

Service Manual



TDS1000 and TDS2000 Series Digital Storage Oscilloscopes

071-1076-02

This document supports 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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Contacting Tektronix

Tektronix, Inc.
14200 SW Karl Braun Drive
P.O. Box 500
Beaverton, OR 97077
USA

For product information, sales, service, and technical support:

- In North America, call 1-800-833-9200.
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Warranty 16

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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.

Only qualified personnel should perform service procedures.

Injury Precautions

Use Proper Power Cord. To avoid fire hazard, use only the power cord specified for this product.

Avoid Electric Overload. To avoid electric shock or fire hazard, do not apply a voltage to a terminal that is outside the range specified for that terminal.

Avoid Overvoltage. To avoid electric shock or fire hazard, do not apply potential to any terminal, including the common terminal, that varies from ground by more than the maximum rating for that terminal.

Avoid Electric Shock. To avoid injury or loss of life, 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.

Connect the Probe Properly. The probe ground lead is at ground potential. Do not connect the ground lead to an elevated voltage.

Do Not Operate Without Covers. To avoid electric shock or fire hazard, do not operate this product with covers or panels removed.

Use Proper Fuse. To avoid fire hazard, use only the fuse type and rating specified for this product.

Do Not Operate in Wet/Damp Conditions. To avoid electric shock, do not operate this product in wet or damp conditions.

Do Not Operate in an Explosive Atmosphere. To avoid injury or fire hazard, do not operate this product in an explosive atmosphere.

Product Damage Precautions

Use Proper Power Source. Do not operate this product from a power source that applies more than the voltage specified.

Provide Proper Ventilation. To prevent product overheating, provide proper ventilation.

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

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:



DANGER
High Voltage



Protective Ground
(Earth) Terminal



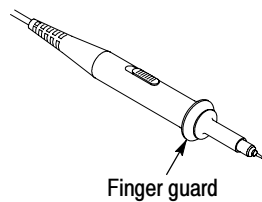
ATTENTION
Refer to Manual



Double
Insulated

Probe Safety

A guard around the probe body provides a finger barrier for protection from electric shock.



WARNING. To avoid electric shock when using the probe, keep fingers behind the guard on the probe body, and do not touch metallic portions of the probe head while it is connected to a voltage source.

Connect the probe to the oscilloscope and connect the ground terminal to ground before you take any measurements.

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, disconnect the main power by means of the power cord or, if provided, the power switch.

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

To avoid electric shock, do not touch exposed connections.

Environmental Considerations

This section provides information about the environmental impact of the product.

Product End-of-Life Handling

Observe the following guidelines when recycling an instrument or component:

Equipment Recycling. Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. In order to avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.



The symbol shown to the left indicates that this product complies with the European Union's requirements according to Directive 2002/96/EC on waste electrical and electronic equipment (WEEE). For information about recycling options, check the Support/Service section of the Tektronix Web site (www.tektronix.com).

Mercury Notification. This product uses an LCD backlight lamp that contains mercury. Disposal may be regulated due to environmental considerations. Please contact your local authorities or, within the United States, the Electronics Industries Alliance (www.eiae.org) for disposal or recycling information.

Restriction of Hazardous Substances

This product has been classified as Monitoring and Control equipment, and is outside the scope of the 2002/95/EC RoHS Directive. This product is known to contain lead, cadmium, mercury, and hexavalent chromium.

Preface

The service manual for the TDS1000- and TDS2000-Series Digital Storage Oscilloscopes provides instructions to verify the performance of, calibrate, troubleshoot, and repair the oscilloscopes to the module level.

Unless noted otherwise, the term “oscilloscope” refers to all of the models in the TDS1000 and TDS2000 series.

Related Manuals

These manuals contain additional documentation for the oscilloscopes:

Language	User manual part number	Extension module instructions part number	Programmer manual part number
English	071-1064-XX	071-0409-XX	071-1075-XX
French	071-1065-XX*	071-0483-XX	
German	071-1067-XX*	071-0485-XX	
Italian	071-1066-XX*	071-0484-XX	
Spanish	071-1068-XX*	071-0482-XX	
Portuguese	071-1070-XX*	071-0486-XX	
Japanese	071-1069-XX*	071-0488-XX	
Korean	071-1073-XX*	071-0491-XX	
Simplified Chinese	071-1071-XX*	071-0489-XX	
Traditional Chinese	071-1072-XX*	071-0490-XX	
Russian	071-1074-XX*	071-0487-XX	

***These manuals contain a language overlay for the front-panel controls.**



Specifications

Specifications

These specifications apply to all TDS1000- and TDS2000-series oscilloscopes. To verify that an oscilloscope meets specifications, it must first meet the following conditions:

- The oscilloscope must have been operating continuously for twenty minutes within the specified operating temperature.
- You must perform the Do Self Cal operation, accessible through the Utility menu, if the operating temperature changes by more than 5 °C.
- The oscilloscope must be within the factory calibration interval of one year.

Specifications begin in Table 1-1. All specifications are guaranteed unless noted “typical.” Specifications that are marked with the ✓ symbol are checked in the chapter *Performance Verification*.

Table 1-1: Oscilloscope specifications

Acquisition		
Acquisition Modes	Sample, Peak Detect, and Average	
Acquisition Rate, typical	Up to 180 waveforms per second, per channel (Sample acquisition mode, no measurements)	
Single Sequence	<i>Acquisition Mode</i>	<i>Acquisition Stops After</i>
	Sample, Peak Detect	Single acquisition, all channels simultaneously
	Average	N acquisitions, all channels simultaneously. N is selectable from 4, 16, 64, and 128
Inputs		
Input Coupling	DC, AC, or GND	
Input Impedance, DC Coupled	1 MΩ ±2% in parallel with 20 pF ±3 pF	
P2200 Probe Attenuation	1X, 10X	
Supported Probe Attenuation Factors	1X, 10X, 100X, 1000X	

Table 1-1: Oscilloscope specifications (Cont.)

Inputs				
Maximum Voltage Between Signal and Common at input BNC	<i>Overvoltage Category*</i>		<i>Maximum Voltage</i>	
	CAT I and CAT II		300 V _{RMS}	
	CAT III		150 V _{RMS}	
	Derate at 20 dB/decade above 100 kHz to 13 V peak AC at 3 MHz and above.			
	For non-sinusoidal waveforms, peak value must be less than 450 V. Excursion above 300 V should be less than 100 ms duration. RMS signal level including any DC component removed through AC coupling must be limited to 300 V. If these values are exceeded, damage to the oscilloscope may result.			
Channel-to-Channel Common Mode Rejection, typical	<i>TDS1001</i>	<i>TDS1002, TDS2002, TDS2004</i>	<i>TDS1012, TDS2012, TDS2014, TDS2022, TDS2024</i>	
	100:1 at 60 Hz 20:1 at 20 MHz	100:1 at 60 Hz 20:1 at 30 MHz	100:1 at 60 Hz 10:1 at 50 MHz	
	Measured on MATH Ch1 - Ch2 waveform, with test signal applied between signal and common of both channels, and with the same VOLTS/DIV and coupling settings on each channel Measured on MATH Ch3 - Ch4 waveform for 4-channel models			
Channel-to-Channel Crosstalk	<i>TDS1001</i>	<i>TDS1002, TDS2002, TDS2004</i>	<i>TDS1012, TDS2012, TDS2014</i>	<i>TDS2022, TDS2024</i>
	≥ 100:1 at 20 MHz	≥ 100:1 at 30 MHz	≥ 100:1 at 50 MHz	≥ 100:1 at 100 MHz
	Measured on one channel, with test signal applied between signal and common of the other channel, and with the same VOLTS/DIV and coupling settings on each channel			
Vertical				
Digitizers	8-bit resolution (except when set to 2 mV/div), each channel sampled simultaneously			
VOLTS/DIV Range	2 mV/div to 5 V/div at input BNC			
Position Range	2 mV/div to 200 mV/div, ±2 V > 200 mV/div to 5 V/div, ±50 V			

* Refer to the Overvoltage Category description on page 1-10.

Table 1-1: Oscilloscope specifications

Vertical				
✓ Analog Bandwidth in Sample and Average modes at BNC or with P2200 probe, DC Coupled	<i>TDS1001</i>	<i>TDS1002, TDS2002, TDS2004</i>	<i>TDS1012, TDS2012, TDS2014</i>	<i>TDS2022, TDS2024</i>
	40 MHz†*	60 MHz†*	100 MHz†*	200 MHz†* 0 °C to +40 °C (32 °F to 104 °F) 160 MHz†* 0 °C to +50 °C (32 °F to 122 °F)
	20 MHz* (when vertical scale is set to < 5 mV)			
Analog Bandwidth in Peak Detect mode (50 s/div to 5 μs/div**), typical	<i>TDS1001</i>	<i>TDS1002, TDS2002, TDS2004</i>	<i>TDS1012, TDS2012, TDS2014, TDS2022, TDS2024</i>	
	30 MHz†*	50 MHz†*	75 MHz†*	
	20 MHz* (when vertical scale is set to < 5 mV)			
Selectable Analog Bandwidth Limit, typical	20 MHz*			
Lower Frequency Limit, AC Coupled	≤ 10 Hz at BNC ≤ 1 Hz when using a 10X passive probe			
Rise Time at BNC, typical	<i>TDS1001</i>	<i>TDS1002, TDS2002, TDS2004</i>	<i>TDS1012, TDS2012, TDS2014</i>	<i>TDS2022, TDS2024</i>
	< 8.4ns	< 5.8 ns	< 3.5 ns	< 2.1 ns
Peak Detect Response**	Captures 50% or greater amplitude of pulses ≥12 ns wide typical (50 s/div to 5 μs/div) in the center 8 vertical divisions			
✓ DC Gain Accuracy	±3% for Sample or Average acquisition mode, 5 V/div to 10 mV/div			
	±4% for Sample or Average acquisition mode, 5 mV/div and 2 mV/div			
✓ DC Measurement Accuracy, Average Acquisition Mode	<i>Measurement Type</i>		<i>Accuracy</i>	
	Average of ≥ 16 waveforms with vertical position at zero		±(3% × reading + 0.1 div + 1 mV) when 10 mV/div or greater is selected	
	Average of ≥ 16 waveforms with vertical position not at zero		±[3% × (reading + vertical position) + 1% of vertical position + 0.2 div] Add 2 mV for settings from 2 mV/div to 200 mV/div Add 50 mV for settings from > 200 mV/div to 5 V/div	
Volts Measurement Repeatability, Average Acquisition Mode	Delta volts between any two averages of ≥ 16 waveforms acquired under same setup and ambient conditions		±(3% × reading + 0.05 div)	

† When vertical scale is set to ≥ 5 mV.

* Bandwidth reduced to 6 MHz with a 1X probe.

** The oscilloscope reverts to Sample mode when the SEC/DIV (horizontal scale) is set from 2.5 μs/div to 5 ns/div on 1 GS/s models, or from 2.5 μs/div to 2.5 ns/div on 2 GS/s models. The Sample mode can still capture 10 ns glitches.

Table 1-1: Oscilloscope specifications (Cont.)

Horizontal		
Sample Rate Range	<i>TDS2022, TDS2024</i>	<i>TDS1001, TDS1002, TDS2004, TDS1012, TDS2002, TDS2012, TDS2014</i>
	5 S/s to 2 GS/s	5 S/s to 1 GS/s
Waveform Interpolation	(sin x)/x	
Record Length	2500 samples for each channel	
SEC/DIV Range	<i>TDS2022, TDS2024</i>	<i>TDS1001, TDS1002, TDS2004, TDS1012, TDS2002, TDS2012, TDS2014</i>
	2.5 ns/div to 50 s/div, in a 1, 2.5, 5 sequence	5 ns/div to 50 s/div, in a 1, 2.5, 5 sequence
✓ Sample Rate and Delay Time Accuracy	±50 ppm over any ≥1 ms time interval	
Delta Time Measurement Accuracy (Full Bandwidth)	<i>Conditions</i>	<i>Accuracy</i>
	Single-shot, Sample mode	±(1 sample interval + 50 ppm × reading + 0.6 ns)
	> 16 averages	±(1 sample interval + 50 ppm × reading + 0.4 ns)
	Sample interval = s/div ÷ 250	
Position Range	5 ns/div to 10 ns/div	(-4 div × s/div) to 20 ms
	25 ns/div to 100 μs/div	(-4 div × s/div) to 50 ms
	250 μs/div to 50 s/div	(-4 div × s/div) to 50 s
	<i>TDS2022, TDS2024</i>	
	2.5 ns/div	(-4 div × s/div) to 20 ms

Table 1-1: Oscilloscope specifications

Trigger				
✓ Trigger Sensitivity, Edge Trigger Type	<i>Coupling</i>	<i>Sensitivity</i>	<i>TDS1001, TDS1002, TDS1012, TDS2002, TDS2004, TDS2012, TDS2014</i>	<i>TDS2022, TDS2024</i>
	DC	EXT	200 mV from DC to 100 MHz*	200 mV from DC to 100 MHz* 350 mV from 100 MHz to 200 MHz*
		EXT/5	1 V from DC to 100 MHz*	1 V from DC to 100 MHz* 1.75 V from 100 MHz to 200 MHz*
		CH1, CH2, CH3, CH4	1 div from DC to 10 MHz*, 1.5 div from 10 MHz to Full	
Trigger Sensitivity, Edge Trigger Type	<i>Coupling</i>	<i>Sensitivity</i>		
	AC	Same as DC at 50 Hz and above		
	NOISE REJ	Reduces the DC-coupled trigger sensitivity by 2 times for > 10 mv/div to 5 V/div		
	HF REJ	Same as the DC-coupled limit from DC to 7 kHz, attenuates signals above 80 kHz		
	LF REJ	Same as the DC-coupled limits for frequencies above 300 kHz, attenuates signals below 300 kHz		
Trigger Level Range	<i>Source</i>	<i>Range</i>		
	CH1, CH2, CH3, and CH4	±8 divisions from center of screen		
	EXT	±1.6 V		
	EXT/5	±8 V		
Trigger Level Accuracy, typical	Accuracies are for signals having rise and fall times ≥ 20 ns			
	<i>Source</i>	<i>Accuracy</i>		
	Internal	±0.2 div × volts/div within ±4 divisions from center screen		
	EXT	±(6% of setting + 40 mV)		
	EXT/5	±(6% of setting + 200 mV)		
SET LEVEL TO 50%, typical	Operates with input signals ≥ 50 Hz			
Default Settings, Video Trigger	Coupling is AC and Auto except for a single sequence acquisition			

* Bandwidth reduced to 6 MHz with a 1X probe.

Table 1-1: Oscilloscope specifications (Cont.)

Trigger	
Sensitivity, Video Trigger Type, typical	Composite video signal
	<i>Source</i>
	Internal
	EXT
	<i>Range</i>
	400 mV
	2 V
Signal Formats and Field Rates, Video Trigger Type	Supports NTSC, PAL, and SECAM broadcast systems for any field or any line
Holdoff Range	500 ns to 10 s
Pulse Width Trigger	
Pulse Width Trigger modes	Trigger when < (Less than), > (Greater than), = (Equal), or \neq (Not Equal); Positive pulse or Negative pulse
Pulse Width Trigger Point	Equal: The oscilloscope triggers when the trailing edge of the pulse crosses the trigger level. Not Equal: If the pulse is narrower than the specified width, the trigger point is the trailing edge. Otherwise, the oscilloscope triggers when a pulse continues longer than the time specified as the Pulse Width. Less than: The trigger point is the trailing edge. Greater than (also called time-out trigger): The oscilloscope triggers when a pulse continues longer than the time specified as the Pulse Width.
Pulse Width Range	Selectable from 33 ns to 10 s
Pulse Width Resolution	16.5 ns or 1 part per thousand, whichever is larger
Equal Guardband	$t > 330 \text{ ns}: \pm 5\% \leq \text{guardband} < \pm(5.1\% + 16.5 \text{ ns})$ $t \leq 330 \text{ ns}: \text{guardband} = \pm 16.5 \text{ ns}$
Not Equal Guardband	$t > 330 \text{ ns}: \pm 5\% \leq \text{guardband} < \pm(5.1\% + 16.5 \text{ ns})$ $165 \text{ ns} < t \leq 330 \text{ ns}: \text{guardband} = -16.5 \text{ ns}/+33 \text{ ns}$ $t \leq 165 \text{ ns}: \text{guardband} = \pm 16.5 \text{ ns}$
Trigger Frequency Counter	
Readout Resolution	6 digits
Accuracy (typical)	$\pm 51 \text{ ppm}$ including all frequency reference errors and ± 1 count errors
Frequency Range	AC coupled, 10 Hz minimum to rated bandwidth

Table 1-1: Oscilloscope specifications (Cont.)

Trigger Frequency Counter	
Signal Source	<p>Pulse Width or Edge Trigger modes: all available trigger sources</p> <p>The Frequency Counter measures trigger source at all times, including when the oscilloscope acquisition is halted due to changes in the run status, or acquisition of a single shot event has completed.</p> <p>Pulse Width Trigger mode: The oscilloscope counts pulses of significant magnitude inside the 250 ms measurement window that qualify as triggerable events, such as narrow pulses in a PWM pulse train if set to < mode and the width is set to a relatively small time.</p> <p>Edge Trigger mode: The oscilloscope counts all edges of sufficient magnitude and correct polarity.</p> <p>Video Trigger mode: The Frequency Counter does not operate.</p>
Measurements	
Cursors	<p>Voltage difference between cursors (ΔV)</p> <p>Time difference between cursors (ΔT)</p> <p>Reciprocal of ΔT in Hertz ($1/\Delta T$)</p>
Automatic Measurements	Frequency, Period, Mean, Pk-Pk, Cycle RMS, Min, Max, Rise Time, Fall Time, Pos Width, Neg Width

Table 1-2: Oscilloscope general specifications

Display	
Display Type	145 mm (5.7 in) diagonal liquid crystal
Display Resolution	320 horizontal by 240 vertical pixels
Display Contrast	Adjustable, temperature compensated
Backlight Intensity, typical	65 cd/m ²
Probe Compensator Output	
Output Voltage, typical	5 V into $\geq 1 \text{ M}\Omega$ load
Frequency, typical	1 kHz
Power Source	
Source Voltage	<p>100 - 120 VAC_{RMS} ($\pm 10\%$) from 45 Hz through 440 Hz, CAT II</p> <p>120 - 240 VAC_{RMS} ($\pm 10\%$) from 45 Hz through 66 Hz, CAT II</p>
Power Consumption	Less than 30 W
Fuse	1 A, T rating, 250 V

Table 1-2: Oscilloscope general specifications (Cont.)

Environmental		
Temperature	Operating	0 °C to +50 °C (32 °F to 122 °F)
	Nonoperating	-40 °C to +71 °C (-40 °F to 159.8 °F)
Cooling Method	Convection	
Humidity	+40 °C or below (+104 °F or below)	≤ 90% relative humidity
	+41° C to +50° C (106 °F to 122 °F)	≤ 60% relative humidity
Altitude	Operating and Nonoperating	3,000 m (10,000 ft)
Random Vibration	Operating	0.31 g _{RMS} from 5 Hz to 500 Hz, 10 minutes on each axis
	Nonoperating	2.46 g _{RMS} from 5 Hz to 500 Hz, 10 minutes on each axis
Mechanical Shock	Operating	50 g, 11 ms, half sine
Mechanical		
Size	Height	151.4 mm (5.96 in)
	Width	323.8 mm (12.75 in)
	Depth	124.5 mm (4.90 in)
Weight (approximate)	When packaged for domestic shipment	3.6 kg (8.0 lbs)

Certifications and Compliances

EN 61326. EMC requirements for Class A electrical equipment for measurement, control, and laboratory use. Annex D.

- IEC 61000-4-2. Electrostatic discharge immunity
- IEC 61000-4-3. RF electromagnetic field immunity
- IEC 61000-4-4. Electrical fast transient / burst immunity
- IEC 61000-4-5. Power line surge immunity
- IEC 61000-4-6. Conducted RF Immunity
- IEC 61000-4-11. Voltage dips and interruptions immunity

EN 61000-3-2. AC power line harmonic emissions¹

EN 61000-3-3. Voltage changes, fluctuations, and flicker

¹ Emissions which exceed the levels required by this standard may occur when this equipment is connected to a test object.

Australia / New Zealand Declaration of Conformity - EMC	Complies with EMC provision of Radiocommunications Act per these standard(s): <ul style="list-style-type: none"> ■ AS/NZS 2064.1/2. Industrial, Scientific, and Medical Equipment: 1992
EMC Compliance	Meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility when it is used with the product(s) stated in the specifications table. Refer to the EMC specification published for the stated products. May not meet the intent of the directive if used with other products.
FCC Compliance	Emissions comply with FCC 47 CFR, Part 15, Subpart B for Class A equipment.
Russian Federation	This product was certified by the GOST ministry of Russia to be in compliance with all applicable EMC regulations.
Peoples Republic of China	This product has received the Chinese Metrology Certification. (CMC).
EC Declaration of Conformity - Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 73/23/EEC, amended by 93/68/EEC. <ul style="list-style-type: none"> ■ EN 61010-1:2001. Safety requirements for electrical equipment for measurement control and laboratory use. ■ EN 61010-2-031:2002. Particular requirements for handheld probe assemblies for electrical measurement and test equipment.
U.S. Nationally Recognized Testing Laboratory Listing	<ul style="list-style-type: none"> ■ UL 61010B-1:2004, 2nd Edition. Standard for electrical measuring and test equipment. ■ UL 61010B-2-031:2003. Particular requirements for handheld probe assemblies for electrical measurement and test equipment.
Canadian Certification	<ul style="list-style-type: none"> ■ CAN/CSA C22.2 No. 1010.1:1997. Particular requirements for electrical equipment for measurement, control, and laboratory use. Part 1. ■ CAN/CSA C22.2 No. 61010-2-031:1994. Particular requirements for handheld probe assemblies for electrical measurement and test equipment.
Additional Compliance	<ul style="list-style-type: none"> ■ IEC 61010-1:2001. Safety requirements for electrical equipment for measurement, control, and laboratory use.

- IEC 61010-031:2002. Particular requirements for handheld probe assemblies for electrical measurement and test equipment.

Equipment Type Test and measuring equipment.

Pollution Degree Descriptions 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 1. No pollution or only dry, nonconductive pollution occurs. Products in this category are generally encapsulated, hermetically sealed, or located in clean rooms.
- 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.
- Pollution Degree 3. Conductive pollution, or dry, nonconductive pollution that becomes conductive due to condensation. These are sheltered locations where neither temperature nor humidity is controlled. The area is protected from direct sunshine, rain, or direct wind.
- Pollution Degree 4. Pollution that generates persistent conductivity through conductive dust, rain, or snow. Typical outdoor locations.

Pollution Degree Pollution Degree 2 (as defined in IEC 61010-1). Note: Rated for indoor use only.

Installation (Overvoltage) Category Descriptions Terminals on this product may have different installation (overvoltage) category designations. The installation categories are:

- Measurement Category IV. For measurements performed at the source of low-voltage installation.
- Measurement Category III. For measurements performed in the building installation.
- Measurement Category II. For measurements performed on circuits directly connected to the low-voltage installation.
- Measurement Category I. For measurements performed on circuits not directly connected to MAINS.

Overvoltage Category Overvoltage Category II (as defined in IEC 61010-1)



Operating Information

Operating Information

TDS1000- and TDS2000-series oscilloscopes are two- or four-channel instruments in small, lightweight, benchtop chassis that you can use to take ground-referenced measurements.

In addition to a list of general features, this chapter covers:

- How to install your product
- How to add extended functions
- How to perform a brief functional check
- How to use the self-calibration routine
- How to restore factory default settings

For more detailed information about oscilloscope operation, refer to your user manual.

General Features

Model	Channels	Bandwidth	Sample rate	Display
TDS1001	2	40 MHz	1.0 GS/s	Monochrome
TDS1002	2	60 MHz	1.0 GS/s	Monochrome
TDS1012	2	100 MHz	1.0 GS/s	Monochrome
TDS2002	2	60 MHz	1.0 GS/s	Color
TDS2004	2	60 MHz	1.0 GS/s	Color
TDS2012	2	100 MHz	1.0 GS/s	Color
TDS2014	4	100 MHz	1.0 GS/s	Color
TDS2022	2	200 MHz	2.0 GS/s	Color
TDS2024	4	200 MHz	2.0 GS/s	Color

- Context-sensitive Help system
- Color or monochrome LCD display
- Selectable 20 MHz bandwidth limit
- 2500-point record length for each channel
- Autoset Menu
- Probe Check Wizard
- Cursors with readouts
- Trigger frequency readout
- Eleven automatic measurements
- Waveform averaging and peak detection
- Dual time base
- Math Fast Fourier Transform (FFT)
- Pulse Width trigger capability
- Video trigger capability with line-selectable triggering
- External trigger
- Setup and waveform storage
- Variable persistence display

- RS-232, GPIB, and Centronics ports with the optional TDS2CMA Communications Extension Module
- User interface in ten user-selectable languages

Installation

Power Cord Use only power cords designed for your oscilloscope. Use a power source that delivers 90 to 264 VAC_{RMS}, 45 to 66 Hz. If you have a 400 Hz power source, it must deliver 90 to 132 VAC_{RMS}, 360 to 440 Hz.

