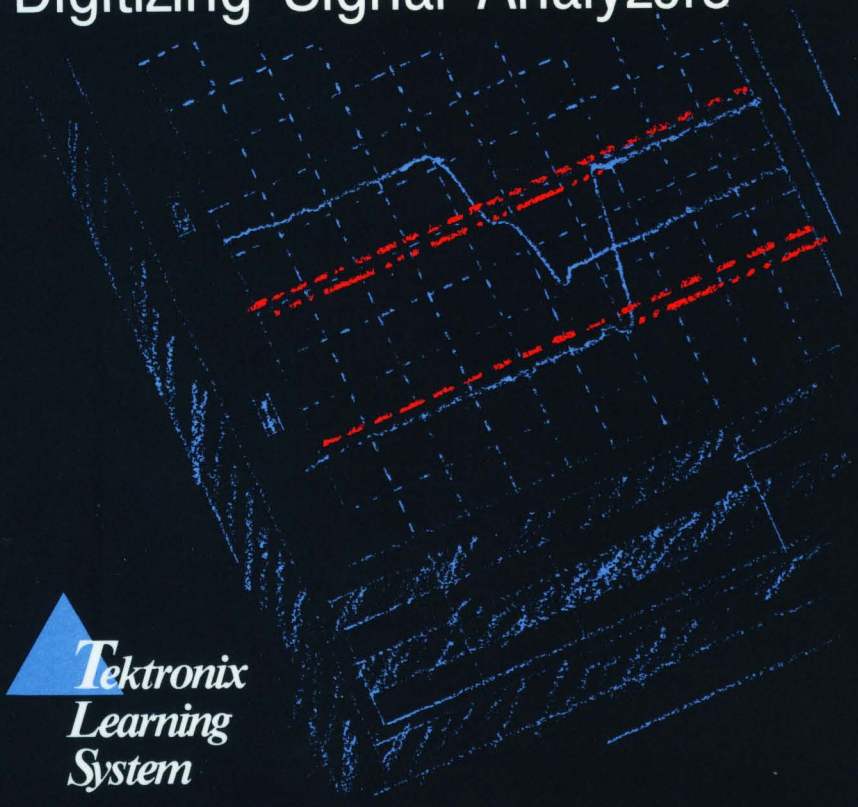
TEK Self-Study Series

Workbook

QuickStart Workbook

DSA 600 Series
Digitizing Signal Analyzers



Tektronix Learning System

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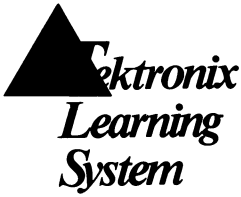
TEK **Self-Study Series**

Part No. 070-7499-00
Product Group 47

QuickStart Workbook

DSA 600 Series
Digitizing Signal Analyzers



Please check for CHANGE INFORMATION at the rear of this manual.

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Instrument Serial Numbers

Each instrument manufactured by Tektronix has a serial number on a panel insert or tag, or stamped on the chassis. The first letter in the serial number designates the country of manufacture. The last five digits of the serial number are assigned sequentially and are unique to each instrument. Those manufactured in the United States have six unique digits. The country of manufacture is identified as follows:

B010000	Tektronix, Inc., Beaverton, Oregon, USA
G100000	Tektronix Guernsey, Ltd., Channel Islands
E200000	Tektronix United Kingdom, Ltd., London
J300000	Sony/Tektronix, Japan
H700000	Tektronix Holland, NV, Heerenveen, The Netherlands

Instruments manufactured for Tektronix by external vendors outside the United States are assigned a two digit alpha code to identify the country of manufacture (e.g., JP for Japan, HK for Hong Kong, etc.).

Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077

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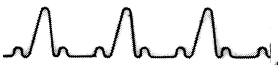
About This Manual



This workbook is part of the *QuickStart Package*, which also includes the QuickStart board and the board reference. There are many real-world examples in this workbook, both beginning and advanced, which will help you learn to use your DSA efficiently and accurately. The *QuickStart Package* is the second part of a training program that begins with the Tutorial.

Major Sections

The three major sections in this workbook are:

- Operator Overview introduces the *DSA 600 Series QuickStart Package* and how to use it with the following examples. Note the important safety information presented. Probe calibration is covered for accurate measurement results. This section is essential for successful completion of the Advanced Application examples.
- Getting Started covers the basics of DSA operation in four examples. Your *DSA 601 and DSA 602 Tutorial* is the preferred introduction to basic operation.
- Advanced Applications is a series of advanced examples that help you learn how use the many features of the DSA together to solve complex, real-world problems.

There are additional manuals that provide reference information and information about programming the DSA. The following page lists these manuals and their part numbers for ordering copies.

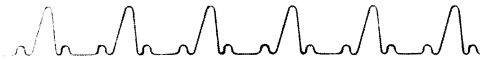
Please check for change information at the rear of this manual.

Related Manuals

Other manuals that complete the documentation set for the DSA 601 and DSA 602 Digitizing Signal Analyzers are:

- The *DSA 601 and DSA 602 Tutorial* (Tektronix part number 070-7249-00) gives step-by-step instructions that demonstrate basic operation of the DSA.
- The *DSA 601 and DSA 602 User Reference* (Tektronix part number 070-7250-00) covers all aspects of front panel operation. Use this manual to quickly gain information about a specific topic, or to get an overview of the menu system.
- The *DSA 601 and DSA 602 Programmer Reference* (Tektronix part number 070-7251-00) describes using a computer to control the DSA through GPIB or RS-232-C interfaces.
- The *DSA 601 and DSA 602 Command Reference* (Tektronix part number 070-7252-00) describes the commands used to program the DSA.
- The *DSA 601 and DSA 602 Service Reference* (Tektronix part number 070-7254-00) provides information to maintain and service components of the DSA, and provides a complete board-level description of DSA operation.

Table of Contents



OPERATOR OVERVIEW

Operator Overview

This section describes safety precautions, how to set up the QuickStart board, how to configure your DSA, and how to calibrate test probes and the QuickStart board. For instructions on how to perform new product installation on your DSA refer to the *DSA 601 and DSA 602 Tutorial* or *User Reference* manual.

Safety

The following safety information is provided for your protection and to prevent damage to the DSA. This safety information applies to all operators and service personnel.

Terms in Manuals

- *CAUTION* statements identify conditions or practices that could result in damage to the equipment or other property.
- *WARNING* statements identify conditions or practices that could result in personal injury or loss of life.

Terms on Equipment

- *CAUTION* indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.
- *DANGER* indicates a personal injury hazard immediately accessible as one reads the marking.

Symbols in Manuals

Static Sensitive Devices

Symbols on Equipment

DANGER
High Voltage

Protective ground
(earth) terminal

ATTENTION
Refer to manual

Power Source

The DSA is intended to operate from a power source that will not apply more than 250 V rms between the

supply conductors or between either supply conductor and ground.

Grounding the Digitizing Signal Analyzer

The DSA is grounded through the power cord. To avoid electric shock, plug the power cord into a properly wired receptacle where earth ground has been verified by a qualified service person. Do this before making connections to the input or output terminals of the DSA.

Without the protective ground, all parts of the DSA are shock hazards. This includes knobs and controls that may appear to be insulators.

Use the Proper Fuse

Using an improper fuse can create a fire hazard. Always use fuses that exactly meet the specifications in the DSA parts list. Match fuse type, voltage rating, and current rating.

CAUTION

Operating the DSA without the covers in place may cause overheating and damage.

Do Not Remove Covers or Panels

To avoid personal injury, do not operate the DSA without the panels or covers.

Do Not Operate in Explosive Atmospheres

The DSA provides no explosion protection from static discharges or arcing components. Do not operate the DSA in an atmosphere of explosive gases.

CAUTION

Applying a voltage outside the range printed on the plug-in amplifier can result in damage. Static electricity is also a hazard.

Electrostatic Discharge

Never apply a voltage to a plug-in amplifier that is outside the range printed on the front panel of the plug-in amplifier. Operate the DSA only in a static-controlled environment.

The QuickStart Package

The *QuickStart Package* includes this workbook, the QuickStart board, and a board reference and a power supply for the QuickStart board. In addition, an introductory video tape was shipped with your DSA that introduces the *QuickStart Package*.

For service or operating instructions for the QuickStart board not covered in this manual, refer to the *QuickStart Board Reference*. The QuickStart board is the test signal generating board that generates the signals for the examples in this workbook.

Replacement Information

You can order replacements for the major components of the *QuickStart Package* or the complete package as listed below:

- *DSA 600 QuickStart Workbook*
  Tektronix part number 070-7499-00
- *QuickStart Board Reference*
  Tektronix part number 070-7500-00
- QuickStart board
  Tektronix part number 671-0799-00
- Power supply (US)
  Tektronix part number 119-3306-00
- Power supply (European)
  Tektronix part number 119-3297-00
- Complete *DSA 600 QuickStart Package* (US)
  Tektronix part number 020-1769-00
- Complete *DSA 600 QuickStart Package* (European) Tektronix part number 020-1770-00

Additional Equipment Needed

You need the following equipment to perform the full QuickStart example set.

- Your DSA 600-Series Digitizing Signal Analyzer.
- Two plug-in amplifiers such as the 11A32 or 11A34 Amplifiers. The probe tip impedance must be 10 kΩ or greater to avoid loading the QuickStart board signals. Hence, a 50 Ω system (for example, an 11A52 Amplifier and a 500 Ω tip-impedance probe) will not work with these examples.
- Two 10X probes compatible with your plug-in amplifiers. The probe tip impedance must be 10 kΩ or greater to avoid loading the QuickStart board signals. If your are using 50 Ω plug-in amplifiers, such as the 11A52, 11A71, or 11A72, you will need high-impedance probes. Tektronix offers the P6201 and the P6202A probes with 50 Ω inputs and 1 MΩ probe tip impedance. Contact your local Tektronix Sales Office for more information on these probes.
- One coaxial BNC cable, approximately 10 inches long (such as Tektronix part number 012-0076-00).

Using the QuickStart Board

The QuickStart board provides signals for use with the workbook examples.

Features of the QuickStart Board

An illustration of the QuickStart board follows this discussion. You may want to refer to this illustration during the workbook examples to locate features.

The QuickStart board contains the following:

- Test points TP1 to TP15 provide probe tip connection to QuickStart board signals.

- Test point ground pins (GND) provide close grounding for the signal probes.
- Jumpers J1 to J8 configure the QuickStart board to provide a variety of signals.
- Reset switch (the push button) resets the QuickStart board when jumper J2 is moved. This switch is also used in some examples to produce random or single-shot pulses on certain test points.
- Power connector and power-on LED provide power connection and on/off status.
- Calibration adjustments 1 and 2 allow you to quickly calibrate the QuickStart board. This will ensure that your DSA response matches the workbook example illustrations.

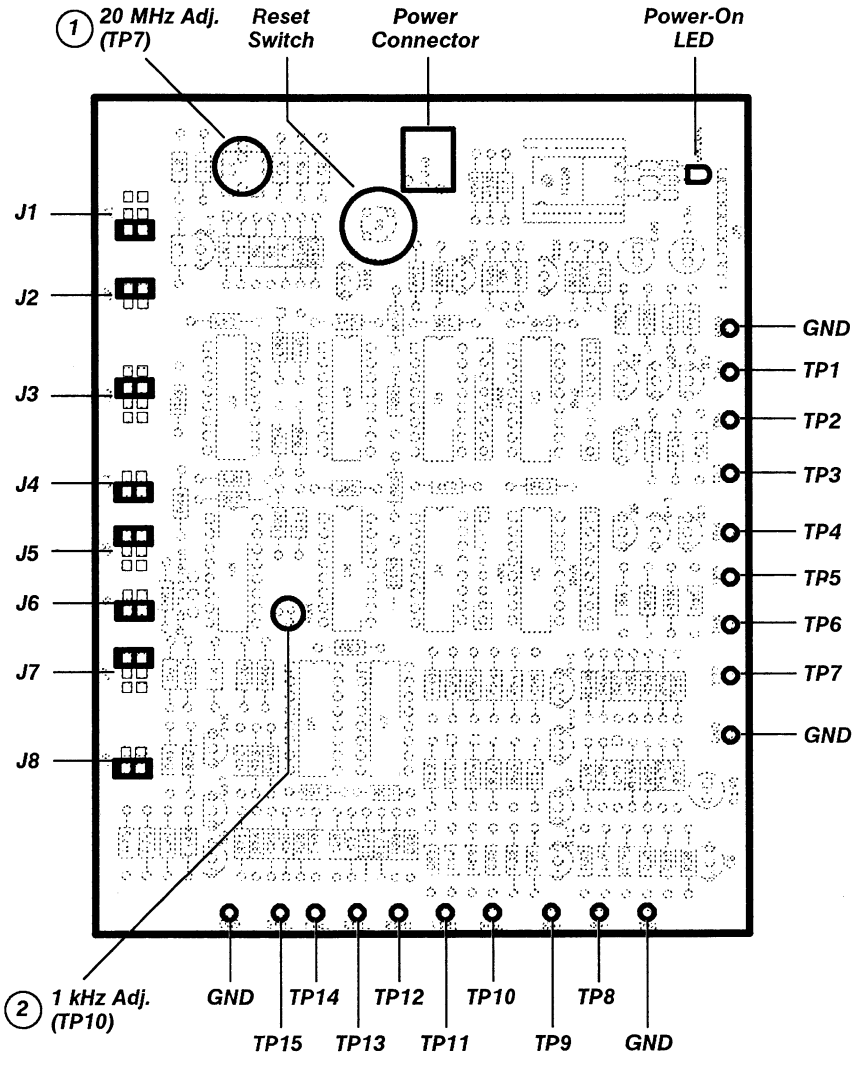
Applying Power to the QuickStart Board

The QuickStart board operates from the 9 V DC power supply included in the *QuickStart Package*. To apply power to the board, connect the power cord to the power connector on the QuickStart board and plug the transformer into your power system. You should see the power-on LED light.

QuickStart Jumpers	
J1	*C*
J2	*A*
J3	*B*
J4	*B*
J5	*A*
J6	*B*
J7	*A*
J8	*B*

Setting the QuickStart Board Jumpers

Each example procedure starts with a jumper setup table like that shown at left. It is very important that you set the QuickStart board jumpers at the start of each procedure. Some examples have the same settings, but many have unique jumper settings.



The QuickStart Board Jumpers, Test Points, and Adjustments

Calibrating the QuickStart Board

You should check the calibration of the QuickStart board to ensure that your DSA response matches the workbook example illustrations. See the previous illustration for adjustment locations and associated test points.

- Step 1: Connect a probe to CH 1 of the left plug-in amplifier. Attach the probe tip to the first adjustment test point, TP7.

QuickStart Jumpers	
J1	*C*
J2	*A*
J3	*B*
J4	*B*
J5	*A*
J6	*B*
J7	*A*
J8	*B*

- Step 2: Set the QuickStart jumpers as shown in the table at left.

- Step 3: Press the **UTILITY** button in the **MENUS** column and touch **Initialize Setting.** Touch **Initialize Setting** in the pop-up menu to verify your selection.

- Step 4: Press the CH 1 button of the left plug-in amplifier, then press the **AUTOSET** button. This will produce a good waveform for calibration.

- Step 5: Set the 20 MHz adjustment (1) for a full cycle duration of 50 ns.

  Alternatively, you can use the Frequency measurement. Press the **MEASURE** button, touch **Measurements** in the major menu, touch **Frequency** in the pop-up menu and **Exit Menu** to finish selection. Now adjust for a 20 MHz readout.

- Step 6: Move the probe tip to TP10 and press the **AUTOSET** button.

- Step 7: Set the 1 kHz frequency adjustment (2) for a full-cycle duration of 1 ms.

For a detailed adjustment procedure refer to the *QuickStart Board Reference* in the *QuickStart Package*.

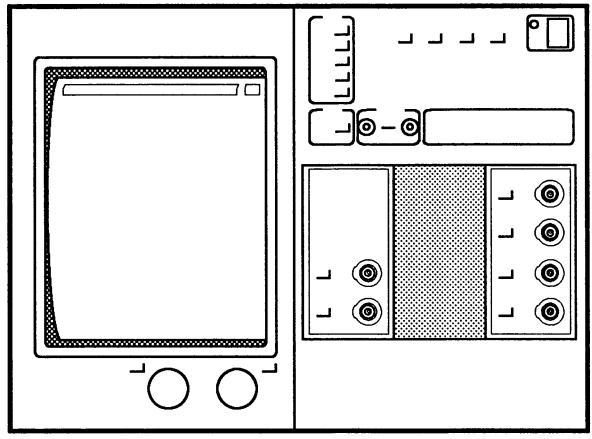
Using the QuickStart Board

You should run Enhanced Accuracy whenever the DSA prompts you during the examples to maintain the most accurate state. Use the nearest ground connector when connecting a probe to a test point to ensure good signal quality.

Always press the reset switch after you change the J2 jumper. This is the Eye Diagram function jumper and the QuickStart board must be reset whenever it is moved.

Setting Up Your DSA

The QuickStart examples assume you have your DSA set up as depicted below. You should have two plug-in amplifiers installed; one in the left and one in the right compartment. Always set the ON/STANDBY switch to STANDBY before installing or removing plug-in amplifiers. You will need two probes and a 10-inch long BNC coaxial cable for use during the examples. You will be asked to connect the probes during the first four examples. Initial installation of your DSA is covered in your *DSA 601 and DSA 602 Tutorial* and *User Reference*.



Initial Configuration of Your DSA

Calibrating and Deskewing Test Probes

You should calibrate each probe using the automated probe calibration function before beginning the Advanced Applications. Calibration takes only a few minutes and will ensure the highest level of measurement accuracy. The **Probes** function balances the vertical signal paths, aligns the trigger location, and adjusts for any differences in propagation delay between all calibrated channels.

Before you begin probe calibration, ensure that your DSA is in Enhanced Accuracy. Look for the symbol **EA** that appears left of the active graticule when Enhanced Accuracy is in effect. To enter Enhanced Accuracy, press the **ENHANCED ACCURACY** button twice. Automatic calibration will run for several minutes.

The DSA must be in Enhanced Accuracy before calibrating probes.

To calibrate each probe:

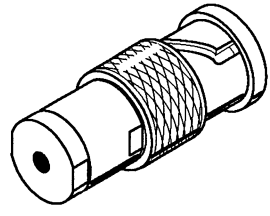
- Step 1: Connect the first probe to the middle **CALIBRATOR** connector and connect the probe ground to the left **CALIBRATOR** connector.
- Step 2: Press the **UTILITY** button in the **MENUS** column.
- Step 3: Touch the **Probes** selector then touch the channel name (for example, L1 or R1) for your probe from the **Probes** pop-up menu.

Calibration will proceed automatically for about a minute. Then you will be shown a rising-edge waveform so you can compensate your probe. When done, touch the **Select Next Chan** label to calibrate your next probe or **Exit Comp** to leave the **Probes** function.

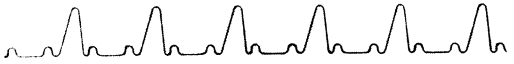
Calibrating Subminiature Probes

To calibrate subminiature probes, use the BNC to subminiature probe adapter that you received with your DSA. See the adapter illustration below. This calibration is particularly important whenever you enable the **Digitizer Interleave** function, such as during Example 8: Repetitive Single-Shot Acquisition.

To use the probe adapter, connect the BNC end to the **CALIBRATOR** BNC connector. Pull the clip off the probe tip, then unscrew the plastic sleeve off the probe tip to expose the metal barrel. This metal barrel fits snugly into the adapter. Carefully insert the probe into the adapter, pressing it in until firmly seated. Now, perform probe calibration as described above.



Adapter for Calibrating Subminiature Probes



GETTING STARTED

Getting Started

This section presents four examples that cover the basics of how to operate the DSA 600 Series Digitizing Signal Analyzers. For a more detailed introduction, you should perform the examples in the *DSA 601 and DSA 602 Tutorial*. If you have already performed the Tutorial examples go on to the Advanced Applications section of this workbook.

In this section you will learn about:

- Using the front panel buttons, touch panel, and on-screen menus
- Using signal inputs
- Creating and removing waveforms
- Using the automatic setup features
- Using the knobs and assigning knob functions
- Establishing a dual-graticule display
- Creating window (delayed sweep) waveforms

Refer to the Operator Overview section of this workbook for information on setting up and using the QuickStart board and for information on recommended plug-in units and probes. Installation instructions for your DSA are covered in the *DSA 601 and DSA 602 Tutorial* and *User Reference*.

You can execute all the examples in this section using your DSA and two plug-in amplifiers installed in the left and right plug-in compartments. You will also need two probes with at least 10 kΩ probe-tip impedance. Certain 50 Ω plug-in unit and probe combinations will not work with the QuickStart board. The examples will request that you to connect the probes.

Once you have completed these examples, you can proceed to the Advanced Applications section.

Example 1: Displaying a Waveform

Read the Operator Overview section for information on how to configure your DSA.

This example shows how you can quickly display a meaningful waveform. You will also become familiar with the basic DSA controls.

You will begin by initializing the DSA to its default settings. Each example in this manual begins with this step.

Major Menu Buttons

To the right of the display is a column of five buttons grouped under the title **MENUS**. Each button has an indicator light that shows which button was pressed last. Associated with each button is a major menu that appears at the bottom of the display.

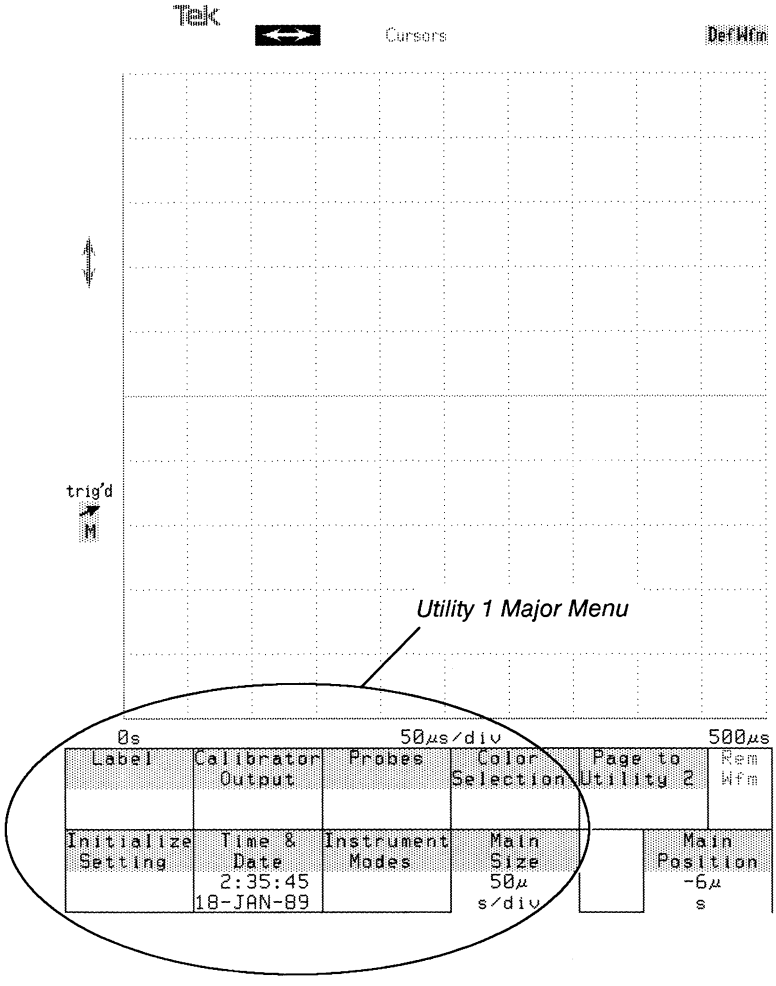
You may wish to press different major menu buttons and observe the changes on the display. Each major menu presents a group of controls that are related to each other.

- **WAVEFORM** controls waveform definition, plug-in amplifiers, and acquisition.
- **TRIGGER** controls triggering parameters, including trigger source, coupling, and slope.
- **MEASURE** controls the automatic measurement system.
- **STORE/RECALL** controls storage and recall of waveform data and DSA settings.
- **UTILITY** controls general DSA parameters such as display colors, GPIB, and RS-232-C settings, and the clock.

The Utility, Store/Recall, and Waveform major menus have two pages each. Press the appropriate menu button to display the first page of the major menu. Press the same button a second time to display the second page of the major menu.

- Step 1: Press the **UTILITY** button, located in the **MENUS** column. If you see a different major menu than is shown on the opposite page, press the **UTILITY** button again to change the page.

This illuminates the **UTILITY** button label and displays the Utility 1 major menu, as shown on the next page.



Utility 1 Major Menu on the Display

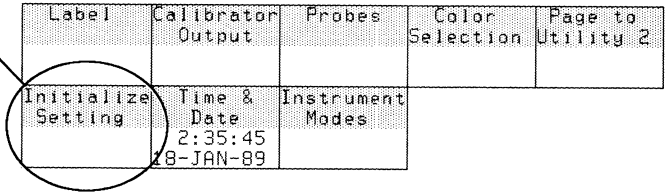
Touch Panel

You make selections from menus by touching the appropriate area. Until you remove your finger from the display, the DSA indicates your potential selection by outlining that selector. You can change your potential selection by dragging your finger to the desired selector before withdrawing it. The DSA does not perform any operation until you *remove* your finger from the display.

Menu Selectors

The Utility 1 major menu has eight selectors in ruled boxes. The top half of each selector shows the name of the selector with a shaded background, while the bottom displays the current status on a black background.

