softDSP

User's Guide

- SDS 200 -

- SoftScope-

PC Based Digital Oscilloscope

www.softdsp.com

Certificate of Product Warranty

This product's warranty, provided by *soft*DSP, Co., Ltd., covers a period of 1 year from the date of purchase. All faulty parts and/or functions, resulting despite user's normal use, will be repaired and/or replaced at no charge during the warranty period.

However, if any of the malfunctions are caused by user carelessness, inadequate maintenance, or natural disaster, *soft*DSP will then provide repair and/or replacement services for a fee regardless of warranty period.

Products covered by this warranty are limited to those that are registered at the *soft*DSP headquarter or branch offices and repairs, replacements, or refunds will be issued according to manufacturer's discretion. When in need of warranty services, the purchaser may visit our headquarter or one of our sales offices with the product or send the product with a detailed description of services required via postal service to any of our sales offices (the purchaser will be responsible for packaging, postage, and any postal insurance). Once repair services are completed, the supplier will return the product to the purchaser (return postage will be paid by the supplier).

However, if we determined required services to be outside the boundaries of the warranty coverage, we will first contact the purchaser and provide an estimate of repair costs and obtain authorization to conduct services before any work is done. In such a case, return postage along with the repair costs will be billed to the purchaser when the repaired product is returned.

*soft*DSP Co., Ltd. will not be held legally liable for any malfunction resulting from user carelessness, abnormal use (e.g. ignorance of warning instructions, etc.), and/or natural disaster. Even if *soft*DSP Co., Ltd. is in receipt of prior notification of such dangers, we will not be held legally liable.

Product Warranty Guide

Please read through the “Precautions for Safety” carefully to obtain a long and safe use of this product.

This product has been processed through careful quality control and testing procedures. Any malfunctions occurring during normal use are covered under the guidelines of the “Certificate of Product Warranty”, which is included in this Manual.

If you experience product malfunction, please contact our headquarters or any of our sales offices.

Precautions for Safety

Recommended Usage Environment

- In Operation

Temperature: 0 °C ~ 40 °C

Relative Humidity: 10 ~ 90% , When being used in a fixed state

- Not in Operation

Temperature: 20°C ~ 60°C

Relative Humidity: 5 ~ 95%, When being used in a fixed state

Power Source

- The USB terminal and SDS 200 are connected via a USB cable for DC +5V power from the PC. The product does not require an outside power source.

Warning: Be careful not to input excessive power voltage

- The product's input power capacity is fixed as shown below to prevent electric shock and/or fire. Please DO NOT use voltage higher than that prescribed below.

<Oscilloscope Max. Voltage Capacity: CH1, CH2, EXT all 42 V_{pk}, AC 30Vrms, DC 60V>

- Please eliminate all unused probes or tester leads so that they do not come in contact with surrounding high voltage parts.

- Make sure that the PC's power source is grounded.

Handling Precautions and After Service

DO NOT open the cover and attempt to repair the product at home. This may cause electric shock and/or other accidents. Please be aware that after service cannot be performed after you've opened the cover at home. All repairs, etc. must be performed at an authorized After Service Center.

WARNING!)

- The equipment parts must not be replaced by the user as there is a danger of electric shock. All repairs must be performed by an authorized technician and/or service center.

- When connecting a probe or signal input cable onto a circuit being tested, the grounded signal input cable must be connected to the grounded signal source. In a floating state, the electric current may vary relative to other devices or grounding, thereby damaging equipment, probes, or other measuring devices.

Usage Location

- If the products crevice is exposed to electric conductors (solids or liquids), the product will short circuit and possibly create dangers of electric shock or fire. Please keep this product away from humidity, water, or dust.

- DO NOT use this product near gas as well as other flammable and/or explosive materials.

- DO NOT place the product on an unstable cart, stand, or tripod. Such usage creates the dangers of accident and/or damage to product.

Maintenance and Storage

- The recommended temperature and humidity for equipment storage is 25 °C at 80% humidity.

Minimum System Requirements

To install and run SoftScope, you should have the following;

Operating System

Windows 98/ME/2000/XP

CPU/Mainboard

Pentium 200MHz , USB equipped mainboard

Memory

32MByte

HDD

20MByte

Graphic Card

Microsoft DirectX supported

Screen resolution: 800x600

Color depth: 16bit

Table of Contents

Ch 1. Introduction

1. What is SDS 200/SoftScope ?

1. SDS 200

SDS 200 developed by *soft*DSP Co., Ltd. is a portable PC-based Digital Oscilloscope.

High performance

SDS 200 has the following features: 200MHz analog bandwidth, 5GS/s equivalent sampling, 100MHz real-time sampling.

USB connected

SDS 200 uses USB that supports plug'n play, with 12Mbps communication speed.

Advanced trigger

SDS 200 has advanced trigger circuitry so that it can detect many complex signals.

Best performance for your dollar

SDS 200 has many features that is comparable to the high speed stand-alone DSOs. But it costs a fraction of the price.

No external power required

SDS 200 does not need an external power source, because it is bus-powered from USB.

2. SoftScope

SoftScope is a Windows software that controls SDS 200.

Easy to use

SoftScope is easy to use. It is intuitive and easy to understand.

Big screen

SoftScope uses 500 x 400 screen size.

Various data format processing

SoftScope can save waveform in the following formats: text file, jpg/bmp graphic file, MS excel/word file.

Fast screen update rate

SoftScope uses Microsoft DirectX, so that it gives upto screens per second update rate. (under Windows98, Pentium II environment)

Many kinds of measurements

SoftScope has 23 measurement functions.

The analog scope effect

SoftScope uses digital persistence and histogram method so that the display resembles an analog oscilloscope screen.

2. Hardware Specification

Input	
Max. sample rate	Realtime sampling: 100MS/s using one channel, 50MS/s using two channels Equivalent sampling: 5GS/s
Channels	2
Bandwidth	200 MHz (-3dB) Single shot bandwidth:50MHz
Vertical resolution	9 bits/channel
Gain range	10mV ~ 10V/div @ x1 probe (10mV, 20mV, 50mV, 100mV, 200mV, 500mV, 1V, 2V, 5V, 10V/div 1,2,5 sequence) 100mV ~ 100V/div @ x10 probe 1V ~ 1000V/div @ x100 probe 10V ~ 10kV/div @x1000 probe
Range	8 divisions
Offset level	+/-4 divisions
Coupling	AC, DC
Offset increments	0.02 div
Impedance	1M ohm
DC accuracy	+/-3%
Input protection	42Vpk (DC + peak AC < 10 kHz, without external attenuation)
Timebase	
Timebase range	2ns/div ~ 10s/div (2ns, 4ns, 10ns, 20ns, 40ns, 100ns, 200ns, 400ns, 1us, 2us, 4us, 10us, 20us, 40us, 100us, 200us, 400us, 1ms, 2ms, 4ms, 10ms, 20ms, 40ms, 100ms, 200ms, 400ms, 1s, 2s, 4s, 10s /div 1-2-4 sequence)
Acquisition mode	Equivalent sampling: 2ns/div ~ 4us/div Realtime sampling: 10us/div ~ 400ms/div Roll mode: 1s/div ~ 10s/div
Range	10 divisions
Pre/Post trigger	0% ~ 1000%
Time resolution	200ps
Buffer size	10K samples

Trigger	
Type	Edge trigger: Rising edge, falling edge Logic trigger: AND, NAND, OR, NOR, XOR, XNOR Pulse trigger: Less than width, more than width (10ns ~ 167ms) Delay trigger: By event (1~16,777,215), by time (10ns ~ 167ms)
Mode	Auto, Normal and Single
Autoset	Yes
Range	10 divisions
Trigger level	+/-4 divisions
Settabillity	0.02 div increments
Math	
Measurements	Vp-p, Vmax, Vmin, Vmean, Vrms, Vamp, Vhigh, Vlow, positive overshoot, negative overshoot, cycle mean, cycle rms, period, frequency, positive pulse width, negative pulse width, rise time (10%~90%), fall time (10%~90%), positive duty cycle, negative duty cycle
Cursor	Time/frequency difference, voltage difference Frequency only in FFT mode
Math	Addition, Subtraction, Multiplication, Division
FFT	Rectangular, Hanning, Hamming, Blackman Window
Physical	
Interface	Universal Serial Bus (USB)
Power	No external power source required. Bus-powered from USB
Dimensions	5.1" x 4.4" x 1.5"

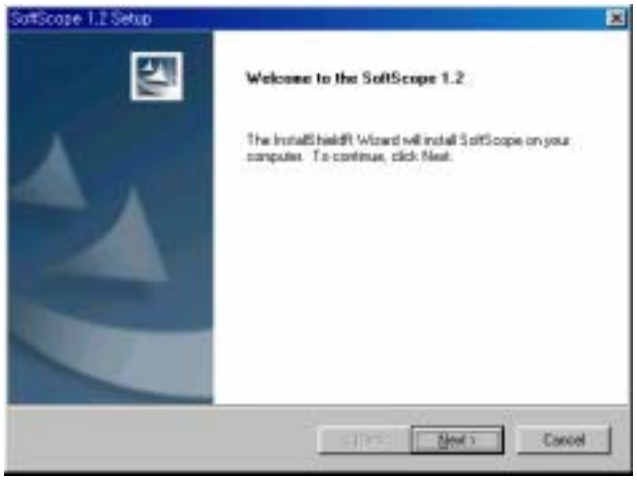
3. SoftScope Installation

Caution!) You must install 'SoftScope' before using SDS 200.

1. While in Windows, insert the installation CD into the CD-ROM drive.

2. The installation should start up automatically. Otherwise in Windows Explorer, switch to the CD-ROM drive and run Setup.exe.

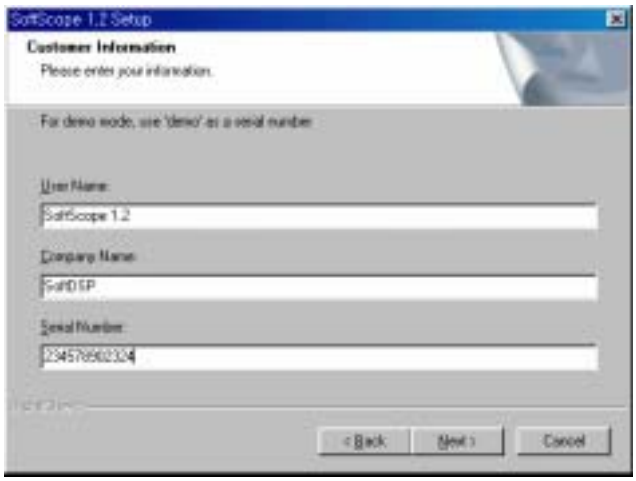
3. The SoftScope Installation is started. Click Next to continue.



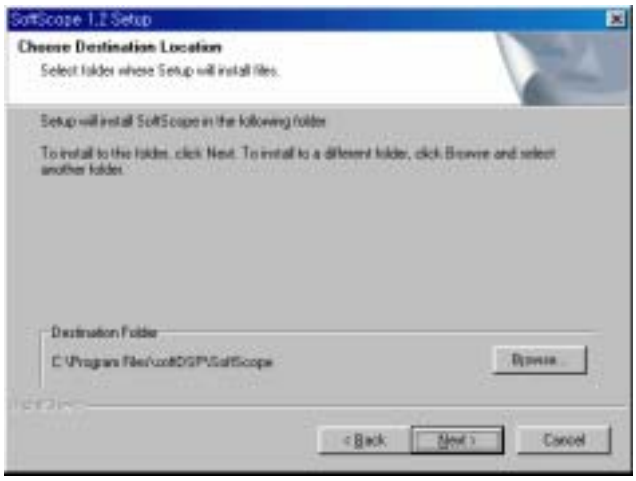
4. If you accept the license agreement, click Yes to continue.

5. Fill in the user information and serial number. Click Next to continue. For demo mode, use 'demo' as a

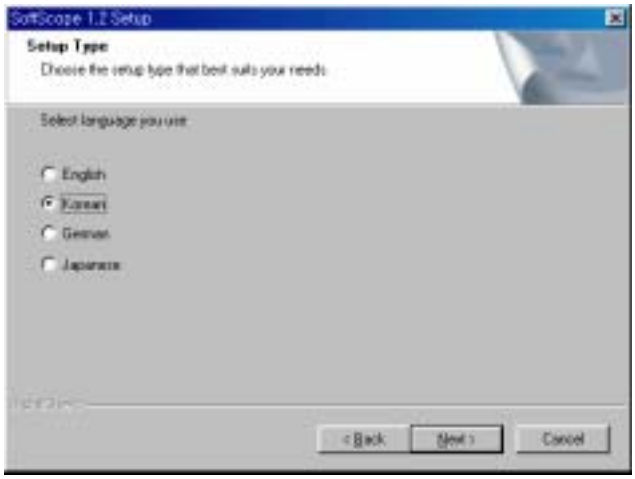
Serial Number.



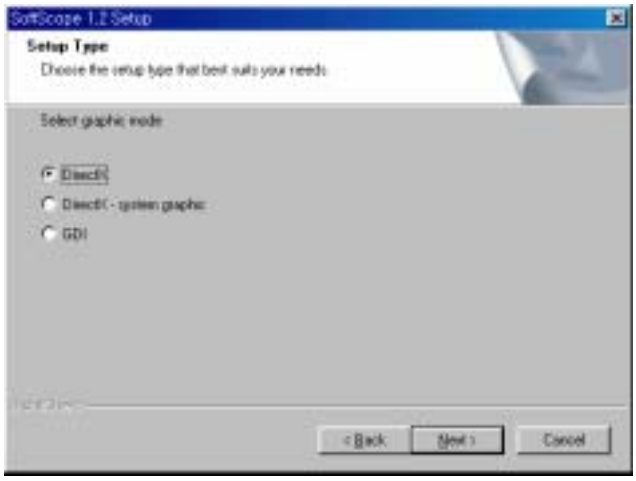
6. Choose a destination directory. Click Next to continue.



