



**TPS2000B Series  
Digital Storage Oscilloscopes  
Service Manual**



077-0447-02





**TPS2000B Series  
Digital Storage Oscilloscopes  
Service Manual**

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.

To avoid potential hazards, use this product only as specified.

*Only qualified personnel should perform service procedures.*

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

### To avoid fire or personal injury

**Use proper power cord.** Use only the power cord specified for this product and certified for the country of use.

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

**Connect and disconnect properly.** Connect the probe output to the measurement instrument before connecting the probe to the circuit under test. Connect the probe reference lead to the circuit under test before connecting the probe input. Disconnect the probe input and the probe reference lead from the circuit under test before disconnecting the probe from the measurement instrument.

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

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

**Do not operate without covers.** Do not operate this product with covers or panels removed.

**Do not operate with suspected failures.** If you suspect that there is damage to this product, have it inspected by qualified service personnel.

**Avoid exposed circuitry.** Do not touch exposed connections and components when power is present.

**Replace batteries properly.** Replace batteries only with the specified type and rating.

**Recharge batteries properly.** Recharge batteries for the recommended charge cycle only.

**Use proper AC adapter.** Use only the AC adapter specified for this product.

**Wear eye protection.** Wear eye protection if exposure to high-intensity rays or laser radiation exists.

**Do not operate in wet/damp conditions.**

**Do not operate in an explosive atmosphere.**

**Keep product surfaces clean and dry.**

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

**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.*

---

**Symbols and 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.

The following symbol(s) may appear on the 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, switch off the instrument power, then disconnect the power cord from the mains power.

**Use care when servicing with power on.** Dangerous voltages or currents may exist in this product. Disconnect power, 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.



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# Preface

This service manual for the TPS2000B Series Digital Storage Oscilloscopes provides instructions to verify the performance of, calibrate, troubleshoot, and repair the oscilloscopes to the module level.

Unless noted otherwise, the term "oscilloscope" refers to all of the models in the TPS2000B Series.

## Products

This manual covers the following products:

- TPS2012B Digital Storage Oscilloscope
- TPS2014B Digital Storage Oscilloscope
- TPS2024B Digital Storage Oscilloscope

## Related manuals

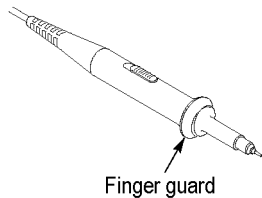
These manuals contain additional documentation for the oscilloscopes. They are available at [www.tektronix.com/manuals](http://www.tektronix.com/manuals).

Language	User manual part number	Programmer manual part number
English	071-2733-XX	077-0444-XX
French	071-2734-XX <sup>1</sup>	
Italian	071-2735-XX <sup>1</sup>	
German	071-2736-XX <sup>1</sup>	
Spanish	071-2737-XX <sup>1</sup>	
Japanese	071-2738-XX <sup>1</sup>	
Portuguese	071-2739-XX <sup>1</sup>	
Simplified Chinese	071-2740-XX <sup>1</sup>	
Traditional Chinese	071-2741-XX <sup>1</sup>	
Korean	071-1450-XX <sup>1</sup>	
Russian	071-2743-XX <sup>1</sup>	

<sup>1</sup> These manuals contain a language overlay for the front-panel controls.

## Probe safety

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



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

---

Connect the probe output to the oscilloscope before connecting the probe to the circuit under test. Disconnect the probe input and the probe reference lead from the circuit under test before disconnecting the probe from the measurement instrument.

# Specifications

These specifications apply to all TPS2000B Series oscilloscopes. To verify that an oscilloscope meets specifications, it must first meet the following conditions:

- The oscilloscope must have been operating continuously for twenty minutes within the specified operating temperature range. (See Table 9.)
- You must perform the Do Self Cal operation, accessible through the Utility menu, if the operating temperature changes by more than 5 °C.
- The oscilloscope must be within the factory calibration interval of one year.
- The V/div specifications apply with the probe calibration set to 1X probe mode.

Specifications begin in the following table. All specifications are guaranteed unless noted "typical." Specifications that are marked with the ✓ symbol are checked in the *Performance Verification* section.

## Signal Acquisition System

Table 1: Signal acquisition system

Characteristic	Description						
Number of Input Channels	Two (TPS2012B) or four (TPS2014B, TPS2024B) identical channels, digitized simultaneously						
Input Coupling	DC, AC, or GND  AC coupling connects a capacitor in series with the input circuitry. The DC input impedance becomes very high, since capacitance is in series with all paths to ground.  Ground coupling mode provides a reference waveform derived from the values identified during SPC. This reference waveform shows visually where signal reference (ground) is expected to be.						
Input Impedance, DC Coupled	1 MΩ ±2% in parallel with 20 pF ±3 pF						
Maximum Input Voltage (between Signal and Reference at input BNC) <sup>1</sup>	<table border="1"> <thead> <tr> <th>Overvoltage Category</th> <th>Maximum Voltage</th> </tr> </thead> <tbody> <tr> <td>CAT I and CAT II</td> <td>300 V<sub>RMS</sub></td> </tr> <tr> <td>CAT III</td> <td>150 V<sub>RMS</sub></td> </tr> </tbody> </table> <p>At front panel connector, 300 V<sub>RMS</sub>; derate at 20 dB/decade above 100 kHz to 13 V peak AC at 3 MHz and above.  All inputs are rated 300 V CAT II, signal to floating common.  Derate at 20 dB/decade above 100 kHz to 13 V peak AC at 3 MHz and above. For nonsinusoidal waveforms, peak value must be less than 450 V. Excursion above 300 V should be less than 100 ms duration. RMS signal level, including any DC component removed through AC coupling, must be limited to 300 V. If these values are exceeded, damage to the oscilloscope may result. Refer to the Overvoltage Category description. (See Table 9 on page 10.)</p>	Overvoltage Category	Maximum Voltage	CAT I and CAT II	300 V <sub>RMS</sub>	CAT III	150 V <sub>RMS</sub>
Overvoltage Category	Maximum Voltage						
CAT I and CAT II	300 V <sub>RMS</sub>						
CAT III	150 V <sub>RMS</sub>						
Maximum Float Voltage	Rated 600 V <sub>RMS</sub> CAT II.  Between instrument common (chassis) and BNC shell. Using rated connectors or accessories.						
Number of Digitized Bits	8-bit resolution (except when set to 2 mV/div), each channel sampled simultaneously.						

**Table 1: Signal acquisition system (cont.)**

Characteristic	Description	
Supported Voltage Probe Attenuation Factors	1X, 10X, 20X, 50X, 100X, 500X, 1000X This adjusts the display scale factor of the instrument to accommodate various probe types. Accuracy of the probe used must be added to the accuracy specifications of instrument. The Tektronix probe Interface is not provided, so the user must adjust the setting to match the probe characteristics.	
Supported Current Probe Scales	1 mV/mA, 5 mV/mA, 1 mV/A, 10 mV/A, 20 mV/A, 50 mV/A, 100 mV/A, 200 mV/A This adjusts the display scale factor of the instrument to accommodate various probe types. Accuracy of the probe used must be added to the accuracy specifications of instrument. The Tektronix probe Interface is not provided, so the user must adjust the setting to match the probe characteristics.	
Acquisition Modes	Sample, Peak Detect, and Average Envelope mode not provided	
✓ DC Gain Accuracy	±3% for Sample or Average acquisition mode, 5 V/div to 10 mV/div ±4% for Sample or Average acquisition mode, 5 mV/div and 2 mV/div	
✓ DC Measurement Accuracy, Average Acquisition Mode	<i>Measurement Type</i>	<i>Accuracy</i>
	Average of ≥16 waveforms with vertical position at zero	±(3% ×  reading  + 0.1 div + 1 mV)
	Average of ≥16 waveforms with vertical position not at zero for 2 mV to 200 mV/div.	±[3% × ( reading + vertical position ) + 1% of  vertical position  + 0.2 div + 2 mV]
	Average of ≥ 16 waveforms with vertical position not at zero for >200 mV to 5 V/div.	±[3% ×  reading + vertical position  + 1% of  vertical position  + 0.2 div + 50mV]
DC Voltage Measurement Repeatability, Average Acquisition Mode	Change in measured volts between any two averages of ≥ 16 waveforms acquired under the same setup and ambient conditions. (3% of  reading  + 0.05 div)	
Analog Bandwidth	Defined in Section 4.6 of IEEE std 1057. The difference between the upper and lower frequencies, at which the amplitude response, as seen in the data record, is 0.707 (-3 dB) of the response seen in the data record at the specified reference frequency. Specified only -3 dB point, does not include in-band response.	
✓ Analog Bandwidth in Sample and Average modes at BNC or with probe set to 10X, DC Coupled, typical	<i>TPS2012B and TPS2014B</i>	<i>TPS2024B</i>
	DC to 100 MHz for all V/div settings with bandwidth limit at full.	DC to 200 MHz for all V/div settings 5 mV and above, for operating temperatures from 0°C to 40 °C. DC to 180 MHz for all V/div settings 5 mV/div and above, for operating temperatures from 40 °C to 50 °C
Analog Bandwidth in Peak Detect mode (50 s/div to 5 ms/div), DC coupled, typical	DC to ≥75 MHz for all V/div settings with bandwidth limit at full.	
Lower Frequency Limit, AC Coupled	≤10 Hz at BNC ≤1 Hz when using a 10X passive probe	



Table 1: Signal acquisition system (cont.)

Characteristic	Description	
Rise Time at BNC, typical	<i>TPS2012B and TPS2014B</i>	<i>TPS2024B</i>
	< 3.5 ns	< 2.1 ns
	Rise time is generally calculated from the following formula: Rise time in ns = 350 / Bandwidth in MHz	
Peak Detect Response	Captures 50% or greater amplitude of pulses $\geq 12$ ns wide typical (50 s/div to 5 $\mu$ s/div) in the center 8 vertical divisions	
Vertical Position Range	2 mV/div to 200 mV/div, $\pm 1.8$ V	
	>200 mV/div to 5 V/div, $\pm 45$ V	
Vertical Position Accuracy	2 mV/div to 200 mV/div, $\pm(1\% \times \text{selected value} + 0.1 \text{ div} + 2 \text{ mV})$ within the range $\pm 1.8$ V	
	>200 mV/div to 5 V/div, $\pm(1\% \times \text{selected value} + 0.1 \text{ div} + 50 \text{ mV})$ within the range $\pm 45$ V	
Single Channel Common Mode Rejection, typical	Greater than 1000:1 up to 50 MHz, derated to 400:1 at 200 MHz	
	Sine wave with VOLTS/DIV setting at 5 mV. Signal applied between the channel (signal and signal reference) and chassis. Ratio of the acquired signal amplitude to the amplitude of the signal.	
Channel-Channel Common Mode Rejection Ratio, typical	100:1 at 60 Hz, reducing to 10:1 with 50 MHz sine wave, with equal volts/div and coupling settings on each channel.	
	With the same signal applied to each channel, this is the ratio of the acquired signal amplitude to the amplitude of the MATH difference waveform, CH1–CH2, CH2–CH1, CH3–CH4, or CH4–CH3.	
Channel-to-Channel Crosstalk	<i>TPS2012B and TPS2014B</i>	<i>TPS2024B</i>
	50 MHz: $\geq 100:1$	100 MHz: $\geq 100:1$
	Measured on one channel, with test signal applied between signal and common of the other channel, and with the same VOLTS/DIV and coupling settings on each channel.	
Waveform acquisition Rate, typical	Up to 180 waveforms per second, per channel (Sample acquisition mode, no measurements)	

<sup>1</sup> The maximum peak-to-peak voltage that can be displayed is 40  $V_{p-p}$  with 1x attenuation.

## Time Base System

Table 2: Time base system

Characteristic	Description	
Sample Rate Range	<i>TPS2012B and TPS2014B</i>	<i>TPS2024B</i>
	5 S/s to 1 GS/s	5 S/s to 2 GS/s
Waveform Interpolation	(sin x)/x Waveform interpolation is activated for sweep speeds of 100 ns/div and faster.	
Record Length	2500 samples for each channel	
Seconds/Division Range	<i>TPS2012B and TPS2014B</i>	<i>TPS2024B</i>
	5 ns/div to 50 s/div, in a 1, 2.5, 5 sequence	2.5 ns/div to 50 s/div, in a 1, 2.5, 5 sequence
✓ Sample Rate and Delay Time Accuracy	$\pm 50$ ppm over any $\geq 1$ ms time interval	

**Table 2: Time base system (cont.)**

Characteristic	Description	
Position Range	2.5 ns/div to 10 ns/div: (-4 div× s/div) to 20 ms	
	25 ns/div to 100 ms/div: (-4 div × s/div) to 50 ms	
	250 μs/div to 10 s/div: (-4 div × s/div) to 50 s	
	25 s/div to 50 s/div: (-4 div× s/div) to 250 s	
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)
The limits apply for signals having amplitude > 5 divisions, slew rate at the measurement points of > 2.0 divisions/ns, and acquired > 10 mV/Div. Sample interval is the time between the samples in the waveform record.		

## Triggering System

**Table 3: Triggering system**

Characteristic	Description
Holdoff Range	500 ns to 10 s  The ability to set large values of Holdoff is limited by the difficulty in adjusting the Holdoff at Sec/Div settings less than 100 ms/div. This is because Holdoff cannot be set in Scan Mode, which begins at 100 ms/div when Trigger Mode is AUTO. By adjusting Trigger Mode to NORMAL, the Scan Mode operation is turned off, and Holdoff can be adjusted at larger Sec/Div settings.
External Trigger Input Impedance	1 M ±2% in parallel with 20 pF ±3 pF
External Trigger Maximum Input Voltage	300 V <sub>RMS</sub> CAT 1 and CAT II 150 V <sub>RMS</sub> CAT III  At front panel connector, signal input to BNC shell, 300 V <sub>RMS</sub> ; derate at 20 dB/decade above 100 kHz to 13 V peak AC at 3 MHz and above.  Based upon sinusoidal or DC input signal. For nonsinusoidal waveforms, peak value must be less than 420 V. Excursion above 300 V should be less than 100 ms duration. RMS signal level must be limited to 300 V. If these values are exceeded, damage to the instrument may result. Input is rated 300 V CAT II, signal to floating common.
External Trigger Maximum Float Voltage	Rated 600 V CAT II. Instrument chassis is normally considered to be at earth ground. Between instrument chassis and BNC shell

Table 3: Triggering system (cont.)

Characteristic	Description	
✓ Trigger Sensitivity, Edge Trigger Type. DC Coupled	<i>Trigger Source</i>	<i>Sensitivity</i>
	All products	1 div from DC to 10 MHz
	TSP2012B	1.5 div from 10 MHz to 100 MHz
	TPS2014B	
	TSP2024B	1.5 div from 10 MHz to 100 MHz
		2 div from 100 MHz to 200 MHz
	EXT	1 $V_{p-p}$ from 50 Hz to 100 MHz
		2 $V_{p-p}$ from 100 MHz to 200 MHz
	EXT/5	5X the value of EXT
	EXT/10	10X the value of EXT
	The minimum signal levels required for stable edge triggering of an acquisition when the trigger Source is DC coupled. A stable trigger is one that results in a uniform, regular visual display, triggered on the selected slope. The trigger point must not switch between opposite slopes on the waveform, and the display must not "roll" across the screen on successive acquisitions. Trigger Frequency Readout typically stabilizes at 25% more signal than generates a stable visual display. At 5 mV/div, 50% additional signal is typically required.	
Trigger Sensitivity, Edge Trigger Type, typical	<i>Coupling</i>	<i>Sensitivity</i>
	AC	Same as DC-coupled limits from 50 Hz and above
	NOISE REJ	Reduces the DC-coupled trigger sensitivity by 2 times for greater than 10 mv/div to 5 V/div
	HF REJ	Same as the DC-coupled limit from DC to 7 kHz, attenuates signals above 80 kHz
	LF REJ	Same as the DC-coupled limits for frequencies above 300 kHz, attenuates signals below 300 kHz
SET LEVEL TO 50%, typical	Operates with input signals equal to or greater than 50 Hz Using a 10 M probe will not affect the operation of this function.	
Trigger Level Range	<i>Source</i>	<i>Range</i>
	CH1, CH2, CH3 <sup>2</sup> , CH4 <sup>2</sup>	±8 divisions from center of screen
	EXT	±4 V
	EXT/5	±20 V
	EXT/10	±35 V
		The adjustable resolution for Trigger Level is 0.02 division for Ch1 or Ch2 source, (and Ch3, Ch4 for the TPS2014B, TPS2024B) 20 mV for Ext source 100 mV for Ext/5 source 200 mV for Ext/10 source

**Table 3: Triggering system (cont.)**

Characteristic	Description	
Trigger Level Accuracy, typical	Accuracies are for signals having rise and fall times $\geq 20$ ns	
	<i>Source</i> <i>Accuracy</i>	
	Internal	$\pm(0.2 \text{ div} + 5 \text{ mV})$ within $\pm 4$ divisions from center screen having rise and fall times of $> 20$ ns.
	EXT	$\pm(6\% \text{ of setting} + 250 \text{ mV})$ for signals less than $\pm 2$ V
	EXT/5	$\pm(6\% \text{ of setting} + 500 \text{ mV})$ for signals less than $\pm 10$ V
	EXT/10	$\pm(6\% \text{ of setting} + 1 \text{ V})$ for signals less than $\pm 20$ V
	A sine wave with 20 ns rise time corresponds to about 18 MHz.	
Default Settings, Video Trigger	Coupling is AC and Auto except for a single sequence acquisition	
Signal Formats and Field Rates, Video Trigger Type	Supports NTSC, PAL, and SECAM broadcast systems for any field or any line	
Sensitivity, Video Trigger Type, typical	Composite video signal	
	<i>Source</i> <i>Range</i>	
	Internal	Peak-to-peak amplitude of 2 div
	EXT	1 V of composite video
	EXT/5	5 V of composite video
	EXT/10	10 V of composite video
	A 2 division composite video signal will have a 0.6 division sync tip.	
<b>Pulse Width Trigger</b>		
Pulse Width Trigger modes	Trigger when < (Less than), > (Greater than), = (Equal), or $\neq$ (Not Equal) Positive pulse or Negative pulse	
Pulse Width Trigger Point	<i>Equal</i> : The oscilloscope triggers when the trailing edge of the pulse crosses the trigger level. <i>Not Equal</i> : If the pulse is narrower than the specified width, the trigger point is the trailing edge. Otherwise, the oscilloscope triggers when a pulse continues longer than the time specified as the Pulse Width. <i>Less than</i> : The trigger point is the trailing edge. <i>Greater than</i> (also called time-out trigger): The oscilloscope triggers when a pulse continues longer than the time specified as the Pulse Width.	
Pulse Width Range	Selectable from 33 ns to 10 s	
Pulse Width Resolution	16.5 ns or 1 part per thousand, whichever is larger	
Equal Guard Band	$t > 330 \text{ ns}$ : $\pm 5\% \leq \text{guard band} < \pm(5.1\% + 16.5 \text{ ns})$ $t \leq 330 \text{ ns}$ : guard band = $\pm 16.5 \text{ ns}$	
Not Equal Guard Band	$t > 330 \text{ ns}$ : $\pm 5\% \leq \text{guard band} < \pm(5.1\% + 16.5 \text{ ns})$ $165 \text{ ns} < t \leq 330 \text{ ns}$ : guard band = $-16.5 \text{ ns} \pm 33 \text{ ns}$ $t \leq 165 \text{ ns}$ : guard band = $\pm 16.5 \text{ ns}$	
<b>Trigger Frequency Counter</b>		
Readout Resolution	6 digits	
Accuracy, typical	$\pm 51$ ppm including all frequency reference errors and $\pm 1$ count errors	

Table 3: Triggering system (cont.)

