

**ORTEC<sup>®</sup>**

***Alpha Duo<sup>®</sup>, Alpha Mega<sup>®</sup>,  
and Alpha Ensemble<sup>®</sup>***

**Integrated Alpha Spectrometer  
Hardware User's Manual**

# **Advanced Measurement Technology, Inc.**

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

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# Safety Instructions and Symbols

This manual contains up to three levels of safety instructions that must be observed in order to avoid personal injury and/or damage to equipment or other property. These are:

**DANGER** Indicates a hazard that could result in death or serious bodily harm if the safety instruction is not observed.

**WARNING** Indicates a hazard that could result in bodily harm if the safety instruction is not observed.

**CAUTION** Indicates a hazard that could result in property damage if the safety instruction is not observed.

In addition, the following symbols may appear on the product:



**DANGER – Hazardous Voltage**



**ATTENTION – Consult the manual in all cases where this symbol is marked in order to determine the nature of the potential hazards and any actions that must be taken to avoid them**



**Protective earth (ground) terminal**

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

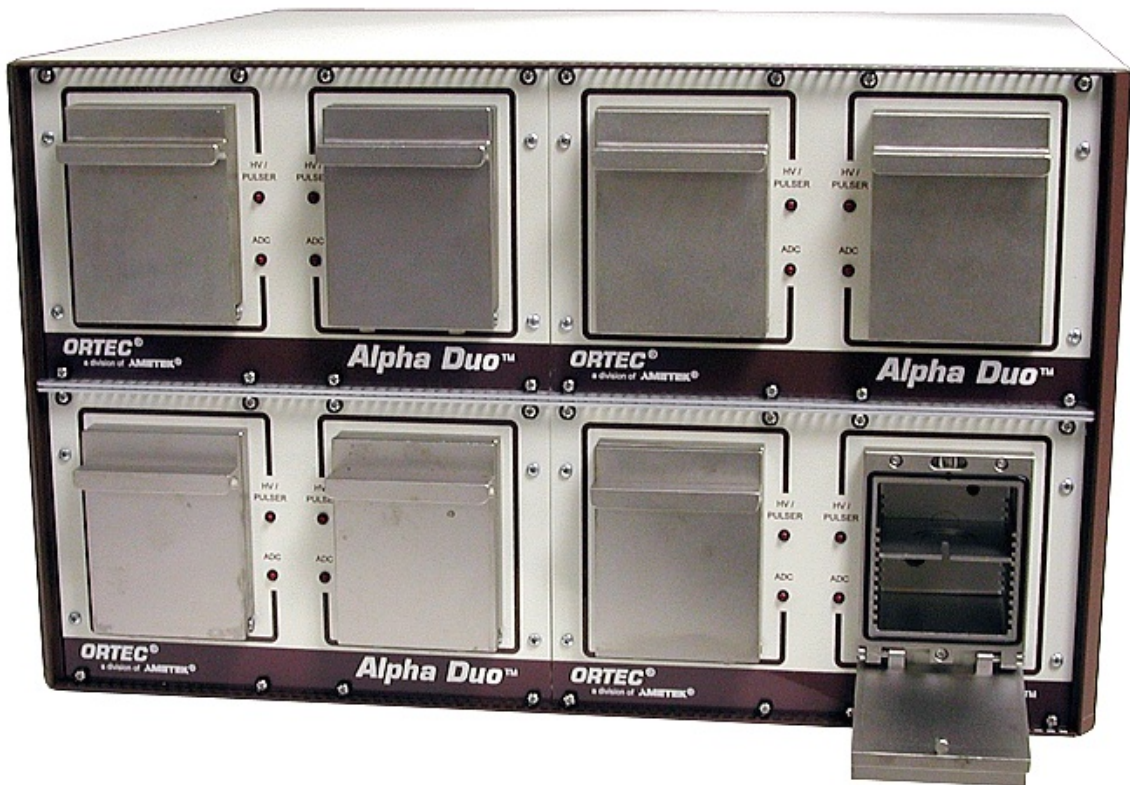
## Cleaning Instructions

To clean the instrument exterior:

- Disconnect the instrument from the power source.
- Remove loose dust on the outside of the instrument with a lint-free cloth.
- Remove remaining dirt with a lint-free cloth dampened in a general-purpose detergent and water solution. Do not use abrasive cleaners.

**CAUTION** To prevent moisture inside of the instrument during external cleaning, use only enough liquid to dampen the cloth or applicator.

- Allow the instrument to dry completely before reconnecting it to the power source.



# 1. INTRODUCTION

With the introduction of the ORTEC® Alpha Suite® of integrated alpha spectrometers, we are able to address the needs of any counting laboratory, large or small, upgrading or just starting out. The ORTEC Alpha Suite consists of the Alpha Aria®, a single-channel NIM; the Alpha Duo®, a compact, dual-channel benchtop system; the Alpha Mega® single-channel benchtop module; and the Alpha Ensemble®, which can house one to four Alpha Duos and Alpha Megs in any combination. The Alpha Ensemble can be mounted in a 19-inch rack or in the tabletop enclosure in which it is supplied.

The latest advanced digital signal processing, together with a modular mechanical approach, aligns value and performance with unparalleled configuration flexibility.

- **Easy System Expansion** — Any of these spectrometers can be added to existing ORTEC systems simply by installing the latest CONNECTIONS Driver Update Kit (P/N 797230) supplied with the instrument. Empty slots in the Alpha Ensemble chassis are covered by easily removed blank panels. Expansion couldn't be easier — simply slide an enclosure-less version of the Alpha Duo or Alpha Mega into an available bay in the chassis, make three simple connections, and the new module is ready for use.
- **Performance**
  - **Duo** Each of the two Alpha Duo channels has a vacuum gauge; variable detector bias supply (positive or negative); preamplifier; test pulser generator with variable amplitude; and leakage current monitor. Each of the two spectrometers has its own digital offset and conversion gain settings for maximum flexibility. Each detector operates independently with completely adjustable energy ranges from 0 to 10 MeV. Each pulse generator is adjustable over a range representing 0 to 10 MeV. The bias supply is adjustable from 0 V to  $\pm 100$  V. The hardware controls, data acquisition settings, detector bias, and leakage current are displayed and controlled with ORTEC CONNECTIONS applications such as the accompanying MAESTRO® MCA Emulator or our AlphaVision® Alpha Particle Spectrum Acquisition and Analysis for Microsoft Windows 7 and XP SP3.
  - **Mega** Except for its larger chamber and sample tray size, the Alpha Mega has the same performance specifications as an individual Duo channel.
- **High-Speed USB or Ethernet Connectivity** — All three units connect to your PC via a single, high-speed USB cable. (The Alpha Ensemble configuration contains an internal USB hub.) Alternatively, you can use our USB-CONC CONNECTIONS Distance Extender (purchased separately) to make a wired or wireless Ethernet connection without the distance limitation of USB communication.

- **Vacuum Connections and Monitoring** — The Alpha Mega chamber has a single vacuum connection and pressure gauge. The Alpha Duo's twin chambers share a vacuum connection, so both chambers operate at the same pressure; thus, any pumping, holding, and venting operation affects both chambers. In the Duo, pressure in both chambers is monitored by a single pressure-gauge head. The Alpha Ensemble chassis has an integral vacuum manifold with a single external connector for attachment to a vacuum pump, and four internal connectors for attachment to four Duos and/or Megas. This simplifies the installation of the vacuum system, and reduces the possibility of vacuum leaks. The pressure in each Duo in the Ensemble is controlled and monitored independently.

The vent/hold/pump functions for the Duo and Mega chambers are software controlled. There are two operation modes: (1) selecting the vent, hold, and pump commands as needed from a dialog; or (2) setting a target chamber pressure, then enabling an automatic pressure control routine. At pressures  $>1$  Torr to  $<13$  Torr, a change of  $\pm 10\%$  between the target and actual pressure triggers the automatic correction. Outside this range, the vacuum may not be controlled within 10%.

**NOTE** The Duo, Mega, and Ensemble do not have a vacuum interlock because bias voltages are  $<100$  V; we have not observed plasma discharges at these low voltages.

- **Recoil Contamination Protection Option (Duo only)** — Our Recoil Contamination Avoidance Process (RCAP) is available as an option for the Alpha Duo. It employs a reverse-biased sample tray (powered by a lithium coin battery on the tray underside; available separately from ORTEC) and careful control of the chamber pressure.
- **Easy Maintenance and Decontamination** — In the event of a contamination problem, the affected Duo or Mega module can be removed for decontamination while you continue using the rest of the Alpha Ensemble chambers.
- **Software Controlled Operation** — All hardware and data acquisition settings are computer controlled with MAESTRO, AlphaVision, or other ORTEC CONNECTIONS applications. The MCB Properties pages in MAESTRO display all pressure, bias, stabilizer, digital offset, ADC, and pulser controls for the selected spectrometer. AlphaVision has a specialized hardware panel that shows these readouts on one screen. (See also Section 3.5.7.)



## 1.1. About this Manual

This manual tells you how to set up and install the Alpha Duo and Alpha Ensemble, with emphasis on the Duo and Mega because they are the building blocks of the Ensemble.<sup>1</sup>

See the MAESTRO or AlphaVision *User's Manual* for instructions on installing the software.

We assume you are familiar with alpha spectroscopy and sample preparation techniques. A good starting reference and further reference materials can be found in “Measurement of Radio-nuclides in Food and the Environment, A Guidebook,” *Technical Reports*, Series No. 295, ISBN 92-0-125189-0, Vienna IAEA.

- **Chapter 2** of this manual provides instructions on installing and configuring the Alpha Duo, Alpha Mega, or Alpha Ensemble and its operating software, connecting the detectors to it, and connecting it to a vacuum pump.
- **Chapter 3** tells how to control the sample chamber pressure, change samples, and operate the Duo and Mega with MAESTRO.
- **Chapter 4** discusses maintenance of both the Duo, Mega, and Ensemble, including how to add a new Duo or Mega module to an Ensemble. This chapter also covers detector and chamber decontamination, chamber replacement, and troubleshooting.
- **Chapter 5** contains the system specifications and feature mask bits.
- **Appendix A** lists the Alpha chamber firmware commands for users who wish to write custom software to control the unit with the ORTEC CONNECTIONS Programmer's Toolkit (A11).
- **Appendix B** tells how to switch to a detector of the opposite polarity.

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<sup>1</sup>Hereinafter, the term *Alpha chamber* refers to individual Alpha Duo or Alpha Mega chambers; *Alpha module* refers to either a Duo or Mega; and *Alpha unit* refers to either the Duo, Mega, or Ensemble.

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# 2. INSTALLATION

Setting up your Alpha Duo, Alpha Mega, or Alpha Ensemble is straightforward:

- Install the included CONNECTIONS Driver Update Kit.
- Install the accompanying version of the MAESTRO® MCA Emulation Software.
- Install AlphaVision or other ORTEC CONNECTIONS software, where applicable.
- Connect the Alpha Suite hardware to the host PC.
- Install the detector.
- Connect to the vacuum pump.

**NOTE** You must have Windows Administrator-level access to install ORTEC software.

Install the CONNECTIONS Driver Update Kit *before* connecting the Alpha unit(s) to your PC.

If you have older versions of CONNECTIONS, MAESTRO, and/or AlphaVision on your PC, remove them using the Control Panel's software install/uninstall utility.

## 2.1. Install CONNECTIONS

*The first step* is to install the accompanying CONNECTIONS Driver Update Kit (P/N 797230) according to its instruction sheet (P/N 932721). On the install wizard's Instrument Setup page, be sure to select the **USB-based instruments** family, otherwise the Alpha unit(s) will not communicate properly with your ORTEC software.

***Be sure to read the entire instruction sheet.*** It discusses MCB support in detail; and explains how to enable and disable the drivers for your ORTEC MCB(s) and share ORTEC MCBs across a network. It also points you to information on selecting the proper network protocol for older, TCP/IP Ethernet units. At the end of installation, you will be directed to restart the PC.

## 2.2. Install MAESTRO and Other Applications

Install MAESTRO, AlphaVision, etc., according to their respective user manuals.

## 2.3. Connect to the PC and Input Power

- 1) The Alpha unit's ac power should be off and the cable disconnected from the mains outlet.
- 2) With the PC on, attach the USB cable between the Alpha hardware's rear-panel USB connector and a high-speed (2.0) or full-speed (1.1) USB port on the PC rear panel. There is a

known issue with super-speed (3.0) USB connectivity and with connections to some PC front-panel USB ports.

- 3) Connect the Alpha unit to ac mains power and turn its rear-panel On/Off switch on.
- 4) A series of “found new hardware” messages will be displayed. If Windows does not locate the driver, a wizard will open. Choose the option that does *not* search the internet for the appropriate driver, go to the next screen and select the “automatically find driver” option, then follow the remaining wizard prompts to complete installation.
- 5) On the PC, run the MCB Configuration program from the Windows Start menu by selecting **MAESTRO**, then **MCB Configuration**. MCB Configuration will automatically detect the new Alpha chambers and add them to the list of detectors available to this PC. (If the new chambers do not show up on the available detectors list, see the troubleshooting guide in Section 4.3.)
- 6) When MAESTRO or AlphaVision is correctly communicating with the new Alpha module, you should be able to select each of its spectrometers from the detector pick list within the software application (at this point, there will be no spectrum to view). See Chapter 3 for instructions on using the Alpha chambers and controlling data acquisition with MAESTRO and AlphaVision.

### 2.3.1. Multiple-Duo / -Mega / -Ensemble Systems

Adding more Alpha modules to your system is fast and straightforward. Simply connect each new module to a USB port on the host PC or to a powered USB hub.

Adding a new expansion module to an Alpha Ensemble takes about 3 minutes. Just power off the Ensemble; remove a front-panel blank; extend the vacuum tube, USB cable, and power cable for that bay and connect them to the expansion module; slide the new unit into the bay; and tighten its front-panel screws. (For more detailed information, see Chapter 4.)

Remember that you must re-run the MCB Configuration program each time you add new MCAs to your system in order to establish communication with them. See the MAESTRO or Alpha-Vision *User's Manual* for instructions.

## 2.4. Install the Detector

The ULTRA-AS series detectors normally used in Alpha chambers have a thin (500 Å) contact which is 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. Therefore, take reasonable precautions when handling these detectors.

If other types of detectors are used, read the detector's instruction sheet before installing and using it. If changing from a positive-polarity detector to a negative-polarity detector (or vice versa), see Appendix B.

- 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. Align the center pin in the top of the chamber with the center socket in the detector connector (threads are right-handed). Install the detector into the connector at the top of the chamber.
- 3) Remove the plastic cover, being careful not to touch the detector face (which will contaminate it).

## 2.5. Connect to the Vacuum Pump

The vacuum connector for the Alpha Duo and Alpha Mega is a 0.25 in. Swagelok® fitting. The Alpha Ensemble has an NW-25 ISO-KF connector.

A rotary pump with an oil mist trap should be used. A pump displacement of 6.7 CFM (190 liters/min) is required. The ALPHA-PPS-115 (or -230) and ALPHA-MINI-PPS are both well-suited to this application.

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# 3. OPERATION

As a “quick start” for users already familiar with ORTEC spectroscopy applications, the first two sections of this chapter tell how to use those applications to operate the Alpha Duo and Alpha Mega vacuum chambers. A more detailed discussion of MAESTRO’s hardware and data acquisition controls can be found in Section 3.5.

**NOTE** You may wish to write a **.JOB** file that automates the operations described below, particularly if you are controlling several Alpha Ensembles. See the chapter on **.JOB** files in the *MAESTRO User’s Manual*.

## 3.1. Controlling Chamber Pressure

The Duo and Mega have three pressure-regulation commands: **Pump**, **Hold**, and **Vent**. The **Pump** setting connects the Mega chamber or *both* Duo chambers to the manifold; the **Hold** position isolates the chamber(s); and the **Vent** position connects the chamber(s) to the atmosphere, after which the doors can be opened.<sup>2</sup>

### 3.1.1. Manual

- **MAESTRO** — Go to the Alpha tab under **Acquire/MCB Properties...** and select the vent, pump, and hold settings as needed from the **Vacuum state** droplist, using the **Actual vacuum** readout to monitor chamber pressure. (See Fig. 9, page 16.)
- **AlphaVision** — On the Detector Grid, click on the desired alpha chamber, then click on the Hardware icon on the outlook sidebar. Select the vent, pump, and hold settings as needed from the **Pump** droplist. (See Fig. 10, page 17.)

