

**Model A-576 A-PAD**  
**Preamplifier, Amplifier, Discriminator**  
**with Bias Supply**  
**Operating and Service Manual**

# **Advanced Measurement Technology, Inc.**

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

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### **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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## ORTEC MODEL A-576 A-PAD Preamplifier, Amplifier, Discriminator with Bias Supply

### 1. DESCRIPTION

The ORTEC Model A-576 A-PAD is a single- wide NIM module intended for performing alpha spectroscopy and counting when used in conjunction with a silicon surface barrier detector. The instrument includes a variable detector bias supply, a preamplifier, a shaping and stretching amplifier, a biased amplifier, a test pulser, and a discriminator (Fig. 1). The detector bias supply and the amplifier have selectable polarity so that it can be used with any charged-particle silicon semiconductor detector. Examples are ORTEC's conventional and Ruggedized™ Si surface barrier detectors and its ion-implanted Si detectors.

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 internal test pulser can provide a signal at 5 MeV, 6 MeV, or 7 MeV by internal jumper selection.

In addition to the calibrated Energy output, the COUNT front-panel BNC connector provides a NIM-standard positive logic pulse for gross alpha counting and/or routing. The DET BIAS MONITOR front-panel test points permit monitoring detector leakage current and detector bias voltage.

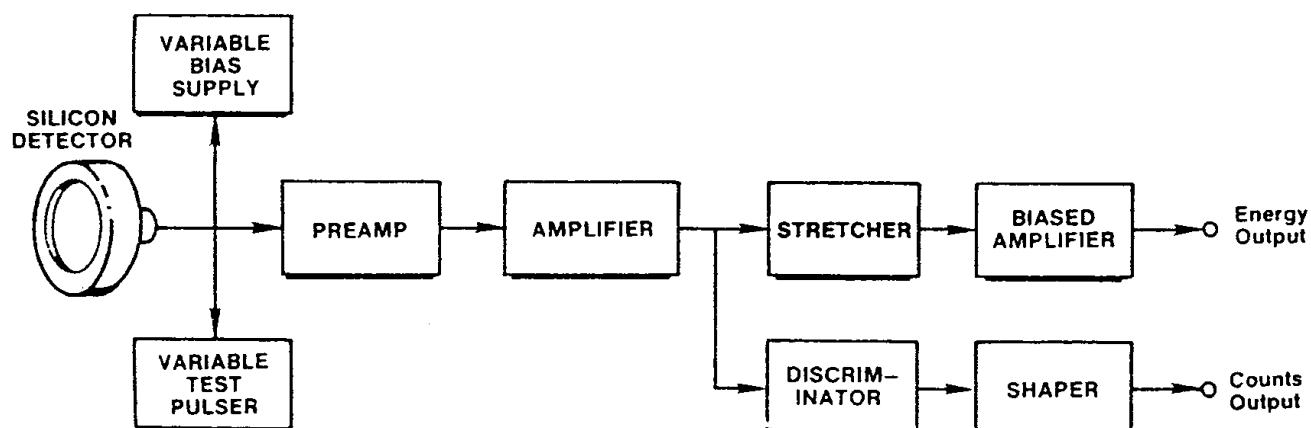


Fig. 1. Block diagram of Alpha Spectrometer.

## 2. SPECIFICATIONS

### 2.1. PERFORMANCE

**DETECTOR AND ELECTRONIC NOISE** <25 keV FWHM when used with ORTEC R Series, 300 mm<sup>2</sup> and 450 mm<sup>2</sup> charged-particle detectors, and <35 keV for 600 mm<sup>2</sup> and 900 mm<sup>2</sup> R Series charged-particle detectors when connection of the Model A-576 to the detector is made with <2 ft of RG-62A/U cable. System noise is dependent on detector capacitance plus cable capacitance and leakage current. Electronic noise is typically 5 keV with a slope of 25 eV/pF silicon equivalent (based on  $\epsilon = 3.6$  eV and  $t = 0.5$   $\mu$ s (internal amplifier).

**PULSE SHAPING** Internal 0.5- $\mu$ s active filter semi-Gaussian pulse shaping amplifier provides a pulse that is stretched prior to being output through the Bias Amplifier to give a 4- $\mu$ s-wide positive output pulse.

