

Service Manual



TDS5000 Series Digital Phosphor Oscilloscopes 071-1004-02

This document applies to firmware version 1.00 and above.

Warning

The servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to all safety summaries prior to performing service.

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

While using this product, you may need to access other parts of the system. Read the *General Safety Summary* in other system manuals for warnings and cautions related to operating the system.

To Avoid Fire or Personal Injury

Use Proper Power Cord. Use only the power cord specified for this product and certified for the country of use.

Connect and Disconnect Properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Ground the Product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Observe All Terminal Ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Do Not Operate Without Covers. Do not operate this product with covers or panels removed.

Use Proper Fuse. Use only the fuse type and rating specified for this product.

Avoid Exposed Circuitry. Do not touch exposed connections and components when power is present.

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Provide Proper Ventilation. Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

Symbols and Terms

Terms in this Manual. These terms may appear in this manual:



WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*



CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Terms on the Product. These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product. The following symbols may appear on the product:



CAUTION
Refer to Manual



WARNING
High Voltage



Protective Ground
(Earth) Terminal

Service Safety Summary

Only qualified personnel should perform service procedures. Read this *Service Safety Summary* and the *General Safety Summary* before performing any service procedures.

Do Not Service Alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect Power. To avoid electric shock, switch off the instrument power, then disconnect the power cord from the mains power.

Use Care When Servicing With Power On. Dangerous voltages or currents may exist in this product. Disconnect power and disconnect test leads before removing protective panels, soldering, or replacing components.

To avoid electric shock, do not touch exposed connections.

Preface

This is the service manual for the TDS5000 Digital Oscilloscope products. Read this preface to learn how this manual is structured, what conventions it uses, and where you can find other information related to servicing this product. Read the *Introduction* following this preface for safety and other important background information needed before using this manual for servicing this product.

Manual Structure

This manual is divided into chapters, which are made up of related subordinate topics. These topics can be cross referenced as sections.

Be sure to read the introductions to all procedures. These introductions provide important information needed to do the service correctly, safely, and efficiently.

Manual Conventions

This manual uses certain conventions that you should become familiar with before attempting service.

Modules

Throughout this manual, any replaceable component, assembly, or part is referred to by the term *module*. A module is composed of electrical and mechanical assemblies, circuit cards, interconnecting cables, and user-accessible controls.

Replaceable Parts

This manual refers to any field-replaceable assembly or mechanical part specifically by its name or generically as a replaceable part. In general, a replaceable part is any circuit board or assembly, such as the hard disk drive, or a mechanical part, such as the I/O port connectors, that is listed in the replaceable parts list of Chapter 10.

Safety

Symbols and terms related to safety appear in the *Service Safety Summary* found at the beginning of this manual.

Related Documentation

The oscilloscope is shipped with the following manuals:

- *TDS5000 User manual.* Tektronix part number 071-0876-XX.
- *TDS5000 Reference manual.* Tektronix part number 020-2398-XX.
- *TDS5000 Series Rackmount Kit (Option 1R) Instructions.* Tektronix part number 071-0971-XX.

Contacting Tektronix

Phone	1-800-833-9200*
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Web site	www.tektronix.com
Sales support	1-800-833-9200, select option 1*
Service support	1-800-833-9200, select option 2*
Technical support	Email: support@tektronix.com 1-800-833-9200, select option 3* 6:00 a.m. - 5:00 p.m. Pacific time

* **This phone number is toll free in North America. After office hours, please leave a voice mail message.
Outside North America, contact a Tektronix sales office or distributor; see the Tektronix web site for a list of offices.**

Specifications

This chapter contains the specifications for the TDS5000 series Digital Phosphor Oscilloscopes. All specifications are guaranteed unless labeled “typical”. Typical specifications are provided for your convenience but are not guaranteed. Specifications that are marked with the ✓ symbol are checked in chapter four, *Performance Verification*.

All specifications apply to all TDS5000 models unless noted otherwise. To meet specifications, the following conditions must be met:

- The oscilloscope must have been calibrated in an ambient temperature between 20 °C and 30 °C.
- The oscilloscope must be operating within the environmental limits listed in Table 1-10.
- The oscilloscope must be powered from a source that meets the specifications listed in Table 1-8.
- The oscilloscope must have been operating continuously for at least 20 minutes within the specified operating temperature range.
- You must perform the Signal Path Compensation procedure after the 20-minute warm-up period, and the ambient temperature must not change more than 5 °C without first repeating the procedure. See *Run the signal path compensation routine* on page 4-6 for instructions to perform this procedure.

Product and Feature Description

The TDS5000 series Digital Phosphor Oscilloscope family consists of the models shown in Table 1-1.

Table 1-1: TDS5000 models

Model	Number of channels	Bandwidth	Maximum sample rate (real time)
TDS5052	2	500 MHz	5 GS/s
TDS5054	4	500 MHz	5 GS/s
TDS5104	4	1 GHz	5 GS/s

Acquisition Features

Separate Digitizers. Ensure accurate timing measurements with separate digitizers for each channel. Acquisition on multiple channels is always concurrent and supports full bandwidth for single-shot acquisitions on each channel. The digitizers can also be combined to yield a higher sample rate on a single channel.

Fast Acquisition. Acquire up to 100,000 waveforms per second to see rapidly changing signals or intermittent signal irregularities.

Long Record Lengths. Choose record lengths from 500 points to up to 100,000 points per channel (up 400,000 points on a single channel). Extend the maximum record length up to a maximum of 8,000,000 points with memory options.

Peak Detect Acquisition Mode. See pulses as narrow as 400 ps even at the slower time base settings. Peak detect helps you see noise and glitches in your signal.

Acquisition Control. Acquire continuously or set up to capture single shot acquisitions. Enable or disable optional acquisition features such as equivalent time or roll mode.

Horizontal Delay. Use delay when you want to acquire a signal at a significant time interval after the trigger point. Toggle delay on and off to quickly compare the signal at two different points in time.

Signal Processing Features

Average, Envelope, and Hi Res Acquisition. Use Average acquisition mode to remove uncorrelated noise from your signal. Use Envelope to capture and display the maximum variation of the signal. Use Hi Res to increase vertical resolution for lower bandwidth signals.

Waveform Math. Set up simple math waveforms using the basic arithmetic functions including FFT, or create more advanced math waveforms using the optional math expression editor. Waveform expressions can even contain measurement results and other math waveforms.

Spectral Analysis. (Optional) Display spectral magnitude and phase waveforms based on your time-domain acquisitions. Control the oscilloscope using the traditional spectrum analyzer controls such as span and center frequency.

Display Features	Color LCD Display. Identify and differentiate waveforms easily with color coding. Waveforms, readouts, and inputs are color matched to increase productivity and reduce operating errors.
	Digital Phosphor. A Digital Phosphor Oscilloscope can clearly display intensity modulation in your signals. The oscilloscope automatically overlays subsequent acquisitions and then decays them to simulate the writing and decay of the phosphor in an analog oscilloscope CRT (cathode-ray tube). The feature results in an intensity-graded or color-graded waveform display that shows the information in the intensity modulation.
	Fit to Screen. The Digital Phosphor technology performs the compression required to represent all record points on the screen, even at the maximum record length settings.
	Zoom. To take advantage of the full resolution of the oscilloscope you can zoom in on a waveform to see the fine details. Both vertical and horizontal zoom functions are available.
Measurement Features	Cursors. Use cursors to take simple voltage, time, and frequency measurements.
	Automatic Measurements. Choose from a large palette of amplitude, time, and histogram measurements. You can customize the measurements by changing reference levels or by adding measurement gating.
Trigger Features	Simple and Advanced Trigger Types. Choose simple edge trigger or choose from eight advanced trigger types to help you capture a specific signal fault or event.
	Dual Triggers. Use the A (main) trigger system alone or add the B trigger to capture more complex events. You can use the A and B triggers together to set up a delay-by-time or delay-by-events trigger condition.
Convenience Features	Autoset. Use Autoset to quickly set up the vertical, horizontal, and trigger controls for a usable display.
	Touch Screen Interface. (Optional) You can operate all oscilloscope functions (except the power switch) from the touch screen interface. You can also install a mouse and keyboard to use the interface.

Toolbar or Menu Bar. You can choose a toolbar operating mode that is optimized for use with the touch screen, or a PC-style menu-bar operating mode that is optimized for use with a mouse.

Open Desktop. The oscilloscope is built on a Microsoft Windows software platform; the oscilloscope application program starts automatically when you apply power to the instrument. You can minimize the oscilloscope application and take full advantage of the built-in PC to run other applications. Moving waveform images and data into other applications is as simple as a copy/paste operation.

Dedicated Front Panel Controls. The front panel contains knobs and buttons to provide immediate access to the most common oscilloscope controls. Separate vertical controls are provided for each channel. The same functions are also available through the screen interface.

Data Storage and I/O. The oscilloscope has a removable hard disk drive, a floppy disk drive, and a CD-ROM reader or optional CD-R/W drive that can be used for storage and retrieval of data. The oscilloscope has GPIB, USB, Parallel, RS232, and Ethernet ports for input and output to other devices.

Online Help. The oscilloscope has a complete online help system that covers all its features. The help system is context sensitive; help for the displayed control window is automatically shown if you touch the help button. Graphical aids in the help windows assist you in getting to the information you need. You can also access the help topics through a table of contents or index.

Specification Tables

Table 1-2: Channel input and vertical specifications

Characteristic	Description
Input coupling	DC, AC, and GND
Input channels	Two or four, all identical
Input impedance, DC coupled	1 M Ω \pm 1.0% in parallel with 18 pF \pm 2 pF 50 Ω \pm 2.5% VSWR: TDS5052 and TDS5054: \leq 1.6:1 typical from DC to 500 MHz TDS5104 \leq 1.5:1 typical from DC to 1 GHz

Table 1-2: Channel input and vertical specifications (Cont.)

Characteristic	Description		
Maximum voltage at input BNC (1 M Ω)	150 V _{RMS} CAT I, and \leq 400 V peak For steady state sinusoidal waveforms, derate at 20 dB/decade above 200 kHz to 9 V _{RMS} at 3 MHz and above		
Maximum voltage at input BNC (50 Ω)	5 V _{RMS} , \pm 30 V peak		
✓ Differential delay at input BNC	\leq 100 ps between any two channels with the coupling settings and with the same scale settings \geq 10 mV/div		
Deskew, typical	\pm 75 ns		
✓ Channel-to-channel crosstalk	\geq 100:1 at 100 MHz, and \geq 30:1 at the rated bandwidth for any two channels with the same scale and coupling settings		
Digitizers	8-bit resolution, separate digitizers for each channel sample simultaneously		
Sensitivity range	1 M Ω : 1 mV/div to 10 V/div, in a 1-2-5 sequence 50 Ω : 1 mV/div to 1 V/div, in a 1-2-5 sequence Fine adjustment available with \leq 1% resolution		
✓ Analog bandwidth	DC 50 Ω coupling, bandwidth limit set to Full, operating ambient \leq 30 °C, derated by 2.5 MHz/°C above 30 °C		
		<i>SCALE range</i>	<i>Bandwidth</i>
	TDS5052/TDS5054	1 mV/div to 1.99 mV/div	DC to 175 MHz
		2 mV/div to 4.98 mV/div	DC to 300 MHz
		5 mV/div to 1 V/div	DC to 500 MHz
	TDS5104	1 mV/div to 1.99 mV/div	DC to 175 MHz
2 mV/div to 1 V/div		DC to 1 GHz	
Analog bandwidth limit, typical	Selectable between 20 MHz, 150 MHz, or Full		
Lower frequency limit, AC coupled	< 10 Hz for 1 M Ω , reduced by a factor of ten when using a 10X probe; <200 kHz for 50 Ω		

Table 1-2: Channel input and vertical specifications (Cont.)

Characteristic	Description		
Calculated rise time, typical	DC 50 Ω coupling, bandwidth limit set to Full		
		<i>SCALE range</i>	<i>Rise time</i>
	TDS5052/TDS5054	1 mV/div to 1.99 mV/div	2.29 ns
		2 mV/div to 4.98 mV/div	1.33 ns
		5 mV/div to 1 V/div	800 ps
	TDS5104	1 mV/div to 1.99 mV/div	2.29 ns
		2 mV/div to 1 V/div	400 ps
Step response settling errors, typical	Bandwidth limit set to Full		
	<i>SCALE range and step amplitude</i>	<i>Settling error at time after step</i>	
	1 mV/div to 99.5 mV/div, with ≤ 2 V step	20 ns: $\leq 0.5\%$	
		100 ns: $\leq 0.2\%$	
		20 ms: $\leq 0.1\%$	
100 mV/div to 1 V/div, with ≤ 20 V step	20 ns: $\leq 1.0\%$		
	100 ns: $\leq 0.5\%$		
	20 ms: $\leq 0.2\%$		
1.01 V/div to 10 V/div, with ≤ 200 V step	20 ns: $\leq 1.0\%$		
	100 ns: $\leq 0.5\%$		
	20 ms: $\leq 0.2\%$		

Table 1-2: Channel input and vertical specifications (Cont.)

Characteristic	Description	
Position range	± 5 divisions	
Offset range	1 M Ω coupling	
	<i>SCALE range</i>	<i>Offset range</i>
	1 mV/div to 99.5 mV/div	±1 V
	100 mV/div to 1V/div	±10 V
	1.01 V/div to 10 V/div	±100 V
TDS5052/5054	50 Ω coupling	
	<i>SCALE range</i>	<i>Offset range</i>
	1 mV/div to 99.5 mV/div	±1 V
	100 mV/div to 1 V/div	±10 V
TDS5104	50 Ω coupling	
	<i>SCALE range</i>	<i>Offset range</i>
	1 mV/div to 50 mV/div	±0.5 V
	50.5 mV/div to 99.5 mV/div	±0.25 V
	100 mV/div to 500 mV/div	±5 V
	505 mV/div to 1 V/div	±2.5 V
Offset accuracy	<i>SCALE range</i>	<i>Offset range</i>
	1 mV/div to 9.95 mV/div	±[(0.2% × net offset) + 1.5 mV + (0.1 div × V/div setting)]
	10 mV/div to 99.5 mV/div	±[(0.35% × net offset) + 1.5 mV + (0.1 div × V/div setting)]
	100 mV/div to 1.0 V/div	±[(0.35% × net offset) + 15 mV + (0.1 div × V/div setting)]
	1.01 V/div to 10 V/div	±[(0.25% × net offset) + 150 mV + (0.1 div × V/div setting)] At temperatures above 40 °C, ±[(0.75% × net offset) + 150 mV + (0.1 div × V/div setting)]
Offset accuracy	where, net offset = offset - (position × volts/division)	

Table 1-2: Channel input and vertical specifications (Cont.)

Characteristic	Description	
DC gain accuracy, Sample or Average acquisition mode	$\pm 1.5\% + 1.0\% \times \text{net offset /offset range} $ TDS5104: $\pm 3\% + 1.0\% \times \text{net offset /offset range} $ for 2 mV/div - 3.98 mV/div Refer to <i>Offset Range</i> specifications	
DC voltage measurement accuracy	<i>Measurement type</i>	<i>DC accuracy (in volts)</i>
Sample acquisition mode, typical	Absolute measurement of any waveform point, and High, Low, Max, and Min measurements	$\pm [1.5\% + 1.0\% \times \text{net offset /offset range} \times \text{reading} - \text{net offset} + \text{offset accuracy} + (0.13 \text{ div} \times \text{V/div setting}) + 0.6 \text{ mV}]$ TDS5104: 2 mV/div - 3.98 mV/div $\pm [1.5\% + 3.0\% \times \text{net offset /offset range} \times \text{reading} - \text{net offset} + \text{offset accuracy} + 0.13 \text{ div} \times \text{V/div setting} + 0.6 \text{ mV}]$
	Delta voltage measurement between any two points acquired under the same setup and ambient conditions, and all other automatic measurements	$\pm [1.5\% + 1.0\% \times \text{net offset /offset range} \times \text{reading} - \text{net offset} + (0.26 \text{ div} \times \text{V/div setting}) + 1.2 \text{ mV}]$ TDS5104: 2 mV/div - 3.98 mV/div $\pm [1.5\% + 3.0\% \times \text{net offset /offset range} \times \text{reading} - \text{net offset} + 0.26 \text{ div} \times \text{V/div setting} + 1.2 \text{ mV}]$
<i>where, net offset = offset - (position × volts/division)</i>		

Table 1-2: Channel input and vertical specifications (Cont.)

Characteristic	Description
✓ Average acquisition mode (≥ 16 averages)	<p>Absolute measurement of any waveform point, and High, Low, Max, and Min measurements</p> <p>$\pm[1.5\% + 1.0\% \times \text{net offset /offset range} \times \text{reading} - \text{net offset} + \text{offset accuracy} + 0.06 \text{ div} \times \text{V/div}]$</p> <p>TDS5104: 2 mV/div - 3.98 mV/div $\pm[1.5\% + 3.0\% \times \text{net offset /offset range} \times \text{reading} - \text{net offset} + \text{offset accuracy} + 0.06 \text{ div} \times \text{V/div}]$</p>
	<p>Delta voltage measurement between any two points acquired under the same setup and ambient conditions, and all other automatic measurements</p> <p>$\pm[1.5\% + 1.0\% \times \text{net offset /offset range} \times \text{reading} - \text{net offset} + (0.1 \text{ div} \times \text{V/div setting}) + 0.3 \text{ mV}]$</p> <p>TDS5104: 2 mV/div - 3.98 mV/div $\pm[1.5\% + 3.0\% \times \text{net offset /offset range} \times \text{reading} - \text{net offset} + 0.1 \text{ div} \times \text{V/div} + 0.3 \text{ mV}]$</p>
	<i>where, net offset = offset - (position \times volts/division)</i>
Nonlinearity, typical	< 1 LSB differential, < 1 LSB integral, independently based

Table 1-2: Channel input and vertical specifications (Cont.)

Characteristic	Description	
Effective bits, typical	Sine wave input at the indicated frequency and pk-pk amplitude, at 50 mV/division and 25 °C	
	<i>Signal and input conditions</i>	<i>Effective bits</i>
TDS5052, TDS5054	1 MHz, 9.2 div, 5 GS/s sample rate, Sample acquisition mode	6.8 bits
	1 MHz, 9.2 div, 10 MS/s sample rate, HiRes acquisition mode	9.1 bits
	500 MHz, 6.5 div, 5 GS/s sample rate, Sample acquisition mode	6.5 bits
TDS5104	1 MHz, 9.2 div, 5 GS/s sample rate, Sample acquisition mode	6.6 bits
	1 MHz, 9.2 div, 10 MS/s sample rate, HiRes acquisition mode	9.0 bits
	1 GHz, 6.5 div, 5 GS/s sample rate, Sample acquisition mode	4.7 bits

Table 1-3: Horizontal and acquisition system specifications

Characteristic	Description	
Acquisition modes	Sample, Peak detect, Hi Res, Average, and Envelope	
Acquisition rate	up to 100,000 waveforms per second in Fast Acquisition mode up to 130 waveforms per second with Fast Acquisition off	
Minimum record length	500 points	
Maximum record length	Depends on the number of active channels and the amount of memory installed	
Standard	100,000 points (3 or 4 channels) 200,000 points (1 or 2 channels) 400,000 points (1 channel)	
Option 1M installed	500,000 points (3 or 4 channels) 1,000,000 points (1 or 2 channels) 2,000,000 points (1 channel)	
Option 2M installed	2,000,000 points (3 or 4 channels) 4,000,000 points (1 or 2 channels) 8,000,000 points (1 channel)	
Real-time sample rate range	<i>Number of channels acquired</i>	<i>Sample rate range</i>
	1	1.25 S/s to 5 GS/s
	2	1.25 S/s to 2.5 GS/s
	3 or 4	1.25 S/s to 1.25 GS/s
Equivalent-time sample rate or interpolated waveform rate range	2.5 GS/s to 250 GS/s Equivalent-time acquisition can be enabled or disabled. When disabled, waveforms are interpolated at the fastest time base settings.	
Seconds/division range	200 ps/div to 40 s/div	
Horizontal delay range	16 ns to 250 s	
✓ Long term sample rate and delay time accuracy	±15 ppm over any ≥ 1 ms interval	
RMS aperture uncertainty, typical	≤ [3 ps + (0.1 ppm × record duration)]	

Table 1-3: Horizontal and acquisition system specifications (Cont.)

Characteristic	Description	
✓ Delta time measurement accuracy	For a single channel, with signal amplitude > 5 div, reference level set at 50%, interpolation set to sin(x)/x, volts/division set to ≥ 5 mV/div, with (displayed risetime)/(sample interval) ratio between 1.4 and 4, where sample interval = 1/(real-time sample rate)	
	<i>Conditions</i>	<i>Accuracy</i>
	Single shot signal, Sample or Hi Res acquisition mode, Full bandwidth	± (15 ppm × reading + 0.3 sample intervals)
	Average acquisition mode, ≥100 averages, Full bandwidth	± (15 ppm × reading + 20 ps)

Table 1-4: Trigger specifications

Characteristic	Description		
Auxiliary trigger input resistance, typical	$\geq 1.5 \text{ k}\Omega$		
Maximum trigger input voltage, typical	$\pm 20 \text{ V}$ (DC or peak AC)		
✓ Edge Trigger Sensitivity	<i>Trigger Source</i>		
	<i>Sensitivity</i>		
	TDS5052, TDS5054	Any channel, DC coupled	0.35 div from DC to 50 MHz, increasing to 1 div at 500 MHz
		Auxiliary input	400 mV from DC to 50 MHz, increasing to 750 mV at 100 MHz
	TDS5104	Any channel, DC coupled	0.35 div from DC to 50 MHz, increasing to 1 div at 1 GHz
		Auxiliary input	400 mV from DC to 50 MHz, increasing to 750 mV at 100 MHz
Edge trigger sensitivity, typical	All sources, for vertical scale settings $\geq 10 \text{ mV/div}$ and $\leq 1 \text{ V/div}$		
	<i>Trigger coupling</i>		
	<i>Sensitivity</i>		
	NOISE REJ	$3 \times$ the DC-coupled limits	
	AC	Same as DC-coupled limits for frequencies $\geq 60 \text{ Hz}$, attenuates signals $< 60 \text{ Hz}$	
	HF REJ	$1.5 \times$ the DC-coupled limits from DC to 30 kHz, attenuates signals $> 30 \text{ kHz}$	
Advanced trigger sensitivity, typical	LF REJ	$1.5 \times$ the DC-coupled limits for frequencies $\geq 80 \text{ kHz}$, attenuates signals $< 80 \text{ kHz}$	
	For all trigger types except Edge, with vertical scale settings $\geq 10 \text{ mV/div}$ and $\leq 1 \text{ V/div}$ 1.0 div, from DC to 500 MHz		
Event count sensitivity, typical	For sequential trigger delayed by events, with vertical scale settings $\geq 10 \text{ mV/div}$ and $\leq 1 \text{ V/div}$ 1.0 div, from DC to 500 MHz		

Table 1-4: Trigger specifications (Cont.)

Characteristic	Description	
Trigger level or threshold range	<i>Trigger Source</i>	
	Any channel	<i>Sensitivity</i> ±10 divisions from center of screen
	Auxiliary input	±8 V
	Line	fixed at zero volts
Trigger level or threshold accuracy, typical	Edge trigger, DC coupling, for signals having rise and fall times ≤20 ns	
	<i>Trigger Source</i>	
	Any channel	<i>Accuracy</i> ± [(2% × setting - net offset) + (0.3 div × volts/div setting) + offset accuracy]
	Auxiliary	Not calibrated or specified
	<i>where, net offset = offset - (position × volts/division)</i>	
Set level to 50% function	Operates with signals ≥30 Hz	
Trigger position error, typical	Edge trigger, DC coupling, for signals having a slew rate at the trigger point of ≥ 0.5 div/ns	
	<i>Acquisition mode</i>	
	Sample, Average	<i>Error</i> ± (1 displayed point + 1ns)
	Envelope	± (2 displayed points + 1ns)
Trigger jitter, typical	σ = 8 ps RMS	
B Event (Delayed) trigger	<i>Trigger After Time</i>	
	Range	<i>Trigger on nth Event</i> Delay time = 16 ns to 250 s Event count = 1 to 10 ⁷
	Minimum time between arm (A Event) and trigger (B Event), typical	2 ns from the end of the time period to the B trigger event 2 ns between the A trigger event and the first B trigger event
	Minimum pulse width, typical	— B event width ≥1 ns
	Maximum frequency, typical	— B event frequency ≤500 MHz

Table 1-4: Trigger specifications (Cont.)

Characteristic	Description	
Advanced trigger timing	For vertical scale settings ≥ 10 mV/div and ≤ 1 V/div	
	<i>Minimum recognizable event width or time</i>	<i>Minimum re-arm time to recognize next event</i>
Glitch type	Minimum glitch width = 1 ns	2 ns + 5% of glitch width setting
Runt or window type	Minimum runt width = 2 ns	2 ns
Runt or window type (time qualified)	Minimum runt width = 2 ns	8.5 ns + 5% of runt width setting
Runt or window type (logic qualified)	Minimum runt width = 2 ns	8.5 ns + 5% of runt width setting
Width type	Minimum difference between upper and lower limits = 1 ns	2 ns + 5% of upper limit setting
Timeout type	Minimum timeout time = 1 ns	2 ns + 5% of timeout setting
Transition type	Minimum transition time = 600 ps	8.5 ns + 5% of transition time setting
Pattern type, typical	Minimum time the pattern is true = 1 ns	1 ns
State type, typical	Minimum true time before clock edge = 1 ns	1 ns
	Minimum true time after clock edge = 1 ns	
Setup/Hold type, typical	<i>Minimum clock pulse width from active edge to inactive edge</i>	<i>Minimum clock pulse width from inactive edge to active edge</i>
	3 ns + hold time setting	2 ns
	<i>Setup and Hold parameters</i>	<i>Limits</i>
	Setup time (time from data transition to clock edge)	-100 ns minimum +100 ns maximum
	Hold time (time from clock edge to data transition)	-1 ns minimum +102 ns maximum
	Setup time + Hold time (algebraic sum of the two settings)	+2 ns minimum +202 ns maximum
Advanced trigger timer ranges	<i>Limits</i>	
Glitch type	1 ns to 1 s	
Runt or window type, wider than	1 ns to 1 s	

Table 1-4: Trigger specifications (Cont.)

Characteristic	Description	
Runt or window type, time qualified	1 ns to 1 s	
Width type	1 ns to 1 s	
Timeout type	1 ns to 1 s	
Transition type	1 ns to 1 s	
Pattern type	1 ns to 1 s	
Setup/Hold type	<i>Setup and Hold timers</i>	<i>Limits</i>
	Setup time (time from data transition to clock edge)	-100 ns to +100 ns
	Hold time (time from clock edge to data transition)	-1 ns to +100 ns
	Setup time + Hold time (algebraic sum of the two settings)	+2 ns to +200 ns
✓ Advanced trigger timer accuracy	For Glitch, Timeout, or Width types	
	<i>Time range</i>	<i>Accuracy</i>
	1 ns to 500 ns	±(20% of setting + 0.5 ns)
	520 ns to 1 s	±(0.01% of setting + 100 ns)
Trigger holdoff range	1.5 μs to 12 s, minimum resolution is 8 μs for settings ≤1.2 ms	

Table 1-5: Display specifications

Characteristic	Description
Display type	211.2 mm (W) × 158.4 mm (H), 264 mm (10.4 in) diagonal, liquid crystal active-matrix color display
Display resolution	640 horizontal × 480 vertical pixels
Pixel pitch	0.33 mm horizontal, 0.33 mm vertical
Contrast ratio, typical	150:1
Response time, typical	50 ms, black to white
Display refresh rate	59.94 frames per second
Displayed intensity levels	Supports Windows SVGA high-color mode (16- or 24-bit)

Table 1-6: Input/output port specifications

Characteristic	Description	
✓ Probe Compensator Output	Front-panel terminals	
	<i>Output voltage</i>	<i>Frequency</i>
	1.0 V (from base to top) ± 1.0% into a ≥ 10 kΩ load	1 kHz ± 5%
✓ Analog Signal Output amplitude	Rear-panel BNC connector, provides a buffered version of the signal that is attached to the channel 3 input 20 mV/div ± 20% into a 1 MΩ load 10 mV/div ± 20% into a 50 Ω load	
Analog Signal Output bandwidth, typical	100 MHz into a 50 Ω load	
✓ Auxiliary Output levels	Rear-panel BNC connector, provides a TTL-compatible, negative-polarity pulse for each A or B trigger (selectable)	
	<i>V_{out high}</i>	<i>V_{out low (true)}</i>
	≥2.5 V into open circuit, ≥1.0 V into 50 Ω load	≤0.7 V with ≤4 ma sink, ≤0.25 V into 50 Ω load
Auxiliary Output pulse width, typical	Pulse width varies, 1 μs minimum	
External Reference Input	Rear-panel BNC connector	
	9.8 MHz to 10.2 MHz	
	200 mV p-p to 7 V p-p	
	>1.5 kΩ in series with ~10 nF DC blocking capacitor	

Table 1-6: Input/output port specifications (Cont.)

Characteristic	Description
Side-panel I/O ports	Ports located on the rear panel
Parallel port (IEEE 1284)	DB-25 connector, supports the following modes: -standard (output only) bidirectional (PS-2 compatible) bidirectional enhanced parallel port (IEEE 1284 standard, mode 1 or mode 2, v 1.7) -bidirectional high-speed extended capabilities
Audio ports	Miniature phone jacks for stereo microphone input and stereo line output
USB port (2)	Allows connection or disconnection of USB keyboard, mouse and/or other devices while scope power is on
Keyboard port	PS-2 compatible, oscilloscope power must be off to make connection
Mouse port	PS-2 compatible, oscilloscope power must be off to make connection
LAN port	RJ-45 connector, supports 10 base-T and 100 base-T
Serial port	DB-9 COM1 port, uses NS16C550-compatible UARTS, transfer speeds up to 115.2 kb/s
SVGA video port	Upper video port, DB-15 female connector, connect a second monitor to use dual-monitor display mode, supports Basic requirements of PC99 specifications
GPIB port	IEEE 488.2 standard interface
Scope VGA video port	Lower video port, DB-15 female connector, 31.6 kHz sync, EIA RS-343A compliant, connect to show the oscilloscope display, including live waveforms, on an external monitor

Table 1-7: Data storage specifications

Characteristic	Description
CD-ROM	Side-panel CD-ROM drive, read only. CD R/W optional
Floppy disk	Front-panel 3.5 in floppy disk drive, 1.44 MB capacity
Hard disk	Internal hard disk drive, \geq 10 GB capacity

Table 1-8: Power source specifications

Characteristic	Description
Source voltage and frequency	100 to 240 V \pm 10%, 47 Hz to 63 Hz
Power consumption	\leq 220 Watts
Overvoltage Category	Overvoltage Category II (as defined in IEC61010-1/A2)

Table 1-9: Mechanical specifications

Characteristic	Description												
Weight													
Benchtop configuration	22 lbs (10 kg) oscilloscope only 55 lbs (25 kg) when packaged for domestic shipment												
Rackmount kit	4 lbs (1.8 kg) rackmount conversion kit 11 lbs (5 kg) kit packaged for domestic shipment												
Dimensions													
Benchtop configuration	11.2 in (284.5 mm) height, 12.8 in (325.1 mm) with feet extended 17.6 in (447 mm) width 11.35 in (288.3 mm) depth												
Rackmount configuration (Option 1R)	10.5 in (267 mm) height 19 in (483 mm) width 11.35 in (288.3 mm) depth												
Cooling	Fan-forced air circulation with no air filter.												
Required clearances	<table border="1"> <tbody> <tr> <td>Top</td> <td>0 in (0 mm)</td> </tr> <tr> <td>Bottom</td> <td>0.25 in minimum or 0 in (0 mm) when standing on the feet</td> </tr> <tr> <td>Left side</td> <td>3 in (76 mm)</td> </tr> <tr> <td>Right side</td> <td>0 in [5 in (126 mm) required to access CDROM]</td> </tr> <tr> <td>Front</td> <td>0 in (0 mm)</td> </tr> <tr> <td>Rear</td> <td>0 in (0 mm)</td> </tr> </tbody> </table>	Top	0 in (0 mm)	Bottom	0.25 in minimum or 0 in (0 mm) when standing on the feet	Left side	3 in (76 mm)	Right side	0 in [5 in (126 mm) required to access CDROM]	Front	0 in (0 mm)	Rear	0 in (0 mm)
Top	0 in (0 mm)												
Bottom	0.25 in minimum or 0 in (0 mm) when standing on the feet												
Left side	3 in (76 mm)												
Right side	0 in [5 in (126 mm) required to access CDROM]												
Front	0 in (0 mm)												
Rear	0 in (0 mm)												
Construction material	Chassis parts are constructed of aluminum alloy, front panel is constructed of plastic laminate, circuit boards are constructed of glass laminate, outer shell is molded and textured from a polycarbonate/ABS blend												

Table 1-10: Environmental specifications

Characteristic	Description
Temperature	
Operating	+5 °C to +45 °C
Nonoperating	-20 °C to +60 °C
Humidity	
Operating	20% to 80% relative humidity with a maximum wet bulb temperature of +29 °C at or below +45 °C, noncondensing Upper limit derated to 30% relative humidity at +45 °C
Nonoperating	With no diskette in floppy disk drive 5% to 90% relative humidity with a maximum wet bulb temperature of +29 °C at or below +60 °C, noncondensing Upper limit derated to 20% relative humidity at +60 °C
Altitude	
Operating	10,000 ft (3,048 m)
Nonoperating	40,000 ft (12, 190 m)
Random vibration	
Operating	0.22 g _{RMS} from 5 Hz to 500 Hz, 10 minutes on each axis
Nonoperating	2.28 g _{RMS} from 5 Hz to 500 Hz, 10 minutes on each axis
Shock, nonoperating	30 g (11 ms half-sine wave or less)

Table 1-11: Certifications and compliances

Category	Standards or description
EC Declaration of Conformity - EMC	<p>Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Union:</p> <p>EN 61326 Emissions ^{1, 3} Class A Radiated and Conducted Emissions</p> <p>EN 61326 Immunity ^{1, 2, 4}</p> <p>IEC 61000-4-2 Electrostatic Discharge Immunity ±4 kV contact discharge, ±8 kV air discharge, performance criterion B</p> <p>IEC 61000-4-3 RF field immunity 3 V/m, 80 MHz to 1 GHz, 80% amplitude modulated with a 1 kHz sinewave performance criterion A</p> <p>IEC 61000-4-4 Electrical Fast Transient/Burst Immunity 1 kV on AC mains, 500 V on I/O cables, performance criterion C</p> <p>IEC 61000-4-5 AC Surge Immunity 500 V differential mode, 1 kV common mode, performance criterion B</p> <p>IEC 61000-4-6 RF Conducted Immunity 3 V, 150 kHz to 80 MHz, amplitude modulated with a 1 kHz sinewave, performance criterion A</p> <p>IEC 61000-4-11 AC Mains Voltage Dips and Interruption Immunity 100% reduction for one cycle, performance criterion B</p> <p>EN 61000-3-2 Power Harmonic Current Emissions</p> <p>¹ If interconnect cables are used, they must be low-EMI shielded cables such as the following Tektronix part numbers or their equivalents: 012-0991-01, 012-0991-02 or 012-0991-03 GPIB Cable; 012-1213-00 (or CA part number 0294-9) RS-232 Cable; 012-1214-00 Centronics Cable; or LCOM part number CTL3VGAMM-5 VGA Cable.</p> <p>² The performance criteria for when the oscilloscope is subjected to the conditions described above are defined as follows: A — ≤0.2 division waveform displacement or ≤0.4 division increase in peak-to-peak noise B — temporary, self-recoverable degradation or loss of performance is allowed, but no change of actual operating state or loss of stored data is allowed C — temporary loss of function is allowed provided that the function is self recoverable or can be restored by the operation of the controls</p> <p>³ Radiated emissions may exceed the levels specified in EN 61326 when this oscilloscope is connected to a test object.</p> <p>⁴ USB mouse and keyboard only, performance criterion C. Normal USB keyboard or mouse operation can be restored by unplugging and reconnecting the USB connector to the oscilloscope. If the USB mouse, front-panel controls, or touch screen do not respond, press the On/Standby switch for five seconds to cycle power.</p>
FCC	Radiated and conducted emissions do not exceed the levels specified in FCC47 CFR, Part 15, Subpart B, for Class A equipment.

Table 1- 11: Certifications and compliances (cont.)

Category	Standards or description
EC Declaration of Conformity - Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Union: Low Voltage Directive 73/23/EEC, amended by 93/68/EEC EN 61010-1/A2:1995 Safety requirements for electrical equipment for measurement control and laboratory use.
U.S. Nationally Recognized Testing Laboratory Listing	UL3111-1, First Edition Standard for electrical measuring and test equipment.
Canadian Certification	CAN/CSA C22.2, No. 1010.1-92 Safety requirements for electrical equipment for measurement, control, and laboratory use.
Additional Compliance	IEC61010-1/A2 Safety requirements for electrical equipment for measurement, control, and laboratory use.
Installation (Overvoltage) Category	Terminals on this product may have different installation (overvoltage) category designations. The installation categories are: CAT III Distribution-level mains (usually permanently connected). Equipment at this level is typically in a fixed industrial location. CAT II Local-level mains (wall sockets). Equipment at this level includes appliances, portable tools, and similar products. Equipment is usually cord-connected. CAT I Secondary (signal level) or battery operated circuits of electronic equipment.
Pollution Degree	A measure of the contaminates that could occur in the environment around and within a product. Typically the internal environment inside a product is considered to be the same as the external. Products should be used only in the environment for which they are rated. Pollution Degree 2 Normally only dry, nonconductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service.
Safety Certification Compliance	
Equipment Type	Test and measuring
Safety Class	Class 1 (as defined in IEC 61010-1/A2) - grounded product
Pollution Degree	Pollution Degree 2 (as defined in IEC 61010-1/A2). Note: Rated for indoor use only.

Operating Information

This chapter covers installation information and basic operation instructions.

Installation

The basic operating software is already installed on the hard disk. Refer to *Software Installation* on page 2-5 for instructions on reinstalling the software.



CAUTION. *Be sure you have an emergency startup disk. You will need this disk if you ever have to reinstall the Windows operating system. Refer to Create an Emergency Startup Disk on page 2-4.*

Before You Start

Verify that all parts and accessories for the oscilloscope are available. Use the graphical packing list that came with the oscilloscope to determine the necessary parts and accessories. You should also verify that the following items are available:

- the correct power cords
- the product-software CD set that includes installation copies of the software installed on the oscilloscope
- all the accessories necessary to operate the oscilloscope

Environmental Considerations

The oscilloscope is designed to operate on a bench or on a cart in the normal position (on the bottom feet). For proper cooling, at least three inches (7.62 cm) of clearance is required on the left side of the oscilloscope. If you operate the oscilloscope while it is resting on the rear feet, make sure that you properly route any cables coming out of the rear of the oscilloscope to avoid damaging them.



CAUTION. *Keep the bottom and sides of the oscilloscope clear of obstructions to ensure proper cooling.*

Tables 1-8 and 1-10 on pages 1-19 and 1-20 list the operating requirements for the oscilloscope. Power source, temperature, humidity, and altitude are listed.

Connect the Peripherals

The peripheral connections are the same as those you would make on a personal computer. The connection points are shown in Figure 2-1 on page 2-3. See Table 2-1 for additional connection information.

Table 2-1: Additional accessory connection information

Item	Description
Monitor	If you use a non-standard monitor, you may need to change the the display settings to achieve the proper resolution for your monitor.
External Printer	Connect the printer to the EPP (enhanced parallel port) connector directly. If your printer has a DB-25 connector, use the adapter cable that came with your printer to connect to the EPP connector. For information on printer usage, see <i>Printing Waveforms</i> in your user oscilloscope manual.
Rackmount	Refer to the <i>TDS5000 Rackmount Installation Instructions</i> for information on installing the rackmount kit.
Other	Refer to the Application release notes on your product CD set for possible additional accessory installation information not covered in this manual.

NOTE. *We recommend that you plug USB devices directly into the USB connectors on the oscilloscope chassis for improved reliability rather than connecting the devices serially in a chain. If your mouse locks up, disconnect and reconnect the USB connector to restore normal operation. If the oscilloscope front panel and/or touch screen do not respond, press the On/Standby switch for at least 5 seconds to cycle power.*



WARNING. Before installing accessories to connectors (mouse, keyboard, etc.), power off the oscilloscope. See Powering Off the Oscilloscope on page 2-4.

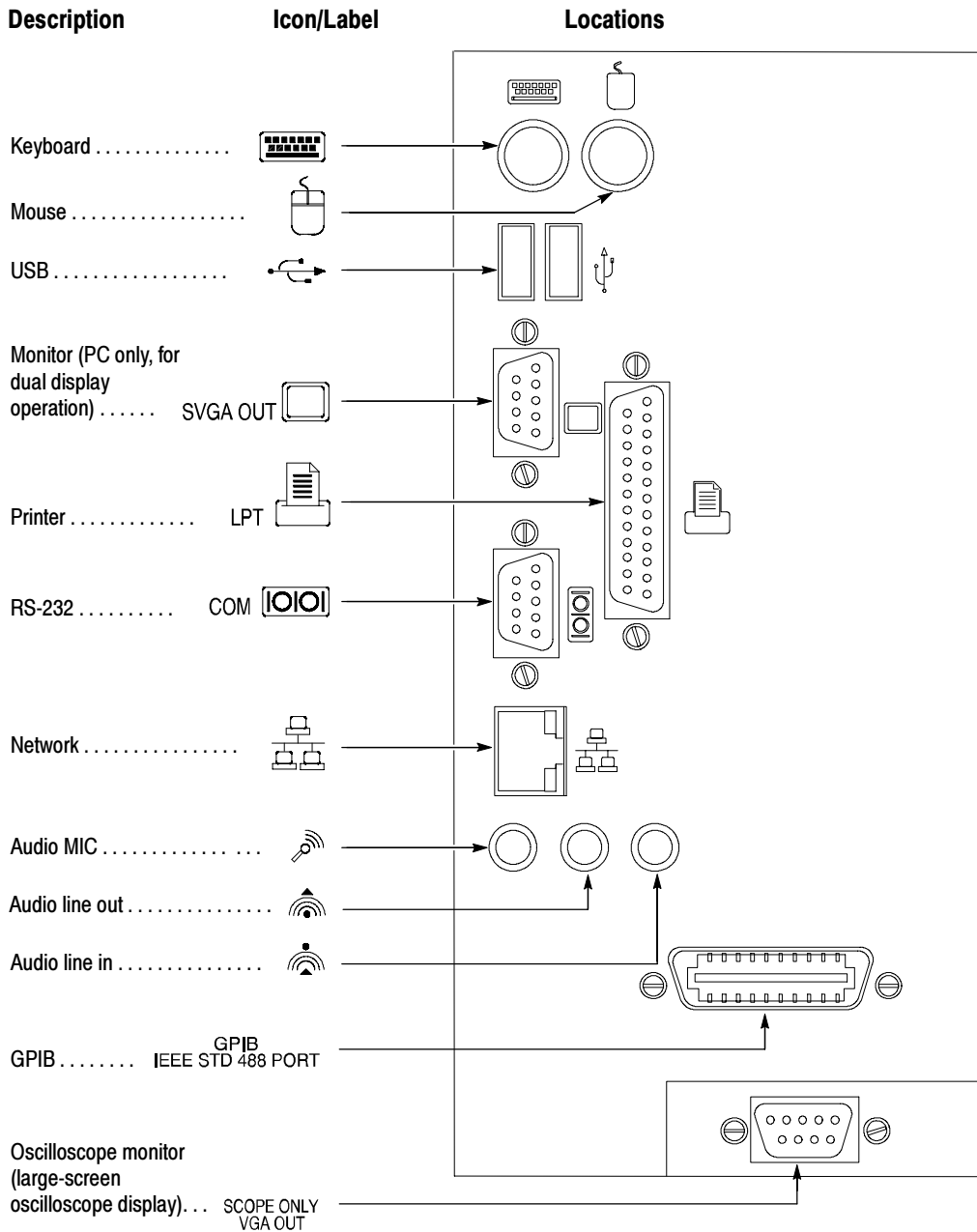


Figure 2-1: Locations of peripheral connectors on the side panel

Power On the Instrument

Follow these steps to power on the instrument.



CAUTION. Connect the keyboard, mouse, and other accessories before applying power to the product.

1. Connect the power cord.
2. If you have an external monitor, connect the power cord and power on the monitor.
3. Press the On/Standby switch to power on the instrument (see Figure 2-2 for the switch location).
4. Wait for the boot routine and low-level self test to complete.

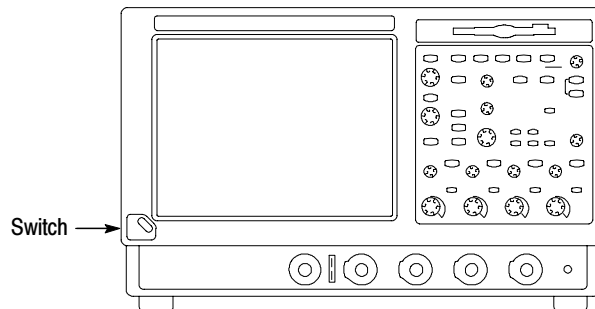


Figure 2-2: On/Standby switch location

Powering Off the Oscilloscope

The oscilloscope has a built-in soft power-off function that safely powers off the oscilloscope when you press the On/Standby switch.

To completely remove power to the instrument, press the On/Standby switch, and then remove the power cord from the rear panel.

Create an Emergency Startup Disk

Now that you have completed the basic installation process, you should create an emergency startup disk that you can use to restart your instrument in case of a major hardware or software failure. You should create this disk, and then store it in a safe place.



CAUTION. Create this disk and store it in a safe place. It may allow you to recover your Windows installation without rebuilding the entire instrument hard disk.

The emergency startup disk contains basic files to restart your instrument. It also contains files to check and format the hard disk.

Follow these steps to create the emergency startup disk:

1. Minimize the oscilloscope application: select Minimize from the File menu.
2. Select the Windows Start button, point to Settings, and then click Control Panel.
3. In the Control Panel, double-click Add/Remove Programs.
4. Click the Startup Disk tab.
5. Insert a floppy disk into the disk drive and follow the on-screen instructions to create the startup disk.

Software Installation

This section describes how to install the system software found on the product-software CD that accompanies this product. The instrument ships with the product software installed, so only perform these procedures if reinstallation becomes necessary.

Software Release Notes. Read the software release notes README.TXT ASCII file on the product-software CD before performing installation procedures. This file contains additional installation and operation information that supercedes other product documentation.

To view the README.TXT file, open the Notepad Windows accessory and open the file on the product-software CD. After installation, you can also read the copy from a directory on the product:

```
C:\Program Files\Tds5000\ReadMe.txt
```

Operating System Restoration. Use the procedure that accompanies your *Operating System Restore* CD should reinstalling system software become necessary.

The compact disc contains the files necessary to restore the Windows operating system and necessary drivers for the oscilloscope.

The Windows operating system and drivers are factory installed on the oscilloscope hard disk. The compact disc serves as a backup in the event that you have to rebuild the hard drive. You must restore the Windows operating system before you can install the oscilloscope firmware and other product software.

Application Installation. Use the procedures that accompany your *Product Software* CD should reinstalling the oscilloscope application software become necessary.

The compact disc contains the files necessary to restore the oscilloscope application and other software for the oscilloscope.

Software Lock for Upgrades. You can use the LockUpgrades utility to prevent users from installing unauthorized firmware upgrades on the instrument. This utility requires that a user enter a password before an upgrade can be installed. To use the utility, run the LockUpgrades .exe file, and follow the on-screen instructions. The LockUpgrades.exe file is in the following directory:

C:\Program Files\Tektronix\TekScope

NOTE. *Using the Operating System Restore CD to reinstall the operating system resets the LockUpgrades utility to the default setting and allows firmware upgrades without password protection.*

Operating Information

This section covers basic operation information so that you can operate and prepare to service the instrument.

Back Up User Files

You should always back up your user files on a regular basis. Use the Microsoft Backup tool to back up files stored on the hard disk. The Backup tool is located in the System Tools folder in the Accessories folder.

1. Minimize the oscilloscope application by selecting Minimize from the File menu.
2. Select the Windows Start button, point to Programs, Accessories, System Tools, and then click Backup.
3. Use the Microsoft Backup tool to select your backup media and to select the files and folders that you want to back up. Use the online help for information on using the Backup tool. You can back up to the floppy drive, or to a third-party storage device over the printer port (side panel).

User Interface Map

This section shows the main parts of the user interface.

Figure 2-3 shows the oscilloscope in the Menu bar mode. All features of the oscilloscope can be accessed through the menus using a mouse or the optional touch screen.

When the oscilloscope is in the Tool bar mode, most of the control windows can be accessed by touching buttons at the top of the display.