### 3.1.2. Automatic

- **MAESTRO** — Go to the Alpha tab under **Acquire/MCB Properties...**, set a **Target vacuum** between 1 Torr and 13 Torr, then click to mark the **Vacuum monitoring** checkbox. If you set a target value outside this range, the chamber vacuum may deviate by more than 10%.
- **AlphaVision** — On the Detector Grid, click on the desired alpha chamber, then click on the **Hardware** icon on the outlook sidebar. Enter a **Target** vacuum between 1 Torr and

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<sup>2</sup>AlphaVision also has a detector group control interface that allows you to select one or more alpha chambers and simultaneously change their pump status, turn detector bias voltage on/off, etc. See the AlphaVision user manual.

13 Torr, then click to mark the **Vacuum monitoring** checkbox. If you set a target value outside this range, the chamber vacuum may deviate by more than 10%.

The software will immediately begin using the vent, pump, and hold controls to maintain your target vacuum  $\pm 10\%$ .

## 3.2. Venting the Alpha Chamber(s)

### 3.2.1. Manual

- **MAESTRO** — Turn off the detector bias/pulser. Go to the Alpha tab of the MCB Properties dialog, click on the **Vacuum state** droplist, and select **VENT**. Use the **Actual vacuum** readout to monitor chamber pressure.
- **AlphaVision** — Turn off the detector bias/pulser. On the Detector Grid, click on the desired alpha chamber, then click on the Hardware icon on the outlook sidebar. On the **Pump** droplist, select **VENT**.

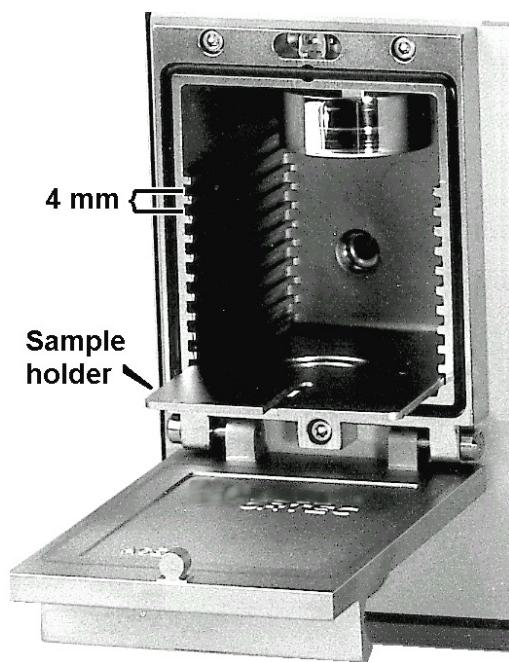
### 3.2.2. Automatic

- **MAESTRO** — Turn off the detector bias/pulser. On the Alpha tab, *unmark* the **Vacuum monitoring**, checkbox, then click on the **Vacuum state** droplist and select **VENT**.
- **AlphaVision** — Turn off the detector bias/pulser. On the Detector Grid, click on the desired alpha chamber, then click on the Hardware icon on the outlook sidebar. On the **Pump** droplist, select **VENT**.

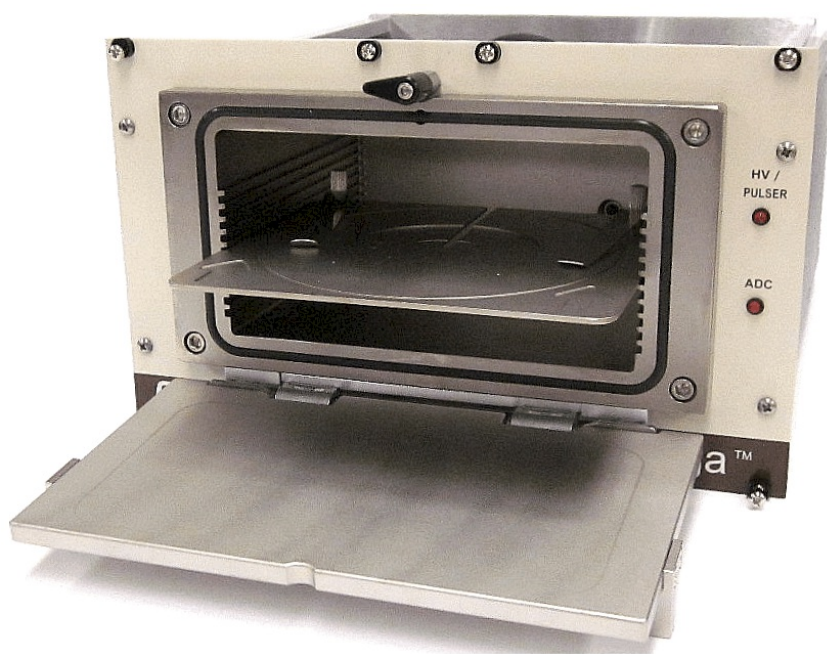
## 3.3. Inserting a Sample into the Vacuum Chamber

- 1) Once the desired vacuum chamber(s) has been vented, open the door. Figures 1 and 2 respectively show open Duo and Mega chamber with a detector, sample holder, and the series of slots that allow you to adjust the sample-to-detector distance in 4 mm increments.
- 2) Slide the sample holder into the slot at the desired height. For optimum resolution, the sample-to-detector spacing should be at least equal to the detector diameter. The maximum spacing is 44 mm. The sample trays shipped with the Alpha Duo are for 0.75 in. (19 mm) and 1 in. (25 mm) samples. The trays for the Alpha Mega can accommodate samples up to 4.2 in. (106 mm), which can optionally be secured to the tray with the included removable clips.
- 3) Close the door, and use MAESTRO or AlphaVision to begin pumping. After a minute or two, when the vacuum has reached a satisfactory value, you are ready to start data collection.





**Fig. 1. Alpha Duo Sample Chamber**



**Fig. 2. Alpha Mega Sample Chamber**

### 3.4. Resolution Measurement and Calibration

The measurement of alpha-particle resolution should be performed in a vacuum with a uniform, ultra-thin source located at a source-to-detector distance at least equal to the detector diameter. Using old or inferior sources may cause apparently poor resolution and can lead to detector contamination due to recoil sputtering. When using a source in an Alpha chamber, either for resolution measurement or system calibration, the following steps should be used for best results.

- 1) Place the source on a sample tray and insert it into the Alpha chamber. Placing the source as far as possible from the detector helps reduce any solid-angle-related and/or count-rate problems.
- 2) Evacuate the chamber.
- 3) Set the target bias and turn the bias on with the controls on the High Voltage property page in MAESTRO (see Section 3.5.5) or the Hardware panel in AlphaVision. Wait 2 minutes.
- 4) Accumulate a peak containing at least 1,000 counts in the peak channel.

- 5) Determining the resolution requires measurement of the full-width at half maximum (FWHM) of the peak. Use the **Peak Info** command in MAESTRO or the **Peak Search** and **Peak Fit** features in AlphaVision.

## 3.5. MCB Properties in MAESTRO

This section discusses the hardware setup dialog you will see within MAESTRO, the AlphaVision advanced chamber properties feature, and all other ORTEC CONNECTIONS software when you click on **Acquire/MCB Properties...** The MCB Properties dialog contains all of the computer-selectable hardware controls including ADC setup parameters, high voltage on/off, chamber pressure controls and readouts, and acquisition presets. Just move from tab to tab and set your hardware parameters, then click on **Close** — it's that easy. Note that as you enter characters in the data-entry fields, the characters will be underlined until you move to another field or until 5 seconds have lapsed since a character was last entered. During the time the entry is underlined, no other program or PC on the network can modify this value.

### 3.5.1. Amplifier

Figure 3 shows the Amplifier tab. Set the amplifier **Fine** gain by adjusting the horizontal slider or entering the value, in the range of 0.25 to 1.00. The effective gain is shown at the top of the **Gain** section.

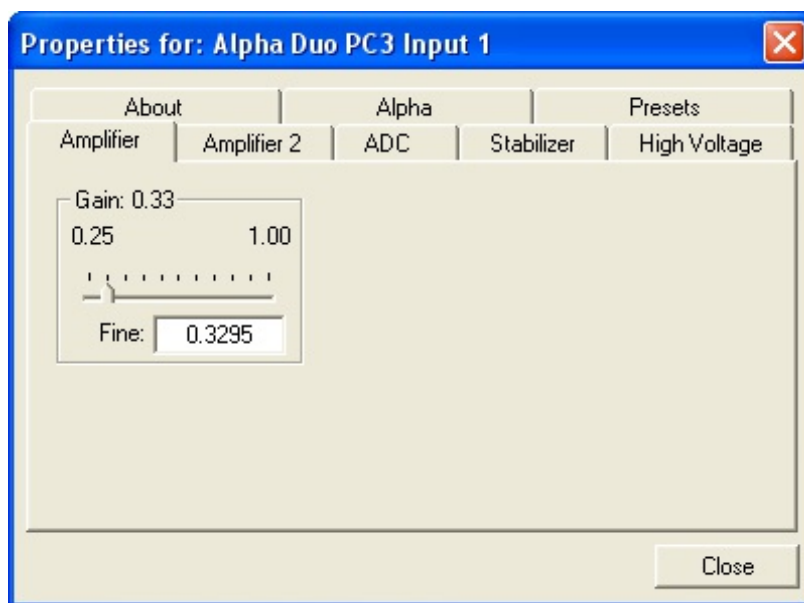


Fig. 3. Amplifier Tab

### 3.5.2. Amplifier 2

Figure 4 shows the Amplifier 2 tab, which accesses the advanced shaping controls including the InSight™ Virtual Oscilloscope mode. This is typically not used in alpha spectroscopy. For more information on the InSight mode, see the MAESTRO *User's Manual*.

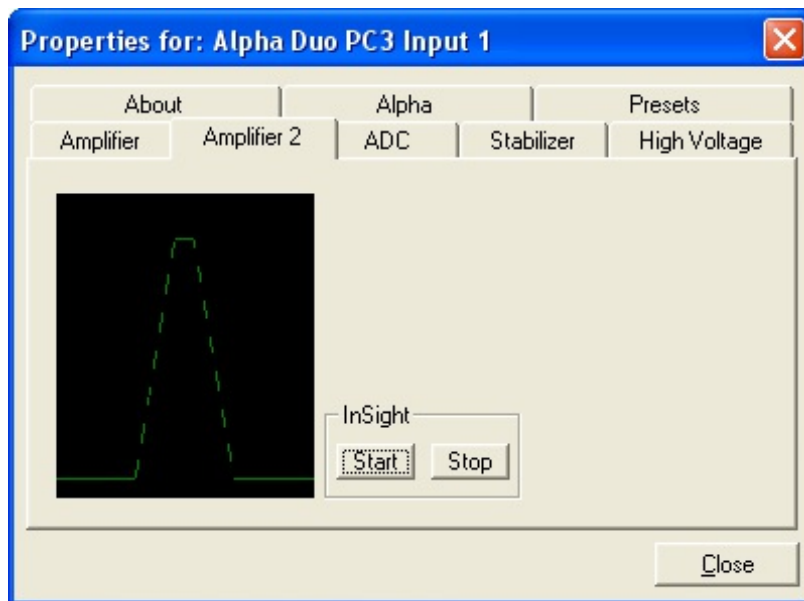


Fig. 4. Amplifier 2 Tab

### 3.5.3. ADC

This tab (Fig. 5) contains the **Conversion Gain**, and **Lower** and **Upper Level Discriminator** controls. In addition, the current real time, live time, and input count rate are monitored at the bottom of the dialog.

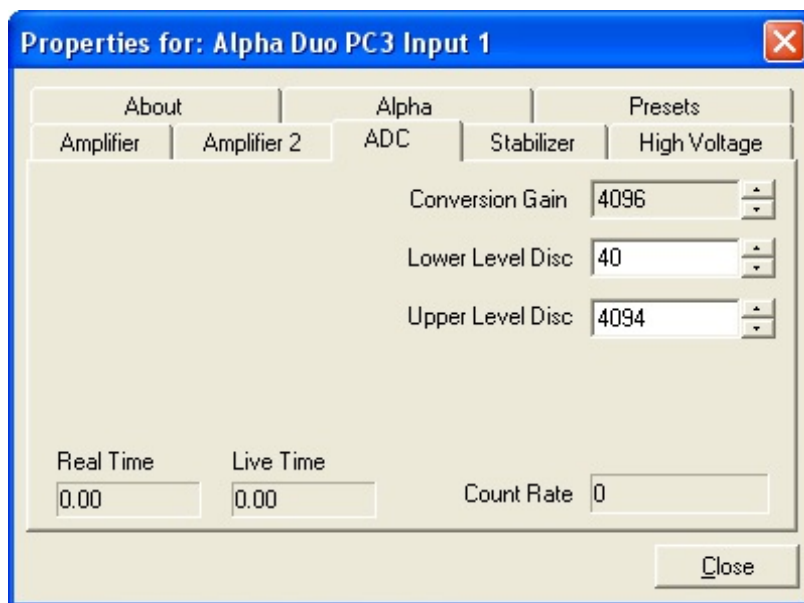


Fig. 5. ADC Tab

### 3.5.4. Stabilizer

The Stabilizer tab (Fig. 6) shows the current settings for the gain stabilizer (gain stabilization is discussed in the MAESTRO *User's Manual*).

The value in the **Adjustment** section shows how much adjustment is currently applied. The **Initialize** button sets the adjustment to 0. If the value approaches 90% or above, the amplifier gain should be adjusted so the stabilizer can continue to function — when the adjustment value reaches 100%, the stabilizer cannot make further corrections in that direction. The **Center Channel** and **Width** fields show the peak currently used for stabilization.

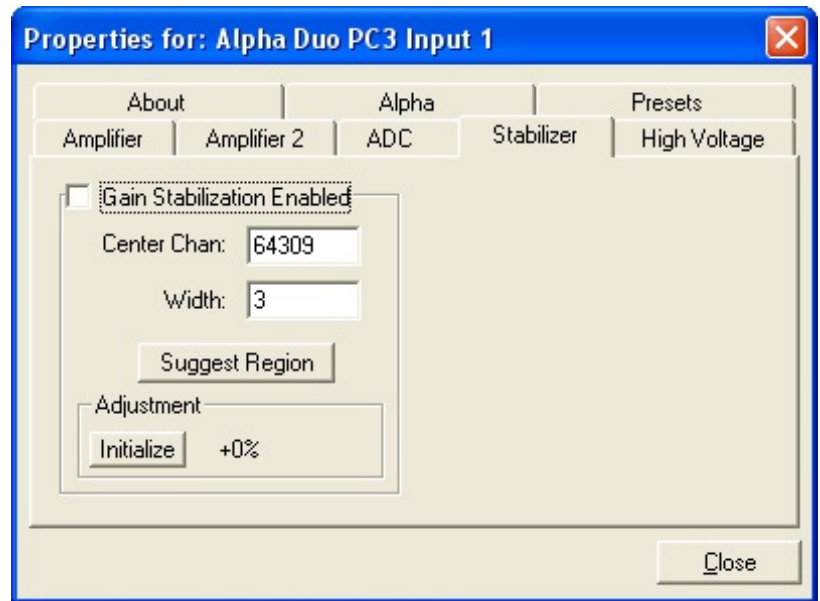


Fig. 6. Stabilizer Tab

To enable the stabilizer, enter the **Center Channel** and **Width** values manually or click on the **Suggest Region** button. **Suggest Region** reads the position of the marker and inserts values into the fields. If the marker is in an ROI, the limits of the ROI are used. If the marker is not in an ROI, the center channel is the marker channel and the width is 3 times the FWHM at this energy. Now click on the appropriate **Enabled** checkbox to turn the stabilizer on. Until changed in this dialog, the stabilizer will stay enabled even if the power is turned off. When the stabilizer is enabled, the **Center Channel** and **Width** cannot be changed.

### 3.5.5. High Voltage

Figure 7 shows the High Voltage tab, which allows you to set the bias voltage from 0 V to  $\pm 100$  V, turn the detector bias on or off, and monitor the voltage (**Actual**) and leakage **Current**.

When the bias is on, the detector leakage current is shown in the **Current** field. The leakage current is detector dependent and will be near zero when the bias is turned off.

While the Properties dialog is open, the computer monitors the Alpha chamber in real time, updating the **Actual** voltage, leakage **Current**, and chamber pressure information.

### 3.5.6. About

This tab (Fig. 8) displays hardware and firmware information about the currently selected Alpha chamber as well as the data **Acquisition Start Time** and **Sample** description. The **Access** field shows whether the MCA is currently locked with a password. **Read/Write** indicates that the MCA is unlocked; **Read Only** means it is locked.

