CyberOptics WaferSense® and ReticleSense® AMS User's Guide

For AMS-300C, AMS-200C, AMS-150C, and AMSR wireless Auto Multi-Sensors

CYBEROPTICS

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General Information

Note: This manual is for the AMS family of products including the AMS-300C, AMS-200C, AMS-150C and AMRS

WaferSense and ReticleSense Device and Link

Changes or modifications not expressly approved by CyberOptics Corporation, may void your authority to operate the AMS device.

The radio contained in the AMS meets all the applicable FCC requirements for RF Safety. While in operation, the FCC requires users and nearby persons to maintain a minimum separation distance of 20 cm (8 inches) or farther from the AMS.

The AMS and Link have been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC COMPLIANCE STATEMENT
CAUTION: Changes or modifications not expressly approved could void your authority to use this equipment. This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The exclamation point within an equilateral triangle is intended to alert the user to the presence of important operating and maintenance instructions in the literature accompanying the device.

Service:
Do not remove cover. No user serviceable parts inside. Return to CyberOptics for service and calibration.

Power Supply and Charging:
Use only the power supply provided with this equipment for charging.
Input: 100-240 VAC, 50-60 Hz, 0.6A
Output: 5 VDC, 3.0A

Lithium Rechargeable Batteries:
Internal lithium batteries, if handled incorrectly, could cause injury or death. Refer to local regulations for handling and disposal of batteries. Battery should only be serviced by CyberOptics.

Static Sensitive Components:
Observe precautions for static sensitive components.

Disposal:
The product must not be disposed of with normal waste. Instead, it is your responsibility to dispose of your waste equipment by arranging to return it to CyberOptics for recycling. By separating and recycling your waste equipment at the time of disposal you will help to conserve natural resources and ensure that the equipment is recycled in a manner that protects human health and the environment. For more information about how to recycle your CyberOptics supplied waste equipment please contact our customer services department at 1-763-542-5000.

Labels on Devices
Hazard labels as they appear on the AMS devices.
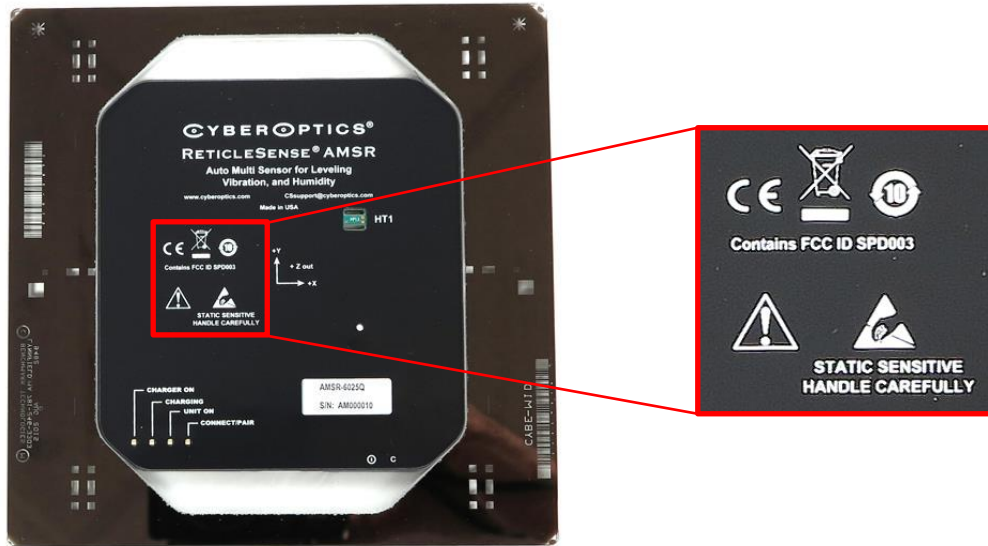
WaferSense and ReticleSense Technical Support

Technical support is available from CyberOptics Corporation.

E-mail:	CSsupport@cyberoptics.com
Phone:	763-542-5000
	800-366-9131 (US and Canada only)

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Introduction

The CyberOptics WaferSense® and ReticleSense® Auto Multi-Sensors measure leveling, vibration and humidity inside semiconductor process equipment. The family of products includes versions for 300mm (AMS-300C), 200mm (AM-200C), 150mm (AMS-150C) and 6 inch reticles (AMSR).

The MultiView™ software application makes it easy to see results in real- time. The large display and wireless link let you place the computer at a convenient distance from the AMS device.

The AMS consists of the following components:

- **AMS hardware**. The AMS is designed with a wafer-like or reticle-like form factor, so it can fit in most handling equipment or tools. The device is also vacuum compatible.

- **MultiView and MultiReview™ software**. The MultiView software application monitors the vibration, humidity, and leveling measurements and other status information in real time. MultiReview lets you play back log files recorded in MultiView. Both applications run on most personal computers that use the Microsoft Windows operating system. See "Specifications" on page 127 for platform requirements.

- **Wireless link**. The software communicates with the AMS by using a Bluetooth wireless link that attaches to a USB port on a personal computer.

- **Charging case**. The AMS is powered by an internal rechargeable battery, which you recharge by placing the AMS into the charging case.

- **Carrying case**. The carrying case makes it easy to take your complete AMS system with you in the plant or on the road.

The following section provides you with instructions for installing your AMS system.

The AMS controls and LED indicators are visible on the outside of the device as shown below.

Figure 1. Controls and LED Indicators

CHARGER ON
CHARGING
UNIT ON
CONNECT/PAIR

Reset switches are located on the edge of the unit

LED indicators
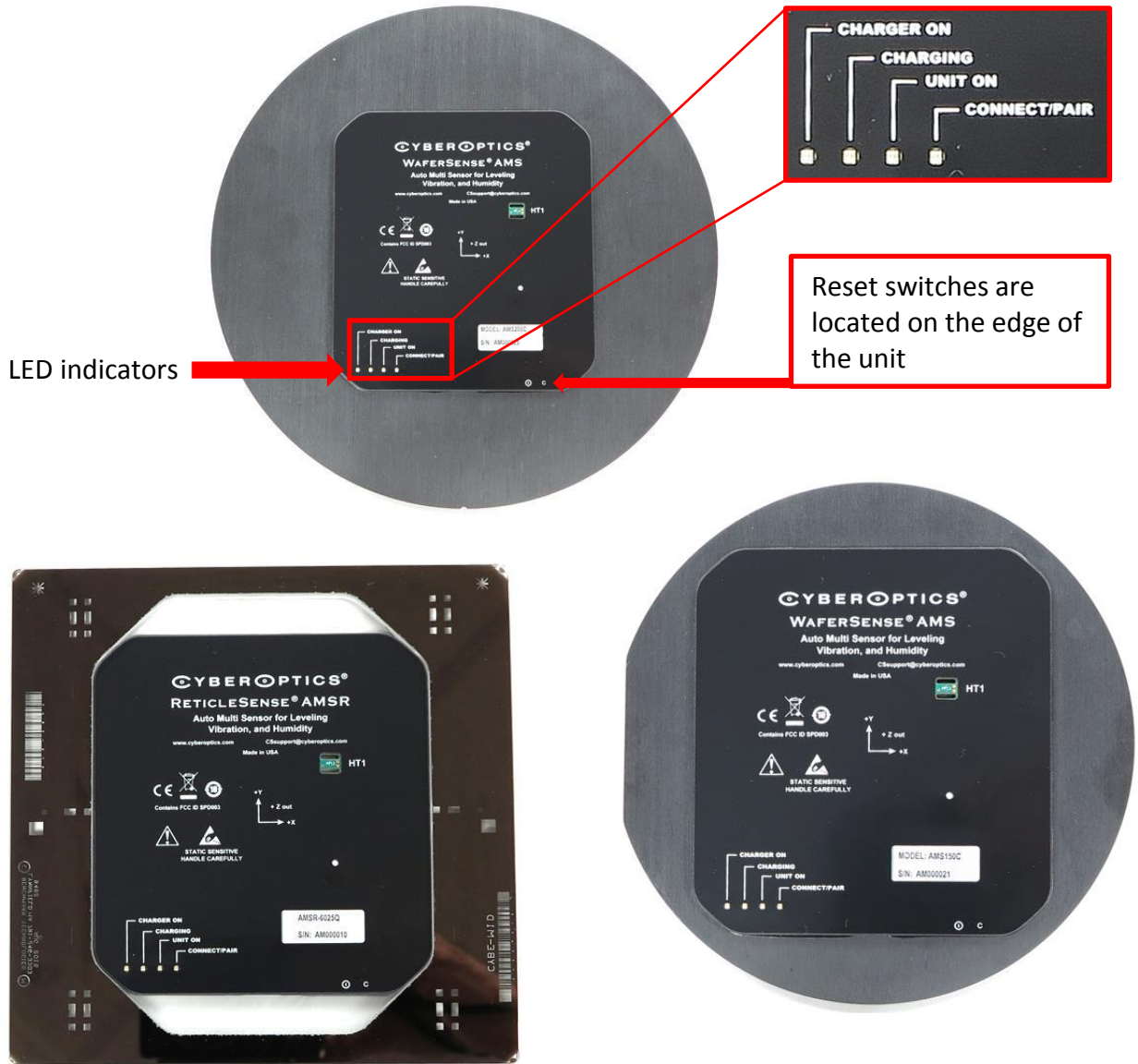
Installing your AMS

This section describes the procedures you need to perform to install your AMS system and get it ready for use. For best results, perform the procedures in the order they are presented in this chapter:

- Installing the AMS software

- Installing the wireless link on the USB port

- Checking communications between the link and the AMS

- Registering your AMS

- Running the MultiView application

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Caution

Dropping the AMS or hitting it against a hard object can bend, break, or chip the housing; damage the internal components; or knock the AMS out of calibration. While it is not as fragile as an actual silicon wafer, handle the AMS with care, as you would any precision instrument. If the AMS is damaged or in need of calibration, see the "Maintaining Your AMS" section.

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<div style="border:1px solid blue;">

Caution

The AMS is thicker than a standard silicon wafer so use extreme care to assure that the wafer has proper clearances when being transported through the tool. For example, when you use the device in a tool for the first time, move the AMS through the tool in manual mode, visually verifying all clearances. Even when clearances are sufficient for safe AMS pass-through, if the robot end-effector is taught too high, you risk crashing and damaging the AMS.

Do not direct compressed air or gas into the humidity sensors on the AMS. Damage to the unit may result.

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Installing the AMS Software

To install and run the AMS software MultiView and MultiReview, your computer must have the following:

- Windows XP, or Windows Vista and Windows 7 (32-bit or 64-bit), Windows 8, Windows 10 operating systems

- One free high-power USB 1.1 or USB 2.0 port

To install the AMS software, do not plug in the link before you start. The software must be installed first using the following steps:

1) Log on using an account with Administrator privileges.

2) Insert the AMS Installation Disk into the CD drive.
   The Setup Wizard starts automatically, as shown in the figure below. If the wizard doesn't start automatically, use Windows Explorer to view the contents of the CD and double-click the **setup.exe** program.
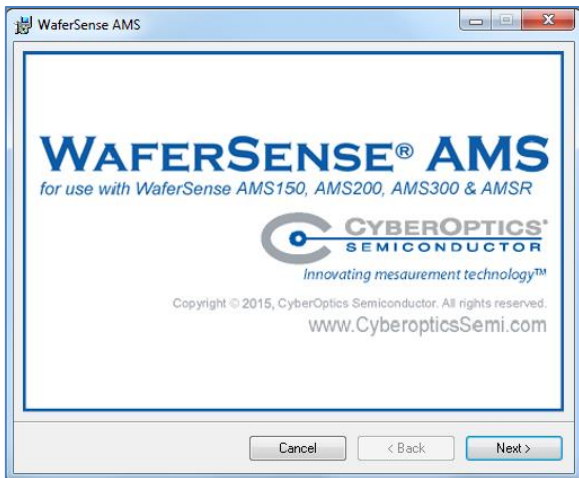
3) Click **Next** and the Welcome screen of the Setup Wizard appears.
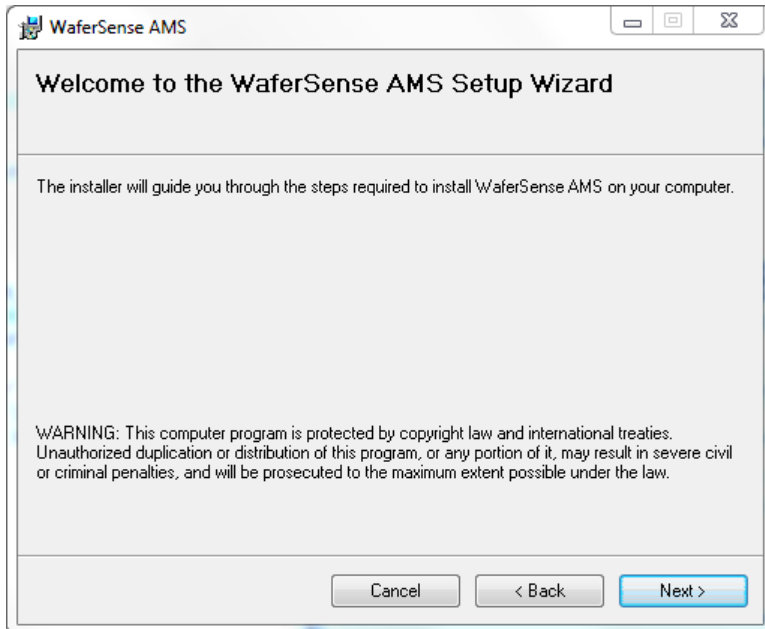
4) Click **Next** and License Agreement screen appears. Click the **I agree** button. Click the **Next** button and the Select Installation Folder screen appears. Either accept the default settings, or enter a different path and access settings.
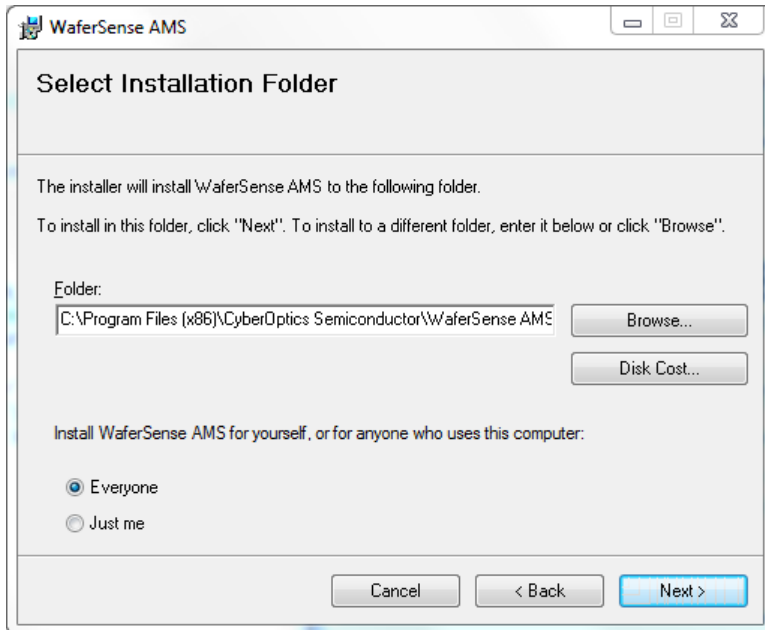
5) Click the **Next** button and Confirm Installation screen appears. Click the **Next** button, and the Setup Wizard starts installing the WaferSense AMS operating software on your computer. A blue progress bar appears and, when the installation is complete, the following screen appears.
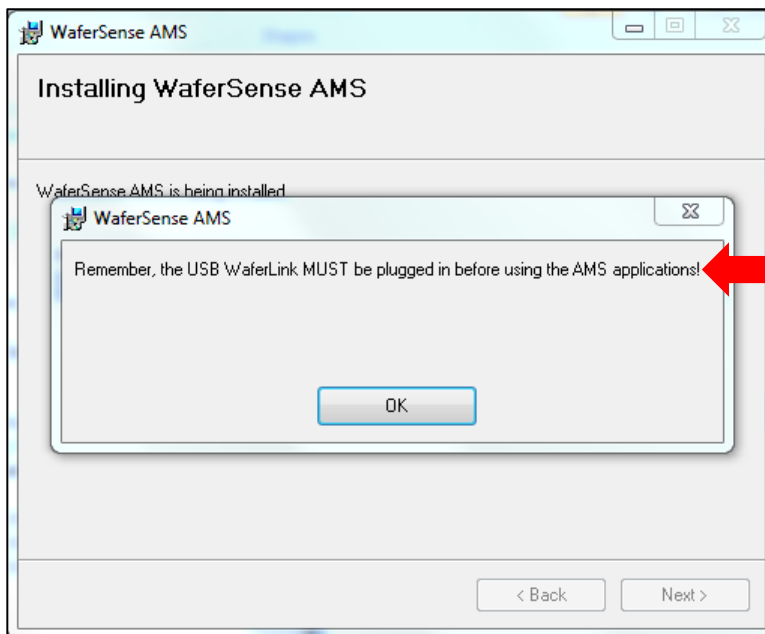
6) Click **OK**. The WaferSense AMS software is now installed. This is important! *Do not run* the AMS software at this time. If you do, you will compromise the overall AMS installation procedure, and get an error message saying **ftd2xx.dll** not found.

7) The next step is to install the wireless link (as described in the next section).

Installing the Wireless Link

Before starting the wireless link installation, complete "Installing the AMS Software" on page 12. To install the wireless link:

1) Turn on your computer.

2) Locate an unused, high-power USB port on your computer. The AMS wireless link module requires a high-power USB port, such as the built-in ports on your computer and ports on USB hubs that have power cords. Unpowered USB hubs won't work.

3) The USB cable provided with your AMS system has a different plug on each end. Locate the end with the plug that matches the USB port on your computer and plug the cable into the port.

4) Plug the other end of the cable into the link module.

5) Windows automatically finds the drivers installed during the Link Device Installer—see the figures on the previous page.

6) The **Power** light on the module turns on indicating that the module is getting power from the USB port. Ignore the **Pair Status** and **Connection Status** lights for now.

Checking the Communications Between the Link and the AMS

To complete the installation, verify that the AMS and link can communicate:

1) The AMS operates from an internal rechargeable battery. Before using the AMS for the first time, charge it for two hours. For information on checking the charge on the battery and the procedure for recharging, see "Using the Rechargeable Battery" on page 28.

2) On the AMS, there are reset switches as described in the "Introduction" section on page 9. These switches are recessed and are rarely used, and require the use of a paper clip, or small device to activate. Placing the unit in the charging case and connecting the charger power supply will start the AMS, see "Opening and Closing the Charging Case" on page 22.

3) Verify that the **Pair Status** lights on both the AMS and link module are on. The AMS and link module in your kit were paired at the factory and will operate with only that particular link module. If either light is not on, your AMS and link might not be paired with each other. To reset the pairing, see "Changing the Pairing between the AMS and Link" on page 31.

4) Immediately after turning on the AMS, the **Connection Status** lights on the AMS and link will blink slowly. After a few seconds the AMS and link will connect and both lights will be on and no longer blinking. If the lights continue to blink, see "Monitoring the Wireless Connection to the AMS Device" on page 30.

5) After starting the MultiView application (see "Running the MultiView Application" on page 17), you can verify the connection to the AMS by comparing the serial number printed on the AMS to the serial number shown in the **About** dialog, which is available in the MultiView application by choosing the **Help** > **About** menu item. If the MultiView application is not running, the AMS turns off automatically after 30 minutes.

That completes the installation of your AMS system.

Registering Your AMS for Calibration Service

To maintain optimum performance, every twelve months you should have your AMS calibrated and the battery replaced. These services can be performed only at the factory.

To help you keep track of the next service date so you can schedule this service when it is convenient, register your AMS with the factory. When you start the MultiView application (see "Running the MultiView Application" on page 17), it prompts you to register your AMS for calibration. You can also register your AMS in any of the following ways:

- On the Internet: http://cyberoptics.com/semiconductor_categories/wsregistration.html

- By sending an e-mail message containing the model, serial number, and contact information to wsregister@cyberoptics.com

Running the MultiView Application

To start the MultiView application:

1) From the Windows **Start** > **Programs** menu, choose **WaferSense AMS** > **MultiView.exe**. The MultiView application starts, as shown in the figure below. Initializing communications usually takes less than a second. If the AMS has not been registered, MultiView will display the **Calibration Registration** dialog. To complete the registration, proceed to the next step.
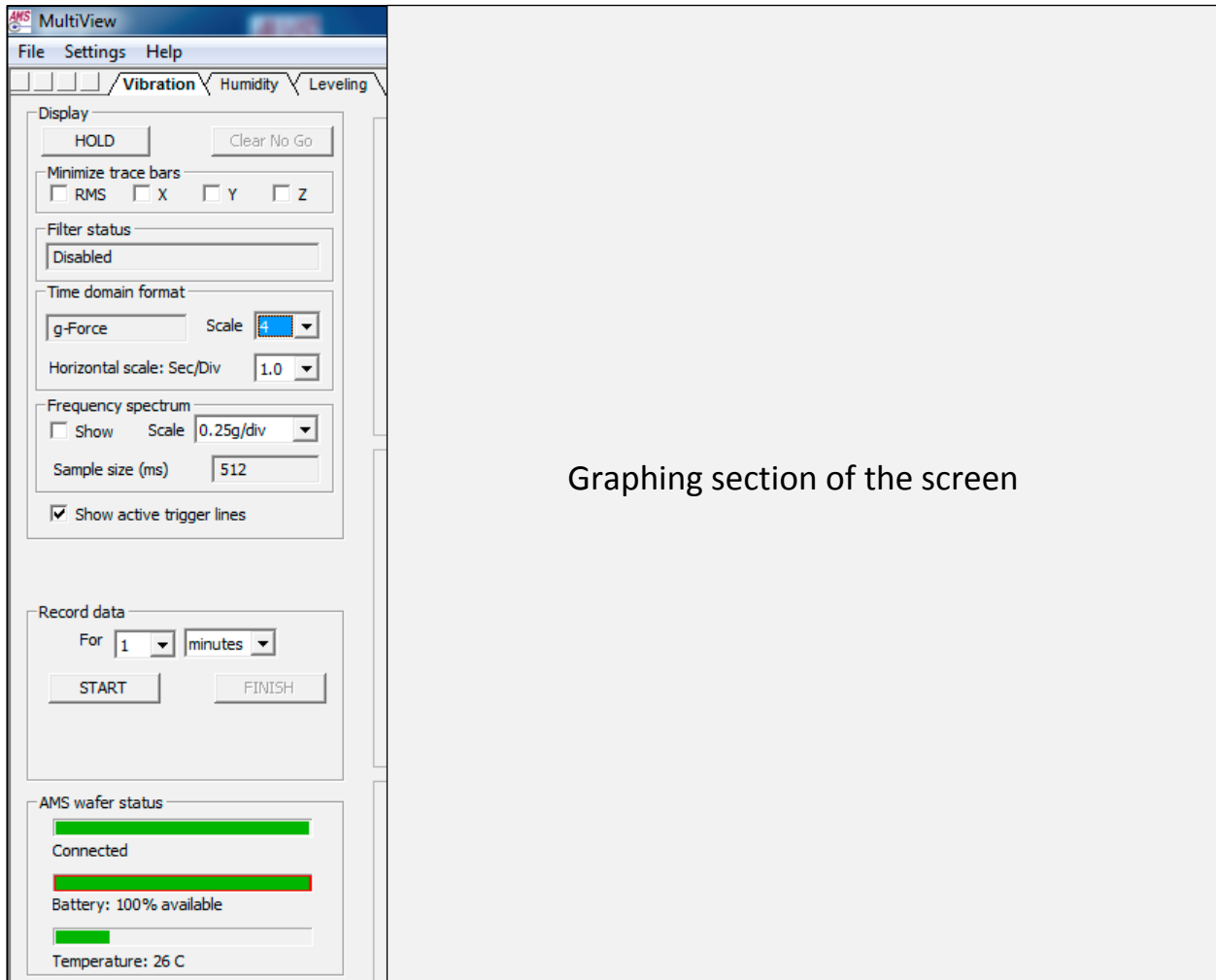
2) If MultiView displays the AMS **Calibration Registration** dialog, as shown in the figure below, you haven't registered your AMS. Follow the instructions in the dialog to complete the registration.
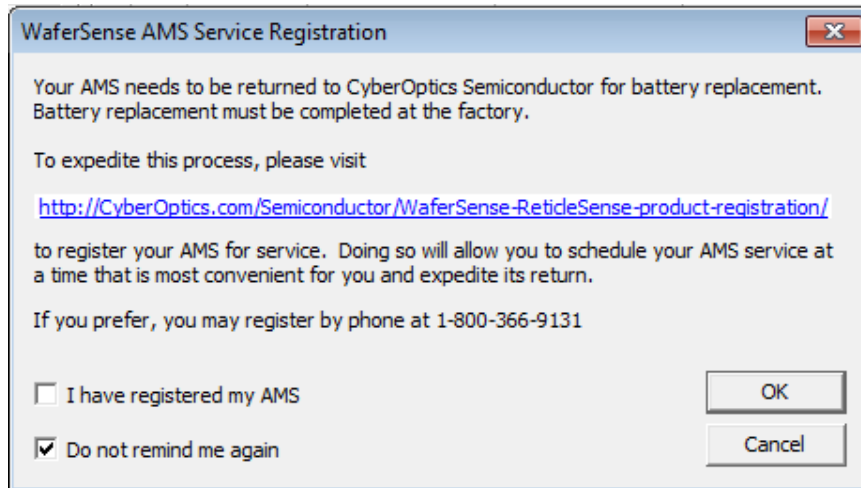
Technical Support

CyberOptics offers free technical support to customers. If the AMS hardware or software appear to be malfunctioning, please contact us, and we'll be happy to assist you.

When you contact us, please make sure that you have the following information available:

- A detailed description of the problem you are having, including the exact text of any error messages and a list of steps to reproduce the problem.

- Information about your computer, including manufacturer, CPU type, version of Windows, and memory size.

- The version of the MultiView application. The software version is available in the MultiView application by choosing the **Help** > **About AMSView** menu item.
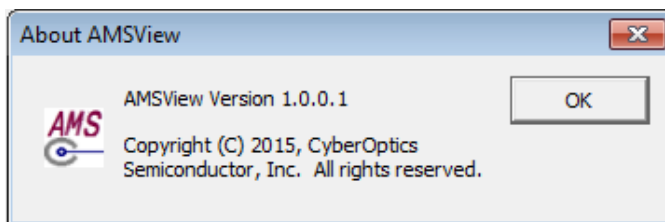
- If you are using MultiReview, a similar dialog is available from the **Help** > **About MultiReview** menu item.

- The serial number of your AMS. The serial number of the AMS is printed on a label on the top of the AMS. In addition, the serial number is also available in the MultiView application by choosing the **Help** > **About** menu item.

Technical support:

- Toll free: 800-366-9131 (US and Canada only)

- E-mail: CSsupport@cyberoptics.com

- Internet: www.Cyberoptics.com

Using
Your AMS

This section gives you instructions for performing the following tasks with the AMS device:

- Open and closing the charging case

- Use the AMS controls

- Use the AMS indicators

- Use the Vibration, Humidity, and Leveling tabs

- Change colors in the trace screen

- Print the MultiView window

- Monitor the operating temperature of the AMS

- Use the rechargeable battery

- Monitor the wireless connection to the AMS device

- Change the pairing between the AMS device and link

Opening and Closing the Charging Case

The AMS device comes in a plastic charging case that is used for storing it when not in use and for charging the rechargeable battery in the AMS (see "Using the Rechargeable Battery" on page 28). The AMS device should be stored in the sealed charging case when not in use.

The charging case is air-tight. After air transport it may be necessary to relieve the pressure differential in order to open the case. To do so, loosen the pressure relief vent screen until air enters the case. Then re-tighten the screw.

Opening the Charging Case

To open the charging case:

1) Loosen the captive screws on the top of the case.
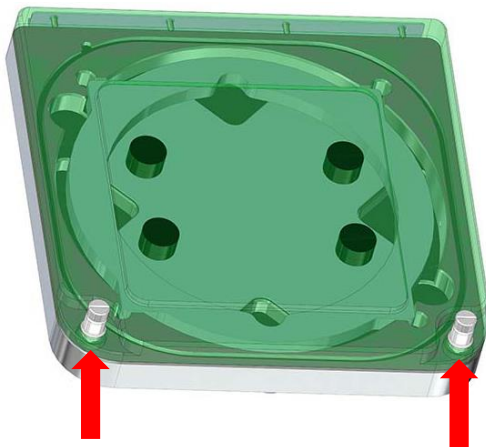
Loosen the captive screws

2) Lift the lid of the charging case using the captive screws.

Closing the Charging Case

To close the charging case:

1) Lower the lid.

2) Tighten the captive screws until the top of the case is secured.

Using the AMS Controls

AMS devices are designed to operate "hands free" in normal use.

- The unit is turned on by inserting the unit in the charging case and applying power to the charging case.

- The unit is completely turned off by activating the "shutdown" button in the MultiView software.

- A "shutdown" turns off all internal electronics in the AMS. After a shutdown the unit must be restarted in the charging case. Therefore, if the intent is to put the unit into standby mode where the electronics are still active, the "stop" button in MultiView should be used instead of the "shutdown" button.

- In abnormal situations, the reset switches on the front panel can be used to activate a shutdown or to turn the unit on from a shutdown. See "Controls and LED Indicators" on page 10 for a view of the reset switches. The switch indicated by a combined "1" and "0" symbol turns the unit both on and off.

Using the AMS Indicators

The AMS has the following status LEDs (see "Controls and LED Indicators" on page 10).

- **Charger On**. Glows green, when power is applied to the charging case.

- **Charging**. Glows red, when the unit is being charged. Goes dark when the battery has reached 100% charge. Glows red, if the charger is connected and the battery discharges below 95%. Goes dark when the inductive charger is no longer powered.

- **Unit On**. Indicates when the device is on.

- **Connect/Pair**. Note: Glows green, when the unit is successfully paired with a link box. Blinks red/green slowly, when it is searching for a link. This usually occurs just after turn on or before the link box is powered by the host computer. Blinks red/ green rapidly, when the pairing function is activated by the "C" reset switch. This rapid blinking indicates it is receptive to a new pairing.

- When the AMS is on and has been removed from its charger and is ready for in-tool use, the "Unit on" and the "Connect/Pair" LEDs should both be glowing steady green. The AMS does not necessarily need to be removed from its charger to be used, nor does it need to be used in-tool.

Using the Vibration, Humidity, and Leveling Tabs

The MultiView opening screen contains three tabs, which allow you to access the following AMS functions.

- Vibration

- Humidity

- Leveling
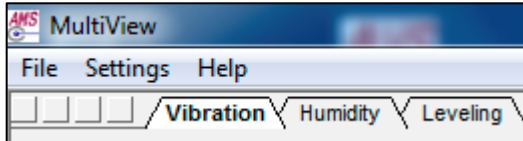
Click on the appropriate tab, and the opening screen for that particular function is displayed.

Changing Colors in the Trace Screen

You can change the colors used to display traces and other elements of the display. The table below shows the display elements that you can change.

Display Element	Description
RMS	RMS trace
X	X trace
Y	Y trace
Z	Z trace
Indicator	Vertical line at the right edge of the trace display, where new data is first displayed
Go/No-Go lines	Horizontal lines showing current active Go/No-Go tolerances
Trigger lines	Horizontal lines showing current active trigger settings
Grid lines	Horizontal and vertical section lines
Text	Labels on axes and for annotation
Background	Background color of the trace

To change colors of the display elements, do the following.

1) From the **Settings** > **Select Colors** menu item, choose the display element you want to change. The color palette is displayed.
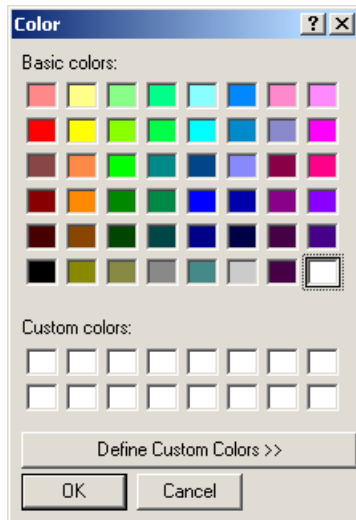
2) If you want to use one of the existing color definitions, skip to the next step. If you want to define a custom color, click **Define Custom Colors**. The color palette expands, as shown below. Specify the color as a combination of hue, saturation, and luminosity, or as a combination of red, green, and blue, and click **Add to Custom Colors**.
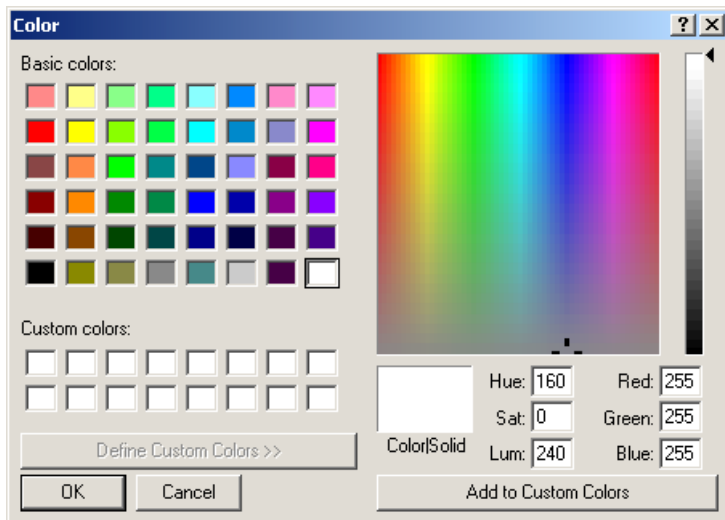
3) Click on the color you want to use for the display element and click **OK**.

4) To reset all colors to the default values, go to the **Settings** > **Select Colors** menu and choose **Restore Defaults to All**.

5) To reset only the background color to the default value, go to the **Settings** > **Select Colors** menu, and choose **Restore Default Background**.

Printing the MultiView Window

You can print an image of the MultiView window to have a graphical record of the session. To print an image of the MultiView window, do the following.

1) Choose **File** > **Print**.

2) In the Print dialog, click **OK**.

3) You can also select a printer other than the default and change the printer setup, or see a preview of what MultiView will print.

- To select a different printer, change the paper selection or print orientation, or set printer properties, choose the **File** > **Print Setup** menu item.

- To see a preview of what MultiView will print, choose the **File** > **Print Preview** menu item.

Monitoring the Operating Temperature of the AMS

The operating range for the AMS is 20–70 °C. The AMS can withstand exposure to higher temperatures for very brief periods, if not in direct contact with a heating element. The **Temperature** monitor in the **AMS wafer status** of the MultiView window shows the current operating temperature of the AMS using a numeric readout and a bar graphic (as shown below).

Low	**Optimum**	**Warning**	**Danger**
<20 °C	20–70 °C	71–80 °C	> 80 °C
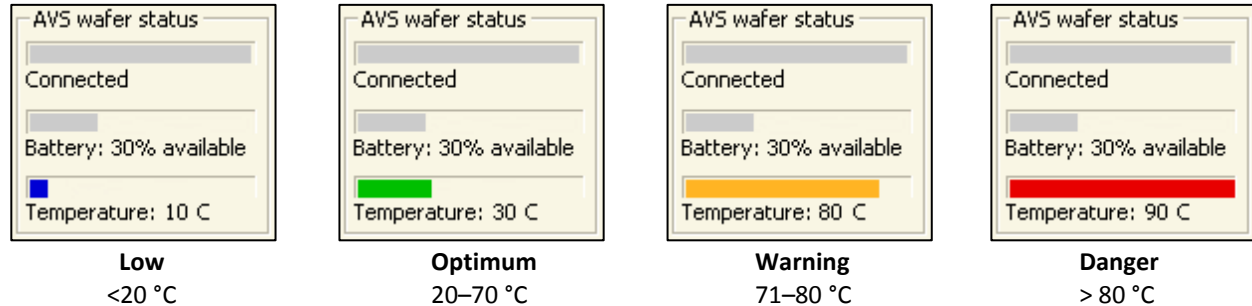
The temperature bar changes color to indicate where the current temperature is relative to the accurate operating range, using the following color-coded bars.

- **Blue**
  Less than 20 °C. The AMS is operating below the range, where it produces accurate readings.

- **Green**
  20–70 °C. The AMS is operating in its optimum temperature range, where it produces readings meeting the specified accuracy.

- **Orange**
  71–80 °C. The AMS is operating above the range, where it produces the most accurate readings, but not so hot that the AMS will be damaged.

- **Red**
  Greater than 80 °C. The AMS is operating at a temperature so high that it might be damaged.

Using the Rechargeable Battery

The AMS operates from an internal rechargeable battery. From a full charge, the battery provides about four hours of continuous use. Before using your AMS device for the first time, charge it for two hours.

The battery can be recharged about 400 times before the charge life starts to degrade significantly. The battery is not user replaceable. For information on replacing the battery, see "Annual Factory Calibration and Battery Replacement" on page 125.

Battery performance degrades at temperatures outside the temperature range: 15–45 °C.

Monitoring the Battery Level

MultiView receives frequent updates from the AMS on the status of the AMS's battery. The **Battery** indicator in the AMS status area of the MultiView window shows the approximate percentage of operating time remaining before you must charge the battery.
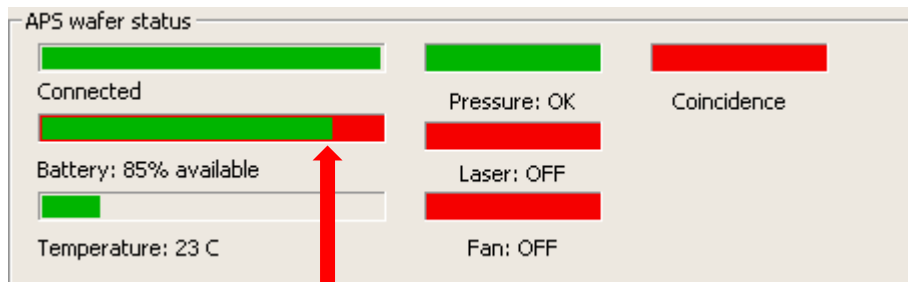
Battery status—connected and at 85% of full charge

Charging the Battery

To charge the AMS device's battery:

1) Use only the battery charger supplied with your AMS device. Using a different battery charger might damage your AMS or create a safety hazard.

2) Do not charge the AMS, if the temperature is higher than 45°C. Charging the AMS device at a temperature higher than 45 °C might damage the AMS housing or create a safety hazard.