Initialize Setting *Selector*



The Utility 1 Major Menu

Selectors can be normal brightness like the ones you see in the Utility 1 major menu. A selector appears very dim if its function is not allowed in the current state. Bright appearance indicates a selector is already selected or being used.

Be sure that the **ON** *label beside the* **TOUCH PANEL** *button is lighted. This button is below the major menu buttons.*

The **Initialize Setting** selector operates when you touch it and then remove your finger:

- Step 2: Touch the **Initialize Setting** selector in the major menu area. Then touch the **Initialize Setting** selector that is displayed in the pop-up menu.

This sequence, pressing the **UTILITY** button and then touching the **Initialize Setting** selector, will always set the DSA to a default state.

Connecting Signals

To view a signal, you must connect it by probe or cable to an input connector on the plug-in amplifier.

- Step 3: Connect a probe to **CH 1** input of the left plug-in amplifier.
- Step 4: Connect the probe tip to TP11 on the QuickStart board.
- Step 5: Set the QuickStart jumpers as shown in the table at left.

QuickStart Jumpers	
J1	*C*
J2	*A*
J3	*B*
J4	*B*
J5	*A*
J6	*B*
J7	*A*
J8	*B*

Pressing the **CH #** button beside an input connector is a quick way to display that channel. The resulting light behind the **CH #** label tells you that channel is being displayed.

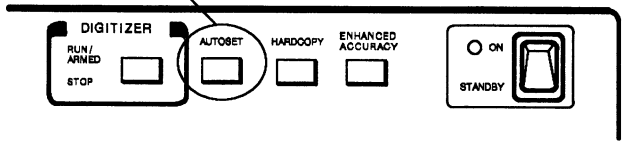
- Step 6: Press the **CH 1** button nearest the input connector that is connected to the probe.

The waveform on the display is not triggered. The trigger icon  is at the left of the graticule. The letter M refers to the Main time base trigger. The word **!not!** appears above the trigger icon meaning the DSA is not triggered. This icon always shows you the status of the trigger.

Autoset

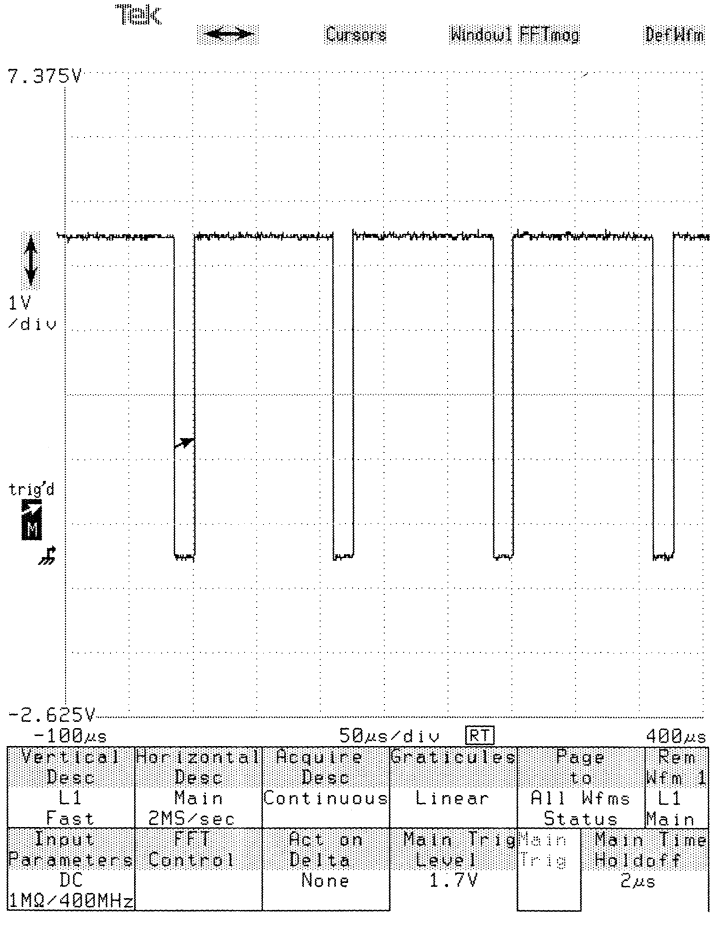
You now see an unstable waveform on the display. To quickly show the desired data, use the Autoset feature. The Autoset feature automatically sets the horizontal, vertical, and trigger parameters to display the connected signal.

The **AUTOSET** *Button*



■ Step 7: Press the **AUTOSET** button.

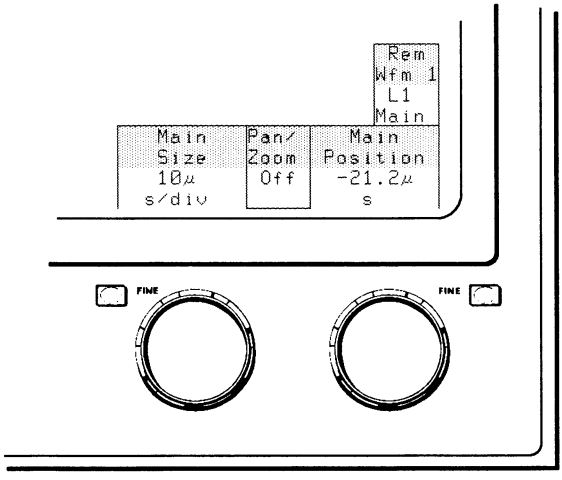
The small arrow at the left of the waveform shows you the trigger point.



QuickStart Board Signal after Pressing the **AUTOSET** *Button*

Knobs

There are two control knobs below the display. They adjust different things at different times. You can always look at the Knob menu to see the current *knob assignment.*



The Knobs and the Knob Menu

At present the Knob menu shows that the left knob controls the **Main Size** (Main time base time per division) parameter, and the right knob **Main Position** (Main time base position). The bottom half of each selector shows the current value of that parameter.

Always glance at the knob labels before using the knobs.

Selectors may perform specific tasks, assign the knobs, or do both. Each knob assignment remains in effect until you change it with another selector or by pressing a major menu button.

When you turn the knobs, you will feel clicks instead of smooth motion. Each click represents a minimum change; the DSA "counts clicks" to measure knob motion.

- Step 8: Turn each knob left and right, and observe the waveform changes. When done, restore the waveform to its original appearance by turning the knobs or by pressing the **AUTOSET** button above the plug-in compartments.

Icons

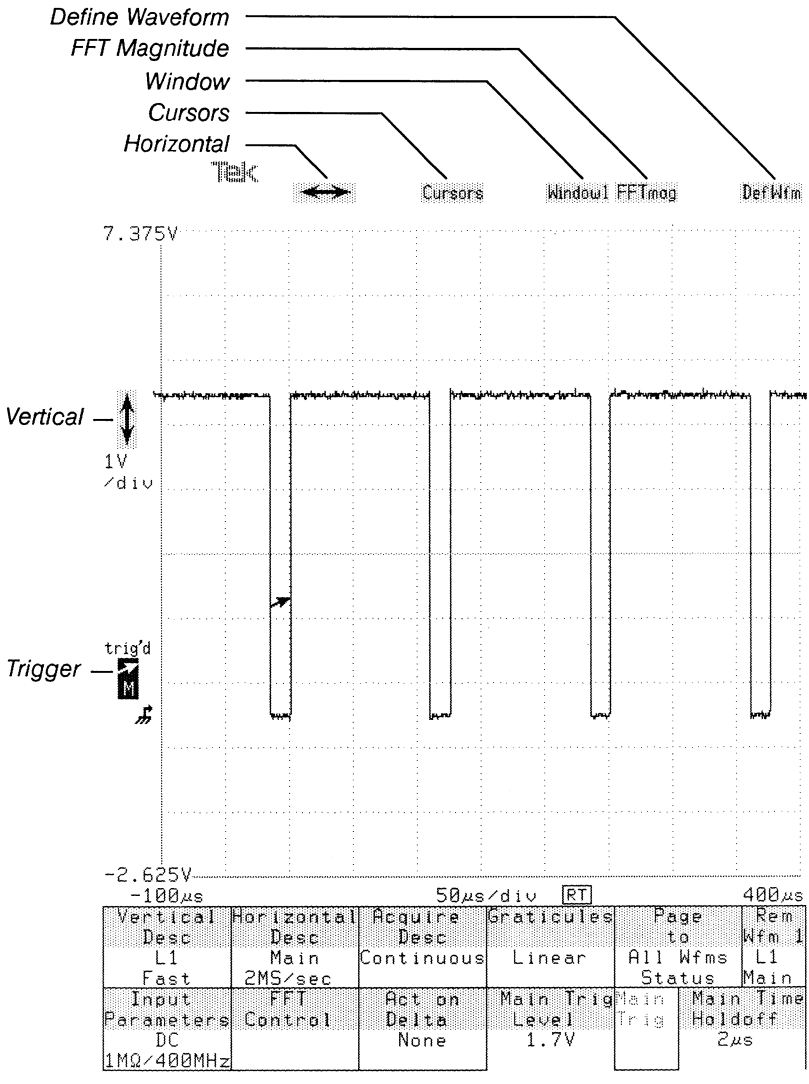
To control the vertical size and offset of a waveform, you need to reassign the knobs. You will use an icon to do this.

Above and to the left of the graticule are several icons. These icons are always available on the display regardless of the major menu being shown. The trigger icon, the vertical icon, and the horizontal icon assign the knobs. Since the current knob assignment is horizontal (main) size and position, the horizontal icon is highlighted.

- Step 9: Touch the vertical icon and turn each knob left and right. Observe that the icon highlights (brightens) and that the knob labels change to **Vertical Size: L1** and **Vertical Offset: L1**.

As you turn each knob left and right, observe the changes in the waveform. **Vertical Size** changes the plug-in amplifier sensitivity while **Vertical Offset** adds a DC offset to the plug-in amplifier input channel.

When all parts of the waveform are above or below the trigger indicator arrow, the waveform is not triggered and the display is not stable. When the waveform is not triggered, the notation **!not! trig'd** appears above the trigger icon.



Locations of Icons

Pop-Up Menus

When you touch some selectors, they display pop-up menus. These menus are a temporary dialog with you and cover a portion of the graticule. Most pop-up menus disappear automatically when you are through with them. Some pop-up menus provide **Exit** selectors to let you remove them.

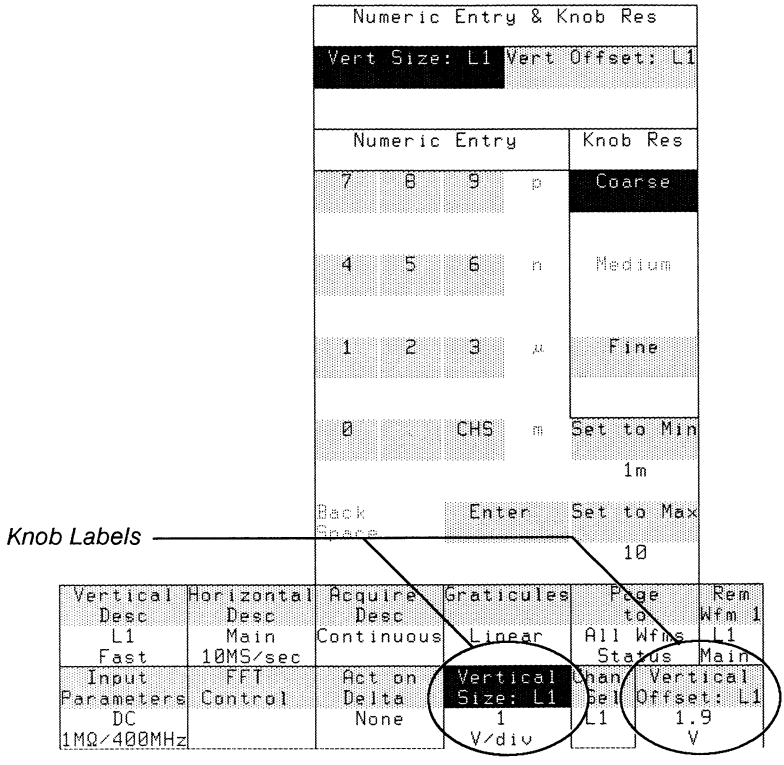
If you inadvertently display a pop-up menu and wish to remove it, touch the selector that displayed the pop-up menu. Or, you can touch a part of the graticule that has no waveforms on it.

Keypad Pop-Up Menu and Knob Resolution

The knobs can be adjusted to fine or coarse resolution using the **FINE** buttons beside the knobs, or using the Keypad pop-up menu. This menu also allows you to enter a numeric value for a knob parameter. The Keypad pop-up menu is displayed by touching either knob label selector in the Knob menu.

- Step 10: Press the **FINE** button next to the right knob and turn the knob.

Observe that the waveform moves in finer increments than before. This allows you to be precise in positioning the waveform.



The Knob Menu and Keypad Pop-Up Menu

Look at the **Set to Min** *and* **Set to Max** *selectors to see the valid range of any parameter.*

The Keypad pop-up menu can also set a parameter to its minimum or maximum using the **Set to Min** or **Set to Max** selectors.

- Step 11: Touch the **Vertical Size: L1** knob label, then touch the **Set to Max** selector in the Keypad pop-up menu.

Vertical Size is now the maximum volts per division, producing the smallest height waveform possible.

You can directly enter any value you wish using the Keypad pop-up menu.

- Step 12: Touch the **Vertical Size: L1** knob label. Then touch the following selectors: **7**, **5**, **0**, and **m**. Notice the entry line being formed above the **Numeric Entry** label in the pop-up menu. Use **Back Space** to remove incorrect entries. Touch **Enter** to complete the entry.

Vertical Size is now set to 750 mV per division.

Major Menu Knob Assignments

Pressing a major menu button can change knob assignments.

Whenever you select a major menu, the knob assignments will be the assignments that were in effect when that major menu was last active.

For example, you have the Waveform major menu selected. The current knob assignments are **Vertical Size: L1** and **Vertical Offset: L1**.

- Step 13: Press the **UTILITY** major menu button in the **MENUS** column.

The knob assignment changes to **Main Size** and **Main Position** because that was the last assignment made using the Utility 1 major menu. Note that the knob labels change color to indicate a change in function.

Example 2: Managing Multiple Waveforms

This example demonstrates multiple waveforms and graticules on the display. It also shows how to select and manage waveforms.

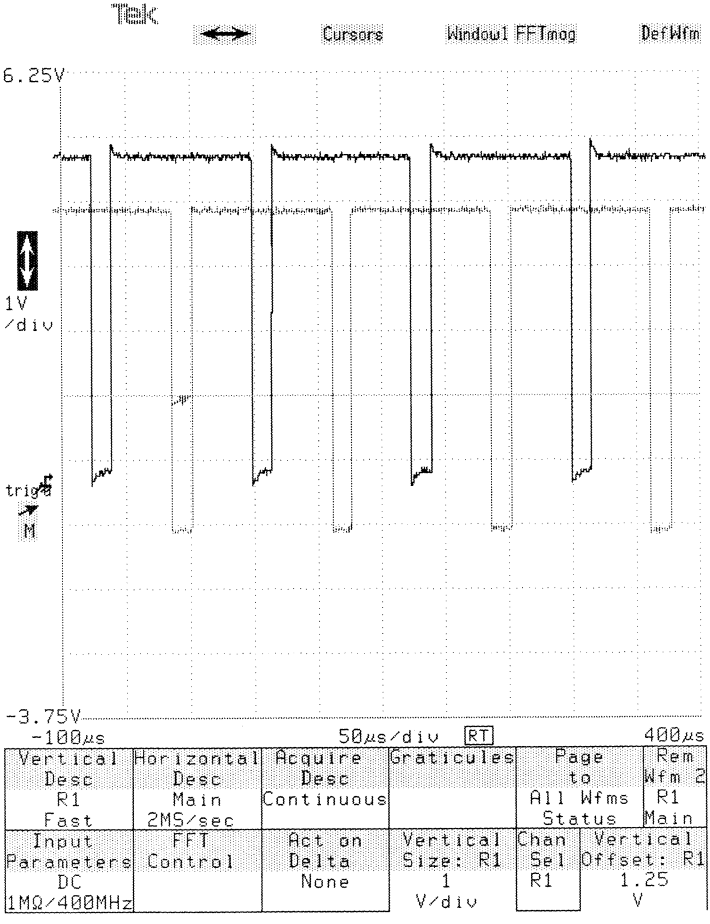
QuickStart Jumpers	
J1	*C*
J2	*A*
J3	*B*
J4	*B*
J5	*A*
J6	*B*
J7	*A*
J8	*B*

- Step 1: Press the **UTILITY** button in the **MENUS** column and touch **Initialize Setting** in the Utility major menu.
- Step 2: Set the QuickStart jumpers as shown in the table at left.
- Step 3: Attach the probe connected to **CH 1** of the left plug-in amplifier to TP11 on the QuickStart board.
- Step 4: Press the **CH 1** button on the left plug-in amplifier.
- Step 5: Press the **AUTOSET** button.

Adding a second waveform is similar to creating the first waveform.

- Step 6: Connect a probe to **CH 1** of the right plug-in amplifier and attach its probe tip to TP12 on the QuickStart board.
- Step 7: Press the **CH 1** button on the right plug-in amplifier.
- Step 8: Touch the vertical icon ↕ and set the **Vertical Size** knob to 1 V per/div. Adjust the **Vertical Offset** knob to position the new waveform above the first waveform, L1, and completely on the graticule.

A second waveform is displayed.



Graticule with Two Waveforms

You should be aware of two important points about this display.

- Both waveforms share the Main time base, and the horizontal axis labels.
- One waveform is displayed in bright yellow and the other in brown. The yellow waveform is the *selected* waveform. While the DSA can display up to eight waveforms at once, there is always one selected waveform. Most menu selectors, the knobs, the status displays, and Autoset apply to or operate on the selected waveform.

Selecting Waveforms by Touch

Touching a waveform makes it the selected waveform. If several waveforms overlap, repeatedly touching the same area will select the waveforms in succession.

■ Step 9: Touch the waveforms to change selections. Try touching an area with one waveform and an area where both appear.

The waveform vertical description is also called the waveform expression.

The Waveform major menu shows the status of the selected waveform. The **Vertical Desc** selector in this major menu shows the description of the selected waveform.

■ Step 10: Observe (don't touch) the **Vertical Desc** selector.

Vertical Desc	Horizontal Desc	Acquire Desc	Graticules	Page to	Rem Wfm 2
R1	Main	Continuous		All Wfms	R1
Fast	2MS/sec			Status	Main
Input Parameters	**FFT Control**	**Act on Delta**	**Vertical Size: R1**	**Chan Sel**	**Vertical Offset: R1**
DC 1MΩ/400MHz		None	1 V/div	R1	1.25 V

The Waveform Major Menu with the Knob Menu

If the selected waveform displays channel 1 of the left plug-in amplifier, then the **Vertical Desc** selector will show **L1**. Channels can be combined to form a single waveform, for example L1 + R2. Example 3 demonstrates combining channels.

The **Rem Wfm #** selector in the Knob menu always contains a description of the selected waveform and its acquiring time base. This selector appears in every major menu unlike the **Vertical Desc** selector which is only in the Waveform major menu.

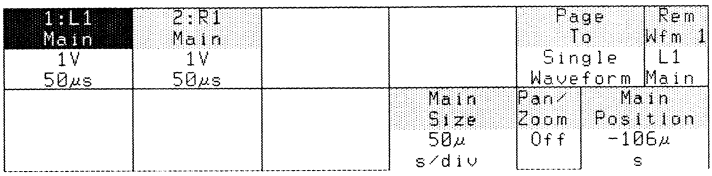
The number (#) in the **Rem Wfm #** selector is assigned by the DSA when the waveform is created. It should not be confused with the waveform description. Waveform numbers range from 1 through 8.

- Step 11: Select each waveform by touch, and observe the **Vertical Desc** and **Rem Wfm #** selectors.

Using the All Waveform Status Menu

Another method of selecting waveforms presents information about all displayed waveforms. The **Page to All Wfms Status** selector of the standard Waveform major menu displays an alternate major menu page.

- Step 12: Touch the **Page to All Wfms Status** selector in the Waveform major menu.



The All Waveforms Status Menu

The All Waveforms Status menu has a **Page to Single Waveform** selector to return you to the normal Waveform major menu—or press the **WAVEFORM** major menu button again.

The All Waveforms Status menu presents one selector for each displayed waveform. You can make any waveform the selected waveform by touching its selector.

- Step 13: Touch the waveform selector in the major menu that is not highlighted. Notice that it becomes highlighted and its waveform is highlighted on the graticule. Finish by touching the **1:L1:** selector to select waveform 1, then touching the **Page to Single Waveform** selector.

Labeling Waveforms

You can label displayed waveforms to help you keep track of them. You can create a label of up to ten characters for each waveform. You use the **Label** pop-up menu in the Utility 1 major menu to establish and control labels.

- Step 14: Press the **UTILITY** major menu button and touch the **Label** selector.

The **Display** selector of the **Label** pop-up menu turns on or off the display of all waveform labels.

- Step 15: If the **Display** selector shows Off, touch it to set it to On.

You touch the selector for the waveform that you want to label. As you type, this selector shows the characters.

- Step 16: If it is not already highlighted, touch the **Displayed Waveforms** selector.

- Step 17: Touch the selector for waveform 1 (the selector with the L1 vertical description).

The lower portion of this pop-up menu displays selectors that let you type the label. The selectors along the very bottom let you change the set of available characters to either **Upper Case**, **Lower Case**, or **Numbers** (which include most punctuation). **Back Space** lets you correct errors. **Erase** removes all label characters. **Exit** removes the pop-up menu.

- Step 18: Type a label of up to 10 characters. You might label the waveform "Left 1" or use your name. Finish by touching the **Exit** selector.

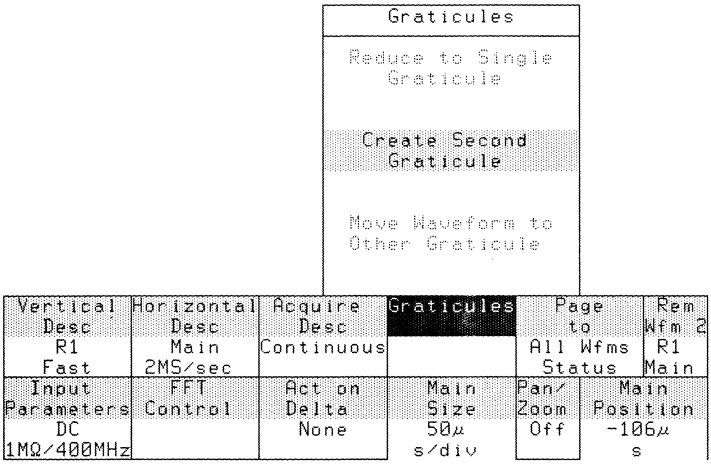
You can control the position of the label relative to the selected waveform. Use the **Position** selector of the **Label** pop-up menu to assign the knobs to position the label for the selected waveform.

- Step 19: Touch the **Label** selector in the major menu area, and touch the the **Position** selector in the **Label** pop-up menu. Use the knobs to position the label horizontally and vertically.

Displaying Dual Graticules

The **Graticules** selector can create a dual-graticule display. You can place waveforms on either graticule.

- Step 20: Press the **WAVEFORM** button, then touch the **Graticules** selector. Touch **Create Second Graticule**.

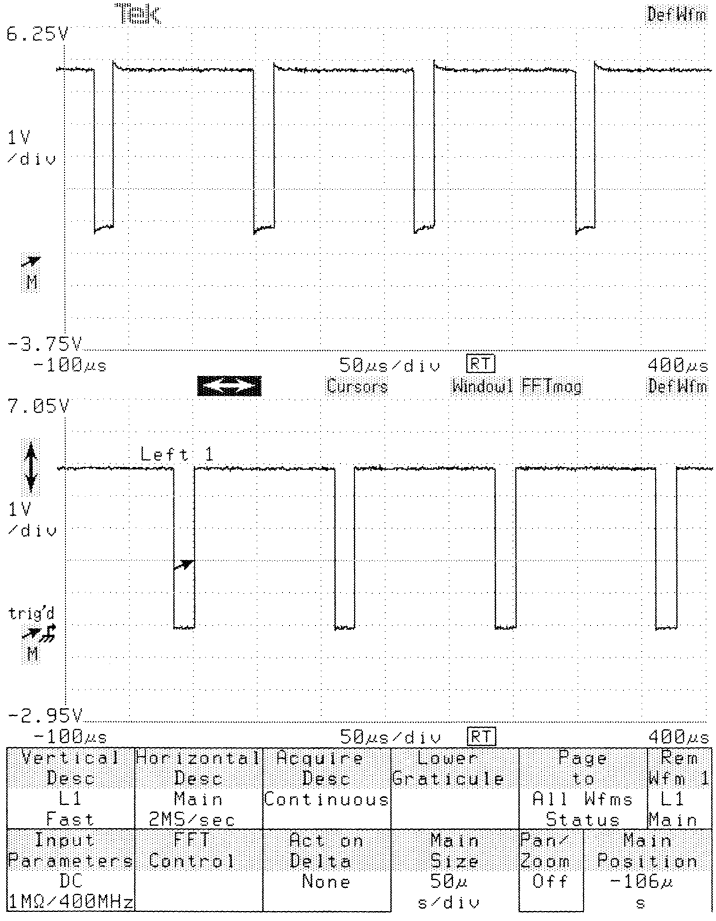


The **Graticules** *Pop-Up Menu*

The selected waveform appears yellow on the graticule with the horizontal ↔ and vertical ↕ icons; this is called the active graticule. If you select a waveform on the other graticule, it will become the active graticule.

