EG&G ORTEC

Model 676
ALPHA-KING Spectrometer
Operating and Service Manual

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ALPHA-KING Spectrometer
Operating and Service Manual

This manual applies to instruments marked
"Rev 00" on rear panel

Printed in U.S.A.

EG&G ORTEC Part No. 717510

3800 0187

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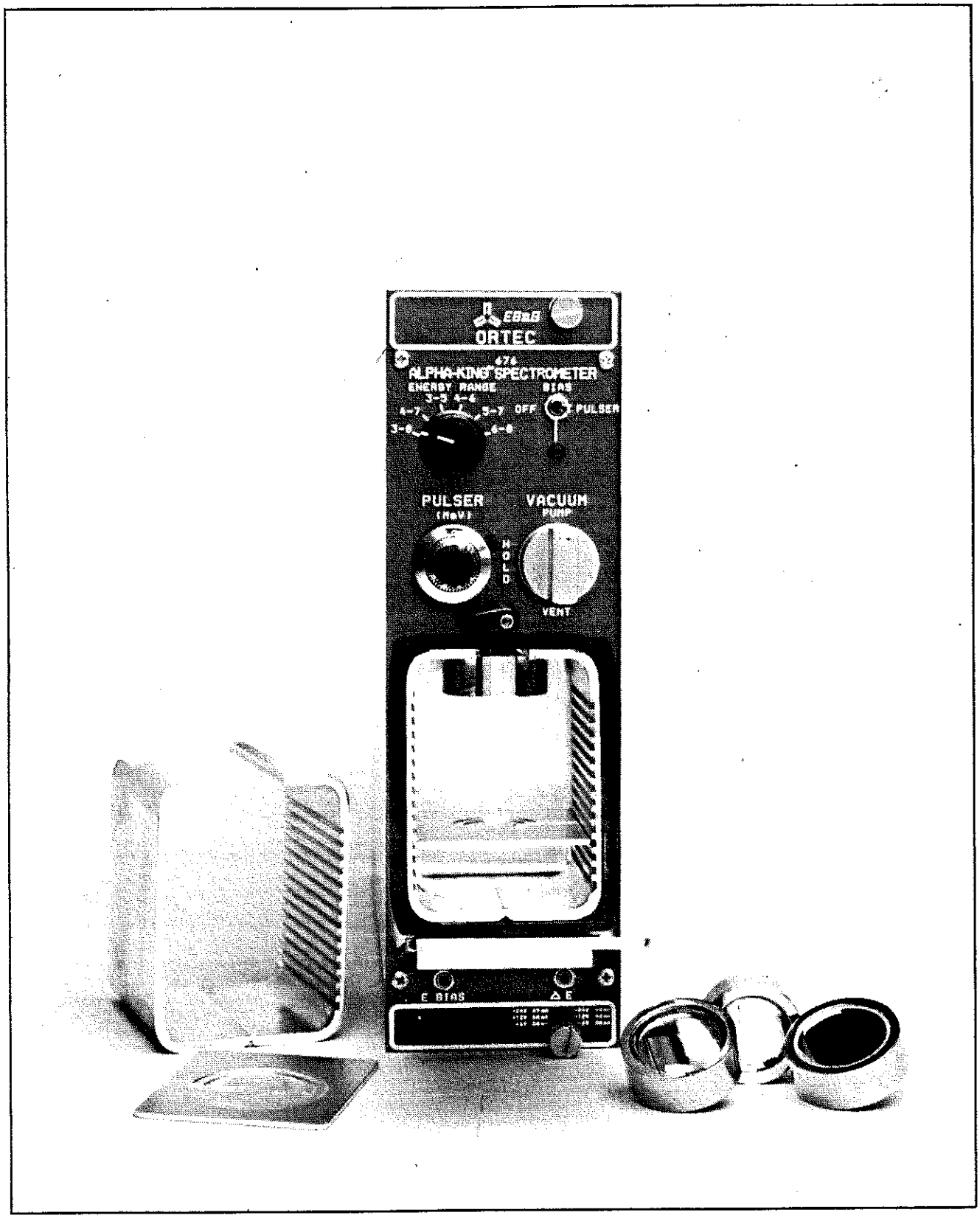
ILLUSTRATIONS


ORTEC
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ALPHA-KING SPECTROMETER
ENERGY RANGE
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EG&G ORTEC MODEL 676 ALPHA-KING™ SPECTROMETER

1. DESCRIPTION

The EG&G ORTEC 676 ALPHA-KING Single-Channel Spectrometer is a self-contained double-width NIM module that includes a variable detector bias supply (positive or negative), a preamplifier, a shaping and stretching amplifier with adjustable gain, a biased amplifier, a test pulser with variable gain, a test pulser with variable amplitude, and a discriminator (Fig. 1.1). A vacuum line is furnished to the detector chamber through a Vent/Hold/Pump valve, controlled on the front panel.

