Department of Electrical and Computer Engineering

Agilent Technologies DSO 3102A Digital Storage Oscilloscope

Principles of Operation

Many electrical signals occur so quickly or are so small that conventional methods with a digital multimeter are inadequate. Often we want to see the time varying qualities of a voltage signal. The oscilloscope is an electronic device that enables us to "see" these voltages. The oscilloscope has two axes. The vertical axis is for the voltage of the signal. The second axis is the horizontal axis and is for time and sometimes another voltage. With the DSO3102A Oscilloscope we can see two voltages displayed versus time or one voltage plotted as a function of the other voltage. With this instrument we can see voltage signals that can occur as quickly as a nanosecond or that can extend over several seconds. The signals are displayed on the screen of the oscilloscope. However, only a portion of the signal over time is shown. This is like a snapshot of the signal. The oscilloscope can be adjusted so that the amount of time taken in this snapshot is shorter (for a fast occurring signal) or longer (for a slower signal). In addition, the display can be scaled vertically so that a small voltage signal can be easily seen on the display while a large voltage signal can be fit into the limits of the screen.

One concern for being able to see voltage signals is that our human reaction times are so slow compared to the speed of these signals, and we cannot tell the oscilloscope when to start the display. Oscilloscopes in general have a means to "trigger" the time of the snapshot so that the part of interest in the signal is captured and can be displayed on the screen. We can choose to have only one snapshot displayed at a time or we can have snapshots displayed repeatedly for a periodic waveform. The following section describes elements of the triggering process as well as the vertical and horizontal scaling within oscilloscopes.

Triggering

The trigger determines when the oscilloscope starts to acquire data and display a waveform. When a trigger is set up properly, it can convert unstable displays or blank screens into meaningful waveforms. The trigger is important to have a stable display. If the oscilloscope is continuously taking snapshots and displaying them, then the result could look like the jumbled mess in the right-hand diagram of Figure 1 instead of the clean waveform in the left-hand diagram. The left-hand diagram is still a continuous series of snapshots, but since the waveform is periodic, then we see the same section of the waveform displayed with each snapshot.

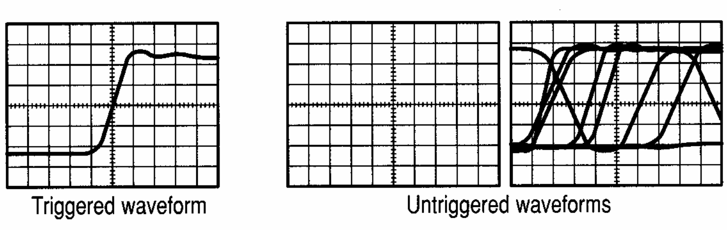


Figure 1. The difference between waveforms that are triggered versus those that are not triggered.

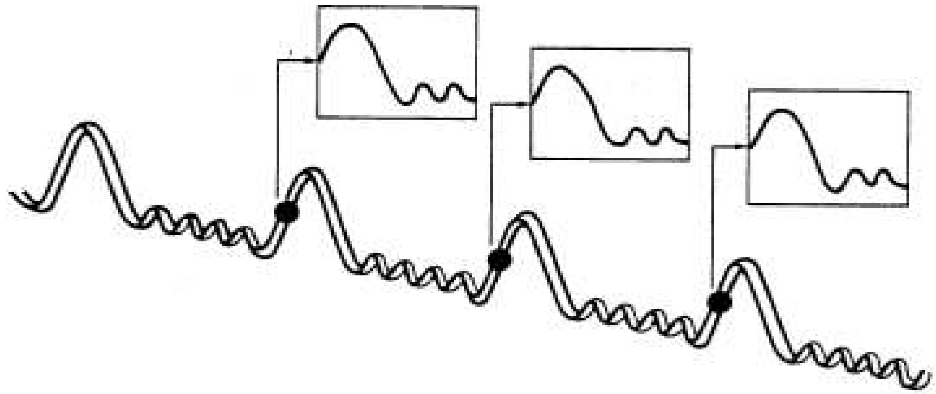


Figure 2. Triggering gives you a stable display because the same trigger point starts the sweep each time. The SLOPE and LEVEL controls define the trigger points on the trigger signal. When you look at a waveform on the screen, you're seeing all those sweeps overlaid in what appears to be a single picture.

When the oscilloscope starts to acquire a waveform, it collects enough data so that it can draw the waveform to the left of the trigger point. The oscilloscope continues to acquire data while waiting for the trigger condition to occur. After it detects a trigger, the oscilloscope continues to acquire enough data so that it can draw the waveform to the right of the trigger point.

Source
You can derive your trigger from various sources: Input channels, AC Line, and External.
Input. The most commonly used trigger source is any of the input channels.
AC Line. You can use this trigger source when you want to look at signals related to the power line frequency, such as lighting equipment and power supply devices. The oscilloscope generates the trigger, so you do not have to input a trigger signal.
External. You can use this trigger source when you want to acquire data on two channels and trigger from a third. For example, you might want to trigger from an external clock or with a signal from another part of the test circuit. The EXT and EXT/5 trigger sources both use the external trigger signal connected to the EXT TRIG connector. The EXT/5 trigger source divides the signal by 5 which extends the trigger level range. This allows the oscilloscope to trigger on a larger signal.

Types
The oscilloscope provides three types of triggers: Edge, Video, and Pulse Width.
Edge. The **Slope** and **Level** controls help to define the Edge trigger. The **Slope** control determines whether the oscilloscope finds the trigger point on the rising or the falling edge of a waveform. The **Level** control determines voltage point on the waveform where the trigger occurs.
Video. Video triggering is used to trigger on fields or lines of NTSC, PAL, or SECAM standard video waveforms. When Video is selected, the trigger coupling is set to **AC**.
Pulse Width
A Pulse Width trigger occurs when a pulse is found in a waveform that matches the pulse definition. The **When** and **Setting** menu buttons control the pulse definition.

Modes
The trigger mode determines how the oscilloscope behaves in the absence of a trigger event. The oscilloscope provides three trigger modes: Auto, Normal, and Single.
Auto. This trigger mode allows the oscilloscope to acquire a waveform even when it does not detect a trigger condition. If no trigger condition occurs while the oscilloscope waits for a specific period (as determined by the time-base setting), it will force itself to trigger.
Refer to a future section for more information on time bases. When forcing invalid triggers, the oscilloscope cannot synchronize the waveform, and the waveform seems to roll across the display. If valid triggers occur, the display becomes stable on the screen. You can use Auto mode to monitor an amplitude level, such as a power supply output, which may cause the waveform to roll across the display.
Normal. The Normal mode allows the oscilloscope to acquire a waveform only when it is triggered. If no trigger occurs, the oscilloscope will not acquire a new waveform, and the previous waveform, if any, will remain on the display.
Single. The Single mode allows the oscilloscope to acquire one waveform each time you press the RUN button, and the trigger condition is detected. The data that the oscilloscope acquires depends on the acquisition mode. Refer to a future section for more information on the type of data each acquisition mode will acquire. *NOTE When you use the Single trigger mode with the Average acquisition mode, the number of waveforms specified in the number of averages are acquired before the acquisition stops.*

Holdoff
Triggers are not recognized during holdoff time (the period that follows each acquisition). For some signals, you need to adjust the holdoff period to produce a stable display. The trigger signal can be a complex waveform with many possible trigger points on it, such as a digital pulse train. Even though the waveform is repetitive, a simple trigger might result in a series of patterns on the screen instead of the same pattern each time.