**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.

**CALIBRATED TEST PULSER** Equivalent Energy 5 MeV, 6 MeV, or 7 MeV. (Shipped at 5 MeV). Rate is 100 Hz.

**DETECTOR BIAS VOLTAGE** Continuously variable over range of 0 to 100 V. Polarity selectable with printed wiring board (PWB) jumper shipped in negative position (appropriate for ORTEC R Series detectors). Shipped set to 100 V.

### 2.2. CONTROLS

**TEST/BIAS/OFF** Front-panel, three-position toggle switch controls both the detector bias voltage and the test pulser. Front-panel LED is illuminated when the bias voltage is on.

**DET BIAS ADJ** Front-panel potentiometer for controlling the bias voltage applied to the detector. Continuously variable from 0 to  $\pm$ 100 V.

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

**E BIAS** 15-turn potentiometer on the front panel permits screwdriver adjustment of the energy output bias point to be varied by  $\pm$ 10% for ease of setup with the data acquisition system.

$\Delta$ **E** 15-turn potentiometer on the front panel permits screwdriver adjustment of the maximum energy output range to be varied from 7.75 to 10.25 V for ease of setup with the data acquisition system.

**TEST PULSER** PWB jumper (J2) allows selection of internal pulser energies of 5 MeV, 6 MeV, or 7 MeV.

**INPUT/BIAS POLARITY** PWB jumpers allow selection of either positive or negative detector voltage polarity. Negative for ORTEC Surface Barrier or Ion-Implanted Ruggedized detectors, or positive for conventional detectors. (Shipped in Negative position.)

### 2.3. INPUT

**PREAMP IN** Front- and rear-panel BNCs accept an input signal from semiconductor charged-particle detectors. Either RG-62A/U or RG-71A/U cable is recommended to minimize excess capacitance and hence noise.

### 2.4. OUTPUTS

**ENERGY** Front- and rear-panel BNC connectors provides a positive stretched pulse from 7.75 to 10.25 V maximum, depending on the setting of the  $\Delta$ E gain control corresponding to an energy range selected on the front-panel switch. Pulse width = 4  $\mu$ s;  $Z_0 = 100$   $\Omega$ ; dc-coupled.

**COUNT** Front-panel BNC connector provides a NIM-standard positive pulse for gross alpha counting or routing. Pulse width 3.5  $\mu$ s for any event with energy >2.5 MeV.  $Z_0 = 50 \Omega$ ; dc-coupled.

**DET BIAS MONITOR** Voltage can be monitored between front-panel test point (labeled HV) and ground. Detector current can be monitored across resistor between front-panel test points DET and HV. The current is 1  $\mu$ A per volt when using a voltmeter with 10-M $\Omega$  input impedance.

## 2.5. ELECTRICAL AND MECHANICAL

**POWER REQUIRED** +12 V, 90 mA; -12 V, 45 mA; +24 V, 100 mA; -24 V, 45 mA.

### WEIGHT

**Net** 0.9 kg (2.0 lb).

**Shipping** 2.25 kg (5.0 lb).

**DIMENSIONS** NIM-standard single-width module 3.43 x 22.13 cm (1.35 x 8.714 in.) per TID-20893 (Rev).

## 3. INSTALLATION

### 3.1. JUMPER SETTINGS

Six plug-in jumpers on the printed circuit board (PWB) must be set for compatible operation. These jumpers are accessible when the side panel is removed from the instrument chassis. Five of the jumpers are used to select either positive or negative detector voltage polarity and the corresponding correct amplifier polarity. Negative bias is required for ORTEC Ruggedized detectors; positive for conventional surface-barrier or ion-implanted detectors. These five internal jumpers need to be changed only when a Ruggedized detector is replaced with one of the other detectors or vice versa. The sixth jumper is used to set the pulse generator equivalent energy (see TEST PULSE).