An EG&G ORTEC surface barrier detector can be mounted at the top of the vacuum chamber. Normally, an EG&G ORTEC Ruggedized™ surface barrier detector is used. This special low-background detector has been processed through EG&G ORTEC's standard quality control procedures. To eliminate the danger of low-level alpha contamination, this detector has not been exposed to alpha particles. Instead, alpha resolution is measured on a representative sample of detectors from each batch of low-background Ruggedized™ detectors produced to ensure that the specified alpha resolution is met. The alpha and noise resolutions are measured in accordance with IEEE Standard 300 and IEC Standard 333 in EG&G ORTEC's standard high-vacuum detector test system.

The detector voltage source has selectable polarity so an EG&G ORTEC standard surface barrier detector can be used if desired. Voltage is variable from 0 to ±100 V.

The detector is furnished in a case that includes a concentric Microdot™ connector, and this connector serves as the mounting for the detector in the chamber. The detector can be installed or removed by hand. **Plastic gloves should be used to prevent contamination of the detector and vacuum chamber, and the protective cover supplied with the detector should be in place to prevent damage to the detector.**

A removable rectangular door closes the entrance to the vacuum chamber. Horizontal sample trays (Fig. 1.2) are placed into the chamber underneath the detector. The

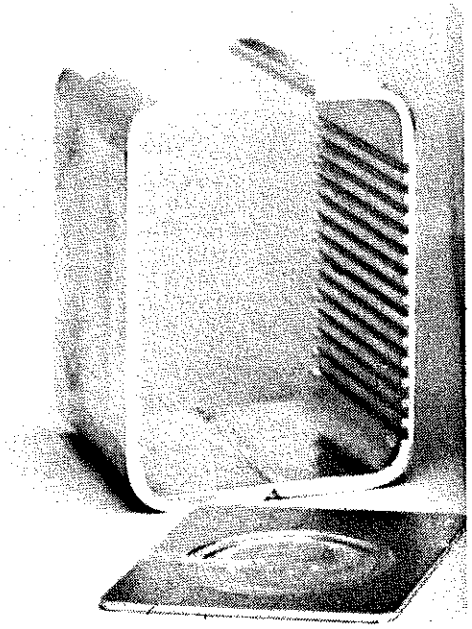

Fig. 1.2. Sample Holder Assembly.

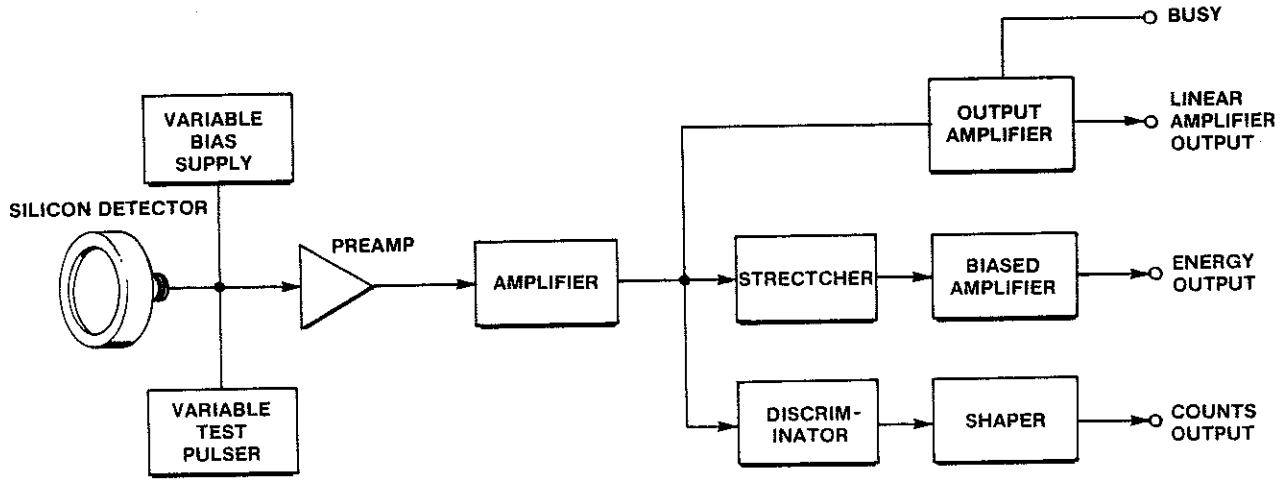

Fig. 1.1. Block Diagram of EG&G ORTEC ALPHA-KING Single-Channel Alpha Spectrometer

sample-to-detector-distance can be varied, within the constraints of the chamber, from 1 to 53 mm in steps of 4 mm. The front of the chamber has an "L" gasket attached to seal the chamber to the door.

The energy ranges controllable from the front panel 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. The variable internal test pulser allows the user to scan the complete range of energies from 0 to 10 MeV.