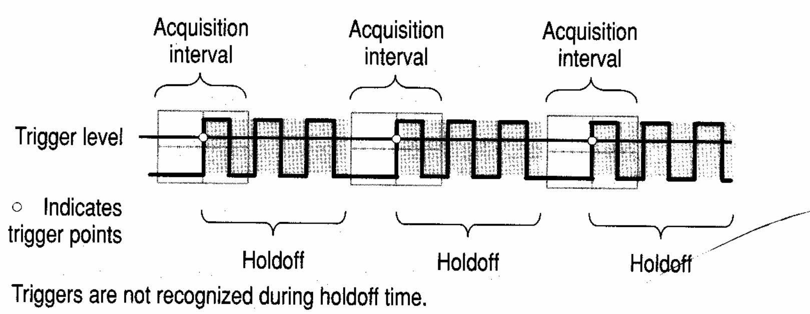


Figure 3. A diagram illustrating the idea of a holdoff.

For example, you could use the holdoff period to prevent triggering on any other pulse except the first one in a pulse train. This way, the oscilloscope would always display the first pulse. To access the Holdoff control, press the HORIZONTAL Menu button, select Holdoff, and use the HOLDOFF knob to change the amount of time in the holdoff period.

Coupling
Trigger coupling determines what part of the signal passes on to the trigger circuit. Coupling types include DC, AC, Noise Rejection, High Frequency Rejection, and Low Frequency Rejection.
DC. DC coupling passes both AC and DC components.
AC. AC coupling blocks DC components.
High Frequency Rejection. HF Reject coupling blocks the high frequency portion and passes on only the low frequency components.
Low Frequency Rejection. LF Reject coupling does the opposite of high frequency rejection.

Position
The horizontal position control establishes the time between the trigger and the screen center. Refer to Horizontal Scale and Position,.

Slope and Level
The Slope and Level controls help to define the trigger. The Slope control determines whether the oscilloscope finds the trigger point on the rising or the falling edge of a signal. To access the trigger slope control, press the TRIGGER Menu button, select Edge, and use the Slope button to select Rising or Falling.

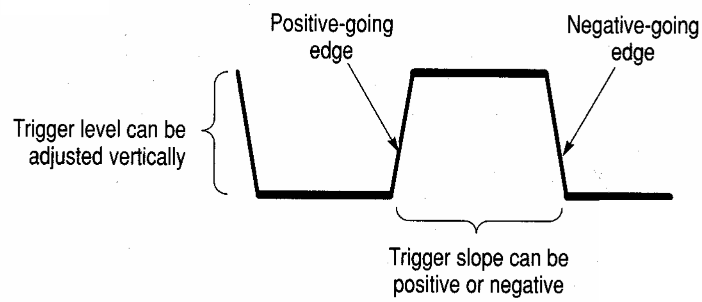


Figure 4. The positive-going and negative-going slopes.

The Level control determines where on the edge the trigger point occurs. To access the trigger level control, press the HORIZONTAL Menu button, select Level, and use the LEVEL knob to change the value.

Acquiring Data
When you acquire analog data, the oscilloscope converts it into a digital form. You can acquire data using three different acquisition modes. The timebase setting affects how rapidly data is acquired.

Acquisition Modes
There are four acquisition modes: Normal, Peak Detect, Analog, and Average.
Normal. In this acquisition mode, the oscilloscope samples the signal in evenly spaced intervals to construct the waveform. This mode accurately represents analog signals most of the time.

However, this mode does not acquire rapid variations in the analog signal that may occur between samples. This can result in aliasing (described on page 18) and may cause narrow pulses to be missed. In these cases, you should use the Peak Detect mode to acquire data.

Peak Detect. In this acquisition mode, the oscilloscope finds the highest and lowest values of the input signal over a sample interval and uses these values to display the waveform. In this way, the oscilloscope can acquire and display narrow pulses, which may have otherwise been missed in Sample mode. Noise will appear to be higher in this mode.

Average. The Average Acquisition mode is should be used to remove random noise from the waveform and to improve measurement accuracy. The averaged waveform is a running average over a specified number of acquisitions from 2 to 256.

Analog. In the Analog Acquisition mode, the oscilloscope calculates a probability based on how often a displayed waveform point occurs over multiple acquisitions. The waveform points that occur the most often are displayed at the highest intensity level. The waveform points that occur the least often are displayed at the lowest intensity level. The waveform points that occur between the highest and lowest probability are display at intensity levels in between the highest and lowest intensity levels.

Time Base

The oscilloscope digitizes waveforms by acquiring the value of an input signal at discrete points. The time base allows you to control how often the values are digitized. To adjust the time base to a horizontal scale that suits your purpose, use the SEC/DIV knob.

Scaling and Positioning Waveforms

You can change the display of waveforms by adjusting their scale and position. When you change the scale, the waveform display will increase or decrease in size. When you change the position, the waveform will move up, down, right, or left. The channel reference indicator (located on the left of the graticule) identifies each waveform on the display. The indicator points to the ground level of the waveform record.

Vertical Scale and Position

You can change the vertical position of waveforms by moving them up or down on the display. To compare data, you can align a waveform above another or you can align waveforms on top of each other. You can change the vertical scale of a waveform. The waveform display will contract or expand about the ground level.

Horizontal Scale and Position; Pretrigger Information

You can adjust the Horizontal Position control to view waveform data before the trigger, after the trigger, or some of each. When you change the horizontal position of a waveform, you are actually changing the time between the trigger and the center of the display. (This appears to move the waveform to the right or left o the display.)

For example, if you want to find the cause of a glitch your test circuit, you might trigger on the glitch and make the pretrigger period large enough to capture data before the glitch. You can then analyze the pretrigger data and perhaps find the cause of the glitch. You change the horizontal scale of all the waveforms by using the SEC/DIV knob. For example, you might want to see just one cycle of a waveform to measure the overshoot on its rising edge.

The oscilloscope shows the time per division in the scale readout. Since all active waveforms use the same time base, the oscilloscope only displays one value for all the active channels, except when you use a Window Zone.

Aliasing.
Aliasing occurs when the oscilloscope does not sample the signal fast enough to construct an accurate waveform record. When aliasing happens, you see a waveform with a frequency lower than the actual waveform being input or a waveform that is not stable even though the oscilloscope triggered.

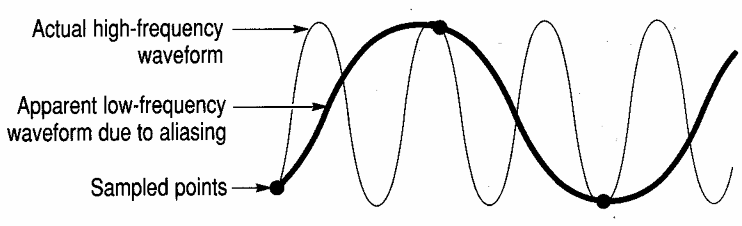


Figure 5. The concept of aliasing comes in when the signal is oscillating faster than the oscilloscope can keep up.

One way to check for aliasing is to slowly change the horizontal scale with the SEC/DIV knob. If the shape of the waveform changes drastically, you may have aliasing. To represent a signal accurately and avoid aliasing, you must sample the signal more than twice as fast as the highest frequency component. For example, a signal with frequency components of 5 MHz would need to be sampled at 10 Megasamples per second or faster.

Taking Measurements
The oscilloscope displays graphs of voltage versus time and can help you to measure the displayed waveform. There are several ways to take measurements. You can use the graticule, the cursors, or an automated measurement.

