Performance Verification

Tektronix

TDS 520 & 540
Digitizing Oscilloscopes

070-8603-00

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
E200000	Tektronix United Kingdom, Ltd., London
J300000	Sony/Tektronix, Japan
H700000	Tektronix Holland, NV, Heerenveen, The Netherlands

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

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Welcome

This is the Performance Verification for the TDS 520 and TDS 540 Oscilloscopes. It contain procedures suitable for determining the instrument functions, was adjusted properly, and that it meets the performance characteristics as warranted.

Also contained in this document is a copy of *Specification* found in Appendix B of the TDS 520 and TDS 540 User Manual. It is included here as a convenient reference.

Related Manuals

The following documents are related to the use or service of the digitizing oscilloscope.

- The TDS 520 and TDS 540 User Manual (Tektronix part number 070-8317-01).
- The TDS Family Programmer Manual (Tektronix part number 070-8318-03) describes using a computer to control the digitizing oscilloscope through the GPIB interface.
- The TDS Reference (Tektronix part number 070-8316-01) gives you a quick overview of how to operate your digitizing oscilloscope.
- The TDS 520 Service Manual (Tektronix part number 070-8312-00) and the TDS 540 Service Manual (070-8314-01) provide information for maintaining and servicing your digitizing oscilloscope to the module level.
- The TDS Family Option 2F Instruction Manual (Tektronix part number 070-8582-00) describes use of the Advanced DSP Math option (for TDS oscilloscopes equipped with that option only).
- The TDS Family Option 13 Instruction Manual (Tektronix part number 070-8567-00) describes using the optional Centronic® and RS232 interfaces for obtaining hardcopy (for TDS oscilloscopes equipped with that option only).

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Safety

Please take a moment to review these safety precautions. They are provided for your protection and to prevent damage to the digitizing oscilloscope. This safety information applies to all operators and service personnel.

Symbols and Terms

These two terms appear 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.

These two terms appear 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.

This symbol appears in manuals:

Static-Sensitive Devices

These symbols appear on equipment:

DANGER
High Voltage

Protective
ground (earth)
terminal

ATTENTION
Refer to
manual

Specific Precautions

Observe all of these precautions to ensure your personal safety and to prevent damage to either the digitizing oscilloscope or equipment connected to it.

Power Source

The digitizing oscilloscope 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. A protective ground connection, through the grounding conductor in the power cord, is essential for safe system operation.

Grounding the Digitizing Oscilloscope

The digitizing oscilloscope 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 digitizing oscilloscope.

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

Use the Proper Power Cord

Use only the power cord and connector specified for your product. Use only a power cord that is in good condition.

Use the Proper Fuse

To avoid fire hazard, use only the fuse specified in the parts list for your product, matched by type, voltage rating, and current rating.

Do Not Remove Covers or Panels

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

Electric Overload

Never apply to a connector on the digitizing oscilloscope a voltage that is outside the range specified for that connector.

Do Not Operate in Explosive Atmospheres

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

Performance Verification Procedures

Performance Verification Procedures

These procedures verify both the TDS 520 and the TDS 540 Digitizing Oscilloscopes.

Brief Procedures

The *Self Tests* use internal routines to confirm basic functionality and proper adjustment. No test equipment is required to do these test procedures.

The *Functional Tests* utilize the probe-compensation output at the front panel as a test-signal source for further verifying that the oscilloscope functions properly. A standard-accessory probe, included with this oscilloscope, is the only equipment required.

General Instructions

Besides the *Brief Procedures,* the set of procedures that can be used to verify oscilloscope performance includes the *Performance Tests,* found later in this section. You may not need to perform all of these procedures, depending on what you want to accomplish:

- To rapidly confirm that this oscilloscope functions and was adjusted properly, just do the procedures under *Self Tests*, which begin on page 1-3.

  Advantages: These procedures are quick to do, require no external equipment or signal sources, and perform extensive functional and accuracy testing to provide high confidence that the oscilloscope will perform properly. They can be used as a quick check before making a series of important measurements.

- To further check functionality, first do the *Self Tests* just mentioned; then do the procedures under *Functional Tests* that begin on page 1-5.

  Advantages: These procedures require minimal additional time to perform, require no additional equipment other than a standard-accessory probe, and more completely test the internal hardware of this oscilloscope. They can be used to quickly determine if the oscilloscope is suitable for putting into service, such as when it is first received.

- If more extensive confirmation of performance is desired, do the *Performance Tests*, beginning on page 1-11, after doing the *Functional* and *Self Tests* just referenced.

  Advantages: These procedures add direct checking of warranted specifications. They require more time to perform and suitable test equipment is required. (See *Equipment Required* on page 1-11.)

If you are not familiar with operating this oscilloscope, read *At a Glance* in Section 3 of the User Manual included with this instrument.

Conventions

Throughout these procedures the following conventions apply:

- Each test procedure uses the following general format:

  Title of Test

  Equipment Required

  Prerequisites

  Procedure

- Each procedure consists of as many steps, substeps, and subparts as required to do the test. Steps, substeps, and subparts are sequenced as follows:

1. First Step
   a. First Substep
      - First Subpart
      - Second Subpart
   b. Second Substep
2. Second Step

- In steps and substeps, the lead-in statement in italics instructs you what to do, while the instructions that follow tell you how to do it: in the example step below, *"Initialize the oscilloscope"* by doing "Press save/recall **SETUP**. Now, press the main-menu button...".

  Initialize the oscilloscope: Press save/recall **SETUP**. Now, press the main-menu button **Recall Factory Setup**; then the side-menu button **OK Confirm Factory Init**.

- Where instructed to use a front-panel button or knob, or select from a main or side menu, or verify a readout or status message, the name of the button or knob appears in boldface type: "press **SHIFT**; then **ACQUIRE MENU**", "press the main-menu button **Coupling**", or "verify that the status message is ***Pass***."

The symbol at the left is accompanied by information you must read to do the procedure properly.

- Refer to Figure 1-1. "Main menu" refers to the menu that labels the seven menu buttons under the display; "side menu" refers to the menu that labels the five buttons to the right of the display. "Pop-up menu" refers to a menu that pops up the when a main-menu button is pressed.

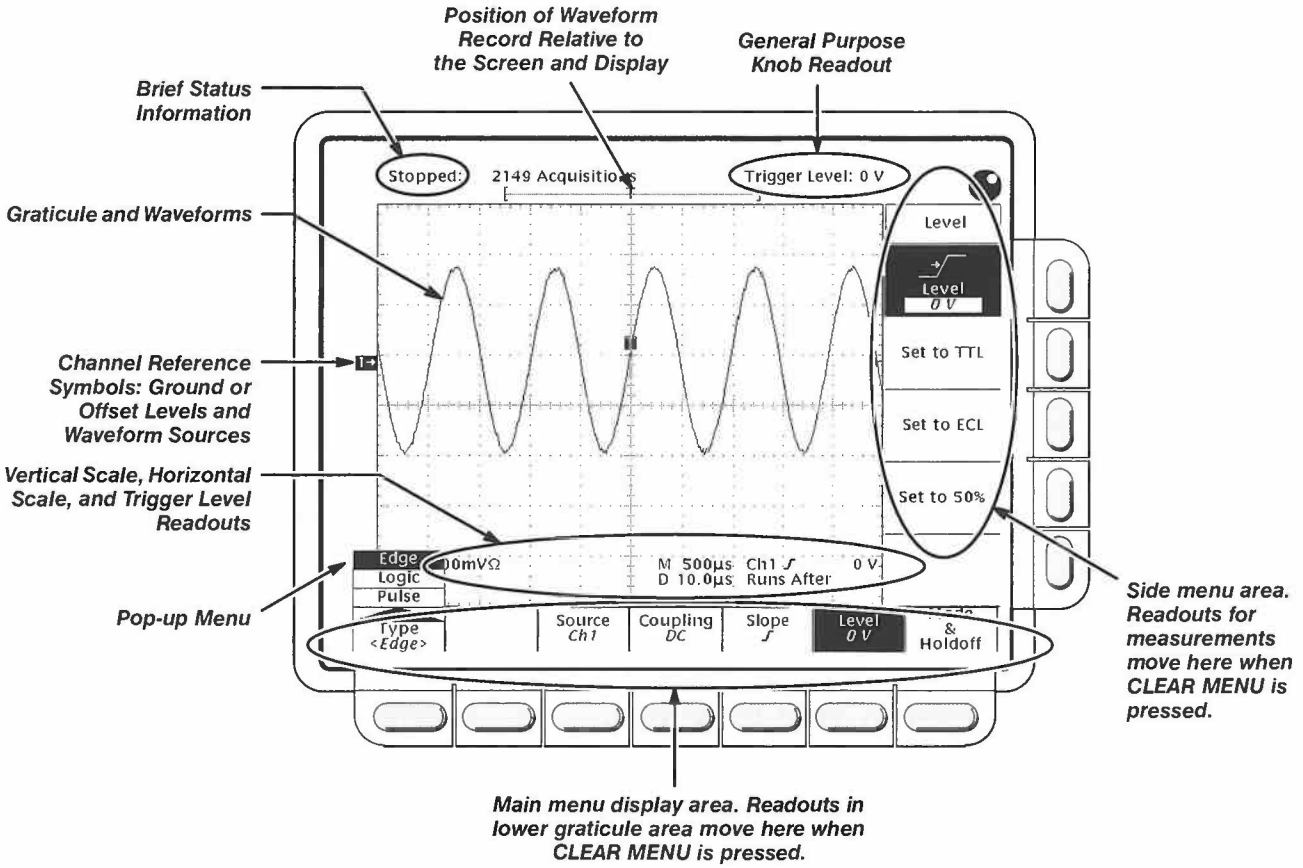


Figure 1-1: Map of Display Functions

Self Tests

This procedure uses internal routines to verify that this oscilloscope functions and was adjusted properly. No test equipment or hookups are required.

Verify Internal Adjustment, Self Compensation, and Diagnostics

Equipment Required: None.

Prerequisites: Power up the oscilloscope and allow a 20 minute warm-up before doing this procedure.

Procedure:

1. *Verify that internal diagnostics pass:* Do the following substeps to verify passing of internal diagnostics.

   a. *Display the System diagnostics menu:*

      - Press **SHIFT**; then press **UTILITY**.

- Repeatedly press the main-menu button **System** until **Diag/Err** is highlighted in the pop-up menu.

b. *Run the System Diagnostics:* Press the main-menu button **Execute**; then press the side-menu button **OK Confirm Run Test**.

c. *Wait:* The internal diagnostics do an exhaustive verification of proper oscilloscope function. This verification will take up to two minutes. When finished, the resulting status will appear on the screen.

d. *Confirm no failures are found:* Verify that no failures are found and reported on-screen.

e. *Confirm the three adjustment sections have passed status:*

- Press the main menu button **SHIFT**; then press **UTILITY**.
- Press the main menu button **System** until **Cal** is highlighted in the pop-up menu.
- Verify that the word ***Pass*** appears in the main menu under the following menu labels: **Voltage Reference**, **Frequency Response**, and **Pulse Trigger**. (See Figure 1-2.)

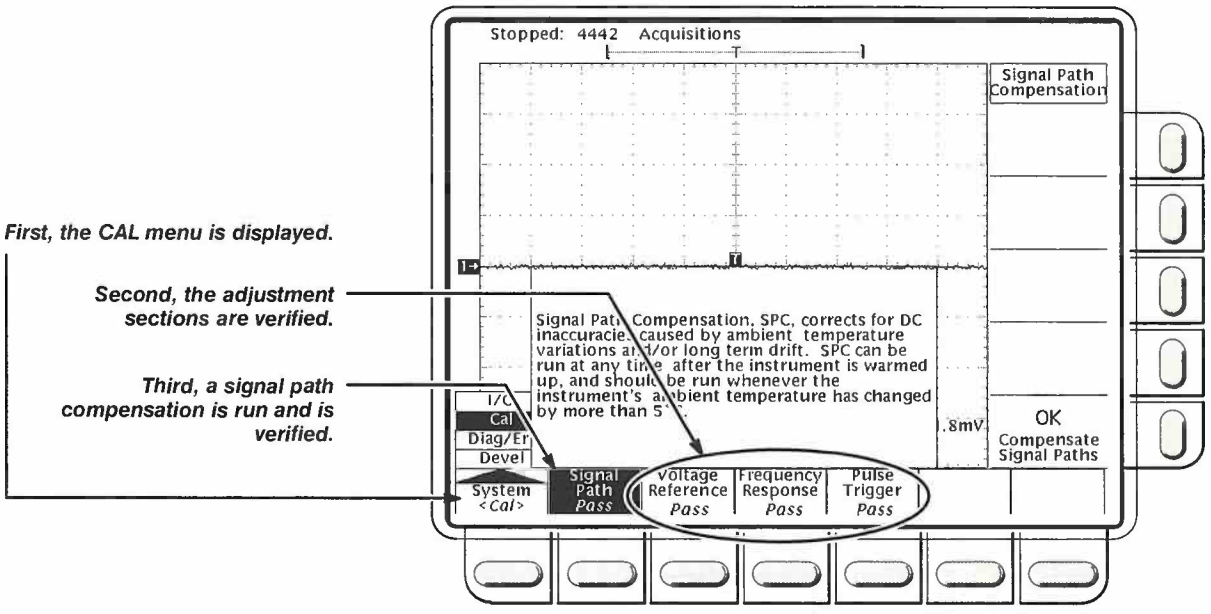


Figure 1-2: Verifying Adjustments and Signal-Path Compensation

When doing steps f and g, do not turn off the oscilloscope until signal-path compensation completes. If you interrupt (or lose) power to the instrument while signal-path compensation is running, a message is logged in the oscilloscope error log. If such a case occurs, rerun signal-path compensation.

f. *Run the signal-path compensation:* Press the main-menu button **Signal Path**; then press the side-menu button **OK Compensate Signal Paths**.

g. *Wait:* Signal-path compensation runs in about one to two minutes. While it progresses, a "clock" icon (shown at left) is displayed on-screen. When compensation completes, the status message will be updated to *Pass* or *Fail* in the main menu (see step h).

h. *Confirm signal-path compensation returns passed status:* Verify the word ***Pass*** appears under **Signal Path** in the main menu. (See Figure 1-2.)

2. *Return to regular service:* Press **CLEAR MENU** to exit the system menus.

Functional Tests

The purpose of these procedures is to confirm that this oscilloscope functions properly. The only equipment required is one of the standard-accessory probes.

These procedures verify functions; that is, they verify that oscilloscope features *operate*. They do *not* verify that they operate within limits.

Therefore, when the instructions in the functional tests that follow call for you to verify that a signal appears on-screen "that is about five divisions in amplitude" or "has a period of about six horizontal divisions", etc., do *NOT* interpret the quantities given as limits. Operation within limits is checked in *Performance Tests*, which begin on page 1-11.

DO NOT make changes to the front-panel settings that are not called out in the procedures. Each verification procedure will require you to set the oscilloscope to certain default settings before verifying functions. If you make changes to these settings other than those called out in the procedure, you may obtain invalid results. In this case, just redo the procedure from step 1.

When you are instructed to press a menu button, the button may already be selected (its label will be highlighted). If this is the case, it is not necessary to press the button.

Verify: **All Input Channels**

Equipment Required: One P6139A probe.

Prerequisites: None.

Procedure:

1. *Install the test hookup and preset the oscilloscope controls:*

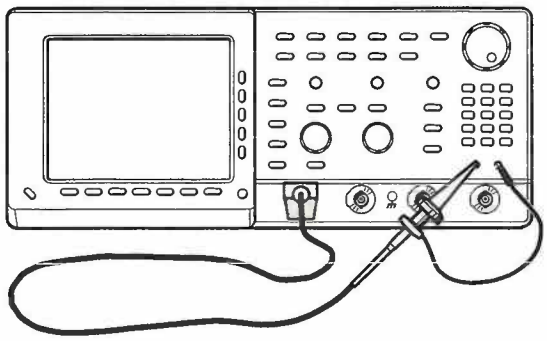


Figure 1-3: Universal Test Hookup for Functional Tests

a. *Hook up the signal source:* Install the probe on **CH 1**. Connect the probe tip to **PROBE COMPENSATION SIGNAL** on the front panel; connect the probe ground to **PROBE COMPENSATION GND**.

b. *Initialize the oscilloscope:*

- Press save/recall **SETUP**.
- Press the main-menu button **Recall Factory Setup**.
- Press the side-menu button **OK Confirm Factory Init**.

2. *Verify that all input channels operate:* Do the following substeps—test CH 1 first, *skipping substep a since CH 1 is already set up for verification from step 1.*

a. *Select an unverified channel:*

- Press **WAVEFORM OFF** to remove the channel just verified from display.
- Press the front-panel button that corresponds to the channel you are to verify.
- Move the probe to the channel you selected.

b. *Set up the selected channel:*

- Press **AUTOSET** to obtain a viewable, triggered display in the selected channel.
- Set the horizontal **SCALE** to 200 µs. Press **CLEAR MENU** to remove any menu that may be on the screen.

c. *Verify that the channel is operational:* Confirm that the following statements are true.

- The vertical scale readout for the channel under test shows a setting of 200 mV, and a square wave probe-compensation signal about 2.5 divisions in amplitude is on-screen. (See Figure 1-1 on page 1-3 to locate the readout.)

- The vertical **POSITION** knob moves the signal up and down the screen when rotated.
- Turning the vertical **SCALE** knob counterclockwise decreases the amplitude of the waveform on-screen, turning the knob clockwise increases the amplitude, and returning the knob to 200 mV returns the amplitude to about 2.5 divisions.

d. *Verify that the channel acquires in all acquisition modes:* Press **SHIFT**; then press **ACQUIRE MENU**. Use the side menu to select, in turn, each of the five hardware acquire modes and confirm that the following statements are true. Refer to the icons at the left of each statement as you confirm those statements.

- **Sample** mode displays an actively acquiring waveform on-screen. (Note that there is noise present on the peaks of the square wave.)

- **Peak Detect** mode displays an actively acquiring waveform on-screen with the noise present in Sample mode "peak detected".

- **Hi Res** mode displays an actively acquiring waveform on-screen with the noise that was present in Sample mode reduced.

- **Envelope** mode displays an actively acquiring waveform on-screen with the noise displayed.

- **Average** mode displays an actively acquiring waveform on-screen with the noise reduced like in Hi Res mode.

TDS 520 only: Substep e will have you repeat the previous substeps to check all input channels. Be sure to check only CH 1 and CH 2 when testing the TDS 520. (Step 3 will test the AUX 1 and AUX 2 inputs.) When testing the TDS 540, test all four channels, CH 1 through CH 4.)

e. *Test all channels:* Repeat substeps a through d until all input channels are verified.