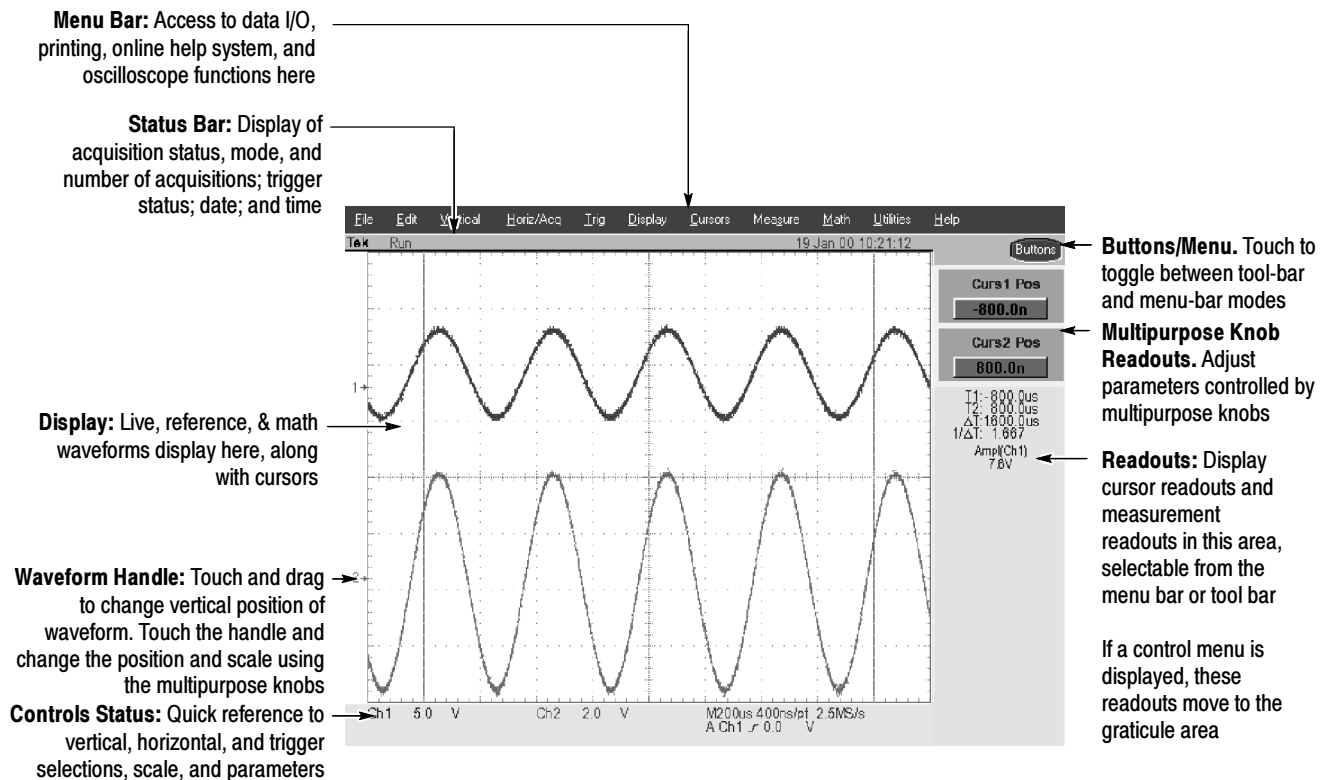


Figure 2-3: User interface

Front Panel I/O Map

Figure 2-4 shows the input/output connectors and floppy disk drive location.

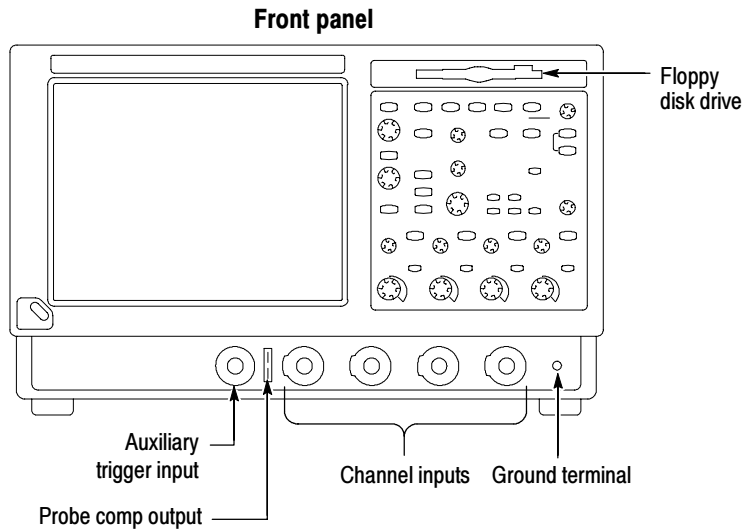


Figure 2-4: Locations of input/output connectors on the front panel

Rear Panel I/O Map

Figure 2-5 shows the input/output connectors on the rear panel.

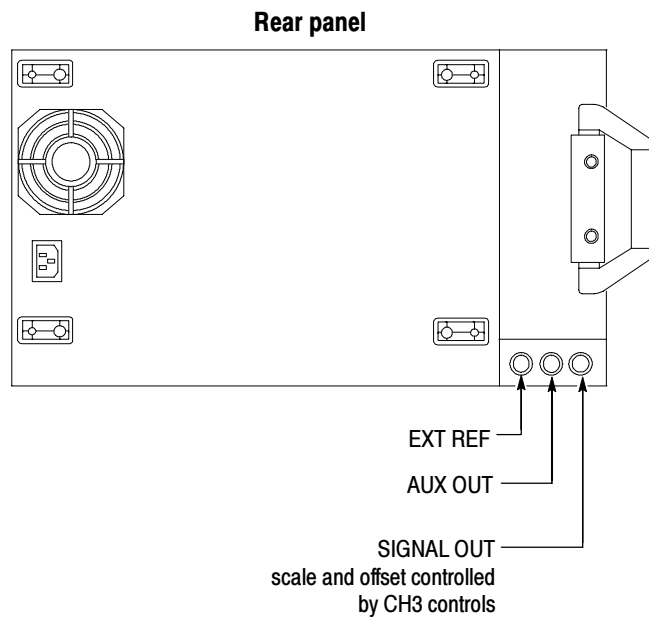


Figure 2-5: Locations of connectors on the rear panel

Front Panel Controls Map Many of the oscilloscope functions can be controlled directly from the front panel controls or in conjunction with the touch-screen interface.

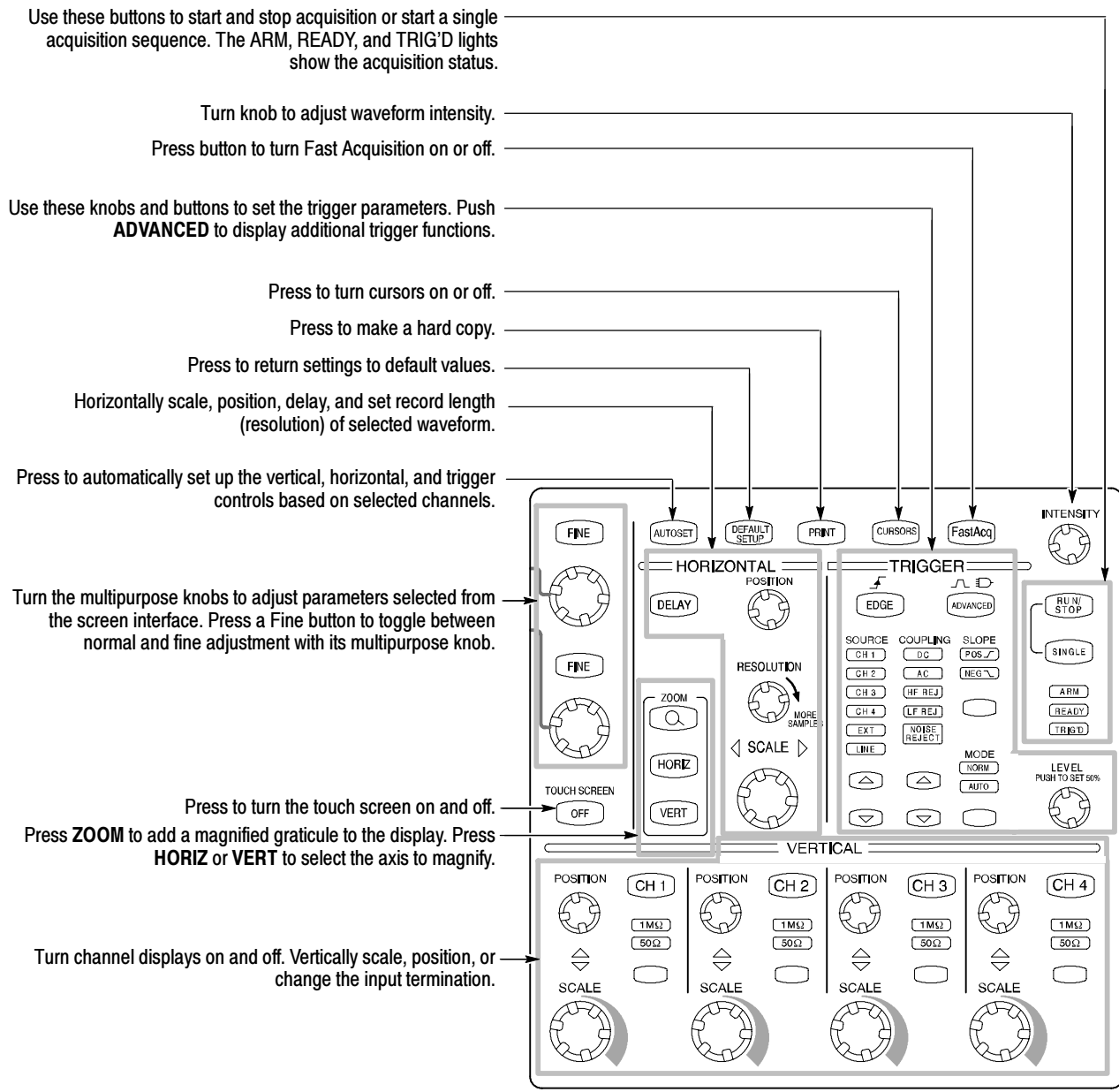


Figure 2-6: Front panel controls

Instrument Diagnostics

Do the following steps to verify the instrument passes the internal diagnostics.

1. Display the diagnostics menu:
 - If the oscilloscope is in tool bar mode, touch the **MENU** button to put the oscilloscope into the menu bar mode.
 - Select **Instrument Diagnostics . . .** from the **Utility** menu.
2. Run the diagnostics.
 - First disconnect any input signals from all four channels.
 - Touch the **Run** button in the diagnostics control window.
3. Wait for the diagnostics to complete.

The internal diagnostics do an exhaustive verification of proper oscilloscope function. This verification may take several minutes to complete. When the verification is finished, the resulting status will appear in the diagnostics control window.

4. Verify that no failures are found. If any failures occur, use the “DIAG:RESULTS:VERBOSE?” query for details on the errors.

Signal Path Compensation

Run the Signal Path Compensation.

NOTE. *The oscilloscope must be warmed up to operating temperature. Signal Path Compensation is not valid until the oscilloscope Calibration Status reaches Temp status.*

1. Select **Instrument Calibration . . .** from the **Utility** menu.
2. Verify that the instrument has had a twenty-minute warm-up before continuing.
3. Touch the **Calibrate** button to start the routine.
4. Wait for the test to complete (the test may take several minutes to complete).
5. Verify that the word **Pass** appears under the Status label in the control window.

Using the Online Help

The user manual represents only part of the assistance available to you — the online help system, integrated as part of the oscilloscope user interface, provides quick-to-access support for operating this oscilloscope.

Two types of online help are available, the oscilloscope online help and the GPIB online programmer's help. The oscilloscope online help provides information on all of the oscilloscope controls and procedures for doing typical tasks. The GPIB online programmer's help is normally installed on a remote PC and provides information for controlling the oscilloscope via the GPIB. This section mainly discusses the online help for the oscilloscope.

Accessing Help in the Tool Bar Mode. When the oscilloscope is in the tool bar mode, touch the Help button in the upper right corner of the screen to display help on whatever control window is displayed. From within the Help window, you can access other help through tabs, links, or buttons. You can also touch the Help Topics button to display the standard Windows Contents, Index, and Find tabs.

Accessing Help in the Menu Bar Mode. When the oscilloscope is in the menu bar mode, you can access the help system from the drop-down help menu. Select Help on Window to display help on the current control window. Select Contents and Index to display the standard Windows Contents, Index, and Find tabs. You can also select other topics from the Help menu such as information on Technical Support or product specifications.

Moving the Help Topics to View the Oscilloscope Display. You may temporarily move any displayed help out of the way while you change control window settings. Touch the Minimize button in the help window to shrink the help window to a button that displays in the upper right corner of the display (with the label Restore Help). Touch the Restore Help button to restore the help window to its normal size.

Theory of Operation

This section describes the electrical operation of the oscilloscope. Figure 9-1 on page 9-2 shows the module interconnections.

Logic Conventions

The oscilloscope contains many digital logic circuits. This manual refers to these circuits with standard logic symbols and terms. Unless otherwise stated, all logic functions are described using the positive-logic convention: the more positive of the two logic levels is the high (1) state, and the more negative level is the low (0) state. Signal states may also be described as “true” meaning their active state or “false” meaning their nonactive state. The specific voltages that constitute a high or low state vary among the electronic devices.

Module Overviews

Module overviews describe the basic operation of each functional circuit block as shown in Figure 9-1 on page 9-2.

General

A PC motherboard and microprocessor system controls the oscilloscope. The oscilloscope features a VGA resolution flat-panel display, an optional transparent touch screen, and a front-panel with direct access to commonly used oscilloscope functions. You can also use the oscilloscope with a mouse pointing device or keyboard.

Input Signal Path

A signal enters the oscilloscope through a direct coaxial connection to the input connector, or a probe connected to the front panel.

Acquisition Board. The acquisition board conditions the input signals, samples them, converts them to digital signals, and controls the acquisition process under direction of the processor system. The acquisition system includes the multi-source trigger, acquisition timebase, and acquisition-mode generation and control circuitry. The acquisition board is located in the bottom compartment of the oscilloscope. Two or four vertical channels are accommodated. All channels feature a Tekprobe Level 2 interface for additional front-end signal conditioning functions like high input-impedance real-time probes.

Processor System. The processor system uses a microprocessor that controls the acquisition system of the oscilloscope. The basic configuration supports two or

four input channels labeled Ch 1 through Ch 4, provides an external trigger input, a trigger output, a Ch 3 signal output, and a probe compensation output.

Each acquisition channel is equipped with a processor that connects to the PAI (Processor Acquisition Interface), which in turn communicates with the microprocessor over the PCI bus.

Display Panel

Waveforms and menus are displayed on a 10.4 inch, color, active-matrix LCD (liquid crystal display) with an optional integral touch panel.

Display System. Text and waveforms are processed by different parts of the display circuitry. The display system (display adapter board and inverter board) sends the text and waveform information to the display panel.

Touch Panel (Optional). The display board sends information from the touch panel to the processor. Any changes in settings are reported to the processor system.

Front Panel

The PC motherboard reads the front-panel switches and encoders. Any changes in their settings are reported to the processor system. The PC motherboard also turns the LEDs on and off.

Menu Switches. Front-panel menu switches are also read by the PC motherboard. The touch screen processor sends any changes in menu selections to the processor system. The **ON/STBY** switch passes through the PC Interface board to the PC motherboard. The PC motherboard creates the signal sent to the power supply to toggle power.

Floppy Drive. The floppy drive provides access to stored waveform data and software to customize your oscilloscope.

PC Interface Board. The PC Interface board provides fast access to the Acquisition board and the display system. The PC motherboard reads the front-panel switches and encoders and implements any changes requested by their settings. The PC Interface board provides a GPIB interface through a side panel connector.

PC Motherboard. The PC motherboard provides standard Windows functionality and I/O port interfaces to the rear panel.

Side Panels

The hard drive and CD-ROM provide access to stored waveform data and software to customize your oscilloscope with your measurement needs. The GPIB port allows for external control of the oscilloscope.

You can make hardcopies on the GPIB, RS-232, and Centronics ports. The PC Interface board includes a VGA connector for an external monitor to display the oscilloscope screen.

The PC motherboard has two USB ports and one serial port on the side panel. A microphone input and earphone output exist on the PC motherboard. The Ethernet connector is RJ-45. Keyboard and mouse are both PS/2.

Power Supply

The power supply is a switching power converter with active power factor control. It supplies power to all of the circuitry in the oscilloscope.

The **ON/STBY** switch, located on the front panel, controls all of the power to the oscilloscope except for part of the circuitry in the standby power supply.

The power supply sends a **Good** signal to the processor system when the power supply voltages are within specifications.

Power is distributed through the PC Interface board and the Disk Drive Adapter board connectors.

Fans

The fan assembly provides forced air cooling for the oscilloscope. The fans are controlled by the microprocessor.

Printer

The optional internal thermal printer allows for quick hard copies of the screen display. The printer receives power and USB signals from the PC Interface board.

Performance Verification

Two types of Performance Verification procedures can be performed on this product: *Brief Procedures* and *Performance Tests*. You may not need to perform all of these procedures, depending on what you want to accomplish.

- To rapidly confirm that the oscilloscope functions and was adjusted properly, just perform the brief procedures under *Self Tests*, which begin on page 4-5.

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 perform the *Self Tests* just mentioned; then do the brief procedures under *Functional Tests* that begin on page 4-6.

Advantages: These procedures require minimal additional time to perform, require no additional equipment other than a 10X probe such as a P5050, and more completely test the internal hardware of the 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 4-17, after doing the *Functional* and *Self Tests* mentioned above.

Advantages: These procedures add direct checking of the warranted specifications that are marked with the ✓ symbol. These procedures are fairly quick to execute but require specific test equipment. (See *Table 4-1: Test equipment* on page 4-18).

If you are not familiar with operating this oscilloscope, read the oscilloscope reference or user manuals or explore the online help.

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, as in the example step below:

Initialize the oscilloscope: Push the front-panel **DEFAULT SETUP** button.

- Where instructed to use a control in the display or a front-panel button or knob, the name of the control, button, or knob appears in boldface type. Where instructed to make or verify a setting, the value of the setting also appears in boldface type.

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

- The term “toolbar” refers to a row of buttons at the top of the display. The term “menu bar” refers to a row of menus at the top of the display. You can switch between toolbar and menu bar operating modes by pushing the button near the top right corner of the display. See Figure 4-1.

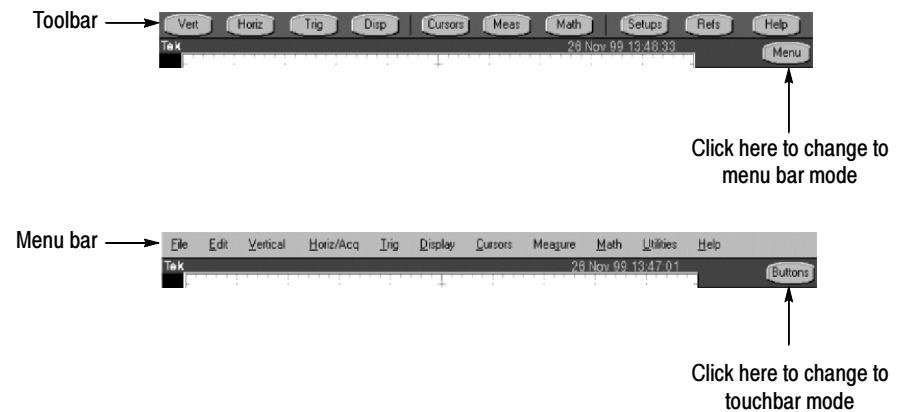


Figure 4-1: Toolbar and menu bar

- The procedures assume you have connected a mouse to the oscilloscope so you can click on the screen controls. If you have not connected a mouse, you can use the optional touch screen to operate all the screen controls.

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 10X probe, such as a P5050, is required to do these test procedures.

Self Tests

This procedure uses internal routines to verify that the 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 on the oscilloscope and allow a 20 minute warm-up before doing this procedure.

1. *Verify that internal diagnostics pass:* Do the following substeps to verify passing of internal diagnostics.
 - a. *Display the System diagnostics menu:*
 - If the oscilloscope is in toolbar mode, click the **MENU** button to put the oscilloscope into menu bar mode.
 - Pull down the **Utility** menu and select **Instrument Diagnostics. . . .** This displays the diagnostics control window.
 - b. *Run the System Diagnostics:*
 - First disconnect all input signals from the instrument.
 - Click the **Run** button in the diagnostics control window.
 - c. *Wait:* The internal diagnostics do an exhaustive verification of proper oscilloscope function. This verification may take several minutes. When the verification is finished, the resulting status will appear in the diagnostics control window.
 - d. *Verify that no failures are found and reported on-screen.* All tests should pass. If any failures occur, use the “DIAG:RESULTS:VERBOSE?” query for details on the errors.

- e. *Run the signal-path compensation routine:*
 - Pull down the **Utilities** menu and select **Instrument Calibration**. . . . This displays the instrument calibration control window.

NOTE. *Signal Path Compensation is not valid until the oscilloscope reaches a valid temperature. Calibration Status must be **Pass**.*

- Click the **Calibrate** button to start the routine.
 - f. *Wait:* Signal-path compensation may take ten minutes to run.
 - g. *Confirm signal-path compensation returns passed status:* Verify that the word **Pass** appears in the instrument calibration control window.
2. *Return to regular service:* Click the **Close** button to exit the instrument calibration control window.

Functional Tests

The purpose of these procedures is to confirm that the oscilloscope functions properly. The only equipment required is a 10X probe, such as a P5050, and to check the file system, a 3.5 inch, 720 K or 1.44 Mbyte, formatted floppy disk.

STOP. *These procedures verify functions; that is, they verify that the 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 4-17.

STOP. *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 front-panel or screen 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 10X oscilloscope probe, such as Tektronix P5050
Prerequisites	None

1. *Initialize the oscilloscope:* Push the front-panel **DEFAULT SETUP** button.
2. *Hook up the signal source:* Connect the probe to the probe compensation connector and the channel input that you want to test (beginning with CH 1) as shown in Figure 4-2.

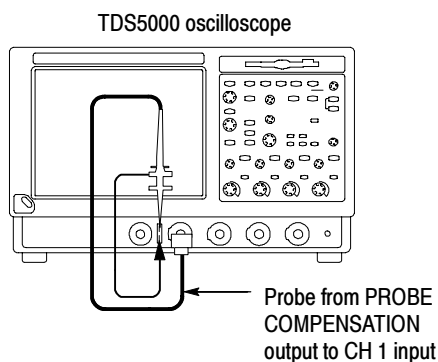


Figure 4-2: Universal test hookup for functional tests - CH 1 shown

3. *Turn off all channels:* If any of the front-panel channel buttons are lighted, push those buttons to turn off the displayed channels. See Figure 4-3.

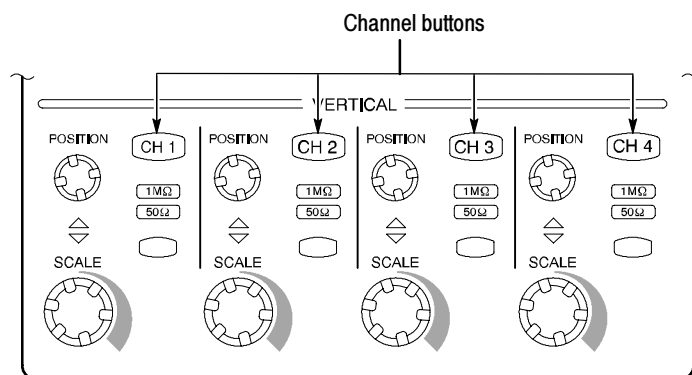


Figure 4-3: Channel button location

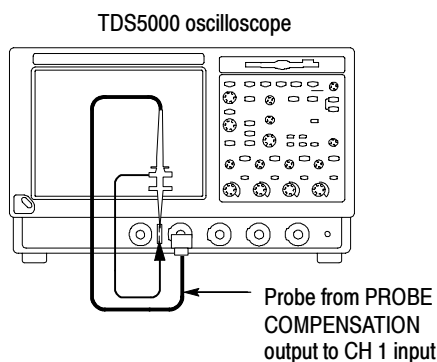
4. *Select the channel to test:* Push the channel button for the channel you are currently testing. The button lights and the channel display comes on.

5. *Set up the oscilloscope:* Push the front panel **AUTOSET** button. This sets the horizontal and vertical scale for a usable display and sets the trigger source to the channel you are testing.
6. *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 500 mV, and a square-wave probe-compensation signal about 2 divisions in amplitude is on-screen.
 - The front-panel vertical **POSITION** knob (for the channel you are testing) moves the signal up and down the screen when rotated.
 - Turning the vertical **SCALE** knob counterclockwise (for the channel you are testing) decreases the amplitude of the waveform on-screen, turning the knob clockwise increases the amplitude, and returning the knob to 500 mV returns the amplitude to about 2 divisions.
7. *Verify that the channel acquires in all acquisition modes:* Pull down the **Horiz/Acq** menu to select **Horizontal/Acquisition Setup**. . . . Click the **Acquisition** tab in the control window that displays. Click each of the five acquisition modes and confirm that the following statements are true.
 - Sample mode displays an actively acquiring waveform on-screen. (Note that there is a small amount of noise present on 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.
 - Average mode displays an actively acquiring waveform on-screen with the noise reduced.
 - Envelope mode displays an actively acquiring waveform on-screen with the noise displayed.
8. *Test all channels:* Repeat steps 2 through 7 until all input channels are verified.
9. *Remove the test hookup:* Disconnect the probe from the channel input and the probe compensation output.

Verify the Time Base

Equipment required	One 10X oscilloscope probe, such as Tektronix P5050
Prerequisites	None

1. *Initialize the oscilloscope:* Push the front-panel **DEFAULT SETUP** button.
2. *Hook up the signal source:* Connect the probe to the probe compensation output and to the CH 1 input as shown in Figure 4-4.

**Figure 4-4: Setup for time base test**

3. *Set up the oscilloscope:* Push the front panel **AUTOSET** button.
4. *Set the time base:* Set the horizontal **SCALE** to **200 μ s/div**. The time-base readout is displayed at the bottom of the graticule.
5. *Verify that the time base operates:* Confirm the following statements.
 - One period of the square-wave probe-compensation signal is about five horizontal divisions on-screen for the 200 μ s/div horizontal scale setting.
 - Rotating the horizontal **SCALE** knob clockwise expands the waveform on-screen (more horizontal divisions per waveform period), counter-clockwise rotation contracts it, and returning the horizontal scale to 200 μ s/div returns the period to about five divisions.
 - The horizontal **POSITION** knob positions the signal left and right on-screen when rotated.
6. *Verify horizontal delay:*
 - a. *Center a rising edge on screen:*
 - Set the horizontal **POSITION** knob so that the rising edge where the waveform is triggered is lined up with the center horizontal graticule.

- Change the horizontal **SCALE** to **20 $\mu\text{s}/\text{div}$** . The rising edge of the waveform should remain near the center graticule and the falling edge should be off screen.
- b. *Turn on and set horizontal delay:*
- Pull down the **Horiz/Acq** menu to select **Horizontal/Acquisition Setup. . . .**
 - Click the **Horizontal** tab in the control window that displays.
 - Click the **Delay Mode** button to turn delay on.
 - Double click the **Horiz Delay** control in the control window to display the pop-up keypad. Click the keypad buttons to set the horizontal delay to **500 μs** and then click the **ENTER** key.
- c. *Verify the waveform:* Verify that a falling edge of the waveform is within a few divisions of center screen.
- d. *Adjust the horizontal delay:* Rotate the upper multipurpose knob to change the horizontal delay setting. Verify that the falling edge shifts horizontally. Rotate the front-panel horizontal **POSITION** knob. Verify that this knob has the same effect (it also adjusts delay, but only when delay mode is on).
- e. *Verify the delay toggle function:*
- Rotate the front-panel horizontal **POSITION** knob to center the falling edge horizontally on the screen.
 - Change the horizontal **SCALE** to **40 ns/div**. The falling edge of the waveform should remain near the center graticule. If not, readjust the delay setting to center the falling edge.
 - Push the front-panel **DELAY** button several times to toggle delay off and on and back off again. Verify that the display switches quickly between two different points in time (the rising and falling edges of this signal).
7. *Remove the test hookup:* Disconnect the probe from the channel input and the probe compensation output.

Verify the A (Main) and B (Delayed) Trigger Systems

Equipment required	One 10X oscilloscope probe, such as Tektronix P5050
Prerequisites	None

1. *Initialize the oscilloscope:* Push the front-panel **DEFAULT SETUP** button.
2. *Hook up the signal source:* Connect the probe to the probe compensation output and to the CH 1 input as shown in Figure 4-5.

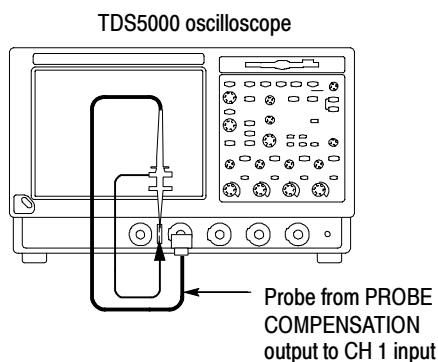


Figure 4-5: Setup for trigger test

3. *Set up the oscilloscope:* Push the front-panel **AUTOSET** button.
4. *Verify that the main trigger system operates:* Confirm that the following statements are true.
 - The trigger level readout for the A (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 *untriggered*).
 - Pushing the front-panel trigger **LEVEL** knob sets the trigger level to the 50% amplitude point of the signal and triggers the signal that you just left untriggered. (Leave the signal triggered.)

5. *Verify that the delayed trigger system operates:*
 - a. *Set up the delayed trigger:*
 - Pull down the **Trig** menu and select **A — B Trigger Sequence. . .**. This displays the A→B Sequence tab of the trigger setup control window.
 - Click the **Trig After Time** button under A Then B.
 - Click the **B Trig Level** control in the control window.
 - Set the Trigger MODE to **NORM**.
 - b. *Confirm that the following statements are true:*
 - The trigger-level readout for the B trigger system changes as you turn the lower multipurpose knob.
 - As you rotate the lower multipurpose knob, the square-wave probe-compensation signal can become triggered and untriggered. (Leave the signal triggered.)
 - c. *Verify the delayed trigger counter:*
 - Double click the **Trig Delay** control to pop up a numeric keypad for that control.
 - Click on the keypad to enter a trigger delay time of **1 second** and then click **Enter**.
 - Verify that the trigger **TRIG'D** indicator on the front panel flashes about once every second as the waveform is updated on-screen.
6. *Remove the test hookup:* Disconnect the probe from the channel input and the probe compensation output.

Verify the File System

Equipment required	One 10X oscilloscope probe, such as Tektronix P5050 One 720 K or 1.44 Mbyte, 3.5 inch DOS-compatible formatted disk.
Prerequisites	None

1. *Initialize the oscilloscope:* Push the front-panel **DEFAULT SETUP** button.
2. *Hook up the signal source:* Connect the probe to the probe compensation output and the CH 1 input as shown in Figure 4-6.

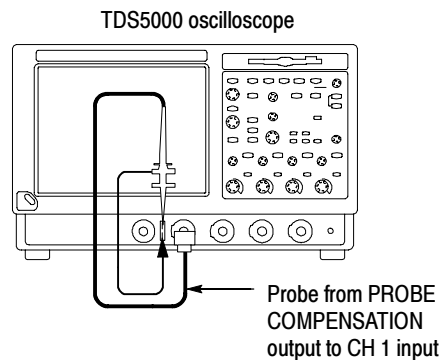


Figure 4-6: Setup for the file system test

3. *Insert the test disk:* Insert the floppy disk in the floppy disk drive at the top of the front panel.
4. *Set up the oscilloscope:* Push the front panel **AUTOSET** button.
5. *Set the time base:* Set the horizontal **SCALE** to **1 ms/div**. The time-base readout is displayed at the bottom of the graticule.
6. *Save the settings:*
 - a. Pull down the **File** menu to select **Instrument Setup. . .** This displays the instrument setups control window.
 - b. Click the **Save** button under Save settings to file in the control window. This displays a familiar Windows dialog box for choosing a destination directory naming the file.
 - c. In the Save Instrument Setups As dialog box, select the **3^{1/2} Floppy (A:)** icon in the **Save in:** drop-down list to set the save destination to the floppy disk.
 - d. Note the default file name and then click the **Save** button to save the setup to the default file name.
7. *Change the settings again:* Set the horizontal **SCALE** to **200 μ s/div**.
8. *Verify the file system works:*
 - a. Click the **Recall Setups** tab in the control window.
 - b. Click the **Recall** button under Recall settings from file in the control window. This displays a familiar Windows dialog box for locating the settings file that you want to recall.
 - c. In the Recall Save Instrument Setups From dialog box, select the **3^{1/2} Floppy (A:)** icon in the **Look in:** drop-down list.

- d. Locate and then double click in the dialog box on the setup file that you previously stored.
 - e. Verify that the oscilloscope retrieved the saved setup from the disk. Do this by noticing the horizontal **SCALE** is again 1 ms and the waveform shows ten cycles just as it did when you saved the setup.
9. *Remove the test hookup:*
- a. Disconnect the probe from the channel input and the probe compensation output.
 - b. Remove the floppy disk from the floppy disk drive.

**Verify the Internal Printer
(Optional)**

Equipment required	Integrated Thermal Printer (Option 1P)
Prerequisites	None

1. From the Windows desktop, open the Control Panel.
2. Open the Printers file.
3. Right-click on the Integrated Thermal Printer icon and select Properties.
4. Click on the General tab.
5. Click Print Test Page.
6. Verify that the test page advances through the printer and prints clearly. Refer to Figure 4-7 on page 4-15 for a sample of the test page.



Windows Millennium Edition

Congratulations!

If you can read this information, you have correctly installed your Integrated Thermal Printer.

The information below describes your printer driver and port settings.

Printer name: Integrated Thermal Printer
 Printer model: Integrated Thermal Printer
 Driver name: ITP.DRV
 Driver version: 4.00
 Color support: No
 Port name: LPTUSB001:
 Data format: RAW

Files used by this driver:
 C:\WINDOWS\SYSTEM\ITP.DRV (GPC
 257.5308840)
 C:\WINDOWS\SYSTEM\UNIDRV.DLL (4.90.3000)
 C:\WINDOWS\SYSTEM\UNIDRV.HLP
 C:\WINDOWS\SYSTEM\ICONLIB.DLL (4.90.3000)

This is the end of the printer test page.

Figure 4-7: Test page from the internal printer

Performance Tests

This section contains a collection of manual procedures for checking that the TDS5000 Series Oscilloscopes perform as warranted. The preceding procedures are faster to complete, and should be done first if you intend to perform the performance tests.

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 *Specifications*. (The characteristics that are checked appear with a ✓ in *Specifications*).

STOP. *These procedures extend the confidence level provided by the basic procedures described on page 4-5. The basic procedures should be done first, then these procedures performed if desired.*

Prerequisites

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

- The cabinet must be installed on the oscilloscope.
- You must have performed and passed the procedures under *Self Tests*, found on page 4-5, and those under *Functional Tests*, found on page 4-6.
- A signal-path compensation must have been 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 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 as listed in Table 1-10. (The warm-up requirement is usually met in the course of meeting the Self Tests and Functional Tests prerequisites listed above).

Equipment Required

The procedures starting on page 4–23 use external, traceable signal sources to directly check warranted characteristics. Table 4–1 lists the required equipment.

Table 4-1: 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. Adapter, BNC female-to-Clip Leads	BNC female-to-Clip Leads	Tektronix part number 013-0076-00	Signal Coupling for Probe Compensator Output Check
4. Terminator, 50 Ω	Impedance 50 Ω ; connectors: female BNC input, male BNC output	Tektronix part number 011-0049-01	Signal Termination for Channel Delay Test
5. Cable, Precision 50 Ω Coaxial (three required)	50 Ω , 36 in, male-to-male BNC connectors	Tektronix part number 012-0482-00	Signal Interconnection
6. Connector, Dual-Banana (two required)	Female BNC-to-dual banana	Tektronix part number 103-0090-00	Various Accuracy Tests
7. Connector, BNC "T"	Male BNC-to-dual female BNC	Tektronix part number 103-0030-00	Checking Trigger Sensitivity
8. Coupler, Dual-Input	Female BNC-to-dual male BNC	Tektronix part number 067-0525-02	Checking Delay Between Channels
9. Probe, 10X	A P5050, P6243, or P6245 probe ³	Tektronix part number P5050 or P6245	Signal Interconnection
10. Floppy disk	3.5 inch, 720 K or 1.44 Mbyte, DOS-compatible floppy disk	Standard IBM PC-compatible disk	Checking File System Basic Functionality
11. Generator, DC Calibration	Variable amplitude to ± 104 V; accuracy to 0.1%	Wavetek 9500 ¹	Checking DC Offset, Gain, and Measurement Accuracy
12. Generator, Calibration	500 mV square wave calibrator amplitude; accuracy to 0.25%	Wavetek 9500 ¹	To check accuracy of Signal Out
13. Generator, Time Mark (optional)	Variable marker frequency from 10 ms to 10 ns; accuracy within 2 ppm	Wavetek 9500 ¹	Checking Sample-Rate and Delay-time Accuracy
14. Generator, Sine Wave	250 kHz to at least 500 MHz (higher for higher-bandwidth oscilloscopes). Variable amplitude from 60 mV to 2 V_{p-p} into 50 Ω . Frequency error >2.0%	Wavetek 9500 ¹	Checking Analog Bandwidth, Trigger Sensitivity, Sample-rate, External Clock, and Delay-Time Accuracy
15. Meter, Level and Power Sensor	Frequency range: 10 MHz to the oscilloscope bandwidth. Amplitude range: 6 mV _{p-p} to 2 V _{p-p}	Wavetek 9500 ¹	Checking Analog Bandwidth and Trigger Sensitivity

Table 4-1: Test equipment (Cont.)

Item number and description	Minimum requirements	Example	Purpose
16. Splitter, Power	Frequency range: DC to 4 GHz. Tracking: >2.0%	Wavetek 9500 ¹	Checking Analog Bandwidth
17. Adapter (three required)	SMA female-to-female	Tektronix part number 015-1012-00	Checking the delay between channels
18. Adapter (three required)	SMA male-to-female BNC	Tektronix part number 015-1018-00	Checking the delay between channels
19. Pulse Generator	250 MHz, ≤ 1 ns rise time, 5 V out	Wavetek 9500 ^{1,2}	Used to Test Delta Time Measurement Accuracy
20. Cable, Coaxial (two required)	50 Ω , 20 in, male-to-male SMA connectors	Tektronix part number 174-1427-00	Used to Test Delta Time Measurement Accuracy
21. Adapter (four required)	Male N-to-female BNC	Tektronix part number 103-0045-00	Checking Analog Bandwidth
22. Adapter	Female N-to-male BNC	Tektronix part number 103-0058-00	Checking Analog Bandwidth
23. Adapter	SMA "T", male to 2 SMA female	Tektronix part number 015-1016-00	Used to Test Delta Time Measurement Accuracy
24. Adapter	SMA female to BNC male	Tektronix part number 015-0572-00	Used to Test Delta Time Measurement Accuracy
25. Adapter	BNC male to female elbow	Tektronix part number 103-0031-00	Used to Test Delta Time Measurement Accuracy
26. Adapter	BNC female to clip lead	Tektronix part number 013-0076-00	Used to Test Probe Compensation Output
27. Terminator	Short circuit, SMA connector	Tektronix part number 015-1021-00	Used to Test Delta Time Measurement Accuracy
28. Attenuator, 2X	Ratio: 2X; impedance 50 Ω ; connectors: female BNC input, male BNC output	Tektronix part number 011-0069-02	Used to Test Delta Time Measurement Accuracy
29. Mouse or keyboard		Tektronix part numbers: 119-6298-xx (mouse) 119-6297-xx (keyboard)	Used to input test selections

¹ Wavetek 9500 with option 100 and an output head (9520, 9530, or 9550) appropriate for the bandwidth of the oscilloscope being tested.

² For Delta Time Measurement Accuracy, use a Wavetek 9500 or a pulse generator with a rise time as shown in Table 4-4 on page 4-43.

³ Warning: The P6243 and P6245 probes that may be used with this oscilloscope provide an extremely low loading capacitance (<1 pF) to ensure the best possible signal reproduction. These probes should not be used to measure signals exceeding ± 8 V, or errors in signal measurement will be observed. Above 40 V, damage to the probe may result. To make measurements beyond ± 8 V, use either the P5050 probe (good to 500 V), or refer to the catalog for a recommended probe.

TDS5000 Test Record

Photocopy this table and use it to record the performance test results for your TDS5000 Series Oscilloscope.

TDS 5000 Test Record

Instrument Serial Number: _____ Certificate Number: _____
 Temperature: _____ RH %: _____
 Date of Calibration: _____ Technician: _____

TDS5000 performance test		Minimum	Incoming	Outgoing	Maximum
DC voltage measurement accuracy (averaged)					
CH1	5 mV Vert scale setting, -5 Div position setting, +1 V offset	+ 1.0353 V	_____	_____	+ 1.0447 V
CH1	5 mV Vert scale setting, +5 Div position setting, -1 V offset	- 1.0447 V	_____	_____	- 1.0353 V
CH1	200 mV Vert scale setting, -5 Div position setting, +10 V offset	+ 11.4989 V	_____	_____	+ 11.7011 V
CH1	200 mV Vert scale setting, +5 Div position setting, -10 V offset	- 11.7011 V	_____	_____	- 11.4989 V
CH1	1.01 V Vert scale setting, -5 Div position setting, +10 V offset	+ 17.602 V	_____	_____	+ 18.398 V
CH1	1.01 V Vert scale setting, +5 Div position setting, -10 V offset	- 18.398 V	_____	_____	- 17.602 V
CH2	5 mV Vert scale setting, -5 Div position setting, +1 V offset	+ 1.0353 V	_____	_____	+ 1.0447 V
CH2	5 mV Vert scale setting, +5 Div position setting, -1 V offset	- 1.0447 V	_____	_____	- 1.0353 V
CH2	200 mV Vert scale setting, -5 Div position setting, +10 V offset	+ 11.4989 V	_____	_____	+ 11.7011 V
CH2	200 mV Vert scale setting, +5 Div position setting, -10 V offset	- 11.7011 V	_____	_____	- 11.4989 V
CH2	1.01 V Vert scale setting, -5 Div position setting, +10 V offset	+ 17.602 V	_____	_____	+ 18.398 V
CH2	1.01 V Vert scale setting, +5 Div position setting, -10 V offset	- 18.398 V	_____	_____	- 17.602 V
CH3	5 mV Vert scale setting, -5 Div position setting, +1 V offset	+ 1.0353 V	_____	_____	+ 1.0447 V
CH3	5 mV Vert scale setting, +5 Div position setting, -1 V offset	- 1.0447 V	_____	_____	- 1.0353 V
CH3	200 mV Vert scale setting, -5 Div position setting, +10 V offset	+ 11.4989 V	_____	_____	+ 11.7011 V

TDS 5000 Test Record (cont.)

Instrument Serial Number: _____ Certificate Number: _____
 Temperature: _____ RH %: _____
 Date of Calibration: _____ Technician: _____

TDS5000 performance test		Minimum	Incoming	Outgoing	Maximum
CH3	200 mV Vert scale setting, +5 Div position setting, -10 V offset	- 11.7011 V	_____	_____	- 11.4989 V
CH3	1.01 V Vert scale setting, -5 Div position setting, +10 V offset	+ 17.602 V	_____	_____	+ 18.398 V
CH3	1.01 V Vert scale setting, +5 Div position setting, -10 V offset	- 18.398 V	_____	_____	- 17.602 V
CH4	5 mV Vert scale setting, -5 Div position setting, +1 V offset	+ 1.0353 V	_____	_____	+ 1.0447 V
CH4	5 mV Vert scale setting, +5 Div position setting, -1 V offset	- 1.0447 V	_____	_____	- 1.0353 V
CH4	200 mV Vert scale setting, -5 Div position setting, +10 V offset	+ 11.4989 V	_____	_____	+ 11.7011 V
CH4	200 mV Vert scale setting, +5 Div position setting, -10 V offset	- 11.7011 V	_____	_____	- 11.4989 V
CH4	1.01 V Vert scale setting, -5 Div position setting, +10 V offset	+ 17.602 V	_____	_____	+ 18.398 V
CH4	1.01 V Vert scale setting, +5 Div position setting, -10 V offset	- 18.398 V	_____	_____	- 17.602 V
Analog bandwidth					
CH1	100 mV	424 mV	_____	_____	N/A
CH2	100 mV	424 mV	_____	_____	N/A
CH3	100 mV	424 mV	_____	_____	N/A
CH4	100 mV	424 mV	_____	_____	N/A
Delay between channels		N/A	_____	_____	100 ps
Channel isolation 100 MHz					
	CH 1	N/A	_____	_____	0.08 divisions
	CH 2	N/A	_____	_____	0.08 divisions
	CH 3	N/A	_____	_____	0.08 divisions
	CH 4	N/A	_____	_____	0.08 divisions
full bandwidth					
	CH 1	N/A	_____	_____	0.16 divisions
	CH 2	N/A	_____	_____	0.16 divisions
	CH 3	N/A	_____	_____	0.16 divisions
	CH 4	N/A	_____	_____	0.16 divisions
Time base system					
Long term sample rate and delay time accuracy @ 100 ns/10.0 ms		-1.5 divisions	_____	_____	+1.5 divisions

Performance Tests

TDS 5000 Test Record (cont.)

Instrument Serial Number: _____ Certificate Number: _____
 Temperature: _____ RH %: _____
 Date of Calibration: _____ Technician: _____

TDS5000 performance test	Minimum	Incoming	Outgoing	Maximum
Delta time measurement	N/A			Pass/Fail
Trigger system accuracy				
Time accuracy for pulse, glitch, timeout, and Width, Hor. scale $\leq 1 \mu\text{s}$				
Lower Limit	3.5 ns	_____	_____	6.5 ns
Upper Limit	3.5 ns	_____	_____	6.5 ns
Time accuracy for pulse, glitch, timeout, and width, Hor. scale $> 1 \mu\text{s}$				
Lower Limit	1.9 μs	_____	_____	2.1 μs
Upper Limit	1.9 μs	_____	_____	2.1 μs
CH1 trigger sensitivity, 50 MHz	Pass/Fail	_____	_____	Pass/Fail
CH1 delayed trigger sensitivity, 50 MHz	Pass/Fail	_____	_____	Pass/Fail
CH1 AUX trigger input, 50 MHz	Pass/Fail	_____	_____	Pass/Fail
CH1 trigger sensitivity, full bandwidth	Pass/Fail	_____	_____	Pass/Fail
CH1 delayed trigger sensitivity, full bandwidth	Pass/Fail	_____	_____	Pass/Fail
CH1 AUX trigger input, 100 MHz	Pass/Fail	_____	_____	Pass/Fail
Output signal checks				
Auxiliary trigger output, open circuit				
High	High $\geq 2.5 \text{ V}$	_____	_____	Low $\leq 0.7 \text{ V}$
Low		_____	_____	
Auxiliary trigger output, 50 Ω				
High	High $\geq 1.0 \text{ V}$	_____	_____	Low $\leq 0.25 \text{ V}$
Low		_____	_____	
Analog signal output, 1 M Ω	p-p $\geq 80 \text{ mV}$	_____	_____	p-p $\leq 120 \text{ mV}$
Analog signal output, 50 Ω	p-p $\geq 44 \text{ mV}$	_____	_____	p-p $\leq 66 \text{ mV}$
Probe compensation output signal				
Frequency	950 Hz	_____	_____	1.050 kHz
Voltage (difference)	990 mV	_____	_____	1010 mV

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 *Specifications*. Refer to Table 4-1 on page 4-18 for test equipment specifications.

NOTE. *References to Ch 3 and Ch 4 apply to the TDS5054 and TDS5104 models only.*

Check DC Voltage Measurement Accuracy



WARNING. *The generator is capable of outputting dangerous voltages. Be sure to set the DC calibration generator to off or 0 volts before connecting, disconnecting, and/or moving the test hookup during the performance of this procedure. Also, check that the calibrator does not have shorting straps installed between the DC and sense outputs or grounds.*

Equipment required	Two dual-banana connectors (Item 6) One BNC T connector (Item 7) One DC calibration generator (Item 11) Two precision 50 Ω coaxial cables (Item 5)
Prerequisites	The oscilloscope must meet the prerequisites listed on page 4-17

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 off or 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. See Figure 4-8.
 - 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**. See Figure 4-8.

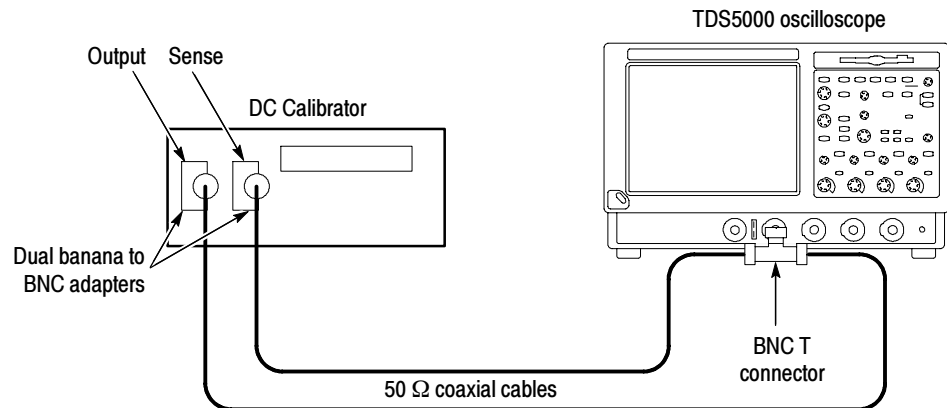


Figure 4- 8: Initial test hookup

- b. *Initialize the oscilloscope:* Press **DEFAULT SETUP**.
 - c. *Modify the default settings:*
 - From the tool bar, click **Horiz** and select the **Acquisition** tab.
 - Click **Average** and set the number of averages to **16**.
 2. *Confirm input channels are within limits for DC accuracy at maximum offset and position:* Do the following substeps — test CH 1 first, *skipping substep 2a since CH 1 is already selected from step 1*.
 - a. *Select an unchecked channel:*
 - From the tool bar, click **MEAS** and then **Clear** to remove the previous measurement.
 - Press the Vertical button of the channel just confirmed to remove the channel from the display.
 - Press the front-panel Vertical 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 selected.
 - b. *Turn on the measurement Mean for the channel:*
 - From the tool bar, click **MEAS** and select the **Ampl** tab, and then click **Mean** to measure the mean of the current channel.
 - Press **Close**.

- c. *Set the vertical scale:* Set the vertical **SCALE** to one of the settings listed in Table 4-2 that is not yet checked. (Start with the first setting listed).