Refer to page 8-8 in the *Replaceable Parts* chapter for a list of power cords available from Tektronix. All power cords must be rated for > 3 Amps, 3 wire, and have an 18 AWG (1.0 mm) Safety Ground lead, or larger.

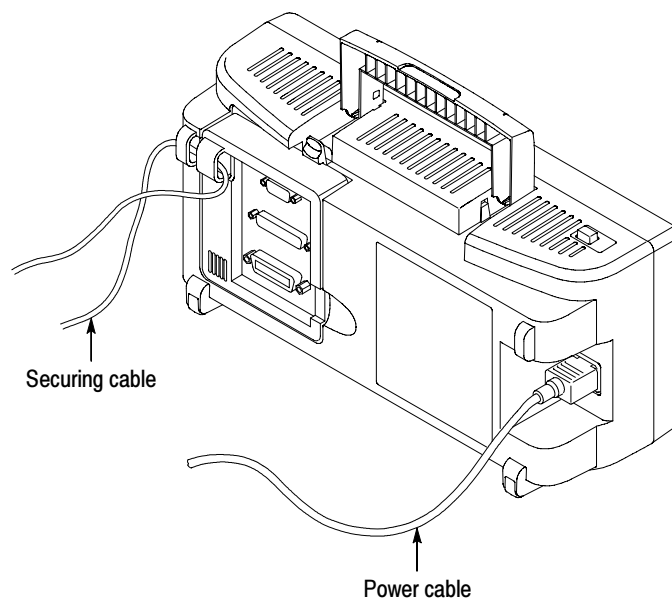


Figure 2-1: Routing the power cord and security cable

Security Loop Use the built-in cable channels to secure both your oscilloscope and extension module to your location.

Extension Modules

You can increase the feature set of your oscilloscope by inserting an extension module. Refer to page 8-8 for more information. Figure 2-2 shows the proper way to install and remove a module without bending the connecting pins.

For more information on extension modules, see your oscilloscope user manual.



CAUTION. *Electrostatic discharge (ESD) can damage components in the extension module and the oscilloscope. Do not operate your instrument with the extension module connector exposed.*

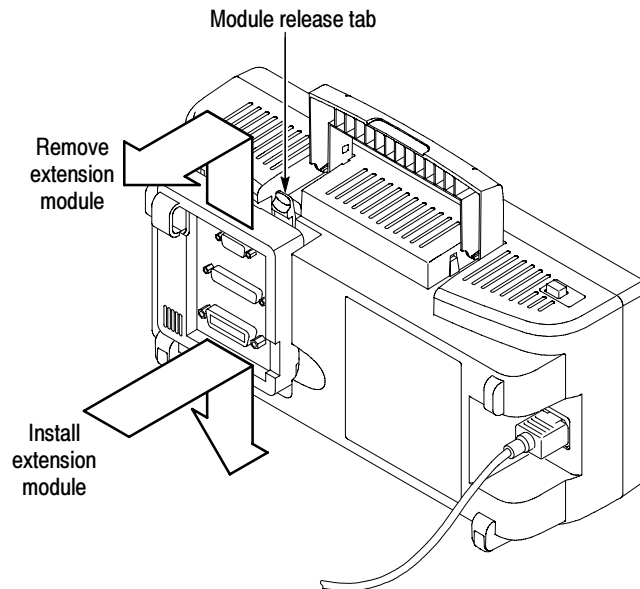
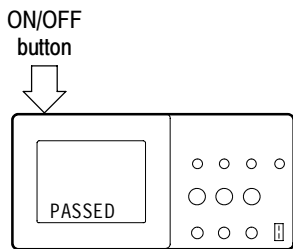


Figure 2-2: Installing and removing an extension module

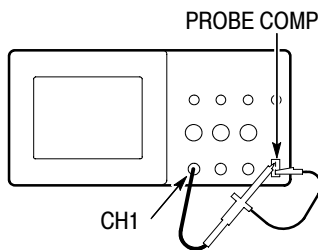
Functional Check

Perform this quick functional check to verify that your oscilloscope is operating correctly.



1. Turn on the oscilloscope.

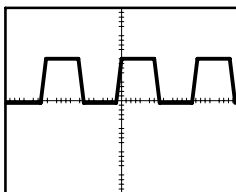
Wait until the display shows that all power-on tests passed. Push the DEFAULT SETUP button. The default Probe menu attenuation setting is 10X.



2. Set the switch to 10X on the P2200 probe and connect the oscilloscope probe to channel 1. To do this, align the slot in the probe connector with the key on the CH1 BNC, push to connect, and twist to the right to lock the probe in place.

Attach the probe tip and reference lead to the PROBE COMP connectors.

AUTO SET



3. Push the AUTOSET button. Within a few seconds, you should see a square wave in the display (approximately 5 V at 1 kHz peak-to-peak).

Move the probe to the CH2 BNC. Repeat step 3. For four-channel models, repeat step 3 for CH3 and CH4. A similar test, described below, can be performed on the EXT TRIG connector, although the amplitude scale factor is undefined.

Connect the probe to the EXT TRIG BNC. Attach the probe tip and reference lead to the PROBE COMP connectors. Push TRIG MENU and push the top option button to select Edge triggering. Then, push the second option button to select Ext as the source. Finally, push and hold the front-panel TRIG VIEW button. Once again, you should see a square wave in the display.

Self Calibration

The self-calibration routine lets you quickly optimize the oscilloscope signal path for maximum measurement accuracy. You can run the routine at any time but you should always run the routine if the ambient temperature changes by 5 °C or more.

To compensate the signal path, disconnect any probes or cables from the channel input connectors. Then, press the UTILITY button and select the Do Self Cal option. Follow the on-screen instructions to proceed.

Default Setup

Table 2-1 lists the state of the oscilloscope after you press DEFAULT SETUP.

NOTE. When you push the DEFAULT SETUP button, the oscilloscope displays the CH1 waveform and removes all other waveforms.

Table 2-1: Default settings

Menu or system	Option, button or knob	Default setting
ACQUIRE	Sample, Peak Detect, and Average	Sample
	Averages: 4, 8, 16, 64, and 128	16
	RUN/STOP	RUN
CURSOR	Type	Off
	Source	CH1
	Horizontal (voltage)	+/- 3.2 divs
	Vertical (time)	+/- 4 divs
DISPLAY	Type	Vectors
	Persist	Off
	Format	YT
HORIZONTAL	Window	Main
	Trig Knob	Level
	POSITION	0.00 s
	SEC/DIV	500 μ s
	Window Zone	50 μ s

Table 2-1: Default settings (Cont.)

Menu or system	Option, button or knob	Default setting
MATH	Operation	CH1 - CH2
	FFT operation: Source	CH1
	Window	Hanning
	FFT Zoom	X1
MEASURE	Source	CH1
	Type	None
TRIGGER Mode	Type	Edge
Edge TRIGGER	Type	Edge
	Source	CH1
	Slope	Rising
	Mode	Auto
	Coupling	DC
	LEVEL	0.00 V
Video TRIGGER	Type	Video
	Source	CH1
	Polarity	Normal
	Sync	All Lines
	Standard	NTSC
Pulse Width TRIGGER	Type	Pulse
	Source	CH1
	When	=
	Set Pulse Width	1.00 ms
	Polarity	Positive
	Mode	Auto
	Coupling	DC
Vertical system, all channels	Coupling	DC
	BW Limit	Off
	Volts/Div	Coarse
	Probe	10X
	Invert	Off
	POSITION	0.00 divs (0.00 V)
	VOLTS/DIV	1.00 V

The DEFAULT SETUP button does not reset the following:

- Language option
- Saved setup files
- Saved reference waveform files
- Display contrast
- Calibration data
- Printer setup
- RS-232 setup
- GPIB setup



Theory of Operation

Theory of Operation

This chapter describes the electrical operation of the TDS1000- and TDS2000-series oscilloscopes to the module level. It describes the basic operation of each functional circuit block shown in Figures 3-1 and 3-2. Of necessity, the descriptions for the two and four channel units, and the color and monochrome units, are slightly different.

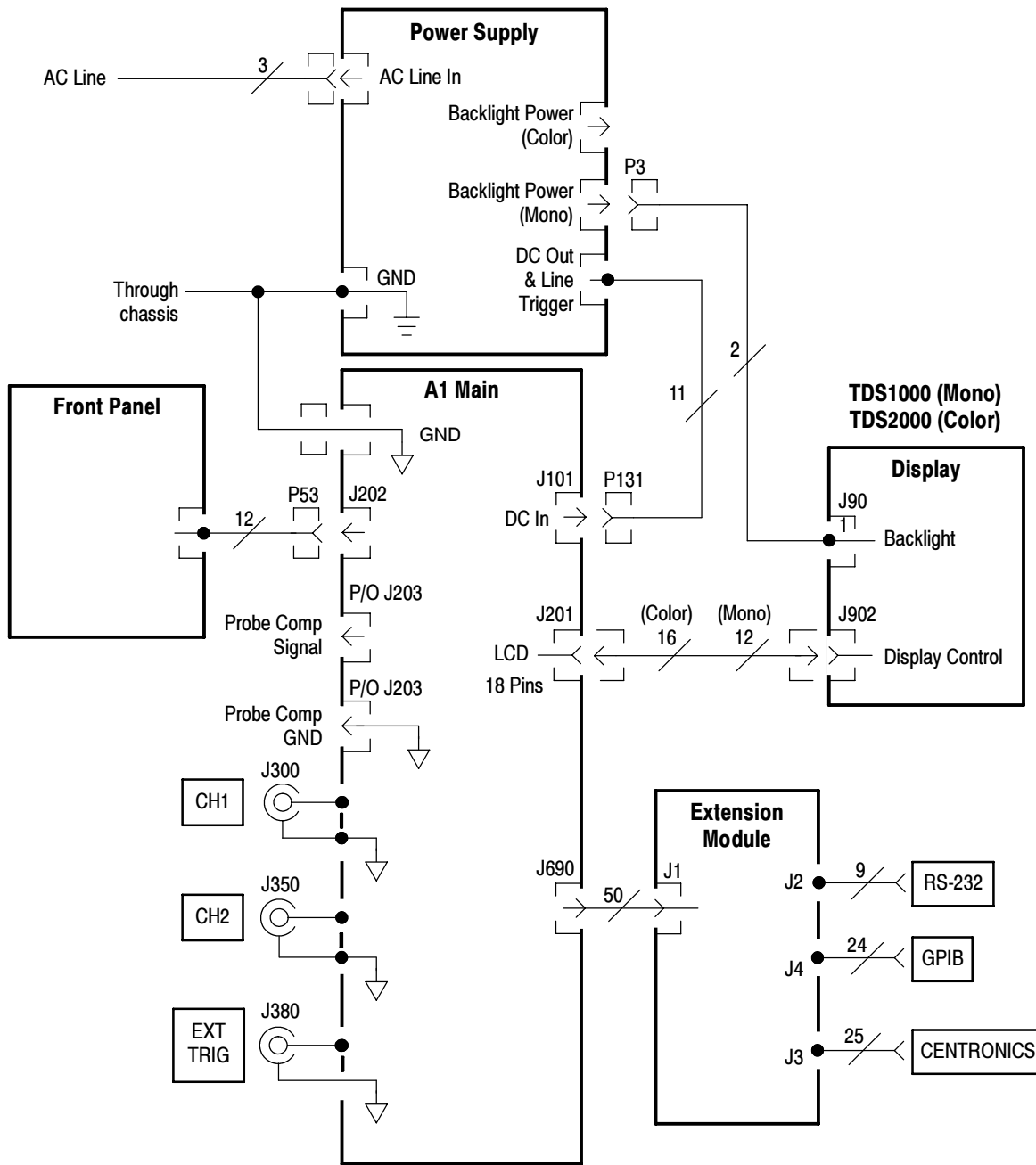


Figure 3-1: Module-level block diagram (two channel)

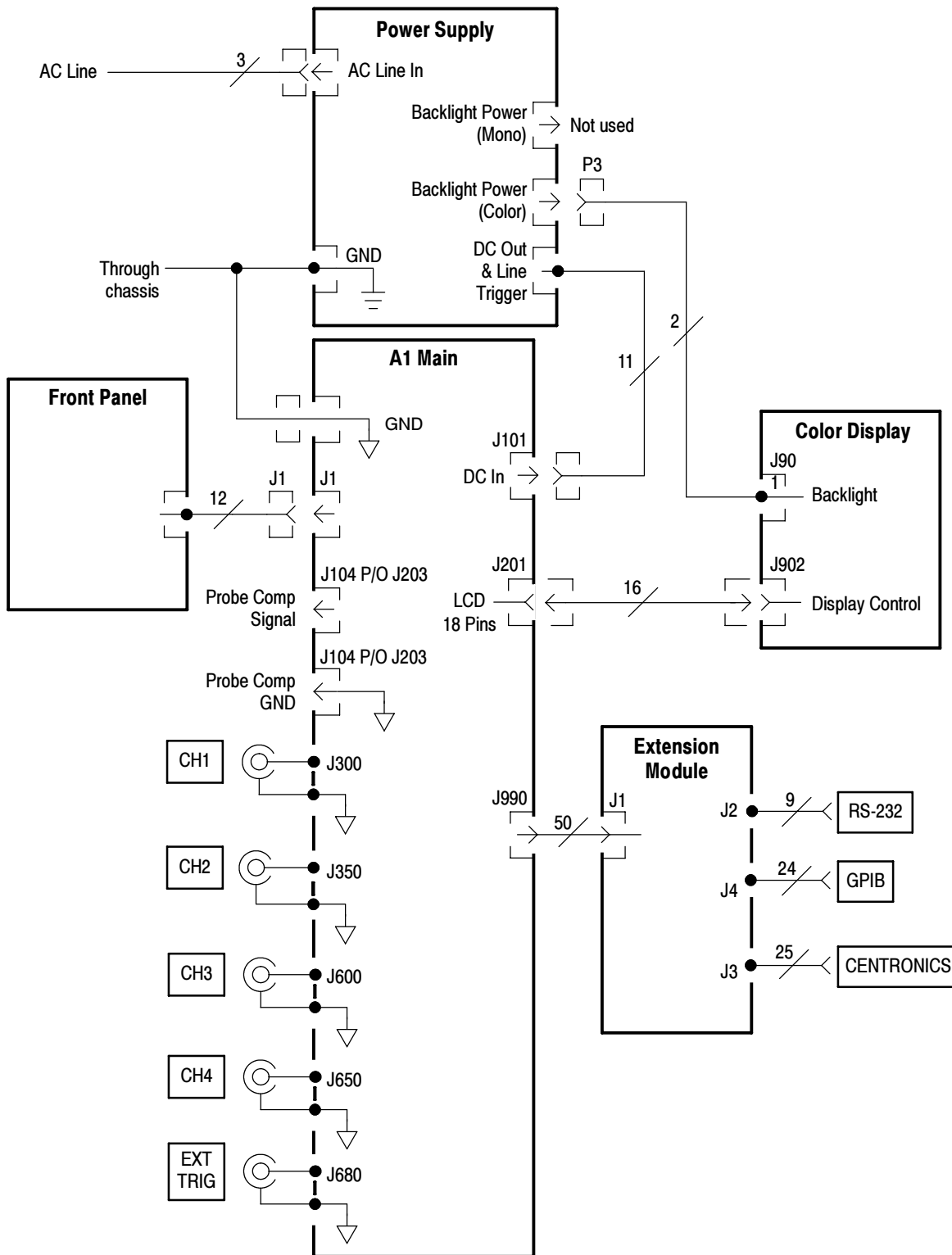


Figure 3-2: Module-level block diagram (four channel)

Main Board

The main board of a four-channel oscilloscope is essentially 2, two-channel oscilloscopes tied together through a common microprocessor, and some special interconnects to support combining the display and trigger systems. For this reason, the focus of the main board discussion will be the two-channel system, with differences noted as necessary.

At a minimum, the main board contains attenuators, an amplifier ASIC, a digitizer/trigger system ASIC, a signal processing/display/system services ASIC, RAM, flash PROM, a microprocessor, and special power supplies. For a four-channel oscilloscope, the attenuators and ASICs are duplicated. Most of the other aspects of the circuitry remain unchanged.

Acquisition System

Signals from the CH 1, CH 2 and other input connectors pass through attenuators and an AC-coupling switch to the amplifier ASIC. The EXT TRIG input has an abbreviated version of this path, lacking some of the attenuator settings and the AC coupling switch.

The amplifier ASIC contains buffers and variable gain amplifiers, as well as filters that provide 20 MHz bandwidth limiting. The task of the amplifier ASIC is to convert from a 1 M Ω single-ended environment in the front end to a much lower impedance differential (and thus less noise-sensitive) environment for the acquisition process. The amplifier ASIC assures that the input signal is amplified to approximately the correct level to allow the fullest possible use of the digitizer.

The acquisition ASIC contains samplers and peak detectors for each input channel, a common amplifier, an A/D converter, and the trigger logic. The digitized waveform samples are transferred to the processing and display ASIC. In four-channel systems, the two acquisition ASICs are interconnected so that a trigger on one ASIC can cause a trigger on the other.

The processor system adds the microprocessor and flash PROM to the processing and display system. The processor system interprets the front-panel control changes detected by the display ASIC, provides control parameters based upon user setting requests, computes waveform measurements, and manages the extension module interface. Saved setups, waveforms, and calibration constants are stored in nonvolatile memory (NVRAM). The processor system shares DRAM with the display system.

Processing and Display System	<p>The processing and display system consists of the display ASIC, DRAM, and system oscillator. Digitized acquisition samples are received by the display ASIC and stored in DRAM. Once data are received by the display ASIC, various corrections are applied, display rasterization is performed, and the waveform is placed into a display buffer. At the same time, the waveform is being read from the display buffers and written to the LCD. Additional circuitry in the display ASIC supports scanning the front panel, handling DRAM refresh, providing the processor clock, and performing various memory mapping tasks required by all elementary microprocessor based systems. In a four-channel system, the two display ASICs are interconnected so that one ASIC may provide display information for the second.</p> <p>The processing and display system handles some of the computational tasks. Other tasks are performed by the processor system. Since all array processing is performed in the processing and display system, no computations can be performed that involve data from two different channel sets. Thus, subtracting channel 3 data from channel 2 is prohibited. Channel 1 and Channel 2 data may be combined in all of the supported ways.</p>
Input Signal Interface	<p>BNC connectors are mounted on the main board for all signal inputs. The signal inputs are compatible with the supplied P2200 probes.</p>
Probe Compensation	<p>The PROBE COMP and ground terminals are provided for probe adjustment.</p>
External Trigger	<p>The EXT TRIG channel is processed on the chain containing the highest numbered normal input channel.</p>
Main Board Power	<p>To support various functions on the main board, a number of secondary power supplies are generated. For the amplifier and acquisitions ASICs, the main board creates a +2.5 V and -2.5 V supply. The +2.5 V supply is derived from the +3.3 V logic supply. The -2.5 V supply is derived from the -4 V supply. A three terminal regulator provides +5 V for option modules and the LCD display.</p> <p>An additional power supply provides the LCD bias voltage which ranges from +19 V to +28 V, depending on contrast setting and display type. This +28 V supply has a temperature sensor on the front-panel board that varies the output voltage of the supply to maintain contrast over a wide temperature range.</p>

Power Supply

The main power supply module for the TDS1000- and TDS2000-series oscilloscopes is a wide input range universal supply. It is capable of providing about 17 W of power for the oscilloscope while allowing the input to run from about +90 V to +264 V. Input frequency ranges from 47 Hz to 440 Hz, which allows operation in virtually all countries in the world and in a number of off-grid environments such as military power on aircraft.

The secondary supplies from the power supply and the approximate current draws are listed in the table on page 6–35 with the associated connector pins on J101.

For information on voltages used in the oscilloscope, refer to the *Troubleshooting* section of this manual.

Display Module

The display module is a standard passive liquid crystal display (LCD). The monochrome unit is patterned with 320 columns by 240 rows, and has the associated drivers and backlight. The backlight is based on a 5 mA side light fluorescent tube.

The color unit is patterned with 320 columns x 3 sub-columns by 240 rows and has associated drivers and backlight. The backlight is based upon a 5 mA top light fluorescent tube which runs a higher voltage and is longer to provide sufficient extra light to overcome the higher loss associated with the color filters.

Front Panel

Two-Channel Oscilloscopes

You can access all of the switches, position encoders, and LEDs on the front-panel board of two-channel oscilloscopes. Additionally, an IC on the front-panel board provides buffering and multiplexing of switch signals to the main board. Two signals and a sense line are provided by the main board to support the front panel. One of these lines resets the scan; a second clocks the scan to the next position; and the sense line receives the current state of the selected switch or encoder position.

For the encoders, some amount of debouncing occurs inside the front-panel IC. All key debouncing is handled in the display ASIC on the main board.

Four-Channel Oscilloscopes

The front-panel board of the four channel units is effectively two panels in parallel. The left side of the board is largely handled by the display ASIC for channels 1 and 2. The right side of the board is handled by the channel 3 and 4 ASIC. Separate front-panel ICs support these data paths.

LEDs

The LEDs are lighted to indicate an alternative use for the associated front-panel knob. For more information, see the User Manual for this oscilloscope.

The LEDs are controlled by latching the value of the Channel 1-2 front panel scan counter when the appropriate scan value is set.

Extension Modules

Optional extension modules add the capability for the microprocessor to interface with IEEE-488 (GPIB) controllers and RS-232 controllers, and provide a PC-like parallel printer interface. These modules contain the necessary chips to provide standard RS-232 and IEEE-488 states. The parallel port interface is controlled by software without significant hardware assistance.



Performance Verification

Performance Verification

This chapter contains performance verification procedures for the specifications marked with the ✓ symbol. The following equipment, or a suitable equivalent, is required to complete these procedures.

Required Equipment

Description	Minimum requirements	Examples
DC Voltage Source	17.5 mV to 7 V, $\pm 0.5\%$ accuracy	Wavetek 9100 Universal Calibration System with Oscilloscope Calibration Module (Option 250) Fluke 5500A Multi-product Calibrator with Oscilloscope Calibration Option (Option 5500A-SC)
Leveled Sine Wave Generator	50 kHz and 200 MHz, $\pm 3\%$ amplitude accuracy	
Time Mark Generator	10 ms period, ± 10 ppm accuracy	
50 Ω BNC Cable	BNC male to BNC male, ≈ 1 m (36 in) long	Tektronix part number 012-0482-XX
50 Ω BNC Cable	BNC male to BNC male, ≈ 25 cm (10 in) long	Tektronix part number 012-0208-XX
50 Ω Feedthrough Termination	BNC male and female connectors	Tektronix part number 011-0049-XX
Dual Banana to BNC Adapter	Banana plugs to BNC female	Tektronix part number 103-0090-XX
BNC T Adapter	BNC male to dual BNC female connectors	Tektronix part number 103-0030-XX
Splitter, Power	Frequency range: DC to 4 GHz. Tracking: $>2.0\%$	Tektronix part number 015-0565-XX
Adapter (four required)	Male N-to-female BNC	Tektronix part number 103-0045-XX
Adapter	Female N-to-male BNC	Tektronix part number 103-0058-XX

Test Record

Serial number	Procedure performed by	Date

Test	Passed	Failed
Self Test		

Oscilloscope tests	Low limit	Test result	High limit
Channel 1 DC Gain Accuracy	5 mV/div	33.6 mV	36.4 mV
	200 mV/div	1.358 V	1.442 V
	2 V/div	13.58 V	14.42 V
Channel 2 DC Gain Accuracy	5 mV/div	33.6 mV	36.4 mV
	200 mV/div	1.358 V	1.442 V
	2 V/div	13.58 V	14.42 V
Channel 3 DC Gain Accuracy ¹	5 mV/div	33.6 mV	36.4 mV
	200 mV/div	1.358 V	1.442 V
	2 V/div	13.58 V	14.42 V
Channel 4 DC Gain Accuracy ¹	5 mV/div	33.6 mV	36.4 mV
	200 mV/div	1.358 V	1.442 V
	2 V/div	13.58 V	14.42 V
Channel 1 Bandwidth	2.12 V		—
Channel 2 Bandwidth	2.12 V		—
Channel 3 Bandwidth ¹	2.12 V		—
Channel 4 Bandwidth ¹	2.12 V		—
Sample Rate and Delay Time Accuracy	-2 divs		+2 divs
Channel 1 Edge Trigger Sensitivity	Stable trigger		—
Channel 2 Edge Trigger Sensitivity	Stable trigger		—
Channel 3 Edge Trigger Sensitivity ¹	Stable trigger		—
Channel 4 Edge Trigger Sensitivity ¹	Stable trigger		—
External Edge Trigger Sensitivity	Stable trigger		—

¹ Channels 3 and 4 are only on four channel oscilloscopes.