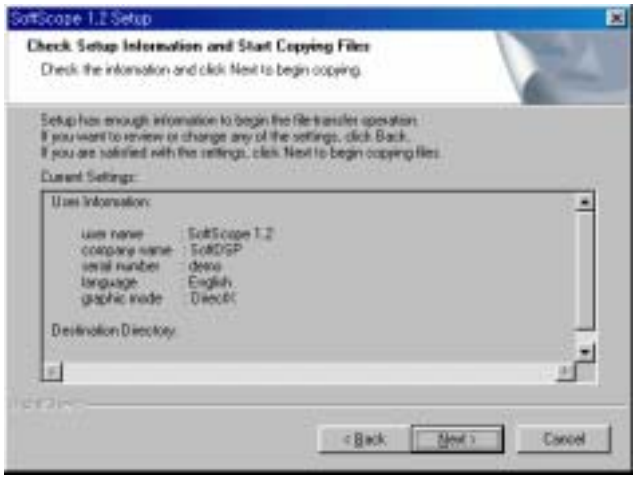
7. Select Language you use. Click Next to continue.



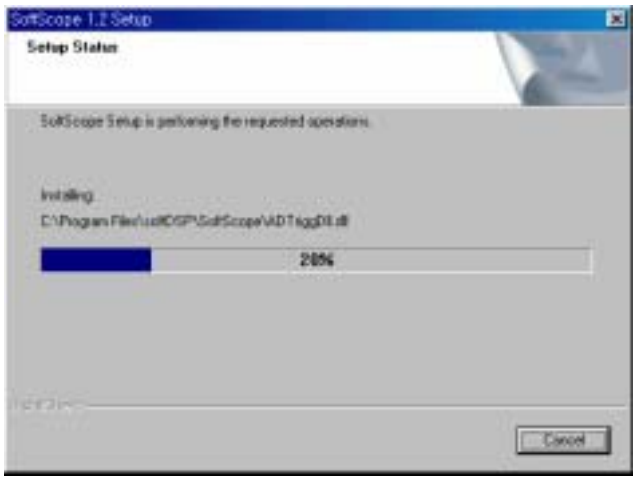
8.Select Graph mode. Click Next to continue.



9.Check the setup information. Click Next to start copying of files.



10. This Status dialog is displayed during copying of files.



11. After Installing SoftScope, the installation program will check the DirectX version of your computer.

If it is later than 6.0, the installation program will skip the DirectX Setup.

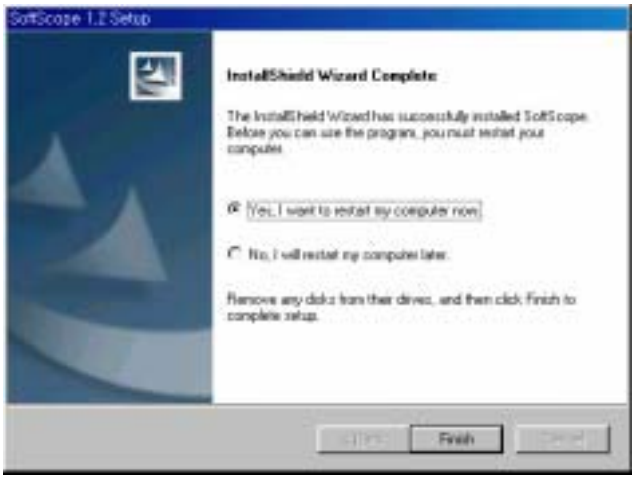
12.1 If it is earlier than 6.0 or no DirectX installed on your computer, you must reinstall DirectX.

if you install from CD-ROM, DirectX Setup will start up.

If you download SoftScope_with_DirectX.exe, DirectX will be installed automatically.
If you download SoftScope.exe, you must download DirectX also.

12.2 Follow the directions of the DirectX Setup.(In case of installing the files downloaded from internet, you must download and install DirectX!)

13. Select if you reboot or not, you must reboot to use SDS 200.



14. The installation is complete.

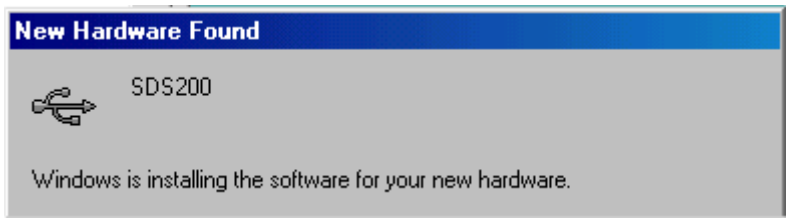
4. SDS200 Setup

Caution!) SoftScope must be installed before using SDS 200. This setup process is done once, at the first time of connection.

1. Connect the A-Type Plug of USB cable to your PC's USB port.

2. Connect the B-Type Plug of USB cable to SDS 200's USB port.

3. SDS 200 will be detected automatically. (The picture is captured under Windows98 SE environment)



5. Setup sds200.inf under windows 2000

When sds200.inf file is not be detected automatically, you see the following dialog box.

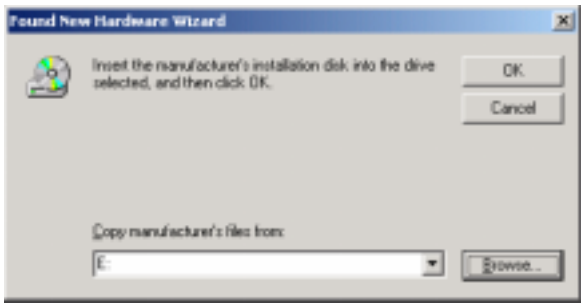
In this case you must install sds200.inf file manually.

1. Choose ‘Search for a suitable driver for my device’ button. Click Next to continue.

2. Specify a location. Click Next to continue.

3. The sds200.inf file is located in SoftScope CD-ROM root directory. Specify the location by either

entering or browsing.



4. sds200.inf file is detected automatically. Click Next to continue.

5. Click Finish.

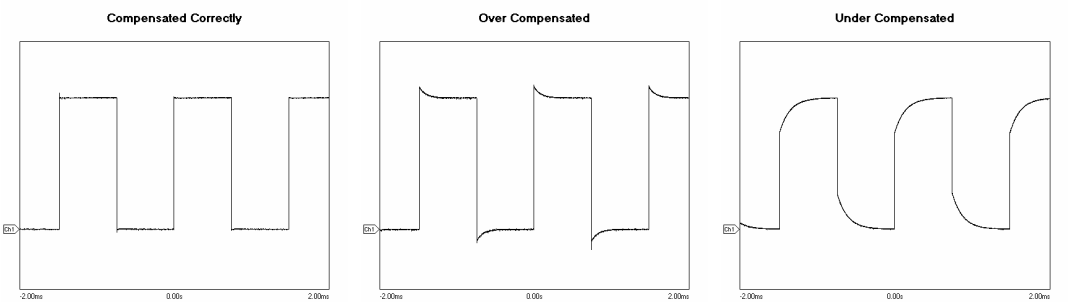
6. Probe Calibration

SDS 200 calibration

1. When manufactured, SDS 200 is calibrated manually to obtain maximum performance.
2. You may calibrate SDS 200 5 or 6 months after purchase.

Probe Compensation

1. You must use a probe with more than 200MHz bandwidth to get undistorted signal.
2. Probe should be compensated whenever it is connected for the first time.
3. Connect calibration signal to channel 1, then push AUTOSET.
4. Check the shape of the displayed waveform.
5. Adjust the probe until the displayed waveform is compensated.



Ch 2. How to use SDS 200/SoftScope

1. Simple Measurement

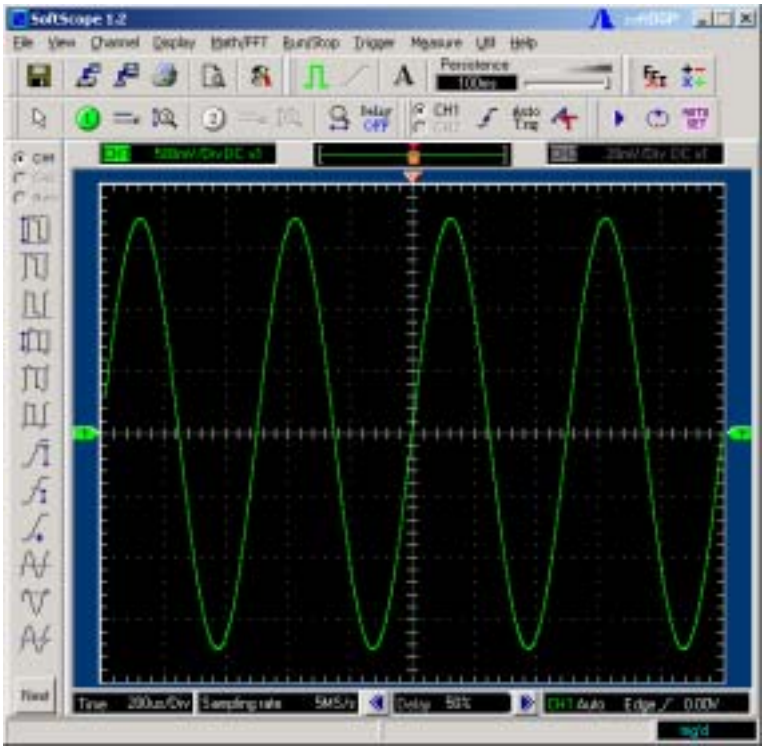
1. Start SoftScope.
2. SoftScope checks the internal state of SDS 200, USB communication status and then read initialization data.

3. Connect channel 1 probe to the calibration terminal.

4. 

Push the autoset button.

5. SoftScope sets vertical/horizontal scale automatically.



6. Join dots to a solid line.

A. SoftScope displays the data from SDS200 as a dotted line.

B. To see the waveform more clearly, push the line-join icon.

7. Add persistence effect.

A. Persistence effect is analog-scope like effect that remembers the history of displayed waveforms. With persistence effect, you can see the more frequent line clearer.

B. Change the persistence effect coefficient.

8. Change the intensity of the waveform.

A. Just as in changing the persistence effect, you can change the intensity.

B. By changing the scroll bar in the menu, you can see a more/less distinct line.

2. Basic Operations

Change Vertical Scale(Volt/Div)

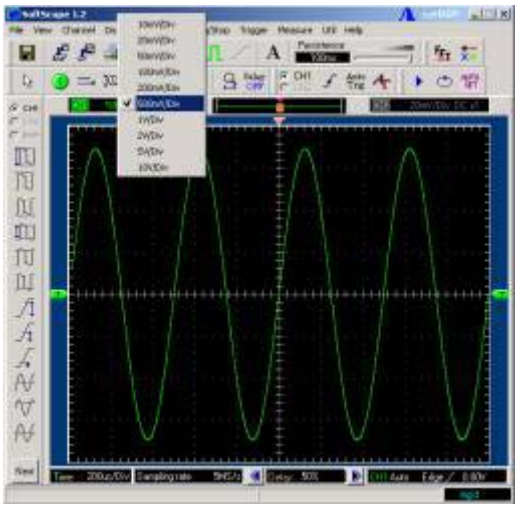
1. Change vertical scale(volt/div) from panel.

   A. 

Push voltage scale change panel.

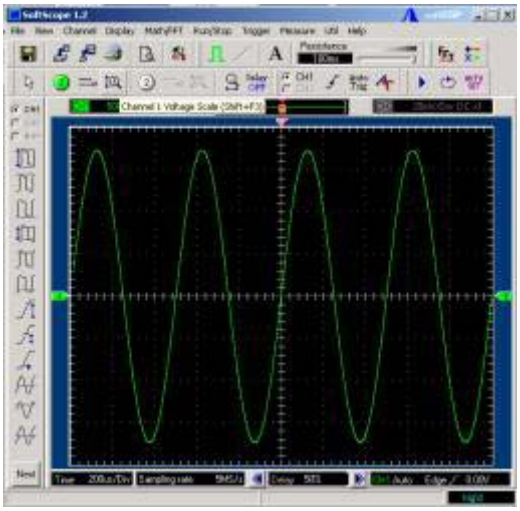
   B. Set the volt/div scale with mouse or keyboard.

   C. Vertical scale is changed.



2. Change vertical scale(volt/div) with mouse button.

   A. 
Push voltage scale change icon.



B. Mouse icon is changed to number 1.

C. Push the left/right mouse button to change volt/div.

D. With mouse that supports scroll button, change the voltage offset.

3. Change vertical scale(volt/div) from menu and hot-key.

A. Channel →Ch1 Setting →Volt Scale

B. Press the appropriate hot-key.

4. Change AC/DC setting.

A. Push the AC/DC icon to change.

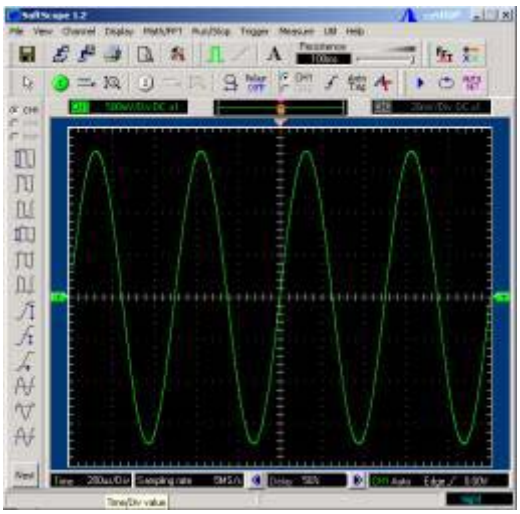
B. Push the same button once more to restore.

