

Service Manual



TDS 200-Series Digital Real-Time Oscilloscope 071-0492-03

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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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

**Certifications and
Compliances**

Refer to the specifications section for a listing of certifications and compliances that apply to this product.

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.

Preface

The service manual for the TDS 200-Series Digital Real-Time Oscilloscope provides information to troubleshoot and repair the instrument to the module level.

Some TDS models have two input channels and an external trigger while other models have four input channels. Most illustrations in this manual show a two channel model. Some parts for the four channel model are slightly different because of the additional channels.

Related Manuals

Additional documentation for the instrument is contained in the related manuals listed below.

Language	User manual part number	Extension module instructions part number	Programmer manual part number
English	071-0398-XX	071-0409-XX	071-0493-XX
French	071-0400-XX*	071-0483-XX	
German	071-0402-XX*	071-0485-XX	
Italian	071-0401-XX*	071-0484-XX	
Spanish	071-0399-XX*	071-0482-XX	
Portuguese	071-0403-XX*	071-0486-XX	
Japanese	071-0405-XX*	071-0488-XX	
Korean	071-0408-XX*	071-0491-XX	
Simplified Chinese	071-0406-XX*	071-0489-XX	
Traditional Chinese	071-0407-XX*	071-0490-XX	
Russian	071-0404-XX	071-0487-XX	

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

Contacting Tektronix

Phone	1-800-833-9200*
Address	Tektronix, Inc. Department or name (if known) 14200 SW Karl Braun Drive P.O. Box 500 Beaverton, OR 97077 USA
Web site	www.tektronix.com
Sales support	1-800-833-9200, select option 1*
Service support	1-800-833-9200, select option 2*
Technical support	Email: techsupport@tektronix.com 1-800-833-9200, select option 3* 1-503-627-2400 6:00 a.m. – 5:00 p.m. Pacific time

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

Product End-of-Life Handling

Components that Contain Mercury. The cold cathode fluorescent tube located in the liquid crystal display backlight contains trace elements of mercury. When you are ready to reclaim the instrument, you must properly transfer it according to local regulations concerning mercury-containing equipment or ship the instrument to the Tektronix Recycling Operations (RAMS). You can contact Tektronix for the RAMS shipping address and instructions.

Specifications

All specifications apply to the TDS 200-Series Digital Real-Time Oscilloscope with a P2100 probe with the Attenuation switch set to 10X unless noted otherwise. To meet specifications, two conditions must first be met:

- The instrument must have been operating continuously for twenty minutes within the specified operating temperature.
- You must perform the Self Cal operation, accessible through the utility menu, if the operating temperature changes by more than 5° C.

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

Table 1-1: 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, all channels	1 MΩ ±2% in parallel with 20 pF ±3 pF	
Input Impedance, DC Coupled, EXT TRIG only	<i>TDS 210 (B099188 to B119999 & C021679 to C029999)</i> <i>TDS 220 (B065810 to B079999 & C021127 to C029999)</i>	<i>All other TDS 210, TDS 220, and TDS 224</i>
	1.2 MΩ ±5% in parallel with 20 pF ±5 pF	1 MΩ ±5% in parallel with 20 pF ±5 pF
P2100 Probe Attenuation	1X, 10X	
Probe Attenuation Factors	1X, 10X, 100X, 1000X	
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} (420 V peak, duty factor < 50%, pulse width < 100 msec.)
	CAT III	150 V _{RMS}
For steady-state sinusoidal waveforms, derate at 20 dB/decade above 100 kHz to 13 V _{pk} at 3 MHz* and above. Also, refer to Overvoltage Category description on page 1-7.		

* **Bandwidth is not valid for the P2100 probe when the switch is set to 1X.**

Table 1-1: Specifications (cont.)

Inputs		
Maximum Voltage Between Probe Tip and ground using P2100 connected to input BNC	<i>Overvoltage Category</i>	<i>Maximum Voltage</i>
	CAT I and CAT II	300 V _{RMS} (500 V peak, duty factor < 35%, pulse width < 100 msec.)
	CAT III	100 V _{RMS}
	Derate at 20 dB/decade above 900 kHz to 13 V _{RMS} at 27 MHz* and above. Also, refer to Overvoltage Category description on page 1-7.	
Time delay between channels, typical	150 ps	
Channel-to-Channel Common Mode Rejection, typical	<i>TDS 210</i>	<i>TDS 220 and TDS 224</i>
	100:1 at 60 Hz 20:1 at 30 MHz*	100:1 at 60 Hz 20:1 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. Also measured on MATH Ch3 - Ch4 waveform for the TDS 224.	
Channel-to-Channel Cross-talk	<i>TDS 210</i>	<i>TDS 220 and TDS 224</i>
	≥ 100:1 at 30 MHz*	≥ 100:1 at 50 MHz*
	Measured on one channel, with 8 division test signal applied between signal and common of the other channel, the same VOLTS/DIV and coupling settings on each channel, and 50 Ω terminators 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 (Full bandwidth at > 5 mV/div to 5 V/div, 20 MHz at 2 mV/div to 5 mV/div, except in Peak Detect mode full bandwidth at > 10 mV/div to 5 V/div [20 MHz at 2 mV/div to 10 mV/div])	
Position Range	2 mV/div to 200 mV/div, ±2 V > 200 mV/div to 5 V/div, ±50 V	
✓ Analog Bandwidth in Sample and Average modes at BNC or with P2100 probe, DC Coupled	<i>TDS 210</i>	<i>TDS 220 and TDS 224</i>
	60 MHz* (when vertical scale set to > 5 mV/div)	100 MHz* (when vertical scale set to > 5 mV/div)
	20 MHz* (when vertical scale set to ≤ 5 mV/div)	
Analog Bandwidth in Peak Detect mode (5 s/div to 5 μs/div), typical	<i>TDS 210</i>	<i>TDS 220 and TDS 224</i>
	50 MHz* (when vertical scale set to > 10 mV/div)	75 MHz* (when vertical scale set to > 10 mV/div)
	20 MHz* (when vertical scale set to ≤ 10 mV/div)	
Selectable Analog Bandwidth Limit, typical	20 MHz*	
Lower Frequency Limit, AC Coupled	≤10 Hz at BNC	
	≤1 Hz when using a 10X passive probe	

* **Bandwidth is not valid for the P2100 probe when the switch is set to 1X.**

Table 1-1: Specifications (cont.)

Vertical		
Rise Time at BNC, typical	<i>TDS 210</i>	<i>TDS220 and TDS 224</i>
	<5.8 ns	<3.5 ns
Peak Detect Response	Captures 50% or greater amplitude of pulses ≥ 10 ns wide (5 s/div to 5 μ s/div) in the center 6 vertical divisions. The oscilloscope reverts to Sample mode when the sec/div (Horizontal scale) setting is from 2.5 μ s/div to 5 ns/div. The Sample mode can still capture 10 ns glitches.	
✓ DC Gain Accuracy	<i>TDS210 and TDS220</i>	<i>TDS224</i>
	2 mV/div and larger, $\pm 3\%$ for Sample or Average acquisition mode	2 mV/div to 5 mV/div, $\pm 4\%$ for Sample or Average acquisition mode 10 mV/div and larger, $\pm 3\%$ for Sample or Average acquisition mode
DC Measurement Accuracy, Average Acquisition Mode	<i>Measurement Type</i>	<i>Accuracy</i>
	Average of ≥ 16 waveforms with vertical position at zero	<i>TDS224:</i> $\pm(4\% \times \text{reading} + 0.1 \text{ div} + 1 \text{ mV})$ and either 2 mV/div or 5 mV/div is selected. $\pm(3\% \times \text{reading} + 0.1 \text{ div} + 1 \text{ mV})$ and 10 mV/div or greater is selected
	Average of ≥ 16 waveforms with vertical position not at zero	<i>TDS210, TDS220 and TDS224:</i> $\pm[3\% \times (\text{reading} + \text{vertical position}) + 1\% \text{ of vertical position} + 0.2 \text{ div}]$ 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.
Delta Volts Measurement Accuracy, Average Acquisition Mode	Delta volts between any two averages of ≥ 16 waveforms acquired under same setup and ambient conditions	3% of reading + 0.05 div
P2100 passive probe	10X position	1X position
Bandwidth	DC to 100 MHz	DC to 7 MHz
Attenuation ratio	10:1	1:1
Compensation Range	18 pf-35 pf	All oscilloscopes with 1 M Ω input
Input resistance	10 M $\Omega \pm 2\%$	1 M $\Omega \pm 2\%$
Input capacitance	14.5 pf-17.5 pf	80 pf-110 pf
Maximum input voltage	300 V _{RMS} CAT I or 300 V DC CAT I 300 V _{RMS} CAT II or 300 V DC CAT II 100 V _{RMS} CAT III or 100 V DC CAT III	150 V _{RMS} CAT I or 150 V DC CAT I 150 V _{RMS} CAT II or 150 V DC CAT II 100 V _{RMS} CAT III or 100 V DC CAT III
Horizontal		
Sample Rate Range	50 S/s to 1 GS/s	
Waveform Interpolation	(sin x)/x	

Table 1-1: Specifications (cont.)

Horizontal			
Record Length	2500 samples for each channel		
SEC/DIV Range	5 ns/div to 5 s/div, in a 1, 2.5, 5 sequence		
✓ Sample Rate and Delay Time Accuracy	±100 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 + 100 ppm × reading + 0.6 ns)
	>16 averages		±(1 sample interval + 100 ppm × reading + 0.4 ns)
	Sample interval = s/div ÷ 250		
Position Range	5 ns/div to 10 ns/div	25 ns/div to 100 μs/div	250 μs/div to 5 s/div
	(-4 div × s/div) to 20 ms	(-4 div × s/div) to 50 ms	(-4 div × s/div) to 50 s
Trigger			
✓ Trigger Sensitivity, Edge Trigger Type	<i>Coupling</i>		<i>Sensitivity</i>
	DC		CH 1, CH 2, CH 3 & CH 4 1 div from DC to 10 MHz*, 1.5 div from 10 MHz* to Full
	<i>TDS 210 and TDS 220</i>		
	EXT		100 mV from DC to 10 MHz*, 150 mV from 10 MHz* to Full
	EXT/5		500 mV from DC to 10 MHz*, 750 mV from 10 MHz* to Full
Trigger Sensitivity, Edge Trigger Type, typical	<i>Coupling</i>		<i>Sensitivity</i>
	AC		Same as DC at 50 MHz and above
	NOISE REJ		Reduces DC-coupled trigger sensitivity by 2 times for > 10 mV/div to 5 V/div
	HF REJ		Same as 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>
	Internal		±8 divisions from center of screen
	<i>TDS 210 and TDS 220</i>		
	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

Table 1-1: Specifications (cont.)

Trigger		
	<i>TDS 210 and TDS 220</i>	
	EXT	$\pm(6\% \text{ of setting} + 40 \text{ mV})$
	EXT/5	$\pm(6\% \text{ of setting} + 200 \text{ mV})$
* Bandwidth is not valid for the P2100 probe when the switch is set to 1X.		
SET LEVEL TO 50%, typical	Operates with input signals $\geq 50 \text{ Hz}$	
Default Settings, Video Trigger	Trigger mode is Auto and Coupling is AC	
Sensitivity, Video Trigger Type, typical	Composite video signal	
	<i>Source</i>	<i>Range</i>
	Internal	Pk-pk amplitude of 2 divisions
	<i>TDS 210 and TDS 220</i>	
	EXT	400 mV
	EXT/5	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	
Measurements		
Cursors	Voltage difference between cursors (ΔV) Time difference between cursors (ΔT) Reciprocal of ΔT in Hertz ($1/\Delta T$)	
Automated Measurements	Cycle RMS, Mean, Pk - Pk, Period, Frequency	

Table 1-2: General specifications

Display	
Display Type	5.9 in (152 mm) diagonal liquid crystal
Display Resolution	320 horizontal by 240 vertical pixels
Display Contrast	Adjustable, temperature compensated
Backlight Intensity, typical	60 cd/m ²
Probe compensator output	
Output Voltage, typical	5 V into $\geq 1 \text{ M}\Omega$ load
Frequency, typical	1 kHz

Table 1-2: General specifications (cont.)

Power Source		
Source Voltage	100 - 120 VAC _{RMS} ± 10% from 45 Hz through 440 Hz, CAT II 120 - 250 VAC _{RMS} ± 10% from 45 Hz through 66 Hz, CAT II	
Power Consumption	<i>TDS 210 and TDS 220</i>	<i>TDS 224</i>
	Less than 20 W	Less than 25 W
Fuse	1 A, T rating, 250 V	
Environmental		
Temperature	Operating	0° C to +50° C
	Nonoperating	-20° C to +60° C
Cooling Method	Convection	
Humidity	+40° C or below	≤90% relative humidity
	+41° C to +50° C	≤60% relative humidity
Altitude	Operating	3,000 m
	Nonoperating	15,000 m
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	304.8 mm (12 in.)
	Depth	120.7 mm (4.75 in.)
Weight (approximate)	When packaged for domestic shipment	3.6 kg (8.0 lbs)

Table 1-2: General specifications (cont.)

Certifications and compliances	
EC Declaration of Conformity (TDS 210, TDS 220 & TDS 224)	Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility*; meets the requirements of FCC Code of Federal Regulations, 47 CFR, Part 15, Subpart B, Class A: CISPR 11 (Class A): Electromagnetic radiated and conducted emissions EN 50082-1 European Community Requirements: IEC 61000-4-2 electrostatic discharge IEC 61000-4-3 radiated susceptibility** IEC 61000-4-4 power line fast transients IEC 61000-4-5 power line surge immunity IEC 61000-4-6 conducted immunity to RF fields IEC 61000-4-11 voltage dips, interrupts and variations AS/NZS 2064, Australian emissions standard for Industrial, Scientific, and Medical Equipment
(TDS 210, TDS 220, TDS 224, P2100)	Low Voltage Directive 73/23/EEC as amended by 93/68/EED: EN61010-1/A2:1995 Safety requirements for electrical equipment for measurement control, and laboratory use
(P2100)	EN 61010-2-031:1994 Particular requirements for hand-held probe assemblies for electrical measurement and test
Certifications (TDS 210, TDS 220, TDS 224) (P2100)	CAN/CSA C22.2 No. 1010.1-92 UL3111-1, First Edition IEC61010-1/A2 IEC61010-2-031
CSA Certified Power Cords	CSA Certification includes the products and power cords appropriate for use in the North America power network. All other power cords supplied are approved for the country of use.
Pollution Degree 2	Do not operate in environments where conductive pollutants may be present.
Overvoltage Category	Category: Examples of Products in this Category: CAT III Distribution-level mains, fixed installation CAT II Local-level mains, appliances, portable equipment CAT I Signal levels in special equipment or parts of equipment, telecommunications, electronics

* Instrument tested with shielded cables.

** Meets Performance Criterion A with allowed degradation of up to 5 major divisions of trace noise increase from 80 MHz to 200 MHz and up to 2 divisions of trace noise increase over the range of 200 MHz to 1000 MHz under a 3 V/m RF field. Ambient RF fields may induce triggering when trigger threshold is offset less than 2.5 major divisions from ground reference.

Adjustment interval

The recommended adjustment interval is one year

Operating Information

TDS 200-Series Digital Oscilloscopes are two or four channel oscilloscopes in small, lightweight, benchtop packages that you can use to take ground-referenced measurements.

In addition to the list of general features, this chapter covers the following topics:

- How to install your product
- How to add extended functions
- How to perform a brief functional check
- How to compensate probes
- How to use the self calibration routine
- How to match your probe attenuation factor

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

General Features

- 100 MHz (TDS 220 and TDS 224) or 60 MHz (TDS 210) bandwidth with selectable 20 MHz bandwidth limit
- 1 GS/s sample rate and 2,500 point record length for each channel
- Cursors with readout
- Five automated measurements
- High-resolution, high-contrast LCD display with temperature compensation and replaceable backlight
- Setup and waveform storage
- Autoset for quick setup
- Waveform averaging and peak detection
- Digital real-time oscilloscope (at least ten-times over sampling)
- Dual time base
- Video trigger capability
- RS-232, GPIB, and Centronics communication ports easily added with optional extension modules
- Variable persistence display
- User interface available in ten user selectable languages

Installation

Power Cord Use only power cords designed for your oscilloscope. Use a power source that delivers 85 to 275 VAC_{RMS}, 47 to 63 Hz. Refer to page 10-9 for a list of available power cords.

Use the power cord notch to help route the cord to the rear of the instrument and avoid inadvertently disconnecting the power source.

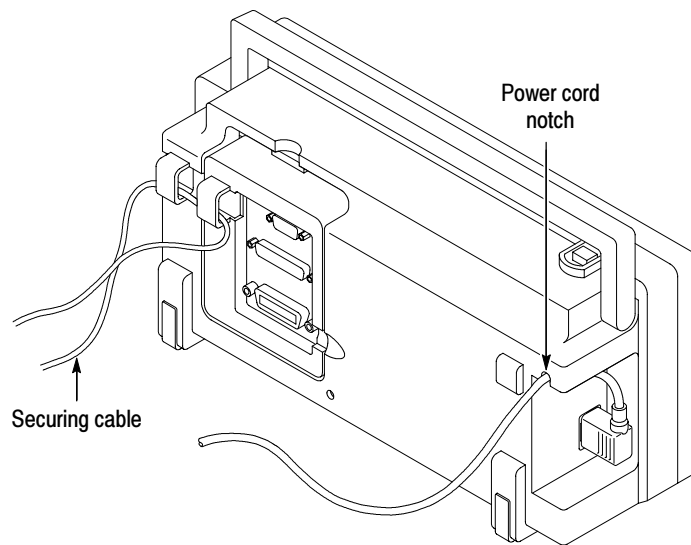


Figure 2-1: Routing the power cord and security cable

Security Loop Use the built-in cable channels to secure both your instrument 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 10-9 for information about the available modules. Figure 2-2 shows the proper way to install a module without bending the connecting pins.



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.*

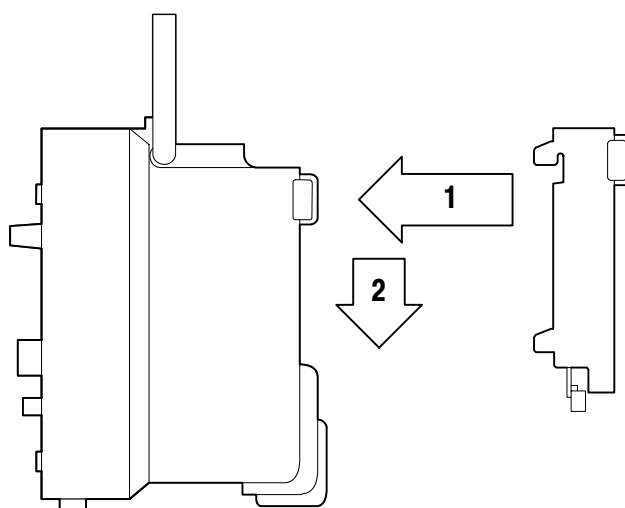
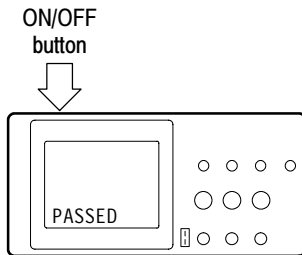


Figure 2-2: Installing an extension module

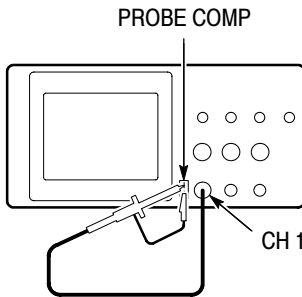
Functional Check

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



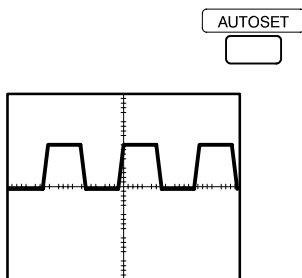
1. Turn on the instrument.

Wait until the display shows that all self tests passed. Push the **SAVE/RECALL** button, select **Setups** in the top menu box and push the **Recall Factory** menu box. The default **Probe** menu attenuation setting is **10X**.



2. Set the switch to **10X** on the **P2100** probe and connect the oscilloscope probe to channel 1. To do this, align the slot in the probe connector with the key on the **CH 1 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.

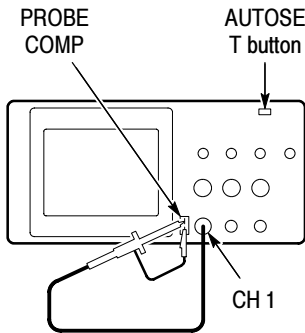


3. Push the **AUTOSET** button. Within a few seconds, you should see a square wave in the display (approximately **5 V** at **1 kHz** peak-to-peak).

Push the **CH 1 MENU** button twice to turn off channel 1, push the **CH 2 MENU** button to turn on channel 2, repeat steps 2 and 3. For **TDS 224**, repeat for **CH 3** and **CH 4**.

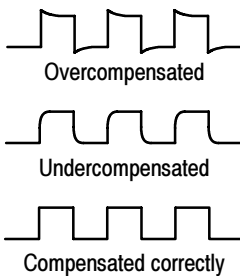
Probe Compensation

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

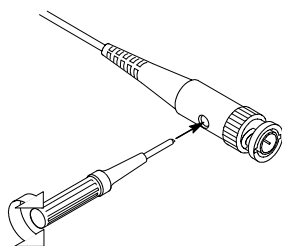


1. Set the Probe menu attenuation to 10X. Set the switch to 10X on the P2100 probe and connect the oscilloscope probe to channel 1. Attach the probe tip and reference lead to the PROBE COMP connectors and then press AUTOSET.

If using the probe hook-tip, ensure a proper connection by firmly twisting the tip onto the probe.



2. Check the shape of the displayed waveform.



3. If necessary, adjust your probe.

Repeat as necessary.

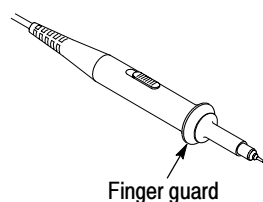
Self Calibration

The self calibration routine lets you quickly optimize the oscilloscope signal path for maximum measurement accuracy. You can run the routine at anytime 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 Do Self Cal to confirm that you are ready to proceed.