3. *TDS 520 Only: Verify auxiliary inputs operate:* Perform the following substeps when checking the AUX 1 and AUX 2 inputs only.

a. *Select an auxiliary channel:*

- Press **WAVEFORM OFF** to remove from display the channel just verified.
- Press the front-panel button that corresponds to the channel you are to verify.
- Move probe to the channel you selected.

b. *Set up the selected channel:* Press **AUTOSET** to obtain a viewable display in the selected channel.

The display obtained might not trigger stably because autoset cannot provide more than about ½ division of probe compensation signal amplitude in an auxiliary channel equipped with a 10X probe. This amount is less than the minimum trigger sensitivity for auxiliary channel trigger sources; therefore, triggering is not required.

c. *Verify that the channel is operational:* Confirm that the following statements are true.

- The vertical scale readout for the channel under test shows a setting of 1 V, and a square-wave probe-compensation signal about ½ division in amplitude is on-screen. (See Figure 1-1 on page 1-3 to locate the readout.)
- The vertical **POSITION** knob moves the signal up and down the screen when rotated.
- Turning the vertical **SCALE** knob counterclockwise to 10 V decreases the amplitude of the waveform on-screen. (The amplitude will drop to near zero when doing this substep.)
- Returning the knob to 1 V returns the amplitude to about ½ division.

d. *Verify that the channel acquires in all acquisition modes:* Disconnect the probe ground lead from the probe-compensation terminal. Do step 2, substep d to verify the five acquire modes.

e. *Test all channels:* Repeat substeps a through d to verify AUX 2.

4. *Remove the test hookup:* Disconnect the probe from the input and the probe-compensation terminals.

Verify: **The Time Base**

Equipment Required: One P6139A probe.

Prerequisites: None.

Procedure:

1. *Install the test hookup and preset the oscilloscope controls:*

a. *Hook up the signal source:* Install the probe on **CH 1**. Connect the probe tip to **PROBE COMPENSATION SIGNAL** on the front panel; connect the probe ground to **PROBE COMPENSATION GND**. (See Figure 1-3 on page 1-6.)

b. *Initialize the oscilloscope:*

- Press save/recall **SETUP**.
- Press the main-menu button **Recall Factory Setup**; then press the side-menu button **OK Confirm Factory Init**.

c. *Modify default settings:*

- Press **AUTOSET** to obtain a viewable, triggered display.
- Set the horizontal **SCALE** to 200 µs.
- Press **CLEAR MENU** to remove the menus from the screen.

2. *Verify that the time base operates:* Confirm the following statements.

a. One period of the square-wave probe-compensation signal is about five horizontal divisions on-screen for the 200 µs horizontal scale setting (set in step 1c).

b. Rotating the horizontal **SCALE** knob clockwise expands the waveform on-screen (more horizontal divisions per waveform period), and that counterclockwise rotation contracts it, and that returning the horizontal scale to 200 µs returns the period to about five divisions.

c. The horizontal **POSITION** knob positions the signal left and right on-screen when rotated.

3. *Remove the test hookup:* Disconnect the probe from the channel input and the probe-compensation terminals.

Verify: **The Main and Delayed Trigger Systems**

Equipment Required: One P6139A probe.

Prerequisites: None.

Procedure:

1. *Install the test hookup and preset the oscilloscope controls:*

a. *Hook up the signal source:* Install the probe on **CH 1**. Connect the probe tip to **PROBE COMPENSATION SIGNAL** on the front panel; connect the probe ground to **PROBE COMPENSATION GND**. (See Figure 1-3 on page 1-6.)

b. *Initialize the oscilloscope:*

- Press save/recall **SETUP**.
- Press the main-menu button **Recall Factory Setup**.
- Press the side-menu button **OK Confirm Factory Init**.

c. *Modify default settings:*

- Press **AUTOSET** to obtain a viewable, triggered display.
- Set the horizontal **SCALE** for the **M** (main) time base to 200 µs.
- Press **TRIGGER MENU**.
- Press the main-menu button **Mode & Holdoff**.
- Press the side-menu button **Normal**.
- Press **CLEAR MENU** to remove the menus from the screen.

2. *Verify that the main trigger system operates:* Confirm that the following statements are true.
   - The trigger level readout for the main trigger system changes with the trigger **LEVEL** knob.
   - The trigger-level knob can trigger and untrigger the square-wave signal as you rotate it. (Leave the signal *un*triggered.)
   - Pressing **SET LEVEL TO 50%** triggers the signal that you just left untriggered. (Leave the signal triggered.)
3. *Verify that the delayed trigger system operates:*
   a. *Select the delayed time base:*
      - Press **HORIZONTAL MENU**.
      - Press the main-menu button **Time Base**.
      - Press the side-menu button **Delayed Triggerable**; then press the side-menu button **Delayed Only**.
      - Set the horizontal **SCALE** for the **D** (delayed) time base to 200 µs.
   b. *Select the delayed trigger level menu:*
      - Press **SHIFT**; then press **DELAYED TRIG**.
      - Press the main-menu button **Level**; then press the side-menu button **Level**.
   c. *Confirm that the following statements are true:*
      - The trigger-level readout for the delayed trigger system changes with the general purpose knob.
      - The general purpose knob can trigger and untrigger the square-wave probe-compensation signal as you rotate it. (Leave the signal *un*triggered.)
      - Pressing the side-menu button **Set to 50%** triggers the probe-compensation signal that you just left untriggered. (Leave the signal triggered.)
   d. *Verify the delayed trigger counter:*
      - Press the main-menu button **Delay by *Time***.
      - Use the keypad to enter a delay time of 1 second (press **1**, then press **ENTER**.
      - Verify that the trigger **READY** indicator on the front panel flashes about once every second as the waveform is updated on-screen.
4. *Remove the test hookup:* Disconnect the standard-accessory probe from the channel input and the probe-compensation terminals.

Performance Tests

This subsection contains a collection of procedures for checking that the TDS 520 and TDS 540 Digitizing Oscilloscopes perform as warranted. Since both models are covered by these procedures, instructions that apply only to one of the models are clearly identified. Otherwise, all test instructions apply to both the TDS 520 and TDS 540.

The procedures are arranged in four logical groupings: *Signal Acquisition System Checks, Time Base System Checks, Triggering System Checks*, and *Output Ports Checks*. They check all the characteristics that are designated as checked in Section 2, *Specification.* (The characteristics that are checked appear in **boldface** type under *Warranted Characteristics* in Section 2.)

These procedures *extend* the confidence level provided by the basic procedures described on page 1-1. The basic procedures should be done first, then these procedures performed if desired.

Prerequisites

The tests in this subsection comprise an extensive, valid confirmation of performance and functionality when the following requirements are met:

- The cabinet must be installed on the digitizing oscilloscope.
- You must have performed and passed the procedures under *Self Tests,* found on page 1-3, and those under *Functional Tests,* found on page 1-5.
- A signal-path compensation must have be done within the recommended calibration interval and at a temperature within ±5°C of the present operating temperature. (If at the time you did the prerequisite *Self Tests,* the temperature was within the limits just stated, consider this prerequisite met.)
- The digitizing oscilloscope must have been last adjusted at an ambient temperature between +20°C and +30°C, must have been operating for a warm-up period of at least 20 minutes, and must be operating at an ambient temperature between 0°C and +50°C. (The warm-up requirement is usually met in the course of meeting the first prerequisite listed above.)

Related Information—Read *General Instructions* and *Conventions* starting on page 1-1. Also, if you are not familiar with operating this digitizing oscilloscope, read *At a Glance* in Section 3 before doing any of these procedures.

Equipment Required

These procedures utilize external, traceable signal sources to directly check warranted characteristics. The required equipment list follows this introduction.

Table 1-1: Test Equipment

Item Number and Description	Minimum Requirements	Example	Purpose
1 Attenuator,10X (two required)	Ratio: 10X; impedance 50 Ω; connectors: female BNC input, male BNC output	Tektronix part number 011-0059-02	Signal Attenuation
2 Attenuator, 5X	Ratio: 5X; impedance 50 Ω; connectors: female BNC input, male BNC output	Tektronix part number 011-0060-02	Signal Attenuation
3 Termination, 50 Ω	Impedance 50 Ω; connectors: female BNC input, male BNC output	Tektronix part number 011-0049-01	Signal Termination for Channel Delay Test
4 Cable, Precision Coaxial (two required)	50 Ω, 36 in, male to male BNC connectors	Tektronix part number 012-0482-00	Signal Interconnection
5 Connector, Dual-Banana (two required)	Female BNC to dual banana	Tektronix part number 103-0090-00	Various Accuracy Tests
6 Connector, BNC "T"	Male BNC to dual female BNC	Tektronix part number 103-0030-00	Checking Trigger Sensitivity
7 Coupler, Dual-Input	Female BNC to dual male BNC	Tektronix part number 067-0525-02	Checking Delay Between Channels
8 Generator, DC Calibration	Variable amplitude to ±110 V; accuracy to 0.1%	Data Precision 8200, with 1 kV option	Checking DC Offset, Gain, and Measurement Accuracy
9 Generator, Calibration	500 mV square wave calibrator amplitude; accuracy to 0.25%	PG 506A[1]	Use to check CH 3 Output accuracy (TDS 540 Only)
10 Generator, Leveled Sine-Wave, Medium-Frequency	200 kHz to 250 MHz; Variable amplitude from 5 mV to 5.5 V_{p-p} into 50 Ω	TEKTRONIX SG 503 Leveled Sine Wave Generator[1]	Checking Trigger Sensitivity at low frequencies
11 Generator, Leveled Sine-Wave, High-Frequency	250 MHz to 500 MHz; Variable amplitude from 500 mV to 4 V_{p-p} into 50 Ω; 6 MHz reference	TEKTRONIX SG 504 Leveled Sine Wave Generator[1] with its Leveling Head	Checking Analog Bandwidth and Trigger Sensitivity at high frequencies
12 Generator, Time Mark	Variable marker frequency from 10 ms to 10 ns; accuracy within 2 ppm	TEKTRONIX TG 501 Time Mark Generator[1]	Checking Sample-Rate and Delay-time Accuracy
13 Probe, 10X, included with this instrument	A P6139A probe	Tektronix number P6139A	Signal Interconnection
14 Adapter, BNC female to Clip Leads	BNC female to Clip Leads	Tektronix part number 013-0076-00	Signal Coupling for Probe Compensator Output Check[2]

[1]**Requires a TM 500 or TM 5000 Series Power Module Mainframe.**

[2]**Required for model TDS 520 with serial numbers B021800 and above and for model TDS 540 with numbers B023300 and above only.**

Signal Acquisition System Checks

These procedures check those characteristics that relate to the signal-acquisition system and are listed as checked under *Warranted Characteristics* in *Section 2: Specification.*

Check: **Accuracy of Offset (Zero Setting)**

Equipment Required: None.

Prerequisites: The oscilloscope must meet the prerequisites listed on page 1-11.

1. *Preset the instrument controls:*
   a. *Initialize the oscilloscope:*
      - Press save/recall **SETUP**.
      - Press the main-menu button **Recall Factory Setup**.
      - Press the side-menu button **OK Confirm Factory Init**.
      - Press **CLEAR MENU** to remove the menus from the screen.
   b. *Modify the default settings:*
      - Set the horizontal **SCALE** to 1 ms.
      - Press **SHIFT**; then **ACQUIRE MENU**.
      - Press the main-menu button **Mode**; then press the side-menu button **Hi Res**.
      - Press **DISPLAY**.
      - Press the main-menu button **Graticule**; then press the side-menu button **Frame**.
      - Press **CURSOR**.
      - Press the main-menu button **Function**; then press the side-menu button **H Bars**.
      - Press **CLEAR MENU**.
2. *Confirm input channels are within limits for offset accuracy at zero offset:* Do the following substeps—test CH 1 first, *skipping substep a since CH 1 is already set up to be checked from step 1.*
   a. *Select an unchecked channel:* Press **WAVEFORM OFF** to remove the channel just confirmed from the display. Then, press the front-panel button that corresponds to the channel you are to confirm.

Follow these rules to match this procedure to the model of the oscilloscope under test:

Model TDS 540 Digitizing Oscilloscope **Only**—When using Table 1-2 to test CH 1—CH 4; ignore the columns for AUX 1 & AUX 2 settings and limits.

Model TDS 520 Digitizing Oscilloscope **Only**—Use Table 1-2 to test input channels; use the columns for CH 1—CH 4 when testing CH 1 and CH 2; use the columns for AUX 1 and AUX 2 when testing those channels.

Table 1-2: DC Offset Accuracy (Zero Setting)

Vertical Scale Setting		Vertical Position and Offset Setting[1]	Offset Accuracy Limits	
CH 1 – CH 4	AUX 1 & AUX 2		CH 1 – CH 4	AUX 1 & AUX 2
1 mV	100 mV	0	±1.6 mV	±10 mV
100 mV	1 V	0	±25 mV	±100 mV
1 V	10 V	0	±250 mV	±1 V

[1]Vertical position is set to 0 divisions and vertical offset to 0 V when the oscilloscope is initialized in step 1.

b. *Set the vertical scale:* Set the vertical **SCALE** to one of the settings listed in Table 1-2 that is not yet checked. (Start with the first setting listed.)

c. *Display the test signal:* The baseline DC test level was initialized for all channels in step 1 and is displayed as you select each channel and its vertical scale. Be sure *not* to use the vertical **POSITION** knob while checking any channel for accuracy of offset, since varying the position invalidates the check.

d. *Measure the test signal:* Rotate the general purpose knob to superimpose the active cursor over the baseline DC test level. (Ignore the other cursor.)

e. Read the measurement results at the absolute (@:) cursor readout, not the delta (Δ:) readout on screen.

f. *Check against limits:* Do the following subparts in the order listed.

- CHECK that the measurement results are within the limits listed for the current vertical scale setting.
- Repeat substeps b through f until all vertical scale settings settings listed in Table 1-2 are checked for the channel under test.

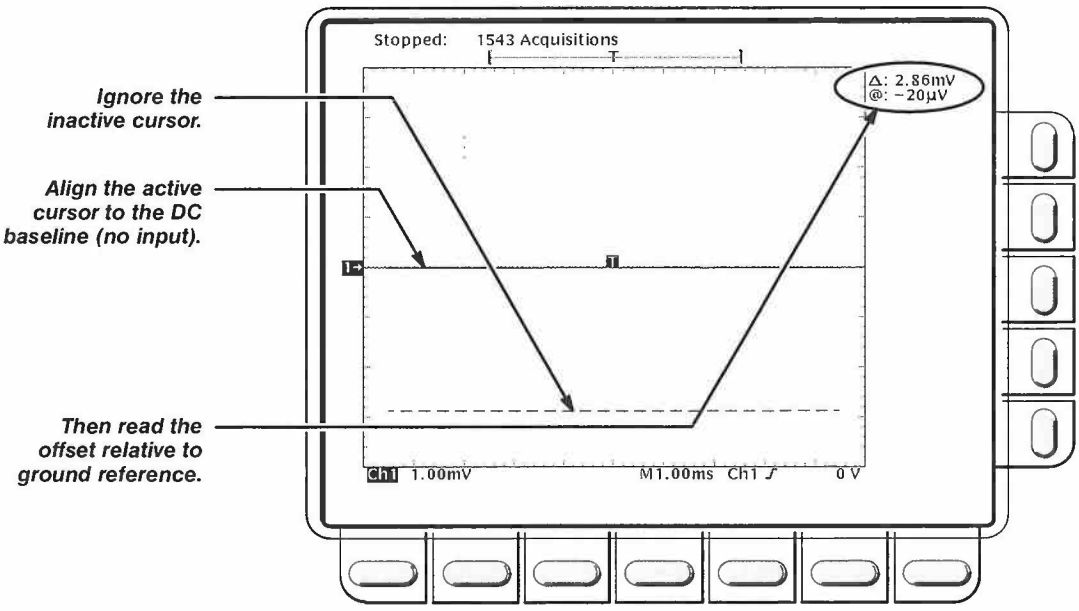


Figure 1-4: Measurement of DC Offset Accuracy at Zero Setting

g. *Test all channels:* Repeat substeps a through f for all input channels.

3. *Disconnect the hookup:* No hookup was required.

Check: **DC Gain and Voltage Measurement Accuracy**

WARNING

Performance of this procedure requires input voltages up to 130 VDC. Be sure to set the DC calibration generator to 0 volts before connecting, disconnecting, and/or moving the test hookup during the performance of this procedure.

Equipment Required: Two dual-banana connectors (Item 5), one BNC T connector (Item 6), one DC calibration generator (Item 8), and two precision coaxial cables (Item 4).

Prerequisites: The oscilloscope must meet the prerequisites listed on page 1-11.

Procedure:

1. *Install the test hookup and preset the instrument controls:*

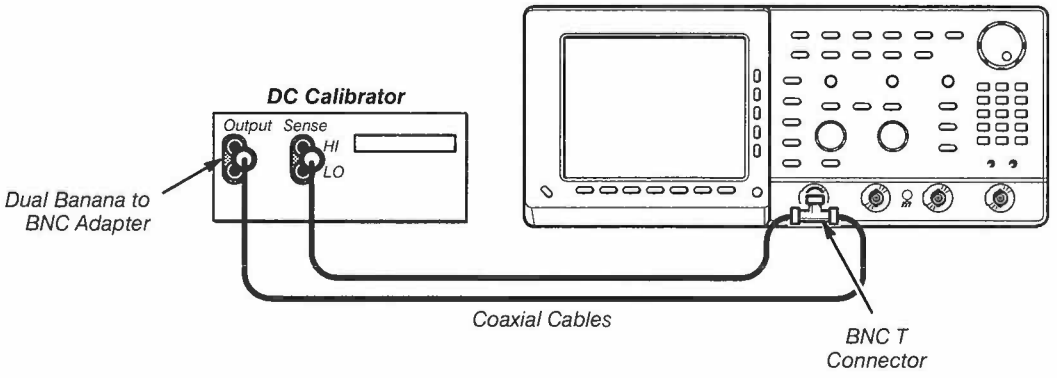


Figure 1-5: Initial Test Hookup

a. *Hook up the test-signal source:*

- Set the output of a DC calibration generator to 0 volts.
- Connect the output of a DC calibration generator through a dual-banana connector followed by a 50 Ω precision coaxial cable to one side of a BNC T connector.
- Connect the Sense output of the generator through a second dual-banana connector followed by a 50 Ω precision coaxial cable to other side of the BNC T connector. Now connect the BNC T connector to **CH 1**.

b. *Initialize the oscilloscope:*

- Press save/recall **SETUP**.
- Press the main-menu button **Recall Factory Setup**.
- Press the side-menu button **OK Confirm Factory Init**.

c. *Modify the default settings:*

- Press **SHIFT**; then **ACQUIRE MENU**.
- Press the main-menu button **Mode**; then press the side-menu button **Average 16**.
- Press **CURSOR**.
- Press the main-menu button **Function**; then press the side-menu button **H Bars**.
- Press **DISPLAY**.
- Press the main-menu button **Graticule**; then press the side-menu button **Frame**.