This screen displays the Alpha Duo's serial number (all Alpha modules have a unique serial number which is read by the software and stored in the spectrum file for verification of the spectrum). The Alpha chamber currently being monitored is shown at the top of the dialog. The name displayed here is the MCB **Description** entered when the MCB Configuration program is run.

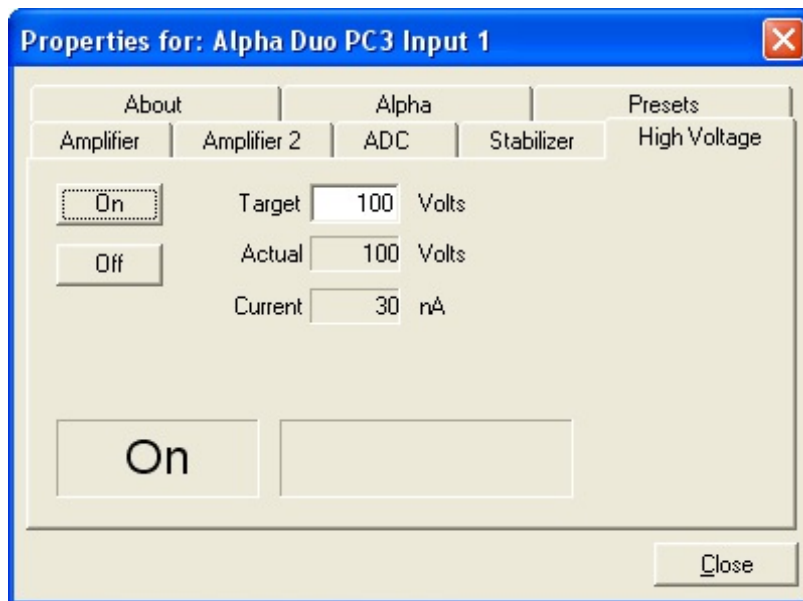


Fig. 7. High Voltage Tab

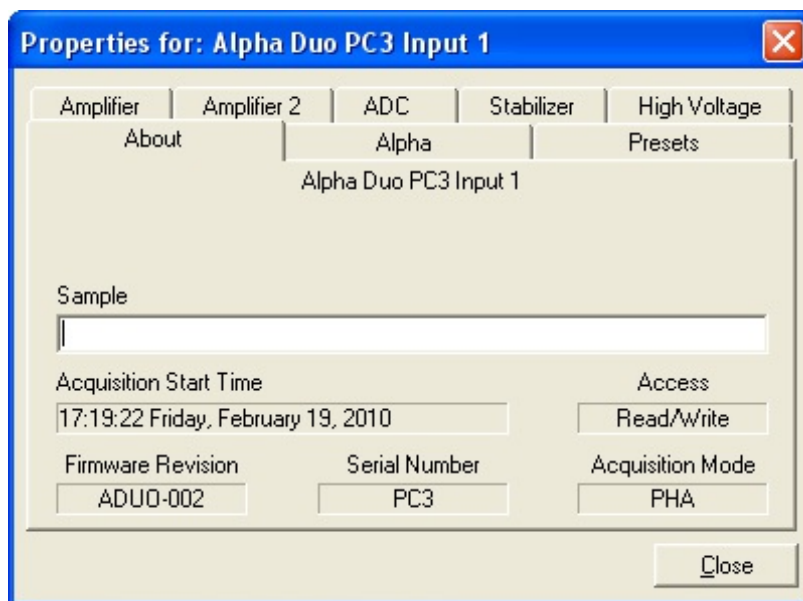


Fig. 8. About Tab

### 3.5.7. Alpha

The Alpha tab (Fig. 9) contains the controls for the chamber pressure, digital offset, and pulser.

#### 3.5.7.1. Vacuum Monitoring

Remember that the Alpha Duo's twin chambers share a vacuum connection, so both chambers operate at the same pressure.

***This means every pumping, holding, and venting operation affects both chambers.***

There are two modes for controlling chamber pressure:

- **Manual** — Choose **Pump**, **Vent**, or **Hold** as needed from the **Vacuum state** droplist, using the **Actual vacuum** readout to monitor chamber pressure.
- **Automatic** — Set a **Target vacuum**, then mark the **Vacuum monitoring** checkbox to start automatic vacuum control. For pressures >1 Torr and <13 Torr, the automatic routine maintains the target pressure  $\pm 10\%$ . For pressures outside this range, pressure may vary by more than 10%.

Note that if you try to assign two different **Target** settings to the chambers in one Alpha Duo, *both chambers will use the most recently entered value*. For more detail on controlling chamber pressure, see Sections 3.1 and 3.2.

#### 3.5.7.2. Data Collection Window

The **Digital offset** and **Display chans** settings are used to control the starting energy and energy range of the spectrum collected. In many cases, the low-energy portion of the spectrum contains no data of interest and can be discarded. Use the digital offset to exclude this region.

#### 3.5.7.3. Internal Pulser

To use the pulser, enter the desired channel in the **Amplitude** field and click to mark the **Enable internal pulser** checkbox. When you start the next data acquisition, pulser data will begin accumulating in the spectrum window. The front-panel HV/PULSER indicator will flash quickly if the bias is on and slowly if the bias is off.

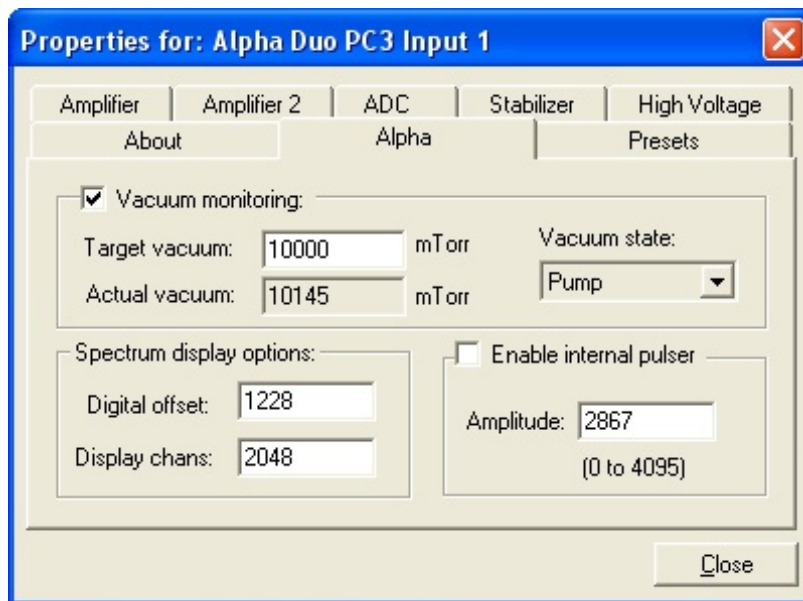


Fig. 9. Alpha Tab

### 3.5.7.4. Alpha Chamber Data Display in AlphaVision

AlphaVision uses a Hardware panel (Fig. 10) to display most of the controls from the Alpha, Stabilizer, and HV tabs. (Note that when you view the AlphaVision **Chamber Properties** for a Duo or Mega chamber, the Properties dialog does not display the Alpha tab.)

Note that some of the field names on the AlphaVision Hardware panel differ slightly from those on the MAESTRO Alpha tab.

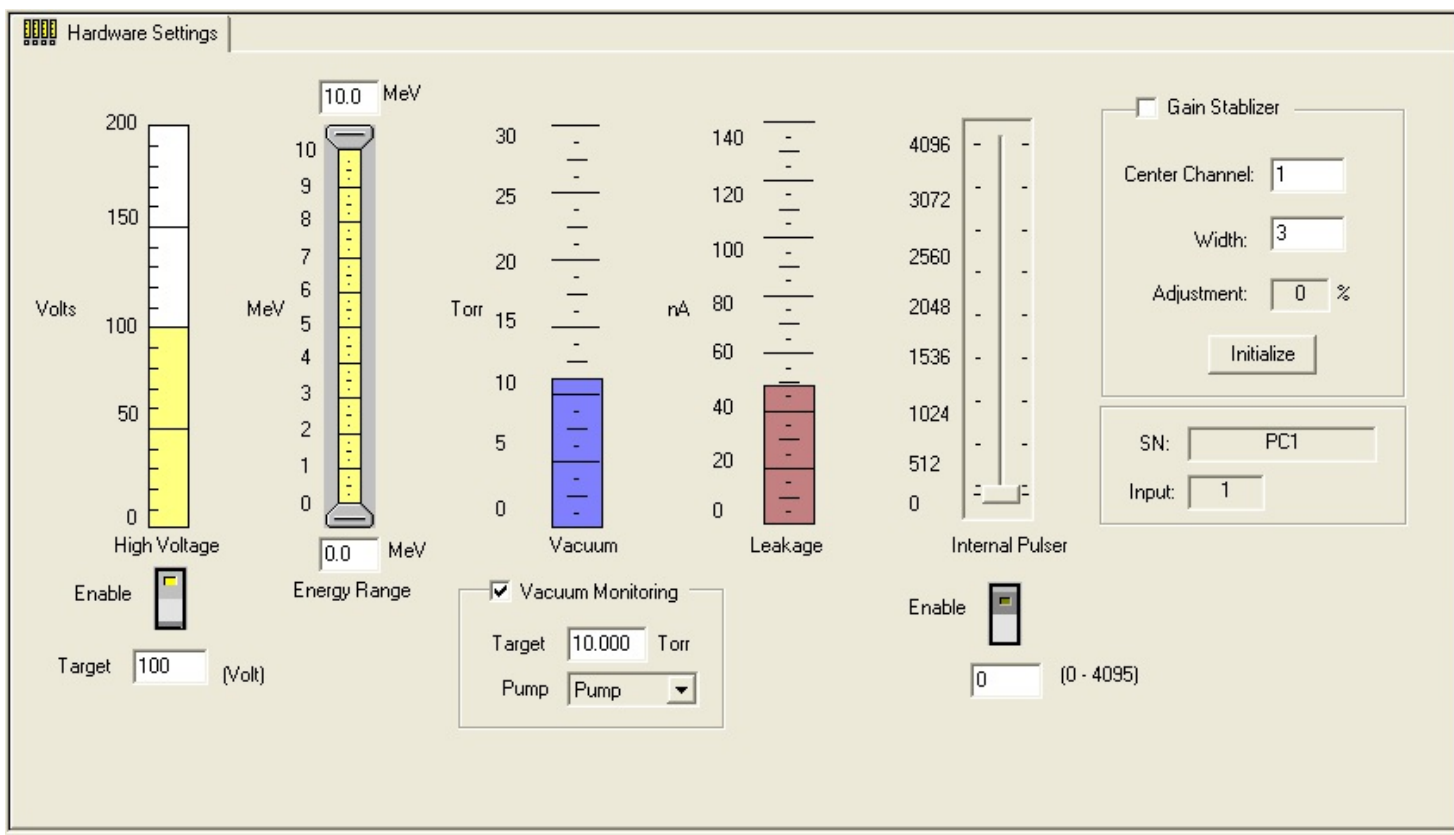


Fig. 10. Alpha Duo or Mega Chamber Hardware Readouts in AlphaVision

### 3.5.8. Presets

Figure 11 shows the Presets tab. The presets can only be set on an MCA that is *not* acquiring data. You can use any or all of the presets at one time. To disable a preset, enter a value of zero. If you disable all of the presets, data acquisition will continue until manually stopped.

When more than one preset is enabled (set to a non-zero value), the first condition met during the acquisition causes the MCA to stop. This can be useful when you are analyzing samples of widely varying activity and do not know the general activity before counting. For example, the **Live Time** preset can be set so that sufficient counts can be obtained for proper calculation of the activity in the sample with the least activity. But if the sample contains a large amount of

this or another nuclide, the dead time could be high, resulting in a long counting time for the sample. If you set the **ROI Peak** preset in addition to the **Live Time** preset, the low-level samples will be counted to the desired fixed live time while the very active samples will be counted for the ROI peak count. In this circumstance, the **ROI Peak** preset can be viewed as a “safety valve.”

The values of all presets for the currently selected MCA are shown on the Status Sidebar. These values do not change as new values are

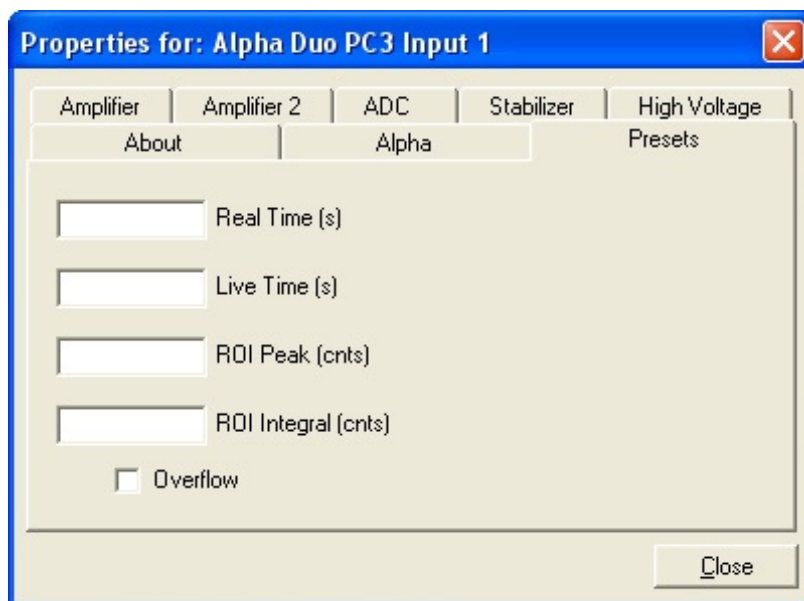
entered on the Presets tab; the changes take place only when you **Close** the Properties dialog.

Enter the **Real Time** and **Live Time** presets in units of seconds and fractions of a second. These values are stored internally with a resolution of 20 milliseconds (ms) since the MCA clock increments by 20 ms. *Real time* means elapsed time or clock time. *Live time* refers to the amount of time that the MCA is available to accept another pulse (i.e., is not busy), and is equal to the real time minus the *dead time* (the time the MCA is not available).

Enter the **ROI Peak** count preset value in counts. With this preset condition, the MCA stops counting when any ROI channel reaches this value unless there are no ROIs marked in the MCA, in which case that MCA continues counting until the count is manually stopped.

Enter the **ROI Integral** preset value in counts. With this preset condition, the MCA stops counting when the sum of all counts in all ROI channels (regardless of the number of ROIs) reaches this value. This has no function if no ROIs are marked in the MCB.

Marking the **Overflow** checkbox terminates acquisition when data in any channel exceeds  $2^{31}-1$  (over  $2 \times 10^9$ ) counts.



**Fig. 11. Presets Tab**



# 4. MAINTENANCE AND SERVICE

## 4.1. Decontamination

The normal background count above 3 MeV for a Alpha chamber detector should be <24 counts per day for the 300 mm<sup>2</sup> and 450 mm<sup>2</sup> ULTRA 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.

**CAUTION** *Non-ULTRA or non-Ruggedized surface barrier detectors cannot be subjected to cleaning procedures; consult the instruction manual for the detector to determine how to clean it.*

### 4.1.1. Chamber Decontamination

To decontaminate an Alpha chamber in place:

- 1) Turn off bias to the detector and vent the chamber.
- 2) Remove the detector from the chamber by rotating it counterclockwise.

**CAUTION** To avoid damaging the detector, make sure its protective cover (supplied) is in place before the detector is removed. Wear plastic gloves to keep from contaminating your hands or the chamber.

- 3) Pour the cleaning agent into a clean beaker. Methanol, or water with a methanol rinse, can be used as the cleaning agent.
- 4) Dip a cotton swab or a cotton-covered stick into the 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.
- 5) When contamination from the surface is visible on the cotton swab, discard it and use a clean one to avoid returning the contaminant to other areas of the chamber.
- 6) When the chamber is clean, blow it dry with clean nitrogen gas.

### 4.1.2. ULTRA Detector Decontamination

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

### 4.1.3. Ruggedized Detector Decontamination

To decontaminate the front (aluminum) surface of a Ruggedized detector:

- 1) Turn off bias to the detector, vent the Alpha chamber, power off its enclosure, and disconnect the enclosure from ac mains power. Optionally, you can slide Alpha chamber out of its enclosure as shown in Figs. 14 and 15 of Appendix B.
- 2) Pour deionized water into a clean beaker.
- 3) Dip a cotton swab into the water and then carefully blot on a clean tissue to remove the excess.
- 4) **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.*
- 5) Clean the housing of the detector and the protective cover in the same way.
- 6) Blow dry with clean nitrogen gas.
- 7) Return the Alpha unit to service by reversing the instructions in step (1).