Characteristic	Description
Frequency Range	AC coupled, 10 Hz minimum to rated bandwidth.
Signal Source	<p><i>Pulse Width/ Edge Trigger:</i> all available trigger sources.</p> <p><i>Frequency Counter</i> measures trigger source at all times, including when the oscilloscope acquisition is halted due to changes in the run status, or acquisition of a single shot event has completed.</p> <p><i>Pulse Width Trigger:</i> The oscilloscope counts pulses of significant magnitude inside the 250 ms measurement window that qualify as triggerable events, such as narrow pulses in a PWM pulse train if set to &lt; mode and the width is set to a relatively small time.</p> <p><i>Edge Trigger:</i> The oscilloscope counts all edges of sufficient magnitude and correct polarity.</p> <p><i>Video Trigger:</i> The Frequency Counter does not operate.</p>

<sup>1</sup> Available only on 4-channel oscilloscopes.

<sup>2</sup> TPS2024B only.

## Display

Table 4: Display

Characteristic	Description
Type	11.5 cm (W) x 8.64 cm (H), 14.38 cm diagonal, ¼ VGA, active TFT color liquid crystal display (LCD) with color characters/waveforms on a black background. Surface anti-glare (3H) treatment
Resolution	320 horizontal by 240 vertical pixels
Brightness, typical	400 typical, 320cd/m <sup>2</sup> min.
Backlight Intensity	<p>Three strings of 5 LEDs in series.</p> <p>Variable minimum is 14.85 V. <sup>1</sup></p> <p>Variable maximum is 18.15 V. <sup>1</sup></p> <p>Typical current is 25 mA for each of the three strings.</p>

<sup>1</sup> Available through the display menu.

## Batteries

Table 5: Batteries

Characteristic	Description
<b>Real-Time Clock Battery</b>	
Real-Time Clock Battery	<p>The battery maintains time-of-day information when the oscilloscope is powered off.</p> <p>The battery is sized to provide 5 years of service life.</p> <p>The estimated time that the clock will remain powered from the battery is 5 years. Environmental conditions, especially humidity, affect the number. The battery is not user-replaceable.</p>
<b>Li Ion Battery Packs</b>	

**Table 5: Batteries (cont.)**

Characteristic	Description
Type	System supports 2 type NI2040 Li Ion Battery Packs
Nominal Capacity	6600 mAH
Battery Life	5.5 hours per battery, 2 channel models 4 hours per battery, 4 channel models 300 charge/discharge cycles. Battery will have 80% of rated capacity after 300 charge cycles.
Charge time, nominal	Instrument nonoperating: 4.5 hours Instrument operating: 6.5 hours

## External DC Input

**Table 6: External DC input**

Characteristic	Description
Voltage	15 V, $\pm 1$ V The input is not protected from the electrically harsh automobile electrical system. Operation from a vehicle requires a specifically designed external power supply.
Current consumption	Typical Power draw from External DC input: 2 channel models, charging a battery: 21 W 2 channel models, no battery: 13 W 4 channel models, charging a battery: 30 W 4 channel models, no battery: 18 W Charging only, instrument OFF: 28 W Maximum power draw from AC line by AC Adapter, 36 watts
Connector type	2.5 mm male. Use a mating connector with a 2.5 mm barrel hole. Center conductor: positive Outer conductor: negative

## External Interfaces

**Table 7: External interfaces**

Characteristic	Description
Interfaces for data communication and probe compensation	RS-232, Parallel port, Compact flash, Probe compensation
Probe Compensator output voltage, typical	5 V p-p, $\pm 10\%$ into $\geq 1$ M $\Omega$ load
Probe Compensator output frequency, typical	1 kHz

## Mechanical Characteristics

Table 8: Mechanical characteristics

Characteristic	Description	
Weight, approximate	Instrument only	2.7 kg (6.0 lbs)
	1 battery installed	3.2 kg (7.0 lbs)
	2 batteries installed	3.7 kg (8.0 lbs)
Dimensions, without front protective cover	Height	161 mm (6.33 in)
	Width	336 mm (13.24 in)
	Depth	130 mm (5.1 in)
Dimensions, with front protective cover	Height	164 mm (6.45 in)
	Width	347 mm (13.65 in)
	Depth	135 mm (5.3 in)
Cooling method	Temperature controlled fan. Intake vents on the bottom; exhaust on the right side.	

## Environmental Performance

Table 9: Environmental performance

Characteristic	Description	
Temperature	<i>Operating</i> <sup>1</sup>	<i>Nonoperating</i> <sup>1</sup>
	Operation without battery: 0 °C to 50 °C (32 °F to 122 °F), with 5°C/minute maximum gradient, noncondensing, up to 3000 altitude.	-40 °C to +71 °C (-40 °F to 159.8 °F), with 5°C/minute maximum gradient.
	Operating with battery: 0 °C to 45 °C (32 °F to 113 °F), with 5°C/minute maximum gradient, noncondensing, up to 3000 altitude. <sup>2</sup>	
Humidity	<i>Operating</i> <sup>3</sup>	<i>Nonoperating</i> <sup>3</sup>
	5% to 90% relative humidity (%RH) at up to +30 °C (86 °F)	5% to 90% relative humidity (%RH) at up to +30 °C (86 °F) <sup>4</sup>
	5% to 60% relative humidity (%RH) at up to +50 °C (122 °F)	5% to 60% relative humidity (%RH) between +30 °C (86 °F) and +71 °C (160 °F) noncondensing. <sup>4</sup>
Altitude, Operating and Nonoperating	3,000 m (10,000 ft) Altitude is limited by possible damage to the LCD at higher altitudes. This damage is independent of operation.	
Pollution Degree	2	
Random Vibration	<i>Operating</i>	<i>Nonoperating</i>
	0.31 g <sub>RMS</sub> from 5 Hz to 500 Hz, 10 minutes on each axis, 3 axes (30 minutes total).	2.46 g <sub>RMS</sub> from 5 Hz to 500 Hz, 10 minutes on each axis, 3 axes (30 minutes total).
Mechanical Shock, operating <sup>5</sup>	Half-sine mechanical shocks, 50 g peak amplitude, 11 ms duration, 3 drops in each direction of each axis (18 total)	

<sup>1</sup> The battery will not charge in the oscilloscope above 35 °C (95 °F). The battery will stop charging above 50 °C (122 °F) and below 0 °C (32 °F) battery temperature (ambient temperature is 10 °C (50 °F) less). Charging battery packs outside this range can damage cells or cause them to leak.

<sup>2</sup> Battery temperature exceeding 55 °C (131 °F) can cause the oscilloscope to shutdown without warning.

<sup>3</sup> Battery packs are rated to operate between -10 °C and +50 °C (-14 °F and +122 °F) with less than 80% relative humidity. Operating outside this range can cause damage. Battery packs will stop discharging above 55 °C (131 °F) and the maximum operating temperature is 45 °C (113 °F). Battery discharge capacity drops significantly at temperatures below 0 °C (32 °F). Operating the battery at a high temperature will reduce battery lifetime.

<sup>4</sup> Max wet bulb.

<sup>5</sup> With one battery pack installed.



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## Operating Information

For information on installing and operating your TPS2000B Series Digital Storage Oscilloscope, refer to the *TPS2000B Series Digital Storage Oscilloscope User Manual*. (See page ix, *Related manuals*.)



# Theory of Operation

This section describes the electrical operation of the TPS2000B Series oscilloscopes to the module level. It describes the basic operation of each functional circuit block shown in the following figure.

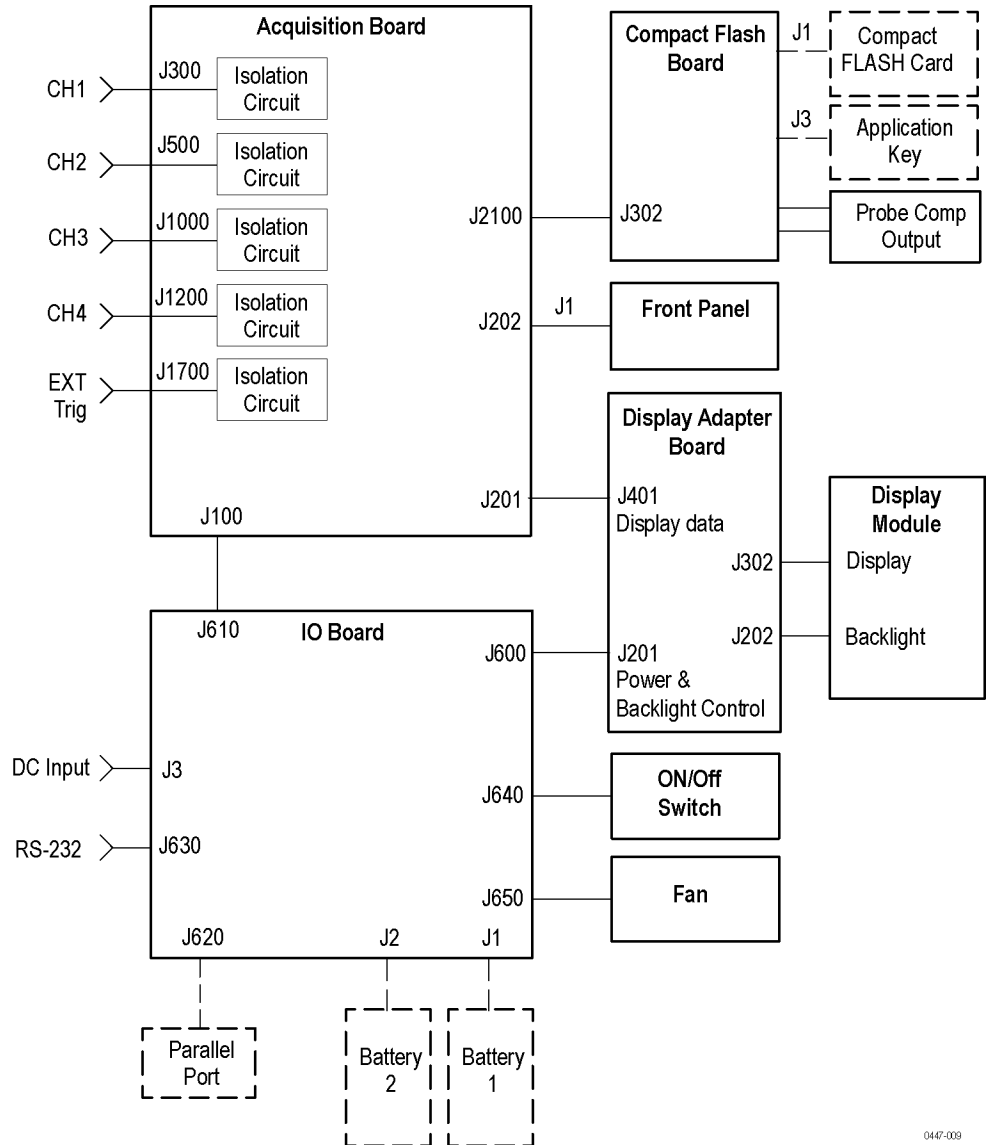


Figure 1: TPS2000B Series module-level block diagram. Remove CH3 and CH4 for a 2-channel version

## Acquisition Board

The Acquisition board of the TPS2000B Series four-channel oscilloscope is essentially a dual, two-channel oscilloscope tied together through a common microprocessor, and some special interconnects. This allows the combining of the display and trigger systems. The focus of this Acquisition board discussion is on the two-channel system, with differences noted as necessary.

At a minimum, the Acquisition board contains the following components:

- Attenuators
- ASIC amplifier
- Isolation circuit
- Digitizer-trigger system ASIC
- Signal-processing/display/system services ASIC
- RAM
- FLASH ROM
- Microprocessor
- Internal peripheral interface
- Power supplies

For a four-channel oscilloscope, the attenuators and ASICs are duplicated. Most of the other aspects of the circuitry are the same as for the two-channel oscilloscope.

### Acquisition System

Signals from the CH 1, CH 2, and other input connectors pass through attenuators and an AC-coupling switch to the amplifier ASIC. The EXT TRIG input uses an abbreviated version of this path, without some of the attenuator settings and the AC coupling switch.

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

The isolation circuit uses a modulation clock to transfer the input signal across the isolation boundary via an isolation transformer. The input signal is demodulated and sent to the acquisition ASIC. Control of the amplifier ASIC across the isolation boundary is provided by an optocoupler. Power is provided to each amplifier ASIC and associated circuits by an isolated switching power supply, dedicated to each channel.

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

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

### **Processing and Display System**

The processing and display system consists of the display ASIC, DRAM, and system oscillator. Digitized acquisition samples are received by the display ASIC and stored in DRAM. Once data are received by the display ASIC, various corrections are applied, display rasterization is performed, and the waveform is placed into a display buffer. At the same time, the waveform is being read from the display buffers and written to the LCD. Additional circuitry in the display ASIC supports scanning of the front panel, provides DRAM refresh, processes the clock, and performs various memory mapping tasks required by all elementary microprocessor-based systems. In a four-channel system, the two display ASICs are interconnected so that one ASIC may provide display information for the second.

The processing and display system handles some of the computational tasks. Other tasks are performed by the processor system. Since all array processing is performed in the processing and display system, no computations can be performed that involve data from two different channel sets. Thus, subtracting channel 3 data from channel 2 is prohibited.

### **Probe Compensation**

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

### **Acquisition Board Power**

The IO board supplies the Acquisition board with 5.0, 3.0, 3.3, and 15 V<sub>DC</sub>. These sources are used directly or as sources for other converters on the Acquisition board. The Acquisition board supplies 35 volts used for series-strings of LEDs on the front panel for button illumination.

## Power Supply and Battery System

The IO board accepts the power input for the oscilloscope from either a 15 V<sub>DC</sub> external supply or from one of two internal Lithium-Ion battery packs. The battery packs are SMBus compliant and user replaceable.

A microcontroller manages the routing of power from the DC input and the two battery packs. It also manages the charging of batteries and communication to the Acquisition board.

The instrument cooling fan is powered by the IO board. The fan can be switched on and off, having its voltage varied by signals from the Acquisition board.

Power for the LCD Backlight Inverter board is supplied by the IO board. A dimming voltage, derived from a PWM pulse train and RC low-pass filter, controls the brightness of the backlight.

RS-232 and Parallel port signals are passed from the Acquisition board through the IO board to their rear-mounted connectors.

## Display Module

The Liquid Crystal Display pattern consists of 320 columns with 3 subcolumns and 240 rows, and has associated drivers and a backlight.

## Front Panel

### Two-Channel Oscilloscopes

All switches, position encoders, and LEDs are mounted on the Front Panel board of the two-channel oscilloscope. Additionally, an IC on this board provides buffering and multiplexing of switch signals for the Acquisition board. (Two signals and a sense line are provided by the Acquisition board to support the front panel.) One of these signals resets the scan, and a second clocks the scan to the next position. The sense line receives the current state of the selected switch or encoder position.

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

### Four-Channel Oscilloscopes

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

**LEDs** The front panel contains three LEDs that light to indicate when the Save or Autorange controls, or the multipurpose knob are active. In addition, most buttons have an LED behind them for illumination in low-light conditions. Button illumination can be turned off in the Utility menu.

**Internal Peripherals** The Acquisition board includes an FPGA that manages communication between the microprocessor and the internal program memory (FLASH), RTC (Real-Time Clock), battery system, and temperature sensor. The temperature sensor is used for fan control.

**External Peripherals** The Acquisition board FPGA also manages communication between the microprocessor and external RS-232 port, Printer Port, and Compact FLASH Card.





# Performance Verification

This section contains performance verification procedures for the specifications marked with the  $\sqrt{\quad}$  symbol. The following equipment, or a suitable equivalent, is required to complete these procedures.