2. *Confirm input channels are within limits for DC delta voltage accuracy:* Do the following substeps—test CH 1 first, *skipping substep a since CH 1 is already selected from step 1.*

a. *Select an unchecked channel:*

- *Set the generator output to 0 V.*
- Press **WAVEFORM OFF** to remove the channel just confirmed from the display.
- Press the front-panel button that corresponds to the next channel you are to confirm.
- Move the test hookup to the channel you select.

b. *Display the test signal:*

- Press **VERTICAL MENU**. Press the main-menu button **Position**.
- Use the keypad to set vertical position to −2.5 divisions (press **−2.5**, then **ENTER**, on the keypad).

c. *Measure the test signal:*

- Press **CURSOR**. Use the general purpose knob to precisely align the active cursor to the DC baseline level on screen.
- Set the generator output to 500 mV.
- Press **TOGGLE**. Use the general purpose knob to precisely align the alternate cursor to the 500 mV DC test level on screen.
- Press **CLEAR MENU**. Read the measurement results from the delta (Δ:) readout, not the absolute (@:) readout. See Figure 1-6 on page 1-17.

d. *Check against limits:* CHECK that the Δ: readout on screen is within 485 mV to 515 mV.

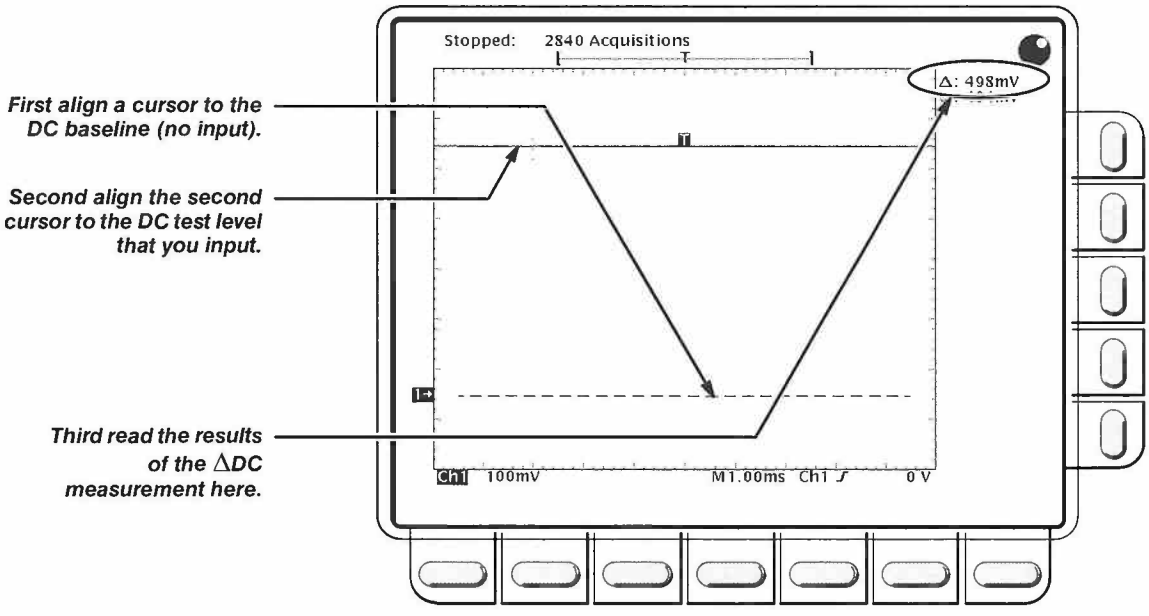


Figure 1-6: Measurement of the DC Accuracy for Delta Measurements

e. *Test all channels:* Repeat substeps a through d for all four channels.

3. *Reestablish the initial test hookup setup:*

   a. *Hook up the test-signal source:*

      - Set the output of a DC calibration generator to 0 volts.
      - Move the BNC T connector back to **CH 1**.

   b. *Initialize the oscilloscope:*

      - Press save/recall **SETUP**.
      - Press the main-menu button **Recall Factory Setup**.
      - Press the side-menu button **OK Confirm Factory Init**.

   c. *Modify the default settings:*

      - Press **SHIFT**; then **ACQUIRE MENU**.
      - Press the main-menu button **Mode**; then press the side-menu button **Average 16**.
      - Press **DISPLAY**.
      - Press the main-menu button **Graticule**; then press the side-menu button **Frame**.

4. *Confirm input channels are within limits for DC accuracy at maximum offset and position:* Do the following substeps—test CH 1 first, *skipping substep a since CH 1 is already selected from step 3.*

   a. *Select an unchecked channel:*

      - Press **WAVEFORM OFF** to remove the channel just confirmed from the display.
      - Press the front-panel button that corresponds to the channel you are to confirm.
      - *Set the generator output to 0 V.*
      - Move the test hookup to the channel you select.

   b. *Turn on the measurement Mean for the channel:*

      - Press **MEASURE**, then press the main-menu button **Select Measurement for CHx**.
      - Press the side menu button **more** until the menu label **Mean** appears in the side menu (its icon is shown at the left). Press the side-menu button **Mean**.

      - Press **CLEAR MENU**.

Follow these rules to match this procedure to the model of the oscilloscope under test:

Model TDS 540 Digitizing Oscilloscope **Only**—Use Table 1-3 to test CH 1—CH 4; ignore Table 1-4 AUX 1 & AUX 2 settings and limits.

Model TDS 520 Digitizing Oscilloscope **Only**—Use Table 1-3 to test CH 1 and CH 2 only; use Table 1-4 to test AUX 1 and AUX 2 only.

c. *Set its vertical scale:* Set the vertical **SCALE** to one of the settings listed in the table matching the channel under test that is not yet checked. (Start with the first setting listed.)

Table 1-3: DC Accuracy: CH 1–CH 4

Scale Setting	Position Setting (Divs)	Offset Setting	Generator Setting	Accuracy Limits
5 mV	−5	+1 V	+1.040 V	+1.0355 V to +1.0445 V
	+5	−1 V	−1.040 V	−1.0355 V to −1.0445 V
200 mV	−5	+10 V	+11.6 V	+11.525 V to +11.675 V
	+5	−10 V	−11.6 V	−11.525 V to −11.675 V
1 V	−5	+100 V	+108 V	+107.450 V to +108.550 V
	+5	−100 V	−108 V	−107.450 V to −108.550 V

Table 1-4: DC Accuracy: AUX 1–AUX 2

Scale Setting	Position Setting (Divs)	Offset Setting	Generator Setting	Accuracy Limits
100 mV	−5	+0.5 V	+1.3 V	+1.271 V to +1.329 V
	+5	−0.5 V	−1.3 V	−1.271 V to −1.329 V
1 V	−5	+5 V	+13 V	+12.710 V to +13.290 V
	+5	−5 V	−13 V	−12.710 V to −13.290 V
10 V	−5	+50 V	+130 V	+127.10 V to +132.90 V
	+5	−50 V	−130 V	−127.10 V to −132.90 V

d. *Display the test signal:*

- Press **VERTICAL MENU**. Press the main-menu button **Position**.
- Use the keypad to set vertical position to −5 divisions (press **−5**, then **ENTER**, on the keypad.) The baseline level will move off screen.
- Press the main-menu button **Offset**.

- Use the keypad to set vertical offset to the positive-polarity setting listed in the table for the current vertical scale setting. The baseline level will remain off screen.
- Set the generator to the level and polarity indicated in the table for the vertical scale, position, and offset settings you have made. The DC test level should appear on screen. (If it doesn't return, the DC accuracy check is failed for the current vertical scale setting of the current channel.

e. *Measure the test signal:* Press **CLEAR MENU**. Read the measurement results at the **Mean** measurement readout. See Figure 1-7.

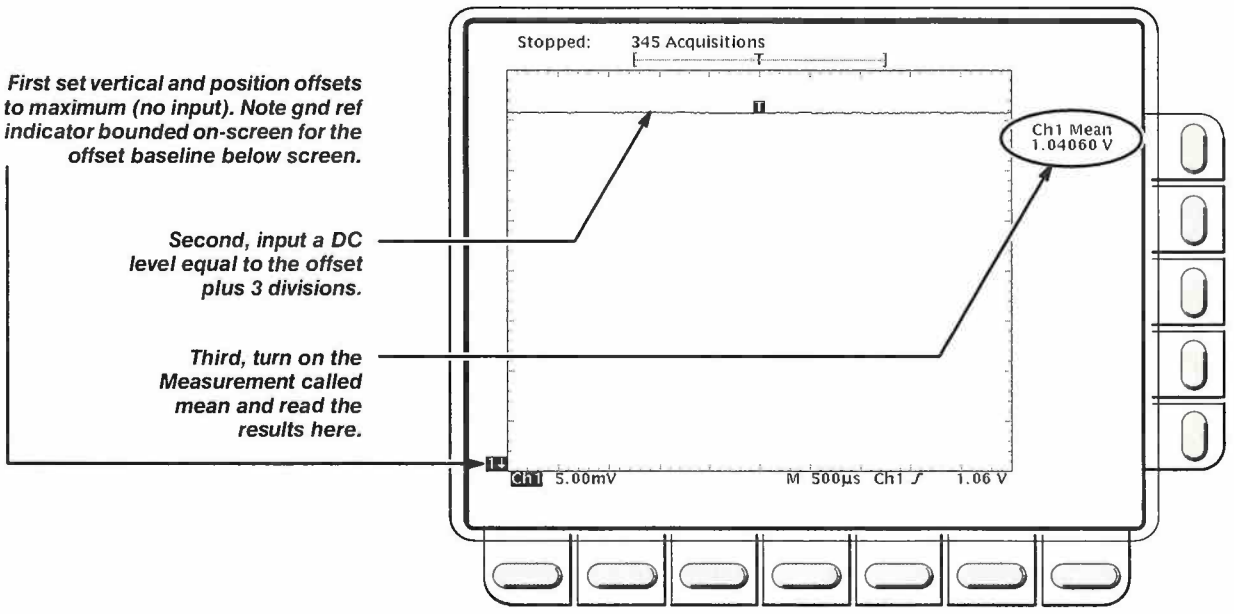


Figure 1-7: Measurement of DC Accuracy at Maximum Offset and Position

f. *Check against limits:*

- CHECK that the readout for the measurement **Mean** readout on screen is within the limits listed for the current vertical scale and position/offset/generator settings.
- Repeat step d, reversing the polarity of the position, offset, and generator settings as is listed in the table.
- CHECK that the **Mean** measurement readout on screen is within the limits listed for the current vertical scale setting and position/offset/generator settings.
- Repeat substeps c through f until all vertical scale settings settings listed in the appropriate table are checked for the channel under test. (Use the table that matches the input under test—CH or AUX.)

g. *Test all channels:* Repeat substeps a through f for all four channels.

5. *Disconnect the hookup:*

   a. *Set the generator output to 0 V.*

   b. Then disconnect the cable from the generator output at the input connector of the channel last tested.

Check: **Analog Bandwidth**

Equipment Required: One high-frequency leveled sine-wave generator and its leveling head (Item 11), plus two 10X attenuators (Item 1).

Prerequisites: *See page 1-11.*

Procedure:

1. *Install the test hookup and preset the instrument controls:*

   a. *Initialize the oscilloscope:*

   - Press save/recall **SETUP**.
   - Press the main-menu button **Recall Factory Setup**.
   - Press the side-menu button **OK Confirm Factory Init**.

   b. *Modify the default settings:*

   - Set the horizontal **SCALE** to 50 ns.
   - Press **SHIFT**; then **ACQUIRE MENU**.
   - Press the main-menu button **Mode**; then press the side-menu button **Average 16**.
   - Press **TRIGGER MENU**.
   - Press the main-menu button **Coupling**; then press the side-menu button **Noise Rej**.

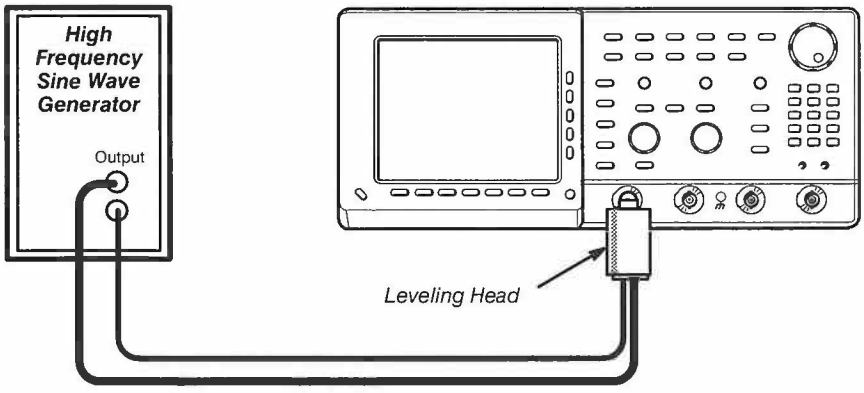


Figure 1-8: Initial Test Hookup

- Press **MEASURE**.
- Press the main-menu button **High-Low Setup**; then press the side-menu button **Min-Max**.

c. *Hook up the test-signal source:* Connect, through its leveling head, the sine-wave output of a high-frequency leveled sine-wave generator to **CH 1**. Set the output of the generator to a reference frequency of 6 MHz.

2. *Confirm the input channels are within limits for analog bandwidth:* Do the following substeps—test CH 1 first, *skipping substeps a and b since CH 1 is already set up for testing from step 1.*

a. *Select an unchecked channel:*

- Press **WAVEFORM OFF** to remove the channel just confirmed from display.
- Press the front-panel button that corresponds to the channel you are to confirm.
- Move the leveling head to the channel you select.

b. *Match the trigger source to the channel selected:*

- Press **TRIGGER MENU**.
- Press the main-menu button **Source**.
- Press the side-menu button that corresponds to the channel selected.

c. *Set its input impedance:*

- Press **VERTICAL MENU**; then press the main-menu button **Coupling**.
- Press the side-menu button Ω to toggle it to the 50 Ω setting.

d. *Set the vertical scale:* Set the vertical **SCALE** to one of the settings listed in Table 1-5 not yet checked. (Start with the 100 mV setting.)

Table 1-5: Analog Bandwidth

Vertical Scale[1]	Attenuators (10X)	Reference Amplitude (at 6 MHz)	Horizontal Scale	Test Frequency	Limits
100 mV	none	600 mV (6 divisions)	1 ns	500 MHz	≥424 mV
1 V	none	5 V (5 divisions)	1 ns	500 MHz	≥3.535 V
500 mV	none	3 V (6 divisions)	1 ns	500 MHz	≥2.121 V
200 mV	none	1.2 V (6 divisions)	1 ns	500 MHz	≥848 mV
50 mV	1	300 mV (6 divisions)	1 ns	500 MHz	≥212 mV
20 mV	1	120 mV (6 divisions)	1 ns	500 MHz	≥84 mV

Table 1-5: Analog Bandwidth (Cont.)

Vertical Scale[1]	Attenuators (10X)	Reference Amplitude (at 6 MHz)	Horizontal Scale	Test Frequency	Limits
10 mV	1	60 mV (6 divisions)	1 ns	500 MHz	≥42 mV
5 mV	2	30 mV (6 divisions)	1 ns	500 MHz	≥21 mV
2 mV	2	12 mV (6 divisions)	2 ns	350 MHz	≥8.4 mV
1 mV	2	6 mV (6 divisions)	2 ns	250 MHz[2]	≥4.2 mV

[1]Only the 100 mV, 1 V, and 10 V vertical scale settings are available for the AUX 1 and AUX 2 input channels. Check only the 100 mV and 1 V settings; ignore all other settings listed when checking those channels.

[2]200 MHz for TDS 540 CH 2.

e. *Display the test signal:* Do the following subparts to first display the reference signal and then the test signal.

- Press **MEASURE**; then press the main-menu button **Select Measurement for CHx**.
- Now press the side menu button **more** until the menu label **Pk-Pk** appears in the side menu (its icon is shown at the left). Press the side-menu button **Pk-Pk**.
- Press **CLEAR MENU**.
- Set the generator output so the CHx Pk-Pk readout equals the reference amplitude in Table 1-5 that corresponds to the vertical scale set in substep d.
- Press the front-panel button **SET LEVEL TO 50%** as necessary to trigger a stable display.

f. *Measure the test signal:*

- Increase the frequency of the generator output to the test frequency in Table 1-5 that corresponds to the vertical scale set in substep d.
- Set the horizontal **SCALE** to 1 ns. Press **SET LEVEL TO 50%** as necessary.
- Read the results at the CHx Pk-Pk readout, which will automatically measure the amplitude of the test signal.

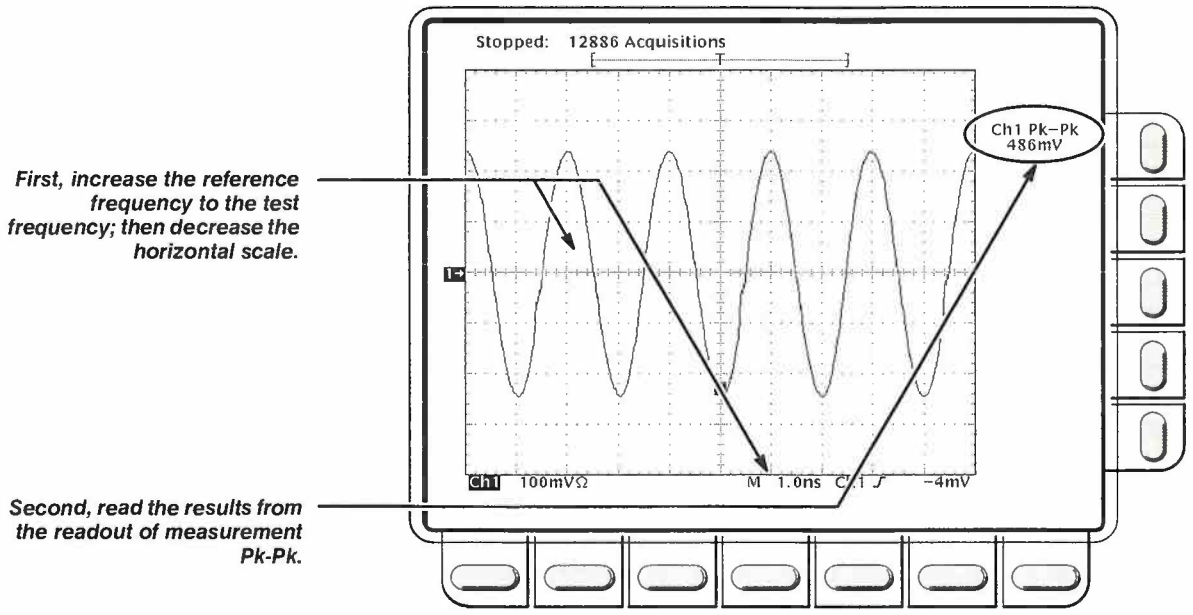


Figure 1-9: Measurement of Analog Bandwidth

g. *Check against limits:*

- CHECK that the **Pk-Pk** readout on screen is within the limits listed in Table 1-5 for the current vertical scale setting.
- When finished checking, set the horizontal **SCALE** back to the 50 ns setting.