## 4.2. Removing and Replacing Chambers

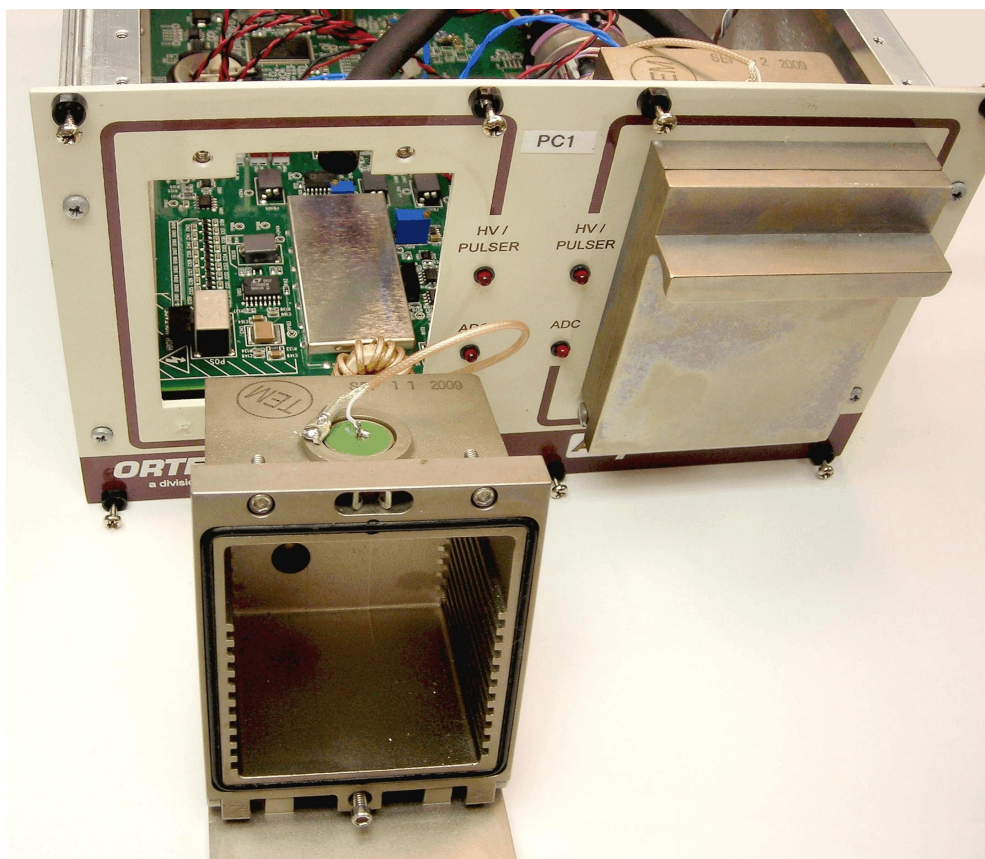
These instructions apply to the removal of a vacuum chamber assembly from an Alpha module for the purpose of cleaning or replacing the chamber. The remaining Ensemble chambers can continue in use.

### 4.2.1. Chamber Removal

- 1) Turn off bias to the detector, vent the Alpha chamber(s), power off its enclosure, and disconnect the enclosure from ac mains power.

- 2) Slide the Alpha module out of its enclosure as shown in Figs. 14 and 15 of Appendix B.
- 3) Place the white protective cap on the detector and remove the detector. ***Do not touch the detector front surface.***
- 4) Use a 3/32 in. hex-head 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 1 in.). Put the screws back in the holes and close the chamber door to trap the screws in place. This prevents losing them and keeps them handy for chamber reinstallation.
- 6) Pull the chamber out a little more until the glass feedthrough on the top of the chamber is exposed. This is shown for an Alpha Duo chamber in Fig. 12.

**CAUTION** *If the cable is caught on the top of the panel, you may damage the feed-through pin by pulling hard on the chamber.*



**Fig. 12. Chamber Removed from Alpha Duo**

- 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. This frees the coaxial signal cable.
- 9) Pull the chamber out far enough to expose the vacuum connection on the back of the chamber. Slide the black rubber vacuum hose off the vacuum port.
- 10) If removing the right-hand chamber, pull it out far enough to expose the octal connector on the thermocouple tube. Remove the connector by *pulling on the black plug, not the wires.*

#### 4.2.2. Chamber Installation

Reinstall the chamber assembly in exactly the reverse order of disassembly.

- 1) Reconnect the octal connector to the vacuum gauge.
- 2) Reconnect the vacuum hose. Make sure it is still connected to the valve below.
- 3) Connect the ground wire, tighten the screw, and solder the center lead on the one-pin feed-through.
- 4) 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.
- 5) Tighten the chamber screws lightly, bottom screw first. When the three screws are in place, tighten them securely, but *do not overtighten.*
- 6) Reconnect the Alpha module to vacuum, USB, and power; slide the unit back into its enclosure; and tighten the eight front-panel Phillips screws. You are now ready to reapply mains power to the enclosure.

### 4.3. Troubleshooting

When installation is complete, you should be able to start up MAESTRO or AlphaVision, go to the detector pick list in the program, and select the spectrometers (two inputs per Alpha Duo; one per Alpha Mega) you configured during setup.

### 4.3.1. Can't Find the Duo or Mega on the Detector Pick List

- Make sure the Alpha module or Ensemble is powered on.
- Check your USB cable and its connection to the PC and Alpha unit. Windows 7 and XP provide a “USB connect/disconnect” audio signal. Switch to a different USB port.
- If you're connected to a network, can you see other devices on the network?
- During CONNECTIONS installation, did you select the **USB-based instruments** connection option? To check this, go to the Windows Control Panel, open **Programs and Features** (Windows 7) or **Add/Remove Programs** (XP), select CONNECTIONS, and choose to modify it. This will reopen the CONNECTIONS wizard. On the Instrument Setup page, select the **USB-based instruments** add-in, then complete the wizard and restart the PC as instructed. Rerun MCB Configuration to locate the Alpha module's chamber(s).
- If necessary, use the Windows Control Panel hardware **Device Manager** utility to confirm the ORTEC USB driver is installed correctly.

For further assistance, contact your ORTEC representative or our Global Service Center.

### 4.3.2. Data or Settings Are Lost When Power Is Turned Off

The memory in the Duo and Mega has battery backup to maintain data when power is removed from the module. The battery is located on the upper-rear quadrant of the PWB. Contact ORTEC for the appropriate replacement.

### 4.3.3. Resolution Problems

Severe degradation in peak resolution can destroy an alpha spectrometer's ability to make meaningful measurements. Apparent degradation of resolution may be due to one or more causes:

- **Poor vacuum** — Check the chamber pressure reading.
- **Excessive electronic noise** — Examine the pulser peak resolution and detector leakage current compared to that specified on the original detector quality-control 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 Global Service Center.

- **Pulser OK But No Source Peaks** — Wrong amplifier polarity. See Appendix B.
- **Spectrum Very Noisy** — Wrong bias polarity. See Appendix B.

#### 4.3.4. Troubleshooting Vacuum Problems in the Alpha Ensemble

The Alpha Ensemble's vacuum system consists of a four-port manifold. Each port is connected to a one-chamber Alpha Mega or two-chamber Alpha Duo via a neoprene vacuum line. A cap is supplied for each of the unused ports. Figure 13 shows vacuum lines 1–4; line 1 is closest to the vacuum pump and line 4 is farthest away.

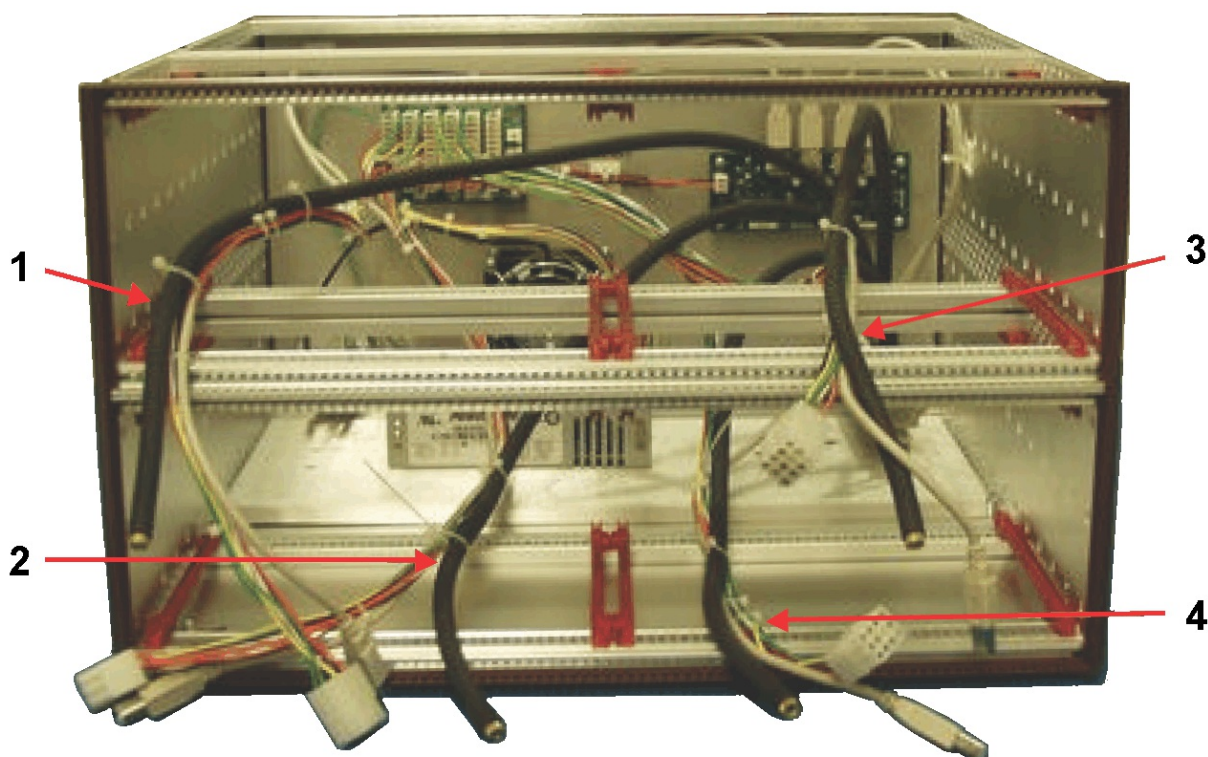


Fig. 13. Alpha Ensemble Vacuum Lines 1–4

When the vacuum valve for an Alpha module is in either the VENT or HOLD position, its chambers are isolated from the vacuum manifold. Most vacuum problems can be easily isolated using a systematic approach starting at the module's valve.

If the total system pressure read at the vacuum pump is too high or all the chamber pressures read high, begin at the lower-right module (vacuum line #4) and, in MAESTRO, set 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 on or damage to the O-ring. A broken feedthrough may also cause a leak, or one of the two electronic valves in the Alpha module may not be responding correctly.

If the problem is not in the lower-right Alpha module, isolate the upper-right module (vacuum line #3), then the lower-left (line #2), then the upper-right (line #1), as needed.

If all valves are in HOLD position and the vacuum does not improve, disconnect the lower-right module from vacuum line #4 and plug the line with the factory-supplied plug. Repeat as needed with the modules on lines #3, #2, and #1.

If all Alpha modules are removed and their vacuum lines plugged but the system vacuum does not improve, the problem is in the manifold, the pump, or the vacuum line connecting them.

If the vacuum pump is very low on oil it will not pump well. If any of the fittings from the back of the Alpha Ensemble to the vacuum pump have been recently disconnected, they are suspect. When looking for vacuum problems, check things that have been recently changed.

If an individual Duo reads high, it is likely to be a thermocouple reading error, since a leak in one chamber will affect the other Duos until its valve is placed in the HOLD position.

Outgassing of contaminants in an Alpha chamber will also cause the pressure to be high in the individual module, but will have only a slight effect on adjoining modules. A “good” chamber should pump down in 5 minutes.

When replacing an O-ring, put a *small* amount of Apiezon<sup>®</sup> L silicone-/halogen-free vacuum grease (available from ORTEC) on the O-ring with your fingers (use plastic gloves). All excess should be thoroughly wiped off. Excess vacuum grease traps dust, which degrades the vacuum seal. A kit of 10 spare O-rings is supplied with each Alpha module. Additional kits can be ordered from ORTEC.

For further assistance with troubleshooting, contact your ORTEC representative or our Global Service Center.

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# 5. SPECIFICATIONS<sup>3</sup>

Note that these specifications, except where noted, apply to the Alpha Duo and/or Alpha Mega because these are the major components of the Alpha Ensemble.

## 5.1. Performance

Unless otherwise specified, performance is based on use with a BU-017-450-100 ULTRA™ Series detector with a good-quality <sup>241</sup>Am point source.

### Maximum Sample Size

- **Duo** — 51 mm (2.030 in.).
- **Mega** — 106 mm (4.2 in.).

**Sample-to-Detector Spacing** Adjustable from nominally 1 mm to 41 mm in 4 mm increments using slide-in sample trays. Maximum distance from detector to bottom of chamber is approximately 44 mm.

### Maximum Detector Size

- **Duo** 1200 mm<sup>2</sup>.
- **Mega** 3000 mm<sup>2</sup>.

**Energy Range** 0 to 10 MeV.

**Energy Resolution**  $\leq 20$  keV (FWHM) with a detector-to-source spacing equal to the detector diameter.

**Detector Efficiency**  $\geq 25\%$  is achievable with close detector-to-source spacing.

**Background** Above 3 MeV,  $\leq 1$  count/hour based on a BU-020-450-AS detector.

## 5.2. Bias Supply

**Range**  $0 \pm 100$  V, 10  $\mu$ A; selected and monitored in software.

**Bias** Computer controlled adjustable in 1 V increments.

**Bias On/Off** Software controlled.

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<sup>3</sup>Subject to change without notice.

### 5.3. Calibration Pulser

**Range** 0 to 10 MeV.

**Pulser** Computer controls the internal pulser. amplitude with 12 bit (2.5 keV) level settings; set to a nominal 7 MeV pulse when shipped.

**Frequency** 100 Hz.

**Frequency Stability**  $\leq \pm 50$  ppm/°C.

**Amplitude Drift** typically  $\leq \pm 150$  ppm/°C.

**Long Term Drift** typically  $\leq \pm 0.005\%$  of full scale / 24 hours at constant temperature.

**On/Off** Computer controlled.

### 5.4. Detector Current Monitor

**Range** 0 to 10,000 nA; read by computer.

**Display Resolution** 3 nA.

### 5.5. Preamplifier

**Charge Sensitive** Nominally 10 mV/MeV.

**Polarity** Positive/negative selectable, typically factory-set for positive bias voltage.

- **Duo** — 3 PWB-mounted slide switches per chamber.
- **Mega** — 3 PWB-mounted slide switches.

## 5.6. Digital MCA

**Digital Filter** 1  $\mu$ s unipolar equivalent.

**Conversion Gain** Software-selectable as 256, 512, 1024, 2048, or 4096. In the Alpha Duo, each spectrometer's conversion gain is independent.

**Fine Gain** Software-selectable range from 0.25 to 1.

**Gain Instability**  $\leq \pm 100$  ppm/ $^{\circ}$ C, measured with external pulser and charge terminator.

**Digital Offset** Software-selectable range from 0 to conversion gain setting (4096 maximum) in 1-channel increments.

**Display Channels** Software-selectable range from 0 to (conversion gain - digital offset).

**Digital Spectrum Stabilizer** Controlled via computer, stabilizes gain errors.

**Dead-Time Correction** Extended live-time correction according to the Gedcke-Hale method.<sup>4</sup>

**Lower-Level Discriminator** Computer controlled from 0 to 100% full scale.

**Upper-Level Discriminator** Computer controlled from 0 to 100% full scale.

## 5.7. Presets

**Real Time/Live Time** Multiples of 20 ms.

**Region of Interest** Peak count/Integral count.

**Data Overflow** Terminates acquisition when any channel exceeds  $2^{31} - 1$ .

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<sup>4</sup>Ron Jenkins, R. W. Gould, and Dale Gedcke, *Quantitative X-Ray Spectrometry* (New York: Marcel Dekker, Inc.), 1981, pp. 266–267.

## 5.8. Vacuum Chamber

**Construction** Cast brass, with nickel plating for ease of decontamination. High-performance O-ring seal.

**Detector Connector Type** Rear microdot (ORTEC B-Mount).

**Sample Trays** Slide-in, nickel-plated brass; one sample tray is included.

- **Duo** — Sample diameters from 13 mm (0.5 in.) to 51 mm (2 in.).
- **Mega** — Sample diameter up to 106 mm (4.2 in.).

