AMP GAIN control for calibration adjustment. Output pulse has a unipolar, semi-Gaussian pulse shape with a 1-μs shaping time constant. Output impedance is 100 Ω, dc-coupled.

BUSY Rear-panel BNC connector produces a NIM-standard positive logic pulse whenever the module is busy processing a pulse. Can be supplied to an ADC or multichannel analyzer to assist in dead-time corrections when dead-time losses are significant. Output impedance is 10 Ω, dc-coupled.

DET/1.1 MEG OHM/HV Rear-panel test jacks permit monitoring the voltage of the detector bias supply, and the detector load current. The bias supply voltage is read at the HV test jack. The voltage measured between the two test jacks permits calculation of the detector load current flowing through the 1.1-MΩ resistor.

2.6. ELECTRICAL AND MECHANICAL

POWER REQUIRED The SOLOIST derives its power from a NIM-standard bin/power supply, such as the EG&G ORTEC Model 4001A/4002A, or 4001A/4002D. The power required is +24 V at 120 mA, +12 V at 90 mA, –12 V at 45 mA, and –24 V at 75 mA.

WEIGHT
Net 2.4 kg (5.2 lb).
Shipping 3.3 kg (7.3 lb).

DIMENSIONS NIM-standard, double-width module 6.90 x 22.13 cm (2.70 x 8.714 in.) front panel per DOE/ER-0457T.

2.7. ACCESSORIES

SPARE CHAMBER GASKETS Replacement O-rings for the vacuum chamber door are available in quantities of 10 in a package. See Table 2.1.

SAMPLE TRAYS A variety of slide-in sample trays are available to hold different sample sizes. See Table 2.1. One SOL-ST-1 sample tray is included with the SOLOIST.

VACUUM MANIFOLD The EG&G ORTEC Model 576-VM Vacuum Manifold and Control is recommended for connecting a common vacuum source to four SOLOIST modules. Ask for the 576-VM data sheet.

PORTABLE PUMP STATION The EG&G ORTEC Model 576A/676A-PPS Portable Pump Station is recommended for evacuating the sample chamber in the SOLOIST. The pump station is available in both 115-V ac and 230-V ac versions, and can be combined with the Model 576-VM Vacuum Manifold to serve multiple SOLOIST modules. The standard pump station is supplied with 1 m (40 in.) of 1-in. ID vacuum hose for connection to the 576-VM, and 0.9 m (36 in.) of 1/4-in. OD vacuum hose for coupling the larger hose to the SOLOIST. If different lengths are required, contact the factory for a special order. See the PPS Portable Pump Station data sheet for further description.

MULTICHANNEL ANALYZERS WITH SOFTWARE The ENERGY output of the SOLOIST is intended for use with a multichannel pulse-height analyzer. Consult the EG&G ORTEC catalog for the appropriate single- or multiplexed-input multichannel analyzer, and alpha-spectroscopy software.

REPLACEMENT DETECTORS Detectors that have been severely contaminated or otherwise damaged beyond use can be replaced by ordering a new detector of the same size from the ULTRA-AS Series of detectors listed in the EG&G ORTEC catalog. Be sure to specify the ULTRA-AS detector with a B Mount.

Table 2.1. SOLOIST Configurations and Accessories.

Model Number	Description
SOLOIST	Alpha Spectrometer without detector
SOLOIST-U0300	Alpha Spectrometer with 300 mm², ULTRA-AS* detector installed
SOLOIST-U0450	Alpha Spectrometer with 450 mm², ULTRA-AS detector installed
SOLOIST-U0600	Alpha Spectrometer with 600 mm², ULTRA-AS detector installed
SOLOIST-U0900	Alpha Spectrometer with 900 mm², ULTRA-AS detector installed
SOLOIST-U1200	Alpha Spectrometer with 1200 mm², ULTRA-AS detector installed
	Accessories
SOL-ST-1	Sample Tray for 3/4-in. (19-mm) and 1-in. (25-mm) diameter samples. (One SOL-ST-1 included with each SOLOIST).
SOL-ST-2	Sample Tray for 1/2-in. (13-mm) and 7/8-in. (22-mm) diameter samples
SOL-ST-3	Sample Tray for 1.25-in. (32-mm) and 1.5-in. (38-mm) diameter samples
SOL-ST-4	Sample Tray for 1.75-in. (44-mm) and 2-in. (51-mm) diameter samples
SOL-ST-K	Set of Sample Trays: One each of all four sizes (1/2 in. through 2 in.)
SOL-CG	Spare gaskets (O-rings) for the vacuum chamber door (package of 10)
576A/676A-PPS-115	115-V Portable Pump Station for the SOLOIST. Also compatible with the 576-VM Vacuum Manifold.
576A/676A-PPS-230	230-V Portable Pump Station for the SOLOIST. Also compatible with the 576-VM Vacuum Manifold.
576-VM	Vacuum Manifold and Control

*For R-Series detectors contact the factory.

3. INSTALLATION

This section describes the steps that must be taken to set up a standard SOLOIST system. The necessary steps include detector setup and installation, vacuum connection, and output voltage adjustment.

3.1. DETECTOR SETUP

POLARITY SWITCH SETTINGS Positive bias voltage is required for silicon dioxide-passivated, ion-implanted detectors (such as EG&G ORTEC ULTRA-AS Series detectors) and surface barrier detectors (such as EG&G ORTEC A Series). If the detectors were installed at the factory, the switches are already properly set. If no detectors were installed, then the unit was shipped with positive bias. There are two slide switches that must be changed when an EG&G ORTEC Ruggedized detector, which requires negative polarity, is used.[1]

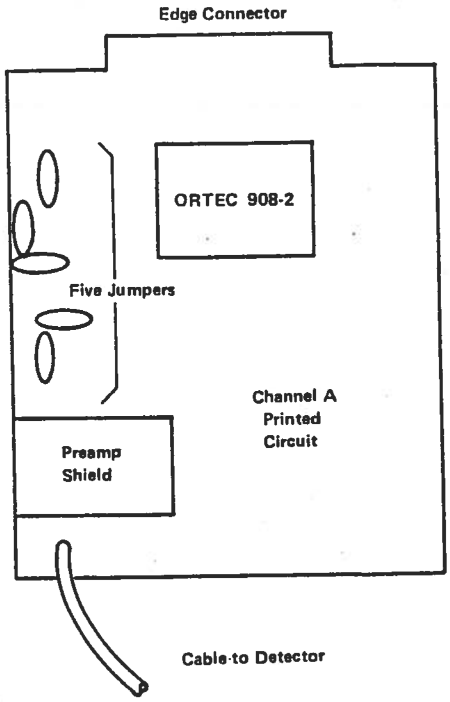

Fig. 3.1. Position of Polarity Switches for Bias and Amplifier.

Five plug-in jumpers on the printed wiring board (PWB) must be set to the correct polarity for the type of detector in use. These jumpers are accessible when the right side panel is removed from the instrument chassis. These five jumpers are used to select either positive or negative detector voltage polarity and the corresponding correct amplifier polarity. Positive bias is required for EG&G ORTEC ULTRA-AS Series, silicon dioxide-passivated, ion-implanted detectors. These five internal jumpers need to be changed only when an ULTRA-AS or A-Series detector is replaced with a Ruggedized detector, or vice versa.