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.

To avoid electric shock while using the probe, do not touch metallic portions of the probe head while it is connected to a voltage source.

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

Probe Attenuation Setting

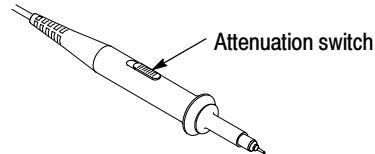
Probes are available with various attenuation factors which affect the vertical scale readout of the oscilloscope.

To change (or check) the probe attenuation setting, press the VERTICAL MENU button (of the channel you're using) and then press the menu selection next to Probe until the correct setting is displayed.

This setting remains in effect until changed again.

NOTE. The default Probe menu attenuation setting is 10X when the oscilloscope is shipped.

Be sure that the Attenuation switch on the P2100 probe is set to match the Probe menu selection in the oscilloscope. The probe switch settings are 1X and 10X.



NOTE. When the Attenuation switch is set to 1X, the P2100 probe limits the bandwidth of the oscilloscope to 7 MHz. To use the full bandwidth of the oscilloscope, be sure to set the switch to 10X.

Factory Setup

The table below lists the state of the instrument after you select Recall Factory from the SAVE/RECALL menu.

Table 2-1: Factory setup settings

Control	Setting
Acquire mode	Sample
Acquire # of averages	16
Channel selection	Channel 1 on
Cursor H Bar position	-3.2 divisions from the center
Cursor V Bar position	-2 divisions from the center
Cursor function	Off
Cursor time units	Seconds
Delayed time base time/div	50 μ s/div
Delay time, delayed runs after main	50 μ s
Display format	YT
Display graticule type	Full
Display contrast	50%
Display style	Vectors
Display accumulate time	500 ms
Edge trigger coupling	DC

Table 2-1: Factory setup settings (cont.)

Control	Setting
Edge trigger level	0.0 V
Edge trigger slope	Rising
Edge trigger source	Channel 1
Horizontal - main trigger position	50%
Horizontal - time base	Main only
Main time base time/div	500 μ s/div
Math waveform function	CH1 + CH2
Saved setups	No change
Saved waveforms	No change
Trigger holdoff	Minimum (500 ns)
Trigger mode	Auto
Trigger type	Edge
Vertical bandwidth (all channels)	Full
Vertical coupling (all channels)	DC
Vertical position (all channels)	0 div
Vertical volts/div. (all channels)	100 mV/div

Theory of Operation

This chapter describes the electrical operation of the TDS 200-Series Digital Real-Time Oscilloscope to the module level. It describes the basic operation of each functional circuit block shown in figures 3-1 and 3-2.

Main Board

The Main board contains a two or four channel acquisition system, trigger system, acquisition/display controller, and system processor. Interfaces are provided for two signal inputs, external trigger input, probe compensation, front panel, LCD display, extension module, and power supply. Acquisition and display functions are implemented in two application specific integrated circuits (ASICs).

Acquisition System

Signals from the CH 1, CH 2, and EXT TRIG, or CH 1, CH 2, CH 3, and CH 4 input connectors pass through attenuators to the acquisition ASIC. The acquisition ASIC contains amplifiers and samplers for each input channel, A/D converter, and trigger logic. The digitized waveform samples are transferred to the display ASIC. Low voltage regulators supply isolated power to the acquisition ASIC.

Display System

The display system consists of the display ASIC, DRAM memory, and system oscillator. Digitized acquisition samples are processed by the display ASIC and stored into DRAM. The Display ASIC formats the waveform data and generates drive signals for the LCD display. Front panel scanning is also performed by the display ASIC.

Processor System

The processor system consists of the microprocessor and memory. The processor system interprets the front panel controls, programs acquisition and display parameters, computes waveform measurements, and manages the extension module interface. Saved setups, waveforms, and calibration constants are stored in nonvolatile memory. The processor system shares DRAM with the display system.

Input Signal Interface

BNC connectors are mounted on the main board for the CH 1, CH 2, and trigger or CH 1, CH 2, CH 3, and CH 4 inputs. The signal inputs are compatible with the P2100 probes supplied.

Probe Compensation

The PROBE COMP and ground terminals are provided for probe adjustment.

Power Supply

The power supply module generates low voltage DC, a line trigger signal for the main board, and high voltage AC to power the LCD backlight. The power supply operates over a wide power line voltage and frequency range.

Display Module

The display module consists of a liquid crystal display (LCD), a display driver, and a florescent backlight.

Front Panel

The front panel board holds the encoders and push button contacts that the operator uses to control the instrument. An elastomer mat holds the conductive pads for the push buttons. Circuits on the front panel convert the matrix into serial data which is read by the display ASIC on the main Board.

Extension Modules

Each extension module also contains a GPIB, RS-232, and Centronics parallel printer interface. A ROM on the extension module contains processor instructions to support the communications interfaces. Extension modules interface with the processor system through the extension module port connector.

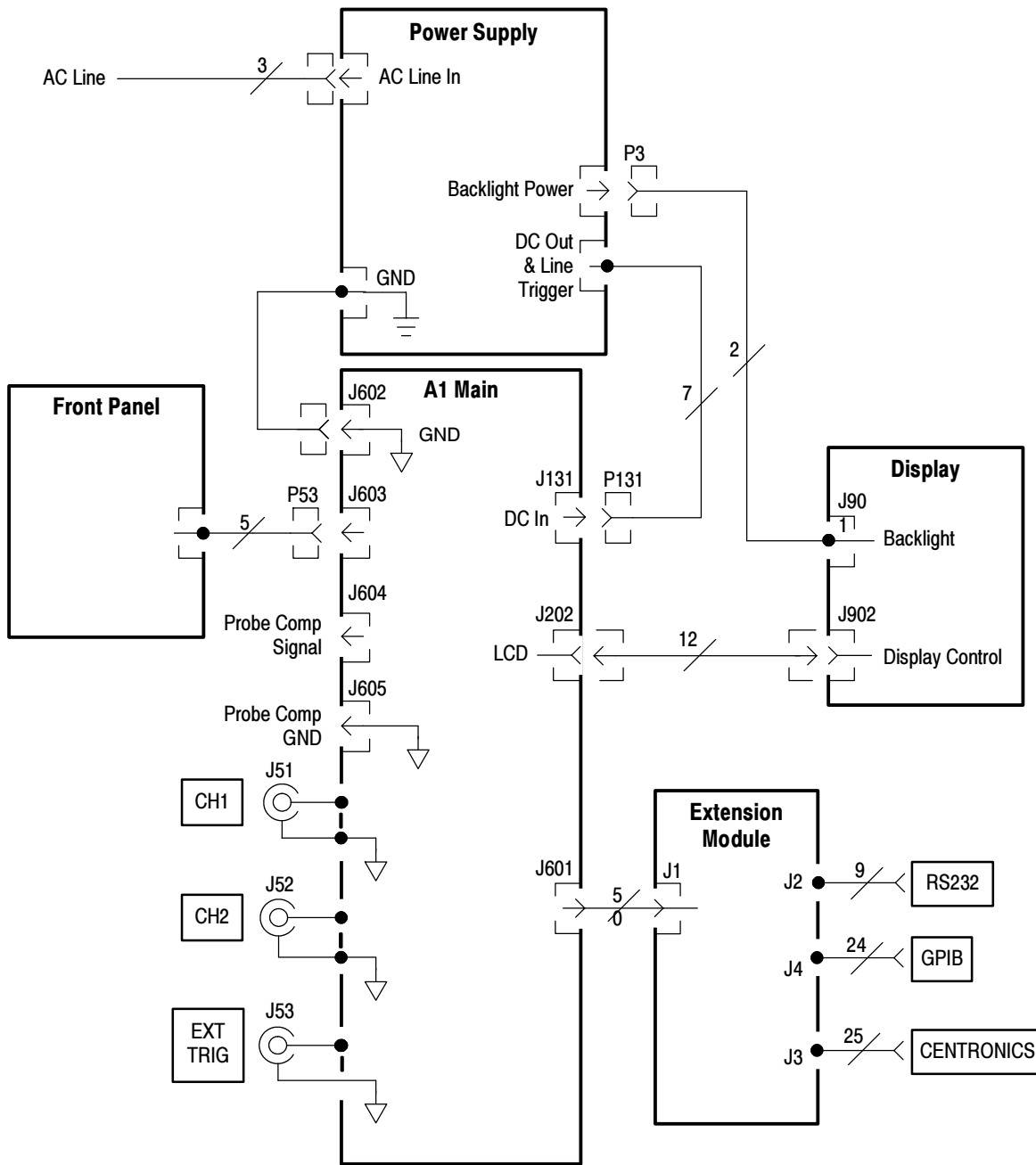


Figure 3-1: Module-level block diagram (two channel)

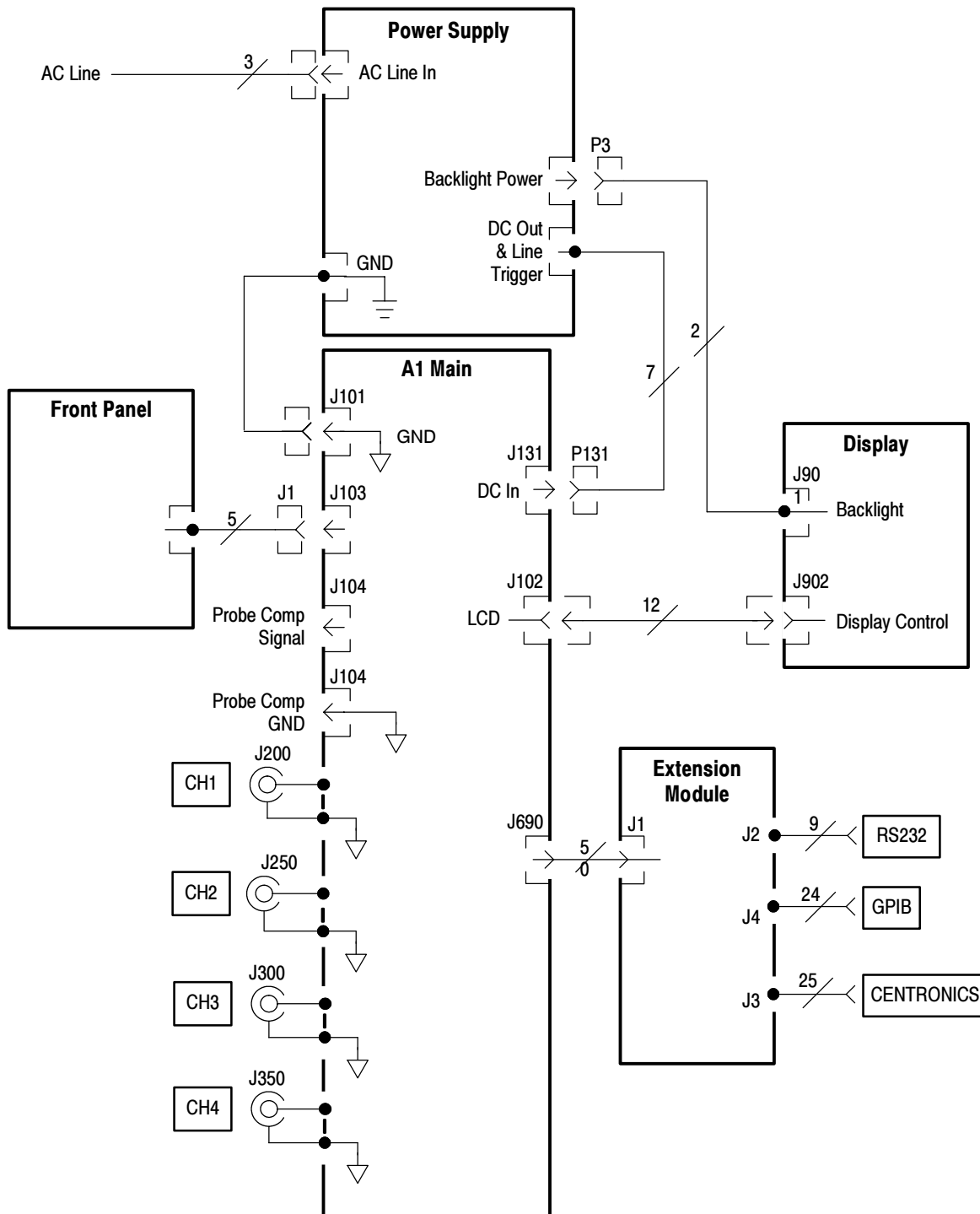


Figure 3-2: Module-level block diagram (four channel)

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.

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)
Leveled Sine Wave Generator	50 kHz and 100 MHz, $\pm 3\%$ amplitude accuracy	Fluke 5500A Multi-product Calibrator with Oscilloscope Calibration Option (Option 5500A-SC)
Time Mark Generator	10 ms period, ± 25 ppm accuracy	
50 Ω BNC Cable	BNC male to BNC male, ≈ 36 in (1 m) long	Tektronix part number 012-0482-00
50 Ω BNC Cable	BNC male to BNC male, ≈ 10 in (25 cm) long	Tektronix part number 012-0208-00
50 Ω Feedthrough Termination	BNC male and female connectors	Tektronix part number 011-0049-01
Dual Banana to BNC Adapter	Banana plugs to BNC female	Tektronix part number 103-0090-00
BNC T Adapter	BNC male to dual BNC female connectors	Tektronix part number 103-0030-00

Test Record

Serial number	Procedure performed by	Date

Test	Passed	Failed
Self Test		

Oscilloscope tests	Low limit	Test result	High limit
DC Gain Accuracy, TDS210 & TDS220			
Channel 1	5 mV/div	34.0 mV	36.0 mV
	200 mV/div	1.358 V	1.442 V
	2 V/div	13.58 V	14.42 V
Channel 2	5 mV/div	34.0 mV	36.0 mV
	200 mV/div	1.358 V	1.442 V
	2 V/div	13.58 V	14.42 V

DC Gain Accuracy, TDS224			
Channel 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 2	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	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	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

Oscilloscope tests	Low limit	Test result	High limit
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 ¹	Stable trigger		—

¹ Channels 3 and 4 are only on four channel instruments, and External Edge trigger is only on two channel instruments.

Performance Verification Procedures

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

- The instrument 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 instrument 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 anytime 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 channel 1 and channel 2 input connectors.
2. Press the UTILITY button and select Do Self Cal to start the routine. The routine takes approximately one minute to complete.
3. Verify that Self calibration passed.

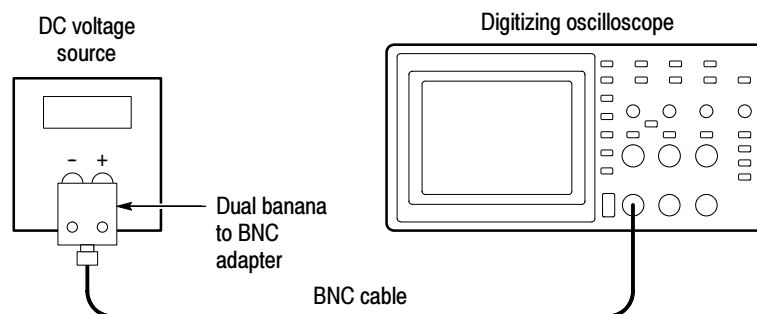
Check DC Gain Accuracy

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 instrument using the following steps:

Press menu button	Select menu item	Select setting
SAVE/ RECALL	Recall Factory	—
CH 1	Probe	1X
ACQUIRE	Average	16
MEASURE	Source	An unchecked channel
	Type	Mean

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



4. For each VOLTS/DIV setting listed in the table at the top of page 4-6, 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 $V_{\text{diff}} = V_{\text{pos}} - V_{\text{neg}}$ 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}
TDS210 & TDS220		
5 mV/div	+17.5 mV, -17.5 mV	34.0 mV to 36.0 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
TDS224		
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.

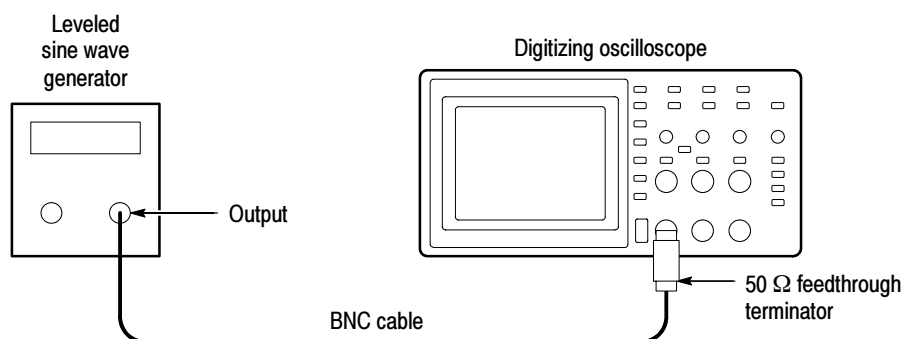
Check Bandwidth

This test checks the bandwidth of all input channels.

1. Set up the instrument using the following steps:

Press menu button	Select menu item	Select setting
SAVE/ RECALL	Recall Factory	—
CH 1	Probe	1X
ACQUIRE	Average	16
TRIGGER	Coupling	Noise Reject
MEASURE	Source	An unchecked channel
	Type	Pk-Pk

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



- Set the instrument VOLTS/DIV to **500 mV/div**.
- Set the instrument SEC/DIV to **10 μs/div**.
- Set the leveled sine wave generator frequency to **50 kHz**.
- Set the leveled sine wave generator output level so the peak-to-peak measurement is between **2.98 V** and **3.02 V**.
- Set the leveled sine wave generator frequency to **60 MHz** if you are checking a TDS 210 or to **100 MHz** if you are checking a TDS 220 or TDS 224.
- Set the instrument SEC/DIV to **10 ns/div**.
- Check that the peak-to-peak measurement is **≥2.12 V**.
- Disconnect the test setup.
- Repeat steps 1 through 10 until all input channels have been checked.

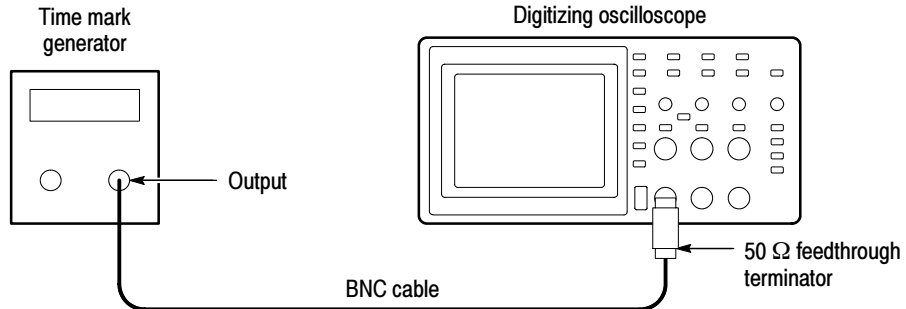
Check Sample Rate and Delay Time Accuracy

This test checks the time base accuracy.

- Set up the instrument using the following steps:

Press menu button	Select menu item	Select setting
SAVE/ RECALL	Recall Factory	—
CH 1	Probe	1X

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



3. Set the time mark generator period to **10 ms**.
4. Set the instrument VOLTS/DIV to **500 mV/div**.
5. Set the instrument 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. Change the instrument setup using the following steps:

Press menu button	Select menu item	Select setting
HORIZONTAL	Window	—

9. Set the instrument Window SEC/DIV to **500 μs/div**.

NOTE. Setting the Window SEC/DIV to a setting slower than the Main SEC/DIV setting resets the main timebase. If this happens, reset the Main SEC/DIV and then the Window SEC/DIV settings.

10. Use the horizontal POSITION control to set the window position to 10.00 ms.
11. Set the instrument Window SEC/DIV to **500 ns/div**.
12. 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 50 ppm time base error.

13. Disconnect the test setup.

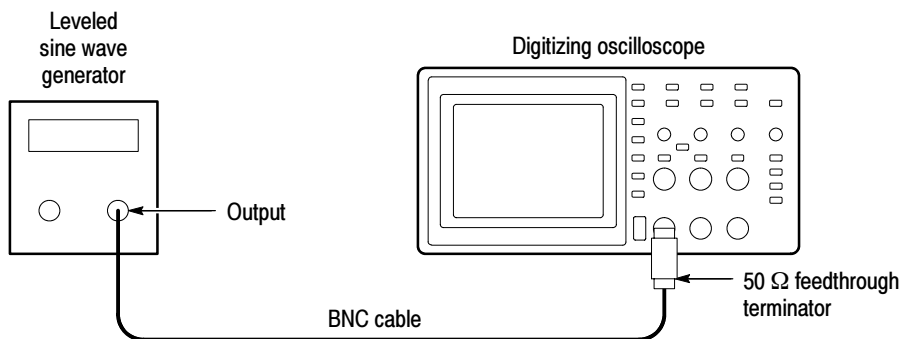
Check Edge Trigger Sensitivity

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

1. Set up the instrument using the following steps:

Press menu button	Select menu item	Select setting
SAVE/ RECALL	Recall Factory	—
CH 1	Probe	1X
TRIGGER	Mode	Normal
ACQUIRE	Sample	—
MEASURE	Source	An unchecked channel
	Type	Pk-Pk

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



- Set the leveled sine wave generator frequency to **60 MHz** if you are checking a TDS 210 or to **100 MHz** if you are checking a TDS 220 or TDS 224.
- Set the instrument VOLTS/DIV to **500 mV/div**.
- Set the instrument SEC/DIV to **10 ns/div**.
- 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.)