- Step 21: Touch the **Lower Graticule** selector of the major menu (it was **Graticules**). Touch **Move Waveform to Other Graticule**; the selected waveform moves to the other graticule.

■ Step 22: Touch the **Upper Graticule** selector of the major menu (it was **Lower Graticule**). Touch **Reduce to Single Graticule**.



A Dual-Graticule Display

Removing Waveforms

Use the Knob menu to remove waveforms from the display.

- Step 23: Above the knob labels, touch the **Rem Wfm #** selector, and then touch **Rem Wfm #** in the pop-up menu.

This removes one of your waveforms, leaving one on the display. You could remove the remaining waveform using **Rem Wfm #** again. You can also remove the remaining waveform by pressing the **CH #** button for that channel.

If the **CH #** light is on, pressing the channel button removes *all* waveforms employing that channel.

- Step 24: Press the **CH #** button beside the lighted plug-in channel to remove the last waveform.

Example 3: Defining Complex Waveforms

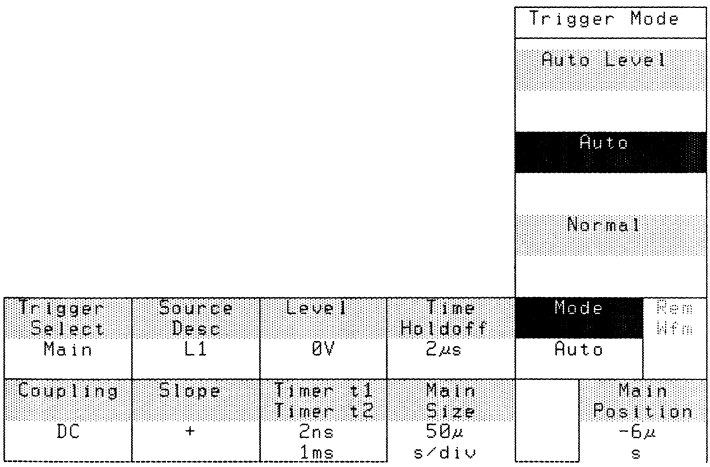
This example shows how you can create waveforms that combine signals from more than one channel.

QuickStart Jumpers	
J1	*C*
J2	*A*
J3	*B*
J4	*B*
J5	*A*
J6	*B*
J7	*A*
J8	*B*

- Step 1: Press the **UTILITY** button in the **MENUS** column and touch **Initialize Setting** in the Utility1 major menu.
- Step 2: Set the QuickStart jumpers as shown in the table at left.
- Step 3: Attach the probe connected to **CH 1** of the left plug-in amplifier to TP11 on the QuickStart board. Attach the probe connected to **CH 1** of the right plug-in amplifier to TP12.

Trigger Mode

This example will use **Auto Level** triggering, which adjusts the trigger level automatically to match the signal. The default trigger mode is **Auto** trigger, not **Auto Level** trigger.



The **Mode** *Pop-Up Menu*

- Step 4: Press the **TRIGGER** button in the **MENUS** column and touch the **Mode** selector in the Trigger major menu. Touch the **Auto Level** selector in the pop-up menu.

Displaying a Waveform Without Autoset

You can also easily display waveforms without using Autoset.

- Step 5: Press the **CH 1** button on the left plug-in amplifier.

Turn the left knob to adjust the **Main Size** to 50 µs/div. *Do not use the* **AUTOSET** *button!*

- Step 6: Touch the vertical icon ↕ and use the left knob to adjust the **Vertical Size** to 2 V/div. Use the right knob to move the waveform to the top portion of the graticule. *Make sure all parts of the waveform remain on the graticule.*

Note that the trigger indicator arrow automatically follows the waveform.

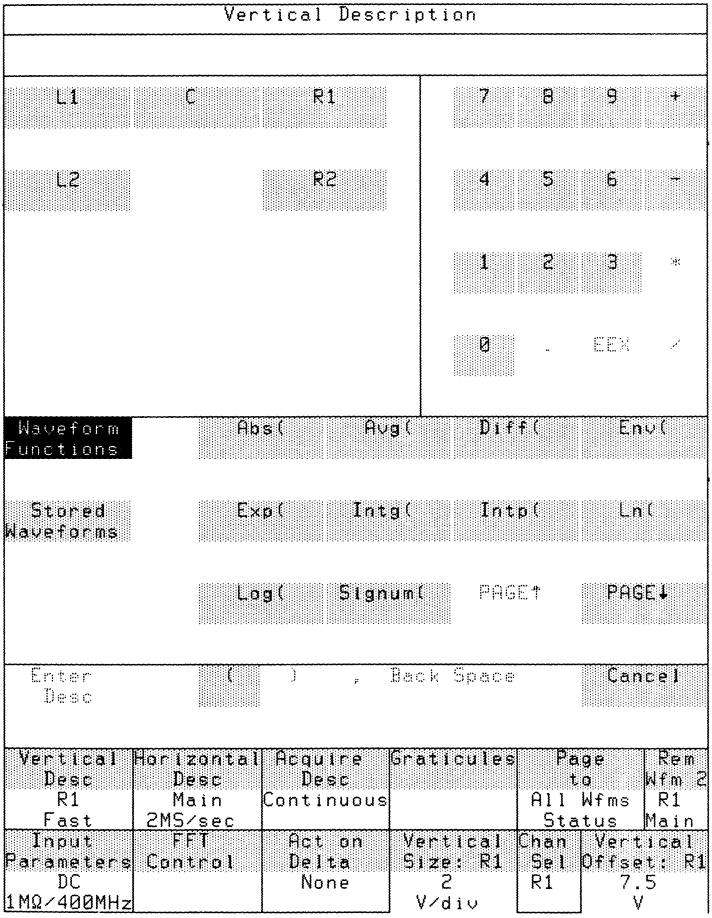
- Step 7: Press the **CH 1** button on the right plug-in amplifier. Use the left knob to set the **Vertical Size** of the new waveform to 2 V/div. Use the right knob to move the waveform to the bottom portion of the graticule. *Make sure all parts of the waveform remain on the graticule.*

Waveform Descriptions

You wish to display a waveform that represents the sum of two signals (L1 + R1). Up to now, you have pressed the channel buttons on the plug-in amplifiers to display single-channel waveforms. That is a shortcut method limited to single-channel waveforms.

If you touch the **DefWfm** *icon by accident, you can touch the* **Cancel** *selector to get out of the pop-up menu.*

The Define Waveform icon (**DefWfm**) defines and creates new waveforms. It displays the same pop-up menu presented when you touch the **Vertical Desc** selector of the Waveform major menu. The **Vertical Desc** selector only allows you to view and change the description of an existing waveform.



The **DefWfm** *Pop-Up Menu*

■ Step 8: Touch the **DefWfm** icon.

The selectors in this pop-up menu are keystrokes that you use to build a waveform description. As you enter keystrokes, the description is shown at the top of the menu. These selectors are available:

You don't need to display the source waveforms to create a complex waveform.

- **Channel Selectors** specify an input channel.
- **Numeric Pad** allows entry of numeric constants and arithmetic operators of addition, subtraction, multiplication, and division.
- **Waveform Functions** specify functions such as logarithms, differentiation, and averaging.
- **Stored Waveforms** specify a previously stored waveform.
- **Syntax** includes parentheses, **Back Space** (which can be used for successive entries), and **Enter Desc** (which enters your completed description, removes the pop-up menu, and creates the waveform).
- **Cancel** removes the pop-up menu and any waveform definitions you have entered.

■ Step 9: Touch **L1**, **+**, **R1**, and **Enter Desc** all in the pop-up menu.

When you create the new waveform, it is the selected waveform. The waveform description, L1 + R1, appears in the **Vertical Desc** selector in the Waveform major menu and in the **Rem Wfm 3** selector in the Knob menu.

Vertical Adjustment of Complex Waveforms

You can change the vertical size and offset of only one input channel at a time, even if the selected waveform represents several inputs.

- Step 10: Touch the top waveform (L1) to select it.
- Step 11: Touch the vertical icon ↕ if it is not already highlighted. Turn the right knob counter-clockwise two or three clicks.

As the selected L1 waveform moves down, the complex L1 + R1 waveform also moves down.

- Step 12: Set the right knob to fine resolution by pressing its **FINE** button.

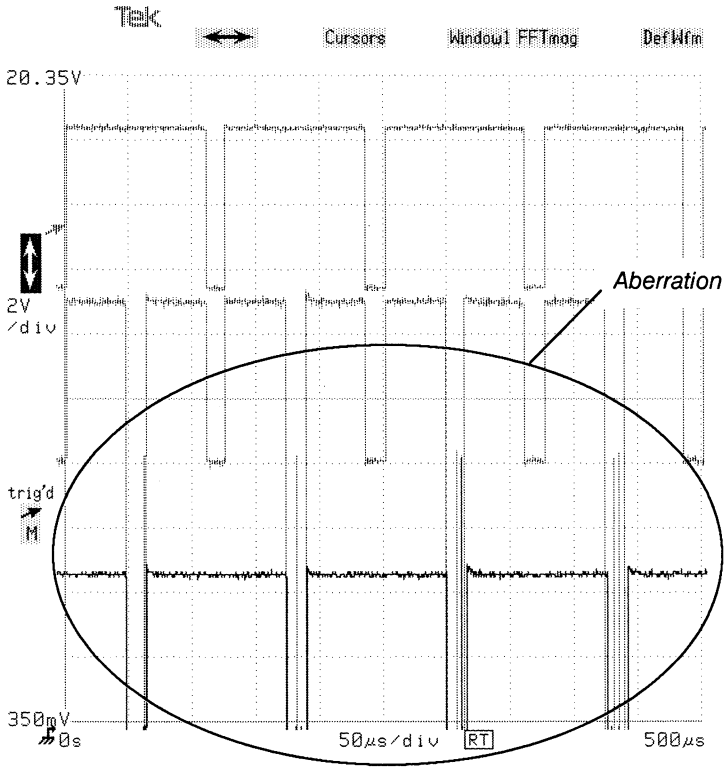
Unless all component waveforms have the same vertical size, a complex waveform will have undefined vertical units.

- Step 13: Touch the bottom waveform to select it. Use the right knob to move the *bottom* edge of this waveform partially off the display.

When the bottom edge of the bottom waveform is partially off the graticule, the complex L1 + R1 waveform becomes ragged. This aberration is caused when a component signal moves off the graticule.

- Step 14: Use the right knob to move the R1 waveform completely back onto the graticule.

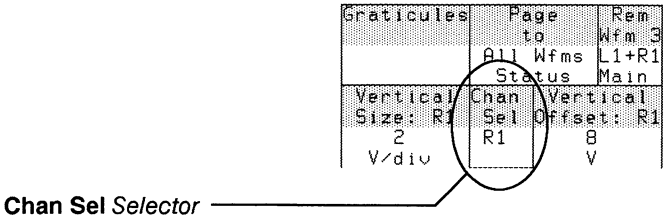
Usually, when you display a complex waveform, the waveforms that represent the individual channel signals are not displayed.



Complex Waveform Aberration Caused by Off-Graticule Component

You can select this complex waveform and move it with the knobs. However, when you do this you are actually moving only one component input channel of the complex waveform.

Whenever the knobs are set to vertical size and offset, the Knob menu selector becomes a **Chan Sel** selector. Repeatedly touching the selector allows you to choose from all of the input channels that make up the waveform.



The **Chan Sel** *Selector in the Knob Menu*

- Step 15: Touch the middle (L1 + R1) waveform to select it.

- Step 16: Touch the **Chan Sel** selector in the Knob menu until it shows **R1**. Use the right knob to position the selected waveform up and down.

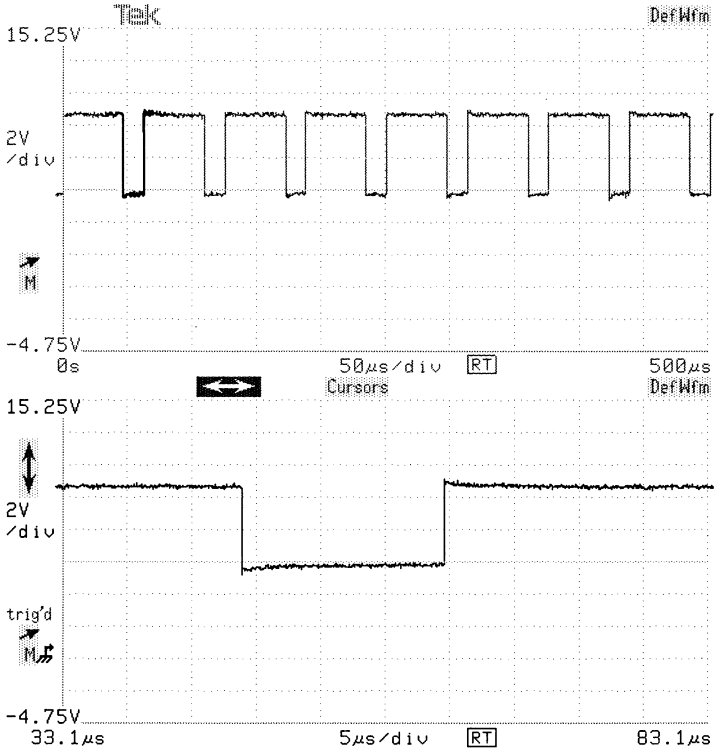
As you move the complex waveform up and down, the R1 waveform moves up and down also. This operates the same as if the R1 waveform were selected.

The remainder of this example is performed without multiple waveforms on the display.

- Step 17: Select and remove each of the simple waveforms that represent a single input channel. Do not remove the waveform (L1+R1). Use the **Rem Wfm #** selector in the Knob menu.

Windows A window is a waveform that represents a horizontally magnified portion of another waveform. A window waveform is sampled independently from the main waveform it is magnifying. Windows are created by touching the **Window1** icon above the graticule.

■ Step 18: Touch the **Window1** icon.



A Window Waveform Display

You can move window waveforms from one graticule to another, or combine them into a single graticule display.

The DSA automatically adds a second graticule with the window waveform. The main waveform is placed on the top graticule and its blue portion shows what the window waveform is displaying.

In Example 2, when you created a dual-graticule display, both waveforms shared the same time base. Here the two waveforms have different time bases. This can be seen in the graticule labels.

- Step 19: Touch the horizontal icon ↔ and turn the right **Window Position** knob left and right. The blue portion of the main waveform moves and the window waveform tracks it.

- Step 20: Turn the left **Window Size** knob left and right one click at a time. The size of the blue area changes and the window waveform reflects that change.

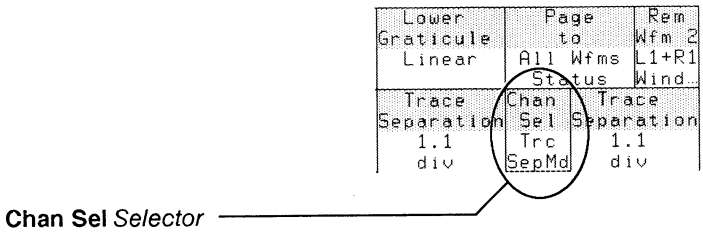
- Step 21: Touch the main waveform on the top graticule to select it. The icons move to the top graticule. Turn the left knob counterclockwise one, and then two, clicks. Observe that resizing the main waveform does not affect the window waveform.

When you made the main waveform the selected one, a **Window2** icon appeared, which allows you to create a second window waveform.

- Step 22: Touch the **Window2** icon on the top graticule.

The second window waveform is created with its own highlighted portion on the main waveform. Both window waveforms share a time base and always have the same horizontal scale.

The two window waveforms are placed on top of each other. You can separate them vertically. Normally, the **Chan Sel** selector of the Knob menu, on successive touching, shows all the channels that are represented in the waveform. For window waveforms, this selector also includes a **Trc Sep Md** (trace separation mode) setting which causes the knobs to move the selected window waveform vertically. This moves only the selected waveform.



The **Chan Sel** *Selector Showing* **Trc Sep Md**

- Step 23: Touch the vertical icon ↕ and then repeatedly touch the **Chan Sel** selector in the Knob menu until it displays **Trc Sep Md**.
- Step 24: Turn either knob and observe the selected window waveform move up or down.

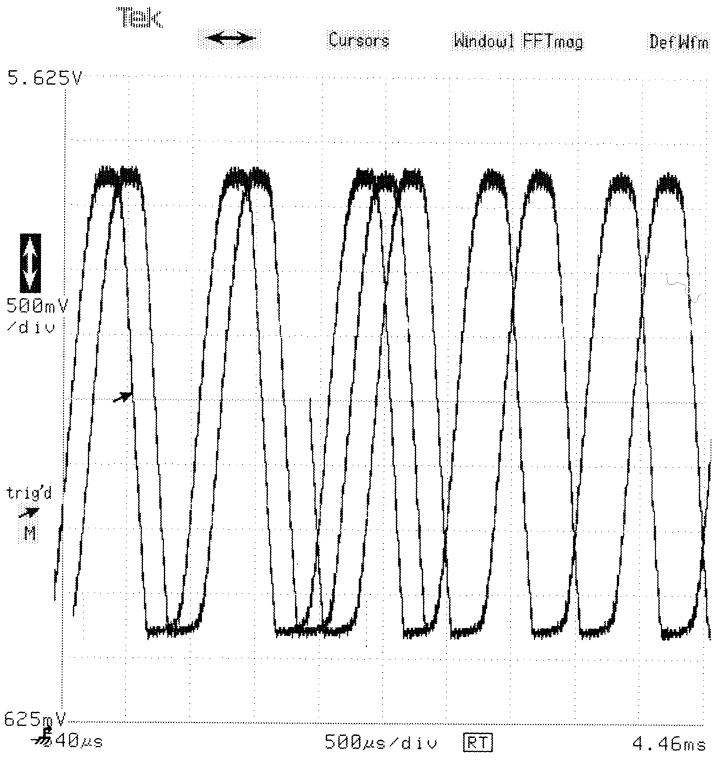
Example 4: Using Signal Processing

This example demonstrates several ways that the DSA processes your signals to provide more meaningful displays.

QuickStart Jumpers	
J1	*B*
J2	*A*
J3	*B*
J4	*B*
J5	*A*
J6	*B*
J7	*A*
J8	*B*

- Step 1: Press the **UTILITY** button in the **MENUS** column and touch **Initialize Setting** in the Utility major menu.
- Step 2: Set the QuickStart jumpers as shown in the table at left.
- Step 3: Attach the probe connected to **CH 1** of the left plug-in amplifier to TP10 on the QuickStart board.
- Step 4: Press the **CH 1** button on the left plug-in amplifier.
- Step 5: Use the left knob to set the **Main Size** to 500 µs/div.
- Step 6: Touch the vertical icon ↕ and set the **Vertical Size** knob to 500 mV/div. Adjust the **Vertical Offset** knob to position the waveform near the middle of the display.

The noise in the signal causes unstable triggering of this waveform. During the course of this example, you will examine the cause of the trigger instability.



The Signal with Trigger Instability

Impedance, Coupling, and Bandwidth Limit

The **Input Parameters** selector of the Waveform major menu lets you set these parameters of any plug-in amplifier channel.

The pop-up menus displayed by the **Input Parameters** selector take into account the capabilities of the plug-in amplifier channels. This pop-up menu displays selectors that match the available channel settings.

- Step 7: Touch the **Input Parameters** selector to display the pop-up menu.

The top part of this pop-up menu lets you select which channel to set. The bottom part of the pop-up menu shows you the possible bandwidth, coupling, and impedance settings for the selected channel. In all parts of this pop-up menu, the current choices are highlighted.

- Step 8: If it's not already highlighted, touch the **L1** selector. Then touch the selector to set the bandwidth to the lowest setting, for example **20 MHz**. Touch the **Input Parameters** selector to remove the pop-up menu.

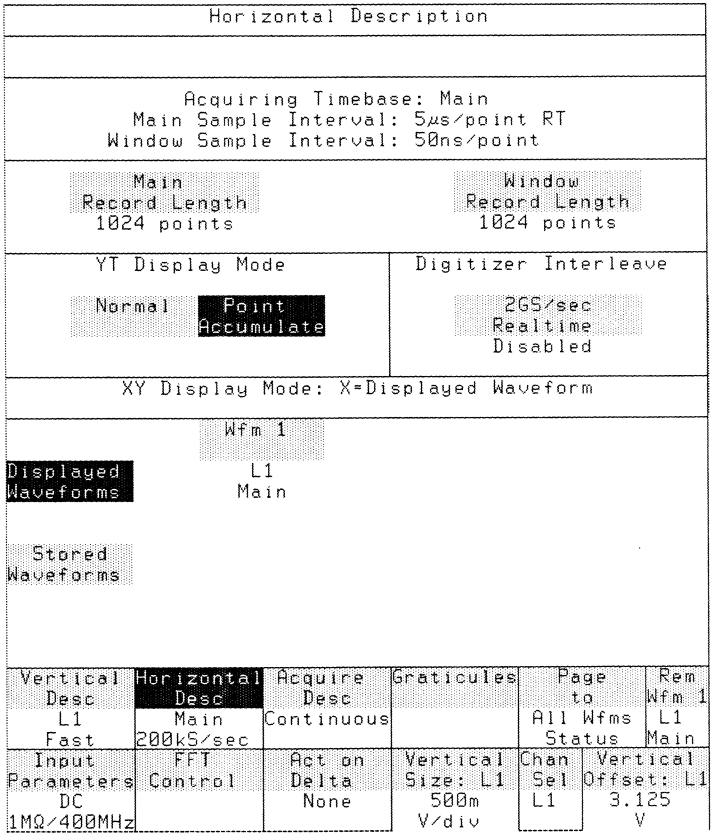
The triggering of the displayed waveform is now stable. This implies that the trigger instability has something to do with high-frequency noise or a high-frequency aberration.

You set impedance and coupling in a similar manner. For the 11A33 Differential Amplifier, you can set coupling separately for each input to a channel.

- Step 9: Reset the bandwidth to the maximum: touch the **Input Parameters** selector in the Waveform major menu, touch the highest frequency bandwidth selector for the channel in the pop-up menu, and touch the **Input Parameters** selector again to remove the pop-up menu.

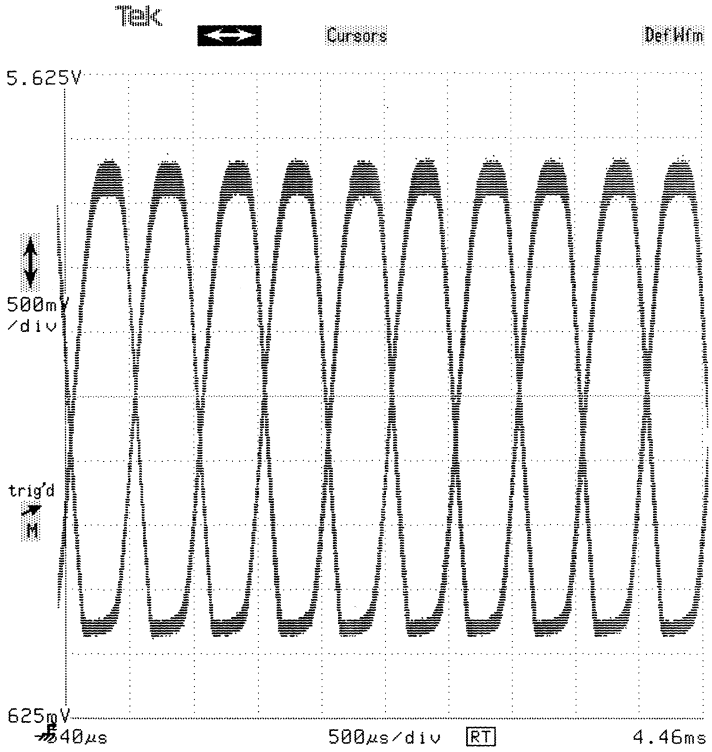
Point Accumulate Mode

Another method for observing waveform noise is to use the Point Accumulate feature, available through the **Horizontal Desc** pop-up menu. This leaves earlier waveform data on the display as new data is added and builds a history of displayed points.



The **Horizontal Desc** *Pop-Up Menu*

- Step 10: Touch the **Horizontal Desc** selector in the major menu and the **Point Accumulate** selector in the pop-up menu.



A Point Accumulate Waveform

The broad waveform shows the noise amplitude and the affects of triggering on both waveform slopes. The triggering is unstable because valid trigger events occur on positive and negative slopes of the sinewave. You will take a closer look at the noise in the next step.

- Step 11: Touch the horizontal icon ↔ and slowly adjust the **Main Size** knob to 100 ns/div.

At each knob click, the waveform is cleared and data accumulation begins. This prevents inappropriate data from being displayed with a point accumulate waveform. The waveform shows the noise amplitude at this horizontal scale. Turn off the point accumulate mode to see the triggered 40 MHz noise.

- Step 12: Touch **Horizontal Desc** in the Waveform major menu and **Normal** in the pop-up menu to turn off point accumulation.

The unstable triggering seen earlier results from the trigger circuit triggering on positive transitions of the noise which occur on both the positive and negative slopes of the slower sine wave.

