Vapor Bus International

A **Wabtec** company

Engineered Bus Door Systems

CLASS Oscilloscope Setup User Manual Version 3.0

CLASS Oscilloscope Setup

Vapor Bus International
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Table of Contents

1 Hardware

This help file explains the steps needed to set up and use an oscilloscope for viewing and measuring CLASS waveforms.

Two types of oscilloscopes are discussed: The Tektronix TDS-220, a stand-alone oscilloscope,
and the Link Instruments DSO 2102 and DSO 8500, both laptop-based oscilloscopes. Each is pictured below.

TDS-220
(See Section 1 3)

DSO 2102
(See Section 2 9)

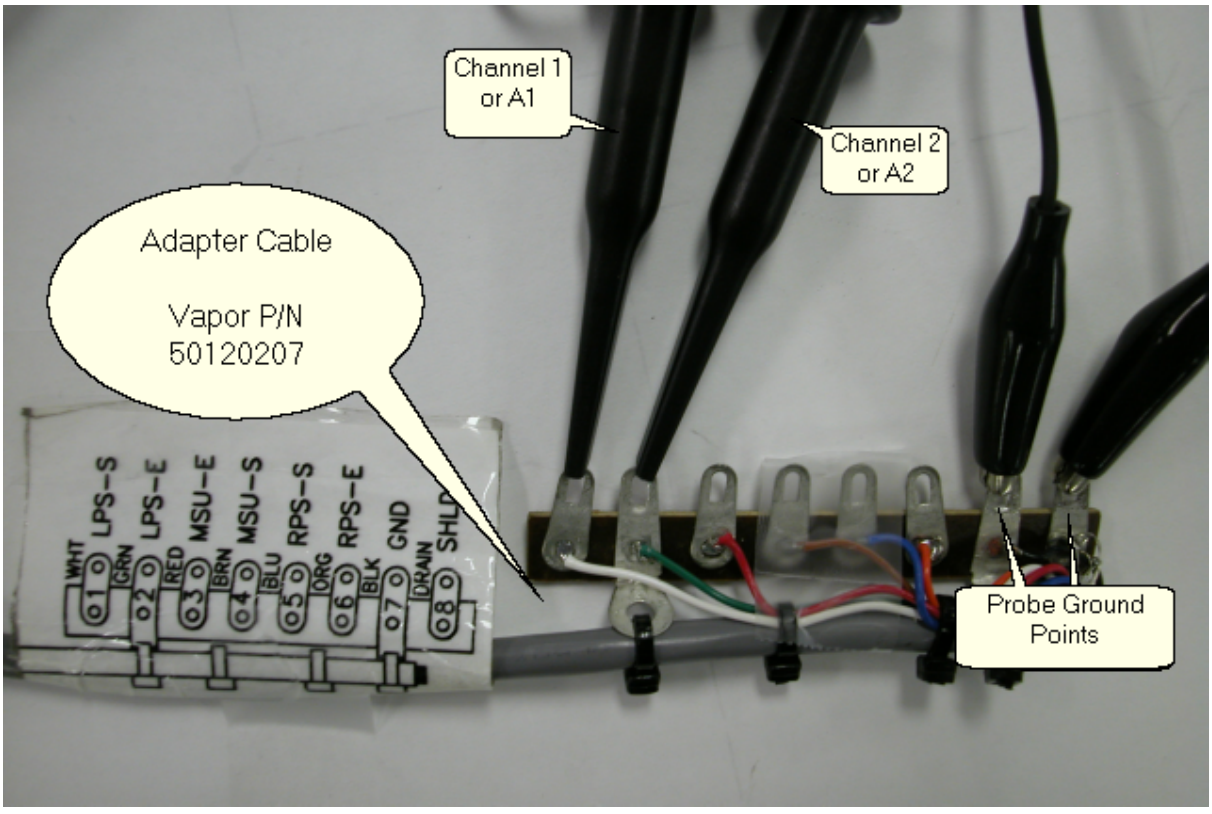
DSO 8500
(See Section 3 23)

2 Connections

To use either oscilloscope, the oscilloscope probes must be connected to the appropriate outputs. This requires use of an adapter cable which plugs into the CLASS controller and provides the appropriate signals in a terminal strip suitable for probe connections.

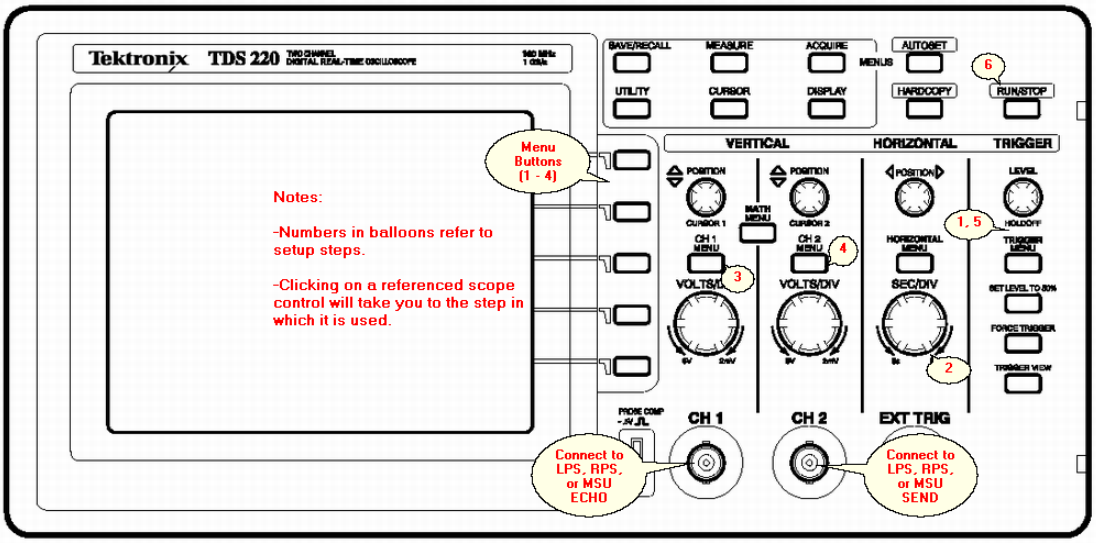
Typical connections are shown below (example shown is for measuring the LPS sensor).

- Channel 1 (TDS-220) or Channel A1 (DSP 2102) is connected to LPS-S (LPS Send)
- Channel 2 (TDS-220) or Channel A2 (DSP 2102) is connected to LPS-E (LPS Echo)
- Note that GND and SHIELD may both be used for the probe GROUND connections.



The other end of the adapter cable plugs into the CLASS controller at the connector labeled "TEST" (J3).

3 TDS-220



3.1 Read First

For the following instructions, a TDS-220 [3] will be used as a typical example. If a different oscilloscope is used, the settings will still generally apply but the methods required to achieve those settings may be different – consult the manual for the oscilloscope in use.

The settings will be based on the assumption that Channel 1 is used for the signal (connected to LPS, RPS, or MSU ECHO) and Channel 2 is used for the trigger (connected to LPS, RPS, or MSU SEND).

Note: connect both probes to the oscilloscope before turning the oscilloscope on. This will ensure that the proper probe settings are detected.

See Connections [2].

3.2 Step 1: Setting the Trigger - Preliminary

1. Press the TRIGGER MENU [3] button

2. Using the Menu buttons (the buttons in a column directly to the right of the screen) set as follows:
   Type = ***Edge***
   Source = ***CH2***
   Slope = ***Rising***
   Mode = ***Auto*** [Note: this setting will be changed later in step 5]
   Coupling = ***DC***

3.3 Step 2: Setting the Time Base

1. Using the SEC/DIV knob, set the time base to ***2.50ms***.
   (This value can be observed in the text portion just below the graphical area of the screen, following the CH1 and CH2 values.)