In addition to the calibrated output, four additional outputs are provided:

1. The Counts rear-panel BNC connector provides a NIM-standard positive logic pulse for gross alpha counting and/or signal routing.

2. The Linear Amplifier (Lin Amp Out) rear-panel BNC connector provides a 0 to 10 V positive pulse corresponding to an energy range of 0 to 10 MeV.

3. The Busy rear-panel BNC connector provides a NIM-standard positive logic pulse indicating that the module is busy processing a pulse.

4. The Detector monitor (DET/HV) rear-panel test points permit monitoring detector leakage current and detector bias voltage.

The 676 must be installed in a NIM-standard bin and power supply such as the EG&G ORTEC 4001/4002 series for operation. In addition to providing physical protection to the module, the bin and power supply provides the operating power requirements to the module.

A vacuum pump connector is included on the rear panel. This is a Swagelok® connector for 1/4-in. OD tubing that must be attached to a roughing pump or a vacuum manifold.

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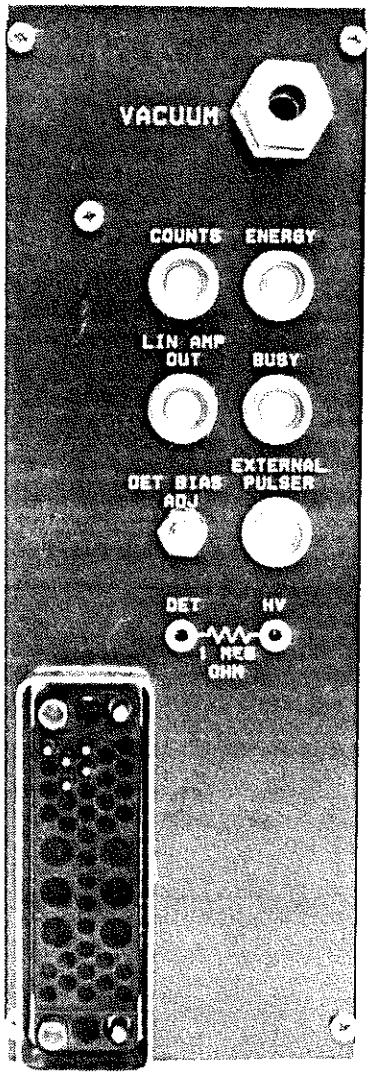


2. SPECIFICATIONS

2.1. PERFORMANCE

DETECTOR AND ELECTRONICS NOISE ≤24 keV FWHM for 300 mm^2 and 450 mm^2 R Series detectors and <35 keV FWHM for 600 mm^2 and 900 mm^2 R Series detectors.

BACKGROUND <30 counts/day above 3.5 MeV (measured counts from Count output) for 300 mm^2 and 450 mm^2 R Series detectors and <40 counts/day for 600 mm^2 and 900 mm^2 R Series detectors.

SAMPLE SIZE Up to 5.08 cm (2 in.) diameter for planchets, filter paper, etc.

SAMPLE SPACING Adjustable from 1 mm to 53 mm from detector housing in steps of 4 mm.

VACUUM CHAMBER SIZE 5.7 cm (2.25 in.) wide x 7.9 cm (3.12 in.) high x 6.8 cm (2.69 in.) deep (nominal).

ENERGY RANGES 3 to 8 MeV, 4 to 7 MeV, 3 to 5 MeV, 4 to 6 MeV, 5 to 7 MeV, 6 to 8 MeV.

NONLINEARITY ≤±0.1% full scale in every energy range selected.

2.2. CONTROLS

PULSER/BIAS/OFF Front-panel position toggle switch containing both high voltage and pulser. Front-panel Bias indicator illuminates when the high voltage is On.

VENT/HOLD/PUMP Front-panel position control for venting or pumping the vacuum chamber. A hold position independently isolates both the pump and the chamber.

ENERGY RANGE Six positions on the front-panel switch for selecting the desired energy range (see 2.1. Performance).

PULSER Front-panel, 10-turn potentiometer for controlling the desired amplitude (equivalent to energy) of the internal pulser (0 to 10 MeV).

DET BIAS ADJ Rear-panel potentiometer for controlling the bias voltage applied to the detector. Continuously variable from 0 to ±100 V. Voltage can be monitored between rear-panel test point, labeled HV, and ground.

VACUUM Rear-panel vacuum pump connector (Swagelok connector for 1/4-in. OD tubing) for connecting module to vacuum pump.

E BIAS Front-panel, 25-turn, screwdriver-adjustable control allows the energy output bias point to be varied by ±10% for ease of setup with the data acquisition system.

ΔE Front-panel, 25-turn, screwdriver-adjustable control allows the maximum energy output range to be varied from 7.75 to 10.25 V for ease of setup with the data acquisition system.

2.3. INPUT

EXTERNAL PULSER Rear-panel BNC connector accepts external pulser. Z_{in} = 100 Ω; dc-coupled. (Positive polarity for Ruggedized detectors.)