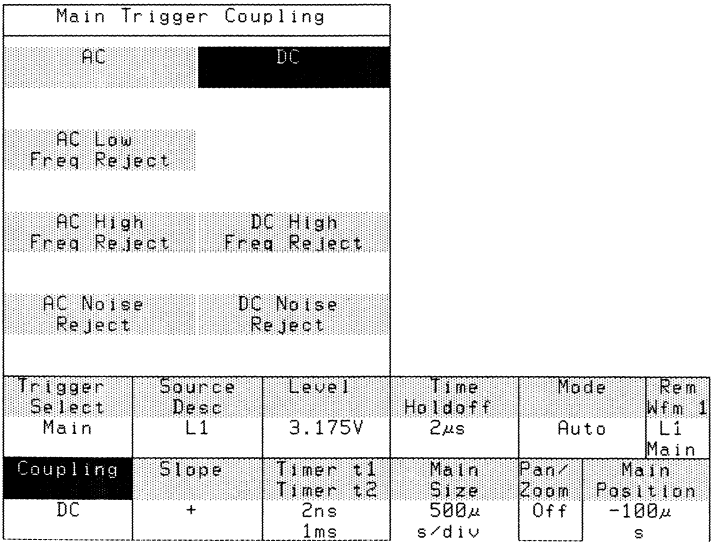
- Step 13: Touch the horizontal icon ↔ and set the **Main Size** knob back to 500 µs/div.

Trigger Coupling

Trigger coupling allows you to choose AC or DC trigger signal coupling and several trigger signal filters. The trigger signal filters can remove low or high frequency noise from the trigger signal to provide a more stable waveform display.

The DC high frequency reject filter will stop your signal from triggering on alternate slopes of the noise. This will ensure a better averaged waveform later.

- Step 14: Press the **TRIGGER** button in the **MENUS** column and touch **Coupling** in the major menu.
- Step 15: Touch the **DC High Freq Reject** selector in the **Coupling** pop-up menu.



The **Coupling** *Pop-Up Menu*

Averaging and Enveloping

An averaged waveform is one where several waveform records (successive waveform acquisitions) are combined. Each displayed point of the resulting waveform is an average of all the corresponding points in the individual records. This reduces the random noise on the displayed waveform.

Enveloping is similar in that several waveform records are collected. Instead of a single-point average, the envelope displays the maximum and minimum excursion of the samples. This shows the accumulated variation of the signal.

The **DefWfm** pop-up menu has **Avg(** and **Env(** selectors. Typically, an averaged waveform description:

Avg(L1 + R1)

would be entered with the selectors:

DefWfm Avg(L1 + R1) and **Enter Desc**.

A shortcut is available to apply averaging or enveloping to an existing waveform description. The Waveform major menu's **Acquire Desc** pop-up menu provides **Average N** and **Envelope N** selectors to set these functions on and off.

- Step 16: Touch the **Acquire Desc** selector in the Waveform major menu.

- Step 17: Touch the **Average N** selector in the pop-up menu and then **Acquire Desc** in the major menu to remove the pop-up menu.

The averaged waveform appears less noisy. While the individual waveforms are acquired, the current record number is displayed in the **Acquire Desc** selector. The waveform description in the **Vertical Desc** selector is Avg(L1), showing that averaging has been added to your earlier description.

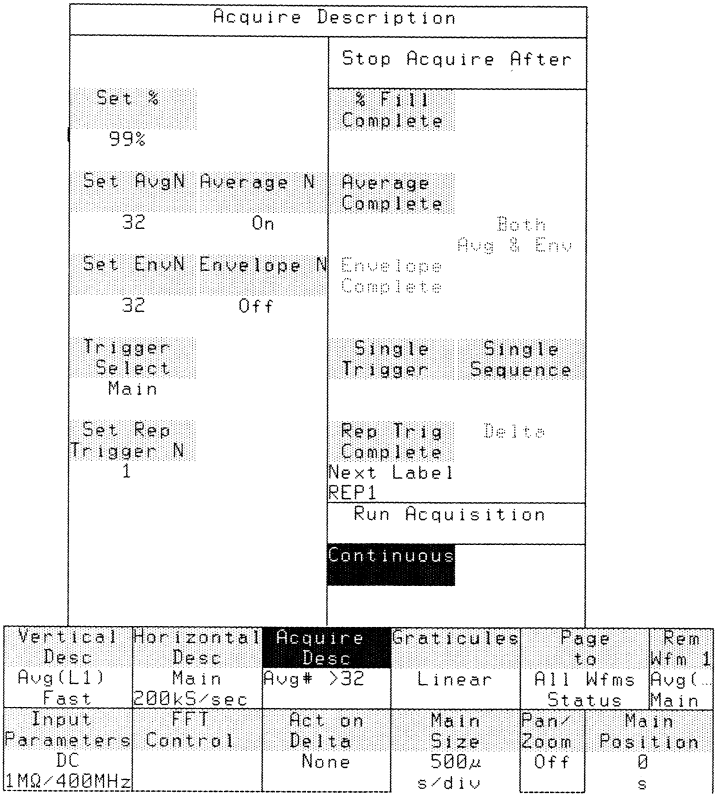
You can change the number of records in an average from the default of 32.

- Step 18: Touch **Acquire Desc** in the major menu and then touch **Set AvgN** in the pop-up menu. Adjust the left knob to change the average count. Touch the **Acquire Desc** selector to remove the pop-up menu.

Each time you click the knob, a new average begins. If you want the DSA to stop acquiring data after the required number of averages, you can use the **Average Complete** selector in the Stop Acquire After section of the pop-up menu.

- Step 19: Touch **Acquire Desc** in the Waveform major menu and **Average Complete** in the pop-up menu. Touch **Acquire Desc** to remove the pop-up menu

The DSA stops acquiring data when the average is complete, leaving a stable display.

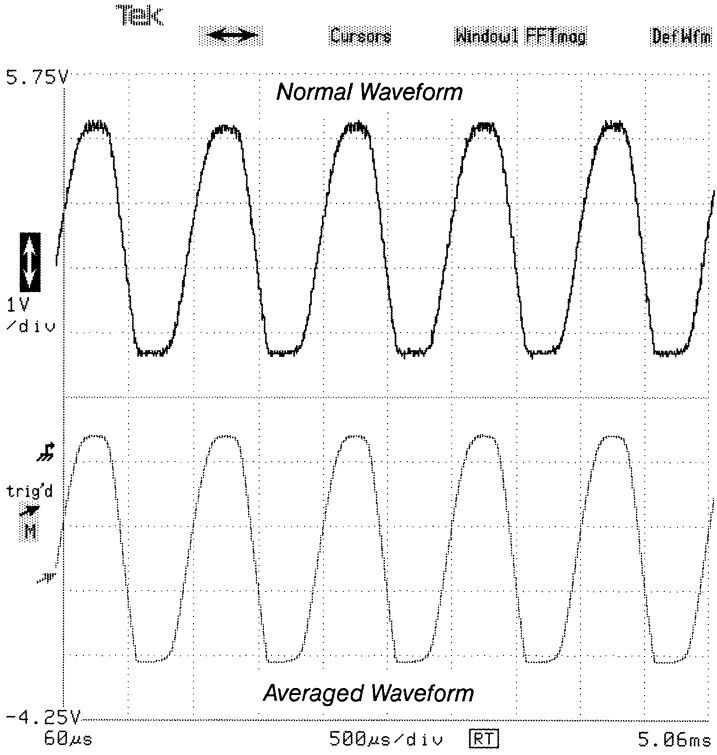


The **Acquire Desc** *Pop-Up Menu*

- Step 20: Touch **Acquire Desc** in the major menu and **Average N** in the pop-up menu to turn off averaging. Touch **Continuous** to resume normal acquisition and remove the pop-up menu.

This is an example of averaging. Enveloping is done similarly, using **Envelope N, Set EnvN**, and **Envelope Complete** selectors.

Both averaging and enveloping can be done simultaneously. To do both, you must enter the waveform description from the **DefWfm** or **Vertical Desc** pop-up menus. No shortcut is available from the **Acquire Desc** pop-up menu.



Normal and Averaged Waveforms

Record Length

You can specify the resolution of a waveform by setting the number of sample points in its waveform record. This is important if you use a remote interface to transfer waveform data to a computer.

- Step 21: Touch **Horizontal Desc** in the Waveform major menu. In the **Horizontal Desc** pop-up menu touch either **Main Record Length** or **Window Record Length** (both selectors assign the knobs identically).

- Step 22: Turn the left **Main Record Len** knob one click at a time to the left and right, and observe the difference in the main waveform.

The right knob similarly controls the window record length.

You should be aware of the following attributes of record length:

- All Main time base waveforms share the same record length.
- All window waveforms share the same record length.
- Initialization sets both record lengths to 1024 points.
- Point accumulate can only be used with record lengths of 512, 1024, or 2048 points.
- Some record lengths do not completely span 10 horizontal divisions. For example, the 4096-point record length has the same resolution as a 5120-point record length, but appears shorter in length. The number of points per division are the same for both so the 4096 record will be shorter. Some computer systems can only handle record lengths that are an exact power of two. These record lengths are provided as a convenience and visual truncation is a natural result. Other short record lengths are 8192, 16,384, and 32,768.

Advanced Applications

This section presents examples that cover advanced operation of the DSA 600 Series Digitizing Signal Analyzers. Before beginning the examples in this section, you should perform the examples in the *DSA 601 and DSA 602 Tutorial* or the Getting Started examples in this workbook. Also, review the Operator Overview section of this manual for important calibration instructions.

In this section you will learn about:

- Taking accurate measurements and using the measurement parameters
- Extended Triggering functions including Boolean and level-qualified triggering, timers, and negation
- Act On Delta testing of signal parameters
- High-precision trigger-to-trigger measurements
- Eye-Diagram displays
- FFT displays with Cursor measurements

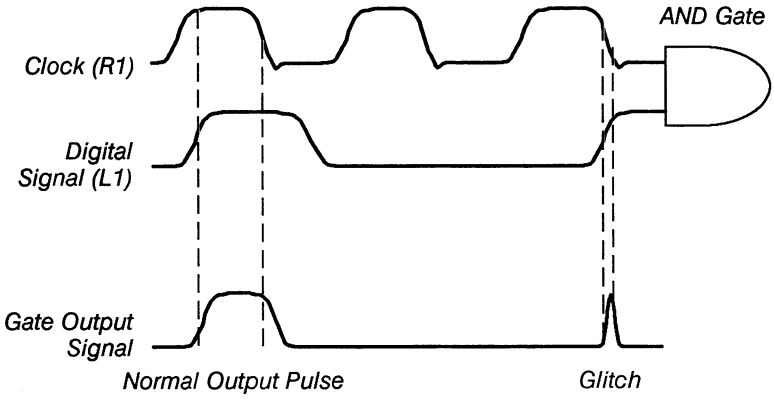
Refer to the Operator Overview section for information on setting up and using the QuickStart board. Installation instructions for your DSA are covered in your *DSA 601 and DSA 602 Tutorial* and *User Reference*.

The probe impedance must be 10 kΩ or more at its tip. You need a special high impedance probe to use a 50 Ω plug-in amplifier for these examples.

You can execute all the examples using your DSA and two plug-in amplifiers installed in the left and right plug-in compartments. You will need two probes with at least 10 kΩ probe-tip impedance. You should connect the probes to CH 1 of the left and right plug-in amplifiers. Calibrate all probes using the instructions given in the Operator Overview section of this workbook.

Example 5: Glitch Capture

This example shows you how to selectively trigger on narrow pulses. You will use the precision timer in the trigger circuit to look for a short duration glitch. The very high sampling rate of the DSA allows you to capture most glitches on a single sweep of the time base.



Triggering Using Timers

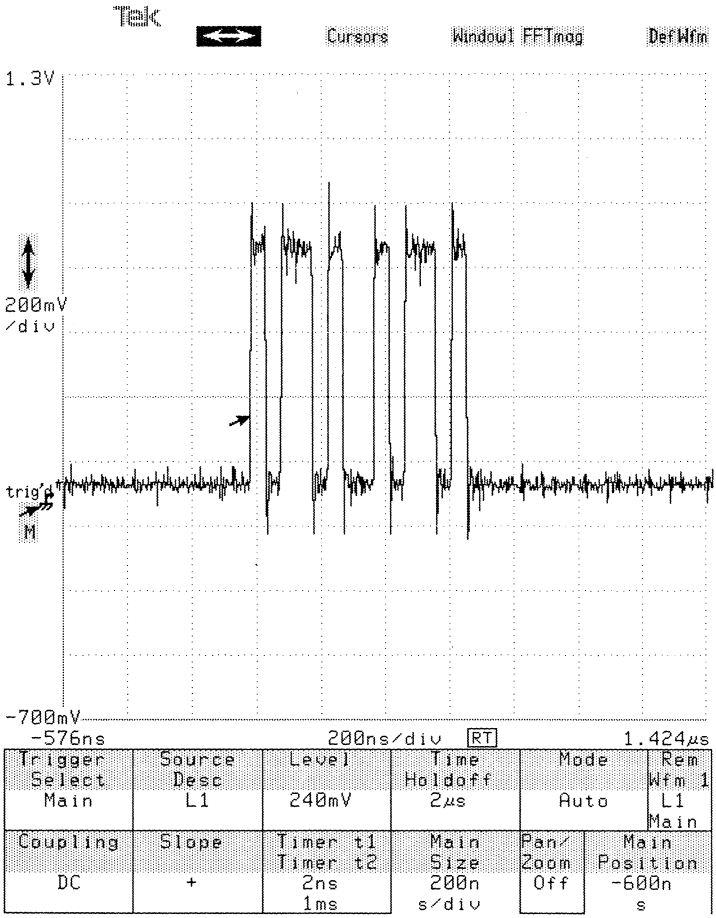
An Application

You are checking a digital circuit that appears to have a thermal problem. As the circuit warms up, undesirable pulses are seen at the output of your AND gate. You want to trigger on this glitch and verify the timing of the input signals and, if necessary, their sources. Triggering on the glitch will help you locate the source of the problem.

QuickStart Jumpers	
J1	*C*
J2	*A*
J3	*B*
J4	*B*
J5	*A*
J6	*A*
J7	*C*
J8	*B*

In the following steps you will display a waveform showing a burst of pulses. It will appear stable with no apparent glitch.

- Step 1: Initialize the DSA by touching **Initialize Setting** in the Utility major menu.
- Step 2: Set the QuickStart board jumpers as shown in the table at left.
- Step 3: Attach the probe connected to CH 1 of the left plug-in amplifier to TP2 on the QuickStart board.
- Step 4: Press the **CH1** button on the left plug-in amplifier to create an L1 waveform.
- Step 5: Select the vertical icon ↕ and set the **Vertical Size** knob to 200 mV/div. Adjust the **Vertical Offset** knob to center the waveform on the display.
- Step 6: Touch the horizontal icon ↔ and set the **Main Size** knob to 200 ns/div. Use the **Main Position** knob to center the group of pulses.
- Step 7: Touch the Main trigger icon and set the **Main Trig Level** knob to 280 mV. This should provide a stable waveform with no visible glitch.



Initial Waveform (L1)

Enabling The Trigger Timer

Next you change the trigger source description to use a trigger timer to reject all pulses that are greater than the timer setting.

- Step 8: Press the **TRIGGER** button in the **MENUS** column.
- Step 9: Change the trigger description: select **Source Desc** and enter channel **L1**, **<t1**, and **Enter Desc**.

Your waveform will become unstably triggered because the timer setting was set to 2 ns when you initialized the DSA.

- Step 10: Touch the Trigger major menu **Timer t1 Timer t2** selector to assign timer control to the knobs. Initially, set the **Main Trig Timer t1** knob to 1 μs.

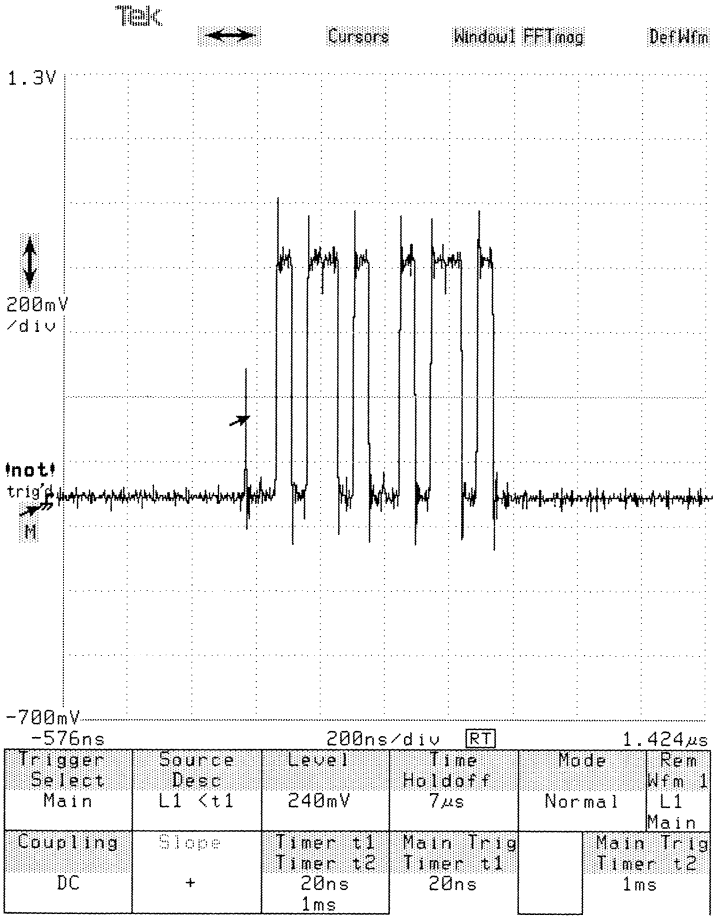
Now the waveform will be properly triggered again because all displayed pulses are shorter than 1 μs.

Selecting Normal Trigger Mode

Next you will select Normal trigger mode to prevent the time base from free running between each glitch pulse.

- Step 11: Select **Mode** from the Trigger major menu then select **Normal** from the pop-up menu.
- Step 12: Slowly adjust the **Main Trig Timer t1** knob down to 20 ns. The DSA should begin to trigger on short duration glitchs at about 40 ns.

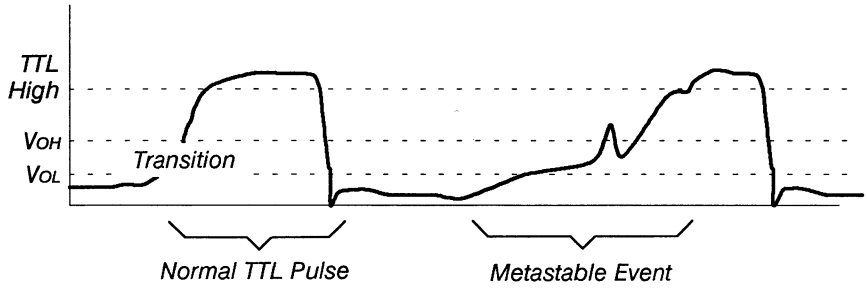
You will have a displayed waveform similar to that shown on the next page but it may be updated slowly. This is because the narrow glitches are infrequent and the DSA triggers and updates the display only when a glitch satisfies the trigger condition.



Showing the Glitch Waveform L1

Example 6: Capturing Metastable Signal States

This example shows you how to use the extended triggering capabilities of Boolean expressions and time-qualification to view a metastable signal. A metastable signal in digital logic is one that has not settled to either of its proper states within an expected period of time.



Waveform Showing Metastable Behavior in Logic Transition Area

Extended Trigger Functions

The DSA offers several powerful triggering capabilities that allow you to capture metastable signals and other transient events. The extended trigger capabilities are:

- Boolean triggering, where triggering depends on satisfying a logical combination of two signals. Signals above the trigger level are a logical high while those below are a logic low. Four logic operators are available: NOT, AND, OR, and XOR. For example, you could trigger when waveform 1 AND waveform 3 are both high.
- Time-qualified triggering, where triggering depends on time comparisons between the duration of some feature of a signal, such as pulse-width, and one or two user-set timer

circuits. For example, you could trigger when the pulse width of waveform 3 is greater than timer t1 and less than timer t2.

- Level-qualified edge triggering, where triggering depends on a transition (positive- or negative-going) while another signal is a logic high or low. For example, you could trigger when waveform 2 goes positive while the waveform 4 level is low.

An Application

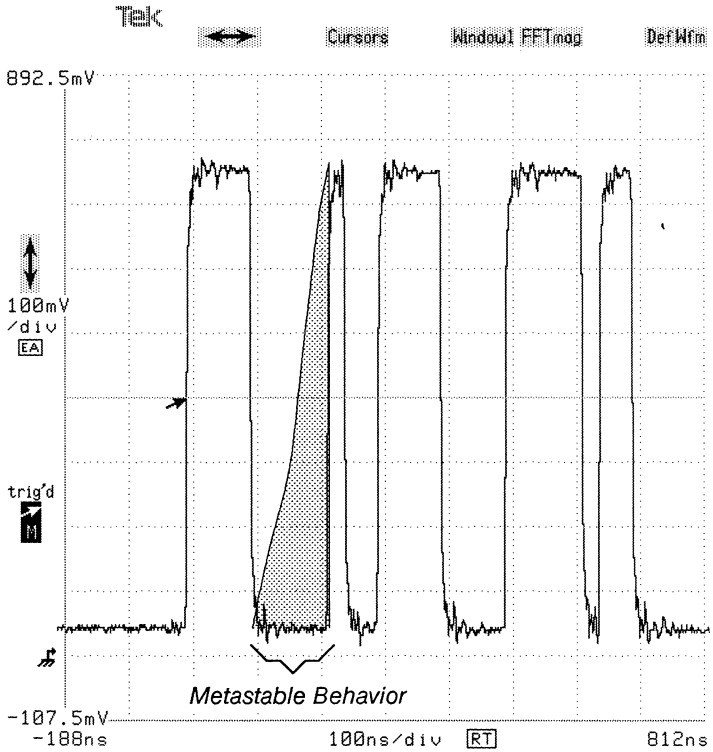
You have a digital circuit, based on the TTL family, that occasionally enters an illegal mode. You suspect a particular signal line may have a metastable state that is causing the problem. It could be a slow rising edge through the logic transition region or a pulse that enters the transition region then returns to its original level. Once you can trigger on this metastable condition you will be able to probe other circuit signals to determine whether they might be causing the metastability.

QuickStart Jumpers	
J1	*C*
J2	*A*
J3	*B*
J4	*B*
J5	*A*
J6	*A*
J7	*C*
J8	*B*

- Step 1: Initialize the DSA by touching **Initialize Setting** in the Utility major menu.
- Step 2: Set the QuickStart board jumpers as shown in the table to the left.
- Step 3: Attach the probes connected to CH 1 of the left and right plug-in amplifiers to TP4 on the QuickStart board.
- Step 4: Press the **CH1** button on the left plug-in amplifier to create an L1 waveform.
- Step 5: Touch the vertical ↕ icon and set **Vertical Size** to 100 mV/div. Position the waveform to screen center with the **Vertical Offset** knob.

- Step 6: Touch the horizontal icon ↔ and set the **Main Size** knob to 100 ns/div. Set the **Main Position** knob to -200 ns to make the trigger indicator and the metastable behavior easier to see.

- Step 7: If triggering is unstable, select the Main trigger icon and adjust trigger level and holdoff with the control knobs.



Waveform L1 Showing Metastable Behavior

You should notice metastable behavior with a slow rising edge as in the illustration above. This is the trigger condition you will define in the following steps. If the metastable behavior is not visible, check that the QuickStart board jumpers are properly set.

Setting Trigger Sensitivity

It is necessary to temporarily display channel R1 in order to set the amplifier sensitivity to a level the trigger circuit can use. You will be using the AND Boolean operator which requires two trigger signals from different plug-in amplifiers.

- Step 8: Press the **CH1** button on the right plug-in amplifier to create the R1 waveform.
- Step 9: Touch the vertical icon ↕ and, use the control knobs to set the vertical size and position of the R1 waveform to the same setting as the L1 waveform. This matches the sensitivity of both trigger circuits.
- Step 10: Touch the **Rem Wfm 2** selector and remove the R1 waveform to cleanup the display.

Defining the Extended Trigger

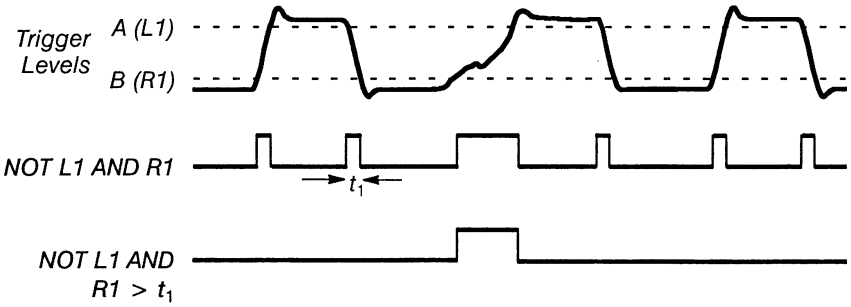
- Step 11: Press the **TRIGGER** button from the **MENUS** column then touch the **Source Desc** selector to display the **Source Desc** pop-up menu.
- Step 12: Touch **NOT**, **L1**, **AND**, **R1**, and **>t1**. Use **Back Space** if you need to make corrections. Select **Enter Desc** to finish. This will temporarily leave your signal untriggered.