**POLARITY** When polarity selection needs to be changed:

- Remove the A-PAD module from the bin and power supply.
- Remove the side panel from the right side of the module as viewed from the front panel.
- Note the locations of all five jumpers on the components side of the PWB (Fig. 2). The "+" and

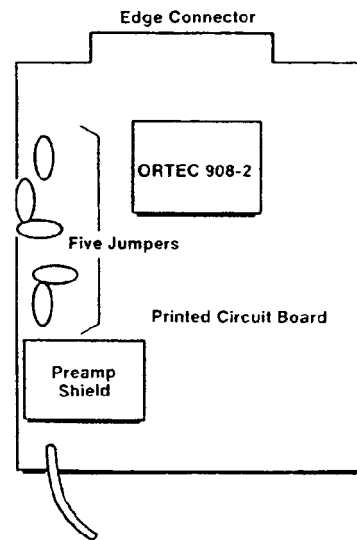


Fig. 2. Jumper Locations for Setting Polarity on the PWB.

"-" orientation for each of the jumpers is etched on the PWB.

- 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.

**TEST PULSE** The sixth jumper is used to set the equivalent energy of the test pulser to 5, 6, or 7 MeV. Change this jumper only if an energy other than 5 MeV is desired from the test pulser. The jumper can be changed through the hole in the side panel to an alternate position (Fig. 3).

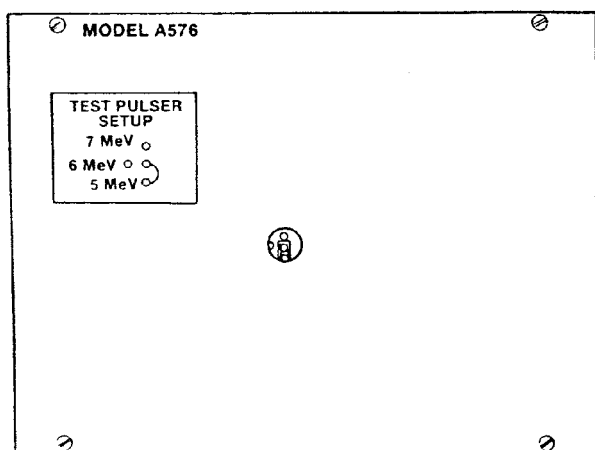


Fig. 3. Side-Panel Test Pulser Selection.

### 3.2. CONNECTION TO DETECTOR

A direct connection with 93- $\Omega$  or 100- $\Omega$  shielded cable should be made between the detector and the PREAMP IN connector on the A-PAD. For best results, keep the length of this cable as short as possible (due to the capacitive loading of the cable) to minimize preamplifier noise and maintain the preamplifier stability.

Type RG-62/U cable is recommended for the detector-to-preamplifier connection. This is 93- $\Omega$  cable with a capacity of 13.5 pF/ft.

### 3.3. CONNECTION TO POWER

The A-PAD is designed for operation in a NIM-standard bin and power supply such as the ORTEC 4001/4002/402 series. The power supply furnishes operating power requirements at  $\pm 12$  V and  $\pm 24$  V. These NIM bins have test points on the power supply control panel to monitor the dc-voltage level.

### 3.4. OUTPUT CONNECTIONS

When an external BNC cable longer than 10 ft is used for the output connection, the characteristic impedance of the cable should match the impedance of the output used. The ENERGY output should use 93- $\Omega$  RG-62A/U cable, and the COUNT outputs should be connected using 50- $\Omega$  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 to 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 TEST/BIAS/OFF switch to TEST. Set the ENERGY RANGE switch to 3–5 MeV with the TEST Pulser jumper set to 5 MeV. Note: Any Range can be used when the TEST Pulser is set to the top of the Range.
2. Observe the ENERGY output on an oscilloscope and trigger on the COUNT output. The output amplitude should be about 10 V.
3. Adjust the front-panel E control for 8-V output. Continue with operation of the A-576.

### NOTICE

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Damage may result to the preamplifier or the detector unless the following precautions are taken:

The TEST/BIAS/OFF switch must be in the **OFF** position before connecting a low impedance or a cable, capacitor, or other capacitive device to the PREAMP IN connector on the A-PAD.

Turn the BIAS switch to OFF before making **ANY** connections to the PREAMP IN connector and before disconnecting the detector.

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## 4. OPERATION

### 4.1. GENERAL

The information in Section 3 includes all of the preliminary selections that are to be made for the A-PAD. Operation consists of connecting a detector and proceeding with data collection.