## Required Equipment

Table 10: Required equipment

Description	Minimum requirements	Examples
DC Voltage Source	17.5 mV to 7 V, $\pm 0.5\%$ accuracy	Fluke 9100 Universal Calibration System
Leveled Sine Wave Generator	50 kHz and 200 MHz, $\pm 3\%$ amplitude accuracy	with Oscilloscope Calibration Module (Option 250)
Time Mark Generator	10 ms period, $\pm 10$ ppm accuracy	Fluke 5500A Multi-product Calibrator with Oscilloscope Calibration Option (Option 5500A-SC)
50 $\Omega$ BNC Cable	BNC male to BNC male, $\approx 1$ m (36 in) long	Tektronix part number 012-0482-XX
50 $\Omega$ BNC Cable	BNC male to BNC male, $\approx 25$ cm (10 in) long	Tektronix part number 012-0208-XX
50 $\Omega$ Feedthrough Termination	BNC male and female connectors	Tektronix part number 011-0049-XX
Dual Banana to BNC Adapter	Banana plugs to BNC female	Tektronix part number 103-0090-00
Splitter, Power	Frequency range: DC to 4 GHz. Tracking: $>2.0\%$	Tektronix part number 015-0565-XX

## Test Record

Table 11: Test record

Instrument Serial Number:

Certificate Number:

Temperature:

RH %:

Date of Calibration:

Technician:

Test		Passed	Failed			
Self Test						
Oscilloscope tests		High value (measured)	Low value (measured)	Low limit	Test result (High value – low value)	High limit
Channel 1	5 mV/div			33.6 mV		36.4 mV
DC Gain	200 mV/div			1.358 V		1.442 V
Accuracy	2 V/div			13.58 V		14.42 V
Channel 2	5 mV/div			33.6 mV		36.4 mV
DC Gain	200 mV/div			1.358 V		1.442 V
Accuracy	2 V/div			13.58 V		14.42 V
Channel 3	5 mV/div			33.6 mV		36.4 mV
DC Gain	200 mV/div			1.358 V		1.442 V
Accuracy	2 V/div			13.58 V		14.42 V
Channel 4	5 mV/div			33.6 mV		36.4 mV
DC Gain	200 mV/div			1.358 V		1.442 V
Accuracy	2 V/div			13.58 V		14.42 V

Channel 1 DC Measurement Accuracy	5 mV/div	$V_{pos}$	
	Vertical Position = 0	15.5 mV	19.5 mV
	Vertical Position = -17.6 mV	31.3 mV	38.6 mV
	200 mV/div		
	Vertical Position = 0	658 mV	742 mV
	Vertical Position = -704 mV	1.33 V	1.46 V
	2 V/div		
	Vertical Position = 0	6.59 V	7.41 V
	Vertical Position = -7.04 V	13.3 V	14.7 V
	5 mV/div	$V_{neg}$	
	Vertical Position = 0	-19.5 mV	-15.5 mV
	Vertical Position = 17.6 mV	-38.6 V	-31.3 V
	200 mV/div		
	Vertical Position = 0	-742 mV	-658 mV
	Vertical Position = 704 mV	-1.46 V	-1.33 V
	2 V/div		
Vertical Position = 0	-7.41 V	-6.59 V	
Vertical Position = 7.04 V	-14.7 V	-13.3 V	
Channel 2 DC Measurement Accuracy	5 mV/div	$V_{pos}$	
	Vertical Position = 0	15.5 mV	19.5 mV
	Vertical Position = -17.6 mV	31.3 mV	38.6 mV
	200 mV/div		
	Vertical Position = 0	658 mV	742 mV
	Vertical Position = -704 mV	1.33 V	1.46 V
	2 V/div		
	Vertical Position = 0	6.59 V	7.41 V
	Vertical Position = -7.04 V	13.3 V	14.7 V
	5 mV/div	$V_{neg}$	
	Vertical Position = 0	-19.5 mV	-15.5 mV
	Vertical Position = 17.6 mV	-38.6 V	-31.3 V
	200 mV/div		
	Vertical Position = 0	-742 mV	-658 mV
	Vertical Position = 704 mV	-1.46 V	-1.33 V
	2 V/div		
Vertical Position = 0	-7.41 V	-6.59 V	
Vertical Position = 7.04 V	-14.7 V	-13.3 V	

## Performance Verification

Channel 3 DC Measurement Accuracy	5 mV/div	$V_{pos}$	
	Vertical Position = 0	15.5 mV	19.5 mV
	Vertical Position = -17.6 mV	31.3 mV	38.6 mV
	200 mV/div		
	Vertical Position = 0	658 mV	742 mV
	Vertical Position = -704 mV	1.33 V	1.46 V
	2 V/div		
	Vertical Position = 0	6.59 V	7.41 V
	Vertical Position = -7.04 V	13.3 V	14.7 V
	5 mV/div	$V_{neg}$	
	Vertical Position = 0	-19.5 mV	-15.5 mV
	Vertical Position = 17.6 mV	-38.6 V	-31.3 V
	200 mV/div		
	Vertical Position = 0	-742 mV	-658 mV
Vertical Position = 704 mV	-1.46 V	-1.33 V	
2 V/div			
Vertical Position = 0	-7.41 V	-6.59 V	
Vertical Position = 7.04 V	-14.7 V	-13.3 V	
Channel 4 DC Measurement Accuracy	5 mV/div	$V_{pos}$	
	Vertical Position = 0	15.5 mV	19.5 mV
	Vertical Position = -17.6 mV	31.3 mV	38.6 mV
	200 mV/div		
	Vertical Position = 0	658 mV	742 mV
	Vertical Position = -704 mV	1.33 V	1.46 V
	2 V/div		
	Vertical Position = 0	6.59 V	7.41 V
	Vertical Position = -7.04 V	13.3 V	14.7 V
	5 mV/div	$V_{neg}$	
	Vertical Position = 0	-19.5 mV	-15.5 mV
	Vertical Position = 17.6 mV	-38.6 V	-31.3 V
	200 mV/div		
	Vertical Position = 0	-742 mV	-658 mV
Vertical Position = 704 mV	-1.46 V	-1.33 V	
2 V/div			
Vertical Position = 0	-7.41 V	-6.59 V	
Vertical Position = 7.04 V	-14.7 V	-13.3 V	
Channel 1 Bandwidth	2.12 V	—	
Channel 2 Bandwidth	2.12 V	—	
Channel 3 Bandwidth <sup>1</sup>	2.12 V	—	

Channel 4 Bandwidth <sup>1</sup>	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 <sup>1</sup>	Stable trigger	—
Channel 4 Edge Trigger Sensitivity <sup>1</sup>	Stable trigger	—
External Edge Trigger Sensitivity	Stable trigger	—

<sup>1</sup> Channels 3 and 4 are only on four channel oscilloscopes.

## Performance Verification Procedures

Before beginning these procedures, two conditions must be met:

- The oscilloscope must have been operating continuously for twenty minutes within the operating temperature range specified in the environmental specifications. (See Table 9 on page 10.)
- You must perform the following Self Calibration operation. If the ambient temperature changes by more than 5 °C, you must perform the Self Calibration operation again.

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



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

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

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

1. Remove signals from all channels.
2. Push the UTILITY button and select the Do Self Cal option to start the calibration. This routine can take up to five minutes to complete.
3. Verify that instrument passed self-calibration.

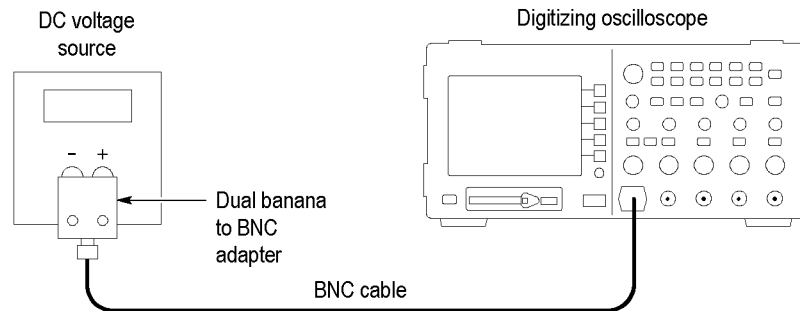
**Check DC Gain Accuracy**

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

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

Press menu button	Select menu option	Select setting
DEFAULT SETUP	—	—
Channel 1	Voltage Probe	1X
ACQUIRE	Average	64
MEASURE	Source	Channel 1
	Type	Mean

3. As shown in the following figure, connect the oscilloscope channel to be tested to the DC voltage source.



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

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

5. Set DC voltage source output level to **0 V**.

6. Disconnect the test setup.
7. Repeat steps 1 through 6 until all input channels have been checked (CH1 and CH2 for a two-channel model; CH1, CH2, CH3, and CH4 for a four-channel model.)

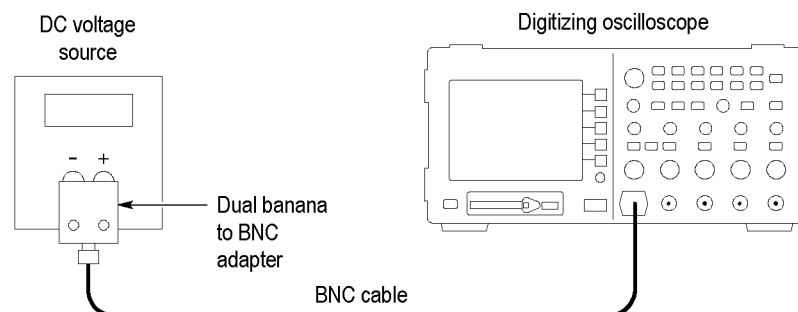
### Check DC Measurement Accuracy

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

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

Press menu button	Select menu option	Select setting
DEFAULT SETUP	—	—
Channel 1	Voltage Probe	1X
ACQUIRE	Average	64
MEASURE	Source	Channel 1
	Type	Mean

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



4. *Record DC Measurement Accuracy with Vertical Position set to 0V*
  - a. Ensure that the Vertical Position is set to zero.
  - b. Set the DC voltage source output level to the positive voltage listed in the following table and write the mean measurement in the test record as  $V_{\text{pos}}$  with Vertical Position at zero.
  - c. Set the DC voltage source output level to the negative voltage listed in the following table and write the mean measurement in the test record as  $V_{\text{neg}}$  with Vertical Position at zero.

- d. Repeat for all settings in the table and ensure that all readings are within the limits given in the test record.

Volts/div setting	DC voltage source output levels when Vertical Position is set to 0V	
	$V_{\text{pos}}$	$V_{\text{neg}}$
5 mV/div	+17.5 mV	-17.5 mV
200 mV/div	+700 mV	-700 mV
2 V/div	+7 V	-7 V

5. Record DC Measurement Accuracy with Vertical Position not set to 0V

- a. Set the instrument's Volts/div with the settings shown in the following table.  
Set the Vertical Position to:  $(-1 \times (\text{the offset value listed in the table}))$ .  
Set the DC voltage source output level to the  $V_{\text{pos}}$  value from the table.  
In the test record, write the mean measurement as  $V_{\text{pos}}$  with Vertical Position not zero.
- b. Set the Vertical Position to the offset value listed in the following table.  
Set the DC voltage source output level to the  $V_{\text{neg}}$  value from the table.  
In the test record, write the mean measurement as  $V_{\text{neg}}$  with Vertical Position not zero.
- c. Repeat for all settings in the table and ensure that all readings are within the limits given in the test record.

Volts/div setting	Offset	DC voltage source output levels When Vertical Position is not set to 0V	
		$V_{\text{pos}}$	$V_{\text{neg}}$
5 mV/div	17.6 mV	+35 mV	-35 mV
200 mV/div	0.704 V	+1.4 V	-1.4 V
2 V/div	7.04 V	+14 V	-14 V

6. Set DC voltage source output level to **0 V**.
7. Disconnect the test setup.
8. Repeat steps 1 through 7 until all input channels have been checked (CH1 and CH2 for a two-channel model; CH1, CH2, CH3, and CH4 for a four-channel model.)

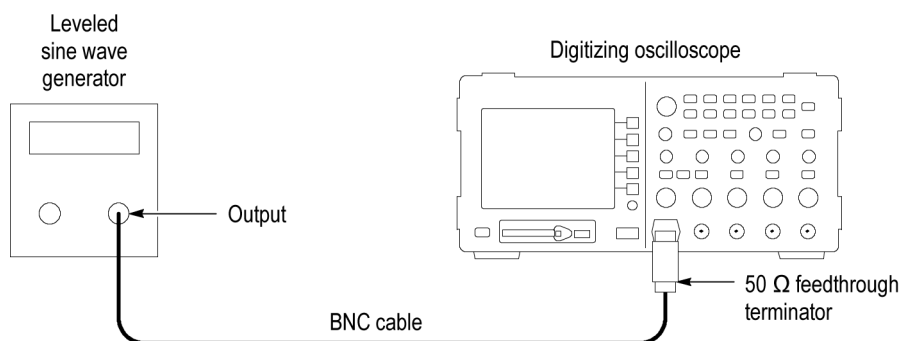


**Check Bandwidth** This test checks the bandwidth of all input channels.

1. Set up the oscilloscope using the following steps:

Press menu button	Select menu option	Select setting
DEFAULT SETUP	—	—
Channel 1	Voltage Probe	1X
ACQUIRE	Average	16
TRIGGER	Coupling	Noise
MEASURE	Source	Channel 1
	Type	Pk-Pk

2. As shown in the following figure, connect the oscilloscope channel selected in the table to the leveled sine wave generator.
3. Set the oscilloscope VOLTS/DIV to **500 mV/div**.



4. Set the oscilloscope SEC/DIV to **10 μs/div**.
5. Set the leveled sine wave generator frequency to **50 kHz**.
6. Set the leveled sine wave generator output level so the peak-to-peak measurement is between **2.98 V** and **3.02 V**.
7. Set the leveled sine wave generator frequency to:
  - **100 MHz** if you are checking a TPS2012B/2014B.
  - **200 MHz** if you are checking a TPS2024B, **180 MHz** for operating temperatures from 40 °C to 50 °C.
8. Set the oscilloscope SEC/DIV to **10 ns/div**.
9. Check that the peak-to-peak measurement is **≥2.12 V**.
10. Disconnect the test setup.
11. Repeat steps 1 through 10 until all input channels have been checked.

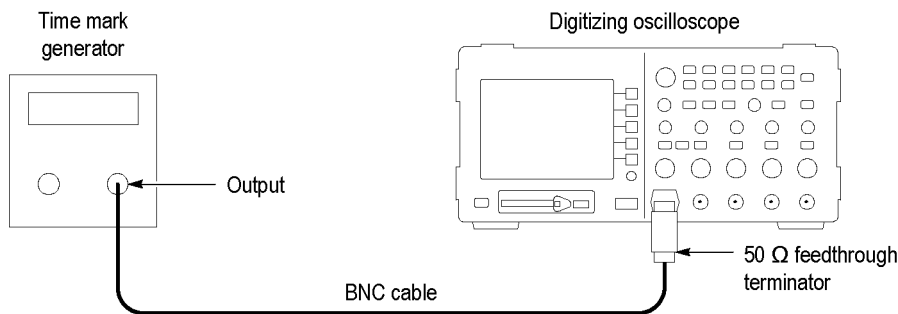
**Check Sample Rate and Delay Time Accuracy**

This test checks the time base accuracy.

1. Set up the oscilloscope using the following steps:

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

2. Connect the oscilloscope to the time mark generator as shown in the following figure.



4. Set the time mark generator period to **10 ms**.
5. Set the oscilloscope VOLTS/DIV to **500 mV/div**.
6. Set the oscilloscope Main SEC/DIV to **1 ms/div**.
7. Press **SET LEVEL TO 50%**.
8. Use the vertical POSITION control to center the test signal on screen.
9. Use the horizontal POSITION control to set the position to **10.00 ms**.
10. Set the oscilloscope SEC/DIV to **250 ns/div**.
11. Check that the rising edge of the marker crosses the center horizontal graticule line within  $\pm 2$  divisions of center graticule.

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

12. Disconnect the test setup.

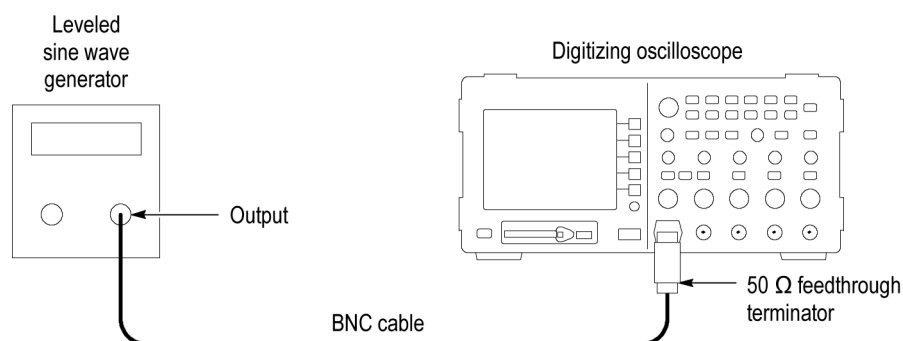
## Check Edge Trigger Sensitivity

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

1. Set up the oscilloscope using the following steps:

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

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



3. Set the oscilloscope VOLTS/DIV to **500 mV/div**.
4. Set the oscilloscope SEC/DIV to **25 ns/div**.
5. Set the leveled sine wave generator frequency to **10 MHz**.
6. Set the leveled sine wave generator output level to approximately **500 mV<sub>p-p</sub>** so that the measured amplitude is approximately **500 mV**. (The measured amplitude can fluctuate around 500 mV.)
7. Press **SET LEVEL TO 50%**. Adjust **TRIGGER LEVEL** as necessary and check that triggering is stable.
8. Set the leveled sine wave generator frequency to the following:
  - **100 MHz** if you are checking a TPS2012B/2014B.
  - **200 MHz** if you are checking TPS2024B.
9. Set the oscilloscope SEC/DIV to **10 ns/div**.
10. Set the leveled sine wave generator output level to approximately **750 mV<sub>p-p</sub>** so that the measured amplitude is approximately **750 mV**. (The measured amplitude can fluctuate around 750 mV.)

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

12. Change the oscilloscope setup using the following step:

Press menu button	Select menu option	Select setting
TRIGGER	Slope	Falling

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

14. Disconnect the test setup.

15. Repeat steps 1 through 14 until all input channels have been checked.

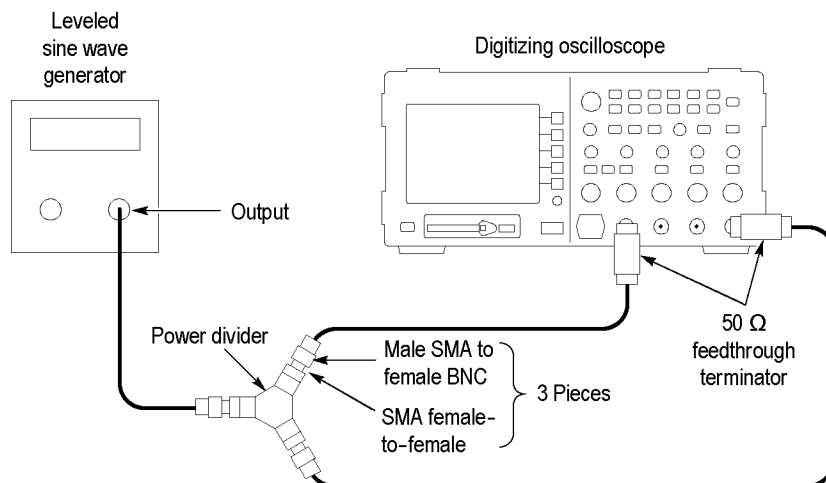
### Check External Edge Trigger Sensitivity

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

1. Set up the oscilloscope using the following steps:

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

2. Connect the oscilloscope to the leveled sine wave generator as shown in the following figure.



3. Set the leveled sine wave generator frequency to the following:
  - **100 MHz** if you are checking a TPS2012B/TPS2014B/TPS2024B (1 V from 10 MHz to 100 MHz).
  - **200 MHz** if you are checking TPS2024B (2 V from 100 MHz to 200 MHz).
4. Set the oscilloscope VOLTS/DIV to **500 mV/div**.
5. Set the oscilloscope SEC/DIV to **10 ns/div**.
6. Set the leveled sine wave generator output to the following levels:
  - TPS2012B/TPS2014B/TPS2024B, 100 MHz measurement: **1 V<sub>p-p</sub>**
  - TPS2024B, 200 MHz measurement: **2 V<sub>p-p</sub>**

---

**NOTE.** *The measured amplitude can fluctuate around 1 V for the TPS2012B/TPS2014B/TPS2024B 100 MHz measurement and 2 V for the TPS2024B 200 MHz measurement.*

---

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

Press menu button	Select menu option	Select setting
TRIGGER	Slope	Falling

9. Press **SET LEVEL TO 50%**. Adjust **TRIGGER LEVEL** as necessary and check that triggering is stable.
10. Disconnect the test setup.