Graticule
This method allows you to make a quick, visual estimate. For example, you might look at a waveform amplitude and determine that it is a little more than 100 mV. You can take simple measurements by counting the major and minor graticule divisions involved and multiplying by the scale factor. For example, if you counted five major vertical graticule divisions between the minimum and maximum values of a waveform and knew you had a scale factor of 100 mV/division, then you could easily calculate your peak-to-peak voltage as follows:

5 divisions x 100 mV/division = 500 mV.

Cursors
This method allows you to take measurements by moving the cursors, which always appear in pairs, and reading their numeric values from the display readouts. There are two types of cursors: Voltage and Time. When you use cursors, be sure to set the Source to the waveform that you want to measure.
Voltage Cursors. Voltage cursors appear as horizontal lines on the display and measure the vertical parameters.

Time Cursors. Time cursors appear as vertical lines on the display and measure the horizontal parameters.

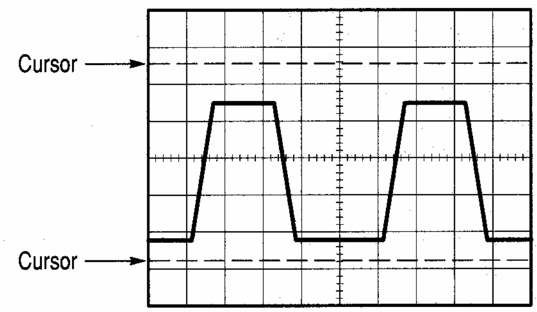


Figure 6. Cursors on the display to take measurements.

Automated

When you take automated measurements, the oscilloscope does all the calculating for you. Because these measurements use the waveform record points, they are more accurate than graticule or cursor measurements. Automated measurements use readouts to show measurement results. These readouts are updated periodically as the oscilloscope acquires new data.

Setting Up the Oscilloscope

You should become familiar with three functions that you will use often when operating your oscilloscope: Autoset, saving a setup, and recalling a setup. Included is a description of the default settings for normal operation of the oscilloscope.

Using Autoset

The Autoset function obtains a stable waveform display for you. It automatically adjusts the vertical and horizontal scaling, as well as the trigger coupling, type, position, slope, level, and mode settings.

Saving a Setup

By default, the oscilloscope saves the setup each time it is powered off. The oscilloscope automatically recalls this setup the next time it is powered on.

Recalling a Setup

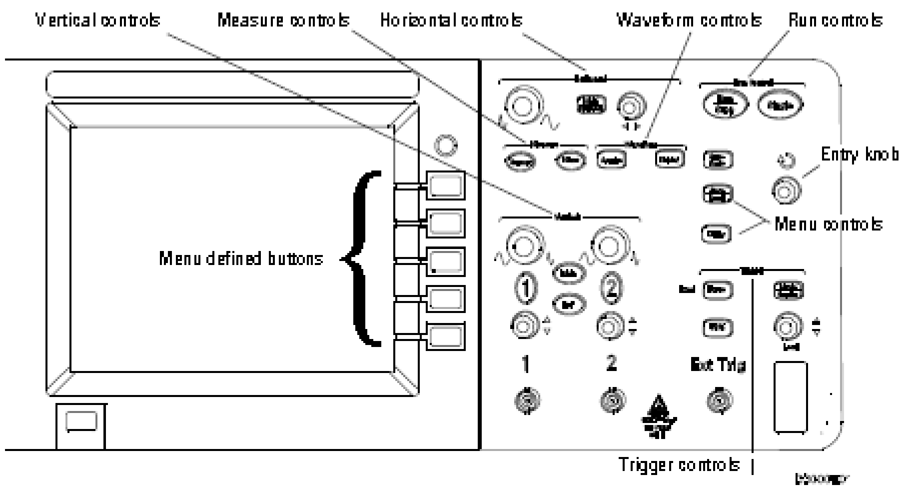
The oscilloscope can recall any of the saved setups or the factory default setup.

Defaults (Factory Setup)

The oscilloscope is set up for normal operation when it is shipped from the factory. You can recall the factory default setup any time you want to operate the oscilloscope using or starting from the factory default settings.

Detailed Operating Basics of the Agilent DSO3102A

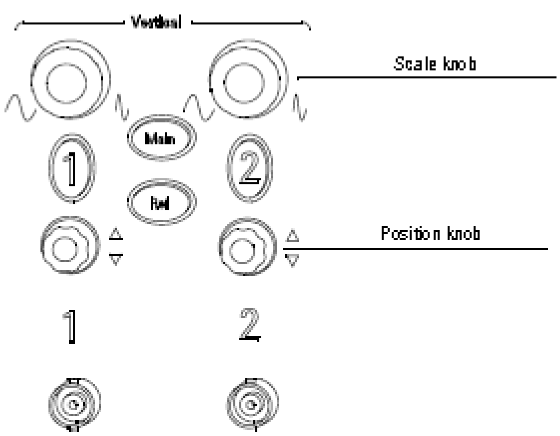
The front panel is divided into functional areas. This section provides an overview of the controls and information on the display.



Vertical Controls

Each channel has a vertical controls menu that appears after pressing either the **1** or the **2** front panel button. This section of the manual describes the vertical channel controls.

Vertical System Setup



The following exercise guides you through the vertical buttons, knobs, and status bar.

1 Center the waveform on the display using the position knob. The position knob moves the waveform vertically. Notice that as you turn the position knob, a voltage value is displayed for a short time indicating how far the ground reference is from the center of the screen. Also notice that the ground symbol on the left side of the display moves in conjunction with the position knob.

2 Notice that changing the vertical setup also affects the status bar. You can quickly determine the vertical setup from the status bar in the display.

- **a** Change the vertical sensitivity with the scale knob and notice that it causes the status bar to change.
- **b** Press the **1** button. The CH1 menu appears and the channel is turned on.
- **c** Toggle each of the menu buttons and notice which button causes the status bar to change. Channels 1 and 2 have a vernier button that allows the scale knob to change the vertical step size in smaller increments. Pressing **Volts/Div** menu button, changes vernier into Fine or Coarse status.
- **d** Pressing the **1** button to turns channel off or on.

Channel Coupling Control

The channel coupling control can be used to remove any dc offset voltage on a waveform. By setting the coupling control to **AC** the dc offset voltage is removed from the input waveform. To remove any dc offset voltage from a waveform on channel 1, press the **1** front panel key. Press the Coupling menu key until **AC** appears.

When **DC** coupling is selected, both **AC** and **DC** components of the input waveform are passed to the oscilloscope.

When **GND** coupling is selected, the waveform is disconnected from the oscilloscope input.

Bandwidth Limit Control

The bandwidth limit control can be used to remove high frequency components on a waveform that are not important to the analysis of the waveform.
To remove high frequency components from a waveform on channel 1, press the **1** front panel key. Press the **BW Limit** menu key until ON appears. Frequencies above 20 MHz will be rejected. When the **BW Limit** control is set to OFF, the oscilloscope is set to full bandwidth.

Probe Attenuation Control

The probe attenuation control changes the attenuation factor for the probe. The attenuation factor changes the vertical scaling of the oscilloscope so that the measurement results reflect the actual voltage levels at the probe tip.
To change the probe attenuation factor for channel 1, press the **1** front panel key. Press the **Probe** menu key to change the attenuation factor to match the probe being used.

Probe attenuation factors and corresponding settings

1:1	1X
10:1	10X
100:1	100X
1000:1	1000X

Invert Control

The invert control inverts the displayed waveform with respect to the ground level. When the oscilloscope is triggered on the inverted waveform, the trigger is also inverted.
To invert the waveform on channel 1, press the **1** front panel key. Press the **1/2** menu key and then press the **Invert** menu key until ON appears.