3) Place the AMS device in the charging case (see "Opening and Closing the Charging Case" on page 22). Close the lid.
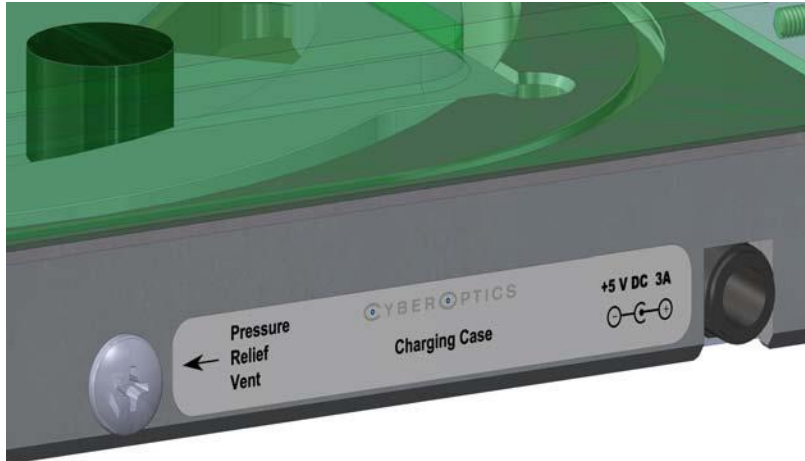
4) Plug the charger line adapter into a 100 VAC to 240 VAC mains, and plug the other end into the charging case connection on the right side of the charging case.

   The charging case is air-tight. After air transport it may be necessary to relieve the pressure differential in order to open the case. To do so, loosen the **Pressure Relief Vent** screw until air enters the case. Then re-tighten the screw.

5) When power is applied to the charging case, the **Charger on** LED will light and the **Charging** LED will also light, unless the unit is already fully charged. In addition, the **Unit on** LED will light. If the unit is still paired to a powered link box, the **Connect/ Pair** LED will light.

6) Charge the unit until the **Charging** LED goes dark. The unit is now fully charged and ready for data collection. However, the unit can be used if not fully charged.

7) The AMS can remain in the charging case with power applied to the case even when fully charged. The battery will not be damaged. The AMS should be stored in the sealed charging case when not in use.

Monitoring the Wireless Connection to the AMS Device

The MultiView application communicates with the AMS device by using a Bluetooth wireless link. The wireless link has a range of up to 30 ft (10 m).

The **Connection** indicator in the **AMS wafer status** area of the MultiView window shows the quality of the wireless connection between the AMS and the link module. The connection quality is indicated by the color of the bar and the wording below the bar.
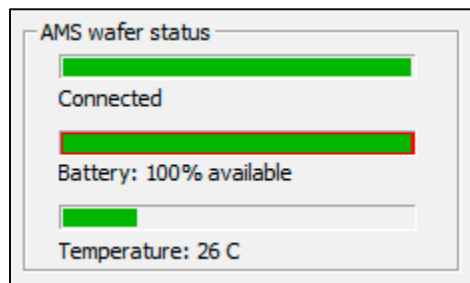
- **Green—Connected**. The connection between the link and AMS is good. With a good connection, the AMS device is sending the maximum number of readings per second to the link module (at least 200 readings per second).

- **Yellow—Poor connection**. There is some interference or other problem with the signal that is preventing the link and AMS device from communicating at their maximum rate. When the indicator is yellow, the readings are still accurate but aren't being updated as frequently.

- **Red—No connection**. Indicates that there is no connection between the AMS device and link module. The values in the display do not update when the indicator is red.

The Bluetooth wireless link technology used in the AMS is a low-power technology that operates in the 2.4 GHz radio frequency band. This unlicensed band is also used by many other types of devices, such as cordless phones and microwave ovens. Another 2.4 GHz device operating in close proximity could interfere with the AMS system. When this happens, separating the devices by at least 6 ft (2 m) usually solves the problem.

Other factors can also affect the wireless link, such as the distance between the AMS device and link, and obstacles between the device and link that block the signal. If MultiView indicates that the connection isn't good, try moving the wireless link module a few feet closer to the AMS device.

After turning off the AMS, the **Connection** indicator might not change to red for a few seconds.

Changing the Pairing between the AMS and Link

The AMS and link module in your kit were paired at the factory and will operate with only that particular link module. You can change this pairing, so that you can use your AMS with a different AMS link module, or vice versa. Link modules for different CyberOptics WaferSense or ReticleSense products, such as Auto Gapping Sensors (AGS), are not interchangeable.

To pair an AMS and link module:

1) If you are changing the pairing of an AMS that is already paired with a link module, first unplug the currently paired link module. You can't pair an AMS with a new link module, while the currently paired link module is powered on.

2) Make sure the **Power** LED is illuminated on the link module you want to pair, and make sure the **Unit on** LED is illuminated on the AMS.

3) On the AMS, press and hold the "C" reset switch until the **Connect/Pair** LED starts to blink rapidly (about four times per second).

4) On the link module, press and hold the **New Pair** button until the **Pair Status** and **Connection Status** LED lights start to blink rapidly (about four times per second).

   The LEDs on the link module and the AMS will continue to blink for a few seconds, until the link and the AMS have established a new pairing, after which the LEDs will be on and no longer blinking.

Overview of Main AMS Sub-Functions

As described above, the AMS collects vibration, humidity, and leveling data from your wafer-manufacturing process in real time. The vibration, humidity, and leveling functions share many of the same *sub-functions*, and all of these sub-functions operate in exactly the same way. The sub-functions, of course, vary slightly in their details (because the vibration, humidity, and leveling functions use different parameters), but operate along the same lines and use the same basic, underlying principles. As a result, once you understand a sub-function in "Vibration," you understand it in "Humidity" and "Leveling" as well.

The purpose of the following sections therefore is to introduce you to some commonly used MultiView sub-functions, so you can quickly get up to speed on the way the MultiView software operates. The idea here is to introduce you to the *underlying concepts* behind each sub-function, so do not worry about the details. The sub-functions that are discussed are as follows.

- **Setting Go/No-Go Tolerances**
  This allows you get an on-screen warning, when a measured parameter strays from its defined limits.

- **Setting Triggers**
  This tells the AMS download current real-time data to a log file, whenever a measured parameter strays beyond its defined Go/No-Go tolerances. The log file can be reviewed during the run, or at a later date.

- **Setting Station Information**
  This allows you to keep track of each AMS run for record-keeping and quality-control purposes.

- **Saving Your MultiView Settings**
  This allows you to save your current function and sub-function settings, so they can be used again.

- **Loading Previously Saved Settings from a File**
  This saves you a lot of time and effort, because you can load settings from previously saved files.

Setting Go/No-Go Tolerances

Setting the Go/No-Go tolerances gives you an on-screen warning, when a measured parameter strays from its defined limits. This is useful, because it alerts you to the fact that something undesirable may be about to happen, so you can keep a very close eye on what is going on as the AMS moves through your manufacturing process.

Example

In this example we are worried that one of the robots that feeds wafers into one of our tools is reaching the end of its service life. Specifically, the robot has logged over 10,000 hours of use, and the bearings in its end-effect that is responsible for horizontal back-and-forth movements (the y axis), is about to fail.

Setting Go/No-Go Tolerances

To set Go/No-Go tolerances, do the following.

1) Open MultiView and click the **Vibration** tab.
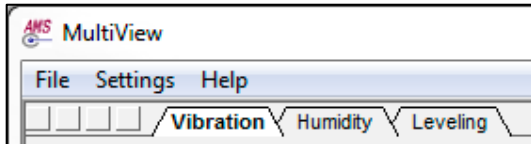
2) Choose the **Settings** > **Set Go/No-Go** menu item.

The dialog shows the default settings for vibration in the x, y, and z axes.

5) Check the appropriate box and enter the Go/no-Go tolerances (in g force) for the x, y, and z axes. Check the root mean square box, if you want MultiView to graph an average vibration trace for all three axes.

Set Go/No Go

Threshold
Units are in g-Force

☐ RMS rises above   0.75

☑ X rises above   0.20
☑ X falls below   -0.20

☑ Y rises above   0.40
☑ Y falls below   -0.40

☐ Z rises above   1.50
☐ Z falls below   0.75

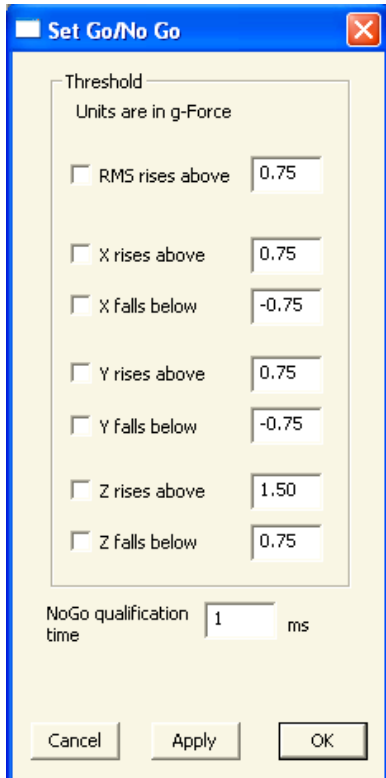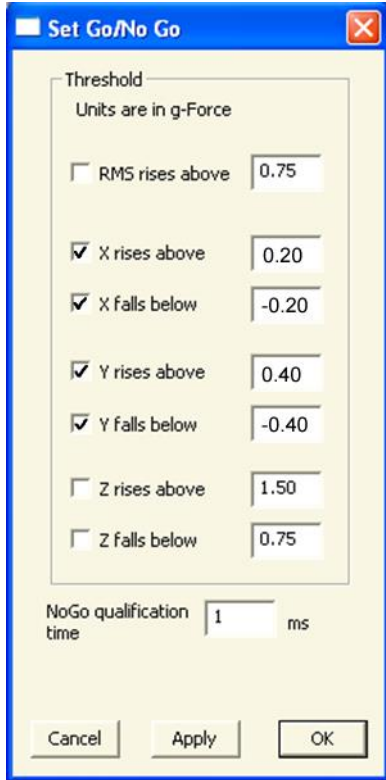NoGo qualification time   1   ms

Cancel   Apply   OK

In our example, our previous experience with this particular brand of robot tells us that the bearings are about to fail, if the vibration exceeds ± 0.4g, and that ± 0.20 is normal. Hence we set ± 0.40 g for horizontal back-and-forth movements (the y axis—the key point here), as these are the bearings we believe are about to fail in the end-effector.

6) In our example, we ran the AMS through our system, and observed the following traces in the Vibration screen. (The bearings are clearly about to fail.)

Red color indicates trace is **beyond** Go/No tolerances

0.4

−0.4

y axis

Green color indicates trace is **within** Go/No tolerances

0.2

−0.2

x axis
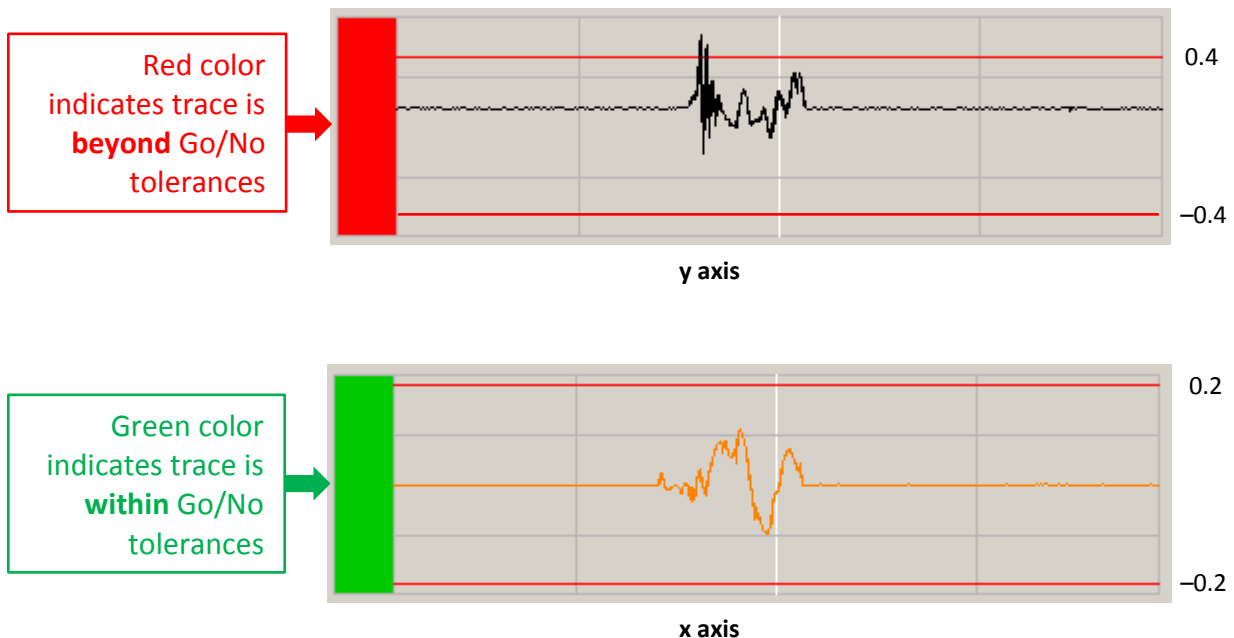
Setting Triggers

Triggers are used to tell the AMS to start capturing real-time data to a log file, as soon as the measured parameter strays beyond its defined upper or lower limits. MultiView continues downloading data for as long as the parameter stays out of bounds, and stops when the parameter is back in bounds.

Clearly, you can set your Trigger values to exactly the same values as those you set for your Go/No-Go tolerances. In this instance, when the measured parameter strays out of bounds, MultiView immediately downloads data to a log file *and* issues an on-screen warning. You can, however, set your Go/No-Go tolerances, so you get an on-screen warning when the parameter is *about to* move close to the upper and lower limits you have set in the Trigger menu. This is useful, because it alerts you to the fact that something undesirable may be about to happen, so you can keep a very close eye on what is going on as the AMS moves through your manufacturing process. And, if the parameter in question actually strays beyond its Trigger settings, MultiView will download a log file of the event for future reference.

Example

In this example, we have just installed a fancy new—and very expensive—dehumidifying system in our clean room, because we need to minimize gallium arsenide oxidation on our wafers. The new dehumidifying system is supposed to keep the relative humidity (RH) in our clean room in the range 6% ± 2%. We are now going to use the AMS to tell us whether the new dehumidifying system is, in fact, keeping the RH *inside* our tools—the key point here—within this critical range.

By setting the appropriate Trigger parameters, the AMS will download humidity data to a log file, every time the RH strays outside the desired range of 4–8% RH. Please note that in this example we are using the 150mm WaferSense AMS, which has only *one* humidity/temperature (HT) sensor, located near the center of the disk (designated "HT1"), as shown below. (Some AMS models have five HT sensors.)

We normally store the AMS in our office, which frequently has an RH in excess of 70%. As a result, we left the AMS *overnight* in our clean room to equilibrate, and to prevent problems with hysteresis (a lag in reading-response times produced when the AMS is moved from one humidity environment to another) before running our experiment.

Setting the Triggers for Humidity

To set the appropriate triggers for monitoring humidity, do the following.

1) Open MultiView and click the **Humidity** tab.

2) Choose the **Settings** > **Set Triggers** menu item.

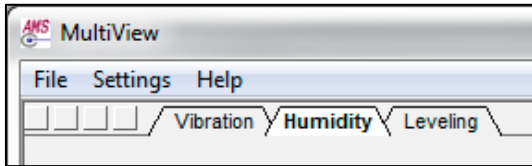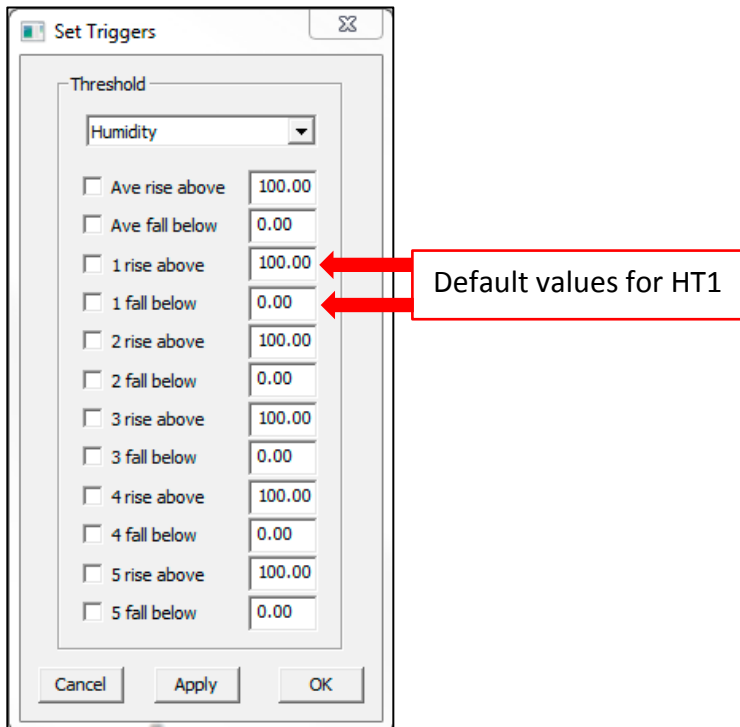MultiView populates the **Set Triggers** dialog with the default values (0% and 100% RH) for the maximum possible number (5) of HT sensors on an AMS unit. As our particular unit has only *one* HT sensor, we are going to enter the upper ("rises above") values and lower ("falls below") values only for HT1, and ignore the default values for HT2 through HT5.

3) Check the HT1 box, and enter the upper and lower trigger values for humidity. (Do the same for the other sensors HT2–HT5, if your AMS is equipped with them.)

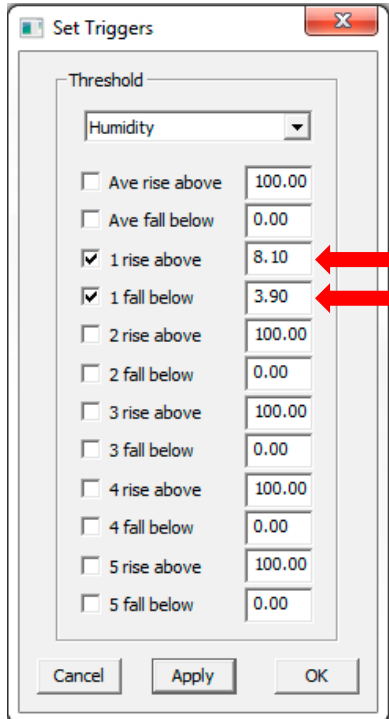In our example, to give ourselves a little leeway and to make sure the RH values actually fall outside the range 4–8% before data is downloaded to a log file. As a result, we have chosen **1 rises above** and **1 falls below** values of 3.90 and 8.10, respectively. (We ignored the other settings, because they do not apply to our particular model of AMS.)

7) Click **Apply** to save the settings you entered.

8) Click **OK** to close the dialog.

Setting Station Information

The **Station Information** screen allows you keep track of each AMS run by entering operator name, tool and station ID, and other relevant information about your AMS run. It is a good idea to 1) always fill in the **Set Station Information** dialog *every* time you run the AMS through your wafer-manufacturing process, and 2) make filling in this dialog part of your everyday record-keeping and quality-control procedures. If you need to refer to your log files in the future, having this detailed information on file will make life much simpler.
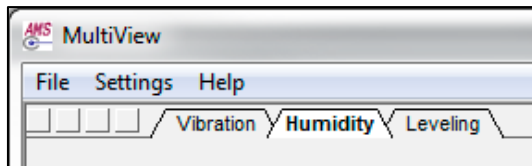
Example

See the humidity example on page .

Setting Station Information

To include user-specified information in your log files, do the following.
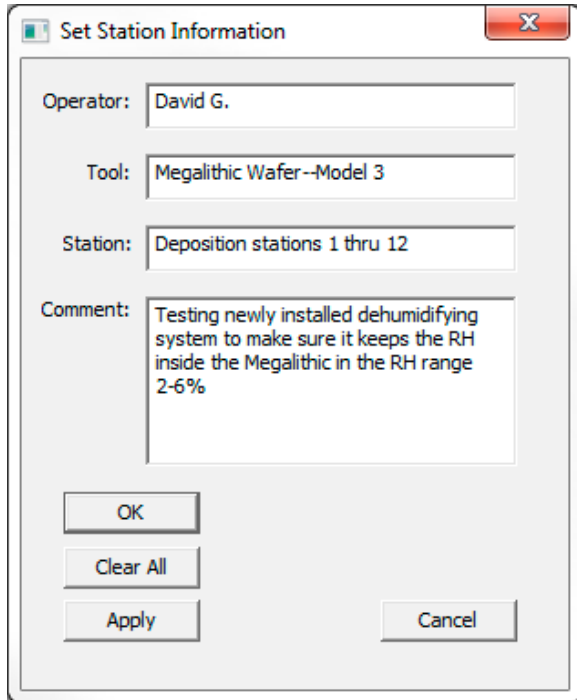
1) Open MultiView and click the appropriate tab.

2) Choose the **Settings** > **Set Station Information** menu item.
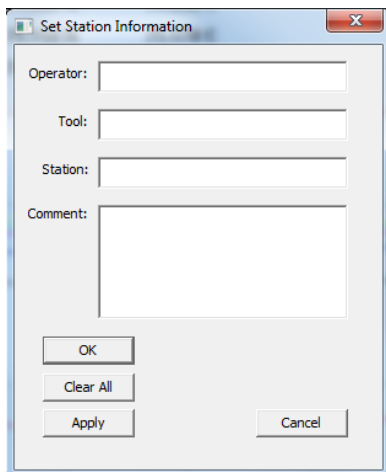
3) Type your text into the Operator, Tool, Station, and Comment text fields. (We entered data for our humidity experiment.)

4) Click **Apply** to accept the changes without closing the dialog. To accept the changes and close the dialog, click **OK** instead.

You can leave the Set Station Information dialog open while using MultiView (drag it off to the side, so it doesn't cover the MultiView window). Doing so makes it easy to change the **Comment** or other fields each time you start recording, or as needed. Be sure to click **Apply** after you finish making changes, though, or MultiView won't use the latest changes for the next log file.

You can change or delete this information at any time for future log files. To quickly clear all of the fields, click **Clear All**.

Saving Your MultiView Settings

Each time you exit MultiView , it saves all your current function and sub-function settings in a log file in the Windows registry. The next time you start MultiView, it restores those saved settings. You can also tell MultiView to save your settings to a file you specify, and you can have MultiView read those settings back at any time. This lets you have several different configurations for MultiView, and be able to switch between them easily, without having to reenter the settings.

To save your settings in a file you specify:

1) Choose the **File** > **Save Settings As** menu item.

2) In the AMS **Settings File** dialog, specify the directory and file name and click **Save**. MultiView saves your settings, and the file you specified becomes the current settings file.

To save your settings in the current settings file:

1) Choose the **File** > **Save Settings** menu item.

2) Each time you start MultiView, the application automatically reads in the most recent settings from the Windows registry, including the last settings file you specified, if any.

Loading Previously Saved Settings from a File

To load previously saved function and sub-function settings from a file:

1) Choose the **File** > **Open Settings** menu item.

2) In the AMS **Settings File** dialog, specify the directory and file name and click **Open**. MultiView reads the settings from the specified file and applies the settings. These settings are also written to the Windows registry, and will be loaded the next time you start the MultiView application.

Using the Vibration Function

The section tells you how to use the AMS to monitor vibration in the X, Y, and Z axes using the MultiView operating software. More specifically, this section tells you how to do the following.

- Read the vibration trace display

- Freeze the trace display

- Monitor traces for excessive vibration levels

- Record the traces

- Chang the pre-recording length

- Place marks in a log file

- Include user-specified information in a log file

- Understand log file names

- Import log files into other applications

- Configure the trace display

Reading the Vibration Trace Display

The AMS is like a seismograph, but instead of charting movements in the earth's plates, you'll probably be using the AMS to look for unwanted vibrations in wafer handling and processing equipment. The AMS continuously detects vibrations and transmits the readings to the MultiView application. MultiView displays the readings as traces, similar to the traces on a seismograph drum. You can place the AMS in a tool, run the manufacturing equipment through its paces, and watch the MultiView display for levels of vibration that might indicate a problems with the equipment, such as places where the AMS is making unwanted contact with a tool. Appendix C describes acoustic resonances and other factors that affect vibration measurements.

To use the AMS **Vibration** system:

1) Make sure the computer running the MultiView software is within the range of the link module, up to 30 ft (10 m).

2) Normally, you would place the AMS on the equipment you want to check, and then start the equipment in motion, monitoring the MultiView display. To get a feeling for how the AMS works, for now just set the AMS on a desk or table.

3) Start the MultiView application.

4) Click the **Vibration** tab and the Vibration Trace screen is displayed.
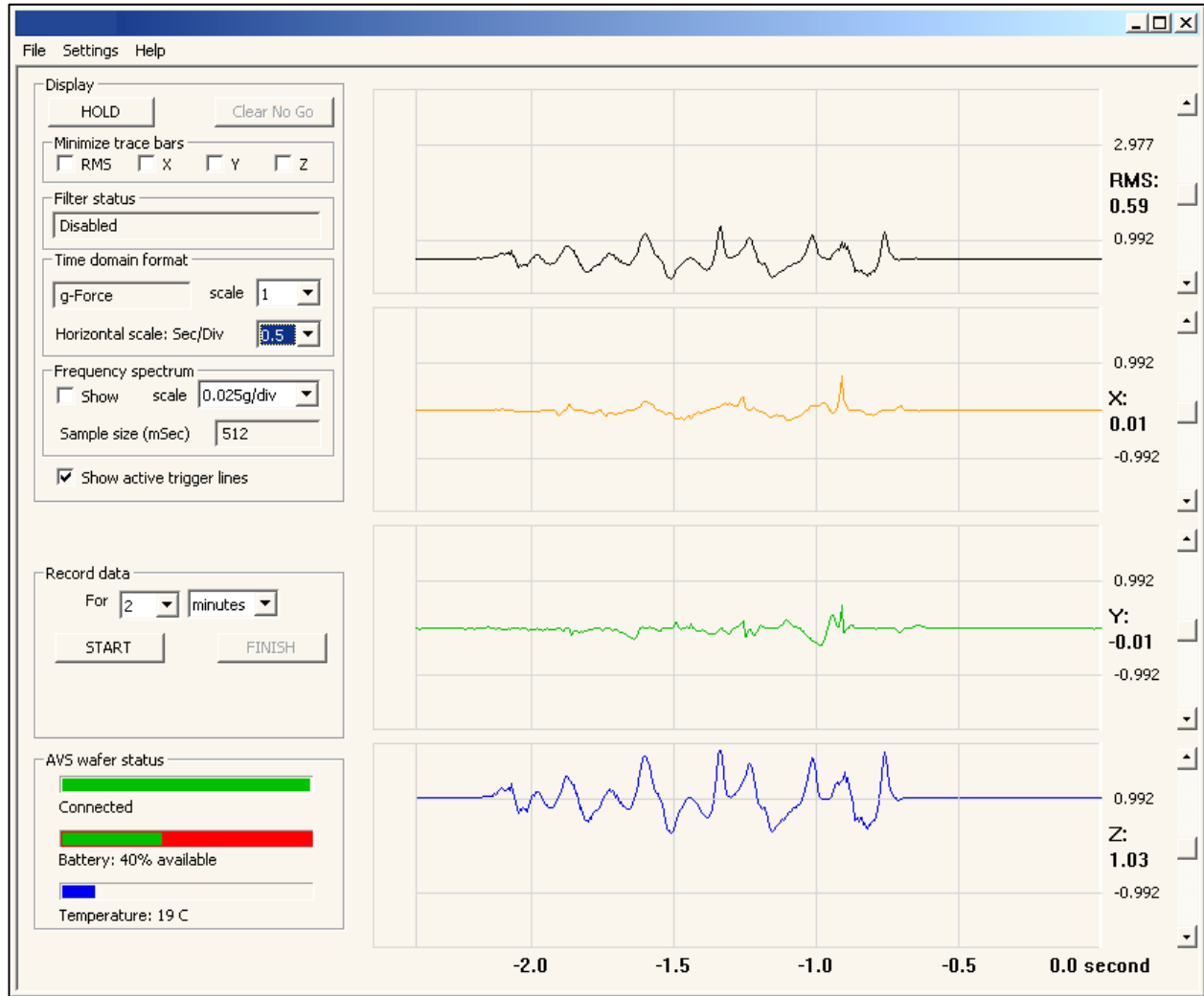
The gridded area of the display on the right shows the traces. When the AMS is turned on and has a connection to the computer running MultiView, the AMS transmits vibration data in nearly real time.

5) Give the AMS a light tap. A spike in the traces will appear at the far right of the MultiView screen. New readings always appear at the far right edge of the display. As more readings are displayed, the spike scrolls to the left and eventually disappears. The trace area of the display is described below.

- **X, Y, and Z Axes**
These traces show the vibration measured in each of three directions. Looking down on the AMS with the logo at the top, the X trace shows horizontal movement to left and right, the Y trace shows horizontal movement to top and bottom, and the Z trace shows vertical movement.

The AMS measures vibration in units of g-force, which is actually a measure of acceleration. One g is the acceleration of gravity (approximately 32 ft/s^2 9.81 m/s^2), with a range from -2 g to +2 g. The number displayed below the label (X, Y, or Z) at the far right of the screen is the current value: the value displayed at that instant at the far right of edge of the trace. The default vertical scale shows units of g-force, but you can change the units to galileos (1 Gal = 0.01 m/s^2). You can also change from displaying acceleration to displaying the signal energy (g^2-s). To change the displayed readings and scales, see "Changing the Time-Domain Format" on page 64.

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You can minimize the display of one or more traces, to focus on the trace or traces of most interest (see "Minimizing the Trace Bars" on page 62).

- **RMS** (Root mean square)

The RMS trace displays the calculated root mean square of the X, Y, and Z values, using the following formula.

$$\sqrt{\tfrac{1}{3} \times (x^2 + y^2 + z^2)}$$

The default vertical scale shows units of g-force, but you can change the units to galileos (1 Gal = 0.01 m/s2). You can also change from displaying acceleration to displaying the signal energy (g^2-s). For more information on displayed readings and scales, see "Changing the Time-Domain Format" on page 64.

- **Grid Lines**

The vertical grid lines represent time intervals. The default interval between grid lines is 0.5 seconds, with 100 data points plotted in each interval. To change the horizontal scale for the traces, see "Changing the Horizontal Time and Scale" on page 66.

- **Scroll Bars**

Scroll bars let you move the traces by ±2g. As you increase the vertical scale factor, you might need to scroll to view the full range of a trace.

Freezing the Trace Display

When the AMS is powered up and connected to the MultiView software, the AMS sends blocks of 100 readings to MultiView every 100 milliseconds. MultiView displays the data continuously in nearly real time. That means that the display is constantly moving. If you notice a spike in one of the traces, it could scroll off the left side of the display and disappear in as little as half a second, depending on the display settings. MultiView includes a **Hold** feature that lets you freeze the display (though not the data stream).

1) To freeze the trace display, click **Hold** (shown below). The **Hold** button changes to **Release** and the traces stop moving, but the AMS continues to send data to MultiView.
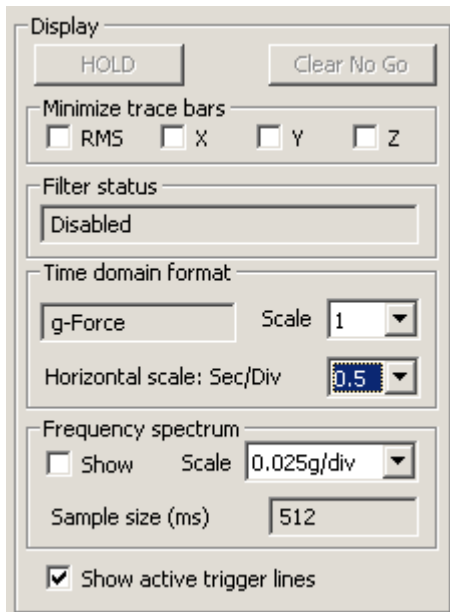
2) To resume the trace display, click **Release**. The traces jump ahead to display the most-current data and start moving again. If the hold is long enough, some of the data received might not be displayed, when the trace resumes.

Monitoring Traces for Excessive Vibration Levels

You can use the **Go/No-Go** feature in MultiView to monitor the traces for excessive levels of vibration and indicate when your specified levels are exceeded. The figure below shows the trace display with the **Go/No-Go** feature active.

Red bar shows RMS trace has exceeded one of the **Go/No-Go** limits

No/No-Go limits for X trace

Green bar shows Y trace is within **Go/No-Go** limits

Parallel red lines in each trace indicate the **Go/No-Go** tolerances, which you can set separately for each trace. A vertical green bar appears at the far left of each trace to indicate that the trace is within your specified tolerances. When the trace continuously exceeds your tolerance settings for more than one millisecond (the qualification time), the vertical bar changes to red. You can specify a qualification time from 1 to 10 milliseconds. If the trace exceeds your settings, but remains so for less than the qualification time, the **No-Go** tolerances are not affected, and the bar remains green.

You can set the amount of time the red bar remains on from 1 to 10 seconds, or it can stay on until you clear it with the **Clear No-Go** button. Extending the length of time the red bar remains on makes it easier to catch narrow spikes. However, if another Go/No-Go event occurs while the bar is already red, it restarts the timer for displaying the red bar. So in practice, a red bar might remain on for many seconds, when multiple events occur in close succession. In addition, MultiView can issue an audible beep to indicate when a trace exceeds a Go/No-Go tolerance.

Setting the Go/No-Go Tolerances

To set the Go/No-Go tolerances:

1) Choose the menu item **Settings** > **Set Go/No-Go**. The **Set Go/No-Go** dialog is displayed.

Click box to activate named Go/No-Go setting

Enter appropriate number for setting
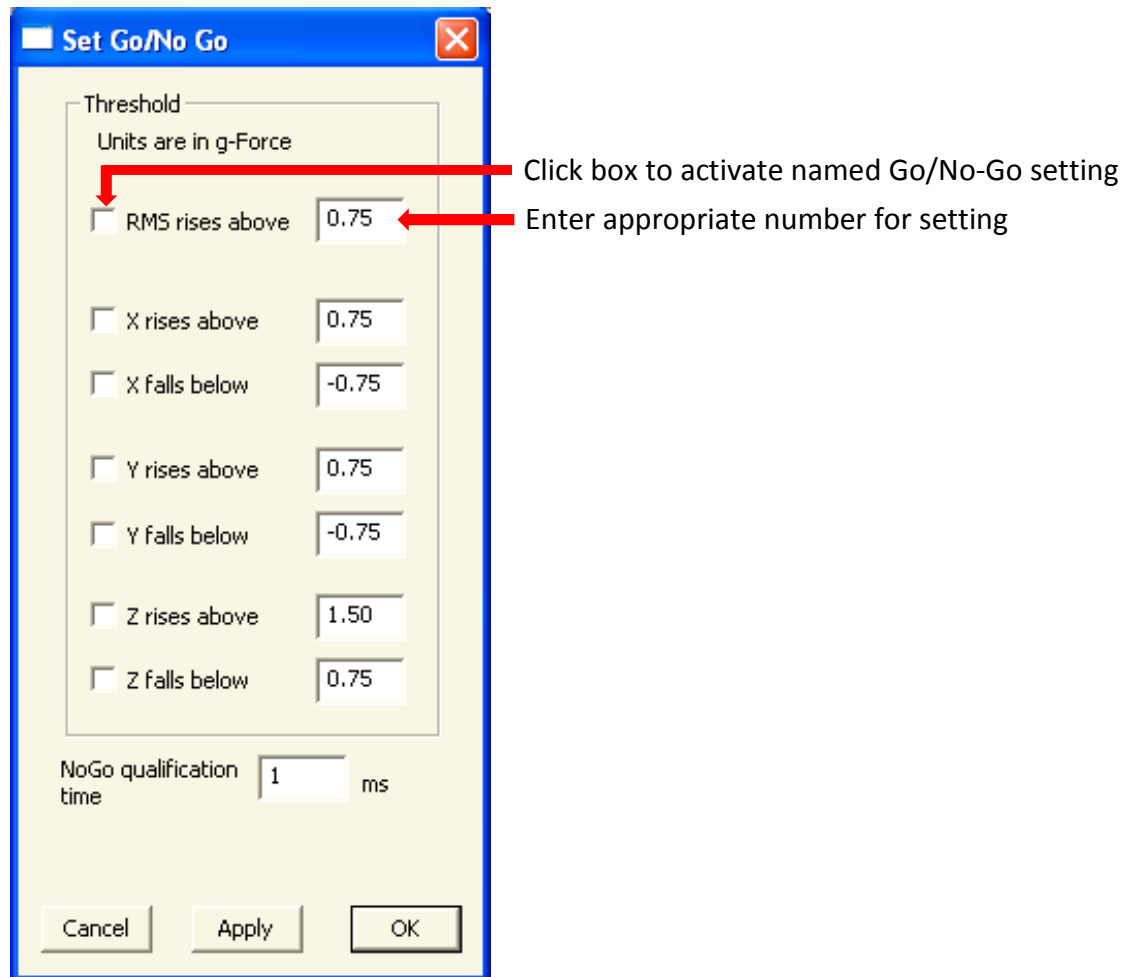
2) Check the boxes to activate Go/No-Go for one or more traces.

3) For each trace you activated, specify the Go/No-Go tolerances. You can specify separate upper and lower settings for X, Y, and Z. The units for Go/No-Go tolerances depend on the time domain format you have specified (see "Changing the Time-Domain Format" on page 64).

4) For the **No-Go qualification time**, specify the length of time any trace must exceed any Go/No-Go tolerance, before the No-Go condition is triggered. A trace that exceeds a tolerance for less than the qualification time will not trigger a No-Go condition.

5) Click **Apply** and the Go/No-Go tolerances take effect immediately. When the next active No-Go event lasting longer than the qualification time occurs, MultiView changes the green Go/No-Go bar to red and beeps, if you enabled this option.

6)   You can leave the "Set Go/No-Go" menu open, while using MultiView. Doing so makes it easy to change the Go/No-Go tolerances. To close the menu, click **OK**.

Setting Options for the No-Go Indicators

To set options for the No-Go indicators:

1)   Choose the menu item **Settings** > **Options**. The options dialog is displayed.