# Adjustment Procedures

This section contains adjustment procedures for the TPS2000B Series oscilloscopes.

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

---

**NOTE.** *The voltage references inside TPS2000B Series oscilloscopes are very stable over time and should not require routine updates. Before performing any procedure in this chapter, verify that the oscilloscope does not meet specifications. Refer to the Performance Verification section to verify the specifications.*

---

## Required Equipment

The equipment described in the following table, or a suitable equivalent, is required to complete the procedure.

Table 12: Required equipment

Description	Minimum requirements	Examples
DC Voltage Source	-20 V to 20 V, $\pm 0.1\%$ accuracy	Fluke 9100 Universal Calibration System with Oscilloscope Calibration Module (Option 250)
Leveled Sine Wave Generator	60 kHz and 200 MHz, $\pm 0.6\%$ amplitude accuracy	Fluke 5500A Multi-product Calibrator with Oscilloscope Calibration Option (Option 5500A-SC)
50 $\Omega$ BNC Cable	BNC male to BNC male, » 1 m (36 in) long	Tektronix part number 012-0482-00
50 $\Omega$ BNC Cable (two)	BNC male to BNC male, » 25 cm (10 in) long	Tektronix part number 012-0208-00
50 $\Omega$ 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 multiple steps for the two-channel oscilloscope, and additional steps for the four-channel model. Each step requires an external voltage source for new calibration constants.

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

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

---

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

---

### Enable the Service Menu

You must enable the Service menu to perform the adjustment procedure.

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

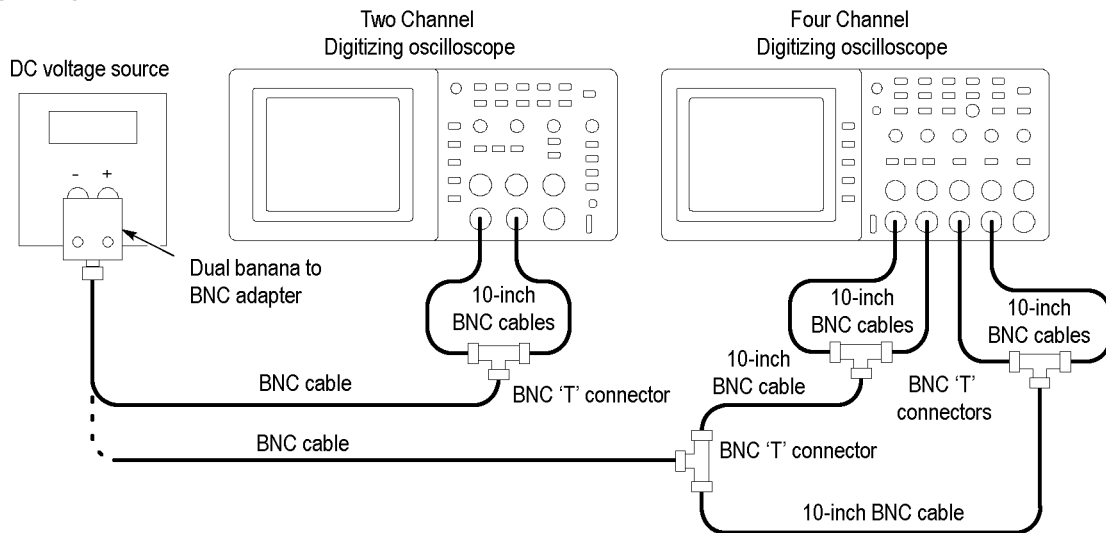
You may now begin executing the sequence of calibration steps required by your oscilloscope and shown in the following procedure. After the adjustment is complete, disable the Service menu by pushing the **UTILITY** front-panel button, and the Service and Service Mode Off option buttons.



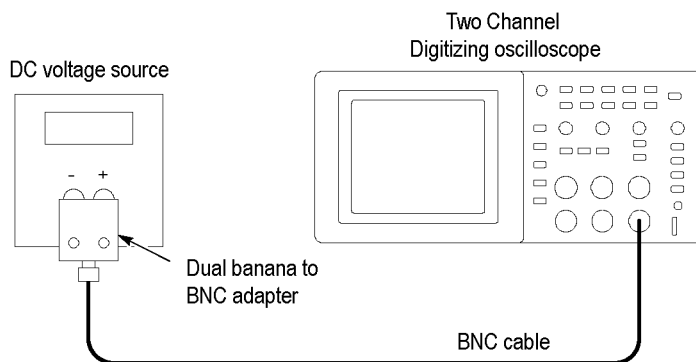
**Setups Required to Complete the Adjustment Procedure**

The following figure shows the setups required to complete the adjustment procedure.

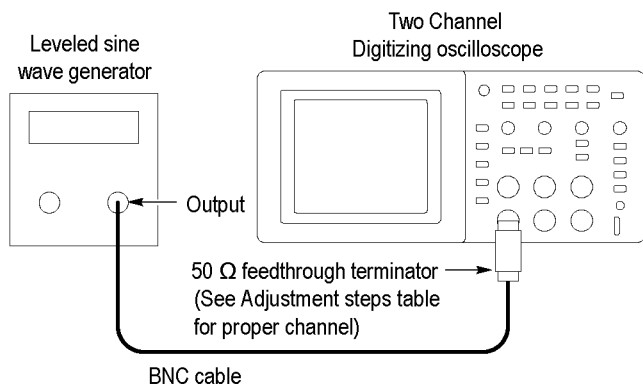
**DC voltage setup 1**



**DC voltage setup 2**



**Sine wave generator setup**



**Edge setup**

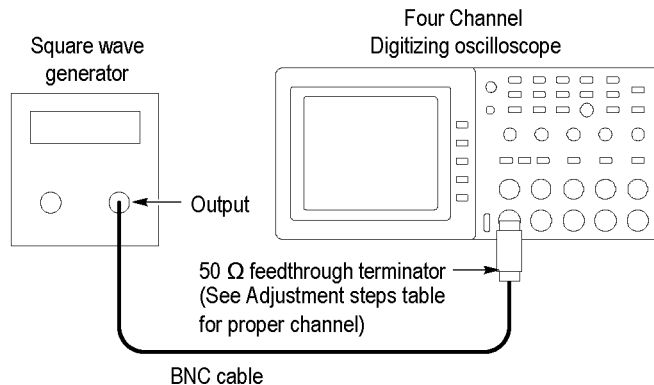


Figure 2: Adjustment setups

**Adjustment Procedure**

Use this procedure to load new calibration constants:

1. Enable the Service menu. (See page 34, *Enable the Service Menu.*)
2. Push the **Service** option button.
3. Push the **Factory Cal** option button.
4. Push the **Warmup Timer** option button.
5. Push the **Start Timer** option button to ensure a 10-minute warm up. After 10 minutes passes, the oscilloscope displays a large black or green cross.
6. Press the front-panel **UTILITY** button and push the **Service** option button.
7. Push the **Factory Cal** option button.
8. Push the **FCAL INIT** option button to initiate the factory calibration routine. You are now in step 1 of the procedure.
9. As indicated by Step 1 in the following table, connect a 0.0 V<sub>DC</sub> source to the channel inputs.
10. Press **FCAL STEP** to load the calibration constant for step 1.
11. Follow the screen prompts and the table for the remainder of the routine, applying the proper signal for each step.

---

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

---

---

**NOTE.** In the following table, "BWL" stands for the bandwidth limit of the particular oscilloscope. The TPS2012B and TPS2014B models have a bandwidth limit of 100 MHz. The TPS2024B has a bandwidth limit of 200 MHz.

---

If the instrument fails any step in the procedure, 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 instrument completes the procedure successfully, a "Pass" message is displayed and the new adjustment takes effect.

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

The following table lists the steps in the procedure and the signal requirements.

**Table 13: Adjustments (steps 73-108 are for 4-CH models only)**

Procedure steps	Signal	Signal source setting	Input
<b>Refer to the DC voltage setup 1 diagram (See page 35, <i>Setups Required to Complete the Adjustment Procedure.</i>)</b>			
1	DC Voltage 1	0.0 V	CH1 through CHx
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 13: Adjustments (steps 73-108 are for 4-CH models only) (cont.)

Procedure steps	Signal	Signal source setting	Input
<b>Refer to the DC voltage setup 2 diagram</b> (See page 35, <i>Setups Required to Complete the Adjustment Procedure.</i> )			
31	DC Voltage 2	-25.0 V	EXT
32	DC Voltage 2	-12.5 V	TRIG
33	DC Voltage 2	-2.5 V	
34	DC Voltage 2	2.5 V	
35	DC Voltage 2	12.5 V	
36	DC Voltage 2	25 V	
<b>Refer to the Sine Wave Generator setup diagram. BW refers to the maximum bandwidth of the oscilloscope.</b> (See page 35, <i>Setups Required to Complete the Adjustment Procedure.</i> )			
37	Sine Wave Generator, 50 $\Omega$	5 kHz, 1 V <sub>p-p</sub>	CH1
38	Sine Wave Generator, 50 $\Omega$	1 MHz, 100 mV <sub>p-p</sub>	
39	Sine Wave Generator, 50 $\Omega$	1 MHz, 1 V <sub>p-p</sub>	
40	Sine Wave Generator, 50 $\Omega$	50 kHz, 1.2 V <sub>p-p</sub>	
41	Sine Wave Generator, 50 $\Omega$	20 MHz, 1.2 V <sub>p-p</sub>	
42	Sine Wave Generator, 50 $\Omega$	BWL, 30 mV <sub>p-p</sub>	
43	Sine Wave Generator, 50 $\Omega$	BWL, 60 mV <sub>p-p</sub>	
44	Sine Wave Generator, 50 $\Omega$	BWL, 120 mV <sub>p-p</sub>	
45	Sine Wave Generator, 50 $\Omega$	BWL, 300 mV <sub>p-p</sub>	
46	Sine Wave Generator, 50 $\Omega$	BWL, 600 mV <sub>p-p</sub>	
47	Sine Wave Generator, 50 $\Omega$	BWL, 1.2 V <sub>p-p</sub>	
48	Sine Wave Generator, 50 $\Omega$	5 kHz, 2.5 V <sub>p-p</sub>	
49	Sine Wave Generator, 50 $\Omega$	1 MHz, 2.5 V <sub>p-p</sub>	
50	Sine Wave Generator, 50 $\Omega$	50 kHz, 2.5 V <sub>p-p</sub>	
51	Sine Wave Generator, 50 $\Omega$	20 MHz, 2.5 V <sub>p-p</sub>	
52	Sine Wave Generator, 50 $\Omega$	BWL, 2.5 V <sub>p-p</sub>	
53	Sine Wave Generator, 50 $\Omega$	BWL, 5 V <sub>p-p</sub>	
54	Sine Wave Generator, 50 $\Omega$	BWL, 1.6 V <sub>p-p</sub>	
<b>Refer to the Edge setup diagram.</b> (See page 35, <i>Setups Required to Complete the Adjustment Procedure.</i> )			
55	Edge, 50 $\Omega$	1 kHz, 0 to -800 mV, fast rising edge	

Table 13: Adjustments (steps 73-108 are for 4-CH models only) (cont.)

Procedure steps	Signal	Signal source setting	Input
<b>Refer to the Sine Wave Generator setup diagram.</b> (See page 35, <i>Setups Required to Complete the Adjustment Procedure.</i> )			
56	Sine Wave Generator, 50 $\Omega$	5 kHz, 1 V <sub>p-p</sub>	CH2
57	Sine Wave Generator, 50 $\Omega$	1 MHz, 100 mV <sub>p-p</sub>	
58	Sine Wave Generator, 50 $\Omega$	1 MHz, 1 V <sub>p-p</sub>	
59	Sine Wave Generator, 50 $\Omega$	50 kHz, 1.2 V <sub>p-p</sub>	
60	Sine Wave Generator, 50 $\Omega$	20 MHz, 1.2 V <sub>p-p</sub>	
61	Sine Wave Generator, 50 $\Omega$	BWL, 30 mV <sub>p-p</sub>	
62	Sine Wave Generator, 50 $\Omega$	BWL, 60 mV <sub>p-p</sub>	
63	Sine Wave Generator, 50 $\Omega$	BWL, 120 mV <sub>p-p</sub>	
64	Sine Wave Generator, 50 $\Omega$	BWL, 300 mV <sub>p-p</sub>	
65	Sine Wave Generator, 50 $\Omega$	BWL, 600 mV <sub>p-p</sub>	
66	Sine Wave Generator, 50 $\Omega$	BWL, 1.2 V <sub>p-p</sub>	
67	Sine Wave Generator, 50 $\Omega$	5 kHz, 2.5 V <sub>p-p</sub>	
68	Sine Wave Generator, 50 $\Omega$	1 MHz, 2.5 V <sub>p-p</sub>	
69	Sine Wave Generator, 50 $\Omega$	50 kHz, 2.5 V <sub>p-p</sub>	
70	Sine Wave Generator, 50 $\Omega$	20 MHz, 2.5 V <sub>p-p</sub>	
71	Sine Wave Generator, 50 $\Omega$	BWL, 2.5 V <sub>p-p</sub>	
72	Sine Wave Generator, 50 $\Omega$	BWL, 5 V <sub>p-p</sub>	
73	Sine Wave Generator, 50 $\Omega$	5 kHz, 1 V <sub>p-p</sub>	CH3
74	Sine Wave Generator, 50 $\Omega$	1 MHz, 100 mV <sub>p-p</sub>	
75	Sine Wave Generator, 50 $\Omega$	1 MHz, 1 V <sub>p-p</sub>	
76	Sine Wave Generator, 50 $\Omega$	50 kHz, 1.2 V <sub>p-p</sub>	
77	Sine Wave Generator, 50 $\Omega$	20 MHz, 1.2 V <sub>p-p</sub>	
78	Sine Wave Generator, 50 $\Omega$	BWL, 30 mV <sub>p-p</sub>	
79	Sine Wave Generator, 50 $\Omega$	BWL, 60 mV <sub>p-p</sub>	
80	Sine Wave Generator, 50 $\Omega$	BWL, 120 mV <sub>p-p</sub>	
81	Sine Wave Generator, 50 $\Omega$	BWL, 300 mV <sub>p-p</sub>	
82	Sine Wave Generator, 50 $\Omega$	BWL, 600 mV <sub>p-p</sub>	
83	Sine Wave Generator, 50 $\Omega$	BWL, 1.2 V <sub>p-p</sub>	
84	Sine Wave Generator, 50 $\Omega$	5 kHz, 2.5 V <sub>p-p</sub>	
85	Sine Wave Generator, 50 $\Omega$	1 MHz, 2.5 V <sub>p-p</sub>	
86	Sine Wave Generator, 50 $\Omega$	50 kHz, 2.5 V <sub>p-p</sub>	
87	Sine Wave Generator, 50 $\Omega$	20 MHz, 2.5 V <sub>p-p</sub>	
88	Sine Wave Generator, 50 $\Omega$	BWL, 2.5 V <sub>p-p</sub>	
89	Sine Wave Generator, 50 $\Omega$	BWL, 5 V <sub>p-p</sub>	
90	Sine Wave Generator, 50 $\Omega$	BWL, 1.6 V <sub>p-p</sub>	

Table 13: Adjustments (steps 73-108 are for 4-CH models only) (cont.)

Procedure steps	Signal	Signal source setting	Input
<b>Refer to the Edge setup diagram.</b> (See page 35, <i>Setups Required to Complete the Adjustment Procedure.</i> )			
91	Edge, 50 $\Omega$	1 kHz, 0 to -800 mV, fast rising edge	
<b>Refer to the Sine Wave setup diagram.</b> (See page 35, <i>Setups Required to Complete the Adjustment Procedure.</i> )			
92	Sine Wave Generator, 50 $\Omega$	5 kHz, 1 V <sub>p-p</sub>	CH4
93	Sine Wave Generator, 50 $\Omega$	1 MHz, 100 mV <sub>p-p</sub>	
94	Sine Wave Generator, 50 $\Omega$	1 MHz, 1 V <sub>p-p</sub>	
95	Sine Wave Generator, 50 $\Omega$	50 kHz, 1.2 V <sub>p-p</sub>	
96	Sine Wave Generator, 50 $\Omega$	20 MHz, 1.2 V <sub>p-p</sub>	
97	Sine Wave Generator, 50 $\Omega$	BWL, 30 mV <sub>p-p</sub>	
98	Sine Wave Generator, 50 $\Omega$	BWL, 60 mV <sub>p-p</sub>	
99	Sine Wave Generator, 50 $\Omega$	BWL, 120 mV <sub>p-p</sub>	
100	Sine Wave Generator, 50 $\Omega$	BWL, 300 mV <sub>p-p</sub>	
101	Sine Wave Generator, 50 $\Omega$	BWL, 600 mV <sub>p-p</sub>	
102	Sine Wave Generator, 50 $\Omega$	BWL, 1.2 V <sub>p-p</sub>	
103	Sine Wave Generator, 50 $\Omega$	5 kHz, 2.5 V <sub>p-p</sub>	
104	Sine Wave Generator, 50 $\Omega$	1 MHz, 2.5 V <sub>p-p</sub>	
105	Sine Wave Generator, 50 $\Omega$	50 kHz, 2.5 V <sub>p-p</sub>	
106	Sine Wave Generator, 50 $\Omega$	20 MHz, 2.5 V <sub>p-p</sub>	
107	Sine Wave Generator, 50 $\Omega$	BWL, 2.5 V <sub>p-p</sub>	
108	Sine Wave Generator, 50 $\Omega$	BWL, 5 V <sub>p-p</sub>	

# Maintenance

This section contains the following information that is needed to perform periodic and corrective maintenance on TPS2000B Series oscilloscopes:

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

## Preparation

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

## Preventing ESD

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



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

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- Minimize handling of static-sensitive modules.
- Transport and store static-sensitive modules in their static-protected containers or on a metal rail. Label any package that contains static-sensitive modules.
- Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these modules.

