MSO Software manual

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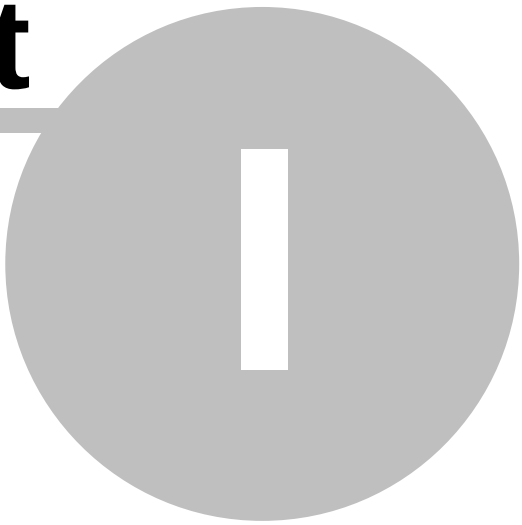
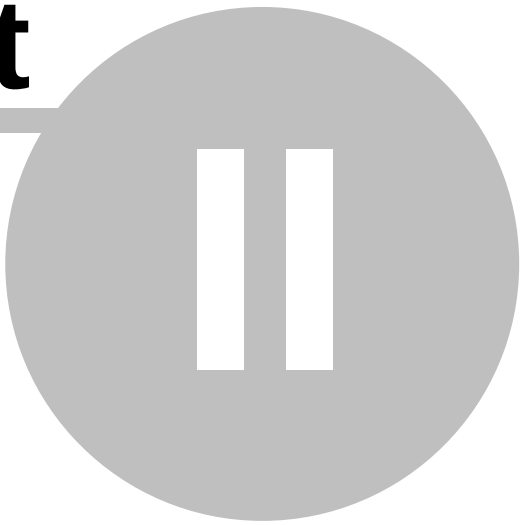
Part



1 Contents

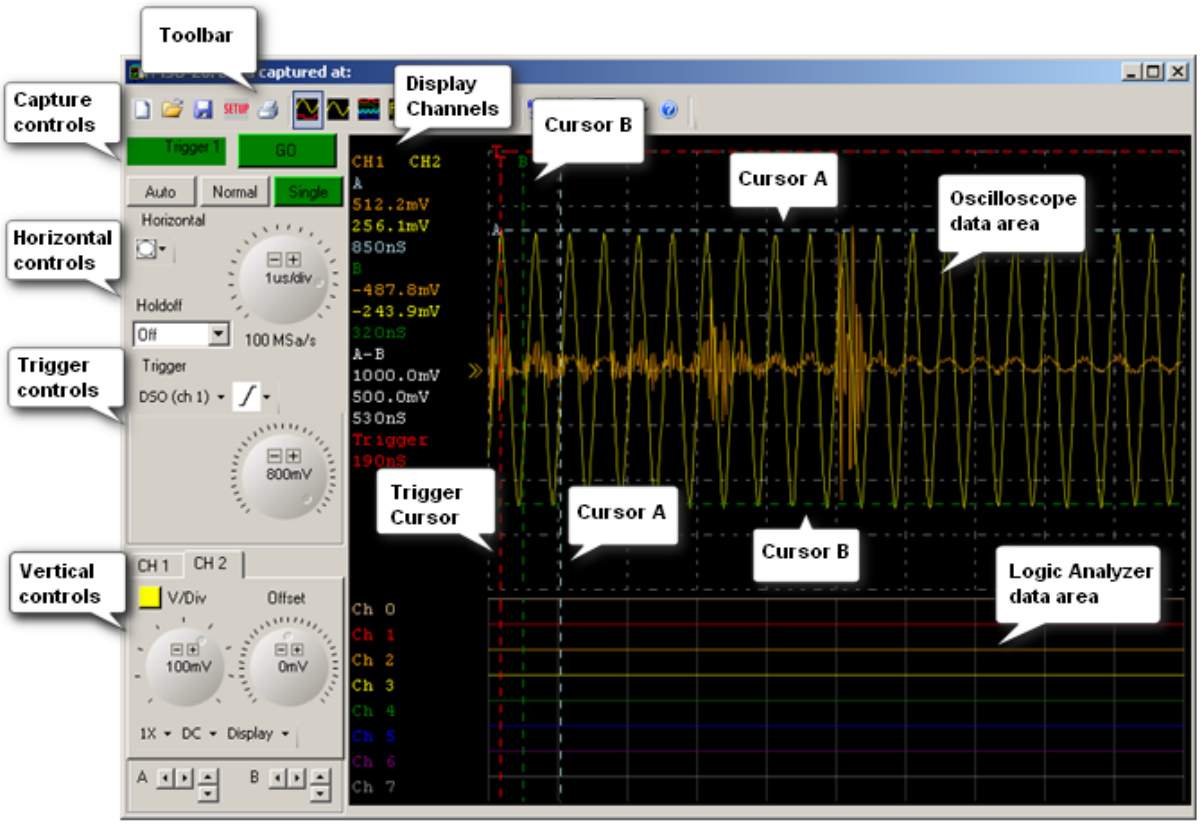
Advanced windows MSO control software

Part



2 How to...

2.1 Getting to know the main screen



Toolbar 21	The toolbar has controls for file, setup, window display, screen capture and help.
Capture controls 39	Acquisition mode, status and start/stop.
Horizontal controls 50	Timebase and zoom.
Trigger controls 52	Trigger settings.
Vertical (voltage) 60	Voltage settings.

2.2 Using the MSO to trigger on a sine wave

Using the MSO to trigger on a sine wave.

Capturing a 1MHz Sine Wave. 2.5V peak-to-peak

Toolbar 21 **section**

Set display mode to Mixed Signal Oscilloscope or Oscilloscope

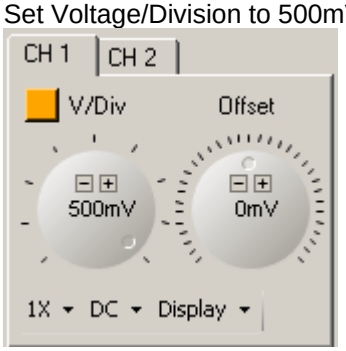
Capture 39 **section**

Set mode to Auto

Vertical 60 **section**

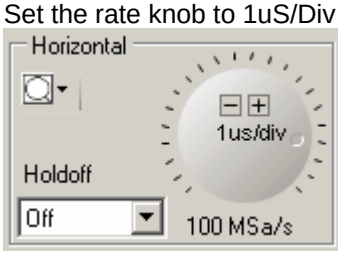
Set probe attenuation to 1X in the software and on your probe. Alternatively you could use a 10x probe and put the software in 10x mode.
Remember that in 1x mode the probe's bandwidth is considerably lower than in 10x mode so if you want to test a higher frequency signal try switching the probe into 10x mode.

Use the tabs at the top of this control to select channel 1 (CH1) or channel 2 (CH2).
Set coupling to DC.
Set Voltage/Division to 500mV and offset to 0mV.



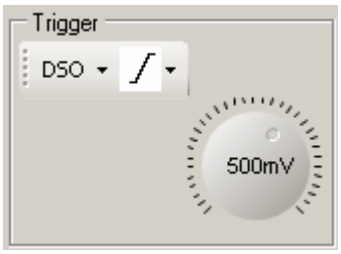
Horizontal 50 **section**

Set the rate knob to 1uS/Div (100MSa/s) and the holdoff control to "Off".

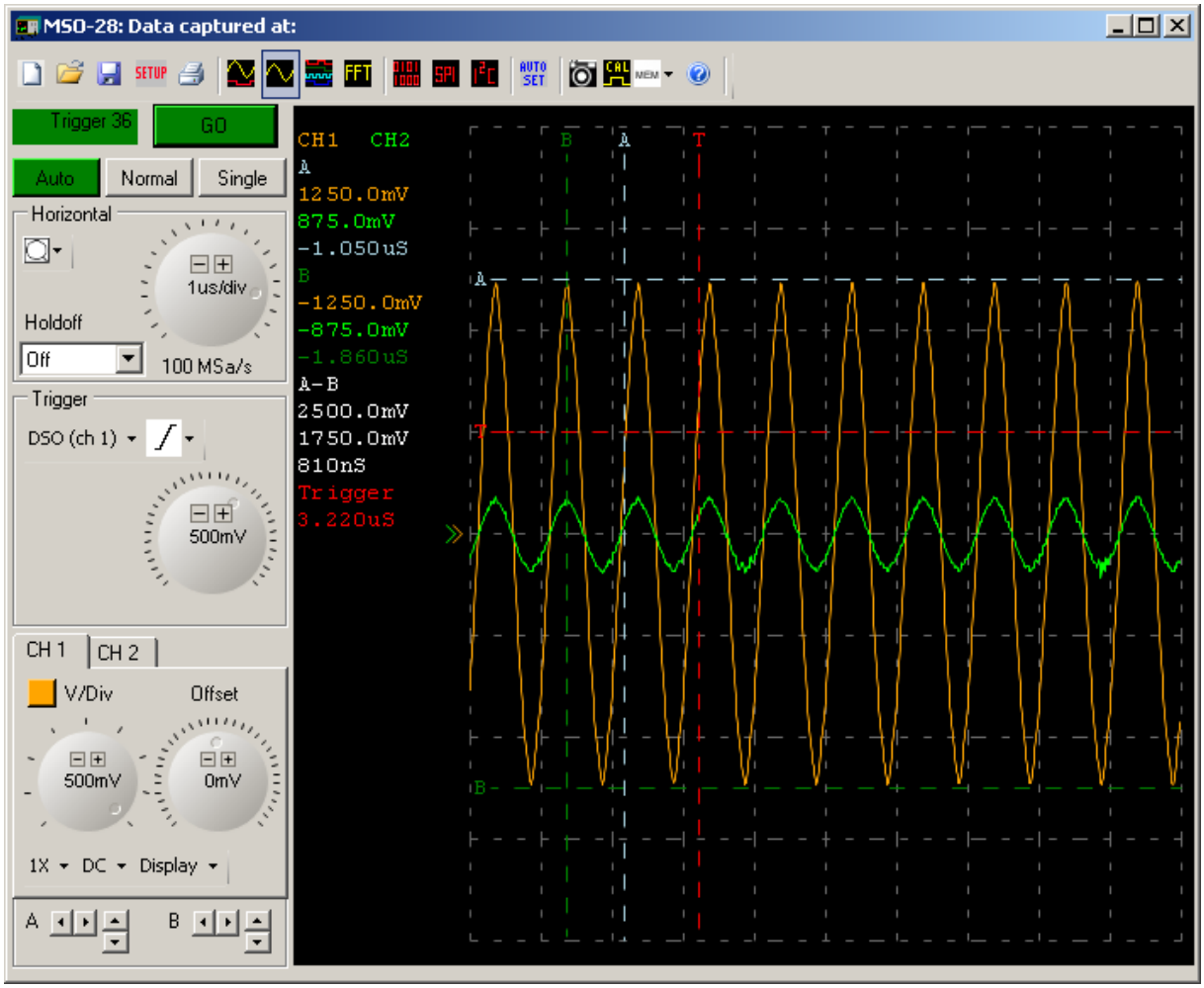


Trigger 55 **section**

Set trigger type to DSO and rising.
Set threshold level to 500mV.



Press Go 



See also: MSO 21, DSO 23 and LA 24.

2.3 Triggering on the Logic Analyzer inputs signal

Using the MSO to trigger on a digital input.

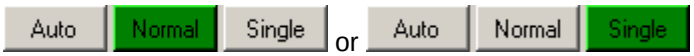
In this example we will show how to trigger on Logic Analyzer channel 0.

Toolbar 21 **section**

Set display mode to Mixed Signal Oscilloscope or Logic Analyzer

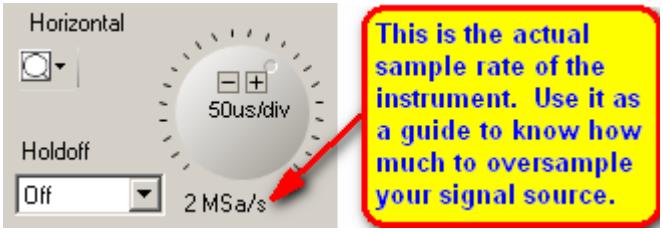
Capture 39 **section**

Set mode to Normal or Single.



Horizontal 50 **section**

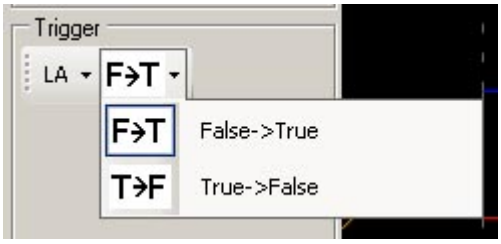
Set the rate knob to a rate 4 or more times faster than your signal and the holdoff control to "Off".



Trigger 55 **section**

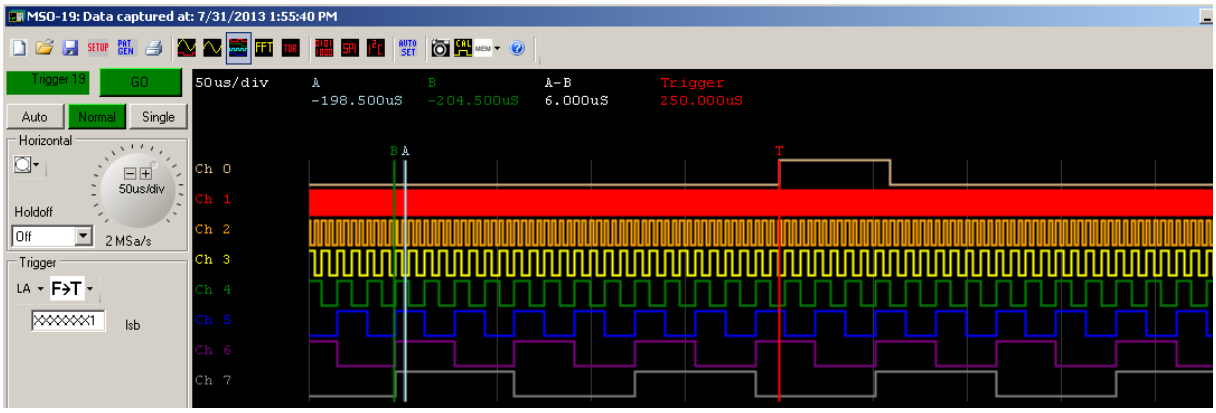
Set trigger type to LA.

Choose the **F->T** if you want it to trigger when the event happens (rising) or **T->F** to trigger when it ends.



In this example we are triggering on channel 0 and we don't care about the other 7 channels.

Press Go 



If you were to increase the sample rate you would see more detail.

See also: MSO 21, DSO 23 and LA 24.

2.4 Triggering on a SPI signal

Triggering on a SPI signal.

When triggering on SPI data you can use the LA trigger for a simple trigger or you can use the more advanced SPI trigger if you want to trigger on a specific SPI word.

LA Trigger:
See the section on LA Triggering 8. It's probably easiest to trigger on channel 0 since it is the SPI select line.

SPI Trigger:
Setup sample rate as you would with simple LA triggering 8, but use the SPI trigger 58 setup to enter your trigger word(s)

2.5 Triggering on a I2C signal

Triggering on a I2C signal.

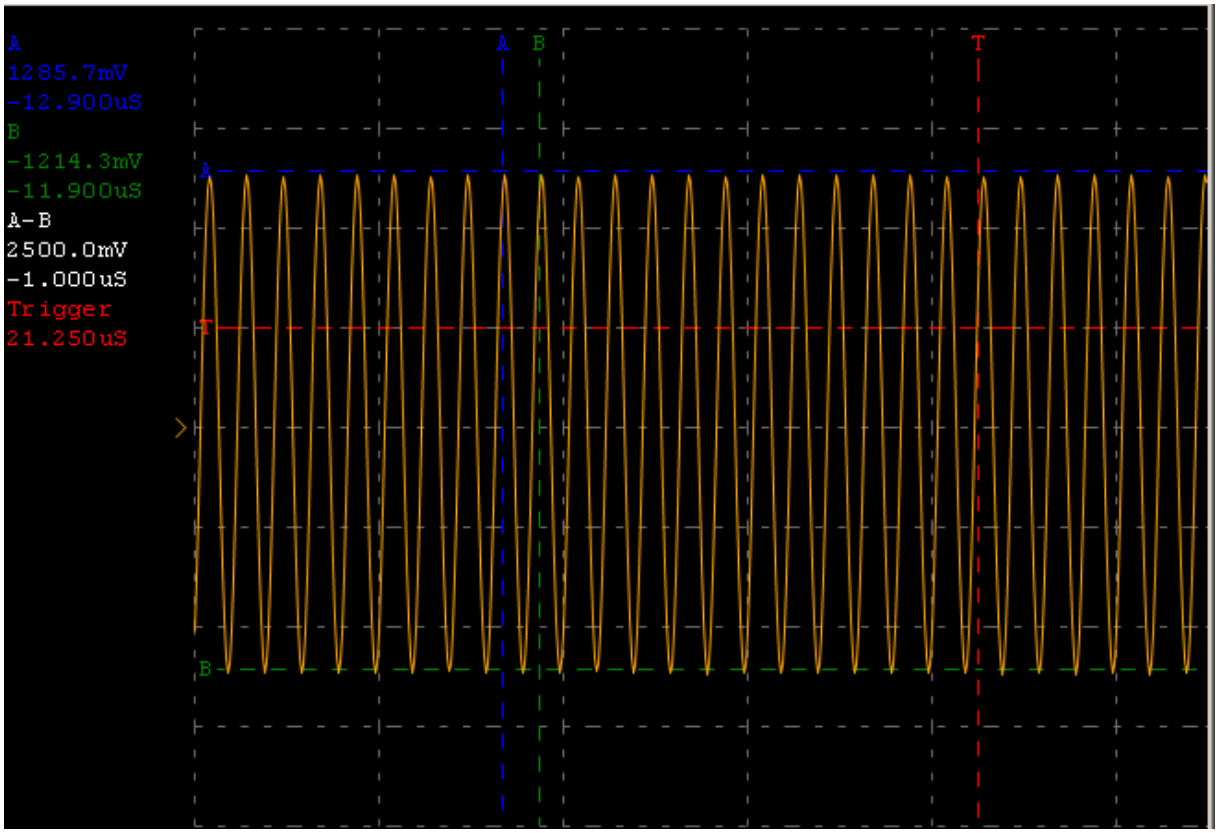
When triggering on I2C data you can use the LA trigger for a simple trigger or you can use the more advanced I2C trigger if you want to trigger on a specific I2C word.

LA Trigger:
See the section on LA Triggering 8. It's probably easiest to trigger on channel 4 since it is the I2C clock line.