Table 4-2: DC Voltage measurement accuracy

Scale setting	Position setting (Divs)	Offset setting	Generator setting	Accuracy limits
5 mV	-5	+1 V	+1.040 V	+1.0353 V to +1.0447 V
	+5	-1 V	-1.040 V	-1.0447 V to -1.0353 V
200 mV	-5	+10 V	+11.6 V	+11.4989 V to +11.7011 V
	+5	-10 V	-11.6 V	-11.7011 V to -11.4989 V
1.01 V	-5	+10 V	+18 V	+17.602 V to +18.398 V
	+5	-10 V	-18 V	-18.398 V to -17.602 V

- d. *Display the test signal:*
- From the tool bar click **VERT**, and then click **Position**.
 - Use the keypad to set vertical position to -5 divisions (press **CLR**, **5**, **-**, and then **ENTER**, on the keypad). The baseline level will move off screen.
 - Click **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 the screen. (If it doesn't return, the DC accuracy check has failed for the current vertical scale setting of the current channel).
- e. *Measure the test signal:* Press **Close**. Read the measurement results at the **Mean** measurement readout. See Figure 4-9.

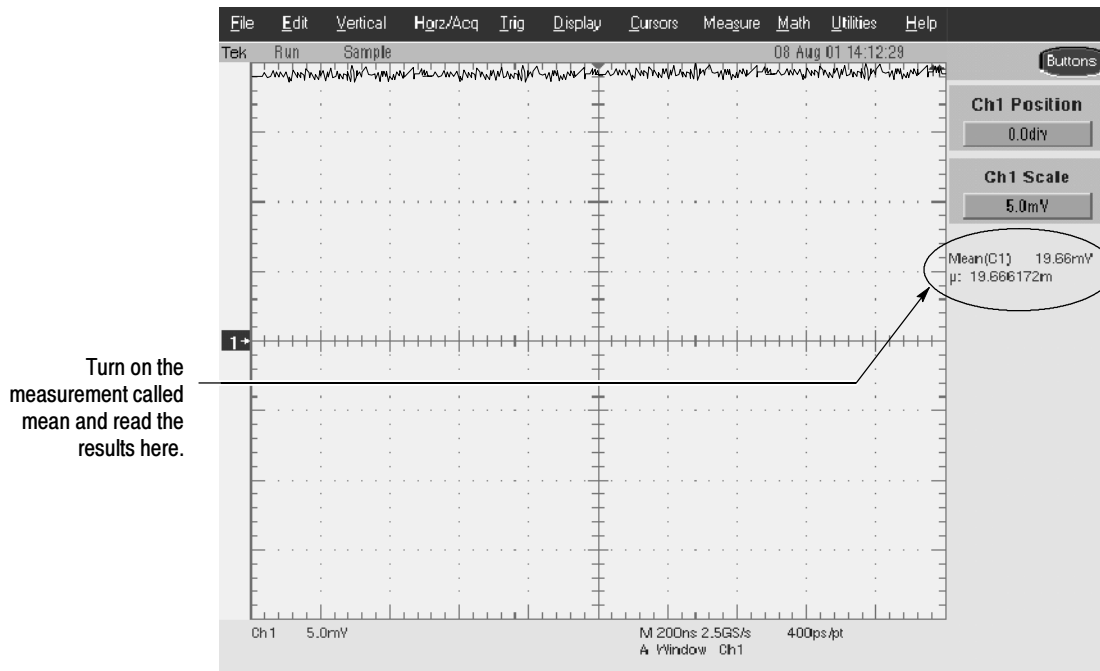


Figure 4-9: Measurement of DC accuracy at maximum offset and position

f. Check against limits:

- CHECK that the **Mean** readout on the screen is within the limits listed for the current vertical scale and position/offset/generator settings. Enter value on test record.
- Repeat substep **d**, reversing the polarity of the position, offset, and generator settings as is listed in the Table 4-2 on page 4-25.
- CHECK that the **Mean** measurement readout on the screen is within the limits listed for the current vertical scale setting and position/offset/generator settings. Enter value on test record.
- Repeat substeps **c** through **f** until all vertical scale settings, listed in Table 4-2, are checked for the channel under test.

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

3. Disconnect the hookup:

- a. Set the generator output to 0 V.**
- b. Disconnect the cable from the generator output at the input connector of the channel last tested.**

Check Analog Bandwidth

Equipment required	One sine wave generator (Item 14) One level meter and power sensor (Item 15) One power divider (Item 16) One female N to male BNC adapter (Item 22) Four male N to female BNC adapters (Item 21) Two 50 Ω precision cables (Item 5) Attenuators (Items 1 and 2) Optional: One high-frequency leveled sine wave generator and its leveling head - replaces items 14, 15, 16, 21, and 22
Prerequisites	See page 4-17

1. *Install the test hookup and preset the instrument controls:*
 - a. *Initialize the oscilloscope:*
 - Press **DEFAULT SETUP**.
 - b. *Modify the default settings:*
 - Turn the horizontal **SCALE** knob to 40 ns.
 - From the tool bar, click **Horiz** and select the Acquisition tab.
 - Click **Average** and set the number of averages to 16.
 - Click Equivalent Time **Auto**.
 - From the tool bar, click **MEAS**. Click Setup **Ref Levs**; then click the Determine Base, Top From **Min-Max** button.

NOTE. *The sine wave generator output amplitude must be leveled to within 0.35 db of the reference frequency (10 MHz) through the bandwidth frequency listed in Table 4-3 on page 4-29. The 0.35 db requirement is necessary to ensure a bandwidth that meets Tektronix specifications.*

You can perform bandwidth Performance Verification using an unleveled sine wave generator (with amplitude error < 0.35 db). Under these conditions, the bandwidth PV is subject to the flatness errors associated with the generator used.

Refer to the Sine Wave Generator Leveling Procedure on page 4-60 if your sine wave generator does not have automatic output amplitude leveling.

- c. *Hook up the test-signal source:* Connect the sine wave output of a leveled sine wave generator to **CH 1**. Set the output of the generator to a reference frequency of 10 MHz or less. See Figure 4-10. For the optional setup using a leveled sine wave generator with a leveling head, see Figure 4-11 and, if using this optional setup with the example Tektronix SG504, set the generator output to 6 MHz.

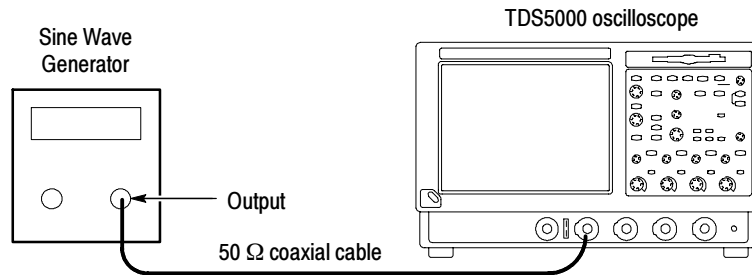


Figure 4- 10: Initial test hookup

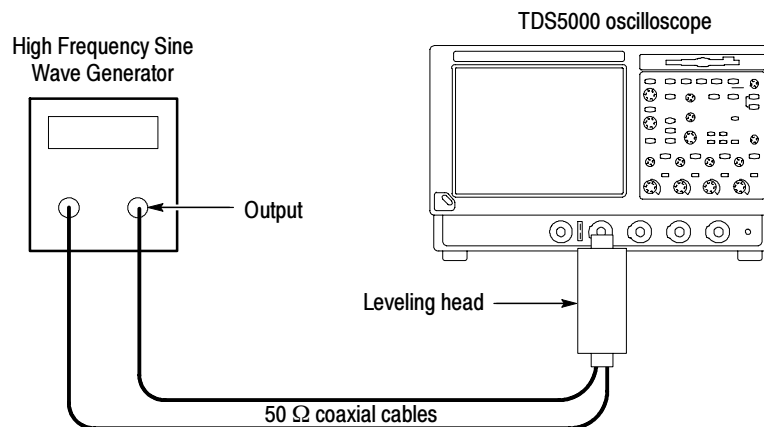


Figure 4- 11: Optional initial test hookup

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:*
 - From the tool bar, click **MEAS** and then **Clear** to remove the previous measurement.
 - Press the **Vertical** button of the channel just confirmed to remove the channel from the display.

- Press the front-panel **Vertical** button that corresponds to the channel you are to confirm.
 - Move the leveling output of the sine wave generator to the channel you selected.
- b. *Match the trigger source to the channel selected:*
- Press the Trigger **SOURCE** button until the source that corresponds to the channel you are to confirm is on.
- c. *Set its input impedance:*
- From the button bar, click the **VERT** button and select the tab for the channel you are to confirm. Click the Termination **50 Ω** button.
- d. *Set the vertical scale:* Set the vertical **SCALE** that corresponds to the channel you are to confirm to one of the settings listed in Table 4-3 not yet checked. (Start with the 100 mV setting).
- e. *Set the triggering coupling:*
- Click the Coupling **DC** button.

Table 4-3: Analog bandwidth

Vertical scale	Reference amplitude (6 divisions)	Horizontal scale	Test frequency		-3 db Limits
			TDS5052 TDS5054	TDS5104	
1 mV	6 mV	1 ns	175 MHz	175 MHz	≥4.24 mV
2 mV	12 mV	1 ns	300 MHz	1 GHz	≥8.48 mV
5 mV	30 mV	1 ns	500 MHz	1 GHz	≥21.2 mV
10 mV	60 mV	1 ns	500 MHz	1 GHz	≥42.4 mV
20 mV	120 mV	1 ns	500 MHz	1 GHz	≥84.8 mV
50 mV	300 mV	1 ns	500 MHz	1 GHz	≥212 mV
100 mV	600 mV	1 ns	500 MHz	1 GHz	≥424 mV
200 mV	1.2 V	1 ns	500 MHz	1 GHz	≥848 mV
500 mV	3 V ¹	1 ns	500 MHz	1 GHz	≥2.12 V ¹
1 V	6 V ¹	1 ns	500 MHz	1 GHz	≥4.24 V ¹

¹ If your generator cannot output 6 divisions of amplitude, determine its maximum output at the Test frequency, and use this for the reference amplitude. The -3 db limit can be calculated as: $0.707 \times \text{reference amplitude}$.

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

- From the button bar click **MEAS**; then select the Time tab.
- Click the **Freq** button to measure the frequency of the current channel.
- Select the Ampl tab. Click the **Pk-Pk** button.
- Click **Close** button.
- Set the generator output so the CHx Pk-Pk readout equals the reference amplitude in Table 4-3 that corresponds to the vertical scale set in substep **d**.
- Press the front-panel **PUSH TO SET 50%** as necessary to trigger a stable display. At full bandwidth, you may also want to make small, manual adjustments to the trigger level. You can use the **Trigger LEVEL** knob to do this. (Full bandwidth varies with TDS model as is shown in Table 4-3).

g. *Measure the test signal:*

- Set the frequency of the generator, as shown on the screen, to the test frequency in Table 4-3 that corresponds to the vertical scale set in substep **d**. See Figure 4-12.
- Set the horizontal **SCALE** to the horizontal scale setting in Table 4-3 that corresponds to the vertical scale set in substep **d**. Press **PUSH TO SET 50%** as necessary to trigger the signal.
- Read the results at the CHx Pk-Pk readout, which will automatically measure the amplitude of the test signal. See Figure 4-12.

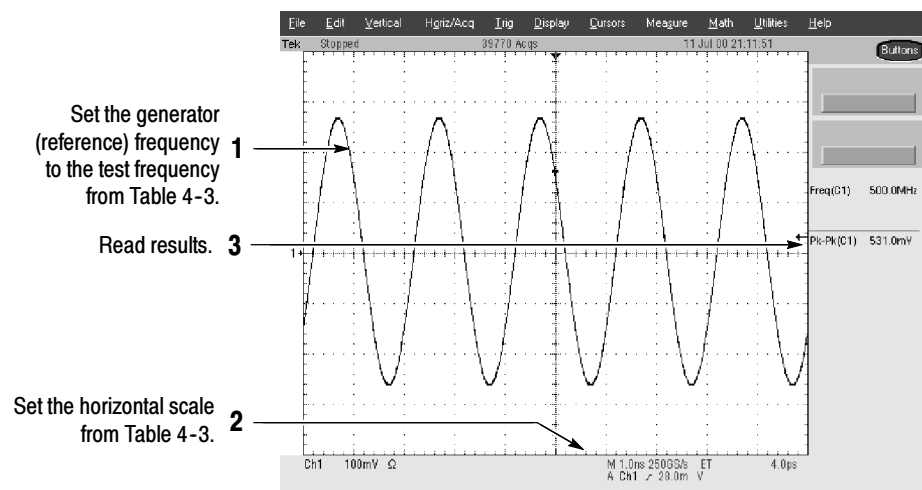


Figure 4- 12: Measurement of analog bandwidth

h. *Check against limits:*

- CHECK that the **Pk-Pk** readout on the screen is within the limits listed in Table 4-3 for the current vertical scale setting.
- Enter voltage on the test record.
- When finished checking, set the horizontal **SCALE** back to the 50 ns setting.

STOP. *Checking the bandwidth of each channel at all vertical scale settings is time consuming and unnecessary. You can skip checking the remaining vertical scale settings in Table 4-3 (that is, skip the following substep, i) if this 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 4-5.

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.*

i. *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 **h** for each of the remaining scale settings listed in Table 4-3 for the channel under test.
- Before doing substep **f**, click the **Clear** button to remove the previous channel measurements.
- When doing substep **f**, skip the subparts that turn on the CHx Pk-Pk measurement until you check a new channel.
- Install/remove attenuators between the generator leveling head and the channel input as needed to obtain the six division reference signals listed in the table.

j. *Test all channels:* Repeat substeps **a** through **h** for all 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 sine wave generator (Item 14) Three precision 50 Ω coaxial cables (Item 5) One power divider (Item 16) or dual input coupler (item 8) 3 SMA female to female adapter connector (Item 17) 3 SMA male-to-female BNC adapter connector (Item 18)
Prerequisites	See page 4-17

STOP. *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 the **DEFAULT SETUP** button.
 - b. *Modify the initialized front-panel control settings:*
 - Do *not* adjust the vertical position of any channel during this procedure.
 - From the toolbar, click the **Vert** button.
 - Set the termination of each channel to 50 Ω by selecting each channel tab and clicking the **Termination 50 Ω** button.
 - Set the horizontal **SCALE** to 400 ps.
 - From the tool bar, click **Horiz** and select the **Acquisition** tab.
 - Click **Average** and set the number of averages to **16**.

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

- Connect the sine wave output of a sine wave generator to a 50 Ω precision coaxial cable.
- Connect the cable to either a coupler, or a power divider and two 50 Ω precision coaxial cables, as shown in Figure 4-13. (See note below).

NOTE. To ensure that you do not introduce errors in the delay measurements, use cables that have a delay difference of less than 10 ps between each other.

You can check the variance in delay between cables by connecting the cables to **CH 1** and **CH 2**. and, using the **V bar** cursors, measure the delay. Reverse the cables and repeat the measurement. Divide the difference between the two delay measurements by 2. If the result is less than 10 ps, you can proceed with the test.

- Connect the coupler or cables to **CH 1** and **CH 2**. See Figure 4-13.

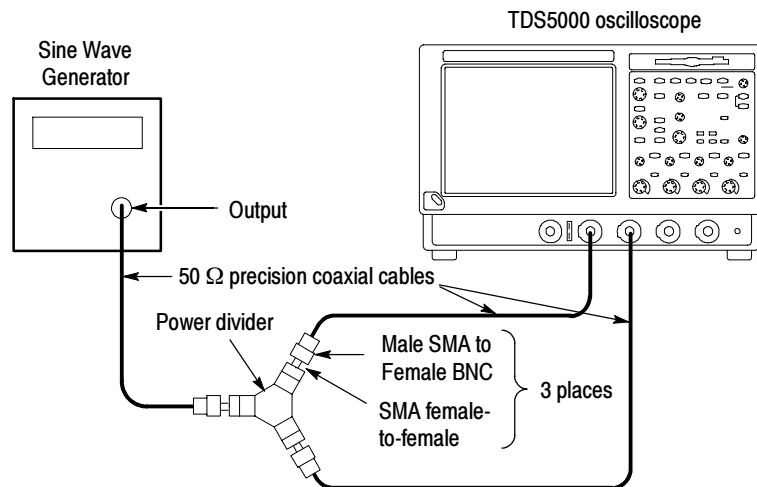


Figure 4-13: Initial test hookup

2. *Confirm all four channels are within limits for channel delay:*

- a. *Set up the generator:* Set the generator frequency to 250 MHz and the amplitude for six to eight divisions in CH 1.

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

- b. Set the horizontal **SCALE** to 200 ps.
- c. *Save a CH 2 waveform:* Press the **CH 2** Vertical button. From the button bar, click the **Refs** button and select the **Ref 2** tab. Click the Save Wfm to Ref2 **Save** button.
- d. *Save CH 3 waveform:*
 - Move the coupler or cable from **CH 2** to **CH 3**, so that **CH 1** and **CH 3** are driven. Press the Vertical **CH 2** button to turn off **CH 2**, and press the Vertical **CH 3** button to turn on **CH 3**. Select the **Ref 3** tab and click the Ch Channel **3** button. Click the Save Wfm to Ref3 **Save** button.
- e. *Display all test signals:*
 - Press the **CH 3** Vertical button to remove CH 3 from the display.
 - Display the live waveform. Move the coupler or cable from **CH 3** to **CH 4**, so that CH 1 and CH 4 are driven. Press the Vertical **CH 4** button to display. See Figure 4-14 on page 4-35.
 - Display the reference waveforms. To do this, click the Ref 3 Display **Off** button to toggle it to On and display the reference. Select the **Ref 2** tab and click the Display **Off** button to toggle it to On. You may notice their overlapping waveform handle icons. See Figure 4-14 on page 4-35. Click on **Close**.
- f. *Measure the test signal:*
 - Locate the time reference points for these waveforms. Do this by first identifying the point where the rising edge of the left-most waveform crosses the center horizontal graticule line. Next, note the corresponding *time reference point* for the right-most waveform. See Figure 4-14 on page 4-35.
 - Press **CURSORS** and select the **V Bars** Cursors Type.
 - Click the **Close** button.
 - Align one V bar 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 by rotating the multipurpose knobs (if necessary, press the FINE buttons). See Figure 4-14 on page 4-35.
 - Read the measurement results at the Δ : cursor readout on the screen.

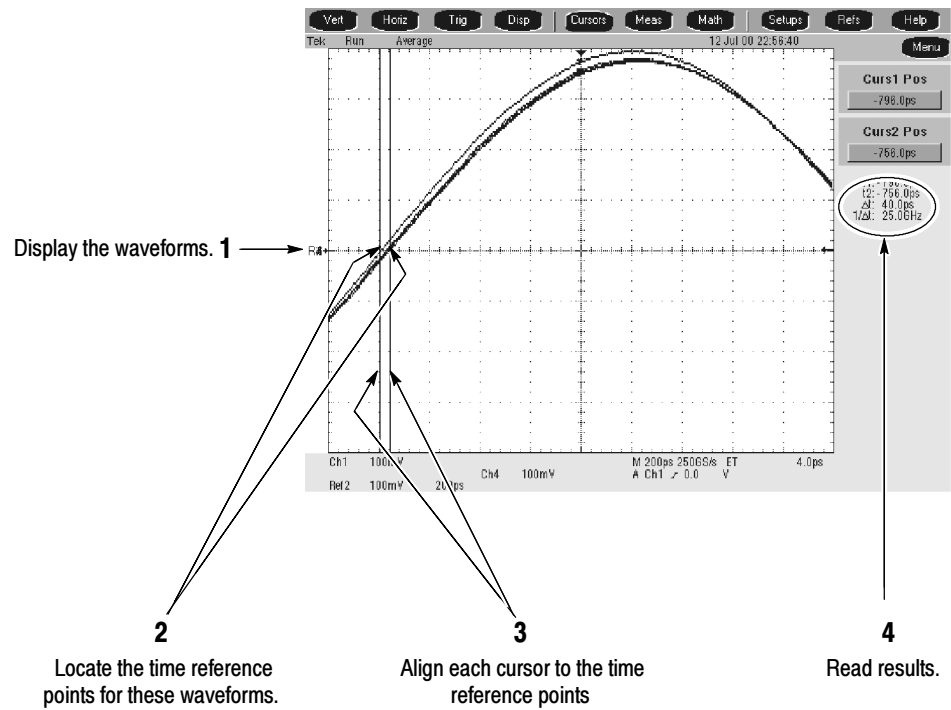
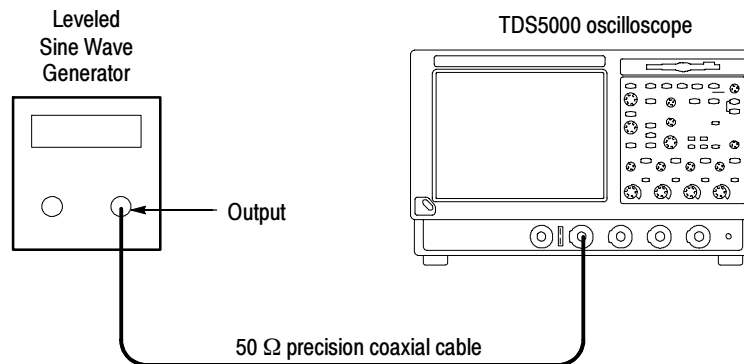


Figure 4-14: Measurement of channel delay

- g. *Check against limits:* CHECK that the cursor readout on the screen is ≤ 100 ps.
 - h. Enter the time on the test record.
3. *Disconnect the hookup:* Disconnect the coupler or cables from the input connectors of the channels.

**Check Channel Isolation
(Crosstalk)**

Equipment required	One leveled sine-wave generator (Item 14) One 50 Ω , precision coaxial cable (Item 5)
Prerequisites	See page 4-17

**Figure 4- 15: 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 output of the generator to **CH 1** (see Figure 4-15).
 - b. *Initialize the oscilloscope:* Press the **DEFAULT SETUP** button.
 - c. *Modify the initialized control settings:*
 - Turn on all vertical channels (press the Vertical button of any off channels: CH 1, CH 2, and, if equipped, CH 3, and CH 4).
 - From the button bar, click the **Vert** button. Set the termination of each channel to 50 Ω by selecting each channel tab and clicking its Termination **50 Ω** button.
 - Set the Vertical SCALE of CH 1, CH 2, CH 3, and CH 4 to **100 mV**.
 - Set the Trigger SOURCE to **CH 1**.
 - Set the Horizontal SCALE **20 ns**.
 - Click the **Close** button.
2. *Check channel isolation against limits:*
 - a. *Display the test signal:* Set the generator frequency to 100 MHz and adjust the output level for an 8-division display.

- b. Check — Amplitude of each trace other than CH 1 is 0.08 division or less (discount trace width). Enter amplitude on the test record.
 - c. Move the signal to the **CH 2** input connector, and change the Trigger SOURCE to **CH 2**.
 - d. Check — Amplitude of each trace other than CH 2 is 0.08 division or less (discount trace width). Enter amplitude on the test record.
 - e. Move the signal to the **CH 3** input connector, and change the Trigger SOURCE to **CH 3**. (TDS5054 or TDS5104) If you are checking a TDS5052, proceed to step i.
 - f. Check — Amplitude of each trace other than CH 3 is 0.08 division or less (discount trace width). Enter amplitude on the test record.
 - g. Move the signal to the **CH 4** input connector, and change the Trigger SOURCE to **CH 4**. (TDS5054 or TDS5104)
 - h. Check — Amplitude of each trace other than CH 4 is 0.08 division or less (discount trace width). Enter amplitude on the test record.
 - i. Move the signal to the **CH 1** input connector, and change the Trigger SOURCE to **CH 1**.
 - j. Set the generator output frequency to 500 MHz for the TDS5054 or 1 GHz for the TDS5104. Set the generator output level for an 8-division display.
 - k. Check — Amplitude of each trace other than CH 1 is 0.16 division or less (discount trace width). Enter amplitude on the test record.
 - l. Move the signal to the **CH 2** input connector, and change the Trigger SOURCE to **CH 2**.
 - m. Check — Amplitude of each trace other than CH 2 is 0.16 division or less (discount trace width). Enter amplitude on the test record.
 - n. Move the signal to the **CH 3** input connector, and change the Trigger SOURCE to **CH 3**. (TDS5054 or TDS5104)
 - o. Check — Amplitude of each trace other than CH 3 is 0.16 division or less (discount trace width). Enter amplitude on the test record.
 - p. Move the signal to the **CH 4** input connector, and change the Trigger SOURCE to **CH 4**. (TDS5054 or TDS5104)
 - q. Check — Amplitude of each trace other than CH 4 is 0.16 division or less (discount trace width). Enter amplitude on the test record.
3. *Disconnect the hookup*: Disconnect the cable from the generator output at the input connector of the channel.

Time Base System Checks

These procedures check those characteristics that relate to the time base system and are listed as checked under *Warranted Characteristics* in *Specifications*.

Check Long-Term Sample Rate and Delay Time Accuracy

Equipment required	One time-mark generator (Item 13), or Sine wave generator (Item 14) One 50 Ω , precision coaxial cable (Item 5)
Prerequisites	See page 4-17

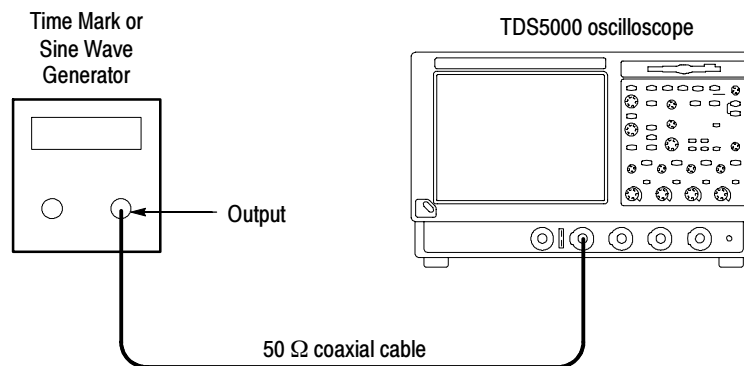


Figure 4- 16: Initial test hookup

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 output of the generator to **CH 1** (see Figure 4-16).
 - If using a time-mark generator, set the output for 10 ms markers.
 - If using a sine wave generator, set the output for 1.2 V and 500 kHz.
 - b. *Initialize the oscilloscope:* Press the **DEFAULT SETUP** button.
 - c. *Modify the initialized front-panel control settings:*
 - Set the Vertical **SCALE** to 200 mV (or 500 mV with the optional Tektronix TG501A Time Mark Generator).
 - Set the Horizontal **SCALE** to 200 ns.
 - From the button bar, click the **Vert** button. Click the Termination **50 Ω** button.
 - Press **PUSH TO SET 50%**.

- Click the **Close** button.
 - Use the Vertical **POSITION** knob to center the test signal on the screen.
 - Press the Trigger **MODE** button to toggle it to **NORMAL**.
2. *Confirm the time base is within limits for accuracies:*
- a. *Measure the test signal:*
 - If using a time-mark generator, align the trigger **T** to the center vertical graticule line by adjusting the Horizontal **POSITION**. See Figure 4-17 on page 4-40.
 - If using a sine wave generator, align the rising edge of the sine wave on the center graticule crosshairs by adjusting the Horizontal **POSITION**.
 - From the button bar, click the **Horiz** button and select the **HORIZONTAL** tab.
 - Press the Horizontal **DELAY Mode** button to toggle it on. See Figure 4-17 on page 4-40.
 - Set the delay time to 10 ms. (Do this by clicking **Horiz Delay** and on the keypad press **10**, then **m** followed by **ENTER**).
 - b. *Check long-term sample rate and delay time accuracies against limits:*
 - **CHECK** that the rising edge of the marker (or sine wave) crosses the center horizontal graticule line at a point within ± 1.5 divisions of the center graticule. See Figure 4-17 on page 4-40.
 - Enter the number of divisions on the test record.

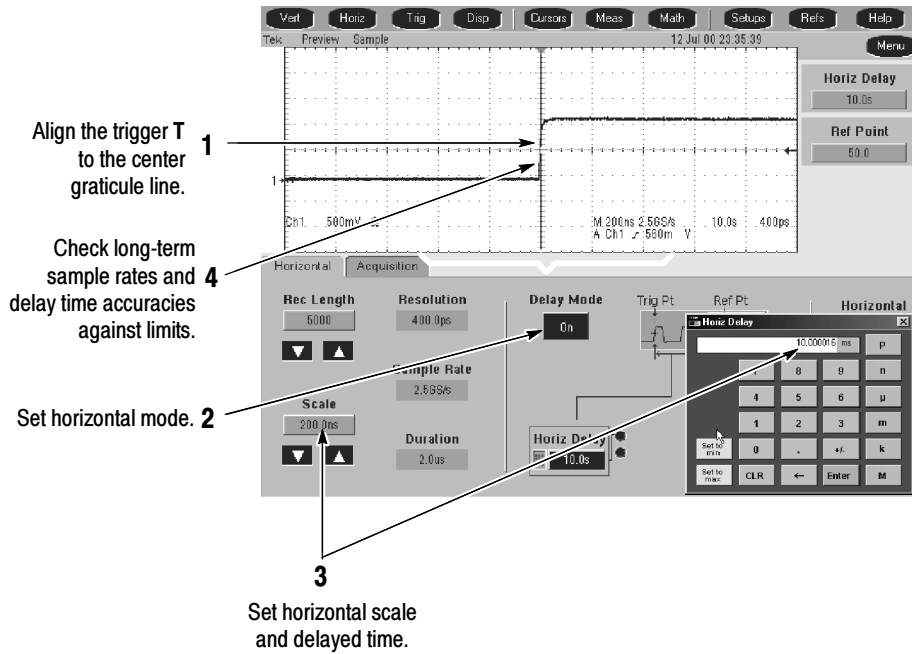


Figure 4- 17: Measurement of accuracy - long-term and delay time

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

Check Delta Time Measurement Accuracy

Equipment required	One 50 Ω , precision coaxial cable (Item 5) One Connector, BNC “T”, male BNC-to-dual female BNC (Item 7) One Pulse Generator, Wavetek 9500 or equivalent (Item 19) Two 50 Ω , coaxial cable, male-to-male SMA connectors (Item 20) One SMA female to BNC male connector (Item 24) One BNC elbow connector (Item 25) One SMA “T”, male to two SMA female connectors (Item 23) Two SMA terminator connectors, short circuit (Item 27) One 2X attenuator, 50 Ω , female BNC-to- male BNC (Item 29)
Prerequisites	See page 4-17

This procedure checks the “sample rate” portion of the Delta Time Measurement Accuracy as listed in *Specifications*. The previous procedure, *Check Long-Term Sample Rate and Delay Time Accuracy*, on page 4-38, verified the “PPM” portion of the delta time specification.

1. *Install the test hookup and preset the instrument controls:*
 - a. *Initialize the oscilloscope:* Press the **DEFAULT SETUP** button.
 - b. *Hook up the pulse generator as shown in Figure 4-18.*

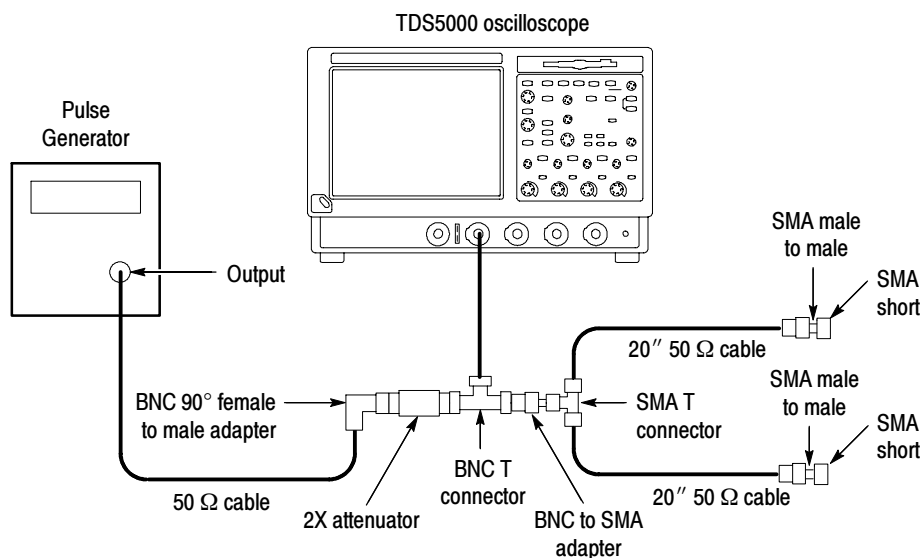


Figure 4-18: Delta time accuracy test hookup

- Set the pulse generator output for a positive-going pulse with a 280 ps - 800 ps rise-time, as shown in Table 4-4 on page 4-43, and for the fastest possible rep rate (at least 1 kHz).
 - Set the pulse generator output for about 500 mV. (This amplitude can be adjusted later to get a 5-division pulse on the screen.)
- c. *Modify the initialized front-panel control settings:*
- From the button bar, click the **Vert** button. Set the termination of the channel to 50 Ω by selecting the channel tab and clicking the Termination **50 Ω** button
 - Press **AUTOSET**. You may see both positive and negative pulses. Adjust the Trigger **LEVEL** knob so the trigger level is about 50% of the rising edge of the positive pulse.
 - From the button bar, click the **Horiz** button and select the Acquisition tab. Press the Equivalent Time **Off** (Real Time Only) button.
 - Set the horizontal SCALE to 5 or 10 ns/division. The pulse width should be about **6 ns**.
 - Adjust pulse amplitude and oscilloscope vertical scale and position as necessary to obtain about **5 divisions** of the **positive** pulse.
- d. *Set up for statistics measurements:*
- Re-adjust the Trigger **LEVEL** knob so the trigger level is about 50% of the rising edge of the positive pulse.
 - Press **RUN/STOP** button to freeze the display.
 - Click **MEAS** and select the **Time** tab to bring up the Time Measurements menu.
 - Click the **Positive Width** button.
 - Click Setup **Statistics**. Click the Measurement Statistics **All** button and then click **Reset** to reset the statistics.
 - Click **Weight n=**. On the keypad press **1000**, then **ENTER**. Click **Setup**.
 - Click Setup **Ref Levs** and set Mid Ref to 50%. Click **Close**.
 - Press the **RUN/STOP** button to start the acquisitions.
 - Wait about 30 seconds.
 - Press **RUN/STOP** button to freeze the display.
 - Record the all statistics values.

- Calculate the difference of the Maximum (M) minus the mean (μ).
- Calculate the difference of the mean (μ) minus the Minimum (m).
- Both differences must be less than or equal to the Delta-time accuracy limit shown in Table 4-4 for your oscilloscope.
- Enter pass/fail result for delta time on the test record.

Table 4-4: Delta time measurement

Pulse rise time range	Delta time accuracy limit
280 ps - 800 ps	≤ 0.060 ns

e. *Repeat for all other channels:*

- Note the vertical scale setting of the channel just confirmed.
- Press the Vertical channel button for the channel just confirmed to remove the channel from display.
- Click **MEAS** and the **Clear** to remove the measurement.
- Press the front-panel button that corresponds to the channel you are to confirm.
- Set vertical **SCALE** to the setting noted in step e, first bullet.
- Press the Trigger Source button to toggle the source to the channel selected.
- Move the test hookup to the channel you selected.
- From the button bar, click the **Vert** button. Set the termination of the channel to 50Ω by selecting the channel tab and clicking the Termination **50 Ω** button
- Press **RUN/STOP** button to start the display.
- Repeat step d.

2. *Disconnect all test equipment from the oscilloscope:*

Trigger System Checks

These procedures check those characteristics that relate to the trigger system and are listed as checked in *Specifications*.

Check Time Accuracy for Pulse, Glitch, Timeout, and Width Triggering

Equipment required	One sine wave generator (Item 14) One 10X attenuator (Item 1) One 50 Ω , precision coaxial cable (Item 5)
Prerequisites	See page 4-17

1. *Install the test hookup and preset the instrument controls:*
 - a. *Initialize the instrument:* Press the **DEFAULT SETUP** button.
 - b. *Modify the default setup:*
 - Set the horizontal **SCALE** to 10 ns.
 - From the button bar, click the **Vert** button. Click the Termination **50 Ω** button.
 - c. *Hook up the test-signal source:* Connect the output of the sine wave generator (Item 14) to CH 1.

Do this through a 50 Ω precision coaxial cable, followed by a 10X attenuator. See Figure 4-19. The 10X attenuator is optional if the SG503 is used.

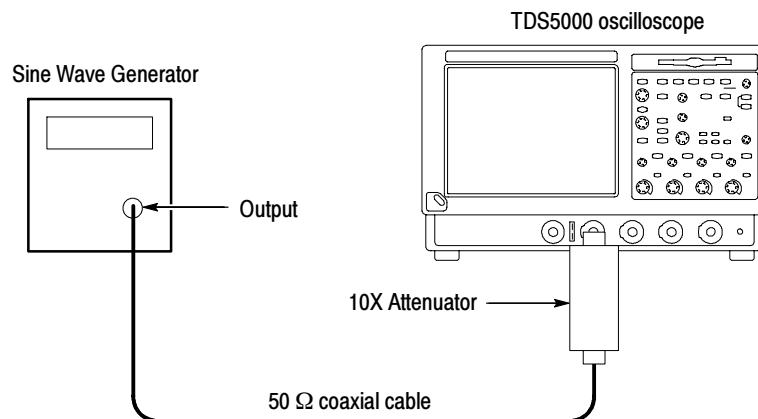


Figure 4- 19: Initial test hookup

2. *Confirm the trigger system is within time-accuracy limits for pulse-glitch or pulse-width triggering (time range ≤ 500 ns):*
 - a. *Display the test signal:* Set the output of the sine wave generator for a 100 MHz, five-division sine wave on the screen. Press **PUSH TO SET 50%**.
 - b. *Set the trigger mode:* Press the Trigger **MODE** button to toggle it to **NORMAL**.
 - c. *Set upper and lower limits that ensure triggering:* See Figure 4-20.
 - Press the front-panel **ADVANCED** button and select the **A Event** tab; then select width triggering by clicking the **Width** button.
 - Click the **Trig When** button and select **Inside** limits.
 - Click **Upper Limit** and use the keyboard to set the upper limit to 10 ns: press **10**, then **n**, and **ENTER**.
 - Click **Lower Limit** and use the keypad to set the lower limit to 2 ns.
 - d. *Change limits until triggering stops:*
 - Press **PUSH TO SET 50%**.
 - While doing the following subparts, monitor the display (it will stop acquiring) and the front-panel light **TRIG'D** (it will extinguish) to determine when triggering is lost. Click **Close**.
 - Click **Lower Limit**.
 - Use the multipurpose knob to *increase* the **Lower Limit** readout until triggering is lost.
 - CHECK that the **Lower Limit** readout, after the oscilloscope loses triggering, is within 3.5 ns to 6.5 ns, inclusive.
 - Enter the time on the test record.
 - Use the keypad to return the **Lower Limit** to 2 ns and reestablish triggering.
 - Click **Upper Limit**; then use the multipurpose knob to slowly *decrease* the **Upper Limit** readout until triggering is lost.
 - CHECK that the **Upper Limit** readout, after the oscilloscope loses triggering, is within 3.5 ns to 6.5 ns, inclusive.
 - Enter the time on the test record.

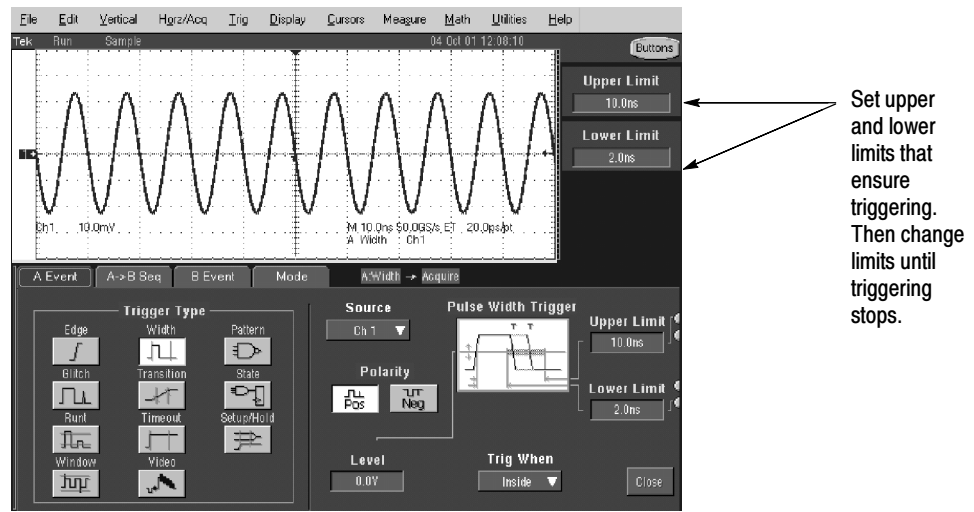


Figure 4-20: Measurement of time accuracy for pulse and glitch triggering

3. Confirm the trigger system is within time-accuracy limits for pulse-glitch or pulse-width triggering (time range >520 ns):

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

- Click **Upper Limit**. Use the keyboard to set the upper limit to 4 μ s.
- Click **Lower Limit**. Use the keypad to set the lower limit to 500 ns.

b. Display the test signal:

- Set the Horizontal **SCALE** to 4 μ s.
- Set the output of the sine wave generator for a 250 kHz, five-division sine wave on the screen. Set the Vertical **SCALE** to 20 mV (the waveform will overdrive the display).
- Press **PUSH TO SET LEVEL 50%**. Click **Close**.

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

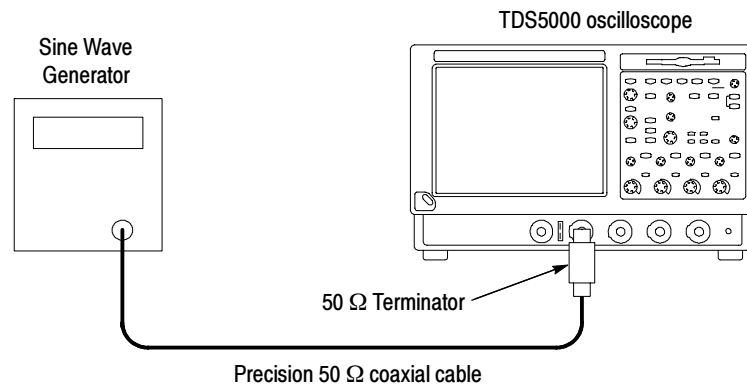
- Click **Lower Limit**.
- Use the multipurpose knob to *increase* the **Lower Limit** readout until triggering is lost.
- CHECK that the **Lower Limit** readout, after the oscilloscope stops triggering, is within 1.9 μ s to 2.1 μ s, inclusive.
- Enter the time on the test record.

- Use the keypad to return the **Lower Limit** to 500 ns and reestablish triggering.
 - Click **Upper Limit**; then use the multipurpose knob to slowly *decrease* the **Upper Limit** readout until triggering stops.
 - CHECK that the **Upper Limit** readout, after the oscilloscope loses triggering, is within 1.9 μ s to 2.1 μ s, inclusive.
 - Enter the time on the test record.
4. *Disconnect the hookup*: Disconnect the cable from the generator output at the input connector of **CH 1**.

Check Sensitivity, Edge Trigger, DC Coupled

Equipment required	One sine wave generator (Item 14) One precision 50 Ω coaxial cable (Item 5) One 50 Ω terminator (Item 4) One 10X attenuator (Item 1) One 5X attenuator (Item 2)
Prerequisites	See page 4-17.

1. *Install the test hookup and preset the instrument controls:*
 - a. *Initialize the oscilloscope:* Press the **DEFAULT SETUP** button.
 - b. *Modify the initialized front-panel control settings:*
 - Set the Horizontal **SCALE** to 20 ns.
 - Press the Trigger **MODE** button to toggle it to **Normal**.
 - From the tool bar, click **Horiz** and select the **Acquisition** tab.
 - Click **Average** and set the number of averages to **16**.
 - c. *Hook up the test-signal source:*
 - Connect one end of a precision 50 Ω coaxial cable to the signal output of the generator. Connect the other end of the coaxial cable to **CH 1** through a 50 Ω terminator. See Figure 4-21.

**Figure 4-21: Initial test hookup**

2. *Confirm the trigger system is within sensitivity limits (50 MHz):*
 - a. *Display the test signal:*

- Set the generator frequency to 50 MHz.
 - From the button bar, click **MEAS**.
 - Click Setup **Ref Levs**; then click the **Min-Max** button.
 - Click the **Setup** button and select the **Ampl** tab; then click the **Amplitude** button.
 - Click **Close**.
 - Press **PUSH TO SET 50%**.
 - Set the test signal amplitude for about three and a half divisions on the 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 terminator (with the 50 Ω precision coaxial cable attached) from **CH 1**, and reconnect it to **CH 1** through a 10X attenuator.
- b. *Check the 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 lighted. It will flash for slower settings.
 - Press the Trigger **Slope** button to select the positive slope.
 - Adjust the Trigger **LEVEL** knob so that there is a stable trigger. CHECK that the trigger is stable for the test waveform on the positive slope.
 - Press the Trigger **Slope** button to select the negative slope. Adjust the Trigger **LEVEL** knob so that there is a stable trigger. CHECK that the trigger is stable for the test waveform on the negative slope.
 - Enter pass/fail result for trigger on the test record.
 - Leave the trigger system triggered on the positive slope of the waveform before continuing to the next step.

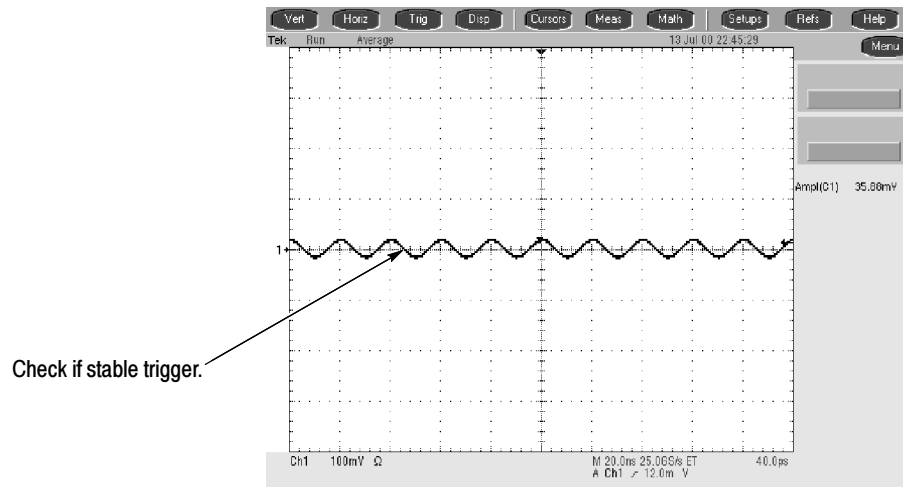


Figure 4-22: Measurement of trigger sensitivity - 50 MHz results shown

- c. *Check Delayed trigger system for stable triggering at limits:* Do the following subparts in the order listed.
 - From the button bar click **Trig**, select the **A Event** tab, and set the **Source** to Line.
 - Select the **A->B Seq** tab, and click the A then B **Trig After Time** button.
 - Select the **B Event** tab, and click the **Set 50%** button.

CHECK that a stable trigger is obtained for the test waveform for both the positive and negative slopes of the waveform. Use the **TRIGGER LEVEL** knob to stabilize the Main trigger. Click **B Trig Level** and use the keypad or the multipurpose knob/FINE button to stabilize the Delayed trigger. Click one of the Slope buttons to switch between trigger slopes. See Figure 4-22 on page 4-50.

- Enter pass/fail result for delayed trigger on the test record.
 - Leave the Delayed trigger system triggered on the positive slope of the waveform before continuing to the next step. Also, return to the main trigger: select the **A->B Seq** tab and click the A->B Sequence **A Only** button. Then select the **A Event** tab.
 - Press **Close**.
3. *Confirm the AUX Trigger input:*
 - a. *Display the test signal:*

- Remove the 10X attenuator, and reconnect the 50 Ω terminator and precision 50 Ω cable to **CH 1**.
 - Press the Trigger **SOURCE** button to select **CH 1**.
 - Set the test signal amplitude for about 4 divisions on the screen.
 - Now fine adjust the generator output until the **CH 1 Amplitude** readout indicates the amplitude is **400 mV**.
- b. *Check the AUX trigger source for stable triggering at 50 MHz: Do the following in the order listed.*
- Move the 50 Ω terminator and precision 50 Ω cable from **CH 1** to **AUX IN**.
 - Press the Trigger **SOURCE** button to set the source to **EXT**.
 - Adjust the Trigger **LEVEL** knob in the positive direction.
 - CHECK for a stable trigger. When a stable trigger is obtained, the TRIG'D indicator is lighted.

NOTE. *You will not see the signal on the display.*

- Press the Trigger **SLOPE** button to toggle to **NEG**.
 - Adjust the Trigger **LEVEL** knob in the negative direction.
 - CHECK for a stable trigger. When a stable trigger is obtained, the TRIG'D indicator is lighted.
 - Enter the pass/fail results on the test record.
 - Set the trigger system to trigger on the positive slope of the waveform before proceeding to the next check.
 - Press the Trigger **SOURCE** button to set the trigger source to **CH 1**.
 - Click **Vert** in the button bar. Click Termination **50 Ω** . Click **Close**.
 - Disconnect the hookup installed in step 1.
4. *Confirm that the trigger system is within sensitivity limits (full bandwidth):*
- a. *Hook up the test-signal source:* Connect the signal output of a high-frequency sine wave generator to **CH 1** through a precision 50 Ω coaxial cable. Some TDS models need a high frequency (>1 GHz) generator; see footnote 1 in Table 4-1 on page 4-18.
 - b. *Set the Horizontal Scale:* Set the Horizontal **SCALE** to 400 ps.

