SonoLabDS3 Help Documentation (1.0.1.11)

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SonoLabDS3

Welcome

SonoLabDS3 is a windows application which interfaces to the Sonometrics Corporation DS3 USB sonomicrometer device. This document provides help and guidelines for the installation and usage of the software.

Help is available on the following topics:

System Requirements (Recommended minimum, NOTE: as of April 2014, Microsoft Corporation no longer provides support for its XP and VISTA operating systems):

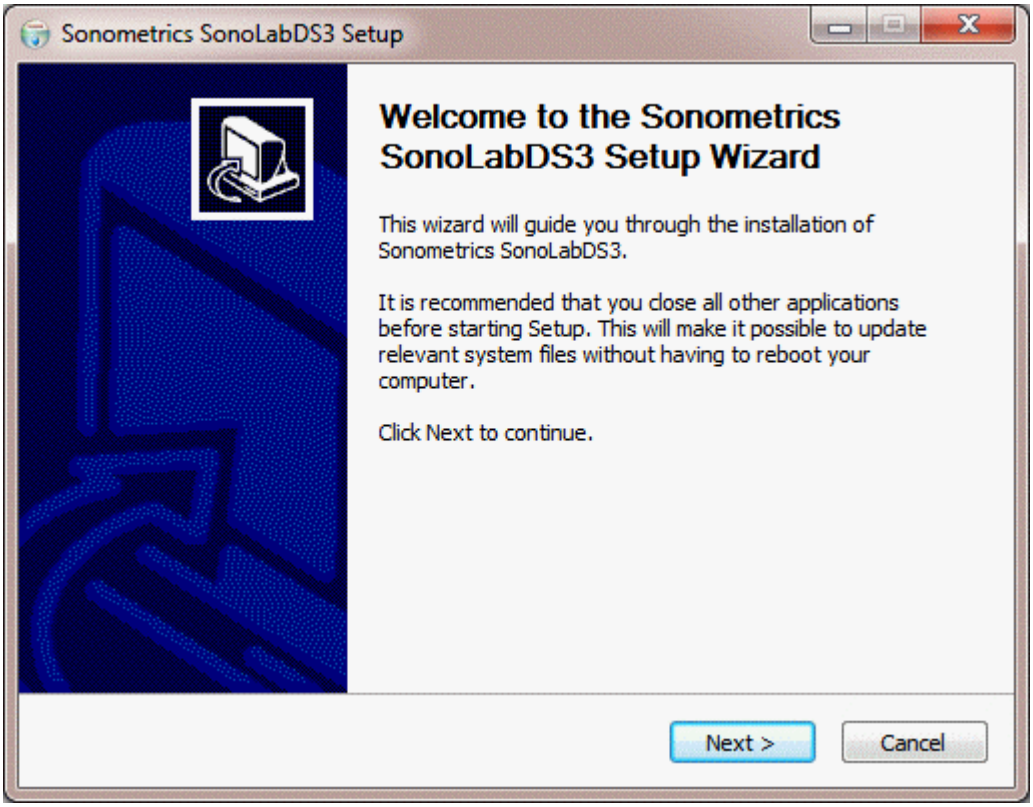
- Pentium 4 Processor, 2 GHz
- Windows 2000 SP4, XP, Vista, 7
- 1024 MB RAM (2048 MB for Vista, 7, 8)
- 500 MB Free Disk Space

- Free 2.0 USB port (to connect the DS3 hardware)
- Video card capable of 1024 x 768 resolution or higher

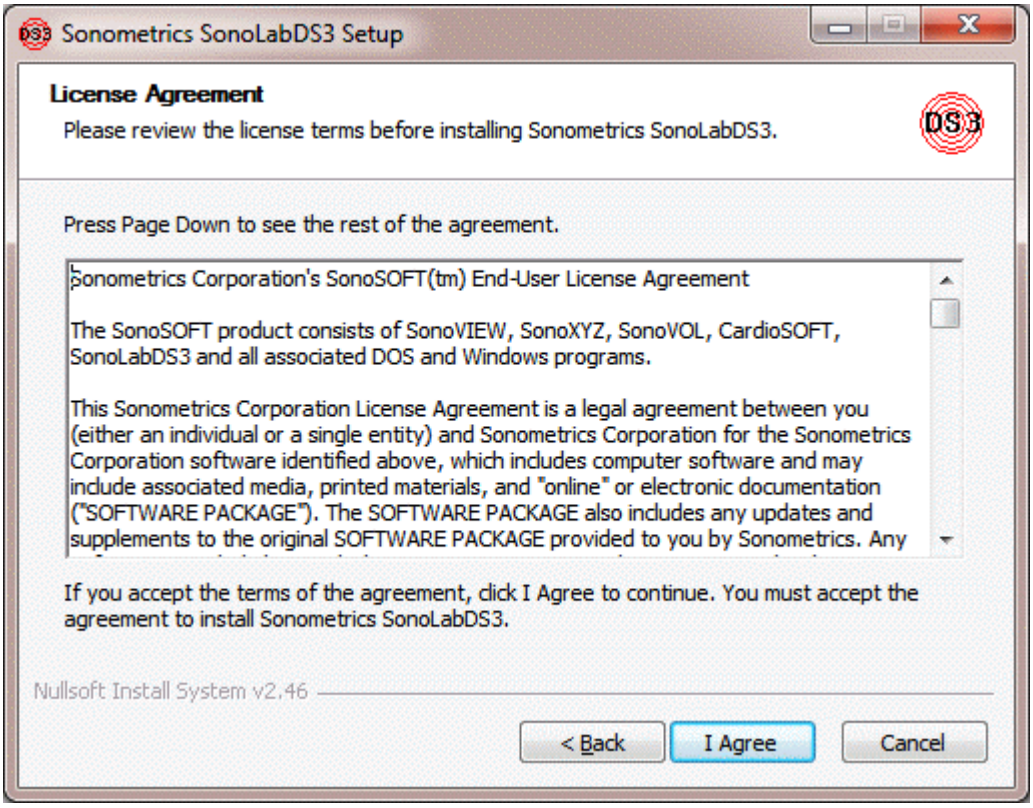
For the current contact information please go to www.sonometrics.com

Software Installation

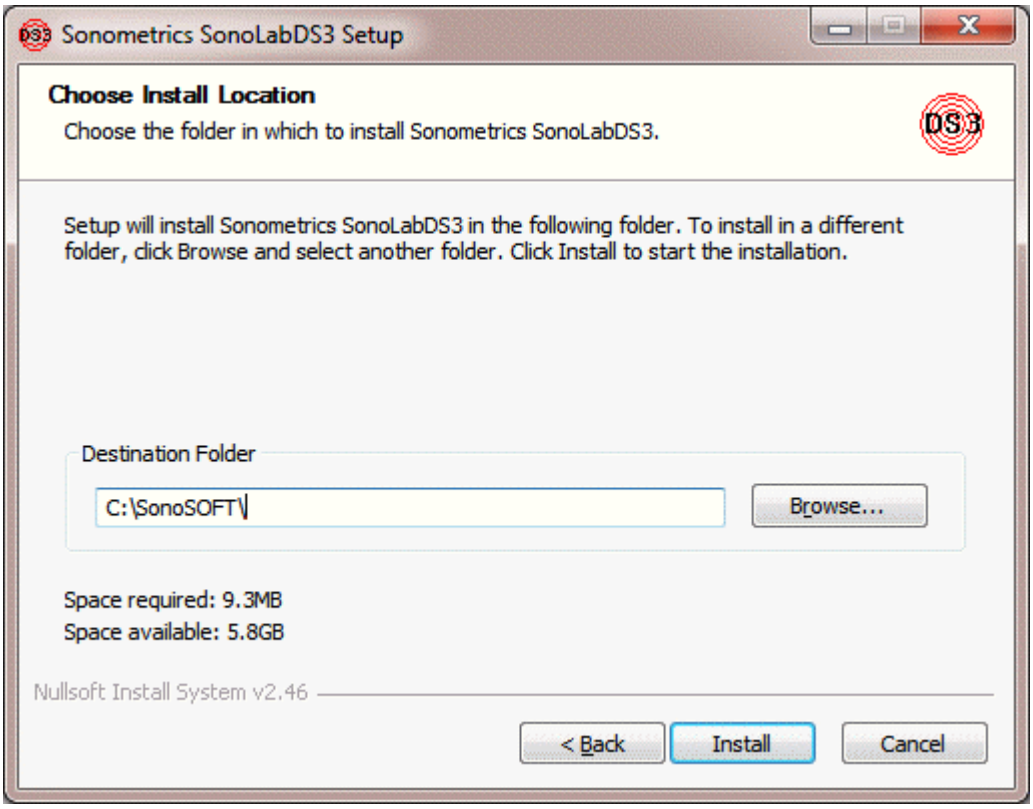
To install SonoLabDS3 on your Windows machine, run the SonoLabDS3Install executable. In Windows 7 or Vista, the user may be asked to permit the installer to make modifications to the system as administrative privileges are required for some portions of the install procedure After being granted installation authority, the following screen should appear:



Activate (or click) on the "Next>" button. The end user license agreement will appear:

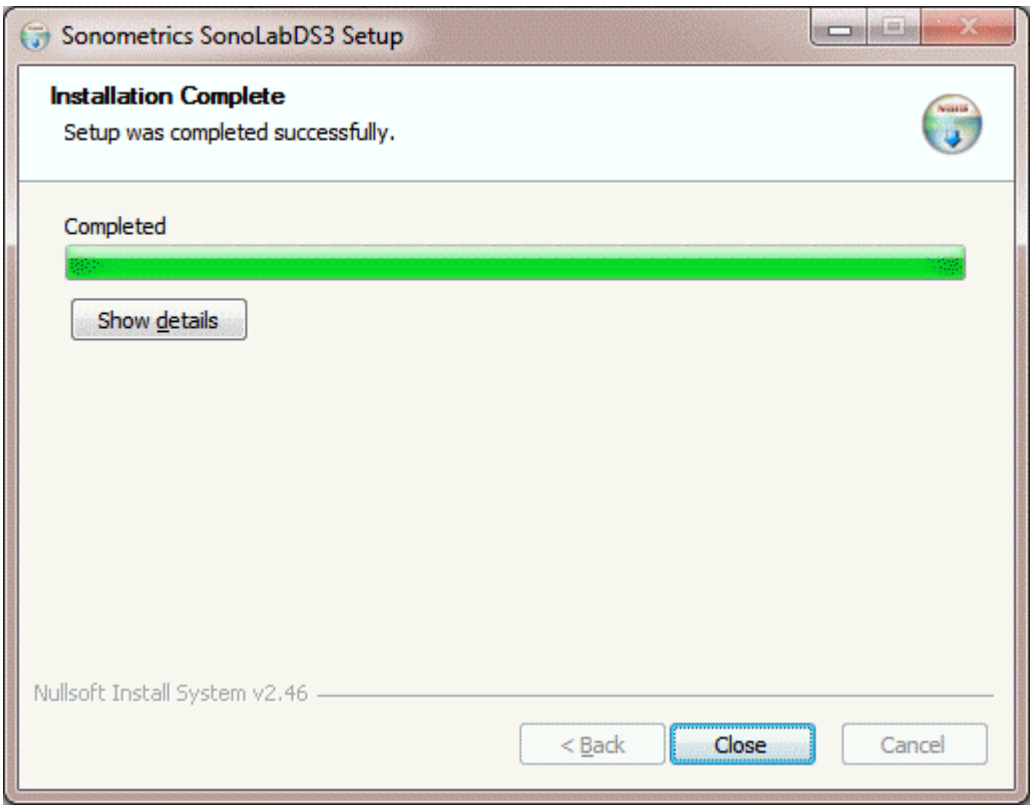


Activate (or click) in the "I Agree" button. The "Choose Install Location" dialog will appear:



The default install directory is shown first. The user may change the location of the installation as required.

The SonoLabDS3 executable, help and support files are installed here. A sub-directory named "FTDI" is also created here. It contains the documentation and drivers required for the DS3 USB device. Activate (or click) the "Install" button to begin installing the files. Upon completing the installation of the files, the following window will appear:



Activating the "Show details" button will expand the progress bar area and show details of the files installed on the system. The user can now close the installer by activating (or clicking) the "Close" button.

DS3 Driver Installation

The specific DS3 driver installation instructions can be found in the PDF files in the FTDI sub-directory of the SonoLabDS3 install directory. There are five files, one for each of the supported Windows operating system versions:

- Windows_2000_Installation_Guide.pdf
- AN_104_FTDI_Drivers_Installation_Guide_for_WindowsXP(FT_000093).pdf
- AN_103_FTDI_Drivers_Installation_Guide_for_VISTA(FT_000080).pdf
- AN_119_FTDI_Drivers_Installation_Guide_for_Windows7.pdf
- AN_234_FTDI_Drivers_Installation_Guide_for_Windows_8.pdf
- AN_396_FTDI_Drivers_Installation_Guide_for_Windows_10.pdf
- AN_396-FTDI-Drivers-Installation-Guide-for-Windows-10_11.pdf

These documents show how to properly install the FTDI common driver model (CDM) D2XX drivers required by the Sonometrics DS3 device. Please note that the DS3 device does not utilize the virtual COM port (VCP) drivers.

The latest documentation and drivers can be obtained from the Future Technology Devices International Ltd web site: http://www.ftdichip.com

NOTE: As of April 2014, Microsoft no longer provides support for the XP and VISTA operating systems. Subsequently, FTDI no longer is able to sign (certify) their new D2XX drivers for XP and VISTA. The last version of foe FTDI drivers that were signed for XP and VISTA is 2.08.30. Their current version (as of November 2016) is 2.12.24. It is possible to install the unsigned drivers under Windows XP and Vista, however, this requires user intervention.

Version History

Version 1.0.1.12

Release Date: August 31, 2022

- An issue with the "2 unique user defined values" AD Channel Calibration has been corrected (c.f. AD Channel Configuration). It had been noted that when the first signal was assigned a zero real value, that the subsequent procedure would incorrectly restart the Calibration process when the user was about to work with the second signal.

Version 1.0.1.11

Release Date: September 24., 2020

- An issue with changing the Sampling Rate while in Monitor mode has been corrected.

Version 1.0.1.10

Release Date: July 29., 2019

- An issue with SonoLabDS3AD application has been corrected. Prior to this version of SonoLabDS3, the SonoLabDS3AD did not properly store certain information in the SLB header file. The range of sampling rates for SonoLabDS3AD has been increased to a range between 87.52 Hz to 7797.27 Hz.

Version 1.0.0.99

Release Date: May 22., 2019

- An issue with the sampling rates on DS3 systems utilizing the updated FTDI FT2232H USB integrated device has been corrected. DS3 systems with an FTDI Serial Number of the format 12??????B (as shown in the SonoLabDS3, Configuration, System Configuration, System Properties page (c.f. System Properties)) were unable to access higher sampling rates.DS3 systems with an FTDI Serial Number of the format FT??????B were unaffected.

Version 1.0.0.98

Release Date: May 2., 2019

- The SonoLabDS3 Sampling Rates section has been updated to reflect the corrections to the sampling rate calculations.
- The delay in the DAC channels are displayed in the DAC Channel Configuration.

Version 1.0.0.97

Release Date: January 25, 2019

- The ability to copy trace settings from another trace in the current configuration has been added to the Trace Settings dialog.
- The DAC Channel Configuration has been updated.
- On save operations, if there are data overruns, their occurrences are recorded in a secondary file with a ".err" extension.
- It is now possible to change the Velocity of Sound by clicking on the "Configuration", "System Properties": "Velocity of Sound" list item field and filling a new value in the presented "Modify Velocity of Sound" dialog.
- The SonoLabDS3 Sampling Rates section has been added. This provides a brief overview of the data sample structure and the sampling limits between the DS3 device and the SonoLabDS3 software.

Version 1.0.0.96

Release Date: June 15, 2018

- The "F3 (TxPulse)" menu item on the Trace Display Window has been renamed to "F3 (TxMute)".

Version 1.0.0.95

Release Date: May 17, 2018

- The maximum number of configurable traces in a Custom View has been increased to 32.
- Several functional issues were corrected.

Version 1.0.0.94

Release Date: March 28, 2018

- This help is now also included as a printable PDF document: SonoLabDS3Help.pdf.
- Several functional issues were corrected.

Version 1.0.0.93

Release Date: December 21, 2017

- Issues with the Grid Lines and Fixed Scales for the XY Plot window have been corrected (XY Plot Options).

Version 1.0.0.92

Release Date: November 2, 2017

- An issue with the Multi-Channel calibration of the AD Channels has been corrected.

Version 1.0.0.91

Release Date: October 20, 2017

- An issue with the calibration of the AD Channels for a single gain has been corrected.
- Support for calibrating the SonoLabDS3 transceiver parameters has been included in this release. More details can found in the Transceiver Parameters Calibration section.
- A new Triggered Trace Display Window has been introduced in this release. Details can be found in the Triggered Trace Display Window section.
- Event Markers can now be generated by the SonoLabDS3 system. See the Event Marker File section for more details.

Version 1.0.0.74

Release Date: November 25, 2016

- An issue with the creation of save directories has been corrected.

Version 1.0.0.73

Release Date: August 29, 2016

- An error in the handling of the parameters for the Data File Options was corrected.

Version 1.0.0.72

Release Date: July 20, 2016

- A Rate calculation is now available for the AD channels. More information is available in the Scale Settings section.
- Issues with adjusting the scale with the mouse have been corrected.

Version 1.0.0.71

Release Date: May 27, 2016

- Some issues with the AUX Channel Configuration and units have been corrected.

Version 1.0.0.70

Release Date: May 5, 2016

- An operational issue in a multi-window configuration. utilizing Custom display settings has been corrected.
- The AUX Channel Configuration has been updated to include a auto unit adjustment feature for LVV trace display.

Version 1.0.0.69

Release Date: March 24, 2016

- The DAC calibration has been redesigned. More information can be found in DAC Channel Configuration. The user is able to specify the DAC Channel being calibrated. This results in selectable output values that are based on DAC Channel's Range. The DAC Channel Range is now calculated utilizing the current value for the velocity of sound.
- All user changes in the DAC Channel Configuration are applied immediately. It is not necessary to activate the Apply or OK button in order to have the selections take effect..

Version 1.0.0.68

Release Date: November 4, 2015

- An issue with the Custom display not properly recognizing a disabled AD channel has been corrected.
- SonoLabDS3 will transition to an idle state if the host computer enters a Screen Save or Monitor sleep mode.

Version 1.0.0.67

Release Date: October 22, 2015

- Some issues with AUXillary LV_V channel units have been corrected.

Version 1.0.0.66

Release Date: October 9, 2015

- Issues with popup trace menu options to add traces to the Custom Trace Window have been corrected
- The AD Channel Configuration now provides additional buttons for loading and saving AD Calibration files.
- When AD Signals window is active, it will display AD signal values during the AD calibration process.

Version 1.0.0.65

Release Date: September 18, 2015

- The F3 enabled minimum Transmit Pulse is reset to the user value upon any state transitions of the SonoLabDS3 software (i.e. Monitor to Save Data)

Version 1.0.0.64

Release Date: July 28, 2015

- An F3 function has been added that toggle the Transmit Pulse value between the current user value and the minimum allowable. Then minimum value is active when the *F3 is visible in the main trace window's menu bar. This can be used to minimize the electrical interference generated by the crystals.
- The velocity of sound is now configurable, by modifying the value in the "VelSound.ini" file. This file is located in the directory containing the SonoLabDS3 executable. The default value is 1.59 mm/us.
- The offset associated with internal signal delays has been modified to 89 cycles of the 32 MHz control clock. The calculated TRx distances will be smaller. It should be noted that this offset is not subtracted from the digital data recorded in the Sonometrics binary SLB files

Version 1.0.0.63

Release Date: June 12, 2015

- For the "Two Trace Windows" Layout, it is possible to configure each window to have its own time scale range. If the "Same as Primary" check box is unchecked the "Display Time (s)" controls will handle either the "PriDsp Time (s)" primary trace window values or the "SecDsp Time (s)" secondary trace window values. Clicking on the heading will toggle between the primary and secondary time scale values. (see Trace Layout Configuration)
- Some issues with the AUX channels have been corrected.
- The scales on the Graph Window can be individually configured to be fixed scale or auto-adjustable. (see Graph Options)
- In the Custom Display mode of the primary trace window, it is possible to overlay AD traces (see Custom Display Configuration)
- Several functional issues were corrected.

Version 1.0.0.62

Release Date: March 10, 2015

- Several functional issues were corrected.

Version 1.0.0.61

Release Date: January 15, 2015

- Added user selectable apply options to the Trace Settings dialog when the "Apply To:", "All Visible" is selected.
- Several functional corrections were made.

Version 1.0.0.59

Release Date: November 21, 2014

- Issues with AD multi-gain calibration have been corrected.

Version 1.0.0.58

Release Date: October 24, 2014

- The Trace Windows now support the "Maximize" button in the title bar.
- The AD Channels support statistical Maximum/Minimum/Average data display in their Watermark.

Version 1.0.0.57

Release Date: August 15, 2014

- Added F4 function key to toggle TRx traces between line and points display (is not stored in the configuration).
- Added F5 function key to toggle all traces between displaying strictly within its own trace boundaries or within the boundaries of the trace display window (is not stored in the configuration).
- Several functional corrections were also made

Version 1.0.0.56

Release Date: July 30, 2014

- Mostly cosmetic changes, larger scale fonts, added track bar controls for changing the main Trace Window parameters.
- TRx Tracking will now go down to 0.5 mm

Version 1.0.0.55

Release Date: June 6, 2014

- Various functional corrections have been made in this release.
- An A/D Signals window has been added. This presents a simplified method of observing the AD channel signals.
- Simultaneous AD Multi-Channel calibration is possible for the "2 unique user defined values" method.

Version 1.0.0.44

Release Date: November 22, 2013

- Various minor issues have been fixed
- Calibration issues for the AD Only version have been corrected

Version 1.0.0.38

Release Date: July 26, 2013

- A/D Calibration for the multi-gain 2 signal method supports estimation of the slope/offset for higher gains if signal clipping has occurred during the sampling processes.

Version 1.0.0.37

Release Date: June 21, 2013

- A/D Calibration provides an option to simultaneously calibrate the channel for all gains using the two signal method
- The base-line values for TRx traces are displayed in the upper left portion of the Water Mark and are updated at the end of each scan.

Version 1.0.0.34

Release Date: November 30, 2012

- The Trace display has been modified so that traces can wonder anywhere within the trace display area.

Version 1.0.0.33

Release Date: November 15, 2012

- The initial control window has been removed, the first window to appear is the Main Trace window.
- A number of stock display options including a Secondary Trace window capability have been added.
- A Custom display capability has been added to the Main Trace window. The user is able add, delete and reorder traces on the custom display window.

Version 1.0.0.30

Release Date: May 10, 2012

- Support for the DIN Option added

Version 1.0.0.28

Release Date March 9, 2012

- Various updates and corrections.

Version 1.0.0.26

Release Date: February 8, 2012

- Various updates and corrections to support an 8 channel DS3 system.

Version 1.0.0.22

Release Date: December 6, 2011

- Initial integration of help documentation for SonoLabDS3.

DS3 Auxiliary Monitoring Port

The DS3 device has an Auxiliary Monitoring Port (labeled AMP Out) to permit the external calibration of voltage signals.

Using the Monitoring Port

In order to see the receive signals on the oscilloscope the monitor port signals need to be connected to the oscilloscope. The table below indicates how the monitoring ports are connected. Use the supplied scope monitoring cable to make the connections as shown in the table below. The scope monitoring cable is color coded to help identify the leads, however how the colors are connected is not critical.

Hooking up the oscilloscope

Digital Out	CH2
Analog Out	CH1
Trig Out	Ext Trig

Below are some typical oscilloscope settings that should help in viewing the sonomicrometer receiver signals. These are just some guideline settings and may need to be adjusted to view proper signals, please refer to your oscilloscope manual for further information if required.

Guideline Scope Settings

Trig Source	External
Trig Coupling	DC
Trig Type	Rising Edge
Trig Level	1.5 volts to 3.5 volts
CH1 Volts/Div	2
CH2 Volts/Div	2
Sec/Div	5us

With everything hooked up and the oscilloscope settings set correctly you should be able to get some signals with a pair of crystals in the water. If you have difficulty getting signals you may need to consult the manual for the oscilloscope or call Sonometrics technical support for help.

The output monitor switch on the front panel is used to select the channel to be viewed on the monitoring port. Keep in mind that both sensitivity adjustments are active regardless of the position of the monitoring switch.

Understanding Oscilloscope Signals

It is not required to use an oscilloscope with the DS3, however it can help to understand what it happening and how to use the DS3 to obtain clean dimension traces. This section will discuss the signals viewed on an oscilloscope to help give a better understanding of how the system works.

Lets take a look at a typical good signal. In all of these images the digital signal is the upper trace and the lower trace is the receive signal from the crystal. The above trace shows a strong receive signal from the crystal and a digital signal that is tracking it well.

You may notice that there is a pulse at the start of the trace. This is the transmit artifact caused by the transmitting crystal. It causes the digital signal to falsely think that there is a receive signal. This is why the "inhibit" adjustment is required. The "inhibit" tells the digital signal to ignore any receive signals during the transmit noise. The front panel of the DS3 has a switch that allows the user to set the inhibit delay. It is best to set the inhibit delay to the largest distance possible, however it can't be set larger than the closest distance that you expect any pair of crystals to be. If the crystals come closer together than the inhibit setting then the receive signal will be ignored, which will lead to erroneous data.

Sometimes it is possible to end up with signals that are difficult for the digital circuit to reliably track. This can cause the signals to have "level shifts". Level shifts are cause when the digital signal is tracking the first riding edge of the crystal signal, but as the signal weakens, it is no longer strong enough for the digital signal to track and starts to track the subsequent waveform edge. On your acquisition hardware you will see this as a positive shift in the dimension trace of about 1-mm. You may be able to correct this by adjusting the sensitivity of the corresponding channel. This can happen when there is a weak acoustic connection between the crystals and the media. The media should have a low attenuation to ultrasound. If the ultrasound signals are heavily attenuated then the signal on the oscilloscope might look like the following figure.

SonoLabDS3 Sampling Rates

The structure of the DS3 data sample may contain three sections:

1. Crystal (TRx) distance data, individual channels being referenced as TR##:## (i.e. TR01:02). Each block of TRx data is a two dimensional matrix with both dimensions being equal to the number of active crystals. Each TRx data element is 16 bit (2 bytes) in size. For a 4 crystal system, a complete data sample would consist of 4 * 4 * 2 (= 32 bytes).
2. Analog data (ADC), consists of 0 to 16 channels of digitized data of 16 bits (2 bytes) for each channel.
3. Auxiliary data (AUX) consists of 0 to 32 channels of 32 bit (4 bytes) of floating point data per channel. In the current SonoLabDS3 systems, only two Auxiliary channels are configurable (c.f. AUX Channel Configuration).

Each data sample that is recorded by the SonoLabDS3 system will contain (in bytes):

(Number of TRx) * (Number of TRx) * 2 + (Number of ADC) * 2 + (Number of AUX) * 4

For a given number of Crystals, we can estimate the amount data that is expected between the DS3 device and the SonoLabDS3 device over the USB 2.0 cable. The following values provide the current upper limits for the DS3 sampling rates based on the number of Crystals (TRx) whilst providing reasonable and reliable throughput:

SonoSOFT Version 5 binary files (.slb, .ssb)

Number of TRx	Lower Limit (Hz)	Upper Limit (Hz)
2	263	7797
3	175	6922
4	131	7767
5	105	6208
6	88	5168
7	75	4425
8	66	2587
9	58	2298
10	53	2067
11	48	1878
12	44	1293
13	40	1193
14	38	1107
15	35	1033
16	33	776
17	31	730
18	29	689
19	28	653
20	26	517
24	22	369
30	17	258
32	16	215

It should be noted that the ability to obtain the higher sampling rates will be dependent on the performance capabilities of the computer system used to run the SonoLabdDS3 software.

DS3 Sampling Rate Calculation

The sampling rate of the DS3 device is given by the following equation:

SamplingRate = (ControlClock) / (NumTx * (CycleLength + NumRx + 2))

where

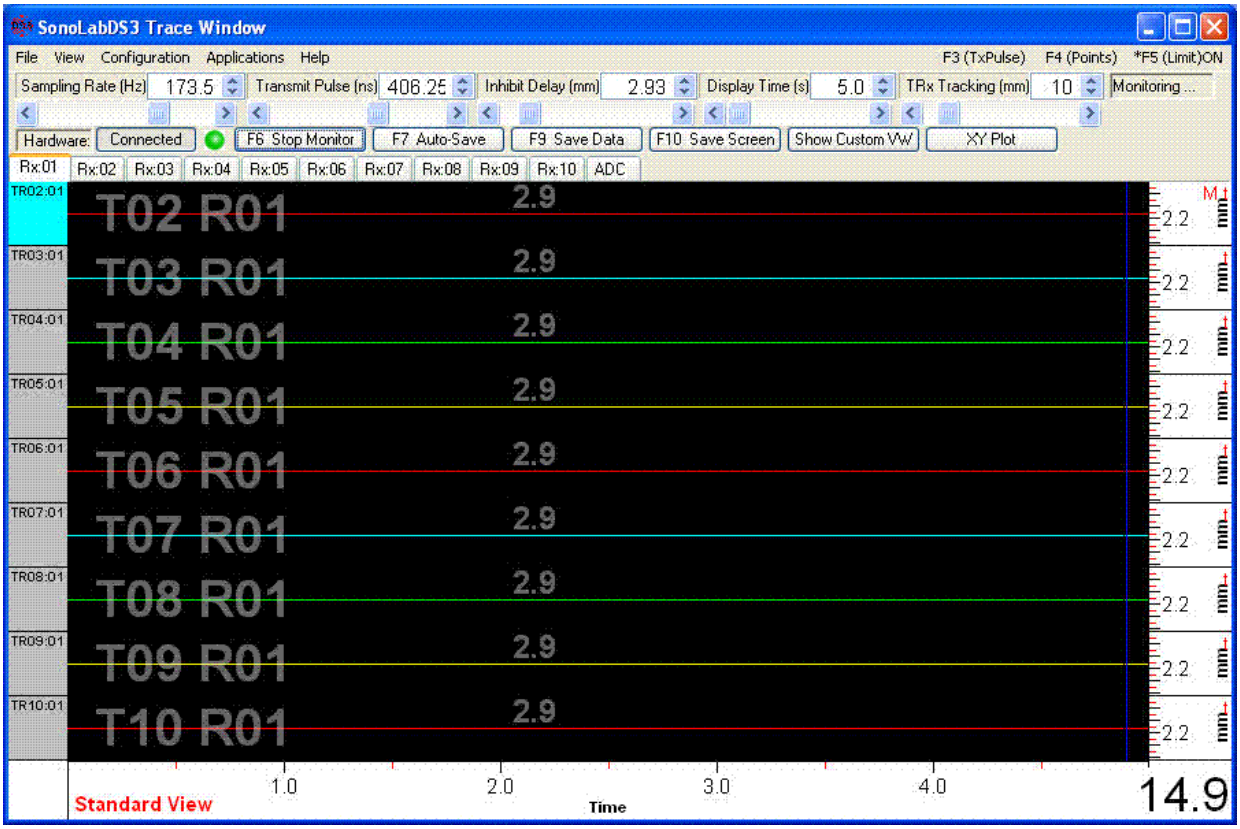
- CountrolClock = 32000000 Hz (32 MHz)
- NumTx is the number of active transmitters
- CycleLength is the number of Control Clock cycles between sequential transmitter excitations during a single sample acquisition
- NumRx is the number of active receivers
- 2 additional Control Clock cycles are required by the DS3 firmware to complete the acquisition process.