I2C Trigger:
Setup sample rate as you would with simple LA triggering 8, but use the I2C Trigger 58 setup to enter your trigger word(s)

2.6 Using the FFT/Spectrum analyzer

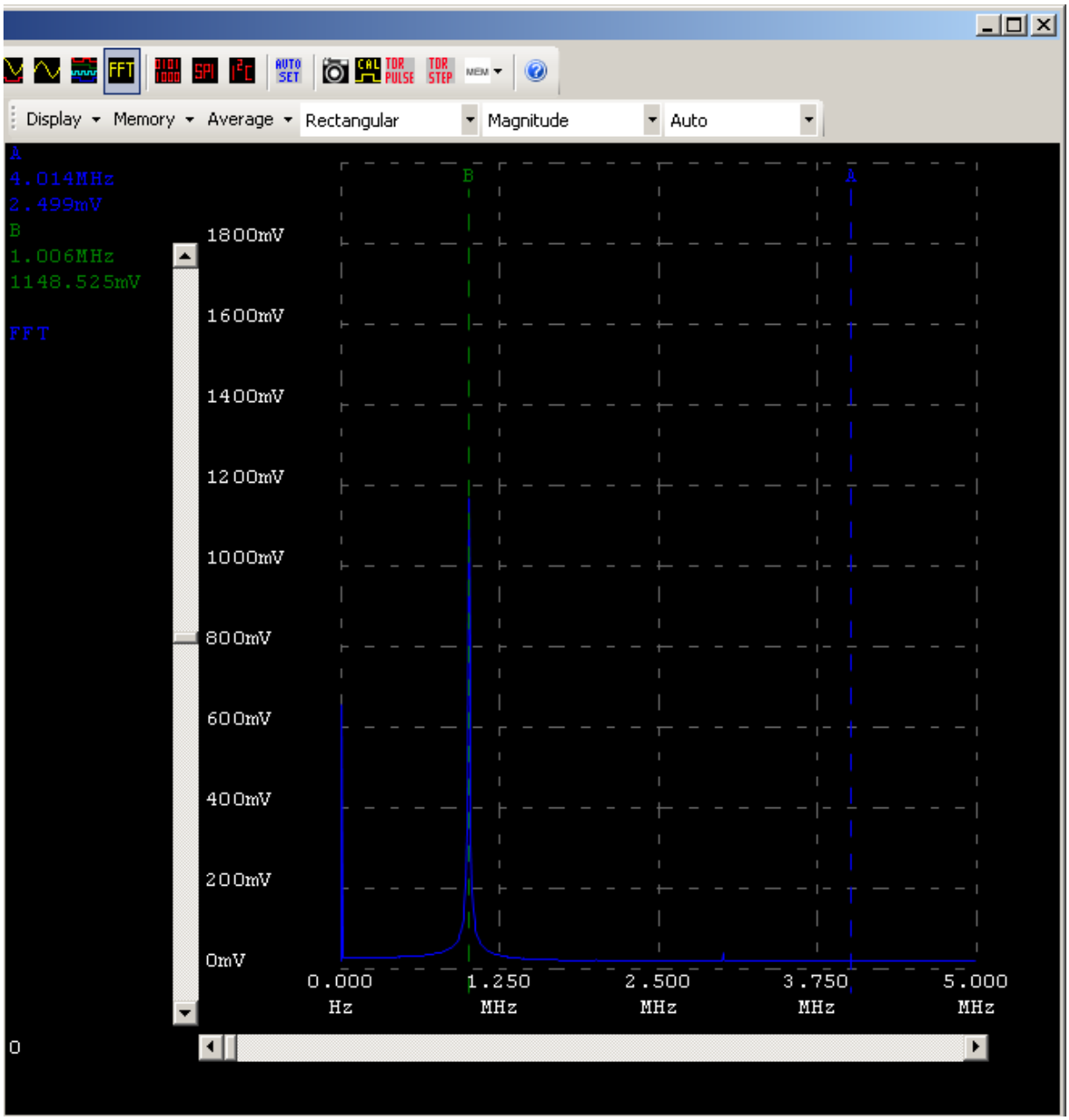
In this example we will start by capturing a 1MHz 2.5V sine wave 7.



Now go to the FFT screen.

Toolbar 21 **section**
Set display mode to FFT FFT

Horizontal 50 **section**
Set the rate knob to 5MHz and the holdoff control to "Off".
You can use the zoom control if you would like to zoom in for more detail.



In this screen you see the spectral plot from 0 to 5MHz.

You see two peaks.

The left most one at 0.000 Hz is the DC offset of the signal.
The one at the "B" cursor (green line) is the signal source and is 1.006MHz.

See also: FFT 25

2.7 Using cursors

Trigger position cursor

The trigger position cursor is a vertical line that shows the pre/post trigger position. The pre-trigger buffer is to the left of the trigger cursor while the post trigger buffer is on the right. Pre-trigger is defined as any event that occurs prior to the trigger, and post-trigger is any event that occurs after the trigger event.
Time cursor A and B are measured relative to this cursor hence the positive and negative numbers.
Note: When this cursor is moved the data is invalid until the next capture.

Time cursors A&B

Time cursors are measurement tools used for placing a time value on an occurrence in the data buffer. The time value will be relative to the trigger cursor. Positions to the left of the trigger position cursor will be negative and positive if located to the right.

Using two cursors allows the user to find the duration of an event time between the two cursors. The intersection of the waveform and timing cursor is the time value which is displayed.

Trigger level cursor

The trigger level cursor is a horizontal line that shows the trigger level target
Note: When this cursor is moved the data is invalid until the next capture.

Voltage cursors A&B

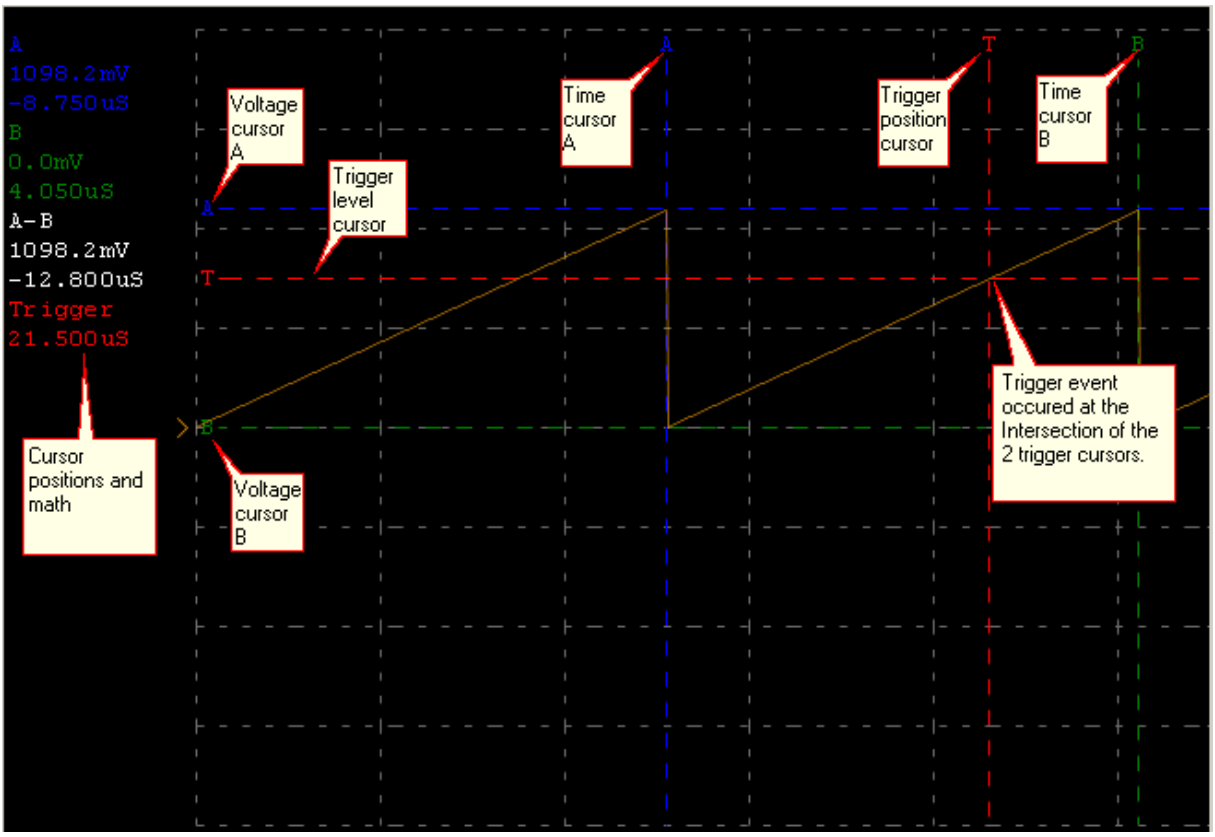
The voltage cursors give the user the ability to measure the voltage of a given signal, and the voltages within the boundaries of two cursors. The value of the voltage cursors is relative to offset.

Moving the cursor:

Cursors can be moved in the following ways:

1. Dragging with the mouse. When you move the mouse over a cursor the pointer will change from  to  or  . When the pointer changes you can left click on the cursor and drag it where you want.
2. Trigger level can be moved with the Trigger level knob.
3. Cursors A and B can be moved with the arrows buttons on the lower left side of the screen 

.
4. A cursor can be placed on the screen by holding the "A", "B" or "T" key while left clicking on the screen.



Cursor A is 8.750 uS before the trigger cursor and cursor B is 4.050 uS after
The time between them is 12.800uS

The Setup window 48 allows you to select how the cursor position values are displayed. Cursor A and B time cursor positions can be depicted relative to the Trigger cursor or the start of the data buffer.

2.8 Using measurements

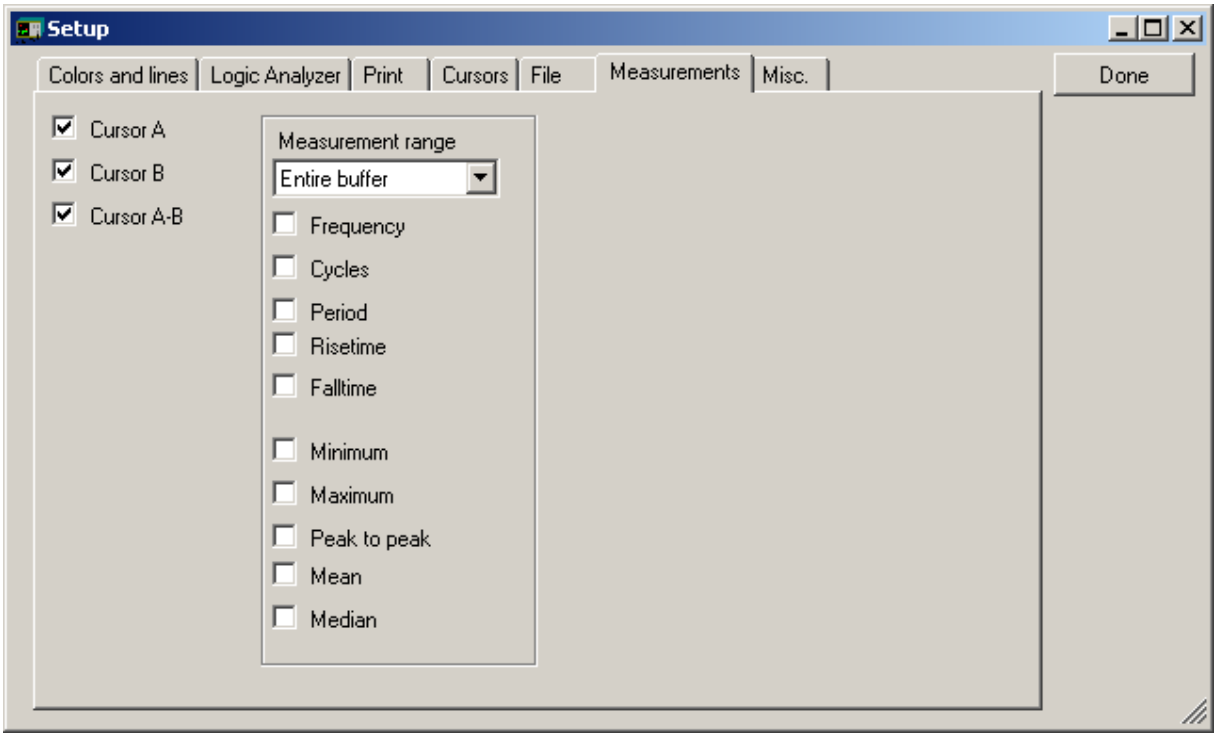
The MSO software can perform a number of waveform measurements 46.

Measurements are configured in the Setup window 46 and displayed in the Timing 6 window.

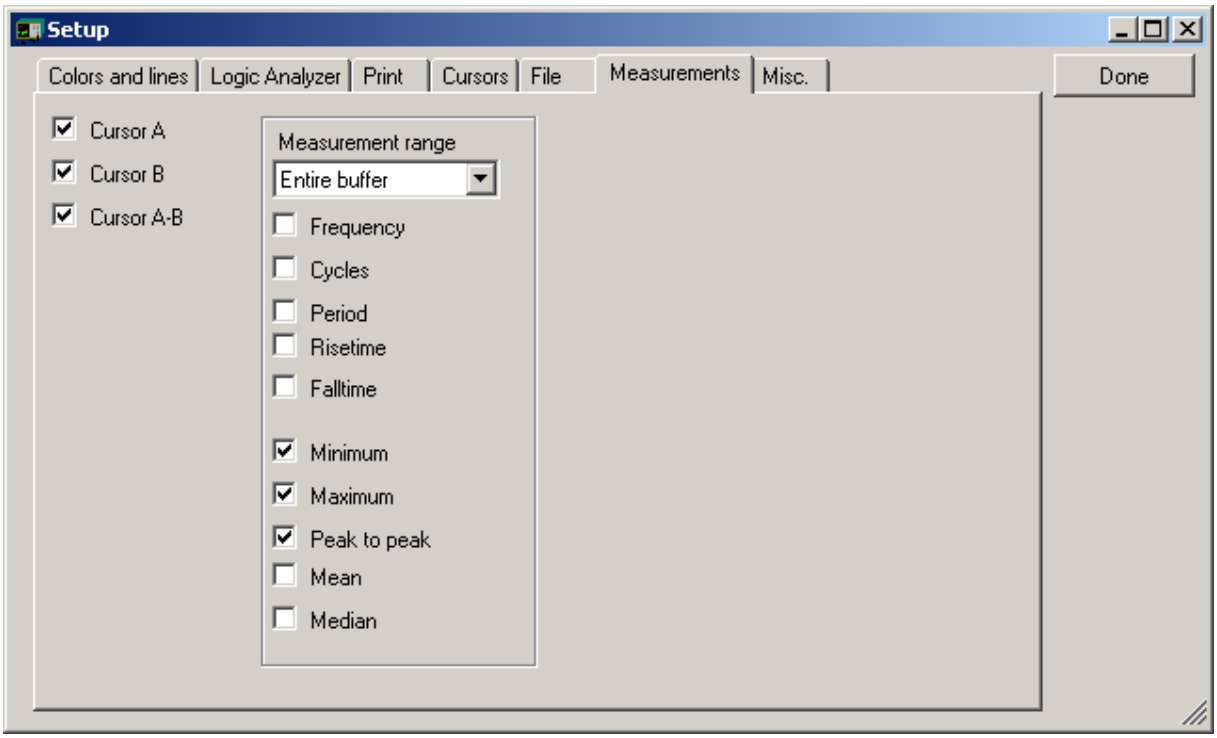
Example: Calculate Maximum, Minimum and Peak to peak voltage.

1) Click on Setup SETUP button on the Toolbar 21

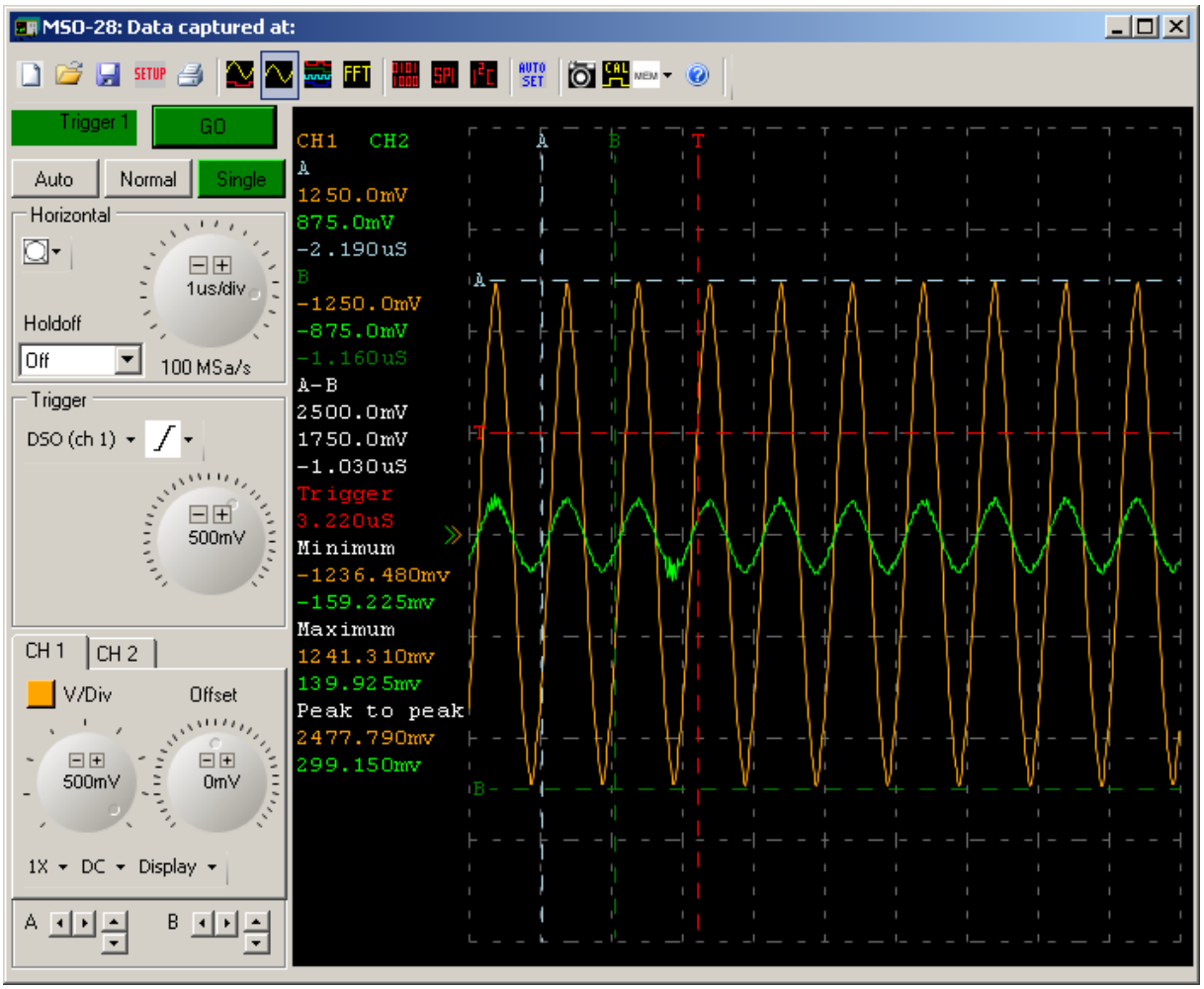
2) Select Measurements tab



3) Select Maximum, Minimum and Peak to peak.