7. Press **SET LEVEL TO 50%**. Adjust **TRIGGER LEVEL** as necessary and then check that triggering is stable.

8. Change the instrument setup using the following steps:

Press menu button	Select menu item	Select setting
TRIGGER	Slope	Falling

9. Press **SET LEVEL TO 50%**. Adjust **TRIGGER LEVEL** as necessary and then check that triggering is stable.

10. Change the instrument setup using the following steps:

Press menu button	Select menu item	Select setting
TRIGGER	Slope	Rising

11. Disconnect the test setup.

12. Repeat steps 1 through 11 until all input channels have been checked.

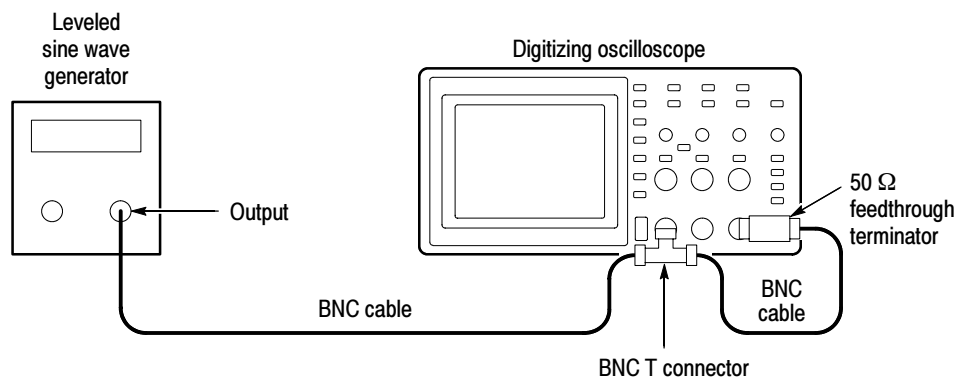
Check External Edge Trigger Sensitivity

TDS 210 and TDS 220 only: this test checks the edge trigger sensitivity for the external trigger.

1. Set up the instrument using the following steps:

Press menu button	Select menu item	Select setting
SAVE/ RECALL	Recall Factory	—
CH 1	Probe	1X
TRIGGER	Source	Ext
	Mode	Normal
ACQUIRE	Sample	—
MEASURE	Source	CH1
	Type	Pk-Pk

- Connect the instrument to the leveled sine wave generator as shown below.



- Set the leveled sine wave generator frequency to **60 MHz** if you are checking a TDS 210 or to **100 MHz** if you are checking a TDS 220.
- Set the instrument VOLTS/DIV to **500 mV/div**.
- Set the instrument SEC/DIV to **10 ns/div**.
- 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.)
- Press **SET LEVEL TO 50%**. Adjust **TRIGGER LEVEL** as necessary and then check that triggering is stable.
- Change the instrument setup using the following steps:

Press menu button	Select menu item	Select setting
TRIGGER	Slope	Falling

- Press **SET LEVEL TO 50%**. Adjust **TRIGGER LEVEL** as necessary and then check that triggering is stable.
- Change the instrument setup using the following steps:

Press menu button	Select menu item	Select setting
TRIGGER	Slope	Rising

- Disconnect the test setup.

Adjustment Procedures

This chapter contains adjustment procedures for the TDS 200-Series Digital Real-Time Oscilloscope.

Only qualified personnel should perform service procedures. Read the *Service Safety Summary* and the *General Safety Summary* before performing any service procedures. Also refer to the chapter *Operating Information* for information about using the TDS 200s.

NOTE. *The voltage references inside the TDS 200s are very stable over time and should not require routine updates. Before performing any procedure in this chapter, first verify that the instrument does not meet specifications. Refer to the chapter Performance Verification to verify the specifications.*

Required Equipment

The following equipment, 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	50 kHz and 100 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, ≈ 36 in (1 m) long	Tektronix part number 012-0482-00
50 Ω BNC Cable (two)	BNC male to BNC male, ≈ 10 in (25 cm) long	Tektronix part number 012-0208-00
50 Ω Feedthrough Termination	BNC male and female connectors	Tektronix part number 011-0049-01
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 55 steps. Each step requires an external voltage source for new calibration constants.

Before performing the adjustment procedure, you must warm up the instrument 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.

The equipment setups, shown in Figure 5-2, are required to complete the adjustment procedure. Tables 5-2 and 5-3 list 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. With the instrument on, insert a narrow object such as a plastic alignment tool into the access hole, shown in Figure 5-1, until you feel the click of the momentary button. Hold this button in and press the front panel UTILITY button.

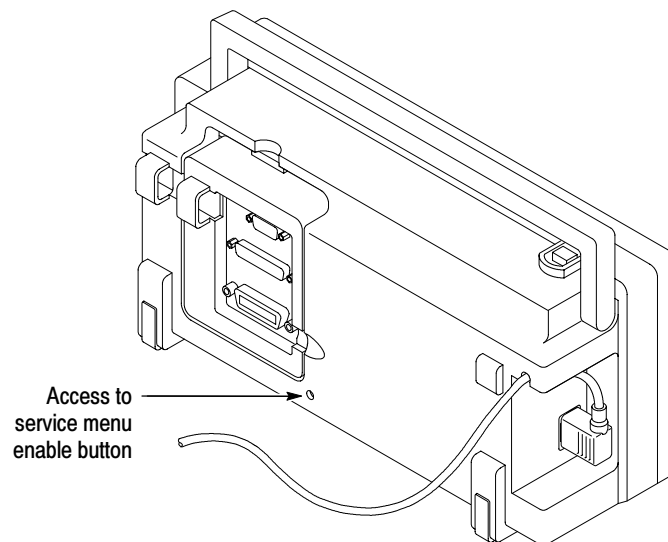
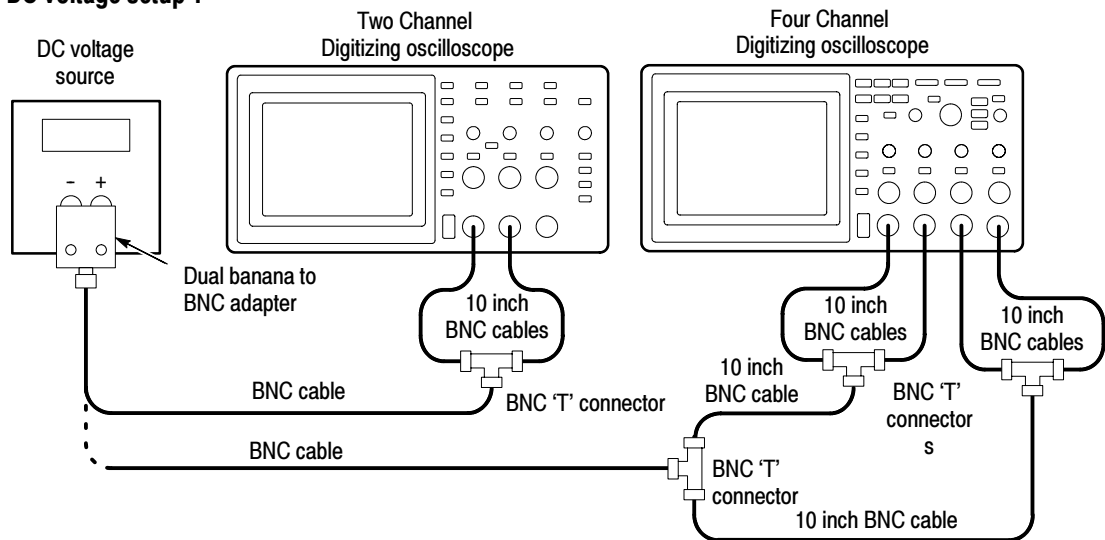


Figure 5-1: Service menu enable button

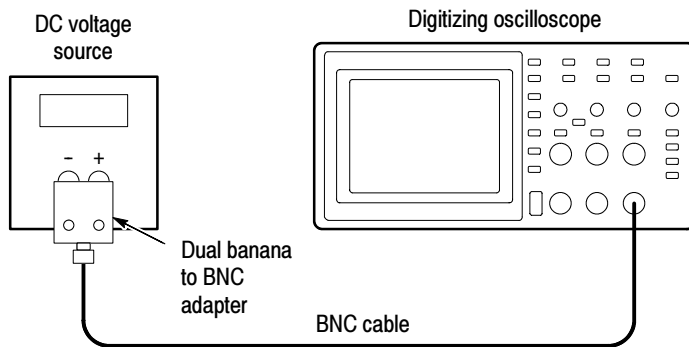
A Service menu selection replaces the Language menu selection, giving you access to the service routines.

After adjustment is complete, disable the service menu by again holding in the internal momentary button and pressing the front panel UTILITY button.

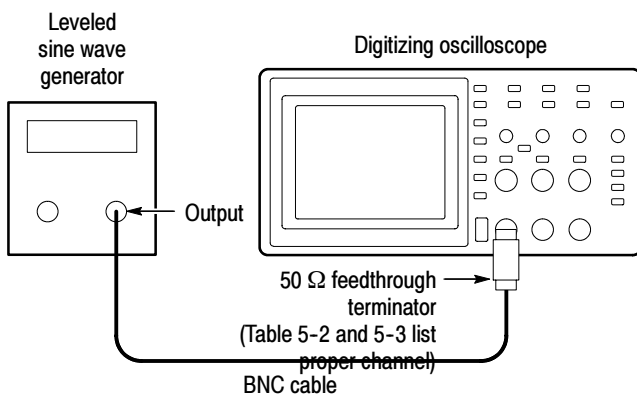
DC voltage setup 1



DC voltage setup 2



Sinewave generator setup



Edge setup

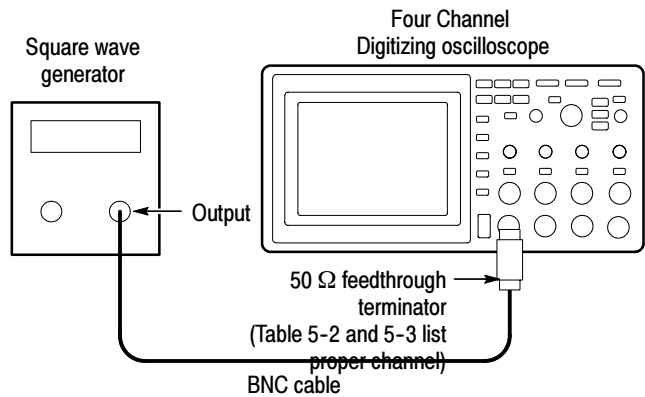


Figure 5-2: Adjustment setups

Adjustment Procedure

Use this procedure to load new calibration constants.

1. Turn on the instrument and let it warm up for at least ten minutes.
2. Enable the Service menu as described on Page 5-2.
3. Press the UTILITY button and select Service from the menus.
4. Select FCAL INIT to initiate the factory calibration routine. You are now in step 1 of the procedure.
5. As indicated by Step 1 in Table 5-2 on page 5-5 (TDS 210 and TDS 220) or Table 5-3 on page 5-7 (TDS 224), connect a 0.0 VDC source to the channel inputs.
6. Press FCAL STEP to load the calibration constant for step 1.
7. Follow the screen prompts along with Table 5-2 on page 5-5 (TDS 210 and TDS 220) or Table 5-3 on page 5-7 (TDS 224) for the remainder of the routine, applying the proper signal for each step.

NOTE. *During some steps, the instrument may appear to be idle for several minutes while it is processing information internally. Please have patience.*

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.

8. 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.
9. Disable the Service menu option.

Table 5-2: TDS 210 and TDS 220 Adjustment steps

Step: Firmware Below V 2.00	Step Firmware V 2.00 and Up	Equipment setup	Signal source setting	Input
1	1	DC Voltage 1	0.0 V	CH1 & CH2
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	
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	

Table 5-2: TDS 210 and TDS 220 Adjustment steps (cont.)

Step: Firmware Below V 2.00	Step Firmware V 2.00 and Up	Equipment setup	Signal source setting	Input
35	35	Sinewave Generator, 50 Ohm	5 kHz, 1 V _{p-p}	CH1
36	36	Sinewave Generator, 50 Ohm	1 MHz, 1 V _{p-p}	
37	37	Sinewave Generator, 50 Ohm	50 kHz, 1 V _{p-p}	
38	38	Sinewave Generator, 50 Ohm	20 MHz, 1 V _{p-p}	
39	39	Sinewave Generator, 50 Ohm	TDS 210: 60 MHz, 1 V _{p-p}	
			TDS 220: 100 MHz, 1 V _{p-p}	
40	40	Sinewave Generator, 50 Ohm	5 kHz, 2.5 V _{p-p}	
41	41	Sinewave Generator, 50 Ohm	1 MHz, 2.5 V _{p-p}	
42	42	Sinewave Generator, 50 Ohm	50 kHz, 2.5 V _{p-p}	
43	43	Sinewave Generator, 50 Ohm	20 MHz, 2.5 V _{p-p}	
44	44	Sinewave Generator, 50 Ohm	TDS 210: 60 MHz, 2.5 V _{p-p}	
			TDS 220: 100 MHz, 2.5 V _{p-p}	
45	45	Sinewave Generator, 50 Ohm	TDS 210: 60 MHz, 2.5 V _{p-p}	
			TDS 220: 100 MHz, 2.5 V _{p-p}	
None	46	Edge, 50 Ohm	1 kHz, 0 to -800 mV	
46	47	Sinewave Generator, 50 Ohm	5 kHz, 1 V _{p-p}	CH2
47	48	Sinewave Generator, 50 Ohm	1 MHz, 1 V _{p-p}	
48	49	Sinewave Generator, 50 Ohm	50 kHz, 1 V _{p-p}	
49	50	Sinewave Generator, 50 Ohm	20 MHz, 1 V _{p-p}	
50	51	Sinewave Generator, 50 Ohm	TDS 210: 60 MHz, 1 V _{p-p}	
			TDS 220: 100 MHz, 1 V _{p-p}	
51	52	Sinewave Generator, 50 Ohm	5 kHz, 2.5 V _{p-p}	
52	53	Sinewave Generator, 50 Ohm	1 MHz, 2.5 V _{p-p}	
53	54	Sinewave Generator, 50 Ohm	50 kHz, 2.5 V _{p-p}	
54	55	Sinewave Generator, 50 Ohm	20 MHz, 2.5 V _{p-p}	
55	56	Sinewave Generator, 50 Ohm	TDS 210: 60 MHz, 2.5 V _{p-p}	
			TDS 220: 100 MHz, 2.5 V _{p-p}	

Table 5-3: TDS 224 Adjustment steps

Step	Equipment setup	Signal source setting	Input
1	DC Voltage 1	0.0 V	CH1, CH2, CH3 & CH4
2	DC Voltage 1	-20.0 V	
3	DC Voltage 1	-2.0 V	
4	DC Voltage 1	-1.6 V	
5	DC Voltage 1	-1.2 V	
6	DC Voltage 1	-0.8 V	
7	DC Voltage 1	-0.4 V	
8	DC Voltage 1	-0.32 V	
9	DC Voltage 1	-0.2 V	
10	DC Voltage 1	-0.16 V	
11	DC Voltage 1	-0.08 V	
12	DC Voltage 1	-0.04 V	
13	DC Voltage 1	-0.03 V	
14	DC Voltage 1	-0.02 V	
15	DC Voltage 1	-0.015 V	
16	DC Voltage 1	0.015 V	
17	DC Voltage 1	0.02 V	
18	DC Voltage 1	0.03 V	
19	DC Voltage 1	0.04 V	
20	DC Voltage 1	0.08 V	
21	DC Voltage 1	0.16 V	
22	DC Voltage 1	0.2 V	
23	DC Voltage 1	0.32 V	
24	DC Voltage 1	0.4 V	
25	DC Voltage 1	0.8 V	
26	DC Voltage 1	1.2 V	
27	DC Voltage 1	1.6 V	
28	DC Voltage 1	2.0 V	
29	DC Voltage 1	20.0 V	
30	DC Voltage 1	0.0 V	

Table 5-3: TDS 224 Adjustment steps (cont.)

Step	Equipment setup	Signal source setting	Input
31	Sinewave Generator, 50 Ohm	5 kHz, 1 V _{p-p}	CH1
32	Sinewave Generator, 50 Ohm	1 MHz, 1 V _{p-p}	
33	Sinewave Generator, 50 Ohm	50 kHz, 1 V _{p-p}	
34	Sinewave Generator, 50 Ohm	20 MHz, 1 V _{p-p}	
35	Sinewave Generator, 50 Ohm	100 MHz, 1 V _{p-p}	
36	Sinewave Generator, 50 Ohm	5 kHz, 2.5 V _{p-p}	
37	Sinewave Generator, 50 Ohm	1 MHz, 2.5 V _{p-p}	
38	Sinewave Generator, 50 Ohm	50 kHz, 2.5 V _{p-p}	
39	Sinewave Generator, 50 Ohm	20 MHz, 2.5 V _{p-p}	
40	Sinewave Generator, 50 Ohm	100 MHz, 2.5 V _{p-p}	
41	Sinewave Generator, 50 Ohm	77.133 MHz, 1 V _{p-p}	
42	Edge, 50 Ohm	1 kHz, 0 to -800 mV	
43	Sinewave Generator, 50 Ohm	5 kHz, 1 V _{p-p}	
44	Sinewave Generator, 50 Ohm	1 MHz, 1 V _{p-p}	
45	Sinewave Generator, 50 Ohm	50 kHz, 1 V _{p-p}	
46	Sinewave Generator, 50 Ohm	20 MHz, 1 V _{p-p}	
47	Sinewave Generator, 50 Ohm	100 MHz, 1 V _{p-p}	
48	Sinewave Generator, 50 Ohm	5 kHz, 2.5 V _{p-p}	
49	Sinewave Generator, 50 Ohm	1 MHz, 2.5 V _{p-p}	
50	Sinewave Generator, 50 Ohm	50 kHz, 2.5 V _{p-p}	
51	Sinewave Generator, 50 Ohm	20 MHz, 2.5 V _{p-p}	
52	Sinewave Generator, 50 Ohm	100 MHz, 2.5 V _{p-p}	
53	Sinewave Generator, 50 Ohm	5 kHz, 1 V _{p-p}	CH3
54	Sinewave Generator, 50 Ohm	1 MHz, 1 V _{p-p}	
55	Sinewave Generator, 50 Ohm	50 kHz, 1 V _{p-p}	
56	Sinewave Generator, 50 Ohm	20 MHz, 1 V _{p-p}	
57	Sinewave Generator, 50 Ohm	100 MHz, 1 V _{p-p}	
58	Sinewave Generator, 50 Ohm	5 kHz, 2.5 V _{p-p}	
59	Sinewave Generator, 50 Ohm	1 MHz, 2.5 V _{p-p}	
60	Sinewave Generator, 50 Ohm	50 kHz, 2.5 V _{p-p}	
61	Sinewave Generator, 50 Ohm	20 MHz, 2.5 V _{p-p}	
62	Sinewave Generator, 50 Ohm	100 MHz, 2.5 V _{p-p}	
63	Sinewave Generator, 50 Ohm	77.133 MHz, 1 V _{p-p}	
64	Edge, 50 Ohm	1 kHz, 0 to -800 mV	

Table 5-3: TDS 224 Adjustment steps (cont.)

Step	Equipment setup	Signal source setting	Input
65	Sinewave Generator, 50 Ohm	5 kHz, 1 V _{p-p}	CH4
66	Sinewave Generator, 50 Ohm	1 MHz, 1 V _{p-p}	
67	Sinewave Generator, 50 Ohm	50 kHz, 1 V _{p-p}	
68	Sinewave Generator, 50 Ohm	20 MHz, 1 V _{p-p}	
69	Sinewave Generator, 50 Ohm	100 MHz, 1 V _{p-p}	
70	Sinewave Generator, 50 Ohm	5 kHz, 2.5 V _{p-p}	
71	Sinewave Generator, 50 Ohm	1 MHz, 2.5 V _{p-p}	
72	Sinewave Generator, 50 Ohm	50 kHz, 2.5 V _{p-p}	
73	Sinewave Generator, 50 Ohm	20 MHz, 2.5 V _{p-p}	
74	Sinewave Generator, 50 Ohm	100 MHz, 2.5 V _{p-p}	

Maintenance

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

- *Preparation* refers you to important information contained elsewhere in this manual.
- *Preventing ESD* provides general information on preventing damage to internal modules when doing maintenance.
- *Inspection and Cleaning* provides procedures for inspecting the instrument and cleaning its external and internal modules.
- *Removal and Installation Procedures* provide 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* before performing any service procedures. Also refer to the chapter *Operating Information* for information about using the oscilloscope.

Preventing ESD

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



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

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

3. Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these modules. Do service of static-sensitive modules only at a static-free work station.
4. Nothing capable of generating or holding a static charge should be allowed on the work station surface.
5. Handle circuit boards by the edges when possible.
6. Do not slide the modules over any surface.
7. 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 instrument. Inspection and cleaning are done as preventive maintenance. Preventive maintenance, when done regularly, may prevent malfunctions and enhance reliability.

Preventive maintenance consists of visually inspecting and cleaning the instrument, and using general care when operating it. How often to do maintenance depends on the severity of the environment in which the instrument is used. A proper time to perform preventive maintenance is just before adjustment of the instrument.

General Care

Protect the instrument from adverse weather conditions. The instrument is not waterproof.

Do not store or leave the instrument where the liquid crystal display (LCD) will be exposed to direct sunlight for long periods of time.

The front and back cases help keep dust out of the instrument and must be in place during normal operation.



CAUTION. *To avoid damage to the instrument or probes, do not expose it to any sprays, liquids, or solvents.*

Inspection and Cleaning Procedures

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

Inspection — Exterior. Inspect the outside of the instrument for damage, wear, and missing parts. Instruments 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 instrument.

Cleaning Procedure — Exterior. To clean the instrument exterior and probes, perform the following steps:

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



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

Inspection — Interior. During normal use, the instrument case guards the internal components against common dust and dirt. However, if it appears that the instrument may have been damaged or has been exposed to an unusually dirty environment, you should inspect and clean the interior.

To inspect and clean the interior, disassemble the instrument by completing each of the disassembly procedures in the order given starting on page 6-12.

Inspect the internal portions of the instrument for damage and wear using Table 6-1 as a guide. Defects found should be repaired immediately.

Table 6-1: Internal inspection check list

Item	Inspect for	Repair action
Front and Back Case	Cracks or deformations. Scratched lettering or display filter. Loose connectors or labels.	Repair or replace defective hardware.
Gasket and Foam Pads	Misplaced or missing pieces.	Relocate or replace defective pieces.