No-Go options, which are described in more detail below
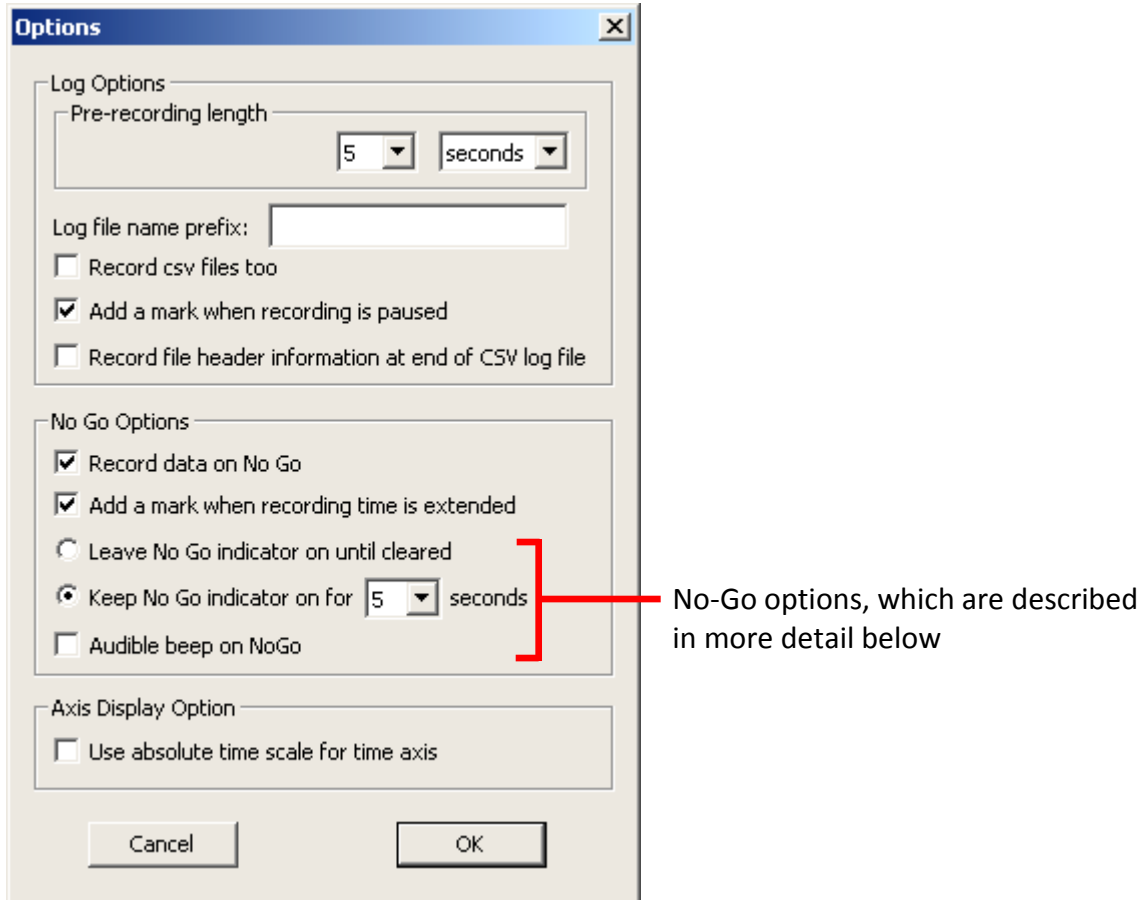
2)   If you want the indicator to remain red for a certain length of time following the event, choose **Keep No-Go indicator on for**, and choose the number of seconds.

3)   If you want MultiView to alert you with an audible beep when a Go/No-Go condition is exceeded, check **Audio Beep on No-Go**.

4)   Click **OK** and the No-Go options take effect immediately.

Recording the Traces

You can record the vibration data to a log file and then play it back later. For information on playing back log files, see "Viewing Log Files" on page 72. You can start a recording session manually or automatically (described below). Once MultiView starts recording, it records for the length of time you specify. The log file includes data for five seconds prior to the event that initiates the recording (see "Changing the Pre-Recording Length" on page 54). Log files include the vibration data, user-specified data, and trigger information. All data received by MultiView (1,000 points per second) is recorded regardless of the display settings. Detailed information on recording log files is described in the following sections.

Manually Recording Traces

With manual recording, you start the recording by clicking a button and the recording runs for the length of time you specify, unless you stop the recording. You can also pause recording and later resume recording in the same log file. The manual recording controls for pausing and stopping recording are active even when recording is started by using triggers or No-Go events (see sections below).

To record vibration data manually:

1) In the **Record Data** menu, use the **For** lists to set the length of time for the recording. You can choose recording times of up to four hours. Note that four hours of recording at 1,000 data points per second will fill about 150 MB of disk space.

2) To start recording, click **Start**. The **Start** button changes to **Pause**. MultiView will record for the specified length of time. The remaining time is shown below the **Pause** button, with a red background to indicate that recording is in progress.
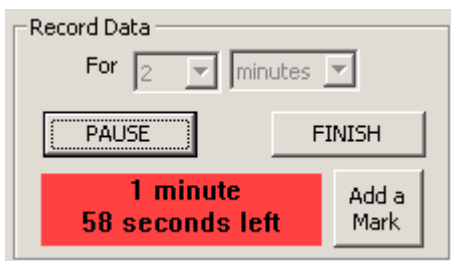
   While a recording is in progress, holding your cursor over the **Pause/Continue** button displays a **ToolTip** with the name of the current log file and the event that initiated recording.

3) To stop the recording before the specified recording time has expired, click **Finish**. Clicking **Finish** closes the current log file.

4) To temporarily stop recording but keep the current log file open, click **Pause**. When you want to continue recording, click **Continue**. While recording is paused, MultiView continues to display data in real time. During a pause, the background color for the countdown timer changes to yellow, and the countdown pauses. While a recording is in progress or paused, holding the cursor over the **Pause/Continue** button displays a **ToolTip** that shows the name of the log file and the trigger event.

Automatically Recording Traces

Instead of starting a recording manually, by clicking **Start**, you can have MultiView start the recording automatically, when one of the MultiView traces rises above, or falls below, a specified value. Once the recording starts, MultiView records for the length of time you specify, or until you click **Finish**.

You have two options for starting to automatically record traces, as follows.

- **Triggers**

The triggers feature is primarily for recording data. Triggers don't give you any visual indication in the display, when the traces exceed your specified limits. You can't set a qualification time for triggers, because a trigger starts recording immediately when the trigger level is exceeded—see section below.

- **Go/No-Go**

The Go/No-Go feature is primarily for helping you view events in the data on the display (see page 46). During a recording initiated by a Go/No-Go event, subsequent events extend the recording time, which is not true for triggers—see section below.
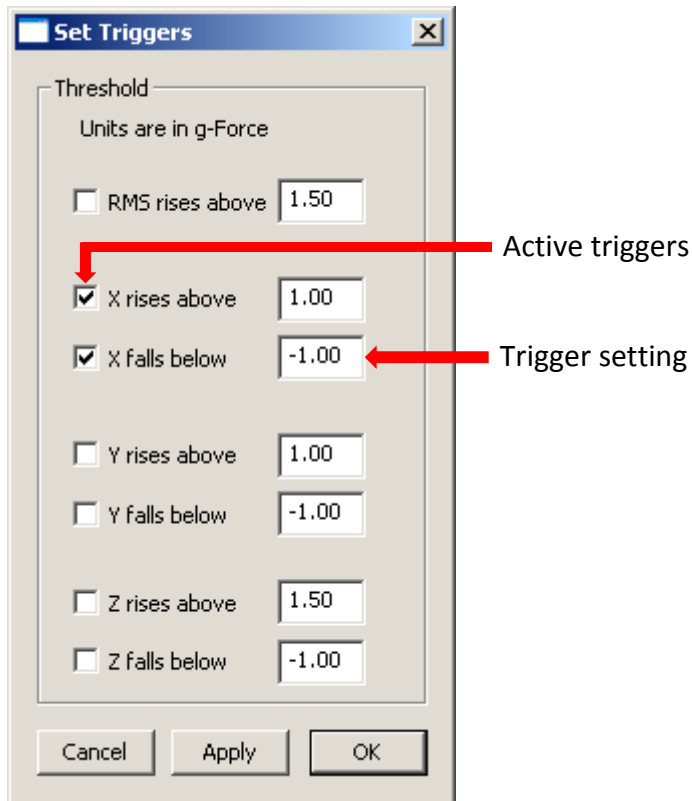
Recording with Triggers

Once recording has started, any subsequent trigger events are ignored. When recording stops, any active trigger event can start a new recording.

To record vibration data using triggers:

1) In the **Record Data** menu, use the **For** lists to set the length of time for the recording. You can choose recording times of up to four hours. Note that four hours of recording at 1,000 data points per second will fill about 150 MB of disk space. Once triggered, MultiView records data for the specified length of time (or until you manually stop or pause recording), regardless of any subsequent trigger events.

2) Choose the menu item **Settings** > **Set Triggers**. The **Set Triggers** dialog is displayed.

3) Check the boxes to activate triggers for any events that you want to trigger the start of recording.

4) For each of the triggers you activated, specify the value that you want to trigger the start of recording. You can have MultiView start recording when a trace rises above a specified value, or when a trace falls below a specified value. The units for trigger settings are the same as the units for the time domain format you have specified—see above.

5) Click **Apply** and the trigger settings take effect immediately.

6) When the next active trigger event occurs, MultiView starts recording data. MultiView records for the specified length of time, unless you click **Finish** or **Pause**—see above. The remaining time is shown below the **Finish** and **Pause** buttons.

7) You can leave the **Set Triggers** menu open while using MultiView. Doing so makes it easy to change the triggers. If you want to close the dialog, click **OK**.

Recording with Go/No-Go

Once recording has started, any subsequent No-Go events cause the recording time to be extended. Recording continues for the specified time from the moment of the most-recent event. When recording stops, any active No-Go event can start a new recording.

To record vibration data using Go/No-Go tolerances:

1) In the **Record Data** menu, use the **For** lists to set the length of time for the recording. You can choose recording times of up to four hours. Note that four hours of recording at 1,000 data points per second will fill about 150 MB of disk space. The recording time is restarted every time a No-Go event occurs. So, if you set the time for 30 seconds, but a second No-Go event occurs after recording has been in process for 20 seconds, the total recording time will be 50 seconds.

2) Choose the menu item **Settings** > **Set Go/No-Go**. The **Set Go/No-Go** dialog is displayed.

Click box to activate named Go/No-Go setting

Enter appropriate number for setting
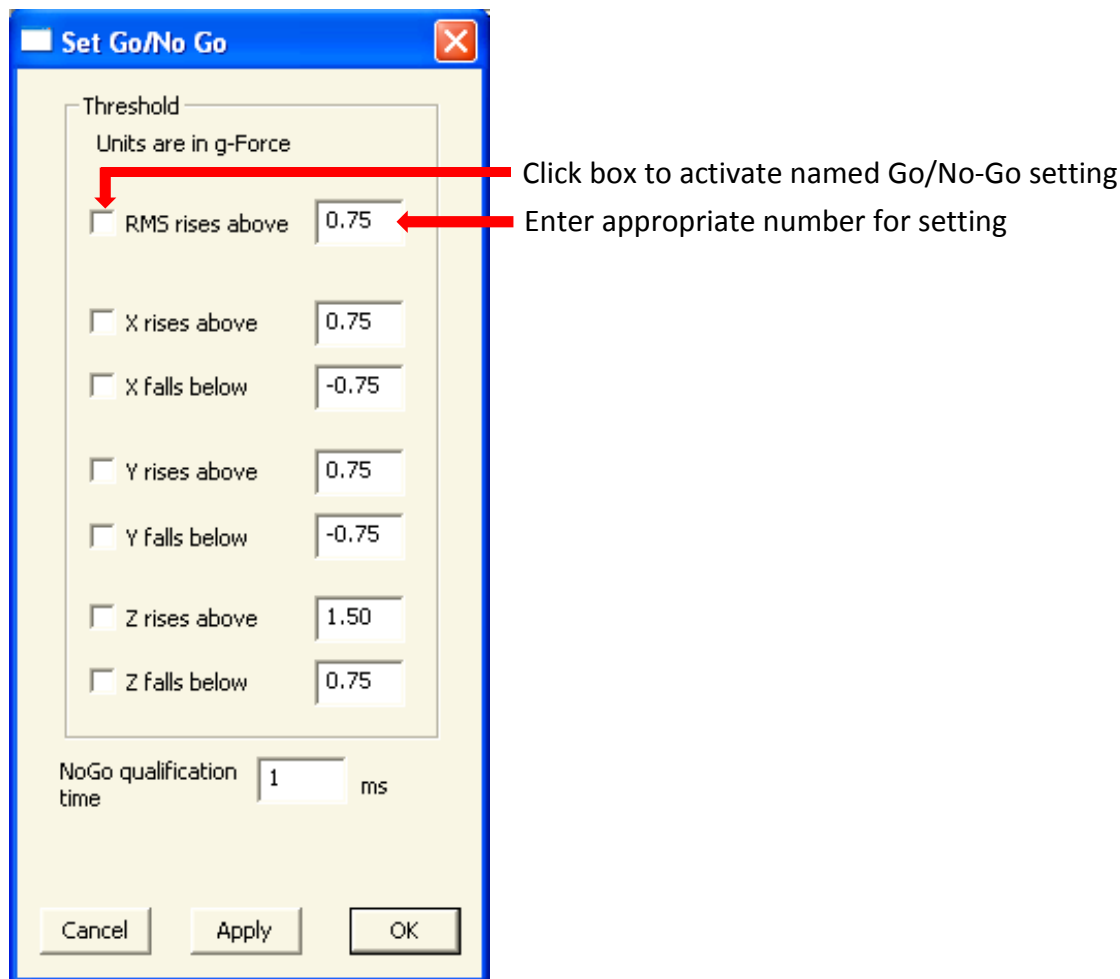
3) Check the boxes to activate Go/No-Go for one or more traces.

4) For each trace you activated, specify the Go/No-Go tolerances. You can specify separate upper and lower settings. The units for Go/No-Go tolerances are the same as the units for the time domain format you have specified—see above.

5) For No-Go qualification time, specify the length of time any trace must exceed any Go/No-Go tolerance before the No-Go condition will start recording. A trace that exceeds a setting for less than the qualification time will not start recording.

6) Click **Apply**.

7) You can leave the Set Go/No-Go menu open, while using MultiView. Doing so makes it easy to change the Go/No-Go tolerances. If you want to close the menu, click **OK**.

8) Choose the menu item **Settings** > **Options**. The options dialog is displayed.
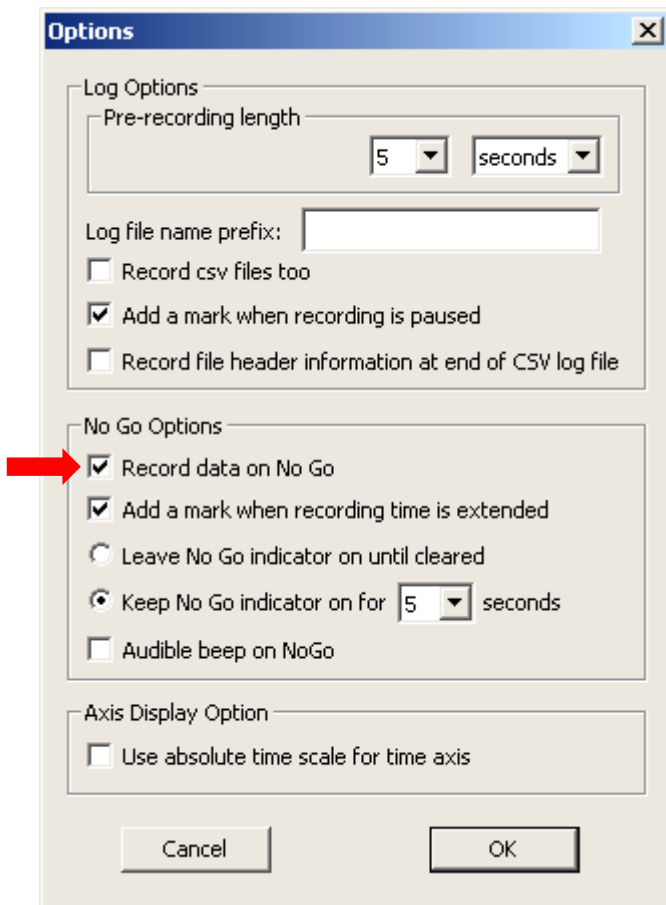

9) Check the **Record data on No-Go** box.

10) Click **OK**.

11) When the next active No-Go event lasting longer than the qualification time occurs, MultiView starts recording data. MultiView records for the specified length of time, unless you click **Finish** or **Pause**, or the time is extended by the occurrence of another No-Go event. The remaining time is shown below the **Finish** and **Pause** buttons.

Changing the Pre-Recording Length

When recording data, MultiView includes data in the log file beginning five seconds prior to the event that initiates the recording, whether that event is the **Start** button, a trigger, or a No-Go event. When you play back a log file in MultiReview, this length of pre-recording data allows you to see a few seconds of data just prior to the event that started the recording. You can adjust the length of this pre-recording data from zero to five minutes.

To set the length of time for pre-recording data:

1) Choose the menu item **Settings** > **Options**. The options dialog is displayed.
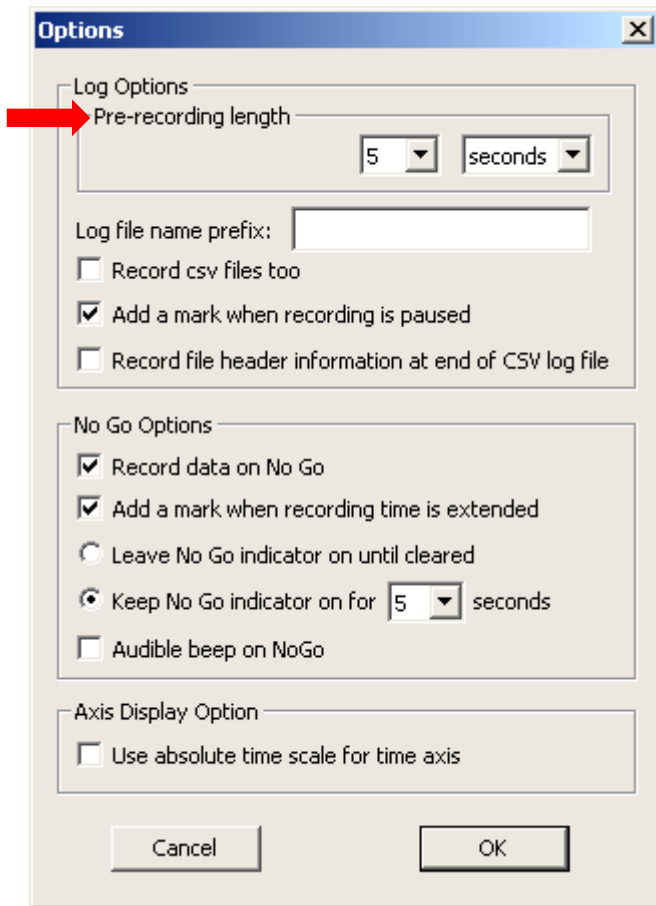
2) Under **Pre-recording length**, choose the interval of time and the units for pre-recording data.

3) Click **OK**.

Placing Marks in a Log File

At the start of recording, at trigger events, at No-Go events, and when MultiView loses communication with the AMS, MultiView automatically places marks in the log file. You can also have MultiView automatically mark locations in the log file for other events. In addition to marks created automatically by MultiView, you can manually create your own marks in a file while you are recording, and you can add annotations to the marks. When you use MultiReview to play back the log file (see "Viewing Log Files" on page 72), you can quickly jump to the location of any mark in the file.

Adding Marks Automatically for Pauses and for Recording Time Extensions

In addition to the marks that MultiView places in the log file for the start of recording, trigger events, No-Go events, and when MultiView loses communication with the wafer, you can have MultiView mark locations in the file where you pause recording and where the recording time is extended by additional No-Go events.

To have MultiView add marks for pauses and for recording time extensions:

1) Choose the menu item **Settings** > **Options**. The options menu is displayed.
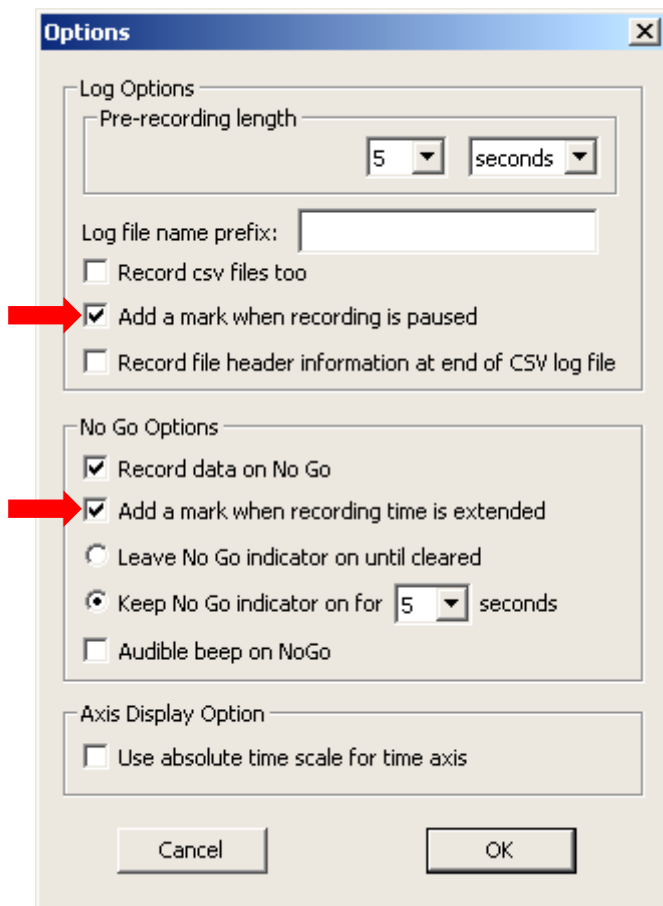
2) To have MultiView add a mark to the log file each time you pause recording, check the **Add a mark when recording is paused** box.

3) To have MultiView add a mark to the log file each time recording is extended by an additional No-Go event, check the **Add a mark when recording is extended** box.
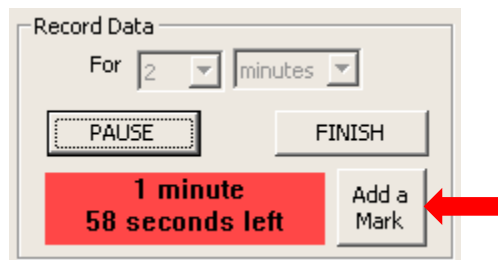
4) Click **OK**.

Adding Marks Manually

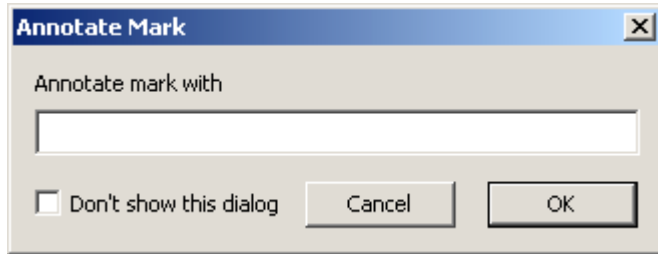To manually add a mark to a log file:

1) Choose the menu **Settings** > **Show Annotation Dialog**. This menu toggles the display of the **Annotate Mark** dialog on and off. The setting is off by default.
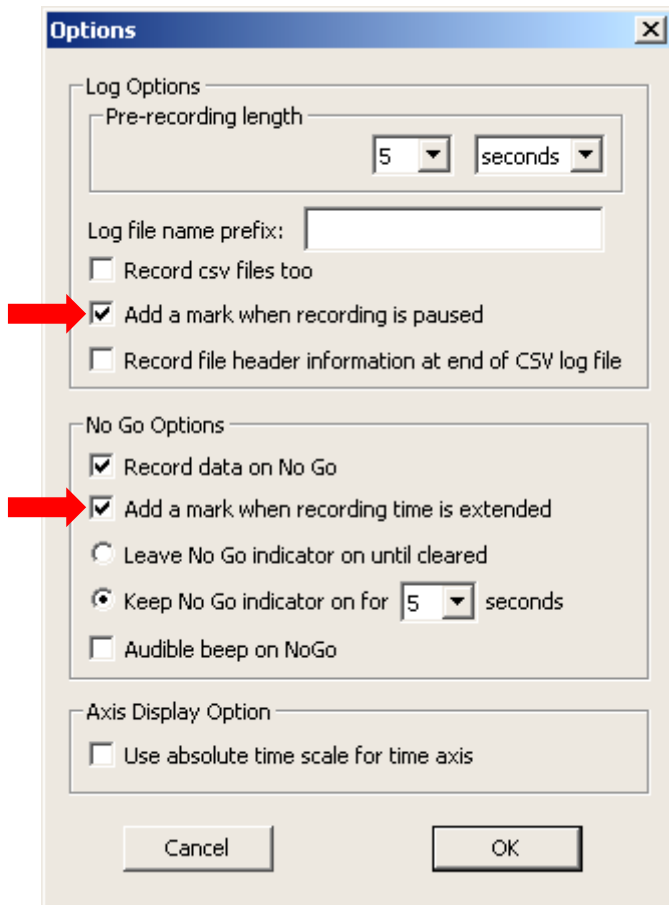
2) While you are recording data, click **Add a Mark**.

3) The **Annotate Mark** dialog is displayed.

4) In the Annotate Mark dialog, type the text you want to record with the mark location in the file and click **OK**. The mark is placed in the log file at the instant you click **Add a Mark**, even though it might be some time before you click **OK** in the Annotate Mark dialog. You can't add another mark until you click **OK**.
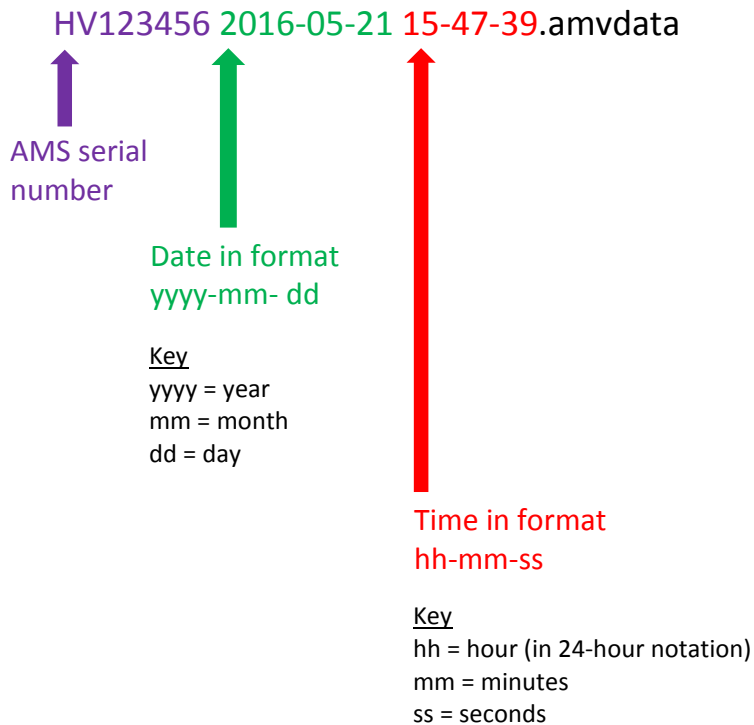
   If you don't want to be prompted with the Annotate Mark dialog when you click **Add a Mark**, the next time the dialog appears, check **Don't show this dialog** and click **OK**. If you have previously checked this box, and you now want to have the dialog displayed again, choose the menu **Settings** > **Show Annotation Dialog** to toggle the display of the Annotate Mark dialog on again.

Including User-Specified Information in the Log File

See "" on page .

Understanding Log File Names

By default, log file names are automatically assigned by MultiView, and consist of the serial number for the AMS wafer followed by the date and time. A sample file name is shown below.

HV123456 2016-05-21 15-47-39.amvdata

AMS serial
number

Date in format
yyyy-mm- dd

Key
yyyy = year
mm = month
dd = day

Time in format
hh-mm-ss

Key
hh = hour (in 24-hour notation)
mm = minutes
ss = seconds

When you add marks to the log file (see "" on page), MultiView creates a second file with the same name as that of the log file, but with the file extension **amvmarks**.

You can specify a different log file name prefix to replace the wafer serial number, in which case, MultiView still adds the date, time, and the appropriate extension.

Specifying a Different Log-File Prefix

When you add marks to the log file (see above), MultiView creates a second file with the same name as that of the log file, but with the file extension **.amvmarks**. You can specify a different log-file-name prefix to replace the AMS serial number, in which case, MultiView still adds the date, time, and the appropriate extension.

To specify a different log-file prefix:

1) Choose the menu item **Settings** > **Options**. The options dialog is displayed.
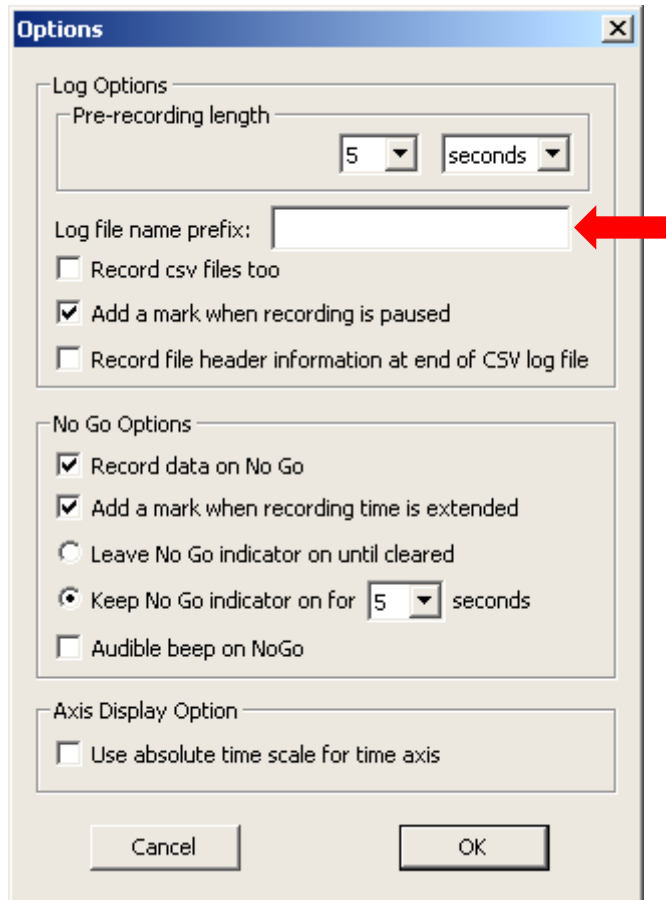
2) In the **Log file name prefix** box, enter the file name prefix you want to use for log files.

3) Click **OK**.

Importing Log Files into Other Applications

If you want to be able to import AMS log files into other programs, such as MATLAB or Microsoft Excel, you need to have the AMS write log files in comma-delimited format (also called comma-separated-values, or CSV, files), as well as the standard binary **.amvdata** file format. Note that only relatively short files (65,000 readings, or about one-minute's worth) can be imported into Excel.

When you set MultiView to record CSV files, MultiView records both the **.amvdata** file and a **.csv** file. Data written to the **.amvdata** file is in g-force units with no filtering. Data written to the **.csv** file has been filtered (if filtering is active), and is converted to the units for the currently set time-domain format (see "Filtering the Data" on page 63 and "Changing the Time-Domain Format" on page 64).

At the top of the file, MultiView writes a file header including the AMS serial number, and the current settings for the filter and time-domain format. Each line of data consists of six entries: RMS, X, Y, Z, Time, and Marks with annotations, if any. You can choose to have the header information recorded at the end of the file, instead of at the beginning (see "Importing Log Files into Other Applications" on page 60), which can be useful for importing the data into some applications.

The comma-delimited files are named as described in "Understanding Log File Names" on page 58, but with two differences, as follows.

- The file extension is **.csv**, rather than **.amvdata**.

- The filter settings are appended to the log file name, as shown below.
  HW123456 2016-05-21 15-47-39 BandPass 1Hz~5Hz.csv

The AMS includes a sample Script M-file that you can use to import files into MATLAB to generate a Fast Fourier Transform frequency analysis. The file is **AvsFft.m** and is located in the **\Program Files\ CyberOptics Semiconductor\WaferSense AMS\Matlab** folder.

Telling the AMS to Record Comma-Delimited Files

To have MultiView record comma-delimited files:

1) Choose the menu item **Settings** > **Options**. The options dialog is displayed.
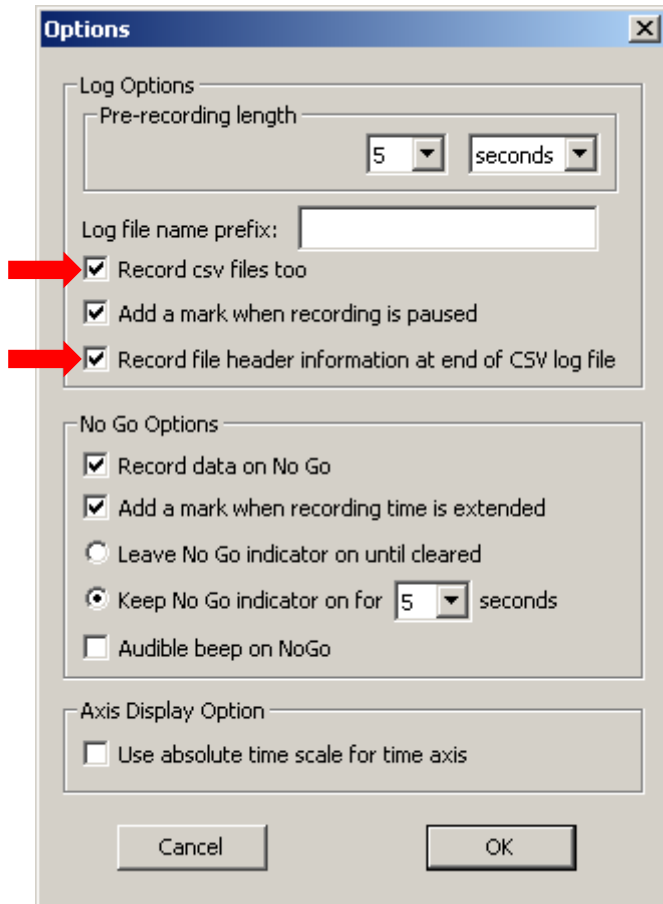
2) Check the **Record csv files too** box.

3) To have MultiView record the header information (AMS serial number and the current settings for the filter and time-domain format) at the end of the file, instead of at the beginning, check the **Record file header information at end of CSV log file** box.

4) Click **OK**.

Changing the Log File Directory

By default, MultiView writes log entries to the directory My Documents\AMS Files\. If you prefer, you can specify a different directory.

To change the log file directory:

1) Choose the **File** > **Select Log Directory** menu item.

2) In the **Browse For Folder** dialog, specify the folder name for the log files, and click **Save**.

Configuring the Trace Display

You can change the way the vibration traces are displayed by minimizing or maximizing the bars for displaying the traces, by applying a filter to the data, by changing the vertical and horizontal scales, by changing the colors of traces and other elements in the display, and by showing or hiding the trigger settings and frequency spectrum.

Minimizing the Trace Bars

You can minimize the bars for displaying the traces. Minimizing the bar for a trace collapses the height of the bar for that trace. The heights of the bars for the remaining traces expand to fill the area. You can minimize the bars for up to three traces at any time—but at least one trace is always maximized.

1) To minimize the bar for displaying a trace, in the **Minimize trace bars** section of the screen, check the boxes for the traces you want to minimize.
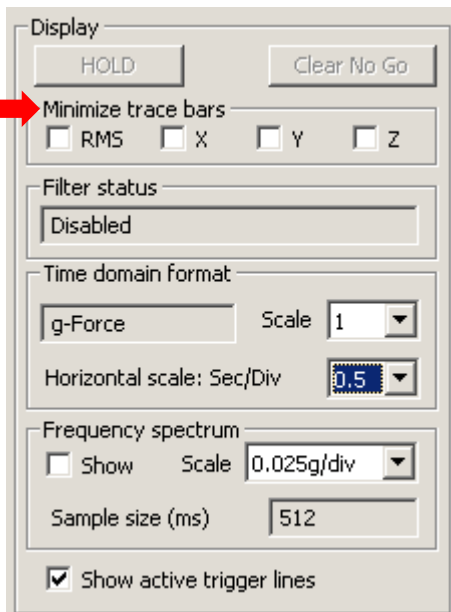
2) To restore the bar for a trace to its normal height, uncheck the box for that trace under the **Minimize trace bars** section of the screen.

Filtering the Data

MultiView can filter the data to remove unwanted parts of the signal spectrum before displaying it. You can choose a low-pass filter, a high-pass filter, or a band-pass filter. Changing the filter can dramatically affect the range of values in the data, which affects the trigger and Go/No-Go values, so when you change filter settings, MultiView automatically disables all trigger and Go/No-Go tolerances. If you make any changes to the filter (enabling, disabling, changing filter type, or band pass settings), you'll need to adjust and re-enable any triggers or Go/No-Go tolerances.

Filters can be useful for a variety of situations, such as the following.

- Removing constant g-force
- Removing very low frequency acceleration resulting from slow moves
- Removing high frequency noise

The filter affects the display of the data, but does not affect the data written to the **.amvdata** log file. However, the filter does affect the data written to the optional **.csv** file (see "Importing Log Files into Other Applications" on page 60).

To set up the filter:

1) Choose the menu item **Settings** > **Set Filter**. The **Set Filter** dialog is displayed.
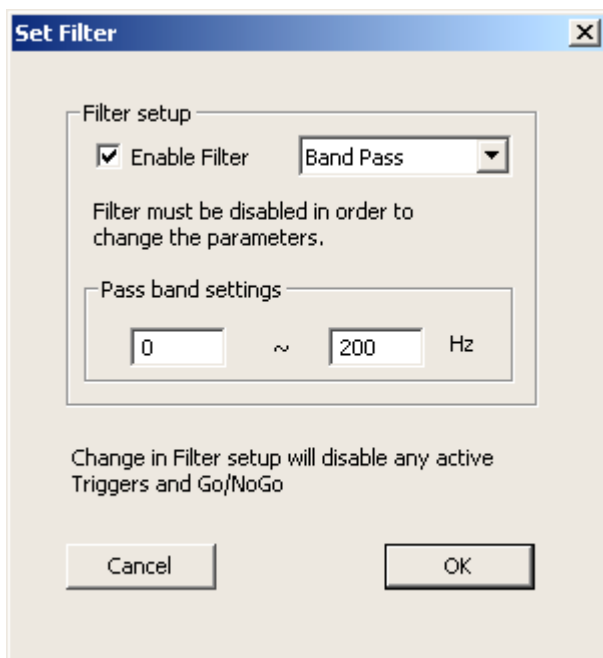
2) If **Enable Filter** is checked, clear the box. You can't make any changes to the filter settings when the filter is enabled.

3) From the list, choose the type of filter you want to apply to the data: Low Pass, High Pass, or Band Pass.

4) Specify the **Pass band settings** for the filter.

5) Check **Enable Filter** and click **OK**. The new filter settings take effect immediately. Any trigger or Go/No-Go tolerances are disabled. If you want to use triggers or Go/No-Go, you must re-enable them.

Changing the Time-Domain Format

MultiView gives you three options for setting the time-domain format for traces, as shown below.