Note: for the DS3 device, both the number of transmitters and receivers are sequential sets, starting with crystal number 1. It is possible to configure differing numbers of receivers and transmitters, with the minimum number being 2 and the maximum being the device's maximum number of crystals.

SonoLabDS3 Usage

Main Dialog

Running the SonoLabDS3 Application should result in a window similar to following becoming visible (if multiple SonoLabDS3 configuration files are present in the default startup directory, the File Open Dialog will appear allowing the user to select the configuration to be loaded on startup. Selecting the Cancel on the File Open dialog will result in the default configuration being loaded):



Additional help is available for the System Configuration (Activating the "Configuration" menu item will bring up the System Configuration property pages (c.f .System Properties)):

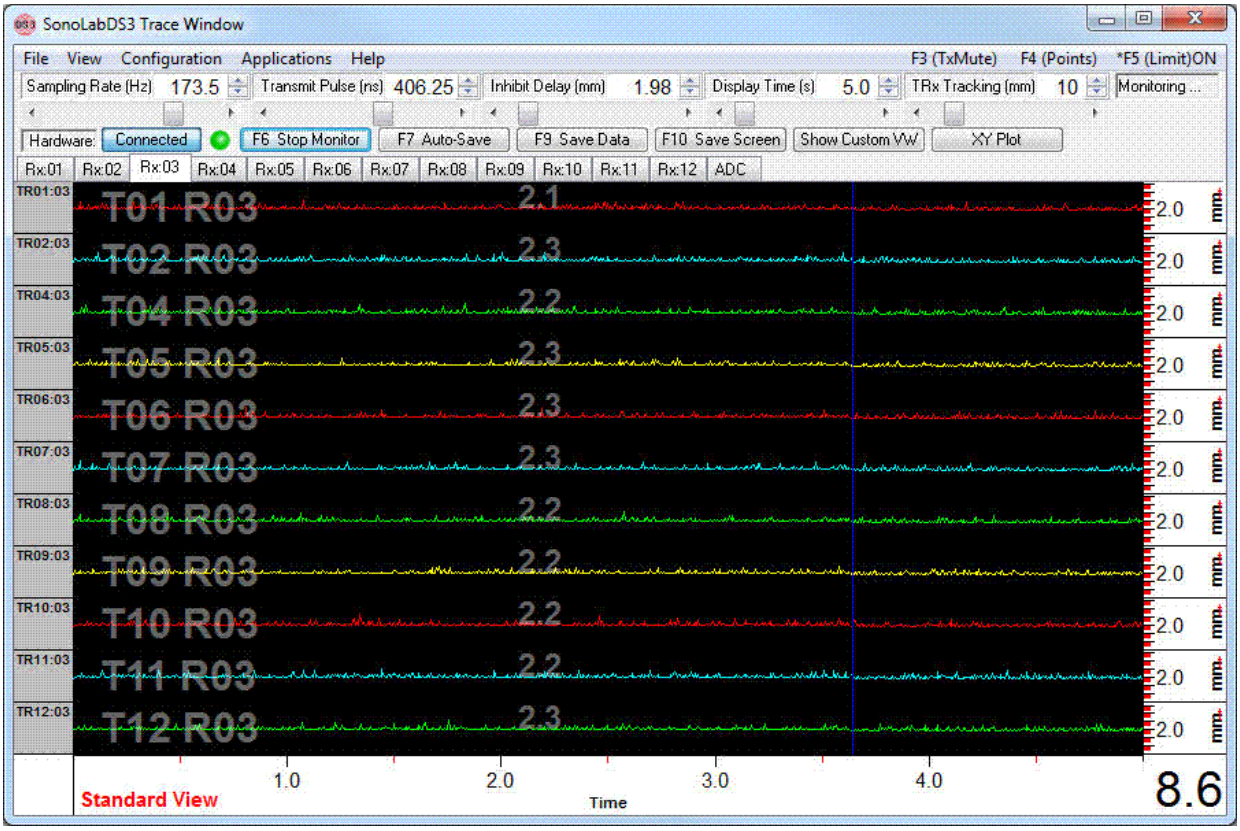
- System Properties
- Crystal Configuration
- AD Channel Configuration
- AUX Channel Configuration
- DAC Channel Configuration
- DIN Option (available only if the DIN option is present)
- File Annotations
- Data File Options
- XY Plot Options (formerly Graph Options)
- Trace Layout Configuration

There is also help for:

- AD Signals
- Custom Display Configuration

Trace Display Window

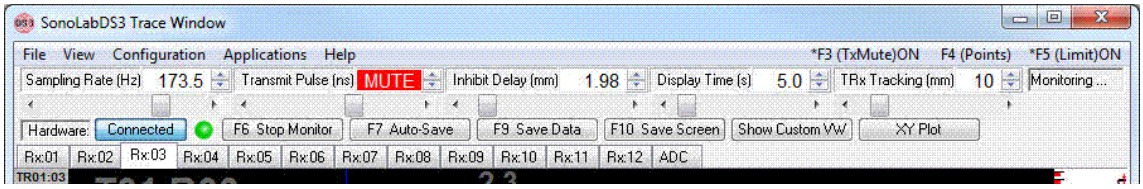
A typical Trace Display window is shown below:



The main features of the Trace Display Window include:

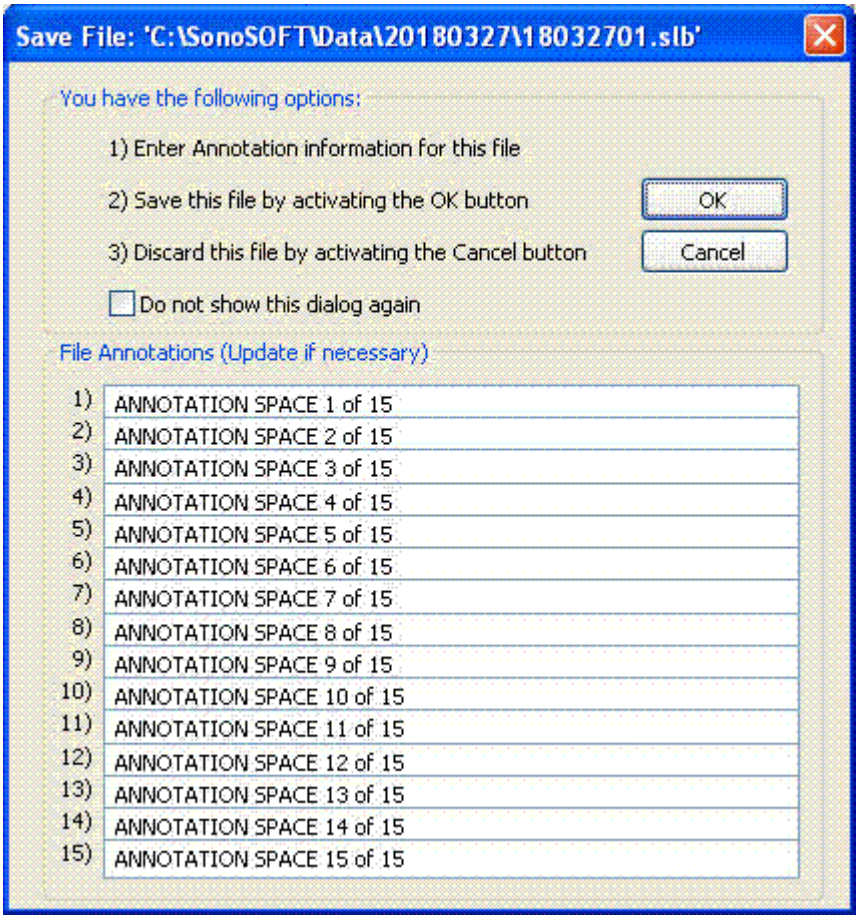
- Adjustment of the Sampling Rate (only in Idle and Monitor modes)
- Adjustment of the Transmit Pulse size (only in Idle and Monitor modes)
- Adjustment of the Inhibit delay (only in Idle and Monitor modes)
- Adjustment of the Trace Display time (1 to 300 seconds)
- Adjustment of the transceiver Tracking value (0.5 to 600 mm)
- Selectable Trace layout (all traces on one page, tabbed TRx traces with AD/AUX traces and all Trace types tabbed (these options are selectable from the Configuration menu popup under the Trace Layout options (see Trace Layout Configuration).
- Individual control of trace and scale parameters (Trace Settings can be accessed by either double clicking on the main body of the trace or by selecting Trace Settings option on the menu displayed when a right click is done on the trace in question).
- Turn trace Auto Scale on or off. This can be accomplished by either double clicking in the scale area of the trace in question or by accessing the trace's Trace Settings dialog (see previous point for methods of access). The Auto Scale feature of a trace is on when there is a Red "a" in the upper right corner of the scale display.
- Adjust the scale settings directly with the mouse. By left click and hold the user is able to drag the scale values up or down. With the mouse cursor within the scale area, rotating the mouse's scroll wheel towards oneself will zoom the scale out. Rotating the mouse's wheel away will zoom the scale in. Additional features are described in the Scale Settings.

- The Custom Display Configuration options are accessible by activating the "View", "Edit Custom Display Dialog" menu sequence. The"Show Custom VW" button toggles the trace display between the Custom (button text: "Show Standard VW") and standard display (button text: "Show Custom VW"). If there is no current custom display configuration, the "Show Custom VW" will bring up the Edit Custom Display dialog.
- "F3 (TxMute)" menu and function key toggles the Transmit Pulse between the user value and the minimum allowable value. The minimum value is active when "*F3 (TxMute)ON" is displayed in the main Trace Window's menu bar and the Transmit Pulse (ns) value is replaced with MUTE ("F3 (TxMute)"along with the Transmit Pulse (ns) numerical value is displayed otherwise). This can be utilized to minimize the signal noise of the crystals. The primary Trace Display Window should appear as follows when *F3 (TxMute)ON" is in effect:



  Each sampling state transition (i.e. from "Monitor" to "Save Data") will reset (turn off) the "TxMute" to the previous Transmit Pulse value. Currently, it is not possible to have the "TxMute" ON across state transitions, it must be manually activated/deactivated during a sampling session.
- "F4 (Points)" menu and function key allows TRx only traces to be switched between the user configured point/line display and strictly point display. The menu will display "F4 (Points)" if in user display mode and "*F4 (Points)ON" if in point mode.
- "F5 (Limit)" menu and function key allows the switching between the traces being able to display over the whole trace display area or bounded within their own trace area. The menu will display "F5 (Limit)" if in whole trace display mode and "*F5 (Limit)ON" if in bounded mode.

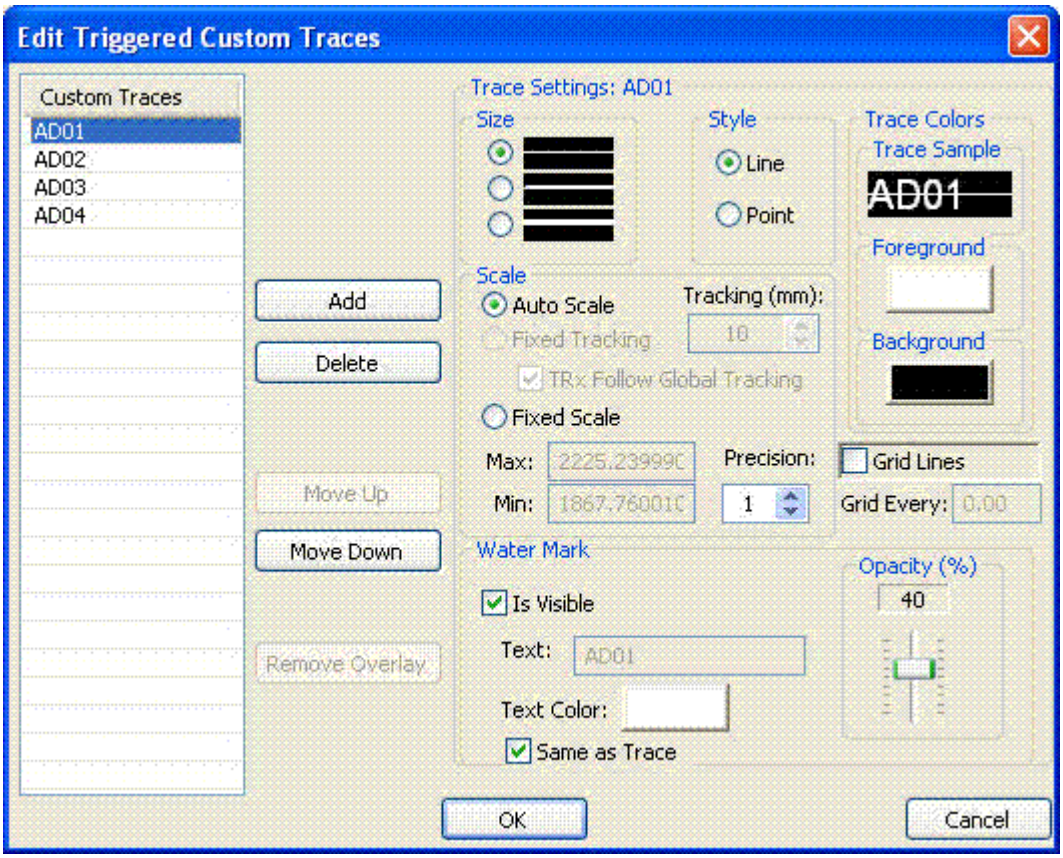
The initial operation of the SonoLabDS3 upon the completion of a Save Data operation (Auto Save, Save Data or Save Screen) will present the following confirmation window



If "Cancel" is pressed. the file 17101201.slb is deleted, however, any Event Markers generated during the save operation will still be recorded in the base Even Marker file (171012.mrk). The Event Marker directly associated with the deleted ".slb" file is also deleted (17101201.mrk). See Event Marker File for more details. Note that this confirmation window can be disabled for subsequent save operations during the current SonoLabDS3 session by checking the "Do not show this dialog again" check box.

Custom Display Configuration

When a user first activates the "Show Custom VW" button on the Trace Display Window the following Edit Custom Traces dialog will appear (provided that a previous Custom display configuration does not exist).

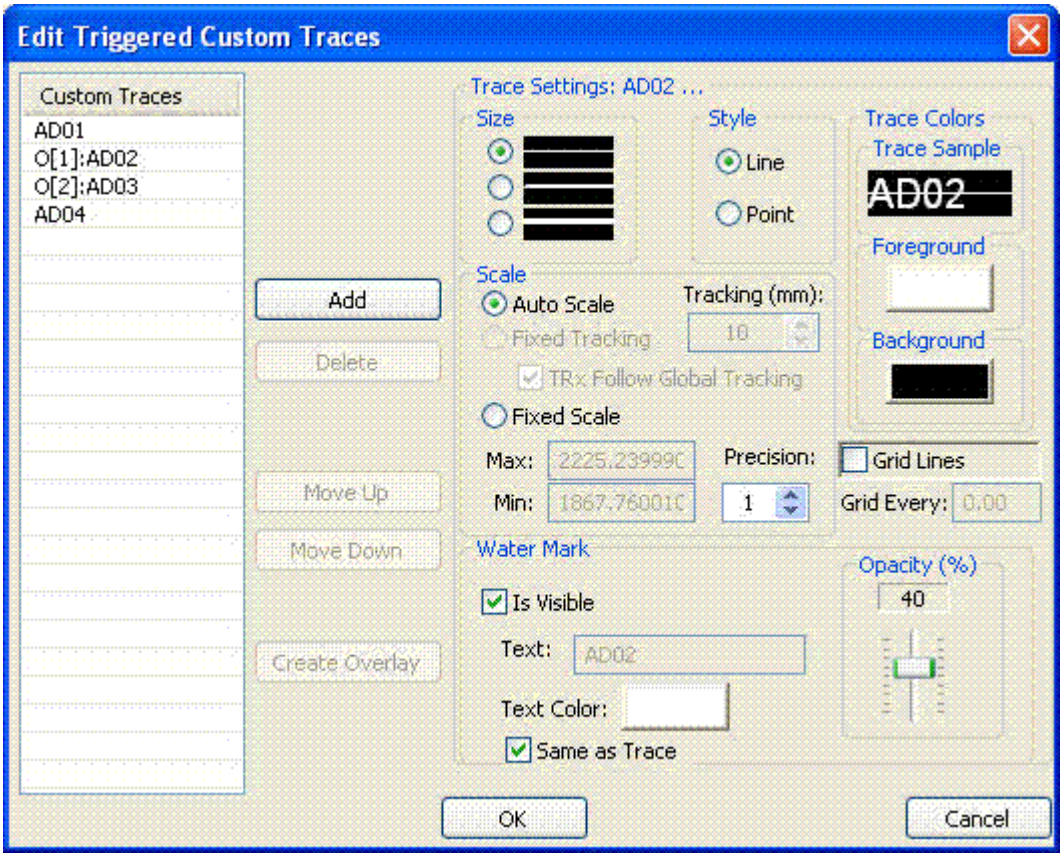


The user is able to define a custom trace display where the order and appearance of traces is configurable to the user's specifications.

AD Trace Overlay

It is possible to configure the overlaying of AD traces in the Custom display either by using the Edit Custom Traces dialog or by utilizing the popup menu items on the Custom display. Both methods are briefly examined below.

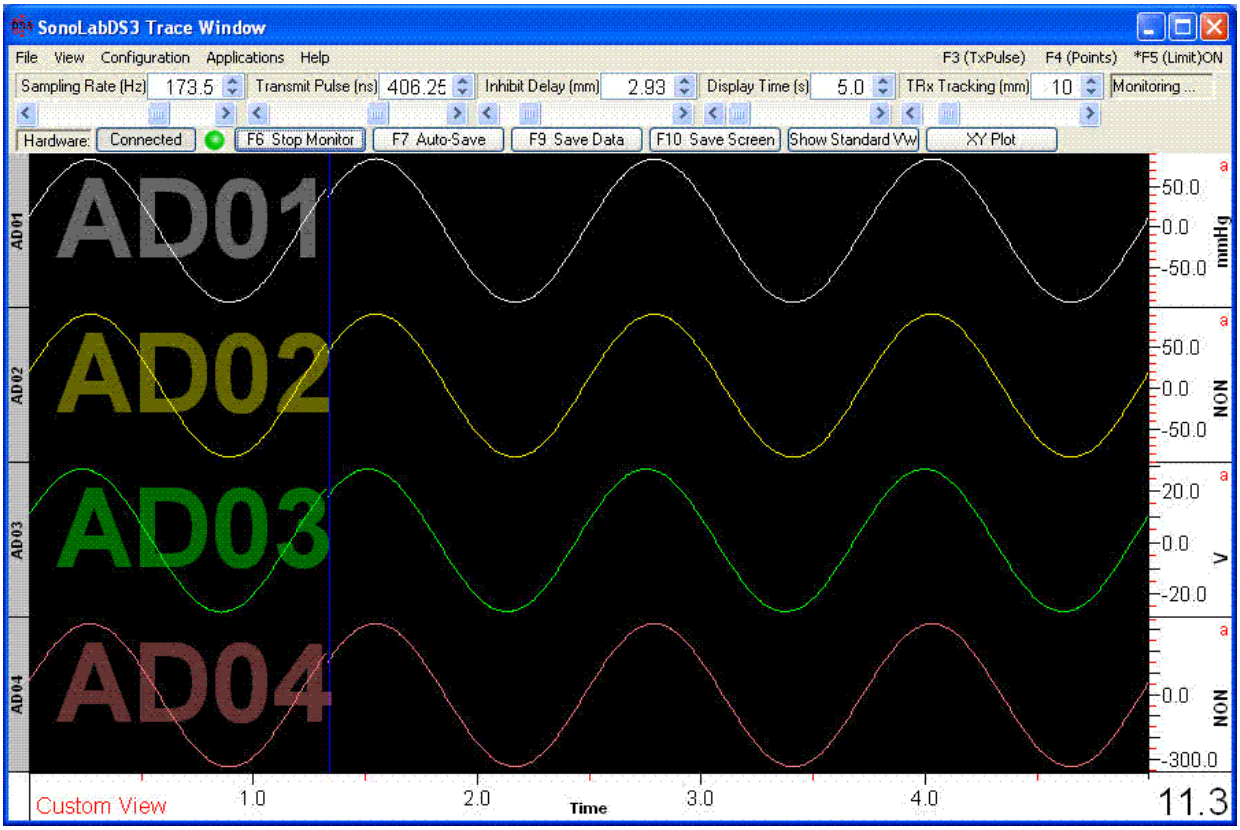
In the Edit Custom Traces dialog, the user must select a sequential set of two or more AD traces and then activate the "Create Overlay" button. For instance having selected AD02 and AD03 in the above figure and then activating the "Create Overlay" button, the updated dialog appears as follows (note that the overlayed traces:have the prefix "O[#]"). Selecting the Custom Traces labeled "O[1]:AD02" and "O[2]:AD03", will update the overlay button to read as "Remove Overlay". If activated, the resulting dialog would appear as above.



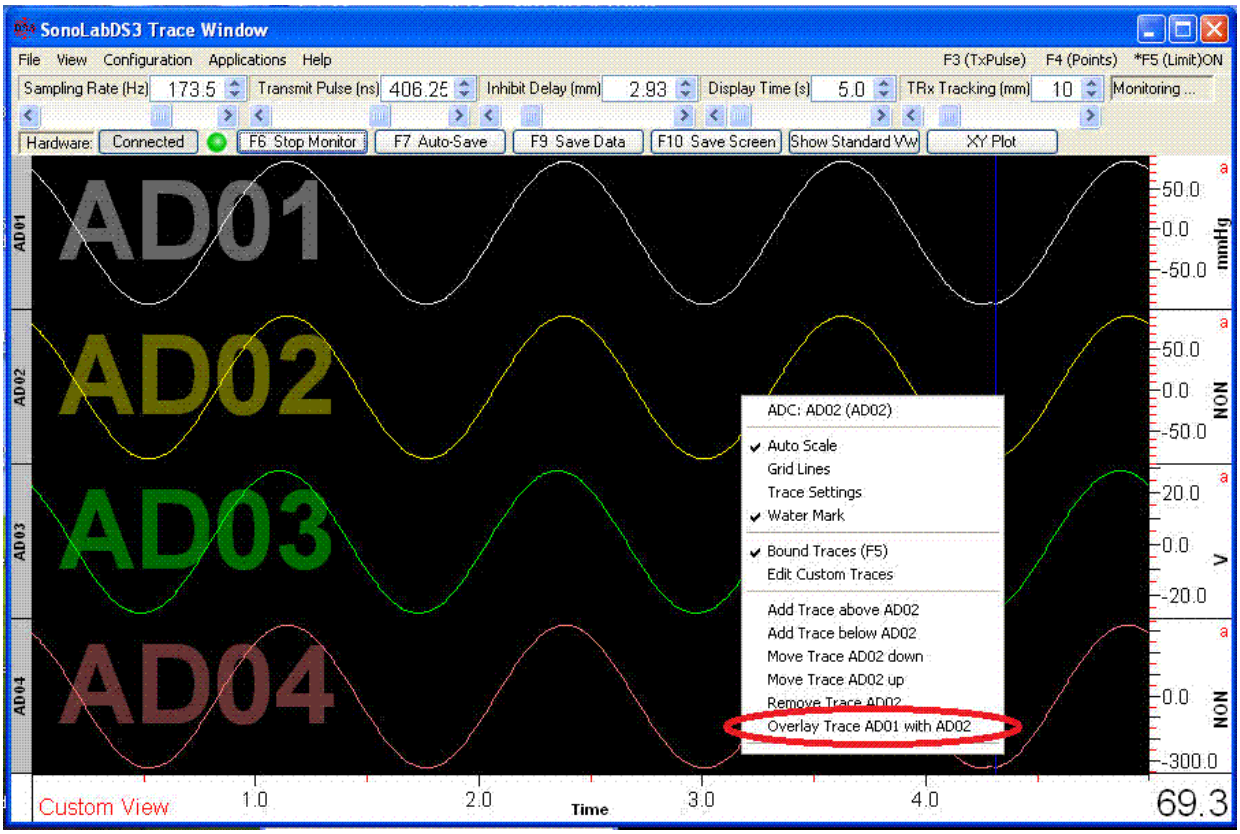
The following is a sequence showing how to overlay sequential AD traces in the Custom Display utilizing the trace popup window commands. The steps shown are as follows:

1. Initial Custom Display with four AD traces
2. Right click on AD02 and select "Overlay Trace AD01 with AD02" (the overlay operation can only be done for a non-overlay AD trace with an AD trace or overly above the non-overlay trace.
3. The resulting display with the overlay, NOTE the pink shading on the left hand heading of the overlay trace
4. Left single click on the overlay trace initially labeled as AD01, brings AD02 to the forefront of the overlay trace. The user is able to right click on the overlay trace and bring up the trace settings for the forefront trace in the overlay. Clicking on the overlay trace will cycle through the traces in the overlay. NOTE: double clicking is not available for overlay traces.
5. Right click on AD03 and select "Overlay Trace AD01 with AD03", note that even through AD02 is at the forefront, AD01 is the nearest neighbor to AD03 in the overlay.
6. After adjusting the scale for AD03, the overlay trace now has AD01, AD02 and AD03, with AD03 at the forefront.
7. With AD03 at the forefront of the overlay, right clicking on the overlay, select "Undo overlay for AD03"
8. The result has AD03 now before the overlay trace. The undoing of the overlay by the popup menu will remove the forefront trace from the overlay and place it above the overlay.

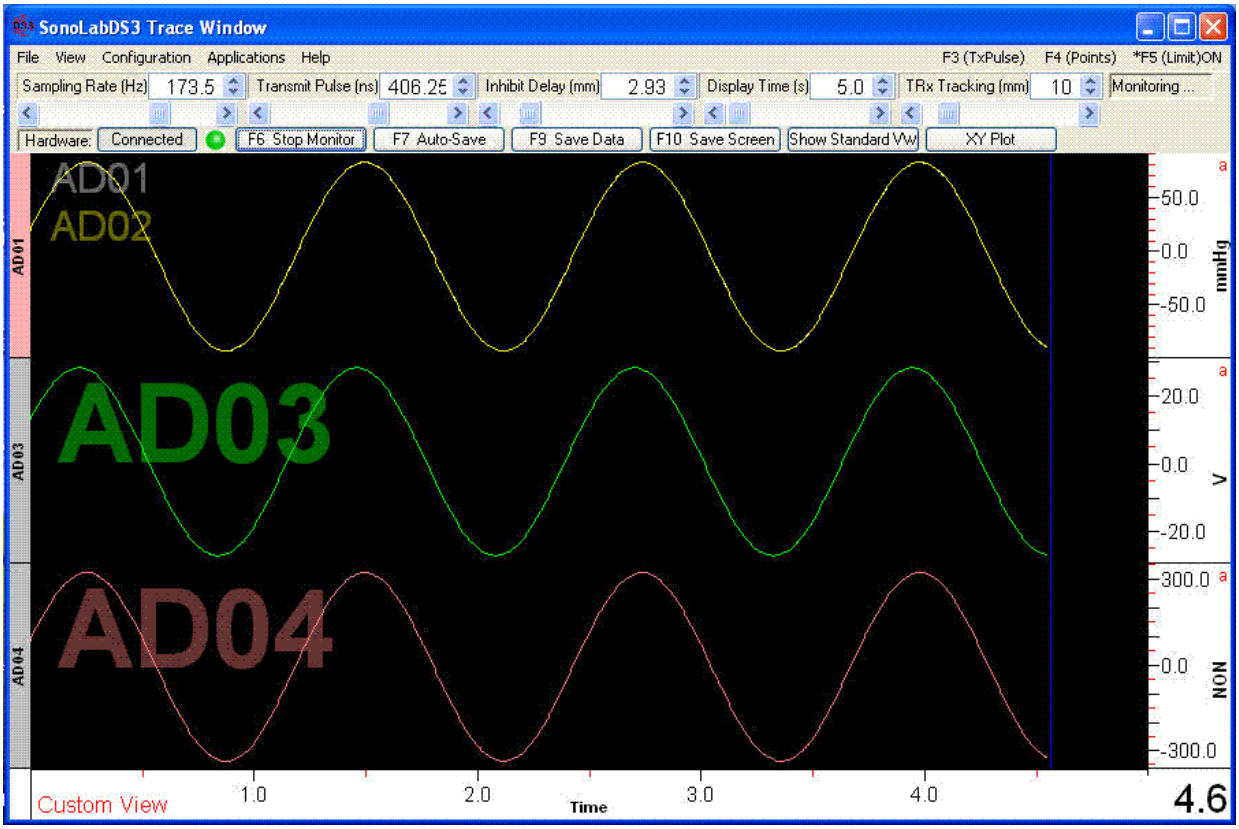
It should be noted that it is possible to have multiple overlay traces provided there are sufficient AD traces..
1) Initial Custom Display with four AD traces



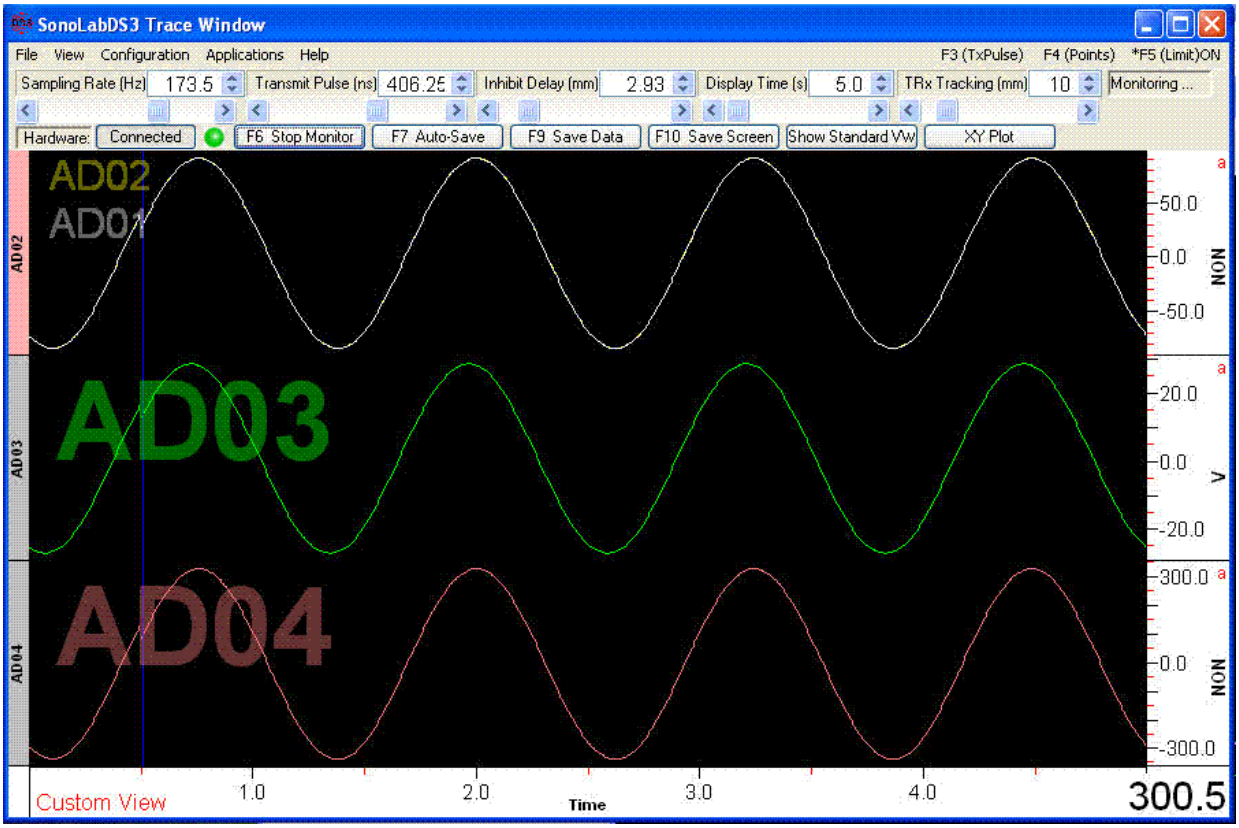
2) Right click on AD02 and select "Overlay Trace AD01 with AD02" (the overlay operation can only be done for a non-overlay AD trace with an AD trace or overly above the non-overlay trace.