3.4 Step 3: Setting Channel 1(Echo)

1. Press the CH1 MENU button

2. Using the Menu buttons (the buttons in a column directly to the right of the screen) set as follows:
   Coupling = ***Ground*** [Note: this setting will be changed later]
   BW Limit = ***Off***
   Volts/Div = ***Coarse***
   Probe = ***1X*** (if probe is set to 1X) or ***10X*** (if probe is set to 10X)
   Invert = ***Off***

3. Using the POSITION knob for Channel 1, adjust the position of the horizontal trace so that it is one division up from the bottom. (The correct trace will have a "1" at its left side)

4. When step 3 is complete, change the Coupling (previously set to *Ground*) to ***DC***

5. Using the VOLTS/DIV knob for Channel 1, set to ***1.00V*** ((This value can be observed in the text portion just below the graphical area of the screen, following the text "CH1".)

3.5 Step 4: Setting Channel 2 (Trigger)

1. Press the CH2 MENU button

2. Using the Menu buttons (the buttons in a column directly to the right of the screen) set as follows:
   Coupling = ***Ground*** [Note: this setting will be changed later]
   BW Limit = ***Off***
   Volts/Div = ***Coarse***
   Probe = ***1X*** (if probe is set to 1X) or ***10X*** (if probe is set to 10X)
   Invert = ***Off***

3. Using the POSITION knob for Channel 2, adjust the position of the horizontal trace so that it is one division down from the top. (The correct trace will have a "2" at its left side)

4. When step3 is complete, change the *Coupling* (previously set in step 2 to *Ground*) to ***DC***

5. Using the VOLTS/DIV knob for Channel 2, set to ***5.00V*** (This value can be observed in the text portion just below the graphical area of the screen, following the text "CH2".)

3.6 Step 5: Setting the Trigger - Final

1. Press the TRIGGER MENU button

2. Using the Menu buttons (the buttons in a column directly to the right of the screen) change settings (set in Setting the Trigger - Preliminary) as follows:
   Mode = ***Normal***

3. Using the LEVEL knob (in the TRIGGER section), adjust for a value of approximately 2.50V. (This value can be observed in the text portion of the screen, just below the graphical area, on the right side. Any value between 1.00V and 4.00V is acceptable; the goal is to be approximately in the middle of the 5-Volt trigger signal.)

3.7 Step 6: Troubleshooting

- If the expected waveforms are not seen, check the following:
  1. Verify that the scope probes are correctly connected
  2. Verify that the sensor being observed is actually on and transmitting.

- Verify that that the RUN/STOP button is not in the STOP position – the word "***Trig'd***" should be seen at the top of the screen.

3.8 Techniques

3.8.1 Time Measurement

3.8.1.1 Timing

To measure the time to an echo:

1. Press the *CURSOR* button on the scope. (This will change the menu items to cursor-related selections, and change the VERTICAL POSITION knobs to Cursor Position knobs)

2. Using the Menu buttons, select:
   Type = Time
   Source = CH2

3. Using the Cursor 1 Position Knob), adjust Cursor 1 so that it lines up with the left

edge of the trigger (See Scope Traces 7)
When correctly alligned, the *Cursor 1* Menu text will read "0.000s"

4. Using the Cursor 2 Position Knob, adjust Cursor 2 so that it lines up with the point to be measured.
For an echo, line it up with the point where the leading (left-most) edge first becomes greater than 2 volts.

5. The *Cursor 2* Menu text will display the time from the trigger to the echo.
If the scope is set per Setting the Time Base 4 to 2.50 ms/Div, the time will be in units of milliseconds (ms).

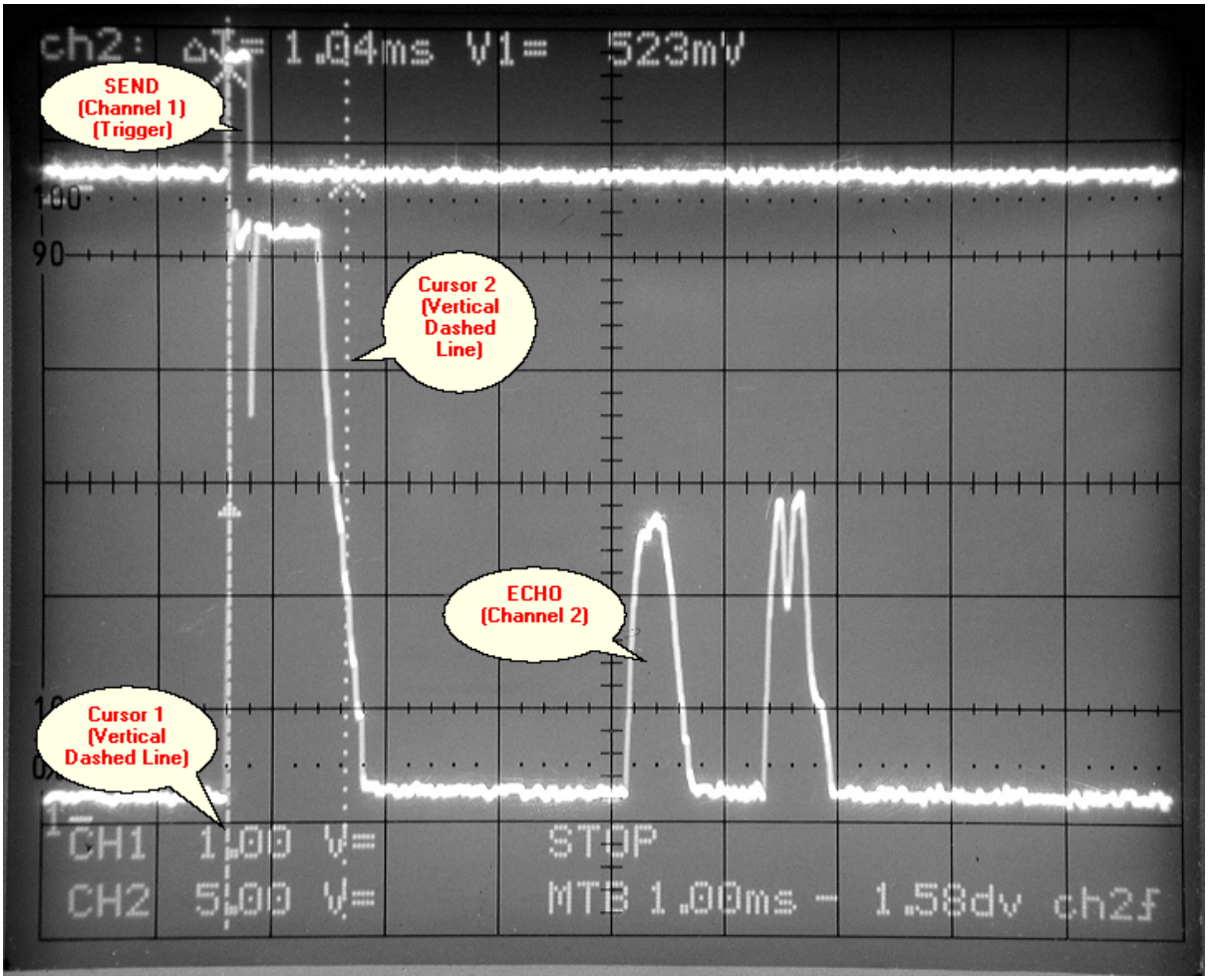
To calculate the distance to the echo:

1. Multiply the time found in step 5 above by 1000 (to convert to microseconds)

2. Divide the result by **59**. The result is the distance in centimeters from the sensor to the target.

Note: The number *59* is a constant that is based on the speed of sound in air at a specific temperature (25 C or about 70 F).
If the actual temperature is different, the calculated distance may not be exactly the same as the measured distance.

3.8.1.2 Scope Traces



3.8.2 Persistence

Persistence is a useful technique for measuring repetitive signals which vary over time, and is especially useful in deciding when to include a potential target in the CLASS target table. If *Persistence* is ON, each trace scan will be "added" to the previous scan, allowing a build-up over time.