- c. *Display the test signal:*
- Set the generator frequency to full bandwidth as follows:
TDS5104 **1 GHz**
TDS5052, TDS5054 **500 MHz**
 - Set the test signal amplitude for about five divisions on the 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. Check that a stable trigger is obtained.
- d. Repeat step 2, substeps b and c only, for the full bandwidth selected.
- Press the Trigger **SOURCE** button to toggle it to **CH 1**.
- e. *Display the test signal:*
- Set the generator frequency to 100 MHz.
 - Set the Horizontal **SCALE** to 10 ns.
 - Remove the 5X attenuator and reconnect the cable to **CH 1**.
 - Set the generator amplitude on the screen for 7.5 divisions.
 - Now fine-adjust the generator output until the **CH 1 Amplitude** readout indicates the amplitude is 750 mV.
- f. Repeat step 1, substep c and step 3, substep b only, to check the full bandwidth of the Aux Trigger source. Set the generator frequency to 100 MHz.

NOTE. *You just checked the trigger sensitivity. If desired, you can repeat steps 1 through 4d for the other channels (CH 2, and, if equipped, CH 3 and CH 4).*

5. *Disconnect the hookup:* Disconnect the cables from AUX IN and from the channel last tested.

Output Signal Checks

The procedure that follows checks those characteristics of the output signals that are listed as checked under *Warranted Characteristics* in *Specifications*. The oscilloscope outputs these signals at its front and rear panels.

Check Outputs — CH 3 Signal Out (TDS5054 and TDS5104) and Aux Trigger Out

Equipment required	Two precision 50 Ω coaxial cables (Item 5) One calibration generator (Item 12)
Prerequisites	See page 4-17. Also, the oscilloscope must have passed <i>Check DC Voltage Measurement Accuracy</i> on page 4-23.

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

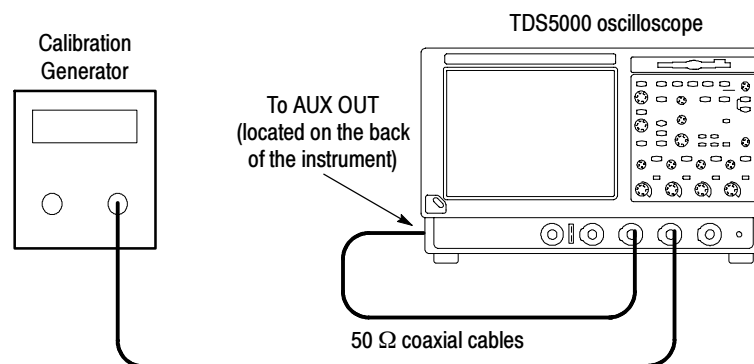


Figure 4-23: Initial test hookup

- Hook up test-signal source 1 (See Figure 4-23):*
 - Connect the standard amplitude output of a calibration generator through a 50 Ω precision coaxial cable to **CH 3**.
 - Set the calibration generator to output a 0.500 V square wave.
- Hook up test-signal source 2: Connect the **Aux Out** at the rear panel to **CH 2** through a 50 Ω precision cable.*
- Initialize the oscilloscope: Press the **DEFAULT SETUP** button.*
- Modify the initialized front-panel control settings:*
 - Press the Vertical **CH 1** button to toggle it off.
 - Press the Vertical **CH 3** button to display that channel.
 - Push **Trigger Source** to toggle the source to **CH 3**.

- Set the Horizontal **SCALE** to 200 μ s.
 - If necessary, adjust the calibration generator output for 5 divisions of amplitude. (For oscilloscopes with 50 Ω inputs, you may need to double the output of the generator to get 5 divisions of amplitude.)
 - From the tool bar, click **Horiz** and select the **Acquisition** tab.
 - Click **Average** and set the number of averages to **64**.
 - Click the **Close** button.
2. *Confirm AUX OUT is within limits for logic levels:*
- a. *Display the test signal:*
 - Press the Vertical **CH 3** button to turn off CH 3.
 - Press the Vertical **CH 2** button to display that channel.
 - Set the **CH 2** Vertical **SCALE** to 1 V.
 - Use the Vertical **POSITION** knob to center the display on the screen.
 - b. *Measure logic levels:*
 - From the button bar, click **MEAS** and select the **Ampl** tab.
 - Click the **High** and **Low** buttons.
 - Click the **Close** button.
 - c. *Check AUX OUT output against limits:*
 - CHECK that the **CH 2 High** readout is ≥ 2.5 volts and that the **CH 2 Low** readout is ≤ 0.7 volts. See Figure 4-24.
 - Enter the high and low voltages on the test record.
 - From the button bar, click the **Vert** button. Click the Termination **50 Ω** button.
 - Click the Close button.
 - CHECK that the **CH 2 High** readout is ≥ 1.0 volt and that the **CH 2 Low** readout ≤ 0.25 volts.
 - Enter the high and low voltages on the test record.

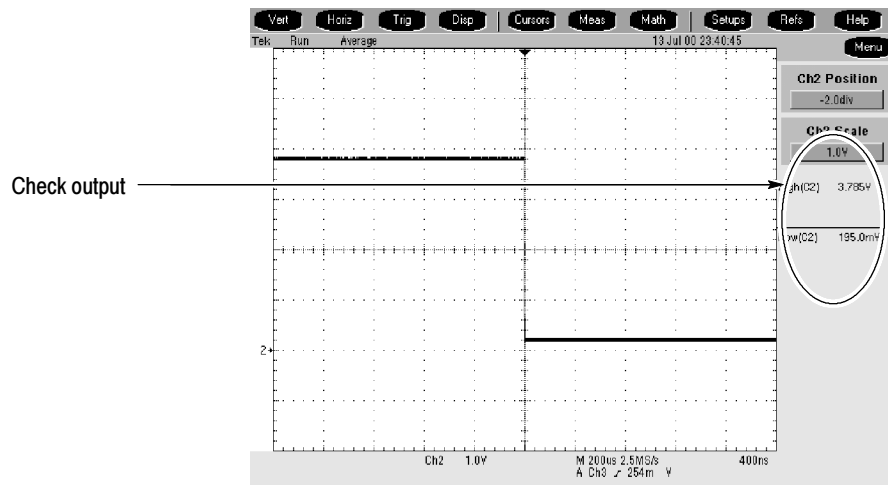


Figure 4-24: Measurement of main trigger out limits

3. Confirm SIGNAL OUT is within limits for gain:

a. Measure gain:

- Move the precision 50 Ω cable from the **AUX OUT** BNC to the **SIGNAL OUT** BNC.
- Set **CH 2** Vertical **SCALE** to 100 mV.
- Press **PUSH TO SET 50%**.
- From the button bar, click **MEAS** and select the **Ampl** tab.
- Click the **Pk-Pk** button.
- Click **Close**.

b. Check against limits:

- From the button bar, click the **Vert** button. Click the Termination **1 M Ω** button.
- Click **Close**.
- CHECK that the readout **Ch2 Pk-Pk** is between 80 mV and 120 mV, inclusive.
- Enter the voltage on the test record.
- From the button bar, click the **Vert** button. Click the Termination **50 Ω** button.
- Click **Close**.

- CHECK that the readout **CH 2 Pk-Pk** is between 44 mV and 66 mV, inclusive.
 - Enter voltage on test record.
4. *Disconnect the hookup:* Disconnect the cables from the channel inputs and the rear panel outputs.

Check Probe Compensation Output

Equipment required	One 10X oscilloscope probe, such as Tektronix P5050
Prerequisites	See page 4-17. Also, the oscilloscope must have passed <i>Check Long-Term Sample Rate and Delay Time Accuracy</i> on page 4-38.

1. *Install the test hookup and preset the instrument controls:*
- a. *Hook up test-signal:* See Figure 4-25.
- Connect the BNC end of the adapter to **CH 1**.
 - Connect the clip leads to the **PROBE COMP** output.

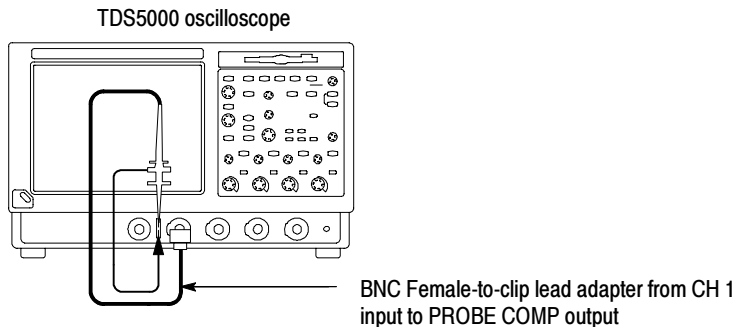


Figure 4-25: Initial test hookup

- b. *Initialize the oscilloscope:* Press the **DEFAULT SETUP** button.
- c. *Modify the initialized front-panel control settings:*
- Set the Vertical **SCALE** to 200 mV.
 - Set the Horizontal **SCALE** to 200 μ s.
 - Press **PUSH TO SET 50%**.
 - Use the Vertical **POSITION** knob to center the display on the screen.

- From the tool bar, click **Horiz** and select the **Acquisition** tab.
 - Click **Average** and set the number of averages to **128**.
2. *Confirm that the Probe Compensator signal is within limits for frequency:*
- a. *Measure the frequency of the probe compensation signal:*
 - From the button bar, click **MEAS** and select the **Time** tab.
 - Click the **Freq** button.
 - b. *Check against limits:*
 - CHECK that the **CH 1 Freq** readout is within 950 Hz to 1.050 kHz, inclusive. See Figure 4-26.
 - Enter the frequency on the test record.
 - Click **Clear** to remove the measurement.

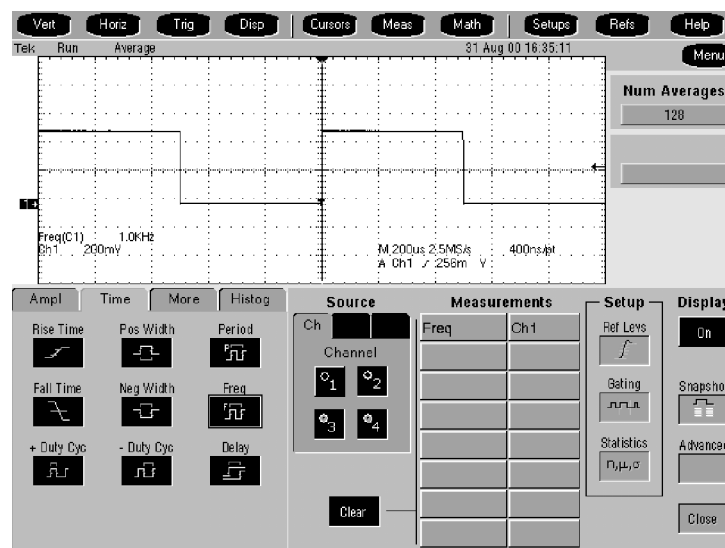


Figure 4-26: Measurement of probe compensator frequency

- c. *Save the probe compensation signal in reference memory:*
 - From the button bar, click **Refs**; then select the **Ref 1** tab.
 - Click the Save Wfm to Ref1 **Save** button to save the probe compensation signal in reference 1.
 - Disconnect the adapter from **CH 1** and the probe compensation connector.

- Click the **Display** button to toggle it to on to displayed the stored signal.
- d. *Hook up the DC standard source:*
- Set the output of a DC calibration generator to off or 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. See Figure 4-27.
 - 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**. See Figure 4-27.

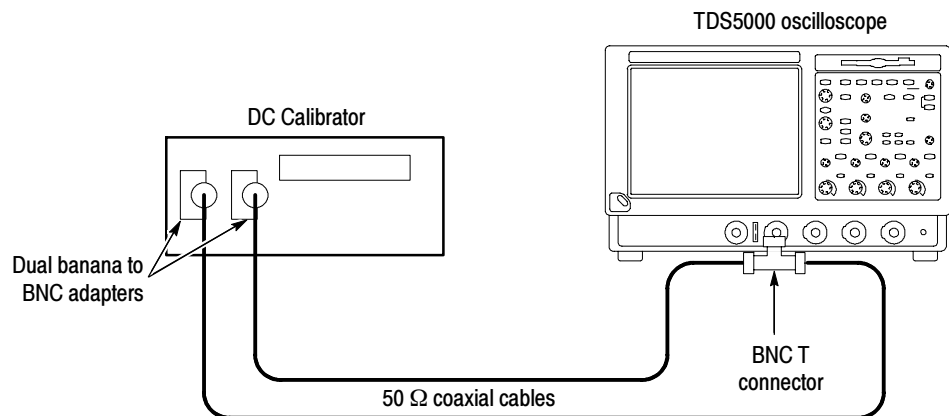


Figure 4-27: Subsequent test hookup

- e. *Measure amplitude of the probe compensation signal:*
- From the tool bar, click **Horiz** and select the **Acquisition** tab.
 - Click **Average** and set the number of averages to **16** using the keypad or the multipurpose knob.
 - Adjust the output of the DC calibration generator until it precisely overlaps the top (upper) level of the stored probe compensation signal. (This value will be near 1000 mV.)
 - Record the setting of the DC generator.
 - Adjust the output of the 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.
- f. Press **Close** to remove the menus from the display. See Figure 4-28.

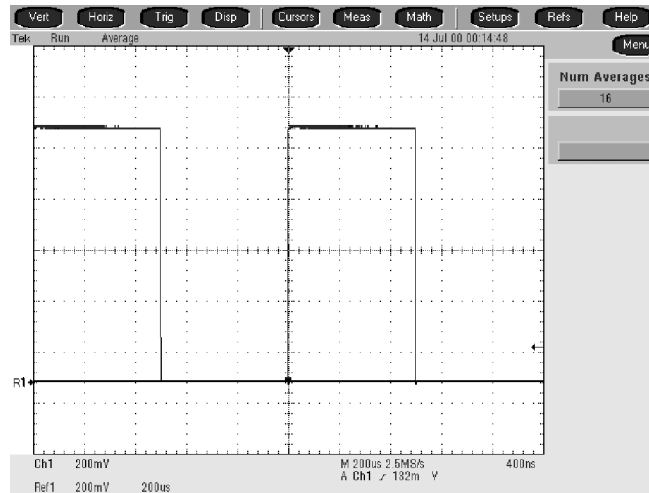


Figure 4-28: Measurement of probe compensator amplitude

- g. *Check against limits:*
- Subtract the value just obtained (base level) from that obtained previously (top level).
 - CHECK that the difference obtained is within 990 mV to 1010 mV, inclusive.
 - Enter voltage difference on test record.

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

This completes the performance verification of the oscilloscope.

Sine Wave Generator Leveling Procedure

Some procedures in this manual require a leveled sine wave generator to produce the necessary test signals. If you do not have a leveled sine wave generator, use one of the following procedures to level the output amplitude of your sine wave generator.

Method A Use this setup if you have a power divider to enable you to monitor the generator output simultaneously with the level meter and the oscilloscope.

Equipment required	Sine wave generator (Item 14) Level meter and power sensor (Item 15) Power divider (Item 16) Two male N to female BNC adapters (Item 21) One precision coaxial cable (Item 5)
Prerequisites	See page 4-17

1. *Install the test hookup:* Connect the equipment as shown in Figure 4-29.

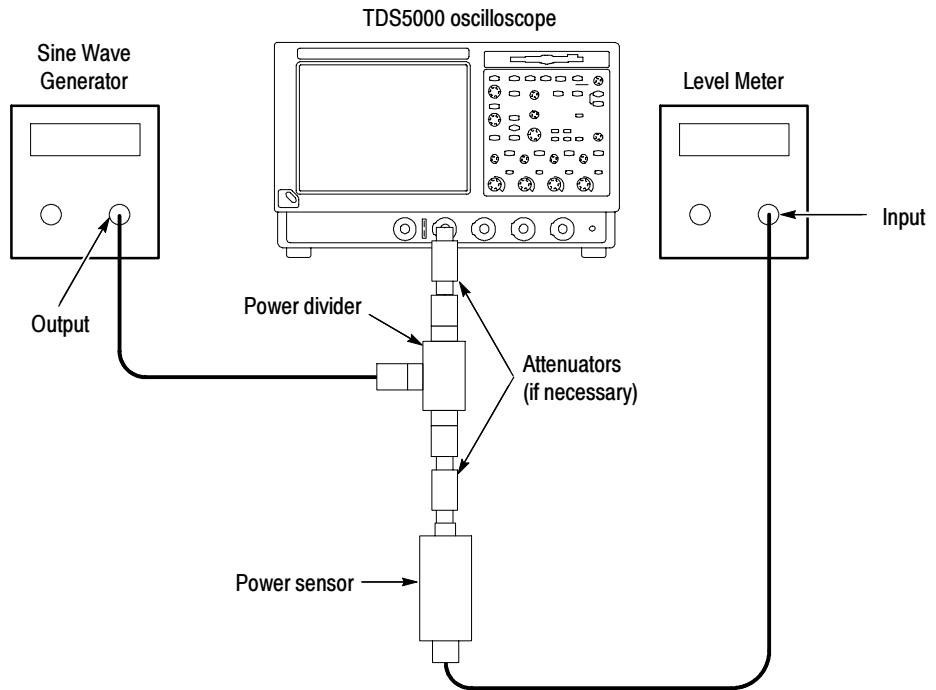


Figure 4-29: Sine wave generator leveling equipment setup (Method A)

2. *Set the Generator:*
 - Set the sine wave generator to a reference frequency of 10 MHz.
 - Adjust the sine wave generator amplitude to the required number of divisions as measured by the oscilloscope.
3. *Record the reference level:* Note the reading on the level meter.
4. *Set the generator to the new frequency and reference level:*
 - Change the sine wave generator to the desired new frequency.
 - Input the correction factor and/or the new frequency into the level meter.
 - Adjust the sine wave generator amplitude until the level meter again reads the value noted in step 3. The signal amplitude is now correctly set for the new frequency for your specific test procedure.

Proceed with the test instructions that require a leveled sine wave generator at the frequency you set in step 4.

Method B Use this setup if you do not have a power divider.

Equipment required	Sine wave generator (Item 14) Level meter and power sensor (Item 15) Two male N to female BNC adapters (Item 21) Two precision coaxial cables (Item 5)
Prerequisites	See page 4-17

1. *Install the test hookup:* Connect the equipment as shown in Figure 4-30 (start with the sine wave generator connected to the oscilloscope).

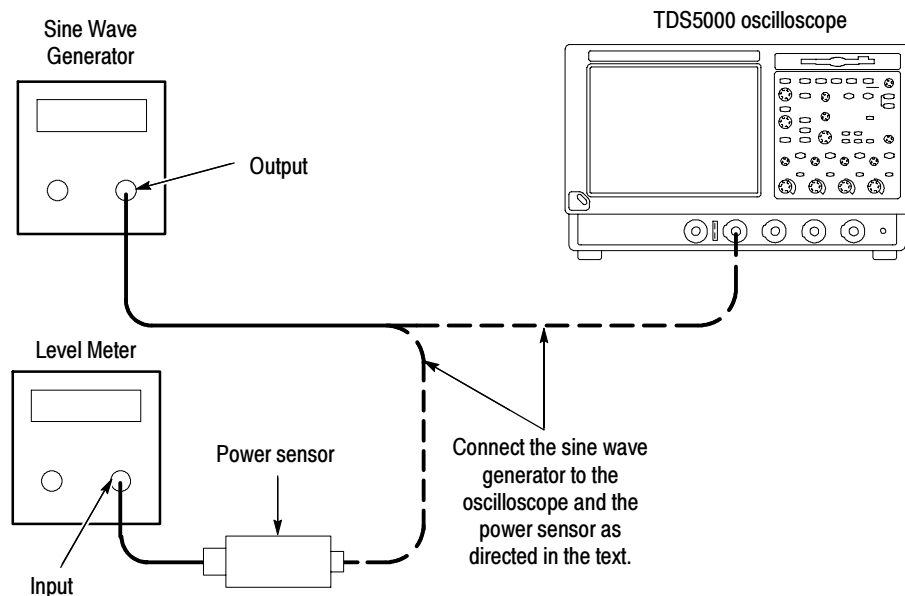


Figure 4-30: Sine wave generator leveling equipment setup (Method B)

2. Set the Generator:

- Set the sine wave generator to a reference frequency of 10 MHz.
- Adjust the sine wave generator amplitude to the required number of divisions as measured by the oscilloscope.

3. Record the reference level:

- Disconnect the sine wave generator from the oscilloscope.
- Connect the sine wave generator to the power sensor.
- Note the level meter reading.

4. Set the generator to the new frequency and reference level:

- Change the sine wave generator to the desired new frequency.
- Input the correction factor and/or the new frequency into the level meter.
- Adjust the sine wave generator amplitude until the level meter again reads the value noted in step 3. The signal amplitude is now correctly set for the new frequency for your specific test procedure.
- Disconnect the sine wave generator from the power sensor.

Connect the sine wave generator to the oscilloscope and proceed with the test instructions that require a leveled sine wave generator at the frequency you set in step 4.

Calibration Procedure

This chapter describes a sample automatic calibration procedure for your oscilloscope. The purpose of this procedure is to make internal configuration adjustments in the oscilloscope to help ensure its accuracy.

Calibration Interval

The voltage and timing references inside the oscilloscope are very stable over time and should not need routine calibration/adjustment. Before performing the procedures in this chapter, first verify that the oscilloscope does not meet specifications. Refer to *Performance Tests* on page 4-17 for a procedure to verify the specifications.

If periodic calibration is one of your requirements, a general rule is to verify performance and perform calibration (only if needed) every 2000 hours of operation or once a year if the oscilloscope is used infrequently.

Calibration Environment

The oscilloscope must be calibrated in a 20 °C to 30 °C ambient temperature environment. The oscilloscope and signal source must warm up at least 20 minutes in this environment before you begin the calibration procedure.

Calibration Dependencies

Some calibration tests may be dependent upon others. The automatic calibration procedure performs the tests in an appropriate sequence to eliminate dependency problems. Always execute the complete automatic calibration procedure. The total time to execute the procedure is approximately 45 minutes (depending somewhat on the processor speed of the controller and the type of GPIB controller — USB is much slower).

Calibration After Repair

After removal and replacement of a module due to electrical failure, you may need to perform the calibration procedure, depending on the module replaced. See Table 5-1.

Table 5-1: Calibration required for module replaced

Module replaced	Calibration required
Front panel assembly	No
Acquisition board	Yes
Processor board	Yes
Micro ATX processor assembly	No

Table 5-1: Calibration required for module replaced (Cont.)

Module replaced	Calibration required
Display panel or display system	No
Power supply	No
Interconnect boards	No
Fans	No

Required Equipment

The sample calibration procedure requires the specific test equipment and materials listed in Table 5-2.

Table 5-2: Required equipment and materials

Category	Specific equipment required	Quantity
Signal source	Wavetek 9500 Oscilloscope Calibrator, with Option 100 (high-stability time base)	1 ea
	Wavetek 9520 or 9530 Standard Output Module	4 ea
Instrument controller	PC-compatible computer with National Instruments GPIB Controller card and National Instruments NI-488.2 for Windows software, running Windows 95 or later. The PC must support Visual Basic win32 applications and be able to provide a TekVisa supported GPIB connection to the Wavetek 9500 as well as to the TDS5000 oscilloscope	1 ea
Test software	Calibration software such as the sample Visual Basic 6 program listed later in this chapter	1 ea
	TekVisa drivers. These are available on the TDS5000 Application CD	1 ea
GPIB cables	GPIB cable, 1 m minimum length, Tektronix part number 002-0991-01 or similar	2 ea

Overview of the Procedure

To execute the sample calibration program listed at the end of this chapter, you must have the specific equipment listed in Table 5-2. You must use a separate computer as the instrument controller.

The sample program allows the user to control both the Wavetek 9500 and the TDS5000 oscilloscope to achieve “Factory Calibration” of the TDS5000. There is no validation of the accuracy of the calibration performed. That is, there is no performance validation within this sample calibration program.

After the controller is set up, you need to install the TekVisa drivers from a CD-ROM that was shipped with the oscilloscope. You also need to input and compile your calibration software, such as the sample program listed later in this chapter.

The sample procedure listed is fully automated. Once the program is started, all of the steps will run without manual intervention.

Instrumentation Setup

Before you can execute the sample calibration program, you need to set up and configure the instrumentation. Make connections according to Figure 5-1.

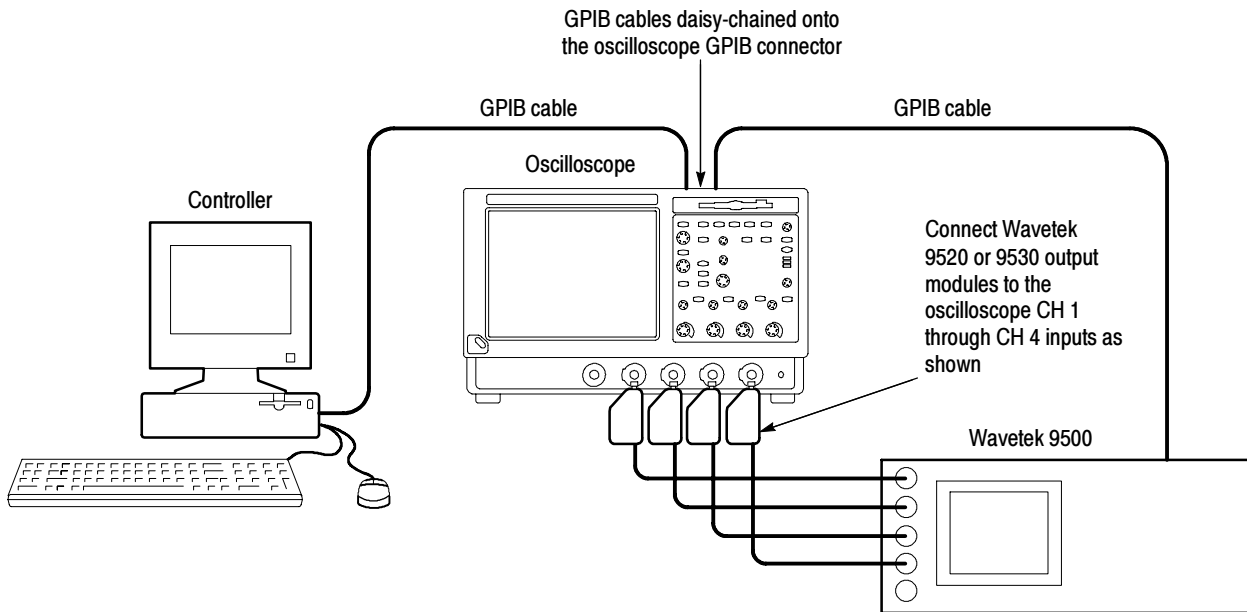


Figure 5- 1: Calibration setup

Once the connections have been made, follow these steps:

NOTE. *If you have just completed the performance verification procedure, you can skip all the following steps in this setup procedure.*

1. **Power on the instruments:** Turn power on for the controller, oscilloscope, and signal source. The oscilloscope and the signal source must warm up for 20 minutes before you can begin to execute the test. However, while you are waiting you can continue with the next steps in this procedure.
2. Ensure that the Wavetek output modules are aligned in time with each other. To do this, perform the Wavetek 95000 precision alignment 9500 channel outputs, zero skew operation. Refer to the Wavetek 9500 documentation for information about doing this procedure.
3. **Check the Wavetek 9500 GPIB address:** Refer to the Wavetek 9500 documentation for information about setting the GPIB address. If the address is set to 0 or 1, change it to an address between 2 and 30 (inclusive). Make a note of the address setting for use later in this procedure.

4. *Set the GPIB address of the oscilloscope.*
 - a. If the oscilloscope powered on in the toolbar mode (the default mode), click the **Menu** button (upper right corner of the display) to put the oscilloscope in menu-bar mode. In menu-bar mode, you should then see a PC-style menu bar across the top of the display.
 - b. Pull down the **Utility** menu and then select **GPIB Configuration** This command will display the GPIB Configuration control window.
 - c. In the GPIB Configuration control window, click the **Talk/Listen** button to select Talk/Listen mode.
 - d. Touch the **Address** readout and then click the up and down arrows or the upper multipurpose knob to set the GPIB address to 1.
 - e. Click the **Close** button to close the control window.
5. *Configure the PC controller:* Use the GPIB software and hardware on the controller as necessary to make the following settings:
 - a. Set the controller GPIB address to **0**.
 - b. Define GPIB devices and their addresses for compatibility with the test program as shown in Table 5-3.

Table 5-3: GPIB devices required by test program

Device name	GPIB address
<controller>	0
DUT1	1

Calibration Program Installation and Execution

Follow these steps to install the calibration program on the instrument controller.

1. *Locate the test program:* Locate your calibration program. You can adapt the sample program listed later in this chapter. Put the program in an appropriate location such a folder labelled `c:\programfiles\tds5000`.
2. Once the instrumentation is connected and configured, allow it to warm up for at least 20 minutes.
3. *Start the program 1:* Select **Run. . .** in the **Start** menu and then enter `c:\programfiles\tds5000\calibrate.exe` (or other appropriate designation for the disk drive, path and program name used if it is not `c:\programfiles\tds5000\calibrate.exe`). (Some PCs and controllers require quotes around the path.)
4. *Start the program 2:* Alternatively, open the directory used and then locate the your calibration program. This is the file you will double click to execute the calibration procedure.
5. For the sample program, program execution is a matter of pressing the “start calibration” button.

Calibration Program Operation

The sample calibration application has two buttons. One starts the calibration process, and one exits the application.

There are two text output windows. The first supports a scrolling step/status list. The second has an update of the current status including a display of a simple progress bar during the calibration.

Press the “Start Calibration” button: After pressing this button, all buttons become inactive until calibration is complete.

The application checks GPIB communication with the TDS5000 oscilloscope and the Wavetek 9500 to insure that it can control these devices and reports in the output window the response of these devices. As each step is performed, the output window will have test signal requirements display and, after the TDS5000 has completed that calibration step, the results will be displayed. That is a scrolling history window and the results from the complete calibration can be reviewed.

The status window will display a rough progress bar during calibration. Some calibration steps can take more than 11 minutes and the status window is only updated between steps, so be patient.

Locate your calibration program. You can adapt the sample program listed on page 5-37. Put the program in an appropriate location such as a folder labeled `c:\programfiles\tds5000`.

Commands

This section supports the GPIB commands with command definitions, syntax, return messages, and examples. The commands are divided into two groups – CALibrate and DIAGnostic.

Calibration Command Group

The calibration commands provide information about the current state of calibration. Table 5-4 lists the CALibrate commands, and descriptions and examples follow the table.

Table 5-4: CALibrate commands

Command	Description
*CAL?	Instructs the instrument to perform self-calibration
CAL?	Returns the internal and factory calibration status and the calibration due date
CALibrate:FACTory	Start the factory calibration
CALibrate:FACTory:ABOrt	Stop the factory calibration without changing the cal file
CALibrate:FACTory:CONTInue	Do the next step in the calibration procedure
CALibrate:FACTory:NOTIfy:DUE?	Return whether the factory calibration is due
CALibrate:FACTory:NOTIfy:HOuRs	Set or return the number of hours until the user is notified that the instrument is due for factory calibration
CALibrate:FACTory:NOTIfy:YEARS	Set or return the number of years until the user is notified that the instrument is due for factory calibration
CALibrate:FACTory:PREVious	Backup to the previous step/group but don't go until a CONTINUE command is sent
CALibrate:FACTory:STARt	Start the factory calibration
CALibrate:FACTory:STATus?	Return the factory calibration status
CALibrate:FACTory:STEPSTATus?	Return the status of the current calibration step
CALibrate:FACTory:STEPSTIMulus?	Return the required stimulus for this calibration step
CALibrate:PRObestate:CH<x>	Returns the calibration status of the attached probe.
CALibrate:RESults?	Returns the status of all calibration subsystems without performing an SPC operation.
CALibrate:RESults SPC?	Returns the results of the last SPC operation.

*CAL?

This query-only command instructs the digitizing oscilloscope to perform a signal path compensation and return its calibration status. This command is equivalent to selecting Instrument Calibration from the Utilities menu and then clicking the Calibrate button.

NOTE. *The self-calibration can take several minutes to respond. No other commands will be executed until calibration is complete.*

Related Commands	CALibrate:RESults:SPC?
Syntax	*CAL?
Returns	0 <NR1> indicating that the calibration did not complete successfully 1 (or any non-zero value) <NR1> indicating that the calibration completed without errors
Example	*CAL? might return 1 indicating that the calibration was successful.

CAL?

This query-only command instructs the digitizing oscilloscope to return the internal and factory calibration status and the calibration due status.

Related Commands	CALibrate:RESults:SPC?
Syntax	CAL?
Returns	0 <NR1> indicating that the calibration did not complete successfully 1 (or any non-zero value) <NR1> indicating that the calibration completed without errors

Example *CAL?
might return
*CALIBRATE:INTERNAL:STATUS PASS;:CALIBRATE:FACTORY:STATUS
PASS;NOTIFY:HOURS 2000;YEARS 1.0E0;DUE 0
indicating the internal and factory calibration status and the calibration due
status.

CALibrate:FACTory

This command starts the factory calibration. This command functions the same
as the CALibrate:FACTory:STARt command.

Syntax CALibrate:FACTory

Example CALIBRATE:FACTORY
starts the factory calibration

CALibrate:FACTory:ABOrt

This command stops the factory calibration, resets to the initialization state, and
exits without changing the calibration data.

Related Commands CALibrate:FACTory:STARt

Syntax CALibrate:FACTory:ABOrt

Example CALIBRATE:FACTORY:ABORT
stops the factory calibration

CALibrate:FACTory:CONTInue

This command does the next step in the calibration procedure. The calibration
step number is incremented on successful completion of this step. If the
calibration step fails, the step number is not incremented. You can use CALi-
brate:FACTory:CONTInue, to repeat a factory calibration step that failed.

Follow this command with `CALibrate:FACTory:STEPstatus?` to determine execution status.

If the current step is the last step and the calibration succeeds, new calibration data and pass status is saved to non-volatile memory and the oscilloscope returns to normal operation in the same state it was in before beginning factory calibration.

If the current step is the last step and any factory calibration step has failed, without a successful pass for repeated steps, a fail status will be saved to non-volatile memory. Factory calibration data will not be saved to non-volatile memory if the factory status is FAIL.

Related Commands `CALibrate:FACTory:START`

Syntax `CALibrate:FACTory:CONTInue`

Example `CALIBRATE:FACTORY:CONTINUE`
causes the instrument to execute the next step in the calibration procedure.

CALibrate:FACTory:NOTify:DUE?

This command returns whether the factory calibration is due.

Syntax `CALibrate:FACTory:NOTify:DUE?`

Returns `0 <NR1>` means that the oscilloscope is not due for factory calibration.
`1 <NR1>` means that the oscilloscope is due for factory calibration.

Example `CALIBRATE:NOTIFY:DUE?`
might return
`:CALIBRATE:FACTORY:NOTIFY:DUE 0`
signifying that factory calibration is not due.

CALibrate:FACTory:NOTify:HOURs

This command sets or returns the number of hours until the user is notified that the instrument is due for factory calibration.

Syntax CALibrate:FACTory:NOTify:HOURs {INFIinite|<NR1>}

Argument INFIinite means whatever the specified maximum is for the instrument.
<NR1> set to an integer value.

Example 1 CALIBRATE:NOTIFY:HOURS 1500
sets the calibration notification time to 1,500 hours.

Example 2 CALIBRATE:FACTORY:NOTIFY:HOURS?
might return
:CALIBRATE:FACTORY:NOTIFY:HOURS 2000
signifying that the calibration due notifier will be displayed 2000 hours after the last calibration.

CALibrate:FACTory:NOTify:YEARs

This command sets or returns the number of years until the user is notified that the instrument is due for factory calibration.

Syntax CALibrate:FACTory:NOTify:YEARs {INFIinite|<NR3>}

Argument INFIinite means whatever the specified maximum is for the instrument.
<NR1> set to a floating point value.

Example 1 CALIBRATE:FACTORY:NOTIFY:HOURS 1.5e0
sets the calibration notification time to 1.5 years.

Example 2 CALIBRATE:FACTORY:NOTIFY:HOURS?

might return

```
:CALIBRATE:FACTORY:NOTIFY:HOURS 1.5e0
```

signifying that the calibration due notifier will be displayed 1.5 years after the last calibration.

CALibrate:FACTory:PREVious

This command backs up the calibration steps one step so that the next CALibrate:FACTory:CONTInue command will repeat the factory calibration step that just finished. Repeated CALibrate:FACTory:PREVious commands can back up as many calibration steps as desired, at least until step one is reached. The appropriate notifier, with signal source information, is displayed after the factory calibration step is adjusted.

Syntax CALibrate:FACTory:PREVious

Example CALIBRATE:FACTORY:PREVIOUS

backs up the calibration steps one step.

CALibrate:FACTory:START

This command starts the factory calibration. The factory calibration process consists of a series of steps. Do not send any other commands that change the state of the oscilloscope until the calibration process is complete.

Related Commands CALibrate:FACTory:ABOrt

Syntax CALibrate:FACTory:START

Example CALIBRATE:FACTORY:START

starts the factory calibration.

CALibrate:FACTory:STATus?

This command returns the factory calibration status.

Syntax CALibrate:FACTory:STATus?

Returns FAIL if the factory calibration failed
 PASS if the factory calibration passed
 UNCAL if the factory calibration has not been run

Example CALIBRATE:FACTORY:STATUS
 might return
 :CALIBRATE:FACTORY:STATUS PASS
 indicating the factory calibration passed

CALibrate:FACTory:STEPSTATus

This command returns the status of the current calibration step.

It returns pass during oscilloscope power on without regard to actual calibration status. It returns pass or fail for the factory calibration step that most recently executed when factory calibration is in progress. Use this query to synchronize programmed factory calibration steps.

Syntax CALibrate:FACTory:STEPSTATus

Returns FAIL if the factory calibration failed
 PASS if the factory calibration passed

Example CALIBRATE:FACTORY:STEPSTATUS
 might return
 :CALIBRATE:FACTORY:STEPSTATUS FAIL
 indicating the last oscilloscope calibration step did not pass

CALibrate:FACTory:STEPSTIMulus

This command returns the required stimulus for this calibration.

Syntax CALibrate:FACTory:STEPSTIMulus

Returns Using the format: <Volts>, <Freq>, <Chan>, <Term>, <Token>

Volts <NR3> is a floating point number representing DC volts if the value for <Freq> is 0 or representing $V_{\text{peak-to-peak}}$ if the value for <Freq> is non-zero.

Freq <NR1> is the frequency in Hz of the applied waveform.

NOTE. This command typically returns the frequency of the signal in hertz. However, if it returns a frequency value of “4” then that means apply the deskew function of the Wavetek 9500 calibrator to all input channels. If it returns a “0” then apply a DC voltage.

Chan <NR1> stands for the channel.

Term <NR1> stands for the ohms of termination. For example,

8.0E-03, 0, 1, 50, C01

means apply 800 mV DC to Channel 1 with 50 ohm termination. If the query is sent before FACTORY CAL has been initialized, the returned string will be:

0.0, 0, 0, 0, END

Token is a unique string identifying the step to be done next.

CALibrate:PRObestate CH<x>?

This query-only command returns the status of the probe calibration for a probe attached to a given channel. The status can be Pass (0), Initialized (1), Fail (-1), or Running (2). The channel is specified by x. The value of x can range from 1 through 2 for two channel instruments and from 1 through 4 for four channel instruments. This command is equivalent to selecting Probe Cal from the Vertical menu.

Syntax CALibrate:PRObestate CH<x>?

Arguments <x> is the channel number the probe is attached to.

Example CALIBRATE:PROBESTATE CH1?

This query returns the status of the probe calibration for a probe attached to CH1. A query might return

:CALIBRATE:PROBESTATE:CH1 0

indicating that the probe calibration passed.

CALibrate:RESults?

This query-only command returns the status of all calibration subsystems without performing an SPC operation. The returned results do not include the calibration status of attached probes. The CALibration:RESults? query is intended to support GO/NoGO testing of the calibration readiness of the instrument: all returned results should indicate Pass status if the oscilloscope is fit for duty. It is quite common, however, to use uncalibrated probes (particularly when the instrument inputs are connected into a test system with coax cables). Not including the probe cal results prompts the instrument to perform a simple “every returned status field must be Pass” test.

This command is equivalent to selecting Instrument Calibration from the Utilities menu and then viewing the contents of the Status field.

Syntax CALibrate:RESults?

Example CALIBRATE:RESULTS?

This query returns the status of all the calibration subsystems. It might return:

:CALIBRATE:RESULTS:SPC

CALibrate:RESults:SPC?

This query-only command returns the results of the last SPC operation. However, this query does not cause an SPC to be run. This command is equivalent to selecting Instrument Calibration from the utilities menu.

Related Commands *CAL?

Syntax CALibrate:RESults:SPC?

Example CALIBRATE:RESULTS:SPC?

Returns the results of the last SPC operation.

Diagnostics Command Group

The diagnostic commands control the selection and execution of diagnostic tests. Table 5-5 lists the DIAgnostic commands. Descriptions and examples follow the table.

Table 5-5: DIAgnostic Commands

Command	Description
DIAG:CONTROL:HALT	Enables or disables halting on first diagnostic failure
DIAG:CONTROL:LOOP	Enables or disables looping of diagnostics
DIAG:EXECUTE	Executes currently selected set of diagnostics
DIAG:ITEM?	Returns all data associated with a selected menu item
DIAG:ITEM:FAILURES?	Returns the total number of failures that occurred
DIAG:ITEM:NAME?	Returns the name of the selected menu item
DIAG:ITEM:RESULT?	Returns the result of the last test executed on this item
DIAG:ITEM:SUBITEMS?	Returns the number of subitems associated with this item
DIAG:LEVEL	Sets the current level of diagnostic test hierarchy
DIAG:LOOPS?	Returns the number of times the diagnostics were completed during the last execution
DIAG:NAME?	Returns the subsystem name, area and test name of the current diagnostic test
DIAG:NAME:AREA?	Returns the selected area of the current diagnostic test
DIAG:NAME:SUBSYS?	Returns the subsystem of the current diagnostic test
DIAG:NAME:TEST?	Returns the name of the current diagnostic test
DIAG:NUMITEMS?	Returns the number of items on the currently selected level of test hierarchy
DIAG:RESuLts?	Returns a brief pass or fail status of the last test execution
DIAG:RESuLts:VERBoSe?	Returns a more explanatory message about the results of the last diagnostic execution
DIAG:SELEct:ALL	Selects all available diagnostics
DIAG:SELEct:AREA	Selects one of the available diagnostic areas
DIAG:SELEct:LAST	Sets the last item of a group of items from the same level of test hierarchy
DIAG:SELEct:SUBSYS	Selects one of the available diagnostic subsystems
DIAG:SELEct:TEST	Selects one of the available diagnostic tests
DIAG:STATE	Sets the instrument operating state

Table 5-5: DIAGnostic Commands

Command	Description
DIAG:STOP	Terminates the execution of diagnostics
TEST	Selects and executes any item at any level of the test hierarchy
TEST:RESults?	Returns a brief pass or fail status of the last test execution
TEST:RESults:VERBose?	Returns a more explanatory message about the results of the last test execution
TEST:STOP	Terminates the execution of the test

DIAG:CONTROL:HALT

This command (no query form) determines whether the next execution of diagnostics will stop on the first diagnostic failure that occurs or will execute the selected set of diagnostic functions. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu and then enabling Halt on Fail.

Related Commands DIAG:CONTROL:LOOP

Syntax DIAG:CONTROL:HALT (ON|OFF|<NR1>)

Arguments ON enables the halt function, causing the execution of diagnostics to halt at the first diagnostic failure that occurs.

OFF disables the halt function, allowing the instrument to execute the entire set of diagnostics before halting, even if a diagnostic failure occurs.

<NR1> A 0 enables the halt function; any other number disables the halt function.

Example DIAG:CONTROL:HALT ON

This command enables the halt function, causing the execution of diagnostics to halt at the first diagnostic failure that occurs.

DIAG:CONTROL:LOOP

This command (no query form) determines whether the next execution of diagnostics executes once or continuously loops on the selected set of diagnostics (assuming the halt control is set to off using the DIAG:CONTROL:HALT command or that the halt control is set to ON but no failures occur). This command is equivalent to selecting Instrument Diagnostics from the Utilities menu and then enabling Loop Control.

Related Commands DIAG:CONTROL:HALT, DIAG:STOP

Syntax DIAG:CONTROL:LOOP (ON|OFF|<NR1>)

Arguments ON enables the loop function, causing the execution of diagnostics to continuously loop.

OFF disables the loop function, causing the oscilloscope to execute the entire set of diagnostics once and then halt.

<NR1>-A 0 enables the loop function; any other number disables the loop function.

Examples DIAG:CONTROL:LOOP ON

This command enables the loop function.

DIAG:EXECUTE

This command (no query form) starts the execution of the currently selected set of diagnostics. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu and then pressing Run.

Related Commands DIAG:STATE

Syntax DIAG:EXECUTE

Example DIAG:EXECUTE

This command starts the execution of the selected set of diagnostics.

DIAG:ITEM?

This query-only command returns all the data associated with a particular menu item. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu and then reviewing the diagnostics settings.

This query can be issued while diagnostics are still in progress.

Related Commands

DIAG:ITEM:FAILURES?, DIAG:ITEM:NAME?, DIAG:ITEM:RESULT?,
DIAG:ITEM:SUBITEMS?

Syntax

DIAG:ITEM? <NR1>

Arguments

<NR1> sets the index item about which data will be returned, which ranges from 0 through 15.

Example

DIAG:ITEM? 2

This query might return:

```
:DIAG:ITEM "TRIGGER", "FAIL", 2, 7
```

DIAG:ITEM:FAILURES?

This query-only command returns the total number of failures. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu and then reviewing the Diagnostic Status.

This query can be issued while diagnostics are still in progress.

Related Commands

DIAG:ITEM?, DIAG:ITEM:NAME?, DIAG:ITEM:RESULT?, DIAG:ITEM:SUB-
ITEMS?

Syntax

DIAG:ITEM:FAILURES? <NR1>

Arguments

<NR1> sets the index item about which data will be returned, which ranges from 0 through 15.

Example DIAG:ITEM:FAILURES? 2

This query might return

 :DIAG:ITEM:FAILURES 2, 0

indicating the number of failures.

DIAG:ITEM:NAME?

This query-only command returns the name of the selected menu item. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu and then reviewing the Subsystem, Area and Test settings.

This query can be issued while diagnostics are still in progress.

Related Commands DIAG:ITEM?, DIAG:ITEM:FAILURES?, DIAG:ITEM:RESULT?,
 DIAG:ITEM:SUBITEMS?

Syntax DIAG:ITEM:NAME? <NR1>

Arguments <NR1> sets the index item about which data will be returned, which ranges from 0 through 15.

Example DIAG:ITEM:NAME? 2

This query might return

 :DIAG:ITEM:NAME 2, "TRIGGER"

indicating that the selected menu item is Trigger.

DIAG:ITEM:RESULT?

This query-only command returns the result from the last execution of the item. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu and then reviewing the Diagnostic Status.

This query can be issued while diagnostics are still in progress.

Related Commands DIAG:ITEM?, DIAG:ITEM:NAME?, DIAG:ITEM:FAILURES?,
 DIAG:ITEM:SUBITEMS?

-
- Syntax** `DIAG:ITEM:RESULT? <NR1>`
- Arguments** `<NR1>` sets the index item about which data will be returned, which ranges from 0 through 15.
- Example 1** `DIAG:ITEM:RESULT? 2`
This query might return
`:DIAG:ITEM:RESULT 2, "PASS"`
indicating that the item passed during the last execution.
- Example 2** `DIAG:ITEM:RESULT? 2`
This query might return
`:DIAG:ITEM:RESULT 2, "FAIL"`
indicating that the item failed during the last execution.
- Example 3** `DIAG:ITEM:RESULT? 2`
This query might return
`:DIAG:ITEM:RESULT 2, "*****"`
indicating that the item was not run.

DIAG:ITEM:SUBITEMS?

This query-only command returns the number of sub-items associated with the item. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu, choosing the Subsystem, Area or Test setting, and then reviewing the resulting sub-items.

This query can be issued while diagnostics are still in progress.

Related Commands `DIAG:ITEM?`, `DIAG:ITEM:NAME?`, `DIAG:ITEM:FAILURES?`,
`DIAG:ITEM:RESULT?`

Syntax `DIAG:ITEM:SUBITEMS? <NR1>`

Arguments <NR1> sets the index item about which data will be returned, which ranges from 0 through 15.

Example DIAG:ITEM:SUBITEMS? 2

This query might return

:DIAG:ITEM:SUBITEMS 2, 15

indicating that there are 15 sub-items associated with the item.

DIAG:LEVEL

This command sets or returns the currently selected level of diagnostic test hierarchy. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu and then reviewing the Diagnostic Status.

Syntax 1 DIAG:LEVEL (SUBSYS|AREA|TEST)

Syntax 2 DIAG:LEVEL?

This query form of the command can be issued while diagnostics are still in progress.

Arguments SUBSYS sets diagnostic testing to the subsystem level.

AREA sets diagnostic testing to the area level.

TEST sets diagnostic testing to the test level.

Example 1 DIAG:LEVEL AREA

sets the diagnostic testing to the area level.

Example 2 DIAG:LEVEL?

This query might return

:DIAG:LEVEL SUBSYS

indicating that the current level of diagnostic test hierarchy is Subsys.

DIAG:LOOPS?

This query-only command returns the number of times that the selected diagnostics set was completed during the last diagnostic execution. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu and then reviewing the Elapsed Count.

This command can be issued while diagnostics are still in progress.

Syntax DIAG:LOOPS?

Example DIAG:LOOPS?

This query might return

```
:DIAG:LOOPS 5
```

indicating that the selected set of diagnostics was completed 5 times during the last diagnostic execution.

DIAG:NAME?

This query-only command returns the names of the subsystem, area and test of the current diagnostic test.

This query can be issued while diagnostics are still in progress.

Related Commands DIAG:NAME:AREA?, DIAG:NAME:SUBSYS?, DIAG:NAME:TEST?

Syntax DIAG:NAME?

Example DIAG:NAME:?

This query might return

```
:DIAG:NAME:SUBSYS "Acquisition"; AREA "Memory"; TEST "DataFormat"
```

indicating the subsystem name, area name and test name of the currently selected diagnostic test.