- **g-Force**

Displays acceleration values from -2 g to +2 g. One g is the acceleration of gravity (approximately 32 ft/s^2 or 9.81 m/s^2). With this vertical scale setting, when the AMS is sitting motionless and horizontal, the Z trace will show 1 g, the X and Y traces will show 0 g, and the RMS trace will show 0.58 g. This is because the AMS senses the acceleration of the earth's gravitational field, which is 1 g in the vertical (Z) direction. You can also choose to display the absolute value of acceleration in g-Force. Using the absolute value can be helpful when comparing traces. When displaying absolute value, you will usually want to also use the high-pass filter (see "Filtering the Data" on page 63).

- **Gal**

Displays values in galileo units, where 1 g = 981 Gal. With this vertical scale setting, when the AMS is sitting motionless and horizontal, the Z trace will show 981 Gal, the X and Y traces will show 0 Gal, and the RMS trace will show 566 Gal. This is because the wafer senses the acceleration of the earth's gravitational field, which is 981 Gal in the vertical (Z) direction. You can also choose to display the absolute value of acceleration in Gals. Using the absolute value can be helpful when comparing traces. When displaying absolute value, you will usually want to also use the high-pass filter (see "Filtering the Data" on page 63).

- **Energy**

Displays the signal energy for the last specified number (*n)* of acceleration values. Signal energy is calculated using the following formula.

$$\frac{1}{N} \sum_{k=1}^{n} x^2 (k)$$

Where:

    N is the sample rate (1 KHz for the AMS).

    n is the number of samples, which is the sample size you have set for the frequency spectrum (see "Displaying the Frequency Spectrum" on page 69).

    x(k) is the kth sample of the acceleration in g-force. Using the energy format with appropriate Go/No-Go tolerances can identify vibrations that don't have large amplitudes (and might not trip the Go/No-Go tolerances for g-force or Gals), but extend for longer periods of time.

Values that are too large to display are truncated.

Changing the time domain format can dramatically affect the range of values in the data, which affects the trigger and Go/No-Go values, so when you change time domain format settings, MultiView automatically disables all trigger and Go/No-Go tolerances. If you change the time-domain format, you'll need to adjust and re-enable any triggers or Go/No-Go tolerances. For more information, see "Recording with Triggers" on page 50 and "Monitoring Traces for Excessive Vibration Levels" on page 46.

Changing the Time-Domain Format

When you change the time-domain format, the triggers and Go/No-Go tolerances are disabled. You might need to re-enable these settings.

To change the time-domain format:

1) Choose the menu item **Settings** > **Set Time Domain Format**. The **Set Time Domain Format** dialog is displayed.
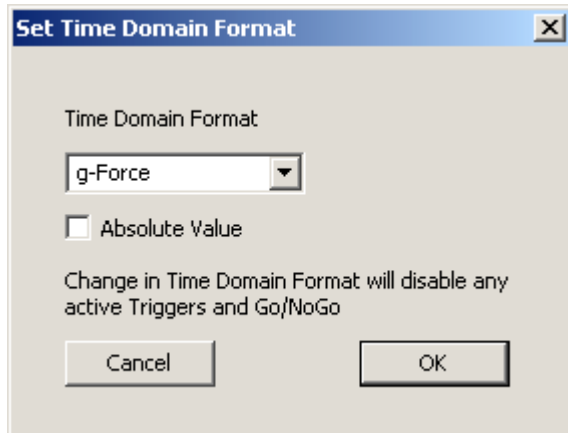

2) Click the down-arrow and, from the list, choose the appropriate time-domain format.

3) If you want MultiView to display the absolute value of the acceleration values, check the box for **Absolute Value**.

4) Click **OK**.

Changing the Horizontal Time and Scale

The default horizontal-axis labels show time relative to the right-edge of the trace, where the newest data points appear.

New data appears here

0.5 seconds—the default setting

Relative time—increases to the left
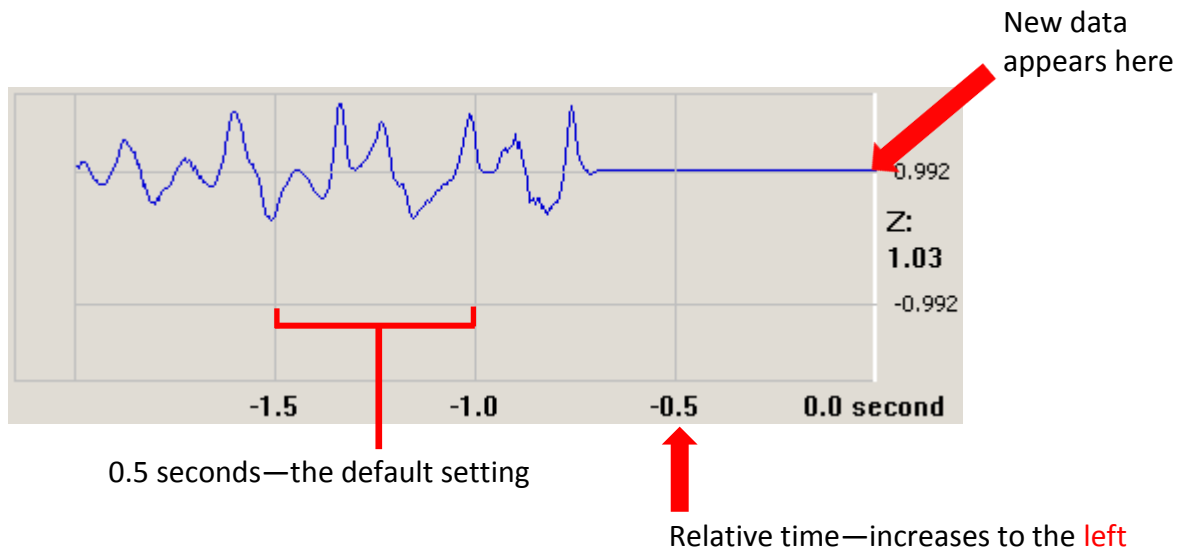
With this relative time scale, the time labels on the horizontal axis indicate the time that has elapsed since the data was first displayed at the right edge. The numbers increase negatively as you move from right to left indicating that the older data is to the left. You can change the horizontal scale to show *absolute* time (as shown in the figure below) since the start of recording, rather than *relative* time (as shown in the figure above) . When you aren't recording, the scale always shows time relative to the right edge.

Absolute time—increases to the right
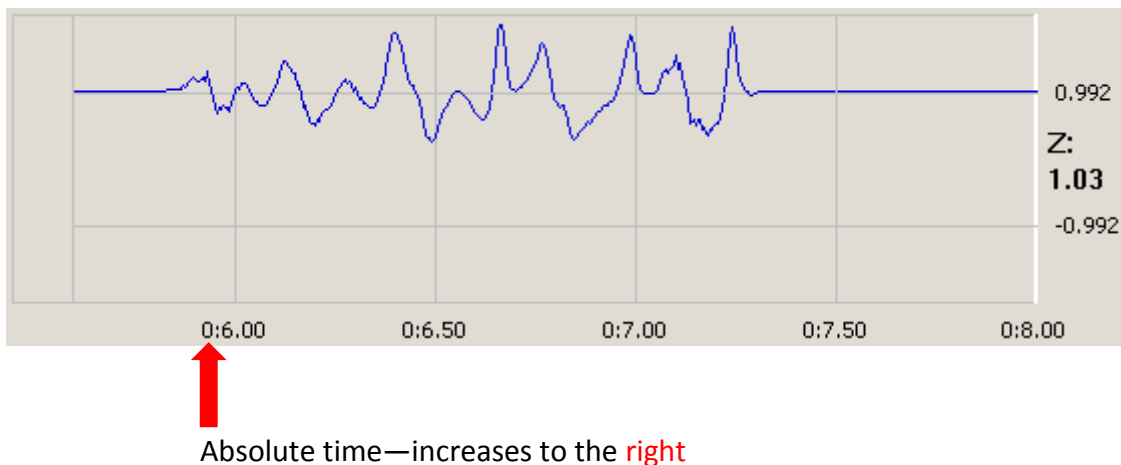
The default horizontal scale shows 0.5 seconds between vertical grid lines and plots one point for every five readings received from the AMS. You can change the horizontal scale to show from 0.1 seconds to 100 seconds between the grid lines. At the 0.1 second setting, MultiView displays every reading received from the AMVS (that is, one data-point per millisecond). When displaying at the higher scales, MultiView can't display every reading received from the AMS, so it displays a vertical bar indicating the range of values for the time span represented by any given point on the horizontal axis. For example, at the default scale of 0.5 seconds/division, each vertical bar plotted represents five readings and shows the range of those five readings. The horizontal-scale setting doesn't affect the data recorded, only the data displayed.

Changing the Horizontal Axis Time

To change the horizontal axis time:

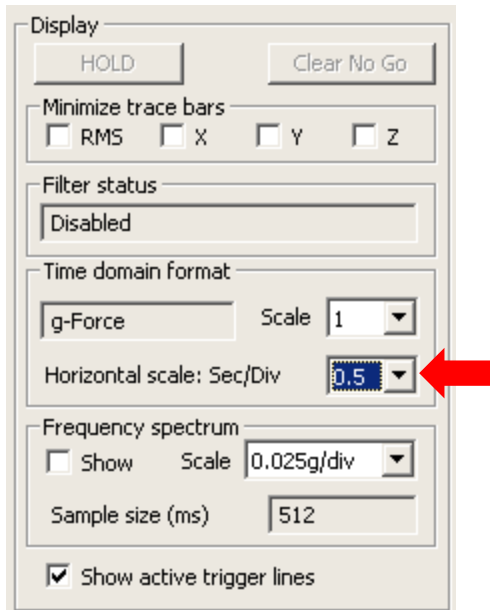1) Choose the menu item **Settings** > **Options**. The options dialog is displayed.
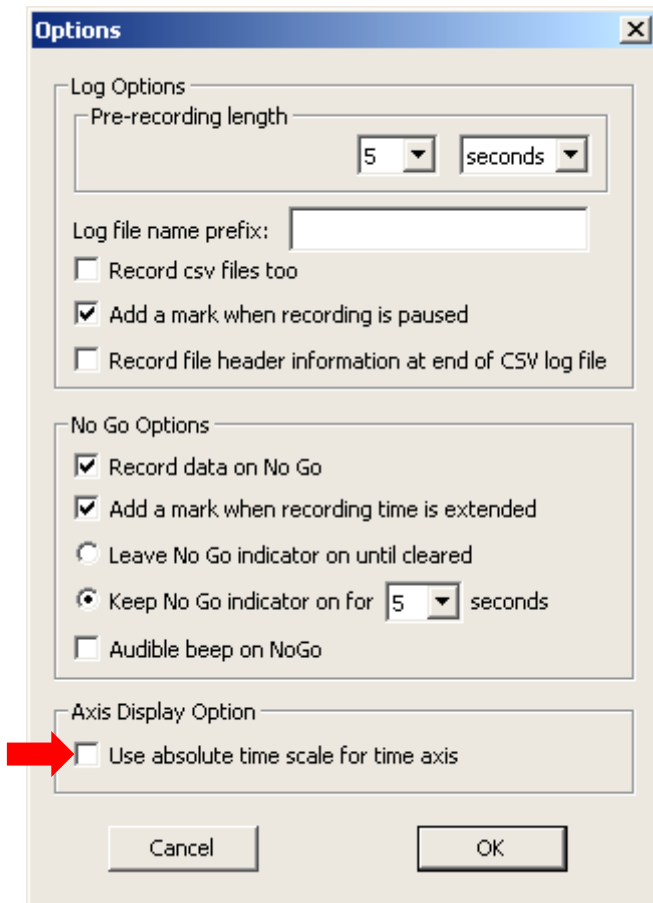
2) For absolute time, check the **Use absolute time scale for time axis** box.

3) Click **OK**.

Changing the Horizontal Scale

To change the horizontal scale:

- Using the **Horizontal scale** list, choose the time interval you want between vertical grid lines and the new scale setting takes effect immediately.

Changing Colors

For more information, see "Changing Colors in the Trace Screen" on page 24.

Displaying the Frequency Spectrum

By default, MultiView displays time-domain data: vibration readings over time. You can also have MultiView display frequency-domain data: the frequency spectrum determined by a Fast Fourier Transform (FFT) of the time-domain data. As shown in the figure below, when displaying a frequency spectrum, MultiView divides the trace area, showing the vibration traces on the right, and the frequency spectrum on the left.
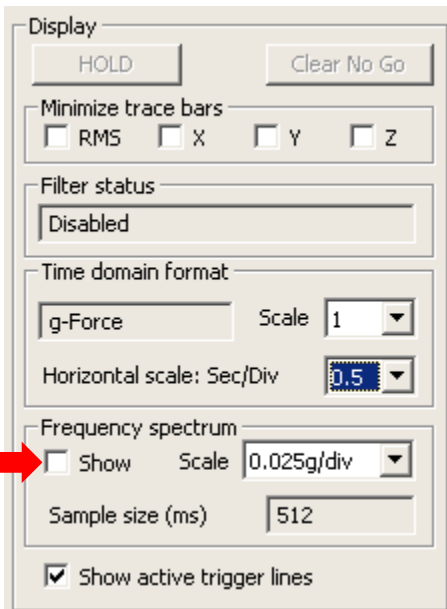

In the frequency-spectrum display, the horizontal axis is the vibration frequency, and the vertical axis displays the amplitude for that frequency. Both scales are linear. Frequencies are limited to 200 Hz and below, by the AMS.

Each frequency display has a vertical green line. The line is positioned at a particular frequency (100 Hz, by default), and the text at the top of the line identifies the frequency and the current amplitude for that frequency. You can move the lines to monitor the amplitude at different frequencies.

By default, MultiView performs the frequency analysis using a sample of 512 data points (512 milliseconds of data). MultiView receives data from the AMS in packets of 100 data points. The FFT is computed every 100 milliseconds, using the latest packet of 100 points, plus the previous 412 data points. You can specify a different sample size. Increasing the sample size increases the resolution of the frequency spectrum, but the additional data points cause the FFT results to respond more slowly to changes, similar to the way a rolling average tends to smooth out changes. When you change the FFT sample size, MultiView automatically disables all trigger and Go/No-Go tolerances. After changing the sample size, you'll need to adjust and re-enable any triggers or Go/No-Go tolerances.

To display a frequency spectrum in MultiView:

1) Under **Frequency spectrum**, check the **Show** box.

2) To adjust the vertical scale of the frequency spectrum, choose a value from the **Scale** list. The new setting takes effect immediately.

3) To display the amplitude for any specific frequency component, move the green lines.
   - To move one of the vertical green lines, right-click in the frequency-spectrum display.
   - To adjust the position of a line after using right-click, press the left- or right-arrow keys.
   - To line up all of the green lines, double-right-click.

   When you move the green line, it moves between the frequency values determined by the FFT, which in general are not integer values.

4) To change the FFT sample size, choose the menu item **Settings** > **Set FFT Sample Size** and the Set FFT Sample Size dialog is displayed.
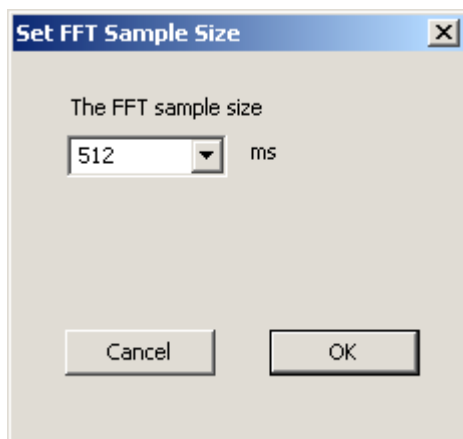
5) From the list, choose a sample size, click **OK** and the new setting takes effect immediately.
When you change the FFT sample size, triggers and Go/No-Go tolerances are disabled. You might need to re-enable these tolerances.

Showing and Hiding Trigger Settings

You can add lines to the trace displays to show the active trigger settings, see "Recording with Triggers" on page 50.

- To show active trigger lines on the display, check the box for **Show active trigger lines** (see figure below).

- To hide all trigger lines on the display, clear the box for **Show active trigger lines**.
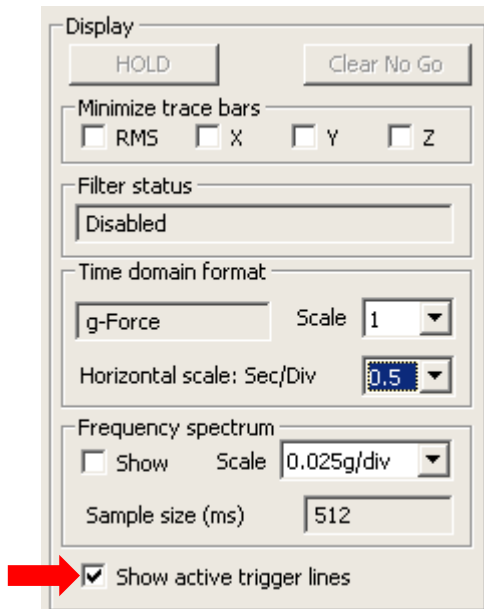
Viewing Log Files

MultiReview allows you to play back the log files you recorded, while running the AMS through your wafer-manufacturing process. More specifically, MultiReview allows you to do the following.

- Run MultiReview

- Use the playback controls

- Work with marks

- Monitor traces for excessive vibration levels

- Compare log files

- Change MultiView settings from MultiReview

- Change log files

- Analyze narrow peaks

- Save a subset of a log file

- Compile summary statistical reports

- Print the MultiReview window

Running MultiReview

To view a log file, do the following.

1) In Windows, press **Start** > **All Programs** > **AMS** > **MultiReview** and the MultiReview screen is displayed.
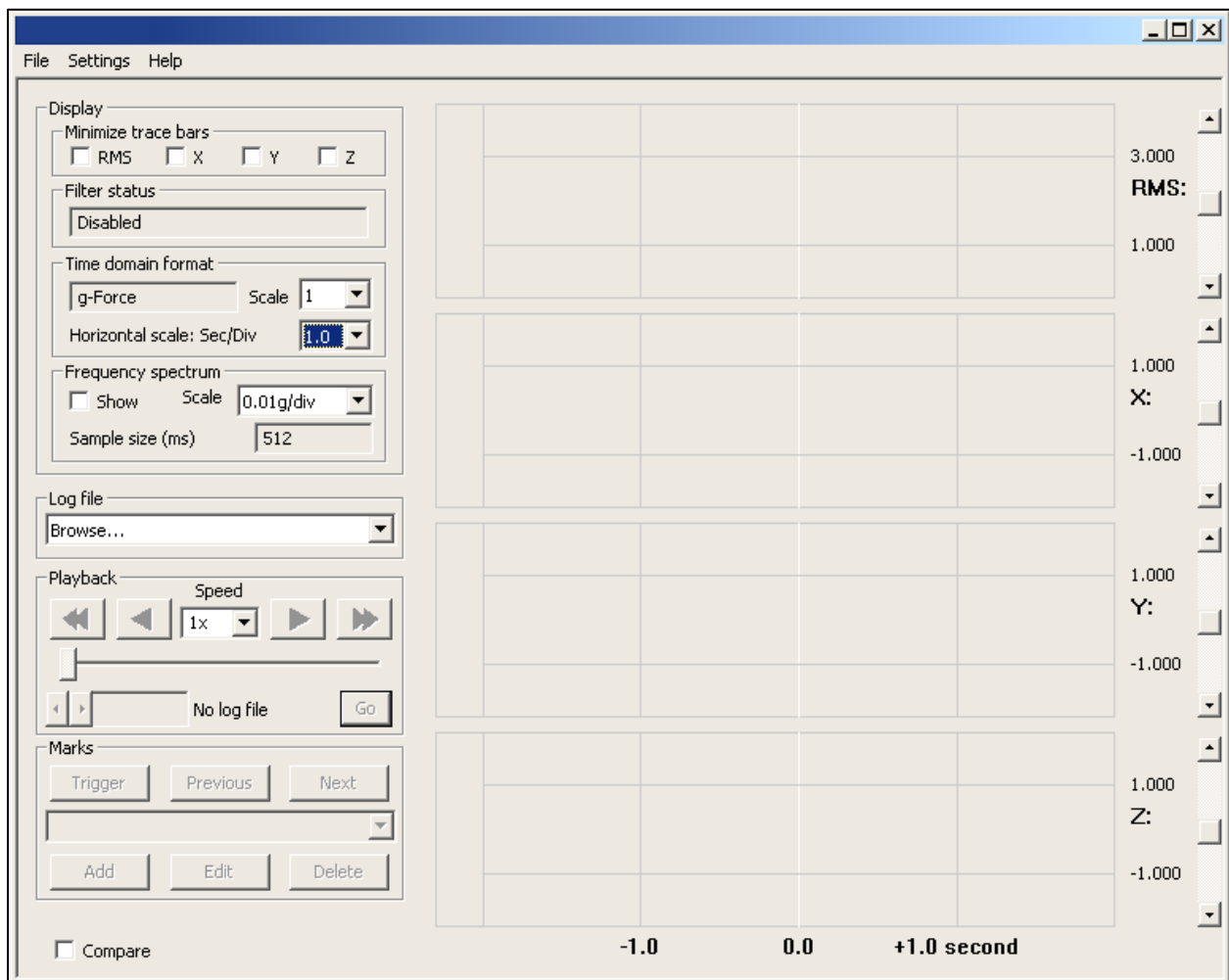
2) From the **File** menu, choose **Open Log File** and the AMS Log Files dialog is displayed.

3) Choose a log file and click **Open**. MultiReview opens the log file, and displays the traces at the beginning of the file.
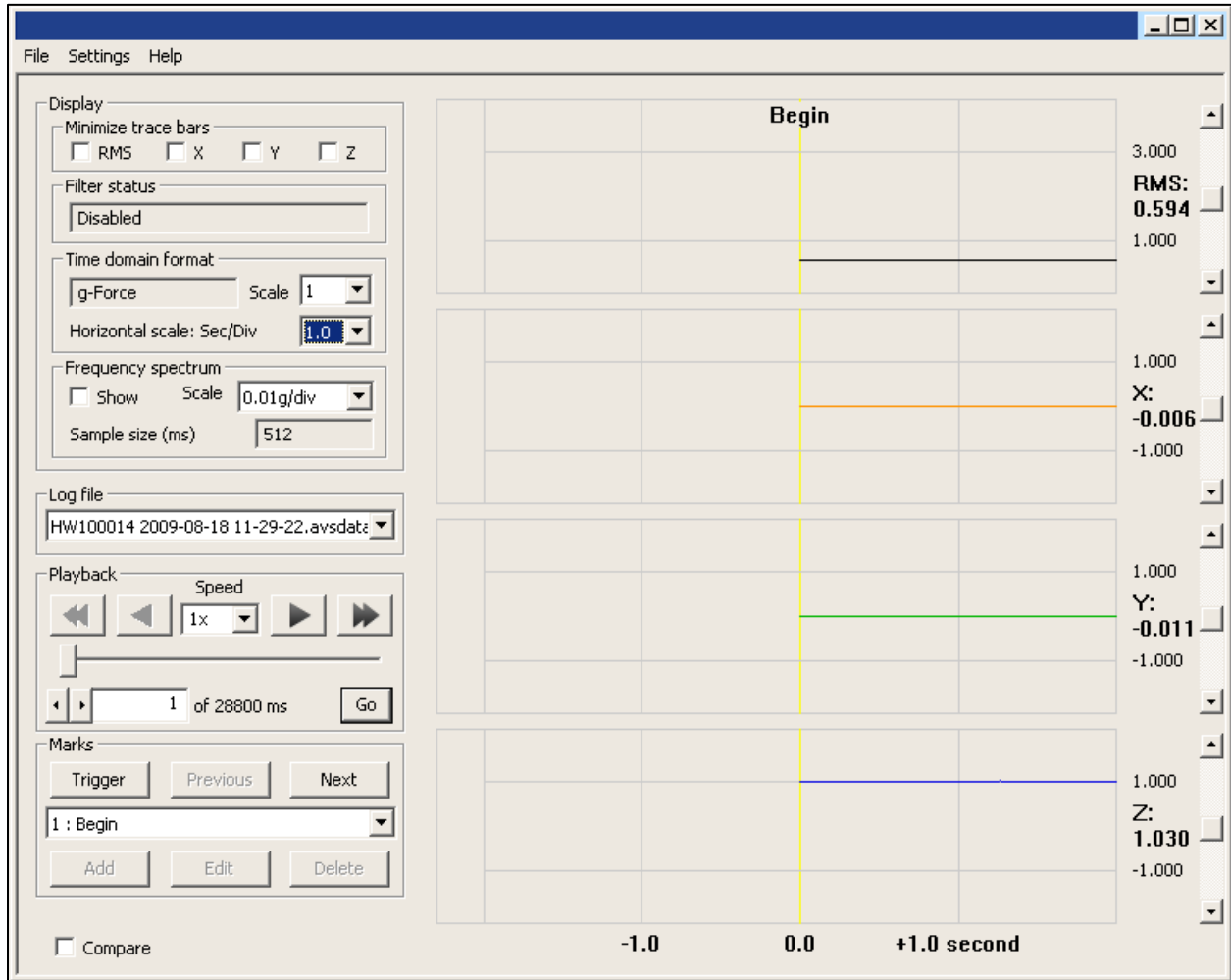
Settings stored in the log file for the filter, FFT sample size, Go/No-Go, and time-domain format are all applied when you open a log file.

4) To start the log file playing, click the **Play** button.

The traces start scrolling from right to left, and the **Play** button changes to **Pause**.

You can use the other Playback controls to jump ahead or back or to a particular place in the file, play the file in reverse, and adjust the playback speed. These are described on the next page.

Using the Playback Controls

You can play a log file forward or in reverse, pause during playback, and jump ahead or back by using the playback controls. You can also move around in log files by jumping to marks or triggers, see "Working with Marks" on page 78.
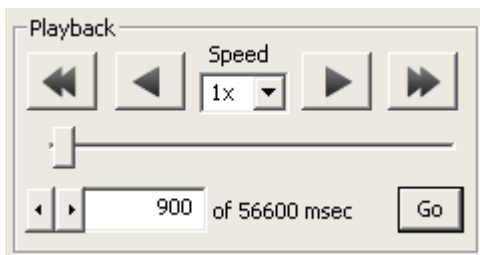
The buttons are described in more detail below.

- **Forward**   **Reverse**   **Pause**

  These buttons start the file playing from the current position forward in the file, and changes the **Play** forward button to a **Pause** button. Clicking **Pause** halts the playback at the current position, and changes the button back to **Play** forward. **Play Reverse** works similarly, but plays backward toward the beginning of the file.

- **Back One Division**   **Forward One Division**

  Jumps forward or back one division. One division refers to the time between the vertical grid lines, which can be from 100–100,000 milliseconds, depending on the horizontal scale setting, see "Configuring the Trace Display" on page 62.
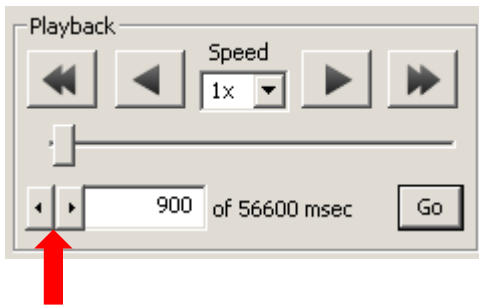
- **Slider**

  Dragging the slider lets you quickly move to any position in the file.

- **Speed**

  The speed control lets choose a playback speed from 1x to 10x. Playing a file containing 60,000 milliseconds of data at 1x takes about 60 seconds; at 10x, the same file plays in about 6 seconds. This playback speed is not affected by the horizontal scale setting.
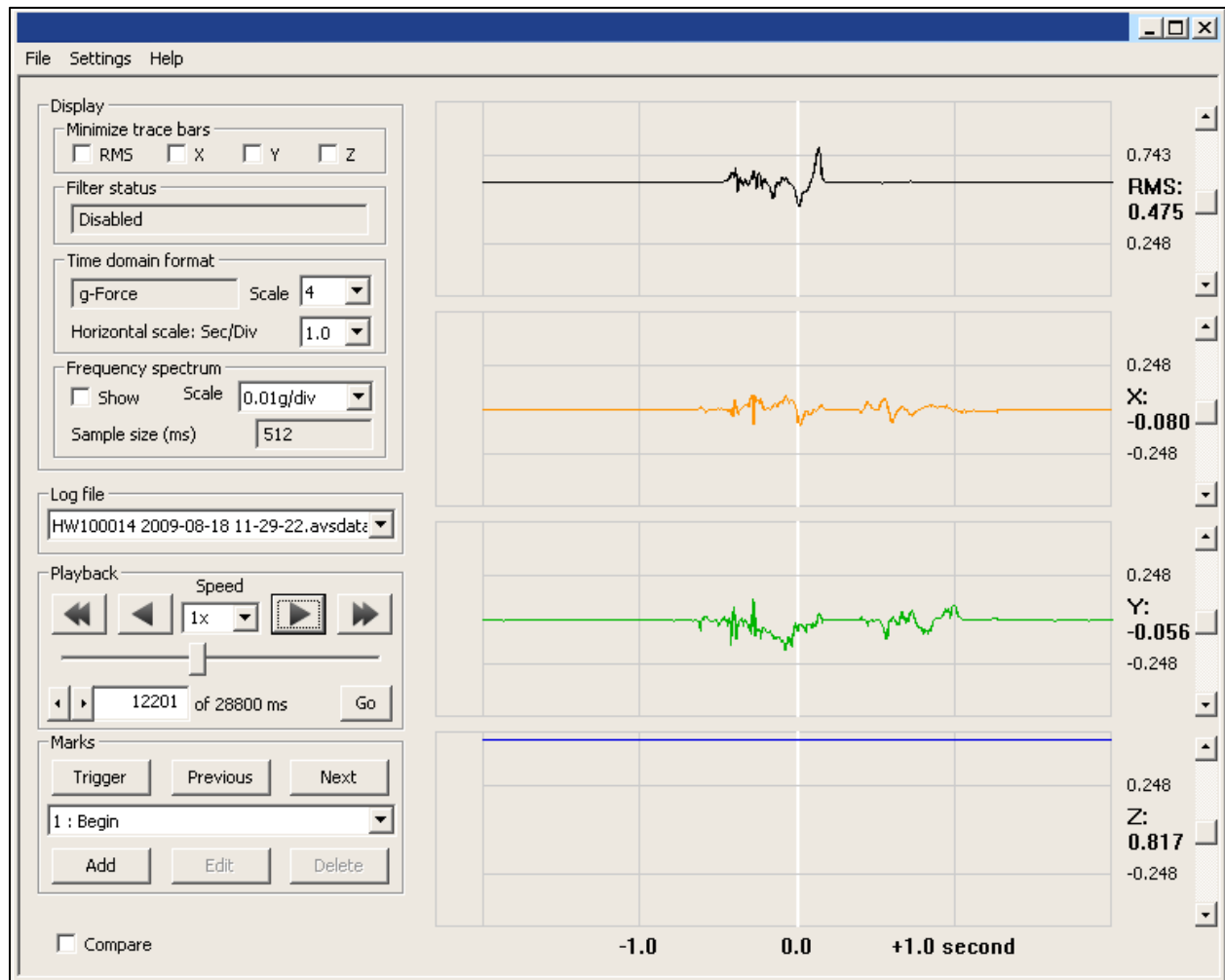
- **Counter**

Spin controls

The counter shows the current position within the file at any given time. The indicator, the white vertical line in the middle of the trace display, marks the point in the trace that corresponds to the counter value—see figure on the next page. The count is the number of milliseconds (equivalent to the number of data points), regardless of the control horizontal scale setting.

The value to the right of the counter is the total length of the file in milliseconds (or data points). To change the position in the file, you can type a number into the counter text field and click **Go**. Compared to the slider, the counter gives you more precise control over positioning within the file.

You can also change the position in the file by using the arrows in the spin control. A single click increments (right arrow) or decrements (left arrow) the counter by one. Clicking and holding causes the counter to increment or decrement repeatedly, changing faster the longer you hold down the arrow button.

Figure 2. MultiReview Screen Showing the "Begin" Indicator Line

Clicking and Dragging Traces

When the trace display is paused, you can use the counter in the playback controls to move the trace display to a different location in the log file. However, for small changes, you might find it easier to move the traces by clicking and dragging. When you click and drag the traces, the counter changes accordingly.

To click and drag the traces:

1) Move the cursor into the trace area, and the cursor changes to a pointing hand.

2) Click and hold the left mouse button.

3) Drag the mouse to the left or right and release the mouse button. When you release the button, the trace display jumps forward or back the distance you moved the mouse.

Working with Marks

Marks indicate points of interest within log files. Every log file has one trigger mark that tells you where recording started and what caused the recording to start. Clicking the **Start** button, the occurrence of the first trigger event in one of the traces, or the first Go/No-Go event, will cause MultiView to place a trigger mark in the file. You can also create your own marks in a file while you are recording in MultiView, and you can add annotations to the marks. For more information on triggers and marks, see "Recording with Triggers" on page 50 and "Placing Marks in a Log File" on page 55.

Finding Marks in a File

In MultiReview, you can quickly go to the position in the file that corresponds to the trigger or to another mark.
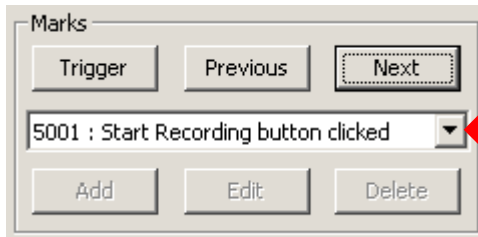
Click here to access named marks

- **Going to a Trigger event**
  To go to the trigger event in a log file, click the **Trigger** button. Note that the "trigger event" can be clicking the **Start** button, an actual trigger, or a No-Go event.

- **Going to specific mark**
  To go to a specific mark in a log file, use the drop-down list to choose a mark. As soon as you click on a mark in the list, MultiReview jumps to that position in the file.

- **Next and Previous buttons**
  The **Next** and **Previous** buttons let you jump to the next or previous marks in the file. At the last mark, clicking **Next** takes you to the end of the file. At the first mark, clicking **Previous** takes you to the beginning of the file. When you go to a trigger mark or to a user-defined mark in the file, the counter shows the file position of the mark. For example, if you go to a mark at 45,000 in a data file, the playback counter will show 45,000, and the list of marks will show 45,000 with the mark annotation, if any. When you use the playback controls to move from that mark, the counter shows the new location, but the list of marks does not change. The counter always shows the current location in the file, but the list of marks shows the last mark that you selected, even if the position in the file has moved from that mark.

When the trigger event is visible in the trace display, the trigger event is marked by a vertical red line with an annotation. Other marks appear as vertical yellow lines with annotations.
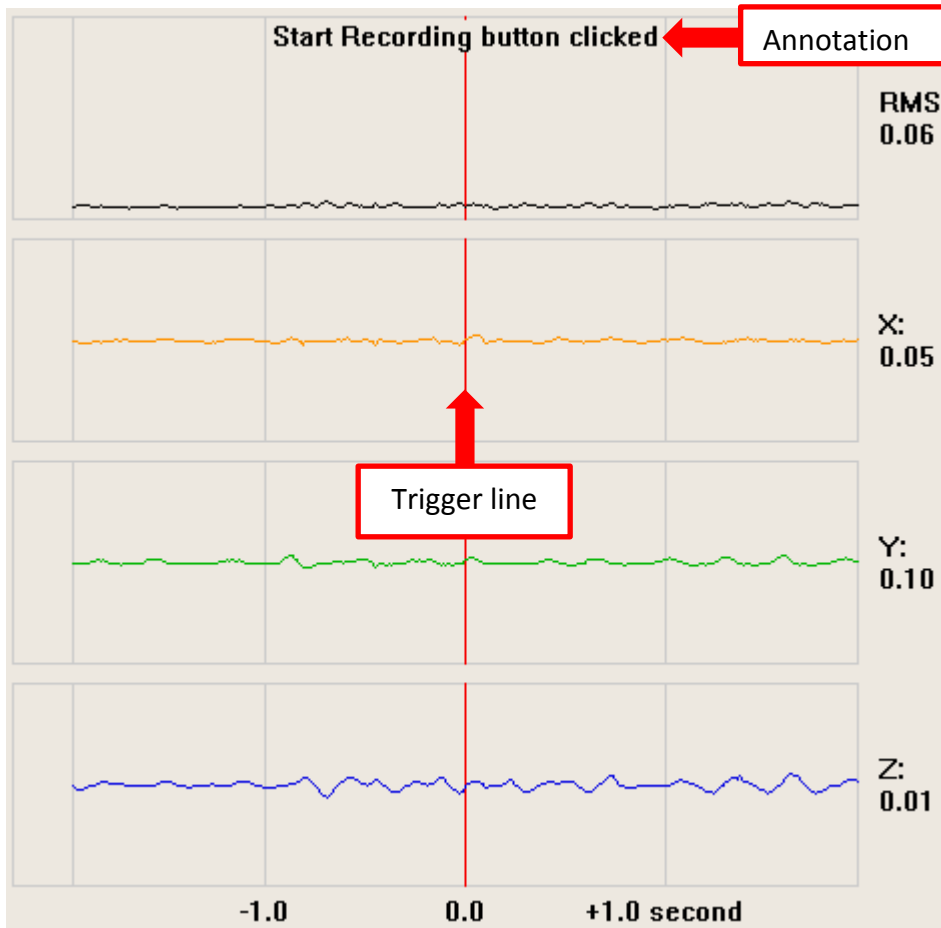

Adding Marks to a File

You can add marks to a file whenever playback is paused. MultiView automatically creates marks at the beginning and end of the file and for the trigger event. You can't add user-created marks where MultiView has created the Begin, End, and Trigger marks. The Add button in MultiReview works just as the Add a Mark button does in MultiView. For more information, see "Placing Marks in a Log File" on page 55.

Editing Existing Marks

You can edit the annotation text that is associated with a user-created mark. You can also delete a user-created mark from a file. You can't edit or delete the **Begin**, **End**, or **Trigger** marks.

 Click here to access named marks
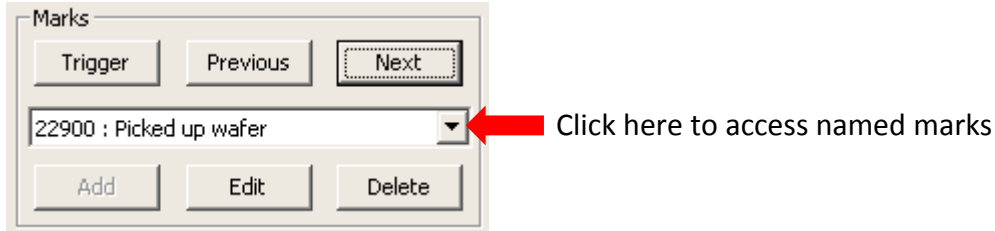
To delete or edit a mark:

1) Choose the mark you want to edit from the drop-down list under **Marks** (playback must be paused). You can also go to the mark using **Next** and **Previous**. When you are at a mark, the **Edit** and **Delete** buttons are active (except for the **Trigger**, **Begin**, and **End** marks).