The completed trigger condition NOT L1 AND R1 > t1 is shown in part below the **Source Desc** selector. With this trigger description, a trigger will only occur when:

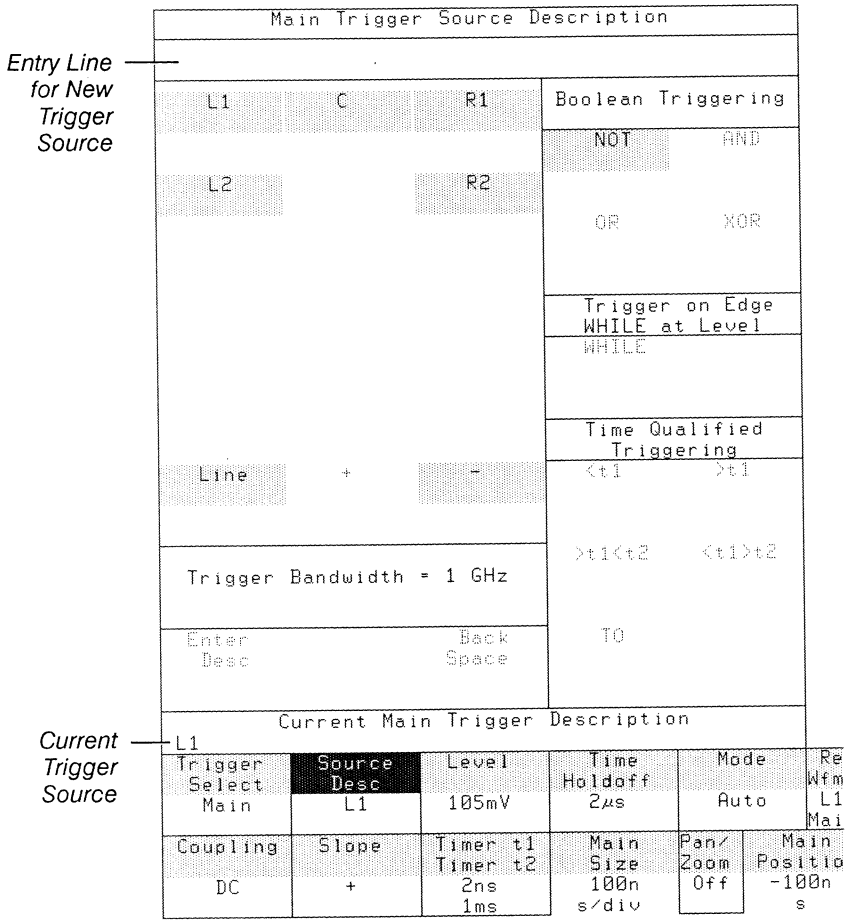
- L1 is less than **Main Trig Level A**, and

- R1 is greater than **Main Trig Level B**, and
- the time delay between **Trig level A** on L1 and **Trig level B** on R1 is greater than the setting for timer **t1**.

The Boolean condition, NOT L1 and L2, triggers on every low-to-high or high-to-low transition. Adding time-qualification limits triggering to the metastable pulses by excluding normal fast transitions.



Triggering on a Metastable Signal



The **Source Desc** *Pop-Up Menu*

Setting the Trigger Levels

Notice that the **Level** selector has changed to **Level A Level B**. The two levels are required for the two signals combined with the AND operator.

- Step 13: Touch the **Level A Level B** selector (or the Main trigger icon) to assign the trigger levels to the knobs.

Signal Triggers:
Trigger Level A - L1
Trigger Level B - R1

- Step 14: Set the **Trig Level A** knob to 500 mV and set the **Trig Level B** knob to 200 mV.

The amplitude difference between the trigger level settings directly affects the time delay between them. Increasing the difference between trigger levels (within the bounds of the peak-to-peak amplitude) directly increases the delay due to the slope of the rising edge.

Setting Timer t1

The time qualification part of the trigger description, NOT L1 AND R1 > t1, rejects all but the metastable pulse.

- Step 15: Touch the **Timer t1 Timer t2** selector to assign the knobs to Trigger Timer 1 and Trigger Timer 2.

- Step 16: Set the **Main Trig Timer t1** knob to 4 ns.

You should now be triggered on the metastable pulse. If not, slightly readjust the trigger levels, always ensuring that Level A is at least 200 mV greater than Level B.

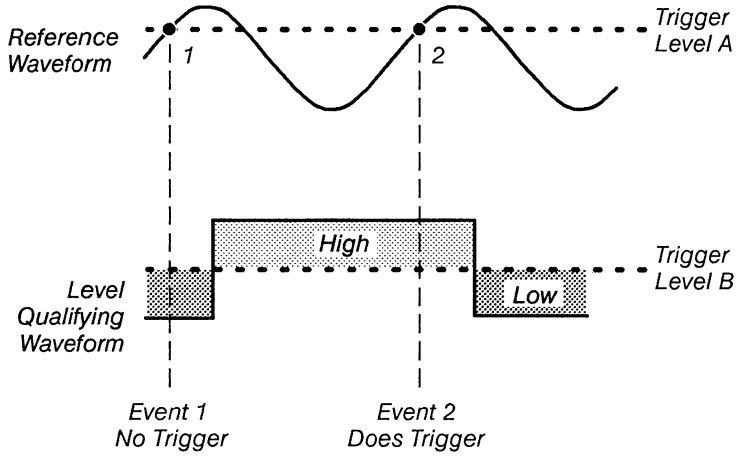
Try adjusting the trigger timer t1 knob to higher values until you lose triggering. Loss of triggering occurs because the time delay between the trigger levels A and B does not exceed the timer setting.

You can change the horizontal size for a closer look at the metastable rising edge. Then you can press the **MEASURE** button and select Rise and other measurements to characterize the metastable event.

Example 7: Triggering on Asynchronous Signals

This example shows you how to use level-qualified edge triggering to capture two asynchronous (non-synchronized) signals. Level-qualified edge triggering uses the two trigger circuits of the DSA to qualify acceptance of an edge trigger on one signal with a specified level on a second signal. Using level-qualified edge triggering, you can trigger on events that Boolean triggering alone cannot capture.

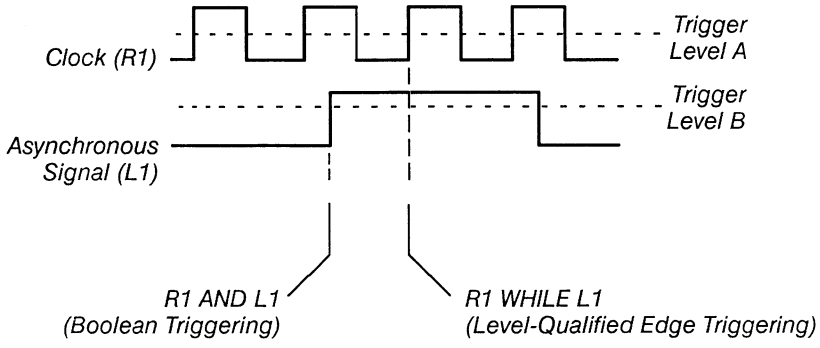
You will need a short BNC cable (about 10 inches in length), in addition to a standard probe.



Level-Qualified Edge Triggering

Conventional Triggering

Conventional edge triggering occurs when the amplitude of a waveform moves upward past a preset trigger level (positive slope triggering), or moves downward past the trigger level (negative-slope triggering).



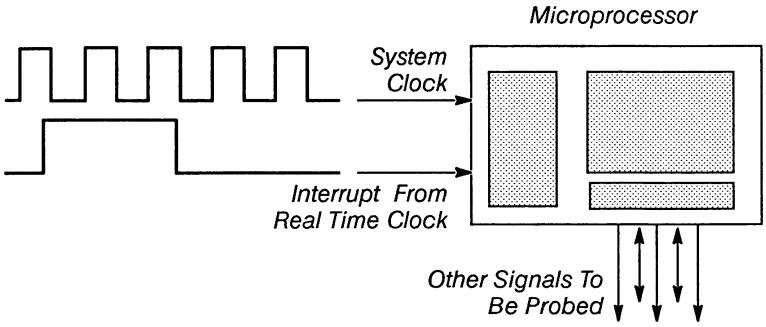
Boolean and Level-Qualified Triggering Contrasted

Level-Qualified Edge Triggering

To use level-qualified edge triggering, you specify a triggering condition with the WHILE operator. For example, the trigger description R1 WHILE L1 means trigger on a high-going transition of R1 while L1 is already high. You may specify the level or transition as low or low-going by preceding it with the NOT operator (i.e., R1 WHILE NOT L1).

An Application

You have a microprocessor system that performs some action when interrupted by a real-time clock. You want to probe other microprocessor signals during this interrupt service routine. By triggering on the first clock edge after the clock interrupt arrives, you will acquire the other microprocessor signals only during this special trigger event.



Testing a Microprocessor System With a Real-Time Clock Interrupt

QuickStart Jumpers	
J1	C
J2	A
J3	B
J4	B
J5	A
J6	B
J7	A
J8	B

- Step 1: Initialize the DSA by touching **Initialize Setting** in the Utility major menu.
- Step 2: Set the QuickStart board jumpers as shown in the table at the left.
- Step 3: Connect a short BNC cable from the **CALIBRATOR** output to **CH 1** of the right plug-in amplifier.
- Step 4: Attach the probe on connected to **CH 1** of the left plug-in amplifier to TP15 on the QuickStart board.
- Step 5: Press the **CH 1** button on the right plug-in amplifier to create an R1 waveform. This will serve as your system clock signal.

- Step 6: Press the **CH 1** button on the left plug-in amplifier to establish an L1 waveform. This signal is not synchronized with the R1 clock signal and will serve as the real-time clock interrupt.

- Step 7: Touch the horizontal icon ↔ and set the **Main Size** knob to 1 μs/div.

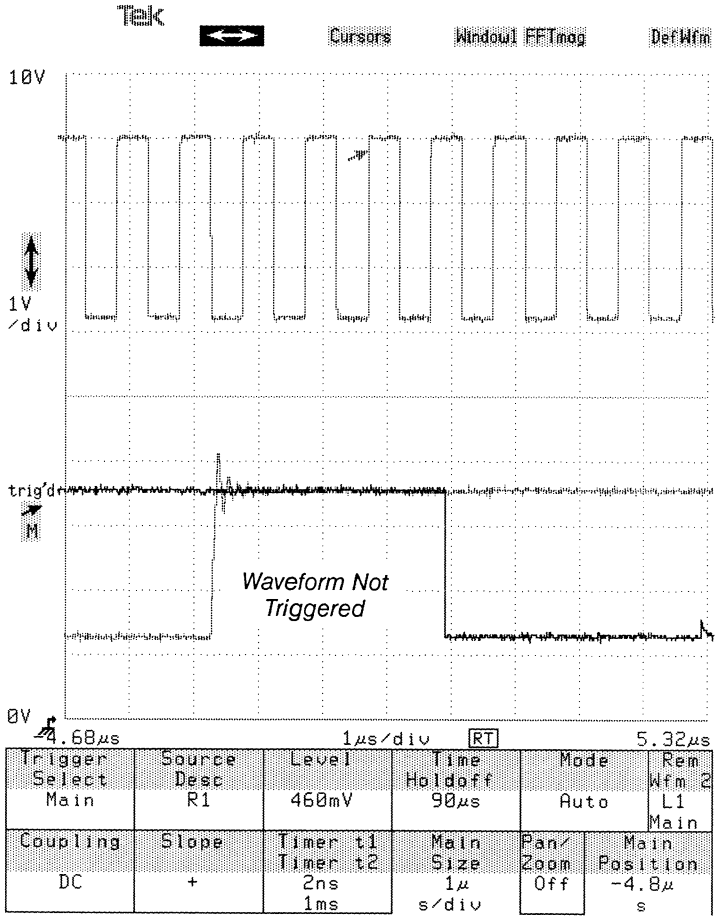
- Step 8: Touch the vertical icon ↕ and set the **Vertical Size** and **Vertical Offset** knobs for both waveforms so that the Clock signal (R1) is positioned above the Interrupt signal (L1).

- Step 9: Touch the Main trigger icon and adjust the **Main Trig Level** knob for a stable display of R1.

- Step 10: Touch the horizontal icon ↔ and adjust the **Main Position** knob to place the trigger indicator at the horizontal center of the waveform.

This setup produces an equal number of pre-trigger sample points and post-trigger sample points. In other words, the trigger point occurs at the middle of the waveform record.

Waveform L1 will not to be triggered because it is not yet synchronized to the triggered clock signal, R1.



Two Waveforms With Only R1 Triggered

Entering the Trigger Description

- Step 11: Press the **TRIGGER** button in the **MENUS** column.
- Step 12: Touch **Mode** and select **Normal** in the Mode pop-up menu. This ensures that acquisitions occur only when the trigger condition is met, eliminating acquisition with a free-running time base.
- Step 13: Touch **Source Desc** from the major menu and touch **R1, WHILE, L1**, and **Enter Desc** from the pop-up menu.

With the trigger description R1 WHILE L1, a trigger event will only occur when R1 has a positive-going transition (edge event) while L1 is high.

Setting Trigger Levels A and B

Notice that the **Level** selector to the right of **Source Desc** is now labeled: **Level A Level B**.

- Step 14: Touch the **Level A Level B** selector.
- Step 15: Set the **Trigger Level A** knob to 100 mV for waveform R1, the clock signal. This is the edge trigger point.
- Step 16: Set the **Trigger Level B** knob to 2 V for waveform L1, the interrupt signal.

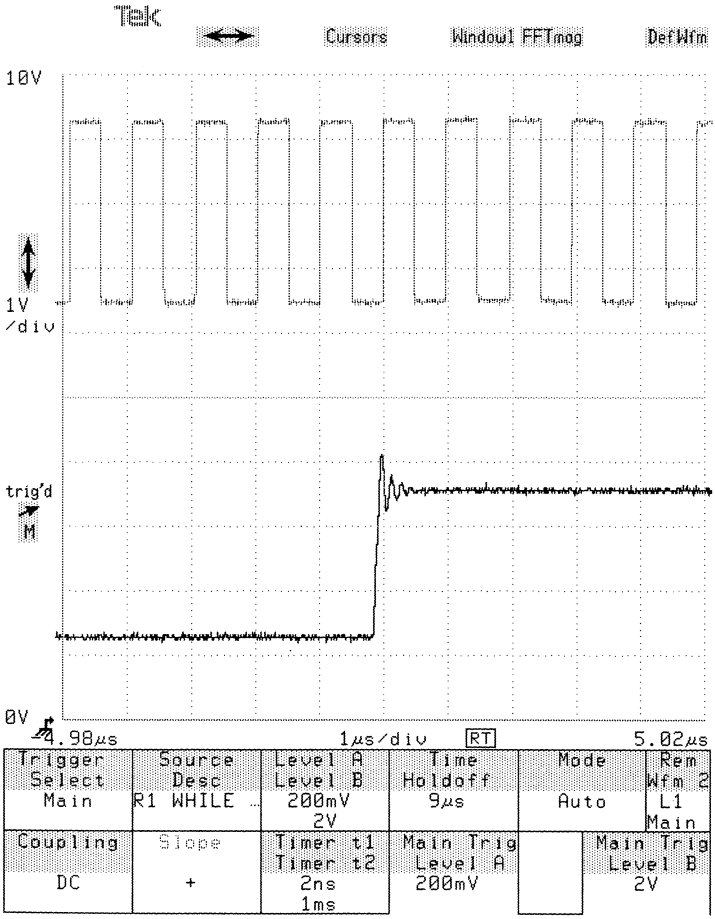
You have now set the trigger level to define a high level, but every clock edge during the interrupt pulse could produce a trigger. You can use time holdoff to ignore all but the first trigger during the interrupt pulse.

- Step 17: Select **Time Holdoff** in the Trigger major menu and set the **Main Time Holdoff** knob to 20 µs. This assumes a pulse duration of 15 µs.

Waveform L1 will have a timing jitter equal to one period of waveform R1. For each acquisition cycle, L1 can transition high anytime before the rising edge of R1, which produces the apparent timing jitter.

More About the Application

You can now begin probing other microprocessor signals during this unique trigger condition. Acquisition will occur only when the trigger condition R1 WHILE L1 is true.

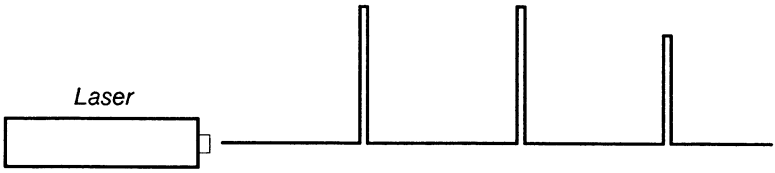


Both Waveforms Triggered Using the WHILE Function

Example 8: Repetitive Single-Shot Acquisition

This example shows you how to capture a series of unique events, such as laser pulses, and store them for later analysis. The very fast digitizing speed of the DSA allows fast pulses to be acquired in one sweep, preserving the unique characteristics of the individual pulses.

In this example you will acquire pulses using three different acquisition modes. First you will use the Continuous acquisition mode with Normal triggering, which displays a pulse each time a trigger occurs. Then you will use the single trigger (single shot) acquisition mode in which you arm the digitizer and acquire the next pulse that arrives. Finally, you will use the repetitive acquisition mode that automatically stores a triggered pulse then rearms the digitizer for the next pulse.



Laser System Emitting Short Duration Pulses

An Application

You are testing a laser system that generates pulses about fifteen times per second. You want to capture a series of pulses in order to characterize the laser's pulse amplitude and duration.

QuickStart Jumpers	
J1	C
J2	A
J3	B
J4	B
J5	A
J6	B
J7	C
J8	B

The QuickStart board signal TP9 produces a 15.5 Hz fast rise pulse that will simulate a series of laser pulses.

- Step 1: Press the **UTILITY** button in the **MENUS** column and touch **Initialize Setting** in the pop-up menu.
- Step 2: Set the QuickStart board jumpers as shown in the table at left.
- Step 3: Attach the probe connected to CH 1 of the left plug-in amplifie to TP9 on the QuickStart board.
- Step 4: Press the **CH 1** button on the left plug-in amplifier to create an L1 waveform.
- Step 5: Touch the horizontal icon ↔ and set the **Main Size** knob to 50 ns/div. Also set the **Main Position** knob to -200 ns. Later, when you acquire a waveform, the pulse will appear at the center of the screen with the Main trigger indicator on the rising edge.

The following steps 6 through 9 will complete the setup for capturing a laser pulse.

Using Digitizer Interleave

Digitizer Interleave provides the highest sampling rate of 1 Gsample/s for the DSA 601 and 2 Gsample/s for the DSA 602. This high sampling rate is only used when the record length and time/div require this rate to fill a record on a single sweep. This is especially important for the single-shot acquisition of high-speed events.

Note the ET indicator at the bottom of the graticule indicating equivalent time operation. This will change to real time mode RT when you select Digitizer Interleave.

- Step 6: Select **Horizontal Desc** from the Waveform major menu and touch the selector under **Digitizer Interleave** to enable the maximum sampling rate.

A message prompting you to run Enhanced Accuracy and calibrate your probes will appear. You should normally do as the prompt requests to guarantee the highest accuracy level of your DSA. For the purpose of this example, you may choose to ignore this prompt and proceed with the example. To Calibrate the system, press the **ENHANCED ACCURACY** button to start self calibration. This takes a few minutes. Refer to the Operator Overview section of this manual for instructions on calibrating your probes.

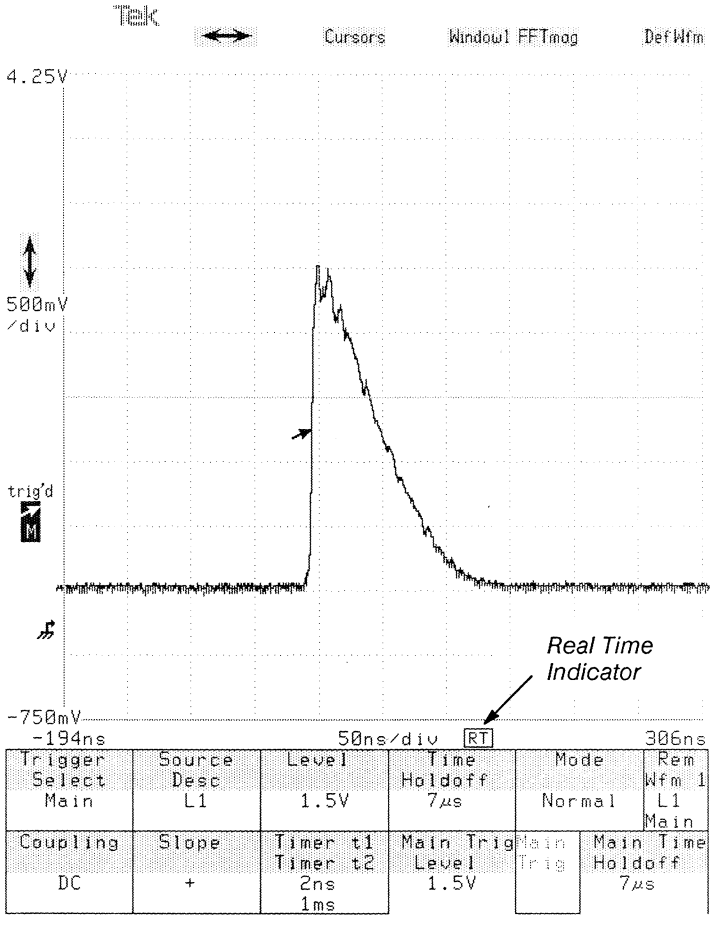
Setting The Trigger Mode

In the following steps you will set the Main trigger to operate in the normal mode. The normal trigger mode is necessary because the laser events occur only 15 times per second. This is too infrequent for the Auto mode which will free run and produce an unstable display.

- Step 7: Press the **TRIGGER** button in the **MENUS** column, then select **Mode** from the major menu and **Normal** in the **Mode** pop-up menu.

- Step 8: Touch the vertical icon ↕ and set the **Vertical Size** knob to 500 mV/div. Adjust the **Vertical Offset** knob to position the bottom of the signal about 2 divisions from the graticule bottom.

- Step 9: Touch the Main trigger icon $\overset{\blacktriangledown}{M}$ and set the **Main Trig Level** knob to 1.0 V.



Pulse Waveform Acquired In Real Time Mode

Using the Single Trigger Mode

The single trigger acquisition mode provides single-shot acquisition. To enter this mode you will set up the trigger and display parameters, then arm the digitizer to acquire on the next trigger event.

- Step 10: Press the **WAVEFORM** button in the **MENUS** column.

- Step 11: Select **Acquire Desc** and then **Single Trigger** in the Stop Acquire After section of the pop-up menu. Touch **Acquire Desc** again to exit the menu.

The **DIGITIZER** button status goes to **STOP** and the last pulse waveform disappears. Now, pressing the **DIGITIZER** button will arm the digitizer to trigger on the next pulse.

- Step 12: Press the **DIGITIZER** button and observe the captured laser pulse. The digitizer is stopped again.

At this point you can store this captured pulse waveform by selecting its selector in the **Store Waveform** pop-up menu from the Store/Recall major menu.

- Step 13: Touch the trigger icon $\overset{\blacktriangledown}{M}$ and adjust the **Main Trig Level** knob to a slightly higher value. Press the **DIGITIZER** button again.

When done, leave the trigger level at 1 V.

Notice that the newly acquired waveform is a different pulse; probably one with a higher amplitude. Changing the trigger level changes the selection criteria for the pulse. Try adjusting the **Main Trig Level** knob several times, pressing the **DIGITIZER** button after each change.

Seting Acquisition for Repetitive Single Trigger Operation

Now you will set the acquisition system to automatically capture and store 20 laser pulse waveforms.

- Step 14: Touch the **Acquire Desc** selector in the Waveform major menu and then select **Rep Trig Complete** from the pop-up menu.

- Step 15: Touch the **Set Rep Trigger N** selector, located left of your last selection, and select 20 repetitions using either knob in **FINE** resolution. Touch the **Acquire Desc** label to remove the pop-up menu.

This sets the acquisition system to trigger and acquire pulses 20 times. At each trigger the acquired pulse waveform is stored. The acquisition system uses the trigger settings you established for single-shot acquisition.

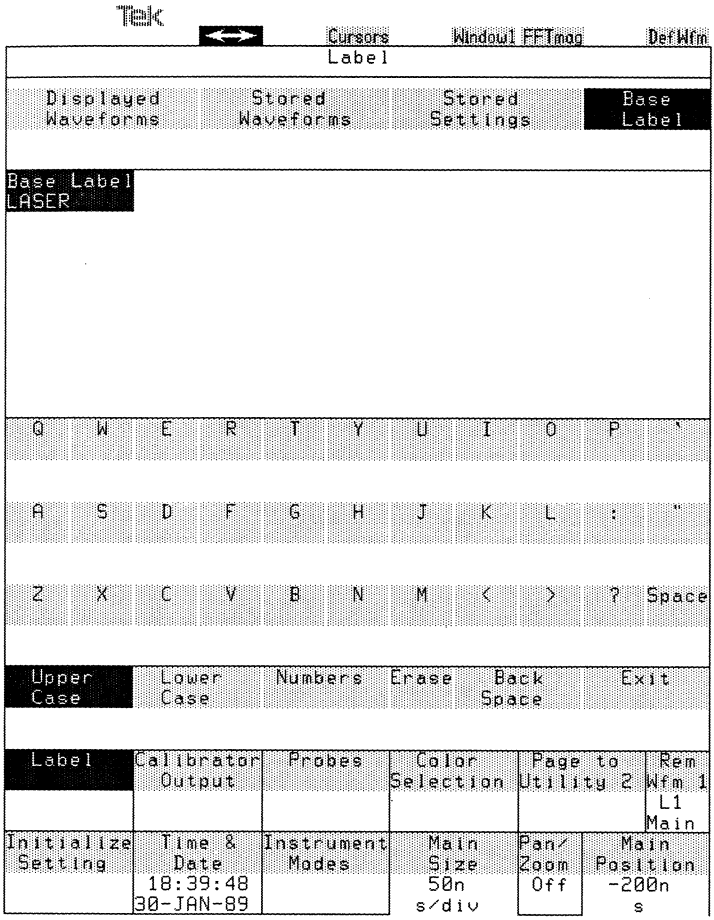
Assigning A Base Label Name

By default, each acquired waveform will be stored internally with a waveform name (base label) **REP#** with **#** being sequential numbers that are automatically assigned. This base label can be changed.