- Service static-sensitive modules only at static-free workstations. Do not allow anything capable of generating or holding a static charge on the workstation surface.
- Handle circuit boards by the edges when possible.
- Do not slide the modules over any surface.
- Avoid handling modules in areas that have a floor or work-surface covering capable of generating a static charge.

## Inspection and Cleaning

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

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

### General Care

For best performance, follow these recommendations:

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

### Inspection and Cleaning Procedures

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

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



**Cleaning procedure, exterior.** To clean the oscilloscope exterior and probes:

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



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

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

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

To inspect and clean the interior, disassemble the oscilloscope by completing each of the disassembly procedures in the order given. (See page 45, *Removal and Installation Procedures*.)

Inspect the internal portions of the oscilloscope for damage and wear using the following table as a guide. Repair defects immediately.

**Table 14: Internal inspection checklist**

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

**Cleaning procedure, interior.** To clean the oscilloscope interior, perform the following steps:

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

---

**NOTE.** *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 of the dust or dirt, all modules in the oscilloscope except the Display Module and Front Panel Module may be spray washed using a solution of 75% isopropyl alcohol.*

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

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

*Proceed 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.** Periodic lubrication is not required for the oscilloscope.

## Removal and Installation Procedures

This section describes how to remove and install the major mechanical and electrical modules of the oscilloscope.

### Preparation



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**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 part of the oscilloscope.*

*To prevent damage to electrical components, read Preventing ESD. (See page 41, Preventing ESD.)*

---

The exploded view diagram gives an overview of how the entire oscilloscope is assembled. (See Figure 16.)

The *Replaceable Parts* section lists all of the replaceable modules. (See page 73, *Replaceable Parts*.)

If you are disassembling the oscilloscope for cleaning, refer to *Inspection and Cleaning* for cleaning instructions. (See page 42.)

### Required Tools

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

- Torque-limiting screwdriver, long shank, 8 in-lb (.85 N·m) range with Torx® T-15 tip
- Torque-limiting screwdriver with Torx® T-8 tip
- 16 mm (5/8 inch) deep socket with wide center hole (S-K Hand Tool Corp., S-K #40820, or equivalent)
- Torque wrench to 40 in-lb (4.5 N·m)
- Screwdriver with 1/4 inch (6.35 mm) flat blade
- Pliers (all-purpose and needle-nose)

**Replacement Procedures**

Disassembly for replacement is best achieved by removing and replacing the modules in the specified order.

To remove and replace the rear case, fan, Display Adapter board, IO board, or Acquisition board, refer to the following table:

**Procedures for removing rear case and associated modules**

Remove module	Prerequisite	Procedure location
Rear case		(See page 47.)
Fan	Remove rear case first.	(See page 49.)
IO board	Remove rear case first.	(See page 50.)
Acquisition board	Remove rear case and IO board first.	(See page 51.)
Display Adapter board	Remove rear case, fan, Acquisition board, and Display module first.	(See page 52.)

To remove and replace the front case, Front Panel board, LCD display, Compact Flash module, or keypad, refer to the following table.

**Procedures for removing front case and associated modules**

Remove module	Prerequisite	Procedure location
Front case		(See page 54.)
Front panel board	Remove front case first.	(See page 56.)
Keypad	Remove front case first.	(See page 58.)
Display module	Remove front case, Front Panel board, and Acquisition board first.	(See page 57.)
Compact flash module	Remove front case and Acquisition board first.	(See page 58.)

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

**Removal.** To remove the rear case, follow these steps. (See Figure 3.)

1. Open the battery door and remove the batteries.
2. Place the oscilloscope face down on a soft surface, such as an antistatic mat.
3. Remove the two small ESD protective covers (rubber plugs) from the bottom left and right sides of the rear case.
4. Remove the five screws that secure the rear case to the chassis. Tilt the handle to gain access to the top two screws.
5. Lift up and remove the rear case from the oscilloscope chassis.

**Installation.** Follow these procedure to reinstall the rear case. (See Figure 3.)

1. Place the oscilloscope face down on a soft surface.
2. Ensure that all cables are routed within the internal chassis area.
3. Place the rear case over the assembled oscilloscope and ensure that:
  - All edges align with the chassis.
  - The RS-232, printer, and power connectors align and feed through the rear case without binding.
4. Install the five screws to attach the rear case. Tilt the handle to access the top two holes.
5. Install the two small ESD protective covers (rubber plugs) on top of the two screws at the bottom left and right of the rear panel.
6. Install the batteries.



---

**CAUTION.** *Avoid cross threading the screws that attach 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 give very little resistance going in.*

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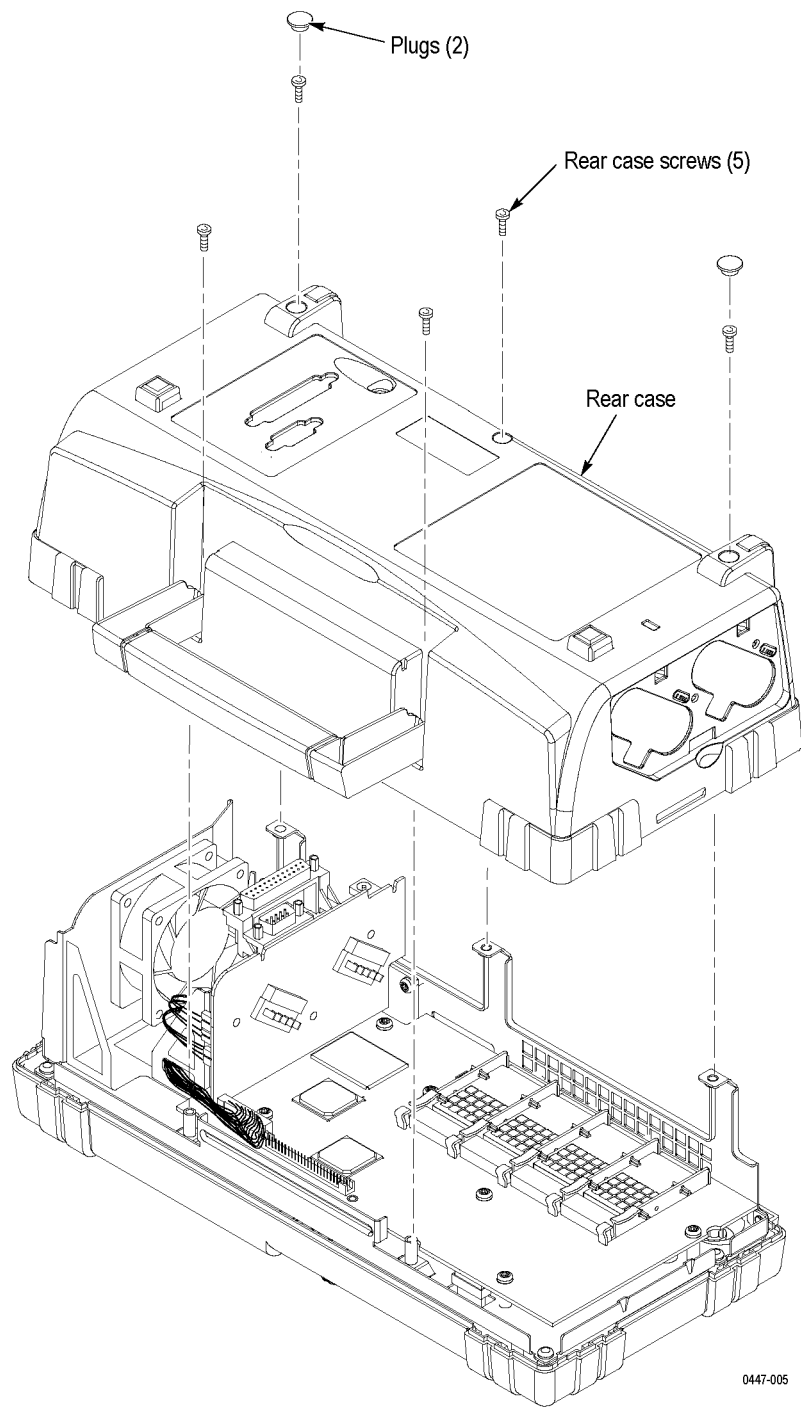


Figure 3: Removing and installing the rear case

**Fan** You will need the T15 screwdriver for this procedure.

**Removal.** To remove the fan, follow these steps. (See Figure 4 on page 50.)

1. Remove the rear case. (See page 47, *Rear Case*.)
2. Disconnect the fan cable from the IO board.
3. Remove the four screws (with washers) and the four standoffs that attach the fan to the chassis. Keep the screws, washers, and standoffs to use when installing the new fan.
4. Remove the fan.

**Installation.** To install a new fan, follow these steps. (See Figure 4.)

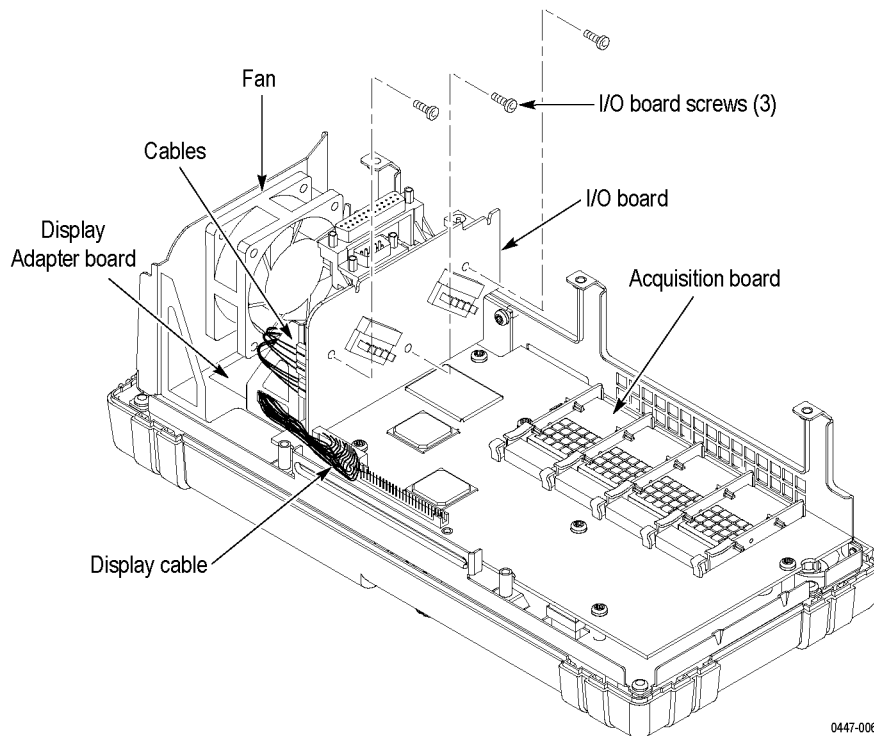
1. Align the fan bracket with the fan. Align the fan so that air blows out the side of the chassis, not into the chassis.
2. Install the four standoffs, four flat washers, four spring washers, and four screws to attach the fan to the chassis.
3. Install the fan cable on the I/O board.
4. Install the rear case.

**I/O Board Removal.** To remove the I/O board, follow these steps. (See Figure 4 on page 50.)

1. Remove the rear case. (See page 47, *Rear Case*.)
2. Disconnect all cables from the I/O board. Note the cable connections so that you can reinstall them.
3. Remove the three chassis mounting screws from the I/O board.
4. Unseat the I/O board from its connector on the Acquisition board and lift up to remove the I/O board.

**Installation.** To install the I/O board, follow these steps. (See Figure 4.)

1. Align the connector on the bottom of the I/O board with the connector on the Acquisition board. Press down to seat the connector.
2. Install the three I/O board mounting screws to attach the board to the support bracket.
3. Connect all cables to the I/O board as noted in step 2 of the Removal procedure.
4. Install the rear case.



**Figure 4: Modules accessed from the rear of the oscilloscope**



**Acquisition Board** You will need a torque-limiting Torx T-15 long-shank screwdriver, a flat-blade screwdriver, and a 16 mm (5/8 inch) deep socket for this procedure.



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**CAUTION.** *The Acquisition board is particularly sensitive to ESD. Read the Preventing ESD section before removing or installing the Acquisition board. (See page 41, Preventing ESD.)*

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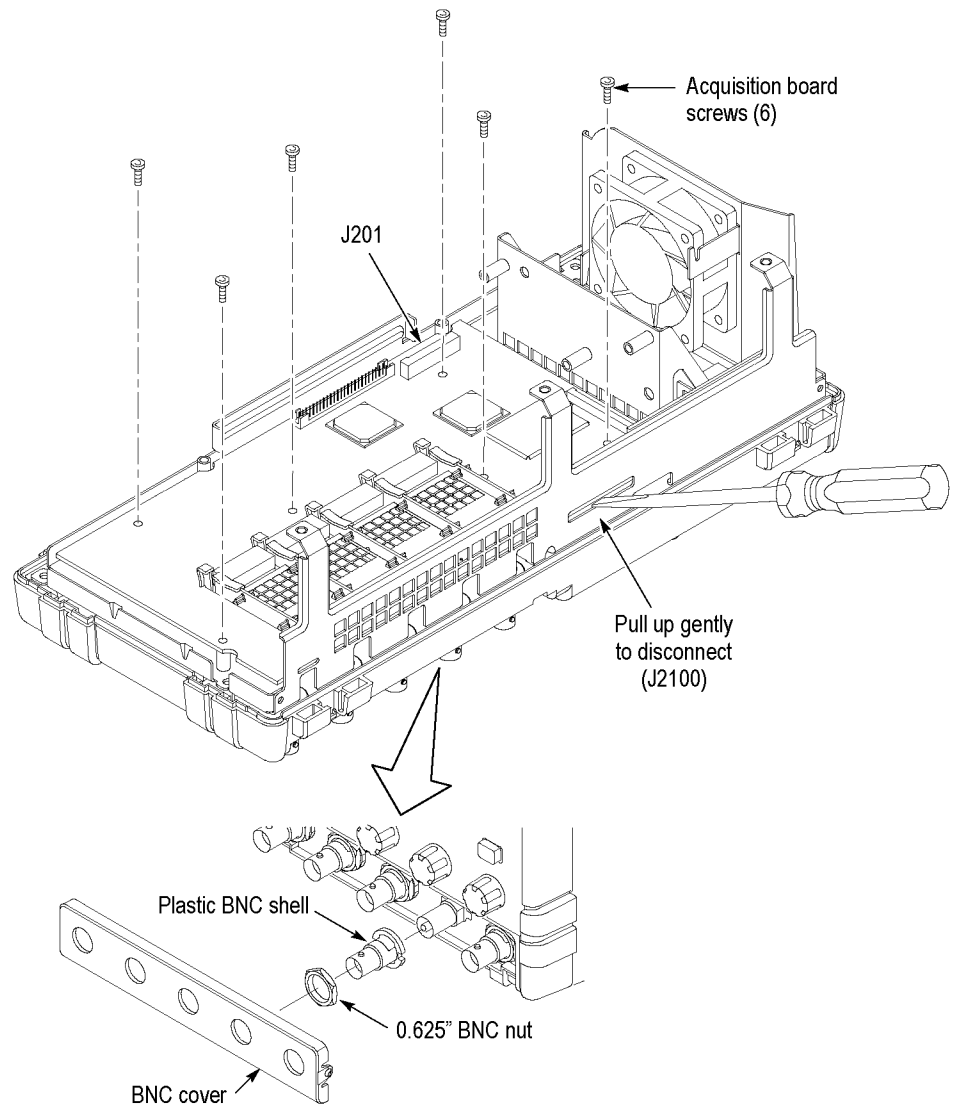
**Removal.** To remove the Acquisition board, follow these steps. (See Figure 5 on page 52.)

1. Remove the rear case. (See page 47, *Rear Case*.)
2. Remove the BNC cover by prying up on the exposed edge. (See Figure 5 on page 52.)
3. Use the 16 mm (5/8 inch) deep socket to remove the nuts from the BNC connectors.
4. Remove the plastic BNC shells from the BNC connectors. Hold the BNC shell with your fingers and pull up to remove the shell.
5. Remove the I/O board. (See page 50, *I/O Board*.)
6. Note how the Display cable at J201 is routed under the corner of the Acquisition board so that you can reinstall it the same way ).
7. Disconnect the Display cable from J201 (leave the other end connected to J401 on the Display Adapter board).
8. Remove the seven screws that attach the Acquisition board to the chassis.
9. Use the flat-blade screwdriver to pull up on the edge of the board and unseat the connection between the Acquisition board and the Compact Flash board.
10. Lift up and remove the Acquisition board.

**Installation.** To install the Acquisition board, follow these steps. (See Figure 5 on page 52.)

1. Position the Acquisition board over the chassis and align the feedthrough connector on the front-panel and compact flash boards.
2. Push down to seat the connector.
3. Route the Display cable under the corner of the Acquisition board.
4. Install the seven screws that attach the Acquisition board to the chassis.
5. Connect the Display cable at J201 (the other end is connected to J401 on the Display Adapter board).
6. Install the I/O board. (See page 50, *I/O Board*.)
7. Install the plastic BNC shells on the BNC connectors.

8. Use the 16 mm (5/8 inch) deep socket and install the BNC nuts on the BNC connectors. Torque the nuts to 40 in-lbs using the torque wrench.
9. Install the BNC cover on the front case.
10. Install the rear case.
11. Install the front-panel knobs.



**Figure 5: Using a screwdriver to remove the Acquisition board**

### Display Adapter Board

You will need T15 screwdriver for this procedure.