Change Horizontal Scale(Time/Div)

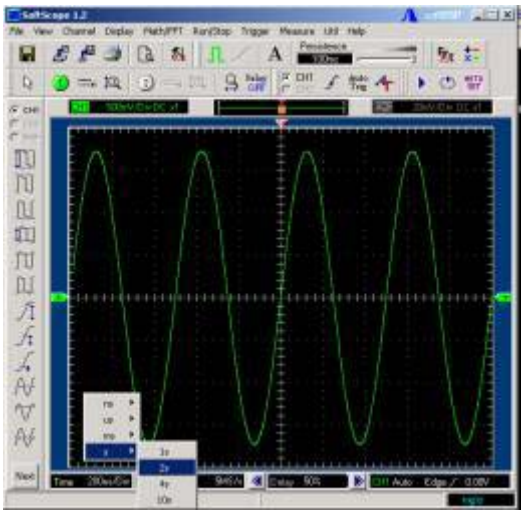
1. Change horizontal scale(time/div) from panel.

A. 

Push time scale change panel.



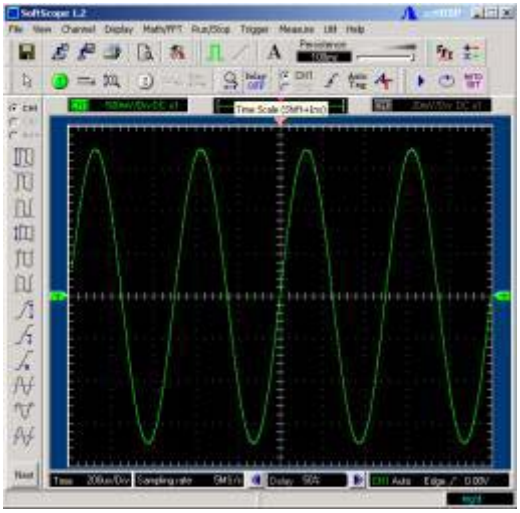
B. Set the time/div scale with mouse or keyboard.



C. Horizontal scale is changed.

2. Change horizontal scale(time/div) with mouse button.

A.  Push time scale change icon.



B. Cursor is changed to “T”.

C. Push the left/right mouse button to change volt/div.

D. With mouse that supports scroll button, change the trigger point.

3. Change horizontal scale(time/div) from menu and hot-key.

A. Channel → Time Scale.

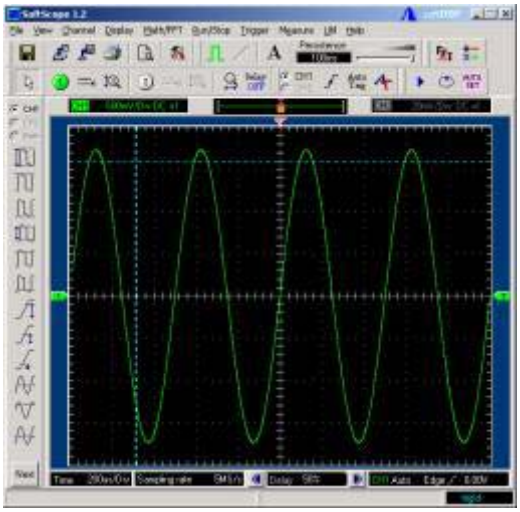
B. Press the appropriate hot-key.

Measurement Using Cursor

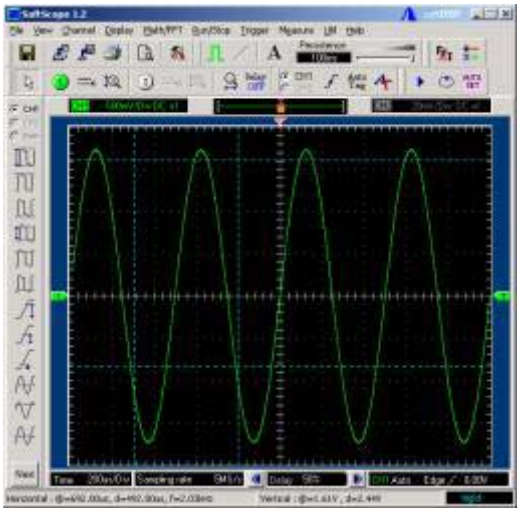
Measure voltage and time offset simply using mouse.

A.  Push icon and the cursor is changed to cross  .

B. Push left mouse button, and the cross lines appear.



C. Drag the mouse button to the point you want to measure.

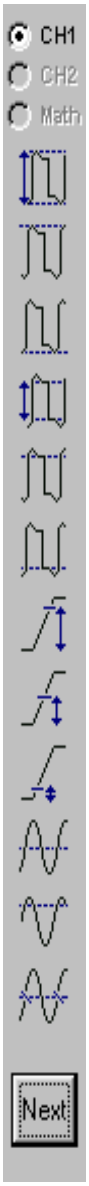


D. Release the left mouse button, the voltage difference and time difference will be shown at the status bar.

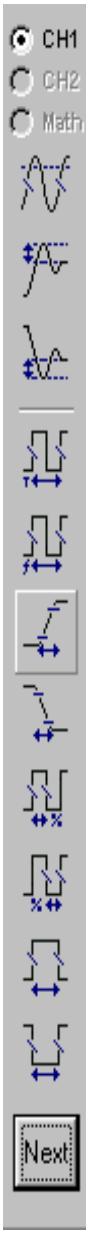
E. Push right mouse button, and the cross lines disappear.

Measurement by Icon

SDS 200 has many measurement functions.



Pk-Pk	-Peak-to-peak = Max – Min -Measured over the entire waveform
Max	-Voltage of the absolute maximum level -Measured over the entire waveform
Min	-Voltage of the absolute minimum level -Measured over the entire waveform
Amp	-Amp = Base – Top -Measured over the entire waveform
Base	-Voltage of the statistical minimum level -Measured over the entire waveform
Top	-Voltage of the statistical maximum level -Measured over the entire waveform
Upper threshold	-Voltage of the 90% level from base to top
Middle threshold	-Voltage of the 50% level from base to top
Lower threshold	-Voltage of the 10% level from base to top
Mean	-The arithmetic mean over the entire waveform
Cycle mean	-The arithmetic mean over the first cycle in the waveform
RMS	-The Root Mean Square voltage over the entire waveform

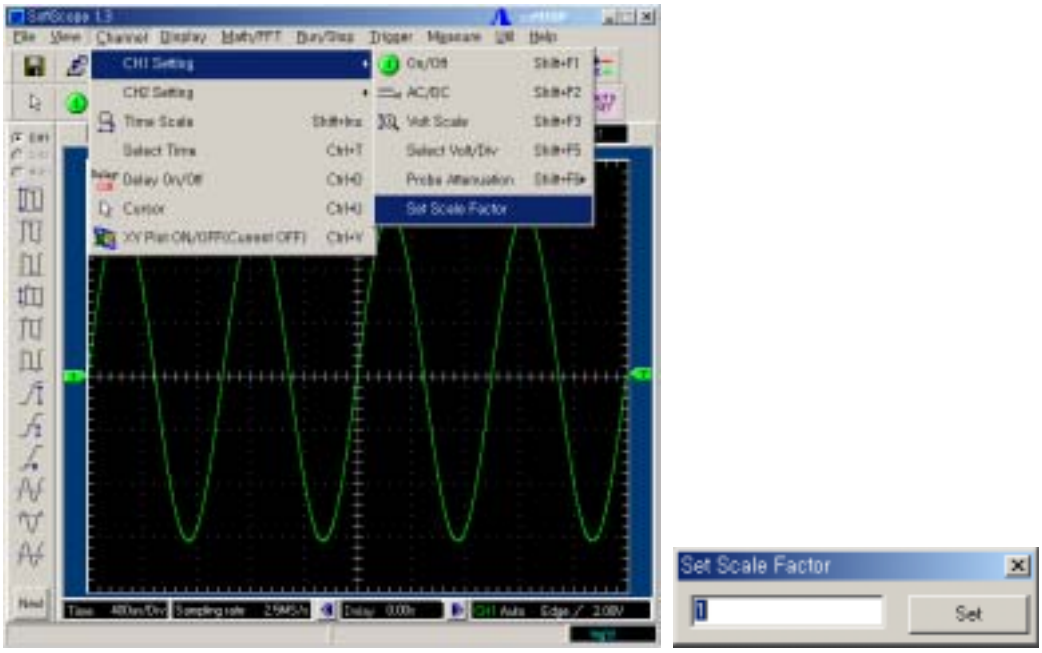


Cycle RMS	- The Root Mean Square voltage over the first cycle in the waveform
Positive Overshoot	- Positive Overshoot = (Max - Top)/Amp x 100 % - Measured over the entire waveform
Negative Overshoot	- Negative Overshoot = (Base - Min)/Amp x 100 % - Measured over the entire waveform
Period	- Time to take for the first signal cycle to complete in the waveform - Measured in seconds
Frequency	- Reciprocal of the period of the first cycle in the waveform - Measured in Hertz(Hz)
Rise time	- Time taken from lower threshold to upper threshold
Fall time	- Time taken from upper threshold to lower threshold
Positive Duty Cycle	- Positive Duty Cycle = (Positive Pulse Width)/Period x 100% - Measured of the first cycle in waveform
Negative Duty Cycle	- Negative Duty Cycle = (Negative Pulse Width)/Period x 100% - Measured of the first cycle in waveform
Positive Pulse Width	- Measured of the first positive pulse in the waveform - The time between the 50% amplitude points
Negative Pulse Width	- Measured of the first
Next	- View next icons

Scale Factor Setting

Set the Scale Factor value of each channel

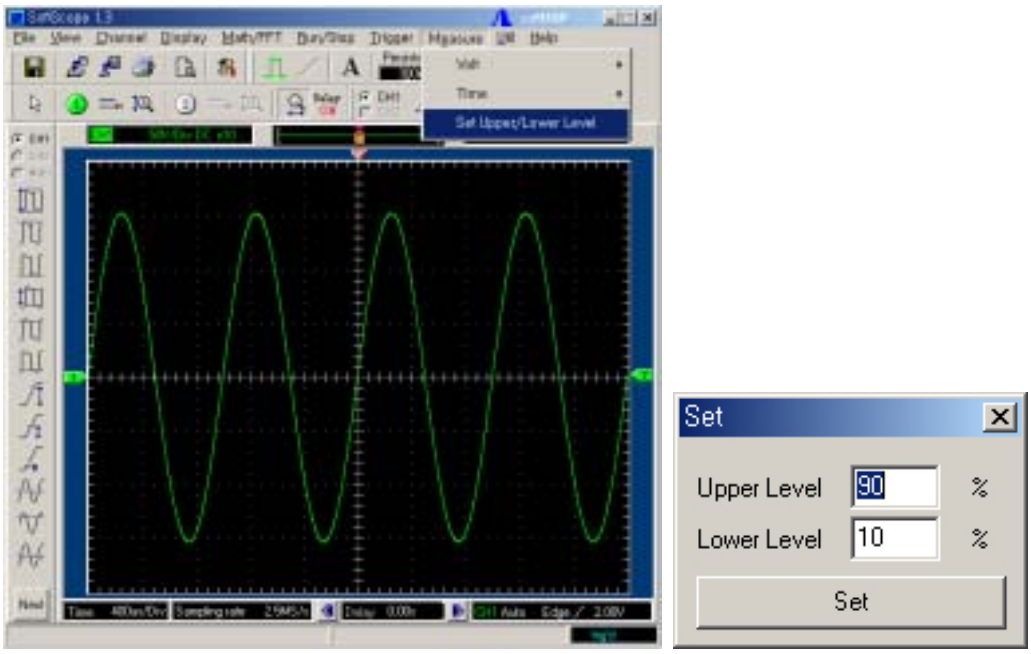
This Scale Factor value is not applied in Display, but is displayed as multiplied at the output voltage value to be saved as DAT file and Measurement.



Upper/Lower Level Setting

Set Upper/Lower Ratio

Upper/Lower standard value should be given to obtain Rising Time and Falling Time. Upper/lower ratio for overall waveform(%) is set using this function and this value is used to calculate Rising/Falling Time Measurement.

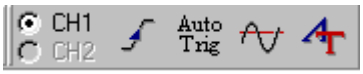


Change Trigger Level & Trigger Point

1.Set the trigger input source.

A. With only one channel on, trigger input source is automatically set to the channel. With 2 channels on, you can choose trigger input source between the two.

B. Change trigger source from the radio-button.



C. Change trigger source from menu bar.

EX) Trigger → Trigger Source CH1 or CH2

D. Change trigger input source using hot key.

2. Change the trigger level.

A.  Move the trigger level icon, you can move the trigger level.

B. Input the trigger level from editor 

3. Change the trigger point.

A.  Move the trigger point icon, you can move the trigger point.

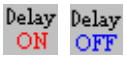
B. Input the trigger point from editor. 

4. Change the trigger condition.

A.  Push the trigger up/down icon to change trigger condition.

B. Use menu or hot-key. (Trigger → Trigger Up/Down)

5. Set delay on/off.

A. 