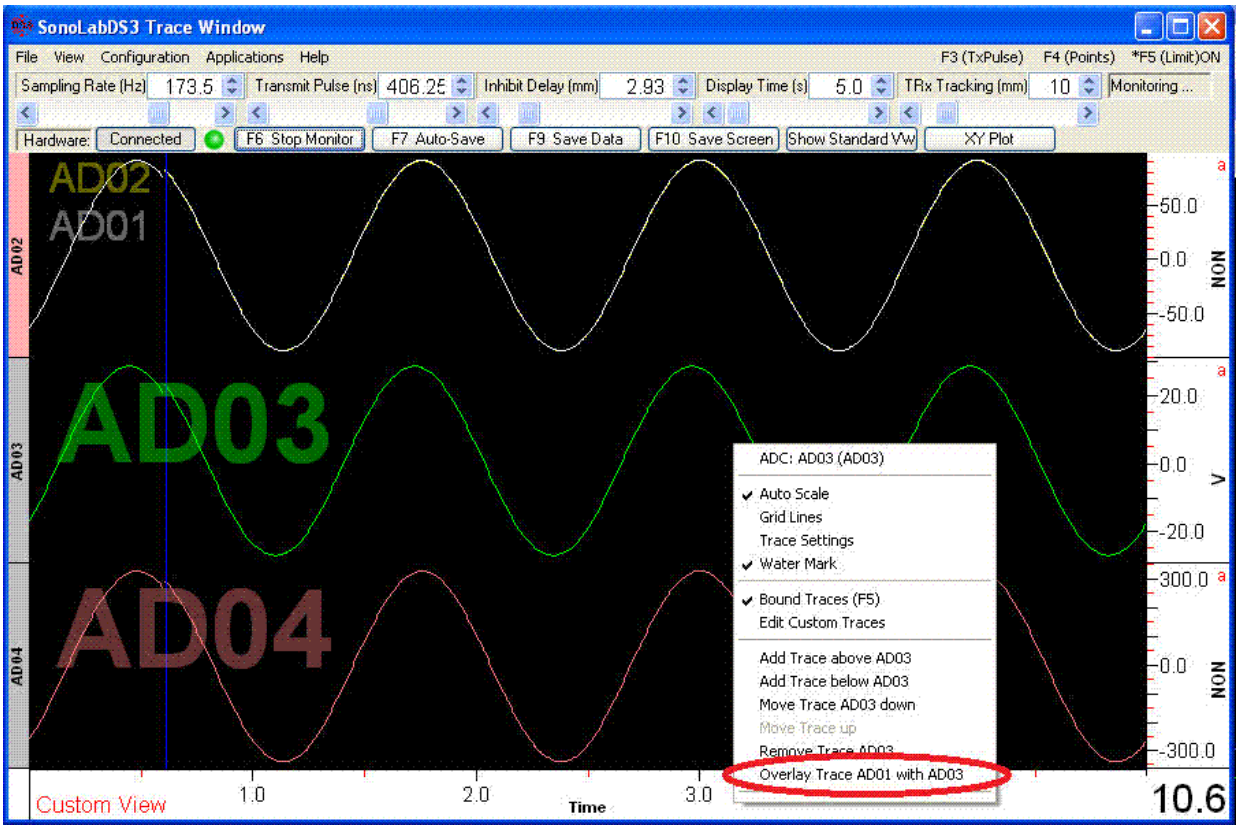
3) The resulting display with the overlay, NOTE the pink shading on the left hand heading of the overlay trace, also in the overlay the traces are listed in the watermark with the top most trace name being the active trace with respect to the overlay's scale (in this case AD01).



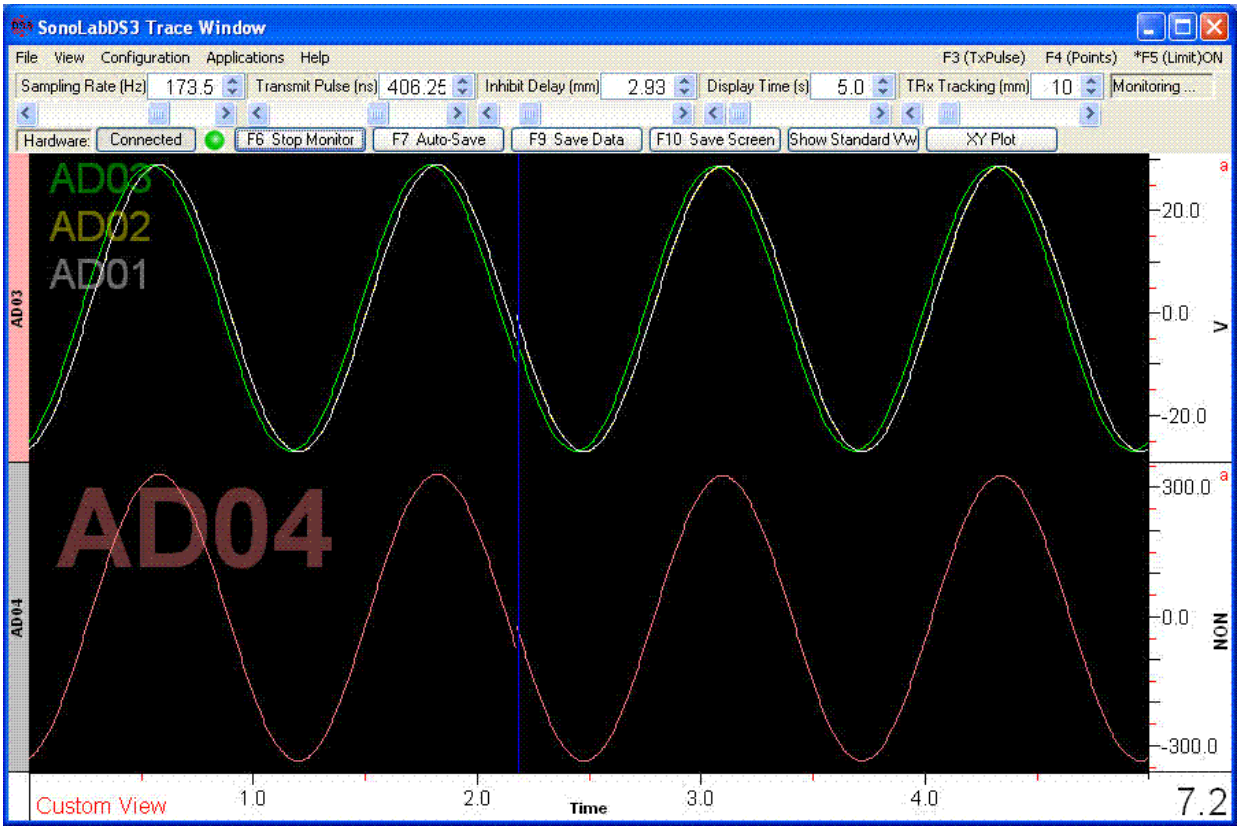
4) Left single click on the overlay trace initially labeled as AD01, brings AD02 to the forefront of the overlay trace. The user is able to right click on the overlay trace and bring up the trace settings for the forefront trace in the overlay. Clicking on the overlay trace will cycle through the traces in the overlay. NOTE: double clicking is not available for overlay traces.



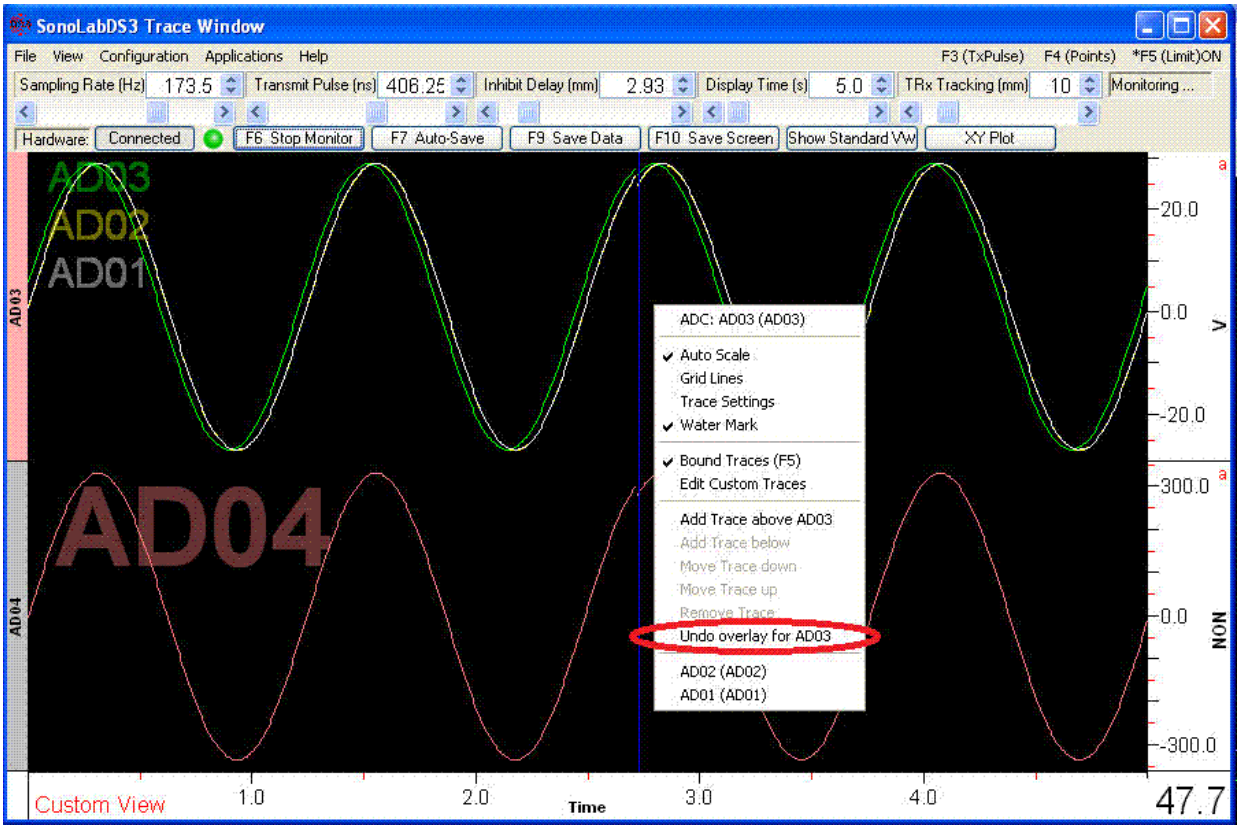
5) Right click on AD03 and select "Overlay Trace AD01 with AD03", note that even through AD02 is at the forefront, AD01 is the nearest neighbor to AD03 in the overlay.



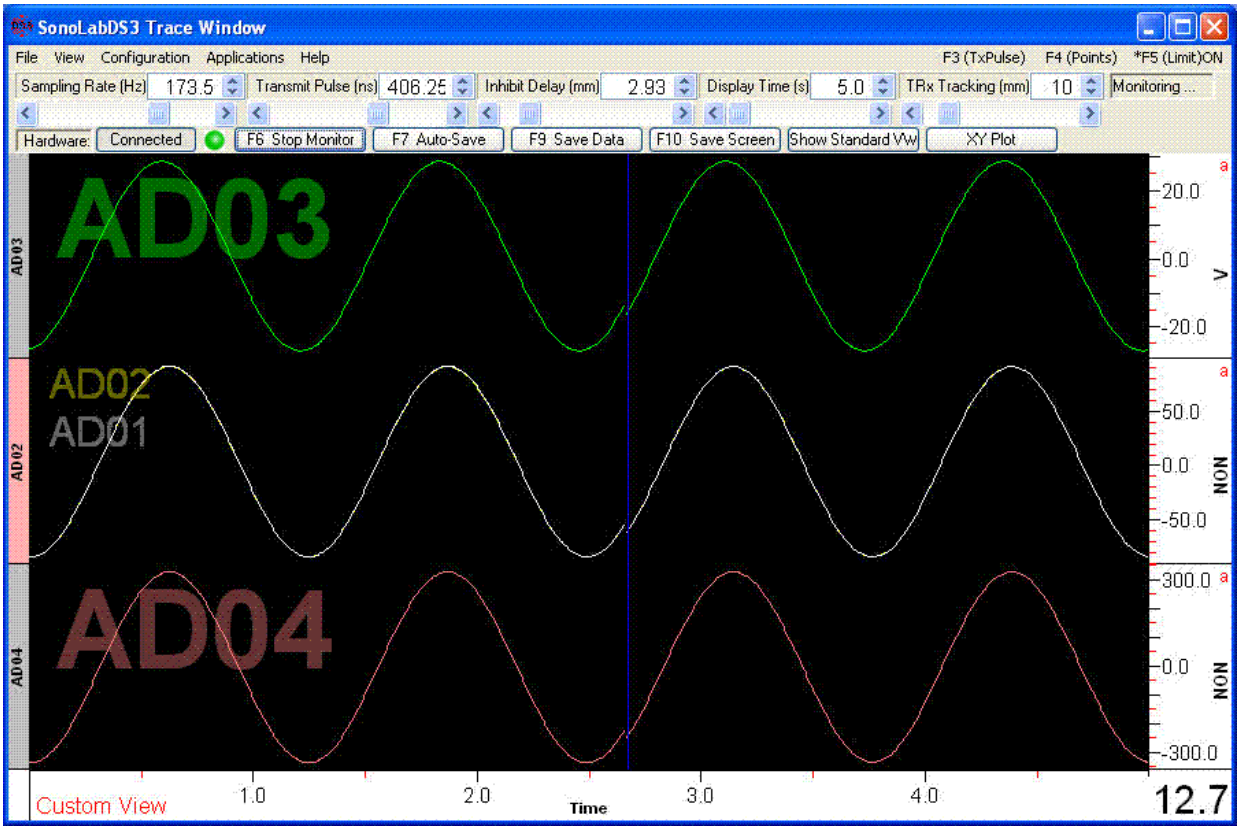
6) After adjusting the scale for AD03, the overlay trace now has AD01, AD02 and AD03, with AD03 at the forefront.



7) With AD03 at the forefront of the overlay, right clicking on the overlay, select "Undo overlay for AD03"



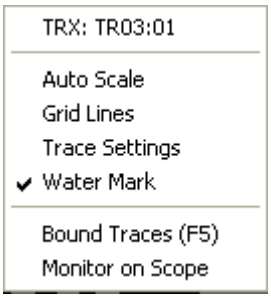
8) The result has AD03 now before the overlay trace. The undoing of the overlay by the popup menu will remove the forefront trace from the overlay and place it above the overlay.



The above layout changes could have also been accomplished in the Edit Custom Traces dialog.

Trace Popup Menu

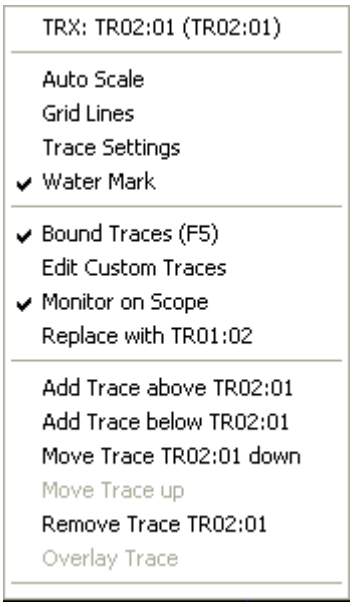
A popup menu similar to the following should appear when one right clicks in the main body of a trace.



It provides access to the following line options or information:

1. The first line contains an information field showing the selected traces name
2. The next line shows the current state of the Auto Scale feature for the trace. Clicking or selecting this option will toggle the Auto Scale state.
3. The displayed Grid Lines can be turned off or on by clicking or selecting the third option
4. Clicking or selecting the Trace Settings, the Trace Settings dialog is opened.
5. Clicking or selecting the Water Mark option will toggle the visibility of the Water Mark text for the given trace
6. Clicking on the "Bound Traces (F5)" toggles all traces between displaying strictly within its own trace boundaries or within the boundaries of the trace display window
7. This is only enabled for TRx traces. Clicking or selecting this option will cause the specified TRx trace's triggering signal to be presented on the Scope output.

For the Custom View Display, the Trace popup menu appears as follows:



Notes:

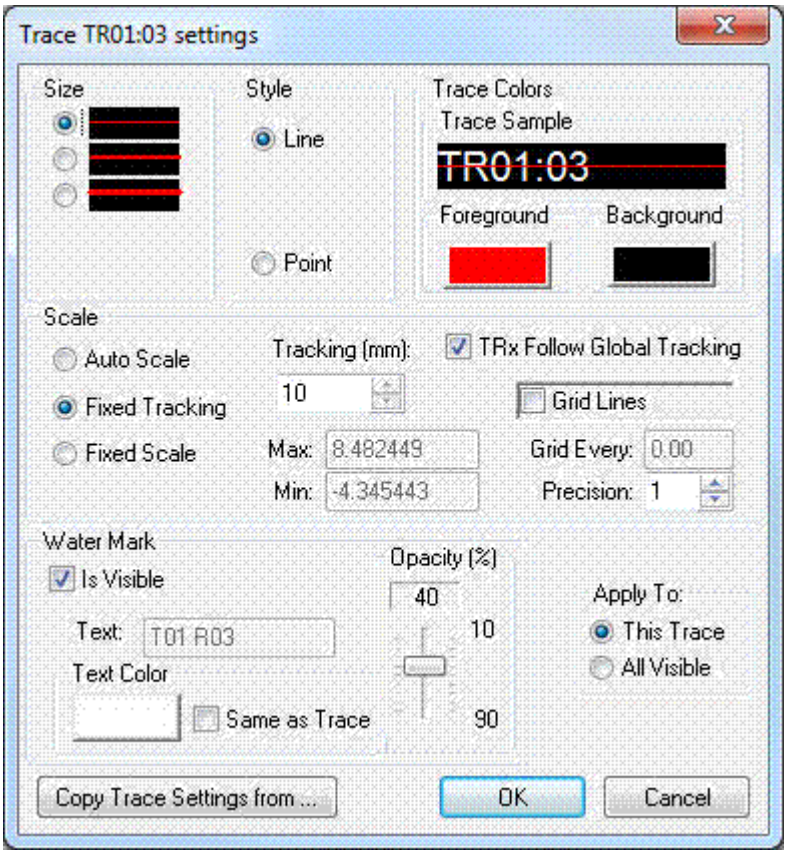
- for the Custom View Displays, there are additional menu items allowing the user to add, move, select and remove traces.
- for overlayed traces in the Custom View Display configuration, the Trace popup will display the other traces in the overlay set as items at the bottom of the popup. Selecting one of these items will refresh the popup so that the newly selected overlay trace's parameters are available (the popup header will change to the selected overlay trace, c.f. Custom Display Configuration for an example).
- for TRx traces on a Custom View Display, it is possible to Replace the current TRx trace with its reciprocal (in this example, we could Replace TR02:01 with TR01:02)

Trace Settings

The Trace Settings dialog can be accessed by doing one of the following operations on the Trace Display Window:

1. Double-click on the main trace body of the trace (using left mouse button)
2. Right-click on the main body of the trace and select "Trace Settings" in the popup menu

Either method should subsequently show the following dialog:



The user is able to adjust the following trace parameters:

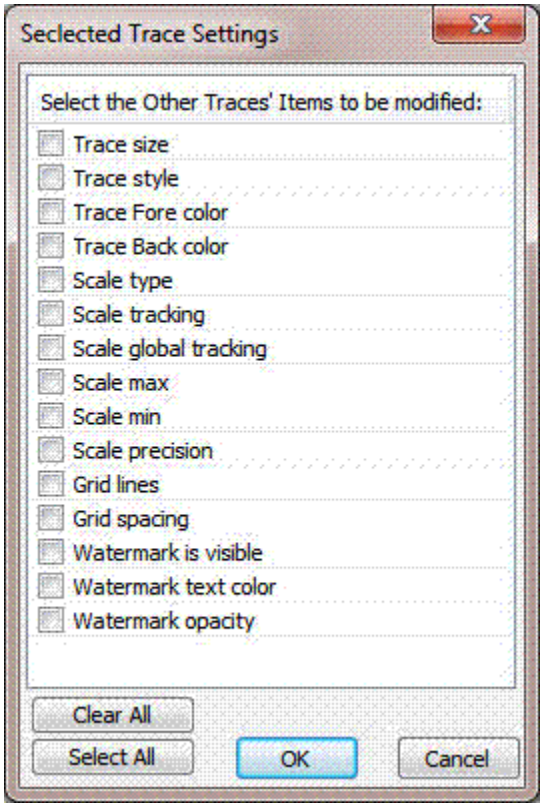
- Trace body parameters
  - Size - the size of the line or points representing the data values on the trace
  - Style - whether the data is draw as a continuous line or as individual points
  - Trace Colors - user selectable fore and/or background color
  - Grid Lines and Spacing
- Scale settings
  - Auto Scale
    - when selected, the upper and lower values of the units are adjusted to fit the displayed data
  - Fixed Tracking (TRx traces only)
    - when selected, and if the "TRx Follow Global Tracking" is unchecked, the spin button for the "Tracking (mm)" is enabled and the user is able to adjust the Tracking value for this trace only.
  - Fixed Scale
    - when selected, the "Max:" and "Min:" values of the scale can be manually entered for this trace.
    - user can select the periodicity of the grid lines, 0 defaults to system periodicity.
  - Precision - the number of decimal places to display in the scale for this trace
- Water Mark parameters
  - Visibility - if checked the watermark is displayed

- Text Color - the foreground color is user selectable. The background color is set to the trace background color. If the "Sane as Trace" check box is checked, then the watermark's name field will be the same color as the trace.
- Opacity - the level of transparency of the watermark, a value between 10 (most transparent) and 90 (least transparent) percent\

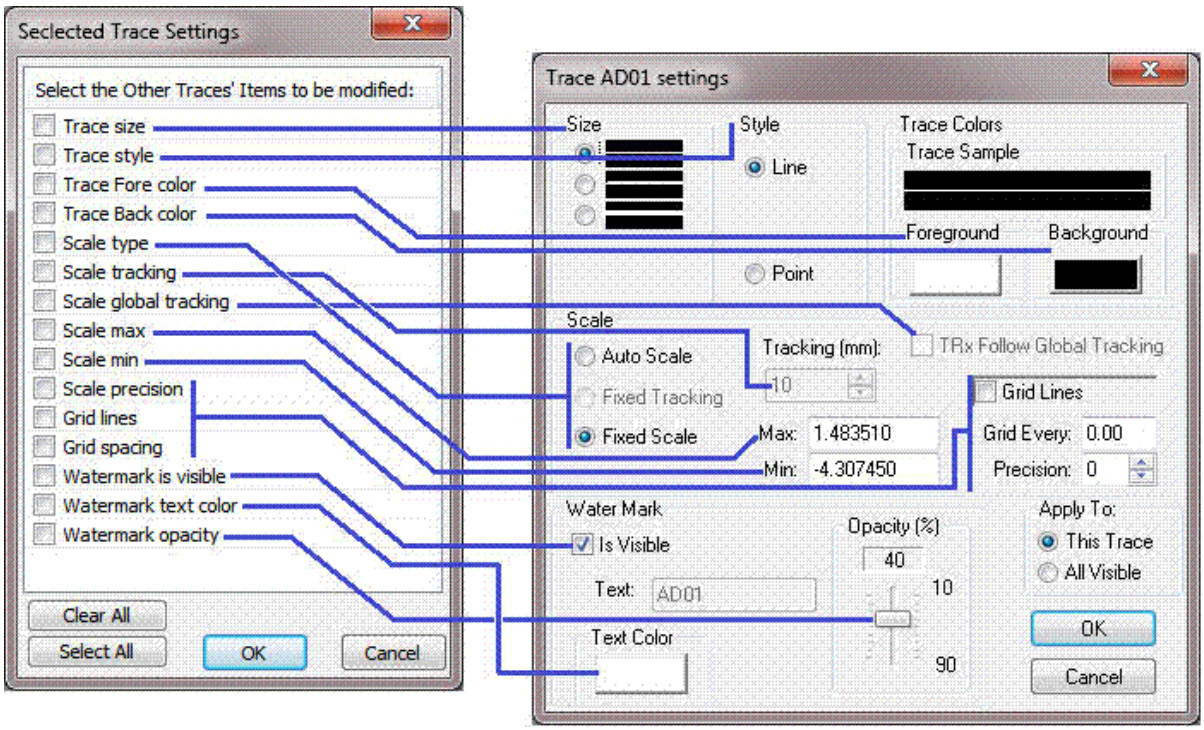
- Copy settings from another trace in the current configuration (see Copy Trace Settings below)

Above the "OK" button, the user is able to select that the trace settings as shown in this Trace Settings dialog will be applied to the current trace ("This Trace", default) only or to all traces visible in the current view of the Trace Display window ("All Visible").

Activating the "All Visible" radio button will bring up the following Trace Settings Selection dialog:



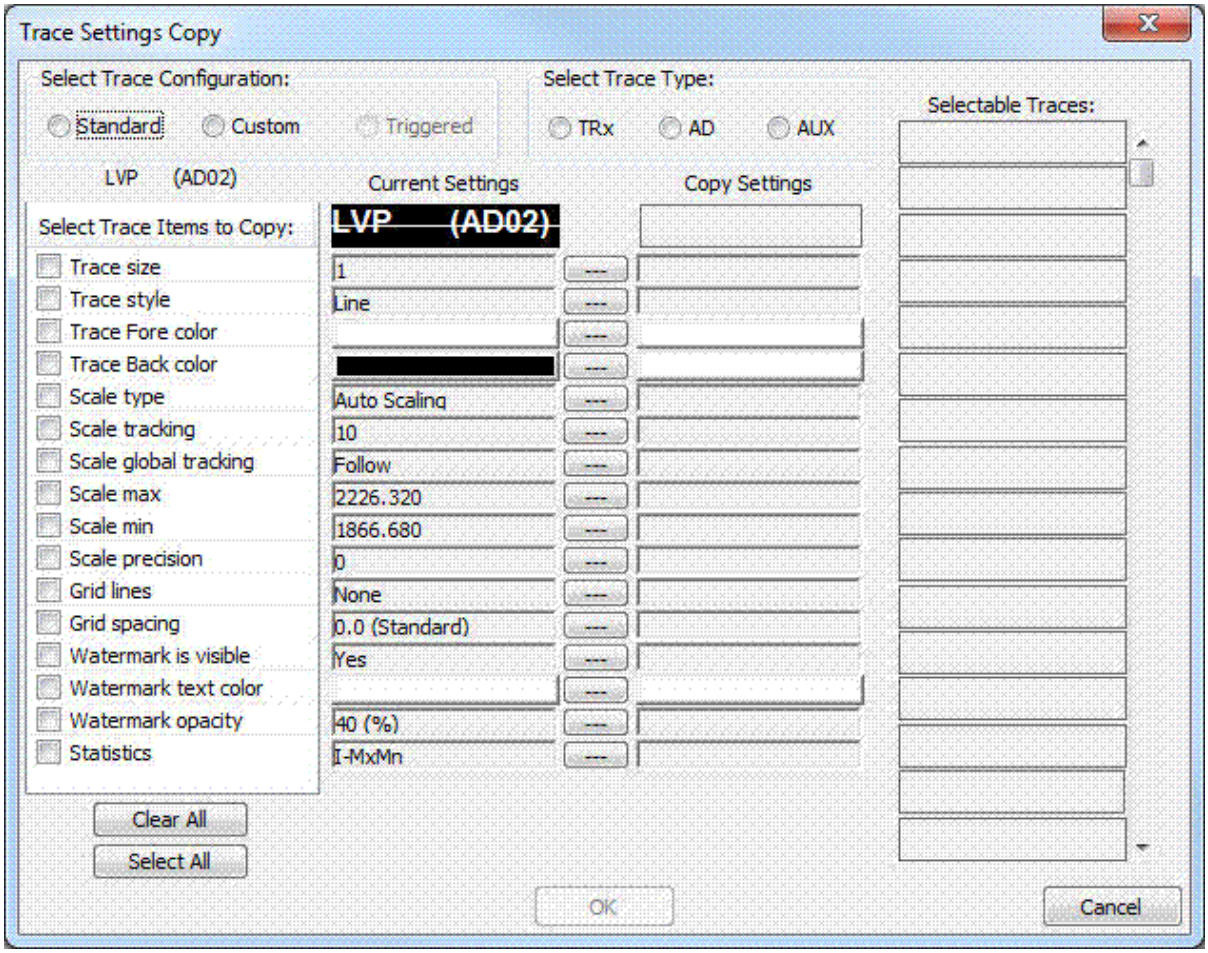
The user is able to select which of the Trace Setting items will be duplicated on the other visible traces by checking the appropriate items. By default, none of the items are selected the first time The various selectable items reference the following sections of the Trace Settings dialog:



NOTE: When using the "All Visible" option, Scale related items will only be copied (provided that the "Scale type".is unchecked) to other traces that have the same Scale type (Auto Scale, Fixed Tracking, Fixed Scale) as the current Trace being modified in the Trace Settings dialog.