POLARITY SELECTION When polarity needs to be changed:

1. Remove the SOLOIST Alpha Spectrometer module from the bin/power supply.

2. Remove the side panel from the right side of the module (as viewed from the front panel).

3. Note the locations of all five jumpers on the component side of the SOLOIST Alpha Spectrometer PWB (Fig. 3.1). The "+" and "–" orientation for each of the jumpers is etched on the PWB.

4. Place all five of these jumpers at "–" for a Ruggedized detector, or at "+" for a conventional surface barrier detector or EG&G ORTEC ULTRA-AS Series, silicon dioxide-passivated, ion-implanted detector.

BIAS VOLTAGE SETTINGS The bias voltage for each detector can be adjusted from 0 to 100 V using the screwdriver rear-panel DET BIAS ADJ potentiometer. The unit is normally shipped with the bias supply set to +50 V. The value of the bias voltage and detector leakage current can be measured on the rear-panel test jacks. Measure the bias voltage at the "HV" test jack, and the detector leakage current between the "DET"and "HV" test jacks. The input impedance of the voltmeter must be ≥10 MΩ for this measurement.

INSTALLING THE DETECTOR The ULTRA-AS Series detectors normally used in the SOLOIST have a thin (500 Å) contact, ion-implanted into the silicon surface. The contact is thus more rugged than that formed by an evaporated gold layer. If the silicon surface is scratched, however, the detector will be damaged. Reasonable precautions should, therefore, be taken when handling these detectors.

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[1]Which detectors do I have? All EG&G ORTEC charged-particle detectors are shipped in a plastic container, accompanied by a QC sheet. Both bear the model number. The first letter gives the mount type (always B rear Microdot®, for SOLOIST). The second letter is the detector type: R = Ruggedized (negative bias), U = ULTRA (positive bias), A = A Series (positive bias).

If other types of detectors are used, read the detector's instruction sheet before installing and using the detector. Then:

1. Turn the detector BIAS off for the chamber into which the detector is being installed.

2. Use clean plastic gloves and make sure the white protective cap for the detector is in place. Carefully align the center pin in the top of the chamber with the center socket in the detector connector. (Any misalignment could bend and damage the center pin.) Screw the detector into the connector at the top of the chamber by rotating the detector (threads are right-handed). If initial resistance is felt, stop and check for center pin misalignment. Otherwise, continue turning the detector until the 5/16-in. hex-nut on the detector presses against the top of the chamber. On new chambers, use of a 5/16-in. ignition wrench may be required for the last turn.

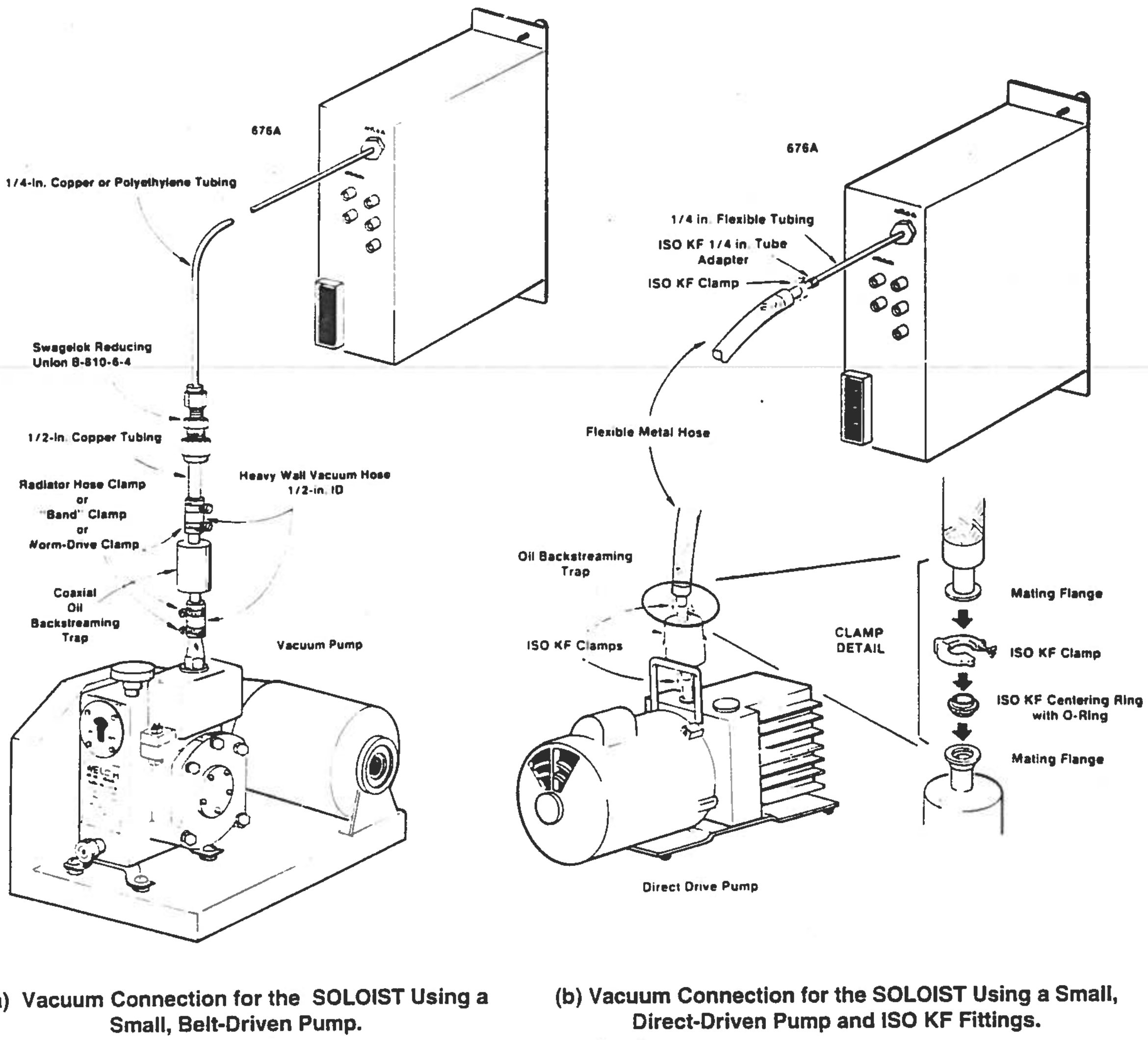
3. Remove the plastic cover, being careful not to touch the detector face and thereby contaminate it.

3.2. CONNECTION TO POWER

The SOLOIST Alpha Spectrometer is designed for operation in a NIM-standard bin/power supply such as the EG&G ORTEC Model 4001/4002 Series. The power supply furnishes operating power requirements at ±12 V and ±24 V. These NIM bins have test jacks on the power supply control panel to monitor the dc-voltage level. Check that the proper voltage is available at these test jacks after all modules have been installed in the bin.

3.3. VACUUM CONNECTION

Apply a clean, dry, oil-free vacuum from a roughing pump or vacuum manifold to the SOLOIST Alpha Spectrometer through the Swagelok connector on the rear panel. This connector accepts 1/4-in. OD tubing



(a) Vacuum Connection for the SOLOIST Using a Small, Belt-Driven Pump.