Performance Verification Procedures

Before beginning these procedures, two conditions must first be met:

- The oscilloscope must have been operating continuously for twenty minutes within the operating temperature range specified.
- You must perform the Self Calibration operation described below. If the ambient temperature changes by more than 5 °C, you must perform the Self Calibration operation again.

The time required to complete the entire procedure is approximately one hour.



WARNING. *Some procedures use hazardous voltages. To prevent electrical shock, always set voltage source outputs to 0 V before making or changing any interconnections.*

Self Test

This internal procedure is automatically performed every time the oscilloscope is powered on. No test equipment or hookups are required. Verify that no error messages are displayed before continuing with this procedure.

Self Calibration

The self calibration routine lets you quickly optimize the oscilloscope signal path for maximum measurement accuracy. You can run the routine at any time, but you should always run the routine if the ambient temperature changes by 5 °C or more.

1. Disconnect any probes or cables from the CH1 and CH2 input connectors.
2. Press the UTILITY button and select the Do Self Cal option to start the routine. The routine takes approximately one minute to complete.
3. Verify that self calibration passed.

Check DC Gain Accuracy

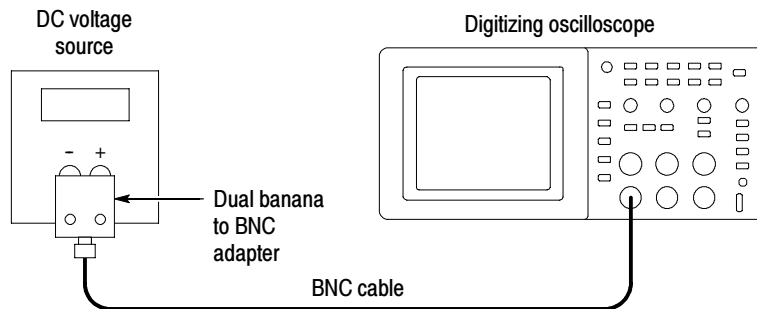
This test checks the DC gain accuracy of all input channels.

1. Set the DC voltage source output level to **0 V**.
2. Set up the oscilloscope using the following steps:

Press menu button	Select menu option	Select setting
1. DEFAULT SETUP	—	—
2. CH 1	Probe	1X
3. ACQUIRE	Average	16

Press menu button	Select menu option	Select setting
4. MEASURE	Source	An unchecked channel
	Type	Mean

3. As shown below, connect the oscilloscope channel selected in the table to the DC voltage source.



4. For each VOLTS/DIV setting listed below, perform the following steps:
 - a. Set the DC voltage source output level to the positive voltage listed and then record the mean measurement as V_{pos} .
 - b. Reverse the polarity of the DC voltage source and then record the mean measurement as V_{neg} .
 - c. Calculate $V_{diff} = V_{pos} - V_{neg}$ and then compare V_{diff} to the accuracy limits in the table.

VOLTS/DIV setting	DC voltage source output levels	Accuracy limits for V_{diff}
5 mV/div	+17.5 mV, -17.5 mV	33.6 mV to 36.4 mV
200 mV/div	+700 mV, -700 mV	1.358 V to 1.442 V
2 V/div	+7.00 V, -7.00 V	13.58 V to 14.42 V

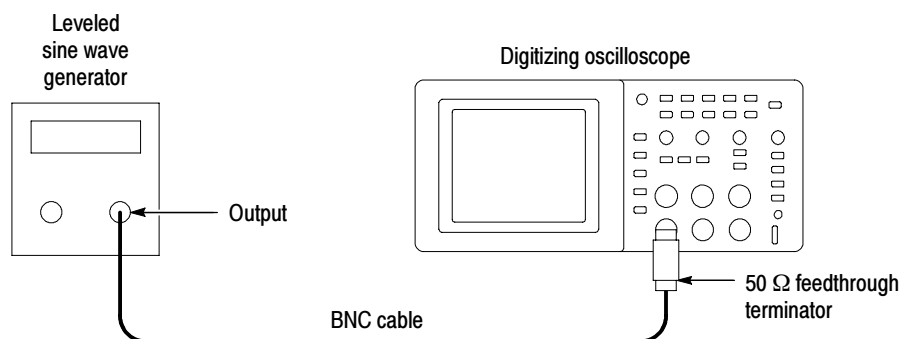
5. Set DC voltage source output level to **0 V**.
6. Disconnect the test setup.
7. Repeat steps 1 through 6 until all input channels have been checked.

Check Bandwidth This test checks the bandwidth of all input channels.

1. Set up the oscilloscope using the following steps:

Press menu button	Select menu option	Select setting
DEFAULT SETUP	—	—
CH 1	Probe	1X
ACQUIRE	Average	16
TRIGGER	Coupling	Noise
MEASURE	Source	An unchecked channel
	Type	Pk-Pk

2. As shown below, connect the oscilloscope channel selected in the table to the leveled sine wave generator.



3. Set the oscilloscope VOLTS/DIV to **500 mV/div**.
4. Set the oscilloscope SEC/DIV to **10 μs/div**.
5. Set the leveled sine wave generator frequency to **50 kHz**.
6. Set the leveled sine wave generator output level so the peak-to-peak measurement is between **2.98 V** and **3.02 V**.
7. Set the leveled sine wave generator frequency to:
 - **40 MHz** if you are checking a TDS1001
 - **60 MHz** if you are checking a TDS1002/2002/2004
 - **100 MHz** if you are checking a TDS1012/2012/2014
 - **200 MHz** if you are checking a TDS2022/2024.

8. Set the oscilloscope SEC/DIV to **10 ns/div**.
9. Check that the peak-to-peak measurement is ≥ 2.12 V.
10. Disconnect the test setup.
11. Repeat steps 1 through 10 until all input channels have been checked.

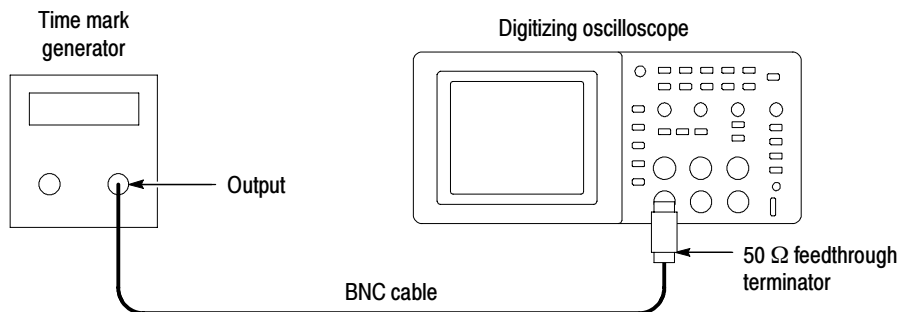
Check Sample Rate and Delay Time Accuracy

This test checks the time base accuracy.

1. Set up the oscilloscope using the following steps:

Press menu button	Select menu option	Select setting
DEFAULT SETUP	—	—
CH 1	Probe	1X

2. Connect the oscilloscope to the time mark generator as shown below.



3. Set the time mark generator period to **10 ms**.
4. Set the oscilloscope VOLTS/DIV to **500 mV/div**.
5. Set the oscilloscope Main SEC/DIV to **1 ms/div**.
6. Press **SET LEVEL TO 50%**.
7. Use the vertical POSITION control to center the test signal on screen.
8. Use the horizontal POSITION control to set the position to **10.00 ms**.
9. Set the oscilloscope SEC/DIV to **250 ns/div**.

10. Check that the rising edge of the marker crosses the center horizontal graticule line within ± 2 divisions of center graticule.

NOTE. One division of displacement from graticule center corresponds to a 25 ppm time base error.

11. Disconnect the test setup.

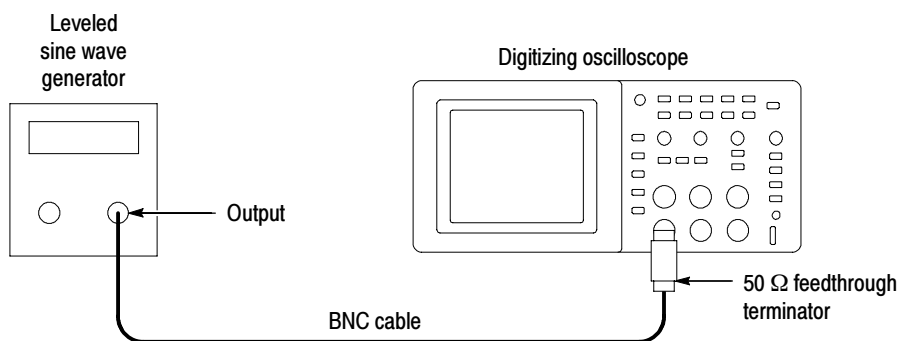
Check Edge Trigger Sensitivity

This test checks the edge trigger sensitivity for all input channels.

1. Set up the oscilloscope using the following steps:

Press menu button	Select menu option	Select setting
DEFAULT SETUP	—	—
CH 1	Probe	1X
TRIGGER	Mode	Normal
ACQUIRE	Sample	—
MEASURE	Source	An unchecked channel
	Type	Pk-Pk

2. As shown below, connect the oscilloscope channel selected in the table to the leveled sine wave generator.



3. Set the oscilloscope VOLTS/DIV to **500 mV/div**.
4. Set the oscilloscope SEC/DIV to **25 ns/div**.

5. Set the leveled sine wave generator frequency to **10 MHz**.
6. Set the leveled sine wave generator output level to approximately **500 mV_{p-p}** so that the measured amplitude is approximately **500 mV**. (The measured amplitude can fluctuate around 500 mV.)
7. Press **SET LEVEL TO 50%**. Adjust **TRIGGER LEVEL** as necessary and then check that triggering is stable.
8. Set the leveled sine wave generator frequency to
 - **40 MHz** if you are checking a TDS1001
 - **60 MHz** if you are checking a TDS1002/2002/TDS2004
 - **100 MHz** if you are checking a TDS1012/2012/2014
 - **200 MHz** if you are checking TDS2022/2024.
9. Set the oscilloscope SEC/DIV to **10 ns/div**.
10. Set the leveled sine wave generator output level to approximately **750 mV_{p-p}** so that the measured amplitude is approximately **750 mV**. (The measured amplitude can fluctuate around 750 mV.)
11. Press **SET LEVEL TO 50%**. Adjust **TRIGGER LEVEL** as necessary and then check that triggering is stable.
12. Change the oscilloscope setup using the following step:

Press menu button	Select menu option	Select setting
TRIGGER	Slope	Falling

13. Press **SET LEVEL TO 50%**. Adjust **TRIGGER LEVEL** as necessary and then check that triggering is stable.
14. Change the oscilloscope setup using the following step:

Press menu button	Select menu option	Select setting
TRIGGER	Slope	Rising

15. Disconnect the test setup.
16. Repeat steps 1 through 15 until all input channels have been checked.

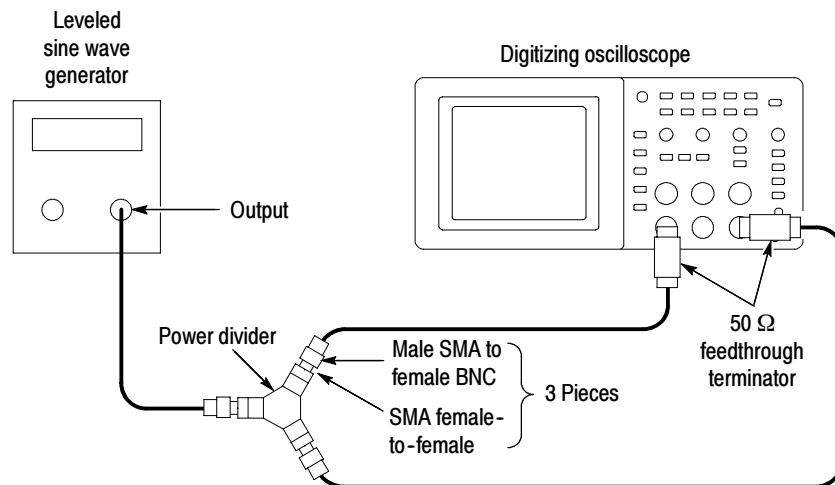
Check External Edge Trigger Sensitivity

This test checks the edge trigger sensitivity for the external trigger.

1. Set up the oscilloscope using the following steps:

Press menu button	Select menu option	Select setting
DEFAULT SETUP	—	—
CH 1	Probe	1X
TRIGGER	Source	Ext
	Mode	Normal
ACQUIRE	Sample	—
MEASURE	Source	CH1
	Type	Pk-Pk

2. Connect the oscilloscope to the leveled sine wave generator as shown below.



3. Set the leveled sine wave generator frequency to
 - **40 MHz** if you are checking a TDS1001
 - **60 MHz** if you are checking a TDS1002/2002/TDS2004
 - **100 MHz** if you are checking a TDS1012/2012/2014
 - **200 MHz** if you are checking TDS2022/2024.
4. Set the oscilloscope VOLTS/DIV to **100 mV/div**.
5. Set the oscilloscope SEC/DIV to **10 ns/div**.

6. Set the sine wave generator output level so that CH1 indicates approximately **200 mV_{p-p}** so that the measured amplitude is approximately **200 mV**. (The measured amplitude can fluctuate around 200 mV.) The output level of the sine wave generator will be approximately 400 mV.
7. Press **SET LEVEL TO 50%**. Adjust **TRIGGER LEVEL** as necessary and then check that triggering is stable.
8. For TDS2022 and TDS2024 models, set the sine wave generator frequency to **200 MHz**.
9. For TDS2022 and TDS2024 models, set the sine wave generator output level for CH1 to approximately **350 mV_{p-p}**.
10. Press **SET LEVEL TO 50%**. Adjust **TRIGGER LEVEL** as necessary and then check that triggering is stable.
11. Change the oscilloscope setup using the following step:

Press menu button	Select menu option	Select setting
TRIGGER	Slope	Falling

12. Press **SET LEVEL TO 50%**. Adjust **TRIGGER LEVEL** as necessary and then check that triggering is stable.
13. Change the oscilloscope setup using the following step:

Press menu button	Select menu option	Select setting
TRIGGER	Slope	Rising

14. Disconnect the test setup.



Adjustment Procedures

Adjustment Procedures

This chapter contains adjustment procedures for the TDS1000- and TDS2000-series oscilloscopes.

Only qualified personnel should perform service procedures. Read the *Service Safety Summary* and the *General Safety Summary* at the beginning of this manual before performing any service procedures. Also refer to the chapter *Operating Information* for information about using the TDS1000 and TDS2000 oscilloscopes.

NOTE. *The voltage references inside the TDS1000 and TDS2000 oscilloscopes are very stable over time and should not require routine updates. Before performing any procedure in this chapter, first verify that the oscilloscope does not meet specifications. Refer to the chapter Performance Verification to verify the specifications.*

Required Equipment

The equipment described in Table 5-1, or a suitable equivalent, is required to complete these procedures.

Table 5-1: Required equipment

Description	Minimum requirements	Examples
DC Voltage Source	-20 V to 20 V, $\pm 0.1\%$ accuracy	Wavetek 9100 Universal Calibration System with Oscilloscope Calibration Module (Option 250)
Leveled Sinewave Generator	60 kHz and 200 MHz, $\pm 0.6\%$ amplitude accuracy	Fluke 5500A Multi-product Calibrator with Oscilloscope Calibration Option (Option 5500A-SC)
50 Ω BNC Cable	BNC male to BNC male, ≈ 1 m (36 in) long	Tektronix part number 012-0482-00
50 Ω BNC Cable (two)	BNC male to BNC male, ≈ 25 cm (10 in) long	Tektronix part number 012-0208-00
50 Ω Feedthrough Termination	BNC male and female connectors	Tektronix part number 011-0049-01

Table 5-1: Required equipment (Cont.)

Description	Minimum requirements	Examples
Dual Banana to BNC Adapter	Banana plugs to BNC female	Tektronix part number 103-0090-00
BNC T	One male and two female BNC connectors	Tektronix part number 103-0030-00

Adjustment Procedure

The adjustment procedure consists of 70 steps for the two-channel oscilloscope, and 106 steps for the four-channel model. Each step requires an external voltage source for new calibration constants.

Before performing the adjustment procedure, you must warm up the oscilloscope for at least ten minutes in an ambient temperature between 20 °C and 30 °C. Adjustments performed prior to warm-up or outside this temperature range may result in poor performance.

If all steps in the procedure are completed successfully, a “Pass” message is displayed and the new calibration constants take affect. If any step fails, the procedure is aborted and the current calibration is not affected. You can choose to abort the procedure at any step by selecting FCAL ABORT without affecting the current calibration.

NOTE. *While performing the adjustment procedure, keep in mind that some of the steps take a significant amount of time (up to 5 minutes) to complete.*

The equipment setups, shown in Figure 5-1, are required to complete the adjustment procedure. Table 5-2 on page 5-6 lists the steps in the procedure and the signal requirement for each step.

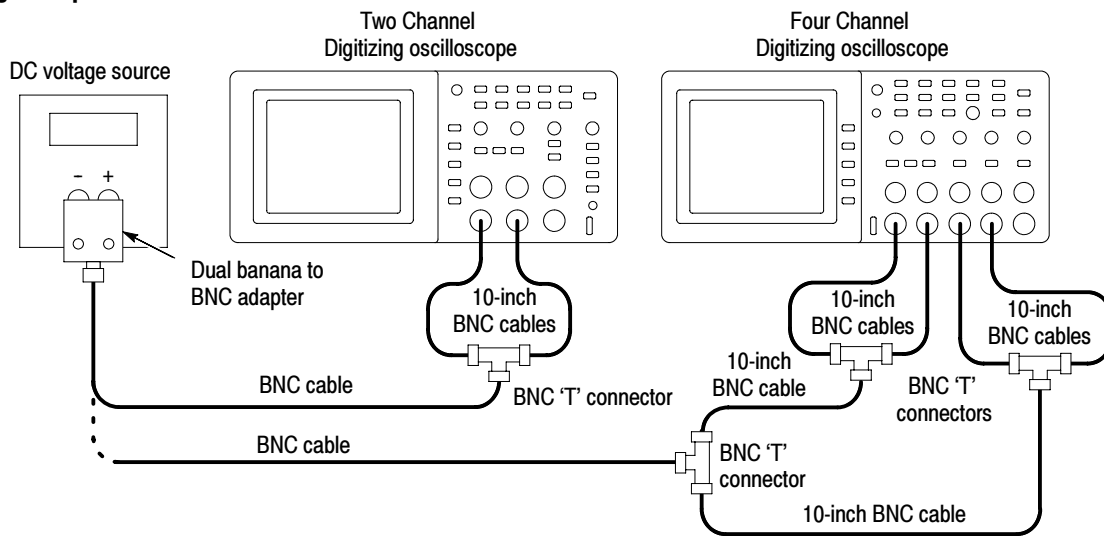
Enable the Service Menu

You must enable the Service menu to perform the adjustment procedure. To do this:

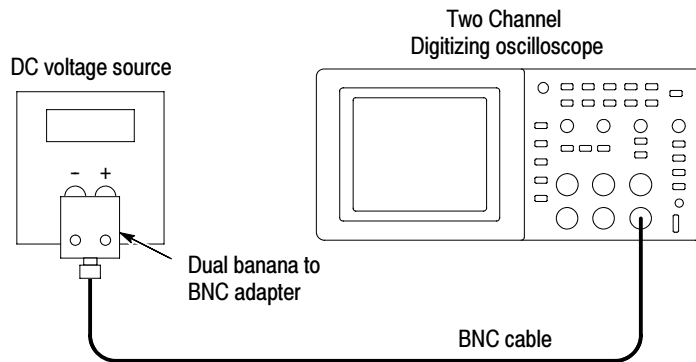
1. Power on the oscilloscope.
2. Push the front-panel **MEASURE** button to access the MEASURE menu.
3. Push the top option button to access the Measure 1 menu.
4. Push and hold the front-panel **SINGLE SEQ** button.
5. Push and hold the front-panel **AUTOSET** button.
6. Wait at least two seconds.
7. Release the **SINGLE SEQ** button.
8. Release the **AUTOSET** button. A message appears in the lower left corner of the screen stating “Service mode ON.”
9. Push the front-panel **UTILITY** button. The last item in the Utility menu is now Service.

After the adjustment is complete, disable the Service menu by pushing the **UTILITY** front-panel button, and the Service and Service Mode Off option buttons.

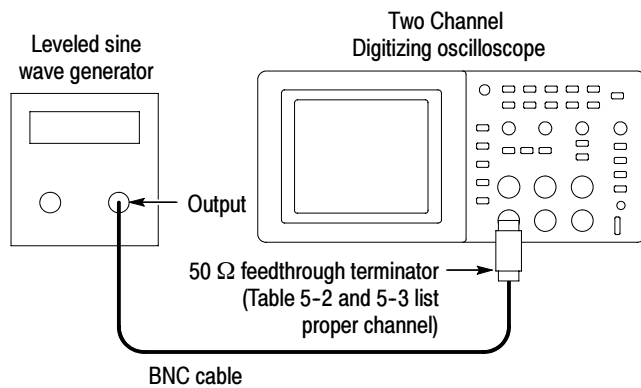
DC voltage setup 1



DC voltage setup 2



Sinewave generator setup



Edge setup

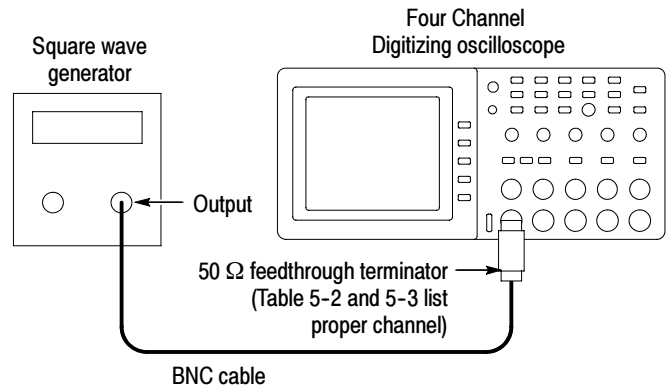


Figure 5-1: Adjustment setups

Adjustment Procedure

Use this procedure to load new calibration constants.

1. Enable the Service menu as described on page 5-3.
2. Push the **Service** option button.
3. Push the **Factory Cal** option button.
4. Push the **Warmup Timer** option button.
5. Push the **Start Timer** option button to ensure a 10-minute warm up. After 10 minutes passes, the oscilloscope displays a large black or green cross.
6. Press the front-panel **UTILITY** button and push the **Service** option button.
7. Push the **Factory Cal** option button.
8. Push the **FCAL INIT** option button to initiate the factory calibration routine. You are now in step 1 of the procedure.
9. As indicated by Step 1 in Table 5-2, connect a 0.0 V_{DC} source to the channel inputs.
10. Press **FCAL STEP** to load the calibration constant for step 1.
11. Follow the screen prompts along with Table 5-2 for the remainder of the routine, applying the proper signal for each step.

NOTE. During some steps, the oscilloscope may appear to be idle for several minutes while it is processing information internally. You must wait for the screen prompt to continue.

If any step in the procedure fails, the procedure terminates. Failure will result if an incorrect signal source is connected. If this happens, you must start the procedure over from the beginning.

If the procedure completes successfully, a “Pass” message is displayed and the new adjustment takes effect.

12. Compensate the signal path by performing the self-calibration routine. Disconnect any probes or cables from the channel input connectors. Then, press the **UTILITY** button and select **Do Self Cal** to confirm that you are ready to proceed.
13. Disable the Service menu option by pushing the **UTILITY** front-panel button, and the **Service** and **Service Mode Off** option buttons.

Table 5-2: Adjustment steps

Step Two-channel models	Step Four-channel models	Signal	Signal source setting	Input
Refer to the DC voltage setup 1 diagram				
1	1	DC Voltage 1	0.0 V	CH1 through CHx
2	2	DC Voltage 1	-20.0 V	
3	3	DC Voltage 1	-2.0 V	
4	4	DC Voltage 1	-1.6 V	
5	5	DC Voltage 1	-1.2 V	
6	6	DC Voltage 1	-0.8 V	
7	7	DC Voltage 1	-0.4 V	
8	8	DC Voltage 1	-0.32 V	
9	9	DC Voltage 1	-0.2 V	
10	10	DC Voltage 1	-0.16 V	
11	11	DC Voltage 1	-0.08 V	
12	12	DC Voltage 1	-0.04 V	
13	13	DC Voltage 1	-0.03 V	
14	14	DC Voltage 1	-0.02 V	
15	15	DC Voltage 1	-0.015 V	
16	16	DC Voltage 1	0.015 V	
17	17	DC Voltage 1	0.02 V	
18	18	DC Voltage 1	0.03 V	
19	19	DC Voltage 1	0.04 V	
20	20	DC Voltage 1	0.08 V	
21	21	DC Voltage 1	0.16 V	
22	22	DC Voltage 1	0.2 V	
23	23	DC Voltage 1	0.32 V	
24	24	DC Voltage 1	0.4 V	
25	25	DC Voltage 1	0.8 V	
26	26	DC Voltage 1	1.2 V	
27	27	DC Voltage 1	1.6 V	
28	28	DC Voltage 1	2.0 V	
29	29	DC Voltage 1	20.0 V	
30	30	DC Voltage 1	0.0 V	

Table 5-2: Adjustment steps (Cont.)