Table 6-1: Internal inspection check list (cont.)

Item	Inspect for	Repair action
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 instrument 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 rinse 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 instrument except the Display Module may be spray washed using a solution of 75% isopropyl alcohol. Proceed with 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. There is no periodic lubrication 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:

- *Tools Required* on page 6-6 describes the tools needed to perform the procedures.
- *List of Modules* on page 6-6 describes where to locate a list of replaceable modules.
- *Summary of Procedures* on page 6-7 lists the procedures for removal and installation of modules.
- *Rear Feet*, on page 6-8, begins a series of procedures that describe the removal and installation of modules.

Preparation

Please read the following warning statement. Then read the following general instructions before removing a module.



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 instrument.

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

1. Use Figure 10-1 (the exploded view of the instrument) on page 10-8 to give you an overview of how the entire instrument is assembled.
2. Read the *Summary of Procedures* on page 6-7 to understand which procedure to use to access a given module. Then read *Tools Required* on page 6-6 for a list of tools needed to remove and install modules in the oscilloscope.
3. If you are disassembling the oscilloscope for cleaning, refer to the *Inspection and Cleaning* procedure on page 6-3 for cleaning instructions.

Tools Required You will need the following tools to remove and replace all the modules in the oscilloscope.

Tools

Torque-limiting screwdriver, 12 in lb (1.3 N · m) range with Torx® T-15 tip

Screwdriver with ¼ inch flat blade

Pliers

Sharp knife (X-ACTO® knife or equivalent)

List of Modules The *Mechanical Parts List* chapter 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

Table 6-2 lists all procedures in order of increasing complexity. Complete disassembly is best achieved by following the procedures in the order given.

Table 6-2: List of procedures

Procedure	Begins on Page
Rear Feet	6-8
Front-Case Label	6-10
Rear-Case Label	6-11
Handle	6-12
Power Button	6-13
Rear Case	6-14
Front Feet	6-16
EMI Clips	6-17
Flip Stand	6-18
Power Line Fuse	6-20
Power Supply Module	6-21
Front Panel Knobs	6-23
Internal Assembly	6-24
Main Board Module	6-26
Display Module	6-28
Front Panel Module	6-30
Keypad	6-33
Display Shield	6-35
Front Case	6-37

Rear Feet No tools are required to remove the feet.

Removal. Use this procedure to remove the rear feet.

1. Place the instrument face down on a soft surface (such as an anti-static mat).
2. Slide the feet up and out of the rear case as shown in Figure 6-1.

NOTE. You may want to use a flat blade screwdriver to pry up on the foot. Use care not to mar the surface of the rear case.

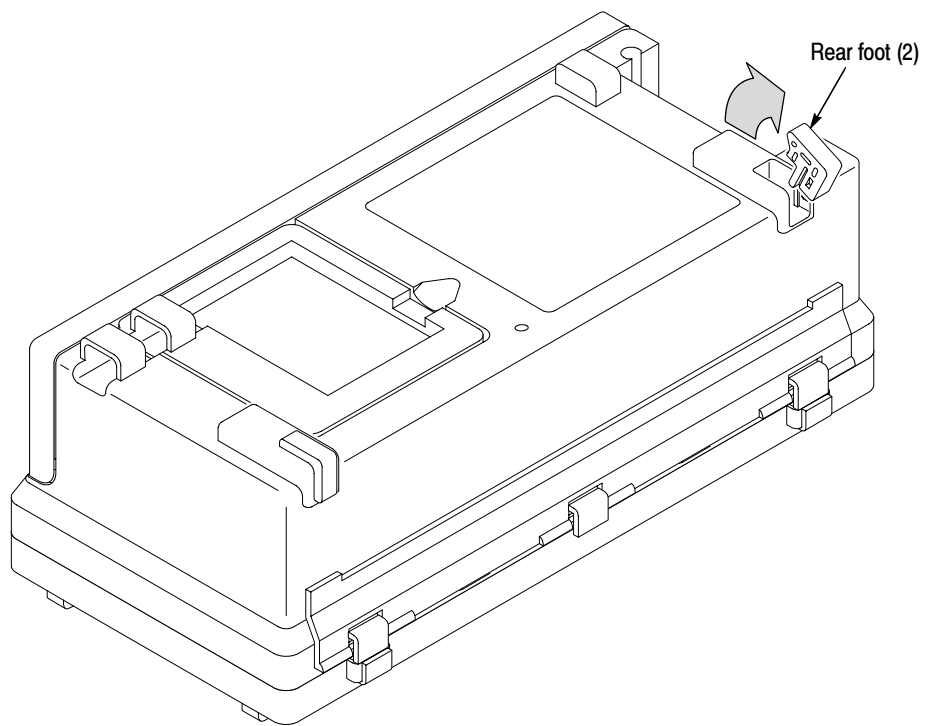


Figure 6-1: Removing the rear feet

Installation. Use this procedure to install the feet.

1. Place the rear case 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 as shown in Figure 6-2 and press the foot in.

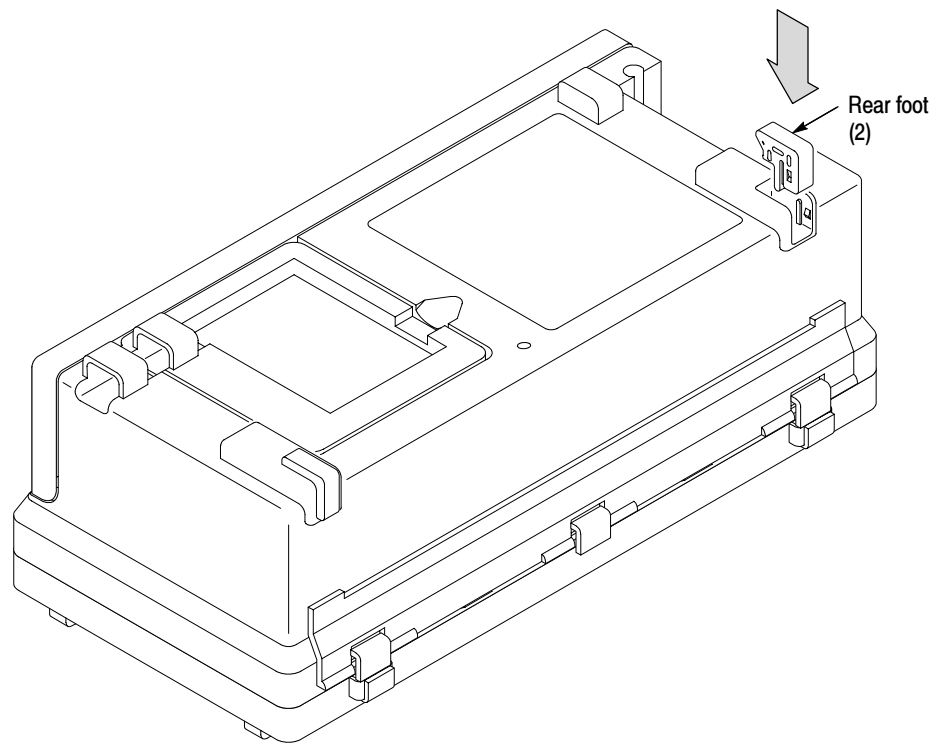


Figure 6-2: Installing the rear feet

Front-Case Label

You will need a sharp knife and needle-nose pliers to remove the front-case label.



CAUTION. Removal of a front-case label will destroy it. Do not remove it unless it needs to be replaced.

Removal. Use the sharp knife to pry up a corner of the label and use the pliers to peel the label off.

Installation. Use this procedure to install a new front-panel label in either a new or the existing front case.

1. Peel the paper off the back side of the new label.
2. Handling the label by its edges only, align it with the recess in the front case as shown in Figure 6-3.
3. When properly aligned, press the new label into place.

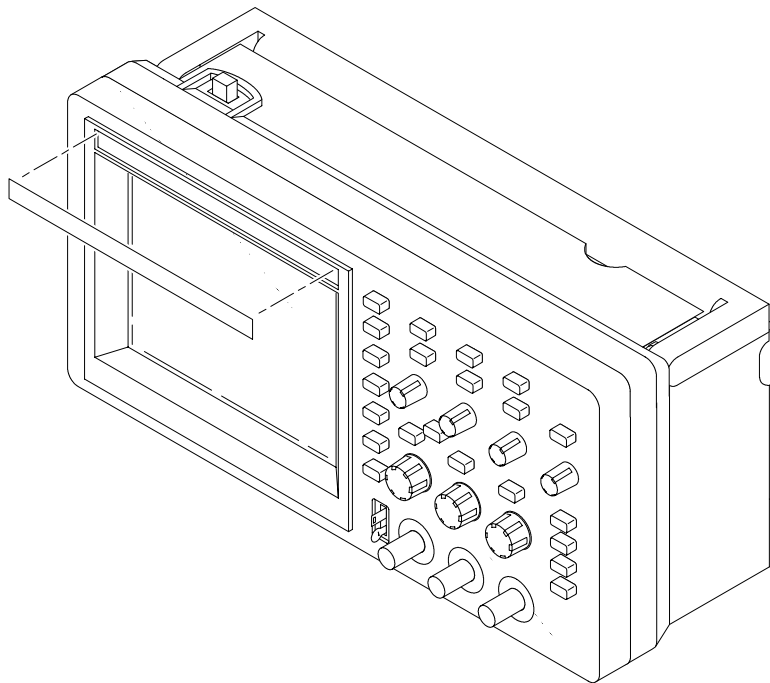


Figure 6-3: Installing a front-case label

Rear-Case Label

You will need a sharp knife and needle-nose pliers to remove the rear-case label.



CAUTION. Removal of a rear-case label will destroy it. Do not remove it unless it needs to be replaced.

Removal. Use the sharp knife to pry up a corner of the label and use the pliers to peel the label off.

Installation. Use this procedure to install a new rear-case label in either a new or the existing rear case.

1. Peel the paper off the back side of the new label.
2. Handling the label by its edges only, align it with the recess in the rear case as shown in Figure 6-4.
3. When properly aligned, press the new label into place.

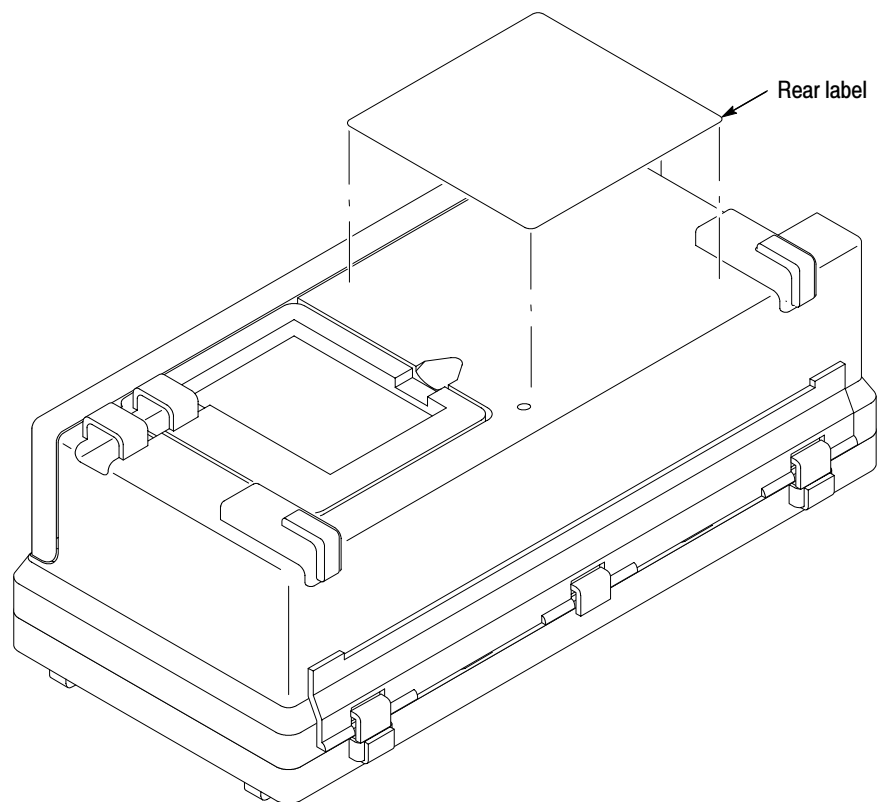


Figure 6-4: Installing a new rear-case label

Handle You will need a flat-blade screw driver to remove the handle.

Removal. Use this procedure to remove the handle.

1. Place the instrument on its feet.
2. With the handle laying down, pry one end of the handle out of the case as shown in Figure 6-5.

NOTE. Use care not to mar the surface with the screwdriver.

3. Slide the handle towards the back of the rear case.

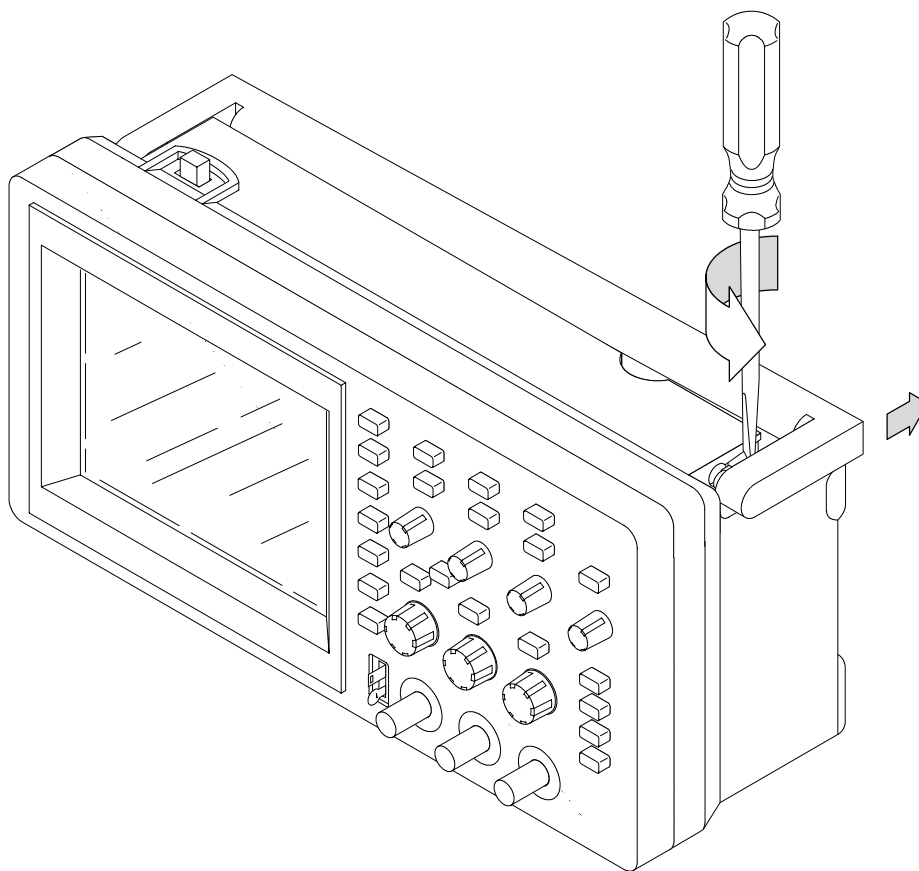


Figure 6-5: Removing the handle

Installation. Use this procedure to install the handle.

1. Place the instrument on its feet.
2. From behind the rear case with the handle laying down, slide the handle along the groves in the case until the handle snaps into place as shown in Figure 6-6.

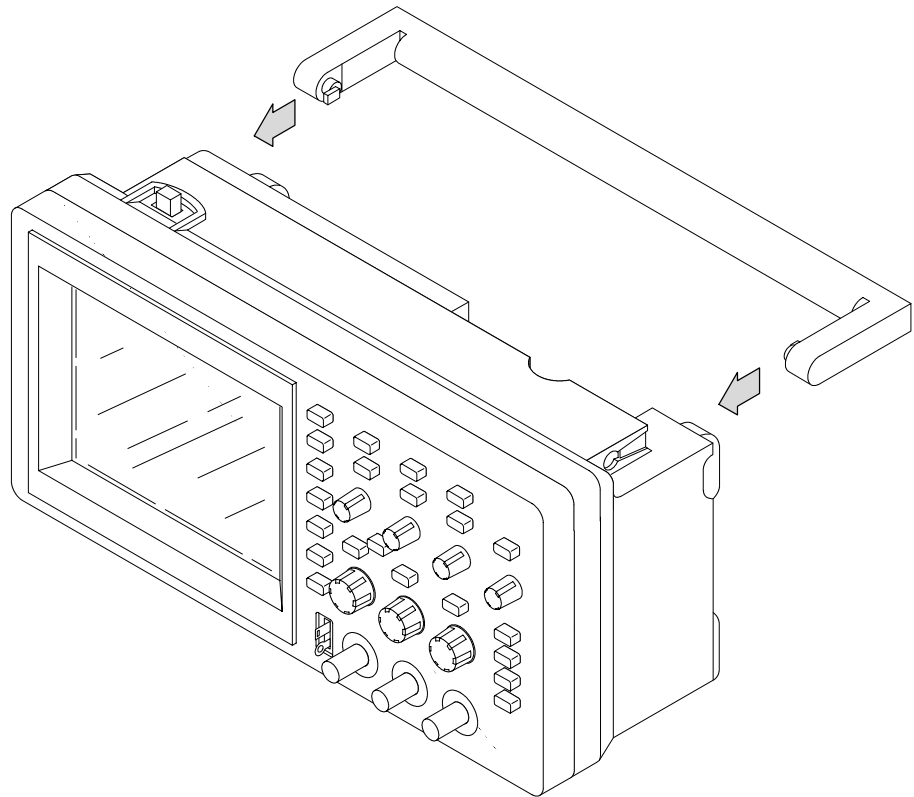


Figure 6-6: Installing the handle

Power Button

Remove the power button by firmly grasping the button (with pliers if necessary) and pull it straight out of the cabinet. Reinstall the button by pressing it onto the power button shaft until it snaps into place.

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

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

Removal. First remove the handle and power button using the procedures on pages 6-12 and 6-13, then use this procedure to remove the rear case.

1. If installed, remove the extension module from the rear of the instrument.



CAUTION. Do not remove the rear case with an extension module installed.

2. Place the instrument face down on a soft surface (such as an anti-static mat).
3. Remove the two screws located in the handle recesses. Refer to Figure 6-7.
4. Slip the flat-blade screwdriver between the rear case and front case at the bottom of the instrument to disengage the tabs and lift the rear case off.

Installation. Use this procedure to install the rear case.

1. Place the instrument face down on a soft surface (such as an anti-static mat).
2. Slide the rear case over the assembly until the bottom tabs of the front case lock into the rear case.



CAUTION. Be careful to align the guide ribs and to not pinch any wires or other parts between the front and rear cases. If used, make sure that the copper mesh grounding tube is in the proper place as shown in Figure 6-7.

3. Install the two screws located in the handle recesses.



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 handle and the power button.

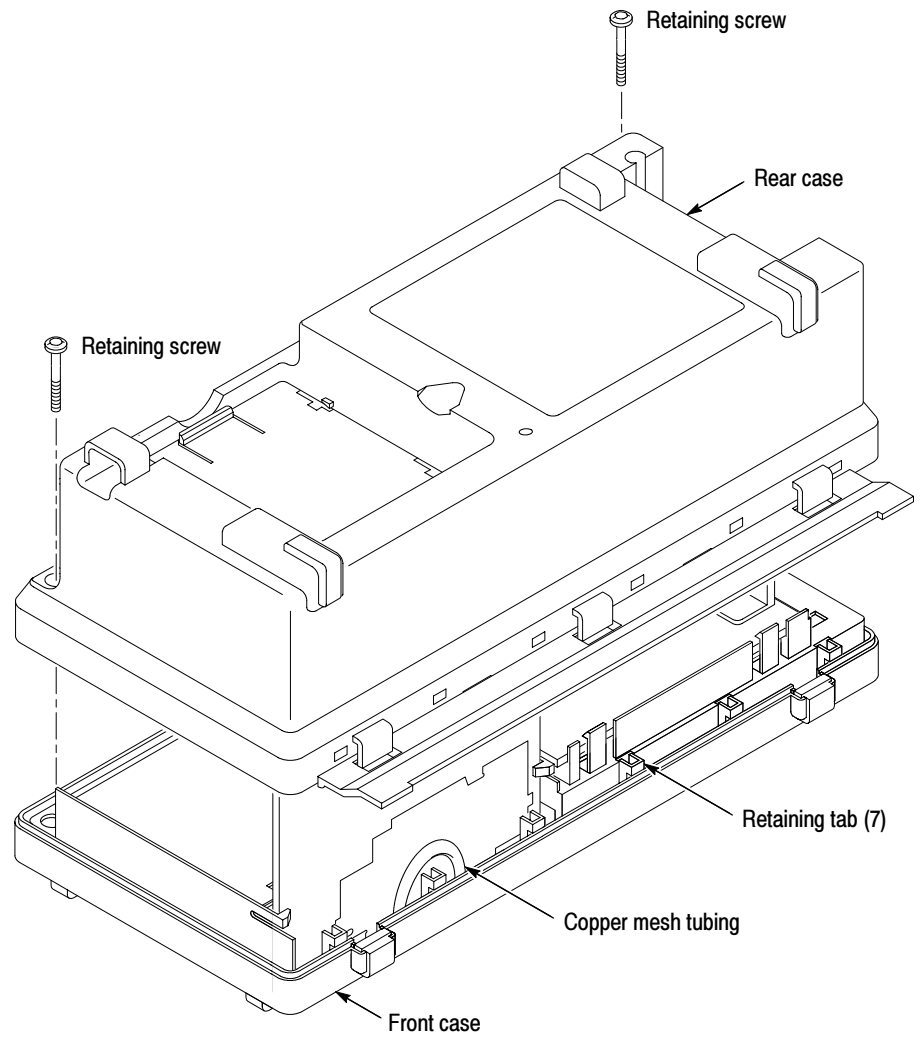


Figure 6-7: Removing and installing the rear cover

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

Removal. First remove the handle, power button, and rear case using the procedures on pages 6-12, 6-13, and 6-14. Then, slide the front feet out of the front case as shown in Figure 6-8.