### 4.2. CONNECTING A DETECTOR

Start with the TEST/BIAS/OFF switch in the OFF position. Connecting the detector with the bias voltage ON may damage the FET transistor at the input of the preamplifier or destroy the detector.

Then proceed as follows:

1. With the bias OFF, connect the detector to the A-PAD with a short cable (preferably RG-62A/U).
2. Set the TEST/BIAS/OFF switch at TEST and adjust the front-panel HV control for the desired bias voltage

between 0 and 100 V. The bias voltage can be monitored on the front-panel test point jacks with a voltmeter. After turning ON, or adjusting, the bias voltage, wait for the preamplifier to settle; this takes about one minute.

3. The ENERGY output should display positive, stretched pulses at a 100-Hz rate with an amplitude of 5 V (shown in Fig. 4), if the Range is set to 4–6 MeV and the TEST pulser jumper is in the 5 MeV position. The COUNT output should have a positive logic pulse with a 6- $\mu$ s width (shown in Fig. 4).

4. System electronic noise can be tested by measuring the FWHM spread of the pulser peak on the MCA from the ENERGY output.

5. The test pulser can then be turned OFF by moving the TEST/BIAS/OFF switch to the BIAS position. The A-PAD is now ready to count alpha samples or do alpha spectrometry.

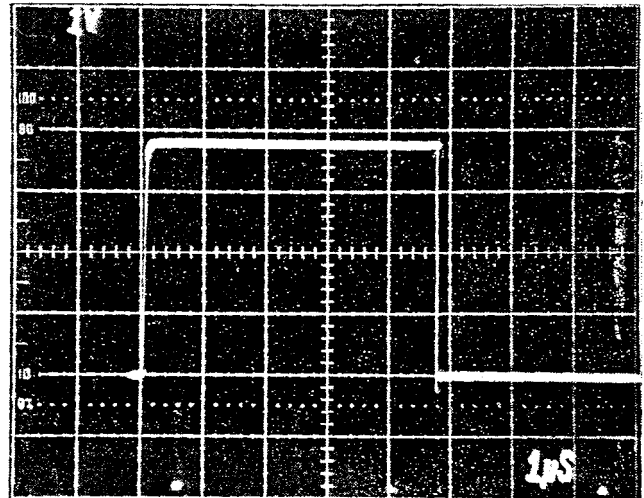
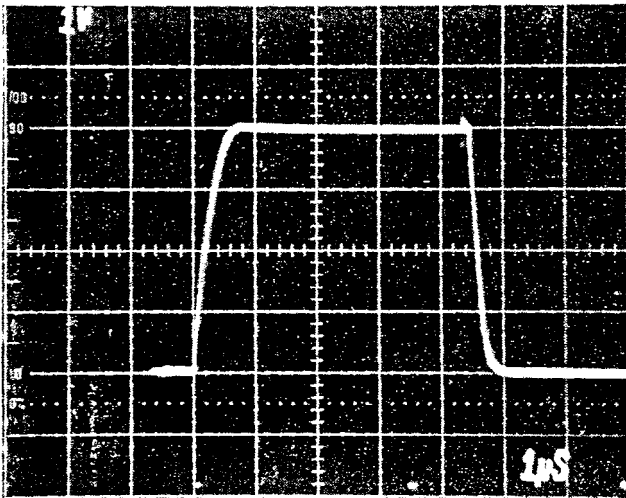


Fig. 4. Typical A-PAD Output Waveforms with 5-MeV Test Pulser.

## 5. THEORY OF OPERATION

The complete schematic for the A-576 A-PAD (No. 752500) is included at the back of this manual. Fig. 5 is a block diagram of the electronics.

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

The polarity is set by Jumper J1, which is actually three separate jumpers (see schematic). The indicated polarity is negative, which is appropriate when an ORTEC Ruggedized detector is used. When the detector voltage is negative, its output pulses are positive. When they pass through the inverting charge-sensitive 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, or ion-implanted, detector is used, all five of these jumpers must be changed to "+" because these detectors, positively biased, generate negative output pulses, which are then inverted, resulting in 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 front-panel test point jack labeled HV.