Math Functions Control

The math functions control allows the selection of the math functions add, subtract, multiply, and FFT (Fast Fourier Transform) for **CH1** and **CH2**. The mathematical result can also be measured using the grid and cursor controls.
To select a math function, press the **Math** button to display the **Math** menu, the settings of this menu are shown in the Table 2-3. The amplitude of the math waveform can be adjusted using the vertical scale knob. The adjustment range is in a 1-2-5 step from 0.1% to 1000%. The scale setting is displayed on the status bar.

Menu	Settings	Description
Operation	**A+B**	Add source A to source B
	A-B	Subtract source B from source A
	AxB	Multiply source B by source A
	FFT	Fast Fourier Transform
Source A	**CH1**	Set CH1 or CH2 as source A
	CH2	
Source B	**CH1**	Set CH1 or CH2 as source B
	CH2	
Invert	**ON**	Inverted display of the Math waveform.
	OFF	Non-inverted display of the Math waveform.

Using the FFT

The FFT math function mathematically converts a time-domain waveform into its frequency components. FFT waveforms are useful for finding the harmonic content and distortion in systems, for characterizing noise in DC power supplies, and for analyzing vibration.

Vertical Position and Scale Controls

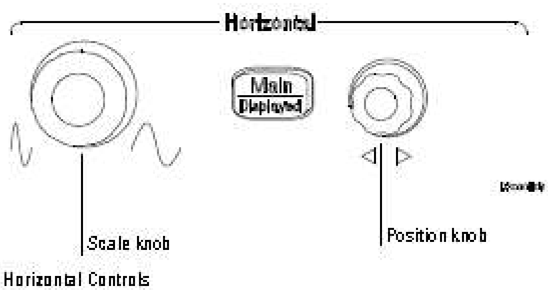
You can use the vertical controls to adjust the vertical scale and position waveforms on channel and channel 2. The vertical position of waveforms (including **Math** and **Ref**) can be changed by moving them up or down on the display. You can compare waveforms by aligning a waveform above another or by aligning waveforms on top of each other.
The vertical scale of a waveform (including **Math** and **Ref**) can be changed. The waveform display will contract or expand about the ground level. If the **Volts/Div** is set to **Coarse**, the waveform scales in a 1-2-5 step sequence from 2 mV to 5 V. If the **Volts/Div** is set to **Fine**, it scales in small steps between the coarse scale settings. When scaling **Math** waveform, amplitude

can be changed with the scale knob in a 1-2-5 step from 0.1% to 1000%. The **Fine** vertical control can be achieved by pressing the vertical scale knob. When you change the vertical position, the position message is displayed in the lower left-hand corner of the screen.

Horizontal Controls

The oscilloscope shows the time per division in the scale readout. Since all waveforms use the same time base, the oscilloscope only displays one value for all channels, except when you use Delayed Sweep. The horizontal controls can change the horizontal scale and position of waveforms. The horizontal center of the screen is the time reference for waveforms. Changing the horizontal scale causes the waveform to expand or contract around the screen center. The horizontal position knob changes the position of the trigger point relative to the center of the screen.

Horizontal System Setup



The following exercise guides you through these buttons, knobs, and status bar.

1 Turn the scale knob and notice the change it makes to the status bar. The scale knob changes the sweep speed in a 1-2-5 step sequence and the value is displayed in the status bar.
2 Turn the position knob to move the trigger point with respect to the center of the screen
3 Press the **Main/Delayed** key to display the TIME menu. In this menu, you can enter or exit the Delayed Sweep mode, set the display to Y-T or X-Y format, and set the horizontal position knob to the **Trig-Offset** or **Holdoff** mode.

Horizontal Knobs

The position knob adjusts the horizontal position of all channels, math functions, and reference waveforms. The resolution of this control varies with the time base. The oscilloscope digitizes waveforms by acquiring the value of an input waveform at discrete points. The time base allows you to control how often the values are digitized. The scale control changes the horizontal time/div the Main and Delayed Seep time base. When Delayed Sweep is enabled, the horizontal scale control changes the width of the Delayed Sweep window.

Horizontal Menu

Pressing the Main/Delayed button displays the TIME menu.

Delayed Sweep

The Delayed Sweep is used to magnify a portion of the main waveform window. You can use Delayed Sweep to locate and horizontally expand part of the main waveform window for a more detailed (higher horizontal resolution) analysis of the waveform.

The screen is divided into two parts. The top half of the display shows the main waveform window. The bottom half of the displays shows an expanded view of the main waveform window. This expanded portion of the main window is called the Delayed Sweep window. Two blocks shadow the top half, the unshadowed portion is expanded in the lower half. The horizontal position and scale knobs control the size and position of the Delayed Sweep window.

The horizontal position knob is used to change the position of the Delayed Sweep Window. The horizontal scale knob is used to adjust the Delayed Sweep window size. To change the Main time base, you must turn off the Delayed Sweep mode. Since both the Main and Delayed Sweep windows are displayed, there are half as many vertical divisions so the vertical scaling is doubled. Notice the changes in the status bar.

X-Y Format

This format compares the voltage level of two waveforms point by point. It is useful for studying phase relationships between two waveforms. This format only applies to channels 1 and 2. Choosing the X-Y display format displays channel 1 on the horizontal axis and channel 2 on the vertical axis. The oscilloscope uses the untriggered sample acquisition mode and waveform data is displayed as dots. The sampling rate can vary from 4 kSa/s to 100 MSa/s, and the default sampling rate is 1 MSa/s.

The following modes or functions will not work in X-Y format.

- The Automatic Measurements
- The Cursor Measurements
- Pass/Fail test
- **Ref** and **Math** Operations
- The Delayed Sweep
- The Vector Display Mode
- Horizontal position knob
- Trigger Controls

Trigger Holdoff

Trigger holdoff can be used to stabilize a waveform. The holdoff time is the oscilloscope's waiting period before starting a new trigger. During the holdoff time oscilloscope will not trigger until the holdoff has expired.

The following exercise guides you through setting the holdoff time.

1 Press the **Main/Delayed**, front panel button to display TIME menu

2 Select the **Holdoff** menu button.

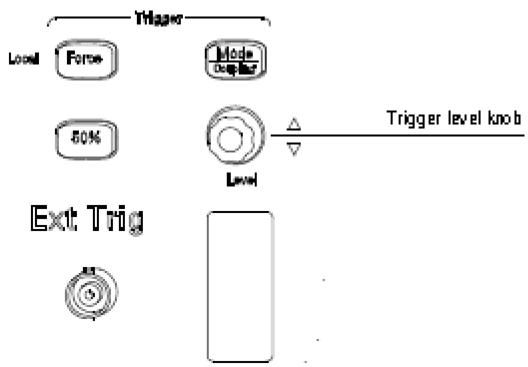
3 Adjust the horizontal position knob to change the Holdoff time until the waveform is stable.

4 Press the **Holdoff Reset** menu button to change the Holdoff time to the 100 ns minimum value.

Trigger Controls

The trigger determines when the oscilloscope starts to acquire data and display a waveform. When a trigger is set up properly, it can convert unstable displays or blank screens into meaningful waveforms. When the oscilloscope starts to acquire a waveform, it collects enough data so that it can draw the waveform to the left of the trigger point. The oscilloscope continues to acquire data while waiting for the trigger condition to occur. After it detects a trigger, the oscilloscope continues to acquire enough data so that it can draw the waveform to the right of the trigger point.

