Bladewerx SabreASM™ Operations Manual

bladewerx™

Cutting-Edge Technology for Instruments and Measurement Applications

BLADEWERX, LLC

SabreASM Operations Manual

Documentation version 2.0

September 2019

Trademarks

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Getting Started

What is the SabreASM?

The Bladewerx SabreASM is an alpha survey meter that can monitor a surface for transuranic alpha contamination while compensating for radon and thoron background tailing into the transuranic region of interest. In addition to measuring the net activity in an energy region, it can also be configured to measure for a specific transuranic isotope and accurately quantify its activity.

A detector hand probe on the end of a 4-foot cable encloses a 2-inch diameter PIPS solid-state detector and pre-amplifier board. The detector is protected by an 80% open-area screen to reduce the chances of damage to the detector face.

Measurements are made by placing the survey probe on a surface and starting a count. Both Fixed-Count-Time (FCT) and Minimum-Count-Time (MCT) modes are available and at the termination of a count the results of the net reading are compared against a user-set Action Level in DPM. High readings are indicated as HIGH ALPHA, while readings below the Action Level are shown as BELOW LIMIT.

Throughout this manual, the sample displays and text refer to **Pu-239** as the isotope-of-interest. The isotope-of-interest, however, is user selectable, and the unit may be set to indicate up to two isotopes of interest, in addition to the normal radon progenies.

The instrument operates from a lithium-ion rechargeable battery with an 8-hour battery life. It can also operate continuously from an AC power adapter.

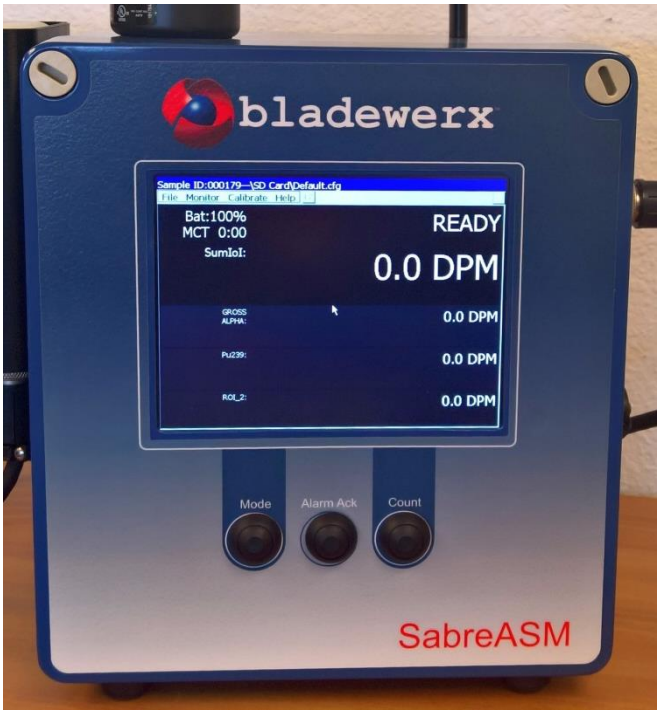
Unpacking and Repacking

Remove the calibration certificate and place it in a secure location. Remove the instrument and ensure that all of the items on the packing list are in the carton. Check individual item serial numbers and insure calibration certificates match between instruments.

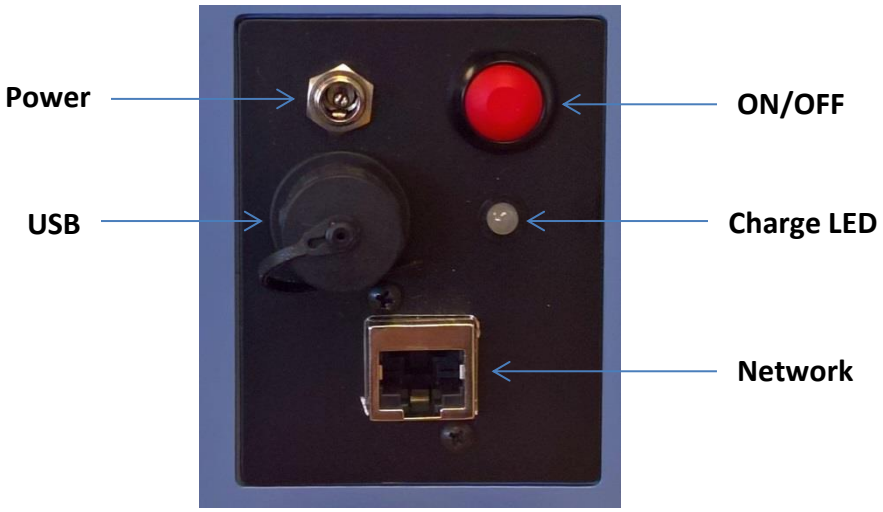
To return an instrument for repair and calibration, provide sufficient packing material to prevent damage during shipment. Every returned instrument must be accompanied by an Instrument RMA number. Call 505.892.5144 or email support@bladewerx.com to request one.

The Parts of the SabreASM

The SabreASM is comprised of a NEMA-rated fiberglass enclosure which houses the LCD screen and electronics. An integrated computer provides the user with a Microsoft Windows user interface and supportable networking features. The LCD is a 6-inch touch-screen and can be operated with a stylus. Three front panel buttons provide functions for starting/stopping a count, acknowledging an alarm, and changing the display mode. The survey probe is attached by a 4-foot shielded cable. A light tower with red/green indicators and a sonalert are mounted to the top.



On the right side of the SabreASM is a large red power button. The power button can be used to turn the unit on and off. Also on the right side panel is a power jack and red/green LED charging indicator. There is also an Ethernet port for connecting to a network and allowing remote retrieval of log files and spectrum data. A mini-USB port can be used for direct communications and log data retrieval with a workstation or laptop.



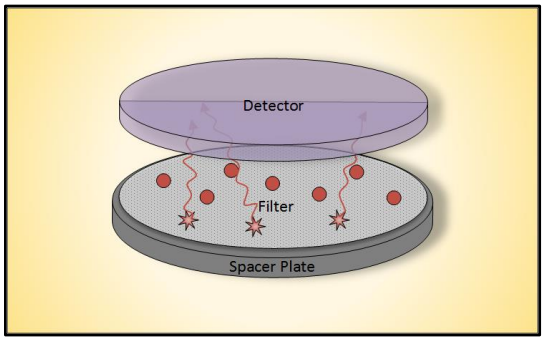
Above the right side panel is the connector panel for the survey probe. Remove the survey probe and cable from the box and attach the probe to the SabreASM with the cable. Both ends of the cable are the same.

In addition to the SabreASM itself, the survey probe and cable are included. Accessories are an AC Adapter for charging the SabreASM, a stylus with holder, and a CD with software and certificates

Understanding the Survey Probe

The solid-state alpha detector is mounted inside the survey probe facing down and covered by a highly open-area screen to help protect the very delicate face of the detector from scratches or damage. **Note: Scratches on the detector face can cause light-leakage which appears to the electronics as alpha activity and will require detector replacement.**

When placed on a surface, the face of the detector is as close as possible to any surface contamination, thus the energy resolution and counting efficiency are maximized. Holding the probe above the surface will result in counts shifted in energy from the regions expected and poor instrument operation will result.



During a count, particulates on the survey surface decay and the emitted **alpha particles** hit the face of the detector and are recorded by the unit.

Turning the Unit On and Off

Once the survey probe is connected to the SabreASM, press the red button located on the right side of unit to turn on the power to the SabreASM. After pressing the button, the SabreASM application will execute automatically. The display should come on immediately if the battery is charged. In general, a cold startup takes about 20 seconds. If the display does not turn on, the unit needs to be charged.

To shut the unit down, hold the power button for 5 seconds or until the display turns off.

Charging the Batteries

Upon receiving a new unit, or when preparing a unit that has been shut down for a length of time, the lithium-ion battery must be fully charged. Plug the AC adapter (rated for 100-240 VAC) into a wall socket and then into the power connector on the right side panel of the instrument.

The SabreASM has a green/red LED on the right-side panel that indicates when the unit is connected to AC power. If the light is red, the battery is charging. A green light indicates that the battery has completed a charge cycle. When the SabreASM is powered on, the battery charge level is displayed in the upper left-hand corner of the screen. When the display shows 100%, the unit is charged, however there may be a delay in the LED changing from red to green.

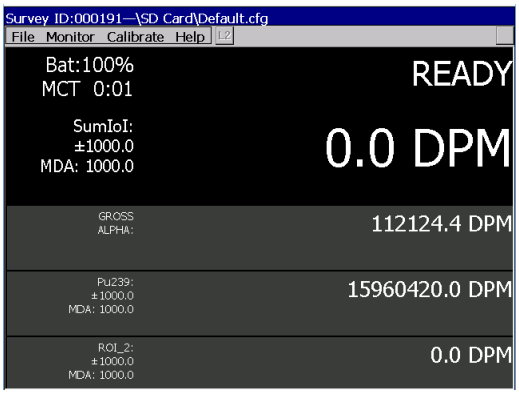
Note: A fully discharged battery will take at least two 4-hour charge cycles to reach full capacity.

Operating the Program

The instrument has been factory-calibrated but because air density changes between sites due to elevation differences can affect the alpha energy calibration, configuration and calibration must be performed prior to putting the unit into service. Please refer to following sections in this manual for details on how to select appropriate parameters and to calibrate the instrument. For the purpose of familiarizing yourself with the operation, factory calibrations are sufficient to continue for now.