The detector leakage current can be measured across the 1.1-M $\Omega$  resistor between front-panel test points HV and DET, using a 10-M $\Omega$  impedance meter. The voltage (in volts) converts to  $\mu$ A of detector current. The output of the Bias supply is applied through a high impedance (totaling 11 M $\Omega$ ) 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 pulser switch (TEST/BIAS/OFF) on the front panel turns power on and off for the test pulser. The test pulser can be set to furnish the equivalent pulse

amplitude for 5, 6, and 7 MeV to the input to the preamplifier. A screwdriver calibration, included on the PWB for factory adjustment of the test pulser circuit, 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  $\sim$ 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 COUNT 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 multichannel analyzer, 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 that 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, which can be adjusted by  $\pm$ 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, and by a factor

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 from 0.1 to 10 V, which is proportional to the amount by

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 (E).

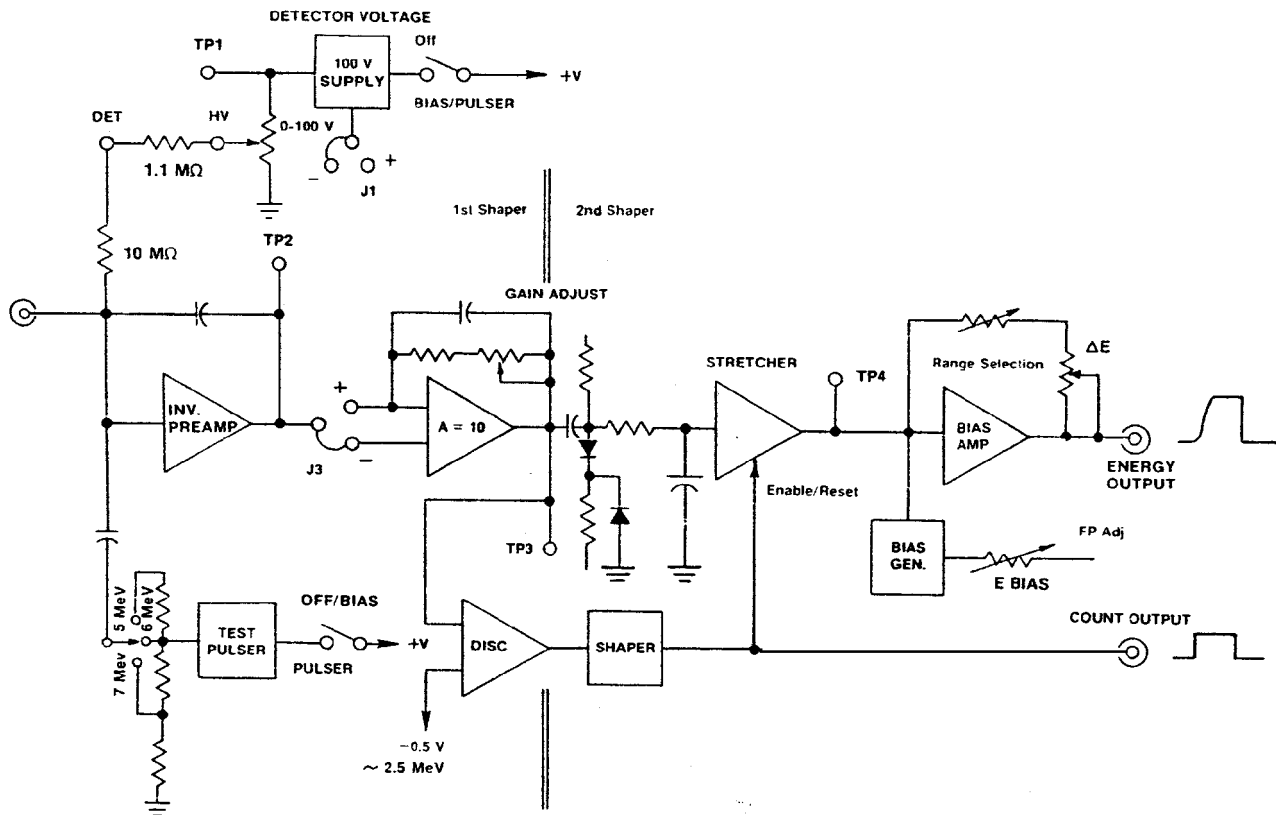


Fig. 5. Detailed Block Diagram of the Model A-576 A-PAD.