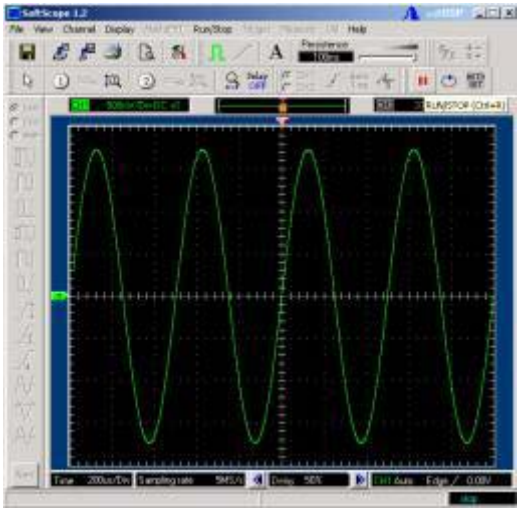
Push the delay button to set delay on or off.

B. When delay on, the trigger point separates from the horizontal expansion point. The horizontal expansion point stays at the center of the screen.

Single Shot/Stop Mode

1. Change state to stop or single shot.

A. Push the stop button  , SDS200 is in stop state.

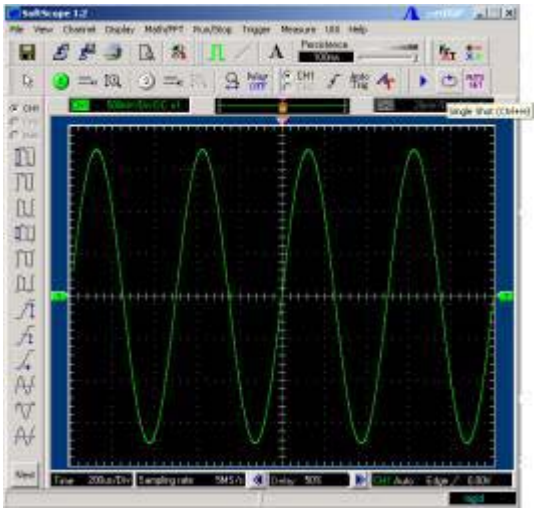


B. Every operation is the same as in the running state.

2. Single-shot action.

A. Push the single-shot button  to acquire only 1 waveform after the trigger condition you set.

B. Single-shot is available only in Real Time mode.



C. Push the single-shot button again to pause, SDS 200 waits for the trigger signal again.

Put Label on The Screen

1. Add a label on the screen.

A.  Push the label icon.

B. The mouse cursor is changed to 'I' shape.

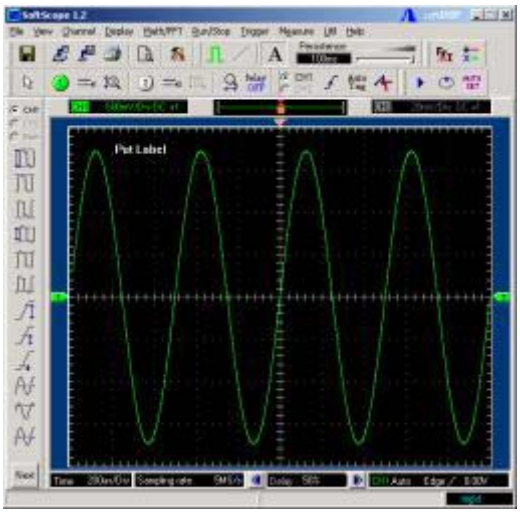
C. Push the left mouse button.

D. Input string.

E. Change the text/back color.

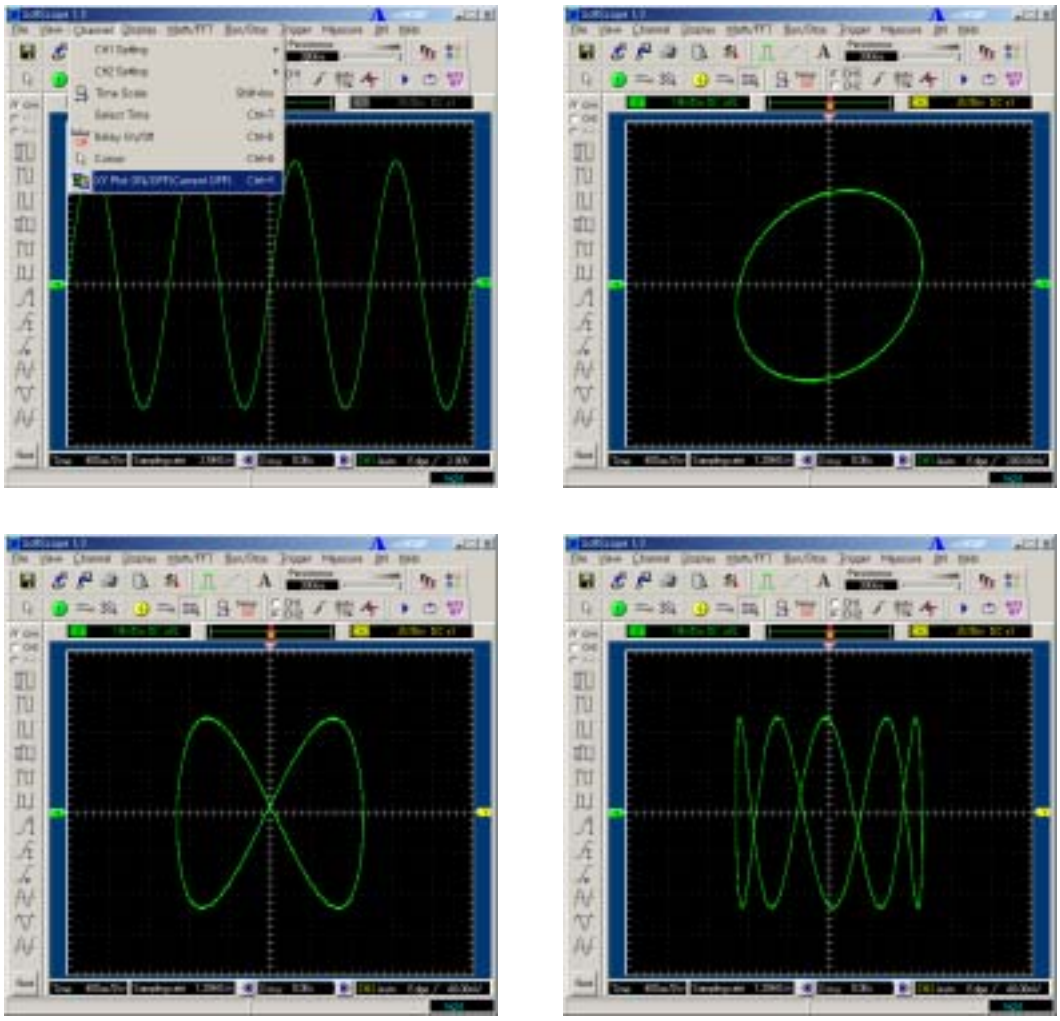
F. Push the confirm button to finish.

G. Change the label by clicking the label again.



XY Plot

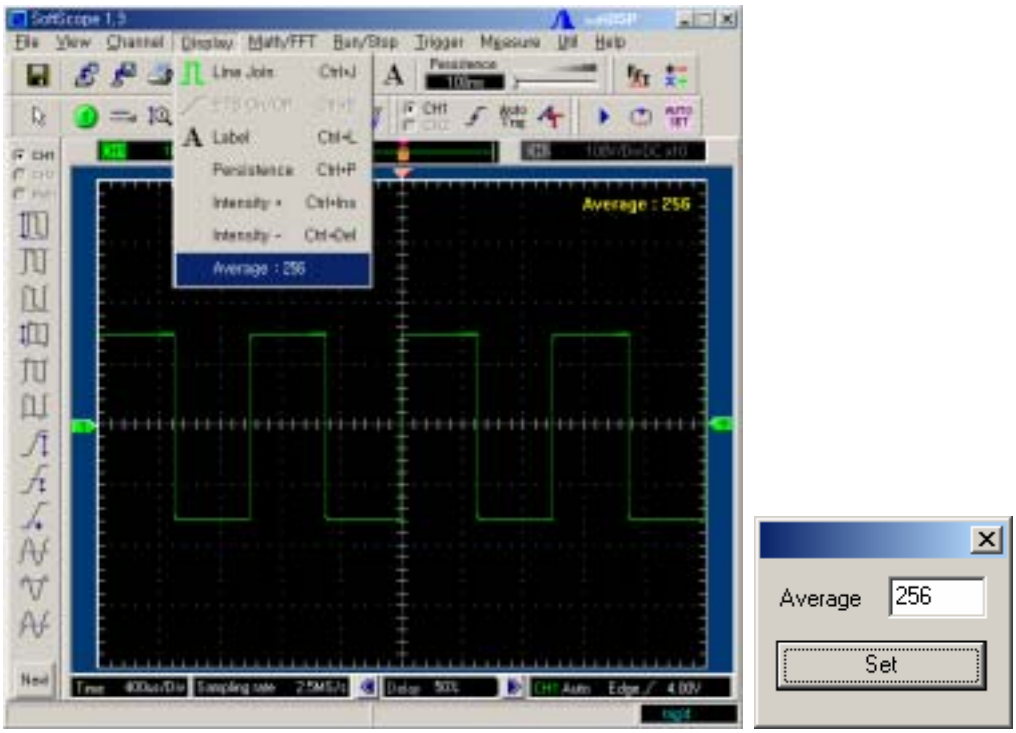
XY Plot acts to analyze correlation of data of two channels. Lissajous diagram is displayed in the screen when you use XY Plot, which enables to compare frequencies, amplitudes and phases of counterpart waveform against the reference waveform. This makes it possible to compare and analyze frequency, amplitude and phase between input and output.



Average

Obtain the average by adding the obtained waveform as many as the number of average and display it in the screen. It performs moving average of the waveform from at least 2 up to 256 and the number of average waveform is displayed in the upper right of the screen.

Average function is applied to real time Mode and ETS Mode, and this function can not be used when role Mode and ETS Mode are turned off.



Print/Save Waveform

1. Save acquired waveform in the following formats.

   A. Text File

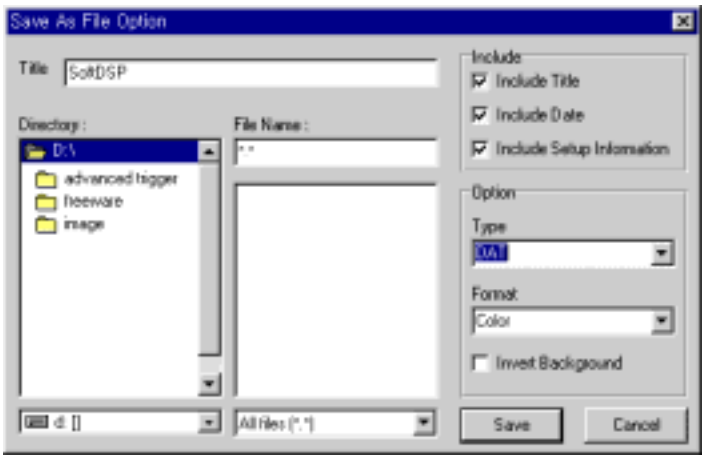
   B. JPG/BMP File

   C. Excel File

   D. Word File

2. Save as text format.

A. Push the save button  and the dialog box appears.



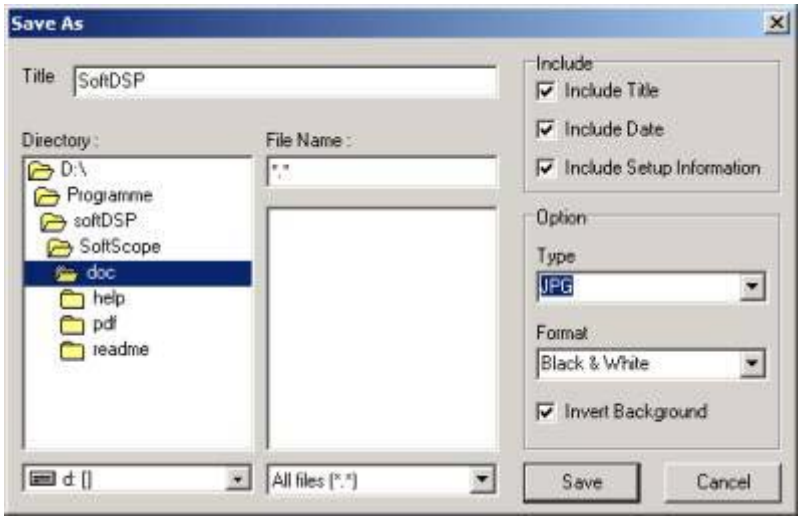
B. Enter the directory that you want to save the data file in.

C. Enter the name of data file that you want to save.

D. Select type 'DAT' at option.

E. Push the save button.

3. Save as JPG/BMP format.



A.  Push the save button.

B. Enter the title you want to give.

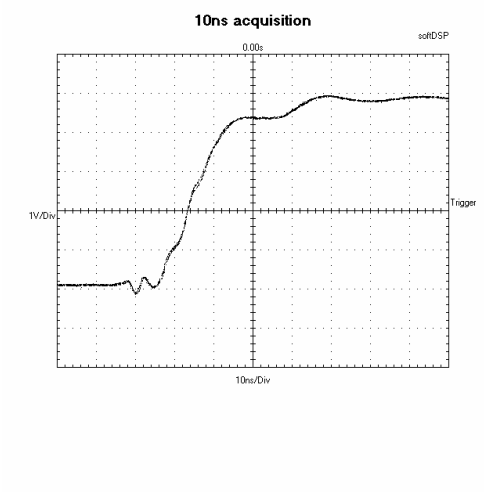
C. Enter the directory you want to save the data file in.