STOP

Checking each channel's bandwidth at all vertical scale settings is time consuming and unnecessary. You may skip checking the remaining vertical scale settings in Table 1-5 (that is, skip the following substep, h) if this digitizing oscilloscope has performed as follows:

- Passed the 100 mV vertical scale setting just checked in this procedure.
- Passed the *Verify Internal Adjustment, Self Compensation, and Diagnostics* procedure found under *Self Tests,* on page 1-3.

NOTE

Passing the signal path compensation confirms the signal path for all vertical scale settings for all channels. Passing the internal diagnostics ensures that the factory-set adjustment constants that control the bandwidth for each vertical scale setting have not changed.

h. *Check remaining vertical scale settings against limits (optional):*

- If desired, finish checking the remaining vertical scale settings for the channel under test by repeating substeps d through g for each of the remaining scale settings settings listed in Table 1-5 for the channel under test.
- When doing substep e, skip the subparts that turn on the CHx Pk-Pk measurement until you check a new channel.
- Install/remove 10X attenuators between the generator leveling head and the channel input as is needed to obtain the six division reference signals listed in the table.

i. *Test all channels:* Repeat substeps a through g for all four channels.

3. *Disconnect the hookup:* Disconnect the test hook up from the input connector of the channel last tested.

Check: **Delay Between Channels**

Equipment Required: One medium-frequency leveled sine-wave generator (Item 10), one precision coaxial cable (Item 4), one 50 Ω terminator (Item 3), and a dual-input-coupler (Item 7).

Prerequisites: *See page 1-11.*

Procedure:

DO NOT use the vertical position knob to reposition any channel while doing this check. To do so invalidates the test.

1. *Install the test hookup and preset the instrument controls:*

a. *Initialize the front panel;*

- Press save/recall **SETUP**.
- Press the main-menu button **Recall Factory Setup**.
- Press the side-menu button **OK Confirm Factory Init**.

b. *Modify the initialized front-panel control settings:*

- Do *not* adjust the vertical position of any channel during this procedure.
- Set the horizontal **SCALE** to 500 ps.
- Press **SHIFT**; then press **ACQUIRE MENU**.
- Press the main-menu button **Mode**, and then press the side-menu button **Average 16**.

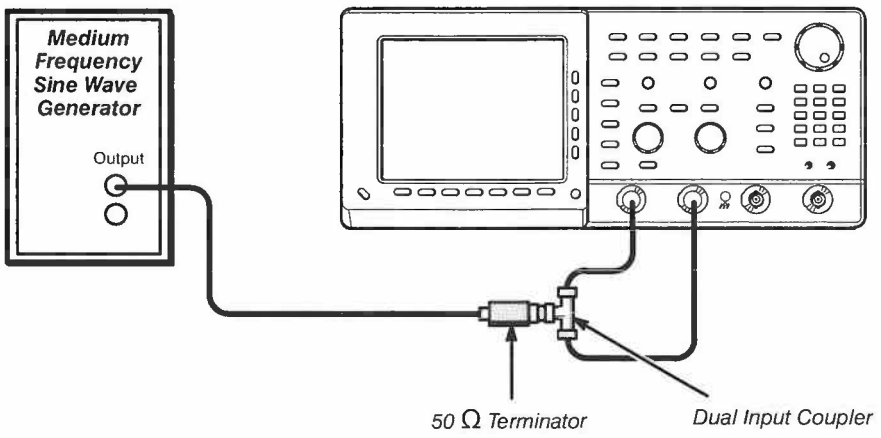


Figure 1-10: Initial Test Hookup

c. *Hook up the test-signal source:*

- Connect, through a 50 Ω precision coaxial cable, followed by a 50 Ω termination, the sine wave output of a medium-frequency sine wave generator to a dual-input coupler.
- Connect the coupler to both **CH 1** and **CH 2**.

2. *Confirm CH 1 through CH 4 are within limits for channel delay:*

a. *Set up the generator:* Set the generator frequency to 250 MHz and the amplitude for about five divisions in CH 1.

Hint: as you are adjusting the generator amplitude, push **SET LEVEL TO 50%** frequently to speed up the updating of the waveform amplitude on screen.

TDS 520 only: Press CH 2; then skip to substep e and continue this check. If testing a TDS 540 model, continue with the next substep, b.

b. *Save a CH 2 waveform:* Press **CH 2**; then press save/recall **WAVEFORM**. Now, press the main-menu button **Save Waveform**; then press the side-menu button **To Ref 2**.

c. *Save CH 3 waveform:* Move the coupler from **CH 2** to **CH 3**, so that **CH 1** and **CH 3** are driven. Press **CH 3**; then press the side-menu button **To Ref 3**.

d. *Display all test signals:*

- Press **WAVEFORM OFF** twice to remove CH 2 and CH 3 from the display.
- Move the coupler from **CH 3** to **CH 4**, so that CH 1 and CH 4 are driven. Press **CH 4** to display.
- Now, press the front-panel button **MORE**. Press the main-menu buttons **Ref 2** and **Ref 3**.

e. *Measure the test signal:*

- Locate the point on the rising edge of the left-most waveform where it crosses the center horizontal graticule line. This is the *time reference point* for this waveform. Note the corresponding *time reference point* for right-most waveform. See Figure 1-11.
- Press **CURSOR**; then press the side-menu button **V Bars**.
- Press **CLEAR MENU**.
- Rotate the General Purpose knob to align one cursor to the *time reference point* of the left-most waveform edge and the other cursor to the *time reference point* of the right-most waveform edge. (Press **TOGGLE** to switch between the two cursors.) See Figure 1-11.
- Read the measurement results at the Δ: cursor readout, not the @: readout on screen.

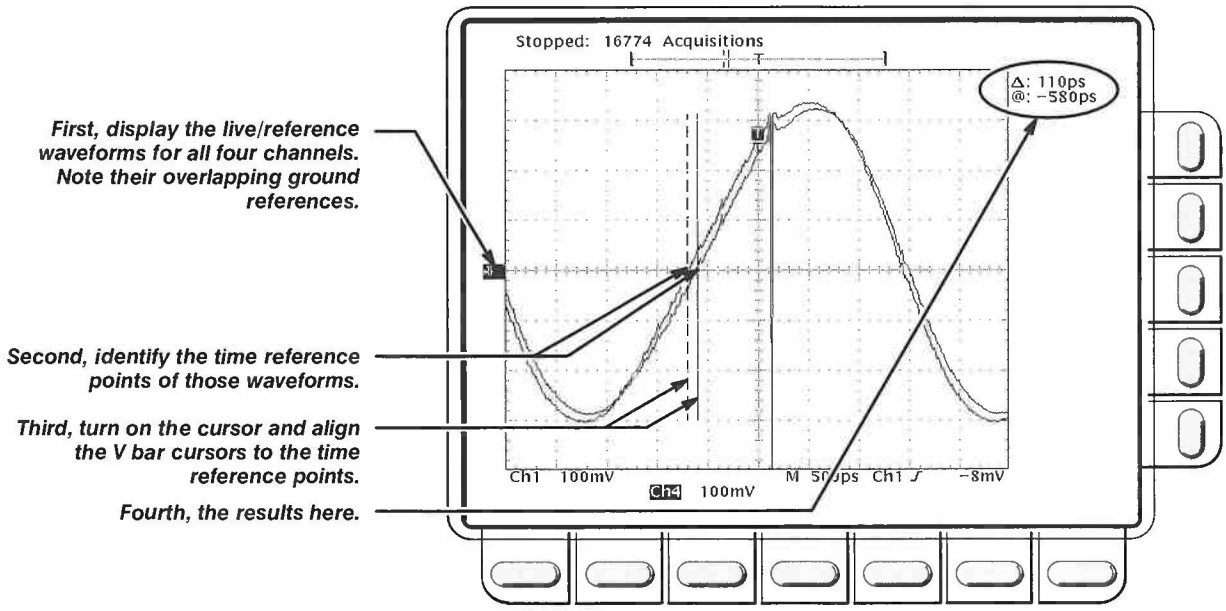


Figure 1-11: Measurement of Channel Delay

f. *Check against limits:* CHECK that the cursor readout on screen is ≤250 ps.

3. *Disconnect the hookup:* Disconnect the cable from the generator output at the input connectors of the channels.

Time Base System Checks

These procedures check those characteristics that relate to the Main and Delayed time base system and are listed as checked under *Warranted Characteristics* in *Section 2: Specification.*

Check: **Accuracy for Long-Term Sample Rate, Delay Time, and Delta Time Measurement**

Equipment Required: One time-marker generator (Item 12) and one precision coaxial cable (Item 4).

Prerequisites: *See page 1-11.*

Procedure:

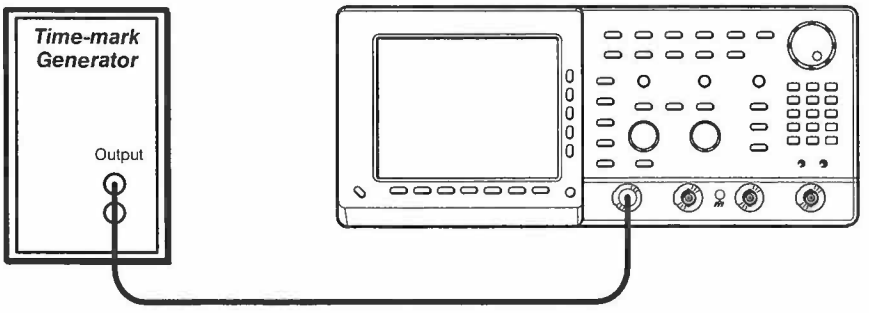


Figure 1-12: Initial Test Hookup

1. *Install the test hookup and preset the instrument controls:*
   a. *Hook up the test-signal source*: Connect, through a 50 Ω precision coaxial cable, the time-mark output of a time-marker generator to **CH 1**. Set the output of the generator for 10 ms markers.
   b. *Initialize the oscilloscope:*
      - Press save/recall **SETUP**.
      - Press the main-menu button **Recall Factory Setup**.
      - Press the side-menu button **OK Confirm Factory Init**.
   c. *Modify the initialized front-panel control settings:*
      - Set the vertical **SCALE** to 500 mV.
      - Press **VERTICAL MENU**; then press the main-menu button **Coupling**. Press the side-menu button Ω to **50 Ω**.
      - Press **SET LEVEL TO 50%**.
      - Use the vertical **POSITION** knob to center the test signal on screen.
      - Set the horizontal **SCALE** of the Main time base to 1 ms.

- Press **TRIGGER MENU**; then press the main-menu button **Mode & Holdoff**. Now press the side-menu button **Normal**.
- Press **SET LEVEL TO 50%**.
- Press horizontal **MENU**. Press the main-menu button **Record Length**; then press the side-menu button **1000 points in 20 divs**.
- Press the main-menu button **Trigger Position**. Press the side-menu button **Pretrigger**; then set pretrigger to 20%: press **20**, then **ENTER**, on the keypad.

2. *Confirm Main and Delayed time bases are within limits for accuracies:*

   a. *Display the test signal:*

   - Adjust the horizontal **POSITION** so the trigger **T** is aligned to the center vertical graticule line.
   - Press the main-menu button **Time Base**
   - Press the side-menu buttons **Delayed Only** and **Delayed Runs After Main**.

   b. *Measure the test signal*:

   - Set the horizontal **SCALE** of the **D** (delayed) time base to 100 ns.
   - Use the keypad to set delayed time to 10 ms. (Press **10**, then **SHIFT**, then **m** followed by **ENTER**.)

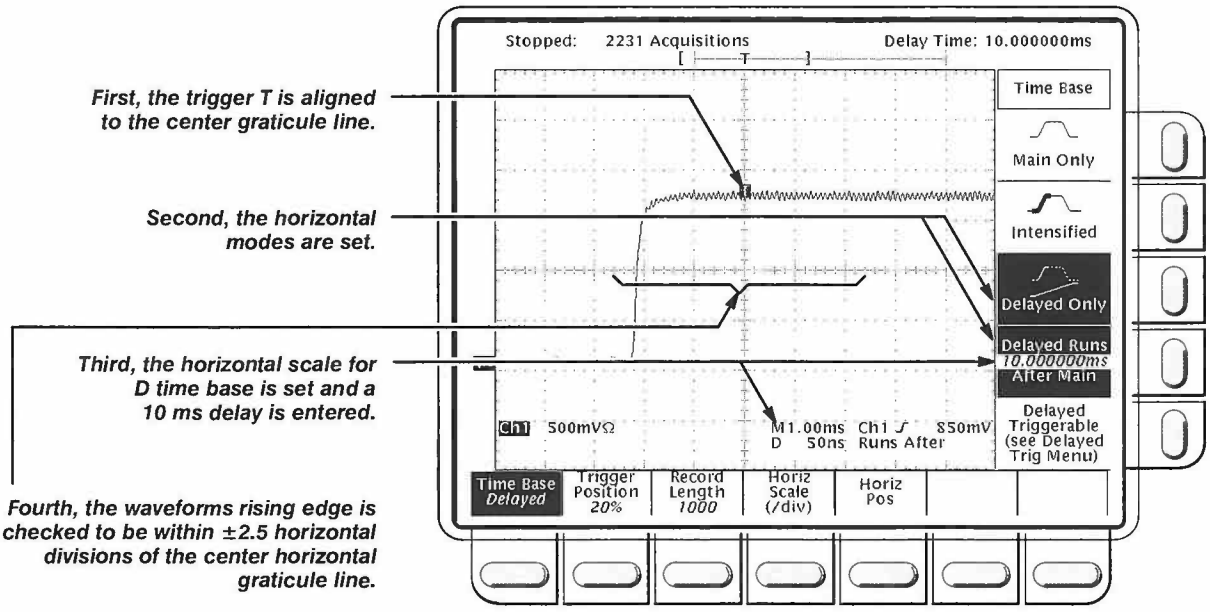


Figure 1-13: Measurement of Accuracy—Long-Term and Delay-Time

c. *Check long-term sample rate and delay time accuracies against limits:* CHECK that the rising edge of the marker crosses the center horizontal graticule line at a point within ±2.5 divisions of center graticule.

d. *Check delta-time accuracy against limits:*

- Press the side-menu button **Main Only**. Set horizontal **SCALE** to 2 ns.
- Set the output of the generator for 20 ns markers.
- Press **SET LEVEL TO 50%**
- Press **SHIFT**; then **ACQUIRE MENU**. Now press the main-menu button **Mode**; then press the side-menu button **Average**.
- Enter **8**, for eight averages, on the keypad.
- Press **MEASURE**.
- Press the main-menu button **High-Low Setup**; then press the side-menu button **Min-Max**.
- Press the main-menu button **Select Measurement for Ch1**.
- Press the side-menu button **−more−**, until **PERIOD** appears in the side menu. Press **PERIOD**.
- Press **CLEAR MENU**.
- CHECK that the readout for **CH 1 Per** is within 19.760 ns to 20.240 ns.

3. *Disconnect the hookup:* Disconnect the cable from the generator output at the input connector of **CH 1**.

Trigger System Checks

These procedures check those characteristics that relate to the Main and Delayed trigger systems and are listed as checked under *Warranted Characteristics* in *Section 2: Specification.*

Check: **Accuracy (Time) for Pulse-Glitch or Pulse-Width Triggering**

Equipment Required: One medium-frequency leveled sine-wave generator (Item 10), one 10X attenuator (Item 1), and one precision coaxial cable (Item 4).

Prerequisites: *See page 1-11.*

Procedure:

1. *Install the test hookup and preset the instrument controls:*
   a. *Initialize the instrument.*
      - Press save/recall **SETUP**.
      - Press the main-menu button **Recall Factory Setup**.
      - Press the side-menu button **OK Confirm Factory Init**.
   b. *Modify the default setup:*
      - Press vertical **MENU**.
      - Press the main-menu button **Coupling**; then press the side-menu button Ω to select 50 Ω coupling.
      - Set the horizontal **SCALE** to 10 ns.

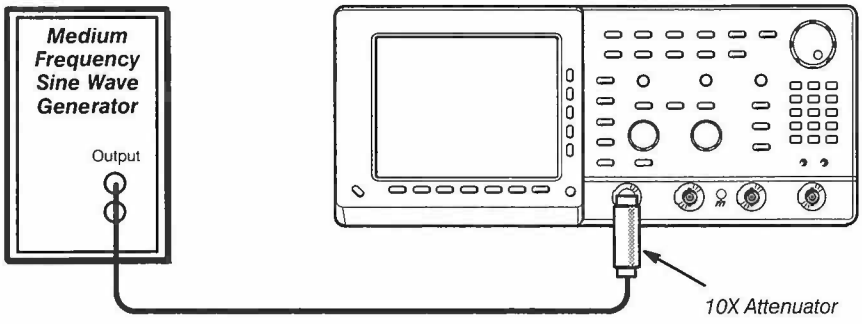


Figure 1-14: Initial Test Hookup

   c. *Hook up the test-signal source*: Connect, through a 50 Ω precision coaxial cable, followed by a 10X attenuator, the output of a medium-frequency leveled sine-wave generator (Item 10).

2. *Confirm the trigger system is within time-accuracy limits for pulse-glitch or pulse-width triggering (Horizontal Scale* ≤1 µs*):*

   a. *Display the test signal:* Set the output of the sine wave generator for a 100 MHz, five-division sine wave on screen. Press **SET LEVEL TO 50%**.

   b. *Set the trigger mode:* Press **TRIGGER MENU**. Now press the main-menu button **Mode & Holdoff**; then the side-menu button **Normal**.

   c. *Set upper and lower limits that ensures triggering:*

      - Press the main-menu button **Type**; then repeatedly press the same button until **Pulse** is highlighted in the menu that pops up.
      - Press the main-menu button **Class**; then repeatedly press the same button until **Width** is highlighted in the menu that pops up.
      - Press the main-menu button **Trig When**; then press the side-menu button **Within Limits.**
      - Press the side-menu button **Upper Limit**. Use the keyboard to set the upper limit to 10 ns: press **10**; then **SHIFT**; then **n**; then **ENTER**.
      - Press the side-menu button **Lower Limit**. Use the keypad to set the lower limit to 2 ns.

   d. *Check against limits:*

      - Press **SET LEVEL 50%.**
      - While doing the following subparts, monitor the display (it will stop acquiring) and the front-panel light **TRIG** (it will extinguish) to determine when triggering is lost.
      - Use the general purpose knob to *increase* the **Lower Limit** readout until triggering is lost.
      - CHECK that the **Lower Limit** readout is within 2.5 ns to 7.5 ns, inclusive.
      - Use the keypad to return the **Lower Limit** to 2 ns and reestablish triggering.
      - Press the side-menu button **Upper Limit**; then use the general purpose knob to slowly *decrease* the the **Upper Limit** readout until triggering is lost.
      - CHECK that the **Upper Limit** readout is within 2.5 ns to 7.5 ns, inclusive.