(b) Vacuum Connection for the SOLOIST Using a Small, Direct-Driven Pump and ISO KF Fittings.

Fig. 3.2.(a) and (b). Suggested Vacuum Connections for the SOLOIST Spectrometer.

and is accessible when the module has been installed in the NIM bin [(Fig. 3.2 (a) and (b)]. For a single SOLOIST Alpha Spectrometer, the pump should have a displacement of about 2 CFM (57 liter/min). If several SOLOIST Alpha Spectrometer modules are connected together via a manifold, the pump should have a displacement of about 4 CFM (113 liter/min). For larger systems (more than four modules), a pump with a displacement of 6.7 CFM (190 liters/min) should be used. An operating pressure of <50 millitorr should be adequate for most applications.

Set the front-panel PUMP/HOLD/VENT control at VENT to isolate the vacuum source from the chamber and to vent the chamber to atmospheric pressure. With the chamber door closed, the control can be set at PUMP to connect the chamber to the vacuum source. Do not set the control at PUMP unless the door is closed, or the vacuum source will be connected directly to atmospheric pressure through the open chamber. The control can be placed in the HOLD position to isolate the chamber from the manifold without venting the sample.

3.4. SIGNAL CONNECTIONS

Figure 3.3 shows the typical signal connections between the SOLOIST, the associated multichannel analyzer, and the optional counter and timer. To gain use of the biased amplifier in the SOLOIST, the rear-panel ENERGY output should be connected to the linear input on the multichannel analyzer. If the bias amplifier is not desired, the LIN AMP OUT can be connected to the multichannel analyzer linear input. The BUSY signal is supplied to the multichannel analyzer to assist in proper dead-time corrections.

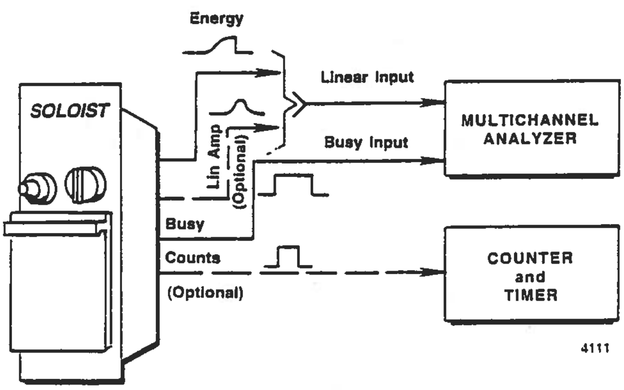


Fig. 3.3. Signal Connections.

When an external BNC cable longer than 3 meters is used for input or output connection, the characteristic impedance of the cable should match the impedance of the input or output used. The EXTERNAL PULSER input and the ENERGY and LIN AMP outputs should use 93-Ω RG-62A/U cable, and the COUNTS and BUSY outputs should be connected using 50-Ω RG-58A/U cable. For cable lengths >3 m, the coaxial cable should be terminated in its characteristic impedance at the receiving end. Use a BNC Tee connector and terminating resistor, if necessary.

3.5. ENERGY OUTPUT FULL-SCALE ADJUSTMENT (Other than 10 V)

The full-scale output from the ENERGY output is normally set for 10 V, which matches the input range of many multichannel analyzers (MCAs). The second most common input range for MCAs is 8 V. The procedure for a 8-V full scale is as follows:

1. Set the OFF/BIAS/PULSER switch to PULSER. Set the ENERGY RANGE switch to 4-6 MeV or the range to be used.

2. Observe the ENERGY output on an oscilloscope, trigger on BUSY, and then adjust the PULSER control for a 10-V output pulse.

3. Adjust the front-panel ΔE control for 8-V output. Turn off the PULSER and continue with operation of the SOLOIST Alpha Spectrometer.

3.6. LINEAR AMP OUTPUT FULL-SCALE ADJUSTMENT (Other than 10 V)

The full-scale output from the LIN AMP OUT is normally set for 10 V, which matches the input range of many multichannel analyzers (MCAs). The second most common input range for MCAs is 8 V. The procedure for 8-V full scale is as follows:

1. Set the OFF/BIAS/PULSER switch to PULSER. Set the PULSER control to 10 MeV (or the range to be used within 5 MeV to 10 MeV).

2. Observe the LIN AMP OUT on an oscilloscope, trigger on BUSY, and then adjust the PULSER control for a 10-V output pulse.

3. Adjust the front-panel AMP GAIN control for 8-V output. Turn off the PULSER and continue with operation of the SOLOIST Alpha Spectrometer.

4. OPERATION

The information in Section 3 includes all of the preliminary selections that are to be made for the SOLOIST Alpha Spectrometer. Operation, then, consists of inserting a sample that is to be examined into the chamber and proceeding with data accumulation.

Basic control settings that should be used before inserting a sample and between operating cycles are:

OFF/BIAS/PULSER	OFF
VACUUM Control	VENT
ENERGY RANGE	Selection for Sample Energy
PULSER Dial	0
DET BIAS ADJ	+50 V for EG&G ORTEC ULTRA-AS detectors. (Other detectors as specified on detector data sheets).

Then use the following steps:

1. Place the standard sample in the chamber.

2. Evacuate the chamber. If this module has a common vacuum with other SOLOIST Alpha Spectrometers, put the other modules on HOLD while this module is pumped down.

3. Turn on the BIAS, and count the standard.

4. Perform the energy and efficiency calibration.

5. Repeat steps 1-3 with a prepared sample. Note: for quantitatively meaningful results, the sample must be placed at the same distance from the detector as the calibration standard.

4.1. OPERATING PUMP/HOLD/VENT VALVE

The PUMP/HOLD/VENT valve is a 3-position valve. The PUMP position connects the chamber to the manifold (see Fig. 4.1), the HOLD position isolates the chamber, and the VENT position connects the chamber to the atmosphere, allowing the door to be opened.

4.2. SAMPLE INSERTION

Turn the chamber valve to the VENT position and open the door. Slide the sample holder into the slot at the desired height. (Note that, for optimum resolution, the sample-to-detector spacing should be at least equal to the detector diameter.) The sample spacing is selectable from 1 mm to 41 mm, in 4-mm increments. The sample trays shipped with the SOLOIST are for 3/4-inch and 1-inch samples. Additional sets of sample trays of 4 different sizes are available. See Section 2.7 for a description of the sample trays.

When the sample is in place, close the door, and turn the vacuum valve to PUMP. After a minute or two, when the vacuum has reached a satisfactory value (100 millitorr or less), start the data collection.

If other chambers connected to the same vacuum manifold have been placed on HOLD (see above), they may now be returned to the PUMP position.

4.3. RESOLUTION MEASUREMENT AND CALIBRATION

The measurement of alpha particle resolution should be performed in a vacuum with an ultra-thin, point source located at a source-to-detector distance at least equal to the detector diameter. The use of old or inferior sources may cause apparently poor resolution and can also lead to detector contamination due to recoil sputtering. When a source is used in an SOLOIST chamber, either for resolution measurement or system calibration, these steps should be followed for optimum results.

4.3.1. RESOLUTION MEASUREMENT

1. Placing a source in the chamber can contaminate the chamber/detector and is not recommended if the low background specification of the SOLOIST is to be maintained. The calibrated Test Pulser can be used to test the system electronic noise by measuring the FWHM spread of the pulser peak on the MCA from the ENERGY or LIN AMP OUT.