DIAG:NAME:AREA?

This query-only command returns the selected area of the current diagnostic test. There are three levels of diagnostic test hierarchy: subsystem, area and test. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu, and then reviewing the Diagnostic Status.

This query can be issued while diagnostics are still in progress.

Related Commands DIAG:NAME?, DIAG:NAME:SUBSYS?, DIAG:NAME:TEST?

Syntax DIAG:NAME:AREA?

Example DIAG:NAME:AREA?

This query might return

```
:DIAG:NAME:AREA "Memory"
```

indicating the selected area name of the currently selected diagnostic test.

DIAG:NAME:SUBSYS?

This query-only command returns the subsystem of the current diagnostic test. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu, and then reviewing the Diagnostic Status.

This query can be issued while diagnostics are still in progress.

Related Commands DIAG:NAME?, DIAG:NAME:AREA?, DIAG:NAME:TEST?

Syntax DIAG:NAME:SUBSYS?

Example DIAG:NAME:SUBSYS?

This query might return

```
:DIAG:NAME:SUBSYS "Acquisition"
```

indicating the subsystem name of the current diagnostic test.

DIAG:NAME:TEST?

This query-only command returns the name of the current diagnostic test. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu, and then reviewing the Diagnostic Status.

This query can be issued while diagnostics are still in progress.

Related Commands DIAG:NAME?, DIAG:NAME:AREA?, DIAG:NAME:SUBSYS?

Syntax DIAG:NAME:TEST?

Example DIAG:NAME:TEST?

This query might return

```
:DIAG:NAME:TEST "diagDataFormatConf"
```

indicating the test name of the current diagnostic test.

DIAG:NUMITEMS?

This query-only command returns the number of items on the currently selected level of test hierarchy, which ranges from 1 through 15. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu, and then reviewing the Diagnostic Status.

This query can be issued while diagnostics are still in progress.

Syntax DIAG:NUMITEMS?

Example DIAG:NUMITEMS?

This query might return

```
:DIAG:NUMITEMS 7
```

indicating the number of items on the currently selected level of test hierarchy.

DIAG:RESuLts?

This query-only command returns an abbreviated status about the results of the last diagnostic (or test) execution. For a more explanatory status message, use the DIAG:RESuLts:VERBoSe query. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu, and then reviewing the Diagnostic Status.

This query can be issued while diagnostics are still in progress.

Related Commands DIAG:RESuLts:VERBoSe?

Syntax DIAG:RESuLts?

Example 1 DIAG:RESULTS?

This query might return

:DIAG:RESULTS "135"

indicating the specific failure code of the first test failure that occurred.

Example 2 DIAG:RESULTS?

This query might return

:DIAG:RESULTS "Pass"

indicating the specific failure code of the first test failure that occurred.

Example 3 DIAG:RESULTS?

This query might return

:DIAG:RESuLts "*****"

indicating the diagnostic test was not run.

DIAG:RESuLts:VERBoSe?

This query-only command returns a more explanatory message about the results of the last diagnostic (or test) execution than the DIAG:RESuLts? query. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu, and then reviewing the Diagnostic Status.

This query can be issued while diagnostics are still in progress.

Related Commands	DIAG:RESuLts?
Syntax	DIAG:RESuLts:VERBOse?
Example	DIAG:RESULTS:VERBOSE? This query might return :DIAG:RESULTS:VERBOSE "DIAG ABORTED, ERROR 15 in A2D-Dmux 1 interconnects"

DIAG:SElect:ALL

This command (no query form) selects all available diagnostics. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu, and then choosing ALL from the Subsystem, Area and Test pull-down lists.

Related Commands	DIAG:NAME:AREA?, DIAG:NAME:SUBSYS?, DIAG:NAME:TEST?, DIAG:EXECUTE
Syntax	DIAG:SElect:ALL ALL
Example	DIAG:SELECT:ALL ALL This command selects all available diagnostics.

DIAG:SElect:AREA

This command (no query form) selects one of the available areas. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu, and then choosing an Area from the pull-down lists.

NOTE. This command should only be executed if *DIAG:LEVEL* is set to *AREA*.

Related Commands	DIAG:SElect:SUBSYS?, DIAG:SElect:TEST?, DIAG:SElect:LAST
Syntax	DIAG:SElect:AREA <NR1>

Arguments <NR1> selects an area by number, which can range from 0 (zero selects all) through 15 (as specified by DIAG:NUMITEMS).

Example DIAG:SELECT:AREA 1
 This command selects Area 1 as the area to be diagnosed.

DIAG:SELEct:LAST

This command (no query form) selects one or more diagnostic menu items to be executed via the DIAG:EXECUTE command. If you specify DIAG:LEVEL:SUBSYS, then menu items come from this diagnostic level and are limited to the value returned by the DIAG:NUMITEMS? query. For example, specifying DIAG:SELECT:SUBSYS 2 and DIAG:NUMITEMS 5 indicates that diagnostics will start from subsystem 2 and that you can specify a range from 2 through 5 for DIAG:SELEct:LAST.

If you enter:
 DIAG:SELEct:LAST 2, only subsystem 2 will be executed.
 DIAG:SELEct:LAST 4, subsystems 2 *through* 4 will be executed.

Related Commands DIAG:EXECUTE, DIAG:LEVEL, DIAG:NAME:AREA?, DIAG:NAME:SUBSYS?, DIAG:NAME:TEST?, DIAG:NUMITEMS?, DIAG:SELEct:SUBSYS

Syntax DIAG:SELEct:LAST <NR1>

Arguments <NR1> selects an integer that identifies the number of the last item that will be executed when the DIAG:EXECUTE command is run.

Example DIAG:SELECT:LAST 2
 specifies that (based on the previous example, only subsystem 2 will be executed.

DIAG:SELEct:SUBSYS

This command (no query form) selects one of the available subsystems. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu and then choosing a Subsystem from the drop-down list.

NOTE. This command should be executed only if *DIAG:LEVEL* is currently set to *SUBSYS*.

Related Commands	DIAG:SElect:AREA, DIAG:SElect:TEST, DIAG:SElect:LAST
Syntax	DIAG:SElect:SUBSYS <NR1>
Arguments	<NR1> selects a subsystem by number, which can range from 0 (zero selects ALL) through 15 (as specified by Diag:NUMITEMS).
Example	DIAG:SELECT:SUBSYS selects Subsystem 1 as the subsystem to be diagnosed.

DIAG:SElect:TEST

This command (no query form) selects one of the available tests. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu and then choosing a Test from the drop down list.

NOTE. This command should be executed only if *DIAG:LEVEL* is currently set to *TEST*.

Related Commands	DIAG:SElect:AREA, DIAG:SElect:SUBSYS, DIAG:SElect:LAST
Syntax	DIAG:SElect:TEST <NR1>
Arguments	<NR1> selects a test by number, which can range from 0 (zero selects ALL) through 15 (as specified by DIAG:NUMITEMS).
Example	DIAG:SELECT:TEST 1 selects Test 1 as the test to be executed.

DIAG:STATE

This command (no query form) changes the oscilloscope operating state. Depending on the argument, diagnostics capabilities are either turned on or off. This command is equivalent to opening the DIAG:STATE dialog (ON) or closing it (OFF).

Related Commands TEST:STOP

Syntax DIAG:STATE {ON|OFF}

Arguments ON puts the instrument into the state in which diagnostics can be run. This argument is used automatically if either DIAG:EXECUTE or DIAG:TEST commands are executed.

OFF disables diagnostics capabilities and returns the oscilloscope to a normal operating state.

Example DIAG:STATE OFF

turns off diagnostics capabilities and returns the instrument to a normal operating state.

DIAG:STOP

This command (no query form) causes diagnostics (or test) execution to terminate at the end of the next low-level test. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu and then clicking Abort.

Related Commands TEST:STOP

Syntax DIAG:STOP

Example DIAG:STOP

terminates diagnostics (or test) execution at the end of the next low-level test.

TEST

This command (no query form) provides the ability to select and execute an item at any level of the test hierarchy (Test, Area or Subsystem). This command is equivalent to selecting Instrument Diagnostics from the Utilities menu, choosing a test and then pressing Run.

NOTE. *Turning off both `DIAG:CONTROL:HALT` and `DIAG:CONTROL:LOOP` before executing the `TEST` command is recommended.*

Syntax	TEST <NR3>
Arguments	<NR3> sets the test ID, which ranges from 0 through 3 characters. If no test ID is specified, all available diagnostics are executed.
Example 1	TEST "1" executes all Acquisition tests (Subsystem: Acquisition)
Example 2	TEST "11" executes all Acquisition Memory tests (Subsystem: Acquisition, Area:Memory)
Example 3	TEST "113" executes a specific Acquisition Memory test (Subsystem: Acquisition, Area: Memory, Test: Address Lines).

TEST:RESuLts?

This query-only command returns an abbreviated status about the results of the last TEST execution. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu and then reviewing the Diagnostic Status.

Related Commands	TEST, TEST:RESuLts:VERBoSe?
Syntax	TEST:RESuLts?
Example 1	TEST:RESULTS?

might return

```
:TEST:RESULTS "135"
```

indicating the specific failure code of the first test failure.

Example 2 TEST:RESULTS?

might return

```
:TEST:RESULTS "PASS"
```

indicating the previously executed test passed

Example 3 TEST:RESULTS?

might return

```
:TEST:RESULTS "*****"
```

indicating the test was not run.

TEST:RESuLts:VERBose?

This query-only command returns a more explanatory message about the results of the last TEST execution than the TEST:RESuLts query.

Related Commands TEST, TEST:RESuLts?

Syntax TEST:RESuLts:VERBose?

Example TEST:RESULTS:VERBOSE?

might return

```
:TEST:RESULTS:VERBOSE DIAG ABORTED, ERROR 15 in A2D-Dmux 1  
interconnects"
```

TEST:STOP

This command (no query form) causes test (or diagnostics) execution to terminate at the end of the next low-level test. This command is equivalent to selecting Instrument Diagnostics from the Utilities menu and then clicking Abort.

Related Commands DIAG:STOP

Syntax TEST:STOP

Example TEST:STOP

Sample Calibration Program

This section includes a listing of a sample calibration program. It is written in Microsoft Visual Basic 6.

Tektronix provides this listing as is with no warranties of any kind, specifically excluding warranties of merchantability and fitness for a particular purpose. Tektronix, Inc. assumes no liability of any kind for your use of this software.

Listing

```
VERSION 5.00
Object = "{DFEB0DA3-D648-11D4-9C5F-EA48B7E9393D}#1.0#0"; "tvc.ocx"
Begin VB.Form frmMain
    AutoRedraw      = -1 'True
    Caption         = "Calibrator for TDS5000"
    ClientHeight    = 4884
    ClientLeft      = 48
    ClientTop       = 324
    ClientWidth     = 8184
    LinkTopic       = "Form1"
    ScaleHeight     = 4884
    ScaleWidth      = 8184
    StartupPosition = 3 'Windows Default
    Begin TVCLib.Tvc TvcWaveTek
        Left        = 3600
        Top         = 2760
        _Version    = 65536
        _ExtentX    = 847
        _ExtentY    = 847
        _StockProps = 0
        VisaDescriptor = "GPIB0::1::INSTR"
        Timeout     = 10000
    End
    Begin TVCLib.Tvc TvcScope
        Left        = 2400
        Top         = 2760
        _Version    = 65536
        _ExtentX    = 847
        _ExtentY    = 847
        _StockProps = 0
        VisaDescriptor = "GPIB0::1::INSTR"
    End
End
```

```
    Timeout      = 10000
End
Begin VB.CommandButton cmdPlay
    Caption      = "Start Calibration"
    Enabled      = 0 'False
    Height       = 492
    Left         = 600
    TabIndex     = 5
    ToolTipText  = "Start Calibration"
    Top         = 4080
    Width       = 1572
End
Begin VB.TextBox txtSignal
    BeginProperty Font
        Name      = "Lucida Console"
        Size      = 7.8
        Charset   = 0
        Weight    = 400
        Underline = 0 'False
        Italic    = 0 'False
        Strikethrough = 0 'False
    EndProperty
    Height       = 372
    Left        = 600
    Locked      = -1 'True
    TabIndex    = 4
    ToolTipText = "Provide this signal to the TDS5000"
    Top        = 3360
    Width      = 7092
End
Begin VB.ListBox lstOutput
    Height       = 2160
    Left        = 480
    TabIndex    = 1
    Top        = 480
    Width      = 7212
End
Begin VB.CommandButton cmdExit
    Cancel      = -1 'True
    Caption     = "E&xit"
    Height      = 492
    Left       = 6120
    TabIndex   = 0
    ToolTipText = "Stop calibrator program"
    Top       = 4080
    Width     = 1572
End
```

```

Begin VB.Label lblSignal
    Caption       = "Status"
    Height        = 252
    Left          = 600
    TabIndex      = 3
    Top           = 3000
    Width         = 1572
End
Begin VB.Label lblOutput
    Caption       = "Output from TDS5000"
    Height        = 252
    Left          = 480
    TabIndex      = 2
    Top           = 120
    Width         = 2052
End
End
Attribute VB_Name = "frmMain"
Attribute VB_GlobalNameSpace = False
Attribute VB_Creatable = False
Attribute VB_PredeclaredId = True
Attribute VB_Exposed = False
' $Header: $
'
' DESCRIPTION:
' The Calibrator is an application that runs on a PC. The PC must support
' visual basic win32 application and provide a TekVisa supported GPIB connection
' to the WaveTek 9500 as well as the TDS5000 instrument. The Calibrator will allow
' the user to control both of these devices to achieve "Factory Calibration" of the
' TDS5000. There will be no validation of the accuracy of the calibration performed
' (no PV). The GPIB interface hardware in the PC has to be able to act as a GPIB
' controller.
'
'
' Original Author:      Tektronix, Inc.
Option Explicit
Dim strEndOfCal As String ' The token string produced by tekScope when
                          ' calibration is finished
Dim devFound As Boolean  ' Has the GPIB devices been found before?
Dim calInitDone As Boolean ' Has the tekScope been told that we are going
                          ' to do factory calibration?
Dim calPassedLastStep As Boolean ' use to allow one retry on a cal step
Dim srcGrounded As Boolean ' tracks if the WaveTek is set in Ground mode
Dim reqVolts As Double   ' voltage needed for the next step
Dim reqChannel As Integer ' channel needed for the next step
Dim reqFreq As Double    ' frequency needed for the next step
Dim reqTermination As Double ' termination in Ohms needed for the next step

```

```

Dim reqStepName As String      ' name of the next step
Dim stepNumber As Integer     ' cal step number
Dim calFailed As Boolean      ' did calibration fail?
' Subroutine to scan for the devices needed.
' tekScope and waveTek devices should be found or we won't be able to complete
' calibration of the oscilloscope.
Private Sub findDevices()
    Dim i As Integer
    Dim dev As Variant
    Dim strResult As String
    Dim strGPIBtekscope As String ' name of tekScope GPIB connection
    Dim strGPIBwavetek As String ' name of WaveTek GPIB connection

    If devFound = False Then ' only need to find the device names once.
        strGPIBwavetek = ""
        strGPIBtekscope = ""
        txtSignal.Text = "Please wait: Initializing"

        TvcScope.SearchCriterion = 0 ' search all devices
                                   ' get detected VISA devices
        dev = TvcScope.FindList
                                   ' populate devices listbox

        If IsArray(dev) Then
            For i = LBound(dev) To UBound(dev)
                If Left(dev(i), 4) = "GPIB" Then
                    lstOutput.AddItem dev(i)
                End If
            Next
        End If

        ' Set to first GPIB device since no internal device found
        For i = 0 To lstOutput.ListCount - 1
            If Left(lstOutput.List(i), 4) = "GPIB" Then
                lstOutput.ListIndex = i
                TvcScope.Descriptor = lstOutput.Text
                strResult = TvcScope.Query("*IDN?")
                Debug.Print strResult
                If Left(strResult, 14) = "TEKTRONIX,TDS5" Then
                    strGPIBtekscope = lstOutput.Text
                    lstOutput.AddItem "tekScope is " & strResult
                End If
                If Left(strResult, 16) = "Wavetek Ltd,9500" Then
                    strGPIBwavetek = lstOutput.Text
                    lstOutput.AddItem "Wavetek is " & strResult
                End If
            End If
        Next
        If strGPIBtekscope = "" Then

```



```
        MsgBox "failed to find TekScope"
    End
End If
TvcScope.Descriptor = strGPIBtekscope
If strGPIBwavetek = "" Then
    MsgBox "failed to find WaveTek 9500"
    End
End If
TvcWaveTek.Descriptor = strGPIBwavetek
txtSignal.Text = "TekScope Ready"
devFound = True
1stOutput.ListIndex = 1stOutput.ListCount - 1
End If
End Sub
' Function to wait for Operation Complete to happen
' from the tekScope.
Private Function tekScopeOPC() As Boolean
    Dim opc As Integer
    Dim strOPC As String
    Dim count As Integer

    On Error Resume Next

    opc = 0
    count = 0
    While (opc <> 1) And (count < 1000)
        Sleep 1000
        strOPC = ""
        strOPC = TvcScope.Query("*OPC?")
        If Len(strOPC) > 0 Then
            opc = Asc(strOPC) - Asc("0")
        Else
            opc = 0
        End If
        count = count + 1
    Wend
    If count > 10 Then
        Debug.Print "OPC happened after " & count & " seconds."
    End If
    If opc <> 1 Then
        Debug.Print "Timed out trying to get OPC on tekScope."
        tekScopeOPC = False
    Else
        tekScopeOPC = True
    End If
End Function
' Resets the WaveTek 9500 to default mode.
```

```

Private Sub resetWaveTek()
    Dim count As Integer
    Dim opc As Integer
    Dim strOPC As String
    Dim esr As Integer
    TvcWaveTek.WriteString "*CLS"
    TvcWaveTek.WriteString "*RST"
    count = 0
    strOPC = TvcWaveTek.Query("*OPC?")
    If Len(strOPC) > 0 Then
        opc = Asc(strOPC) - Asc("0")
    Else
        opc = 0
    End If
    While (opc <> 1) And (count < 20)
        Sleep 1000
        strOPC = TvcWaveTek.Query("*OPC?")
        If Len(strOPC) > 0 Then
            opc = Asc(strOPC) - Asc("0")
        Else
            opc = 0
        End If
        count = count + 1
    Wend
    If opc <> 1 Then
        Debug.Print "Unable to reset calibrator."
        Exit Sub
    Else
        Sleep 1000
        esr = TvcWaveTek.Query("*ESR?")
        If esr <> 0 Then
            Debug.Print "Non-zero event status after *RST from waveTek 9500. " & _
                "*ESR? returned: " & esr
        End If
    End If
    srcGrounded = False
End Sub
' Sets the WaveTek 9500 signal to the needed value for the next cal step
Private Sub setWaveTek()
    Dim strCommand As String

    TvcWaveTek.WriteString "OUTPUT OFF"
    If reqVolts > 2.9 Then ' make sure we won't get an overload error
        TvcWaveTek.WriteString "ROUTE:SIGNAL:IMPEDANCE 1000000"
    End If
    Select Case reqFreq
        Case 0

```

```

Debug.Print "use " & reqVolts & " DC signal on channel " & reqChannel & _
    " term: " & reqTermination & " ohms"
TvcWaveTek.WriteString "SOUR:FUNC:SHAPE DC"
If reqVolts = 0 Then
    strCommand = "SOUR:PAR:DC:GROUND ON"
    srcGrounded = True
Else
    If srcGrounded = True Then
        srcGrounded = False
        strCommand = "SOUR:PAR:DC:GROUND OFF"
        TvcWaveTek.WriteString strCommand
    End If
    strCommand = "SOUR:VOLTAGE " & reqVolts
End If
TvcWaveTek.WriteString strCommand
strCommand = "ROUTE:SIGNAL:PATH CH" & reqChannel
TvcWaveTek.WriteString strCommand
strCommand = "ROUTE:SIGNAL:IMPEDANCE " & reqTermination
TvcWaveTek.WriteString strCommand
Case 4
    Debug.Print "use deskew signal"
    TvcWaveTek.WriteString "SOUR:FUNC:SHAPE SKEW"
    TvcWaveTek.WriteString "SOUR:PAR:SKEW:ALIG PREC"
    TvcWaveTek.WriteString "SOUR:FREQ:FIX 1000000"
    TvcWaveTek.WriteString "ROUT:SIGN:SKEW CH1, ON"
    TvcWaveTek.WriteString "ROUT:SIGN:SKEW CH2, ON"
    TvcWaveTek.WriteString "ROUT:SIGN:SKEW CH3, ON"
    TvcWaveTek.WriteString "ROUT:SIGN:SKEW CH4, ON"
    TvcWaveTek.WriteString "ROUT:SIGN:SKEW CH5, ON"
Case Else
    Debug.Print "use AC signal"
    TvcWaveTek.WriteString "SOUR:FUNC:SHAPE SIN"
    strCommand = "SOURCE:FREQ " & reqFreq
    TvcWaveTek.WriteString strCommand
    strCommand = "SOUR:VOLT " & reqVolts
    TvcWaveTek.WriteString strCommand
    strCommand = "ROUTE:SIGNAL:PATH CH" & reqChannel
    TvcWaveTek.WriteString strCommand
    strCommand = "ROUTE:SIGNAL:IMPEDANCE " & reqTermination
    TvcWaveTek.WriteString strCommand
End Select
TvcWaveTek.WriteString "OUTPUT ON"
Sleep 1000
End Sub
' Subroutine parses the information from the TDS5000 as to the required signal
' for the next calibration step.

```

```

Private Sub updateSignal(strRequired As String)
    Dim strSignal() As String
    Dim strMessage As String
    Dim stepStrLen As Integer
    Dim stepStr As String          ' text progress bar

    If strRequired = strEndOfCal Then
        lstOutput.AddItem "Calibration complete"
        calInitDone = False
        Exit Sub
    End If
    strSignal = Split(strRequired, ",")
    reqVolts = Mid(strSignal(0), 2)
    reqFreq = strSignal(1)
    reqChannel = strSignal(2)
    reqTermination = strSignal(3)
    reqStepName = strSignal(4)

    strMessage = reqVolts & " volts "
    If reqFreq = 0 Then
        strMessage = strMessage & " DC "
    Else
        strMessage = strMessage & reqFreq & " AC "
    End If
    strMessage = strMessage & "channel " & reqChannel & " "
    If reqTermination = 1000000 Then
        strMessage = strMessage & "1 Meg Ohms"
    Else
        strMessage = strMessage & reqTermination & " Ohms"
    End If

    stepStrLen = 2
    stepStr = "[]"
    If Left(reqStepName, 3) = "S01" Then
        stepStrLen = 24
        stepStr = "[   long operation   ]"
    End If
    If Left(reqStepName, 3) = "D01" Then
        stepStrLen = 10
        stepStr = "[   wait   ]"
    End If
    txtSignal.Text = "[" & String(stepNumber, "+") & stepStr & String(110 - (stepNumber + step-
StrLen), ".") & "]"
    txtSignal.Refresh
    stepNumber = stepNumber + 1
    If Left(reqStepName, 3) = "S01" Then
        stepNumber = stepNumber + 23
    End If
End Sub

```

```

End If
If Left(reqStepName, 3) = "D01" Then
    stepNumber = stepNumber + 9
End If
lstOutput.AddItem "Provide the following signal: " & strMessage
lstOutput.ListIndex = lstOutput.ListCount - 1
lstOutput.Refresh
End Sub
' Subroutine turns on the correct buttons for the current mode of operation at
' the end of the calibration step.
Private Sub turnOnButtons()
    cmdPlay.Enabled = True
    cmdExit.Enabled = True
End Sub
' Subroutine to turn off the buttons that will not work during the current
' calibration step.
Private Sub turnOffButtons()
    cmdPlay.Enabled = False
    cmdExit.Enabled = False
End Sub
' Subroutine to handle the Exit button.
' This button is only available during single step mode or before calibration
' has started.
Private Sub cmdExit_Click()
    End
End Sub
' Subroutine to handle the Next step.
Private Sub cmdNextStep()
    Dim strResult As String

    turnOffButtons
    setWaveTek
    TvcScope.WriteString ":CALIBRATE:FACTORY CONTINUE"
    If tekScopeOPC = False Then
        Debug.Print "factory calibration step did not complete"
        Exit Sub
    End If
    Sleep 1000
    strResult = TvcScope.Query(":CALIBRATE:FACTORY:STEPSTATUS?")
    If Left(strResult, 4) = "PASS" Then
        lstOutput.AddItem "Passed step " + reqStepName
        calPassedLastStep = True
        Sleep 1000
        strResult = TvcScope.Query("CALIBRATE:FACTORY:STEPSTIMULUS?")
        updateSignal (strResult)
        Debug.Print strResult
    Else
        If calPassedLastStep = False Then

```

Sample Calibration Program

```
        calFailed = True
        calInitDone = False
    Else
        Debug.Print "Will retry last step"
    End If
    lstOutput.AddItem "Failed step " + reqStepName
    calPassedLastStep = False
End If
lstOutput.ListIndex = lstOutput.ListCount - 1
turnOnButtons
End Sub
' Subroutine to handle the Play button.
' This will place the TDS5000 in factory calibration mode and if single step
' mode is not active repeatedly do next step until calibration is complete.
Private Sub cmdPlay_Click()
    Dim strResult As String
    Dim str20Blanks

    turnOffButtons
    findDevices
    calPassedLastStep = True
    calFailed = False
    stepNumber = 0
    txtSignal.Text = "Starting Calibration"
    txtSignal.Refresh
    resetWaveTek
    TvcScope.WriteString ":CALIBRATE:FACTORY ABORT"
    If tekScopeOPC = False Then
        Debug.Print "factory calibration abort command did not complete"
        turnOnButtons
        Exit Sub
    End If
    strEndOfCal = TvcScope.Query("CALIBRATE:FACTORY:STEPSTIMULUS?")
    txtSignal.Text = strEndOfCal
    lstOutput.AddItem "Ending string will be " & strEndOfCal
    Debug.Print strEndOfCal
    TvcScope.WriteString "CALIBRATE:FACTORY START"
    txtSignal.Text = "TekScope Reset"
    If tekScopeOPC = False Then
        Debug.Print "factory calibration start did not complete"
        Exit Sub
    End If
    Sleep 1000
    strResult = TvcScope.Query("CALIBRATE:FACTORY:STEPSTIMULUS?")
    txtSignal.FontSize = 5
    updateSignal (strResult)
    Debug.Print strResult
```

```
calInitDone = True
While calInitDone = True
    cmdNextStep
Wend
txtSignal.FontSize = 8
strResult = TvcScope.Query(":CALIBRATE:FACTORY:STATUS?")
' If strResult = "PASS" Then
If calFailed = False Then
    lstOutput.AddItem "Calibration of TDS5000 succeeded"
    txtSignal.Text = "Calibration of TDS5000 succeeded"
Else
    lstOutput.AddItem "Calibration of TDS5000 failed"
    txtSignal.Text = "Calibration of TDS5000 failed"
End If
turnOnButtons
End Sub
Private Sub Form_Activate()
    txtSignal.Text = "Calibrator is Ready"
    turnOnButtons
End Sub
Private Sub Form_Load()
    devFound = False
    calInitDone = False
End Sub
```


Maintenance

This section contains the information needed to do periodic and corrective maintenance on the oscilloscope. The following subsections are included:

- **Preventing ESD** — General information on preventing damage by electrostatic discharge.
- *Inspection and Cleaning* — Information and procedures for inspecting the oscilloscope and cleaning its external and internal modules.
- *Removal and Installation Procedures* — Procedures for the removal of defective modules and replacement of new or repaired modules. Also included is a procedure for disassembly of the oscilloscope for cleaning.
- *Troubleshooting* — Information for isolating failed modules. Included are instructions for operating the oscilloscope diagnostic routines and troubleshooting trees. Most of the trees make use of the internal diagnostic routines to speed fault isolation to a module.
- **Repackaging Instructions** — Information on returning an oscilloscope for service.

Preventing ESD

Before servicing this product, read the *Safety Summary* and *Introduction* at the front of the manual and the ESD information below.



CAUTION. *Static discharge can damage any semiconductor component in this oscilloscope.*

When performing any service which requires internal access to the oscilloscope, adhere to the following precautions to avoid damaging internal modules and their components due to electrostatic discharge (ESD).

1. Minimize handling of static-sensitive circuit boards and components.
2. Transport and store static-sensitive modules in their static protected containers or on a metal rail. Label any package that contains static-sensitive boards.
3. Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these modules. Do service of static-sensitive modules only at a static-free work station.

4. Nothing capable of generating or holding a static charge should be allowed on the work station surface.
5. Handle circuit boards by the edges when possible.
6. Do not slide the circuit boards over any surface.
7. Avoid handling circuit boards in areas that have a floor or work-surface covering capable of generating a static charge.

Inspection and Cleaning

Inspection and Cleaning describes how to inspect for dirt and damage. It also describes how to clean the exterior and interior of the oscilloscope. Inspection and cleaning are done as preventive maintenance. Preventive maintenance, when done regularly, may prevent oscilloscope malfunction and enhance its reliability.

Preventive maintenance consists of visually inspecting and cleaning the oscilloscope and using general care when operating it.

How often to do maintenance depends on the severity of the environment in which the oscilloscope is used. A proper time to perform preventive maintenance is just before oscilloscope adjustment.

General Care

The cabinet helps keep dust out of the oscilloscope and should normally be in place when operating the oscilloscope.

Interior Cleaning

Use a dry, low-velocity stream of air to clean the interior of the chassis. Use a soft-bristle, non-static-producing brush for cleaning around components. If you must use a liquid for minor interior cleaning, use a 75% isopropyl alcohol solution and rinse with deionized water.



WARNING. Before performing any procedure that follows, power off the instrument and disconnect it from line voltage.

Exterior Cleaning

Clean the exterior surfaces of the chassis with a dry lint-free cloth or a soft-bristle brush. If any dirt remains, use a cloth or swab dipped in a 75% isopropyl alcohol solution. Use a swab to clean narrow spaces around controls and connectors. Do not use abrasive compounds on any part of the chassis that may damage the chassis.

Clean the On/Standby switch using a dampened cleaning towel. Do not spray or wet the switch directly.



CAUTION. Avoid the use of chemical cleaning agents which might damage the plastics used in this oscilloscope. Use only deionized water when cleaning the menu buttons or front-panel buttons. Use a 75% isopropyl alcohol solution as a cleaner and rinse with deionized water. Before using any other type of cleaner, consult your Tektronix Service Center or representative.

Inspection — Exterior. Inspect the outside of the oscilloscope for damage, wear, and missing parts, using Table 6-1 as a guide. Immediately repair defects that could cause personal injury or lead to further damage to the oscilloscope.

Table 6-1: External inspection check list

Item	Inspect for	Repair action
Cabinet, front panel, and cover	Cracks, scratches, deformations, damaged hardware	Repair or replace defective module
Front-panel knobs	Missing, damaged, or loose knobs	Repair or replace missing or defective knobs
Connectors	Broken shells, cracked insulation, and deformed contacts. Dirt in connectors	Repair or replace defective modules. Clear or wash out dirt
Carrying handle, and cabinet feet	Correct operation	Repair or replace defective module
Accessories	Missing items or parts of items, bent pins, broken or frayed cables, and damaged connectors	Repair or replace damaged or missing items, frayed cables, and defective modules

Flat Panel Display Cleaning

The display is a soft plastic display and must be treated with care during cleaning.



CAUTION. Improper cleaning agents or methods can damage the flat panel display.

Avoid using abrasive cleaners or commercial glass cleaners to clean the display surface.

Avoid spraying liquids directly on the display surface.

Avoid scrubbing the display with excessive force.

Clean the flat panel display surface by gently rubbing the display with a clean-room wipe (such as Wypall Medium Duty Wipes, #05701, available from Kimberly-Clark Corporation).

If the display is very dirty, moisten the wipe with distilled water or a 75% isopropyl alcohol solution and gently rub the display surface. Avoid using excess force or you may damage the plastic display surface.



CAUTION. To prevent getting moisture inside the oscilloscope during external cleaning, use only enough liquid to dampen the cloth or applicator.

Inspection — Interior. To access the inside of the oscilloscope for inspection and cleaning, refer to the *Removal and Installation Procedures* in this section.

Inspect the internal portions of the oscilloscope for damage and wear, using Table 6-2 as a guide. Defects found should be repaired immediately.

If any circuit board is replaced, check Table 6-2 in Section 5 to see if it is necessary to adjust the oscilloscope.



CAUTION. To prevent damage from electrical arcing, ensure that circuit boards and components are dry before applying power to the oscilloscope.

Table 6-2: Internal inspection check list

Item	Inspect for	Repair action
Circuit boards	Loose, broken, or corroded solder connections. Burned circuit boards. Burned, broken, or cracked circuit-run plating.	Remove and replace damaged circuit board.
Resistors	Burned, cracked, broken, blistered condition.	Remove and replace damaged circuit board.
Solder connections	Cold solder or rosin joints.	Resolder joint and clean with isopropyl alcohol.
Capacitors	Damaged or leaking cases. Corroded solder on leads or terminals.	Remove and replace damaged circuit board.
Semiconductors	Loosely inserted in sockets. Distorted pins.	Firmly seat loose semiconductors. Remove devices that have distorted pins. Carefully straighten pins (as required to fit the socket), using long-nose pliers, and reinsert firmly. Ensure that straightening action does not crack pins, causing them to break off.

Table 6-2: Internal inspection check list (Cont.)

Item	Inspect for	Repair action
Wiring and cables	Loose plugs or connectors. Burned, broken, or frayed wiring.	Firmly seat connectors. Repair or replace modules with defective wires or cables.
Chassis	Dents, deformations, and damaged hardware.	Straighten, repair, or replace defective hardware.

Cleaning Procedure — Interior. To clean the oscilloscope interior, do the following steps:

1. Blow off dust with dry, low-pressure, deionized air (approximately 9 psi).
2. Remove any remaining dust with a lint-free cloth dampened in isopropyl alcohol (75% solution) and rinse with warm deionized water. (A cotton-tipped applicator is useful for cleaning in narrow spaces and on circuit boards.)

STOP. *If, after doing steps 1 and 2, a module is clean upon inspection, skip the remaining steps.*

3. If steps 1 and 2 do not remove all the dust or dirt, the oscilloscope may be spray washed using a solution of 75% isopropyl alcohol by doing steps 4 through 8.
4. Gain access to the parts to be cleaned by removing easily accessible shields and panels (see *Removal and Installation Procedures*).
5. Spray wash dirty parts with the isopropyl alcohol and wait 60 seconds for the majority of the alcohol to evaporate.
6. Use hot (120 °F to 140 °F) deionized water to thoroughly rinse them.
7. Dry all parts with low-pressure, deionized air.
8. Dry all components and assemblies in an oven or drying compartment using low-temperature (125 °F to 150 °F) circulating air.

Lubrication. There is no periodic lubrication required for this oscilloscope.

Removal and Installation Procedures

This subsection contains procedures for removal and installation of all mechanical and electrical modules.

Preparation



WARNING. Before doing this or any other procedure in this manual, read the Safety Summary found at the beginning of this manual. Also, to prevent possible injury to service personnel or damage to the oscilloscope components, read Installation in Section 2, and Preventing ESD in this section.

This subsection contains the following items:

- This preparatory information that you need to properly do the procedures that follow.
- List of tools required to remove all modules.
- Procedures for removal and reinstallation of the electrical and mechanical modules.
- A disassembly procedure for removal of all the major modules from the oscilloscope at one time and for reassembly of those modules into the oscilloscope. Instructions for doing the actual cleaning are found under *Inspection and Cleaning* at the beginning of this section.



WARNING. Before doing any procedure in this subsection, disconnect the power cord from the line voltage source. Failure to do so could cause serious injury or death.

NOTE. Read Equipment Required for a list of the tools needed to remove and install modules in this oscilloscope. See Table 6-3, page 6-8. Read the cleaning procedure before disassembling the oscilloscope for cleaning.

Equipment Required. Most modules in the TDS5000 Digital Oscilloscope can be removed with a screwdriver handle mounted with a size T-15, Torx® screwdriver tip. *Use this tool whenever a procedure step instructs you to remove or install a screw unless a different size screwdriver is specified in that step.* All equipment required to remove and reinstall each module is listed in the first step of its procedure.

Table 6-3: Tools required for module removal

Item no.	Name	Description	General tool number
1	Screwdriver handle	Accepts Torx®-driver bits	620-440
2	T-10 Torx tip	Used for removing the electrical or optical module chassis. Torx®-driver bit for T-10 size screw heads	640-235
3	T-15 Torx tip	Used for removing most oscilloscope screws. Torx®-driver bit for T-15 size screw heads	640-247
4	1/8 inch flat-bladed screwdriver	Screwdriver for unlocking cable connectors	Standard tool
5	#0 phillips screwdriver	Screwdriver for removing small phillips screws, CD, floppy & hard drive	Standard tool
6	Angle-Tip Tweezers	Used to remove front panel knobs	Standard tool
7	3/16 inch open-end wrench	Used to remove the rear panel nut posts	Standard tool
8	5/16 inch open-end wrench	Used to remove the rear panel nut posts	Standard tool
9	MA-800G Soldering Aid	Used to remove the front panel trim	Standard tool

Procedures for External Modules

The following procedures are found here and are listed in order presented.

- Line Cord
- Front Panel Knobs
- Trim (all)
- Bottom cover
- Left and Right covers

Line cord

1. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its rear is facing you.
2. *Remove the line cord:* Pull the line cord away from the AC power connector.

Front-Panel Knobs

1. *Assemble equipment and locate modules to be removed:*
2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its front is facing you.
3. *Remove the knob(s):* Grasp the knob you want to remove and pull it straight out from the front panel $\frac{1}{4}$ inch to create some clearance between the base of the knob and the front panel. Insert the angled-tip tweezers between the knob and front panel and use them to remove the knob. See Figure 6-1 on page 6-10.
4. *Reinstallation:* To reinstall, align knob to shaft and push it in until it snaps.



CAUTION. To prevent damage to the encoders located on the circuit board, apply pressure to the encoders while pushing the knob on the shaft.

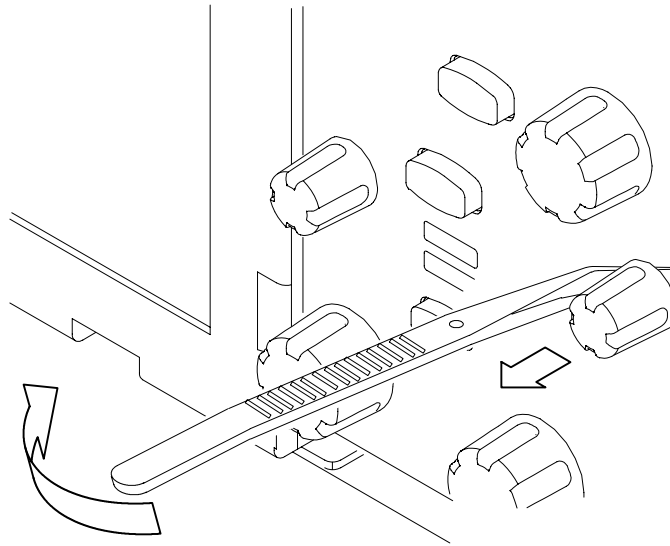


Figure 6-1: Knob removal

Trim and Carrying Handle

1. *Locate module to be removed:* Locate the Trim in the locator diagram. See Figure 6-2, page 6-12.
2. *Remove the carrying handle and the left side panel:* Use Figure 6-2, page 6-12 as a guide.
 - a. Remove the two T-15 Torxdrive screws that secure the handle to the oscilloscope. Remove the handle from the oscilloscope.
 - b. Slide the left side panel towards the rear of the oscilloscope allowing the tabs to clear the cover openings, then pull out to remove the panel from the oscilloscope.

NOTE. For many service operations you do not need to remove the left panel.

3. *Remove the right side panel:* Use Figure 6-2, page 6-12 as a guide.
 - a. Remove the CD Drive trim by inserting a flat blade screwdriver in the bottom slot of the CD trim and gently prying the trim piece out of the side panel. Pull the trim up and out from the oscilloscope.
 - b. Slide the right side panel towards the rear of the oscilloscope allowing the tabs to clear the cover openings, then pull out to remove the panel from the oscilloscope.
4. *Remove the VGA panel:* Use Figure 6-2, page 6-12 as a guide.

- a. Remove the VGA panel by gently pulling the trim up and out from the oscilloscope.
5. *Remove the top cover:* Use Figure 6-2, page 6-12 as a guide.
 - a. Remove the accessory tray door or printer door.
 - b. Remove the accessory tray or internal printer (two T-15 Torxdrive screws).
 - c. If the internal printer is installed, disconnect the cable from the printer.
 - d. Remove the feet from the top rear of the oscilloscope by removing the two T-15 Torxdrive screws.
 - e. Slide the top cover towards the rear of the oscilloscope allowing the tabs to clear the cover openings, then pull out to remove the cover from the oscilloscope.
6. *Remove the front panel trim:*
 - a. To prevent the power button from falling out of the front panel trim, place a piece of tape over the button.
 - b. Remove the three T-15 Torxdrive screws that secure the front panel trim to the oscilloscope.
 - c. Grasp the trim ring by its top edge and pull toward you to detach the three plastic snaps. (Alternatively, you can use a flat-bladed solder aid or other small prying tool to help you detach the snaps.)
 - d. Grasp the trim ring by its side edges and slide it back and forth to release the snap in the middle of the trim ring. The snap is at the bottom “T” of the front panel above the channel 1 and 2 BNC’s.
 - e. Pull off the trim ring. As you do so, take care not to lose the 3 pem inserts in the bottom of the trim ring.
7. *Remove the acquisition trim:* Use Figure 6-2, page 6-12 as a guide.
 - a. Remove the acquisition trim from the oscilloscope.
8. *Reinstallation:* Do in reverse steps 2 through 4 to reinstall the appropriate trim.

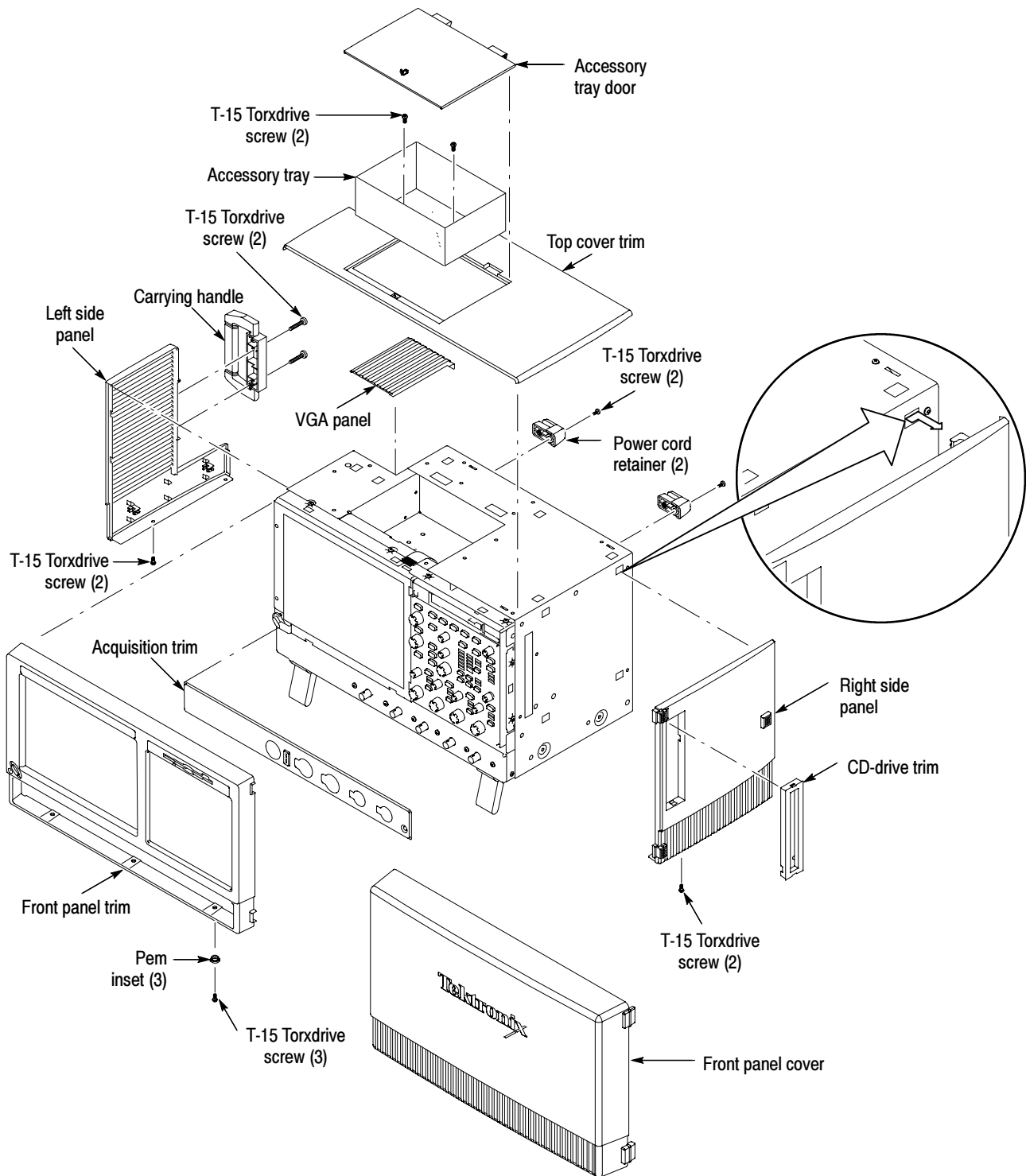
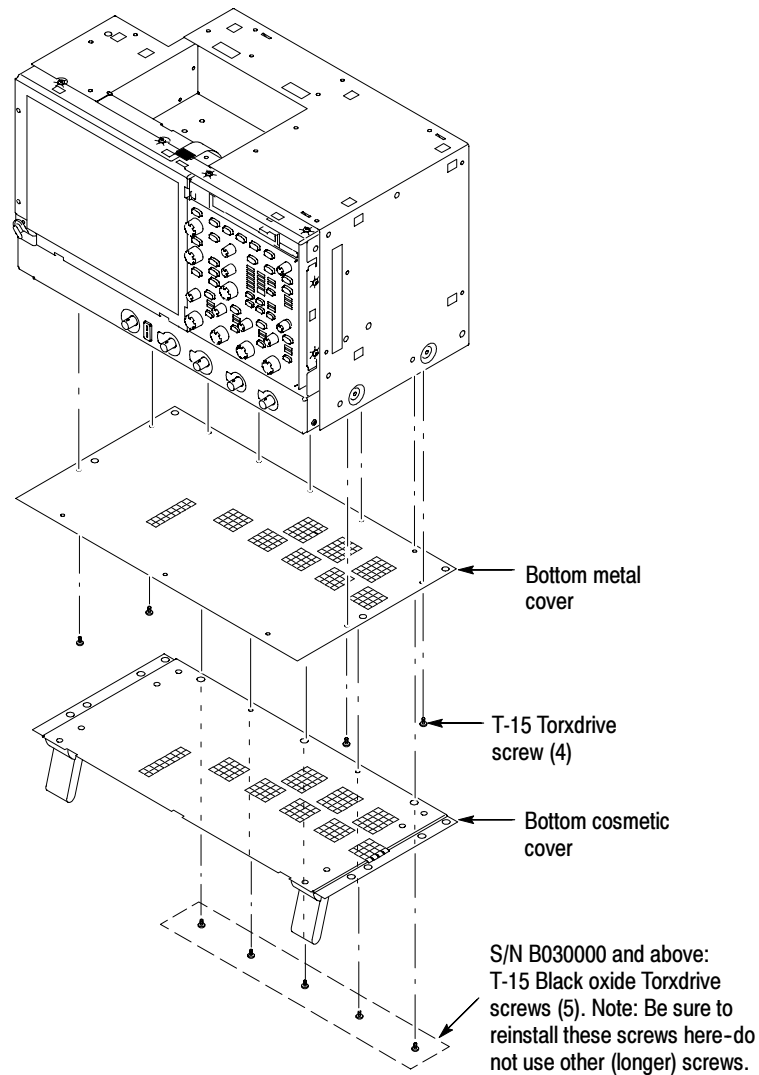


Figure 6-2: Trim removal

Bottom Covers

1. *Remove the bottom covers:* See Figure 6-3.
2. *Orient the oscilloscope:* Set the oscilloscope so its top is down on the work surface and its bottom is facing you.
 - a. Remove the two T-15 Torxdrive screws that secure the bottom cosmetic cover to the oscilloscope, and remove the cover.
 - b. Remove the seven T-15 Torxdrive screws that secure the bottom metal cover to the oscilloscope, and remove the cover.
3. *Reinstallation:* Do in reverse steps a through b to reinstall the bottom covers. Be sure to properly locate the 5 black screws (if present; see Figure 6-3).

**Figure 6-3: Bottom cover removal**

Right-Side Cover

1. *Remove the right-side cover:* See Figure 6-4.
 - Trim (all)
 - Bottom cover
2. *Orient the oscilloscope:* Set the oscilloscope so its rear is on the work surface and the front of the oscilloscope facing you.

NOTE. All mounting screw holes are indicated by a star etched around the mounting hole.

- a. Remove the fourteen T-15 Torxdrive screws that secure the right-side cover to the top and right sides of the chassis.
- b. Remove the right-side cover.



CAUTION. Take care not to bind or snag the covers on the oscilloscope internal cabling as you remove or install.

3. *Reinstallation:* Do in reverse steps a through b to reinstall the right-side cover. Be sure to properly locate the black screw (if present; see Figure 6-4).