Step Two-channel models	Step Four-channel models	Signal	Signal source setting	Input
Refer to the DC voltage setup 2 diagram				
31	31	DC Voltage 2	-5.0 V	EXT TRIG
32	32	DC Voltage 2	-1.0 V	
33	33	DC Voltage 2	1.0 V	
34	34	DC Voltage 2	5.0 V	
Refer to the Sinewave generator setup diagram. BWL refers the maximum bandwidth of the oscilloscope.				
35	35	Sinewave Generator, 50 Ohm	5 kHz, 1 V _{p-p}	CH1
36	36	Sinewave Generator, 50 Ohm	1 MHz, 100 mV _{p-p}	
37	37	Sinewave Generator, 50 Ohm	1 MHz, 1 V _{p-p}	
38	38	Sinewave Generator, 50 Ohm	50 kHz, 1 V _{p-p}	
39	39	Sinewave Generator, 50 Ohm	20 MHz, 1 V _{p-p}	
40	40	Sinewave Generator, 50 Ohm	BWL, 25 mV _{p-p}	
41	41	Sinewave Generator, 50 Ohm	BWL, 50 mV _{p-p}	
42	42	Sinewave Generator, 50 Ohm	BWL, 100 mV _{p-p}	
43	43	Sinewave Generator, 50 Ohm	BWL, 250 mV _{p-p}	
44	44	Sinewave Generator, 50 Ohm	BWL, 500 mV _{p-p}	
45	40	Sinewave Generator, 50 Ohm	BWL, 1 V _{p-p}	
46	46	Sinewave Generator, 50 Ohm	5 kHz, 2.5 V _{p-p}	
47	47	Sinewave Generator, 50 Ohm	1 MHz, 2.5 V _{p-p}	
48	48	Sinewave Generator, 50 Ohm	50 kHz, 2.5 V _{p-p}	
49	49	Sinewave Generator, 50 Ohm	20 MHz, 2.5 V _{p-p}	
50	50	Sinewave Generator, 50 Ohm	BWL, 2.5 V _{p-p}	
51	51	Sinewave Generator, 50 Ohm	BWL, 5 V _{p-p}	
52	52	Sinewave Generator, 50 Ohm	BWL, 1.6 V _{p-p}	
53	53	Edge, 50 Ohm. Refer to Edge setup diagram.	1 kHz, 0 to -800 mV	

Table 5-2: Adjustment steps (Cont.)

Step Two-channel models	Step Four-channel models	Signal	Signal source setting	Input
54	54	Sinewave Generator, 50 Ohm	5 kHz, 1 V _{p-p}	CH2
55	55	Sinewave Generator, 50 Ohm	1 MHz, 100 mV _{p-p}	
56	56	Sinewave Generator, 50 Ohm	1 MHz, 1 V _{p-p}	
57	57	Sinewave Generator, 50 Ohm	50 kHz, 1 V _{p-p}	
58	58	Sinewave Generator, 50 Ohm	20 MHz, 1 V _{p-p}	
59	59	Sinewave Generator, 50 Ohm	BWL, 25 mV _{p-p}	
60	60	Sinewave Generator, 50 Ohm	BWL, 50 mV _{p-p}	
61	61	Sinewave Generator, 50 Ohm	BWL, 100 mV _{p-p}	
62	62	Sinewave Generator, 50 Ohm	BWL, 250 mV _{p-p}	
63	63	Sinewave Generator, 50 Ohm	BWL, 500 mV _{p-p}	
64	64	Sinewave Generator, 50 Ohm	BWL, 1 V _{p-p}	
65	65	Sinewave Generator, 50 Ohm	5 kHz, 2.5 V _{p-p}	
66	66	Sinewave Generator, 50 Ohm	1 MHz, 2.5 V _{p-p}	
67	67	Sinewave Generator, 50 Ohm	50 kHz, 2.5 V _{p-p}	
68	68	Sinewave Generator, 50 Ohm	20 MHz, 2.5 V _{p-p}	
69	69	Sinewave Generator, 50 Ohm	BWL, 2.5 V _{p-p}	
70	70	Sinewave Generator, 50 Ohm	BWL, 5 V _{p-p}	

Table 5-2: Adjustment steps (Cont.)

Step Two-channel models	Step Four-channel models	Signal	Signal source setting	Input
NA	71	Sinewave Generator, 50 Ohm	5 kHz, 1 V _{p-p}	CH3
	72	Sinewave Generator, 50 Ohm	1 MHz, 100 mV _{p-p}	
	73	Sinewave Generator, 50 Ohm	1 MHz, 1 V _{p-p}	
	74	Sinewave Generator, 50 Ohm	50 kHz, 1 V _{p-p}	
	75	Sinewave Generator, 50 Ohm	20 MHz, 1 V _{p-p}	
	76	Sinewave Generator, 50 Ohm	BWL, 25 mV _{p-p}	
	77	Sinewave Generator, 50 Ohm	BWL, 50 mV _{p-p}	
	78	Sinewave Generator, 50 Ohm	BWL, 100 mV _{p-p}	
	79	Sinewave Generator, 50 Ohm	BWL, 250 mV _{p-p}	
	80	Sinewave Generator, 50 Ohm	BWL, 500 mV _{p-p}	
	81	Sinewave Generator, 50 Ohm	BWL, 1 V _{p-p}	
	82	Sinewave Generator, 50 Ohm	5 kHz, 2.5 V _{p-p}	
	83	Sinewave Generator, 50 Ohm	1 MHz, 2.5 V _{p-p}	
	84	Sinewave Generator, 50 Ohm	50 kHz, 2.5 V _{p-p}	
	85	Sinewave Generator, 50 Ohm	20 MHz, 2.5 V _{p-p}	
	86	Sinewave Generator, 50 Ohm	BWL, 2.5 V _{p-p}	
	87	Sinewave Generator, 50 Ohm	BWL, 5 V _{p-p}	
	88	Sinewave Generator, 50 Ohm	BWL, 1.6 V _{p-p}	
	89	Edge, 50 Ohm. Refer to Edge setup diagram.	1 kHz, 0 to -800 mV	

Table 5-2: Adjustment steps (Cont.)

Step Two-channel models	Step Four-channel models	Signal	Signal source setting	Input
NA	90	Sinewave Generator, 50 Ohm	5 kHz, 1 V _{p-p}	CH4
	91	Sinewave Generator, 50 Ohm	1 MHz, 100 mV _{p-p}	
	92	Sinewave Generator, 50 Ohm	1 MHz, 1 V _{p-p}	
	93	Sinewave Generator, 50 Ohm	50 kHz, 1 V _{p-p}	
	94	Sinewave Generator, 50 Ohm	20 MHz, 1 V _{p-p}	
	95	Sinewave Generator, 50 Ohm	BWL, 25 mV _{p-p}	
	96	Sinewave Generator, 50 Ohm	BWL, 50 mV _{p-p}	
	97	Sinewave Generator, 50 Ohm	BWL, 100 mV _{p-p}	
	98	Sinewave Generator, 50 Ohm	BWL, 250 mV _{p-p}	
	99	Sinewave Generator, 50 Ohm	BWL, 500 mV _{p-p}	
	100	Sinewave Generator, 50 Ohm	BWL, 1 V _{p-p}	
	101	Sinewave Generator, 50 Ohm	5 kHz, 2.5 V _{p-p}	
	102	Sinewave Generator, 50 Ohm	1 MHz, 2.5 V _{p-p}	
	103	Sinewave Generator, 50 Ohm	50 kHz, 2.5 V _{p-p}	
	104	Sinewave Generator, 50 Ohm	20 MHz, 2.5 V _{p-p}	
	105	Sinewave Generator, 50 Ohm	BWL, 2.5 V _{p-p}	
106	Sinewave Generator, 50 Ohm	BWL, 5 V _{p-p}		



Maintenance

Maintenance

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

- *Preparation* tells you how to get ready to do oscilloscope maintenance.
- *Preventing ESD* provides general information on preventing damage to internal modules when doing maintenance.
- *Inspection and Cleaning* provides procedures for inspecting the oscilloscope and cleaning its external and internal modules.
- *Removal and Installation Procedures* provides procedures for the removal and installation of modules.
- *Troubleshooting* provides information for isolating failed modules.
- *Repackaging Instructions* provides packaging information for shipment or storage.

Preparation

Only qualified personnel should perform service procedures. Read the *Service Safety Summary* and the *General Safety Summary* sections of this manual before performing any service procedures. Also refer to the chapter *Operating Information* and your oscilloscope user manual for information about using the oscilloscope.

Preventing ESD

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



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

- Minimize handling of static-sensitive modules.
- Transport and store static-sensitive modules in their static protected containers or on a metal rail. Label any package that contains static-sensitive modules.

- Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these modules.
- Service static-sensitive modules only at static-free workstations. Do not allow anything capable of generating or holding a static charge on the workstation surface.
- Handle circuit boards by the edges when possible.
- Do not slide the modules over any surface.
- Avoid handling modules in areas that have a floor or work-surface covering capable of generating a static charge.

Inspection and Cleaning

This section describes how to inspect for dirt and damage, and how to clean the oscilloscope. Inspection and cleaning are done as preventive maintenance which, when done regularly, may prevent malfunctions and enhance reliability.

Preventive maintenance consists of visually inspecting and cleaning the oscilloscope, and using general care when operating it. Perform preventive maintenance more often if you operate the oscilloscope in a severe environment. A good time to perform preventive maintenance is just before adjustment of the oscilloscope.

General Care

For optimum performance, follow these recommendations:

- Protect the oscilloscope from adverse weather conditions. The oscilloscope is not waterproof.
- Do not store or leave the oscilloscope where the liquid crystal display (LCD) will be exposed to direct sunlight or high humidity for long periods of time.
- The front and rear cases help keep dust out of the oscilloscope and must be in place during normal operation.
- To avoid damage to the oscilloscope or probes, do not expose them to any sprays, liquids, or solvents.

Inspection and Cleaning Procedures

The collection of dirt on internal components can cause them to overheat and fail. Dirt also provides an electrical conduction path that could cause an oscilloscope failure, especially under high-humidity conditions. Inspect and clean the oscilloscope and probes as often as operating conditions require.

Inspection, Exterior. Inspect the outside of the oscilloscope for damage, wear, and missing parts. Oscilloscopes that appear to have been dropped or otherwise abused should be checked thoroughly to verify correct operation and performance. Immediately repair defects that could cause personal injury or lead to further damage to the oscilloscope.

Cleaning Procedure, Exterior. To clean the oscilloscope exterior and probes:

1. Remove loose dust on the outside of the oscilloscope and probes with a lint-free cloth. Use care to avoid scratching the clear glass display shield.
2. Use a soft cloth dampened with water to clean the oscilloscope, or use a 75% isopropyl alcohol solution for more efficient cleaning.



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

To avoid damage to the surface of the oscilloscope or probes, do not use any abrasive or chemical cleaning agents.

Inspection, Interior. Inspect and clean the interior if it appears that the oscilloscope may have been damaged or exposed to an unusually dirty environment.

To inspect and clean the interior, disassemble the oscilloscope by completing each of the disassembly procedures in the order given starting on page 6-6.

Inspect the internal portions of the oscilloscope for damage and wear using Table 6-1 as a guide. Repair defects immediately.

Table 6-1: Internal inspection check list

Item	Inspect for	Repair action
Front and Rear Case	Cracks or deformations. Scratched lettering or display filter. Loose connectors or labels.	Repair or replace defective hardware.
Circuit boards	Loose, broken, or corroded solder connections. Burned circuit boards. Burned, broken, or cracked circuit-run plating.	Remove failed module and replace with a new module.
Solder connections	Cold solder or rosin joints.	Resolder joint and clean with isopropyl alcohol.
Wiring and cables	Loose plugs or connectors. Burned, broken, or frayed wiring.	Firmly seat connectors. Repair or replace modules with defective wires or cables.

Cleaning Procedure, Interior. To clean the oscilloscope interior, perform 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 then wipe with a lint-free cloth dampened with warm deionized water. A cotton-tipped applicator is useful for cleaning in narrow spaces and on circuit boards.

STOP. *If, after performing steps 1 and 2, a module is clean upon inspection, skip steps 3 and 4. Proceed with step 5.*

If steps 1 and 2 do not remove all the dust or dirt, all modules in the oscilloscope except the Display Module and Front Panel Module may be spray washed using a solution of 75% isopropyl alcohol.

Extensive cleaning of the Display Module is difficult because water must not be trapped between the display shield and the display. The polarizers integrated into the display degrade with long-term exposure to water. The display shield and display must be replaced as an assembly if significant moisture or debris become trapped inside. Cotton tipped applicators and lint-free rags moistened in isopropyl alcohol and/or deionized water offer the best cleaning with the least opportunity for damage to the assembly.

The Front Panel module can be damaged by deposition of film or debris inside the knob encoders. To avoid this, care must be taken to not drip liquid or blow debris into the encoders.

Proceed to step 3.

3. Spray wash dirty parts with the 75% isopropyl alcohol solution and wait 60 seconds for the majority of the alcohol to evaporate.
4. Use hot (49 °C to 60 °C / 120 °F to 140 °F) deionized water to thoroughly rinse the parts.
5. Dry all parts with low-pressure, deionized air.
6. Dry all components and assemblies in an oven or drying compartment using low-temperature (52 °C to 66 °C / 125 °F to 150 °F) circulating air.

Lubrication. Periodic lubrication is not required for the oscilloscope.

Removal and Installation Procedures

This section describes how to remove and install the major mechanical and electrical modules. It provides the following information:

- *Required Tools* on page 6-6 describes the tools needed to perform the procedures.
- *List of Modules* on page 6-5 describes where to locate a list of replaceable modules.
- *Summary of Procedures* on page 6-6 lists the procedures for removal and installation of modules.
- *Rear Feet*, on page 6-7, begins a series of procedures that describe the removal and installation of modules.

Preparation

Read this section to prepare for module removal and installation.



WARNING. Only qualified personnel should perform service procedures. Before doing this or any other procedure in this manual, read the General Safety Summary and Service Safety Summary found at the beginning of this manual.

Always disconnect the power cord before disassembling any portion of the oscilloscope.

To prevent damage to electrical components, read Preventing ESD on page 6-1.

- See Figure 8-1 on page 8-7 for an overview of how the entire oscilloscope is assembled.
- Read the *Summary of Procedures* on page 6-6 to understand which procedure to use to access a given module. Then read *Required Tools* on page 6-6 for a list of tools needed to remove and install modules in the oscilloscope.
- If you are disassembling the oscilloscope for cleaning, refer to *Inspection and Cleaning* on page 6-2 for cleaning instructions.

List of Modules

The *Replaceable Parts List* provides a list of all replaceable modules. Any electrical or mechanical module, assembly, or part listed in the parts list is referred to as a module.

Summary of Procedures

Complete disassembly is best achieved by following the procedures in the order given in Table 6-2 .

Table 6-2: List of procedures

Procedure	Begins on page
Rear Feet	6-7
Flip Feet	6-9
Front-Panel Knobs	6-10
Power Button	6-10
Rear Case	6-10
Front Feet	6-14
Power Supply Module	6-15
Internal Assembly	6-17
Display Cable	6-19
Front-Panel Cable	6-21
Main Board Module	6-22
Display Module	6-24
Front-Panel Module	6-26
Keypad	6-28
Front Case	6-30

Required Tools

Use the following tools to remove and replace all modules in the oscilloscope:

- Torque-limiting screwdriver, long shank, 12 in-lb (1.3 N·m) range with Torx® T-15 tip
- 9/16 inch deep socket with wide center hole (S-K Hand Tool Corp., S-K #40818, or equivalent)
- Torque wrench to 40 in-lb (4.5 N·m)
- Screwdriver with 1/4 inch flat blade
- Pliers (all-purpose and needle-nose)
- Sharp knife (X-ACTO® knife or equivalent)

Rear Feet You will need a flat-blade screwdriver to remove the rear feet.

Removal. To remove the rear feet, refer to Figure 6-1 and follow these steps:

1. Place the oscilloscope face down on a soft surface such as an anti-static mat.
2. Use a flat-blade screwdriver to pry out the foot, or twist the foot as you are removing it so that it disengages from the guides. Use care not to mar the surface of the rear case.

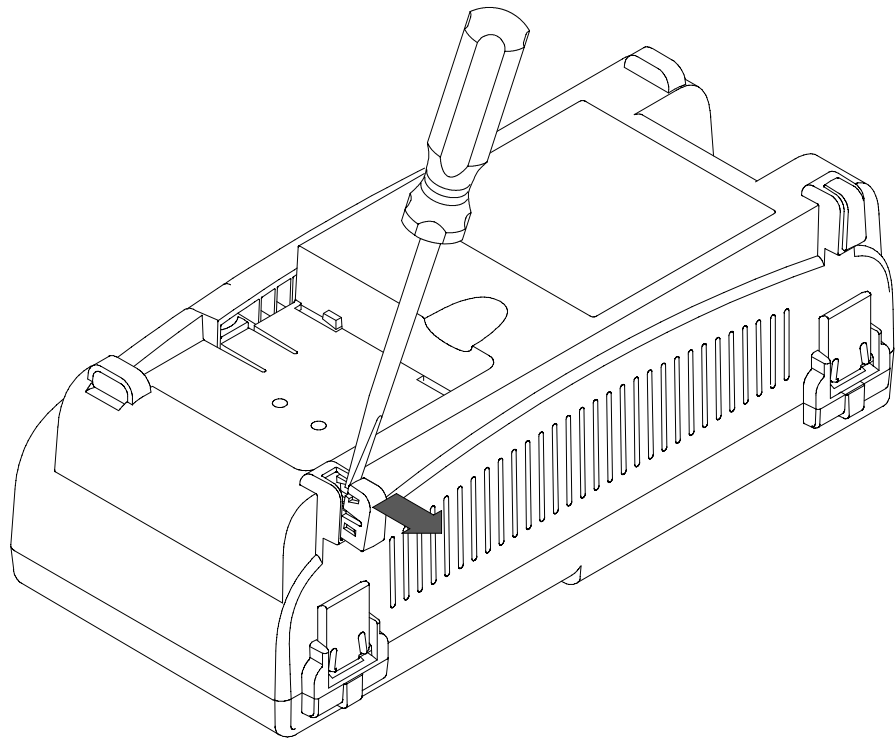


Figure 6-1: Removing the rear feet

Installation. To install the rear feet, refer to Figure 6-2 and follow these steps:

1. Place the oscilloscope face down on a soft surface such as an anti-static mat.
2. Align the slots of the rear foot with the guides in the rear case and press the foot in.

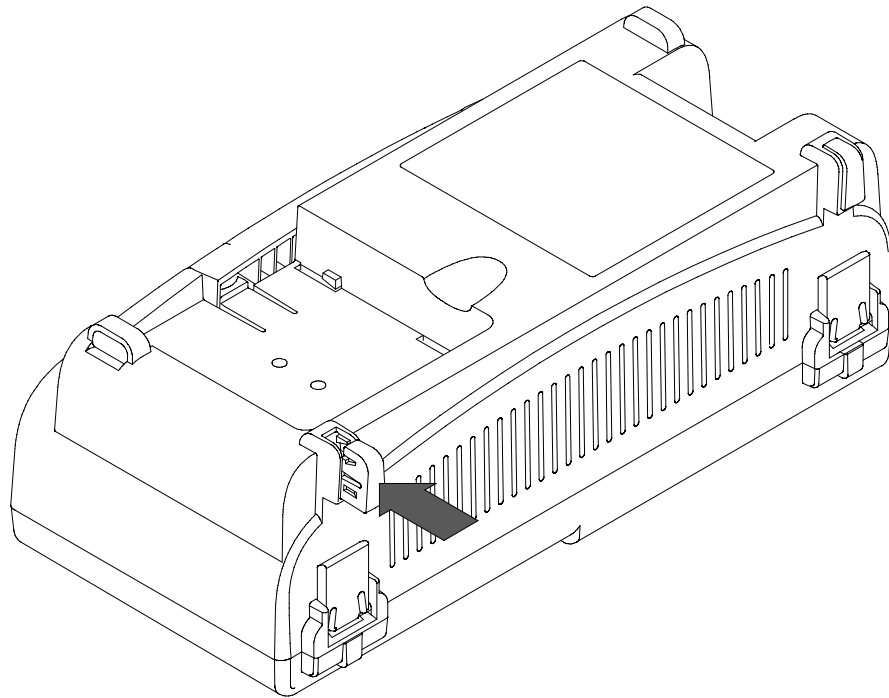


Figure 6-2: Installing the rear feet

Flip Feet You will need a pair of needle-nose pliers to remove the flip feet.

Removal. To remove the flip feet, refer to Figure 6-3 and follow these steps:

1. Place the oscilloscope face down on a soft surface such as an anti-static mat.
2. Grip the flip foot with the pliers as close to the notches as possible and squeeze gently on the foot.
3. Twist slightly to swing one hinge free of the slot.

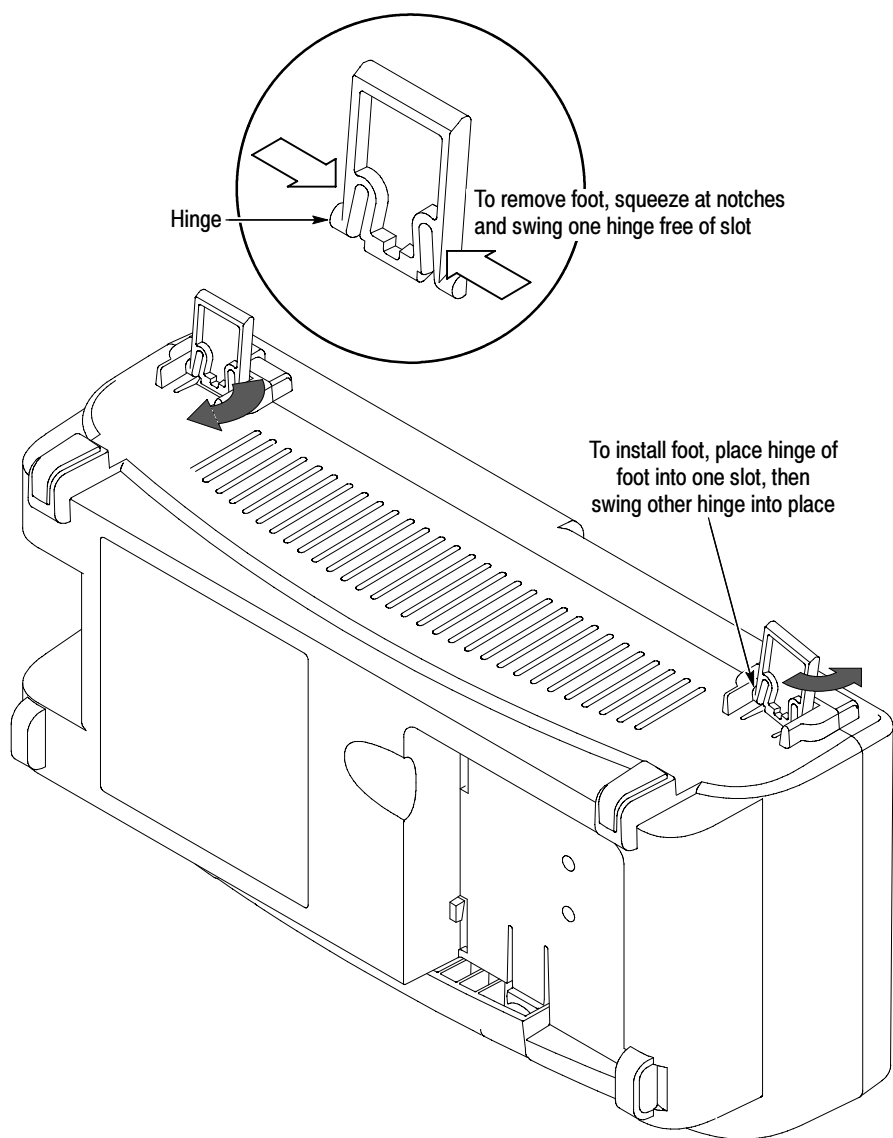


Figure 6-3: Removing and installing the flip feet

Installation. To install the flip feet, refer to Figure 6-3 and follow these steps:

1. Place the oscilloscope face down on a soft surface such as an anti-static mat.
2. Hold the flip foot with the smooth side facing down.
3. Gently squeeze the foot so that the hinge on one side fits into the slot, and twist slightly to snap into the slot on the other side.

Front-Panel Knobs

Remove each front-panel knob by firmly grasping the knob (with pliers if necessary) and pulling it away from the front panel.

NOTE. *Wrap the plier jaws with tape (such as electrical) to avoid marring the knob surface.*

Install front-panel knobs by aligning the keyed knob with the shaft and pressing the knob onto the shaft.