2.4. OUTPUTS

COUNTS Rear-panel BNC connector provides a NIM-standard positive pulse for gross alpha counting or routing. Pulse width 3.5 μs for any event with energy >2.5 MeV. Z_o = 50 Ω; dc-coupled.

ENERGY Rear-panel BNC connector provides a positive pulse 7.75 to 10.25 V maximum depending on the setting of the ΔE gain control corresponding to an energy range selected on the front-panel switch. Z_o = 100 Ω; dc-coupled.

LIN AMP OUT Rear-panel BNC connector provides 0 to 10 V positive unipolar pulse which corresponds to 0 to 10 MeV. Z_o = 100 Ω; dc-coupled.

BUSY Rear-panel BNC connector provides a NIM-standard positive logic pulse indicating the module is busy processing a pulse. Z_o = 50 Ω; dc-coupled. This pulse can also be used as a trigger.

DET/HV Rear-panel test points, labeled DET and HV, for monitoring detector load current and bias voltage. The voltage (in volts), between DET and HV converts to μA of detector current.

2.5. ELECTRICAL AND MECHANICAL

POWER REQUIRED +24 V, 120 mA; +12 V, 90 mA; −24 V, 75 mA; −12 V, 45 mA.

WEIGHT
Net 2.9 kg (6.4 lb).
Shipping 3.86 kg (8.5 lb).

DIMENSIONS Standard two-wide NIM module 6.90 x 22.13 cm (2.70 x 8.714 in.) per TID 20893 (Rev).

2.6. 676 ALPHA-KING SPECTROMETER STANDARD CONFIGURATIONS

Model No.	Description
676-300R*	676 module with one 300 mm^2 Ruggedized low-background silicon surface barrier detector
676-450R*	676 module with one 450 mm^2 Ruggedized low-background silicon surface barrier detector
676-600R*	676 module with one 600 mm^2 Ruggedized low-background silicon surface barrier detector
676-900R*	676 module with one 900 mm^2 Ruggedized low-background silicon surface barrier detector
676-xxx*	676 module without detectors

*Includes sample trays for 3/4-, 1-, 1-1/4-, and 1-1/2-inch planchets.

2.7. 676 ACCESSORIES AND SAMPLE TRAY ASSEMBLIES

Model No.	Description
676-CG	"L" gaskets for vacuum chamber seal (package of 2)
676-ST-1	Sample tray for 3/4- and 1-inch samples
676-ST-2	Sample tray for 1-1/4- and 1-1/2-inch samples
676-ST-3	Sample tray for 1/2- and 7/8-inch samples
676-ST-4	Sample tray for 1-3/4- and 2-inch samples
676-ST-K	Sample tray set (2 trays) consisting of 676-ST-1 and 676-ST-2 (normally furnished with the 676).
676-ST-S	Customized sample tray designed to customer's specifications

3. INSTALLATION

3.1. POLARITY JUMPER SETTINGS

Five plug-in jumpers on the printed wiring board (PWB) must be set for compatible operation. These jumpers are accessible when the 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. Negative bias is required for EG&G ORTEC Ruggedized detectors and positive bias for conventional surface barrier detectors or silicon dioxide-passivated, ion-implanted detectors. These five internal jumpers need to be changed only when a Ruggedized detector is replaced with a standard detector or vice versa.

POLARITY SELECTION When polarity needs to be changed:

1. Remove the 676 module from the bin and 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 676 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 silicon dioxide-passivated, ion-implanted detector.

3.2. CONNECTION TO POWER

The ALPHA-KING spectrometer is designed for operation in a NIM-standard bin and power supply such as the EG&G ORTEC 4001/4002 series. The power supply furnishes operating power requirements at ±12 V and ±24 V. These NIM bins have test points on the power supply control panel to monitor the dc-voltage level.

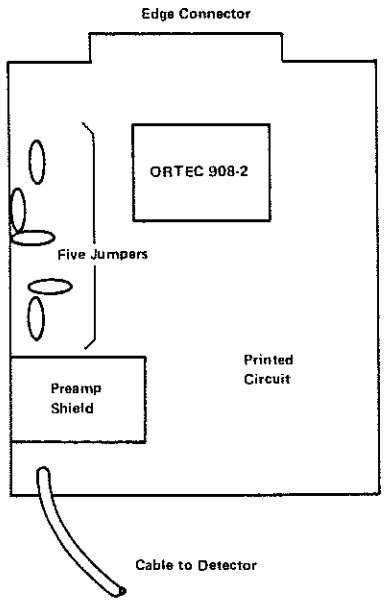


Fig. 3.1. Jumper Locations for Setting Polarity on the PWB.