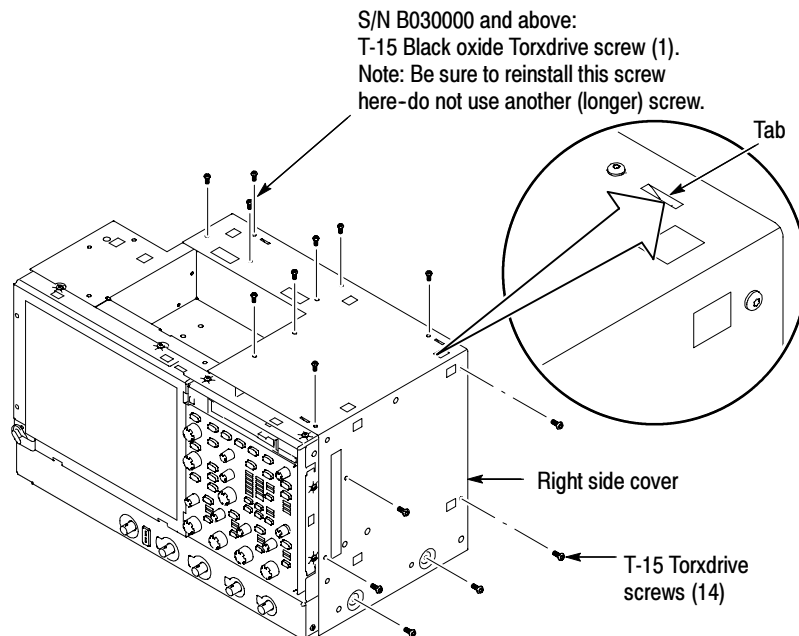


Figure 6-4: Right-side cover removal

Printer Frame

1. *Remove the printer frame:* See Figure 6-5.
 - CD-Rom Trim
 - Right-side panel
 - Printer or accessory tray
 - Top two rear feet
 - Top cover trim
 - Right-side cover
2. *Orient the oscilloscope:* Set the oscilloscope so its rear is on the work surface and the front of the oscilloscope facing you.
 - a. Remove the four T-15 Torxdrive screws that secure the printer frame to the chassis.
 - b. Remove the two T-15 Torxdrive screws that secure the cable restraint to the printer frame.
 - c. Remove the printer frame from the chassis.



CAUTION. *Take care not to bind or snag the covers on the oscilloscope internal cabling as you remove or install components.*

3. *Reinstallation:* Do in reverse steps a through c to reinstall the cabinet covers.

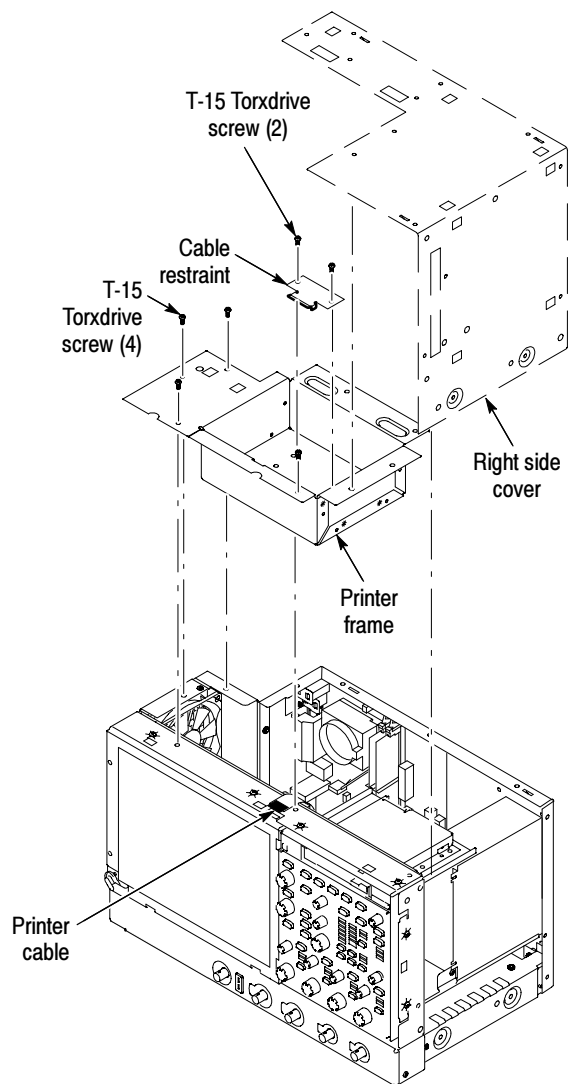


Figure 6-5: Printer frame removal

4. Reverse the procedure to reinstall.

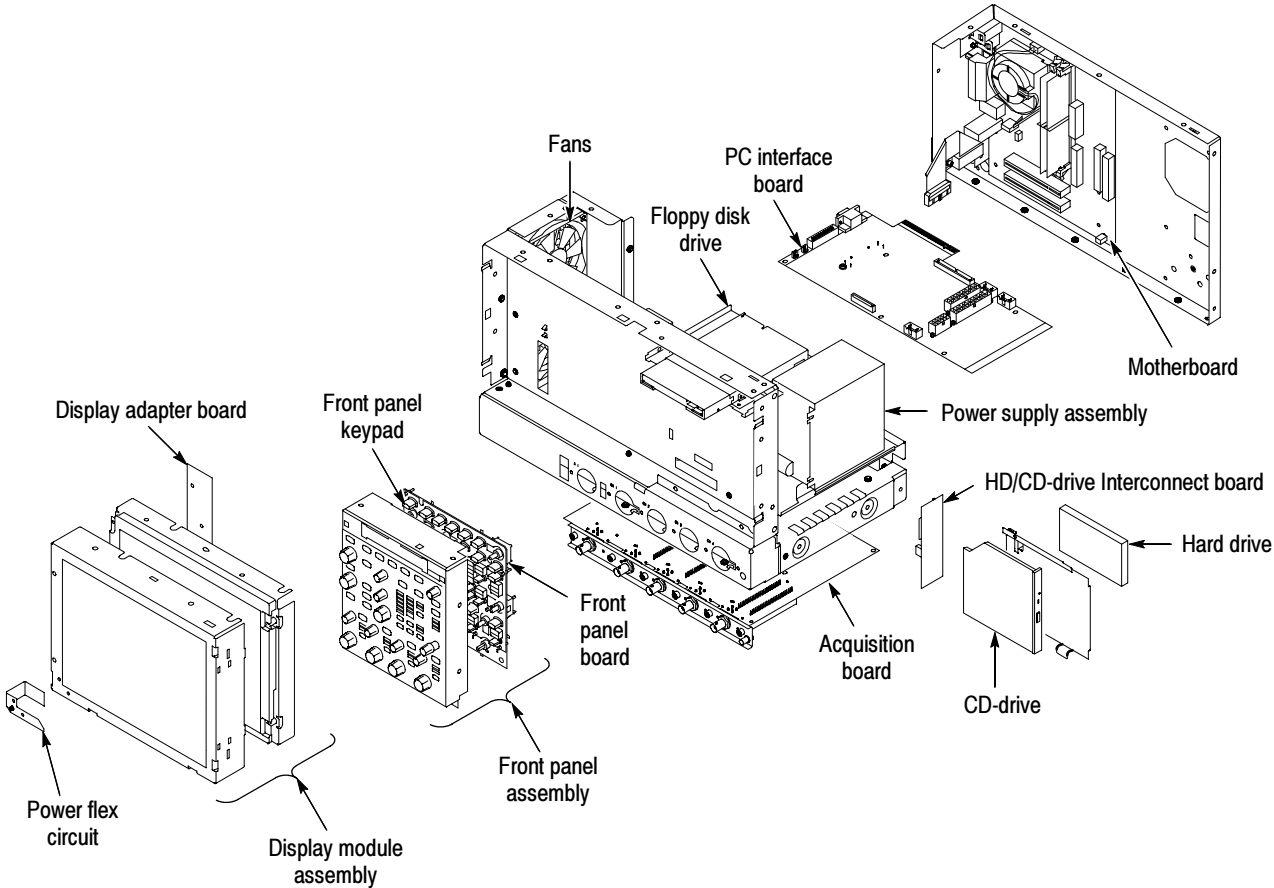


Figure 6-6: Internal modules

Procedures for Modules

You should have completed the *Procedures For External Modules* before doing many of the procedures in this collection. The procedures found here are listed in disassembly order:

- Front Panel assembly
- Front Panel Board
- Front Panel Keypad
- Display assembly
- Display Adapter Board
- On/Standby Switch Flex Circuit
- Floppy Disk Drive
- Hard Disk Drive
- CD Drive
- Fan assembly
- Power Supply
- Motherboard
- PC Interface Board
- Acquisition Board

Front Panel Assembly

1. *Locate module to be removed:* Locate the Front-Panel assembly in Figure 6-7, on page 6-19. Additional modules to be removed:
 - Trim (Front-Panel)
2. *Remove the Front-Panel assembly:* See Figure 6-7, page 6-19.
3. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its front panel is facing you.
 - a. Remove the six T-15 Torx screws that secure the Front-Panel assembly to the front chassis.
 - b. Grasp the top of Front Panel assembly and pull forward to allow access to the ribbon-cable connector on the Front-Panel Board.
 - c. Use the $\frac{1}{8}$ inch flat-bladed screwdriver to carefully lift the J1 cable connector lock up to disconnect J1 flex cable from the display module

assembly. See Figure 6-8, page 6-20. Note the pin 1 index mark on the connector and the black stripe on the cable for later reassembly.

- d. Pull the Front-Panel assembly forward and remove from the oscilloscope.
4. *Reinstallation:* Do in reverse steps a through d to reinstall the Front-Panel assembly.

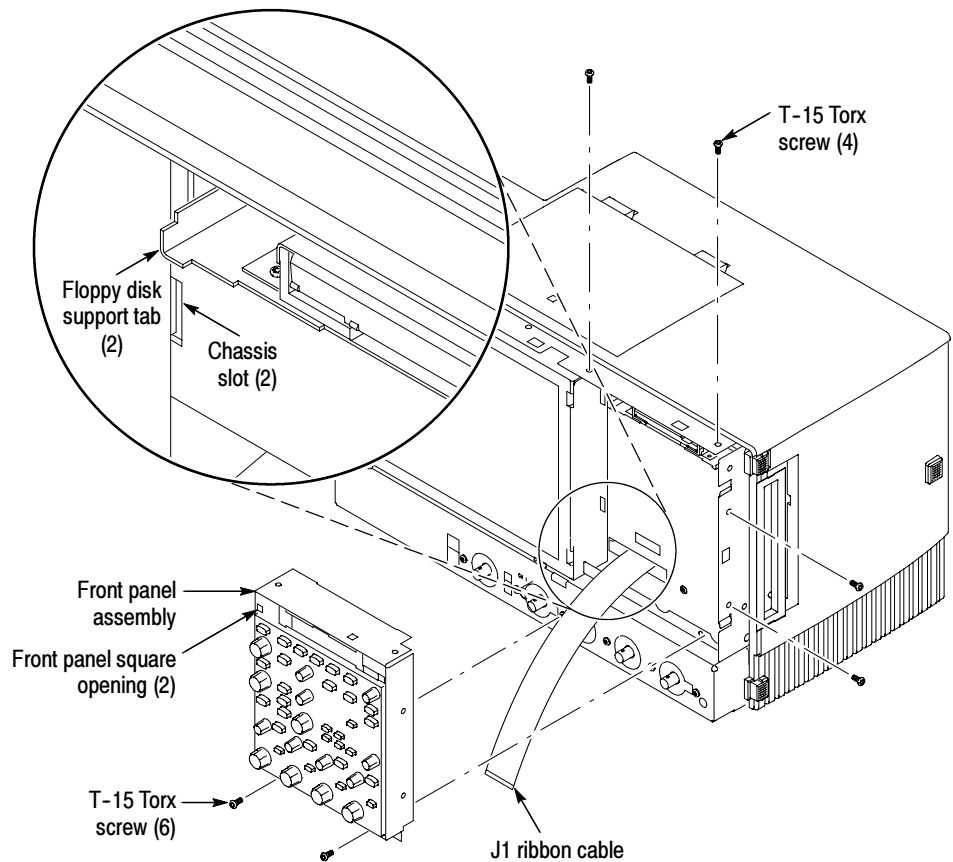


Figure 6-7: Front-panel assembly removal

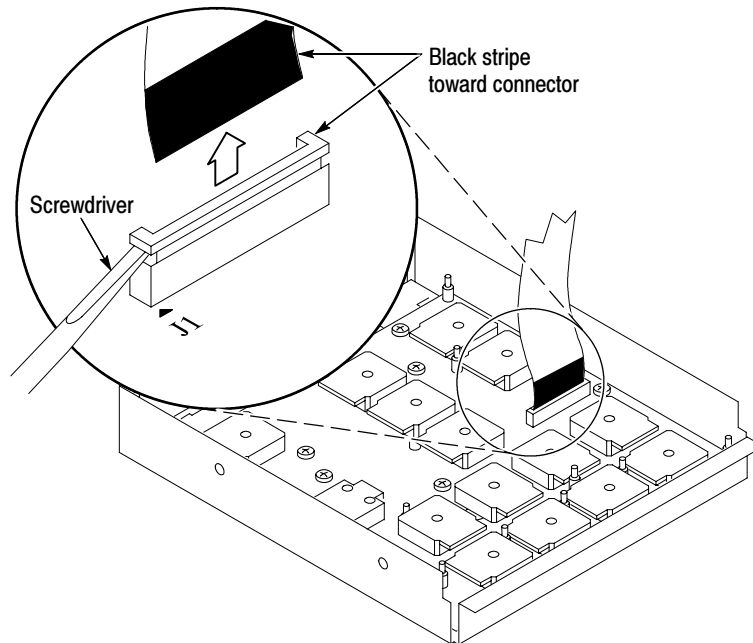


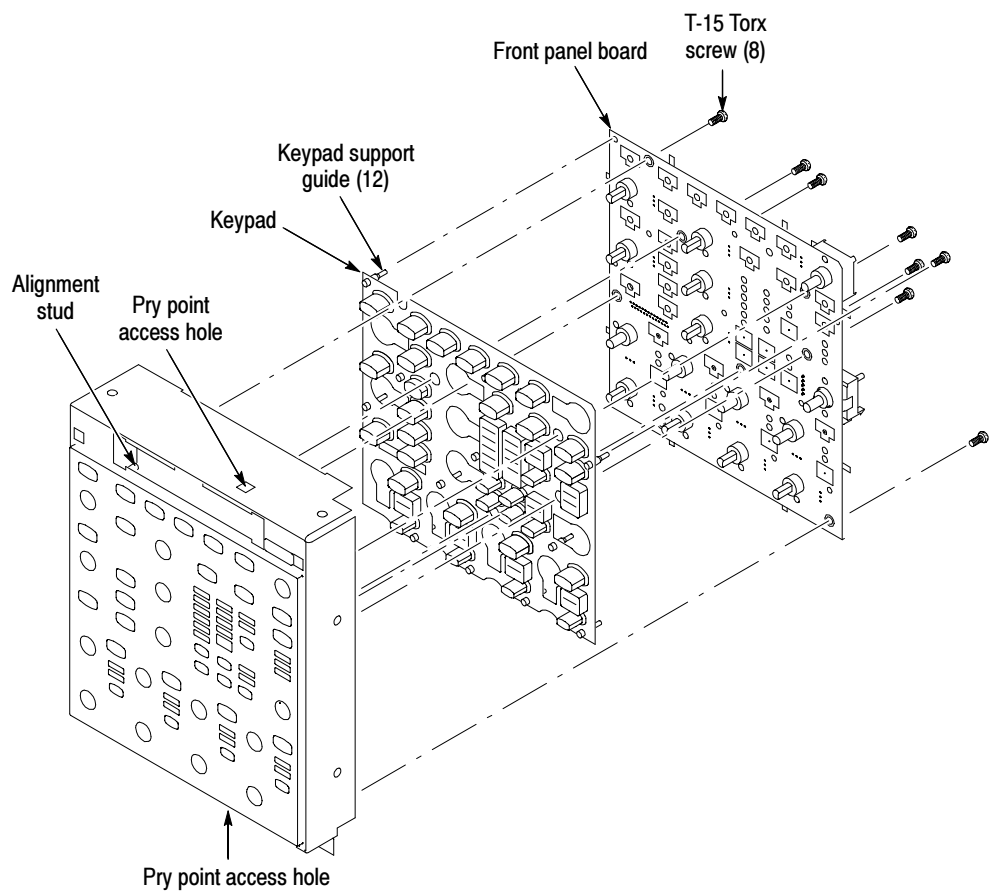
Figure 6-8: J1 flex cable connector removal

Front Panel Board

1. *Locate module to be removed:* Locate the Front Panel assembly Figure 6-7, page 6-19. Additional modules to be Removed:
 - Front Panel Knobs
 - Trim (front panel)
 - Front Panel assembly
2. *Remove the Front Panel board:* See Figure 6-9, page 6-21.
 - a. Remove the eight T-15 Torx screws that secure the Front Panel board to the Front Panel assembly.
 - b. Pry the board up off the alignment studs. Place a flat-bladed screwdriver in the pry-point access holes to pry the board up from the assembly.
 - c. Remove the board from the assembly.
3. *Reinstallation:* Do in reverse steps a through c to reinstall the Front Panel board.

Front Panel Keypad

1. *Locate module to be removed:* Locate the Front Panel assembly in Figure 6-7, on page 6-19. Additional modules to be removed:
 - Front Panel Knobs
 - Trim (front panel)
 - Front Panel assembly
 - Front Panel Board
2. *Remove the Front Panel keypad:* See Figure 6-9.
 - a. Pull on each of the keypad support guides to separate the keypad from the Front Panel board. Use a pair of tweezers or equivalent tool to pull the twelve keypad support guides.
 - b. Remove the keypad from the Front Panel board.

**Figure 6-9: Front panel board and keyboard removal**



CAUTION. *When removing or installing the keypad, make sure you do not touch the switch contacts with your fingers. The oils in your fingers will degrade or damage the switch contacts. To help prevent damage to the keypad use cotton gloves when removing or installing the keyboard pad.*

3. *Reinstallation:* Do in reverse step 2 to reinstall the keypad, front panel board, and the front panel assembly. Then see the following instructions:
 - a. Make sure the keypad is aligned properly on the Front Panel board.
 - b. Make sure the ribbon cable is routed correctly when installing the Front Panel into the chassis.
 - c. Insert the two floppy disk support tabs into the front panel square openings. Both left front panel tabs must go into the chassis slots. See Figure 6-7, page 6-19.

Display Assembly

1. *Locate module to be removed:* Locate the Display assembly, Figure 6-10, page 6-23. *Additional modules to be Removed:*
 - Trim (front panel & top)
2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its front panel is facing you.



CAUTION. *To avoid damage to the front panel Standby/On switch assembly, do not set the Display module assembly on a work surface. Sliding the oscilloscope over the edge of the work surface could break off the On/Standby switch assembly.*

3. *Remove the Display assembly:* See Figure 6-10, page 6-23.
 - a. Remove the four T-15 Torx screws that secure the display assembly to the chassis.
 - b. Grasp the display assembly at the finger reliefs located at the top-right and bottom-left corners of the display assembly and pull forward far enough to allow access to the flex cable connector.
 - c. Disconnect J5 flex cable from the display assembly. Remove the display module assembly from the oscilloscope. See Figure 6-10, page 6-23.

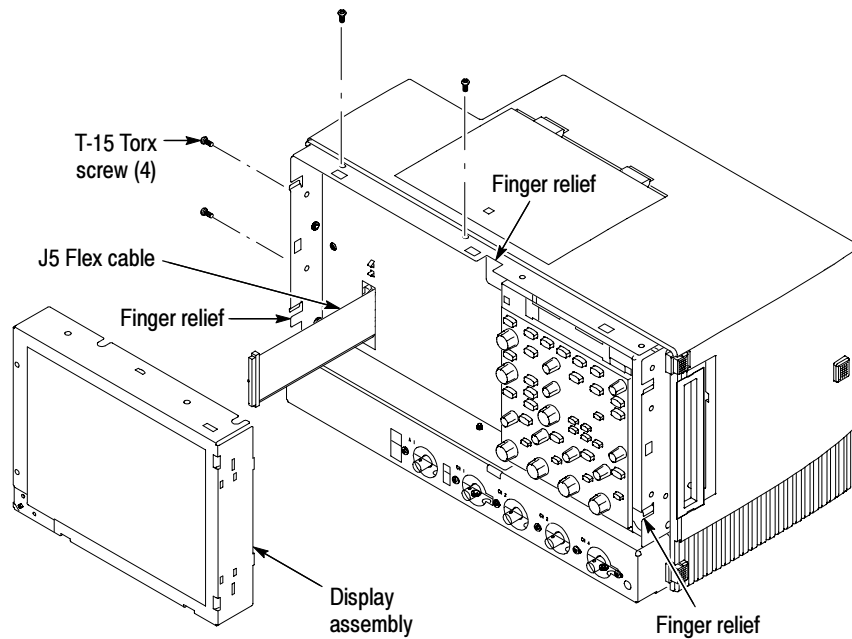


Figure 6-10: Display removal

4. *Remove the Touch panel from the Display assembly:* See figures 6-11 and 6-12, on pages 6-24 and 6-25.



CAUTION. *To prevent degradation of the display sharpness, this procedure must be performed in a dust free environment. The service technician should wear cotton gloves to prevent finger oils from contaminating any surfaces of the display glass.*

- a. Disconnect cables J1 and J7 from the Display Adapter circuit board.
- b. Separate the assembly by carefully prying the (outer) Touch panel assembly from the (inner) Display assembly. Insert a flat-bladed screwdriver in the access notches to push out on the Touch panel assembly.

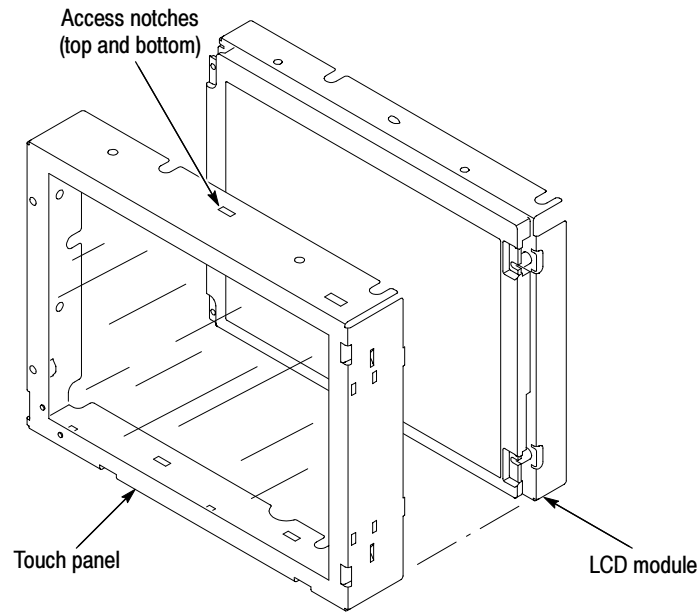


Figure 6-11: Touch panel and Display assembly removal

5. *Reinstallation:* Do in reverse steps 1 through 5 to reinstall the Display assembly.

Display Adapter Board

1. *Locate module to be removed:* Locate the display adapter board in the locator diagram *Internal Modules*, Figure 6-6, on page 6-17. Additional modules to be Removed:
 - Trim (front panel & top)
 - Display assembly
2. *Remove the Display Adapter Board:* See Figure 6-12, pages 6-25.
 - a. Disconnect cables J1, J6, J5, and J7 from the Display Adapter board.
 - b. Slide the connector clip, if present, off of J4.
 - c. Disconnect cable J4 from the Display Adapter board.
 - d. Remove the three T-15 Torx screws that secure the Display Adapter circuit board to the Display assembly. Remove the Display Adapter from the assembly.
3. *Reinstallation:* Do in reverse steps a and d to reinstall the board.

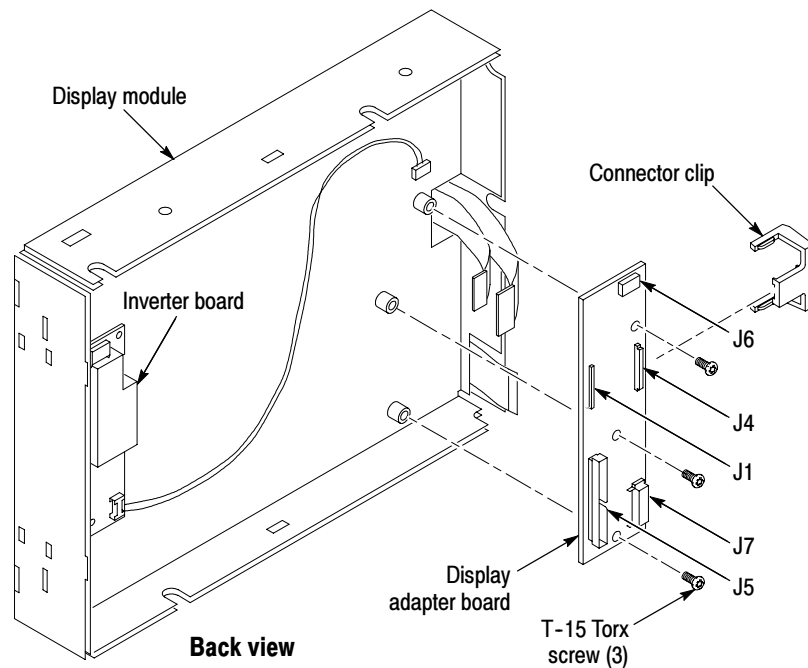


Figure 6-12: Display adapter board removal

On/Standby Switch Power Flex Circuit Removal

1. *Locate module to be removed:* Locate the On/Standby Switch power flex circuit in the locator diagram *Internal Modules*, Figure 6-6, page 6-17. Additional modules to be removed:
 - Trim (front panel)
 - Display assembly
2. *Orient the assembly:* Set the display adapter so its back is down on the work surface and its front is facing you.
3. *Remove the On/Standby Switch power flex circuit:* See Figure 6-13, on page 6-26.
 - a. Peel the On/Standby switch power flex circuit away from the front of the display assembly.
 - b. Disconnect the flex circuit from J7 on the Display Adapter circuit board.
 - c. Grasp the flex circuit and pull it out of the Display assembly.
4. *Reinstallation:* Do following procedure to reinstall the On/Standby Switch.
 - a. Remove the protective backing on the power flex circuit.

- b. Slide the connector end of the power flex circuit through the slot in the Display assembly. Make sure the flex circuit connector aligns with J7 on the Display Adapter circuit board.
- c. Align the holes in the power flex circuit to the two index posts on the front side of the Display assembly.
- d. Firmly press the flex circuit to the Display assembly chassis surface.

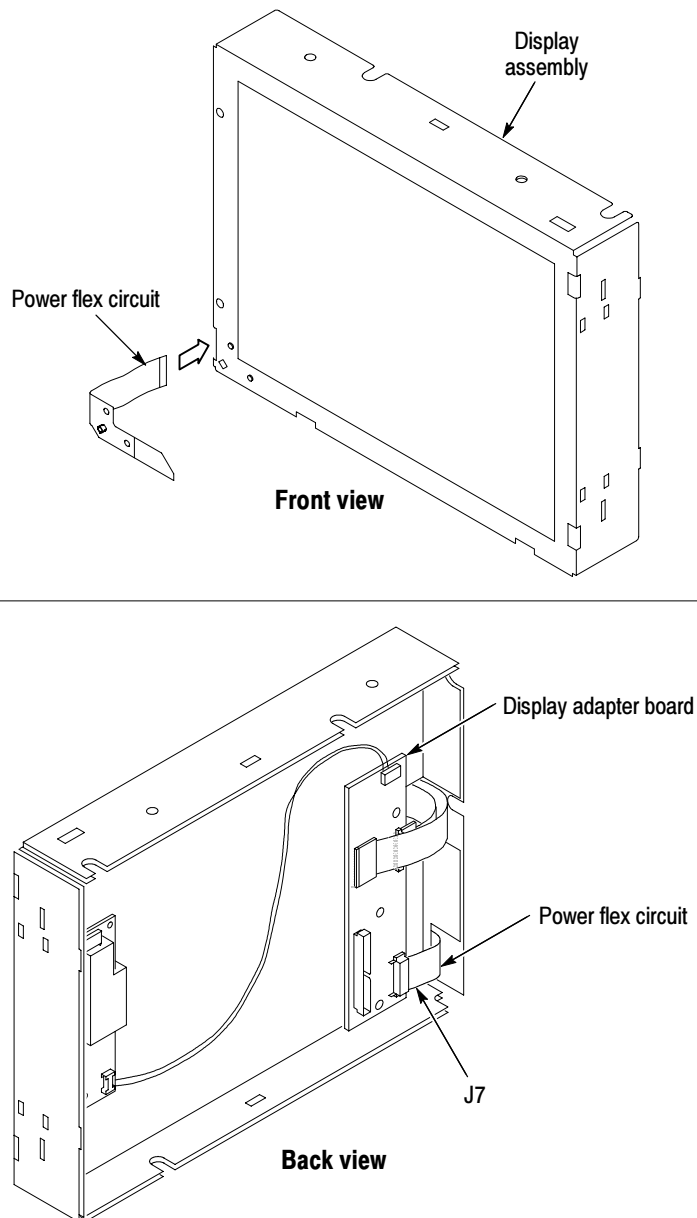
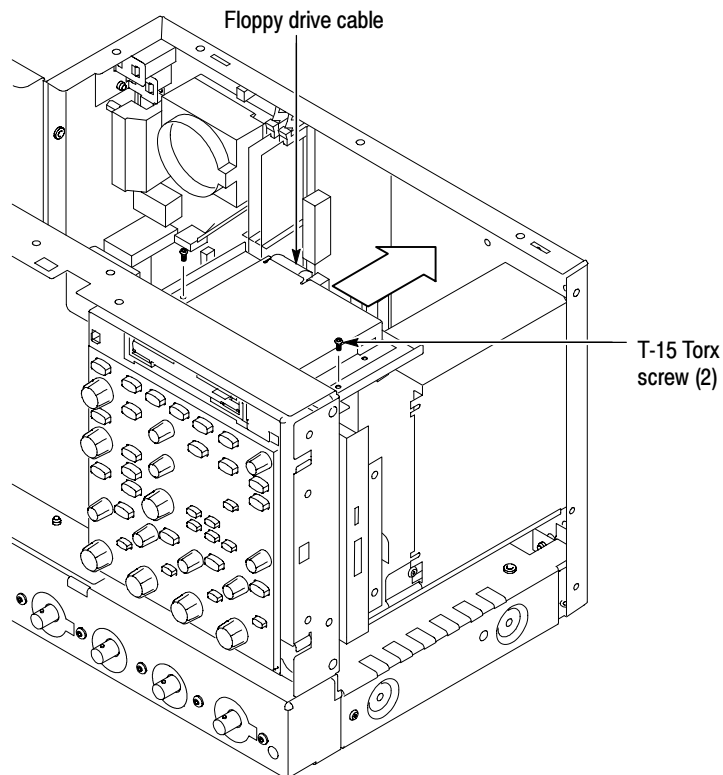


Figure 6-13: Power flex circuit removal

Floppy Disk Drive

1. *Locate modules to be removed:* Locate the Floppy Disk Drive in the locator diagram *Internal Modules*, Figure 6-6, page 6-17. Additional modules to be Removed:
 - Trim (front panel)
 - Cover (top)
2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its front panel is facing you.
3. *Remove the floppy disk drive:* Use Figure 6-14 as a guide. A #0 phillips screwdriver is required for this procedure.
 - a. Remove the cable from the back of the floppy disk drive.
 - b. Remove the two T-15 Torx screws that secure the floppy disk drive assembly to the chassis.

**Figure 6-14: Floppy disk drive assembly removal**

- c. Remove the two small phillips screws that secure the floppy disk drive assembly to the bracket.

- d. Remove the floppy drive from the bracket.

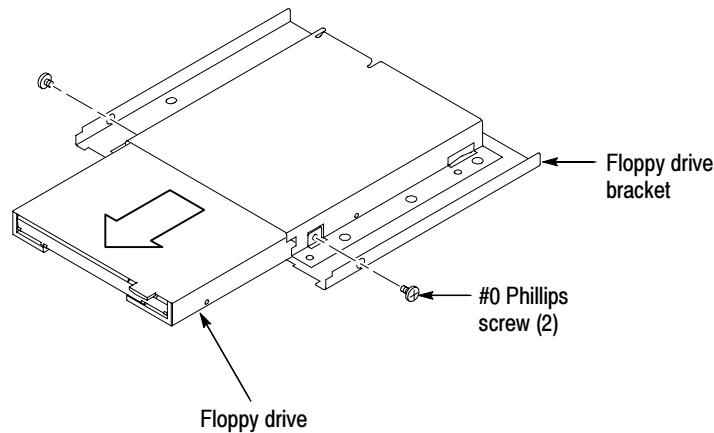


Figure 6-15: Floppy disk drive removal

4. *Reinstallation:* Do in reverse steps a through d to reinstall the floppy disk drive.

CD and Hard Disk Drive

1. *Locate module to be removed:* The CD and Hard Disk Drives are mounted on a common assembly which must first be removed to gain access to either drive. Locate the CD and Hard Disk Drive assembly in the locator diagram *Internal Modules*, Figure 6-6, page 6-17.



CAUTION. Do not remove the hard drive when the oscilloscope is powered on.

The hard disk drive may be permanently damaged if it is removed while the oscilloscope is powered on.

Always power off the oscilloscope before removing the hard disk drive.

2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its right-side panel is facing you.
3. *Remove the CD/Hard Disk Drive assembly:* See Figure 6-16, on page 6-29.
- a. Verify that the oscilloscope is powered off.
 - b. Remove the T-15 Torx screw that secures the CD/Hard Disk Drive assembly to the chassis.
 - c. Pull the CD/Hard Disk Drive assembly away from the chassis far enough to access the drives.

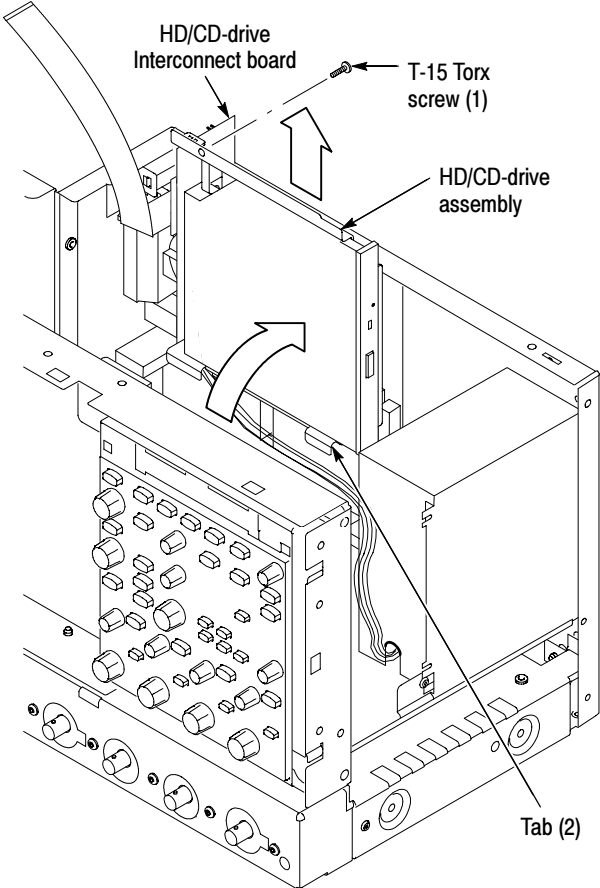


Figure 6-16: CD/Hard disk drive assembly removal

4. *Remove the CD or Hard Disk Drive from the assembly:* See Figure 6-17.
 - a. Remove the four Phillips screws that secure the drive to the bracket.
 - b. Gently pull the drive away from the connector and remove the drive from the bracket.

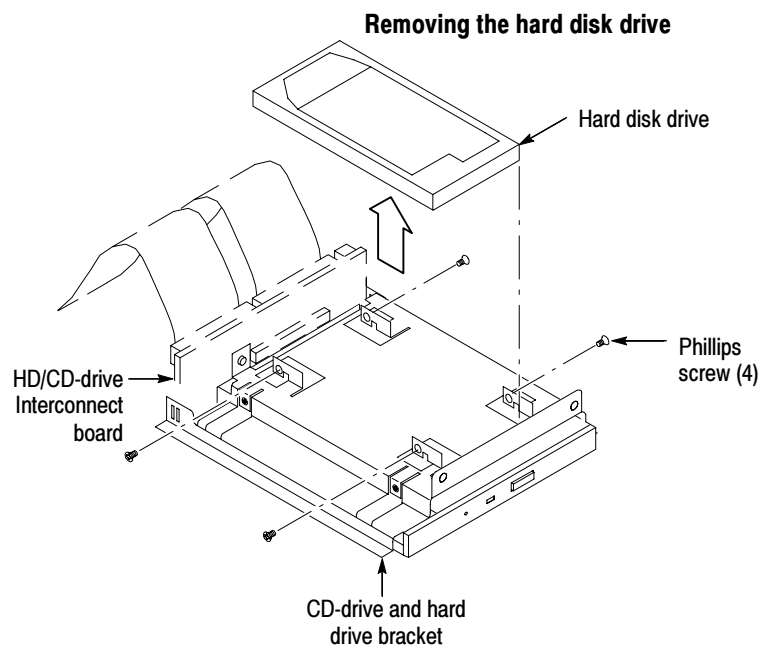
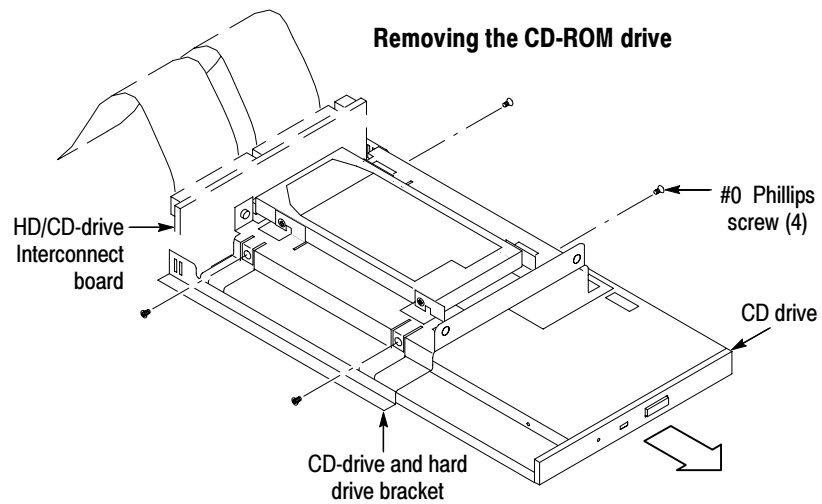


Figure 6-17: Removing the CD drive or hard disk drive from the bracket

5. *Reinstallation:* To avoid damaging connector pins, use the following procedure to reinstall either drive:
 - a. Loosen the T-15 Torx screw that secures the interconnect board to the CD/Hard Disk Drive assembly. This allows the interconnect board to float, making connector alignment easier.
 - b. Connect the replacement drive to the interconnect board by carefully aligning the connector and gently seating it to the drive.
 - c. Install the four screws that secure the drive to the bracket.
 - d. Tighten the T-15 Torx screw that secures the interconnect board to the CD/Hard Disk Drive assembly.
 - e. Align the tabs at the bottom of the CD/Hard Disk Drive assembly to the slots on the back of the front panel assembly.
 - f. Install the T-15 Torx screw that secures the CD/Hard Disk Drive assembly to the chassis.

Fan Removal

1. *Locate module to be removed:* Locate the fans in the locator diagram *Internal Modules*, Figure 6-6, page 6-17. Additional modules to be Removed:
 - Trim (all except front panel and acquisition)
2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its left side is facing you.
3. *Remove the fans:* See Figure 6-18, page 6-32.
 - a. Remove the four plastic fasteners that secure each of the fans to the chassis. See Figure 6-18.

NOTE. A wire cutter can help you remove each fastener. First, use the cutter to pry up and retract the fastener head. Then use it to remove the fastener body. Be careful to only pry with the wire cutters and NOT to cut!

- b. Lift the fan cable up and out from the cable clamp.

NOTE. A needle-nose priers can serve as an effective tool to remove the cable clamp if you use it to carefully squeeze the clamp's top and bottom latches

- c. Disconnect the fan cable from the PC interface board. See Figure 6-19.
 - d. Lift the fan assembly up and out from the chassis.
4. *Reinstallation:* Do in reverse steps a through d to reinstall the fan assembly.



CAUTION. Take care when handling the fans; the fan blades are brittle and can be easily damaged.

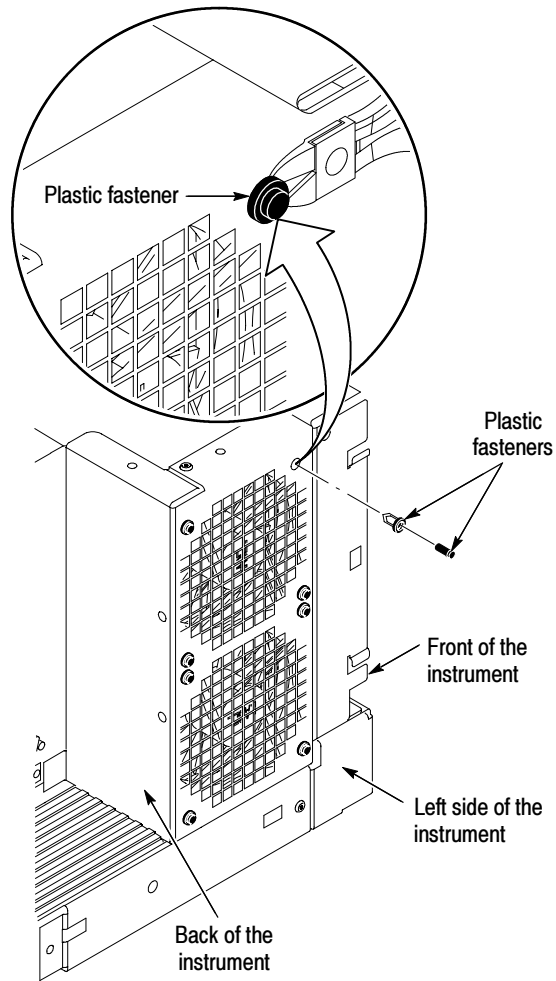


Figure 6-18: Fan fastener removal

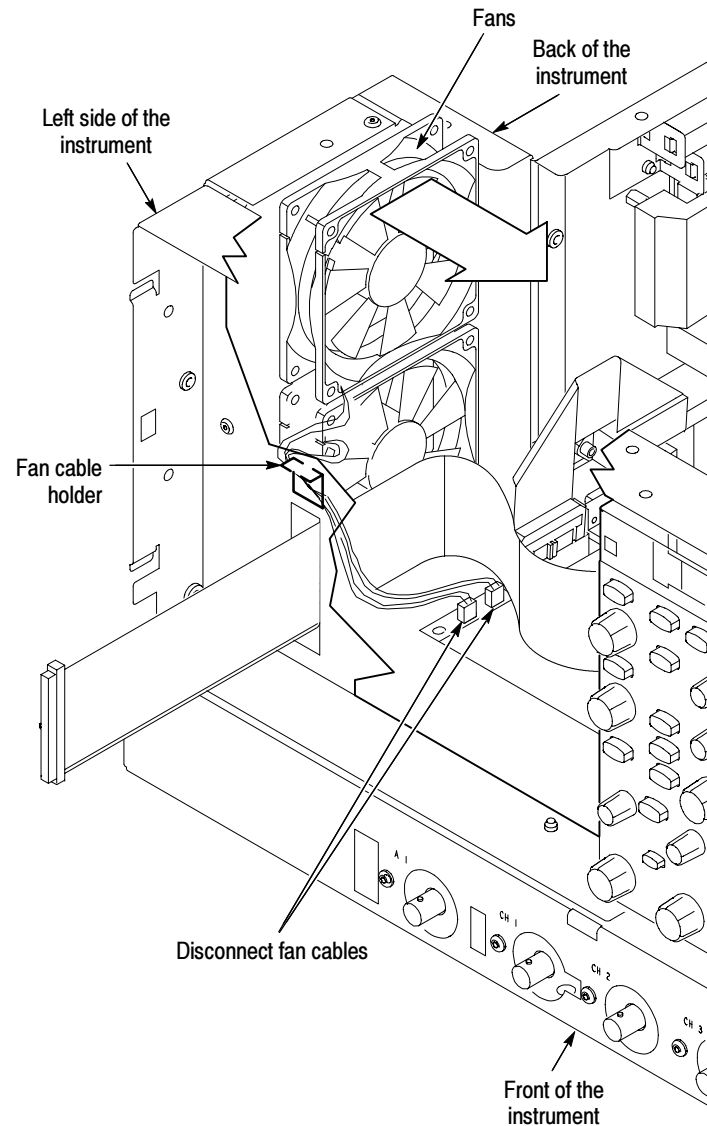


Figure 6-19: Disconnecting the fan cables

Power Supply

1. *Assemble equipment and locate modules to be removed:* Locate the modules to be removed in the locator diagram *Internal Modules*, Figure 6-6, on page 6-17. Additional modules to be Removed:
 - Trim (all)
 - Right-side cover
2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and the back is facing you.

3. *Remove the power supply:* See Figure 6-20, on page 6-34.
 - a. Remove the four T-15 Torx screws that secure the power supply to the back of the chassis.
 - b. Remove the T-15 Torx screw that secures the power supply to the right side of the chassis.
 - c. Move the power supply towards the back of the instrument to access the cables and unplug the three power supply cables from the circuit boards.
 - d. Lift the power supply away from the chassis and guide the cables out.
4. *Reinstallation:* Do in reverse steps a through d to reinstall the power supply.

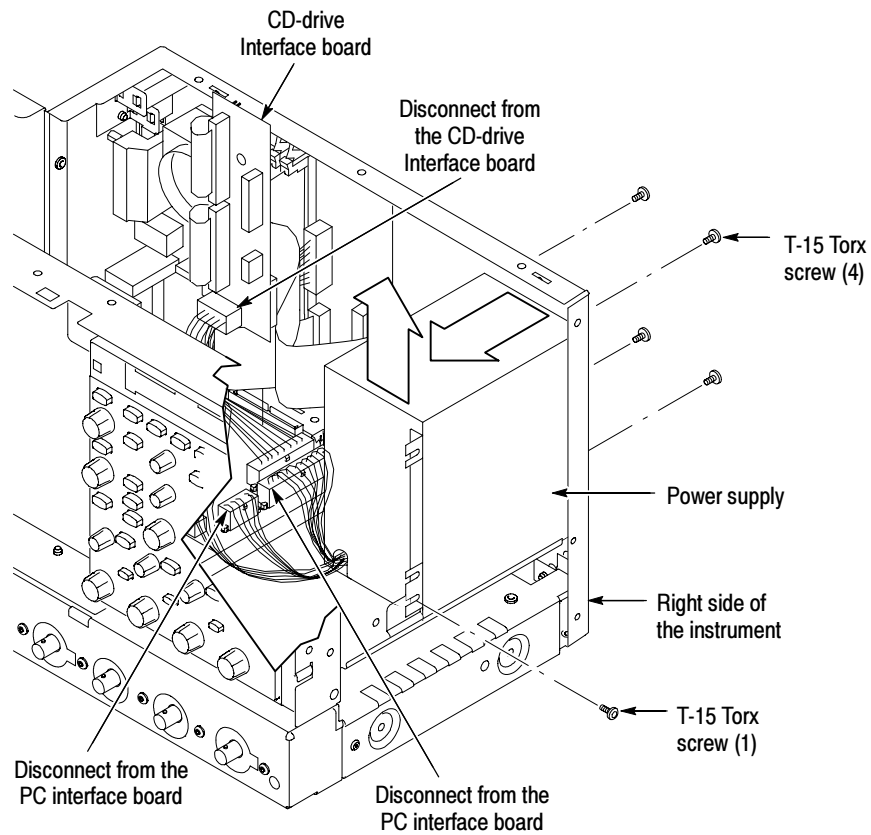


Figure 6-20: Power supply removal

Motherboard

1. *Locate module to be removed:* Locate the Motherboard in the locator diagram *Internal Modules*, Figure 6-6, on page 6-17. Additional modules to be removed:
 - Trim (all)
 - Bottom cover
 - Left and Right covers
 - Power Supply
2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its top panel is facing you.
3. *Remove the Motherboard assembly:* See Figure 6-21, on page 6-36.

NOTE. *The motherboard and rear chassis is removed as one assembly.*

- a. Remove the four T-15 Torx screws that secure the motherboard assembly to the side of the chassis.
- b. Remove the two bottom feet from the chassis of the motherboard assembly.

NOTE. *You only need to separately remove the two bottom feet if you plan to replace the sheet metal and reuse the feet. Also, if you do plan to replace the sheet metal, then remember that it has stickers with important information on it such as the serial #, option label and safety data.*

- c. Remove the two jack screws that secure the VGA connector to the bracket.
 - d. Disconnect the three cables from the motherboard assembly.
 - e. Disconnect the GPIB cable from the PC interface board.
 - f. Carefully lift the assembly out of the chassis.
4. *Orient the Motherboard assembly:* Set the Motherboard assembly so its bottom is down on the work surface and its connector panel is facing you.
 5. *Remove the Motherboard from the rear chassis:*
 - a. Remove the six jack screws that secure the Motherboard connectors to the connector panel of the rear chassis.
 - b. Remove the six T-15 Torx screws that secure the Motherboard to the rear chassis.