**Removal.** To remove the Display Adapter board, follow these steps.

1. Refer to the exploded view and the rear-panel locator diagram. (See Figure 4 on page 50.) (See Figure 16 on page 78.)
2. Remove the rear case and fan. (See page 47, *Rear Case*.) (See page 49, *Fan*.)
3. Remove the Acquisition board. (See page 51, *Acquisition Board*.)
4. Remove the Display module. (See page 57, *Display Module*.)
5. Disconnect all cables except the LCD data cable from the Display Adapter board, noting the connections so that you can reconnect the cables during installation.
6. Disconnect the LCD data cable from the Display module and pass enough cable through the hole in the chassis so that you will be able to lift the Display Adapter board off the chassis with this cable still connected.
7. Remove the four screws that attach the Display Adapter board to the chassis and lift the board off the chassis enough to access the LCD data cable connector. Disconnect this cable and remove the Display Adapter board from the instrument.

**Installation.** To install the Display Adapter board, follow these steps. (See Figure 4.)

1. Connect the four cables to the Display Adapter board as noted in step 5 in the Removal procedure, as follows:

Cable	From	To
LCD backlight cable	Display module	Display Adapter board J202
LCD data cable 174-5861-00	Display module	Display Adapter board J302
Display cable 174-5897-00	Acquisition board J201	Display Adapter board J401
Display Adapter power supply cable 174-4949-01	I/O board J600	Display Adapter board J201

2. Route the LCD data cable through the slot in the chassis to where it will connect to the Display module.
3. Align the Display Adapter board with the mounting holes in the chassis.
4. Install the four screws that attach the Display Adapter board to the chassis.
5. Connect the other end of the LCD data cable to the Display module.
6. Install all of the modules that were removed.
7. Install the front case and the rear case.

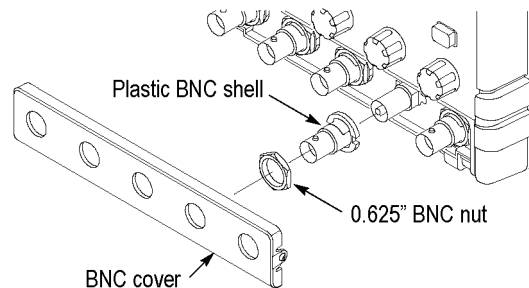
**Front-Panel Knob** Remove each front-panel knob by firmly grasping the knob and pulling it off of the front panel. If necessary, insert a screwdriver between the front panel and knob and lift up.

Install the front-panel knobs by aligning the keyed knob with the shaft, and press the knob on the shaft.

**Front Case** You will need a torque-limiting Torx T-15 screwdriver and 16 mm (5/8 inch) deep socket for this procedure.

**Removal.** To remove the front case, follow these steps. (See Figure 7 on page 55.)

1. Remove the front-panel knobs. (See page 54, *Front-Panel Knob*.)
2. Place the oscilloscope with its rear case down on a soft surface, such as an antistatic mat.
3. Remove the BNC cover by prying up on the exposed edge.
4. Use the 16 mm (5/8 inch) deep socket to remove the nuts from the BNC connectors.
5. Remove the plastic BNC shells from the BNC connectors. Hold the BNC shell with your fingers and pull up to remove the shell. (See Figure 6.)



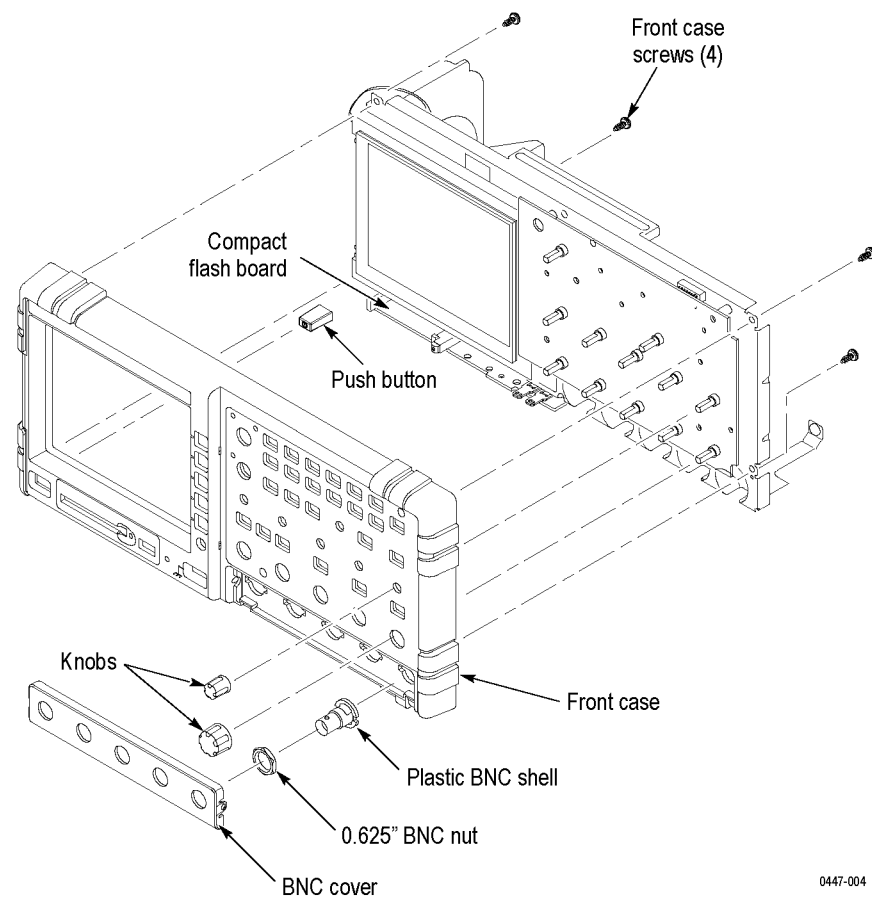
**Figure 6: Removing the BNC cover, shell, and retaining nuts**

6. Follow the procedure to remove the rear case. (See page 47, *Rear Case*.)
7. Remove the four screws from the internal chassis that attach the chassis to the front cover. (See Figure 7.)
8. Lift the chassis off of the front case.

**Installation.** To install the front case, follow these steps. (See Figure 7.)

1. Place the front case face down on a soft surface.
2. Verify that the switch keypad is aligned and feeds through the front case. Follow the keypad installation procedure. (See page 59, *Installation*.)
3. Align the power switch, BNC connectors, and knob shafts so they feed through the front case.

4. Lower the chassis onto the front case.
5. Install the four screws on the inside of the chassis that attach the chassis to the front cover. (See Figure 7.)
6. Follow the procedure to install the rear case. (See page 47, *Installation*.)
7. Install the plastic BNC shells on the BNC connectors.
8. Use the 16 mm (5/16 inch) deep socket and install the BNC nuts on the BNC connectors. Torque the nuts to 40 in-lbs using the torque wrench.
9. Install the BNC cover and front-panel knobs.



0447-004

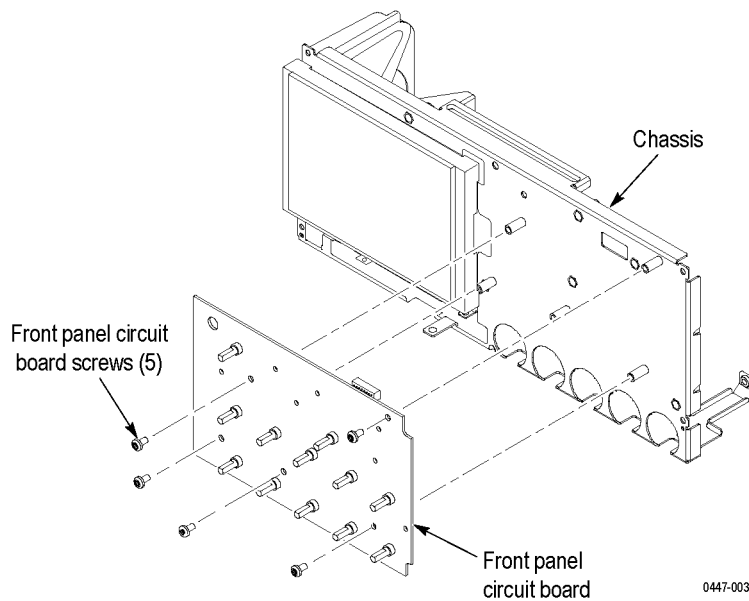
**Figure 7: Removing the front case**

## Front-Panel Board

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

**Removal.** To remove the Front-Panel board, follow these steps. (See Figure 8.)

1. Remove the front case. (See page 54, *Front Case*.)
2. Remove the five screws that attach the Front-Panel board to the chassis.
3. Pull out to remove the Front-Panel board from the chassis. (This will unseat the feedthrough connection between the Front-Panel board and the Acquisition board on the opposite side.)



**Figure 8: Removing the Front-Panel module**

**Installation.** To install the Front-Panel module, follow these steps. (See Figure 8.)

1. Align the Front-Panel board over the front chassis and reseal the feed-through connection between the Front-Panel board and the Acquisition board on the opposite side.
2. Install the five screws to attach the Front-Panel board to the chassis.
3. Install the front case.

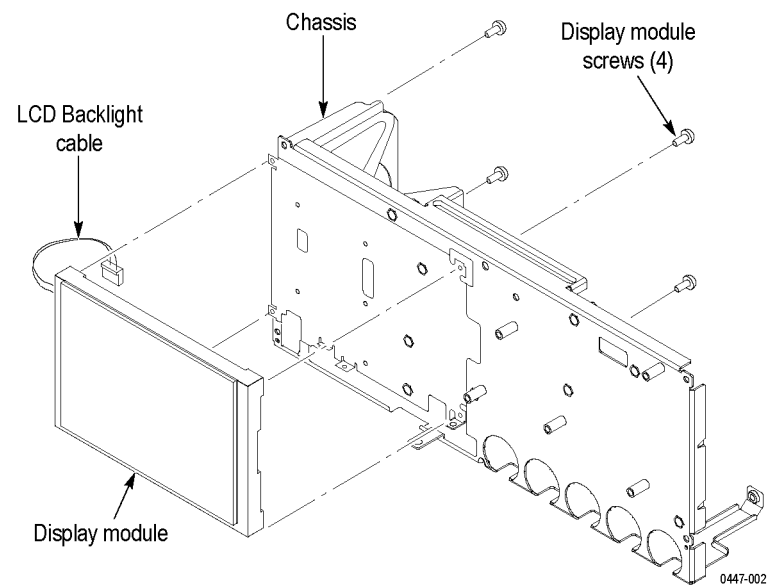
**Display Module** You will need a torque-limiting Torx T-8 screwdriver and pliers for this procedure.

**Removal.** To remove the Display module, follow these steps. (See Figure 9.)

1. Remove the front case. (See page 54, *Front Case*.)
2. Remove the front panel board. (See page 56, *Front-Panel Board*.)
3. Remove the I/O board. (See page 50, *I/O Board*.)
4. Remove the Acquisition board. (See page 51, *Acquisition Board*.)
5. Disconnect the LCD backlight cable from J202 on the Display Adapter board. (See Figure 4 on page 50.)
6. Remove the four screws that attach the Display module to the chassis. Support the display with your hand.
7. Remove the copper tape and disconnect the LCD data cable from the Display module (leave the other end connected to J302 on the Display Adapter board). (See Figure 9.)



**CAUTION.** Do not separate the display shield from the Display module. Removing the shield will destroy the attaching gasket.



**Figure 9: Removing the Display module**

**Installation.** To install the Display module, follow these steps. (See Figure 9.)

1. Connect the LCD data cable to the display (it routes through the slot in the chassis, from the Display Adapter board J302).
2. Align the Display module with the mounting tabs on the front of the chassis.
3. Install the four screws that attach the Display module to the chassis.
4. Reposition the copper tape to cover the LCD data cable.
5. Connect the LCD backlight cable, through the slot in the chassis, to the Display Adapter board J202.
6. Install the Acquisition and I/O boards.
7. Install the Front-Panel board.
8. Install the front case.

### Compact Flash Board

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

**Removal.** To remove the Compact Flash board, perform the follow these steps. (See Figure 7 on page 55.)

1. Remove the Acquisition board. (See page 51, *Acquisition Board*.)
2. Remove the two screws below the I/O board mounting bracket that attach the Compact Flash board to the internal chassis. (See Figure 4 on page 50.)
3. Remove the single screw below the Display module that attaches the Compact Flash board to the external chassis.
4. Remove the Compact Flash board.

**Installation.** To install a new Compact Flash board, follow these steps:

1. Align the Compact Flash board with the mounting bracket on the front of the chassis and the mounting posts on the inside of the chassis.
2. Install the screws the attach the compact board to the chassis.
3. Reinstall the Acquisition board.

### Keypad

You will need a torque-limiting Torx T-15 screwdriver and 16 mm (5/8 inch) deep socket for this procedure.

**Removal.** To remove the switch keypad, follow these steps. (See Figure 10.)

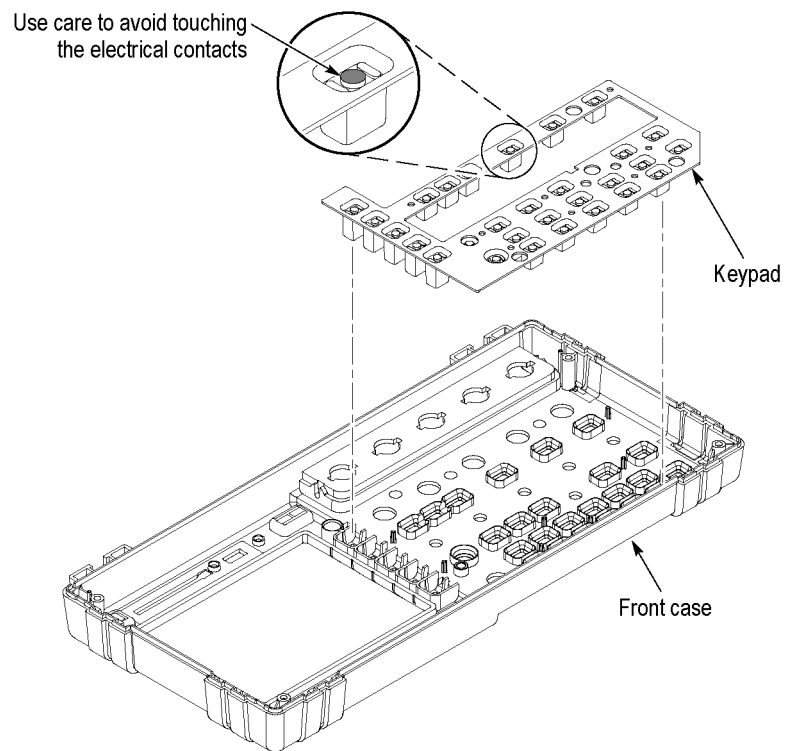
1. Remove the front case. (See Figure 7.)
2. Lift the keypad out of the front case.



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

---





**Figure 10: Removing and installing the keypad**

**Installation.** To install the switch keypad, follow these steps. (See Figure 10.)

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



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

3. Verify that all buttons are properly seated into place before proceeding.
4. Place the entire internal assembly into the front case.

## Troubleshooting

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




---

**WARNING.** *Before you perform this or any other procedure in this manual, read the General Safety Summary and Service Safety Summary found at the beginning of this manual. Also, to prevent possible injury or damage to electrical components, read Preventing ESD. (See page 41.)*

---

### Adjustment After Repair

If you replace the acquisition circuit board, you must adjust the oscilloscope after repair. Refer to the *Adjustment Procedures*. (See page 33.)

### Required Tools and Equipment

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

Tools and equipment	Example
Oscilloscope with probes	Tektronix TDS1000 Series or TDS2000 Series with probes
DMM	3.5 or greater digit DMM

**Troubleshooting Tree**

To isolate a problem to a specific troubleshooting procedure, use the troubleshooting tree in the following four figures.