Copying Trace Settings

Activating the "Copy Trace Settings from ..." button will display a dialog similar to:

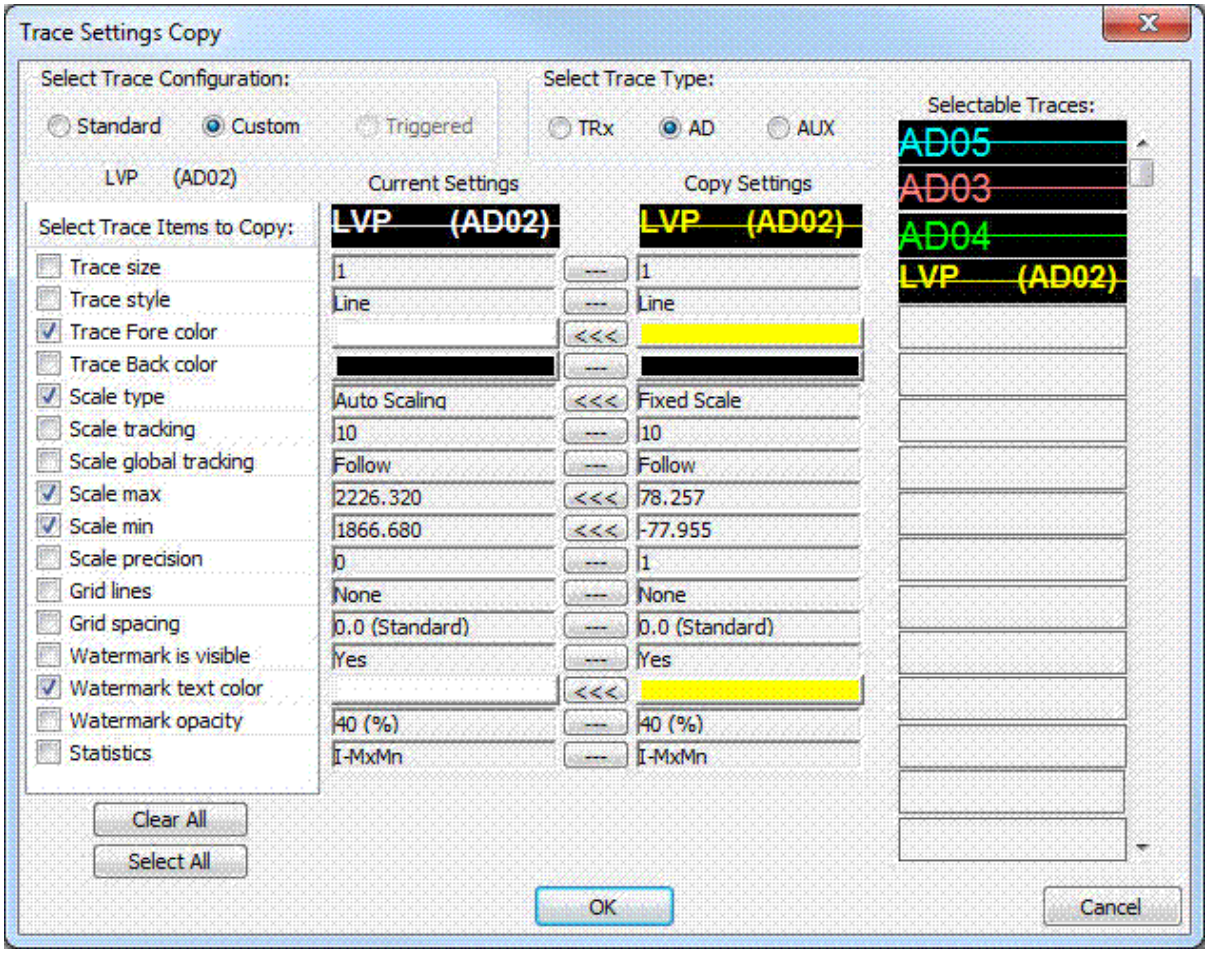


As an example, having defined the desired settings for the AD channel LVP (AD02) in the Custom display, it is possible to now simply copy the selected settings to another trace. In this example, we desire that the LVP (AD02) trace on the Standard View will appear the same as in the Custom View.

The following steps were taken in this example:

1. Select the Trace Configuration "Custom"
2. Select Trace Type "AD"
3. Select source trace from desired trace shown in the Selectable Traces
4. Select the desired Items (Settings) to be copied

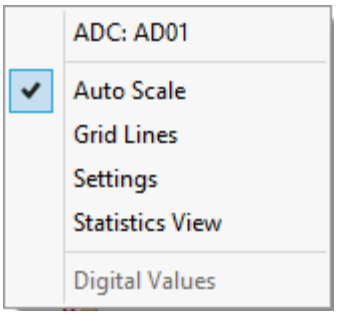
The result:



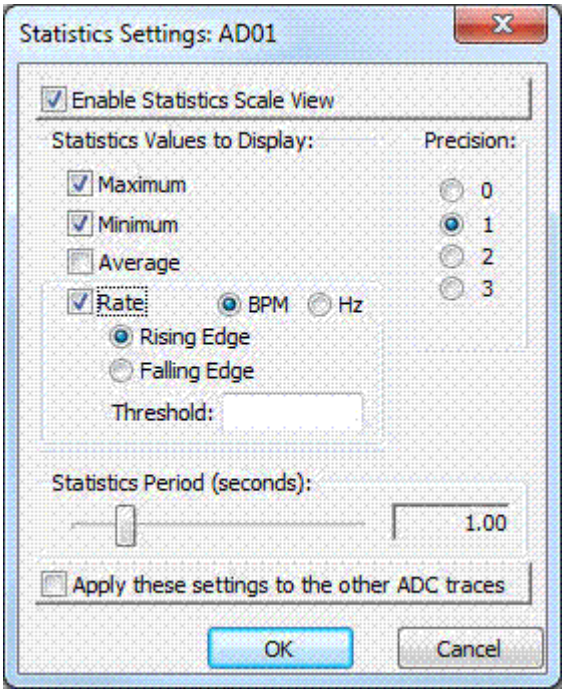
Activating the OK will cause the LVP (AD02) on the Standard View to adopt the selected color and scale settings as the selected Custom trace. Cancel will dismiss the dialog and leave the setting unchanged.

Scale Settings

The Scale Popup Menu will be displayed when the user right clicks on the scale area of a trace. The typical Scale Popup menu appears as follows:



This menu is similar to the Trace Popup Menu , except that it has "Statistics View" and "Digital Values" menu items. The "Statistics View" menu item is only available for AD traces. If the ."Statistics View" menu item is available, selecting this menu item should bring up the following Statistics Settings dialog:

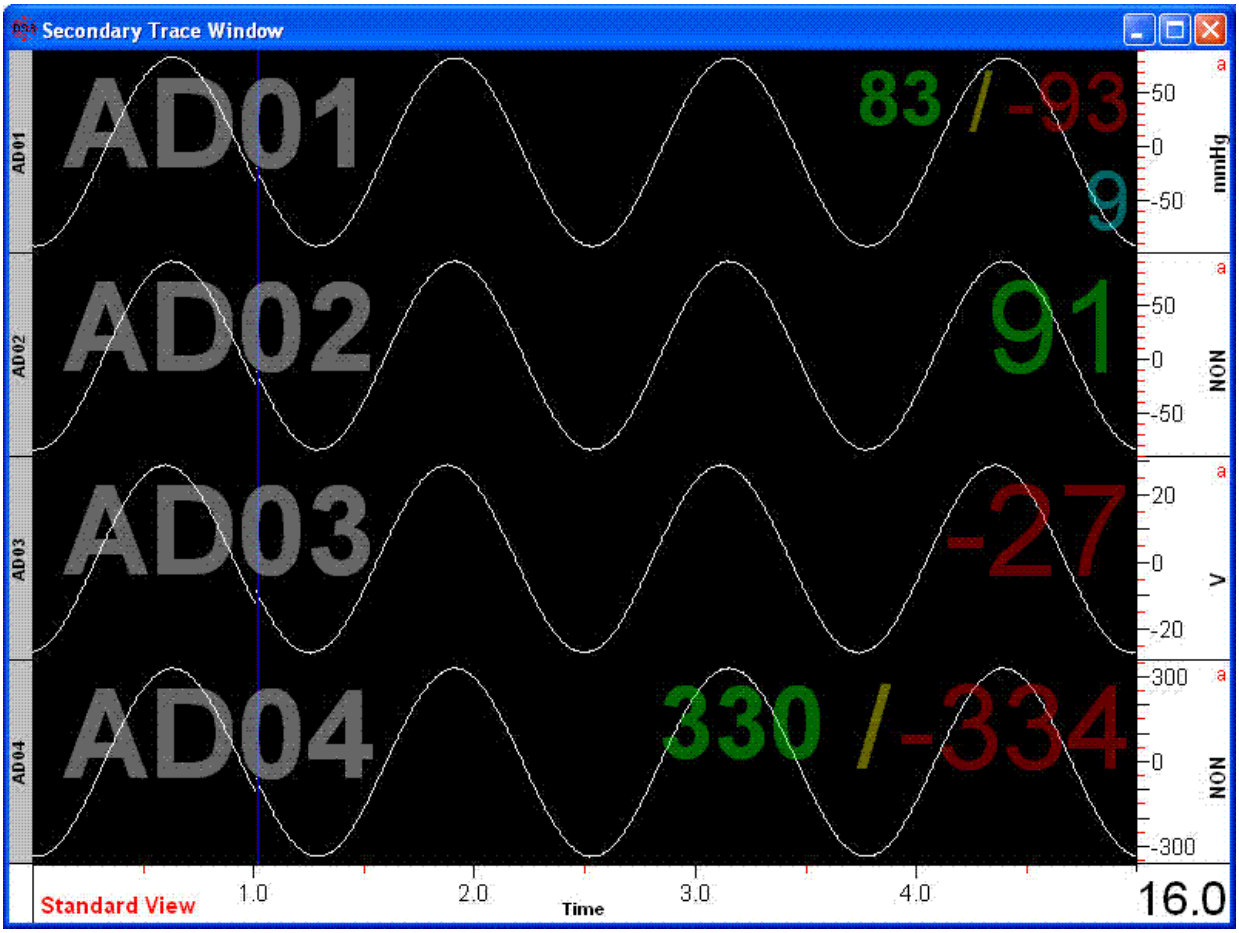


To enable the Statistic View for the selected AD channel, check the "Enable Statistics Scale View". Then select one or more of the "Maximum", 'Minimum", "Average" or "Rate" values to display (default is "Maximum" and "Minimum" only), the "Precision" and the "Statistics Period (seconds)".

For the Rate the user is able to select the detection on the Rising or Falling edge of signal at a specified threshold. Also, the user is able to select whether the Rate is displayed in hertz (Hz) or beats per minute (BPM). If a threshold value is not provided the rate algorithm uses the average value of the signal for the given period. The Rate is the average of the last ten threshold transitions recorded. The Rate is displayed in yellow.

The Statistics View can be enabled individually for each AD trace or collectively (by checking the "Apply these settings to the other ADC traces" check box).

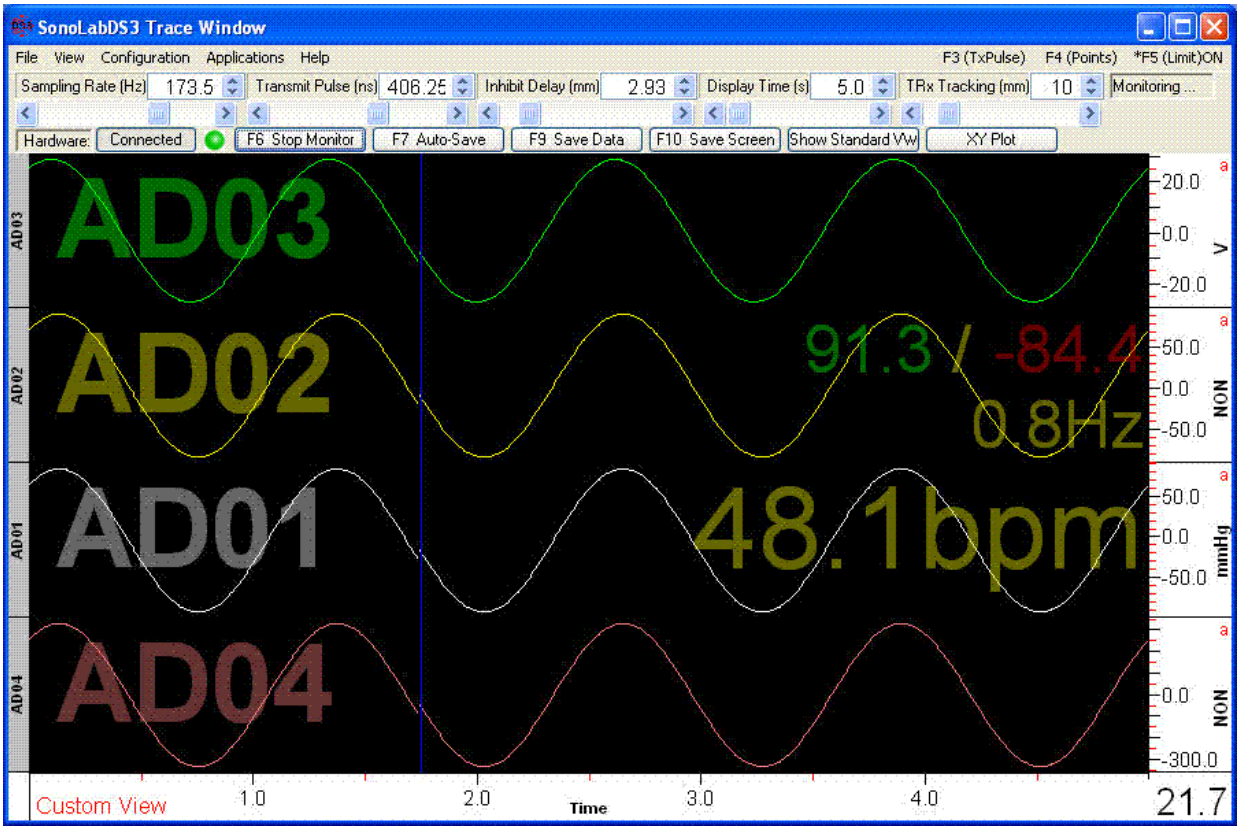
The Statistics Scale View should appear similar to the following screen:



In the above screen the following values were defined:

Channel	Maximum (green)	Minimum (red)	Average (light blue)
AD01	X	X	X
AD02	X		
AD03		X	
AD04	X	X	

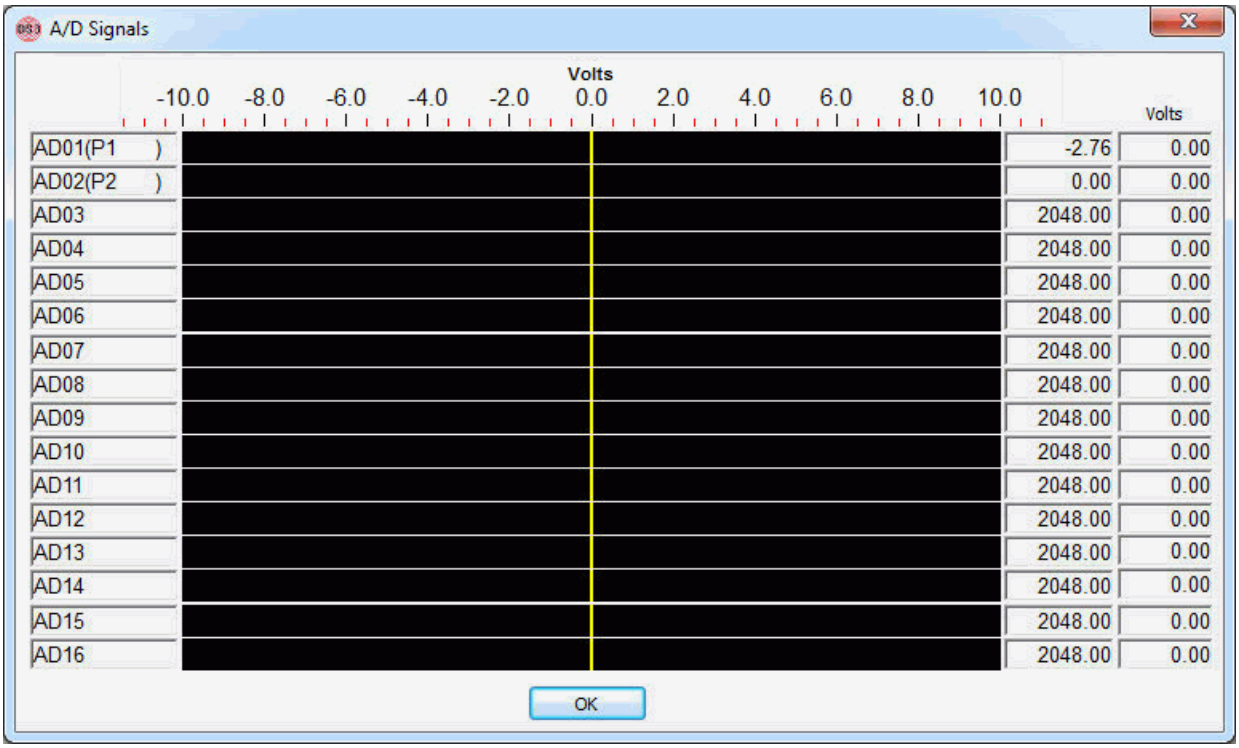
A screen shot with Rates is shown below:



Note that if using a Custom Display with overlayed traces, the top-most's trace statistic will be displayed in the overlay set In the above example, AD02 is showing the Max, Min and Rate in Hz, and AD01 is showing the Rate in BPM.

AD Signals Window

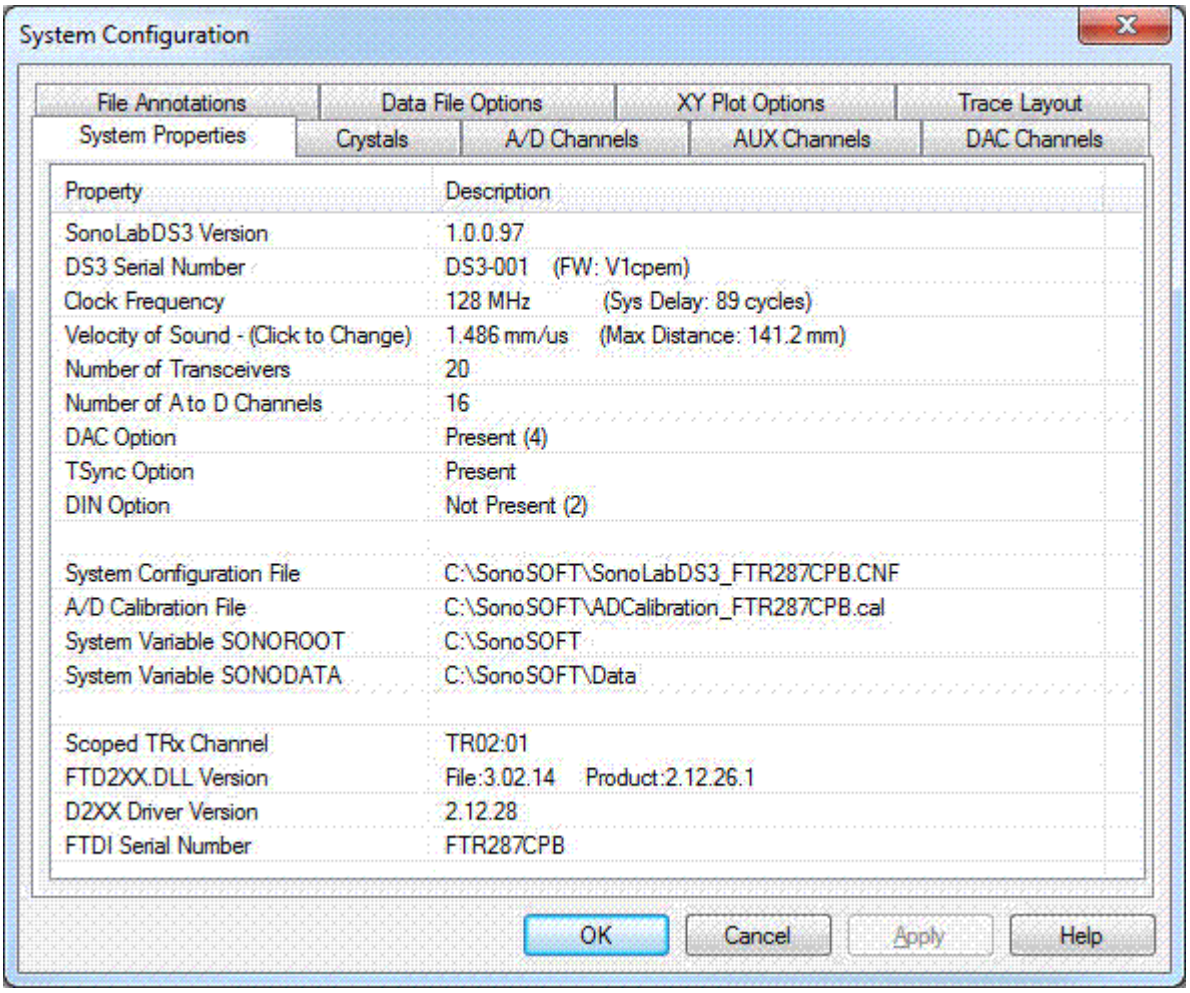
The A/D Signals window provides a simplified display for quick inspection of the A/D signals being received by the DS3 hardware. The A/D Signals window is activated by selecting the "View", "A/D Signals" menu item on the main SonoLabDS3 Trace Window and should be similar to the following:



The yellow lines indicate the signal levels for each of the active AD channels. The non-active channels are greyed out. The voltage scale across the top is valid only for channels with a gain of 1.

System Properties

The system properties page provides information on the DS3 model configuration and can be accessed by selecting the "Configuration" menu item on the Main Trace window. The page similar to the following should appear:



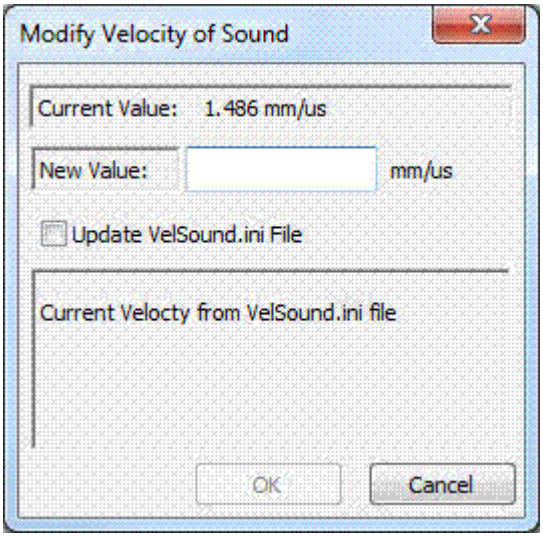
SonoLabDS3 determines the Velocity of Sound in the following sequence:

1. If the file TRxParam.ini exists, the value in this file is used (generated in Transceiver Parameters Calibration)
2. If the file VelSound.ini exists and the TRxParam.ini does not exist, the value from VelSound.ini is use.
3. If neither TRxParam.ini andr VelSound.ini exist, the default value of 1.59 mm/us is used.

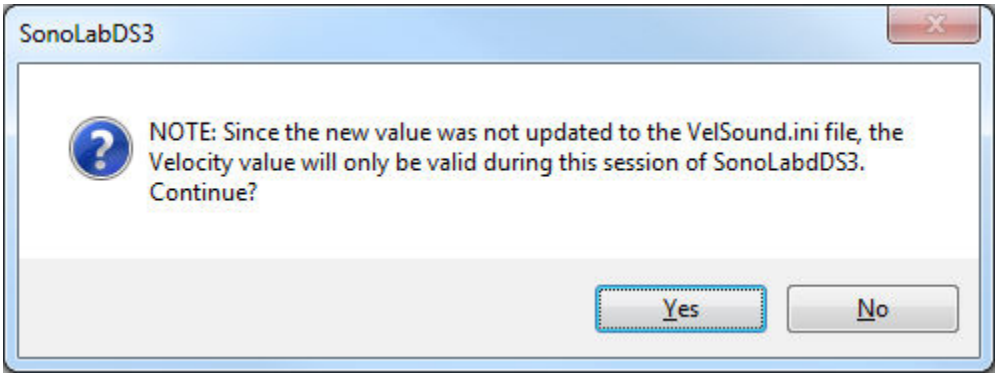
The TRxParm.ini and VelSound.ini files if they exist, reside in the same directory as the SonoLabDS3.exe executable file.

In SonoLabDS3 version 1.0.0.97, another method was added to permit the changing of the Velocity of Sound.

If the "Velocity of Sound"in the above shown System Properties page is clicked or selected and activated, the "Modify Velocity of Sound" dialog should appear:



Entering a number in the New Value: field, greater than 1 mm/us, will enable the OK button. If the value is meant to be used in subsequent sessions, then check the "Update VelSound.in File" before activating the OK button. If the Velocity of Sound is only going be used in the current SonoLabDS3 session, simply activate the OK with the "Update VelSound.ini File" unchecked. The following message box will appear:

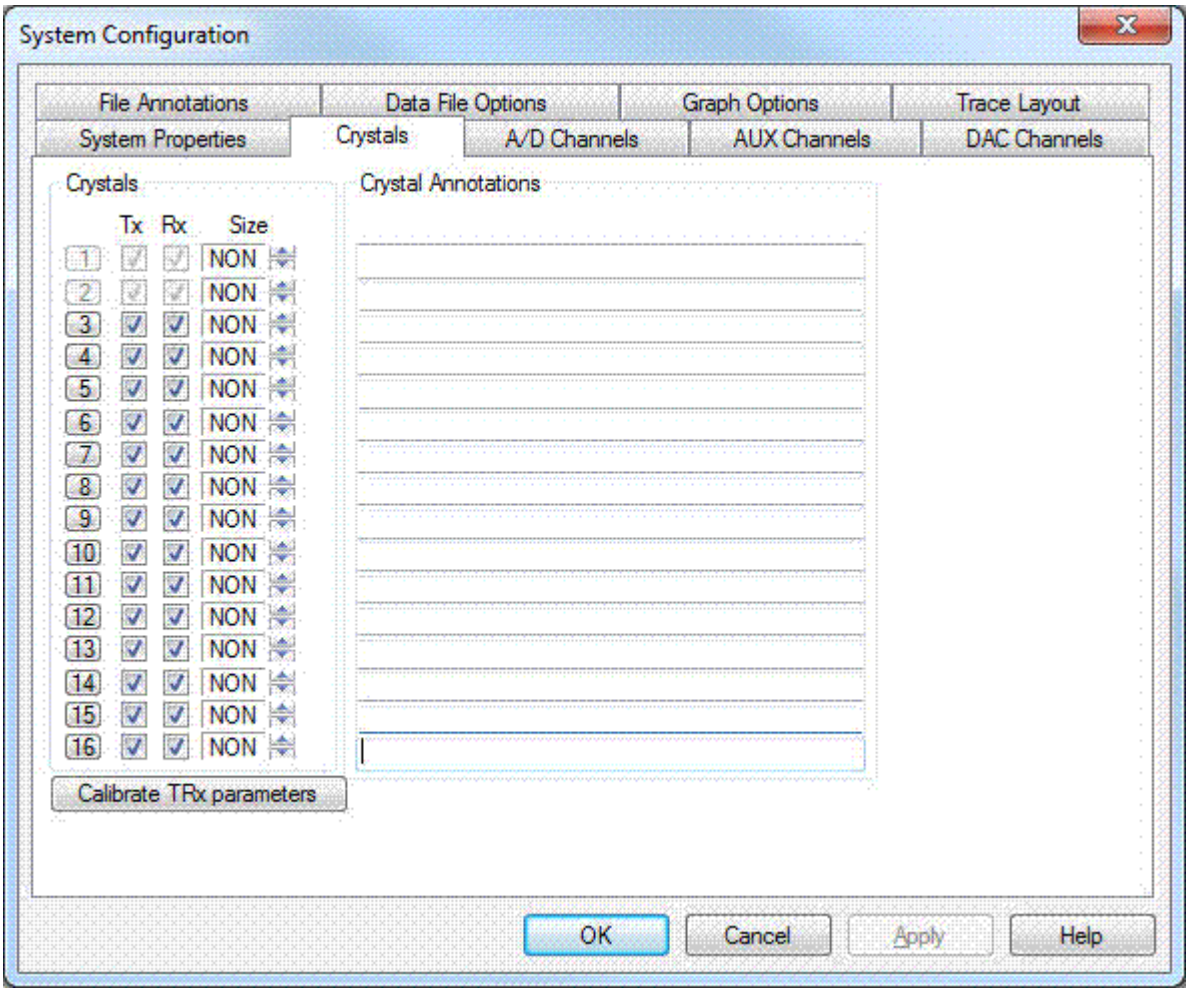


Clicking on Yes will maintain the temporary sessional state of the new Velocity of Sound and VelSound.ini file will not updated. On next SonoLabDS3 session, SonoLabDS3 will start with the Velocity of Sound value stored in the VelSound.ini file.