D. Enter the name of data file you want to save.

E. Select type 'BMP/JPG' at option.

F. Push the save button.

Example) Saved BMP File



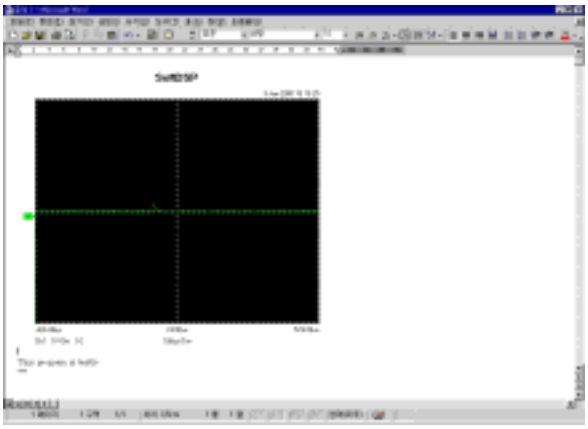
4. Copy the image into clipboard.

A. Select Copy from the File menu.

B. Waveform is copied into clipboard.

C. Paste the image into any program that supports clipboard paste.

Example). Copied to MS Word

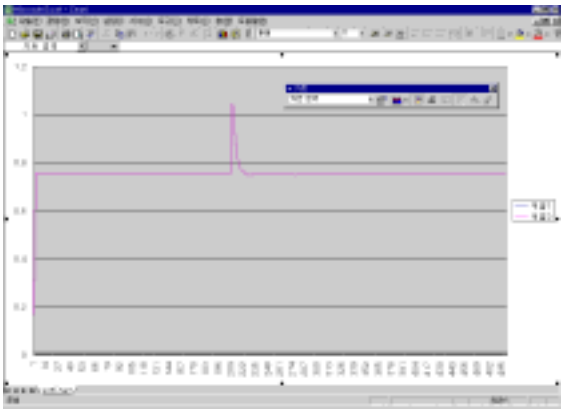


5. Transfer the data to MS Excel using ActiveX automation.

A. Select Copy at the File menu.

B. MS Excel is activated and then data is transferred by using ActiveX.

Example). Data transferred to MS Excel



6. You can save the data to MS Word using ActiveX automation.

   A. Select Copy at the File menu.

   B. MS Word is activated and then data is transferred by using ActiveX.

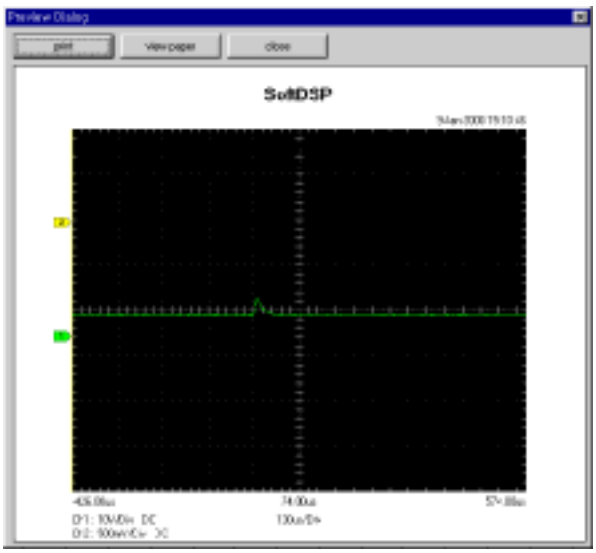
7. Print the waveform.

   A.  Push the print button.

   B.  Push the preview button to preview the image.

   C. Push 'OK' button.

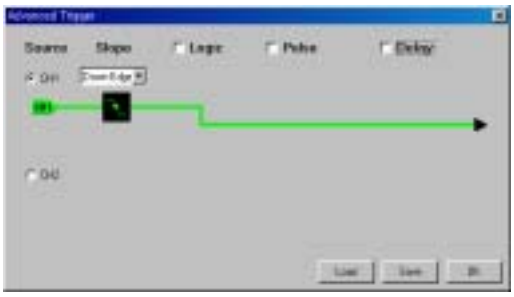
   Example) Preview screen



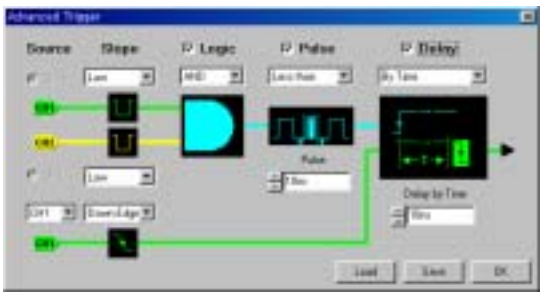
Ch 3. Advanced Technique

1. Advanced Trigger

You can return to normal trigger mode by uncheck Logic, Pulse, Delay check box in the advanced trigger dialog box.



(Normal trigger mode)



(Advanced trigger mode)

Edge Trigger

The Edge Trigger generates a trigger when the source signal passes through a specified level in either positive or negative direction, set by the user. This is the same trigger type found in a conventional analog oscilloscope. The source, the slope and the level must be set for Edge Trigger operation.

Source: CH1/CH2

-Selects the trigger source.

Slope: Up Edge/Down Edge

-Selects the slope of the source.

Level: +/- 4 vertical screen divisions (Full screen range)

-Selects the level of the input signal where the Edge Trigger is generated. The level is selected by trigger level pointer at the right-hand side of the display screen and the source is selected from the tool bar radio button.

Logic Trigger

The Logic Trigger generates a trigger depending on the logical relation between the state of the two input

channels. AND, NAND, OR, NOR, XOR, XNOR Logic Triggers are available and the two input states can be negated if selected.

Ch1 state: High/Low

-Selects the state of channel 1 signal for Logic Trigger input

Ch2 state: High/Low

-Selects the state of channel 2 signal for Logic Trigger input

Logic type: AND, NAND, OR, NOR, XOR, XNOR

-Selects logic type

Pulse Trigger

The Pulse Trigger generates a trigger if the pulse width of the input signal is either less or more than the preset time.

Equation: Less than/More than

- Selects whether the trigger is generated when the pulse is less than or more than the preset pulse time value.

Time: 10ns ~ 167ms

- Selects the pulse width time

Delay Trigger

The Delay Trigger generates a trigger by waiting for a preset time or number of events after a primary trigger from combination of edge, logic and pulse trigger is generated and when the first trigger from the secondary trigger source is detected.

Equation: By time/By event

- Selects the delay condition either by time or by event.

Delay condition: By time (10ns ~ 167ms)/By event (1 ~ 16,777,215 events)

Secondary trigger source: CH1/CH2

- Selects the trigger source of the secondary trigger.

Secondary trigger slope: Rising/Falling

- Selects the slope of the secondary trigger.

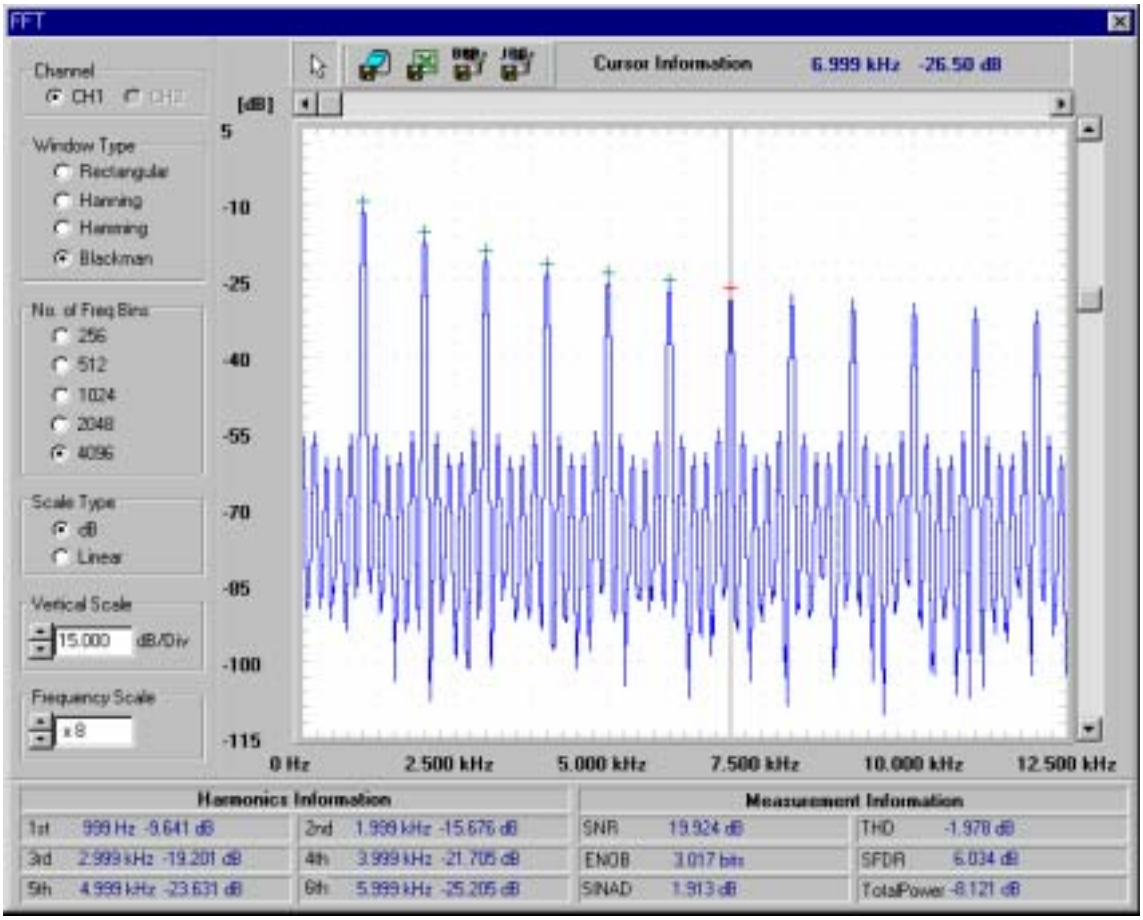
2. FFT function

FFT(Fast Fourier Transform)

This function analyze the frequency component of current waveform.

1.  Pushing the FFT icon, the FFT dialog box appears.

< The voltage component analyzed using FFT is displayed as Volt unit, and the value transformed as log scale or by other computation is displayed as rms(root mean square) value.>



2. The left setting menu of the FFT dialog box.

Channel	Sets input source for FFT analysis
Window Type	Sets digital filter type
No. of Freq Bins	Sets size of digital filter
Scale Type	Sets y scale type as Linear or Log scale
Vertical Scale	Sets vertical scale
Frequency Scale	Sets horizontal scale

	If the information is more than the quantity displayed to the display window, more information is displayed by using scroll bar.

3. The above menu bar of the FFT dialog box

:Save the FFT information as various data type

- Save As Text : This Button saves the FFT information as text formation.
- Save As Excel : This Button transfers the FFT information to MS Excel using ActiveX automation.
- Save As Bmp : This Button saves the FFT information as Bitmap Image.
- Save As Jpg : This Button saves the FFT information as Jpeg Image.

: This shows the information of Cursor.

Example) This means that frequency of cursor point is 3.6MHz and amplitude is 0.029Volts.

:FFT Cursor On/Off

4. The below information window of the FFT dialog box

Harmonics Information			
1st	999 Hz -9.641 dB	2nd	1.999 kHz -15.676 dB
3rd	2.999 kHz -19.201 dB	4th	3.999 kHz -21.705 dB
5th	4.999 kHz -23.631 dB	6th	5.999 kHz -25.205 dB

: This shows the information of Harmonics.

Measurement Information			
SNR	19.924 dB	THD	-1.978 dB
ENOB	3.017 bits	SFDR	6.034 dB
SINAD	1.913 dB	TotalPower	-8.121 dB

: This shows the information about measurement of FFT.

$\sum V_i$: Amplitude of the fundamental frequency

$\sum H_i$: Sum of Amplitude of Harmornic(excluding fundamental frequency)

$\sum N_i^2$: Sum of Noise (excluding fundamental frequency, Harmonics, DC and Nyquist bins)

F : Total Number of bins

F_h : Total Number of bins of Harmonic

F_n : Total Number of bins of Noise.

- SNR(Signal to Noise Ratio) : The ratio of the amplitude of the fundamental frequency to the Noise.

$$SNR = 10log_{10}\left[\frac{\sum V_i^2}{\frac{F}{F_n}\sum N_i^2}\right] dB$$

ENOB(Effective Number of Bits) : The number of bits in an ideal converter that would be required to give the same SNR performance.

$$ENOB = \frac{SNR - 1.76}{6.02} bits$$

- SINAD(Signal to Noise and Distortion) : The ratio of the amplitude of fundamental frequency to the Noise, but Noise include Harmonics.

$$SINAD = 10log_{10}\left[\frac{\sum V_i^2}{\frac{F - F_h}{F_n}\sum N_i^2 + \sum H_i^2}\right]$$

- THD(Total Harmonic Distortion) : The ratio of the rms sum of the harmonics to the rms value of the fundamental.

$$THD = 10log_{10}\left[\frac{\sum H_i^2}{\sum V_i^2}\right] dB$$

- SFDR(Spurious Free Dynamic Range) The ratio of the rms signal amplitude to the rms value of the peak spurious spectral component. The peak spurious component may or may not be a harmonic.