Trigger System Setup



The following exercise guides you through these trigger buttons, knobs, and status bar.
1 Turn the trigger **Level** knob and notice the changes it makes to the display.
As you turn the **Level** knob two things happen on the display. First, the trigger level value is displayed at the lower left-hand corner of the screen. If the trigger is DC coupled, it is displayed as a voltage. If the trigger is AC coupled or LF reject coupled, it is displayed as a percentage of the trigger range. Second, a line is displayed showing the location of the trigger level with respect to the waveform except for AC coupling or LF reject coupling modes.
2 Change the trigger setup and notice how these changes affect the status bar.

- **a** Press the **Mode/Coupling** button in the trigger controls area. The TRIGGER menu appears. Figure 2-18 displays this trigger menu.
- **b** Press the top trigger Mode menu button and notice the differences between Edge trigger, Video trigger, and Pulse trigger. Leave in the Edge mode.
- **c** Press the trigger Slope menu button to notice the differences between Rising Edge and Falling Edge.
- **d** Press the trigger Source menu button to select trigger source choices.
- **e** Press the bottom trigger Mode menu button to select Auto or Normal.
- **f** Press the Coupling menu button and notice how AC, DC, and LF Reject affect the waveform display.

3 Press the **50%** key and watch it set the trigger level to center of the waveform.
4 Press the **Force** button to start an acquisition even if a valid trigger has not been found. This button has no effect if the acquisition is already stopped.

Trigger Types

The oscilloscope provides three trigger types: Edge, Video, and Pulse. Edge trigger can be used with analog and digital circuits. An edge trigger occurs when the trigger input passes through a specified voltage level with the specified slope. Video is used to trigger on fields or lines for standard video waveforms. Pulse trigger is used to find pulses with certain pulse widths.

Edge Trigger

The **Slope** and **Level** controls help to define the Edge trigger. The **Slope** control determines whether the oscilloscope finds the trigger point on the rising or the falling edge of a waveform. The **Level** control determines voltage point on the waveform where the trigger occurs.

Edge Trigger Menu Buttons

Menu	Settings	Comments
Source	**CH1**	Sets **CH1** as the trigger waveform
	CH2	Sets **CH2** as the trigger waveform
	EXT	Sets EXT TRIG as the trigger waveform
	EXT/5	Sets EXT TRIG/5 as the trigger waveform
	AC Line	Sets the power line as the trigger waveform
	EXT(50 Ω)	Sets EXT TRIG(50 Ω) as the trigger waveform
Slope	**Rising**	Trigger on rising edge
	Falling	Trigger on falling edge
Mode	**Auto**	Acquire waveform even when no trigger occurs
	Normal	Acquire waveform when trigger occurs.
	Single	Acquire one waveform when trigger occurs then stop
Coupling	**AC**	Sets the input coupling to AC use for waveforms greater than 50 Hz
	DC	Sets the input coupling to DC
	LF Reject	Sets the input coupling to low frequency reject (100 kHz cutoff)
	HF Reject	

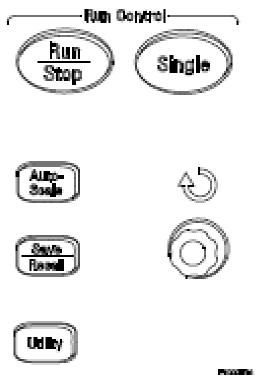
Video Trigger

Video triggering is used to trigger on fields or lines of NTSC, PAL, or SECAM standard video waveforms. When Video is selected, the trigger coupling is set to **AC**.

Pulse Width

A Pulse Width trigger occurs when a pulse is found in a waveform that matches the pulse definition. The **When** and **Setting** menu buttons control the pulse definition.

Storing and Recalling Waveforms or Setups



Pressing the **Save/Recall** button produces the **STORAGE** menu as follows:

Table 2-12 STORAGE Menu Buttons

Menu	Settings	Comments
Save/Recall	**Waveforms** **Setups**	Save or recall waveforms Save or recall an oscilloscope setup
Waveform Setup	**No.1** through **No. 10** **No.1** through **No. 10**	Sets the storage location of the waveform Sets the storage location of the setup
Load		Recall waveforms, factory setup, of saved setup
Save		Save waveforms or setups

Waveforms
You can save 10 waveforms for the two channels in the nonvolatile memory of the oscilloscope and overwrite the previously saved contents as needed.

Setups
You can save 10 settings in the nonvolatile memory of the oscilloscope and overwrite previously saved setups. By default, the oscilloscope saves the current setup each time it is turned off. The oscilloscope automatically recalls this setup the next time it is turned on.

Factory
You can recall the factory default setup any time you want to return the oscilloscope to the state it was in when you received it.

Load
The saved waveforms, setups, and factory setup can be recalled by pressing the **Load** menu button.

Save
Either the waveforms or the current settings of the oscilloscope are saved to nonvolatile memory by pressing the **Save** menu button. Wait at least five seconds before turning off the oscilloscope.

Saving on USB Mass Storage Device

You can save the oscilloscope's current setup, waveform trace and display on the USB mass storage device by following the steps below:

1. Connect the USB mass storage device to the USB host port on the rear of the oscilloscope. Take note that the USB host ports are rectangular and USB device port is square.
2. To access the Save/Recall menu, press **Save/Recall**.
3. The **USB** option will be available under **Storage** softkey only if the USB mass storage device has been connected to the oscilloscope.
4. Select your preferred **File Type**. The available options are **Waveform**, **Setup**, **Bitmap** and **CSV**.

- **Waveform** - This option saves the visible portion of the acquisition (the displayed waveform) for later recall and comparison with other measurements.
- **Setup** - This option captures all settings including measurements, cursors, math functions, and horizontal, vertical, and trigger settings.
- **Bitmap** - This option captures the image of the screen according to the selected bmp format. There are two Bitmap options:
- **8 bit** - The screen image is converted to a smaller, lower resolution bitmap file of the screen.
- **24 bit** - This is a larger, high-resolution bitmap file of the screen.
- **CSV** - This creates a file of comma-separated variable values of displayed channels and math waveforms. This format is suitable for spreadsheet analysis.

5. Press the **Save** softkey. This option prompts a screen that shows the available directory and files on the USB mass storage device. It also shows a softkey keyboard at the bottom of the directory.
6. The knob symbol at **Location** softkey is highlighted. Now, determine the **Location** or directory you want to save the file by turning the Entry knob. Press **Enter** softkey at your preferred directory.
7. Now, the knob symbol at **File Name** softkey is highlighted. To name the file, turn the Entry knob and select the characters. Once you are at your preferred character, press **Enter** softkey.
8. Repeat this till you have named the file. Use **Delete Character** softkey to delete unwanted characters.
9. Press the **Save** softkey to save the file.

Loading Setup/Waveform from USB Mass Storage Device

You can load the setup and waveform trace from the USB mass storage device by using DSO3000 series oscilloscope.

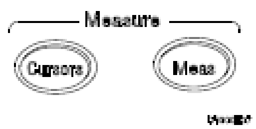
1. Connect the USB mass storage device to the USB host port on the rear of the oscilloscope.
2. To access the Save/Recall menu, press **Save/Recall**.
3. The **USB** option will be available under **Storage** softkey, only if the USB mass storage device has been connected to the oscilloscope.
4. Select the type of information to load from the **File Type** option, either **Waveform** or **Setup**.

- **Waveform** - This option saves the visible portion of the acquisition (the displayed waveform) for later recall and comparison with other measurements.