**Vacuum Manifold Connector** 0.25 in. Swagelok tube fitting.

**Vacuum Pump Requirements** Rotary vacuum pump, 6.7 CFM (190 L/min) displacement, with oil mist trap. The ORTEC ALPHA-PPS-115 (or -230) is available for this application.

**Recoil Protection (RCAP) Option (Duo only)** Automatic pressure controller, requires addition of optional biased sample holders. Controls chamber pressure in the range of >1 Torr to <13 Torr  $\pm 10\%$ . Biased sample tray not available for the Alpha Mega.

## 5.9. Indicators

**ADC** Red front-panel LED flashes once for each pulse digitized by ADC.

**HV/PULSER** Red front-panel LED. Continuous on = bias on; slow flash = bias off, pulser on; fast flash = bias on, pulser on.

## 5.10. Controls

All vacuum chamber, data acquisition, ADC, amplifier, and bias controls and readouts are software controlled with MAESTRO, AlphaVision, or other ORTEC CONNECTIONS applications. See Sections 3.1, 3.2, and 3.5.

**Polarity Switches (+/-)** Three switches on the PWB select the polarity of the amplifier gain and the detector bias voltage to match the polarity of voltage required by the detector. Typically shipped in the positive (+) position.

## 5.11. Connectors

### Vacuum Connector

- **Duo and Mega** — Rear-panel Swagelok connector for 0.25 in. OD tubing.
- **Ensemble** — Rear-panel NW-25 ISO-KF connector.

**High-Speed USB Port** Rear-panel standard “B”-type USB connector.

## 5.12. Electrical and Mechanical

**CE** Conforms to CE standards for radiated and conducted emissions, susceptibility, and low-voltage power directives.

### 5.12.1. Alpha Duo and Mega

**Power Input** 120/240 V ac, 50/60 Hz.

**Power Consumption** 10 W input power.

**Operating Environment** 0° to 50°C to 95% relative humidity, non-condensing.

**Dimensions** 25.7 cm W × 36.6 cm D × 15.2 cm H (10.1 in. × 14.4 in. × 6.0 in.) enclosure.

### Weight

- Net Weight:
  - Alpha Duo Net Weight: 7.5 kg (16.5 lb).
  - Alpha Mega Net Weight: 8.5 kg (18.7 lb).
- Shipping Weight: 11.5 kg (25.0 lb).

### 5.12.2. Alpha Ensemble

**Power Input** 120/240 V ac, 50/60 Hz.

**Power Consumption** 50 W input power.

**Operating Environment** 0° to 50°C to 95% relative humidity, non-condensing.

**Dimensions** 48.2 cm W × 49.3 cm D × 27.2 cm H (19.0 in. × 19.4 in. × 10.7 in.) enclosure.

**Weight** (with 4 Alpha Duo and/or Mega modules installed)

- Net Weight: 26.6 kg (58.4 lb).
- Shipping Weight: 29.5 kg (65.0 lb).
- Module Weights:
  - Alpha Duo: 3.9 kg (8.5 lb).
  - Alpha Mega: 4.8 kg (10.5 lb).

## 5.13. Battery Backup

The memory in the Duo and Mega is backed up by battery to maintain settings data when power to the module is off. The battery is located on the upper-rear quadrant of the PWB. Contact ORTEC for the appropriate replacement.

## 5.14. Feature Mask Bits

The following table describes the feature bits for the SHOW\_FEATURES command discussed on page 47. If the feature is supported in the Duo or Mega, the bit will be set to 1; if the feature is not supported, the bit will be 0.

<b>Bit</b>	<b>Meaning</b>
0	Software-selectable conversion gain
1	Software-selectable coarse gain
2	Software-selectable fine gain
3	Gain stabilizer
4	Zero stabilizer
5	PHA mode functions available
6	MCS mode functions available
7	918-style list mode functions available
8	Sample mode functions available
9	Digital Offset (e.g., 920)
10	Software-selectable analog offset
11	HV power supply
12	Enhanced HV (SET_HV, SET/SHOW_HV_POL, SHOW_HV_ACT)
13	Software-selectable HV range (ENA_NAI, DIS_NAI)
14	Auto PZ (START_PZ_AUTO)
15	Software-selectable manual PZ (SET/SHOW_PZ)
16	Battery-backed, real-time clock (SHOW_DATE/TIME, SHOW_DATE/TIME_START)
17	Sample changer support (SET/SHOW_OUTPUT, SHOW_INPUT)

- 18 One-button acquisition (ENA/DIS/SHOW\_TRIG\_SPEC, MOVE)
- 19 Nomadic (likely to move between opens)
- 20 Local app data (SET\_DATA\_APP, SHOW\_DATA\_APP)
- 21 Software-retrievable serial number (SHOW\_SNUM)
- 22 Power management commands
- 23 Battery status support (SHOW\_STAT\_BATT)
- 24 Software-selectable AMP polarity (SET/SHOW\_GAIN\_POLAR)
- 25 Support for flattop optimization (ENA/DIS\_OPTI)
- 26 Stoppable AutoPZ (STOP\_PZ\_AUTO)
- 27 Network support (e.g., DSPEC)
- 28 Multi-drop serial support (e.g., MicroNOMAD<sup>®</sup>)
- 29 Software-selectable DPM address (SET\_DPM\_ADDR)
- 30 Multiple devices (e.g., 919)
- 31 Software-selectable ADC gate mode (SET\_GATE...)  
*Start of second word*
- 32 Software-downloadable firmware
- 33 Time histogramming functions available (e.g., 9308)
- 34 Software-selectable lower level discriminator
- 35 Software-selectable upper level discriminator
- 36 MCS-mode SCA input available
- 37 MCS-mode positive TTL input available
- 38 MCS-mode fast-negative NIM input available
- 39 MCS-mode discriminator input available
- 40 Software-switchable MCS-mode discriminator edge
- 41 Software-programmable MCS-mode discriminator level
- 42 Software-programmable SCA upper and lower thresholds
- 43 Software-selectable MCS-mode input sources
- 44 Uncertainty/statistical preset (SET\_UNCERT\_PRES)
- 45 Features vary by input (SHOW\_FEATURES depends on device/segment; multi-input MCBs only)
- 46 Software-selectable HV shutdown mode (SET/SHOW/VERI\_SHUT)
- 47 Software-selectable shaping time constants (SET\_SHAP)
- 48 Explorable shaping time constants (SHOW\_CONFIG\_SHAP)
- 49 Advanced shaping time (SET\_SHAP\_RISE, SET\_SHAPE\_FLAT, etc.)
- 50 Software-selectable BLR (ENA/DIS/SHO\_BLR\_AUTO SET/SHO/VERI\_BLR)
- 51 SHOW\_STATUS command supported (returns \$M record)
- 52 Overflow preset (ENA/DIS/SHO\_OVER\_PRES)

- 53 Software-enabled, MicroNOMAD-style audio clicker (ENA/DIS\_CLICK)
  - 54 Software-readable thermistor (SHOW\_THERM)
  - 55 Floating-point fine gain (SET/SHO/VERI/LIST\_GAIN\_FINE)
  - 56 Software-enabled pileup rejector. (ENA/DIS/SHO\_PUR, SET/VERI\_WIDT\_REJ)
  - 57 Alpha-style HV power (SHOW\_HV\_CURRENT)
  - 58 Software-readable vacuum (SHOW\_VACUUM)
  - 59 Acquisition alarms (ENA/DIS/SHO\_ALARM)
  - 60 Hardware acquisition trigger (ENA/DIS/SHO\_TRIG)
  - 61 Ordinal numbers for shaping times (SET\_SHAP 0, SET\_SHAP 1, ...)
  - 62 Explorable gain ranges (LIST/VERI\_GAIN\_FINE, ...\_COAR, ...\_CONV)
  - 63 Routable inputs (SET/SHOW\_INPUT\_ROUTE)
- Start of third word*
- 64 External dwell support (ENA/DIS\_DWELL\_EXT)
  - 65 Selectable SUM or REPLACE MCS modes (ENA/DIS\_SUM)
  - 66 External start of pass support (ENA/DIS/SHO\_START\_EXT)
  - 67 Explorable with MCS list commands (LIST\_SOURCE, LIST\_LLSCA, LIST\_ULSCA)
  - 68 Device supports the MDA preset
  - 69 Software-selectable ADC type (MatchMaker™)
  - 70 Has ability to daisy-chain MCBs (DART)
  - 71 Zero Dead Time functions available (DSPEC-series, ASPEC-927)
  - 72 DSPEC Plus-style Insight triggering (LIST/SET\_TRIG\_SAMP)
  - 73 Multiple inputs per connection (for example, OCTÊTE® Plus)
  - 74 Hardware count-rate meter (SH\_CRM)
  - 75 Multiple ZDT modes (SET/SHOW/LIST\_MODE\_ZDT)
  - 76 Multi-nuclide MDA preset
  - 77 MCS Replace then Sum Mode (SET\_RPLSUM)
  - 78 Programmable external dwell voltage capability
  - 79 NO Peak Preset feature (M<sup>3</sup>CA and OASIS)
  - 80 Programmable pulser (OASIS)
  - 81 Programmable Vacuum/HV interlock (OASIS)
  - 82 Programmable Current/HV interlock (OASIS)
  - 83 Explorable Stabilizer (LIST\_GAIN\_ADJU, LIST\_ZERO\_ADJU)
  - 84 Programmable input impedance (MCS)
  - 85 Advanced shaping-time feature has no CUSP (digiDART, DSPEC jr 2.0, DSPEC Pro)
  - 86 Selectable HV rise-time (SET/SHOW/LIST\_HV\_RISE) (SBS-60)
  - 87 Explorable ADC GATE settings (LIST\_GATE, SET\_GATE n)



- 88 Monitor command support (SHOW\_MONI\_MAX/LABEL/VALUE)
- 89 SMART-1 Detector support (SHOW\_SMART\_DET, SHOW\_SNUM\_DET, SHOW\_HV\_RECO)
- 90 Nuclide report (SET/SHOW\_NUCL\_COEF, SET/SHOW\_ROI\_NUCL, ...)
- 91 Interactive Display Features Such as Nuclide Report
- 92 Advanced Stored Spectra (SH\_SPEC\_COUNT, SET/SHOW\_SPEC\_ID, MOVE)
- 93 SET/SHOW\_VIEW in MCBs with Dual-Port Memory or printer port interfaces, LIST\_VIEW in all MCBs
- 94 Connected to MCB via RS-232 (slow) port
- 95 No SET\_HV\_POSI, SET\_HV\_NEGA, ENA\_NAI and DIS\_N
- Start of fourth word*
- 96 Low Frequency Rejecter (ENA/DIS/SHOW\_LFR)
- 97 Resolution Enhancer (ENA/DIS/SH\_RENHANCER, SET/SHOW\_RETABLE idx,val)
- 98 SET\_MODE\_RELIST for Resolution Enhancer List Mode
- 99 Readable Sample mode time per channel (SH\_TIME\_SAMPLE)
- 100 Adjustable Sample mode time per channel (SET/LIST\_TIME\_SAMPLE)
- 101 List Mode data streamed and formatted as in digiBASE
- 102 Supports ETP mode (ENA/DIS/SHOW\_ETP)
- 103 List Mode data streamed and formatted as in DSPEC Pro
- 104 SET/SHOW/LIST\_PZ using floating point microseconds
- 105 Rise time, flattop width and cusp not changeable from property page
- 106 HV not user changeable from property page (requires Bit 12)
- 107 Coarse and fine gain not user changeable from property page
- 108 PZ and flattop tilt not user changeable from property page
- 109 LFR not user changeable from property page (requires Bit 96)
- 110 Portal Monitor style List Mode Synch is available
- 111 DSPEC-Pro Auxiliary BNC input available
- 112 SET\_DISPLAY is NOT used to select ZDT data view (requires Bit 93)
- 113 ID Reports (DO\_ID, SHOW\_REPORT, SHOW\_REPO\_LINES)
- 114 Has neutron detector (SHOW\_CRM 2 returns valid number)
- 115 —
- 116 Has the ORTEC new Alpha feature set
- 117 —
- 118 —

119	—
120	—
121	—
122	—
123	—
124	—
125	—
126	—
127	Extended feature mask available (SH_FEAT_EXT)

# APPENDIX A. FIRMWARE COMMANDS AND RESPONSES

Most software communication with the Alpha Duo or Alpha Mega will be through the CONNECTIONS software layer. CONNECTIONS is used by all ORTEC software and can be accessed for other software development with our CONNECTIONS Programmer's Toolkit with Microsoft ActiveX® Controls (A11). Use the DLL interface call **MIOComm** or the ActiveX control UCONN's **Comm** method to send commands to instruments and receive responses.

## A.1. Command Format

The commands consist of a command header that may be followed by numeric parameter values. The header consists of a verb; a verb and noun; or a verb, noun, and modifier; each separated by underscores. The first four letters of a word in a command will always be enough to uniquely identify that word when composing commands for the instrument. For example, the command **ENABLE\_GAIN\_STABILIZATION** can be abbreviated to **ENAB\_GAIN\_STAB**.

Numeric parameters are unsigned integer numbers that follow the command header separated by one or more spaces. Specific commands require multiple parameters, separated by commas, that specify numeric quantities related to the operation of the MCB, such as live time or conversion gain. The command **SET\_WINDOW 0,8192** has two parameters, 0 and 8192, which set the window of interest to start at channel 0 and continue for 8192 channels.

Some parameters are optional and are delimited by square brackets in the command prototype line to distinguish them from mandatory parameters (e.g., **SET\_WINDOW [start,length]**). Commands with optional parameters can be sent to the MCB without the optional parameters, in which case the instrument behavior will be explained in the command description.

## A.2. Error Codes

On each completion of the command, the MCB returns a macro error code and micro error code. The macro error code represents the general class of error with 0 meaning no error, and the micro error code represents the sub-class of error with 0 meaning no error. In case of error condition, you can use the **MIOGetLastError** (DLL interface) or **GetErrMajor, GetErrMinor** (ActiveX control interface).

Macro error codes:

0	Success
1	Power-up just occurred
2	Battery-backed data lost

129	Command syntax error
131	Command execution error
132	Invalid Command

For macro code 129 (syntax error) or 131 (execution error), the following apply:

1	Invalid Verb
2	Invalid Noun
4	Invalid Modifier
128	Invalid first parameter
129	Invalid second parameter
130	Invalid third parameter
131	Invalid fourth parameter
132	Invalid number of parameters
133	Invalid command
134	Response buffer too small
135	Not applicable while active
136	Invalid command in this mode
137	Hardware error
138	Requested data not found

Micro error codes:

0	Success
1	Input already started/stopped
2	Preset already exceeded
4	Input not started/stopped
64	Parameter was rounded (for decimal numbers)
128	No sample data available

### A.2.1. Dollar Response Records

SHOW and STEP commands respond with a single dollar response record followed immediately by a percent response record. All valid dollar response records for each command are listed in the command dictionary.

The following list provides the general form of each dollar response record for the MCB API. In this list, lower case letters represent numeric values. The letters “ccc” always represent an 8-bit unsigned checksum of all characters on the record up to but not including the checksum characters, and <CR> represents the ASCII carriage return character.

<b>\$Axxxccc&lt;CR&gt;</b>	xxx is a single 8-bit unsigned number.
<b>\$Cxxxxxccc&lt;CR&gt;</b>	xxxxx is a single 16-bit unsigned number.
<b>\$Dxxxxxyyyyccc&lt;CR&gt;</b>	xxxxx and yyyy are 16-bit unsigned numbers.
<b>\$Exxxxxccc&lt;CR&gt;</b>	xxxxx is a single 16-bit alarm mask.
<b>\$Fsss...&lt;CR&gt;</b>	sss... is a variable length ASCII character sequence (no checksum is sent with this record).
<b>\$Gxxxxxxxxxxxccc&lt;CR&gt;</b>	xxxxxxxxxxx is a single 32-bit unsigned number.
<b>\$IT&lt;CR&gt;</b>	True response to a SHOW command (no checksum).
<b>\$IF&lt;CR&gt;</b>	False response to a SHOW command (no checksum).
<b>\$Jxxxxxyyyy...ccc&lt;CR&gt;</b>	Response to SHOW_CONFIGURATION command.
<b>\$Mxxxxxxxxxxx...ccc&lt;CR&gt;</b>	Response to SHOW_STATUS command.
<b>\$Nxyyyzzzccc&lt;CR&gt;</b>	xxx, yyy, and zzz are 8-bit unsigned numbers.