Understanding the Display

After powering on, the interface will open the SabreASM program automatically. The basic display for the SabreASM includes a standard Windows pull-down **Menu** bar across the top.

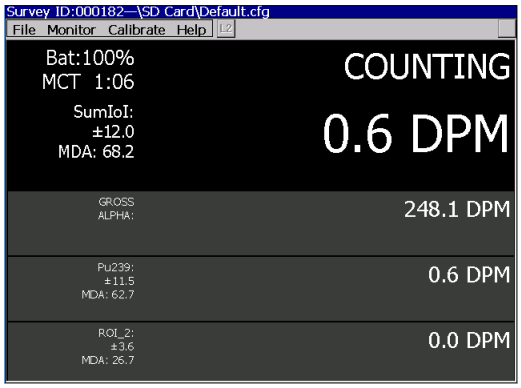


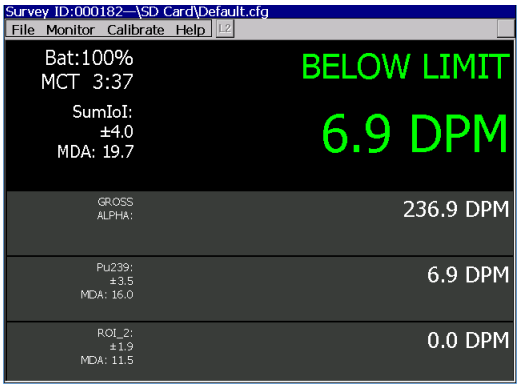
Below are several digital readouts or **Meters**. The number of meters shown will change depending on the configuration of Regions-of-Interest (ROIs), or Isotopes-of-Interest (IoIs).

The **Menu** bar across the top of the screen provides access to instrument operation, configuration, and calibration functions. The menu will look different depending on the level of password security.

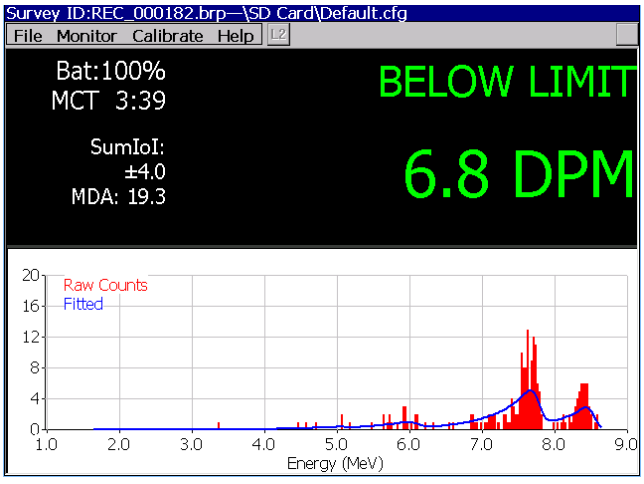
A small disabled button to the right of the menu bar indicates the security level the user has selected: Operation Only (button not present), Configuration Level (L1) or Calibration Level (L2).

The **Meter** area displays the status and current data as a survey count progresses, and then the results of the count. It will display the gross alpha readings, the net activity readings of two channels, and their sum activity. The first line indicates the battery level, count mode and time, and current status. The subsequent lines report the readings for each channel, as well as their margin of error in DPM at the 1-sigma level.





The **Spectrum** can also be viewed in the lower portion of the screen by pressing the **Mode** button on the front panel. The spectrum is displayed as a histogram made up of the detected counts in each of 256 channels, increasing in energy (with channel 0 on the left) along the X-axis. The actual raw counts are represented with the red bars, while the blue curve represents a best-fit spectrum model as determined by the alpha peak-shape fitting algorithm. If radon products are present on the survey surface during the count, two or three peaks may appear on the right end of the spectrum. Any counts associated with transuranics will also appear in their respective energy channels between 1 and 5.7 MeV.



Performing a survey

A filter paper that has had air drawn through it for several hours makes a good "test" sample. Lay the filter on a surface—collection side up—and place the survey probe over the filter with the detector crosshair marking directly over the filter center. Press the **Count** button on the front panel of the SabreASM.

The unit assigns a unique identifier for each survey count, which is listed as the **Survey ID** on each log entry and in the display title bar. This ID is incremented after each actual survey count—whether completed or cancelled—then used as the ID for the next survey.
As counts are received from the detector, data will be displayed and updated in real time.
The meters will display the elapsed time, gross activity, net readings and MDA in DPM for each channel and the Sum channel. The Spectrum will display the energy spectrum and "curve fit" as counts are detected if the Spectrum display was activated.

As the count progresses, the green element in the light tower will blink and the SabreASM will display a fluctuating ROI reading that eventually stabilizes as the measurement accuracy improves. As the count progresses and statistics improve, the MDA will begin to drop towards the user-defined Action Level.

The count is automatically terminated by reaching the fixed count time parameter (in Fixed-Count-Time mode), or when the MDA drops below the Action Level (Minimum-Count-Time mode) provided the reading is below the Action Level. The count is terminated when one or more readings are above the action level but within a user-specified confidence (See pg. 23). The count can also be cancelled by pressing **Count** button.
When the count is finished, the display will indicate the color-coded survey result (e.g., HIGH ALPHA or BELOW LIMIT) in red for an alarm, or green. If the reading was below the Action Level, the Green element will also illuminate in the light tower. If the reading is above the Action Level, the Red element will be illuminated and the audible sonalert will sound continuously until the **Alarm Ack** button is pressed to silence it.

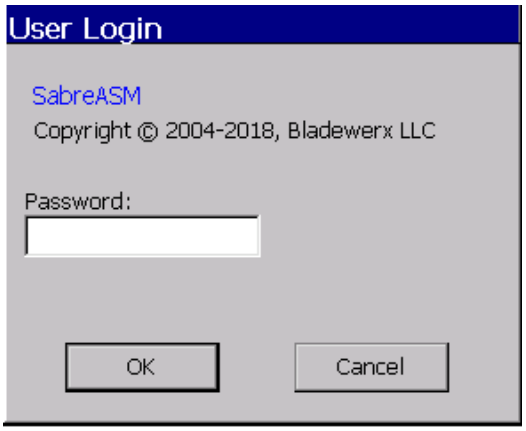
Survey Logging

Data from a survey is saved in several ways.

- **Log File—**the results from each survey are entered as comma-delimited line of text, denoted by the Survey_ID, in a continuous log file.
- **Replay File—**for each survey, a file containing comma-delimited line entries for each alpha event detected received during the survey. This data contains the elapsed time (in milliseconds) that the event occurred, along with the energy channel of the event.
- **Spectrum File—**for each survey, the last spectrum is saved for the survey, including both the raw spectrum counts and the fitted spectrum curve data.

Password Security

The SabreASM has three levels of security. *File-Use Security* must be checkmarked before the *File--Login* feature is available. After selecting *Login*, the User Login screen will appear. If a user is not logged in, he is at the lowest security level and is able to perform survey counts and response checks but is unable to change the configuration or calibration parameters. If you are not logged in at the appropriate level, certain functions will be 'grayed out', or unavailable, and you will be unable to select them.



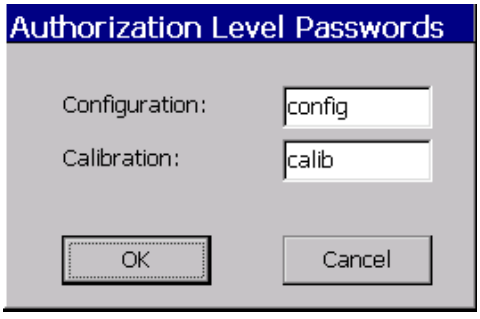
The next level (**L1**) of security is the Configuration level. At the **L1** level, the user may create different configuration profiles, change isotopes, action levels, count times, etc.

The default password for configuration is: config

The highest level (**L2**) of security is the Calibration level. At the **L2** level the user has full access and, in addition to the configuration features, may calibrate the instrument, exit the software application for Windows setup control, and edit the passwords.

The default password for configuration is: calib

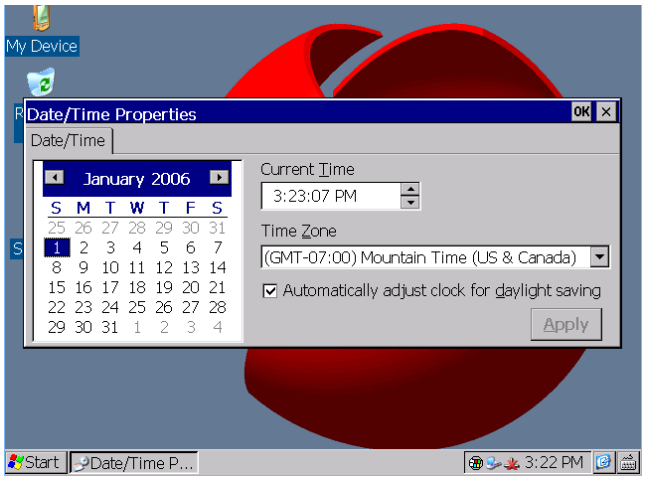
To edit the security passwords from the default settings, select *File—Security Options* **Authorization Level Passwords** dialog from the menu (*File-Use Security* must be checkmarked).



Note: Be sure to record the new passwords in a safe place, as a forgotten password would require factory support (or a registry Restore) to reset.

Setting the Clock

The SabreASM is configured with a real-time clock which can be manually set. The unit is factory calibrated to the correct customer time-zone before shipment. Whenever the battery and external power are disconnected from the main processor board during maintenance or repair, the clock may be reset to a default date. To access the Date/Time properties dialog, exit the SabreASM application to the Windows Desktop screen and double-tap the time displayed in the lower right of the desktop, then *Change Date and Time Settings*.