Installation. Slide the feet into the slots provided in the front case as shown in Figure 6-8. Use the installation procedures for each module removed to reassemble the instrument.

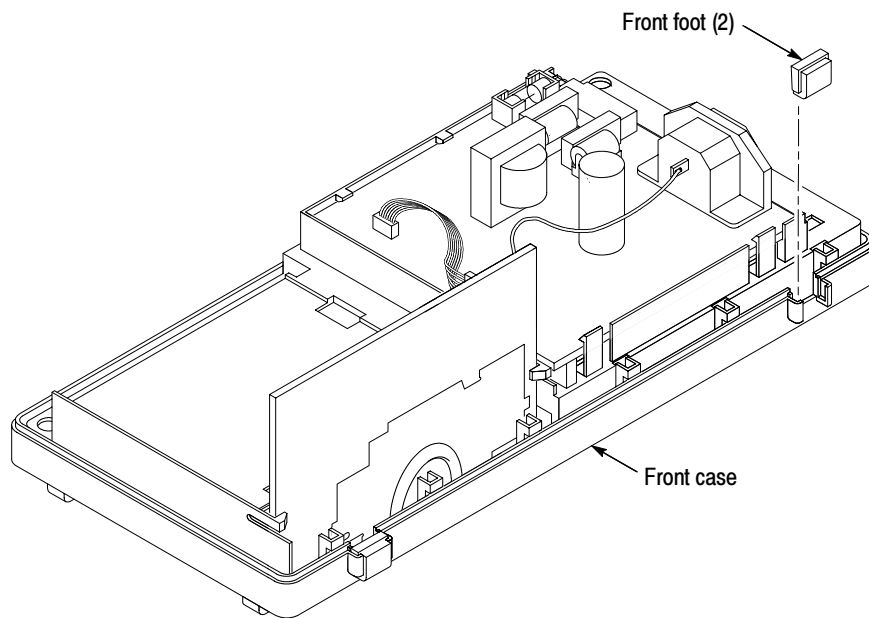


Figure 6-8: Removing and installing the front feet

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

Removal. First remove the handle, power button, and rear case using the procedures on pages 6-12, 6-13, and 6-14. Then, slide the four EMI clips out of the rear case as shown in Figure 6-9.

NOTE. *The EMI clips can be pushed out from the rear of the case using a narrow flat-blade screwdriver.*

Installation. Slide the four EMI clips into the slots provided in the rear case as shown in Figure 6-9. Use the installation procedures for each module removed to reassemble the instrument.

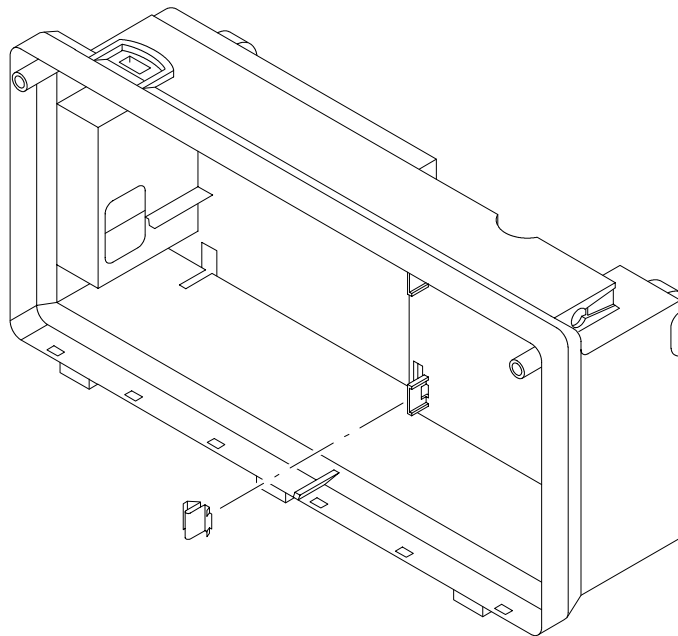


Figure 6-9: Removing and installing the EMI clips

Flip Stand

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

Removal. First remove the handle, power button, and rear case using the procedures on pages 6-12, 6-13, and 6-14. Then, use the following procedure to remove the flip stand.

1. Place the rear case face down on a soft surface (such as an anti-static mat).
2. With the stand folded against the rear case (in the up position), push the stand out of the rear case channels as shown in Figure 6-10.

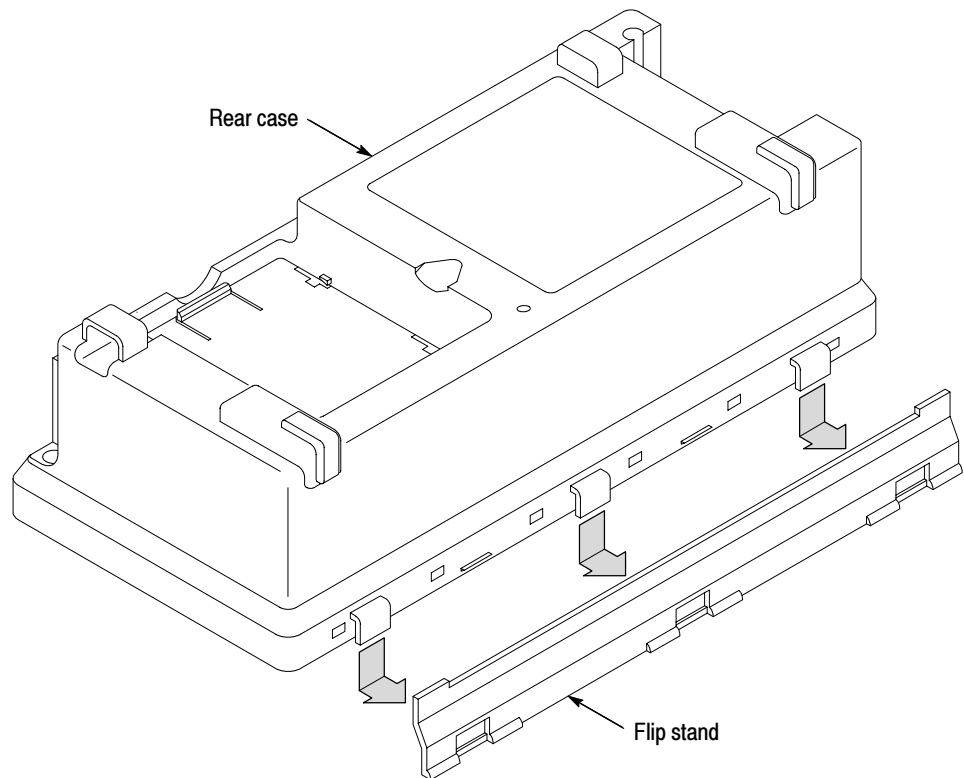


Figure 6-10: Removing the flip stand

Installation. Use this procedure to install the flip stand.

1. Orient the flip stand to the rear case, aligning the flip stand slots to the rear case tabs as shown in Figure 6-11.
2. With the stand in the folded up position, snap the stand into place.
3. Use the installation procedures for each module removed to reassemble the instrument.

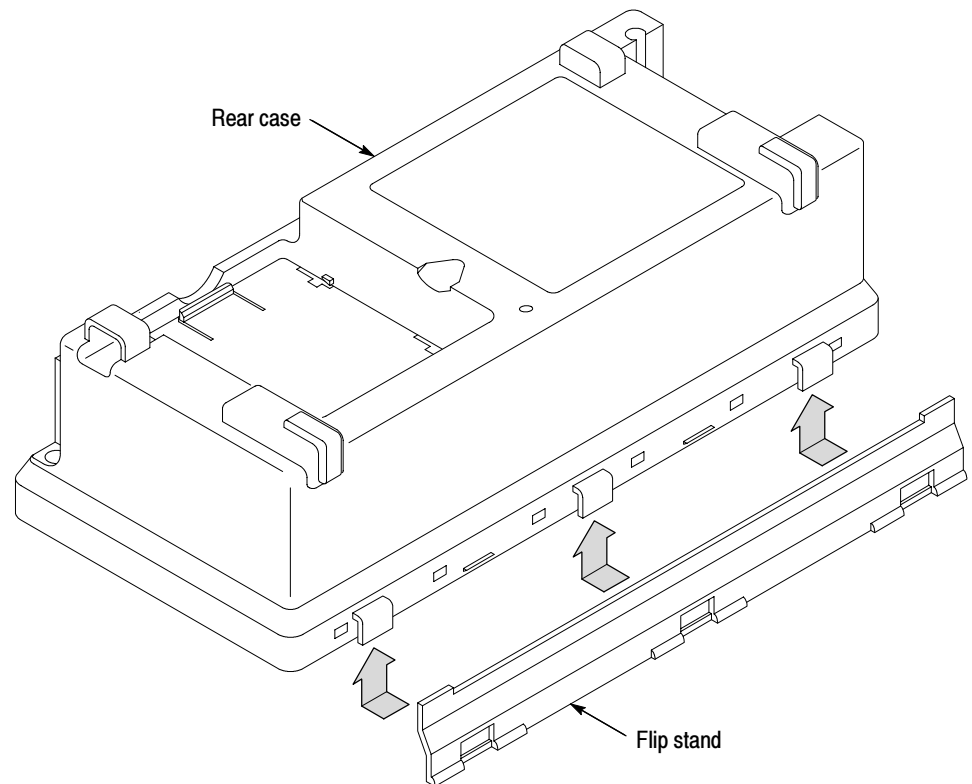


Figure 6-11: Installing the flip stand

Power Line Fuse

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

First remove the handle, power button, and rear case using the procedures on pages 6-12, 6-13, and 6-14 to access the line fuse.

The line fuse is located on the power supply module as shown in Figure 6-12. If the fuse tests bad, replace it with a fuse of the same type and rating.

Use the installation procedures for each module removed to reassemble the instrument.

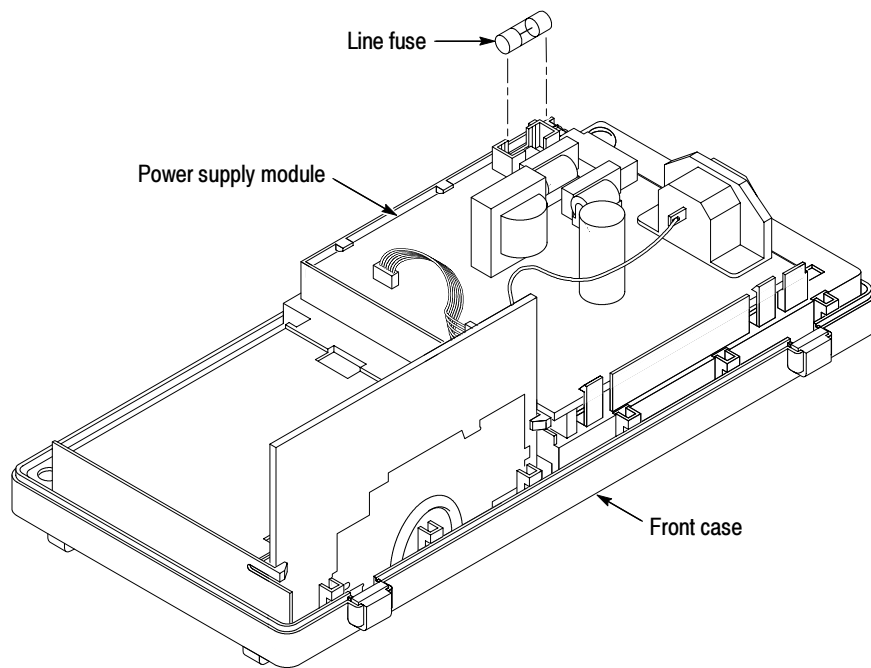


Figure 6-12: Line fuse location

Power Supply Module

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

Removal. First remove the handle, power button, and rear case using the procedures on pages 6-12, 6-13, and 6-14. Then, use the following procedure to remove the power supply module. Refer to Figure 6-13.

1. Disconnect the following wires.
 - a. The line cord ground wire on the main board at J602 or J101.
 - b. The seven-conductor ribbon cable on the main board at J131.
 - c. The two-conductor backlight cable on the power supply module.
2. Slightly bend back the two securing tabs at the bottom of the power supply module and lift the module out of the inner chassis.

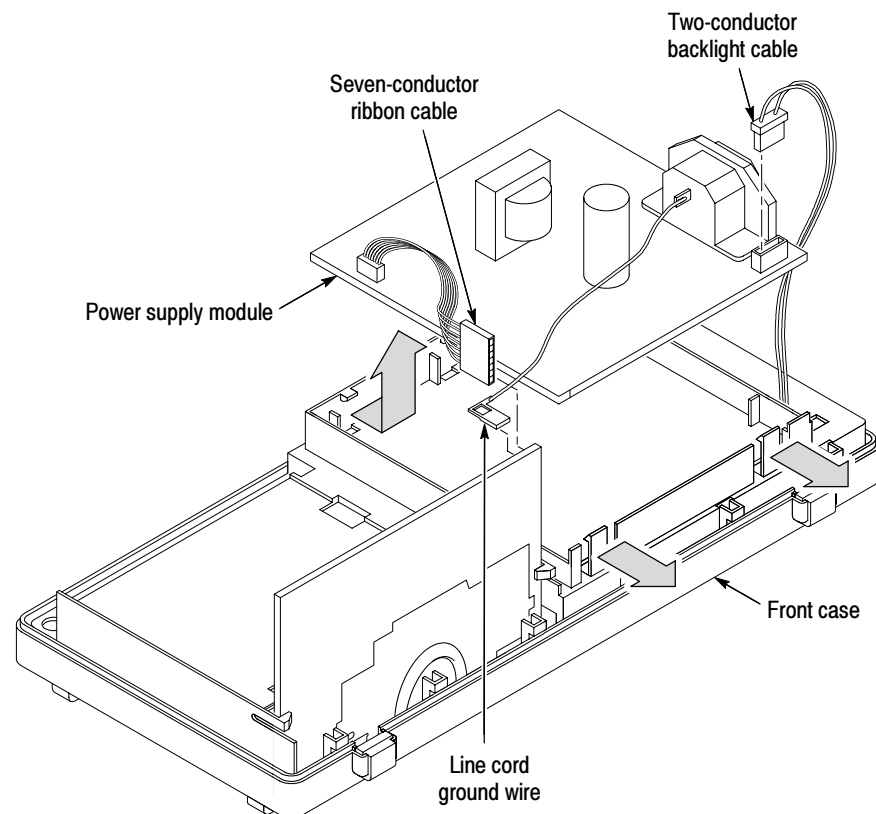


Figure 6-13: Removing the power supply module

Installation. Use this procedure to install the power supply module. Refer to Figure 6-14.

1. Place the power supply module into the inner chassis, placing the board under the three tabs at the top of the inner chassis.
2. Snap the bottom of the module into place.
3. Reconnect the following wires.
 - a. The line cord ground wire on the main board at J602 or J101.
 - b. The seven-conductor ribbon cable on the main board at J131.
 - c. The two-conductor backlight cable on the power supply module.
4. Use the installation procedures for each module removed to reassemble the instrument.

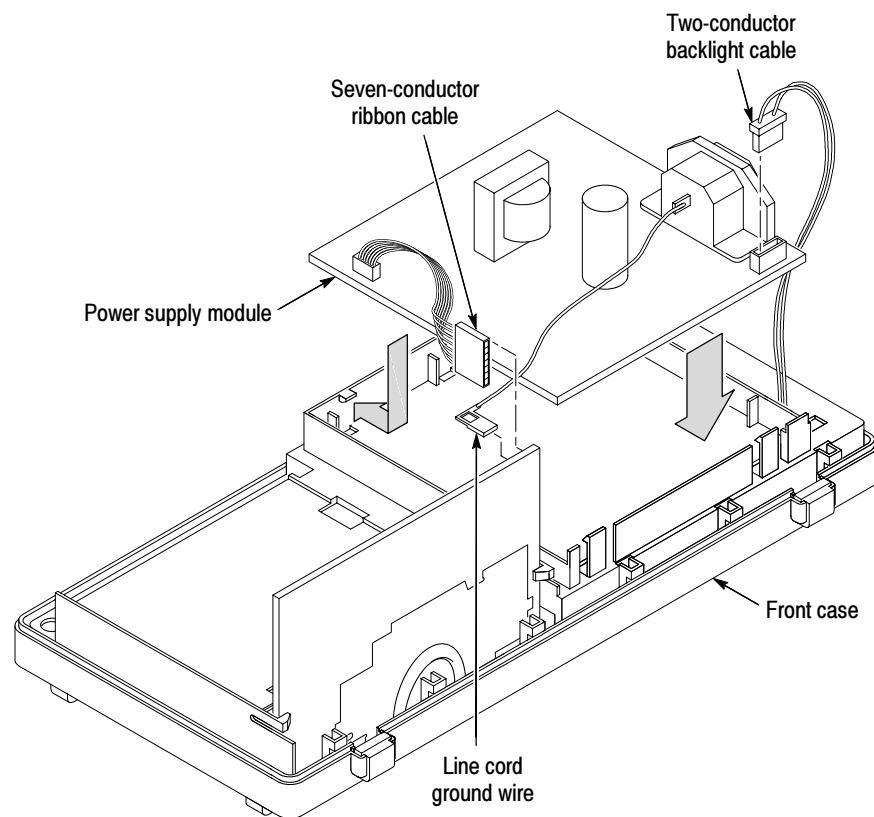


Figure 6-14: Installing the power supply module

Front-Panel Knobs

Remove the front panel knobs by firmly grasping the knob (with pliers if necessary) and pull it away from the front panel. Install front panel knobs by aligning the keyed knob with the shaft and pressing the knob onto the shaft.

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

Internal Assembly

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

Removal. First remove the handle, power button, and rear case using the procedures on pages 6-12, 6-13, and 6-14. Then, use the following procedure to remove the internal assembly.

1. Remove all the front panel knobs.
2. Lift the entire internal assembly (housing all of the boards and the display screen) out of the front case as shown in Figure 6-15.

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

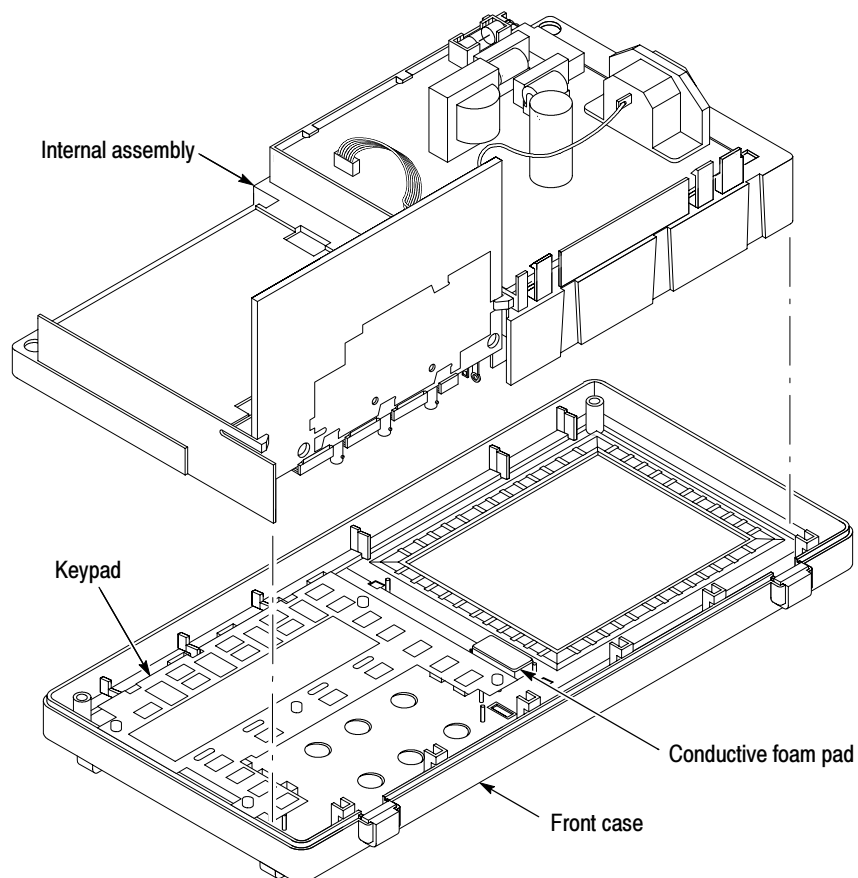


Figure 6-15: Removing and installing the internal assembly

Installation. Use this procedure to install the internal assembly.

1. Place the internal assembly into the front case as shown in Figure 6-15.
2. If used, place the copper mesh grounding tube between the main board module shield and the front case as shown in Figure 6-16. This part is not used on later instruments; check the *Mechanical Parts List* for your serial number (see page 10-8).
3. Use the installation procedures for each module removed to reassemble the instrument.

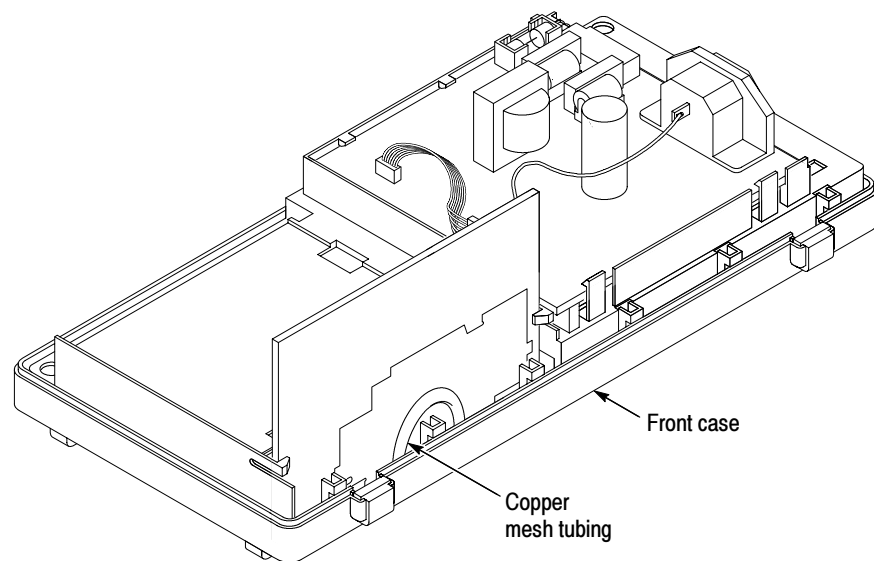


Figure 6-16: Installing the copper mesh grounding tube

Main Board Module

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

Removal. First remove the handle, power button, and rear case using the procedures on pages 6-12, 6-13, and 6-14. Then, use the following procedure to remove the main board module.