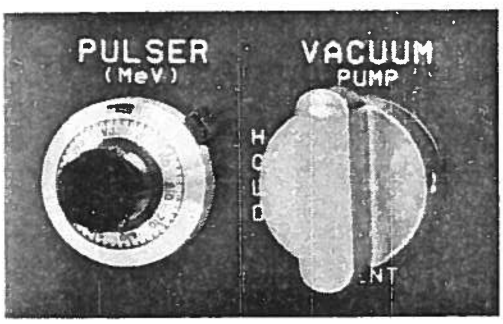


Fig. 4.1. PUMP/HOLD/VENT Valve.

2. Evacuate the chamber.

3. Turn the BIAS on. Wait for 2 minutes.

4. Accumulate a peak containing at least 1,000 counts in the peak channel.

5. Determination of the resolution requires the measurement of the full-width at 1/2 maximum (FWHM) of the peak.

Note: If the source is to be used, place the source on a sample tray and insert it into the SOLOIST chamber. Placing the source as far as possible from the detector helps reduce any solid-angle-related and/or count-rate problems.

4.3.2. CALIBRATION

System calibration is essentially composed of two parts:

1. Counting a known standard containing two alpha emitters, and using the known energies to determine the energy calibration. For low-background applications the calibrated Test Pulser can be used to place a peak near each end of the selected Energy Range then:

$$E_n = A + B * Chn$$

where A is the energy of the lowest channel in the system in MeV and B is the gain in MeV/channel. E_n is the energy of channel Chn. This process is carried out easily via the MCA Emulation software (see relevant manual). For use with other MCA systems see the pertinent manual.

2. Performing an efficiency calibration. The efficiency calibration is a determination of the ratio between the number of alpha particles of a particular nuclide and energy emitted by the source, and the number actually recorded from that source in the corresponding spectral peak.

Efficiency calibration may be determined manually, or may be determined as a part of a quantitative analysis package such as EG&G ORTEC's ALPHAMAT™. Unlike gamma-ray detectors, the efficiency of a solid-state alpha detector is constant over the energy range of interest to alpha spectroscopists.

5. THEORY OF OPERATION

The complete schematics for the SOLOIST Alpha Spectrometer [Part No. 761250 (Alpha Spectrometer) and 764030 (Linear Amplifier)] are included at the back of this manual. Figure 5.1 is a block diagram of the electronics.

The detector voltage (OFF/BIAS/PULSER) switch on the front panel turns power on and off for the variable 100-V power supply. The power is on in both the BIAS and PULSER positions.

The polarity is set by jumper J1, which is actually three separate jumpers (see schematics). The indicated polarity is positive, which is appropriate when an EG&G ORTEC ULTRA-AS or standard detector is used. When the detector voltage is positive, its output pulses are negative. When they pass through the inverting preamplifier they are positive, and this is the polarity that is then selected by the pair of jumpers J3, on the PWB. If a Ruggedized surface barrier detector is used, all five of these jumpers must be changed to "–" because the Ruggedized detector operates on a negative voltage and generates positive output pulses, which are then inverted and are negative pulses at the J3 location in the circuit.

The 100-V power supply output on the PWB can be tested for both polarity and amplitude at test point TP1, which is identified on the PWB. The variable 0 to 100 V bias voltage can be measured at the rear-panel test jack labeled HV. The detector leakage current can be calculated from the voltage across the 1.1-MΩ resistor, between rear-panel test jacks DET and HV. A 10-MΩ impedance meter should be used. The output of the BIAS supply is applied through a high impedance (totaling 23 MΩ) to the dc connection between the detector and the preamplifier.

The output from the charge sensitive preamplifier can be checked at TP2. The nominal conversion gain is 45 mV/MeV. The preamplifier gain from the EXTERNAL PULSER input is nominally "–1" at TP2.

The front-panel PULSER switch (OFF/BIAS/PULSER) turns power on and off for the test pulser. The test pulser can be set using the 10-turn, front-panel poten-

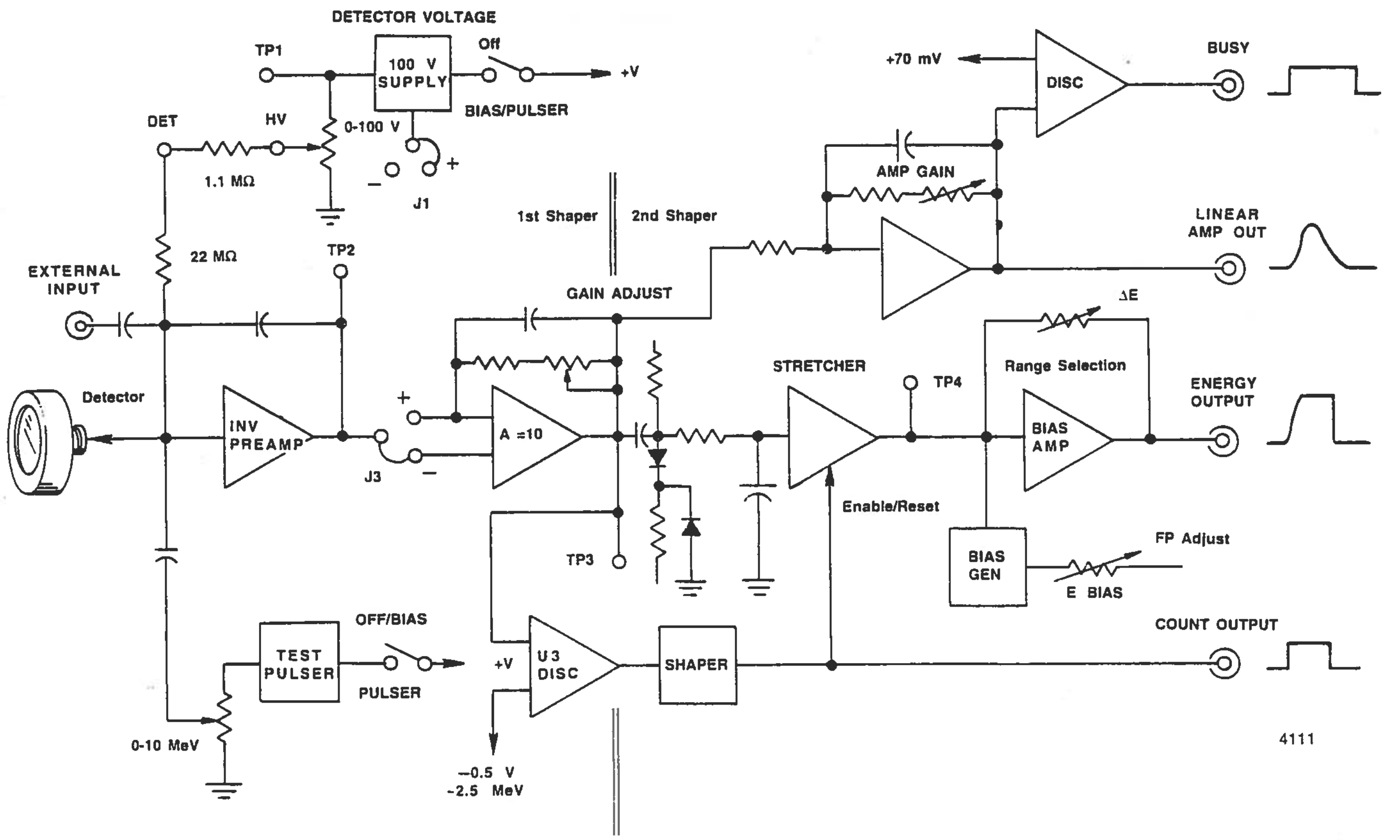


Fig. 5.1. Detailed Block Diagram of the SOLOIST Alpha Spectrometer.

tiometer to furnish the equivalent pulse amplitude for 0 to 10 MeV at the input to the preamplifier. A screwdriver calibration is included on the PWB for factory adjustment of the test pulser circuit and should not be changed by the customer. When the front-panel toggle switch is set at BIAS, the test pulser is turned off and does not appear in the output spectrum.