NOTE: if the Transceiver Parameters Calibration was used and the results saved to the TRxParam.ini file, the Velocity of Sound in this file takes precedence over the VelSound.ini file. If you want the VelSound.ini to have precedence, then the TRxParam.ini file should be renamed (i.e. reanme TRxParam.ini to TRxPararm_25Jan2019.ini).

Crystal Configuration

Selecting the Crystals tab on the System Configuration dialog should present a page similar to:

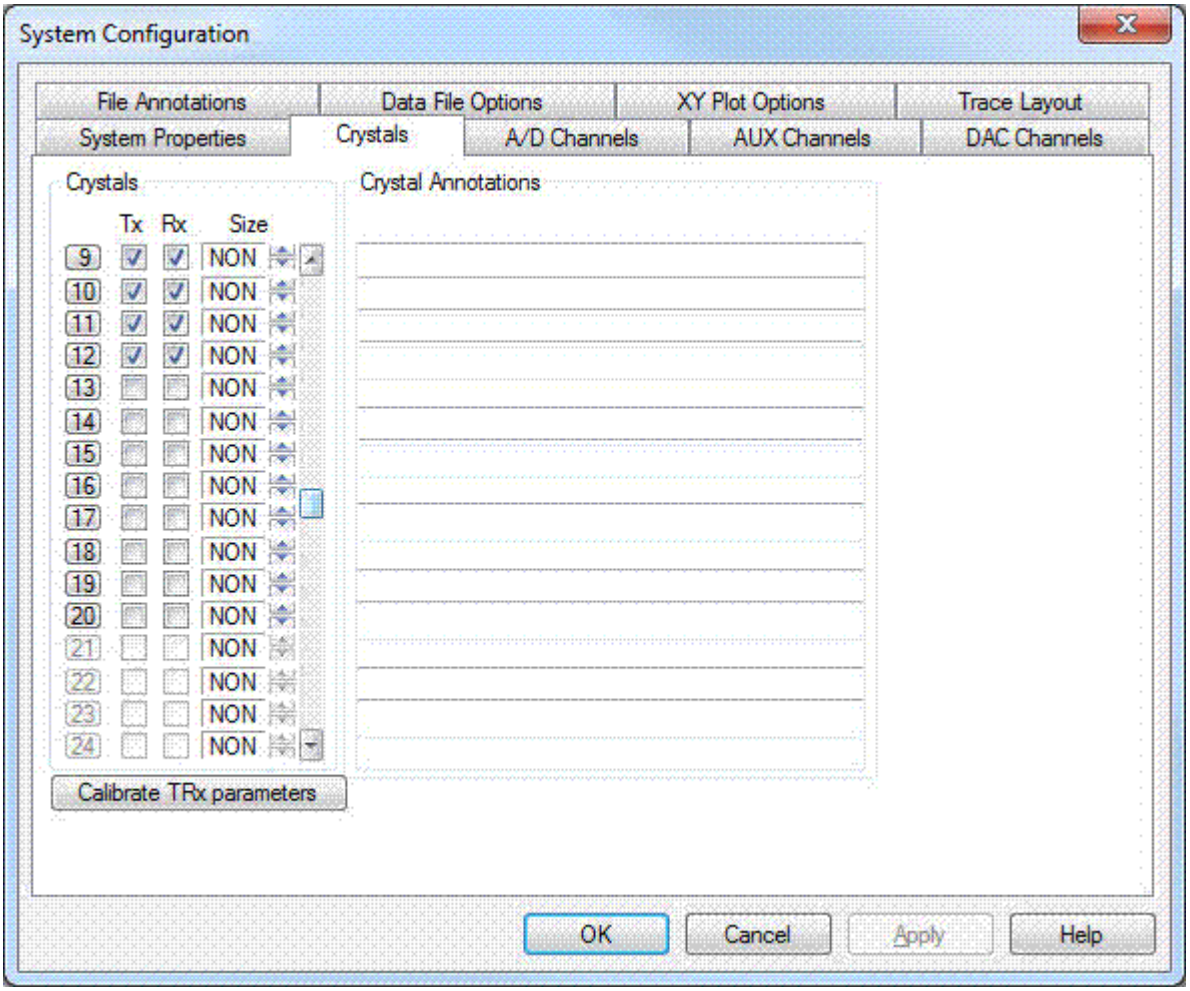


The DS3 firmware design currently limits how transmitters and receivers can be disabled. Only contiguous transceiver ranges, always including crystals 1 and 2, are allowed. Unchecking an individual transmitter, receiver or crystal will result in all subsequent transmitters, receivers or crystals, including the current transmitter, receiver or crystal, being unchecked. Clicking or pressing the Crystal number button will operate simultaneously on the transmitter and receiver check boxes for that crystal.

NOTE: It is possible to have different transmitter and receiver ranges, i.e. for say an eight channel TRx system it is possible to configure crystals 1 to 5 as transmitters and 1 to 8 as receivers; the ranges must start at 1 and be contiguous to the last transmitter and/or receiver.

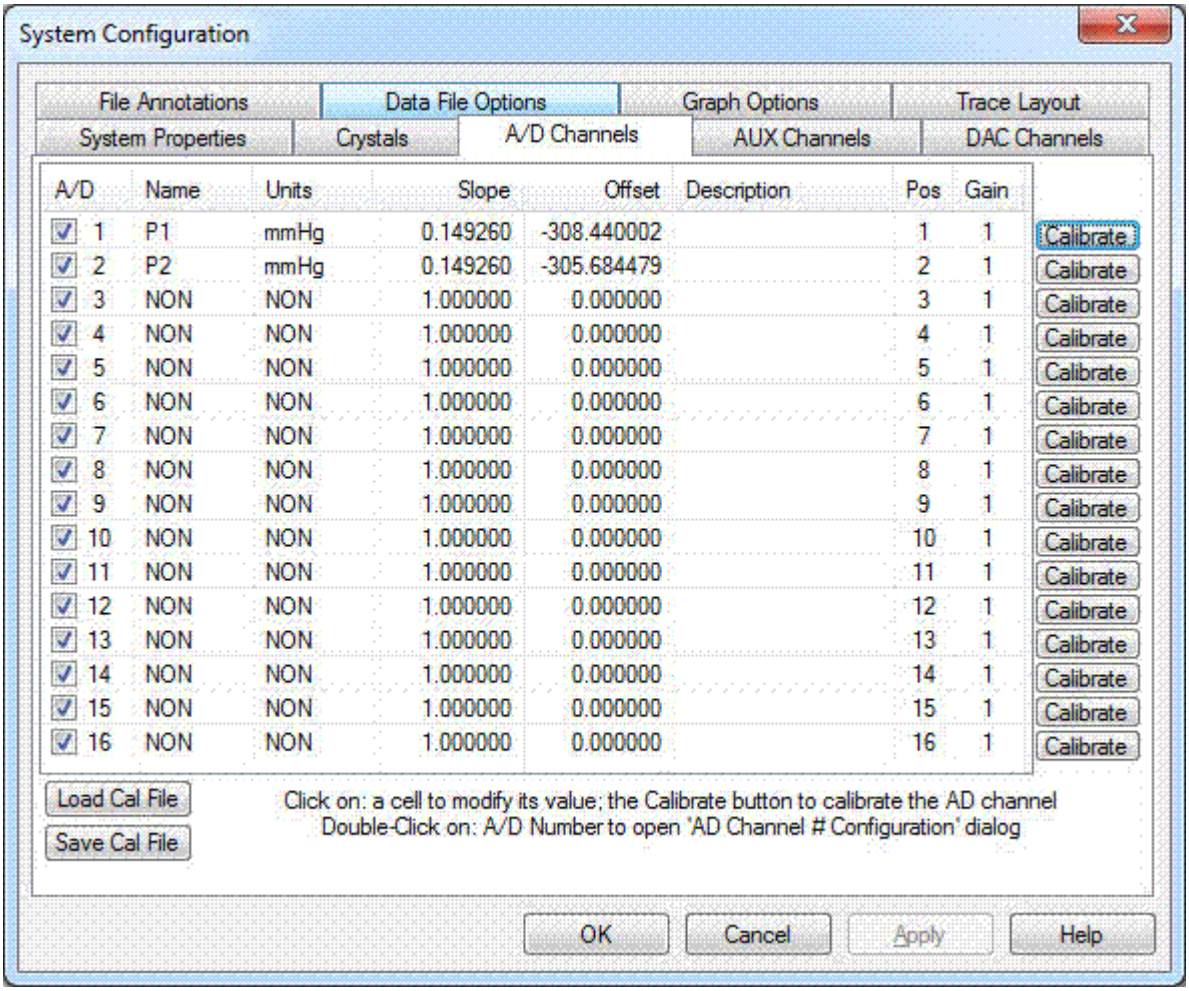
Starting with SonoLabDS3 version 1.0.0.91, the "Calibrate TRx parameters" button was been added, making it possible to run a calibration process which calculates the system specific TRx parameters (c.f. Transceiver Parameters Calibration for a more detailed discussion).

For DS3 systems that have more than 16 TRx channels, the crystal configuration dialog appears with a scroll bar beside the Size up/down controls allowing the user to access up to 32 crystals (crystals numbered 3 and above that are not part of the DS3 hardware configuration will be greyed out):


System Configuration
File Annotations
Data File Options
XY Plot Options
Trace Layout
System Properties
Crystals
A/D Channels
AUX Channels
DAC Channels
Crystals
Tx Rx Size
9 NON
10 NON
11 NON
12 NON
13 NON
14 NON
15 NON
16 NON
17 NON
18 NON
19 NON
20 NON
21 NON
22 NON
23 NON
24 NON
Crystal Annotations
Calibrate TRx parameters
OK
Cancel
Apply
Help

AD Channel Configuration

Selecting the A/D Channels tab on the System Configuration dialog should present a page similar to:



A/D	Name	Units	Slope	Offset	Description	Pos	Gain	
1	P1	mmHg	0.149260	-308.440002		1	1	Calibrate
2	P2	mmHg	0.149260	-305.684479		2	1	Calibrate
3	NON	NON	1.000000	0.000000		3	1	Calibrate
4	NON	NON	1.000000	0.000000		4	1	Calibrate
5	NON	NON	1.000000	0.000000		5	1	Calibrate
6	NON	NON	1.000000	0.000000		6	1	Calibrate
7	NON	NON	1.000000	0.000000		7	1	Calibrate
8	NON	NON	1.000000	0.000000		8	1	Calibrate
9	NON	NON	1.000000	0.000000		9	1	Calibrate
10	NON	NON	1.000000	0.000000		10	1	Calibrate
11	NON	NON	1.000000	0.000000		11	1	Calibrate
12	NON	NON	1.000000	0.000000		12	1	Calibrate
13	NON	NON	1.000000	0.000000		13	1	Calibrate
14	NON	NON	1.000000	0.000000		14	1	Calibrate
15	NON	NON	1.000000	0.000000		15	1	Calibrate
16	NON	NON	1.000000	0.000000		16	1	Calibrate

The "Load Cal File" and "Save Cal File" buttons provide the user with the ability to load and save specific AD Calibration files. These files contain the hardware serial number (FTDI Serial Number) that will cause a warning to be presented in the event that file's serial number does not match the connected hardware. Note that the default AD Calibration file has a name of the form "ADCalibration_########.cal". The sequence "########" is the FTDI Serial Number (i.e. FTR287CPB) shown on the System Properties tab of the System Configuration window (c..f. Main Dialog).

There are two methods of editing the A/D channel parameter:

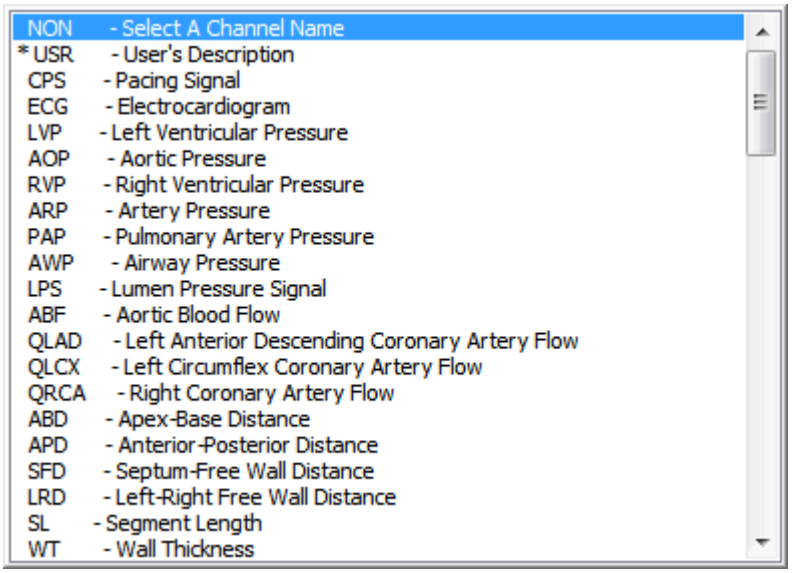
1. The first method is to simply left Click on the list view cell that you wish to modify.
2. The second method is to access the ADC Edit dialog. This is done by double clicking on the A/D number in the list view cell in the column labeled "A/D".

First Method

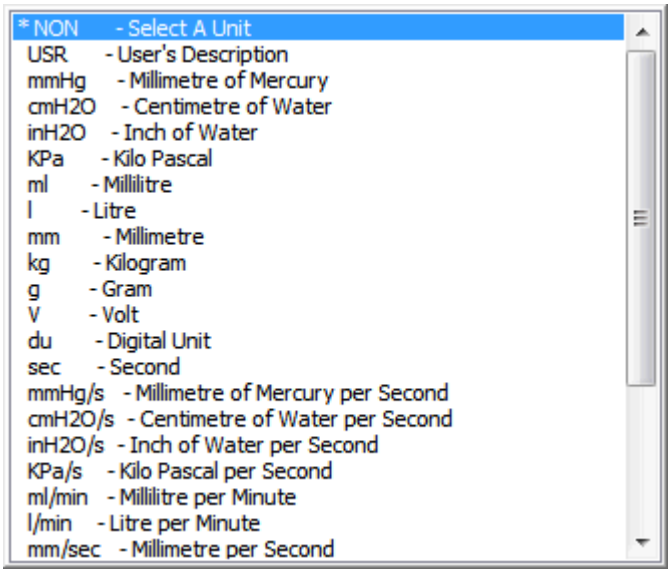
Clicking on a cell in the Gain column, will display a popup window allowing the user to modify the Gain immediately.

Clicking on other list view cells will allow the user to modify that cell directly. For instance, clicking on the

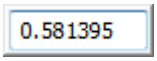
"Name" column will display a list selection control (instruction are below the list view, selecting "USR - User's Description" will cause the ADC Edit dialog to popup):



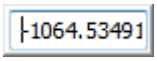
Clicking on a "Units" cell will display the following (selecting "USR - User's Description" will cause the ADC Edit dialog to popup)



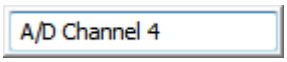
Clicking on a "Slope" Cell:



Clicking on an "Offset" Cell:

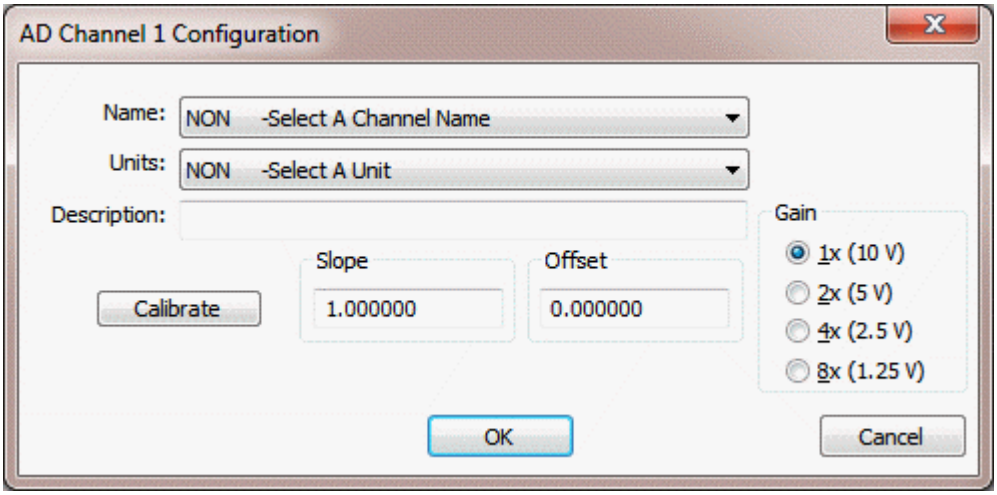


Clicking on a "Description" Cell

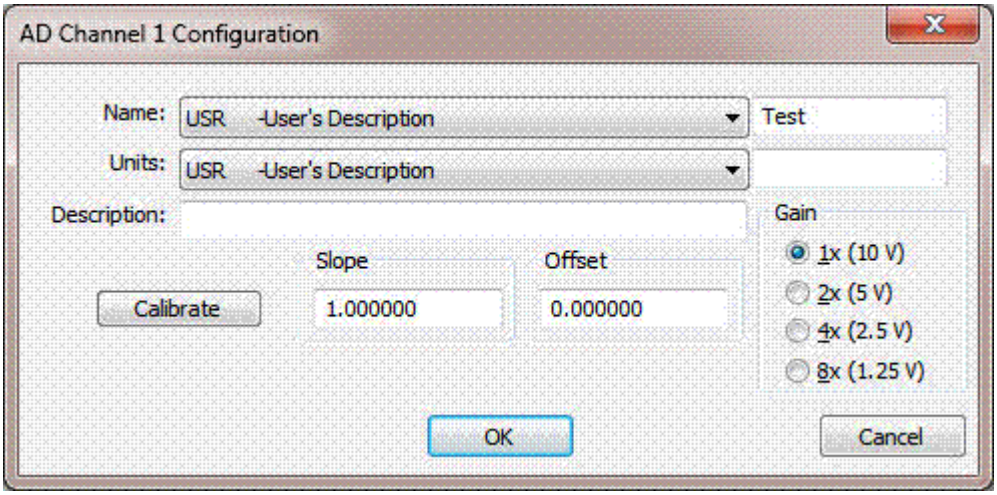


Second method

The ADC Edit dialog is as follow (to activate this dialog from the A/D Channels System Configuration tab, double click on the number in the A/D column):

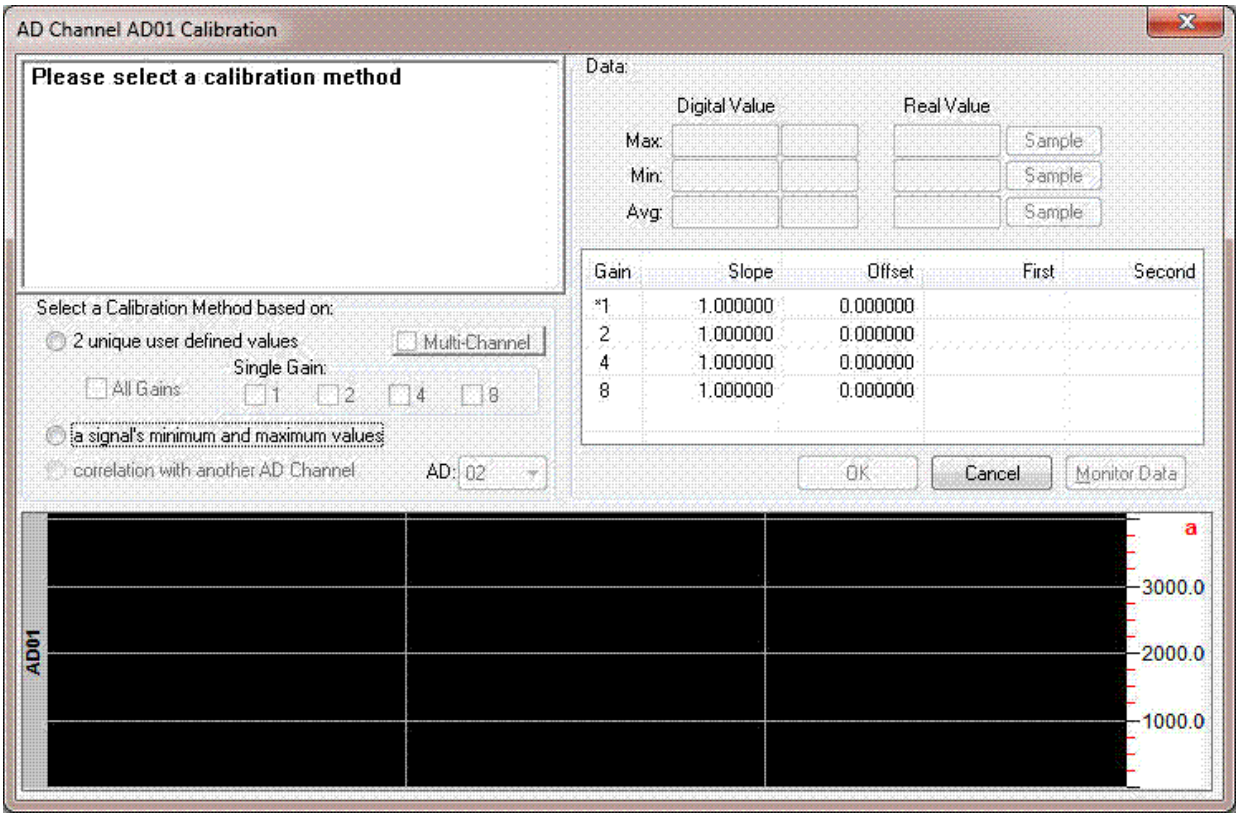


This dialog will automatically popup when the "USR - User's Description" is selected in either the Name or Units column. For the USR selection, this dialog appears as follows (additional edit box(es) for User Descriptions of up to 8 characters):



A/D Channel Calibration

Selecting the Calibrate button will bring up the following dialog window:



Calibration is accomplished by following the instructions given in the "Please select a calibration method" area.

For the "2 unique user defined values", "All Gains" Calibration method, the input signals are sampled at each of the four gains in immediate succession during each of the two/three sampling periods Unchecking the "All Gains" check box will permit the selection of the gain to be used in the calibration process. For the "All Gains" case, if more than three of the gained signals are clipped, the user is asked to restart the process. If three or fewer of the gained signals ares clipped, the user is given the option of continuing with the calculated/estimated slope/offset values or the option of providing a recommended third sample value.

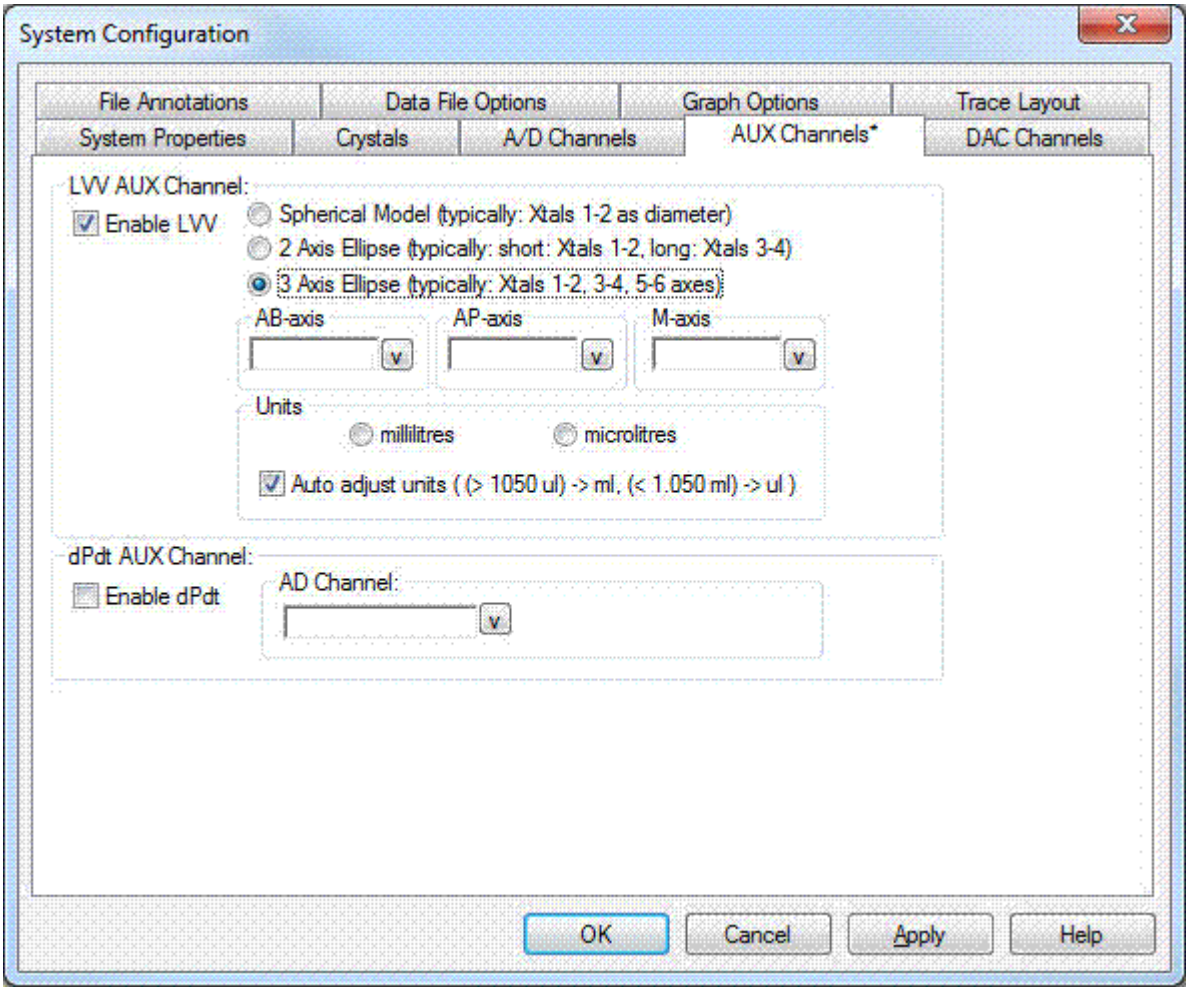
For the "a signal's minimum and maximum values" method, the sampling is done only at the current gain setting.

NOTE: It is now possible to calibrate multiple channels in one pass. This is accomplished by supplying the reference signals simultaneously to the channels being calibrated, by checking the "Multi-Channel" check box and then indicating which AD channels are also being calibrated.

NOTE: If the AD Signals window is active, it will update the AD signals during the calibration process.

AUX Channel Configuration

Selecting the AUX Channels tab on the System Configuration dialog should present a page similar to:



NOTES:

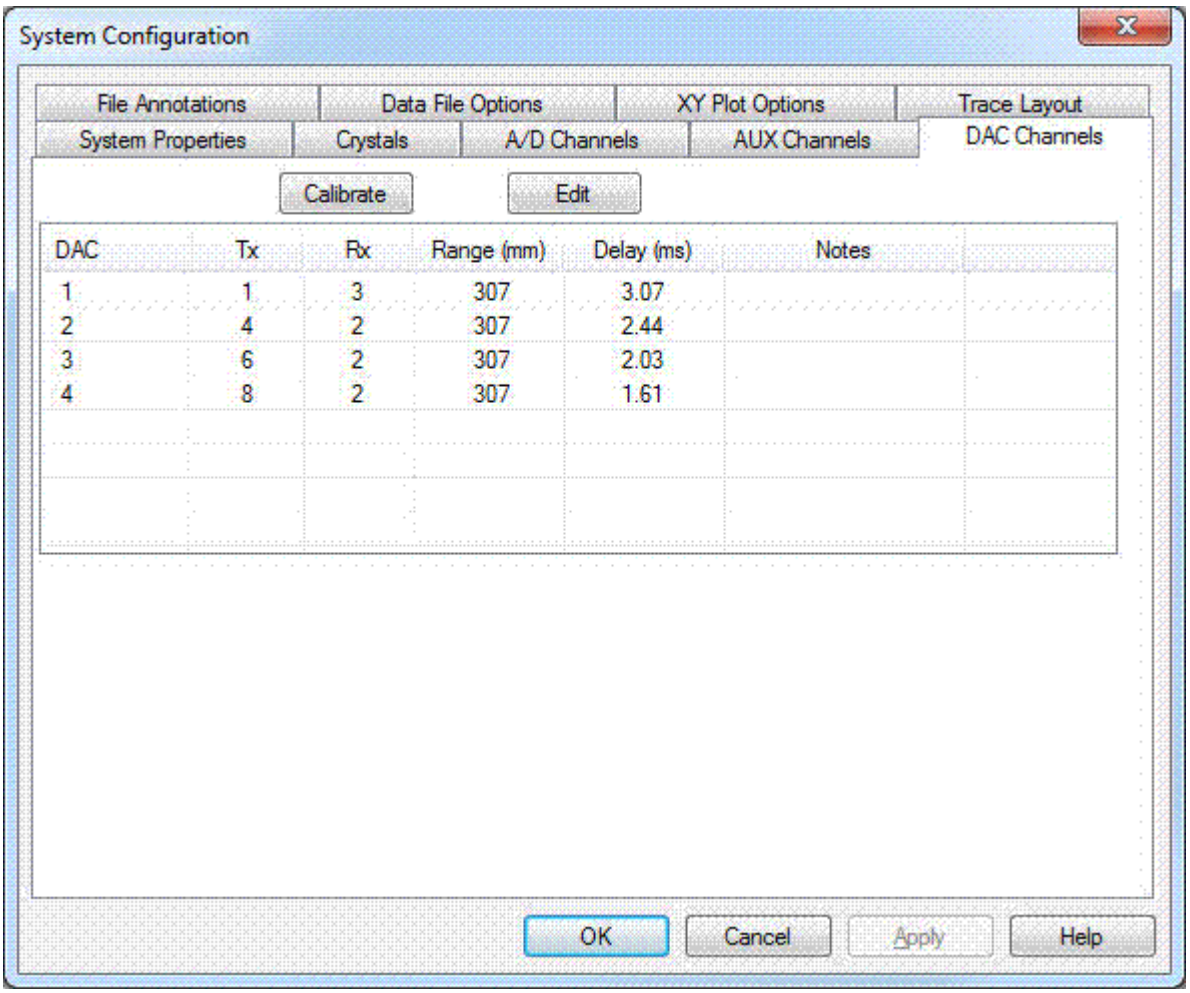
- For the "LVV AUX Channel", at least 4 crystals must be active
    - for the "2 Axis Ellipse (short: Xtals 1-2, long: Xtals 3-4)"
    - and at least 6 crystals for the "3 Axis Ellipse (Xtals 1-2, 3-4, 5-6 axes)"
    - If fewer crystals are active, only the LVV AUX Channels that are valid are shown as options.
- Selecting any of the LVV models will automatically check the "Enable LVV" check box.
- Selecting the little down arrow ("v") buttons beside the text box will bring up the channel selector dialog.
- The Auto adjust units (for LVV Aux channels only), will cause the changing of the LVV channels trace units to adjust accordingly. This setting is ignored if a fixed scale setting has been selected. The scale may not update until a "Stop Monitor"/"Monitor" sequence has been processed and/or a complete pass of the trace ha occurred.