4) The results will be displayed on the Timing 6 window.



2.9 Tips on high voltage testing

High voltage testing requires a differential probe to isolate the scope and the device linked to its USB port. There are certain steps that need to be addressed before attempting to test a high voltage system. A differential probe is **required** when working in moderate to high voltage situations common in industry; this safeguards the test device (non-isolated), as well as your computer's communication bus.

Another scenario is that the ground of the device under test is at a different potential than the oscilloscope's ground reference. By connecting the two ground will result in an undesirable effect of current flow between the two grounds, which will introduce errors in the measurement or damage the equipment.

In a differential probe, ground isn't used in the measurement. The measurement is based off of the difference in voltage between the two inputs. So the ground potential difference is no longer an issue.

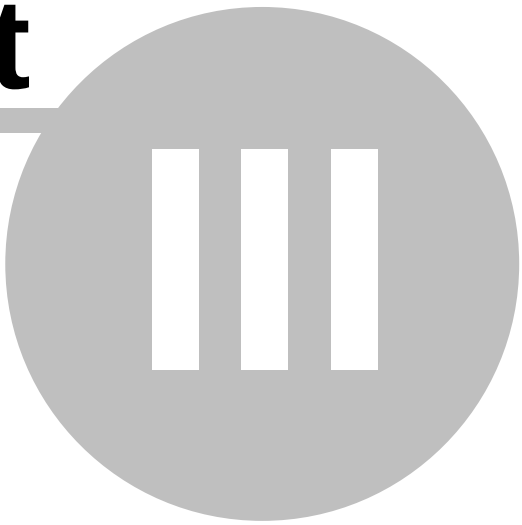
This type of probe is also required when testing voltage signals of power systems with multiple phases unrelated to the ground of the DSO. Working without a differential probe increases the risk of a short circuit in a grounded power system; even probing within a ground referenced signal presents hazards to the scope because of a ground loop.

When being used in power systems with single or multiple phases a single differential probe is needed to test each phase, a 2-phase system requires 2 probes.

Voltage limitation of the ADF25A differential probe.
Input Voltage ± 70V DC Peak AC@10:1 or 50V RMS
Max. Differential ± 700V DC Peak AC@100:1 or 500V RMS
Common Mode Max. ± 1400V DC Peak AC or 1000V RMS

Rate limitation of the ADF25A differential probe.
100x setting: DC -25MHz (-3dB)
10x setting: DC -20MHz (-3dB)

Part



3 FrontPanel Controls

3.1 Toolbar controls

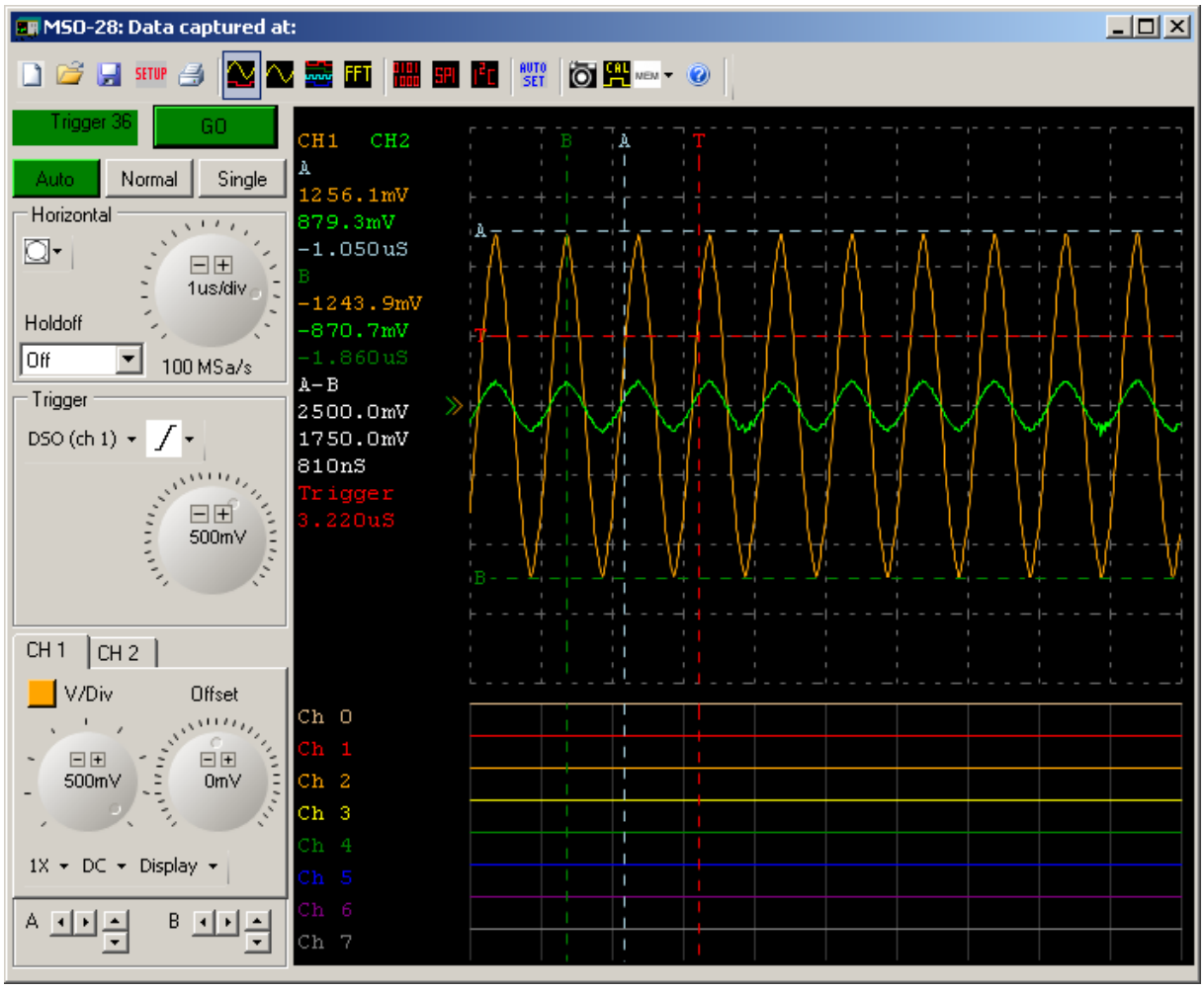
	Clear data buffer 41	
	File open 39	
	File save 39	The file save will save the users Data & Settings (*.MSD) or just Settings (*.MSS).
SETUP	Setup 41	
	Print 38	
	MSO window 21	Display both the DSO + LA data on the screen.
	DSO window 23	Displays only the DSO data pattern on the screen.
	Logic analyzer timing window 24	Displays only the logic analyzer data on the screen.
FFT	FFT window 25	
	Statelist window 32	
SPI	SPI window 30	
I²C	I2C window 28	
AUTO SET	Autosetup 38	
	Screen capture 37	
CAL	Calibrate probe 37	
MEM	Memory 35	

3.2 Display windows

Enter topic text here.

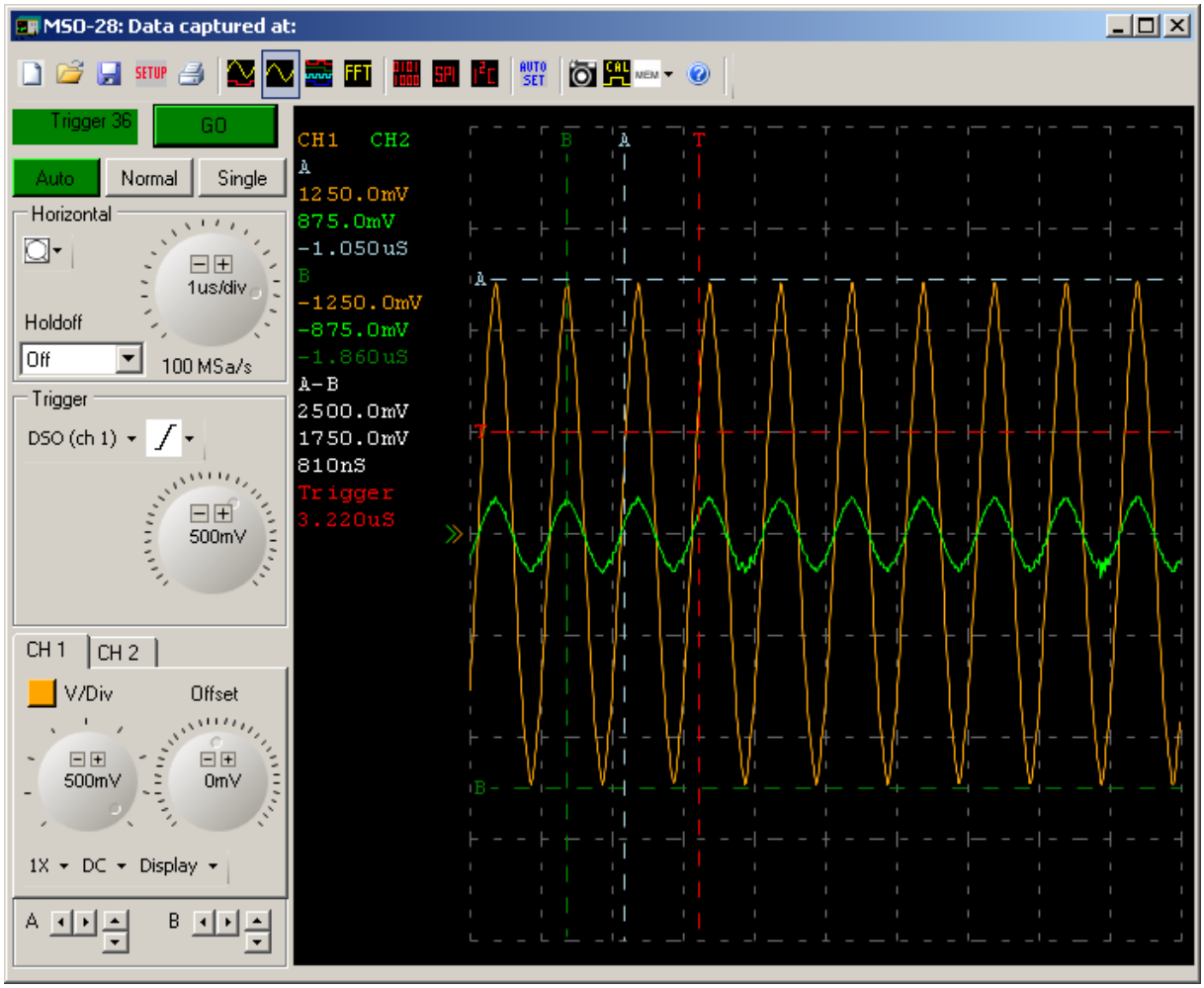
3.3 MSO window

Toolbar button:
This button will display the DSO & LA timing screens on the main screen.



3.4 DSO window

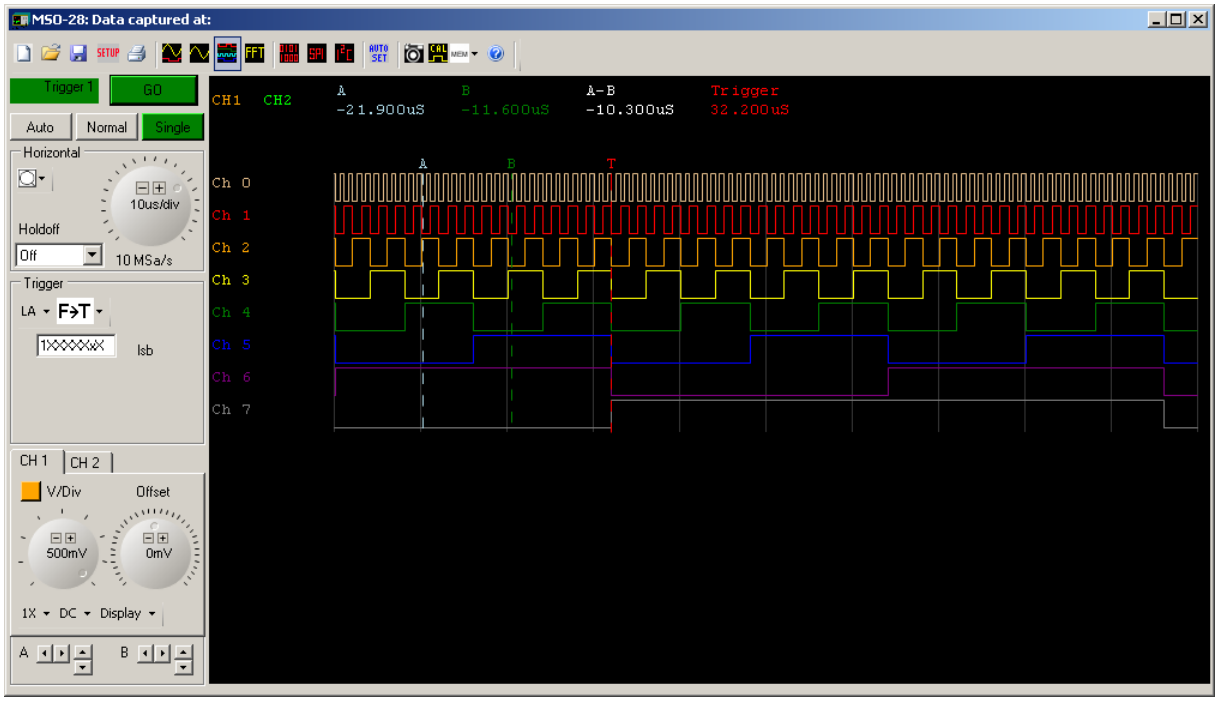
Toolbar button:
This button will bring up the DSO timing window to the main screen.



3.5 Logic Analyzer timing window

Toolbar button: 

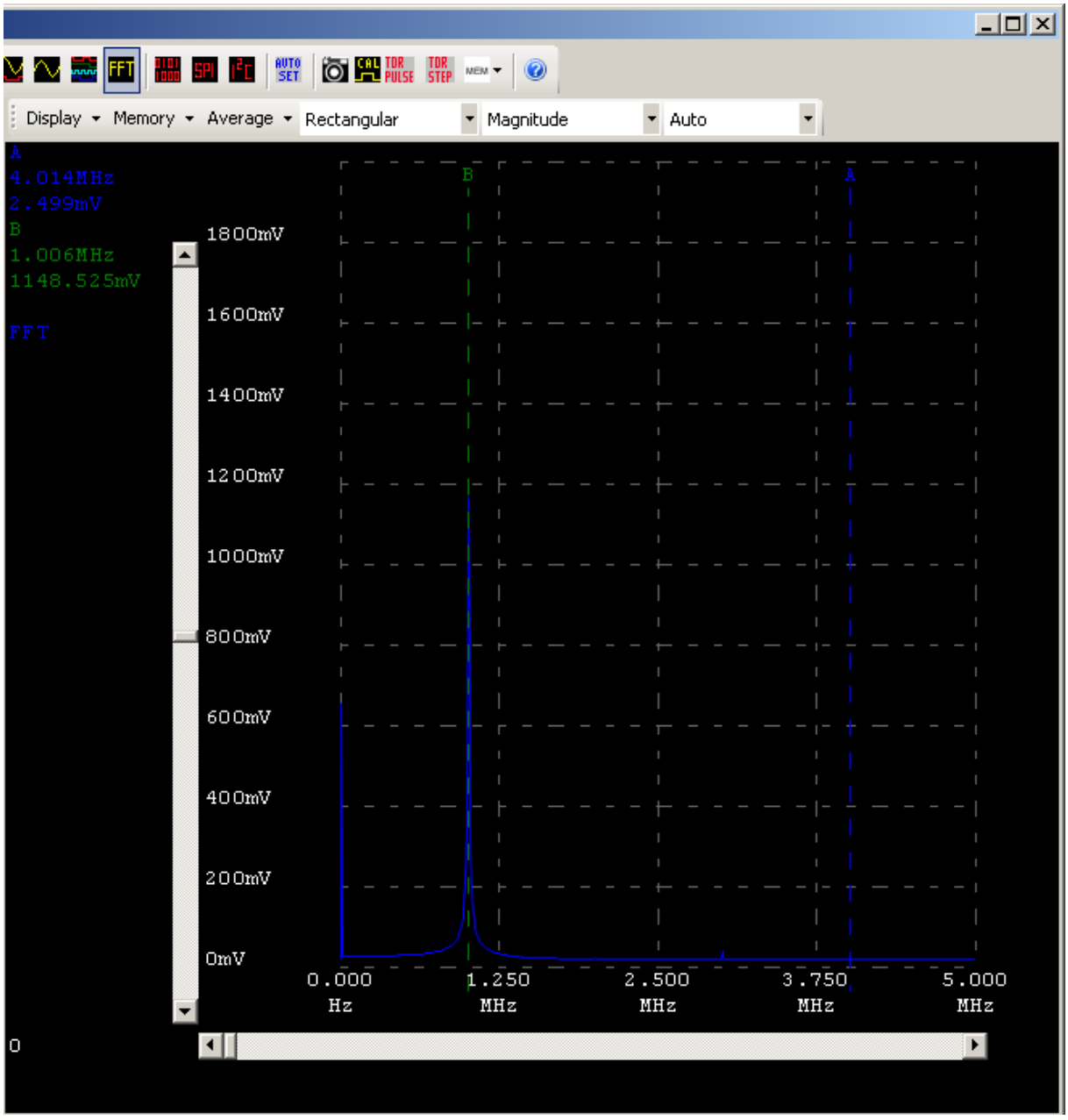
This button will display the LA timing screen on the main screen.



3.6 FFT window

Toolbar button:

This button will bring up the FFT timing window to the main screen. FFT stands for Fast Fourier Transform, it converts input data from time domain to frequency domain. Which turns the DSO into spectrum analyzer. Our FFT software has a wide range of windowing functions such as Blackman-Harris and Hamming that allow the user to manipulate the data at hand.



Display – Display, controls which trace is being displayed on the FFT window. It can also display a

mathematical difference between the Memory trace and the Averaged trace.

Memory – Store the captured FFT to memory for later use. The stored FFT data can be used as a reference to compare against another capture. One can also store Averaged trace from the averaging function.

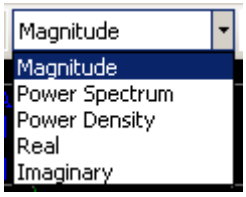
Average – Multiple FFT captures can be averaged together to create a better representation of the spectral data. The averaging process removes unique instance conversion errors and smoothing out boundary attenuation due to the windowing function itself. The number of captures required to create the averaged FFT is user adjustable.