## A.2.2. MCB Commands

This section lists each command with a description of its operation. The descriptions include a list of any error codes that may result. As described in the two preceding sections, the usual response is a macro error code of 0 and a micro error code of 0 (no errors). Though syntax and communication error responses may result from any command, in practice, these error responses rarely occur on systems with reliable communication hardware running debugged software.

The commands are listed in alphabetical order, each starting with a command prototype line. Uppercase letters, numeric digits, blank space, and special symbols such as the underscore “\_” and comma “,” in the prototype line are *literal text to be sent to the MCB exactly as they appear*. Lowercase letters in the prototype line represent numeric values as described in the accompanying text; they should not be sent literally to the MCB but should be replaced by an appropriate numeric value. In this section the term <CR> represents the ASCII carriage return character, decimal value 13; and the character “\_” represents the ASCII underscore character, decimal value 95.

### CLEAR

The channels of spectral data in the window of interest (see SET\_WINDOW command) for the currently selected segment are set to zero. The live time and true time counters for the currently selected segment are also set to zero. This command is equivalent to the combination of CLEAR\_COUNTERS and CLEAR\_DATA commands.

**CLEAR\_ALL**

This command is equivalent to the combination of CLEAR\_COUNTERS, CLEAR\_DATA, CLEAR\_PRESETS, and CLEAR\_ROI commands.

**CLEAR\_COUNTERS**

The live-time and true-time counters for the currently selected segment are set to zero.

**CLEAR\_DATA**

The channels of spectral data in the window of interest (see SET\_WINDOW command) for the currently selected segment are set to zero. The ROI flags and presets are not changed.

**CLEAR\_PRESETS**

The live time, true time, ROI integral, ROI peak and overflow presets are all set to zero (disabled) for the currently selected segment.

**CLEAR\_ROI**

If start and length are not specified, the region-of-interest flags for the channels in the window of interest (see SET\_WINDOW) are cleared. If start and length are specified, region-of-interest flags for the channels specified by start and length are cleared.

**DISABLE\_GAIN\_STABILIZATION**

Stops stabilization of the gain peak while data is being acquired. The gain stabilization adjustment is held at its current value until either gain stabilization is reenabled with the ENABLE\_GAIN\_STABILIZATION command or reinitialized with the INITIALIZE\_GAIN\_STABILIZATION, SET\_GAIN\_PEAK or SET\_GAIN\_WIDTH command. See also SHOW\_GAIN\_STABILIZATION.

**DISABLE\_HV**

Turns off the high-voltage enable signal for the selected segment. See also ENABLE\_HV and SHOW\_HV.

**DISABLE\_OVERFLOW\_PRESET**

Disables the overflow preset for the currently selected segment. Channels that receive a count when they contain 2147483647 counts, the maximum number of counts, will roll over to zero counts if the overflow preset is disabled. See also ENABLE\_OVERFLOW\_PRESET and SHOW\_OVERFLOW\_PRESET.

**DISABLE\_PULSER**

Turns off the internal pulser.

**ENABLE\_GAIN\_STABILIZATION**

Enables the stabilization of the gain peak by the previously selected method, either Gauss mode or point mode (see SET\_MODE\_GAUSS and SET\_MODE\_POINT). See also DISABLE\_GAIN\_STABILIZATION, SHOW\_GAIN\_STABILIZATION, and INITIALIZE\_GAIN\_STABILIZATION.

**ENABLE\_HV**

Turns on the high voltage.

**ENABLE\_OVERFLOW\_PRESET**

Enables the overflow preset for the currently selected segment. Channels that receive a count when they contain 2147483647 counts, the maximum number of counts, will stop the acquisition for that channel's device if the overflow preset is disabled. The channel that caused the preset to complete will contain 2147483647 counts. An alarm response record will be sent to the host if alarms are enabled for the device whose acquisition is stopped (see ENABLE\_ALARM command). Overflow presets may be independently set for each of the devices in an Alpha Duo. See also DISABLE\_OVERFLOW\_PRESET and SHOW\_OVERFLOW\_PRESET commands.

**ENABLE\_PULSER**

Turns on the internal pulser.

**INITIALIZE**

Returns the Alpha chamber to the factory default settings.

**INITIALIZE\_GAIN\_STABILIZATION**

Resets the gain peak stabilization adjustment to unity (no adjustment). This value is reported as 2048 by the SHOW\_GAIN\_ADJUSTMENT command. See also SET\_GAIN\_ADJUSTMENT, ENABLE\_GAIN\_STABILIZATION, and DISABLE\_GAIN\_STABILIZATION.

**LIST\_GAIN\_ADJUST**

Lists the range of valid gain stabilizer adjustments.

Response:

**GAIN\_ADJU -100 100 -100 100**                      Gain stabilizer adjustment ranges from -100% to +100%.

**LIST\_GAIN\_CONVERSION**

Returns a string that enumerates each legal conversion gain setting separated by a space.

Response:

**GAIN\_CONV 256 512 1024 2048 4096**

**LIST\_GAIN\_FINE**

Lists the valid fine-gain settings.

Response:

**GAIN\_FINE 0.250 1.0 1032192 4128768** Valid fine gain settings range from 0.25 to 1.0.

**LIST\_HV**

Lists the valid bias settings. The Alpha Duo accepts bias values between 0 and +1200 V in 960 steps (1.25 V/step).

**LIST\_VACUUM\_MODE**

Lists the available vacuum modes (e.g. vent, pump, or hold).

Response:

**VACU\_MODE VENT PUMP HOLD**

**RESET**

Resets the Alpha Duo to the state just after power is applied. This command responds with a % response that indicates power-up just occurred.

**SET\_DATA** start channel,width,count

If the optional start and channels parameters are included in this command, the range of channels specified by start and channels is loaded with value. If start and channels are not specified, sets all channels of spectral data in the window of interest (see SET\_WINDOW command) to the specified value. ROI flags are not affected.

**SET\_DATA\_APP** “entry”,”data”

Stores information such as sample descriptions and energy calibrations in the MCB internal memory that can be used by other programs. Entry (32 characters maximum) specifies the type of information to store with data (128 characters maximum).

**SET\_GAIN\_CHANNEL** chan

Sets the center channel for the stabilizer gain peak. If a gain channel is chosen such that the beginning channel or ending channel would be below channel 0 or above the maximum channel as determined by the conversion gain, the gain peak width is reduced until the peak fits the device boundaries. A gain channel and width must be set before gain stabilization can be enabled.

**SET\_GAIN\_CONVERSION** chans

Sets the conversion gain. The conversion gain defines the number of channels within the device that will be used for spectral data. See also LIST\_GAIN\_CONVERSION and SHOW\_GAIN\_CONVERSION.



Legal Commands:

<b>SET_GAIN_CONVERSION 0&lt;CR&gt;</b>	Conversion gain set to default (4096).
<b>SET_GAIN_CONVERSION 4096&lt;CR&gt;</b>	Conversion gain set to 4096 channels (full ADC resolution).
<b>SET_GAIN_CONVERSION 2048&lt;CR&gt;</b>	Conversion gain set to 2048 channels.
<b>SET_GAIN_CONVERSION 1024&lt;CR&gt;</b>	Conversion gain set to 1024 channels.
<b>SET_GAIN_CONVERSION 512&lt;CR&gt;</b>	Conversion gain set to 512 channels.
<b>SET_GAIN_CONVERSION 256&lt;CR&gt;</b>	Conversion gain set to 256 channels.

**SET\_GAIN\_FINE** value

This sets the fine gain to value. Value is a floating point value from 0.25 to 1.0. See also LIST\_GAIN\_FINE and SHOW\_GAIN\_FINE.

**SET\_GAIN\_WIDTH** chans

Sets the width in channels for the stabilizer gain peak. The gain width must be chosen such that the beginning channel is no lower than channel 0 and the ending channel is no higher than the maximum channel as determined by the conversion gain. The gain channel and width must be set before gain stabilization can be enabled. The absolute minimum width for the gain peak is 3 channels. See also SHOW\_GAIN\_WIDTH, SET\_GAIN\_CHANNEL and SHOW\_GAIN\_CHANNEL.

**SET\_HV** value

This sets the bias to value, in volts, and stores value as the target HV.

**SET\_INTEGRAL\_PRESET** count

Sets the ROI integral preset for the currently selected segment to the specified count. During data acquisition when the sum of the counts contained in the channels of a segment that have the ROI flag set reaches the integral preset count, the preset is complete and the acquisition is stopped. The actual number of counts in the ROI integral may exceed the preset value by up to 512 counts due to the pipelined architecture of the Alpha Duo. Setting an integral preset to 0 counts disables the preset. The integral preset can be set to from 0 (disabled) to 4294967295 counts. See also CLEAR\_PRESETS and SHOW\_INTEGRAL\_PRESET.

**SET\_LIVE** ticks

Sets the live-time counter for the currently selected segment to the specified number of ticks. The number represents live time in units of 20 ms (50 ticks per second). Normally this value is set by the Alpha Duo during data acquisition. See also CLEAR\_COUNTERS and SHOW\_LIVE.

**SET\_LIVE\_PRESET** ticks

Sets the live-time preset for the currently selected segment to the specified number of ticks. During data acquisition when the live-time counter reaches the preset number of ticks, the preset is complete and the acquisition is stopped. Setting a live-time preset to 0 ticks disables the preset. See also CLEAR\_PRESETS and SHOW\_LIVE\_PRESET.

**SET\_LLD** chan

Sets the lower level discriminator to chan, which must be between 0 and 4095. See also SHOW\_LLD.

**SET\_MODE\_PHA**

Sets the MCB to pulse height analysis mode for collection of histogram data.

**SET\_MODE\_SAMPLE**

Starts InSight Virtual Oscilloscope mode.

**SET\_OFFSET** chans

Sets the digital offset to the specified number of channels. The digital offset represents the number of channels that the spectrum is shifted to the lower energy side of the segment. Note that if the digital offset is set to a value greater than the current conversion gain setting, no counts can be processed since the entire spectrum is shifted out of the segment. See also SHOW\_OFFSET.

Legal Commands:

<b>SET_OFFSET 0</b>	Digital offset set to 0 channels (no offset).
<b>SET_OFFSET 1</b>	Digital offset set to 1 channel.
<b>SET_OFFSET 2</b>	Digital offset set to 2 channels.
...	...
<b>SET_OFFSET 4095</b>	Digital offset set to 4095 (maximum offset).

**SET\_PEAK\_PRESET** count

Sets the ROI peak preset for the currently selected segment to the specified count. During data acquisition when the contents of any channel of a segment that has the ROI flag set reaches the peak preset count, the preset is complete and the acquisition is stopped. The actual number of counts in the ROI peak may exceed the preset value by a small number of counts due to the pipelined architecture of the Alpha Duo. Setting a peak preset to 0 counts disables the preset. The peak preset can be set to from 0 (disabled) to 2147483647 counts. See also CLEAR\_PRESETS and SHOW\_PEAK\_PRESET.

**SET\_PULAMP** pulseramplitude

Sets the pulser amplitude (from 0 to 4095).

**SET\_RCAP**

Turns on automatic vacuum monitoring and regulation (same as marking the **Vacuum monitoring** checkbox on the Alpha tab under **Acquire/MCB Properties** in MAESTRO). See also **SHOW\_RCAP**.

**SET\_ROI** start\_chan,number\_of\_chans

Sets the ROI flags for the specified channels in the currently selected segment. This command can be used multiple times to set ROI flags without affecting previously set flags. ROI flags specify channels within a segment that are considered for ROI integral and ROI peak presets.

**SET\_SEGMENT** number

The segment number is used to represent the default input (chamber) for commands such as **START** and **STOP**. Normally, our interface software transparently manages the segment number, and application programs should not attempt to change it. Always 1 for the Alpha Duo.

**SET\_TRUE** ticks

Sets the true-time counter for the currently selected segment to the specified number of ticks. The number represents true time in units of 20 ms (50 ticks per second). Normally this value is set by the Alpha Duo during data acquisition. See also **CLEAR\_COUNTERS** and **SHOW\_TRUE**.

**SET\_TRUE\_PRESET** ticks

Sets the true-time preset for the currently selected segment to the specified number of ticks. During data acquisition when the true-time counter reaches the preset number of ticks, the preset is complete and the acquisition is stopped. Setting a true-time preset to 0 ticks disables the preset. See also **CLEAR\_PRESETS** and **SHOW\_TRUE\_PRESET**.

**SET\_ULD** value

This sets the upper level discriminator to value, in channels.

**SET\_VACUUM\_MODE** setting

Sets the vacuum mode. Setting 0 = vent, 1 = pump, 2 = hold. See also **SHOW\_VACUUM\_MODE**.

**SET\_VACUUM\_TARG** milliTorr

Sets the target pressure for both Alpha Duo chambers in milliTorr. See also **SHOW\_VACUUM\_TARG**.

**SET\_WINDOW** [start, length]

Sets the window of interest to the specified start channel and number of channels. The channels of spectral data in the window of interest are affected by commands such as CLEAR and SET\_DATA. If neither start nor length is provided, the window is set to the maximum size allowed by the conversion gain specified.

**SHOW\_ACTIVE**

Reports which segments are currently acquiring data. Always 1 for the Alpha Duo.

Responses:**\$C00000087<CR>**

No segments are acquiring data.

**\$C00001088<CR>**

Only segment 1 is acquiring data.

**SHOW\_CONFIGURATION**

Returns a record that indicates the hardware configuration of the MCB. The record contains information about the number of segments in an MCB device, and the current conversion gain for each segment. The record is organized as follows:

**\$J0819200001aaaaa00000**[65 zeros here for total of 75 zeros]**00000ccc**

where **aaaaa** represents the conversion gain for segment 1, and **ccc** represents the record checksum. See Section ? for more information about response records and checksums.

**SHOW\_CONFIGURATION\_MASK**

Returns two masks, the first of which can be “anded” with data from the MCB to clear the ROI bit from the data. When the second mask value is “anded” with data from the MCB, the data bits are removed and only the ROI bit remains.

Response:**CONF\_MASK 02147483647 02147483648****SHOW\_CRM**

Returns the current reading of the count-rate meter.

Response:**\$G0000050781096**

Current input count rate is 50781 counts/s.

**SHOW\_DATA\_APPLICATION** “entry”

If entry matches entry from a previous SET\_DATA\_APPLICATION command, the data from the SET\_DATA\_APPLICATION command is returned in a \$F record.

**SHOW\_DEVICE**

Included for compatibility with other MCBs. Always returns one for the number of the currently selected device.

**SHOW\_FEATURES**

Responds with four 32-bit masks that indicate which features are present in the MCB. See Section 5.14 for a complete description of each bit in the mask.

Example Response:

**FEATURES 00003152173 01116798988 02684945664 00001114120**

**SHOW\_GAIN\_ADJUST**

Returns the gain-stabilizer setting.

**SHOW\_GAIN\_CONVERSION**

This command returns the conversion gain for the currently selected segment.

Responses:

<b>\$C00256100&lt;CR&gt;</b>	Conversion gain reported as 256 channels.
<b>\$C00512095&lt;CR&gt;</b>	Conversion gain reported as 512 channels.
<b>\$C01024094&lt;CR&gt;</b>	Conversion gain reported as 1024 channels.
<b>\$C02048101&lt;CR&gt;</b>	Conversion gain reported as 2048 channels.
<b>\$C04096106&lt;CR&gt;</b>	Conversion gain reported as 4096 channels.

**SHOW\_GAIN\_FINE**

Returns the current fine gain setting. See SET\_GAIN\_FINE.

Sample Response:

<b>GAIN_FINE 000000000000.5</b>	Parameter is set to 0.5.
---------------------------------	--------------------------

**SHOW\_GAIN\_STABILIZATION**

Reports the state of gain peak stabilization. See also ENABLE\_GAIN\_STABILIZATION and DISABLE\_GAIN\_STABILIZATION.

Responses:

<b>\$IT&lt;CR&gt;</b>	Gain stabilization is currently enabled.
<b>\$IF&lt;CR&gt;</b>	Gain stabilization is currently disabled.

**SHOW\_GAIN\_WIDTH**

Reports the current width for the stabilizer gain peak. See also SET\_GAIN\_WIDTH, SET\_GAIN\_CHANNEL, and SHOW\_GAIN\_CHANNEL.

Responses:

<b>\$C00001088&lt;CR&gt;</b>	Gain width has not been set.
<b>\$C00003089&lt;CR&gt;</b>	Gain width is 3 channels (lowest possible width).
...	...
<b>\$C00256100&lt;CR&gt;</b>	Gain width is 256 channels.