1. Remove the entire internal assembly from the front case using the procedure on page 6-24.
2. Disconnect the following wires on the main board. Refer to Figure 6-17.
 - a. The line cord ground wire at J602 or J101 and the seven-conductor ribbon cable at J131 from the power supply module.
 - b. The ribbon cable at J603 or J103 from the front panel module.
 - c. The ribbon cable at J202 or J102 from the display module.
3. From the bottom of the internal chassis, slightly bend the two securing tabs and tilt the board down until it clears the tabs. Refer to Figure 6-17.
4. Pull the board out of the front slots of the internal chassis (near the BNC connectors).

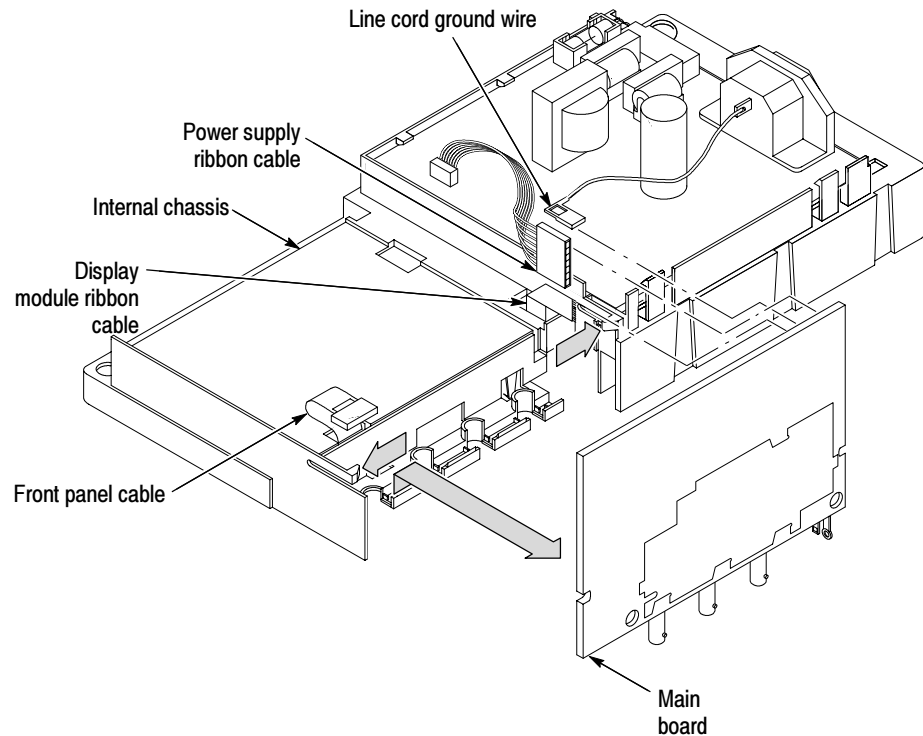


Figure 6-17: Main board removal

Installation. Use this procedure to install the main board module. Refer to Figure 6-18.

1. Working from the bottom of the internal chassis, place the front of the main board module into the slots on the internal chassis (near the BNC connectors).
2. Keeping the module in place, press the board into place so that the securing tabs lock onto the bottom of the board. Note that there are two board guides on the chassis that must match the cutouts on the main board.
3. Reconnect the following wires on the main board. Refer to Figure 6-17.
 - a. The line cord ground wire at J602 or J101 and the seven-conductor ribbon cable at J131 from the power supply module.
 - b. The ribbon cable at J603 or J103 from the front panel module.
 - c. The ribbon cable at J202 or J102 from the display module.
4. Place the entire internal assembly (housing all of the boards and the display screen) into the front case as shown in Figure 6-16.

5. Use the installation procedures for each module removed to reassemble the instrument.

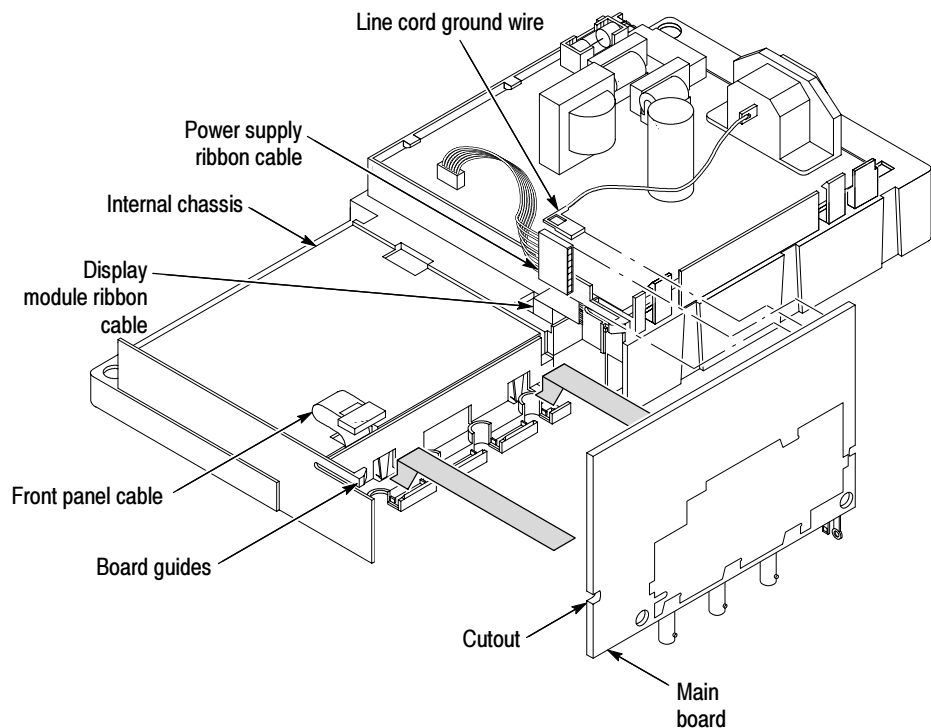


Figure 6-18: Main board installation

Display Module

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

Removal. First remove the handle, power button, and rear case using the procedures on pages 6-12, 6-13, and 6-14. Then, use the following procedure to remove the display module.

1. Remove the entire internal assembly from the front case using the procedure on page 6-24.
2. Disconnect the display module ribbon cable at J202 or J102 on the main board by pulling straight up from the connector. Refer to Figure 6-17.
3. Disconnect the backlight cable from the power supply module. Refer to Figure 6-14.
4. Slightly bend the two securing tabs on the left side of the display module and lift the left side up until it clears the tabs. Then slide the display to the left until the right-side tabs are disengaged. Refer to Figure 6-19.



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

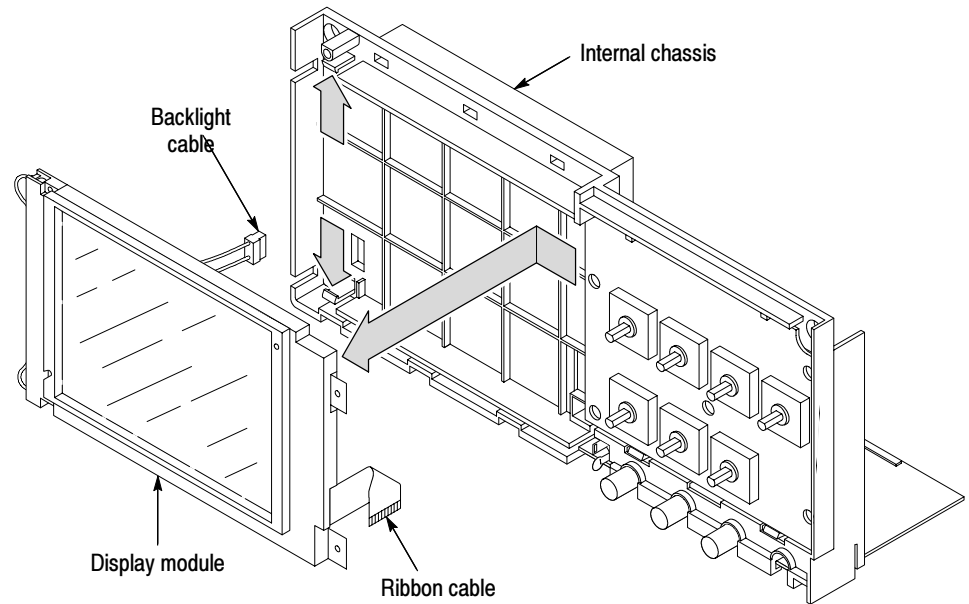


Figure 6-19: Removing the display module

Installation. Use this procedure to install the display module.

1. Route the display ribbon cable through the opening in the internal chassis as shown in Figure 6-20. If installing a new module, fold the ribbon cable as shown.
2. Place the tabs on the right side of the display module into the slots of the internal chassis located under the front panel board. It is not necessary to remove the front panel board. Refer to Figure 6-20.
3. Route the backlight cable through the opening in the internal chassis as shown in Figure 6-20.
4. Lower the left side of the display module into the internal chassis until the two securing tabs lock on to the display module. Note that the backlight cable protruding from each end of the module must align with the cutouts of the inner chassis. Refer to Figure 6-20.
5. Reconnect the display module ribbon cable at J202 or J102 on the main board by pushing the cable straight down into the connector. Refer to Figure 6-17.

6. Reconnect the backlight cable to the power supply module. Refer to Figure 6-14.
7. Place the entire internal assembly into the front cover. Refer to Figure 6-16.
8. Use the installation procedures for each module removed to reassemble the instrument.

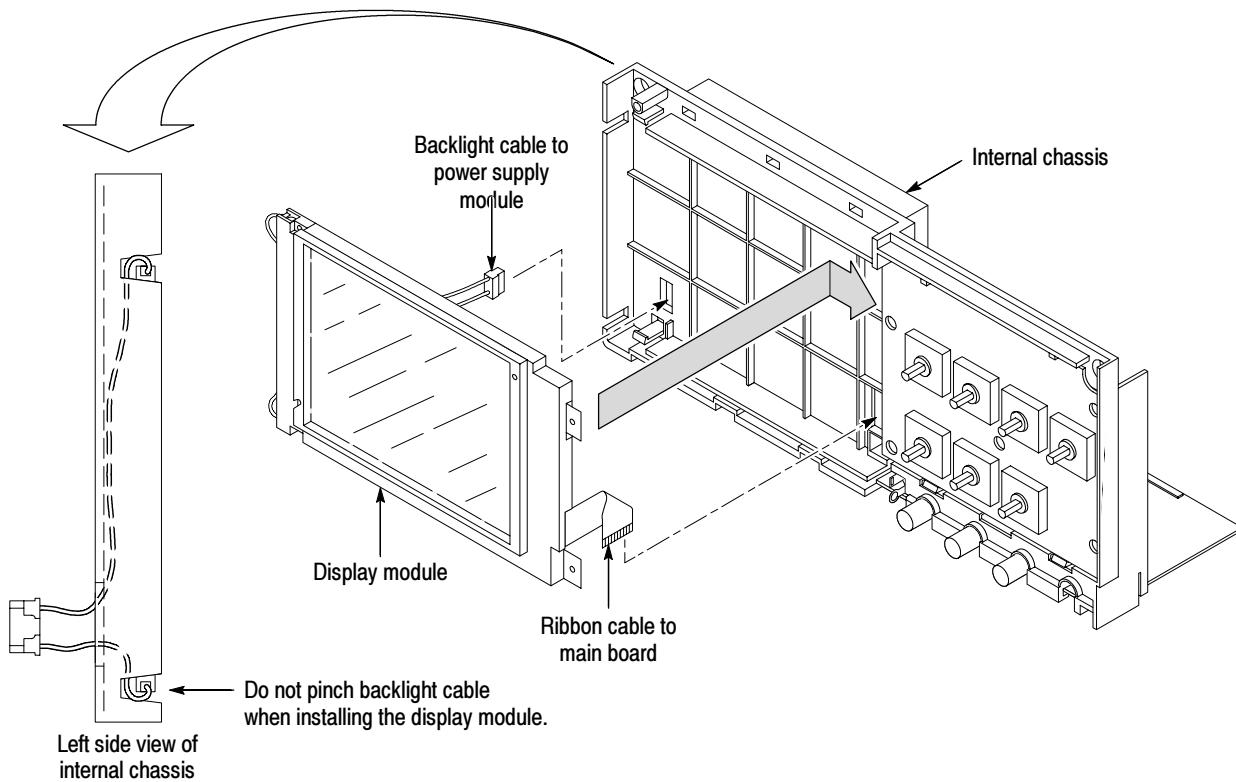


Figure 6-20: Installing the display module

Front Panel Module

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

Removal. First remove the handle, power button, and rear case using the procedures on pages 6-12, 6-13, and 6-14. Then, use the following procedure to remove the front panel module.

1. Remove the entire internal assembly from the front case using the procedure on page 6-24.
2. Disconnect the front panel ribbon cable at J200 on the main board. Refer to Figure 6-17.

3. Disengage the two securing tabs at the bottom of the board and slide the board down and out of the internal chassis. Refer to Figure 6-21

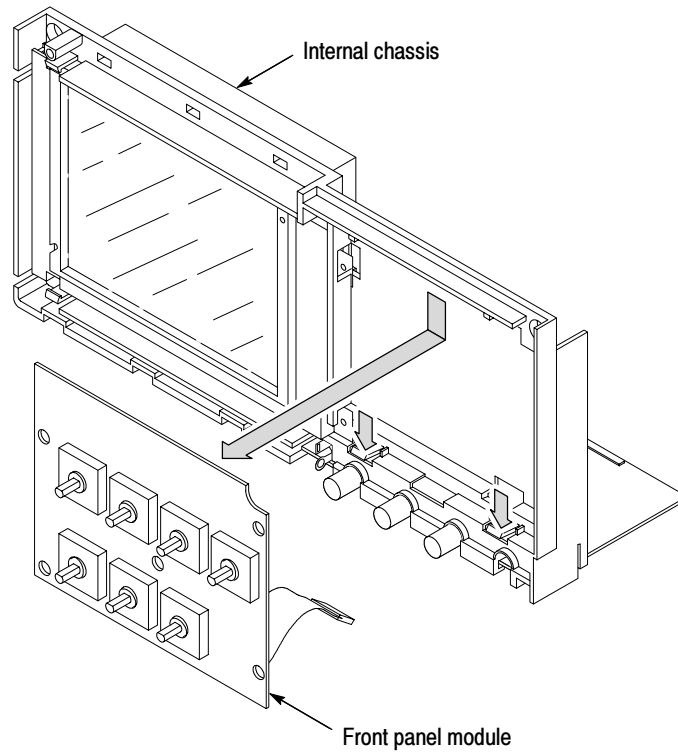


Figure 6-21: Removing the front panel module

Installation. Use this procedure to install the front panel module.

1. Route the front panel ribbon cable through the opening in the chassis as shown in Figure 6-22.
2. Insert the top of the front panel module under the tabs at the top of the chassis and press the board down until the securing tabs at the bottom of the chassis lock into place. Refer to Figure 6-21.
3. Reconnect the front panel ribbon cable at J603 or J103 on the main board. Refer to Figure 6-17.
4. Place the entire internal assembly into the front case as shown in Figure 6-15.
5. Use the installation procedures for each module removed to reassemble the instrument.

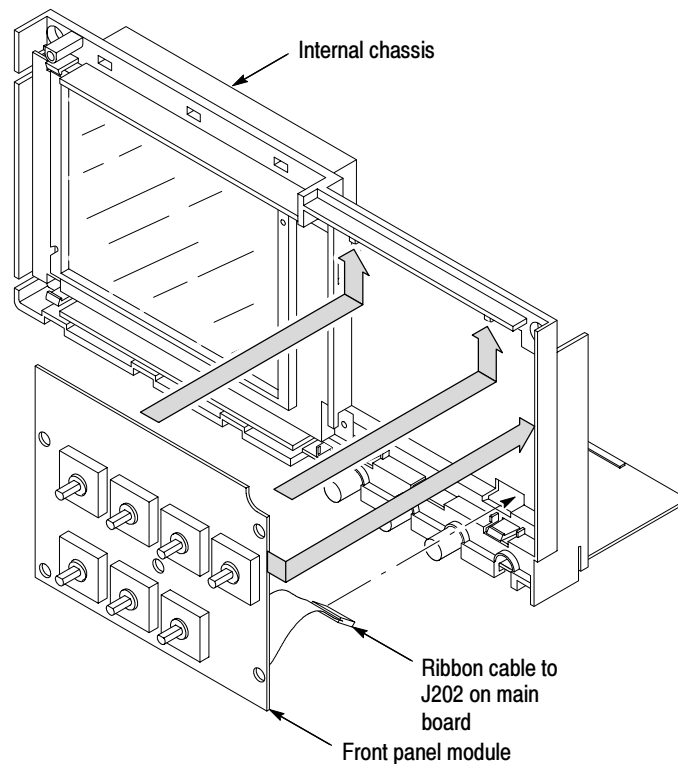


Figure 6-22: Installing the front panel module

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

Removal. First remove the handle, power button, and rear case using the procedures on pages 6-12, 6-13, and 6-14. Then, use the following procedure to remove the switch keypad.

1. Remove the entire internal assembly from the front case using the procedure on page 6-24.
2. Lift the keypad out of the front case. Refer to Figure 6-23.



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

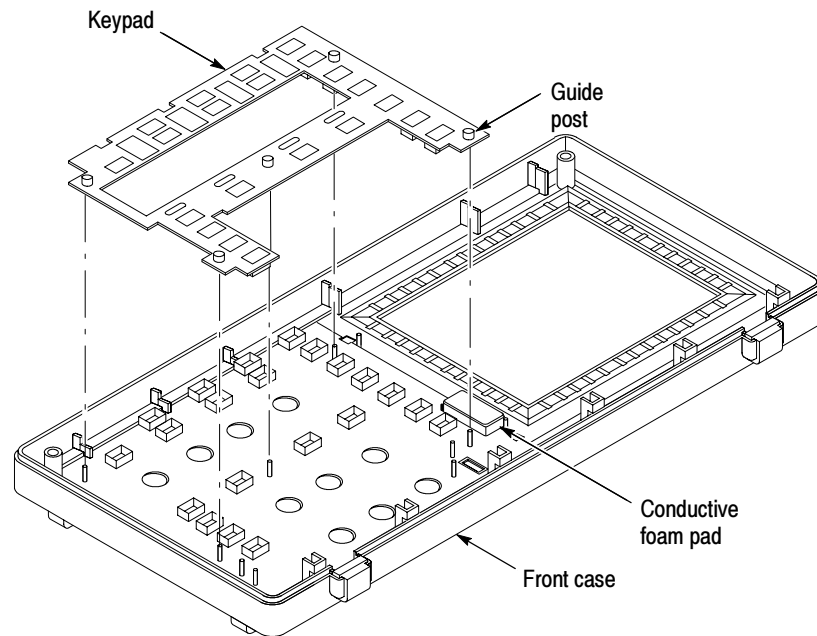


Figure 6-23: Removing and installing the keypad

Installation. Use this procedure to install the switch keypad.

1. Align the switch keypad into the front case using the five guide posts as shown in Figure 6-23.



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

2. Check that all buttons are properly seated into place before proceeding.
3. Place the entire internal assembly into the front case as shown in Figure 6-16.
4. Use the installation procedures for each module removed to reassemble the instrument.

Display Shield

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

STOP. Removing the display shield from the display module will destroy the display shield gasket. Only remove the shield if you intend to replace it with a new shield and gasket assembly.

Removal. First remove the handle, power button, and rear case using the procedures on pages 6-12, 6-13, and 6-14. Then, use the following procedure to remove the display shield.

1. Remove the entire internal assembly from the front case using the procedure on page 6-24.
2. Remove the shield from the display module. Refer to Figure 6-24.

NOTE. You may have to cut through the display shield gasket to remove the shield. Carefully remove any remaining gasket and adhesive from the LCD display module.

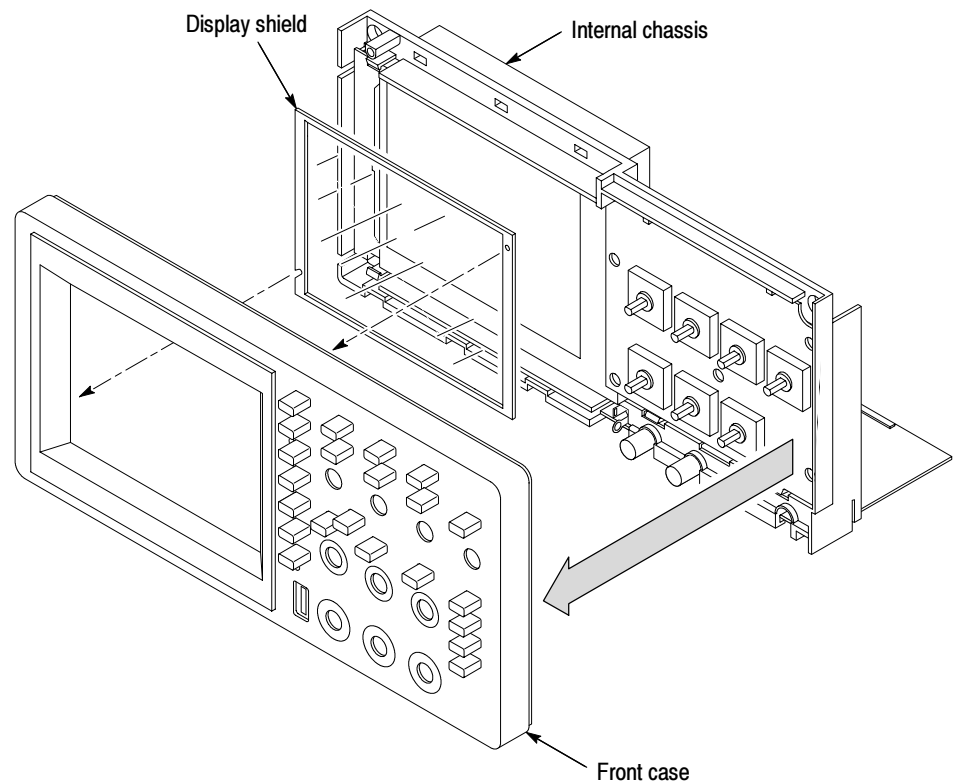


Figure 6-24: Removing the display shield

Installation. Use this procedure to install the display shield.