SECTION

2

Calibration

Calibration Concerns

To produce accurate alpha measurements, **the SabreASM must be calibrated for each surface type** to be surveyed. Different surface types (e.g., shiny, smooth, textured, rough, or pitted) attenuate the emitted alpha energy differently, so that the particle energy that reaches the detector will be more or less, depending on the surface. The resulting alpha peak shapes and their channel positions in the spectrum will be different, as well. This means that, unless the calibration reflects where the radon progeny peaks will be expected, the radon background subtraction algorithm may behave poorly or frequent POOR FIT statuses encountered.

The SabreASM software accommodates different surface types by allowing a Configuration file to be saved for each spectrum type resulting from surface attenuation characteristics. The SabreASM makes this easy by allowing the user to create several different configuration (***.cfg**) profiles which can be used to match the current survey type to a set of configuration and calibration settings. See the section on Configuration for more information on how to save separate configuration files. For now, calibration settings will be saved in the "**default.cfg**" file.

Calibration Steps

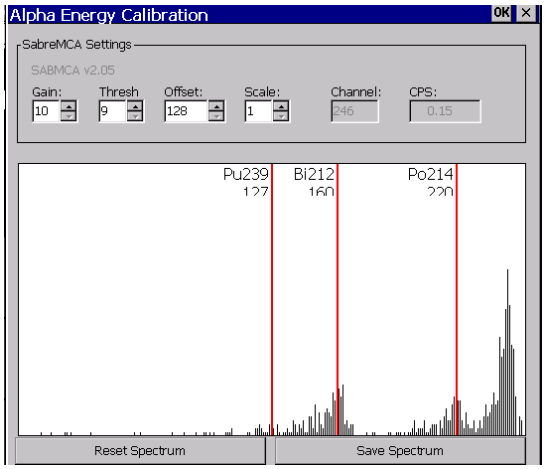
There are two alpha calibration steps: Energy calibration, and Efficiency calibration. The purpose of alpha Energy calibration is to insure that the peak-fitting algorithm can identify

the radon progeny and isotope-of-interest peaks in the alpha spectrum. The peak-fitting algorithm will fail (causing a sonalert *beep*) and the instrument will fail to make accurate measurements if the peaks do not appear in the expected locations.

The calibration functions are accessed from the menu *Calibration* tab. The calibration dialogs can only be accessed when logged in at the calibration (**L2**) security level. Again, there are two steps to calibrating the SabreASM for alpha: *Alpha Energy* calibration and *Alpha Efficiency* calibration. **The energy calibration step should always be performed before the Efficiency calibration steps.** Only an adjustment of the Alpha Energy marker channels is typically necessary for a new unit.

Alpha Energy Calibration

To prepare for Alpha Energy calibration, a filter is needed that has been sampling air long enough to have a good radon spectrum, usually for more than 4 hours. Open the calibration dialog window by selecting *Calibration—Alpha Energy* in the menu.



The **Alpha Energy Calibration** dialog will be displayed showing the SabreMCA settings and a window to display the spectrum. The x-axis represents the possible energies, assigned to channels 0 to 255. The vertical scale adjusts automatically to display the highest peak as counts accumulate in each channel.

Several vertical red lines are shown in the spectrum window. The number of lines depends on the operating configuration of the SabreASM. There are markers for the primary alpha isotopes-of-interest, plus the **Bi-212/Po-218** and **Po-214** radon-progeny peak markers. The three marker positions are used to by the software to calculate the channel-to-energy conversion. These lines indicate the position of the alpha peaks to the program, and are adjusted by dragging them to match up with the peak location. When dragged, the number at the top of each red line reflects the channel number for the marker.

SabreMCA Settings

The four fields on the top of the Alpha Energy Calibration dialog each correspond to one of the four configuration settings: the parameters for **Gain**, **Threshold**, **Offset** and **Scale**, which determine the view of the alpha spectrum on the display. These configuration settings

affect the location, width, spacing and offset of alpha peaks on the spectrum. The Threshold, Gain and Scale should **never** be adjusted from factory settings, so **only the Offset** may have to be changed based on the elevation of the instrument's location.

The instrument is initially calibrated at the Bladewerx manufacturing facility, located in Rio Rancho, New Mexico at 5100 feet MSL. Alpha Energy calibration is elevation dependent because of air density effects on energy attenuation of alpha particles, so it is important that this is addressed if the elevation of the unit has changed by more than 1000 feet. See the **Theory of Operation** section for more information on these parameters.

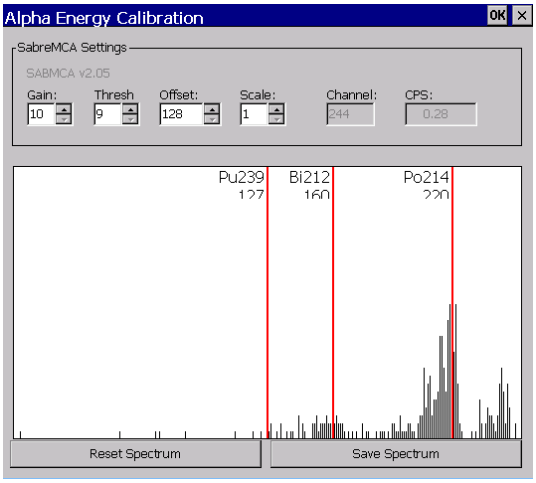
Setting the Progeny Peak Locations

To begin the calibration, you should record the current channels at the top of each line (under its label) for a brief calculation later, but also in case you need to restore the previous calibration settings.

You will need an air filter that has been collecting a sample for at least the past 24 hours. Do not remove the filter from the air sampler unless you are ready to proceed with calibration **immediately**, as the particles will begin to decay and their peaks will not build up.

Place the filter on a surface and place the survey probe on the filter, with the detector crosshair lined up with the center of the filter. Press the *Reset Spectrum* button on the dialog and allow the counts to build up for at least 10 minutes.

There should be two or three peaks becoming visible in the spectrum: **Bi-212** at 6.05 MeV (merged with **Po-218** at 6.00 MeV), **Po-214** at 7.69 MeV, and possibly **Po-212** at 8.78 MeV (no marker for this one). The **Bi-212** peak should be located near the center of the window and the **Po-212** peak at the right end of the window. If the spectrum is not positioned similar to the example shown, use the up/down **Offset** spin buttons to adjust the setting and shift the spectrum right or left as needed. For more information on how the settings affect the spectrum, see the section on **Theory of Operation**.



When two or three peaks are defined and visible, **drag the Bi-212 line** to the peak farthest left on the spectrum. Then drag the **Po-214** line to the middle peak. The numbers under the **Bi-212** and **Po-214** labels indicate the new channel number of that peak marker. Make a note of how many channels and the direction you moved the **Po-214** marker, to be used later. In the example, the marker moved 6 channels to the left from 219 to the peak at channel 213. Once the peak marker lines are in the correct positions, the first step of Energy Calibration is complete and you can remove the filter from under the probe.

The *Save Spectrum* button saves the spectrum data to a "comma-separated-variable" (***.csv**) file readable by Microsoft Excel.
The *Reset Spectrum* button on the screen clears the spectrum.
If the peaks or lines do not appear as described or appear with poor resolution, see the **Notes for Troubleshooting** in this section.

Setting the Primary Isotope-of-Interest Peak Location

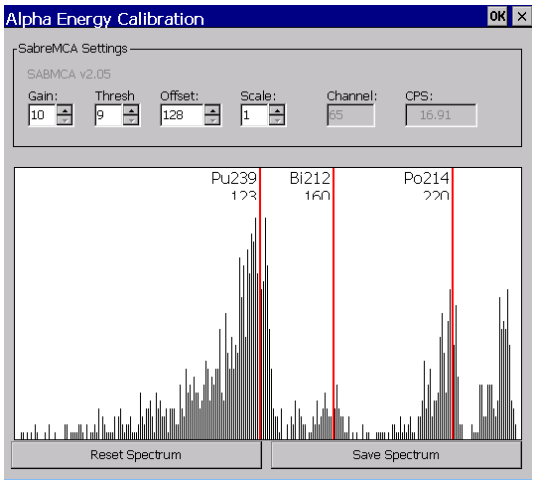
The isotope-of-interest also needs to be Energy calibrated at this point. You may choose one of three processes to follow:

- **Calibration Source Method** – using a matching isotope calibration source
- **Channel Calculation Method** – using the Isotope-of-Interest Channel Calculator
- **Mirror Method** – moving the IoI marker in the same way as the **Po-214** marker

Using a **calibration source** is the traditional procedure for adjusting the peak marker at a different elevation, as well as setting a new primary isotope-of-interest. It requires that the source matches the isotope-of-interest. If one is not available, use the **Channel Calculation** method. For elevation adjustment from the factory, the **Mirror Method** is sufficient.

Option A: Calibration Source Method

Place the probe over the calibration source (with the crosshair centered over the center of the source). Watch the Spectrum window as a well-defined peak becomes visible on the screen. When the peak becomes well-defined, but not too large, remove the probe.
Finally, drag the Isotope-of-Interest marker to align with the actual peak location.