DAC Channel Configuration

The DAC (Digital to Analog Converters) option provides the user with either 4 or 8 output voltage signal channels from the DS3 sonomicrometer device that are representative of the user selected TRx channels. Each individual DAC channel can be configured to provide a signal for any active TRx channel (user specifies the Tx and Rx) and the desired Range. The Range is configurable to one of 8 values, these are multiples of two of the maximum measurable distance (Max) (i.e.., Max, Max/2, Max/4, Max/8, Max/16, Max/32, Max/64, Max/128). The maximum distance is determined by the sampling rate, the number of active transmitters and the velocity of sound. It is calculated as follows (accurate to about 1 mm):

Maximum_Distance = (((1 / Sampling_Rate} / Number_Active_TRx) - 1us) * Velocity_of_Sound

Selecting the DAC Channels tab on the System Configuration dialog should present a page similar to:



To configure a DAC channel either use the mouse to click on the DAC channel's Tx Rx or Range value and select the desired Tx, Rx and Range values or select the desired DAC channel and activate the Edit button. The Edit button will bring up the "DAC Channel # Configuration" (# being the numeric value of the DAC channel):

NOTE: It is possible to configure Tx = Rx, however, it is best to configure values so that Tx and Rx do not reference the same crystal for a given DAC channel. If the transmitting and receiving crystals are the same, the DAC channel's Notes column will contain the text "NOTE: Tx = Rx" as a reminder.

NOTE: The conversion of the sampled TRx data for a configured DAC channel is done with the TRx data from the previous sample. For that reason, the DAC data is delayed with respect to the original TRx data. This delay value (in milliseconds) is now displayed on the DAC Channel Configuration .The delay is related to the sampling rate, the transmitter and the DAC conversion time (in seconds):

DAC_Delay = ((NumTx - Tx + 1) * SubCycle) + DAC_Conv

where

NumTx is the number of active transmitters

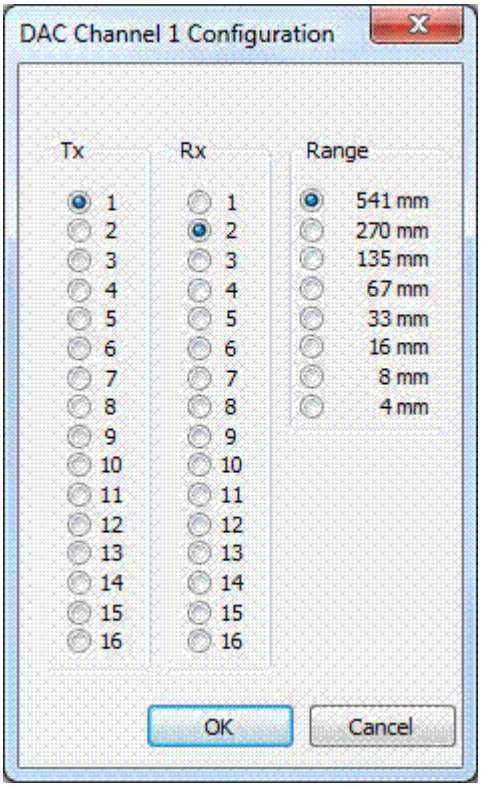
Tx is the transmitter number

SubCycle is the time between successive transmitter excitations (= 1 / (SamplingRate * NumTx))

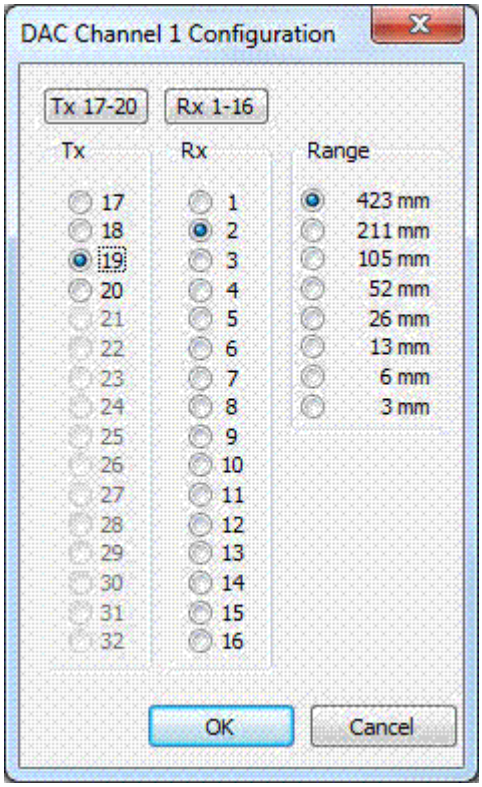
DAC_Conv is the time required for the DAC conversion (digital TRx data to an analog output signal value); for DAC1 to DAC4 it is 0.001403 seconds and for DAC5 to DAC8 it is 0.001406 seconds.

During a sampling period, the transmitters are always excited in sequence from transmitter 1 to the last configured active transmitter. For this reason, the DAC delay will be less for the later transmitters. In the example shown above for an 8 transmitter DS3 configuration, sampling at about 600.1 Hz, the delay for a DAC for say TRx01:03 will be more (3.07 ms) than for a DAC configured with TRx08:02 (1,61 ms). Since the Receiver is not directly involved in the delay calculations, the delay for a DAC with TRx01:08 would also be 3.07 ms and a DAC with TRx08:01 would have a delay of 1.61 ms.

For DS3 systems with 16 or less TRx active channels:



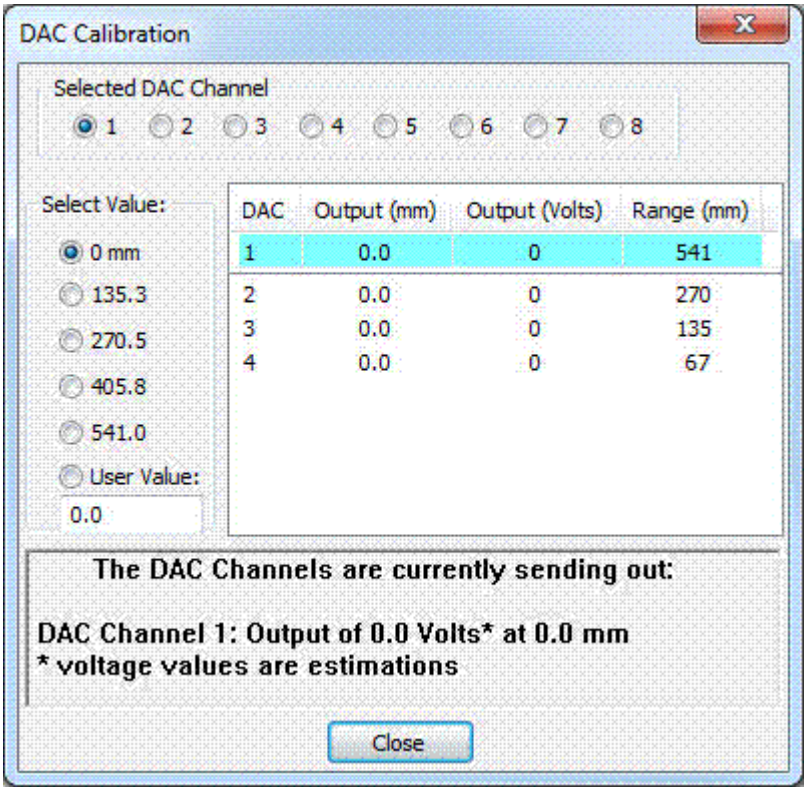
and for DS3 systems with more than 16 TRx, the Range buttons become active:



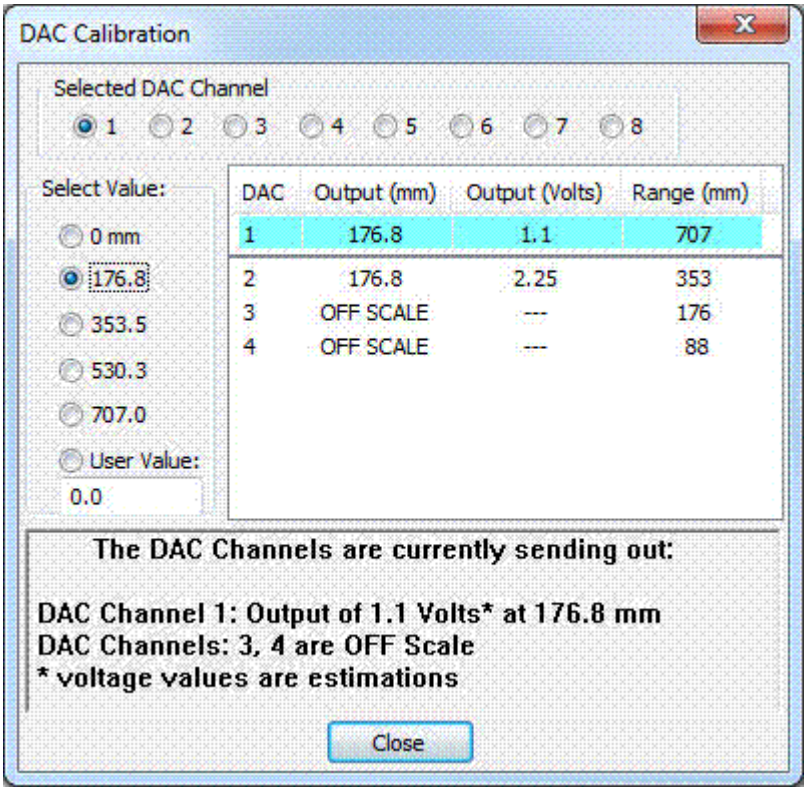
Select the desired values and activate the OK button to save the configuration.

Selecting the Calibrate button should result in the DAC Calibration dialog appearing. The user is able to calibrate the DAC channels by selecting the appropriate DAC Channel and output value. The Main Trace window will monitor the TRx trace values accordingly.

Note that the Selected DAC Channel is the top most item in the list and is highlighted in pale blue.

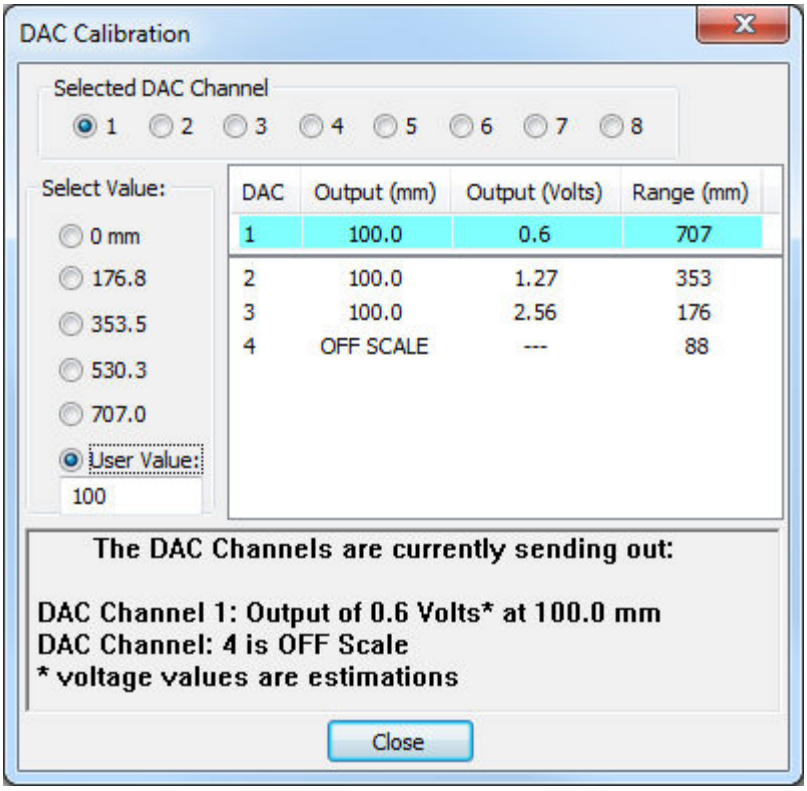


In the event that the selected output value generates a signal that is beyond the range of any given DAC Channel's range, the "Output (mm)" column will contain the value "OFF SCALE" as shown below.



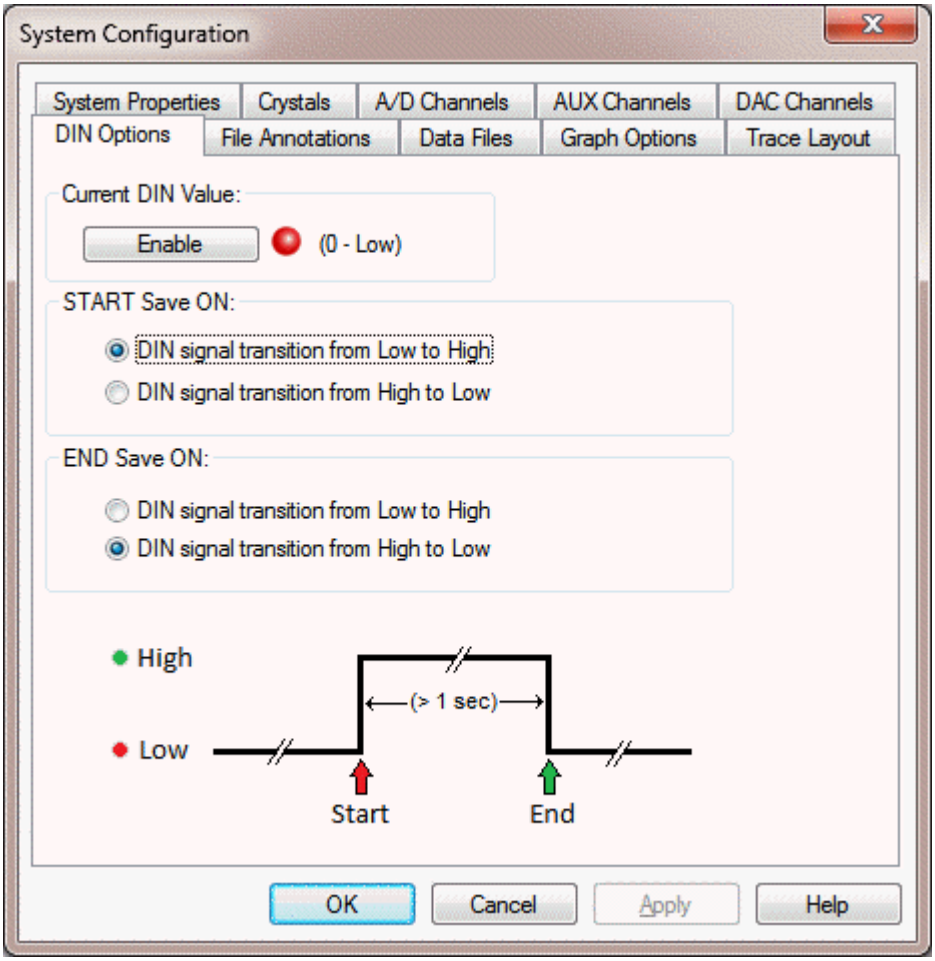
With release Version 1.0.0.97, two controls were added, a "User Value"radio button and edit box. This provides the ability to enter a specific value for DAC calibration.

NOTE: after entering a user value in the edit box, it is necessary to activate the "User Value" radio button for the value to become active. If a new user value is desired, one can update the edit box but must again activate the "User Value" radio button in order for the updated value to become active.


DAC Calibration
Selected DAC Channel
1 2 3 4 5 6 7 8
Select Value:
0 mm
176.8
353.5
530.3
707.0
User Value:
100
DAC Output (mm) Output (Volts) Range (mm)
1 100.0 0.6 707
2 100.0 1.27 353
3 100.0 2.56 176
4 OFF SCALE --- 88
The DAC Channels are currently sending out:
DAC Channel 1: Output of 0.6 Volts* at 100.0 mm
DAC Channel: 4 is OFF Scale
* voltage values are estimations
Close

DIN Option

The DIN Option provides a mechanism to control the save operations by an external device connected to the DIN input of the DS3 hardware. The configuration of the DIN Option is available on the main SonoLabDS3 window as shown below (Note: if the DIN Option is not present or the Device is a DS4-###, the DIN Options tab is not displayed):



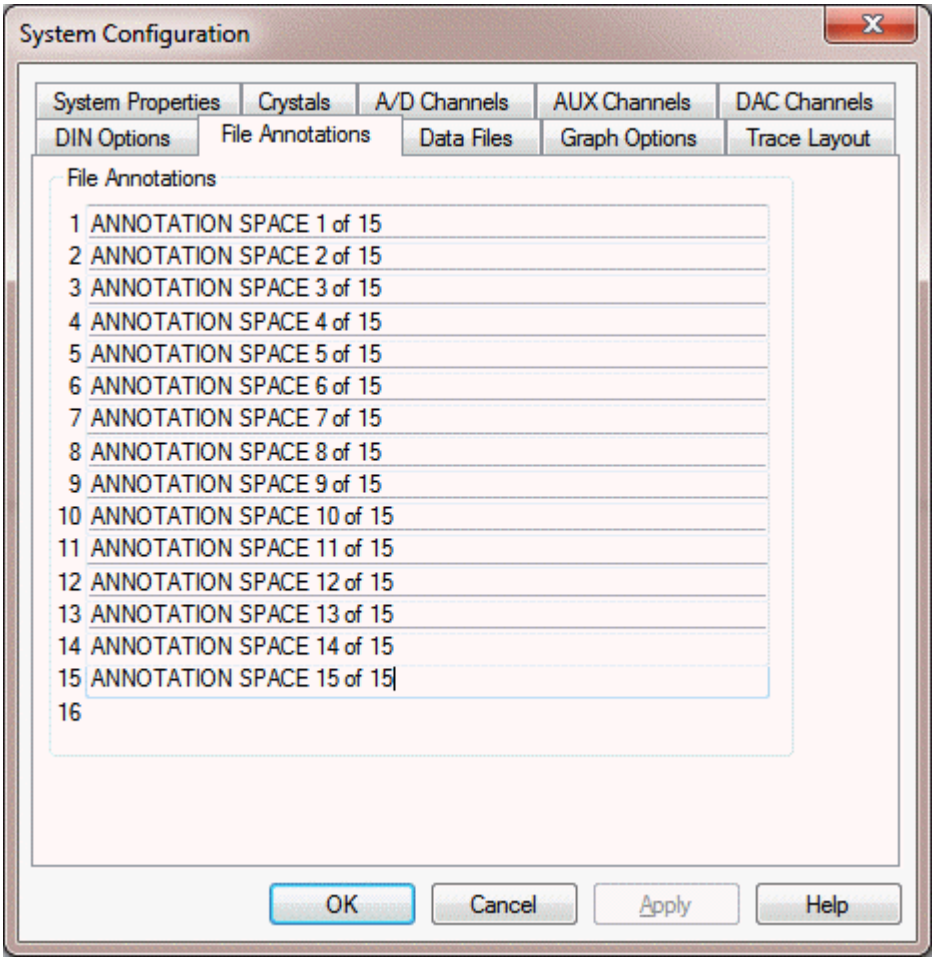
In order for the DIN operations to be active, the user must activate the "Enable" button. When the DIN Option is enabled this button will be highlighted and has the caption "Disable". Activating this button again will disable the DIN Option operations. There are four different configurations available for sensing the DIN Option signals that control the save operations.

NOTES:

- **IMPORTANT**, the DIN signal is only available while the data stream is active (SonoLabDS3 software is monitoring or saving data from the DS3 hardware). If the system is in an Idle state and data is not being streamed from the hardware, changes in the DIN input signal will not be recognized.
- The DIN input is normally high and needs to be pulled low by external hardware to change its value to zero (0). The DIN value is transmitted in every data sample.
- There is a one second delay in the SonoLabDS3 software before the next DIN transition is recognized (a debounce delay).

File Annotations

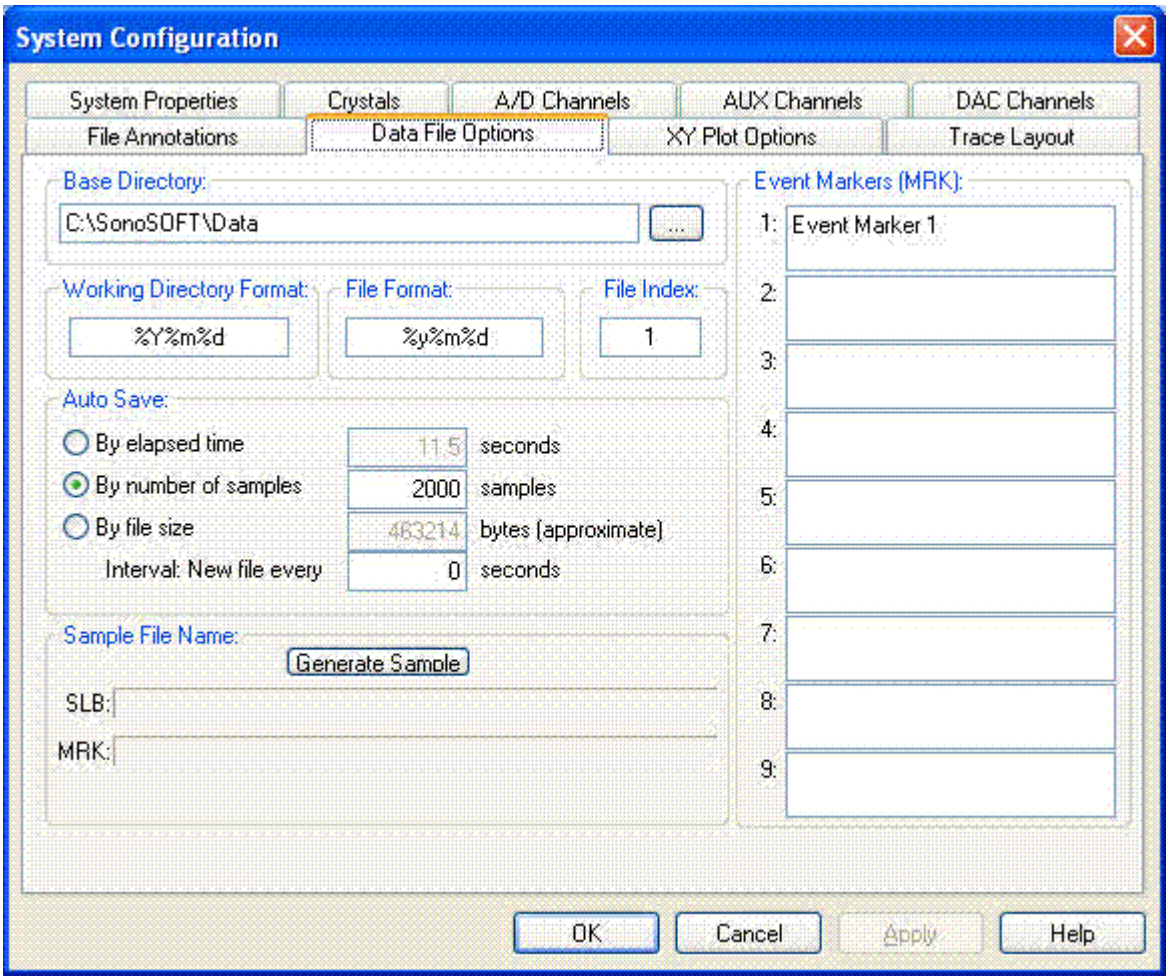
Selecting the File Annotations tab on the System Configuration dialog should present a page similar to:



The user is able to modify the annotations for the file(s) being saved. Note that the user is able to modify the annotations on files saved by invoking the F(Save Data button on the Main Trace window or by pressing F9 whilst the Main or Secondary Trace window have user focus.

Data File Options

Selecting the "Data File Options" item in the SonoLabDS3 Configuration area will result in the following display:



The user is able change the location and generated names of saved data files. Also the characteristics of the Auto Save feature can be modified.

Please note the following file save limitations:

- A file can have a maximum size of 134,217,727 bytes (2^27 - 1)
- A file can contain up to and including 1,048,575 samples (2^20 - 1). if the number of samples would generate a file that exceeds the maximum file size, the maximum number of samples is adjusted appropriately.
- The elapsed time is limited by the smaller of the two previous items.

The "Working Directory Format" and the "File Format" fields support the following recommended formatting codes used by the strftime function:

- %a Abbreviated weekday name (Sun Mon ...)
- %A Full weekday name (Sunday Monday ...)
- %b Abbreviated month name (Jan Feb ...)

- %B Full month name (January February ...)
- %d Day of month as decimal number (01 ... 31)
- %H Hour in 24-hour format (00 ... 23)
- %I Hour in 12-hour format (01 ... 12)
- %j Day of year as decimal number (001 ... 366)
- %m Month as decimal number (01 ... 12)
- %M Minute as decimal number (00 ... 59)
- %p Current locale's A.M./P.M. indicator for 12-hour clock
- %S Second as decimal number (00 ... 59)
- %U Week of year as decimal number, with Sunday as first day of week (00 ... 53)
- %w Weekday as decimal number (0 ... 6; Sunday is 0)
- %W Week of year as decimal number, with Monday as first day of week (00 ... 53)
- %y Year without century, as decimal number (00 ... 99)
- %Y Year with century, as decimal number

These format codes generate the appropriate string for the data and time at the time of generation.

The default for the "Working Directory Format" is " %Y%m%d" which results in string similar to "20130621".

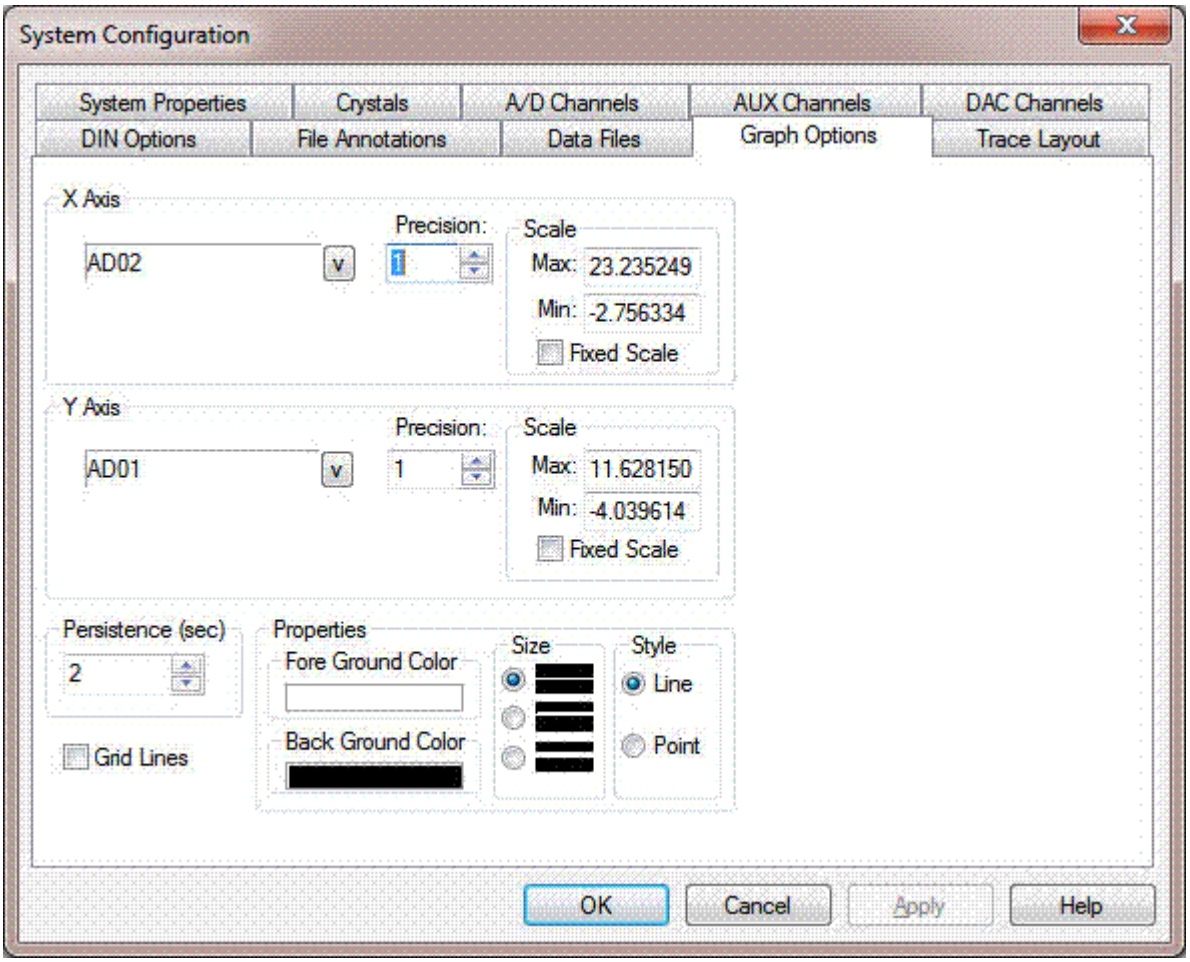
The default for the "File Format" is "%y%m%d". It generates a string similar to "130621".

Activating the "Generate Sample" button will take the various directory and file format codes and should generate a sample similar to: "C:\SonoSOFT\Data\20130621\13062101.slb". Note that the file name as a 01 appended to the main file name, corresponding to the current file index. The file name generation creates unique file names so if the file 11121501.slb exists in the current working directory, it will use 11121502.slb and so on. See Event Marker File for details on the Event Markers.