$\sum S_i^2$: The rms value of the peak spurious spectral component.

$$SFDR = 10log_{10}\left[\frac{\sum V_i^2}{\sum S_i^2}\right] dB$$

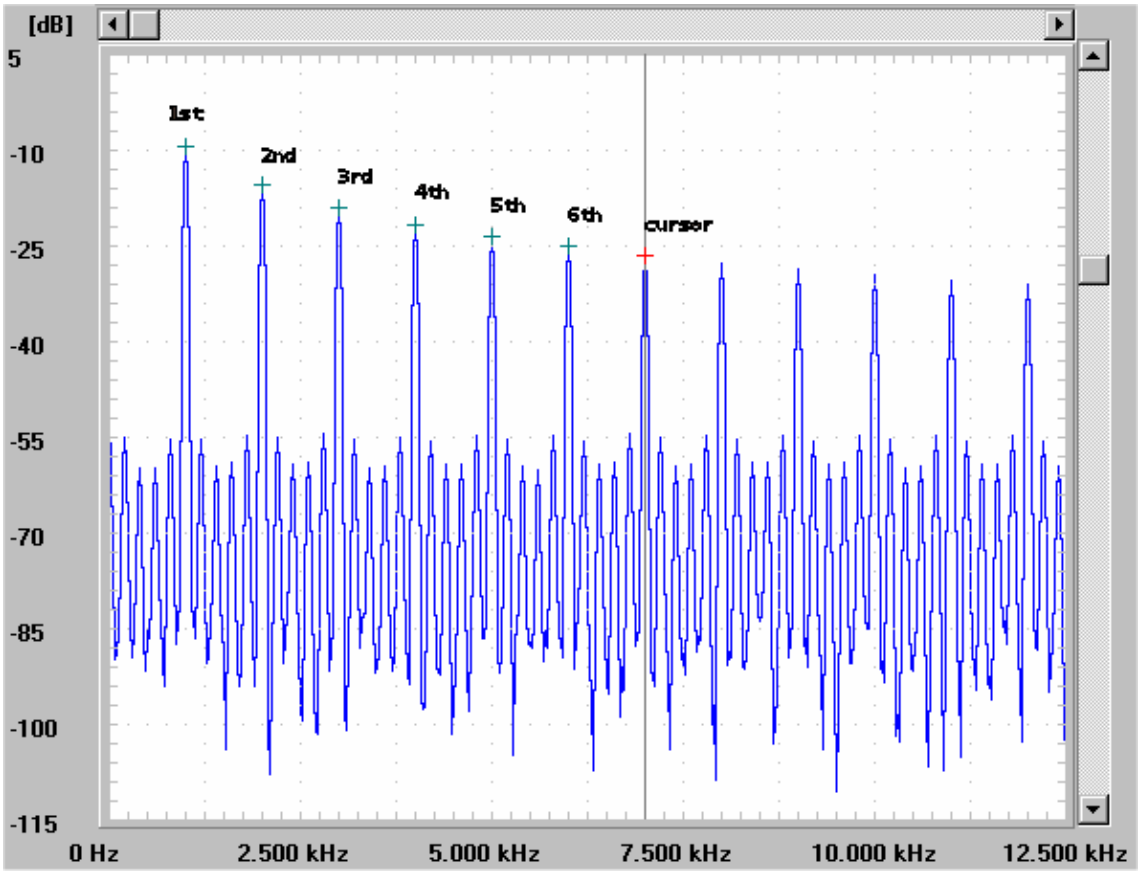
- Total Power : The rms value of the sum of all spectral components.

$\sum A_i^2$: Sum of Noise excluding DC and Nyquist.

$$Total\,Power = 10log_{10}\left[\sum A_i^2\right] dB$$

$$THD = 20\log_{10}\frac{\sqrt{V_2^2+V_3^2+V_4^2+V_5^2+V_6^2}}{V_1}$$

5. The FFT display window



:Each green cross points to the Harmonics and red cross points to the cursor.

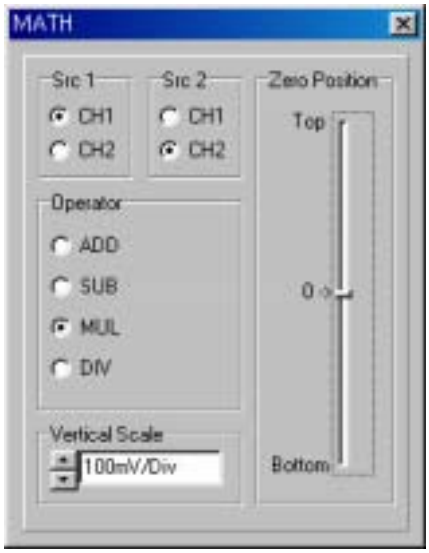
A coordinate axis of X displays the frequency and a coordinate axis of Y displays the amplitude of the frequency.

The scrollbar of horizontal and vertical move the base of coordinate axis of X and Y.

3. Math

Add/Subtract/Multiply/Divide the two waveforms.

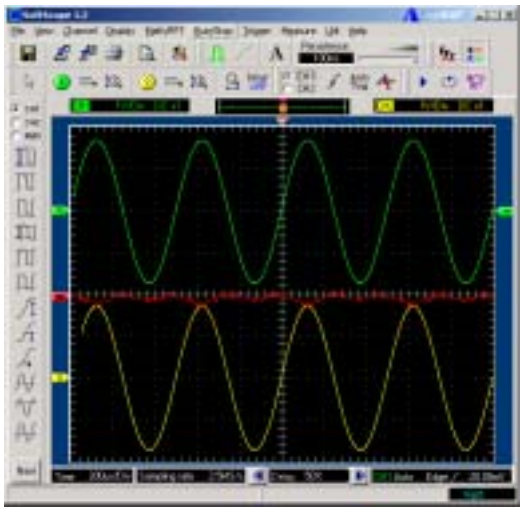
1.  Push the Math icon.



Src1/Src2	Sets input source.
Operator	Sets operation method
Vertical Scale	Sets vertical scale
Zero Position	Sets offset

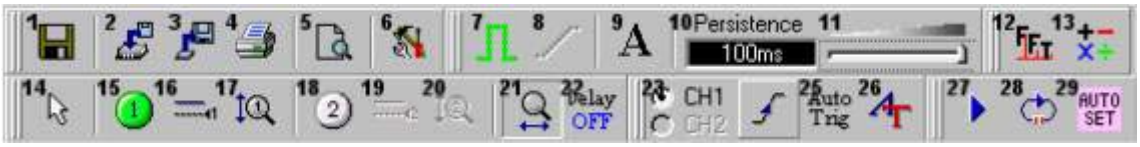
2. Select source 1, source 2 and operator from the dialog box.

Example) Input1 waveform + Input2 waveform



Ch 4. Toolbars, Menus, Dialog boxes & Screen Information

1. Toolbar



1. Save As	-Saves current waveform as dat, bmp or jpg file
2. Load State	-Loads state file into current state
3. Save State	-Saves current state to file
4. Print	-Prints current waveform
5. Preview	-Previews current waveform
6. Option	-Shows option dialog box
7. Line Join	-Joins the dots to lines
8.ETS ON/OFF	-Sets ETS(Equivalent Time Sampling) On/Off
9. Label	-Shows label on the screen
10. Persistence	-Sets persistence time
11. Intensity	-Sets intensity of the waveform
12. FFT	-Shows FFT dialog box
13. Math	-Shows Math dialog box
14. Cursor	-Shows measurement cursor
15. Channel 1 On / Off	-Sets channel 1 on -Sets channel 1 off
16. Channel 1 AC / DC	-Selects DC coupling -Selects AC coupling
17. Channel 1 Voltage Scale	-Changes vertical scale factor of Channel 1
18. Channel 2 On / Off	-Sets channel 2 on -Sets channel 2 off
19. Channel 2 AC / DC	-Selects DC coupling

	-Selects AC coupling
20. Channel 2 Voltage Scale	-Changes vertical scale factor of Channel 2
21. Time Scale	-Changes horizontal scale factor
22.Delay On  / Off 	-Sets trigger delay on -Sets trigger delay off
23. Trigger Source	-Sets trigger source to a specific channel
24. Trigger Up  / Down 	-Triggers on the rising edge of the signal -Triggers on the falling edge of the signal
25. Trigger auto  / Normal 	-Enables free running waveform acquisitions -Triggers only on valid trigger events
26. Advanced Trigger	-Shows advanced trigger dialog box
27. Run  / Stop 	-Starts waveform acquisitions -Stops waveform acquisitions
28. Single Shot	-Executes a single-shot acquisition
29. Autoset	-Adjusts the vertical, horizontal, and trigger controls for a usable display automatically

2. Menu

File

Name	Sub Menu	Operation	Hot-key
Load State		Loads file to current file	F2
Save State		Saves current state to file	F3
Save As		Saves waveform as bmp, jpg, dat file	Ctrl +S
Save As Word		Saves waveform as word file	F4
Save As Excel		Saves waveform as excel file	F5
Copy		Saves waveform to clipboard	Ctrl + C
Option		Selects the waveform or screen option	F6
Preview		Previews the waveform	F7
Print		Prints the waveform	Ctrl + P
Exit		Stops the SoftScope and return	Ctrl + X

View

Name	Sub Menu	Operation	Hot-key
File Toolbar		Shows/Hides File Toolbar	Ctrl + F1
Display Toolbar		Shows/Hides Display Toolbar	Ctrl + F2
FFT/Math Toolbar		Shows/Hides FFT/Math Toolbar	Ctrl + F3
Channel Toolbar		Shows/Hides Channel Toolbar	Ctrl + F4
Trigger Toolbar		Shows/Hides Trigger Toolbar	Ctrl + F5
Run/Stop Toolbar		Shows/Hides Run/Stop Toolbar	Ctrl + F6

Channel

Name	Sub Menu	Operation	Hot-key
CH1 Setting	On/Off	Changes ON/OFF	Shift + F1
	AC/DC	Changes AC/DC	Shift + F2
	Volt Scale	Increases/Decreases Voltage	Shift + F3
	Select Volt/Div	Changes Volt/Div	Shift + F5
	Probe Attenuation	Changes Probe Attenuation	Shift + F6
	Set Scale Factor	Change CH1's Scale Factor	

CH2 Setting	On/Off AC/DC Volt Scale Select Volt/Div Probe Attenuation Set Scale Factor	Changes ON/OFF Changes AC/DC Increases/Decreases Voltage Changes Volt/Div Changes Probe Attenuation Change CH2' s Scale Factor	Shift + F7 Shift + F8 Shift + F9 Shift + F11 Shift + F12
Time Scale		Increases/Decreases Time/Div	Shift + Ins
Select Time		Changes Time	Ctrl + T
Delay On/Off		Changes Delay ON/OFF	Ctrl + D
Cursor		Changes Cursor ON/OFF	Ctrl + U
XY plot On/Off		Changes XY plot ON/Off	Ctrl + Y

Display

Name	Sub Menu	Operation	Hot-key
Line Join		Joins the waveform with line	Ctrl + J
ETS On/Off		Sets ETS On/Off	Ctrl + O
Label		Inserts text to waveform	Ctrl + L
Persistence		Changes the persistence effect	Ctrl + E
Intensity +		Increases intensity of waveform	Ctrl + Inc
Intensity -		Decreases intensity of waveform	Ctrl + Del
Average		Obtain average by obtained waveform	

Math/FFT

Name	Sub Menu	Operation	Hot-key
Math		Calculates several signal	Ctrl + M
FFT		Changes signal to FFT	Ctrl + F

Run/Stop

Name	Sub Menu	Operation	Hot-key
Run/Stop		Starts/Stops acquiring waveform	Ctrl + R
Single Shot		Begins Single Shot operation	Ctrl + H

Auto Set		Changes horizontal/vertical scale for waveform	Ctrl + A

Trigger

Name	Sub Menu	Operation	Hot-key
Trigger Source CH1		Selects CH1 from trigger source	Shift+Ctrl+F1
Trigger Source CH2		Selects CH2 from trigger source	Shift+Ctrl+F2
Trigger Up/Down		Selects Up/Down from Trigger Up/Down	Shift+Ctrl+F3
Normal/Auto		Selects Normal/Auto from Trigger Normal/Auto	Shift+Ctrl+F4
Advanced Trigger		Selects Advanced trigger	Shift+Ctrl+F5

Measure

Name	Sub Menu	Operation	Hot-key
Volt	Peak to Peak	Measurement of Peak to Peak Voltage	Ctrl+Alt + P
	Maximum	Measurement of Maximum Voltage	Ctrl+Alt + X
	Minimum	Measurement of Minimum Voltage	Ctrl+Alt + N
	Amplitude	Measurement of Amplitude Voltage	Ctrl+Alt + A
	Top	Measurement of Top Voltage	Ctrl+Alt + T
	Base	Measurement of Base Voltage	Ctrl+Alt + B
	Upper	Measurement of Upper Voltage	Ctrl+Alt + U
	Middle	Measurement of Middle Voltage	Ctrl+Alt + M
	Lower	Measurement of Lower Voltage	Ctrl+Alt + L
	Mean	Measurement of Mean Voltage	Ctrl+Alt + E
	Cycle Mean	Measurement of Cycle Mean Voltage	Ctrl+Alt + C
	RMS	Measurement of RMS Voltage	Ctrl+Alt + R
	Cycle RMS	Measurement of Cycle RMS Voltage	Ctrl+Alt + Y
	Positive Overshoot	Measurement of Positive Overshoot Voltage	Ctrl+Alt + S
	Negative Overshoot	Measurement of Negative Overshoot Voltage	Ctrl+Alt + G

Time	Period	Measurement of Period	Ctrl+Alt + I
	Frequency	Measurement of Frequency	Ctrl+Alt + F
	Rise Time	Measurement of Rise Time	Ctrl+Alt + R
	Fall Time	Measurement of Fall Time	Ctrl+Alt + Z
	Positive Duty Cycle	Measurement of Positive Duty Cycle	Ctrl+Alt + E
	Negative Duty Cycle	Measurement of Negative Duty Cycle	Ctrl+Alt + D
	Positive Pulse Width	Measurement of Positive Pulse Width	Ctrl+Alt + W
	Negative Pulse Width	Measurement of Negative Pulse Width	Ctrl+Alt + H
Set Upper/Lower Level		Set Upper/Lower ratio	

Util

Name	Sub Name	Operation	Hot-key
Zero Calibration		Begins offset calibration	Shift+Ctrl+F6

Help

Name	Sub Name	Operation	Hot-key
Help		Shows help file	F1
About		Displays about Dialog Box	F9

3. Screen Information

SoftScope has the following windows to show the internal states and settings.