- Step 16: Press the **UTILITY** button in the **MENUS** column, then touch **Label** in the Utility major menu

- Step 17: Select **Base Label** from the **Label** pop-up menu then **Erase** (mid-bottom of menu) to remove the default name, REP.

- Step 18: Touch letters to rename your base label such as **L**, **A**, **S**, **E**, **R** and then **EXIT** in the lower right.



Entering a Base Label in the Label Pop-Up Menu

Starting Repetitive Acquisition

In the next step, you will start repetitive acquisition, storing each acquired laser pulse with the name LASER(#).

- Step 19: Press the **DIGITIZER** button to acquire the 20 pulse waveforms. Acquisition occurs very quickly ending with the **DIGITIZER** button status finally remaining at **STOP**.

Viewing the Pulse Waveforms with the Scan Function

In the following steps you will use the Scan function to view all the laser pulse waveforms you acquired. Each waveform is displayed for one second with its base label name and number on sthe creen. You will then delete the stored waveforms to free the memory for other use.

- Step 20: Press the **STORE/RECALL** button twice to enter the Scan page of the Store/Recall major menu.

- Step 21: Touch the **Scan/Stop** selector to begin scanning the waveforms stored with the repetitive single trigger acquisition.

Each waveform is displayed for 1 second and then is replaced by the next waveform in sequence. Touch the **Scan/Stop** selector to stop or resume scanning. When the last waveform is displayed it remains on screen. You can use the **Previous** and **Next** selectors to move around in the list of stored waveforms or you can scan all the waveforms again by touching the **Scan/Stop** selector.

You can acquire a large number of waveforms in the repetitive mode and use up the available memory. Removing the waveforms frees the memory.

- Step 22: Touch the **Page to Store/Recall** selector.

- Step 23: Touch **Delete Waveform** then touch any stored waveform with the LASER (or your own) label to select all similar base-labeled waveforms. If you wish to delete the last waveform displayed by Scan, touch its label on the left (Displayed Waveforms) then its label on the right (Stored Waveforms). Touch **Delete Selected Waveforms** to remove the selected waveforms.

Returning to Continuous Acquisition

The repetitive acquisition mode will remain in effect until you either select continuous (normal) acquisition or initialize the DSA.

- Step 24: Press the **WAVEFORM** button in the **MENUS** column.

- Step 25: Touch **Acquire Desc** then **Continuous** at the bottom of the **Acquire Desc** pop-up menu. The DSA will resume acquiring pulses in the continuous mode.

Example 9: Act On Delta

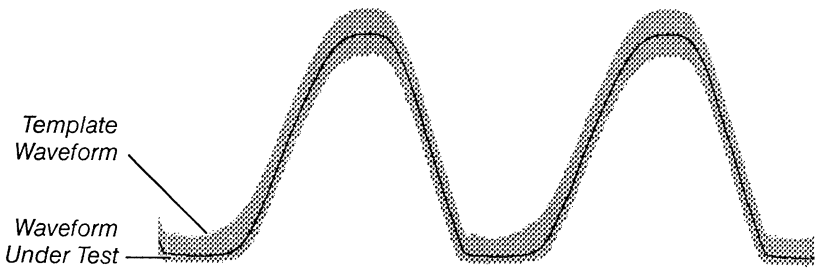
Act on Delta allows you to monitor a continuous waveform and detect when a subtle deviation occurs. In this example, you will compare a signal against a template that you define with the envelope waveform function. If the acquired waveform exceeds the envelope you are alerted and, optionally, the aberrant waveform is stored.

Glitch Capture Using Act on Delta

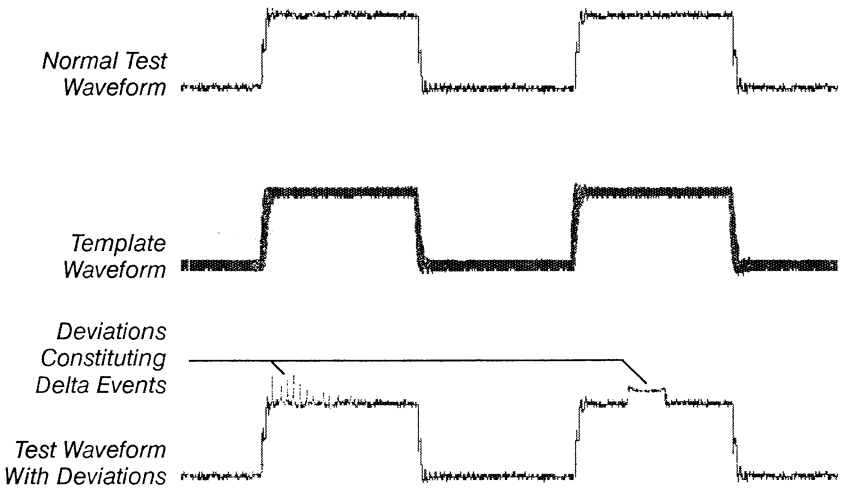
Act on Delta is a powerful feature that lets you specify any or all of these automatic responses to the capture of a signal glitch:

- Store the waveform that contains the glitch
- Make a hardcopy of the display
- Sound an audible alarm (beep)
- Send a GPIB signal to a controller

Act on Delta operates in a single event mode or you can select a repetitive event mode similar to the one used in Example 8, Repetitive Single-Shot Acquisition. In the repetitive mode, after a signal glitch is discovered, the DSA will perform the specified actions then re-arm for the next glitch.



Test Signal and Template Waveform



Act on Delta Waveforms

Act on Delta Operation

The delta decision is based on an envelope waveform, which is a template that sets the outer bounds for acceptable waveforms. Act on Delta compares an active waveform to the template to identify any glitches or changes. The envelope template may be an active envelope waveform or a stored envelope waveform.

An Application

You are checking components in a manufacturing environment for compliance with vertical amplitude and horizontal timing specifications.

QuickStart Jumpers	
J1	*C*
J2	*A*
J3	*B*
J4	*B*
J5	*A*
J6	*A*
J7	*A*
J8	*B*

In the following steps you will display a waveform in preparation for creating an envelope template waveform.

- Step 1: Initialize the DSA by pressing the **UTILITY** button in the **MENUS** column then touching **Initialize Setting** in the Utility major menu.
- Step 2: Set the QuickStart board jumpers as shown in the table at left.
- Step 3: Attach the probe connected to CH1 on the left plug-in amplifier to TP10 on the QuickStart board.
- Step 4: Press the **CH1** button on the left plug-in amplifier to create an L1 waveform.
- Step 5: Touch the horizontal icon ↔ and set the **Main Size** knob to 200 µs/div.
- Step 6: Touch the vertical icon ↕ and set the **Vertical Size** knob to 500 mV/div. Use the **Vertical Offset** knob to center the waveform on the display.

You should see a noisy signal that is not well triggered.

Select DC High Frequency Reject Trigger Coupling

- Step 7: Press the **TRIGGER** button in the **MENUS** column and select **Coupling** then **DC High Freq Reject** in the **Coupling** pop-up menu.

This will provide a more stable trigger by attenuating frequencies above 30 kHz for the trigger circuit.

- Step 8: Adjust the **Main Trig Level** and **Main Time Holdoff** knobs as necessary.

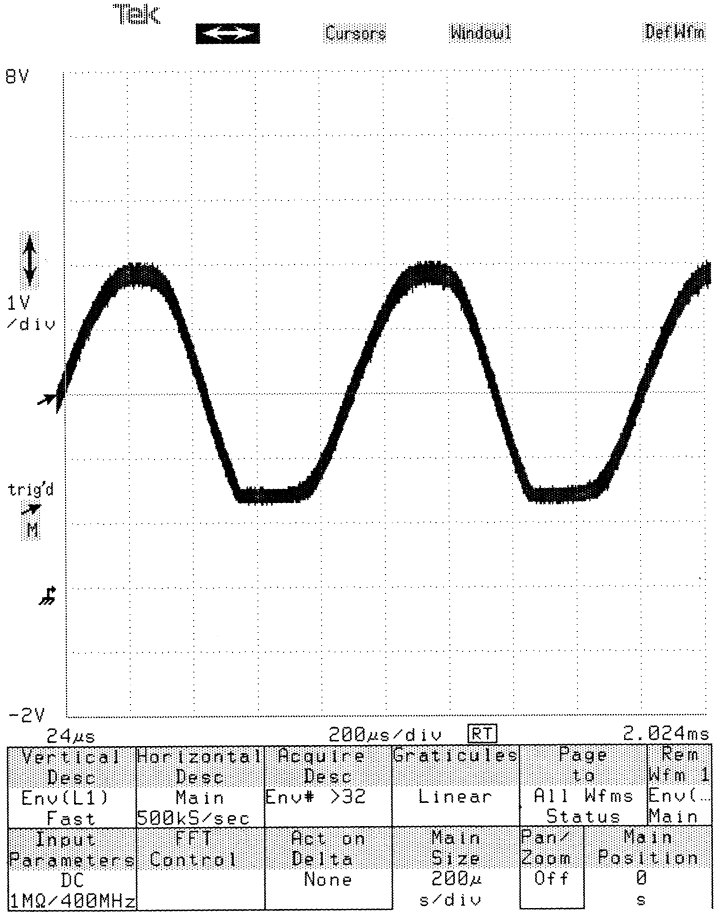
Making A Template Waveform

The template waveform can be created from the waveform you are testing. You will use the **Envelope** function to create an envelope waveform which you will then store for use as a template.

- Step 9: Press the **WAVEFORM** button from the **MENUS** column and select **Acquire Desc** from the major menu.

- Step 10: Select **Envelope N** from the **Acquire Desc** pop-up menu then touch **Acquire Desc** to exit the menu.

The L1 waveform should now be an envelope waveform with the width of the envelope equal to the noise on the signal. An example is shown on the following page.



Active Envelope Waveform

Storing the Template

- Step 11: Press the **STORE/RECALL** button in the **MENUS** column and touch the **Store Waveform** selector in the major menu.

Since the envelope waveform was selected before the pop-up menu appeared, its **Wfm 1** selector will be highlighted. Note the **Next Storage:** # status at the top of the menu. This number (#) identifies the stored waveform you will later recall.

- Step 12: Touch the **Wfm 1** selector in the **Store Waveform** pop-up menu.

The pop-up menu disappears after you make the selection and the envelope waveform is now stored in memory.

Turn Off Enveloping

Before you recall the stored template, turn off enveloping on the displayed waveform, L1. This will become your test signal.

- Step 13: Press the **WAVEFORM** button in the **MENUS** column and select **Acquire Desc** from the major menu

- Step 14: Select **Envelope N** from the **Acquire Desc** pop-up menu to turn enveloping off, then press the **STORE/RECALL** button in the **MENUS** column. This is a quick way to exit a pop-up menu and enter a major menu.

Displaying the Template Waveform

■ Step 15: Touch the **Recall Waveform** selector.

The **Recall Waveform** pop-up menu appears and a selector displays **Stored 1**. The pop-up menu may contain other waveforms stored previously.

■ Step 16: Touch the **Stored 1** selector. If your waveform was stored with a different number choose the waveform selector with that number.

Do not change the position or size of the recalled template waveform. Stored waveforms are restored with the same position and size they had when stored. This original position is necessary for proper alignment with the active test waveform.

■ Step 17: Select the active L1 waveform by touching it or, if it is obscured by the recalled template waveform, just touch the template waveform and the active waveform will come to the front and be selected.

The active waveform should be entirely within the template waveform.

■ Step 18: *If necessary,* adjust the position of the test waveform so it lies in the center of the template waveform, otherwise go on. Select **FINE** knob resolution for precise vertical and horizontal adjustments. If you adjusted the trigger level after saving the envelope waveform, matching will be affected.

Stored vs Displayed Template

Act on Delta uses the stored template waveform in memory for comparison. The displayed template waveform represents the stored template but changes made to the display do not affect the stored template. This means you could move the displayed copy of the stored waveform about on the screen without affecting the Act on Delta comparison. However, moving the displayed template will corrupt *your view* of the alignment of test and template waveforms.

The Delta Description

With the delta description you specify both the template waveform and the waveform to test.

- Step 19: Press the **WAVEFORM** button in the **MENUS** column.

- Step 20: Touch the **Act on Delta** selector.

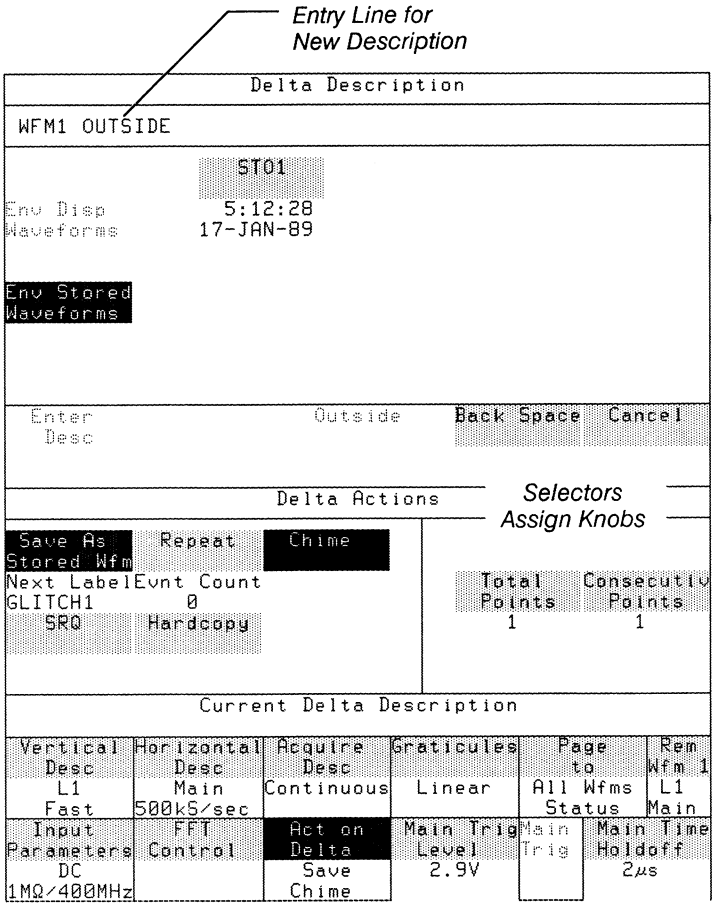
At the bottom of the **Act on Delta** pop-up menu is the **Current Delta Description**. It is blank now but later it will show your Act on Delta description.

- Step 21: Touch the following selectors: **Wfm 1**, **Outside**, **Env Stored Waveforms** and **Stored 1** (assuming **Wfm 1** is the test waveform, and **Stored 1** is the template).

Notice that your selections appear in the entry line at the top of the **Act on Delta** pop-up menu.

- Step 22: Touch the **Save As Stored Wfm** and **Chime** selectors.

At the first delta event the DSA will beep and store the out-of-bounds waveform.



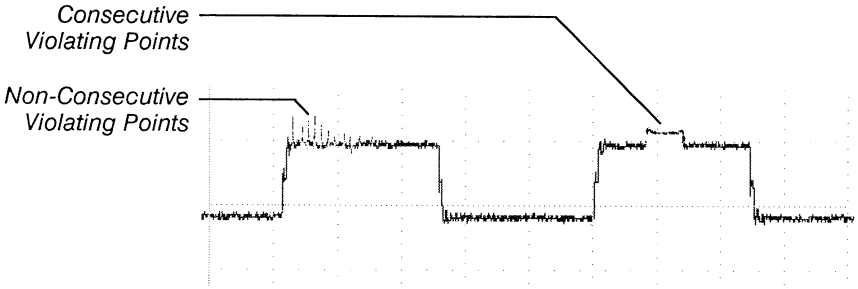
The **Act on Delta** *Pop-Up Menu*

The Delta Event

A delta event occurs when a specified number of points of a waveform fall outside the enveloped template waveform. Two parameters specify a delta event:

- Total Points, which is the total number of out-of-bounds points.
- Consecutive Points, which is the number of out-of-bounds points consecutive in time.

A delta event occurs when the out-of-bounds points of a waveform exceed the values set for total points and consecutive points.



Consecutive and Non-Consecutive Violating Points

■ Step 23: Touch **Total Points** and select **FINE** knob resolution. Set the **Total Points** knob to 3 and leave the **Consecutive Points** knob set to 1. If the test signal has an excursion of 3 points outside the template, over the duration of the waveform, a delta event will occur.

Activating Act on Delta

- Step 24: Touch **Enter Desc** to complete the Act on Delta description and exit the pop-up menu.

- Step 25: Press the **DIGITIZER** button to arm Act on Delta.

Act on Delta will now compare the active and template waveforms, and store any waveform that exceeds the bounds of the template waveform.

- Step 26: Hold down the QuickStart board button to generate glitches.

In a short time you will hear a beep and the **DIGITIZER** button will switch to **STOP** status. This Indicates a glitch was found and its waveform stored. The stored waveform is named with the base label, sequentially numbered, and time/date-stamped.

- Step 27: Press the **STORE/RECALL** button, touch **Recall Waveform** in the major menu, and select the captured waveform that has your base label.

The stored waveform is displayed with its label.

- Step 28: Touch the vertical icon ↕ and use the **Vertical Offset** knob to position the base-labeled waveform down for clear viewing.

- Step 29: Touch the **Cursors** icon and note that the left cursor dot is on the first out-of-bounds point on the waveform.

You can read the glitch amplitude and its time from the trigger as the **v1** and **t1** readouts in the Cursor major menu.

- Step 30: Hold down the QuickStart board button (reset switch) while you repeatedly press the **DIGITIZER** button.

This will capture additional glitch waveforms, sequentially numbering them and sounding a beep.

You can set Act on Delta to automatically re-arm after each glitch capture by selecting **Repeat** in the **Delta Actions** section of the **Act on Delta** pop-up menu. You will continue to capture and store glitch waveforms until the memory is full or you press the **DIGITIZER** button to manually stop delta acquisition. When memory is full, you will continue acquiring glitches, but they will not be stored in memory. Other selected actions, such as **Chime**, will continue.

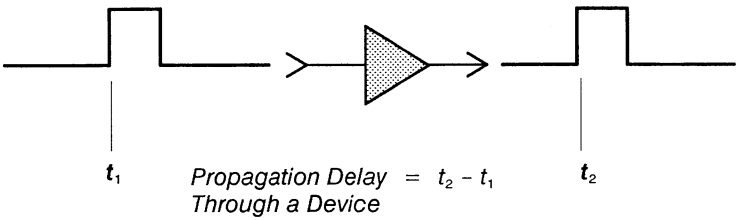
- Step 31: Resume normal acquisition by selecting **Acquire Desc** in the Waveform major menu then touching **Continuous** at the bottom of the pop-up menu.

These stored waveforms can be viewed with the Scan feature described in Example 8, Repetitive Single-Shot Acquisition.

Example 10: Trigger-To-Trigger Measurements

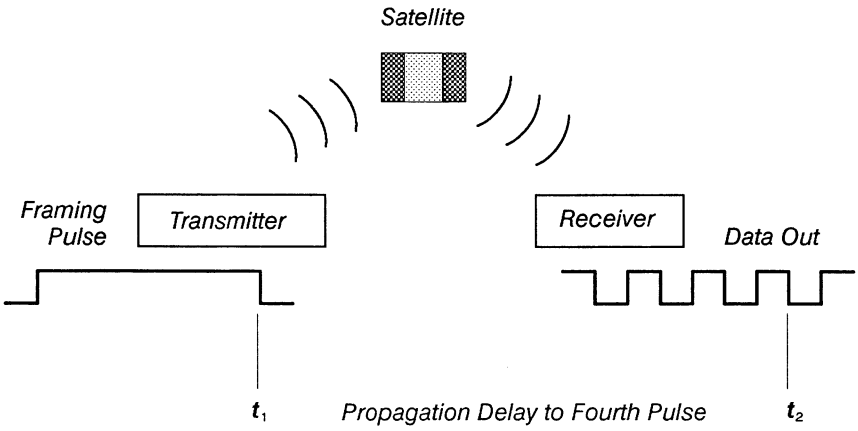
This example shows you how to use the trigger-to-trigger time measurement to take precise propagation delay measurements. The trigger-to-trigger measurement uses special trigger circuits to measure the time delay between the Main trigger and the Window trigger.

Why not use the Prop Delay measurement to accomplish this task? It is an easier method, but its resolution depends primarily on the interval between the samples in a waveform record. This interval may be more than a microsecond for long-duration records. For instance, a 10 ms duration (1 ms/div), 1024 point record has a sample interval (and measurement resolution) of 10 μs. In contrast, the resolution of a trigger-to-trigger measurement is 1 ps or eight decimal digits, whichever is less. Following the example above, measuring the full duration of a 10 ms record provides a precise 1 ns measurement resolution.



Propagation Delay Measurement

In this example, you will use both the the Main and Window trigger circuits. You will use the Window Holdoff by Events function to set the measurement endpoint. Once the two triggers are set, you will use the Main to Window Trigger Time measurement to take the propagation delay.



Testing a Satellite Transmitter-Receiver System

An Application

You must test a satellite transmitter-receiver system. The signal transit time is relatively long, on the order of microseconds, but the pulse timing information must be known to a precision of at least 10 ns. In addition, you are interested in the timing and appearance of the fourth data pulse from the receiver. The framing pulse at the transmitter synchronizes transmission. You will use its falling edge as your trigger source and to start your measurement.

QuickStart Jumpers	
J1	*C*
J2	*A*
J3	*B*
J4	*B*
J5	*A*
J6	*B*
J7	*C*
J8	*B*

The QuickStart board signal TP6 will serve as the Framing pulse that marks the end of transmission. The QuickStart board signal TP3 will be your received data waveform. It has a burst of four negative-going pulses during each TP6 pulse.

- Step 1: Initialize the DSA by pressing the **UTILITY** button in the **MENUS** column and touching **Initialize Setting** in the Utility 1 major menu.
- Step 2: Set the QuickStart board jumpers as shown in the table at left.

Defining the Framing Waveform

In the following steps you will create a framing waveform (R1) displaying two pulses. This will be your Main trigger source. The first framing pulse is the transmit pulse that starts your measurement.

- Step 3: Attach the probe connected to **CH 1** in the right plug-in amplifier to TP6 on the QuickStart board. Attach the probe connected to **CH 1** in the left plug-in amplifier to TP3.

- Step 4: Press the **CH 1** button on the right plug-in amplifier to create an R1 waveform.

Creating R1 (TP6) first automatically establishes it as your trigger source. This waveform will serve as the transmitter framing pulse.

- Step 5: Touch the horizontal icon ↔ and set the **Main Size** knob to 2 µs/div. Also set the **Main Position** knob to -1 µs to make the Main trigger indicator easier to see.

- Step 6: Touch the vertical icon ↕ and set the **Vertical Size** knob to 200 mV/div. Adjust the **Vertical Offset** knob to position waveform R1 to the upper half of the graticule.

- Step 7: Touch the Main trigger icon and adjust the **Main Trig Level** knob for a stable waveform.

Defining the Data Waveform

In the following steps you will create the data waveform (L1), which will have two bursts with four narrow pulses each. The second data burst, the received data, will be your measurement endpoint.

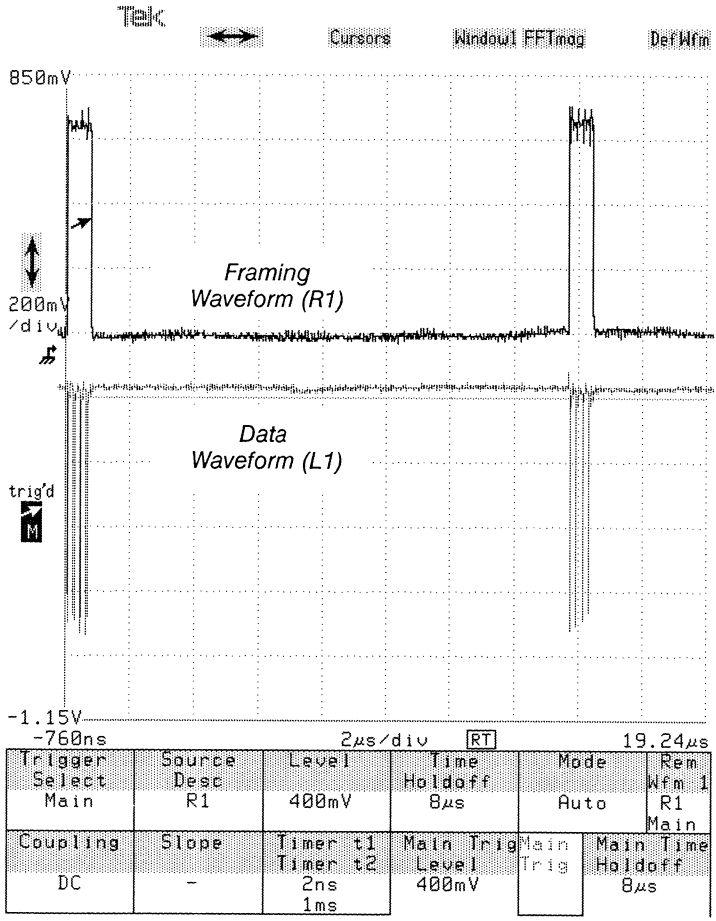
- Step 8: Press the **CH 1** button on the left plug-in amplifier. This will be your data waveform detected by the receiver.