Windowing Functions

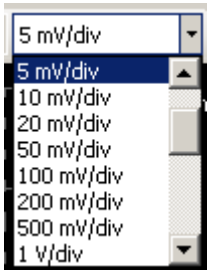
Windowing is a process where signal data is multiplied by a function which smoothes the outer boundary data towards zero; by doing this discontinuities are removed in the repetitive signal. Smoothing out the signal will reduce or remove spectral leakage. The multiplier function is known as the window function, and the function is applied to the data over a select time window. In other signal types where there is a limited amount of periodic repetition performing a FFT on that signal will result in erroneous frequency resolution, amplitude resolution or increase spectral leakage. Using a window function on that data will eliminate some of these errors if the correct window is selected for that purpose. The process of smoothing out a signal's outer boundaries within a window introduces the attenuated boundaries into the window calculation meaning that more of the same calculation might be necessary to create a better FFT representation. Hence the Averaging function.

Rectangular (Dirichlet) Rectangular window works best for transient signals and has excellent frequency resolution for this type of signal but has poor spectral leakage and amplitude representation. $W(n) = 1$
Tapered Rectangle (Tukey) Tukey window works best for random signals and has good frequency resolution for this type of signal but as with the rectangular window has poor spectral leakage and amplitude representation.
Triangular (Bartlett) Triangular window works best for random signals and has good frequency resolution along with fair spectral leakage and amplitude representation.
Hamming Hamming window works best for random signals and has good frequency resolution along with spectral leakage. Hamming has a good frequency resolution and is useful when identifying a resonant frequency of a structure being affected by a random/mixed signal. $W(n) = 0.54 – 0.46 (2\pi n/N), 0 \leq n \leq N$
Hann Hann window works best for random signals and has good frequency resolution along with handling spectral leakage better than the Hamming window. Hann windowing is another method used in audio work due to its ability to limit spectral leakage given audio signals spectra vary over time. $W(n) = 0.5 (1 – \cos(2\pi n/N)), 0 \leq n \leq N$
Flat-Top Flat-top window works best for sinusoidal harmonic signals and has poor frequency resolution but has a good handle on spectral leakage. Flat-top is also the best at representing the signals amplitude. In the example with the hamming window where the resonant frequency of a structure needed to be found, a random signal was injected into the system. However if a sinusoidal signal is injected into the system the Flat-top would do best due to its ability to represent signal amplitudes giving more accurate readings for amplitude response differentials. $W(n) = a_0 + a_1 \cos (2\pi n/ N) + a_2 \cos(4\pi n/ N) - a_3 \cos(6\pi n / N) + a_4 \cos(8\pi n / N)$
Blackman-Harris Blackman-Harris window works best for random and mixed signals and has poor

frequency resolution but handles spectral leakage the best. Blackman-Harris represents signal amplitude well. This window function is commonly used in audio work due to its ability to limit spectral leakage, given that audio signals have variable spectra over time. $W(n) = a_0 + a_1 \cos (2\pi n/ N) + a_2 \cos(2\pi*2n/ N) + a_3 \cos(2\pi* 3n / N)$



Magnitude – Magnitude displays the combined real an imaginary spectral energy in mV.
Power Spectrum – Power Spectrum is the square of the magnitude spectrum which is displayed in dBm form. (V^2) where (V) is the peak waveform value.
Power Density – Power density is the power spectrum divided by the noise bandwidth of the filter in Hertz. (V^2/Hz) **Real** – This window feature will display the real component of the signal.
Imaginary – This window feature will display the imaginary components of the signal.



Voltage per Division – This function is used to adjust the vertical sensitivity of the FFT, in the same manner as in the DSO mode. The vertical scale can be set to read dB or mV.

Scrollbar FFT

Vertical Scroll Bar –

This scroll bar allows the user to view different portions of the voltage or dB spectrum.

Horizontal Scroll Bar –

This scroll bar allows the user to pan across the frequency domain.

3.7 I2C window

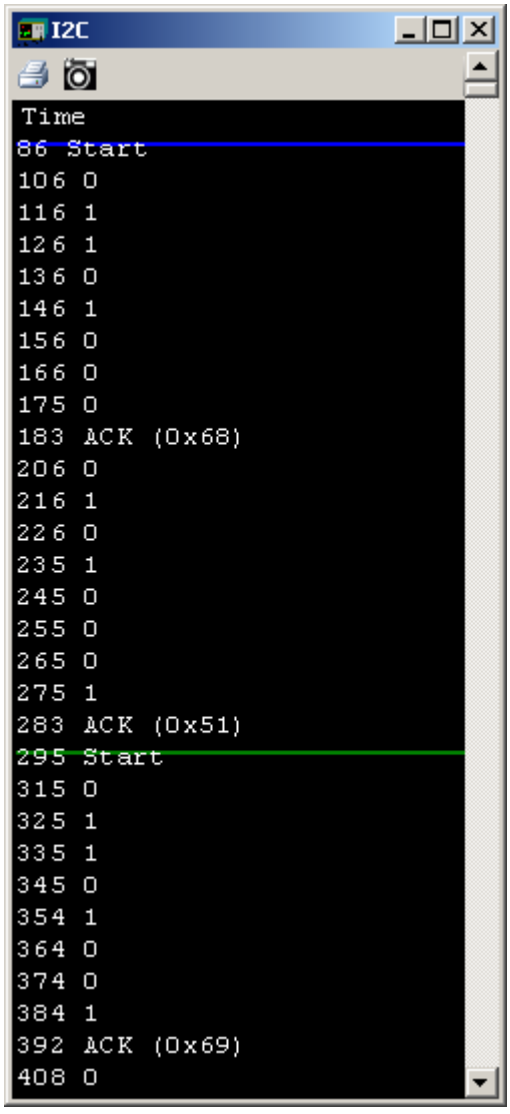
Toolbar button: 

I2C state list displays a list of qualified I2C commands, captured in LA channels.

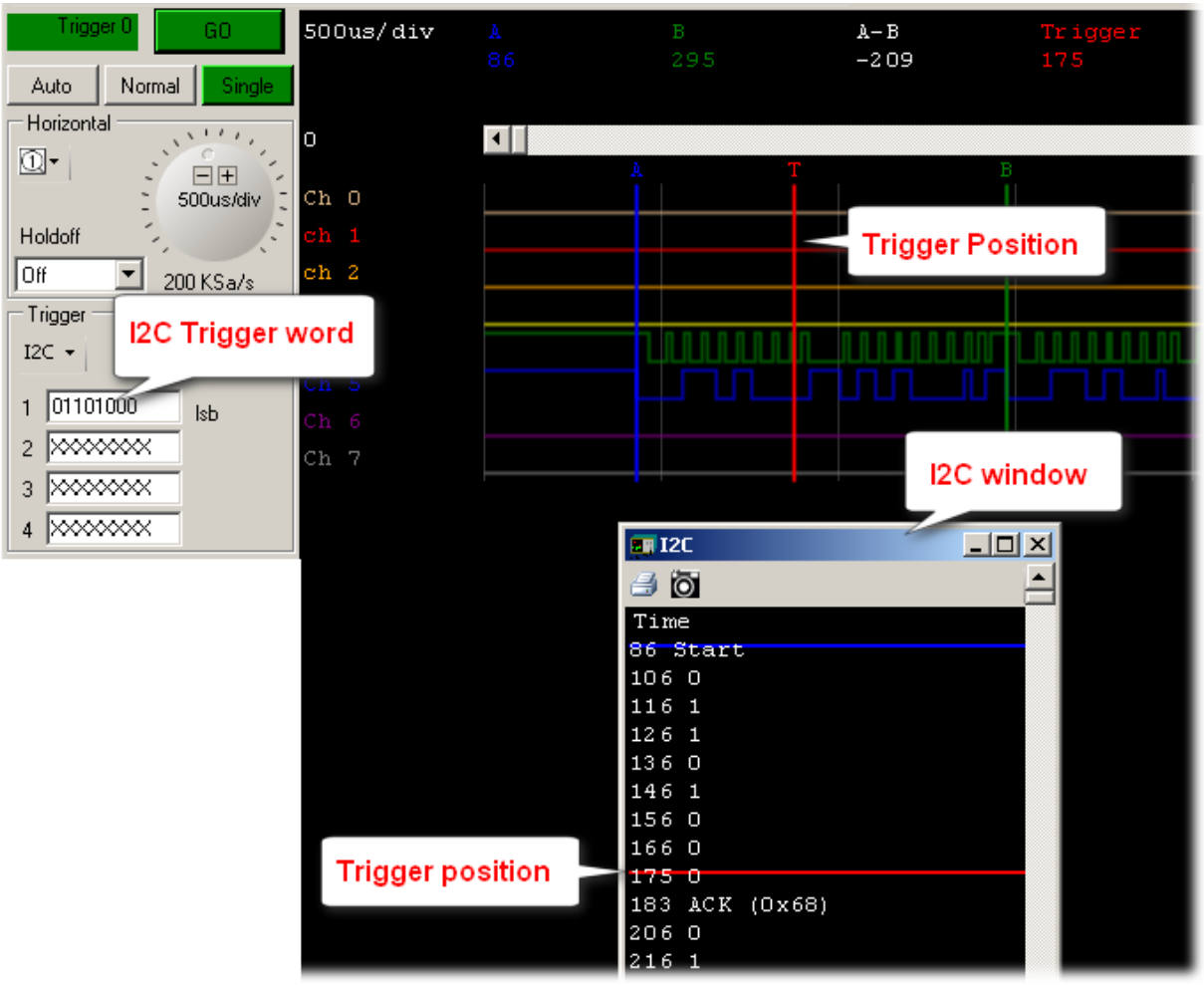
I2C Channels:

SDA is on Logic Analyzer channel 5
SCL is on Logic Analyzer channel 4

I2C window



Main window + I2C window



Notice I2C trigger value of 01101000 in the trigger word area and the same value in the I2C window and the timing window.

3.7.1 Print

Toolbar button:

Send screen data to printer.

see toolbar 21

3.7.2 Screen capture

Toolbar button: 

save screen image as JPG, PNG, GIF or Tiff file.

Save screen image as JPG, PNG, GIF or Tiff file.

A file save window will appear asking for a location in which to save the screen shot, enter the name of the file, select format and press ok. A file with current MSO screen contents will be saved to that location.

see toolbar 21

3.8 SPI window

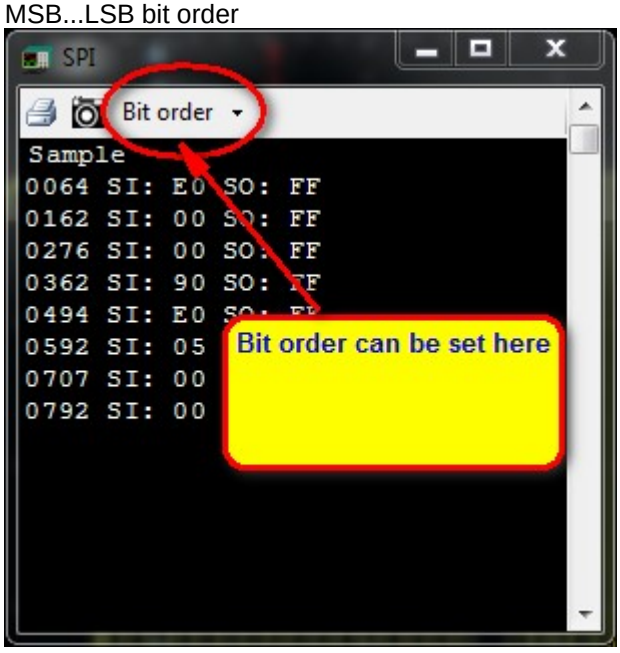
Toolbar button: 

SPI state list displays a list of qualified SPI commands captured in the LA channels.

SPI Channels:

SEL is on Logic Analyzer channel 0
CLK is on Logic Analyzer channel 1
SI is on Logic Analyzer channel 2
S0 is on Logic Analyzer channel 3

SPI words can be decoded with LSB or MSB first. Use the "Bit order" menu to set LSB...MSB or MSB...LSB bit order



3.8.1 Print

Toolbar button:

Send screen data to printer.

see toolbar 21

3.8.2 Screen capture

Toolbar button: 

save screen image as JPG, PNG, GIF or Tiff file.

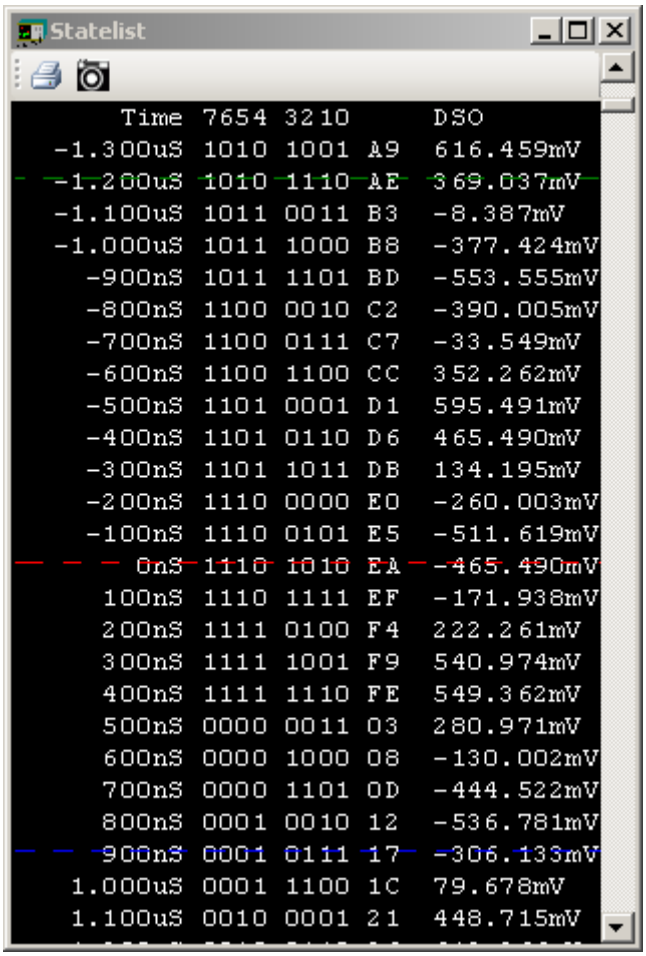
Save screen image as JPG, PNG, GIF or Tiff file.

A file save window will appear asking for a location in which to save the screen shot, enter the name of the file, select format and press ok. A file with current MSO screen contents will be saved to that location.

see toolbar 21

3.9 Statelist window

Toolbar button: 
The state list provides a capture timestamp and the logic state of the logic analyzer's 8 channels, Hex value of LA state, and DSO voltage values. The State list starts on the leftmost side (beginning) of the display buffer. The trigger event is defined as time zero, everything to the left is read in the negative scale and everything to the right is positive. Notice that the red trigger cursor is also displayed across time zero, the remaining two timing cursors will be displayed at their current locations in time. The time base within the state list is tied to the rate knob and will increase or decrease with rate. The state list is an important feature in the MSO because the user can view an array of all of the values whether DSO (volts) or LA (bits and hex) at a certain time or at a defined cursor within the buffer.



3.9.1 Print

Toolbar button: 

Send screen data to printer.

see toolbar 21

3.9.2 Screen capture

Toolbar button:

save screen image as JPG, PNG, GIF or Tiff file.

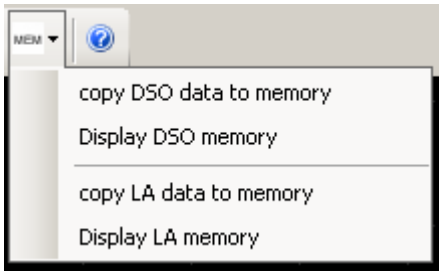
Save screen image as JPG, PNG, GIF or Tiff file.

A file save window will appear asking for a location in which to save the screen shot, enter the name of the file, select format and press ok. A file with current MSO screen contents will be saved to that location.

see toolbar 21

3.10 Memory

Toolbar button: MEM



Memory mode is an important feature which allows the user to store a waveform then recapture and compare the two waveforms with ease. The differences between waveforms captured in DSO mode are very distinct being that the two waveforms overlaid over each other should look identical. Any discrepancies can point out an error in timing or logic.

Copying the DSO data to memory will store the timing window to memory buffer. Once the waveform has been stored, you can capture another waveform.

Displaying the DSO memory data stored in memory will be overlaid the current capture, displaying two waveforms in the same window.

Note: If settings such as time base or voltage per division are changed in the new capture the waveform in memory will not reflect these changes, and no longer relate to the current capture.

Copy LA data to memory
Copying the LA data to memory will store the timing window to memory buffer. Once the waveform has been stored, you can capture another waveform.

Display LA memory
Displaying the LA data stored in memory will push a new LA timing window underneath the original window with the same settings and characteristics.

Note: If settings such as time base or trigger slope are changed in the new capture the

waveform in memory will not reflect these changes, and no longer relate to the current capture.

3.11 Calibrate probe

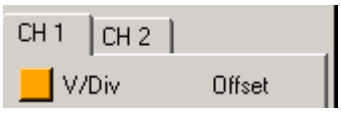
Toolbar button: 

Calibration Procedure
For the most accurate measurements possible, the probes must be calibrated. There is a built in calibration signal point on the white wire of the wire harness. Follow this procedure to calibrate each probe:

Hardware Setup:

Verify that the probe attenuation setting matches the actual probe.
If the probe is physically set to 10 to 1 set the software attenuation to 10 to 1.

Software Setup:

Choose the channel by clicking on CH 1 or CH 2 

in the horizontal section of the screen.
Click on the Calibrate button  on the toolbar and follow the directions.
When done hit button "Hit when done".

Calibration:

1. Hold the probe's tip against the center white wire of wireharness.
2. A Square wave signal should appear on the screen.
3. Adjust the probe calibration (turn screw on probe near the BNC) until a true square wave is shown on the screen, noting the corners of the waveform which should be sharp and square, not rounded over or peaky.

3.12 Screen capture

Toolbar button: 

save screen image as JPG, PNG, GIF or Tiff file.

Save screen image as JPG, PNG, GIF or Tiff file.

A file save window will appear asking for a location in which to save the screen shot, enter the name of the file, select format and press ok. A file with current MSO screen contents will be saved to that location.

see toolbar 21

3.13 Autosetup

Toolbar button: 

Autosetup automatically finds the best fit parameter to display the oscilloscope signal on the timing window.

see toolbar 21

3.14 Print

Toolbar button: 

Send screen data to printer. The timing window will be transformed into a printable view.
The print out will contain the whole data window as well as the settings bar. The whole buffer is usually able to fit within the data window.

see toolbar 21

3.15 File save

Toolbar button: 

The MSO software can save two types of files:

1) .MSD Data and settings file
   This file has 3 main sections:
   A) Settings - in a similar format to a .INI file
   B) DSO data & LA data - in a comma separated Ascii format

2) .MSS Settings file
   This file has 1 section:
   A) Settings - in a similar format to a .INI file

3) .CSV Export file. Used with Excel, Mathcad, etc...
   This file has 3 main sections:
   A) Settings
   B) DSO data & LA data - in a comma separated Ascii format

3.16 File open

Toolbar button: 

The MSO software can open two types of files:

1) .MSD Data and settings file
2) .MSS Settings file

Datalog files

Datalogging will automatically save each capture buffer to a unique file. These files will be sequentially numbered and time stamped. This option is configured in the Setup 44 window.