1. 

: Channel 1 Information window
   A. Click on this window, to change the voltage setting.
   B. The following information is displayed.
      a. Volt/Div
      b. AC/DC coupling
      c. 1:1/10:1 probe

2. 

: Channel 2 Information window
   A. Same as channel 1

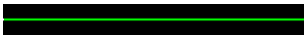
3. 

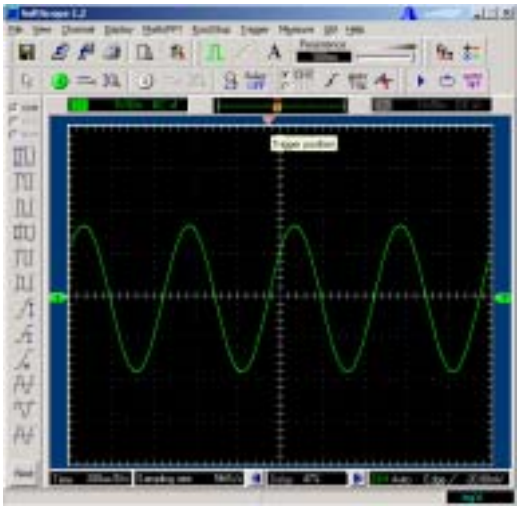
: Time information window
   A. Click on this window to change the time setting.
   B. The current time/div setting is displayed.

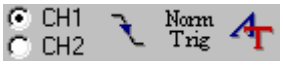
4.  : Trigger point information window
   A. 

When SDS 200 is in a delay-on state it shows the current trigger point using time dimension.
   B. 

When SDS 200 is in a delay-off state it shows the current trigger point using % scale.

5.  : Trigger point display window
   A.  The trigger point shows the trigger position in the acquired waveform.
   B.  This line shows the whole acquired waveform.
   C.  You can see the data currently showing using [ ] mark.
   D.  This mark shows the reference point when horizontal scale(time/div) is changed.



6. 

: Trigger state selection tool bar

   A. 

Trigger source selection radio button

   B. 

Trigger mode (Auto/Normal)

   C. 
Trigger condition (Up edge/Down edge)

   D. 

Triger state display window.

7. 

: Trigger state of current acquired waveform

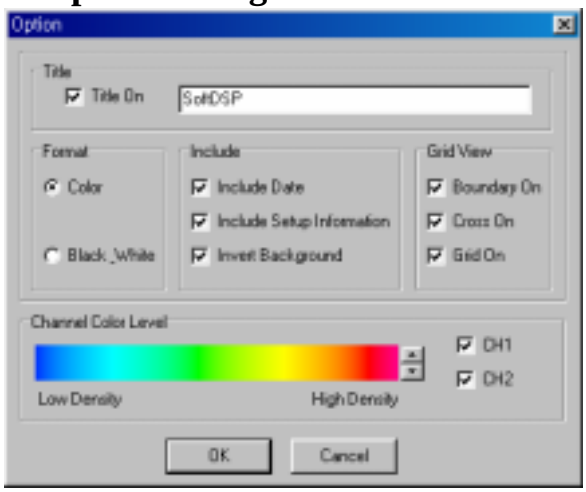
   A. 'Auto trig'd' - Trigger signal is automatically generated because of no valid triggered signal.

   B. Waiting – SDS 200 is waiting for the incoming trigger.

   C. Trig'd – Acquired waveform is triggered.

   D. RIS waiting – SDS is waiting for the incoming trigger in the RIS mode.

4. Option Dialog Box



Title On	-Check to include title on file/print output
Title	-Use to set the title on file/print output
Format	-Sets color or Black or white type
Include	-Check to include informations
Grid View	-Sets the graticule type
Channel Color Level	-Sets color level of waveform -Check to display waveform in color

Appendix

1. Three Operational Modes of SDS 200

Realtime mode

In realtime mode SDS 200 acquires 10,000 sample data from the input source.

It can show the real data simultaneously. But because of the sampling speed limit of A/D converter, it is limited only to 10us/div time/div.

ETS(Equivalent Time Sampling) mode

In ETS mode SDS acquires waveform as well as TDC value, and rearrange the waveforms using the TDC value to form one waveform.

For example, with first acquisition sampled data forms waveform A. With second acquisition sampled forms waveform B. Over and over again waveforms are interpolated to give a complete waveform. SDS 200 has a 200ps time resolution in RIS mode.

Roll mode

To handle low frequency signals, SDS 200 has a roll mode. In roll mode acquired waveform is displayed and moved from the right side of the screen to the left. As a result, it appears that the waveform is moving constantly.

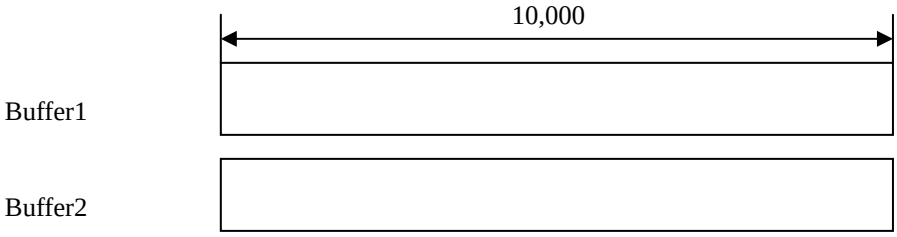
SDS 200 operates each mode in the following time scale base:

Time/Div	2ns~4us	10us~400ms	1s~10s
Sampling Mode	ETS mode	Realtime Mode	Roll Mode

2. SoftScope Buffer Structure

Buffer and Data Structure of SoftScope

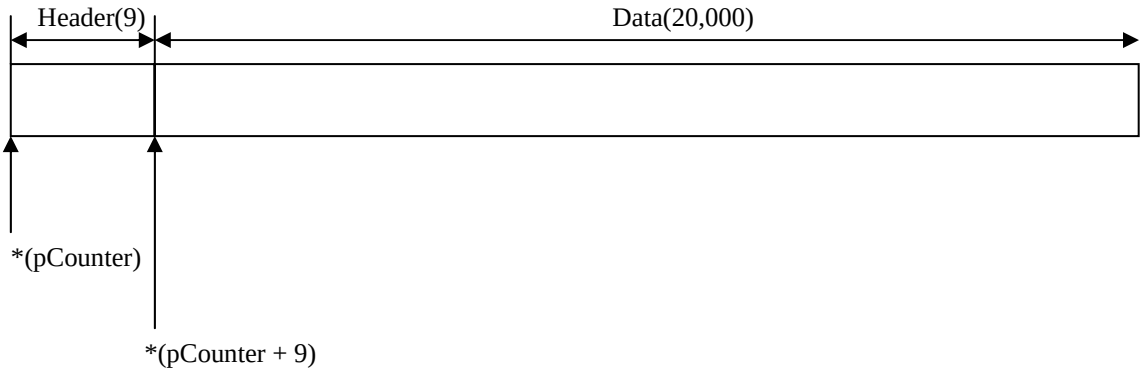
Basically, SDS 200 collects the data of 10,000 points at once and delivers it to PC. However, this value is little different for ETS Mode, RIS/RT Mode and Roll Mode. SoftScope has 2 memories that can store up to 10,000 data that has 16bit unsigned type so that it can receive all data regardless of all data.



Data from SDS200 consists of 12 bit and exact data is made by multiplying calibration information to this data. Physical signal is made by multiplying uniform value according to the current volt/div setting again. SoftScope displays the data on the screen using 12 bit Data(0 – 4095) by default and converts it to voltage value when delivering the data outside.

Structure of MMF Buffer

SoftScope can communicate with external program using MMF(Memory Mapped File) provided in Win32. For this purpose, it has 9 information data and 20,000 points data for above 2 buffers as shared memory. This data is saved in the form of firm decimal point.



9 Data has following meaning and can be approached with a pointer of float* called pCounter.

A) *(pCounter+0) : CH1 On/Off.
B) *(pCounter+1) : CH2 On/Off
C) *(pCounter+2) : Means the data size of current waveform.
D) *(pCounter+3) : Means the time interval of currently saved data.
E) *(pCounter+4) : Trigger source
F) *(pCounter+5) : Trigger status – AUTO(0)/NORMAL(1)
G) *(pCounter+6) : Trigger Up/Down status – DOWN(0)/UP(1)
H) *(pCounter+7) : Trigger voltage level value
I) *(pCounter+8) : Trigger location at X axis of screen

The number saved in *(pCounter + 3) has following meaning.

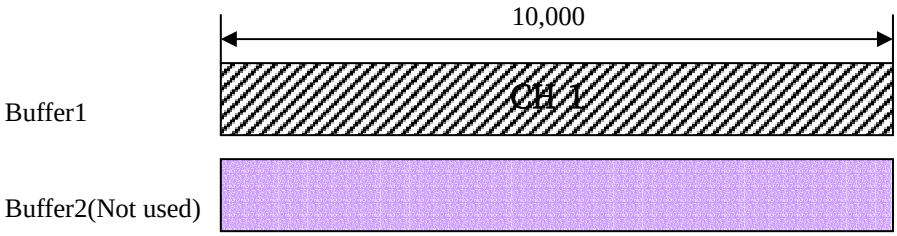
Real Time Mode(Real Time Mode) - Time/Div : 10us – 400ms

SDS 200 collects the data of 10,000 points at one time and delivers it to PC. If two channels are used at the same time, No. 1 channel is used for the first half of the buffer and No. 2 channel is used for the second half of the buffer.
Available variables are defined as followings.

```
#define DATA_SIZE 10000          // Total Data Size
#define HALF_DATA_SIZE 5000      // 1/2 of Data Size
#define RESERVE 9                // 9 Header Information
```

1. If One Channel is used (Use 10,000 points)

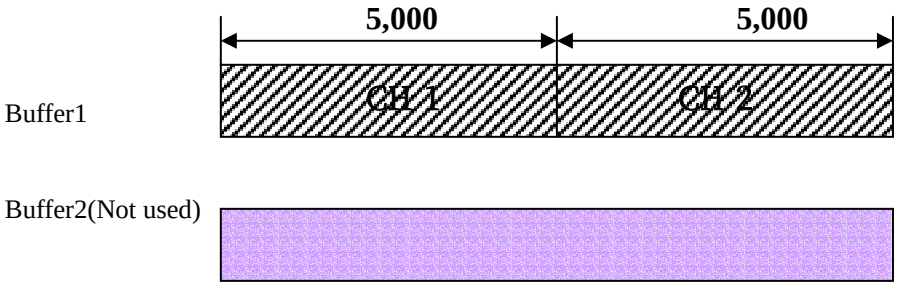
SoftScope Buffer



MMF Buffer

2. If Two Channels are used(Use 5,000 points for each channel)

SoftScope Buffer



MMF Buffer

EX) If buffer is allocated to Channel 1,2

*(pCounter + RESERVE) = CH 1 Data starts

*(pCounter + RESERVE + HALF_DATA_SIZE) = CH 2 Data Start

Roll Mode(Roll Mode) - Time/Div : 1s – 10s

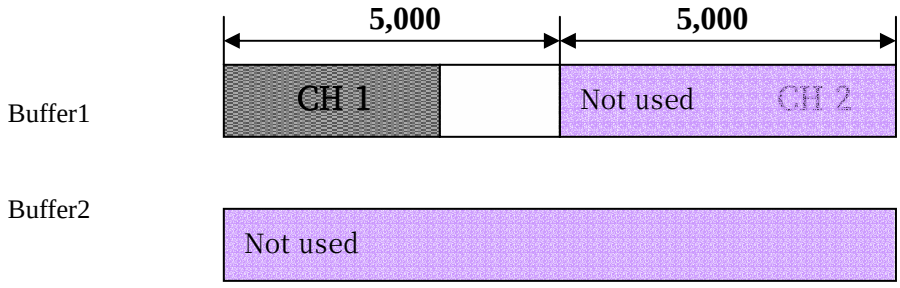
Roll Mode is to receive data little by little real time and to scatter it in the screen since it takes too long to receive all data at one time if Time/div is very late. As a result, the screen seems to be flown from the right to the left.

Since Roll Mode receives 3000 point data for each channel, it will display 6 point data for each x axis, different from real time mode which prints 20 points for each x axis.