3.3. VACUUM CONNECTION

Apply a clean, dry, oil-free vacuum from a roughing pump or vacuum manifold to the 676 through the Swagelok connector on the rear panel. This connector accepts 1/4-in. OD tubing and is accessible when the module has been installed in the bin (Fig. 3.2 (a) and (b)). For a single 676, the pump should have a displacement of about 2 CFM (57 liter/min). If several 676 modules are connected together via a manifold, the pump should have a displacement of about 6.7 CFM (113 liter/min). An operating pressure of <10 millitorr should be adequate for most applications.

Set the front-panel Vent/Hold/Pump 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

When an external BNC cable longer than 10 ft 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 Count and Busy outputs should be connected using 50-Ω RG-58A/U cable.

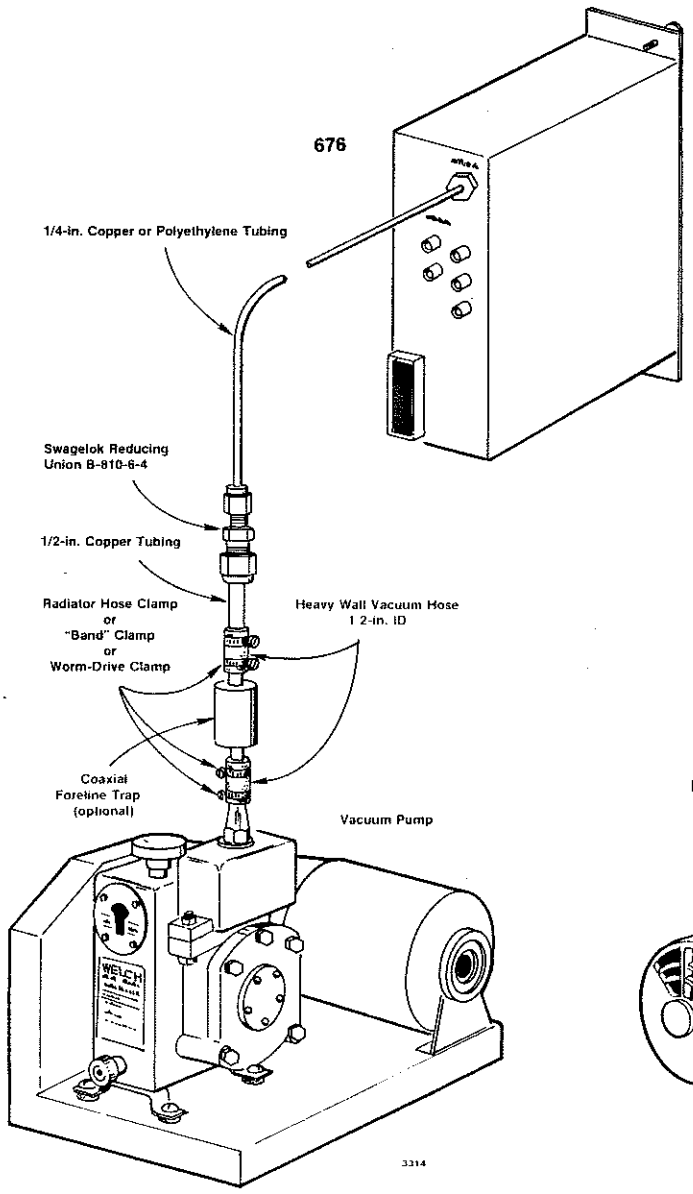
3.5. ENERGY OUTPUT FULL SCALE ADJUSTMENT (Other than 10 V)

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 8-V full scale is as follows:

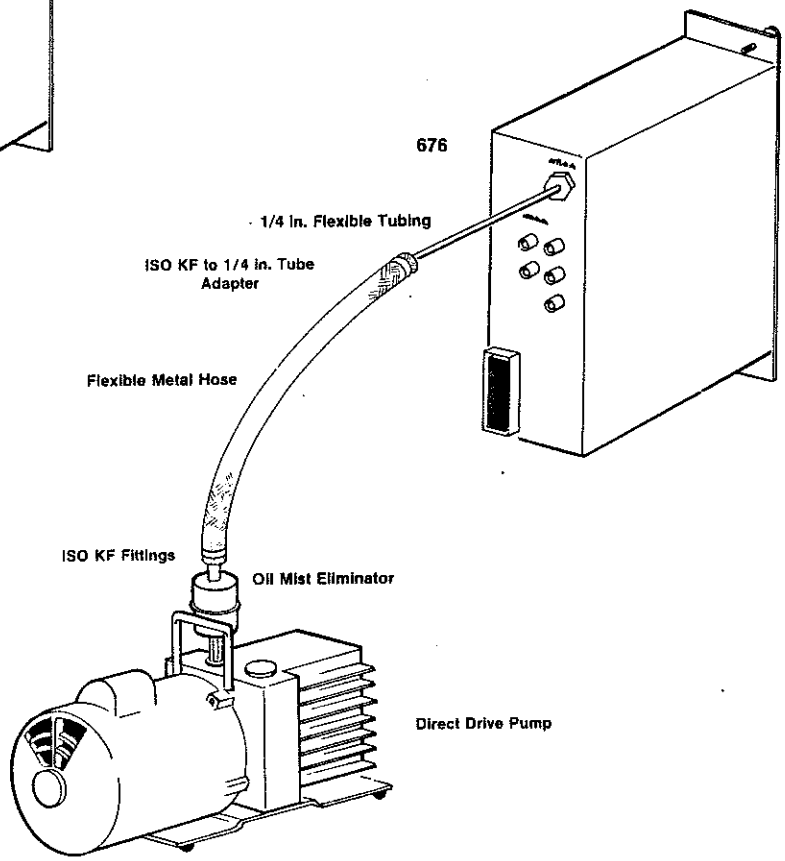
1. Set the Pulser/Bias/Off switch to Pulser. Set the Energy Range switch to 4-6 MeV or range to be used.