When you open a Datalog file 44 two extra icons appear on the toolbar.  These buttons allow you to step forwards and backwards through the Datalog files.

3.17 Capture

Go & Stop Buttons

A two state button will start or stop the current capture.

Start a capture.

Stop the current capture.

Hotkeys:

"G"	GO/Stop 39
"g"	GO/Stop 39
"0"	GO/Stop 39
F5	GO/Stop 39

Capture mode buttons

Single – After pressing GO 

the MSO will look for the trigger 52 event. Once the trigger event if found the MSO will fill the data buffer, stop acquiring, transfer data to the PC and display the trace data on the screen.

Normal – This is very similar to Single. The only difference is that it will repeat the process after the trace data is displayed. The screen will refresh and the trigger status counter will increment after each capture. The STOP 

button must be pressed to stop capturing in this mode.

Auto – The MSO will start acquiring data after pressing GO 

without regard to the trigger 52 event. Once the data buffer is full it will stop acquiring, transfer data to the PC, display the trace data on the screen and repeat the process. The STOP 

button must be pressed to stop capturing in this mode.

Trigger status

The trigger status is displayed on the upper left corner of the section.

3.18 Clear data buffers

Toolbar button: 

Clears the trace buffers and lets you start acquiring data with a clear screen.

Note:
There is no need to clear the buffers before a capture or a load since they overwrite the current buffers.

see toolbar 21

3.19 Setup

Toolbar button: 

The setup window controls settings related to:

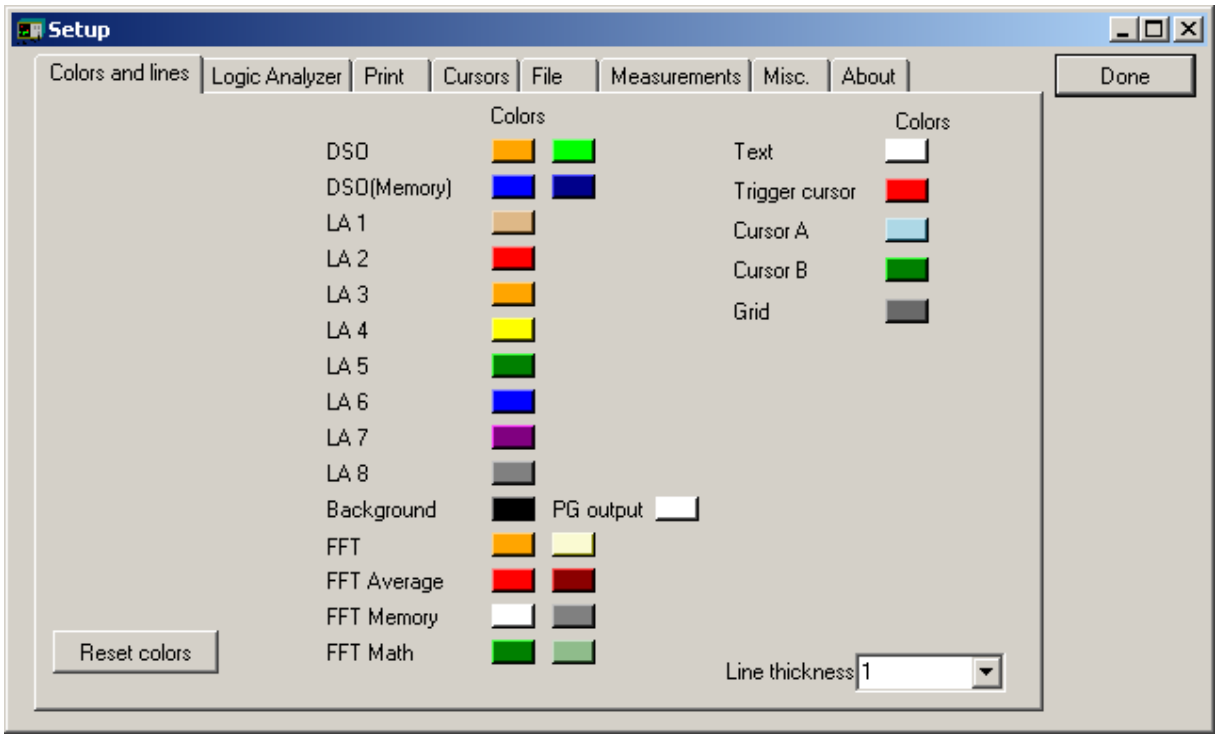
Colors and lines 41
Logic Analyzer 42
Print 43
File 44
Cursors 45
Measurements 46
Miscellaneous 48

3.19.1 Colors and lines

Toolbar button: 

-> Colors and lines tab

Color setup window displays the current color scheme; each color button will bring up a color pallet to edit the selected item. The color display gives the users the flexibility to edit the colors of the DSO, LA, FFT signals, background, text and grid colors.



3.19.2 Logic Analyzer

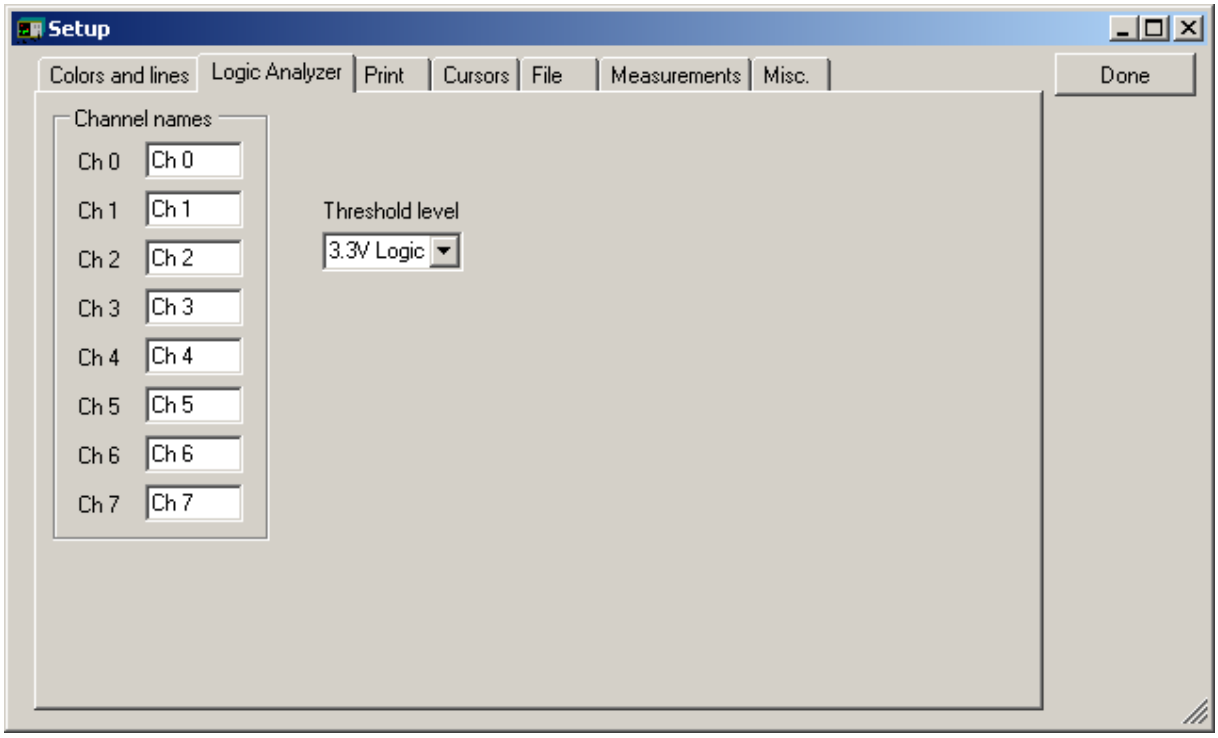
Toolbar button: SETUP - Logic Analyzer tab

The LA Setup window lists the physical channel names in top down order and includes edit boxes to rename the channels. Changing the physical channel name reduces the chances for identification

errors when debugging specific channels.

To the right of the channel name is the threshold level menu. The menu contains 6 selectable threshold voltage families.

Channel colors can be set in the colors and lines 41 tab.



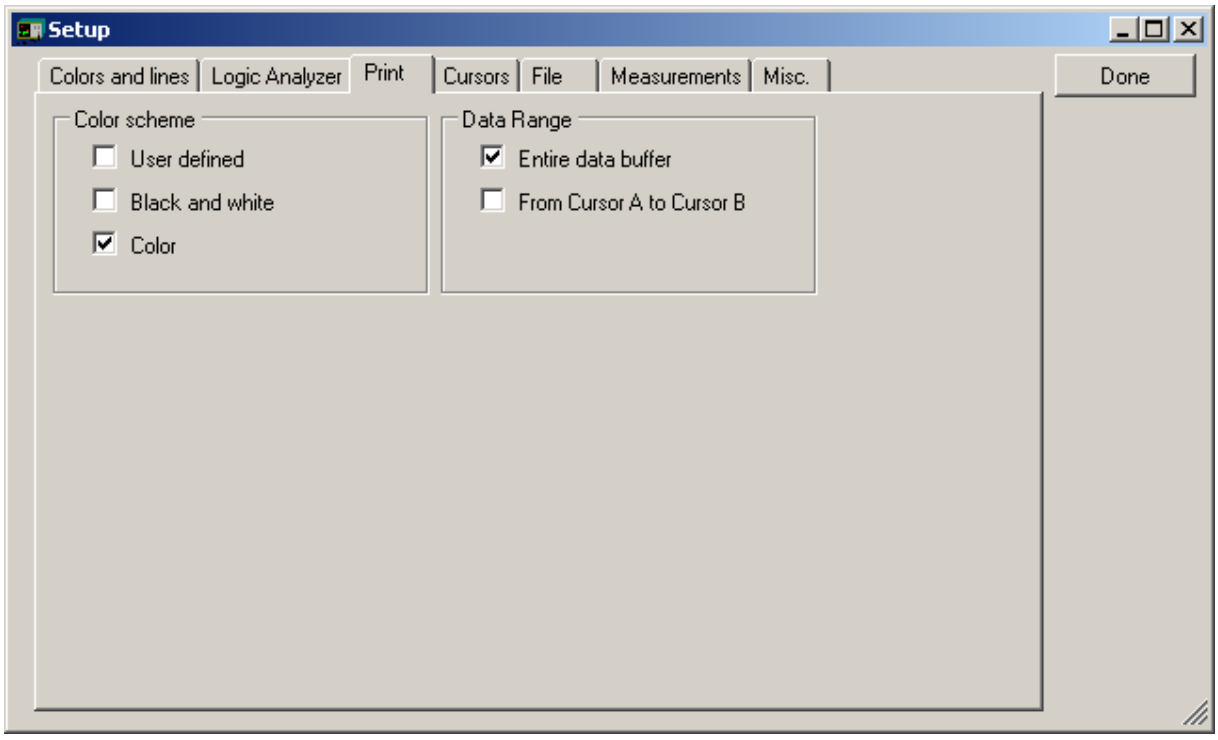
Logic Analyzer Threshold Level

Logic family threshold voltages:
1.2V – LVDS, TTL, TTL/CMOS, LowV
1.5V –TTL, TTL/CMOS, CMOS, ETL, LowV, BTL
1.8V – BTL
2.4V – CMOS
3.0V –
3.3V –

3.19.3 Print

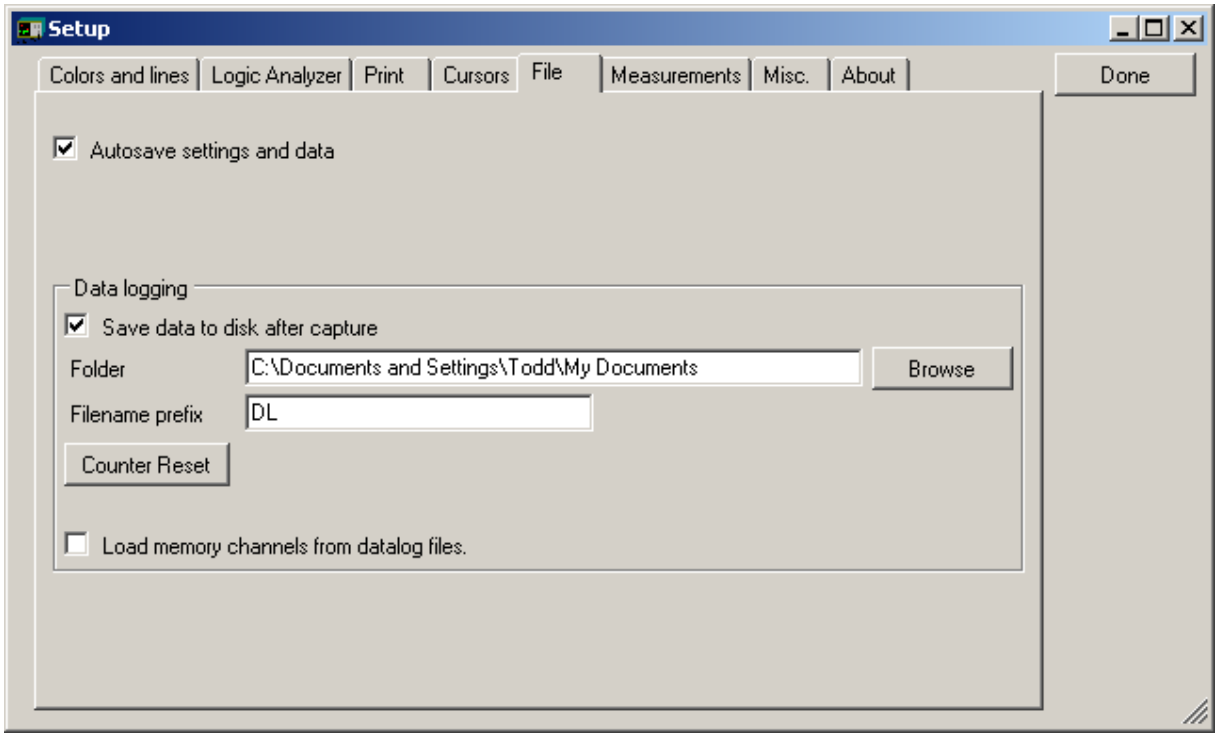
Toolbar button: SETUP -> Print tab

The print setup window defines color schemes and print range.



3.19.4 File

Toolbar button: SETUP ->File tab



Auto save settings
When "Autosave settings and data" is checked the MSO saves the system settings and trace data when you exit the software. The next time you run the software the settings and data will load automatically.

Data Logging
The MSO can be configured to automatically save data and settings after each capture.

When "Save data to disk after capture" is checked the MSO will save data and settings after the buffer is transferred to the PC.
Use the "Browse" button to select the folder that data will be saved to.
The filename will begin with the text from the "Filename prefix" box. The rest of the name will be a 6 digit number that will increment with each capture.
The "Counter Reset" button will set the filename counter back to 000000.

When "Load memory channels from datalog files" is checked the MSO will load the DSO and LA memory data when a datalog file are opened. Uncheck this if you want to use the memory channels as a way to compare captures.

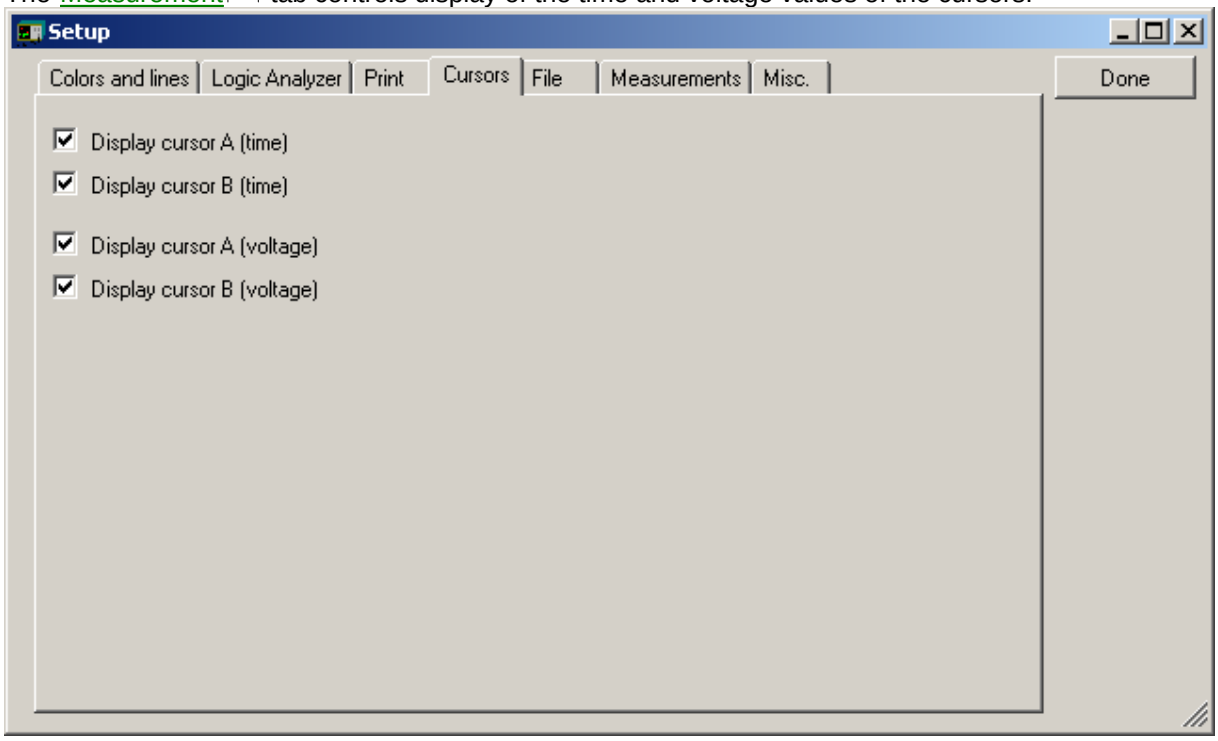
Viewing Datalog files
See: File open 39

3.19.5 Cursors

Toolbar button: SETUP -> Cursors tab

This window controls display of the cursors.