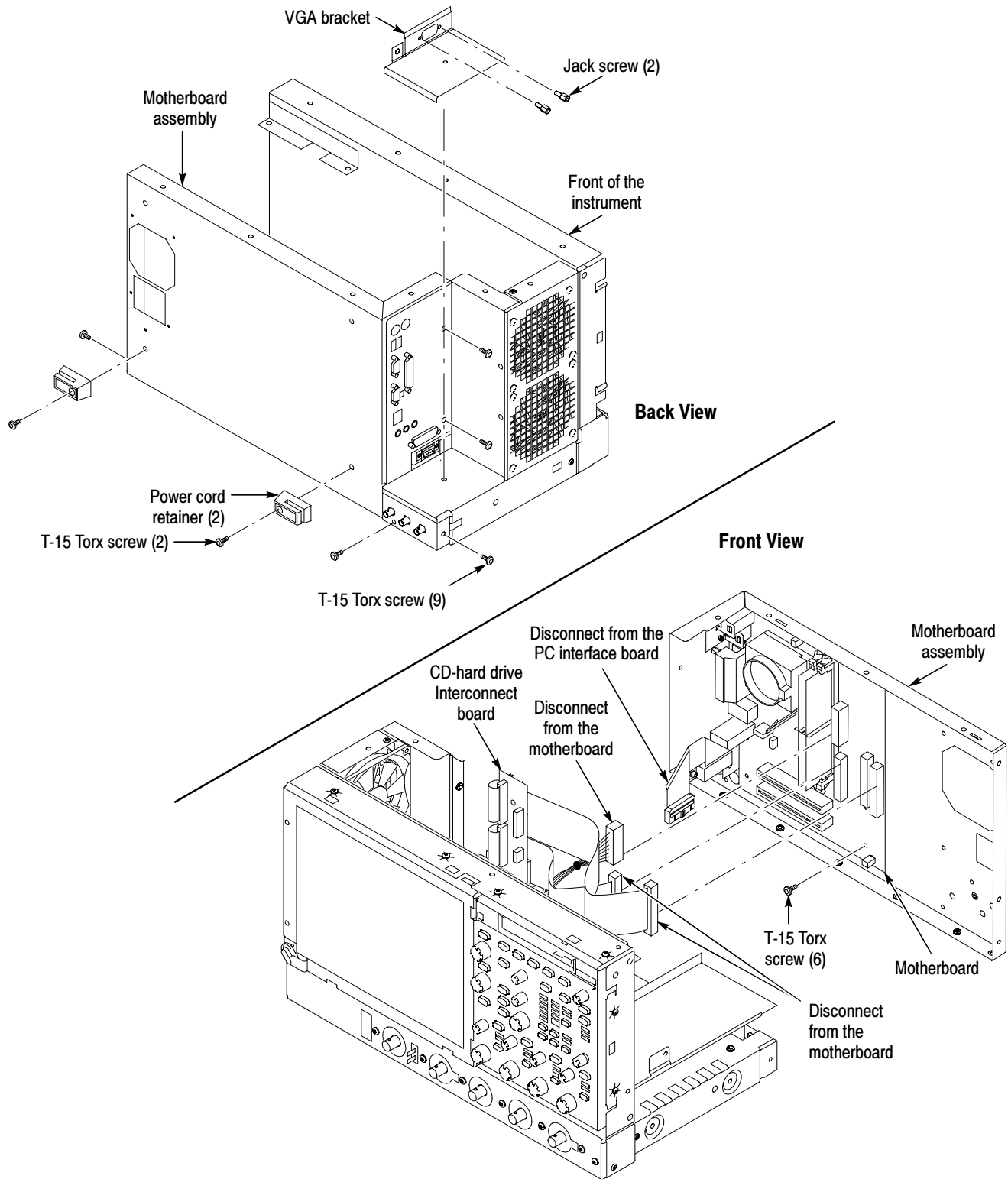


Figure 6-21: Motherboard removal

- c. Carefully lift the Motherboard out of the rear chassis.
6. *Reinstallation:* Do in reverse steps 3 through 5 to reinstall the motherboard assembly.

PC Interface Board

1. *Locate module to be removed:* Locate the PC interface board in the locator diagram *Internal Modules*, Figure 6-6, on page 6-6.



CAUTION. Before installing the PC Interface Board, fully install the Acquisition Board. Doing this helps ensure correct alignment of the 125-pin connector between the Acquisition Board and the PC Interface Board.

Additional modules to be removed:

- Trim (all)
 - Right-side cover
 - CD/Hard drive assembly
 - Power supply
 - Motherboard assembly
2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its top panel is facing you.
 3. *Remove the PC interface board:* See Figure 6-22 on page 6-38.
 - a. Disconnect the two cables from the PC interface board.
 - b. Remove the six T-15 Torx screws that secure the PC interface board to the chassis.



CAUTION. Do not remove the screw next to J1800 (See Figure 6-22 on page 6-38). The screw secures an indexing pin used to align the J1800 connectors together.

- c. Grasp the PC interface board near J1800 (see Figure 6-22) and carefully pull the board up to disconnect J1800. Once you have cleared the connector, remove the board from the chassis.
4. *Reinstallation:*
 - a. When installing the PC interface board, set the board in place and align the J1800 halves using the guide pin. Gently press the board into place to seat the connector between the PC interface board and the acquisition board.

- b. Install the six T-15 Torx screws that secure the PC interface board to the chassis.
- c. Connect the two cables to the PC interface board.

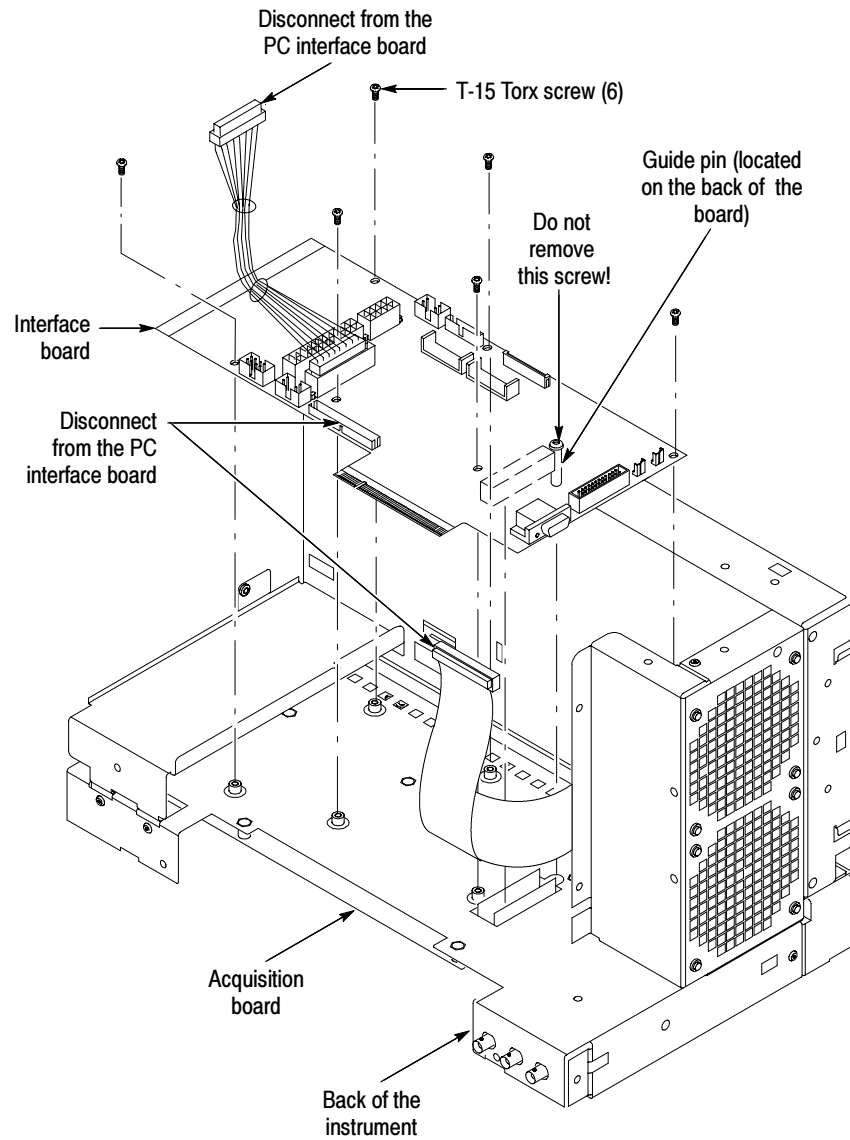


Figure 6-22: PC interface board removal

Acquisition Board

1. *Locate module to be removed:* Locate the Acquisition board in the locator diagram, Figure 6-6, on page 6-17. Additional modules to be removed:
 - Trim (all)
 - Bottom cover
2. *Orient the oscilloscope:* Set the oscilloscope so its top is down on the work surface and its bottom is facing up.
3. *Remove the Acquisition board:* See Figure 6-23, page 6-40.
 - a. Remove the seven T-15 Torx screws that secure the bottom panel to the chassis.
 - b. Disconnect the three coaxial cables from the Acquisition board.
 - c. Disconnect the ribbon cable from the Acquisition board.
 - d. Remove the six T-15 Torx screws that secure the board to the chassis.
 - e. Remove the six T-15 Torx screws that secure the board to the front panel.
 - f. Grasp the Acquisition board on the edge near J1800 (see Figure 6-23) and carefully pull the board up to disconnect J1800. Once you have cleared the connector, remove the board from the chassis.
4. *Reinstallation:*
 - a. When installing the Acquisition board, set the board in place and align the J1800 halves using the guide pin. Gently press the board into place to seat the connector between the PC interface board and the Acquisition board.
 - b. Install the six T-15 Torx screws that secure the Acquisition board to the front panel.
 - c. Install the six T-15 Torx screws that secure the Acquisition board to the chassis.
 - d. Connect the three coaxial cables to the Acquisition board.

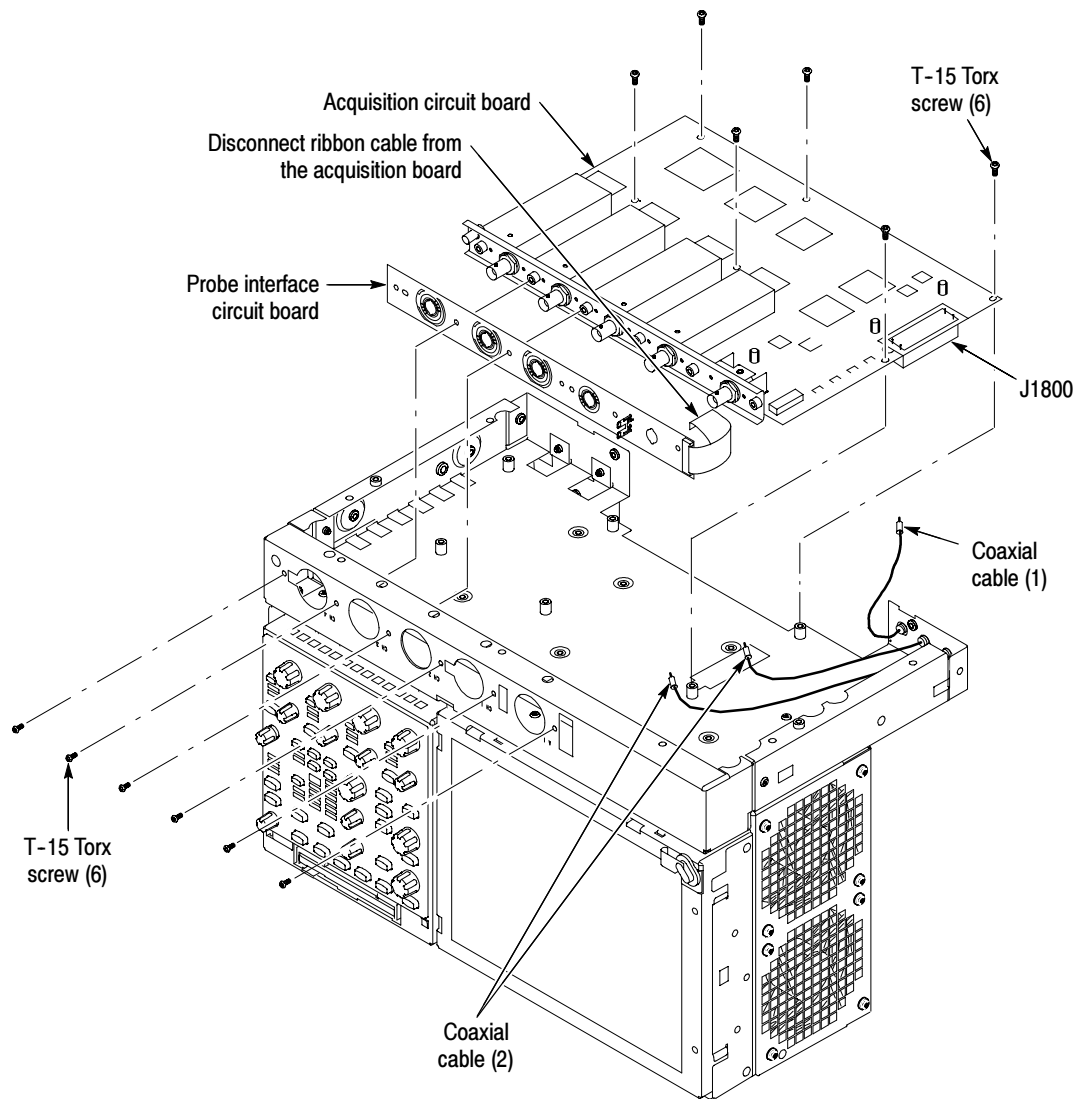


Figure 6-23: Acquisition circuit board removal

Troubleshooting



WARNING. Before performing this or any other procedure in this manual, read the General Safety Summary and Service Safety Summary found at the beginning of this manual.

To prevent possible injury to service personnel or damage to electrical components, please read Preventing ESD on page 6-1.

This section contains information and procedures designed to help you isolate faults to a module.

This section assumes that service personnel have the prerequisite skills required to work on this oscilloscope, including PC troubleshooting and Windows ME skills. Details of PC and Windows ME operation and service are not in this manual.

For assistance, contact your local Tektronix Service Center.

Service Level

This subsection contains information and procedures designed to help you isolate faulty modules in the oscilloscope. If a module needs to be replaced, follow the *Removal and Installation Procedures* located in this section.

Check for Common Problems

Use Table 6-4 to quickly isolate possible failures. The table lists problems and possible causes. The list is not exhaustive, but it may help you eliminate a problem that is quick to fix, such as a blown fuse or loose cable.

Table 6-4: Failure symptoms and possible causes

Symptom	Possible cause(s)
Oscilloscope will not power on	<ul style="list-style-type: none">■ Power cord not plugged in■ Faulty power supply
Front panel light comes on (oscilloscope powers on), but one or more fans will not operate	<ul style="list-style-type: none">■ Faulty fan cable■ Defective fan assembly■ Faulty power supply

Table 6-4: Failure symptoms and possible causes (Cont.)

Symptom	Possible cause(s)
PC motherboard appears “dead”; power light comes on, but monitor screen(s) is (are) blank, oscilloscope emits no beeps	<ul style="list-style-type: none"> ■ DIMM memory module incorrectly installed or missing. Missing DIMMs will cause a POST fault and PC motherboard will beep ■ Defective PC motherboard ■ Hold down on-standby button on the PC Interface board , if system boots, replace the power supply
Hard disk drive related symptoms	<ul style="list-style-type: none"> ■ Defective hard disk drive ■ Incorrect hard disk type selected in the BIOS setup ■ Replaceable hard disk drive not installed ■ Power supply failure ■ Corrupted BIOS module firmware, reinstall firmware ■ Hard disk drive not configured as bootable (slave) master hard disk drive ■ Loose cable ■ Faulty PC motherboard
CD-ROM related symptoms	<ul style="list-style-type: none"> ■ Defective CD-ROM ■ Defective disk drive adapter board ■ Defective cable from PC Interface board to display adapter board ■ Defective PC Interface board ■ Incorrect CD-ROM configuration in the BIOS setup
Flat panel display blank	<ul style="list-style-type: none"> ■ Display selection jumper set incorrectly on front panel board (there are no jumpers on the board when the oscilloscope is shipped from the factory; this is the correct default setting) ■ Video adapter set to AGP (connect monitor to VGA port, enter BIOS, set Video Adapter = PCI) ■ BIOS setting not Advance > Video Configuration > Primary Video Adapter = PCI ■ Defective cable from front panel board to display adapter board ■ Defective cable from inverter board to display adapter board ■ Defective cable from inverter board to backlighting display lamp ■ Defective backlighting display lamp ■ Faulty display ■ Faulty controller board ■ Faulty inverter board ■ Faulty display adapter board
BIOS error messages	<ul style="list-style-type: none"> ■ Refer to the BIOS error message table on page 6-52

Equipment Required

You will need a digital multimeter to take measurements and to check power supply voltages, as described on page 6-46.

Testing might also be required to correct some faults. Under those circumstances, you will need the test equipment listed in the *Performance Verification and Adjustment Procedures* in this manual.

Fault Isolation Procedure

Follow the primary troubleshooting tree in Figure 6-24 on page 6-44 for fault isolation. This tree calls for you to run the diagnostics programs, and check for BIOS errors.

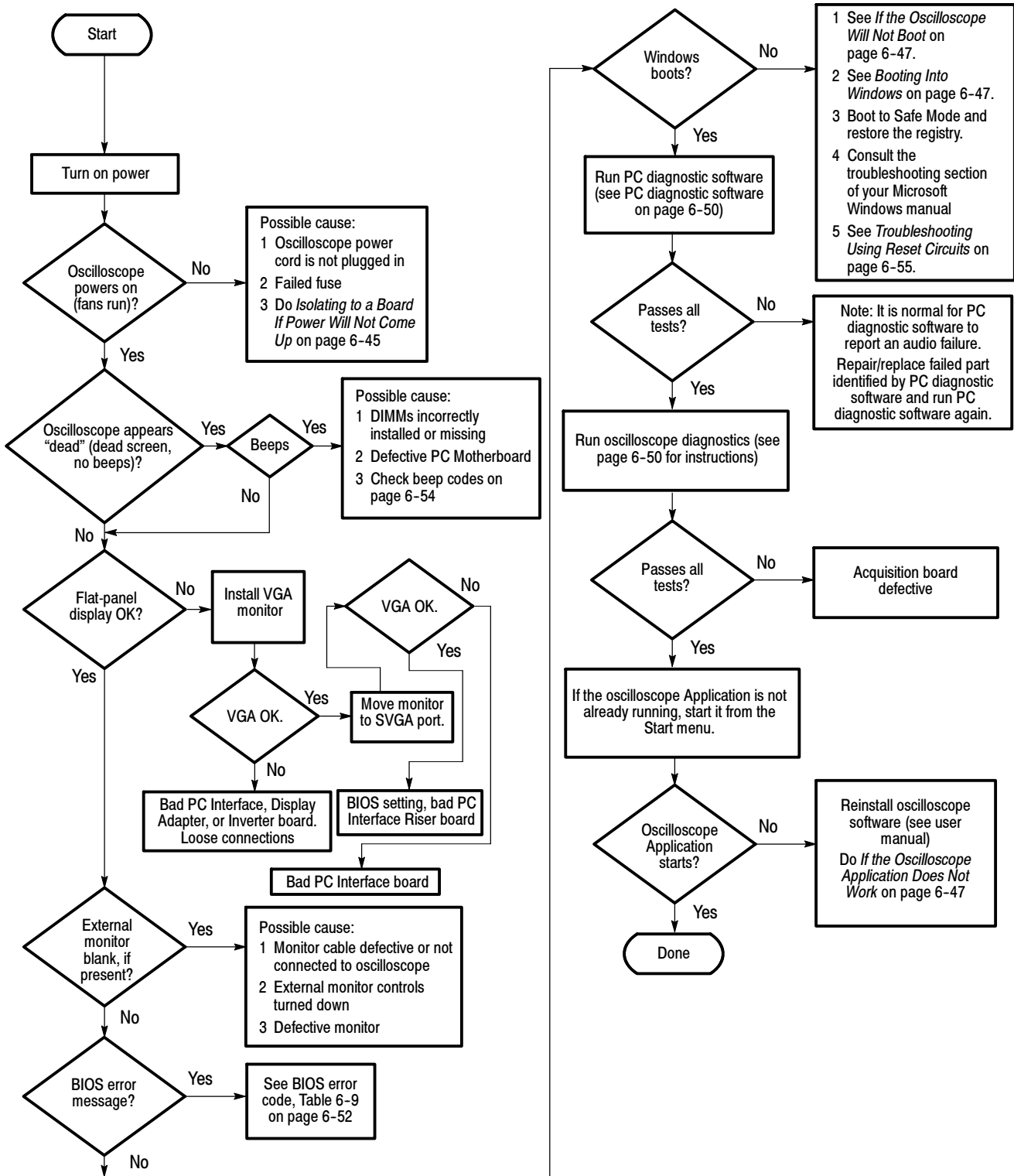


Figure 6-24: Primary troubleshooting tree

Isolating to a Board if Power Will Not Come Up

If the instrument will not power on, you can isolate the problem by observing the specific symptoms and comparing them to those listed below.

If the mains power cord is connected and the oscilloscope is not on, (power supply is in standby mode), +5 V will be present on pin 9 of P1, the power supply connector. If +5 V is not present, replace the power supply.

If the PSON signal on J1100, pin 2 is low, the oscilloscope interprets this signal as an indication that the power is on. If the PSON signal is high, measure the resistance from J510, pin 50 to ground, and J520, pin 6 to ground, while depressing the ON/STBY button on the front panel. If the resistance measures less than 500 ohms in either test, replace the PC motherboard.

If the oscilloscope powers on momentarily, an over current condition exists. Remove boards one at a time to locate a fault (the display, disk drive adapter board, acquisition board, and the PC motherboard). If you remove the PC motherboard, you must jumper the forced power-on pins (see Figure 6-25). The PC Interface board is required for power to come up.

If removing the boards did not find the problem, replace the power supply.

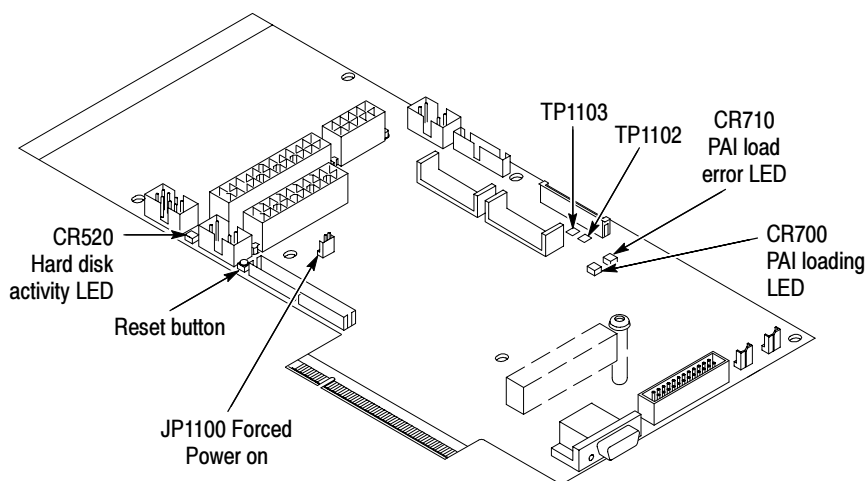


Figure 6-25: Location of jumpers and reset button

Checking the Power Supply Voltages

To check the power supply voltages, power on the oscilloscope and connect the reference lead of a digital voltmeter to chassis ground. Measure the power supply voltages with the voltmeter and compare each reading to the values listed in the tables. If the voltages are within about 5% of the nominal voltages, your power supply is functional.

The pins that carry power supply voltages are listed in Table 6-5.

Table 6-5: Power supply voltages

Power supply cable/pin #	Voltage
P1, Pins 1, 2, 12, 13 (orange)	+3.3 V
P1, Pins 4, 6, 21, 22, 23 (red)	+5.1 V
P1, Pin 8 (grey)	+5.1 V
P1, Pin 9 (violet, +5VSB)	+5.1 V
P1, Pins 10, 11 (yellow)	+11.6 V
P1, Pin 14 (blue)	-11.8 V
P2/P3, Pin 1 (yellow)	+11.6 V
P2/P3, Pin 4 (red)	+5.1 V
P13, Pin 2 (green)	+2.7 V
P13, Pin 3 (orange)	+3.3 V
P13, Pin 5 to Pin 10 (blue, tan)	+7 mV rms

After you check the voltages on the power supply connector, check the voltages on the acquisition board, at J1800. The pins that carry voltages are listed in Table 6-6.

Table 6-6: Acquisition board voltages

J1800 pin number	Voltage
Pins A1, A4, A8, A12, A16, A20, A24, A25	+3.3 V
Pin B23	+11.6 V
Pin B25	-11.8 V
Pins C20, C21, C22, C23, C24, C25	+5.1 V
Pin E12	+16.3 V
Pins E13, E14, E15, E16, E17, E18	+5.5 V
Pins E19, E20, E21, E22, E23, E24	-5.4 V
Pin E25	-16.4 V

If the Oscilloscope Will Not Boot

If there is a display on the VGA port, but not on the LCD, replace the display assembly (LCD, lamps, and cable).

If the display adapter is bad, the BIOS should report it using beep codes (see Table 6-10, on page 6-54).

If nothing is displayed, is the display turned on? At boot time and while using an external monitor connected to the PC motherboard external video port, press F2 to enter the BIOS setup. The Advanced Video Configuration menu lets you select PCI (LCD) or AGP (the PC motherboard port on the upper-side panel). The lower VGA port on the side panel is the PCI video port (driven by the same video controller as the LCD).

Bootting Into Windows

If the oscilloscope will not boot, press F8 to enter the start up menu, and boot to the command prompt. If you can boot to the command prompt, use the MSDOS Edit program to edit the autoexec.bat file to run the CMOS restore utility (see *Update/Restore the PC Motherboard CMOS* on page 6-58).

If booting starts, finds the hard disk, but hangs at the Windows splash screen:

1. Select the AGP video port using the setup menu.
2. Disconnect the PC motherboard from the PC Interface board.
3. If the system boots (It will only boot to Windows; the oscilloscope application will not run) to the external PC motherboard video port, replace the PC Interface board.

If the Oscilloscope Application Does Not Work

If the oscilloscope boots into Windows, but the oscilloscope application does not work (the DPO Man graphic is displayed), check the following:

1. The application software.
2. The Acquisition board.
3. The PC Interface board.
4. Did someone exit the application using the Task Manager and then try to reenter the application without rebooting?
5. If the relays click, the acquisition is running.
6. Check the desktop properties (right click on the desktop and select Properties). On the Settings tab, 16 bit is required. Video merge will not work with other settings. If you change the setting, reboot.
7. On the Settings tab of the desktop properties, select Advanced and then the Performance tab. Hardware Acceleration must be set to Full for video merge to work. If you change the setting, reboot.

PC Interface and PC Motherboard Diagnostics

The primary diagnostics for the oscilloscope are the power-on diagnostics, the PC diagnostic software, and the oscilloscope diagnostics. Procedures for running these diagnostics are described below.

Power-On Diagnostics

The power-on diagnostics check the basic functionality of the oscilloscope at every power on. If any failures occur at power on, the screen displays the calibration and diagnostics property page. Table 6-7 lists a subset of the power on tests. Use the results of the tests to help you isolate problems to system modules.

The power on tests ensure that hardware is installed and can be accessed by the software. The tests provide limited diagnostic information, but do not provide any performance information. The oscilloscope diagnostics provide more extensive tests than the power-on diagnostics.

The power on tests check the generic hardware including the keyboard, mouse, memory, CPU, and associated peripherals. The interrupt lines and trigger lines are also checked.

If there are no failures, you can view the results of the tests in the Instrument Diagnostics page under the Utilities menu.

Table 6-7: Power-on diagnostic tests

Component	Group & test	Power on	Extended
Processor	Memory DRAM Walk1	✓	✓
	Memory DRAM Cell	✓	✓
	Memory DRAM March	✓	✓
	Memory NVRAM		✓
	PCI Bus Scan		✓
	Registers PAI	✓	✓
Display	Registers Display	✓	✓
Acquisition	Registers DAC	✓	✓
	Registers Demux	✓	✓
	Registers Preamp	✓	✓
	Registers PLL	✓	✓
	Registers ADC	✓	✓
	Memory MemData	✓	✓
	Memory MemAddr	✓	✓
	Memory DataFormat	✓	✓
	Memory MemSpeed		✓

Table 6-7: Power-on diagnostic tests (Cont.)

Component	Group & test	Power on	Extended
	Acq Modes SubSample	✓	✓
	Acq Modes PeakDetect	✓	✓
	Acq Modes HiRes	✓	✓
	Interrupt Bit Tests	✓	✓
	HF Step PhaseCal		✓
	Demuxes InstaVuXY		✓
	Vertical 50OhmOvld	✓	✓
	Vertical ADC Connects	✓	✓
	PLL Clock Freq	✓	✓
Trigger	Registers GTL	✓	✓
	Registers HITL	✓	✓
	Registers ExtTvTrg	✓	✓
	TrgLvlComp LogicComp1	✓	✓
	TrgLvlComp LogicComp2	✓	✓
	TrgLvlComp LogicComp3	✓	✓
	TrgLvlComp LogicComp4	✓	✓
	GTL TICounters	✓	✓
	GTL GTLBigCntrs	✓	✓
	HITL Ch1Edge	✓	✓
	HITL AfterDBE	✓	✓
	HITL AfterDBT	✓	✓
	HITL Slewrate	✓	✓
	HITL LineTrig	✓	✓
	HITL HITL	✓	✓
	Extended Glitch	✓	✓
	Extended PulseWidth	✓	✓
	Nibble Bus	✓	✓
Misc	GPIB Interface	✓	✓

PC Diagnostic Software

If the oscilloscope passes all the BIOS tests and Windows boots, the primary tree calls for you to run PC diagnostic software (such as QAPlus/Win).

Use a comprehensive diagnostic software application to check and verify the operation of the PC hardware in the oscilloscope.

To run the diagnostic software, you must have a working keyboard (a working mouse or other pointing device is optional) and have the Windows operating system running. Repair or replace any failed component identified by the diagnostic software.

NOTE. *To run PC diagnostic software, you must have either a working keyboard or a working mouse (or other pointing device) and Windows running.*

To run the PC diagnostic software, do the following steps:

1. Exit the oscilloscope application.
 - a. Display the Task Manager by pressing CTRL, ALT, and Delete.
 - b. Select TDS5000 and then touch **End Task**.
 - c. Display the Task Manager by pressing CTRL, ALT, and Delete.
 - d. Select Windowsscopeservices and then touch **End Task**.
2. Exit all other applications and exit all windows.
3. Install and start the PC diagnostic software.
4. Touch **OK** and select the tests you want to perform.
5. To restore the oscilloscope to normal operating condition, reboot the oscilloscope after the diagnostic tests are complete.

Oscilloscope Diagnostics. If the oscilloscope passes all the tests, the primary tree calls for you to run the oscilloscope Diagnostics. The oscilloscope Diagnostics are a comprehensive software test that checks the functionality of the oscilloscope. If the oscilloscope Diagnostics test fails, the oscilloscope is defective.

To run the oscilloscope Diagnostics, do the following steps:

1. Turn off all other applications.
2. From the menu bar, touch **Utilities** and then select **Instrument Diagnostics**.

Diagnostics The oscilloscope has two levels of internal diagnostics that focus on verifying, adjusting, and if need be, isolating faulty modules.

Both levels of internal diagnostics report any bad modules. If a bad module is found, replace the module.

The two levels of diagnostics are the short confidence set and the extended set that tests the oscilloscope circuitry in depth and takes more time. At power on, the oscilloscope automatically executes the short set. The extended set is optional and is executed by using the following procedure:

1. *Display the System diagnostics menu:*
 - a. From the menu bar, touch **Utilities** and then select **Instrument Diagnostics**.

Firmware Updates

Firmware updates are easy to do. Simply install the firmware CD in your oscilloscope and follow the displayed instructions or the instructions that accompany the CD.

If you want to order a firmware update, contact your Tektronix service center.

After Repair

After removal and replacement of a module due to electrical failure, you must perform the calibration or software update as indicated in Table 6-8.

Table 6-8: Action required for module replaced

Module replaced	Calibration required	Software update required
Front panel assembly	No	None
Acquisition board	Yes	Boot ROM and authorization code
PC Interface board	No	Boot ROM and authorization code
PC motherboard assembly	No	Windows, oscilloscope application
Display panel or display system	No	None
Power supply	No	None
Interconnect boards	No	None
Fans	No	None

BIOS Error Messages

Table 6-9 lists error messages displayed by the BIOS.

Table 6-9: BIOS Error messages

Error message	Explanation
GA20 Error	An error occurred with Gate-A20 when switching to protected mode during the memory test.
Pri Master HDD Error Pri Slave HDD Error Sec Master HDD Error Sec Slave HDD Error	Could not read sector from corresponding drive.
Pri Master Drive - ATAPI Incompatible Pri Slave Drive - ATAPI Incompatible Sec Master Drive - ATAPI Incompatible Sec Slave Drive - ATAPI Incompatible	Could not read sector from corresponding drive.
Cache Memory Bad	An error occurred while testing L2 cache. Memory may be bad.
CMOS Battery Low	The battery may be losing power. Replace the battery soon.
CMOS Display Type Wrong	The display type is different than what has been stored in CMOS. Check Setup to make sure type is correct.
CMOS Check Sum Bad	The CMOS checksum is incorrect. CMOS memory may have been corrupted. Run Setup to reset values.
CMOS Settings Wrong	CMOS values are not the same as the last boot. These values have either been corrupted or the battery has failed.
CMOS Date/Time Not Set	The time and/or date values stored in CMOS are invalid. Run Setup to set correct values.
DMA Error	Error during read/write test of DMA controller.
HDC Failure	Error while trying to access hard disk controller.
Checking NVRAM...	NVRAM is being checked to see if it is valid.
Update OK!	NVRAM was invalid and has been updated.
Update Failed	NVRAM was invalid but was unable to be updated.
Keyboard is locked	The system keyboard lock is engaged. The system must be unlocked to continue to boot.
Keyboard Error	Error in the keyboard connection. Make sure keyboard is connected properly.
KB/Interface Error	Keyboard interface test failed.
Memory Size Decreased	Memory size has decreased since the last boot. If no memory was removed, then memory may be bad.

Table 6-9: BIOS Error messages (Cont.)

Error message	Explanation
Memory Size Increased	Memory size has increased since the last boot. If no memory was added, then memory may be bad.
Memory Size Changed	Memory size has changed since the last boot. If no memory was added or removed, then memory may be bad.
No Boot Device Available	System did not find a boot device.
Off Board Parity Error	A parity error occurred on an off-board card. This error is followed by an address.
On Board Parity Error	A parity error occurred in onboard memory. This error is followed by an address.
Parity Error	A parity error occurred in onboard memory at an unknown address.
NVRAM/CMOS/PASSWORD cleared by Jumper	NVRAM, CMOS, and passwords have been cleared. The system should be powered off and the jumper removed.
<CTRL_N> Pressed	CMOS is ignored and NVRAM is cleared. User must enter Setup.

BIOS Beep Codes

When an error occurs during the power on self test (POST), the BIOS displays an error message describing the problem. The BIOS also issues a beep code (one long tone followed by two short tones) during POST if the video configuration fails (a faulty video card or no card installed) or if an external ROM module does not properly checksum to zero.

An external ROM module (for example, a video BIOS) can also issue audible errors, usually consisting of one long tone followed by a series of short tones. For more information on the beep codes, check the documentation for the device.

There are several POST routines that issue a POST terminal error and shut down the system if they fail. Before shutting down the system, the terminal-error handler issues a beep code (see Table 6-10) signifying the test point error, writes the error to I/O port 80h, attempts to initialize the video, and writes the error in the upper left corner of the screen (using both monochrome and color adapters).

If the POST completes normally, the BIOS issues one short beep before passing control to the operating system.

Table 6-10: Beep codes

Beeps	Description
1	Refresh failure
2	Parity cannot be reset
3	First 64 K memory failure
4	Timer not operational
5	Not used
6	8042 Gate A20 cannot be toggled
7	Exception interrupt error
8	Display memory R/W error
9	Not used
10	CMOS shutdown register test error
11	Invalid BIOS (for example, POST module not found, etc.)

PC Interface LEDs

When the oscilloscope is powered on, the PAI Loading and the Load Error LEDs (CR700 and CR710) will turn on momentarily, and then turn off. The hard disk activity can be monitored by observing the status of CR520.

Troubleshooting Using Reset Circuits

The PC Interface board uses a combination of removable jumpers and test points to manipulate circuit reset for troubleshooting.

There are two PCI busses on the PC Interface board; the PC motherboard primary PCI bus, and the L2 PCI bus. A hardware fault on any of these busses can prevent Windows from starting properly.

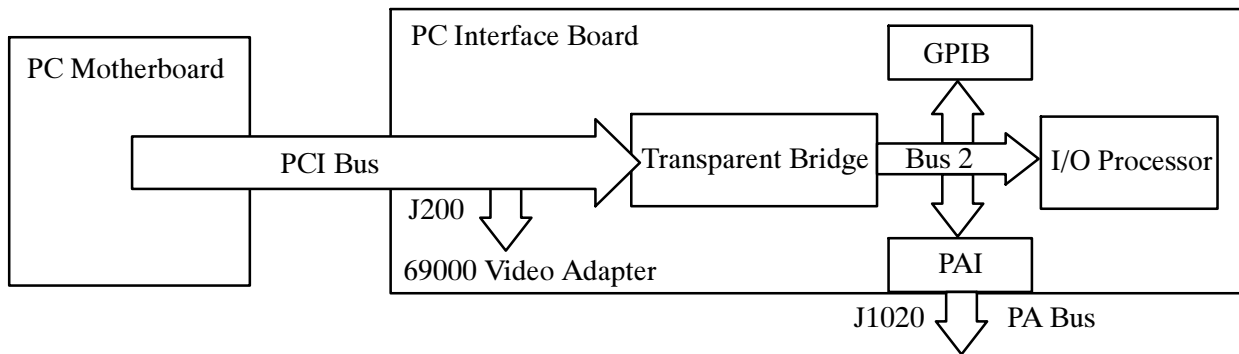


Figure 6-26: The PCI busses

By grounding test points TP1102 or TP1103 (see Figure 6-27) you can selectively remove components from the PC motherboard primary PCI bus. This is useful when Windows will not start. The PC Interface board components on the PC motherboard primary PCI bus are the 21152 transparent bridge, and the 69000 video adapter.

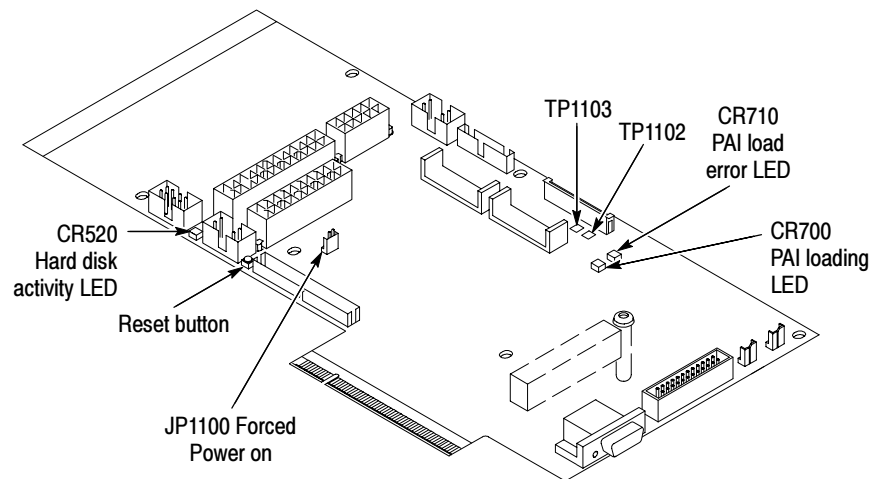


Figure 6-27: Location of jumpers and reset button

Grounding TP1103 forces the transparent bridge and all components on the L2 PCI bus into reset. Ground TP1103 to determine if the instrument will boot to Windows.

If Windows forces a safe boot mode, be sure to keep TP1103 grounded until Windows is fixed in safe mode and can be booted up into normal mode. Once Windows can be booted into normal mode, unground TP1103 and reset the unit. This will enable the bus line previously grounded by TP1103.

Grounding TP1102 resets the 69000 video adapter. Note, neither the PC Interface board VGA port or the LCD will function if TP1102 is grounded. Use the PC motherboard SVGA port (see Figure 6-28 on page 6-57). This requires a configuration change in the BIOS.

To enter the BIOS setup utility, do the following:

1. Restart Windows while holding down the F2 key.
2. Select Video Configuration from the Advanced Menu.
3. Set the Primary video adapter to AGP.
4. Exit the BIOS setup and save the changes.

If TP1102 is grounded before the video configuration is changed to AGP, reset the screen by hitting CTRL-ALT-DEL twice. This resets Windows and TP1102.

5. When you are done troubleshooting, change the BIOS setting back to PCI.

NOTE. *The 69000 video adapter located on the Tektronix PC Interface board is the primary video adapter. A second video adapter is located on the PC motherboard. The PC motherboard has an AGP video adapter and the 69000 is a PCI bus video adapter. The 69000 is made the primary video adapter because it can drive LCD panels. Tektronix forces the 69000 to be the primary video adapter via BIOS setting Advance→ Video Configuration→ Primary Video Adapter = PCI.*

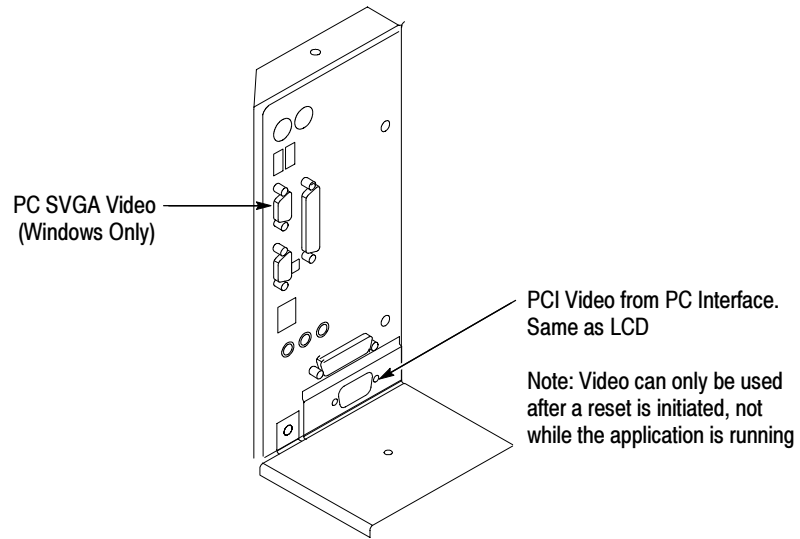


Figure 6-28: PCI and AGP video connectors

Installing the PC Motherboard Serial Number

To install a serial number into the oscilloscope do the following steps:

1. Connect a PC with a GPIB interface to the GPIB interface of the oscilloscope.



WARNING. Make sure the unique identifier does not end in all zeros before generating or setting the key.

2. Use the following command to install the serial number (the actual serial number should be in single quotes):


```
:HWAccountant:SERIAL 'serialNumber'
```
3. After sending this command, reboot the instrument. After rebooting, a valid unique ID (UID) is available.

Update/Restore the PC Motherboard CMOS

If the CMOS parameters become corrupted, restore the CMOS memory using the following procedure:



CAUTION. Only install CMOS parameters from Tektronix. CMOS parameters from other manufacturers may make your oscilloscope inoperable.

1. Edit the autoexec.bat file.
2. Remove comments CMOS restore parameters.
3. Boot the instrument.
4. Re-edit the autoexec.bat file to re-comment the CMOS restore parameters.

If you cannot restore the CMOS memory, replace the battery.

Installing an Authorization Key

If you replace your PC Interface board or add a new option, you must install a new authorization key, using the following procedure:

1. From the oscilloscope menu bar, touch the **Utilities** menu, select **Option Installation**, and then touch **Continue**.
2. Enter the new key using an attached keyboard.
3. Touch **Continue**.

Hard Disk Drive Maintenance

Use the same procedures to maintain the oscilloscope hard disk drive that you use to maintain a hard disk drive in a personal computer.

Using ScanDisk, attempt to fix the disk without destroying data on the disk. To use ScanDisk, perform the following steps:

1. Power on the oscilloscope and run ScanDisk. Set ScanDisk to perform a thorough surface scan and to automatically fix errors.
 - Using Microsoft Windows ME: select Start\Programs\Accessories\System Tools\ScanDisk
 - Using Microsoft MSDOS: enter SCANDISK *drive:* /SURFACE /AUTOFIX

2. If ScanDisk will not repair the disk, format the hard disk drive using the File Utilities Format command. Format will destroy all data currently on the disk.
3. If reformatting the hard disk and reloading the software will not repair the disk, install a new hard disk drive.

Repackaging Instructions

This section contains the information needed to repack the oscilloscope for shipment or storage.

Packaging

When repacking the oscilloscope for shipment, use the original packaging. If the packaging is unavailable or unfit for use, contact your local Tektronix representative to obtain new packaging.

Seal the shipping carton with an industrial stapler or strapping tape.

Shipping to the Service Center

Contact the Service Center to get an RMA (return material authorization) number, and any return or shipping information you may need.

If the oscilloscope is being shipped to a Tektronix Service Center, enclose the following information:

- The RMA number.
- The owner's address.
- Name and phone number of a contact person.
- Type and serial number of the oscilloscope.
- Reason for returning.
- A complete description of the service required.

Mark the address of the Tektronix Service Center and the return address on the shipping carton in two prominent locations.

Options and Accessories

This section lists the standard and optional accessories available for the TDS5000 Series oscilloscopes, as well as the product options.

Options

You can order the options shown in Table 7-1 with the oscilloscope.

Table 7-1: Instrument options

Hardware options	
16	CD-RW drive (replaces CD-ROM drive)
17	Additional 256 MB of PC RAM
18	Touch-screen interface
1P	Built-in thermal printer
Acquisition memory options	
1M	2M/1M/500k on 1/2/4 channels (2M/1M on 1/2 channels on TDS5052)
2M	8M/4M/2M on 1/2/4 channels (8M/4M on 1/2 channels on TDS5052)
Mounting options	
1K	K420 oscilloscope cart with mouse accessory tray
1R	Rackmount kit
Software options	
2A	Advanced analysis—equation editor, spectral FFT, and histograms
DVD	TDSDVD—Optical storage analysis software
J1	TDSJIT2—Jitter & timing analysis software
J2	TDSDDM2—Disk drive measurements software
JT3	TDSJIT3—Jitter & timing analysis with Rj/Dj and BER estimation
PWR	TDSPWR2—Power analysis software
USB	TDSUSBS—USB2.0 compliance test software only
Probe options	
33	Add (1) P6158 3.0 GHz, 20x low capacitance probe
34	Add (1) P6247 1.0 GHz differential probe

Table 7-1: Instrument options (Cont.)

Probe options	
35	Add (1) P6243 1.0 GHz active probe
37	Add (1) P6245 1.5 GHz active probe
39	Add (1) P6248 1.7 GHz differential probe
53	Add (1) P5050 500 MHz, 10x passive probe
Power cord options	
A1	Universal European power cord (220 V, 50 Hz)
A2	UK power cord (240 V, 50 Hz)
A3	Australia power cord (240 V, 50 Hz)
A5	Switzerland power cord (220 V, 50 Hz)
AC	China power cord (240 V, 50 Hz)
A99	No power cord
Service options	
D1	Calibration data report
C3	Additional 2 years of calibration
D3	Calibration data report for Option C3
R3	Additional 2 years of repair
C5	Additional 4 years of calibration
D5	Calibration data report for Option C5
R6	Additional 4 years of repair

You can order the upgrade kits shown in Table 7-2 to extend the performance of your instrument after its initial purchase. Contact your local Tektronix representative for details and the most current information.

Table 7-2: Instrument upgrades

TDS5UP upgrade*	Description
Option 16	CD-RW drive (replaces CD-ROM drive)
Option 18	Touch-screen interface
Option MU	256 MB of PC RAM
Option M01	Upgrade acquisition memory depth from standard to option 1M
Option M02	Upgrade acquisition memory depth from standard to option 2M
Option M12	Upgrade acquisition memory depth from option 1M to option 2M
Option 1P	Built-in thermal printer

Table 7-2: Instrument upgrades (Cont.)

TDS5UP upgrade*	Description
Option W2K	Windows 2000 Professional Edition (contact your local Tektronix representative for details)
Option CPU	Upgrade to current motherboard and processor (contact your local Tektronix representative for details)
Option 2A	Advanced analysis—equation editor, spectral FFT, and histograms
Option DVD	TDSDVD—Optical storage analysis software
Option J1	TDSJIT2—Jitter & timing analysis software
Option J2	TDSDDM2—Disk drive measurements software
Option J23	TDSJIT2—TDSJIT3 upgrade
Option JT3	TDSJIT3—Jitter & timing analysis with Rj/Dj and BER estimation
Option PWR	TDSPWR2—Power analysis software
Option USB	TDSUSBS—USB2.0 compliance test software only
Option IF	Service installation of selected options

***When ordering a TDS5Up upgrade kit, you must order at least one option.**

Accessories

This section lists the standard and optional accessories available for this oscilloscope.

Standard The accessories shown in Table 7-3 are shipped with the oscilloscope.

Table 7-3: Standard accessories

Accessory	Part number
<i>TDS5000 Series Graphical Packing List</i>	071-1003-xx
<i>TDS5000 Series Digital Phosphor Oscilloscopes User Manual</i>	071-0876-xx

Table 7-3: Standard accessories (cont.)

Accessory	Part number
<i>TDS5000 Series Digital Phosphor Oscilloscopes Reference</i> English French German Italian Spanish Portuguese Japanese Korean Simplified Chinese Traditional Chinese	020-2398-xx
<i>Oscilloscope Analysis and Connectivity Made Easy</i> manual with software	020-2449-xx
<i>TDS5000 Series Product Software</i> CD-ROM (includes application, online help, <i>TDS5000 Series Online Programmer Guide</i> (GPIB online help and PDF), Performance Verification PDF, release notes, VISA information)	063-3508-xx
<i>TDS5000 Series Operating System Restore</i> CD-ROM	063-3509-xx
<i>Optional Applications Software for Tektronix Windows-Based TDS Instruments</i> CD-ROM and manuals	020-2450-xx
Calibration Certificate documenting NIST traceability, Z540-1 compliance, and ISO9001 registration	— —
U.S. power cord	161-0230-xx
Mouse	119-6298-00
Front cover	200-4651-00
Two (TDS5052) or four (TDS5054) 500 MHz 10x passive probes	P5050

Optional

The accessories in Table 7-4 are orderable for use with the oscilloscope at the time this manual was published. Consult a current Tektronix catalog for additions, changes, and details.