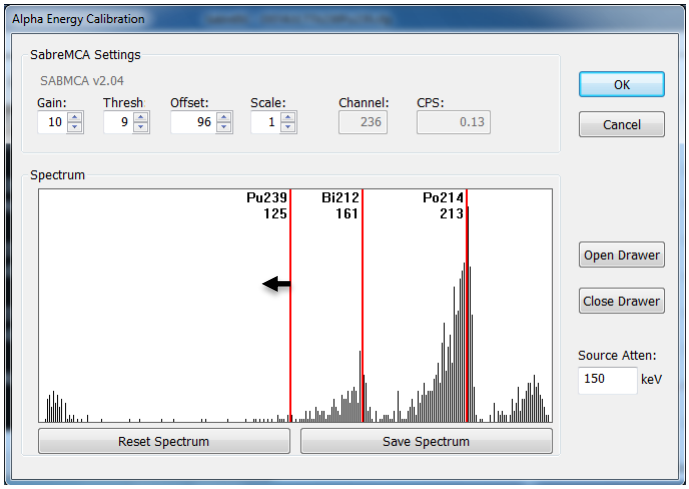
Option B: **Channel Calculation Method**

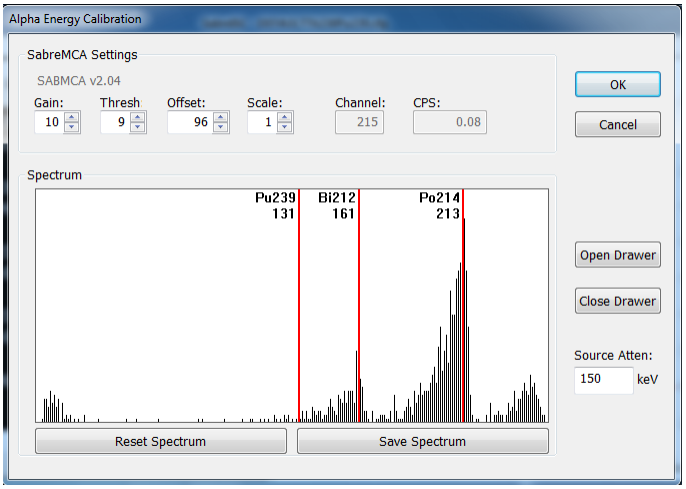
Use the Isotope-of-Interest Channel Calculator (found on the CD) to determine the peak location **without a matching source**. Based on the locations of the known peaks and their energies, the location of the isotope-of-interest peak is calculated.
In the Microsoft Excel calculator, you enter the known variables and a resulting channel is generated. Then you can move the peak marker accordingly.

Option C: **Mirror Method**

In the Mirror Method, the **Pu-239** marker is moved the same direction and number of channels as the **Po-214** marker was just moved. This method is the least accurate of the three, but still a viable method for general operation as the peak fit algorithm will account for small shifts in peak positions. It is normally only used for elevation adjustment from the factory, not for changing the primary isotope.

In this method, based on your notes from adjusting the **Po-214** progeny marker, move the IoI marker (**Pu-239**) in a mirror fashion. For example, the **Po-214** marker moved 6 channels to the left from channel 219 to line up with its peak at channel 213. Now mirror that movement by dragging the **Pu-239** marker from channel 131 to channel 125.
Once all of the peaks have been successfully lined up, tap the **OK** button.





Notes for Troubleshooting

If no thoron progeny is present in the survey, only two peaks will be present; the farthest right will be the **Po-214** peak.

If the filter used for the calibration is from a site without thoron progeny, the **Bi-212** (**Po-218**) peak must be set within ten minutes of accumulating counts since the **Po-218** half-life is shorter than the **Po-214** half-life, and much shorter than the **Bi-212** half-life. After an hour the **Po-214** can be set.

If the filter used for calibration is from a site with thoron progeny, the spectrum should be allowed to accumulate counts for several hours, after which both the **Bi-212** peak and the **Po-214** peaks can be set.

If thoron progeny is present, make sure the entire **Po-212** peak (the third peak) is set at 8.78 MeV.

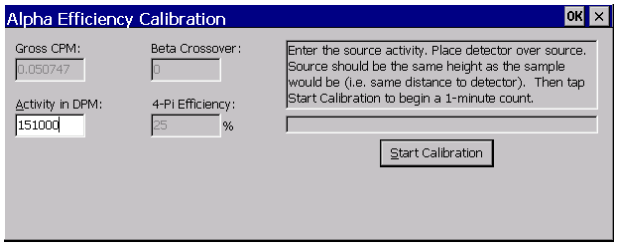
Alpha Efficiency Calibration

Alpha Efficiency Calibration is used to determine the detector counting efficiency to the primary alpha isotope-of-interest. This efficiency is used to produce accurate activity measurements in DPM (or Bq). For each survey surface type and with a different isotope-of-interest, a configuration file should be saved with its own efficiency.

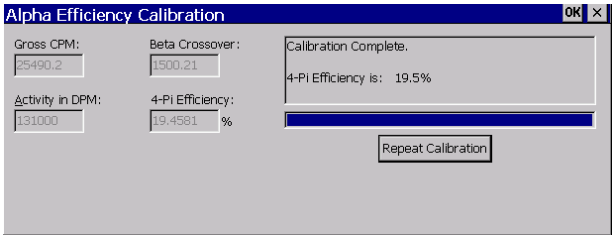
An Alpha Efficiency is most affected by three factors, so these factors should be given the most care in matching between the *source* and *surface characteristics*. If a factor is unable to be matched between the source and surface charteristics, you may consider adjusting the Action Level in the configuration settings in order to account for the variation. In order of importance, the factors are:

- **Size of Active Area** – The source should be the same as the active area of the surface area being counted. The Survey probe uses a 2-inch diameter detector so sources with active area diameter greater than 2 inches will have part of their activity masked off by the detector housing and an artificially low efficiency will result.
- **Distance to Detector** – The surface of the source needs to be the same distance from the detector as the survey surface will be during a count. A source should be centered under the probe crosshair marking.
- **Alpha Isotope** – The isotope of the source needs to either match or be of a very similar energy as the expected isotope-of-interest. **Am-241** is an appropriate replacement for **Pu-239**. **Th-230** is also an acceptable calibration source if the Primary IoI is set to match.

To begin the efficiency calibration, select the *Calibration—Alpha Efficiency* menu item. The Efficiency Calibration dialog will be displayed showing the current efficiency. Enter the source activity in DPM (which should be written on the source, its container or certification sheet) in the dialog **Activity in DPM** field. Place the calibration source on a surface and place the probe over the source, making sure to closely align the center of the source with the crosshair mark on the probe. Tap *Start Calibration*. The calibration will run for two minutes or until it has reached 10,000 counts, whichever is longer.



The routine will compare the gross count rate and source activity and display the Gross CPM and calculated 4-Pi Efficiency. When the count completes, the final calculated efficiency is displayed. Depending on the source quality and active area, an efficiency reading between 18-22% should be expected for a 1-inch active area source, the efficiency will be slightly less for a 2-inch diameter source.



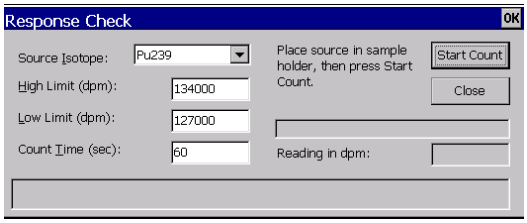
Repeat the calibration if desired or click the **OK** button and remove the source. The Efficiency Calibration dialog will close, saving the new setting. To cancel a calibration or to exit without saving, select the **Cancel** (X) button.

Notes for Troubleshooting

The curve fit to a calibration source may not initially line up precisely with the spectrum from the calibration source. This is acceptable since the peak fitting algorithm automatically adjusts the peak location once adequate counts from the source are in the spectrum. The efficiency is based on the area under the peak (including the calculated counts below the Threshold). Peak locations for an isotope almost always differ between a plated source and deposits on an actual filter paper or surface because of surface attenuation differences. Older **Pu-239** sources often have noticeable activities of **Am-241** ingrowth. If these sources are used, select **Am-241** as the alternate isotope-of-interest so that the **Am-241** counts are considered in the efficiency calculation.

Calibration Validation

The calibration can be checked periodically using the **Response Check** feature. Access the **Response Check** by selecting *Monitor—Response Check* menu item. The Source Isotope should match the source used. The drop-down menu lists the primary isotope-of-interest. If an alternate isotope-of-interest is defined, that isotope will be listed also, along with an entry specifying both isotopes (e.g., **Pu-239+Am-241**).



This choice should be selected when the source includes an abundance of both isotopes.

Specify High and Low Limits (in DPM or Bq) within which the source reading is acceptable and specify a count time that provides acceptable counting statistics for the source activity. If you are performing a response check for two isotopes-of-interest, the limits should be set as the overall source activity in DPM. Once the parameters are set, place the source again under the probe crosshair and click *Start Count*. The program will perform a fixed count time count of the source then test for a resultant count rate within the High/Low Limits and post the outcome in the results window.

If the test passes, the High/Low Limit and Count Time parameters will be saved and appear as the default the next time the Response Check is performed. Select **Close** to exit.

SECTION

3

Configuration

Configuration Files

All instrument settings, *with the exception of the MCA Gain, Threshold, Offset, and Scale settings,* are saved in a configuration file. The purpose of Configuration files is so the user can quickly configure the instrument for different surface types or surface characteristics and have all calibration settings restored for that configuration when the file is loaded. For instance, the user may have one file where the SabreASM was calibrated for a shiny smooth painted surface survey. In another case, the file may contain calibration settings for a rough painted wood surface. All that is needed to stop counting the shiny surfaces and start surveying wood surfaces, is to load the ***.cfg** file for the wood surface calibration.