Pulses from the detector and/or the test pulser are inverted by the preamplifier and are furnished as the input to the amplifier that includes the first integration and differentiation shaping circuits. The amplifier can be calibrated by a factory-adjusted trim potentiometer on the PWB. The output is a shaped negative pulse that can be observed at test point TP3.

The pulse at TP3 is furnished into a fixed-level discriminator U3 and through a diode dc-restorer and integration network. If the amplitude represents ~2.5-MeV or more, the discriminator fires and generates a positive-shaped pulse that is used to enable the stretcher. This pulse is also provided as the COUNTS output signal. The pulse from the second integration shaping circuit is furnished to the stretcher. If the stretcher is enabled, the peak amplitude is stretched to improve the measurement accuracy of the MCA, which uses the ENERGY output for measurement. If the stretcher is not enabled (because the pulse represents <2.5 MeV), the output is passed to the biased amplifier without being stretched. The output of the stretcher is a negative pulse and can be monitored at test point TP4 on the PWB.

The biased amplifier accepts the stretcher output and the bias level selected by the front-panel ENERGY RANGE switch (low end of range). The bias level, or lower level, accepted into the biased amplifier can be set at 3, 4, 5, or 6 MeV by the ENERGY RANGE switch and can be adjusted by ±10% by the front-panel screwdriver control, E BIAS. The function of the biased amplifier is to subtract the bias level from the input pulse amplitude and to amplify the excess amplitude by a factor of 10 on the 3-5, 4-6, 5-7, and 6-8 MeV ranges, a factor of 6.7 on the 4-7 MeV range, or a factor of 4 on the 3-8 MeV range. The output of the biased amplifier is a positive pulse with an amplitude in the range of 0 to 10 V that is proportional to the amount by which the detected input energy exceeds the selected bias level. The full-scale output of 10 V can be adjusted down to 7.75 V using the front-panel screwdriver control, ΔE.

5.1. SOLOIST ALPHA SPECTROMETER LINEAR AMPLIFIER SCHEMATIC

The pulse at TP3 is also furnished to a positive gain of 10 amplifier with a diode-limited, continuous dc-restoration loop (see Linear Amplifier schematic). The second integration for the rear-panel LIN AMP OUT is implemented in the amplifier input network. The LIN AMP OUT is a positive 1-μs shaped pulse.

The output amplitude is adjustable over a 5-MeV to 10-MeV range by the front-panel screwdriver control, AMP GAIN. The output is factory set to 10 MeV at 10 V.

The BUSY output pulse is generated by a discriminator that provides a +5 V level whenever the LIN AMP OUT exceeds the discriminator's 70-mV reference voltage.

6. MAINTENANCE AND SERVICE

6.1. DECONTAMINATION

The normal background count above 3 MeV for each channel in the SOLOIST should be <24 counts per day for the 300- and 450-mm^2 ULTRA-AS Series detectors. If an increase of background is noted, this may be caused by contamination of the chamber and/or the detector by residual deposits of alpha-emitting materials. Decontamination of the chamber and of the detector (if ULTRA™ or Ruggedized) is indicated. **Non-Ruggedized surface barrier detectors cannot be subjected to cleaning procedures; consult the instruction manual for the detector to determine any measures that may be helpful.**

6.1.1. CHAMBER DECONTAMINATION

Use the following steps to decontaminate a SOLOIST chamber.

1. Ensure that the power and BIAS switches are turned off. Remove the detector from the chamber by rotating it counterclockwise (right-hand threads). The protective cover supplied with the detector should be in place prior to its removal to prevent damage to the detector. Plastic gloves should be used to prevent contamination of the hands or chamber.

2. Pour the cleaning agent into a clean beaker. Methanol, or water with a methanol rinse, can be used as the cleaning agent.

3. Moisten a cotton swab or a cotton-covered stick with the cleaning agent and gently wipe the internal surfaces of the chamber to remove any contamination. Avoid contaminating vacuum or vacuum gauge ports. Plug holes if necessary.

4. When contamination from the surface is visible on the cotton swab, discard and use a clean one in order to avoid returning the contaminant to other areas of the chamber.

5. When the chamber is clean, blow dry with clean nitrogen gas.

6.1.2. ULTRA-AS DETECTOR DECONTAMINATION

The front surface of an ULTRA-AS detector can be cleaned with a cotton swab moistened with acetone. Gently rub the detector surface with the swab. Repeat with fresh acetone. Blow dry with dry nitrogen gas. Before applying bias, leave the detector under vacuum for 30 minutes to remove all surface moisture.

6.1.3. RUGGEDIZED DETECTOR DECONTAMINATION

Use the following steps to decontaminate the front (aluminum) surface of a Ruggedized detector:

1. Pour deionized water into a clean beaker.

2. Dip a cotton swab into the water and then carefully blot on a clean tissue to remove the excess.

3. **GENTLY** swab the aluminum surface of the detector. **DO NOT** "scrub" the detector. Gently wiping the detector's aluminum surface with the damp swab a few times should pick up most of the removable contamination. If cotton-covered sticks are used, loosen the cotton around the stick and be careful not to allow the end of the stick to contact the aluminum surface.

4. Clean the detector housing and the protective cover in the same way.

5. Blow dry with clean nitrogen gas. Do not use a house air supply.

6.2. SOLOIST CHAMBER REMOVAL AND REPLACEMENT

These instructions apply to the removal of a vacuum chamber assembly from the SOLOIST for the purpose of cleaning or replacing the chamber.

6.2.1. CHAMBER REMOVAL

1. TURN OFF THE SOLOIST POWER.

2. Turn the VACUUM Valve Knob to VENT and open the chamber door.

3. Place the white protective cap on the detector and remove the detector. The detector front surface should not be touched.

4. Use a 3/32-in. Allen wrench to unscrew the three socket head cap screws holding the chamber in place. Remove the two top screws first and the bottom screw last.

5. Pull the chamber out slightly (about one inch). Put the screws back in the holes and close the chamber

door to trap the screws in place. This avoids losing them and keeps them in place for replacement.

6. Pull the chamber out a little more until the glass feedthrough on the top of the chamber is exposed. USE CARE! If the cable is caught on the top of the panel, you may damage the feedthrough pin by pulling hard on the chamber.