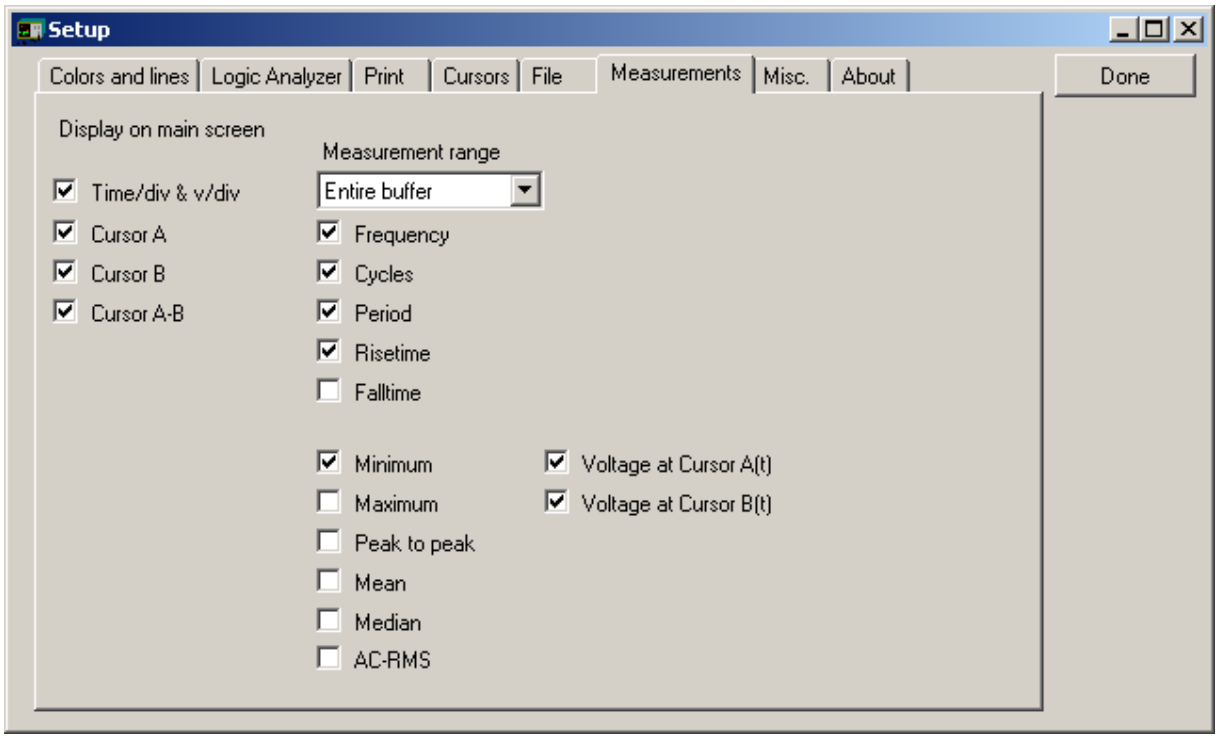
The Measurement 46 tab controls display of the time and voltage values of the cursors.



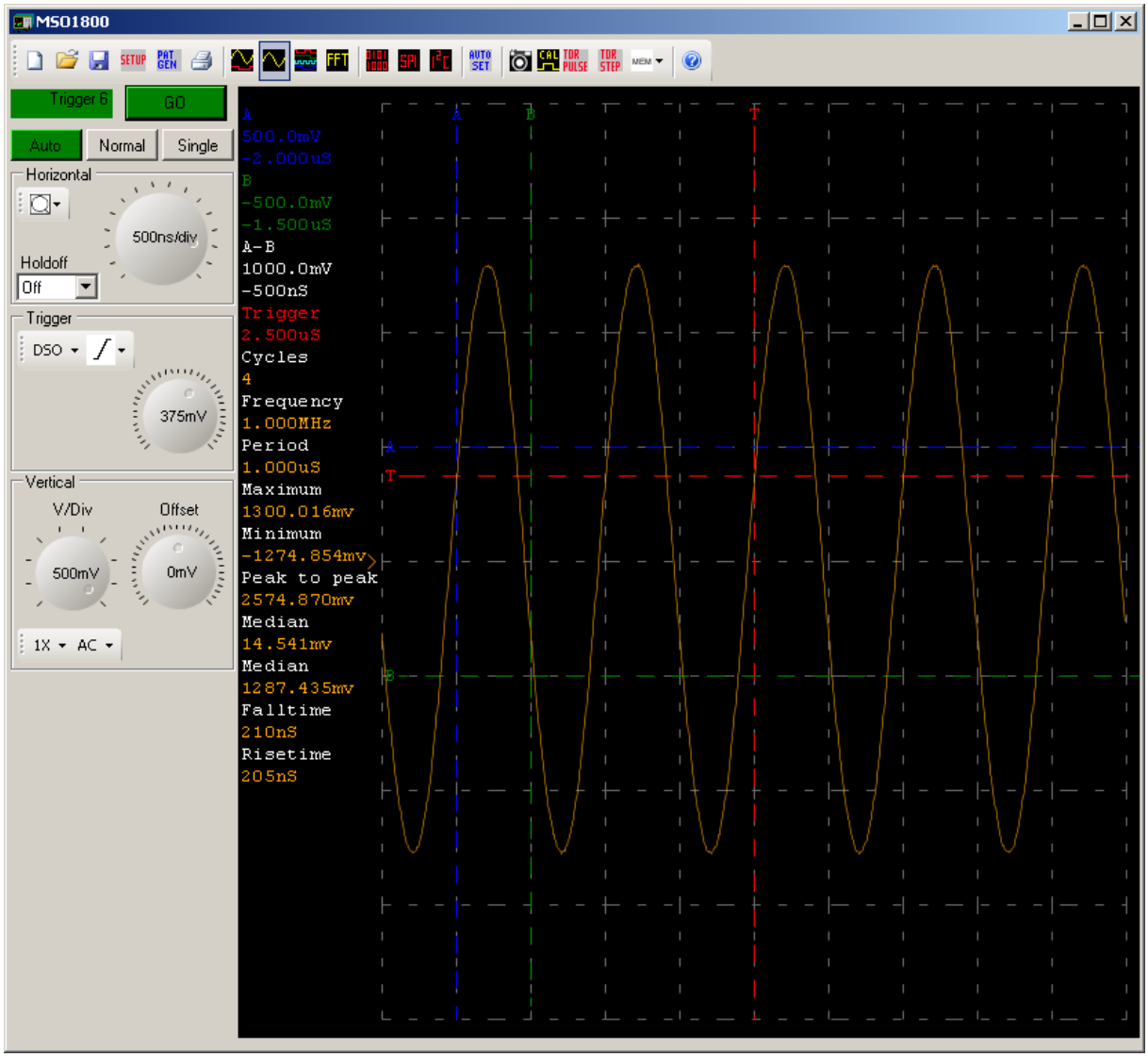
3.19.6 Measurements

Toolbar button: SETUP -> Measurements tab

The MSO software can perform a number of waveform measurements.



All measurements need to have a definitive measurement range. Measurements can be taken within a cursor limit or within the whole buffer. There are four data ranges: Entire buffer, cursor A to B, cursor A to T and cursor B to T.



Peak voltage - maximum voltage achieved by captured signal

Min voltage - minimum voltage achieved by captured signal

Peak-to-Peak Voltage – difference between the maximum and minimum voltage achieved by captured signal.

Mean voltage – mean average of captured signal voltage.

Median – the median average of a signal.

Frequency – frequency of the periodic waveform is the measurement of the number repetitive occurrences in a unit of time (second). If there are 1000 period occurrences in a second the signal has a frequency of 1 KHz or 1000 cycles per second.

Cycle Count – cycles of a waveform can be counted within the data buffer for every occurrence of a pair rising or falling edges (80-20% of peak voltage). If a waveform has a two period duration then the cycle count will equal 2. Cycles can be counted within the entire buffer or between two cursors.

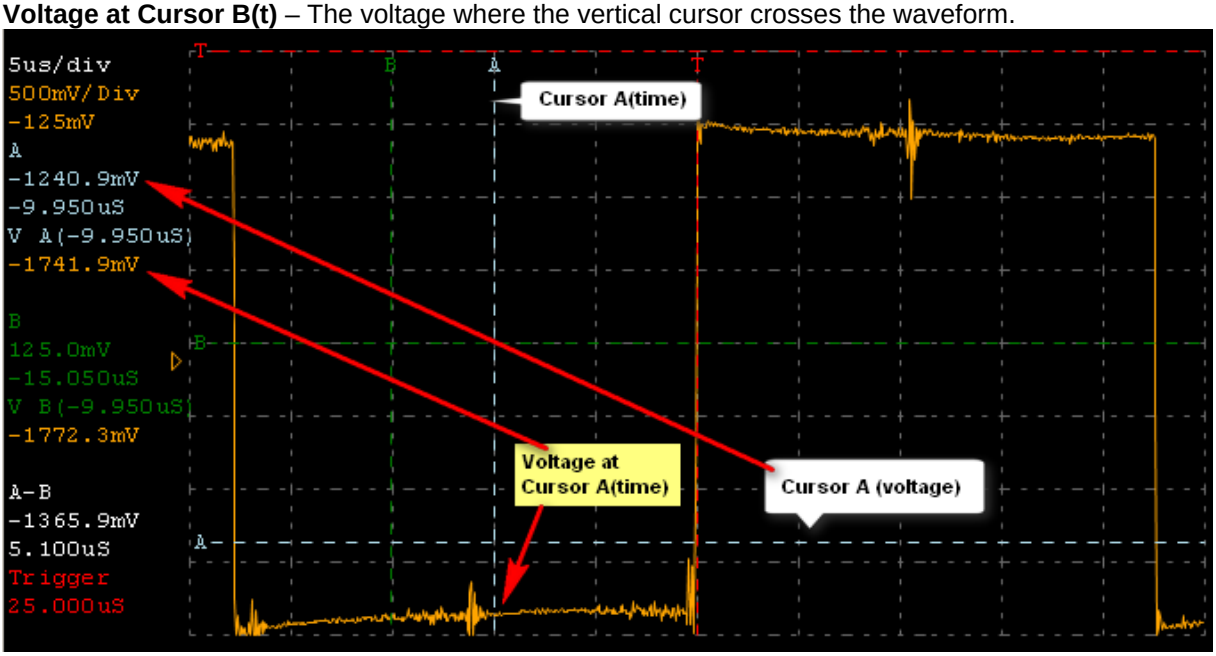
Period – The period of a waveform is the average width of pulses in the waveform.

Pulse count – the number of pulses

Rise Time – the time it takes for a pulse to go from low to high. The time it takes for a signal to rise from 20% of its peak to 80% of the peak value.

Fall Time – the time it takes for a pulse to go from high to low. The time it takes for a signal to fall from 80% of its peak to 20% of the peak value.

Voltage at Cursor A(t) –
Voltage at Cursor B(t) – The voltage where the vertical cursor crosses the waveform.



Measurements are displayed on the left side of the timing window. The number of measurements that can be displayed is a function of the window height.

3.19.7 Misc.

Toolbar button: SETUP -> Misc. tab

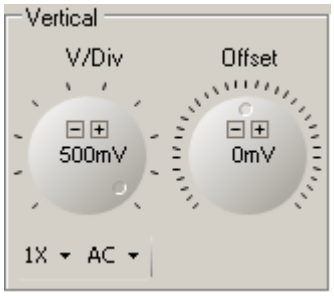
Cursor measurements relative to trigger position:
Cursor measurements can be displayed by their position in the buffer or relative to the Trigger cursor 60.

Time displayed as time:
Horizontal time measurements can be displayed in terms of time or by position in data buffer.

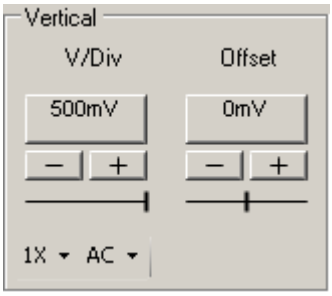
Display sample rate:
Display the sampling rate in addtion to time/division 51.

Use knob controls:
Select control style for Timebase 51, V/Div 62 and Offset 64 controls.

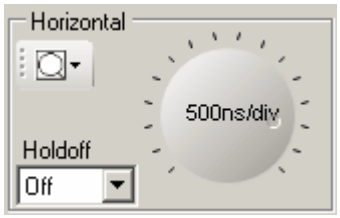
Knob controls



Slider controls



3.20 Horizontal (Time)



This section of the screen is divided into three sections

Timebase 51 The Timebase knob shows the time per division.

Holdoff 51 Holdoff allows you to trigger on an event, but to postpone the data acquisition to a later time. Use this feature when the data you are interested in more than a buffer length away from the trigger event.

Zoom 52 Use this to zoom in/out on the timing window. It may affect the Timebase(time per division) and number of horizontal divisions.

Time per acquisition:

Time per acquisition = timebase * number of horizontal divisions
or
Time per acquisition = buffer length * sample rate

Number of horizontal divisions

Zoom to fit 52	10
Zoom 1:1 52	10
Zoom 1:2 52	20
Zoom 1:5 52	50
Zoom 1:10 52	100

Samples per Division:

Zoom to fit 52	100
Zoom 1:1 52	100
Zoom 1:2 52	50
Zoom 1:5 52	20
Zoom 1:10 52	10

Calculating sampling rate:

Sample rate = Time per division / Samples per division
for example:
If Time per division = 500ns/div and zoom was set to "zoom to fit"
sample rate = 500ns/div / 100samples/division = 5ns/sample

Calculating sampling frequency:

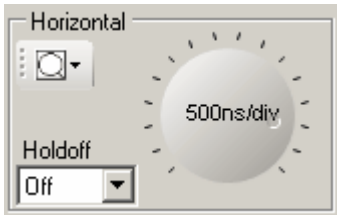
Sampling frequency = 1 / (sample rate)

Buffer length:

The MSO-28 has a 1000 point data for the oscilloscope and logic analyzer channels.

See also: FAQ's 70

3.20.1 Timebase



Timebase – Turning the knob in a clockwise direction will select a faster timebase. The two fastest rates put the MSO into RIS (Random interleave sampling) mode and (RIS) will be displayed on the knob.

The value displayed on the knob is displayed in terms of time/division.

The time/division values are a function of knob position and zoom 52.

Nyquist Keep in mind that the Nyquist sampling theorem states that in order for a signal to be reconstructed the sampling rate must be at least twice that of the test signal's maximum frequency. Sampling a 1MHz signal will require at least a 2MHz sampling rate, over sampling with a 5-10MHz sampling rate will more likely reconstruct the signal without aliasing. Looking at a 1MHz (1uS period) square wave set sample rate to 5MHz (0.2uS samples/S) to accurately view the waveform .

RIS mode (Random interleave sampling) is a sampling method used to increase the effective sampling rate by collecting data over multiple captures and coming it to build a single waveform. This technique is only available for waveforms that are repetitive. The logic analyzer is not available in RIS mode.

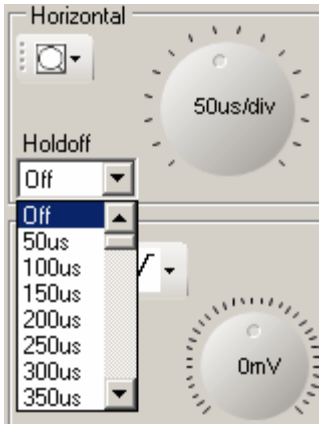
Hotkeys:

"+" Rate up (Time per division) 51
"-" Rate down (Time per division) 51

See also: FAQ's 70

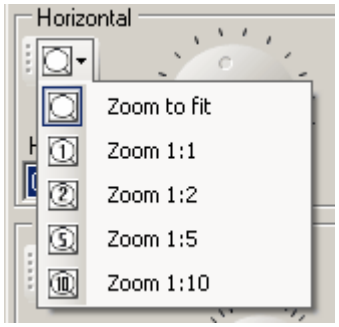
3.20.2 Holdoff

The holdoff feature allows you to trigger on an event, but to capture data that happens at a later point in time. The holdoff time defines how much time the MSO will wait after the trigger occurs before it starts to acquire data.



See also: FAQ's 70

3.20.3 Zoom

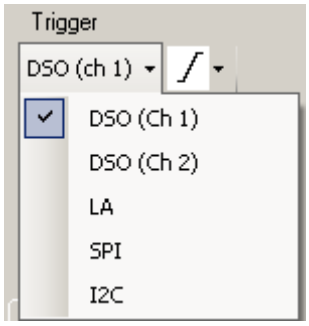


The zoom controls affects the horizontal distribution of data on the screen.

See also: FAQ's 70

3.21 Trigger controls

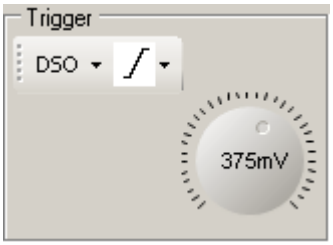
The trigger circuit works in conjunction with capture mode 39 and the Go/Stop 39 button.

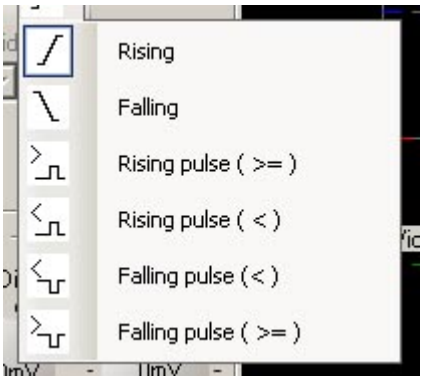


The MSO has five basic trigger modes:

DSO (ch 1) and DSO (ch 2)

Acquire data based on an analog event captured on the one of the Oscilloscope inputs.

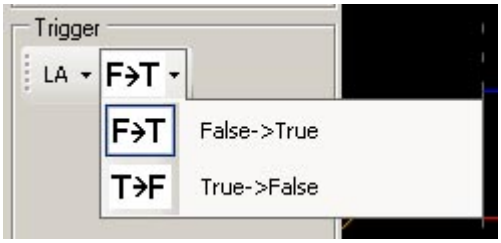




The trigger level (threshold is set with the knob), trigger edge and pulse width modes are selected in the pull down menu. Additional controls are visible when in pulse width trigger mode.

Logic Analyzer

Acquire data based on a digital event captured on the Logic Analyzer inputs.



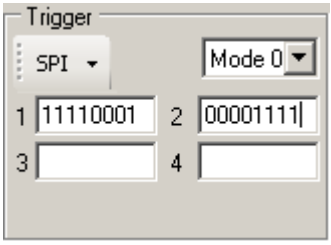
The trigger event is based on the 8 bit trigger word and the mode.

Each bit in the word can be set to "1" (high), "0" (low) or "X" (don't care).

The mode "False->True" and "True->False" defines the whether the LA will trigger when the word becomes true or when it becomes false.

SPI

Acquire data based on a digital event captured on the Logic Analyzer inputs



The trigger event is based on the four 8 bit trigger words, the true/false mode and SPI translation mode.