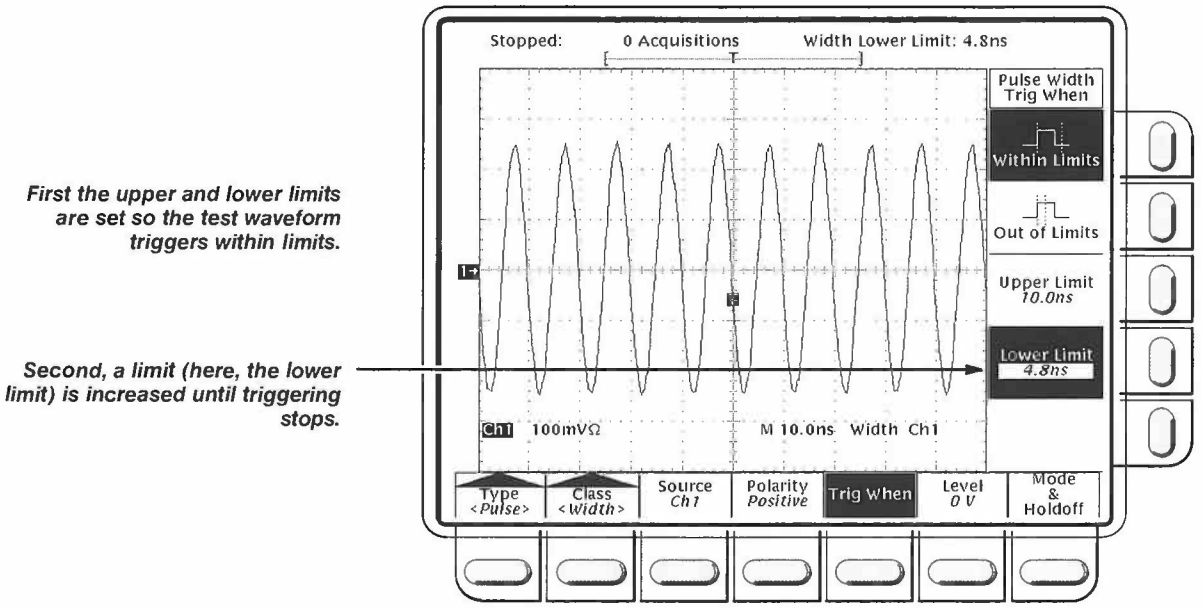


Figure 1-15: Measurement of Time Accuracy for Pulse and Glitch Triggering

3. *Confirm the trigger system is within time-accuracy limits for pulse-glitch or pulse-width triggering (horizontal scale* >1 µs*):*

   a. *Set upper and lower limits that ensures triggering at 250 kHz:*

      - Press the side-menu button **Upper Limit**. Use the keyboard to set the upper limit to 4 µs.
      - Press the side-menu button **Lower Limit**. Use the keypad to set the lower limit to 500 ns.

   b. *Display the test signal:*

      - Set the horizontal **SCALE** to 5 µs.
      - Set the output of the sine-wave generator for a 250 kHz, five-division sine wave on screen. Set the vertical **SCALE** to 20 mV (the waveform will overdrive the display).
      - Press **SET LEVEL TO 50%.**

   c. *Check against limits:* Do the following subparts in the order listed.

      - Use the general purpose knob to *increase* **Lower Limit** readout until triggering is lost.
      - CHECK that the **Lower Limit** readout is within 1 µs to 3 µs, inclusive.
      - Use the keypad to return the **Lower Limit** to 500 ns and reestablish triggering.

- Press the side-menu button **Upper Limit**; then use the general purpose knob to slowly *decrease* the the **Upper Limit** readout until triggering is lost.
- CHECK that the **Upper Limit** readout is within 1 µs to 3 µs, inclusive.

4. *Disconnect the hookup:* Disconnect the cable from the generator output at the input connector of **CH 1**.

Check: **Accuracy, Trigger-level or Threshold, DC Coupled**

Equipment Required: One DC calibration generator (Item 8), one BNC T connector (Item 6), and two precision coaxial cables (Item 4).

Prerequisites: The oscilloscope must meet the prerequisites listed on page 1-11.

Procedure:

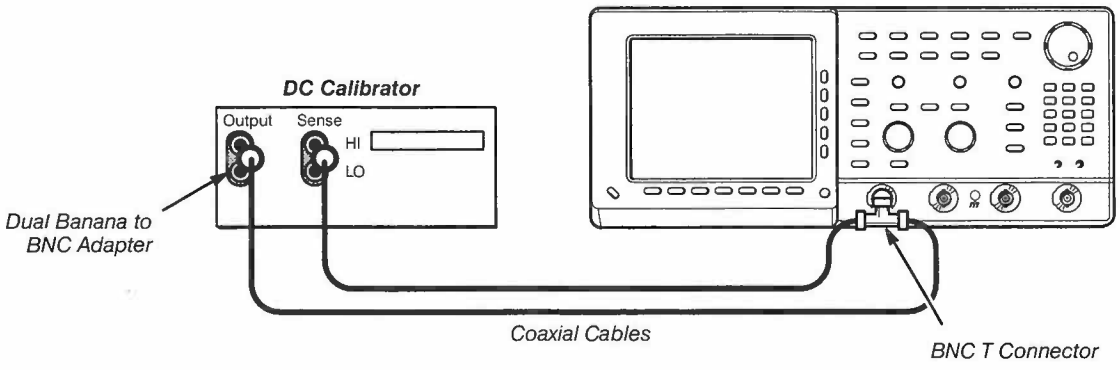


Figure 1-16: Initial Test Hookup

1. *Install the test hookup and preset the instrument controls:*
   a. *Hook up the test-signal source*:
      - Set the output of a DC calibration generator to 0 volts.
      - Connect the output of a DC calibration generator through a dual-banana connector followed by a 50 Ω precision coaxial cable to one side of a BNC T connector.
      - Connect the Sense output of the generator, through a second dual-banana connector followed by a 50 Ω precision coaxial cable, to other side of the BNC T connector. Now connect the BNC T connector to **CH 1**.

b. *Initialize the oscilloscope:*

- Press save/recall **Setup**.
- Press the main-menu button **Recall Factory Setup**.
- Press the side-menu button **OK Confirm Factory Init**.

c. *Select Delayed Triggerable:*

- Press **HORIZONTAL MENU**.
- Press the main menu button **Time Base**. Press the side-menu button **Delayed Triggerable**.

2. *Confirm Main trigger system is within limits for Trigger-level/Threshold accuracy:*

a. *Display the test signal:*

- Press **VERTICAL MENU**. Press the main-menu button **Position**.
- Use the keypad to set vertical position to −3 divisions (press **−3**, then **ENTER**, on the keypad.) The baseline level will move down three divisions.
- Press the main-menu button **Offset**.
- Use the keypad to set vertical offset to +10 volts. The baseline level will move off-screen.
- Set the standard output of a DC calibration generator to +10 volts. The DC test level will appear on screen.

b. *Measure the test signal:*

- Press **SET LEVEL TO 50%**.
- Press **TRIGGER MENU**.
- Read the measurement results from the readout below the label **Level** in the menu; not the trigger readout in the graticule area.

c. *Check against limits:*

- CHECK that the **Level** readout in the main menu is within 9.940 V to 10.060 V, inclusive.
- Press **TRIGGER MENU**. Press the main-menu button **Slope**; then press the side-menu button for negative slope. (See icon at left.) Repeat substep b.
- CHECK that the **Level** readout in the main menu is within 9.940 V to 10.060 V, inclusive.

3. *Confirm Delayed trigger system is within limits for Trigger-level/Threshold accuracy:*

a. *Select the Delayed time base:*

- Press **HORIZONTAL MENU**.

- Press the main-menu button **Time Base**. Press the side-menu buttons **Delayed Only**.
- Set **D** (delayed) horizontal **SCALE** to 500 µs.

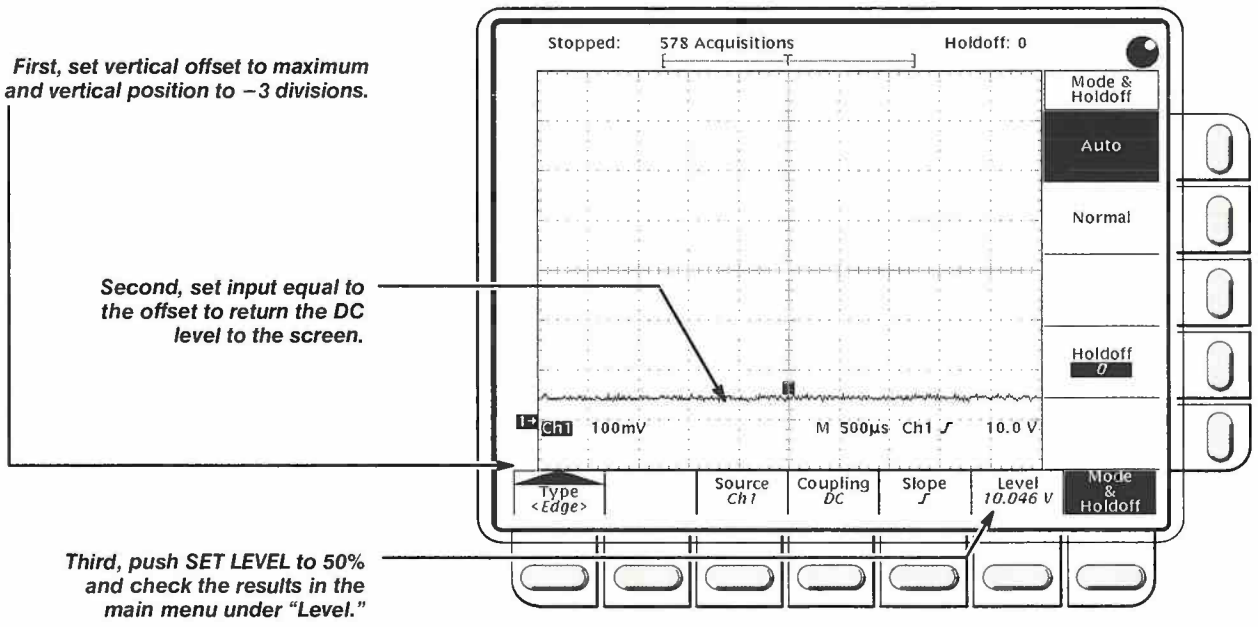


Figure 1-17: Measurement of Trigger-Level Accuracy

b. *Select the Delayed trigger system:*
   - Press **SHIFT**; then press the front-panel button **DELAYED TRIG**.
   - Press the main-menu button **Level**.

c. *Measure the test signal:* Press the *side-menu button* **SET TO 50%**. Read the measurement results in the side menu below the label **Level**.

d. *Check against limits:* Do the following subparts in the order listed.
   - CHECK that the **Level** readout in the side menu is within 9.940 V to 10.060 V, inclusive.
   - Press the main-menu button **Slope**; then press the side-menu button for negative slope. (See icon at left.) Press the main-menu button **Level**. Repeat substep c.
   - CHECK that the **Level** readout in the side menu is within 9.940 V to 10.060 V, inclusive.

4. *Disconnect the hookup:*
   a. *First set the output of the DC calibration generator to 0 volts.*
   b. Then disconnect the cable from the generator output at the input connector of **CH 1**.

Check: **Sensitivity, Edge Trigger, DC Coupled**

Equipment Required: One medium-frequency leveled sine-wave generator (Item 10), one high-frequency leveled sine-wave generator (Item 11), one precision 50 Ω coaxial cable (Item 4), one 5X attenuator (Item 2), and one 10X attenuator (Item 1). When checking the TDS 540 Oscilloscope, a BNC T connector (Item 6) and a second precision 50 Ω coaxial cable (Item 4) are also required.

Prerequisites: *See page 1-11.*

Procedure:

1. *Install the test hookup and preset the instrument controls:*

   a. *Initialize the oscilloscope:*

      - Press save/recall **SETUP**.
      - Press the main-menu button **Recall Factory Setup**.
      - Press the side-menu button **OK Confirm Factory Init**.

   b. *Modify the initialized front-panel control settings:*

      - Set the horizontal **SCALE** for **M** (main) time base to 20 ns.
      - Press **HORIZONTAL MENU**; then press the main-menu button **Time Base**.
      - Press the side-menu button **Delayed Only**; then the side-menu button **Delayed Triggerable**.
      - Set the horizontal **SCALE** for the **D** (delayed) time base to 20 ns; then press the side-menu button **Main Only**.
      - Press **TRIGGER MENU**; then press the main-menu button **Mode & Holdoff**. Now press the side-menu button **Normal**.
      - Press **VERTICAL MENU**; then press the main-menu button **Coupling**. Now press the side-menu button Ω select the 50 Ω setting.
      - Press **SHIFT**; then press **ACQUIRE MENU**. Now press the main-menu button **Mode**; then the side-menu button **Average 16**.

c. *Hook up the test-signal source:*

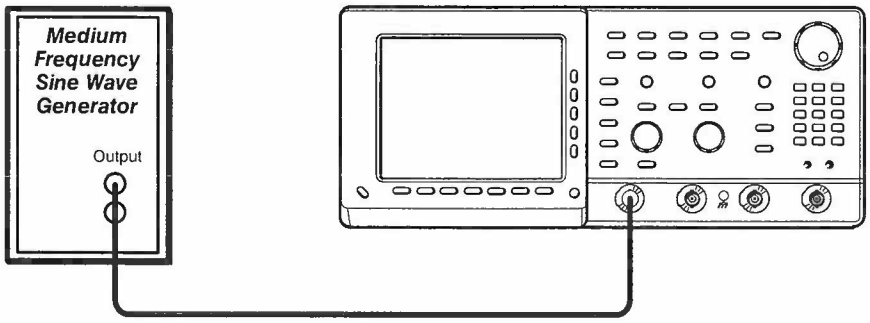


Figure 1-18: Initial Test Hookup—TDS 520 Only

- TDS 520 only: Connect, through a 50 Ω precision coaxial cable, the signal output of a medium-frequency sine wave generator to **CH 1**. See Figure 1-18.

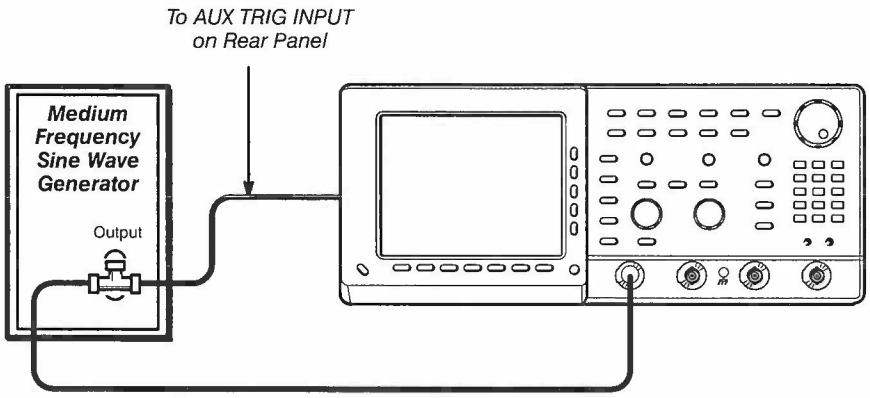


Figure 1-19: Initial Test Hookup—TDS 540 Only

- TDS 540 only: Connect the signal output of a medium-frequency sine wave generator to a BNC T connector. Connect one output of the T connector to **CH 1** through a 50 Ω precision coaxial cable; connect the other output of the T connector to the **AUX TRIG INPUT** at the rear panel. See Figure 1-19.

2. *Confirm Main and Delayed trigger systems are within sensitivity limits (50 MHz):*

   a. *Display the test signal:*

   - Set the generator frequency to 50 MHz.
   - Press **MEASURE**.

- Press the main-menu button **High-Low Setup**; then press the side-menu button **Min-Max**.
- Press the main-menu button **Select Measurement for Ch 1**.
- Press the side-menu button **–more–** until **Amplitude** appears in the side menu (its icon is shown at the left). Press the side-menu button **Amplitude**.

- Press **SET LEVEL TO 50%**.
- Press **CLEAR MENU**.
- Set the test signal amplitude for about three divisions on screen. Now fine adjust the generator output until the **CH 1 Amplitude** readout indicates the amplitude is 350 mV. (Readout may fluctuate around 350 mV.)
- Disconnect the 50 Ω precision coaxial cable at **CH 1** and reconnect it to **CH 1** through a 10X attenuator.

b. *Check for Main trigger system for stable triggering at limits:*

- Read the following definition: A stable trigger is one that is consistent; that is, one that results in a uniform, regular display triggered on the selected slope (positive or negative). This display should *not* have its trigger point switching between opposite slopes, nor should it "roll" across the screen. At horizontal scale settings of 2 ms/division and faster, **TRIG'D** will remain constantly lit. It will flash for slower settings.
- Press **TRIGGER MENU**; then press the main-menu button **Slope**.
- Press **SET LEVEL TO 50%**. CHECK that a stable trigger is obtained for the test waveform on both the positive and negative slopes. (Use the side menu to switch between trigger slopes; use the **TRIGGER LEVEL** knob to stabilize the trigger if required.)
- Leave the Main trigger system triggered on the positive slope of the waveform before continuing to the next step. (The Main trigger system *must* be triggered to check the delayed trigger system in the next step.)