- **Setup** - This option captures all settings including measurements, cursors, math functions, and horizontal, vertical, and trigger settings.

5. Press the **Load** softkey. This option prompts a screen that shows the available directory and files on the USB mass storage device.
6. Turn the Entry knob to select the directory and the file to be loaded.
7. Press the **Load** softkey.

Cursor Measurements



There are three cursor measurement modes.
• Manual
• Track
• Auto Measure
Only the Manual mode will be presented here:

Manual

In the manual mode, the screen displays two parallel cursors. You can move the cursors to make custom voltage or time measurements on the waveform. The cursor values are displayed in the boxes at the bottom of the menu. Before using cursors, you should make sure that you have set the waveform source to the channel that is to be measured.

Menu	**Settings**	**Comments**
Mode	**Manual**	Set Manual mode for cursor measurement.
Type	**Voltage**	Use cursors to measure voltage parameters.
	Time	Use cursors to measure time parameters.
Source	**CH1**	Sets the measurement waveform source.
	CH2	
	Math	

To do manual cursor measurements, use the following steps.
1 Press the Mode menu button until Manual appears.
2 Press the Source menu button until the source you want to measure appears.
3 Press Type menu button until the units that you want to measure appears.
4 Move the cursors to the desired measurement position using the information in the following table:

Cursor	**Type**	**Operation**
Cursor A	**Voltage**	Turn the Vertical **position** knob to move cursor A up or down.
	Time	Turn the Vertical **position** knob to move cursor A left or right.
Cursor B	**Voltage**	Turn the horizontal **position** knob to move cursor B up or down.
	Time	Turn the horizontal **position** knob to move cursor B left or right.

Menu	Type	Description
CurA	Voltage	Shows the current voltage value for Cursor A.
	Time	Shows the time position for Cursor A.
CurB	Voltage	Shows the current voltage value for Cursor A.
	Time	Shows the time position for Cursor A.
ΔY	Voltage	Shows the voltage difference between Cursor A and Cursor B.
ΔX	Time	Shows the time difference between Cursor A and Cursor B.
1/ΔX	Time	Shows the frequency difference between Cursor A and Cursor B.

Cursor movement is only possible while the CURSOR menu is being displayed.

The Oscilloscope Probe

Compensating Probes

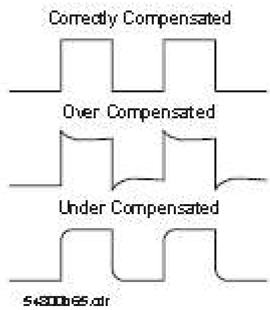
Perform this adjustment to match your probe to the input channel. This should be done whenever you attach a probe for the first time to any input channel.

Low Frequency Compensation

1 Set the Probe menu attenuation to 10X. If you use the probe hooktip, ensure a proper connection by firmly inserting the tip onto the probe.

2 Attach the probe tip to the probe compensation connector and the ground lead to the probe compensator ground connector

3 Press the **Auto-Scale** front panel button.



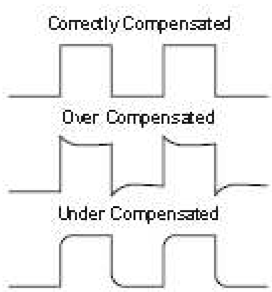
4 If waveform does not appear like the Correctly Compensated waveform shown in Figure 1-3, then use a nonmetallic tool to adjust the low frequency compensation adjustment on the probe for the flattest square wave possible.

High Frequency Compensation

1 Using the BNC adapter, connect the probe to a square wave generator.

2 Set the square wave generator to a frequency of 1 MHz, an amplitude of 3 Vp-p, and an output termination of 50 Ω.

3 Press the **Auto-Scale** front panel button.

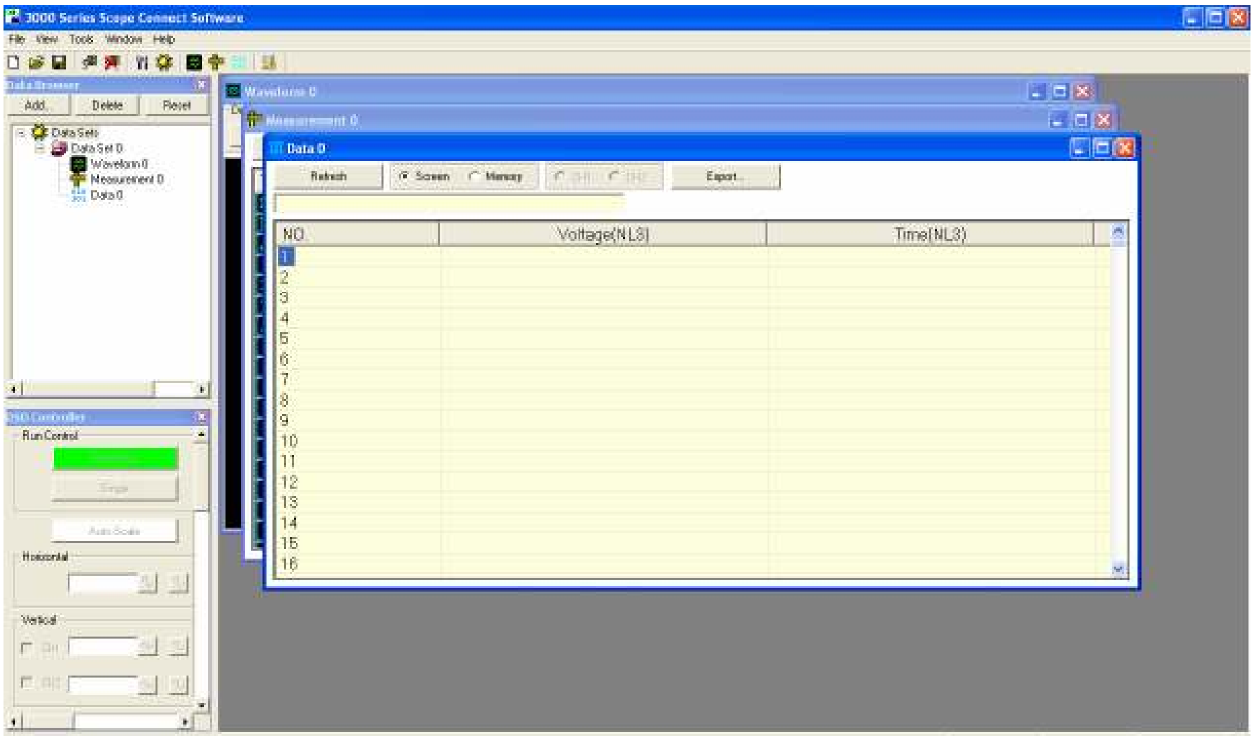


4 If waveform does not appear like the Correctly Compensated waveform shown in Figure 1-4, then use a nonmetallic tool to adjust the 2 high frequency compensation adjustments on the probe for the flattest square wave possible.