To use *Persistence* to detect targets, connect to the desired sensor, turn the sensor on (using diagnostic test mode), and allow enough time for the scans to "build". If a target appears only occasionally, with *Persistence* ON the trace will be stored and the target will easily be seen.

To turn on persistence:

1. Press the scope's DISPLAY 3 button. This will change the menus to reflect Display properties.

2. Press the MENU button adjacent to ***Persist***.

Each press of the button will cycle to the next option.
(Setting options are: *Off, 1 Sec, 2 Sec, 5 Sec,* and *Infinite*.)

The *Persist* value determines how long a signal is maintained on the screen for viewing.

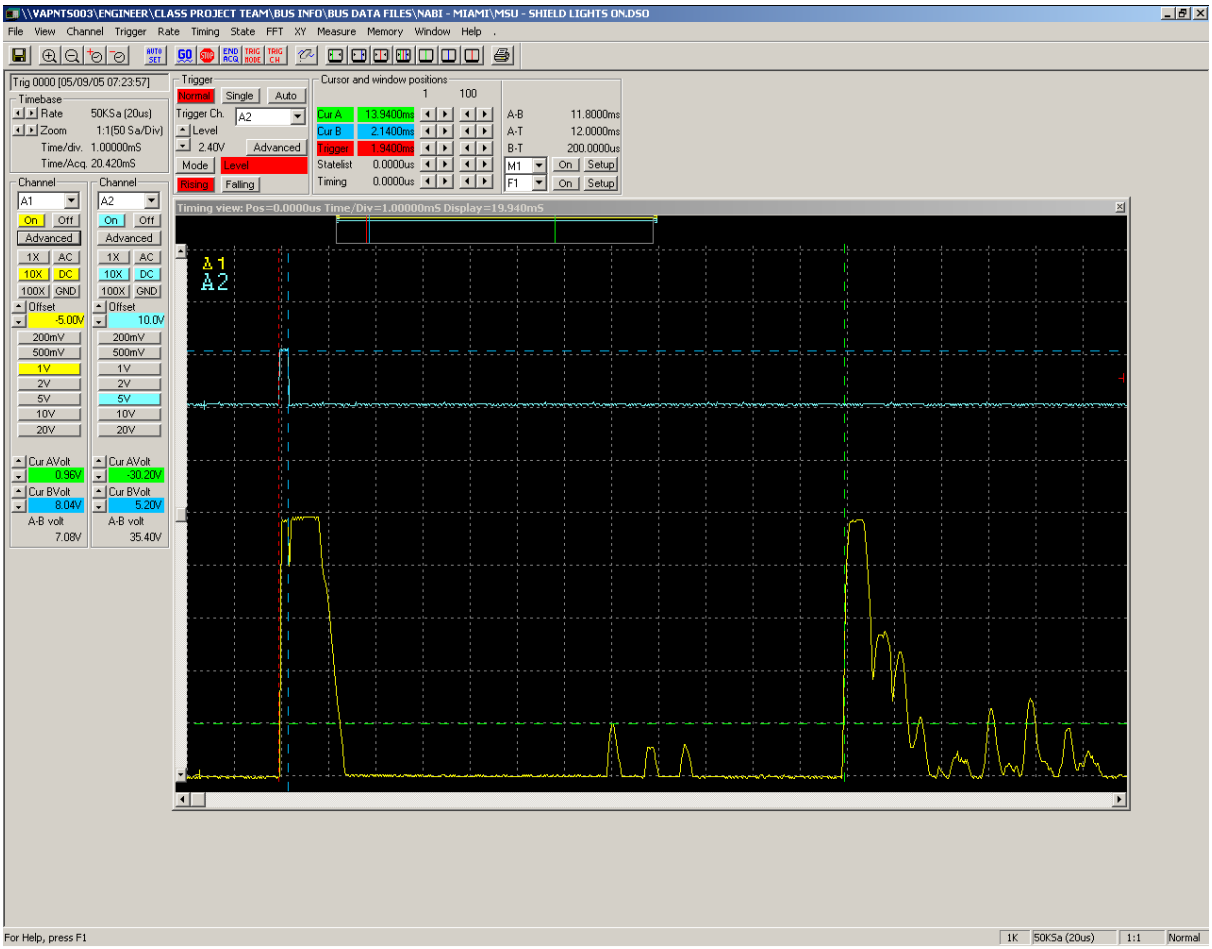
Setting to *Infinite* will allow monitoring of an echo over an extended period and will capture the peak value for that period.

If a target's peak value is greater than 25% of the CLASS *VREF Normal* setting, that target should be added to the target table.

(For the typical case of VREF Normal = 2.0V, any echo which peaks above 0.5V should be added to the table.)

When finished using Persistence, remember to set it back to *Off.*

4 DSO 2102



4.1 Read First

For the following instructions, a DSO 2102 [9] will be used as a typical example. If a different oscilloscope is used, the settings will still generally apply but the methods required to achieve those settings may be different – consult the manual for the oscilloscope in use.

(Note: the colors shown in the examples may not be the same as those in your configuration.)

The settings will be based on the assumption that Channel A1 is used for the ECHO (connected to LPS, RPS, or MSU ECHO) and Channel A2 is used for the trigger (connected to LPS, RPS, or MSU SEND).

See Connections [2].

The DSO2102 may be used with a parallel connection or a USB connection.

Although the parallel cable is larger, for maximum reliability it is suggested that the parallel connection be used.

If the USB connection is used, follow this sequence:

1. Attach the probes to the DSO 2102 hardware box
2. Connect power to the DSO 2102 hardware box
3. Connect the USB cable to the DSO 2102 hardware box
4. Connect the USB cable to the laptop (it is important that this is the last step)

Now the DSO 2102 software may be run.
If error messages regarding USB are seen, log out (or re-boot) and retry the sequence.

If there still are USB problems (assuming Windows XP):

- Right-Click *My Computer* and select *Properties*.
- Select the *Hardware* tab, then click on *Device Manager*.
- Click on the + to the left of *Universal Serial Bus Controllers* to expand the list
- For each *USB Root Hub*:
  - Right click and select *Properties*
  - Select the *Power Management* tab
  - Uncheck *Allow the computer to turn off this device to save power*
  - Click *OK*
- When finished, close *Device Manager*

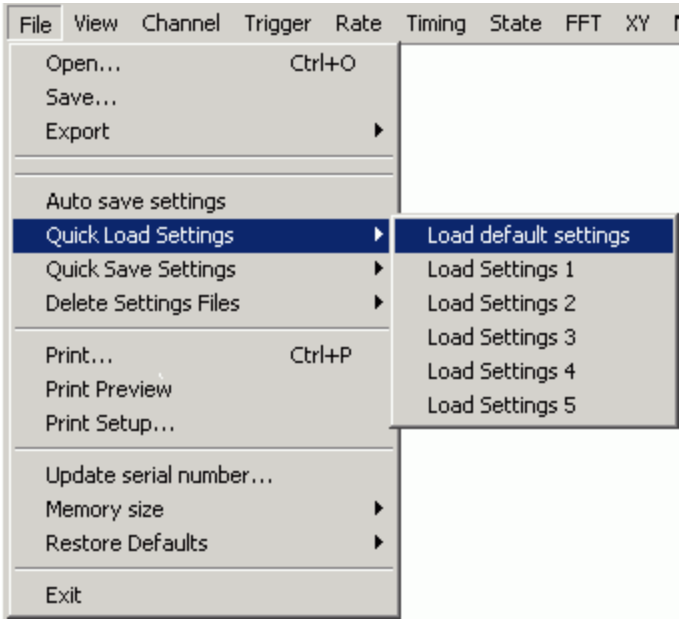
4.2 DefaultSettings

Default Settings are automatically loaded each time the DSO 2102 software is run. Once properly set (and *Default Settings* are saved) the program will be ready to run thereafter without having to reload settings each time.