2) To delete the mark, click **Delete**. To edit the annotation associated with the mark, click **Edit**. When you click **Edit**, the **Annotate Mark** dialog appears.

3) If you clicked **Edit**, edit the text in the **Annotate Mark** dialog and click **OK** to save the change.

# Monitoring Traces for Excessive Vibration Levels

Monitoring your traces for excessive vibration levels has already been discussed in detail above—see page 46. Use the **Playback** and **Marks** features of the MultiReview screen (see page 77) to go to the marks you want to review.

Comparing Log Files

You can compare two log files, using the playback controls to move through the traces from both files in unison. When comparing files, by default MultiReview displays all individual traces from the first file, but only one trace from the second file. You can select which trace (X, Y, Z, or RMS) to display from the second file. In addition to having MultiReview display one of the traces from the second file, you can have it overlay all traces from the second file in the traces for the first file. Overlaid traces appear in gray along with the colored traces from the first file.

To compare two log files:

1) From the **File** menu, choose **Open Log File** and the AMS Log Files dialog is displayed.

2) Choose the first log file you want to compare, and click **Open**. MultiReview opens the log file and displays the traces at the beginning of the file.

3) In the lower-left corner of the MultiReview window, check the **Compare** box and a second set of log file controls appears.
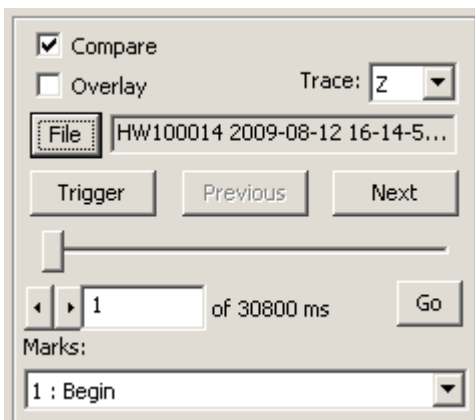

4) In the **Compare** controls, click **File** and the AMS Log Files dialog is displayed.

5) Choose the second log file you want to compare, and click **Open**. MultiReview opens the log file and displays one of the traces at the bottom of the window, below the traces for the first file. By default, MultiReview displays all traces from the first file but only one trace at a time from the second file.
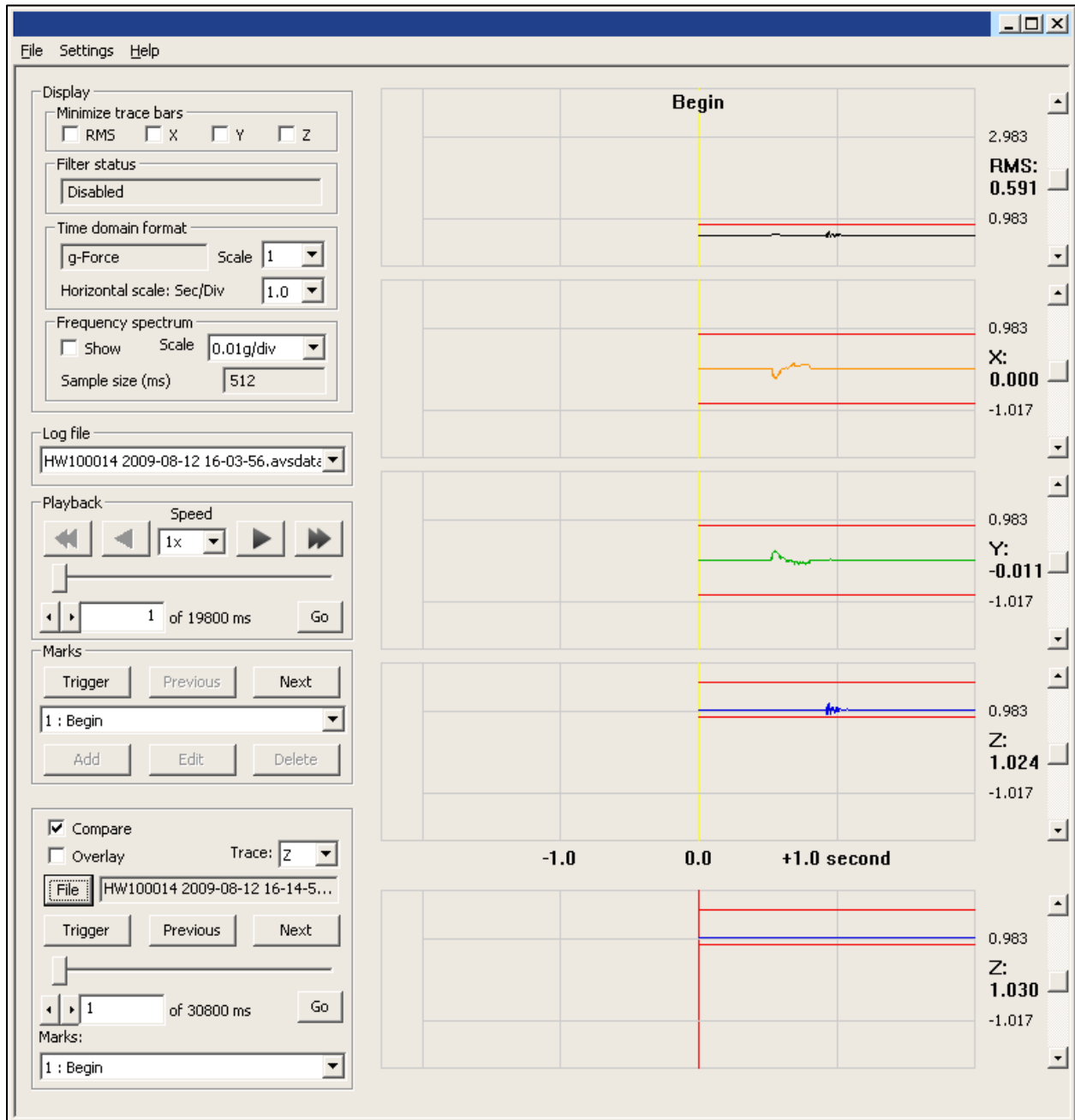
6) To change which trace from the second file is displayed at the bottom of the window, select a different trace from the **Trace** drop-down menu (see figure on the previous page).

7) To have MultiReview overlay all traces from the second file on the corresponding traces from the first file, in the **Compare** controls, check **Overlay**. The traces from the second file appear as gray lines over the traces from the first file.
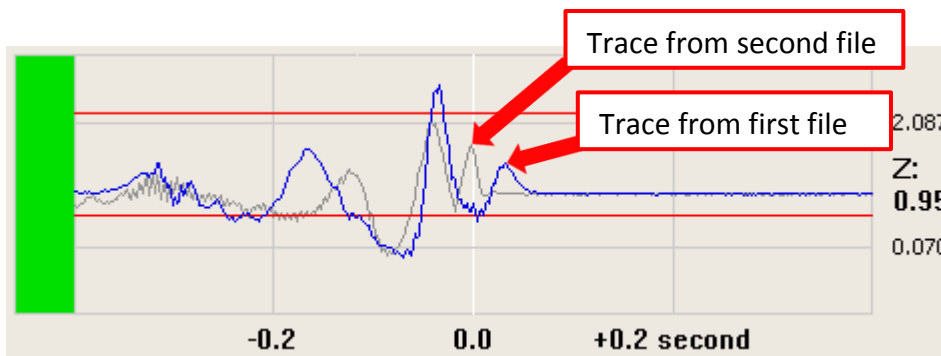
8) To synchronize the two files to a common event, use **Trigger**, **Next**, and **Previous** or **Marks** to find corresponding events for the two files. To synchronize based on times, use the counters for each file. You can also make adjustments by clicking and dragging the traces, see "Clicking and Dragging Traces" on page 77. Separate slider, counter, and marks controls for each file let you manipulate them independently.

9) When you have the traces synchronized, use the playback controls to play the log files. The playback controls play both log files in unison, see "Using the Playback Controls" on page 75.

Changing MultiView Settings from MultiReview

Based on what you see in reviewing a log file in MultiReview, you might want to change some of the settings that you will use for a subsequent run in MultiView. For example, you might notice a specific event in the log file that you want to take a closer look at with another MultiView run. MultiReview makes this easy to do by allowing you to open a MultiView settings file, make changes, and save the file without leaving MultiReview. In MultiReview, you can change MultiView settings for Go/No-Go events, for filters, for time-domain formats, for FFT sample sizes, and for the user-specified information.

To change MultiView settings from MultiReview:

1) In MultiReview, make your selections for the parameters listed below.
   - Go/No-Go tolerances   —see "Monitoring Traces for Excessive Vibration Levels" on page 80.
   - Filter   —see "Filtering the Data" on page 63.
   - Time-domain format   —see "Changing the Time-Domain Format" on page 64.
   - FFT sample size   —see "Displaying the Frequency Spectrum" on page 69.

2) Choose the menu item **Settings** > **Modify MultiView Settings**. The **Modify MultiView Settings** dialog is displayed.
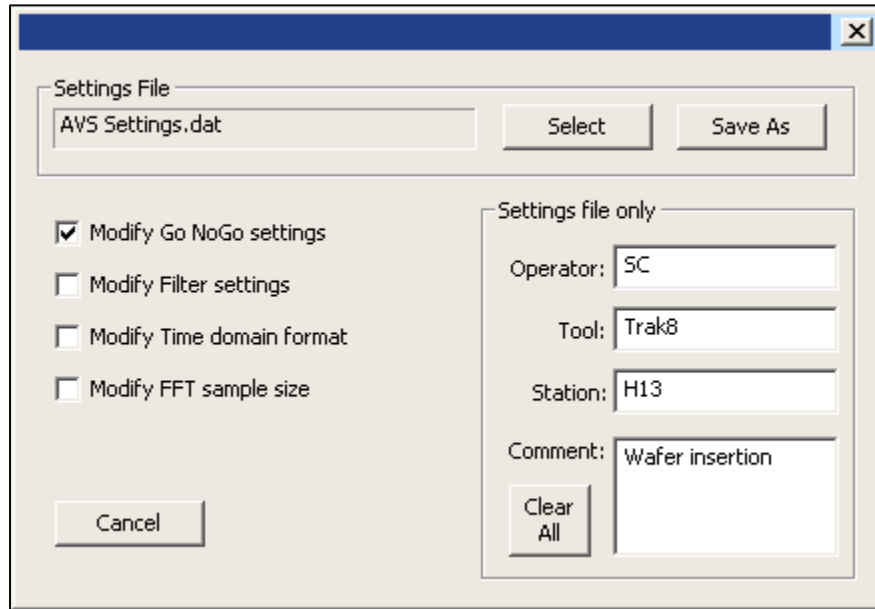
3) To open a MultiView settings file, click **Select**, choose a settings file from the AMS Settings File dialog, and click **Open**.

4) In the Modify MultiView Settings dialog, check the **Modify** boxes for any settings you want to save in the settings file.

5) Modify any of the user-defined information for **Operator**, **Tool**, **Station**, and **Comment**. **Clear All** lets you clear all of these fields.

6) To save the settings for a future MultiView run, click **Save As**. In the AMS Settings File dialog, edit the file as needed, and click **Save**. Note the file name, so you can open it in MultiView.

7) To close the Modify MultiView Settings dialog, click **Cancel**.

Changing Log Files

You can open a log file using the **Open Log File** command on the **File** menu, see "Running MultiReview" on page 73. If you have previously opened files in MultiReview, the last few files you opened are listed in the **Log file** pull-down menu. That gives you a quick way to select a recently opened log file. If you don't see the file you want in the list, choose **Browse** at the end of the list to open the log file. Note that any settings stored in the log file for the filter, FFT sample size, Go/No-Go, and time-domain format are all applied, when you open a new log file.
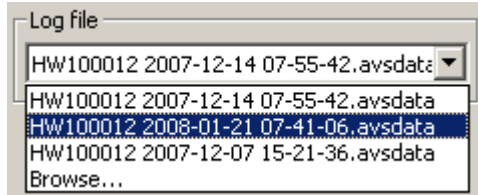

Analyzing Narrow Peaks

This function allows you to more easily analyze narrow peaks in your traces. As such, please see "Configuring the Trace Display" on page 62 for more information about configuring the trace display in MultiView. MultiReview, however, offers one additional feature, the ability to analyze narrow peaks in greater detail that is not available in MultiView.

Narrow peaks in the traces can be difficult to analyze, because of the need to pause and position the peak right on the indicator to check the amplitude. To make it easier to analyze peaks, you can tell MultiReview to hold a peak for a specified period of time. When the hold-peak feature is active, each time a signal peak is detected, MultiReview holds the trace level at that peak value for the time period you specify.
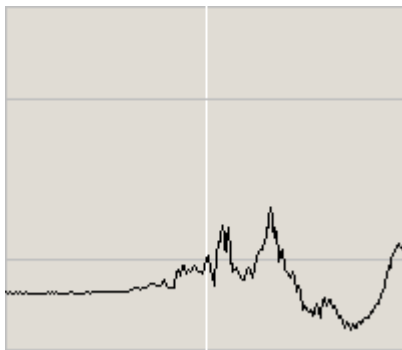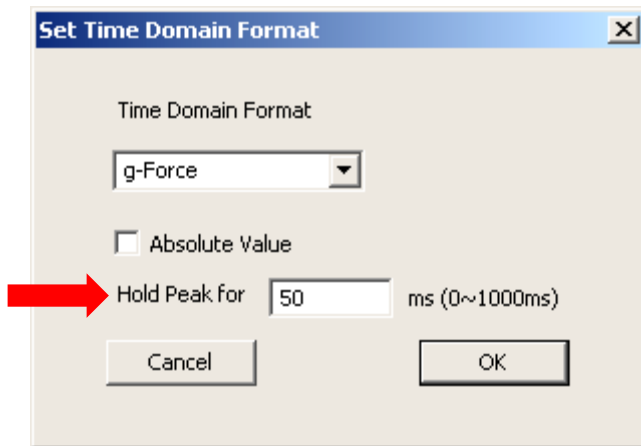

Standard trace
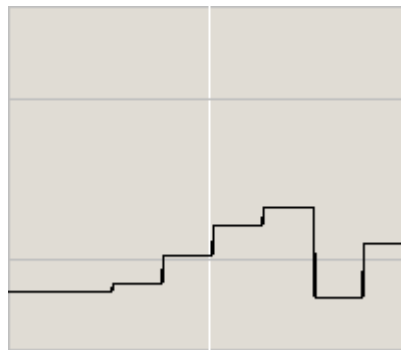
Trace with Hold Peak active

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To activate the Hold Peak function:

1) Choose the menu item **Settings** > **Set Time Domain Format**. The **Set Time Domain Format** dialog is displayed.

2) From the **Time Domain Format** list, choose your time domain format from the drop-down menu.

3) If you want MultiReview to display the absolute value of the acceleration values, check the box for **Absolute Value**.

4) If you want MultiReview to hold and display peak values, specify the hold time in the **Hold Peak for** box.

5) Click **OK**.

6) When you change the time domain format, you might need to adjust Go/No-Go tolerances.

Saving a Sub-Set of a Log File

The AMS takes readings at the rate of 1,000/second, so log files can become quite large. You can save a subset of a log file by specifying the beginning position and the ending position, so that the partial log file contains only your selected data. You can also modify the associated filter setting, time domain format, FFT size, and Go/No-Go tolerances when saving a partial log file.

To save a subset of a log file:

1) From the **File** menu, choose **Save Partial Log File**. The **Save Partial Data** dialog is displayed prompting you to specify the start position of the subset of the log file that you want to save.
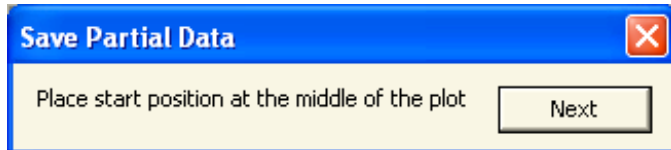
2) Using the playback controls, locate the starting point of the data subset you want to save, aligning that point on the indicator line in the center of the trace display.

3) In the **Save Partial Data** dialog, click **Next**. The **Save Partial Data** dialog now prompts you to specify the end position of the subset of the log file that you want to save.
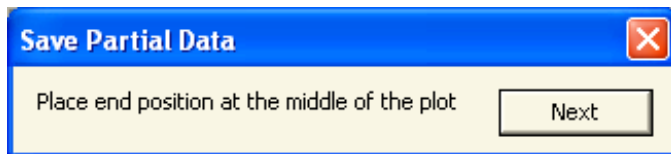
4) Using the playback controls again, locate the end position of the subset of the log file that you want to save.

5) In the **Save Partial Data** dialog, click **Next**. The AMS **Data Log File** dialog is displayed.

6) Specify a filename for the partial log file that you want to save, and click **Save**. MultiReview saves the partial log file.

Compiling Summary Statistical Reports

This section tells you how to use MultiReview to compile summary statistical reports on the following data collected from your traces.

- Peak-acceleration data

- Peak-excursion data

- Time-domain data

Compiling a Peak-Acceleration Summary Report

A peak acceleration summary report shows, for each mark in each file, the frequency at which the maximum acceleration was recorded and the amplitude of that acceleration for each of the X, Y, and Z traces. The report can summarize data from up to 50 log files.

Different log files can have different settings for time-domain format, filter, and FFT sample size, so when compiling a report, MultiReview uses the same settings for all files. The settings are determined by the following.
- The settings for the most-recent log file opened (other than a comparison file).
- The settings you make using the **Settings** menu items.

The default report format uses a vertical layout for each of the X, Y, and Z traces: the table of amplitude data is listed first, and the table of frequency data follows below the amplitude data. You have the option of choosing a horizontal layout: the table of frequency data is listed to the right of the table of amplitude data.

Different log files can have different annotations for the marks in the file, so by default, the report identifies the marks as Mark1, Mark2, Mark *n*…, and so on. You have the option of having the report identify the marks by using the annotations for the marks from the first file you open.

To compile a peak-acceleration summary report:

1) Choose the menu item **Settings** > **Options**. The options dialog is displayed.

Figure 3. MultiView Options Dialog
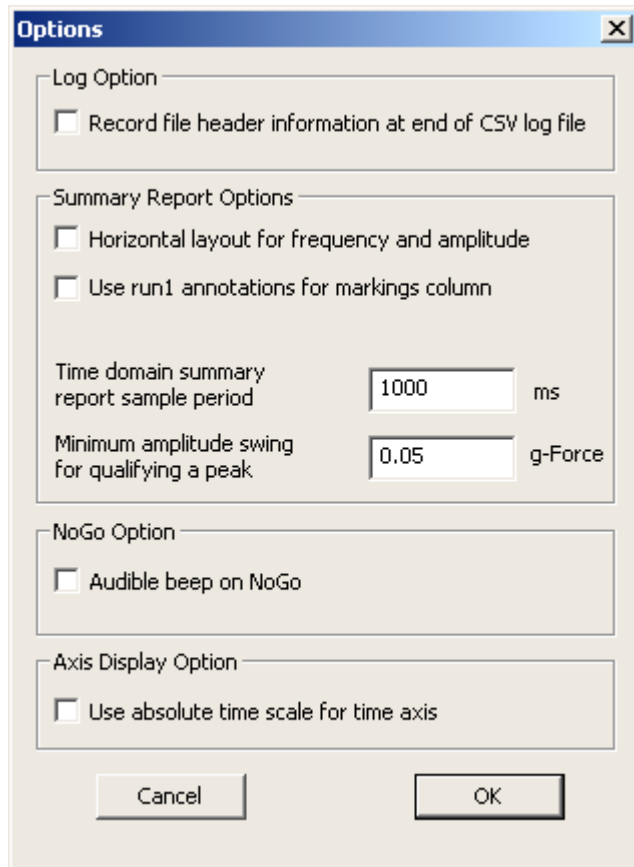
2) If you want the frequency and amplitude data shown horizontally in the report, check the box **Horizontal layout for frequency and amplitude**. If you want the frequency data shown below the amplitude data in the report, clear the check box.

3) If you want the marks identified with the annotations for the marks in the first file you open, check the box **Use run1 annotations for markings column**. If you want the marks identified generically (Mark 1, Mark 2, Mark *n*..., and so on), clear the check box.

4) Click **OK**.

5) Choose the menu item **File** > **Create CSV File** > **Compile Summary Report** > **Peak Acceleration and Frequency**. The AMS log files dialog is displayed.

6) Select the files that you want to include in the report. To select a range of files, click the first filename, and then shift-click the last filename. To select multiple files individually, select each using control-click. When you have selected all files you want, click **Open**. The CSV file dialog is displayed.

7) Enter a name for the peak-acceleration summary report file, and click **Save**. MultiReview compiles and saves the summary report. You can open the report in applications, such as Microsoft Excel, that can read CSV files.

Compiling a Peak-Excursion Summary Report

A peak-excursion summary report shows, for each mark in each file, the frequency at which the maximum displacement (peak excursion) of the AMS was recorded, and the amplitude of that displacement for each of the X, Y, and Z traces. The amplitude is shown in units of millimeters. The peak excursion at each mark is found from the frequency-domain data by calculating the displacement (d) for each frequency, using the following formula.

$$d = \frac{A}{\omega^2}$$

Where the frequency is $\omega/2\pi$ Hz, and A is the amplitude at that frequency. The maximum excursion for a given mark is the largest value of d for the frequency spectrum at that mark, with the following restrictions.

- Only frequencies above 5 Hz are evaluated because of limits in the AMS electronics.

- Only sustained signals are evaluated, that is signals that last longer than the FFT sample size.

The report can summarize data from up to 50 log files. Different log files can have different settings for filter and FFT sample size, so when compiling a report, MultiReview uses the same settings for all file. The settings are determined by the following.

- The settings for the most recent log file opened (other than a comparison file).

- The settings you make using the **Settings** menu items.

The default report format uses a vertical layout for each of the X, Y, and Z traces: the table of amplitude data is listed first, and the table of frequency data follows below the amplitude data. You have the option of choosing a horizontal layout: the table of frequency data is listed to the right of the table of amplitude data.

Different log files can have different annotations for the marks in the file, so by default, the report identifies the marks as Mark 1, Mark 2, Mark n...,and so on. You have the option of having the report identify the marks by using the annotations for the marks from the first file you open.

To compile a peak-excursion summary report:

1) Choose the menu item **Settings** > **Options**. The options dialog is displayed.
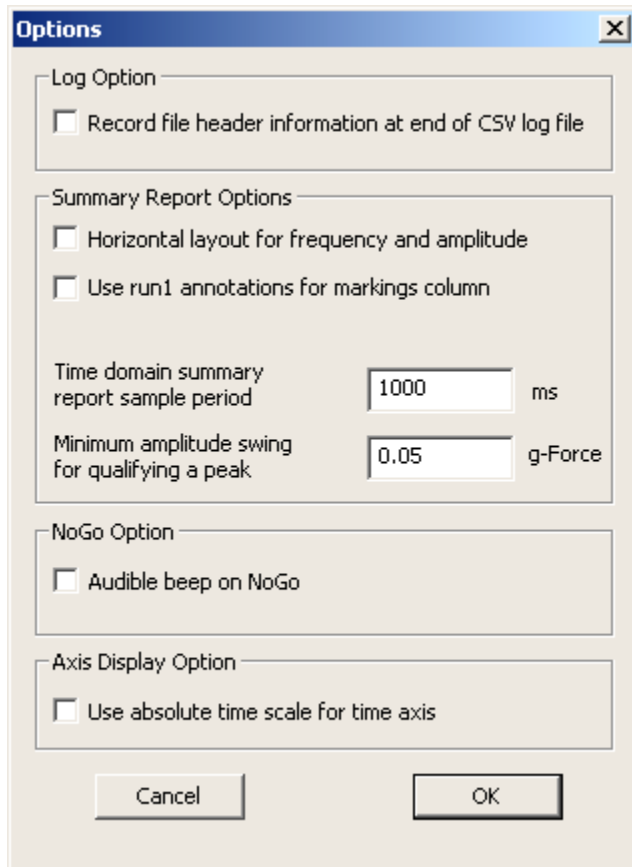
2) Follow steps 2–7, starting on page 89.

Compiling a Time-Domain Statistics Summary Report

A time-domain statistics summary report shows the slippage factor for each mark in each file. For each mark in each file, for the X, Y, and Z traces, the report also shows the following statistics: number of peaks, mean, maximum, minimum, standard deviation, and integral. The slippage factor is defined using the following formula.

$$\frac{\sqrt{x^2 + y^2}}{z}$$

For counting the number of peaks, you can have the report ignore small peaks by specifying the minimum amplitude swing that qualifies a peak to be counted. The statistics are computed at each mark in the file over a user-specified sample period beginning at the mark. Different log files can have different annotations for the marks in the file, so by default, the report identifies the marks as Mark 1, Mark 2, Mark *n*…, and so on. You have the option of having the report identify the marks by using the annotations for the marks from the first file you open.

To compile a time domain statistics summary report:

1) Choose the menu item **Settings** > **Options**. The options dialog is displayed—see page 89.

2) If you want the marks identified with the annotations for the marks in the first file you open, check the box **Use run1 annotations for markings column**. If you want the marks identified generically (Mark 1, Mark 2, Mark *n*…, and so on), clear the check box.

3) In the **Time domain summary report sample period** box, specify the sample period you want MultiReview to use in calculating statistics for each mark.

4) In the **Minimum amplitude swing for qualifying a peak** box, specify the minimum amplitude you want MultiReview to use for counting an amplitude change as a peak.

5) Click **OK**.

6) Choose the menu item **File** > **Create CSV File** > **Compile Summary Report** > **Time Domain Statistics**. The AMS log files dialog is displayed.

7) Select the files that you want to include in the report. To select a range of files, click the first filename and then shift-click the last filename. To select multiple files individually, use control-click. When you have selected all files, click **Open** and the CSV file dialog is displayed.

8) Enter a name for the time domain statistics summary report file and click **Save**. MultiReview compiles and saves the summary report. You can open the report in applications, such as Microsoft Excel, that can read CSV files.

Printing the MultiReview Window

You can print an image of the MultiReview window to have a graphical record of the session. To print an image of the MultiReview window:

1) Choose **File** > **Print**.

2) In the Print dialog, click **OK**. You can also select a printer other than the default and change the printer setup, or see a preview of what MultiReview will print.

- To select a different printer, change the paper selection or print orientation, or set printer properties, choose the **File** > **Print Setup** menu item.

- To see a preview of what MultiReview will print, choose the **File** > **Print Preview** menu item.

Using the Humidity Function

The humidity function allows you to measure both humidity and temperature at up to five locations (depends which model you bought) on the upper surface of the AMS, as shown below.
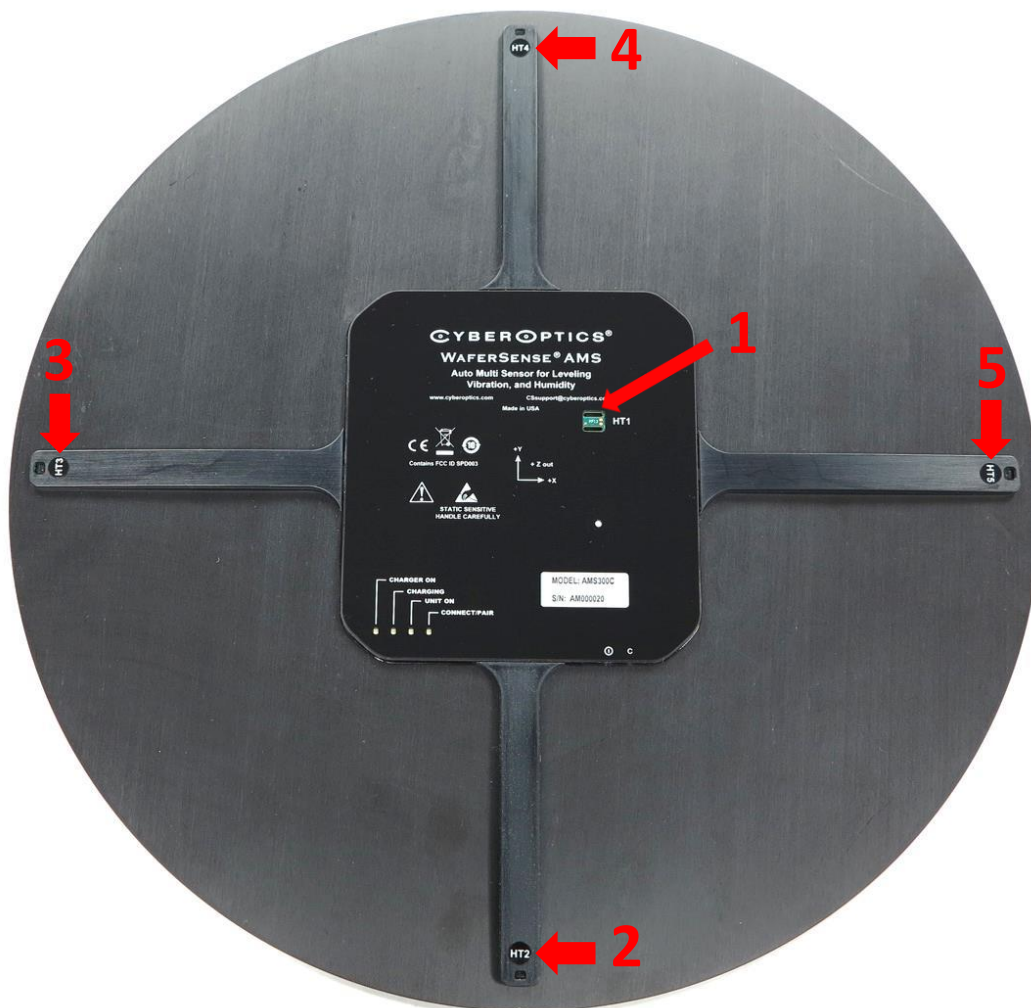
How the Humidity/Temperature Sensors Work

The following sections provide a detailed overview of how the humidity sensors in the AMS operate, and outlines some of the cautions you should be aware of, when recording and interpreting the RH readings generated by the AMS. In particular, please note that varying temperatures, high air-flow environments, and hysteresis can have significant effects on the RH readings.

General Principles

The AMS uses solid state MEMS humidity/temperature sensors. Each sensor contains a capacitive-type humidity sensor, a band-gap temperature sensor, and specialized analog and digital circuitry, all inside the IC package. The capacitor inside the sensor contains a polymer between the electrodes, which absorbs and desorbs water molecules as the relative humidity changes. The change in capacitance is translated into a relative humidity output by the internal circuitry. Each sensor is internally calibrated at the time of manufacture to be within 2% relative humidity over most of the 0–100% RH range. However, in order to increase accuracy, the AMS undergoes an additional calibration that corrects the factory calibration and extends it to lower RH values. Thus the internal sensor calibration is corrected via look-up tables in the AMS firmware. Then these values are displayed in MultiView.

Relative Humidity versus Absolute Humidity

Relative humidity (RH) measures the amount of moisture in the air relative to the maximum amount of moisture that can be held in the air at that temperature. Zero % (0%) RH means there is a negligible amount of moisture in the air. One hundred % (100%) RH means that the air cannot contain any more moisture before the moisture begins to condense. Relative humidity is extremely temperature sensitive. Hence the reason for including a very precise (± 0.3 °C accuracy) air-temperature sensor.

Absolute humidity measures the total amount of moisture in the air and is independent of the temperature. Absolute humidity can be specified in a number of ways: dew point, ppm on a volume basis, and ppm on a weight basis (kg/kg of dry air). Appendix A (see "Appendix A—Moisture Conversion Table" on page 136) contains a table that gives corresponding values for these units at room temperature. Appendix A also contains a psychrometric chart that allows you to convert humidity to dew point, vapor pressure, and the parts-per-million concentration of water on a volume or weight basis.

Effect of Temperature

As noted above, relative humidity can be extremely sensitive to the local air temperature. Assuming the air in a chamber all contains the same amount of absolute humidity, the relative humidity will vary greatly, if there is local heating of the air.

For instance, at 85% RH and 20°C, the dew point will be 17.4° C. If the air near the sensor is heated by only 1°C, the RH will change to 80% RH—a 5% RH change for just a 1°C change in temperature. At low RH the situation is somewhat better; a 1°C change in temperature at 10% RH only causes a 0.6 % RH change.

In order to record relative humidity accurately, the air temperature must be extremely uniform. The humidity/temperature sensors in the AMS should be shielded from any external heat source—such as a strong convective-flow of heated or cooled air, radiant heat, and any heat conduction into the AMS housing. The AMS humidity/temperature sensors are designed so that there is very little self-heating from the internal circuitry. In addition, the central AMS humidity/temperature sensor (labelled "HT1") that resides in the central housing, has constricted heat paths to the sensor in order to minimize heat conduction to the HT1 sensor from the other AMS internal electronics. Please note that the air-temperature sensor on the HT sensors will display a different temperature from the internal electronics temperature sensor.

Differences between Various AMS Models

There are at least 10 different AMS models that utilize the same basic electronics. Most of these models contain a single central humidity/temperature sensor designated as HT1. However, there is one model, the AMS-300C that contains four additional sensors near the edge of the AMS. The five humidity/ temperature sensors in the AMS-300C allow you to characterize a large wafer area for variations in humidity and temperature.

Storage and Handling of the AMS

Because of the polymer sensing element in the humidity/temperature (HT) sensors, the AMS requires special care in handling. Prior to calibration at CyberOptics, all the HT sensors are reconditioned to bring them back to their original, uniform response. This reconditioning consists of a mild bake out to 82 °C in order to evaporate any contamination hydrocarbons, followed by a re-hydration step at greater than 74% RH in order to return the polymer to its original hydrated state. Under normal operating conditions this reconditioning is not required again.

CAUTION. Do not place the AMS in close proximity to volatile chemicals such as solvents or other organic compounds. Also avoid exposure to ozone, acids and bases, and cleaning agents. Do not wipe the top surface of the AMS with IPA. In general, if a material emits a strong odor, it should not be used in close proximity to the HT sensors.

CAUTION. Do not direct strong air blasts into the HT sensors.

CAUTION. Store the AMS unit at a temperature of 10–50 °C and in the range of 20–60% RH. Short times (up to four hours) at RH levels outside of this range are acceptable. If the AMS is stored at RH levels outside of this range for longer than four hours, the AMS should be returned to an environment of 20–60% RH for 12 or more hours to return the AMS to its normal sensitivity and accuracy.

CAUTION. Do not store the AMS unit in polyethylene antistatic bags (light blue, pink, or rose color). If it is necessary to use tape in the vicinity of the HT sensors, use only Kapton Electrical Tape 92 manufactured by 3M.

Hysteresis and Long-Term Stability of the RH Readings

Almost all humidity sensors exhibit hysteresis. That is, the RH reading will vary depending on the recent exposure. Sensors with a dry history carry some negative offset, while sensors with a humid history carry some positive offset—that is, the reading will be slightly higher than the actual RH. The amount of hysteresis is roughly 1 %RH in the range of 40–80% RH, and smaller at RH levels above and below this range. The HT sensors are calibrated by starting at low RH values and moving upwards. So maximum accuracy is obtained by following the same procedure during measurement. Try to acclimate the AMS at RH levels lower than those expected during measurement. The long-term stability of the HT sensors is better than 0.25% RH per year, and for temperature is better than 0.03°C per year.

Relative Humidity Measurement Range

The AMS RH sensors are calibrated in the range of 2–85% RH. In the 0–2% RH range the sensors will output the same "zero" reading, indicating that the actual RH is in this range. Above 85% RH the sensor will output readings that may not be as accurate as those below 85% RH.

Response Time

The AMS RH sensors have an inherent response time of eight seconds. That is, with a sudden step change in RH level, the sensor will respond with a reading of 63% of the step within eight seconds. However, this sudden change of RH level is difficult to achieve, except in special test setups. It is very difficult in most "real world" situations to totally change the air in a chamber in this short amount of time. So, the AMS HT sensors will almost always be faster than the change in the air environment.

The HT1 Sensor and Its Thermal Environment

Because RH sensors are so dependent on the thermal environment, it is often necessary to correct the RH reading to account for heating around the sensor. One such case occurs in the AMS, because the central (HT1) humidity/temperature sensor is in close proximity to the AMS electronics. CyberOptics has taken great precautions to isolate the HT1 sensor as much as possible from its surroundings. The heat path to HT1 has been constricted via slots in the PCB. The air around HT1 is totally isolated from the air inside the AMS electronics cavity. However, there is still a 0.8°C temperature difference between the air near HT1 and the outside surrounding air. The AMS unit was calibrated with this 0.8°C offset, since this offset is the normal long-term environment for the sensor.

Shown below is a correction graph for HT1. The other satellite HT sensors on the AMS-300C do not need to be corrected, since they are far away from internal heat sources. In the following circumstances, you should correct the MultiView reading on the HT1 sensor by adding the correction to the indicated RH reading.