1. Align the display shield into the front case, using the two guide posts as shown in Figure 6-25.
2. Remove the paper backing from the adhesive lining of the gasket.
3. Carefully place the entire internal assembly into the front case as shown in Figure 6-25 making sure that the display module properly contacts the display shield foam.
4. Use the installation procedures for each module removed to reassemble the instrument.

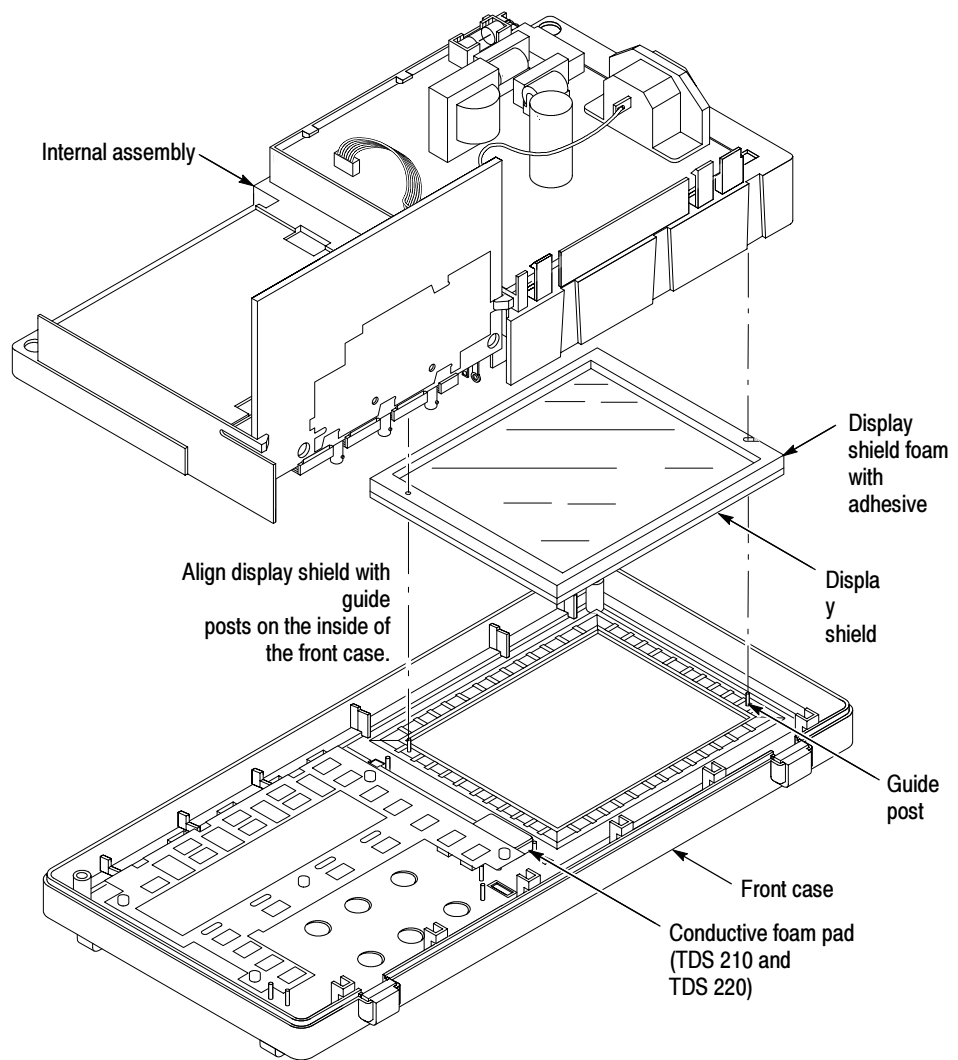


Figure 6-25: Installing the display shield

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

Removal. First remove the handle, power button, and rear case using the procedures on pages 6-12, 6-13, and 6-14. Then, use the following procedure to remove the display shield.

1. Remove the entire internal assembly from the front case using the procedure on page 6-24.
2. Remove the switch keypad using the procedure on page 6-33.
3. Remove (TDS 210 and TDS 220 only) the conductive foam pad from the front case (see Figure 6-15 on page 6-24).

Installation. Use this procedure to install the front case. Refer to Figure 6-15 on page 6-24.

1. Place (TDS 210 and TDS 220 only) the conductive foam pad into the front case.
2. Place the switch keypad into the front case.
3. Place the entire internal assembly into the front case.
4. Use the installation procedures for each module removed to reassemble the instrument.
5. If installing a new front case, place a new front-panel label onto the case as described on page 6-10.

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 to service personnel or damage to electrical components, read Preventing ESD on page 6-1.

Adjustment After Repair

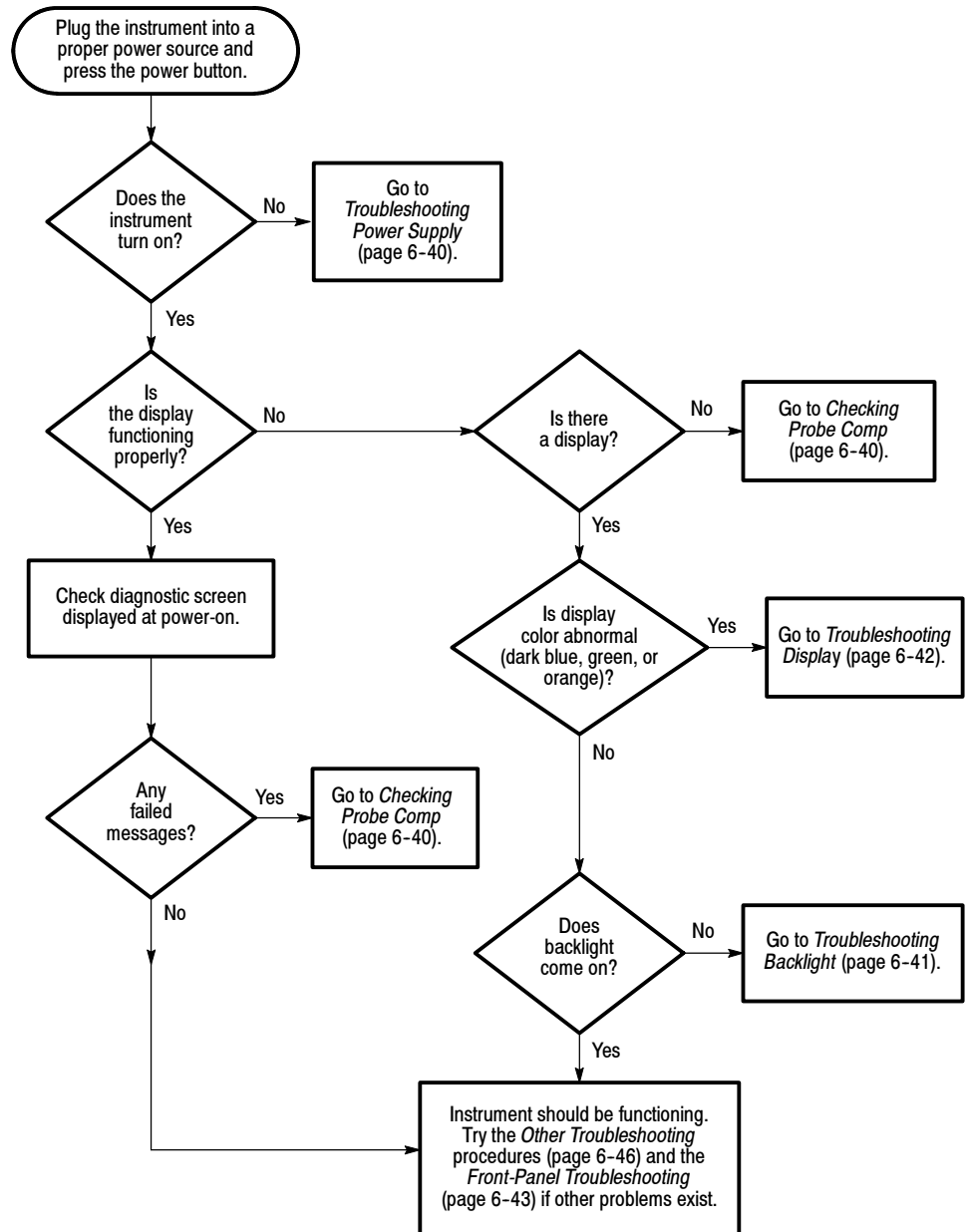
If you replace the main board or power supply, you must adjust the instrument after repair. Refer to the chapter *Adjustment Procedures*.

Required Tools and Equipment

You may need the the following tools and equipment to troubleshoot the instrument.

Tools and equipment	Example
Oscilloscope with 1X/10X and 100X probes	Tektronix TDS 200- or TDS 300-series with standard accessory 1X/10X probe and optional 100X probe
DMM	Tektronix TX-series digital multimeter

Begin Here Begin with this troubleshooting tree to isolate a problem to a specific troubleshooting procedure.



PROBE COMP Output

When the instrument 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.

Signal at PROBE COMP	Possible problem
1 kHz signal, no display	Go to <i>Display Troubleshooting</i> (Page 6-42)
No signal	Go to <i>Power Supply Troubleshooting</i> (Page 6-40)
> 1.2 kHz signal	Go to <i>Power Supply Troubleshooting</i> (Page 6-40)

Power Supply Troubleshooting

Follow these steps to troubleshoot the power supply.

1. Remove the rear case using the procedure *Rear Case* on page 6-14.
2. Use the test oscilloscope to measure the voltages from the power supply module at J131 on the main board module. The table below lists the voltages you should expect to see.

Voltage at J131	Description
Pin 1 (marked with ◀)	+4.85 VDC to +5.15 VDC
Pin 2	+4.85 VDC to +5.15 VDC
Pin 3	GND
Pin 4	-4.35 VDC to -5.15 VDC (slightly higher if disconnected)
Pin 5	-23 VDC to -25 VDC
Pin 6	GND
Pin 7	1.4 V _{pk-pk} to 5 V _{pk-pk} , 47 to 63 Hz square wave

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, continue with step 5.
5. Turn off the instrument and disconnect the cable at connector J131 on the main board module.
6. Turn on the instrument and check the voltages at the loose end of the cable disconnected from J131, checking for the same voltages as in step 2.

7. If all of the voltages are missing, check the line fuse on the power supply module. If the fuse is defective, replace the fuse. If the fuse is ok, continue with step 8.
8. If all or some of the voltages are missing, the power supply module is probably defective. Replace it.

Backlight Troubleshooting

Follow these steps to troubleshoot a nonfunctional backlight.

1. Remove the rear case using the procedure *Rear Case* on page 6-14.
2. Turn the instrument on.



WARNING. To avoid electrical shock, do not touch the two-wire backlight connector on the power supply module. The output connector is the one closest to the power line cord.

3. Set the test oscilloscope (with a 100X probe) to measure a 1270 V_{pk-pk} (450 V_{RMS}) signal at approximately 60 kHz. Attach the probe ground lead to the ground lug on the AC line connector and the probe tip to the backlight connector as shown in Figure 6-26.

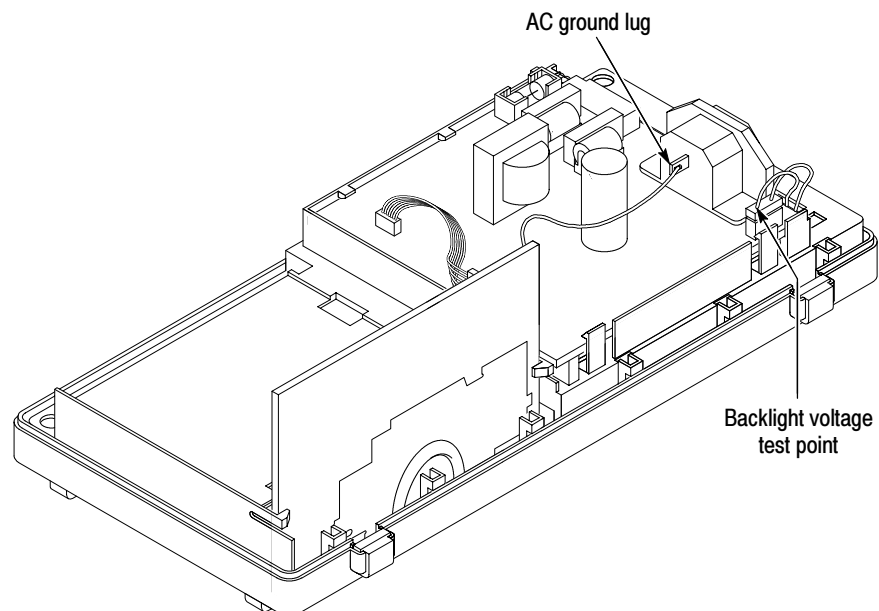


Figure 6-26: Measuring the backlight voltage

4. If the 1270 V_{pk-pk} signal is present, the backlight is probably defective. Replace the display. If the signal is not present proceed with step 5.

- If the 1270 V_{pk-pk} signal is missing, the power supply module is probably defective. Replace it.

Display Troubleshooting

Follow these steps to troubleshoot a nonfunctional display.

- Remove the rear case using the procedure *Rear Case* on page 6-14.
- Turn the instrument on.

NOTE. Without a functional display module, the simplest way to verify that the instrument 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 squarewave.

- Use the test oscilloscope and set the Attenuation switch to 10X on the P2100 probe to probe the display cable connector at J202 (two channel instruments) or J102 (four channel instruments) on the main board. The table below describes the signals you should expect to see.

Signal at J202/J102	Description
Pin 1 (marked with ◀)	-10 VDC to -22 VDC
Pin 2	-23 VDC to -25 VDC
Pin 3	Digital data, high = 5 V, low = 0 V
Pin 4	Digital data, high = 5 V, low = 0 V
Pin 5	Digital data, high = 5 V, low = 0 V
Pin 6	Digital data, high = 5 V, low = 0 V
Pin 7	0 V (ground)
Pin 8	0 V (ground)
Pin 9	+5 V _{DC}
Pin 10	1.89 MHz clock (528 ns period), ≈ 50% duty cycle, appears in bursts, high = 5 V, low = 0 V
Pin 11	19.3 kHz clock (51.7 μs period), ≈ 16% duty cycle, high = 5 V, low = 0 V
Pin 12 (closest to BNC end of instrument)	75.5 Hz clock (13.2 ms period), ≈ 0.4% duty cycle, high = 5 V, low = 0 V

- If all the signals are present, the display module is probably defective. Replace it. If all or some of the signals are missing, continue with step 5.

5. Turn the instrument off and disconnect the display module cable at J202 or J102 on the main board. Carefully pull the cable straight up from the connector to avoid damage.
6. Turn the instrument on.
7. Probe the pins of J202 or J102, 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.

Front-Panel Troubleshooting

Follow these steps to troubleshoot a nonfunctional front panel.

Buttons. Use the manufacturing tests to check that each of the front-panel controls operate properly.

1. To execute the internal diagnostic tests, remove all input signals from the instrument and enable the service menus as described on page 5-2.
2. Press the UTILITY button and select Service from the menu selection.

Menu	Settings	Comments
System Status		Displays the system menus
Do Self Cal		Performs a self calibration
Error Log		Displays a list of any errors logged This list is useful when contacting a Tektronix Service Center for help troubleshooting problems
Service		Displays the service menus for adjustment procedures and diagnostics

3. Select Service Diag. from the menu selection.

Menu	Settings	Comments
FCAL INIT		Initiates the factory calibration routine to load new calibration constants
FCAL STEP		Steps through the calibration routine steps
FCAL ABORT		Aborts the factory calibration routine without affecting any calibration constants
Service Diag.		Displays the service diagnostics menus

4. Select Mfg. Tests to start the front panel controls test.

Menu	Settings	Comments
Mfg. Tests		Displays a front panel simulation used to check that all front panel controls are operational
Loop Diag.		Displays a menu of choices of how to run the diagnostics used during manufacturing of the instrument
Repair		
Clear Error Log		Remove all Error Log entries from memory and set the power cycle count to zero

5. Select Test FP to start the front panel controls test.

Menu	Settings	Comments
Test FP		Displays a front panel simulation used to check the operation of all front panel controls All buttons must be pressed 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 press of the button
Incr. Contrast		Allows you to check the display contrast operation across 100% of the hardware range
Decr. Contrast		Allows you to check the display contrast operation across 100% of the hardware range
Stop Test		Exits the front panel test (Test FP) after all buttons and knobs have been tested successfully and exits the screen test (Test Screen)

6. Press each button and rotate each knob to verify the operation of all controls. If all buttons and knobs have pass the test, pressing 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. Use the 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 P2100 probe to probe the front panel module cable connector at J603 (two channel oscilloscopes) or J103 (four channel oscilloscopes) on the main board. The table below describes the signals you should expect to see.

Signal J603	Description
1 FDCLR	Positive Pulses, 100 ns wide (typical), 280 μ s period
2 +5 V	+5 V
3 FPCLR	Negative clock pulses, 100 ns wide (typical), 4.5 μ s period
4 GND	0 V (ground)
5 FPDATA	Negative pulse burst, 300 μ s period (typical)

Signal J103	Description
1	GND (0 V)
2	Negative clk pulse, 80 ns wide, 4.5 μ s period (typical)
3	Positive pulse, 100 ns wide (typical), 280 μ s period
4	Positive pulse, 100 ns wide, 280 μ s period (typical)
5	Negative pulse, 80 μ s wide, 4.5 μ s period (typical)
6	GND (0 V)
7	Negative pulse burst, 300 μ s (typical)
8	+5 V
9	Negative pulse burst, 300 μ s (typical)
10	−14 V (typical)

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 the instrument off and disconnect the front panel module cable from the main board at connector J603 or J103.
13. Turn on the instrument and check connector J603 or J103 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.

Diagnostics The instrument runs an extensive self diagnostics at every power-on. Running the diagnostics from the service menu will provide no additional information than the power-up screen and therefore is not needed. The menu selections are only used during manufacturing of the instrument.

Other Troubleshooting Use these techniques to troubleshoot other parts of the instrument.

Input Connections. Follow these steps to troubleshoot the input connections only if the following condition is true: the instrument appears to function normally in every way except you have determined that an input signal is not getting into the instrument as expected.

1. Remove the rear cover using the procedure *Rear Case* on page 6-14.
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.

Error Log. Failures that occur during the power-up diagnostics place an entry in the error log. The error log list can be accessed anytime by pressing the UTILITY button and selecting Error Log. Table 6-3 lists the possible error codes and possible causes.

Menu	Settings	Comments
System Status		Displays the system menus
Do Self Cal		Performs a self calibration
Error Log		Displays a list of any errors logged This list is useful when contacting a Tektronix Service Center for help troubleshooting problems
Service		Displays the service menus for adjustment procedures and diagnostics

Table 6-3: List of error codes

Error code	Description	Probable cause
0 DI	Diagnostics internal error	Contact Tektronix
4 DI	CH1 diagnostics failed	Main board or power supply failure

Table 6-3: List of error codes (cont.)

Error code	Description	Probable cause
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	ADG321 diagnostics failed	Main board or power supply failure
10 DI	Extension module RAM failed	Extension module failure
11 DI	Extension module checksum failed	Extension module failure
255 Software		Contact Tektronix

Clearing the Error Log. After fixing a problem, clear the error log.

1. To clear the error log, enable the service menus as described on page 5-2.
2. Press the UTILITY button and select Service from the menu selection.
3. Select Service Diag. from the menu selection.
4. Select Clear Error Log to clear the error log of past failures.

Repackaging Instructions

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

Packaging

Use a corrugated cardboard shipping carton having a test strength of at least 275 pounds (125 kg) and with an inside dimension at least six inches (15.25 cm) greater than the instrument dimensions.

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

- The owner's address
- Name and phone number of a contact person
- Type and serial number of the instrument
- 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 (instrument 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.



Options

There are no options available for the TDS 200-Series Digital Real-Time Oscilloscopes. For a list of available accessories, refer to chapter *Mechanical Parts List*.



Electrical Parts List

Refer to the *Mechanical Parts List* chapter for a complete listing and description of replaceable parts for the TDS 200-Series Digital Real-Time Oscilloscope.

Diagrams

See Figure 3-1 on page 3-3 or Figure 3-2 on page 3-4 for a block/interconnect diagram of your oscilloscope. There are no additional diagrams in this chapter.

Replaceable Parts

This chapter contains a list of the replaceable modules for the TDS 200-Series Digital Real-Time Oscilloscope. Use this list to identify and order replacement parts.

Parts Ordering Information

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

Changes to Tektronix 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.

Change information, if any, is located at the rear of this manual.

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. The following table describes each column in the parts list.