If "Auto save settings" is checked, any changes made will be saved to the *Default Settings* when the program is closed. Click the "Auto save settings" menu item to turn it on or off.

Once settings are saved as desired, un-check "Auto save settings" to prevent further changes. It is also recommended that the same settings are saved to a second location, such as *Settings 5*, in case default settings are changed inadvertently.

"Quick Save Settings" will save default settings or Settings 1 through Settings 5
"Quick Load Settings" will load any saved settings.



Once the DSO2102 is connected and the program is run, settings may be changed as necessary if required.

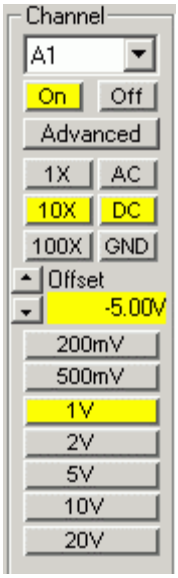
When the desired settings are made, press GO to begin sampling. Waveforms similar to those shown in DSO 2102 should be seen.

Note: if the USB connection is used, it is highly recommended to press STOP before closing the program.

4.3 Channel A1 - Echo

Channel A1 is assumed to be used for ECHO.

Settings are as follows (see full screen here: DSO 2102 9):

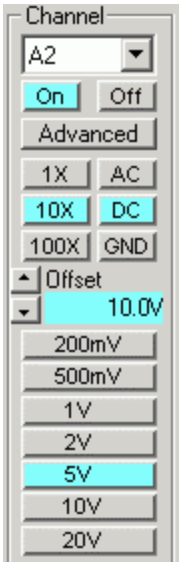


Note:
The Offset setting will determine where the trace "zero" lies. The Offset is related to the Sensitivity (volts per division) and to the center of the display.
An Offset of -5.00 V, at 1V per division, will result in the trace zero-point baseline being 5 divisions down from centerline.

4.4 Channel A2 - Send

Channel A2 is assumed to be used for SEND.

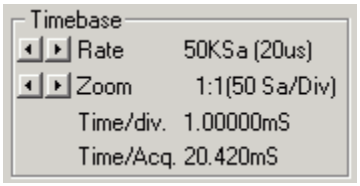
Settings are as follows (see full screen here: DSO 2102 9):



Note:
The Offset setting will determine where the trace "zero" lies. The Offset is related to the Sensitivity (volts per division) and to the center of the display.
An Offset of 10.0 V, at 5V per division, will result in the trace zero-point baseline being 2 divisions up from centerline.

4.5 Timebase

The **Timebase** is set to *50 KSa* as shown below (full screen here: DSO 2102 9).

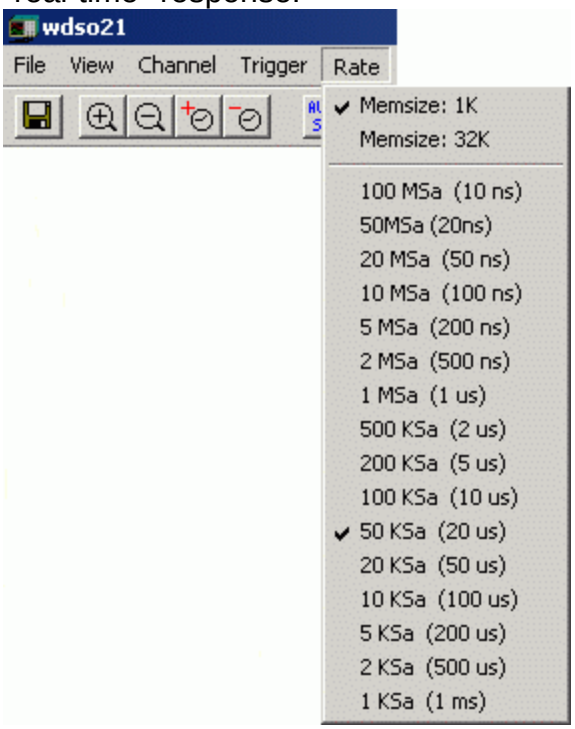


Use the ◄ and ► buttons to change the rate and thus change the Time per Division

The rate above is given in units of samples per second.
"50KSa" means 50,000 samples per second; the time per sample (NOT the Time per Division) is the inverse: 1/50,000 = 20μs (microseconds).

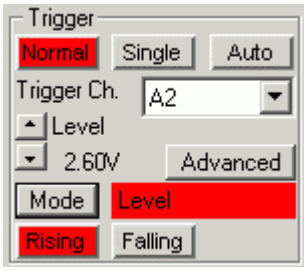
Time per Division ("Time/div.") is displayed below the "Zoom" setting and is set to 1.00000mS

Also:
Set Memsize to *1K*. This will provide faster screen refesh rates, and a more "real-time" response.



4.6 Trigger

Trigger settings are as follows (see full screen here: DSO 2102 9):

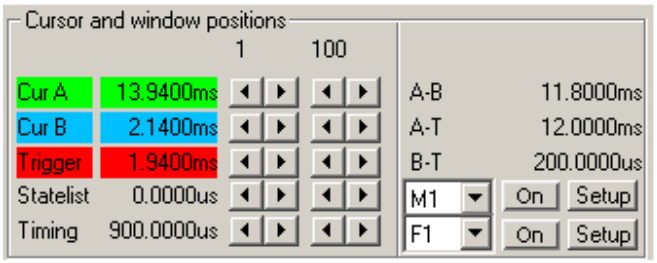


Notes:
1. Channel A2 (SEND) is used as the trigger source.
2. The Level (2.60 V shown) may be anywhere in the 0V to 5V range of the SEND pulse; near midpoint is usually best.

The trigger level may be seen graphically as a '+' on the right side of the screen, relative to the designated channel.

4.7 Time Cursors

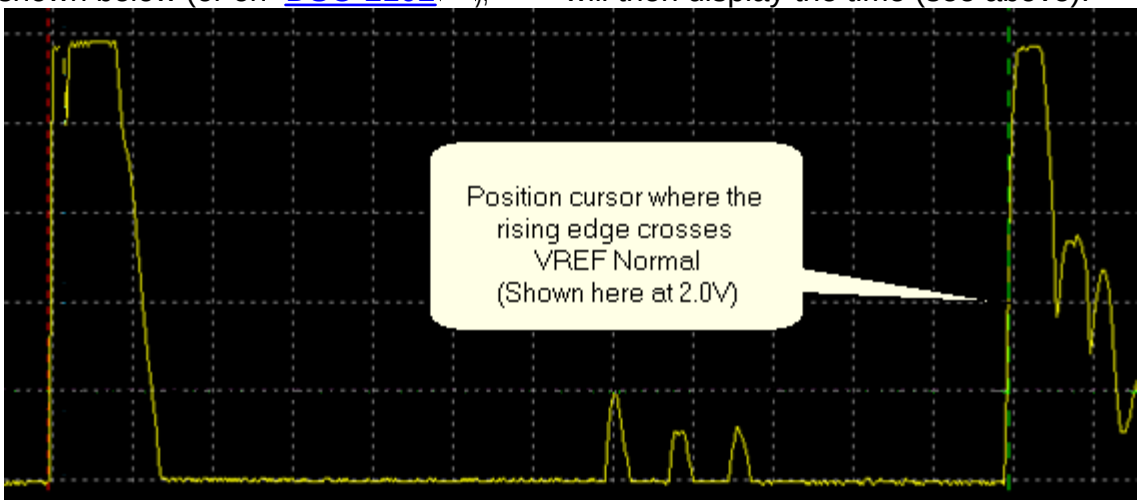
Time Cursors (vertical cursors on horizontal axis) are set in the area below (see full screen here: DSO 2102 9).