Table 7-4: Optional accessories

Accessory	Part number
<i>TDS5000 Series Digital Phosphor Oscilloscopes Service Manual</i>	071-1004-xx
USB keyboard	119-6297-xx
K420 scope cart with mouse accessory Tray	K420, 436-0317-xx
Transit case	016-1522-xx

Table 7-4: Optional accessories (cont.)

Accessory	Part number
Thermal printer (including five rolls of paper)	655-4920-xx
Thermal printer paper (one roll)	016-1897-xx
TDS5000 Series rackmount Kit	016-1887-xx
Probe calibration, compensation, and deskew adapter (requires a separate pulse generator)	067-0405-00
Video display clamp	013-0278-00
P5050 500 MHz 10x passive probe	P5050
P6158 20x low-capacitance probe	P6158
P6247 1 GHz differential probe	P6247
P6243 1 GHz high speed active probe	P6243
P6245 1.5 GHz high speed active probe	P6245
P6248 1.7 GHz differential probe	P6248
P6246 400 MHz differential probe	P6246
TCP202 current probe	TCP202
CT-6 current probe	CT-6
AM503S DC/AC current measurement system	AM503S
AMT75 1 GHz 75 Ω adapter	AMT75
P5205 high voltage differential probe	P5205
P5210 high voltage differential probe	P5210
P5100 high voltage probe	P5100
P6105A high voltage probe	P6105A
AD400A differential preamplifier	AD400A
P6701B optical/electrical converter (multimode)	P6701B
P6703B optical/electrical converter (single mode)	P6703B
Stylus	016-1441-00
Click 'n Burn software (packaged with Option 16 CD-RW drive)	065-3575-xx
TDSJIT2 jitter and timing analysis software	TDSJIT2
TDSJIT3 jitter and timing analysis software with Rj/Dj and BER	TDSJIT3
TDSDDM2 disk drive measurement software	TDSDDM2
TDSUSB2 USB2.0 compliance test package	TDSUSB2
TDSUSBS USB2.0 compliance test software only	TDSUSBS
TDSUSBF USB2.0 compliance test fixture only	TDSUSBF

Table 7-4: Optional accessories (cont.)

Accessory	Part number
WSTRO WaveStar software; remote instrument control and waveform data acquisition	WSTRO
TDSPWR2 power measurement software	TDSPWR2
TDSDVD optical storage analysis software	TDSDVD
Wavewriter AWG and waveform creation software	S3FT400
Vocallink voice control software	VCLNKP
GPIB cable (3.3 ft, or 1 m)	012-0991-01
GPIB cable (6.6 ft, or 2 m)	012-0991-00
RS-232 cable	012-1298-00
Centronics cable	012-1250-00



Electrical Parts List

The modules that make up this instrument are often a combination of mechanical and electrical subparts. Therefore, all replaceable modules are listed in Section 10, *Mechanical Parts List*. Refer to that section for part numbers when using this manual.

Diagrams

This section describes the electrical operation of the TDS5000 Digital Oscilloscope and modules using the major circuit blocks or modules. Figure 9-1 on page 9-2 shows the oscilloscope module interconnections.

Symbols

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975. Abbreviations are based on ANSI Y1.1-1972.

Logic symbology is based on ANSI/IEEE Std 91-1984 in terms of positive logic. Logic symbols depict the logic function performed and can differ from the manufacturer's data.

The tilde (~) preceding a signal name indicates that the signal performs its intended function when in the low state.

Other standards used in the preparation of diagrams by Tektronix, Inc. are:

- Tektronix Standard 062-2476 Symbols and Practices for Schematic Drafting
- ANSI Y14.159-1971 Interconnection Diagrams
- ANSI Y32.16-1975 Reference Designations for Electronic Equipment
- MIL-HDBK-63038-1A Military Standard Technical Manual Writing Handbook

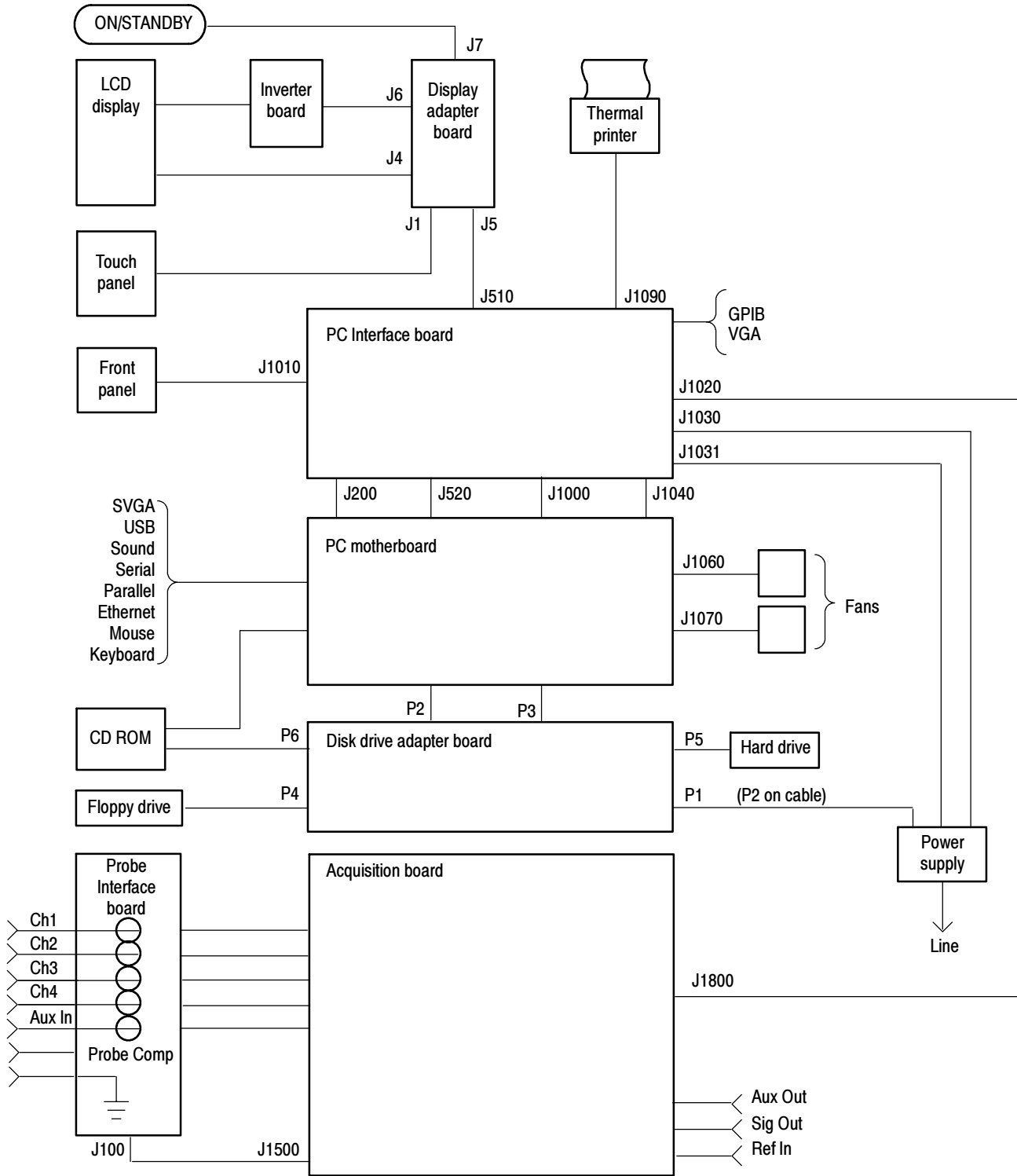


Figure 9- 1: TDS5000 series block diagram

Mechanical Parts List

This section contains a list of the replaceable modules for the oscilloscope. Use this list to identify and order replacement parts.

Parts Ordering Information

Replacement parts are available through your local Tektronix field office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest circuit improvements. Therefore, when ordering parts, it is important to include the following information in your order.

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If you order a part that has been replaced with a different or improved part, your local Tektronix field office or representative will contact you concerning any change in part number.

Module Servicing

Modules can be serviced by selecting one of the following three options. Contact your local Tektronix service center or representative for repair assistance.

Module Exchange. In some cases you may exchange your module for a remanufactured module. These modules cost significantly less than new modules and meet the same factory specifications. For more information about the module exchange program, call 1-800-833-9200, select option 2.

Module Repair and Return. You may ship your module to us for repair, after which we will return it to you.

New Modules. You may purchase replacement modules in the same way as other replacement parts.

Using the Replaceable Parts List

This section contains a list of the mechanical and/or electrical components that are replaceable for the oscilloscope. Use this list to identify and order replacement parts. The following table describes each column in the parts list.

Parts list column descriptions

Column	Column name	Description
1	Figure & Index Number	Items in this section are referenced by component number.
2	Tektronix Part Number	Use this part number when ordering replacement parts from Tektronix.
3 and 4	Serial Number	Column three indicates the serial number at which the part was first effective. Column four indicates the serial number at which the part was discontinued. No entries indicates the part is good for all serial numbers.
5	Qty	This indicates the quantity of parts used.
6	Name & Description	An item name is separated from the description by a colon (:). Because of space limitations, an item name may sometimes appear as incomplete. Use the U.S. Federal Catalog handbook H6-1 for further item name identification.
7	Mfr. Code	This indicates the code of the actual manufacturer of the part. (Code to name and address cross reference is located after this page.)
8	Mfr. Part Number	This indicates the actual manufacturer's or vendor's part number.

Abbreviations Abbreviations conform to American National Standard ANSI Y1.1-1972.

Mfr. Code to Manufacturer Cross Index

The following table cross indexes codes, names, and addresses of manufacturers or vendors of components listed in the parts list.

Manufacturers cross index

Mfr. code	Manufacturer	Address	City, state, zip code
060D9	UNITREK CORPORATION	3000 COLUMBIA HOUSE BLVD, SUITE 120	VANCOUVER, WA 98661
0J9P9	GEROME MFG CO INC	PO BOX 737 403 NORTH MAIN	NEWBERG, OR 97132
0KB01	STAUFFER SUPPLY CO	810 SE SHERMAN	PORTLAND, OR 97214-4657
12136	PHC INDUSTRIES INC	1643 HADDON AVE PO BOX 1448	CAMDEN, NJ 08103
1DM20	PARLEX CORP	7 INDUSTRIAL WAY	SALEM, NH 03079
22670	GM NAMEPLATE INCORPORATED	2040 15TH AVE WEST	SEATTLE, WA 98119-2783
24931	FCI/BERG ELECTRONICS INC	RF/COAXIAL DIV 2100 EARLYWOOD DR PO BOX 547	FRANKLIN, IN 46131
34649	INTEL CORPORATION	3065 BOWERS PO BOX 58130	SANTA CLARA, CA 95051-8130
46628	LOGITECH INC	6505 KAISER DR	FREMONT, CA 94555
4T165	NEC ELECTRONICS, INC.	2880 SCOTT BLVD PO BOX 58062	SANTA CLARA, CA 95052-2554
50356	TEAC AMERICA INC	7733 TELEGRAPH RD PO BOX 750	MONTEBELLO, CA 90640-6537
52833	KEY TRONIC CORPORATION	N 4424 SULLIVAN RD PO BOX 14687	SPOKANE, WA 99214-0687
61058	MATSUSHITA ELECTRIC CORP OF AMERICA	PANASONIC INDUSTRIAL CO DIV TWO PANASONIC WAY	SECAUCUS, NJ 07094
74594	COMPONENT RESOURCES INC	BUSSMAN PARTS C/O CASEY LAKEY 14525 SW WALKER ROAD	BEAVERTON, OR 97006
7X318	KASO PLASTICS INC	5720-C NE 121ST AVE, STE 110	VANCOUVER, WA 98682
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON, OR 97077-0001
93907	CAMCAR DIV OF TEXTRON INC	ATTN: ALICIA SANFORD 516 18TH AVE	ROCKFORD, IL 611045181
S3109	FELLER U.S. CORPORATION	68 VERONICA AVE, UNIT #5	SOMERSET, NJ 08873
S5769	NEC CORPORATION	NEC BUILDING 7-1, SHIBA 5 CHOME MINATO-KU	TOKYO, JP 108
TK1373	PATELEC-CEM	10156 TORINO VAICENTALLO 62/456	ITALY,
TK1943	NEILSEN MANUFACTURING INC	3501 PORTLAND RD NE	SALEM, OR 97303
TK2250	ARROW ELECTRONICS INC.	9500 SW NIMBUS AVE, BLDG E	BEAVERTON, OR 97008-7163
TK2541	AMERICOR ELECTRONICS LTD	UNIT-H 2682 W COYLE AVE	ELK GROVE VILLAGE, IL 60007
TK2548	XEROX CORPORATION	14181 SW MILLIKAN WAY	BEAVERTON, OR 97005
TK2565	VISION PLASTICS INC	26000 SW PARKWAY CENTER DRIVE	WILSONVILLE, OR 97070
TK2582	TUFF CAT USA LLC	814 N HAYDEN MEADOWS DRIVE	PORTLAND, OR 97217
TK6159	ARROW/RICHEY ELECTRONICS	ARROW/RICHEY VALUE ADDED 3601 SW MURRY BLVD SUITE 60	BEAVERTON, OR 97005
TK6253	VOLEX INTERCONNECT INC	646 CARRIBEAN DR	SUNNYVALE, CA 94089-1108
TK6314	MCX INC	1315 OREGON AVE	KLAMATH FALLS, OR 97601-6540

External Parts

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discount'd	Qty	Name & description	Mfr. code	Mfr. part number
10-1-1	200-4669-00			1	DOOR:ACCESSORY TRAY,0.050 AL	TK2565	200-4669-00
	200-4668-00			1	CABINET,TOP:PRINTER TRAY,0.050 AL, Opt. 1P	OJ9P9	200-4668-00
-2	436-0408-00			1	TRAY,;ACCESSORY	TK2565	436-0408-00
-3	200-4649-00			1	TOP:PLASTIC	TK2565	200-4649-00
-4	211-1050-00			8	SCREW,MACHINE:6-32 X 0.312 L,PNH,STL CAD,T15	OKB01	OBD
-5	348-1685-00			4	FOOT:REAR,PC/ABS	TK2565	348-1685-00
-6	200-4639-00			1	COVER,SIDE:RIGHT,FR110	TK2565	200-4639-00
-7	200-4652-00			1	COVER:CDROM,PC/ABS	TK2565	200-4652-00
-8	333-4388-00			1	PANEL ASSEMBLY:FRONT,LOWER,2 CH	TK1943	333-4388-00
	333-4363-00			1	PANEL ASSEMBLY:FRONT,LOWER,4 CH	7X318	333-4363-00
-9	101-0158-00			1	TRIM RING:FR110 (PC/ABS)	TK2565	101-0158-00
-10	-----			1	PEM		PEM SOS-6143-4
-11	200-4651-00			1	COVER,FRONT:PC/ABS ALLOY BAYBLEND,FR110,TEK BLUE	TK2565	200-4651-00
-12	260-2746-00			1	SWITCH,KEYPAD:ELASTOMERIC,ON/STANBY,PUSHBUTTON	22670	260-2746-00
-13	200-4640-00			1	COVER,SIDE:LEFT,FR110	TK2565	200-4640-00
-14	367-0528-00			1	HANDLE,CARRYING:DUAL DUROMETER MOLDED,POLYPROPYLENE,VINYL GRIP SECTION,	12136	367-0528-00
-15	407-4838-00			1	BRACKET:HANDLE BASE,PC/ABS ALLOY,BAYER BAYBLEND FR-110,TEK BLUE	TK2565	407-4838-00
-16	212-0213-00			1	SCREW,MACHINE:8-32 X 0.75 L,PNH,STL, BLACK OXIDE PL,TORX	OKB01	212-0213-00
-17	200-4667-00			1	COVER:VGA PANEL,PC/ABS ALLOY,BAYER,BAYBLEND FR,TEK BLUE	TK2565	200-4667-00
-18	214-5003-00			1	FASTENER,LATCHG:PUSH LOCK,1V60-3-9-999-9	80009	214-5003-00
-19	211-0738-00			2	SCREW,MACHINE:6-32 X 0.625,PNH,STL BLK ZI,TORX	93907	ORDER BY DESC

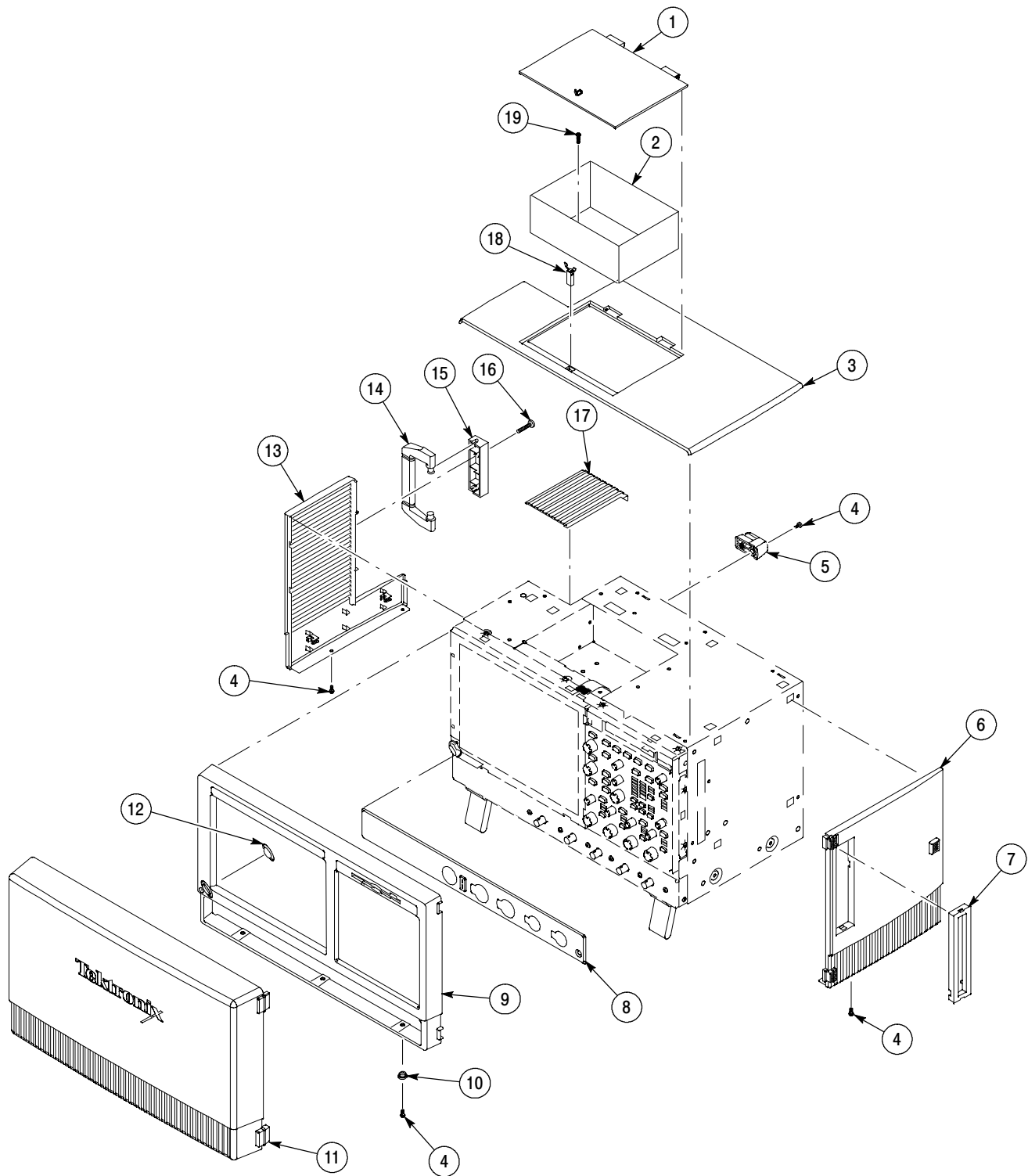


Figure 10-1: External parts

Inner Panels

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
2-1	407-4822-00			1	BRACKET:VGA	TK1943	407-4822-00
-2	211-1050-00		B029999	8	SCREW,MACHINE:6-32 X 0.312 L,PNH,STL CAD,T15	0KB01	OBD
	211-1050-00	B030000		2	SCREW,MACHINE:6-32 X 0.312 L,PNH,STL CAD,T15	0KB01	OBD
-3	344-0591-00			1	CLIP,CABLE:0.050 AL,	TK1943	344-0591-00
-4	200-4662-00			1	COVER,TOP:PRINTER TRAY,0.050 AL	TK1943	200-4662-00
-5	390-1205-00			1	CABINET,TOP:0.05 ALUMINUM,	TK1943	390-1205-00
-6	200-4641-00			1	COVER:BOTTOM,AL	TK1943	200-4641-00
-7	200-4661-00			1	COVER:BOTTOM,COSMETIC,0.040 AL,W/BLACK VINYL ONE SIDE	0J9P9	200-4661-00
-8	211-1164-00	B030000		6	SCREW,MACHINE:6-32 X 0.25 L,PNH,T15,BLACK OXIDE	0KB01	211-1164-00

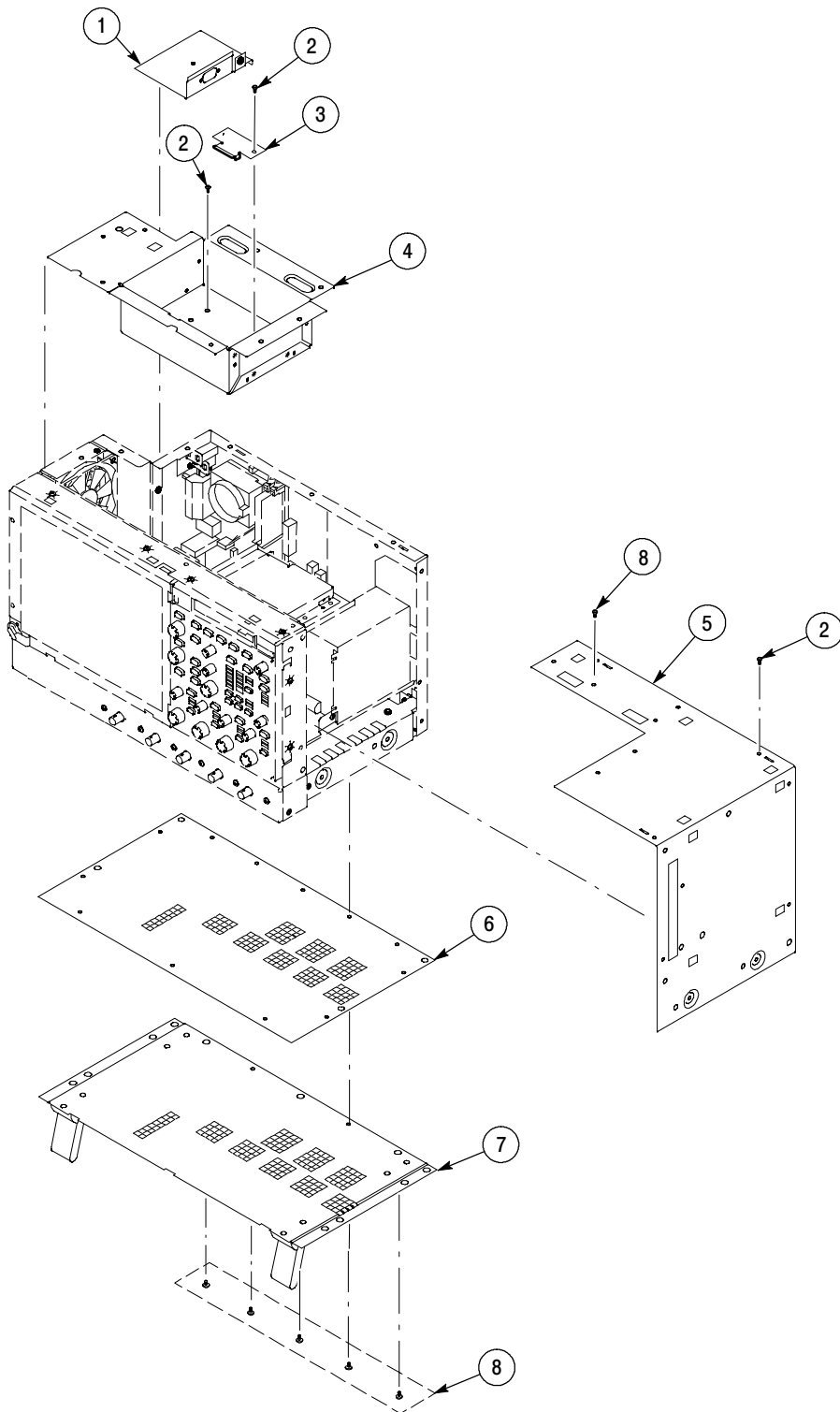


Figure 10-2: Inner panels

Modules

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
3-1	650-4317-00			1	PRINTER,THERMAL:TDS5000 SERIES PRINTER	80009	650-4317-00
-2	211-0738-00			2	SCREW,MACHINE:6-32 X 0.625,PNH,STL BLK ZI,TORX	93907	ORDER BY DESC
-3	174-4427-00			1	CA ASSY, SP:DESCRETE,CPD,20, 18 AWG, 8.0L, 2 X 10,RCPT,STR,2X10 BOTH ENDS	060D9	174-4427-00
-4	174-4514-00			1	CA ASSY,SP:GPIB,RIBBON	TK6314	174-4514-00
-5	039-0118-00		B029999	1	COMPUTER BOARD:PROCESSOR,PENTIUM III,800 MHZ	34649	LABECBSL1
	039-0118-01	B030000		1	COMPUTER BOARD:PROCESSOR,PENTIUM III,1.2 GHZ	34649	LABECBSL1
-6	156-4828-00		B020240	1	IC,MEMORY:CMOS,SDRAM,16MEG X 64, SYNC, UNBUFFERED,3.3V,MC-4516CD646-A10,DIMM168,TDS5052	S5769	MC4516CD646-A10
	156-9074-00	B020241		1	IC,MEMORY; CMOS,DRAM;32MEG X 64, 256MEG, SDRAM,PC100;MT16LSDT3264AG-10E,DIMM168,TDS5052	S5769	MT16LSDT3264AG-10E
	156-4828-00		B021061	1	IC,MEMORY:CMOS,SDRAM,16MEG X 64, SYNC, UNBUFFERED,3.3V,MC-4516CD646-A10,DIMM168,TDS5054	S5769	MC4516CD646-A10
	156-9074-00	B021062		1	IC,MEMORY; CMOS,DRAM;32MEG X 64, 256MEG, SDRAM,PC100;MT16LSDT3264AG-10E,DIMM168,TDS5054	S5769	MT16LSDT3264AG-10E
	156-4828-00		B020910	1	IC,MEMORY:CMOS,SDRAM,16MEG X 64, SYNC, UNBUFFERED,3.3V,MC-4516CD646-A10,DIMM168,TDS5104	S5769	MC4516CD646-A10
	156-9074-00	B020911		1	IC,MEMORY; CMOS,DRAM;32MEG X 64, 256MEG, SDRAM,PC100;MT16LSDT3264AG-10E,DIMM168,TDS5104	S5769	MT16LSDT3264AG-10E
-7	211-1050-00			16	SCREW,MACHINE:6-32 X 0.312 L,PNH,STL CAD,T15	0KB01	OBD
-8	174-4428-00			1	CA ASSY, SP:RIBBON,IDC,10,28 AWG,8.0L,0.050 CTR,FEMALE,STR,2 X 5,BOTH ENDS	060D9	174-4428-00
-9	174-4429-00			1	CA ASSY, SP:RIBBON,IDC,10,28 AWG,4.0L,0.050 STR,FEMALE,STR,2 X 5,BOTH ENDS	060D9	174-4429-00
-10	671-5123-00			1	CKT BD SUBASSY:PC INTERFACE	80009	679-5123-00
-11	119-6480-00			1	POWER SUPPLY:300W,AC-DC,STANDARD,ATX PC SUPPLY,90-132 180-264VAC 50-60 HZ IN,+3.3V 16A +5V 26		CVN300-96P01-A0 1-REV1B
-12	614-1002-00			1	PANEL ASSEMBLY:FRONT,4 CH-NO TS	80009	614-1002-00
	614-1003-00			1	PANEL ASSEMBLY:FRONT,2 CH	80009	614-1003-00
	614-1004-00			1	PANEL ASSEMBLY:FRONT,2 CH-NO TS	80009	614-1004-00
	614-1007-00			1	PANEL ASSEMBLY:FRONT	80009	614-1007-00
-13	366-0819-00			1	KNOB,EPS:PUSH BUTTON ENCODER,SOFT FEEL COATING,PC/ABS BAYBLEND,FR110,TEK SILVER GRAY	22670	366-0819-00
-14	366-0820-00			7	KNOB,CAP:0.425 D,PC/ABS,TEK SILVER GRAY	22670	366-0820-00
-15	366-0821-00			7	KNOB,CAP:0.650 D,PC/ABS,TEK SILVER GRAY	22670	366-0821-00
-16	174-4321-00			1	CABLE ASSY:FLAT FLEX,26POS,10.4L,FRONT PANEL	060D9	174-4321-00
-17	259-0155-01			1	FLEX CIRCUIT; POWER SWITCH,W/LED	80009	259-0155-01
-18	650-4186-01			1	COMPONENT KIT:DISPLAY MODULE, TOUCH SCREEN	80009	650-4186-01
-19	650-4224-00			1	COMPONENT KIT:DISPLAY MODULE - STANDARD	80009	650-4224-00
	650-4189-02			1	MODULE ASSY: DISPLAY MODULE - TOUCH SCREEN	80009	650-4189-02
-20	343-1676-00			1	CLAMP,CABLE; PC/ABS ALLOY,SILVER GREY	80009	343-1676-00

Modules (Cont.)

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discontinued	Qty	Name & description	Mfr. code	Mfr. part number
-21	671-5279-00			1	CKT BD SUBASSY:DISPLAY INTERFACE	80009	671-5279-00
	671-5244-00			1	CKT BD SUBASSY:DISPLAY INTERFACE, TOUCH SCREEN	80009	679-5244-00
-22	119-6260-00			1	POWER SUPPLY:INVERTER BOARD, FOR NEC 10.4 IN LCD	4T165	104PWBR1
-23	174-3618-00			1	CABLE ASSY SP:RIBBON, CPR, 28 AWG, 9.5 L, 1X5, 0.049CTR, LZ SERIES, MOLEX 50058 S	060D9	OBD
-24	174-4425-00			1	CA ASSY, SP:RIBBON, IDC, 50, 28 AWG, 13.0L, 2 X 25, 0.039 CTR BOX MTE 30 GOLD X 2 X 25 0.039	060D9	174-4250-00
-25	210-0164-00			1	RIVET, SOLID: 0.163 OD X 0.415 L, PANEL RANGE HEAD STYLE, NYLON	74594	D30-0156-01
-26	119-6441-00			1	FAN, TUBE AXIAL: 12VDC, 0.15A, 1.8W, 48CFM, 2450RPM, 30DBA, 92MM X 92MM X 26MM, W/ 7IN LEADS & CONNECTO	61058	FBA09A12M
-27	174-4531-00			1	CABLE: PRINTER	1DM20	174-4531-00

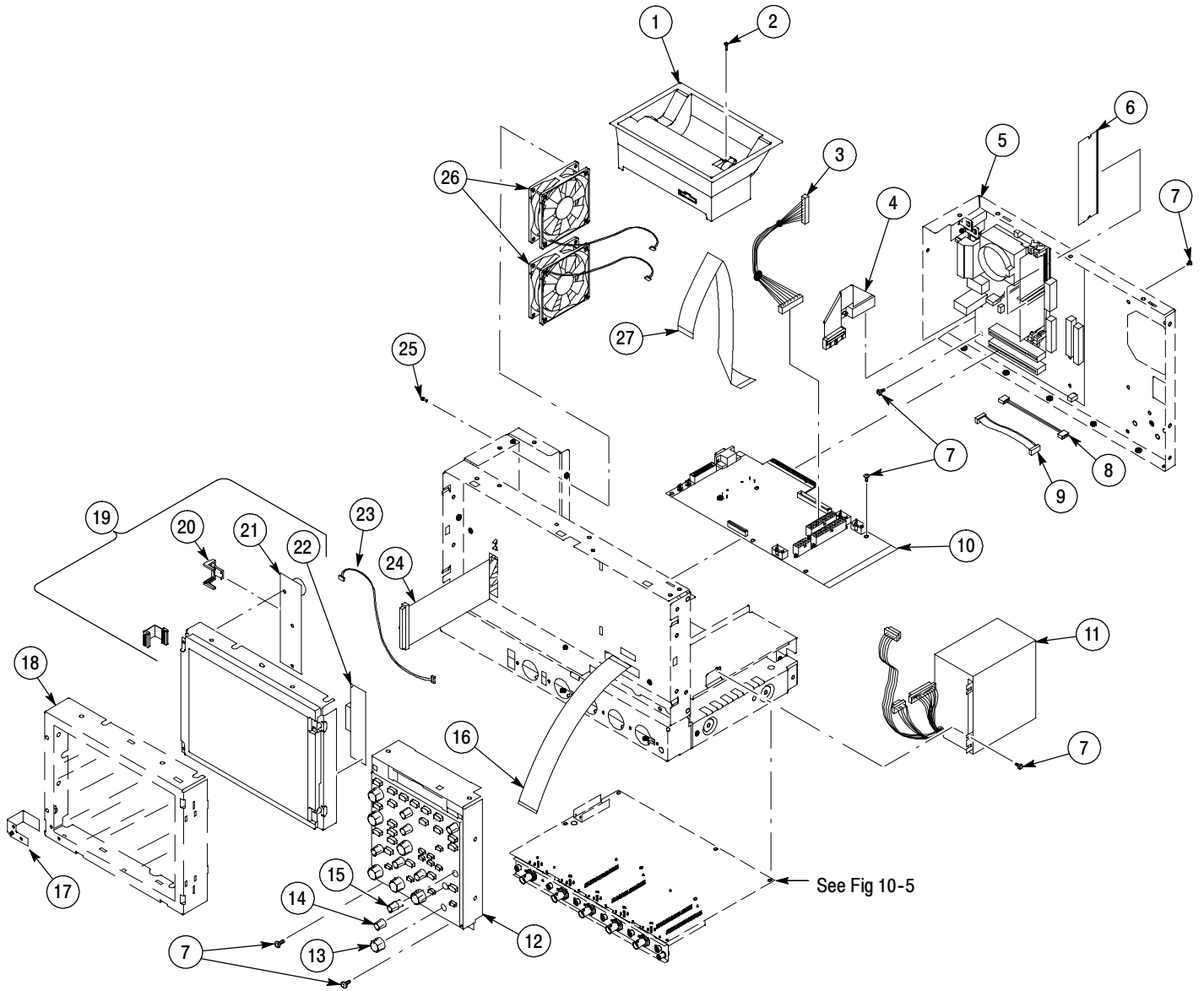


Figure 10-3: Modules

Drives

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discontinued	Qty	Name & description	Mfr. code	Mfr. part number
4-1	119-6106-00			1	DISK DRIVE:FLOPPY,3.5INCH,1.44 MB,0.5 IN HIGH	TK2250	FD-05HF5630
-2	407-4706-00			1	BRACKET:FLOPPY DRIVE,6.064 X 5.075,ALUMINUM	TK1943	407-4706-00
-3	211-1079-00			2	SCREW,MACHINE:2.6 X 0.45 MM,3.0L,PNH,STL,PHILLIPS	0KB01	10310188-0
-4	174-4320-00			1	CA ASSY:FLAT FLEX,26 POS, 9.753L FLOPPY DRIVE	060D9	174-4320-00
-5	211-1050-00			2	SCREW,MACHINE:6-32 X 0.312 L,PNH,STL CAD,T15	0KB01	OBD
-6	671-5145-00			1	CKT BD SUBASSY:DISK DRIVE ADAPTOR	80009	679-5145-00
-7	211-1081-00			4	SCREW,MACHINE:M3 X 0.5 X 3.5MM,FLAT WAFER HD W/SERRATIONS STRESS RELIEVED,PHL,0.0002 STL ZI PL	0KB01	211-1081-00
-8	211-0950-00			1	SCREW,MACHINE:M2X3MM,PHL, PNH, STL NI PL	0KB01	0310248-0
-9	650-4283-00		B020552	1	DRIVE ASSY:REMOVEABLE HARD DISK DRIVE, TDS5104	80009	650-4283-00
	650-4283-01	B020553		1	DRIVE ASSY:REMOVEABLE HARD DISK DRIVE, TDS5104	80009	650-4283-01
	650-4283-00		B020614	1	DRIVE ASSY:REMOVEABLE HARD DISK DRIVE, TDS5054	80009	650-4283-00
	650-4283-01	B020615		1	DRIVE ASSY:REMOVEABLE HARD DISK DRIVE, TDS5054	80009	650-4283-01
	650-4283-00		B020150	1	DRIVE ASSY:REMOVEABLE HARD DISK DRIVE, TDS5052	80009	650-4283-00
	650-4283-01	B020151		1	DRIVE ASSY:REMOVEABLE HARD DISK DRIVE, TDS5052	80009	650-4283-01
-10	407-4794-00			1	BRACKET:DISK DRIVE,AL,PEM	TK1943	407-4794-00
-11	119-5728-00			1	DISK DRIVE:OPTICAL,644MB,CD-ROM,16.7 MB/SEC Option 16 - Optical Disk Drive	50356	CD-224E-903
	119-6582-00		B020448	1	DISKDRIVE:OPTICAL,644MB,CD-RW,16.6MB/SEC,TDS5104	50356	CDW24E
	119-6691-00	B020449		1	DISKDRIVE:OPTICAL,644MB,CD-RW,16.6MB/SEC,TDS5104	50356	CD-W28E-93
	119-6582-00		B020519	1	DISKDRIVE:OPTICAL,644MB,CD-RW,16.6MB/SEC,TDS5054	50356	CDW24E
	119-6691-00	B020520		1	DISKDRIVE:OPTICAL,644MB,CD-RW,16.6MB/SEC,TDS5054	50356	CD-W28E-93
	119-6582-00		B020132	1	DISKDRIVE:OPTICAL,644MB,CD-RW,16.6MB/SEC,TDS5052	50356	CDW24E
	119-6691-00	B020133		1	DISKDRIVE:OPTICAL,644MB,CD-RW,16.6MB/SEC,TDS5052	50356	CD-W28E-93
-12	174-4671-00			1	CA ASSY,SP:ULTRA DMA/ATA HARD DISK DRIVE,IDE,18" L	TK6159	F2N1107
-13	174-4667-00			1	CA ASSY,SP:FLOPPY DRIVE,19" L,DUAL ENDED	TK6159	F3G736

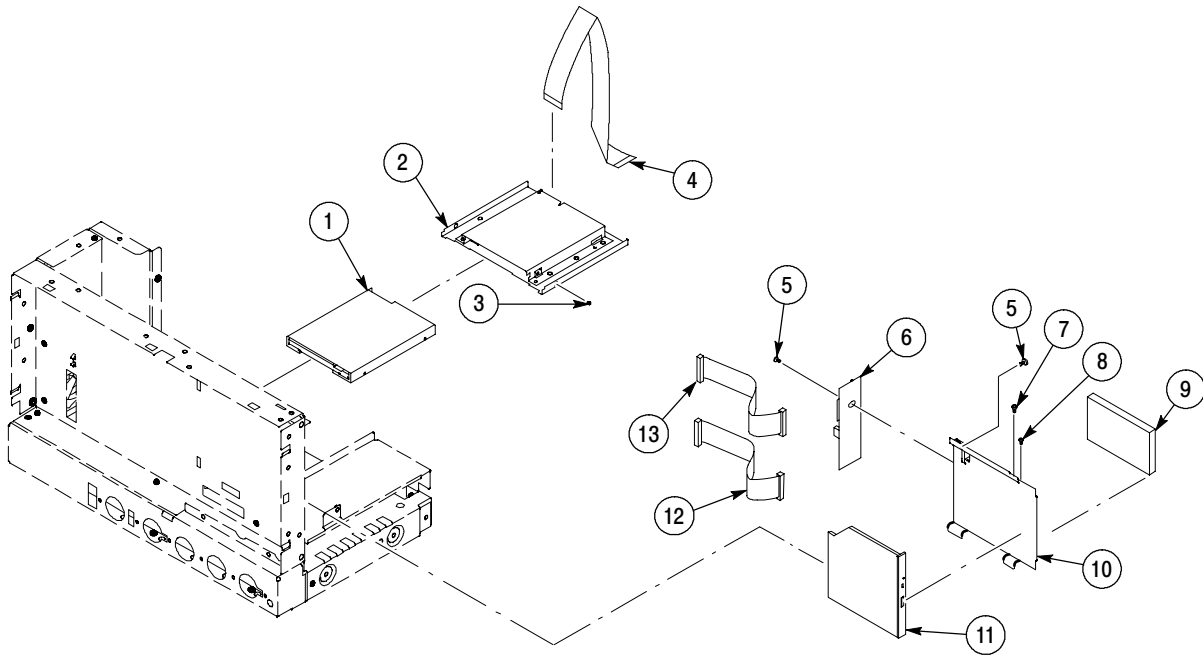


Figure 10-4: Drives

Acquisition assembly

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discontinued	Qty	Name & description	Mfr. code	Mfr. part number
5-1	671-5124-00		B020249	1	CKT BD SUBASSY:ACQUISITION, TDS5104	80009	671-5124-00
	671-5124-01	B020250	B030008	1	CKT BD SUBASSY:ACQUISITION, TDS5104	80009	671-5124-01
	671-5124-02	B030009		1	CKT BD SUBASSY:ACQUISITION, TDS5104	80009	671-5124-02
	671-5278-00		B020255	1	CKT BD SUBASSY:ACQUISITION, TDS5054	80009	671-5278-00
	671-5278-01	B020256	B030011	1	CKT BD SUBASSY:ACQUISITION, TDS5054	80009	671-5278-01
	671-5278-02	B030012		1	CKT BD SUBASSY:ACQUISITION, TDS5054	80009	671-5278-02
	671-5299-00		B020075	1	CKT BD SUBASSY:ACQUISITION, TDS5052	80009	671-5299-00
	671-5299-01	B020076	B030004	1	CKT BD SUBASSY:ACQUISITION, TDS5052	80009	671-5299-01
	671-5299-02	B030005		1	CKT BD SUBASSY:ACQUISITION, TDS5052	80009	671-5299-02
-2	211-1050-00			6	SCREW,MACHINE:6-32 X 0.312 L,PNH,STL CAD,T15	0KB01	OBD
-3	174-2729-00			1	CABLE ASSY:COAX,RFP,50 OHM,5.5 L,PELTOLA BOTH ENDS	060D9	174-2729-00
-4	174-2637-00			1	CABLE ASSY:,RF,50 OHM COAX,7.0 L,,PELTOLA BOTH ENDS	060D9	174-2637-00
-5	175-8029-00			1	CABLE ASSY,RF:50 OHM COAX,12.0 L,PELTOLA X PELTOLA	060D9	175-8029-00
-6	131-1315-01			3	CONN,RF JACK:BNC/PNL,50 OHM PELTOLA/REAR PNL, WITH HARDWARE	24931	28JR306-1
-7	174-4483-00			1	CABLE ASSY:FLEX,20 COND,PROBE INTERFACE	1DM20	174-4483-00
-8	679-5209-00			1	CKT BD SUBASSY:PROBE INTERFACE	80009	679-5209-00

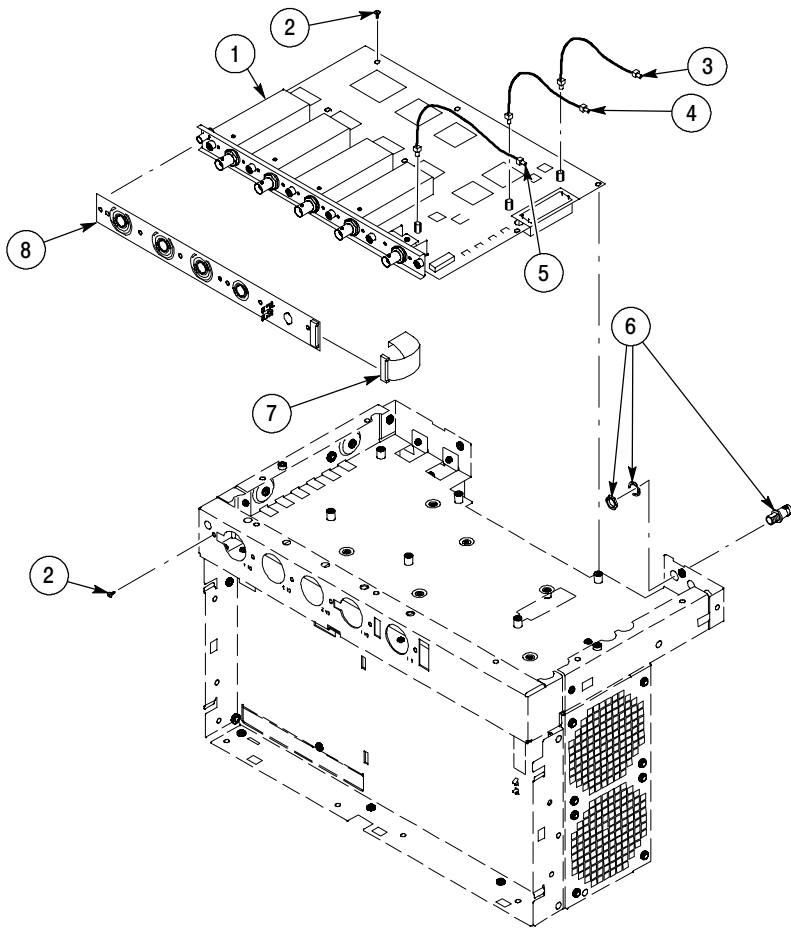


Figure 10-5: Acquisition assembly

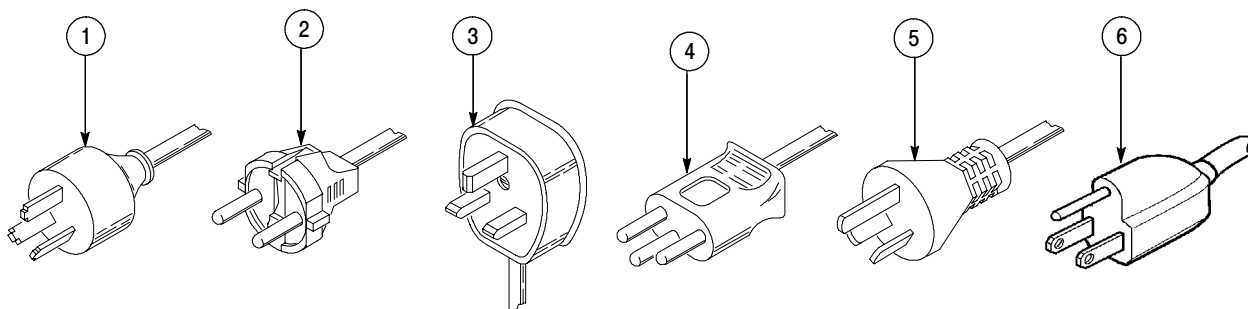


Figure 10-6: Accessories

Accessories

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
STANDARD ACCESSORIES							
6-1	161-0104-05			1	CA ASSY,PWR:3,1.0MM SQ,250V/10A,2.5 METER, (OPTION A3 - AUSTRALIA)	TK1373	161-0104-05
-2	161-0104-06			1	CA ASSY,PWR:3,1.0MM SQ,250V/10A,2.5 METER, (OPTION A1 - EUROPEAN)	TK1373	ORDER BY DESCRIPTION
-3	161-0104-07			1	CA ASSY,PWR:3,1.0MM SQ,240V/10A,2.5 METER,FUSED, (13A FUSE) (OPTION A2 - UNITED KINGDOM)	TK2541	ORDER BY DESCRIPTION
-4	161-0167-00			1	CA ASSY,PWR:3,0.75MM SQ,250V/10A,2.5 METER, (OPTION A5 - SWITZERLAND)	S3109	ORDER BY DESCRIPTION
-5	161-0306-00			1	CA ASSY,PWR:3,1.0MM SQ,250V/10A,2.5 M (OPTION AC - CHINA)	TK6253	92-2637-250BKH
-6	161-0066-00			1	CABLE ASSY,PWER,;3,18 AWG,92 L (STANDARD CABLE - NORTH AMERICA)	TK1373	161-0066-00
-----				1	POUCH, PLASTIC:POUCH	TK2582	TK1441 BLACK CORDURA
	020-2349-00			1	SOFTWARE KIT:CONTAINS LICENSE CERTIFICATE EASY RESTORE,CERTIFICATE AUTHENTICITY,WIN 98 AND WI	80009	020-2349-00
	020-2398-00			1	REFERENCE KIT:LANGUAGE MANUALS,TDS5000 SERIES	80009	020-2398-00
	071-0876-XX			1	MANUAL,TECH:USER,TDS5000 SERIES	TK2548	071-0876-XX
	119-6298-00			1	MOUSE:LOGITECCH WHEEL MOUSE	46628	830306-001
OPTIONAL ACCESSORIES							
	119-6633-00			1	KEYBOARD:USB,W/2 USB PORTS,104 KEY,KEYTRONIC E06101USB-C, HPP PLATFORM	52833	E06101USB-C
	071-1004-XX			1	MANUAL,TECH:SERVICE TDS5000	TK2548	071-1004-XX
	016-1887-00			1	Kit:RACKMOUNT (OPTION 1R)	80009	016-1887-00
	655-4920-00			1	MODULAR KIT:PRINTER,STAND ALONE,TDS5000 SERIES	80009	655-4920-00