7. Unsolder the center lead of the coaxial signal cable.

8. Unscrew the slotted screw holding the ground wire of the coaxial signal cable about one turn. Do not remove this screw. Remove the ground wire connector. Note if and where a plastic cable tie is used to tie the cable to the vacuum hose and then cut the cable tie. This frees the coaxial signal cable. See Fig. 6.1.

9. Pull the chamber out farther to expose the vacuum connection on the back of the chamber. Slide the black rubber vacuum hose off the vacuum port.

6.2.2. CHAMBER INSTALLATION

Reinstallation of the chamber assembly should proceed exactly in the reverse order of the disassembly.

1. Reconnect the vacuum hose. It may be necessary to remove the module right side panel. Make sure it is still connected to the valve above.

2. Connect the ground wire, tighten the screw, and solder the center lead on the one-pin feedthrough. Position the cable in the original position and use a cable tie to secure it to the vacuum hose.

3. Restore the chamber assembly to its position against the front panel. Be certain that the signal wire is not trapped under the chamber assembly flange.

4. Tighten the chamber screws lightly, bottom screw first. Fully tighten all screws.

5. Install the detector.

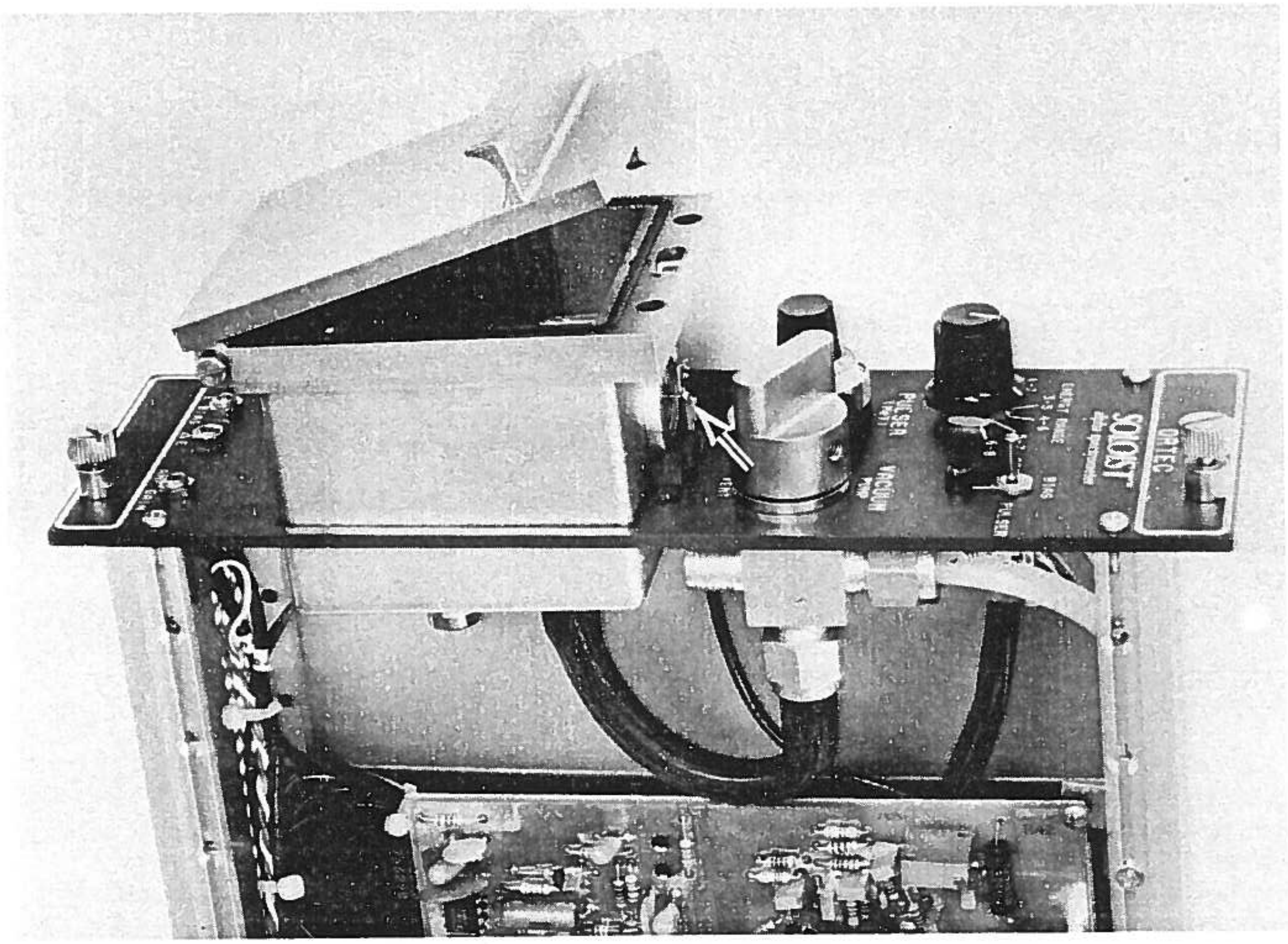


Figure 6.1. Vacuum Chamber and Coaxial Cable Connection.

6.3. TROUBLESHOOTING GUIDE

This section of the manual contains some troubleshooting hints. Below are listed several problems and possible solutions.

6.3.1. RESOLUTION PROBLEMS

A severe degradation in peak resolution can destroy the ability of an alpha spectrometer to make meaningful measurements.

Apparent degradation of resolution may be due to one or more causes:

1. Poor vacuum: this can be checked by reference to the pressure reading.

2. Excessive electronic noise: this can be checked by examining the pulser peak resolution and detector leakage current compared to that specified on the original detector QC sheet. Sometimes a noisy detector can be restored by the simple act of removal and replacement, which reseats the connector pin. If detector substitution demonstrates the problem to be in the electronics, contact the EG&G ORTEC Customer Service.

6.3.2. VACUUM PROBLEMS

The vacuum valve is connected to each vacuum chamber with a neoprene vacuum line (see Fig. 6.1). When the vacuum valve is in either the HOLD or VENT position, the chamber is isolated from the vacuum manifold. Most vacuum problems can be easily isolated using a systematic approach starting at the chamber valve.

If the total system pressure read at the vacuum pump is too high in a system with multiple chambers connected to a vacuum line or manifold, begin at the chamber farthest from the pump and turn the vacuum valve to the HOLD position. If the system pressure improves significantly, the problem is isolated to that chamber. The most common problem affecting the vacuum will be dirt or nicks on the O-ring. A broken feedthrough may also cause a leak. If the problem is not in the last chamber, continue isolating chambers until the vacuum improves or until all valves have been operated. If all valves are in HOLD and the vacuum does not improve, the problem is in the manifold or something common to all the chambers such as the vacuum pump. If the vacuum pump is very low on oil, it will not pump well. If any of the fittings from the back of the SOLOIST to the vacuum pump have been recently disconnected, they are suspect. When looking for vacuum problems, check things that have been recently changed.