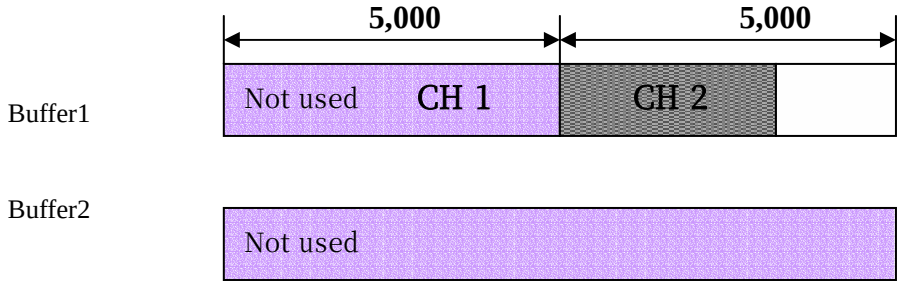
In terms of Buffer usage, when 1Channel is used, Roll Mode uses 0 – 2999th buffer for CH1 and 5000-7999th buffer for CH2, different from real time mode which uses all buffers regardless of CH1/CH2.

1. If Turning on one Channel (Use 3000 points for each channel)

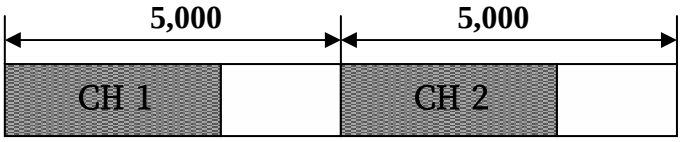
SoftScope Buffer (If using CH1)



SoftScope Buffer (If using CH2)

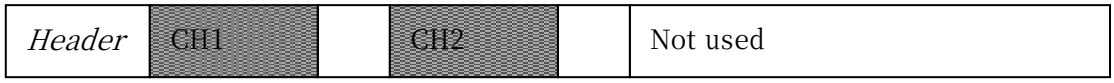


2. If using 2 Channels at the same time (Use 3000 points for each channel)



*(pCounter + RESERVE) = CH 1 Start point;

*(pCounter + RESERVE + HALF_DATA_SIZE) = CH 2 Start point;



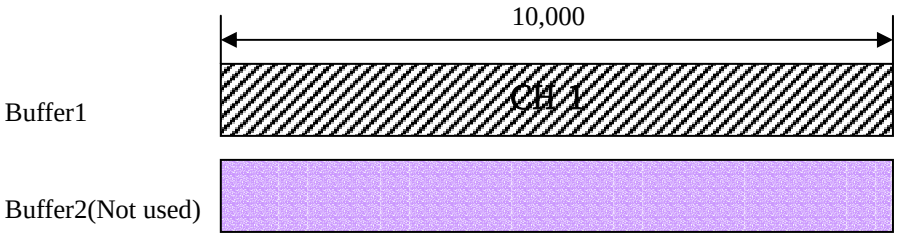
Equivalent Time Sampling Mode (ETS Mode) - Time/Div : 100ns – 2ns

ETSMode uses the data of 10,000 points for each channel when using 2 channels at the same time.

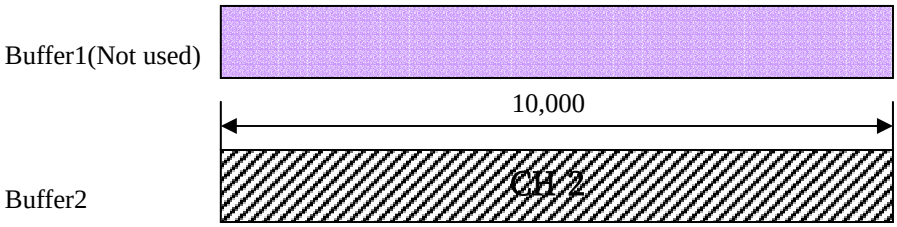
The value below 200ns/div is for software process and same in terms of hardware.

1. If Turning on one Channel (Use 10,000 points)

SoftScope Buffer (If using CH1)



SoftScope Buffer (If using CH2)

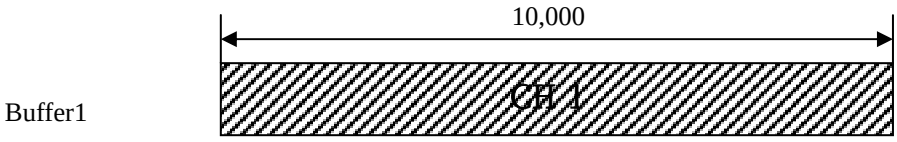


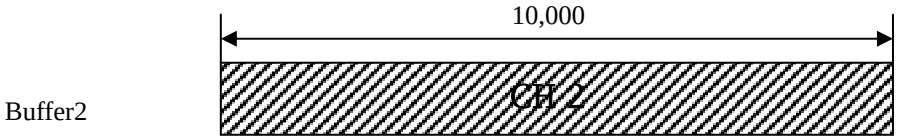
MMF Buffer

EX) If allocating buffer to Channel 1

*(pCounter + RESERVE) = CH 1 Start

2. If Turning on Two Channels





MMF Buffer

Header	Use 10,000points(CH1)	Use 10,000points(CH2)

If allocating buffer to Channel 1,2

*(pCounter + RESERVE) = CH 1 Start

*(pCounter + RESERVE + DATA_SIZE) = CH 2 Start

RIS-RT Mode - Time/Div : 100ns – 2ns

Same as ETS Mode in the time area, but while ETS Mode receives partial data and reconstruct the waveform, RIS-RTMode performs Sinc interpolation of the data received at one time.

3. Communication Programming with SoftScope

SoftScope Control using Message

Use SendMessage API of Win32 to give commands to SoftScope. At this time, the commanding part and receiving part should have common message format and following messages are defined.

Following is how to use SendMessage API.

Description on Each Message

1. Channel On/Off

Message	WM_CHANGE_ONOFF
Parameter	Upper 16bit => Channel, Lower 16bit => On/Off
Channel	CH1 = 0, CH2 = 1
On/Off	Off = 0, On = 1

2. Channel AC/DC Coupling

Message	WM_CHANGE_ACDC_COUPLING
Parameter	Upper 16bit => Channel, Lower 16bit => AC/DC Coupling
Channel	CH1 = 0, CH2 = 1
AC/DC Coupling	DC_COUPLING = 0, AC_COUPLING = 1

3. Channel Volt/Div

Message	WM_CHANGE_VOLT_DIV
Parameter	Upper 16bit => Channel, Lower 16bit => Volt/Div
Channel	CH1 = 0, CH2 = 1
Volt/Div	10mV/Div = 1, 20mV/Div =2, 50mV/Div = 3, 100mV/Div = 4, 200mV/Div = 5, 500mV/Div = 6, 1V/Div = 7, 2V/Div = 8, 5V/Div = 9, 10V/Div = 10

4. Channel Offset(Display)

Message	WM_CHANGE_VOLT_OFFSET
Parameter	Upper 16bit => Channel, Lower 16bit => Offset
Channel	CH1 = 0, CH2 = 1
Offset	Set it as 200 for Offset OV, if coordinate of Y at display is 400.

	Accordingly, Offset Volt has value - 4 times as many as Volt/Div currently set if it is 0, and 4 times as many as Volt/Div if it is 400. Ex) If Volt/Div is 1V/Div, Offset is 0 : -4V, 200 : 0V, 400 : 4V

5. Change Time/Div

Message	WM_CHANGE_TIME_DIV
Parameter	Time/Div
Time/Div	2ns/Div = 0, 4ns/Div = 1, 10ns/Div = 2, 20ns/Div = 3, 40ns/Div = 4, 100ns/Div = 5, 200ns/Div = 6, 400ns/Div = 7, 1us/Div = 8, 2us/Div = 9, 4us/Div = 10, 10us/Div = 11, 20us/Div = 12, 40us/Div = 13, 100us/Div = 14, 200us/Div = 15, 400us/Div = 16, 1ms/Div = 17, 2ms/Div = 18, 4ms/Div = 19, 10ms/Div = 20, 20ms/Div = 21, 40ms/Div = 22, 100ms/Div = 23, 200ms/Div = 24, 400ms/Div = 25, 1s/Div = 26, 2s/Div = 27, 4s/Div = 28, 10s/Div = 29

6. Change Trig Source

Message	WM_CHANGE_TRIG_SOURCE
Parameter	Channel
Channel	CH1 = 0, CH2 = 1

7. Change Trig Slope

Message	WM_CHANGE_TRIG_SLOPE
Parameter	Slope
Slope	DOWN_EDGE = 0, UP_EDGE = 1

8. Change Trig Position

Message	WM_CHANGE_TRIG_POSITION
Parameter	Trig Position
Trig Position	Set it as 200 for Trig Position 0V if the coordinate of Y at Display is 400. Accordingly, Trig Position has value - 4 times as many as Volt/Div currently set if it is 0, and 4 times as many as Volt/Div if it is 400. Ex) Trig Position if Volt/Div is 1V/Div 0 : -4V, 200 : 0V, 400 : 4V

9. Change Trig Auto/Normal

Message	WM_CHANGE_TRIG_AUTO_NORMAL
Parameter	Trig Auto/Normal
Trig Auto/Normal	AUTO = 0, NORMAL = 1

10. Change Delay On/Off

Message	WM_CHANGE_TIME_DELAY
Parameter	Delay On/Off
Delay On/Off	OFF = 0, ON = 1

Find Memory Mapped File and Read Data

* Find and open handle of Memory Mapped File

* Read data at Memory Mapped File

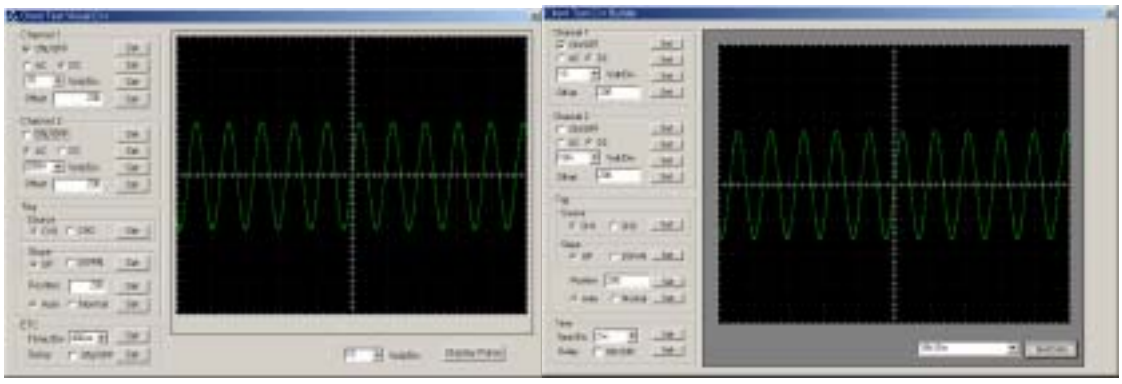
(Ex)

res = *(pCounter + RESERVE + 0);

Refer to the program available at the time of installation for concrete programming.

Currently, examples are provided in Visual C++/MFC and C++ Builder/VCL.

Following is the screen when the example program is executed.

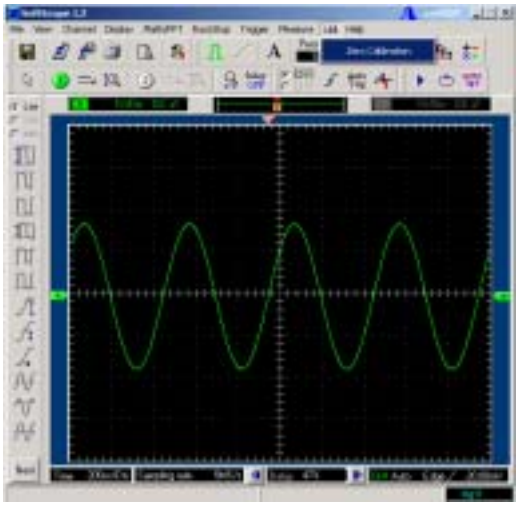


4. Software Calibration

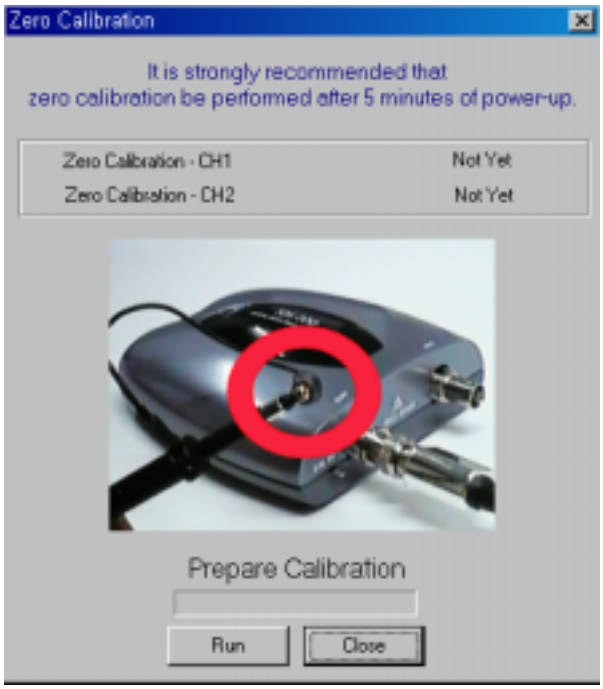
It is necessary for you to calibrate regularly to make the measurements as accurate as possible

1. Short input signal as shown below.

2. Select Zero Calibration from menu.



3. Zero calibration dialog box appears.



4. Calibration is done automatically.