**SHOW\_GATE**

Reports the current mode of operation of the ADC gate input. See also SET\_GATE\_OFF, SET\_GATE\_COINCIDENT, and SET\_GATE\_ANTICOINCIDENT.

Responses:

<b>\$FOFF&lt;CR&gt;</b>	Reports the ADC gate is off or ignored.
<b>\$FCOI&lt;CR&gt;</b>	Reports the ADC gate is in coincident mode.
<b>\$FANT&lt;CR&gt;</b>	Reports the ADC gate is in anticoincident mode.

**SHOW\_HV**

Reports the high voltage and the status of the high voltage power supply in the form

**\$Dvvvvvsssssccc<CR>**

where **vvvvv** represents the output voltage if the high voltage is enabled, or the rear-panel high voltage setting if the high voltage is disabled. **sssss** represents the status of the high voltage bias supply as a 16-bit decimal number with the following bit definitions:

<b>Bit 0 (LSB):</b>	Bias supply polarity (0=positive, 1=negative).
<b>Bit 1:</b>	Bias supply overload (0=overload, 1=normal).
<b>Bit 2:</b>	High voltage enabled (0=disabled, 1=enabled).

Example Responses:

<b>\$D0200000003077&lt;CR&gt;</b>	2000 V, negative, not overloaded, disabled.
<b>\$D0200000002076&lt;CR&gt;</b>	2000 V, positive, not overloaded, disabled.
<b>\$D0200000007082&lt;CR&gt;</b>	2000 V, negative, not overloaded, enabled.

**SHOW\_HV\_ACTUAL**

Returns the value of HV actually on the detector.

**SHOW\_HV\_CURRENT**

Returns the bias supply current for the default input for the selected segment as follows:

**\$Crrrrrccc<CR>**

where **rrrrr** represents the output current in nanoamps.

**SHOW\_HV\_TARGET**

Under normal operation, the HV will go to this value when the HV is enabled. Reports the current HV setting (see SET\_HV) and the status of the HV power supply in the form:

**\$Dvvvvvsssssccc<CR>**

where **vvvvv** represents the HV setting, and **sssss** represents the status of the HV bias supply as a 16-bit decimal number with the following bit definitions:

<b>Bit 0 (LSB):</b>	Bias supply polarity (0=positive, 1=negative).
<b>Bit 1:</b>	Bias supply overload (0=overload, 1=normal).
<b>Bit 2:</b>	HV enabled (0=disabled, 1=enabled).

Example Responses:

<b>\$D0200000003077&lt;CR&gt;</b>	2000 V, negative, not overloaded, disabled.
<b>\$D0200000002076&lt;CR&gt;</b>	2000 V, positive, not overloaded, disabled.
<b>\$D0200000007082&lt;CR&gt;</b>	2000 V, negative, not overloaded, enabled.

**SHOW\_INTEGRAL** [start\_chan,number\_of\_chans]

Reports the sum of the specified group of spectral data channels for the currently selected segment. If start\_chan and number\_of\_chans is not provided, SHOW\_INTEGRAL reports the sum of all channels in the currently selected segment that have their ROI flag set.

Responses:

<b>\$G0000000000075&lt;CR&gt;</b>	Integral reported as 0.
...	...
<b>\$G4294967294131&lt;CR&gt;</b>	Integral reported as 4294967294.
<b>\$G4294967295132&lt;CR&gt;</b>	Integral reported as greater than or equal to 4294967295 (maximum reportable value).

**SHOW\_INTEGRAL\_PRESET**

Reports the current ROI integral preset value for the currently selected segment. See SET\_INTEGRAL\_PRESET for more information about the ROI integral preset. See also SHOW\_INTEGRAL.

Responses:

<b>\$G0000000000075&lt;CR&gt;</b>	Integral preset reported as 0.
...	...
<b>\$G4294967295132&lt;CR&gt;</b>	Integral reported as 4294967295.

**SHOW\_LIVE**

Reports the contents of the live-time counter for the currently selected segment in units of 20 ms (50 ticks per second). See also CLEAR\_COUNTERS and SET\_LIVE.

Responses:

<b>\$G0000000000075&lt;CR&gt;</b>	Live time reported as 0 ticks
<b>\$G0000000001076&lt;CR&gt;</b>	Live time reported as 1 tick (20 ms)
...	...
<b>\$G4294967295132&lt;CR&gt;</b>	Live time reported as 4294967295 ticks (over 23,000 days).

**SHOW\_LIVE\_PRESET**

Reports the current live-time preset for the currently selected segment in units of 20 ms (50 ticks per second). See also CLEAR\_PRESETS and SET\_LIVE\_PRESET.

Responses:

<b>\$G0000000000075&lt;CR&gt;</b>	Live-time preset reported as disabled.
<b>\$G0000000001076&lt;CR&gt;</b>	Live-time preset reported as 1 tick.

**\$G4294967295132<CR>**

Live-time preset reported as 4294967295 ticks.

**SHOW\_LLD**

Shows the lower level discriminator setting. See also SET\_LLD.

Responses:**\$C00050092**

The LLD is 50.

**SHOW\_MODE**

Reports mode of operation (PHA, or Sample [InSight]). Response: \$FPHA&lt;CR&gt; PHA mode. \$FLIS&lt;CR&gt; List mode. \$FSAM&lt;CR&gt; Sample (InSight) mode.

Responses:**\$FPHA<CR>**

PHA mode.

**\$FSAM<CR>**

Sample (InSight) mode.

**SHOW\_NEXT**

Used in conjunction with the SHOW\_ROI command, SHOW\_NEXT reports the next continuous group of channels in the currently selected segment that have the ROI flag set. The response is of the form:

**\$Dssssnnnnnccc<CR>**where **sssss** represents an integer number that is the number of the first channel of the “next” group of channels that all have their ROI bit set, and **nnnnn** represents an integer number that is the number of channels in the group. If no more channels have their ROI bit set, SHOW\_NEXT returns a first channel of 0 and a number of channels of 0. The SHOW\_ROI command is used to report the “first” group of channels that all have their ROI bit set.Example Responses:**\$D0100000050078<CR>**

Next ROI group starts at chan 1000 and is 50 channels long.

**\$D0215000150086<CR>**

Next ROI group starts at chan 2150 and is 150 channels long.

**\$D0000000000072<CR>**

No other ROI groups to report.

**SHOW\_OFFSET**

This command returns the digital offset for the input routed to the currently selected segment. If more than one input is routed to the currently selected segment this command returns the offset for the lowest numbered input routed to the currently selected segment. See also SET\_OFFSET and SET\_INPUT\_ROUTE.

Responses:**\$C00000087<CR>**

Digital offset reported as 0 channels.

**\$C00001088<CR>**

Digital offset reported as 1 channel.

...

...

**\$C01000088<CR>**

Digital offset reported as 1000 channels.



**SHOW\_OVERFLOW\_PRESET**

Reports the state of the overflow preset for the currently selected segment.

Responses:**\$IT<CR>**

Overflow preset enabled for the currently selected segment.

**\$IF<CR>**

Overflow preset disabled for the currently selected segment.

**SHOW\_PEAK**

This command returns the contents of the ROI channel with the largest number of counts. An ROI channel is a channel that has the ROI flag set. The maximum possible value is 2147483647, which is the maximum number of counts that can be stored in a 31-bit channel.

Responses:**\$G0000000000075<CR>**

Maximum count in an ROI channel is zero or no ROI channels were found.

**\$G0000000001076<CR>**

Maximum count in an ROI channel is 1.

...

...

**\$G2147483646120<CR>**

Maximum count in an ROI channel is 2147483646.

**\$G2147483647121<CR>**

Maximum count in an ROI channel is 2147483647.

**SHOW\_PEAK\_CHANNEL**

This command returns the number of the ROI channel with the largest number of counts. An ROI channel is a channel that has the ROI flag set. The lowest number ROI channel with the largest count is reported if more than one channel contains the largest number of counts. Channel 4096 is the highest numbered channel.

Responses:**\$C00000087<CR>**

Maximum count was found in channel 0 or no ROI channels were found.

**\$C00001088<CR>**

Maximum count was found in channel 1.

...

...

**\$C00412094<CR>**

Maximum count was found in channel 412.

**SHOW\_PEAK\_PRESET**

Reports the value of the ROI peak preset for the currently selected segment. See SET\_PEAK\_PRESET for information about the ROI peak preset.

Responses:**\$G0000000000075<CR>**

Peak preset disabled.

**\$G0000000001076<CR>**

Peak preset set to 1 count.

...

...

**\$G2147483646120<CR>**

Peak preset set to 2147483646 counts.

**\$G2147483647121<CR>**

Peak preset set to 2147483647 counts.

**SHOW\_PULAMP**

Reports the pulser amplitude (from 0 to 4095).

Response:

**PULAMP 00000000002000**                      Pulser amplitude set to 2000.

**SHOW\_PULSER**

Reports whether pulser is on (true) or off (false).

Response:

**\$IT<CR>**    Pulser is on.

**\$IF<CR>**    Pulser is off.

**SHOW\_RCAP**

Reports whether automatic vacuum monitoring and regulation is turned on (true) or off (false). See also SET\_RCAP.

Response:

**\$IT<CR>**    Automatic vacuum monitoring is on.

**\$IF<CR>**    Automatic vacuum monitoring is off.

**SHOW\_ROI**

Used in conjunction with the SHOW\_NEXT command, SHOW\_ROI reports the first continuous group of channels in the currently selected segment that have the ROI flag set. The response is of the form:

**\$Dssssnnnnccc<CR>**

where **sssss** represents an integer number that is the number of the first channel of the “first” group of channels that all have their ROI bit set, and **nnnnn** represents an integer number that is the number of channels in the group. The SHOW\_NEXT command is used to report the “next” group of channels that all have their ROI bit set.

Responses:

**\$D0100000050078<CR>**                      First ROI group starts at chan 1000 and is 50 channels long.

**\$D0215000150086<CR>**                      First ROI group starts at chan 2150 and is 150 channels long.

**\$D0000000000072<CR>**                      No ROI groups to report.

**SHOW\_SEGMENT**

Returns the current segment number. Always 1 for the Alpha Duo.

**SHOW\_SNUM**

Responds with a \$F record indicating the serial number of the MCB.

Response:

**\$F100**    Serial Number = 100.

**SHOW\_STATUS**

Returns system status information in the following format:

**\$MIIIIIIIIIttttttttttaaaaahhhhccc<CR>**

where **IIIIIIII** represents the live time as returned by the SHOW\_LIVE command, **tttttttt** represents the true time for the current segment as returned by the SHOW\_TRUE command, **aaaaa** represents the active device mask as returned by the SHOW\_ACTIVE\_DEVICES command, and **hhhhh** represents the hardware status, which is an ASCII representation of a 16-bit decimal number with the following bit definitions:

<b>Bit 0 (LSB):</b>	Bias Supply Polarity (0 = positive, 1 = negative).
<b>Bit 1:</b>	Bias Supply Overload (0 = overload, 1 = normal).
<b>Bit 2:</b>	High Voltage Enabled (0 = disabled, 1 = enabled).
<b>Bit 3:</b>	Unused.
<b>Bit 4:</b>	Amplifier pole-zeroed since initialization (0 = normal, 1 = needs pole zeroing).
<b>Bits 5–7:</b>	Unused.
<b>Bit 8:</b>	Amplifier Automatic Pole Zero (1 = Auto Pole Zero in progress, 0 = normal).
<b>Bits 9–14:</b>	Unused.
<b>Bit 15 (MSB):</b>	Reserved.

**SHOW\_TRUE**

Reports the contents of the true-time counter for the currently selected segment in units of 20 ms (50 ticks per second). See also CLEAR\_COUNTERS and SET\_TRUE.

Responses:

<b>\$G0000000000075&lt;CR&gt;</b>	True time reported as 0 ticks.
<b>\$G0000000001076&lt;CR&gt;</b>	True time reported as 1 tick (20 ms).
...	...
<b>\$G4294967295132&lt;CR&gt;</b>	True time reported as 4294967295 ticks (over 23,000 days).

**SHOW\_TRUE\_PRESET**

Reports the current true-time preset for the currently selected segment in units of 20 ms (50 ticks per second). See also CLEAR\_PRESETS and SET\_TRUE\_PRESET.

Responses:

<b>\$G0000000000075&lt;CR&gt;</b>	True-time preset reported as disabled.
<b>\$G0000000001076&lt;CR&gt;</b>	True-time preset reported as 1 tick.
...	...
<b>\$G4294967295132&lt;CR&gt;</b>	True-time preset reported as 4294967295 ticks.

## SHOW\_ULD

Returns the value of the ULD in channels, as a \$C record.

Example Response:

**\$C01023093** The ULD is 1023.

## SHOW\_VACUUM

Returns the vacuum for the selected segment as follows:

**\$Cvvvvvccc<CR>**

where **vvvvv** represents the vacuum reading in mTorr.

## SHOW\_VACUUM\_TARG

Returns the target vacuum for the selected segment as follows:

**\$Cvvvvvccc<CR>**

where **vvvvv** represents the vacuum reading in mTorr.

## SHOW\_VACUUM\_MODE

Shows the current vacuum mode (e.g. VENT, PUMP, or HOLD).

Example Responses:

**VACU\_MODE HOLD** The chamber is currently in HOLD mode.

## SHOW\_VERSION

Reports the Alpha Duo firmware version number in the form:

**Fmmmm-vvv<CR>**

where **mmmm** is a 4-character model designator and **vvv** is a 3-character version designator.

Example Responses:

**\$FADUO-002<CR>** Alpha Duo firmware version 2 reported.

## SHOW\_WINDOW

Reports the start channel and number of channels that are in the window of interest for the currently selected segment in the form:

**\$Dxxxxxyyyyyccc<CR>**

where **xxxxx** is the start channel (0 through 4095) and **yyyyy** is the number of channels (1–4096). See SET\_WINDOW for more information about the window of interest.

Example Responses:

**\$D0000004096091<CR>** Window of interest reported as starting at channel 0 and continuing for 4096 channels.

**\$D0000002048086<CR>** Window of interest reported as starting at channel 0 and continuing for 2048 channels (first 1/2).

**\$D0204802048100<CR>** Window of interest reported as starting at channel 2048 and continuing for 2048 channels (last 1/2).

**START** [seg-mask]

Starts data acquisition. The optional segment mask is provided for compatibility with other MCBs and may be any value from 0 to 65535 but is ignored by the Alpha Duo.

**STOP** [seg-mask]

Stops the acquisition of spectral data in the currently selected segment. The optional segment mask is provided for compatibility with other MCBs and can be any value from 0 to 65535, but is ignored by the Alpha Duo.

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# APPENDIX B. CHANGING TO AN OPPOSITE-POLARITY DETECTOR

Switching to an opposite-polarity detector<sup>5</sup> requires changing three slide switches *per chamber* on the printed wiring board (PWB) and recalibrating the pulser. After making these hardware changes, you must use MAESTRO or AlphaVision to recalibrate the detector.

Procedure:

- 1) Disconnect the instrument from ac mains power.
- 2) Remove the Alpha module from its benchtop or Ensemble enclosure by unscrewing the eight Phillips-head screws from the top and bottom edges of the front panel, then pulling the module forward and out. The internal vacuum line, USB cable, and power cable are long enough that they do not have to be disconnected. (However, disconnection and reconnection are very simple, should you wish to do so.)

Figure 14 shows an Alpha Duo partially removed from its benchtop housing. The housing cover has been removed for illustrative purposes.

Figure 15 shows a Duo module being removed from an Alpha Ensemble. The vacuum, USB, and power connections from the Ensemble housing to the Duo rear panel are clearly visible.

- 3) Next, unscrew the Phillips-head screws from the top panel of the module and set the panel aside. Figure 16 shows the interior of a Duo, and Fig. 17 shows an Alpha Mega faceplate and chamber pulled out of the housing. Note that the vacuum gauge is attached to the right-hand chamber of a Duo and the right side of the Mega chamber.
- 4) The polarity switches for the left and right chambers are located on the left- and right-front quadrants of the board, respectively. These two quadrants are mirrors of one another. In the Duo, all switches and the pulser adjustment pots can be reached without removing the vacuum chambers. The deeper Mega chamber obscures the switches so it must be removed.

---

<sup>5</sup>All ORTEC charged-particle detectors are shipped in a plastic container, accompanied by a quality-control sheet. Both bear the model number. The first letter gives the mount type (for Alpha Suite modules, this is always B rear Microdot). The second letter is the detector type: R = Ruggedized (negative bias), U = ULTRA (positive bias), and A = A Series (positive bias).