2. Observe the energy output on an oscilloscope, trigger on Busy, and then adjust the Pulser potentiometer for a 10-V output pulse.

3. Adjust the front panel E Bias control for 8-V output. Continue with operation of the 676.



(a) Vacuum Connection for the 676 Using a Small, Belt-Driven Pump.



(b) Vacuum Connections for the 676 Using a Small, Direct-Driven Pump and 150 KF Fittings.

Fig. 3.2.(a) and (b). Suggested Vacuum Connections for the 676 Spectrometer.

4. OPERATION

The information in Section 3 includes all of the preliminary selections that are to be made for the 676. 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:

Pulser/Bias/Off	Off
Vacuum Control	Vent
Energy Range	Selection for Sample Energy
Pulser Dial	0

Then use the following steps:

1. Mount the sample on the sample tray.

2. Place the sample tray in the sample holder at the desired spacing. The tray should be flush with the front of the sample holder.

3. Close the chamber door. If this module has a common vacuum with other 676s, put the other modules on Hold while this module is pumped down.

4. Turn the Vacuum control to Pump and wait until the chamber is evacuated.

5. If other modules have been placed in Hold, return them to the Pump position.

6. Set the Pulser/Bias/Off switch at Pulser and wait for the preamplifier to settle; this takes about one minute.

7. Set the Pulser dial to check the operation of the system and the proper location in the spectrum of the selected pulse level. The outputs through the Counts connector include the test pulses while the Pulser/Bias/Off switch is in either the Pulser or Bias position.

8. System electronic noise can be tested by measuring the FWHM spread of the pulser peak on the MCA from the Energy or Lin Amp outputs.

9. When counting is complete, return the Pulser/Bias/Off switch to Off and turn the Vacuum control to Vent. Open the chamber door to change the sample and prepare for the next counting interval.

5. THEORY OF OPERATION

The complete schematics for the 676 ALPHA-KING (No. 729080 and 729060) are included at the back of this manual. Figure 5.1 is a block diagram of the electronics.

The detector voltage (Pulser/Bias/Off) switch on the front panel turns power On and Off for the variable 100-V power supply. The power is on in both the Pulser and Bias positions.

The polarity is set by jumper J1, which is actually three separate jumpers (see schematics). The indicated polarity is negative, which is appropriate when an EG&G ORTEC Ruggedized detector is used. When the detector voltage is negative, its output pulses are positive. When they pass through the inverting preamplifier they are negative, and this is the polarity that is then selected by the pair of jumpers, J3, on the PWB. If a conventional surface barrier detector is used, all five of these jumpers must be changed to "+" because the standard detector operates on a positive voltage and generates negative output pulses, which are then inverted and are positive 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 point jack labeled HV. The detector leakage current can be measured across the 1.1-MΩ resistor between rear-panel test points HV and DET using a 10-MΩ impedance meter, the voltage (in volts) converts to μA of detector current. The output of the Bias supply is applied through a high impedance (totaling 11 MΩ) to the dc connection between the detector and the preamplifer.

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 pulser switch (Pulser/Bias/Off) on the front panel turns power On and Off for the test pulser. The test pulser can be set using the 10-turn, front-panel potentiometer 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 gain of 20 to 60 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