The SabreASM can be configured from the *File—Save Configuration* and *File—Save Configuration As* menu items. The *Save Configuration* allows the user to update the current configuration and calibration settings to the SabreASM under the current configuration filename. By loading this file, the settings may be restored at a later time. The *Save Configuration As* allows the user to save the current configuration settings to a different ***.cfg** configuration filename. The *File—Open Configuration* allows the user to open one of these previously-saved configuration files in order to restore the SabreASM to the settings saved in the configuration file.

NOTE: Saving configurations can only be accessed by a user who is logged into the Calibration (L2) or Configuration (L1) security levels. Any user can load a previously saved configuration.

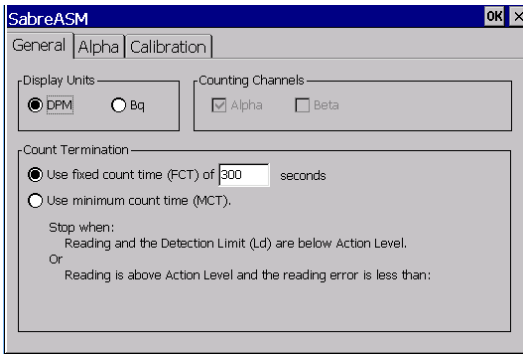
Instrument Options

Select *Monitor—Instrument Options* from the menu. The Instrument Options window includes these basic operating mode settings:

- The General tab is used to set the count time mode; either fixed count time mode or automatic count time mode.
- The Alpha tab is used to configure which energy region(s) or transuranic isotope(s) you want to measure. The basic configuration is to measure for a single Region-of-Interest (ROI) and automatically compensate for any radon daughters by mathematically fitting a spectrum curve to the radon daughter peaks and subtracting out the curve tailing counts that cross the ROI. An alternate ROI or IoI can also be specified and the SabreASM will measure and report on both isotopes, along with the summed activity of the two. Primary or Alternate selections can be either a specific isotope (fitted), or ROI (unfitted). The list of available isotopes stored in the file "**isotopes.csv**" on the ***SD Card*** folder. This file is editable by the user but must be copied to a PC, edited, then copied back to the ***SD Card*** folder.
- The Calibration tab is used to specify the maximum calendar days between energy calibrations but also shows factory-configuration settings.

General Tab

Display Units—this field allows the user to select the units in which the display presents the counts. The units can be set to disintegrations per minute (DPM) or Becquerels (Bq).

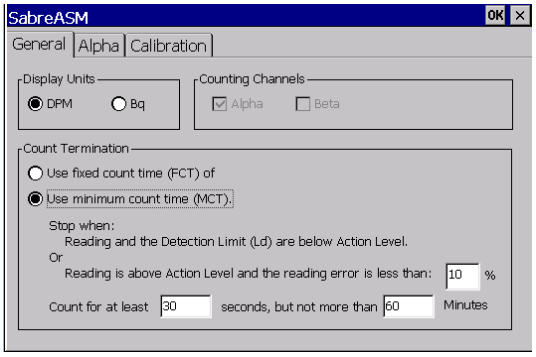


Counting Channels—this field allows the user to set the SabreASM to count in the Beta channel. Instruments with beta capability can still be operated in alpha-only mode by unchecking this field. *This field is disabled for the SabreASM.*

Count Termination—these parameters control when the count cycle is terminated. There are two modes of operation, either fixed count time or automatic count termination. If the automatic mode is selected, then the count cycle will terminate when either of the two following conditions are fulfilled:

- The **MDA** falls below the Action Level and the alpha (primary ROI only, or Primary + Alternate sum) readings are below the action level.
- The **MDA** falls below the Action Level and a reading is above the action level and has a reading error within the confidence value entered on this screen. *The default is 10% confidence.*

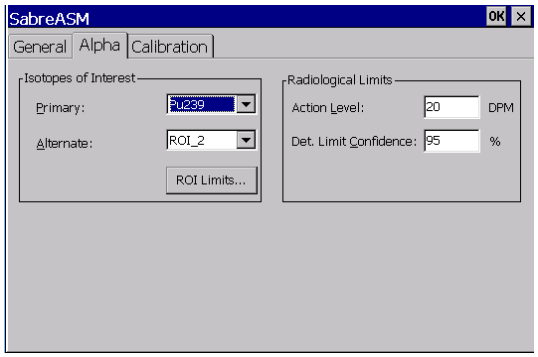
In either case, the count time must exceed the minimum count time specified before the count will terminate, and regardless of these two conditions, the count will terminate once the count time reaches the maximum count time entered on this screen.



Count for at least—This parameter selects the Minimum count time, the surface count will always last at least this long. *The default is 60 sec.*

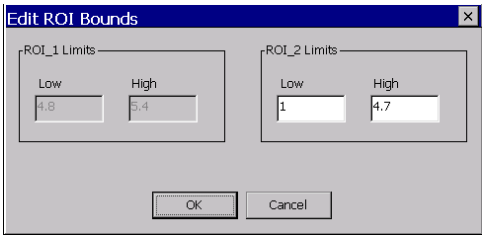
but not more than—This parameter selects the Maximum count time, after which the count cycle is automatically terminated, regardless of any other conditions. *The default is 60 min.* If fixed count time is selected, then the count time in minutes is entered and used by the SabreASM.

Alpha Tab



Primary—this pull-down list provides for the selection of Isotope-of-Interest or Region-of-Interest. This selection affects only the transuranics and not the measurement of radon daughters, which are always monitored. The list of isotopes on the pull-down menu is determined by the contents of the user-editable file "**isotopes.csv**", plus ROI_1 and ROI_2. The reading for this channel is shown in the main display during a count. *Default Primary is **Pu-239**.*

Alternate—this pull-down list provides for the selection of an additional ROI or IoI. The reading for this isotope is shown in the main display. *Default Alternate is None.*



ROI Limits—this dialog allows setting of the energy region to be monitored for transuranic activity. The instrument is capable of monitoring two ROIs with separate non-overlapping regions between 0 and 5.7 MeV. The ROI_1 or ROI_2 fields will be disabled if that ROI is not a Primary or Alternate selection.

Action Level—this parameter is the alarm limit used in the automatic count cycle termination logic. If the alternate isotope is "None" then the action level is compared to the only the reading from the primary isotope. If the alternate isotope is ROI_1, ROI_2 or any of the list of isotopes on the pull-down menu, then the action level is compared to the SUM of the readings from the primary and alternate isotopes. *Default is 20 DPM.*

Det. Limit Confidence—this parameter selects the confidence level used in the **MDA** calculation. Requiring a higher confidence level will lengthen the count time when the reading is above the action level. *Default is 95%.*

Changing the Isotopes Table

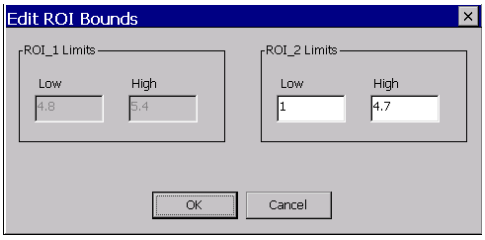
The isotopes included on the Primary and Alternate isotopes pull-down menus come from a disk file named "**isotopes.csv**". An example is shown on the right.

Isotope	keV	Half-life
Cm244	5805	5.72E+08
Am241	5486	1.36E+10
Pu238	5499	2.77E+09
Po210	5305	1.20E+07
Pu239	5150	7.62E+11
U234	4776	7.72E+12
U235	4396	2.22E+16
U238	4196	2.22E+16
Th230	4670	2.22E+16
Th232	3990	2.22E+16

This file can be edited by copying the file from the ***SD Card*** folder to a PC. The file can then be opened in a Notepad window and can be edited from there. Isotopes can be added according to the same format as the others in the list: Isotope, keV, Half-life. Note that energy is always in keV and the Half-life is in seconds. Half-life values are used only for very short–lived isotopes and can be arbitrarily set to 1.00E+16 for long-lived isotopes. After making changes, you must be sure to save the file as a comma delimited (***.csv**) file type and copy it back to the instrument.

NOTE: Do not change the name of the file. If the name is changed, the SabreASM program will NOT be able to access the file.

Regions of Interest



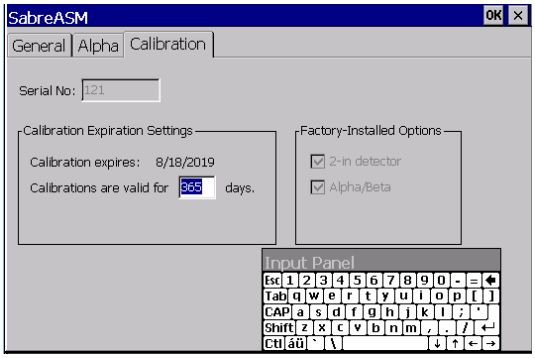
The SabreASM is capable of operating with a Region-of-Interest (ROI) instead of an Isotope-of-Interest with either the Primary or Alternate IoI selection. The Isotope drop-down list includes entries for ROI_1 and ROI_2. When selected, the **ROI Limits** button is enabled which allows editing of the ROI energy limits for one or both ROIs. Energy limits of the two ROIs cannot overlap when both ROIs are selected. **If an IoI is selected for the Primary or Alternate isotope, the ROI cannot overlap the isotope peak energy or approach the peak on the low-side within 500 keV, or on the high-side within 200 keV.**

Once an ROI is selected, the SabreASM will report the net counts within the limits. The net counts are the *total* counts between those energy channels, *minus* the tailing from any radon progeny peaks into that region.