Notes:

1. The highlight colors shown above are those of the individual cursors on the scope display (Cursor A is Green, etc.).
2. Cursor placement: The ◄ and ► buttons in the column labeled "100" will move the cursor in large steps,
   the "1" column is used for small steps.
   Tip: the cursors may also be moved by click-and-drag.
3. On the right side of the cursor window, time measurements are displayed as folows:
   a. A-B: Time interval between Cursor A and Cursor B
   b. A-T: Time interval between Cursor A and the Trigger Cursor
   c. B-T: Time interval between Cursor B and the Trigger Cursor

To measure the time from the SEND pulse to an ECHO, position the Trigger Cursor (Red) and Cursor A (Green)
as shown below (or on DSO 2102 9); **A-T** will then display the time (see above).

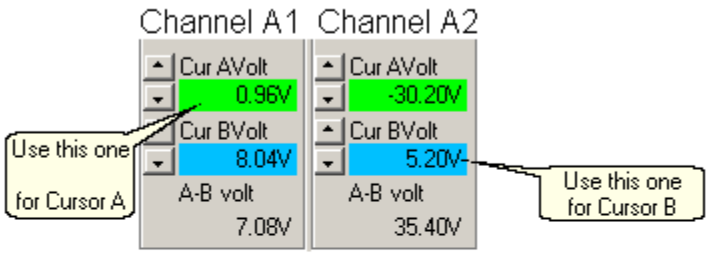


See Time Measurement 21 for details on converting a time measurement to the distance to an Echo.

See Customizing 21 to have the DSO 2102 software automatically display distance to the target.

4.8 Voltage Cursors

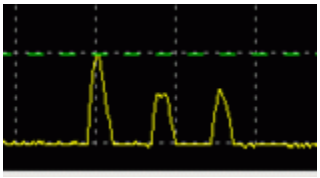
Voltage Cursors (horizontal cursors on vertical axis) are set in the area below (see full screen here: DSO 2102 9).



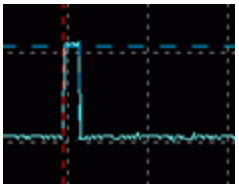
Notes:

1. The highlight colors shown above are those of the individual cursors on the scope display (Cursor A is Green, etc.).
2. Cursor placement: Use the ▲ and ▼ buttons to move the chosen cursor to the desired measurement position on screen.
   Useful Tip: the cursors may also be moved by click-and-drag.

3. Voltage measurement:
   a. Cursor A Voltage (Cur AVolt) in the Channel A1 column is referenced to the zero-point baseline of Channel A1.



   b. Cursor B Voltage (Cur BVolt) in the Channel A2 column is referenced to the zero-point baseline of Channel A2.



Use those to measure the respective voltages.
The other measurements reference the respective cursor to the opposite channel's

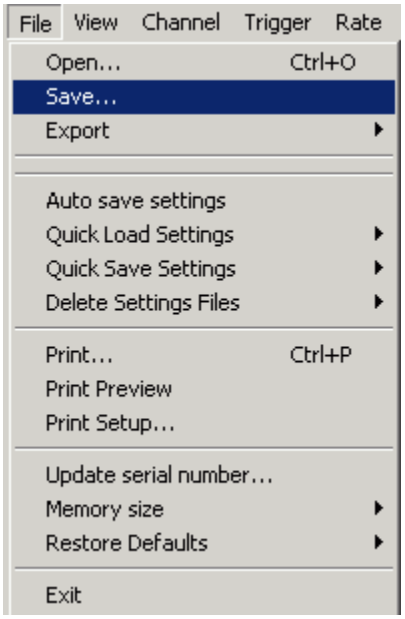
baseline.

In DSO 2102 9, Cur Avolt (Channel A1) is being used to display the amplitude of the small echo (0.96V),
Cur Bvolt (Channel A2) is displaying the amplitude of the SEND pulse (5.20V).

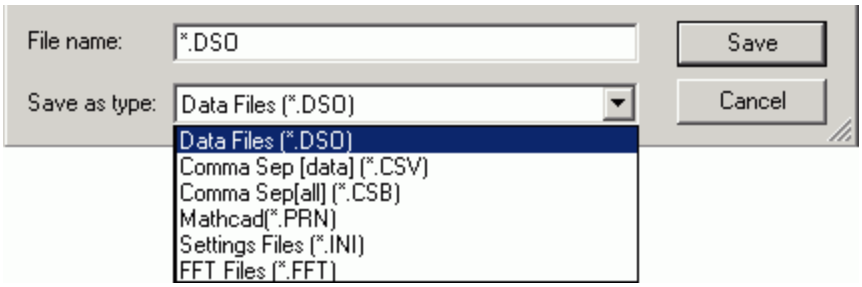
4. The A-B volt numbers shown measure the voltage between Cursor A and Cursor B, and are calculated by multiplying the number of divisions between the cursors by the volts/divison sensitivity of the respective channel.

4.9 Saving Waveforms

Select **File | Save** to save waveforms. You can save as many waveforms as you have harddisk space to accomodate.



If waveforms are saved as type "*.DSO", they will be viewable later with the DSO 2102 [9] software even if it is not connected to the scope (running in Demo mode).



Saved *.DSO waveforms may be recalled, viewed, measured, and then re-saved as *.CSV (which will allow direct importing into Excel).

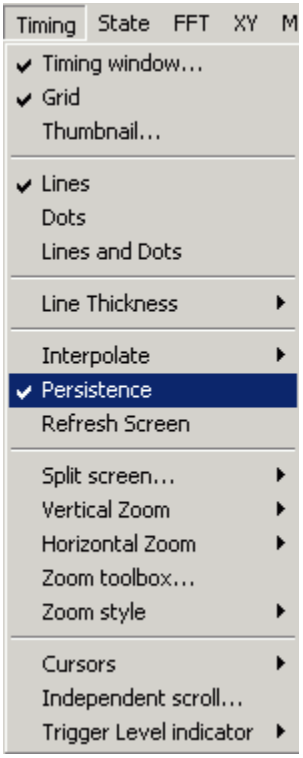
4.10 Techniques

4.10.1 Persistence

Persistence is a useful technique for measuring repetitive signals which vary over time, and is especially useful in deciding when to include a potential target in the CLASS target table. If *Persistence* is ON, each trace scan will be "added" to the previous scan, allowing a build-up over time.

To use *Persistence* to detect targets, connect to the desired sensor, turn the sensor on (using diagnostic test mode), and allow enough time for the scans to "build". If a target appears only occasionally, with *Persistence* ON the trace will be stored and the target will easily be seen.

Persistance may be turned on (or turned off) by clicking on the menu item as shown.



RESULTS:
If a target's peak value is greater than 25% of the CLASS *VREF Normal* setting, that target should be added to the target table.

(For the typical case of VREF Normal = 2.0V, any echo which peaks above 0.5V should be added to the table.)

When finished using *Persistence*, remember to turn it OFF.

4.10.2 Time Measurement

To measure the time to an echo:

Adjust the Time Cursors as discussed in the Time Cursors 16 section. Read the resultant A-T value. (Readings should be in milliseconds.)

To calculate the distance to the echo:

1. Multiply the time in milliseconds found above by 1000 (to convert to microseconds)

2. Divide the result by **59**. The result is the distance in centimeters from the sensor to the target.

Note: The number *59* is a constant that is based on the speed of sound in air at a specific temperature (25 C or about 70 F).
If the actual temperature is different, the calculated distance may not be exactly the same as the measured distance.

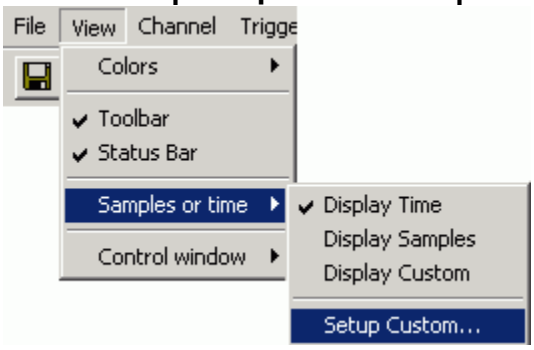
To directly display the distance to the echo:

Adjust the Time Cursors as discussed in the Time Cursors 16 section. Refer to Customizing 21 to change the display to centimeters.