Power Button

Remove the power button by firmly grasping the button (with pliers if necessary) and pull it straight out of the cabinet.

NOTE. *Wrap the plier jaws with tape (such as electrical) to avoid marring the button surface.*

Install the button by pressing it onto the power button shaft until it snaps into place.

Rear Case

You will need a torque-limiting Torx T-15 screwdriver and pliers for this procedure.

Removal. To remove the rear case, refer to Figure 6-4 and follow these steps:

1. Remove the power button using the procedure on page 6-10.
2. If installed, remove the extension module from the rear of the oscilloscope. For instructions, refer to the *TDS1000- and TDS2000-Series User Manual*.



CAUTION. *To avoid damage, do not remove the rear case with an extension module installed.*

3. Place the oscilloscope face down on a soft surface such as an anti-static mat.

4. Remove the four screws located on the rear case. Tilt the handle to gain better access to the top two screws.
5. Lift the rear case off of the oscilloscope.

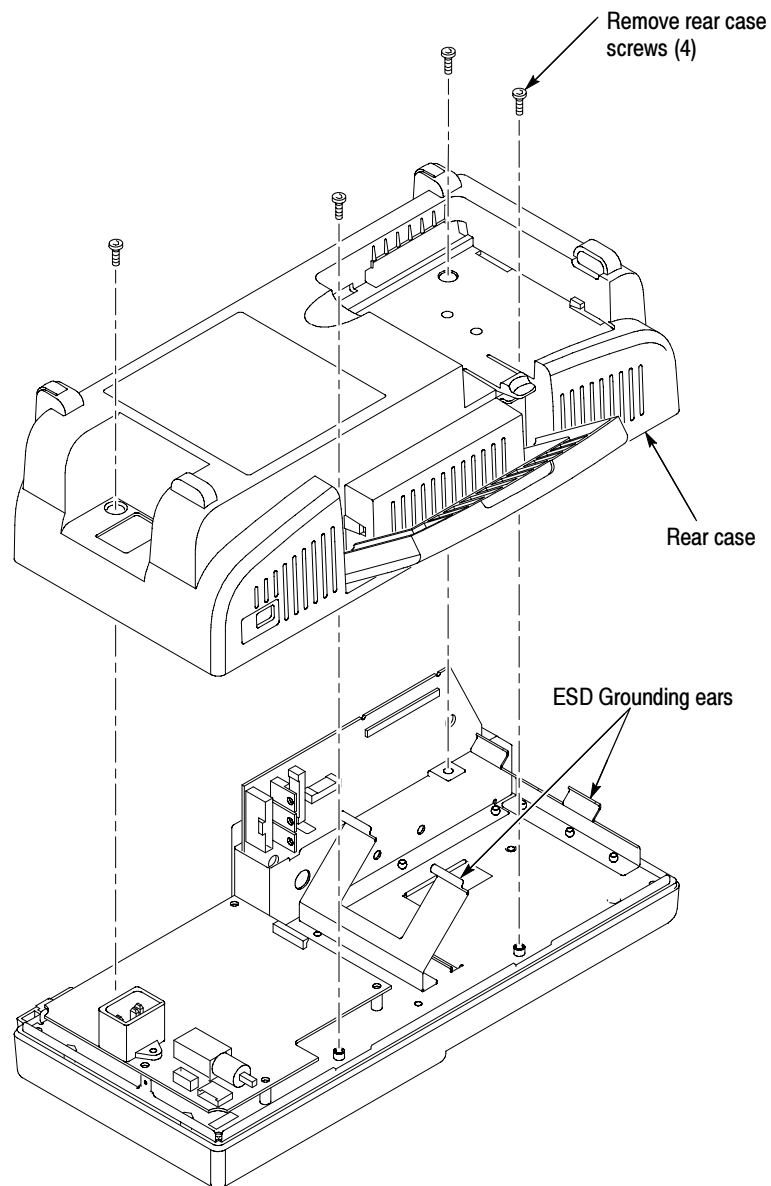


Figure 6-4: Removing and installing the rear case

Installation. Use this procedure to install the rear case.

1. Place the oscilloscope face down on a soft surface (such as an anti-static mat).
2. Place the rear case onto the assembled oscilloscope and ensure that:
 - All of the edges align with the front case.
 - The ESD grounding ears align with the rear case slots. If not, they must be bent into the correct position. Figure 6-5 shows proper alignment.
 - The notches on the edge of the main board module align with ridges on the rear case near the extension module connector slot. Figure 6-5 shows the location of the notches.



CAUTION. *Failure to properly align the ESD grounding ears may result in ESD damage to the extension module and/or the oscilloscope. Refer to Figure 6-5.*

Be careful not to pinch any wires or other parts between the front and rear cases.

3. Install the four screws in the rear case. Tilt the handle to better access the top two holes.



CAUTION. *Avoid cross threading the screws that secure the rear case to the front case. An easy way to avoid this is to slip the screw into the hole and, using slight pressure, slowly rotate the screw counterclockwise until you feel the screw slip into the screw threads. Then tighten the screw clockwise. A properly started screw will have very little resistance going in.*

4. Install the power button as described on page 6-10.

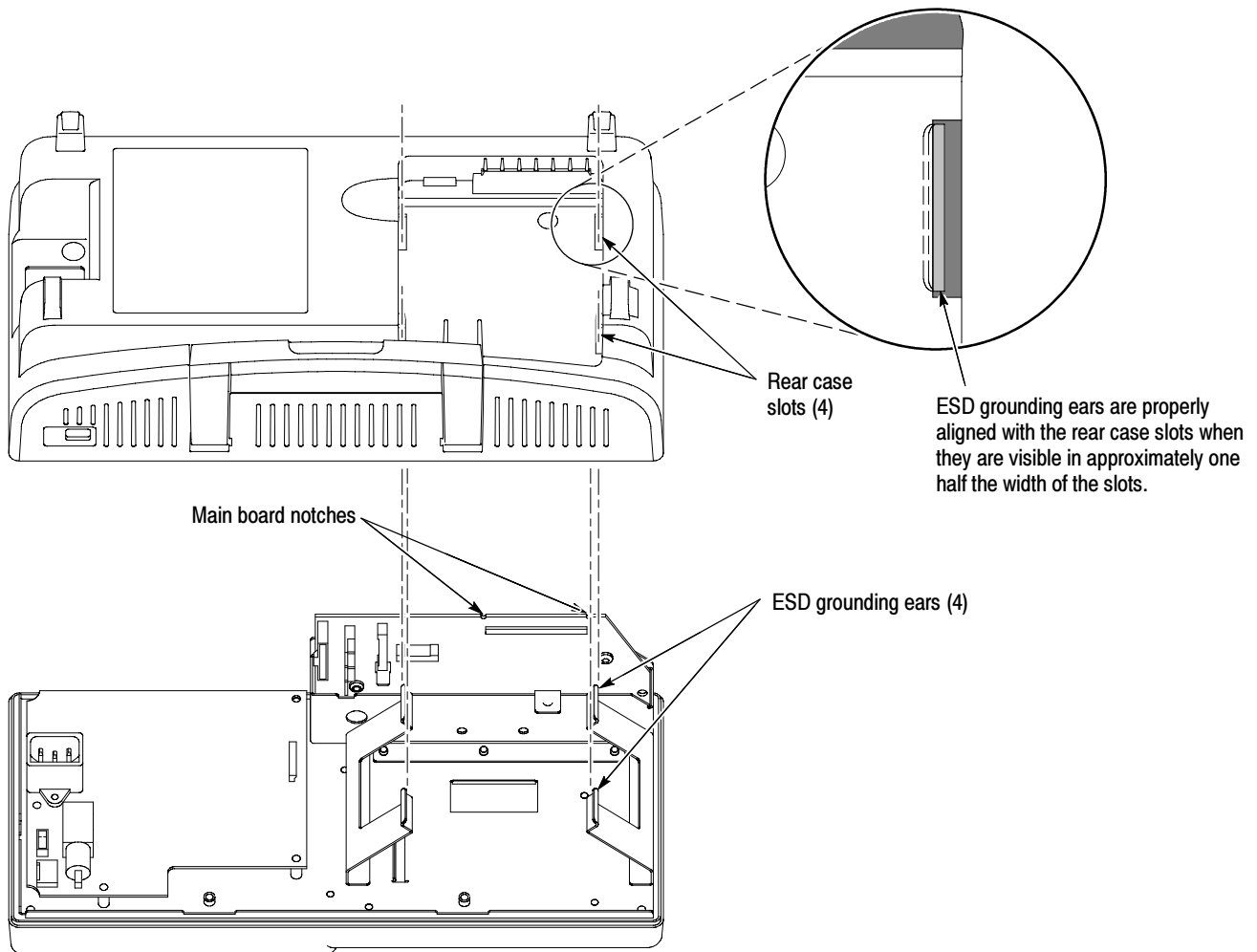


Figure 6-5: Aligning the oscilloscope rear case

Front Feet You will need a torque-limiting Torx T-15 screwdriver and pliers for this procedure.

Removal. First, remove the power button and rear case using the procedures on page 6-10. Then, slide the front feet out of the front case as shown in Figure 6-6.

Installation. Slide the feet into the slots provided in the front case as shown in Figure 6-6. Use the installation procedures for each module removed to reassemble the oscilloscope.

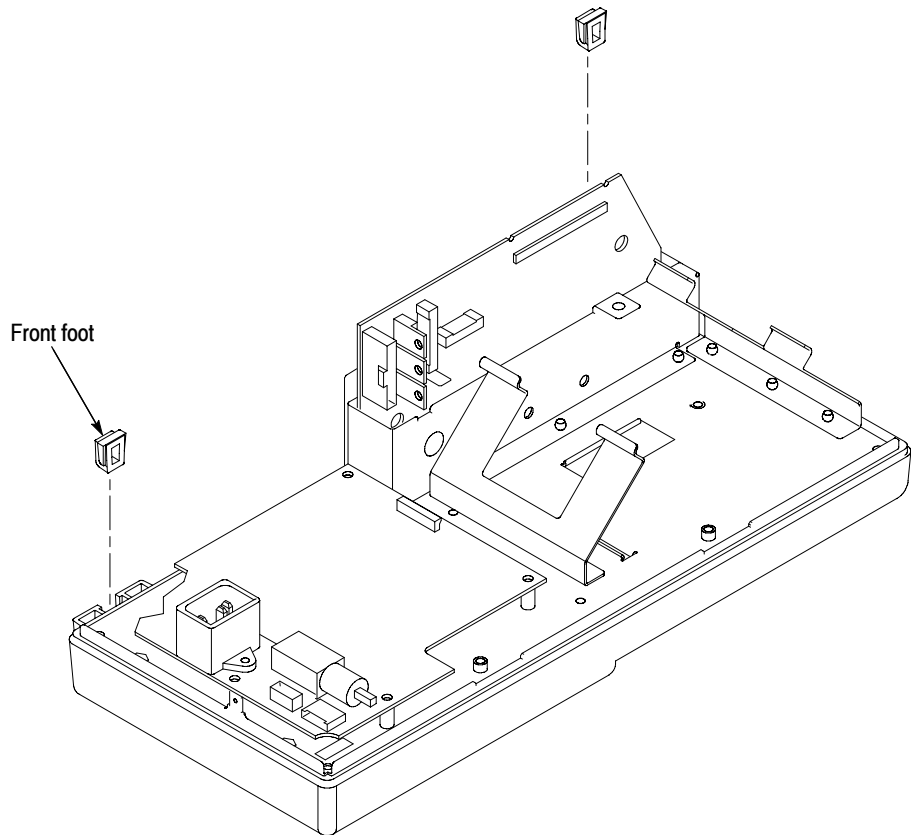


Figure 6-6: Removing and installing the front feet

Power Supply Module

Use a torque-limiting Torx T-15 screwdriver and pliers for this procedure.

Removal. To remove the module, refer to Figure 6-7 and follow these steps:

1. Remove the power button and rear case using the procedures on page 6-10.
2. Disconnect the following wires:
 - The ground wire on the power supply module from the chassis ground lug.
 - The two-conductor backlight cable on the power supply module.
 - The power supply ribbon cable on the main board at J101. Press down on the latch while pulling up on the cable.
3. Remove the four screws connecting the power supply module to the chassis and lift the module from the internal assembly.

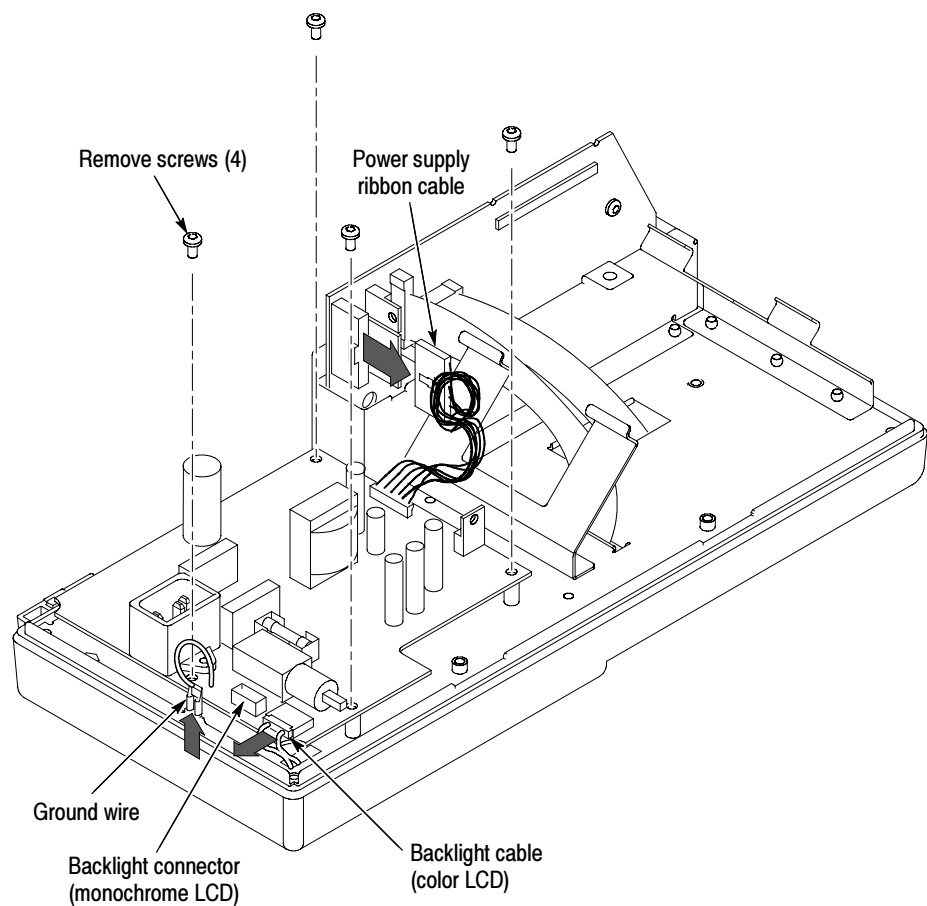


Figure 6-7: Removing the power supply module

Installation. To install the power supply module, refer to Figure 6-8 and follow these steps:

1. Align and place the power supply module into the internal assembly.
2. Install the four screws. Do not put a screw into the empty hole in Figure 6-8.
3. Reconnect the following wires:
 - The ground wire on the power supply module to the chassis ground lug. You may need to use pliers to secure the wire in place.
 - The two-conductor backlight cable on the power supply module. Connect to the black socket for a monochrome LCD, and to the white socket for a color LCD.
 - The power supply ribbon cable to the main board at J101. Twist the cable four revolutions to keep it from contact with the boards and chassis.
4. Use the installation procedure for each module removed to reassemble the oscilloscope.

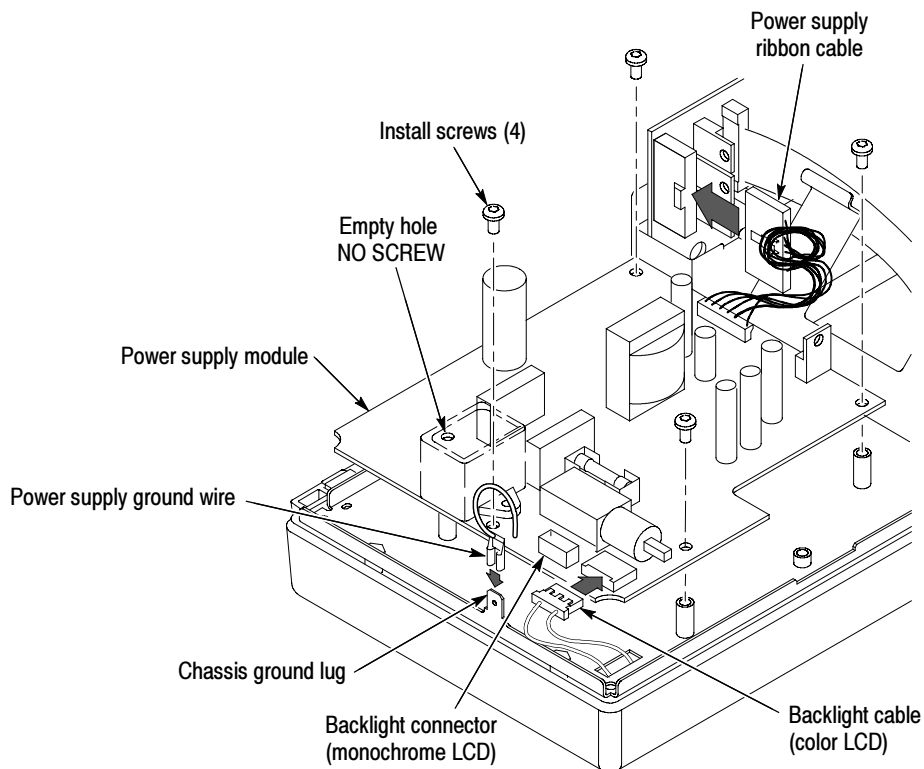


Figure 6-8: Installing the power supply module

Internal Assembly

You will need a torque-limiting Torx T-15 screwdriver and a flat-blade screwdriver for this procedure.

Removal. To remove the assembly, refer to Figure 6-9 and follow these steps:

1. Remove the front-panel knobs, power button, and rear case using the procedures on page 6-10.
2. Remove the four screws attaching the internal assembly to the front case.
3. Lift the entire internal assembly (consisting of the chassis, all of the boards, and the display screen) out of the front case.

NOTE. The switch keypad will most likely remain inside the front case. It does not need to be removed with the internal assembly.

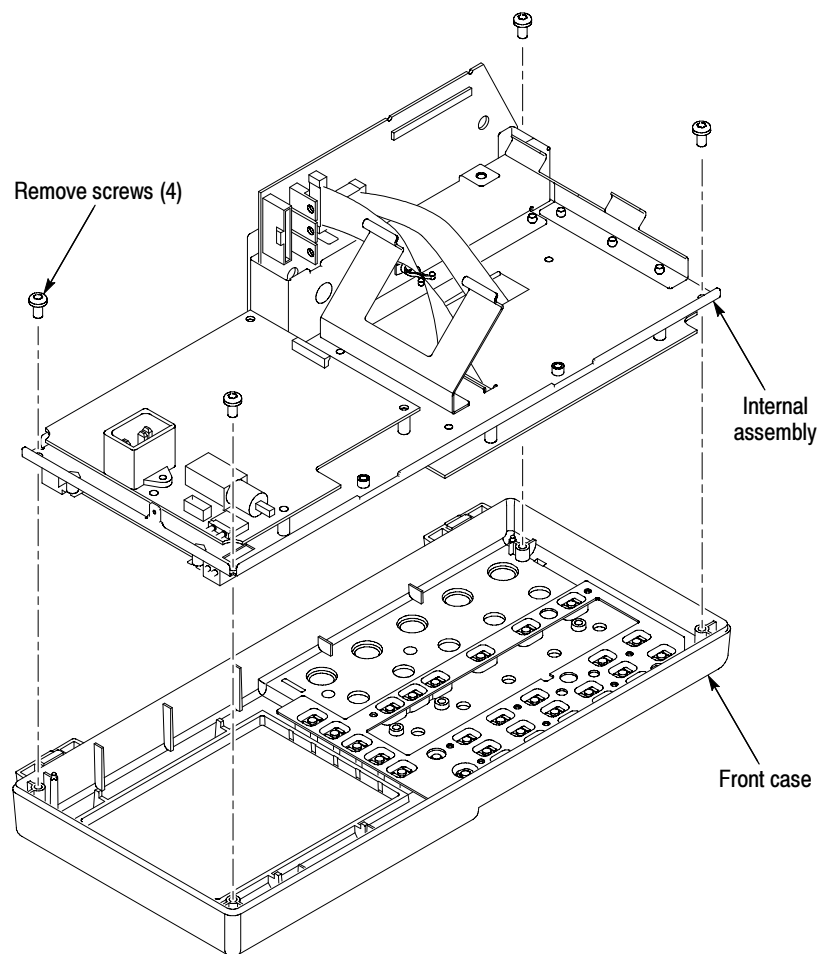


Figure 6-9: Removing and installing the internal assembly

Installation. To install the internal assembly, refer to Figure 6-9 and follow these steps:

1. Use the installation procedure for each module removed to reassemble the oscilloscope.
2. Place the internal assembly into the front case.
3. Install the four screws to attach the internal assembly to the front case.

Display Cable

You will need a torque-limiting Torx T-15 screwdriver and pliers for this procedure.

Removal. To remove the display cable, refer to Figure 6-10 and follow these steps:

1. Remove the power button and rear case using the procedures on page 6-10.
2. Untwist the cable tie to release the display cable.
3. Disconnect the display cable at J201 on the main board by pulling straight up from the connector.
4. Disconnect the display cable on the display module by pulling it through the horizontal slot on the chassis.

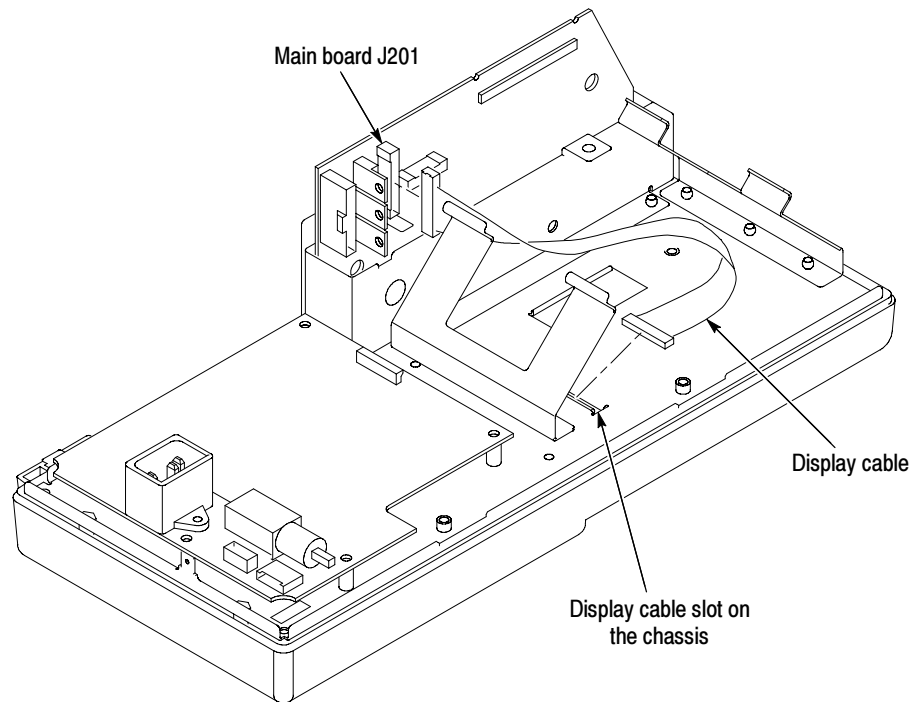


Figure 6-10: Removing the display cable

Installation. To install the display cable, refer to Figure 6-11 and follow these steps:

1. Remove the display module using the procedure on page 6-24.
2. Attach the display cable to the appropriate connector on the display module at the location shown in Figure 6-11: 12-pin for the monochrome display, and 15-pin for the color display.
3. With the display module in place but not connected, thread the display cable through the appropriate slot on the chassis.
4. Twist the cable two revolutions to keep it from contact with the boards and chassis, and secure using the left cable tie.
5. Connect the display cable at J201 on the main board by pushing the cable straight down into the connector.
6. Install the four screws to attach the display module to the internal assembly.