The following circumstances require correction.
- When the AMS has been on for only a short period of time (less than 20 minutes).
- When the AMS is in rapidly circulating air.
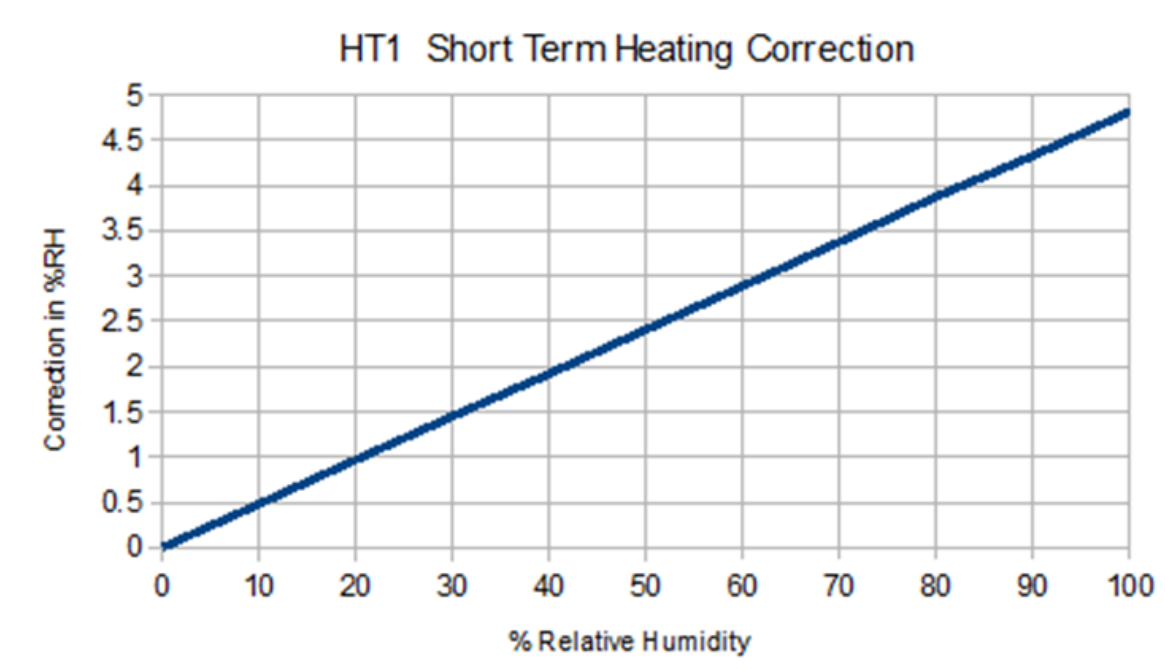
Factors to Consider When Making Humidity Measurements

If you are using the 300 mm WaferSense AMS (see page), which has five humidity/temperature (HT) sensors, please note that the HT1 sensor is near the center of the wafer (close to the warm electronics), but the other four sensors (HT2 through HT5) are on the cooler periphery of the wafer. As a result, the HT1 sensor usually returns a higher temperature reading than HT2–HT5, and—the key point here—also returns a lower RH reading than the other sensors, as shown in the figure below.
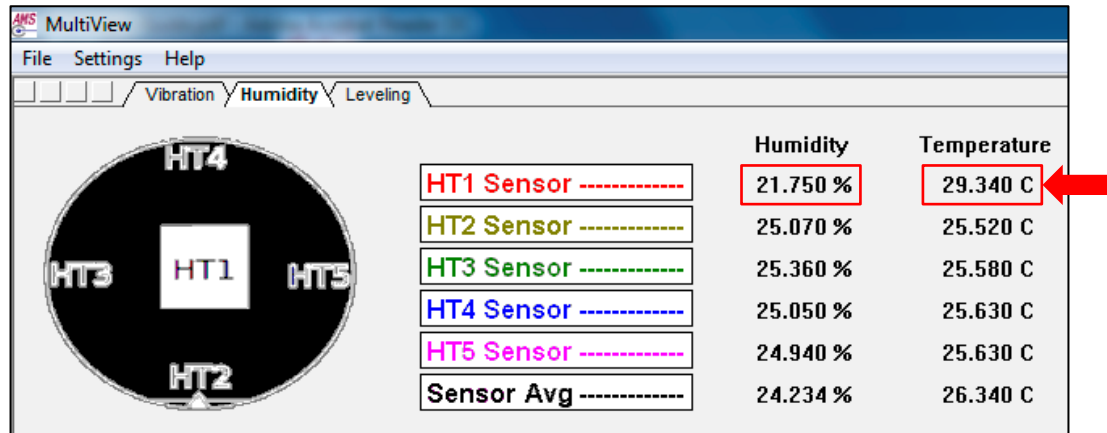
The sections below, tell you how to do the following.

- Set Go/No-Go Tolerances for humidity

- Set Triggers for humidity

- Access other humidity menus and functions

Setting Go/No-Go Tolerances

To set Go/No-Go tolerances, do the following.

1) Open MultiView and click the **Humidity** tab.
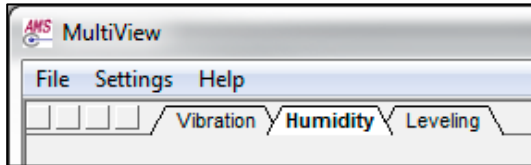
2) Choose the **Settings** > **Set Go/No-Go** menu item.
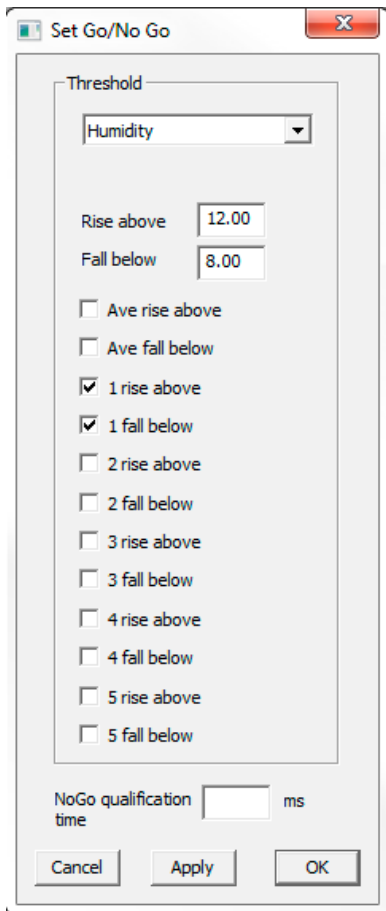
MultiView populates the **Set Go/No-Go** dialog with the default values (12.00 and 8.00).

3) Enter the appropriate values in the **Rise above** and **Fall below** data-entry box. (If your AMS has additional HT sensors, check the HT2–HT5 boxes, if you want to set tolerances for these sensors.)

4) Click **Apply** to save your entries.

5) Click **OK** to close the dialog.

Setting Triggers

See page .

Using Other Humidity Menus and Functions

Here's how to get information about other Humidity menus and functions

File Menu

- Select Log Directory —see page 60
- Open Settings —see page 60
- Save Settings —see page 40
- Print —see page 26
- Print Preview —see page 26
- Print Set-Up —see page 26
- Exit —select Exit to close the MultiView software

Settings Menu

- Show Annotation Dialog —see page 55
- Set Go/No-Go tolerances —see page 99
- Set Triggers —see page 35
- Set Station Information —see page 38
- Select Colors —see page 68
- Options —see page 48

Help Menu

- Display On-Line Manual —select to display the AMS manual
- Register WaferSense AMS —see page 16
- About Your AMS Wafer —see page 19
- About AMS View —see page 19

MultiReview

- Using MultiReview —see page 73

Using the Leveling Function

The AMS uses electronic inclinometer technology to give you more precise and efficient inclination measurements than is possible using the human eye or traditional bubble levels. The large leveling screen shown in the MultiView allows you to quickly and precisely adjust the robots and other components in your manufacturing process.

The leveling function allows you to make inclination measurements in the horizontal plane.

Using Your AMS

This section tells you how to do the following.

- Open the leveling function

- Use the AMS leveling wafer buttons and indicators

- Perform horizontal inclination measurements

- Perform vertical inclination measurements

- Log your readings

Opening the Leveling Function

1) Locate the **Leveling** tab in the top-left corner of the MultiView opening screen.
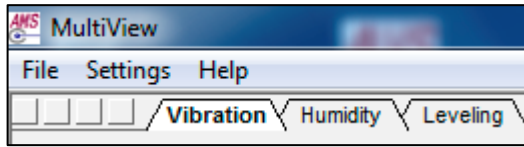
2) Click the **Leveling** tab and the following screen appears. Wait while the system initializes.
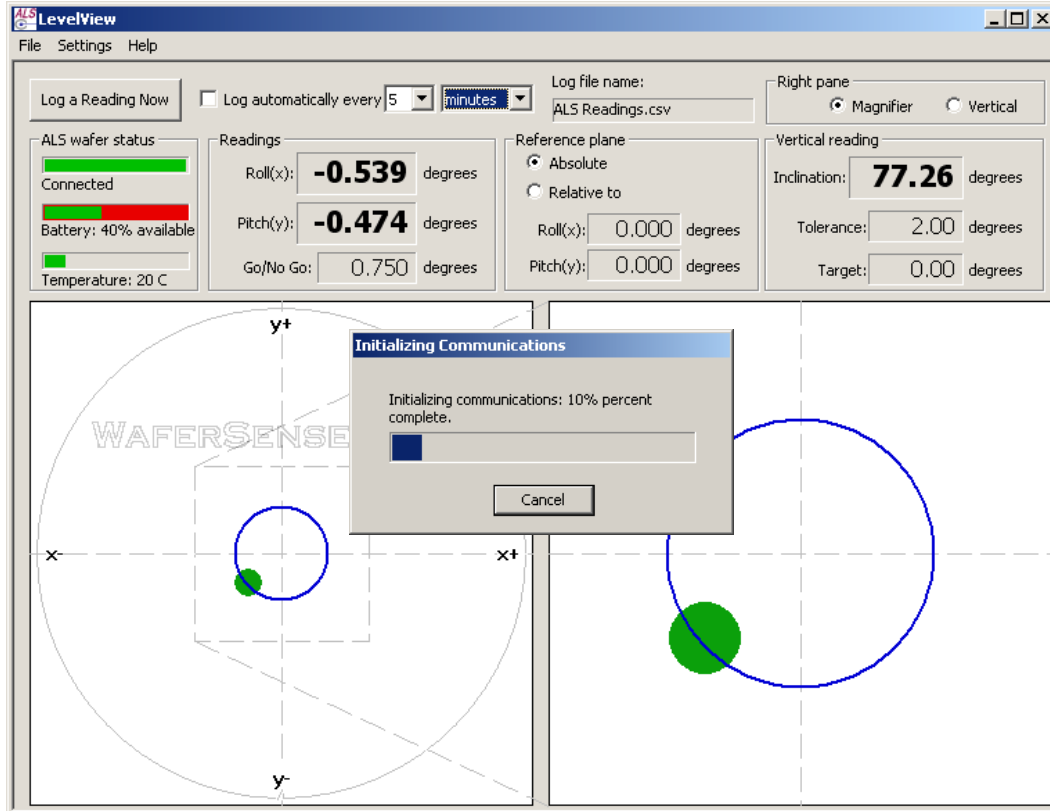
Performing Horizontal Inclination Measurements

MultiView shows the angle of inclination for horizontal measurements using two types of readouts (see figure below).

- Graphical readouts that mimic bubble levels.

- Numeric readouts that show inclination in two dimensions. MultiView updates the readings several times per second, so you see any changes in real time.

The left bubble-display (see figure below) shows a representation the whole AMS wafer, and the right shows a magnified view that allows you to make very precise leveling adjustments.

Figure 4. Whole Disk Bubble and Magnified Bubble Display

Whole Disk Bubble Display   Magnified Bubble Display
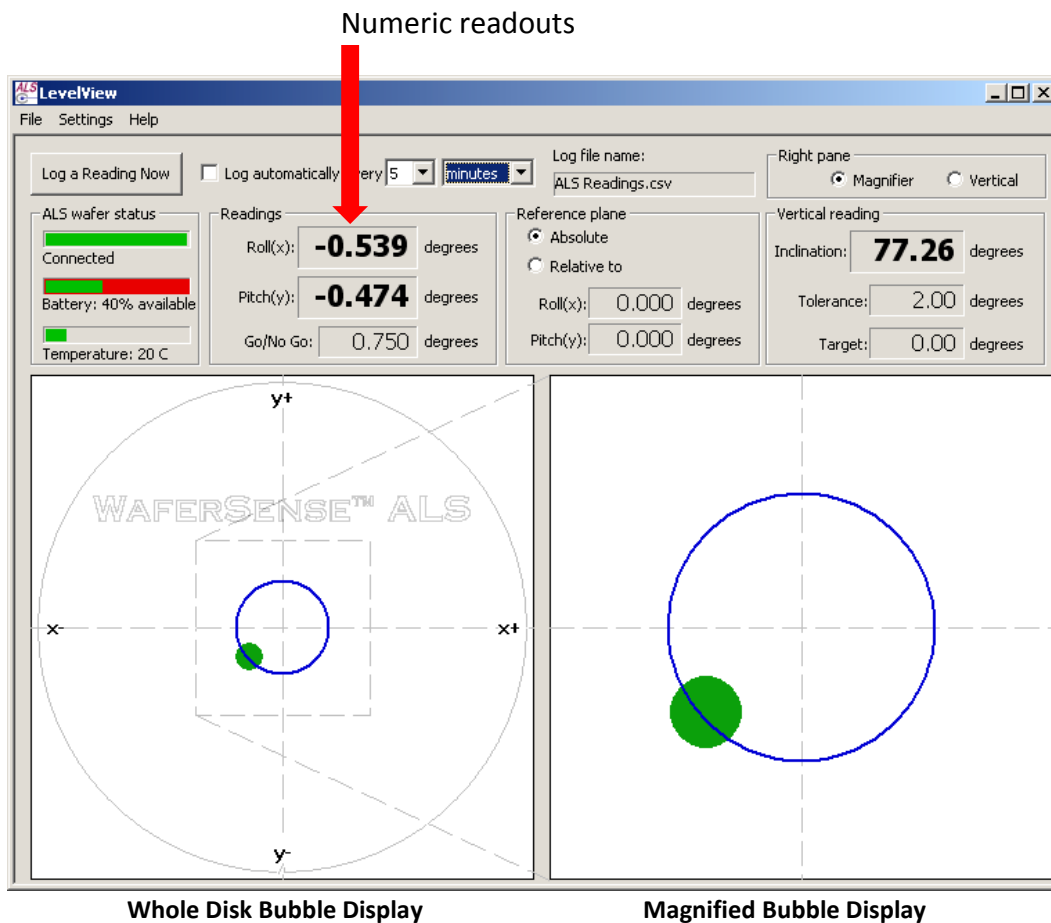
To perform a basic inclination measurement:

1) Make sure the computer running the MultiView application is within the range of the link module, about 30 ft (10 m).

2) In the MultiView window, for Right pane, choose Magnifier.

3) Place the leveling wafer on the equipment you want to check. Align the leveling wafer so it matches the MultiView display by doing the following.

    - Rotating the AMS until logo is right-side up.

    - Depending the model you are using, rotating the AMS so the notch is *pointing toward you* as you view the AMS, or the flat side of the AMS is to the *left* as you view the AMS, as shown in the figure below.

**Figure 5. Orienting the AMS**
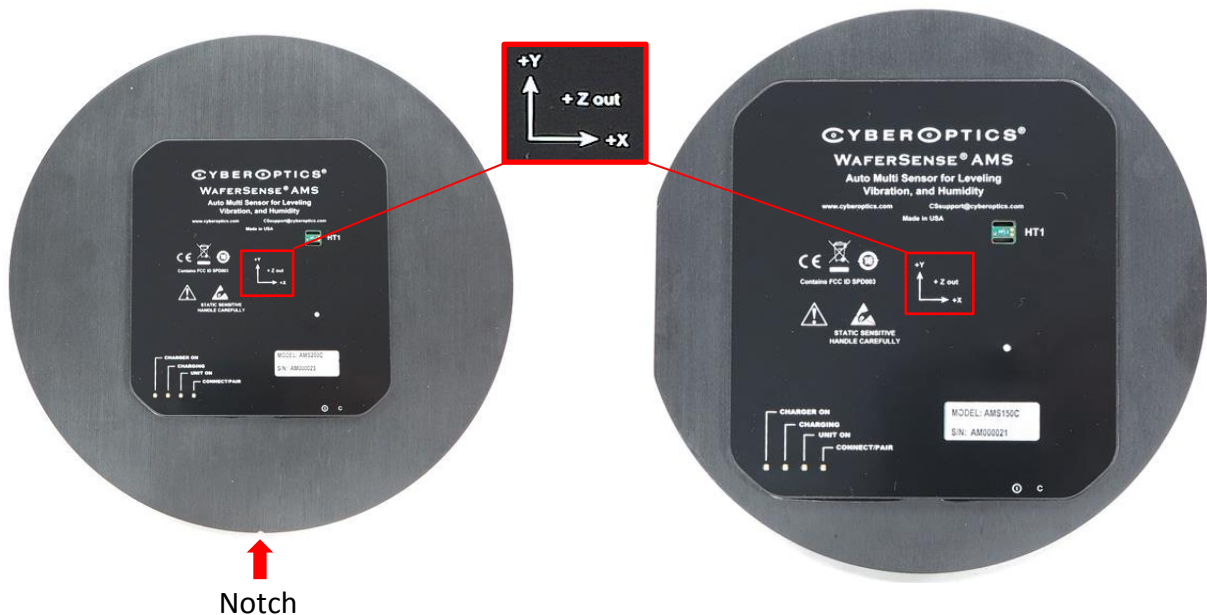
Notch

When you move the leveling wafer, the readings typically need some time to stabilize. The bubble displays and numerical readouts are shaded during this stabilization period. For ALS1 systems, a message in the left bubble display counts down the seconds (see the figure on the next page). Whenever the leveling wafer detects movement, MultiView restarts the stabilization countdown. For ALS1 systems, you can set the length of the stabilization period and the sensitivity that triggers the countdown (see "Setting the Stabilization Criteria" on page 109). For ALS2 and ALS2 Vertical wafers, MultiView determines the necessary stabilization time automatically. You can't set the stabilization criteria for ALS2 or ALS2 Vertical wafers.

Countdown for stabilizing the readings
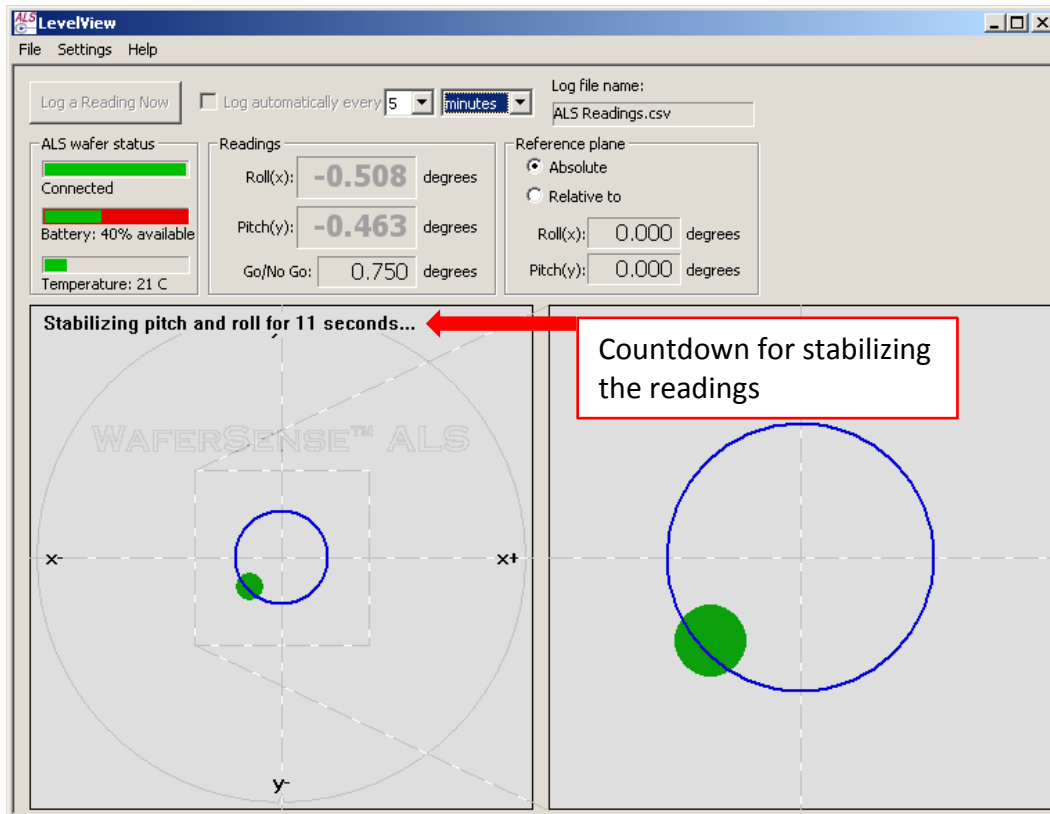
4) The numeric readouts and bubble displays indicate the inclination of the leveling wafer.

- The **Horizontal readings** (see figure below) can be displayed using different units and different conventions for measuring the inclination. For more information, see "Choosing Display Units and Conventions" on page 106.

  Readings outside the working range of the leveling wafer are displayed as ####. Readings within the working range, but beyond the range where readings meet the specified accuracy, are shown in gray. MultiView always displays a fixed number of decimal places for readings, which might not reflect the actual accuracy of the measurement. For information on the accuracy of the readings, see "Specifications" on page 127.
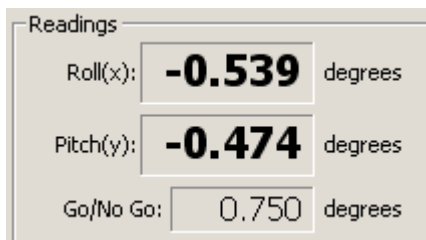
- The **bubble level** displays (see the figure on the next page) show the inclination graphically in real time. In both displays, the solid green circle represents inclination as a bubble in a bubble level would. The blue circle indicates the Go/No-Go tolerance, which you can adjust (see "Setting the Go/No-Go Tolerance" on page 110). In the left display, the perimeter represents the maximum inclination reading in the specified accuracy range of the wafer, which depends on the wafer model (see "Specifications" on page 127). The display on the right is a magnified view showing just the area within the dashed magnifier square of the display on the left. The size of the magnifier square adjusts to keep the bubble in the right display visible.

Go/No-Go circle

Bubble
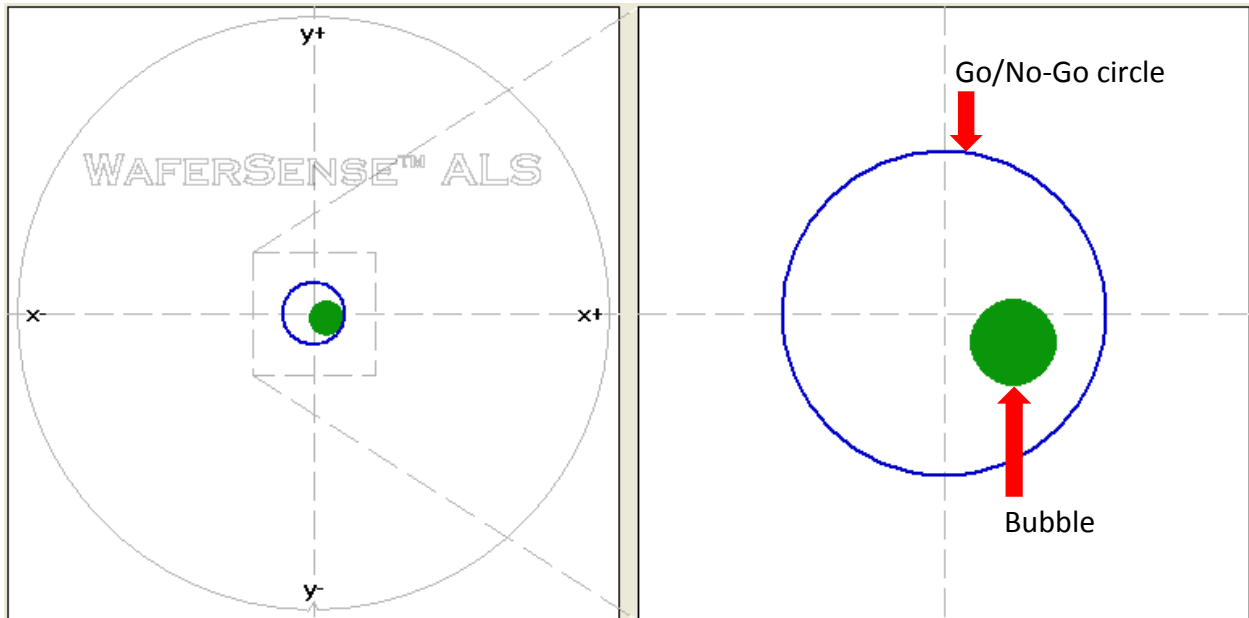
Choosing Display Units and Conventions

By default, MultiView displays horizontal readings in degrees using the roll and pitch convention. You can choose different conventions and also different units.

Conventions for Horizontal Inclination

For displaying horizontal inclination, you can choose between the Cartesian roll and pitch convention and the polar magnitude and direction convention.

- Cartesian **Roll** and **Pitch** (see figure below) indicate the inclination angle in two dimensions. Assuming you aligned the WaferSense™ AMS logo as described above (see page 104), **Roll** indicates side-to-side tilt, and **Pitch** indicates front-to-back tilt. If the front edge is higher than the back, or the right edge is higher than the left, the readings are positive.
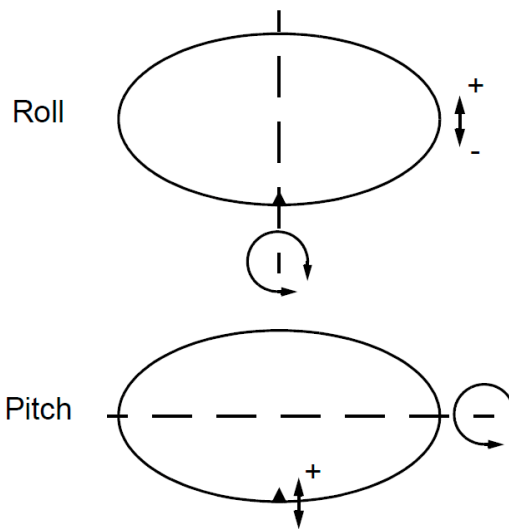
The precision of displayed readings depends on the units you choose. For example, readings in degrees are displayed to three decimal places. However, that doesn't mean that the readings are accurate to 1/1000ths of a degree. In general, you can't assume that readings are accurate to all displayed decimal places. For information on the accuracy of the readings, see "Specifications" on page 127.

- Polar **Magnitude** and **Direction** indicate the angle of inclination in the direction of maximum inclination. In the figure below, the highest point on the edge of the wafer is indicated by the arrow, **Direction** is the angle the arrow makes with the x-axis, and **Magnitude** is the angle between the wafer and the horizontal (or reference) plane. Direction is measured counter-clockwise from the x-axis and is always positive. **Magnitude** is also always positive.
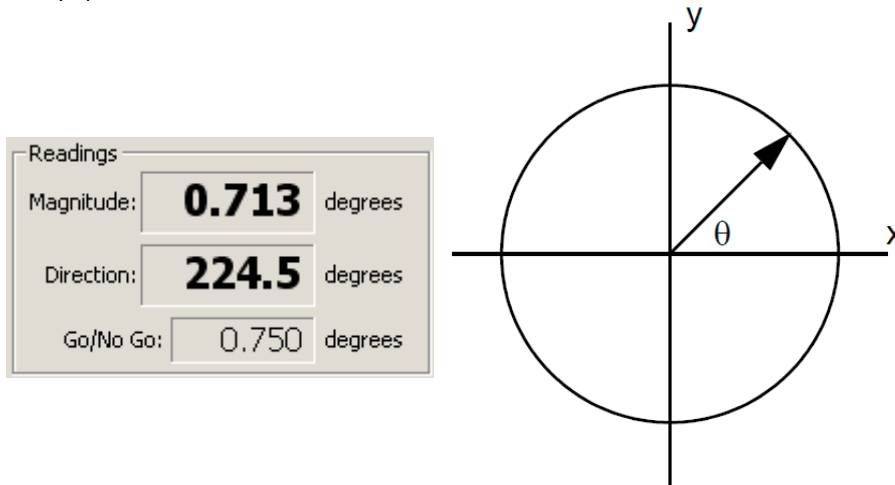
Display Units for Horizontal Inclination

Horizontal inclination angles can be displayed in degrees or milliradians (mradians), or as rise over run. Rise over run is the vertical height of a point on the edge of the wafer relative to the center of the wafer (rise over radius) or relative to a point on the opposite edge (rise over diameter), as shown below.

Rise over Radius   **Rise over Diameter**
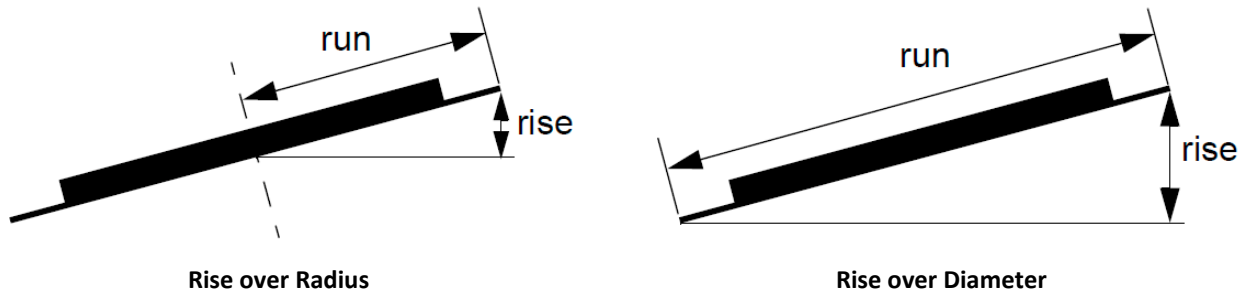
In addition to choosing whether to display the measured rise over the radius or diameter of the wafer, you can also choose to display the value in either inches or millimeters:

- **mm/r**   Millimeters of rise over the radius.

- **in/r**   Thousandths of an inch of rise over the radius.

- **mm/d**   Millimeters of rise over the diameter.

- **in/d**   Thousandths of an inch of rise over the diameter.

Setting Display Units and Conventions

To set the units and conventions used to display horizontal inclination:

1) Choose the menu item **Settings > Set Display Units** (on the ALS2 Vertical, choose **Set Horizontal Units**). The Set Display Units (or Set Horizontal Units) dialog is displayed, as shown in the figure below.
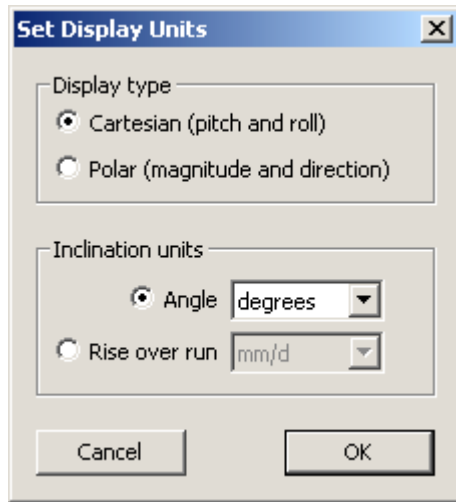
2) For **Display type**, if you want pitch and roll angles displayed, choose Cartesian; if you want the direction and magnitude of maximum inclination displayed, choose Polar.

3) For **Inclination** units, choose either **Angle** or **Rise over run** and then select the units. If the **Rise over run** choice isn't available, MultiView isn't connected to a leveling wafer. After you turn on the wafer and establish a connection, you can make that selection.

4) To save your settings, click **OK**.

Note: You can also set the display units and conventions in the dialog used to set the Go/No-Go tolerance. The result is the same using either dialog. For more information, see "Setting the Go/No-Go Tolerance" on page 110.

Setting the Stabilization Criteria

When you move the leveling wafer, the readings typically need some time to stabilize. The bubble displays and numerical readouts are shaded during this stabilization period. The length of time that the readings need to stabilize depends on the type of leveling wafer, the operating conditions, and your required tolerance for stability. For ALS2 and ALS2 Vertical wafers, MultiView determines the necessary stabilization time automatically. You can't set the stabilization criteria for ALS2 or ALS2 Vertical wafers, so this section applies only to ALS1 systems.

The default stabilization time (20 seconds) and stabilization sensitivity (0.01 degrees) provide for the maximum stability. These default settings yield the most accurate measurements for all types of situations. However, when the position of the leveling wafer changes only a small amount between successive measurements, you can adjust these settings so that you can work more quickly, without sacrificing accuracy.

To specify the stabilization criteria:

1) Choose the menu item **Settings > Set Stabilization Criteria**. The Set Stabilization Criteria dialog is displayed, as shown below.
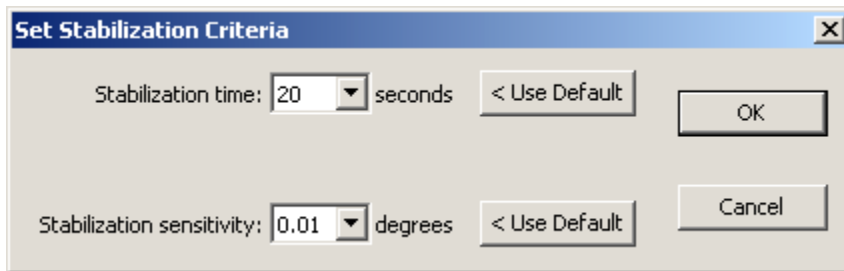
2) In the **Stabilization time** list, choose the number of seconds you want MultiView to pause to allow readings to stabilize, or click **Use Default** to reset the time to the default 20 seconds.

3) In the **Stabilization sensitivity** list, choose the fraction of a degree in pitch or roll movement that you want to trigger MultiView to restart the stabilization counter. To reset the value to the default, click **Use Default** to reset the sensitivity to 0.01 degree.

4) Click **OK**.

Setting the Go/No-Go Tolerance

The Go/No-Go tolerance sets the diameter of the blue circle in the center of the bubble displays. This circle makes it easy to see when you have leveled a piece of equipment to within an acceptable tolerance. When the center of the bubble is within the Go/No-Go circle, the bubble is green, indicating that the reading is within your specified tolerance. When the center of the bubble reaches or passes the edge of the Go/No-Go circle, the bubble changes to red to indicate the reading exceeds your specified tolerance. When the readings are beyond the specified accuracy range of the sensor, the bubble is pinned against the edge of the display area, and the color of the bubble changes to amber.
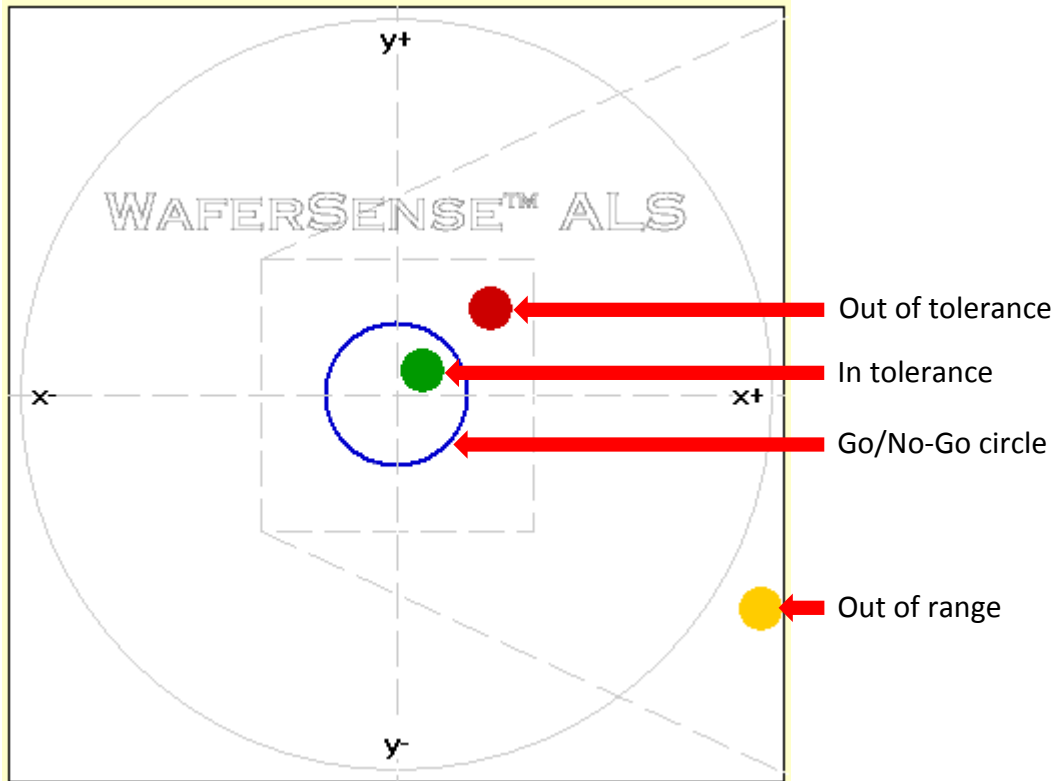
To change the Go/No-Go value:

1) Choose the menu item **Settings > Set Go/No-Go Tolerance**. The Set Go/No-Go Tolerance dialog is displayed.

2) Specify the **New Go/No-Go** tolerance and click **OK**.

You can set the tolerance to any value in the range 0.05 to 3.8 degrees. However, if you are using a reference plane (see the next page), the maximum value is less than 3.8 degrees. You can't set a tolerance that would extend the Go/No-Go circle beyond the edge of the left bubble display area. If you try to set a value that is too large or too small, MultiView prompts you to enter a value that is within the correct range.

You can also set the Horizontal display type and inclination units in this dialog. For more information on these settings, see "Choosing Display Units and Conventions" on page 106.

Specifying a Reference Plane

By default, the leveling wafer indicates absolute degrees of inclination, which is relative to a plane perpendicular to the direction of the earth's gravitational force. You can specify a different reference plane, and the leveling wafer will indicate degrees of inclination relative to that plane.

To specify a reference plane:

1) Place the leveling wafer on the surface that you want to use as your reference plane.

2) Choose the menu item **Settings > Set Reference Plane**. The leveling wafer takes the current absolute inclination readings as offsets to the new relative plane. The offsets are displayed in the Horizontal reference plane readouts.
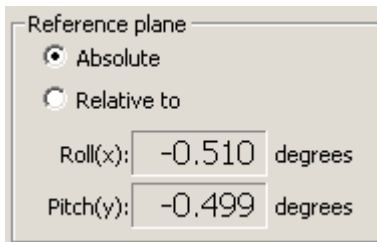
3) Select the **Relative to** option above the Horizontal reference plane readouts.

You can switch the leveling wafer between indicating absolute and relative inclination by clicking the corresponding option button (see the figure above). Switching between **Absolute** and **Relative to** does not affect the current offsets for the reference plane inclination angles; MultiView retains the last offsets until you change them.

When you specify a reference plane and set MultiView to display **Relative to** that plane, the coordinate axes of the left bubble-display shift within the display area, as shown below.
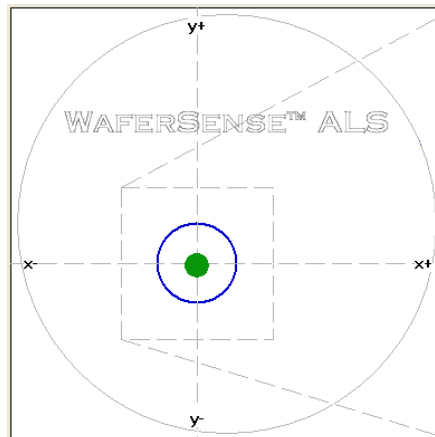
This shift in the axes reflects the fixed range of the leveling wafer relative to absolute level. For a leveling wafer that has a range of -4 degrees to +4 degrees from absolute level, if you set a reference plane at -2 degrees absolute pitch, the range of the leveling wafer relative to that reference plane is -2 degrees to +6 degrees pitch. Shifting the center of the bubble display to the left accurately represents the new range of the leveling wafer relative to the reference plane. For more information on the working range of different models, see "Specifications" on page 127.