NOTE: In the *Calibrate–Alpha Energy* dialog, an ROI marker will be not be displayed in place of the Primary peak marker if an ROI is selected as the Primary IoI. The User should NOT attempt energy calibration when an ROI is selected as the Primary IoI. If the unit alerts that it is out of calibration, change the Primary IoI to a regular isotope and proceed with calibration. The unit can then return to ROI as the Primary IoI after.

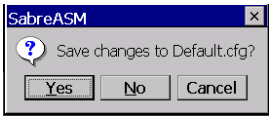
Calibration Tab

This allows the user to determine the calibration interval. The unit will post "OUTOFCAL" in the status pane screen if the current date is beyond the calculated calibration expiration date, and it will post "Overdue" in the "Calibration expires:" field. The user can still perform survey counts even if the unit is out of calibration.



Saving New Settings

Like most Windows dialog boxes, you can use either the *OK* button to save your changes or *Cancel* (X) to disregard any changes and exit the dialog.



More on Configuration Files

All of the configuration settings are stored in a configuration file in the ***SD Card*** folder on the desktop (note that the MCA settings are saved by the MCA itself and are not a part of the configuration file). The user may create and maintain multiple configuration files. This should be done for various isotopes and for various types of survey characteristics. The default configuration file is named "**default.cfg**". This will always be the configuration loaded when the SabreASM is turned on. To select a different configuration, once the instrument is operating, from the *File* menu, either select one of the last three **Most Recently Used** configurations from the **MRU** list, or select *Open Configuration* and choose the file.

The user can open saved configuration files and load the parameters stored there using *File—Open Configuration.*

The user can save the current parameters to the current configuration file using the *File—Save Configuration.*

The user can save the current parameters under a new configuration filename using the *File—Save Configuration As.*

NOTE: Configuration settings are saved to the disk file ONLY upon user command. Whenever you change configuration settings, you must use one of the commands on the Configuration tab to update the configuration file on disk or create a new one. When you exit the SabreASM Assistant program you will be prompted as to whether or not you want to save changes to the configuration file.

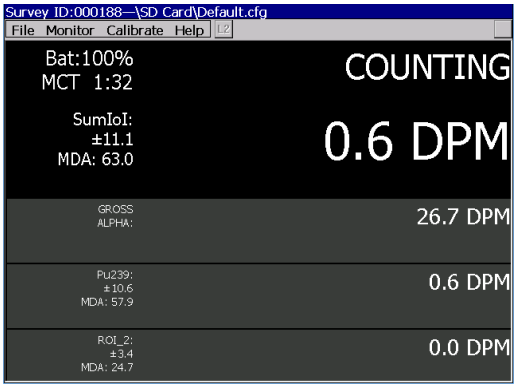
SECTION

4

Survey Counts

Performing a Survey Count

Surveys are performed by placing the probe on a flat surface and pressing the **Count** button on the front panel (or selecting *Monitor—Begin Count* from the menu). Pressing the Count button again (or selecting *Monitor—Cancel Count* from the menu) will cancel the operation and return the instrument to the ready state, ready to start a new count.



It is important not to move the probe during a count!

On the screen, the title bar will reflect the Survey ID number. As the measurement proceeds, data will be displayed in the meters and updated in real time:

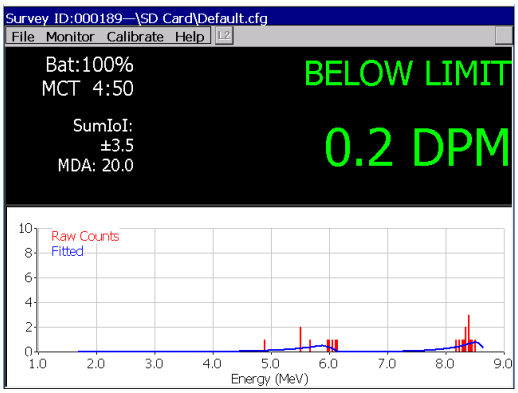
- The top meter will indicate the battery charge level, the counting mode (fixed- or minimum-count time, abbreviated FCT or MCT respectively), the elapsed count time in minutes:seconds, and the status of "COUNTING."

- The next meter shows the Primary or combined Primary+Alternate measurement result with the Description, the 1-sigma uncertainty, the MDA, and finally, in large type, the net activity in DPM or Bq.
- The gross alpha activity meter is next. This shows the total alpha activity measured in DPM or Bq.
- The next two meters, if shown, indicate the individual Primary and Alternate measurement results with Description, the 1-sigma uncertainty, the MDA, and the net activity in DPM or Bq. This meter data is displayed only if the Alternate IoI is defined (i.e., not set to **None**) in which case, the SumIoI meter becomes the output for the Primary channel.

If the Spectrum is shown in the lower half of the display by toggling the display Mode with the Mode button, the Spectrum display will show the following:

- The raw 256-channel alpha energy spectrum and peak fit curve. In the display, a histogram of counts (Y-axis) versus energy (X-axis) is shown where the horizontal scale shows energy in MeV and the vertical scale tracks the channel counts and adjusts automatically to display the channel with the highest counts.

As the count progresses, you will typically see a highly fluctuating net reading that eventually stabilizes as the measurement accuracy improves. Depending on the configuration settings, the **MDA** may be very large, but as the count progresses and statistics improve, the **MDA** will trend lower, approaching the action level. If the activity of the radon progeny is not too excessive, the **MDA** will eventually dip below the Action Level. In unusually high radon situations, the **MDA** may not reach the sensitivity represented by the Action Level, requiring the Action Level to be raised, or perhaps allowing the radon progeny to be decayed for 30 minutes before re-surveying.



In **FCT**, or Fixed Count Time mode, the count is automatically terminated one of two ways:

- The Fixed Count Time has elapsed.
- The count is terminated by pressing the **Count** button.

In **MCT**, or Minimum Count Time mode, the count is automatically stopped for the following reasons:

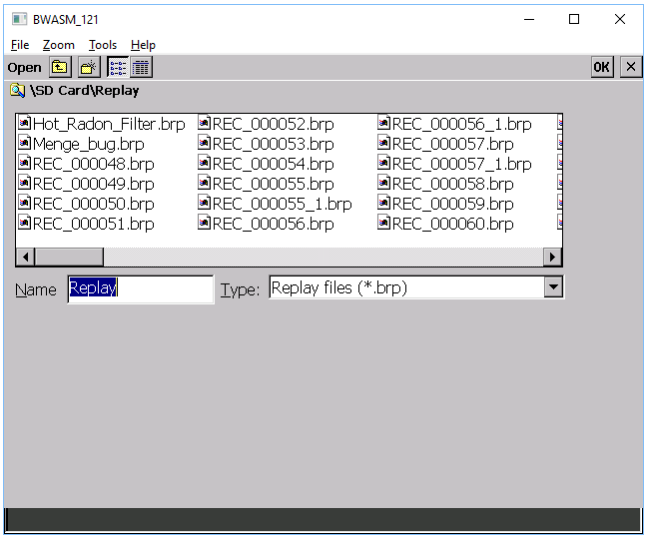
- The [combined] alpha **MDA** is below the Action Level ***and*** the elapsed time exceeds the MCT Minimum Count Time.
- The [combined] alpha **MDA** is below the Action Level ***and*** the isotope reading is above the Action Level ***and*** the alpha reading has an error less than the user-defined confidence ***and*** the elapsed time exceeds the MCT Minimum Count Time.
- The MCT Maximum Count time is reached.
- The count is terminated by pressing the **Count** button.

If counts are terminated normally, the following results are possible:

- **BELOW LIMIT**—this means that there is confidence that there is no transuranic activity above the Action Level. The green indicator will light continuously and the sonalert will beep. Pressing the **Alarm Ack** button will clear the alarm and turn off the green indicator.
- **HIGH ALPHA**—this means that there is high confidence that the reading in excess of the Action Level is within the confidence (typically ±10%) of the reported value. The red indicator will light and the sonalert will alarm continuously. The audible output may be silenced by pressing the **Alarm Ack** button once. Pressing the **Alarm Ack** button again will clear the alarm and turn off the red indicator.
- **POOR FIT**—this means that the alpha peak shape fit algorithm was unable to resolve peaks from the spectrum and that the results are unreliable. *This is usually indicative of a misconfiguration or noisy spectrum.*

If the count is cancelled by the user, the result line will indicate **CANCELLED**.

Above, the term **[Combined]** indicates the two possible values for the main meter reading: the Primary-only value, and in the case where the Alternate channel is enabled, the "SumIoI" or Primary+Alternate activity value.



Note: When a count is completed or cancelled, the software will log the results and status to the log file.

After a survey count is completed, the user may move the probe to a different location and press the **Count** button to start the next survey count.

Replaying a Sample Count

The raw counts, during every survey count, are recorded in a "**replay**" file along with a timestamp of elapsed milliseconds when they occurred. This file allows the instrument to replay the recording in real-time using different configuration files. Survey counts can be replayed—with **L1** security access—from the *Monitor*—*Replay Count* menu item.

NOTE: The *Replay Count* menu item will only be available when logged in.

A file explorer window will open to the *SD Card**Replay* folder allowing the user to open a previous "**REC_xxxx.brp**" count file (where xxxx is the Sample ID). After opening the file, the counts will be replayed exactly as if a survey count was being taken with the active probe.