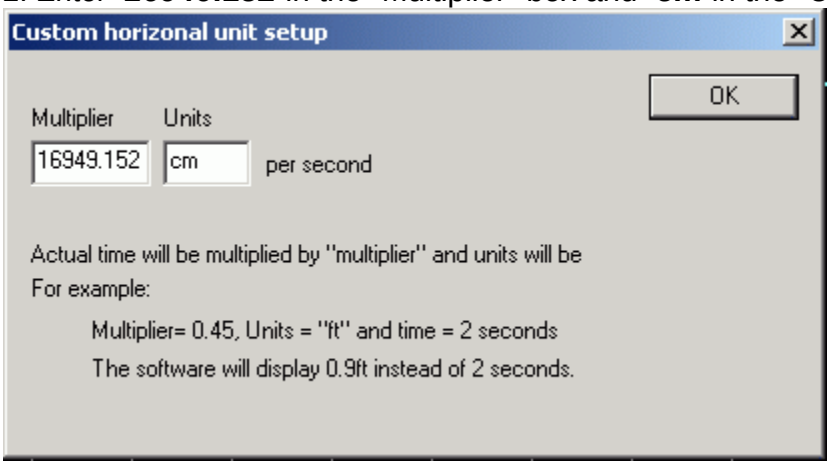
4.10.3 Customizing

Time measurements can be customized to directly display distance (to a target) in centimeters as follows:

1. Select **View | Samples or Time | Setup Custom...**

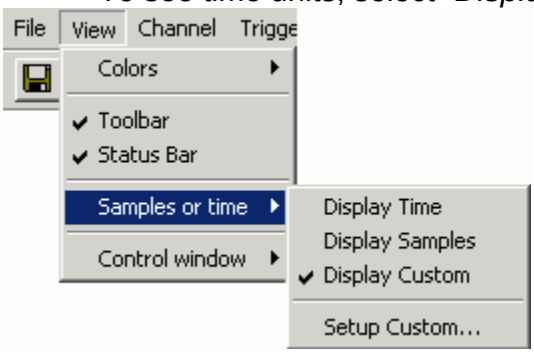


2. Enter ***16949.152*** in the "Multiplier" box and ***cm*** in the "Units" box. Click **OK**.

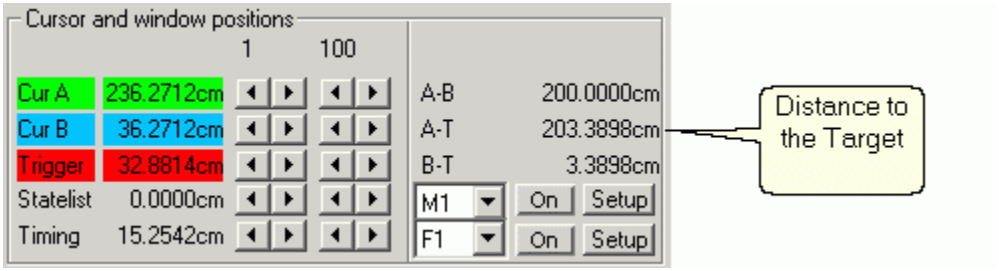


3. If *Display Custom* is selected, the Time Display will show centimeters to the target (if the cursor is on the target) as shown.

To see time units, select *Display Time* instead.

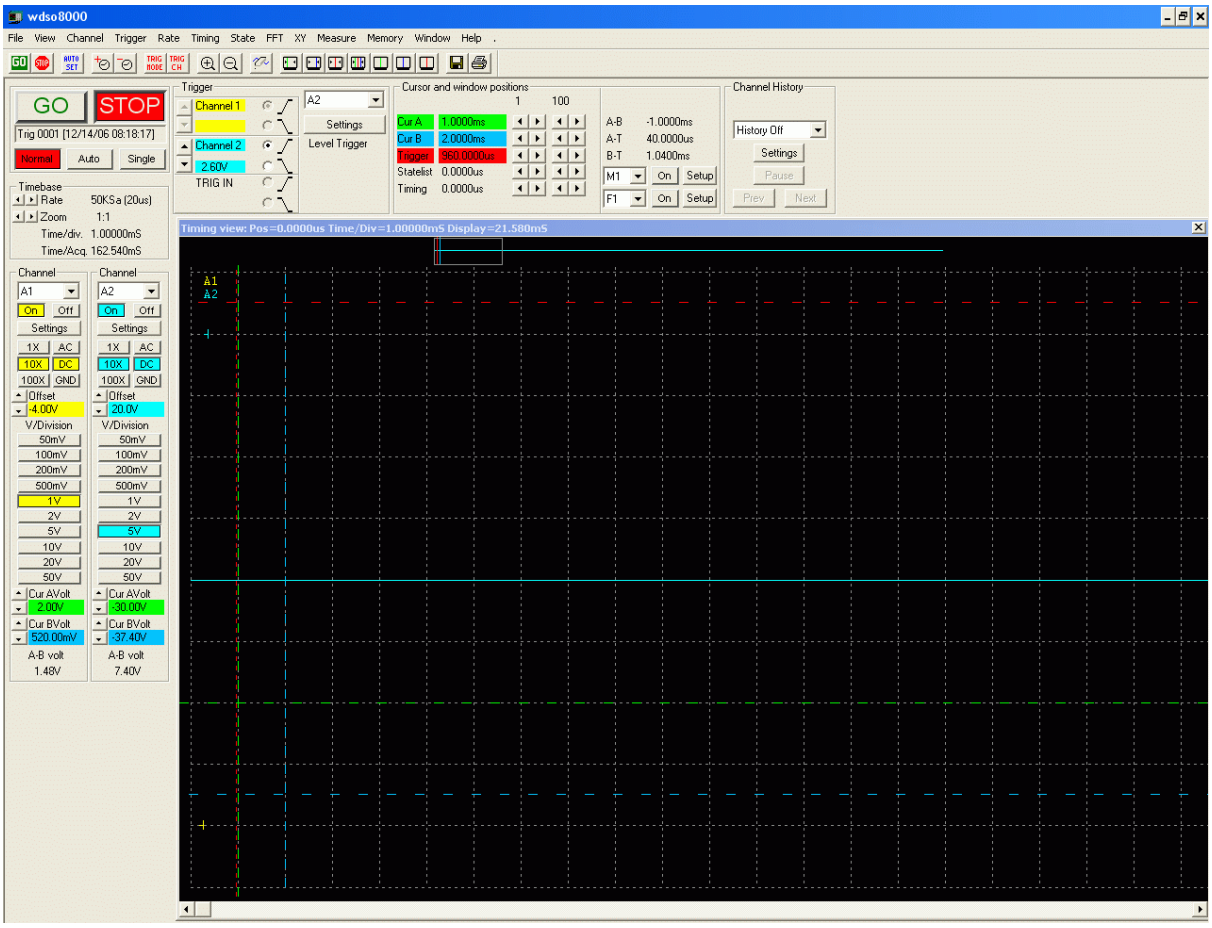


Result:



4. Once the file is saved, the Custom Settings will be saved as well.

5 DSO 8500



5.1 Read First

For the following instructions, a DSO 8500 23 will be used as a typical example. If a different oscilloscope is used, the settings will still generally apply but the methods required to achieve those settings may be different – consult the manual for the oscilloscope in use.

(Note: the colors shown in the examples may not be the same as those in your configuration.)

The settings will be based on the assumption that Channel A1 is used for the ECHO (connected to LPS, RPS, or MSU ECHO) and Channel A2 is used for the trigger (connected to LPS, RPS, or MSU SEND).

See Connections 2.

The DSO 8500 is only used with a USB connection.