Calibration for zero point drift (Field Calibration)

The zero point of the electronic inclinometers used in the AMS can drift slightly over time. If you use absolute level as your reference plane, you might want to calibrate for zero-point drift occasionally. You can perform this calibration in your own facility by using the calibration routine built into the MultiView application. If you work relative to a reference plane other than absolute level, zero point drift won't affect your measurements, and you don't need to perform this calibration procedure. In the following procedure for calibrating the zero point of the AMS, the software instructs you to place the leveling wafer on a flat, level surface. The software takes an inclination reading, instructs you to rotate the leveling wafer in place 180 degrees, and then takes a second reading. The two readings are used to set the new zero point. It is important that the center of the leveling wafer is in the same position on the surface before and after you rotate the leveling wafer. Most surfaces are not perfectly flat, so moving the leveling wafer while rotating it can affect the accuracy of the calibration. The procedure, therefore, instructs you to place marks on the surface at four points around the outside edge of the leveling wafer. You can use these marks to rotate the leveling wafer without moving it off center relative to the first calibration reading.


Caution

Performing a zero-point calibration improperly can actually cause the AMS to produce absolute level readings that are less accurate than readings from the AMS prior to the zero-point calibration. This is likely to be true if the surface used for the calibration is not sufficiently stable and flat. To remove a zero-point field calibration, run the zero-point calibration procedure again and click **Reset to Factory Default** in the first step of the procedure.


To calibrate your AMS using MultiView:

Locate a surface large enough to hold the AMS and having the following characteristics:
- Level to within about 1 degree.
- Stable enough to ensure that the inclination of the surface does not change during the procedure.
- Sufficiently smooth and flat that the inclination readings of the AMS don't change if you move the AMS slightly in any direction.
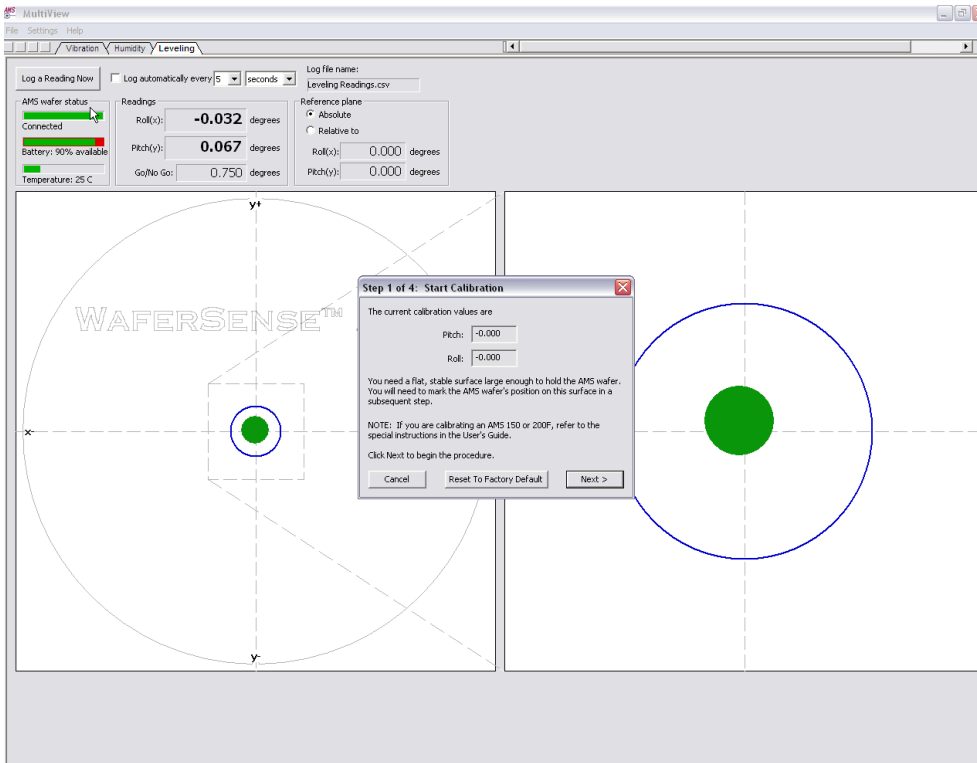
If the surface doesn't meet these requirements, it might introduce an error in the calibration results.
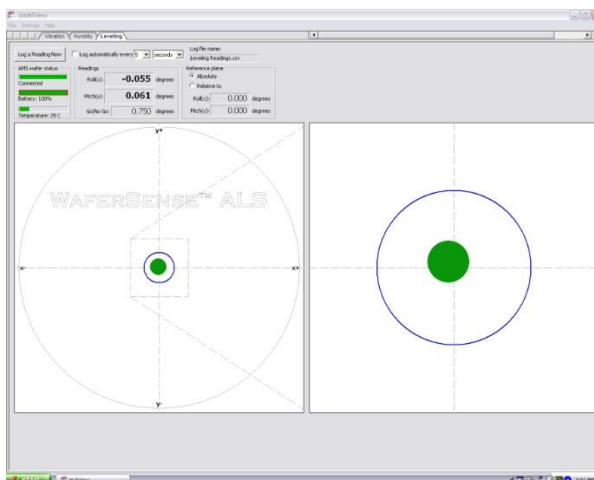
1. Choose the menu item **Settings > Calibrate**.
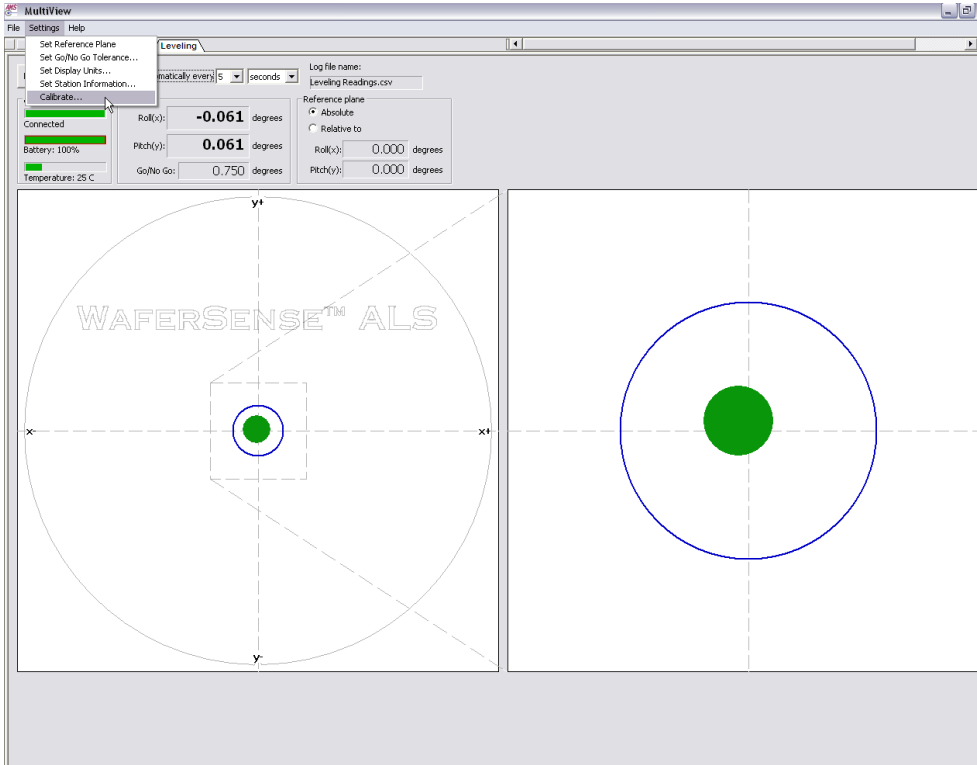
The Field Cal Wizard will pop up and show any existing field Cal values.

This dialog displays the current calibration values. If you haven't calibrated the AMS since the last factory calibration, both values are zero. Clicking **Reset to Factory Default** changes the calibration values to the values set when the leveling wafer was last calibrated at the factory.

2. Allow the Pitch and Roll values to stabilize (around 30 seconds) and then hit **Next**.
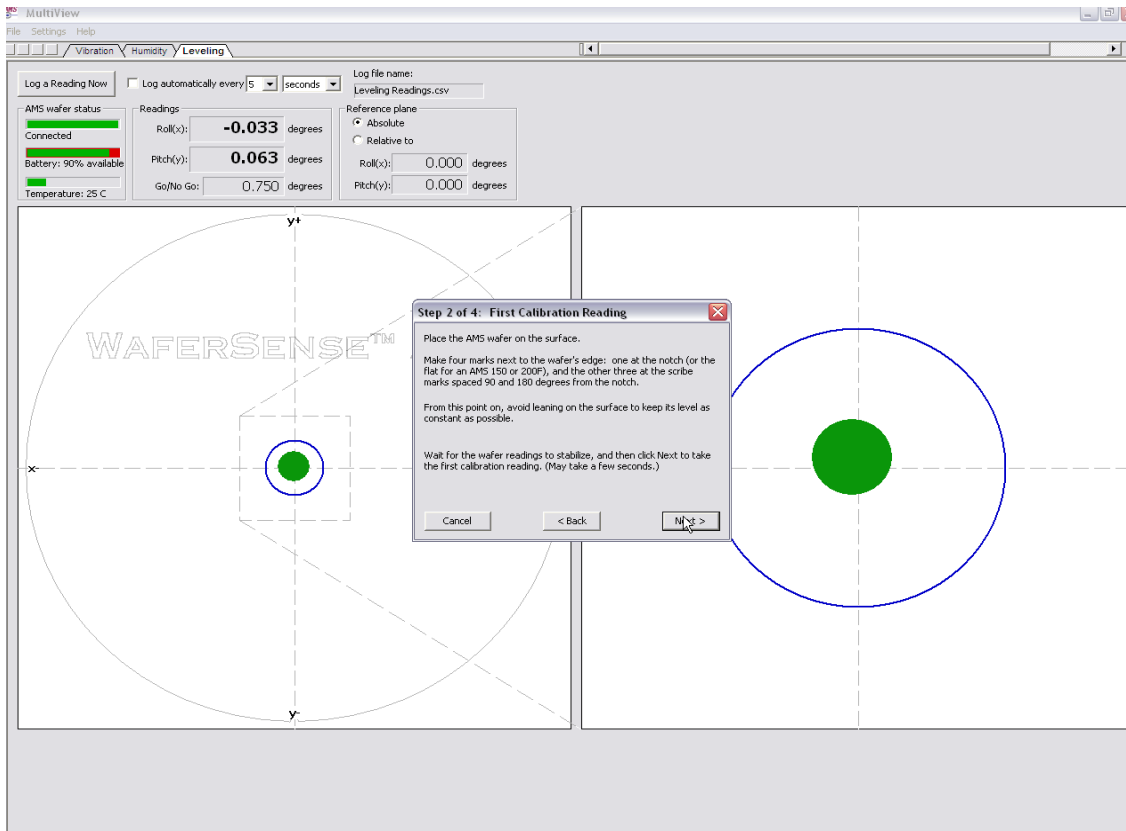

This step calls for marking the position of the AMS on the reference surface. For 300mm or 200mm wafers with notch, place a mark on the surface (or on tape on the surface) next to the edge of the AMS at the notch. Place three additional marks on the surface next to the edge of the AMS at the scribe marks that are 90 degrees, 180 degrees, and 270 degrees from the notch or flat side. Always mark all four positions.
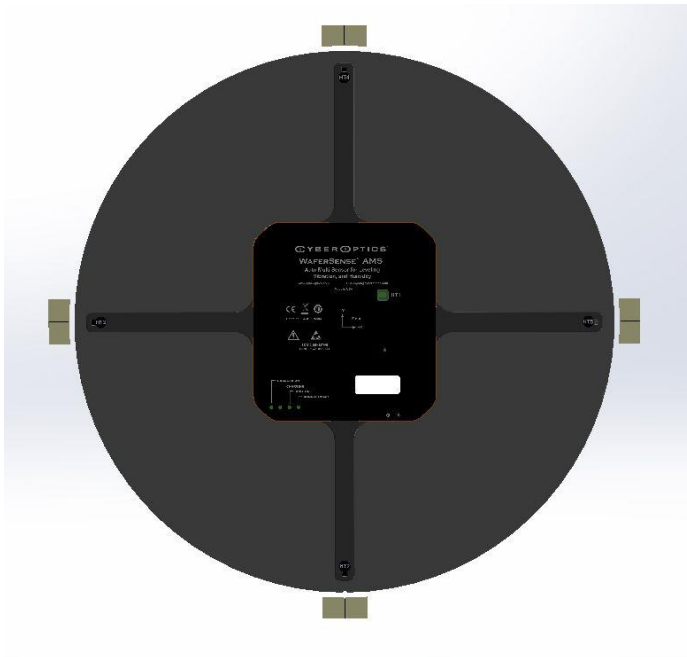
3. Wait for the AMS readings to stabilize and then click **Next** to take the first calibration reading.

After a few seconds, the wizard displays the Step 3 of 4 Second Calibration Reading Dialog.
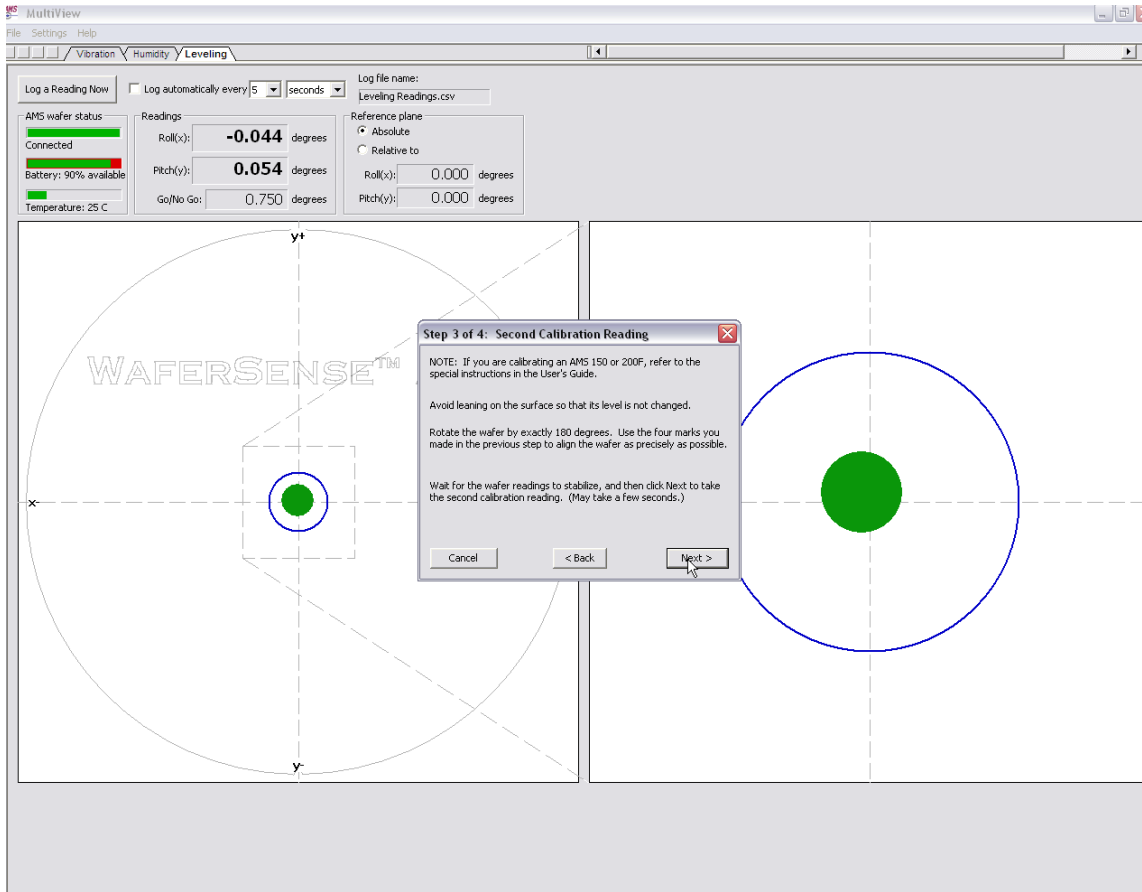
Rotate the AMS 180 degrees and align the AMS with the four marks you made in the earlier steps, as shown below. Be sure to line up all four marks, so that the rotated AMS is as close as possible to the same position it was in when you took the first calibration reading.
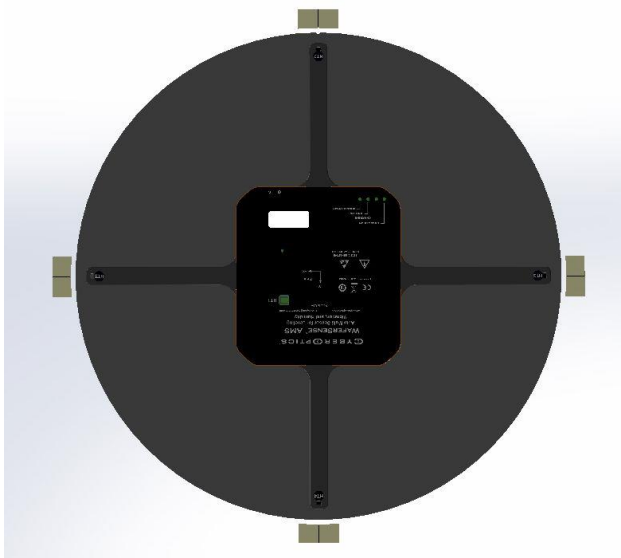
4. Click **Next** to take the second calibration reading.
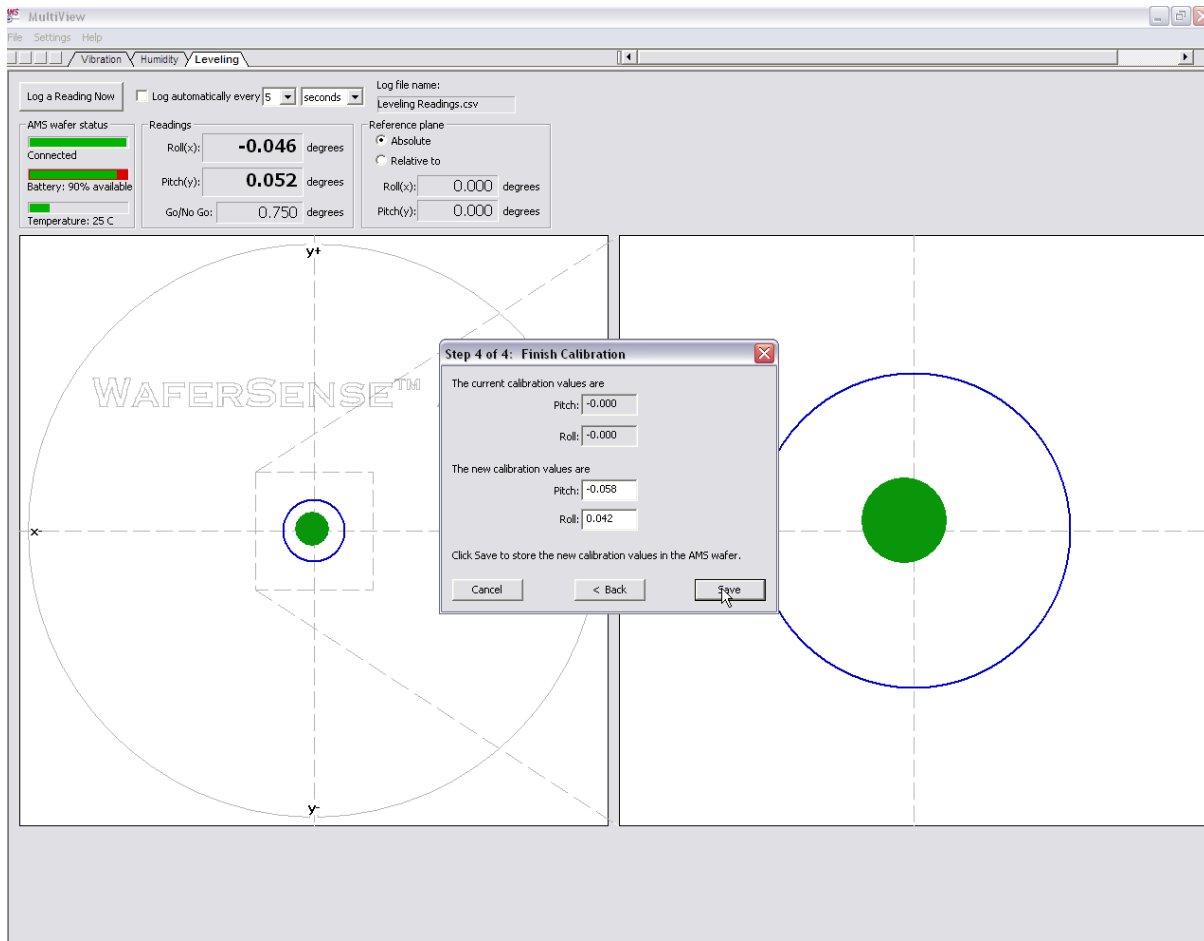
If the new calibration offsets are too large (> 0.5 degrees) for your AMS to operate reliably, a dialog displays telling you to contact customer support at CyberOptics.

If the new calibration offsets are within the allowed limits, the wizard displays the
Step 4 of 4 Finish Calibration dialog, as shown above.

Click **Save** to save the new calibration values. That completes the zero-point calibration.

Viewing Leveling Log Files

The MultiReview application lets you view log files that you previously recorded using MultiView. This section gives you instructions for performing the following tasks with MultiReview:

- Running MultiReview

- Choosing display units and conventions

- Temporarily changing the Go/No-Go tolerance

- Temporarily changing the vertical tolerance and target

- Changing log files

- Displaying station and wafer information

- Printing the MultiReview window

This section assumes that you are familiar with the information in "Using Your AMS" starting on page 21.

Running MultiReview

To view a log file:

1) From the Windows **Start > All Programs** menu, choose **WaferSense AMS > MultiReview**.

2) The MultiReview application starts. Click the **Leveling** tab.

3) From the **File** menu, choose **Open Log File**. The AMS Log File dialog is displayed.

4) Choose a log file and click **Open**. MultiReview opens the log file and displays the data for the first entry in the file (see figure below).
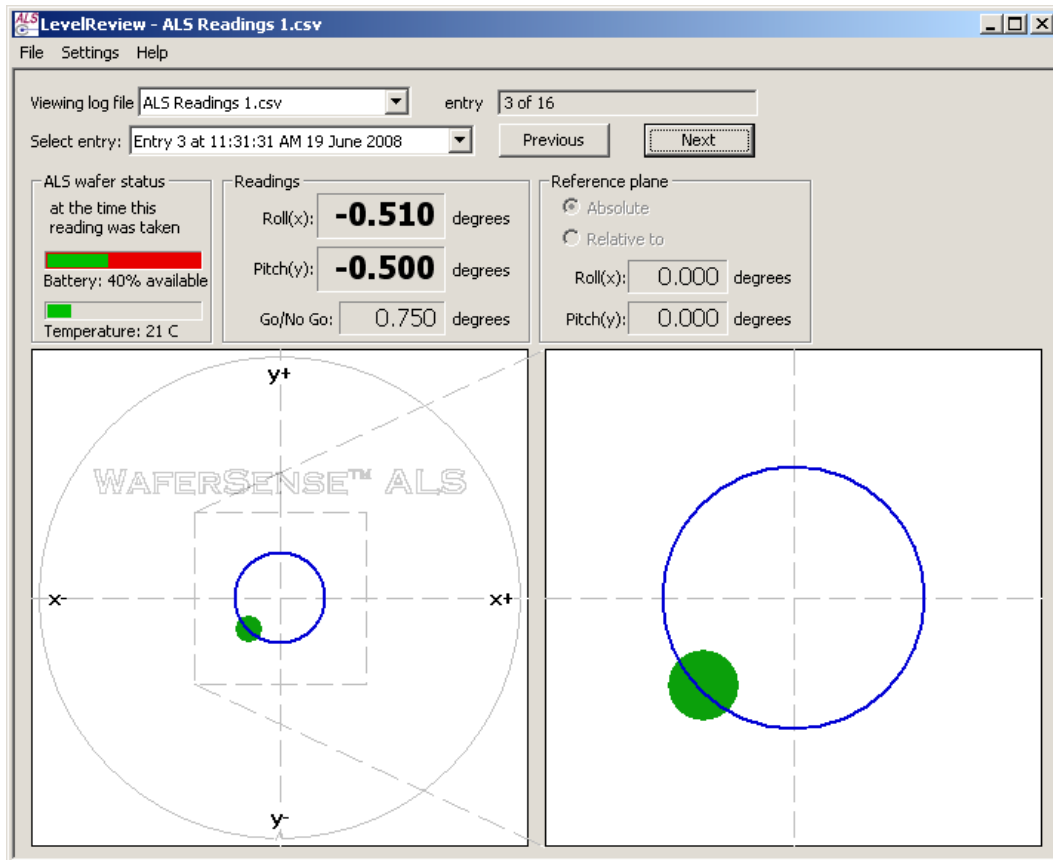
5) To view the data for a different entry in the log file, use the **Next** and **Previous** buttons, or choose an entry from the **Select entry** list.

Choosing Display Units and Conventions

By default, MultiReview displays horizontal readings in degrees using the roll and pitch convention. You can choose different conventions and also different units.

Conventions for Horizontal Inclination

For displaying horizontal inclination, you can choose between the Cartesian roll and pitch convention and the polar magnitude and direction convention. For more information, see "Choosing Display Units and Conventions" on page 106.

Display Units for Horizontal Inclination

Horizontal inclination angles can be displayed in degrees or milliradians (mradians), or as rise over run. For more information, see "Choosing Display Units and Conventions" on page 106.

Setting Display Units and Conventions

To set the units and convention used to display horizontal inclination:

1) Choose the menu item **Settings > Set Display Units** (on the ALS2 Vertical, choose **Set Horizontal Units**). The Set Display Units (or Set Horizontal Units) dialog is displayed, as shown below.
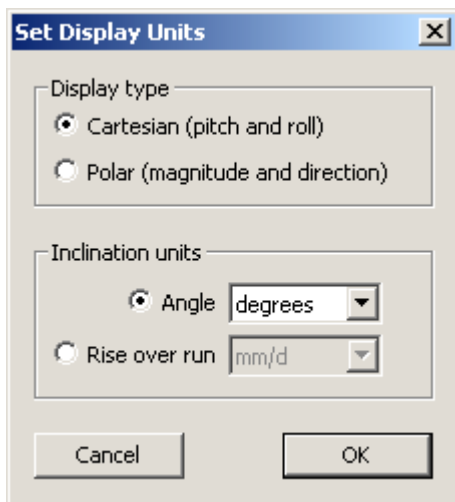
2) For **Display type**, if you want pitch and roll angles displayed, choose **Cartesian**; if you want the direction and magnitude of maximum inclination displayed, choose **Polar**.

3) For **Inclination units**, choose either **Angle** or **Rise over run** and then select the units.
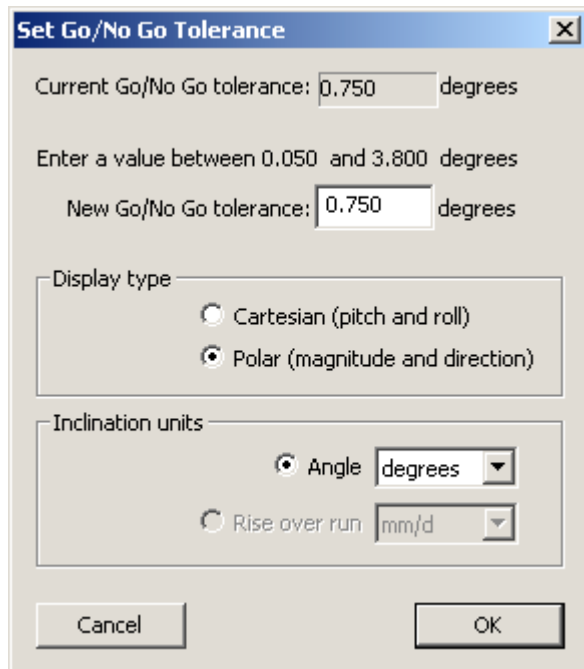
4) To save your settings, click **OK**.

You can also set the display units and conventions on in the dialog used to set the Go/No-Go tolerance. The result is the same using either dialog. For more information, see the next page.

Temporarily Changing the Go/No-Go Tolerance

The Go/No-Go tolerance in effect at the time a log file entry is made is recorded in the log file as part of the log entry. That value is used when you first display an entry from the log file. You can temporarily change the Go/No-Go tolerance for the entry you are currently viewing. However, as soon as you select a new entry from the log file, the Go/No-Go tolerance displayed reverts to that of the log file entry.

To temporarily change the Go/No-Go tolerance:

1) Choose the menu item **Settings > Set Go/No-Go Tolerance**. The Set Go/No-Go Tolerance dialog is displayed, as shown below.

2) Specify the **New Go/No-Go tolerance** and click **OK**.

You can set the tolerance to any value in the range 0.05 to 3.8 degrees. However, if you are using a reference plane (see "Specifying a Reference Plane" on page 112), the maximum value is less than 3.8 degrees. You can't set a tolerance that would extend the Go/No-Go circle beyond the edge of the left bubble display area. If you try to set a value that is too large, MultiReview prompts you to enter a value that is within the correct range.
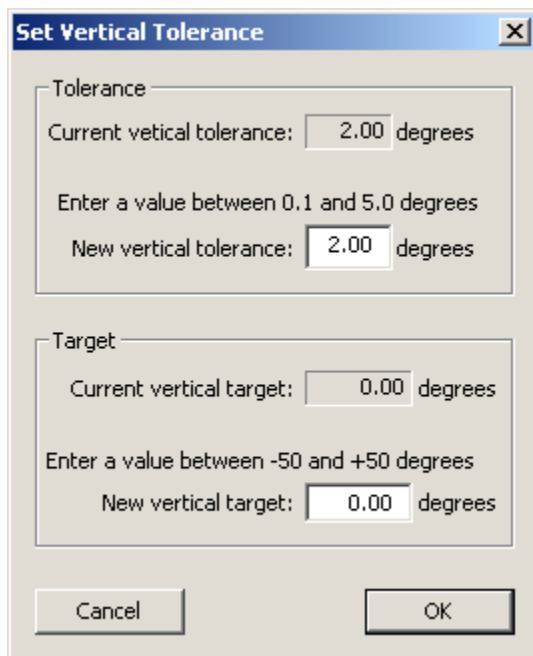
You can also set the Horizontal display type and inclination units in this dialog. For more information on these settings, see "Choosing Display Units and Conventions" on page 106.

Temporarily Changing the Vertical Tolerance and Target

The vertical tolerance and target in effect at the time a log file entry is made are recorded in the log file as part of the log entry. Those values are used when you first display an entry from the log file. You can temporarily change vertical tolerance and target for the entry you are currently viewing. However, as soon as you select a new entry from the log file, the vertical tolerance and target displayed revert to that of the log file entry.

To change the target and tolerance settings:

1) Choose the menu item **Settings > Set Vertical Tolerance**.

2) The Set Vertical Tolerance dialog is displayed, as shown below. The currently set values for both **Tolerance** and **Target** are shown.

3) Enter the **New vertical tolerance** and **New vertical target values**, and click **OK**.

4) If you want to return to measuring relative to absolute vertical, change the **Target** setting back to zero.

Using Other MultiReview Functions

Here's how to access other MultiReview Functions.

Changing Log Files

See page .

Displaying Station and Wafer Information

See page .

Printing the MultiReview Window

See page .

Maintaining Your AMS

This section provides details about the following.

- Annual factory calibration and battery replacement

- Battery use and disposal

WARNING. The edges of the AMS are thin. It may be possible to sustain injury from these edges, if the AMS device is not handled with proper care. Protection afforded by compliance EN61010-1 (2010) may be impaired, if the equipment is not used as specified.

CAUTION. Use extreme care to assure that the AMS has proper clearances, when being transported through the tool. For example, when you use the AMS in the tool for the first time, move the device through the tool in manual mode, visually verifying all clearances. Even when clearances are sufficient for safe AMS pass-through, if the robot end-effector is taught too high, you risk crashing and damaging the AMS.

Periodic calibration and battery replacement is the only regular maintenance your AMS requires:

Annual Calibration and Battery Replacement
Once a year, you should have your AMS calibrated, and the internal rechargeable battery replaced by returning the AMS to the CyberOptics factory.

Cleaning the AMS
If cleaning is required, wipe the outside of the AMS with IPA (isopropyl alcohol). However, do not apply IPA near any of the humidity sensors. If the AMS is used in a clean environment, follow proper procedures for this environment.

⚠️ **WARNING.** Do not immerse the AMS or the link module in liquid. Do not spill liquid on the AMS or on the link module. Do not apply IPA near any of the humidity (HT) sensors.

⚠️ **WARNING.** The use of controls, adjustments, or procedures other than those specified in this manual may result in exposure to hazardous optical radiation.

Annual Factory Calibration and Battery Replacement

Every 12 months, you should return your AMS to the CyberOptics factory, where we will calibrate the AMS and replace the internal rechargeable battery. You can find the date when the AMS was last calibrated at the factory by choosing the **Help**> **About AMS View** menu item in the MultiView application.
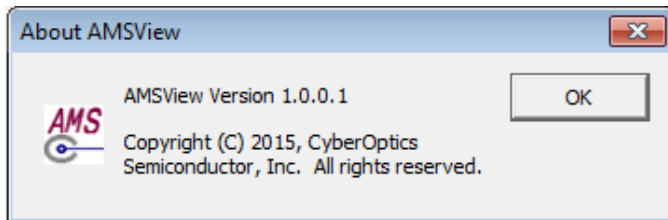
When the date for calibration approaches, MultiView will occasionally notify you by displaying the AMS calibration status dialog.
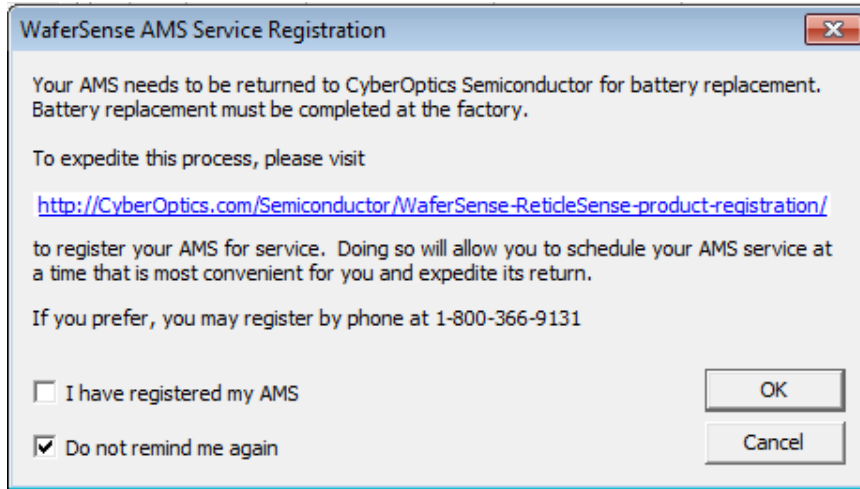
If you drop the AMS or suspect that it is no longer in calibration, contact CyberOptics technical support (see page 19.

Battery Use and Disposal

Please dispose of AMS and the lithium-ion battery it contains in a responsible manner.

WARNING. Your AMS contains a lithium-polymer battery. To avoid damage to the AMS, only use the supplied charger. Do not charge the AMS at temperatures outside the specified range (0–45° C). Do not incinerate or dispose of the AMS into fire. Do not immerse the AMS when cleaning, or spill liquids on the AMS.

For proper battery disposal, please return the AMS to CyberOptics. Contact customer support (see page 19).
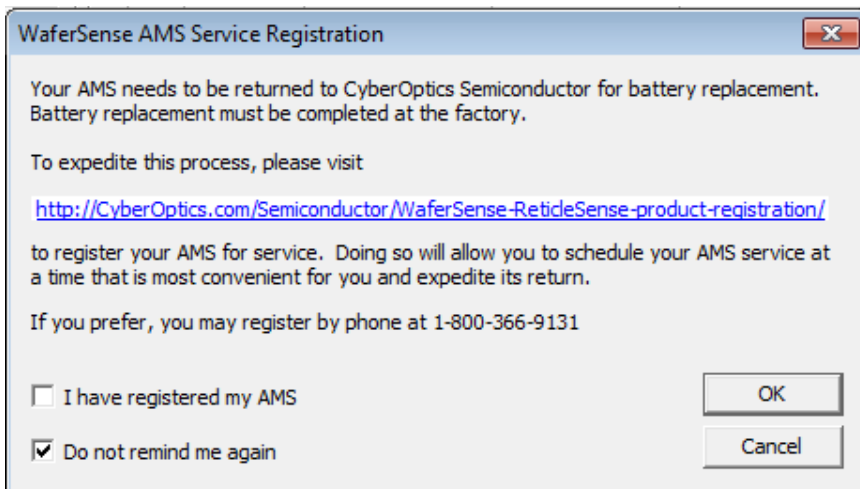
Specifications

Here are the AMS specifications.