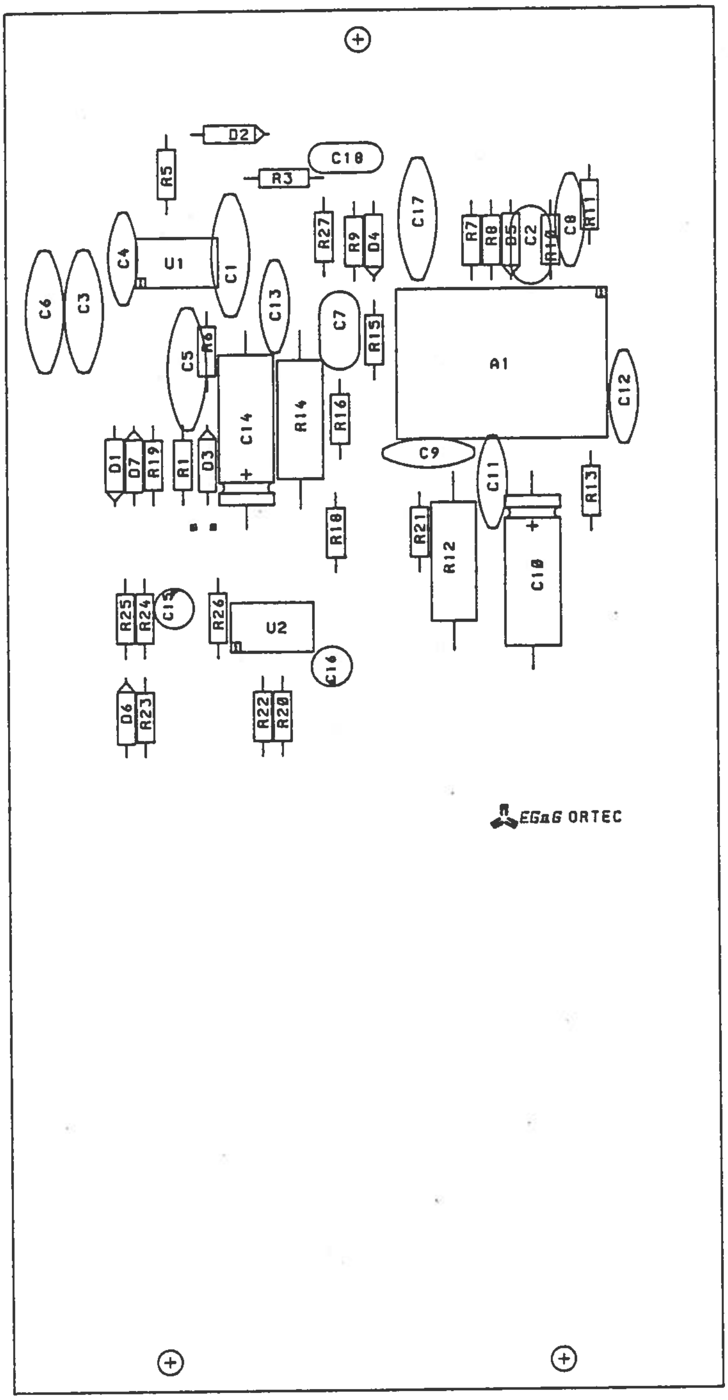
Outgassing of contaminants in the vacuum chamber will also cause the pressure to be high in the individual chamber, but will have only a slight effect on adjoining chambers. A "good" chamber should pump to less than 50 millitorr in 5 minutes.

If it is found necessary to replace an O-ring, a small amount of silicone vacuum grease should be smeared onto the O-ring with the fingers (use plastic gloves). All excess should be wiped off. Excess vacuum grease traps dust, which degrades the vacuum seal. O-ring kits may be ordered from EG&G ORTEC, under the model number SOL-CG.

BIN/MODULE CONNECTOR PIN ASSIGNMENTS FOR STANDARD NUCLEAR INSTRUMENT MODULES PER DOE/ER-0457T

Pin	Function	Pin	Function
1	+3 volts	23	Reserved
2	−3 volts	24	Reserved
3	Spare Bus	25	Reserved
4	Reserved Bus	26	Spare
5	Coaxial	27	Spare
6	Coaxial	*28	+24 volts
7	Coaxial	*29	−24 volts
8	200 volts dc	30	Spare Bus
9	Spare	31	Spare
*10	+6 volts	32	Spare
*11	−6 volts	*33	117 volts 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 volts	38	Coaxial
*17	−12 volts	39	Coaxial
18	Spare Bus	40	Coaxial
19	Reserved Bus	*41	117 volts ac (Neut.)
20	Spare	*42	High Quality Ground
21	Spare	G	Ground Guide Pin
22	Reserved		

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



QTY REQD	FIND NO.	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	REMARKS
-001			PARTS LIST	