The Auto Save feature gives the user the ability to sample at periodic intervals without having to provide operator intervention. The file's elapsed time or number of samples or size can be specified. The interval between consecutive saves is specified in seconds (60 seconds = I minute, 3600 seconds = 1 hour).

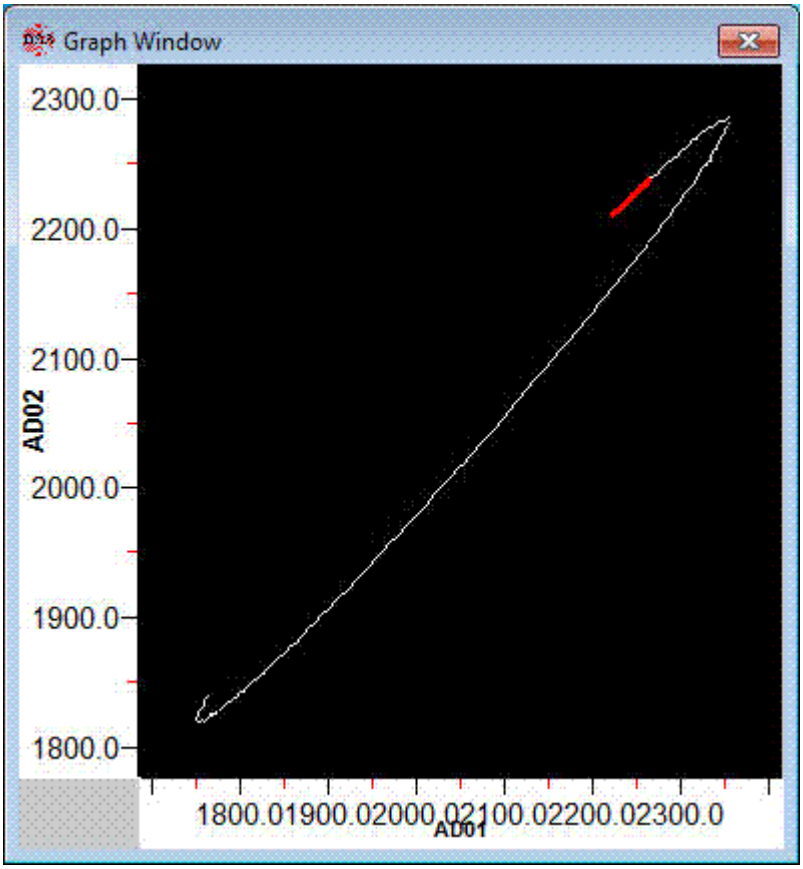
XY Plot Options (formerly Graph Options)

The Graph Options screen provides a configuration dialog to define a two dimensional graph window which can be used to display the real-time signals of selected two channels. The Graph Options screen appears as follows:



The most recent 0.03 seconds of data is drawn as the head of the plot as a large Red line or series of points. This data is redrawn as regular line or points (as per user plot settings) when the next 0.03 seconds of data is plotted. Plotted data that is older than the Persistence value is erased from the graph.

Clicking on the OK button will result in a Graph window being displayed (if no channels have been selected for the x, y axes, both will default to TR01:01 (SonoLabDS3) or AD01 (SonoLabDS3AD):



Various features of the Graph Window:

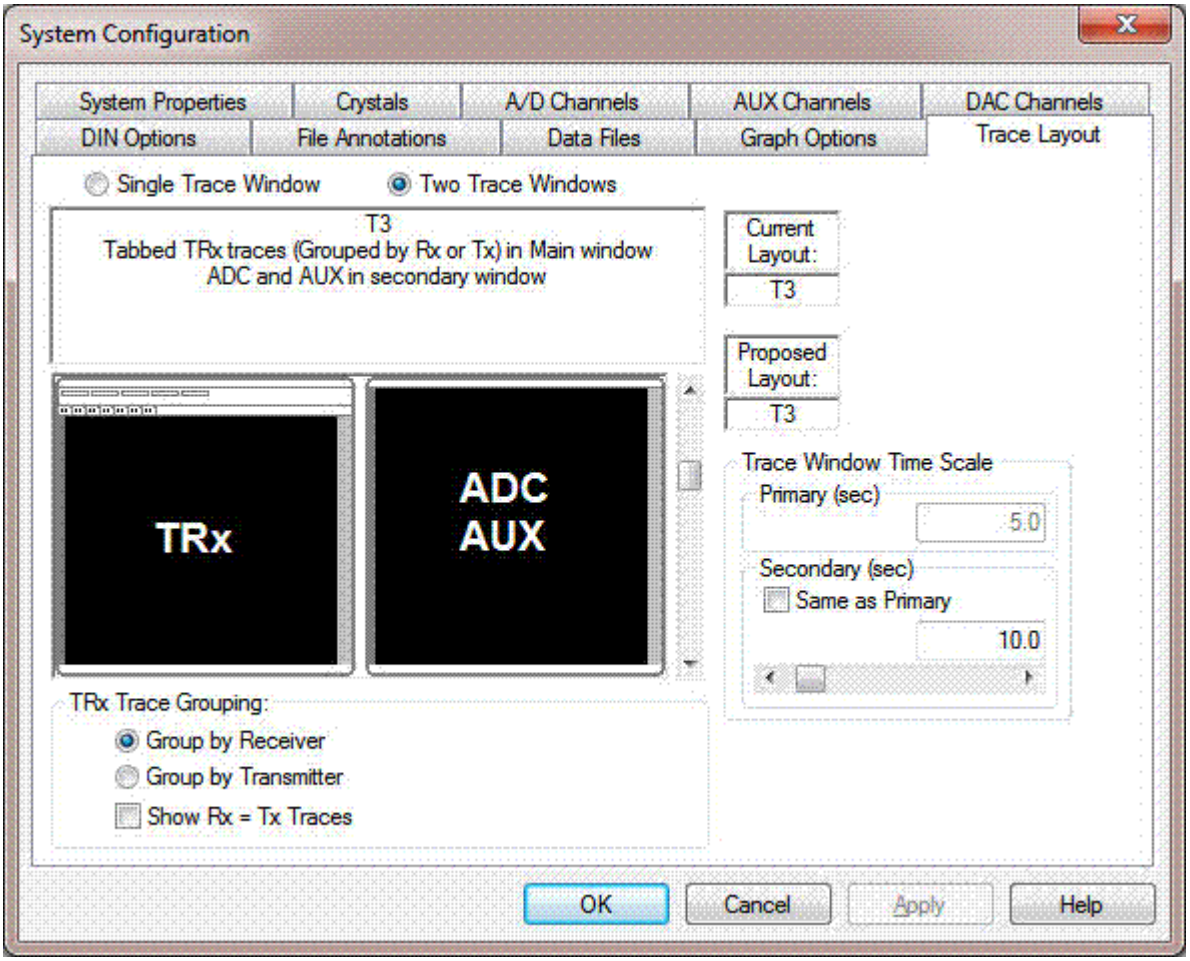
- Double clicking on the scales or body of the Graph Window will bring up the Graph Options/Settings dialog
- Left click and hold will permit the dragging of the graph contents. If done on the main body, the dragging is done in two dimensions, if done on the scale area, only that scale will shift.
- If you have a wheel mouse, rotating the wheel away will zoom the scale(s) in, rotating the wheel towards oneself will zoom the scale(s) out. The location of the mouse cursor (over a specific scale or the body of the graph) will determine if the operation is done on one or both dimensions.
- Right clicking on the main body of the graph will bring up a popup menu selection:

This allows the user to:

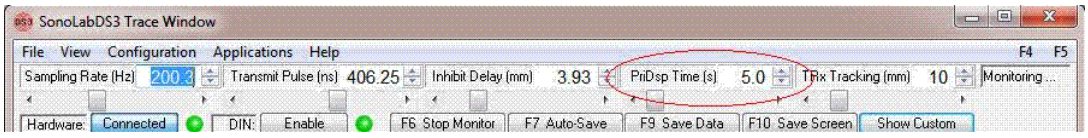
- "Center Plot" - force a recalculation of the graph scales so that the plot will appear in the visible region of the graph (NOTE: this will only work for the scales that have the "Fixed Scale" check boxes unchecked, if either scale is Fixed, the user is given the option of over riding the Fixed Scale values and subsequently centering the current plot)
- "Grid Lines" - turns the Grid Lines on or off
- "Refresh" - forces a refresh of the graph
- "Settings" - opens the Graph Settings / Graph Options dialog

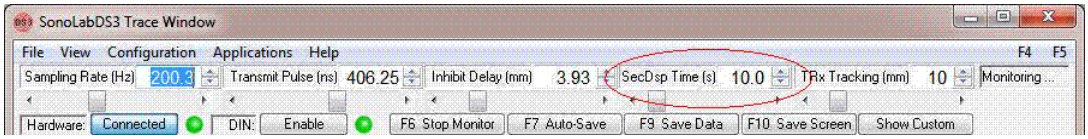
Trace Layout Configuration

The Trace Layout Configuration page allows the user to select from several stock trace window options. Selecting the Trace Window menu Configuration and then selecting the Trace Layout tab will result in a window similar to the following:



NOTE: for the "Two Trace Windows" configurations, it is possible to set different time scales for the primary and secondary trace windows provided the "Same as Primary" check box has been unchecked. The value for the secondary time scale may be entered in this property page or by using the "Display Time (s)" controls on the primary Trace Window (renamed to "SecDsp Time (s)" for the secondary time scale and "PriDsp Time (s)" for the primary trace window, clicking on the heading will toggle between the two scales).



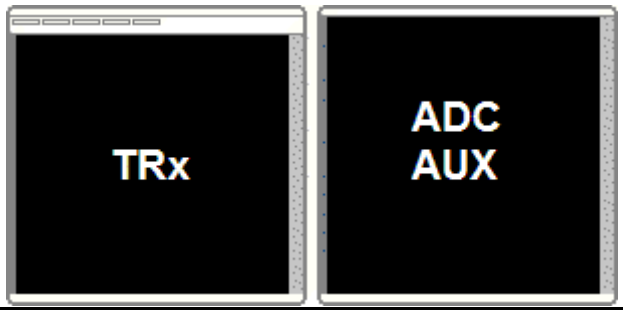
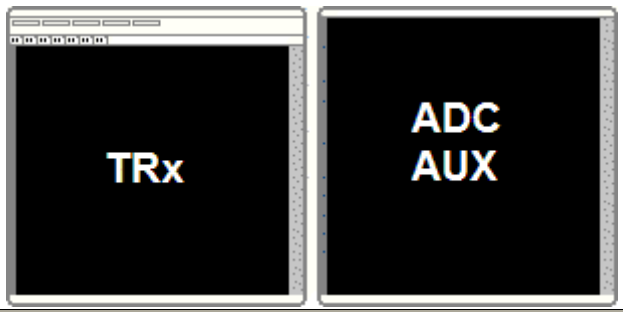


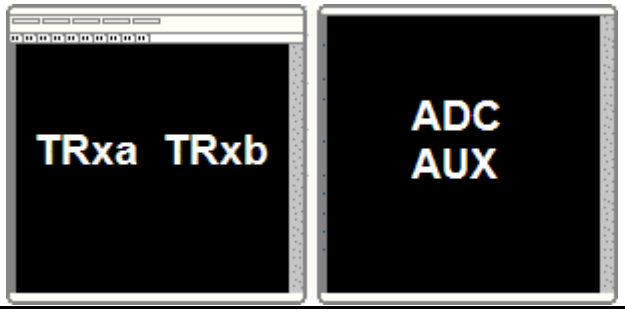
The user is able to select between a Single or Two window trace display. For the Single Trace Window selection the following options are currently available (certain limitations occur when the number of the total traces exceeds about 32 in a non-tabbed single trace window, in which case, it is not possible to select certain trace layouts):

Layout	Description	Sample
S1	All traces are shown in a single trace window. This layout is only available for configurations with 4 or less crystals active.	
S2	This single window has two panes with the upper pane containing the TRx traces, tabbed according to either Receiver or Transmitter grouping. The lower pane contains the ADC and AUX channels. Receiver grouping, for example, might have a Tab labeled Rx01 contains traces:. TR02:01, TR03:01, ... TR32:01. Transmitter grouping might have a. Tab labeled Tx01 containing traces: TR01:02, TR01:03, ... TR01:32.	
S3	This single window has two panes with the upper pane containing Split TRx traces, tabbed according to either Receiver or Transmitter grouping. The lower pane contains the ADC and AUX channels. For a Receiver grouping, the Tabs would appear as R01:02-17, R01:18-32, R02:01-17, R02:18-32. The R01:02-17 would have the traces TR02:01, TR03:01, TR04:01, ... TR17:01 (Lo range). The R01:18-32 would have the traces TR18:01, TR19:01, TR20:01, ... TR32:01(Hi range). The Split attempts to half the number of Receiver/Transmitters.	
S4	This single window has each trace grouping in its own tab including tabs for ADC and AUX.	

S5	This single window has each trace grouping in its own tab including tabs for ADC and AUX. The TRx Tabs are Split into high and low range groups as noted in the S3 Layout	

If the two trace window option is selected, then the following stock display configurations are available (similar limitations apply):

Layout	Description	Sample
T1	All TRx traces are shown in the Main Trace window (No Tabs). The ADC and AUX traces are shown in the Secondary Trace window (No Tabs).	
T2	The ADC and AUX traces are shown in the Main Trace window (No Tabs). All the Trx traces are shown in the Secondary Trace window (No Tabs).	
T3	The TRx traces are shown in Tabs grouped by either Receiver or Transmitter in the Main Trace window. The ADC and AUX traces are shown in the Secondary Trace window (No Tabs).	

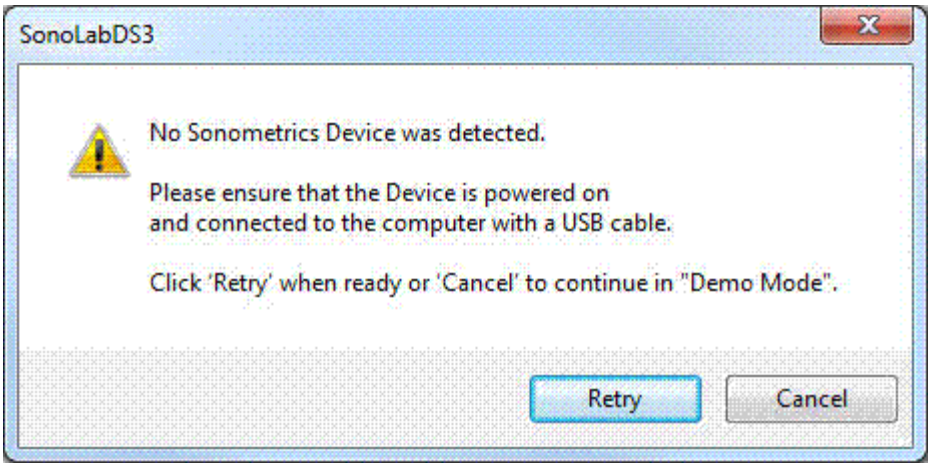
T4	The ADC and AUX traces are shown in the Main Trace window (No Tabs). The TRx traces are shown in Tabs grouped by either Receiver or Transmitter in the Secondary Trace window.	
T5	The TRx traces are shown in Split Lo/Hi Tabs grouped by either Receiver or Transmitter in the Main Trace window. The ADC and AUX are shown in the Secondary Trace window (No Tabs).	
T6	The ADC and AUX traces are shown in the Main Trace window. The TRx traces are shown in Split Lo/Hi Tabs grouped by either Receiver or Transmitter in the Secondary Trace window.	
T7	The TRx traces in the Split Lo range Tabs as well as the ADC and AUX traces (non-tabbed) are shown in the Main Trace window. The TRx traces in the Split Hi range Tabs as well as the ADC and AUX traces (non-tabbed) are shown in the Secondary Trace window.	
T8	The TRx traces in the Split Lo range Tabs are shown in the Main Trace window. The TRx traces in the Split Hi range Tabs as well as the ADC and AUX traces (non-tabbed) are shown in the Secondary Trace window.	

T9	The Main Trace window has the TRx Split Lo range Tabs as well as Tabs for ADC and AUX traces. The Secondary Trace window has the TRx Split Hi range Tabs as well as Tabs for ADC and AUX traces.	

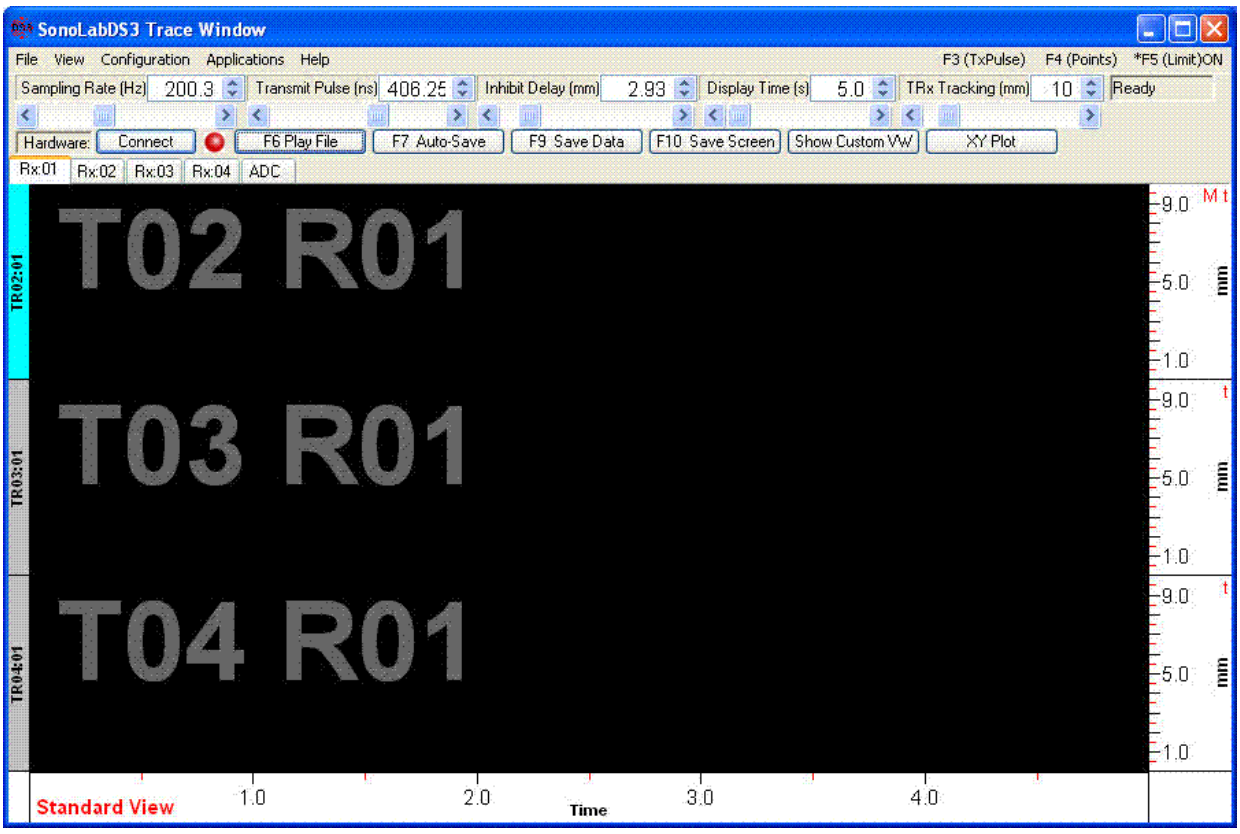
File Play Back

In order to play back a previously recorded data file (.slb/.ssb), it is necessary that the connected Sonometrics' DSx device be powered off (the LED on the main Trace Window should be Red):

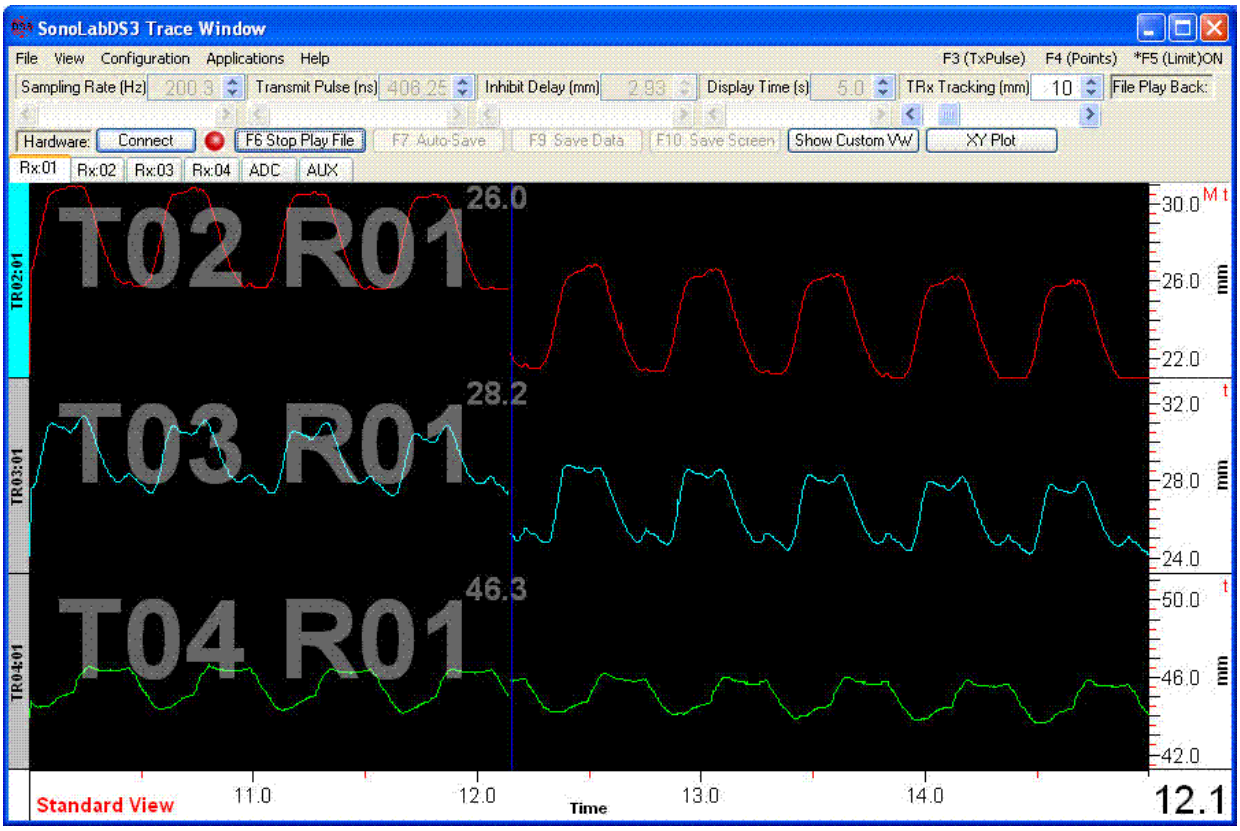
If SonoLabDS3 is started without the DS3 device powered on the following message will appear:



Click on the "Cancel" button to enter the "Demo Mode" which will permit the Play back of a Sonometrics' binary .slb/.ssb file. In this case the Main trace window should appear as follows:



Activating the "F6 Monitor" or "F6 Play File" button on the main Trace Window will bring up a file open dialog. Navigate to the desired file and open it. The trace window may appear as follows:



.Various configuration options such as trace layout, graph windows are available for configuration of the play back. Note that the file will need to be re-selected after each configuration operation, and the resulting configuration will be saved for subsequent playback. In this example, the binary Sonometrics' data file "EsEdPVRa.slb" will have a configuration file with the name "EsEdPVRa.cnf".

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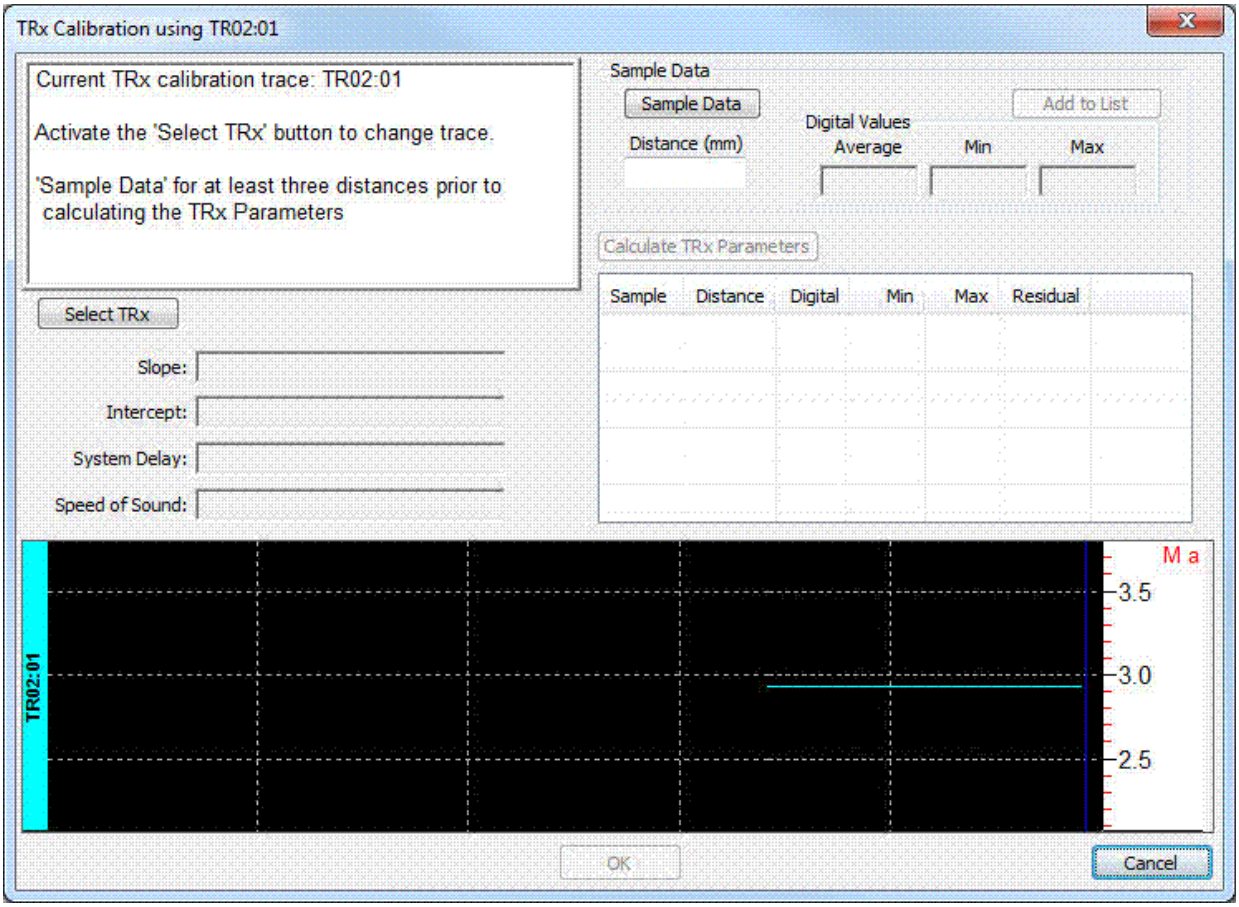
Transceiver Parameters Calibration

It is now possible to run a calibration process which calculates the TRx parameters, namely:

- the slope and intercept values used to convert the digital distance counter values to millimetres (mm)
- the system delay (in clock cycles) inherent in the circuitry.
- the speed of sound for the ultrasound medium used during the calibration process

In the Crystal Configuration page, there is the "Calibrate TRx parameters" button. Upon activating this button the following window will appear:



The TRx Calibration window provides a mechanism which can be used to determine the characteristics of the current SonoLabDS3 hardware and if so desired, utilized them in the display and capture of the TRx data. This is a statistical tool that can determine the following TRx parameters:

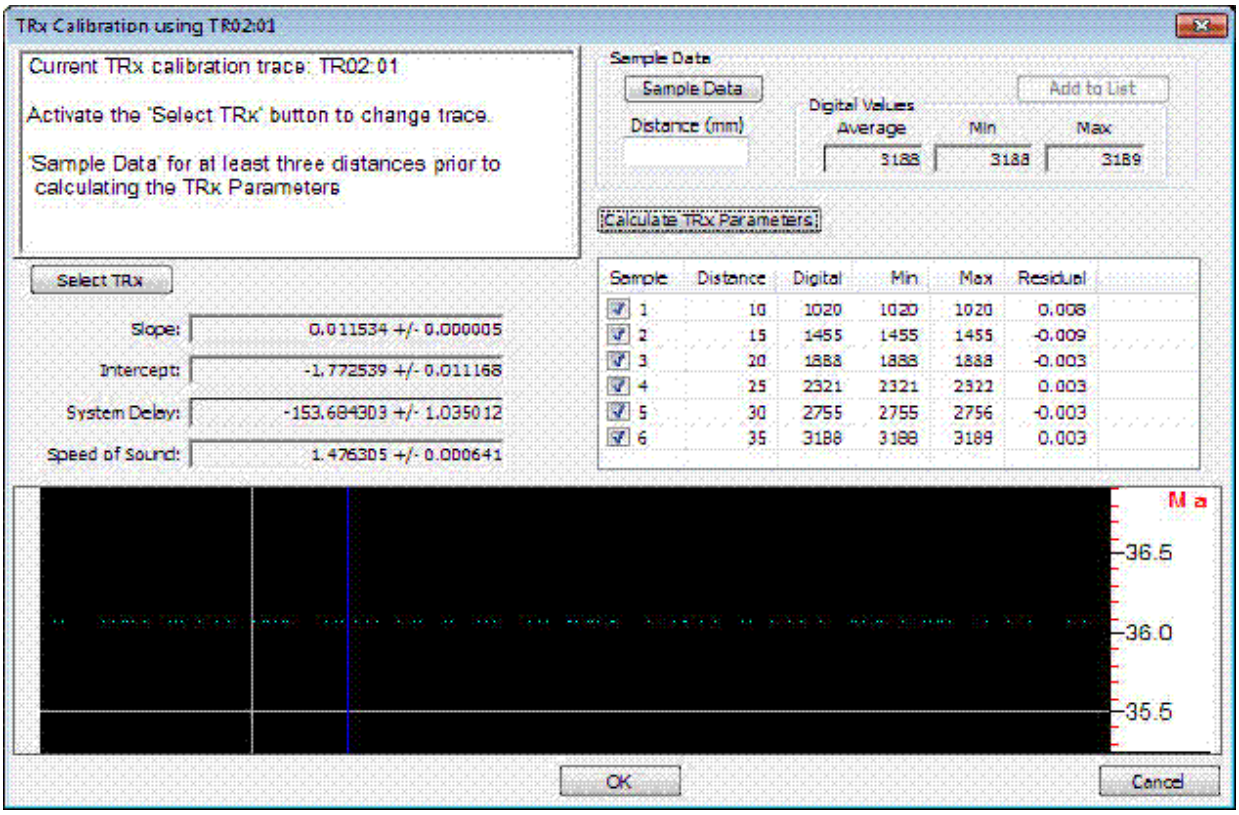
1. The slope and intercept (or offset) used to convert the digital TRx values into distances.
2. The delay associated with the SonoLabDS3 hardware, also used in the TRx distance calculations.
3. The velocity of sound for the media being used during the calibration process.