LED Functions:

The **Red LED** is ON when:
1. The DSO is connected, and
2. The DSO is powered, and
3. The software is running

Yellow LED:
1. Blinks 4 times at selftest completion
2. Is ON when DSO is in acquisition mode

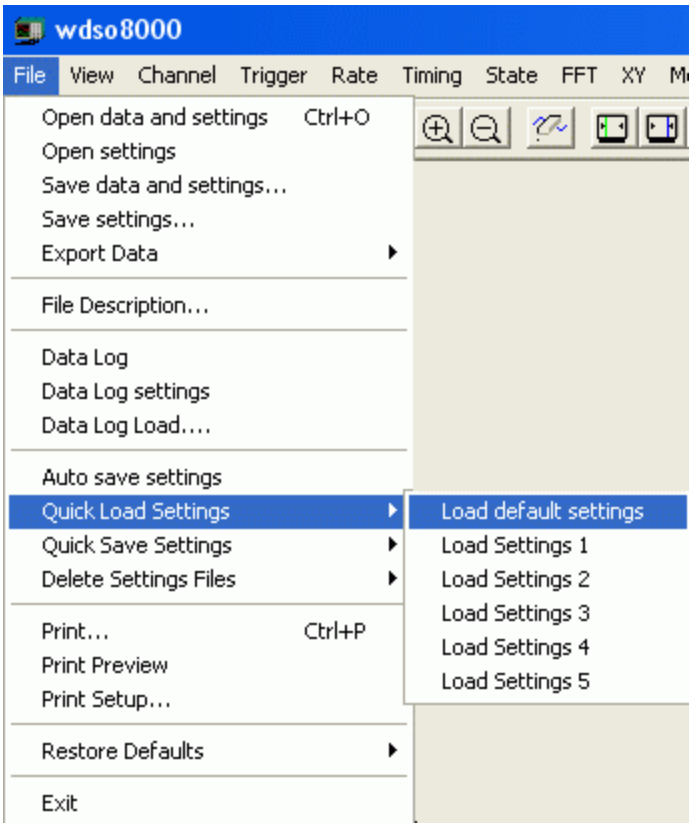
5.2 DefaultSettings

Default Settings are automatically loaded each time the DSO 8500 [23] software is run. Once properly set (and *Default Settings* are saved) the program will be ready to run thereafter without having to reload settings each time.

If "Auto save settings" is checked, any changes made will be saved to the *Default Settings* when the program is closed. Click the "Auto save settings" menu item to turn it on or off.

Once settings are saved as desired, un-check "Auto save settings" to prevent further changes. It is also recommended that the same settings are saved to a second location, such as *Settings 5*, in case default settings are changed inadvertently.

"Quick Save Settings" will save default settings or Settings 1 through Settings 5
"Quick Load Settings" will load any saved settings.



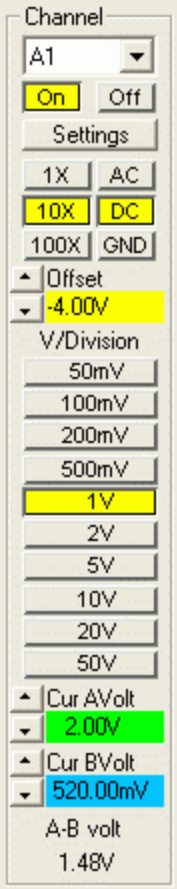
Once the DSO8500 is connected and the program is run, settings may be changed as necessary if required.

When the desired settings are made, press GO to begin sampling. Note: since the USB connection is used, it is highly recommended to press STOP before closing the program.

5.3 Channel A1 - Echo

Channel A1 is assumed to be used for ECHO.

Settings are as follows (see full screen here: DSO 8500 23):

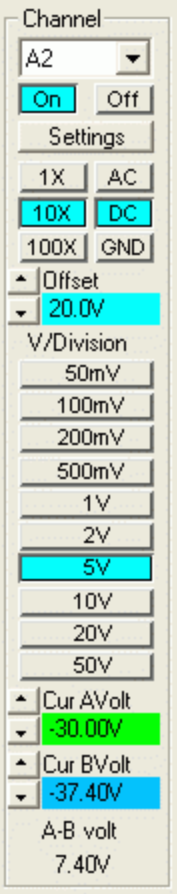


Note:
The Offset setting will determine where the trace "zero" lies. The Offset is related to the Sensitivity (volts per division) and to the center of the display.
An Offset of -4.00 V, at 1V per division, will result in the trace zero-point baseline being 4 divisions down from centerline.

5.4 Channel A2 - Send

Channel A2 is assumed to be used for SEND.

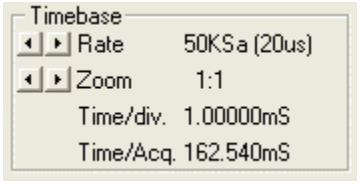
Settings are as follows (see full screen here: DSO 8500 23):



Note:
The Offset setting will determine where the trace "zero" lies. The Offset is related to the Sensitivity (volts per division) and to the center of the display.
An Offset of 20.0 V, at 5V per divison, will result in the trace zero-point baseline being 4 divisions up from centerline.

5.5 Timebase

The **Timebase** is set to *50 KSa* as shown below (full screen here: DSO 8500 23).

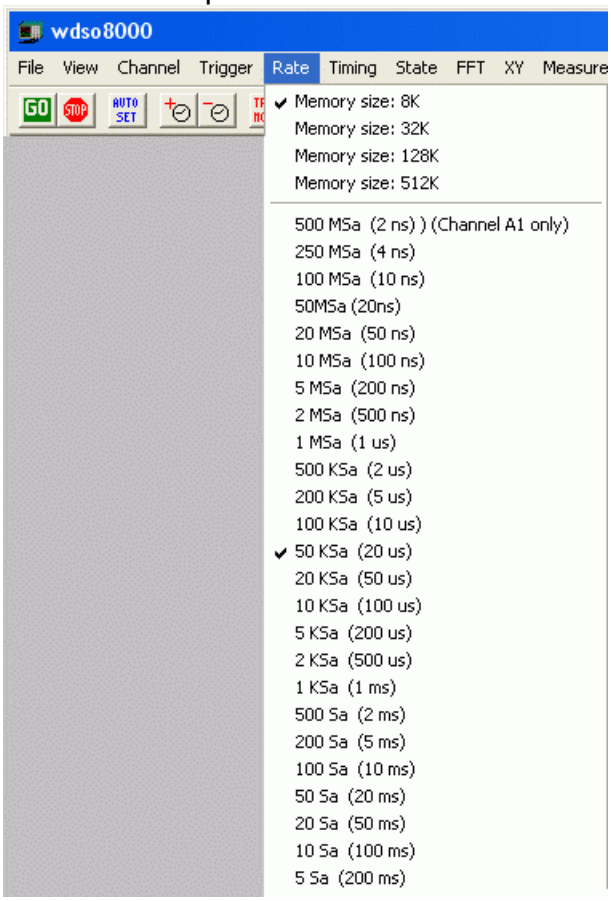


Use the ◄ and ► buttons to change the rate and thus change the Time per Division

The rate above is given in units of samples per second.
"50KSa" means 50,000 samples per second; the time per sample (NOT the Time per Division) is the inverse: 1/50,000 = 20µs (microseconds).

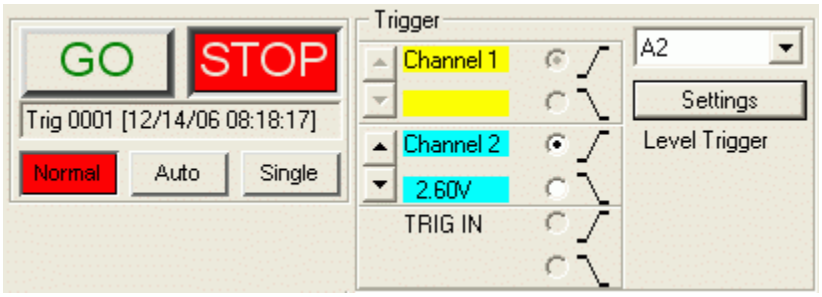
Time per Division ("Time/div.") is displayed below the "Zoom" setting and is set to 1.00000mS

Also:
Set Memsize to 8*K*. This will provide faster screen refesh rates, and a more "real-time" response.