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES
DO NOT SCALE THIS DRAWING
TOLERANCES ARE

FRACTIONS	DECIMALS	ANGLES	FINISH
± 1/64			√

MATERIAL

FINISH

APPLIED PRACTICES

REVISIONS

LTR	ECN NUMBER	DATE	APPR
A	Release	3-30-93	

EG&G ORTEC

100 MIDLAND ROAD, OAK RIDGE, TENNESSEE 37□.

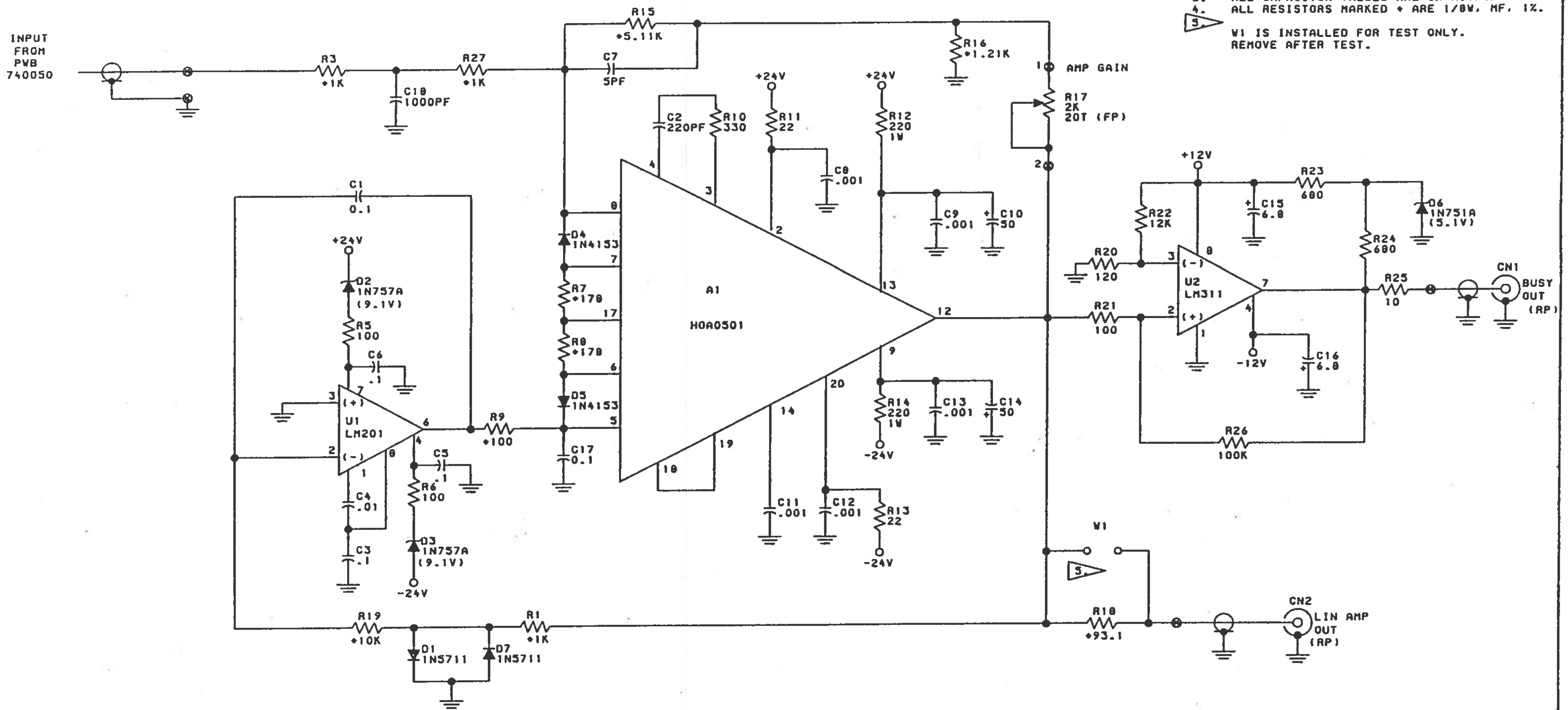
SOLOIST

PWB ASSY, LINEAR AMP

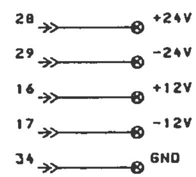
DRAFTER	DATE			
CS	3/93			
CHECKED		DESIGN ENGR TBECKER	PROJECT	
			DRAWING NO. 729940	
MPM	3-30-93	SCALE 2/1	SHEET	OF

NOTES UNLESS OTHERWISE SPECIFIED

NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTOR VALUES ARE IN OHMS.
2. ALL RESISTORS ARE 1/4W, CF, 5%.
3. ALL CAPACITOR VALUES ARE IN MICROFARADS.
4. ALL RESISTORS MARKED • ARE 1/8W, MF, 1%.
5. W1 IS INSTALLED FOR TEST ONLY. REMOVE AFTER TEST.



BIN PWR CONNECTOR



QTY REQD	FIND NO.	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	REMARKS
	-001		PARTS LIST	

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES TOLERANCES ARE

FRACTIONS	DECIMALS	ANGLES	FINISH
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REVISIONS

REV	ECN NUMBER	DATE	APPR
A	Release	3-30-93	

EG&G ORTEC

100 MIDLAND ROAD, OAK RIDGE, TENNESSEE, 37830

SOLOIST

DIAG. SCHEM. LINEAR AMPLIFIER

CSAp 3/29/93 TKBecker 3/30/93

T.BECKER

SIZE C

3-30-93

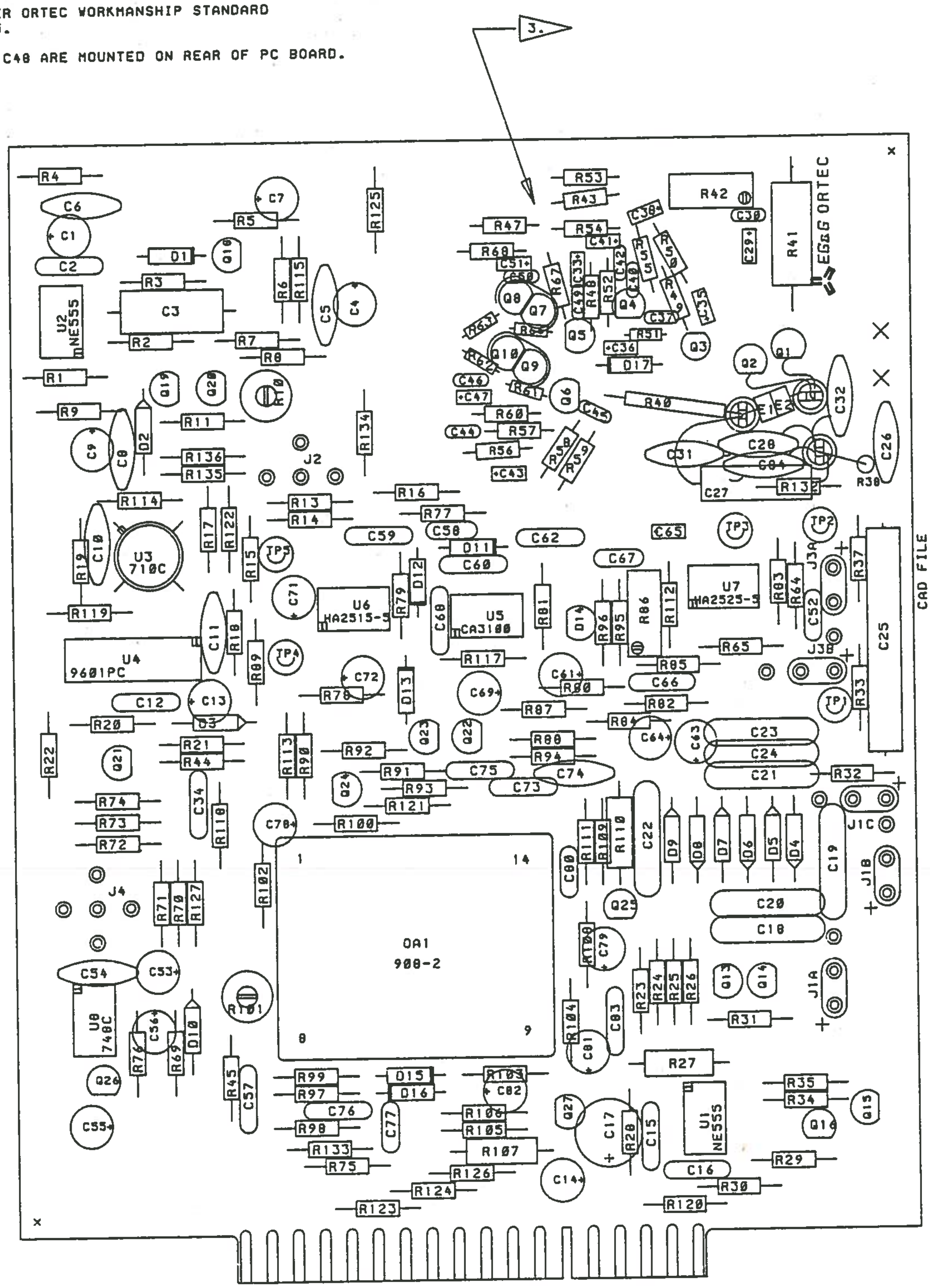
SCALE NONE

764030

SHEET 1 OF 1

NOTES UNLESS OTHERWISE SPECIFIED:

1. ASSEMBLE COMPONENTS IN ACCORDANCE WITH ORTEC WORKMANSHIP STANDARD SECTION 4; P.C. ASSEMBLY.
2. SOLDER PER ORTEC WORKMANSHIP STANDARD SECTION 5.
3. C39 & C40 ARE MOUNTED ON REAR OF PC BOARD.



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	100 MIDLAND ROAD, OAK RIDGE, TENNESSEE 378	
	SOLOIST	
	PWB ASSY, ALPHA SPECTROMETER	
CS 3/93	T Becker 7/30/93	
	T BECKER	729890
3-30-93	SCALE 2/1	SHEET OF

A Release 3-30-93