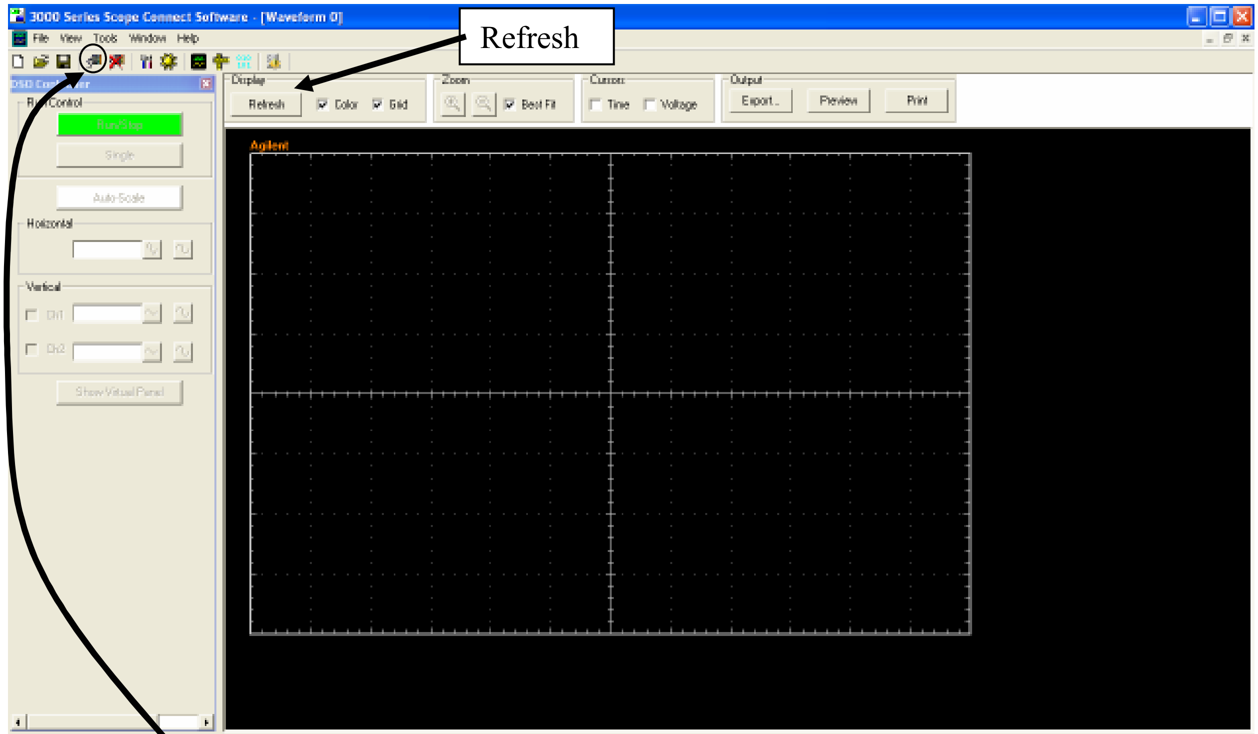
Remote access with the DSO3102A

All of the operations that have been described can be performed remotely via the PC. One advantage of remote access is that you may now be able to upload the screens of the DSO 3102A to the PC and insert them into your Microsoft Word document.

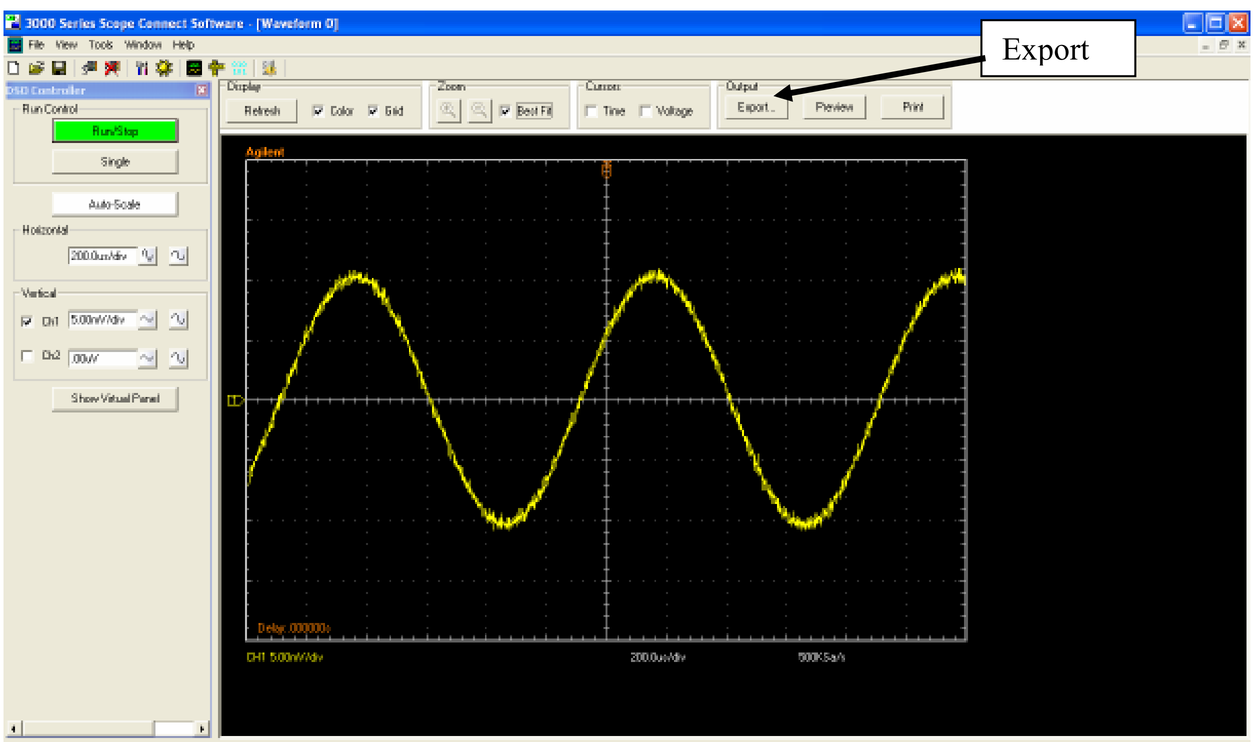
1. Double click the icon for the shortcut labeled "DSO3000."



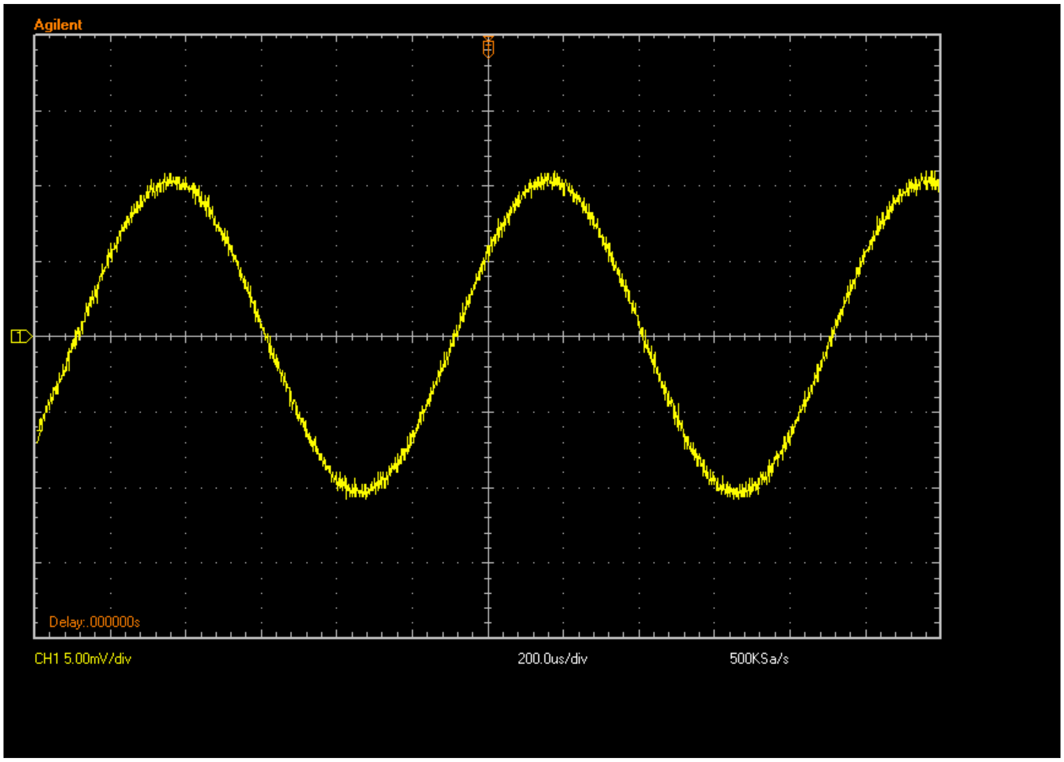
2. For simplicity, close the "Data0" and "Measurement0" windows and maximize the "Waveform0" window. Also, close the "Data Browser" window on the upper left.