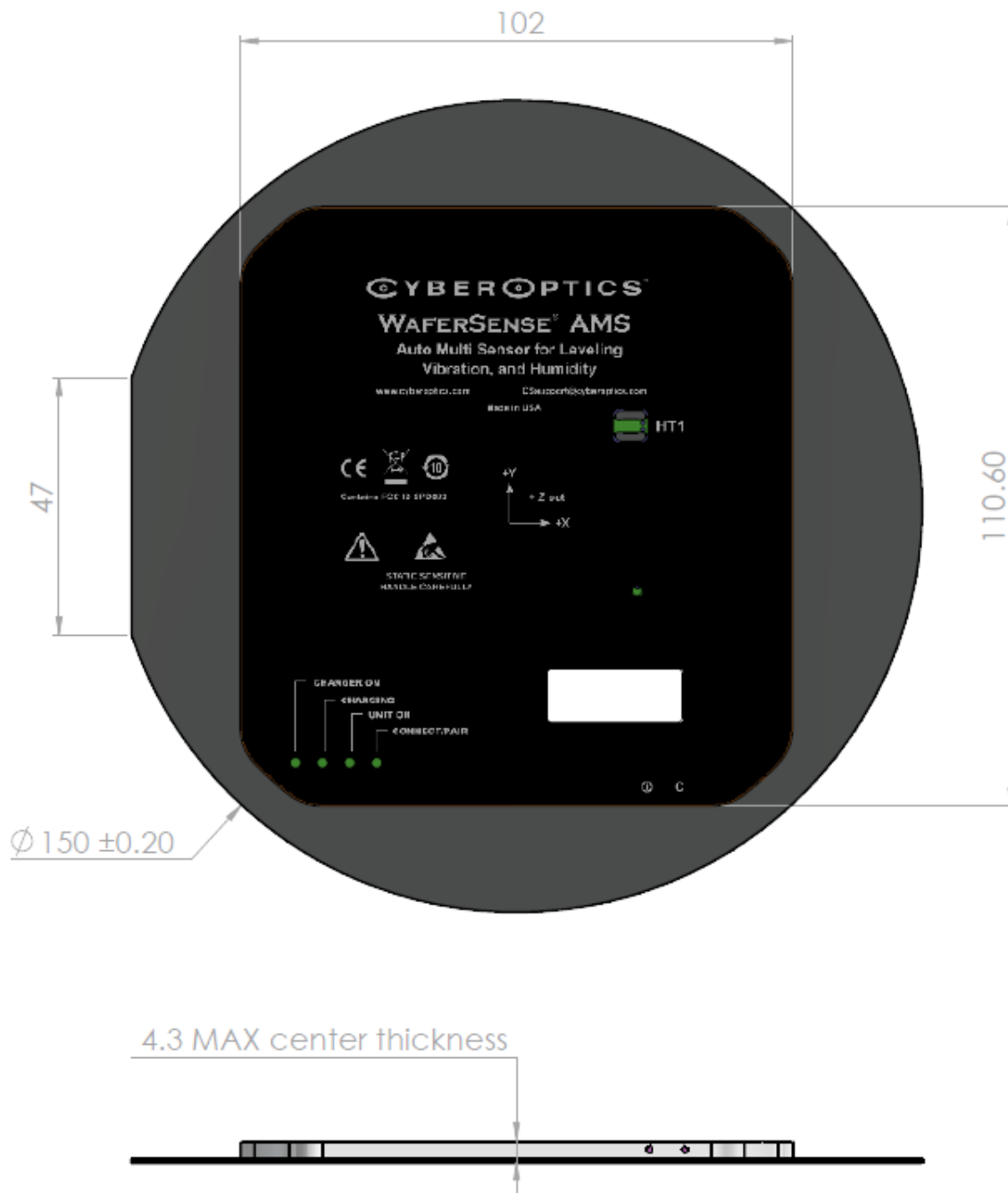| Specification	AMS-300C, AMS-200C, AMS-150C	AMSR-6025Q
Wireless, reticle-shaped, and battery powered		
Easy to use software: MultiView and MultReview		
Inductive wireless charging and hands-free operation		
Durable housing - see outline drawing for dimensions	4.1mm nominal – 4.3mm max housing center thickness —-- Carbon fiber composite over-coated with Parylene C	6.35mm housing thickness. Quartz outer frame. Rear surface of quartz is an uninterrupted quartz surface. Dimensions, chamfers, and squareness conform to SEMI standards for 6 inch square reticles. Bar-codes and alignment marks allow placement in most scanners and steppers
Weight		340 grams +/-15g
Operating Pressure	0-1.6 atmosphere	0-1.6 atmosphere
Operating internal temperature	15-60ºC non-condensing, up to 82ºC for short periods	15-60ºC non-condensing, up to 82ºC for short periods
Storage temperature	-15-+60ºC, non-condensing	-15-+60ºC, non-condensing
Charging temperature range	0-45ºC	0-45ºC
Link Box	Blue-tooth, Class 1, 2.4GHz connected via USB	Blue-tooth, Class 1, 2.4GHz connected via USB
Systems Requirements	Operating systems: Windows 7,8,10, XP, Vista ---------One free high-powered USB 1.1 or 2.0 port	Operating systems: Windows 7,8,10, XP, Vista ---------One free high-powered USB 1.1 or 2.0 port
Product components	AMS unit, charging case, carrying suitcase, link module, USB cable, charging supply, application software CD,	AMS unit, charging case, carrying suitcase, link module, USB cable, charging supply, application software CD,

	calibration certificate, and start guide	calibration certificate, and start guide
Calibration	Factory calibration recommended annually	Factory calibration recommended annually
Horizontal leveling range	+/- 14 degrees from absolute horizontal	+/- 14 degrees from absolute horizontal
Horizontal leveling accuracy	+/- 0.03 deg within +/-7 deg from absolute horizontal. Field calibrate before use for maximum accuracy (see page 113)	+/- 0.03 deg within +/-7 deg from absolute horizontal. Field calibrate before use for maximum accuracy (see page 113)
Leveling resolution	0.002 degrees	0.002 degrees
Vibration range	Range: +/- 2 G	Range: +/- 2 G
Vibration resolution	0.01G	0.01G
Vibration frequency response	0-200Hz (3dB point)	0-200Hz (3dB point)
Humidity and temperature range and accuracy	RH Range: 2.5-85%RH RH Accuracy:+/-2%RH at 20ºC T Range 15-60ºC T Accuracy +/-0.3ºC	RH Range: 2.5-85%RH RH Accuracy:+/-2%RH at 20ºC T Range 15-60ºC T Accuracy +/-0.3ºC
Humidity and temperature resolution	0.02%RH, 0.01ºC	0.02%RH, 0.01ºC
Humidity response time	8 seconds to 63% of step change	8 seconds to 63% of step change
Number of humidity and temperature sensors	5-AMS-300C 1-AMS-200C 1-AMS-150C	1
Battery Life	2 hours minimum	2 hours minimum

Dimensional Drawings

Here are the dimensional drawings for the AMS.

AMS 150C

Dimensions = millimeters

AMS 200mm

Dimensions = millimeters

102

110.60

$\emptyset\,200 \pm 0.20$

Standard SEMI notch

4.3 MAX center thickness

AMS 300C

Dimensions = millimeters

102

143.05 typ

140 typ

110.60

CYBEROPTICS
WAFERSENSE® AMS
Auto Multi Sensor for Leveling
Vibration, and Humidity

HT1

Humidity
sensors

Ø 300 ±0.20

Standard SEMI notch
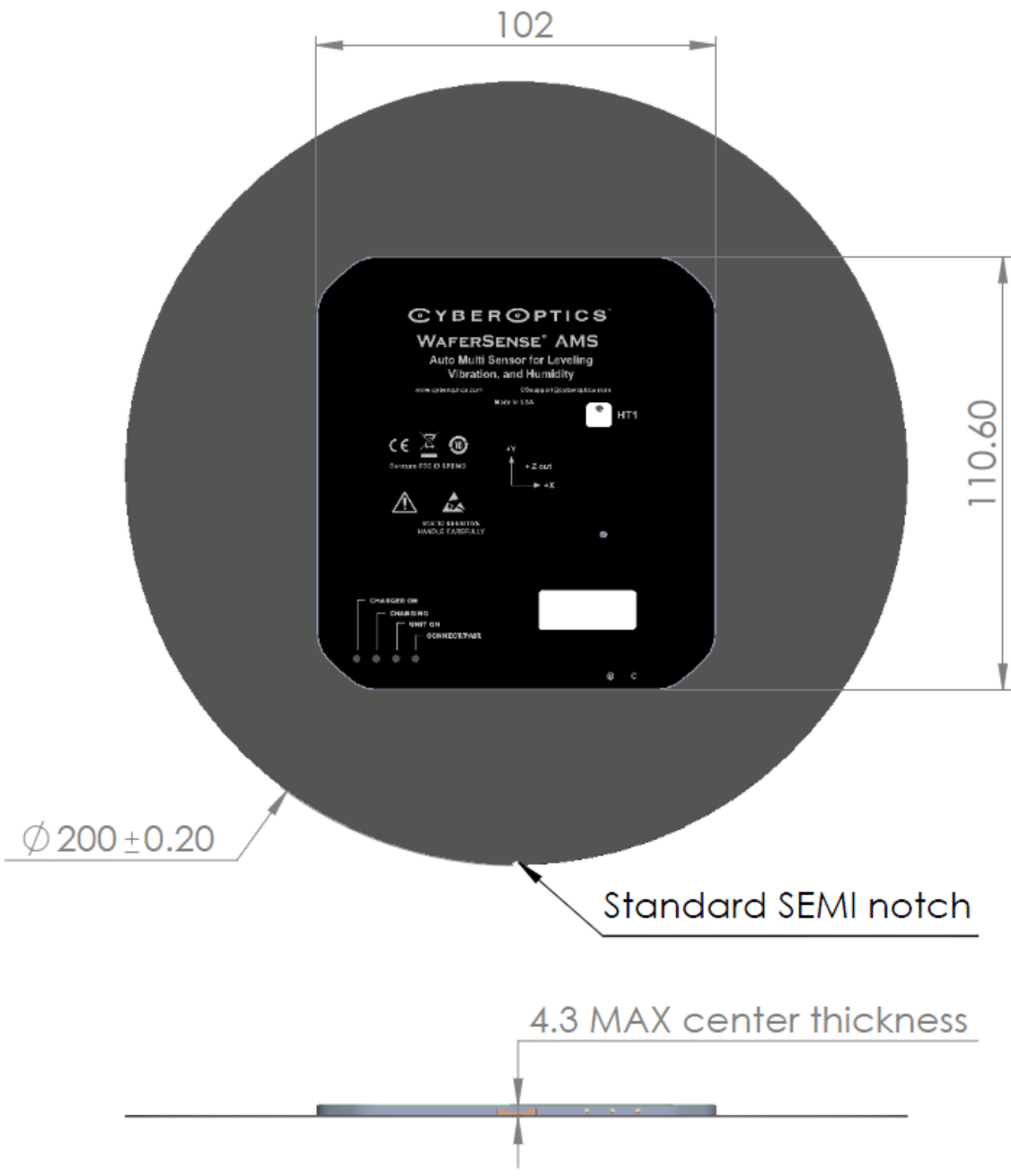
4.3 MAX center thickness
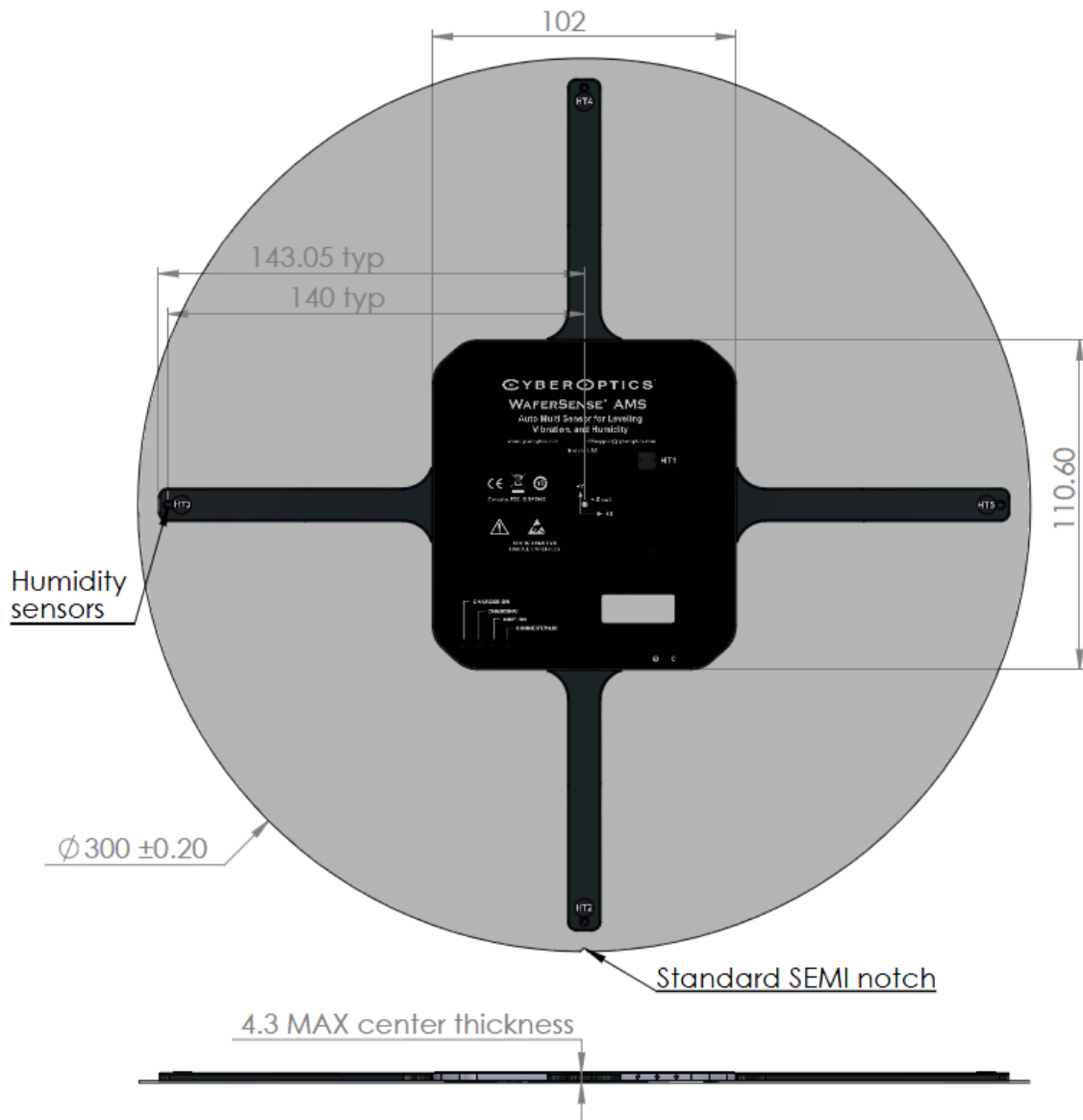
AMSR

Dimensions = millimeters
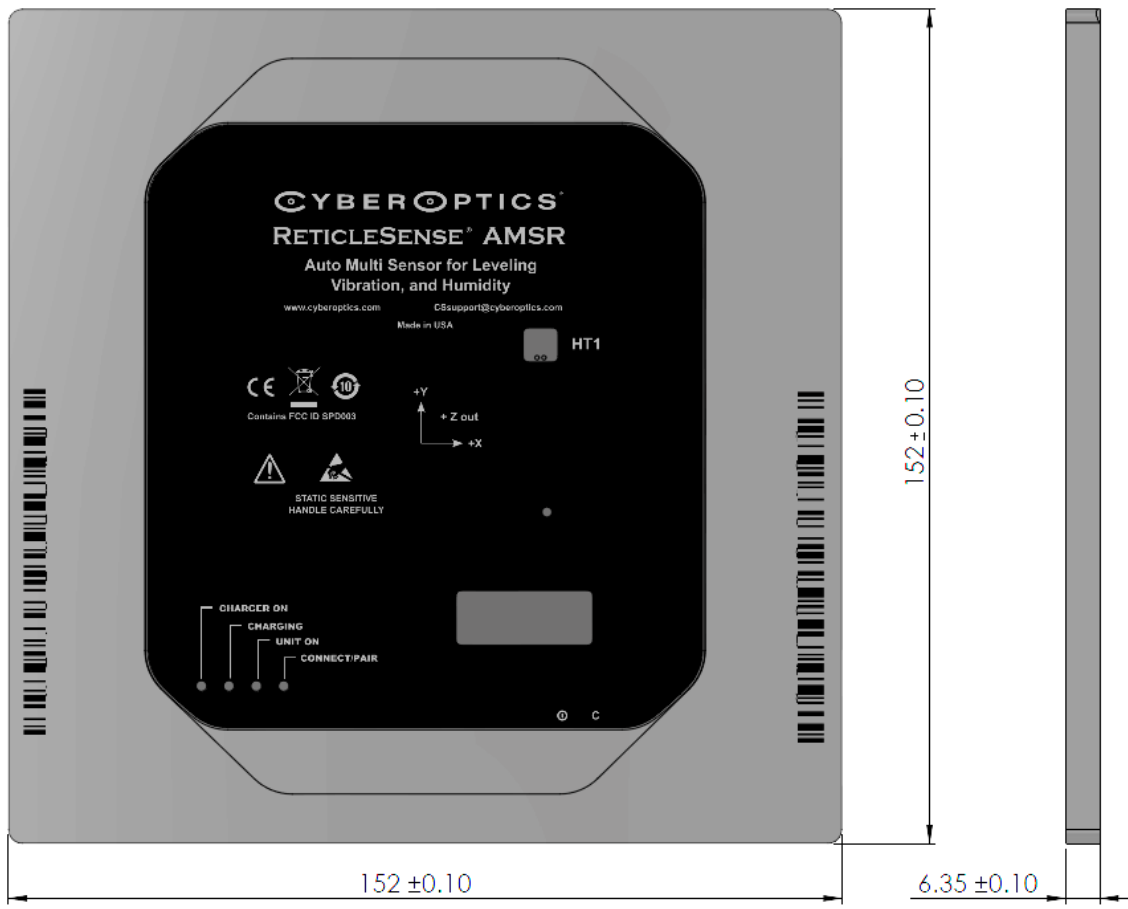
Glossary

Acronym	Description
AGS	Auto-gapping sensor
AMS	Auto multi-sensor
APS2	Air-borne particle sensor—Model 2
APSR	Air-borne particle sensor reticle
APSRQ	Air-borne particle sensor reticle quartz
ATM	Atmospheres
CD	Compact disk
CPU	Central processing unit
CSV	Comma-separated values
FCC	Federal Communications Commission
FFT	Fast Fourier transform
HT	Humidity/temperature sensor (on the upper surface of the AMS)
IC	Integrated circuit
ID	Identity
IPA	Isopropyl alcohol
ISM	Institute for Supply Management
LED	Light-emitting diode
MB	Megabytes

Acronym	Description
MEMS	Micro-electro-mechanical system
PCB	Printed-circuit board
PPM	Parts per million
RF	Radio frequency
RMS	Root mean square
RH	Relative humidity
USB	Universal serial bus

Appendices

The appendices contain additional information about humidity measurements, as follows.

- Appendix A—Moisture Conversion Table

- Appendix B—Psychrometric Chart

- Appendix C—Acoustic Resonances and other factors Affecting Acceleration Measurements

Appendix A—Moisture Conversion Table

Moisture Conversion Table

| Relative Humidity at 20ºC & 1 atm	Dew Point in ºC at 1 atm	PPM on volume basis at 1 atm	PPM on weight basis in air	Partial water vapor pressure in mbar
95	19.2	22390	13897	22.19
90	18.3	21187	13150	21.02
85	17.4	19987	12405	19.85
80	16.5	18788	11662	18.67
75	15.4	17594	10920	17.52
70	14.4	16402	10180	16.35
65	13.2	15212	9442	15.18
60	12	14026	8705	14.02
55	10.7	12842	7971	12.85
50	9.3	11661	7238	11.68
45	7.7	10483	6506	10.51
40	6	9307	5777	9.34
35	4.1	8134	5049	8.17
30	1.9	6964	4322	7.01
25	-0.5	5797	3598	5.84
20	-3.2	4632	2875	4.67
15	-6.6	3470	2154	3.5
10	-11.2	2311	1434	2.34
9	-12.4	2079	1290	2.1
8	-13.6	1848	1147	1.87
7	-15.1	1616	1003	1.63
6	-16.8	1385	860	1.4
5	-18.7	1154	716	1.17
4	-21	923	573	0.934
3	-24	692	430	0.701
2	-28	461	286	0.467
1	-32.6	285	177	0.288

Appendix B—Psychrometric Chart
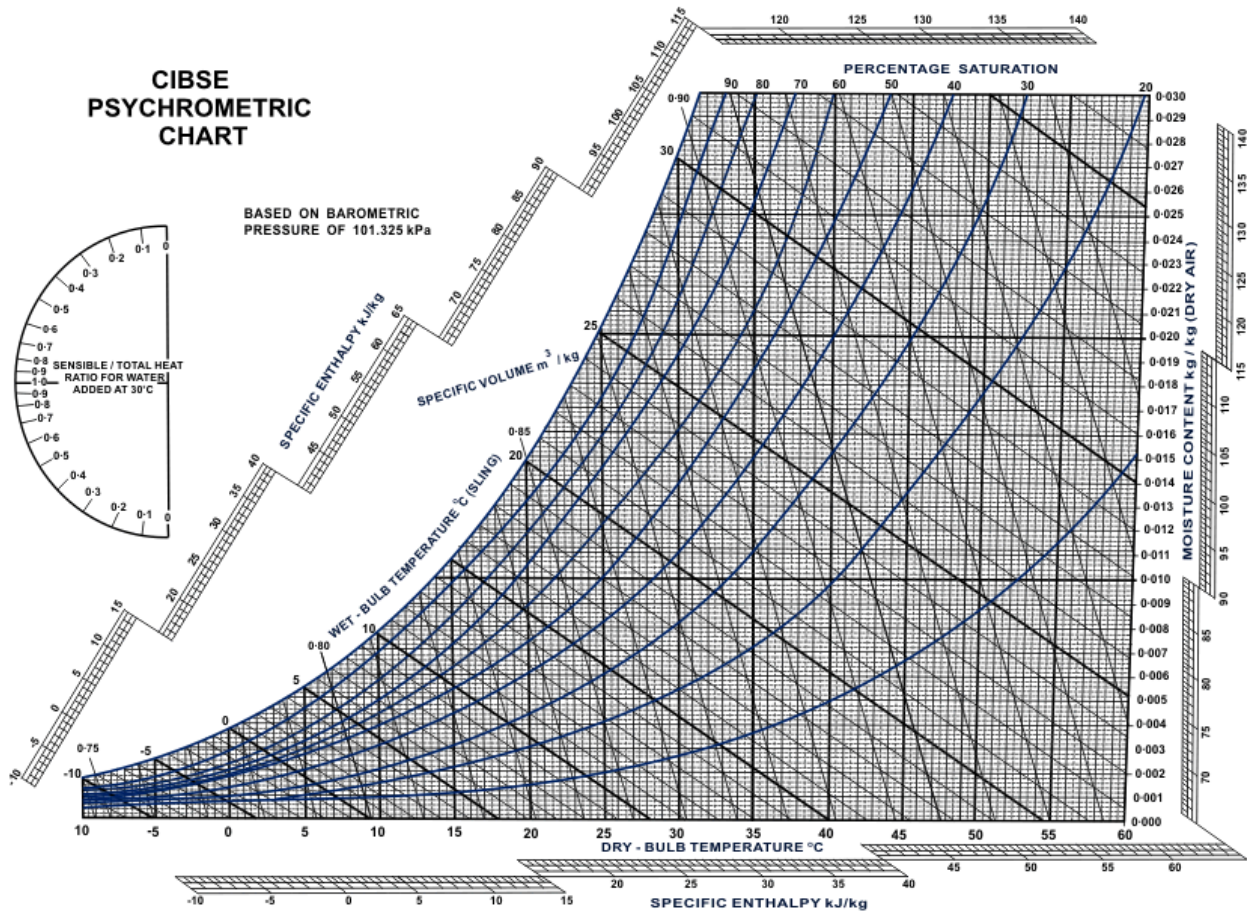
Appendix C—Acoustic Resonances and other factors Affecting Acceleration Measurements

Any mechanical system has acoustic resonances that can be excited by either sinusoidal acceleration or repeated impulses. Traditional accelerometers are usually mounted into metal blocks that have thicknesses comparable to their lateral dimensions. This is done so that the resonance frequency of the mechanical system is driven to high frequencies and therefore does not interfere with the acceleration measurement. However, in trying to measure accelerations in systems that handle semiconductor wafers, the thin flat shape of the wafer and the relatively low resonant frequencies makes comparative acceleration measurements difficult.

Semiconductor wafers can have "drumhead" resonances at relatively low frequencies. As the name suggests, these resonances occur in the direction normal to the flat surface of the wafer. Because of the large diameter to thickness ratio, the resonant frequencies can be quite low. A typical illustration of one of the lower order drumhead mode patterns (0,1) is shown below. Depending on the excitation frequency, multiple modes, such as (0,0), (0,1), (2,1), etc. can be excited.
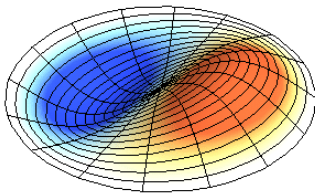
In the same way, Wafersense units that measure vibration, such as AVS and AMS, also have these modes, as well as other smaller resonances caused by the housing structures. The resonance frequency is primarily determined by the thickness, area and material density. So, an AMS unit will have different resonances from an AVS unit which will have different resonances from a silicon wafer.

The method of clamping, whether uniformly clamped at the edge, clamped in a few places at the edge, or supported in the middle, will also change the resonant frequencies in both Wafersense units as well as silicon wafers.

The amplitude of the driving force, i.e. the acceleration, will not affect the resonant frequencies, but will determine which resonances show up in the measurement.

One common question is whether two AVS units or two AMS units will show the same waveform if vibrated or translated in the same manner. The answer is that two units of the same type will show the same acceleration if a resonance is not excited. Even an AVS and an AMS unit will show almost the same waveform off resonance. Below in figure 1 is a comparison of an AVS unit (top) and an AMS unit (bottom) that were clamped together and simultaneously shaken in the z direction. As you can see, their waveforms are very similar but not identical. One would not expect them to be identical since the housing construction of the two are different. The AMS housing is much thinner and the electronics enclosure is smaller in diameter than the AVS housing.
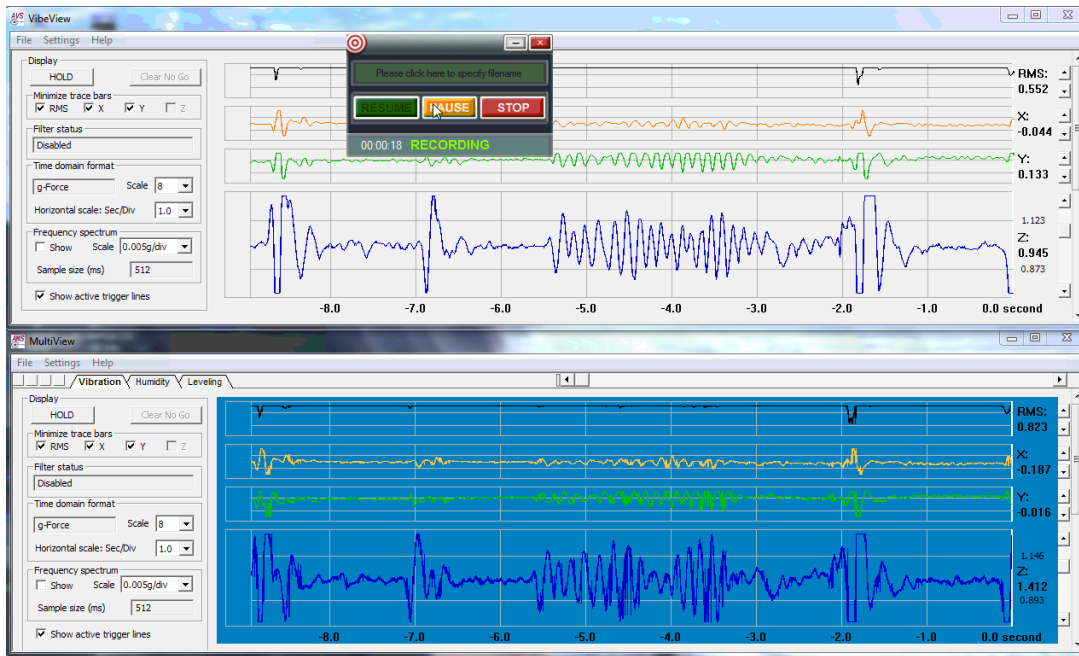
Figure 1: Response of AVS unit (top) and AMS unit (bottom) clamped together and simultaneously shaken in the z direction.

An AMS unit compared to another AMS unit will have traces almost identical to each other. Figure 2 below shows a 200mm AMS unit (top) compared to a 300mm AMS unit (bottom).
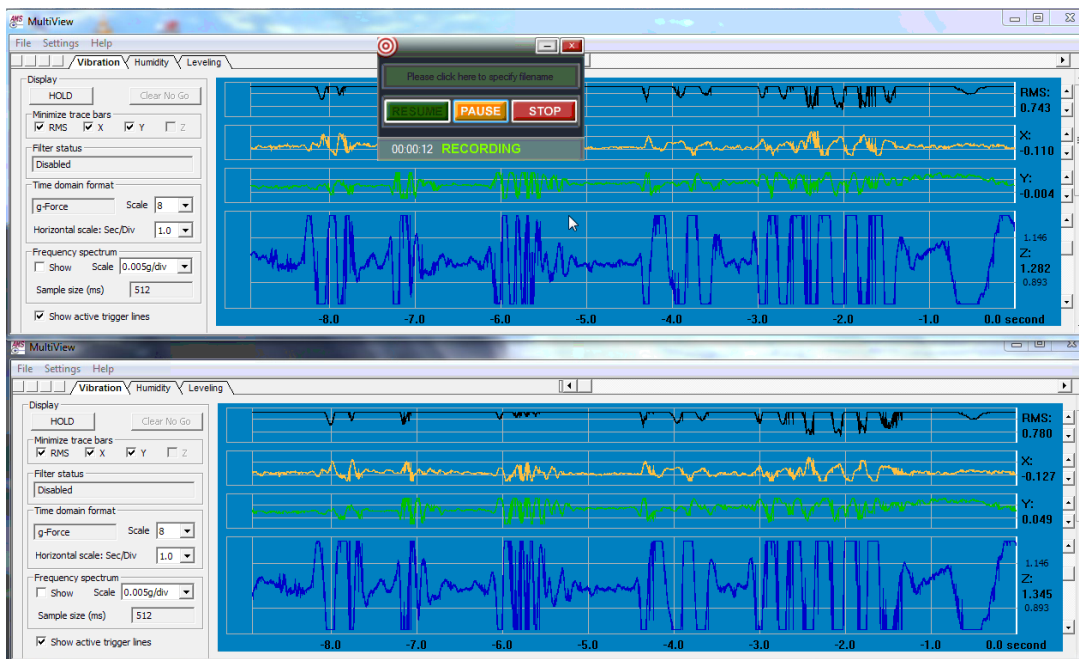

Figure 2: Response of 200mm AMS unit (top) and 300mm AMS unit (bottom) clamped together and simultaneously shaken in the z direction.

An AVS unit and another AVS unit will also have identical traces if they are not on resonance. As shown in figure 1 above, the z axis correspondence of an AMS and AVS unit are good but not perfect. The correspondence in the x and y directions is also very good. So, the z direction correspondence shown above is close to the worst-case condition.

But, AVS units will not show the same waveform as AMS units if, in one of the cases, a resonance is excited by the movement.

One potential way to lessen the resonance problem is with acoustic damping. Adding a plate that consists of a resilient and low density material (foam or rubber) sandwiched between the AVS or AMS housing and another stiff, high density material will attenuate resonances. The alternating layers of high and low density materials damp the resonances.

Therefore, when AMS and AVS units are compared against each other there will be some unavoidable differences caused by the resonances and different housing construction. Resonances cause the largest differences. But even off resonance there will be some differences between AMS and AVS units.
Both the AMS and AVS units cover the same frequency bandwidth with the same sensitivity. Both are calibrated at 0 Hz and in both units any cross-axis sensitivities are corrected out. Because of the simpler internal structure, the AVS may have slightly less noise and a cleaner response to a single excitation frequency.

AHS Addendum

Wafersense AHS

This addendum is for the humidity only WaferSense AHS sensor.

MultiView

AMS/AHS automatic detection

When MultiView attaches to a wafer it automatically checks to determine whether it is an AMS or AHS WaferSense. The application then configures the main screen to display the appropriate view. When the device is an AHS wafer the main screen will hide the tab control and display the humidity view (see Figure A.1). The tab control is used to switch between the vibration, humidity and leveling views. Since vibration and leveling are not available on AHS wafers the tab control is unnecessary.

Main Screen

The MultiView main screen, in AHS mode, looks and functions like the humidity view tab in AMS mode. This view is described in the AMS manual. The only distinction in AHS mode is that recording now generates humidity log files only.
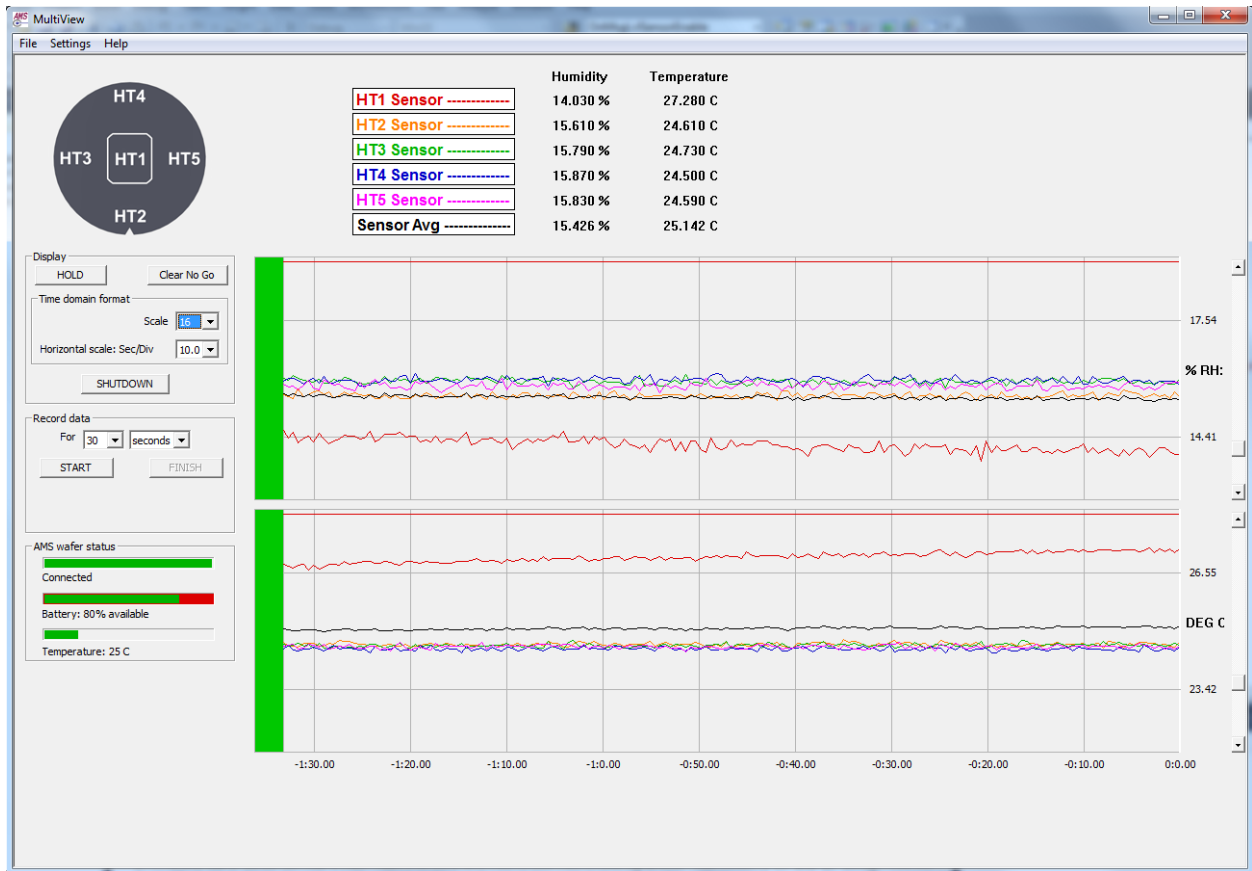
Figure A.1: AHS Mode MultiView Main Screen

MultiReview

Main Screen

When log files are recorded in MultiView using a WaferSense AHS device are opened in MultiReview, the application will configure the main screen similarly to MultiView with the tab control hidden and the humidity tab as the main view (see Figure A.2). The MultiReview main screen, in AHS mode, looks and functions like the MultiReview humidity view tab in AMS mode. This view is described in the AMS manual.
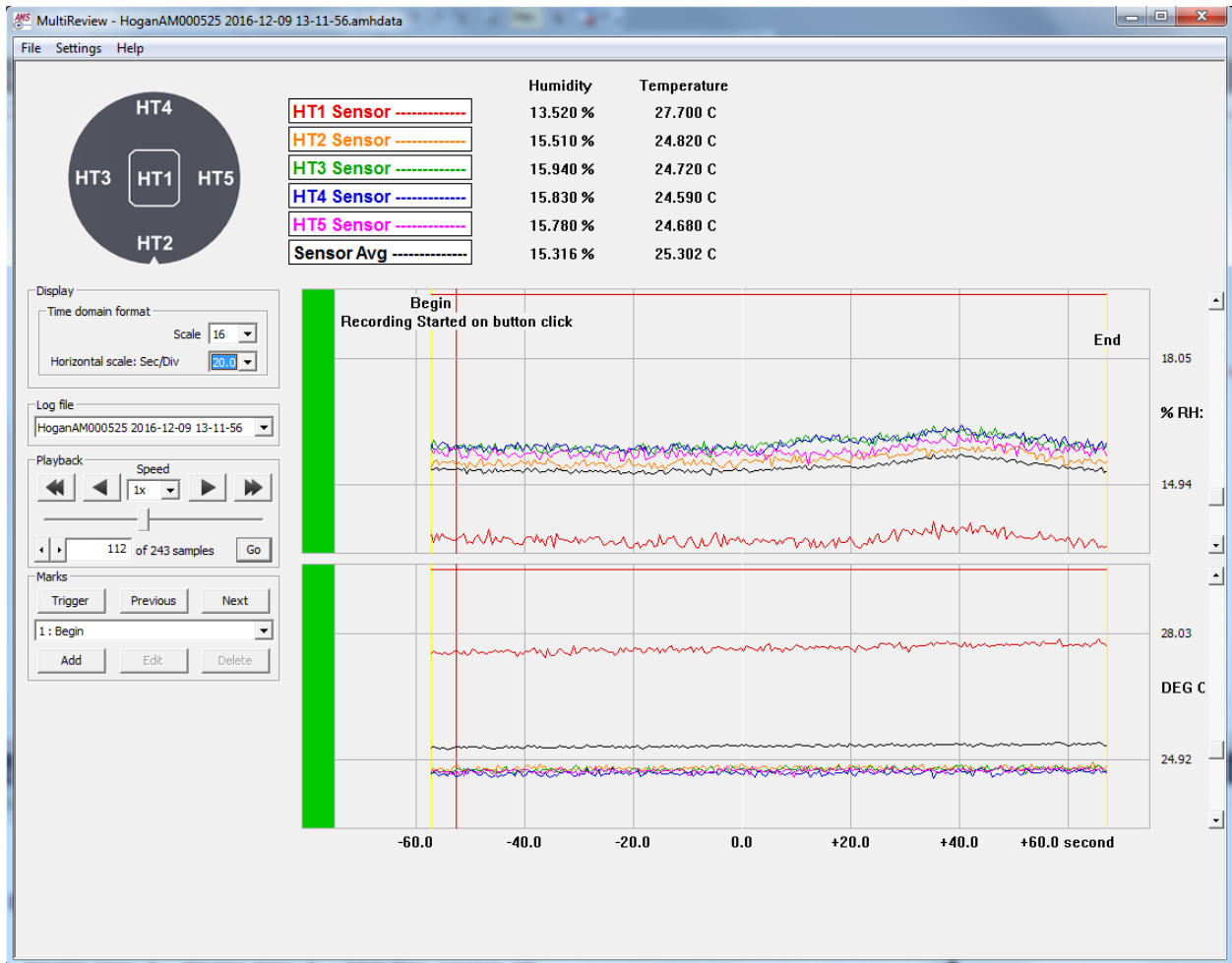
Figure A.2: AHS Mode MultiReview Main Screen