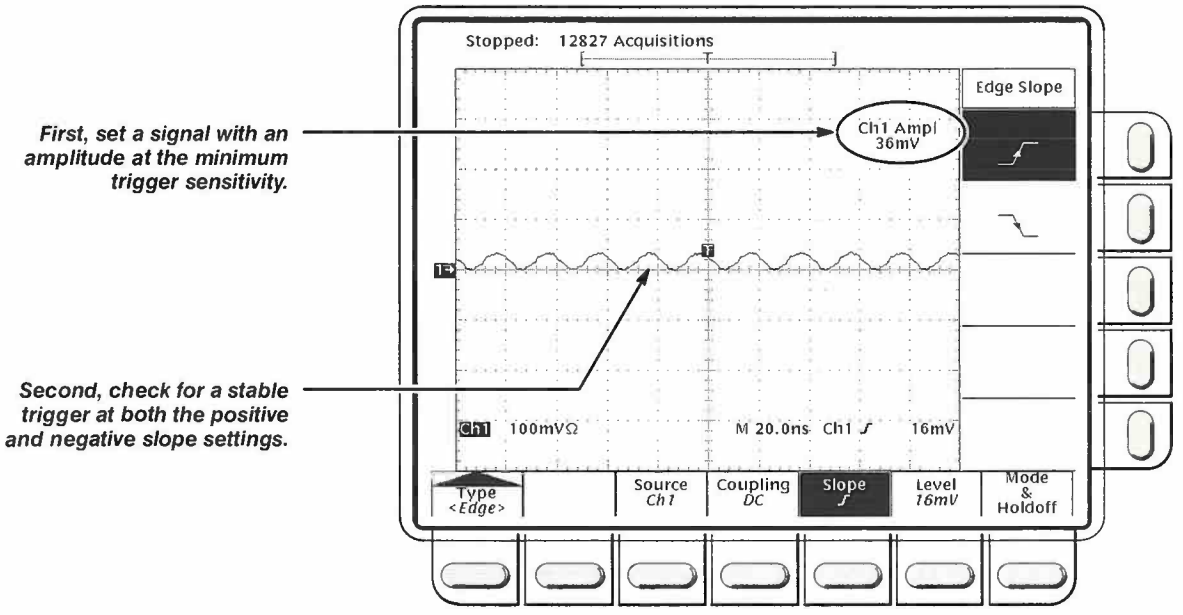


Figure 1-20: Measurement of Trigger Sensitivity

c. *Check delayed trigger system for stable triggering at limits* Do the following subparts in the order listed.

- Press **HORIZONTAL MENU**; then press the main-menu button **Time Base**. Now press the side-menu button **Delayed Only**.
- Press **SHIFT**; then press **DELAYED TRIG**. Press the main-menu button **Level**.
- Press the *side-menu* button **SET TO 50%**. CHECK that a stable trigger is obtained for the test waveform for both the positive and negative slopes of the waveform. (Use the General Purpose knob to stabilize the trigger if required.) Press the main-menu button **Slope**; then use the side menu to switch between trigger slopes.
- Leave the delayed trigger system triggered on the positive slope of the waveform before continuing to the next step. Also, return to the main time base: Press **HORIZONTAL MENU**; then press the main-menu button **Time Base**. Now press the side-menu button **Main Only**.

TDS 520 only: Skip to step 4 since the TDS 520 is not equipped with an AUX Trigger input. If testing the TDS 540, continue with step 3.

3. *Confirm the AUX Trigger input:*

a. *Display the test signal:*

- Remove the 10X attenuator and reconnect the cable to **CH 1**.
- Set the test signal amplitude for about 2.5 divisions on screen.

- Now fine adjust the generator output until the **CH 1 Amplitude** readout indicates the amplitude is 250 mV. (Readout may fluctuate around 250 mV.)

b. *Check for AUX trigger source for stable triggering at limits:* Do the following in the order listed.

- Use the definition for stable trigger from step 2.
- Press **TRIGGER MENU**; then press the main-menu button **Source**.
- Press the side-menu button **–more–** until the side-menu label **Auxiliary** appears; then press **Auxiliary**.
- Press **SET LEVEL TO 50%**. CHECK that a stable trigger is obtained for the test waveform on both the positive and negative slopes. Press the main-menu button **Slope**; then use the side menu to switch between trigger slopes. Use the **TRIGGER LEVEL** knob to stabilize the trigger if required.
- Leave the Main trigger system triggered on the positive slope of the waveform before proceeding to the next check.
- Press the main-menu button **Source**; then press the side-menu button **–more–** until **CH 1**. Press **CH 1**.

4. *Confirm that the Main and Delayed trigger systems are within sensitivity limits (500 MHz):*

a. *Hook up the test-signal source:* Disconnect the hookup installed in step 1. Connect, through its leveling head, the signal output of a high-frequency leveled sine-wave generator to **CH 1**.

b. *Set the Main and Delayed Horizontal Scales:*

- Set the horizontal **SCALE** to 500 ps for the **M** (Main) time base.
- Press **HORIZONTAL MENU**.
- Push the main-menu button **Time base**; then press the side-menu button **Delayed Triggerable**.
- Press the side-menu button **Delayed Only**.
- Set the horizontal **SCALE** to 500 ps for the **D** (Delayed) time base. Press the side-menu button **Main Only**.

c. *Display the test signal:*

- Set the generator frequency to 500 MHz.
- Set the test signal amplitude for about five divisions on screen. Now fine adjust the generator output until the **CH 1 Amplitude** readout indicates the amplitude is 500 mV. (Readout may fluctuate around 500 mV.)
- Disconnect the leveling head at **CH 1** and reconnect it to **CH 1** through a 5X attenuator.

d. Repeat step 2, substeps b and c only, since only the 500 MHz frequency is to be checked here.

5. *Confirm that the Main and Delayed trigger systems couple trigger signals from all channels:* If you have not done the procedure *Check Analog Bandwidth,* which begins of page 1-21, do so after finishing this procedure. See the following notes.

NOTE

Steps 1 through 4 confirmed trigger sensitivity for the Main and Delayed triggering systems using the CH 1 input. Doing the procedure Check Analog Bandwidth *ensures that trigger signals are coupled from all four channels.*

When checking delayed triggering sensitivity at 500 MHz, the waveform record may have some missing interpolated record points. The waveform is still stably triggered. (See definition of a stable trigger earlier in this procedure.)

6. *Disconnect the hookup:* Disconnect the cable from the generator output at the input connector of the channel last tested.

Output Signals Checks

These procedures check those characteristics that are available at the various output ports on the oscilloscope and are listed as checked under *Warranted Characteristics* in *Section 2: Specification.*

Check: **Outputs—CH 3 and Main and Delayed Trigger (TDS 540 only)**

Equipment Required: Two 50 Ω precision cables (Item 4), and one calibration generator (Item 9).

Prerequisites: See page 1-11. Also, this digitizing oscilloscope must have passed *Check Accuracy—Long-Term Sample Rate, Delay time, Time Measurement* on page 1-28 and *Check Accuracy for DC Gain and Voltage Measurements* on page 1-15.

Procedure:

1. *Install the test hookup and preset the instrument controls:*

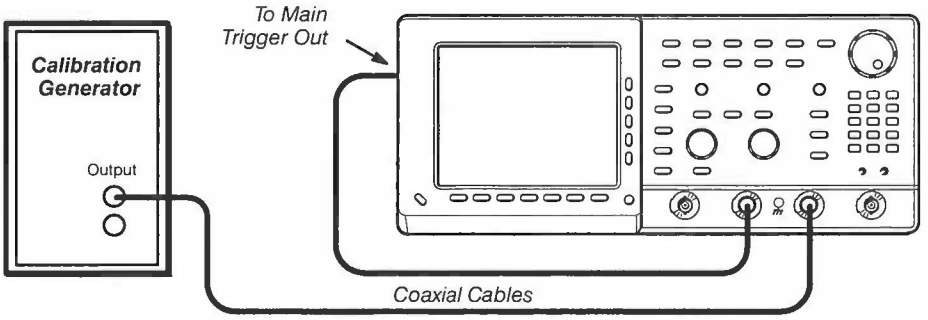


Figure 1-21: Initial Test Hookup

a. *Hook up test-signal source 1:*

- Connect the standard amplitude output of a calibration generator through a 50 Ω precision coaxial cable to **CH 3**.
- Set the output of the calibration generator to 0.500 V.

b. *Hook up test-signal source 2:* Connect the **Main Trigger Out** at the rear panel to **CH 2** through a 50 Ω precision cable.

c. *Initialize the oscilloscope:*

- Press save/recall **SETUP**.
- Press the main-menu button **Recall Factory Setup**.
- Press the side-menu button **OK Confirm Factory Init**.

d. *Modify the initialized front-panel control settings:*

- Set the horizontal **SCALE** to 200 µs.
- Press **SHIFT**; then press **ACQUIRE MENU**.
- Press the main-menu button **Mode**; then press the side-menu button **Hi Res**.

2. *Confirm Main and Delayed Trigger outputs are within limits for logic levels:*

a. *Display the test signal:*

- Press **WAVEFORM OFF** to turn off CH 1; then press **CH 2** to display that channel.
- Set the vertical **SCALE** to 1 V.
- Press **TRIGGER MENU**.
- Press the main-menu button **Source**; then press the side-menu button **CH 3**. Press **SET LEVEL TO 50%**.
- Use the vertical **POSITION** knob to center the display on screen.

b. *Measure logic levels:*

- Press **MEASURE**; then press the main-menu button **Select Measurement for Ch 2**.
- Repeatedly press the side-menu button **–more–** until **High** and **Low** appear in the side menu (their icons are shown at the left). Press both side-menu buttons **High** and **Low**.

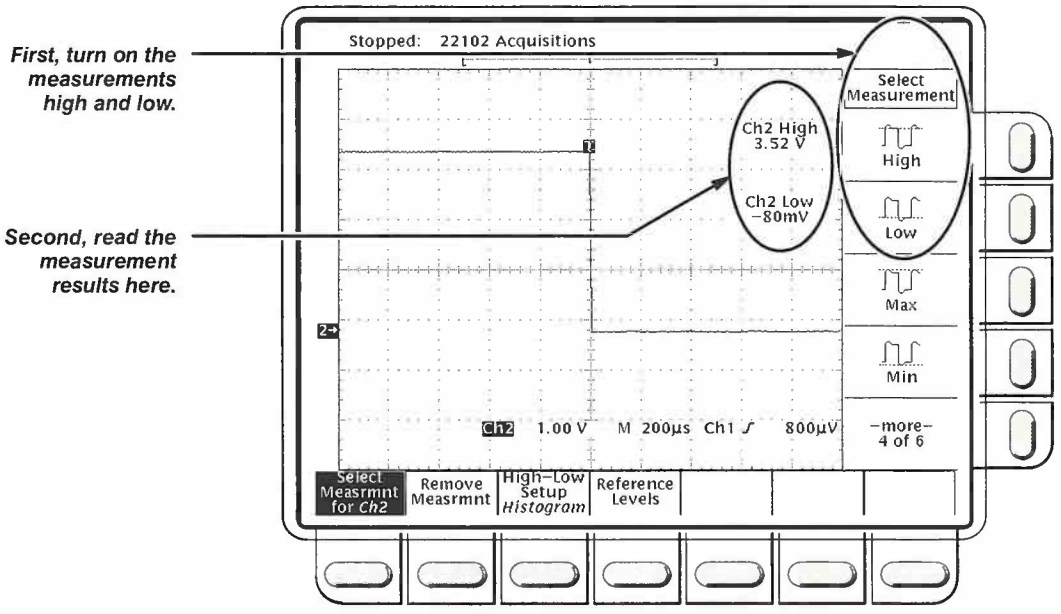


Figure 1-22: Measurement of Main Trigger Out Limits

c. *Check Main Trigger output against limits:*

- CHECK that the **Ch 2 High** readout is ≥2.5 volts and that the **Ch 2 Low** readout is ≤700 mV.
- Press **VERTICAL MENU**; then press the main-menu button **Coupling**. Now press the side-menu button Ω to toggle it to the 50 Ω setting.
- CHECK that the **Ch 2 High** readout is ≥1.0 volts and that the **Ch 2 Low** readout ≤250 mV.

d. *Check Delayed Trigger output against limits:*

- Move the precision 50 Ω cable from the **Main Trigger Output** BNC to the **Delayed Trigger Output** BNC.
- CHECK that the **Ch 2 High** readout is ≥1.0 volts and that the **Ch 2 Low** readout ≤250 mV.
- Press the side-menu button Ω select the 1 MΩ setting.
- Press **CLEAR MENU**.

- CHECK that the **Ch 2 High** readout is ≥2.5 volts and that the **Ch 2 Low** readout is ≤700 mV.

3. *Confirm CH 3 output is within limits for gain:*

   a. *Measure gain:*

   - Move the precision 50 Ω cable from the **DELAYED TRIGGER OUTPUT** BNC to the **CH 3 OUTPUT** BNC.
   - Press **SHIFT**; then press **DELAYED TRIG**.
   - Press the main-menu button **Source**; then press the side-menu button **Ch 3**.
   - Press **HORIZONTAL MENU.**
   - Press the main-menu button **Time Base**; then press the side-menu button **Delayed Triggerable**.
   - Set vertical **SCALE** to 100 mV.
   - Press **MEASURE**; then press the main-menu button **Select Measurements for Ch 2**.
   - Repeatedly press the side-menu button **–more–** until **Pk-Pk** appears in the side menu (its icon is shown at the left). Press the side-menu button **Pk-Pk**.

   - Press **CLEAR MENU**.

   b. *Check against limits:*

   - CHECK that the readout **Ch 2 Pk–Pk** is between 90 mV and 110 mV, inclusive.
   - Press **VERTICAL MENU**; then press the side-menu button Ω to toggle to the 50 Ω setting.
   - Set vertical **SCALE** to 10 mV.
   - Press **CLEAR MENU**.
   - CHECK that the readout **Ch 2 Pk-Pk** is between 45 mV and 55 mV, inclusive.

4. *Disconnect the hookup:* Disconnect the cable from the generator output at the input connector of the channel last tested.

Check: **Output—Probe Compensator**

Equipment Required:

TDS 520, (serial numbers B021799 and below) and TDS 540 (serial numbers B023299 and below): One standard-accessory 10X probe (Item 13).

TDS 520, (serial numbers B021800 and above) and TDS 540 (serial numbers B023300 and above): One female BNC to clip adapter (item 14), two dual-banana connectors (Item 5), one BNC T connector (Item 6), two 50 Ω precision cables (Item 4), and one DC calibration generator (Item 8).

Prerequisites: See page 1-11. Also, the Digitizing Oscilloscope must have passed *Check Accuracy—Long-Term Sample Rate, Delay time, Time Measurement* on page 1-28.

Procedure:

1. *Install the test hookup and preset the instrument controls:*

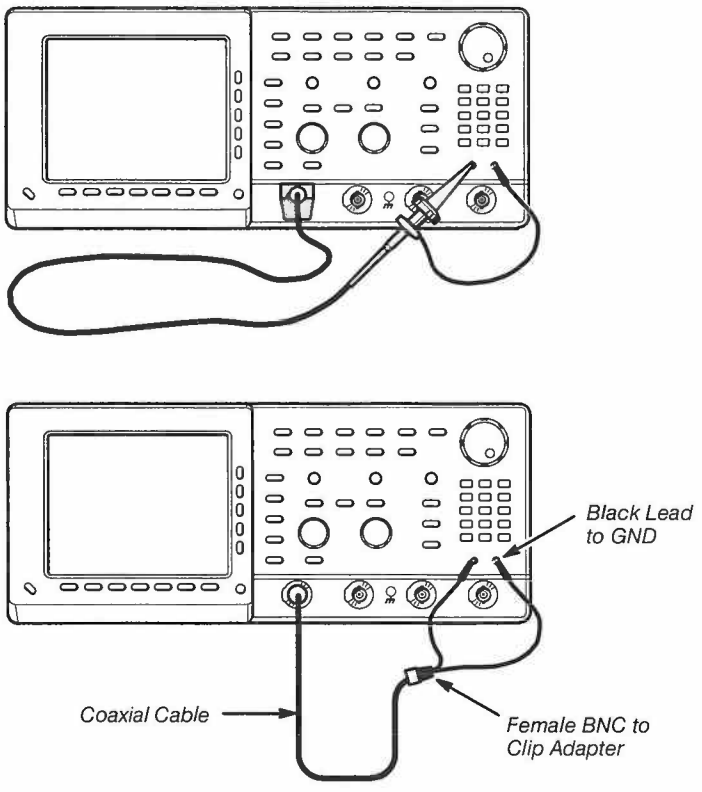


Figure 1-23: Initial Test Hookup

a. *Hook up test-signal:*

- Check your instrument serial number and note for use in the following subparts.
- For TDS 520 oscilloscopes with serial numbers B021799 and below, or for TDS 540 oscilloscopes with serial numbers B023299 and below, connect **CH 1** to **PROBE COMPENSATION SIGNAL** and to **PROBE COMPENSATION GND** through a probe as is shown in the *top* hookup illustration of Figure 1-23.

- For TDS 520 oscilloscopes with serial numbers B021800 and above, or for TDS 540 oscilloscopes with serial numbers B023300 and above, connect **CH 1** to **PROBE COMPENSATION SIGNAL** and to **PROBE COMPENSATION GND** through a precision coaxial cable and a BNC to clip adapter as is shown in the *bottom* hookup illustration of Figure 1-23.

b. *Initialize the oscilloscope:*

- Press save/recall **SETUP**.
- Press the main-menu button **Recall Factory Setup**.
- Press the side-menu button **OK Confirm Factory Init.**

c. *Modify the initialized front-panel control settings:*

- Set the vertical **SCALE** to 100 mV as required.
- Set the horizontal **SCALE** to 200 μs.
- Press **SET LEVEL TO 50%**.
- Use the vertical **POSITION** knob to center the display on screen.
- Press **SHIFT**; then press **ACQUIRE MENU**.
- Press the main-menu button **Mode**; then press the side-menu button **Average**.
- Select **128** averages.

2. *Confirm that the Probe Compensator signal is within limits for frequency:*

a. *Measure the frequency of the probe compensation signal:*

- Press **MEASURE**; then press the main-menu button **Select Measurement for Ch1**.

- Repeatedly press the side-menu button **–more–** until **Frequency** appears in the side menu (its icon is shown at the left). Press the side-menu button **Frequency**.
- Press **CLEAR MENU** to remove the menus from the display. See Figure 1-24.