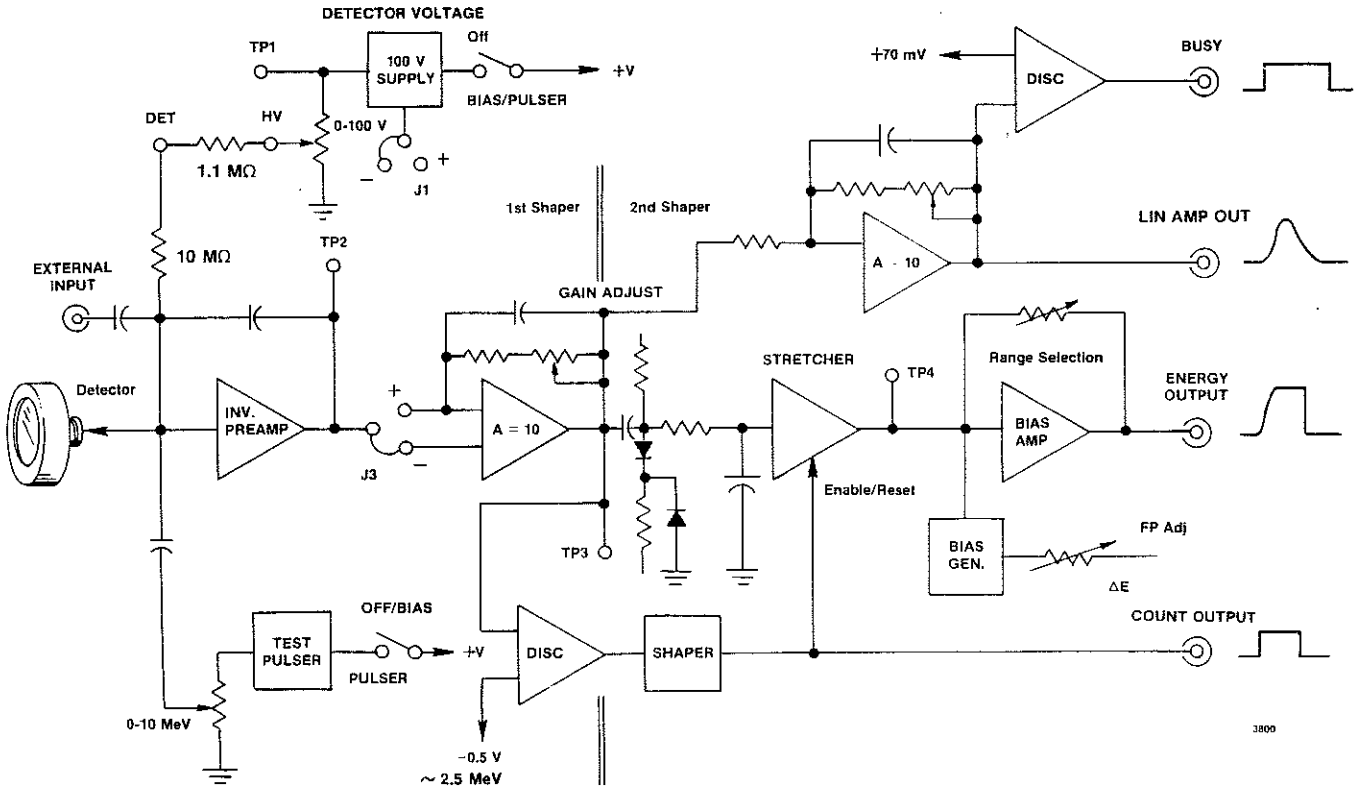


Fig. 5.1. Detailed Block Diagram of the 676 ALPHA-KING Spectrometer.

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 bias 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 bias 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 bias amplifier is a positive pulse with an amplitude in the range of 0.1 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.

676 AMPLIFIER SCHEMATIC The pulse at TP3 is also furnished to a positive gain of 10 amplifier with a diode-limited, continuous dc-restoration loop. The second integration for the rear-panel Lin Amp Out is implemented in the amplifier feedback network. The Linear Amp Out is a positive 1-μs shaped pulse with an amplitude of 1 V/MeV.

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

6.1. DECONTAMINATION

The normal background count for each channel in the 676 should be <30 counts per day for the 300 and 450 mm^2 detectors and <40 counts per day for the 600 and 900 mm^2 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. To preserve the accuracy of information that is obtained from the 676, decontamination of the chamber and of the detector (if Ruggedized) is necessary. **Standard surface barrier detectors cannot be subjected to cleaning procedures; consult the instruction manual for the detector to determine any measures that may be helpful.**

Use the following steps to decontaminate the 676 chamber.

1. Remove the detector from the chamber. 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. Either methanol or water with a methanol rinse can be used as the cleaning agent.

3. Dip a cotton swab or a cotton-covered stick into the agent and gently wipe the internal surfaces of the chamber to remove the contamination.

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 air or nitrogen.

Use the following steps to decontaminate the aluminum surface of the Ruggedized detector:

1. Pour deionized water into clean beaker.

2. Dip cotton swab into beaker of water and then carefully blot on clean tissue to remove excess moisture.

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

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

5. Blow dry with clean air or nitrogen.

6. Return the detector to its mounting in the Microdot™ connector at the rear of the chamber.

6.2. FACTORY REPAIR

This instrument can be returned to the EG&G ORTEC factory for service and repair at a nominal cost. Our standard procedure for repair ensures the same quality control and checkout that are used for a new instrument. Always contact Customer Services at EG&G ORTEC, (615) 482-4411, before sending in an instrument for repair to obtain shipping instructions. Information concerning the problem and/or failure mode and a return shipping address should accompany all returning instruments.