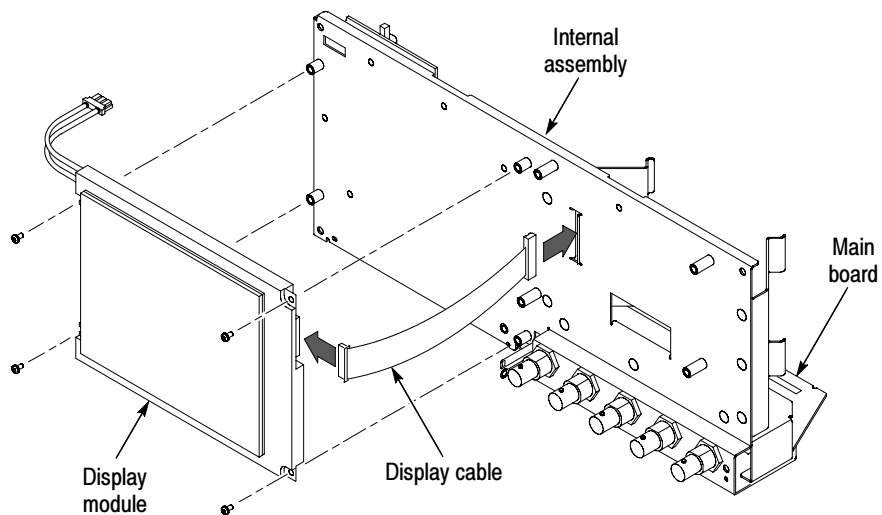


Figure 6-11: Installing the display cable

Front-Panel Cable

You will need a torque-limiting Torx T-15 screwdriver and pliers for this procedure.

Removal. To remove the front-panel cable, refer to Figure 6-12 and follow these steps:

1. Remove the power button and rear case using the procedures on page 6-10.
2. Untwist the cable tie to release the front-panel cable.
3. Disconnect the front-panel cable at J202 on the main board by pulling straight up from the connector.
4. Disconnect the front-panel cable at J1 on the front-panel module.

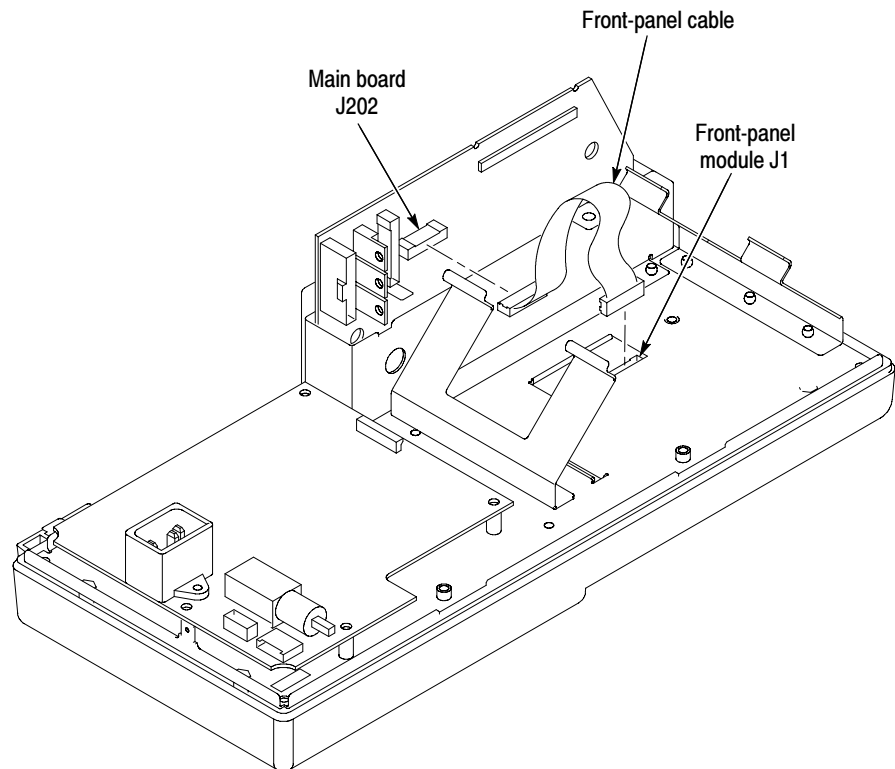


Figure 6-12: Removing and installing the front-panel cable

Installation. To install the front-panel cable, refer to Figure 6-12 and follow these steps:

1. Connect the front-panel cable to the front-panel module at J1 through the appropriate slot on the chassis.
2. Twist the cable two revolutions to keep it from contact with the boards and chassis, and secure using the right cable tie.
3. Connect the front-panel cable at J202 on the main board by pushing the cable straight down into the connector.

Main Board Module

You will need a torque-limiting Torx T-15 long shank screwdriver, a torque wrench, and a 9/16 inch deep socket for this procedure.



CAUTION. *The main board module is particularly sensitive to ESD. Read the Preventing ESD section on page 6-1 before removing or installing the main board.*

Removal. To remove the main board module, refer to Figure 6-13 and follow these steps:

1. Remove the power button and rear case using the procedures on page 6-10.
2. Remove the internal assembly from the front case using the procedure on page 6-17.
3. Disconnect the following wires from the main board by pulling straight up from the connector:
 - The power supply ribbon cable at J101. Press down on the latch while pulling up on the cable.
 - The display cable at J201.
 - The front-panel cable at J202.
4. Use the screwdriver to remove the two screws attaching the main board module to the internal assembly.
5. Use the socket to remove the nuts and washers from the BNC connectors.
6. Pull the board out from the front slots of the internal assembly.

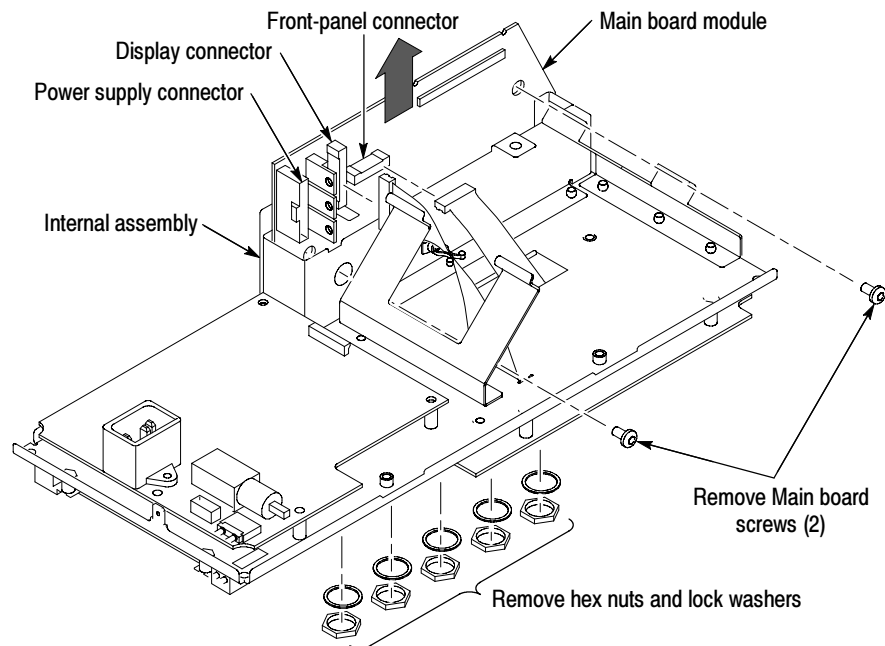


Figure 6-13: Main board removal

Installation. To install the main board module, refer to Figure 6-13 and follow these steps:

1. Working from the bottom of the internal assembly, place the front of the main board module into the slots on the assembly (near the the BNC connectors).
2. Use the deep socket to attach the washers and nuts to each BNC connector so that the main board is securely attached to the chassis. Torque the nuts to 40 in-lbs using the torque wrench.
3. Install the two screws attaching the main board module to the internal assembly.
4. Reconnect the following wires on the main board:
 - The power supply ribbon cable at J101.
 - The display cable at J201.
 - The front-panel cable at J202.
5. Use the installation procedure for each module removed to reassemble the oscilloscope.

Display Module

You will need a torque-limiting Torx T-15 screwdriver and pliers for this procedure.

Removal. To remove the display module, refer to Figure 6-14 and follow these steps:

1. Remove the power button and rear case using the procedures on page 6-10.
2. Remove the internal assembly from the front case using the procedure on page 6-17.
3. Disconnect the display cable using the procedure on page 6-19.
4. Disconnect the backlight cable from the power supply module.
5. Remove the four screws attaching the display module to the internal assembly. The location of the screws as shown in Figure 6-14 will vary between the color and monochrome displays.



CAUTION. The display shield is attached to the display module. Removing the shield will destroy the attaching gasket.

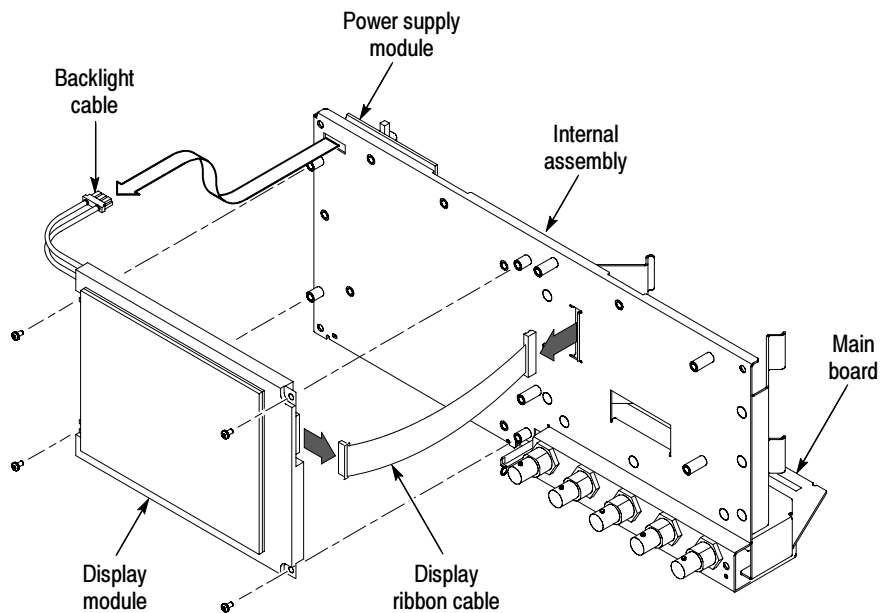


Figure 6-14: Removing the display module

Installation. To install the display module, refer to Figure 6-15 and follow these steps:

1. Reconnect the display cable at J201 on the main board by pushing the cable straight down into the connector.
2. Route the display ribbon cable through the opening in the chassis. For more information, see the display cable procedure on page 6-19.
3. Route the backlight cable through the opening in the internal assembly.
4. Install the four screws to attach the display module to the internal assembly. The location of the screws will vary between color and monochrome displays.
5. Reconnect the backlight cable to the power supply module. Connect to the black socket for a monochrome LCD, and to the white socket for a color LCD.
6. Use the installation procedure for each module removed to reassemble the oscilloscope.

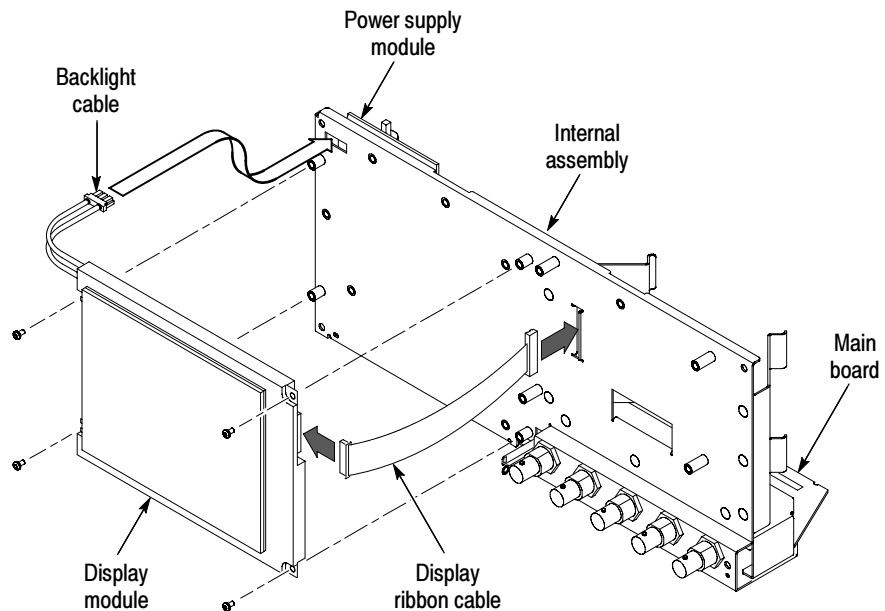


Figure 6-15: Installing the display module

Front-Panel Module

You will need a torque-limiting Torx T-15 screwdriver and a flat-blade screwdriver for this procedure.

Removal. To remove the front-panel module, refer to Figure 6-16 and follow these steps:

1. Remove the power button and rear case using the procedures on pages 6-10.
2. Remove the entire internal assembly from the front case using the procedure on page 6-17.
3. Disconnect the front-panel ribbon cable at J202 on the main board by pulling straight up from the connector.
4. Remove the four screws attaching the front-panel module to the internal assembly.
5. Pull the module away from the internal assembly.

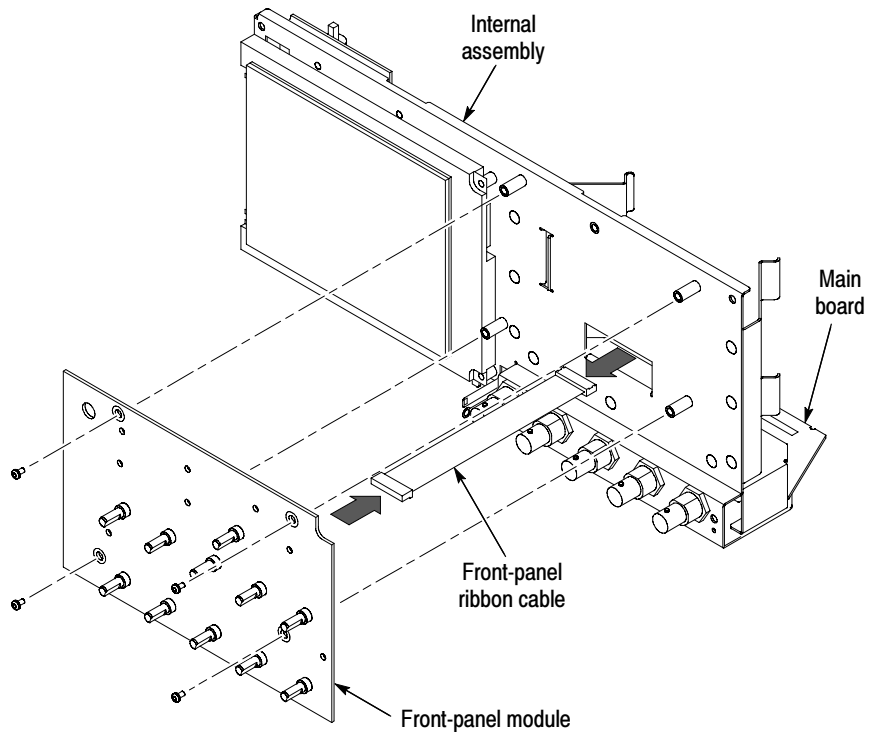


Figure 6-16: Removing the front-panel module

Installation. To install the front-panel module, refer to Figure 6-17 and follow these steps:

1. Reconnect the front-panel cable at J202 on the main board by pushing the cable straight down into the connector.
2. Route the front-panel cable through the opening in the internal assembly. For more information, see the procedure on page 6-21.
3. Install the four screws to attach the front-panel module to the internal assembly.
4. Use the installation procedure for each module removed to reassemble the oscilloscope.

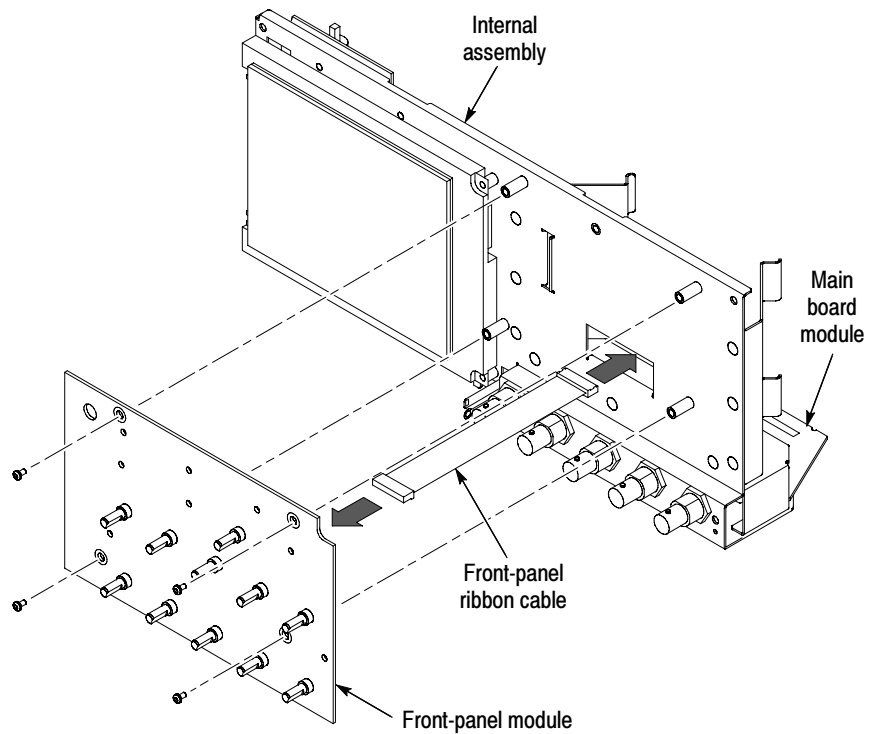


Figure 6-17: Installing the front-panel module

Keypad You will need a torque-limiting Torx T-15 screwdriver for this procedure.

Removal. To remove the switch keypad, refer to Figure 6-18 and follow these steps:

1. Remove the power button and rear case using the procedures on page 6-10.
2. Remove the entire internal assembly from the front case using the procedure on page 6-17.
3. Lift the keypad out of the front case.



CAUTION. *Keep the electrical contacts on the back of the keypad clean. Skin oils and dust will inhibit good electrical contact.*

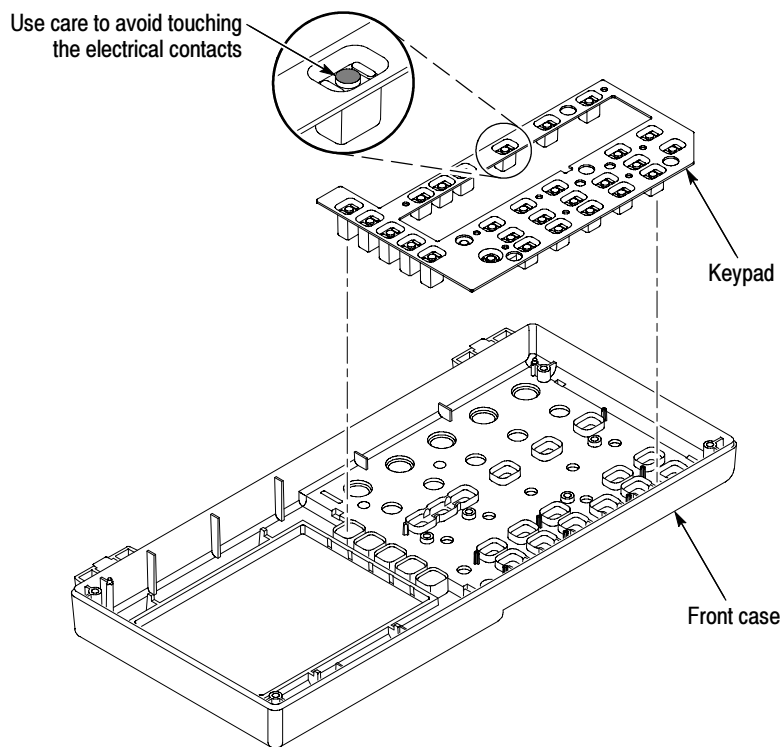


Figure 6-18: Removing and installing the keypad

Installation. To install the switch keypad, refer to Figure 6-18 and follow these steps:

1. Place the front case face down on a soft surface.
2. Align the switch keypad into the front case using the guide posts and the holes in the keypad.



CAUTION. *Keep the electrical contacts on the back of the switch pad clean. Skin oils and dust will inhibit good electrical contact.*

3. Check that all buttons are properly seated into place before proceeding.
4. Place the entire internal assembly into the front case.
5. Use the installation procedure for each module removed to reassemble the oscilloscope.

Front Case You will need a torque-limiting Torx T-15 screwdriver for this procedure.

Removal. To remove the front case, follow these steps:

1. Remove the power button and rear case using the procedures on page 6-10.
2. Remove the entire internal assembly from the front case using the procedure on page 6-17.
3. Remove the switch keypad using the procedure on page 6-28.

Installation. To install the front case, refer to Figure 6-9 on page 6-17 and follow these steps:

1. Place the switch keypad into the front case.
2. Place the entire internal assembly into the front case.
3. Use the installation procedure for each module removed to reassemble the oscilloscope.

Troubleshooting

This section contains information and procedures to help you isolate a defective module in the oscilloscope.



WARNING. Before doing this or any other procedure in this manual, read the General Safety Summary and Service Safety Summary found at the beginning of this manual. Also, to prevent possible injury or damage to electrical components, read Preventing ESD on page 6-1.

Adjustment After Repair

If you replace the main board or power supply, you must adjust the oscilloscope after repair. Refer to the chapter *Adjustment Procedures*.

Required Tools and Equipment

You may need the the following tools and equipment to troubleshoot the oscilloscope:

Tools and equipment	Example
Oscilloscope with 1X/10X and 100X probes	Tektronix TDS1000- or TDS2000-series oscilloscope with standard accessory 1X/10X probe (P2200) and optional 100X probe (P5100 or P5200)
DMM	3.5 or greater digit DMM

Troubleshooting Tree

To isolate a problem to a specific troubleshooting procedure, use the troubleshooting tree in Figures 6-19, 6-20, and 6-21. Detailed procedures follow the tree.