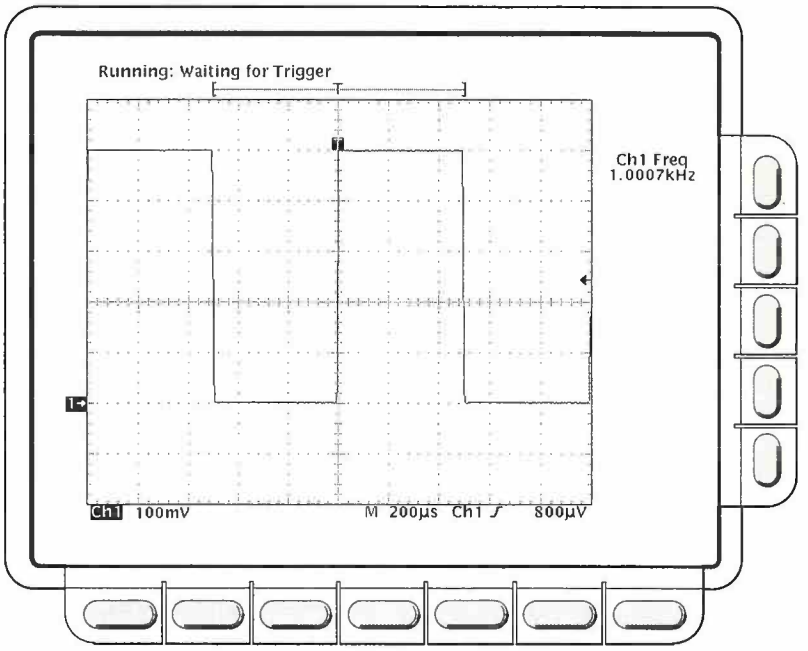


Figure 1-24: Measurement of Probe Compensator Frequency

b. *Check against limits:* CHECK that the **CH 1 Freq** readout is within 950 Hz to 1.050 kHz, inclusive.

STOP Check the serial number of the oscilloscope you are testing. Then do the following to confirm that the Probe Compensator signal amplitude is within limits:

- If your oscilloscope is a TDS 520, with a serial number B021799 or below, or a TDS 540, with a serial number B023299 or below, do step 3. Do *not* do step 4.
- If your oscilloscope is a TDS 520 with a serial number B021800 or above) or a TDS 540, serial numbers B023300 or above, do step 4. Do *not* do step 3.

3. *Confirm that the Probe Compensator signal is within limits for amplitude:*

   a. *Measure the amplitude of the probe compensation signal:* Repeatedly press the side-menu button **–more–** until **Amplitude** appears in the side menu (its icon is shown at the left). Press the side-menu button **Amplitude**.

   b. *Check against limits:* CHECK that the readout for **Ch 1 Ampl** is within 475 mV to 525 mV, inclusive.

   c. Skip to end of procedure (step 5.)

4. *Confirm that the Probe Compensator signal is within limits for amplitude:*

a. *Save the probe compensation signal in reference memory:*

- Press **SAVE/RECALL WAVEFORM**; then press the main-menu button **Save Waveform Ch 1**.
- Press the side-menu button **Ref 1** to save the probe compensation signal in reference 1.
- Disconnect the cable from **CH 1** and the clips from the probe compensation terminals.
- Press **MORE**; then press the main-menu button **Ref 1** to displayed the stored signal.
- Press **CH 1**.

b. *Hook up the DC standard source:*

- Set the output of a DC calibration generator to 0 volts.
- Connect the output of a DC calibration generator through a dual-banana connector followed by a 50 Ω precision coaxial cable to one side of a BNC T connector.
- Connect the Sense output of the generator through a second dual-banana connector followed by a 50 Ω precision coaxial cable to the other side of the BNC T connector. Now connect the BNC T connector to **CH 1**.

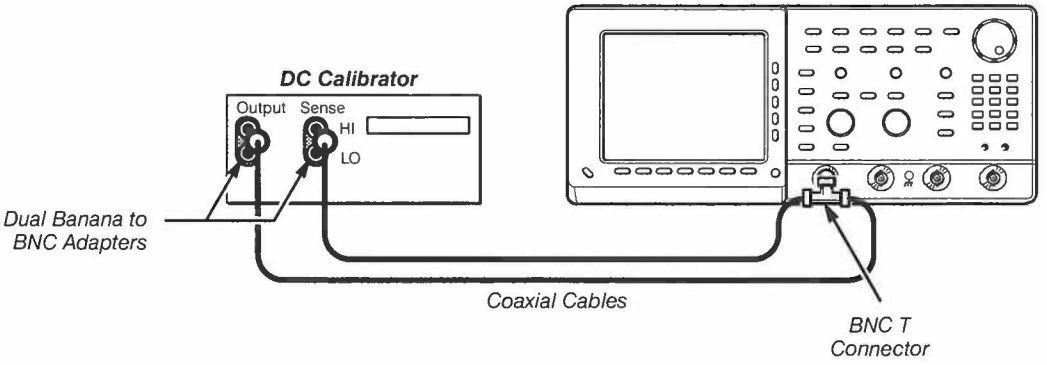


Figure 1-25: Subsequent Test Hookup

c. *Measure amplitude of the probe compensation signal:*

- Press **SHIFT**; then press **ACQUIRE MENU**. Then use the keypad to set **AVERAGE** to **16** in the side menu.
- Adjust the output of DC calibration generator until it precisely overlaps the top (upper) level of the stored probe compensation signal. (This value will be near 500 mV.)
- Record the setting of the DC generator.

- Adjust the output of DC calibration generator until it precisely overlaps the base (lower) level of the stored probe compensation signal. (This value will be near zero volts.)
- Record the setting of the DC generator.

d. Press **CLEAR MENU** to remove the menus from the display. See Figure 1-26.

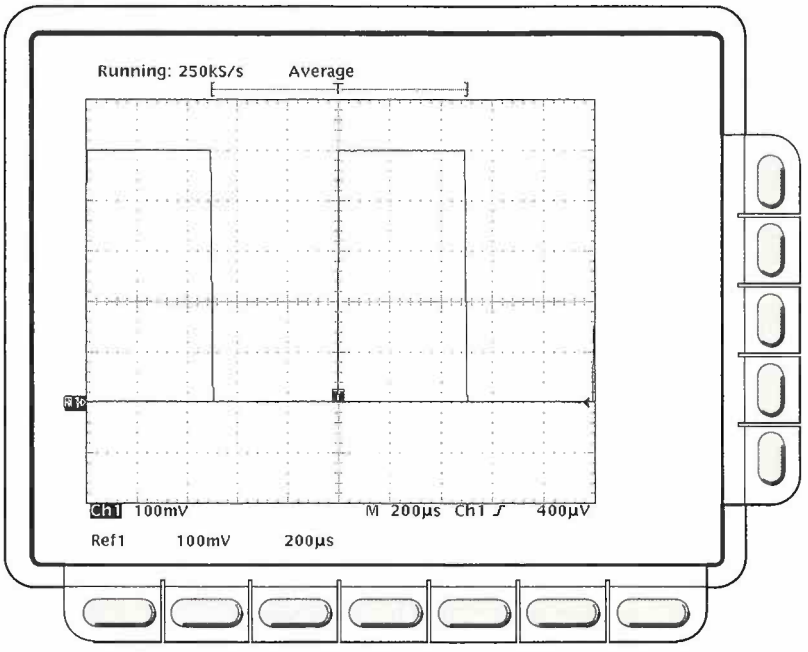
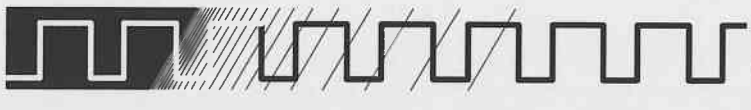


Figure 1-26: Measurement of Probe Compensator Amplitude

e. *Check against limits:*

- Subtract the value just obtained (base level) from that obtained previously (top level).
- CHECK that the difference obtained is within 495 mV to 505 mV, inclusive.

5. *Disconnect the hookup:* Disconnect the cable from **CH 1**.



Specification

Specification

This subsection begins with a general description of the traits of the TDS 520 and TDS 540 Digitizing Oscilloscope. Three subsections follow, one for each of three classes of traits: *nominal traits, warranted characteristics*, and *typical characteristics*.

General Product Description

The Tektronix TDS 520 and 540 Digitizing Oscilloscopes are both portable, four-channel instruments suitable for use in a variety of test and measurement applications and systems. Key differences between the two models are as follows:

- The TDS 540 supplies four full-featured vertical channels. The TDS 520 supplies two full-featured channels; the remaining two channels are auxiliary channels with fewer vertical scale factors.
- The TDS 540 acquires all four channels simultaneously; the TDS 520 can acquire any two channels at the same time.
- The TDS 540 has a maximum digitizing rate of 1 Gigasample/second with an analog bandwidth of 500 MHz; the TDS 520 has a maximum digitizing rate of 500 Megasample/second with an analog bandwidth of 500 MHz.

Key features they have in common are:

- Real time sampling, plus equivalent-time sampling on repetitive signals or interpolation of points sampled on non-repetitive signals. Both equivalent time and interpolation can increase the apparent sample rate on the waveform when maximum real-time rates are reached.
- Five acquisition modes: peak-detect, high-resolution, sample, envelope, and average modes
- Three horizontal display modes: main only, main intensified, and delayed only.
- Selectable record lengths of 500 to 15,000 points. A 50,000-point record length is available with the 1M option.
- Extensive triggering capabilities: such as edge, logic, and glitch.
- Full programmability and printer/plotter output.
- Advanced functions like continuously updated measurements.
- Specialized display modes, such as infinite and variable persistence.
- A unique graphical user interface (GUI), an on-board help mode, and a logical front-panel layout which combine to deliver a new standard in usability.

- Measurement aids, such as three types of cursors for making parametric measurements on displayed waveforms and Measure, which can automatically extract parameters from a signal and display them on screen.
- Our proprietary digital signal processor, the DSP. This dedicated processor supports advanced analysis of your waveforms when doing such compute-intensive tasks as interpolation, waveform math, and signal averaging. It also teams with a custom display system to deliver specialized display modes.
- Four nonvolatile REF (reference) memories for storing waveforms.
- The digitizing oscilloscope is fully controllable and capable of sending and receiving waveforms over its GPIB interface (IEEE Std 488.1-1987).
- Hardcopy output (no system controller is required) in variety of popular output formats.
- Flexible display options to control the intensity of the display elements, style of waveform display (vectors or dots, intensified or non-intensified samples, and infinite or variable persistence), and display format (XY or YT and graticule type).
- Zoom, for magnifying waveform features you wish to examine up close.

Nominal Traits

This subsection contains a collection of tables that list the various *nominal traits* that describe the TDS 520 and 540 Digitizing Oscilloscopes. (Traits that differ according to model or only apply to one model are preceded by the appropriate model number, TDS 520 or TDS 540, in the tables.) Included are electrical and mechanical traits.

Nominal traits are described using simple statements of fact such as "Four, all identical" for the trait "Input Channels, Number of," rather than in terms of limits that are performance requirements.

Table 2-1: Nominal Traits—Signal Acquisition System

Name	Description	
Bandwidth Selections	20 MHz, 100 MHz, and FULL (500 MHz)	
TDS 540: Digitizers, Number of	Four, all identical	
TDS 520: Digitizers, Number of	Two, both identical	
Digitized Bits, Number of	8 bits[1]	
TDS 540: Input Channels, Number of	Four, all identical	
TDS 520: Input Channels, Number of	Two full-featured (CH 1 and CH 2), plus two limited, auxiliary inputs (AUX 1 and AUX 2)	
Input Coupling[2]	DC, AC, or GND	
Input Impedance Selections	1 MΩ or 50 Ω	
TDS 540: Ranges, Offset, All Channels	**Volts/Div Setting**	**Offset Range**
	1 mV/div–99.5 mV/div	±1 V
	100 mV/div–995 mV/div	±10 V
	1 V/div–10 V/div	±100 V
TDS 520: Ranges, Offset, CH 1 and CH 2	Same as is listed for the TDS 540	
TDS 520: Ranges, Offset, AUX 1 and AUX 2	**Volts/Div Setting**	**Offset Range**
	100 mV/div	±0.5 V
	1 V/div	±5.0 V
	10 V/div	±50 V
Range, Position	±5 divisions	

[1]Displayed vertically with 25 digitization levels (DLs) per division and 10.24 divisions dynamic range with zoom off. A DL is the smallest voltage level change that can be resolved by the 8-bit A-D Converter, with the input scaled to the volts/division setting of the channel used. Expressed as a voltage, a DL is equal to 1/25 of a division times the volts/division setting.

[2]The input characteristics *(Input Coupling, Input Impedance Selections,* etc.) apply to both full-featured and auxiliary inputs except where otherwise specified.

Table 2-1: Nominal Traits—Signal Acquisition System (Cont.)

Name	Description
TDS 540: Range, Sensitivity, All Channels	1 mV/div to 10 V/div[3]
TDS 520: Range, Sensitivity, CH 1 and CH 2	Same as listed for the TDS 540
TDS 520: Range, Sensitivity, AUX 1 and AUX 2	100 mV/div, 1 V/div, and 10 V/div[4]

[3]The sensitivity ranges from 1 mV/div to 10 V/div in a 1–2–5 sequence of coarse settings. Between a pair of adjacent coarse settings, the sensitivity can be finely adjusted. The resolution of such a fine adjustment is 1% of the more sensitive of the pair. For example, between 50 mV/div and 100 mV/div, the volts/division can be set with 0.5 mV resolution.

[4]There is no fine adjustment between the three sensitivity selections for AUX 1 and AUX 2.

Table 2-2: Nominal Traits—Time Base System

Name	Description		
TDS 540: Range, Sample-Rate[1,3]	**Number of Channels On**	**Sample-Rate Range**	
	1	5 Samples/s–1 GSample/s	
	2	5 Samples/s–500 MSamples/s	
	3 or 4	5 Samples/s–250 MSamples/s	
TDS 520: Range, Sample-Rate[1,3]	**Input Channel**	**Number of Channels On**	**Sample-Rate Range**
	CH 1 or CH 2	1	5 Samples/s–500 MSamples/s
	CH 1 or CH 2	2	5 Samples/s–250 MSamples/s
	AUX 1 or AUX 2	Doesn't matter	5 Samples/s–250 MSamples/s
Range, Equivalent Time or Interpolated Waveform Rate[2,3]	500 MSamples/s to 100 GSamples/s (2 ns/Sample to 1 ps/Sample)		
Range, Seconds/Division	500 ps/div to 10 s/div		
Range, Time Base Delay Time	16 ns to 250 seconds		
Record Length Selection[4]	500 points, 1000 points, 2500 points, 5000 points, 15000 points. A record length 50000 points is available with Option 1M.		

[1]The range of real-time rates, expressed in samples/second, at which a digitizer samples signals at its inputs and stores the samples in memory to produce a record of time-sequential samples

[2]The range of waveform rates for equivalent time or interpolated waveform records.

[3]The Waveform Rate (WR) is the equivalent sample rate of a waveform record. For a waveform record acquired by real-time sampling of a single acquisition, the waveform rate is the same as the real-time sample rate; for a waveform created by interpolation of real-time samples from a single acquisition or by equivalent-time sampling of multiple acquisitions, the waveform rate is faster than the real time sample rate. For all three cases, the waveform rate is 1/(Waveform Interval) for the waveform record, where the waveform interval (WI) is the time between the samples in the waveform record.

[4]The maximum record length of 15,000 points (50,000 points with Option 1M) is selectable with all acquisition modes except Hi Res. In Hi Res, the maximum record length is 5,000 points (15,000 points with Option 1M).

Table 2-3: Nominal Traits—Triggering System

Name	Description	
Range, Delayed Trigger Time Delay	16 ns to 250 seconds	
Range, Events Delay	2 to 10,000,000	
Range (Time) for Pulse-Glitch or Pulse-Width Triggering	2 ns to 1 s	
Ranges, Trigger Level or Threshold	**Source**	**Range**
	Any Channel	±12 divisions from center of screen
	Auxiliary (TDS 540 only)	±4 V
	Line	±300 V

Table 2-4: Nominal Traits—Display System

Name	Description
Video Display Resolution	640 pixels horizontally by 480 pixels vertically in a display area of 5.2 inches horizontally by 3.9 inches vertically
Waveform Display Graticule	Single Graticule: 401 × 501 pixels/8 × 10 divisions, where divisions are 1 cm by 1 cm
Waveform Display Grey Scale	Sixteen levels in infinite-persistence and variable persistence display styles

Table 2-5: Nominal Traits—Interfaces, Output Ports, and Power Fuse

Name	Description
Interface, GPIB	GPIB interface complies with IEEE Std 488.1-1987 and IEEE Std 488.2-1987.
Interface, RS-232 (Option 13 only)	RS-232 interface complies with EIA/TIA 574
Interface, Centronics (Option 13 only)	Centronics interface complies with Centronics interface standard C332-44 Feb 1977, REV A
Logic Polarity for Main- and Delayed-Trigger Outputs	Negative TRUE. High to low transition indicates the trigger occurred.
Fuse Rating	Either of two fuses[1] may be used: a .25″ × 1.25″ (UL 198.6, 3AG): 6 A FAST, 250 V, or a 5 mm × 20 mm, (IEC 127): 5 A (T), 250 V.

[1] **Each fuse type requires its own fuse cap.**

Table 2-6: Nominal Traits—Mechanical

Name	Description
Cooling Method	Forced-air circulation with no air filter.
Construction Material	Chassis parts constructed of aluminum alloy; front panel constructed of plastic laminate; circuit boards constructed of glass-laminate. Cabinet is aluminum and is clad in Tektronix Blue vinyl material.
Finish Type	Tektronix Blue vinyl-clad aluminum cabinet.
Weight	Standard digitizing oscilloscope 12.3 kg (27 lbs), with front cover. 20.0 kg (44 lbs), when packaged for domestic shipment. Rackmount digitizing oscilloscope 12.3 kg (27 lbs) plus weight of rackmount parts, for the rackmounted digitizing oscilloscope (Option 1R). 20.5 kg (45 lbs), when the rackmounted digitizing oscilloscope is packaged for domestic shipment. Rackmount conversion kit 2.3 kg (5 lbs), parts only; 3.6 kg (8 lbs), parts plus package for domestic shipping.
Overall Dimensions	Standard digitizing oscilloscope Height: 193 mm (7.6 in), without the accessories pouch installed. Width: 445 mm (17.5 in), with handle. Depth: 434 mm (17.1 in), with front cover installed. Rackmount digitizing oscilloscope Height: 178 mm (7.0 in). Width: 483 mm (19.0 in). Depth: 558.8 mm (22.0 in).

Warranted Characteristics

This subsection lists the various *warranted characteristics* that describe the TDS 540 and 520 Digitizing Oscilloscopes. (Characteristics that differ according to model or only apply to one model are preceded by the appropriate model number, TDS 520 or TDS 540, in the tables.) Included are electrical and environmental characteristics.

Warranted characteristics are described in terms of quantifiable performance limits which are warranted.

NOTE

In these tables, those warranted characteristics that are checked in the procedure Performance Verification*, found in Section 1, appear in* ***boldface type*** *under the column* **Name**.

As stated above, this subsection lists only warranted characteristics. A list of *typical characteristics* starts on page 2-13.

Performance Conditions

The electrical characteristics found in these tables of warranted characteristics apply when the scope has been adjusted at an ambient temperature between +20°C and +30°C, has had a warm-up period of at least 20 minutes, and is operating at an ambient temperature between 0°C and +50°C (unless otherwise noted).