7. CALIBRATION AND RESOLUTION MEASUREMENT

If a source is to be used in a 676 chamber, either for resolution measurement or system calibration, these steps should be followed for optimum results.

1. With the source on the sample tray, place the tray on the sample holder of the 676. Placing the source as far as possible from the detector helps reduce any solid-angle-related and/or count-rate problem.

2. Evacuate the chamber.

3. Turn on bin power and detector voltage supply.

4. With the Pulser/Bias/Off switch on Bias, accumulate a peak height of at least 1000 counts.

5. Another source of different energy should be used to calibrate the system.

Figures 7.1 and 7.2 are sample spectra using the 676 ALPHA-KING Spectrometer.

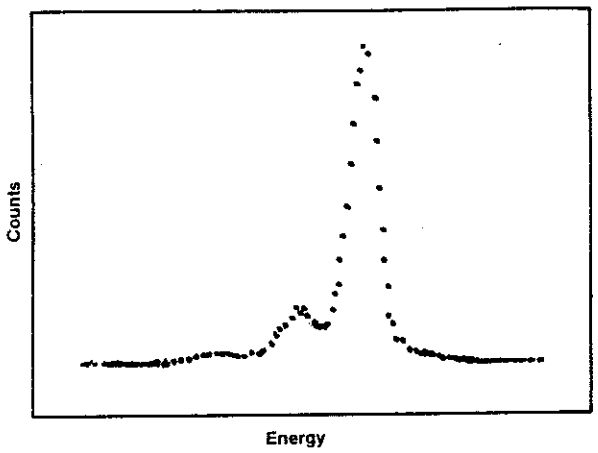


Fig. 7.1. A ^{241}Am Alpha Spectrum Using a 450 mm^2 Detector in a 676 ALPHA-KING Spectrometer. A 0.1-μCi Source was Placed on the Sample Tray and Set in the Lowest Position on the Sample Holder. Resolution = 21.9 keV FWHM; System Noise = 14.3 keV FWHM.

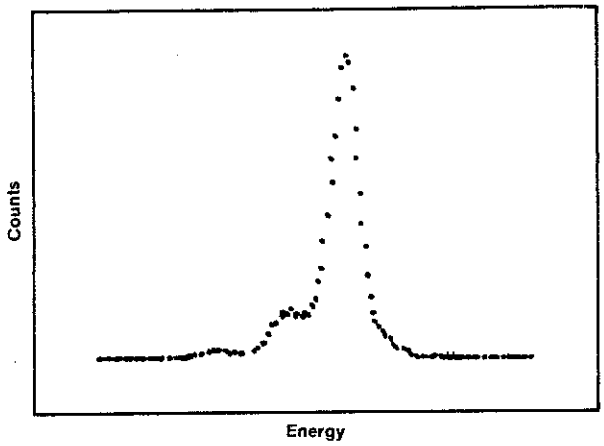


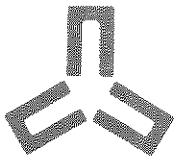
Fig. 7.2. A ^{241}Am Alpha Spectrum Using a 600 mm^2 Detector in a 676 ALPHA-KING Spectrometer. A 0.1-μCi Source Was Placed on the Sample Tray and Set in the Lowest Position on the Sample Holder. Resolution = 26.9 keV FWHM; System Noise = 18.0 keV FWHM.

BIN/MODULE CONNECTOR PIN ASSIGNMENTS FOR AEC STANDARD NUCLEAR INSTRUMENT MODULES PER TID-20893 (Rev 4) (adopted by DOE)

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, 4001B, 4001C, 401A, and 401B Modular System Bins.

Pins marked (*) and (**) are installed in EG&G ORTEC-HEP M250/N and M350/N NIMBINS.



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For more information on EG&G ORTEC products and their applications contact your local EG&G ORTEC Representative or:

United States:
EG&G ORTEC
100 Midland Road, Oak Ridge, Tennessee 37831-0895
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Canada: EG&G Instruments Div., Markham, Ontario
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Telephone: 089-926920; Telex: 528257 EGGI D

France:
EG&G Instruments SARL, Evry, Cedex
Telephone: (33) 1-60.77.93.66; Telex: 690785 EGGSARL F

Italy:
EG&G Instruments s.r.l., Milan
Telephone: (39) 2-7610267; Telex: 320377 EGGSRL I

United Kingdom:
EG&G Instruments, Ltd., Bracknell, Berks
Telephone: 0344-423931; Telex: 847164 EGGBDL G

The Netherlands:
EG&G Instruments B.V., AB Nieuwegein
Telephone: 030-877520, Telex: 40830 EGGBV NL

Japan:
SEIKO EG&G Co., Ltd., Koto-Ku, Tokyo, 136
Telephone: 03-638-1506; Telex: 02622232 ESEIKO J

People's Republic of China:
EG&G China Representative Office, Xuanwumen, Beijing
Telephone: 342855; Telex: 22737 EGGBJ CN