- Step 9: Touch the vertical icon ↕ and set the **Vertical Size** knob to 200 mV/div. Adjust the **Vertical Offset** knob to position waveform L1 to the lower half of the graticule.

Your display should closely resemble the illustration on the following page. If not, check the QuickStart board jumpers and the DSA settings.

- Step 10: Press the **TRIGGER** button in the **MENUS** column. Then touch **Slope** in the Trigger major menu to select a negative slope (–) for the Main trigger.

This selects the negative or falling edge of the framing pulse to be the Main trigger and the start of your propagation delay measurement.



Display With Framing and Data Waveforms

Creating and Positioning a Window

The time/division setting required to display two data bursts is so long that the individual data pulses on the Main waveform (L1) are difficult to see. In the following steps you will make a Window waveform on the data waveform (L1) to view a single data pulse. Eventually you will adjust the Window to display the fourth data pulse, your measurement endpoint.

- Step 11: Touch the data waveform, L1, so that it is the selected waveform.

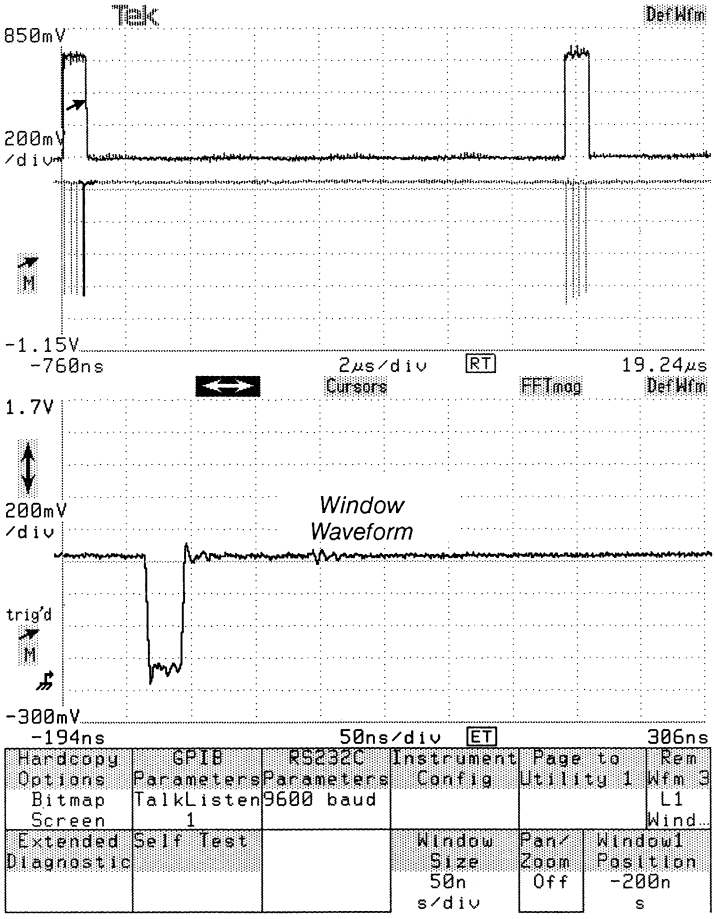
- Step 12: Touch the **Window1** icon to create a Window on the data waveform, L1.

Notice the blue highlighted region on the Main waveform and the Main trigger-point indicator (➶) near the left edge of the waveform.

- Step 13: Set the horizontal scale of the lower graticule to 50 ns/div with the **Window Size** knob.

- Step 14: Set the **Window1 Position** knob to -200 ns. This will move the highlighted region on the Main waveform L1 to the last pulse in the first (left) data burst. You may need to adjust the trigger level and holdoff. If so, ensure that the Main trigger arrow remains on the falling edge of the main waveform R1.

The expanded data pulse is now displayed in the lower graticule (see the illustration on the following page).



Display With Expanded Window Waveform Of Data Pulse

Selecting the Trigger-to-Trigger Measurement

■ Step 15: Press the **MEASURE** button from the **MENUS** column, then touch **Measurements** in the Measurements major menu, and **Main → Win Trig Time** and **Exit Menu** in the **Measurements** pop-up menu.

The **Main → Win Trig Time** measurement has an undefined readout because the Window time base is still triggered from the Main trigger.

Defining the Window Trigger Source

In the following steps you will assign a Window trigger source and activate the Window trigger. Activating the Window trigger does two things:

- Provides an endpoint for your trigger-to-trigger measurement.
- Provides the capability to precisely place the trigger on the fourth pulse in a data burst.

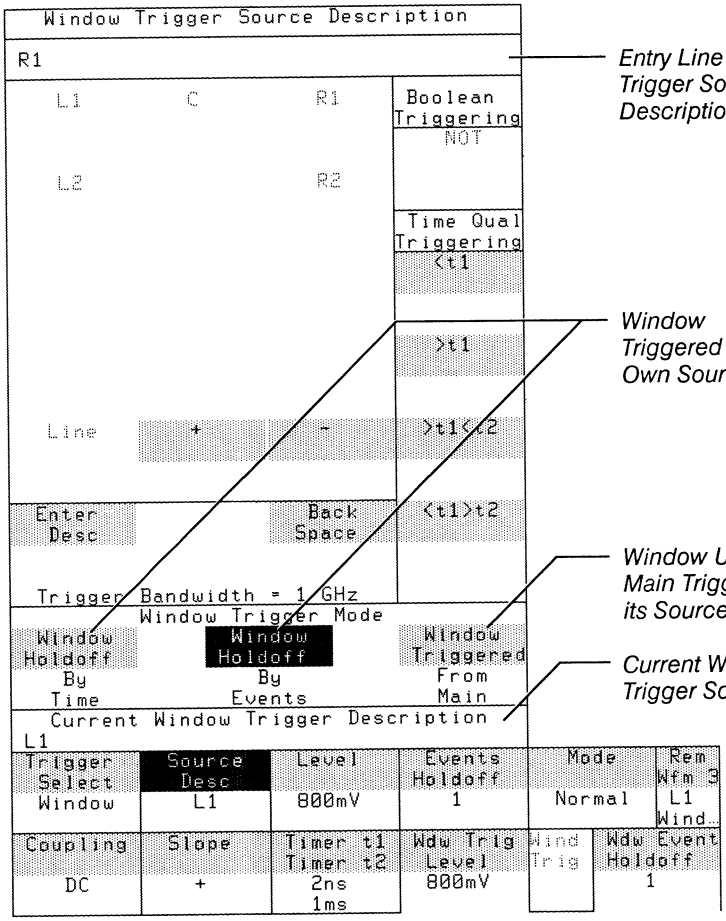
The Window Trigger source and the Main Trigger source must be from different plug-in amplifiers

■ Step 16: Press the **TRIGGER** button from the **MENUS** column.

Notice that the **Trigger Select** selector reads Main. The Trigger major menu has two pages, one for Main trigger parameters and one for Window trigger parameters. You use **Trigger Select** to switch between the Main and Window pages.

■ Step 17: Touch **Trigger Select** to display the Window trigger parameters.

■ Step 18: Touch the **Source Desc** selector to get the **Source Desc** pop-up menu for the Window trigger.



Window Trigger **Source Desc** *Pop-Up Menu*

An independent Window trigger is not available when you use Boolean conditions for the Main Trigger

The **Source Desc** pop-up menu lets you change the Window trigger mode and select a source for the Window trigger circuit. You can choose to trigger the Window time base separate from the Main time base using either Holdoff by Time or a number of Window trigger events. Both holdoff modes delay acceptance of a Window trigger event for a certain period after the Main trigger event.

Selecting Holdoff By Events

With Window Holdoff by Events you can set the number of Window trigger events that will be ignored before the Window time base runs. The first event can occur 4 ns after the Main trigger event and the maximum number of events is almost unlimited (1 x E9).

- Step 19: Touch the pop-up menu **Window Holdoff By Events** selector then select **L1** and **Enter Desc**.

Notice that:

- The status field of the **Source Desc** selector of the Trigger major menu now reads L1 instead of Main Trigger.
- The **Time Holdoff** selector in the Trigger major menu (next to the **Level** selector) is replaced by the **Events Holdoff** selector.
- The Window trigger icon  at the left of the graticule has a W in it, telling you the Window has its own trigger source.
- There is now a blue, Window trigger-point indicator on the upper graticule. It is positioned on the Main waveform (L1) to show the Window trigger settings.

Adjusting the Window Trigger

In the following steps you will adjust the Window trigger and select negative slope. This ensures that the trigger-to-trigger measurement is taken from one negative edge (Main trigger) to another negative edge (Window trigger). You will also expand the Window waveform for a clearer view.

- Step 20: Touch the Window trigger icon and adjust the Window trigger level on the lower waveform (L1) to get a stable Window waveform. Note that Window Holdoff Events is assigned to the knob.

- Step 21: Touch the **Slope** selector to set the Window trigger slope to negative (–).

- Step 22: Touch the horizontal icon ↔ and set the **Window Size** knob to 10 ns. Adjust the **Window Position** knob to center the first data pulse (about -50 ns). Use **FINE** resolution as necessary.

Observing the Measurement Results

The Window now displays the first receiver data pulse. This is also the same pulse the Window time base is triggered on. In the following steps you will observe the measurement results while incrementing the holdoff event count to four. When the fourth pulse is reached, the desired measurement endpoint will be displayed and the measurement readout will give the desired propagation delay.

- Step 23: Press the **MEASURE** button from the **MENUS** column.

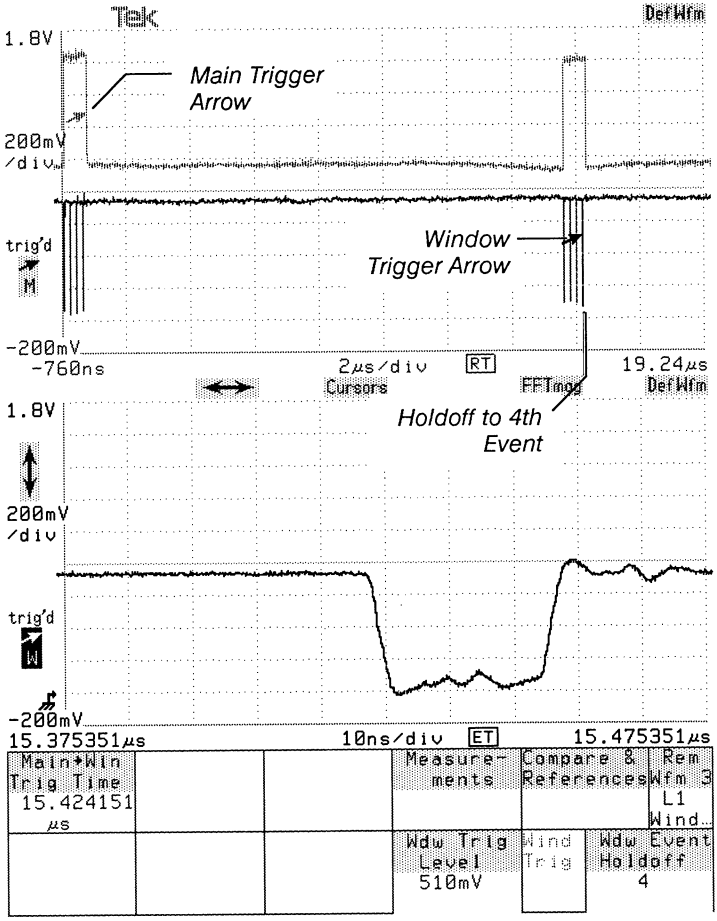
Notice the **Main → Win Trig Time** selector in the Measure major menu no longer reads Undefined. It now displays a valid time interval in its status field. This should be about 14.9 µs. Note that the measurement resolution is six decimal places or 1 ps.

- Step 24: Touch the Window trigger icon .

- Step 25: Slowly rotate the **Events Holdoff** knob clockwise while watching the data waveform and the measurement readout.

With each increase in the number of holdoff events, the Window time base is held off by one more Window trigger event and the Window region moves one pulse to the right on the data waveform. Also note that the trigger-to-trigger time measurement increases by about 180 ns.

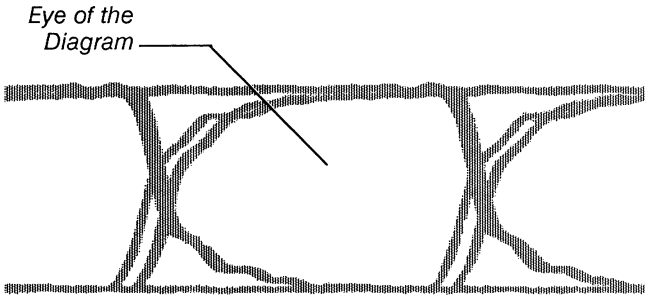
- Step 26: Adjust the Window trigger level and note the effect on the waveform and the measurement readout. The end points of the time measurement change slightly because of the fall time of the pulses.



Main Trigger to Window Trigger Time Measurement

Example 11: Eye Diagrams

This example shows you how to produce eye diagrams in two ways. The first technique uses the nonvectored display mode of the DSA which displays a dot for each acquired sample point. The normal vectored mode displays samples connected by lines (vectors) to produce a waveform shape. This works well for typical waveforms, but you can use the nonvectored mode to produce other useful displays such as eye diagrams.



Eye Diagram Display

The second technique uses the point accumulate mode which operates similar to the nonvectored mode. A nonvectored display is updated with each new acquisition of a channel. You can display a history of samples taken during a large number of acquisitions with the point accumulate mode. The point accumulate mode produces a display similar to the infinite-persistence feature of CRT storage oscilloscopes. This acquisition mode constantly adds new samples to the display to show the full range of signal transitions. Point accumulate mode can produce an eye diagram that shows a history of a signal.

Eye Diagrams

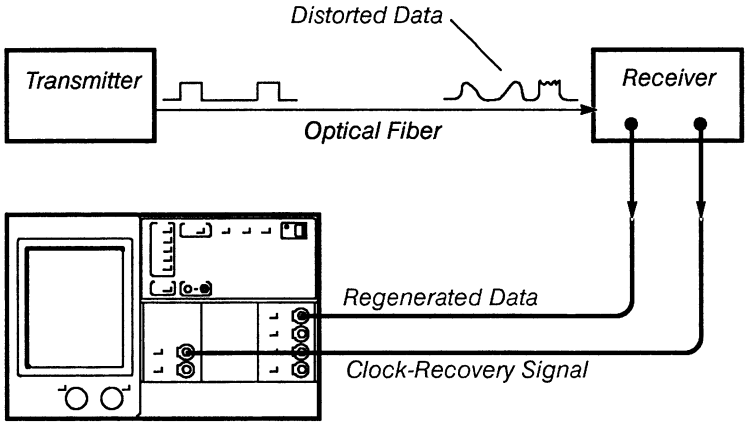
Eye diagrams have broad applications. For example, they are useful in aligning disk drives. An increasingly important application is the diagnosis of digital communications links. Long-haul transmission channels such as undersea cables with many repeaters, which quickly distort pulse shapes and timing.

With the eye diagram you can visually distinguish the effects of distortion, non-linearity, jitter, cross talk, etc. The eye diagram method presented in this example is updated constantly to show the results of any alignment or adjustment you make on the system under test. Then the point accumulate mode lets you build a history of transitions.

Eye diagram data from the nonvectored display may be transferred by GPIB or RS-232-C to a remote computer for analysis. Software utilities available from Tektronix can produce specialized graphics plots which enhance the diagnostic capabilities of the eye diagram.

An Application

In the optical link shown below, a transmitter converts digital electronic signals into well-defined optical pulses. After travelling through the cable, the optical signal is distorted by dispersion, phase distortion, cross talk, etc.



Eye Diagram Testing of Optical Link

The receiver is designed to turn the distorted pulses into clean ones. First a clock-recovery circuit analyzes the incoming pulses and generates a clock signal. A decision circuit then compares the data with the regenerated clock signal and decodes the data. The clock signal provides a trigger to produce the eye diagram.

QuickStart Jumpers	
J1	C
J2	B
J3	B
J4	B
J5	A
J6	B
J7	A
J8	B

The QuickStart board clock signal TP7 will serve as the clock-recovery signal and TP13 will be the data signal.

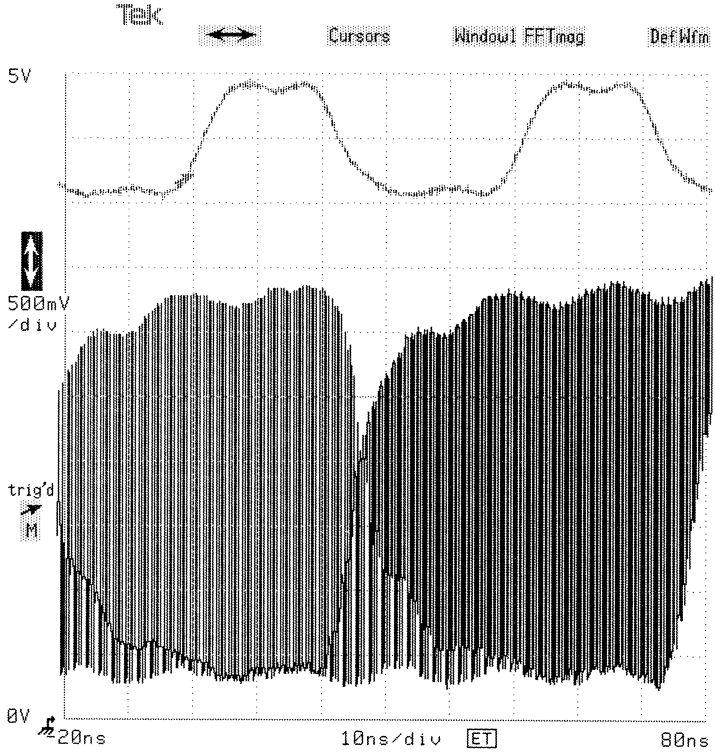
- Step 1: Initialize the DSA by pressing the **UTILITY** button in the **MENU** column then touching **Initialize Setting** in the Utility major menu.
- Step 2: Set the QuickStart board jumpers as shown in the table at left. You must press the reset button on the QuickStart board to activate the eye diagram circuit enabled with J2B.

Press the Reset button on the QuickStart board.

- Step 3: Attach the probe connected to **CH 1** of the left plug-in amplifier to TP7, the clock signal, and the probe connected to **CH 1** of the right plug-in amplifier to TP13, the data signal.
- Step 4: Press the **CH 1** button on the left plug-in amplifier to display the clock signal.
- Step 5: Touch the horizontal icon ↔ and set the **Main Size** knob to 10 ns/div.
- Step 6: Touch the vertical icon ↕ and set the **Vertical Size** knob to 1 V/div. Position the clock waveform to the graticule top with the **Vertical Offset** knob. This setup will provide more space for your data waveform.
- Step 7: Touch the Main trigger icon and adjust the **Main Trig Level** and **Main Time Holdoff** knobs for a stable clock signal.
- Step 8: Press the **CH 1** button on the right plug-in amplifier to display the data signal.

- Step 9: Touch the vertical icon ↕ and set the **Vertical Size** knob to 500 mV/div and position the data waveform near the graticule bottom with the **Vertical Offset** knob.

As shown in the illustration on the following page, the data waveform will appear improperly triggered. The following steps will resolve the apparent triggering problem and complete the eye diagram setup.



Clock Waveform and Untriggered Data Waveform

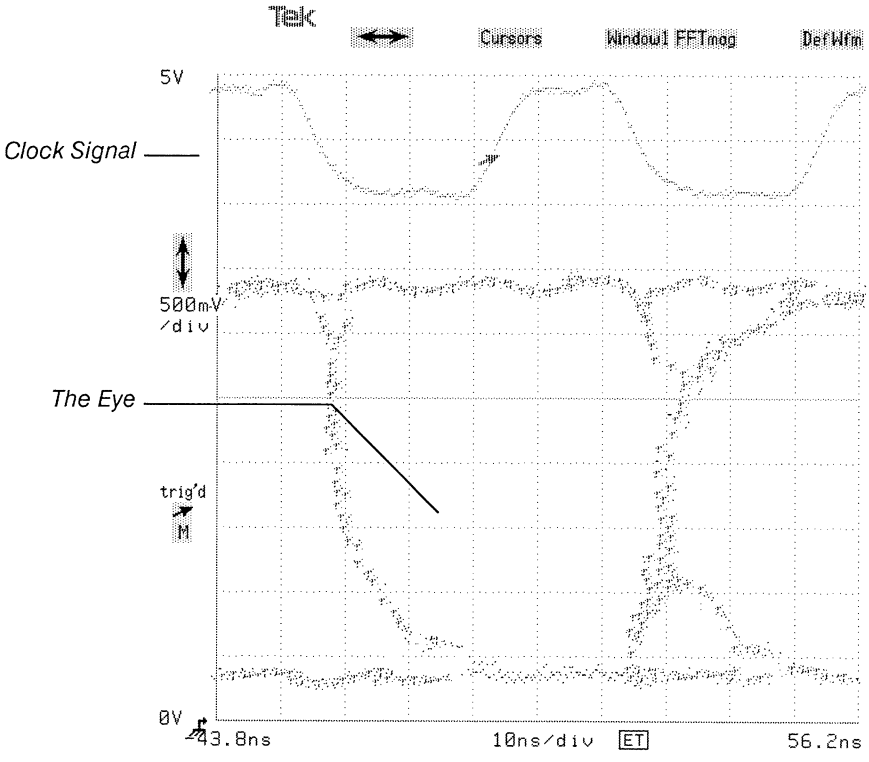
Selecting the Nonvectored Display Mode

The nonvectored mode will display eye diagrams when a waveform display has only 512 points, so you will need to change the record length. Once the record length is set, you will select the nonvectored mode to produce the eye diagram.

- Step 10: Press the **WAVEFORM** button, touch **Horizontal Desc**, and select **Main Record Length** from the **Horizontal Desc** pop-up menu.
- Step 11: Set the **Main Record Len** knob (left) to 512 points.
- Step 12: Press the **UTILITY** button in the **MENUS** column, select **Instrument Modes** in the major menu, and touch **Vectored Waveforms** in the **Instrument Modes** pop-up menu to turn the vectors off. Touch **Instrument Modes** again to remove the pop-up menu.

You now have an eye diagram of your data signal composed of changing dot samples. It should look like the one on the following page.

You may want to adjust the trigger level and holdoff to improve the eye diagram display. Adjust the trigger level and holdoff by touching the trigger icon and using the control knobs.



Eye Diagram Using the Nonvectored Display Mode

Creating a Point Accumulate Eye Diagram

This active eye diagram is useful for viewing the current state of your receiver system. However, you may want to produce an eye diagram that shows the full range of transition timing and amplitude variations over a long period. The point accumulate mode provides this function by combining sample points from a large number of acquisitions on one waveform display. You must select a waveform so that it can be acquired with the point accumulate mode.

- Step 13: Touch the data signal (R1) waveform located at the graticule bottom, to ensure that it is selected.

- Step 14: Press the **WAVEFORM** button, touch **Horizontal Desc** in the major menu and then select **Point Accumulate** from the pop-up menu.

The eye diagram will now begin to fill in.

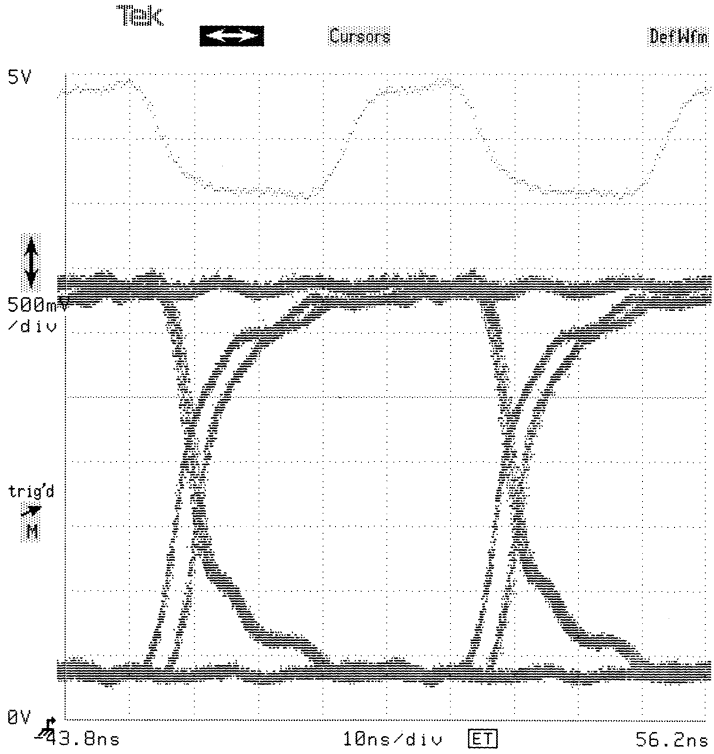
You may want to adjust the trigger level and holdoff to improve the eye diagram display. Changing the trigger level or holdoff (and horizontal size or position) restarts the accumulation of waveform points.