Table 2-7: Warranted Characteristics—Signal Acquisition System

Name	Description	
Accuracy, DC Gain	±1%	
Accuracy, DC Voltage Measurement, Averaged[3]	**Measurement Type**	**DC Accuracy**
	Average of ≥16 waveforms	±(1.0% × (reading − Net Offset[1]) + Offset Accuracy + 0.06 div)
	Delta volts between any two averages of ≥16 waveforms[2]	±(1.0% × reading + 0.1 div + 0.3 mV)

[1]Net Offset = Offset − (Position x Volts/Div). Net Offset is the voltage level at the center of the A-D converter's dynamic range. Offset Accuracy is the accuracy of this Voltage level.

[2]The samples must be acquired under the same setup and ambient conditions.

[3]To ensure the most accurate measurements possible, run an SPC calibration first. When using the TDS 520 and/or TDS 540 Digitizing Oscilloscope at a Volts/Div setting ≤5 mV/div, an SPC calibration should be run once per week to ensure that instrument performance levels meet specifications.

Table 2-7: Warranted Characteristics—Signal Acquisition System (Cont.)

Name	Description	
TDS 540: Accuracy, Offset	**Volts/Div Setting**	**Offset Accuracy**
	1 mV/div – 99.5 mV/div	± (0.2% of Net Offset[1] + 1.5 mV + 0.1 div)
	100 mV/div – 995 mV/div	± (0.35% of Net Offset[1] + 15 mV + 0.1 div)
	1 V/div – 10 V/div	±(0.35% of Net Offset[1] + 150 mV + 0.1 div)
TDS 520: Accuracy, Offset (CH 1 and CH 2)	Same as is listed for the TDS 540	
TDS 520: Accuracy, Offset (AUX 1 and AUX 2)	± (1% of Net Offset[1] + 0.1 div)	
Analog Bandwidth, DC-50 Ω Coupled	**Volts/Div**	**Bandwidth[3]**
	5 mV/div – 10 V/div	DC – 500 MHz
	2 mV/div – 4.98 mV/div	DC – 350 MHz
	1 mV/div – 1.99 mV/div	DC – 250 MHz
Cross Talk (Channel Isolation)	≥100:1 at 100 MHz and ≥30:1 at the rated bandwidth (see above) for any two channels having equal volts/division settings	
Delay Between Channels, Full Bandwidth, Equivalent Time	≤250 ps for any two channels with equal volts/division and coupling settings	
Input Impedance, DC-1 MΩ Coupled	1 MΩ ±0.5% in parallel with 10 pF ±2 pF	
Input Impedance, DC-50 Ω Coupled	50 Ω ±1% with VSWR ≤1.3:1 from DC – 500 MHz	
Input Voltage, Maximum, DC-1 MΩ, AC-1 MΩ, or GND Coupled	±400 V (DC + peak AC); derate at 20 dB/decade above 1 MHz	
Input Voltage, Maximum, DC-50 Ω or AC-50 Ω Coupled	5 V rms, with peaks less than or equal to ±30 V	
Lower Frequency Limit, AC Coupled	≤10 Hz when AC-1 MΩ Coupled; ≤200 kHz when AC-50 Ω coupled[4]	

[1]Net Offset = Offset – (Position x Volts/Div). Net Offset is the voltage level at the center of the A-D converter's dynamic range. Offset Accuracy is the accuracy of this voltage level.

[2]The samples must be acquired under the same setup and ambient conditions.

[3]The limits given are for the ambient temperature range of 0°C to +30°C. Reduce the upper bandwidth frequencies by 2.5 MHz for each °C above +30°C.

[4]The AC Coupled Lower Frequency Limits are reduced by a factor of 10 when 10X, passive probes are used.

Table 2-8: Warranted Characteristics—Time Base System

Name	Description
Accuracy, Long Term Sample Rate and Delay Time	±25 ppm over any ≥1 ms interval
TDS 540: Accuracy, Delta Time Measurement	For single-shot acquisitions using sample or high-resolution acquisition modes: **Channels On/Bandwidth Selected** — **Measurement Accuracy[1,2]** 1 or 2 channels/100 MHz — ± (1 WI + 25 ppm of Reading + 500 ps) 3 or 4 channels/20 MHz — ± (1 WI + 25 ppm of Reading + 1.3 ns) For repetitive acquisitions using average acquisition mode with ≥8 averages: **Channels On/Bandwidth Selected** — **Measurement Accuracy[1,2]** 1 to 4 Channels/Full Bandwidth — ± (1 WI + 25 ppm of Reading + 200 ps)
TDS 520: Accuracy, Delta Time Measurement	For single-shot acquisitions using sample or high-resolution acquisition modes on CH 1 and/or CH 2: **Channels On/Bandwidth Selected** — **Measurement Accuracy[1,2]** 1 channel/100 MHz — ± (1 WI + 25 ppm of Reading + 500 ps) 2 channels/20 MHz — ± (1 WI + 25 ppm of Reading + 1.3 ns) For repetitive acquisitions using average acquisition mode with ≥8 averages: **Channels On/Bandwidth Selected** — **Measurement Accuracy[1,2]** 1 to 2 Channels/Full Bandwidth — ± (1 WI + 25 ppm of Reading + 200 ps)

[1]For input signals ≥ 5 divisions in amplitude and a slew rate of ≥ 2.0 divisions/ns at the delta time measurement points. Signal must have been acquired at a volts/division setting ≥ 5 mV/division.

[2]The WI (waveform interval) is the time between the samples in the waveform record. Also, see the footnotes for *Sample Rate Range* and *Equivalent Time or Interpolated Waveform Rates* in Table 2-2 on page 2-5.

Table 2-9: Warranted Characteristics—Triggering System

Name	Description		
Accuracy (Time) for Pulse-Glitch or Pulse-Width Triggering	**Time Range**		**Accuracy**
	2 ns to 1 µs		±(20% of setting + 0.5 ns)
	1.02 µs to 1 s		±(100 ns + .0025% of setting)
Accuracy, Trigger Level or Threshold, DC Coupled[1]	**Trigger Source**		**Accuracy**
	Any Channel		±(2% of (Setting − Net Offset[2]) + 0.3 div × volts/div setting + Offset Accuracy)
	Auxiliary (TDS 540 only)		±(6% of Setting + 8% of p-p signal + 100 mV)
TDS 520: Sensitivity, Edge-Type Trigger, DC Coupled[3]	**Trigger Source**		**Sensitivity**
	CH 1 and CH 2		0.35 division from DC to 50 MHz, increasing to 1 division at 500 MHz
	AUX 1 and AUX 2		0.55 division from DC to 50 MHz, increasing to 1.5 division at 500 MHz
TDS 540: Sensitivity, Edge-Type Trigger, DC Coupled[3]	**Trigger Source**		**Sensitivity**
	Any Channel		0.35 division from DC to 50 MHz, increasing to 1 division at 500 MHz
	Auxiliary		0.25 volts from DC to 50 MHz
Width, Minimum Pulse and Rearm, for Pulse Triggering	**Pulse Class**	**Minimum Pulse Width**	**Minimum Rearm Width**
	Glitch	2 ns	2 ns + 5% of Glitch Width Setting
	Runt	2.5 ns	2.5 ns
	Width	2 ns	2 ns + 5% of Width Upper Limit Setting

[1]For signals having rise and fall times ≥ 20 ns.

[2]Net Offset = Offset − (Position x Volts/Div). Net Offset is the voltage level at the center of the A-D converter's dynamic range. Offset Accuracy is the accuracy of this voltage level.

[3]The minimum sensitivity for obtaining a stable trigger. A stable trigger results in a uniform, regular display triggered on the selected slope. The trigger point must not switch between opposite slopes on the waveform, and the display must not "roll" across the screen on successive acquisitions. The TRIG'D LED stays constantly lighted when the SEC/DIV setting is 2 ms or faster but may flash when the SEC/DIV setting is 10 ms or slower.

Table 2-10: Warranted Characteristics—Output Ports, Probe Compensator and Power

Name	Description	
TDS 540: Logic Levels, Main- and Delayed-Trigger Outputs	**Characteristic**	**Limits**
	Vout (HI)	≥2.5 V open circuit; ≥1.0 V into a 50 Ω load to ground
	Vout (LO)	≤0.7 V into a load of ≤4 mA; ≤0.25 V into a 50 Ω load to ground

Table 2-10: Warranted Characteristics—Output Ports, Probe Compensator and Power (Cont.)

Name	Description	
Output Voltage and Frequency, Probe Compensator	**Characteristic**	**Limits**
	Voltage	
	TDS 520 (B021799 and below); TDS 540 (B023299 and below):	0.5 V (base-top) ±5% into a 1 MΩ load; 0.25 V (base-top) ±7.5% into a 50 Ω load
	TDS 520 (B021800 and above); TDS 540 (B023300 and above):	0.5 V (base-top) ±1% into a 50 Ω load to ground
	Frequency	1 kHz ±5%
TDS 540: Output Voltage, Channel 3 Signal Out	20 mV/division ±10% into a 1 MΩ load; 10 mV/division ±10% into a 50 Ω load	
Source Voltage	90 to 250 VAC_{rms}, continuous range	
Source Frequency	47 Hz to 63 Hz	
Power Consumption	≤300 W (450 VA)	

Table 2-11: Warranted Characteristics—Environmental, Safety, and Reliability

Name	Description
Atmospherics	Temperature: 0°C to +50°C, operating; −40°C to +75°C, non-operating Relative humidity: 0 to 95%, at or below +40°C; 0 to 75%, +41°C to 50°C Altitude: To 15,000 ft. (4570 m), operating; to 40,000 ft. (12190 m), non-operating
Dynamics	Random vibration: 0.31 g rms, from 5 to 500 Hz, 10 minutes each axis, operating; 3.05 g rms, from 5 to 500 Hz, 10 minutes each axis, non-operating
Emissions	Meets or exceeds the requirements of the following standards: MIL-STD-461C CE-03, part 4, curve #1, RE-02, part 7 VDE 0871, Category B FCC Rules and Regulations, Part 15, Subpart J, Class A
User-Misuse Simulation	Electrostatic Discharge Susceptibility: Up to 8 kV with no change to settings or impairment of normal operation; up to 15 kV with no damage that prevents recovery of normal operation

Typical Characteristics

This subsection contains tables that list the various *typical characteristics* that describe the TDS 520 and 540 Digitizing Oscilloscope.(Characteristics that differ according to model or only apply to one model are preceded by the appropriate model number, TDS 520 or TDS 540, in the tables.)

Typical characteristics are described in terms of typical or average performance. Typical characteristics are not warranted.

This subsection lists only typical characteristics. A list of warranted characteristics starts on page 2-8.

Table 2-12: Typical Characteristics—Signal Acquisition System

Name	Description	
Accuracy, DC Voltage Measurement, Not Averaged	**Measurement Type**	**DC Accuracy**
	Any Sample	±(1.0% × (reading − Net Offset[1]) + Offset Accuracy + 0.13 div + 0.6 mV)
	Delta Volts between any two samples[2]	±(1.0% × reading + 0.26 div + 1.2 mV)
TDS 540: Frequency Limit, Upper, 100 MHz Bandwidth Limited (All Channels)	100 MHz	
TDS 520: Frequency Limit, Upper, 100 MHz Bandwidth Limited (CH 1 and CH 2 only)	Same as listed for the TDS 540	
TDS 540: Frequency Limit, Upper, 20 MHz Bandwidth Limited (All Channels)	20 MHz	
TDS 520: Frequency Limit, Upper, 20 MHz Bandwidth Limited (CH 1 and CH 2 only)	Same as listed for the TDS 540	
Calculated Rise Time[3]	**Volts/Div Setting**	**Rise Time**
	5 mV/div–10 V/div	800 ps
	2 mV/div–4.98 mV/div	1.2 ns
	1 mV/div–1.99 mV/div	1.6 ns

[1]Net Offset = Offset − (Position × Volts/Div). Net Offset is the voltage level at the center of the A-D converter's dynamic range. Offset Accuracy is the accuracy of this voltage level.

[2]The samples must be acquired under the same setup and ambient conditions.

[3]The numbers given are valid 0°C to +30°C and will increase as the temperature increases due to the degradation in bandwidth. Rise time is calculated from the bandwidth. It is defined by the following formula:

$$Rise\ Time\ (ns) = \frac{400}{BW\ (MHz)}$$

Note that if you measure rise time, you must take into account the rise time of the test equipment (signal source, etc.) that you use to provide the test signal. That is, the measured rise time (RT_m) is determined by the instrument rise time (RT_i) and the rise time of the test signal source (RTgen) according to the following formula:

$$RT_m^{\ 2} = RT_i^{\ 2} + RT_{gen}^{\ 2}$$

Table 2-12: Typical Characteristics—Signal Acquisition System (Cont.)

Name	Description				
Nonlinearity	<1 DL, differential; ≤1 DL, integral, independently based				
TDS 540: Step Response Settling Errors	**Volts/Div Setting**	**Step Amplitude**	**Settling Error (%)[4]**		
			20 ns	**100 ns**	**20 ms**
	1 mV/div–99.5 mV/div	≤2 V	≤0.5	≤0.2	≤0.1
	100 mV/div–995 mV/div	≤20 V	≤1.0	≤0.5	≤0.2
	1 V/div–10 V/div	≤200 V	≤1.0	≤0.5	≤0.2
TDS 520: Step Response Settling Errors (CH 1 and CH 2 only)	Same as is listed for the TDS 540				

[4]The values given are the maximum absolute difference between the value at the end of a specified time interval after the mid-level crossing of the step, and the value one second after the mid-level crossing of the step, expressed as a percentage of the step amplitude.

Table 2-13: Typical Characteristics—Time Base System

Name	Description
Aperture Uncertainty	≤(50 ps + 0.03 ppm × Record Duration)$_{rms}$, for real-time or interpolated records having duration ≤1 minute; ≤(50 ps + 0.06 × WI[1])$_{rms}$, for equivalent time records

[1]The WI (waveform interval) is the time between the samples in the waveform record. Also, see the footnotes for *Sample Rate Range* and *Equivalent Time* or *Interpolated Waveform Rates* in Table 2-2 on page 2-5.

Table 2-14: Typical Characteristics—Triggering System

Name	Description	
TDS 540: Input, Auxiliary Trigger	The input resistance is ≥1.5 kΩ; the maximum safe input voltage is ±20 V (DC + peak AC).	
Error, Trigger Position, Edge Triggering	**Acquire Mode**	**Trigger-Position Error[1,2]**
	Sample, Hi-Res, Average	±(1 WI + 1 ns)
	Peak Detect, Envelope	±(2 WI + 1 ns)
Holdoff, Variable, Main Trigger	Minimum: For any horizontal scale setting, *minimum* holdoff is10 × that setting, but is never less than 1 µs or more than 5 s. Maximum: For any horizontal scale setting, *maximum* holdoff is at least 2 times the minimum holdoff for that setting, but is never more than 10 times the minimum holdoff for that setting.	
Lowest Frequency for Successful Operation of "Set Level to 50%" Function	30 Hz	
Sensitivity, Edge Trigger, Not DC Coupled[3]	**Trigger Coupling**	**Typical Signal Level for Stable Triggering**
	AC	Same as DC-coupled limits[4] for frequencies above 60 Hz. Attenuates signals below 60 Hz.
	Noise Reject	Three and one half times the DC-coupled limits.[4]
	High Frequency Reject	One and one half times times the DC-coupled limits[4] from DC to 30 kHz. Attenuates signals above 30 kHz.
	Low Frequency Reject	One and one half times the DC-coupled limits[4] for frequencies above 80 kHz. Attenuates signals below 80 kHz.
Sensitivities, Logic-Type Trigger Events-Delay, DC Coupled [5]	1.0 division, from DC to 100 MHz with a minimum slew rate of 25 div/µs at the trigger level or the threshold crossing.	
Sensitivities, Pulse-Type Runt Trigger[5]	1.0 division, from DC to 200 MHz with a minimum slew rate of 25 div/µs at the trigger level or the threshold crossing.	
Sensitivities, Pulse-Type Trigger Width and Glitch[5]	1.0 division with a minimum slew rate of 25 div/µs at the trigger level or the threshold crossing. For <5 nsec pulse width or rearm time, divisions are required.	

[1]The trigger position errors are typically less than the values given here. These values are for triggering signals having a slew rate at the trigger point of ±0.5 division/ns.

[2]The waveform interval (WI) is the time between the samples in the waveform record. Also, see the footnote for the characteristics *Sample Rate Range* and *Equivalent Time or Interpolated Waveform Rates* in Table 2-2 on page 2-5.

[3]The minimum sensitivity for obtaining a stable trigger. A stable trigger results in a uniform, regular display triggered on the selected slope. The trigger point must not switch between opposite slopes on the waveform, and the display must not "roll" across the screen on successive acquisitions. The TRIG'D LED stays constantly lighted when the SEC/DIV setting is 2 ms or faster but may flash when the SEC/DIV setting is 10 ms or slower.

[4]See the characteristic *Sensitivity, Edge-Type Trigger, DC Coupled* in Table 2-9, which begins on page 2-11.

[5]The minimum signal levels required for stable logic or pulse triggering of an acquisition or for stable counting of a DC coupled events delay signal. (Stable counting of events is counting that misses no events.)

Table 2-14: Typical Characteristics—Triggering System

Name	Description
TDS 520: Sensitivity, Derating Aux Channel Trigger	All trigger sensitivities are derated by 50% for AUX 1 and AUX 2 inputs.
Width, Minimum Pulse and Rearm, for Logic Triggering or Events Delay[6]	5 ns

[6]The minimum pulse width and rearm width required for logic-type triggering or events delaying to occur.

Table 2-15: Typical Characteristics—Data Handling

Name	Description
Time, Data-Retention, Nonvolatile Memory[1,2]	5 years

[1]The time that reference waveforms, stored setups, and calibration constants are retained when there is no power to the digitizing oscilloscope.

[2]Data is maintained by small lithium-thionyl-chloride batteries internal to the memory ICs. The amount of lithium is so small in these ICs that they can typically be safely disposed of with ordinary garbage in a sanitary landfill.

MANUAL CHANGE INFORMATION

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

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MANUAL CHANGE INFORMATION

Date: 16-APRIL-92 **Change Reference:** C2-0492

Product: TDS 520/TDS 540 Performance Verification **Manual Part No.:** 070-8603-00

DESCRIPTION **Product Group 55**

Effective for All Serial Numbers

Add this insert to page 2-9,
Table 2-7: Warranted Characteristics–Signal Acquisition System

Name	Description	
Analog Bandwidth, DC-50 Ω Coupled	**Volts/Div**	**Channel 2 Bandwidth**[1]
	1 mV/div	DC – 200 MHz

[1]The limits given are for the ambient temperature range of 0°C to +30°C. Reduce the upper bandwidth frequencies by 2.5 MHz for each °C above +30°C.