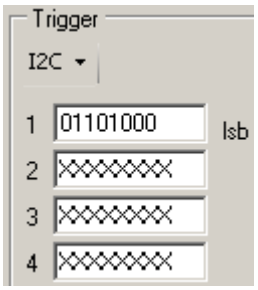
Each bit in the word can be set to "1" (high), "0" (low) or "X" (don't care).

The SPI mode should be set to match the SPI mode of your circuit.

The mode "False->True" and "True->False" defines the whether the SPI will trigger when the word becomes true or when it becomes false.

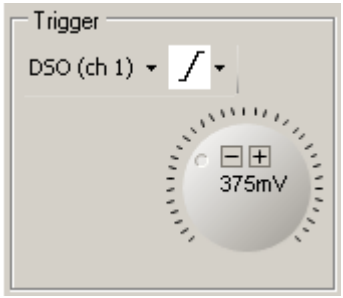
I2C

Acquire data based on a digital event captured on the Logic Analyzer inputs



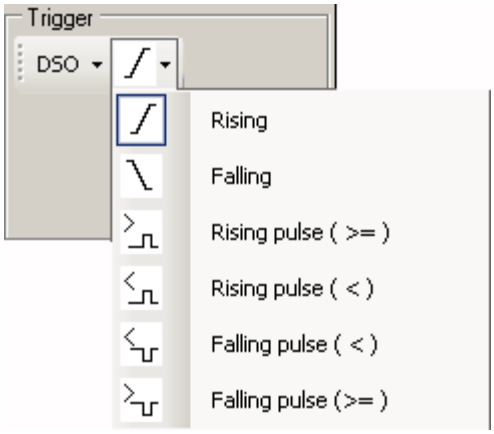
The trigger event is based on the four 8 bit trigger words and the true/false mode.
Each bit in the word can be set to "1" (high), "0" (low) or "X" (don't care).
The mode "False->True" and "True->False" defines the whether the I2C will trigger when the word becomes true or when it becomes false.

3.21.1 DSO Trigger



The DSO trigger has 6 modes

	Rising 55	Trigger on the rising edge of a signal when it crosses the trigger level 57.
	Falling 55	Trigger on the falling edge of a signal when it crosses the trigger level 57.
	Rising pulse greater than or equal to 55	Trigger on a rising pulse that is wider than specified width.
	Rising pulse less than 55	Trigger on a rising pulse that is narrower than specified width.
	Falling pulse greater than or equal to 55	Trigger on a falling pulse that is wider than specified width.
	Falling pulse less than 55	Trigger on a falling pulse that is narrower than specified width.



Rising/Falling edge trigger

In the case of a rising edge, a signal must cross over the set trigger level 57 to cause a trigger. While a falling edge must cross under the trigger level 57 to trigger.

In the case of a rising edge, a signal must cross over the set trigger level 57 (red horizontal dashed line) to cause a trigger. The trigger position cursor 60 (red vertical dashed line) defines the pre/post trigger buffer. Notice how the rising edge of the trace crosses though the intersection of these cursors. If a falling edge trigger had been selected the falling edge of the trace would have crossed this intersection.

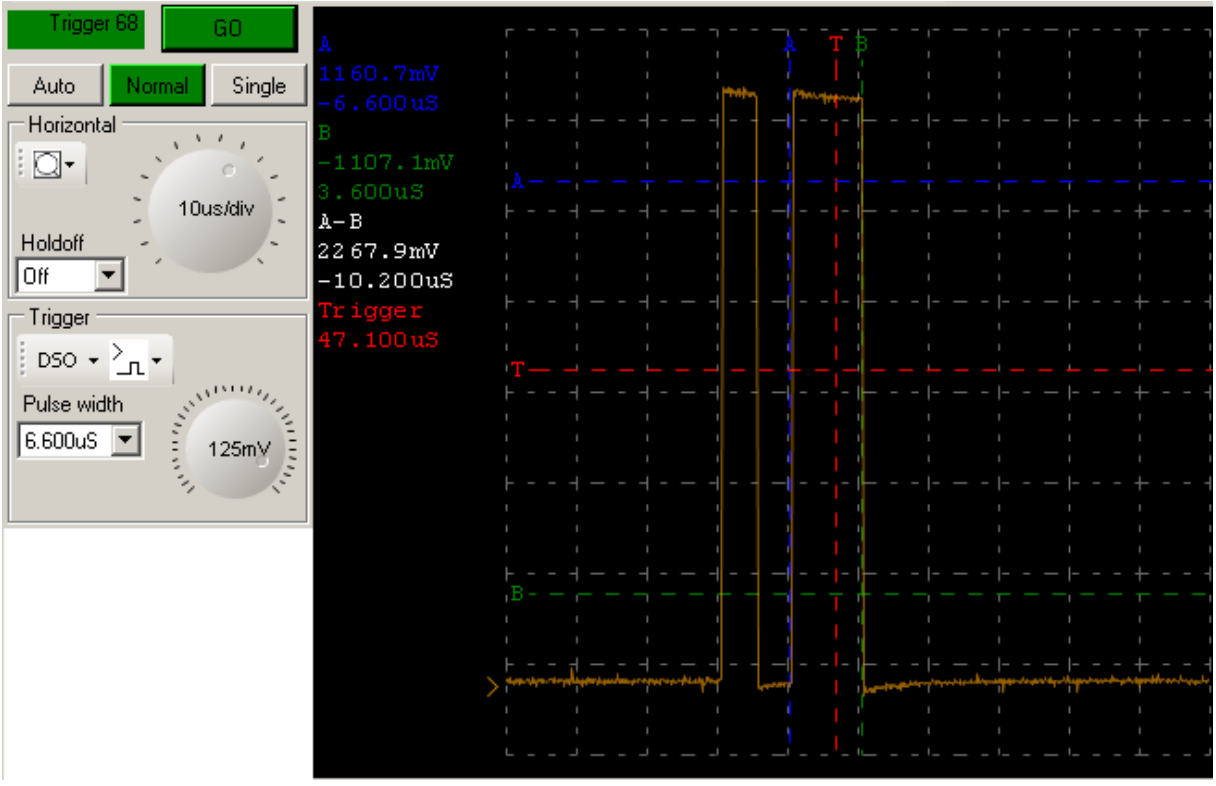
Pulse width trigger

Triggering on a pulse duration can be done using pulse width triggering. There are four pulse width triggering modes:

Rising Pulse Greater Than or Equal To	Trigger on a rising pulse that has a width greater than or equal to the specified pulse width.
Rising Pulse Less Than	Trigger on a rising pulse that has a width less than the specified pulse width.
Falling Pulse Greater Than or Equal To	Trigger on a falling pulse that has a width greater than or equal to the specified pulse width.
Falling Pulse Less Than	Trigger on a falling pulse that has a width less than the specified pulse width.

Sampling rate and pulse width
As the sampling rate increases the selectable pulse width decreases.

Pulse width detection
The MSO must detect the initial rising or falling edge to determine width.

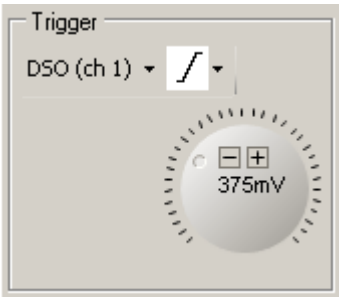


Trigger was set to **Rising Pulse Greater Than or Equal To**  **with a pulse width of 6.6uS**

Notice the time measurements on the left side of the screen.
The time between A and B is 10.200uS (actual width of the second pulse)
The cursor A time measurement is -6.600uS indicated that the A cursor is 6.6uS before the Trigger position cursor.

See: Normal 39, Auto 39, Single 39, Trigger voltage level 57, cursor measurements 13 and Trigger position cursor 60.

3.21.1.1 Trigger voltage level



The trigger level is set using the trigger level knob seen below. The minimum and maximum trigger voltages are based on the voltage per division setting, maximum being four times the V/div setting and minimum being the inverse of maximum.

Trigger voltage level also changes as the voltage per division knob is adjusted compensating for the new voltage scale.

Hotkeys:

"8"	Trigger level up 57
"T"	Trigger level up 57
"5"	Trigger level down 57
"t"	Trigger level down 57

3.21.2 Logic Analyzer Trigger

Trigger word:
An 8 bit Trigger word representing the logic channels can be entered into the input box. 1 being **True**, 0 **False**, and X meaning "**Don't care**". The MSO will trigger when the data on the 8 channels matches the 8 bit trigger word. Using X (don't care) allows the user to distinguish which bit(s) should be triggered on by ignoring the logic state of the bit(s) set to X.

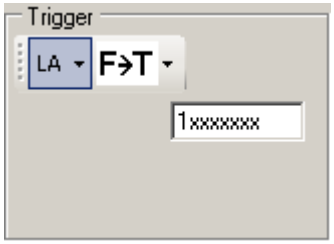
Trigger mode:

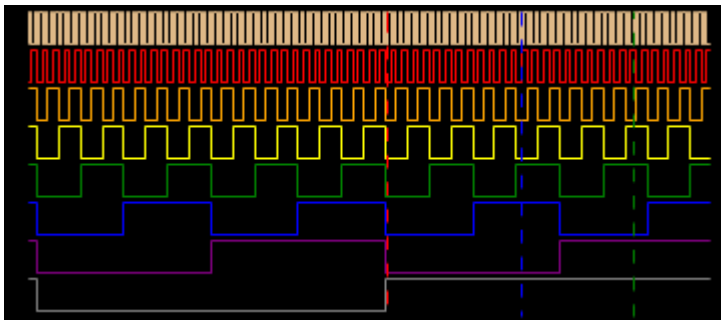
The logic analyzer trigger mode will determine how a match is made. In **False to True mode**  a trigger will occur when a match is found. In **True to False mode**  a trigger occurs when a match disappears and becomes False.

Threshold level is the defining level in which a signal is considered true or false, a signal with a

voltage greater than the selected threshold level will be defined as logic 1 (high). While a signal less than the threshold level will be defined as 0 (low). Setting the threshold level is imperative when triggering on specific logic families and varying voltage levels. Improper threshold level can cause the instrument to interpret the signal incorrectly. In a TTL system capturing with a 1.4V threshold is sufficient for properly capturing data, but if the threshold level on the logic analyzer is set to 0.2V many false glitches can occur due to the reduction in tolerances for logic high.

In the example below we are triggering when bit 7 is logic high (1) and we don't care what the status of the other 7 channels is.





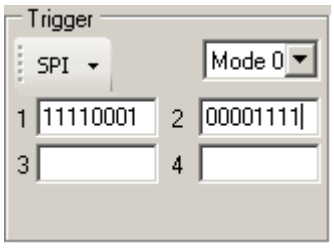
See: Normal 39, Auto 39, Single 39 and Trigger position cursor 60.

3.21.3 SPI Trigger

Trigger on the SPI serial bus protocol.

The SPI trigger will operate on any of the 4 standard SPI modes (0, 1, 2 or 3).

The MSO can trigger on a SPI stream of 4 bytes (8 bits each). The pattern is entered in binary. Each bit can be either a 1, 0 or X (don't care).



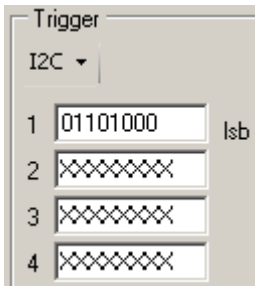
SPI Channels:

SEL is on Logic Analyzer channel 0
CLK is on Logic Analyzer channel 1
SI is on Logic Analyzer channel 2
S0 is on Logic Analyzer channel 3

3.21.4 I2C Trigger

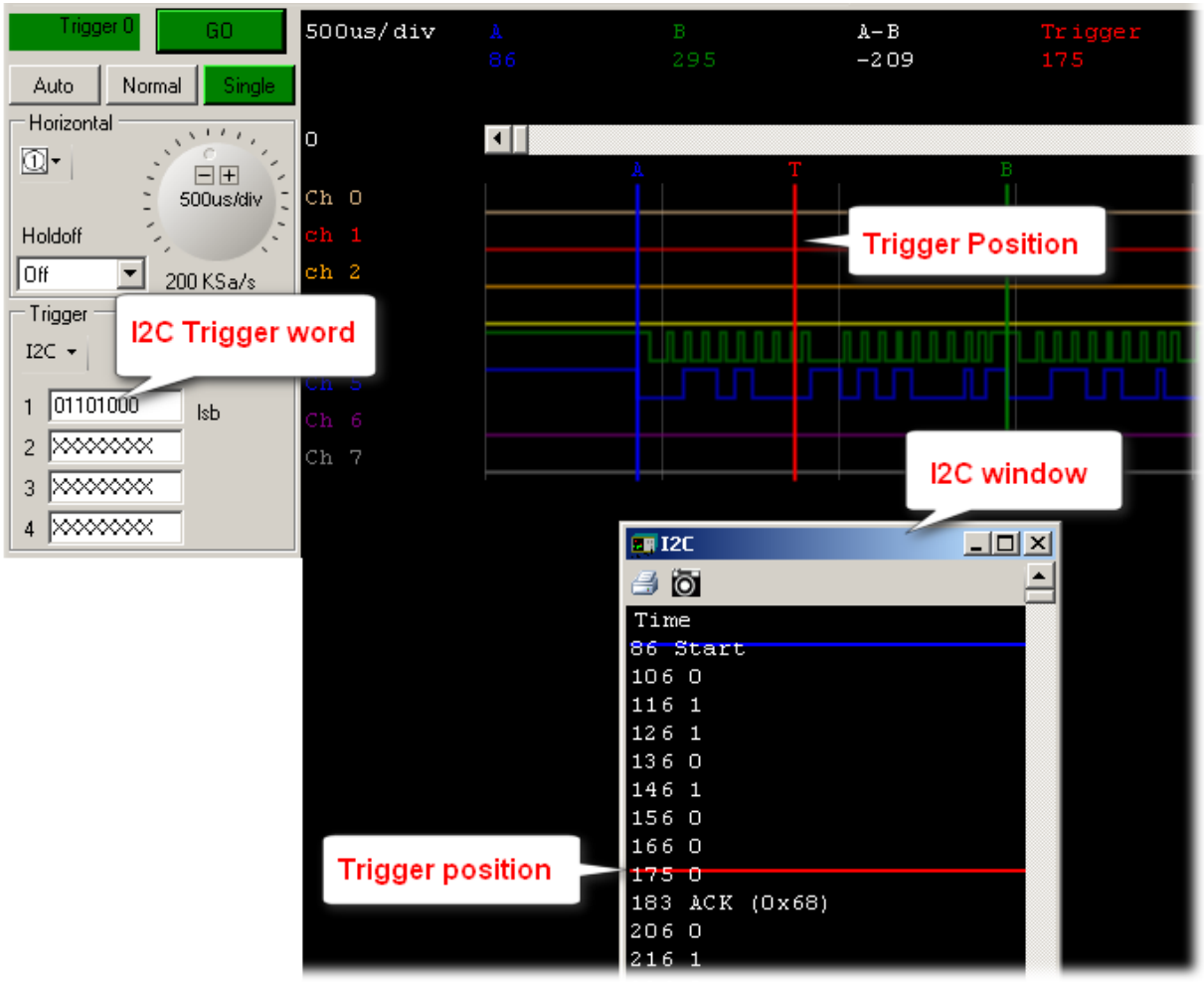
Trigger on the I2C serial bus protocol.

The MSO can trigger on a I2C stream of 4 bytes (8 bits each). The pattern is entered in binary. Each bit can be either a 1, 0 or X (don't care).



I2C Channels:

SDA is on Logic Analyzer channel 5
SCL is on Logic Analyzer channel 4



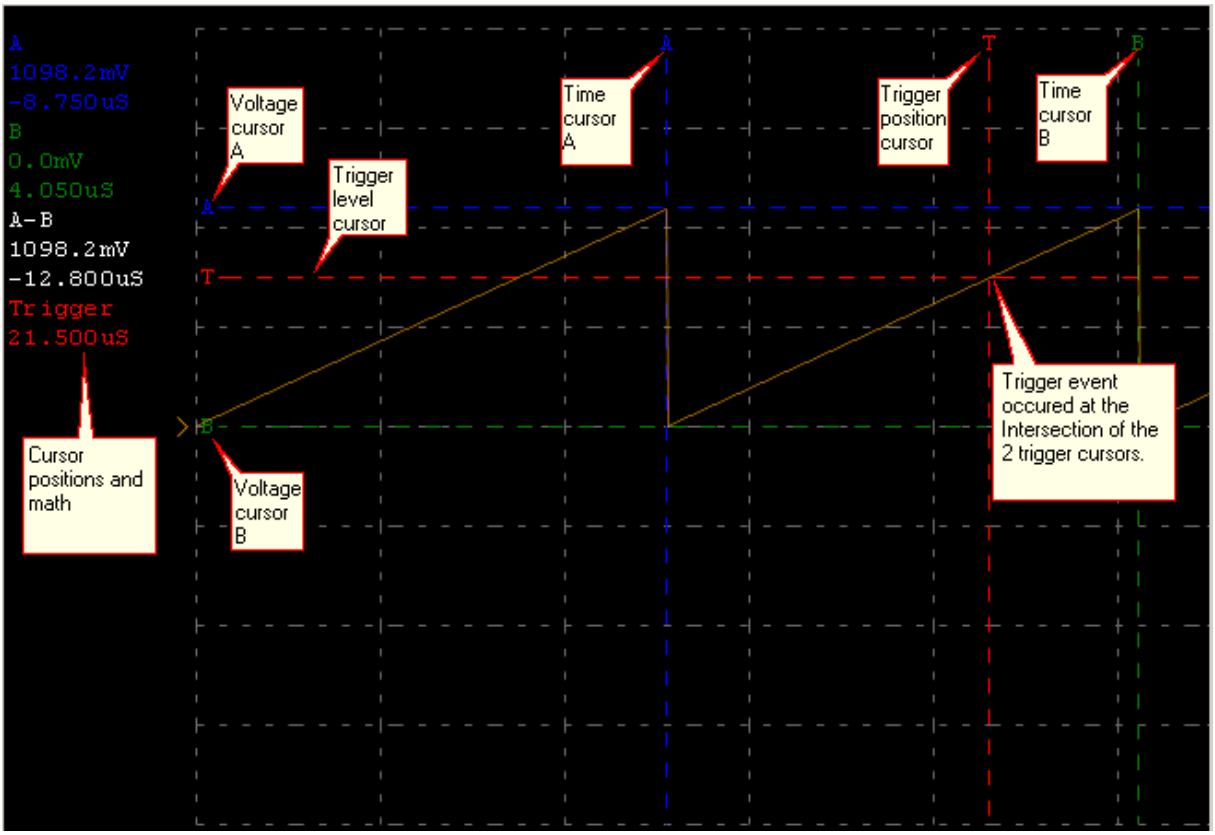
The I2C trigger word is 01101000 XXXXXXXX XXXXXXXX XXXXXXXX

If you look at the I2C window you will see that the MSO triggered on the value of 01101000.