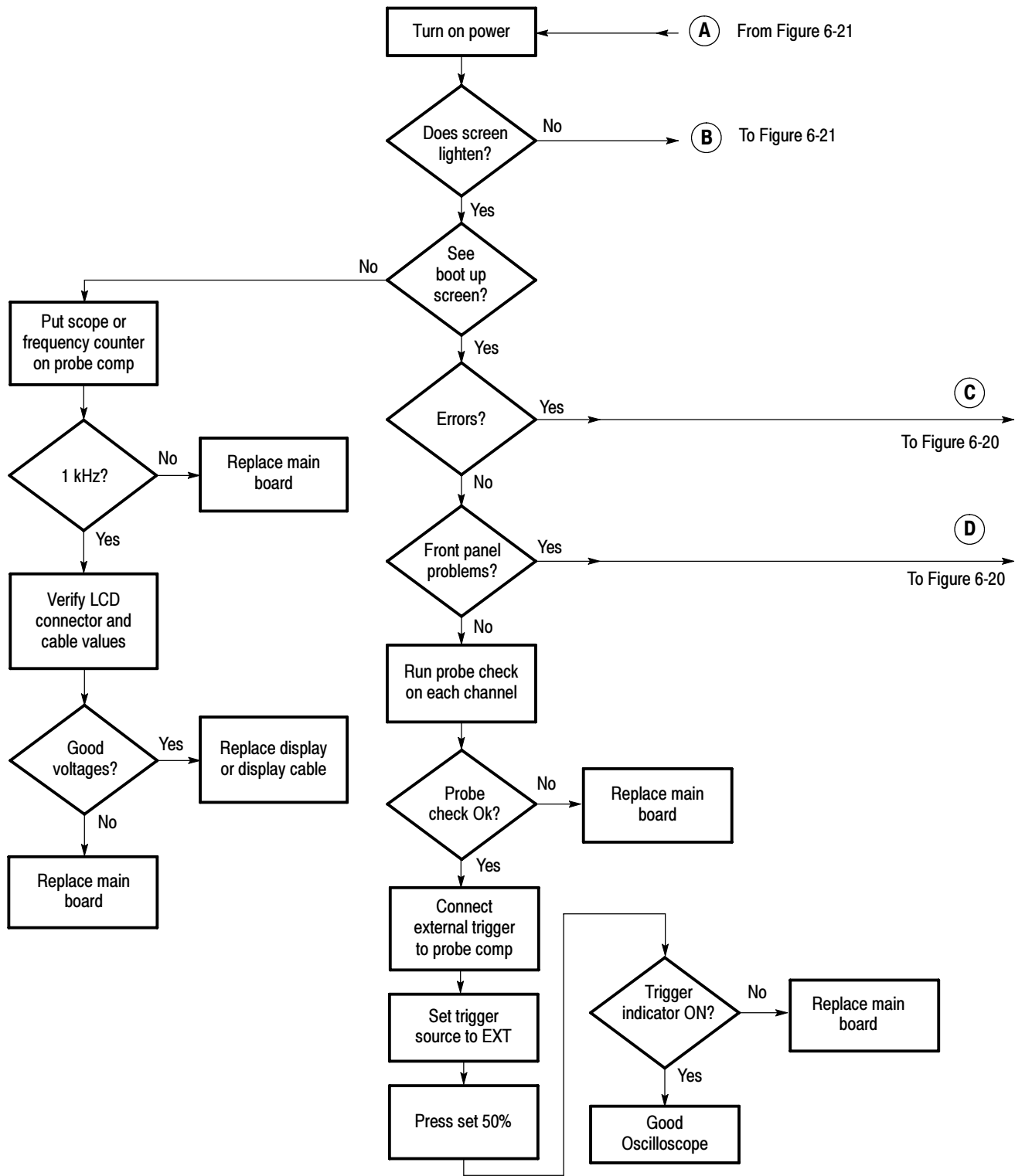


Figure 6-19: Oscilloscope troubleshooting tree (1 of 3)

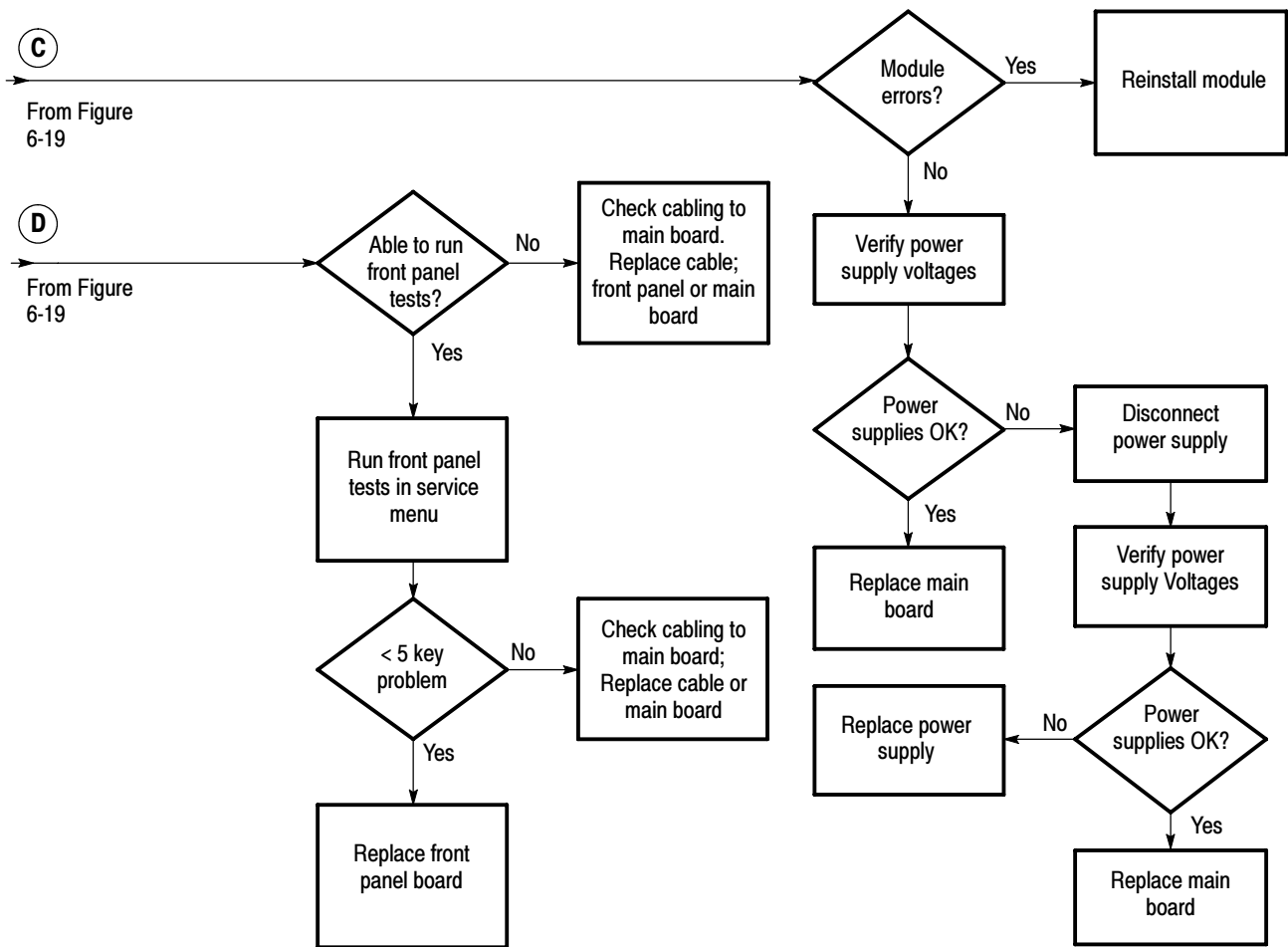


Figure 6-20: Oscilloscope troubleshooting tree (2 of 3)

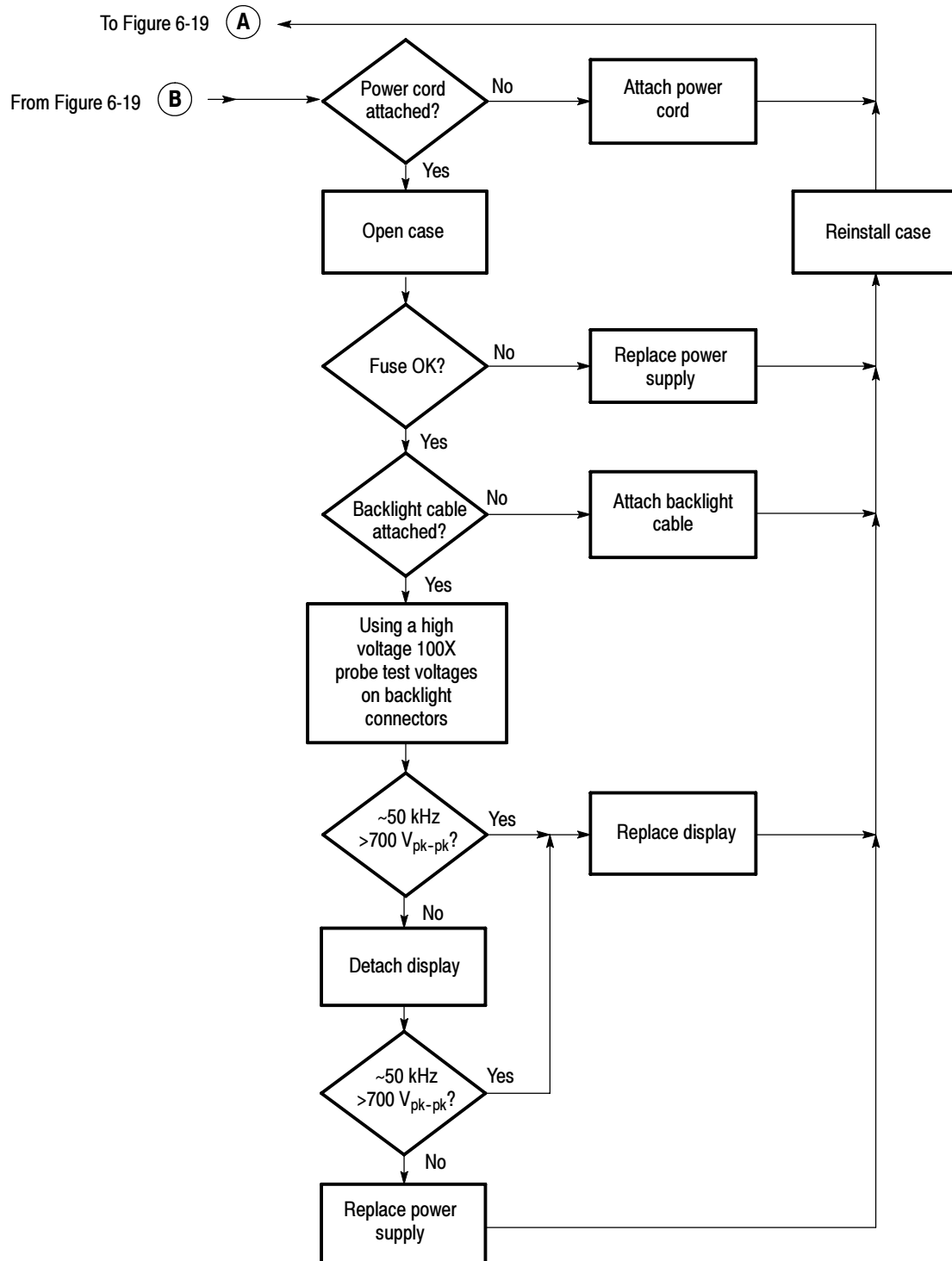


Figure 6-21: Oscilloscope troubleshooting tree (3 of 3)

PROBE COMP Output

When the oscilloscope is on and operating properly, the PROBE COMP output should generate a square wave, approximately 5 V in amplitude, at a 1 kHz frequency. Use the oscilloscope and set the Attenuation switch to 10X on the P2100 probe to probe this output.

As shown in the table below, there are two cases of defects. Either the 1 kHz signal is on and the power supply and main board are both active and functionally capable of doing acquisition, or one of those two modules is not performing correctly. While a large number of different possible frequencies exist, all involve detected failures on the main board due to main board failure or power supply failure.

Signal at PROBE COMP	Possible problem
1 kHz signal, no display	Refer to <i>Troubleshooting the Display</i> (page 6-36)
Non-1 kHz signal	Refer to <i>Troubleshooting the Main Board</i> (page 6-43)
No signal	Refer to <i>Troubleshooting the Power Supply</i> (page 6-35)

Troubleshooting the Power Supply

To troubleshoot the power supply, follow these steps:

1. Remove the rear case using the procedure *Rear Case* on page 6-10.
2. Use the test oscilloscope to measure the voltages from the power supply module at J101 on the main board module. The table below lists the voltages you should expect to see.

Supply	Voltage range*	Maximum Current Draw	J101 power pins	J101 return pins	Derived supplies
35 V	30 V _{DC} to 40 V _{DC} floating. Pin 2 connected to +3.3 V on the main board.	15 mA	1	2	+28 V LCD
+6 V	5.5 V to 6.5 V	0.7 A	4	3, 5, 8, 10	+5 V
+3.3 V	3.0 V to 3.6 V. Requires minimum load to maintain regulation.	1.5 A	6, 7	3, 5, 8, 10	3.3 V, +2.5 V
-4 V	-5.0 V to -3.5 V	0.8 A	9	3, 5, 8, 10	-2.5 V
Line trigger	-2 V to 6 V open circuit. ±1 diode drop when attached to the main board.	1 mA	11	3, 5, 8, 10	Line trigger

Supply	Voltage range*	Maximum Current Draw	J101 power pins	J101 return pins	Derived supplies
Backlight (mono-chrome or color)	>500 V _{pk-pk} , ~50 kHz		NA	NA	NA

* With 3 W minimum load; still functions with no load.

3. If all of the voltages are present, the main board is probably defective. Replace it.
4. If all or some of the voltages are missing, turn off the oscilloscope and disconnect the cable at connector J101 on the main board module.
5. Turn on the oscilloscope and check the voltages at the loose end of the cable disconnected from J101, checking for the same voltages as in step 2.
6. If all of the voltages are missing, check the line fuse on the power supply module. If the fuse is defective, replace the power supply module.
7. If the fuse is okay, and all or some of the voltages are missing, the power supply module is probably defective. Replace it.

Troubleshooting the Display

To troubleshoot a nonfunctional display, follow these steps:

1. Remove the rear case using the procedure *Rear Case* on page 6-10.
2. Turn on the oscilloscope and ensure that the display lights up. If it does not, either the display or power supply is defective. If this procedure is not conclusive, continue with *Troubleshooting the Power Supply* on page 6-35

NOTE. Without a functional display module, the simplest way to verify that the oscilloscope is on and functioning is to check for a signal at the PROBE COMP output. The PROBE COMP output generates approximately a 5 V, 1 kHz square wave.

3. Use the test oscilloscope and set the Attenuation switch to 10X on the P2200 probe to probe the display cable connector at J201 on the main board. The following table describes the signals you should expect to see. See the

exploded diagrams in *Replaceable Parts* for the location and orientation of the connector on the main board.

Signal at J201	Description, Monochrome	Description, Color
Pin 1 (marked with ◀)	No fixed pattern. Depends upon display data.	No fixed pattern. Depends upon display data.
Pin 2	No fixed pattern. Depends upon display data.	No fixed pattern. Depends upon display data.
Pin 3	No fixed pattern. Depends upon display data.	No fixed pattern. Depends upon display data.
Pin 4	No fixed pattern. Depends upon display data.	No fixed pattern. Depends upon display data.
Pin 5	Not connected	No fixed pattern. Depends upon display data.
Pin 6	Not connected	No fixed pattern. Depends upon display data.
Pin 7	Not connected	No fixed pattern. Depends upon display data.
Pin 8	Not connected	No fixed pattern. Depends upon display data.
Pin 9	24 V _{DC} ²	26.5 V _{DC} ²
Pin 10	Ground	Ground
Pin 11	+5 V _{DC}	+5 V _{DC}
Pin 12	HI when display active	HI when display active
Pin 13	Data rate clock. 1.36 MHz Square wave ³	Data rate clock. 1.36 MHz Square wave
Pin 14	Line rate clock 17 kHz, 500 ns high pulse from low baseline ³	Line rate clock 11.4 kHz, 500 ns high pulse from low baseline
Pin 15	Frame rate clock 70 Hz, 750 ns high pulse from low baseline ³	Frame rate clock 43 Hz, 350 ns high pulse from low baseline
Pin 16	Low ⁴	High (> 2.4 V)
Pin 17	Ground	Ground
Pin 18	Ground	Ground

² Value varies with temperature, contrast setting, and display type.

³ Frequency may vary slightly with software version.

⁴ With monochrome display cable attached. If no cable is attached, default condition is High (color).

4. If all the signals are present, the display module is probably defective. Replace it.
5. If all or some of the signals are missing, turn off the oscilloscope and disconnect the display cable at J201 on the main board. Carefully pull the cable straight up from the connector to avoid damage.
6. Turn on the oscilloscope.
7. Probe the pins of J201, checking for the same signals as in step 3.
8. If any of the signals are missing, the main board module is probably defective. Replace it.

Troubleshooting the Backlight

To troubleshoot a nonfunctional backlight, follow these steps:

1. Remove the rear case using the procedure *Rear Case* on page 6-10.
2. Turn on the oscilloscope.



WARNING. To avoid electrical shock, do not touch the backlight connectors on the power supply module. See Figure 6-22 for the location of the connectors. Typically, the monochrome connector is black and the color connector is white.

3. Set the test oscilloscope (with a 100X probe) to measure a $1270 V_{pk-pk}$ ($450 V_{RMS}$) signal at approximately 50 kHz.
4. Attach the probe ground lead to the ground lug on the AC line connector and the probe tip to the one of the leads on the relevant (monochrome or color) backlight connector as shown in Figure 6-22. Record the voltage of the signal.
5. Attach the probe tip to the other lead on the backlight connector as shown in Figure 6-22. Record the voltage of the signal.

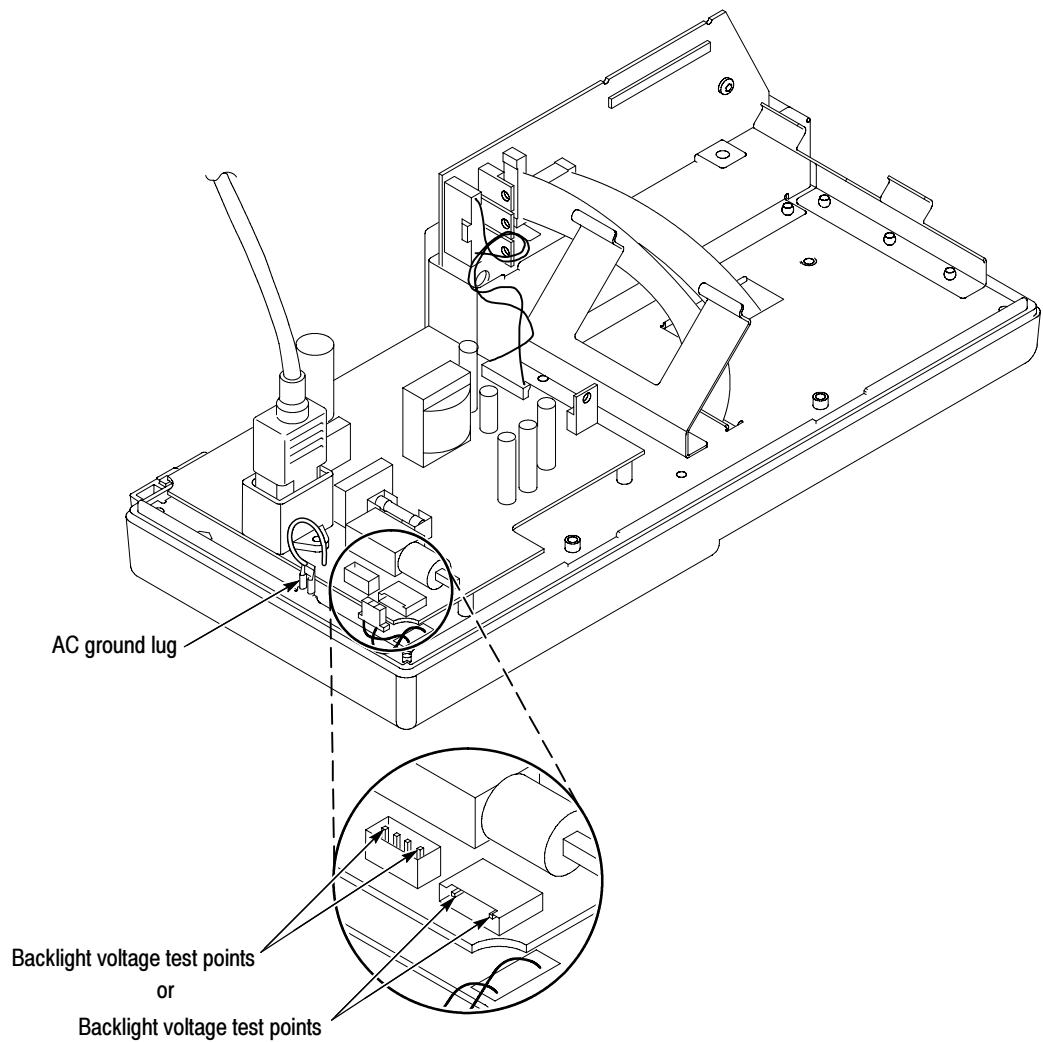


Figure 6-22: Measuring the backlight voltage

6. Add the results of both readings. If a signal greater than $1400 V_{pk-pk}$ is present, the backlight is probably defective. Replace the display.

If the signal is not present, proceed with step 7.

7. If the signal is missing, detach the display using the procedure on page 6-24 and probe the backlight connector leads again.
8. Add the results of both readings. If a signal greater than $1400 V_{pk-pk}$ is present, the display is probably defective. Replace it.

If the signal is not present, the power supply module is probably defective. Replace it.

Troubleshooting the Front Panel

To troubleshoot a nonfunctional front panel, follow these steps:

1. To execute the internal diagnostic tests, remove all input signals from the oscilloscope and enable the Service menu as described on page 5-3.
2. Push the **UTILITY** button and push the **Service** option button. The following options appear:

Menu	Comments
Factory Cal	Steps through the calibration routine steps.
Total Init	Writes factory default settings to all saved setups, writes factory default data to all reference waveforms, turns off Service Mode, and performs the same actions as the front-panel DEFAULT SETUP button.
Service Diag.	Displays the service diagnostics menus.
Service Mode Off	Disables the Service menu.

3. Select **Service Diag.** The following options appear:

Menu	Comments
Mfg. Tests	Displays a front-panel simulation used to check that all front panel controls are operational.
Loop Diag.	Opens a menu that enables you to re-run a subset of the power-on self tests.
Peek/Poke	For engineering use only
Clear Error Log	Removes all Error Log entries from memory and sets the power cycle count to zero.

4. Select **Mfg. Tests** to start the front-panel controls test. The following options appear:

Menu	Comments
Test FP	Displays a front-panel simulation used to check the operation of all front panel controls. All buttons must be pushed and all knobs must be turned in both directions before you can exit this test.
Test Screen	Checks the display screen pixels with different patterns from each push of the button.
Contrast	Allows you to check the display contrast operation across 100% of the hardware range.

Menu	Comments
Warmup Timer	Ensures a ten-minute warm-up time for the oscilloscope before executing the calibration procedure.
Stop Test	Exits the front-panel test (Test FP) and the screen test (Test Screen).

5. Select **Test FP** to start the front-panel controls test.
6. Push each button and rotate each knob to verify the operation of all controls. If all buttons and knobs have passed the test, pushing the lower menu button (EXIT) exits the test.
7. If any button fails to operate, inspect and/or clean the switch keypad and the front panel board contacts. If cleaning does not solve the problem, the switch keypad, front panel board, or main board may be defective. Follow the remaining steps in this procedure below to isolate the problem.
8. Replace the switch keypad and then retest the buttons. If the problem persists, proceed to step 9.
9. Use the test oscilloscope and set the Attenuation switch to 10X on the P2200 probe to probe the front-panel cable connector at J202 on the main board (two-channel models) or J1 (four-channel models). The table below describes the signals you should expect to see.

Signal at J202 (2-channel models) or J1 (4-channel models)	Description
1 FPLED_P	LED latch line 6.44kHz. High with 120 ns low pulses. Location of pulse relative to FPCLR_12_P determines which lights are lit.
2 FPCLR_12_P	Clear Front Panel Scan line A 6.44kHz. Low pulsing high with 50ns pulses. Determines beginning of a scan sequence for first half of front panel.
3 FPCLK_12_P	Front Panel Clock line A 405 kHz. High with 50 ns pulses going low. Each clock after FPCLR_12_P increments the scan location by one.
4 FPDATA_12_P	Front Panel Scan Data line A No fixed pattern. Stable when triggered from FPCLR_12_P. Pattern depends upon rotation of knobs being scanned.
5 GND	0 V (ground)
6 FPTHERMSTR_P	Front Panel Temp Sense About 2 V _{DC} depending upon temperature, contrast setting, and display type.
7 FP_PWR 3.3V	3.3 V _{DC}
8 FPTHERMGND_P	Temp Sense Return Ground.

Signal at J202 (2-channel models) or J1 (4-channel models)	Description
9 GND	0 V (ground)
10 FPDATA_34_P ¹	Front Panel Scan Data line B No fixed pattern. Stable when triggered from FPCLR_34_P. Pattern depends upon rotation of knobs being scanned.
11 FPCLR_34_P ²	Front Panel Clock line B 405 kHz. High with 50 ns pulses going low. Each clock after FPCLR_34_P increments the scan location by one.
12 FPCLK_34_P ²	Clear Front Panel Scan line B 6.44 kHz. Low pulsing high with 50 ns pulses. Determines beginning of a scan sequence for second half of front panel.

¹ **Unused and open on two-channel models**

² **Unused and tied low on two-channel models**

- 10.** If all of the signals are present, the front-panel board is probably defective. Replace it.
- 11.** If some or all of the signals are missing, continue with step 12.
- 12.** Turn off the oscilloscope and disconnect the front-panel cable from the main board at connector J202 (two-channel models) or J1 (four-channel models).
- 13.** Turn on the oscilloscope and check connector J202 (two-channel models) or J1 (four-channel models) for the same signals as in step 9.
- 14.** If some or all of the signals are missing, the main board is probably defective. Replace it.

Troubleshooting the Main Board

To troubleshoot the main board, follow these steps:

1. Remove the rear case using the procedure *Rear Case* on page 6-10.
2. Use the test oscilloscope to measure the voltages from the power supply module at J101 on the main board module. The table below lists the voltages you should expect to see.

Supply	Voltage range*	Maximum Current Draw	J101 power pins	J101 return pins	Derived supplies
35 V	30 V _{DC} to 40 V _{DC} floating. Pin 2 connected to +3.3 V on the main board.	15 mA	1	2	+28 V LCD
+6 V	5.5 V to 6.5 V	0.7 A	4	3, 5, 8, 10	+5 V
+3.3 V	3.0 V to 3.6 V. Requires minimum load to maintain regulation.	1.5 A	6, 7	3, 5, 8, 10	3.3 V, +2.5 V
-4 V	-5.0 V to -3.5 V	0.8 A	9	3, 5, 8, 10	-2.5 V
Line trigger	-2 V to 6 V open circuit. ±1 diode drop when attached to the main board.	1 mA	11	3, 5, 8, 10	Line trigger

* With 3 W minimum load; still functions with no load.

3. If all of the voltages are present, the main board is probably defective. Replace it.

Running Diagnostics

The oscilloscope runs an extensive self-diagnostic routine at every power-on. Running the diagnostics from the Service menu will provide no additional information and therefore is not needed. The menu selections are only used during manufacturing of the oscilloscope.

Troubleshooting Input Connections

Follow these steps to troubleshoot the input connections only if the oscilloscope appears to function normally in every way. However, you have determined that an input signal is not getting into the oscilloscope as expected.

1. Remove the rear case using the procedure *Rear Case* on page 6-10.
2. Check that the coaxial connections to the back side of the BNC connectors are intact. Use the DMM to measure continuity from the BNC connector to the end of the coaxial cable where it attaches to the main board.