It is recommended that you contact Sonometrics to discuss the various nuances associated with the TRx calibration process. They are not discussed in this document.

The calibration setup will require the following in a suitable test work space:

1. The SonoLabDS3 hardware being calibrated for the TRx parameters (connected to a computer running the SonoLabDS3 software)
2. An oscilloscope to monitor the TRx signal.
3. A pair of crystals.
4. An appropriate media tank, containing the desired media being used in calibration process.
5. A measuring device (i.e. calipers)

The following screen was captured by a test setup as described above.



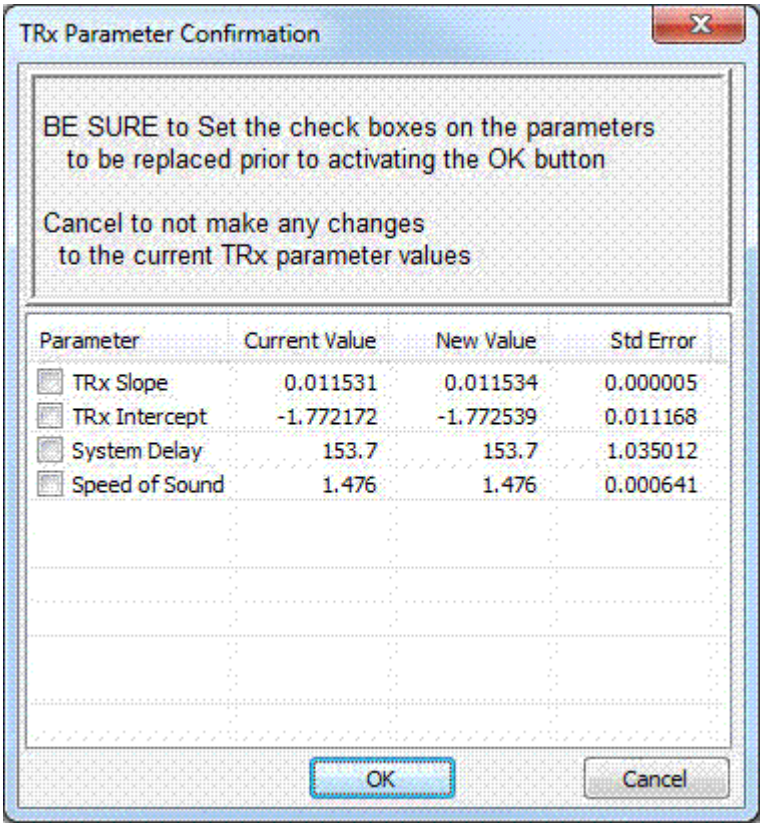
In this instance, the 1 mm crystals were attached to a digital caliber so that the distances read from the calibers accurately determined the current distance between the crystals.

The rectangular media bath (12 cm (W) x 12 cm ((L) x 10 cm (H)) contained tap water at room temperature (~ 20 degrees Celsius).

The crystals attached to the calipers were immersed in the media and six readings were carefully taken at 10 mm, 15 mm, 20 mm, 25 mm, 30 mm and 35 mm caliper distances. Each reading required adjusting the caliper to the desired distance, activating the "Sample Data" button, entering the distance into the appropriate field and finally, activating the "Add to List" button.

After adding the six readings to the list, the "Calculate TRx Parameters" was activated and the results are shown in the boxes labelled "Slope:", "Intercept:", "System Delay:" and "Speed of Sound:".All calculations include standard errors. In this instance, the errors indicate a good set of values. Note that the "Calculate TRx Parameters" button is not enabled until 3 samples have been entered into the list. Also, if a particular sample is deemed to be questionable, it's contribution to the calculations can be removed by unchecking the list item and redoing the calculation.

Activating the "OK" button will bring a confirmation dialog box similar to:



Follow the instructions given to set the desired parameters. If none of the parameters are checked and the OK button is activated, there are no parameter updates.

With the check boxes checked, activating the OK button will result in a file named "TRxParam.ini" being written into the main SonoLabDS3 install directory. The "TRxParam.ini" file has the following contents:

```
; SonoLabDS3 TRx Parameters File
; Generated on: 2017/11/22 15:33:12
;

; TRx Slope and Intercept
; TRxSlope: 0.011534 +/- 0.000005
TRxSlope: 0.011534
; TRxIntercept: -1.772539 +/- 0.011168
TRxIntercept: -1.772539

; System Delay
; SystemDelay: 153.684296 +/- 1.035012
SystemDelay: 153.684296

; Speed of Sound
; SpeedOfSound: 1.476305 +/- 0.000641
SpeedOfSound: 1.476305
```

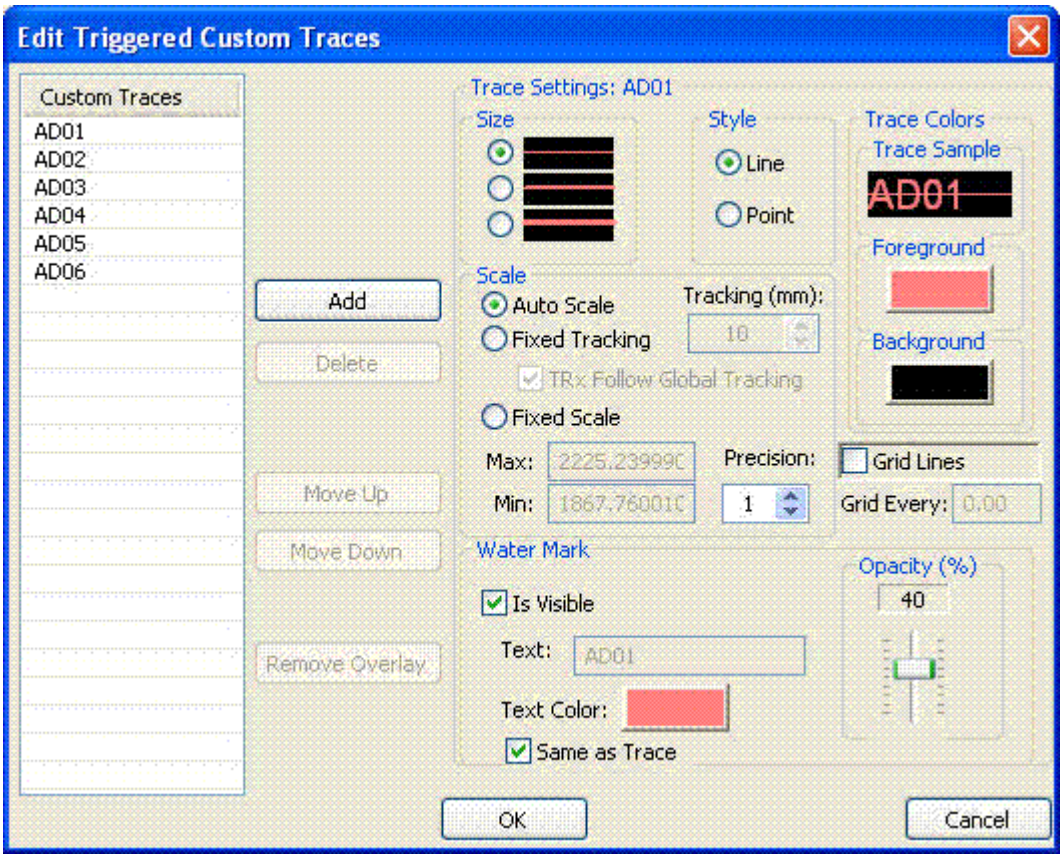
It should be noted that the parameter values along with the calculated standard errors are included as comments in this file. If this file exists, it is read by the SonoLabDS3 software at startup and are used to determine the TRx display values.

If a previous version of the TRxParam.ini file existed, the preexisting file is renamed to something like: TRxParam_20171116_172859.ini. The additional text in the file name are the date and time of the original file's creation.

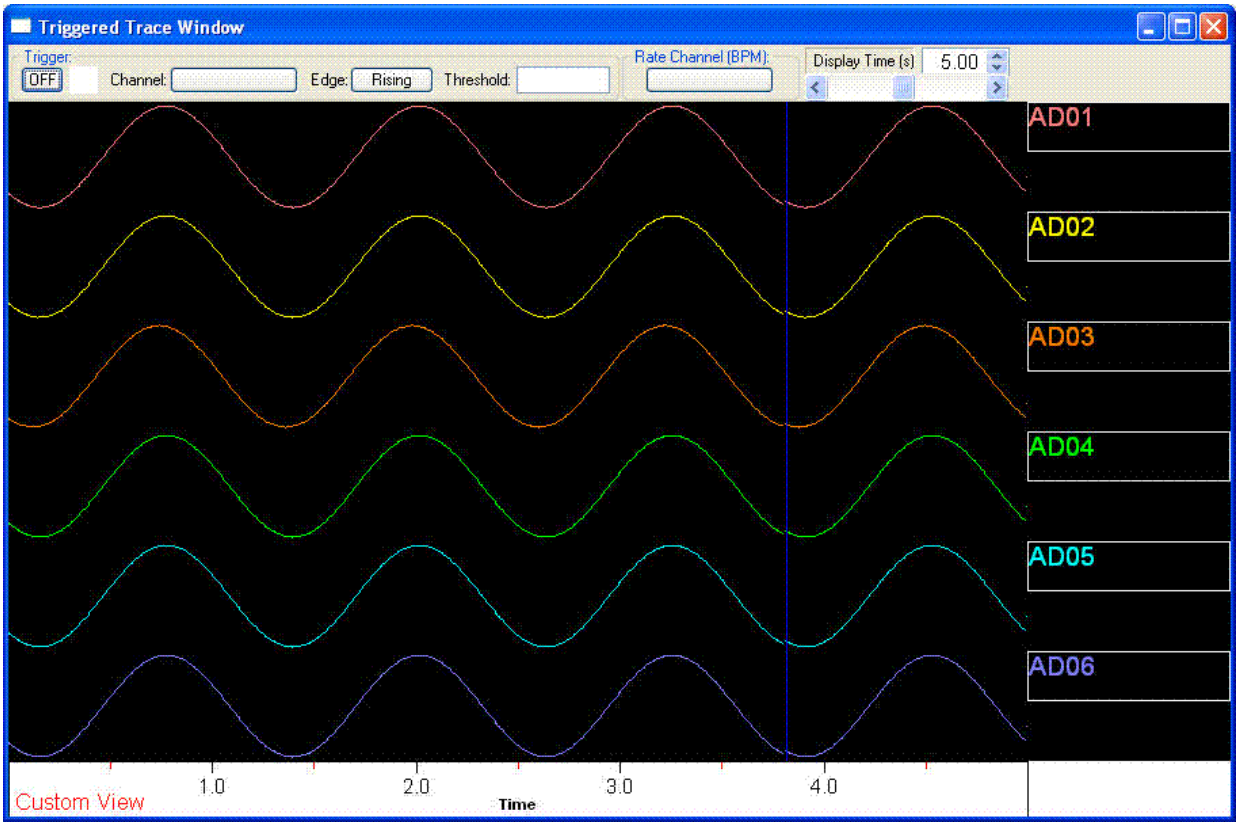
Triggered Trace Display Window

The Triggered Trace Display Window is a specialized custom trace display which can be used to repeatedly show periodic trace segments at a definable trigger point. The trigger point is defined by a transition that is specified as a user selected value for the trigger channel. The transition can be either on the rising or falling edge of the trigger signal.

The first time activation of the Triggered Trace Display Window is accomplished by selecting the "Triggered Trace Window" menu option under the "View" menu on the "SonoLabDS3 Trace Window". If this window has not been previously defined, the "Edit Triggered Custom Traces" dialog will appear (c.f. Custom Display Configuration), for example:



Upon completing the desired trace layout (selecting channels, changing trace colors, defining overlays, etc.), activating the OK button will bring up the Triggered Trace Window:

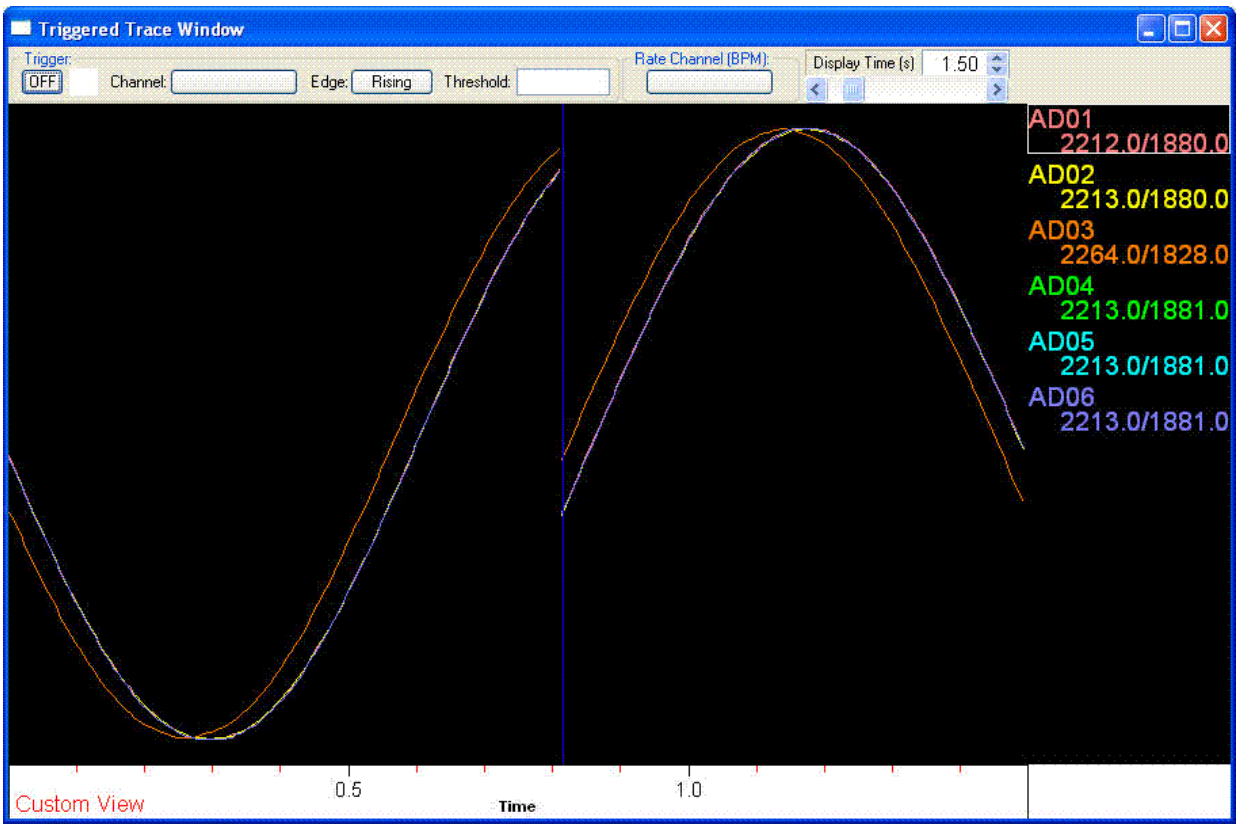


els,

Applying the following steps:

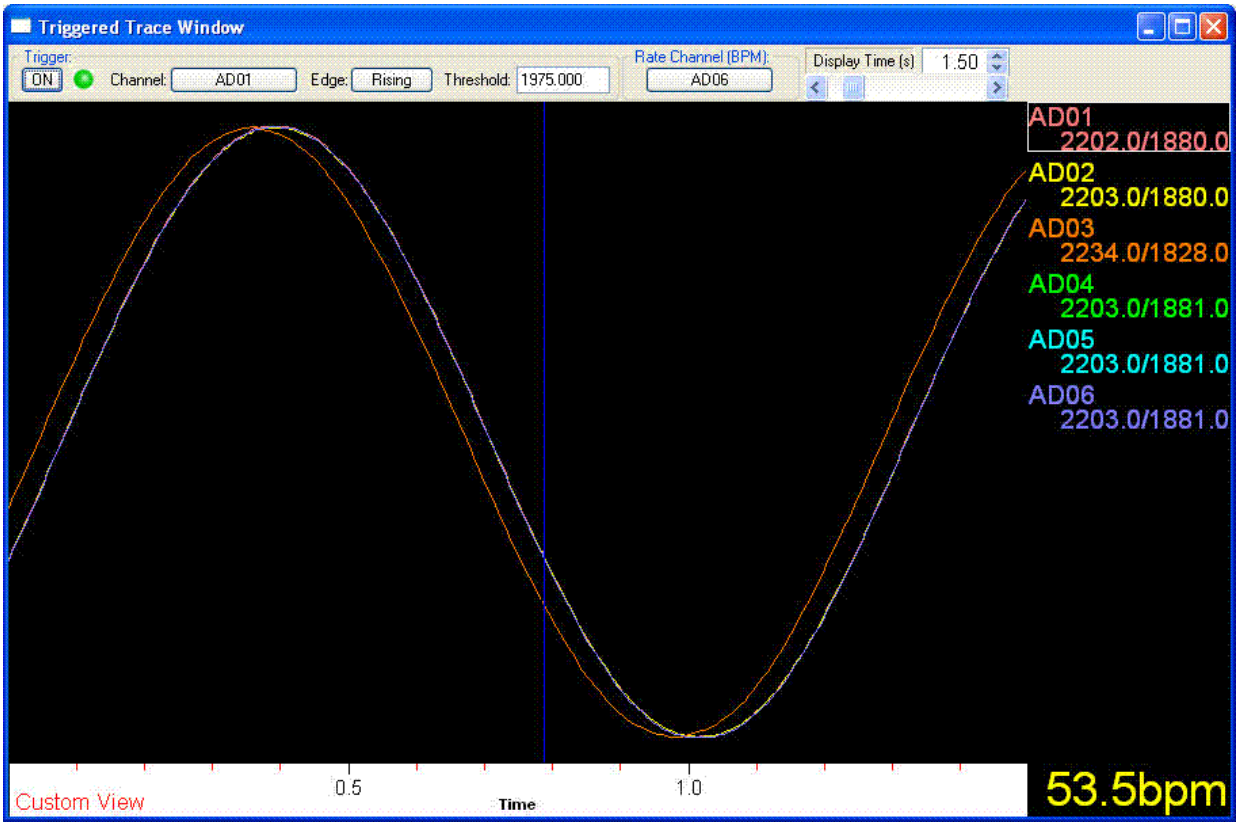
1. Modify each trace's "Statistic View" by right clicking with the mouse in the right hand side of the trace on the name/legend area and enabling the appropriate statistics (in this instance, it was accomplished by checking the "Maximum" and "Minimum" Statistics for AD01 and checking the "Apply these settings to the other ADC traces" in the Statistics Settings:AD01 dialog, prior to activating the OK button)
2. Open the "Edit Triggered Traces" by right clicking in the main body of any trace and selecting the afore mentioned menu item, we overlayed all of the AD traces (only AD traces can be overlayed) and adjusted the time scale to 1.5 seconds.

The result:



Additional settings that were applied:

1. Select Trigger Channel AD01
2. Set the Threshold to 1975
3. Select AD06 for the "Rate Channel (BPM)"
4. Set the Trigger button to "ON"

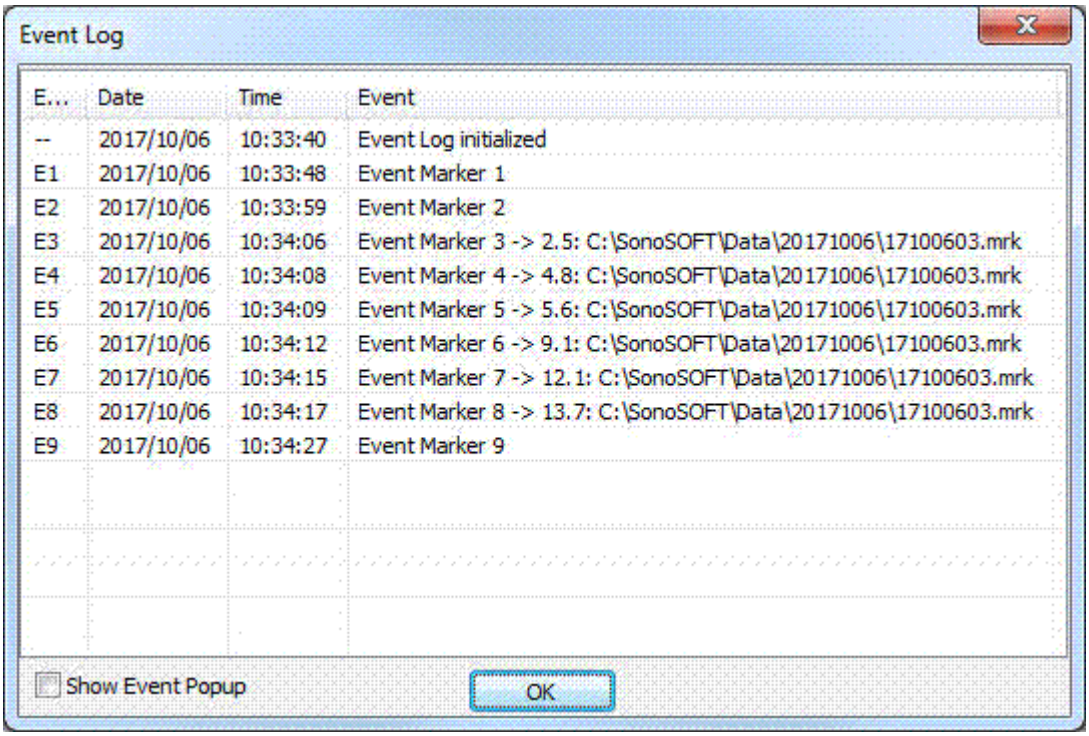


The Trigger marker icon appears next to the Trigger: button, and should alternate between Red and Green (provided that the displays are active and not Idle). When the icon is Red the Triggered Trace Window is seeking for a trigger event, namely when the AD01 signal passes from a value below 1975 to one above this threshold. When the trigger event occurs, the icon turns Green and the display is updated until the sweep reaches the end of display by the trace legends and statistics. The sweep stops, the icon turns Red and the Trigger Trace Window is back to seeking triggered event mode. This permits the user to see variations between adjacent periodic events.

If the Trigger: button is OFF, the Triggered Trace Window behaves as a continuous display similar to the SonoLabDS3 Trace Display Window.

Event Marker File

The user is now able to generate Event Marker data. The Event Marker data is display after the first Event has been generated and is shown to the user in the Event Log Dialog as shown below:



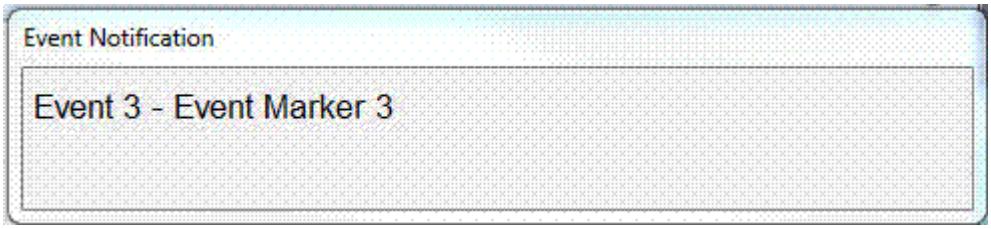
The above window is shown when the first Event Marker is generated during a day's SonoLabDS3 session. Event Markers are generated by holding down the Alt key and pressing one of the numeric keys 1 through 9. This can be done on the main keyboard or on the "Num Lock"ed keypad

The Event Markers are recorded in one of two types of files:

1. If data is not being saved, the Event Markers are saved to the "File Format:" field for the ".slb" file name as defined in the Data File Options (activate the "Generate Sample" button for verification of the desired formats).They are saved in the data save directory along with the sessions' ".slb" files. By default the "File Format:" is YYMMDD. The base Event Marker file, in this example, would have a name like 171006.mrk. All Events, including the ones generated with an associated ".slb" are recorded in the base Event Marker file. It has the complete history of the Events generated during a day's SonoLabDS3 sessions.
2. If data is being saved (Auto Save, Save Data or Save Screen), the Event Markers are saved to a file with the same name as the ".slb" binary file (i.e. if the current save is to 17100601.slb, the associated Event Marker file is 17100610.mrk).

The text to be displayed for each Event (enumerated as 1 through 9) can be set by the user under the "Event Markers (MRK): section of the Data File Options page in the Configuration. If an event without user defined text is activated, the text "Event Maker #" is used (where # is one of the numeric characters 1 through 9).

If the "Show Event Popup" check box is checked in the Event Log dialog window, then a popup window will appear momentarily for approximately 2 to 3 seconds as shown below (NOTE: if this option is enabled the next Event Marker is not processed until the popup has dismissed):



The Event Marker file has the following fields for each Event:

1. Event Number (one of E1 .. E9)
2. Date (YYYY/MM/DD)
3. Time (HH:MM:SS)
4. Sample number (if this is 0, then data is not being saved)
5. Sample time in seconds
6. Event Marker text
7. Event Marker file name if saving data

An sample base Event Marker is shown below:

```
; SonoLabDS3 Base Event Marker File: C:\SonoSOFT\Data\20171006\171006.mrk
; Created on: 2017/10/06 08:41:23
; Event# Date Time Sample# Samp_Time Event_Text Save_MRK
E1 2017/10/06 08:41:23 0 0.000000 "Event Marker 1" ""
E2 2017/10/06 08:42:54 0 0.000000 "Event Marker 2" ""
E3 2017/10/06 08:42:54 0 0.000000 "Event Marker 3" ""
E4 2017/10/06 08:42:54 0 0.000000 "Event Marker 4" ""
E5 2017/10/06 08:42:55 0 0.000000 "Event Marker 5" ""
E6 2017/10/06 08:42:55 0 0.000000 "Event Marker 6" ""
E7 2017/10/06 08:42:55 0 0.000000 "Event Marker 7" ""
E8 2017/10/06 08:42:56 0 0.000000 "Event Marker 8" ""
E9 2017/10/06 08:42:56 0 0.000000 "Event Marker 9" ""
E1 2017/10/06 10:23:10 301 1.735114 "Event Marker 1"
"C:\SonoSOFT\Data\20171006\17100601.mrk"
E2 2017/10/06 10:23:10 369 2.127100 "Event Marker 2"
"C:\SonoSOFT\Data\20171006\17100601.mrk"
E3 2017/10/06 10:23:11 407 2.346151 "Event Marker 3"
"C:\SonoSOFT\Data\20171006\17100601.mrk"
E4 2017/10/06 10:23:11 456 2.628612 "Event Marker 4"
"C:\SonoSOFT\Data\20171006\17100601.mrk"
E1 2017/10/06 10:27:35 0 0.000000 "Event Marker 1" ""
E1 2017/10/06 10:32:23 0 0.000000 "Event Marker 1" ""
E2 2017/10/06 10:32:25 0 0.000000 "Event Marker 2" ""
E3 2017/10/06 10:32:30 349 2.011810 "Event Marker 3"
"C:\SonoSOFT\Data\20171006\17100602.mrk"
E1 2017/10/06 10:33:48 0 0.000000 "Event Marker 1" ""
E2 2017/10/06 10:33:59 0 0.000000 "Event Marker 2" ""
E3 2017/10/06 10:34:06 427 2.461441 "Event Marker 3"
"C:\SonoSOFT\Data\20171006\17100603.mrk"
E4 2017/10/06 10:34:08 840 4.842180 "Event Marker 4"
"C:\SonoSOFT\Data\20171006\17100603.mrk"
E5 2017/10/06 10:34:09 975 5.620387 "Event Marker 5"
"C:\SonoSOFT\Data\20171006\17100603.mrk"
E6 2017/10/06 10:34:12 1587 9.148261 "Event Marker 6"
"C:\SonoSOFT\Data\20171006\17100603.mrk"
E7 2017/10/06 10:34:15 2102 12.116979 "Event Marker 7"
"C:\SonoSOFT\Data\20171006\17100603.mrk"
E8 2017/10/06 10:34:17 2374 13.684922 "Event Marker 8"
"C:\SonoSOFT\Data\20171006\17100603.mrk"
E9 2017/10/06 10:34:27 0 0.000000 "Event Marker 9" ""
```

In this example, the file 17100601.mrk contains the following:

```
; SonoLabDS3 Event Marker File: C:\SonoSOFT\Data\20171006\17100603.mrk
; Created on: 2017/10/06 10:34:06
; Event Date Time Sample Samp_Time Event_Text
E3 2017/10/06 10:34:06 427 2.461441 "Event Marker 3"
"C:\SonoSOFT\Data\20171006\17100603.mrk"
E4 2017/10/06 10:34:08 840 4.842180 "Event Marker 4"
"C:\SonoSOFT\Data\20171006\17100603.mrk"
```

```
E5 2017/10/06 10:34:09 975 5.620387 "Event Marker 5"
"C:\SonoSOFT\Data\20171006\17100603.mrk"
E6 2017/10/06 10:34:12 1587 9.148261 "Event Marker 6"
"C:\SonoSOFT\Data\20171006\17100603.mrk"
E7 2017/10/06 10:34:15 2102 12.116979 "Event Marker 7"
"C:\SonoSOFT\Data\20171006\17100603.mrk"
E8 2017/10/06 10:34:17 2374 13.684922 "Event Marker 8"
"C:\SonoSOFT\Data\20171006\17100603.mrk"
```

In the situation were the save data file is not saved (i.e. by pressing Cancel button when the Save File dialog appears, c.f. Trace Display Window), the Event Marker file associated with the deleted ".slb" file is also deleted if it existed. Note that the Event Markers generated for the deleted save are still present in the base Event Marker file.

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