**Fig. 14. Alpha Duo Partially Removed from Benchtop Enclosure**

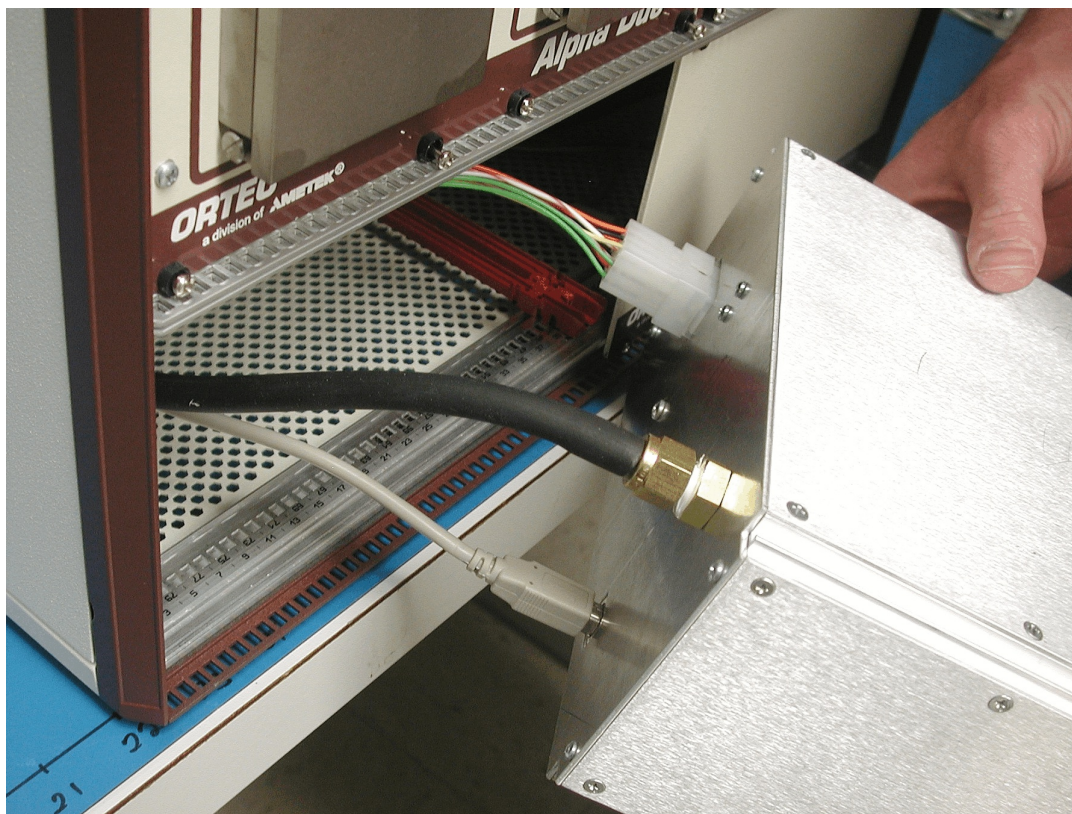
- 5) To remove the chamber(s), use a Phillips screwdriver to remove the four (4) screws that hold the faceplate to the chassis, then pull the faceplate/chamber assembly *gently* forward.

Note that, on the Duo, the four wires for the front-panel LEDs may be short enough that they must be disconnected from the PWB before you can pull the faceplate/chamber assembly out of the enclosure. As you detach the connectors, make sure each is labeled with its corresponding PWB input (the only consequence of improper reconnection is that the HV/Pulser and ADC front-panel signals will be mixed up).<sup>6</sup>

---

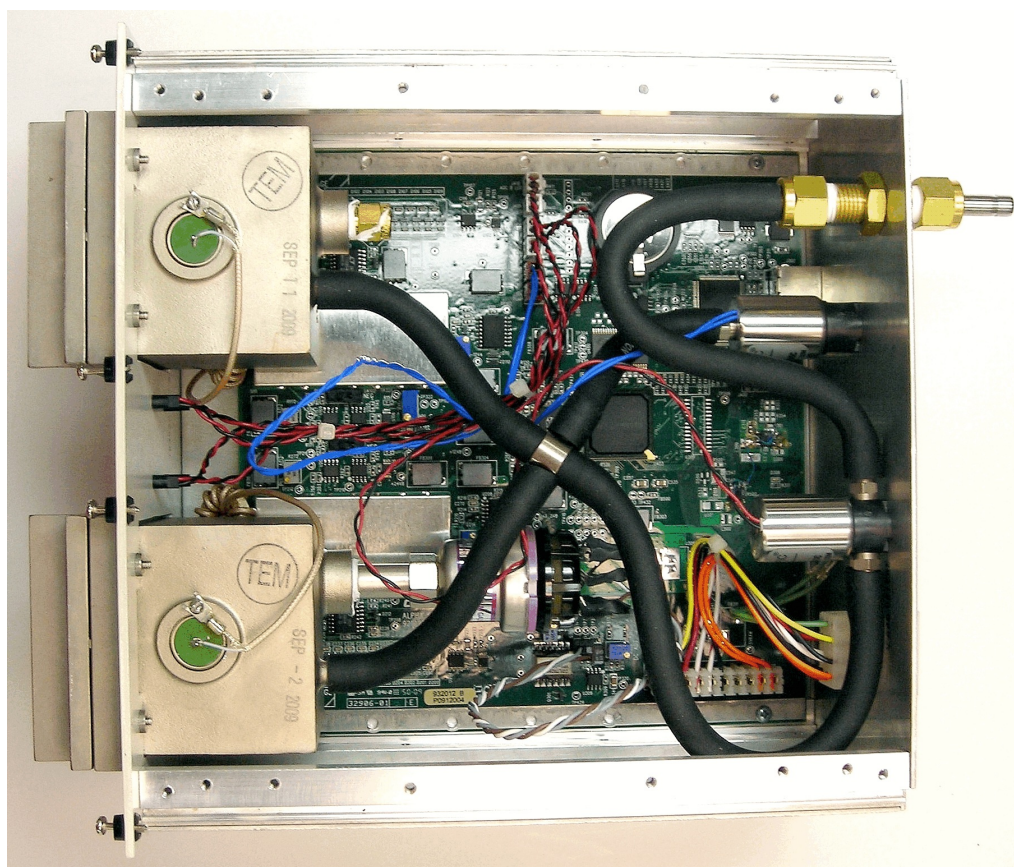
<sup>6</sup>Alternatively, you can remove the chamber(s) by opening the chamber door and loosening the three 3/32 in. hex-head screws (refer back to Fig. 1, page 10), then pulling the chamber *gently* forward, *being careful not to damage the detector connections or feedthrough on top of the chamber.*



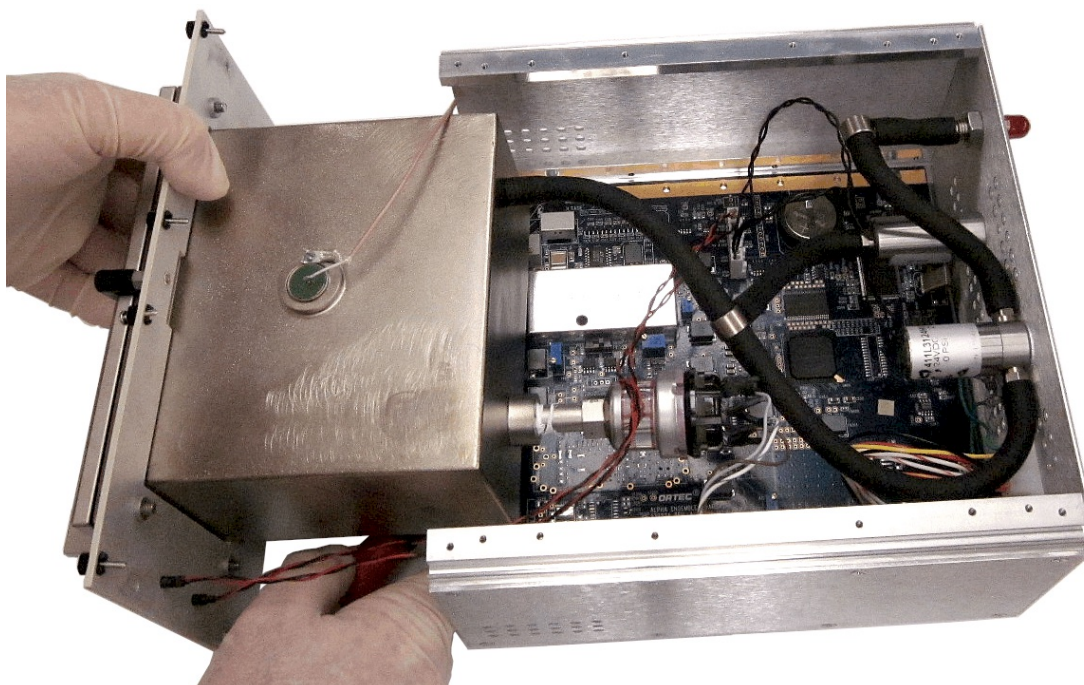


**Fig. 15. Removing an Alpha Module from the Alpha Ensemble Enclosure**

- **Duo**      The three switches for the left chamber are SW 101, SW 102, and SW 100. The right-chamber switches are similarly numbered SW 201, SW 202, and SW 200. Switch SW 101 and SW 201 are located at their respective side edge of the PWB. SW 102 and 202 are nearest the center line of the board, just inboard of each side's silver amplifier shield. SW 100 and 200 are located under each side's respective amplifier shield. Use your fingernail or a jeweler's screwdriver to *gently* pop off the shield.
- **Mega**      The three switches are the same as for the Duo left chamber, e.g., SW 101, SW 102, and SW 100.



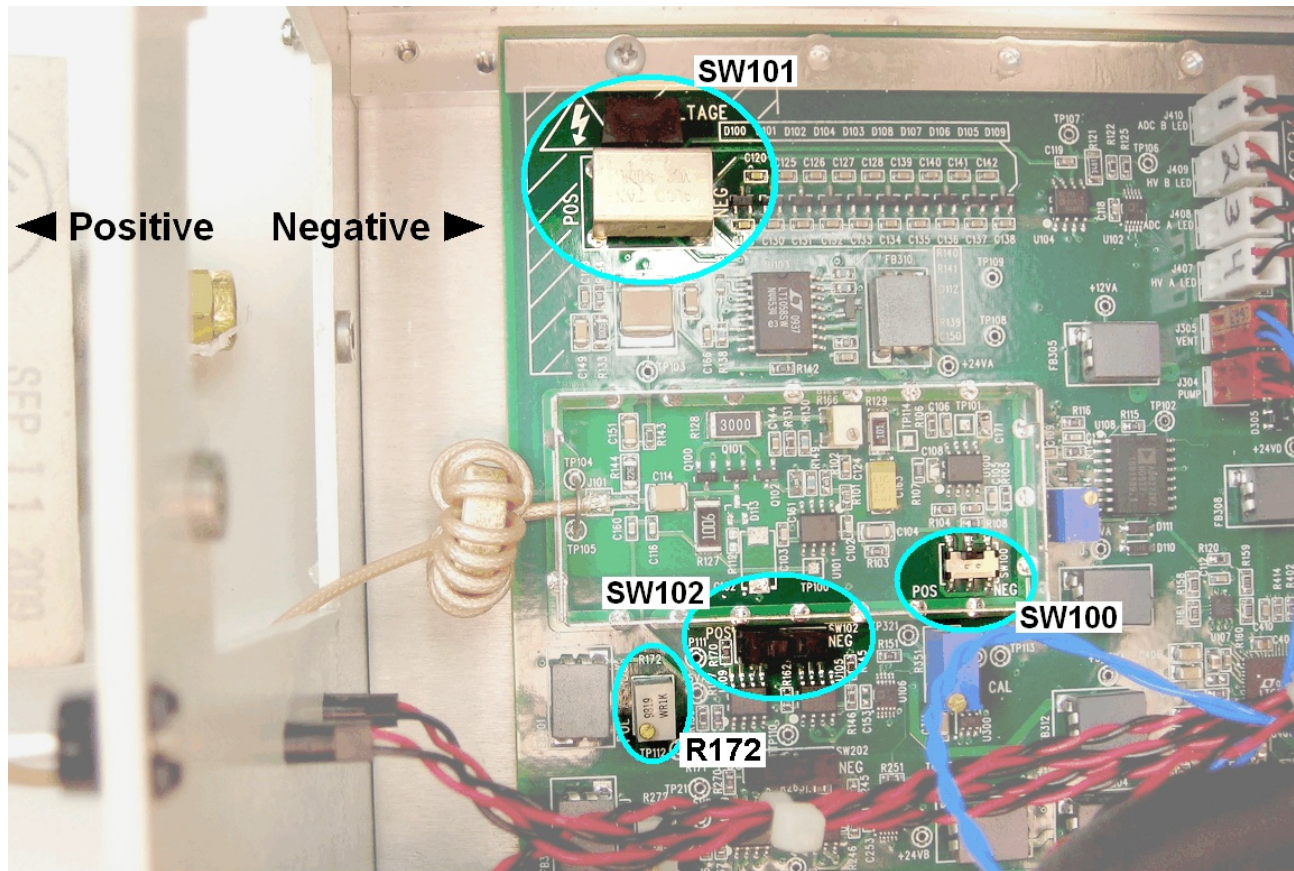
**Fig. 16. Inside the Alpha Duo**



**Fig. 17. Alpha Mega Faceplate and Chamber Pulled Out of Enclosure**

- 6) Figure 18 highlights the three switches that control the polarity for the left chamber. Move the three sliders toward the back of the housing to switch them to negative polarity, or toward the front panel for positive polarity.

**NOTE** *Each Duo chamber is independent, i.e., one can be set to positive and the other to negative so detector types can be mixed. Be sure the three switches for a particular are either all positive or all negative.*



**Fig. 18. Polarity Switches and Pulser Adjustment for Left Chamber**

- 7) Replace the amplifier shield; it should click into place.
- 8) Install the new detector according to Section 2.4.
- 9) You are now ready to recalibrate the unit according to the steps in the next section.

## B.1. Recalibration

The following instructions require a good-quality  $^{241}\text{Am}$  source, and peak location is based on its 5.945 MeV alpha peak.

- 1) Leaving the top panel off, reattach the Alpha Duo to its vacuum, USB, and power connections, and power the unit ON.
- 2) Place the source in the appropriate chamber and close the door.
- 3) Start MAESTRO, select the appropriate Alpha Duo chamber from the detector pick list, then click on **Acquire/MCB Properties** to open the Properties dialog. (Refer as needed to the MCB Properties instructions in Section 3.5).
- 4) On the ADC tab, set the following:
  - Conversion Gain = 4096
  - Lower Level Disc = 40
  - Upper Level Disc = 4095
- 5) On the Stabilizer, make sure the **Gain Stabilization Enabled** checkbox is *unmarked*.
- 6) On the Alpha tab, set the following:
  - Digital offset = 0
  - Display chans = 4096
  - Enable internal pulser = off (unmarked)
- 7) On the Alpha tab, select **Pump** from the **Vacuum state** droplist, and evacuate the chamber.
- 8) On the High Voltage tab, enter the **Target** bias and turn the HV **On**.
- 9) Select **Calculate/Calibration...** from the menu bar, and click on the **Destroy Calibration** button. The status line below the spectrum will now read only in channels, not energy.
- 10) Press <Alt + F7> to ensure the Expanded Spectrum Window is fully zoomed out. Start data acquisition by clicking on **Acquire/Start**. A peak will begin accumulating in the spectrum window.
- 11) On the Amplifier tab, adjust the fine gain until the peak is in channel 2247.

- 12) Stop acquisition and clear the MCA memory by clicking on **Acquire/Stop** then **Acquire/Clear**.
- 13) In the Properties dialog, go to the High Voltage tab and turn the HV **Off**.
- 14) Vent the chamber, remove the source, evacuate the chamber again, and turn the HV **On**.
- 15) On the Alpha tab, set the pulser **Amplitude** to 2246, then click to mark the **Enable internal pulser** checkbox. The front-panel HV/Pulser indicator should begin blinking and a peak should begin accumulating in the spectrum window.
- 16) Referring to Fig. 18, turn the pulser adjustment screw-potentiometer — R172 for the LEFT chamber and R272 for the RIGHT chamber — until the pulser peak is in channel 2246.
- 17) Turn off the HV and pulser, and vent the chamber.
- 18) You are now ready to turn off the enclosure mains power, replace the Alpha Duo's top panel, reassemble and reconnect the unit, then return to MAESTRO to set the MCA settings and calibrate for the data window of interest.

For more information, contact your ORTEC representative or our Global Service Center.

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