Table 10-1: 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 10-2: Manufacturers cross index

Mfr. code	Manufacturer	Address	City, state, zip code
07416	NELSON NAME PLATE COMPANY	3191 CASITAS AVENUE	LOS ANGELES, CA 90039-2410
0KB01	STAUFFER SUPPLY CO	810 SE SHERMAN	PORTLAND, OR 97214-4657
0KB05	NORTH STAR NAMEPLATE INC	5750 NE MOORE COURT	HILLSBORO, OR 97124-6474
0KM03	INSTRUMENT SPECIALTIES CO INC.	505 PORTER WAY	PLACENTIA, CA 92670
14310	AULT INC	7300 BOONE AVE NORTH BROOKLINE PARK	MINNEAPOLIS, MN 55428
32997	BOURNS INC	TRIMPOT DIVISION 1200 COLUMBIA AVE	RIVERSIDE, CA 92507-2114
77824	SCHLEGEL CORP	1555 JEFFERSON RD P O BOX 23197	ROCHESTER, NY 14692
80009	TEKTRONIX INC	14200 SW KARL BRAUN DR PO BOX 500	BEAVERTON, OR 97077-0001
TK0JD	LIGHTWORKS EDITING SYSTEMS LTD	ARIEL HOUSE 74A CHAROLETT ST	LONDON, GB W1P1LR
TK1163	POLYCAST INC	9898 SW TIGARD ST	TIGARD, OR 97223
TK1326	NORTHWEST FOURSLIDE INC	13945 SW GALBREATH DR	SHERWOOD, OR 97140
TK2376	CONDUCTIVE RUBBER TECH	22125 17TH AVE SE, SUITE 117	BOTHELL, WA 98021
TK2569	SHARP CORPORATION	C/O TJBO LIAISON M/S 78-210	BEAVERTON, OR 97077
TK2647	INSTRUMENT SPECIALTIES CO INC.	C/O TEMCO NW 1336 SE 51ST STREET	HILLSBORO, OR 97123
TK6181	IMC PLASTICS INC	19400 SW TETON AVE	TUALATIN, OR 97062

Table 10-3: Replaceable parts list

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
10-1-1	202-0345-00	B010100	B016657	1	CASE,BACKMACROBLEND DP4-1368,TDS210	TK1163	202034500
	202-0345-01	B016658		1	CASE,BACK:BAYBLEND FR110,TDS210	TK1163	202-0345-01
	202-0345-00	B010100	B016533	1	CASE,BACK:MACROBLEND DP4-1368,TDS220	TK1163	202034500
	202-0345-01	B016534		1	CASE,BACK:BAYBLEND FR110,TDS220	TK1163	202-0345-01
	202-0345-01			1	CASE,BACK:BAYBLEND FR110,TDS224	TK1163	202-0345-01
10-1-2	366-0774-00			1	PUSH BUTTON:PC/ABS BAYBLEND,FR110,TEXTURED	TK1163	366-0774-00
10-1-3	213-1099-00			2	SCREW,TPG,PT:K40-1.79 X 31 MM,STEEL,ZINC BLACK CHROMATE,T-15 TORX- SLOT,FLAT TOP PNH	0KB01	213-1099-00
10-1-4	334-9262-00			1	MARKER,IDENT:LABEL,MARKED WARNING TO AVOID ELECTRIC,3.765 X 3.990,0.010 POLY	0KB05	334-9262-00
10-1-5					EXTENSION MODULE:OPTIONAL PLUG-IN ACCESSORY,TDS2CM	80009	TDS2CM
10-1-6	367-0472-00			1	HANDLE,CARRYING:MACROBLEND	TK1163	367-0472-00
10-1-7	348-1484-01			2	FOOT:SANTOPRENE,BLACK,101-64,TEXTURED	TK1163	348-1484-01
10-1-8	159-0399-00			1	FUSE:6.3 AMP,5 X 20 MM,TIME DELAY	TK0JD	159-0399-00
10-1-9	119-5417-00	B010100 C010100	B040351 C010445	1	POWER SUPPLY:11W,5.0V 1.0A,-5.0V 0.3A,-23V 10MA,450VAC 30KHZ 5MA,85-275VAC 45-66HZ INPUT,TDS210	14310	SW422KA0000F02
	119-5417-01	B040352 C010446	B049398 C010878	1	POWER SUPPLY:CUSTOM,AC-DC,11W,85-275VAC45-66HZ INPUT,5.0V 1.0A -5.0V 0.3A -23V 10MA 450VAC 30KHZ 5MA OUTPUT,TDS210	14310	SW422KA0000F02
	119-5417-02	B049399 C010879	B089999 C019999	1	POWER SUPPLY:CUSTOM,AC-DC,11W,85-275VAC45-66HZ INPUT,5.0V 1.0A -5.0V 0.3A -23V 10MA 450VAC 30KHZ 5MA OUTPUT,TDS210	14310	SW422KA0000F02
	119-5417-00	B010100 C010100	B034184 C010519	1	POWER SUPPLY:11W,5.0V 1.0A,-5.0V 0.3A,-23V 10MA,450VAC 30KHZ 5MA,85-275VAC 45-66HZ INPUT,TDS220	14310	SW422KA0000F02
	119-5417-01	B034185 C010520	B041057 C011173	1	POWER SUPPLY:CUSTOM,AC-DC,11W,85-275VAC45-66HZ INPUT,5.0V 1.0A -5.0V 0.3A -23V 10MA 450VAC 30KHZ 5MA OUTPUT,TDS220	14310	SW422KA0000F02
	119-5417-02	B041058 C011174	B059999 C019999	1	POWER SUPPLY:CUSTOM,AC-DC,11W,85-275VAC45-66HZ INPUT,5.0V 1.0A -5.0V 0.3A -23V 10MA 450VAC 30KHZ 5MA OUTPUT,TDS220	14310	SW422KA0000F02
	119-6025-00	B090100 C020100		1	POWER SUPPLY:CUSTOM,12W,5VDC 1.25A,-5VDC 0.7A,-24VDC 15MA,450 VRMS 6MA 60KHZ,85-275VAC,TDS210	14310	SW422KA0000F03
	119-6025-00	B060100 C020100		1	POWER SUPPLY:CUSTOM,12W,5VDC 1.25A,-5VDC 0.7A,-24VDC 15MA,450 VRMS 6MA 60KHZ,85-275VAC,TDS220	14310	SW422KA0000F03
	119-6025-00			1	POWER SUPPLY:CUSTOM,12W,5VDC 1.25A,-5VDC 0.7A,-24VDC 15MA,450 VRMS 6MA 60KHZ,85-275VAC,TDS224	14310	SW422KA0000F03
10-1-10	441-2082-00			1	CHASSIS ASSY:CKT BD & LCD SUPPORT, MACROBLEND DP4-1368	TK1163	441-2082-00

Table 10-3: Replaceable parts list (cont.)

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discontinued	Qty	Name & description	Mfr. code	Mfr. part number
10-1-11	671-3546-00	B010100	B014281	1	CKT BB ASSY:MAIN,TDS210	80009	671-3546-00
	671-3546-01	B014282	B024456	1	CIRCUIT BD ASSY:MAIN,TDS210	80009	671-3546-01
	671-3546-02	B024457 C010100	B038049 C010495	1	CIRCUIT BD ASSY:MAIN,TESTED,TDS210	80009	671-3546-02
	671-3546-03	B038050 C010496	B051919 C011104	1	CIRCUIT BD ASSY:MAIN,TESTED,TDS210	80009	671-3546-03
	671-3546-04	B051920 C011105	B089999 C019999	1	CIRCUIT BD ASSY:MAIN,TESTED,TDS210	80009	671-3546-04
	671-4806-00	B090100 C020100	B096042 C020839	1	CIRCUIT BD ASSY:MAIN,TESTED,TDS210	80009	671-4806-00
	671-4806-01	B096043 C020840	B099187 C021678	1	CIRCUIT BD ASSY:MAIN,TESTED,TDS210	80009	671-4806-01
	671-4806-02	B099188 C021679	B103999 C022228	1	CIRCUIT BD ASSY:MAIN,TESTED,TDS210	80009	671-4806-02
	671-4806-03	B104000 C022229	B119999 C029999	1	CIRCUIT BD ASSY:MAIN,TESTED,TDS210	80009	671-4806-03
	671-4806-04	B120000 C030000		1	CIRCUIT BD ASSY:MAIN,TESTED,TDS210	80009	671-4806-04
	671-4024-00	B010100	B014264	1	CIRCUIT BD ASSY:MAIN,TDS220	80009	671-4024-00
	671-4024-01	B014265	B022715	1	CIRCUIT BD ASSY:MAIN,TDS220	80009	671-4024-01
	671-4024-02	B022716 C010100	B032608 C010567	1	CIRCUIT BD ASSY:MAIN,TDS220	80009	671-4024-02
	671-4024-03	B032609 C010568	B042661 C011439	1	CIRCUIT BD ASSY:MAIN,TESTED,TDS220	80009	671-4024-03
	671-4024-04	B042662 C011440	B059999 C019999	1	CIRCUIT BD ASSY:MAIN,TESTED,TDS220	80009	671-4024-04
	671-5088-00	B060100 C020100	B063739 C020787	1	CIRCUIT BD ASSY:MAIN,TESTED,TDS220	80009	671-5088-00
	671-5088-01	B063740 C020788	B065809 C021126	1	CIRCUIT BD ASSY:MAIN,TESTED,TDS220	80009	671-5088-01
	671-5088-02	B065810 C021127	B068701 C021265	1	CIRCUIT BD ASSY:MAIN,TESTED,TDS220	80009	671-5088-02
	671-5088-03	B068702 C021266	B079999 C029999	1	CIRCUIT BD ASSY:MAIN,TESTED,TDS220	80009	671-5088-03
	671-5088-04	B080000 C030000		1	CIRCUIT BD ASSY:MAIN,TESTED,TDS220	80009	671-5088-04
	671-4514-01	B010100	B020701	1	CIRCUIT BD ASSY:MAIN BOARD,TESTED,TDS224	80009	671-4514-01
	671-4514-02	B020702	B021579	1	CIRCUIT BD ASSY:MAIN BOARD,TESTED,TDS224	80009	671-4514-02
	671-4514-03	B021580		1	CIRCUIT BD ASSY:MAIN BOARD,TESTED,TDS224	80009	671-4514-03

Table 10-3: 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
10-1-12	348-1526-00	B010100 C010100	B089999 C019999	1	SHLD,TUBE:COPRESSION,KNITTED WIRE SHIELDING TUBE,0.312 OD,ACCOM 0.292X0.234 GROOVE, TDS 210	OKM03	8502-0310-40
	348-1526-00	B010100 C010100	B059999 C019999		SHLD,TUBE:COPRESSION,KNITTED WIRE SHIELDING TUBE,0.312 OD,ACCOM 0.292X0.234 GROOVE, TDS 220	OKM03	8502-0310-40
	348-1526-00	B010100	B019999		SHLD,TUBE:COPRESSION,KNITTED WIRE SHIELDING TUBE,0.312 OD,ACCOM 0.292X0.234 GROOVE, TDS 224	OKM03	8502-0310-40
	348-1616-00	B090100 C020100		1	SHLD GSKT,ELEC FOLD OVER,ADHESIVE,0.25L X 0.51W,BECU BRIGHT NI PLT;TX1/TX3, TDS 210	TK2647	0097-0521-19
	348-1616-00	B060100 C020100			SHLD GSKT,ELEC FOLD OVER,ADHESIVE,0.25L X 0.51W,BECU BRIGHT NI PLT;TX1/TX3, TDS 220	TK2647	0097-0521-19
	348-1616-00	B020100			SHLD GSKT,ELEC FOLD OVER,ADHESIVE,0.25L X 0.51W,BECU BRIGHT NI PLT;TX1/TX3, TDS 224	TK2647	0097-0521-19
10-1-13	679-3743-00			1	CKT BD SUBASSY:OEM FRONT PANEL,3 DETENTED & 4 NON-DETENTED ENCODERS,TDS210/TDS220	32997	3777S-TEK-001
	671-4680-00			1	CIRCUIT BD ASSY:FRONT PANEL,ENCODER,TDS224	80009	671-4680-00
10-1-14	260-2654-00			1	SWITCH:ELASTOMER KEY PAD,TDS210,TDS220	TK2376	260-2654-00
	260-2722-00			1	SWITCH:PUSHBUTTON SET,ELASTOMERIC,TDS224	TK2376	260-2722-00
10-1-15	119-4991-10	B010100	B011848	1	LCD SHIELD ASSY:119-4991-00 & 337-4069-00	80009	119-4991-10
	119-4991-11	B011849		1	LCD SHIELD ASSY:119-4991-00 & 337-4069-00	80009	119-4991-11
	119-4991-10	B010100	B012275	1	LCD SHIELD ASSY:119-4991-00 & 337-4069-00	80009	119-4991-10
	119-4991-11	B012276		1	LCD SHIELD ASSY:119-4991-00,337-4069-00,119-5585-00	80009	119-4991-11
10-1-16	348-1534-00			1	GASKET,EMI:0.375 X 0.50 X 1.0 INCH LONG,OPEN CELL URETHANE FOAM,W/ADHESIVE STRIP (TDS 210 and TDS 220 only)	77824	E6819T00100
10-1-17	348-1525-00			2	FOOT:SANTOPRENE,BLACK,64 DEROMETER,TEXTURED	TK1163	348-1525-00
10-1-18	366-0771-00			3	KNOB,CAP:PC/ABS BAYBLEND FR110,SILVER GRAY,0.650 DIA X 0.520 H	TK1163	366-0771-00
10-1-19	366-0772-00			4	KNOB,CAP:PC/ABS BAYBLEND FR110,SIVER GRAY,0.425 DIA X 0.520 H	TK1163	366-0772-00
10-1-20	334-8682-00			1	MARKER,IDENT:FRONT BEZEL LABEL,MARKED TDS220,5.470 X 0.345,0.010 POLY FILM, ADEH	OKB05	334-8682-00
	334-9261-00			1	MARKER,IDENT:FRONT BEZEL LABEL,MARKED TDS210,5.470 X 0.345,0.010 POLY FILM, ADEH	OKB05	334-9261-00
	334-9884-00			1	MARKER,IDENT:FRONT BEZEL,MKD TDS224,0.010 POLY,W/ADHESIVE	OKB05	334-9884-00
10-1-21	202-0346-00	B010100 C010100	B089999 C019999	1	CASE,FRONT:ABS,BAYBLEND,FR110,TDS210	TK1163	202-0346-00
	202-0346-01	B090100 C020100		1	CASE,FRONT:ABS,BAYBLEND,FR110,TDS210	TK1163	202-0346-01
	202-0346-00	B010100 C010100	B059999 C019999	1	CASE,FRONT:ABS,BAYBLEND,FR110,TDS220	TK1163	202-0346-00
	202-0346-01	B060100 C020100		1	CASE,FRONT:ABS,BAYBLEND,FR110,TDS220	TK1163	202-0346-01

Table 10-3: Replaceable parts list (cont.)

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discontinued	Qty	Name & description	Mfr. code	Mfr. part number
	333-4306-00			1	PANEL,FRONT:ABS,TDS224	TK6181	333-4306-00
10-1-22	337-4069-00			1	SHIELD,ELEC:DISPLAY,0.062 GE LEXAN,HARDCOATED BOTH SURFACES,PKG W/PROTECTIVE SHEETS,	07416	337-4069-00
10-1-23	367-0476-00			1	FLIP STAND:PC/ABS BAYBLEND,FR110,TEXTURED	TK1163	367-0476-00
10-1-24	131-6173-00	B010100	B024106	4	CONTACT,ESD:ESD CLIP,0.005 C17200 BECU,ACCOM 0.062 PCB,0.5 X 0.335 WIDE CONTACT,W/0.230 H X 0.5,3 PRONGED TAB,TDS210	TK1326	131-6173-00
	131-6173-01	B024107		4	CONTACT,ESD:ESD CLIP,0.005 C17200 BECU,ACCOM 0.062 PCB,0.5 X 0.335 WIDE CONTACT,W/0.230 H X 0.5,3 PRONGED TAB,TDS210	TK1326	131-6173-00
	131-6173-00	B010100	B022380	4	CONTACT,ESD:ESD CLIP,0.005 C17200 BECU,ACCOM 0.062 PCB,0.5 X 0.335 WIDE CONTACT,W/0.230 H X 0.5,3 PRONGED TAB,TDS220	TK1326	131-6173-00
	131-6173-01	B022381		4	CONTACT,ESD:ESD CLIP,0.005 C17200 BECU,ACCOM 0.062 PCB,0.5 X 0.335 WIDE CONTACT,W/0.230 H X 0.5,3 PRONGED TAB,TDS220	TK1326	131-6173-00
	131-6173-01			4	CONTACT,ESD:ESD CLIP,0.005 C17200 BECU,ACCOM 0.062 PCB,0.5 X 0.335 WIDE CONTACT,W/0.230 H X 0.5,3 PRONGED TAB,TDS224	TK1326	131-6173-00
NOT SHOWN	119-5585-00	B010100	B012275	1	LAMP:CCFT,REPLACEMENT FOR LCD W/LEADS	TK2569	LM0F2964

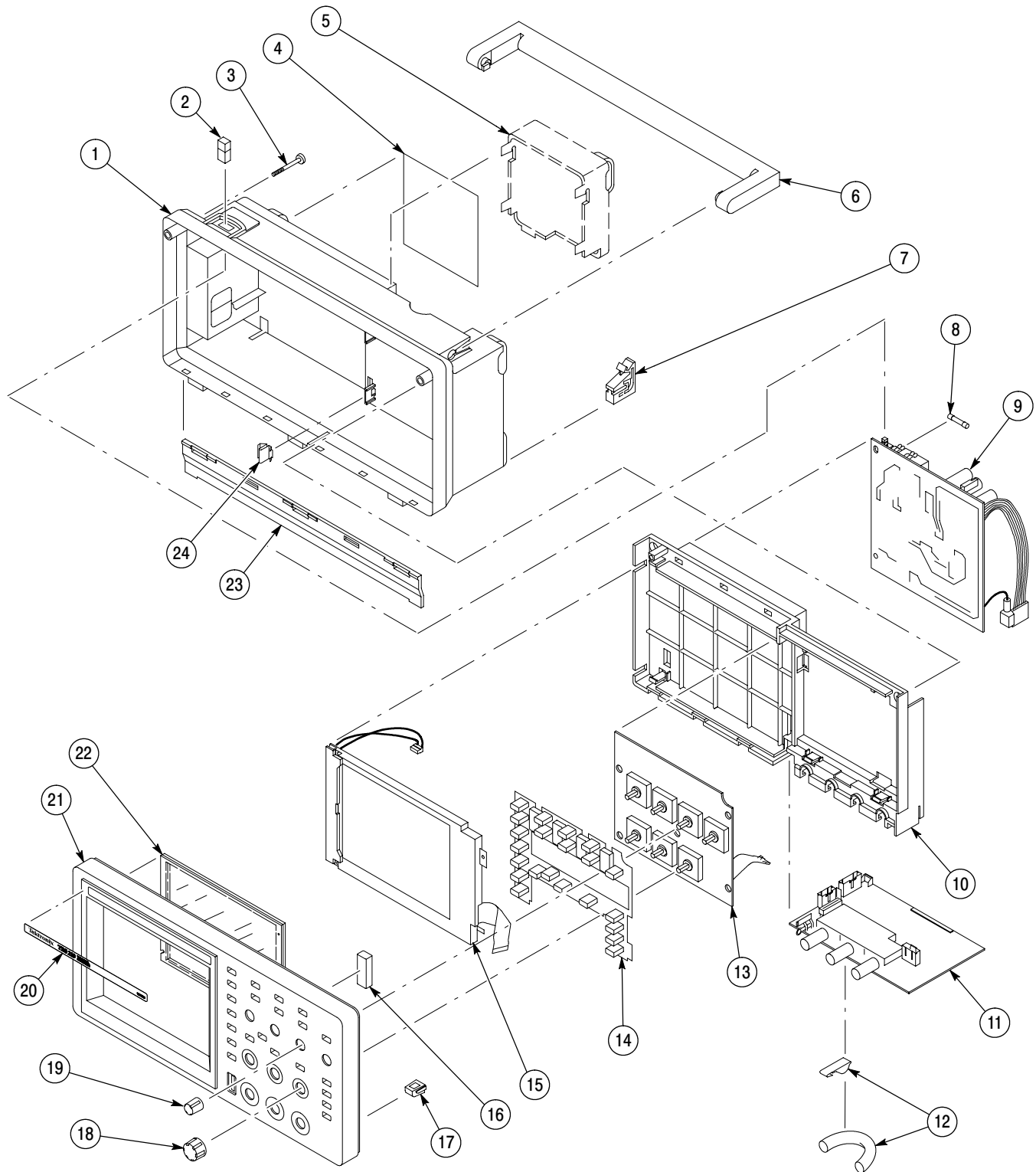


Figure 10-1: Exploded diagram

Table 10-4 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 10-1.

Table 10-4: Replaceable standard accessories

Description of accessory		Tektronix part number or nomenclature
Passive 1X/10X probes		P2100
Replacement user manual		
English		071-0398-XX
French		071-0400-XX*
German		071-0402-XX*
Italian		071-0401-XX*
Spanish		071-0399-XX*
Portuguese		071-0403-XX*
Japanese		071-0405-XX*
Korean		071-0408-XX*
Simplified Chinese		071-0406-XX*
Traditional Chinese		071-0407-XX*
Russian		071-0404-XX
Replacement power cords		
North American	120 V, 60 Hz	161-0230-01
North American	240 V, 60 Hz	161-0104-08
Universal European	230 V, 50 Hz	161-0104-06
United Kingdom	230 V, 50 Hz	161-0104-07
Switzerland	230 V, 50 Hz	161-0167-00
Australian	240 V, 50 Hz	161-0104-05
China	220 V, 50 Hz	161-0304-00

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

Table 10-5: Replaceable optional accessories

Description of accessory	Tektronix part number or nomenclature
Soft case	AC220
Transit case*	HCTDS32
Measurement Extension Module	TDS2MM
Communications Extension Module	TDS2CM
Rackmount Kit	RM200

* Requires the soft case which fits inside.

Table 10-5: Replaceable optional accessories (cont.)

Description of accessory	Tektronix part number or nomenclature
Replacement extension module instructions	
English	071-0409-XX
French	071-0483-XX
German	071-0485-XX
Italian	071-0484-XX
Spanish	071-0482-XX
Portuguese	071-0486-XX
Japanese	071-0488-XX
Korean	071-0491-XX
Simplified Chinese	071-0489-XX
Traditional Chinese	071-0490-XX
Russian	071-0487-XX
Replacement programmer manual	071-0493-XX