5.6 Trigger

Trigger settings are as follows (see full screen here: DSO 8500 23):

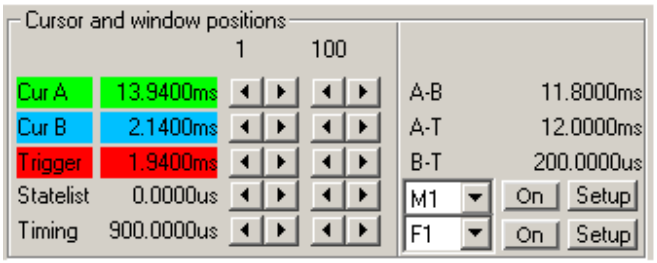


Notes:
1. Channel A2 (SEND) is used as the trigger source.
2. The Level (2.60 V shown) may be anywhere in the 0V to 5V range of the SEND pulse; near midpoint is usually best.

The trigger level may be seen graphically as a dashed horizontal red line.

5.7 Time Cursors

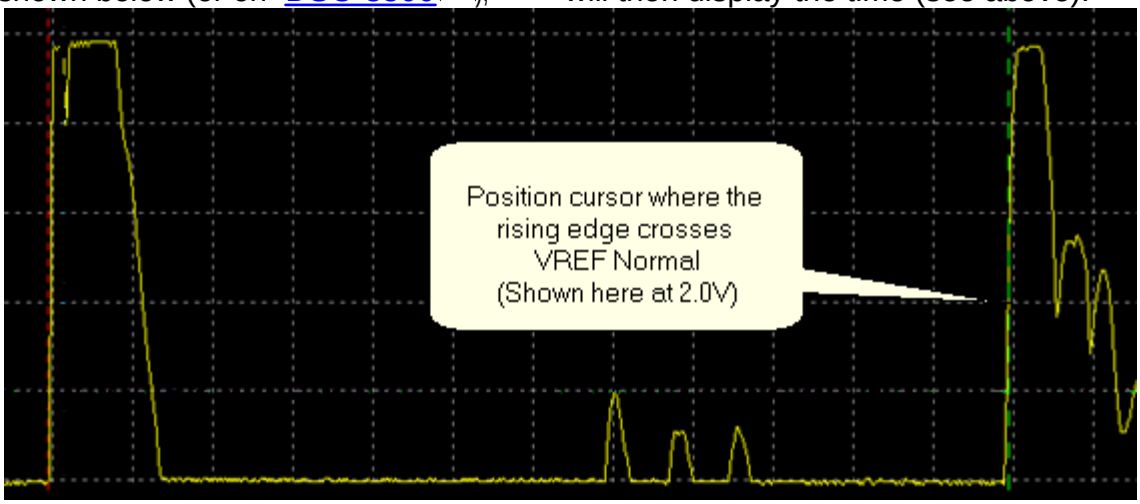
Time Cursors (vertical cursors on horizontal axis) are set in the area below (see full screen here: DSO 8500 23).



Notes:

1. The highlight colors shown above are those of the individual cursors on the scope display (Cursor A is Green, etc.).
2. Cursor placement: The ◄ and ► buttons in the column labeled "100" will move the cursor in large steps,
   the "1" column is used for small steps.
   Tip: the cursors may also be moved by click-and-drag.
3. On the right side of the cursor window, time measurements are displayed as folows:
   a. A-B: Time interval between Cursor A and Cursor B
   b. A-T: Time interval between Cursor A and the Trigger Cursor
   c. B-T: Time interval between Cursor B and the Trigger Cursor

To measure the time from the SEND pulse to an ECHO, position the Trigger Cursor (Red) and Cursor A (Green)
as shown below (or on DSO 8500 23); **A-T** will then display the time (see above).

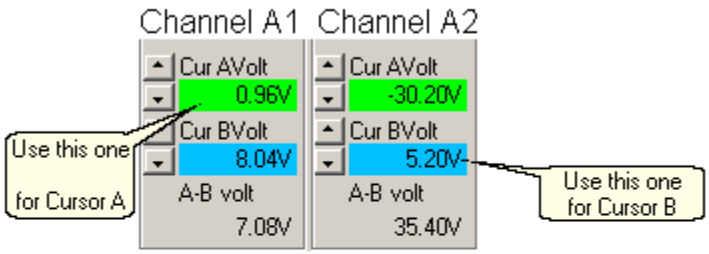


See Time Measurement 21 for details on converting a time measurement to the distance to an Echo.

See Customizing 21 to have the DSO 8500 software automatically display distance to the target.

5.8 Voltage Cursors

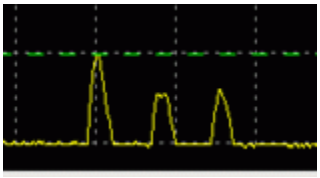
Voltage Cursors (horizontal cursors on vertical axis) are set in the area below (see full screen here: DSO 8500 23).



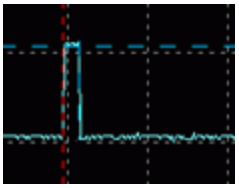
Notes:

1. The highlight colors shown above are those of the individual cursors on the scope display (Cursor A is Green, etc.).
2. Cursor placement: Use the ▲ and ▼ buttons to move the chosen cursor to the desired measurement position on screen.
   Useful Tip: the cursors may also be moved by click-and-drag.

3. Voltage measurement:
   a. Cursor A Voltage (Cur AVolt) in the Channel A1 column is referenced to the zero-point baseline of Channel A1.



   b. Cursor B Voltage (Cur BVolt) in the Channel A2 column is referenced to the zero-point baseline of Channel A2.



Use those to measure the respective voltages.
The other measurements reference the respective cursor to the opposite channel's

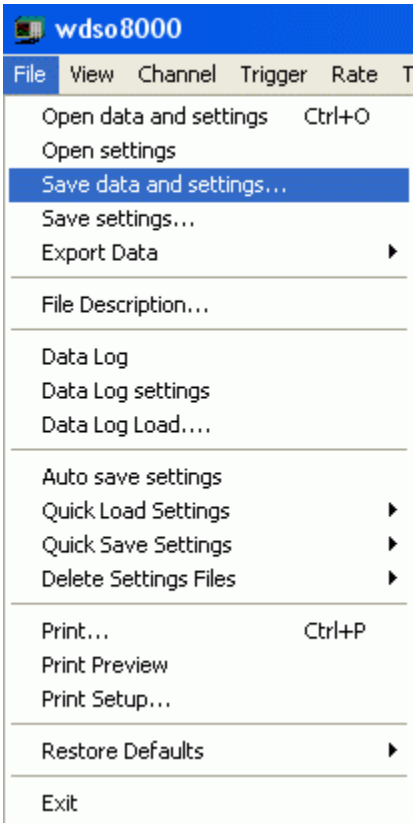
baseline.

In DSO 8500 23, Cur Avolt (Channel A1) is being used to display the amplitude of the small echo (0.96V),
Cur Bvolt (Channel A2) is displaying the amplitude of the SEND pulse (5.20V).

4. The A-B volt numbers shown measure the voltage between Cursor A and Cursor B, and are calculated by multiplying the number of divisions between the cursors by the volts/divison sensitivity of the respective channel.

5.9 Saving Waveforms

Select **File | Save data and settings** to save waveforms. You can save as many waveforms as you have harddisk space to accomodate.



Waveforms are saved as type "*.DSO", and will be viewable later with the DSO 8500 software even if it is not connected to the scope (running in Demo mode).

Saved *.DSO waveforms may be recalled, viewed, measured, and then exported as *.CSV (which will allow direct importing into Excel).

6 Revisions

Revision List

3.0: Added DSO 8500 section