3. If no problem is found and the trouble persists, the main board is probably defective in some way that the internal diagnostics cannot detect. Replace it.

Using the Error Log

Failures that occur during the power-up diagnostics or normal oscilloscope operation place an entry in the error log.

Accessing the error log. The error log list can be accessed anytime by pushing the UTILITY button and selecting Error Log. Table 6-3 lists the error codes and probable causes.

Table 6-3: List of error codes

Error code	Description	Probable cause
0 DI	Diagnostics internal error	Contact Tektronix
1 DI	ADG522 diagnostics failed	Main board or power supply failure
2 DI	PROM diagnostics failed	Main board or power supply failure
3 DI	MEMORY diagnostics failed	Main board or power supply failure
4 DI	CH1 diagnostics failed	Main board or power supply failure
5 DI	CH2 diagnostics failed	Main board or power supply failure
6 DI	Line trigger diagnostics failed	Main board or power supply failure
7 DI	ADG421 diagnostics failed	Main board or power supply failure
8 DI	GPIB diagnostics failed	Extension module failure
9 DI	RS-232 diagnostics failed	Extension module failure
10 DI	Extension module RAM failed	Extension module failure
11 DI	Extension module checksum failed	Extension module failure
12 DI	CH3 diagnostics failed	Main board or power supply failure
13 DI	CH4 diagnostics failed	Main board or power supply failure
14 DI	ADG421 #2 diagnostics failed	Main board or power supply failure
15 DI	ADG522 #2 diagnostics failed	Main board or power supply failure
16 DI	DRAM2 diagnostics failed	Main board or power supply failure
255	Software	Contact Tektronix

Clearing the Error Log. To clear the error log after fixing a problem, follow these steps:

1. Enable the Service menus as described on page 5-3.
2. Push the **UTILITY** button and push the **Service** option button to display the Service menu.
3. Push the **Service Diag.** option button to display the Diagnostics menu.
4. Push the **Clear Error Log** option button to clear the error log of past failures. This also sets the Power Cycle count to zero.

Repackaging Instructions

Use these procedures to repack the oscilloscope for shipment or storage.

Packaging

Use a corrugated cardboard shipping carton having a test strength of at least 125 kg (275 pounds), and with an inside dimension at least 15.25 cm (six inches) greater than the oscilloscope dimensions. Make sure that the oscilloscope is adequately padded with a cushioning material like foam, paper, or bubble wrap. The oscilloscope should not move around inside of the carton when sealed.

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

- The owner 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

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

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

Storage

The oscilloscope should be stored in a clean, dry environment. The following environmental characteristics apply for both shipping and storage (oscilloscope not operating):

- Temperature range: -20 °C to +60 °C
- Altitude: To 15,000 m

See the chapter *Specifications* for a complete listing of the environmental characteristics.



Diagrams

Diagrams

This section describes the electrical operation of the TDS1000- and TDS2000-series oscilloscopes using the major circuit blocks or modules. Figure 7-1 shows the oscilloscope module interconnections.

The shaded area in Figure 7-1 represents modules and circuits used only in four-channel oscilloscopes.

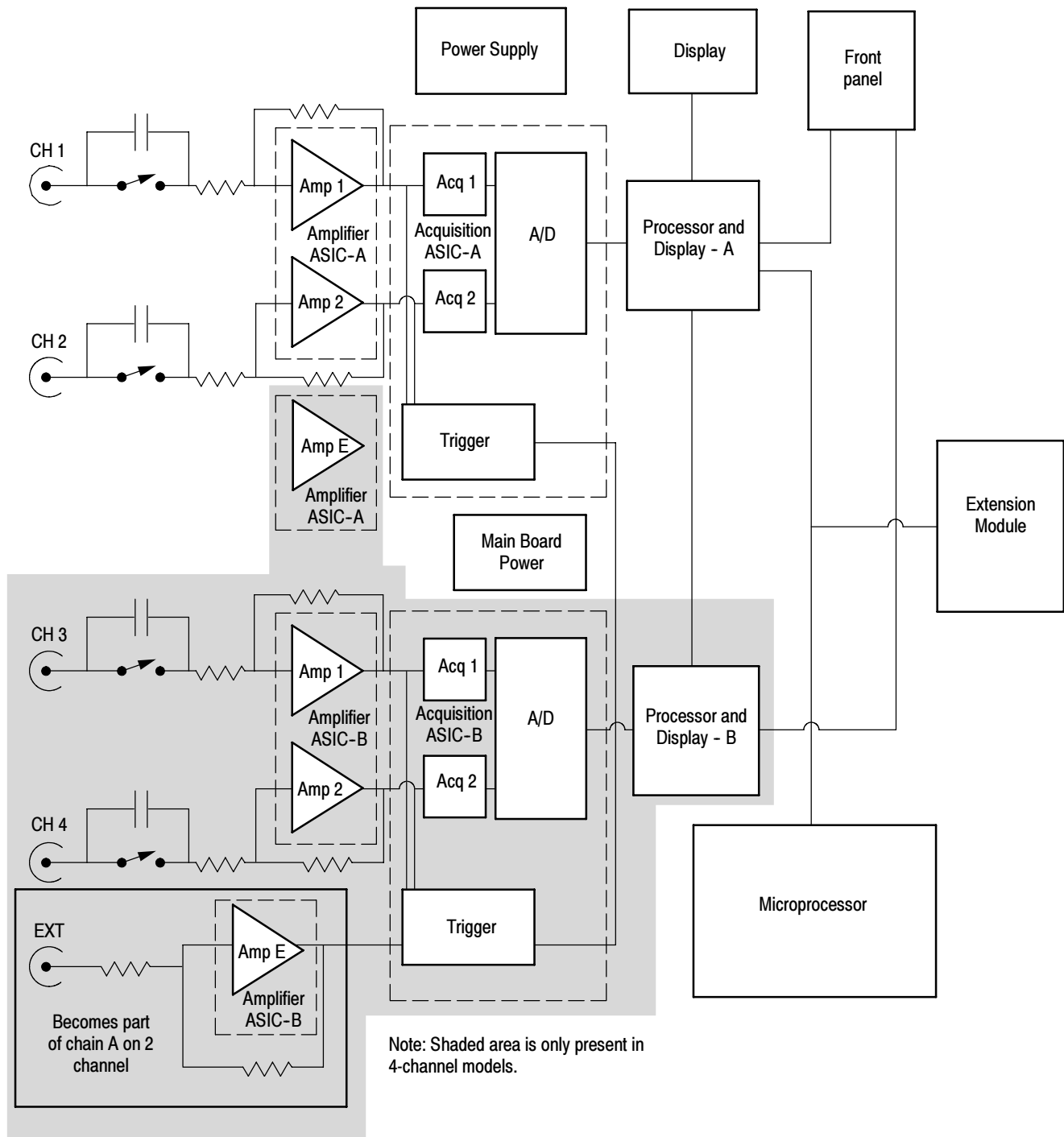


Figure 7-1: TDS1000 and TDS2000 series block diagram



Replaceable Parts

Replaceable Parts

This chapter contains a list of the replaceable modules for the TDS1000- and TDS2000-series oscilloscopes. 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 products are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest 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 two 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 and select option 2.

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. Table 8-1 describes each column in the parts list.

Table 8-1: Parts list column descriptions

Column	Column name	Description
1	Figure & Index Number	Items in this section are referenced by figure and index numbers to the exploded view illustrations that follow.
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.
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 table titled Manufacturers cross index shows codes, names, and addresses of manufacturers or vendors of components listed in the parts list.

Table 8-2: Manufacturers cross index

Mfr. code	Manufacturer	Address	City, state, zip code
06915	RICHCO	5825 N TRIPP AVE P.O. BOX 804238	CHICAGO, IL 60646
0KB01	STAUFFER SUPPLY CO	810 SE SHERMAN	PORTLAND, OR 97214-4657
22670	GM NAMEPLATE INCORPORATED	2040 15TH AVE WEST	SEATTLE, WA 98119-2783
80009	TEKTRONIX INC	14200 SW KARL BRAUN DR PO BOX 500	BEAVERTON, OR 97077-0001
TK1163	POLYCAST INC	14140 SW 72ND AVE SUITE 100	TIGARD, OR 97224
TK2288	CAMCAR DIV OF TEXTRON INC	826 E MADISON ST	BELVIDERE, IL 61008
TK6430	AULT (XIANGHEI) ELECTRONIC CO LTD	ANPING ECONOMIC AND TECHNOLOGY DEVELOPEMENT ZONE	XIANGHE, HEBEI PROV, CN 065402
TK6431	BOURNS (XIAMEN) LTD	4/5F GUANGYAO BUILDING, TORCH HI-TECH INDUSTRIAL DEVELOPMENT ZONE	XIAMEN, FUJIAN PROV, CN 361006
TK6433	I-SHENG ELECTRIC WIRE & PLASTIC (KUNSHAN) CO LTD	85 FUMING ROAD ECONOMIC ZONE	KUNSHAN, JIANGSU, CN
TK6549	TYCO ELECTRONICS (KUNSHAN) LTD	ZHANGPU TOWN, KUNSHAN ECONOMIC AND TECHNOLOGICAL DEVELOPMENT ZONE	KUNSHAN, JIANGSU PROV, CN 215321
TK6552	SAM SEIKI METAL & PLASTIC PRODUCTS CO LTD	BLOCK 18, 19, 1ST HUAI DE IND DISTR FU YONG BAO AN	SHEN ZHEN, CN
TK6352	QIAOKUN COLOR PRINTED CO LTD	168 SHENGXI ROAD~BINGXI INDUSTRIAL COOPERATIVE ZONE	KUNSHAN, JIANGSU CN

Table 8-3: Replaceable parts list

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
10-1	650-4348-00			1	FRAME ASSEMBLY; DISPLAY,MONO (TDS1000)	80009	650-4348-00
	650-4349-00			1	FRAME ASSEMBLY; DISPLAY, COLOR (TDS2000)	80009	650-4349-00
-2	174-4672-00			1	CA ASSY,SP; DATA,MONO (TDS1000), 6.0 L	TK6549	174-4672-00
	174-4673-00			1	CA ASSY,SP; DATA,COLOR (TDS2000), 7.0 L	TK6549	174-4673-00
-3	441-2287-00			1	CHASSIS ASSY; 2 CH,MONO (TDS1000), STEEL, SAFETY CONTROLLED	TK6552	441-2287-00
	441-2288-00			1	CHASSIS ASSY; 2 CH,COLOR (TDS2000), STEEL, SAFETY CONTROLLED	TK6552	441-2288-00
	441-2289-00			1	CHASSIS ASSY; 4 CH,COLOR (TDS2000), STEEL, SAFETY CONTROLLED	TK6552	441-2289-00
-4	211-1143-00			4	SCREW,PT; K35-1.57,PAN HEAD,T-15	TK2288	211-1143-00
-5	343-1673-00			2	CLAMP,CABLE; CABLE TIE,NYLON 6/6, COLOR NATURAL	06915	STL-250-3-01
-6	119-6610-00			1	POWER SUPPLY; CUSTOM,TDS1000/2000 SERIES, AC-DC;85-275 VAC 45-440HZ IN, +6VDC 0.7A, +3.3VDC 1.5A, -4VDC 0.8A, 35V 0.015A OUT, SAFETY CONTROLLED	TK6430	119-6610-00
-7	366-0774-00			1	PUSH BUTTON; POWER,PC/ABS TEXTURED	TK6433	366-0774-00
-8	211-0722-00			14	SCREW,MACHINE; 6-32 X 0.250,PNH,STL,CDPL,T-15	0KB01	OBD
-9	211-1152-00			4	SCREW,PT; M3 X 10M,FLAT TOP PNH,T15,STL,ZINC PLT	TK2288	3BE-P8006-00
-10	334-9262-04			1	MARKER,IDENT; LABEL,MKD WARNING TO AVOID ELECTRIC,3.765 X 3.990,0.010 POLY,W/ADHESIVE, SAFETY CONTROLLED	80009	334-9262-04
-11	348-1704-00			2	FOOT; REAR,SANTOPRENE,BLACK	TK6433	348-1704-00
-12	202-0390-00			1	CASE,REAR; PC/ABS,PLASTIC BLEND,TEK BLUE, SAFETY CONTROLLED	TK6433	202-0390-00
-13	348-1703-00			2	FOOT; FRONT,FLIPMPC/ABS,SILVER GRAY	TK6433	348-1703-00
-14	650-4410-00			1	REAR CASE ASSY; COVER,W/FEET & HANDLE;TDS1000,TDS2000	TK6433	650-4410-00
-15	671-6182-00			1	CIRCUIT BD ASSY; MAIN,2 CH,200MHZ,TDS1001	80009	671-6182-00
	671-5580-00			1	CIRCUIT BD ASSY; MAIN,2 CH,60MHZ,MONO,TDS1002	80009	671-5580-00
	671-5581-00			1	CIRCUIT BD ASSY; MAIN,2 CH,100MHZ,MONO,TDS1012	80009	671-5581-00
	671-5585-00			1	CIRCUIT BD ASSY; MAIN,2 CH,60MHZ,COLOR,TDS2002	80009	671-5585-00
	671-6183-00			1	CIRCUIT BD ASSY; MAIN,4 CH,200MHZ,TDS2004	80009	671-6183-00
	671-5586-00			1	CIRCUIT BD ASSY; MAIN,2 CH,100MHZ,COLOR,TDS2012	80009	671-5586-00
	671-5582-00			1	CIRCUIT BD ASSY; MAIN,4 CH,100MHZ,COLOR, TDS2014	80009	671-5582-00
	671-5583-00			1	CIRCUIT BD ASSY; MAIN,2 CH,200MHZ,COLOR,TDS2022	80009	671-5583-00
	671-5584-00			1	CIRCUIT BD ASSY; MAIN,4 CH,200MHZ,COLOR,TDS2024	80009	671-5584-00
-16	210-1039-00			3	WASHER,LOCK;2 CH, 0.521 ID,0.025 THK,SST, TDS1001, TDS1002, TDS1012, TDS2002, TDS2012, TDS2022	0KB01	210-1039-00
	210-1039-00			5	WASHER,LOCK;4 CH, 0.521 ID,0.025 THK,SST, TDS2004, TDS2014	0KB01	210-1039-00
-17	220-0497-00			3	NUT,PLAIN,HEX;2 CH, 0.5-28 X 0.562 HEX,BRS CD PL	0KB01	220-0497-00
	220-0497-00			5	NUT,PLAIN,HEX;4 CH, 0.5-28 X 0.562 HEX,BRS CD PL	0KB01	220-0497-00

Table 8-3: Replaceable parts list (cont.)

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discontinued	Qty	Name & description	Mfr. code	Mfr. part number
-18	174-4658-00			1	CA ASSY,SP; DISCRETE,26 AWG,5.5 L,FEMALE,1 X 12,0.059 (1.5 MM) CTR,DUAL ENDED,FRONT PANEL	TK6549	174-4658-00
-19	679-5439-00			1	CKT BD SUBASSY;FRONT PANEL,2 CH, TDS2002,TDS2012,TDS2022,TDS1002,TDS1012	TK6431	679-5439-00
	679-5440-00			1	CKT BD SUBASSY;FRONT PANEL,4 CH, TDS2014, TDS2024	TK6431	679-5440-00
-20	260-2763-00			1	SWITCH,KEYPAD; ELASTOMERIC,2 CHANNEL,MONO, TDS1002, TDS1012	22670	260-2763-00
	260-2764-00			1	SWITCH,KEYPAD; ELASTOMERIC,2 CHANNEL,COLOR, TDS2002, TDS2012, TDS2022	22670	260-2764-00
	260-2765-00			1	SWITCH,KEYPAD; ELASTOMERIC,4 CHANNEL,COLOR, TDS2014, TDS2024	22670	260-2765-00
-21	348-1525-00			2	FOOT; FRONT,SANTOPRENE,BLACK	TK6433	348-1525-00
-22	202-0388-00			1	CASE,FRONT; 2 CH,PC/ABS,PLASTIC BLEND,SILVER GRAY,SAFETY CONTROLLED	TK6433	202-0388-00
	202-0389-00			1	CASE,FRONT; 4 CH,OB,CAP;2 CH, PC/ABS,PLASTIC BLEND,SILVER GRAY,SAFETY CONTROLLED	TK6433	202-0389-00
-23	335-0714-00			1	MARKER,IDENT; LABEL,FRONT PANEL,2 CH MONO,5.2 X 5.66,W/ADHESIVE BACK,SAFETY CONTROLLED, TDS1002, TDS1012	80009	335-0714-00
	335-0715-00			1	MARKER,IDENT; LABEL,FRONT PANEL,2 CH COLOR,5.2 X 5.66,W/ADHESIVE BACK,SAFETY CONTROLLED, TDS2002, TDS2012, TDS2022	80009	335-0715-00
	335-0716-00			1	MARKER,IDENT; LABEL,FRONT PANEL,4 CH,COLOR,5.20 X 5.975,W/ADHESIVE BACK,SAFETY CONTROLLED, TDS2014, TDS2024	80009	335-0716-00
-24	366-0771-00			3	KNPC/ABS,SILVER GRAY,0.650 DIA X 0.520 H	TK1163	366-0771-00
	366-0771-00			5	KNOB,CAP;4 CH, PC/ABS,SILVER GRAY,0.650 DIA X 0.520 H	TK1163	366-0771-00
-25	366-0772-00			4	KNOB,CAP;2 CH, PC/ABS,SILVER GRAY,0.425 DIA X 0.520 H	TK1163	366-0772-00
	366-0772-00			6	KNOB,CAP;4 CH, PC/ABS,SILVER GRAY,0.425 DIA X 0.520 H	TK1163	366-0772-00
-26	335-1471-00			1	MARKER,IDENT; LABEL,MKD TDS1001,PC FILM, LEXAN,W/ADHESIVE BACK,SAFETY CONTROLLED	TK6352	335147100
	335-0725-00			1	MARKER,IDENT; LABEL,MKD TDS1002, PC FILM, LEXAN,W/ADHESIVE BACK,SAFETY CONTROLLED	80009	335-0725-00
	335-0726-00			1	MARKER,IDENT; LABEL,MKD TDS1012, PC FILM, LEXAN,W/ADHESIVE BACK,SAFETY CONTROLLED	80009	335-0726-00
	335-0708-00			1	MARKER,IDENT; LABEL,MKD TDS2002, PC FILM, LEXAN,W/ADHESIVE BACK,SAFETY CONTROLLED	80009	335-0708-00
	335-1472-00			1	MARKER,IDENT; LABEL,MKD TDS2004,PC FILM, LEXAN,W/ADHESIVE BACK,SAFETY CONTROLLED	TK6352	335147200
	335-0709-00			1	MARKER,IDENT; LABEL,MKD TDS2012, PC FILM, LEXAN,W/ADHESIVE BACK,SAFETY CONTROLLED	80009	335-0709-00
	335-0710-00			1	MARKER,IDENT; LABEL,MKD TDS2014, PC FILM, LEXAN,W/ADHESIVE BACK,SAFETY CONTROLLED	80009	335-0710-00
	335-0711-00			1	MARKER,IDENT; LABEL,MKD TDS2022, PC FILM, LEXAN,W/ADHESIVE BACK,SAFETY CONTROLLED	80009	335-0711-00

Table 8-3: Replaceable parts list (cont.)

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
	335-0712-00			1	MARKER,IDENT; LABEL,MKD TDS2024, PC FILM, LEXAN,W/ADHESIVE BACK,SAFETY CONTROLLED	80009	335-0712-00
not shown	335-1473-00			1	WARNING LABEL;REAR CASE;TDS1001,TDS2004	TK6352	335-1473-00

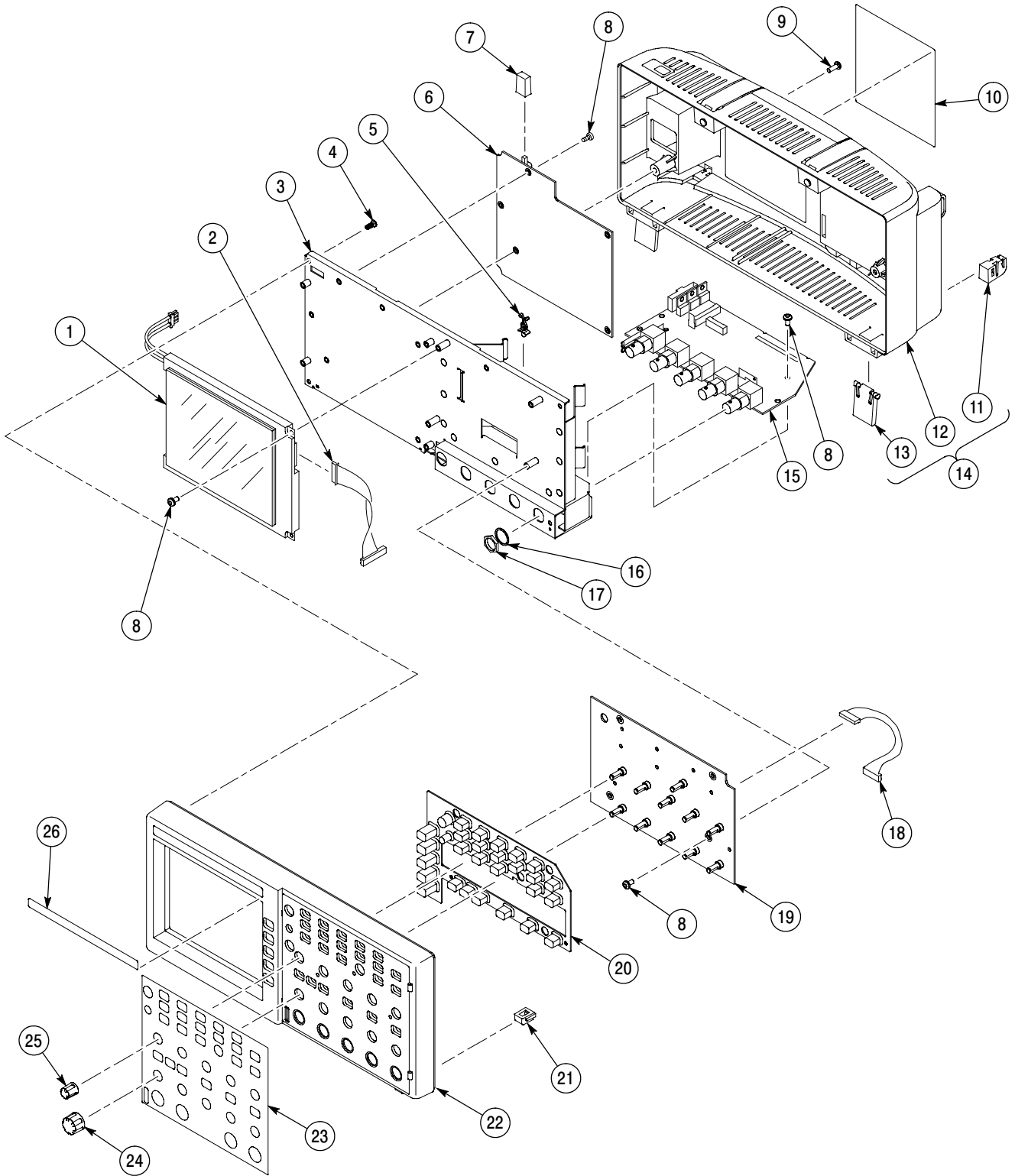


Figure 8-1: Exploded diagram

Table 8-4 lists the replaceable standard accessories for the oscilloscope and the instrument options that included them in the original shipment. These accessories are not shown in Figure 8-1.

Table 8-4: Replaceable standard accessories

Description of accessory	Tektronix part number or nomenclature
Passive 1X/10X probes	P2200
Replacement user	
English	071-1064-XX
French	071-1065-XX*
Italian	071-1066-XX*
German	071-1067-XX*
Spanish	071-1068-XX*
Japanese	071-1069-XX*
Portuguese	071-1070-XX*
Simplified Chinese	071-1071-XX*
Traditional Chinese	071-1072-XX*
Korean	071-1073-XX*
Russian	071-1074-XX*
Replacement power cords	
Option A0, Std North American 120 V, 60 Hz	161-0066-00
Option A1, European 230 V, 50 Hz	161-0066-09
Option A2, United Kingdom 230 V, 50 Hz	161-0066-10
Option A3, Australian 240 V, 50 Hz	161-0066-11
Option A5, Switzerland 230 V, 50 Hz	161-0154-00
Option A6, Japan 100 V, 60 Hz	161-0298-00
Option AC, China 220 V, 50/60 Hz	161-0304-00
Option A99, No power cord	

* These manuals contain a language overlay for the front-panel controls.

Table 8-5: Replaceable optional accessories

Description of accessory	Tektronix part number or nomenclature
Replacement programmer manual	071-1075-XX
Soft case	AC220
Transit case*	HCTDS32
Communications Extension Module	TDS2CMA
Rackmount Kit	RM2000

* Requires the soft case which fits inside.