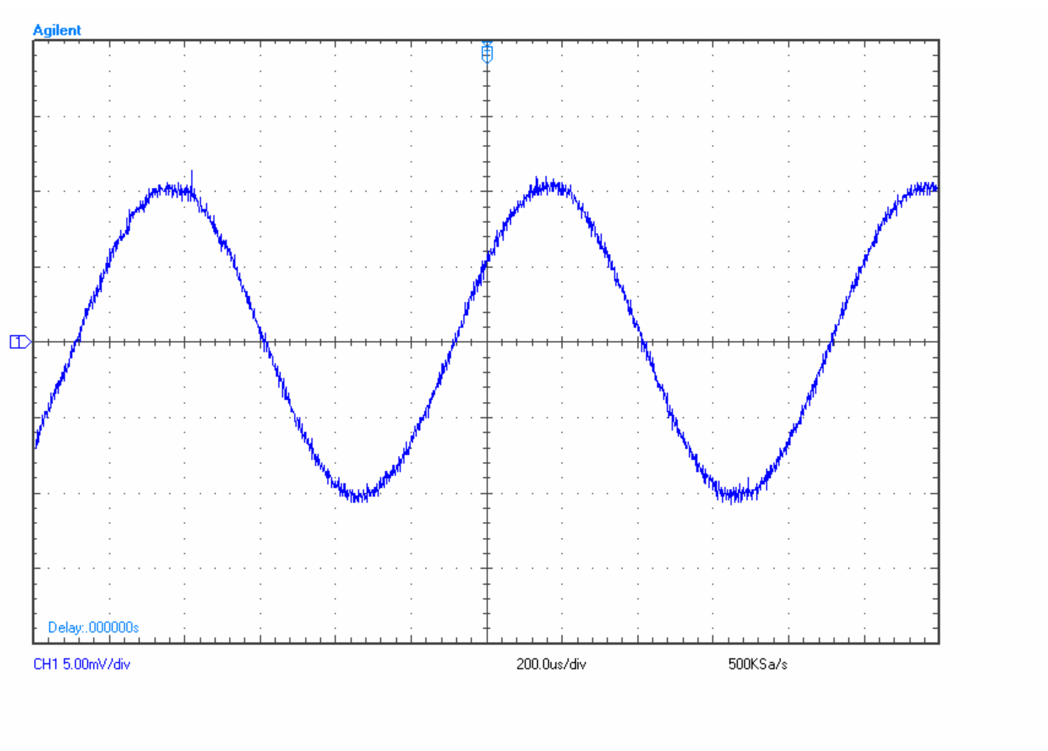
3. Click the icon in the toolbar (just below "Tools") for "Connect to Oscilloscope.) The front panel to the oscilloscope will now be <u>disabled</u>. Next click on "Refresh" and you should see after a few moments a view on the PC of what was on the oscilloscope:



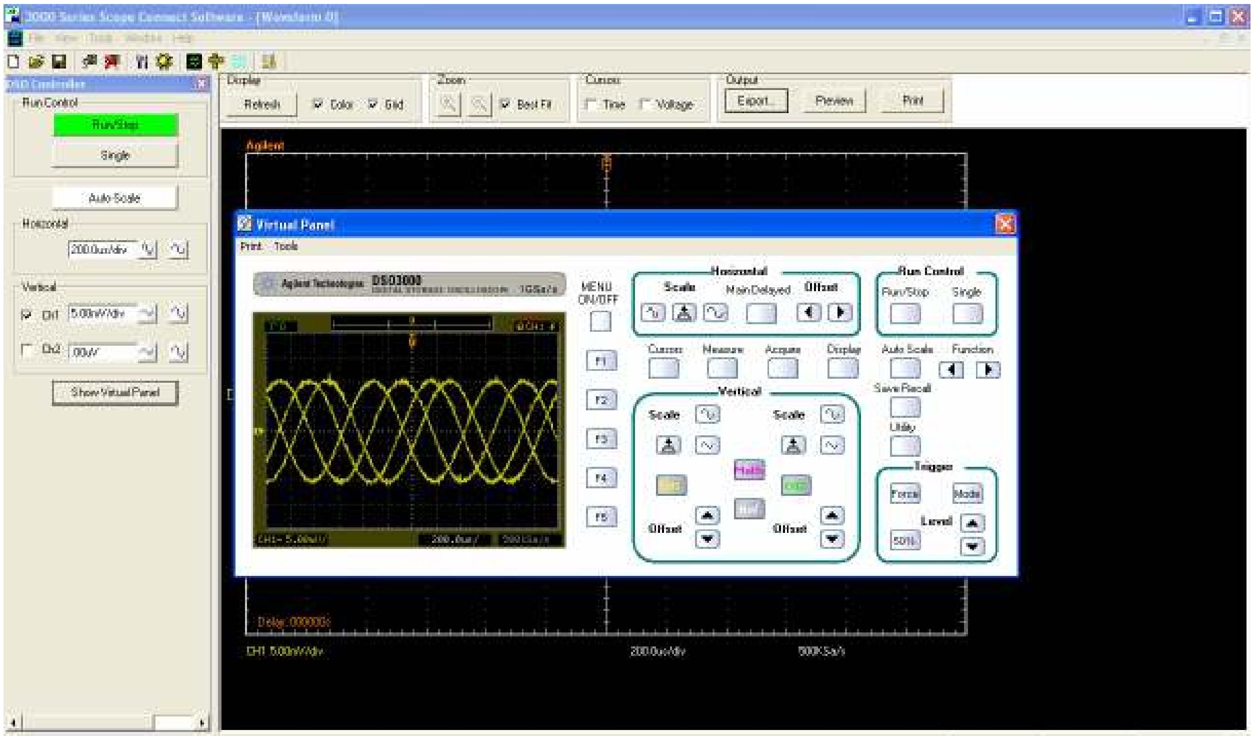
4. You can now export this oscilloscope screenshot by the "Export" button. You will have to specify a location and a filename. The above waveform (a bitmap file) is seen on the next page.



5. Anticipating the need to be able to print out the file and wanting to save on printer ink/toner, I opened up the image in Microsoft Paint and Inverted the colors. Now the black background is white and looks better (I think).



6. Lastly, if you were to click on the "Show Virtual Panel" on the left window, you will see the following:



All of the pushbuttons and menus that you would see on the actual oscilloscope can now be seen on the PC. You cannot turn the knobs on the oscilloscope, but there are arrow buttons to click to make the same changes. You can also make adjustments through the "DSO Controller" in the left window. The small buttons to the right of the window showing the settings (Volts/Div or Sec/Div) increase or decrease the settings in a fairly descriptive manner.