SECTION

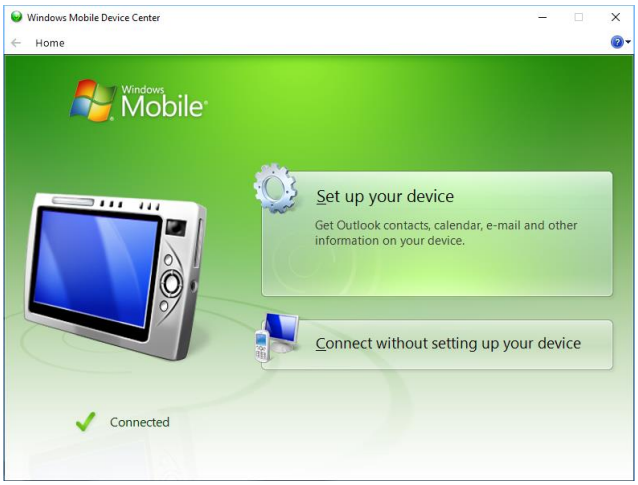
5

Sample Data Reporting

Accessing SabreASM Log Files

SabreASM log files must be accessed from a PC, then copied locally to the PC for archiving and analysis. This can be done via the supplied USB cable, or via a network connection when the SabreASM is configured for the local network.
Using the USB cable, connect the SabreASM to the PC. After a few seconds, the Windows Mobile Device Center (WMDC) screen will appear.

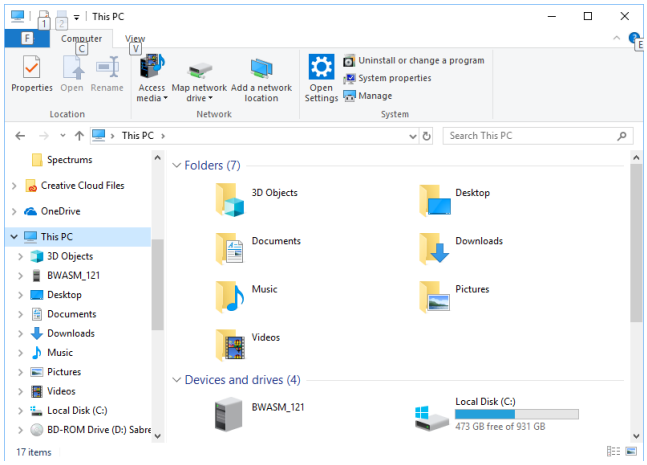
Once the USB connection to the SabreASM has been established, the WMDC will look like the following:



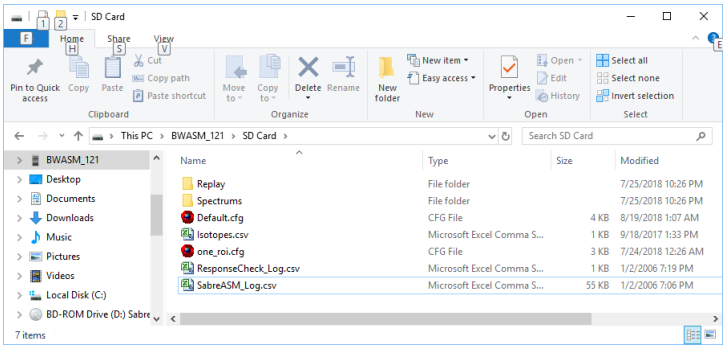
At this point, you can just minimize the WMDC or click *Connect without setting up your device*.

From now on, you can just use Windows File Explorer to access the files on the SabreASM.

Open a File Explorer window and click on the This PC. You will see the SabreASM (BWASM_121) in the right-hand pane under Devices and drives:



Double-click on the BWASM_121 (your serial number will be different!), click the **SD Card** folder, and you can now see the log files on the **SD Card**. The replay files are saved in the **Replay** folder, while spectrums are saved in the **Spectrums** folder. All other log files are saved in the root of the **SD Card**.



NOTE: Some IT Security departments do not install the WMDC by default and it may need to be installed manually. Copies of the 32- and 64-bit versions of WMDC are included on the CD provided with your SabreASM for manual installation.

Survey Results Log

The SabreASM displays readings on a continual basis during a count cycle. At the end of the count cycle, the readings are logged to a file in the **SD Card** folder in a file named "**SabreASM_log.csv**" (or other user-specified file name).

- To start a new log, select *File—New Log* from the menu.
- To open an existing log, select *File—Open Log* from the menu.

Log files can be viewed by simply double clicking on the file name from Windows File Explorer. An example log file is shown below:

```
Index, SampleID, Isotope1, Net DPM, MDA, Error, Isotope2, Net DPM, MDA, Error, Total, Net DPM, MDA, Error, Gross DPM, Count Time, Result, Date
0000000001, 000001, ROI_1,    79572.3,    115.7,   1401.2,,,,,,,,    80278.6, 00:00:10, HIGH ALPHA, 7/9/2018 11:06:00 AM
0000000002, 000002, ROI_1,        0.0, 1000000.0, 1000000.0,,,,,,,,        0.0, 00:00:00, CANCELLED, 7/9/2018 11:12:29 AM
0000000003, 000003, ROI_1,        0.0,   1000.0,    381.6,,,,,,,,        0.0, 00:00:01, CANCELLED, 7/9/2018 11:12:31 AM
0000000002, 000002, ROI_1,    68771.3,    117.8,   1310.9,,,,,,,,    68823.7, 00:00:10, HIGH ALPHA, 7/9/2018 11:15:28 AM
0000000002, 000002, ROI_1,        0.0,     53.7,      7.3,,,,,,,,        0.0, 00:00:34, CANCELLED, 2/8/2017 12:00:44 PM
0000000003, 000003, ROI_1,        0.0,   1000.0,      7.1,,,,,,,,        0.0, 00:00:01, CANCELLED, 2/8/2017 12:05:07 PM
0000000002, 000002, ROI_1,      127.5,     36.1,     28.5,,,,,,,,      148.0, 00:00:39, CANCELLED, 2/8/2017 12:06:08 PM
0000000003, 000003, ROI_1,    81368.6,     19.8,    641.9,,,,,,,,    81548.2, 00:00:48, CANCELLED, 2/8/2017 12:07:12 PM
0000000004, 000004, ROI_1,    88441.9,    107.0,   1436.8,,,,,,,,    88529.0, 00:00:11, HIGH ALPHA, 2/8/2017 12:07:37 PM
0000000005, 000005, ROI_1,        0.0,     19.8,      2.7,,,,,,,,        0.0, 00:01:30, CLEAN, 2/8/2017 12:58:07 PM
0000000006, 000006, ROI_1,       39.5,      2.1,    5.3, ROI_2,  31.0,   2.1,   4.7, SumIoI,  70.6, 3.0, 7.1,   69.7, 00:05:40, HIGH ALPHA, 2/8/2017 1:17:37 PM
0000000002, 000002, ROI_1,        0.0,     13.6,      1.8, ROI_2,  0.0,  13.6,  1.8, SumIoI, 0.0,  19.2, 2.6,     0.0, 00:02:12, CANCELLED, 2/8/2017 12:03:14 PM
0000000002, 000002, ROI_1,        5.1,      6.7,      1.9, ROI_2,  0.0,   4.3,  0.7, SumIoI, 5.1, 7.9,  2.0, 319.1, 00:10:00, CLEAN, 6/1/2016 4:58:45 PM
0000000003, 000003, ROI_1,   127813.5,     17.8,    652.3,,,,,,,,   128948.0, 00:01:58, CANCELLED, 6/1/2016 5:04:31 PM
0000000004, 000004, ROI_1,   125365.2,    194.0,   2264.8,,,,,,,,   126936.5, 00:00:10, HIGH ALPHA, 6/1/2016 5:05:05 PM
0000000005, 000005, ROI_1,        0.0,     20.0,      3.7,,,,,,,,      430.3, 00:06:43, CLEAN, 6/1/2016 5:19:20 PM
0000000006, 000006, ROI_1,        0.0,     20.0,      3.7,,,,,,,,      226.9, 00:06:31, CLEAN, 6/1/2016 6:51:38 PM
0000000007, 000007, ROI_1,        0.0,    209.2,     28.4,,,,,,,,       80.5, 00:00:15, CANCELLED, 6/2/2016 3:06:20 PM
0000000008, 000008, ROI_1,        0.0,     20.0,      2.7,,,,,,,,       43.4, 00:02:23, CLEAN, 6/2/2016 3:18:11 PM
0000000009, 000009, ROI_1,        0.0,     19.9,      2.7,,,,,,,,       56.8, 00:02:24, CLEAN, 6/2/2016 4:24:35 PM
0000000010, 000010, ROI_1,        0.0,     19.9,      2.7,,,,,,,,       32.3, 00:02:24, CLEAN, 6/2/2016 5:06:26 PM
0000000004, REP000004, ROI_1,    77297.3,    115.1,   1378.1,,,,,,,,    78307.7, 00:00:11, HIGH ALPHA, 7/11/2018 4:50:08 PM
```