3.21.5 Trigger position cursor (pre/post trigger)

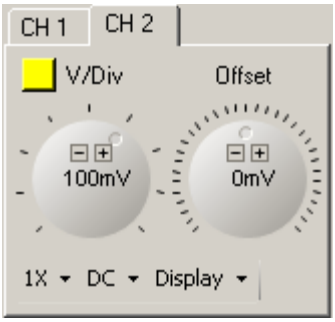
The trigger position cursor is a vertical line that shows the pre/post trigger position. The pre-trigger buffer is to the left of the trigger cursor while the post trigger buffer is on the right. Pre-trigger is defined as any event that occurs prior to the trigger, and post-trigger is any event that occurs after the trigger event.
Time cursor A and B are measured relative to this cursor hence the positive and negative numbers.

Note: When this cursor is moved the data is invalid until the next capture.



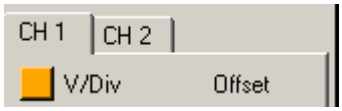
See also: How to.. Using cursors 13.

3.22 Vertical (voltage)



Channel

Select channel with CH 1 and CH 2 tabs



Hotkey:

"." Vertical control channel selector (MSO-28 only) 60

Voltage per division 62

The VDiv (voltage per division) knob sets the vertical range of the Oscilloscope input. There are 8 vertical divisions so the full range voltage will be 8 * VDiv.

The probe attenuation type 63 must be set correctly before you can set the VDiv.

This setting will also affect Trigger level range 57 and Offset range 64.

Offset 64

Offset sets the relative voltage of ground. The total range of offset is from (4 * VDiv) to (-4*VDiv).

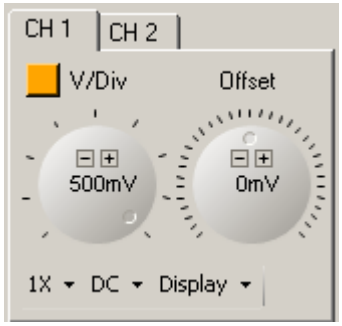
Probe attenuation: 1X/10X 63

The probe attenuation selection should match the physical probe you are using. The software setting does not affect the hardware in any way. The setting allows the software to display the correct voltage reading on the screen.

Coupling 66

The AC/DC menu selects whether the MSO should be AC or DC coupled to the signal.

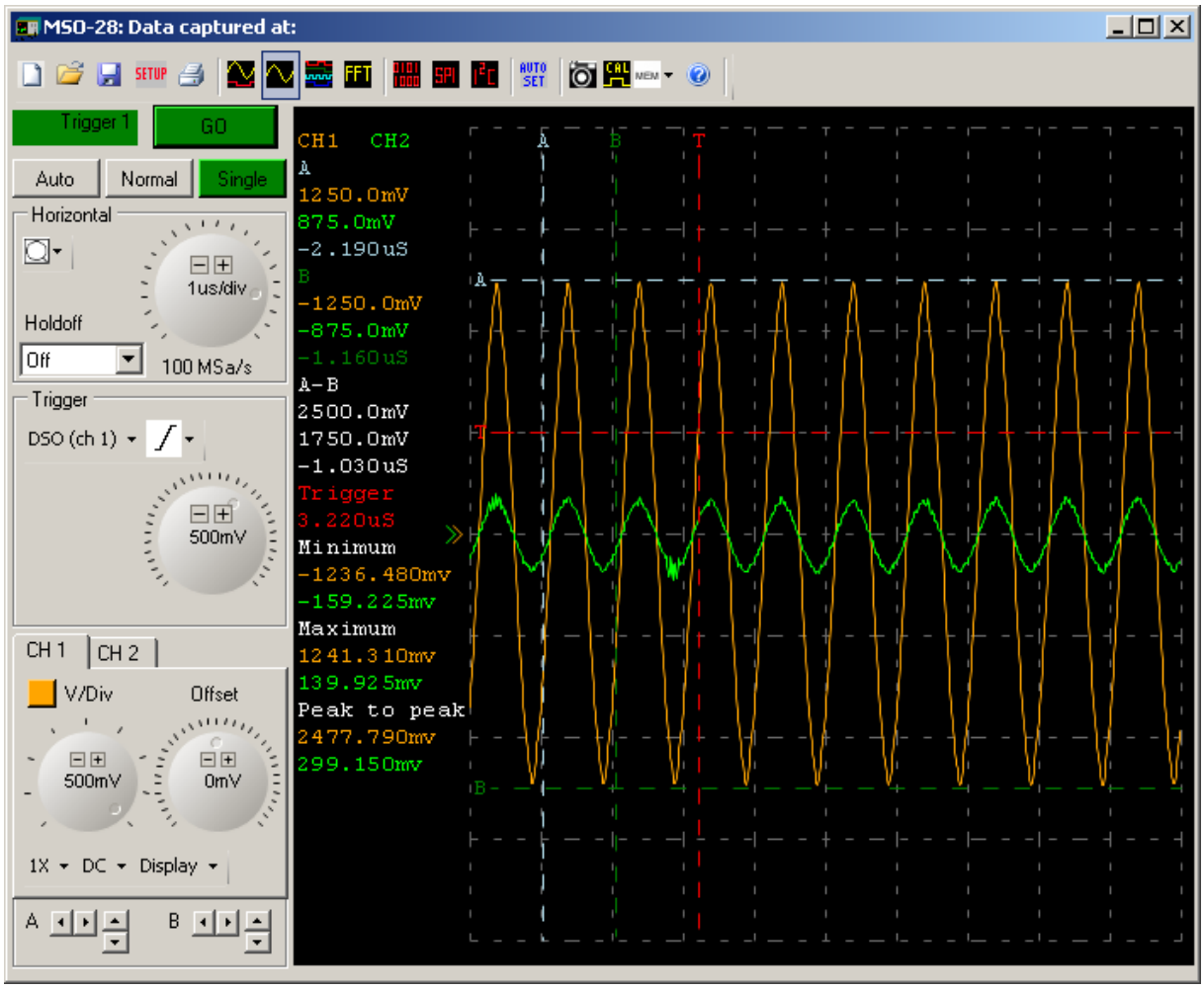
3.22.1 Voltage per division (V/Div)



Voltage per division knob adjusts the sensitivity of the vertical scaling, offset 64 and trigger level 57 range. The range of this control is dictated by the probe 63 type.

The MSO-28 has 8 vertical divisions and full scale voltage is 8 * V/Div.

Probe setting	V/Div range	Full scale voltage (8 divisions tall)
BNC cable (use 1X setting)	50mv/div to 500mv/div	400mv to 4v
1X	50mv/div to 500mv/div	400mv to 4v
10X	500mv/div to 5V/div	4v to 40v

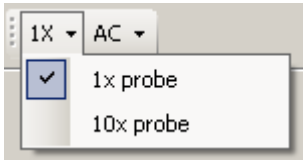


Hotkeys:

"7" V/div up 62
"V" V/div up 62

"4" V/div down 62
"v" V/div down 62

3.22.2 Probe attenuation



The probe attenuation selection should match the physical probe you are using. The software setting does not affect the hardware in any way. The setting allows the software to display the correct voltage reading on the screen.

The probe should be appropriate for the signal you are measuring. Adjusting the attenuation of the physical probe will affect the voltage level at the BNC connector and will protect you, the MSO and your computer. A 10X probe will divide the voltage by a factor of 10 and allow you to work with a higher

voltage. A 1X probe not affect voltage level.

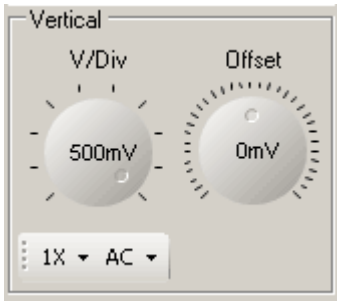
Probe attenuation ratios have different load characteristics as well; load is inversely proportional to the attenuation. A normal 1X probe has a 1MΩ and 100pf load. The 1X setting on a 1x/10x probe has a maximum bandwidth of 10MHz and introduces more capacitance than the 10X setting which might not be acceptable for some analysis. A 10X probe has a 10MΩ and 10pf load, which is the recommended attenuation for most circuit analysis.

To increase the input voltage range, one can attenuate the input signal via the x10 slider switch on the scope probe. Be sure to select the matching 1X/10X setting on the software.

The probe type affects the V/Div (voltage per division) 62, offset 64 and trigger level 57 ranges that are displayed.

Probe setting	**V/Div range**	**Full scale voltage (8 divisions tall)**
BNC cable (use 1X setting)	50mv/div to 500mv/div	400mv to 4v
1X	50mv/div to 500mv/div	400mv to 4v
10X	500mv/div to 5V/div	4v to 40v

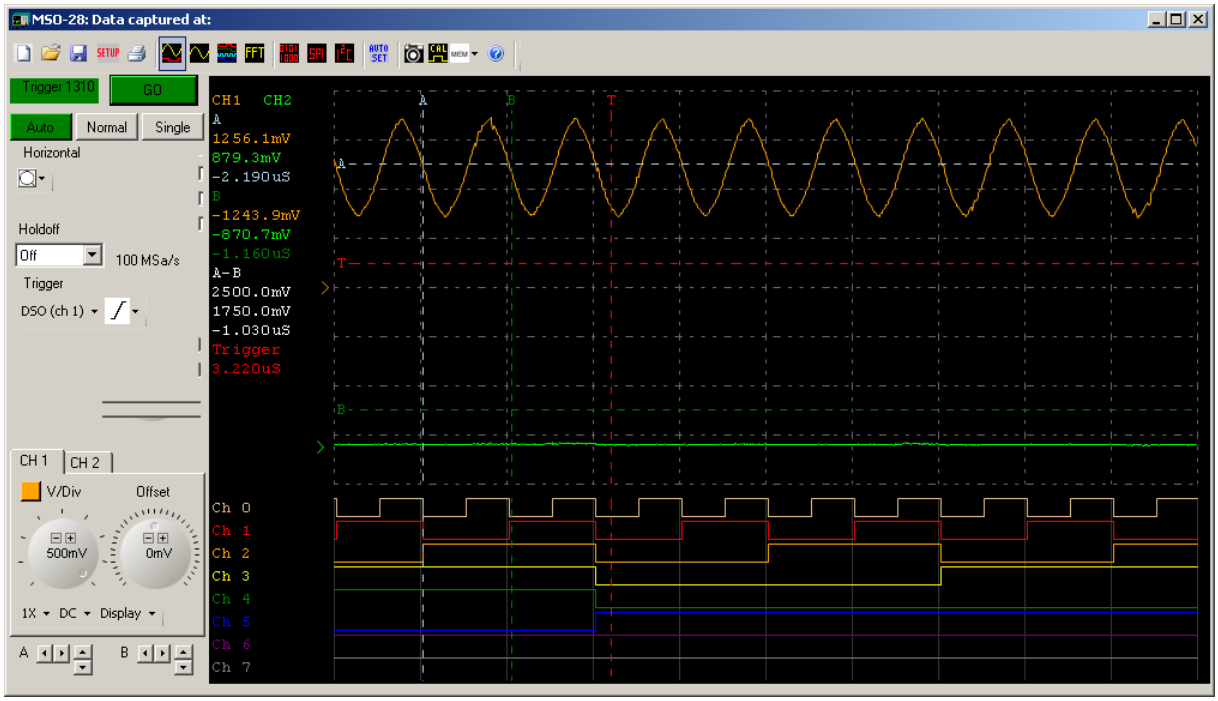
3.22.3 Offset



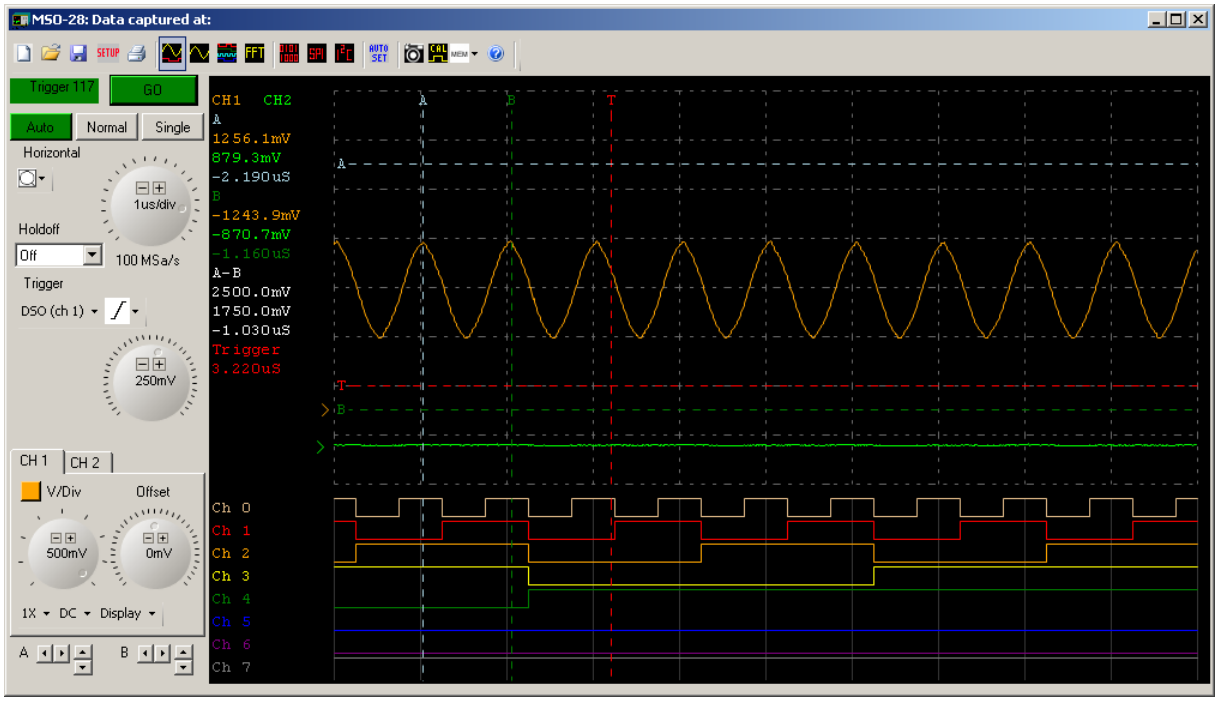
Offset sets the relative voltage of ground. The total range of offset is from (4 * VDiv 62) to (-4*VDiv 62).

Moving offset will change the voltage of ground and will change the voltage range of the input. It will also have the effect of a vertical scroll on the next capture of data.

For example:



This screen shows a signal a signal with significant offset.



By adjusting the offset control we are able to bring the waveform back to the center of the screen. We can now adjust V/Div 62 to make the waveform taller and make it easier to see details.

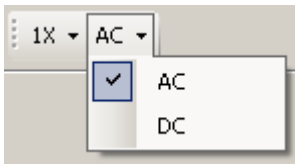
Hotkeys:

"9" Offset up 64

"O" Offset up 64

"6" Offset down 64
"o" Offset down 64

3.22.4 Coupling



The AC/DC menu selects whether the MSO should be AC or DC coupled to the signal.

AC mode: The DC component of the signal is blocked and only the AC signal can pass through. By removing the DC bias, one can place more gain on the AC noise without fear of saturating the input stage. This is particularly important in measuring an AC signal that has a very high DC offset, ie power supply switch noise on the DC supply line.

DC mode: Both AC and DC components are allowed to pass through to the MSO.

Part

4 Support

Technical support

Link Instruments
17a Daniel road east
Fairfield, NJ 07004

Phone: 973-808-8990

Email: support@linkinstruments.com

Web: www.linkinstruments.com

Part V

5 FAQs

Demo Mode

If the software does not detect the hardware it goes into Demo Mode. In this mode a simulated waveform will be displayed and you will see "Demo mode" near the top of the display area.

Number of horizontal divisions

Zoom to fit 52 10
Zoom 1:1 52 10
Zoom 1:2 52 20
Zoom 1:5 52 50
Zoom 1:10 52 100

Samples per Division:

Zoom to fit 52 100
Zoom 1:1 52 100
Zoom 1:2 52 50
Zoom 1:5 52 20
Zoom 1:10 52 10

The total time for an accession is the timebase * 10 (since there are 10 division on the screen).

Calculating sampling rate:

Sample rate = Time per division / Samples per division
for example:
If Time per division = 500ns/div and zoom was set to "zoom to fit"
sample rate = 500ns/div / 100samples/division = 5ns/sample

Calculating sampling frequency:

Sampling frequency = 1 / (sample rate)

Buffer length:

The MSO-28 has a 1000 point data for the oscilloscope and logic analyzer channels.

Time per acquisition:

Time per acquisition = timebase * number of horizontal divisions
or
Time per acquisition = buffer length * sample rate

Manual (Software and hardware)

A .PDF version of the manual is in the folder that the software was installed to. The default locations is c:\program files\link instruments\MSO-28\mso28.pdf

The manual can also be accessed by going to "Start->Programs->MSO-28->MSO-28 Manual" or "windows orb"->All Programs->MSO-28->MSO-28 Manual

I2C Channels:

SDA is on Logic Analyzer channel 5
SCL is on Logic Analyzer channel 4

SPI Channels:

SEL is on Logic Analyzer channel 0
CLK is on Logic Analyzer channel 1
SI is on Logic Analyzer channel 2

S0 is on Logic Analyzer channel 3

Part

6 Hot keys (keyboard shortcuts)

Hot keys (keyboard shortcuts)

"G"	GO/Stop 39
"g"	GO/Stop 39
"0"	GO/Stop 39
F5	GO/Stop 39
"."	Vertical control channel selector (MSO-28 only) 60
"+"	Rate up (Time per division) 51
"-"	Rate down (Time per division) 51
"7"	V/div up 62
"V"	V/div up 62
"4"	V/div down 62
"v"	V/div down 62
"9"	Offset up 64
"O"	Offset up 64
"6"	Offset down 64
"o"	Offset down 64
"8"	Trigger level up 57
"L"	Trigger level up 57
"5"	Trigger level down 57
"l"	Trigger level down 57

A cursor can be placed on the screen by holding the "A", "B" or "T" key while left clicking on the screen.
"A" plus left click positions cursor A at the point clicked.
"B" plus left click positions cursor B at the point clicked.
"T" plus left click positions the Trigger at the point clicked.

Part

7 Warranty and copyright

Limited Warranty on Hardware
LINK COMPUTER GRAPHICS, INC. ("Link") warrants the MSO-28 against defects in materials and workmanship for a period of one year (365 days) from the date of original retail purchase.

If you discover a defect, Link will, at its option, repair, replace, or refund the purchase price of the product at no charge to you, provided you return it during the warranty period, transportation charges prepaid, to Link. Please attach your name, address, telephone number, a description of the problem and a copy of the bill of sale bearing the appropriate Link serial numbers as proof of date of original retail purchase, to each product returned to warranty service.

This warranty applies only to hardware products; Link software media and manuals are warranted pursuant to a separate written statement.

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Copyright

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