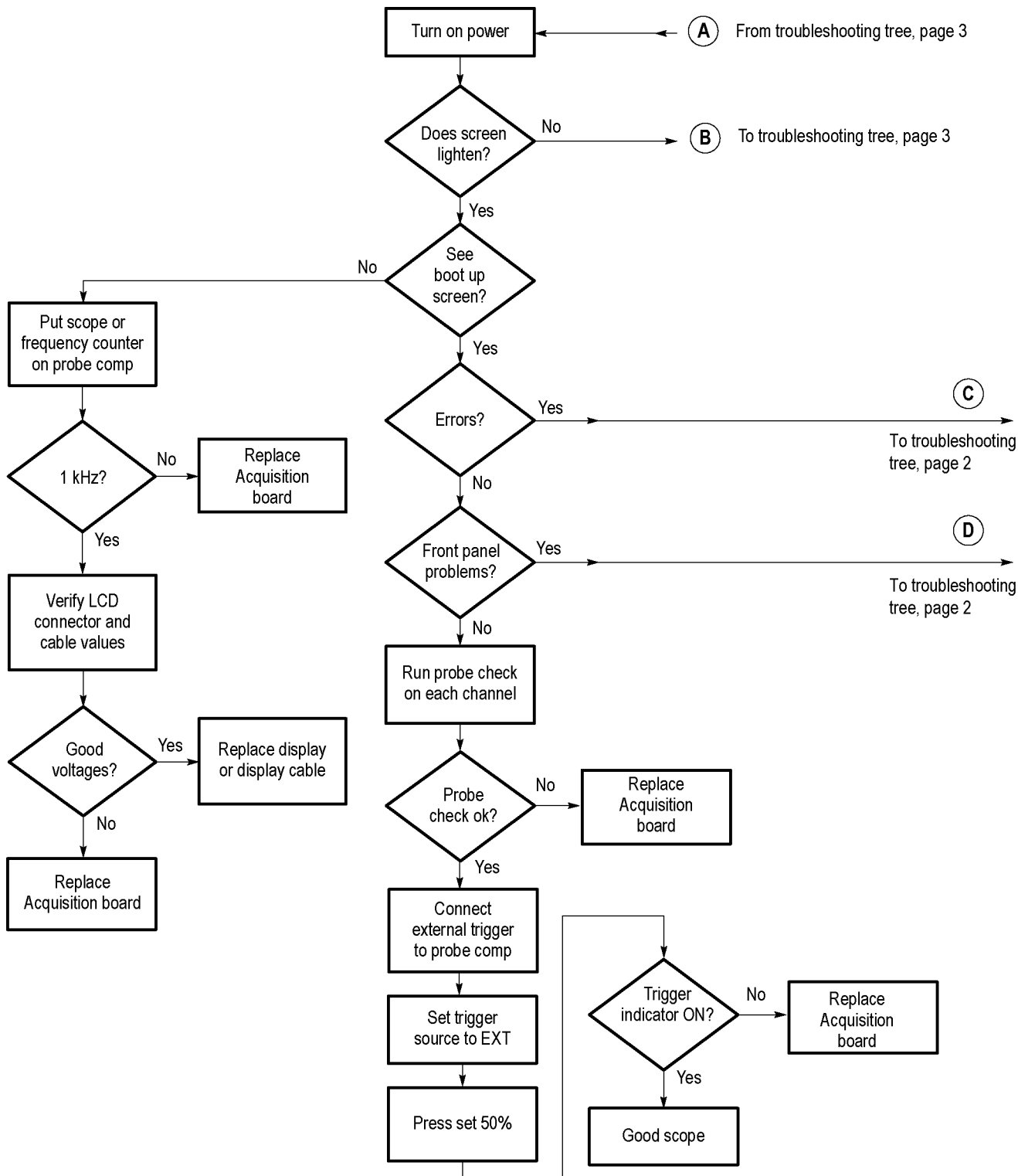


Figure 11: Oscilloscope troubleshooting tree (page 1 of 4)

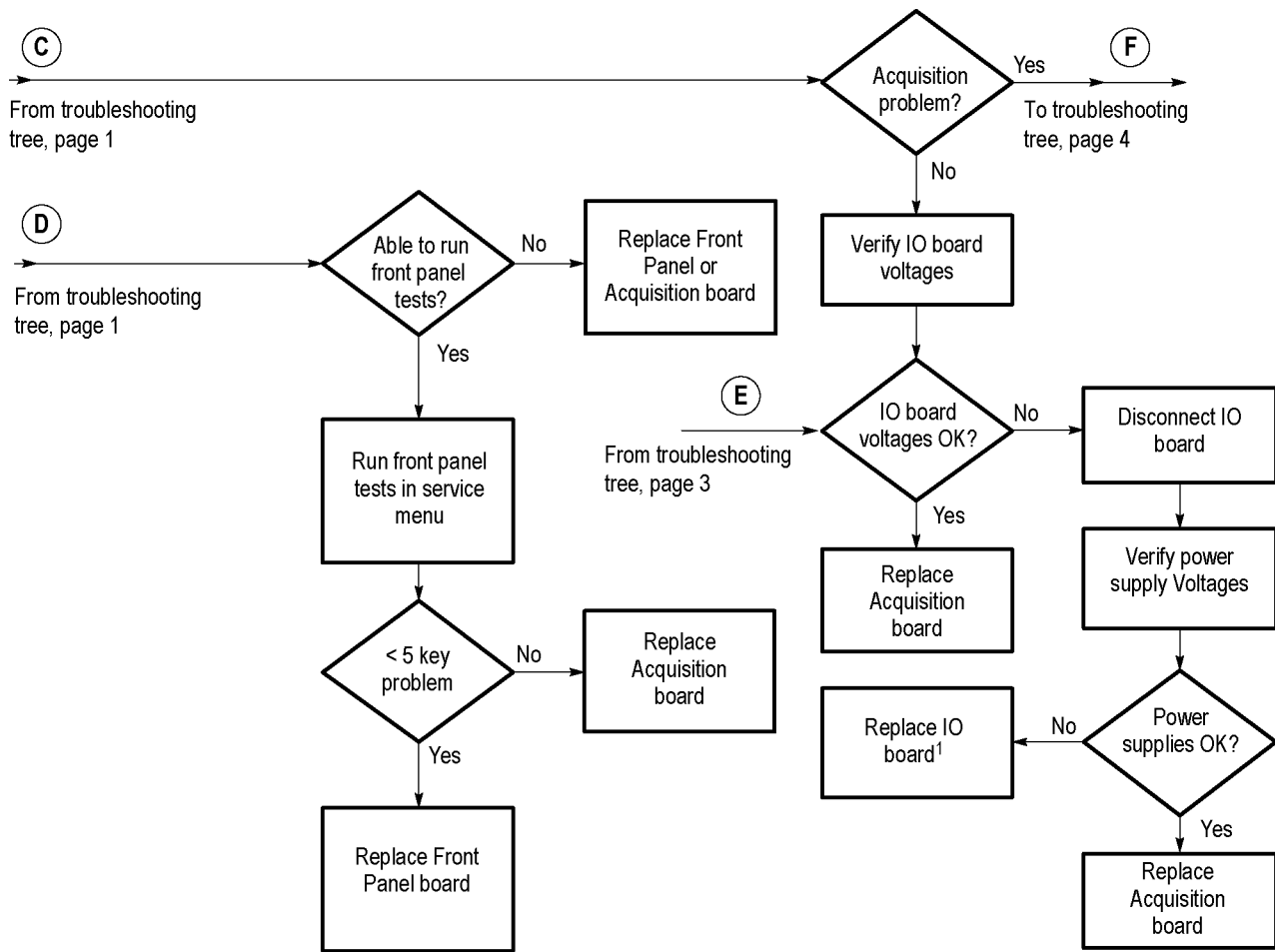


Figure 12: Oscilloscope troubleshooting tree (page 2 of 4)

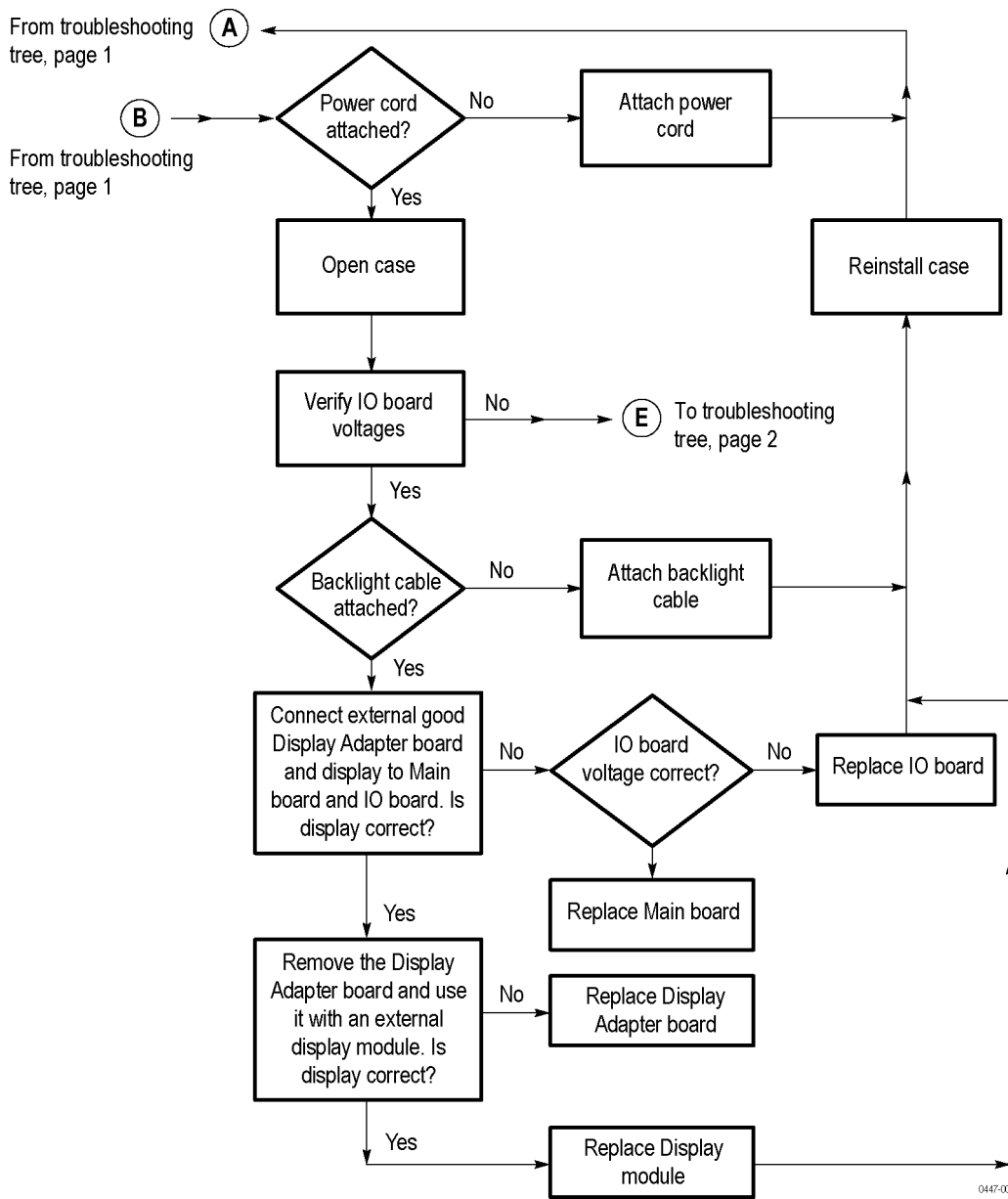


Figure 13: Oscilloscope troubleshooting tree (page 3 of 4)

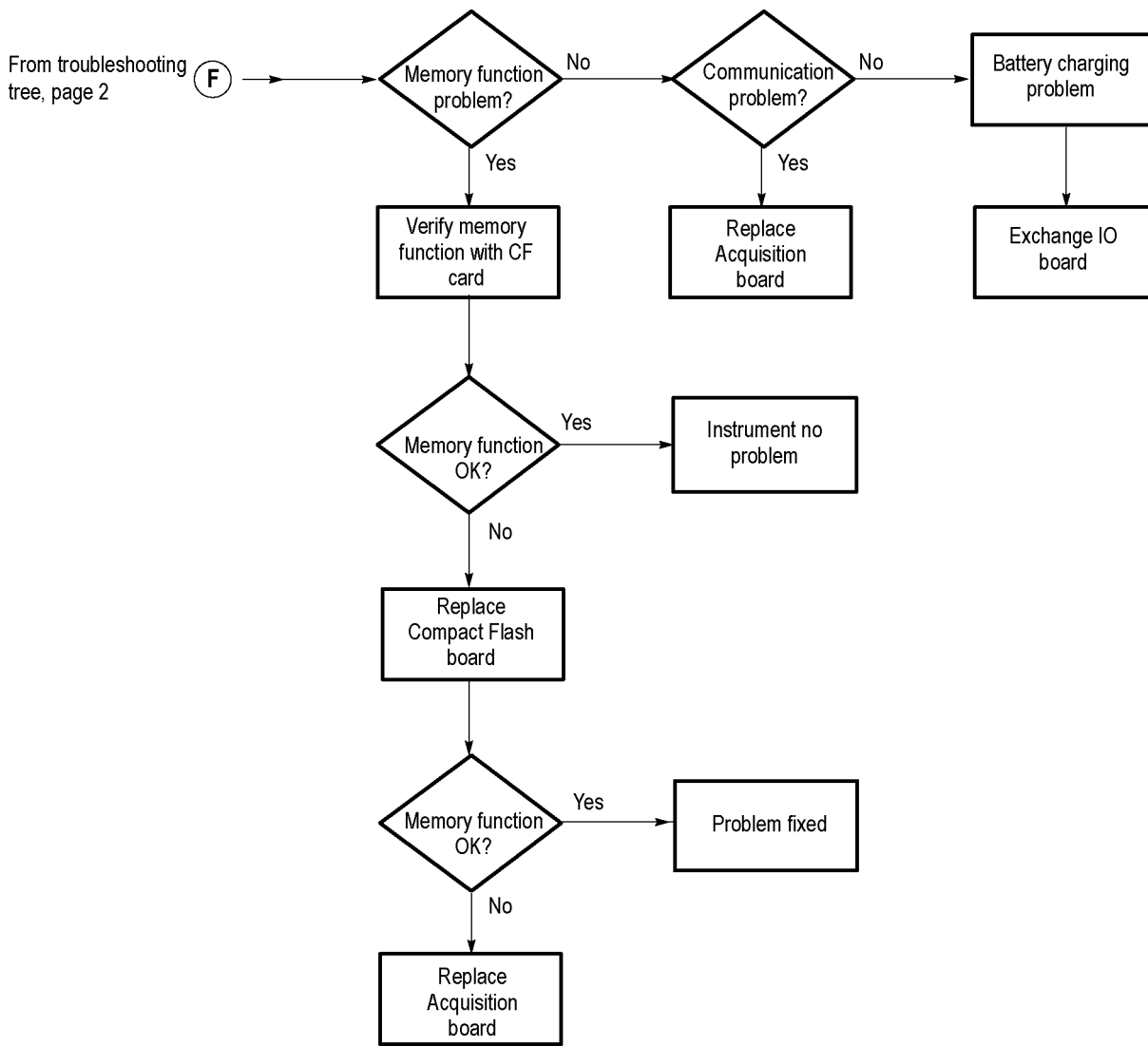


Figure 14: Oscilloscope troubleshooting tree (page 4 of 4)

**PROBE COMP Output**

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

As shown in the following table, there are two cases of defects. Either the 1 kHz signal is on and the I/O and Acquisition boards are both active and functionally capable of performing an acquisition, or one of those two modules is not performing correctly. While many different possible frequencies exist, all involve detected failures on the Acquisition or I/O boards due to failure.

Signal at PROBE COMP	Possible problem
1 kHz signal, no display	Troubleshoot the display
Signal other than 1 kHz	Troubleshoot the Acquisition board
No signal	Troubleshoot the power supply

**Using the Error Log**

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

The error log list can be accessed any time by pushing the UTILITY button and selecting **Options > Error Log**. The following table lists the error codes.

**Table 15: List of error codes**

No.	ID	Description	Probable cause
0	Battery	Battery 1 alarm	Battery hardware failure; replace battery. If errors persist, contact Tektronix.
1	Battery	Battery 2 alarm	
2	Battery	PIC Communication	May occur sporadically during normal operation. If errors occur repeatedly, a hardware failure may exist. Contact Tektronix.
3	Battery	PIC HW Failure	
0	Diagnostics	Diagnostics internal error	Contact Tektronix.
4	Diagnostics	CH1 diagnostics failed	Acquisition board or power supply failure.
5	Diagnostics	CH2 diagnostics failed	Acquisition board or power supply failure.
7	Diagnostics	ADG421 diagnostics failed	Acquisition board or power supply failure.
12	Diagnostics	CH3 diagnostics failed	Acquisition board or power supply failure
13	Diagnostics	CH4 diagnostics failed	Acquisition board or power supply failure.
14	Diagnostics	ADG421 #2 diagnostics failed	Acquisition board or power supply failure.
255	Software	Software defect	Contact Tektronix.

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

1. Enable the Service menus. (See page 34, *Enable the Service Menu*.)
2. Push the **UTILITY** button and push the **Service** option button to display the Service menu.
3. Push the **Service Diag.** option button to display the Diagnostics menu.
4. Push the **Clear Error Log** option button to clear the error log of past failures. This also sets the Power Cycle count to zero.

## Lithium-Ion Battery Maintenance

Lithium-Ion rechargeable batteries require routine maintenance and care in their use and handling. Read and follow the information in this document to safely use Lithium-Ion batteries and achieve the maximum battery life span.

### Key Information

Use only Tektronix-approved batteries in your Tektronix products.

Do not leave batteries unused for extended periods of time, either in the product or in storage. When a battery has not been used for six months, check the charge status and charge or dispose of the battery as appropriate.

The typical estimated life of a Lithium-Ion battery is about two to three years or approximately 300 charge cycles, whichever occurs first. One charge cycle is a period of use from fully charged, to fully discharged, and fully recharged again. Use a two to three year life expectancy for batteries that do not run through complete charge cycles.

Rechargeable Lithium-Ion batteries have a limited life and will gradually lose their capacity to hold a charge. This loss of capacity (aging) is irreversible. As the battery loses capacity, the length of time it will power the product (run time) decreases.

Lithium-Ion batteries continue to slowly discharge (self-discharge) when not in use or while in storage. Routinely check the battery charge status. Check the latest TPS2000B user manual for information on how to check battery status and for battery charging instructions. The latest TPS2000B manuals are available at [www.tektronix.com/manuals](http://www.tektronix.com/manuals).

Removing the battery from the instrument when not in use is recommended. Batteries will only recharge from self-discharge while inside the instrument for a limited number of times. When the limit is reached, the battery must be used (discharged) before it can be charged again.



**Battery Maintenance**

Pay attention to these points when monitoring Lithium-Ion batteries:

- Observe and note the run time that a new fully charged battery provides for powering your product. Use this new battery run time as a basis to compare run times for older batteries. The run time of your battery will vary depending on the product configuration and the applications that you run.
- Routinely check the battery charge status.
- Carefully monitor batteries that are approaching the end of their estimated life.
- Consider replacing the battery with a new one if you note either of the following conditions:
  - The battery run time drops below about 80% of the original run time.
  - The battery charge time increases significantly.

**Charging**

Always follow the charging instructions provided with your product. Refer to your product user manual and/or online help for detailed information about charging its battery. The latest version of your Tektronix product user manual is available at [www.tektronix.com](http://www.tektronix.com).

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**NOTE.** *When you troubleshoot battery issues for dual-battery configurations, only one battery pack should be installed. You need to test one battery pack and one battery slot at a time.*

---

**Storage**

Follow these recommendations when storing a Lithium-Ion battery:

- Charge or discharge the battery to approximately 50% of capacity before storage.
- Remove the battery and store it separately from the product.
- Store the battery at temperatures between 5 °C and 20 °C (41 °F and 68 °F).
- Charge the battery to approximately 50% of capacity at least once every six months.

---

**NOTE.** *The battery self-discharges during storage. Higher temperatures (above 20 °C or 68 °F) reduce the battery storage life.*

---



**CAUTION.** *If a battery is stored or otherwise unused for an extended period without following these instructions, and the battery has no charge remaining when you check it, consider it to be damaged. Do not attempt to recharge it or to use it. Replace it with a new battery.*

---

### Handling Precautions

Pay attention to the following when handling batteries:

- Do not disassemble, open, crush, bend, deform, puncture, or shred a battery.
- Do not drop a battery or expose the battery to excessive shock or vibration.
- Do not short circuit a battery or allow metallic or conductive objects to contact the battery terminals.
- Do not dispose of a battery in fire or water.
- Do not use the battery to power any devices other than the instrument for which it was designed.
- Keep the battery away from personnel that are not trained to use the instrument.
- Do not expose a battery to temperatures above 60 °C (140 °F).
- Keep the battery away from children.
- Do not use a damaged battery.
- If a battery pack is leaking fluids, do not touch any fluids. Properly dispose of a leaking battery pack (see *Disposal and Recycling* in this document).