Survey Spectrum Log

At the end of the count cycle, the final spectrum is logged to a file in the **SD Card\Spectrums** folder. A separate spectrum log file is created for each survey count or count replay named "**Spectrum_xxxx.txt**" for survey counts (where xxxx is the Survey ID), and "**Spectrum_yyyy.brp.txt**" for recounts (where yyyy is the name of the replay file).
The format of the spectrum logs is again comma-delimited-text as follows:

```
Chan, Counts, Fit
   0,        0, 0.0000E+000
   1,        0, 0.0000E+000
   2,        1, 5.8069E-001
   3,        1, 6.0116E-001
   4,        2, 6.2240E-001
   5,        0, 6.4445E-001
   6,        0, 6.6734E-001
   7,        2, 6.9110E-001
   8,        1, 7.1578E-001
   9,        2, 7.4142E-001
  10,        2, 7.6806E-001
  11,        1, 7.9575E-001
  12,        4, 8.2454E-001
  13,        2, 8.5447E-001
  14,        1, 8.8560E-001
  15,        4, 9.1799E-001
                    *
                    *
                    *
  96,       32, 3.2425E+001
  97,       44, 3.4211E+001
  98,       44, 3.6104E+001
  99,       36, 3.8112E+001
 100,       39, 4.0243E+001
 101,       50, 4.2503E+001
 102,       47, 4.4902E+001
 103,       43, 4.7448E+001
 104,       48, 5.0152E+001
 105,       54, 5.3023E+001
 106,       45, 5.6074E+001
 107,       40, 5.9315E+001
 108,       72, 6.2761E+001
 109,       68, 6.6423E+001
 110,       71, 7.0318E+001
 111,       69, 7.4460E+001
 112,       73, 7.8868E+001
 113,       77, 8.3558E+001
 114,       99, 8.8550E+001
 115,      101, 9.3864E+001
 116,       85, 9.9519E+001
 117,      128, 1.0553E+002
 118,      118, 1.1189E+002
 119,      110, 1.1856E+002
 120,      133, 1.2536E+002
 121,      139, 1.3191E+002
 122,      120, 1.3750E+002
 123,      145, 1.4094E+002
 124,      124, 1.4073E+002
 125,      122, 1.3531E+002
 126,      149, 1.2374E+002
 127,      113, 1.0633E+002
 128,       92, 8.4884E+001
 129,       60, 6.2318E+001
 130,       40, 4.1711E+001
 131,       13, 2.5263E+001
 132,       20, 1.3758E+001
 133,        6, 6.7007E+000
 134,        3, 2.9058E+000
 135,        4, 1.1179E+000
                    *
                    *
                    *
 247,        0, 6.7832E-003
 248,        0, 7.1506E-003
 249,        0, 7.4431E-003
 250,        0, 7.5675E-003
 251,        0, 7.4056E-003
 252,        0, 6.8572E-003
 253,        0, 5.9032E-003
 254,        0, 4.6479E-003
 255,        0, 3.2998E-003
```

Response Check Log

The SabreASM automatically logs the results of a source Response Check, indicating the PASS/FAIL determination. The log file is named "**ResponseCheck_Log.csv**" and is saved in the **SD Card** folder.

The log file lists the date/time of the source check, along with the isotope selected, acceptable bounds, the reading, and the result as follows:

```
Date,                  Isotope,       HiLimit, LoLimit, Reading, Result
10/18/2012 4:45:18 PM, Pu239+Am241,   141000,   121000, 124471.1, PASSED
10/18/2012 5:06:14 PM, Pu239+Am241,   141000,   121000, 128238.6, PASSED
10/18/2012 5:10:03 PM, Pu239+Am241,   141000,   121000, 127706.6, PASSED
10/18/2012 5:13:37 PM, Pu239+Am241,   141000,   121000, 127375.3, PASSED
```

Note: In this case, the SabreASM was configured to measure both **Pu-239** and **Am-241**. This file may also be imported/opened in Microsoft Excel.

Importing the Data into Microsoft Excel

Survey Results log files (e.g., "**SabreASM_log.csv**") and Response Check log files ("**ResponseCheck_Log.csv**") are in Comma-Separated-Variable (***.csv**) format and can be opened and viewed directly from *Microsoft Excel* by simply double-clicking on the file.

The Spectrum log files are comma-delimited but saved with a ***.txt** extension, which means they are most easily viewed with Notepad. They can, however, be imported easily into Excel, or the file extension can be changed to ***.csv** and then opened by double-clicking.

When **graphing the Spectrum data** is important, a more convenient method for viewing different files is to open a blank Excel spreadsheet and then select *Data—Get External Data—Import Text File*. Next, select the **Spectrum_xxxx.txt** log file. Be sure to click the **Delimited** button, as well as the **Comma** checkbox on the next screen. Finally, import it at cell A1. The data can now be graphed and analyzed. Save the spreadsheet to preserve the charts and link to the imported data. To examine the Spectrum data from a different session, it is only necessary to open the previously saved spreadsheet, then select *Data—Refresh Data* and point to the new log file. The charts will be updated automatically.

SECTION

6

Theory of Operation

Multi-channel Analyzer

At the heart of the SabreASM is a multi-channel spectrum analyzer (MCA) which allows the alpha spectroscopy necessary for accurate radon background subtraction. Internally, the SabreMCA utilizes a 1024-Channel discriminator, whose output can be translated to the 256-channel MCA output through four configuration settings. These are factory-set and rarely need change by a user.

During a count, the SabreASM processor board receives individual counts from the SabreMCA via an internal RS-232 communications port. The MCA channel (0-255) of the count is transmitted to the processor as each count is received. The software then processes each of the counts into the appropriate spectrum channel counts to create the alpha spectrum histogram.

Next, the peak fit algorithm processes the spectrum approximately once per second and returns the radon (and IoI) fit information necessary for the software to perform the radon subtraction.

Calculations

Radon Background Subtraction

Alpha spectroscopy allows the SabreASM to determine individual radon progeny activities for **Po-212**, **Po-214** and **Po-218/Bi-212**. Tail counts from these interferents are automatically separated from the Isotope-of-Interest or Region-of-Interest counts during peak fitting so no additional calculations are necessary for alpha background subtraction.

Uncertainties in Peak Counts

In most ROI-based analyzers, the minimum detection limit is based on the statistical uncertainty of the background counts that fall within the region, in combination with the uncertainty of any counts in excess of the background. In the SabreASM, the **MDA** is not directly related to the spectrum counts, but to the uncertainties in the spectrum peak fit.

When the peak fit is completed, values are returned which represent the counts under each isotope peak. These values are statistically Gaussian-distributed about the 'true' peak areas and therefore have known probabilities of being within 1-sigma, 2-sigma, etc. of the true area. A characteristic of the alpha-peak-shape-fit algorithm is that in the course of solving the minimization problem, a "covariance matrix" is calculated, which describes the errors associated in the solution of the peak areas. In other words, the curve fit routine returns the actual variances for the peak areas so that uncertainties due to interfering isotopes (i.e., background) have already been considered.

An examination of the peak area variances confirms that when the counts due to an interfering isotope greatly outnumber the counts due to the isotope-of-interest, the variance of the isotope-of-interest increases. Likewise, when there are very few interfering counts from other isotopes, the variance begins to approach a value equal to the peak area counts.

Calculation of the MDA for Isotopes-of-Interest

A modified version of the *Currie formula* for MDA is used in the SabreASM. The variance returned from the peak fit routine for a transuranic IoI includes contributions for the tailing from radon decay products as well as the uncertainty of any IoI counts themselves. The variance used *is the difference of the fit variance with the Gaussian variance of the net IoI counts*. This is because the Currie formula requires the sigma of the background—not the sigma of the background *plus sample*.

$$MDA = \frac{K^2 + 2\sqrt{2}K\sqrt{Variance_P - Net_P}}{T_C \times Eff}$$

Where, T_C is the count time, Eff is the detector efficiency, K is the sigma factor for the user selected confidence level, $Variance_P$ is the variance of the fitted peak area of the isotope-of-interest, and Net_P is the fitted peak area IoI counts. It should be noted that only positive Net_P counts are ever returned by the peak fit.

Activity Calculation Method for Isotopes-of-Interest

The curve fit function produces coefficients for each isotope that correspond to the counts under the IoI peak.

$$Activity = \frac{Net_P}{T_C \times Eff}$$

The 1-Sigma error associated with the activity determination is simply the square root of $Variance_P$.

Calculation of Regions-of-Interest Counts

Counts within a ROI are treated differently form fitted IoI counts. With ROIs, the peak fit algorithm does not attempt to least-squares fit counts within an ROI—only spectrum counts outside the ROI(s). Tailing from the combined (i.e., all radon progeny peaks) peak fit curve that extend within an ROI are subtracted from the ROI total, resulting in the net ROI counts Net_P.

A similar method is used to calculate the ROI variance $Variance_P$.

Calculation of the MDA for Regions-of-Interest

Once the Net_P and $Variance_P$ have been calculated for the ROI(s), the MDA calculation is identical to that for the IoI.

Activity Calculation Method for Regions-of-Interest

Again, the calculation is now identical for the IoI case.

$$Activity = \frac{Net_P}{T_C \times Eff}$$

SECTION

7

Appendix

Specifications

Survey Probe

- Detector: Solid-state passivated ion-implanted planar silicon (2-in. dia., 2000 mm² active area)
- Pre-Amplifier: Trans-impedance type

Data Analysis

- MCA: 1024-channel ADC
- Alpha-Peak-Shape-Fitting (APSF) algorithm for radon progeny background subtraction and up to two additional alpha isotopes or ROIs
- Max Count Rate: 100,000 cpm
- Alpha Efficiency: ~15% 4-Pi (when detector diameter is the same as sample source diameter)

Physical

- A/C Adapter provided
- Weight: 7.5 lbs. (3.4 kg)
- Dimensions:
  - Instrument (L x W x H): 5.4 x 9.8 x 13.1 in.
  - Probe (L x W x H): 6 x 3 x 4.8 in.
  - Cable length: 48 in.
- Temperature: 0 to 122 °F (-20 to 50°C)
- Humidity: 5 to 90% (non-condensing)