You can also restart acquisition of the Point Accumulate waveform from the **STORE/RECALL** major menu by selecting **Clear Waveform** and touching **Clear All** in the pop-up menu.

Interpreting an Eye Diagram

A typical eye diagram is displayed below the clock waveform, as shown on the next page. It gets its name from the shape of the central opening.

The narrower the eye, the more timing errors; the shorter the eye, the more amplitude errors. An ideal eye diagram—in the case of perfect transmission—is a rectangle.



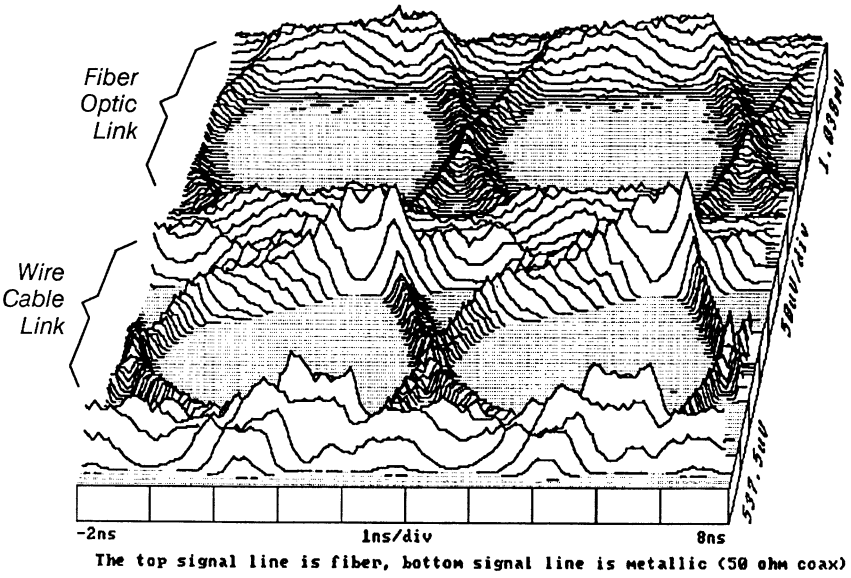
Eye Diagram Using the Point Accumulate Acquisition Mode

Other Presentations of Eye Diagram Data

Diagnosis of transmission link problems is greatly facilitated by advanced methods of presenting the eye diagram data. The waveform data may be transferred via RS-232-C or GPIB to a controller (a remote computer) for further analysis.

Tektronix offers software utilities that plot eye diagram data in special ways to simplify identification of the individual sources of distortion; such as dispersion, noise, and jitter.

One such special plot is the wireframe perspective plot shown below.



Wireframe Plot of Eye Diagram Data

This wireframe plot shows two eye diagrams:

- The rear half is an eye diagram for an optical fiber link.
- The front half is for a coaxial cable (wire) link.

Notice that shapes and relative heights of peaks differ in the optical link and the wire link. These features are brought out more strongly than on the DSA display. The Tektronix software also generates pseudo-color plots.

Example 12: FFT Displays And Measurements

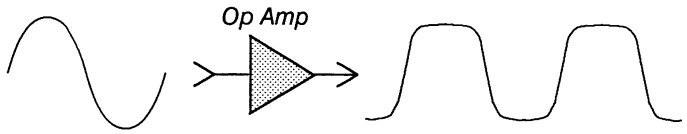
This example shows you how to use the FFT (Fast Fourier Transformation) function to produce frequency domain displays. You can then use the cursors to take measurements on the frequency waveform.

Fast Fourier Transformation

The Fourier transformation is an extremely powerful tool for converting data from the time domain to the frequency domain. The FFT function provides a quick and practical implementation.

Features of the FFT function are:

- Magnitude and phase displays
- Six windows: Blackman, Blackman-Harris, Hamming, Hanning, rectangular, and triangular
- Two vertical scales for magnitude: linear and logarithmic (dB)
- Optional signal pre-averaging
- Full cursor measurement capability, with direct amplitude measurements in dB or volts



Operational Amplifier Showing Harmonic Distortion on the Output Signal

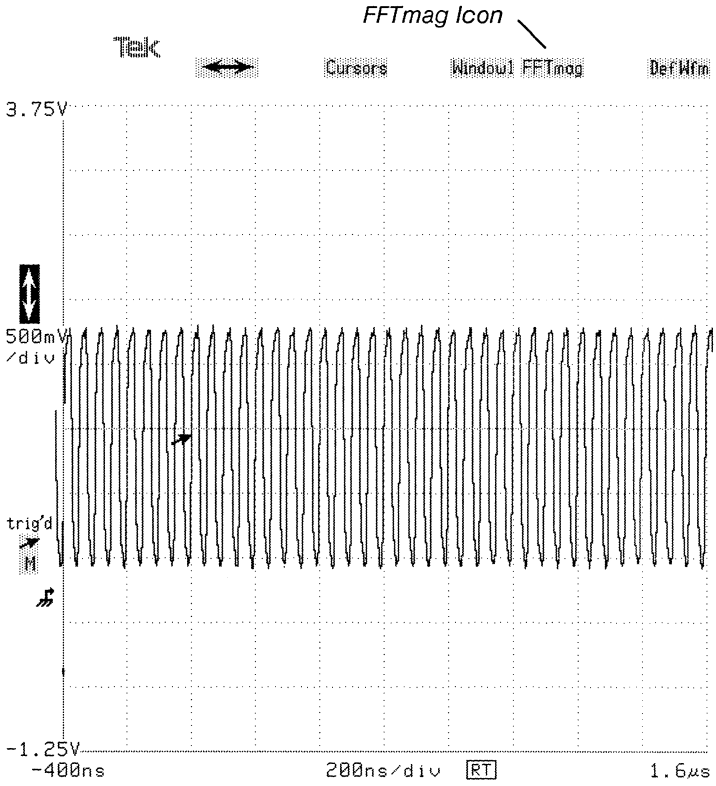
An Application

You have an operational amplifier (op amp) that distorts a sine wave with slew rate limiting and compression. You want to look at the output signal with the DSA 600's FFT function to get an estimate of the harmonic distortion.

QuickStart Jumpers	
J1	*C*
J2	*A*
J3	*D*
J4	*B*
J5	*A*
J6	*B*
J7	*A*
J8	*B*

A distorted sinewave provides a good example to demonstrate how the Fourier transform displays the frequency spectrum of a signal.

- Step 1: Initialize the DSA by pressing the **UTILITY** button in the **MENUS** column and touching **Initialize Setting** in the Utility major menu.
- Step 2: Set the QuickStart board jumpers as shown in the table at left.
- Step 3: Attach the probe connected to CH1 of the left plug-in amplifier to TP7 on the QuickStart board.
- Step 4: Press the **CH1** button on the left plug-in amplifier to create an L1 waveform.
- Step 5: Touch the horizontal icon ↔ and set the **Main Size** knob to 200 ns/div, which will display about 40 cycles (4 per division).
- Step 6: Touch the vertical icon ↕ and set the **Vertical Size** knob to 500 mV/div. Position the waveform to screen center with the **Vertical Offset** knob.
- Step 7: Select the Main trigger icon and adjust the **Main Trig Level** and **Main Time Holdoff** knobs for a stable waveform.



Initial Time-Domain Waveform and Location of **FFTmag** *Icon*

Creating an FFT Waveform

Now you are ready to create a frequency domain waveform. You can use the **FFTmag** icon or the **DefWfm** icon to create an FFT waveform. When using the **DefWfm** icon, you select FFTmag or FFTpha from page two of the Waveform Functions section of the **DefWfm** pop-up menu. You will use the **FFTmag** icon in this example. The FFT waveform appears on the lower graticule and is identified as FFTmag(L1) in the **Vertical Desc** selector.

- Step 8: Touch the FFT magnitude (**FFTmag**) icon.

A dual-graticule display is created with the original waveform in the upper graticule and the FFT waveform in the lower graticule.

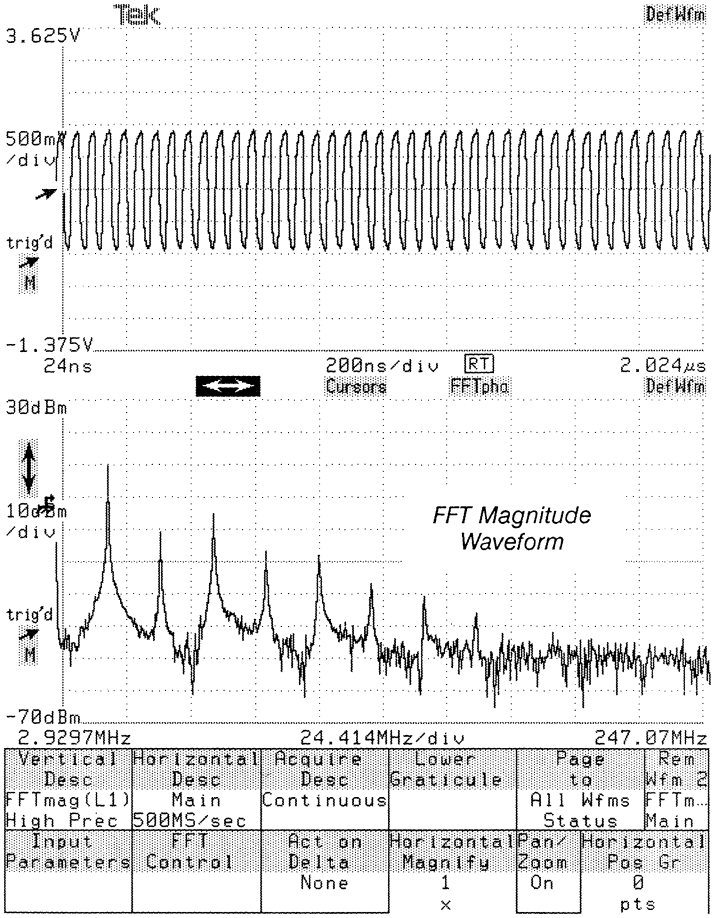
Using Pan/Zoom

The original L1 waveform sets the horizontal resolution of the lower FFT waveform. Pan/Zoom allows you to expand the FFT waveform. In this example, the fundamental frequency is on the left so you will want to change the Pan/Zoom pivot point, used when expanding the waveform, to the left side.

- Step 9: Press the **UTILITY** button, select **Instrument Modes** from the major menu, and touch **Pan/Zoom pivot** twice to select **Left**. Press the **WAVEFORM** button to leave the pop-up menu and return to the Waveform major menu.

- Step 10: Select the horizontal icon ↔ and set the **Horizontal Magnify** knob to 2. Adjust the **Horizontal Pos Gr** knob counterclockwise to pan through the FFT waveform.

Notice that the waveform expands in normal Pan/Zoom fashion. Panning also operates in the usual way.



Normal and FFT Waveforms

Taking Cursor Measurements

You will see a number of harmonic spikes on the FFT waveform. The left-most of these is the fundamental frequency of the signal. This will be about 20 MHz for a calibrated QuickStart board. The Cursors provide an excellent way to identify the frequency and amplitude of the peaks. The amplitude can be measured directly in dB (decibels).

- Step 11: Set the **Horizontal Magnify** knob back to 1.
- Step 12: Touch the **Cursors** icon and move the left cursor to the first spike with the **Cursor1** knob. Select **FINE** resolution for precise cursor control.
- Step 13: Use the **Cursor 2** knob to move the right cursor dot to the spike just to the right of the first cursor. Read the frequency difference from the Δf readout in the **Cursor** major menu below the f1 and f2 readouts.

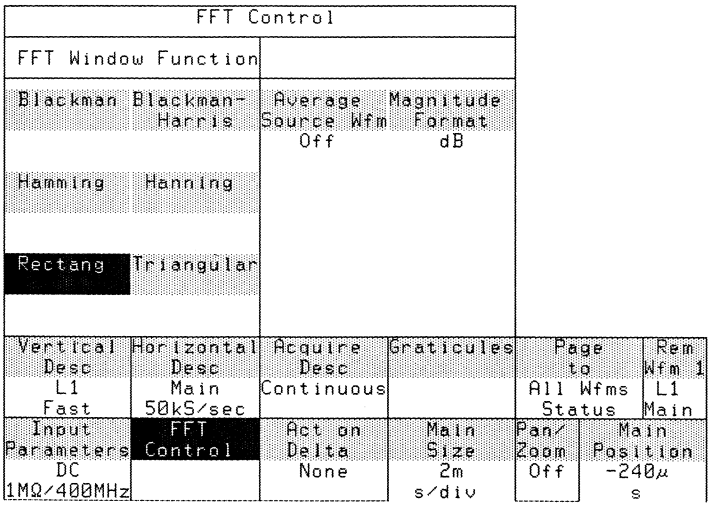
The cursor 1 frequency is f1 and the cursor 2 frequency is f2. Note that the ΔV value shows the amplitude difference in dB between the cursor positions.

Linear Scaling

The FFT vertical logarithmic scale makes low amplitude, frequency components, including the noise, more visible. You can display the FFT waveform with a linear scale to see a linear amplitude comparison of the spectral components.

- Step 14: Press the **WAVEFORM** button, touch **FFT Control** to display the **FFT Control** pop-up menu, and touch **Magnitude Format** to select linear scaling. Touch **FFT Control** again to remove the pop-up menu.

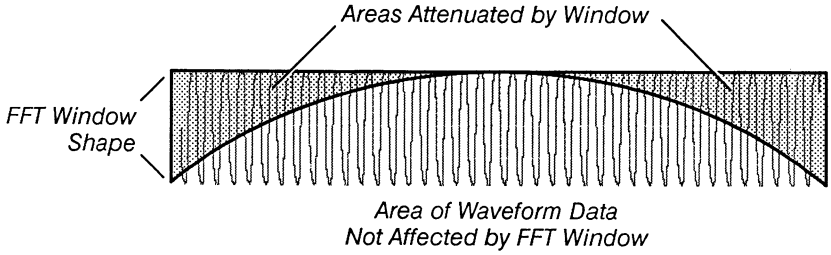
Now the structures on both sides of the peaks (the wings) are suppressed and all low amplitude noise is gone.



FFT Control *Pop-Up Menu*

FFT Windows

The **FFT Control** pop-up menu allows you to select from several types of window functions. The FFT window functions are applied to the time-domain waveform data before the Fourier Transformation is calculated. The purpose of the FFT windows is to reduce certain aberrations that sometimes appear in the frequency waveform. Each FFT window has a different filter shape (see the following illustration). The default window function is rectangular and has no affect on the aberrations.



FFT Windowing Filter on Time-Domain Waveform Data

Most FFT window functions attenuate the time-domain waveform data to near zero at the the beginning and end of the record. This reduces the wings seen on either side of the peaks in the frequency domain waveform.

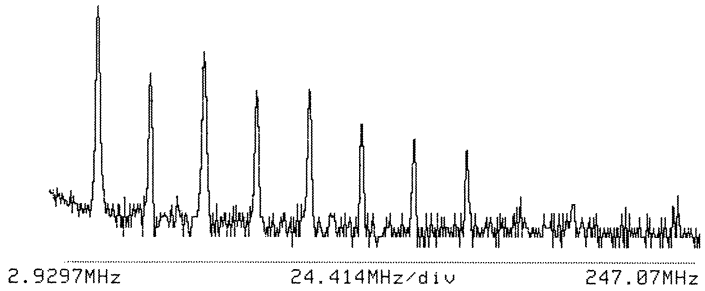
The wings, which are called leakage, occur because the time-domain waveform does not have an integer number of cycles displayed. As a result, the first and last waveform points have unequal amplitudes. Without an attenuating FFT window this discontinuity between the two endpoints is interpreted by the FFT as a very fast step in the signal. The fast step constitutes a broadband (white noise) spectrum that has the effect of raising the noise floor and producing the wings on the peaks.

Changing the FFT Window

- Step 15: Touch **FFT Control** then **Magnitude Format** to return to the dB scale.
- Step 16: Select **Hanning** in the FFT Window Function section. Touch **FFT Control** again to remove the pop-up menu.

The wings on the frequency peaks will now be greatly reduced. You can further reduce the FFT waveform noise by using the waveform pre-averaging feature. Averaging removes high frequency noise and is performed before the FFT function.

- Step 17: Touch **FFT Control** then **Average Source Wfm** to start pre-averaging. Touch **FFT Control** again to remove the pop-up menu.



FFT Waveform with Hanning Windowing and Averaging

FFT Phase Waveforms

When an FFT magnitude waveform is displayed, you can create an FFT phase waveform by selecting the FFT phase icon (**FFTpha**). This new lower-graticule waveform has a vertical scale marked in degrees. The phase waveform shares the horizontal scale with the FFT magnitude waveform so you can observe the phase shift for particular frequency peaks.

Horizontal Scale of the FFT Waveform

The horizontal scale of the FFT waveform is set by the sampling rate and the number of points in the waveform record. You can derive an approximation of the horizontal scale by dividing the sampling rate displayed in the **Horizontal Desc** selector by two. This gives you the upper end of the frequency range (displayed at the right-most graticule line). You then divide this number by 10 (divisions) to approximate the horizontal scale.

The discrepancy between the calculated and the actual horizontal scale is caused in part by the points that extend off each end of the graticule. The left edge of the *waveform* is at 0 Hz whereas the left edge of the graticule is at some frequency above 0 Hz.

Changing either the **Main Size** of the upper waveform (L1) or the record length will change the sampling rate and, hence, the horizontal scale of the FFT waveform.

- Step 18: Touch the upper waveform, L1, to select it.

- Step 19: Touch the horizontal icon ↔ and set the **Main Size** knob to 100 ns/div, then 400 ns/div, while observing the FFT waveform and its horizontal scale. Note also the change in sampling rate (shown in the **Horizontal Desc** selector).

Congratulations. You have completed the Advanced Application examples of the *QuickStart Workbook* and are now ready to pursue your own projects. For additional information on any of the functions used in this workbook, refer to your *DSA 601 and DSA 602 User Reference*.

Glossary

Acquisition
The process of sampling the signals coming through the input channels and accumulating the samples into waveforms.

Act On Delta
An acquisition mode in which the DSA compares an actively acquired waveform to an enveloped waveform and performs some action when a specified number of points in the actively acquired waveform record are outside the bounds defined by the enveloped waveform.

Active Graticule
In a dual-graticule display, the graticule that shows the selected waveform.

Annotation Lines
Lines that appear on a waveform to show the measurement parameters.

Autoset
A means of letting the DSA set itself to provide a stable and meaningful display of the selected waveform.

Averaging
Displaying a waveform that is the combined result of several acquisitions, thereby reducing apparent noise.

Axis Label
There are three notations on each axis. The first and last notation on each axis show the numeric value of the graticule edge (*not* the edge of the displayed points, which are slightly outside the graticule). The center notation is the scale factor expressed in units per division.

Base Label

The first characters of the labels of waveforms acquired in the repetitive single trigger or Act on Delta acquisition mode. The label of each such waveform consists of the base label followed by a sequentially assigned number.

Calibration

Fine-tuning of the system for vertical and horizontal (time base) accuracy. The DSA, plug-in units, and probes or cables must be calibrated together as a system for best accuracy. See Enhanced Accuracy.

Channel

The input connector on a plug-in unit, to which you attach a probe or cable connected to the signal source. Also, the smallest component of a waveform expression.

Channel Number

The number assigned to a specific signal input connector.

Compensation

For probes, the adjustment of controlling elements that compensate for undesirable characteristics.

Complex Waveform

A waveform with a waveform description beyond a single channel specification. Any waveform using a numeric value, a function (other than Average), a reference to a stored waveform, or an arithmetic operator is a complex waveform.

Control Knob

see Knob

Cursor

Any of four styles of paired markers that you position with the knobs. The DSA displays the positions of the cursors and the distance between them, in axis units.

Default Measurement Parameter

A value from the default set of measurement parameters. You can change the default values. Whenever a waveform is created, the measurement parameters are copied from the default set.

Delayed Sweep

see Window

Distal

The most distant point from a reference point. As used here, the ending measurement point for timing measurements.

Dual Graticule

A display with two graticules. Each one is half the height of the single graticule.

Enhanced Accuracy

An automatic self-calibration of the DSA and any installed plug-in units as a system. Probes or cables must also be calibrated as part of the system for best accuracy.

Entry Line

A text line that shows your input as you enter selections in a pop-up menu.

Enveloping

Displaying a waveform that shows the extremes of variation of the input signal(s) over several acquisitions.

Equivalent Time
An acquisition mode in which waveform data from several triggered sweeps of the time base are combined into a single waveform record.

FFT (Fast Fourier Transform)
A function that produces a display of the frequency spectrum of a waveform. The DSA can display the magnitude and the phase of components in the frequency spectrum.

GPIB (General Purpose Interface Bus)
An interface (IEEE standard 488) that can be used for remote computer control of, and data capture from, the DSA.

Graticule
The grid where waveforms are displayed.

Horizontal Size
see Main Size

Icon
A marker near the edge of the graticule that performs a specific function when touched.

Initialization
Setting the DSA to a completely known, default condition.

Keypad Menu
A pop-up menu that controls knob resolution and lets you enter specific numeric values for any control to which a knob is assigned.

Knob
One of the two large rotary controls below the DSA screen.

Knob Assignment
The value that a knob will adjust at a given time.

Knob Menu

The on-screen menu that always displays the current knob assignment. The knob menu also lets you display the Keypad menu.

Knob Resolution

The amount of change caused by each click of a knob.

Label

An identifying word associated with a waveform or a stored setting. Waveform labels can be displayed with their waveforms.

Main Size

The span of time displayed within each horizontal graticule division on the Main time base.

Main Time Base

The time base on which waveforms other than window waveforms are acquired.

Major Menu

The menu that is displayed at the bottom of the screen. One of the several major menus is always displayed.

Major Menu Button

A labeled button to the right of the display that determines which major menu is displayed.

Measurement

An automated numeric readout that the DSA provides and updates directly from the displayed waveform in real time.

Measurement Parameter

One of several controls, including reference values and limits, that determine how measurements are taken. You can change these parameters to control the automated measurements.

Measurement Tracking
The process of automatically adjusting the measurement parameters to reflect changes in the waveform.

Mesial
The middle point of a range of points. As used in the DSA, the middle measurement point between proximal and distal points for timing measurements, and the intermediate height between baseline and topline for amplitude measurements.

Plug-In Unit
An amplifier that scales the incoming signal of a channel before sending it to the DSA to be digitized.

Point Accumulate Mode
A mode of operation where the DSA displays newly acquired waveform data points while keeping the previously acquired data points on the screen.

Pop-up Menu
A temporary menu that provides an interactive dialog for a specific function. A sub-menu of a major menu.

Principal Power Switch
The master power switch located on the rear panel of the DSA.

Proximal
The point closest to a reference point. As used here, the beginning measurement point for timing measurements.

Real Time
An acquisition mode in which all the samples for a waveform record are taken from a single triggered sweep of the time base.

Record Length
The number of samples (data points) that make up a waveform record.

RS-232-C
An interface that allows remote computer control of, and data capture from, the DSA.

Sample Interval
The time interval between successive samples in a waveform record.

Sampling Rate
The speed with which the DSA acquires samples, expressed in samples per second.

Selected Waveform
The waveform that is acted on by the knobs and menu selectors, and to which measurement readouts apply.

Selector
An area of a menu that performs some action when you touch it.

Setting
The state of the front panel and system at a given time.

Single Trigger
An acquisition mode in which acquisition is stopped after a single trigger is detected and the time base duration has expired.

Single Shot
see Single Trigger

Stored Waveform
A collection of sampled points that constitute a single waveform acquisition that is saved in memory.

Time Base

The time-dependent specifications that control the acquisition of a waveform. The time base determines when and for how long to acquire and digitize signal data points.

Tracking

The process of automatically adjusting the measurement parameters or window position to reflect changes in the waveform.

Trigger

An electrical event that is used as a horizontal reference for acquired waveform samples.

Vertical Description

see Waveform Description

Vertical Size

The number of vertical axis units displayed within a vertical division of the graticule. Usually the vertical units are volts, and the vertical size corresponds to plug-in amplifier sensitivity.

Waveform

The visible representation of an input signal or combination of signals.

Waveform Description

The definition of what the waveform displays. It can include one or more channels combined arithmetically and modified by functions.

Waveform Number

A number assigned by the DSA to identify a waveform. Displayed waveforms are numbered 1 through 8. A new waveform is always given the lowest available number.

Window

A waveform that represents a horizontally expanded portion of another waveform. Window waveforms are acquired using a time base that is independent of the main time base.

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MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

Tektronix
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MANUAL CHANGE INFORMATION

Date: 9/89 Change Reference: C1/0989

Product: DSA 601 & DSA 602 QuickStart Workbook Manual Part No: 070-7499-00

Product Group: 47

These changes are for instruments with firmware version 1.2 or above (including all new instruments). For earlier firmware versions, ignore these changes.

TEXT CHANGES

The following changes apply throughout the manual:

The **Initialize Setting** selector now reads **Initialize.**

The **Page to All Wfms Menu** selector now reads **Page to All Wfms Status.**

The **Instrument Modes** selector now reads **Modes.**

Point Accumulate mode should be *Infinite Persistence mode.* The **Point Accumulate** selector in the **Horizontal Desc** pop-up menu is now the **Infinite** (persistence mode) selector.