**WARNING.** *Eye contact with battery fluids can damage the eye. In case of eye contact with battery fluids, do not rub eyes. Immediately flush eyes thoroughly with water for at least 15 minutes, lifting upper and lower lids, until no evidence of the fluid remains. Seek medical attention.*

---

### Transportation, Disposal and Recycling

See *Environmental Considerations* in the TPS2000B user manual.

## Repackaging Instructions

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



---

**CAUTION.** Remove rechargeable battery packs from the instrument before shipping, and store the batteries in an approved area. Failure to do so can cause damage to the oscilloscope. (See page 66, *Lithium-Ion Battery Maintenance*.)

---

### Packaging

To ship the instrument for repair, use the original packaging container if possible. If the container is unfit for use or unavailable, package the instrument as follows:

- Use a corrugated cardboard shipping carton having a test strength of at least 125 kg (275 pounds).
- The shipping carton should have an inside dimension at least 15.25 cm (six inches) greater than the oscilloscope dimensions.
- Make sure to remove the battery before placing the oscilloscope into the shipping carton. Store the battery according to the recommendations. (See page 67, *Storage*.)
- Make sure that the oscilloscope is adequately padded with a cushioning material such as foam, paper, or bubble wrap. The oscilloscope should not move around inside of the carton when sealed.

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

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

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

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

### Storage

Store the oscilloscope in a clean, dry environment. The following characteristics apply to both shipping and storage (oscilloscope not operating):

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**NOTE.** Remove the battery and store it separately from the oscilloscope. See the battery storage recommendations. (See page 67, *Storage*.)

---

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

See *Specifications* for a complete list of the environmental characteristics.

# Diagrams

This section describes the electrical operation of the TPS2000B Series oscilloscope using the major circuit blocks. The following figure shows the oscilloscope interconnections used in the four-channel version.

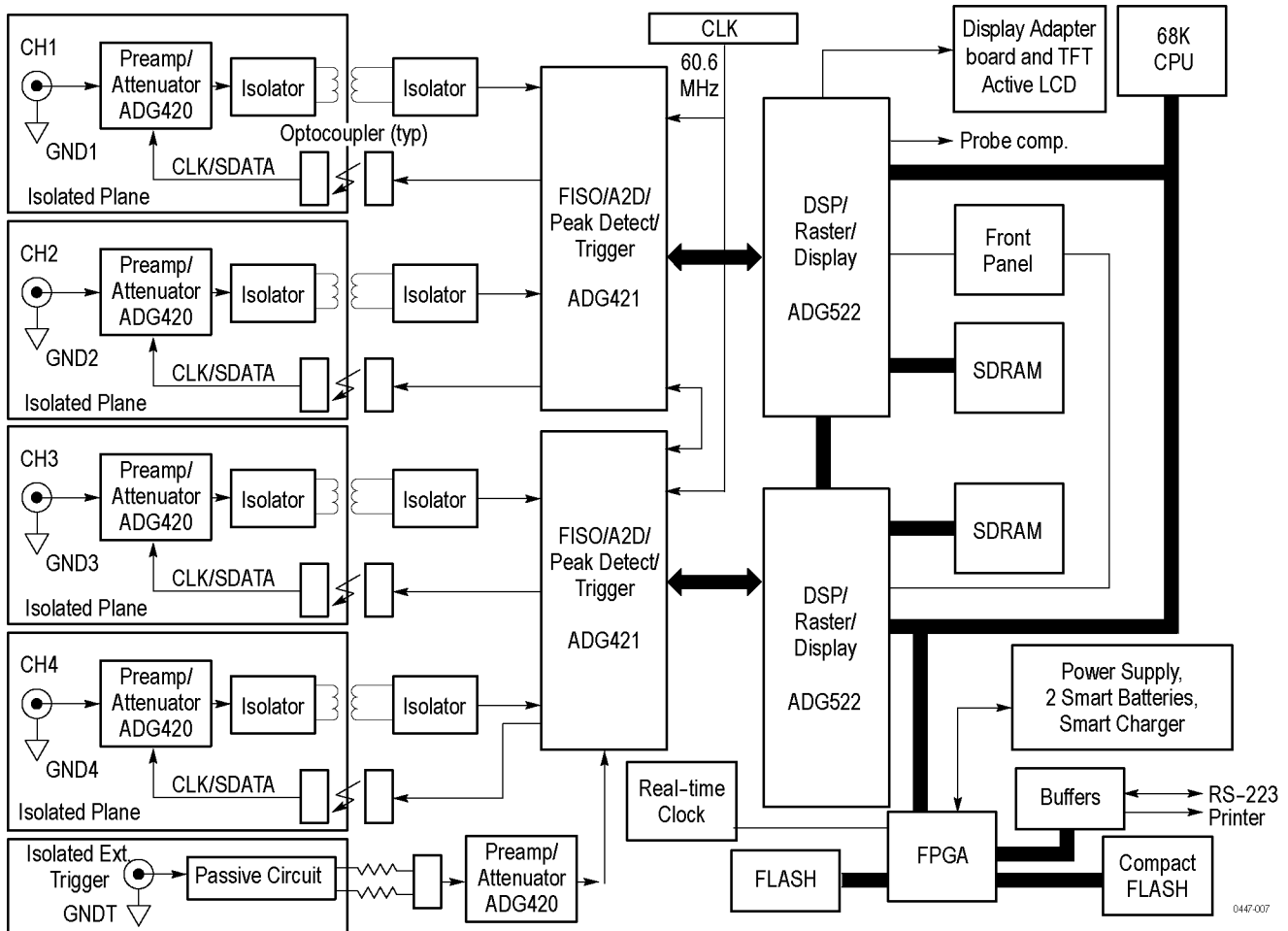


Figure 15: TPS2000B Series block diagram



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# Replaceable Parts

This section contains a list of the replaceable modules for the TPS2000B Series oscilloscopes. Use this list to identify and order replacement parts.

## Parts Ordering Information

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

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

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

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

### Module Servicing

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

**Module exchange.** In some cases you may exchange your module for a remanufactured module.

These modules cost significantly less than new modules and meet the same factory specifications. For more information about the module exchange program, call 1-800-833-9200 and select option 2.

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

## Using the Replaceable Parts List

This section contains a list of the mechanical and 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 16: Parts list column descriptions**

<b>Column</b>	<b>Column name</b>	<b>Description</b>
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.

**Abbreviations**      Abbreviations conform to American National Standard ANSI Y1.1-1972.



Table 17: Replaceable parts list

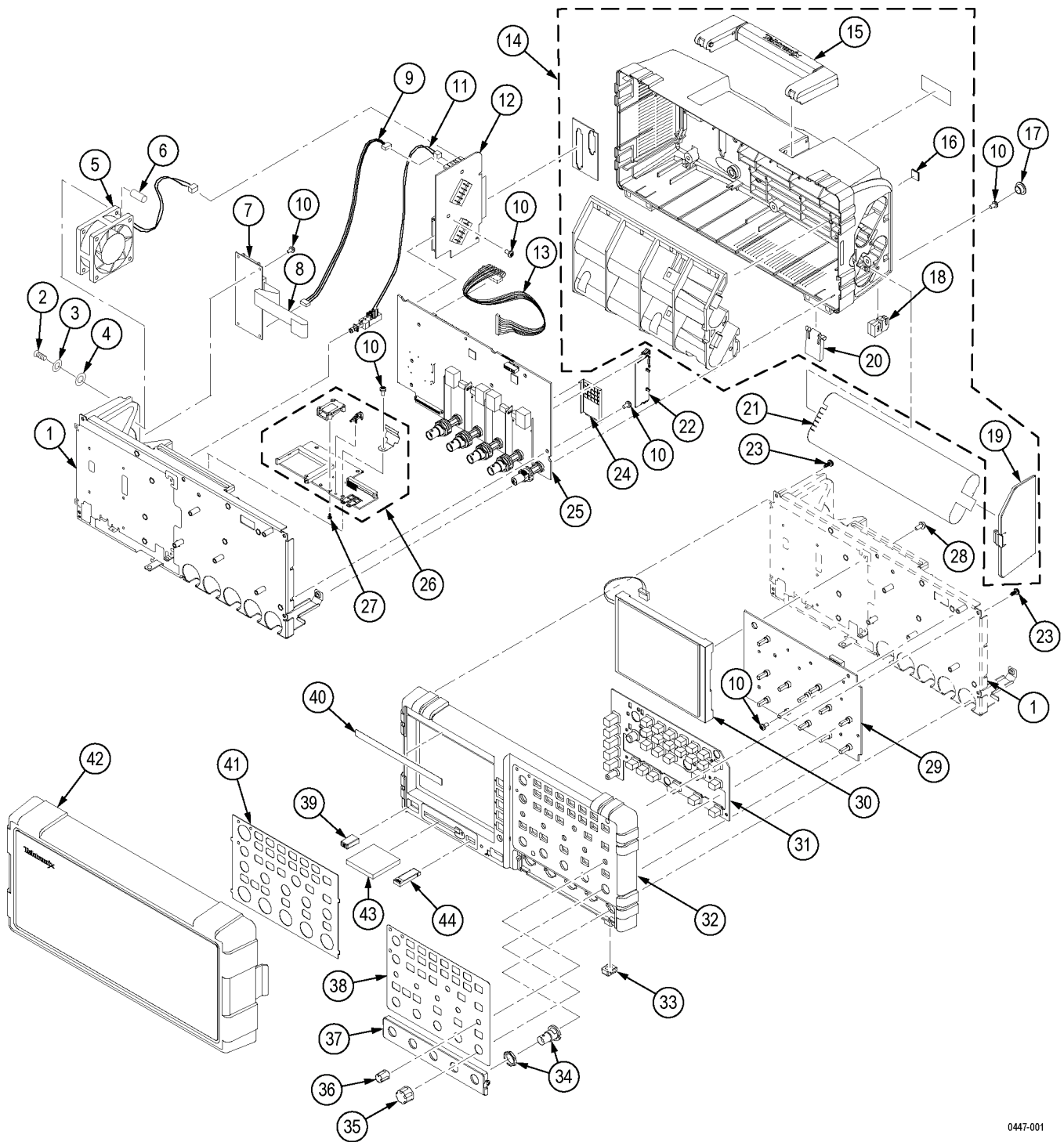
Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discount'd	Qty	Name & description
16-1	441-2637-XX			1	CHASSIS 2 CH
	441-2638-XX			1	CHASSIS 4 CH
-2	211-1432-XX			4	SCREW, M3.0X30MM, FLAT HEAD, FAN ATTACHING
-3	210-1607-XX			4	SPRING WASHER, M3, FAN ATTACHING
-4	210-1608-XX			4	PLAIN WASHER, M3, FAN ATTACHING
-5	119-6965-XX			1	FAN, DC, TUBEAXIAL; 12 VDC, 170 MA, 4200 RPM, 32 DBA, 19 CFM, 60 X 60 MM X 25 MM; UL, CSA, TUV, SAFETY CONTROLLED
-6	220-0293-XX			4	THRU-HOLE THREAD STANDOFFS,3.5M3,LENGTH=18MM
-7	878-0392-XX			1	CIRCUIT BOARD SUBASSY; DISPLAY ADAPTER BOARD
-8	174-5861-XX			1	CABLE, FFC, 33 PIN, PITCH=0.5MM; DISPLAY DATA CABLE
-9	174-4949-XX			1	CABLE ASSY; (UL1061), 28 AWG, v6.0 L, 1 X 5, 0.049 CTR: DISPLAY ADAPTER POWER SUPPLY CABLE
-10	211-1272-XX			23	SCREW, MACHINE; 6-32 X 0.250, PNH, STL, ZNPL, T-15
-11	174-4904-XX			1	ON/OFF SWITCH, CABLE ASSEMBLY
-12	878-0597-XX			1	CKT BD ASSY; ACQUISITION BD, 2CH
	878-0598-XX			1	CKT BD ASSY; ACQUISITION BD, 4CH
-13	174-5897-XX			1	CA ASSY, SP; DISPLAY CABLE
-14	202-0485-XX			1	ASSEMBLY, REAR CASE
-15	367-0538-XX			1	HANDLE, OVERMOLDED
-16	348-1791-XX			2	FOOT; REAR, BLACK, 0.4 X 0.4 X 0.1 (HEIGHT)
-17	200-5105-XX			2	COVER, ESD PROTECTION
-18	348-1704-XX			2	FOOT; REAR, SANTOPRENE, BLACK
-19	200-4844-XX			1	COVER, BATTERY DOOR
-20	348-1703-XX			2	FOOT; FRONT, FLIPMPC/ABS,SILVER GRAY
-21	146-0150-XX			2	BATTERY, LITHIUM-ION, RECHARGEABLE, 11 V, 6.6 AH, SMBUS, RECESSED TERMINALS, UL, SAFETY CONTROLLED
-22	200-4847-XX			5	COVER, ISOLATION BARRIER
-23	211-1273-XX			9	EXACT DUPLICATE OF 211-1143-XX SCREW, PT; K35-1.57, PAN HEAD, STL, ZNPL, T-15
-24	337-4305-XX			4	SHIELD, CHANNEL ATTENUATION
-25	878-0620-XX			1	CKT BD ASSY; I/O BOARD
-26	878-0037-XX			1	MODULAR ASSEMBLY; COMPACT FLASH ASSEMBLY
-27	213-1139-XX			2	SCREW, TPG, TF; 2-28 X 0.188, PLASTITE, PHILLIPS, PNH, STL ZN PL
-28	211-1216-XX			4	SCREW, PAN HEAD, PT, T8 (3MM X 1.34 X 4.3MM), LCD
-29	878-0444-XX			1	CKT BD ASSY; FRONT PANEL BD, 2CH
	878-0445-XX			1	CKT BD ASSY; FRONT PANEL BD, 4CH
-30	850-0115-XX			1	DISPLAY, COLOR

Table 17: Replaceable parts list (cont.)

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description
-31	260-2906-XX			1	SWITCH, KEYPAD; ELASTOMERIC, FRONT PANEL, TPS, 2CH COLOR
	260-2907-XX			1	SWITCH, KEYPAD; ELASTOMERIC, FRONT PANEL, TPS, 4CH COLOR
-32	202-0480-XX			1	CASE, FRONT; 2 CHANNEL, METALIZED; SAFETY CONTROLLED
	202-0481-XX				CASE, FRONT; 4 CHANNEL, METALIZED; SAFETY CONTROLLED
-33	348-1525-XX			2	FOOT; FRONT, SANTOPRENE, BLACK, 64 DEROMETER, TEXTURED
-34	020-2917-XX			1	REPLACEMENT KIT BNC SHELL
-35	366-0862-XX			6	ASSEMBLY, KNOB; .470 DIAMETER
-36	366-0863-XX			6	ASSEMBLY, KNOB; .685 DIAMETER
-37	200-5136-XX			1	COVER; BNC DOOR, 2 CHANNEL
	200-5137-XX			1	COVER; BNC DOOR, 4 CHANNEL
-38	335-2232-XX			1	MARKER, IDENT: 2 CH FRONT PANEL, COLOR
	335-2233-XX			1	MARKER, IDENT: 4 CH FRONT PANEL, COLOR
-39	366-0845-XX			1	PUSH BUTTON; POWER, PC/ABS BAYBLEND,FR110,SILVER
-40	335-2227-XX			1	MARKER, IDENT: BEZEL, TPS2012B (100MHZ)
	335-2228-XX			1	MARKER, IDENT:BEZEL, TPS2014B (100MHZ)
	335-2229-XX			1	MARKER, IDENT:BEZEL, TPS2024B (200MHZ)

Table 17: Replaceable parts list (cont.)

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discontin'd	Qty	Name & description
-41	335-2328-XX			1	LABEL, 2 CH LANGUAGE, FRENCH
	335-2329-XX			1	LABEL, 2 CH LANGUAGE, ITALIAN
	335-2330-XX			1	LABEL, 2 CH LANGUAGE, GERMAN
	335-2331-XX			1	LABEL, 2 CH LANGUAGE, SPANISH
	335-2332-XX			1	LABEL, 2 CH LANGUAGE, JAPANESE
	335-2333-XX			1	LABEL, 2 CH LANGUAGE, PORTUGUESE
	335-2334-XX			1	LABEL, 2 CH LANGUAGE, CHINESE (SIMPLIFIED)
	335-2335-XX			1	LABEL, 2 CH LANGUAGE, CHINESE (TRADITIONAL)
	335-2336-XX			1	LABEL, 2 CH LANGUAGE, KOREAN
	335-2337-XX			1	LABEL, 2 CH LANGUAGE, RUSSIAN
	335-2338-XX			1	LABEL, 4 CH LANGUAGE, FRENCH
	335-2339-XX			1	LABEL, 4 CH LANGUAGE, ITALIAN
	335-2340-XX			1	LABEL, 4 CH LANGUAGE, GERMAN
	335-2341-XX			1	LABEL, 4 CH LANGUAGE, SPANISH
	335-2342-XX			1	LABEL, 4 CH LANGUAGE, JAPANESE
	335-2343-XX			1	LABEL, 4 CH LANGUAGE, PORTUGUESE
	335-2344-XX			1	LABEL, 4 CH LANGUAGE, CHINESE (SIMPLIFIED)
	335-2345-XX			1	LABEL, 4 CH LANGUAGE, CHINESE (TRADITIONAL)
	335-2346-XX			1	LABEL, 4 CH LANGUAGE, KOREAN
335-2347-XX			1	LABEL, 4 CH LANGUAGE, RUSSIAN	
-42	200-4845-XX			1	COVER, FRONT PROTECTIVE
<b>OPTIONAL ACCESSORIES</b>					
The following parts are commonly ordered for use with these oscilloscopes. For a complete list of standard and optional accessories, refer to your product user manual, available for download at: <a href="http://www.tektronix.com/manuals">www.tektronix.com/manuals</a> .					
-43	TPS2PWR1			1	POWER APPLICATION SOFTWARE MODULE
-44	156-9413-XX			1	IC, MEMORY; CMOS, FLASH; 32 MB OR MORE, MEMORY MODULE, COMPACT FLASH, (CF), TYPE 1; SDCFB16-101-00, 50 PIN MODULE 1 EA A0 CT8MBC1.MD



0447-001

Figure 16: Exploded view diagram